Appendix K
Additional Reports

4. Additional Reports – Utilities

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    b. Projected CT Operating Hours

        - PICES PUC B9-4 RUN Generation & Fuel Summary

    c. Northern District Wastewater Treatment Plant Outfall Assessment – Phase 2

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    g. Groundwater in Northern Guam Sustainable Yield and Ground Water Development

    h. Northern Guam Lens Study Aquifer Yield Report

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Appendix K - Utilities

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Guam Power Generation Study Report for Proposed USMC Relocation

July 2008, Revision 1

Department of the Navy
Naval Facilities Engineering Command, Pacific
258 Makalapa Drive, Suite 100
Pearl Harbor, HI 96860-3134

Contract Number N62742-06-D-1870/TO 0018

Guam Power Generation Study Report for Proposed USMC Relocation

July 2008, Revision 1

Prepared for:

Department of the Navy
Naval Facilities Engineering Command, Pacific
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Contract Number N62742-06-D-1870/TO 0018

EXECUTIVE SUMMARY

The purpose of this study is to evaluate the increase in electrical load to the Island-Wide Power System (IWPS) required to support the proposed United States Marine Corps (USMC) relocation to Guam, hereafter referred to as "USMC relocation," and study the interconnection to the IWPS and options available for power generation in Guam. The outcome of this study needs to provide sufficiently detailed information to support the Environmental Impact Statement process. In September 2007, the Naval Facilities Engineering Command, Pacific (NAVFAC Pacific), under Master Contract No. N62742-06-D-1870 issued a Task Order to TEC JV to prepare a Guam Power Generation Study Report that evaluates the impact resulting from the USMC relocation and identify viable options for power generation technologies and evaluate interconnection options for the power generation system. Earth Tech visited Naval Base Guam Pacific facilities in Guam between 1 October and 12 October 2007, and met with respective decision makers within NAVFAC Marianas and several other agencies in Guam to understand the regulatory requirements, siting conditions, and design features required for this project. This report presents the findings of our evaluations based on the information gathered during the field study, information provided by NAVFAC Pacific, and subsequent detailed analysis of the Guam power generation options.

The first step for evaluating the power needs related to the USMC relocation to Guam and future Department of Defense (DoD) loads associated with the military buildup involves determining what new preliminary loads would be added to the island. A summary of those preliminary loads is included in Table ES-1.

Table ES-1 lists the anticipated preliminary loads for each component of the military buildup and results in an anticipated demand load of 47.53 megawatts (MW) attributed to USMC activities and 160.53 MW of demand with all anticipated preliminary DoD loads (existing and future). Each of the load values in Table ES-1 also includes 25 percent capacity for future loads and is based on a demand factor of 0.27 applied to the anticipated connected loads to arrive at the demand load.

Load projections provided by NAVFAC support a preliminary total DoD future planned demand load of 160.53 MW (Table ES-1) which includes 47.7 MW of other planned DoD loads at Apra Harbor and a total of 47.53 MW of future loads associated with the USMC relocation. A major portion of the Apra Harbor load is associated with the transient CVN berthing. This is the preliminary basis for recommending the potential base load demand of 60 MW with peaking generation for the remaining 40 MW of total future DoD load. The majority of the peaking load is associated with the CVN berthing expected to occur three times per year for approximately 3 weeks each time. The result is 100 MW (not including reliability reserve of 60 percent) of additional generation demand to meet the preliminary loads associated with USMC and other DoD facilities planned for Guam (included in the last line of Table ES-1).

The majority of the USMC relocation is expected to complete construction between 2013 and 2015. The military buildup in Guam also coincides with Guam Power Authority (GPA) exceeding their 1 day in 4.5 years reserve capacity to meet reliability goals. In general, the capacity GPA uses to meet the 1 day in 4.5 years represents 1.6 times the demand capacity required. That is to say that 1.6 MW of capacity is required for every 1.0 MW of demand load.

As indicated in GPA's demand forecast, the reserve capacity is exceeded in 2016 based on the GPA load projections for the IWPS. GPA's demand forecast is based on an installed generation capacity of 550 MW. Review of one year of GPA's actual generation capacity indicates an average daily generation capacity of 455 MW or nearly 20 percent less than their stated capacity. This is largely related to units out of service for extended periods of time and units simply not available to be scheduled into the generation capacity for the daily report.

Consideration of GPA's published daily available capacity (455 MW), demand forecast and indicated reserve capacity to maintain a 1 day in 4.5 years reserve indicates that GPA will exceed their reserve capacity in 2008 (or regardless of the projected loads required by the USMC or Apra Harbor. The lower actual generation capacity is the primary basis for suggesting the need for additional generation in the near future. However, as stated elsewhere in this report, the decision to add generation to the IWPS is GPA's responsibility as regulated by the Public Utilities Commission.

Table ES-1: Current and Preliminary Future Military Electrical Loads for Guam in MW

Load Description	Existing Demand Load (MW)	MILCON Preliminary Planned Demand (MW)	USMC Notional Increase Demand (MW)	Preliminary Total DoD Future Planned Demand (MW)
Existing Navy electrical demand for 19 service locations (based on peak demand data in GIMDP report dated July 2006 [HHF 2006])	47.55	na	na	na
AAFB	18.1	10.80	0.57	29.47
Northwest Field	0.5	1.35	0.00	1.80
Andy South – MARBO	1.0	0.00	0.00	1.00
NCTS (North) – Finegayan plus utilities	1.2	3.53	20.10	24.83
South Finegayan Housing Area	1.5	0.00	8.15	9.65
Barrigada	1.3	0.00	0.00	1.3
Naval Hospital	3.2	2.07	0.00	5.27
Apra Harbor (NAVBASE Guam)	20.75	47.70	18.71	87.16
Total Electrical Loads (MW)	47.55	65.45	47.53	160.53

AAFB	Andersen Air Force Base
MILCON	military construction
MW	megawatt
MARBO	Marianas Bonins Command
na	not applicable
NAVBASE	Naval Base
NCTS	Naval Computer and Telecommunications Station

POWER GENERATION/INTERCONNECTION ALTERNATIVES

The following four power generation alternatives are considered for this Project:

- *Option 1*: Recapitalize, modernize, and modify the GPA system to support the added base load to the GPA grid. The added generation will be provided by GPA.
- *Option 2A:* Construct a new Special Purpose Entity (SPE) owned/operated base load power plant on DoD-provided land specifically to meet load requirements for the facilities associated with the USMC relocation. The facility would have the ability to provide excess power to the GPA grid. Also, the GPA grid would be used for back-up power in the event the SPE Plant is out of service.
- *Option 2B:* Construct a new SPE owned/operated base load power plant on DoD or other provided land. The normal operation of this base load plant will be to provide power to the GPA grid at the best available location as an Independent Power Producer (IPP). The new Marine loads would be connected to the IWPS but not at the point of the new SPE facility.
- *Option 3:* Construct a new SPE owned/operated base load power plant for load on N. Finegayan with no connection to GPA. This option would require spare capacity to provide necessary generation with one unit out of service and failure of the largest unit (if units are not the same size).

SUMMARY OF FINDINGS

The report evaluates three main issues and will require that each be considered separately in the final approach. The three main issues evaluated were as follows:

- Power requirements for additional military loads associated with relocating Marines to Guam plus planned DoD loads.
- Power interconnection options to meet anticipated future military loads in Guam.
- Power generation alternatives for both conventional and alternatives sources of power.

The power requirements are anticipated to be 160.53 MW peak demand and include all known existing and future DoD requirements for the various branches and the transient CVN load at Apra Harbor. The base load increase attributed to the USMC relocation is approximately 47 MW. Preliminary DoD demand loads estimated by the Guam Integrated Military Development Plan (GIMDP) (HHF 2006) were presented in October 2007 to the GPA for preliminary analysis and planning for the IWPS. Current load projections are based on the loading plans provided by the U.S. Navy and are presented in Table ES-1 in units of MW in Table ES-1.

The recommendation supported by the load analysis is to provide generation that meets the load requirements and includes capacity that supports the system reliability needs (1.6 times base load provides a level of generation that includes capacity to meet reliability expectations). The generation would be made up of 60 percent base load and 40 percent peaking generation capacity. This generation mix is based on recommendations included in the business case analysis for planned DoD loads. This will require 75 MW (45 MW base load and 30 MW peaking generation) for USMC projected loads and 104 MW (62.4 MW base load and 41.6 MW peaking generation) for other DoD loads anticipated in Guam. Each of these values includes 60 percent capacity to support system reliability requirements.

The detailed results of GPA's load flow analysis and anticipated IWPS improvements required to support those loads are presented elsewhere in this report and summarized below:

- The IWPS will require upgrades to existing transmission lines and facilities to alleviate line overloading and unacceptable voltages. The results of the analysis are presented in

  Appendix A Guam Power Authority Load Flow Analysis Data

  Appendix B Customer Service Agreement

  Appendix C Navy-Provided Outage Data

  Appendix D Detailed Cost Tables for IWPS Improvements
- There is a need to add generation within the next 5–7 years to meet system requirements.
- The responsibility for system improvements and additional generation lies with GPA (reference current Customer Service Agreement Article 1, pages I-1 through 3 between Navy and GPA, which is included in Appendix B).

Option 3 is not considered viable for the following primary reason:

- The facilities required for an independent power system that approaches the level of quality and reliability required by DoD are not considered cost effective

The evaluation of power source options also included review of both conventional sources of fuel or energy and alternative sources of fuel or energy. The summary of that analysis is that conventional fuel alternatives would include coal, liquefied natural gas (LNG), heavy fuel oil (No. 6), and No. 2 diesel fuel. Each of these options is summarized below:

- Coal would require a substantial investment in handling facilities but potentially offers a more stable future cost basis that adds stability in the future cost of electricity by diversifying fuel sources used in Guam.
- LNG does not appear to offer a reasonable option for a new facility based on preliminary evaluation of terminal facilities cost and potential difficulty in permitting the necessary facilities. There is no infrastructure in place and will require the generating facility to be located near the fuel offloading and storage facility.
- Both fuel oil options are currently in use in Guam and offer a variety of fuel supply options and potential sites with fuel available that requires minimal infrastructure improvements.

The alternative energy analysis resulted in several options that should be considered in future plans for energy in Guam. Alternative energy options will not be considered as a base load generation source due to the inability to be dispatched (scheduled) under all conditions regardless of the availability of sun, wind, ocean wave or geothermal at the time. The alternative energy options identified with anticipated energy costs at or below the current cost of electricity in Guam (January 2008) are listed below:

- Wind energy
- Simple or combined cycle biofuel plant (Biodiesel fuel)
- Geothermal (potentially viable)
- Solar thermal electric (somewhat higher cost per kWhr than current GPA rates)
- Distributed solar photovoltaic systems with the facilities construction
- Ocean Thermal Energy Conversion (OTEC)
- Wave energy as a technology to watch as it matures. While not considered commercially viable at this time, the technology may likely become more cost competitive in the future

A common conclusion associated with these options is that any generation solution that meets future power needs for the planned DoD facilities will require significant upgrades to existing transmission and distribution systems. Future energy plans could include wind energy, biofuel/biodiesel, geothermal (if additional evaluation proved viable), OTEC, wave energy and possibly solar thermal (based on land requirements, state of technology and limitations related to potential typhoons). These options are not considered further for base load generation as they do not meet the reliability expectations for base load generation. It is expected that alternative energy could make up as much as 50 percent of the anticipated new energy consumption (not base load generation) if suitable locations can be found for wind turbines and solar thermal proves out in a more detailed evaluation.

Providing 50 percent of the new energy consumption would equate to approximately 25 percent of the DoD energy needs. This would allow the DoD to comply with the Energy Policy Act of 2005 and the DoD's goal of 25 percent alternative energy use by 2025. This will not adequately address the base load generation needs, but would provide a renewable source of energy and meet a valuable need in Guam for non-oil based power.

Anticipated energy production cost for some alternative energy sources are projected at less than current GPA retail rates. GPA anticipates additional rate increases in February 2008 and October 2008 with the exception that rates will likely increase further if oil prices continue to rise.

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ACRONYMS AND ABBREVIATIONS

°F	degree Fahrenheit
AAFB	Andersen Air Force Base
AC	alternating current
ANSI	American National Standards Institute
BTU	British Thermal Unit
COMNAVMARIANAS	Commander, Naval Forces Marianas
CSA	Customer Service Agreement
CVN	nuclear-powered aircraft carrier
DC	direct current
DoD	Department of Defense
EAF	Equivalent Availability Factor
EFOR	Equivalent Forced Outage Rate
EIA	Energy Information Administration
EIS	environmental impact statement
ft^2	square foot
GIMDP	Guam Integrated Military Development Plan
GJMMP	Guam Joint Military Master Plan
GovGuam	Government of Guam
GPA	Guam Power Authority
gpm	gallons per minute
Hz	hertz
IPP	Independent Power Producer
IRP	Integrated Resource Plan
IWPS	Island Wide Power System
JGMMP	Joint Guam Military Master Plan
JGPO	Joint Guam Program Office
kV	kilovolt
kW	kilowatt
kW/yr	kilowatt of generation capacity per year
kWh	kilowatt hour
LNG	liquefied natural gas
LOLP	loss of load probability
MARBO	Marianas Bonins Command
m^2	square meter
mph	mile per hour
MVA	megavolt ampere
MVAR	megavolt ampere reactive
MW	megawatt
MWh	megawatt hour
na	not applicable
N/A	not available
NAVFAC Pacific	Naval Facilities Engineering Command, Pacific
NCTS	U.S. Naval Computer and Telecommunications Station
NELHA	National Energy Laboratory Hawaii
NO_x	generic abbreviation for mono-nitrogen oxides
O&M	Operation and Maintenance
OTEC	Ocean Thermal Energy Conversion

PUC	Public Utilities Commission
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
SPE	Special Purpose Entity
SWAC	Sea Water Air Conditioning
Therm	Term that equals 100,000 BTUs
U.S.	United States
USMC	United States Marine Corps
V	volt

1. Introduction

1.1 PURPOSE

The purpose of this study is to evaluate power requirements for proposed facilities and establish generation capacity needs, evaluate interconnection options with Guam Power Authority (GPA), and to evaluate alternative energy options that are viable on Guam. The power required for proposed facilities will consider the United States Marine Corps (USMC) relocation, hereafter referred to as the "USMC relocation," nuclear-powered aircraft carrier (CVN) berthing and related power needs identified in earlier reports for the future military impacts to electrical system on Guam.

There are 4 interconnection options identified in the project definition as described below:

- *Option 1:* Recapitalize, modernize and modify the GPA system to support the added base load to the GPA grid. The added generation will be provided by GPA.
- *Option 2A:* Construct a new Special Purpose Entity (SPE) owned/operated base load power plant on Department of Defense (DoD)-provided land specifically to meet load requirements for the facilities associated with the USMC relocation. The facility would have the ability to provide excess power to the GPA grid. Also, the GPA grid would be used for back-up power in the event the SPE Plant is out of service.
- *Option 2B:* Construct a new SPE owned/operated base load power plant on DoD or other provided land. The normal operation of this base load plant will be to provide power to the GPA grid at the best available location as an Independent Power Producer (IPP). The new Marine loads would be connected to the island wide power system (IWPS) but not at the point of the new SPE facility.
- *Option 3:* Construct a new SPE owned/operated base load power plant for load on N. Finegayan with no connection to GPA. This option would require spare capacity to provide necessary generation with one unit out of service and failure of the largest unit (if units are not the same size).

These options will be described in more detail in Section 3 of the report. Results and supplemental information are provided in the following appendixes to this report:

Appendix A Guam Power Authority Load Flow Analysis Data

Appendix B Customer Service Agreement

Appendix C Navy-Provided Outage Data

Appendix D Detailed Cost Tables for IWPS Improvements

This study will evaluate a list of alternative energy options to determine whether each option is viable in Guam. The general requirements for each option will be described and reviewed against the limitations of Guam as related to natural resources, land use, interconnection with the existing grid and other issues identified for each alternative energy option. The sources of alternative energy that are evaluated in the study are listed below:

- Ocean thermal energy conversion (OTEC)
- Wind power generation
- Solar energy conversion

- Biofuel power generation
- Waste-to-energy generation
- Fuel cell power generation
- Wave energy conversion
- Geothermal

1.2 BACKGROUND INFORMATION

Guam is the southernmost and largest of the Mariana Islands, a group of 15 islands located approximately 3,600 miles west of Hawaii and 1,400 miles south of Japan. The island is a territory of the United States (U.S.). The main axis of the island runs NE–SW for a total length of 30 miles and the varies from 8 miles wide at its northern tip, to 4 miles wide near the center to 11.5 miles in the south. The total area of the island is 212 square miles. The current population of Guam is approximately 171,000.

The Guam Integrated Military Development Plan (GIMDP) (HHF 2006), formerly the Joint Guam Military Master Plan (JGMMP), identified a potential military build-up on Guam. The GIMDP was initiated by the U.S. Pacific Command (USPACOM). As of this writing, Naval Facilities Engineering Command, Pacific (NAVFAC Pacific) is conducting the Guam Joint Military Master Plan (GJMMP), which is the master plan for future build-up of Guam with detailed plans for the USMC relocation to Guam. Naval Computer and Telecommunications Station (NCTS) Finegayan, South Finegayan Housing area, Andersen Air Force Base (AAFB), AAFB Northwest Field, and Andersen South will provide locations for most of the facilities associated USMC relocation to Guam and result in the electrical load increase to the IWPS. Electrical service for DoD facilities is currently provided through the GPA and 19 service locations throughout the island. These service locations are governed by a customer service agreement (CSA) between the Navy and GPA. The electrical rates are based on information contained in Schedule N as referenced in the CSA.

Based on the findings presented in the GIMDP, NAVFAC Pacific has made the decision to perform an electrical power generation study to identify all reasonable alternatives for power generation to support the USMC relocation to Guam. The study will address all reasonable alternatives with sufficient and detailed information to support the Environmental Impact Statement (EIS) process. The study will evaluate and recommend power generation, transmission and distribution improvements anticipated to support the proposed USMC relocation to Guam.

1.2.1 GPA Background

The GPA provides power to all military facilities on Guam through a CSA. This agreement establishes the electrical rates paid to GPA and is in force until 2012. A recent review of the CSA identified a number of concerns. A copy of the CSA is included in Appendix B. Those concerns described in that document and also of importance to this report are listed below:

- Navy has not generated power for the IWPS nor furnished fuel to GPA for at least three fiscal years, FY04–FY06. (Article 3)
- The CSA requires Navy to notify GPA of anticipated DoD–Guam load increases. (Article 8)
- CSA can only be amended by written agreement between both parties—thus prohibiting either party from unilaterally amending the CSA for any reason. (Article 15)
- GPA's service rules and regulations must be considered in the planning of future DoD–Guam facilities and infrastructure improvements—particularly with regard to parallel

operations and line extensions. The Navy is responsible for selecting and installing protective relaying devices and setting parameters for the relays to coordinate with GPA's protective devices to avoid unnecessary service interruptions. (Article 28)

- GPA will construct, own, operate and maintain electric lines and equipment only under, along, upon and over public streets, roads and highways where it has the legal right to do so, and on public lands and private property across which it has otherwise obtained rights-of-way or other necessary rights satisfactory to GPA. (Article 28)
- A cursory examination based on available DoD project data determined that at least 7 Navy joint-use transmission facility items of the 26 listed in CSA Table 3 will potentially be affected.

1.2.1.1 GENERATION SYSTEM

The existing generation system consists of units operated by the Navy, units operated by GPA and units operated by IPPs. A list of installed generation units is included in Table 1-1. This table lists all available units, fuel used, entity responsible for operation, and whether the unit is considered base load, peaking or backup capacity.

Table 1-1: Existing Generation System Resources

Plants	Capacity MW	Technology	Year Installed	Fuel	Type	Owner	Operator
NCTS Finegayan	7.5	N/A	N/A	N/A	Back-up	DOD	DOD
Radio Barrigada	4	N/A	N/A	N/A	Back-up	DOD	DOD
Orote	19.8	N/A	N/A	N/A	Back-up	DOD	DOD
NavHosp.	2	N/A	N/A	N/A	Back-up	DOD	DOD
*Cabras #1	66	Steam Turbine	1974	RFO No. 6	Base Load	GPA	GPA
*Cabras #2	66	Steam Turbine	1975	RFO No. 6	Base Load	GPA	GPA
*Cabras #3	40	Slow Speed Turbine	1996	RFO No. 6	Base Load	GPA	GPA
*Cabras #4	40	Slow Speed Turbine	1996	RFO No. 6	Base Load	GPA	GPA
*Tanguisson #1	26.5	Steam Turbine	1976	RFO No. 6	Base Load	GPA	IPP
*Tanguisson #2	26.5	Steam Turbine	1976	RFO No. 6	Base Load	GPA	IPP
*Temes	40	Combustion Turbine	1997	Diesel No. 2	Peaking Load	GPA	IPP
*PITI #8 (MEC)	44	Slow Speed Diesel	1999	RFO No. 6	Base Load	GPA	IPP
*PITI #9 (MEC)	44	Slow Speed Diesel	1999	RFO No. 6	Base Load	GPA	IPP
Manengon 1 & 2	8.8	Medium Speed Diesel	1993	Diesel No. 2	Peaking Load	GPA	GPA
Dededo CT #1	23	Combustion Turbine	1992	Diesel No. 2	Peaking Load	GPA	GPA
Dededo CT #2	23	Combustion Turbine	1994	Diesel No. 2	Peaking Load	GPA	GPA
Dededo (D) #1, 2, 3, 4	10	Combustion Turbine	1972	Diesel No. 2	Peaking Load	GPA	GPA
Macheche	21	Combustion Turbine	1993	Diesel No. 2	Peaking Load	GPA	GPA
Yigo (CT)	21	Combustion Turbine	1993	Diesel No. 2	Peaking Load	GPA	GPA
Talafofo #1 & 2	10	Medium Speed Diesel	1994	Diesel No. 2	Peaking Load	GPA	GPA
Mt. Tenjo	26.4	Medium Speed Diesel	1994	Diesel No. 2	Peaking Load	GPA	GPA

Plants	Capacity MW	Technology	Year Installed	Fuel	Type	Owner	Operator
Marbo CT	14	Combustion Turbine	1993	Diesel No. 2	Peaking Load	GPA	GPA

*Denotes unit managed by independent power producer (IPP) or private management contract (PMC).
N/A not available

Capacity (Base Load/Peak)

The GPA operates and has agreements for purchasing power from units as listed in Table 1-1. There are basically two types of units listed. The larger units operated from heavy fuel oil (No. 6) are typically base load capacity units and have limited operating ranges that favor operation at or near rated capacity. The other type of units are considered peaking units and can be started and placed on line quickly, are more distributed, rated at lower capacity per unit/engine and typically more costly to operate. The peaking units are typically operated for short periods of time, and not intended to meet daily demands from the IWPS loads.

Quality/Reliability

There are two general characteristics of delivered power that were reviewed in this report. One is the power quality and can be described in terms of voltage level, alternating current (AC) frequency of the power delivered, disturbances on the system such as voltage sags, voltage spikes and harmonics in the system that impact sensitive equipment connected to the power system.

The other main characteristic is the power reliability. This refers to events that interrupt the power supply to the customer and is typically measured in outage rate and outage duration. Power utility measurements for these aspects use two main parameters to evaluate reliability performance.

- System Average Interruption Frequency Index (SAIFI)
- System Average Interruption Duration Index (SAIDI)

Each of these parameters is tracked for all customers (average interruption duration or SAIDI in minutes of outages per customer per year and average frequency of interruptions is outages per customer per year). These parameters are evaluated by most utilities and are used in reviewing performance improvements from year to year and to establish goals for utilities to achieve. A graph of recent data from the GPA is included for reference (Figure 1-1) (the units for SAIDI are average total minutes of outage per customer and for SAIFI are the average number of outage events per customer with both values calculated on a yearly basis).

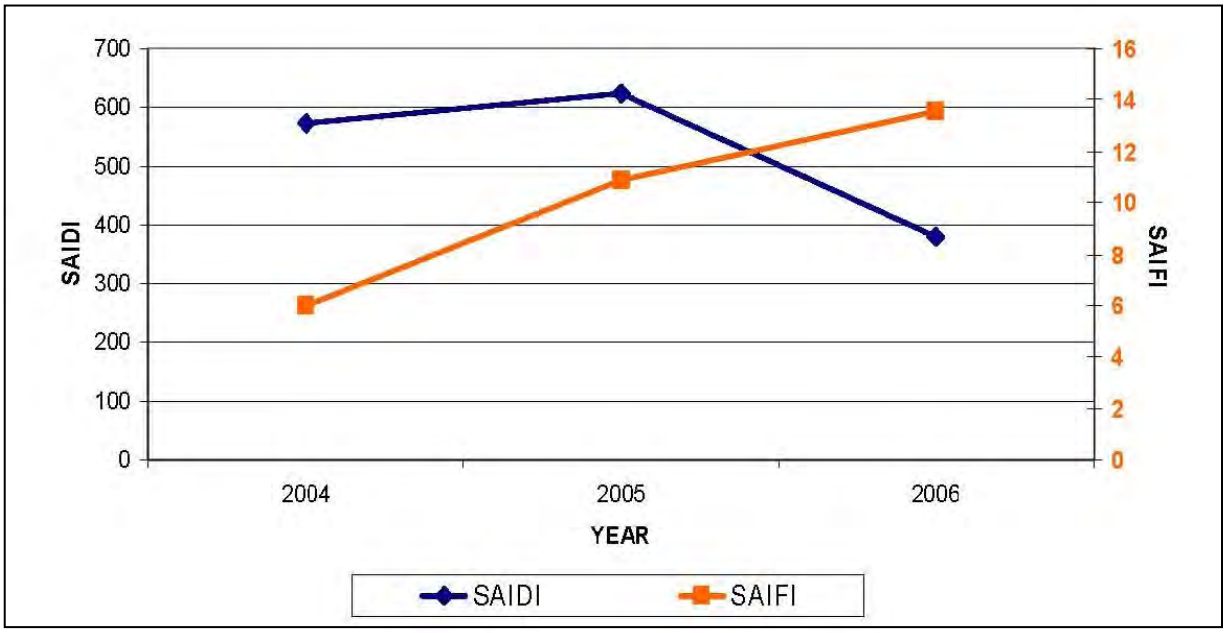

Figure 1-1: Recent SAIDI/SAIFI Data from GPA

NAVFAC Pacific has been working to establish expected performance characteristics for each of the parameters that have been presented to this point and they are included here for information purposes. It should be noted that the requirements have not been finalized and should be considered preliminary at this time.

Table 1-2: Expected Performance Characteristics for each Parameter

Parameter	CSA Agreement Levels	Requirements
Voltage	Voltage delivery should be within 5% of the prescribed voltage.	Voltage Range for 13.8 kV nominal voltage - minimum 13,460V (-2 1/2%) to maximum 14,490V (+ 5%), Reference ANSI C84.1-1995 (ANSI 2005)
Frequency	Alternating service of approximately 60 Hz will be regularly supplied. (Direct current will not be supplied).	Frequency Range for 13.8kV nominal voltage: 59.5Hz – 60.5 Hz. Reference based on IEEE STD 446 (Orange Book) (IEEE 1996)
Generation Reliability Standards	LOLP of 1 day in 10 years and operating reliability of 4 days in 10 years. Equivalent forced outage rate of 15% and average forced outage rate of 8% calculated as a four year rolling average. Equivalent availability factor of 85 %.	LOLP, Planning Reliability Purposes - 1 day in 10 years LOLP, Operating Reliability Purposes - 4 days in 10 years EFOR - 9% National Industry Performance EAF - 85% National Industry Performance
Distribution Reliability Standards	Substation and transmission outages should contribute no more than 0.10 days (144 minutes) per year to loss of load incidence. Distribution outages should contribute no more than 0.30 days (432 minutes) per year No overloaded circuits in a normally configured system (calculated by comparing monthly peak load with circuit rating)	SAFI : 1.10 interruptions/year/customer SAIDI: 1.50 hours/year/customer (90 minutes)

ANSI	American National Standards Institute	kV	kilovolt
EAF	Equivalent Availability Factor	LOLP	loss of load probability
EFOR	Equivalent Forced Outage Rate	V	volt
Hz	hertz		

1.2.2 Renewable Alternative Energy

The GPA has been evaluating alternative energy as part of their Integrated Resource Plan (IRP). They have been working with the firm of R. W. Beck, Inc. to identify costs and impacts of several fuel options that include alternative energy as well as conventional fuel sources for power generation. GPA has not completed the process but did provide a copy of a document prepared by R. W. Beck, Inc. to indicate what they have been investigating relative to Guam's future power needs.

1.2.3 Operations and Maintenance

GPA has the responsibility of meeting requirements for system operation and maintenance (O&M) as defined in the current CSA with the Navy.

1.3 20-YEAR PLAN

The loads associated with the military buildup in Guam represent the major loads anticipated over the next 10 years and impact GPA planning for facilities over the next 20 years. NAVFAC provided best available information to GPA in October 2007 (GIMDP demand load projections) to allow them to begin this planning process with preliminary loads and general load locations. It is anticipated that this information will be incorporated into the 20-year plan for GPA.

1.3.1 Alternative Energy

GPA has incorporated alternative energy into its plans for future energy needs in Guam. The main options considered by GPA to date include wind turbines, biomass, and ocean thermal. GPA has a report that considers the opportunity of installing an ocean thermal facility to provide energy for cooling systems to the major consumers in Tamun and Tamuning Bays in Guam. There have been no specific plans made to implement such a project at this time.

1.3.2 Reliability/Power Quality

The system performance will continue to be an important issue with GPA in planning for system improvements. The GPA has been conducting stake holder meetings as part of their Strategic Planning and Operations Research Department (SPORD) planning process. This planning will continue into 2008.

The CSA requirements for reliability and power quality are established under the current CSA and have been determined as being met by an independent auditor as defined in the CSA. The result of GPA meeting the requirements was that facility control was turned over to them for complete responsibility to operate and manage the IWPS.

1.4 MILITARY BACKGROUND

The significance of the history for this study primarily relates to the CSA established between the Navy and GPA. This document dates back to 1989 and was extended for a 10-year period that will end in 2012. A new agreement will need to be established prior to expiration of the current CSA.

1.4.1 Build-Up Loads

There were several sources of data available that included data for planned electrical loads in Guam. Initial load projections that were provided to GPA for system analysis were obtained from the GIMDP (HHF 2006). These loads are summarized in Table 1-3 as MW values.

Table 1-3: Current and Preliminary Future Military Electrical Loads for Guam in MW

Load Description	Existing Demand Load (MW)	MILCON Preliminary Planned Demand (MW)	USMC Preliminary Future Planned Demand (MW)	Preliminary Total DoD Future Planned Demand (MW)
Existing Navy electrical demand for 19 service locations (based on peak demand data in GIMDP report dated July 2006 [HHF 2006])	47.55	na	na	na
AAFB	18.1	10.80	0.57	29.87
Northwest Field	0.5	1.35	0.0	1.80
Andy South – MARBO		0.00	0.00	0.00
NCTS (North) – Finegayan	1.2	3.53	20.10	24.83
South Finegayan Housing Area	1.5	0.00	8.15	9.65
Barrigada	1.3	0.00	0.00	1.3
Naval Hospital	3.2	2.07	0.00	5.27
Apra Harbor (NAVBASE Guam)	20.75	47.70	18.71	87.16
Total Electrical Loads (MW)	47.55	65.45	47.53	160.53

na	not applicable
MILCON	military construction
MW	megawatt
MARBO	Marianas Bonins Command
NAVBASE	Naval Base
NCTS	Naval Computer and Telecommunications Station

1.4.2 Schedule

The major portion of these loads is expected to add about 50 megawatts (MW) to the power system between 2010 and 2015 with the remaining loads added in the following 5–10 years. A more specific schedule for adding loads can be created as the master planning is concluded.

1.4.3 DoD Loads

The preliminary load list for DoD planned facilities included all military loads for master planning and included loads associated with the transient CVN in Apra Harbor.

1.4.4 GIMDP Loads

The loads identified in GIMDP were essentially developed based on facility planning associated with a potential military build-up developed by the services. The GJMMP will provide better facility planning information when the study is completed and may be used to determine electrical demand loads that will impact the IWPS.

2. Evaluation of Power Generation Sources

2.1 CONVENTIONAL POWER GENERAL

Conventional power generation refers to the use of carbon-based fuels for this report. Those fuels considered are liquefied natural gas (LNG), coal, diesel No. 2, and heavy fuel oil No. 6 (also referred to as bunker oil). These fuel sources were considered as potentially suitable for Guam, given the current world energy market and resources available to Guam.

In general, facility costs and cost per megawatt hour (MWh) are based on a report conducted by GPA in 2006 (IRP) with fuel costs based on average energy costs for 2006 (latest available from Energy Information Administration). The average costs of energy ($/MWh) were calculated from heat rates indicated in the GPA IRP and fuel costs from the EIA data that considers all types of fuel for a given category (coal costs include prices paid for various types of fuel for all sources tracked by the Energy Information Administration).

2.1.1 Liquefied Natural Gas

LNG is one of many fuel types that are used for power generation in various parts of the world. While LNG has a long history of safe use in the United State, it is not without a long list of issues associated with the infrastructure required to utilize the fuel as a significant source of electrical power for Guam. One of the most difficult issues to evaluate for any generating station will continue to be cost of fuel. World use of LNG appears to be increasing and would indicate the potential for continued rising of fuel costs. This study has not attempted to evaluate the long-term fuel costs for a LNG-based facility.

LNG is a hazardous fuel frequently shipped in tankers from various parts of the world to destinations with ports suitable for offloading the fuel. LNG is not currently available in quantities large enough to support power generation in Guam and would require new facilities for import and handling to support this need. LNG infrastructure is highly visible and easily identified; it can also be vulnerable to terrorist attack due to the highly visible nature of the facilities (tanks and related facilities are exposed and unique in configuration). Nonetheless, public concerns about LNG risks continue to raise questions about LNG security. While LNG has historically made up a small part of power generation (this percentage varies depending on local resources and power needs), variability in worldwide fuel costs and rising natural gas prices in various areas in the world will impact the worldwide cost of LNG due to worldwide increasing LNG demand.

2.1.1.1 FUEL DELIVERY/STORAGE

The fuel delivery infrastructure for LNG requires three major facility elements: tanker ships, marine terminals, and storage facilities.

LNG Tanker Ships

LNG is transported in very large (generally 150,000–270,000 cubic meters), specially designed tanker ships. LNG tankers are double-hulled, containing several massive refrigerated tanks, each sealed and insulated to maintain a safe LNG temperature and prevent leakage during transit. Approximately 200 tankers are in service around the world, with a combined cargo capacity of over 16 million cubic meters of LNG, equivalent to over five times the average daily U.S. natural gas consumption in 2001. Another 125 tankers with 22 million cubic meters of capacity are on order.

LNG Marine Terminals

LNG tankers unload their cargo at dedicated marine terminals which store and re-gasify the LNG for distribution to local markets. These terminals consist of docks, LNG handling equipment, storage

tanks, and interconnections to regional gas transmission pipelines. Guam does not currently have facilities for off-loading, storing, re-gasifying (if provided to natural gas pipelines), or distributing LNG. It is anticipated that LNG facilities in Guam would require transport of LNG to the power generating facility for re-gasification and use. This is due to the lack of a natural gas infrastructure in Guam and the prohibitive costs associated with this infrastructure.

The LNG industry is often described as a "LNG chain." This is in reference to the fact that LNG systems require that large interdependent investments that must be closely coordinated to be successful. All links of the chain must work together for natural gas to be produced, liquefied and exported, transported, imported, re-gasified and sold as natural gas to consumers. LNG projects require significant fuel reserves and must produce substantial volumes. Overall systems may require end-to-end investments of 2 to 5 billion dollars and consumption volumes of up to 1.0 billion cubic feet per day to be profitable. The large initial capital investment results in an extended payback period, and corresponding financial risk, which means that most of the world's LNG is sold under long-term contracts (typically 20–25 years). There are, however some short-term and medium-term markets and, occasionally, there are sales of individual cargoes.

This generally indicates that LNG is not reasonably feasible for Guam due to the extensive infrastructure required, the high cost of infrastructure and the large volumes of consumption required to make LNG facilities cost-effective. Table 2-1, presented at the end of this section, compares fuel alternatives for a 50 MW generating facility.

2.1.1.2 Operation and Maintenance

Operation and maintenance costs for LNG-based generation facilities will generally be less than those costs for oil-fueled or coal-fueled facilities. It is anticipated that scheduled maintenance will require less than 4 weeks of downtime each year or about 7 percent of the year. Fixed operating cost for a new facility could be approximately $60 per kilowatt of generation capacity per year (kW/yr) with additional variable operating costs of $2.5 per MWh produced.

2.1.1.3 Construction Time/Schedule

As with any capital project of this nature, the time schedule requires permitting, engineering and construction as the main components of the project. The anticipated implementation of a LNG facility will require additional time associated with the offloading facilities for LNG. The anticipated time for the LNG facilities is indicated below:

- Permitting at 30 months
- Start of Engineering to Closeout at 28 months
- Total duration (accounting for overlap) 48 months

It should be noted that the anticipated schedule duration is general and does not account for any special siting or permitting issues that may apply to an actual project.

2.1.1.4 Cost per MW (Capital) Cost per Megawatt Hour (Production)

Capital costs anticipated for this report do not account for land acquisition but do account for the cost of shore delivery facilities due to the variability in cost. Costs for capital facilities and energy production from LNG are listed below:

- Cost per MW installed capacity (60 MW facility)—$5 million per MW
- Cost per MWh production (based on cost of $11/MMBtu)—$55.87 per MWh

2.1.1.5 SITE (REQUIREMENTS LAND AREA)

The site requirement for a 60 MW facility is anticipated to be 15–30 acres and would include both the offloading facilities and the power station collocated at the same site. Space requirements and logistics will be different if the generation station is located some distance from the offloading facilities.

2.1.1.6 POWER QUALITY– RELIABILITY

The power quality for any of the generation options is expected to meet all government service requirements that are affected by the power generating station. Reliability requirements that are a function of the overall IWPS are impacted by a proposed facility but do not rely solely on the proposed power facility. As a result, the reliability impact of the proposed generating facility cannot be evaluated separately. A proposed LNG facility would be expected to have a maximum capacity factor (availability of the generation facility) of 90 percent.

2.1.1.7 BASE LOAD, PEAKING LOAD

LNG fuel is used to supply both base-load and peaking facilities for power generation. The power needs for Guam would dictate a base-load facility. The existing diesel-fueled engines would continue to provide necessary peaking load capacity for the IWPS.

2.1.1.8 DESIGN LIFE

The expected design life for a LNG facility is 30 years.

2.1.1.9 ENVIRONMENTAL – EMISSION, WATER, REMEDIATION

The environmental issues related to a LNG facility are complex and vary by selected site. This paragraph will present general issues associated with environmental impacts related to an LNG facility.

Environmental studies covered in an EIS for a proposed LNG terminal include impacts on air quality, biological resources (aquatic and terrestrial), water resources, cultural resources, land use, coastal zone management, transportation (on-shore traffic and marine navigation), socioeconomics, visual resources, waste management, noise, geology and soils, recreation, public health and safety, and environmental justice. State agencies are invited to comment and may play a role in permitting. LNG terminal applicants must obtain permit for air emissions, coastal zone management, water discharge, and land use.

Construction of a LNG terminal facility affects relatively large areas of land and water resources. A recent LNG terminal application described the required land and water area as approximately 188 acres, of which 68 acres would be utilized for temporary construction facilities. Construction typically requires the use of diesel-powered heavy construction equipment to dredge ship channels, drive pilings for pier construction, clear vegetation, and construct LNG storage tanks, ancillary buildings, and service facilities. The most significant impacts will arise from dredging and material handling.

The most significant impacts occurring during the operational phase of an LNG terminal include impacts to air and water quality and the visual impact of the facility. These will be long-term impacts, as LNG terminals are typically designed to operate for at least 25 to 30 years. Impacts to air and water resources are cumulative and mitigation measures are designed and implemented accordingly.

Ultimately, LNG plants will face decommissioning. The most significant impacts resulting from the decommissioning phase of an LNG terminal are associated with demolition and disposal of wastes.

Air quality impacts are generated by demolition equipment and truck transport of demolition wastes. Some components of the facility such as buried pipelines can be safely abandoned in place after being flushed and capped. Site characterization studies may be required by regulatory agencies to determine the extent of (possible or potential) soil or groundwater contamination that may have occurred at the facility during the operational phase. In the event that contaminants are discovered, appropriate remediation plans may need to be developed and implemented.

2.1.1.10 WATER REQUIREMENTS

Water requirements are expected to be nominal at 225 gallons per minute (gpm) of fresh water for a 60 MW facility.

2.1.2 Coal

Coal represents about 36 percent of the world production of electricity (based on Report #DOE/EIA-0484 (2007) [DOE 2007b]) and about 26 percent of the world energy consumption. Coal is generally available from locations in the region near Guam. Australia, China, Vietnam, and Africa are all exporters of coal.

2.1.2.1 FUEL DELIVERY STORAGE

Coal delivery and storage facilities do not exist in Guam at the level required for commercial power production. These facilities would need to be developed in advance of any coal-fueled generating station for Guam. The potential for a coal facility in Guam was discussed with the GPA, Government of Guam (GovGuam), and a local business. Each organization expressed an interest in the diversity that coal-based power generation could provide on Guam, the potential for a more stable fuel source for electricity production and that a suitable facility could be sited in Guam if the proper support were available at all levels of industry and government.

It was anticipated in a report prepared for the GPA that the port facilities for coal handling may cost $25 million. There has been no detailed analysis of site location for Guam.

2.1.2.2 O&M

Operation and maintenance requirements for a coal-based facility are higher than for many other fuel options (such as natural gas, No. 6 fuel oil, and diesel) due to the type of fuel, emissions, and complexity of the facility. These costs are typically higher than similar costs for LNG, diesel and fuel oil based systems. Scheduled maintenance duration each year is anticipated at just over 5 weeks or about 10 percent of each year. Fixed operating cost for a new facility could be approximately $80/kW/yr with additional variable operating costs of $4.5 per MWh produced.

2.1.2.3 CONSTRUCTION TIME/SCHEDULE

Coal facilities have long implementation schedules. This is partly due to permitting requirements and the complexity of construction for coal handling facilities and generation plant. The plant schedule for a coal facility is expected to be as follows:

- Permitting at 30 months
- Start of Engineering to Closeout at 36 months
- Total duration (accounting for overlap) 56 months

It should be noted that the anticipated schedule duration is general and does not account for any special siting or permitting issues that may apply to an actual project.

2.1.2.4 COST PER MW (CAPITAL) COST PER MW (PRODUCTION)

Capital costs anticipated for this report do not account for land acquisition but do account for a $25 million cost for coal handling facilities. Costs for capital facilities and energy production from coal are listed below:

- Cost per MW installed capacity (60 MW facility)—$4.4 million per MW
- Cost per MWh production—$17.75 per MWh

2.1.2.5 SITE (REQUIREMENTS/LAND AREA)

The site requirement for a 60 MW facility is anticipated to be 200–300 acres (largest site requirements of all fuel sources reviewed) and would include both the coal handling facilities and the power station collocated at the same site. Space requirements and logistics will be different if the generation station is located any distance from the offloading facilities.

2.1.2.6 QUALITY POWER/RELIABILITY

The power quality for any of the generation options is expected to meet all government service requirements that are affected by the power generating station. Reliability requirements that are a function of the overall IWPS are impacted by a proposed facility but do not rely solely on the proposed power facility. As a result, the reliability impact of the proposed generating facility cannot be evaluated separately. A proposed coal-fueled generating facility would be expected to have a maximum capacity factor of 85 percent.

2.1.2.7 BASE LOAD, PEAKING LOAD

Coal-based generation is used as to meet base-load power generation. The power needs for Guam would dictate a base-load facility. The existing diesel-fueled engines would continue to provide necessary peaking load capacity for the IWPS.

2.1.2.8 DESIGN LIFE

The expected design life for a coal fueled facility is 30 years.

2.1.2.9 ENVIRONMENTAL – EMISSION, WATER, REMEDIATION

Fossil fuel power contributes to acid rain, global warming, and air pollution (electricity generation is responsible for 39 percent of U.S. carbon dioxide emissions). Acid rain is caused by the emission of nitrogen oxides and sulfur dioxide into the air. These compounds may be only mildly acidic, yet when they react with the atmosphere; they create acidic compounds such as sulfurous acid, nitric acid and sulfuric acid that fall as rain, hence the term acid rain. In Europe and the U.S., stricter emission laws have reduced the environmental hazards associated with this problem.

Another danger related to coal combustion is the emission of fly ash, tiny solid particles that are dangerous for public health. (Natural gas plants emit virtually no fly ash) These can be filtered out of the stack gas, although this does not happen everywhere. All coal burning power plants emit carbon dioxide. Research has shown that increased concentration of carbon dioxide in the atmosphere is positively correlated with a rise in mean global temperature, also known as climate change.

Coal also contains low levels of uranium, thorium, and other naturally occurring radioactive isotopes whose release into the environment leads to radioactive contamination. While these substances are present as very small trace impurities, enough coal is burned that significant amounts of these substances are released. A 1,000 MW coal-burning power plant (much larger than the 60 MW facility being considered for Guam) could release as much as 5.2 tons/year of uranium (containing

74 pounds of uranium-235) and 12.8 tons/year of thorium. The radioactive emission from this coal power plant is 100 times greater than a comparable nuclear power plant with the same electrical output; including processing output, the coal power plant's radiation output is over 3 times greater.

Trace amounts of mercury exist in coal and other fossil fuels. When these fuels burn, toxic mercury is released and can accumulate in food chains, which is especially harmful to aquatic ecosystems. According to the U.S. Department of Energy, the worldwide emission of mercury from both natural and human sources was 5,500 tons in 1995, of which coal-fired plants in the U.S.A release an estimated 48 tons annually or less than 1 percent of the worldwide emissions. The Environmental Working Group (a privately funded environmental advocacy organization) alleges that coal-fired power plants are the largest emitters of mercury in the United States.

2.1.2.10 WATER REQUIREMENTS

A 60 MW coal fueled facility is expected to require approximately 1000 gpm of water for various processes (primarily makeup water for the steam process and cooling water).

2.1.3 Diesel No. 2

Number (No.) 2 diesel fuel is one of the most common fuel source for standby power generation and often used for peak power generation under some conditions. The basic issues related to the use of No. 2 diesel as a peaking source are listed below:

- High cost of fuel as compared to other generally available fuels such as natural gas heavy fuel oil or coal
- High maintenance costs for reciprocating engines as compared to combined cycle technology
- Overall efficiency of the installation is approximately 40 percent without a viable use for waste heat from the engines (which would increase efficiency to approximately 80 percent but require the system to operate continuously)
- Units are typically limited by engine size (typically less than 2.5 MW per engine with limited availability of larger units)

These issues are typically over-ridden by the low cost of installation, ability to bring on-line in a short time and the high reliability as a peaking source for electrical power generation for relatively small installation (10 MW or less).

2.1.3.1 FUEL DELIVERY STORAGE

No. 2 diesel is available in large quantity and is a widely used source of fuel in Guam. Both military and civilian organizations use the fuel for a variety of applications in Guam. The result is a developed infrastructure for fuel delivery from tankers, fuel storage, and distribution through various pipelines in Guam. The availability of fuel will vary depending on location of facility.

2.1.3.2 O&M

Operation and maintenance requirements for a No. 2 diesel-fueled facility generally consist of relatively short outages for limited service requirement and extended outages associated with engine overhaul. Scheduled maintenance duration each year is anticipated at approximately 5.5 weeks per year or about 10 percent of the available hours each year. Fixed operating cost for a new facility could be approximately $40/kW/yr with additional variable operating costs of $4.5 per MWh produced.

2.1.3.3 CONSTRUCTION TIME/SCHEDULE

Diesel-fueled facilities would be expected to have the following general schedule for implementation:

- Permitting at 24 months
- Start of Engineering to Closeout at 18 months
- Total duration (accounting for overlap) 30 months

It should be noted that the anticipated schedule duration is general and does not account for any special siting or permitting issues that may apply to an actual project.

2.1.3.4 COST PER MW (CAPITAL) COST PER MW (PRODUCTION)

Capital costs anticipated for this report do not account for land acquisition. Costs for capital facilities and energy production from No. 2 diesel are listed below:

- Cost per MW installed capacity (60 MW facility)—$1.7 million per MW
- Cost per MWh production—$52.96 per MWh

2.1.3.5 SITE (REQUIREMENTS/LAND AREA)

The site requirement for a 40 MW facility is anticipated to be 10–25 acres. Space requirements and logistics will vary with the specific location and fuel availability and storage requirements.

2.1.3.6 QUALITY POWER/RELIABILITY

The power quality for any of the generation options based on conventional fuels is expected to meet all government service requirements that are affected by the power generating station. Reliability requirements that are a function of the overall IWPS are impacted by a proposed facility but do not rely solely on the proposed power facility. As a result, the reliability impact of the proposed generating facility cannot be evaluated separately. A proposed No. 2 diesel facility would be expected to have a maximum capacity factor near 85 percent.

2.1.3.7 BASE LOAD, PEAKING LOAD

Number 2 diesel-based generation (with reciprocating engines) can be used as to meet base-load power generation but is not a widely used application for base load capacity. The power needs for Guam would dictate a base-load facility. The existing diesel-fueled engines would continue to provide necessary peaking load capacity for the IWPS.

2.1.3.8 DESIGN LIFE

The expected design life for a diesel-fueled facility is 30 years.

2.1.3.9 ENVIRONMENTAL – EMISSION, WATER, REMEDIATION

Fossil fuel power contributes to acid rain, global warming, and air pollution. Acid rain is caused by the emission of nitrogen oxides and sulfur dioxide into the air. These compounds may be only mildly acidic, yet when they react with the atmosphere; they create acidic compounds such as sulfurous acid, nitric acid and sulfuric acid that fall as rain, hence the term acid rain. In Europe and the U.S., stricter emission laws have reduced the environmental hazards associated with this problem.

2.1.3.10 WATER REQUIREMENTS

A 40 MW No. 2 diesel-fueled facility is expected to require less than 50 gpm of water for various processes.

2.1.4 Heavy Fuel Oil (No. 6)

No. 6 fuel oil is used to fuel a major portion of the installed generation capacity in Guam. The basic issues associated with the use of No. 6 fuel oil as a fuel source are listed below:

- Cost of fuel is lower than No. 2 diesel
- Lower maintenance cost for combustion turbine technology when compared against maintenance costs for reciprocating engines.
- Overall efficiency of the installation is approximately 40–45 percent without a viable use for waste heat from the engines (which would increase efficiency to approximately 80 percent but require the system to operate continuously and a system to recover and receive beneficial use of the waste heat from the generation system)
- Units are typically limited by engine size (typically less than 2.5 MW per engine with limited availability of larger units up to 10–20 MW rating)

These issues are typically over-ridden by the availability of fuel and the lack of readily available alternative fuel sources.

2.1.4.1 FUEL DELIVERY STORAGE

No. 6 fuel oil is available in large quantity and is a widely used fuel to provide electricity in Guam. Both military and civilian organizations use the fuel for a variety of applications in Guam. The result is a developed infrastructure for fuel delivery from tankers, fuel storage, and fuel distribution through various pipelines in Guam. The specific availability of fuel will vary depending on actual facility location.

2.1.4.2 O&M

Operation and maintenance requirements for a No. 6 fuel oil fueled facility generally consist of relatively short outages for limited service requirement and extended outages associated with engine overhaul. Scheduled maintenance duration each year is anticipated at approximately 3.5 weeks per year or about 7 percent of the available hours each year. Fixed operating cost for a new facility could be approximately $40/kW/yr with additional variable operating costs of $4.5 per MWh produced.

2.1.4.3 CONSTRUCTION TIME/SCHEDULE

No. 6 fuel oil fueled facilities would be expected to have the following general schedule for implementation:

- Permitting at 24 months
- Start of Engineering to Closeout at 18 months
- Total duration (accounting for overlap) 30 months

It should be noted that the anticipated schedule duration is general and does not account for any special siting or permitting issues that may apply to an actual project. Also, this anticipated schedule is based on information provided by GPA as related to re-powering (replacing) an existing generation unit located in an existing facility.

2.1.4.4 COST PER MW (CAPITAL) COST PER MW (PRODUCTION)

Capital costs anticipated for this report do not account for land acquisition. Costs for capital facilities and energy production from No. 6 fuel oil are listed below:

- Cost per MW installed capacity (60 MW facility)—$0.6 million per MW (based on information provided by GPA and re-powering an existing unit, located at the Piti site, to provide 60 MW of capacity)
- Cost per MWh production—$50.46 per MWh

2.1.4.5 SITE (REQUIREMENTS/LAND AREA)

The site requirement for a 60 MW facility is anticipated to be 10–25 acres. The space requirements for re-powering an existing unit within GPA facilities would require less space (5–15 acres) and be significantly more cost-effective for an equivalent facility separately located elsewhere in Guam. Space requirements and logistics will vary with the specific location and fuel availability and storage requirements.

2.1.4.6 QUALITY POWER/RELIABILITY

The power quality for any of the generation options based on conventional fuels is expected to meet all government service requirements that are affected by the power generating station. Reliability requirements that are a function of the overall IWPS are impacted by a proposed facility but do not rely solely on the proposed power facility. As a result, the reliability impact of the proposed generating facility cannot be evaluated separately. A proposed heavy fuel oil based facility would be expected to have a maximum capacity factor near 91 percent.

2.1.4.7 BASE LOAD, PEAKING LOAD

No. 6 fuel oil based generation (with a combined cycle turbine) can be used as to meet base-load power generation. The existing diesel-fueled engines would continue to provide necessary peaking load capacity for the IWPS.

2.1.4.8 DESIGN LIFE

The expected design life for a heavy fuel oil fueled facility is 30 years.

2.1.4.9 ENVIRONMENTAL – EMISSION, WATER, REMEDIATION

Fossil fuel power contributes to acid rain, global warming, and air pollution. Acid rain is caused by the emission of nitrogen oxides and sulfur dioxide into the air. These compounds may be only mildly acidic, yet when they react with the atmosphere; they create acidic compounds such as sulfurous acid, nitric acid and sulfuric acid that fall as rain, hence the term acid rain. In Europe and the U.S., stricter emission laws have reduced the environmental hazards associated with this problem.

2.1.4.10 WATER REQUIREMENTS

A 60 MW No. 6 fuel oil fueled facility is expected to require approximately 300 gpm of water for the various processes.

2.1.5 Summary

The conventional fuel sources were evaluated to provide a basis for any decision related to power generation facilities and identifying a rough cost basis for capital facilities and energy costs. It should be noted that the fuel costs may differ significantly from those presented in this report, given the current volatility of fuels. Basic alternative comparisons are presented in Table 2-1 below.

Table 2-1: Conventional Fuel Source Comparison

Fuel Type	Capital Cost Per MW of Installed Capacity (60 MW Facility) $U.S. million	Production Cost per MWh (Based on Cost of $11/MMBtu) $U.S.	Water Usage Gallons per Minute (60 MW Facility)	Land Requirements in Acres (60 MW Facility)
Liquefied natural gas	5.0	55.87	225	15–30
Coal	4.4	17.75	1,000	200–300
Diesel Fuel No. 2	1.7	52.96	50	10–25 [a]
Heavy Fuel Oil (No. 6)	1.7[b]	50.46	300	10–25

[a] Based on 40 MW facility. Larger space will be required for a 60 MW facility.
[b] Based on new facilities, renovation of existing unit could be implemented for approximately $0.6 million per MW up to a 60 MW facility.

General information has been presented regarding environmental impact from the conventional power generation fuel options. While there is variability in emissions for each type of fuel and different grades of fuel, some data were evaluated for small generating stations (100 –150 MW) based on data in a report conducted by the Commission for Environmental Cooperation for 2002. Please refer to emission data that indicate average kg/MWh for the number of plants in the data set and between 100 and 150 MW (Table 2-2).

Table 2-2: Power Plant Average Emissions

Fuel Type	No. of Plants	2002 EPA SO_2 kg/MWh	2002 EPA CO_2 kg/MWh	2002 EPA NO_x kg/MWh
Oil	3	3.136	855.453	1.286
Gas	56	0.120	987.834	0.811
Coal	23	8.857	1188.331	2.677

Source: Commission for Environmental Cooperation of North America. (2002). *North Power Plan Air Emissions*

2.2 ALTERNATIVE ENERGY SOURCES

Guam is a fairly attractive location for alternative energy development due to its geographical features and location in the western North Pacific. Possible renewable energy sources that can be utilized include ocean thermal, wind, solar, wave, and geothermal energy. In addition, biomass, waste-to-energy, fuel cells, and other technologies are also appropriate for consideration given the size of its population and the island's agricultural and industrial base.

Guam is the southernmost island in the Marianas archipelago, and is situated at 13 N latitude and 144 E longitude (Figure 2-1). It is approximately 30 miles long and between 4 to 12 miles wide, with a total land area of 212 square miles. The island is comprised of two inactive volcanoes: the central and northern portions are primarily limestone, and the southern portion is largely volcanic. The highest point on the island is Mount Lamlam with an elevation of 1,332 feet.

Due to its location in the western north Pacific near the equator, the ocean currents are heavily influenced by the North Pacific Equatorial current which moves westward across the Pacific. Winds are predominantly trade winds that come from the northeast. These conditions contribute to the tropical climate on Guam, which averages between 86 to 76 degrees Fahrenheit (°F) dry bulb, and between 84 percent and 66 percent relative humidity. While the island is outside of the most active tropical cyclone activity area, it is frequently impacted by cyclones during the wet season that extends from July through November.

Guam is situated just to the east of the Mariana Trench, which has the deepest ocean depths in the world, and is the subduction zone between the Philippine and Pacific plates. This adjacency makes the Marianas islands a volcanically active area with the potential for large earthquakes.

The population on Guam as of 2006 is approximately 174,000, with approximately 20 percent of the residents in active U.S. military service or dependants. The total power demand on the island peaks near 250 MW, and the average electrical energy production is around 2,000,000 MWh/year. All of the electricity on the island is produced by the GPA. The utility lists a total generating capacity of 550 MW, with the all of its generation capacity supplied from fossil fuel fired plants.

Figure 2-1: Map of Guam

The U.S. military currently purchases all of its power from the GPA under a customer service agreement and rate schedule N. While power is drawn from the grid at 20 separate locations, all of the military's electricity is billed as if it were drawn from a single meter based on the concurrent peak demands and aggregate energy consumption. Currently, the United States (U.S.) military's total peak demand averages about 47 MW per month with 330,000 MWh per year in electrical energy consumption. Based on the present fuel oil charges, the average cost for electricity for the U.S. military is $.20 per kilowatt hour (kWh).

2.2.1 Ocean Thermal Energy Conversion

OTEC systems utilize the temperature gradient between warm surface ocean waters and cold deep ocean waters to drive either an ammonia closed cycle, an open cycle, or a combined cycle power plant. While none of these systems are in commercial production, the technology has been proven several times. In 1979, a 50 kW demonstration plant was operated at the National Energy Laboratory of Hawaii Authority (NELHA). This plant generated a 50 kW of gross power and a net power of 10 kW with about 40 kW required for pumping. Although this plant is not currently operating, the U.S. Navy is examining a barge-mounted OTEC facility for its Diego Garcia base, and a 1 MW net power output production plant is being built at the NELHA.

Guam is an ideal location for OTEC since its western coastline fringes on cold deep ocean water from the Marianas Trench. In fact, a 40-degree difference can be found between sea level and 1,000 meters below sea level at a location less than 1 kilometer from Guam's shore.[1] This cold ocean water, in conjunction with Guam's warm coastal surface waters, can provide a renewable and sustainable energy source that is non-polluting. Cold water pumped from the deep ocean can also be used for aquaculture, as a direct cooling source for central chilled water air conditioning systems, and as a source of fresh water that is generated as a by-product in open OTEC cycles. Since the supply of the deep cold water and warm surface water is always available diurnally throughout the year, OTEC systems could provide a reliable source of power that could either serve as continuous duty, or even as a back-up or supplemental power generation power plants.

Because the thermal gradient between cold ocean water at 40°F and warm surface water at 80°F is relatively low, the overall thermodynamic efficiency of these systems is only on the order of 2 to 3 percent. A 5 MW power plant will need a cold water pipeline approximately 12 feet in diameter for a flow rate of around 160,000 gpm. The pipeline costs and parasitic pumping power losses for these systems are large and need to be accounted for in the design.

2.2.1.1 QUANTIFICATION OF RESOURCE:

Given the large magnitude of the ocean thermal gradient resource, the amount of power that can be generated from OTEC technology is significantly larger than the 50 MW of generating capacity required to support the load growth. However, the cost and economics for this resource will be impacted by the high cost for the construction of the cold water pipeline, the materials that need to be utilized for the heat exchangers and pumps in the power plant due to the corrosive sea water environment, and the cost for research and development of the system which has not yet been put into commercial production.

2.2.1.2 O&M

Since the technology has not been commercially developed, the cost for operation and maintenance of OTEC systems cannot be readily quantified. However, the power plant cycle will require full time

[1] NREL. Markets for OTEC. http://www.nrel.gov/otec/markets.html

24 hour staffed plant operators. Upkeep and annual maintenance and inspection of the cold water pipe line will be required. The heat exchangers, pumps, and other components exposed to seawater will also require annual cleaning of biofouling deposits and other maintenance. The power plant equipment, including the turbine, generator, switchgear, and other components will also require annual maintenance and repair.

2.2.1.3 CONSTRUCTION TIME/SCHEDULE

Due to the lack of commercial development, the timeline for the implementation of an OTEC plant is expected to be between 5 to 10 years at best. Oceanographic studies to determine the best location for the cold water intake and routing of the pipeline to the shoreline will take 2 to 3 years. An EIS will also be required for the pipeline, the disposal of the cold water influent, and for the power plant facility. Construction of the facility after the necessary studies and environmental assessment is completed will take another 3 to 5 years.

2.2.1.4 COST PER MW (CAPITAL) COST PER MW (PRODUCTION)

Based on very preliminary numbers, the cost for a 50 MW OTEC power plant is estimated at approximately $10,000-$15,000 per kW.[2] [3]A continuous duty 50 MW OTEC plant will generate approximately 394,000 MWh per year assuming 90 percent availability. Based on a design life of 20 years, the average cost per kWh not including O&M costs, and transmission/distribution costs is estimated at approximately 12 to 18 cents per kWh.

2.2.1.5 SITE (REQUIREMENTS LAND AREA)

The land area for a 50 MW OTEC power plant is estimated at approximately 2 acres, or approximately the same land area as for a conventional plant. However, the facility will also require an easement and shoreline access for the cold water pipeline and warm water intake and discharges. As an alternative, a sea-based off-shore OTEC platform could also be utilized in lieu of a land based facility. However, the rights for an ocean platform and the undersea electric cable that would need to be installed may prolong the time for a sea-based system to be placed on line.

2.2.1.6 QUALITY POWER/RELIABILITY

Since the OTEC power plant operates on the ocean thermal temperature differential which remains fairly constant independent of the time of day and season, the power plant should be able to operate as a continuous duty power generation facility.

2.2.1.7 BASE LOAD, PEAKING LOAD

Due to the large capital investment that would be required for an OTEC power plant, operation of the plant as a base loaded unit is recommended. However, the plant can be controlled to operate as a load following unit if needed. Operation of the OTEC system as a peaking unit is not recommended.

2.2.1.8 DESIGN LIFE

The design life of an OTEC power plant is anticipated to be between 20 to 30 years with proper operation and maintenance. The pipelines and electrical generation, distribution, and transmission equipment should have even longer lives.

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[2] Energy Unit, South Pacific Applied Geosciences Commission. "Ocean Thermal Energy Conversion and the Pacific Islands." March 2001.

[3] Guam Power Authority. A Technical and Economic Feasibility Assessment of a Deep Sea Water Cooling System at Tumon Bay, Guam. January 2006

2.2.1.9 ENVIRONMENTAL – EMISSION, WATER, REMEDIATION

OTEC systems will have very little environmental impact, other than the potential thermal pollution caused by the discharge of cold ocean water which is warmed, and the warm surface that is cooled, as they provide the heat sink and heat source for the cycle. The system may also require chlorination or other measures to prevent biofouling of equipment such as the heat exchangers and pumps.

2.2.1.10 WATER REQUIREMENTS

OTEC systems do not require potable or other sources of fresh water to operate. Fresh water may be generated as a by-product if an open cycle OTEC plant is utilized.

2.2.1.11 SPECIAL USES – AC FOR HOTELS, ETC.

Another potential use for the cold ocean water is to use it for cooling of central chilled water systems. This would be of tremendous benefit to Guam's hotel and resort areas, and to large Navy facilities that utilize central chilled water systems. The benefit of utilizing deep ocean water for cooling has a potential thermal efficiency of 30 per cent if it is used to displace cooling that would otherwise be cooled by electric chillers versus 2 to 3 percent if it is used to generate power through an OTEC cycle. However, the cost for the piping to the resort areas, and for large district cooling chilled water systems that would need to be provided on the military bases to take advantage of this technology will add to the cost and complexity of the systems.

2.2.1.12 STATE OF TECHNOLOGY

The only OTEC power plant in operation is a demonstration plant at NELHA in Kailua Kona, Hawaii. The Navy is currently developing an OTEC plant for Diego Garcia, and a new 1 MW production OTEC system is also being designed and installed at NELHA. GPA also contracted with Makai Engineering to conduct a feasibility study for the application of a Sea Water Air Conditioning system for Tumon Bay. It was found that SWAC is a technically feasible means of providing up to 16,000 tons of air conditioning to the Tumon Bay area and financially feasible for loads that exceed 8,100 tons. Energy usage could be reduced by 8.4 MW. [4]

2.2.1.13 SUMMARY VIABLE/NON-VIABLE TECH FOR ISLAND

Based on this analysis, while OTEC technology appears to be economically viable and feasible for Guam, it is too far out in terms of delivery schedule to be constructed in time to meet the planned expansion deadlines.

2.2.2 Wind Power Generation

Wind turbines for electrical generation are commercially available in sizes from 25 kW to 3,000 kW. Based on our review of the available wind studies for Guam, the best areas for wind development for the military include AAFB for the Air Force, which is located on the northeastern tip of the island, and the ridgeline at the Navy Munitions Site and Orote Peninsula on the Main Base (Figure 2-2) for the Navy that are located along the central portion of the island. While long-term historic wind data are not available for AAFB, data were gathered for the Guam Airport and the winds at these locations are estimated to average around 11 miles per hour (mph) at 50 meters above ground or a Class 2 rating. Based on current capital costs, the use of wind energy is generally considered to be marginally cost effective on sites that have at least a Class 3 wind speed rating with average wind speeds of approximately 15 mph. This is based on a wind speed rating scale that ranges from a Class

[4] Guam Power Authority. A Technical and Economic Feasibility Assessment of a Deep Sea Water Cooling System at Tumon Bay, Guam. January 2006

1 rating for the least favorable sites to a Class 7 rating for the most favorable sites. Since power varies with the cube of the wind speed, a 12 mph wind site will have only one-half the potential wind power output of a 15 mph wind speed site. However, since the electrical costs for Guam are much higher than the U.S. average costs, the 12 mph wind speeds may be adequate to make this wind development viable. This fact must also be weighed against Guam's construction cost which is also much higher than average U.S. construction costs.

Wind energy provides the benefit of being a renewable and sustainable energy source that is non-polluting. However, aesthetics and the large land area required for the siting of the wind turbines are major considerations. In additional, this energy source is intermittent depending on the actual wind speeds present at the site, and cannot be used as a reliable means of power generation to serve as a continuous duty, or even as a back-up source of power.

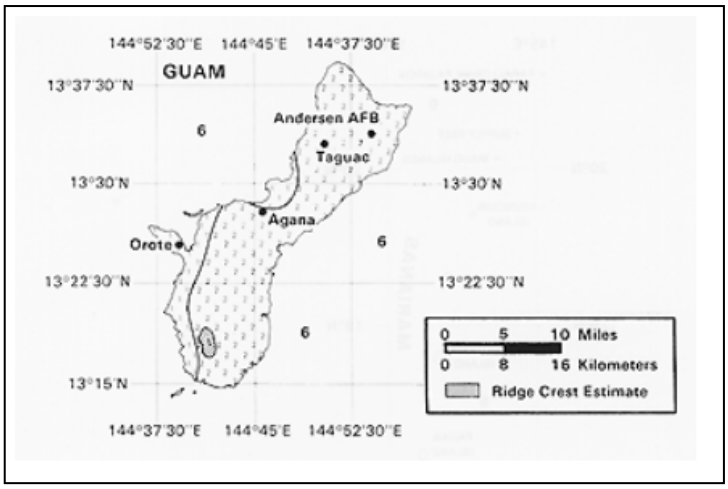

Figure 2-2: Average Wind Velocity

2.2.2.1 QUANTIFICATION OF WIND RESOURCE:

Average anticipated wind speeds around 11 mph on Guam appear to be less than ideal for wind energy development. Typical nominal 3 MW wind turbines designed for 15 mph winds will only generate 1.5 MW at 12 mph.[5] Approximately 30 to 40, 3 MW nominal wind turbines will thus be needed to generate 50 MW of electrical power. The previous studies for the development of wind power on Guam have identified approximately 16 MW of wind development potential for the Navy sites at the ridgeline at the Navy Munitions Site and Orote Peninsula. The potential yield for AAFB has yet to be quantified.

2.2.2.2 O&M

Based on data from wind turbine farms that are already in commercial development, the cost for operation and maintenance of wind power systems averages between 2 and 3 cents per kWh.[6] Full-time 24-hour staffed plant operators are not required for wind farms. However, upkeep and annual maintenance and inspection of the turbines, generators, inverters, switchgear, and other components will be required.

[5]General Electric. GE Wind Energy. gewindenergy.com

[6] U.S. Department of Energy Efficiency and Renewable Energy DOE 2007a

2.2.2.3 CONSTRUCTION TIME/SCHEDULE

Since wind turbines are readily available in the commercial market, the timeline for the implementation of a wind farm development is between 3 to 5 years, not accounting for interconnect to existing grid requirements. Wind studies to determine the best location for the wind farms will take 1 to 2 years. An EIS will also be required for each wind farm development. Construction of the facilities after the necessary studies and environmental assessment is completed will take another 1 to 2 years.

2.2.2.4 COST PER MW (CAPITAL) COST PER MW (PRODUCTION)

Based on previous wind farm developments, the cost for wind farm developments is estimated at approximately $3,000 per kW for ideal wind sites. Based on a capacity factor of 26[7] percent assumed in the previous wind studies for Guam, wind farm developments with a total capacity of 50 MW will generate approximately 45,900-61,200 MWh per year. Based on a design life of 20 years, the average cost per kWh not including O&M costs, and transmission/distribution costs is estimated at approximately 23 cents per kWh.

2.2.2.5 SITE (REQUIREMENTS LAND AREA)

The land area for a single 2.5 to 3.6 MW wind turbine with a 280 to 340 foot diameter rotor is approximately 2 acres. A 50 MW wind farm development with 30 to 40 turbines will require a land area of between 60 to 80 acres.

2.2.2.6 QUALITY POWER/RELIABILITY

Since the wind farm developments are totally reliant on the strength of the winds, power production is not very consistent and reliable. The power is typically converted and stored as direct current (DC), and then inverted to AC power to maintain 60 Hz power regardless of wind speed and load.

2.2.2.7 BASE LOAD, PEAKING LOAD

Due to the intermittent nature of wind power, it cannot be used for base loaded or peaking operation. However, it can provide a significant portion of the electricity that would otherwise need to be generated using fossil fuels.

2.2.2.8 DESIGN LIFE

The design life of wind turbines is anticipated to be between 20 and 30 years with proper operation and maintenance. The supporting electrical generation, distribution, and transmission equipment should have similar life spans. However, the life of the storage batteries is significantly lower and will need to be replaced every 2 to 3 years. Modern turbines are designed to generate power in winds up to 25 mph. Beyond this wind speed, they are designed to shut down but maintain their orientation to the prevailing winds to minimize potential wind load damage. In this configuration, they are able to withstand gusts up to 156 mph. Since 50-year typhoon 2-second interval wind gusts on Guam are predicted to exceed 170 mph, there is some potential for a severe typhoon to damage the wind turbines. Additional research and possible design enhancements are needed to mitigate the potential for wind damage.

[7] Global Energy Concepts. Preliminary Assessment of Wind Energy Development Potential for Guam Naval Facilities. October 2007

2.2.2.9 ENVIRONMENTAL – EMISSION, WATER, REMEDIATION

Wind power systems will have some environmental impact, including the potential noise from the turbines, aesthetic concerns on how the turbines may impact the surrounding landscape, potential harmful impact on flying birds and bats, and interference with radar and other electro magnetic frequency signals.

2.2.2.10 WATER REQUIREMENTS

Wind farms do not require potable or other sources of fresh water to operate.

2.2.2.11 SPECIAL USES – AC FOR HOTELS, ETC.

Not applicable.

2.2.2.12 STATE OF TECHNOLOGY

Wind turbine technology is in widespread use. There are over 74,000 MW of wind turbines that have already been installed and operating worldwide as of 2006. The most recent improvements have been in the turbine design to reduce noise and increase efficiency, and in the power generation and control of the system.

2.2.2.13 SUMMARY VIABLE/NON-VIABLE TECH FOR ISLAND

Based on this analysis, wind farm development appears to be economically viable and feasible for Guam, and a plant can be constructed in time to meet the planned expansion deadlines. However, wind energy cannot be used as a reliable source of power for base loaded or peak shaving operation and the implementation of a large wind farm will require considerable land area.

2.2.3 Solar Energy Generation

The majority of photovoltaic panels for electrical generation are commercially available in crystalline, poly-crystalline, and amorphous silicon panels. Typical systems are in the range of 2 kW for residential systems, and 50 kW or larger in commercial application. Inverters are used to convert the DC power output from the panels into AC power. Most of these systems are installed at the house or building level, and supply the power at 120V or 220V. Large land or large roof top areas are required for panel installation.

Based on the available solar insolation data for Guam made available by National Renewable Energy Laboratory, a majority of the U.S. military lands in Guam are in areas with an average of 5.08 kWh/m^2/day[8] (Figure 2-3), which makes the use of photovoltaics attractive. Additional radiation data was collected at the Guam International Airport providing an average of 5.03 kWh/ m^2/day. However, large land or large roof top areas are required for panel installation. As a rule of thumb, 1 kW of power output will require 100 square feet (ft^2) of roof area. A 5 MW system will thus require 500,000 ft^2 of area, and a 50 MW system will require 5,000,000 ft^2 of area.

Based on current capital costs, the use of photovoltaics (PV) will be marginally cost effective at current electrical rates, but the economics are improving, especially when tax credits and incentives are considered. While there are no known incentives from the GPA at this time. PV systems also have the benefit of being a renewable and sustainable energy source that is non-polluting. However, this energy source is available only during sunlight hours, and is also interm ittent depending on the

[8] Global Energy Concepts. Preliminary Assessment of Wind Energy Development Potential for Guam Naval Facilities. October 2007

weather. Consequently, PV cannot be used as a reliable means of power generation to serve as a continuous duty, or even as a back-up source of power.

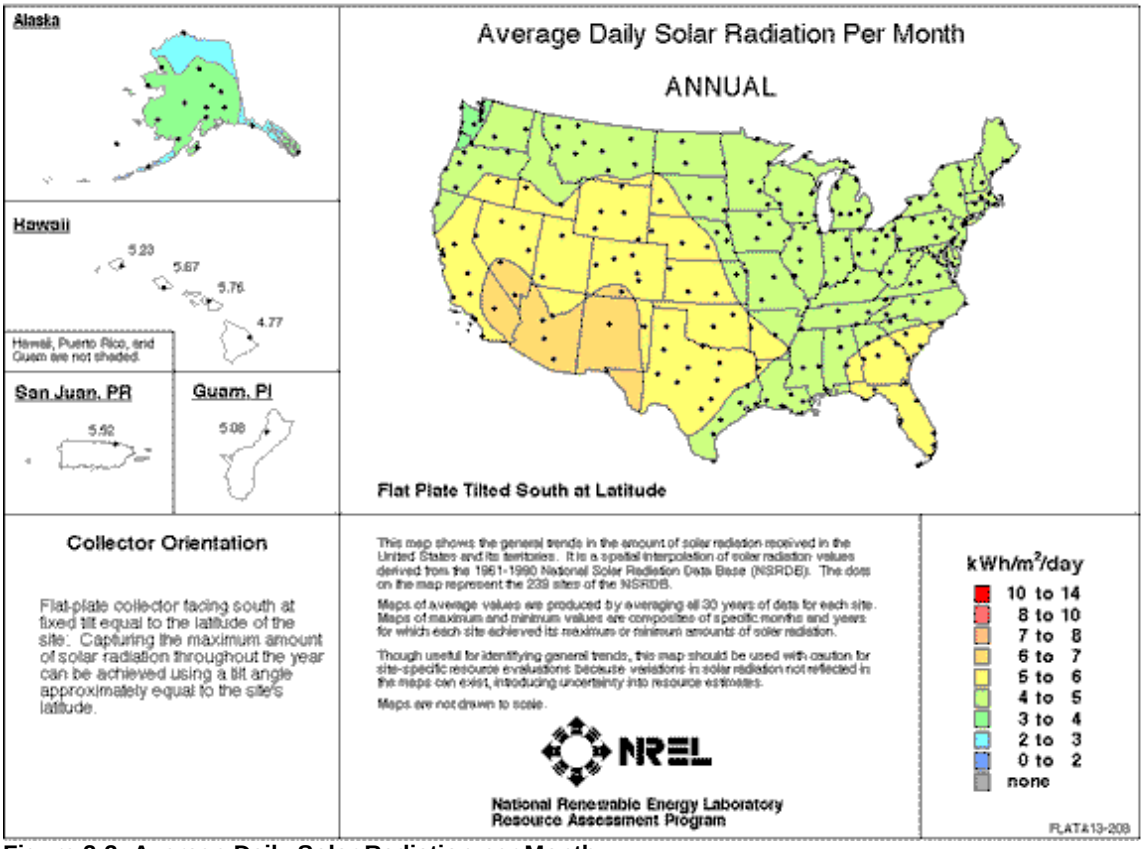

Figure 2-3: Average Daily Solar Radiation per Month

2.2.3.1 *Quantification of Solar Energy Resource*

Average solar insolation values for Guam are favorable for PV and other forms of solar energy development. Based on typical sizing of 1 kW per 100 ft^2, 5,000,000 ft^2 of roof area is required to support the development of a 50 MW system. The most practical means to achieve this level of PV development is to place smaller distributed systems on the roofs of the planned facilities. The preliminary facilities planning indicates that total roof area available is over 5,000, 000 ft^2. The area offers the potential to provide up to 50 MW of PV power generation capacity during peak sun periods.

2.2.3.2 *O&M*

PV systems are very passive and require very little active maintenance or system monitoring. The cost for operation and maintenance of PV systems is minimal and averages less than 1 cent per kWh for annual panel cleaning and maintenance checks of the inverter system and electrical system interface.

2.2.3.3 *Construction Time/Schedule*

Since PV systems are readily available in the commercial market, the timeline for the implementation of a PV power system is between 1 to 2 years. No additional studies or an EIS will be required. Construction of the PV systems can be phased to coincide with the development of the family housing units.

2.2.3.4 COST PER MW (CAPITAL) COST PER MW (PRODUCTION)

Based on previous PV installations, the cost for photovoltaic system development is estimated at approximately $8,000 per kW. Assuming an average of 5.03 kW h/m^2/day of solar insolation and a 15 percent efficiency[9], the PV development will generate approximately 76,000 MWh per year. Based on a design life of 20 years, the average cost per kWh not including O&M costs, and transmission/distribution costs is estimated at approximately 45 cents per kWh.

2.2.3.5 SITE (REQUIREMENTS LAND AREA)

The land area for PV is not required as long as they are located on the roofs of the new buildings that will be a part of the housing expansion on the island for the military.

2.2.3.6 QUALITY POWER/RELIABILITY

Since PV systems are totally reliant on the sun, they are only operational during the daytime hours and will be impacted by inclement weather. The power is typically converted and stored as DC current, and then inverted to AC power to maintain 60 Hz power.

2.2.3.7 BASE LOAD, PEAKING LOAD

Due to the intermittent nature of solar energy, it cannot be used for base loaded or peaking operation. However, it can provide a significant portion of the electricity that would otherwise need to be generated using fossil fuels.

2.2.3.8 DESIGN LIFE

The design life of PV systems is anticipated to be between 20 to 30 years with proper operation and maintenance. The supporting electrical generation, distribution, and transmission equipment should have similar life spans. Flat panel collectors with properly designed structural supports can withstand the high wind speeds from typhoons. However, they are still susceptible to impact damage unless they are protected by parapets or other devices to shield them from flying projectiles. Another solution would be to utilize amorphous silica panels that are direct mounted on the roofs of the buildings.

2.2.3.9 ENVIRONMENTAL – EMISSION, WATER, REMEDIATION

PV systems will have very little environmental impact. They should also have very little aesthetic concerns since the PV panels would be integrated into the roof forms of the buildings.

2.2.3.10 WATER REQUIREMENTS

PV systems do not require potable or other sources of fresh water to operate

2.2.3.11 SPECIAL USES – AC FOR HOTELS, ETC.

Not applicable

[9] Electric Power Research Institute. "Renewables: A Promising Coalition of Many" Journal EPRI, Summer 2007.

2.2.3.12 STATE OF TECHNOLOGY

PV technology is in widespread use. There are over 5,000 MW [10] of PV systems that have already been installed and operating over the past 20 years. The most recent improvements have been in the types of materials used for the PV panels that increase efficiency and reduce production and manufacturing costs, and in the power generation and control of the system.

2.2.3.13 SUMMARY VIABLE/NON-VIABLE TECH FOR ISLAND

Based on this analysis, PV systems, although more expensive than competing renewable technologies, appear to be economically viable and feasible for Guam. A significant number of distributed PV systems can be constructed in time to meet the planned expansion deadlines. While solar energy cannot be used as a reliable source of power for base loaded or peak shaving operation, it can displace a significant portion of the electrical load that would otherwise need to be generated using fossil fuels.

2.2.4 Biofuel (Biodiesel) Power Generation

Biofuels can utilize either simple or combined Brayton cycle combustion turbines that were originally developed for aircraft jet engine technology, or reciprocating gas or diesel engine technology. These turbines and engines principally use fossil fuel for power generation; however, they can also burn other fuels such as biofuels, ethanol, and hydrogen, if and when those fuels become available. Combustion turbines can operate on either ethanol or biodiesel. Gas engines can operate on ethanol, while diesel engines would be used to operate on biodiesel fuels. Air emissions from biofuel power plants will be lower than for power plants that utilize conventional fossils fuels. Improvements in air emission control technology such as low NO_x control burners will also help to further reduce NO_x emissions. Further reduction in air emissions is possible with the use of water or steam injection, or with the use of selective catalytic reduction (SCR) technology. However, these additional emission controls add a significant capital and operational maintenance costs.

Currently, there is no agricultural business on Guam that is developing crops for the biofuel market, and there are no producers of biofuel on the island. Currently, 20 percent of the land on Guam is used for agriculture, and another 15 percent used for pasture land. While there is some potential for further development, the implementation of biofuels on a sustainable basis is not realistic at this time. It thus appears that biofuels will need to be imported to the island if they are utilized within the immediate future.

2.2.4.1 QUANTIFICATION OF BIOFUEL ENERGY RESOURCE

Given the lack of biofuel production facilities on Guam, all of the fuel must be imported for the immediate future. Based on a 35 percent efficiency plant, a 50 MW power plant operating on biofuels will require a tank farm with approximately 500,000 gallons per month of storage capacity if it is operated as a base-loaded, continuous duty plant. The storage and handling requirements for this fuel will be similar to the requirements for conventional fuels discussed in the previous sections.

2.2.4.2 O&M

A continuous duty biofuel power plant will require full time 24 hour staffed plant operators. Upkeep and annual maintenance and inspection of the generating units and ancillary systems, including the emission control system, fuel system, switchgear, controls, and switchgear will also be required. If a

[10] Electric Power Research Institute. "Renewables: A Promising Coalition of Many" Journal EPRI, Summer 2007.

combined cycle system is utilized, than additional maintenance on the boilers, condenser water system, heat exchangers, pumps, and other components will also be required.

2.2.4.3 CONSTRUCTION TIME/SCHEDULE

Since biofuel power plants would utilize standard conventional generating equipment, the timeline for the implementation of a biofuel power plant is between 2 to 3 years. The EIS and air permits for biofuel power plant will require approximately 1 year. Construction of the facility after the necessary studies and environmental assessment is completed will take another 1 to 2 years.

2.2.4.4 COST PER MW (CAPITAL) COST PER MW (PRODUCTION)

The cost for a biofuel power facility is estimated at approximately $1,500 per kW for the use of simple cycle combustion turbines, or reciprocating gas or diesel engine generators. The cost for a combined cycle combustion turbine or reciprocating engine plant with heat recovery boilers and steam turbine generators is estimated at $2,500 per kW. Another $500 per kW will be needed for additional air emission control devices if the units are operated as base loaded or continuous duty units. A 50 MW system could produce up to approximately 394,000 MWh per year if it is operated as base-loaded generators assuming a 90 percent availability factor. Based on an design life of 20 years, the average cost per kWh not including O&M costs, and transmission/distribution costs is estimated at approximately 22 cents per kWh for simple cycle turbines and reciprocating gas or diesel engines, or 17 cents per kWh for combined cycle power systems assuming that the biofuels are purchased at the equivalent cost per therm as oil at $100 per barrel.

2.2.4.5 SITE (REQUIREMENTS LAND AREA)

The land area for a 50 MW biofuel power plant is estimated at approximately 2 to 3 acres, including the fuel storage tanks and electrical substation. Additional easements and shoreline access may also be required for condenser water intake and discharge piping if direct ocean cooling is allowed, and for the electrical transmission lines from the substation back to the gird.

2.2.4.6 QUALITY POWER/RELIABILITY

Biofuel power generation facilities can provide continuous, reliable power as long as the fuel supplies are adequate and can either operate continuously or intermittently to support the gird.

2.2.4.7 BASE LOAD, PEAKING LOAD

Biofuel power plants can operate as either base-loaded, load following, or peaking units. Combined cycle plants should be utilized for continuous base loaded duty due to their higher efficiency. However, additional heat recovery equipment, air emission controls, and additional maintenance will be required if a combined cycle plant is provided for continuous duty operation.

2.2.4.8 DESIGN LIFE

The design life of a biofuel power plant is anticipated to be between 20 to 30 years with proper operation and maintenance. The fuel storage system and electrical generation, distribution, and transmission equipment should have even lower lives.

2.2.4.9 ENVIRONMENTAL – EMISSION, WATER, REMEDIATION

Biofuel power plants will have a significant environmental impact, including noise and air emissions from the turbines or engines, and aesthetic concerns on how the plant may impact the surrounding landscape. In addition, a source of water for combined cycle operation will also need to be developed.

2.2.4.10 WATER REQUIREMENTS

Combined cycle systems will require water for condenser cooling. This will most likely require an on-site well for brackish water if it is available or the use of ocean water for direct cooling. The discharge of the condenser water can create some thermal pollution if it is discharged back into the ocean.

2.2.4.11 SPECIAL USES – AC FOR HOTELS, ETC.

Not applicable

2.2.4.12 STATE OF TECHNOLOGY

Biofuel power plants are commercially in production and are an adaptation of conventional power plants. Additional technology to adapt standard engines to operate more efficiently on biofuels is being developed, including development of better NO_x controls and burner technology that is tailored to these fuels.

2.2.4.13 SUMMARY VIABLE/NON-VIABLE TECH FOR ISLAND

Biofuel power plants are viable and readily available for implementation on Guam for use as reliable base loaded power units as well as intermittent peaking operation units. However, all of the biofuel supplies must be imported as Guam does not have the agricultural base to support the production of local biofuels at this time.

2.2.5 Waste-to-Energy (Biomass) Generation

Biomass power plants typically consist of steam power plants that burn bagasse from sugar processing or other agricultural by-products such as wood chips or hay. Since the biomass must be burned to generate steam, air emissions are a primary issue. Combustion air emission controls, and scrubbing of the waste exhaust air stream are normally required, which add to the complexity and operating costs for the system.

Similar to biofuels, there are no agricultural businesses on Guam that is developing crops for the biomass market. Currently, 20 percent of the land on Guam is used for agriculture, and another 15 percent used for pasture land. While there is some potential for further development, the implementation of biomass on a sustainable basis is not realistic at this time

2.2.5.1 QUANTIFICATION OF BIOMASS ENERGY RESOURCE

There is a lack of large scale biomass agriculture and biomass processing facilities on Guam. Due to the bulk and weight of biomass, it is not practical to import biomass for fuel into Guam. Based on current land use, the 15 percent of pasture land can be used for some biomass crop development. Approximately 80,000 – 230,000 acres will be needed for a 50 MW power plant to sustain its use.[11] This would require significantly more land area than the amount currently in use for agricultural and pasture land. Since it is not practical to develop agricultural biomass crops on military lands, and biomass facility would have to be developed in conjunction with the public or private sectors.

2.2.5.2 O&M

A continuous duty biomass power plant will require full time 24 hour staffed plant operators. Upkeep and annual maintenance and inspection of the boilers, condenser water system, heat

[11] State Energy Conservation Office. Energy Crops for Fuel. http://www.seco.cpa.state.tx.us/re_biomass-crops.htm

exchangers, pumps, generating units, and ancillary systems, including the emission control system, fuel system, switchgear, controls, and switchgear will also be required.

2.2.5.3 CONSTRUCTION TIME/SCHEDULE

Since biomass power plants would utilize standard conventional generating equipment, the timeline for the implementation of a biomass power plant is between 2 to 3 years. The EIS and air permits for a biomass power plant will require approximately 1 year. Construction of the facility after the necessary studies and environmental assessment is completed will take another 1 to 2 years. The main concern on the construction of a biomass facility is the time it would take to develop sustainable levels of biomass crops.

2.2.5.4 COST PER MW (CAPITAL) COST PER MW (PRODUCTION)

The cost for a biomass power facility is estimated at approximately $3,000–$5,000 per kW.[12] Another $500 per kW will be needed for additional air emission control devices if the units are operated as base loaded or continuous duty units. A 50 MW system could produce up to 394,000 MWh per year if it is operated as base-loaded generators assuming a 90 percent availability factor. Based on an design life of 20 years, the average cost per kWh not including O&M costs, and transmission/distribution costs is estimated at approximately 25 cents per kWh for simple cycle turbines and reciprocating gas or diesel engines, or 19 cents per kWh for combined cycle power systems assuming that the biomass is purchased at the equivalent cost per therm as oil at $100 per barrel.

2.2.5.5 SITE (REQUIREMENTS LAND AREA)

The land area for a 50 MW biomass power plant is estimated at approximately 2 to 3 acres, including the biomass processing area and electrical substation. Additional easements and shoreline access may also be required for condenser water intake and discharge piping, and for the electrical transmission lines from the substation back to the gird

2.2.5.6 QUALITY POWER/RELIABILITY

Biomass power generation facilities can provide continuous, reliable power as long as the fuel supplies are adequate and can either operate continuously or intermittently to support the gird. Base Load, Peaking Load

Biomass power plants can operate as either base-loaded, load following, or peaking units. Base loaded plants should be designed with additional heat recovery to boost their efficiency. However, additional heat recovery equipment, air emission controls, and additional maintenance will be required for continuous duty operation.

2.2.5.7 DESIGN LIFE

The design life of a biofuel power plant is anticipated to be between 20 to 30 years with proper operation and maintenance. The fuel storage system and electrical generation, distribution, and transmission equipment should have even longer lives.

2.2.5.8 ENVIRONMENTAL – EMISSION, WATER, REMEDIATION

Biomass power plants will have a significant environmental impact, including noise and air emissions from the boilers and turbines, and aesthetic concerns on how the plant may impact the

[12] IEA Energy Technology Essentials http://www.iea.org/Textbase/techno/essentials.ntm

surrounding landscape. In addition, a source of water for the turbine condenser will also need to be developed.

2.2.5.9 WATER REQUIREMENTS

A biomass power plant will require water for condenser cooling. This will most likely require an on-site well for brackish water if it is available or the use of ocean water for direct cooling. The discharge of the condenser water can create some thermal pollution if it is discharged back into the ocean. One possible solution would be to use on-site injection wells to discharge the effluent.

2.2.5.10 SPECIAL USES – AC FOR HOTELS, ETC.

Not applicable

2.2.5.11 STATE OF TECHNOLOGY

Biomass power plants are commercially in production and are an adaptation of conventional power plants. Additional technology to operate boilers more efficiently on biofuels is being developed, including development of better NO_x controls and burner technology that is tailored to these fuels. Additional air emission control technology will also be required to support the operation of biomass plants.

2.2.5.12 SUMMARY VIABLE/NON-VIABLE TECH FOR ISLAND

Biomass power plants are viable and readily available for implementation on Guam for use as reliable base loaded power units as well as intermittent peaking operation units. However, Guam does not have the agricultural base to support the production of biomass at this time. The development of sustainable supplies of biomass crops is needed to support the implementation of this technology, and will require the development of additional lands in the public or private sector outside of the military.

2.2.6 Fuel Cell Power Generation

Fuel cells operate on the chemical reaction between hydrogen and oxygen which produces electricity, and water as a by-product. Although there are a few installations in operation, it is still in commercial development. While the technology is also non-polluting, it relies on hydrogen as its fuel source.

Hydrogen is not commercially available as a fuel source, and the extraction of hydrogen from water and/or the reduction of gas or other fuels into hydrogen currently still require additional equipment in the process. Natural gas is often utilized as a fuel stock for the fuel cells. However, Guam lacks natural gas resources, so the natural gas must be imported if it is utilized. Because this technology is not commercially available, and because sustainable sources for the production of hydrogen fuel have not yet been developed, the use of fuel cell generators is not recommended at this time. Since natural gas or propane must currently be used to operate the fuel cells, this technology is not considered a renewable and an alternate energy technology and is not evaluated in further detail at this time.

2.2.6.1 FUEL DELIVERY STORAGE

Not applicable

2.2.6.2 O&M

Not applicable

2.2.6.3 CONSTRUCTION TIME/SCHEDULE

Not applicable

2.2.6.4 COST PER MW (CAPITAL) COST PER MW (PRODUCTION)

Not applicable

2.2.6.5 SITE (REQUIREMENTS LAND AREA)

Not applicable

2.2.6.6 QUALITY POWER/RELIABILITY

Not applicable

2.2.6.7 BASE LOAD, PEAKING LOAD

Not applicable

2.2.6.8 DESIGN LIFE

Not applicable

2.2.6.9 ENVIRONMENTAL – EMISSION, WATER, REMEDIATION

Not applicable

2.2.6.10 WATER REQUIREMENTS

Not applicable

2.2.6.11 SPECIAL USES – AC FOR HOTELS, ETC.

Not applicable

2.2.6.12 STATE OF TECHNOLOGY

Not applicable

2.2.6.13 SUMMARY VIABLE/NON-VIABLE TECH FOR ISLAND

Not applicable

2.2.7 Waste-to-Energy Conversion/Generation

Waste-to-energy power plants have conventionally been steam power plants that sort and burn solid wastes. Since the wastes are normally burned to generate steam, air emissions are a primary issue. Combustion air emission controls, and scrubbing of the waste exhaust air stream are normally required, which add to the complexity and operating costs for the system.

Alternative technologies to conventional waste-to-energy steam power plants include gasification, smelting, and plasma-arc technologies. However, none of these competing technologies are available yet in the commercial market.

Based on rule of thumb estimates, the population on Guam can support a 10 to 20 MW waste-to-energy power plant. Since the military will comprises approximately 30 percent of the island's population after the relocation, a waste energy plant sized only for the military would be between 5 to 10 MW.

2.2.7.1 QUANTIFICATION OF WASTE ENERGY RESOURCE

Based on the military's resident population on Guam and the projected load growth, the total waste stream available for a waste-to-energy power plant is approximately 10 to 20 MW. A waste storage and processing center for this waste stream will also be needed to support this facility.

2.2.7.2 O&M

A continuous duty waste-to-energy power plant will require full time 24 hour staffed plant operators. The sorting and processing of the waste stream will require a full time crew. Upkeep and annual maintenance and inspection of the waste processing equipment, boilers, condenser water system, heat exchangers, pumps, generating units and ancillary systems, including the emission control system, fuel system, switchgear, controls, and switchgear will also be required.

2.2.7.3 CONSTRUCTION TIME/SCHEDULE

Since the waste-to-energy power plant would utilize standard conventional generating equipment, the timeline for the implementation of waste-to-energy power plant is between 3 to 5 years. The EIS and air permits for a waste-to-energy power plant, and to develop a waste stream collection and sorting plan will require approximately 2 years. Construction of the facility after the necessary studies and environmental assessment is completed will take another 2 to 3 years.

2.2.7.4 COST PER MW (CAPITAL) COST PER MW (PRODUCTION)

The cost for a waste-to-energy power facility is estimated at approximately $3,000 per kW. Another $500 per kW will be needed for additional air emission control devices if the units are operated as base loaded or continuous duty units. A 10 to 20 MW system could produce up to approximately 79,000 to 158,000 MWh per year if it is operated as base-loaded generators assuming a 90 percent availability factor. Based on a design life of 20 years, the average cost per kWh not including O&M costs, and transmission/distribution costs is estimated at approximately 22 cents per kWh assuming that the tipping fees are credited to the facility at $20 per ton, and that disposal and landfill costs are ignored.

2.2.7.5 SITE (REQUIREMENTS LAND AREA)

The land area for a 10 to 20 MW biomass power plant is estimated at approximately 4 acres, including the waste processing and sorting area and electrical substation. Additional easements and shoreline access may also be required for condenser water intake and discharge piping, and for the electrical transmission lines from the substation back to the grid.

2.2.7.6 QUALITY POWER/RELIABILITY

Waste-to-energy power generation facilities can provide continuous, reliable power as long as the fuel supplies are adequate and can either operate continuously or intermittently to support the gird.

2.2.7.7 BASE LOAD, PEAKING LOAD

Waste-to-energy power plants are normally operated as base-loaded units to maximize the return on the initial higher cost for the equipment. This will normally also require the plant to be designed with additional heat recovery to boost their efficiency, and air emission controls, and additional maintenance for continuous duty operation.

2.2.7.8 DESIGN LIFE

The design life of a waste-to-energy power plant is anticipated to be between 20 to 30 years with proper operation and maintenance. The electrical generation, distribution, and transmission

equipment should have even lower lives. However, the processing and sorting equipment will typically need to be replaced more frequently.

2.2.7.9 ENVIRONMENTAL – EMISSION, WATER, REMEDIATION

Waste-to-energy power plants will have a significant environmental impact, including the processing and treatment of the waste and sludge disposal, noise and air emissions from the boilers and turbines, and aesthetic concerns on how the plant may impact the surrounding landscape. In addition, a source of water for the turbine condenser will also need to be developed.

2.2.7.10 WATER REQUIREMENTS

A waste-to-energy power plant will require water for condenser cooling. This will most likely require an on-site well for brackish water if it is available or the use of ocean water for direct cooling. The discharge of the condenser water can create some thermal pollution if it is discharged back into the ocean. One possible solution would be to use on-site injection wells to discharge the effluent.

2.2.7.11 SPECIAL USES – AC FOR HOTELS, ETC.

Not applicable

2.2.7.12 STATE OF TECHNOLOGY

Pre-engineering waste-to-energy or custom designed waste-to-energy power plants are commercially available and utilize of conventional power plant technology. Additional technology to operate boilers more efficiently and to lower emissions is being developed. Additional air emission control technology will also be required to support the operation of waste-to-energy plants. Competing technologies including gasification, smelting, and plasma-arc technologies are currently under development but are not in commercial production at this time.

2.2.7.13 SUMMARY VIABLE/NON-VIABLE TECH FOR ISLAND

Waste-to-energy power plants are suitable as base loaded power units. This technology may be viable if Guam were to change existing restrictions to incineration.

2.2.8 Geothermal Power Generation

Guam is situated several miles east of the southern projection of historically active line of volcanoes that comprise the Mariana volcanic arc (Figure 2-4). The area is still subject to volcanic activity, with the nearest known active volcanism being an underwater eruption that occurred 100 miles north just south of Saipan. Since the Marianas island chain is at the edge of the subduction zone between the Philippine and Pacific plates, Guam is subject to frequent earthquakes and tectonic plate movements that make the island a likely candidate for subterranean volcanic activity and possible geothermal development.

However, there are no known detailed studies or assessment of the geothermal potential for Guam other than a report from the Colorado School of Mines published in 1975 that provided a general overview of the potential for geothermal energy in the pacific region. Additional geological studies and drilling is needed to quantify and determine the extent of the potential for geothermal development on Guam.

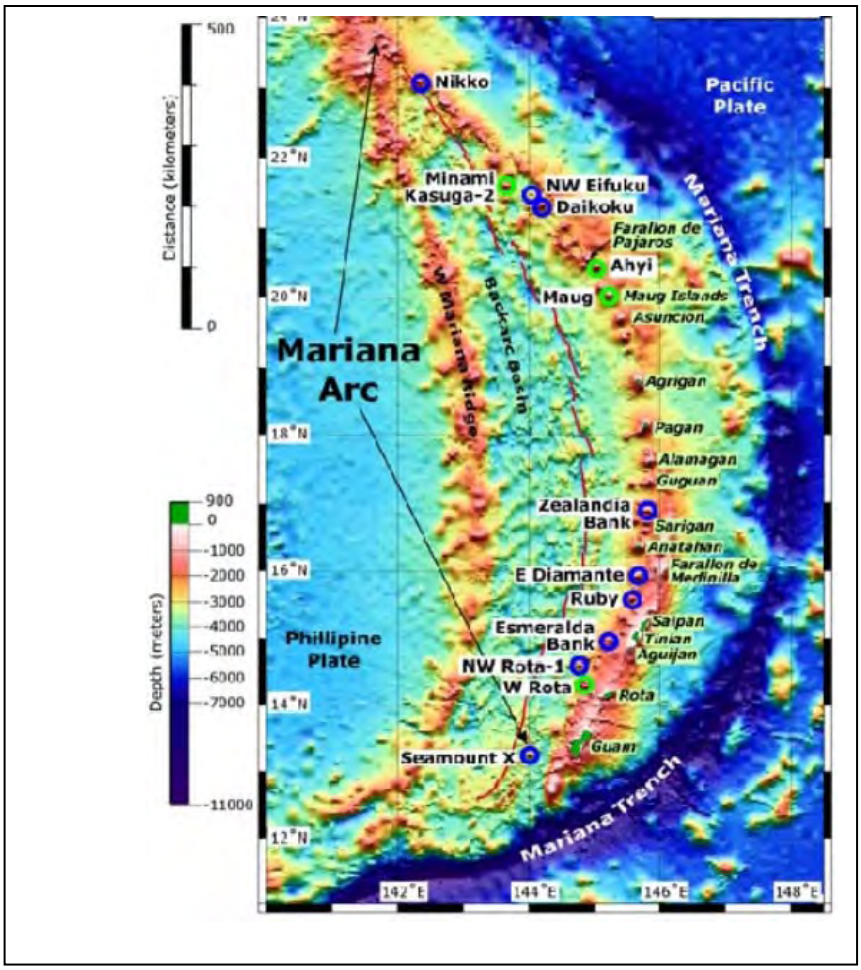

Figure 2-4: Mariana Arc

2.2.8.1 QUANTIFICATION OF GEOTHERMAL ENERGY RESOURCE

It is difficult to quantify the potential yield for geothermal energy without further studies and geological exploration for this resource. However, if there are active geothermal heat sources within the area, a geothermal power plant in the range of 30 to 50 MW should be feasible as long as an adequate number and size of geothermal wells are provided for sustained operation.

2.2.8.2 O&M

A geothermal power plant will require full time 24 hour manned plant operators. Upkeep and annual maintenance and inspection of the wells heat exchangers, condenser water system, pumps, generating units, and ancillary systems, including the emission control system, fuel system, switchgear, controls, and switchgear will also be required.

2.2.8.3 CONSTRUCTION TIME/SCHEDULE

Due to the lack of geological research, the time line for the implementation of a geothermal power plant is between 4 to 6 years. Geology and drilling studies to characterize the potential for geothermal energy and to determine the best location for drilling to support this resource will take 2 to 3 years. An EIS will also be required for the geothermal wells and venting issues, and for the power plant facility. Construction of the facility after the necessary studies and environmental assessment is completed will take another 2 to 3 years.

2.2.8.4 COST PER MW (CAPITAL) COST PER MW (PRODUCTION)

The cost for a geothermal power facility is estimated at approximately $2,000 per kW, plus the cost to develop the geothermal well resource. A 30 to 50 MW system could produce up to approximately 237,000 MWh to 394, 000 MWh per year when operated as base-loaded generators assuming 90 percent availability. Based on a design life of 20 years, the average cost per kWh not including O&M costs, and transmission/distribution costs is estimated at approximately 3 cents per kWh.

2.2.8.5 SITE (REQUIREMENTS LAND AREA)

The land area for a 30 to 50 MW geothermal power plant is estimated at approximately 2 to 3 acres, including the well, power plant, and electrical substation. Additional easements and shoreline access may also be required for condenser water intake and discharge piping, and for the electrical transmission lines from the substation back to the gird

2.2.8.6 QUALITY POWER/RELIABILITY

Geothermal power generation facilities can provide continuous, reliable power as long as the wells sustain their projected yields and can either operate continuously or intermittently to support the gird.

2.2.8.7 BASE LOAD, PEAKING LOAD

Geothermal energy power plants are normally operated as base-loaded units to maximize the return on the initial higher cost for the equipment. The use of geothermal power for peaking duty is not recommended.

2.2.8.8 DESIGN LIFE

The design life of a geothermal energy power plant is anticipated to be between 20 to 30 years with proper operation and maintenance. The source wells, electrical generation, distribution, and transmission equipment should have even longer lives.

2.2.8.9 ENVIRONMENTAL – EMISSION, WATER, REMEDIATION

Geothermal power plants will have a significant environmental impact, including the drilling for geothermal energy, disposal of the effluent, venting of gases from the well, noise and air emissions from the turbines, and aesthetic concerns on how the plant may impact the surrounding landscape. In addition, a source of water for the turbine condenser will also need to be developed.

2.2.8.10 WATER REQUIREMENTS

A geothermal power plant will require water for condenser cooling. This will most likely require an on-site well for brackish water if it is available or the use of ocean water for direct cooling. The discharge of the condenser water can create some thermal pollution if it is discharged back into the ocean. One possible solution would be to use on-site injection wells to discharge the effluent.

2.2.8.11 SPECIAL USES – AC FOR HOTELS, ETC.

Not applicable

2.2.8.12 STATE OF TECHNOLOGY

Geothermal power plants are in widespread use throughout the world in areas with active geothermal resources and are an adaptation of conventional power plants. The technology to utilize geothermal energy is time tested and widely available. The Big Island of Hawaii currently has a 30 MW geothermal power plant that has been in operation for the past 15 years and has recently expanded in production from 30 to 50 MW.

2.2.8.13 SUMMARY VIABLE/NON-VIABLE TECH FOR ISLAND

Geothermal power systems are proven and time tested. However, the potential yield for a geothermal system in Guam requires additional geological survey and exploration to quantify the potential for this resource.

2.2.9 Solar Thermal Electric

Solar thermal electric systems utilize large collecting mirror arrays to concentrate or focus solar radiation to heat water or to generate steam for heating or to drive a power plant. Most of these systems are not yet available commercially, but the projected implementation costs for these technologies show promise in significantly reducing costs over photovoltaic systems. Solar Thermal Electric systems are ideal for high solar intensity insolation areas with clear near cloudless skies. Based on the solar insolation data, a majority of the U.S. military lands in Guam are in areas with an average of 5.03 kWh/m ^{2}/day, which makes the use of solar thermal electric systems, in addition to photovoltaics, marginally attractive. These systems do have the benefit of being a renewable and sustainable energy source that is non-polluting. However, these systems will only operate during sunlight hours and are intermittent depending on the weather.

Large land areas are required for the collecting mirror array installation. A 10 MW system will require approximately 60 acres of land area. Solar thermal systems cannot be used as a reliable means of power generation to serve as a continuous duty, or even as a back-up source of power without the use of supplemental fuel-fired burners to generate steam when solar energy is unavailable. However, they can provide supplemental energy to the grid to reduce the overall energy use.

2.2.9.1 QUANTIFICATION OF SOLAR ENERGY RESOURCE

Based on the available solar insolation data, a majority of the U.S. military lands in Guam are in areas with an average of 5.03 kWh/m^2/day, which makes the use of solar thermal electric systems viable. These systems can be scaled to fit within the available space. While power generation from solar energy appears feasible, it is limited in that the energy is only available during daytime hours and is affected by weather.

2.2.9.2 O&M

Solar thermal electric systems are fairly passive, but do require active monitoring and maintenance since the steam produced from the solar concentrations is used to drive an active steam turbine and require very little active maintenance or system monitoring. Upkeep and annual maintenance and inspection of the collector arrays, steam concentrator, turbine, condenser water system, pumps, controls, and switchgear will also be required.

2.2.9.3 CONSTRUCTION TIME/SCHEDULE

The timeline for the implementation of a solar thermal electric plant is between 2 to 3 years. Approximately 1 year will be needed to prepare an EIS for the collection system, power plant facility, and water use. Construction of the facility after the necessary studies and environmental assessment is completed will take another 1 to 2 years.

2.2.9.4 COST PER MW (CAPITAL) COST PER MW (PRODUCTION)

Based on previous installations, the cost for solar thermal electric system development is estimated at approximately $5000 per kW. Assuming an average of 5.03 kWh/m^2/day of solar insolation and a 15

percent efficiency[13], the PV development will generate approximately 76,000 MWh per year. Based on a design life of 20 years, the average cost per kWh not including O&M costs, and transmission/distribution costs is estimated at approximately 31 cents per kWh.

2.2.9.5 SITE (REQUIREMENTS LAND AREA)

Based on rule of thumb guidelines, a 50 MW power plant will require approximately 300 acres in land area. This includes the space requirements for the collectors, steam power plant, and substation.

2.2.9.6 QUALITY POWER/RELIABILITY

Since solar thermal electric systems are totally reliant on the sun, they are only operational during the daytime hours and will be impacted by inclement weather. The power output from the turbine will thus vary throughout the day depending on the actual weather conditions.

2.2.9.7 BASE LOAD, PEAKING LOAD

Due to the intermittent nature of solar energy, it cannot be used for base loaded or peaking operation. However, it can provide a significant portion of the electricity that would otherwise need to be generated using fossil fuels.

2.2.9.8 DESIGN LIFE

The design life of solar thermal electric systems is anticipated to be between 20 to 30 years with proper operation and maintenance. The supporting electrical generation, distribution, and transmission equipment should have similar life spans.

2.2.9.9 ENVIRONMENTAL – EMISSION, WATER, REMEDIATION

Solar thermal electric systems will have some environmental impact. Aesthetic concerns could be raised since the collectors would be highly visible. In addition, a source of water for the turbine condenser will also need to be developed.

2.2.9.10 WATER REQUIREMENTS

The solar thermal electric power plant will require water for condenser cooling. This will most likely require an on-site well for brackish water if it is available or the use of ocean water for direct cooling. The discharge of the condenser water can create some thermal pollution if it is discharged back into the ocean.

2.2.9.11 SPECIAL USES – AC FOR HOTELS, ETC.

Not applicable

2.2.9.12 STATE OF TECHNOLOGY

The use of solar thermal electric is gaining in popularity since it has the potential for significantly lower construction costs over PV technology. The most recent improvements have been in the design of the collectors, the steam power plant equipment selection, and in the control of the system. Hawaii Electric Light Company on the Big Island of Hawaii is commissioning a solar thermal electric system under contract to Sopogy. Sopogy is also proposing a similar solar thermal electric system to

[13] Electric Power Research Institute. "Renewables: A Promising Coalition of Many" Journal EPRI, Summer 2007.

the GPA. Pacific Gas and Electric has contracted with Solel to buy power from a 553 MW solar thermal electric plant that will cover 9 square miles in the Mojave Desert.

2.2.9.13 SUMMARY VIABLE/NON-VIABLE TECH FOR ISLAND

Based on this analysis, solar thermal electric systems appear to be economically viable and feasible for Guam. In addition, the technology has developed enough so that it can be integrated in time to support the planned expansion. While solar energy cannot be used as a reliable source of power for base loaded or peak shaving operation, it can displace a significant portion of the electrical load that would otherwise need to be generated using fossil fuels.

2.2.10 Wave Energy Generation

Wave energy generators take advantage of the energy carried in the waves that flow across the coastline to exact energy primarily using mechanical action generators. There are no wave energy generators that are commercially available, however, there is wave energy demonstration project sponsored by the Department of Defense that is being constructed offshore of Marine Corps Base Hawaii. While wave energy generators are non-polluting and renewable, the amount of power extracted from these units will be intermittent and dependent on the strength of the ocean waves. These units cannot be used to provide a reliable means of power for continuous duty, peak shaving, or for emergency power.

2.2.10.1 QUANTIFICATION OF WAVE ENERGY RESOURCE

Information on the average wave energy yields along the coastal areas on Guam is not readily available. However, typical wave energy yields in similar areas such as Hawaii are in the range of 4.6 kW per lf[14]. Typical wave generator designs are in the 1 to 1.5 MW per unit range. The number of wave energy generators can be scaled up to provide the target of 50 MW of electrical power.

2.2.10.2 O&M

Since the technology has not been commercially developed, the cost for operation and maintenance of wave generator systems cannot be readily quantified. However, the equipment does not require full time 24 hour manned plant operators. Mechanical pumps, housings, controls, and other components exposed to seawater will also require annual cleaning of biofouling deposits and corrosion, and other maintenance. The power plant equipment, including the generator, switchgear, and other components will also require annual maintenance and repair.

2.2.10.3 CONSTRUCTION TIME/SCHEDULE

Due to the lack of commercial development, the timeline for the implementation of an wave generators is between 3 to 5 years. Wave energy studies to determine the best location for the generating units will take 2 to 3 years. An EIS will also be required for the impact of the generators on coastal wave action and the shoreline, and for the power plant facility. Construction of the facility after the necessary studies and environmental assessment is completed will take another 1 to 2 years.

2.2.10.4 COST PER MW (CAPITAL) COST PER MW (PRODUCTION)

Based on very preliminary numbers, the cost for a 50 MW wave energy farm is estimated at approximately $3,000 to $4,000 per kW. Assuming that the wave generators will operate at design output 40 percent of the time, they will generate approximately 175,200,000 kWh per year. Based on

[14] U.S. Department of the Interior. Wave Energy Potential on the U.S. Outer Continental Shelf. http://ocsenergy.anl.gov

a design life of 20 years, the average cost per kWh not including O&M costs, and transmission/distribution costs can range from 8 to 10 cents per kWh depending on the amount of wave energy available.

2.2.10.5 SITE (REQUIREMENTS LAND AREA)

Most of the wave generation equipment will most likely be placed out in the ocean. However, a shore facility with a substation to intercept and distribute the power will be required. The land area for this facility is estimated at approximately 1 acre.

2.2.10.6 QUALITY POWER/RELIABILITY

Since the wave farm development is totally reliant on the strength of the waves, power production is not very consistent and reliable. The power is typically converted and stored as DC current, and then inverted to AC power to maintain 60 Hz power regardless of wave speed and load.

2.2.10.7 BASE LOAD, PEAKING LOAD

Due to the intermittent nature of the wave energy, it cannot be used for base loaded or peaking operation. However, it can provide a significant portion of the electricity that would otherwise need to be generated using fossil fuels.

2.2.10.8 DESIGN LIFE

The design life of wave generators is anticipated to be between 20 to 30 years with proper operation and maintenance. The supporting electrical generation, distribution, and transmission equipment should have similar life spans. However, the life of the storage batteries is significantly lower and will need to be replaced every 2 to 3 years.

2.2.10.9 ENVIRONMENTAL – EMISSION, WATER, REMEDIATION

Wave energy systems will have some impact on the ocean environment and shoreline, and on aesthetic concerns on how the turbines may impact the surrounding seascape.

2.2.10.10 WATER REQUIREMENTS

Wave generators do not require potable or other sources of fresh water to operate.

2.2.10.11 SPECIAL USES – AC FOR HOTELS, ETC.

Not applicable

2.2.10.12 STATE OF TECHNOLOGY

Wave energy generators are still in the developmental stage. There are numerous competing designs, none that have been issued for production. The Navy is testing a 1 MW output unit at Marine Corps Base Hawaii.

2.2.10.13 SUMMARY VIABLE/NON-VIABLE TECH FOR ISLAND

Based on this analysis, wave energy systems appear to be economically viable and feasible for Guam. However, the technology has not developed enough so that it can be integrated in time to support the planned expansion. While wave energy cannot be used as a reliable source of power for base loaded or peak shaving operation, it can displace a significant portion of the electrical load that would otherwise need to be generated using fossil fuels.

2.2.11 Description of GPA Present and Future Alt. Energy Projects Summary – Viable/Non-Viable for GUAM

2.2.12 Summary and Recommendations for Alternative Energy Development on Guam

Based on this analysis, a summary of the alternative energy technologies for Guam are summarized in Table 2-3.

This assessment would suggest that alternate energy resources have the potential to generate a significant portion of the military's electrical energy consumption of Guam which currently averages 330,000 MWh per year. Energy use by the military will also increase significantly due to the planned expansion. The most viable alternative energy technologies that should be considered to supplement the power generated from conventional power plants are the following:

- OTEC has the potential to provide a continuous, reliable source of electrical power. However, the time frame for its development is 5 to 10 years out.
- Wind energy development should be explored, provided that the military has the satisfactory land area to accommodate the wind farm developments.
- Biofuel
- Installation of distributed photovoltaics should be considered to supplement the power drawn from the grid, possibly through third party power contracts.
- The installation of a solar thermal electric system using a third party power producer should be considered. However, the land area required for a solar thermal system will be significantly greater than for the other technologies.
- Geothermal (potentially viable)

A combination of the implementation of several renewable technologies, for example, some wind and distributed solar energy development for the near term, supplemented by OTEC and solar thermal electric in the future, could be considered a viable option for the military's energy strategy on Guam.

Table 2-3: Summary Assessment of Alternative Energy Technologies for Guam

Alternative Energy Technology	Mode of Operation	Size (MW per unit)	Capital Cost Per kW	Area Required for 50 MW Power Plant	Cost for 50 MW Power Plant (If applicable)	Annual MWh Output for 50 MW Plant	Approximate Cost per kWh	Commercially Available Technology	Site Specific	Renewable	Construction Time Frame	Life Expectancy
OTEC	Base load	10 to 100	$10,000 to $15,000	2 to 3 acres	$500 Mil to $750 Mil	394,200	$0.12 to $0.18	NO	YES - On Coastline	YES	5–10 years	25 years
Wind Energy	As Available 12.5 mph average	0.6 to 3 (wind turbine) 10 (Farm typ.)	$3,000	60 to 80 acres	$150 Mil	113,880	$0.14 to $0.15	YES	YES - Min. Class 3–4 site	YES	2–3 years	25 years
Photovoltaics	As Available 5.03[a] kWh/m^2/day	0.004 to 0.050	$8,000	5,000,000 ft^2	$400 Mil	76,000[b]	$0.45	YES	YES Rooftops	YES	1–2 years	25 years
Simple Cycle Biofuel Plant	Peaking or Base Load	10 to 20	$1,500	2 to 3 acres	$75 Mil	394,000	$0.17 to $0.22	YES	NO	YES, but no biofuels on island	2–3 years	25 years
Combined Cycle Biofuel Plant	Peaking or Base Load	10 to 20	$2,500	2 to 3 acres	$150 Mil	394,000	$0.17 to $0.22	YES	NO	YES, but no biofuels on island	2–3 years	25 years
Biomass Plant	Base Load	10 to 20	$1,000	80,000 to 230,000	$150 Mil to $275 Mil	394,000	$0.19 to $0.25	YES	NO	YES, but no biomass on island	2–3 years	25 years
Fuel Cells	Base Load	0.1 to 0.25	$8,000	Not Recommended	Not Recommended	Not Recommended	$0.08 to $0.12	NO	NO	Depends on fuel source	na	25 years
Waste to Energy Plant	Base Load	10 to 20	$1,000	4 acres	$175 Mil	394,000	$0.19 to $0.22	YES	NO	NO	2–3 years	25 years
Geothermal	Base Load	10 to 20	$1,000	2 to 3 acres	$100 Mil	394,000	$0.02	YES	YES	YES	3–5 years	25 years
Solar Thermal Electric	As Available 5.03[a] kWh/m^2/day	1.2 to 200	$5,000	300 acres	$250 Mil	76,000[b]	$0.31	YES	YES	YES	2–3 years	25 years
Wave Energy	As Available	1	$5,000	1 acre	$150 Mil to $250 Mil	175,200	$0.08 to $0.11	NO	YES - On Coastline	YES	3–5 years	25 years

Mil million
na not applicable
[a] Based on actual radiation data taken at Guam International Airport
[b] The analysis was conducted using PV Solar Design Pro, which uses the historical daily solar radiation data from Guam International Airport to determine the system yield

3. Analysis of Power Generation Options

Four options were identified as possible approaches to meet future power requirements for the USMC relocation. Each option is presented in this section with advantages and disadvantages associated with the option.

3.1 OPTION 1

This option is based on recapitalizing, modernizing, and modifying the existing GPA system to support the proposed base load from the GPA Grid. The added generation will be provided by GPA.

3.1.1 Load Impact to Existing System

The preliminary additional loads anticipated for the military buildup are listed in Table 3-1. The loads are distributed throughout the island as indicated by the map depicted in Figure 3-1. The map shows the major facility locations. These general locations were provided to GPA to allow a preliminary analysis of load impacts due to the proposed loads.

Table 3-1: Current and Preliminary Future Military Electrical Loads for Guam

Load Description	Existing Demand Load (MW)	USMC Notional Increase (MW)	Future Planned Demand (MW)
Existing Navy electrical demand for 19 service locations (based on peak demand data in GIMDP report dated July 2006 [HHF 2006]) and broken down as follows:	47.55		
Andersen Air Force Base	18.1	0.57	29.47
Northwest Field	0.5	0	1.80
Andy South – MARBO	1.0	0	1.0
NCTS (North) – Finegayan	1.2	20.10	24.83
South Finegayan Housing Area	1.5	8.15	9.65
Barrigada	1.3	0	1.3
Naval Hospital	3.2	0	5.27
Apra Harbor (NAVBASE)	20.75	18.71	87.16
Total Electrical Loads (Includes 25 percent spare capacity on new loads)	47.55	47.53	160.53

MARBO Marianas Bonins Command
NAVBASE Naval Base
NCTS Naval Computer and Telecommunications Station
MVA megavolt ampere
MW megawatt

Table 3-2: Current and Future Military Populations in Guam

Service	Active Duty	Dependents	On-base Civilian	Total
Baseline (FY06)				
USMC	3	2	1	6
Air Force	2145	2950	805	5900
Navy	39	66	1481	1586
Army	30	50	11	91
USCG	0	0	0	0
SOF	0	0	0	0
Notional Increase				
USMC	8552	9000	3207	20759
Air Force	1656	1100	244	3000
Navy	1300	50	487	1837
Army	630	950	236	1816
USCG	81	103	30	214
SOF	350	630	131	1111
Total Future Loading				
USMC	8555	9002	3208	20765
Air Force	3801	4050	1049	8900
Navy	1330	116	1968	3423
Army	660	1000	247	1907
USCG	81	103	30	214
SOF	350	630	131	1111

The GPA performed a load analysis to evaluate system voltage and line capacity based on the proposed loads. The results of this analysis are included in Appendix A – Guam Power Authority Load Flow Analysis Data. This analysis resulted in a series of recommended line and equipment upgrades to the IWPS. These are detailed in Table 3-5 and Table 3-6. The upgrades described in the tables will be required for any generation solution that locates the additional generation near existing Piti and Cabras.

3.1.2 Sites

Generating facility sites were not considered as part of this option as the responsibility for additional generation is under GPA's control and responsibility.

These loads are based on anticipated electrical demand to support personnel loading presented in Table 3-2 and include USMC Notional Increase and planned total future loads.

3.1.3 Costs Related to Power Generation, Transmission and Distribution

Load requirements are to be provided to the GPA for planning purposes to accommodate the future loads. Costs associated with any requirements over and above normal transmission service from GPA are to be calculated based on the CSA and paid by the Navy. Article 18 of the CSA defines the responsibility of GPA to provide service to new facilities as follows:

"28.17 Line Extensions. Extensions of 1ines necessary to furnish permanent 34.5 kV service to the Navy will be made by modifications to this Agreement in accordance with the following provisions:

28.17.1 General

28-17.1.1 Ownership, Operation and Maintenance. GPA will construct, own, operate and maintain electric lines and equipment only under, along, upon and over public streets, roads and highways where it has the legal right to do so, and on public lands and private property across which it has otherwise obtained rights-of-way or other necessary rights satisfactory to GPA.

28-17.1.2 Special Facilities. GPA will install only those facilities which it deems necessary to render service in accordance with GPA's standard facilities for 34.5 kV service. If the Navy requests facilities which are acceptable to GPA but are in addition to, or in substitution for, the standard facilities which GPA normally would install, the Navy shall make a contribution to cover the extra cost thereof."

The current CSA also includes Article 19 which indicates that a rate study is to be conducted to determine the allocation of costs associated with Navy services. It appears that the costs associated with improvements required by the Navy would be similarly allocated and evaluated based on the current CSA (in force until 2012).

3.1.4 Plant Production Capacity vs. Reliability

The system reliability requirements are impacted by the availability and capacity of generating units in service or available for service within the IWPS. The additional loads will impact the IWPS reliability by utilizing system capacity and reducing the available capacity in both spinning reserve and peaking units available for service. While evaluation of this option does not address specific generation requirements, it should be noted that the future reliability of the IWPS relies on the system analysis that provides adequate reserve capacity to allow units to be out of service for regular maintenance and out of service due to unexpected failures.

3.1.5 Existing Generation System Description

The existing GPA generation system consists of generation units owned by GPA, generation contracted to GPA and Navy owned generation units that are available to GPA for dispatch based on conditions in the CSA. The list of generation units is included in an example of the GPA generation status report prepared daily and submitted to the Navy's Utility Group. This example is indicated in Table 3-3 and represents installed capacity (553.4 MW) and units available for use (429.8 MW).

Figure 3-1: Guam Facility Location Map

Table 3-3: Example of a Generation Status Report

Plants	Rated Capacity	Actual Capacity	Capacity Used	First Year to Service	Remarks
DoD Diesels					
NCTS Finegayan	7.5	7.5	0	Unknown	
Radio Barrigada	4	4	0	Unknown	
Orote	19.8	19.8	0	Unknown	
NavHosp.	2	2	0	Unknown	
DoD Total	**33.3**	**33.3**	**0**		
GPA Steam					
Cabras #1	66	66	52	1974	
Cabras #2	66	66	47	1975	
Cabras #3	40	39	37	1996	
Cabras #4	40	39	37	1996	
Tanguisson #1	26.5	26.5	15	1976	
Tanguisson #2	26.5	26.5	15	1976	
Temes	40	40	0	1997	
Enron #8	44	0	0	1999	9/27/07 0745HRS: Tagged out for overhaul
Enron #9	44	44	42	1999	
GPA Diesels					
Manengon	10	8.8	0	Unknown	
Dededo CT #1	23	21	0	1992	
Dededo CT #2	23	0	0	1994	
Dededo (D)	10	5	0	1972	
Macheche	22	20	0	1993	
Yigo (CT)	22	0	0	1993	
Talafofo	10	4	0	1993	
Mt. Tenjo	26.4	24	0	1993	
Marbo CT	14	0	0		
GPA Total	**553.4**	**429.8**			**System Power Factor - 0.900**
System Total	**586.7**	**463.1**			
Peak Load Total			245		

3.1.5.1 CONDITION

The condition of the IWPS is an extremely complicated issue to evaluate in great detail. We can review the performance of the system based on a number of performance criteria. Some of this has been presented in Section 1.2.1 of this report.

3.1.5.2 SYSTEM DEFICIENCIES

General concerns with the IWPS revolve around power quality and reliability. Interviews with various agencies indicate that power quality (frequency, voltage level, harmonics) meets expectations. However, power outages (system reliability) have historically been more frequent than is acceptable to customers.

The GPA authority has made changes and improvements within the IWPS to reduce the power outages. Part of the system evaluation included a stability study GPA performed to determine what system improvements would have the most impact on the IWPS. The study was completed in July 2005. The summary of recommended capital improvements to the IWPS address the major recommendations in the report to improve the stability of the system and reduce unnecessary outages.

This report will not provide a detailed analysis of historical outages or improvements in performance since GPA changed load shedding scheme in early 2007. This report does provide information related to data provided by the Navy as it relates to outages in recent years. A summary of outage reports from October 2005 to July 2006 is included in Appendix C. The summary indicates the following as related to system outages:

- There were 214 outages during the period indicated.
- GPA system failures accounted for 39 of those outages which further break down to 10 generation outages and 29 transmission and distribution system outages.
- The Navy system accounts for 175 of the outages.

This summary covers a relatively short period of time and is not intended to provide a comprehensive evaluation of the IWPS performance or to detail outages down to specific circuits or devices. The summary does show that nearly 85 percent of the outages in a 9-month period were beyond the GPA system. A more detailed evaluation of the outage data should be able to identify specific system components (lines, breakers, switch gear, transformers or similar components) that represent a larger portion of the outages and suggest upgrades that will have the greatest impact to system performance.

3.1.5.3 AGE

The age of generation units within the IWPS varies from over 30 years old to less than 10 years old. A summary of the base load generation units and their therm of efficiency is listed in Table 3-4.

3.1.5.4 FUEL EFFICIENCIES CONDITION CAPACITY

Basic information regarding fuel efficiency of base load generation units was evaluated to determine level of efficiency being maintained by the GPA system. This information is presented in Table 3-4.

Table 3-4: Fuel Efficiency of Base Load Generation Units

Power Plant	Generation (MWh)	% to Total	Specific FOC (lit/Kwh)	Thermal Efficiency (%)
Cabras #1	156,953	16.41	0.259	34.35
Cabras #2	138,191	14.45	0.260	34.13
Cabras #3	131,124	13.71	0.211	42.18
Cabras #4	137,732	14.40	0.2178	40.84
Tanguisson #1	47,140	4.92	0.3361	26.46
Tanguisson #2	39,123	4.09	0.3517	25.29
Enron IPP Plt #8	160,932	16.83	0.2073	42.91

Power Plant	Generation (MWh)	% to Total	Specific FOC (lit/Kwh)	Thermal Efficiency (%)
Enron IPP Plt #9	144,994	15.16	0.2078	42.78
Total	956,189	100		

Specific FOC and Thermal Efficiency data provided by GPA.

The information presented in Table 3-4 confirms that while there are units in operation that perform at a relatively low efficiency, those units provide a relatively low percentage of total power delivered. That number would change as the system loads increase due to the USMC relocation. It is anticipated that any new projected loads given to the GPA will result in a revised capital improvement plan to address the system efficiency and capacity.

3.1.5.5 QUALITY/RELIABILITY

The basic requirements established by the CSA were evaluated independently and determined to have been met by the GPA as a condition to transfer the facilities to GPA control.

3.1.6 Transmission and Distribution

The transmission and distribution systems are the responsibility of the GPA. This stipulation is outlined in the current CSA is force until 2012.

3.1.6.1 SYSTEM DESCRIPTION

The GPA distributes power to the Navy at transmission level voltage and consists of 19 service locations. Each of these locations is metered as described in the CSA.

3.1.6.2 RELIABILITY

The information reviewed in preparation of this report included outage data from the Navy utilities staff, data from GPA and references to unscheduled outages in GIMDP. The results of this review are that the existing transmission system has greatly improved reliability in recent years and that recent (2007) changes in load shedding strategies has reduced unscheduled outages to Navy service locations. The NAVFAC Marianas staff has indicated in meetings that the vast majority of power outages experienced by their customers are the result of an aging infrastructure and the difficult environment in which the equipment operates.

3.1.6.3 CONDITION

The general condition of the transmission and distribution system throughout Guam is in good repair. There are some areas still affected by damage related to the most recent typhoon but the IWPS continues to be improved and planned projects will both maintain and improve the performance of the power system.

3.2 OPTION 2A

This option would construct a new SPE owned/operated base load power plant on DoD-provided land specifically to meet load requirements for the facilities associated with the USMC relocation. The facility would have the ability to provide excess power to the GPA grid. Also, the GPA grid would be used for back-up power in the event the SPE Plant is out of service. There are potential alternatives to this option that would address different generation capacities, and location of generation facilities near the major loads projected for the USMC relocation.

This interconnection option also anticipates that the SPE would contract with GPA for backup capacity to allow units to be taken out of service for maintenance or provide capacity through

peaking units in the event a unit trips from the grid. This would require GPA to initiate a project and establish the project criteria under current Guam Public Utilities Commission (PUC) rules.

For the purpose of this evaluation, the option will be based on a 60 MW base load generation facility potentially located near the major load at North Finegayan (location for a majority of the housing and base loads for the Marine facilities and represents approximately 80 percent of the anticipated demand load for proposed facilities when the Apra Harbor loads are not included). The 60 MW base load is less than the projected demand load because only a portion of the planned loads are located to allow distribution from the power facility.

3.2.1 Loads

The preliminary GIMDP Study describes additional loads anticipated for the military buildup that are listed in Table 3-1. The loads are distributed throughout the island as indicated by the map depicted in Figure 3-1. The map shows the major facility locations. These general locations were provided to GPA to allow an analysis of load impacts due to the proposed loads. In general, these loads, and the load and transmission system analysis apply to all options in Section 3.

GPA performed a preliminary load analysis to evaluate system voltage and line capacity based on the proposed loads. The results of this analysis are included in Appendix A. This analysis resulted in a GPA recommendation of improvements to alleviate the overloading of lines and reduced voltage due to the military loads projected by 2014. This list of proposed upgrades would improve several transmission lines and install facilities as described in Table 3-5 below. Detailed backup for costs presented in Table 3-5 appear in Appendix D. These costs are based on 2008 dollars.

Table 3-5: Anticipated GPA Improvements to Meet Military Load Increases, Part I

Project Description	Project List	System Overhead/Underground	Voltage	Project Cost ($M)	See Figure
Upgrade Piti X20 to Orote X35 line	A	Overhead	34.5kV	$1.8	A
Upgrade Harmon X87 to Andersen X73 line	A	Overhead	34.5kV	$3.1	A
Upgrade Piti X21 to Orote X31line Double Circuit	A	Overhead	34.5kV	$3.5	A
Dededo CT X150/ !55 to Andersen X71line Double Circuit	A	Overhead	34.5kV	$7.6	A
Upgrade Harmon X88 to Dededo X151/154 line Double Circuit	A	Overhead	34.5kv	$5.8	A
Upgrade Harmon X82 to Yigo X160 line	A	Overhead	34.5kv	$3.9	A
New 24 MVAR Capacitor Bank at Orote 13.8kV	A	N/A	13.8kv	$0.8	A
New 3 MVAR Capacitor Bank at SRF 13.8kV	A	N/A	13.8kV	$0.3	A
New 24 MVAR Capacitor Bank at Andersen 13.8kV	A	N/A	13.8kV	$0.8	A
New 18 MVAR Capacitor Bank at NCS	A	N/A	13.8kV	$0.6	A
Total Costs	A			$28.2	

Information developed from Guam Power Authority/Consolidated Commission on Utilities (CCU) *Mission Critical Infrastructure: A Partnership Presentation*. Figure A located at end of report.
MVAR megavolt ampere reactive

This option list is based on upgrades to lines and additional capacitor installations and does not upgrade voltage level for any lines. This approach is a minimal approach and does not completely alleviate the adverse impacts of proposed loads. A more complete upgrade would involve the proposed project list described in Table 3-6 below. Detailed backup for costs presented in Table 3-6 appears in Appendix D.

Table 3-6: Anticipated GPA Improvements to Meet Military Load Increases, Part II

Project Description	Project List	System Overhead/Underground	Voltage	Project Cost ($M)	See Figure
New Harmon to Andersen line	B	Overhead	115kV	$8.2	B
New Andersen Substation With 112 MVA Power Transformer	B	Overhead	115kV	$9.6	B
New Piti Orote line	B	Overhead	115kV	$2.8	B
New Orote Substation With 112 MVA Power Transformer	B	Overhead	115kV	$9.6	B
Upgrade Harmon X87 to Andersen X73	B	Overhead	115kV	$4.7	B
Piti X20 to Orote X35 line	B	Overhead	115kV	$4.9	B
New 24 MVAR Capacitor Bank at Orote 13.8kV	B	N/A	13.8kv	$0.8	B
New 3 MVAR Capacitor Bank at SRF 13.8kV	B	N/A	13.8kV	$0.3	B
New 24 MVAR Capacitor Bank at Andersen 13.8kV	B	N/A	13.8kV	$0.8	B
New 18 MVAR Capacitor Bank at NCS	B	N/A	13.8kV	$0.6	B
Total Costs Option B	B			$42.3	

Information developed from Guam Power Authority/Consolidated Commission on Utilities (CCU) Mission Critical Infrastructure: A Partnership Presentation. Figure B located at end of report.
MVAR megavolt ampere reactive

The main difference between the two solutions is that rather than adding an additional parallel transmission line to existing facilities, the approach increases the transmission line voltage and upgrades the affected substation transformers. This solution results in an improvement over the Option A approach. The Line analysis data are included in Appendix A.

3.2.2 Sites

This paragraph provides an overview of potential power generation facility sites that have been considered in Guam by several organizations and issues associated with each site. It should be noted that no site has been eliminated as a result of this study but simply identified, relative considerations discussed and potential interconnect with GPA identified near the site in order to provide a starting point for future consideration.

North Guam

North Finegayan

- Results in an industrial facility located within an area of predominantly operational type facilities
- Places the generation near a major portion of the load
- Significant issue associated with permitting a facility in that area of the island due to prevailing winds and proximity to commercial and residential development
- Current land allocation does not provide sufficient space required for anticipated facilities (allocation based on limited information available at time planning document was issued)
- Will require extending power distribution network to anticipated location of power facilities

Potts Junction

- Existing fuel pipeline that currently carries JP-8 fuel runs along edge of property (capacity for fuel delivery was not available)
- Location allows reasonably simple access to IWPS transmission and distribution network
- Residential development located near the site identified for this use may impact permitting

South Guam

Existing GPA Facility at Piti

- Lower capital cost for new generation
- Simpler EPA permitting due to existing land use
- Industrial site with limited commercial and no residential development near the location

Existing infrastructure for power distribution

- Land available near Shell Oil site
- Rural location near an existing fuel storage tank farm
- Relatively close to distribution interconnect
- EPA permitting likely to be easier in southern Guam due to land use and environmental differences

3.2.3 Costs – Capital, Power Gen/T&D

Costs associated with system improvements could not be included due to the timing of information acquired to base the costs on.

3.2.4 Plant Production (MW)

Power plant production capability will be based on projected load requirements and coordination with GPA as the organization responsible for the IWPS. General capacity has been established at 60 MW for planning purposes.

3.2.5 Existing Generation System Description

The existing generation system is described in Section 3.1.5.

3.2.6 Transmission and Distribution

The existing transmission and distribution system is described in Section 3.1.6.

3.3 OPTION 2B

This option would construct a new SPE owned/operated base load power plant on DoD or other provided land. The normal operation of this base load plant will be to provide power to the GPA grid at the best available location as an Independent Power Producer (IPP). The new Marine loads would be connected to the IWPS but not necessarily at the point of the new SPE facility. The main difference between this option and option 2A is that this option allows much more flexibility in locating the generation facility. Option 2A is intended to locate the power generation facility near the major loads. Option 2A would primarily provide power to the proposed loads with an ability to sell excess power to the GPA through an interconnection with GPA.

This interconnection would also allow the SPE to contract with GPA for backup capacity to allow units to be taken out of service for maintenance or provide capacity through peaking units in the event a unit trips from the grid.

3.3.1 Loads

The preliminary additional loads anticipated for the military buildup are listed in Table 3-1. The loads are distributed throughout the island as indicated by the map depicted in Figure 3-1. The map shows the major facility locations. These general locations were provided to GPA to allow an analysis of load impacts due to the proposed loads.

The GPA performed a preliminary load analysis to evaluate system voltage and line capacity based on the proposed loads. The results of this analysis are included in Appendix A. This solution results in an improvement over the Option A approach. The Line analysis data are included in Appendix A.

3.3.2 Sites

Basic site options identified are listed in Section 3.2.2.

3.3.3 Costs

Costs associated with transmission system improvements required to support additional generation requirements are summarized in Table 3-5 and Table 3-6 and detailed in Appendix D.

3.3.4 Plant Production MW, Base Load/Military Requirements/Base Load with Unit Out/1 Unit Maintained

Power plant production capability will be based on projected load requirements and coordination with GPA as the organization responsible for the IWPS. General capacity has been established at 60 MW for planning purposes. It should be noted that system generation requirements will be based on a business case analysis that reflects both base load generation and peaking generation requirements.

3.3.5 Existing Generation System Description

The existing generation system is described in Section 3.1.5.

3.3.6 Transmission and Distribution

The existing transmission and distribution system is described in Section 3.1.6.

3.4 OPTION 3

This option would establish a separate grid system for planned loads. One of the main issues associated with this approach is backup power and reliability of the system. In general, a power facility with a firm capacity of 60 MW (e.g. 3–20 MW units) would require an additional two units to be installed to provide the ability to remove one unit from service, have a unit fail and still provide the ability to meet the 60 MW firm capacity rating. The system reliability would also be affected by the distribution system design. Most distribution systems provide multiple paths to provide power to a location. The number of paths would depend on the voltage level and type of equipment located at the point in question.

Either of these two issues (generation and distribution) will have a tremendous effect on the installed cost for this option. The generation impact could require twice the firm capacity to be installed to meet reliability expectations and the distribution system would need to be designed such that alternate feeders were available given failure of one feeder to maintain an equivalent level of redundancy that currently exists within the existing GPA transmission system.

It should be anticipated that backup power may be required for all facilities with a moderate to high level of mission critical rating. The requirement for local standby generators and the associated space and cost would need to be considered in the master planning if the level of reliability was not met with the proposed generation and distribution system for this option.

3.4.1 Loads

The loads anticipated for the military buildup are listed in Table 3-1. The loads are distributed throughout the island as indicated by the map depicted in Figure 3-1. The map shows the major facility locations. These general locations were provided to GPA in October 2007 to allow an analysis of load impacts due to the proposed loads.

The GPA performed a load analysis to evaluate system voltage and line capacity based on the proposed loads. The results of this analysis are included in Appendix A. The analysis resulted in two improvement options for the transmission systems (Option A and Option B). Option B represents a higher cost associated with the 115 kV or high voltage approach but also provides a better long term solution over Option A and better system performance based on the data available.

3.4.2 Sites

The site options are generally those discussed for the Northern portion of Guam. Much of the central portion of Guam is commercial and residential and limits the availability of a site for power generation.

3.4.3 Costs – Capital, Power Gen/T&D

Costs associated with system improvements were not able to be included due to the timing of information acquired to base the costs on.

3.4.4 Plant Production (MW)

Power plant production capability will be based on projected load requirements and coordination with GPA as the organization responsible for the IWPS. General capacity has been established at 60 MW for planning purposes. The capacity for this option will require additional study and evaluation due to

the costs associated with an independent power distribution system. It is not clear that this option can be considered viable with the current CSA agreement between the Navy and GPA.

3.4.5 Existing Generation System Description

The existing generation system is described in Section 3.1.5.

3.4.6 Transmission and Distribution

The existing transmission and distribution system is described in Section 3.1.6. The proposed transmission and distribution for this option would require an independent power system with no GPA interconnect.

3.4.6.1 SYSTEM DESCRIPTION

This system approach will require a robust distribution (transmission system for remote locations) to meet the reliability and quality requirements described in Section 1, Introduction. The system would need to provide the demand capacity with specific segment failures. This report does not provide any detailed level of design for this approach.

3.4.6.2 RELIABILITY

The system reliability will need to meet the requirements described in Table 1-2. These requirements establish the minimum system criteria for the detailed design of the electrical system.

3.5 GENERAL POWER GENERATION CONSIDERATIONS

The existing IWPS relies solely on fossil fuels for power generation in Guam. System planning and future power requirements must incorporate a diverse portfolio of power generation to reduce the impact on the economy from any one source of energy. GPA has conducted evaluations of alternative power generation and has ongoing plans that continue to evaluate alternative sources of energy for Guam. Their integrated resource plan has been updated several times in the past and will continue to include alternative energy options in evaluating the future of GPA generation plans.

3.5.1 Alternative Energy Options

Alternative energy does not typically provide a reliable source of power to the electrical grid. There are exceptions to this statement, such as waste-to-energy, ocean thermal, geothermal and to a lesser extent, wave technology. Alternative energy sources such as wind, solar, and biomass are all less reliable than the aforementioned technologies.

Alternative energy can offer a relatively reliable and renewable source of energy. It is the renewable aspect that is not provided by any significant source in Guam at this time. The alternative technologies continue to change and their cost/benefit ratios change with the ever-increasing cost of energy throughout the world. Sources of energy such as heavy fuel oil and No. 2 diesel are expected to increase in cost and the higher costs will have a substantial effect on the economy of Guam.

It is for these reasons that any future plans for additional power generation capacity in Guam should include a portion of that energy produced from alternative sources.

3.5.2 Military CSA

A customer service agreement (CSA) is in force between the Navy and GPA. Portions of the CSA are included in Appendix B, Customer Service Agreement. The significant aspects of the agreement that are relevant to this study are listed below:

- The CSA established performance metrics that the Navy expects to be met at the service points throughout the system.
- The CSA provides limited authority to the Navy for reselling power to other customers.
- The Navy is responsible for providing information to the GPA for planning purposes to allow them the opportunity to make system improvements to meet anticipated load increases in a timely manner.

3.5.3 Backup

There are no specific backup requirements to be provided by GPA. The GPA is responsible for meeting basic requirements for the number of minutes of service interruption during a year and for meeting availability requirements for loss of generation probability.

This means that any facility that cannot tolerate a minimum level of power outages and duration of outages in minutes to hours will require a backup power supply. This backup supply may include a standby generation that can restore power within seconds and operate for hours to day, an uninterruptible power supply (UPS) system that provides uninterrupted service for several minutes to a few hours or a combination of both systems. A combination of both UPS and standby generator is capable of providing uninterrupted service for a period of hours or days and would be limited be fuel supply and permitted operating limitations.

3.5.4 IPP Involvement

Use of the terms independent power producer (IPP) and special purpose entity (SPE) are similar and only separated to differentiate between an organization that is specifically defined to represent a company contracted to meet requirements of the USMC relocation (the SPE) and a more generic term (IPP) that simply represents an organization that has a long-term agreement with GPA to provide electricity at a specific quality and quantity within a minimum and maximum range of production rate.

The GPA has the sole responsibility to provide power through the IWPS and currently has long-term agreements with long established IPPs. Any new IPP agreements or increase in power requirements to existing agreements are expected to be initiated by GPA.

3.5.5 SPE Involvement, GOJ

The capital improvements required to provide additional power generation are anticipated to be provided by an SPE that recovers the capital investment through the sale of energy over the contracted period. The details of the capital facilities are not defined in this report. This report identifies anticipated load requirements, describes interconnection options for the power generation needs, and evaluates potentially viable alternative energy options for Guam.

4. Recommendations

This section summarizes each of the options discussed above and provides a general description of recommended direction supported by this study.

4.1 INTERCONNECTION OPTIONS

The four interconnection options introduced in Section 1 represent the alternatives identified in the basis of this study. These options are repeated again below for reference:

- *Option 1:* Recapitalize, modernize and modify the GPA system to support the added base load to the GPA grid. The added generation will be provided by GPA.
- *Option 2A:* Construct a new SPE owned/operated base load power plant on DoD-provided land specifically to meet load requirements for the facilities associated with the USMC relocation. The facility would have the ability to provide excess power to the GPA grid. Also, the GPA grid would be used for back-up power in the event the SPE Plant is out of service.
- *Option 2B:* Construct a new SPE owned/operated base load power plant on DoD or other provided land. The normal operation of this base load plant will be to provide power to the GPA grid at the best available location as an IPP. The new USMC loads would be connected to the IWPS but not at the point of the new SPE facility.
- *Option 3:* Construct a new SPE owned/operated base load power plant for load on North Finegayan with no connection to GPA. This option would require spare capacity to provide necessary generation with one unit out of service and failure of the largest unit (if units are not the same size).

Additional alternatives were discussed but do not offer substantial differences that warrant identifying additional options for evaluation. These options identify variations for interconnection of new generation to the system that would support the anticipated future loads.

4.1.1 Option 1

This option would keep GPA as the provider for all energy requirements for the Navy. The future load requirements would be met by additional generation capacity that meets the reliability and quality levels identified in the CSA. Specific levels that are to be met by GPA are listed in Table 1-2.

The existing system was reviewed to determine GPA's ability to meet the substantial increase in loads between 2010 and 2014. There are essentially two major considerations with the system's ability to meet these future load requirements. The first is the ability of the transmission and distribution systems to support the additional loads on the circuits that interconnect the power system. The second is the generation capacity of the system and the ability to meet future load increases.

NAVFAC provided a list of preliminary load locations and demand levels to GPA as a first step for a system analysis. GPA evaluated these loads to determine the impacts to the existing IPWS. The data that illustrate the system impacts are included in Appendix A. These impacts were further evaluated by GPA and resulted in two approaches that were considered by GPA to alleviate these effects.

The first approach is to simply increase the line capacity at each of the overloaded lines and add capacitor banks at several locations to address unacceptable voltage conditions at several other locations in the distribution system. The improvements are listed in Table 3-5 and indicated in the drawing titled Figure A, located in a pocket at the back of this report. While these improvements

address the immediate needs of the system, they do not provide much additional benefit for future growth in the system and are somewhat short-term solutions to the system impacts.

The second approach, described in Table 3-6, is based on replacing and increasing the voltage rating to four transmission lines. This approach will provide a longer range solution to the anticipated increase in demand to the IWPS. The improvements associated with this approach are indicated in the drawing titled Figure B, located in a pocket at the back of this report. The proposed lines increase the system transmission capacity to meet the increased load demand at the northern end of Guam and in Apra Harbor. These are the two main load concentrations that impact the IWPS.

Table 1-2 indicates expectations included in the current CSA. The CSA's agreement expires in 2012. A recent review of the CSA resulted in a recommendation that the Navy begins in 2009 to develop a replacement agreement.

4.1.2 Option 2A

This option anticipates that an SPE would construct a new power generating facility (on DoD provided land) to meet the anticipated load requirements for the USMC relocation to Guam. This facility would be configured primarily to provide energy to support DoD loads and includes the ability to sell excess power to GPA. The facility would rely on GPA for backup power requirements.

The concept of selling excess power to GPA presumes that GPA needs the additional power, that GPA will contract to provide backup capacity for the SPE and that the existing regulations allow the approach to be carried out. This option will likely require improvements to the IWPS in addition to the power generation facility. The type of improvements will vary substantially with the site location for the additional generation.

The load analysis performed in this study would indicate that projected continuous/average load increases are in the range of 50–60 MW, with an additional capacity requirement of approximately 60 MW for transient loads in Apra Harbor (these loads are primarily associated with a planned CVN berthing in Apra Harbor). Additional analysis is required to determine the optimum generation capacity for the planned loads. Load planning will need to be developed with GPA to evaluate the system performance, maintain an adequate spinning reserve, and have sufficient spare capacity to allow maintenance cycles on operating units and respond to the unexpected unit failure.

4.1.3 Option 2B

This option is essentially the same as Option 2A except for the generating facility location. This option would open consideration for locations outside of DoD property, would primarily interconnect with GPA at a location that works for the generation station and rely on system improvements to address the transmission requirements.

4.1.4 Option 3

This option would establish a separate power generation and distribution system. There are several other major considerations make this option undesirable. The major items are listed below:

- A separate system would require the power producer to provide the necessary system backup and spinning reserve capacity to meet system demands and reliability requirements.
- The system would require privately owned transmission lines to deliver power to remote load locations for loads associated with the USMC relocation and require the associated rights-of-way for these transmission line routes.

- The facility design requirements may require additional standby generation units to address reliability requirements that may not be provided by an isolated power system.

These issues will result in a cost basis that cannot be supported with a competitive cost for electricity to the new customers associated with the USMC relocation.

4.2 ALTERNATIVE ENERGY

A series of alternative energy options were identified and evaluated for use in Guam. The alternative energy technologies evaluated are listed below:

- OTEC
- Wind energy
- Photovoltaics
- Simple cycle biofuel plant (combined cycle biofuel plant)
- Biomass plant
- Fuel cells
- Waste-to-energy plant
- Geothermal
- Solar thermal electric
- Wave energy

4.2.1 Viable Options

These options were evaluated to determine which are viable in Guam. The aspects evaluated to determine viability are summarized in Table 2-1. The viable options were selected as those that could provide a reliable source of energy and an acceptable (relatively close to current energy costs) and could be supported with current infrastructure in Guam. Those alternative energy sources identified as viable are listed below:

- Wind energy
- Simple cycle biofuel plant (combined cycle biofuel plant)
- Solar thermal electric (this option is marginally viable based on preliminary evaluation and could warrant additional review to determine if the technology is viable in some form)
- Distributed solar photovoltaic systems installed as part of the facility construction
- Geothermal (potentially viable)
- Wave (although not currently available at commercial levels similar to Guam, it should be re-evaluated in 5-10 years as technology matures)

Each of these sources indicates that the source of energy is available in sufficient quantities to support a commercial installation and produce energy at or near the current market price for electricity and provide a payback.

4.2.2 Non-Viable Options

These alternative energy options were identified and non-viable due to a lack of natural resources to support the facility, excessive costs of energy for the resulting facility or a technology that is not commercially available to support a facility.

- Ocean thermal energy conversion (OTEC)
- Photovoltaics
- Biomass plant
- Fuel cells
- Wave energy

A detailed evaluation of each alternative energy source is included in Section 2.

4.3 CONVENTIONAL POWER GENERATION

For the purposes of this report, power generation refers to the use of fossil fuels to produce electricity. This report considered four fuel options to produce power for Guam. Those options are coal, liquefied natural gas (LNG), heavy fuel oil (No. 6) and No. 2 diesel. While each of these fuels are in wide use throughout the world, fuel availability and cost vary for each location and greatly impact the viability of the fuel for each application.

The greatest mitigating factor to consider for the future generation plans in Guam is related to diversification of energy sources. The current generation system in Guam relies on heavy fuel oil and No. 2 diesel as the sources of energy to produce electricity. This results in a highly volatile environment when considering the future cost of electricity in Guam. Any future plans for energy in Guam should heavily consider diversification to mitigate the impact from a single fuel source on the cost of energy in Guam.

4.3.1 Viable Options

Viable options are those that appear to be supportable with supply and distribution systems within Guam or those where new handling facilities could be constructed in such a manner that the lower cost of energy would pay for the facilities. Existing distribution networks for fuel oil and diesel make them readily available with limited additions to infrastructure (the additions will vary depending on the actual facility location). There are currently no facilities for handling large volumes of coal or LNG in Guam.

Coal handling facilities were considered for Guam. A potentially viable site from a technical engineering standpoint was identified near existing generation facilities in Piti. There appear to be nearly 200 acres of land controlled by GPA and the Government of Guam in that area. However, this site would be in a non-attainment area. Additional analysis is needed to determine the viability of a facility at this location.

4.3.2 Non-Viable Options

The infrastructure required for LNG results in a substantial impact to implement. The tankers, storage, re-gasification and generation facilities result in the highest cost of construction for any of the fuel alternatives. Growing world demand for LNG is likely to increase pressure on prices and increase the cost on energy produced with this fuel. This fuel source is not considered viable at this time without additional investigation into the specific facilities and infrastructure required to support the system.

4.4 RECOMMENDATIONS

This report evaluated the anticipated energy needs associated with the USMC relocation and other DoD loads and the interconnection options associated with planned generation facilities and alternative energy options for Guam. Each of these issues can be complicated and is affected by other items. As such, these recommendations are based on the main issues described for each recommendation.

4.4.1 Power Generation

The loads presented in Table 1-3 reflect USMC and DoD facility requirements to meet future facility plans. The table summary reflects total loads in MW without future capacity requirements for 25 percent capacity. These load values represent the basic demand load requirements that reflect connected loads multiplied by 0.27 to obtain a demand load value. The 0.27 was calculated from similar facilities in operation.

The power generation demand requirements for the USMC facilities are 40 MW with an additional 60 MW from other DoD loads that include a transient CVN berthing requirement at Apra Harbor. It is anticipated that these loads will be supplied by a combination of base load facilities that operate essentially continuously and peaking facilities that operate as needed daily or seasonally. Initial business case analysis has recommended a mix of 60 percent base load capacity and 40 percent peaking load capacity for the planned loads.

A summary of this mix of capacity (base load and peaking) in presented in Table 4-1. This table establishes the recommended generation required to support USMC and other DoD loads expected to be added by 2019 (USMC relocation expected to occur by 2014).

Table 4-1: Recommended Generation Levels/Costs

	Load (MW)		Generation[a] (MW)		Total USMC+Other DoD Generation Costs
	USMC	Other DoD	USMC	Other DoD	
Recommended Generation Levels					
Generation Type					
Base load	28.3	52.3	45.28	84	na
Peaking	18.89	34.86	30.224	56	na
Generation Facility Costs ($M)					
Baseload Generation					
Heavy Fuel Oil	na	na	$77	$142	na
Coal	na	na	$199	$245	na
LNG	na	na	$226	$279	na
Peaking Generation Costs					
Diesel	na	na	$36	$67	na
Total Generation Cost (base load plus peaking)					
Heavy Fuel Oil Base Load	na	na	$113	$209	$322
Coal Base Load	na	na	$236	$312	$548
LNG Base Load	na	na	$263	$346	$608

na not applicable
[a] - Generation includes additional capacity to meet system reliability requirements.

The power generation evaluation also included review of conventional generation fuel alternatives. These alternatives consisted of oil (No. 2 diesel and heavy fuel oil), LNG, and coal. Each of these fuels was evaluated with regard to Guam's ability to support with existing infrastructure or requirement for new infrastructure, availability of the fuel and facility requirements (e.g., space, O&M, water, environmental impact). The general conclusions were that coal and LNG would require significant infrastructure improvements to accommodate a new generation facility with that fuel source.

Of those two, coal appears to be more technically feasible due to simpler fuel handling facilities (LNG facilities can be extremely difficult to permit due to the nature of the fuel), and more stable fuel costs. However, the potential for carbon emission penalties would adversely impact the use of coal and favor LNG. The long-term costs associated with LNG appear to trend upward more than coal but historical information is no indication of future changes based on recent world energy markets.

4.4.2 Generation Interconnection

Four options for system interconnection were evaluated for power generation. Three of the options have the potential for overlap depending on the funding mechanism and purchased power agreement that meets the requirements for additional loads. These options are 1, 2A and 2B. Option 3 would result in a separate power generation and transmission system for some or all of the planned loads and is not considered a viable option due to costs associated with an entirely new system and the need for installed standby/backup capacity to meet reliability requirements.

Options 1, 2A, and 2B are all considered viable and will depend on the business case analysis conclusions as well as GPA and the direction they will take in procuring additional generation capacity for the IWPS. It is anticipated that the generation location will be determined by final site analysis but likely be located near existing industrial zoned areas due to noise and emission impacts.

4.4.3 Alternative Energy

Alternative energy options evaluated resulted in several technologies that are considered viable based on current energy costs, maturity of the technology, and available information related to Guam for wind, geothermal, solar and related resource data. The options considered viable are listed below for reference.

- OTEC has the potential to provide a continuous, reliable source of electrical power. However, the time frame for its development is 5 to 10 years out.
- Wind energy development should be explored, provided that the military has the satisfactory land area to accommodate the wind farm developments.
- Biofuel
- Installation of distributed photovoltaics should be considered to supplement the power drawn from the grid, possibly through third party power contracts.
- The installation of a solar thermal electric system using a third party power producer should be considered. However, the land area required for a solar thermal system will be significantly greater than for most of the other technologies.
- Geothermal (potentially viable). The main limitation at this point is the lack of geothermal data. The data available to the study was general and does not include specific site data.

Current energy policy (EPAct 2005) commits to a 25 percent level of energy from renewable energy sources by 2025. The decisions related to power generation in Guam should consider this commitment to renewable energy by planning to include as much as 50 percent of the long-term planned generation to renewable energy sources.

5. References

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Appendix A
Guam Power Authority Load Flow Analysis Data

Voltage Limit Report

Name	kV	Outage	Existing 2007 Load	New DOD Loads	Line Upgrades w/ No 115 kV	Line Upgrades Including 115 kV	Outage description
Pagat 34	34.5	line_38	0.9115	0.8987	0.9213	0.9434	Line Harmon 3 34.5 to Macheche 34.5 Circuit 1
Pulantat	34.5	line_22	0.8724	0.8815	0.9106	0.956	Line Pulantat 34.5 to Barrigad 34.5 Circuit 1
Tamuning	34.5	line_67	0.9148	0.8761	0.9362	0.9566	Line Agana 34 34.5 to Tamuning 34.5 Circuit 1 and Tamuning T600
Tamuning	115	line_5	0.966	0.847	0.9571	0.9575	Line Agana115 115.0 to Tamuning 115.0 Circuit 1
San Vito	34.5	line_67	0.9167	0.8792	0.9391	0.9594	Line Agana 34 34.5 to Tamuning 34.5 Circuit 1 and Tamuning T600
Harmn115	115	line_5	0.9688	0.8527	0.9606	0.9604	Line Agana115 115.0 to Tamuning 115.0 Circuit 1
Harmn115	115	line_61	0.9619	0.8498	0.9616	0.9609	Line Piti 115 115.0 to Harmn115 115.0 and Agana T400
Harmn115	115	line_62	0.9664	0.8662	0.9636	0.9612	Line Piti 115 115.0 to Harmn115 115.0 and Piti T700
Harmn115	115	line_63	0.9641	0.8476	0.9623	0.9619	Line Piti 115 115.0 to Harmn115 115.0 and Tamuning T600
Pagat 34	34.5	line_63	0.9263	0.8916	0.944	0.9626	Line Piti 115 115.0 to Harmn115 115.0 and Tamuning T600
Pagat 34	34.5	line_61	0.9188	0.8963	0.9442	0.9626	Line Piti 115 115.0 to Harmn115 115.0 and Agana T400
Harmn115	115	line_65	0.9696	0.8552	0.9637	0.9627	Line Tamuning 115.0 to Harmn115 115.0 and Tamuning T600
Harmn115	115	line_64	0.9698	0.8555	0.9639	0.9627	Line Agana115 115.0 to Tamuning 115.0 Circuit 1 and Tamuning T600
Tamuning	115	line_64	0.9699	0.8555	0.9639	0.9628	Line Agana115 115.0 to Tamuning 115.0 Circuit 1 and Tamuning T600
Tumon 34	34.5	line_67	0.9234	0.8836	0.9431	0.9633	Line Agana 34 34.5 to Tamuning 34.5 Circuit 1 and Tamuning T600
Harmn115	115	line_4	0.9694	0.8606	0.9637	0.9638	Line Piti 115 115.0 to Harmn115 115.0 Circuit 1
Harmn115	115	line_54	0.9785	0.8618	0.9713	0.9651	Line Cabr 115 115.0 to Piti 115 115.0 Circuit 1 and Line Cabr 115 115.0 to Agana
NCS Fine	34.5	line_37	0.9373	na	0.8791	0.967	Line Harmon 1 34.5 to NCS Fine 34.5 Circuit 1
Pagat 34	34.5	line_67	0.9313	0.892	0.9465	0.9677	Line Agana 34 34.5 to Tamuning 34.5 Circuit 1 and Tamuning T600
Harmn115	115	line_6	0.9799	0.8772	0.9717	0.9709	Line Tamuning 115.0 to Harmn115 115.0 Circuit 1
Harmn115	115	line_55	0.9805	0.8772	0.972	0.9713	Line Tamuning 115.0 to Harmn115 115.0 and Line Giattap 34.5 to Harmon 1 34.5
Tamuning	115	line_54	0.9817	0.869	0.9755	0.9715	Line Cabr 115 115.0 to Piti 115 115.0 Circuit 1 and Line Cabr 115 115.0 to Agana
Potts Jc	34.5	line_37	0.9381	na	0.8844	0.9719	Line Harmon 1 34.5 to NCS Fine 34.5 Circuit 1
Harmn115	115	line_59	0.9788	0.8818	0.9745	0.972	Line Cabr 115 115.0 to Agana115 115.0 Circuit 1 and Piti T700
Harmn115	115	line_58	0.9847	0.8767	0.9783	0.9726	Line Cabr 115 to Piti 115 and Agana T400
Harmn115	115	line_57	0.979	0.8745	0.9735	0.9728	Line Cabr 115 115.0 to Agana115 115.0 Circuit 1 and Agana T400
Tamuning	115	line_62	0.9792	0.8812	0.9756	0.9736	Line Piti 115 115.0 to Harmn115 115.0 and Piti T700
Harmn115	115	line_2	0.9806	0.8764	0.9737	0.9741	Line Cabr 115 115.0 to Agana115 115.0 Circuit 1
Harmn115	115	line_3	0.9806	0.8764	0.9737	0.9741	Line Cabr 115 115.0 to Agana115 115.0 Circuit 2
Tamuning	115	line_61	0.9785	0.8684	0.9753	0.9748	Line Piti 115 115.0 to Harmn115 115.0 and Agana T400
Tamuning	115	line_59	0.9809	0.8833	0.9767	0.9752	Line Cabr 115 115.0 to Agana115 115.0 Circuit 1 and Piti T700
Harmn115	115	line_66	0.9835	0.8767	0.9761	0.9756	Line Piti 345 34.5 to Anigua 3 34.5 Circuit 1 and Agana T400
Talofofo	34.5	line_22	0.8946	0.903	0.9314	0.9757	Line Pulantat 34.5 to Barrigad 34.5 Circuit 1
Tamuning	115	line_4	0.9819	0.8749	0.9752	0.976	Line Piti 115 115.0 to Harmn115 115.0 Circuit 1
Harmn115	115	line_67	0.9804	0.8634	0.975	0.9761	Line Agana 34 34.5 to Tamuning 34.5 Circuit 1 and Tamuning T600
Agana115	115	line_54	0.9854	0.8765	0.9802	0.9769	Line Cabr 115 115.0 to Piti 115 115.0 Circuit 1 and Line Cabr 115 115.0 to Agana
Tamuning	115	line_63	0.9799	0.8679	0.977	0.977	Line Piti 115 115.0 to Harmn115 115.0 and Tamuning T600
Tamuning	115	line_2	0.9829	0.8783	0.9762	0.9775	Line Cabr 115 115.0 to Agana115 115.0 Circuit 1
Tamuning	115	line_3	0.9829	0.8783	0.9762	0.9775	Line Cabr 115 115.0 to Agana115 115.0 Circuit 2
Tamuning	115	line_57	0.9846	0.8797	0.978	0.9779	Line Cabr 115 115.0 to Agana115 115.0 Circuit 1 and Agana T400
Yigo_345	34.5	line_61	0.9187	0.8569	0.9441	0.9787	Line Piti 115 115.0 to Harmn115 115.0 and Agana T400
Harmn115	115	line_34	0.9877	0.8806	0.9777	0.9788	Line Tanguiss 34.5 to Harmon 3 34.5 Circuit 2
Harmn115	115	tran_50	0.9859	0.8843	0.979	0.9788	Tran Agana 34 34.50 to Agana115 115.00 Circuit 1
Harmn115	115	line_1	0.9888	0.881	0.9801	0.9788	Line Cabr 115 115.0 to Piti 115 115.0 Circuit 1
Harmn115	115	line_9	0.9873	0.8922	0.9817	0.9788	Line Cabrs345 34.5 to Piti 345 34.5 Circuit 1
Harmn115	115	tran_48	0.9873	0.8922	0.9817	0.9788	Tran Cabrs345 34.50 to Cabr 115 115.00 Circuit 1
Yigo_345	34.5	line_63	0.9252	0.8518	0.944	0.9791	Line Piti 115 115.0 to Harmn115 115.0 and Tamuning T600
Harmn115	115	line_60	0.9882	0.894	0.982	0.9791	Line Cabr 115 to Piti 115 and Piti T700
Harmn115	115	line_23	0.9868	0.8833	0.9786	0.9792	Line Agana 34 34.5 to Barrigad 34.5 Circuit 1
Agana115	115	line_59	0.9841	0.8883	0.9806	0.9792	Line Cabr 115 115.0 to Agana115 115.0 Circuit 1 and Piti T700
Harmn115	115	line_17	0.9885	0.8761	0.9779	0.9793	Line Apra 34. 34.5 to Tenjotap 34.5 Circuit 1
Harmn115	115	line_14	0.9879	0.8846	0.9792	0.9794	Line Talofofo 34.5 to Apra 34. 34.5 Circuit 1
Harmn115	115	line_38	0.9883	0.884	0.9794	0.9794	Line Harmon 3 34.5 to Macheche 34.5 Circuit 1

Voltage Limit Report

Name	kV	Outage	Existing 2007 Load	New DOD Loads	Line Upgrades w/ No 115 kV	Line Upgrades Including 115 kV	Outage description
Harmn115	115	tran_49	0.9878	0.8912	0.9816	0.9794	Tran Piti 345 34.50 to Piti 115 115.00 Circuit 1
Harmn115	115	line_33	0.9887	0.8765	0.9773	0.9795	Line Tanguiss 34.5 to Harmon 1 34.5 Circuit 1
Harmn115	115	tran_51	0.9867	0.8838	0.9792	0.9796	Tran Tamuning 34.50 to Tamuning 115.00 Circuit 1
Harmn115	115	line_13	0.9886	0.884	0.979	0.9797	Line Piti 345 34.5 to Anigua 3 34.5 Circuit 1
Yigo_345	34.5	line_5	0.9354	0.8713	0.9469	0.98	Line Agana115 115.0 to Tamuning 115.0 Circuit 1
Harmn115	115	line_35	0.9875	0.8776	0.978	0.9801	Line Harmon 3 34.5 to Dededo 3 34.5 Circuit 1
Harmn115	115	line_19	0.9887	0.8825	0.9789	0.9801	Line Piti 345 34.5 to Cld Stor 34.5 Circuit 1
Harmn115	115	line_12	0.989	0.8847	0.9795	0.9802	Line Piti 345 34.5 to Agana 34 34.5 Circuit 1
Harmn115	115	line_39	0.988	0.8818	0.9791	0.9803	Line Harmon 1 34.5 to Yigo_345 34.5 Circuit 1
Harmn115	115	line_25	0.9881	0.8847	0.9796	0.9803	Line Agana 34 34.5 to Tamuning 34.5 Circuit 1
Yigo_345	34.5	line_62	0.9331	0.8873	0.9491	0.9804	Line Piti 115 115.0 to Harmn115 115.0 and Piti T700
Harmn115	115	line_28	0.9881	0.885	0.9795	0.9804	Line Tamuning 34.5 to Tumon 34 34.5 Circuit 1
Yigo_345	34.5	line_64	0.9327	0.8651	0.9465	0.9805	Line Agana115 115.0 to Tamuning 115.0 Circuit 1 and Tamuning T600
Harmn115	115	line_11	na	0.882	0.9794	0.9805	Line Piti 345 34.5 to Orote 34 34.5 Circuit 1
Harmn115	115	line_24	0.9883	0.8845	0.9794	0.9805	Line Agana 34 34.5 to Radio Ba 34.5 Circuit 1
Harmn115	115	line_21	0.989	0.8857	0.9799	0.9805	Line Pulantat 34.5 to Talofofo 34.5 Circuit 1
Yigo_345	34.5	line_65	0.9326	0.8649	0.9464	0.9806	Line Tamuning 115.0 to Harmn115 115.0 and Tamuning T600
Harmn115	115	line_31	0.9896	0.8857	0.9802	0.9806	Line Anigua 3 34.5 to Agana 34 34.5 Circuit 1
Harmn115	115	line_10	0.9885	0.8888	0.9813	0.9806	Line Piti 345 34.5 to Tenjotap 34.5 Circuit 1
Harmn115	115	line_27	0.9885	0.8848	0.9797	0.9807	Line Radio Ba 34.5 to Marbo 34 34.5 Circuit 1
Harmn115	115	line_40	0.9885	0.8848	0.9797	0.9807	Line Dededo 3 34.5 to Marbo 34 34.5 Circuit 1
Harmn115	115	line_29	0.9883	0.8853	0.9798	0.9807	Line Tamuning 34.5 to San Vito 34.5 Circuit 1
Harmn115	115	line_26	0.9891	0.8855	0.9802	0.9808	Line Barrigad 34.5 to GAA 34.5 34.5 Circuit 1
Harmn115	115	line_15	0.989	0.8824	0.98	0.9809	Line Apra 34. 34.5 to Orote 34 34.5 Circuit 1
Harmn115	115	line_18	0.9889	0.8854	0.98	0.9809	Line Orote 34 34.5 to Cld Stor 34.5 Circuit 1
Harmn115	115	line_44	0.9889	0.8858	0.9802	0.9809	Line Macheche 34.5 to GAA 34.5 34.5 Circuit 1
Harmn115	115	base	0.989	0.8859	0.9803	0.9809	Base system (n-0)
Harmn115	115	line_30	0.9892	0.8859	0.9803	0.9809	Line Tumon 34 34.5 to Harmon 3 34.5 Circuit 1
Harmn115	115	line_47	0.989	0.8857	0.9804	0.9809	Line GIAT 34.5 to Harmon 1 34.5 Circuit 1
Harmn115	115	line_22	0.9894	0.887	0.9811	0.9809	Line Pulantat 34.5 to Barrigad 34.5 Circuit 1
Harmn115	115	line_32	0.9892	0.886	0.9803	0.981	Line San Vito 34.5 to Harmon 3 34.5 Circuit 1
Harmn115	115	line_46	0.9891	0.8858	0.9804	0.981	Line GAA 34.5 34.5 to GIAT 34.5 Circuit 1
Harmn115	115	line_41	0.9888	0.8855	0.9803	0.9811	Line NCS Fine 34.5 to Potts Jc 34.5 Circuit 1
Harmn115	115	line_42	0.9888	0.8855	0.9803	0.9811	Line Potts Jc 34.5 to Andersen 34.5 Circuit 1
Harmn115	115	line_45	0.989	0.8858	0.9803	0.9811	Line Yigo_345 34.5 to Andersen 34.5 Circuit 1
Agana115	115	line_2	0.9861	0.8833	0.9801	0.9815	Line Cabr 115 115.0 to Agana115 115.0 Circuit 1
Agana115	115	line_3	0.9861	0.8833	0.9801	0.9815	Line Cabr 115 115.0 to Agana115 115.0 Circuit 2
Harmn115	115	line_16	0.9898	0.887	0.981	0.9819	Line Apra 34. 34.5 to Umatac34 34.5 Circuit 1
Agana115	115	line_62	0.9877	0.8928	0.9843	0.9821	Line Piti 115 115.0 to Harmn115 115.0 and Piti T700
NCS Fine	34.5	line_61	0.9403	0.8202	0.9545	0.9825	Line Piti 115 115.0 to Harmn115 115.0 and Agana T400
NCS Fine	34.5	line_63	0.9459	0.8151	0.9545	0.9829	Line Piti 115 115.0 to Harmn115 115.0 and Tamuning T600
Tamuning	115	line_58	0.9935	0.8897	0.9865	0.9829	Line Cabr 115 to Piti 115 and Agana T400
Tamuning	115	line_66	0.9914	0.885	0.9829	0.983	Line Piti 345 34.5 to Anigua 3 34.5 Circuit 1 and Agana T400
Harmn115	115	tran_53	na	0.8787	0.9834	0.9831	Tran Harmon 1 34.50 to Harmn115 115.00 Circuit 2
Yigo_345	34.5	line_4	0.9368	0.8818	0.9499	0.9833	Line Piti 115 115.0 to Harmn115 115.0 Circuit 1
Potts Jc	34.5	line_61	0.935	0.8255	0.9524	0.9834	Line Piti 115 115.0 to Harmn115 115.0 and Agana T400
Agana115	115	line_57	0.9908	0.8877	0.9838	0.9834	Line Cabr 115 115.0 to Agana115 115.0 Circuit 1 and Agana T400
Harmn115	115	line_68	0.9888	0.88	0.9835	0.9835	Line Tamuning 34.5 to Tumon 34 34.5 Circuit 1 and Harmon T500
Yigo_345	34.5	line_54	0.9428	0.8799	0.9549	0.9836	Line Cabr 115 115.0 to Piti 115 115.0 Circuit 1 and Line Cabr 115 115.0 to Agana
Potts Jc	34.5	line_63	0.941	0.8204	0.9524	0.9837	Line Piti 115 115.0 to Harmn115 115.0 and Tamuning T600
Harmn115	115	tran_52	0.992	0.8883	0.9838	0.9837	Tran Harmon 3 34.50 to Harmn115 115.00 Circuit 1
Pagat 34	34.5	base	0.9548	0.9443	0.9645	0.9838	Base system (n-0)
NCS Fine	34.5	line_5	0.9551	0.834	0.9568	0.9839	Line Agana115 115.0 to Tamuning 115.0 Circuit 1

Voltage Limit Report

Name	kV	Outage	Existing 2007 Load	New DOD Loads	Line Upgrades w/ No 115 kV	Line Upgrades Including 115 kV	Outage description
Marbo 34	34.5	line_61	0.9287	0.898	0.9584	0.984	Line Piti 115 115.0 to Harmn115 115.0 and Agana T400
Agana115	115	line_63	0.9872	0.8773	0.9839	0.984	Line Piti 115 115.0 to Harmn115 115.0 and Tamuning T600
NCS Fine	34.5	line_62	0.9529	0.8509	0.959	0.9842	Line Piti 115 115.0 to Harmn115 115.0 and Piti T700
Dededo 3	34.5	line_61	0.9285	0.8931	0.9583	0.9843	Line Piti 115 115.0 to Harmn115 115.0 and Agana T400
Agana115	115	line_4	0.9901	0.8859	0.9835	0.9843	Line Piti 115 115.0 to Harmn115 115.0 Circuit 1
NCS Fine	34.5	line_65	0.9529	0.8284	0.9566	0.9844	Line Tamuning 115.0 to Harmn115 115.0 and Tamuning T600
NCS Fine	34.5	line_64	0.953	0.8286	0.9567	0.9844	Line Agana115 115.0 to Tamuning 115.0 Circuit 1 and Tamuning T600
Dededo 3	34.5	line_63	0.9359	0.8883	0.9581	0.9844	Line Piti 115 115.0 to Harmn115 115.0 and Tamuning T600
Tamuning	115	line_34	0.9924	0.8856	0.9825	0.9844	Line Tanguiss 34.5 to Harmon 3 34.5 Circuit 2
Tamuning	115	line_9	0.9922	0.8975	0.9866	0.9844	Line Cabrs345 34.5 to Piti 345 34.5 Circuit 1
Tamuning	115	tran_48	0.9922	0.8975	0.9866	0.9844	Tran Cabrs345 34.50 to Cabr 115 115.00 Circuit 1
Potts Jc	34.5	line_5	0.9504	0.8397	0.9549	0.9847	Line Agana115 115.0 to Tamuning 115.0 Circuit 1
Tamuning	115	line_38	0.9929	0.8888	0.984	0.9847	Line Harmon 3 34.5 to Macheche 34.5 Circuit 1
Tamuning	115	line_17	0.9933	0.8811	0.9827	0.9848	Line Apra 34. 34.5 to Tenjotap 34.5 Circuit 1
Agana115	115	line_61	0.9903	0.8833	0.9858	0.9849	Line Piti 115 115.0 to Harmn115 115.0 and Agana T400
Tamuning	115	tran_49	0.9925	0.8962	0.9863	0.9849	Tran Piti 345 34.50 to Piti 115 115.00 Circuit 1
Tamuning	115	line_14	0.9928	0.8896	0.9841	0.985	Line Talofofo 34.5 to Apra 34. 34.5 Circuit 1
Potts Jc	34.5	line_62	0.9482	0.8563	0.9571	0.9851	Line Piti 115 115.0 to Harmn115 115.0 and Piti T700
Tamuning	115	line_13	0.9935	0.8889	0.9838	0.9851	Line Piti 345 34.5 to Anigua 3 34.5 Circuit 1
Potts Jc	34.5	line_65	0.948	0.8337	0.9546	0.9852	Line Tamuning 115.0 to Harmn115 115.0 and Tamuning T600
Piti 115	115	line_54	1.0094	0.8866	0.9968	0.9852	Line Cabr 115 115.0 to Piti 115 115.0 Circuit 1 and Line Cabr 115 115.0 to Agana
Potts Jc	34.5	line_64	0.9482	0.8339	0.9547	0.9853	Line Agana115 115.0 to Tamuning 115.0 Circuit 1 and Tamuning T600
Tamuning	115	line_33	0.9936	0.8828	0.9826	0.9853	Line Tanguiss 34.5 to Harmon 1 34.5 Circuit 1
Tamuning	115	line_60	0.9923	0.8972	0.985	0.9855	Line Cabr 115 to Piti 115 and Piti T700
Marbo 34	34.5	line_63	0.939	0.8959	0.9597	0.9856	Line Piti 115 115.0 to Harmn115 115.0 and Tamuning T600
Tamuning	115	line_19	0.9936	0.8875	0.9838	0.9856	Line Piti 345 34.5 to Cld Stor 34.5 Circuit 1
Tamuning	115	line_12	0.9939	0.8897	0.9843	0.9856	Line Piti 345 34.5 to Agana 34 34.5 Circuit 1
Tamuning	115	line_35	0.9923	0.8829	0.9829	0.9857	Line Harmon 3 34.5 to Dededo 3 34.5 Circuit 1
Harmn115	115	line_43	0.9933	0.8923	0.9849	0.9857	Line Macheche 34.5 to Pagat 34 34.5 Circuit 1
Tamuning	115	line_25	0.993	0.8898	0.9844	0.9858	Line Agana 34 34.5 to Tamuning 34.5 Circuit 1
Tamuning	115	line_23	0.9929	0.89	0.9846	0.9858	Line Agana 34 34.5 to Barrigad 34.5 Circuit 1
Tamuning	115	tran_50	0.9937	0.8922	0.9856	0.9858	Tran Agana 34 34.50 to Agana115 115.00 Circuit 1
Tamuning	115	line_39	0.9928	0.8867	0.984	0.986	Line Harmon 1 34.5 to Yigo_345 34.5 Circuit 1
Tamuning	115	line_11	na	0.8871	0.9842	0.986	Line Piti 345 34.5 to Orote 34 34.5 Circuit 1
Tamuning	115	line_30	0.9934	0.891	0.9848	0.986	Line Tumon 34 34.5 to Harmon 3 34.5 Circuit 1
Tamuning	115	line_21	0.9938	0.8907	0.9848	0.9861	Line Pulantat 34.5 to Talofofo 34.5 Circuit 1
Tamuning	115	line_47	0.9934	0.8906	0.9849	0.9861	Line GIAT 34.5 to Harmon 1 34.5 Circuit 1
Tamuning	115	line_31	0.9944	0.8907	0.985	0.9861	Line Anigua 3 34.5 to Agana 34 34.5 Circuit 1
Tamuning	115	line_10	0.9933	0.894	0.9862	0.9862	Line Piti 345 34.5 to Tenjotap 34.5 Circuit 1
Tamuning	115	line_24	0.9935	0.8902	0.9846	0.9863	Line Agana 34 34.5 to Radio Ba 34.5 Circuit 1
Tamuning	115	line_46	0.9936	0.8908	0.985	0.9863	Line GAA 34.5 34.5 to GIAT 34.5 Circuit 1
Tamuning	115	line_27	0.9936	0.8905	0.9847	0.9864	Line Radio Ba 34.5 to Marbo 34 34.5 Circuit 1
Tamuning	115	line_40	0.9936	0.8905	0.9847	0.9864	Line Dededo 3 34.5 to Marbo 34 34.5 Circuit 1
Tamuning	115	line_15	0.9938	0.8873	0.9848	0.9864	Line Apra 34. 34.5 to Orote 34 34.5 Circuit 1
Tamuning	115	line_67	0.9905	0.8771	0.9849	0.9864	Line Agana 34 34.5 to Tamuning 34.5 Circuit 1 and Tamuning T600
Tamuning	115	line_32	0.9936	0.8913	0.9849	0.9864	Line San Vito 34.5 to Harmon 3 34.5 Circuit 1
Tamuning	115	line_1	0.9938	0.8897	0.9858	0.9864	Line Cabr 115 115.0 to Piti 115 115.0 Circuit 1
Tamuning	115	line_22	0.9941	0.8919	0.9858	0.9864	Line Pulantat 34.5 to Barrigad 34.5 Circuit 1
Andersen	34.5	line_61	0.9165	0.8445	0.9451	0.9865	Line Piti 115 115.0 to Harmn115 115.0 and Agana T400
Tamuning	115	line_18	0.9938	0.8904	0.9848	0.9865	Line Orote 34 34.5 to Cld Stor 34.5 Circuit 1
Tamuning	115	line_26	0.9938	0.8909	0.985	0.9865	Line Barrigad 34.5 to GAA 34.5 34.5 Circuit 1
Tamuning	115	line_44	0.9938	0.8909	0.9851	0.9865	Line Macheche 34.5 to GAA 34.5 34.5 Circuit 1
Tamuning	115	base	0.9939	0.8909	0.9851	0.9865	Base system (n-0)

Voltage Limit Report

Name	kV	Outage	Existing 2007 Load	New DOD Loads	Line Upgrades w/ No 115 kV	Line Upgrades Including 115 kV	Outage description
Harmn115	115	line_20	0.9905	0.8946	0.9861	0.9865	Line Cld Stor 34.5 to Cold Sto 34.5 Circuit 1
Tamuning	115	line_41	0.9935	0.8907	0.985	0.9866	Line NCS Fine 34.5 to Potts Jc 34.5 Circuit 1
Tamuning	115	line_42	0.9935	0.8907	0.985	0.9866	Line Potts Jc 34.5 to Andersen 34.5 Circuit 1
Tamuning	115	line_45	0.9938	0.8906	0.9851	0.9866	Line Yigo_345 34.5 to Andersen 34.5 Circuit 1
Andersen	34.5	line_63	0.9235	0.8393	0.9449	0.9868	Line Piti 115 115.0 to Harmn115 115.0 and Tamuning T600
Tamuning	115	line_28	0.9937	0.8914	0.9853	0.9869	Line Tamuning 34.5 to Tumon 34 34.5 Circuit 1
Tamuning	115	line_29	0.9939	0.8915	0.9853	0.9869	Line Tamuning 34.5 to San Vito 34.5 Circuit 1
NCS Fine	34.5	line_4	0.9564	0.845	0.9598	0.9873	Line Piti 115 115.0 to Harmn115 115.0 Circuit 1
Tamuning	115	tran_52	0.993	0.8903	0.9857	0.9873	Tran Harmon 3 34.50 to Harmn115 115.00 Circuit 1
Tamuning	115	line_16	0.9946	0.8921	0.9858	0.9874	Line Apra 34. 34.5 to Umatac34 34.5 Circuit 1
Tamuning	115	tran_53	na	0.8809	0.9859	0.9874	Tran Harmon 1 34.50 to Harmn115 115.00 Circuit 2
NCS Fine	34.5	line_54	0.9626	0.8434	0.9651	0.9875	Line Cabr 115 115.0 to Piti 115 115.0 Circuit 1 and Line Cabr 115 115.0 to Agana
Andersen	34.5	line_5	0.9342	0.8602	0.9483	0.9877	Line Agana115 115.0 to Tamuning 115.0 Circuit 1
Tamuning	115	tran_51	0.994	0.8933	0.9869	0.9879	Tran Tamuning 34.50 to Tamuning 115.00 Circuit 1
Andersen	34.5	line_62	0.9319	0.876	0.9504	0.9881	Line Piti 115 115.0 to Harmn115 115.0 and Piti T700
Potts Jc	34.5	line_4	0.9518	0.8506	0.9579	0.9881	Line Piti 115 115.0 to Harmn115 115.0 Circuit 1
Tamuning	115	line_68	0.991	0.8837	0.9864	0.9881	Line Tamuning 34.5 to Tumon 34 34.5 Circuit 1 and Harmon T500
Piti 115	115	line_58	1.01	0.8949	0.9996	0.9881	Line Cabr 115 to Piti 115 and Agana T400
Andersen	34.5	line_65	0.9309	0.8527	0.9474	0.9883	Line Tamuning 115.0 to Harmn115 115.0 and Tamuning T600
Andersen	34.5	line_64	0.9311	0.8529	0.9475	0.9883	Line Agana115 115.0 to Tamuning 115.0 Circuit 1 and Tamuning T600
Potts Jc	34.5	line_54	0.9579	0.8488	0.9631	0.9884	Line Cabr 115 115.0 to Piti 115 115.0 Circuit 1 and Line Cabr 115 115.0 to Agana
Yigo_345	34.5	line_58	0.9405	0.8892	0.9575	0.9891	Line Cabr 115 to Piti 115 and Agana T400
Yigo_345	34.5	tran_53	na	0.8475	0.936	0.9894	Tran Harmon 1 34.50 to Harmn115 115.00 Circuit 2
Yigo_345	34.5	line_57	0.9347	0.8855	0.9532	0.9894	Line Cabr 115 115.0 to Agana115 115.0 Circuit 1 and Agana T400
NCS Fine	34.5	tran_53	na	0.8031	0.9435	0.9895	Tran Harmon 1 34.50 to Harmn115 115.00 Circuit 2
Agana115	115	line_34	0.997	0.8924	0.9877	0.9896	Line Tanguiss 34.5 to Harmon 3 34.5 Circuit 2
Agana115	115	line_38	0.9972	0.8952	0.9888	0.9896	Line Harmon 3 34.5 to Macheche 34.5 Circuit 1
Umatac34	34.5	line_56	na	na	0.8841	0.9897	Line Piti 345 34.5 to Orote 34 34.5 and Piti to Apra w/ Tenjo Tap 34.5
Pulantat	34.5	base	0.9455	0.9448	0.9619	0.9898	Base system (n-0)
Yigo_345	34.5	line_67	0.9333	0.8564	0.9495	0.99	Line Agana 34 34.5 to Tamuning 34.5 Circuit 1 and Tamuning T600
Agana115	115	line_17	0.9979	0.8878	0.9878	0.99	Line Apra 34. 34.5 to Tenjotap 34.5 Circuit 1
Agana115	115	line_14	0.9974	0.8962	0.9892	0.9902	Line Talofofo 34.5 to Apra 34. 34.5 Circuit 1
Agana115	115	line_13	0.998	0.8956	0.9889	0.9903	Line Piti 345 34.5 to Anigua 3 34.5 Circuit 1
Agana115	115	line_66	0.9994	0.8954	0.9904	0.9903	Line Piti 345 34.5 to Anigua 3 34.5 Circuit 1 and Agana T400
Agana115	115	line_33	0.9981	0.8899	0.9879	0.9905	Line Tanguiss 34.5 to Harmon 1 34.5 Circuit 1
Yigo_345	34.5	line_39	0.9158	0.8396	0.9381	0.9906	Line Harmon 1 34.5 to Yigo_345 34.5 Circuit 1
Agana115	115	line_19	0.9981	0.8942	0.9889	0.9907	Line Piti 345 34.5 to Cld Stor 34.5 Circuit 1
Tamuning	115	line_43	0.9977	0.897	0.9893	0.9908	Line Macheche 34.5 to Pagat 34 34.5 Circuit 1
Agana115	115	line_12	0.9984	0.8963	0.9894	0.9908	Line Piti 345 34.5 to Agana 34 34.5 Circuit 1
Agana115	115	line_35	0.9967	0.8894	0.988	0.9909	Line Harmon 3 34.5 to Dededo 3 34.5 Circuit 1
Andersen	34.5	line_4	0.9357	0.8707	0.9514	0.9911	Line Piti 115 115.0 to Harmn115 115.0 Circuit 1
Agana115	115	line_39	0.9973	0.8934	0.9891	0.9911	Line Harmon 1 34.5 to Yigo_345 34.5 Circuit 1
Tamuning	115	line_55	0.9977	0.8955	0.9892	0.9911	Line Tamuning 115.0 to Harmn115 115.0 and Line Giattap 34.5 to Harmon 1 34.5
Agana115	115	line_11	na	0.8937	0.9893	0.9911	Line Piti 345 34.5 to Orote 34 34.5 Circuit 1
Dededo 3	34.5	line_67	0.9409	0.889	0.9609	0.9912	Line Agana 34 34.5 to Tamuning 34.5 Circuit 1 and Tamuning T600
Agana115	115	line_67	0.995	0.8834	0.9894	0.9912	Line Agana 34 34.5 to Tamuning 34.5 Circuit 1 and Tamuning T600
Agana115	115	line_47	0.9979	0.8971	0.9899	0.9912	Line GIAT 34.5 to Harmon 1 34.5 Circuit 1
Agana115	115	line_30	0.998	0.8975	0.9899	0.9912	Line Tumon 34 34.5 to Harmon 3 34.5 Circuit 1
Yigo_345	34.5	line_66	0.9376	0.8844	0.9539	0.9913	Line Piti 345 34.5 to Anigua 3 34.5 Circuit 1 and Agana T400
Agana115	115	line_21	0.9983	0.8973	0.9899	0.9913	Line Pulantat 34.5 to Talofofo 34.5 Circuit 1
Agana115	115	line_31	0.9988	0.8973	0.9901	0.9913	Line Anigua 3 34.5 to Agana 34 34.5 Circuit 1
Agana115	115	line_25	0.9981	0.8968	0.9898	0.9914	Line Agana 34 34.5 to Tamuning 34.5 Circuit 1
Agana115	115	line_46	0.9981	0.8974	0.9901	0.9914	Line GAA 34.5 34.5 to GIAT 34.5 Circuit 1

Voltage Limit Report

Name	kV	Outage	Existing 2007 Load	New DOD Loads	Line Upgrades w/ No 115 kV	Line Upgrades Including 115 kV	Outage description
Agana115	115	line_23	0.9979	0.8973	0.9902	0.9914	Line Agana 34 34.5 to Barrigad 34.5 Circuit 1
Agana115	115	line_22	0.9984	0.8983	0.9907	0.9914	Line Pulantat 34.5 to Barrigad 34.5 Circuit 1
Andersen	34.5	line_54	0.9412	0.8684	0.9562	0.9915	Line Cabr 115 115.0 to Piti 115 115.0 Circuit 1 and Line Cabr 115 115.0 to Agana
Agana115	115	line_15	0.9983	0.8938	0.9898	0.9915	Line Apra 34. 34.5 to Orote 34 34.5 Circuit 1
Agana115	115	line_27	0.9983	0.8973	0.9899	0.9915	Line Radio Ba 34.5 to Marbo 34 34.5 Circuit 1
Agana115	115	line_40	0.9983	0.8973	0.9899	0.9915	Line Dededo 3 34.5 to Marbo 34 34.5 Circuit 1
Agana115	115	line_32	0.9981	0.8978	0.99	0.9915	Line San Vito 34.5 to Harmon 3 34.5 Circuit 1
Tamuning	115	line_6	0.9984	0.8958	0.9898	0.9916	Line Tamuning 115.0 to Harmn115 115.0 Circuit 1
Agana115	115	line_24	0.9982	0.8971	0.9898	0.9916	Line Agana 34 34.5 to Radio Ba 34.5 Circuit 1
Agana115	115	line_18	0.9983	0.897	0.9899	0.9916	Line Orote 34 34.5 to Cld Stor 34.5 Circuit 1
Agana115	115	base	0.9983	0.8975	0.9901	0.9916	Base system (n-0)
Agana115	115	line_44	0.9983	0.8975	0.9901	0.9916	Line Macheche 34.5 to GAA 34.5 34.5 Circuit 1
Agana115	115	line_26	0.9983	0.8977	0.9901	0.9916	Line Barrigad 34.5 to GAA 34.5 34.5 Circuit 1
Agana115	115	tran_51	0.9974	0.8976	0.9905	0.9916	Tran Tamuning 34.50 to Tamuning 115.00 Circuit 1
Agana115	115	line_41	0.998	0.8974	0.99	0.9917	Line NCS Fine 34.5 to Potts Jc 34.5 Circuit 1
Agana115	115	line_42	0.998	0.8974	0.99	0.9917	Line Potts Jc 34.5 to Andersen 34.5 Circuit 1
Agana115	115	line_45	0.9983	0.8972	0.9902	0.9917	Line Yigo_345 34.5 to Andersen 34.5 Circuit 1
Agana115	115	line_28	0.9982	0.898	0.9903	0.992	Line Tamuning 34.5 to Tumon 34 34.5 Circuit 1
Agana115	115	line_29	0.9984	0.898	0.9903	0.992	Line Tamuning 34.5 to San Vito 34.5 Circuit 1
Potts Jc	34.5	tran_53	na	0.8117	0.9428	0.9921	Tran Harmon 1 34.50 to Harmn115 115.00 Circuit 2
Agana115	115	tran_52	0.997	0.8964	0.9903	0.9921	Tran Harmon 3 34.50 to Harmn115 115.00 Circuit 1
Tamuning	115	line_20	0.9953	0.8998	0.991	0.9922	Line Cld Stor 34.5 to Cold Sto 34.5 Circuit 1
Agana115	115	tran_53	na	0.8873	0.9905	0.9923	Tran Harmon 1 34.50 to Harmn115 115.00 Circuit 2
Yigo_345	34.5	line_2	0.9448	0.8966	0.957	0.9925	Line Cabr 115 115.0 to Agana115 115.0 Circuit 1
Yigo_345	34.5	line_3	0.9448	0.8966	0.957	0.9925	Line Cabr 115 115.0 to Agana115 115.0 Circuit 2
Agana115	115	line_16	0.9991	0.8987	0.9909	0.9926	Line Apra 34. 34.5 to Umatac34 34.5 Circuit 1
Agana115	115	line_1	0.9984	0.898	0.9913	0.9926	Line Cabr 115 115.0 to Piti 115 115.0 Circuit 1
Talofofo	34.5	line_17	0.9331	0.8993	0.9497	0.9927	Line Apra 34. 34.5 to Tenjotap 34.5 Circuit 1
Agana115	115	line_68	0.9952	0.89	0.9909	0.9928	Line Tamuning 34.5 to Tumon 34 34.5 Circuit 1 and Harmon T500
NCS Fine	34.5	line_58	0.9616	0.8542	0.9681	0.9929	Line Cabr 115 to Piti 115 and Agana T400
NCS Fine	34.5	line_57	0.9559	0.8505	0.9637	0.9932	Line Cabr 115 115.0 to Agana115 115.0 Circuit 1 and Agana T400
Umatac34	34.5	line_17	0.9317	0.8733	0.9374	0.9934	Line Apra 34. 34.5 to Tenjotap 34.5 Circuit 1
Marbo 34	34.5	line_67	0.9454	0.8988	0.9636	0.9934	Line Agana 34 34.5 to Tamuning 34.5 Circuit 1 and Tamuning T600
Dededo 3	34.5	line_68	0.9248	0.8978	0.9564	0.9935	Line Tamuning 34.5 to Tumon 34 34.5 Circuit 1 and Harmon T500
NCS Fine	34.5	line_67	0.9548	0.8214	0.9605	0.9937	Line Agana 34 34.5 to Tamuning 34.5 Circuit 1 and Tamuning T600
NCS Fine	34.5	line_59	0.9624	0.8653	0.967	0.9937	Line Cabr 115 115.0 to Agana115 115.0 Circuit 1 and Piti T700
Potts Jc	34.5	line_58	0.9562	0.8591	0.966	0.9939	Line Cabr 115 to Piti 115 and Agana T400
Potts Jc	34.5	line_57	0.9506	0.8553	0.9615	0.9941	Line Cabr 115 115.0 to Agana115 115.0 Circuit 1 and Agana T400
Dededo 3	34.5	line_35	0.9051	0.8394	0.9373	0.9945	Line Harmon 3 34.5 to Dededo 3 34.5 Circuit 1
Ded CT#1	13.8	line_35	0.9051	0.8994	0.9374	0.9945	Line Harmon 3 34.5 to Dededo 3 34.5 Circuit 1
Yigo_345	34.5	line_68	0.9219	0.8684	0.9485	0.9946	Line Tamuning 34.5 to Tumon 34 34.5 Circuit 1 and Harmon T500
Potts Jc	34.5	line_59	0.9576	0.8704	0.9649	0.9946	Line Cabr 115 115.0 to Agana115 115.0 Circuit 1 and Piti T700
Potts Jc	34.5	line_67	0.9493	0.826	0.9581	0.9947	Line Agana 34 34.5 to Tamuning 34.5 Circuit 1 and Tamuning T600
Harmon 1	34.5	tran_53	na	0.8971	0.9602	0.9949	Tran Harmon 1 34.50 to Harmn115 115.00 Circuit 2
NCS Fine	34.5	line_6	0.9669	0.8662	0.9679	0.9949	Line Tamuning 115.0 to Harmn115 115.0 Circuit 1
NCS Fine	34.5	line_66	0.959	0.8498	0.9645	0.995	Line Piti 345 34.5 to Anigua 3 34.5 Circuit 1 and Agana T400
Yigo_345	34.5	tran_50	0.9416	0.8973	0.958	0.9953	Tran Agana 34 34.50 to Agana115 115.00 Circuit 1
Yigo_345	34.5	tran_51	0.9463	0.8956	0.9574	0.9957	Tran Tamuning 34.50 to Tamuning 115.00 Circuit 1
Potts Jc	34.5	line_6	0.9624	0.8717	0.9661	0.9958	Line Tamuning 115.0 to Harmn115 115.0 Circuit 1
Potts Jc	34.5	line_66	0.9536	0.8544	0.9623	0.996	Line Piti 345 34.5 to Anigua 3 34.5 Circuit 1 and Agana T400
Cold Storage	34.5	line_19	0.9494	0.8633	0.9142	0.9962	Line Piti 345 34.5 to Cld Stor 34.5 Circuit 1
NCS Fine	34.5	line_2	0.9646	0.8609	0.9672	0.9963	Line Cabr 115 115.0 to Agana115 115.0 Circuit 1
NCS Fine	34.5	line_3	0.9646	0.8609	0.9672	0.9963	Line Cabr 115 115.0 to Agana115 115.0 Circuit 2

Voltage Limit Report

Name	kV	Outage	Existing 2007 Load	New DOD Loads	Line Upgrades w/ No 115 kV	Line Upgrades Including 115 kV	Outage description
Marbo 34	34.5	line_35	0.9143	0.8571	0.9425	0.9964	Line Harmon 3 34.5 to Dededo 3 34.5 Circuit 1
Yigo_345	34.5	line_35	0.9197	0.841	0.9433	0.9965	Line Harmon 3 34.5 to Dededo 3 34.5 Circuit 1
NCS Fine	34.5	line_55	0.9691	0.8664	0.9696	0.9967	Line Tamuning 115.0 to Harmn115 115.0 and Line Giattap 34.5 to Harmon 1 34.5
Agana115	115	line_64	1.0013	0.897	0.996	0.9968	Line Agana115 115.0 to Tamuning 115.0 Circuit 1 and Tamuning T600
Yigo_345	34.5	line_33	0.9526	0.8892	0.9563	0.9969	Line Tanguiss 34.5 to Harmon 1 34.5 Circuit 1
Agana115	115	line_65	1.0014	0.8971	0.9961	0.9969	Line Tamuning 115.0 to Harmn115 115.0 and Tamuning T600
Tamuning	115	line_65	1.0014	0.8971	0.9961	0.9969	Line Tamuning 115.0 to Harmn115 115.0 and Tamuning T600
Andersen	34.5	line_58	0.9376	0.8765	0.9584	0.9972	Line Cabr 115 to Piti 115 and Agana T400
Potts Jc	34.5	line_2	0.9598	0.8661	0.9652	0.9972	Line Cabr 115 115.0 to Agana115 115.0 Circuit 1
Potts Jc	34.5	line_3	0.9598	0.8661	0.9652	0.9972	Line Cabr 115 115.0 to Agana115 115.0 Circuit 2
Yigo_345	34.5	tran_52	0.9352	0.8935	0.9542	0.9973	Tran Harmon 3 34.50 to Harmn115 115.00 Circuit 1
Potts Jc	34.5	line_55	0.9643	0.8719	0.9675	0.9974	Line Tamuning 115.0 to Harmn115 115.0 and Line Giattap 34.5 to Harmon 1 34.5
Andersen	34.5	line_57	0.9318	0.8727	0.954	0.9975	Line Cabr 115 115.0 to Agana115 115.0 Circuit 1 and Agana T400
Andersen	34.5	line_59	0.9407	0.8887	0.9578	0.9979	Line Cabr 115 115.0 to Agana115 115.0 Circuit 1 and Piti T700
Yigo_345	34.5	line_17	0.9526	0.8952	0.9607	0.9979	Line Apra 34. 34.5 to Tenjotap 34.5 Circuit 1
Andersen	34.5	line_67	0.9302	0.8423	0.9497	0.9982	Line Agana 34 34.5 to Tamuning 34.5 Circuit 1 and Tamuning T600
NCS Fine	34.5	line_68	0.9461	0.8349	0.9603	0.9982	Line Tamuning 34.5 to Tumon 34 34.5 Circuit 1 and Harmon T500
Yigo_345	34.5	line_24	0.949	0.8989	0.9602	0.9984	Line Agana 34 34.5 to Radio Ba 34.5 Circuit 1
Talofofo	34.5	base	0.9444	0.9451	0.9658	0.9989	Base system (n-0)
Andersen	34.5	line_6	0.9466	0.8913	0.9596	0.999	Line Tamuning 115.0 to Harmn115 115.0 Circuit 1
NCS Fine	34.5	line_41	0.9873	0.8518	0.9822	0.999	Line NCS Fine 34.5 to Potts Jc 34.5 Circuit 1
NCS Fine	34.5	line_42	0.9873	0.8518	0.9822	0.999	Line Potts Jc 34.5 to Andersen 34.5 Circuit 1
Potts Jc	34.5	line_42	0.9873	0.8518	0.9822	0.999	Line Potts Jc 34.5 to Andersen 34.5 Circuit 1
NCS Fine	34.5	tran_50	0.9626	0.8627	0.9687	0.9991	Tran Agana 34 34.50 to Agana115 115.00 Circuit 1
Potts Jc	34.5	line_68	0.9395	0.8389	0.9575	0.9992	Line Tamuning 34.5 to Tumon 34 34.5 Circuit 1 and Harmon T500
NCS Fine	34.5	line_23	0.9672	0.8643	0.9688	0.9992	Line Agana 34 34.5 to Barrigad 34.5 Circuit 1
NCS Fine	34.5	tran_51	0.9666	0.861	0.9681	0.9994	Tran Tamuning 34.50 to Tamuning 115.00 Circuit 1
Andersen	34.5	line_66	0.9345	0.8711	0.9545	0.9995	Line Piti 345 34.5 to Anigua 3 34.5 Circuit 1 and Agana T400
NCS Fine	34.5	line_38	0.9704	0.8679	0.9703	0.9995	Line Harmon 3 34.5 to Macheche 34.5 Circuit 1
Yigo_345	34.5	base	0.9534	0.9081	0.9635	0.9996	Base system (n-0)
Andersen	34.5	line_55	0.9473	0.8914	0.9603	0.9998	Line Tamuning 115.0 to Harmn115 115.0 and Line Giattap 34.5 to Harmon 1 34.5
Potts Jc	34.5	tran_50	0.9573	0.8675	0.9665	1.0001	Tran Agana 34 34.50 to Agana115 115.00 Circuit 1
NCS Fine	34.5	line_33	0.9718	0.8498	0.9657	1.0004	Line Tanguiss 34.5 to Harmon 1 34.5 Circuit 1
Potts Jc	34.5	tran_51	0.9616	0.8657	0.9659	1.0004	Tran Tamuning 34.50 to Tamuning 115.00 Circuit 1
Potts Jc	34.5	line_23	0.9627	0.8698	0.9669	1.0004	Line Agana 34 34.5 to Barrigad 34.5 Circuit 1
Andersen	34.5	line_2	0.9431	0.8849	0.9582	1.0006	Line Cabr 115 115.0 to Agana115 115.0 Circuit 1
Andersen	34.5	line_3	0.9431	0.8849	0.9582	1.0006	Line Cabr 115 115.0 to Agana115 115.0 Circuit 2
NCS Fine	34.5	line_9	0.971	0.8774	0.974	1.0006	Line Cabrs345 34.5 to Piti 345 34.5 Circuit 1
NCS Fine	34.5	tran_48	0.971	0.8774	0.974	1.0006	Tran Cabrs345 34.50 to Cabr 115 115.00 Circuit 1
Potts Jc	34.5	line_38	0.9664	0.8739	0.9688	1.0009	Line Harmon 3 34.5 to Macheche 34.5 Circuit 1
NCS Fine	34.5	line_35	0.9512	0.8225	0.9584	1.001	Line Harmon 3 34.5 to Dededo 3 34.5 Circuit 1
NCS Fine	34.5	tran_52	0.9578	0.8597	0.9656	1.001	Tran Harmon 3 34.50 to Harmn115 115.00 Circuit 1
NCS Fine	34.5	line_60	0.9717	0.8793	0.974	1.0011	Line Cabr 115 to Piti 115 and Piti T700
NCS Fine	34.5	line_1	0.9728	0.8683	0.9737	1.0014	Line Cabr 115 115.0 to Piti 115 115.0 Circuit 1
NCS Fine	34.5	tran_49	0.9715	0.8768	0.9741	1.0014	Tran Piti 345 34.50 to Piti 115 115.00 Circuit 1
Potts Jc	34.5	line_33	0.9673	0.8566	0.9641	1.0015	Line Tanguiss 34.5 to Harmon 1 34.5 Circuit 1
Andersen	34.5	tran_53	na	0.8426	0.9401	1.0016	Tran Harmon 1 34.50 to Harmn115 115.00 Circuit 2
NCS Fine	34.5	line_17	0.9722	0.8595	0.9709	1.0016	Line Apra 34. 34.5 to Tenjotap 34.5 Circuit 1
Potts Jc	34.5	line_9	0.9663	0.8825	0.972	1.0016	Line Cabrs345 34.5 to Piti 345 34.5 Circuit 1
Potts Jc	34.5	tran_48	0.9663	0.8825	0.972	1.0016	Tran Cabrs345 34.50 to Cabr 115 115.00 Circuit 1
NCS Fine	34.5	line_14	0.9713	0.871	0.9724	1.0016	Line Talofofo 34.5 to Apra 34. 34.5 Circuit 1
Potts Jc	34.5	line_35	0.9412	0.8197	0.9541	1.0017	Line Harmon 3 34.5 to Dededo 3 34.5 Circuit 1
NCS Fine	34.5	line_34	0.973	0.8674	0.9722	1.0018	Line Tanguiss 34.5 to Harmon 3 34.5 Circuit 2

Voltage Limit Report

Name	kV	Outage	Existing 2007 Load	New DOD Loads	Line Upgrades w/ No 115 kV	Line Upgrades Including 115 kV	Outage description
NCS Fine	34.5	line_28	0.9707	0.8686	0.9714	1.0019	Line Tamuning 34.5 to Tumon 34 34.5 Circuit 1
NCS Fine	34.5	line_13	0.9728	0.87	0.9722	1.0019	Line Piti 345 34.5 to Anigua 3 34.5 Circuit 1
Apra 34.	34.5	line_56	na	na	0.8979	1.002	Line Piti 345 34.5 to Orote 34 34.5 and Piti to Apra w/ Tenjo Tap 34.5
Potts Jc	34.5	tran_52	0.9518	0.8641	0.963	1.002	Tran Harmon 3 34.50 to Harmn115 115.00 Circuit 1
Potts Jc	34.5	line_60	0.967	0.8843	0.972	1.0021	Line Cabr 115 to Piti 115 and Piti T700
NCS Fine	34.5	line_39	0.9656	0.8555	0.9684	1.0023	Line Harmon 1 34.5 to Yigo_345 34.5 Circuit 1
NCS Fine	34.5	line_24	0.9697	0.8653	0.971	1.0023	Line Agana 34 34.5 to Radio Ba 34.5 Circuit 1
Potts Jc	34.5	line_1	0.9681	0.8736	0.9718	1.0023	Line Cabr 115 115.0 to Piti 115 115.0 Circuit 1
NCS Fine	34.5	line_29	0.9707	0.8696	0.972	1.0024	Line Tamuning 34.5 to San Vito 34.5 Circuit 1
Potts Jc	34.5	tran_49	0.9668	0.8819	0.9721	1.0024	Tran Piti 345 34.50 to Piti 115 115.00 Circuit 1
NCS Fine	34.5	line_19	0.9726	0.8682	0.9721	1.0025	Line Piti 345 34.5 to Cld Stor 34.5 Circuit 1
NCS Fine	34.5	line_12	0.9733	0.871	0.9729	1.0025	Line Piti 345 34.5 to Agana 34 34.5 Circuit 1
Potts Jc	34.5	line_17	0.9675	0.8647	0.9689	1.0026	Line Apra 34. 34.5 to Tenjotap 34.5 Circuit 1
Potts Jc	34.5	line_14	0.9666	0.8763	0.9704	1.0026	Line Talofofo 34.5 to Apra 34. 34.5 Circuit 1
Umatac34	34.5	line_11	na	0.8974	0.9491	1.0027	Line Piti 345 34.5 to Orote 34 34.5 Circuit 1
Potts Jc	34.5	line_34	0.9678	0.872	0.97	1.0027	Line Tanguiss 34.5 to Harmon 3 34.5 Circuit 2
NCS Fine	34.5	line_21	0.9729	0.8724	0.9732	1.0027	Line Pulantat 34.5 to Talofofo 34.5 Circuit 1
NCS Fine	34.5	line_25	0.9719	0.8712	0.9731	1.0028	Line Agana 34 34.5 to Tamuning 34.5 Circuit 1
Potts Jc	34.5	line_28	0.9659	0.8737	0.9693	1.0029	Line Tamuning 34.5 to Tumon 34 34.5 Circuit 1
Potts Jc	34.5	line_13	0.9681	0.8752	0.9702	1.0029	Line Piti 345 34.5 to Anigua 3 34.5 Circuit 1
NCS Fine	34.5	line_11	na	0.8674	0.9726	1.0029	Line Piti 345 34.5 to Orote 34 34.5 Circuit 1
NCS Fine	34.5	line_10	0.9722	0.8759	0.9747	1.0029	Line Piti 345 34.5 to Tenjotap 34.5 Circuit 1
Andersen	34.5	line_68	0.9165	0.8533	0.9478	1.003	Line Tamuning 34.5 to Tumon 34 34.5 Circuit 1 and Harmon T500
Potts Jc	34.5	line_39	0.9583	0.8564	0.9652	1.003	Line Harmon 1 34.5 to Yigo_345 34.5 Circuit 1
NCS Fine	34.5	line_27	0.971	0.8671	0.9722	1.003	Line Radio Ba 34.5 to Marbo 34 34.5 Circuit 1
NCS Fine	34.5	line_40	0.971	0.8671	0.9722	1.003	Line Dededo 3 34.5 to Marbo 34 34.5 Circuit 1
NCS Fine	34.5	line_31	0.974	0.8724	0.9738	1.003	Line Anigua 3 34.5 to Agana 34 34.5 Circuit 1
NCS Fine	34.5	line_26	0.9734	0.871	0.9737	1.0031	Line Barrigad 34.5 to GAA 34.5 34.5 Circuit 1
Potts Jc	34.5	line_24	0.9645	0.8696	0.9687	1.0032	Line Agana 34 34.5 to Radio Ba 34.5 Circuit 1
NCS Fine	34.5	line_15	0.9729	0.8688	0.9735	1.0032	Line Apra 34. 34.5 to Orote 34 34.5 Circuit 1
NCS Fine	34.5	line_18	0.9728	0.8719	0.9734	1.0033	Line Orote 34 34.5 to Cld Stor 34.5 Circuit 1
Cabras_4	13.8	base	1.007	0.9236	1.0027	1.0033	Base system (n-0)
Potts Jc	34.5	line_29	0.9659	0.8747	0.97	1.0034	Line Tamuning 34.5 to San Vito 34.5 Circuit 1
Potts Jc	34.5	line_19	0.9679	0.8734	0.9701	1.0034	Line Piti 345 34.5 to Cld Stor 34.5 Circuit 1
NCS Fine	34.5	base	0.9729	0.8726	0.9737	1.0034	Base system (n-0)
Potts Jc	34.5	line_12	0.9687	0.8763	0.9709	1.0035	Line Piti 345 34.5 to Agana 34 34.5 Circuit 1
NCS Fine	34.5	line_44	0.9729	0.8726	0.9737	1.0035	Line Macheche 34.5 to GAA 34.5 34.5 Circuit 1
NCS Fine	34.5	line_32	0.9739	0.8721	0.974	1.0035	Line San Vito 34.5 to Harmon 3 34.5 Circuit 1
Andersen	34.5	tran_50	0.9386	0.8846	0.9589	1.0036	Tran Agana 34 34.50 to Agana115 115.00 Circuit 1
NCS Fine	34.5	line_45	0.9728	0.8696	0.9741	1.0036	Line Yigo_345 34.5 to Andersen 34.5 Circuit 1
NCS Fine	34.5	line_22	0.9742	0.8749	0.9753	1.0036	Line Pulantat 34.5 to Barrigad 34.5 Circuit 1
Cabras_2	13.8	base	1.007	0.9236	1.0031	1.0036	Base system (n-0)
Potts Jc	34.5	line_25	0.9672	0.8764	0.9711	1.0037	Line Agana 34 34.5 to Tamuning 34.5 Circuit 1
Potts Jc	34.5	line_21	0.9683	0.8776	0.9712	1.0037	Line Pulantat 34.5 to Talofofo 34.5 Circuit 1
NCS Fine	34.5	line_30	0.9741	0.8723	0.9744	1.0037	Line Tumon 34 34.5 to Harmon 3 34.5 Circuit 1
Potts Jc	34.5	line_11	na	0.8727	0.9706	1.0039	Line Piti 345 34.5 to Orote 34 34.5 Circuit 1
Potts Jc	34.5	line_10	0.9675	0.8812	0.9728	1.0039	Line Piti 345 34.5 to Tenjotap 34.5 Circuit 1
Andersen	34.5	line_35	0.9062	0.8097	0.9395	1.004	Line Harmon 3 34.5 to Dededo 3 34.5 Circuit 1
Andersen	34.5	tran_51	0.944	0.8827	0.9581	1.004	Tran Tamuning 34.50 to Tamuning 115.00 Circuit 1
Potts Jc	34.5	line_27	0.966	0.8716	0.9702	1.004	Line Radio Ba 34.5 to Marbo 34 34.5 Circuit 1
Potts Jc	34.5	line_40	0.966	0.8716	0.9702	1.004	Line Dededo 3 34.5 to Marbo 34 34.5 Circuit 1
Potts Jc	34.5	line_31	0.9694	0.8777	0.9718	1.004	Line Anigua 3 34.5 to Agana 34 34.5 Circuit 1
Potts Jc	34.5	line_26	0.9687	0.8763	0.9717	1.0041	Line Barrigad 34.5 to GAA 34.5 34.5 Circuit 1

Voltage Limit Report

Name	kV	Outage	Existing 2007 Load	New DOD Loads	Line Upgrades w/ No 115 kV	Line Upgrades Including 115 kV	Outage description
Potts Jc	34.5	line_15	0.9683	0.8741	0.9715	1.0042	Line Apra 34. 34.5 to Orote 34 34.5 Circuit 1
Potts Jc	34.5	line_18	0.9682	0.8771	0.9714	1.0043	Line Orote 34 34.5 to Cld Stor 34.5 Circuit 1
NCS Fine	34.5	line_46	0.9743	0.8722	0.975	1.0043	Line GAA 34.5 34.5 to GIAT 34.5 Circuit 1
Potts Jc	34.5	line_44	0.9682	0.8778	0.9717	1.0044	Line Macheche 34.5 to GAA 34.5 34.5 Circuit 1
Potts Jc	34.5	base	0.9683	0.8779	0.9718	1.0044	Base system (n-0)
NCS Fine	34.5	line_16	0.9738	0.8741	0.9745	1.0044	Line Apra 34. 34.5 to Umatac34 34.5 Circuit 1
Potts Jc	34.5	line_32	0.9694	0.8773	0.9721	1.0045	Line San Vito 34.5 to Harmon 3 34.5 Circuit 1
Andersen	34.5	line_23	0.9467	0.8895	0.9604	1.0046	Line Agana 34 34.5 to Barrigad 34.5 Circuit 1
Potts Jc	34.5	line_30	0.9695	0.8775	0.9724	1.0046	Line Tumon 34 34.5 to Harmon 3 34.5 Circuit 1
Potts Jc	34.5	line_22	0.9695	0.8802	0.9733	1.0046	Line Pulantat 34.5 to Barrigad 34.5 Circuit 1
Potts Jc	34.5	line_45	0.9679	0.8733	0.9722	1.005	Line Yigo_345 34.5 to Andersen 34.5 Circuit 1
NCS Fine	34.5	line_47	0.975	0.873	0.9759	1.005	Line GIAT 34.5 to Harmon 1 34.5 Circuit 1
Potts Jc	34.5	line_46	0.9694	0.8775	0.9729	1.0051	Line GAA 34.5 34.5 to GIAT 34.5 Circuit 1
Andersen	34.5	line_33	0.9514	0.8811	0.9583	1.0054	Line Tanguiss 34.5 to Harmon 1 34.5 Circuit 1
Potts Jc	34.5	line_16	0.9692	0.8793	0.9726	1.0054	Line Apra 34. 34.5 to Umatac34 34.5 Circuit 1
Andersen	34.5	line_39	0.9328	0.8596	0.954	1.0055	Line Harmon 1 34.5 to Yigo_345 34.5 Circuit 1
Apra 34.	34.5	line_17	0.9448	0.8873	0.9504	1.0056	Line Apra 34. 34.5 to Tenjotap 34.5 Circuit 1
Andersen	34.5	tran_52	0.9307	0.8799	0.954	1.0057	Tran Harmon 3 34.50 to Harmn115 115.00 Circuit 1
Umatac34	34.5	base	0.95	0.9406	0.9652	1.0057	Base system (n-0)
Potts Jc	34.5	line_47	0.9699	0.8781	0.9737	1.0057	Line GIAT 34.5 to Harmon 1 34.5 Circuit 1
Andersen	34.5	line_34	0.9496	0.8886	0.9622	1.0058	Line Tanguiss 34.5 to Harmon 3 34.5 Circuit 2
Andersen	34.5	line_1	0.9517	0.8926	0.9648	1.0058	Line Cabr 115 115.0 to Piti 115 115.0 Circuit 1
Piti 115	115	base	1.0163	0.9187	1.0056	1.0058	Base system (n-0)
Andersen	34.5	line_38	0.9522	0.8952	0.9633	1.0059	Line Harmon 3 34.5 to Macheche 34.5 Circuit 1
Dededo 3	34.5	base	0.9644	0.9426	0.9785	1.0059	Base system (n-0)
Andersen	34.5	line_17	0.9511	0.8835	0.9619	1.0061	Line Apra 34. 34.5 to Tenjotap 34.5 Circuit 1
Andersen	34.5	line_14	0.9502	0.895	0.9634	1.0061	Line Talofofo 34.5 to Apra 34. 34.5 Circuit 1
SRF	34.5	line_9	na	0.8997	0.9507	1.0062	Line Cabrs345 34.5 to Piti 345 34.5 Circuit 1
SRF	34.5	tran_48	na	0.8997	0.9507	1.0062	Tran Cabrs345 34.50 to Cabr 115 115.00 Circuit 1
SRF	34.5	line_62	na	0.8997	0.9513	1.0064	Line Piti 115 115.0 to Harmn115 115.0 and Piti T700
Andersen	34.5	line_24	0.9462	0.8851	0.9609	1.0064	Line Agana 34 34.5 to Radio Ba 34.5 Circuit 1
Andersen	34.5	line_13	0.9518	0.8939	0.9632	1.0064	Line Piti 345 34.5 to Anigua 3 34.5 Circuit 1
Andersen	34.5	line_28	0.9492	0.8918	0.962	1.0065	Line Tamuning 34.5 to Tumon 34 34.5 Circuit 1
Cabr 115	115	base	1.0163	0.9195	1.0058	1.0065	Base system (n-0)
Marbo 34	34.5	base	0.9667	0.9486	0.9798	1.0067	Base system (n-0)
Andersen	34.5	line_29	0.9491	0.8929	0.9628	1.0069	Line Tamuning 34.5 to San Vito 34.5 Circuit 1
Andersen	34.5	line_19	0.9515	0.8922	0.9631	1.0069	Line Piti 345 34.5 to Cld Stor 34.5 Circuit 1
Andersen	34.5	line_12	0.9524	0.895	0.9639	1.007	Line Piti 345 34.5 to Agana 34 34.5 Circuit 1
Cabras_3	13.8	base	1.007	0.9289	1.007	1.007	Base system (n-0)
MEC 8	13.8	base	1.007	0.9338	1.007	1.007	Base system (n-0)
MEC 9	13.8	base	1.007	0.9366	1.007	1.007	Base system (n-0)
Andersen	34.5	line_21	0.9519	0.8964	0.9642	1.0072	Line Pulantat 34.5 to Talofofo 34.5 Circuit 1
Andersen	34.5	line_25	0.9508	0.8952	0.9642	1.0073	Line Agana 34 34.5 to Tamuning 34.5 Circuit 1
Andersen	34.5	line_11	na	0.8914	0.9636	1.0074	Line Piti 345 34.5 to Orote 34 34.5 Circuit 1
Andersen	34.5	line_27	0.9486	0.8879	0.9629	1.0075	Line Radio Ba 34.5 to Marbo 34 34.5 Circuit 1
Andersen	34.5	line_40	0.9486	0.8879	0.9629	1.0075	Line Dededo 3 34.5 to Marbo 34 34.5 Circuit 1
Andersen	34.5	line_31	0.9532	0.8964	0.9649	1.0075	Line Anigua 3 34.5 to Agana 34 34.5 Circuit 1
Andersen	34.5	line_10	0.9511	0.8999	0.9659	1.0075	Line Piti 345 34.5 to Tenjotap 34.5 Circuit 1
Andersen	34.5	line_15	0.9519	0.8928	0.9646	1.0077	Line Apra 34. 34.5 to Orote 34 34.5 Circuit 1
Andersen	34.5	line_26	0.9522	0.8953	0.9647	1.0077	Line Barrigad 34.5 to GAA 34.5 34.5 Circuit 1
Andersen	34.5	line_18	0.9518	0.8959	0.9644	1.0078	Line Orote 34 34.5 to Cld Stor 34.5 Circuit 1
SRF	34.5	line_19	na	0.8687	0.927	1.0079	Line Piti 345 34.5 to Cld Stor 34.5 Circuit 1
Andersen	34.5	line_44	0.9518	0.8966	0.9648	1.0079	Line Macheche 34.5 to GAA 34.5 34.5 Circuit 1

Voltage Limit Report

Name	kV	Outage	Existing 2007 Load	New DOD Loads	Line Upgrades w/ No 115 kV	Line Upgrades Including 115 kV	Outage description
Andersen	34.5	base	0.9519	0.8966	0.9648	1.0079	Base system (n-0)
Andersen	34.5	line_32	0.9532	0.8959	0.9652	1.008	Line San Vito 34.5 to Harmon 3 34.5 Circuit 1
Andersen	34.5	line_22	0.9532	0.8989	0.9665	1.0081	Line Pulantat 34.5 to Barrigad 34.5 Circuit 1
Andersen	34.5	line_30	0.9534	0.8962	0.9656	1.0082	Line Tumon 34 34.5 to Harmon 3 34.5 Circuit 1
Andersen	34.5	line_46	0.9522	0.8965	0.9656	1.0082	Line GAA 34.5 34.5 to GIAT 34.5 Circuit 1
Andersen	34.5	line_47	0.9522	0.8966	0.9661	1.0084	Line GIAT 34.5 to Harmon 1 34.5 Circuit 1
SRF	34.5	line_56	na	na	0.8946	1.0087	Line Piti 345 34.5 to Orote 34 34.5 and Piti to Apra w/ Tenjo Tap 34.5
Andersen	34.5	line_16	0.9528	0.8981	0.9657	1.0089	Line Apra 34. 34.5 to Umatac34 34.5 Circuit 1
NCS Fine	34.5	line_43	0.9789	0.8821	0.9802	1.0089	Line Macheche 34.5 to Pagat 34 34.5 Circuit 1
NCS Fine	34.5	line_20	0.9745	0.8832	0.9802	1.009	Line Cld Stor 34.5 to Cold Sto 34.5 Circuit 1
Orote 34	34.5	line_19	0.9516	0.8714	0.929	1.0098	Line Piti 345 34.5 to Cld Stor 34.5 Circuit 1
Potts Jc	34.5	line_43	0.9744	0.8873	0.9783	1.01	Line Macheche 34.5 to Pagat 34 34.5 Circuit 1
Potts Jc	34.5	line_20	0.9699	0.8884	0.9783	1.01	Line Cld Stor 34.5 to Cold Sto 34.5 Circuit 1
Andersen	34.5	line_45	0.9509	0.8864	0.9657	1.0102	Line Yigo_345 34.5 to Andersen 34.5 Circuit 1
Orote 34	34.5	line_56	na	na	0.8967	1.0105	Line Piti 345 34.5 to Orote 34 34.5 and Piti to Apra w/ Tenjo Tap 34.5
SRF	34.5	line_61	na	0.9	0.9589	1.0106	Line Piti 115 115.0 to Harmn115 115.0 and Agana T400
SRF T1	13.8	line_11	na	0.884	1.0142	1.0108	Line Piti 345 34.5 to Orote 34 34.5 Circuit 1
Cold Storage	34.5	line_17	0.955	0.8899	0.962	1.011	Line Apra 34. 34.5 to Tenjotap 34.5 Circuit 1
Cold Storage	34.5	line_11	na	0.855	0.9525	1.0116	Line Piti 345 34.5 to Orote 34 34.5 Circuit 1
SRF T2	13.8	line_11	na	0.884	0.9941	1.0122	Line Piti 345 34.5 to Orote 34 34.5 Circuit 1
SRF	34.5	line_11	na	0.8441	0.9375	1.0125	Line Piti 345 34.5 to Orote 34 34.5 Circuit 1
SRF	34.5	line_17	na	0.8838	0.9532	1.013	Line Apra 34. 34.5 to Tenjotap 34.5 Circuit 1
OroteT13	13.8	line_11	na	0.8873	0.9964	1.0142	Line Piti 345 34.5 to Orote 34 34.5 Circuit 1
OroteT99	13.8	line_11	na	0.8873	0.9964	1.0142	Line Piti 345 34.5 to Orote 34 34.5 Circuit 1
Orote 34	34.5	line_11	na	0.8469	0.9395	1.0144	Line Piti 345 34.5 to Orote 34 34.5 Circuit 1
Orote 34	34.5	line_17	0.954	0.8864	0.9552	1.0148	Line Apra 34. 34.5 to Tenjotap 34.5 Circuit 1
Cold Storage	34.5	base	0.9622	0.9265	0.9723	1.0149	Base system (n-0)
Cold Storage	34.5	line_15	0.9622	0.8985	0.9671	1.0153	Line Apra 34. 34.5 to Orote 34 34.5 Circuit 1
SRF	34.5	base	na	0.9228	0.9667	1.0178	Base system (n-0)
SRF	34.5	line_15	na	0.8926	0.9595	1.0185	Line Apra 34. 34.5 to Orote 34 34.5 Circuit 1
Orote 34	34.5	base	0.9621	0.9253	0.9686	1.0196	Base system (n-0)
Orote 34	34.5	line_15	0.9621	0.8952	0.9614	1.0203	Line Apra 34. 34.5 to Orote 34 34.5 Circuit 1
Marbo CT	13.8	line_35	0.9377	0.8791	0.9667	1.022	Line Harmon 3 34.5 to Dededo 3 34.5 Circuit 1
AnderT16	13.8	line_35	1.0138	0.8717	1.0163	1.0318	Line Harmon 3 34.5 to Dededo 3 34.5 Circuit 1
AnderT15	13.8	line_35	0.9951	0.8718	1.0163	1.0318	Line Harmon 3 34.5 to Dededo 3 34.5 Circuit 1
OroteT11	13.8	line_11	na	0.8874	1.0119	1.0411	Line Piti 345 34.5 to Orote 34 34.5 Circuit 1
OroteT12	13.8	line_11	na	0.8864	1.0124	1.0417	Line Piti 345 34.5 to Orote 34 34.5 Circuit 1
Cabrs345	34.5	line_9	0.9902	1.0766	1.0473	1.0574	Line Cabrs345 34.5 to Piti 345 34.5 Circuit 1

Overload Report

Name	kV	Name	kV	Type	Rated Mva	Outage	Existing 2007 Load	New DOD Loads	Line Upgrades w/ No 115 kV	Line Upgrades Including 115 kV	Outage description
Piti 345	34.5	Cld Stor	34.5	Line	59	line_11	na	238.60%	47.80%	44.50%	Line Piti 345 34.5 to Orote 34 34.5 Circuit 1
Harmon 1	34.5	NCS Fine	34.5	Line	59	line_35	58.60%	188.00%	50.20%	53.30%	Line Harmon 3 34.5 to Dededo 3 34.5 Circuit 1
Piti 345	34.5	Cld Stor	34.5	Line	59	line_17	58.80%	179.10%	40.10%	45.10%	Line Apra 34. 34.5 to Tenjotap 34.5 Circuit 1
Orote 34	34.5	Cld Stor	34.5	Line	59	line_11	na	168.80%	33.00%	20.00%	Line Piti 345 34.5 to Orote 34 34.5 Circuit 1
Harmon 1	34.5	NCS Fine	34.5	Line	59	line_41	3.90%	165.60%	27.50%	54.10%	Line NCS Fine 34.5 to Potts Jc 34.5 Circuit 1
Harmon 1	34.5	NCS Fine	34.5	Line	59	line_42	3.90%	165.60%	27.50%	54.10%	Line Potts Jc 34.5 to Andersen 34.5 Circuit 1
Piti 345	34.5	Cld Stor	34.5	Line	59	line_15	36.10%	164.70%	35.20%	36.30%	Line Apra 34. 34.5 to Orote 34 34.5 Circuit 1
Harmon 1	34.5	NCS Fine	34.5	Line	59	line_39	45.90%	164.50%	43.40%	52.50%	Line Harmon 1 34.5 to Yigo_345 34.5 Circuit 1
Cabr 115	115	Cabras_1	13.8	Tran	80	line_67	83.60%	162.80%	85.30%	82.50%	Line Agana 34 34.5 to Tamuning 34.5 Circuit 1 and Tamuning T600
Cabr 115	115	Cabras_1	13.8	Tran	80	line_63	83.50%	160.00%	84.80%	83.00%	Line Piti 115 115.0 to Harmn115 115.0 and Tamuning T600
Cabr 115	115	Cabras_1	13.8	Tran	80	line_17	79.70%	157.50%	84.50%	81.30%	Line Apra 34. 34.5 to Tenjotap 34.5 Circuit 1
Cabr 115	115	Cabras_1	13.8	Tran	80	tran_53	na	157.40%	83.40%	79.80%	Tran Harmon 1 34.50 to Harmn115 115.00 Circuit 2
Cabr 115	115	Cabras_1	13.8	Tran	80	line_61	82.90%	156.50%	84.00%	82.80%	Line Piti 115 115.0 to Harmn115 115.0 and Agana T400
Cabr 115	115	Cabras_1	13.8	Tran	80	line_65	82.40%	156.20%	84.20%	82.20%	Line Tamuning 115.0 to Harmn115 115.0 and Tamuning T600
Cabr 115	115	Cabras_1	13.8	Tran	80	line_64	82.30%	156.10%	84.20%	82.20%	Line Agana115 115.0 to Tamuning 115.0 Circuit 1 and Tamuning T600
Cabr 115	115	Cabras_1	13.8	Tran	80	line_35	81.50%	156.00%	84.60%	80.60%	Line Harmon 3 34.5 to Dededo 3 34.5 Circuit 1
Harmon 1	34.5	NCS Fine	34.5	Line	59	line_67	35.90%	155.40%	39.10%	47.30%	Line Agana 34 34.5 to Tamuning 34.5 Circuit 1 and Tamuning T600
Cabr 115	115	Cabras_1	13.8	Tran	80	line_68	83.10%	155.30%	83.80%	80.30%	Line Tamuning 34.5 to Tumon 34 34.5 Circuit 1 and Harmon T500
Harmon 1	34.5	NCS Fine	34.5	Line	59	line_68	40.80%	155.10%	40.70%	47.10%	Line Tamuning 34.5 to Tumon 34 34.5 Circuit 1 and Harmon T500
Cabr 115	115	Cabras_1	13.8	Tran	80	line_33	79.40%	154.70%	83.90%	80.70%	Line Tanguiss 34.5 to Harmon 1 34.5 Circuit 1
Dededo 3	34.5	Andersen	34.5	Line	42	line_39	60.60%	154.50%	31.30%	16.70%	Line Harmon 1 34.5 to Yigo_345 34.5 Circuit 1
Cabr 115	115	Cabras_1	13.8	Tran	80	line_5	81.30%	153.60%	83.70%	81.60%	Line Agana115 115.0 to Tamuning 115.0 Circuit 1
Harmon 1	34.5	NCS Fine	34.5	Line	59	line_63	32.90%	153.00%	37.80%	48.50%	Line Piti 115 115.0 to Harmn115 115.0 and Tamuning T600
Cabr 115	115	Cabras_1	13.8	Tran	80	line_66	81.40%	152.60%	84.00%	82.40%	Line Piti 345 34.5 to Anigua 3 34.5 Circuit 1 and Agana T400
Cabr 115	115	Cabras_1	13.8	Tran	80	line_11	na	152.60%	83.40%	80.30%	Line Piti 345 34.5 to Orote 34 34.5 Circuit 1
Cabr 115	115	Cabras_1	13.8	Tran	80	line_34	79.80%	152.10%	83.60%	81.20%	Line Tanguiss 34.5 to Harmon 3 34.5 Circuit 2
Cabr 115	115	Cabras_1	13.8	Tran	80	line_39	80.40%	152.00%	83.40%	80.30%	Line Harmon 1 34.5 to Yigo_345 34.5 Circuit 1
Harmon 1	34.5	NCS Fine	34.5	Line	59	line_61	34.00%	152.00%	37.90%	48.70%	Line Piti 115 115.0 to Harmn115 115.0 and Agana T400
Cabr 115	115	Cabras_1	13.8	Tran	80	line_15	79.30%	151.80%	82.70%	80.00%	Line Apra 34. 34.5 to Orote 34 34.5 Circuit 1
Cabr 115	115	Cabras_1	13.8	Tran	80	line_19	79.40%	151.00%	84.10%	80.70%	Line Piti 345 34.5 to Cld Stor 34.5 Circuit 1
Cabr 115	115	Cabras_1	13.8	Tran	80	line_4	80.90%	150.90%	83.50%	81.60%	Line Piti 115 115.0 to Harmn115 115.0 Circuit 1
Cabr 115	115	Cabras_1	13.8	Tran	80	line_38	80.80%	150.20%	84.00%	81.90%	Line Harmon 3 34.5 to Macheche 34.5 Circuit 1
Harmon 1	34.5	NCS Fine	34.5	Line	59	line_65	32.00%	149.70%	37.40%	48.40%	Line Tamuning 115.0 to Harmn115 115.0 and Tamuning T600
Cabr 115	115	Cabras_1	13.8	Tran	80	line_57	81.10%	149.60%	83.20%	81.80%	Line Cabr 115 115.0 to Agana115 115.0 Circuit 1 and Agana T400
Harmon 1	34.5	NCS Fine	34.5	Line	59	line_64	32.00%	149.60%	37.40%	48.40%	Line Agana115 115.0 to Tamuning 115.0 Circuit 1 and Tamuning T600
Cabr 115	115	Cabras_1	13.8	Tran	80	tran_51	81.10%	149.30%	83.50%	81.20%	Tran Tamuning 34.50 to Tamuning 115.00 Circuit 1
Cabr 115	115	Cabras_1	13.8	Tran	80	line_13	79.60%	148.90%	82.90%	80.40%	Line Piti 345 34.5 to Anigua 3 34.5 Circuit 1
Harmon 1	34.5	NCS Fine	34.5	Line	59	line_66	35.80%	148.90%	38.70%	47.90%	Line Piti 345 34.5 to Anigua 3 34.5 Circuit 1 and Agana T400
Cabr 115	115	Cabras_1	13.8	Tran	80	tran_52	81.00%	148.80%	83.00%	80.00%	Tran Harmon 3 34.50 to Harmn115 115.00 Circuit 1
Cabr 115	115	Cabras_1	13.8	Tran	80	line_14	79.80%	148.70%	83.00%	80.90%	Line Talofofo 34.5 to Apra 34. 34.5 Circuit 1
Cabr 115	115	Cabras_1	13.8	Tran	80	line_23	80.40%	148.50%	83.20%	80.80%	Line Agana 34 34.5 to Barrigad 34.5 Circuit 1
Cabr 115	115	Cabras_1	13.8	Tran	80	line_12	79.40%	148.30%	82.60%	80.20%	Line Piti 345 34.5 to Agana 34 34.5 Circuit 1
Cabr 115	115	Cabras_1	13.8	Tran	80	line_2	80.20%	148.20%	82.90%	80.90%	Line Cabr 115 115.0 to Agana115 115.0 Circuit 1
Cabr 115	115	Cabras_1	13.8	Tran	80	line_3	80.20%	148.20%	82.90%	80.90%	Line Cabr 115 115.0 to Agana115 115.0 Circuit 2

Overload Report

Name	kV	Name	kV	Type	Rated Mva	Outage	Existing 2007 Load	New DOD Loads	Line Upgrades w/ No 115 kV	Line Upgrades Including 115 kV	Outage description
Cabr 115	115	Cabras_1	13.8	Tran	80	line_24	79.50%	148.00%	82.50%	80.00%	Line Agana 34 34.5 to Radio Ba 34.5 Circuit 1
Cabr 115	115	Cabras_1	13.8	Tran	80	line_25	79.30%	148.00%	82.40%	79.90%	Line Agana 34 34.5 to Tamuning 34.5 Circuit 1
Cabr 115	115	Cabras_1	13.8	Tran	80	line_18	79.30%	147.90%	82.60%	79.90%	Line Orote 34 34.5 to Cld Stor 34.5 Circuit 1
Cabr 115	115	Cabras_1	13.8	Tran	80	line_47	79.50%	147.90%	82.40%	80.20%	Line GIAT 34.5 to Harmon 1 34.5 Circuit 1
Cabr 115	115	Cabras_1	13.8	Tran	80	line_45	79.30%	147.90%	82.20%	80.00%	Line Yigo_345 34.5 to Andersen 34.5 Circuit 1
Harmon 1	34.5	NCS Fine	34.5	Line	59	tran_52	37.80%	147.90%	39.40%	47.10%	Tran Harmon 3 34.50 to Harmn115 115.00 Circuit 1
Cabr 115	115	Cabras_1	13.8	Tran	80	line_41	79.60%	147.80%	82.70%	79.80%	Line NCS Fine 34.5 to Potts Jc 34.5 Circuit 1
Cabr 115	115	Cabras_1	13.8	Tran	80	line_42	79.60%	147.80%	82.70%	79.80%	Line Potts Jc 34.5 to Andersen 34.5 Circuit 1
Cabr 115	115	Cabras_1	13.8	Tran	80	line_27	79.40%	147.80%	82.40%	80.00%	Line Radio Ba 34.5 to Marbo 34 34.5 Circuit 1
Cabr 115	115	Cabras_1	13.8	Tran	80	line_40	79.40%	147.80%	82.40%	80.00%	Line Dededo 3 34.5 to Marbo 34 34.5 Circuit 1
Cabr 115	115	Cabras_1	13.8	Tran	80	line_21	79.20%	147.70%	82.40%	79.90%	Line Pulantat 34.5 to Talofofo 34.5 Circuit 1
Cabr 115	115	Cabras_1	13.8	Tran	80	line_31	79.20%	147.70%	82.30%	80.00%	Line Anigua 3 34.5 to Agana 34 34.5 Circuit 1
Cabr 115	115	Cabras_1	13.8	Tran	80	line_55	79.70%	147.60%	82.60%	80.40%	Line Tamuning 115.0 to Harmn115 115.0 and Line Giattap 34.5 to Harmon 1 34.5
Cabr 115	115	Cabras_1	13.8	Tran	80	line_46	79.40%	147.60%	82.30%	80.00%	Line GAA 34.5 34.5 to GIAT 34.5 Circuit 1
Cabr 115	115	Cabras_1	13.8	Tran	80	base	79.30%	147.60%	82.30%	79.90%	Base system (n-0)
Cabr 115	115	Cabras_1	13.8	Tran	80	line_44	79.20%	147.60%	82.20%	79.90%	Line Macheche 34.5 to GAA 34.5 34.5 Circuit 1
Cabr 115	115	Cabras_1	13.8	Tran	80	tran_50	80.30%	147.50%	82.70%	81.00%	Tran Agana 34 34.50 to Agana115 115.00 Circuit 1
Cabr 115	115	Cabras_1	13.8	Tran	80	line_22	80.00%	147.50%	82.50%	80.40%	Line Pulantat 34.5 to Barrigad 34.5 Circuit 1
Cabr 115	115	Cabras_1	13.8	Tran	80	line_28	79.70%	147.50%	82.50%	80.00%	Line Tamuning 34.5 to Tumon 34 34.5 Circuit 1
Cabr 115	115	Cabras_1	13.8	Tran	80	line_30	79.40%	147.50%	82.40%	80.10%	Line Tumon 34 34.5 to Harmon 3 34.5 Circuit 1
Harmon 1	34.5	NCS Fine	34.5	Line	59	line_57	34.60%	147.50%	38.10%	48.00%	Line Cabr 115 115.0 to Agana115 115.0 Circuit 1 and Agana T400
Cabr 115	115	Cabras_1	13.8	Tran	80	line_29	79.60%	147.40%	82.50%	79.90%	Line Tamuning 34.5 to San Vito 34.5 Circuit 1
Cabr 115	115	Cabras_1	13.8	Tran	80	line_6	79.50%	147.40%	82.40%	80.20%	Line Tamuning 115.0 to Harmn115 115.0 Circuit 1
Cabr 115	115	Cabras_1	13.8	Tran	80	line_26	79.30%	147.40%	82.30%	79.90%	Line Barrigad 34.5 to GAA 34.5 34.5 Circuit 1
Cabr 115	115	Cabras_1	13.8	Tran	80	line_32	79.30%	147.30%	82.30%	79.90%	Line San Vito 34.5 to Harmon 3 34.5 Circuit 1
Dededo 3	34.5	Andersen	34.5	Line	42	tran_53	na	147.00%	37.00%	13.60%	Tran Harmon 1 34.50 to Harmn115 115.00 Circuit 2
Harmon 1	34.5	NCS Fine	34.5	Line	59	line_24	34.50%	146.80%	38.40%	48.60%	Line Agana 34 34.5 to Radio Ba 34.5 Circuit 1
Harmon 1	34.5	NCS Fine	34.5	Line	59	line_34	34.10%	146.70%	39.00%	52.90%	Line Tanguiss 34.5 to Harmon 3 34.5 Circuit 2
Harmon 1	34.5	NCS Fine	34.5	Line	59	line_58	34.50%	146.70%	37.90%	48.00%	Line Cabr 115 to Piti 115 and Agana T400
Harmon 1	34.5	NCS Fine	34.5	Line	59	line_5	30.00%	146.20%	36.40%	48.50%	Line Agana115 115.0 to Tamuning 115.0 Circuit 1
Harmon 1	34.5	NCS Fine	34.5	Line	59	line_54	31.10%	145.70%	36.70%	48.20%	Line Cabr 115 115.0 to Piti 115 115.0 Circuit 1 and Line Cabr 115 115.0 to Agana
Harmon 1	34.5	NCS Fine	34.5	Line	59	line_45	29.90%	145.70%	36.30%	43.30%	Line Yigo_345 34.5 to Andersen 34.5 Circuit 1
Harmon 1	34.5	NCS Fine	34.5	Line	59	line_27	33.80%	145.60%	38.10%	48.30%	Line Radio Ba 34.5 to Marbo 34 34.5 Circuit 1
Harmon 1	34.5	NCS Fine	34.5	Line	59	line_40	33.80%	145.60%	38.10%	48.30%	Line Dededo 3 34.5 to Marbo 34 34.5 Circuit 1
Harmon 1	34.5	NCS Fine	34.5	Line	59	tran_51	33.50%	145.60%	37.90%	47.40%	Tran Tamuning 34.50 to Tamuning 115.00 Circuit 1
Harmon 1	34.5	NCS Fine	34.5	Line	59	tran_50	34.50%	145.30%	37.90%	47.60%	Tran Agana 34 34.50 to Agana115 115.00 Circuit 1
Cabr 115	115	Cabras_1	13.8	Tran	80	line_16	75.10%	145.00%	78.30%	75.90%	Line Apra 34. 34.5 to Umatac34 34.5 Circuit 1
Cabr 115	115	Cabras_1	13.8	Tran	80	line_10	79.70%	144.50%	81.60%	80.10%	Line Piti 345 34.5 to Tenjotap 34.5 Circuit 1
Harmon 1	34.5	NCS Fine	34.5	Line	59	line_4	30.00%	144.30%	36.30%	48.30%	Line Piti 115 115.0 to Harmn115 115.0 Circuit 1
Cabr 115	115	Cabras_1	13.8	Tran	80	line_54	79.50%	144.20%	80.70%	79.80%	Line Cabr 115 115.0 to Piti 115 115.0 Circuit 1 and Line Cabr 115 115.0 to Agana
Harmon 1	34.5	NCS Fine	34.5	Line	59	line_62	30.50%	143.70%	36.60%	48.50%	Line Piti 115 115.0 to Harmn115 115.0 and Piti T700
Cabr 115	115	Cabras_1	13.8	Tran	80	line_1	79.20%	143.40%	81.00%	78.00%	Line Cabr 115 115.0 to Piti 115 115.0 Circuit 1
Harmon 1	34.5	NCS Fine	34.5	Line	59	line_17	30.80%	143.20%	36.60%	47.20%	Line Apra 34. 34.5 to Tenjotap 34.5 Circuit 1
Piti 345	34.5	Cld Stor	34.5	Line	59	line_10	58.90%	143.10%	32.30%	35.50%	Line Piti 345 34.5 to Tenjotap 34.5 Circuit 1

Overload Report

Name	kV	Name	kV	Type	Rated Mva	Outage	Existing 2007 Load	New DOD Loads	Line Upgrades w/ No 115 kV	Line Upgrades Including 115 kV	Outage description
Harmon 1	34.5	NCS Fine	34.5	Line	59	line_2	31.20%	142.90%	36.70%	47.70%	Line Cabr 115 115.0 to Agana115 115.0 Circuit 1
Harmon 1	34.5	NCS Fine	34.5	Line	59	line_3	31.20%	142.90%	36.70%	47.70%	Line Cabr 115 115.0 to Agana115 115.0 Circuit 2
Harmon 1	34.5	NCS Fine	34.5	Line	59	line_59	31.70%	142.80%	37.00%	47.80%	Line Cabr 115 115.0 to Agana115 115.0 Circuit 1 and Piti T700
Cabr 115	115	Cabras_1	13.8	Tran	80	line_58	79.60%	142.70%	80.80%	80.00%	Line Cabr 115 to Piti 115 and Agana T400
Harmon 1	34.5	NCS Fine	34.5	Line	59	line_28	31.60%	142.20%	36.90%	47.20%	Line Tamuning 34.5 to Tumon 34 34.5 Circuit 1
Harmon 1	34.5	NCS Fine	34.5	Line	59	line_47	33.70%	141.80%	37.30%	49.50%	Line GIAT 34.5 to Harmon 1 34.5 Circuit 1
Harmon 1	34.5	NCS Fine	34.5	Line	59	line_29	31.40%	141.80%	36.70%	47.30%	Line Tamuning 34.5 to San Vito 34.5 Circuit 1
Cabr 115	115	Cabras_1	13.8	Tran	80	line_60	80.60%	141.70%	83.30%	79.20%	Line Cabr 115 to Piti 115 and Piti T700
Harmon 1	34.5	NCS Fine	34.5	Line	59	line_11	na	141.70%	36.50%	47.30%	Line Piti 345 34.5 to Orote 34 34.5 Circuit 1
Cabr 115	115	Cabras_1	13.8	Tran	80	line_62	81.90%	141.50%	82.30%	82.30%	Line Piti 115 115.0 to Harmn115 115.0 and Piti T700
Harmon 1	34.5	NCS Fine	34.5	Line	59	line_19	30.80%	141.50%	36.50%	47.30%	Line Piti 345 34.5 to Cld Stor 34.5 Circuit 1
Harmon 1	34.5	NCS Fine	34.5	Line	59	line_13	31.10%	141.40%	36.70%	47.40%	Line Piti 345 34.5 to Anigua 3 34.5 Circuit 1
Harmon 1	34.5	NCS Fine	34.5	Line	59	line_15	30.80%	141.40%	36.40%	47.30%	Line Apra 34. 34.5 to Orote 34 34.5 Circuit 1
Harmon 1	34.5	NCS Fine	34.5	Line	59	line_55	32.10%	141.30%	36.60%	49.40%	Line Tamuning 115.0 to Harmn115 115.0 and Line Giattap 34.5 to Harmon 1 34.5
Harmon 1	34.5	NCS Fine	34.5	Line	59	line_1	30.70%	141.20%	36.40%	47.40%	Line Cabr 115 115.0 to Piti 115 115.0 Circuit 1
Harmon 1	34.5	NCS Fine	34.5	Line	59	line_46	32.90%	141.10%	37.00%	48.70%	Line GAA 34.5 34.5 to GIAT 34.5 Circuit 1
Harmon 1	34.5	NCS Fine	34.5	Line	59	line_12	30.90%	141.10%	36.60%	47.30%	Line Piti 345 34.5 to Agana 34 34.5 Circuit 1
Harmon 1	34.5	NCS Fine	34.5	Line	59	line_25	30.90%	140.90%	36.50%	47.20%	Line Agana 34 34.5 to Tamuning 34.5 Circuit 1
Harmon 1	34.5	NCS Fine	34.5	Line	59	line_14	30.90%	140.90%	36.50%	47.00%	Line Talofofo 34.5 to Apra 34. 34.5 Circuit 1
Harmon 1	34.5	NCS Fine	34.5	Line	59	line_44	31.30%	140.80%	36.60%	47.60%	Line Macheche 34.5 to GAA 34.5 34.5 Circuit 1
Harmon 1	34.5	NCS Fine	34.5	Line	59	line_32	30.60%	140.80%	36.40%	47.30%	Line San Vito 34.5 to Harmon 3 34.5 Circuit 1
Harmon 1	34.5	NCS Fine	34.5	Line	59	line_18	30.80%	140.80%	36.40%	47.20%	Line Orote 34 34.5 to Cld Stor 34.5 Circuit 1
Harmon 1	34.5	NCS Fine	34.5	Line	59	line_31	30.70%	140.70%	36.50%	47.30%	Line Anigua 3 34.5 to Agana 34 34.5 Circuit 1
Harmon 1	34.5	NCS Fine	34.5	Line	59	line_21	30.80%	140.70%	36.40%	47.10%	Line Pulantat 34.5 to Talofofo 34.5 Circuit 1
Harmon 1	34.5	NCS Fine	34.5	Line	59	base	30.80%	140.60%	36.40%	47.20%	Base system (n-0)
Harmon 1	34.5	NCS Fine	34.5	Line	59	line_30	30.40%	140.60%	36.30%	47.30%	Line Tumon 34 34.5 to Harmon 3 34.5 Circuit 1
Harmon 1	34.5	NCS Fine	34.5	Line	59	line_26	30.70%	140.60%	36.30%	46.80%	Line Barrigad 34.5 to GAA 34.5 34.5 Circuit 1
Harmon 1	34.5	NCS Fine	34.5	Line	59	line_23	29.70%	140.60%	36.00%	45.50%	Line Agana 34 34.5 to Barrigad 34.5 Circuit 1
Harmon 1	34.5	NCS Fine	34.5	Line	59	line_9	31.30%	140.50%	36.70%	47.40%	Line Cabrs345 34.5 to Piti 345 34.5 Circuit 1
Harmon 1	34.5	NCS Fine	34.5	Line	59	tran_48	31.30%	140.50%	36.70%	47.40%	Tran Cabrs345 34.50 to Cabr 115 115.00 Circuit 1
Harmon 1	34.5	NCS Fine	34.5	Line	59	tran_49	31.20%	140.40%	36.60%	47.40%	Tran Piti 345 34.50 to Piti 115 115.00 Circuit 1
Harmon 1	34.5	NCS Fine	34.5	Line	59	line_6	29.50%	140.40%	35.90%	47.80%	Line Tamuning 115.0 to Harmn115 115.0 Circuit 1
Harmon 1	34.5	NCS Fine	34.5	Line	59	line_60	31.50%	140.30%	36.70%	47.40%	Line Cabr 115 to Piti 115 and Piti T700
Harmon 1	34.5	NCS Fine	34.5	Line	59	line_16	30.70%	140.30%	36.40%	47.20%	Line Apra 34. 34.5 to Umatac34 34.5 Circuit 1
Cabr 115	115	Cabras_1	13.8	Tran	80	tran_49	79.90%	140.20%	81.00%	80.50%	Tran Piti 345 34.50 to Piti 115 115.00 Circuit 1
Harmon 1	34.5	NCS Fine	34.5	Line	59	line_22	30.70%	140.20%	36.30%	47.40%	Line Pulantat 34.5 to Barrigad 34.5 Circuit 1
Cabr 115	115	Cabras_1	13.8	Tran	80	line_59	80.90%	140.00%	81.60%	81.60%	Line Cabr 115 115.0 to Agana115 115.0 Circuit 1 and Piti T700
Harmon 1	34.5	NCS Fine	34.5	Line	59	line_10	30.80%	139.90%	36.30%	47.30%	Line Piti 345 34.5 to Tenjotap 34.5 Circuit 1
Harmon 1	34.5	NCS Fine	34.5	Line	59	line_43	30.20%	138.60%	36.00%	47.50%	Line Macheche 34.5 to Pagat 34 34.5 Circuit 1
Harmon 1	34.5	NCS Fine	34.5	Line	59	line_20	30.70%	138.50%	36.00%	47.00%	Line Cld Stor 34.5 to Cold Sto 34.5 Circuit 1
Harmon 1	34.5	NCS Fine	34.5	Line	59	tran_53	na	138.30%	29.70%	32.40%	Tran Harmon 1 34.50 to Harmn115 115.00 Circuit 2
Piti 345	34.5	Cld Stor	34.5	Line	59	line_22	50.30%	138.00%	31.80%	35.50%	Line Pulantat 34.5 to Barrigad 34.5 Circuit 1
Cabr 115	115	Cabras_1	13.8	Tran	80	line_43	63.00%	137.70%	66.80%	64.50%	Line Macheche 34.5 to Pagat 34 34.5 Circuit 1
Cabr 115	115	Cabras_1	13.8	Tran	80	line_9	79.90%	137.50%	80.20%	80.40%	Line Cabrs345 34.5 to Piti 345 34.5 Circuit 1

Overload Report

Name	kV	Name	kV	Type	Rated Mva	Outage	Existing 2007 Load	New DOD Loads	Line Upgrades w/ No 115 kV	Line Upgrades Including 115 kV	Outage description
Cabr 115	115	Cabras_1	13.8	Tran	80	tran_48	79.90%	137.50%	80.20%	80.40%	Tran Cabrs345 34.50 to Cabr 115 115.00 Circuit 1
Harmon 1	34.5	NCS Fine	34.5	Line	59	line_38	26.90%	137.50%	34.60%	44.00%	Line Harmon 3 34.5 to Macheche 34.5 Circuit 1
Harmon 1	34.5	NCS Fine	34.5	Line	59	line_33	31.00%	137.50%	34.10%	42.40%	Line Tanguiss 34.5 to Harmon 1 34.5 Circuit 1
Piti 345	34.5	Cld Stor	34.5	Line	59	line_61	45.70%	135.60%	30.80%	31.70%	Line Piti 115 115.0 to Harmn115 115.0 and Agana T400
Piti 345	34.5	Cld Stor	34.5	Line	59	line_23	46.30%	135.20%	31.20%	35.80%	Line Agana 34 34.5 to Barrigad 34.5 Circuit 1
Piti 345	34.5	Cld Stor	34.5	Line	59	line_66	45.60%	134.70%	30.90%	35.10%	Line Piti 345 34.5 to Anigua 3 34.5 Circuit 1 and Agana T400
Piti 345	34.5	Cld Stor	34.5	Line	59	line_63	44.40%	134.70%	30.60%	32.80%	Line Piti 115 115.0 to Harmn115 115.0 and Tamuning T600
Cabr 115	115	Cabras_1	13.8	Tran	80	line_20	73.50%	133.70%	64.80%	62.80%	Line Cld Stor 34.5 to Cold Sto 34.5 Circuit 1
Piti 345	34.5	Cld Stor	34.5	Line	59	line_57	44.80%	133.70%	30.60%	32.40%	Line Cabr 115 115.0 to Agana115 115.0 Circuit 1 and Agana T400
Piti 345	34.5	Cld Stor	34.5	Line	59	line_58	44.30%	133.50%	30.50%	37.10%	Line Cabr 115 to Piti 115 and Agana T400
Piti 345	34.5	Cld Stor	34.5	Line	59	line_64	43.80%	133.50%	30.50%	33.80%	Line Agana115 115.0 to Tamuning 115.0 Circuit 1 and Tamuning T600
Piti 345	34.5	Cld Stor	34.5	Line	59	line_65	43.80%	133.50%	30.50%	33.80%	Line Tamuning 115.0 to Harmn115 115.0 and Tamuning T600
Piti 345	34.5	Cld Stor	34.5	Line	59	line_67	43.30%	133.50%	30.40%	34.60%	Line Agana 34 34.5 to Tamuning 34.5 Circuit 1 and Tamuning T600
Piti 345	34.5	Cld Stor	34.5	Line	59	tran_53	na	133.40%	30.50%	34.10%	Tran Harmon 1 34.50 to Harmn115 115.00 Circuit 2
Piti 345	34.5	Cld Stor	34.5	Line	59	tran_50	44.30%	132.80%	30.50%	32.70%	Tran Agana 34 34.50 to Agana115 115.00 Circuit 1
Piti 345	34.5	Cld Stor	34.5	Line	59	line_68	44.00%	132.80%	30.40%	34.10%	Line Tamuning 34.5 to Tumon 34 34.5 Circuit 1 and Harmon T500
Piti 345	34.5	Cld Stor	34.5	Line	59	line_54	43.10%	132.80%	30.30%	39.50%	Line Cabr 115 115.0 to Piti 115 115.0 Circuit 1 and Line Cabr 115 115.0 to Agana
Piti 345	34.5	Cld Stor	34.5	Line	59	line_5	43.40%	132.70%	30.40%	34.10%	Line Agana115 115.0 to Tamuning 115.0 Circuit 1
Piti 345	34.5	Cld Stor	34.5	Line	59	line_62	42.90%	132.50%	30.40%	29.90%	Line Piti 115 115.0 to Harmn115 115.0 and Piti T700
Piti 345	34.5	Cld Stor	34.5	Line	59	line_4	43.40%	132.30%	30.40%	33.40%	Line Piti 115 115.0 to Harmn115 115.0 Circuit 1
Piti 345	34.5	Cld Stor	34.5	Line	59	line_38	43.60%	132.20%	30.50%	34.50%	Line Harmon 3 34.5 to Macheche 34.5 Circuit 1
Piti 345	34.5	Cld Stor	34.5	Line	59	line_59	42.50%	132.00%	30.30%	30.50%	Line Cabr 115 115.0 to Agana115 115.0 Circuit 1 and Piti T700
Piti 345	34.5	Cld Stor	34.5	Line	59	tran_51	43.10%	131.80%	30.40%	33.70%	Tran Tamuning 34.50 to Tamuning 115.00 Circuit 1
Piti 345	34.5	Cld Stor	34.5	Line	59	tran_52	43.50%	131.60%	30.30%	34.00%	Tran Harmon 3 34.50 to Harmn115 115.00 Circuit 1
Piti 345	34.5	Cld Stor	34.5	Line	59	line_2	43.10%	131.60%	30.30%	33.80%	Line Cabr 115 115.0 to Agana115 115.0 Circuit 1
Piti 345	34.5	Cld Stor	34.5	Line	59	line_3	43.10%	131.60%	30.30%	33.80%	Line Cabr 115 115.0 to Agana115 115.0 Circuit 2
Piti 345	34.5	Cld Stor	34.5	Line	59	line_35	42.50%	131.60%	30.20%	34.20%	Line Harmon 3 34.5 to Dededo 3 34.5 Circuit 1
Piti 345	34.5	Cld Stor	34.5	Line	59	line_33	42.40%	131.50%	30.20%	34.30%	Line Tanguiss 34.5 to Harmon 1 34.5 Circuit 1
Piti 345	34.5	Cld Stor	34.5	Line	59	line_13	42.80%	131.30%	30.30%	36.00%	Line Piti 345 34.5 to Anigua 3 34.5 Circuit 1
Piti 345	34.5	Cld Stor	34.5	Line	59	line_34	42.50%	131.20%	30.20%	34.30%	Line Tanguiss 34.5 to Harmon 3 34.5 Circuit 2
Piti 345	34.5	Cld Stor	34.5	Line	59	line_12	42.60%	131.10%	30.20%	35.60%	Line Piti 345 34.5 to Agana 34 34.5 Circuit 1
Piti 345	34.5	Cld Stor	34.5	Line	59	line_39	42.40%	131.10%	30.10%	34.30%	Line Harmon 1 34.5 to Yigo_345 34.5 Circuit 1
Piti 345	34.5	Cld Stor	34.5	Line	59	line_9	41.60%	131.00%	30.10%	30.30%	Line Cabrs345 34.5 to Piti 345 34.5 Circuit 1
Piti 345	34.5	Cld Stor	34.5	Line	59	tran_48	41.60%	131.00%	30.10%	30.30%	Tran Cabrs345 34.50 to Cabr 115 115.00 Circuit 1
Piti 345	34.5	Cld Stor	34.5	Line	59	line_55	43.00%	130.90%	30.20%	34.40%	Line Tamuning 115.0 to Harmn115 115.0 and Line Giattap 34.5 to Harmon 1 34.5
Piti 345	34.5	Cld Stor	34.5	Line	59	line_47	42.90%	130.90%	30.20%	34.30%	Line GIAT 34.5 to Harmon 1 34.5 Circuit 1
Piti 345	34.5	Cld Stor	34.5	Line	59	line_1	42.30%	130.90%	30.10%	37.40%	Line Cabr 115 115.0 to Piti 115 115.0 Circuit 1
Piti 345	34.5	Cld Stor	34.5	Line	59	tran_49	41.80%	130.90%	30.10%	31.40%	Tran Piti 345 34.50 to Piti 115 115.00 Circuit 1
Piti 345	34.5	Cld Stor	34.5	Line	59	line_31	42.40%	130.80%	30.20%	34.90%	Line Anigua 3 34.5 to Agana 34 34.5 Circuit 1
Piti 345	34.5	Cld Stor	34.5	Line	59	line_6	42.60%	130.80%	30.20%	34.40%	Line Tamuning 115.0 to Harmn115 115.0 Circuit 1
Piti 345	34.5	Cld Stor	34.5	Line	59	line_46	42.70%	130.70%	30.20%	34.30%	Line GAA 34.5 34.5 to GIAT 34.5 Circuit 1
Piti 345	34.5	Cld Stor	34.5	Line	59	line_60	41.70%	130.70%	30.10%	34.40%	Line Cabr 115 to Piti 115 and Piti T700
Piti 345	34.5	Cld Stor	34.5	Line	59	line_28	42.40%	130.60%	30.10%	34.40%	Line Tamuning 34.5 to Tumon 34 34.5 Circuit 1
Piti 345	34.5	Cld Stor	34.5	Line	59	line_24	42.30%	130.60%	30.10%	34.40%	Line Agana 34 34.5 to Radio Ba 34.5 Circuit 1

Overload Report

Name	kV	Name	kV	Type	Rated Mva	Outage	Existing 2007 Load	New DOD Loads	Line Upgrades w/ No 115 kV	Line Upgrades Including 115 kV	Outage description
Piti 345	34.5	Cld Stor	34.5	Line	59	line_27	42.30%	130.60%	30.10%	34.40%	Line Radio Ba 34.5 to Marbo 34 34.5 Circuit 1
Piti 345	34.5	Cld Stor	34.5	Line	59	line_40	42.30%	130.60%	30.10%	34.40%	Line Dededo 3 34.5 to Marbo 34 34.5 Circuit 1
Piti 345	34.5	Cld Stor	34.5	Line	59	line_29	42.40%	130.60%	30.10%	34.30%	Line Tamuning 34.5 to San Vito 34.5 Circuit 1
Piti 345	34.5	Cld Stor	34.5	Line	59	line_41	42.40%	130.60%	30.10%	34.20%	Line NCS Fine 34.5 to Potts Jc 34.5 Circuit 1
Piti 345	34.5	Cld Stor	34.5	Line	59	line_42	42.40%	130.60%	30.10%	34.20%	Line Potts Jc 34.5 to Andersen 34.5 Circuit 1
Piti 345	34.5	Cld Stor	34.5	Line	59	base	42.30%	130.60%	30.10%	34.20%	Base system (n-0)
Piti 345	34.5	Cld Stor	34.5	Line	59	line_45	42.30%	130.60%	30.10%	34.20%	Line Yigo_345 34.5 to Andersen 34.5 Circuit 1
Piti 345	34.5	Cld Stor	34.5	Line	59	line_25	42.20%	130.50%	30.10%	34.70%	Line Agana 34 34.5 to Tamuning 34.5 Circuit 1
Piti 345	34.5	Cld Stor	34.5	Line	59	line_30	42.30%	130.50%	30.10%	34.20%	Line Tumon 34 34.5 to Harmon 3 34.5 Circuit 1
Piti 345	34.5	Cld Stor	34.5	Line	59	line_32	42.30%	130.50%	30.10%	34.20%	Line San Vito 34.5 to Harmon 3 34.5 Circuit 1
Piti 345	34.5	Cld Stor	34.5	Line	59	line_44	42.20%	130.50%	30.10%	34.20%	Line Macheche 34.5 to GAA 34.5 34.5 Circuit 1
Piti 345	34.5	Cld Stor	34.5	Line	59	line_26	42.20%	130.00%	30.00%	34.20%	Line Barrigad 34.5 to GAA 34.5 34.5 Circuit 1
Piti 345	34.5	Cld Stor	34.5	Line	59	line_43	41.80%	129.60%	29.90%	34.20%	Line Macheche 34.5 to Pagat 34 34.5 Circuit 1
Piti 345	34.5	Orote 34	34.5	Line	54	line_19	na	129.20%	46.60%	42.70%	Line Piti 345 34.5 to Cld Stor 34.5 Circuit 1
Piti 345	34.5	Cld Stor	34.5	Line	59	line_21	40.80%	129.00%	29.40%	33.00%	Line Pulantat 34.5 to Talofofo 34.5 Circuit 1
Piti 345	34.5	Cld Stor	34.5	Line	59	line_16	39.60%	127.90%	29.40%	33.60%	Line Apra 34. 34.5 to Umatac34 34.5 Circuit 1
Dededo 3	34.5	Andersen	34.5	Line	42	line_33	33.40%	127.40%	27.60%	19.70%	Line Tanguiss 34.5 to Harmon 1 34.5 Circuit 1
Piti 345	34.5	Cld Stor	34.5	Line	59	line_14	35.00%	125.90%	28.30%	31.80%	Line Talofofo 34.5 to Apra 34. 34.5 Circuit 1
Dededo 3	34.5	Andersen	34.5	Line	42	line_5	36.30%	122.30%	24.70%	15.70%	Line Agana115 115.0 to Tamuning 115.0 Circuit 1
Dededo 3	34.5	Andersen	34.5	Line	42	line_45	32.20%	122.30%	22.90%	11.90%	Line Yigo_345 34.5 to Andersen 34.5 Circuit 1
Dededo 3	34.5	Andersen	34.5	Line	42	line_63	33.10%	121.30%	22.50%	10.90%	Line Piti 115 115.0 to Harmn115 115.0 and Tamuning T600
Dededo 3	34.5	Andersen	34.5	Line	42	line_38	39.20%	120.50%	26.10%	16.20%	Line Harmon 3 34.5 to Macheche 34.5 Circuit 1
Piti 345	34.5	Agana 34	34.5	Line	29	line_66	98.60%	120.40%	110.50%	110.40%	Line Piti 345 34.5 to Anigua 3 34.5 Circuit 1 and Agana T400
Dededo 3	34.5	Andersen	34.5	Line	42	line_4	36.10%	120.30%	24.40%	14.90%	Line Piti 115 115.0 to Harmn115 115.0 Circuit 1
Dededo 3	34.5	Andersen	34.5	Line	42	line_61	32.10%	120.30%	22.40%	10.60%	Line Piti 115 115.0 to Harmn115 115.0 and Agana T400
Dededo 3	34.5	Andersen	34.5	Line	42	line_65	33.60%	120.00%	23.10%	12.40%	Line Tamuning 115.0 to Harmn115 115.0 and Tamuning T600
Dededo 3	34.5	Andersen	34.5	Line	42	line_64	33.60%	119.90%	23.10%	12.40%	Line Agana115 115.0 to Tamuning 115.0 Circuit 1 and Tamuning T600
Dededo 3	34.5	Andersen	34.5	Line	42	line_54	34.00%	118.90%	23.30%	12.10%	Line Cabr 115 115.0 to Piti 115 115.0 Circuit 1 and Line Cabr 115 115.0 to Agana
Dededo 3	34.5	Andersen	34.5	Line	42	line_62	35.80%	118.60%	24.10%	14.30%	Line Piti 115 115.0 to Harmn115 115.0 and Piti T700
Dededo 3	34.5	Andersen	34.5	Line	42	line_23	35.60%	117.50%	24.20%	12.90%	Line Agana 34 34.5 to Barrigad 34.5 Circuit 1
Dededo 3	34.5	Andersen	34.5	Line	42	line_6	35.90%	117.00%	24.40%	16.80%	Line Tamuning 115.0 to Harmn115 115.0 Circuit 1
Dededo 3	34.5	Andersen	34.5	Line	42	line_17	33.50%	115.90%	23.00%	12.30%	Line Apra 34. 34.5 to Tenjotap 34.5 Circuit 1
Dededo 3	34.5	Andersen	34.5	Line	42	line_2	33.60%	115.70%	23.00%	11.90%	Line Cabr 115 115.0 to Agana115 115.0 Circuit 1
Dededo 3	34.5	Andersen	34.5	Line	42	line_3	33.60%	115.70%	23.00%	11.90%	Line Cabr 115 115.0 to Agana115 115.0 Circuit 2
Dededo 3	34.5	Andersen	34.5	Line	42	line_55	32.00%	115.50%	23.00%	15.00%	Line Tamuning 115.0 to Harmn115 115.0 and Line Giattap 34.5 to Harmon 1 34.5
Dededo 3	34.5	Andersen	34.5	Line	42	line_67	28.10%	115.30%	20.00%	17.10%	Line Agana 34 34.5 to Tamuning 34.5 Circuit 1 and Tamuning T600
San Vito	34.5	Harmon 3	34.5	Line	29	line_67	114.90%	115.20%	106.70%	104.50%	Line Agana 34 34.5 to Tamuning 34.5 Circuit 1 and Tamuning T600
Dededo 3	34.5	Andersen	34.5	Line	42	line_1	33.60%	115.10%	23.00%	12.60%	Line Cabr 115 115.0 to Piti 115 115.0 Circuit 1
Dededo 3	34.5	Andersen	34.5	Line	42	line_26	33.60%	114.90%	23.10%	12.50%	Line Barrigad 34.5 to GAA 34.5 34.5 Circuit 1
Dededo 3	34.5	Andersen	34.5	Line	42	line_11	na	114.80%	23.00%	12.50%	Line Piti 345 34.5 to Orote 34 34.5 Circuit 1
Dededo 3	34.5	Andersen	34.5	Line	42	line_19	33.50%	114.80%	23.00%	12.50%	Line Piti 345 34.5 to Cld Stor 34.5 Circuit 1
Dededo 3	34.5	Andersen	34.5	Line	42	line_15	33.50%	114.70%	22.90%	12.50%	Line Apra 34. 34.5 to Orote 34 34.5 Circuit 1
Dededo 3	34.5	Andersen	34.5	Line	42	line_30	33.90%	114.40%	23.10%	12.90%	Line Tumon 34 34.5 to Harmon 3 34.5 Circuit 1
Dededo 3	34.5	Andersen	34.5	Line	42	line_14	33.50%	114.40%	22.90%	11.80%	Line Talofofo 34.5 to Apra 34. 34.5 Circuit 1

Overload Report

Name	kV	Name	kV	Type	Rated Mva	Outage	Existing 2007 Load	New DOD Loads	Line Upgrades w/ No 115 kV	Line Upgrades Including 115 kV	Outage description
Dededo 3	34.5	Andersen	34.5	Line	42	line_18	33.50%	114.30%	22.90%	12.50%	Line Orote 34 34.5 to Cld Stor 34.5 Circuit 1
Dededo 3	34.5	Andersen	34.5	Line	42	line_21	33.50%	114.30%	22.90%	12.30%	Line Pulantat 34.5 to Talofofo 34.5 Circuit 1
Dededo 3	34.5	Andersen	34.5	Line	42	line_25	33.50%	114.30%	22.90%	12.00%	Line Agana 34 34.5 to Tamuning 34.5 Circuit 1
Dededo 3	34.5	Andersen	34.5	Line	42	line_32	33.70%	114.20%	23.00%	12.60%	Line San Vito 34.5 to Harmon 3 34.5 Circuit 1
Dededo 3	34.5	Andersen	34.5	Line	42	base	33.50%	114.20%	22.90%	12.40%	Base system (n-0)
Dededo 3	34.5	Andersen	34.5	Line	42	line_31	33.60%	114.20%	22.80%	12.00%	Line Anigua 3 34.5 to Agana 34 34.5 Circuit 1
Dededo 3	34.5	Andersen	34.5	Line	42	line_59	33.20%	114.20%	22.60%	11.70%	Line Cabr 115 115.0 to Agana115 115.0 Circuit 1 and Piti T700
Dededo 3	34.5	Andersen	34.5	Line	42	line_16	33.50%	114.10%	22.90%	12.50%	Line Apra 34. 34.5 to Umatac34 34.5 Circuit 1
Dededo 3	34.5	Andersen	34.5	Line	42	line_12	33.30%	114.10%	22.70%	11.60%	Line Piti 345 34.5 to Agana 34 34.5 Circuit 1
Dededo 3	34.5	Andersen	34.5	Line	42	line_13	33.20%	114.10%	22.60%	11.40%	Line Piti 345 34.5 to Anigua 3 34.5 Circuit 1
Dededo 3	34.5	Andersen	34.5	Line	42	line_22	33.50%	114.00%	22.90%	12.50%	Line Pulantat 34.5 to Barrigad 34.5 Circuit 1
Dededo 3	34.5	Andersen	34.5	Line	42	line_10	33.50%	113.90%	22.90%	12.40%	Line Piti 345 34.5 to Tenjotap 34.5 Circuit 1
Dededo 3	34.5	Andersen	34.5	Line	42	line_44	32.80%	113.90%	22.60%	12.00%	Line Macheche 34.5 to GAA 34.5 34.5 Circuit 1
Dededo 3	34.5	Andersen	34.5	Line	42	line_29	32.80%	113.80%	22.60%	12.30%	Line Tamuning 34.5 to San Vito 34.5 Circuit 1
Dededo 3	34.5	Andersen	34.5	Line	42	line_28	32.60%	113.70%	22.40%	12.10%	Line Tamuning 34.5 to Tumon 34 34.5 Circuit 1
Dededo 3	34.5	Andersen	34.5	Line	42	line_57	29.60%	113.70%	21.20%	11.60%	Line Cabr 115 115.0 to Agana115 115.0 Circuit 1 and Agana T400
Dededo 3	34.5	Andersen	34.5	Line	42	line_46	30.50%	113.60%	21.90%	11.70%	Line GAA 34.5 34.5 to GIAT 34.5 Circuit 1
Orote 34	34.5	Cld Stor	34.5	Line	59	line_17	40.60%	113.50%	26.00%	21.90%	Line Apra 34. 34.5 to Tenjotap 34.5 Circuit 1
Dededo 3	34.5	Andersen	34.5	Line	42	line_43	33.80%	113.40%	23.00%	13.40%	Line Macheche 34.5 to Pagat 34 34.5 Circuit 1
Dededo 3	34.5	Andersen	34.5	Line	42	line_58	29.30%	113.20%	21.10%	11.60%	Line Cabr 115 to Piti 115 and Agana T400
Dededo 3	34.5	Andersen	34.5	Line	42	line_20	33.50%	113.10%	22.90%	12.80%	Line Cld Stor 34.5 to Cold Sto 34.5 Circuit 1
Dededo 3	34.5	Andersen	34.5	Line	42	tran_49	33.10%	112.90%	22.60%	12.30%	Tran Piti 345 34.50 to Piti 115 115.00 Circuit 1
Harmon 1	34.5	Yigo_345	34.5	Line	29	line_35	82.20%	112.80%	38.90%	35.70%	Line Harmon 3 34.5 to Dededo 3 34.5 Circuit 1
Dededo 3	34.5	Andersen	34.5	Line	42	line_9	33.00%	112.60%	22.50%	12.20%	Line Cabrs345 34.5 to Piti 345 34.5 Circuit 1
Dededo 3	34.5	Andersen	34.5	Line	42	tran_48	33.00%	112.60%	22.50%	12.20%	Tran Cabrs345 34.50 to Cabr 115 115.00 Circuit 1
Dededo 3	34.5	Andersen	34.5	Line	42	line_47	29.30%	112.30%	21.30%	12.00%	Line GIAT 34.5 to Harmon 1 34.5 Circuit 1
Dededo 3	34.5	Andersen	34.5	Line	42	line_60	32.70%	112.10%	22.40%	12.70%	Line Cabr 115 to Piti 115 and Piti T700
Dededo 3	34.5	Andersen	34.5	Line	42	tran_51	30.30%	112.00%	21.10%	13.10%	Tran Tamuning 34.50 to Tamuning 115.00 Circuit 1
Dededo 3	34.5	Andersen	34.5	Line	42	line_66	27.80%	111.90%	20.00%	14.00%	Line Piti 345 34.5 to Anigua 3 34.5 Circuit 1 and Agana T400
Dededo 3	34.5	Andersen	34.5	Line	42	tran_50	29.20%	111.70%	21.00%	12.20%	Tran Agana 34 34.50 to Agana115 115.00 Circuit 1
Agana115	115	Tamuning	115	Line	181	line_61	98.40%	110.90%	99.40%	96.50%	Line Piti 115 115.0 to Harmn115 115.0 and Agana T400
Dededo 3	34.5	Andersen	34.5	Line	42	line_68	21.90%	110.00%	17.60%	23.00%	Line Tamuning 34.5 to Tumon 34 34.5 Circuit 1 and Harmon T500
Dededo 3	34.5	Andersen	34.5	Line	42	line_27	29.60%	109.60%	20.10%	10.20%	Line Radio Ba 34.5 to Marbo 34 34.5 Circuit 1
Dededo 3	34.5	Andersen	34.5	Line	42	line_40	29.60%	109.60%	20.10%	10.20%	Line Dededo 3 34.5 to Marbo 34 34.5 Circuit 1
Dededo 3	34.5	Andersen	34.5	Line	42	tran_52	24.90%	109.40%	19.00%	17.70%	Tran Harmon 3 34.50 to Harmn115 115.00 Circuit 1
Dededo 3	34.5	Andersen	34.5	Line	42	line_24	28.60%	108.80%	19.80%	11.90%	Line Agana 34 34.5 to Radio Ba 34.5 Circuit 1
Dededo 3	34.5	Andersen	34.5	Line	42	line_34	28.90%	107.90%	18.60%	10.20%	Line Tanguiss 34.5 to Harmon 3 34.5 Circuit 2
Piti 345	34.5	Orote 34	34.5	Line	54	line_17	na	105.70%	34.90%	39.10%	Line Apra 34. 34.5 to Tenjotap 34.5 Circuit 1
Dededo 3	34.5	Andersen	34.5	Line	42	line_41	46.80%	103.60%	29.80%	12.80%	Line NCS Fine 34.5 to Potts Jc 34.5 Circuit 1
Dededo 3	34.5	Andersen	34.5	Line	42	line_42	46.80%	103.60%	29.80%	12.80%	Line Potts Jc 34.5 to Andersen 34.5 Circuit 1
Piti 345	34.5	Orote 34	34.5	Line	54	line_18	na	101.30%	35.60%	30.40%	Line Orote 34 34.5 to Cld Stor 34.5 Circuit 1
Orote 34	34.5	Cld Stor	34.5	Line	59	line_20	34.00%	100.90%	20.70%	21.10%	Line Cld Stor 34.5 to Cold Sto 34.5 Circuit 1
Piti 345	34.5	Cld Stor	34.5	Line	59	line_20	34.00%	100.90%	20.70%	21.10%	Line Cld Stor 34.5 to Cold Sto 34.5 Circuit 1
Tanguiss	34.5	Harmon 1	34.5	Line	54	tran_53	na	100.70%	90.40%	60.80%	Tran Harmon 1 34.50 to Harmn115 115.00 Circuit 2

Overload Report

Name	kV	Name	kV	Type	Rated Mva	Outage	Existing 2007 Load	New DOD Loads	Line Upgrades w/ No 115 kV	Line Upgrades Including 115 kV	Outage description
GIAT	34.5	Harmon 1	34.5	Line	29	line_38	101.00%	87.70%	89.90%	88.20%	Line Harmon 3 34.5 to Macheche 34.5 Circuit 1
								134.97%			

Appendix B
Customer Service Agreement

GUAM POWER AUTHORITY
UTILITY SERVICE CONTRACT

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CUSTOMER AGREEMENT

The United States of America, hereinafter called "Navy," and the Guam Power Authority, hereinafter called "GPA," agree as follows:

ARTICLE 1

Recitals

1.1 This Agreement describes the terms, conditions and rate setting procedures and service rules and regulations applicable to energy and capacity sold and delivered by GPA to Navy, the services Navy will provide to GPA during the interim period and Navy's compensation thereof and services other than electric service that GPA will provide to Navy and compensation thereof. Nothing in this Agreement is intended to be determinative of the issue of ownership of Navy electrical production, transmission and distribution facilities on Guam.

1.2 Navy operates electrical production, transmission and certain distribution facilities which are used jointly for the supply of electricity to Department of Defense (DOD) installations on Guam and to GPA for retail distribution to GPA's customers.

1.3 GPA operates electric production, transmission and distribution facilities which are used for the supply of electricity for retail distribution to GPA's customers and to Department of Defense installations on Guam.

1.4 The Island-Wide Power System is dispatched and controlled by GPA from the GPA Dispatch Control Center.

1.5 GPA and Navy agree to terminate the Power Pool Agreement and amendments thereto which now exist between the parties as of the effective date of this Agreement.

1.6 GPA and Navy desire to establish a relationship whereby Navy and other Department of Defense facilities on Guam become a firm service customer of GPA.

1.7 Navy will operate and maintain their assets during the interim period to allow time for GPA to achieve defined performance standards. Navy pledges the output and use of the joint use Navy generation and transmission assets to GPA during the interim period except in emergency situations as defined in Article 17.

1.8 GPA desires the output and use of the joint use Navy generation and transmission assets and the related services Navy will provide during the interim period.

1.9 Navy and GPA desire to continue to have GPA operate and maintain Tanguisson Unit No. 1.

1.10 Navy and GPA desire transfer of responsibility for the Island-Wide Power System to GPA when the conditions described in Article 7.4 have been met.

1.11 Any disputes will be resolved in accordance with the disputes resolution procedures contained in Article 26.

ARTICLE 3

Services Navy Will Provide and Assets Navy Will Make Available During the Interim Period

3.1 During the interim period, the Navy will provide certain services to GPA in support of the IWPS and will make certain Navy joint use generation, transmission assets and other mutually agreed assets available to the IWPS. GPA agrees to accept the services offered by Navy during the interim period and the use of Navy joint use generation and transmission assets. For the services described in Article 3.5 below, Navy has and will continue to offer GPA the option of assuming responsibility to provide the service with proper notification to Navy of GPA's intent to assume such responsibility.

3.2 At the termination of the interim period, Navy will discontinue provision of all interim period services to the IWPS as described under this Article.

3.3 At the termination of the interim period, the Navy joint use generation, transmission and other mutually agreed assets and associated real estate as listed in Table 3 will be made available to GPA for use in the IWPS.

3.4 Navy will provide personnel, materials and support to operate and maintain the Navy joint use generation, transmission and other mutually agreed assets and facilities except that GPA will continue to operate and maintain Tanguisson No. 1 in accordance with the terms and conditions of Appendix B. The assets and facilities contemplated for Navy to operate and maintain are listed in Table 3 and Table 4. At Navy's option, with GPA's written concurrence, Navy may transfer responsibility for operation and maintenance of specific Navy assets or facilities to GPA during the interim period.

3.5 In addition to providing personnel, materials, subcontractors and other requirements to operate and maintain the Navy's joint use generation and transmission system, the Navy will continue provision of the following services during the interim period:

3.5.1 Navy will operate, maintain and make available the use of telephone circuits used in the dispatch and control of the IWPS during the interim period. At its option and with six (6) months notice, GPA can elect to provide through ownership or contract, all or part of the telecommunications requirements for dispatch and control of the IWPS. In this event, Navy retains the right to leave its facilities in place including operation and maintenance thereof during the interim period, but Navy would not be compensated by GPA for facilities no longer required for the IWPS.

3.5.2 Navy will continue to supply fresh water to the power generation facilities installed on Guam from the effective date of this contract through the interim period. During the interim period, Navy will supply fresh water for other requirements or new facilities under supplemental agreements on a best efforts basis. At its option, with six (6) months notice, GPA can elect to provide some or all of the fresh water requirements including transportation thereof for the IWPS.

3.5.3 Navy will continue to purchase, store and make low sulphur fuel oil available to the IWPS during the interim period. Navy will continue to transport low sulphur fuel oil through Navy's pipeline facilities and otherwise transport such fuel for use in the IWPS during the interim period. At its option, with six (6) months prior notice, GPA can assume responsibility for supply and/or transportation of low-sulphur fuel oil during the interim period provided that GPA meets all EPA environmental requirements and the Navy is released from any responsibility to provide such fuel under agreements between the parties to this Agreement and EPA.

3.5.4 Navy will continue to allow GPA pole attachments to Navy joint use poles during the interim period. Navy will be advised in writing with two (2) week advance notice of proposed GPA attachments prior to their installation. Navy may reject a proposed GPA pole

attachment prior to the scheduled attachment date if the attachment may impair the structural integrity or stability of the pole or the proposed attachment impairs the integrity of the Navy system to operate on a stand-alone basis.

3.5.5 Navy may allow GPA pole attachments to Navy non-joint use poles.

3.5.6 Navy will continue to provide certain engineering services of the Pacific Division, Naval Facilities Engineering Command through the interim period. GPA may request and Pacific Division will supply such services on an as available basis. These services have and will continue to be generally limited to relay coordination and power system analysis.

3.5.7 Navy will continue to provide transportation of distilled water between power plants and transportation of fuel oil to the Tanguisson power plant when required.

3.5.8 Navy will continue to provide input to the planning of IWPS generation and transmission facilities. Navy will continue to design and execute facilities changes in the Navy joint use generation, transmission and other mutually agreed facilities. GPA shall be given an opportunity to review and provide written input to proposed Navy changes to joint use assets.

3.5.9 Navy may provide assistance as GPA may request on GPA's or Navy's joint use system.

3.5.10 Navy will continue to make certain Navy buildings that house Navy and GPA joint use generation and transmission facilities available during the interim period. GPA will request Navy approval of all modifications or expansion of GPA facilities in Navy buildings in writing with necessary plans and drawings and cannot begin modifications without written Navy authorization. The criteria Navy will use to evaluate whether to approve the building use include the following:

--The use proposed by GPA will not interfere with existing or proposed Navy facilities

--There are no other suitable buildings available to GPA for the same or similar use

--The space requested in the building is the minimum space required to accomplish GPA's facilities plans

Navy's approval will not be unreasonably withheld or unnecessarily delayed.

3.6 Navy personnel providing services to the IWPS shall be properly trained and supervised. Navy facilities shall be operated, maintained and improved in accordance with good and generally accepted utility standards and Navy operation and maintenance standards. Navy will provide services in a safe, efficient and cost-effective manner.

3.7 Existing land use permits granted to GPA by Navy will be continued through the interim period or until such time as such land use permits are converted into easements. Requests by GPA for use of Navy land or easements after the effective date of this Agreement will be a request for an easement on Navy land or assignment of an interest in a Navy easement if such interest is assignable. The Navy will not be responsible for acquisition of additional real estate interests from private parties for the benefit of GPA. Navy shall grant such easements in accordance with its regulations and applicable federal law. Navy shall grant easements in perpetuity subject to the following conditions:

--GPA's attainment of the standards or otherwise assuming full responsibility for the IWPS

--Use by GPA is restricted to a specific use, e.g., 34.5 kV substation or 115 kV line

--Navy may request return of all or any portion of the easement to the extent necessary to eliminate undue interference with its activities; provided that, unless Navy determines that relocation is not feasible, it will convey without charge a substitute easement permitting GPA to relocate its easement facilities elsewhere on Navy land at GPA's sole cost and expense except for easements covering Navy-designated utility corridor areas for which relocation costs will be shared on a 50-50 basis, the Navy share to be included as a cost item in

any Navy project requiring such easement relocation. The Navy-designated utility corridor areas will be established when the easements are granted

--Use by GPA is limited to IWPS facilities

--Easements may be revoked if conditions for use are not met

GPA will file an application for easement with the Navy which will include a drawing and legal description of the proposed easement area together with an explanation of the purpose for which the land is to be used. The criteria Navy will use to evaluate whether to grant an easement include the following:

--The land use proposed by GPA will not interfere with existing or proposed Navy use of the land

--There is no other available land that could reasonably be used for the purpose proposed by GPA

--The land requested under easement is the minimum land needed to accomplish GPA's facility plans

Navy approval of an easement will not be unreasonably withheld or unnecessarily delayed.

3.8 The services Navy is to provide during the interim period described in Article 3.5 terminate at the end of the interim period. Navy has no continuing obligation to provide such services under this Agreement after the termination of the interim period.

3.9 Both parties recognize the desirability of maintaining a highly trained and experienced work force to operate the IWPS electrical facilities. Appropriate federal procedures will be used at the end of the interim period to disestablish the associated units of the Power Division of the Utilities Department and Maintenance Department of the Navy PWC Guam. The Navy and GPA agree to cooperate fully to ensure that the Navy can continue to successfully recruit personnel during the interim period and to ensure that GPA can recruit qualified Navy PWC Guam personnel for the turnover.

3.9.1 Navy will provide GPA information as allowed by federal privacy, freedom of information, and personnel management laws and regulations to apprise GPA of the dedicated full-time staffing required to operate the facilities. Navy will allow a reasonable amount of duty time for personnel of such positions for employment interviews with GPA. Navy will provide its personnel with assistance in obtaining private information required by GPA to allow GPA to devise incentives to recruit Navy PWC Guam personnel.

3.9.2 GPA will provide Navy information relevant to its employee benefits to assist in maintaining adequate Navy staffing during the interim period. GPA offers right of first refusal to all Navy PWC Guam personnel assigned to work centers of the Power Division of the Utilities Department and Maintenance Department of the Navy PWC Guam who are dedicated full-time to those facilities to be transferred to

GPA. Navy PWC Guam personnel must exercise right of first refusal not later than three months before the end of the interim period to allow outside recruitment if needed.

3.9.3 Details of the transition of personnel at the completion of the interim period will be included in a transition plan developed in accordance with Appendix C.

3.10 As Navy facilities listed in Table 3, or their maintenance and operation, are transferred to GPA, the special tools, equipment, supplies and transportation equipment associated with these facilities will be made available to GPA at no cost, as permitted by U.S. Public Law 100-202. The details of the transfer of special tools, equipment, supplies and transportation equipment will be included in a transition plan developed in accordance with Appendix C. The determination of the quantity to be transferred will be in accordance with Appendix D.

3.11 Navy will continue to make capital improvements to the Navy joint use generation and transmission facilities during the interim period. GPA shall be given an opportunity to review and provide written input to proposed changes to Navy joint use assets. Navy will pay for such capital improvements and they shall become part of the Navy's joint use generation and transmission facilities. In the event that Navy offers and GPA accepts an early

termination of the interim period, with respect to part or all of the Navy facilities, GPA will forthwith assume responsibility for planning, executing and funding capital improvements to such facilities.

3.12 Navy will obtain for a finite number of GPA emergency service workers the required security clearances to allow them access to DOD-secured facilities which contain those portions of the electrical equipment necessary for GPA to perform its IWPS dispatch, operation and maintenance responsibilities. GPA emergency service workers proposed for security clearances must meet applicable clearance criteria as defined by DOD directives. These clearances will be prearranged for the emergency service workers so that they can access transmission and substation equipment for the purpose of diagnosing the cause of trouble and making that cause of trouble safe. The repair crews necessary to complete permanent repairs would require additional clearances which would be arranged at the time that such repair crews required access to on-base facilities.

ARTICLE 8

Forecasts of Reimbursable Costs

8.1 Under the terms of this Agreement GPA and Navy may incur costs that are reimbursable in whole or part by the other party. The reimbursement of such cost is subject to the terms of this Agreement. To assist both parties in the planning, budgeting and control of their respective organizations, GPA and Navy will provide certain forecast data to the other party.

8.2 Forecast cost data will be provided in good faith in accordance with the terms of this Agreement. The forecasts will not be binding on the supplier of the forecast. To facilitate exchange of information about costs incurred on behalf of the other party, budget review meetings will be held quarterly to discuss budget/actual status and revised budget expectations.

8.3 GPA shall annually provide to Navy a monthly budget for a two (2) year period of operation and maintenance expenses for Tanguisson No. 1 and other services it provides to Navy and a separate five (5) year annual forecast of capital expenditures for Tanguisson No. 1. The monthly two (2) year budget and the annual five (5) year forecast will be provided in the format of the monthly service billing/cost summary by July 31 of each year.

8.4 Navy shall annually provide to GPA a monthly budget for a two (2) year period of operation and maintenance expenses to be incurred on Navy joint use assets and in providing other services to GPA. The budget shall reflect not only expenses to be incurred but also the amounts Navy anticipates GPA will reimburse under the terms of this Agreement. Navy shall provide a five (5) year annual forecast of capital expenditures that Navy will be reimbursed by GPA based upon GPA's request for assistance. Budgets and forecasts will be provided in the format of the monthly service billing/cost summary by July 31 of each year.

8.5 In addition to budgets and forecasts of reimbursable costs described above, GPA and Navy will exchange budget and forecast information, including load forecasts, on their respective operations as such information becomes available.

8.6 Navy shall notify GPA promptly of any anticipated change in Navy operations or maintenance activities which would significantly affect Navy's load characteristics or resource capabilities, to the extent such changes are not reflected in information already submitted to GPA.

ARTICLE 15

Miscellaneous Provisions

15.1 This Agreement, including tables, appendices and attachments, can be amended only by written agreement between both of the parties.

15.2 The failure of GPA or Navy to insist in any one or more instances upon strict performance of any provisions of this Agreement or to take advantage of any rights hereunder, shall not be construed as a waiver of any provisions or rights, which shall remain in full force and effect.

15.3 This Agreement is intended by the parties as the final expression of their agreement and is intended also as a complete and exclusive expression of the terms of their agreement. All prior written or oral understandings, offers or other communications pertaining to this Agreement are abrogated and withdrawn.

15.4 If the incremental energy cost of a party is used in determining compensation for a particular transaction, supporting documentation on all components of such cost will be provided upon request of the other party.

ARTICLE 18

Rates and Regulation

18.1 The PUC is acknowledged to be an eligible regulatory body in accordance with the Armed Services Procurement Regulation, Supplement 5. Accordingly, the Navy agrees, for the purpose of this Agreement, as a matter of comity rather than law, to comply with the current regulations, practices and decisions of the PUC concerning accounting practices, allowability of costs, pricing and rates, subject to appeal to the Guam Superior Court and continuing through normal judicial channels.

18.2 Both parties agree, subject to the approval of the PUC, to have a fixed cost of service and rate structure methodology to determine the cost associated with serving the Navy and non-Navy loads and to develop Navy's rates in accordance with Article 19 for a five (5) year period to provide for stability and predictability in setting rates.

18.3 Navy and GPA agree to the methodology for establishing initial rates to be paid by Navy, as set forth in Article 19. Rates to be charged Navy at the effective date of this Agreement shall be established in accordance with this methodology and will become a part of this Agreement. (Article 19.6 specifies the procedures and guidelines for implementing these initial rates.) Navy and GPA agree to support the use of this methodology for future

rate adjustments unless changes in IWPS operations and/or system conditions cause this methodology to produce a result that is no longer reflective of the cost (including return as described in Articles 19.6 and 19.7 of this Agreement) of serving the Navy and non-Navy customer classes.

18.4 No changes will be made in the cost of service and rate structure methodology for a period of five (5) years from the effective date of this Agreement, if the PUC, in approving this Agreement, orders GPA to utilize this cost of service and rate structure methodology for a five (5) year period to determine the costs associated with serving Navy and non-Navy loads and to develop Navy's rates in accordance with Article 19. If the PUC does not issue such an order in approving this Agreement, this Agreement shall not be effective.

Further, if GPA and Navy mutually agree that there is a significant change in IWPS operations and/or system conditions that cause this methodology to produce a result that is no longer reflective of the cost (including return as described in Articles 19.6 and 19.7 of this Agreement) of serving the Navy and non-Navy customer classes, GPA may propose and Navy will support a change in the cost of service and rate structure methodology in GPA's next general rate filing.

18.5 After the period specified in Articles 18.2 and 18.4, if changes in cost of service and rate structure methodology are sought, the procedures specified in this Article shall be followed.

18.5.1 If GPA or PUC determines it is necessary to seek a change in the methodology in effect for setting rates, GPA shall give Navy forty-five (45) days notice of its desire together with the recommended changes. If Navy agrees to the change in methodology, GPA will submit such modifications to the PUC for its approval or other action.

18.5.2 If Navy determines it is necessary to seek a change in the methodology in effect for setting rates, Navy shall give GPA forty-five (45) days notice of its desire together with Navy's recommended changes. If GPA agrees to the change in methodology, GPA will submit such modifications to the PUC for its approval or other action.

18.5.3 If GPA and Navy are unable to reach an agreement as to any matter relating to methodology within an additional forty-five (45) days of one party's notice to the other, GPA will then submit its position to the PUC pursuant to the rules and regulations of the PUC. Navy shall have the right to submit its position to the PUC, and no changes may be made until the PUC has conducted a hearing to consider both parties' positions and has rendered its decision. Pending a decision of the PUC, GPA agrees to continue to furnish electric service to the Navy at the rates then applicable.

18.6 If changes in rate levels are sought, the procedures specified below will be followed:

18.6.1 If GPA seeks an increase in the level of rates applicable to the Navy, the procedures specified in Article 19.7 shall be followed.

18.6.2 If GPA seeks a decrease in the level of the rates applicable to the Navy, GPA may either follow the procedures set forth in Article 19.7, or the procedures set forth in Articles 18.5.1 and 18.5.3.

18.6.3 If Navy determines to seek a decrease in the level of rates which it is paying, it may, at any time, enter into negotiations with GPA respecting such rate levels. In such instance, the procedures specified in Articles 18.5.2 and 18.5.3 will be followed.

ARTICLE 28

Service Rules and Regulations

28.1 Characteristics of Service

28.1.1 Alternating current service of approximate sixty (60) hertz will be regularly supplied. (Direct current will not be supplied.)

28.1.2 Voltages referred to herein are cited at nominal levels as normally intended to be delivered. Actual levels may vary within acceptable industry limits as defined in American National Standard C84.

28.2 Phase and Voltage Specification. Services will be provided at 34.5 kV three phase, three wire, except as noted in Table 1.

28.3 Equipment Protection

28.3.1 Protection of Navy's Facilities. The Navy is responsible for furnishing, calibrating, installing, inspecting and keeping in good and safe condition at its own risk and expense, all appropriate protection devices of any kind or character, which may be required to properly protect the Navy's facilities. GPA will not be

responsible for any loss or damage caused by the negligence or wrongful act of the Navy or Navy's agents, employees or licensees in omitting, installing, maintaining, using, operating or interfering with any such protective devices.

28.3.2 Protection from Service Interruptions. The Navy is responsible for selecting and installing the protective devices as necessary to coordinate properly with GPA's protective devices to avoid exposing other customers to unnecessary service interruptions.

28.4 Interference with Service

28.4.1 Voltage. If the Navy operates equipment which causes detrimental voltage fluctuations, Navy must reasonably limit those fluctuations. The Navy will be required to provide whatever corrective measures are necessary.

28.4.2 Current. If the Navy superimposes a current of any frequency upon any part of its electric system, other than the current supplied by GPA, Navy shall, at its expense, prevent the transmission of such current beyond its electrical system.

28.5 Other Conditions of Service. The Navy's loads shall be balanced on the three phases in accordance with good engineering practice.

28.6 Billings for Electric Utility Service

28.6.1 Navy is required to pay the charges assessed in accordance with GPA's established rates and billing cycle for the electric utility services provided.

28.6.2 Billing Period. Electric utility services will be billed monthly.

28.6.3 Metered Service. Bills for metered service will be based on meter registration. Meters will be read as required for the preparation of regular bills.

28.6.4 Estimated Bills. If, because of unusual conditions or for reasons beyond its control, GPA is unable to read the Navy's meters on the scheduled reading date, GPA may bill the Navy for estimated demand and consumption during the billing period, and make any necessary corrections when a reading is obtained. Estimated demand and consumption for this purpose will be calculated considering the Navy's prior usage. Adjustments for any under or overestimate of a Navy's demand and consumption will be reflected on the next regularly scheduled billing based on an actual reading following the period of inaccessibility.

28.6.5 Conjunctive Billing. The Navy's billing will be on a conjunctive basis.

28.7 Payment of Bills. Payment will be made in accordance to the Prompt Payment Act of 1982 and Article 4.

28.8 Meter Test

28.8.1 GPA will conduct meter testing to ensure accurate meter registration.

28.8.2 National Standards

28.8.2.1 Meters and associated metering devices will be tested and adjusted by GPA personnel in conformity with the standards of the American National Standards Institute Code for Electricity Metering (ANSI) C12-1975, or latest edition.

28.8.2.2 GPA will test meters individually. No meter will be placed in service or allowed to remain in service which is found to have more than a two percent (2%) registration error under normal operating conditions.

28.8.2.3 When tested, all meters and/or associated devices will be adjusted by GPA personnel as close to the condition of zero error as possible. All tolerances are to be interpreted as maximum permissible variations from the condition of zero error. When making adjustments, the prescribed tolerance limits shall not be taken advantage of.

28.8.2.4 GPA will not install a meter which is known to be defective. The capacity of the meter and the index mechanism shall be consistent with the Navy electric power requirements.

28.8.3 Testing Removed Meters

28.8.3.1 When deemed necessary, meters and/or associated devices will be tested after they are removed from service. These tests will be done before the meters and/or associated devices are adjusted, repaired or retired. No meter will be allowed to remain in service which is found to have an error in registration in excess of the prescribed tolerance limit.

28.8.4 Navy Requested Test. Navy may request GPA to test their electric meter at no charge once every six (6) months. The cost of any additional tests will be borne by the Navy if the percentage of error is found to be no more than two percent (2%). Tests will be conducted within ten (10) working days of receipt of request.

28.8.5 Test Report. The Navy will have the right to witness GPA's test of the meter or, if it desires, have the presence of an expert or other representative appointed by the Navy. A report giving the results of the test will be provided to the Navy within ten (10) working days of the test. A copy of the report, together with a complete record of each test, will be kept on file by GPA for at least three (3) years.

28.9 Adjustment of Bills

28.9.1 For Meter Error

28.9.1.1 If, after testing, any meter is found to be registering more than two percent (2%) fast, GPA will refund or credit to the Navy the overcharge based on corrected meter readings for the period in which the meter was in use, not to exceed one hundred eighty (180) days, unless it can be shown that the error was due to a particular cause, the date of which can be reliably established or computed back to but not beyond that date, and in no case beyond twelve (12) months.

28.9.1.2 If, after testing, a meter is found to register more than two percent (2%) slow, GPA's billing adjustment will be for electric energy consumed up to one hundred eighty (180) days prior to date of test. If the actual period of error has been determined to exceed one hundred eighty (180) days, the adjustment will cover that total period, but in no case beyond twelve (12) months.

28.9.2 For Billing Error

28.9.2.1 If the Navy is overcharged as a result of incorrect reading of the meter, incorrect application of the rate schedule, incorrect connection of the meter, incorrect multiplier or other similar reasons, the amount of the overcharge will be adjusted, refunded or credited to the Navy based on corrected billing for the preceding one hundred eighty (180) days, subject to the provisions of Article 28.9.2.3 below.

28.9.2.2 If the Navy is undercharged as a result of incorrect reading of the meter, incorrect application of the rate schedule, incorrect connection of the meter, incorrect multiplier or other similar reasons, the undercharge will be billed to the Navy based on corrected billing for the preceding one hundred eighty (180) days, subject to the provisions of Article 28.9.2.3 below.

28.9.2.3 When it is found that a billing error has been made, the date of which can be reliably established, the overcharge or undercharge will be computed back to but not beyond that date, and not beyond twelve (12) months.

28.10 Service Connections and Facilities on Navy's Premises

28.10.1 All meters will be installed by GPA at approved locations on Navy's premises and will be placed so they are easily accessible for inspections, reading and testing.

28.10.2 The Navy will, at its expense, provide an alternate and approved location for all meters in order to comply with the foregoing whenever the existing meter or meters becomes inaccessible for inspection, reading or testing by reason of any changes made by the Navy.

28.10.3 All GPA meters and related metering equipment will be sealed by GPA and no seal will be tampered with or broken except by a duly authorized representative of GPA.

28.11 No Unauthorized Work. Only a duly authorized representative of GPA or a Navy employee under the direction of the IWPS power dispatcher may connect or disconnect the Navy's conductors to or from GPA's conductors.

28.12 Responsibility for Navy Electrical Facilities

28.12.1 Good and Safe Condition. The Navy will, at its sole risk and expense, furnish, install, inspect and keep in good and safe condition all electrical facilities beyond the point of delivery required for receiving electric energy, including any necessary protective devices, regardless of the location of the transformers, meters or other GPA equipment.

28.12.2 Navy Side (Point of Delivery). The Navy will be solely responsible for the delivery of all electric energy on its side of the point of delivery.

28.12.3 Adjusting Protective Equipment. Whenever GPA determines coordination is required between the Navy's protective equipment and that of the GPA, GPA will review and, if it approves, will agree to the arrangement and setting of the Navy's protective equipment. In the interest of service reliability to the Navy and other customers, GPA may from time to time require the Navy to submit evidence that the agreed upon coordination is maintained.

28.12.4 Navy Responsibility for Actions. GPA will not be responsible for loss or damage caused by the negligence, lack of proper care or the wrongful act of the Navy, its agents, employees, or licensees in installing lines, machinery, apparatus or equipment.

28.13 Access to Premises. GPA shall have access to any premises served at all reasonable times during the continuance of this Agreement and at its termination for the purposes of installing, repairing and removing GPA's equipment, and for any other proper purpose hereunder provided, however, that Navy may limit or restrict such right of access in any manner considered by the Navy to be necessary or advisable.

28.14 Shortage of Electric Supply and Interruption of Delivery

28.14.1 Shortage and Interruption. GPA will exercise reasonable diligence and care to furnish and deliver a continuous and sufficient supply of electric energy to the Navy. However, it does not guarantee continuity or sufficiency of supply since electric service is inherently subject to interruption, suspension, curtailment and fluctuation.

28.14.2 Temporary Suspension for Repairs. Whenever temporary suspension is necessary for the purpose of making repairs or improvements, GPA will notify and coordinate with the Navy and proceed as rapidly as possible to avoid Navy inconvenience.

28.15 Resale of Electric Energy. It is expressly understood and agreed that Navy has the right to resell electric utility services to its customers as defined in Article 2.3.

28.16 Parallel Operations. The operation of Navy generating facilities in parallel with the IWPS will be planned and coordinated with and approved by the IWPS power dispatcher.

28.17 Line Extensions. Extensions of lines necessary to furnish permanent 34.5 kV service to the Navy will be made by modifications to this Agreement in accordance with the following provisions:

28.17.1 General

28.17.1.1 Ownership, Operation and Maintenance. GPA will construct, own, operate and maintain electric lines and equipment only under, along, upon and over public streets, roads and highways where it has the legal right to do so, and on public lands and private property across which it has otherwise obtained rights-of-way or other necessary rights satisfactory to GPA.

28.17.1.2 Special Facilities. GPA will install only those facilities which it deems necessary to render service in accordance with GPA's standard facilities for 34.5 kV service. If the Navy requests facilities which are acceptable to GPA but are in addition to, or in substitution for, the standard facilities which GPA normally would install, the Navy shall make a contribution to cover the extra cost thereof.

28.17.1.3 Refunds. GPA will have the right to connect subsequent customers to all Navy line extensions. If these are permanent connections and are made within five (5) years of the date the line extension is energized, subsequent customers connected will be treated for purposes of extension allowance and charges as if they were included among the customers for whom the extension was originally constructed. Reallocation of these charges among the customers will be made on the same basis. Refunds, if any, to the Navy will also be made on the same basis. The line extension allowance will be calculated from a permanent customer's point of delivery toward the source of supply. No refund will be made on any contribution to GPA for any cost of line extension beyond the free length if the Navy should terminate its original request less than thirty (30) months of the date permanent power was installed.

28.17.2 Overhead Extensions

28.17.2.1 Extension Allowance. Overhead line extensions will be made by GPA at its expense provided the cost of the line required does not exceed thirty (30) months' estimated revenue derived from the line. GPA will install, own, operate and maintain the necessary meters and switching and protective equipment at its expense, except where the Navy requests special facilities as covered by Article 28.17.1.2 above.

28.17.2.2 Extensions Beyond Allowance. For overhead line extensions whose estimated cost exceeds the thirty (30) months' estimated revenue to be derived from the line, the Navy shall make a contribution equal to the difference between the estimated line cost and the thirty (30) months' estimated revenue. The estimated line cost will exclude meters, switching and protective equipment, and will be based on the route determined by GPA. When a line extension is to be installed on Navy property, the route of any portion on Navy property must be mutually agreed to by Navy and GPA.

28.17.3 Underground Extensions

28.17.3.1 General. GPA will install underground line extensions only when the Navy makes a contribution of the estimated difference between the cost of the underground system and the cost to the Navy of an equivalent overhead system in accordance with Article 28.17.2 or when, for engineering and operating reasons, GPA may install the system underground at its own expense. The type of underground system that will be installed under this rule shall meet engineering construction standards of GPA. When an underground line extension is to be installed on Navy property, the Navy will normally provide

necessary supporting structures (ducts, manholes, etc.) and appropriate rights-of-way. GPA will install, own, operate and maintain the underground facilities outside of Navy property.

28.17.3.2 Replacement of Overhead with Underground Facilities. When mutually-agreed upon by the Navy and GPA, overhead facilities will be replaced with underground facilities, provided the Navy makes a contribution of the estimated cost installed of the underground facilities less the estimated net salvage of the overhead facilities removed.

28.18 Discontinuance of Service. GPA will not provide service to electrical equipment which, when operated, will be detrimental to GPA's or another customer's equipment. GPA will discontinue service to a Navy delivery point if the Navy continues to operate the equipment at that delivery point after being notified in writing by GPA to discontinue the operation. Discontinuance of service to any Navy delivery point will in no way affect service at other Navy delivery points.

28.19 Ability to Serve Other Customers From Facilities on Navy Property. All facilities installed by GPA at its expense on Navy's premises for the purpose of delivering electric energy to the Navy will continue to be the property of GPA and will be removed at the termination of service. These facilities may also be used to supply other customers whether or not on the same premises, provided the proper easement agreements have been obtained.

28.20 Navy Responsibility for GPA's Property. In the event of loss or damage to GPA's property on the Navy's premises caused by the Navy's tenants, agents or employees, either intentionally or arising from negligence, carelessness or misuse, the cost of repairs or replacements will be at the Navy's expense.

28.21 Unsafe Equipment or Condition

28.21.1 Service Refusal. GPA will have the right to refuse or discontinue service to a GPA point of delivery to Navy if Navy wiring or other equipment at that delivery point, or the use thereof, GPA has determined is unsafe or in violation of applicable laws, ordinances, rules or regulations of any public authority. GPA can also refuse service at a GPA point of delivery to Navy if it finds that any condition on the Navy's premises at that delivery point could endanger GPA's service facilities. Refusal or discontinuance of service to any Navy delivery point will in no way affect service at other Navy delivery points.

28.21.2 Service Discontinued. GPA may discontinue service to a Navy delivery point immediately and without notice if GPA determines a hazardous condition exists or if the Navy threatens to create a hazardous condition at that delivery point. Service will not be restored until GPA is satisfied changes have been made to eliminate

the hazardous condition. Discontinuance of service to any Navy delivery point will in no way affect service at other Navy delivery points.

28.21.3 Navy Notification of Defect. GPA does not assume any responsibility to inspect or repair the Navy's electrical system, other equipment or any part thereof. In the event the Navy has knowledge that its service is in any way defective, it is its responsibility to notify GPA at once. GPA will not be liable or responsible for any electrical system, appliances, facilities, or other equipment beyond the point of delivery which it does not own or maintain in accordance with these rules except for damage where GPA's characteristics of service do not meet acceptable industry limits per Article 28.1.

Appendix C
Navy-Provided Outage Data

Total of 214 unscheduled power outages documented for the period October 2005 to July 2006. Breakdown is as follows:

GPA System Failure – 39

Generators tripping off-line – 10
Transmission and Distribution system fault - 29

3 outages affected all of Naval Station, Naval Magazine, Camp Covington, Apra Housing areas, Cold Storage and Polaris Point.
4 outages affected all of Naval Hospital.
5 outages affected all housing areas, barracks, and administrative facilities at NCTS Finagayan and Air Force Det. 5 facilities at Northwest Field.
13 outages affected AAFB housing areas and Marbo water wells.
9 outages affected Naval Magazine, Camp Covington and Apra Housing areas.

Navy System Failure – 175

124 – Equipment failure
25 – Snakes, rodents, birds, etc.
14 - Unknown
4 - Lightning
3 – Vegetation
2 – Contactor
2 – False report
1 – Vehicular accident

S.E.T. – Pacific, Inc.

DOCUMENT TRANSMITTAL FORM

CUSTOMER: Raytheon Technical Services Guam, Inc. (RTSG)
FACILITY: Annex 8
LOCATION: Guam Naval Facilities

LOG #: 2347
SET Contract No: Sub-000002
ISSUE CODE:
DATE: Nov. 04, 2005

TO: DZSP 21
P.O. Box GH
Agana, Guam 96932
ATTENTION: Mr. Wally Toma, Subcontract Administrator

We are sending you: X Attached _Under Separate Cover via:_____the: __Shop Drawings

__Prints __Samples __Specifications __Reports __Inspections __Test Schedules __Copy of Letter

_Change Order __Constr.Progress Chart/Schedule __Payment Estimate X As Stated _____

Copies	Reference No.	Category Type	Description and Purpose
1	Annex 1602	CDRL No. F-1602000-F	Power System Dispatcher's Unscheduled and Scheduled Outage Report (4 pages)

Name of: Subcontractor, Supplier/Manufacturer _____

__For Approval __Approved as Submitted __Resubmit __copies for approval X For Your Use

__Approved as Noted __Submit __copies for distribution X As Requested __Returned for Corrections

__Return __corrected prints __For Review and Comment __Other: _____

I certify that the attached information is ready for execution and that the attached information complies with the requirements of the contract documents.

By:_____ 11-04-05
T.J. Jacot, Senior Vice-President

FROM (WED) 11 9 2005 15:38/ST. 15:38/NO. 5013361015 P 3

S.E.T. – Pacific, Inc.

ELECTRIC DISTRIBUTION LOG (UNSCHEDULED OUTAGES)

SEQUENTIAL LOG FOR 4.16, 13.8, 34.5 KV | RELAY TARGETS ACTION | MONTH: SEP 28 TO OCT 31 YEAR: 2005

UO#	DATE	TIME			LOCATION			LOAD	OVER CURRENT					XFMER DIFF	OUTAGE CAUSE*	SPECIFIC CAUSE OF OUTAGE / COMMENTS
		LOSS (TRIP)	RETURN (CLOSE)	ELAPSED HOURS	BASE / SUBSTATION	CIRCUIT BREAKER	AREA CUT-OFF OR AFFECTED	KV	KF	A	B	C	GRD			
206	09/29/05 – 09/30/05	0905	0913	1 DAY :08	POLARIS PT.	ON P-2	RECREATION CABANA AREA	SEC.							D2	SECONDARY PANEL DAMAGED BY VEHICLE.
207	09/30/05	0840	1125	2:45	AAFB	P-91	HOUSIN AREA: CAPEHART/PARTIAL OF FLEMING HTS.	13.8		I			I		D7	P-91-16P SWITCHGEAR FLASHED OVER.
208	09/30/05	1119	1220	1:01	OROTE	P-129	SECURITY/COAST GUARD/NAVFAC ADMIN AREAS, LOCKWOOD/SOUTH TIP HSG, CHAPEL, CDC, GYM, THEATER, OROTE TELEX	13.8			T				B2	PRIMARY LINES FELL ON POLES NT-16/NT-17/NT-18/NT-18-3.
208	09/30/05	1119	1657	5:38	CNM	ON P-129	NORTH TIP. HSG	13.8							B2	PRIMARY LINES FELL ON POLES NT-16/NT-17/NT-18/NT-18-3.
209	09/30/05	1827	2120	2:53	CNM	ON P-129	BLDG 2016 SWIMMING POOL	SEC.							C1	BROKEN SECONDARY CONNECTION.
01	10/02/05	0535	0612	:37	ANIGUA	P-281	NRMC AREA: NAVHOSP BLR ON GENERATOR	13.8							D6	GPA P-281 BREAKER TRIPPED/FAULT ON GPA CIRCUIT.
02	10/06/05	0101	0526	4:25	MARBO	ON P-51	AIR FORCE WELLS #5, 6, 7, 8	13.8							D3	FUSE BLEW ON POLE # MB-2-1/HEAVY RAIN IN THE AREA.
03	10/06/05	0535	0602	:27	POTTS JCT	T-110	COAST/GEODETIC SURVEY HSG, DET-T, MMS-1 COMPOUND, GTA, FAME OFFICE	13.8				I			D3	NO FINDINGS/HEAVY RAIN IN THE AREA.
04	10/06/05	0728	1206	4:38	AAFB	ON P-68	PARTIAL OF FLEMING HTS HSG: ST-9/10/11/12/13/15/16/17 AND BLDG 28125	13.8							D7	FL-3 SWITCHGEAR FLASHED OVER/HEAVY RAIN IN THE AREA.
05	10/06/05	1520	1755	2:35	OROTE/OLD STORAGE	T-11/T-12/T-13/T-132	OLD/NEW APRA HSG; ALL OF CNM AND NAVMAG AREA	13.8							D6	GPA X-20/X-35, X-31, X-36 BREAKERS TRIPPED.
05	10/06/05	1520	1609	:49	OROTE	P-129	SECURITY/COAST GUARD/NAVFAC ADMIN COMPOUND, NORTH/SOUTH TIP/LOCKWOOD HSG, CHAPEL, CDC, GYM, OROTE TELEX AND DRMO	13.8							D6	GPA X-20/X-35, X-31, X-36 BREAKERS TRIPPED.
05	10/06/05	1520	1609	:49	OROTE	P-16	COMMISSARY, NEX COMPLEX/BLDGS	13.8							D6	GPA X-20/X-35, X-31, X-36 BREAKERS TRIPPED.

*LEGEND: A1: LOAD SHEDDING; A2: GENERATOR TRIP; B1: STORM; B2: LIGHTNING; B3: EARTHQUAKE; C1: LINE; C2: TRANSFORMER; C3: RELAY; C4: BREAKER; D1: HUMAN ERROR; D2: VEHICLE ACCIDENT; D3: UNKNOWN; D4: TREE; D5: SNAKE; D6: GPA POWER SURGE; D7: OTHER

S.E.T.-Pacific, Inc. Proprietary

(WED) 11 9 2005 15:38/ST. 15:38/NO. 5013361015 P 4

S.E.T. – Pacific, Inc.

ELECTRIC DISTRIBUTION LOG (UNSCHEDULED OUTAGES)

SEQUENTIAL LOG FOR 4.16, 13.8, 34.5 KV | RELAY TARGETS ACTION | MONTH: SEP 28 TO OCT 31 YEAR: 2005

U/O#	DATE	TIME			LOCATION			LOAD	OVER CURRENT					XFMER DIFF	OUTAGE CAUSE*	SPECIFIC CAUSE OF OUTAGE / COMMENTS
		LOSS (TRIP)	RETURN (CLOSE)	ELAPSED HOURS	BASE / SUBSTATION	CIRCUIT BREAKER	AREA CUT-OFF OR AFFECTED	KV	KF	A	B	C	GRD			
05	10/06/05	1520	1611	:51	OROTE	T-17	WWTP, BARRACKS COMPLEX, CLUB RUMORS, SUMAY MARINA, PORT OPGS, DZSP MAINT COMPOUND, CSS-15, SLS-16, GSY, BLDG 2116	4.16							D6	GPA X-20/X-35, X-31, X-36 BREAKERS TRIPPED.
05	10/06/05	1520	1612	:52	OROTE	P-128	HARBOR/BAYVIEW HSG	13.8							D6	GPA X-20/X-35, X-31, X-36 BREAKERS TRIPPED.
05	10/06/05	1520	1612	:52	OROTE	P-14	VICTOR #2 SUB, MSC/MSF/SEALS COMPOUND, GSY, KILO PIER AND DENTAL CLINIC	13.8							D6	GPA X-20/X-35, X-31, X-36 BREAKERS TRIPPED.
05	10/06/05	1520	1616	:56	OROTE	P-25	ALPHA/BRAVO PIER: USS CITY OF CORPUS CHRISTI	13.8							D6	GPA X-20/X-35, X-31, X-36 BREAKERS TRIPPED.
05	10/06/05	1520	1754	2:34	COLD STORAGE	P-134	CAMP COVINGTON, OLD/NEW APRA HSG, DODEA, NAVMAG AREA	13.8							D6	GPA X-20/X-35, X-31, X-36 BREAKERS TRIPPED.
05	10/06/05	1520	1755	2:35	COLD STORAGE	P-133	COLD STORAGE COMPOUND	13.8							D6	GPA X-20/X-35, X-31, X-36 BREAKERS TRIPPED.
06	10/08/05 – 10/09/05	2352	0012	:20	CNM	ON P-129	QTRS. #17/19 HUTCHINS, QTRS. #26/28 OROTE PT. LOCKWOOD	13.8							C1	DEFECTIVE CUT-OUT ASSEMBLY ON POLE # JB-49-16.
07	10/12/05	0823	1032	2:09	AAFB	P-91	CAPEHART HSG AND PARTIAL OF ROBERTS TERRACE HSG	13.8		I	I	I			D7	FLASHOVER/MOISTURE AT CL-5.
08	10/12/05	1527	1555	:28	AAFB	ON P-94	BLDG 14540 SEWER LIFT STA.	13.8							D5	BLOWN FUSE ON POLE #NB-35-1 CAUSED BY SNAKE.
09	10/13/05	0809	0938	1:23	MARBO	ON P-51	WATER BOOSTER #3 STATION	13.8							C1	DEFECTIVE CUT-OUT ASSEMBLY ON POLE # MB-29.
10	10/13/05	0913	1046	1:33	AAFB	P-82	CONTROL TOWER, MATS TERMINAL, 3RD DIV. HDQTRS, BX, AIR COMM	13.8		I	I	I		13.8	D7	FLASHOVER AT MH-119 (P-81 SIDE).
11	10/15/05	0149	0517	3:28	MARBO	ON P-51	AIR FORCE WELLS # 5/6/7/8	13.8							D6	GPA SURGE/FUSE BLEW ON POLE MA-2-1.
12	10/18/05	1027	1611	5:44	POLARIS PT.	ON P-2	BLDG 4445 QTR DECK	SEC.							D7	BURNT KWH METER BASE.

*LEGEND: A1: LOAD SHEDDING A2: GENERATOR TRIP B1: STORM B2: LIGHTNING B3: EARTHQUAKE C1: LINE C2: TRANSFORMER C3: RELAY C4: BREAKER D1: HUMAN ERROR D2: VEHICLE ACCIDENT D3: UNKNOWN D4: TREE D5: SNAKE D6: GPA POWER SURGE D7: OTHER

FROM

S.E.T.-Pacific, Inc. Proprietary

FROM (WED) 11 9 2005 15:39/ST. 15:38/NO. 5013361015 P 5

S.E.T. – Pacific, Inc.

ELECTRIC DISTRIBUTION LOG (UNSCHEDULED OUTAGES)

SEQUENTIAL LOG FOR 4.16, 13.8, 34.5 KV | RELAY TARGETS ACTION | MONTH: SEP 28 TO OCT 31 YEAR: 2005

UO#	DATE	TIME			LOCATION			LOAD	OVER CURRENT					XFMER DIFF	OUTAGE CAUSE*	SPECIFIC CAUSE OF OUTAGE / COMMENTS
		LOSS (TRIP)	RETURN (CLOSE)	ELAPSED HOURS	BASE / SUBSTATION	CIRCUIT BREAKER	AREA CUT-OFF OR AFFECTED	KV	KF	A	B	C	GRD			
13	10/20/05	0840	1110	2:30	MARBO	ON P-51	AIR FORCE WELLS #5/6/7/8	13.8							C1	DEFECTIVE CUT-OUT ASSEMLY ON POLE # MA-2-1.
14	10/21/05	1348	1400	:12	ROMEO CNM	ON P-130	USS PASADENA	.48							D1	SUBMARINERS OVERLOADED R-3C/3D/3E/3F BREAKERS.
15	10/22/05	0804	1149	3:45	AAFB	P-91	CAPEHART HSG AND PARTIAL OF ROBERTS TERRACE HSG.	13.8		I	I	I	I		D7	CL-7 SWITCHGEAR FLASHED OVER/MOISTURE.
16	10/22/05	0937	0941	:04	AAFB	P-93	PARTIAL OF ROBERTS TERRACE	13.8					I		D6	GPA POWER SURGE.
17	10/22/05	0947	1006	:19	COLD STORAGE	P-134	OLD/NEW APRA HSG, NAVMAG AREA, PARTIAL OF CAMP COVINGTON	13.8					I		D6	GPA POWER SURGE.
18	10/22/05	1616	1805	1:49	AAFB	ON P-93	PARTIAL OF FLEMING HTS. HSG	13.8							D7	MH-205/MH-206 FLASHED OVER/MOISTURE.
19	10/24/05	0018	0243	2:25	ROMEO CNM	ON P-130	USS PASADENA	.48							D1	SUBMARINERS OVERLOADED R-3C/3D/3E/3F BREAKERS.
	10/24/05	0132	0402	2:30	HARMON/ AAFB	ON X-87/ X-73	NCTS 4 KV (F-2/F-3/F-4) AND POTTS JCT SUBSTATIONS	4.16 13.8							D6	GPA X-87/X-73 LINE TRIPPED.
20	10/28/05	2117	2314	1:57	MARBO	ON P-51	AIR FORCE WELLS #7/8	13.8							D3	FUSE BLEW ON POLE # MB-2-1.
21	10/29/05	1052	1124	:32	AAFB	P-91	CAPEHART HSG AND PARTIAL OF ROBERTS TERRACE	13.8							D6	GPA X-42/X-80 LINE TRIPPED.

*LEGEND:
A1: LOAD SHEDDING A2: GENERATOR TRIP B1: STORM B2: LIGHTNING B3: EARTHQUAKE C1: LINE C2: TRANSFORMER C3: RELAY
C4: BREAKER D1: HUMAN ERROR D2: VEHICLE ACCIDENT D3: UNKNOWN D4: TREE D5: SNAKE D6: GPA POWER SURGE D7: OTHER

S.E.T.-Pacific, Inc. Proprietary

S.E.T. – Pacific, Inc.

DOCUMENT TRANSMITTAL FORM

CUSTOMER: Raytheon Technical Services Guam, Inc. (RTSG)
FACILITY: Annex 8
LOCATION: Guam Naval Facilities

LOG #: 2347
SET Contract No: Sub-000002
ISSUE CODE:
DATE: Nov. 04, 2005

TO: DZSP 21
P.O. Box GH
Agana, Guam 96932
ATTENTION: Mr. Wally Toma, Subcontract Administrator

We are sending you: X Attached _Under Separate Cover via:_____the: __Shop Drawings

__Prints __Samples __Specifications __Reports __Inspections __Test Schedules __Copy of Letter

_Change Order __Constr.Progress Chart/Schedule __Payment Estimate X As Stated _____

Copies	Reference No.	Category Type	Description and Purpose
1	Annex 1602	CDRL No. F-1602000-F	Power System Dispatcher's Unscheduled and Scheduled Outage Report (4 pages)

Name of: Subcontractor, Supplier/Manufacturer _____

__For Approval __Approved as Submitted __Resubmit __copies for approval X For Your Use

__Approved as Noted __Submit __copies for distribution X As Requested __Returned for Corrections

__Return __corrected prints __For Review and Comment __Other: _____

I certify that the attached information is ready for execution and that the attached information complies with the requirements of the contract documents.

By:_____ 11-04-05
T.J. Jacot, Senior Vice-President

FROM (WED) 11 9 2005 15:38/ST. 15:38/NO. 5013361015 P 3

S.E.T. – Pacific, Inc.

ELECTRIC DISTRIBUTION LOG (UNSCHEDULED OUTAGES)

SEQUENTIAL LOG FOR 4.16, 13.8, 34.5 KV | RELAY TARGETS ACTION | MONTH: SEP 28 TO OCT 31 YEAR: 2005

UO#	DATE	TIME			LOCATION			LOAD	OVER CURRENT					XFMER DIFF	OUTAGE CAUSE*	SPECIFIC CAUSE OF OUTAGE / COMMENTS
		LOSS (TRIP)	RETURN (CLOSE)	ELAPSED HOURS	BASE / SUBSTATION	CIRCUIT BREAKER	AREA CUT-OFF OR AFFECTED	KV	KF	A	B	C	GRD			
206	09/29/05 – 09/30/05	0905	0913	1 DAY :08	POLARIS PT.	ON P-2	RECREATION CABANA AREA	SEC.							D2	SECONDARY PANEL DAMAGED BY VEHICLE.
207	09/30/05	0840	1125	2:45	AAFB	P-91	HOUSIN AREA: CAPEHART/PARTIAL OF FLEMING HTS.	13.8		I			I		D7	P-91-16P SWITCHGEAR FLASHED OVER.
208	09/30/05	1119	1220	1:01	OROTE	P-129	SECURITY/COAST GUARD/NAVFAC ADMIN AREAS, LOCKWOOD/SOUTH TIP HSG, CHAPEL, CDC, GYM, THEATER, OROTE TELEX	13.8			T				B2	PRIMARY LINES FELL ON POLES NT-16/NT-17/NT-18/NT-18-3.
208	09/30/05	1119	1657	5:38	CNM	ON P-129	NORTH TIP. HSG	13.8							B2	PRIMARY LINES FELL ON POLES NT-16/NT-17/NT-18/NT-18-3.
209	09/30/05	1827	2120	2:53	CNM	ON P-129	BLDG 2016 SWIMMING POOL	SEC.							C1	BROKEN SECONDARY CONNECTION.
01	10/02/05	0535	0612	:37	ANIGUA	P-281	NRMC AREA: NAVHOSP BLR ON GENERATOR	13.8							D6	GPA P-281 BREAKER TRIPPED/FAULT ON GPA CIRCUIT.
02	10/06/05	0101	0526	4:25	MARBO	ON P-51	AIR FORCE WELLS #5, 6, 7, 8	13.8							D3	FUSE BLEW ON POLE # MB-2-1/HEAVY RAIN IN THE AREA.
03	10/06/05	0535	0602	:27	POTTS JCT	T-110	COAST/GEODETIC SURVEY HSG, DET-T, MMS-1 COMPOUND, GTA, FAME OFFICE	13.8				I			D3	NO FINDINGS/HEAVY RAIN IN THE AREA.
04	10/06/05	0728	1206	4:38	AAFB	ON P-68	PARTIAL OF FLEMING HTS HSG: ST-9/10/11/12/13/15/16/17 AND BLDG 28125	13.8							D7	FL-3 SWITCHGEAR FLASHED OVER/HEAVY RAIN IN THE AREA.
05	10/06/05	1520	1755	2:35	OROTE/OLD STORAGE	T-11/T-12/T-13/T-132	OLD/NEW APRA HSG; ALL OF CNM AND NAVMAG AREA	13.8							D6	GPA X-20/X-35, X-31, X-36 BREAKERS TRIPPED.
05	10/06/05	1520	1609	:49	OROTE	P-129	SECURITY/COAST GUARD/NAVFAC ADMIN COMPOUND, NORTH/SOUTH TIP/LOCKWOOD HSG, CHAPEL, CDC, GYM, OROTE TELEX AND DRMO	13.8							D6	GPA X-20/X-35, X-31, X-36 BREAKERS TRIPPED.
05	10/06/05	1520	1609	:49	OROTE	P-16	COMMISSARY, NEX COMPLEX/BLDGS	13.8							D6	GPA X-20/X-35, X-31, X-36 BREAKERS TRIPPED.

*LEGEND: A1: LOAD SHEDDING; A2: GENERATOR TRIP; B1: STORM; B2: LIGHTNING; B3: EARTHQUAKE; C1: LINE; C2: TRANSFORMER; C3: RELAY; C4: BREAKER; D1: HUMAN ERROR; D2: VEHICLE ACCIDENT; D3: UNKNOWN; D4: TREE; D5: SNAKE; D6: GPA POWER SURGE; D7: OTHER

S.E.T.-Pacific, Inc. Proprietary

(WED) 11 9 2005 15:38/ST. 15:38/NO. 5013361015 P 4

S.E.T. – Pacific, Inc.

ELECTRIC DISTRIBUTION LOG (UNSCHEDULED OUTAGES)

SEQUENTIAL LOG FOR 4.16, 13.8, 34.5 KV | RELAY TARGETS ACTION | MONTH: SEP 28 TO OCT 31 YEAR: 2005

U/O#	DATE	TIME			LOCATION			LOAD	OVER CURRENT					XFMER DIFF	OUTAGE CAUSE*	SPECIFIC CAUSE OF OUTAGE / COMMENTS
		LOSS (TRIP)	RETURN (CLOSE)	ELAPSED HOURS	BASE / SUBSTATION	CIRCUIT BREAKER	AREA CUT-OFF OR AFFECTED	KV	KF	A	B	C	GRD			
05	10/06/05	1520	1611	:51	OROTE	T-17	WWTP, BARRACKS COMPLEX, CLUB RUMORS, SUMAY MARINA, PORT OPGS, DZSP MAINT COMPOUND, CSS-15, SLS-16, GSY, BLDG 2116	4.16							D6	GPA X-20/X-35, X-31, X-36 BREAKERS TRIPPED.
05	10/06/05	1520	1612	:52	OROTE	P-128	HARBOR/BAYVIEW HSG	13.8							D6	GPA X-20/X-35, X-31, X-36 BREAKERS TRIPPED.
05	10/06/05	1520	1612	:52	OROTE	P-14	VICTOR #2 SUB, MSC/MSF/SEALS COMPOUND, GSY, KILO PIER AND DENTAL CLINIC	13.8							D6	GPA X-20/X-35, X-31, X-36 BREAKERS TRIPPED.
05	10/06/05	1520	1616	:56	OROTE	P-25	ALPHA/BRAVO PIER: USS CITY OF CORPUS CHRISTI	13.8							D6	GPA X-20/X-35, X-31, X-36 BREAKERS TRIPPED.
05	10/06/05	1520	1754	2:34	COLD STORAGE	P-134	CAMP COVINGTON, OLD/NEW APRA HSG, DODEA, NAVMAG AREA	13.8							D6	GPA X-20/X-35, X-31, X-36 BREAKERS TRIPPED.
05	10/06/05	1520	1755	2:35	COLD STORAGE	P-133	COLD STORAGE COMPOUND	13.8							D6	GPA X-20/X-35, X-31, X-36 BREAKERS TRIPPED.
06	10/08/05 – 10/09/05	2352	0012	:20	CNM	ON P-129	QTRS. #17/19 HUTCHINS, QTRS. #26/28 OROTE PT. LOCKWOOD	13.8							C1	DEFECTIVE CUT-OUT ASSEMBLY ON POLE # JB-49-16.
07	10/12/05	0823	1032	2:09	AAFB	P-91	CAPEHART HSG AND PARTIAL OF ROBERTS TERRACE HSG	13.8		I	I	I			D7	FLASHOVER/MOISTURE AT CL-5.
08	10/12/05	1527	1555	:28	AAFB	ON P-94	BLDG 14540 SEWER LIFT STA.	13.8							D5	BLOWN FUSE ON POLE #NB-35-1 CAUSED BY SNAKE.
09	10/13/05	0809	0938	1:23	MARBO	ON P-51	WATER BOOSTER #3 STATION	13.8							C1	DEFECTIVE CUT-OUT ASSEMBLY ON POLE # MB-29.
10	10/13/05	0913	1046	1:33	AAFB	P-82	CONTROL TOWER, MATS TERMINAL, 3RD DIV. HDQTRS, BX, AIR COMM	13.8		I	I	I		13.8	D7	FLASHOVER AT MH-119 (P-81 SIDE).
11	10/15/05	0149	0517	3:28	MARBO	ON P-51	AIR FORCE WELLS # 5/6/7/8	13.8							D6	GPA SURGE/FUSE BLEW ON POLE MA-2-1.
12	10/18/05	1027	1611	5:44	POLARIS PT.	ON P-2	BLDG 4445 QTR DECK	SEC.							D7	BURNT KWH METER BASE.

*LEGEND: A1: LOAD SHEDDING A2: GENERATOR TRIP B1: STORM B2: LIGHTNING B3: EARTHQUAKE C1: LINE C2: TRANSFORMER C3: RELAY C4: BREAKER D1: HUMAN ERROR D2: VEHICLE ACCIDENT D3: UNKNOWN D4: TREE D5: SNAKE D6: GPA POWER SURGE D7: OTHER

FROM

S.E.T.-Pacific, Inc. Proprietary

FROM (WED) 11 9 2005 15:39/ST. 15:38/NO. 5013361015 P 5

S.E.T. – Pacific, Inc.

ELECTRIC DISTRIBUTION LOG (UNSCHEDULED OUTAGES)

SEQUENTIAL LOG FOR 4.16, 13.8, 34.5 KV | RELAY TARGETS ACTION | MONTH: SEP 28 TO OCT 31 YEAR: 2005

UO#	DATE	TIME			LOCATION			LOAD	OVER CURRENT					XFMER DIFF	OUTAGE CAUSE*	SPECIFIC CAUSE OF OUTAGE / COMMENTS
		LOSS (TRIP)	RETURN (CLOSE)	ELAPSED HOURS	BASE / SUBSTATION	CIRCUIT BREAKER	AREA CUT-OFF OR AFFECTED	KV	KF	A	B	C	GRD			
13	10/20/05	0840	1110	2:30	MARBO	ON P-51	AIR FORCE WELLS #5/6/7/8	13.8							C1	DEFECTIVE CUT-OUT ASSEMLY ON POLE # MA-2-1.
14	10/21/05	1348	1400	:12	ROMEO CNM	ON P-130	USS PASADENA	.48							D1	SUBMARINERS OVERLOADED R-3C/3D/3E/3F BREAKERS.
15	10/22/05	0804	1149	3:45	AAFB	P-91	CAPEHART HSG AND PARTIAL OF ROBERTS TERRACE HSG.	13.8		I	I	I	I		D7	CL-7 SWITCHGEAR FLASHED OVER/MOISTURE.
16	10/22/05	0937	0941	:04	AAFB	P-93	PARTIAL OF ROBERTS TERRACE	13.8					I		D6	GPA POWER SURGE.
17	10/22/05	0947	1006	:19	COLD STORAGE	P-134	OLD/NEW APRA HSG, NAVMAG AREA, PARTIAL OF CAMP COVINGTON	13.8					I		D6	GPA POWER SURGE.
18	10/22/05	1616	1805	1:49	AAFB	ON P-93	PARTIAL OF FLEMING HTS. HSG	13.8							D7	MH-205/MH-206 FLASHED OVER/MOISTURE.
19	10/24/05	0018	0243	2:25	ROMEO CNM	ON P-130	USS PASADENA	.48							D1	SUBMARINERS OVERLOADED R-3C/3D/3E/3F BREAKERS.
	10/24/05	0132	0402	2:30	HARMON/ AAFB	ON X-87/ X-73	NCTS 4 KV (F-2/F-3/F-4) AND POTTS JCT SUBSTATIONS	4.16 13.8							D6	GPA X-87/X-73 LINE TRIPPED.
20	10/28/05	2117	2314	1:57	MARBO	ON P-51	AIR FORCE WELLS #7/8	13.8							D3	FUSE BLEW ON POLE # MB-2-1.
21	10/29/05	1052	1124	:32	AAFB	P-91	CAPEHART HSG AND PARTIAL OF ROBERTS TERRACE	13.8							D6	GPA X-42/X-80 LINE TRIPPED.

*LEGEND:
A1: LOAD SHEDDING A2: GENERATOR TRIP B1: STORM B2: LIGHTNING B3: EARTHQUAKE C1: LINE C2: TRANSFORMER C3: RELAY
C4: BREAKER D1: HUMAN ERROR D2: VEHICLE ACCIDENT D3: UNKNOWN D4: TREE D5: SNAKE D6: GPA POWER SURGE D7: OTHER

S.E.T.-Pacific, Inc. Proprietary

S.E.T. – Pacific, Inc.

DOCUMENT TRANSMITTAL FORM

CUSTOMER: DZSP21
FACILITY: Electrical, Steam, Hot Water & Demineralized Water
LOCATION: Guam Naval Facilities

LOG #: 2390
SET Contract No. SUB-000002
ISSUE CODE
DATE: 02 December 2005

TO: DZSP21
P.O. Box GH
Hagatna, Guam 96932
ATTENTION: Wally Toma, Subcontract Administrator

We are sending you: XX Attached __Under Separate Cover via:_____the: __Shop Drawings

__Prints __Samples __Specifications __Reports __Inspections __Test Schedules __Copy of Letter

__Change Order __Constr.Progress Chart/Schedule __Payment Estimate __As Stated _____

Copies	Reference No.	Category Type	Description and Purpose
1	Annex 1602	CDRL F-1602000-F	Power System Dispatcher's Unscheduled and Scheduled Outage Report – November 2005 (5 pages)

Name of: Subcontractor, Supplier/Manufacturer _____

__For Approval __Approved as Submitted __Resubmit __Copies for approval XX For Your Use

__Approved as Noted __Submit __Copies for distribution __As Requested __Returned for Corrections

__Return __corrected prints __For Review and Comment __Other: _____

I certify that the attached information is ready for execution and that the attached information complies with the requirements of the contract documents.

By: _____ 12 / 02 / 05
Jay D. Miller, President

cc:

Received By: _____ Date: _____

Systems,
Energy &
Technologies, Inc.

S.E.T. – Pacific, Inc.

POWER SYSTEM DISPATCHER'S UNSCHEDULED AND SCHEDULED OUTAGE REPORT			
CDRL No: F-1602000-F	Prepared By: Connie Judicpa	Month/Year: November 2005	No. of Page(s): 6
FREQUENCY: Monthly.			

- **Unscheduled Outage Report**
  - See attached (4 pages)

- **Scheduled Outage Report**
  - See attached (1 page)

ELECTRIC DISTRIBUTION LOG (UNSCHEDULED OUTAGES)

SEQUENTIAL LOG FOR 4.16, 13.8, 34.5 KV | RELAY TARGETS ACTION | MONTH: NOVEMBER YEAR: 2005

UO#	DATE	TIME			LOCATION			LOAD	OVER CURRENT					XFMER DIFF	OUTAGE CAUSE*	SPECIFIC CAUSE OF OUTAGE / COMMENTS
		LOSS (TRIP)	RETURN (CLOSE)	ELAPSED HOURS	BASE / SUBSTATION	CIRCUIT BREAKER	AREA CUT-OFF OR AFFECTED	KV	KF	A	B	C	GRD			
22	11/01/05	0801	1319	5:18	CNM	ON P-14	BLDG 5545 KILO PIER	SEC							C4	LOOSE CONNECTION ON A 100 AMP BREAKER AT BLDG 5545.
23	11/03/05	0042	0501	4:19	CNM	ON P-14	BLDGS 3000/3001/3002 SEALS COMPOUND	13.8							D3	BLOWN IN-LINE FUSE ON POLE JC-27.
24	11/04/05	0944	1006	:22	AAFB	P-93	ROBERTS TERRACE HSG AND PARTIAL OF CAPEHART HSG.	13.8	√						A2	GPA MEC GENERATOR #9 TRIPPED.
24	11/04/05	0944	1028	:44	MARBO	P-51	AIR FORCE WELLS #5-9 AND BOOSTER PUMP STATION	13.8	√						A2	GPA MEC GENERATOR #9 TRIPPED.
25	11/04/05	1344	1408	:24	OROTE	P-129	SECURITY/COAST GUARD COMPOUND, SLS – 14/23, NAVFACMAR ADMIN COMPLEX, TRANSPORTATION AND VICTOR BOWTS	13.8					T		C1	DEFECTIVE TERMINATOR ON P-15 RISER POLE.
25	11/04/05	1344	1701	3:17	OROTE	P-129	NORTH/SOUTH TIP AND LOCKWOOD HSG, CDC GYM, THEATER, USDA, CHAPEL, BOQ, BEQ, OROTE TELEX AND SLS-17	13.8					I		C1	DEFECTIVE TERMINATOR ON P-15 RISER POLE.
26	11/04/05	1515	1541	:26	OROTE	T-11	P-14/P-16/T-17/P-115	13.8						LO	C1	GPA X-31 PRIMARY JUMPER BURNT.
26	11/04/05	1515	1537	:22	OROTE	P-11S	BARRACKS #14 AND #15	13.8							C1	GPA X-31 PRIMARY JUMPER BURNT.
26	11/04/05	1515	1539	:24	OROTE	P-16	NEX COMPLEX/BLDGS AND COMMISSARY AND McDONALDS	13.8							C1	GPA X-31 PRIMARY JUMPER BURNT.
26	11/04/05	1515	1539	:24	OROTE	T-17	WWTP, BARRACKS COMPLEX, CLUB RUMORS, LAUNDROMAT, SUMAY COVE, FIRE STA, GSY, DZSP-21 MAINT COMPOUND, SLS-16, CSS-15	13.8							C1	GPA X-31 PRIMARY JUMPER BURNT.

*LEGEND: A1: LOAD SHEDDING A2: GENERATOR TRIP B1: STORM B2: LIGHTNING B3: EARTHQUAKE C1: LINE C2: TRANSFORMER C3: RELAY C4: BREAKER D1: HUMAN ERROR D2: VEHICLE ACCIDENT D3: UNKNOWN D4: TREE D5: SNAKE D6: GPA POWER SURGE D7: OTHER

S.E.T.-Pacific, Inc. Proprietary

ELECTRIC DISTRIBUTION LOG (UNSCHEDULED OUTAGES)

SEQUENTIAL LOG FOR 4.16, 13.8, 34.5 KV								RELAY TARGETS ACTION							MONTH: NOVEMBER YEAR: 2005
UO#	DATE	TIME			LOCATION			LOAD	OVER CURRENT					XFMER DIFF	OUTAGE CAUSE*	SPECIFIC CAUSE OF OUTAGE / COMMENTS
		LOSS (TRIP)	RETURN (CLOSE)	ELAPSED HOURS	BASE / SUBSTATION	CIRCUIT BREAKER	AREA CUT-OFF OR AFFECTED	KV	KF	A	B	C	GRD			
26	11/04/05	1515	1541	:26	OROTE	P-14	VICTOR PIER #2, SEALS/MSC/MFC/EOD COMPOUNDS, BLDGS 3179, 3180, 2118, KILO PIER, DENTAL CLINIC, GYS, SLS-21/22	13.8							C1	GPA X-31 PRIMARY JUMPER BURNT.
27	11/05/05	2008	2130	1:22	AAFB	P-93	ROBERTS TERRACE HSG AND PARTIAL OF CAPEHART HSG.	13.8	√						A2	GPA MEC GENERATOR #9 TRIPPED.
27	11/05/05	2008	2232	2:24	MARBO	P-51	AIR FORCE WELLS #5-9 AND BOOSTER PUMP STATION.	13.8	√						A2	GPA MEC GENERATOR #9 TRIPPED.
28	11/07/05	0653	0958	3:05	AAFB	P-94	EXCHANGE GAS STA, POL, LOX PLANT, ILS STROBE LIGHT, MSA-1/TARAGUE AREA	13.8		T	T				B2	PRIMARY JUMPER BURNT ON POLE #NB-20.
29	11/08/05	1013	1159	1:46	AAFB	P-95	SUBSTATIONS "D"/"F"/20-MEG: ALL INDUSTRIAL AREAS	13.8		T		T			D3	P-95 BREAKER TRIPPED.
30	11/09/05	1022	1159	1:37	AAFB	P-95	SUBSTATIONS "D"/"F"/20-MEG: ALL INDUSTRIAL AREAS	13.8		T		T			D7	P-95 BREAKER TRIPPED.
30	11/09/05	1337	1405	:28	AAFB	P-95	SUBSTATIONS "D"/"F"/20-MEG: ALL INDUSTRIAL AREAS	13.8		T					D7	P-95 BREAKER TRIPPED.
31	11/10/05	1625	1654	:29	CNM	ON P-14	SEALS COMPOUND: BLDGS #3000/3001/3002	13.8							C1	DEFECTIVE IN-LINE CUT-OUT ASSEMBLY.
32	11/11/05	0921	1219	2:58	NAVMAG	ON P-134	BLDGS #402/405/406/879/1005/1014	13.8							D5	FUSES BLEW ON POLE JG-104-10-2/JG-104-10-2-8.
33	11/11/05 – 11/12/05	2219	0105	2:46	NAVMAG	ON P-134	BLDG 407 FIRE STATION	SEC.							D7	SECONDARY DOUBLE THROW SWITCH BURNT.
34	11/13/05	1711	2044	3:33	AAFB	P-91	CAPEHART HSG AND PARTIAL OF ROBERTS TERRACE HSG.	13.8			T	T	1		D7	CL-33 SWITCHGEAR FLASHED OVER DUE TO MOISTURE.

*LEGEND: A1: LOAD SHEDDING A2: GENERATOR TRIP B1: STORM B2: LIGHTNING B3: EARTHQUAKE C1: LINE C2: TRANSFORMER C3: RELAY C4: BREAKER D1: HUMAN ERROR D2: VEHICLE ACCIDENT D3: UNKNOWN D4: TREE D5: SNAKE D6: GPA POWER SURGE D7: OTHER

S.E.T.-Pacific, Inc. Proprietary

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SEQUENTIAL LOG FOR 4.16, 13.8, 34.5 KV									RELAY TARGETS ACTION							MONTH: NOVEMBER YEAR: 2005
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		LOSS (TRIP)	RETURN (CLOSE)	ELAPSED HOURS	BASE / SUBSTATION	CIRCUIT BREAKER	AREA CUT-OFF OR AFFECTED	KV	KF	A	B	C	GRD			
35	11/13/05 – 11/14/05	2336	0715	7:39	AAFB	P-93	FLEMING HTS AND PARTIAL OF ROBERTS TERRACE HSG.	13.8		I	I	I			D5	SNAKE CAUSED A SHORT AT MH-212.
36	11/14/05	0746	1217	4:31	COLD STORAGE	P-134	OLD/NEW APRA HSG, DODEA, NAVMAG, PARTIAL OF CAMP COVINGTON	13.8					T		C1	DEAD-END BELL DEFECTIVE ON POLE AH-12-10-5-5.
37	11/14/05	0841	1040	1:59	CNM	ON P-129	MAIN GATE/SENTRY POST #1	13.8							D5	SNAKE CAUSED FUSE TO BLOW ON H-FRAME STRUCTURE.
38	11/23/05	1118	-	-	CNM	ON P-14	VICTOR #2 PIER OLD POLISHING TRAILER OUTLET	13.8							C2	DEFECTIVE 25KVA TRANSFORMER ON POLE #JC-2-10.
39	11/27/05	1020	1241	2:21	AAFB	P-62	HSG MAINT, POL, PASS/ID OFFICE, MAIN GATE, RECYCLE/CONTRACTOR'S OFFICE	13.8					T		D7	GPA 34.5 KV GUY WIRE BROKE COMING IN CONTACT WITH THE PRIMARY LINE ON POLE #NE-49.
40	11/28/05	1325	1449	1:24	CAMP COVINGTON	ON P-134	BLDG 526 NEX BEE-QUICK	13.8							C1	TRANSFORMER SECONDARY WIRE CAME OFF.
41	11/29/05	0921	1000	:56	MARBO	ON P-51	BLDG 1301 STATION POWER	13.8							D5	SNAKE CAUSED FUSE TO BLOW ON POLE #MB-1-1A.
42	11/30/05	0045	0319	2:34	OROTE/COLD STORAGE	T-11/T-12, T-13 AND T-132	OROTE AND COLD STORAGE SUBSTATIONS	13.8							C4	GPA X-20/X-21/X-35/X-36 BREAKERS TRIPPED.
42	11/30/05	0045	0254	2:09	OROTE	P-25	USS FRANK CABLE AND USS HOUSTON	13.8							C4	GPA X-20/X-21/X-35/X-36 BREAKERS TRIPPED.
42	11/30/05	0045	0255	2:10	OROTE	P-129	SECURITY/COAST GUARD COMPOUND, SLS – 14/23, NAVFACMAR ADMIN COMPLEX, TRANSPORTATION AND VICTOR BOWTS. NORTH/SOUTH TIP AND LOCKWOOD HSG, CDC GYM, THEATER, USDA, CHAPEL, BOQ, BEQ, OROTE TELEX AND SLS-17	13.8							C4	GPA X-20/X-21/X-35/X-36 BREAKERS TRIPPED.

*LEGEND: A1: LOAD SHEDDING A2: GENERATOR TRIP B1: STORM B2: LIGHTNING B3: EARTHQUAKE C1: LINE C2: TRANSFORMER C3: RELAY
C4: BREAKER D1: HUMAN ERROR D2: VEHICLE ACCIDENT D3: UNKNOWN D4: TREE D5: SNAKE D6: GPA POWER SURGE D7: OTHER

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ELECTRIC DISTRIBUTION LOG (UNSCHEDULED OUTAGES)

SEQUENTIAL LOG FOR 4.16, 13.8, 34.5 KV									RELAY TARGETS ACTION							MONTH: NOVEMBER YEAR: 2005
UO#	DATE	TIME			LOCATION			LOAD	OVER CURRENT					XFMER DIFF	OUTAGE CAUSE*	SPECIFIC CAUSE OF OUTAGE / COMMENTS
		LOSS (TRIP)	RETURN (CLOSE)	ELAPSED HOURS	BASE / SUBSTATION	CIRCUIT BREAKER	AREA CUT-OFF OR AFFECTED	KV	KF	A	B	C	GRD			
42	11/30/05	0045	0256	2:11	OROTE	P-128	HARBOR/BAYVIEW HSG	13.8							C4	GPA X-20/X-21/X-35/X-36 BREAKERS TRIPPED.
42	11/30/05	0045	0256	2:11	OROTE	P-130	BLGS #3190/3191, SIERRA AND ROMEO PIERS	13.8							C4	GPA X-20/X-21/X-35/X-36 BREAKERS TRIPPED.
42	11/30/05	0045	0257	2:12	OROTE	P-16	NEX COMPLEX/BLDGS AND COMMISSARY AND McDONALDS	13.8							C4	GPA X-20/X-21/X-35/X-36 BREAKERS TRIPPED.
42	11/30/05	0045	0258	2:13	OROTE	P-11S	BARRACKS #14 AND #15	13.8							C4	GPA X-20/X-21/X-35/X-36 BREAKERS TRIPPED.
42	11/30/05	0045	0258	2:13	OROTE	T-17	WWTP, BARRACKS COMPLEX, CLUB RUMORS, LAUNDROMAT, SUMAY COVE, FIRE STA, GSY, DZSP-21 MAINT COMPOUND, SLS-16, CSS-15	13.8							C4	GPA X-20/X-21/X-35/X-36 BREAKERS TRIPPED.
42	11/30/05	0045	0259	2:14	OROTE	P-14	VICTOR PIER #2, SEALS/MSC/MFC/EOD COMPOUNDS, BLDGS 3179, 3180, 2118, KILO PIER, DENTAL CLINIC, GYS, SLS-21/22	13.8							C4	GPA X-20/X-21/X-35/X-36 BREAKERS TRIPPED.
42	11/30/05	0045	0316	2:31	COLD STORAGE	P-133	BLDGD 3202 WAREHOUSE #6, COLD STORAGE PLANT, BATTERY LOCKER	13.8							C4	GPA X-20/X-21/X-35/X-36 BREAKERS TRIPPED.
42	11/30/05	0045	0319	2:34	COLD STORAGE	P-134	OLD/NEW APRA HSG, NAVMAG, DODEA MIDDLE SCHOOL, PARTIAL CAMP COVINGTON	13.8							C4	GPA X-20/X-21/X-35/X-36 BREAKERS TRIPPED.
43	11/30/05	0700	0750	:50	AAFB	P-82	HANGARS/DOCKS, AUTOMATION BLDG, COLD STORAGE, SUPPLY BLDGS.	13.8		T	T	T			D7	SWITCH P-82-31 BURNT AT MH-131.
43	11/30/05	0700	1339	6:39	AAFB	ON P-82	BLDGS 19017/19028/20016/20025	13.8							D7	SWITCH P-82-31 BURNT AT MH-131.
44	11/30/05 – 12/01/05	2122	0030	3:08	AAFB	ON P-81	BLDGS 23002/23003	13.8							C1	TRANSFORMER PRIMARY JUMPER BURNT.

*LEGEND: A1: LOAD SHEDDING; A2: GENERATOR TRIP; B1: STORM; B2: LIGHTNING; B3: EARTHQUAKE; C1: LINE; C2: TRANSFORMER; C3: RELAY; C4: BREAKER; D1: HUMAN ERROR; D2: VEHICLE ACCIDENT; D3: UNKNOWN; D4: TREE; D5: SNAKE; D6: GPA POWER SURGE; D7: OTHER

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S.E.T. – Pacific, Inc.

DOCUMENT TRANSMITTAL FORM

CUSTOMER: DZSP21
FACILITY: Electrical, Steam, Hot Water & Demineralized Water
LOCATION: Guam Naval Facilities

LOG #: 2390
SET Contract No. SUB-000002
ISSUE CODE
DATE: 02 December 2005

TO: DZSP21
P.O. Box GH
Hagatna, Guam 96932
ATTENTION: Wally Toma, Subcontract Administrator

We are sending you: XX Attached __Under Separate Cover via:_____the: __Shop Drawings

__Prints __Samples __Specifications __Reports __Inspections __Test Schedules __Copy of Letter

__Change Order __Constr.Progress Chart/Schedule __Payment Estimate __As Stated _____

Copies	Reference No.	Category Type	Description and Purpose
1	Annex 1602	CDRL F-1602000-F	Power System Dispatcher's Unscheduled and Scheduled Outage Report – November 2005 (5 pages)

Name of: Subcontractor, Supplier/Manufacturer _____

__For Approval __Approved as Submitted __Resubmit __Copies for approval XX For Your Use

__Approved as Noted __Submit __Copies for distribution __As Requested __Returned for Corrections

__Return __corrected prints __For Review and Comment __Other: _____

I certify that the attached information is ready for execution and that the attached information complies with the requirements of the contract documents.

By: _____ 12 / 02 / 05
Jay D. Miller, President

cc:

Received By: _____ Date: _____

Systems,
Energy &
Technologies, Inc.

S.E.T. – Pacific, Inc.

POWER SYSTEM DISPATCHER'S UNSCHEDULED AND SCHEDULED OUTAGE REPORT			
CDRL No: F-1602000-F	Prepared By: Connie Judicpa	Month/Year: November 2005	No. of Page(s): 6
FREQUENCY: Monthly.			

- **Unscheduled Outage Report**
  - See attached (4 pages)

- **Scheduled Outage Report**
  - See attached (1 page)

ELECTRIC DISTRIBUTION LOG (UNSCHEDULED OUTAGES)

SEQUENTIAL LOG FOR 4.16, 13.8, 34.5 KV | RELAY TARGETS ACTION | MONTH: NOVEMBER YEAR: 2005

UO#	DATE	TIME			LOCATION			LOAD	OVER CURRENT					XFMER DIFF	OUTAGE CAUSE*	SPECIFIC CAUSE OF OUTAGE / COMMENTS
		LOSS (TRIP)	RETURN (CLOSE)	ELAPSED HOURS	BASE / SUBSTATION	CIRCUIT BREAKER	AREA CUT-OFF OR AFFECTED	KV	KF	A	B	C	GRD			
22	11/01/05	0801	1319	5:18	CNM	ON P-14	BLDG 5545 KILO PIER	SEC							C4	LOOSE CONNECTION ON A 100 AMP BREAKER AT BLDG 5545.
23	11/03/05	0042	0501	4:19	CNM	ON P-14	BLDGS 3000/3001/3002 SEALS COMPOUND	13.8							D3	BLOWN IN-LINE FUSE ON POLE JC-27.
24	11/04/05	0944	1006	:22	AAFB	P-93	ROBERTS TERRACE HSG AND PARTIAL OF CAPEHART HSG.	13.8	√						A2	GPA MEC GENERATOR #9 TRIPPED.
24	11/04/05	0944	1028	:44	MARBO	P-51	AIR FORCE WELLS #5-9 AND BOOSTER PUMP STATION	13.8	√						A2	GPA MEC GENERATOR #9 TRIPPED.
25	11/04/05	1344	1408	:24	OROTE	P-129	SECURITY/COAST GUARD COMPOUND, SLS – 14/23, NAVFACMAR ADMIN COMPLEX, TRANSPORTATION AND VICTOR BOWTS	13.8					T		C1	DEFECTIVE TERMINATOR ON P-15 RISER POLE.
25	11/04/05	1344	1701	3:17	OROTE	P-129	NORTH/SOUTH TIP AND LOCKWOOD HSG, CDC GYM, THEATER, USDA, CHAPEL, BOQ, BEQ, OROTE TELEX AND SLS-17	13.8					I		C1	DEFECTIVE TERMINATOR ON P-15 RISER POLE.
26	11/04/05	1515	1541	:26	OROTE	T-11	P-14/P-16/T-17/P-115	13.8						LO	C1	GPA X-31 PRIMARY JUMPER BURNT.
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30	11/09/05	1022	1159	1:37	AAFB	P-95	SUBSTATIONS "D"/"F"/20-MEG: ALL INDUSTRIAL AREAS	13.8		T		T			D7	P-95 BREAKER TRIPPED.
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42	11/30/05	0045	0319	2:34	OROTE/COLD STORAGE	T-11/T-12, T-13 AND T-132	OROTE AND COLD STORAGE SUBSTATIONS	13.8							C4	GPA X-20/X-21/X-35/X-36 BREAKERS TRIPPED.
42	11/30/05	0045	0254	2:09	OROTE	P-25	USS FRANK CABLE AND USS HOUSTON	13.8							C4	GPA X-20/X-21/X-35/X-36 BREAKERS TRIPPED.
42	11/30/05	0045	0255	2:10	OROTE	P-129	SECURITY/COAST GUARD COMPOUND, SLS – 14/23, NAVFACMAR ADMIN COMPLEX, TRANSPORTATION AND VICTOR BOWTS. NORTH/SOUTH TIP AND LOCKWOOD HSG, CDC GYM, THEATER, USDA, CHAPEL, BOQ, BEQ, OROTE TELEX AND SLS-17	13.8							C4	GPA X-20/X-21/X-35/X-36 BREAKERS TRIPPED.

*LEGEND: A1: LOAD SHEDDING A2: GENERATOR TRIP B1: STORM B2: LIGHTNING B3: EARTHQUAKE C1: LINE C2: TRANSFORMER C3: RELAY
C4: BREAKER D1: HUMAN ERROR D2: VEHICLE ACCIDENT D3: UNKNOWN D4: TREE D5: SNAKE D6: GPA POWER SURGE D7: OTHER

S.E.T.-Pacific, Inc. Proprietary

ELECTRIC DISTRIBUTION LOG (UNSCHEDULED OUTAGES)

SEQUENTIAL LOG FOR 4.16, 13.8, 34.5 KV									RELAY TARGETS ACTION							MONTH: NOVEMBER YEAR: 2005
UO#	DATE	TIME			LOCATION			LOAD	OVER CURRENT					XFMER DIFF	OUTAGE CAUSE*	SPECIFIC CAUSE OF OUTAGE / COMMENTS
		LOSS (TRIP)	RETURN (CLOSE)	ELAPSED HOURS	BASE / SUBSTATION	CIRCUIT BREAKER	AREA CUT-OFF OR AFFECTED	KV	KF	A	B	C	GRD			
42	11/30/05	0045	0256	2:11	OROTE	P-128	HARBOR/BAYVIEW HSG	13.8							C4	GPA X-20/X-21/X-35/X-36 BREAKERS TRIPPED.
42	11/30/05	0045	0256	2:11	OROTE	P-130	BLGS #3190/3191, SIERRA AND ROMEO PIERS	13.8							C4	GPA X-20/X-21/X-35/X-36 BREAKERS TRIPPED.
42	11/30/05	0045	0257	2:12	OROTE	P-16	NEX COMPLEX/BLDGS AND COMMISSARY AND McDONALDS	13.8							C4	GPA X-20/X-21/X-35/X-36 BREAKERS TRIPPED.
42	11/30/05	0045	0258	2:13	OROTE	P-11S	BARRACKS #14 AND #15	13.8							C4	GPA X-20/X-21/X-35/X-36 BREAKERS TRIPPED.
42	11/30/05	0045	0258	2:13	OROTE	T-17	WWTP, BARRACKS COMPLEX, CLUB RUMORS, LAUNDROMAT, SUMAY COVE, FIRE STA, GSY, DZSP-21 MAINT COMPOUND, SLS-16, CSS-15	13.8							C4	GPA X-20/X-21/X-35/X-36 BREAKERS TRIPPED.
42	11/30/05	0045	0259	2:14	OROTE	P-14	VICTOR PIER #2, SEALS/MSC/MFC/EOD COMPOUNDS, BLDGS 3179, 3180, 2118, KILO PIER, DENTAL CLINIC, GYS, SLS-21/22	13.8							C4	GPA X-20/X-21/X-35/X-36 BREAKERS TRIPPED.
42	11/30/05	0045	0316	2:31	COLD STORAGE	P-133	BLDGD 3202 WAREHOUSE #6, COLD STORAGE PLANT, BATTERY LOCKER	13.8							C4	GPA X-20/X-21/X-35/X-36 BREAKERS TRIPPED.
42	11/30/05	0045	0319	2:34	COLD STORAGE	P-134	OLD/NEW APRA HSG, NAVMAG, DODEA MIDDLE SCHOOL, PARTIAL CAMP COVINGTON	13.8							C4	GPA X-20/X-21/X-35/X-36 BREAKERS TRIPPED.
43	11/30/05	0700	0750	:50	AAFB	P-82	HANGARS/DOCKS, AUTOMATION BLDG, COLD STORAGE, SUPPLY BLDGS.	13.8		T	T	T			D7	SWITCH P-82-31 BURNT AT MH-131.
43	11/30/05	0700	1339	6:39	AAFB	ON P-82	BLDGS 19017/19028/20016/20025	13.8							D7	SWITCH P-82-31 BURNT AT MH-131.
44	11/30/05 – 12/01/05	2122	0030	3:08	AAFB	ON P-81	BLDGS 23002/23003	13.8							C1	TRANSFORMER PRIMARY JUMPER BURNT.

*LEGEND: A1: LOAD SHEDDING; A2: GENERATOR TRIP; B1: STORM; B2: LIGHTNING; B3: EARTHQUAKE; C1: LINE; C2: TRANSFORMER; C3: RELAY; C4: BREAKER; D1: HUMAN ERROR; D2: VEHICLE ACCIDENT; D3: UNKNOWN; D4: TREE; D5: SNAKE; D6: GPA POWER SURGE; D7: OTHER

S.E.T.-Pacific, Inc. Proprietary

S.E.T. – Pacific, Inc.

DOCUMENT TRANSMITTAL FORM

CUSTOMER: DZSP 21
FACILITY: Electrical, Steam, Hot Water & Demin Water
LOCATION: Guam Naval Facilities

LOG #: **2432**
SET Contract No: SUB-000002
ISSUE CODE
DATE: January 3, 2006

TO: DZSP 21
P.O. Box GH
Agana, Guam 96932
ATTENTION: Mr. Wally Toma, Subcontract Administrator

We are sending you: **X** Attached _Under Separate Cover via:_____the: __Shop Drawings

__Prints __Samples __Specifications __Reports __Inspections __Test Schedules __Copy of Letter

__Change Order __Constr.Progress Chart/Schedule __Payment Estimate **X** As Stated _____

Copies	Reference No.	Category Type	Description and Purpose
1	Annex 1602	CDRL No. F-1602000-F	Power System Dispatcher's Unscheduled and Scheduled Outage Reports (5 pages)

Name of: Subcontractor, Supplier/Manufacturer _____

__For Approval __Approved as Submitted __Resubmit __copies for approval **X** For Your Use

__Approved as Noted __Submit __copies for distribution **X** As Requested __Returned for Corrections

__Return __corrected prints __For Review and Comment __Other: _____

I certify that the attached information is ready for execution and that the attached information complies with the requirements of the contract documents.

By:_____ 01/03/06
D. J. Jacot, Senior Vice-President

Systems,
Energy &
Technologies, Inc.

S.E.T. – Pacific, Inc.

POWER SYSTEM DISPATCHER'S UNSCHEDULED AND SCHEDULED OUTAGE REPORT			
CDRL No: F-1602000-F	Prepared By: Peter Blas	Month/Year: December 2005	No. of Pages: 4
FREQUENCY: Monthly.			

- **Unscheduled Outage Report**
  - See attached (2 pages)

- **Scheduled Outage Report**
  - See attached (2 pages)

ELECTRIC DISTRIBUTION LOG (UNSCHEDULED OUTAGES)

SEQUENTIAL LOG FOR 4.16, 13.8, 34.5 KV | RELAY TARGETS ACTION | MONTH: DECEMBER YEAR: 2005

UO#	DATE	TIME			LOCATION			LOAD	OVER CURRENT					XFMER DIFF	OUTAGE CAUSE*	SPECIFIC CAUSE OF OUTAGE / COMMENTS
		LOSS (TRIP)	RETURN (CLOSE)	ELAPSED HOURS	BASE / SUBSTATION	CIRCUIT BREAKER	AREA CUT-OFF OR AFFECTED	KV	KF	A	B	C	GRD			
45	12/08/05	1015	1110	:55	PAD-5	P-25/A2	USS FRANK CABLE AND USS HOUSTON AT ALPHA PIER	13.8							D1	UNKNOWN PARTY TRIPPED A2 PRIMARY BREAKER.
46	12/08/05	1840	2016	1:36	AAFB	P-93	FLEMING HEIGHTS AND PARTIAL OF ROBERTS TERRACE HSG.	13.8							C4	P-93 TRIPPED ON OVER CURRENT.
47	12/11/05 – 12/12/05	1330	1215	22:45	AAFB	ON P-94	SIRENA AND PATI POINT BEACHES, FIRING RANGE AND WELL/SPRINGS	13.8							D7	IGUANA ON POLE NB-105-24-8.
48	12/12/05	1318	1657	3:39	PITI	P-6	VHF REPEATER STA, FAA VORTAC STA, NIMITZ HILL AREA, NRMC NEX COMPLEX, DZSP21 MAINT. OFFICE	13.8							D2	GARBAGE TRUCK HIT STEEL POLE.
49	12/14/05	1434	1449	:15	AAFB	P-93	FLEMING HEIGHTS AND PARTIAL OF ROBERTS TERRACE HSG.	13.8							C4	P-93 TRIPPED ON OVER CURRENT.
50	12/14/05	1809	2000	1:51	AAFB	ON P-93	ROBERTS TERRACE QTRS. 1040, 1043, 1047, 1049 ROTA	13.8							D7	FORMICA BOARD FLASHED OVER AT STNB TRANSFORMER SWITCHGEAR.
51	12/16/05	1856	2004	1:08	COLD STORAGE	P-134	OLD/NEW APRA HSG, DODEA MIDDLE SCHOOL, NAVMAG AREA, PARTIAL OF CAMP COVINGTON	13.8					I		C4	P-134 TRIPPED ON OVER CURRENT.
52	12/17/05	0303	0424	1:21	CNM	ON P-129	SOUTH TIP HSG.	13.8							C1	DOWNED PRIMARY LINE BETWEEN POLES #JG-37-74-17 AND JG-37-74-18.
53	12/17/05	2120	2320	2:00	MARBO	ON P-51	MARBO WELLS #8/#9	13.8							D3	FUSE BLEW ON POLE # MB-2-2-2; CAUSE UNKNOWN; NO FINDINGS.
54	12/19/05	1342	1459	1:17	CNM	ON P-16	NEX BOOKSTORE BLDG 258	13.8							D7	TWO FUSES BLEW ON POLE JD-32-2 CAUSED BY BIRDS.
55	12/19/05	1536 1536	1855 1548	3:19 :12	OROTE	P-129	SOUTH TIP HSG, BACK GATE, LANDFILL AND PARTIAL OF CAMP COVINGTON, SECURITY/COAST GUARD/NAVFAC COMPOUND/PASS/ID, LOCKWOOD, NORTH TIP HSG, CDC, CHAPEL, GYM, THEATER, BEQ/BOQ	13.8							D7	DEFECTIVE POLE TOP SWITCH 13-06.

*LEGEND: A1: LOAD SHEDDING; A2: GENERATOR TRIP; B1: STORM; B2: LIGHTNING; B3: EARTHQUAKE; C1: LINE; C2: TRANSFORMER; C3: RELAY; C4: BREAKER; D1: HUMAN ERROR; D2: VEHICLE ACCIDENT; D3: UNKNOWN; D4: TREE; D5: SNAKE; D6: GPA POWER SURGE; D7: OTHER

S.E.T.-Pacific, Inc. Proprietary

ELECTRIC DISTRIBUTION LOG (UNSCHEDULED OUTAGES)

SEQUENTIAL LOG FOR 4.16, 13.8, 34.5 KV | RELAY TARGETS ACTION | MONTH: DECEMBER YEAR: 2005

UO#	DATE	TIME			LOCATION			LOAD	OVER CURRENT					XFMER DIFF	OUTAGE CAUSE*	SPECIFIC CAUSE OF OUTAGE / COMMENTS
		LOSS (TRIP)	RETURN (CLOSE)	ELAPSED HOURS	BASE / SUBSTATION	CIRCUIT BREAKER	AREA CUT-OFF OR AFFECTED	KV	KF	A	B	C	GRD			
56	12/22/05	1007	1053	:46	CNM	ON P-14	BLDGS 18803/5545 KILO WHARF	.480							C4	BREAKER TRIPPED ON OVERLOAD.
57	12/22/05	1639 1639	1831 1654	1:52 :15	AAFB AAFB	P-91 P-93	CAPEHART AND PARTIAL OF ROBERTS TERRACE AND FLEMING HTS AND PARTIAL OF ROBERTS TERRACE	13.8 13.8			I		I I		D7	FLASHED OVER AT CL-14.
58	12/23/05	1212	-	-	CNM	ON P-130	USS HOUSTON AT ROMEO PIER.	.480							C4	BREAKERS TRIPPED ON OVERLOAD.
59	12/26/05 – 12/27/05	2041	0249	6:08	CNM	ON P-129	QTRS. #27/28/30/32/33/34 GILMORE LOCKWOOD HSG	13.8							C2	DEFECTIVE 75 KVA TRANSFORMER ON POLE JB-49-47.
60	12/27/05	0800	0856	:56	CNM	ON P-14	BLDGS 18803/5545 KILO	.480							C2	DEFECTIVE DRY-TYPE TRANSFORMER.
61	12/30/05	1137	1502	3:25	CNM	ON P-134	SOUTH TIP HSG 601 A/B & 602A/B LEARY ST.	13.8							C2	DEFECTIVE 50 KVA TRANSFORMER ON POLE #JG-37-74-29.

*LEGEND:
A1: LOAD SHEDDING; A2: GENERATOR TRIP; B1: STORM; B2: LIGHTNING; B3: EARTHQUAKE; C1: LINE; C2: TRANSFORMER; C3: RELAY
C4: BREAKER; D1: HUMAN ERROR; D2: VEHICLE ACCIDENT; D3: UNKNOWN; D4: TREE; D5: SNAKE; D6: GPA POWER SURGE; D7: OTHER

S.E.T.-Pacific, Inc. Proprietary

S.E.T. – Pacific, Inc.

DOCUMENT TRANSMITTAL FORM

CUSTOMER: DZSP 21
FACILITY: Electrical, Steam, Hot Water & Demin Water
LOCATION: Guam Naval Facilities

LOG #: **2490**
SET Contract No: SUB-000002
ISSUE CODE
DATE: February 01, 2006

TO: DZSP 21
P.O. Box GH
Agana, Guam 96932
ATTENTION: Mr. Wally Toma, Subcontract Administrator

We are sending you: **X** Attached _Under Separate Cover via:_____the: __Shop Drawings

__Prints __Samples __Specifications __Reports __Inspections __Test Schedules __Copy of Letter

_Change Order __Constr.Progress Chart/Schedule __Payment Estimate **X** As Stated _____

Copies	Reference No.	Category Type	Description and Purpose
1	Annex 1602	CDRL No. F-1602000-F	Power System Dispatcher's Unscheduled and Scheduled Outage Reports – Jan. 2006 (6 pages)

Name of: Subcontractor, Supplier/Manufacturer _____

__For Approval __Approved as Submitted __Resubmit __copies for approval **X** For Your Use

__Approved as Noted __Submit __copies for distribution **X** As Requested __Returned for Corrections

__Return __corrected prints __For Review and Comment __Other: _____

I certify that the attached information is ready for execution and that the attached information complies with the requirements of the contract documents.

By: _____ Feb. 01, 2006
Jay D. Miller, President

Systems,
Energy &
Technologies, Inc.

S.E.T. – Pacific, Inc.

POWER SYSTEM DISPATCHER'S UNSCHEDULED AND SCHEDULED OUTAGE REPORT			
CDRL No: F-1602000-F	Prepared By: Peter Blas	Month/Year: Jan. 2006	No. of Pages: 5
FREQUENCY: Monthly.			

- **Unscheduled Outage Report**
  - See attached (4 pages)

- **Scheduled Outage Report**
  - See attached (1 page)

ELECTRIC DISTRIBUTION LOG (UNSCHEDULED OUTAGES)

SEQUENTIAL LOG FOR 4.16, 13.8, 34.5 KV									RELAY TARGETS ACTION							MONTH: JANUARY YEAR: 2006
LO#	DATE	TIME			LOCATION			LOAD	OVER CURRENT					XFMER DIFF	OUTAGE CAUSE*	SPECIFIC CAUSE OF OUTAGE / COMMENTS
		LOSS (TRIP)	RETURN (CLOSE)	ELAPSED HOURS	BASE / SUBSTATION	CIRCUIT BREAKER	AREA CUT-OFF OR AFFECTED	KV	KF	A	B	C	GRD			
01	01/03/06	1301	1326	:25	CNM	ON P-14	BLDGS 1803/5545 AT KILO	.480							C4	480V BREAKER TRIPPED ON OVERCURRENT.
02	01/04/06	1022	1141	1:19	CNM	ON P-14	BLDGS 1803/5545 AT KILO	.480							C4	480V BREAKER TRIPPED ON OVERCURRENT.
03	01/07/06	1318	1649	3:31	AAFB	ON P-91	CT-77/CT-78 CAPEHART HSG	13.8							D7	P-91-16P SWITCH FLASHED OVER AT CL-7.
04	01/07/06	1915	2159	2:44	CNM	ON P-134	#25/27/29/31 FERN ST, SOUTH TIP. HSG	13.8							C1	DEFECTIVE CUT-OUT ASSEMBLY ON POLE J6-37-74-6
05	01/08/06	0858	0952	:54	AAFB	P-91	CAPEHART HSG AND PARTIAL OF ROBERTS TERRACE HSG	13.8							D7	BUSS FLASHED OVER AT CL-7 SWITCHGEAR.
	01/08/06	0858	1655	6:57	AAFB	ON P-91	CT-77/CT-78 CAPEHART HSG.	13.8							D7	BUSS FLASHED OVER AT CL-7 SWITCHGEAR.
06	01/08/06	1534	1750	2:16	CNM	ON P-134	BLDG 529 CAMP COVINGTON	13.8							D5	SNAKE CAUSED FUSES TO BLOW ON POLE #JG-26-2.
07	01/09/06	1103	1515	4:12	CNM	ON P-134	#1, 3, 5, 7 JASMIN AND #2, 4, 6, 8 CARNATION, SOUTH TIP HSG	13.8							C1	TRANSFORMER SECONDARY WIRE BURNT ON POLE #JG-37-74-9-1.
08	01/10/06	1954	2215	2:21	CNM	ON P-129	#15/17/19/21/23/25 NORTH COLUMBUS, NORTH TIP.	13.8							C1	BLOWN FUSE ON POLE NT-29-2.
	01/11/06	1000	1044	:44	AAFB	ON P-67	BLDG 1625 CDC	13.8							D7	BLOWN FUSES AT SWITCHGEAR.
09	01/12/06	1634	2003	3:29	SOUTH FIN	ON P-87	#21/22/23 ORCHID LANE	13.8							C1	SECONDARY TERMINAL BLOCK BURNT.
10	01/14/06	0210	0318	1:08	AAFB	P-91	CAPEHART AND PARTIAL OF ROBERTS TERRACE HSG	13.8							A2	GPA MEC GENS #8/9 TRIPPED.
10	01/14/06	0210	0320	1:10	AAFB	P-93	PARTIAL OF ROBERTS TERRACE HSG	13.8							A2	GPA MEC GENS #8/9 TRIPPED.
10	01/14/06	0210	0343	1:33	COLD STORAGE	P-134	OLD/NEW APRA HSG, APRA DODEA AND CAMP COVINGTON	13.8							A2	GPA MEC GENS #8/9 TRIPPED.

*LEGEND: A1: LOAD SHEDDING A2: GENERATOR TRIP B1: STORM B2: LIGHTNING B3: EARTHQUAKE C1: LINE C2: TRANSFORMER C3: RELAY C4: BREAKER D1: HUMAN ERROR D2: VEHICLE ACCIDENT D3: UNKNOWN D4: TREE D5: SNAKE D6: GPA POWER SURGE D7: OTHER

S.E.T.-Pacific, Inc. Proprietary

ELECTRIC DISTRIBUTION LOG (UNSCHEDULED OUTAGES)

SEQUENTIAL LOG FOR 4.16, 13.8, 34.5 KV | RELAY TARGETS ACTION | MONTH: JANUARY YEAR: 2006

UO#	DATE	TIME			LOCATION			LOAD	OVER CURRENT					XFMER DIFF	OUTAGE CAUSE*	SPECIFIC CAUSE OF OUTAGE / COMMENTS
		LOSS (TRIP)	RETURN (CLOSE)	ELAPSED HOURS	BASE / SUBSTATION	CIRCUIT BREAKER	AREA CUT-OFF OR AFFECTED	KV	KF	A	B	C	GRD			
11	01/14/06	2013	2306	2:51	OROTE/COLD STORAGE	T-11 T-12 T-13 T-132	OROTE AND COLD STORAGE SUBSTATIONS	13.8							C4	GPA X-20/X-21/X-36 BREAKERS TRIPPED.
11	01/14/06	2013	2231	2:18	OROTE	P-25	USS CORPUS CHRISTI AND USS FRANK CABLE	13.8							C4	GPA X-20/X21/X-36 BREAKERS TRIPPED.
11	01/14/06	2013	2232	2:19	OROTE	P-128	HARBOR/BAYVIEW HSG	13.8							C4	GPA X-20/X21/X-36 BREAKERS TRIPPED.
11	01/14/06	2013	2233	2:20	OROTE	P-130	BLDGS. 3190/3191 AND SIERRA #1/2/ROMEO PIERS	13.8							C4	GPA X-20/X21/X-36 BREAKERS TRIPPED.
11	01/14/06	2013	2234	2:21	OROTE	P-17	SEWAGE TREATMENT PLT/BARRACKS COMPLEX, CLUB RUMORS, BOWLING, SLS-16, MAINT. COMP, SUMAY MARINA, PORT OPS AND GSY	4.16							C4	GPA X-20/X21/X-36 BREAKERS TRIPPED.
11	01/14/06	2013	2235	2:22	OROTE	P-115	BARRACKS #14/15	13.8							C4	GPA X-20/X21/X-36 BREAKERS TRIPPED.
11	01/14/06	2013	2236	2:23	OROTE	P-14	VICTOR #2 SUB, BLDGS 3179/3180/2118, SEALS/MSC/MSF/EOD COMPOUNDS, GSY, SLS-21, DENTAL CLINIC AND KILO PIER	13.8							C4	GPA X-20/X21/X-36 BREAKERS TRIPPED.
11	01/14/06	2013	2237	2:24	OROTE	P-16	McDONALDS, NEX AUTOPORT, GARAGE, NEX COMPLEX AND COMMISSARY	13.8							C4	GPA X-20/X21/X-36 BREAKERS TRIPPED.
11	01/14/06	2013	2254	2:41	OROTE	P-129	COAST GUARD/SECURITY/NAVFAC ADMIN COMPOUND, PASS/ID, MAIN GATE, LOCKWOOD/NORTH TIP HSG, CHAPEL, CDC, GYM, THEATER, OROTE TELEX, USDA, BOQ/BEQ, SLS-14/17/23, DRMO AND TRANSPORTATION	13.8							C4	GPA X-20/X21/X-36 BREAKERS TRIPPED.

*LEGEND:
A1: LOAD SHEDDING
A2: GENERATOR TRIP
B1: STORM
B2: LIGHTNING
B3: EARTHQUAKE
C1: LINE
C2: TRANSFORMER
C3: RELAY
C4: BREAKER
D1: HUMAN ERROR
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D4: TREE
D5: SNAKE
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S.E.T.-Pacific, Inc. Proprietary

ELECTRIC DISTRIBUTION LOG (UNSCHEDULED OUTAGES)

SEQUENTIAL LOG FOR 4.16, 13.8, 34.5 KV									RELAY TARGETS ACTION							MONTH: JANUARY YEAR: 2006
UO#	DATE	TIME			LOCATION			LOAD	OVER CURRENT					XFMER DIFF	OUTAGE CAUSE*	SPECIFIC CAUSE OF OUTAGE / COMMENTS
		LOSS (TRIP)	RETURN (CLOSE)	ELAPSED HOURS	BASE / SUBSTATION	CIRCUIT BREAKER	AREA CUT-OFF OR AFFECTED	KV	KF	A	B	C	GRD			
11	01/14/06	2013	2300	2:47	OROTE	X-34	US COAST GUARD SHIPS	34.5							C4	GPA X-20/X-21/X-36 BREAKERS TRIPPED.
11	01/14/06	2013	2300	2:47	COLD STORAGE	P-133	WHSE #6 BLDG 3202, COLD STORAGE PLANT/BATTERY LOCKER	13.8							C4	GPA X-20/X-21/X-36 BREAKERS TRIPPED.
11	01/14/06	2013	2306	2:51	COLD STORAGE	P-134	CAMP COVINGTON, SOUTH TIP HSG, OLD/NEW APRA HSG AND APRA DODEA	13.8							C4	GPA X-20/X-21/X-36 BREAKERS TRIPPED.
12	01/16/06	1515	1715	2:00	CNM	ON P-16	BLDG 701 NEX AUTO-PORT	13.8							C1	DEFECTIVE CUT-OUT ASSEMBLY ON POLE JH-18-17-1.
13	01/17/06	0724	0831	1:07	CNM	ON F-5	DZSP21 MAINT. COMPOUND	4.16							C1	SECONDARY LINE SHORTED OUT AT BLDG 1767.
14	01/17/06	1448	1539	:51	NIMITZ HILL	ON P-137	SEWER LIFT STA #4	13.8							D5	SNAKE ON POLE KC-21-5A.
15	01/17/06	2236	0104	2:28	ANIGUA	P-282	NRMC AREA EXCEPT NEX BLDGS. NAVHOSP/BLR ON GENERATOR POWER	13.8							D6	GPA ANIGUA SUBSTATION TRIPPED.
16	01/18/06	1304	1332	:18	COLD STORAGE	P-134	CAMP COVINGTON, SOUTH TIP HSG, OLD/NEW APRA HSG AND APRA DODEA	13.8							A2	GPA CABRAS GENERATOR #3 TRIPPED.
16	01/18/06	1304	1336	:32	AAFB	P-91	CAPEHART HSG AND PARTIAL OF ROBERTS TERRACE HSG	13.8							A2	GPA CABRAS GENERATOR #3 TRIPPED.
17	01/18/06	1934	2132	1:58	NCTS	F-3	WATER SOFTENER PLANT/ELEVATED TANK, NEX BLDGS, BARRACKS, CHAPEL AND PARTIAL HSG	4.16							C1	FOUND LOOSE PRIMARY JUMPER ON POLE # F5-11.
18	01/19/06	1316	1347	:31	NIMITZ HILL	P-136	DODEA HIGH SCHOOL ON GENERATOR POWER	13.8							D4	COCONUT LEAVES STRUCK POWER LINE.
19	01/19/06	1712	1933	2:21	NCTS	F-3	WATER SOFTENER PLANT/ELEVATED TANK, NEX BLDGS, BARRACKS, CHAPEL AND PARTIAL HSG	4.16					T		C1	DEFECTIVE CUT-OUT ASSEMBLY ON H-FRAME.
20	01/21/06	1139	1310	1:31	MARBO	ON P-51	AIR FORCE WELLS #7/8	13.8							C1	DEFECTIVE CUT-OUT ASSEMBLY ON POLES #MA-2-1/MA-6.

*LEGEND: A1: LOAD SHEDDING; A2: GENERATOR TRIP; B1: STORM; B2: LIGHTNING; B3: EARTHQUAKE; C1: LINE; C2: TRANSFORMER; C3: RELAY; C4: BREAKER; D1: HUMAN ERROR; D2: VEHICLE ACCIDENT; D3: UNKNOWN; D4: TREE; D5: SNAKE; D6: GPA POWER SURGE; D7: OTHER

S.E.T.-Pacific, Inc. Proprietary

ELECTRIC DISTRIBUTION LOG (UNSCHEDULED OUTAGES)

SEQUENTIAL LOG FOR 4.16, 13.8, 34.5 KV

MONTH: JANUARY YEAR: 2006

UO#	DATE	TIME			LOCATION			LOAD	RELAY TARGETS ACTION							
		LOSS (TRIP)	RETURN (CLOSE)	ELAPSED HOURS	BASE / SUBSTATION	CIRCUIT BREAKER	AREA CUT-OFF OR AFFECTED	KV	OVER CURRENT KF	A	B	C	GRD	XFMER DIFF	OUTAGE CAUSE*	SPECIFIC CAUSE OF OUTAGE / COMMENTS
21	01/21/06	1637	1845	2:08	AAFB	P-91	CAPEHART HSG AND PARTIAL OF ROBERTS TERRACE HSG	13.8					T		D7	CL-14 FLASHED OVER.
22	01/24/06	0928	1304	3:36	NCTS	ON F-3	NEX BLDGS 206/207	4.16							C1	DEFECTIVE INSULATORS ON POLES FS-9-FS-93.
23	01/24/06	1438	1613	1:35	AAFB	ON P-68	BLDG 21001 POST OFFICE	13.8							C1	BLOWN FUSE IN MH-168-1/P-65-45.
24	01/25/06	0946	1115	1:29	NCTS	ON F-2	McDONALDS BLDGS 111/492/134/338	4.16							C1	DEFECTIVE CUT-OUT ASSEMBLY ON H-FRAME.
25	01/28/06	1218	1740	5:22	AAFB	ON P-65	BLDG 25014 CHILLER PLANT	13.8							D7	CAT CAUSED THE TRANSFORMER SWITCHGEAR TO FLASH OVER.
26	1/30/06	1714	1905	1:51	COLD STORAGE	T-132	COLD STORAGE SUB.	13.8							C1	GPA X-20/X-35 LINE TRIPPED.
26	1/30/06	1714	1909	1:55	COLD STORAGE	P-134	CAMP COVINGTON, OLD/NEW APRA, SOUTH TIP HSG, APRA DODEA, CNM BACK GATE, LANDFILL	13.8							C1	GPA X-20/X-35 LINE TRIPPED.
26	1/30/06	1714	1911	1:57	COLD STORAGE	P-133	BLDG. 3202 WHSE #6, COLD STORAGE PLANT/BATTERY LOCKER	13.8							C1	GPA X-20/X-35 LINE TRIPPED.

*LEGEND:
A1: LOAD SHEDDING
A2: GENERATOR TRIP
B1: STORM
B2: LIGHTNING
B3: EARTHQUAKE
C1: LINE
C2: TRANSFORMER
C3: RELAY
C4: BREAKER
D1: HUMAN ERROR
D2: VEHICLE ACCIDENT
D3: UNKNOWN
D4: TREE
D5: SNAKE
D6: GPA POWER SURGE
D7: OTHER

S.E.T.-Pacific, Inc. Proprietary

S.E.T. – Pacific, Inc.

DOCUMENT TRANSMITTAL FORM

CUSTOMER: DZSP 21
FACILITY: Electrical, Steam, Hot Water & Demin Water
LOCATION: Guam Naval Facilities

LOG #: **2565**
SET Contract No: SUB-000002
ISSUE CODE:
DATE: March 02, 2006

TO: DZSP 21
P.O. Box GH
Agana, Guam 96932
ATTENTION: Mr. Wally Torna, Subcontract Administrator

We are sending you: X Attached __Under Separate Cover via:_____the: __Shop Drawings

__Prints __Samples __Specifications __Reports __Inspections __Test Schedules __Copy of Letter

__Change Order __Constr.Progress Chart/Schedule __Payment Estimate X As Stated _____

Copies	Reference No.	Category Type	Description and Purpose
1	Annex 1602	CDRL No. F-1602000-F	Power System Dispatcher's Unscheduled and Scheduled Outage Reports – Feb. 2006 (5 pages)

Name of: Subcontractor, Supplier/Manufacturer _____

__For Approval __Approved as Submitted __Resubmit __copies for approval X For Your Use

__Approved as Noted __Submit __copies for distribution X As Requested __Returned for Corrections

__Return __corrected prints __For Review and Comment __Other: _____

I certify that the attached information is ready for execution and that the attached information complies with the requirements of the contract documents.

By: _____ Mar. 02, 2006
Jay D. Miller, President

Systems,
Energy &
Technologies, Inc.

S.E.T. – Pacific, Inc.

POWER SYSTEM DISPATCHER'S UNSCHEDULED AND SCHEDULED OUTAGE REPORT			
CDRL No: F-1602000-F	Prepared By: Peter Blas	Month/Year Feb. 2006	No. of Pages: 4
FREQUENCY: Monthly.			

- **Unscheduled Outage Report**
  - See attached (3 pages)
- **Scheduled Outage Report**
  - See attached (1 page)

ELECTRIC DISTRIBUTION LOG (UNSCHEDULED OUTAGES)

SEQUENTIAL LOG FOR 4.16, 13.8, 34.5 KV									RELAY TARGETS ACTION								MONTH: FEBRUARY YEAR: 2006
		TIME			LOCATION			LOAD	OVER CURRENT					XFMER DIFF	OUTAGE CAUSE*	SPECIFIC CAUSE OF OUTAGE / COMMENTS
UO#	DATE	LOSS (TRIP)	RETURN (CLOSE)	ELAPSED HOURS	BASE / SUBSTATION	CIRCUIT BREAKER	AREA CUT-OFF OR AFFECTED	KV	KF	A	B	C	GRD			
27	02/02/06	1008	1300	2:52	AAFB	ON P-82	BLDG 19009 WATER TREATMENT PLANT	13.8							C2	DEFECTIVE 25 KVA PAD-MOUNTED TRANSFORMER TO BLDG. 19006.
27	02/02/06 – 02/07/06	1008	1543	5 DAYS 5:35	AAFB	ON P-82	BLDG 19008 WATER TOWER	13.8							C2	DEFECTIVE 25 KVA PAD-MOUNTED TRANSFORMER TO BLDG. 19006.
28	02/02/06 – 02/03/06	2346	0135	1:49	COLD STORAGE	T-132	COLD STORAGE PLANT, WHSE#5, APRA DODEA/MINI-MART, LANDFILL, BACK GATE, CAMP COVINGTON, OLD/NEW APRA AND SOUTH TIP. HSG.	13.8							C1	GPA X-20/X-35 LINE TRIPPED.
29	02/03/06	0412	0609	1:57	COLD STORAGE	T-132	COLD STORAGE PLANT, WHSE#5, APRA DODEA/MINI-MART, LANDFILL, BACK GATE, CAMP COVINGTON, OLD/	13.8							C1	GPA X-20/X-35 LINE TRIPPED.
30	02/04/06	0051	0254	2:03	RADIO BARR/MARBO	P-142/T-14	RADIO BARR. GOLF COURSE, WELLS 3/4/8, ARMY RESERVE, MARBO WELLS/BOOSTER PUMPS, AIR FORCE WHSE	13.8							C1	DOWNED PRIMARY LINE ON GPA P-213 CIRCUIT.
31	02/06/06	0806	1039	2:33	NCTS 4 KV	T-47	McDONALDS, MAIN GATE, ADMIN, GYM, NEX BLDGS, CHAPEL, HOUSING/BARRACKS, WATER TOWER/SOFTENER PLANT	4.16							C1	GPA X-87/X-73 CIRCUIT BREAKER TRIPPED DUE TO A DEFECTIVE 34.5 KV CONNECTION.
32	02/07/06	0830	1615	7:45	AAFB	ON P-94	BLDG 9034 MSA-1	13.8							C1	DEFECTIVE LIGHTNING ARRESTOR ON POLE NB-133.
33	02/07/06 – 02/09/06	1310	1754	1 DAY 4:44	CNM	ON P-14	BLDG 6010 MSC MEDICAL SUPPLY BLDG	SEC.							D1	J.L. BAKER & SONS TRACTOR TRAILER DAMAGED THE SECONDARY LINE FEEDING BLDG 6010.
34	02/07/06 – 02/08/06	1816	2149	3:33	AAFB	ON P-94	BLDG 9008 MSA-1	13.8							C1	BLOWN LIGHTNING ARRESTOR ON POLE NB-123.
35	02/10/06	0401	0625	2:24	COLD STORAGE	P-134	CAMP COVINGTON, OLD/NEW APRA AND LANDFILL, CNM BACK GATE, SOUTH TIP HS, APRA DODEA/MINI-MART	13.8					T		D4	TREE BRANCHES TOUCHED PRIMARY LINE DURING HIGH WINDS AT QTRS. 34/38 CABRAS, OLD APRA HSG.

*LEGEND: A1: LOAD SHEDDING A2: GENERATOR TRIP B1: STORM B2: LIGHTNING B3: EARTHQUAKE C1: LINE C2: TRANSFORMER C3: RELAY
C4: BREAKER D1: HUMAN ERROR D2: VEHICLE ACCIDENT D3: UNKNOWN D4: TREE D5: SNAKE D6: GPA POWER SURGE D7: OTHER

S.E.T.-Pacific, Inc. Proprietary

ELECTRIC DISTRIBUTION LOG (UNSCHEDULED OUTAGES)

SEQUENTIAL LOG FOR 4.16, 13.8, 34.5 KV									RELAY TARGETS ACTION							MONTH: FEBRUARY YEAR: 2006
UO#	DATE	TIME			LOCATION			LOAD	OVER CURRENT					XFMER DIFF	OUTAGE CAUSE*	SPECIFIC CAUSE OF OUTAGE / COMMENTS
		LOSS (TRIP)	RETURN (CLOSE)	ELAPSED HOURS	BASE / SUBSTATION	CIRCUIT BREAKER	AREA CUT-OFF OR AFFECTED	KV	KF	A	B	C	GRD			
35	02/10/06	0401	1020	6:19	CAMP COVINGTON	ON P-134	BLDGS 542/546/548	13.8							C.	BLOWN FUSE ON POLE JG-37-8-1-2.
36	02/10/06	1031	1049	:18	AAFB	P-91	CAPEHART HSG AND PARTIAL OF ROBERTS TERRACE HSG	13.8	√						A2	GPA MEC GEN. #8 TRIPPED.
36	02/10/06	1031	1051	:20	COLD STORAGE	P-134	CAMP COVINGTON, OLD/NEW APRA AND LANDFILL, CNM BACK GATE, SOUTH TIP HS, APRA DODEA/MINI-MART	13.8	√						A2	GPA MEC GEN. #8 TRIPPED.
37	02/11/06	0943	1034	:51	POTTS JCT	P-110	AIR FORCE MMS AREA, GTA, GAME OFFICE, DET-5. COAST/GEODETIC SURVEY	13.8			I	I			D1	BUCKET TRUCK BOOM MADE CONTACT WITH 2 PRIMARY LINES.
38	02/16/06 – 02/17/06	2251	0122	2:29	CNM	ON P-129	SOUTH TIP HSG	13.8							C1	DOWNED PRIMARY LINE CAUSED BY BURNT SADDLE (ALUMINUM/COPPER CONNECTOR).
39	02/17/06	0938	1030	:52	POLARIS PT	ON P-2	CONCESSION GROUNDS SITE 3	SEC.							C1	DEFECTIVE CONNECTION ON SECONDARY SPLIT BOLT AT TRANSFORMER.
40	02/17/06	1917	2207	2:50	CNM	ON P-129	BLDG 2016 SWIMMING POOL	SEC.							D1	THE MOTOR VOLTAGE RATING THAT WAS INSTALLED DID NOT MATCH THE POWER SOURCE.
41	02/17/06	-	-	-	POLARIS PT	ON P-25	ARCHING ON POLE KD-58-40	13.8							D7	SALT SPRAY CAUSED THE OUTAGE.
42	02/17/05	2207	2245	:38	POLARIS PT	ON P-25	USS CITY OF CORPUS CHRISTI	.480							C1	GPA X-21/X-31 LINE TRIPPED.
43	02/18/06	1632	1751	1:19	NIMITZ HILL	P-137	TOP O'THE MAR, LIFT STA. #1, BOQ, FLAG CIRCLE, TURNER/SHERMAN HSG, ADELUP RESERVOIR AND DODEA GYM	13.8		T	T				C1	BROKEN DEAD END BELL ON POLE KC-15.
44	02/20/06	2135	2348	2:13	AAFB	P-91	CAPEHART HSG AND PARTIAL OF ROBERTS TERRACE HSG	13.8	√						A2	GPA CABRAS GENERATOR #2 TRIPPED.

*LEGEND:
A1: LOAD SHEDDING
C4: BREAKER
A2: GENERATOR TRIP
D1: HUMAN ERROR
B1: STORM
D2: VEHICLE ACCIDENT
E2: LIGHTNING
E3: UNKNOWN
B3: EARTHQUAKE
D4: TREE
C1: LINE
D5: SNAKE
C2: TRANSFORMER
D6: GPA POWER SURGE
C3: RELAY
D7: OTHER

S.E.T.-Pacific, Inc. Proprietary

ELECTRIC DISTRIBUTION LOG (UNSCHEDULED OUTAGES)

SEQUENTIAL LOG FOR 4.16, 13.8, 34.5 KV									RELAY TARGETS ACTION							MONTH: FEBRUARY YEAR: 2006
UO#	DATE	TIME			LOCATION			LOAD	OVER CURRENT					XFMER DIFF	OUTAGE CAUSE*	SPECIFIC CAUSE OF OUTAGE / COMMENTS
		LOSS (TRIP)	RETURN (CLOSE)	ELAPSED HOURS	BASE / SUBSTATION	CIRCUIT BREAKER	AREA CUT-OFF OR AFFECTED	KV	KF	A	B	C	GRD			
44	02/20/06	2135	2314	1:39	COLD STORAGE	P-134	OLD/NEW APRA HSG, NAVMAG AREA, APRA DODEA/MINI-MART, PARTIAL OF CAMP COVINGTON	13.8	√						A2	GPA CABRAS GENERATOR #2 TRIPPED.
45	02/21/06	1600	1707	1:07	AAFB	P-65	CLINIC/MEDICAL BLDG, COMMISSARY, BARRACKS, CHILLER PLANT, EXCHANGE GLDGS, TROPICANA CLUB, GALLEY AND GYM	13.8			T				C1	DEFECTIVE UNDERGROUND SPLICE AT MH-148 WAS DONE BY BLACK CONSTRUCTION CO.
46	02/23/06	0740	1410	6:30	AAFB	ON P-94	SIRENA/PATI POINT BEACHES	13.8							C1	BROKEN DEAD END BELLS ON POLE NB-105-24.
47	02/24/06	2217	2337	1:20	MARBO	ON P-51	AIR FORCE WELLS #7/8	13.8							C1	BLOWN FUSE ON POLE MB-2-1.
48	02/25/06 – 02/26/06	2240	1044	12:04	AAFB	ON P-91	QTRS #1863/1865/1922/1924 DUPLEX PACIFICO, CAPEHART HSG	13.8							C2	DEFECTIVE 100 KVA PAD-MOUNTED TRANSFORMER CT-47 (LEAKING).
49	02/27/06	1224	1350	1:26	PITI	P-2	DELTA/ECHO, OSIR, LOWER/UPPER SASA, POLARIS PT, TENJO VISTA, REEFER VANS, OLD ARMY RESERVE, ATM AND GPA	13.8					T		D5	SNAKE AT POLE TOP SWITCH 13-29 LOWER SASA CAUSED THE OUTAGE.

*LEGEND:
A1: LOAD SHEDDING A2: GENERATOR TRIP B1: STORM E2: LIGHTNING B3: EARTHQUAKE C1: LINE C2: TRANSFORMER C3: RELAY
C4: BREAKER D1: HUMAN ERROR D2: VEHICLE ACCIDENT D3: UNKNOWN D4: TREE D5: SNAKE D6: GPA POWER SURGE D7: OTHER

S.E.T.-Pacific, Inc. Proprietary

S.E.T. – Pacific, Inc.

DOCUMENT TRANSMITTAL FORM

CUSTOMER: DZSP 21
FACILITY: Electrical, Steam, Hot Water & Demin Water
LOCATION: Guam Naval Facilities

LOG #: **2638**
SET Contract No: SUB-000002
ISSUE CODE
DATE: April 03, 2006

TO: DZSP 21
P.O. Box GH
Agana, Guam 96932
ATTENTION: Mr. Wally Toma, Subcontract Administrator

We are sending you: X Attached _Under Separate Cover via:_____the: __Shop Drawings

__Prints __Samples __Specifications __Reports __Inspections __Test Schedules __Copy of Letter

_Change Order __Constr.Progress Chart/Schedule __Payment Estimate X As Stated _____

Copies	Reference No.	Category Type	Description and Purpose
1	Annex 1602	CDRL No. F-1602000-F	Unscheduled and Scheduled Outage Reports – Mar. 2006 (5 pages)

Name of: Subcontractor, Supplier/Manufacturer _____

__For Approval __Approved as Submitted __Resubmit __copies for approval X For Your Use

__Approved as Noted __Submit __copies for distribution X As Requested __Returned for Corrections

__Return __corrected prints __For Review and Comment __Other: _____

I certify that the attached information is ready for execution and that the attached information complies with the requirements of the contract documents.

By: _____ Apr. 03, 2006
Jay D. Miller, President

Systems,
Energy &
Technologies, Inc.

S.E.T. – Pacific, Inc.

UNSCHEDULED AND SCHEDULED OUTAGE REPORT			
CDRL No: F-1602000-F	Prepared By: Peter Blas	Month/Year: Mar. 2006	No. of Pages: 4
FREQUENCY: Monthly.			

- **Unscheduled Outage Report**
  - See attached (2 pages)

- **Scheduled Outage Report**
  - See attached (2 page)

ELECTRIC DISTRIBUTION LOG (UNSCHEDULED OUTAGES)

SEQUENTIAL LOG FOR 4.16, 13.8, 34.5 KV | RELAY TARGETS ACTION | MONTH: MARCH YEAR: 2006

UO#	DATE	TIME			LOCATION			LOAD	OVER CURRENT					XFMER DIFF	OUTAGE CAUSE*	SPECIFIC CAUSE OF OUTAGE / COMMENTS
		LOSS (TRIP)	RETURN (CLOSE)	ELAPSED HOURS	BASE / SUBSTATION	CIRCUIT BREAKER	AREA CUT-OFF OR AFFECTED	KV	KF	A	B	C	GRD			
	03/04/06 – 03/05/06	2334	0016	:42	NCTS 4KV	T-47	McDONALD'S, MAIN GATE, ADMIN, HOUSING, BARRACKS, CHAPEL, NEX BLDGS, MESS, WATER SOFTENING PLT, GYM & CDC	4.16							C1	GPA "HOT SPOT" REPAIRS ON X-87/SW 34-63.
50	03/05/06	1504	1754	2:50	AAFB	P-93	PARTIAL OF CAPEHART AND ROBERTS TERRACE HSG.	13.8		I	I	I			D7	FLASHED OVER AT MH-214.
50	03/05/06	1504	2131	6:27	MH-214 AAFB	ON P-93	STATION TRANSFORMERS 7B & 8A	13.8							D7	FLASHED OVER AT MH-214.
51	03/10/06	0552	1727	1135	CAMP COVINGTON	ON P-134	BLDGS 556A-B, BLDG. 560	13.8							C1	SECONDARY AT TRANSFORMER GOING TO BLDG 560 WAS BURNED DUE TO OVERLOAD.
52	03/11/06	0010	0250	2:40	MARBO	ON P-51	AIR FORCE WELLS #7/8	13.8							C1	FUSE ON POLE #MA-2-1 WAS BLOWN.
53	03/11/06	0552	1829	12:37	MARBO	ON P-51	AIR FORCE WELLS #7/8	13.8							D7	TERMITES DAMAGED UNDERGROUND CABLE/SPLICE AT MH-1.
54	03/11/06	-	-	-	MARBO	ON P-51	AIR FORCE WELL #6	SEC.							D7	SECONDARY RELAY TRIPPED ON OVERLOAD.
	03/13/06	0216 0216	0452 0300	2:36 :44	POTTS JCT NCTS 4KV	T-110 T-47	POTTS JCT SUB (P-110) NCTS 4 KV SUB (F-2/F-3/F-4)	13.8 4KV							C1	GPA X-87/X-73 LINE TRIPPED.
	03/13/06	1308	1344	36	NCTS 4KV	T-47	NCTS 4KV SUB (F-2/F-3/F-4)	4KV							C1	X-87 WAS DE-ENERGIZED DUE TO DEFECTIVE POLE TOP SWITCH.
55	03/16/06	-	-	-	POTTS JCT	ON P-110	NONE	13.8							C1	DITCH TRENCHER HIT/DAMAGED OLD 15 KV UNDERGROUND CABLE (NOT IN USE).
56	03/17/06	1527	2147	6:20	PITI	ON P-2	ECHO PIER	13.8							C2	DEFECTIVE 100KVA TRANSFORMER ON POLE KD-13-49-1.
57	03/20/06	0148	0430	2:42	OROTE	ON P-16	BLDG 257 COMMISSARY	SEC.							C4	1700-AMP MAIN SECONDARY BREAKER TRIPPED.

*LEGEND: A1: LOAD SHEDDING A2: GENERATOR TRIP B1: STORM B2: LIGHTNING B3: EARTHQUAKE C1: LINE C2: TRANSFORMER C3: RELAY C4: BREAKER D1: HUMAN ERROR D2: VEHICLE ACCIDENT D3: UNKNOWN D4: TREE D5: SNAKE D6: GPA POWER SURGE D7: OTHER

S.E.T.-Pacific, Inc. Proprietary

ELECTRIC DISTRIBUTION LOG (UNSCHEDULED OUTAGES)

SEQUENTIAL LOG FOR 4.16, 13.8, 34.5 KV | RELAY TARGETS ACTION | MONTH: MARCH YEAR: 2006

UO#	DATE	TIME			LOCATION			LOAD	OVER CURRENT					XFMER DIFF	OUTAGE CAUSE*	SPECIFIC CAUSE OF OUTAGE / COMMENTS
		LOSS (TRIP)	RETURN (CLOSE)	ELAPSED HOURS	BASE / SUBSTATION	CIRCUIT BREAKER	AREA CUT-OFF OR AFFECTED	KV	KF	A	B	C	GRD			
58	03/24/06	1058	1108	:10	COLD STORAGE	P-134	OLD/NEW APRA HSG, APRA DODEA/MINI-MART & PARTIAL OF CAMP COVINGTON	13.8	√						C4	THERE WERE PROBLEMS WITH GPA CABRAS GENERATORS #3/4.
59	03/24/06 – 03/25/06	1925	0402	8:37	AAFB	ON P-68	QTRS. #28132 TO 28135 FLEMING HTS.	13.8							C2	75KVA PAD-MOUNTED TRANSFORMER AT STA #16 WAS DEFECTIVE.
60	03/26/06	1315	1518	2:03	CNM	ON P-130	USS CHOSIN AT ROMEO	SEC.							C4	CIRCUIT BREAKERS #R-2A/R-2B/R-3C WOULD NOT CLOSE.
61	03/27/06	1543	1752	2:09	MARBO	ON P-51	AIR FORCE WELL #9	SEC.							C4	MAIN SECONDARY BREAKER TRIPPED.
62	03/29/06	0923			UPPER SASA	ON P-2	BLDG 1714	2.4							C2	POTENTIAL TRANSFORMER WAS DEFECTIVE.

*LEGEND: A1: LOAD SHEDDING A2: GENERATOR TRIP B1: STORM B2: LIGHTNING B3: EARTHQUAKE C1: LINE C2: TRANSFORMER C3: RELAY C4: BREAKER D1: HUMAN ERROR D2: VEHICLE ACCIDENT D3: UNKNOWN D4: TREE D5: SNAKE D6: GPA POWER SURGE D7: OTHER

S.E.T.-Pacific, Inc. Proprietary

S.E.T. – Pacific, Inc.

DOCUMENT TRANSMITTAL FORM

CUSTOMER: DZSP| 21
FACILITY: Bldg 104
LOCATION: Guam Naval Facilities

LOG #: **2713**
SET Contract No: SUB-000002
ISSUE CODE:
DATE: May 01, 2006

TO: DZSP 21
P.O. Box GH
Agana, Guam 96932
ATTENTION: Mr. Wally Toma, Subcontract Administrator

We are sending you: X Attached __Under Separate Cover via:_____the: __Shop Drawings

__Prints __Samples __Specifications __Reports __Inspections __Test Schedules __Copy of Letter

__Change Order __Constr.Progress Chart/Schedule __Payment Estimate X As Stated _____

Copies	Reference No.	Category Type	Description and Purpose
1	Annex 1602	CDRL No. F-1602000-F	Unscheduled and Scheduled Outage Reports – Apr. 2006 (6 pages)

Name of: Subcontractor, Supplier/Manufacturer _____

__For Approval __Approved as Submitted __Resubmit __copies for approval X For Your Use

__Approved as Noted __Submit __copies for distribution X As Requested __Returned for Corrections

__Return __corrected prints __For Review and Comment __Other: _____

I certify that the attached information is ready for execution and that the attached information complies with the requirements of the contract documents.

By: Jay D. Miller May 01, 2006
Jay D. Miller, President

Systems,
Energy &
Technologies, Inc.

S.E.T. – Pacific, Inc.

UNSCHEDULED AND SCHEDULED OUTAGE REPORT			
CDRL No: F-1602000-F	Prepared By: Peter Blas	Month/Year: Apr. 2006	No. of Pages: 5
FREQUENCY: Monthly.			

- **Unscheduled Outage Report**
  - See attached (3 pages)

- **Scheduled Outage Report**
  - See attached (2 pages)

ELECTRIC DISTRIBUTION LOG (UNSCHEDULED OUTAGES)

SEQUENTIAL LOG FOR 4.16, 13.8, 34.5 KV									RELAY TARGETS ACTION							MONTH: APRIL YEAR: 2006
UO#	DATE	TIME			LOCATION			LOAD	OVER CURRENT					XFMER DIFF	OUTAGE CAUSE*	SPECIFIC CAUSE OF OUTAGE / COMMENTS
		LOSS (TRIP)	RETURN (CLOSE)	ELAPSED HOURS	BASE / SUBSTATION	CIRCUIT BREAKER	AREA CUT-OFF OR AFFECTED	KV	KF	A	B	C	GRD			
63	04/01/06	0530	0758	2:28	COLD STORAGE	T-132	COLD STORAGE PLANT/WHSE, OLD/NEW APRA HSG, NAVMAG AREA, APRA DODEA/MINI-MART, PARTIAL OF CAMP COVINGTON	13.8							C2	GPA'S 34.5 KV PTS BURNT/X-22/X-37 LINE AND X-20 TO X-35 LINE TRIPPED.
64	04/03/06	1136	1438	3:02	RADIO BARR/MARBO	ON P-213	BLDGS 49/50/54/55/58/59, GOLF COURSE WELLS 3/4/8 AND MARBO WELLS	13.8							C1	GPA'S IN-LINE FUSE BLEW/CORRODED FUSE BARREL ON POLE LS-1-1.
65	04/06/06 – 04/07/06	1637	0155	9:18	AAFB	ON P-91	QTRS. #1954/1955 CAPEHART HSG.	13.8							C2	DEFECTIVE 50 KVA PAD-MOUNTED TRANSFORMER (CT-51).
66	04/06/06 – 04/07-06	2345	0130	1:45	ANIGUA	P-282	NRMC AREA (EXCEPT NEX BLDGS) HOSPITAL/BLR PLT ON GENERATOR	13.8							D7	BIRD ON POLE #KG-60 TRIPPED P-282 BREAKER AND BLEW 2 FUSES TO GATE BARRICADES.
67	04/08/06	0946	1010	:24	PITI	P-2	DELTA/ECHO PIERS, OSIR, LOWER/UPPER SASA, POLARIS PT., ALPHA/BRAVO PIERS, TENJO VISTA, ATM, REEFER VANS, OLD ARMY RESERVE	13.8							D7	BIRD ON POLE #KD-58-39 TRIPPED P-2 BREAKER.
68	04/10/06	2215	2259	:44	COLD STORAGE	P-134	OLD/NEW APRA HSG, APRA DODEA/MINI-MART, NAVMAG, PARTIAL CAMP COVINGTON	13.8	√						C1	GPA 115KV LINE (CABRAS TO AGANA) TRIPPED.
68	04/10/06 – 04/11/06	2215	0039	2:24	AAFB	P-91	CAPEHART HSG AND PARTIAL OF ROBERTS TERRACE HSG.	13.8	√						C1	GPA 115KV LINE (CABRAS TO AGANA) TRIPPED.
69	04/12/06	2024	2231	2:07	AAFB	ON P-93	QTRS. AT PONAPE/PARADISE LANE ON STA. #8 ROBERTS TERRACE HSG	13.8							D7	FLASH-OVER AT MH-214/STA #8.
70	04/19/06 – 04/21/06	1634	1727	2 DAYS :53	AAFB	P-98	MSA II/TACAN AREA	13.8							C1	DEFECTIVE Y-SPLICE AT MH-23.
71	04/19/06	1728	-	-	MARBO	ON P-51	AIR FORCE WELLS #5-9	SEC.							C2	HIGH VOLTAGE ON GPA T-55 TRANSFORMER AT DEDEDO.

*LEGEND: A1: LOAD SHEDDING A2: GENERATOR TRIP B1: STORM B2: LIGHTNING B3: EARTHQUAKE C1: LINE C2: TRANSFORMER C3: RELAY C4: BREAKER D1: HUMAN ERROR D2: VEHICLE ACCIDENT D3: UNKNOWN D4: TREE D5: SNAKE D6: GPA POWER SURGE D7: OTHER

S.E.T.-Pacific, Inc. Proprietary

ELECTRIC DISTRIBUTION LOG (UNSCHEDULED OUTAGES)

SEQUENTIAL LOG FOR 4.16, 13.8, 34.5 KV									RELAY TARGETS ACTION							MONTH: APRIL YEAR: 2006
UO#	DATE	TIME			LOCATION			LOAD	OVER CURRENT					XFMER DIFF	OUTAGE CAUSE*	SPECIFIC CAUSE OF OUTAGE / COMMENTS
		LOSS (TRIP)	RETURN (CLOSE)	ELAPSED HOURS	BASE / SUBSTATION	CIRCUIT BREAKER	AREA CUT-OFF OR AFFECTED	KV	KF	A	B	C	GRD			
72	04/19/06	2204	2347	1:43	POTTS JCT	P-110	COAST/GEODETIC SURVEY, DET-5, GTA, GAME OFFICE, MMS-1 COMPOUND	13.8							D3	NO VISIBLE CAUSE FOUND.
73	04/20/06	0613	0654	:41	AAFB	P-91	CAPEHART HSG AND PARTIAL OF ROBERTS	13.8	√						A2	GPA CABRAS GENERATOR #3 TRIPPED.
73	04/20/06	0613	0717	1:04	COLD STORAGE	P-134	OLD/NEW APRA HSG, DODEA, NAVMAG PARTIAL OF CAMP COVINGTON	13.8	√						A2	GPA CABRAS GENERATOR #3 TRIPPED.
74	04/20/06	0739	1010	2:31	CNM	ON P-14	BLDG 267	13.8							C1	LOOSE PRIMARY JUMPERS ON POLE # FE-7.
75	04/23/06	0850	1000	1:10	ANIGUA	P-282	CHAPEL, CDC, WELLS #1-2-3, HSG, SLS-3, POOL, FAMILY CENTER, GYM, NAVHOSP, NURSES QTRS., MAIN GATE	13.8							C4	GPA P-282/P-283 BREAKERS TRIPPED.
	04/25/06	1942	2354	3:12	HARMON/AAFB	X-87/X-73	4KV NCTS SUBSTATION POTTS-JCT SUBSTA.	4.16 13.8							C1	DEFECTIVE DEAD-END BELL ON GPA X-87/X-73 LINE.
	04/25/06	2225	2302	:37	AAFB	P-94	GTA, CIV GAS STA, POL, LOX PLANT, HC-5/MSA-1/MSA-2/TARAGUE AREA	13.8							C1	DEFECTIVE DEAD-END BELL ON GPA X-87/X-73 LINE.
	04/27/06	1116	1617	5:01	DEDEDO	P-87	SOUTH FIN HSG AREA	13.8							C1	DEFECTIVE UG ON GPA P-87 CIRCUIT.
76	04/28/06	1054	1327	2:33	NCTS	F-3	NEX BLDGS, CHAPEL, BARRACKS, CDC, WATER SOFTENING PLT, PARTIAL OF HSG	4.16					T		D3	NO VISIBLE CAUSE FOUND.
77	04/28/06	1102	1116	:14	COLD STORAGE	P-134	OLD/NEW APRA HSG, APRA DODEA/MINI-MART, NAVMAG, PARTIAL CAMP COVINGTON	13.8	√						A2	GPA DEDEDO GAS TURBINE TRIPPED.
78	04/30/06	0926	1648	7:22	CNM	ON P-129	QTRS. #2246A OROTE PT RD, LOCKWOOD HSG	SEC.							C4	DEFECTIVE MAIN SECONDARY BREAKER.

*LEGEND: A1: LOAD SHEDDING A2: GENERATOR TRIP B1: STORM B2: LIGHTNING B3: EARTHQUAKE C1: LINE C2: TRANSFORMER C3: RELAY C4: BREAKER D1: HUMAN ERROR D2: VEHICLE ACCIDENT D3: UNKNOWN D4: TREE D5: SNAKE D6: GPA POWER SURGE D7: OTHER

S.E.T.-Pacific, Inc. Proprietary

ELECTRIC DISTRIBUTION LOG (UNSCHEDULED OUTAGES)

SEQUENTIAL LOG FOR 4.16, 13.8, 34.5 KV									RELAY TARGETS ACTION							MONTH: APRIL YEAR: 2006
UO#	DATE	TIME			LOCATION			LOAD	OVER CURRENT					XFMER DIFF	OUTAGE CAUSE*	SPECIFIC CAUSE OF OUTAGE / COMMENTS
		LOSS (TRIP)	RETURN (CLOSE)	ELAPSED HOURS	BASE / SUBSTATION	CIRCUIT BREAKER	AREA CUT-OFF OR AFFECTED	KV	KF	A	B	C	GRD			
79	04/30/06 – 05/01/06	2330	0144	2:14	POTTS JCT	P-110	COAST/GEODETIC SURVEY, DET-5, GTA, GAME OFFICE, MMS-1 COMPOUND	13.8				I			C1	BROKEN DEAD-END BELLS ON POLES NG-72-3/72-4.

*LEGEND: A1: LOAD SHEDDING A2: GENERATOR TRIP B1: STORM B2: LIGHTNING B3: EARTHQUAKE C1: LINE C2: TRANSFORMER C3: RELAY C4: BREAKER D1: HUMAN ERROR D2: VEHICLE ACCIDENT D3: UNKNOWN D4: TREE D5: SNAKE D6: GPA POWER SURGE D7: OTHER

S.E.T.-Pacific, Inc. Proprietary

S.E.T. – Pacific, Inc.

DOCUMENT TRANSMITTAL FORM

CUSTOMER: DZSP| 21
FACILITY: Bldg 104
LOCATION: Guam Naval Facilities

LOG #: **2792**
SET Contract No: SUB-000002
ISSUE CODE
DATE: June 05, 2006

TO: DZSP 21
P.O. Box GH
Agana, Guam 96932
ATTENTION: Mr. Wally Toma, Subcontract Administrator

We are sending you: X Attached __Under Separate Cover via:_____the: ___Shop Drawings

___Prints ___Samples ___Specifications ___Reports ___Inspections ___Test Schedules ___Copy of Letter

__Change Order __Constr.Progress Chart/Schedule __Payment Estimate X As Stated _____

Copies	Reference No.	Category Type	Description and Purpose
1	Annex 1602	CDRL No. F-1602000-F	Unscheduled and Scheduled Outage Reports – May. 2006 (5 pages)

Name of: Subcontractor, Supplier/Manufacturer _____

___For Approval ___Approved as Submitted ___Resubmit ___copies for approval X For Your Use

___Approved as Noted ___Submit ___copies for distribution X As Requested ___Returned for Corrections

___Return ___corrected prints ___For Review and Comment ___Other: _____

I certify that the attached information is ready for execution and that the attached information complies with the requirements of the contract documents.

By:_____ June 05, 2006
Jay D. Miller, President

Systems,
Energy &
Technologies, Inc.

S.E.T. – Pacific, Inc.

UNSCHEDULED AND SCHEDULED OUTAGE REPORT			
CDRL No: F-1602000-F	Prepared By: Peter Blas	Month/Year: May 2006	No. of Pages: 4
FREQUENCY: Monthly.			

- **Unscheduled Outage Report**
  - See attached (2 pages)

- **Scheduled Outage Report**
  - See attached (2 pages)

ELECTRIC DISTRIBUTION LOG (UNSCHEDULED OUTAGES)

SEQUENTIAL LOG FOR 4.16, 13.8, 34.5 KV								RELAY TARGETS ACTION							MONTH: MAY YEAR: 2006
UO#	DATE	TIME			LOCATION			LOAD	OVER CURRENT					XFMER DIFF	OUTAGE CAUSE*	SPECIFIC CAUSE OF OUTAGE / COMMENTS
		LOSS (TRIP)	RETURN (CLOSE)	ELAPSED HOURS	BASE / SUBSTATION	CIRCUIT BREAKER	AREA CUT-OFF OR AFFECTED	KV	KF	A	B	C	GRD			
80	05/02/06	1842	1938	:51	NCTS	ON F-3	BLDG 303 AUTO-PORT	SEC.							D1	FALSE REPORT; FOUND BLDG STILL HAS POWER.
81	05/02/06	1419	1438	:19	COLD STORAGE	P-134	OLD/NEW APRA HSG, APRA DODEA/MINI-MART, NAVMAG, PARTIAL CAMP COVINGTON	13.8	√						A2	GPA MEC GENERATOR #8 TRIPPED.
	05/02/06	1450	-	-	DEDEDO	P-87	SOUTH FIN. HSG.	13.8							D6	GPA DEDEDO SUBSTATION LOST POWER.
	05/02/06	1450	-	-	DEDEDO	P-89	AIR FORCE WELLS 1-2-3-5-6-7-8-9, BOOSTER PUMPS 1-2-3	13.8							D6	GPA DEDEDO SUBSTATION LOST POWER.
	05/02/06	1909	-	-	DEDEDO	P-89	AIR FORCE WELLS 1-2-3-5-6-7-8-9, BOOSTER PUMPS 1-2-3	13.8							C4	GPA P-89 BREAKER TRIPPED.
	05/02/06	2029	-	-	HARMON/DEDEDO	X-88/X-151/154	USNS SUMNER AT SIERRA 2	SEC.							D6	GPA X-88 TO X-151/154 LINE TRIPPED.
82	05/02/06	1842	2000	1:18	NCTS	ON F-3	BLDG 303 AUTO-PORT	SEC.							D1	FALSE REPORT; FOUND BLDG STILL HAS POWER.
83	05/06/06	1805	2048	2:43	AAFB	ON P-93	QTRS AT PARADISE/PONAPE AVE. ROBERTS TERRACE HSG	13.8							D7	FLASHOVER AT MH-214/STN. #8.
84	05/09/06	0950	1159	2:09	AAFB	ON P-93	QTRS AT PARADISE/PONAPE AVE. ROBERTS TERRACE HSG	13.8							D7	DEFECTIVE TERMINATOR AT MH-2H/STN #8.
85	05/11/06	0600	1557	9:57	HARMON	T-22	P-48: WELLS A, 2, 5, TEL HUT P-114: NCTS BLDG 309 ON GEN.	13.8							D7	RAT SHORTED OUT T-22 BREAKER.
86	05/13/06	1434	1621	1:48	ALPHA PIER	ON P-25	USS FRANK CABLE	SEC.							D1	CUSTOMER OVERLOADED A2-2 BREAKER.
87	05/16/06	0120	0750	6:30	SOUTH FIN.	ON P-87	PARTIAL OF SOUTH FIN HSG	13.8							C1	DEFECTIVE PRIMARY UG CABLE (T-8A/T-11A).
88	05/16/06	1511	1538	:27	AAFB	P-93	PARTIAL OF ROBERTS TERRACE HSG.	13.8	√						C1	GPA X-87/X-73 LINE TRIPPED.
89	05/16/06	2050	2228	1:38	AAFB	ON P-93	QTRS AT PARADISE/PONAPE AVE. ROBERTS TERRACE HSG	13.8							D3	BLOWN FUSE AT MH-214/STN #7B; FOUND NO VISIBLE CAUSE.

*LEGEND: A1: LOAD SHEDDING A2: GENERATOR TRIP B1: STORM B2: LIGHTNING B3: EARTHQUAKE C1: LINE C2: TRANSFORMER C3: RELAY C4: BREAKER D1: HUMAN ERROR D2: VEHICLE ACCIDENT D3: UNKNOWN D4: TREE D5: SNAKE D6: GPA POWER SURGE D7: OTHER

S.E.T.-Pacific, Inc. Proprietary

ELECTRIC DISTRIBUTION LOG (UNSCHEDULED OUTAGES)

SEQUENTIAL LOG FOR 4.16, 13.8, 34.5 KV								RELAY TARGETS ACTION							MONTH: MAY YEAR: 2006
UO#	DATE	TIME			LOCATION			LOAD	OVER CURRENT					XFMER DIFF	OUTAGE CAUSE*	SPECIFIC CAUSE OF OUTAGE / COMMENTS
		LOSS (TRIP)	RETURN (CLOSE)	ELAPSED HOURS	BASE / SUBSTATION	CIRCUIT BREAKER	AREA CUT-OFF OR AFFECTED	KV	KF	A	B	C	GRD			
90	05/19/06	0627	1340	7:13	CNM	ON P-128	QTRS. AT KELP/JETTY COVE.	13.8							C2	DEFECTIVE 250 KVA PAD-MOUNTED TRANSFORMER.
91	05/21/06	1735	2032	2:57	CNM	ON P-129	BLDG 71 ARMORY, CNM	13.8							C1	BLOWN FUSE; FOUND NO VISIBLE CAUSE.
92	05/22/06	0448	0756	3:08	HARMON/ AAFB	T-47/ T-110	NCTS 4 KV SUBSTATION AND POTTS JCT. SUBSTATION	4:16 13.8							C1	GPA X-87/X-73 LINE TRIPPED.
93	05/22/06	1840	2045	2:05	AAFB	P-93	PARTIAL OF ROBERTS TERRACE HSG.	13.8					I/ T		D7	TOADS SHORTED OUT STN #8 AT MH-214.
94	05/23/06	0339	0522	1:43	AAFB	P-91	CAPEHART HSG AND PARTIAL OF ROBERTS TERRACE HSG	13.8							C1	GPA X-87/X-73 LINE TRIPPED.
94	05/23/06	0339	0532	1:53	HARMON/ AAFB	T-47/ T-110	NCTS 4 KV SUBSTATION AND POTTS JCT. SUBSTATION	4.16 13.8							C1	GPA X-87/X-73 LINE TRIPPED.
	05/24/06	1909	1926	:17	DEDEDO	P-87	SOUTH FIN HSG.	13.8							C4	GPA P-87 BREAKER TRIPPED ON OVERLOAD.
95	05/28/06	0700	0735	:35	NRMC	ON P-138	NAVHOSP/BOILER/FIRE STATION	13.8							C1	DEFECTIVE FUSE HOLDER.
96	05/31/06	1416	-	-	LOWER SASA	ON P-2	PUMPS #1 TO #6	4.16							D7	FAULT ON MOTOR CIRCUIT.
97	05/31/06	1830	2056	2:26	AAFB	ON P-82	BLDG 22021 COMMISSARY	13.8							C2	BLOWN TRANSFORMER INTERNAL FUSE; FOUND NO VISIBLE CAUSE.

*LEGEND: A1: LOAD SHEDDING A2: GENERATOR TRIP B1: STORM B2: LIGHTNING B3: EARTHQUAKE C1: LINE C2: TRANSFORMER C3: RELAY C4: BREAKER D1: HUMAN ERROR D2: VEHICLE ACCIDENT D3: UNKNOWN D4: TREE D5: SNAKE D6: GPA POWER SURGE D7: OTHER

S.E.T.-Pacific, Inc. Proprietary

S.E.T. – Pacific, Inc.

DOCUMENT TRANSMITTAL FORM

CUSTOMER: DZSP| 2I
FACILITY: Bldg I04
LOCATION: Guam Naval Facilities

LOG #: **2860**
SET Contract No: SUB-000002
ISSUE CODE:
DATE: July 03, 2006

TO: DZSP 21
P.O. Box GH
Agana, Guam 96932
ATTENTION: Mr. Wally Toma, Subcontract Administrator

We are sending you: **X** Attached __Under Separate Cover via:_____the: __Shop Drawings

__Prints __Samples __Specifications ___Reports __Inspections __Test Schedules __Copy of Letter

__Change Order __Constr.Progress Chart/Schedule __Payment Estimate **X** As Stated _____

Copies	Reference No.	Category Type	Description and Purpose
1	**Annex 1602**	**CDRL No. F-1602000-F**	**Unscheduled and Scheduled Outage Reports – Jun. 2006 (5 pages)**

Name of: Subcontractor, Supplier/Manufacturer _____

__For Approval __Approved as Submitted __Resubmit __copies for approval **X** For Your Use

__Approved as Noted __Submit __copies for distribution **X** As Requested __Returned for Corrections

__Return __corrected prints __For Review and Comment __Other: _____

I certify that the attached information is ready for execution and that the attached information complies with the requirements of the contract documents.

By: Chris Stewart for Ty Jacot July 03, 2006
Ty J. Jacot, Senior Vice President

Systems,
Energy &
Technologies, Inc.

S.E.T. – Pacific, Inc.

UNSCHEDULED AND SCHEDULED OUTAGE REPORT			
CDRL No: F-1602000-F	Prepared By: Peter Blas	Month/Year: Jun 2006	No. of Pages: 4
FREQUENCY: Monthly.			

- **Unscheduled Outage Report**
  - See attached (2 pages)

- **Scheduled Outage Report**
  - See attached (2 pages)

ELECTRIC DISTRIBUTION LOG (UNSCHEDULED OUTAGES)

SEQUENTIAL LOG FOR 4.16, 13.8, 34.5 KV									RELAY TARGETS ACTION							MONTH: JUN YEAR: 2006
UO#	DATE	TIME			LOCATION			LOAD	OVER CURRENT					XFMER DIFF	OUTAGE CAUSE*	SPECIFIC CAUSE OF OUTAGE / COMMENTS
		LOSS (TRIP)	RETURN (CLOSE)	ELAPSED HOURS	BASE / SUBSTATION	CIRCUIT BREAKER	AREA CUT-OFF OR AFFECTED	KV	KF	A	B	C	GRD			
98	06/02/06	1116	1151	:35	OROTE	P-16	McDONALD, COMMISSARY, NEX AUTO PORT/GARAGE, AUTO SALES OFFICE, HOME GALLERY MAIN NEX BLDG 258	13.8					T		C1	DEFECTIVE LIGHTNING ARRESTOR ON POLE JH-48-9-1.
98	06/02/06	1116	1555	4:39	CNM	ON P-16	BLDG 700 NEX II	13.8							C1	DEFECTIVE LIGHTNING ARRESTOR ON POLE JH-48-9-1.
99	06/02/06 – 06/10/06	1216	1100	8 DAYS 22:44	MH-130-1 AAFB	ON P-82	BLDGS #18027, 18030, 19013 AND 19021 (WASHRACK/HANGER AREA)	13.8							D1	DICK PACIFIC SUBCONTRACTOR "SG5" HIT/DAMAGED UNDERGROUND LINE WHILE EXCAVATING AT MH-130-1/P-82-2B CIRCUIT.
100	06/02/06	0826	0919	:53	AAFB	P-66	SUBSTATIONS "D" AND "F": INDUSTRIAL AREAS	13.8							D3	NO VISIBLE CAUSE FOUND.
101	06/02/06	0928	1420	4:52	AAFB	P-94	CIV GAS STATION/GARAGE, POL, LOX PLANT, LANDFILL/MSA-1 AND TARAGUE AREA, HC-5 LIFT STA AND ILS	13.8					T		C1	DEFECTIVE UNDERGROUND CABLE AT MH-7 TO MH-8.
102	06/04/06	1044	1352	2:25	AAFB	P-93	PARTIAL OF ROBERTS TERRACE HSG.	13.8		I	I		I		D7	TOADS SHORTED-OUT STN #8 AT MH-214.
102	06/04/06	1044	1533	4:49	AAFB	ON P-93	STN #7/STN #8 AT MH-214.	13.8							D7	TOADS SHORTED-OUT STN #8 AT MH-214.
103	06/05/06	0804	0952	1:48	AAFB	ON P-94	BLDG 14529 WHSE.	13.8							D5	SNAKE ON POLE #NE-34-1.
104	06/06/06	1823	2145	3:22	AAFB	P-68	WING HDQTRS , BARRACKS, COMMISSARY, AIR NAIONAL GUARD, GYM/BOWLING/CAR SALES, FLEMING HEIGHTS HSG & MESS	13.8			T		T		C1	BLOWN SPLICE AT MH-141.
104	06/06/06	1823	2221	3:58	AAFB	ON P-93	STN #7/STN #8 AT MH-214.	13.8							D7	TOADS SHORTED OUT STN #7 AT MH-214.
105	06/07/06	0953	1120	1:27	HARMON/NCTS	P-48/P-58	TELEPHONE HUT, WELLS #2/5/A NCTS BLDG 309	13.8			√		T		D3	NO VISIBLE CAUSE FOUND.
106	06/08/06	2141	2345	2:04	AAFB	ON P-94	ILS STROBE LIGHTS	13.8							D5	SNAKE ON POLE #NB-44.

*LEGEND: A1: LOAD SHEDDING A2: GENERATOR TRIP B1: STORM B2: LIGHTNING B3: EARTHQUAKE C1: LINE C2: TRANSFORMER C3: RELAY C4: BREAKER D1: HUMAN ERROR D2: VEHICLE ACCIDENT D3: UNKNOWN D4: TREE D5: SNAKE D6: GPA POWER SURGE D7: OTHER

S.E.T.-Pacific, Inc. Proprietary

ELECTRIC DISTRIBUTION LOG (UNSCHEDULED OUTAGES)

SEQUENTIAL LOG FOR 4.16, 13.8, 34.5 KV									RELAY TARGETS ACTION							MONTH: JUNE YEAR: 2006
UO#	DATE	TIME			LOCATION			LOAD	OVER CURRENT					XFMER DIFF	OUTAGE CAUSE*	SPECIFIC CAUSE OF OUTAGE / COMMENTS
		LOSS (TRIP)	RETURN (CLOSE)	ELAPSED HOURS	BASE / SUBSTATION	CIRCUIT BREAKER	AREA CUT-OFF OR AFFECTED	KV	KF	A	B	C	GRD			
107	06/11/06	0559	0815	2:16	AAFB	P-94	CIV GAS STATION/GARAGE, POL, LOX PLANT, LANDFILL/MSA-1 AND TARAGUE AREA, HC-5 LIFT STA AND ILS	13.8				T			C1	BROKEN DEAD-END BELLS ON POLE #NB-33-4.
107	06/11/06	0559	1047	4:48	AAFB	ON P-94	CATHODIC PROTECTION.	13.8							C1	BROKEN DEAD-END BELLS ON POLE #NB-33-4.
108	06/12/06	1121	1135	:14	AAFB	ON P-93	PARTIAL OF FLEMING HTS HSG.	13.8	√						A2	GPA CABRAS GENERATOR #3 TRIPPED.
109	06/13/06 - 06/14/06	1428	1321	22:53	NRMC	ON P-138	DICK PACIFIC FIELD OFFICE	SEC.							D7	CONTRACTOR'S DEFECTIVE KWH METER SOCKET.
110	06/15/06	1140	1430	2:50	NAVMAG	ON P-134	BLDG 859/860 (BEQ/BLR)	13.8							B3	NO VISIBLE CAUSE FOUND.
111	06/16/06	0940	1345	4:05	RADIO BARRIGADA	ON P-213	BLDGS #54/55/56, OLD/NEW ARMY RESERVE CENTERS	13.8							D5	SNAKE ON POLE #LS-1-4-2/BLOWN FUSE ON LS-1-4/LS-1-4-2.
112	06/23/06	0337	0818	4:41	NAVMAG	ON P-134	ALL OF NAVMAG AREA	13.8							C1	BROKEN DEAD-END BELLS ON POLE #JG-146-1
113	06/26/06	1308	1423	1:15	CAMP COVINGTON	ON P-129	BLDGS 542/546/548	13.8							D7	BIRD ON POLE #JG-37-8-1-2.

*LEGEND: A1: LOAD SHEDDING; A2: GENERATOR TRIP; B1: STORM; B2: LIGHTNING; B3: EARTHQUAKE; C1: LINE; C2: TRANSFORMER; C3: RELAY; C4: BREAKER; D1: HUMAN ERROR; D2: VEHICLE ACCIDENT; D3: UNKNOWN; D4: TREE; D5: SNAKE; D6: GPA POWER SURGE; D7: OTHER

S.E.T.-Pacific, Inc. Proprietary

S.E.T. – Pacific, Inc.

DOCUMENT TRANSMITTAL FORM

CUSTOMER: DZSP| 21
FACILITY: Bldg 104
LOCATION: Guam Naval Facilities

LOG #: **2936**
SET Contract No: SUB-000002
ISSUE CODE:
DATE: August 01, 2006

TO: DZSP 21
P.O. Box GH
Agana, Guam 96932
ATTENTION: Mr. Wally Toma, Subcontract Administrator

We are sending you: **X** Attached __Under Separate Cover via:_____the: __Shop Drawings

__Prints __Samples __Specifications __Reports __Inspections __Test Schedules __Copy of Letter

__Change Order __Constr.Progress Chart/Schedule __Payment Estimate **X** As Stated _____

Copies	Reference No.	Category Type	Description and Purpose
1	Annex 1602	CDRL No. F-1602000-F	Unscheduled and Scheduled Outage Reports – Jul. 2006 (7 pages)

Name of: Subcontractor, Supplier/Manufacturer _____

__For Approval __Approved as Submitted __Resubmit __copies for approval **X** For Your Use

__Approved as Noted __Submit __copies for distribution **X** As Requested __Returned for Corrections

__Return __corrected prints __For Review and Comment __Other: _____

I certify that the attached information is ready for execution and that the attached information complies with the requirements of the contract documents.

By:_____ Aug. 01, 2006
Jay D. Miller, President

Systems,
Energy &
Technologies, Inc.

S.E.T. – Pacific, Inc.

UNSCHEDULED AND SCHEDULED OUTAGE REPORT			
CDRL No: F-1602000-F	Prepared By: Peter Blas	Month/Year: Jul 2006	No. of Pages: 6
FREQUENCY: Monthly.			

- **Unscheduled Outage Report**
  - See attached (4 pages)

- **Scheduled Outage Report**
  - See attached (2 pages)

ELECTRIC DISTRIBUTION LOG (UNSCHEDULED OUTAGES)

SEQUENTIAL LOG FOR 4.16, 13.8, 34.5 KV									RELAY TARGETS ACTION							MONTH: JUL YEAR: 2006
UO#	DATE	TIME			LOCATION			LOAD	OVER CURRENT					XFMER DIFF	OUTAGE CAUSE*	SPECIFIC CAUSE OF OUTAGE / COMMENTS
		LOSS (TRIP)	RETURN (CLOSE)	ELAPSED HOURS	BASE / SUBSTATION	CIRCUIT BREAKER	AREA CUT-OFF OR AFFECTED	KV	KF	A	B	C	GRD			
114	07/01/06	1804	1904	:60	AAFB	P-91	CAPEHART HSG AND PARTIAL OF ROBERTS TERRACE	13.8					T		D6	GPA X-161 TO X-70 LINE TRIPPED.
115	07/03/06	0830	2030	12:00	HARMON/ NCTS	P-114/ P-59	UNDERGROUND LINE TO NCTS BLDG 309	13.8		T	T T	T T			D7	DEFECTIVE SWITCHGEAR #5/INSULATOR BACKET SHORTED OUT.
116	07/03/06	1228	1401	1:33	HARMON/ NCTS	P-48/ P-58	TEL HUT, WELLS #2/5/"A" AND NCTS BLDG 309	13.8					T		D3	NO VISIBLE CAUSE FOUND.
117	07/06/06	0047	0148	1:01	ANIGUA	P-282	NRMC: MAIN GATE, SLS-3, CHAPEL, CDC, GYM, POOLL, HSG, DODEA OFFICE, NURSES QTRS, WELLS #1-2-3	13.8				T	T		D6	GPA X-23/X-43 AND P-282 TRIPPED.
118	07/07/06	0745	0950	2:05	MARBO	P-53	AIR FORCE WELLS #1-9/BOOSTER PUMPS #1-3, APPLIANCE WAREHOUSE AND GPA	13.8				I	I		D5	SNAKE ON POLE AT AIR FORCE WELL #1/BOOSTER #2.
118	07/07/06	0745	1119	3:34	MARBO	P-52	GPA CUSTOMERS	13.8		I	I		I		D3	NO VISIBLE CAUSE FOUND.
119	07/07/06	0825	0924	:59	NRMC	ON P-138	DICK PACIFIC FIELD OFFICE	13.8							D3	NO VISIBLE CAUSE FOUND.
120	07/07/06	1225	1433	2:08	OROTE	P-14	VICTOR #2 PIER, WHSE #3/4, B2118, KILO PIER, SLS-21, GABGAB BEACH, SIERRA/ROMEO SEALS/EOD/MSC/MSF COMPOUND AND GSY	13.8					I		D5	SNAKE ON POLE JB-61-36.
121	07/08/06	1239	1640	4:01	AAFB	P-91	CAPEHART HOUSING AND PARTIAL OF ROBERT TERRACE HSG	13.8		I	I	I	I		D7	FLASHED-OVER AT CL-25 SWITCHGEAR.
	07/08/06	1734	1738	:04	ANIGUA	P-282	NRMC AREA: HOUSING, CDC, CHAPEL, WELLS #1-2-3, MAIN GATE, SLS-3, BLDG 100, GYM, POOL AND NURSES QTRS.	13.8							D6	GPA P-282 BREAKER TRIPPED.
122	07/08/06 – 07/09/06	1734	0008	6:34	NRMC	ON P-282	NRMC AREA: HOUSING, CDC, CHAPEL, WELLS #1-2-3, MAIN GATE, SLS-3, BLDG 100, GYM, POOL AND NURSES QTRS.	13.8							D4	VEGETATION ON PRIMARY LINE ON POLES K6-59-13/15.
123	07/09/06	0202	1018	8:16	NRMC	ON P-282	WELL #3	13.8							C2	DEFECTIVE 15 KVA TRANSFORMER.

*LEGEND: A1: LOAD SHEDDING; A2: GENERATOR TRIP; B1: STORM; B2: LIGHTNING; B3: EARTHQUAKE; C1: LINE; C2: TRANSFORMER; C3: RELAY; C4: BREAKER; D1: HUMAN ERROR; D2: VEHICLE ACCIDENT; D3: UNKNOWN; D4: TREE; D5: SNAKE; D6: GPA POWER SURGE; D7: OTHER

S.E.T.-Pacific, Inc. Proprietary

ELECTRIC DISTRIBUTION LOG (UNSCHEDULED OUTAGES)

SEQUENTIAL LOG FOR 4.16, 13.8, 34.5 KV									RELAY TARGETS ACTION							MONTH: JULY YEAR: 2006
UO#	DATE	TIME			LOCATION			LOAD	OVER CURRENT					XFMER DIFF	OUTAGE CAUSE*	SPECIFIC CAUSE OF OUTAGE / COMMENTS
		LOSS (TRIP)	RETURN (CLOSE)	ELAPSED HOURS	BASE / SUBSTATION	CIRCUIT BREAKER	AREA CUT-OFF OR AFFECTED	KV	KF	A	B	C	GRD			
124	07/09/06 – 07/10/06	2311	0819	9:08	AAFB	P-93	PARTIAL OF ROBERT TERRACE HSG.	13.8					I		D7	BURNT INSULATORS ON P-67-54 SWITCH AT MH-207A.
125	07/10/06	1358	1625	2:27	ASAN	ON P-1	ASAN BOOSTER PUMP	13.8							D5	SNAKE ON POLE #KF-50.
126	07/12/06	0912	1307	3:55	AAFB	ON P-67	BLDG 1625 CDC	13.8							D6	OLD SWITCHGEAR AT MH-C6 SHORTED OUT.
127	07/12/06 – 07/13/06	1650	2335	1 DAY 6:45	AAFB	P-98	MSA-III AREA	13.8			T				D6	BURNT SPLICES AT MH-20.
127	07/12/06	1857	1936	:39	AAFB	P-97	20 MEG SUBSTATION	13.8			T				D6	BURNT SPLICES AT MH-20.
127	07/12/06	1857	1942	:45	AAFB	P-95	USDA, CATHODIC/POL, FIRE TRNG, BASECOM, DOG KENNEL AND HC-5	13.8							D6	BURNT SPLICES AT MH-20.
128	07/13/06	0312	0523	2:11	MARBO	ON P-51	AIR FORCE BOOSTER PUMP #3	13.8							D3	NOVISIBLE CAUSE FOUND.
129	07/13/06	1245	1334	:49	NRMC	ON P-138	DICK PACIFIC FIELD OFFICE	13.8							D6	BIRD ON POLE #NH-2-1
130	07/13/06	2138	2251	1:13	OROTE	P-16	NEX COMPLEX/AUTO PORT/NEX II, MCDONALDS, AND COMMISSARY	13.8					T		C1	BLOWN LIGHTNING ARRESTOR.
131	07/14/06 – 07/18/06	1425	1705	4 DAYS 2:40	NRMC	ON P-282	WELL #3	13.8							D6	BURNT MOTOR, KWH METER/SOCKET/WIRE.
132	07/15/06	1258	2127	2:05	AAFB	P-93	ROBERT TERRACE HSG	13.8					I		D6	BLOWN SPLICES AT CL-43 SWITCHGEAR.
133	07/25/06	2157	2210	:13	PAD-5	ON P-14	USS LAJOLLA AT ALPHA PIER	.480							D1	CUSTOMER OVERLOADED A3-4 CIRCUIT BREAKER.
134	07/17/06	0926	1236	3:10	PITI	ON P-2	TENJO VISTA FUEL FARM, VALVE PIT	.480							D4	VEGETATION ON SECONDARY LINES.
135	07/17/06	0929	1015	:46	AAFB	ON P-62	BLDG 2408 RECYCLE CENTER	13.8							D3	NO VISIBLE CAUSE FOUND.

*LEGEND: A1: LOAD SHEDDING A2: GENERATOR TRIP B1: STORM B2: LIGHTNING B3: EARTHQUAKE C1: LINE C2: TRANSFORMER C3: RELAY C4: BREAKER D1: HUMAN ERROR D2: VEHICLE ACCIDENT D3: UNKNOWN D4: TREE D5: SNAKE D6: GPA POWER SURGE D7: OTHER

S.E.T.-Pacific, Inc. Proprietary

ELECTRIC DISTRIBUTION LOG (UNSCHEDULED OUTAGES)

SEQUENTIAL LOG FOR 4.16, 13.8, 34.5 KV								RELAY TARGETS ACTION							MONTH: JUL YEAR: 2006
UO#	DATE	TIME			LOCATION			LOAD	OVER CURRENT					XFMER DIFF	OUTAGE CAUSE*	SPECIFIC CAUSE OF OUTAGE / COMMENTS
		LOSS (TRIP)	RETURN (CLOSE)	ELAPSED HOURS	BASE / SUBSTATION	CIRCUIT BREAKER	AREA CUT-OFF OR AFFECTED	KV	KF	A	B	C	GRD			
136	07/18/06	1352	1712	3:20	CNM	ON P-16	BLDG 257 HOME GALLEY/LAUNDROMAT	13.8							D5	SNAKE ON POLE #JD-23-6.
137	07/19/06	1133	1608	4:35	RADIO BARRIGADA	ON P-213	BLDGS #50/55/56 AND THE OLD/NEW ARMY RESERVE CENTER	13.8							B2	LIGHTNING/DOWNED POLE #LS-1-6 PRIMARY LINE; DEFECTIVE DEADEND BELLS.
138	07/19/06	2114	2219	1:05	AAFB	P-94	CIVILIAN GAS STATION, POL, LOX PLANT, ILS, CATHODIC PROTECTION, LANDFILL, MSA-I/TARAGUE AREA	13.8				T/I			C1	BLOWN LIGHTNING ARRETOR ON POLE #NB-13.
139	07/19/06	2135	2201	:26	AAFB	P-91	CAPEHART HSG AND PARTIAL OF ROBERT TERRACE HSG	13.8		I	I	I	I		D3	NO VISIBLE CAUSE FOUND.
140	07/21/06	0757	0800	:03	ANIGUA	P-282	NRMC AREA: HOUSING, CDC, CHAPEL, NURSES QTRS, BLDG 13, GYM, DODEA OFFICE, POOL, SLS-3 AND GATE	13.8							D6	BIRD ON POLE #KG-59.
141	07/21/06	1612	1648	:36	OROTE	P-14	VICTOR #2 PIER, WHSE #3/4, B2118, KILO PIER, SLS-21, GABGAB BEACH, EOD/MSC/MSF COMPOUND AND GSY	13.8					I		D6	BIRD ON POLE #JC-27.
141	07/21/06	1612	1837	2:25	CNM	ON P-14	SEALD COMDPOUND BLDGS 3000-3002	13.8							D6	BIRD ON POLE #JC-27.
142	07/22/06	1750	2307	5:17	AAFB	ON P-91	CT-42/CT-43/CT-44 QTRS AT CAPEHART HSG.	13.8							D6	BLOWN TERMINATOR AT CL-14 SWITCHGEAR.
143	07/26/06	0816	1830	10:14	NAVMAG	ON P-134	BLDGS 401, 403, 769, 400, 734 AND 879 GYM	13.8							B2	LIGHTNING; BURNT POLE/ACCESSORIES. DEFECTIVE DEAD END BELLS ON POLE #JG-104-10-7-3 AND POLE JG-104-10-2.
144	07/26/06	1447	1714	2:27	AAFB	P-98	BLDGS #2800/2820 TACAN AND MSA-II AREA	13.8		T		T			D3	NO VISIBLE CAUSE FOUND.
145	07/29/06-07/30/06	1713	0042	7:29	CNM	ON P-129	QTRS #14/16/18/20 GILMORE AND 2228A/B McMILLAN LOCKWOOD	13.8							B2	LIGHTNING/DEFECTIVE T-14 75 KVA PAD-MOUNTED TRANSFORMER.
146	07/29/06-07/30/06	2241	0159	3:18	AAFB	ON P-62	BLDGS #9000/9001/9002	13.8							D5	SNAKE ON POLE #NB-113.

*LEGEND: A1: LOAD SHEDDING A2: GENERATOR TRIP B1: STORM B2: LIGHTNING B3: EARTHQUAKE C1: LINE C2: TRANSFORMER C3: RELAY C4: BREAKER D1: HUMAN ERROR D2: VEHICLE ACCIDENT D3: UNKNOWN D4: TREE D5: SNAKE D6: GPA POWER SURGE D7: OTHER

S.E.T.-Pacific, Inc. Proprietary

ELECTRIC DISTRIBUTION LOG (UNSCHEDULED OUTAGES)

SEQUENTIAL LOG FOR 4.16, 13.8, 34.5 KV									RELAY TARGETS ACTION							MONTH: JUL YEAR: 2006
UO#	DATE	TIME			LOCATION			LOAD	OVER CURRENT					XFMER DIFF	OUTAGE CAUSE*	SPECIFIC CAUSE OF OUTAGE / COMMENTS
		LOSS (TRIP)	RETURN (CLOSE)	ELAPSED HOURS	BASE / SUBSTATION	CIRCUIT BREAKER	AREA CUT-OFF OR AFFECTED	KV	KF	A	B	C	GRD			
147	07/30/06	0107	0127	:20	NEW APRA	ON P-134	GUARDHOUSE NEW APRA HSG	SEC							D3	NO VISIBLE CAUSE FOUND.
148	07/30/06	0542	0854	3:12	MARBO	P-51	AIR FORCE BOOSTER PUMP #3, WELLS #5-9	13.8				I	I		D3	NO VISIBLE CAUSE FOUND.
149	07/31/06	1215	1710	4:55	OROTE	T-12	P-128/P-129/P-130		UNDERVOLTAGE AND LOCKOUT 786B.						D6	A PHASE DIFFERENTIAL RELAY SHORTED OUT; WATER WAS INSIDE THE RELAY BOX.
149	07/31/06	1215	1407	1:52	OROTE	P-129	COAST GUARD/SECURITY/NFM COMPOUND, TRANSPORTATION, CDC, CHAPEL, GYM, NORTH/SOUTH TIP/LOCKWOOD HSG AND DRMO	13.8							D6	A PHASE DIFFERENTIAL RELAY SHORTED OUT; WATER WAS INSIDE THE RELAY BOX.
149	07/31/06	1215	1710	4:55	OROTE	P-128	HARBOR/BAYVIEW HSG	13.8							D6	A PHASE DIFFERENTIAL RELAY SHORTED OUT; WATER WAS INSIDE THE RELAY BOX.
149	07/31/06	1215	1711	4:56	OROTE	P-130	BLDGS #3190/3191	13.8							D6	A PHASE DIFFERENTIAL RELAY SHORTED OUT; WATER WAS INSIDE THE RELAY BOX.

*LEGEND: A1: LOAD SHEDDING A2: GENERATOR TRIP B1: STORM B2: LIGHTNING B3: EARTHQUAKE C1: LINE C2: TRANSFORMER C3: RELAY C4: BREAKER D1: HUMAN ERROR D2: VEHICLE ACCIDENT D3: UNKNOWN D4: TREE D5: SNAKE D6: GPA POWER SURGE D7: OTHER

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Appendix D
Detailed Cost Tables for IWPS Improvements

Project Description: **Upgrade Piti X20 to Orote X35 34.5kV Line** **Project List: A (1)**

Description	Unit	Unit Cost	Quantity	Cost	References	Remarks
336 ACSR Conductor	WMile	$37,800	20	$756,000.00	RSMeans	Includes cable sag length factor .01
1/0 ACSR Ground Wire	WMile	$37,800	2.5	$94,500.00	RSMeans	Includes cable sag length factor .01
Conductor Pulley Setups	Mile	$600	88	$52,800.00	RSMeans	
Pulling Conductors	WMile	$9,600	20	$192,000.00	RSMeans	
Insulators 34.5kV	Ea	$270	792	$213,840.00	RSMeans	
Insulators 115kV	Ea	$300		$0.00		
Concrete Pole w/ Crossarm	Ea	$60,000		$0.00		
Circuit Breaker 115kV, Gas, Outdoor	Ea	$943,500		$0.00		
Circuit Breaker 34.5kV, Outdoor	Ea	$153,000	2	$306,000.00	RSMeans	
112 MVA Station Type Transformer	MVA	$48,000		$0.00		
115kV Substation Gravel Base	Cu Yd	$156		$0.00		
115kV Substation Grounding	Sq Ft	$60		$0.00		
115kV Substation Fence	Ln Ft	$300		$0.00		
115kV Substation Switchgear Bldg	Sq Ft	$1,032		$0.00		
115kV Substation HV Equip. Structure	Ea	$300,000		$0.00		
Concrete Equipment Pad	Ea	$7,500	2	$15,000.00	Engineer Jugement/RSMeans	
Substation Bus Connection	Ea	$45,000	2	$90,000.00	Engineer Jugement/RSMeans	
Gang Switch 115kV	Ea	$105,000		$0.00		
34.5 kV Switchgear	Bay	$120,000		$0.00		

Total Construction Materials and Labor **$1,720,140.00**

Contingencies 10% **$172,014.00**

TOTAL **$1,892,154.00**

Project Description: **Upgrade Harmon X87 to Andersen X73 34.5kV Line** **Project List: A (2)**

Description	Unit	Unit Cost	Quantity	Cost	References	Remarks
336 ACSR Conductor	WMile	$37,800	40.6	$1,534,680.00	RSMeans	Includes cable sag length factor .01
1/0 ACSR Ground Wire	WMile	$37,800	5.1	$192,780.00	RSMeans	Includes cable sag length factor .01
Conductor Pulley Setups	Mile	$600	176	$105,600.00	RSMeans	
Pulling Conductors	WMile	$9,600	40.6	$389,760.00	RSMeans	
Insulators 34.5kV	Ea	$270	1408	$380,160.00	RSMeans	
Insulators 115kV	Ea	$300		$0.00		
Concrete Pole w/ Crossarm	Ea	$60,000		$0.00		
Circuit Breaker 115kV, Gas, Outdoor	Ea	$943,500		$0.00		
Circuit Breaker 34.5kV, Outdoor	Ea	$153,000	2	$306,000.00	RSMeans	
112 MVA Station Type Transformer	MVA	$48,000		$0.00		
115kV Substation Gravel Base	Cu Yd	$156		$0.00		
115kV Substation Grounding	Sq Ft	$60		$0.00		
115kV Substation Fence	Ln Ft	$300		$0.00		
115kV Substation Switchgear Bldg	Sq Ft	$1,032		$0.00		
115kV Substation HV Equip. Structure	Ea	$300,000		$0.00		
Concrete Equipment Pad	Ea	$7,500	2	$15,000.00	Engineer Judgement/RSMeans	
Substation Bus Connection	Ea	$45,000	2	$90,000.00	Engineer Judgement/RSMeans	
Gang Switch 115kV	Ea	$105,000		$0.00		
34.5 kV Switchgear	Bay	$120,000		$0.00		

Total Construction Materials and Labor	**$2,820,000.00**
Contingencies 10%	**$282,000.00**
TOTAL	**$3,102,000.00**

Project Description: **Upgrade Piti X21 to Orote X31 Double Circuit 34.5kV Line** **Project List: A (3)**

Description	Unit	Unit Cost	Quantity	Cost	References	Remarks
336 ACSR Conductor	WMile	$37,800	40	$1,512,000.00	RSMeans	Includes cable sag length factor .01
1/0 ACSR Ground Wire	WMile	$37,800	2.5	$94,500.00	RSMeans	Includes cable sag length factor .01
Conductor Pulley Setups	Mile	$600	174	$104,400.00	RSMeans	
Pulling Conductors	WMile	$9,600	40	$384,000.00	RSMeans	
Insulators 34.5kV	Ea	$270	2784	$751,680.00	RSMeans	
Insulators 115kV	Ea	$300		$0.00		
Concrete Pole w/ Crossarm	Ea	$60,000		$0.00		
Circuit Breaker 115kV, Gas, Outdoor	Ea	$943,500		$0.00		
Circuit Breaker 34.5kV, Outdoor	Ea	$153,000	2	$306,000.00	RSMeans	
112 MVA Station Type Transformer	MVA	$48,000		$0.00		
115kV Substation Gravel Base	Cu Yd	$156		$0.00		
115kV Substation Grounding	Sq Ft	$60		$0.00		
115kV Substation Fence	Ln Ft	$300		$0.00		
115kV Substation Switchgear Bldg	Sq Ft	$1,032		$0.00		
115kV Substation HV Equip. Structure	Ea	$300,000		$0.00		
Concrete Equipment Pad	Ea	$7,500	2	$15,000.00	Engneer Judgement/RSMeans	
Substation Bus Connection	Ea	$45,000	2	$90,000.00	Engneer Judgement/RSMeans	
Gang Switch 115kV	Ea	$105,000		$0.00		
34.5 kV Switchgear	Bay	$120,000		$0.00		

Total Construction Materials and Labor	**$3,160,000.00**
Contingencies 10%	**$316,000.00**
TOTAL	**$3,476,000.00**

Project Description: **Dededo CT X150/X155 to Andersen X71 Double Circuit 34.5kV Line** **Project List: A (4)**

Description	Unit	Unit Cost	Quantity	Cost	References	Remarks
336 ACSR Conductor	WMile	$37,800	117	$4,422,600.00	RSMeans	Includes cable sag length factor .01
1/0 ACSR Ground Wire	WMile	$37,800	7.3	$275,940.00	RSMeans	Includes cable sag length factor .01
Conductor Pulley Setups	Mile	$600	255	$153,000.00	RSMeans	
Pulling Conductors	WMile	$9,600	117	$1,123,200.00	RSMeans	
Insulators 34.5kV	Ea	$270	2040	$550,800.00	RSMeans	
Insulators 115kV	Ea	$300		$0.00		
Concrete Pole w/ Crossarm	Ea	$60,000		$0.00		
Circuit Breaker 115kV, Gas, Outdoor	Ea	$943,500		$0.00		
Circuit Breaker 34.5kV, Outdoor	Ea	$153,000	3	$459,000.00	RSMeans	
112 MVA Station Type Transformer	MVA	$48,000		$0.00		
115kV Substation Gravel Base	Cu Yd	$156		$0.00		
115kV Substation Grounding	Sq Ft	$60		$0.00		
115kV Substation Fence	Ln Ft	$300		$0.00		
115kV Substation Switchgear Bldg	Sq Ft	$1,032		$0.00		
115kV Substation HV Equip. Structure	Ea	$300,000		$0.00		
Concrete Equipment Pad	Ea	$7,500	3	$22,500.00	Engineer Judgement/RSMeans	
Substation Bus Connection	Ea	$45,000	3	$135,000.00	Engineer Judgement/RSMeans	
Gang Switch 115kV	Ea	$105,000		$0.00		
34.5 kV Switchgear	Bay	$120,000		$0.00		

Total Construction Materials and Labor	**$6,870,000.00**
Contingencies 10%	**$687,000.00**
TOTAL	**$7,557,000.00**

Project Description: **Upgrade harmon X88 to Dededo X151/154 Double Circuit 34.5kV Line** **Project List: A (5)**

Description	Unit	Unit Cost	Quantity	Cost	References	Remarks
336 ACSR Conductor	WMile	$37,800	83	$3,137,400.00	RSMeans	Includes cable sag length factor .01
1/0 ACSR Ground Wire	WMile	$37,800	2.6	$98,280.00	RSMeans	Includes cable sag length factor .01
Conductor Pulley Setups	Mile	$600	182	$109,200.00	RSMeans	
Pulling Conductors	WMile	$9,600	83	$796,800.00	RSMeans	
Insulators 34.5kV	Ea	$270	2184	$589,680.00	RSMeans	
Insulators 115kV	Ea	$300		$0.00		
Concrete Pole w/ Crossarm	Ea	$60,000		$0.00		
Circuit Breaker 115kV, Gas, Outdoor	Ea	$943,500		$0.00		
Circuit Breaker 34.5kV, Outdoor	Ea	$153,000	3	$459,000.00	RSMeans	
112 MVA Station Type Transformer	MVA	$48,000		$0.00		
115kV Substation Gravel Base	Cu Yd	$156		$0.00		
115kV Substation Grounding	Sq Ft	$60		$0.00		
115kV Substation Fence	Ln Ft	$300		$0.00		
115kV Substation Switchgear Bldg	Sq Ft	$1,032		$0.00		
115kV Substation HV Equip. Structure	Ea	$300,000		$0.00		
Concrete Equipment Pad	Ea	$7,500	3	$22,500.00	Engineer Judgement/RSMeans	
Substation Bus Connection	Ea	$45,000	3	$135,000.00	Engineer Judgement/RSMeans	
Gang Switch 115kV	Ea	$105,000		$0.00		
34.5 kV Switchgear	Bay	$120,000		$0.00		

Total Construction Materials and Labor	**$5,250,000.00**
Contingencies 10%	**$525,000.00**
TOTAL	**$5,775,000.00**

Project Description: **Upgrade HarmonX82 to Yigo X160 34.5kV Line** **Project List: A (6)**

Description	Unit	Unit Cost	Quantity	Cost	References	Remarks
336 ACSR Conductor	WMile	$37,800	52	$1,965,600.00	RSMeans	Includes cable sag length factor .01
1/0 ACSR Ground Wire	WMile	$37,800	6.5	$245,700.00	RSMeans	Includes cable sag length factor .01
Conductor Pulley Setups	Mile	$600	228	$136,800.00	RSMeans	
Pulling Conductors	WMile	$9,600	52	$499,200.00	RSMeans	
Insulators 34.5kV	Ea	$270	1824	$492,480.00	RSMeans	
Insulators 115kV	Ea	$300		$0.00		
Concrete Pole w/ Crossarm	Ea	$60,000		$0.00		
Circuit Breaker 115kV, Gas, Outdoor	Ea	$943,500		$0.00		
Circuit Breaker 34.5kV, Outdoor	Ea	$153,000	2	$306,000.00	RSMeans	
112 MVA Station Type Transformer	MVA	$48,000		$0.00		
115kV Substation Gravel Base	Cu Yd	$156		$0.00		
115kV Substation Grounding	Sq Ft	$60		$0.00		
115kV Substation Fence	Ln Ft	$300		$0.00		
115kV Substation Switchgear Bldg	Sq Ft	$1,032		$0.00		
115kV Substation HV Equip. Structure	Ea	$300,000		$0.00		
Concrete Equipment Pad	Ea	$7,500	2	$15,000.00	Engineer Judgement/RSMeans	
Substation Bus Connection	Ea	$45,000	2	$90,000.00	Engineer Judgement/RSMeans	
Gang Switch 115kV	Ea	$105,000		$0.00		
34.5 kV Switchgear	Bay	$120,000		$0.00		

Total Construction Materials and Labor	**$3,510,000.00**
Contingencies 10%	**$351,000.00**
TOTAL	**$3,861,000.00**

Project Description: **New Capacitor Bank at Orote Substation 13.8kV** **Project List: A (7)**

Description	Unit	Unit Cost	Quantity	Cost	References	Remarks
Capacitor Bank	Mvars	$21,975	24	$527,400.00	RSMeans	
Concrete Equipment Pad	LS	$7,500	1	$7,500.00	Engineer Judgement/RSMeans	
Outdoor Air Circuit Breaker 13.8 kV	Ea	$160,275	1	$160,275.00	RSMeans	

Total Construction Materials and Labor **$700,000.00**

Contingencies 10% **$70,000.00**

TOTAL **$770,000.00**

Project Description: **New Capacitor Bank at SRF Substation 13.8kV** **Project List: A (8)**

Description	Unit	Unit Cost	Quantity	Cost	References	Remarks
Capacitor Bank	Mvars	$21,975	3	$65,925.00	RSMeans	
Concrete Equipment Pad	LS	$7,500	1	$7,500.00	Engineer Judgement/RSMeans	
Outdoor Air Circuit Breaker 13.8 kV	Ea	$160,275	1	$160,275.00	RSMeans	

Total Construction Materials and Labor **$230,000.00**

Contingencies 10% **$23,000.00**

TOTAL **$253,000.00**

Project Description: **New Capacitor Bank at Andersen Substation 13.8kV** **Project List: A (9)**

Description	Unit	Unit Cost	Quantity	Cost	References	Remarks
Capacitor Bank	Mvars	$21,975	24	$527,400.00	RSMeans	
Concrete Equipment Pad	LS	$7,500	1	$7,500.00	Engineer Judgement/RSMeans	
Outdoor Air Circuit Breaker 13.8 kV	Ea	$160,275	1	$160,275.00	RSMeans	

Total Construction Materials and Labor **$700,000.00**

Contingencies 10% **$70,000.00**

TOTAL **$770,000.00**

Project Description: **New Capacitor Bank at NCS Substation 13.8kV** **Project List: A (10)**

Description	Unit	Unit Cost	Quantity	Cost	References	Remarks
Capacitor Bank	Mvars	$21,975	18	$395,550.00	RSMeans	
Concrete Equipment Pad	LS	$7,500	1	$7,500.00	Engineeer Judgement/RSMeans	
Outdoor Air Circuit Breaker 13.8 kV	Ea	$160,275	1	$160,275.00	RSMeans	

Total Construction Materials and Labor **$560,000.00**

Contingencies 10% **$56,000.00**

TOTAL **$616,000.00**

Project Description: **New Harmon to Andersen 115kV Line** **Project List: B (1)**

Description	Unit	Unit Cost	Quantity	Cost	References	Remarks
336 ACSR Conductor	WMile	$37,800	40.6	$1,534,680.00	RSMeans	Includes cable sag length factor .01
1/0 ACSR Ground Wire	WMile	$37,800	5.1	$192,780.00	RSMeans	Includes cable sag length factor .01
Conductor Pulley Setups	Mile	$600	106	$63,600.00	RSMeans	Length/pole spc x 2
Pulling Conductors	WMile	$9,600	40.6	$389,760.00	RSMeans	
Insulators 34.5kV	Ea	$270		$0.00		
Insulators 115kV	Ea	$300	265	$79,500.00	RSMeans	
Concrete Pole w/ Crossarm	Ea	$60,000	53	$3,180,000.00	Engineer Judgement/RSMeans	
Circuit Breaker 115kV, Gas, Outdoor	Ea	$943,500	2	$1,887,000.00	RSMeans	
Circuit Breaker 34.5kV, Outdoor	Ea	$153,000		$0.00		
112 MVA Station Type Transformer	MVA	$48,000		$0.00		
115kV Substation Gravel Base	Cu Yd	$156		$0.00		
115kV Substation Grounding	Sq Ft	$60		$0.00		
115kV Substation Fence	Ln Ft	$300		$0.00		
115kV Substation Switchgear Bldg	Sq Ft	$1,032		$0.00		
115kV Substation HV Equip. Structure	Ea	$300,000		$0.00		
Concrete Equipment Pad	Ea	$7,500	2	$15,000.00	Engineer Judgement/RSMeans	
Substation Bus Connection	Ea	$45,000		$0.00		
Gang Switch 115kV	Ea	$105,000	2	$210,000.00	RSMeans	
34.5 kV Switchgear	Bay	$120,000		$0.00		

Total Construction Materials and Labor **$7,360,000.00**

Contingencies 10% **$736,000.00**

TOTAL **$8,096,000.00**

Project Description: **New Andersen Substation with 112MVA Power Transformer** **Project List: B (2)**

Description	Unit	Unit Cost	Quantity	Cost	References	Remarks
336 ACSR Conductor	WMile	$37,800		$0.00		
1/0 ACSR Ground Wire	WMile	$37,800		$0.00		
Conductor Pulley Setups	Mile	$600		$0.00		
Pulling Conductors	WMile	$9,600		$0.00		
Insulators 34.5kV	Ea	$270		$0.00		
Insulators 115kV	Ea	$300		$0.00		
Concrete Pole w/ Crossarm	Ea	$60,000		$0.00		
Circuit Breaker 115kV, Gas, Outdoor	Ea	$943,500	1	$943,500.00	RSMeans	
Circuit Breaker 34.5kV, Outdoor	Ea	$153,000		$0.00		
112 MVA Station Type Transformer	MVA	$48,000	112	$5,376,000.00	RSMeans	
115kV Substation Gravel Base	Cu Yd	$156	50	$7,800.00	Engineer Judgement	
115kV Substation Grounding	Sq Ft	$60	43,560	$2,613,600.00	Engineer Judgement	
115kV Substation Fence	Ln Ft	$300	833	$249,900.00	Engineer Judgement	
115kV Substation Switchgear Bldg	Sq Ft	$1,032	800	$825,600.00	Engineer Judgement	Land Provided by DOD
115kV Substation HV Equip. Structure	Ea	$300,000	1	$300,000.00	Engineer Judgement	
Concrete Equipment Pad	Ea	$7,500	2	$15,000.00	Engineer Judgement/RSMeans	
Substation Bus Connection	Ea	$45,000	1	$45,000.00	Engineer Judgement/RSMeans	
Gang Switch 115kV	Ea	$105,000		$0.00		
34.5 kV Switchgear	Bay	$120,000	6	$720,000.00	Engineer Judgement/RSMeans	

Total Construction Materials and Labor	**$11,100,000.00**
Contingencies 10%	**$1,110,000.00**
TOTAL	**$12,210,000.00**

Project Description: **New Piti to Orote 115kV Line** **Project List: B (3)**

Description	Unit	Unit Cost	Quantity	Cost	References	Remarks
336 ACSR Conductor	WMile	$37,800	10.1	$381,780.00	RSMeans	Includes cable sag length factor .01
1/0 ACSR Ground Wire	WMile	$37,800	2.5	$94,500.00	RSMeans	Includes cable sag length factor .01
Conductor Pulley Setups	Mile	$600	27	$16,200.00	RSMeans	Length/pole spc x 2
Pulling Conductors	WMile	$9,600	10.1	$96,960.00	RSMeans	
Insulators 34.5kV	Ea	$270		$0.00		
Insulators 115kV	Ea	$300	135	$40,500.00	RSMeans	
Concrete Pole w/ Crossarm	Ea	$60,000	27	$1,620,000.00	Engineer Judgement/RSMeans	
Circuit Breaker 115kV, Gas, Outdoor	Ea	$943,500		$0.00		
Circuit Breaker 34.5kV, Outdoor	Ea	$153,000		$0.00		
112 MVA Station Type Transformer	MVA	$48,000		$0.00		
115kV Substation Gravel Base	Cu Yd	$156		$0.00		
115kV Substation Grounding	Sq Ft	$60		$0.00		
115kV Substation Fence	Ln Ft	$300		$0.00		
115kV Substation Switchgear Bldg	Sq Ft	$1,032		$0.00		
115kV Substation HV Equip. Structure	Ea	$300,000		$0.00		
Concrete Equipment Pad	Ea	$7,500	2	$15,000.00	Engineer Judgement/RSMeans	
Substation Bus Connection	Ea	$45,000		$0.00		
Gang Switch 115kV	Ea	$105,000	2	$210,000.00	RSMeans	
34.5kV Switchgear	Bay	$120,000				

Total Construction Materials and Labor **$2,470,000.00**

Contingencies 10% **$247,000.00**

TOTAL **$2,717,000.00**

Project Description: **New Orote Substation with 112MVA Power Transformer** **Project List: B (4)**

Description	Unit	Unit Cost	Quantity	Cost	References	Remarks
336 ACSR Conductor	WMile	$37,800		$0.00		
1/0 ACSR Ground Wire	WMile	$37,800		$0.00		
Conductor Pulley Setups	Mile	$600		$0.00		
Pulling Conductors	WMile	$9,600		$0.00		
Insulators 34.5kV	Ea	$270		$0.00		
Insulators 115kV	Ea	$300		$0.00		
Concrete Pole w/ Crossarm	Ea	$60,000		$0.00		
Circuit Breaker 115kV, Gas, Outdoor	Ea	$943,500	1	$943,500.00	RSMeans	
Circuit Breaker 34.5kV, Outdoor	Ea	$153,000		$0.00		
112 MVA Station Type Transformer	MVA	$48,000	112	$5,376,000.00	RSMeans	
115kV Substation Gravel Base	Cu Yd	$156	50	$7,800.00	Enigineer Judgement	
115kV Substation Grounding	Sq Ft	$60	43,560	$2,613,600.00	Enigineer Judgement	
115kV Substation Fence	Ln Ft	$300	833	$249,900.00	Enigineer Judgement	
115kV Substation Switchgear Bldg	Sq Ft	$1,032	800	$825,600.00	Enigineer Judgement	Land Provided by DOD
115kV Substation HV Equip. Structure	Ea	$300,000	1	$300,000.00	Enigineer Judgement	
Concrete Equipment Pad	Ea	$7,500	2	$15,000.00	Engineer Judgement/RSMeans	
Substation Bus Connection	Ea	$45,000	1	$45,000.00	Engineer Judgement/RSMeans	
Gang Switch 115kV	Ea	$105,000		$0.00		
34.5 kV Switchgear	Bay	$120,000	6	$720,000.00	Engineer Judgement/RSMeans	

Total Construction Materials and Labor	**$11,100,000.00**
Contingencies 10%	**$1,110,000.00**
TOTAL	**$12,210,000.00**

Project Description: **Upgrade Harmon X87 to Andersen X73 115kV Line** **Project List: B (5)**

Description	Unit	Unit Cost	Quantity	Cost	References	Remarks
336 ACSR Conductor	WMile	$37,800	40.6	$1,534,680.00	RSMeans	Includes cable sag length factor .01
1/0 ACSR Ground Wire	WMile	$37,800	5.1	$192,780.00	RSMeans	Includes cable sag length factor .01
Conductor Pulley Setups	Mile	$600	53	$31,800.00	RSMeans	Length/pole spc x 2
Pulling Conductors	WMile	$9,600	40.6	$389,760.00	RSMeans	
Insulators 34.5kV	Ea	$270		$0.00		
Insulators 115kV	Ea	$300	265	$79,500.00	RSMeans	
Concrete Pole w/ Crossarm	Ea	$60,000		$0.00		
Circuit Breaker 115kV, Gas, Outdoor	Ea	$943,500	2	$1,887,000.00	RSMeans	
Circuit Breaker 34.5kV, Outdoor	Ea	$153,000		$0.00		
112 MVA Station Type Transformer	MVA	$48,000		$0.00		
115kV Substation Gravel Base	Cu Yd	$156		$0.00		
115kV Substation Grounding	Sq Ft	$60		$0.00		
115kV Substation Fence	Ln Ft	$300		$0.00		
115kV Substation Switchgear Bldg	Sq Ft	$1,032		$0.00		
115kV Substation HV Equip. Structure	Ea	$300,000		$0.00		
Concrete Equipment Pad	Ea	$7,500	2	$15,000.00	Engineer Judgement/RSMeans	
Substation Bus Connection	Ea	$45,000	2	$90,000.00	Engineer Judgement/RSMeans	
Gang Switch 115kV	Ea	$105,000		$0.00		
		$120,000				

Total Construction Materials and Labor	**$4,220,000.00**
Contingencies 10%	**$422,000.00**
TOTAL	**$4,642,000.00**

Project Description: **New Piti X20 to Orote X35 115kV Line** **Project List: B (6)**

Description	Unit	Unit Cost	Quantity	Cost	References	Remarks
336 ACSR Conductor	WMile	$37,800	10.1	$381,780.00	RSMeans	Includes cable sag length factor .01
1/0 ACSR Ground Wire	WMile	$37,800	2.5	$94,500.00	RSMeans	Includes cable sag length factor .01
Conductor Pulley Setups	Mile	$600	27	$16,200.00	RSMeans	Length/pole spc x 2
Pulling Conductors	WMile	$9,600	10.1	$96,960.00	RSMeans	
Insulators 34.5kV	Ea	$270		$0.00		
Insulators 115kV	Ea	$300	135	$40,500.00	RSMeans	
Concrete Pole w/ Crossarm	Ea	$60,000	27	$1,620,000.00	Engineer Judgement/RSMeans	
Circuit Breaker 115kV, Gas, Outdoor	Ea	$943,500	2	$1,887,000.00	RSMeans	
Circuit Breaker 34.5kV, Outdoor	Ea	$153,000		$0.00		
112 MVA Station Type Transformer	MVA	$48,000		$0.00		
115kV Substation Gravel Base	Cu Yd	$156		$0.00		
115kV Substation Grounding	Sq Ft	$60		$0.00		
115kV Substation Fence	Ln Ft	$300		$0.00		
115kV Substation Switchgear Bldg	Sq Ft	$1,032		$0.00		
115kV Substation HV Equip. Structure	Ea	$300,000		$0.00		
Concrete Equipment Pad	Ea	$7,500	2	$15,000.00	Engineer Judgement/RSMeans	
Substation Bus Connection	Ea	$45,000	2	$90,000.00	Engineer Judgement/RSMeans	
Gang Switch 115kV	Ea	$105,000		$0.00		
Connection at Intermediate Substat	Ea	$120,000	2	$240,000.00	Engineer Judgement/RSMeans	

Total Construction Materials and Labor **$4,480,000.00**

Contingencies 10% **$448,000.00**

TOTAL **$4,928,000.00**

Project Description: **New Capacitor Bank at Orote Substation 13.8kV** **Project List: B (7)**

Description	Unit	Unit Cost	Quantity	Cost	References	Remarks
Capacitor Bank	Mvars	$21,975	24	$527,400.00	RSMeans	
Concrete Equipment Pad	LS	$7,500	1	$7,500.00	Engineer Judgement/RSMeans	
Outdoor Air Circuit Breaker 13.8 kV	Ea	$160,275	1	$160,275.00	RSMeans	

Total Construction Materials and Labor **$700,000.00**

Contingencies 10% **$70,000.00**

TOTAL **$770,000.00**

Project Description: **New Capacitor Bank at SRF Substation 13.8kV** **Project List: B (8)**

Description	Unit	Unit Cost	Quantity	Cost	References	Remarks
Capacitor Bank	Mvars	$21,975	3	$65,925.00	RSMeans	
Concrete Equipment Pad	LS	$7,500	1	$7,500.00	engineer Judgement/RSMeans	
Outdoor Air Circuit Breaker 13.8 kV	Ea	$160,275	1	$160,275.00	RSMeans	

Total Construction Materials and Labor **$230,000.00**

Contingencies 10% **$23,000.00**

TOTAL **$253,000.00**

Project Description: **New Capacitor Bank at Andersen Substation 13.8kV** **Project List: B (9)**

Description	Unit	Unit Cost	Quantity	Cost	References	Remarks
Capacitor Bank	Mvars	$21,975	24	$527,400.00	RSMeans	
Concrete Equipment Pad	LS	$7,500	1	$7,500.00	Engineer Judgement/RSMeans	
Outdoor Air Circuit Breaker 13.8 kV	Ea	$160,275	1	$160,275.00	RSMeans	

Total Construction Materials and Labor **$700,000.00**

Contingencies 10% **$70,000.00**

TOTAL **$770,000.00**

Project Description: **New Capacitor Bank at NCS Substation 13.8kV** **Project List: B (10)**

Description	Unit	Unit Cost	Quantity	Cost	References	Remarks
Capacitor Bank	Mvars	$21,975	18	$395,550.00	RSMeans	
Concrete Equipment Pad	LS	$7,500	1	$7,500.00	Engineer Judgement/RSMeans	
Outdoor Air Circuit Breaker 13.8 kV	Ea	$160,275	1	$160,275.00	RSMeans	

Total Construction Materials and Labor **$560,000.00**

Contingencies 10% **$56,000.00**

TOTAL **$616,000.00**

Ocean Thermal Energy Conversion

Electricity Generation			Construction/Operating Cost		
Nominal Size	50	MW	Initial Cost Low	10000	$/kW
Availability Factor	90	%	Initial Cost High	15000	$/kW
Operating Days	365	days	Operating Cost Low	0.02	$/kWh
Operaating Time	24	hrs/day	Operating Cost High	0.03	$/kWh
Design Life	20	yrs			
Electricity Generated	394,200,000	kWh/yr	Total Cost Low	$500,000,000	initial cost
			Total Cost High	$750,000,000	initial cost
Cost/kWh					
Interest Rate	7	%			
Cost/kWh - Low	**$0.12**	**/kwh**	**no O & M cost**		
Cost/kWh - High	**$0.18**	**/kwh**	**no O & M cost**		
Cost/kWh - Low	$0.14	/kwh	with O & M cost		
Cost/kWh - High	$0.21	/kwh	with O & M cost		

Resources

http://www.nrel.gov/otec/markets.html

Guam Power Authority. A Technical and Economic Feasibility Assessment of a Deep Sea Water District Cooling System at Tumon Bay, Guam. January 2006

Wind Farm

Electricity Generation			Construction/Operating Cost			113880000
Nominal Size	50	MW	Initial Cost Low	3000	$/kW	
Capacity Factor	26	%	Initial Cost High	3000	$/kW	
Operating Days	365	days	Operating Cost Low	0.02	$/kWh	
Operaating Time	24	hrs/day	Operating Cost High	0.03	$/kWh	
Design Life	20	yrs				
Electricity Generated	61,200,000	kWh/yr	Total Cost Low	$150,000,000	initial cost	
			Total Cost High	$150,000,000	initial cost	
Cost/kWh						
Interest Rate	7	%				
Cost/kWh - Low	**$0.23**	**/kwh**	**no O & M cost**			
Cost/kWh - High	$0.23	/kwh	no O & M cost			
Cost/kWh - Low	$0.25	/kwh	with O & M cost			
Cost/kWh - High	$0.26	/kwh	with O & M cost			

Resources

Lawrence Berkely National Laboratory. Annual Report on U.S. Wind Power Installation, Cost and Performance Trends: 2006.
GE Energy http://www.gepower.com/prod_serv/products/wind_turbines/en/index.htm

Photovoltaics

Electricity Generation			Construction/Operating Cost			
Solar Insolation	5.88	kWh/m^2/Day	Initial Cost Low	8000	$/kW	145158672
Area	5,000,000	ft^2	Initial Cost High	8000	$/kW	
Operating Days	365	days	Operating Cost Low	0	$/kWh	
Efficiency	15	%	Operating Cost High	0	$/kWh	
Design Life	25	yrs				
Electricity Generated	76,549,474	kWh/yr	Total Cost Low	$400,000,000	initial cost	
			Total Cost High	$400,000,000	initial cost	

Cost/kWh			
Interest Rate	7	%	
Cost/kWh - Low	**$0.45**	**/kwh**	**no O & M cost**
Cost/kWh - High	$0.45	/kwh	no O & M cost
Cost/kWh - Low	$0.45	/kwh	with O & M cost
Cost/kWh - High	$0.45	/kwh	with O & M cost

Biodiesel

Electricity Generation			Construction/Operating Cost		
Nominal Size	50	MW	Initial Cost Low	1500	$/kW
Availability Factor	90	%	Initial Cost High	3000	$/kW
Operating Days	365	days	Operating Cost Low	0.15	$/kWh
Operaating Time	24	hrs/day	Operating Cost High	0.18	$/kWh
Design Life	20	yrs			
Electricity Generated	394,200,000	kWh/yr	Total Cost Low	$75,000,000	initial cost
			Total Cost High	$150,000,000	initial cost

Cost/kWh			
Interest Rate	7	%	
Cost/kWh - Low	$0.02	/kwh	no O & M cost
Cost/kWh - High	$0.04	/kwh	no O & M cost
Cost/kWh - Low	**$0.17**	**/kwh**	**with O & M cost**
Cost/kWh - High	**$0.22**	**/kwh**	**with O & M cost**

Waste to Energy - Biomass

Electricity Generation			Construction/Operating Cost		
Nominal Size	50	MW	Initial Cost Low	3000	$/kW
Availability Factor	90	%	Initial Cost High	5500	$/kW
Operating Days	365	days	Operating Cost Low	0.15	$/kWh
Operaating Time	24	hrs/day	Operating Cost High	0.18	$/kWh
Design Life	20	yrs			
Electricity Generated	394,200,000	kWh/yr	Total Cost Low	$150,000,000	initial cost
			Total Cost High	$275,000,000	initial cost

Cost/kWh			
Interest Rate	7	%	
Cost/kWh - Low	$0.04	/kwh	no O & M cost
Cost/kWh - High	$0.07	/kwh	no O & M cost
Cost/kWh - Low	**$0.19**	**/kwh**	**with O & M cost**
Cost/kWh - High	**$0.25**	**/kwh**	**with O & M cost**

Area Required			
Ethanol Production			
Sorghum - Low	172	gallons/acre	http://www.seco.cpa.state.tx.us/re_biomass-crops.htm
Sugarcane - High	500	gallons/acre	
Energy Content of Ethanol	84000	Btu/gallon	http://bioenergy.ornl.gov/papers/misc/energy_conv.html
	24.61177849	kWh/gallon	
Efficiecny	40	%	
For a 50-MW Plant	40041803.57	gallons/yr	
Area Required Low	80,084	acres	
Area Required High	232,801	acres	

Waste to Energy - Conversion

Electricity Generation			Construction/Operating Cost		
Nominal Size	50	MW	Initial Cost Low	3500	$/kW
Availability Factor	90	%	Initial Cost High	3500	$/kW
Operating Days	365	days	Operating Cost Low	0.15	$/kWh
Operaating Time	24	hrs/day	Operating Cost High	0.18	$/kWh
Design Life	20	yrs			
Electricity Generated	394,200,000	kWh/yr	Total Cost Low	$175,000,000	initial cost
			Total Cost High	$175,000,000	initial cost

Cost/kWh			
Interest Rate	7	%	
Cost/kWh - Low	$0.04	/kwh	no O & M cost
Cost/kWh - High	$0.04	/kwh	no O & M cost
Cost/kWh - Low	**$0.19**	**/kwh**	**with O & M cost**
Cost/kWh - High	**$0.22**	**/kwh**	**with O & M cost**

Geothermal

Electricity Generation			Construction/Operating Cost			
Nominal Size	50	MW	Initial Cost Low		2000	$/kW
Availability Factor	90	%	Initial Cost High	N/A		$/kW
Operating Days	365	days	Operating Cost Low		0	$/kWh
Operaating Time	24	hrs/day	Operating Cost High		0	$/kWh
Design Life	20	yrs				
Electricity Generated	394,200,000	kWh/yr	Total Cost Low		$100,000,000	initial cost
			Total Cost High	N/A		initial cost
Cost/kWh						
Interest Rate	7	%				
Cost/kWh - Low	$0.02	/kwh	no O & M cost			
Cost/kWh - High	N/A	/kwh	no O & M cost			

Solar Thermal Electric

Electricity Generation			Construction/Operating Cost			96772448
Solar Insolation	5.88	kWh/m^2/Day	Initial Cost Low	5000	$/kW	
Area	5,000,000	ft^2	Initial Cost High	5000	$/kW	
Operating Days	365	days	Operating Cost Low	0	$/kWh	
Efficiency	15	%	Operating Cost High	0	$/kWh	
Design Life	20	yrs				
Electricity Generated	76,549,474	kWh/yr	Total Cost Low	$250,000,000	initial cost	
			Total Cost High	$250,000,000	initial cost	
Cost/kWh						
Interest Rate	7	%				
Cost/kWh - Low	**$0.31**	**/kwh**	**no O & M cost**			
Cost/kWh - High	$0.31	/kwh	no O & M cost			
Cost/kWh - Low	$0.31	/kwh	with O & M cost			
Cost/kWh - High	$0.31	/kwh	with O & M cost			

Resources

U.S. Department of Energy Energy Efficiency and Renewable Energy. Parabolic Trough Solar thermal Electric Power Plants. July 2006

Wave Energy

Electricity Generation			Construction/Operating Cost		
Nominal Size	50	MW	Initial Cost Low	3000	$/kW
Availability Factor	40	%	Initial Cost High	4000	$/kW
Operating Days	365	days			
Operaating Time	24	hrs/day			
Design Life	20	yrs			
Electricity Generated	175,200,000	kWh/yr	Total Cost Low	$150,000,000	initial cost
			Total Cost High	$200,000,000	initial cost
Cost/kWh					
Interest Rate	7	%			
Cost/kWh - Low	$0.08	/kwh	no O & M cost		
Cost/kWh - High	$0.11	/kwh	no O & M cost		

ENRON PLANT

CABRAS PLANT

3mVARS CAPACITOR BANK ON 13.8kV LINE AT SRF

TEMES PLANT

HARMON SUBSTATION

PROTEUS POINT

YFP-10 SUBSTATION

A (UPGRADE DOUBLE CIRCUIT)

TANGUISSON PLANT

PITI 115kV GIS

A (UPGRADE)

DEDEDO CT

COLD STORAGE

VICTOR DOCKS

PITI SUBSTATION

18mVARS CAPACITOR BANK ON 13.8kV LINE

NCS FINEGAYAN

A (UPGRADE)

POTTS JUNCTION

A (UPGRADE)

A (UPGRADE DOUBLE CIRCUIT)

DEDEDO SUBSTATION

MACHECHE SUBSTATION

OROTE PLANT

A 24mVARS ON 13.8kV LINE

ANIGUA SUBSTATION

UMATAC SUBSTATION

PAGAT SUBSTATION

APRA HEIGHTS SUBSTATION

TUMON SUBSTATION

TENJO SUBSTATION

SAN VITORES SUBSTATION

MARBO SUBSTATION

TALOFOFO SUBSTATION

AGANA SUBSTATION

TAMUNING SUBSTATION

A (UPGRADE)

YIGO SUBSTATION

GAA SUBSTATION

GIAT SWITCHING STATION

ANDERSEN SUBSTATION

24mVARS CAPACITOR BANK ON 13.8kV LINE

UPGRADED YR04-06

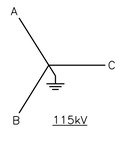
PULANTAT SUBSTATION

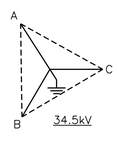
BARRIGADA SUBSTATION

RADIO BARRIGADA

LEGEND

- 115kV (NEW)
- 115kV (EXISTING)
- 34.5kV OH (NEW)
- 34.5kV OH (EXISTING)
- 34.5kV UG (NEW)
- 34.5kV UG (EXISTING)
- FUTURE OR UNDER CONSTRUCTION (NEW)
- FUTURE OR UNDER CONSTRUCTION (EXISTING)
- DISCONNECT NORMALLY CLOSED (NEW)
- DISCONNECT NORMALLY CLOSED (EXISTING)
- DISCONNECT NORMALLY OPEN (NEW)
- DISCONNECT NORMALLY OPEN (EXISTING)
- GANG DISCONNECT (NEW)
- GANG DISCONNECT (EXISTING)
- CIRCUIT SWITCHER (NEW)
- CIRCUIT SWITCHER (EXISTING)
- DRAW-OUT TYPE CIRCUIT BREAKER (NEW)
- DRAW-OUT TYPE CIRCUIT BREAKER (EXISTING)
- OUTDOOR TYPE CIRCUIT BREAKER (NEW)
- OUTDOOR TYPE CIRCUIT BREAKER (EXISTING)
- POWER LINE CARRIER (NEW)
- POWER LINE CARRIER (EXISTING)





SYSTEM PHASING

EarthTech
A Tyco International Ltd. Company

FIGURE A

ANTICIPATED GPA IMPROVEMENTS TO MEET MILITARY LOAD INCREASES 34.5kV TRANSMISSION ONE-LINE DIAGRAM

102079

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B
3mVARS
CAPACITOR BANK
ON 13.8kV LINE
AT SRF

CABRAS PLANT

ENRON PLANT

TEMES PLANT

HARMON
SUBSTATION

PROTEUS
POINT

YFP-10
SUBSTATION

PITI 115kV GIS

TANGUISSON PLANT

COLD
STORAGE

VICTOR
DOCKS

PITI
SUBSTATION

DEDEDO CT

B
24mVARS
CAPACITOR BANK
ON 13.8kV LINE

NCS FINEGAYAN

POTTS
JUNCTION

B
(UPGRADE
TO 115kV)

DEDEDO
SUBSTATION

MACHECHE
SUBSTATION

B
(NEW 115kV)

OROTE
PLANT

ANIGUA
SUBSTATION

B
24mVARS
CAPACITOR BANK
ON 13.8kV LINE

UMATAC
SUBSTATION

B
112mVA
115kV
NEW SUBSTATION

TUMON
SUBSTATION

PAGAT
SUBSTATION

APRA HEIGHTS
SUBSTATION

TENJO
SUBSTATION

SAN VITORES
SUBSTATION

MARBO
SUBSTATION

TALOFOFO
SUBSTATION

AGANA
SUBSTATION

TAMUNING
SUBSTATION

B
(UPGRADE
TO 115kV)

YIGO
SUBSTATION

B
(NEW 115kV)

GAA
SUBSTATION

GIAT
SWITCHING
STATION

ANDERSEN
SUBSTATION

B
112mVA
115kV
NEW SUBSTATION

B
24mVARS
CAPACITOR BANK
ON 13.8kV LINE

UPGRADED
YR04-06

PULANTAT
SUBSTATION

BARRIGADA
SUBSTATION

RADIO
BARRIGADA

LEGEND

- 115kV (NEW)
- 115kV (EXISTING)
- 34.5kV OH (NEW)
- 34.5kV OH (EXISTING)
- 34.5kV UG (NEW)
- 34.5kV UG (EXISTING)
- FUTURE OR UNDER CONSTRUCTION (NEW)
- FUTURE OR UNDER CONSTRUCTION (EXISTING)
- DISCONNECT NORMALLY CLOSED (NEW)
- DISCONNECT NORMALLY CLOSED (EXISTING)
- DISCONNECT NORMALLY OPEN (NEW)
- DISCONNECT NORMALLY OPEN (EXISTING)
- GANG DISCONNECT (NEW)
- GANG DISCONNECT (EXISTING)
- CIRCUIT SWITCHER (NEW)
- CIRCUIT SWITCHER (EXISTING)
- DRAW-OUT TYPE CIRCUIT BREAKER (NEW)
- DRAW-OUT TYPE CIRCUIT BREAKER (EXISTING)
- OUTDOOR TYPE CIRCUIT BREAKER (NEW)
- OUTDOOR TYPE CIRCUIT BREAKER (EXISTING)
- POWER LINE CARRIER (NEW)
- POWER LINE CARRIER (EXISTING)

A B C 115kV

A B C 34.5kV

SYSTEM PHASING

EarthTech
A Tyco International Ltd. Company

FIGURE B

ANTICIPATED GPA IMPROVEMENTS TO MEET MILITARY LOAD INCREASES 115kV TRANSMISSION ONE-LINE DIAGRAM

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Appendix K – Projected CT Operating Hours

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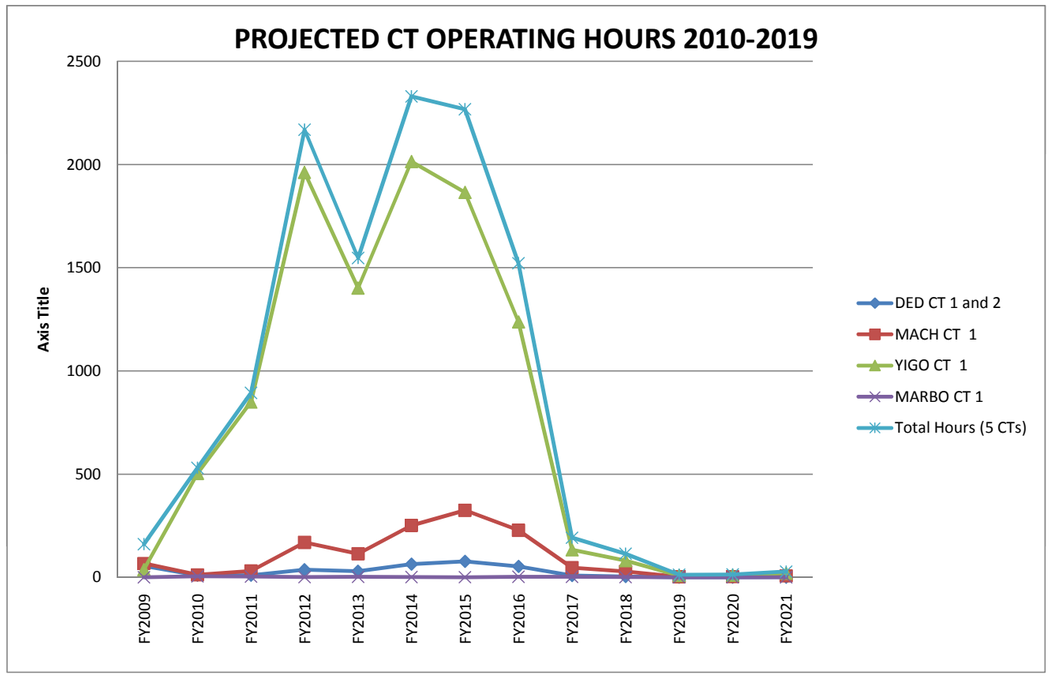
Historical CT operation

Location	2003	2004	2005	2006	2007	2008	2009	average	Capacity (hrs or gallons)
Dededo 1	0	1413	59	105	192	93.63	100.61	392.648	7760 at full load 1000 at 50 percent load
Dededo 2	2492	399	0	0	0	0	0	578.2	7760 at full load 1000 at 50 percent load
Yigo	1363245	391320	333057	0	0	0	65.18		4280 at full load
Macheche	0	1639	285	160	584	164.92	112.59	533.6	4280 at full load
Marbo	7690 gallor	7067	0	0	0	0	0	1413.4	2654 at full load (cannot operate below 50 percent load)

Data from GPA document identified as "PICES PUC B9-4 RUN Generation Fuel Summary (ALL) V1.xls"

unit	Permit hrs
DED CT 1 and 2	7760
MACH CT 1	4280
YIGO CT 1	4280
MARBO CT 1	2654
Total Hours (5 CTs)	

FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017	FY2018	FY2019	FY2020	FY2021
55.8	10.04615	9.947856	36.83296	29.34547	64.00659	77.50387	53.21771	8.81772	4.336549	0.433367	0.592513	0.961471
66.9	11.89322	30.47286	169.2461	113.5417	251.3201	324.3237	228.2423	46.81547	27.8616	2.984821	3.338258	7.009081
37.6	503.5419	849.1601	1961.609	1401.38	2013.909	1864.665	1237.533	133.9078	81.54905	9.276812	9.945924	19.86457
0	4.517222	3.719631	0.869603	2.958599	0.97495	0.796327	2.652858	2.196718	0.860896	0.002273	0.005494	0.017016
160	529.9985	893.3005	2168.558	1547.226	2330.21	2267.288	1521.646	191.7377	114.6081	12.69727	13.88219	27.85214



README for File: ***PICES PUC B9-4 RUN Generation & Fuel Summary (ALL).xls)***

GPA completed a reliability analysis in 2009 which identified a Reserve Margin minimal requirement of 54.4% to comply with Loss of Load

1. **Summary** - *Summarizes generation output and permit compliance from 2010 thru 2021 from the modified planning software model. It includes projected operating hours, fuel consumption, and unit capacity factors.*
2. **Reserve Margin** - *Analyzes resource plans between IRP model and the PICES PUC model.*
3. **PIVOT TABLE** - *formats strategist output data found in RUN DATA used for the SUMMARY report.*
4. **Limits** - *Summarizes operating permit restrictions for GPA units based on 2009 issued permits.*
5. **FY09 Actual** - *Contains actual generation production data for FY 2009 provided by Generation Division.*
6. **Run Data** - *PICES PUC B9-4 output data.*
7. **Lookup Table** - *Miscellaneous information used in categorizing or converting Run Data.*

GENERAL NOTES:

a. Base 9-4 is the strategist model used for the GPA 2008 Integrated Resource Plan. PICES PUC B9-4 is a modified version of the IRP model restricting addition of any new units thru year 2014, excludes the GSWAC transaction (DSM program equivalent to 92 GWH per year), and adjusts the Reserve Margin minimal requirements from 50% to 54.5% which complies with a Loss of Load Expectation (LOLE) reliability standard of 1 in 4.5 years.

b. Other references for the PICES PUC Model which evaluate LOLE of 1day per 4.5 years can be found in the following files.

Excel File: Reliability Analysis (Aug09) 083109.xls
PICES INP File: FY2009_PUCstd_083109.inp

c. Environmental Limits was provided by P&R on 8/14/09 (reflect 2009 permits, expiring 2014)

d. Installed Capacity is the sum of the Nameplate Rating capacities of Generation Resources, including new units, however it only accounts for 12% of WIND (as renewable proxy) which is 4.8 MW for each new wind farm.

e. Plant operational hours are calculated assuming loading is at 100%, using NP Rating, and forecasted generation.

f. Heat content for RFO is 6.1 MBTU/BBL for Low Sulfur and 6.15 MBTU/BBL for High Sulfur. For summary analysis 6.10 MBTU/BBL is used for calculating fuel consumption by BBL for RFO from MBTU.

g. Heat content for DSL is 5.78 MBTU/BBL which is used to calculate DSL consumption in BBLs from MBTU.

h. Capacity Factor is based on NP rating from IWPS Reports with the exception of WIND. WIND capacity factor is based on 4.8MW firm capacity.

jgs/February 18, 2010

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Appendix K – PICES PUC B9-4 RUN Generation & Fuel Summary

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README for File: ***PICES PUC B9-4 RUN Generation & Fuel Summary (ALL).xls)***

GPA completed a reliability analysis in 2009 which identified a Reserve Margin minimal requirement of 54.4% to comply with Loss of Load Expection reliability standard of 1 in 4.5 years. The Reserve Margin requirement was modeled into GPA's resource planning software (Strategist) to determine impacts on resource planning as compared to the GPA 2008 Integrated Resource Plan to satisfy Military Buildup concerns. This file contains several reports and information necessary to complete the evaluation of reliability standards and impact on generation resource planning and use. General notes regarding data and resources used in this report are provided below. This file includes the following:

1. **Summary** - *Summarizes generation output and permit compliance from 2010 thru 2021 from the modified planning software model. It includes projected operating hours, fuel consumption, and unit capacity factors.*
2. **Reserve Margin** - *Analyzes resource plans between IRP model and the PICES PUC model.*
3. **PIVOT TABLE** - *formats strategist output data found in RUN DATA used for the SUMMARY report.*
4. **Limits** - *Summarizes operating permit restrictions for GPA units based on 2009 issued permits.*
5. **FY09 Actual** - *Contains actual generation production data for FY 2009 provided by Generation Division.*
6. **Run Data** - *PICES PUC B9-4 output data.*
7. **Lookup Table** - *Miscellaneous information used in categorizing or converting Run Data.*

GENERAL NOTES:

a. Base 9-4 is the strategist model used for the GPA 2008 Integrated Resource Plan. PICES PUC B9-4 is a modified version of the IRP model restricting addition of any new units thru year 2014, excludes the GSWAC transaction (DSM program equivalent to 92 GWH per year), and adjusts the Reserve Margin minimal requirements from 50% to 54.5% which complies with a Loss of Load Expectation (LOLE) reliability standard of 1 in 4.5 years.

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e. Plant operational hours are calculated assuming loading is at 100%, using NP Rating, and forecasted generation.

f. Heat content for RFO is 6.1 MBTU/BBL for Low Sulfur and 6.15 MBTU/BBL for High Sulfur. For summary analysis 6.10 MBTU/BBL is used for calculating fuel consumption by BBL for RFO from MBTU.

g. Heat content for DSL is 5.78 MBTU/BBL which is used to calculate DSL consumption in BBLs from MBTU.

h. Capacity Factor is based on NP rating from IWPS Reports with the exception of WIND. WIND capacity factor is based on 4.8MW firm capacity.

jgs/February 18, 2010

Summary of Strategist Modeling Output using Reserve Margin based on Planning Criteria of 1day/4.5 years LOLE[1,2]

		Actual												
		FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017	FY2018	FY2019	FY2020	FY2021
PEAK DEMAND	MW	268.00	283.34	294.76	304.69	316.72	324.86	331.80	340.61	348.05	357.11	364.66	373.93	383.26
INSTALLED CAPACITY[3]	MW	552.80	552.80	552.80	552.80	552.80	552.80	557.60	572.40	577.20	642.00	646.80	646.80	646.80

OPERATING HOURS[4] (Based on NP Rating - 100% Loading)

Fuel Type	PLANT	ANNUAL LIMITS[5]	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017	FY2018	FY2019	FY2020	FY2021
RFO	CAB 12		8,491	10,267	10,638	9,352	11,293	11,196	11,669	11,322	11,078	10,431	8,067	8,057	8,143
	TANGO 12		5,138	3,310	3,770	5,053	4,586	5,021	4,936	4,261	2,600	1,919	649	496	714
	CAB 34		12,626	11,099	11,198	11,799	11,503	11,830	11,785	11,794	11,793	11,459	10,670	10,688	10,790
	MEC 89		14,288	15,273	15,297	15,089	15,306	15,306	15,306	15,308	15,162	14,852	12,774	12,712	13,090
DSL	TEMES 1	6273	165	778	958	1,369	1,197	1,319	1,310	855	-	-	-	-	-
	DED CT 12	7760	56	10	10	37	29	64	78	53	9	4	0	1	1
	MACH CT 1	4280	67	12	30	169	114	251	324	228	47	28	3	3	7
	YIGO CT 1	4280	38	504	849	1,962	1,401	2,014	1,865	1,238	134	82	9	10	20
	MARBO CT 1	2654	-	5	4	1	3	1	1	3	2	1	0	0	0
	TENJO DSL 1-6		3,797	9,677	14,044	26,300	22,449	26,070	25,872	19,081	4,402	2,784	415	376	668
	TAL DSL 12	4640	263	3,891	4,850	5,171	5,168	5,156	5,154	5,107	2,626	1,798	297	256	429
	MDI DSL 12		299	48	166	3,304	3,188	3,441	3,416	3,007	503	302	38	39	75
	DED DSL 1-4		45	18	15	3	12	4	3	11	-	-	-	-	-
	OROTE 1			-	-	-	-	-	-	-	-	-	-	-	-
	RETR 99			-	-	-	-	-	-	924	3,730	3,033	1,470	1,168	1,488
LNG	CLNG 96			-	-	-	-	-	-	-	-	1,541	7,837	7,827	7,827
WIND	WIND 100			-	-	-	-	-	5,083	21,523	21,463	21,441	21,257	21,176	21,208
	WIND 98			-	-	-	-	-	-	5,083	21,463	21,459	21,410	21,404	21,381
	WIND 97			-	-	-	-	-	-	-	5,083	21,463	21,460	21,505	21,453
	WIND 95			-	-	-	-	-	-	-	-	5,083	21,463	21,523	21,463
	WIND 94			-	-	-	-	-	-	-	-	-	5,083	21,523	21,463

Summary of Strategist Modeling Output using Reserve Margin based on Planning Criteria of 1day/4.5 years LOLE[1,2]

		Actual												
		FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017	FY2018	FY2019	FY2020	FY2021
PEAK DEMAND	MW	268.00	283.34	294.76	304.69	316.72	324.86	331.80	340.61	348.05	357.11	364.66	373.93	383.26
INSTALLED CAPACITY[3]	MW	552.80	552.80	552.80	552.80	552.80	552.80	557.60	572.40	577.20	642.00	646.80	646.80	646.80

TOTAL FUEL CONSUMED (BBL)[6,7]

Fuel Type	PLANT	ANNUAL LIMITS[5]	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017	FY2018	FY2019	FY2020	FY2021
RFO	CAB 12		1,027,539	1,181,069.82	1,218,616.76	1,064,079.71	1,285,225.17	1,270,621.56	1,324,922.20	1,289,621.42	1,264,048.33	1,198,502.26	958,322.71	962,933.69	965,892.19
	TANGO 12		294,558	216,770.33	246,776.58	329,749.69	299,715.54	327,254.59	321,668.76	278,171.54	170,354.95	125,727.62	42,536.78	32,522.59	46,764.28
	CAB 34		661,989	613,552.37	619,885.57	658,102.41	639,430.77	660,413.78	657,601.50	657,864.45	658,185.67	637,952.26	595,113.19	596,105.78	601,178.62
	MEC 89		848,133	931,481.01	932,943.02	920,384.66	933,448.03	933,492.85	933,476.60	933,641.34	924,979.63	906,944.56	787,565.88	784,932.08	806,225.43
DSL	TEMES 1	532,458	16,013	89,266.45	109,977.39	157,353.59	137,481.90	151,636.31	150,598.01	98,137.19	-	-	-	-	-
	DED CT 12		3,649	522.69	535.87	2,295.37	1,773.38	3,993.64	4,842.83	3,275.73	502.08	251.35	27.12	36.95	59.15
	MACH CT 1	170,000	3,090	462.91	1,227.24	6,763.10	4,543.99	10,025.29	13,006.27	9,219.64	1,938.44	1,154.50	123.57	137.55	290.40
	YIGO CT 1	170,000	1,637	20,928.74	35,302.86	81,250.03	58,068.81	83,206.68	76,916.76	51,093.05	5,554.89	3,383.12	384.50	411.85	823.68
	MARBO CT 1	113,333	0	183.57	151.16	35.34	120.24	39.64	32.46	108.09	89.41	35.22	0.12	0.28	0.85
	TENJO DSL 1-6		31,355	68,041.34	98,743.45	184,916.77	157,840.78	183,299.54	181,901.85	134,158.97	30,949.45	19,572.72	2,918.81	2,642.41	4,700.12
	TAL DSL 12	35,258	1,956	26,467.47	32,991.99	35,172.12	35,150.77	35,075.41	35,059.78	34,736.47	17,860.51	12,230.01	2,021.23	1,741.13	2,915.14
	MDI DSL 12	31,084	1,956	430.55	1,487.74	29,670.44	28,626.99	30,899.42	30,675.27	27,003.51	4,515.94	2,710.30	340.02	347.31	671.21
	DED DSL 1-4		212	107.48	89.36	20.43	70.22	23.64	20.37	64.94	-	-	-	-	-
	OROTE 1			-	-	-	-	-	-	-	-	-	-	-	-
	RETR 99			-	-	-	-	-	-	81,038.14	327,647.64	266,418.58	129,180.37	102,627.33	130,759.85
LNG	CLNG 96			-	-	-	-	-	-	-	-	744,559.20	3,789,278.32	3,786,360.60	3,784,996.58
WIND	WIND 100			-	-	-	-	-	24,399.36	103,311.36	103,023.36	102,917.32	102,033.09	101,645.34	101,800.00
	WIND 98			-	-	-	-	-	-	24,399.36	103,023.36	103,005.55	102,766.43	102,740.68	102,630.44
	WIND 97			-	-	-	-	-	-	-	24,399.36	103,023.36	103,008.93	103,222.39	102,974.59
	WIND 95			-	-	-	-	-	-	-	-	24,399.36	103,023.36	103,311.36	103,022.69
	WIND 94			-	-	-	-	-	-	-	-	-	24,399.36	103,311.36	103,023.36

Summary of Strategist Modeling Output using Reserve Margin based on Planning Criteria of 1day/4.5 years LOLE[1,2]

		Actual												
		FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017	FY2018	FY2019	FY2020	FY2021
PEAK DEMAND	MW	268.00	283.34	294.76	304.69	316.72	324.86	331.80	340.61	348.05	357.11	364.66	373.93	383.26
INSTALLED CAPACITY[3]	MW	552.80	552.80	552.80	552.80	552.80	552.80	557.60	572.40	577.20	642.00	646.80	646.80	646.80

CAPACITY FACTOR (%)[8]

Fuel Type	UNIT	NP Rating	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017	FY2018	FY2019	FY2020	FY2021
RFO	CAB ST 1	66	56.37	57.04	58.83	51.71	61.72	58.39	63.69	61.93	60.46	57.24	48.12	46.26	44.83
	CAB ST 2	66	40.56	60.17	62.62	55.05	67.19	69.43	69.52	67.31	66.00	61.83	43.97	45.72	48.13
	TANGO 1	26.5	26.74	17.64	20.24	28.13	25.21	27.89	27.44	23.34	13.73	9.90	2.86	2.38	3.51
	TANGO 2	26.5	31.92	20.14	22.80	29.55	27.14	29.42	28.91	25.30	15.96	12.01	4.55	3.29	4.64
	CAB SSD 3	39.3	71.20	63.15	63.83	67.78	65.84	67.82	67.45	67.49	67.68	65.21	58.44	58.67	59.69
	CAB SSD 4	39.3	72.94	63.56	64.00	66.91	65.48	67.22	67.09	67.14	66.94	65.60	63.37	63.34	63.49
	MEC 1	44.2	80.16	87.30	87.35	86.75	87.37	87.37	87.37	87.47	86.71	84.76	74.30	74.07	76.05
	MEC 2	44.2	82.95	87.05	87.28	85.49	87.36	87.36	87.36	87.28	86.37	84.78	71.52	71.05	73.38
DSL	TEMES 1	40	1.88	8.88	10.94	15.63	13.66	15.06	14.96	9.75	-	-	-	-	-
	DED CT 1	23	0.64	0.06	0.06	0.28	0.22	0.48	0.58	0.40	0.06	0.03	0.00	0.00	0.01
	DED CT 2	22	-	0.06	0.05	0.14	0.12	0.25	0.31	0.21	0.04	0.02	0.00	0.00	0.00
	MACH CT 1	22	0.76	0.14	0.35	1.93	1.30	2.87	3.70	2.61	0.53	0.32	0.03	0.04	0.08
	YIGO CT 1	22	0.43	5.75	9.69	22.39	16.00	22.99	21.29	14.13	1.53	0.93	0.11	0.11	0.23
	MARBO CT 1	16	-	0.05	0.04	0.01	0.03	0.01	0.01	0.03	0.03	0.01	0.00	0.00	0.00
	TENJO 1	4.4	8.14	24.29	33.66	56.43	48.35	54.42	54.47	42.18	12.99	8.52	1.35	1.20	2.01
	TENJO 2	4.4	7.59	21.95	30.54	53.87	46.23	52.61	52.57	40.19	11.38	7.49	1.18	1.02	1.76
	TENJO 3	4.4	7.85	19.60	27.85	51.65	44.03	50.70	50.44	37.50	10.15	6.41	0.97	0.89	1.56
	TENJO 4	4.4	7.77	17.18	25.21	49.18	41.74	48.82	48.16	34.74	6.11	3.62	0.47	0.46	0.90
	TENJO 5	4.4	6.72	14.82	22.74	45.96	39.24	46.67	46.03	32.64	5.18	3.09	0.41	0.39	0.75
	TENJO 6	4.4	5.27	12.63	20.31	43.13	36.69	44.40	43.67	30.58	4.44	2.64	0.35	0.33	0.65
	TAL DSL 1	4.4	1.47	29.01	38.59	54.67	49.62	53.78	54.30	44.53	15.66	10.88	1.83	1.56	2.60
	TAL DSL 2	4.4	1.53	15.40	16.78	4.36	9.37	5.09	4.53	13.77	14.31	9.64	1.56	1.36	2.29
	PULANTAT 1	5.3	1.70	0.32	1.05	31.45	26.70	32.03	31.99	22.55	3.10	1.84	0.23	0.24	0.46
	PULANTAT 2	5.3	1.71	0.23	0.84	6.27	9.69	7.25	7.01	11.78	2.64	1.61	0.20	0.20	0.40
	DED DSL 1	2.5	0.13	0.05	0.04	0.01	0.03	0.01	0.01	0.03	-	-	-	-	-
	DED DSL 2	2.5		0.05	0.04	0.01	0.03	0.01	0.01	0.03	-	-	-	-	-
	DED DSL 3	2.5		0.05	0.04	0.01	0.03	0.01	0.01	0.03	-	-	-	-	-
	DED DSL 4	2.5		0.05	0.04	0.01	0.03	0.01	0.01	0.03	-	-	-	-	-
	OROTE 1	16		-	-	-	-	-	-	-	-	-	-	-	-
	RETR 99	60		-	-	-	-	-	-	10.55	42.58	34.62	16.78	13.33	16.99
LNG	CLNG 96	60		-	-	-	-	-	-	-	-	17.59	89.46	89.35	89.35
WIND	WIND 100	4.8		-	-	-	-	-	58.03	245.70	245.01	244.76	242.66	241.74	242.10
	WIND 98	4.8		-	-	-	-	-	-	58.03	245.01	244.97	244.40	244.34	244.08
	WIND 97	4.8		-	-	-	-	-	-	-	58.03	245.01	244.98	245.49	244.90
	WIND 95	4.8		-	-	-	-	-	-	-	-	58.03	245.01	245.70	245.01
	WIND 94	4.8		-	-	-	-	-	-	-	-	-	58.03	245.70	245.01

Summary of Strategist Modeling Output using Reserve Margin based on Planning Criteria of 1day/4.5 years LOLE[1,2]

NOTES

1. Data output from Strategist IRP Model Base9-4 with revisions to minimum Reserve Margin = 54.5 based on PICES PUC Standard run for LOLE of 1day per 4.5 years.
   Excel File: *Reliability Analysis (Aug09) 083109.xls*
   PICES INP File: *FY2009_PUCstd_083109.inp*
2. Strategist run excludes GSWAC (DSM transaction) and any new alternatives (units), including WIND (as renewable proxy), thru FY2014. Along with the Reserve Margin modifications the resource plan has also changed primarily to accomodate the deferred WIND options and the loss of energy conversion from the removal of the GSWAC transaction (~92 GWH energy savings per year).
3. Installed Capacity is the sum of the Nameplate Rating capacities of Generation Resources, including new units, however it only accounts for 12% of WIND (as renewable proxy) which is 4.8 MW for each new wind farm.
4. Plant operational hours are calculated assuming loading is at 100%, using NP Rating, and forecasted generation.
5. Environmental Limits was provided by P&R on 8/14/09 (reflect 2009 permits, expiring 2014)
6. Heat content for RFO is 6.1 MBTU/BBL for Low Sulfur RFO and 6.15 MBTU/BBL for High Sulfur RFO. For summary analysis 6.10 MBTU/BBL is used for calculating fuel consumption by BBL for RFO from MBTU.
7. Heat content for DSL is 5.78 MBTU/BBL which is used to calculate DSL consumption in BBLs from MBTU.
8. Capacity Factor is based on NP rating from IWPS Reports with the exception of WIND. WIND capacity factor is based on 4.8MW firm capacity.

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Reserve Margin & Resource Plan Comparison
GPA IRP Model & PICES PUC Model

	BASE 9-4 Strategist Model				PICES PUC B9-4 Strategist Model				Both Models	
FY	Max Reserve Margin (%)	Min Reserve Margin (%)	Reserve Margin (%)	RESOURCE PLAN	Max Reserve Margin (%)	Min Reserve Margin (%)	Output Reserve Margin (%)	RESOURCE PLAN	Unit Retirements	NOTES
2006	100	50	100.94		100	54.5	100.94		OROTE	
2007	100	50	105.69		100	54.5	105.69			
2008	100	50	100.52		100	54.5	100.52			
2009	100	50	94.24		100	54.5	94.24			
2010	100	50	86.56		100	54.5	86.56			
2011	100	50	79.33	WIND	100	54.5	79.33			
2012	100	50	75.06	WIND, TEML	100	54.5	73.49			
2013	100	50	69.93		100	54.5	66.90			
2014	100	50	65.67		100	54.5	62.71			
2015	100	50	62.21		100	54.5	59.32	WIND		
2016	60	50	58.01		60	54.5	56.60	RETR, WIND	DED DSL, TEMES CT (unit converted)	RETR converts TEMES CT into combined cycle adding 20MW capacity offsetting renewables & DSM transaction GSWAC in IRP Model to meet Reserve Margin requirements for next year.
2017	60	50	51.82	SSD	60	54.5	57.79	WIND		
2018	60	50	59.17	WIND	60	54.5	55.14	CLNG, WIND		
2019	60	50	57.19		70	54.5	69.69	WIND		
2020	60	50	53.29	WIND	70	54.5	66.77			
2021	60	50	50.81	CLNG	70	54.5	62.71			

PV Utility Costs (thru 2035): 5,732,314 | 5,915,034

Additional PV Utility Cost from IRP Model (thru 2035): (182,720)

NOTES

1. Base 9-4 is the strategist model used for the GPA 2008 Integrated Resource Plan. PICES PUC B9-4 is a modified version of the IRP model restricting addition of any new units thru year 2014, excludes the GSWAC transaction (DSM program equivalent to 92 GWH per year), and adjusts the Reserve Margin minimal requirements from 50% to 54.5% which complies with a Loss of Load Expectation (LOLE) reliability standard of 1 in 4.5 years.
2. Other references for the PICES PUC Model which evaluate LOLE of 1day per 4.5 years can be found in the following files.
   Excel File: *Reliability Analysis (Aug09) 083109.xls*
   PICES INP File: *FY2009_PUCstd_083109.inp*

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Data	Unit				2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Peak Demand	MW				283.34	294.76	304.69	316.72	324.86	331.8	340.61	348.05	357.11	364.66

Data Item	Unit	Fuel Type	THERMAL UNIT	NP Rating	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
GENERATION	GWH	RFO	CAB ST 1	66	329.7692	340.1043	298.9724	356.8535	337.5738	368.2534	358.0367	349.5633	330.9586	278.2220
			CAB ST 2	66	347.8737	362.0328	318.2571	388.4583	401.3947	401.9309	389.1853	381.5613	357.4961	254.2267
			TANGO 1	26.5	40.9597	46.9945	65.3050	58.5291	64.7522	63.6919	54.1707	31.8703	22.9874	6.6488
			TANGO 2	26.5	46.7599	52.9179	68.6029	63.0118	68.3063	67.1139	58.7401	37.0387	27.8685	10.5570
			CAB SSD 3	39.3	217.3931	219.7577	233.3586	226.6546	233.4946	232.2021	232.3588	233.0134	224.4960	201.1790
			CAB SSD 4	39.3	218.8009	220.3314	230.3578	225.4212	231.4086	230.9547	231.1268	230.4389	225.8502	218.1608
			MEC 1	44.2	338.0068	338.1943	335.9029	338.2727	338.2813	338.2820	338.6688	335.7449	328.2003	287.6936
			MEC 2	44.2	337.0569	337.9429	331.0109	338.2365	338.2609	338.2483	337.9415	334.4271	328.2548	276.9314
		DSL	TEMES 1	40	31.1259	38.3213	54.7636	47.8811	52.7775	52.4142	34.1809	0.0000	0.0000	0.0000
			DED CT 1	23	0.1166	0.1253	0.5708	0.4380	0.9602	1.1622	0.7971	0.1287	0.0655	0.0069
			DED CT 2	22	0.1095	0.0990	0.2644	0.2266	0.4897	0.5934	0.4083	0.0709	0.0328	0.0029
			MACH CT 1	22	0.2617	0.6704	3.7234	2.4979	5.5290	7.1351	5.0213	1.0299	0.6130	0.0657
			YIGO CT 1	22	11.0779	18.6815	43.1554	30.8304	44.3060	41.0226	27.2257	2.9460	1.7941	0.2041
			MARBO CT 1	16	0.0723	0.0595	0.0139	0.0473	0.0156	0.0127	0.0424	0.0351	0.0138	0.0000
			TENJO 1	4.4	9.3631	12.9749	21.7500	18.6341	20.9746	20.9960	16.2564	5.0082	3.2853	0.5215
			TENJO 2	4.4	8.4620	11.7727	20.7643	17.8196	20.2797	20.2621	15.4891	4.3862	2.8871	0.4565
			TENJO 3	4.4	7.5551	10.7341	19.9084	16.9696	19.5400	19.4404	14.4545	3.9109	2.4717	0.3745
			TENJO 4	4.4	6.6206	9.7180	18.9576	16.0871	18.8156	18.5632	13.3891	2.3540	1.3947	0.1830
			TENJO 5	4.4	5.7123	8.7666	17.7159	15.1241	17.9870	17.7420	12.5815	1.9985	1.1907	0.1580
			TENJO 6	4.4	4.8674	7.8279	16.6257	14.1429	17.1129	16.8314	11.7868	1.7105	1.0193	0.1332
			TAL DSL 1	4.4	11.1831	14.8732	21.0723	19.1261	20.7274	20.9312	17.1631	6.0372	4.1941	0.7051
			TAL DSL 2	4.4	5.9374	6.4677	1.6788	3.6112	1.9612	1.7472	5.3063	5.5159	3.7169	0.6024
			PULANTAT 1	5.3	0.1480	0.4894	14.6003	12.3962	14.8719	14.8510	10.4699	1.4411	0.8531	0.1086
			PULANTAT 2	5.3	0.1061	0.3887	2.9119	4.5001	3.3657	3.2543	5.4682	1.2243	0.7466	0.0920
			DED DSL 1	2.5	0.0115	0.0095	0.0022	0.0076	0.0026	0.0022	0.0070	0.0000	0.0000	0.0000
			DED DSL 2	2.5	0.0114	0.0096	0.0021	0.0074	0.0024	0.0022	0.0070	0.0000	0.0000	0.0000
			DED DSL 3	2.5	0.0114	0.0095	0.0023	0.0074	0.0026	0.0021	0.0068	0.0000	0.0000	0.0000
			DED DSL 4	2.5	0.0113	0.0094	0.0022	0.0074	0.0025	0.0021	0.0068	0.0000	0.0000	0.0000
			OROTE 1	16	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
			RETR 99	60	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	55.4335	223.7860	181.9510	88.2094
		LNG	CLNG 96	60	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	92.4449	470.2241

GENERATION	GWH	WIND	WIND 100	4.8	0.0000	0.0000	0.0000	0.0000	0.0000	24.3994	103.3114	103.0234	102.9173	102.0331
			WIND 98	4.8	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	24.3994	103.0234	103.0055	102.7664
			WIND 97	4.8	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	24.3994	103.0234	103.0089
			WIND 95	4.8	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	24.3994	103.0234
			WIND 94	4.8	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	24.3994
TOTAL FUEL CONSUMED	BBL	RFO	CAB ST 1	66	577,468.82	594,171.88	520,909.48	621,878.36	588,230.74	641,742.04	624,932.96	610,854.93	580,735.90	498,283.41
			CAB ST 2	66	603,600.99	624,444.88	543,170.23	663,346.81	682,390.82	683,180.15	664,688.46	653,193.40	617,766.35	460,039.30
			TANGO 1	26.5	101,316.72	116,173.87	160,879.72	144,418.53	159,294.38	156,676.17	133,527.25	78,873.12	56,892.05	16,457.83
			TANGO 2	26.5	115,453.61	130,602.72	168,869.97	155,297.01	167,960.21	164,992.60	144,644.29	91,481.83	68,835.57	26,078.95
			CAB SSD 3	39.3	307,846.44	311,575.21	332,932.59	322,459.32	333,253.93	331,214.14	331,385.98	332,675.56	320,159.73	289,782.91
			CAB SSD 4	39.3	305,705.93	308,310.37	325,169.82	316,971.46	327,159.84	326,387.36	326,478.47	325,510.11	317,792.53	305,330.27
			MEC 1	44.2	466,387.48	466,642.35	463,526.35	466,748.57	466,760.33	466,761.41	467,312.69	463,363.74	453,445.10	400,527.66
			MEC 2	44.2	465,093.53	466,300.67	456,858.31	466,699.46	466,732.52	466,715.19	466,328.65	461,615.89	453,499.46	387,038.21
		DSL	TEMES 1	40	89,266.45	109,977.39	157,353.59	137,481.90	151,636.31	150,598.01	98,137.19	0.00	0.00	0.00
			DED CT 1	23	271.16	304.28	1,572.66	1,179.86	2,649.11	3,210.25	2,176.90	331.24	170.85	19.09
			DED CT 2	22	251.53	231.59	722.71	593.52	1,344.53	1,632.58	1,098.84	170.83	80.49	8.03
			MACH CT 1	22	462.91	1,227.24	6,763.10	4,543.99	10,025.29	13,006.27	9,219.64	1,938.44	1,154.50	123.57
			YIGO CT 1	22	20,928.74	35,302.86	81,250.03	58,068.81	83,206.68	76,916.76	51,093.05	5,554.89	3,383.12	384.50
			MARBO CT 1	16	183.57	151.16	35.34	120.24	39.64	32.46	108.09	89.41	35.22	0.12
			TENJO 1	4.4	14,961.76	20,733.17	34,755.23	29,776.25	33,516.20	33,550.42	25,976.76	8,002.81	5,249.76	833.29
			TENJO 2	4.4	13,521.75	18,812.07	33,180.09	28,474.75	32,405.73	32,377.64	24,750.62	7,008.91	4,613.39	729.45
			TENJO 3	4.4	12,072.67	17,152.45	31,812.49	27,116.48	31,223.81	31,064.68	23,097.52	6,249.43	3,949.59	598.47
			TENJO 4	4.4	10,579.33	15,528.78	30,293.18	25,706.29	30,066.20	29,662.92	21,395.06	3,761.53	2,228.60	292.35
			TENJO 5	4.4	9,127.98	14,008.45	28,308.90	24,167.42	28,742.23	28,350.65	20,104.45	3,193.46	1,902.62	252.47
			TENJO 6	4.4	7,777.85	12,508.53	26,566.87	22,599.59	27,345.36	26,895.54	18,834.56	2,733.31	1,628.75	212.78
			TAL DSL 1	4.4	17,288.52	22,993.18	32,576.81	29,568.06	32,043.54	32,358.69	26,533.25	9,333.15	6,483.81	1,090.01
			TAL DSL 2	4.4	9,178.95	9,998.81	2,595.31	5,582.71	3,031.87	2,701.09	8,203.23	8,527.37	5,746.20	931.22
			PULANTAT 1	5.3	250.74	829.20	24,736.93	21,002.60	25,196.99	25,161.59	17,738.90	2,441.64	1,445.40	184.07
			PULANTAT 2	5.3	179.81	658.53	4,933.51	7,624.39	5,702.43	5,513.68	9,264.61	2,074.29	1,264.90	155.95
			DED DSL 1	2.5	27.02	22.28	5.14	17.85	6.12	5.21	16.55	0.00	0.00	0.00
			DED DSL 2	2.5	26.89	22.58	4.88	17.44	5.68	5.15	16.44	0.00	0.00	0.00
			DED DSL 3	2.5	26.92	22.33	5.32	17.50	6.04	5.05	15.90	0.00	0.00	0.00
			DED DSL 4	2.5	26.64	22.16	5.08	17.42	5.81	4.97	16.06	0.00	0.00	0.00
			OROTE 1	16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			RETR 99	60	0.00	0.00	0.00	0.00	0.00	0.00	81,038.14	327,647.64	266,418.58	129,180.37

TOTAL FUEL	MCF	LNG	CLNG	96	60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	744,559.20	3,789,278.32
	WIND	WIND	WIND	100	4.8	0.00	0.00	0.00	0.00	0.00	24,399.36	103,311.36	103,023.36	102,917.32	102,033.09
			WIND	98	4.8	0.00	0.00	0.00	0.00	0.00	0.00	24,399.36	103,023.36	103,005.55	102,766.43
			WIND	97	4.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	24,399.36	103,023.36	103,008.93
			WIND	95	4.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	24,399.36	103,023.36
			WIND	94	4.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	24,399.36

2020	2021
373.93	383.26

2020	2021
267.4550	259.2098
264.3345	278.2548
5.5276	8.1446
7.6273	10.7709
201.9910	205.4781
218.0640	218.5882
286.7836	294.4605
275.0898	284.1279
0.0000	0.0000
0.0098	0.0137
0.0037	0.0080
0.0734	0.1542
0.2188	0.4370
0.0001	0.0003
0.4623	0.7747
0.3921	0.6792
0.3430	0.5996
0.1774	0.3484
0.1506	0.2906
0.1282	0.2489
0.6002	1.0015
0.5261	0.8842
0.1115	0.2119
0.0935	0.1843
0.0000	0.0000
0.0000	0.0000
0.0000	0.0000
0.0000	0.0000
0.0000	0.0000
70.0793	89.2954
469.6081	469.6155

101.6453	101.8000
102.7407	102.6304
103.2224	102.9746
103.3114	103.0227
103.3114	103.0234
482,042.02	464,779.51
480,891.67	501,112.68
13,681.88	20,158.80
18,840.70	26,605.48
290,642.25	294,943.75
305,463.53	306,234.87
399,784.72	409,618.46
385,147.36	396,606.97
0.00	0.00
26.91	37.44
10.04	21.70
137.55	290.40
411.85	823.68
0.28	0.85
738.77	1,237.95
626.55	1,085.24
548.15	958.07
283.42	556.75
240.71	464.30
204.82	397.80
927.88	1,548.20
813.26	1,366.94
188.88	359.03
158.43	312.18
0.00	0.00
0.00	0.00
0.00	0.00
0.00	0.00
0.00	0.00
102,627.33	130,759.85

3,786,360.60	3,784,996.58
101,645.34	101,800.00
102,740.68	102,630.44
103,222.39	102,974.59
103,311.36	103,022.69
103,311.36	103,023.36

Facility Condition Emission Limits (Table 1-1)

Facility	Load Limit (MW load)		Permit Limit Parameters									
	50% load limit	100% load limit	SO2 (lbs/hr)	NOx @ 15% O2	NOx (ppmdv)	NOx (lbs/hr)	CO @ 15% O2	CO (ppmdv)	CO (lbs/hr)	UHC (lbs/hr)	VOC (lbs / hr)	PM 10 (lbs/hr)
Cabras												
Cabras 3 & 4	-	40 ea	737	950 ppm		1,219	-		110	-	96	93
Diesel Plants												
Dededo Diesel 1-4	-		57.6	-	-	320	-	-	-	-	-	32
Manenggon Diesel 1 & 2	-	3 ea	29.8	-	-	127.85	-	-	17.10	6.10	-	4.95
Talofofo Diesel 1 & 2	-	5 ea	27	-	-	107.70	-	-	23.94	5.24	-	9.27
Tenjo Vista Units 1 - 6	-	4 ea	13.5	660 ppm		120	240 ppm		24	-	5	6.50
Combustion Turbines												
Macheche CT at 50% load	11.5	-	-	-	-	-	-	-	-	4	-	-
Macheche CT at 100% load	-	23	125	59 ppmdv	-	55.80	-	-	21.8	-	-	20
Yigo CT at 50% load	11	-	-	-	-	-	-	-	21.8	4	-	-
Yigo CT at 100% load	-	22	125	59 ppm		55.80	-	-	-	-	-	20
Marbo CT at 100% load	-	16	64.8	75 ppmdv	-	36.5	-	-	22.1	10.3		6.57
Dededo CT 1 & 2 at 50% load	11.5 ea	-	-	-	-	49	-	170	86	14	-	-
Dededo CT 1 & 2 at 100% load	-	23 ea	218	-	59	83	-	25	21	4	-	19.8

Facility Operation Condition Limits (Table 1-2)

Facility	Maximum Sulfur Content in % by wt.	Minimum Water to fuel ratio	Max. Annual Fuel Consumption (in gallons)	Maximum Load Hours	
				Below 80% Load	Above 80% Load
Cabras					
Cabras HSFO	2.00	0.33	-		-
Cabras LSFO	1.19				
Diesel Plants					
Dededo Diesel 1-4	0.60	-	-		-
Manenggon Diesel 1 & 2	0.60	-	1,305,543		-
Talofofo Diesel 1 & 2	0.60	-	1,480,851		2,320 hrs 2 units or 4,640 for 1 unit
Tenjo Vista Units 1 - 6	0.30	-	-		-
Combustion Turbines					
Macheche CT at 50% load	0.50	0.73@30%load	7,140,000	-	4,280
Macheche CT at 100% load	0.50	0.82@100%load			
Yigo CT at 50% load	0.50	0.77	7,140,000	-	4,280
Yigo CT at 100% load	0.50	0.91			
Marbo CT at 100% load	0.75	0.41	4,760,000	-	2,654
Dededo CT 1 & 2 at 50% load	0.60	0.63@50% load	-	-	-
Dededo CT 1 & 2 at 100% load	0.60	0.59@100%load	-	1,000	7,760

Based on the GEPA Air Pollution Control Permit as of May 11, 2009

GENERATION 12-MONTH ROLLING PRODUCTION SUMMARY

ROLLING AVERAGE

No. of Days: 365

	Year Installed	NP Rating (MW)	Gross Generation (KWH)	Station Power (KWH)	Net Generation (KWH)	Aux Power % of Gross	Fuel Consumption (Gals)	Fuel Consumption (bbls)	Net Fuel Efficiency (KWH/Gal)	Gross Heat Rate (BTU/KWH)	Net Heat Rate (BTU/kWH)	EAF (%)	EFOR (%)	Thermal Efficiency NET	Net Capacity Factor
RFO #6 - Baseload Units															
Cabras Unit #1	1974	66	325,885,200	24,920,077	300,965,123	8%	25,390,142	604,527	12	11,627	12,590	94%	6%	27%	52.06%
Cabras Unit #2	1975	66	234,490,600	17,238,960	217,251,640	7%	17,766,482	423,011	12	11,308	12,205	58%	29%	27%	37.58%
Tanguisson Unit #1	1971	26.5	62,063,400	6,431,290	55,632,110	10%	5,656,543	134,680	10	13,606	15,179	92%	8%	0%	23.96%
Tanguisson Unit #2	1973	26.5	74,097,300	6,829,889	67,267,411	9%	6,714,875	159,878	10	13,535	14,910	88%	9%	23%	28.98%
Cabras Unit #3	1995	39.3	245,110,807	14,888,962	230,221,845	6%	14,313,798	340,805	16	8,728	9,293	92%	3%	37%	66.87%
Cabras Unit #4	1996	39.3	251,096,824	11,699,372	239,397,452	5%	13,489,723	321,184	18	8,030	8,422	95%	1%	41%	69.54%
MEC Unit #8	1999	44	310,366,500	17,474,950	292,891,550	6%	17,521,355	417,175	17	8,438	8,941	93%	1%	37%	75.99%
MEC Unit #9	1999	44	321,176,700	7,432,200	313,744,500	2%	18,100,226	430,958	17	8,430	8,630	96%	1%	40%	81.40%
SUBTOTAL:		351.6	1,824,287,331	106,915,700	1,717,371,631	6%	118,953,144	2,832,218	14	9,741	10,347			33%	55.76%
Diesel No. 2 - Peaking Units															
Dededo CT #1	1992	23	1,283,400	15,584	1,267,816	1%	153,265	3,649	8	16,448	16,650	90%	0%	20%	0.63%
Dededo CT #2	1994	22	0	0	0	0%	0	0	0	-	-	0%	0%	0%	0.00%
Macheche CT	1993	22	1,472,400	16,232	1,456,168	1%	129,798	3,090	11	12,142	12,277	55%	0%	28%	0.76%
Marbo CT	1995	16	0	0	0	0%	0	0	0	-	-	0%	0%	0%	0.00%
TEMES CT	1998	40	6,584,683	110,068	6,474,616	2%	672,540	16,013	10	14,067	14,307	99%	0%	24%	1.85%
Yigo CT	1993	22	828,000	13,248	814,752	2%	68,759	1,637	12	11,438	11,624	23%	0%	29%	0.42%
Dededo Diesel Plant	1971	10	111,500	2,567	127,691	2%	8,920	212	14	11,019	9,621	75%	0%	0%	0.15%
Manenggon Diesel #1	1994	5.3	789,756	18,220	771,536	2%	54,850	1,306	14	9,566	9,792	100%	0%	35%	1.66%
Manenggon Diesel #2	1994	5.3	795,391	17,536	743,206	2%	33,185	790	22	5,746	6,150	100%	0%	35%	1.60%
Talofofo Diesel #1	1993	4.4	566,640	8,496	558,144	1%	42,601	1,014	13	10,355	10,513	100%	0%	55%	1.45%
Talofofo Diesel #2	1993	4.4	589,680	8,841	580,839	1%	39,571	942	15	9,243	9,383	67%	0%	32%	1.51%
Tenjo Unit #1	1993	4.4	3,139,200	47,267	3,135,375	2%	213,156	5,075	15	9,386	9,397	100%	0%	36%	8.13%
Tenjo Unit #2	1993	4.4	2,923,920	43,856	2,880,064	1%	198,084	4,716	15	9,364	9,507	97%	0%	36%	7.47%
Tenjo Unit #3	1993	4.4	3,026,160	45,296	2,980,864	1%	206,830	4,925	14	9,447	9,591	100%	0%	36%	7.73%
Tenjo Unit #4	1993	4.4	2,996,640	44,950	3,058,782	2%	203,465	4,844	15	9,385	9,194	100%	0%	37%	7.94%
Tenjo Unit #5	1993	4.4	2,591,280	38,778	2,552,502	1%	175,708	4,184	15	9,373	9,515	99%	0%	36%	6.62%
Tenjo Unit #6	1993	4.4	2,031,120	31,104	2,042,496	2%	140,549	3,346	15	9,565	9,512	88%	3%	36%	5.30%
SUBTOTAL:		200.8	29,729,770	462,043	29,444,850	2%	2,341,281	55,745	13	10,860	10,965			31%	1.67%
Totals:		552.4	1,854,017,101	107,377,743	1,746,816,481	6%	121,294,425	2,887,962	14	9,759	9,398	9,974		36%	36.10%
		Baseload	98.40%	99.57%	98.31%	RFO	98.07%	98.07%		8,430	8,430				
		Peaking	1.60%	0.43%	1.69%	DIESEL	1.93%	1.93%		9,565	9,565				
		CT	10,168,483	155,132	10,013,351	0	1,024,362	24,390		13,875	14,090				
		MED DSL	19,561,287	306,911	19,431,499	0	1,316,919	31,355		9,306	9,368				

Data Item	THERMAL UNIT	Units	YEAR	Data Value	NP Rating	Units
GENERATION	CAB ST 1	"GWH"	2006	293.1240845	66	GWH
GENERATION	CAB ST 1	"GWH"	2007	270.2495117	66	GWH
GENERATION	CAB ST 1	"GWH"	2008	310.3511963	66	GWH
GENERATION	CAB ST 1	"GWH"	2009	278.1334229	66	GWH
GENERATION	CAB ST 1	"GWH"	2010	329.769165	66	GWH
GENERATION	CAB ST 1	"GWH"	2011	340.1042786	66	GWH
GENERATION	CAB ST 1	"GWH"	2012	298.9723816	66	GWH
GENERATION	CAB ST 1	"GWH"	2013	356.8535461	66	GWH
GENERATION	CAB ST 1	"GWH"	2014	337.573822	66	GWH
GENERATION	CAB ST 1	"GWH"	2015	368.253418	66	GWH
GENERATION	CAB ST 1	"GWH"	2016	358.0367126	66	GWH
GENERATION	CAB ST 1	"GWH"	2017	349.563324	66	GWH
GENERATION	CAB ST 1	"GWH"	2018	330.9586182	66	GWH
GENERATION	CAB ST 1	"GWH"	2019	278.2219543	66	GWH
GENERATION	CAB ST 1	"GWH"	2020	267.4550476	66	GWH
GENERATION	CAB ST 1	"GWH"	2021	259.2097778	66	GWH
GENERATION	CAB ST 1	"GWH"	2022	270.5259094	66	GWH
GENERATION	CAB ST 1	"GWH"	2023	204.2484436	66	GWH
GENERATION	CAB ST 1	"GWH"	2024	151.377594	66	GWH
GENERATION	CAB ST 1	"GWH"	2025	147.9780273	66	GWH
GENERATION	CAB ST 1	"GWH"	2026	146.8802185	66	GWH
GENERATION	CAB ST 1	"GWH"	2027	0	66	GWH
GENERATION	CAB ST 1	"GWH"	2028	0	66	GWH
GENERATION	CAB ST 1	"GWH"	2029	0	66	GWH
GENERATION	CAB ST 1	"GWH"	2030	0	66	GWH
GENERATION	CAB ST 1	"GWH"	2031	0	66	GWH
GENERATION	CAB ST 1	"GWH"	2032	0	66	GWH
GENERATION	CAB ST 1	"GWH"	2033	0	66	GWH
GENERATION	CAB ST 1	"GWH"	2034	0	66	GWH
GENERATION	CAB ST 1	"GWH"	2035	0	66	GWH
GENERATION	CAB ST 2	"GWH"	2006	302.9854736	66	GWH
GENERATION	CAB ST 2	"GWH"	2007	307.0669861	66	GWH
GENERATION	CAB ST 2	"GWH"	2008	324.0669556	66	GWH
GENERATION	CAB ST 2	"GWH"	2009	285.5048828	66	GWH
GENERATION	CAB ST 2	"GWH"	2010	347.8737488	66	GWH
GENERATION	CAB ST 2	"GWH"	2011	362.0328369	66	GWH
GENERATION	CAB ST 2	"GWH"	2012	318.2570801	66	GWH
GENERATION	CAB ST 2	"GWH"	2013	388.4583435	66	GWH
GENERATION	CAB ST 2	"GWH"	2014	401.3946838	66	GWH
GENERATION	CAB ST 2	"GWH"	2015	401.9309082	66	GWH
GENERATION	CAB ST 2	"GWH"	2016	389.1852722	66	GWH
GENERATION	CAB ST 2	"GWH"	2017	381.5612793	66	GWH
GENERATION	CAB ST 2	"GWH"	2018	357.4960938	66	GWH
GENERATION	CAB ST 2	"GWH"	2019	254.2266693	66	GWH
GENERATION	CAB ST 2	"GWH"	2020	264.3345032	66	GWH
GENERATION	CAB ST 2	"GWH"	2021	278.2547607	66	GWH
GENERATION	CAB ST 2	"GWH"	2022	268.0661621	66	GWH
GENERATION	CAB ST 2	"GWH"	2023	186.3939514	66	GWH
GENERATION	CAB ST 2	"GWH"	2024	140.0792847	66	GWH
GENERATION	CAB ST 2	"GWH"	2025	135.5813141	66	GWH
GENERATION	CAB ST 2	"GWH"	2026	126.4509659	66	GWH

GENERATION	CAB ST 2	"GWH"	2027	132.9377594	66	GWH
GENERATION	CAB ST 2	"GWH"	2028	0	66	GWH
GENERATION	CAB ST 2	"GWH"	2029	0	66	GWH
GENERATION	CAB ST 2	"GWH"	2030	0	66	GWH
GENERATION	CAB ST 2	"GWH"	2031	0	66	GWH
GENERATION	CAB ST 2	"GWH"	2032	0	66	GWH
GENERATION	CAB ST 2	"GWH"	2033	0	66	GWH
GENERATION	CAB ST 2	"GWH"	2034	0	66	GWH
GENERATION	CAB ST 2	"GWH"	2035	0	66	GWH
GENERATION	CAB SSD 3	"GWH"	2006	215.1764832	39.3	GWH
GENERATION	CAB SSD 3	"GWH"	2007	215.1783142	39.3	GWH
GENERATION	CAB SSD 3	"GWH"	2008	216.020462	39.3	GWH
GENERATION	CAB SSD 3	"GWH"	2009	216.9189148	39.3	GWH
GENERATION	CAB SSD 3	"GWH"	2010	217.3931427	39.3	GWH
GENERATION	CAB SSD 3	"GWH"	2011	219.7577057	39.3	GWH
GENERATION	CAB SSD 3	"GWH"	2012	233.3586273	39.3	GWH
GENERATION	CAB SSD 3	"GWH"	2013	226.6545868	39.3	GWH
GENERATION	CAB SSD 3	"GWH"	2014	233.4946136	39.3	GWH
GENERATION	CAB SSD 3	"GWH"	2015	232.2020721	39.3	GWH
GENERATION	CAB SSD 3	"GWH"	2016	232.3588257	39.3	GWH
GENERATION	CAB SSD 3	"GWH"	2017	233.0134125	39.3	GWH
GENERATION	CAB SSD 3	"GWH"	2018	224.4960327	39.3	GWH
GENERATION	CAB SSD 3	"GWH"	2019	201.1790161	39.3	GWH
GENERATION	CAB SSD 3	"GWH"	2020	201.9909821	39.3	GWH
GENERATION	CAB SSD 3	"GWH"	2021	205.4781189	39.3	GWH
GENERATION	CAB SSD 3	"GWH"	2022	202.0021667	39.3	GWH
GENERATION	CAB SSD 3	"GWH"	2023	179.2559662	39.3	GWH
GENERATION	CAB SSD 3	"GWH"	2024	170.3679962	39.3	GWH
GENERATION	CAB SSD 3	"GWH"	2025	170.5313568	39.3	GWH
GENERATION	CAB SSD 3	"GWH"	2026	165.7613831	39.3	GWH
GENERATION	CAB SSD 3	"GWH"	2027	156.3195953	39.3	GWH
GENERATION	CAB SSD 3	"GWH"	2028	160.9678802	39.3	GWH
GENERATION	CAB SSD 3	"GWH"	2029	157.2333069	39.3	GWH
GENERATION	CAB SSD 3	"GWH"	2030	148.5924225	39.3	GWH
GENERATION	CAB SSD 3	"GWH"	2031	149.9743042	39.3	GWH
GENERATION	CAB SSD 3	"GWH"	2032	151.0583496	39.3	GWH
GENERATION	CAB SSD 3	"GWH"	2033	151.1248932	39.3	GWH
GENERATION	CAB SSD 3	"GWH"	2034	152.0453949	39.3	GWH
GENERATION	CAB SSD 3	"GWH"	2035	150.173172	39.3	GWH
GENERATION	CAB SSD 4	"GWH"	2006	217.4944153	39.3	GWH
GENERATION	CAB SSD 4	"GWH"	2007	217.5050659	39.3	GWH
GENERATION	CAB SSD 4	"GWH"	2008	218.249527	39.3	GWH
GENERATION	CAB SSD 4	"GWH"	2009	218.6117554	39.3	GWH
GENERATION	CAB SSD 4	"GWH"	2010	218.8008881	39.3	GWH
GENERATION	CAB SSD 4	"GWH"	2011	220.3314362	39.3	GWH
GENERATION	CAB SSD 4	"GWH"	2012	230.3577881	39.3	GWH
GENERATION	CAB SSD 4	"GWH"	2013	225.4212494	39.3	GWH
GENERATION	CAB SSD 4	"GWH"	2014	231.4086151	39.3	GWH
GENERATION	CAB SSD 4	"GWH"	2015	230.9546814	39.3	GWH
GENERATION	CAB SSD 4	"GWH"	2016	231.1268311	39.3	GWH
GENERATION	CAB SSD 4	"GWH"	2017	230.4389038	39.3	GWH
GENERATION	CAB SSD 4	"GWH"	2018	225.850174	39.3	GWH

GENERATION	CAB SSD	4	"GWH"	2019	218.1607971	39.3 GWH
GENERATION	CAB SSD	4	"GWH"	2020	218.0640411	39.3 GWH
GENERATION	CAB SSD	4	"GWH"	2021	218.5882263	39.3 GWH
GENERATION	CAB SSD	4	"GWH"	2022	218.0124969	39.3 GWH
GENERATION	CAB SSD	4	"GWH"	2023	213.2255096	39.3 GWH
GENERATION	CAB SSD	4	"GWH"	2024	184.4500732	39.3 GWH
GENERATION	CAB SSD	4	"GWH"	2025	183.6985016	39.3 GWH
GENERATION	CAB SSD	4	"GWH"	2026	181.2526245	39.3 GWH
GENERATION	CAB SSD	4	"GWH"	2027	167.2907715	39.3 GWH
GENERATION	CAB SSD	4	"GWH"	2028	172.8913574	39.3 GWH
GENERATION	CAB SSD	4	"GWH"	2029	167.7056732	39.3 GWH
GENERATION	CAB SSD	4	"GWH"	2030	154.3517609	39.3 GWH
GENERATION	CAB SSD	4	"GWH"	2031	156.3229828	39.3 GWH
GENERATION	CAB SSD	4	"GWH"	2032	158.1113739	39.3 GWH
GENERATION	CAB SSD	4	"GWH"	2033	158.0285492	39.3 GWH
GENERATION	CAB SSD	4	"GWH"	2034	160.4264984	39.3 GWH
GENERATION	CAB SSD	4	"GWH"	2035	158.7306519	39.3 GWH
GENERATION	OROTE	1	"GWH"	2006	0.015764283	16 GWH
GENERATION	OROTE	1	"GWH"	2007	0	16 GWH
GENERATION	OROTE	1	"GWH"	2008	0	16 GWH
GENERATION	OROTE	1	"GWH"	2009	0	16 GWH
GENERATION	OROTE	1	"GWH"	2010	0	16 GWH
GENERATION	OROTE	1	"GWH"	2011	0	16 GWH
GENERATION	OROTE	1	"GWH"	2012	0	16 GWH
GENERATION	OROTE	1	"GWH"	2013	0	16 GWH
GENERATION	OROTE	1	"GWH"	2014	0	16 GWH
GENERATION	OROTE	1	"GWH"	2015	0	16 GWH
GENERATION	OROTE	1	"GWH"	2016	0	16 GWH
GENERATION	OROTE	1	"GWH"	2017	0	16 GWH
GENERATION	OROTE	1	"GWH"	2018	0	16 GWH
GENERATION	OROTE	1	"GWH"	2019	0	16 GWH
GENERATION	OROTE	1	"GWH"	2020	0	16 GWH
GENERATION	OROTE	1	"GWH"	2021	0	16 GWH
GENERATION	OROTE	1	"GWH"	2022	0	16 GWH
GENERATION	OROTE	1	"GWH"	2023	0	16 GWH
GENERATION	OROTE	1	"GWH"	2024	0	16 GWH
GENERATION	OROTE	1	"GWH"	2025	0	16 GWH
GENERATION	OROTE	1	"GWH"	2026	0	16 GWH
GENERATION	OROTE	1	"GWH"	2027	0	16 GWH
GENERATION	OROTE	1	"GWH"	2028	0	16 GWH
GENERATION	OROTE	1	"GWH"	2029	0	16 GWH
GENERATION	OROTE	1	"GWH"	2030	0	16 GWH
GENERATION	OROTE	1	"GWH"	2031	0	16 GWH
GENERATION	OROTE	1	"GWH"	2032	0	16 GWH
GENERATION	OROTE	1	"GWH"	2033	0	16 GWH
GENERATION	OROTE	1	"GWH"	2034	0	16 GWH
GENERATION	OROTE	1	"GWH"	2035	0	16 GWH
GENERATION	DED CT	1	"GWH"	2006	0.169204473	23 GWH
GENERATION	DED CT	1	"GWH"	2007	0.180999145	23 GWH
GENERATION	DED CT	1	"GWH"	2008	0.151053369	23 GWH
GENERATION	DED CT	1	"GWH"	2009	0.090835921	23 GWH
GENERATION	DED CT	1	"GWH"	2010	0.116579995	23 GWH

GENERATION	DED CT	1	"GWH"	2011	0.125256926	23 GWH
GENERATION	DED CT	1	"GWH"	2012	0.570769012	23 GWH
GENERATION	DED CT	1	"GWH"	2013	0.438002169	23 GWH
GENERATION	DED CT	1	"GWH"	2014	0.960180104	23 GWH
GENERATION	DED CT	1	"GWH"	2015	1.162180185	23 GWH
GENERATION	DED CT	1	"GWH"	2016	0.797149777	23 GWH
GENERATION	DED CT	1	"GWH"	2017	0.128732473	23 GWH
GENERATION	DED CT	1	"GWH"	2018	0.065461859	23 GWH
GENERATION	DED CT	1	"GWH"	2019	0.006915712	23 GWH
GENERATION	DED CT	1	"GWH"	2020	0.009782059	23 GWH
GENERATION	DED CT	1	"GWH"	2021	0.013743569	23 GWH
GENERATION	DED CT	1	"GWH"	2022	0.007626226	23 GWH
GENERATION	DED CT	1	"GWH"	2023	0	23 GWH
GENERATION	DED CT	1	"GWH"	2024	0	23 GWH
GENERATION	DED CT	1	"GWH"	2025	0	23 GWH
GENERATION	DED CT	1	"GWH"	2026	0	23 GWH
GENERATION	DED CT	1	"GWH"	2027	0	23 GWH
GENERATION	DED CT	1	"GWH"	2028	0	23 GWH
GENERATION	DED CT	1	"GWH"	2029	0	23 GWH
GENERATION	DED CT	1	"GWH"	2030	0	23 GWH
GENERATION	DED CT	1	"GWH"	2031	0	23 GWH
GENERATION	DED CT	1	"GWH"	2032	0	23 GWH
GENERATION	DED CT	1	"GWH"	2033	0	23 GWH
GENERATION	DED CT	1	"GWH"	2034	0	23 GWH
GENERATION	DED CT	1	"GWH"	2035	0	23 GWH
GENERATION	DED CT	2	"GWH"	2006	0.166617841	22 GWH
GENERATION	DED CT	2	"GWH"	2007	0.181273922	22 GWH
GENERATION	DED CT	2	"GWH"	2008	0.17007561	22 GWH
GENERATION	DED CT	2	"GWH"	2009	0.077829123	22 GWH
GENERATION	DED CT	2	"GWH"	2010	0.109503895	22 GWH
GENERATION	DED CT	2	"GWH"	2011	0.099041849	22 GWH
GENERATION	DED CT	2	"GWH"	2012	0.264372081	22 GWH
GENERATION	DED CT	2	"GWH"	2013	0.226641685	22 GWH
GENERATION	DED CT	2	"GWH"	2014	0.489711821	22 GWH
GENERATION	DED CT	2	"GWH"	2015	0.593434453	22 GWH
GENERATION	DED CT	2	"GWH"	2016	0.408298522	22 GWH
GENERATION	DED CT	2	"GWH"	2017	0.070854433	22 GWH
GENERATION	DED CT	2	"GWH"	2018	0.032788392	22 GWH
GENERATION	DED CT	2	"GWH"	2019	0.002919049	22 GWH
GENERATION	DED CT	2	"GWH"	2020	0.003678543	22 GWH
GENERATION	DED CT	2	"GWH"	2021	0.008006347	22 GWH
GENERATION	DED CT	2	"GWH"	2022	0.004275104	22 GWH
GENERATION	DED CT	2	"GWH"	2023	0.002371432	22 GWH
GENERATION	DED CT	2	"GWH"	2024	0.001483947	22 GWH
GENERATION	DED CT	2	"GWH"	2025	0	22 GWH
GENERATION	DED CT	2	"GWH"	2026	0	22 GWH
GENERATION	DED CT	2	"GWH"	2027	0	22 GWH
GENERATION	DED CT	2	"GWH"	2028	0	22 GWH
GENERATION	DED CT	2	"GWH"	2029	0	22 GWH
GENERATION	DED CT	2	"GWH"	2030	0	22 GWH
GENERATION	DED CT	2	"GWH"	2031	0	22 GWH
GENERATION	DED CT	2	"GWH"	2032	0	22 GWH

GENERATION	DED CT 2	"GWH"	2033	0	22 GWH
GENERATION	DED CT 2	"GWH"	2034	0	22 GWH
GENERATION	DED CT 2	"GWH"	2035	0	22 GWH
GENERATION	MACH CT 1	"GWH"	2006	0.199821711	22 GWH
GENERATION	MACH CT 1	"GWH"	2007	0.218985572	22 GWH
GENERATION	MACH CT 1	"GWH"	2008	0.211980522	22 GWH
GENERATION	MACH CT 1	"GWH"	2009	0.298295289	22 GWH
GENERATION	MACH CT 1	"GWH"	2010	0.26165089	22 GWH
GENERATION	MACH CT 1	"GWH"	2011	0.670402884	22 GWH
GENERATION	MACH CT 1	"GWH"	2012	3.723413706	22 GWH
GENERATION	MACH CT 1	"GWH"	2013	2.497917414	22 GWH
GENERATION	MACH CT 1	"GWH"	2014	5.529043198	22 GWH
GENERATION	MACH CT 1	"GWH"	2015	7.135121346	22 GWH
GENERATION	MACH CT 1	"GWH"	2016	5.02132988	22 GWH
GENERATION	MACH CT 1	"GWH"	2017	1.029940248	22 GWH
GENERATION	MACH CT 1	"GWH"	2018	0.612955093	22 GWH
GENERATION	MACH CT 1	"GWH"	2019	0.065666065	22 GWH
GENERATION	MACH CT 1	"GWH"	2020	0.073441669	22 GWH
GENERATION	MACH CT 1	"GWH"	2021	0.154199779	22 GWH
GENERATION	MACH CT 1	"GWH"	2022	0.107363686	22 GWH
GENERATION	MACH CT 1	"GWH"	2023	0.005786944	22 GWH
GENERATION	MACH CT 1	"GWH"	2024	0	22 GWH
GENERATION	MACH CT 1	"GWH"	2025	0	22 GWH
GENERATION	MACH CT 1	"GWH"	2026	0	22 GWH
GENERATION	MACH CT 1	"GWH"	2027	0	22 GWH
GENERATION	MACH CT 1	"GWH"	2028	0	22 GWH
GENERATION	MACH CT 1	"GWH"	2029	0	22 GWH
GENERATION	MACH CT 1	"GWH"	2030	0	22 GWH
GENERATION	MACH CT 1	"GWH"	2031	0	22 GWH
GENERATION	MACH CT 1	"GWH"	2032	0	22 GWH
GENERATION	MACH CT 1	"GWH"	2033	0	22 GWH
GENERATION	MACH CT 1	"GWH"	2034	0	22 GWH
GENERATION	MACH CT 1	"GWH"	2035	0	22 GWH
GENERATION	YIGO CT 1	"GWH"	2006	0.821457803	22 GWH
GENERATION	YIGO CT 1	"GWH"	2007	0.897462368	22 GWH
GENERATION	YIGO CT 1	"GWH"	2008	1.613933921	22 GWH
GENERATION	YIGO CT 1	"GWH"	2009	8.383166313	22 GWH
GENERATION	YIGO CT 1	"GWH"	2010	11.07792282	22 GWH
GENERATION	YIGO CT 1	"GWH"	2011	18.68152237	22 GWH
GENERATION	YIGO CT 1	"GWH"	2012	43.15540314	22 GWH
GENERATION	YIGO CT 1	"GWH"	2013	30.83036232	22 GWH
GENERATION	YIGO CT 1	"GWH"	2014	44.30598831	22 GWH
GENERATION	YIGO CT 1	"GWH"	2015	41.02262115	22 GWH
GENERATION	YIGO CT 1	"GWH"	2016	27.2257328	22 GWH
GENERATION	YIGO CT 1	"GWH"	2017	2.945972443	22 GWH
GENERATION	YIGO CT 1	"GWH"	2018	1.794079185	22 GWH
GENERATION	YIGO CT 1	"GWH"	2019	0.204089865	22 GWH
GENERATION	YIGO CT 1	"GWH"	2020	0.218810335	22 GWH
GENERATION	YIGO CT 1	"GWH"	2021	0.43702051	22 GWH
GENERATION	YIGO CT 1	"GWH"	2022	0.224296048	22 GWH
GENERATION	YIGO CT 1	"GWH"	2023	0.008308155	22 GWH
GENERATION	YIGO CT 1	"GWH"	2024	0	22 GWH

GENERATION	YIGO CT 1	"GWH"	2025	0	22 GWH
GENERATION	YIGO CT 1	"GWH"	2026	0	22 GWH
GENERATION	YIGO CT 1	"GWH"	2027	0	22 GWH
GENERATION	YIGO CT 1	"GWH"	2028	0	22 GWH
GENERATION	YIGO CT 1	"GWH"	2029	0	22 GWH
GENERATION	YIGO CT 1	"GWH"	2030	0	22 GWH
GENERATION	YIGO CT 1	"GWH"	2031	0	22 GWH
GENERATION	YIGO CT 1	"GWH"	2032	0	22 GWH
GENERATION	YIGO CT 1	"GWH"	2033	0	22 GWH
GENERATION	YIGO CT 1	"GWH"	2034	0	22 GWH
GENERATION	YIGO CT 1	"GWH"	2035	0	22 GWH
GENERATION	MARBO CT 1	"GWH"	2006	0.11094632	16 GWH
GENERATION	MARBO CT 1	"GWH"	2007	0.122697182	16 GWH
GENERATION	MARBO CT 1	"GWH"	2008	0.116475701	16 GWH
GENERATION	MARBO CT 1	"GWH"	2009	0.049626939	16 GWH
GENERATION	MARBO CT 1	"GWH"	2010	0.072275557	16 GWH
GENERATION	MARBO CT 1	"GWH"	2011	0.05951409	16 GWH
GENERATION	MARBO CT 1	"GWH"	2012	0.013913653	16 GWH
GENERATION	MARBO CT 1	"GWH"	2013	0.047337584	16 GWH
GENERATION	MARBO CT 1	"GWH"	2014	0.015599199	16 GWH
GENERATION	MARBO CT 1	"GWH"	2015	0.012741234	16 GWH
GENERATION	MARBO CT 1	"GWH"	2016	0.042445727	16 GWH
GENERATION	MARBO CT 1	"GWH"	2017	0.035147488	16 GWH
GENERATION	MARBO CT 1	"GWH"	2018	0.013774335	16 GWH
GENERATION	MARBO CT 1	"GWH"	2019	3.63609E-05	16 GWH
GENERATION	MARBO CT 1	"GWH"	2020	8.79011E-05	16 GWH
GENERATION	MARBO CT 1	"GWH"	2021	0.000272248	16 GWH
GENERATION	MARBO CT 1	"GWH"	2022	0.000139174	16 GWH
GENERATION	MARBO CT 1	"GWH"	2023	4.39462E-06	16 GWH
GENERATION	MARBO CT 1	"GWH"	2024	0	16 GWH
GENERATION	MARBO CT 1	"GWH"	2025	0	16 GWH
GENERATION	MARBO CT 1	"GWH"	2026	0	16 GWH
GENERATION	MARBO CT 1	"GWH"	2027	0	16 GWH
GENERATION	MARBO CT 1	"GWH"	2028	0	16 GWH
GENERATION	MARBO CT 1	"GWH"	2029	0	16 GWH
GENERATION	MARBO CT 1	"GWH"	2030	0	16 GWH
GENERATION	MARBO CT 1	"GWH"	2031	0	16 GWH
GENERATION	MARBO CT 1	"GWH"	2032	0	16 GWH
GENERATION	MARBO CT 1	"GWH"	2033	0	16 GWH
GENERATION	MARBO CT 1	"GWH"	2034	0	16 GWH
GENERATION	MARBO CT 1	"GWH"	2035	0	16 GWH
GENERATION	DED DSL 1	"GWH"	2006	0.018343303	2.5 GWH
GENERATION	DED DSL 1	"GWH"	2007	0.019715758	2.5 GWH
GENERATION	DED DSL 1	"GWH"	2008	0.018459685	2.5 GWH
GENERATION	DED DSL 1	"GWH"	2009	0.00791661	2.5 GWH
GENERATION	DED DSL 1	"GWH"	2010	0.011481657	2.5 GWH
GENERATION	DED DSL 1	"GWH"	2011	0.0094669	2.5 GWH
GENERATION	DED DSL 1	"GWH"	2012	0.002182128	2.5 GWH
GENERATION	DED DSL 1	"GWH"	2013	0.00758379	2.5 GWH
GENERATION	DED DSL 1	"GWH"	2014	0.002600276	2.5 GWH
GENERATION	DED DSL 1	"GWH"	2015	0.00221409	2.5 GWH
GENERATION	DED DSL 1	"GWH"	2016	0.00703105	2.5 GWH

GENERATION	DED DSL 1	"GWH"	2017	0	2.5 GWH
GENERATION	DED DSL 1	"GWH"	2018	0	2.5 GWH
GENERATION	DED DSL 1	"GWH"	2019	0	2.5 GWH
GENERATION	DED DSL 1	"GWH"	2020	0	2.5 GWH
GENERATION	DED DSL 1	"GWH"	2021	0	2.5 GWH
GENERATION	DED DSL 1	"GWH"	2022	0	2.5 GWH
GENERATION	DED DSL 1	"GWH"	2023	0	2.5 GWH
GENERATION	DED DSL 1	"GWH"	2024	0	2.5 GWH
GENERATION	DED DSL 1	"GWH"	2025	0	2.5 GWH
GENERATION	DED DSL 1	"GWH"	2026	0	2.5 GWH
GENERATION	DED DSL 1	"GWH"	2027	0	2.5 GWH
GENERATION	DED DSL 1	"GWH"	2028	0	2.5 GWH
GENERATION	DED DSL 1	"GWH"	2029	0	2.5 GWH
GENERATION	DED DSL 1	"GWH"	2030	0	2.5 GWH
GENERATION	DED DSL 1	"GWH"	2031	0	2.5 GWH
GENERATION	DED DSL 1	"GWH"	2032	0	2.5 GWH
GENERATION	DED DSL 1	"GWH"	2033	0	2.5 GWH
GENERATION	DED DSL 1	"GWH"	2034	0	2.5 GWH
GENERATION	DED DSL 1	"GWH"	2035	0	2.5 GWH
GENERATION	DED DSL 2	"GWH"	2006	0.018197848	2.5 GWH
GENERATION	DED DSL 2	"GWH"	2007	0.019785779	2.5 GWH
GENERATION	DED DSL 2	"GWH"	2008	0.01859531	2.5 GWH
GENERATION	DED DSL 2	"GWH"	2009	0.007626412	2.5 GWH
GENERATION	DED DSL 2	"GWH"	2010	0.01142681	2.5 GWH
GENERATION	DED DSL 2	"GWH"	2011	0.009593387	2.5 GWH
GENERATION	DED DSL 2	"GWH"	2012	0.002075304	2.5 GWH
GENERATION	DED DSL 2	"GWH"	2013	0.007411714	2.5 GWH
GENERATION	DED DSL 2	"GWH"	2014	0.002412591	2.5 GWH
GENERATION	DED DSL 2	"GWH"	2015	0.002186634	2.5 GWH
GENERATION	DED DSL 2	"GWH"	2016	0.006984639	2.5 GWH
GENERATION	DED DSL 2	"GWH"	2017	0	2.5 GWH
GENERATION	DED DSL 2	"GWH"	2018	0	2.5 GWH
GENERATION	DED DSL 2	"GWH"	2019	0	2.5 GWH
GENERATION	DED DSL 2	"GWH"	2020	0	2.5 GWH
GENERATION	DED DSL 2	"GWH"	2021	0	2.5 GWH
GENERATION	DED DSL 2	"GWH"	2022	0	2.5 GWH
GENERATION	DED DSL 2	"GWH"	2023	0	2.5 GWH
GENERATION	DED DSL 2	"GWH"	2024	0	2.5 GWH
GENERATION	DED DSL 2	"GWH"	2025	0	2.5 GWH
GENERATION	DED DSL 2	"GWH"	2026	0	2.5 GWH
GENERATION	DED DSL 2	"GWH"	2027	0	2.5 GWH
GENERATION	DED DSL 2	"GWH"	2028	0	2.5 GWH
GENERATION	DED DSL 2	"GWH"	2029	0	2.5 GWH
GENERATION	DED DSL 2	"GWH"	2030	0	2.5 GWH
GENERATION	DED DSL 2	"GWH"	2031	0	2.5 GWH
GENERATION	DED DSL 2	"GWH"	2032	0	2.5 GWH
GENERATION	DED DSL 2	"GWH"	2033	0	2.5 GWH
GENERATION	DED DSL 2	"GWH"	2034	0	2.5 GWH
GENERATION	DED DSL 2	"GWH"	2035	0	2.5 GWH
GENERATION	DED DSL 3	"GWH"	2006	0.018344585	2.5 GWH
GENERATION	DED DSL 3	"GWH"	2007	0.019751089	2.5 GWH
GENERATION	DED DSL 3	"GWH"	2008	0.018552478	2.5 GWH

GENERATION	DED DSL 3	"GWH"	2009	0.008049458	2.5 GWH
GENERATION	DED DSL 3	"GWH"	2010	0.011436333	2.5 GWH
GENERATION	DED DSL 3	"GWH"	2011	0.009489375	2.5 GWH
GENERATION	DED DSL 3	"GWH"	2012	0.002261559	2.5 GWH
GENERATION	DED DSL 3	"GWH"	2013	0.007436432	2.5 GWH
GENERATION	DED DSL 3	"GWH"	2014	0.002564431	2.5 GWH
GENERATION	DED DSL 3	"GWH"	2015	0.00214492	2.5 GWH
GENERATION	DED DSL 3	"GWH"	2016	0.006755251	2.5 GWH
GENERATION	DED DSL 3	"GWH"	2017	0	2.5 GWH
GENERATION	DED DSL 3	"GWH"	2018	0	2.5 GWH
GENERATION	DED DSL 3	"GWH"	2019	0	2.5 GWH
GENERATION	DED DSL 3	"GWH"	2020	0	2.5 GWH
GENERATION	DED DSL 3	"GWH"	2021	0	2.5 GWH
GENERATION	DED DSL 3	"GWH"	2022	0	2.5 GWH
GENERATION	DED DSL 3	"GWH"	2023	0	2.5 GWH
GENERATION	DED DSL 3	"GWH"	2024	0	2.5 GWH
GENERATION	DED DSL 3	"GWH"	2025	0	2.5 GWH
GENERATION	DED DSL 3	"GWH"	2026	0	2.5 GWH
GENERATION	DED DSL 3	"GWH"	2027	0	2.5 GWH
GENERATION	DED DSL 3	"GWH"	2028	0	2.5 GWH
GENERATION	DED DSL 3	"GWH"	2029	0	2.5 GWH
GENERATION	DED DSL 3	"GWH"	2030	0	2.5 GWH
GENERATION	DED DSL 3	"GWH"	2031	0	2.5 GWH
GENERATION	DED DSL 3	"GWH"	2032	0	2.5 GWH
GENERATION	DED DSL 3	"GWH"	2033	0	2.5 GWH
GENERATION	DED DSL 3	"GWH"	2034	0	2.5 GWH
GENERATION	DED DSL 3	"GWH"	2035	0	2.5 GWH
GENERATION	DED DSL 4	"GWH"	2006	0.018363377	2.5 GWH
GENERATION	DED DSL 4	"GWH"	2007	0.01970149	2.5 GWH
GENERATION	DED DSL 4	"GWH"	2008	0.018592272	2.5 GWH
GENERATION	DED DSL 4	"GWH"	2009	0.00791661	2.5 GWH
GENERATION	DED DSL 4	"GWH"	2010	0.011318668	2.5 GWH
GENERATION	DED DSL 4	"GWH"	2011	0.009415288	2.5 GWH
GENERATION	DED DSL 4	"GWH"	2012	0.002160105	2.5 GWH
GENERATION	DED DSL 4	"GWH"	2013	0.007402562	2.5 GWH
GENERATION	DED DSL 4	"GWH"	2014	0.002467704	2.5 GWH
GENERATION	DED DSL 4	"GWH"	2015	0.002109902	2.5 GWH
GENERATION	DED DSL 4	"GWH"	2016	0.006821812	2.5 GWH
GENERATION	DED DSL 4	"GWH"	2017	0	2.5 GWH
GENERATION	DED DSL 4	"GWH"	2018	0	2.5 GWH
GENERATION	DED DSL 4	"GWH"	2019	0	2.5 GWH
GENERATION	DED DSL 4	"GWH"	2020	0	2.5 GWH
GENERATION	DED DSL 4	"GWH"	2021	0	2.5 GWH
GENERATION	DED DSL 4	"GWH"	2022	0	2.5 GWH
GENERATION	DED DSL 4	"GWH"	2023	0	2.5 GWH
GENERATION	DED DSL 4	"GWH"	2024	0	2.5 GWH
GENERATION	DED DSL 4	"GWH"	2025	0	2.5 GWH
GENERATION	DED DSL 4	"GWH"	2026	0	2.5 GWH
GENERATION	DED DSL 4	"GWH"	2027	0	2.5 GWH
GENERATION	DED DSL 4	"GWH"	2028	0	2.5 GWH
GENERATION	DED DSL 4	"GWH"	2029	0	2.5 GWH
GENERATION	DED DSL 4	"GWH"	2030	0	2.5 GWH

GENERATION	DED DSL 4	"GWH"	2031	0	2.5 GWH
GENERATION	DED DSL 4	"GWH"	2032	0	2.5 GWH
GENERATION	DED DSL 4	"GWH"	2033	0	2.5 GWH
GENERATION	DED DSL 4	"GWH"	2034	0	2.5 GWH
GENERATION	DED DSL 4	"GWH"	2035	0	2.5 GWH
GENERATION	PULANTAT 1	"GWH"	2006	0.671150565	5.3 GWH
GENERATION	PULANTAT 1	"GWH"	2007	0.73766613	5.3 GWH
GENERATION	PULANTAT 1	"GWH"	2008	1.32791841	5.3 GWH
GENERATION	PULANTAT 1	"GWH"	2009	6.173215389	5.3 GWH
GENERATION	PULANTAT 1	"GWH"	2010	0.147993147	5.3 GWH
GENERATION	PULANTAT 1	"GWH"	2011	0.489416271	5.3 GWH
GENERATION	PULANTAT 1	"GWH"	2012	14.60031796	5.3 GWH
GENERATION	PULANTAT 1	"GWH"	2013	12.39622784	5.3 GWH
GENERATION	PULANTAT 1	"GWH"	2014	14.8718586	5.3 GWH
GENERATION	PULANTAT 1	"GWH"	2015	14.85096264	5.3 GWH
GENERATION	PULANTAT 1	"GWH"	2016	10.4699173	5.3 GWH
GENERATION	PULANTAT 1	"GWH"	2017	1.441115499	5.3 GWH
GENERATION	PULANTAT 1	"GWH"	2018	0.853109062	5.3 GWH
GENERATION	PULANTAT 1	"GWH"	2019	0.108643562	5.3 GWH
GENERATION	PULANTAT 1	"GWH"	2020	0.111478493	5.3 GWH
GENERATION	PULANTAT 1	"GWH"	2021	0.211907372	5.3 GWH
GENERATION	PULANTAT 1	"GWH"	2022	0.109786704	5.3 GWH
GENERATION	PULANTAT 1	"GWH"	2023	0.005472269	5.3 GWH
GENERATION	PULANTAT 1	"GWH"	2024	0.000894028	5.3 GWH
GENERATION	PULANTAT 1	"GWH"	2025	0	5.3 GWH
GENERATION	PULANTAT 1	"GWH"	2026	0	5.3 GWH
GENERATION	PULANTAT 1	"GWH"	2027	0	5.3 GWH
GENERATION	PULANTAT 1	"GWH"	2028	0	5.3 GWH
GENERATION	PULANTAT 1	"GWH"	2029	0	5.3 GWH
GENERATION	PULANTAT 1	"GWH"	2030	0	5.3 GWH
GENERATION	PULANTAT 1	"GWH"	2031	0	5.3 GWH
GENERATION	PULANTAT 1	"GWH"	2032	0	5.3 GWH
GENERATION	PULANTAT 1	"GWH"	2033	0	5.3 GWH
GENERATION	PULANTAT 1	"GWH"	2034	0	5.3 GWH
GENERATION	PULANTAT 1	"GWH"	2035	0	5.3 GWH
GENERATION	PULANTAT 2	"GWH"	2006	0.388918728	5.3 GWH
GENERATION	PULANTAT 2	"GWH"	2007	0.4327268	5.3 GWH
GENERATION	PULANTAT 2	"GWH"	2008	0.774958074	5.3 GWH
GENERATION	PULANTAT 2	"GWH"	2009	3.933485985	5.3 GWH
GENERATION	PULANTAT 2	"GWH"	2010	0.10612566	5.3 GWH
GENERATION	PULANTAT 2	"GWH"	2011	0.388680667	5.3 GWH
GENERATION	PULANTAT 2	"GWH"	2012	2.911872625	5.3 GWH
GENERATION	PULANTAT 2	"GWH"	2013	4.500094414	5.3 GWH
GENERATION	PULANTAT 2	"GWH"	2014	3.365707636	5.3 GWH
GENERATION	PULANTAT 2	"GWH"	2015	3.254305124	5.3 GWH
GENERATION	PULANTAT 2	"GWH"	2016	5.46819067	5.3 GWH
GENERATION	PULANTAT 2	"GWH"	2017	1.224295974	5.3 GWH
GENERATION	PULANTAT 2	"GWH"	2018	0.74657464	5.3 GWH
GENERATION	PULANTAT 2	"GWH"	2019	0.092043415	5.3 GWH
GENERATION	PULANTAT 2	"GWH"	2020	0.093511648	5.3 GWH
GENERATION	PULANTAT 2	"GWH"	2021	0.184254274	5.3 GWH
GENERATION	PULANTAT 2	"GWH"	2022	0.09218628	5.3 GWH

GENERATION	PULANTAT 2	"GWH"	2023	0.0049907	5.3 GWH
GENERATION	PULANTAT 2	"GWH"	2024	0.00088411	5.3 GWH
GENERATION	PULANTAT 2	"GWH"	2025	0	5.3 GWH
GENERATION	PULANTAT 2	"GWH"	2026	0	5.3 GWH
GENERATION	PULANTAT 2	"GWH"	2027	0	5.3 GWH
GENERATION	PULANTAT 2	"GWH"	2028	0	5.3 GWH
GENERATION	PULANTAT 2	"GWH"	2029	0	5.3 GWH
GENERATION	PULANTAT 2	"GWH"	2030	0	5.3 GWH
GENERATION	PULANTAT 2	"GWH"	2031	0	5.3 GWH
GENERATION	PULANTAT 2	"GWH"	2032	0	5.3 GWH
GENERATION	PULANTAT 2	"GWH"	2033	0	5.3 GWH
GENERATION	PULANTAT 2	"GWH"	2034	0	5.3 GWH
GENERATION	PULANTAT 2	"GWH"	2035	0	5.3 GWH
GENERATION	TENJO 1	"GWH"	2006	2.465346336	4.4 GWH
GENERATION	TENJO 1	"GWH"	2007	2.674108982	4.4 GWH
GENERATION	TENJO 1	"GWH"	2008	4.436698437	4.4 GWH
GENERATION	TENJO 1	"GWH"	2009	13.47601128	4.4 GWH
GENERATION	TENJO 1	"GWH"	2010	9.363145828	4.4 GWH
GENERATION	TENJO 1	"GWH"	2011	12.97492599	4.4 GWH
GENERATION	TENJO 1	"GWH"	2012	21.75001144	4.4 GWH
GENERATION	TENJO 1	"GWH"	2013	18.6341362	4.4 GWH
GENERATION	TENJO 1	"GWH"	2014	20.974617	4.4 GWH
GENERATION	TENJO 1	"GWH"	2015	20.99602699	4.4 GWH
GENERATION	TENJO 1	"GWH"	2016	16.25639153	4.4 GWH
GENERATION	TENJO 1	"GWH"	2017	5.008198261	4.4 GWH
GENERATION	TENJO 1	"GWH"	2018	3.285329342	4.4 GWH
GENERATION	TENJO 1	"GWH"	2019	0.521479547	4.4 GWH
GENERATION	TENJO 1	"GWH"	2020	0.46232605	4.4 GWH
GENERATION	TENJO 1	"GWH"	2021	0.774715662	4.4 GWH
GENERATION	TENJO 1	"GWH"	2022	0.52930969	4.4 GWH
GENERATION	TENJO 1	"GWH"	2023	0.0275025	4.4 GWH
GENERATION	TENJO 1	"GWH"	2024	0	4.4 GWH
GENERATION	TENJO 1	"GWH"	2025	0	4.4 GWH
GENERATION	TENJO 1	"GWH"	2026	0	4.4 GWH
GENERATION	TENJO 1	"GWH"	2027	0	4.4 GWH
GENERATION	TENJO 1	"GWH"	2028	0	4.4 GWH
GENERATION	TENJO 1	"GWH"	2029	0	4.4 GWH
GENERATION	TENJO 1	"GWH"	2030	0	4.4 GWH
GENERATION	TENJO 1	"GWH"	2031	0	4.4 GWH
GENERATION	TENJO 1	"GWH"	2032	0	4.4 GWH
GENERATION	TENJO 1	"GWH"	2033	0	4.4 GWH
GENERATION	TENJO 1	"GWH"	2034	0	4.4 GWH
GENERATION	TENJO 1	"GWH"	2035	0	4.4 GWH
GENERATION	TENJO 2	"GWH"	2006	2.021636248	4.4 GWH
GENERATION	TENJO 2	"GWH"	2007	2.211775064	4.4 GWH
GENERATION	TENJO 2	"GWH"	2008	3.687870264	4.4 GWH
GENERATION	TENJO 2	"GWH"	2009	12.28341484	4.4 GWH
GENERATION	TENJO 2	"GWH"	2010	8.461982727	4.4 GWH
GENERATION	TENJO 2	"GWH"	2011	11.77269173	4.4 GWH
GENERATION	TENJO 2	"GWH"	2012	20.76427841	4.4 GWH
GENERATION	TENJO 2	"GWH"	2013	17.81964684	4.4 GWH
GENERATION	TENJO 2	"GWH"	2014	20.27967834	4.4 GWH

GENERATION	TENJO	2	"GWH"	2015	20.2620945	4.4 GWH
GENERATION	TENJO	2	"GWH"	2016	15.48907089	4.4 GWH
GENERATION	TENJO	2	"GWH"	2017	4.386212826	4.4 GWH
GENERATION	TENJO	2	"GWH"	2018	2.887084484	4.4 GWH
GENERATION	TENJO	2	"GWH"	2019	0.45649147	4.4 GWH
GENERATION	TENJO	2	"GWH"	2020	0.392096072	4.4 GWH
GENERATION	TENJO	2	"GWH"	2021	0.679151416	4.4 GWH
GENERATION	TENJO	2	"GWH"	2022	0.449014246	4.4 GWH
GENERATION	TENJO	2	"GWH"	2023	0.02493263	4.4 GWH
GENERATION	TENJO	2	"GWH"	2024	0	4.4 GWH
GENERATION	TENJO	2	"GWH"	2025	0	4.4 GWH
GENERATION	TENJO	2	"GWH"	2026	0	4.4 GWH
GENERATION	TENJO	2	"GWH"	2027	0	4.4 GWH
GENERATION	TENJO	2	"GWH"	2028	0	4.4 GWH
GENERATION	TENJO	2	"GWH"	2029	0	4.4 GWH
GENERATION	TENJO	2	"GWH"	2030	0	4.4 GWH
GENERATION	TENJO	2	"GWH"	2031	0	4.4 GWH
GENERATION	TENJO	2	"GWH"	2032	0	4.4 GWH
GENERATION	TENJO	2	"GWH"	2033	0	4.4 GWH
GENERATION	TENJO	2	"GWH"	2034	0	4.4 GWH
GENERATION	TENJO	2	"GWH"	2035	0	4.4 GWH
GENERATION	TENJO	3	"GWH"	2006	1.659512401	4.4 GWH
GENERATION	TENJO	3	"GWH"	2007	1.7981987	4.4 GWH
GENERATION	TENJO	3	"GWH"	2008	3.054781199	4.4 GWH
GENERATION	TENJO	3	"GWH"	2009	11.20829868	4.4 GWH
GENERATION	TENJO	3	"GWH"	2010	7.555138588	4.4 GWH
GENERATION	TENJO	3	"GWH"	2011	10.73409271	4.4 GWH
GENERATION	TENJO	3	"GWH"	2012	19.90842628	4.4 GWH
GENERATION	TENJO	3	"GWH"	2013	16.96963501	4.4 GWH
GENERATION	TENJO	3	"GWH"	2014	19.54002762	4.4 GWH
GENERATION	TENJO	3	"GWH"	2015	19.44043922	4.4 GWH
GENERATION	TENJO	3	"GWH"	2016	14.45454788	4.4 GWH
GENERATION	TENJO	3	"GWH"	2017	3.91092515	4.4 GWH
GENERATION	TENJO	3	"GWH"	2018	2.471673965	4.4 GWH
GENERATION	TENJO	3	"GWH"	2019	0.374526799	4.4 GWH
GENERATION	TENJO	3	"GWH"	2020	0.343033224	4.4 GWH
GENERATION	TENJO	3	"GWH"	2021	0.599567711	4.4 GWH
GENERATION	TENJO	3	"GWH"	2022	0.391317487	4.4 GWH
GENERATION	TENJO	3	"GWH"	2023	0.019682288	4.4 GWH
GENERATION	TENJO	3	"GWH"	2024	0	4.4 GWH
GENERATION	TENJO	3	"GWH"	2025	0	4.4 GWH
GENERATION	TENJO	3	"GWH"	2026	0	4.4 GWH
GENERATION	TENJO	3	"GWH"	2027	0	4.4 GWH
GENERATION	TENJO	3	"GWH"	2028	0	4.4 GWH
GENERATION	TENJO	3	"GWH"	2029	0	4.4 GWH
GENERATION	TENJO	3	"GWH"	2030	0	4.4 GWH
GENERATION	TENJO	3	"GWH"	2031	0	4.4 GWH
GENERATION	TENJO	3	"GWH"	2032	0	4.4 GWH
GENERATION	TENJO	3	"GWH"	2033	0	4.4 GWH
GENERATION	TENJO	3	"GWH"	2034	0	4.4 GWH
GENERATION	TENJO	3	"GWH"	2035	0	4.4 GWH
GENERATION	TENJO	4	"GWH"	2006	1.354189157	4.4 GWH

GENERATION	TENJO	4	"GWH"	2007	1.47852385	4.4 GWH
GENERATION	TENJO	4	"GWH"	2008	2.527096748	4.4 GWH
GENERATION	TENJO	4	"GWH"	2009	9.930316925	4.4 GWH
GENERATION	TENJO	4	"GWH"	2010	6.620597839	4.4 GWH
GENERATION	TENJO	4	"GWH"	2011	9.717992783	4.4 GWH
GENERATION	TENJO	4	"GWH"	2012	18.95763016	4.4 GWH
GENERATION	TENJO	4	"GWH"	2013	16.08712959	4.4 GWH
GENERATION	TENJO	4	"GWH"	2014	18.815588	4.4 GWH
GENERATION	TENJO	4	"GWH"	2015	18.56320953	4.4 GWH
GENERATION	TENJO	4	"GWH"	2016	13.38914013	4.4 GWH
GENERATION	TENJO	4	"GWH"	2017	2.353987217	4.4 GWH
GENERATION	TENJO	4	"GWH"	2018	1.394672036	4.4 GWH
GENERATION	TENJO	4	"GWH"	2019	0.18295306	4.4 GWH
GENERATION	TENJO	4	"GWH"	2020	0.177363664	4.4 GWH
GENERATION	TENJO	4	"GWH"	2021	0.348418683	4.4 GWH
GENERATION	TENJO	4	"GWH"	2022	0.18329607	4.4 GWH
GENERATION	TENJO	4	"GWH"	2023	0.007233323	4.4 GWH
GENERATION	TENJO	4	"GWH"	2024	0	4.4 GWH
GENERATION	TENJO	4	"GWH"	2025	0	4.4 GWH
GENERATION	TENJO	4	"GWH"	2026	0	4.4 GWH
GENERATION	TENJO	4	"GWH"	2027	0	4.4 GWH
GENERATION	TENJO	4	"GWH"	2028	0	4.4 GWH
GENERATION	TENJO	4	"GWH"	2029	0	4.4 GWH
GENERATION	TENJO	4	"GWH"	2030	0	4.4 GWH
GENERATION	TENJO	4	"GWH"	2031	0	4.4 GWH
GENERATION	TENJO	4	"GWH"	2032	0	4.4 GWH
GENERATION	TENJO	4	"GWH"	2033	0	4.4 GWH
GENERATION	TENJO	4	"GWH"	2034	0	4.4 GWH
GENERATION	TENJO	4	"GWH"	2035	0	4.4 GWH
GENERATION	TENJO	5	"GWH"	2006	1.092301488	4.4 GWH
GENERATION	TENJO	5	"GWH"	2007	1.17752707	4.4 GWH
GENERATION	TENJO	5	"GWH"	2008	2.075635672	4.4 GWH
GENERATION	TENJO	5	"GWH"	2009	8.222949982	4.4 GWH
GENERATION	TENJO	5	"GWH"	2010	5.712337494	4.4 GWH
GENERATION	TENJO	5	"GWH"	2011	8.766563416	4.4 GWH
GENERATION	TENJO	5	"GWH"	2012	17.71585846	4.4 GWH
GENERATION	TENJO	5	"GWH"	2013	15.12409973	4.4 GWH
GENERATION	TENJO	5	"GWH"	2014	17.98703575	4.4 GWH
GENERATION	TENJO	5	"GWH"	2015	17.74198723	4.4 GWH
GENERATION	TENJO	5	"GWH"	2016	12.58147144	4.4 GWH
GENERATION	TENJO	5	"GWH"	2017	1.998481393	4.4 GWH
GENERATION	TENJO	5	"GWH"	2018	1.190669537	4.4 GWH
GENERATION	TENJO	5	"GWH"	2019	0.157998279	4.4 GWH
GENERATION	TENJO	5	"GWH"	2020	0.150640413	4.4 GWH
GENERATION	TENJO	5	"GWH"	2021	0.290561795	4.4 GWH
GENERATION	TENJO	5	"GWH"	2022	0.15658322	4.4 GWH
GENERATION	TENJO	5	"GWH"	2023	0.006986808	4.4 GWH
GENERATION	TENJO	5	"GWH"	2024	0	4.4 GWH
GENERATION	TENJO	5	"GWH"	2025	0	4.4 GWH
GENERATION	TENJO	5	"GWH"	2026	0	4.4 GWH
GENERATION	TENJO	5	"GWH"	2027	0	4.4 GWH
GENERATION	TENJO	5	"GWH"	2028	0	4.4 GWH

GENERATION	TENJO	5	"GWH"	2029	0	4.4 GWH
GENERATION	TENJO	5	"GWH"	2030	0	4.4 GWH
GENERATION	TENJO	5	"GWH"	2031	0	4.4 GWH
GENERATION	TENJO	5	"GWH"	2032	0	4.4 GWH
GENERATION	TENJO	5	"GWH"	2033	0	4.4 GWH
GENERATION	TENJO	5	"GWH"	2034	0	4.4 GWH
GENERATION	TENJO	5	"GWH"	2035	0	4.4 GWH
GENERATION	TENJO	6	"GWH"	2006	0.866701305	4.4 GWH
GENERATION	TENJO	6	"GWH"	2007	0.94897908	4.4 GWH
GENERATION	TENJO	6	"GWH"	2008	1.68595767	4.4 GWH
GENERATION	TENJO	6	"GWH"	2009	7.207866669	4.4 GWH
GENERATION	TENJO	6	"GWH"	2010	4.867422104	4.4 GWH
GENERATION	TENJO	6	"GWH"	2011	7.827905178	4.4 GWH
GENERATION	TENJO	6	"GWH"	2012	16.62568665	4.4 GWH
GENERATION	TENJO	6	"GWH"	2013	14.14293957	4.4 GWH
GENERATION	TENJO	6	"GWH"	2014	17.11286736	4.4 GWH
GENERATION	TENJO	6	"GWH"	2015	16.83137131	4.4 GWH
GENERATION	TENJO	6	"GWH"	2016	11.7867651	4.4 GWH
GENERATION	TENJO	6	"GWH"	2017	1.710520148	4.4 GWH
GENERATION	TENJO	6	"GWH"	2018	1.019281626	4.4 GWH
GENERATION	TENJO	6	"GWH"	2019	0.133160457	4.4 GWH
GENERATION	TENJO	6	"GWH"	2020	0.128176793	4.4 GWH
GENERATION	TENJO	6	"GWH"	2021	0.248947635	4.4 GWH
GENERATION	TENJO	6	"GWH"	2022	0.133629918	4.4 GWH
GENERATION	TENJO	6	"GWH"	2023	0.006633717	4.4 GWH
GENERATION	TENJO	6	"GWH"	2024	0	4.4 GWH
GENERATION	TENJO	6	"GWH"	2025	0	4.4 GWH
GENERATION	TENJO	6	"GWH"	2026	0	4.4 GWH
GENERATION	TENJO	6	"GWH"	2027	0	4.4 GWH
GENERATION	TENJO	6	"GWH"	2028	0	4.4 GWH
GENERATION	TENJO	6	"GWH"	2029	0	4.4 GWH
GENERATION	TENJO	6	"GWH"	2030	0	4.4 GWH
GENERATION	TENJO	6	"GWH"	2031	0	4.4 GWH
GENERATION	TENJO	6	"GWH"	2032	0	4.4 GWH
GENERATION	TENJO	6	"GWH"	2033	0	4.4 GWH
GENERATION	TENJO	6	"GWH"	2034	0	4.4 GWH
GENERATION	TENJO	6	"GWH"	2035	0	4.4 GWH
GENERATION	TAL DSL	1	"GWH"	2006	3.589191198	4.4 GWH
GENERATION	TAL DSL	1	"GWH"	2007	3.783447981	4.4 GWH
GENERATION	TAL DSL	1	"GWH"	2008	6.077517986	4.4 GWH
GENERATION	TAL DSL	1	"GWH"	2009	14.99798012	4.4 GWH
GENERATION	TAL DSL	1	"GWH"	2010	11.18309116	4.4 GWH
GENERATION	TAL DSL	1	"GWH"	2011	14.8731575	4.4 GWH
GENERATION	TAL DSL	1	"GWH"	2012	21.0723381	4.4 GWH
GENERATION	TAL DSL	1	"GWH"	2013	19.12612152	4.4 GWH
GENERATION	TAL DSL	1	"GWH"	2014	20.7273941	4.4 GWH
GENERATION	TAL DSL	1	"GWH"	2015	20.93124008	4.4 GWH
GENERATION	TAL DSL	1	"GWH"	2016	17.16305161	4.4 GWH
GENERATION	TAL DSL	1	"GWH"	2017	6.037154675	4.4 GWH
GENERATION	TAL DSL	1	"GWH"	2018	4.194058895	4.4 GWH
GENERATION	TAL DSL	1	"GWH"	2019	0.705072761	4.4 GWH
GENERATION	TAL DSL	1	"GWH"	2020	0.600196719	4.4 GWH

GENERATION	TAL DSL 1	"GWH"	2021	1.001457214	4.4	GWH
GENERATION	TAL DSL 1	"GWH"	2022	0.700236976	4.4	GWH
GENERATION	TAL DSL 1	"GWH"	2023	0.034270257	4.4	GWH
GENERATION	TAL DSL 1	"GWH"	2024	0	4.4	GWH
GENERATION	TAL DSL 1	"GWH"	2025	0	4.4	GWH
GENERATION	TAL DSL 1	"GWH"	2026	0	4.4	GWH
GENERATION	TAL DSL 1	"GWH"	2027	0	4.4	GWH
GENERATION	TAL DSL 1	"GWH"	2028	0	4.4	GWH
GENERATION	TAL DSL 1	"GWH"	2029	0	4.4	GWH
GENERATION	TAL DSL 1	"GWH"	2030	0	4.4	GWH
GENERATION	TAL DSL 1	"GWH"	2031	0	4.4	GWH
GENERATION	TAL DSL 1	"GWH"	2032	0	4.4	GWH
GENERATION	TAL DSL 1	"GWH"	2033	0	4.4	GWH
GENERATION	TAL DSL 1	"GWH"	2034	0	4.4	GWH
GENERATION	TAL DSL 1	"GWH"	2035	0	4.4	GWH
GENERATION	TAL DSL 2	"GWH"	2006	3.004975319	4.4	GWH
GENERATION	TAL DSL 2	"GWH"	2007	3.197347403	4.4	GWH
GENERATION	TAL DSL 2	"GWH"	2008	4.464890957	4.4	GWH
GENERATION	TAL DSL 2	"GWH"	2009	5.416194916	4.4	GWH
GENERATION	TAL DSL 2	"GWH"	2010	5.937414646	4.4	GWH
GENERATION	TAL DSL 2	"GWH"	2011	6.467737198	4.4	GWH
GENERATION	TAL DSL 2	"GWH"	2012	1.678775787	4.4	GWH
GENERATION	TAL DSL 2	"GWH"	2013	3.61117959	4.4	GWH
GENERATION	TAL DSL 2	"GWH"	2014	1.961167216	4.4	GWH
GENERATION	TAL DSL 2	"GWH"	2015	1.747202754	4.4	GWH
GENERATION	TAL DSL 2	"GWH"	2016	5.306264877	4.4	GWH
GENERATION	TAL DSL 2	"GWH"	2017	5.515933514	4.4	GWH
GENERATION	TAL DSL 2	"GWH"	2018	3.71693325	4.4	GWH
GENERATION	TAL DSL 2	"GWH"	2019	0.602361798	4.4	GWH
GENERATION	TAL DSL 2	"GWH"	2020	0.526057005	4.4	GWH
GENERATION	TAL DSL 2	"GWH"	2021	0.884206355	4.4	GWH
GENERATION	TAL DSL 2	"GWH"	2022	0.60476768	4.4	GWH
GENERATION	TAL DSL 2	"GWH"	2023	0.030843742	4.4	GWH
GENERATION	TAL DSL 2	"GWH"	2024	0	4.4	GWH
GENERATION	TAL DSL 2	"GWH"	2025	0	4.4	GWH
GENERATION	TAL DSL 2	"GWH"	2026	0	4.4	GWH
GENERATION	TAL DSL 2	"GWH"	2027	0	4.4	GWH
GENERATION	TAL DSL 2	"GWH"	2028	0	4.4	GWH
GENERATION	TAL DSL 2	"GWH"	2029	0	4.4	GWH
GENERATION	TAL DSL 2	"GWH"	2030	0	4.4	GWH
GENERATION	TAL DSL 2	"GWH"	2031	0	4.4	GWH
GENERATION	TAL DSL 2	"GWH"	2032	0	4.4	GWH
GENERATION	TAL DSL 2	"GWH"	2033	0	4.4	GWH
GENERATION	TAL DSL 2	"GWH"	2034	0	4.4	GWH
GENERATION	TAL DSL 2	"GWH"	2035	0	4.4	GWH
GENERATION	TANGO 1	"GWH"	2006	17.14564705	26.5	GWH
GENERATION	TANGO 1	"GWH"	2007	18.93506813	26.5	GWH
GENERATION	TANGO 1	"GWH"	2008	25.6617775	26.5	GWH
GENERATION	TANGO 1	"GWH"	2009	50.66033936	26.5	GWH
GENERATION	TANGO 1	"GWH"	2010	40.95973206	26.5	GWH
GENERATION	TANGO 1	"GWH"	2011	46.99453735	26.5	GWH
GENERATION	TANGO 1	"GWH"	2012	65.30500793	26.5	GWH

GENERATION	TANGO	1	"GWH"	2013	58.52910614	26.5	GWH
GENERATION	TANGO	1	"GWH"	2014	64.75224304	26.5	GWH
GENERATION	TANGO	1	"GWH"	2015	63.69191742	26.5	GWH
GENERATION	TANGO	1	"GWH"	2016	54.17066574	26.5	GWH
GENERATION	TANGO	1	"GWH"	2017	31.87029457	26.5	GWH
GENERATION	TANGO	1	"GWH"	2018	22.98740196	26.5	GWH
GENERATION	TANGO	1	"GWH"	2019	6.648762226	26.5	GWH
GENERATION	TANGO	1	"GWH"	2020	5.527570724	26.5	GWH
GENERATION	TANGO	1	"GWH"	2021	8.144568443	26.5	GWH
GENERATION	TANGO	1	"GWH"	2022	6.564793587	26.5	GWH
GENERATION	TANGO	1	"GWH"	2023	0.517792165	26.5	GWH
GENERATION	TANGO	1	"GWH"	2024	0.00415679	26.5	GWH
GENERATION	TANGO	1	"GWH"	2025	0.001697593	26.5	GWH
GENERATION	TANGO	1	"GWH"	2026	0.003359187	26.5	GWH
GENERATION	TANGO	1	"GWH"	2027	0.008715856	26.5	GWH
GENERATION	TANGO	1	"GWH"	2028	0.008166095	26.5	GWH
GENERATION	TANGO	1	"GWH"	2029	0	26.5	GWH
GENERATION	TANGO	1	"GWH"	2030	0	26.5	GWH
GENERATION	TANGO	1	"GWH"	2031	0	26.5	GWH
GENERATION	TANGO	1	"GWH"	2032	0	26.5	GWH
GENERATION	TANGO	1	"GWH"	2033	0	26.5	GWH
GENERATION	TANGO	1	"GWH"	2034	0	26.5	GWH
GENERATION	TANGO	1	"GWH"	2035	0	26.5	GWH
GENERATION	TANGO	2	"GWH"	2006	24.85468292	26.5	GWH
GENERATION	TANGO	2	"GWH"	2007	26.29432297	26.5	GWH
GENERATION	TANGO	2	"GWH"	2008	33.99887085	26.5	GWH
GENERATION	TANGO	2	"GWH"	2009	56.19168091	26.5	GWH
GENERATION	TANGO	2	"GWH"	2010	46.75988007	26.5	GWH
GENERATION	TANGO	2	"GWH"	2011	52.9179039	26.5	GWH
GENERATION	TANGO	2	"GWH"	2012	68.60292816	26.5	GWH
GENERATION	TANGO	2	"GWH"	2013	63.0117569	26.5	GWH
GENERATION	TANGO	2	"GWH"	2014	68.30626678	26.5	GWH
GENERATION	TANGO	2	"GWH"	2015	67.11392975	26.5	GWH
GENERATION	TANGO	2	"GWH"	2016	58.7400589	26.5	GWH
GENERATION	TANGO	2	"GWH"	2017	37.03868866	26.5	GWH
GENERATION	TANGO	2	"GWH"	2018	27.86852646	26.5	GWH
GENERATION	TANGO	2	"GWH"	2019	10.55696392	26.5	GWH
GENERATION	TANGO	2	"GWH"	2020	7.627311707	26.5	GWH
GENERATION	TANGO	2	"GWH"	2021	10.77091026	26.5	GWH
GENERATION	TANGO	2	"GWH"	2022	8.972349167	26.5	GWH
GENERATION	TANGO	2	"GWH"	2023	0.857408583	26.5	GWH
GENERATION	TANGO	2	"GWH"	2024	0.009854277	26.5	GWH
GENERATION	TANGO	2	"GWH"	2025	0.004383123	26.5	GWH
GENERATION	TANGO	2	"GWH"	2026	0.012992294	26.5	GWH
GENERATION	TANGO	2	"GWH"	2027	0.009350931	26.5	GWH
GENERATION	TANGO	2	"GWH"	2028	0.008494855	26.5	GWH
GENERATION	TANGO	2	"GWH"	2029	0.009142993	26.5	GWH
GENERATION	TANGO	2	"GWH"	2030	0	26.5	GWH
GENERATION	TANGO	2	"GWH"	2031	0	26.5	GWH
GENERATION	TANGO	2	"GWH"	2032	0	26.5	GWH
GENERATION	TANGO	2	"GWH"	2033	0	26.5	GWH
GENERATION	TANGO	2	"GWH"	2034	0	26.5	GWH

GENERATION	TANGO	2	"GWH"	2035	0	26.5 GWH
GENERATION	MEC	1	"GWH"	2006	331.9345398	44.2 GWH
GENERATION	MEC	1	"GWH"	2007	332.4535522	44.2 GWH
GENERATION	MEC	1	"GWH"	2008	336.7198181	44.2 GWH
GENERATION	MEC	1	"GWH"	2009	328.5270691	44.2 GWH
GENERATION	MEC	1	"GWH"	2010	338.0068359	44.2 GWH
GENERATION	MEC	1	"GWH"	2011	338.1943054	44.2 GWH
GENERATION	MEC	1	"GWH"	2012	335.9028625	44.2 GWH
GENERATION	MEC	1	"GWH"	2013	338.2726746	44.2 GWH
GENERATION	MEC	1	"GWH"	2014	338.2812805	44.2 GWH
GENERATION	MEC	1	"GWH"	2015	338.2820435	44.2 GWH
GENERATION	MEC	1	"GWH"	2016	338.6687927	44.2 GWH
GENERATION	MEC	1	"GWH"	2017	335.7449341	44.2 GWH
GENERATION	MEC	1	"GWH"	2018	328.2003479	44.2 GWH
GENERATION	MEC	1	"GWH"	2019	287.693573	44.2 GWH
GENERATION	MEC	1	"GWH"	2020	286.7836304	44.2 GWH
GENERATION	MEC	1	"GWH"	2021	294.4605103	44.2 GWH
GENERATION	MEC	1	"GWH"	2022	286.033783	44.2 GWH
GENERATION	MEC	1	"GWH"	2023	219.3195343	44.2 GWH
GENERATION	MEC	1	"GWH"	2024	140.1792755	44.2 GWH
GENERATION	MEC	1	"GWH"	2025	137.9647522	44.2 GWH
GENERATION	MEC	1	"GWH"	2026	132.1333771	44.2 GWH
GENERATION	MEC	1	"GWH"	2027	101.3988113	44.2 GWH
GENERATION	MEC	1	"GWH"	2028	112.3330154	44.2 GWH
GENERATION	MEC	1	"GWH"	2029	103.4331894	44.2 GWH
GENERATION	MEC	1	"GWH"	2030	80.66482544	44.2 GWH
GENERATION	MEC	1	"GWH"	2031	83.99339294	44.2 GWH
GENERATION	MEC	1	"GWH"	2032	85.94910431	44.2 GWH
GENERATION	MEC	1	"GWH"	2033	86.78556061	44.2 GWH
GENERATION	MEC	1	"GWH"	2034	90.35635376	44.2 GWH
GENERATION	MEC	1	"GWH"	2035	87.67788696	44.2 GWH
GENERATION	MEC	2	"GWH"	2006	324.6766052	44.2 GWH
GENERATION	MEC	2	"GWH"	2007	325.9742126	44.2 GWH
GENERATION	MEC	2	"GWH"	2008	332.2223816	44.2 GWH
GENERATION	MEC	2	"GWH"	2009	321.5759888	44.2 GWH
GENERATION	MEC	2	"GWH"	2010	337.0569153	44.2 GWH
GENERATION	MEC	2	"GWH"	2011	337.9429016	44.2 GWH
GENERATION	MEC	2	"GWH"	2012	331.0109253	44.2 GWH
GENERATION	MEC	2	"GWH"	2013	338.2364502	44.2 GWH
GENERATION	MEC	2	"GWH"	2014	338.2609253	44.2 GWH
GENERATION	MEC	2	"GWH"	2015	338.2482605	44.2 GWH
GENERATION	MEC	2	"GWH"	2016	337.9415283	44.2 GWH
GENERATION	MEC	2	"GWH"	2017	334.427124	44.2 GWH
GENERATION	MEC	2	"GWH"	2018	328.2547607	44.2 GWH
GENERATION	MEC	2	"GWH"	2019	276.931366	44.2 GWH
GENERATION	MEC	2	"GWH"	2020	275.0898132	44.2 GWH
GENERATION	MEC	2	"GWH"	2021	284.1278687	44.2 GWH
GENERATION	MEC	2	"GWH"	2022	274.5913391	44.2 GWH
GENERATION	MEC	2	"GWH"	2023	199.3833923	44.2 GWH
GENERATION	MEC	2	"GWH"	2024	129.3405762	44.2 GWH
GENERATION	MEC	2	"GWH"	2025	130.1504059	44.2 GWH
GENERATION	MEC	2	"GWH"	2026	122.4136658	44.2 GWH

GENERATION	MEC	2	"GWH"	2027	95.01837158	44.2	GWH
GENERATION	MEC	2	"GWH"	2028	106.0986023	44.2	GWH
GENERATION	MEC	2	"GWH"	2029	95.22080231	44.2	GWH
GENERATION	MEC	2	"GWH"	2030	77.20336914	44.2	GWH
GENERATION	MEC	2	"GWH"	2031	79.8964386	44.2	GWH
GENERATION	MEC	2	"GWH"	2032	83.41473389	44.2	GWH
GENERATION	MEC	2	"GWH"	2033	83.31430054	44.2	GWH
GENERATION	MEC	2	"GWH"	2034	84.80404663	44.2	GWH
GENERATION	MEC	2	"GWH"	2035	84.05001831	44.2	GWH
GENERATION	TEMES	1	"GWH"	2006	11.2920084	40	GWH
GENERATION	TEMES	1	"GWH"	2007	12.23641014	40	GWH
GENERATION	TEMES	1	"GWH"	2008	18.06395531	40	GWH
GENERATION	TEMES	1	"GWH"	2009	42.11833572	40	GWH
GENERATION	TEMES	1	"GWH"	2010	31.12590218	40	GWH
GENERATION	TEMES	1	"GWH"	2011	38.32129288	40	GWH
GENERATION	TEMES	1	"GWH"	2012	54.76357269	40	GWH
GENERATION	TEMES	1	"GWH"	2013	47.8810997	40	GWH
GENERATION	TEMES	1	"GWH"	2014	52.77749252	40	GWH
GENERATION	TEMES	1	"GWH"	2015	52.4142189	40	GWH
GENERATION	TEMES	1	"GWH"	2016	34.18085098	40	GWH
GENERATION	TEMES	1	"GWH"	2017	0	40	GWH
GENERATION	TEMES	1	"GWH"	2018	0	40	GWH
GENERATION	TEMES	1	"GWH"	2019	0	40	GWH
GENERATION	TEMES	1	"GWH"	2020	0	40	GWH
GENERATION	TEMES	1	"GWH"	2021	0	40	GWH
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GENERATION	TEMES	1	"GWH"	2023	0	40	GWH
GENERATION	TEMES	1	"GWH"	2024	0	40	GWH
GENERATION	TEMES	1	"GWH"	2025	0	40	GWH
GENERATION	TEMES	1	"GWH"	2026	0	40	GWH
GENERATION	TEMES	1	"GWH"	2027	0	40	GWH
GENERATION	TEMES	1	"GWH"	2028	0	40	GWH
GENERATION	TEMES	1	"GWH"	2029	0	40	GWH
GENERATION	TEMES	1	"GWH"	2030	0	40	GWH
GENERATION	TEMES	1	"GWH"	2031	0	40	GWH
GENERATION	TEMES	1	"GWH"	2032	0	40	GWH
GENERATION	TEMES	1	"GWH"	2033	0	40	GWH
GENERATION	TEMES	1	"GWH"	2034	0	40	GWH
GENERATION	TEMES	1	"GWH"	2035	0	40	GWH
GENERATION	CFB	1	"GWH"	2006	0	#N/A	GWH
GENERATION	CFB	1	"GWH"	2007	0	#N/A	GWH
GENERATION	CFB	1	"GWH"	2008	0	#N/A	GWH
GENERATION	CFB	1	"GWH"	2009	0	#N/A	GWH
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GENERATION	CFB	1	"GWH"	2011	0	#N/A	GWH
GENERATION	CFB	1	"GWH"	2012	0	#N/A	GWH
GENERATION	CFB	1	"GWH"	2013	0	#N/A	GWH
GENERATION	CFB	1	"GWH"	2014	0	#N/A	GWH
GENERATION	CFB	1	"GWH"	2015	0	#N/A	GWH
GENERATION	CFB	1	"GWH"	2016	0	#N/A	GWH
GENERATION	CFB	1	"GWH"	2017	0	#N/A	GWH
GENERATION	CFB	1	"GWH"	2018	0	#N/A	GWH

GENERATION	CFB	1	"GWH"	2019	0	#N/A	GWH
GENERATION	CFB	1	"GWH"	2020	0	#N/A	GWH
GENERATION	CFB	1	"GWH"	2021	0	#N/A	GWH
GENERATION	CFB	1	"GWH"	2022	0	#N/A	GWH
GENERATION	CFB	1	"GWH"	2023	0	#N/A	GWH
GENERATION	CFB	1	"GWH"	2024	0	#N/A	GWH
GENERATION	CFB	1	"GWH"	2025	0	#N/A	GWH
GENERATION	CFB	1	"GWH"	2026	0	#N/A	GWH
GENERATION	CFB	1	"GWH"	2027	0	#N/A	GWH
GENERATION	CFB	1	"GWH"	2028	0	#N/A	GWH
GENERATION	CFB	1	"GWH"	2029	0	#N/A	GWH
GENERATION	CFB	1	"GWH"	2030	0	#N/A	GWH
GENERATION	CFB	1	"GWH"	2031	0	#N/A	GWH
GENERATION	CFB	1	"GWH"	2032	0	#N/A	GWH
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GENERATION	CFB	1	"GWH"	2035	0	#N/A	GWH
GENERATION	RECIP	1	"GWH"	2006	0	#N/A	GWH
GENERATION	RECIP	1	"GWH"	2007	0	#N/A	GWH
GENERATION	RECIP	1	"GWH"	2008	0	#N/A	GWH
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GENERATION	RECIP	1	"GWH"	2011	0	#N/A	GWH
GENERATION	RECIP	1	"GWH"	2012	0	#N/A	GWH
GENERATION	RECIP	1	"GWH"	2013	0	#N/A	GWH
GENERATION	RECIP	1	"GWH"	2014	0	#N/A	GWH
GENERATION	RECIP	1	"GWH"	2015	0	#N/A	GWH
GENERATION	RECIP	1	"GWH"	2016	0	#N/A	GWH
GENERATION	RECIP	1	"GWH"	2017	0	#N/A	GWH
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GENERATION	RECIP	1	"GWH"	2019	0	#N/A	GWH
GENERATION	RECIP	1	"GWH"	2020	0	#N/A	GWH
GENERATION	RECIP	1	"GWH"	2021	0	#N/A	GWH
GENERATION	RECIP	1	"GWH"	2022	0	#N/A	GWH
GENERATION	RECIP	1	"GWH"	2023	0	#N/A	GWH
GENERATION	RECIP	1	"GWH"	2024	0	#N/A	GWH
GENERATION	RECIP	1	"GWH"	2025	0	#N/A	GWH
GENERATION	RECIP	1	"GWH"	2026	0	#N/A	GWH
GENERATION	RECIP	1	"GWH"	2027	0	#N/A	GWH
GENERATION	RECIP	1	"GWH"	2028	0	#N/A	GWH
GENERATION	RECIP	1	"GWH"	2029	0	#N/A	GWH
GENERATION	RECIP	1	"GWH"	2030	0	#N/A	GWH
GENERATION	RECIP	1	"GWH"	2031	0	#N/A	GWH
GENERATION	RECIP	1	"GWH"	2032	0	#N/A	GWH
GENERATION	RECIP	1	"GWH"	2033	0	#N/A	GWH
GENERATION	RECIP	1	"GWH"	2034	0	#N/A	GWH
GENERATION	RECIP	1	"GWH"	2035	0	#N/A	GWH
GENERATION	MSW	1	"GWH"	2006	0	#N/A	GWH
GENERATION	MSW	1	"GWH"	2007	0	#N/A	GWH
GENERATION	MSW	1	"GWH"	2008	0	#N/A	GWH
GENERATION	MSW	1	"GWH"	2009	0	#N/A	GWH
GENERATION	MSW	1	"GWH"	2010	0	#N/A	GWH

GENERATION	MSW	1	"GWH"	2011	0	#N/A	GWH
GENERATION	MSW	1	"GWH"	2012	0	#N/A	GWH
GENERATION	MSW	1	"GWH"	2013	0	#N/A	GWH
GENERATION	MSW	1	"GWH"	2014	0	#N/A	GWH
GENERATION	MSW	1	"GWH"	2015	0	#N/A	GWH
GENERATION	MSW	1	"GWH"	2016	0	#N/A	GWH
GENERATION	MSW	1	"GWH"	2017	0	#N/A	GWH
GENERATION	MSW	1	"GWH"	2018	0	#N/A	GWH
GENERATION	MSW	1	"GWH"	2019	0	#N/A	GWH
GENERATION	MSW	1	"GWH"	2020	0	#N/A	GWH
GENERATION	MSW	1	"GWH"	2021	0	#N/A	GWH
GENERATION	MSW	1	"GWH"	2022	0	#N/A	GWH
GENERATION	MSW	1	"GWH"	2023	0	#N/A	GWH
GENERATION	MSW	1	"GWH"	2024	0	#N/A	GWH
GENERATION	MSW	1	"GWH"	2025	0	#N/A	GWH
GENERATION	MSW	1	"GWH"	2026	0	#N/A	GWH
GENERATION	MSW	1	"GWH"	2027	0	#N/A	GWH
GENERATION	MSW	1	"GWH"	2028	0	#N/A	GWH
GENERATION	MSW	1	"GWH"	2029	0	#N/A	GWH
GENERATION	MSW	1	"GWH"	2030	0	#N/A	GWH
GENERATION	MSW	1	"GWH"	2031	0	#N/A	GWH
GENERATION	MSW	1	"GWH"	2032	0	#N/A	GWH
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GENERATION	MSW	1	"GWH"	2035	0	#N/A	GWH
GENERATION	RETR	1	"GWH"	2006	0	#N/A	GWH
GENERATION	RETR	1	"GWH"	2007	0	#N/A	GWH
GENERATION	RETR	1	"GWH"	2008	0	#N/A	GWH
GENERATION	RETR	1	"GWH"	2009	0	#N/A	GWH
GENERATION	RETR	1	"GWH"	2010	0	#N/A	GWH
GENERATION	RETR	1	"GWH"	2011	0	#N/A	GWH
GENERATION	RETR	1	"GWH"	2012	0	#N/A	GWH
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GENERATION	RETR	1	"GWH"	2016	0	#N/A	GWH
GENERATION	RETR	1	"GWH"	2017	0	#N/A	GWH
GENERATION	RETR	1	"GWH"	2018	0	#N/A	GWH
GENERATION	RETR	1	"GWH"	2019	0	#N/A	GWH
GENERATION	RETR	1	"GWH"	2020	0	#N/A	GWH
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GENERATION	RETR	1	"GWH"	2022	0	#N/A	GWH
GENERATION	RETR	1	"GWH"	2023	0	#N/A	GWH
GENERATION	RETR	1	"GWH"	2024	0	#N/A	GWH
GENERATION	RETR	1	"GWH"	2025	0	#N/A	GWH
GENERATION	RETR	1	"GWH"	2026	0	#N/A	GWH
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GENERATION	RETR	1	"GWH"	2029	0	#N/A	GWH
GENERATION	RETR	1	"GWH"	2030	0	#N/A	GWH
GENERATION	RETR	1	"GWH"	2031	0	#N/A	GWH
GENERATION	RETR	1	"GWH"	2032	0	#N/A	GWH

GENERATION	RETR	1	"GWH"	2033	0	#N/A	GWH
GENERATION	RETR	1	"GWH"	2034	0	#N/A	GWH
GENERATION	RETR	1	"GWH"	2035	0	#N/A	GWH
GENERATION	CLNG	1	"GWH"	2006	0	#N/A	GWH
GENERATION	CLNG	1	"GWH"	2007	0	#N/A	GWH
GENERATION	CLNG	1	"GWH"	2008	0	#N/A	GWH
GENERATION	CLNG	1	"GWH"	2009	0	#N/A	GWH
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GENERATION	CLNG	1	"GWH"	2011	0	#N/A	GWH
GENERATION	CLNG	1	"GWH"	2012	0	#N/A	GWH
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GENERATION	CLNG	1	"GWH"	2016	0	#N/A	GWH
GENERATION	CLNG	1	"GWH"	2017	0	#N/A	GWH
GENERATION	CLNG	1	"GWH"	2018	0	#N/A	GWH
GENERATION	CLNG	1	"GWH"	2019	0	#N/A	GWH
GENERATION	CLNG	1	"GWH"	2020	0	#N/A	GWH
GENERATION	CLNG	1	"GWH"	2021	0	#N/A	GWH
GENERATION	CLNG	1	"GWH"	2022	0	#N/A	GWH
GENERATION	CLNG	1	"GWH"	2023	0	#N/A	GWH
GENERATION	CLNG	1	"GWH"	2024	0	#N/A	GWH
GENERATION	CLNG	1	"GWH"	2025	0	#N/A	GWH
GENERATION	CLNG	1	"GWH"	2026	0	#N/A	GWH
GENERATION	CLNG	1	"GWH"	2027	0	#N/A	GWH
GENERATION	CLNG	1	"GWH"	2028	0	#N/A	GWH
GENERATION	CLNG	1	"GWH"	2029	0	#N/A	GWH
GENERATION	CLNG	1	"GWH"	2030	0	#N/A	GWH
GENERATION	CLNG	1	"GWH"	2031	0	#N/A	GWH
GENERATION	CLNG	1	"GWH"	2032	0	#N/A	GWH
GENERATION	CLNG	1	"GWH"	2033	0	#N/A	GWH
GENERATION	CLNG	1	"GWH"	2034	0	#N/A	GWH
GENERATION	CLNG	1	"GWH"	2035	0	#N/A	GWH
GENERATION	WIND	1	"GWH"	2006	0	#N/A	GWH
GENERATION	WIND	1	"GWH"	2007	0	#N/A	GWH
GENERATION	WIND	1	"GWH"	2008	0	#N/A	GWH
GENERATION	WIND	1	"GWH"	2009	0	#N/A	GWH
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GENERATION	WIND	1	"GWH"	2018	0	#N/A	GWH
GENERATION	WIND	1	"GWH"	2019	0	#N/A	GWH
GENERATION	WIND	1	"GWH"	2020	0	#N/A	GWH
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GENERATION	WIND	1	"GWH"	2022	0	#N/A	GWH
GENERATION	WIND	1	"GWH"	2023	0	#N/A	GWH
GENERATION	WIND	1	"GWH"	2024	0	#N/A	GWH

GENERATION	WIND	1	"GWH"	2025	0	#N/A	GWH
GENERATION	WIND	1	"GWH"	2026	0	#N/A	GWH
GENERATION	WIND	1	"GWH"	2027	0	#N/A	GWH
GENERATION	WIND	1	"GWH"	2028	0	#N/A	GWH
GENERATION	WIND	1	"GWH"	2029	0	#N/A	GWH
GENERATION	WIND	1	"GWH"	2030	0	#N/A	GWH
GENERATION	WIND	1	"GWH"	2031	0	#N/A	GWH
GENERATION	WIND	1	"GWH"	2032	0	#N/A	GWH
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GENERATION	WIND	1	"GWH"	2035	0	#N/A	GWH
GENERATION	CAB LNG	1	"GWH"	2006	0	#N/A	GWH
GENERATION	CAB LNG	1	"GWH"	2007	0	#N/A	GWH
GENERATION	CAB LNG	1	"GWH"	2008	0	#N/A	GWH
GENERATION	CAB LNG	1	"GWH"	2009	0	#N/A	GWH
GENERATION	CAB LNG	1	"GWH"	2010	0	#N/A	GWH
GENERATION	CAB LNG	1	"GWH"	2011	0	#N/A	GWH
GENERATION	CAB LNG	1	"GWH"	2012	0	#N/A	GWH
GENERATION	CAB LNG	1	"GWH"	2013	0	#N/A	GWH
GENERATION	CAB LNG	1	"GWH"	2014	0	#N/A	GWH
GENERATION	CAB LNG	1	"GWH"	2015	0	#N/A	GWH
GENERATION	CAB LNG	1	"GWH"	2016	0	#N/A	GWH
GENERATION	CAB LNG	1	"GWH"	2017	0	#N/A	GWH
GENERATION	CAB LNG	1	"GWH"	2018	0	#N/A	GWH
GENERATION	CAB LNG	1	"GWH"	2019	0	#N/A	GWH
GENERATION	CAB LNG	1	"GWH"	2020	0	#N/A	GWH
GENERATION	CAB LNG	1	"GWH"	2021	0	#N/A	GWH
GENERATION	CAB LNG	1	"GWH"	2022	0	#N/A	GWH
GENERATION	CAB LNG	1	"GWH"	2023	0	#N/A	GWH
GENERATION	CAB LNG	1	"GWH"	2024	0	#N/A	GWH
GENERATION	CAB LNG	1	"GWH"	2025	0	#N/A	GWH
GENERATION	CAB LNG	1	"GWH"	2026	0	#N/A	GWH
GENERATION	CAB LNG	1	"GWH"	2027	0	#N/A	GWH
GENERATION	CAB LNG	1	"GWH"	2028	0	#N/A	GWH
GENERATION	CAB LNG	1	"GWH"	2029	0	#N/A	GWH
GENERATION	CAB LNG	1	"GWH"	2030	0	#N/A	GWH
GENERATION	CAB LNG	1	"GWH"	2031	0	#N/A	GWH
GENERATION	CAB LNG	1	"GWH"	2032	0	#N/A	GWH
GENERATION	CAB LNG	1	"GWH"	2033	0	#N/A	GWH
GENERATION	CAB LNG	1	"GWH"	2034	0	#N/A	GWH
GENERATION	CAB LNG	1	"GWH"	2035	0	#N/A	GWH
GENERATION	CAB LNG	2	"GWH"	2006	0	#N/A	GWH
GENERATION	CAB LNG	2	"GWH"	2007	0	#N/A	GWH
GENERATION	CAB LNG	2	"GWH"	2008	0	#N/A	GWH
GENERATION	CAB LNG	2	"GWH"	2009	0	#N/A	GWH
GENERATION	CAB LNG	2	"GWH"	2010	0	#N/A	GWH
GENERATION	CAB LNG	2	"GWH"	2011	0	#N/A	GWH
GENERATION	CAB LNG	2	"GWH"	2012	0	#N/A	GWH
GENERATION	CAB LNG	2	"GWH"	2013	0	#N/A	GWH
GENERATION	CAB LNG	2	"GWH"	2014	0	#N/A	GWH
GENERATION	CAB LNG	2	"GWH"	2015	0	#N/A	GWH
GENERATION	CAB LNG	2	"GWH"	2016	0	#N/A	GWH

GENERATION	CAB LNG 2	"GWH"	2017	0	#N/A	GWH
GENERATION	CAB LNG 2	"GWH"	2018	0	#N/A	GWH
GENERATION	CAB LNG 2	"GWH"	2019	0	#N/A	GWH
GENERATION	CAB LNG 2	"GWH"	2020	0	#N/A	GWH
GENERATION	CAB LNG 2	"GWH"	2021	0	#N/A	GWH
GENERATION	CAB LNG 2	"GWH"	2022	0	#N/A	GWH
GENERATION	CAB LNG 2	"GWH"	2023	0	#N/A	GWH
GENERATION	CAB LNG 2	"GWH"	2024	0	#N/A	GWH
GENERATION	CAB LNG 2	"GWH"	2025	0	#N/A	GWH
GENERATION	CAB LNG 2	"GWH"	2026	0	#N/A	GWH
GENERATION	CAB LNG 2	"GWH"	2027	0	#N/A	GWH
GENERATION	CAB LNG 2	"GWH"	2028	0	#N/A	GWH
GENERATION	CAB LNG 2	"GWH"	2029	0	#N/A	GWH
GENERATION	CAB LNG 2	"GWH"	2030	0	#N/A	GWH
GENERATION	CAB LNG 2	"GWH"	2031	0	#N/A	GWH
GENERATION	CAB LNG 2	"GWH"	2032	0	#N/A	GWH
GENERATION	CAB LNG 2	"GWH"	2033	0	#N/A	GWH
GENERATION	CAB LNG 2	"GWH"	2034	0	#N/A	GWH
GENERATION	CAB LNG 2	"GWH"	2035	0	#N/A	GWH
GENERATION	DED LNG 1	"GWH"	2006	0	#N/A	GWH
GENERATION	DED LNG 1	"GWH"	2007	0	#N/A	GWH
GENERATION	DED LNG 1	"GWH"	2008	0	#N/A	GWH
GENERATION	DED LNG 1	"GWH"	2009	0	#N/A	GWH
GENERATION	DED LNG 1	"GWH"	2010	0	#N/A	GWH
GENERATION	DED LNG 1	"GWH"	2011	0	#N/A	GWH
GENERATION	DED LNG 1	"GWH"	2012	0	#N/A	GWH
GENERATION	DED LNG 1	"GWH"	2013	0	#N/A	GWH
GENERATION	DED LNG 1	"GWH"	2014	0	#N/A	GWH
GENERATION	DED LNG 1	"GWH"	2015	0	#N/A	GWH
GENERATION	DED LNG 1	"GWH"	2016	0	#N/A	GWH
GENERATION	DED LNG 1	"GWH"	2017	0	#N/A	GWH
GENERATION	DED LNG 1	"GWH"	2018	0	#N/A	GWH
GENERATION	DED LNG 1	"GWH"	2019	0	#N/A	GWH
GENERATION	DED LNG 1	"GWH"	2020	0	#N/A	GWH
GENERATION	DED LNG 1	"GWH"	2021	0	#N/A	GWH
GENERATION	DED LNG 1	"GWH"	2022	0	#N/A	GWH
GENERATION	DED LNG 1	"GWH"	2023	0	#N/A	GWH
GENERATION	DED LNG 1	"GWH"	2024	0	#N/A	GWH
GENERATION	DED LNG 1	"GWH"	2025	0	#N/A	GWH
GENERATION	DED LNG 1	"GWH"	2026	0	#N/A	GWH
GENERATION	DED LNG 1	"GWH"	2027	0	#N/A	GWH
GENERATION	DED LNG 1	"GWH"	2028	0	#N/A	GWH
GENERATION	DED LNG 1	"GWH"	2029	0	#N/A	GWH
GENERATION	DED LNG 1	"GWH"	2030	0	#N/A	GWH
GENERATION	DED LNG 1	"GWH"	2031	0	#N/A	GWH
GENERATION	DED LNG 1	"GWH"	2032	0	#N/A	GWH
GENERATION	DED LNG 1	"GWH"	2033	0	#N/A	GWH
GENERATION	DED LNG 1	"GWH"	2034	0	#N/A	GWH
GENERATION	DED LNG 1	"GWH"	2035	0	#N/A	GWH
GENERATION	DED LNG 2	"GWH"	2006	0	#N/A	GWH
GENERATION	DED LNG 2	"GWH"	2007	0	#N/A	GWH
GENERATION	DED LNG 2	"GWH"	2008	0	#N/A	GWH

GENERATION	DED LNG 2	"GWH"	2009	0	#N/A	GWH
GENERATION	DED LNG 2	"GWH"	2010	0	#N/A	GWH
GENERATION	DED LNG 2	"GWH"	2011	0	#N/A	GWH
GENERATION	DED LNG 2	"GWH"	2012	0	#N/A	GWH
GENERATION	DED LNG 2	"GWH"	2013	0	#N/A	GWH
GENERATION	DED LNG 2	"GWH"	2014	0	#N/A	GWH
GENERATION	DED LNG 2	"GWH"	2015	0	#N/A	GWH
GENERATION	DED LNG 2	"GWH"	2016	0	#N/A	GWH
GENERATION	DED LNG 2	"GWH"	2017	0	#N/A	GWH
GENERATION	DED LNG 2	"GWH"	2018	0	#N/A	GWH
GENERATION	DED LNG 2	"GWH"	2019	0	#N/A	GWH
GENERATION	DED LNG 2	"GWH"	2020	0	#N/A	GWH
GENERATION	DED LNG 2	"GWH"	2021	0	#N/A	GWH
GENERATION	DED LNG 2	"GWH"	2022	0	#N/A	GWH
GENERATION	DED LNG 2	"GWH"	2023	0	#N/A	GWH
GENERATION	DED LNG 2	"GWH"	2024	0	#N/A	GWH
GENERATION	DED LNG 2	"GWH"	2025	0	#N/A	GWH
GENERATION	DED LNG 2	"GWH"	2026	0	#N/A	GWH
GENERATION	DED LNG 2	"GWH"	2027	0	#N/A	GWH
GENERATION	DED LNG 2	"GWH"	2028	0	#N/A	GWH
GENERATION	DED LNG 2	"GWH"	2029	0	#N/A	GWH
GENERATION	DED LNG 2	"GWH"	2030	0	#N/A	GWH
GENERATION	DED LNG 2	"GWH"	2031	0	#N/A	GWH
GENERATION	DED LNG 2	"GWH"	2032	0	#N/A	GWH
GENERATION	DED LNG 2	"GWH"	2033	0	#N/A	GWH
GENERATION	DED LNG 2	"GWH"	2034	0	#N/A	GWH
GENERATION	DED LNG 2	"GWH"	2035	0	#N/A	GWH
GENERATION	MAC LNG 1	"GWH"	2006	0	#N/A	GWH
GENERATION	MAC LNG 1	"GWH"	2007	0	#N/A	GWH
GENERATION	MAC LNG 1	"GWH"	2008	0	#N/A	GWH
GENERATION	MAC LNG 1	"GWH"	2009	0	#N/A	GWH
GENERATION	MAC LNG 1	"GWH"	2010	0	#N/A	GWH
GENERATION	MAC LNG 1	"GWH"	2011	0	#N/A	GWH
GENERATION	MAC LNG 1	"GWH"	2012	0	#N/A	GWH
GENERATION	MAC LNG 1	"GWH"	2013	0	#N/A	GWH
GENERATION	MAC LNG 1	"GWH"	2014	0	#N/A	GWH
GENERATION	MAC LNG 1	"GWH"	2015	0	#N/A	GWH
GENERATION	MAC LNG 1	"GWH"	2016	0	#N/A	GWH
GENERATION	MAC LNG 1	"GWH"	2017	0	#N/A	GWH
GENERATION	MAC LNG 1	"GWH"	2018	0	#N/A	GWH
GENERATION	MAC LNG 1	"GWH"	2019	0	#N/A	GWH
GENERATION	MAC LNG 1	"GWH"	2020	0	#N/A	GWH
GENERATION	MAC LNG 1	"GWH"	2021	0	#N/A	GWH
GENERATION	MAC LNG 1	"GWH"	2022	0	#N/A	GWH
GENERATION	MAC LNG 1	"GWH"	2023	0	#N/A	GWH
GENERATION	MAC LNG 1	"GWH"	2024	0	#N/A	GWH
GENERATION	MAC LNG 1	"GWH"	2025	0	#N/A	GWH
GENERATION	MAC LNG 1	"GWH"	2026	0	#N/A	GWH
GENERATION	MAC LNG 1	"GWH"	2027	0	#N/A	GWH
GENERATION	MAC LNG 1	"GWH"	2028	0	#N/A	GWH
GENERATION	MAC LNG 1	"GWH"	2029	0	#N/A	GWH
GENERATION	MAC LNG 1	"GWH"	2030	0	#N/A	GWH

GENERATION	MAC LNG 1	"GWH"	2031	0	#N/A	GWH
GENERATION	MAC LNG 1	"GWH"	2032	0	#N/A	GWH
GENERATION	MAC LNG 1	"GWH"	2033	0	#N/A	GWH
GENERATION	MAC LNG 1	"GWH"	2034	0	#N/A	GWH
GENERATION	MAC LNG 1	"GWH"	2035	0	#N/A	GWH
GENERATION	YIG LNG 1	"GWH"	2006	0	#N/A	GWH
GENERATION	YIG LNG 1	"GWH"	2007	0	#N/A	GWH
GENERATION	YIG LNG 1	"GWH"	2008	0	#N/A	GWH
GENERATION	YIG LNG 1	"GWH"	2009	0	#N/A	GWH
GENERATION	YIG LNG 1	"GWH"	2010	0	#N/A	GWH
GENERATION	YIG LNG 1	"GWH"	2011	0	#N/A	GWH
GENERATION	YIG LNG 1	"GWH"	2012	0	#N/A	GWH
GENERATION	YIG LNG 1	"GWH"	2013	0	#N/A	GWH
GENERATION	YIG LNG 1	"GWH"	2014	0	#N/A	GWH
GENERATION	YIG LNG 1	"GWH"	2015	0	#N/A	GWH
GENERATION	YIG LNG 1	"GWH"	2016	0	#N/A	GWH
GENERATION	YIG LNG 1	"GWH"	2017	0	#N/A	GWH
GENERATION	YIG LNG 1	"GWH"	2018	0	#N/A	GWH
GENERATION	YIG LNG 1	"GWH"	2019	0	#N/A	GWH
GENERATION	YIG LNG 1	"GWH"	2020	0	#N/A	GWH
GENERATION	YIG LNG 1	"GWH"	2021	0	#N/A	GWH
GENERATION	YIG LNG 1	"GWH"	2022	0	#N/A	GWH
GENERATION	YIG LNG 1	"GWH"	2023	0	#N/A	GWH
GENERATION	YIG LNG 1	"GWH"	2024	0	#N/A	GWH
GENERATION	YIG LNG 1	"GWH"	2025	0	#N/A	GWH
GENERATION	YIG LNG 1	"GWH"	2026	0	#N/A	GWH
GENERATION	YIG LNG 1	"GWH"	2027	0	#N/A	GWH
GENERATION	YIG LNG 1	"GWH"	2028	0	#N/A	GWH
GENERATION	YIG LNG 1	"GWH"	2029	0	#N/A	GWH
GENERATION	YIG LNG 1	"GWH"	2030	0	#N/A	GWH
GENERATION	YIG LNG 1	"GWH"	2031	0	#N/A	GWH
GENERATION	YIG LNG 1	"GWH"	2032	0	#N/A	GWH
GENERATION	YIG LNG 1	"GWH"	2033	0	#N/A	GWH
GENERATION	YIG LNG 1	"GWH"	2034	0	#N/A	GWH
GENERATION	YIG LNG 1	"GWH"	2035	0	#N/A	GWH
GENERATION	TJO LNG 1	"GWH"	2006	0	#N/A	GWH
GENERATION	TJO LNG 1	"GWH"	2007	0	#N/A	GWH
GENERATION	TJO LNG 1	"GWH"	2008	0	#N/A	GWH
GENERATION	TJO LNG 1	"GWH"	2009	0	#N/A	GWH
GENERATION	TJO LNG 1	"GWH"	2010	0	#N/A	GWH
GENERATION	TJO LNG 1	"GWH"	2011	0	#N/A	GWH
GENERATION	TJO LNG 1	"GWH"	2012	0	#N/A	GWH
GENERATION	TJO LNG 1	"GWH"	2013	0	#N/A	GWH
GENERATION	TJO LNG 1	"GWH"	2014	0	#N/A	GWH
GENERATION	TJO LNG 1	"GWH"	2015	0	#N/A	GWH
GENERATION	TJO LNG 1	"GWH"	2016	0	#N/A	GWH
GENERATION	TJO LNG 1	"GWH"	2017	0	#N/A	GWH
GENERATION	TJO LNG 1	"GWH"	2018	0	#N/A	GWH
GENERATION	TJO LNG 1	"GWH"	2019	0	#N/A	GWH
GENERATION	TJO LNG 1	"GWH"	2020	0	#N/A	GWH
GENERATION	TJO LNG 1	"GWH"	2021	0	#N/A	GWH
GENERATION	TJO LNG 1	"GWH"	2022	0	#N/A	GWH

GENERATION	TJO LNG 1	"GWH"	2023	0	#N/A	GWH
GENERATION	TJO LNG 1	"GWH"	2024	0	#N/A	GWH
GENERATION	TJO LNG 1	"GWH"	2025	0	#N/A	GWH
GENERATION	TJO LNG 1	"GWH"	2026	0	#N/A	GWH
GENERATION	TJO LNG 1	"GWH"	2027	0	#N/A	GWH
GENERATION	TJO LNG 1	"GWH"	2028	0	#N/A	GWH
GENERATION	TJO LNG 1	"GWH"	2029	0	#N/A	GWH
GENERATION	TJO LNG 1	"GWH"	2030	0	#N/A	GWH
GENERATION	TJO LNG 1	"GWH"	2031	0	#N/A	GWH
GENERATION	TJO LNG 1	"GWH"	2032	0	#N/A	GWH
GENERATION	TJO LNG 1	"GWH"	2033	0	#N/A	GWH
GENERATION	TJO LNG 1	"GWH"	2034	0	#N/A	GWH
GENERATION	TJO LNG 1	"GWH"	2035	0	#N/A	GWH
GENERATION	TAN LNG 1	"GWH"	2006	0	#N/A	GWH
GENERATION	TAN LNG 1	"GWH"	2007	0	#N/A	GWH
GENERATION	TAN LNG 1	"GWH"	2008	0	#N/A	GWH
GENERATION	TAN LNG 1	"GWH"	2009	0	#N/A	GWH
GENERATION	TAN LNG 1	"GWH"	2010	0	#N/A	GWH
GENERATION	TAN LNG 1	"GWH"	2011	0	#N/A	GWH
GENERATION	TAN LNG 1	"GWH"	2012	0	#N/A	GWH
GENERATION	TAN LNG 1	"GWH"	2013	0	#N/A	GWH
GENERATION	TAN LNG 1	"GWH"	2014	0	#N/A	GWH
GENERATION	TAN LNG 1	"GWH"	2015	0	#N/A	GWH
GENERATION	TAN LNG 1	"GWH"	2016	0	#N/A	GWH
GENERATION	TAN LNG 1	"GWH"	2017	0	#N/A	GWH
GENERATION	TAN LNG 1	"GWH"	2018	0	#N/A	GWH
GENERATION	TAN LNG 1	"GWH"	2019	0	#N/A	GWH
GENERATION	TAN LNG 1	"GWH"	2020	0	#N/A	GWH
GENERATION	TAN LNG 1	"GWH"	2021	0	#N/A	GWH
GENERATION	TAN LNG 1	"GWH"	2022	0	#N/A	GWH
GENERATION	TAN LNG 1	"GWH"	2023	0	#N/A	GWH
GENERATION	TAN LNG 1	"GWH"	2024	0	#N/A	GWH
GENERATION	TAN LNG 1	"GWH"	2025	0	#N/A	GWH
GENERATION	TAN LNG 1	"GWH"	2026	0	#N/A	GWH
GENERATION	TAN LNG 1	"GWH"	2027	0	#N/A	GWH
GENERATION	TAN LNG 1	"GWH"	2028	0	#N/A	GWH
GENERATION	TAN LNG 1	"GWH"	2029	0	#N/A	GWH
GENERATION	TAN LNG 1	"GWH"	2030	0	#N/A	GWH
GENERATION	TAN LNG 1	"GWH"	2031	0	#N/A	GWH
GENERATION	TAN LNG 1	"GWH"	2032	0	#N/A	GWH
GENERATION	TAN LNG 1	"GWH"	2033	0	#N/A	GWH
GENERATION	TAN LNG 1	"GWH"	2034	0	#N/A	GWH
GENERATION	TAN LNG 1	"GWH"	2035	0	#N/A	GWH
GENERATION	TAN LNG 2	"GWH"	2006	0	#N/A	GWH
GENERATION	TAN LNG 2	"GWH"	2007	0	#N/A	GWH
GENERATION	TAN LNG 2	"GWH"	2008	0	#N/A	GWH
GENERATION	TAN LNG 2	"GWH"	2009	0	#N/A	GWH
GENERATION	TAN LNG 2	"GWH"	2010	0	#N/A	GWH
GENERATION	TAN LNG 2	"GWH"	2011	0	#N/A	GWH
GENERATION	TAN LNG 2	"GWH"	2012	0	#N/A	GWH
GENERATION	TAN LNG 2	"GWH"	2013	0	#N/A	GWH
GENERATION	TAN LNG 2	"GWH"	2014	0	#N/A	GWH

GENERATION	TAN LNG 2	"GWH"	2015	0	#N/A		GWH
GENERATION	TAN LNG 2	"GWH"	2016	0	#N/A		GWH
GENERATION	TAN LNG 2	"GWH"	2017	0	#N/A		GWH
GENERATION	TAN LNG 2	"GWH"	2018	0	#N/A		GWH
GENERATION	TAN LNG 2	"GWH"	2019	0	#N/A		GWH
GENERATION	TAN LNG 2	"GWH"	2020	0	#N/A		GWH
GENERATION	TAN LNG 2	"GWH"	2021	0	#N/A		GWH
GENERATION	TAN LNG 2	"GWH"	2022	0	#N/A		GWH
GENERATION	TAN LNG 2	"GWH"	2023	0	#N/A		GWH
GENERATION	TAN LNG 2	"GWH"	2024	0	#N/A		GWH
GENERATION	TAN LNG 2	"GWH"	2025	0	#N/A		GWH
GENERATION	TAN LNG 2	"GWH"	2026	0	#N/A		GWH
GENERATION	TAN LNG 2	"GWH"	2027	0	#N/A		GWH
GENERATION	TAN LNG 2	"GWH"	2028	0	#N/A		GWH
GENERATION	TAN LNG 2	"GWH"	2029	0	#N/A		GWH
GENERATION	TAN LNG 2	"GWH"	2030	0	#N/A		GWH
GENERATION	TAN LNG 2	"GWH"	2031	0	#N/A		GWH
GENERATION	TAN LNG 2	"GWH"	2032	0	#N/A		GWH
GENERATION	TAN LNG 2	"GWH"	2033	0	#N/A		GWH
GENERATION	TAN LNG 2	"GWH"	2034	0	#N/A		GWH
GENERATION	TAN LNG 2	"GWH"	2035	0	#N/A		GWH
GENERATION	TEM LNG 1	"GWH"	2006	0	#N/A		GWH
GENERATION	TEM LNG 1	"GWH"	2007	0	#N/A		GWH
GENERATION	TEM LNG 1	"GWH"	2008	0	#N/A		GWH
GENERATION	TEM LNG 1	"GWH"	2009	0	#N/A		GWH
GENERATION	TEM LNG 1	"GWH"	2010	0	#N/A		GWH
GENERATION	TEM LNG 1	"GWH"	2011	0	#N/A		GWH
GENERATION	TEM LNG 1	"GWH"	2012	0	#N/A		GWH
GENERATION	TEM LNG 1	"GWH"	2013	0	#N/A		GWH
GENERATION	TEM LNG 1	"GWH"	2014	0	#N/A		GWH
GENERATION	TEM LNG 1	"GWH"	2015	0	#N/A		GWH
GENERATION	TEM LNG 1	"GWH"	2016	0	#N/A		GWH
GENERATION	TEM LNG 1	"GWH"	2017	0	#N/A		GWH
GENERATION	TEM LNG 1	"GWH"	2018	0	#N/A		GWH
GENERATION	TEM LNG 1	"GWH"	2019	0	#N/A		GWH
GENERATION	TEM LNG 1	"GWH"	2020	0	#N/A		GWH
GENERATION	TEM LNG 1	"GWH"	2021	0	#N/A		GWH
GENERATION	TEM LNG 1	"GWH"	2022	0	#N/A		GWH
GENERATION	TEM LNG 1	"GWH"	2023	0	#N/A		GWH
GENERATION	TEM LNG 1	"GWH"	2024	0	#N/A		GWH
GENERATION	TEM LNG 1	"GWH"	2025	0	#N/A		GWH
GENERATION	TEM LNG 1	"GWH"	2026	0	#N/A		GWH
GENERATION	TEM LNG 1	"GWH"	2027	0	#N/A		GWH
GENERATION	TEM LNG 1	"GWH"	2028	0	#N/A		GWH
GENERATION	TEM LNG 1	"GWH"	2029	0	#N/A		GWH
GENERATION	TEM LNG 1	"GWH"	2030	0	#N/A		GWH
GENERATION	TEM LNG 1	"GWH"	2031	0	#N/A		GWH
GENERATION	TEM LNG 1	"GWH"	2032	0	#N/A		GWH
GENERATION	TEM LNG 1	"GWH"	2033	0	#N/A		GWH
GENERATION	TEM LNG 1	"GWH"	2034	0	#N/A		GWH
GENERATION	TEM LNG 1	"GWH"	2035	0	#N/A		GWH
GENERATION	RECIP 83	"GWH"	2006	0		40	GWH

GENERATION	RECIP	83	"GWH"	2007	0	40 GWH
GENERATION	RECIP	83	"GWH"	2008	0	40 GWH
GENERATION	RECIP	83	"GWH"	2009	0	40 GWH
GENERATION	RECIP	83	"GWH"	2010	0	40 GWH
GENERATION	RECIP	83	"GWH"	2011	0	40 GWH
GENERATION	RECIP	83	"GWH"	2012	0	40 GWH
GENERATION	RECIP	83	"GWH"	2013	0	40 GWH
GENERATION	RECIP	83	"GWH"	2014	0	40 GWH
GENERATION	RECIP	83	"GWH"	2015	0	40 GWH
GENERATION	RECIP	83	"GWH"	2016	0	40 GWH
GENERATION	RECIP	83	"GWH"	2017	0	40 GWH
GENERATION	RECIP	83	"GWH"	2018	0	40 GWH
GENERATION	RECIP	83	"GWH"	2019	0	40 GWH
GENERATION	RECIP	83	"GWH"	2020	0	40 GWH
GENERATION	RECIP	83	"GWH"	2021	0	40 GWH
GENERATION	RECIP	83	"GWH"	2022	0	40 GWH
GENERATION	RECIP	83	"GWH"	2023	0	40 GWH
GENERATION	RECIP	83	"GWH"	2024	0	40 GWH
GENERATION	RECIP	83	"GWH"	2025	0	40 GWH
GENERATION	RECIP	83	"GWH"	2026	0	40 GWH
GENERATION	RECIP	83	"GWH"	2027	0	40 GWH
GENERATION	RECIP	83	"GWH"	2028	0	40 GWH
GENERATION	RECIP	83	"GWH"	2029	0	40 GWH
GENERATION	RECIP	83	"GWH"	2030	0	40 GWH
GENERATION	RECIP	83	"GWH"	2031	0	40 GWH
GENERATION	RECIP	83	"GWH"	2032	0	40 GWH
GENERATION	RECIP	83	"GWH"	2033	0	40 GWH
GENERATION	RECIP	83	"GWH"	2034	13.6864109	40 GWH
GENERATION	RECIP	83	"GWH"	2035	78.46430969	40 GWH
GENERATION	RECIP	84	"GWH"	2006	0	40 GWH
GENERATION	RECIP	84	"GWH"	2007	0	40 GWH
GENERATION	RECIP	84	"GWH"	2008	0	40 GWH
GENERATION	RECIP	84	"GWH"	2009	0	40 GWH
GENERATION	RECIP	84	"GWH"	2010	0	40 GWH
GENERATION	RECIP	84	"GWH"	2011	0	40 GWH
GENERATION	RECIP	84	"GWH"	2012	0	40 GWH
GENERATION	RECIP	84	"GWH"	2013	0	40 GWH
GENERATION	RECIP	84	"GWH"	2014	0	40 GWH
GENERATION	RECIP	84	"GWH"	2015	0	40 GWH
GENERATION	RECIP	84	"GWH"	2016	0	40 GWH
GENERATION	RECIP	84	"GWH"	2017	0	40 GWH
GENERATION	RECIP	84	"GWH"	2018	0	40 GWH
GENERATION	RECIP	84	"GWH"	2019	0	40 GWH
GENERATION	RECIP	84	"GWH"	2020	0	40 GWH
GENERATION	RECIP	84	"GWH"	2021	0	40 GWH
GENERATION	RECIP	84	"GWH"	2022	0	40 GWH
GENERATION	RECIP	84	"GWH"	2023	0	40 GWH
GENERATION	RECIP	84	"GWH"	2024	0	40 GWH
GENERATION	RECIP	84	"GWH"	2025	0	40 GWH
GENERATION	RECIP	84	"GWH"	2026	0	40 GWH
GENERATION	RECIP	84	"GWH"	2027	0	40 GWH
GENERATION	RECIP	84	"GWH"	2028	0	40 GWH

GENERATION	RECIP	84	"GWH"	2029	0	40 GWH
GENERATION	RECIP	84	"GWH"	2030	0	40 GWH
GENERATION	RECIP	84	"GWH"	2031	0	40 GWH
GENERATION	RECIP	84	"GWH"	2032	13.15293121	40 GWH
GENERATION	RECIP	84	"GWH"	2033	79.58295441	40 GWH
GENERATION	RECIP	84	"GWH"	2034	79.06989288	40 GWH
GENERATION	RECIP	84	"GWH"	2035	76.15919495	40 GWH
GENERATION	CLNG	85	"GWH"	2006	0	60 GWH
GENERATION	CLNG	85	"GWH"	2007	0	60 GWH
GENERATION	CLNG	85	"GWH"	2008	0	60 GWH
GENERATION	CLNG	85	"GWH"	2009	0	60 GWH
GENERATION	CLNG	85	"GWH"	2010	0	60 GWH
GENERATION	CLNG	85	"GWH"	2011	0	60 GWH
GENERATION	CLNG	85	"GWH"	2012	0	60 GWH
GENERATION	CLNG	85	"GWH"	2013	0	60 GWH
GENERATION	CLNG	85	"GWH"	2014	0	60 GWH
GENERATION	CLNG	85	"GWH"	2015	0	60 GWH
GENERATION	CLNG	85	"GWH"	2016	0	60 GWH
GENERATION	CLNG	85	"GWH"	2017	0	60 GWH
GENERATION	CLNG	85	"GWH"	2018	0	60 GWH
GENERATION	CLNG	85	"GWH"	2019	0	60 GWH
GENERATION	CLNG	85	"GWH"	2020	0	60 GWH
GENERATION	CLNG	85	"GWH"	2021	0	60 GWH
GENERATION	CLNG	85	"GWH"	2022	0	60 GWH
GENERATION	CLNG	85	"GWH"	2023	0	60 GWH
GENERATION	CLNG	85	"GWH"	2024	0	60 GWH
GENERATION	CLNG	85	"GWH"	2025	0	60 GWH
GENERATION	CLNG	85	"GWH"	2026	0	60 GWH
GENERATION	CLNG	85	"GWH"	2027	0	60 GWH
GENERATION	CLNG	85	"GWH"	2028	0	60 GWH
GENERATION	CLNG	85	"GWH"	2029	82.26402283	60 GWH
GENERATION	CLNG	85	"GWH"	2030	411.8312378	60 GWH
GENERATION	CLNG	85	"GWH"	2031	417.8154907	60 GWH
GENERATION	CLNG	85	"GWH"	2032	422.1568909	60 GWH
GENERATION	CLNG	85	"GWH"	2033	421.2757568	60 GWH
GENERATION	CLNG	85	"GWH"	2034	425.6578064	60 GWH
GENERATION	CLNG	85	"GWH"	2035	418.3822937	60 GWH
GENERATION	RECIP	86	"GWH"	2006	0	40 GWH
GENERATION	RECIP	86	"GWH"	2007	0	40 GWH
GENERATION	RECIP	86	"GWH"	2008	0	40 GWH
GENERATION	RECIP	86	"GWH"	2009	0	40 GWH
GENERATION	RECIP	86	"GWH"	2010	0	40 GWH
GENERATION	RECIP	86	"GWH"	2011	0	40 GWH
GENERATION	RECIP	86	"GWH"	2012	0	40 GWH
GENERATION	RECIP	86	"GWH"	2013	0	40 GWH
GENERATION	RECIP	86	"GWH"	2014	0	40 GWH
GENERATION	RECIP	86	"GWH"	2015	0	40 GWH
GENERATION	RECIP	86	"GWH"	2016	0	40 GWH
GENERATION	RECIP	86	"GWH"	2017	0	40 GWH
GENERATION	RECIP	86	"GWH"	2018	0	40 GWH
GENERATION	RECIP	86	"GWH"	2019	0	40 GWH
GENERATION	RECIP	86	"GWH"	2020	0	40 GWH

GENERATION	RECIP	86	"GWH"	2021	0	40 GWH
GENERATION	RECIP	86	"GWH"	2022	0	40 GWH
GENERATION	RECIP	86	"GWH"	2023	0	40 GWH
GENERATION	RECIP	86	"GWH"	2024	0	40 GWH
GENERATION	RECIP	86	"GWH"	2025	0	40 GWH
GENERATION	RECIP	86	"GWH"	2026	0	40 GWH
GENERATION	RECIP	86	"GWH"	2027	0	40 GWH
GENERATION	RECIP	86	"GWH"	2028	15.02525997	40 GWH
GENERATION	RECIP	86	"GWH"	2029	84.49000549	40 GWH
GENERATION	RECIP	86	"GWH"	2030	76.58130646	40 GWH
GENERATION	RECIP	86	"GWH"	2031	77.46611023	40 GWH
GENERATION	RECIP	86	"GWH"	2032	78.38510132	40 GWH
GENERATION	RECIP	86	"GWH"	2033	75.96186066	40 GWH
GENERATION	RECIP	86	"GWH"	2034	75.93138123	40 GWH
GENERATION	RECIP	86	"GWH"	2035	74.93928528	40 GWH
GENERATION	RECIP	87	"GWH"	2006	0	40 GWH
GENERATION	RECIP	87	"GWH"	2007	0	40 GWH
GENERATION	RECIP	87	"GWH"	2008	0	40 GWH
GENERATION	RECIP	87	"GWH"	2009	0	40 GWH
GENERATION	RECIP	87	"GWH"	2010	0	40 GWH
GENERATION	RECIP	87	"GWH"	2011	0	40 GWH
GENERATION	RECIP	87	"GWH"	2012	0	40 GWH
GENERATION	RECIP	87	"GWH"	2013	0	40 GWH
GENERATION	RECIP	87	"GWH"	2014	0	40 GWH
GENERATION	RECIP	87	"GWH"	2015	0	40 GWH
GENERATION	RECIP	87	"GWH"	2016	0	40 GWH
GENERATION	RECIP	87	"GWH"	2017	0	40 GWH
GENERATION	RECIP	87	"GWH"	2018	0	40 GWH
GENERATION	RECIP	87	"GWH"	2019	0	40 GWH
GENERATION	RECIP	87	"GWH"	2020	0	40 GWH
GENERATION	RECIP	87	"GWH"	2021	0	40 GWH
GENERATION	RECIP	87	"GWH"	2022	0	40 GWH
GENERATION	RECIP	87	"GWH"	2023	0	40 GWH
GENERATION	RECIP	87	"GWH"	2024	0	40 GWH
GENERATION	RECIP	87	"GWH"	2025	0	40 GWH
GENERATION	RECIP	87	"GWH"	2026	0	40 GWH
GENERATION	RECIP	87	"GWH"	2027	13.39643478	40 GWH
GENERATION	RECIP	87	"GWH"	2028	86.19451141	40 GWH
GENERATION	RECIP	87	"GWH"	2029	78.20159912	40 GWH
GENERATION	RECIP	87	"GWH"	2030	75.05103302	40 GWH
GENERATION	RECIP	87	"GWH"	2031	75.31452942	40 GWH
GENERATION	RECIP	87	"GWH"	2032	75.80982971	40 GWH
GENERATION	RECIP	87	"GWH"	2033	74.92185974	40 GWH
GENERATION	RECIP	87	"GWH"	2034	74.93004608	40 GWH
GENERATION	RECIP	87	"GWH"	2035	74.60743713	40 GWH
GENERATION	CLNG	88	"GWH"	2006	0	60 GWH
GENERATION	CLNG	88	"GWH"	2007	0	60 GWH
GENERATION	CLNG	88	"GWH"	2008	0	60 GWH
GENERATION	CLNG	88	"GWH"	2009	0	60 GWH
GENERATION	CLNG	88	"GWH"	2010	0	60 GWH
GENERATION	CLNG	88	"GWH"	2011	0	60 GWH
GENERATION	CLNG	88	"GWH"	2012	0	60 GWH

GENERATION	CLNG	88	"GWH"	2013	0	60 GWH
GENERATION	CLNG	88	"GWH"	2014	0	60 GWH
GENERATION	CLNG	88	"GWH"	2015	0	60 GWH
GENERATION	CLNG	88	"GWH"	2016	0	60 GWH
GENERATION	CLNG	88	"GWH"	2017	0	60 GWH
GENERATION	CLNG	88	"GWH"	2018	0	60 GWH
GENERATION	CLNG	88	"GWH"	2019	0	60 GWH
GENERATION	CLNG	88	"GWH"	2020	0	60 GWH
GENERATION	CLNG	88	"GWH"	2021	0	60 GWH
GENERATION	CLNG	88	"GWH"	2022	0	60 GWH
GENERATION	CLNG	88	"GWH"	2023	0	60 GWH
GENERATION	CLNG	88	"GWH"	2024	0	60 GWH
GENERATION	CLNG	88	"GWH"	2025	0	60 GWH
GENERATION	CLNG	88	"GWH"	2026	86.48969269	60 GWH
GENERATION	CLNG	88	"GWH"	2027	429.5563965	60 GWH
GENERATION	CLNG	88	"GWH"	2028	441.51828	60 GWH
GENERATION	CLNG	88	"GWH"	2029	429.1626892	60 GWH
GENERATION	CLNG	88	"GWH"	2030	393.7597351	60 GWH
GENERATION	CLNG	88	"GWH"	2031	400.0482788	60 GWH
GENERATION	CLNG	88	"GWH"	2032	406.2178345	60 GWH
GENERATION	CLNG	88	"GWH"	2033	403.971344	60 GWH
GENERATION	CLNG	88	"GWH"	2034	410.3742065	60 GWH
GENERATION	CLNG	88	"GWH"	2035	400.8505859	60 GWH
GENERATION	RECIP	89	"GWH"	2006	0	40 GWH
GENERATION	RECIP	89	"GWH"	2007	0	40 GWH
GENERATION	RECIP	89	"GWH"	2008	0	40 GWH
GENERATION	RECIP	89	"GWH"	2009	0	40 GWH
GENERATION	RECIP	89	"GWH"	2010	0	40 GWH
GENERATION	RECIP	89	"GWH"	2011	0	40 GWH
GENERATION	RECIP	89	"GWH"	2012	0	40 GWH
GENERATION	RECIP	89	"GWH"	2013	0	40 GWH
GENERATION	RECIP	89	"GWH"	2014	0	40 GWH
GENERATION	RECIP	89	"GWH"	2015	0	40 GWH
GENERATION	RECIP	89	"GWH"	2016	0	40 GWH
GENERATION	RECIP	89	"GWH"	2017	0	40 GWH
GENERATION	RECIP	89	"GWH"	2018	0	40 GWH
GENERATION	RECIP	89	"GWH"	2019	0	40 GWH
GENERATION	RECIP	89	"GWH"	2020	0	40 GWH
GENERATION	RECIP	89	"GWH"	2021	0	40 GWH
GENERATION	RECIP	89	"GWH"	2022	0	40 GWH
GENERATION	RECIP	89	"GWH"	2023	0	40 GWH
GENERATION	RECIP	89	"GWH"	2024	0	40 GWH
GENERATION	RECIP	89	"GWH"	2025	0	40 GWH
GENERATION	RECIP	89	"GWH"	2026	14.34082508	40 GWH
GENERATION	RECIP	89	"GWH"	2027	82.09374237	40 GWH
GENERATION	RECIP	89	"GWH"	2028	78.38666534	40 GWH
GENERATION	RECIP	89	"GWH"	2029	75.37757111	40 GWH
GENERATION	RECIP	89	"GWH"	2030	74.63142395	40 GWH
GENERATION	RECIP	89	"GWH"	2031	74.67909241	40 GWH
GENERATION	RECIP	89	"GWH"	2032	74.99606323	40 GWH
GENERATION	RECIP	89	"GWH"	2033	74.58537292	40 GWH
GENERATION	RECIP	89	"GWH"	2034	74.59687042	40 GWH

GENERATION	RECIP	89	"GWH"	2035	74.53896332	40 GWH
GENERATION	RECIP	90	"GWH"	2006	0	40 GWH
GENERATION	RECIP	90	"GWH"	2007	0	40 GWH
GENERATION	RECIP	90	"GWH"	2008	0	40 GWH
GENERATION	RECIP	90	"GWH"	2009	0	40 GWH
GENERATION	RECIP	90	"GWH"	2010	0	40 GWH
GENERATION	RECIP	90	"GWH"	2011	0	40 GWH
GENERATION	RECIP	90	"GWH"	2012	0	40 GWH
GENERATION	RECIP	90	"GWH"	2013	0	40 GWH
GENERATION	RECIP	90	"GWH"	2014	0	40 GWH
GENERATION	RECIP	90	"GWH"	2015	0	40 GWH
GENERATION	RECIP	90	"GWH"	2016	0	40 GWH
GENERATION	RECIP	90	"GWH"	2017	0	40 GWH
GENERATION	RECIP	90	"GWH"	2018	0	40 GWH
GENERATION	RECIP	90	"GWH"	2019	0	40 GWH
GENERATION	RECIP	90	"GWH"	2020	0	40 GWH
GENERATION	RECIP	90	"GWH"	2021	0	40 GWH
GENERATION	RECIP	90	"GWH"	2022	0	40 GWH
GENERATION	RECIP	90	"GWH"	2023	0	40 GWH
GENERATION	RECIP	90	"GWH"	2024	18.79891586	40 GWH
GENERATION	RECIP	90	"GWH"	2025	96.82310486	40 GWH
GENERATION	RECIP	90	"GWH"	2026	93.48773193	40 GWH
GENERATION	RECIP	90	"GWH"	2027	76.07115173	40 GWH
GENERATION	RECIP	90	"GWH"	2028	74.81798553	40 GWH
GENERATION	RECIP	90	"GWH"	2029	74.52711487	40 GWH
GENERATION	RECIP	90	"GWH"	2030	74.54984283	40 GWH
GENERATION	RECIP	90	"GWH"	2031	74.53783417	40 GWH
GENERATION	RECIP	90	"GWH"	2032	74.76345825	40 GWH
GENERATION	RECIP	90	"GWH"	2033	74.52430725	40 GWH
GENERATION	RECIP	90	"GWH"	2034	74.52301788	40 GWH
GENERATION	RECIP	90	"GWH"	2035	74.52703094	40 GWH
GENERATION	CLNG	91	"GWH"	2006	0	60 GWH
GENERATION	CLNG	91	"GWH"	2007	0	60 GWH
GENERATION	CLNG	91	"GWH"	2008	0	60 GWH
GENERATION	CLNG	91	"GWH"	2009	0	60 GWH
GENERATION	CLNG	91	"GWH"	2010	0	60 GWH
GENERATION	CLNG	91	"GWH"	2011	0	60 GWH
GENERATION	CLNG	91	"GWH"	2012	0	60 GWH
GENERATION	CLNG	91	"GWH"	2013	0	60 GWH
GENERATION	CLNG	91	"GWH"	2014	0	60 GWH
GENERATION	CLNG	91	"GWH"	2015	0	60 GWH
GENERATION	CLNG	91	"GWH"	2016	0	60 GWH
GENERATION	CLNG	91	"GWH"	2017	0	60 GWH
GENERATION	CLNG	91	"GWH"	2018	0	60 GWH
GENERATION	CLNG	91	"GWH"	2019	0	60 GWH
GENERATION	CLNG	91	"GWH"	2020	0	60 GWH
GENERATION	CLNG	91	"GWH"	2021	0	60 GWH
GENERATION	CLNG	91	"GWH"	2022	0	60 GWH
GENERATION	CLNG	91	"GWH"	2023	89.7039566	60 GWH
GENERATION	CLNG	91	"GWH"	2024	446.7869263	60 GWH
GENERATION	CLNG	91	"GWH"	2025	445.0155029	60 GWH
GENERATION	CLNG	91	"GWH"	2026	440.8112183	60 GWH

GENERATION	CLNG	91	"GWH"	2027	412.4188538	60 GWH
GENERATION	CLNG	91	"GWH"	2028	423.8888855	60 GWH
GENERATION	CLNG	91	"GWH"	2029	416.6557617	60 GWH
GENERATION	CLNG	91	"GWH"	2030	376.2974243	60 GWH
GENERATION	CLNG	91	"GWH"	2031	382.6398315	60 GWH
GENERATION	CLNG	91	"GWH"	2032	386.6685791	60 GWH
GENERATION	CLNG	91	"GWH"	2033	386.2592163	60 GWH
GENERATION	CLNG	91	"GWH"	2034	391.3708801	60 GWH
GENERATION	CLNG	91	"GWH"	2035	384.8566284	60 GWH
GENERATION	RECIP	92	"GWH"	2006	0	40 GWH
GENERATION	RECIP	92	"GWH"	2007	0	40 GWH
GENERATION	RECIP	92	"GWH"	2008	0	40 GWH
GENERATION	RECIP	92	"GWH"	2009	0	40 GWH
GENERATION	RECIP	92	"GWH"	2010	0	40 GWH
GENERATION	RECIP	92	"GWH"	2011	0	40 GWH
GENERATION	RECIP	92	"GWH"	2012	0	40 GWH
GENERATION	RECIP	92	"GWH"	2013	0	40 GWH
GENERATION	RECIP	92	"GWH"	2014	0	40 GWH
GENERATION	RECIP	92	"GWH"	2015	0	40 GWH
GENERATION	RECIP	92	"GWH"	2016	0	40 GWH
GENERATION	RECIP	92	"GWH"	2017	0	40 GWH
GENERATION	RECIP	92	"GWH"	2018	0	40 GWH
GENERATION	RECIP	92	"GWH"	2019	0	40 GWH
GENERATION	RECIP	92	"GWH"	2020	0	40 GWH
GENERATION	RECIP	92	"GWH"	2021	0	40 GWH
GENERATION	RECIP	92	"GWH"	2022	0	40 GWH
GENERATION	RECIP	92	"GWH"	2023	21.87997437	40 GWH
GENERATION	RECIP	92	"GWH"	2024	87.72034454	40 GWH
GENERATION	RECIP	92	"GWH"	2025	80.4724884	40 GWH
GENERATION	RECIP	92	"GWH"	2026	78.7433548	40 GWH
GENERATION	RECIP	92	"GWH"	2027	74.84566498	40 GWH
GENERATION	RECIP	92	"GWH"	2028	74.74143219	40 GWH
GENERATION	RECIP	92	"GWH"	2029	74.52082062	40 GWH
GENERATION	RECIP	92	"GWH"	2030	74.55658722	40 GWH
GENERATION	RECIP	92	"GWH"	2031	74.54344177	40 GWH
GENERATION	RECIP	92	"GWH"	2032	74.76368713	40 GWH
GENERATION	RECIP	92	"GWH"	2033	74.52549744	40 GWH
GENERATION	RECIP	92	"GWH"	2034	74.52187347	40 GWH
GENERATION	RECIP	92	"GWH"	2035	74.5248642	40 GWH
GENERATION	CLNG	93	"GWH"	2006	0	60 GWH
GENERATION	CLNG	93	"GWH"	2007	0	60 GWH
GENERATION	CLNG	93	"GWH"	2008	0	60 GWH
GENERATION	CLNG	93	"GWH"	2009	0	60 GWH
GENERATION	CLNG	93	"GWH"	2010	0	60 GWH
GENERATION	CLNG	93	"GWH"	2011	0	60 GWH
GENERATION	CLNG	93	"GWH"	2012	0	60 GWH
GENERATION	CLNG	93	"GWH"	2013	0	60 GWH
GENERATION	CLNG	93	"GWH"	2014	0	60 GWH
GENERATION	CLNG	93	"GWH"	2015	0	60 GWH
GENERATION	CLNG	93	"GWH"	2016	0	60 GWH
GENERATION	CLNG	93	"GWH"	2017	0	60 GWH
GENERATION	CLNG	93	"GWH"	2018	0	60 GWH

GENERATION	CLNG	93	"GWH"	2019	0	60 GWH
GENERATION	CLNG	93	"GWH"	2020	0	60 GWH
GENERATION	CLNG	93	"GWH"	2021	0	60 GWH
GENERATION	CLNG	93	"GWH"	2022	90.52962494	60 GWH
GENERATION	CLNG	93	"GWH"	2023	458.942688	60 GWH
GENERATION	CLNG	93	"GWH"	2024	431.9277344	60 GWH
GENERATION	CLNG	93	"GWH"	2025	429.967926	60 GWH
GENERATION	CLNG	93	"GWH"	2026	427.1270142	60 GWH
GENERATION	CLNG	93	"GWH"	2027	393.1609497	60 GWH
GENERATION	CLNG	93	"GWH"	2028	406.9033813	60 GWH
GENERATION	CLNG	93	"GWH"	2029	397.1719055	60 GWH
GENERATION	CLNG	93	"GWH"	2030	359.1801758	60 GWH
GENERATION	CLNG	93	"GWH"	2031	365.1410828	60 GWH
GENERATION	CLNG	93	"GWH"	2032	369.8579102	60 GWH
GENERATION	CLNG	93	"GWH"	2033	370.2626343	60 GWH
GENERATION	CLNG	93	"GWH"	2034	375.3148804	60 GWH
GENERATION	CLNG	93	"GWH"	2035	368.6856384	60 GWH
GENERATION	WIND	94	"GWH"	2006	0	4.8 GWH
GENERATION	WIND	94	"GWH"	2007	0	4.8 GWH
GENERATION	WIND	94	"GWH"	2008	0	4.8 GWH
GENERATION	WIND	94	"GWH"	2009	0	4.8 GWH
GENERATION	WIND	94	"GWH"	2010	0	4.8 GWH
GENERATION	WIND	94	"GWH"	2011	0	4.8 GWH
GENERATION	WIND	94	"GWH"	2012	0	4.8 GWH
GENERATION	WIND	94	"GWH"	2013	0	4.8 GWH
GENERATION	WIND	94	"GWH"	2014	0	4.8 GWH
GENERATION	WIND	94	"GWH"	2015	0	4.8 GWH
GENERATION	WIND	94	"GWH"	2016	0	4.8 GWH
GENERATION	WIND	94	"GWH"	2017	0	4.8 GWH
GENERATION	WIND	94	"GWH"	2018	0	4.8 GWH
GENERATION	WIND	94	"GWH"	2019	24.39936066	4.8 GWH
GENERATION	WIND	94	"GWH"	2020	103.3113632	4.8 GWH
GENERATION	WIND	94	"GWH"	2021	103.0233612	4.8 GWH
GENERATION	WIND	94	"GWH"	2022	103.0233612	4.8 GWH
GENERATION	WIND	94	"GWH"	2023	103.0232468	4.8 GWH
GENERATION	WIND	94	"GWH"	2024	103.1214676	4.8 GWH
GENERATION	WIND	94	"GWH"	2025	102.6850662	4.8 GWH
GENERATION	WIND	94	"GWH"	2026	102.7457123	4.8 GWH
GENERATION	WIND	94	"GWH"	2027	100.9654236	4.8 GWH
GENERATION	WIND	94	"GWH"	2028	102.7643356	4.8 GWH
GENERATION	WIND	94	"GWH"	2029	101.6438904	4.8 GWH
GENERATION	WIND	94	"GWH"	2030	95.23790741	4.8 GWH
GENERATION	WIND	94	"GWH"	2031	97.31922913	4.8 GWH
GENERATION	WIND	94	"GWH"	2032	98.61820984	4.8 GWH
GENERATION	WIND	94	"GWH"	2033	97.76542664	4.8 GWH
GENERATION	WIND	94	"GWH"	2034	99.48832703	4.8 GWH
GENERATION	WIND	94	"GWH"	2035	97.03400421	4.8 GWH
GENERATION	WIND	95	"GWH"	2006	0	4.8 GWH
GENERATION	WIND	95	"GWH"	2007	0	4.8 GWH
GENERATION	WIND	95	"GWH"	2008	0	4.8 GWH
GENERATION	WIND	95	"GWH"	2009	0	4.8 GWH
GENERATION	WIND	95	"GWH"	2010	0	4.8 GWH

GENERATION	WIND	95	"GWH"	2011	0	4.8 GWH
GENERATION	WIND	95	"GWH"	2012	0	4.8 GWH
GENERATION	WIND	95	"GWH"	2013	0	4.8 GWH
GENERATION	WIND	95	"GWH"	2014	0	4.8 GWH
GENERATION	WIND	95	"GWH"	2015	0	4.8 GWH
GENERATION	WIND	95	"GWH"	2016	0	4.8 GWH
GENERATION	WIND	95	"GWH"	2017	0	4.8 GWH
GENERATION	WIND	95	"GWH"	2018	24.39936066	4.8 GWH
GENERATION	WIND	95	"GWH"	2019	103.0233612	4.8 GWH
GENERATION	WIND	95	"GWH"	2020	103.3113632	4.8 GWH
GENERATION	WIND	95	"GWH"	2021	103.0226898	4.8 GWH
GENERATION	WIND	95	"GWH"	2022	103.0018616	4.8 GWH
GENERATION	WIND	95	"GWH"	2023	102.9796219	4.8 GWH
GENERATION	WIND	95	"GWH"	2024	101.2243347	4.8 GWH
GENERATION	WIND	95	"GWH"	2025	100.9568558	4.8 GWH
GENERATION	WIND	95	"GWH"	2026	100.6690369	4.8 GWH
GENERATION	WIND	95	"GWH"	2027	96.23300934	4.8 GWH
GENERATION	WIND	95	"GWH"	2028	99.77478027	4.8 GWH
GENERATION	WIND	95	"GWH"	2029	97.40203857	4.8 GWH
GENERATION	WIND	95	"GWH"	2030	88.11067963	4.8 GWH
GENERATION	WIND	95	"GWH"	2031	90.83399963	4.8 GWH
GENERATION	WIND	95	"GWH"	2032	92.50312805	4.8 GWH
GENERATION	WIND	95	"GWH"	2033	91.87372589	4.8 GWH
GENERATION	WIND	95	"GWH"	2034	93.89740753	4.8 GWH
GENERATION	WIND	95	"GWH"	2035	90.60780334	4.8 GWH
GENERATION	CLNG	96	"GWH"	2006	0	60 GWH
GENERATION	CLNG	96	"GWH"	2007	0	60 GWH
GENERATION	CLNG	96	"GWH"	2008	0	60 GWH
GENERATION	CLNG	96	"GWH"	2009	0	60 GWH
GENERATION	CLNG	96	"GWH"	2010	0	60 GWH
GENERATION	CLNG	96	"GWH"	2011	0	60 GWH
GENERATION	CLNG	96	"GWH"	2012	0	60 GWH
GENERATION	CLNG	96	"GWH"	2013	0	60 GWH
GENERATION	CLNG	96	"GWH"	2014	0	60 GWH
GENERATION	CLNG	96	"GWH"	2015	0	60 GWH
GENERATION	CLNG	96	"GWH"	2016	0	60 GWH
GENERATION	CLNG	96	"GWH"	2017	0	60 GWH
GENERATION	CLNG	96	"GWH"	2018	92.44490814	60 GWH
GENERATION	CLNG	96	"GWH"	2019	470.2240601	60 GWH
GENERATION	CLNG	96	"GWH"	2020	469.6080627	60 GWH
GENERATION	CLNG	96	"GWH"	2021	469.6155396	60 GWH
GENERATION	CLNG	96	"GWH"	2022	467.983551	60 GWH
GENERATION	CLNG	96	"GWH"	2023	449.6123047	60 GWH
GENERATION	CLNG	96	"GWH"	2024	413.5510559	60 GWH
GENERATION	CLNG	96	"GWH"	2025	412.3118896	60 GWH
GENERATION	CLNG	96	"GWH"	2026	410.0223694	60 GWH
GENERATION	CLNG	96	"GWH"	2027	376.1826477	60 GWH
GENERATION	CLNG	96	"GWH"	2028	388.5504456	60 GWH
GENERATION	CLNG	96	"GWH"	2029	377.5757446	60 GWH
GENERATION	CLNG	96	"GWH"	2030	346.0486145	60 GWH
GENERATION	CLNG	96	"GWH"	2031	351.2200928	60 GWH
GENERATION	CLNG	96	"GWH"	2032	355.1283264	60 GWH

GENERATION	CLNG	96	"GWH"	2033	355.6791077	60	GWH
GENERATION	CLNG	96	"GWH"	2034	359.2224121	60	GWH
GENERATION	CLNG	96	"GWH"	2035	355.0300293	60	GWH
GENERATION	WIND	97	"GWH"	2006	0	4.8	GWH
GENERATION	WIND	97	"GWH"	2007	0	4.8	GWH
GENERATION	WIND	97	"GWH"	2008	0	4.8	GWH
GENERATION	WIND	97	"GWH"	2009	0	4.8	GWH
GENERATION	WIND	97	"GWH"	2010	0	4.8	GWH
GENERATION	WIND	97	"GWH"	2011	0	4.8	GWH
GENERATION	WIND	97	"GWH"	2012	0	4.8	GWH
GENERATION	WIND	97	"GWH"	2013	0	4.8	GWH
GENERATION	WIND	97	"GWH"	2014	0	4.8	GWH
GENERATION	WIND	97	"GWH"	2015	0	4.8	GWH
GENERATION	WIND	97	"GWH"	2016	0	4.8	GWH
GENERATION	WIND	97	"GWH"	2017	24.39936066	4.8	GWH
GENERATION	WIND	97	"GWH"	2018	103.0233612	4.8	GWH
GENERATION	WIND	97	"GWH"	2019	103.008934	4.8	GWH
GENERATION	WIND	97	"GWH"	2020	103.2223892	4.8	GWH
GENERATION	WIND	97	"GWH"	2021	102.9745865	4.8	GWH
GENERATION	WIND	97	"GWH"	2022	102.8780289	4.8	GWH
GENERATION	WIND	97	"GWH"	2023	102.2426529	4.8	GWH
GENERATION	WIND	97	"GWH"	2024	97.7287674	4.8	GWH
GENERATION	WIND	97	"GWH"	2025	97.12879944	4.8	GWH
GENERATION	WIND	97	"GWH"	2026	97.0859375	4.8	GWH
GENERATION	WIND	97	"GWH"	2027	90.67864227	4.8	GWH
GENERATION	WIND	97	"GWH"	2028	95.19435883	4.8	GWH
GENERATION	WIND	97	"GWH"	2029	92.07860565	4.8	GWH
GENERATION	WIND	97	"GWH"	2030	80.9744339	4.8	GWH
GENERATION	WIND	97	"GWH"	2031	84.17432404	4.8	GWH
GENERATION	WIND	97	"GWH"	2032	86.06494141	4.8	GWH
GENERATION	WIND	97	"GWH"	2033	85.44548798	4.8	GWH
GENERATION	WIND	97	"GWH"	2034	87.92793274	4.8	GWH
GENERATION	WIND	97	"GWH"	2035	83.79335785	4.8	GWH
GENERATION	WIND	98	"GWH"	2006	0	4.8	GWH
GENERATION	WIND	98	"GWH"	2007	0	4.8	GWH
GENERATION	WIND	98	"GWH"	2008	0	4.8	GWH
GENERATION	WIND	98	"GWH"	2009	0	4.8	GWH
GENERATION	WIND	98	"GWH"	2010	0	4.8	GWH
GENERATION	WIND	98	"GWH"	2011	0	4.8	GWH
GENERATION	WIND	98	"GWH"	2012	0	4.8	GWH
GENERATION	WIND	98	"GWH"	2013	0	4.8	GWH
GENERATION	WIND	98	"GWH"	2014	0	4.8	GWH
GENERATION	WIND	98	"GWH"	2015	0	4.8	GWH
GENERATION	WIND	98	"GWH"	2016	24.39936066	4.8	GWH
GENERATION	WIND	98	"GWH"	2017	103.0233612	4.8	GWH
GENERATION	WIND	98	"GWH"	2018	103.0055466	4.8	GWH
GENERATION	WIND	98	"GWH"	2019	102.7664337	4.8	GWH
GENERATION	WIND	98	"GWH"	2020	102.7406845	4.8	GWH
GENERATION	WIND	98	"GWH"	2021	102.6304398	4.8	GWH
GENERATION	WIND	98	"GWH"	2022	102.4162216	4.8	GWH
GENERATION	WIND	98	"GWH"	2023	100.4361954	4.8	GWH
GENERATION	WIND	98	"GWH"	2024	92.83220673	4.8	GWH

GENERATION	WIND	98	"GWH"	2025	92.59036255	4.8 GWH
GENERATION	WIND	98	"GWH"	2026	91.81439209	4.8 GWH
GENERATION	WIND	98	"GWH"	2027	83.94683838	4.8 GWH
GENERATION	WIND	98	"GWH"	2028	89.50230408	4.8 GWH
GENERATION	WIND	98	"GWH"	2029	85.75909424	4.8 GWH
GENERATION	WIND	98	"GWH"	2030	73.13785553	4.8 GWH
GENERATION	WIND	98	"GWH"	2031	76.74212646	4.8 GWH
GENERATION	WIND	98	"GWH"	2032	78.98526764	4.8 GWH
GENERATION	WIND	98	"GWH"	2033	78.67233276	4.8 GWH
GENERATION	WIND	98	"GWH"	2034	81.42318726	4.8 GWH
GENERATION	WIND	98	"GWH"	2035	76.87942505	4.8 GWH
GENERATION	RETR	99	"GWH"	2006	0	60 GWH
GENERATION	RETR	99	"GWH"	2007	0	60 GWH
GENERATION	RETR	99	"GWH"	2008	0	60 GWH
GENERATION	RETR	99	"GWH"	2009	0	60 GWH
GENERATION	RETR	99	"GWH"	2010	0	60 GWH
GENERATION	RETR	99	"GWH"	2011	0	60 GWH
GENERATION	RETR	99	"GWH"	2012	0	60 GWH
GENERATION	RETR	99	"GWH"	2013	0	60 GWH
GENERATION	RETR	99	"GWH"	2014	0	60 GWH
GENERATION	RETR	99	"GWH"	2015	0	60 GWH
GENERATION	RETR	99	"GWH"	2016	55.43346786	60 GWH
GENERATION	RETR	99	"GWH"	2017	223.786026	60 GWH
GENERATION	RETR	99	"GWH"	2018	181.9510498	60 GWH
GENERATION	RETR	99	"GWH"	2019	88.20943451	60 GWH
GENERATION	RETR	99	"GWH"	2020	70.07929993	60 GWH
GENERATION	RETR	99	"GWH"	2021	89.29537964	60 GWH
GENERATION	RETR	99	"GWH"	2022	80.7631073	60 GWH
GENERATION	RETR	99	"GWH"	2023	13.79027462	60 GWH
GENERATION	RETR	99	"GWH"	2024	0.287293404	60 GWH
GENERATION	RETR	99	"GWH"	2025	0.075842671	60 GWH
GENERATION	RETR	99	"GWH"	2026	0.301337451	60 GWH
GENERATION	RETR	99	"GWH"	2027	0.007743305	60 GWH
GENERATION	RETR	99	"GWH"	2028	1.692778468	60 GWH
GENERATION	RETR	99	"GWH"	2029	0.282089204	60 GWH
GENERATION	RETR	99	"GWH"	2030	0.09830372	60 GWH
GENERATION	RETR	99	"GWH"	2031	0.079888031	60 GWH
GENERATION	RETR	99	"GWH"	2032	0.099656232	60 GWH
GENERATION	RETR	99	"GWH"	2033	0.038671229	60 GWH
GENERATION	RETR	99	"GWH"	2034	0.034837168	60 GWH
GENERATION	RETR	99	"GWH"	2035	0.037885521	60 GWH
GENERATION	WIND	100	"GWH"	2006	0	4.8 GWH
GENERATION	WIND	100	"GWH"	2007	0	4.8 GWH
GENERATION	WIND	100	"GWH"	2008	0	4.8 GWH
GENERATION	WIND	100	"GWH"	2009	0	4.8 GWH
GENERATION	WIND	100	"GWH"	2010	0	4.8 GWH
GENERATION	WIND	100	"GWH"	2011	0	4.8 GWH
GENERATION	WIND	100	"GWH"	2012	0	4.8 GWH
GENERATION	WIND	100	"GWH"	2013	0	4.8 GWH
GENERATION	WIND	100	"GWH"	2014	0	4.8 GWH
GENERATION	WIND	100	"GWH"	2015	24.39936066	4.8 GWH
GENERATION	WIND	100	"GWH"	2016	103.3113632	4.8 GWH

GENERATION	WIND	100	"GWH"	2017	103.0233612	4.8 GWH
GENERATION	WIND	100	"GWH"	2018	102.9173203	4.8 GWH
GENERATION	WIND	100	"GWH"	2019	102.0330887	4.8 GWH
GENERATION	WIND	100	"GWH"	2020	101.64534	4.8 GWH
GENERATION	WIND	100	"GWH"	2021	101.8000031	4.8 GWH
GENERATION	WIND	100	"GWH"	2022	101.3968887	4.8 GWH
GENERATION	WIND	100	"GWH"	2023	97.5836792	4.8 GWH
GENERATION	WIND	100	"GWH"	2024	86.90519714	4.8 GWH
GENERATION	WIND	100	"GWH"	2025	86.72759247	4.8 GWH
GENERATION	WIND	100	"GWH"	2026	86.15300751	4.8 GWH
GENERATION	WIND	100	"GWH"	2027	77.10820007	4.8 GWH
GENERATION	WIND	100	"GWH"	2028	83.14096069	4.8 GWH
GENERATION	WIND	100	"GWH"	2029	79.1869278	4.8 GWH
GENERATION	WIND	100	"GWH"	2030	65.49352264	4.8 GWH
GENERATION	WIND	100	"GWH"	2031	69.39580536	4.8 GWH
GENERATION	WIND	100	"GWH"	2032	71.85830688	4.8 GWH
GENERATION	WIND	100	"GWH"	2033	71.62987518	4.8 GWH
GENERATION	WIND	100	"GWH"	2034	74.59816742	4.8 GWH
GENERATION	WIND	100	"GWH"	2035	69.85338593	4.8 GWH
FIRM CAPACITY	CAB ST	1	"MW"	2006	61.38000107	66 MW
FIRM CAPACITY	CAB ST	1	"MW"	2007	61.38000107	66 MW
FIRM CAPACITY	CAB ST	1	"MW"	2008	61.38000107	66 MW
FIRM CAPACITY	CAB ST	1	"MW"	2009	61.38000107	66 MW
FIRM CAPACITY	CAB ST	1	"MW"	2010	61.38000107	66 MW
FIRM CAPACITY	CAB ST	1	"MW"	2011	61.38000107	66 MW
FIRM CAPACITY	CAB ST	1	"MW"	2012	61.38000107	66 MW
FIRM CAPACITY	CAB ST	1	"MW"	2013	61.38000107	66 MW
FIRM CAPACITY	CAB ST	1	"MW"	2014	61.38000107	66 MW
FIRM CAPACITY	CAB ST	1	"MW"	2015	61.38000107	66 MW
FIRM CAPACITY	CAB ST	1	"MW"	2016	61.38000107	66 MW
FIRM CAPACITY	CAB ST	1	"MW"	2017	61.38000107	66 MW
FIRM CAPACITY	CAB ST	1	"MW"	2018	61.38000107	66 MW
FIRM CAPACITY	CAB ST	1	"MW"	2019	61.38000107	66 MW
FIRM CAPACITY	CAB ST	1	"MW"	2020	61.38000107	66 MW
FIRM CAPACITY	CAB ST	1	"MW"	2021	61.38000107	66 MW
FIRM CAPACITY	CAB ST	1	"MW"	2022	61.38000107	66 MW
FIRM CAPACITY	CAB ST	1	"MW"	2023	61.38000107	66 MW
FIRM CAPACITY	CAB ST	1	"MW"	2024	61.38000107	66 MW
FIRM CAPACITY	CAB ST	1	"MW"	2025	61.38000107	66 MW
FIRM CAPACITY	CAB ST	1	"MW"	2026	61.38000107	66 MW
FIRM CAPACITY	CAB ST	1	"MW"	2027	0	66 MW
FIRM CAPACITY	CAB ST	1	"MW"	2028	0	66 MW
FIRM CAPACITY	CAB ST	1	"MW"	2029	0	66 MW
FIRM CAPACITY	CAB ST	1	"MW"	2030	0	66 MW
FIRM CAPACITY	CAB ST	1	"MW"	2031	0	66 MW
FIRM CAPACITY	CAB ST	1	"MW"	2032	0	66 MW
FIRM CAPACITY	CAB ST	1	"MW"	2033	0	66 MW
FIRM CAPACITY	CAB ST	1	"MW"	2034	0	66 MW
FIRM CAPACITY	CAB ST	1	"MW"	2035	0	66 MW
FIRM CAPACITY	CAB ST	2	"MW"	2006	61.38000107	66 MW
FIRM CAPACITY	CAB ST	2	"MW"	2007	61.38000107	66 MW
FIRM CAPACITY	CAB ST	2	"MW"	2008	61.38000107	66 MW

FIRM CAPACITY	CAB ST 2	"MW"	2009	61.38000107	66 MW
FIRM CAPACITY	CAB ST 2	"MW"	2010	61.38000107	66 MW
FIRM CAPACITY	CAB ST 2	"MW"	2011	61.38000107	66 MW
FIRM CAPACITY	CAB ST 2	"MW"	2012	61.38000107	66 MW
FIRM CAPACITY	CAB ST 2	"MW"	2013	61.38000107	66 MW
FIRM CAPACITY	CAB ST 2	"MW"	2014	61.38000107	66 MW
FIRM CAPACITY	CAB ST 2	"MW"	2015	61.38000107	66 MW
FIRM CAPACITY	CAB ST 2	"MW"	2016	61.38000107	66 MW
FIRM CAPACITY	CAB ST 2	"MW"	2017	61.38000107	66 MW
FIRM CAPACITY	CAB ST 2	"MW"	2018	61.38000107	66 MW
FIRM CAPACITY	CAB ST 2	"MW"	2019	61.38000107	66 MW
FIRM CAPACITY	CAB ST 2	"MW"	2020	61.38000107	66 MW
FIRM CAPACITY	CAB ST 2	"MW"	2021	61.38000107	66 MW
FIRM CAPACITY	CAB ST 2	"MW"	2022	61.38000107	66 MW
FIRM CAPACITY	CAB ST 2	"MW"	2023	61.38000107	66 MW
FIRM CAPACITY	CAB ST 2	"MW"	2024	61.38000107	66 MW
FIRM CAPACITY	CAB ST 2	"MW"	2025	61.38000107	66 MW
FIRM CAPACITY	CAB ST 2	"MW"	2026	61.38000107	66 MW
FIRM CAPACITY	CAB ST 2	"MW"	2027	61.38000107	66 MW
FIRM CAPACITY	CAB ST 2	"MW"	2028	0	66 MW
FIRM CAPACITY	CAB ST 2	"MW"	2029	0	66 MW
FIRM CAPACITY	CAB ST 2	"MW"	2030	0	66 MW
FIRM CAPACITY	CAB ST 2	"MW"	2031	0	66 MW
FIRM CAPACITY	CAB ST 2	"MW"	2032	0	66 MW
FIRM CAPACITY	CAB ST 2	"MW"	2033	0	66 MW
FIRM CAPACITY	CAB ST 2	"MW"	2034	0	66 MW
FIRM CAPACITY	CAB ST 2	"MW"	2035	0	66 MW
FIRM CAPACITY	CAB SSD 3	"MW"	2006	36.93999863	39.3 MW
FIRM CAPACITY	CAB SSD 3	"MW"	2007	36.93999863	39.3 MW
FIRM CAPACITY	CAB SSD 3	"MW"	2008	36.93999863	39.3 MW
FIRM CAPACITY	CAB SSD 3	"MW"	2009	36.93999863	39.3 MW
FIRM CAPACITY	CAB SSD 3	"MW"	2010	36.93999863	39.3 MW
FIRM CAPACITY	CAB SSD 3	"MW"	2011	36.93999863	39.3 MW
FIRM CAPACITY	CAB SSD 3	"MW"	2012	36.93999863	39.3 MW
FIRM CAPACITY	CAB SSD 3	"MW"	2013	36.93999863	39.3 MW
FIRM CAPACITY	CAB SSD 3	"MW"	2014	36.93999863	39.3 MW
FIRM CAPACITY	CAB SSD 3	"MW"	2015	36.93999863	39.3 MW
FIRM CAPACITY	CAB SSD 3	"MW"	2016	36.93999863	39.3 MW
FIRM CAPACITY	CAB SSD 3	"MW"	2017	36.93999863	39.3 MW
FIRM CAPACITY	CAB SSD 3	"MW"	2018	36.93999863	39.3 MW
FIRM CAPACITY	CAB SSD 3	"MW"	2019	36.93999863	39.3 MW
FIRM CAPACITY	CAB SSD 3	"MW"	2020	36.93999863	39.3 MW
FIRM CAPACITY	CAB SSD 3	"MW"	2021	36.93999863	39.3 MW
FIRM CAPACITY	CAB SSD 3	"MW"	2022	36.93999863	39.3 MW
FIRM CAPACITY	CAB SSD 3	"MW"	2023	36.93999863	39.3 MW
FIRM CAPACITY	CAB SSD 3	"MW"	2024	36.93999863	39.3 MW
FIRM CAPACITY	CAB SSD 3	"MW"	2025	36.93999863	39.3 MW
FIRM CAPACITY	CAB SSD 3	"MW"	2026	36.93999863	39.3 MW
FIRM CAPACITY	CAB SSD 3	"MW"	2027	36.93999863	39.3 MW
FIRM CAPACITY	CAB SSD 3	"MW"	2028	36.93999863	39.3 MW
FIRM CAPACITY	CAB SSD 3	"MW"	2029	36.93999863	39.3 MW
FIRM CAPACITY	CAB SSD 3	"MW"	2030	36.93999863	39.3 MW

FIRM CAPACITY	CAB SSD	3	"MW"	2031	36.93999863	39.3 MW
FIRM CAPACITY	CAB SSD	3	"MW"	2032	36.93999863	39.3 MW
FIRM CAPACITY	CAB SSD	3	"MW"	2033	36.93999863	39.3 MW
FIRM CAPACITY	CAB SSD	3	"MW"	2034	36.93999863	39.3 MW
FIRM CAPACITY	CAB SSD	3	"MW"	2035	36.93999863	39.3 MW
FIRM CAPACITY	CAB SSD	4	"MW"	2006	37.34000015	39.3 MW
FIRM CAPACITY	CAB SSD	4	"MW"	2007	37.34000015	39.3 MW
FIRM CAPACITY	CAB SSD	4	"MW"	2008	37.34000015	39.3 MW
FIRM CAPACITY	CAB SSD	4	"MW"	2009	37.34000015	39.3 MW
FIRM CAPACITY	CAB SSD	4	"MW"	2010	37.34000015	39.3 MW
FIRM CAPACITY	CAB SSD	4	"MW"	2011	37.34000015	39.3 MW
FIRM CAPACITY	CAB SSD	4	"MW"	2012	37.34000015	39.3 MW
FIRM CAPACITY	CAB SSD	4	"MW"	2013	37.34000015	39.3 MW
FIRM CAPACITY	CAB SSD	4	"MW"	2014	37.34000015	39.3 MW
FIRM CAPACITY	CAB SSD	4	"MW"	2015	37.34000015	39.3 MW
FIRM CAPACITY	CAB SSD	4	"MW"	2016	37.34000015	39.3 MW
FIRM CAPACITY	CAB SSD	4	"MW"	2017	37.34000015	39.3 MW
FIRM CAPACITY	CAB SSD	4	"MW"	2018	37.34000015	39.3 MW
FIRM CAPACITY	CAB SSD	4	"MW"	2019	37.34000015	39.3 MW
FIRM CAPACITY	CAB SSD	4	"MW"	2020	37.34000015	39.3 MW
FIRM CAPACITY	CAB SSD	4	"MW"	2021	37.34000015	39.3 MW
FIRM CAPACITY	CAB SSD	4	"MW"	2022	37.34000015	39.3 MW
FIRM CAPACITY	CAB SSD	4	"MW"	2023	37.34000015	39.3 MW
FIRM CAPACITY	CAB SSD	4	"MW"	2024	37.34000015	39.3 MW
FIRM CAPACITY	CAB SSD	4	"MW"	2025	37.34000015	39.3 MW
FIRM CAPACITY	CAB SSD	4	"MW"	2026	37.34000015	39.3 MW
FIRM CAPACITY	CAB SSD	4	"MW"	2027	37.34000015	39.3 MW
FIRM CAPACITY	CAB SSD	4	"MW"	2028	37.34000015	39.3 MW
FIRM CAPACITY	CAB SSD	4	"MW"	2029	37.34000015	39.3 MW
FIRM CAPACITY	CAB SSD	4	"MW"	2030	37.34000015	39.3 MW
FIRM CAPACITY	CAB SSD	4	"MW"	2031	37.34000015	39.3 MW
FIRM CAPACITY	CAB SSD	4	"MW"	2032	37.34000015	39.3 MW
FIRM CAPACITY	CAB SSD	4	"MW"	2033	37.34000015	39.3 MW
FIRM CAPACITY	CAB SSD	4	"MW"	2034	37.34000015	39.3 MW
FIRM CAPACITY	CAB SSD	4	"MW"	2035	37.34000015	39.3 MW
FIRM CAPACITY	OROTE	1	"MW"	2006	0	16 MW
FIRM CAPACITY	OROTE	1	"MW"	2007	0	16 MW
FIRM CAPACITY	OROTE	1	"MW"	2008	0	16 MW
FIRM CAPACITY	OROTE	1	"MW"	2009	0	16 MW
FIRM CAPACITY	OROTE	1	"MW"	2010	0	16 MW
FIRM CAPACITY	OROTE	1	"MW"	2011	0	16 MW
FIRM CAPACITY	OROTE	1	"MW"	2012	0	16 MW
FIRM CAPACITY	OROTE	1	"MW"	2013	0	16 MW
FIRM CAPACITY	OROTE	1	"MW"	2014	0	16 MW
FIRM CAPACITY	OROTE	1	"MW"	2015	0	16 MW
FIRM CAPACITY	OROTE	1	"MW"	2016	0	16 MW
FIRM CAPACITY	OROTE	1	"MW"	2017	0	16 MW
FIRM CAPACITY	OROTE	1	"MW"	2018	0	16 MW
FIRM CAPACITY	OROTE	1	"MW"	2019	0	16 MW
FIRM CAPACITY	OROTE	1	"MW"	2020	0	16 MW
FIRM CAPACITY	OROTE	1	"MW"	2021	0	16 MW
FIRM CAPACITY	OROTE	1	"MW"	2022	0	16 MW

FIRM CAPACITY	OROTE	1	"MW"	2023	0	16 MW
FIRM CAPACITY	OROTE	1	"MW"	2024	0	16 MW
FIRM CAPACITY	OROTE	1	"MW"	2025	0	16 MW
FIRM CAPACITY	OROTE	1	"MW"	2026	0	16 MW
FIRM CAPACITY	OROTE	1	"MW"	2027	0	16 MW
FIRM CAPACITY	OROTE	1	"MW"	2028	0	16 MW
FIRM CAPACITY	OROTE	1	"MW"	2029	0	16 MW
FIRM CAPACITY	OROTE	1	"MW"	2030	0	16 MW
FIRM CAPACITY	OROTE	1	"MW"	2031	0	16 MW
FIRM CAPACITY	OROTE	1	"MW"	2032	0	16 MW
FIRM CAPACITY	OROTE	1	"MW"	2033	0	16 MW
FIRM CAPACITY	OROTE	1	"MW"	2034	0	16 MW
FIRM CAPACITY	OROTE	1	"MW"	2035	0	16 MW
FIRM CAPACITY	DED CT	1	"MW"	2006	22.77000046	23 MW
FIRM CAPACITY	DED CT	1	"MW"	2007	22.77000046	23 MW
FIRM CAPACITY	DED CT	1	"MW"	2008	22.77000046	23 MW
FIRM CAPACITY	DED CT	1	"MW"	2009	22.77000046	23 MW
FIRM CAPACITY	DED CT	1	"MW"	2010	22.77000046	23 MW
FIRM CAPACITY	DED CT	1	"MW"	2011	22.77000046	23 MW
FIRM CAPACITY	DED CT	1	"MW"	2012	22.77000046	23 MW
FIRM CAPACITY	DED CT	1	"MW"	2013	22.77000046	23 MW
FIRM CAPACITY	DED CT	1	"MW"	2014	22.77000046	23 MW
FIRM CAPACITY	DED CT	1	"MW"	2015	22.77000046	23 MW
FIRM CAPACITY	DED CT	1	"MW"	2016	22.77000046	23 MW
FIRM CAPACITY	DED CT	1	"MW"	2017	22.77000046	23 MW
FIRM CAPACITY	DED CT	1	"MW"	2018	22.77000046	23 MW
FIRM CAPACITY	DED CT	1	"MW"	2019	22.77000046	23 MW
FIRM CAPACITY	DED CT	1	"MW"	2020	22.77000046	23 MW
FIRM CAPACITY	DED CT	1	"MW"	2021	22.77000046	23 MW
FIRM CAPACITY	DED CT	1	"MW"	2022	22.77000046	23 MW
FIRM CAPACITY	DED CT	1	"MW"	2023	0	23 MW
FIRM CAPACITY	DED CT	1	"MW"	2024	0	23 MW
FIRM CAPACITY	DED CT	1	"MW"	2025	0	23 MW
FIRM CAPACITY	DED CT	1	"MW"	2026	0	23 MW
FIRM CAPACITY	DED CT	1	"MW"	2027	0	23 MW
FIRM CAPACITY	DED CT	1	"MW"	2028	0	23 MW
FIRM CAPACITY	DED CT	1	"MW"	2029	0	23 MW
FIRM CAPACITY	DED CT	1	"MW"	2030	0	23 MW
FIRM CAPACITY	DED CT	1	"MW"	2031	0	23 MW
FIRM CAPACITY	DED CT	1	"MW"	2032	0	23 MW
FIRM CAPACITY	DED CT	1	"MW"	2033	0	23 MW
FIRM CAPACITY	DED CT	1	"MW"	2034	0	23 MW
FIRM CAPACITY	DED CT	1	"MW"	2035	0	23 MW
FIRM CAPACITY	DED CT	2	"MW"	2006	22.77000046	22 MW
FIRM CAPACITY	DED CT	2	"MW"	2007	22.77000046	22 MW
FIRM CAPACITY	DED CT	2	"MW"	2008	22.77000046	22 MW
FIRM CAPACITY	DED CT	2	"MW"	2009	22.77000046	22 MW
FIRM CAPACITY	DED CT	2	"MW"	2010	22.77000046	22 MW
FIRM CAPACITY	DED CT	2	"MW"	2011	22.77000046	22 MW
FIRM CAPACITY	DED CT	2	"MW"	2012	22.77000046	22 MW
FIRM CAPACITY	DED CT	2	"MW"	2013	22.77000046	22 MW
FIRM CAPACITY	DED CT	2	"MW"	2014	22.77000046	22 MW

FIRM CAPACITY	DED CT 2	"MW"	2015	22.77000046	22 MW
FIRM CAPACITY	DED CT 2	"MW"	2016	22.77000046	22 MW
FIRM CAPACITY	DED CT 2	"MW"	2017	22.77000046	22 MW
FIRM CAPACITY	DED CT 2	"MW"	2018	22.77000046	22 MW
FIRM CAPACITY	DED CT 2	"MW"	2019	22.77000046	22 MW
FIRM CAPACITY	DED CT 2	"MW"	2020	22.77000046	22 MW
FIRM CAPACITY	DED CT 2	"MW"	2021	22.77000046	22 MW
FIRM CAPACITY	DED CT 2	"MW"	2022	22.77000046	22 MW
FIRM CAPACITY	DED CT 2	"MW"	2023	22.77000046	22 MW
FIRM CAPACITY	DED CT 2	"MW"	2024	22.77000046	22 MW
FIRM CAPACITY	DED CT 2	"MW"	2025	0	22 MW
FIRM CAPACITY	DED CT 2	"MW"	2026	0	22 MW
FIRM CAPACITY	DED CT 2	"MW"	2027	0	22 MW
FIRM CAPACITY	DED CT 2	"MW"	2028	0	22 MW
FIRM CAPACITY	DED CT 2	"MW"	2029	0	22 MW
FIRM CAPACITY	DED CT 2	"MW"	2030	0	22 MW
FIRM CAPACITY	DED CT 2	"MW"	2031	0	22 MW
FIRM CAPACITY	DED CT 2	"MW"	2032	0	22 MW
FIRM CAPACITY	DED CT 2	"MW"	2033	0	22 MW
FIRM CAPACITY	DED CT 2	"MW"	2034	0	22 MW
FIRM CAPACITY	DED CT 2	"MW"	2035	0	22 MW
FIRM CAPACITY	MACH CT 1	"MW"	2006	21.55999947	22 MW
FIRM CAPACITY	MACH CT 1	"MW"	2007	21.55999947	22 MW
FIRM CAPACITY	MACH CT 1	"MW"	2008	21.55999947	22 MW
FIRM CAPACITY	MACH CT 1	"MW"	2009	21.55999947	22 MW
FIRM CAPACITY	MACH CT 1	"MW"	2010	21.55999947	22 MW
FIRM CAPACITY	MACH CT 1	"MW"	2011	21.55999947	22 MW
FIRM CAPACITY	MACH CT 1	"MW"	2012	21.55999947	22 MW
FIRM CAPACITY	MACH CT 1	"MW"	2013	21.55999947	22 MW
FIRM CAPACITY	MACH CT 1	"MW"	2014	21.55999947	22 MW
FIRM CAPACITY	MACH CT 1	"MW"	2015	21.55999947	22 MW
FIRM CAPACITY	MACH CT 1	"MW"	2016	21.55999947	22 MW
FIRM CAPACITY	MACH CT 1	"MW"	2017	21.55999947	22 MW
FIRM CAPACITY	MACH CT 1	"MW"	2018	21.55999947	22 MW
FIRM CAPACITY	MACH CT 1	"MW"	2019	21.55999947	22 MW
FIRM CAPACITY	MACH CT 1	"MW"	2020	21.55999947	22 MW
FIRM CAPACITY	MACH CT 1	"MW"	2021	21.55999947	22 MW
FIRM CAPACITY	MACH CT 1	"MW"	2022	21.55999947	22 MW
FIRM CAPACITY	MACH CT 1	"MW"	2023	21.55999947	22 MW
FIRM CAPACITY	MACH CT 1	"MW"	2024	0	22 MW
FIRM CAPACITY	MACH CT 1	"MW"	2025	0	22 MW
FIRM CAPACITY	MACH CT 1	"MW"	2026	0	22 MW
FIRM CAPACITY	MACH CT 1	"MW"	2027	0	22 MW
FIRM CAPACITY	MACH CT 1	"MW"	2028	0	22 MW
FIRM CAPACITY	MACH CT 1	"MW"	2029	0	22 MW
FIRM CAPACITY	MACH CT 1	"MW"	2030	0	22 MW
FIRM CAPACITY	MACH CT 1	"MW"	2031	0	22 MW
FIRM CAPACITY	MACH CT 1	"MW"	2032	0	22 MW
FIRM CAPACITY	MACH CT 1	"MW"	2033	0	22 MW
FIRM CAPACITY	MACH CT 1	"MW"	2034	0	22 MW
FIRM CAPACITY	MACH CT 1	"MW"	2035	0	22 MW
FIRM CAPACITY	YIGO CT 1	"MW"	2006	21.55999947	22 MW

FIRM CAPACITY	YIGO CT 1	"MW"	2007	21.55999947	22 MW
FIRM CAPACITY	YIGO CT 1	"MW"	2008	21.55999947	22 MW
FIRM CAPACITY	YIGO CT 1	"MW"	2009	21.55999947	22 MW
FIRM CAPACITY	YIGO CT 1	"MW"	2010	21.55999947	22 MW
FIRM CAPACITY	YIGO CT 1	"MW"	2011	21.55999947	22 MW
FIRM CAPACITY	YIGO CT 1	"MW"	2012	21.55999947	22 MW
FIRM CAPACITY	YIGO CT 1	"MW"	2013	21.55999947	22 MW
FIRM CAPACITY	YIGO CT 1	"MW"	2014	21.55999947	22 MW
FIRM CAPACITY	YIGO CT 1	"MW"	2015	21.55999947	22 MW
FIRM CAPACITY	YIGO CT 1	"MW"	2016	21.55999947	22 MW
FIRM CAPACITY	YIGO CT 1	"MW"	2017	21.55999947	22 MW
FIRM CAPACITY	YIGO CT 1	"MW"	2018	21.55999947	22 MW
FIRM CAPACITY	YIGO CT 1	"MW"	2019	21.55999947	22 MW
FIRM CAPACITY	YIGO CT 1	"MW"	2020	21.55999947	22 MW
FIRM CAPACITY	YIGO CT 1	"MW"	2021	21.55999947	22 MW
FIRM CAPACITY	YIGO CT 1	"MW"	2022	21.55999947	22 MW
FIRM CAPACITY	YIGO CT 1	"MW"	2023	21.55999947	22 MW
FIRM CAPACITY	YIGO CT 1	"MW"	2024	0	22 MW
FIRM CAPACITY	YIGO CT 1	"MW"	2025	0	22 MW
FIRM CAPACITY	YIGO CT 1	"MW"	2026	0	22 MW
FIRM CAPACITY	YIGO CT 1	"MW"	2027	0	22 MW
FIRM CAPACITY	YIGO CT 1	"MW"	2028	0	22 MW
FIRM CAPACITY	YIGO CT 1	"MW"	2029	0	22 MW
FIRM CAPACITY	YIGO CT 1	"MW"	2030	0	22 MW
FIRM CAPACITY	YIGO CT 1	"MW"	2031	0	22 MW
FIRM CAPACITY	YIGO CT 1	"MW"	2032	0	22 MW
FIRM CAPACITY	YIGO CT 1	"MW"	2033	0	22 MW
FIRM CAPACITY	YIGO CT 1	"MW"	2034	0	22 MW
FIRM CAPACITY	YIGO CT 1	"MW"	2035	0	22 MW
FIRM CAPACITY	MARBO CT 1	"MW"	2006	15.35999966	16 MW
FIRM CAPACITY	MARBO CT 1	"MW"	2007	15.35999966	16 MW
FIRM CAPACITY	MARBO CT 1	"MW"	2008	15.35999966	16 MW
FIRM CAPACITY	MARBO CT 1	"MW"	2009	15.35999966	16 MW
FIRM CAPACITY	MARBO CT 1	"MW"	2010	15.35999966	16 MW
FIRM CAPACITY	MARBO CT 1	"MW"	2011	15.35999966	16 MW
FIRM CAPACITY	MARBO CT 1	"MW"	2012	15.35999966	16 MW
FIRM CAPACITY	MARBO CT 1	"MW"	2013	15.35999966	16 MW
FIRM CAPACITY	MARBO CT 1	"MW"	2014	15.35999966	16 MW
FIRM CAPACITY	MARBO CT 1	"MW"	2015	15.35999966	16 MW
FIRM CAPACITY	MARBO CT 1	"MW"	2016	15.35999966	16 MW
FIRM CAPACITY	MARBO CT 1	"MW"	2017	15.35999966	16 MW
FIRM CAPACITY	MARBO CT 1	"MW"	2018	15.35999966	16 MW
FIRM CAPACITY	MARBO CT 1	"MW"	2019	15.35999966	16 MW
FIRM CAPACITY	MARBO CT 1	"MW"	2020	15.35999966	16 MW
FIRM CAPACITY	MARBO CT 1	"MW"	2021	15.35999966	16 MW
FIRM CAPACITY	MARBO CT 1	"MW"	2022	15.35999966	16 MW
FIRM CAPACITY	MARBO CT 1	"MW"	2023	15.35999966	16 MW
FIRM CAPACITY	MARBO CT 1	"MW"	2024	0	16 MW
FIRM CAPACITY	MARBO CT 1	"MW"	2025	0	16 MW
FIRM CAPACITY	MARBO CT 1	"MW"	2026	0	16 MW
FIRM CAPACITY	MARBO CT 1	"MW"	2027	0	16 MW
FIRM CAPACITY	MARBO CT 1	"MW"	2028	0	16 MW

FIRM CAPACITY	MARBO CT 1	"MW"	2029	0	16 MW
FIRM CAPACITY	MARBO CT 1	"MW"	2030	0	16 MW
FIRM CAPACITY	MARBO CT 1	"MW"	2031	0	16 MW
FIRM CAPACITY	MARBO CT 1	"MW"	2032	0	16 MW
FIRM CAPACITY	MARBO CT 1	"MW"	2033	0	16 MW
FIRM CAPACITY	MARBO CT 1	"MW"	2034	0	16 MW
FIRM CAPACITY	MARBO CT 1	"MW"	2035	0	16 MW
FIRM CAPACITY	DED DSL 1	"MW"	2006	2.450000048	2.5 MW
FIRM CAPACITY	DED DSL 1	"MW"	2007	2.450000048	2.5 MW
FIRM CAPACITY	DED DSL 1	"MW"	2008	2.450000048	2.5 MW
FIRM CAPACITY	DED DSL 1	"MW"	2009	2.450000048	2.5 MW
FIRM CAPACITY	DED DSL 1	"MW"	2010	2.450000048	2.5 MW
FIRM CAPACITY	DED DSL 1	"MW"	2011	2.450000048	2.5 MW
FIRM CAPACITY	DED DSL 1	"MW"	2012	2.450000048	2.5 MW
FIRM CAPACITY	DED DSL 1	"MW"	2013	2.450000048	2.5 MW
FIRM CAPACITY	DED DSL 1	"MW"	2014	2.450000048	2.5 MW
FIRM CAPACITY	DED DSL 1	"MW"	2015	2.450000048	2.5 MW
FIRM CAPACITY	DED DSL 1	"MW"	2016	2.450000048	2.5 MW
FIRM CAPACITY	DED DSL 1	"MW"	2017	0	2.5 MW
FIRM CAPACITY	DED DSL 1	"MW"	2018	0	2.5 MW
FIRM CAPACITY	DED DSL 1	"MW"	2019	0	2.5 MW
FIRM CAPACITY	DED DSL 1	"MW"	2020	0	2.5 MW
FIRM CAPACITY	DED DSL 1	"MW"	2021	0	2.5 MW
FIRM CAPACITY	DED DSL 1	"MW"	2022	0	2.5 MW
FIRM CAPACITY	DED DSL 1	"MW"	2023	0	2.5 MW
FIRM CAPACITY	DED DSL 1	"MW"	2024	0	2.5 MW
FIRM CAPACITY	DED DSL 1	"MW"	2025	0	2.5 MW
FIRM CAPACITY	DED DSL 1	"MW"	2026	0	2.5 MW
FIRM CAPACITY	DED DSL 1	"MW"	2027	0	2.5 MW
FIRM CAPACITY	DED DSL 1	"MW"	2028	0	2.5 MW
FIRM CAPACITY	DED DSL 1	"MW"	2029	0	2.5 MW
FIRM CAPACITY	DED DSL 1	"MW"	2030	0	2.5 MW
FIRM CAPACITY	DED DSL 1	"MW"	2031	0	2.5 MW
FIRM CAPACITY	DED DSL 1	"MW"	2032	0	2.5 MW
FIRM CAPACITY	DED DSL 1	"MW"	2033	0	2.5 MW
FIRM CAPACITY	DED DSL 1	"MW"	2034	0	2.5 MW
FIRM CAPACITY	DED DSL 1	"MW"	2035	0	2.5 MW
FIRM CAPACITY	DED DSL 2	"MW"	2006	2.450000048	2.5 MW
FIRM CAPACITY	DED DSL 2	"MW"	2007	2.450000048	2.5 MW
FIRM CAPACITY	DED DSL 2	"MW"	2008	2.450000048	2.5 MW
FIRM CAPACITY	DED DSL 2	"MW"	2009	2.450000048	2.5 MW
FIRM CAPACITY	DED DSL 2	"MW"	2010	2.450000048	2.5 MW
FIRM CAPACITY	DED DSL 2	"MW"	2011	2.450000048	2.5 MW
FIRM CAPACITY	DED DSL 2	"MW"	2012	2.450000048	2.5 MW
FIRM CAPACITY	DED DSL 2	"MW"	2013	2.450000048	2.5 MW
FIRM CAPACITY	DED DSL 2	"MW"	2014	2.450000048	2.5 MW
FIRM CAPACITY	DED DSL 2	"MW"	2015	2.450000048	2.5 MW
FIRM CAPACITY	DED DSL 2	"MW"	2016	2.450000048	2.5 MW
FIRM CAPACITY	DED DSL 2	"MW"	2017	0	2.5 MW
FIRM CAPACITY	DED DSL 2	"MW"	2018	0	2.5 MW
FIRM CAPACITY	DED DSL 2	"MW"	2019	0	2.5 MW
FIRM CAPACITY	DED DSL 2	"MW"	2020	0	2.5 MW

FIRM CAPACITY	DED DSL 2	"MW"	2021	0	2.5 MW
FIRM CAPACITY	DED DSL 2	"MW"	2022	0	2.5 MW
FIRM CAPACITY	DED DSL 2	"MW"	2023	0	2.5 MW
FIRM CAPACITY	DED DSL 2	"MW"	2024	0	2.5 MW
FIRM CAPACITY	DED DSL 2	"MW"	2025	0	2.5 MW
FIRM CAPACITY	DED DSL 2	"MW"	2026	0	2.5 MW
FIRM CAPACITY	DED DSL 2	"MW"	2027	0	2.5 MW
FIRM CAPACITY	DED DSL 2	"MW"	2028	0	2.5 MW
FIRM CAPACITY	DED DSL 2	"MW"	2029	0	2.5 MW
FIRM CAPACITY	DED DSL 2	"MW"	2030	0	2.5 MW
FIRM CAPACITY	DED DSL 2	"MW"	2031	0	2.5 MW
FIRM CAPACITY	DED DSL 2	"MW"	2032	0	2.5 MW
FIRM CAPACITY	DED DSL 2	"MW"	2033	0	2.5 MW
FIRM CAPACITY	DED DSL 2	"MW"	2034	0	2.5 MW
FIRM CAPACITY	DED DSL 2	"MW"	2035	0	2.5 MW
FIRM CAPACITY	DED DSL 3	"MW"	2006	2.450000048	2.5 MW
FIRM CAPACITY	DED DSL 3	"MW"	2007	2.450000048	2.5 MW
FIRM CAPACITY	DED DSL 3	"MW"	2008	2.450000048	2.5 MW
FIRM CAPACITY	DED DSL 3	"MW"	2009	2.450000048	2.5 MW
FIRM CAPACITY	DED DSL 3	"MW"	2010	2.450000048	2.5 MW
FIRM CAPACITY	DED DSL 3	"MW"	2011	2.450000048	2.5 MW
FIRM CAPACITY	DED DSL 3	"MW"	2012	2.450000048	2.5 MW
FIRM CAPACITY	DED DSL 3	"MW"	2013	2.450000048	2.5 MW
FIRM CAPACITY	DED DSL 3	"MW"	2014	2.450000048	2.5 MW
FIRM CAPACITY	DED DSL 3	"MW"	2015	2.450000048	2.5 MW
FIRM CAPACITY	DED DSL 3	"MW"	2016	2.450000048	2.5 MW
FIRM CAPACITY	DED DSL 3	"MW"	2017	0	2.5 MW
FIRM CAPACITY	DED DSL 3	"MW"	2018	0	2.5 MW
FIRM CAPACITY	DED DSL 3	"MW"	2019	0	2.5 MW
FIRM CAPACITY	DED DSL 3	"MW"	2020	0	2.5 MW
FIRM CAPACITY	DED DSL 3	"MW"	2021	0	2.5 MW
FIRM CAPACITY	DED DSL 3	"MW"	2022	0	2.5 MW
FIRM CAPACITY	DED DSL 3	"MW"	2023	0	2.5 MW
FIRM CAPACITY	DED DSL 3	"MW"	2024	0	2.5 MW
FIRM CAPACITY	DED DSL 3	"MW"	2025	0	2.5 MW
FIRM CAPACITY	DED DSL 3	"MW"	2026	0	2.5 MW
FIRM CAPACITY	DED DSL 3	"MW"	2027	0	2.5 MW
FIRM CAPACITY	DED DSL 3	"MW"	2028	0	2.5 MW
FIRM CAPACITY	DED DSL 3	"MW"	2029	0	2.5 MW
FIRM CAPACITY	DED DSL 3	"MW"	2030	0	2.5 MW
FIRM CAPACITY	DED DSL 3	"MW"	2031	0	2.5 MW
FIRM CAPACITY	DED DSL 3	"MW"	2032	0	2.5 MW
FIRM CAPACITY	DED DSL 3	"MW"	2033	0	2.5 MW
FIRM CAPACITY	DED DSL 3	"MW"	2034	0	2.5 MW
FIRM CAPACITY	DED DSL 3	"MW"	2035	0	2.5 MW
FIRM CAPACITY	DED DSL 4	"MW"	2006	2.450000048	2.5 MW
FIRM CAPACITY	DED DSL 4	"MW"	2007	2.450000048	2.5 MW
FIRM CAPACITY	DED DSL 4	"MW"	2008	2.450000048	2.5 MW
FIRM CAPACITY	DED DSL 4	"MW"	2009	2.450000048	2.5 MW
FIRM CAPACITY	DED DSL 4	"MW"	2010	2.450000048	2.5 MW
FIRM CAPACITY	DED DSL 4	"MW"	2011	2.450000048	2.5 MW
FIRM CAPACITY	DED DSL 4	"MW"	2012	2.450000048	2.5 MW

FIRM CAPACITY	DED DSL 4	"MW"	2013	2.450000048	2.5 MW
FIRM CAPACITY	DED DSL 4	"MW"	2014	2.450000048	2.5 MW
FIRM CAPACITY	DED DSL 4	"MW"	2015	2.450000048	2.5 MW
FIRM CAPACITY	DED DSL 4	"MW"	2016	2.450000048	2.5 MW
FIRM CAPACITY	DED DSL 4	"MW"	2017	0	2.5 MW
FIRM CAPACITY	DED DSL 4	"MW"	2018	0	2.5 MW
FIRM CAPACITY	DED DSL 4	"MW"	2019	0	2.5 MW
FIRM CAPACITY	DED DSL 4	"MW"	2020	0	2.5 MW
FIRM CAPACITY	DED DSL 4	"MW"	2021	0	2.5 MW
FIRM CAPACITY	DED DSL 4	"MW"	2022	0	2.5 MW
FIRM CAPACITY	DED DSL 4	"MW"	2023	0	2.5 MW
FIRM CAPACITY	DED DSL 4	"MW"	2024	0	2.5 MW
FIRM CAPACITY	DED DSL 4	"MW"	2025	0	2.5 MW
FIRM CAPACITY	DED DSL 4	"MW"	2026	0	2.5 MW
FIRM CAPACITY	DED DSL 4	"MW"	2027	0	2.5 MW
FIRM CAPACITY	DED DSL 4	"MW"	2028	0	2.5 MW
FIRM CAPACITY	DED DSL 4	"MW"	2029	0	2.5 MW
FIRM CAPACITY	DED DSL 4	"MW"	2030	0	2.5 MW
FIRM CAPACITY	DED DSL 4	"MW"	2031	0	2.5 MW
FIRM CAPACITY	DED DSL 4	"MW"	2032	0	2.5 MW
FIRM CAPACITY	DED DSL 4	"MW"	2033	0	2.5 MW
FIRM CAPACITY	DED DSL 4	"MW"	2034	0	2.5 MW
FIRM CAPACITY	DED DSL 4	"MW"	2035	0	2.5 MW
FIRM CAPACITY	PULANTAT 1	"MW"	2006	5.139999866	5.3 MW
FIRM CAPACITY	PULANTAT 1	"MW"	2007	5.139999866	5.3 MW
FIRM CAPACITY	PULANTAT 1	"MW"	2008	5.139999866	5.3 MW
FIRM CAPACITY	PULANTAT 1	"MW"	2009	5.139999866	5.3 MW
FIRM CAPACITY	PULANTAT 1	"MW"	2010	5.139999866	5.3 MW
FIRM CAPACITY	PULANTAT 1	"MW"	2011	5.139999866	5.3 MW
FIRM CAPACITY	PULANTAT 1	"MW"	2012	5.139999866	5.3 MW
FIRM CAPACITY	PULANTAT 1	"MW"	2013	5.139999866	5.3 MW
FIRM CAPACITY	PULANTAT 1	"MW"	2014	5.139999866	5.3 MW
FIRM CAPACITY	PULANTAT 1	"MW"	2015	5.139999866	5.3 MW
FIRM CAPACITY	PULANTAT 1	"MW"	2016	5.139999866	5.3 MW
FIRM CAPACITY	PULANTAT 1	"MW"	2017	5.139999866	5.3 MW
FIRM CAPACITY	PULANTAT 1	"MW"	2018	5.139999866	5.3 MW
FIRM CAPACITY	PULANTAT 1	"MW"	2019	5.139999866	5.3 MW
FIRM CAPACITY	PULANTAT 1	"MW"	2020	5.139999866	5.3 MW
FIRM CAPACITY	PULANTAT 1	"MW"	2021	5.139999866	5.3 MW
FIRM CAPACITY	PULANTAT 1	"MW"	2022	5.139999866	5.3 MW
FIRM CAPACITY	PULANTAT 1	"MW"	2023	5.139999866	5.3 MW
FIRM CAPACITY	PULANTAT 1	"MW"	2024	5.139999866	5.3 MW
FIRM CAPACITY	PULANTAT 1	"MW"	2025	0	5.3 MW
FIRM CAPACITY	PULANTAT 1	"MW"	2026	0	5.3 MW
FIRM CAPACITY	PULANTAT 1	"MW"	2027	0	5.3 MW
FIRM CAPACITY	PULANTAT 1	"MW"	2028	0	5.3 MW
FIRM CAPACITY	PULANTAT 1	"MW"	2029	0	5.3 MW
FIRM CAPACITY	PULANTAT 1	"MW"	2030	0	5.3 MW
FIRM CAPACITY	PULANTAT 1	"MW"	2031	0	5.3 MW
FIRM CAPACITY	PULANTAT 1	"MW"	2032	0	5.3 MW
FIRM CAPACITY	PULANTAT 1	"MW"	2033	0	5.3 MW
FIRM CAPACITY	PULANTAT 1	"MW"	2034	0	5.3 MW

FIRM CAPACITY	PULANTAT 1	"MW"	2035	0	5.3 MW
FIRM CAPACITY	PULANTAT 2	"MW"	2006	5.190000057	5.3 MW
FIRM CAPACITY	PULANTAT 2	"MW"	2007	5.190000057	5.3 MW
FIRM CAPACITY	PULANTAT 2	"MW"	2008	5.190000057	5.3 MW
FIRM CAPACITY	PULANTAT 2	"MW"	2009	5.190000057	5.3 MW
FIRM CAPACITY	PULANTAT 2	"MW"	2010	5.190000057	5.3 MW
FIRM CAPACITY	PULANTAT 2	"MW"	2011	5.190000057	5.3 MW
FIRM CAPACITY	PULANTAT 2	"MW"	2012	5.190000057	5.3 MW
FIRM CAPACITY	PULANTAT 2	"MW"	2013	5.190000057	5.3 MW
FIRM CAPACITY	PULANTAT 2	"MW"	2014	5.190000057	5.3 MW
FIRM CAPACITY	PULANTAT 2	"MW"	2015	5.190000057	5.3 MW
FIRM CAPACITY	PULANTAT 2	"MW"	2016	5.190000057	5.3 MW
FIRM CAPACITY	PULANTAT 2	"MW"	2017	5.190000057	5.3 MW
FIRM CAPACITY	PULANTAT 2	"MW"	2018	5.190000057	5.3 MW
FIRM CAPACITY	PULANTAT 2	"MW"	2019	5.190000057	5.3 MW
FIRM CAPACITY	PULANTAT 2	"MW"	2020	5.190000057	5.3 MW
FIRM CAPACITY	PULANTAT 2	"MW"	2021	5.190000057	5.3 MW
FIRM CAPACITY	PULANTAT 2	"MW"	2022	5.190000057	5.3 MW
FIRM CAPACITY	PULANTAT 2	"MW"	2023	5.190000057	5.3 MW
FIRM CAPACITY	PULANTAT 2	"MW"	2024	5.190000057	5.3 MW
FIRM CAPACITY	PULANTAT 2	"MW"	2025	0	5.3 MW
FIRM CAPACITY	PULANTAT 2	"MW"	2026	0	5.3 MW
FIRM CAPACITY	PULANTAT 2	"MW"	2027	0	5.3 MW
FIRM CAPACITY	PULANTAT 2	"MW"	2028	0	5.3 MW
FIRM CAPACITY	PULANTAT 2	"MW"	2029	0	5.3 MW
FIRM CAPACITY	PULANTAT 2	"MW"	2030	0	5.3 MW
FIRM CAPACITY	PULANTAT 2	"MW"	2031	0	5.3 MW
FIRM CAPACITY	PULANTAT 2	"MW"	2032	0	5.3 MW
FIRM CAPACITY	PULANTAT 2	"MW"	2033	0	5.3 MW
FIRM CAPACITY	PULANTAT 2	"MW"	2034	0	5.3 MW
FIRM CAPACITY	PULANTAT 2	"MW"	2035	0	5.3 MW
FIRM CAPACITY	TENJO 1	"MW"	2006	4.360000134	4.4 MW
FIRM CAPACITY	TENJO 1	"MW"	2007	4.360000134	4.4 MW
FIRM CAPACITY	TENJO 1	"MW"	2008	4.360000134	4.4 MW
FIRM CAPACITY	TENJO 1	"MW"	2009	4.360000134	4.4 MW
FIRM CAPACITY	TENJO 1	"MW"	2010	4.360000134	4.4 MW
FIRM CAPACITY	TENJO 1	"MW"	2011	4.360000134	4.4 MW
FIRM CAPACITY	TENJO 1	"MW"	2012	4.360000134	4.4 MW
FIRM CAPACITY	TENJO 1	"MW"	2013	4.360000134	4.4 MW
FIRM CAPACITY	TENJO 1	"MW"	2014	4.360000134	4.4 MW
FIRM CAPACITY	TENJO 1	"MW"	2015	4.360000134	4.4 MW
FIRM CAPACITY	TENJO 1	"MW"	2016	4.360000134	4.4 MW
FIRM CAPACITY	TENJO 1	"MW"	2017	4.360000134	4.4 MW
FIRM CAPACITY	TENJO 1	"MW"	2018	4.360000134	4.4 MW
FIRM CAPACITY	TENJO 1	"MW"	2019	4.360000134	4.4 MW
FIRM CAPACITY	TENJO 1	"MW"	2020	4.360000134	4.4 MW
FIRM CAPACITY	TENJO 1	"MW"	2021	4.360000134	4.4 MW
FIRM CAPACITY	TENJO 1	"MW"	2022	4.360000134	4.4 MW
FIRM CAPACITY	TENJO 1	"MW"	2023	4.360000134	4.4 MW
FIRM CAPACITY	TENJO 1	"MW"	2024	0	4.4 MW
FIRM CAPACITY	TENJO 1	"MW"	2025	0	4.4 MW
FIRM CAPACITY	TENJO 1	"MW"	2026	0	4.4 MW

FIRM CAPACITY	TENJO	1	"MW"	2027	0	4.4 MW
FIRM CAPACITY	TENJO	1	"MW"	2028	0	4.4 MW
FIRM CAPACITY	TENJO	1	"MW"	2029	0	4.4 MW
FIRM CAPACITY	TENJO	1	"MW"	2030	0	4.4 MW
FIRM CAPACITY	TENJO	1	"MW"	2031	0	4.4 MW
FIRM CAPACITY	TENJO	1	"MW"	2032	0	4.4 MW
FIRM CAPACITY	TENJO	1	"MW"	2033	0	4.4 MW
FIRM CAPACITY	TENJO	1	"MW"	2034	0	4.4 MW
FIRM CAPACITY	TENJO	1	"MW"	2035	0	4.4 MW
FIRM CAPACITY	TENJO	2	"MW"	2006	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	2	"MW"	2007	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	2	"MW"	2008	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	2	"MW"	2009	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	2	"MW"	2010	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	2	"MW"	2011	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	2	"MW"	2012	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	2	"MW"	2013	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	2	"MW"	2014	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	2	"MW"	2015	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	2	"MW"	2016	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	2	"MW"	2017	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	2	"MW"	2018	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	2	"MW"	2019	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	2	"MW"	2020	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	2	"MW"	2021	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	2	"MW"	2022	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	2	"MW"	2023	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	2	"MW"	2024	0	4.4 MW
FIRM CAPACITY	TENJO	2	"MW"	2025	0	4.4 MW
FIRM CAPACITY	TENJO	2	"MW"	2026	0	4.4 MW
FIRM CAPACITY	TENJO	2	"MW"	2027	0	4.4 MW
FIRM CAPACITY	TENJO	2	"MW"	2028	0	4.4 MW
FIRM CAPACITY	TENJO	2	"MW"	2029	0	4.4 MW
FIRM CAPACITY	TENJO	2	"MW"	2030	0	4.4 MW
FIRM CAPACITY	TENJO	2	"MW"	2031	0	4.4 MW
FIRM CAPACITY	TENJO	2	"MW"	2032	0	4.4 MW
FIRM CAPACITY	TENJO	2	"MW"	2033	0	4.4 MW
FIRM CAPACITY	TENJO	2	"MW"	2034	0	4.4 MW
FIRM CAPACITY	TENJO	2	"MW"	2035	0	4.4 MW
FIRM CAPACITY	TENJO	3	"MW"	2006	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	3	"MW"	2007	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	3	"MW"	2008	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	3	"MW"	2009	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	3	"MW"	2010	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	3	"MW"	2011	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	3	"MW"	2012	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	3	"MW"	2013	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	3	"MW"	2014	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	3	"MW"	2015	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	3	"MW"	2016	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	3	"MW"	2017	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	3	"MW"	2018	4.360000134	4.4 MW

FIRM CAPACITY	TENJO	3	"MW"	2019	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	3	"MW"	2020	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	3	"MW"	2021	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	3	"MW"	2022	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	3	"MW"	2023	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	3	"MW"	2024	0	4.4 MW
FIRM CAPACITY	TENJO	3	"MW"	2025	0	4.4 MW
FIRM CAPACITY	TENJO	3	"MW"	2026	0	4.4 MW
FIRM CAPACITY	TENJO	3	"MW"	2027	0	4.4 MW
FIRM CAPACITY	TENJO	3	"MW"	2028	0	4.4 MW
FIRM CAPACITY	TENJO	3	"MW"	2029	0	4.4 MW
FIRM CAPACITY	TENJO	3	"MW"	2030	0	4.4 MW
FIRM CAPACITY	TENJO	3	"MW"	2031	0	4.4 MW
FIRM CAPACITY	TENJO	3	"MW"	2032	0	4.4 MW
FIRM CAPACITY	TENJO	3	"MW"	2033	0	4.4 MW
FIRM CAPACITY	TENJO	3	"MW"	2034	0	4.4 MW
FIRM CAPACITY	TENJO	3	"MW"	2035	0	4.4 MW
FIRM CAPACITY	TENJO	4	"MW"	2006	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	4	"MW"	2007	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	4	"MW"	2008	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	4	"MW"	2009	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	4	"MW"	2010	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	4	"MW"	2011	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	4	"MW"	2012	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	4	"MW"	2013	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	4	"MW"	2014	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	4	"MW"	2015	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	4	"MW"	2016	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	4	"MW"	2017	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	4	"MW"	2018	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	4	"MW"	2019	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	4	"MW"	2020	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	4	"MW"	2021	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	4	"MW"	2022	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	4	"MW"	2023	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	4	"MW"	2024	0	4.4 MW
FIRM CAPACITY	TENJO	4	"MW"	2025	0	4.4 MW
FIRM CAPACITY	TENJO	4	"MW"	2026	0	4.4 MW
FIRM CAPACITY	TENJO	4	"MW"	2027	0	4.4 MW
FIRM CAPACITY	TENJO	4	"MW"	2028	0	4.4 MW
FIRM CAPACITY	TENJO	4	"MW"	2029	0	4.4 MW
FIRM CAPACITY	TENJO	4	"MW"	2030	0	4.4 MW
FIRM CAPACITY	TENJO	4	"MW"	2031	0	4.4 MW
FIRM CAPACITY	TENJO	4	"MW"	2032	0	4.4 MW
FIRM CAPACITY	TENJO	4	"MW"	2033	0	4.4 MW
FIRM CAPACITY	TENJO	4	"MW"	2034	0	4.4 MW
FIRM CAPACITY	TENJO	4	"MW"	2035	0	4.4 MW
FIRM CAPACITY	TENJO	5	"MW"	2006	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	5	"MW"	2007	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	5	"MW"	2008	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	5	"MW"	2009	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	5	"MW"	2010	4.360000134	4.4 MW

FIRM CAPACITY	TENJO	5	"MW"	2011	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	5	"MW"	2012	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	5	"MW"	2013	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	5	"MW"	2014	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	5	"MW"	2015	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	5	"MW"	2016	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	5	"MW"	2017	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	5	"MW"	2018	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	5	"MW"	2019	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	5	"MW"	2020	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	5	"MW"	2021	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	5	"MW"	2022	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	5	"MW"	2023	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	5	"MW"	2024	0	4.4 MW
FIRM CAPACITY	TENJO	5	"MW"	2025	0	4.4 MW
FIRM CAPACITY	TENJO	5	"MW"	2026	0	4.4 MW
FIRM CAPACITY	TENJO	5	"MW"	2027	0	4.4 MW
FIRM CAPACITY	TENJO	5	"MW"	2028	0	4.4 MW
FIRM CAPACITY	TENJO	5	"MW"	2029	0	4.4 MW
FIRM CAPACITY	TENJO	5	"MW"	2030	0	4.4 MW
FIRM CAPACITY	TENJO	5	"MW"	2031	0	4.4 MW
FIRM CAPACITY	TENJO	5	"MW"	2032	0	4.4 MW
FIRM CAPACITY	TENJO	5	"MW"	2033	0	4.4 MW
FIRM CAPACITY	TENJO	5	"MW"	2034	0	4.4 MW
FIRM CAPACITY	TENJO	5	"MW"	2035	0	4.4 MW
FIRM CAPACITY	TENJO	6	"MW"	2006	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	6	"MW"	2007	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	6	"MW"	2008	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	6	"MW"	2009	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	6	"MW"	2010	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	6	"MW"	2011	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	6	"MW"	2012	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	6	"MW"	2013	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	6	"MW"	2014	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	6	"MW"	2015	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	6	"MW"	2016	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	6	"MW"	2017	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	6	"MW"	2018	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	6	"MW"	2019	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	6	"MW"	2020	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	6	"MW"	2021	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	6	"MW"	2022	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	6	"MW"	2023	4.360000134	4.4 MW
FIRM CAPACITY	TENJO	6	"MW"	2024	0	4.4 MW
FIRM CAPACITY	TENJO	6	"MW"	2025	0	4.4 MW
FIRM CAPACITY	TENJO	6	"MW"	2026	0	4.4 MW
FIRM CAPACITY	TENJO	6	"MW"	2027	0	4.4 MW
FIRM CAPACITY	TENJO	6	"MW"	2028	0	4.4 MW
FIRM CAPACITY	TENJO	6	"MW"	2029	0	4.4 MW
FIRM CAPACITY	TENJO	6	"MW"	2030	0	4.4 MW
FIRM CAPACITY	TENJO	6	"MW"	2031	0	4.4 MW
FIRM CAPACITY	TENJO	6	"MW"	2032	0	4.4 MW

FIRM CAPACITY	TENJO 6	"MW"	2033	0	4.4 MW
FIRM CAPACITY	TENJO 6	"MW"	2034	0	4.4 MW
FIRM CAPACITY	TENJO 6	"MW"	2035	0	4.4 MW
FIRM CAPACITY	TAL DSL 1	"MW"	2006	4.360000134	4.4 MW
FIRM CAPACITY	TAL DSL 1	"MW"	2007	4.360000134	4.4 MW
FIRM CAPACITY	TAL DSL 1	"MW"	2008	4.360000134	4.4 MW
FIRM CAPACITY	TAL DSL 1	"MW"	2009	4.360000134	4.4 MW
FIRM CAPACITY	TAL DSL 1	"MW"	2010	4.360000134	4.4 MW
FIRM CAPACITY	TAL DSL 1	"MW"	2011	4.360000134	4.4 MW
FIRM CAPACITY	TAL DSL 1	"MW"	2012	4.360000134	4.4 MW
FIRM CAPACITY	TAL DSL 1	"MW"	2013	4.360000134	4.4 MW
FIRM CAPACITY	TAL DSL 1	"MW"	2014	4.360000134	4.4 MW
FIRM CAPACITY	TAL DSL 1	"MW"	2015	4.360000134	4.4 MW
FIRM CAPACITY	TAL DSL 1	"MW"	2016	4.360000134	4.4 MW
FIRM CAPACITY	TAL DSL 1	"MW"	2017	4.360000134	4.4 MW
FIRM CAPACITY	TAL DSL 1	"MW"	2018	4.360000134	4.4 MW
FIRM CAPACITY	TAL DSL 1	"MW"	2019	4.360000134	4.4 MW
FIRM CAPACITY	TAL DSL 1	"MW"	2020	4.360000134	4.4 MW
FIRM CAPACITY	TAL DSL 1	"MW"	2021	4.360000134	4.4 MW
FIRM CAPACITY	TAL DSL 1	"MW"	2022	4.360000134	4.4 MW
FIRM CAPACITY	TAL DSL 1	"MW"	2023	4.360000134	4.4 MW
FIRM CAPACITY	TAL DSL 1	"MW"	2024	0	4.4 MW
FIRM CAPACITY	TAL DSL 1	"MW"	2025	0	4.4 MW
FIRM CAPACITY	TAL DSL 1	"MW"	2026	0	4.4 MW
FIRM CAPACITY	TAL DSL 1	"MW"	2027	0	4.4 MW
FIRM CAPACITY	TAL DSL 1	"MW"	2028	0	4.4 MW
FIRM CAPACITY	TAL DSL 1	"MW"	2029	0	4.4 MW
FIRM CAPACITY	TAL DSL 1	"MW"	2030	0	4.4 MW
FIRM CAPACITY	TAL DSL 1	"MW"	2031	0	4.4 MW
FIRM CAPACITY	TAL DSL 1	"MW"	2032	0	4.4 MW
FIRM CAPACITY	TAL DSL 1	"MW"	2033	0	4.4 MW
FIRM CAPACITY	TAL DSL 1	"MW"	2034	0	4.4 MW
FIRM CAPACITY	TAL DSL 1	"MW"	2035	0	4.4 MW
FIRM CAPACITY	TAL DSL 2	"MW"	2006	4.360000134	4.4 MW
FIRM CAPACITY	TAL DSL 2	"MW"	2007	4.360000134	4.4 MW
FIRM CAPACITY	TAL DSL 2	"MW"	2008	4.360000134	4.4 MW
FIRM CAPACITY	TAL DSL 2	"MW"	2009	4.360000134	4.4 MW
FIRM CAPACITY	TAL DSL 2	"MW"	2010	4.360000134	4.4 MW
FIRM CAPACITY	TAL DSL 2	"MW"	2011	4.360000134	4.4 MW
FIRM CAPACITY	TAL DSL 2	"MW"	2012	4.360000134	4.4 MW
FIRM CAPACITY	TAL DSL 2	"MW"	2013	4.360000134	4.4 MW
FIRM CAPACITY	TAL DSL 2	"MW"	2014	4.360000134	4.4 MW
FIRM CAPACITY	TAL DSL 2	"MW"	2015	4.360000134	4.4 MW
FIRM CAPACITY	TAL DSL 2	"MW"	2016	4.360000134	4.4 MW
FIRM CAPACITY	TAL DSL 2	"MW"	2017	4.360000134	4.4 MW
FIRM CAPACITY	TAL DSL 2	"MW"	2018	4.360000134	4.4 MW
FIRM CAPACITY	TAL DSL 2	"MW"	2019	4.360000134	4.4 MW
FIRM CAPACITY	TAL DSL 2	"MW"	2020	4.360000134	4.4 MW
FIRM CAPACITY	TAL DSL 2	"MW"	2021	4.360000134	4.4 MW
FIRM CAPACITY	TAL DSL 2	"MW"	2022	4.360000134	4.4 MW
FIRM CAPACITY	TAL DSL 2	"MW"	2023	4.360000134	4.4 MW
FIRM CAPACITY	TAL DSL 2	"MW"	2024	0	4.4 MW

FIRM CAPACITY	TAL DSL 2	"MW"	2025	0	4.4	MW
FIRM CAPACITY	TAL DSL 2	"MW"	2026	0	4.4	MW
FIRM CAPACITY	TAL DSL 2	"MW"	2027	0	4.4	MW
FIRM CAPACITY	TAL DSL 2	"MW"	2028	0	4.4	MW
FIRM CAPACITY	TAL DSL 2	"MW"	2029	0	4.4	MW
FIRM CAPACITY	TAL DSL 2	"MW"	2030	0	4.4	MW
FIRM CAPACITY	TAL DSL 2	"MW"	2031	0	4.4	MW
FIRM CAPACITY	TAL DSL 2	"MW"	2032	0	4.4	MW
FIRM CAPACITY	TAL DSL 2	"MW"	2033	0	4.4	MW
FIRM CAPACITY	TAL DSL 2	"MW"	2034	0	4.4	MW
FIRM CAPACITY	TAL DSL 2	"MW"	2035	0	4.4	MW
FIRM CAPACITY	TANGO 1	"MW"	2006	23.85000038	26.5	MW
FIRM CAPACITY	TANGO 1	"MW"	2007	23.85000038	26.5	MW
FIRM CAPACITY	TANGO 1	"MW"	2008	23.85000038	26.5	MW
FIRM CAPACITY	TANGO 1	"MW"	2009	23.85000038	26.5	MW
FIRM CAPACITY	TANGO 1	"MW"	2010	23.85000038	26.5	MW
FIRM CAPACITY	TANGO 1	"MW"	2011	23.85000038	26.5	MW
FIRM CAPACITY	TANGO 1	"MW"	2012	23.85000038	26.5	MW
FIRM CAPACITY	TANGO 1	"MW"	2013	23.85000038	26.5	MW
FIRM CAPACITY	TANGO 1	"MW"	2014	23.85000038	26.5	MW
FIRM CAPACITY	TANGO 1	"MW"	2015	23.85000038	26.5	MW
FIRM CAPACITY	TANGO 1	"MW"	2016	23.85000038	26.5	MW
FIRM CAPACITY	TANGO 1	"MW"	2017	23.85000038	26.5	MW
FIRM CAPACITY	TANGO 1	"MW"	2018	23.85000038	26.5	MW
FIRM CAPACITY	TANGO 1	"MW"	2019	23.85000038	26.5	MW
FIRM CAPACITY	TANGO 1	"MW"	2020	23.85000038	26.5	MW
FIRM CAPACITY	TANGO 1	"MW"	2021	23.85000038	26.5	MW
FIRM CAPACITY	TANGO 1	"MW"	2022	23.85000038	26.5	MW
FIRM CAPACITY	TANGO 1	"MW"	2023	23.85000038	26.5	MW
FIRM CAPACITY	TANGO 1	"MW"	2024	23.85000038	26.5	MW
FIRM CAPACITY	TANGO 1	"MW"	2025	23.85000038	26.5	MW
FIRM CAPACITY	TANGO 1	"MW"	2026	23.85000038	26.5	MW
FIRM CAPACITY	TANGO 1	"MW"	2027	23.85000038	26.5	MW
FIRM CAPACITY	TANGO 1	"MW"	2028	23.85000038	26.5	MW
FIRM CAPACITY	TANGO 1	"MW"	2029	0	26.5	MW
FIRM CAPACITY	TANGO 1	"MW"	2030	0	26.5	MW
FIRM CAPACITY	TANGO 1	"MW"	2031	0	26.5	MW
FIRM CAPACITY	TANGO 1	"MW"	2032	0	26.5	MW
FIRM CAPACITY	TANGO 1	"MW"	2033	0	26.5	MW
FIRM CAPACITY	TANGO 1	"MW"	2034	0	26.5	MW
FIRM CAPACITY	TANGO 1	"MW"	2035	0	26.5	MW
FIRM CAPACITY	TANGO 2	"MW"	2006	24.12000084	26.5	MW
FIRM CAPACITY	TANGO 2	"MW"	2007	24.12000084	26.5	MW
FIRM CAPACITY	TANGO 2	"MW"	2008	24.12000084	26.5	MW
FIRM CAPACITY	TANGO 2	"MW"	2009	24.12000084	26.5	MW
FIRM CAPACITY	TANGO 2	"MW"	2010	24.12000084	26.5	MW
FIRM CAPACITY	TANGO 2	"MW"	2011	24.12000084	26.5	MW
FIRM CAPACITY	TANGO 2	"MW"	2012	24.12000084	26.5	MW
FIRM CAPACITY	TANGO 2	"MW"	2013	24.12000084	26.5	MW
FIRM CAPACITY	TANGO 2	"MW"	2014	24.12000084	26.5	MW
FIRM CAPACITY	TANGO 2	"MW"	2015	24.12000084	26.5	MW
FIRM CAPACITY	TANGO 2	"MW"	2016	24.12000084	26.5	MW

FIRM CAPACITY	TANGO	2	"MW"	2017	24.12000084	26.5 MW
FIRM CAPACITY	TANGO	2	"MW"	2018	24.12000084	26.5 MW
FIRM CAPACITY	TANGO	2	"MW"	2019	24.12000084	26.5 MW
FIRM CAPACITY	TANGO	2	"MW"	2020	24.12000084	26.5 MW
FIRM CAPACITY	TANGO	2	"MW"	2021	24.12000084	26.5 MW
FIRM CAPACITY	TANGO	2	"MW"	2022	24.12000084	26.5 MW
FIRM CAPACITY	TANGO	2	"MW"	2023	24.12000084	26.5 MW
FIRM CAPACITY	TANGO	2	"MW"	2024	24.12000084	26.5 MW
FIRM CAPACITY	TANGO	2	"MW"	2025	24.12000084	26.5 MW
FIRM CAPACITY	TANGO	2	"MW"	2026	24.12000084	26.5 MW
FIRM CAPACITY	TANGO	2	"MW"	2027	24.12000084	26.5 MW
FIRM CAPACITY	TANGO	2	"MW"	2028	24.12000084	26.5 MW
FIRM CAPACITY	TANGO	2	"MW"	2029	24.12000084	26.5 MW
FIRM CAPACITY	TANGO	2	"MW"	2030	0	26.5 MW
FIRM CAPACITY	TANGO	2	"MW"	2031	0	26.5 MW
FIRM CAPACITY	TANGO	2	"MW"	2032	0	26.5 MW
FIRM CAPACITY	TANGO	2	"MW"	2033	0	26.5 MW
FIRM CAPACITY	TANGO	2	"MW"	2034	0	26.5 MW
FIRM CAPACITY	TANGO	2	"MW"	2035	0	26.5 MW
FIRM CAPACITY	MEC	1	"MW"	2006	42.68000031	44.2 MW
FIRM CAPACITY	MEC	1	"MW"	2007	42.68000031	44.2 MW
FIRM CAPACITY	MEC	1	"MW"	2008	42.68000031	44.2 MW
FIRM CAPACITY	MEC	1	"MW"	2009	42.68000031	44.2 MW
FIRM CAPACITY	MEC	1	"MW"	2010	42.68000031	44.2 MW
FIRM CAPACITY	MEC	1	"MW"	2011	42.68000031	44.2 MW
FIRM CAPACITY	MEC	1	"MW"	2012	42.68000031	44.2 MW
FIRM CAPACITY	MEC	1	"MW"	2013	42.68000031	44.2 MW
FIRM CAPACITY	MEC	1	"MW"	2014	42.68000031	44.2 MW
FIRM CAPACITY	MEC	1	"MW"	2015	42.68000031	44.2 MW
FIRM CAPACITY	MEC	1	"MW"	2016	42.68000031	44.2 MW
FIRM CAPACITY	MEC	1	"MW"	2017	42.68000031	44.2 MW
FIRM CAPACITY	MEC	1	"MW"	2018	42.68000031	44.2 MW
FIRM CAPACITY	MEC	1	"MW"	2019	42.68000031	44.2 MW
FIRM CAPACITY	MEC	1	"MW"	2020	42.68000031	44.2 MW
FIRM CAPACITY	MEC	1	"MW"	2021	42.68000031	44.2 MW
FIRM CAPACITY	MEC	1	"MW"	2022	42.68000031	44.2 MW
FIRM CAPACITY	MEC	1	"MW"	2023	42.68000031	44.2 MW
FIRM CAPACITY	MEC	1	"MW"	2024	42.68000031	44.2 MW
FIRM CAPACITY	MEC	1	"MW"	2025	42.68000031	44.2 MW
FIRM CAPACITY	MEC	1	"MW"	2026	42.68000031	44.2 MW
FIRM CAPACITY	MEC	1	"MW"	2027	42.68000031	44.2 MW
FIRM CAPACITY	MEC	1	"MW"	2028	42.68000031	44.2 MW
FIRM CAPACITY	MEC	1	"MW"	2029	42.68000031	44.2 MW
FIRM CAPACITY	MEC	1	"MW"	2030	42.68000031	44.2 MW
FIRM CAPACITY	MEC	1	"MW"	2031	42.68000031	44.2 MW
FIRM CAPACITY	MEC	1	"MW"	2032	42.68000031	44.2 MW
FIRM CAPACITY	MEC	1	"MW"	2033	42.68000031	44.2 MW
FIRM CAPACITY	MEC	1	"MW"	2034	42.68000031	44.2 MW
FIRM CAPACITY	MEC	1	"MW"	2035	42.68000031	44.2 MW
FIRM CAPACITY	MEC	2	"MW"	2006	42.68000031	44.2 MW
FIRM CAPACITY	MEC	2	"MW"	2007	42.68000031	44.2 MW
FIRM CAPACITY	MEC	2	"MW"	2008	42.68000031	44.2 MW

FIRM CAPACITY	MEC	2	"MW"	2009	42.68000031	44.2 MW
FIRM CAPACITY	MEC	2	"MW"	2010	42.68000031	44.2 MW
FIRM CAPACITY	MEC	2	"MW"	2011	42.68000031	44.2 MW
FIRM CAPACITY	MEC	2	"MW"	2012	42.68000031	44.2 MW
FIRM CAPACITY	MEC	2	"MW"	2013	42.68000031	44.2 MW
FIRM CAPACITY	MEC	2	"MW"	2014	42.68000031	44.2 MW
FIRM CAPACITY	MEC	2	"MW"	2015	42.68000031	44.2 MW
FIRM CAPACITY	MEC	2	"MW"	2016	42.68000031	44.2 MW
FIRM CAPACITY	MEC	2	"MW"	2017	42.68000031	44.2 MW
FIRM CAPACITY	MEC	2	"MW"	2018	42.68000031	44.2 MW
FIRM CAPACITY	MEC	2	"MW"	2019	42.68000031	44.2 MW
FIRM CAPACITY	MEC	2	"MW"	2020	42.68000031	44.2 MW
FIRM CAPACITY	MEC	2	"MW"	2021	42.68000031	44.2 MW
FIRM CAPACITY	MEC	2	"MW"	2022	42.68000031	44.2 MW
FIRM CAPACITY	MEC	2	"MW"	2023	42.68000031	44.2 MW
FIRM CAPACITY	MEC	2	"MW"	2024	42.68000031	44.2 MW
FIRM CAPACITY	MEC	2	"MW"	2025	42.68000031	44.2 MW
FIRM CAPACITY	MEC	2	"MW"	2026	42.68000031	44.2 MW
FIRM CAPACITY	MEC	2	"MW"	2027	42.68000031	44.2 MW
FIRM CAPACITY	MEC	2	"MW"	2028	42.68000031	44.2 MW
FIRM CAPACITY	MEC	2	"MW"	2029	42.68000031	44.2 MW
FIRM CAPACITY	MEC	2	"MW"	2030	42.68000031	44.2 MW
FIRM CAPACITY	MEC	2	"MW"	2031	42.68000031	44.2 MW
FIRM CAPACITY	MEC	2	"MW"	2032	42.68000031	44.2 MW
FIRM CAPACITY	MEC	2	"MW"	2033	42.68000031	44.2 MW
FIRM CAPACITY	MEC	2	"MW"	2034	42.68000031	44.2 MW
FIRM CAPACITY	MEC	2	"MW"	2035	42.68000031	44.2 MW
FIRM CAPACITY	TEMES	1	"MW"	2006	39.20000076	40 MW
FIRM CAPACITY	TEMES	1	"MW"	2007	39.20000076	40 MW
FIRM CAPACITY	TEMES	1	"MW"	2008	39.20000076	40 MW
FIRM CAPACITY	TEMES	1	"MW"	2009	39.20000076	40 MW
FIRM CAPACITY	TEMES	1	"MW"	2010	39.20000076	40 MW
FIRM CAPACITY	TEMES	1	"MW"	2011	39.20000076	40 MW
FIRM CAPACITY	TEMES	1	"MW"	2012	39.20000076	40 MW
FIRM CAPACITY	TEMES	1	"MW"	2013	39.20000076	40 MW
FIRM CAPACITY	TEMES	1	"MW"	2014	39.20000076	40 MW
FIRM CAPACITY	TEMES	1	"MW"	2015	39.20000076	40 MW
FIRM CAPACITY	TEMES	1	"MW"	2016	39.20000076	40 MW
FIRM CAPACITY	TEMES	1	"MW"	2017	0	40 MW
FIRM CAPACITY	TEMES	1	"MW"	2018	0	40 MW
FIRM CAPACITY	TEMES	1	"MW"	2019	0	40 MW
FIRM CAPACITY	TEMES	1	"MW"	2020	0	40 MW
FIRM CAPACITY	TEMES	1	"MW"	2021	0	40 MW
FIRM CAPACITY	TEMES	1	"MW"	2022	0	40 MW
FIRM CAPACITY	TEMES	1	"MW"	2023	0	40 MW
FIRM CAPACITY	TEMES	1	"MW"	2024	0	40 MW
FIRM CAPACITY	TEMES	1	"MW"	2025	0	40 MW
FIRM CAPACITY	TEMES	1	"MW"	2026	0	40 MW
FIRM CAPACITY	TEMES	1	"MW"	2027	0	40 MW
FIRM CAPACITY	TEMES	1	"MW"	2028	0	40 MW
FIRM CAPACITY	TEMES	1	"MW"	2029	0	40 MW
FIRM CAPACITY	TEMES	1	"MW"	2030	0	40 MW

FIRM CAPACITY	TEMES	1	"MW"	2031	0		40	MW
FIRM CAPACITY	TEMES	1	"MW"	2032	0		40	MW
FIRM CAPACITY	TEMES	1	"MW"	2033	0		40	MW
FIRM CAPACITY	TEMES	1	"MW"	2034	0		40	MW
FIRM CAPACITY	TEMES	1	"MW"	2035	0		40	MW
FIRM CAPACITY	CFB	1	"MW"	2006	0	#N/A		MW
FIRM CAPACITY	CFB	1	"MW"	2007	0	#N/A		MW
FIRM CAPACITY	CFB	1	"MW"	2008	0	#N/A		MW
FIRM CAPACITY	CFB	1	"MW"	2009	0	#N/A		MW
FIRM CAPACITY	CFB	1	"MW"	2010	0	#N/A		MW
FIRM CAPACITY	CFB	1	"MW"	2011	0	#N/A		MW
FIRM CAPACITY	CFB	1	"MW"	2012	0	#N/A		MW
FIRM CAPACITY	CFB	1	"MW"	2013	0	#N/A		MW
FIRM CAPACITY	CFB	1	"MW"	2014	0	#N/A		MW
FIRM CAPACITY	CFB	1	"MW"	2015	0	#N/A		MW
FIRM CAPACITY	CFB	1	"MW"	2016	0	#N/A		MW
FIRM CAPACITY	CFB	1	"MW"	2017	0	#N/A		MW
FIRM CAPACITY	CFB	1	"MW"	2018	0	#N/A		MW
FIRM CAPACITY	CFB	1	"MW"	2019	0	#N/A		MW
FIRM CAPACITY	CFB	1	"MW"	2020	0	#N/A		MW
FIRM CAPACITY	CFB	1	"MW"	2021	0	#N/A		MW
FIRM CAPACITY	CFB	1	"MW"	2022	0	#N/A		MW
FIRM CAPACITY	CFB	1	"MW"	2023	0	#N/A		MW
FIRM CAPACITY	CFB	1	"MW"	2024	0	#N/A		MW
FIRM CAPACITY	CFB	1	"MW"	2025	0	#N/A		MW
FIRM CAPACITY	CFB	1	"MW"	2026	0	#N/A		MW
FIRM CAPACITY	CFB	1	"MW"	2027	0	#N/A		MW
FIRM CAPACITY	CFB	1	"MW"	2028	0	#N/A		MW
FIRM CAPACITY	CFB	1	"MW"	2029	0	#N/A		MW
FIRM CAPACITY	CFB	1	"MW"	2030	0	#N/A		MW
FIRM CAPACITY	CFB	1	"MW"	2031	0	#N/A		MW
FIRM CAPACITY	CFB	1	"MW"	2032	0	#N/A		MW
FIRM CAPACITY	CFB	1	"MW"	2033	0	#N/A		MW
FIRM CAPACITY	CFB	1	"MW"	2034	0	#N/A		MW
FIRM CAPACITY	CFB	1	"MW"	2035	0	#N/A		MW
FIRM CAPACITY	RECIP	1	"MW"	2006	0	#N/A		MW
FIRM CAPACITY	RECIP	1	"MW"	2007	0	#N/A		MW
FIRM CAPACITY	RECIP	1	"MW"	2008	0	#N/A		MW
FIRM CAPACITY	RECIP	1	"MW"	2009	0	#N/A		MW
FIRM CAPACITY	RECIP	1	"MW"	2010	0	#N/A		MW
FIRM CAPACITY	RECIP	1	"MW"	2011	0	#N/A		MW
FIRM CAPACITY	RECIP	1	"MW"	2012	0	#N/A		MW
FIRM CAPACITY	RECIP	1	"MW"	2013	0	#N/A		MW
FIRM CAPACITY	RECIP	1	"MW"	2014	0	#N/A		MW
FIRM CAPACITY	RECIP	1	"MW"	2015	0	#N/A		MW
FIRM CAPACITY	RECIP	1	"MW"	2016	0	#N/A		MW
FIRM CAPACITY	RECIP	1	"MW"	2017	0	#N/A		MW
FIRM CAPACITY	RECIP	1	"MW"	2018	0	#N/A		MW
FIRM CAPACITY	RECIP	1	"MW"	2019	0	#N/A		MW
FIRM CAPACITY	RECIP	1	"MW"	2020	0	#N/A		MW
FIRM CAPACITY	RECIP	1	"MW"	2021	0	#N/A		MW
FIRM CAPACITY	RECIP	1	"MW"	2022	0	#N/A		MW

FIRM CAPACITY	RECIP	1	"MW"	2023	0	#N/A	MW
FIRM CAPACITY	RECIP	1	"MW"	2024	0	#N/A	MW
FIRM CAPACITY	RECIP	1	"MW"	2025	0	#N/A	MW
FIRM CAPACITY	RECIP	1	"MW"	2026	0	#N/A	MW
FIRM CAPACITY	RECIP	1	"MW"	2027	0	#N/A	MW
FIRM CAPACITY	RECIP	1	"MW"	2028	0	#N/A	MW
FIRM CAPACITY	RECIP	1	"MW"	2029	0	#N/A	MW
FIRM CAPACITY	RECIP	1	"MW"	2030	0	#N/A	MW
FIRM CAPACITY	RECIP	1	"MW"	2031	0	#N/A	MW
FIRM CAPACITY	RECIP	1	"MW"	2032	0	#N/A	MW
FIRM CAPACITY	RECIP	1	"MW"	2033	0	#N/A	MW
FIRM CAPACITY	RECIP	1	"MW"	2034	0	#N/A	MW
FIRM CAPACITY	RECIP	1	"MW"	2035	0	#N/A	MW
FIRM CAPACITY	MSW	1	"MW"	2006	0	#N/A	MW
FIRM CAPACITY	MSW	1	"MW"	2007	0	#N/A	MW
FIRM CAPACITY	MSW	1	"MW"	2008	0	#N/A	MW
FIRM CAPACITY	MSW	1	"MW"	2009	0	#N/A	MW
FIRM CAPACITY	MSW	1	"MW"	2010	0	#N/A	MW
FIRM CAPACITY	MSW	1	"MW"	2011	0	#N/A	MW
FIRM CAPACITY	MSW	1	"MW"	2012	0	#N/A	MW
FIRM CAPACITY	MSW	1	"MW"	2013	0	#N/A	MW
FIRM CAPACITY	MSW	1	"MW"	2014	0	#N/A	MW
FIRM CAPACITY	MSW	1	"MW"	2015	0	#N/A	MW
FIRM CAPACITY	MSW	1	"MW"	2016	0	#N/A	MW
FIRM CAPACITY	MSW	1	"MW"	2017	0	#N/A	MW
FIRM CAPACITY	MSW	1	"MW"	2018	0	#N/A	MW
FIRM CAPACITY	MSW	1	"MW"	2019	0	#N/A	MW
FIRM CAPACITY	MSW	1	"MW"	2020	0	#N/A	MW
FIRM CAPACITY	MSW	1	"MW"	2021	0	#N/A	MW
FIRM CAPACITY	MSW	1	"MW"	2022	0	#N/A	MW
FIRM CAPACITY	MSW	1	"MW"	2023	0	#N/A	MW
FIRM CAPACITY	MSW	1	"MW"	2024	0	#N/A	MW
FIRM CAPACITY	MSW	1	"MW"	2025	0	#N/A	MW
FIRM CAPACITY	MSW	1	"MW"	2026	0	#N/A	MW
FIRM CAPACITY	MSW	1	"MW"	2027	0	#N/A	MW
FIRM CAPACITY	MSW	1	"MW"	2028	0	#N/A	MW
FIRM CAPACITY	MSW	1	"MW"	2029	0	#N/A	MW
FIRM CAPACITY	MSW	1	"MW"	2030	0	#N/A	MW
FIRM CAPACITY	MSW	1	"MW"	2031	0	#N/A	MW
FIRM CAPACITY	MSW	1	"MW"	2032	0	#N/A	MW
FIRM CAPACITY	MSW	1	"MW"	2033	0	#N/A	MW
FIRM CAPACITY	MSW	1	"MW"	2034	0	#N/A	MW
FIRM CAPACITY	MSW	1	"MW"	2035	0	#N/A	MW
FIRM CAPACITY	RETR	1	"MW"	2006	0	#N/A	MW
FIRM CAPACITY	RETR	1	"MW"	2007	0	#N/A	MW
FIRM CAPACITY	RETR	1	"MW"	2008	0	#N/A	MW
FIRM CAPACITY	RETR	1	"MW"	2009	0	#N/A	MW
FIRM CAPACITY	RETR	1	"MW"	2010	0	#N/A	MW
FIRM CAPACITY	RETR	1	"MW"	2011	0	#N/A	MW
FIRM CAPACITY	RETR	1	"MW"	2012	0	#N/A	MW
FIRM CAPACITY	RETR	1	"MW"	2013	0	#N/A	MW
FIRM CAPACITY	RETR	1	"MW"	2014	0	#N/A	MW

FIRM CAPACITY	RETR	1	"MW"	2015	0	#N/A	MW
FIRM CAPACITY	RETR	1	"MW"	2016	0	#N/A	MW
FIRM CAPACITY	RETR	1	"MW"	2017	0	#N/A	MW
FIRM CAPACITY	RETR	1	"MW"	2018	0	#N/A	MW
FIRM CAPACITY	RETR	1	"MW"	2019	0	#N/A	MW
FIRM CAPACITY	RETR	1	"MW"	2020	0	#N/A	MW
FIRM CAPACITY	RETR	1	"MW"	2021	0	#N/A	MW
FIRM CAPACITY	RETR	1	"MW"	2022	0	#N/A	MW
FIRM CAPACITY	RETR	1	"MW"	2023	0	#N/A	MW
FIRM CAPACITY	RETR	1	"MW"	2024	0	#N/A	MW
FIRM CAPACITY	RETR	1	"MW"	2025	0	#N/A	MW
FIRM CAPACITY	RETR	1	"MW"	2026	0	#N/A	MW
FIRM CAPACITY	RETR	1	"MW"	2027	0	#N/A	MW
FIRM CAPACITY	RETR	1	"MW"	2028	0	#N/A	MW
FIRM CAPACITY	RETR	1	"MW"	2029	0	#N/A	MW
FIRM CAPACITY	RETR	1	"MW"	2030	0	#N/A	MW
FIRM CAPACITY	RETR	1	"MW"	2031	0	#N/A	MW
FIRM CAPACITY	RETR	1	"MW"	2032	0	#N/A	MW
FIRM CAPACITY	RETR	1	"MW"	2033	0	#N/A	MW
FIRM CAPACITY	RETR	1	"MW"	2034	0	#N/A	MW
FIRM CAPACITY	RETR	1	"MW"	2035	0	#N/A	MW
FIRM CAPACITY	CLNG	1	"MW"	2006	0	#N/A	MW
FIRM CAPACITY	CLNG	1	"MW"	2007	0	#N/A	MW
FIRM CAPACITY	CLNG	1	"MW"	2008	0	#N/A	MW
FIRM CAPACITY	CLNG	1	"MW"	2009	0	#N/A	MW
FIRM CAPACITY	CLNG	1	"MW"	2010	0	#N/A	MW
FIRM CAPACITY	CLNG	1	"MW"	2011	0	#N/A	MW
FIRM CAPACITY	CLNG	1	"MW"	2012	0	#N/A	MW
FIRM CAPACITY	CLNG	1	"MW"	2013	0	#N/A	MW
FIRM CAPACITY	CLNG	1	"MW"	2014	0	#N/A	MW
FIRM CAPACITY	CLNG	1	"MW"	2015	0	#N/A	MW
FIRM CAPACITY	CLNG	1	"MW"	2016	0	#N/A	MW
FIRM CAPACITY	CLNG	1	"MW"	2017	0	#N/A	MW
FIRM CAPACITY	CLNG	1	"MW"	2018	0	#N/A	MW
FIRM CAPACITY	CLNG	1	"MW"	2019	0	#N/A	MW
FIRM CAPACITY	CLNG	1	"MW"	2020	0	#N/A	MW
FIRM CAPACITY	CLNG	1	"MW"	2021	0	#N/A	MW
FIRM CAPACITY	CLNG	1	"MW"	2022	0	#N/A	MW
FIRM CAPACITY	CLNG	1	"MW"	2023	0	#N/A	MW
FIRM CAPACITY	CLNG	1	"MW"	2024	0	#N/A	MW
FIRM CAPACITY	CLNG	1	"MW"	2025	0	#N/A	MW
FIRM CAPACITY	CLNG	1	"MW"	2026	0	#N/A	MW
FIRM CAPACITY	CLNG	1	"MW"	2027	0	#N/A	MW
FIRM CAPACITY	CLNG	1	"MW"	2028	0	#N/A	MW
FIRM CAPACITY	CLNG	1	"MW"	2029	0	#N/A	MW
FIRM CAPACITY	CLNG	1	"MW"	2030	0	#N/A	MW
FIRM CAPACITY	CLNG	1	"MW"	2031	0	#N/A	MW
FIRM CAPACITY	CLNG	1	"MW"	2032	0	#N/A	MW
FIRM CAPACITY	CLNG	1	"MW"	2033	0	#N/A	MW
FIRM CAPACITY	CLNG	1	"MW"	2034	0	#N/A	MW
FIRM CAPACITY	CLNG	1	"MW"	2035	0	#N/A	MW
FIRM CAPACITY	WIND	1	"MW"	2006	0	#N/A	MW

FIRM CAPACITY	WIND	1	"MW"	2007	0	#N/A	MW
FIRM CAPACITY	WIND	1	"MW"	2008	0	#N/A	MW
FIRM CAPACITY	WIND	1	"MW"	2009	0	#N/A	MW
FIRM CAPACITY	WIND	1	"MW"	2010	0	#N/A	MW
FIRM CAPACITY	WIND	1	"MW"	2011	0	#N/A	MW
FIRM CAPACITY	WIND	1	"MW"	2012	0	#N/A	MW
FIRM CAPACITY	WIND	1	"MW"	2013	0	#N/A	MW
FIRM CAPACITY	WIND	1	"MW"	2014	0	#N/A	MW
FIRM CAPACITY	WIND	1	"MW"	2015	0	#N/A	MW
FIRM CAPACITY	WIND	1	"MW"	2016	0	#N/A	MW
FIRM CAPACITY	WIND	1	"MW"	2017	0	#N/A	MW
FIRM CAPACITY	WIND	1	"MW"	2018	0	#N/A	MW
FIRM CAPACITY	WIND	1	"MW"	2019	0	#N/A	MW
FIRM CAPACITY	WIND	1	"MW"	2020	0	#N/A	MW
FIRM CAPACITY	WIND	1	"MW"	2021	0	#N/A	MW
FIRM CAPACITY	WIND	1	"MW"	2022	0	#N/A	MW
FIRM CAPACITY	WIND	1	"MW"	2023	0	#N/A	MW
FIRM CAPACITY	WIND	1	"MW"	2024	0	#N/A	MW
FIRM CAPACITY	WIND	1	"MW"	2025	0	#N/A	MW
FIRM CAPACITY	WIND	1	"MW"	2026	0	#N/A	MW
FIRM CAPACITY	WIND	1	"MW"	2027	0	#N/A	MW
FIRM CAPACITY	WIND	1	"MW"	2028	0	#N/A	MW
FIRM CAPACITY	WIND	1	"MW"	2029	0	#N/A	MW
FIRM CAPACITY	WIND	1	"MW"	2030	0	#N/A	MW
FIRM CAPACITY	WIND	1	"MW"	2031	0	#N/A	MW
FIRM CAPACITY	WIND	1	"MW"	2032	0	#N/A	MW
FIRM CAPACITY	WIND	1	"MW"	2033	0	#N/A	MW
FIRM CAPACITY	WIND	1	"MW"	2034	0	#N/A	MW
FIRM CAPACITY	WIND	1	"MW"	2035	0	#N/A	MW
FIRM CAPACITY	CAB LNG	1	"MW"	2006	0	#N/A	MW
FIRM CAPACITY	CAB LNG	1	"MW"	2007	0	#N/A	MW
FIRM CAPACITY	CAB LNG	1	"MW"	2008	0	#N/A	MW
FIRM CAPACITY	CAB LNG	1	"MW"	2009	0	#N/A	MW
FIRM CAPACITY	CAB LNG	1	"MW"	2010	0	#N/A	MW
FIRM CAPACITY	CAB LNG	1	"MW"	2011	0	#N/A	MW
FIRM CAPACITY	CAB LNG	1	"MW"	2012	0	#N/A	MW
FIRM CAPACITY	CAB LNG	1	"MW"	2013	0	#N/A	MW
FIRM CAPACITY	CAB LNG	1	"MW"	2014	0	#N/A	MW
FIRM CAPACITY	CAB LNG	1	"MW"	2015	0	#N/A	MW
FIRM CAPACITY	CAB LNG	1	"MW"	2016	0	#N/A	MW
FIRM CAPACITY	CAB LNG	1	"MW"	2017	0	#N/A	MW
FIRM CAPACITY	CAB LNG	1	"MW"	2018	0	#N/A	MW
FIRM CAPACITY	CAB LNG	1	"MW"	2019	0	#N/A	MW
FIRM CAPACITY	CAB LNG	1	"MW"	2020	0	#N/A	MW
FIRM CAPACITY	CAB LNG	1	"MW"	2021	0	#N/A	MW
FIRM CAPACITY	CAB LNG	1	"MW"	2022	0	#N/A	MW
FIRM CAPACITY	CAB LNG	1	"MW"	2023	0	#N/A	MW
FIRM CAPACITY	CAB LNG	1	"MW"	2024	0	#N/A	MW
FIRM CAPACITY	CAB LNG	1	"MW"	2025	0	#N/A	MW
FIRM CAPACITY	CAB LNG	1	"MW"	2026	0	#N/A	MW
FIRM CAPACITY	CAB LNG	1	"MW"	2027	0	#N/A	MW
FIRM CAPACITY	CAB LNG	1	"MW"	2028	0	#N/A	MW

FIRM CAPACITY	CAB LNG 1	"MW"	2029	0	#N/A	MW
FIRM CAPACITY	CAB LNG 1	"MW"	2030	0	#N/A	MW
FIRM CAPACITY	CAB LNG 1	"MW"	2031	0	#N/A	MW
FIRM CAPACITY	CAB LNG 1	"MW"	2032	0	#N/A	MW
FIRM CAPACITY	CAB LNG 1	"MW"	2033	0	#N/A	MW
FIRM CAPACITY	CAB LNG 1	"MW"	2034	0	#N/A	MW
FIRM CAPACITY	CAB LNG 1	"MW"	2035	0	#N/A	MW
FIRM CAPACITY	CAB LNG 2	"MW"	2006	0	#N/A	MW
FIRM CAPACITY	CAB LNG 2	"MW"	2007	0	#N/A	MW
FIRM CAPACITY	CAB LNG 2	"MW"	2008	0	#N/A	MW
FIRM CAPACITY	CAB LNG 2	"MW"	2009	0	#N/A	MW
FIRM CAPACITY	CAB LNG 2	"MW"	2010	0	#N/A	MW
FIRM CAPACITY	CAB LNG 2	"MW"	2011	0	#N/A	MW
FIRM CAPACITY	CAB LNG 2	"MW"	2012	0	#N/A	MW
FIRM CAPACITY	CAB LNG 2	"MW"	2013	0	#N/A	MW
FIRM CAPACITY	CAB LNG 2	"MW"	2014	0	#N/A	MW
FIRM CAPACITY	CAB LNG 2	"MW"	2015	0	#N/A	MW
FIRM CAPACITY	CAB LNG 2	"MW"	2016	0	#N/A	MW
FIRM CAPACITY	CAB LNG 2	"MW"	2017	0	#N/A	MW
FIRM CAPACITY	CAB LNG 2	"MW"	2018	0	#N/A	MW
FIRM CAPACITY	CAB LNG 2	"MW"	2019	0	#N/A	MW
FIRM CAPACITY	CAB LNG 2	"MW"	2020	0	#N/A	MW
FIRM CAPACITY	CAB LNG 2	"MW"	2021	0	#N/A	MW
FIRM CAPACITY	CAB LNG 2	"MW"	2022	0	#N/A	MW
FIRM CAPACITY	CAB LNG 2	"MW"	2023	0	#N/A	MW
FIRM CAPACITY	CAB LNG 2	"MW"	2024	0	#N/A	MW
FIRM CAPACITY	CAB LNG 2	"MW"	2025	0	#N/A	MW
FIRM CAPACITY	CAB LNG 2	"MW"	2026	0	#N/A	MW
FIRM CAPACITY	CAB LNG 2	"MW"	2027	0	#N/A	MW
FIRM CAPACITY	CAB LNG 2	"MW"	2028	0	#N/A	MW
FIRM CAPACITY	CAB LNG 2	"MW"	2029	0	#N/A	MW
FIRM CAPACITY	CAB LNG 2	"MW"	2030	0	#N/A	MW
FIRM CAPACITY	CAB LNG 2	"MW"	2031	0	#N/A	MW
FIRM CAPACITY	CAB LNG 2	"MW"	2032	0	#N/A	MW
FIRM CAPACITY	CAB LNG 2	"MW"	2033	0	#N/A	MW
FIRM CAPACITY	CAB LNG 2	"MW"	2034	0	#N/A	MW
FIRM CAPACITY	CAB LNG 2	"MW"	2035	0	#N/A	MW
FIRM CAPACITY	DED LNG 1	"MW"	2006	0	#N/A	MW
FIRM CAPACITY	DED LNG 1	"MW"	2007	0	#N/A	MW
FIRM CAPACITY	DED LNG 1	"MW"	2008	0	#N/A	MW
FIRM CAPACITY	DED LNG 1	"MW"	2009	0	#N/A	MW
FIRM CAPACITY	DED LNG 1	"MW"	2010	0	#N/A	MW
FIRM CAPACITY	DED LNG 1	"MW"	2011	0	#N/A	MW
FIRM CAPACITY	DED LNG 1	"MW"	2012	0	#N/A	MW
FIRM CAPACITY	DED LNG 1	"MW"	2013	0	#N/A	MW
FIRM CAPACITY	DED LNG 1	"MW"	2014	0	#N/A	MW
FIRM CAPACITY	DED LNG 1	"MW"	2015	0	#N/A	MW
FIRM CAPACITY	DED LNG 1	"MW"	2016	0	#N/A	MW
FIRM CAPACITY	DED LNG 1	"MW"	2017	0	#N/A	MW
FIRM CAPACITY	DED LNG 1	"MW"	2018	0	#N/A	MW
FIRM CAPACITY	DED LNG 1	"MW"	2019	0	#N/A	MW
FIRM CAPACITY	DED LNG 1	"MW"	2020	0	#N/A	MW

FIRM CAPACITY	DED LNG 1	"MW"	2021	0	#N/A	MW
FIRM CAPACITY	DED LNG 1	"MW"	2022	0	#N/A	MW
FIRM CAPACITY	DED LNG 1	"MW"	2023	0	#N/A	MW
FIRM CAPACITY	DED LNG 1	"MW"	2024	0	#N/A	MW
FIRM CAPACITY	DED LNG 1	"MW"	2025	0	#N/A	MW
FIRM CAPACITY	DED LNG 1	"MW"	2026	0	#N/A	MW
FIRM CAPACITY	DED LNG 1	"MW"	2027	0	#N/A	MW
FIRM CAPACITY	DED LNG 1	"MW"	2028	0	#N/A	MW
FIRM CAPACITY	DED LNG 1	"MW"	2029	0	#N/A	MW
FIRM CAPACITY	DED LNG 1	"MW"	2030	0	#N/A	MW
FIRM CAPACITY	DED LNG 1	"MW"	2031	0	#N/A	MW
FIRM CAPACITY	DED LNG 1	"MW"	2032	0	#N/A	MW
FIRM CAPACITY	DED LNG 1	"MW"	2033	0	#N/A	MW
FIRM CAPACITY	DED LNG 1	"MW"	2034	0	#N/A	MW
FIRM CAPACITY	DED LNG 1	"MW"	2035	0	#N/A	MW
FIRM CAPACITY	DED LNG 2	"MW"	2006	0	#N/A	MW
FIRM CAPACITY	DED LNG 2	"MW"	2007	0	#N/A	MW
FIRM CAPACITY	DED LNG 2	"MW"	2008	0	#N/A	MW
FIRM CAPACITY	DED LNG 2	"MW"	2009	0	#N/A	MW
FIRM CAPACITY	DED LNG 2	"MW"	2010	0	#N/A	MW
FIRM CAPACITY	DED LNG 2	"MW"	2011	0	#N/A	MW
FIRM CAPACITY	DED LNG 2	"MW"	2012	0	#N/A	MW
FIRM CAPACITY	DED LNG 2	"MW"	2013	0	#N/A	MW
FIRM CAPACITY	DED LNG 2	"MW"	2014	0	#N/A	MW
FIRM CAPACITY	DED LNG 2	"MW"	2015	0	#N/A	MW
FIRM CAPACITY	DED LNG 2	"MW"	2016	0	#N/A	MW
FIRM CAPACITY	DED LNG 2	"MW"	2017	0	#N/A	MW
FIRM CAPACITY	DED LNG 2	"MW"	2018	0	#N/A	MW
FIRM CAPACITY	DED LNG 2	"MW"	2019	0	#N/A	MW
FIRM CAPACITY	DED LNG 2	"MW"	2020	0	#N/A	MW
FIRM CAPACITY	DED LNG 2	"MW"	2021	0	#N/A	MW
FIRM CAPACITY	DED LNG 2	"MW"	2022	0	#N/A	MW
FIRM CAPACITY	DED LNG 2	"MW"	2023	0	#N/A	MW
FIRM CAPACITY	DED LNG 2	"MW"	2024	0	#N/A	MW
FIRM CAPACITY	DED LNG 2	"MW"	2025	0	#N/A	MW
FIRM CAPACITY	DED LNG 2	"MW"	2026	0	#N/A	MW
FIRM CAPACITY	DED LNG 2	"MW"	2027	0	#N/A	MW
FIRM CAPACITY	DED LNG 2	"MW"	2028	0	#N/A	MW
FIRM CAPACITY	DED LNG 2	"MW"	2029	0	#N/A	MW
FIRM CAPACITY	DED LNG 2	"MW"	2030	0	#N/A	MW
FIRM CAPACITY	DED LNG 2	"MW"	2031	0	#N/A	MW
FIRM CAPACITY	DED LNG 2	"MW"	2032	0	#N/A	MW
FIRM CAPACITY	DED LNG 2	"MW"	2033	0	#N/A	MW
FIRM CAPACITY	DED LNG 2	"MW"	2034	0	#N/A	MW
FIRM CAPACITY	DED LNG 2	"MW"	2035	0	#N/A	MW
FIRM CAPACITY	MAC LNG 1	"MW"	2006	0	#N/A	MW
FIRM CAPACITY	MAC LNG 1	"MW"	2007	0	#N/A	MW
FIRM CAPACITY	MAC LNG 1	"MW"	2008	0	#N/A	MW
FIRM CAPACITY	MAC LNG 1	"MW"	2009	0	#N/A	MW
FIRM CAPACITY	MAC LNG 1	"MW"	2010	0	#N/A	MW
FIRM CAPACITY	MAC LNG 1	"MW"	2011	0	#N/A	MW
FIRM CAPACITY	MAC LNG 1	"MW"	2012	0	#N/A	MW

FIRM CAPACITY	MAC LNG 1	"MW"	2013	0	#N/A	MW
FIRM CAPACITY	MAC LNG 1	"MW"	2014	0	#N/A	MW
FIRM CAPACITY	MAC LNG 1	"MW"	2015	0	#N/A	MW
FIRM CAPACITY	MAC LNG 1	"MW"	2016	0	#N/A	MW
FIRM CAPACITY	MAC LNG 1	"MW"	2017	0	#N/A	MW
FIRM CAPACITY	MAC LNG 1	"MW"	2018	0	#N/A	MW
FIRM CAPACITY	MAC LNG 1	"MW"	2019	0	#N/A	MW
FIRM CAPACITY	MAC LNG 1	"MW"	2020	0	#N/A	MW
FIRM CAPACITY	MAC LNG 1	"MW"	2021	0	#N/A	MW
FIRM CAPACITY	MAC LNG 1	"MW"	2022	0	#N/A	MW
FIRM CAPACITY	MAC LNG 1	"MW"	2023	0	#N/A	MW
FIRM CAPACITY	MAC LNG 1	"MW"	2024	0	#N/A	MW
FIRM CAPACITY	MAC LNG 1	"MW"	2025	0	#N/A	MW
FIRM CAPACITY	MAC LNG 1	"MW"	2026	0	#N/A	MW
FIRM CAPACITY	MAC LNG 1	"MW"	2027	0	#N/A	MW
FIRM CAPACITY	MAC LNG 1	"MW"	2028	0	#N/A	MW
FIRM CAPACITY	MAC LNG 1	"MW"	2029	0	#N/A	MW
FIRM CAPACITY	MAC LNG 1	"MW"	2030	0	#N/A	MW
FIRM CAPACITY	MAC LNG 1	"MW"	2031	0	#N/A	MW
FIRM CAPACITY	MAC LNG 1	"MW"	2032	0	#N/A	MW
FIRM CAPACITY	MAC LNG 1	"MW"	2033	0	#N/A	MW
FIRM CAPACITY	MAC LNG 1	"MW"	2034	0	#N/A	MW
FIRM CAPACITY	MAC LNG 1	"MW"	2035	0	#N/A	MW
FIRM CAPACITY	YIG LNG 1	"MW"	2006	0	#N/A	MW
FIRM CAPACITY	YIG LNG 1	"MW"	2007	0	#N/A	MW
FIRM CAPACITY	YIG LNG 1	"MW"	2008	0	#N/A	MW
FIRM CAPACITY	YIG LNG 1	"MW"	2009	0	#N/A	MW
FIRM CAPACITY	YIG LNG 1	"MW"	2010	0	#N/A	MW
FIRM CAPACITY	YIG LNG 1	"MW"	2011	0	#N/A	MW
FIRM CAPACITY	YIG LNG 1	"MW"	2012	0	#N/A	MW
FIRM CAPACITY	YIG LNG 1	"MW"	2013	0	#N/A	MW
FIRM CAPACITY	YIG LNG 1	"MW"	2014	0	#N/A	MW
FIRM CAPACITY	YIG LNG 1	"MW"	2015	0	#N/A	MW
FIRM CAPACITY	YIG LNG 1	"MW"	2016	0	#N/A	MW
FIRM CAPACITY	YIG LNG 1	"MW"	2017	0	#N/A	MW
FIRM CAPACITY	YIG LNG 1	"MW"	2018	0	#N/A	MW
FIRM CAPACITY	YIG LNG 1	"MW"	2019	0	#N/A	MW
FIRM CAPACITY	YIG LNG 1	"MW"	2020	0	#N/A	MW
FIRM CAPACITY	YIG LNG 1	"MW"	2021	0	#N/A	MW
FIRM CAPACITY	YIG LNG 1	"MW"	2022	0	#N/A	MW
FIRM CAPACITY	YIG LNG 1	"MW"	2023	0	#N/A	MW
FIRM CAPACITY	YIG LNG 1	"MW"	2024	0	#N/A	MW
FIRM CAPACITY	YIG LNG 1	"MW"	2025	0	#N/A	MW
FIRM CAPACITY	YIG LNG 1	"MW"	2026	0	#N/A	MW
FIRM CAPACITY	YIG LNG 1	"MW"	2027	0	#N/A	MW
FIRM CAPACITY	YIG LNG 1	"MW"	2028	0	#N/A	MW
FIRM CAPACITY	YIG LNG 1	"MW"	2029	0	#N/A	MW
FIRM CAPACITY	YIG LNG 1	"MW"	2030	0	#N/A	MW
FIRM CAPACITY	YIG LNG 1	"MW"	2031	0	#N/A	MW
FIRM CAPACITY	YIG LNG 1	"MW"	2032	0	#N/A	MW
FIRM CAPACITY	YIG LNG 1	"MW"	2033	0	#N/A	MW
FIRM CAPACITY	YIG LNG 1	"MW"	2034	0	#N/A	MW

FIRM CAPACITY	YIG LNG 1	"MW"	2035	0	#N/A	MW
FIRM CAPACITY	TJO LNG 1	"MW"	2006	0	#N/A	MW
FIRM CAPACITY	TJO LNG 1	"MW"	2007	0	#N/A	MW
FIRM CAPACITY	TJO LNG 1	"MW"	2008	0	#N/A	MW
FIRM CAPACITY	TJO LNG 1	"MW"	2009	0	#N/A	MW
FIRM CAPACITY	TJO LNG 1	"MW"	2010	0	#N/A	MW
FIRM CAPACITY	TJO LNG 1	"MW"	2011	0	#N/A	MW
FIRM CAPACITY	TJO LNG 1	"MW"	2012	0	#N/A	MW
FIRM CAPACITY	TJO LNG 1	"MW"	2013	0	#N/A	MW
FIRM CAPACITY	TJO LNG 1	"MW"	2014	0	#N/A	MW
FIRM CAPACITY	TJO LNG 1	"MW"	2015	0	#N/A	MW
FIRM CAPACITY	TJO LNG 1	"MW"	2016	0	#N/A	MW
FIRM CAPACITY	TJO LNG 1	"MW"	2017	0	#N/A	MW
FIRM CAPACITY	TJO LNG 1	"MW"	2018	0	#N/A	MW
FIRM CAPACITY	TJO LNG 1	"MW"	2019	0	#N/A	MW
FIRM CAPACITY	TJO LNG 1	"MW"	2020	0	#N/A	MW
FIRM CAPACITY	TJO LNG 1	"MW"	2021	0	#N/A	MW
FIRM CAPACITY	TJO LNG 1	"MW"	2022	0	#N/A	MW
FIRM CAPACITY	TJO LNG 1	"MW"	2023	0	#N/A	MW
FIRM CAPACITY	TJO LNG 1	"MW"	2024	0	#N/A	MW
FIRM CAPACITY	TJO LNG 1	"MW"	2025	0	#N/A	MW
FIRM CAPACITY	TJO LNG 1	"MW"	2026	0	#N/A	MW
FIRM CAPACITY	TJO LNG 1	"MW"	2027	0	#N/A	MW
FIRM CAPACITY	TJO LNG 1	"MW"	2028	0	#N/A	MW
FIRM CAPACITY	TJO LNG 1	"MW"	2029	0	#N/A	MW
FIRM CAPACITY	TJO LNG 1	"MW"	2030	0	#N/A	MW
FIRM CAPACITY	TJO LNG 1	"MW"	2031	0	#N/A	MW
FIRM CAPACITY	TJO LNG 1	"MW"	2032	0	#N/A	MW
FIRM CAPACITY	TJO LNG 1	"MW"	2033	0	#N/A	MW
FIRM CAPACITY	TJO LNG 1	"MW"	2034	0	#N/A	MW
FIRM CAPACITY	TJO LNG 1	"MW"	2035	0	#N/A	MW
FIRM CAPACITY	TAN LNG 1	"MW"	2006	0	#N/A	MW
FIRM CAPACITY	TAN LNG 1	"MW"	2007	0	#N/A	MW
FIRM CAPACITY	TAN LNG 1	"MW"	2008	0	#N/A	MW
FIRM CAPACITY	TAN LNG 1	"MW"	2009	0	#N/A	MW
FIRM CAPACITY	TAN LNG 1	"MW"	2010	0	#N/A	MW
FIRM CAPACITY	TAN LNG 1	"MW"	2011	0	#N/A	MW
FIRM CAPACITY	TAN LNG 1	"MW"	2012	0	#N/A	MW
FIRM CAPACITY	TAN LNG 1	"MW"	2013	0	#N/A	MW
FIRM CAPACITY	TAN LNG 1	"MW"	2014	0	#N/A	MW
FIRM CAPACITY	TAN LNG 1	"MW"	2015	0	#N/A	MW
FIRM CAPACITY	TAN LNG 1	"MW"	2016	0	#N/A	MW
FIRM CAPACITY	TAN LNG 1	"MW"	2017	0	#N/A	MW
FIRM CAPACITY	TAN LNG 1	"MW"	2018	0	#N/A	MW
FIRM CAPACITY	TAN LNG 1	"MW"	2019	0	#N/A	MW
FIRM CAPACITY	TAN LNG 1	"MW"	2020	0	#N/A	MW
FIRM CAPACITY	TAN LNG 1	"MW"	2021	0	#N/A	MW
FIRM CAPACITY	TAN LNG 1	"MW"	2022	0	#N/A	MW
FIRM CAPACITY	TAN LNG 1	"MW"	2023	0	#N/A	MW
FIRM CAPACITY	TAN LNG 1	"MW"	2024	0	#N/A	MW
FIRM CAPACITY	TAN LNG 1	"MW"	2025	0	#N/A	MW
FIRM CAPACITY	TAN LNG 1	"MW"	2026	0	#N/A	MW

FIRM CAPACITY	TAN LNG 1	"MW"	2027	0	#N/A	MW
FIRM CAPACITY	TAN LNG 1	"MW"	2028	0	#N/A	MW
FIRM CAPACITY	TAN LNG 1	"MW"	2029	0	#N/A	MW
FIRM CAPACITY	TAN LNG 1	"MW"	2030	0	#N/A	MW
FIRM CAPACITY	TAN LNG 1	"MW"	2031	0	#N/A	MW
FIRM CAPACITY	TAN LNG 1	"MW"	2032	0	#N/A	MW
FIRM CAPACITY	TAN LNG 1	"MW"	2033	0	#N/A	MW
FIRM CAPACITY	TAN LNG 1	"MW"	2034	0	#N/A	MW
FIRM CAPACITY	TAN LNG 1	"MW"	2035	0	#N/A	MW
FIRM CAPACITY	TAN LNG 2	"MW"	2006	0	#N/A	MW
FIRM CAPACITY	TAN LNG 2	"MW"	2007	0	#N/A	MW
FIRM CAPACITY	TAN LNG 2	"MW"	2008	0	#N/A	MW
FIRM CAPACITY	TAN LNG 2	"MW"	2009	0	#N/A	MW
FIRM CAPACITY	TAN LNG 2	"MW"	2010	0	#N/A	MW
FIRM CAPACITY	TAN LNG 2	"MW"	2011	0	#N/A	MW
FIRM CAPACITY	TAN LNG 2	"MW"	2012	0	#N/A	MW
FIRM CAPACITY	TAN LNG 2	"MW"	2013	0	#N/A	MW
FIRM CAPACITY	TAN LNG 2	"MW"	2014	0	#N/A	MW
FIRM CAPACITY	TAN LNG 2	"MW"	2015	0	#N/A	MW
FIRM CAPACITY	TAN LNG 2	"MW"	2016	0	#N/A	MW
FIRM CAPACITY	TAN LNG 2	"MW"	2017	0	#N/A	MW
FIRM CAPACITY	TAN LNG 2	"MW"	2018	0	#N/A	MW
FIRM CAPACITY	TAN LNG 2	"MW"	2019	0	#N/A	MW
FIRM CAPACITY	TAN LNG 2	"MW"	2020	0	#N/A	MW
FIRM CAPACITY	TAN LNG 2	"MW"	2021	0	#N/A	MW
FIRM CAPACITY	TAN LNG 2	"MW"	2022	0	#N/A	MW
FIRM CAPACITY	TAN LNG 2	"MW"	2023	0	#N/A	MW
FIRM CAPACITY	TAN LNG 2	"MW"	2024	0	#N/A	MW
FIRM CAPACITY	TAN LNG 2	"MW"	2025	0	#N/A	MW
FIRM CAPACITY	TAN LNG 2	"MW"	2026	0	#N/A	MW
FIRM CAPACITY	TAN LNG 2	"MW"	2027	0	#N/A	MW
FIRM CAPACITY	TAN LNG 2	"MW"	2028	0	#N/A	MW
FIRM CAPACITY	TAN LNG 2	"MW"	2029	0	#N/A	MW
FIRM CAPACITY	TAN LNG 2	"MW"	2030	0	#N/A	MW
FIRM CAPACITY	TAN LNG 2	"MW"	2031	0	#N/A	MW
FIRM CAPACITY	TAN LNG 2	"MW"	2032	0	#N/A	MW
FIRM CAPACITY	TAN LNG 2	"MW"	2033	0	#N/A	MW
FIRM CAPACITY	TAN LNG 2	"MW"	2034	0	#N/A	MW
FIRM CAPACITY	TAN LNG 2	"MW"	2035	0	#N/A	MW
FIRM CAPACITY	TEM LNG 1	"MW"	2006	0	#N/A	MW
FIRM CAPACITY	TEM LNG 1	"MW"	2007	0	#N/A	MW
FIRM CAPACITY	TEM LNG 1	"MW"	2008	0	#N/A	MW
FIRM CAPACITY	TEM LNG 1	"MW"	2009	0	#N/A	MW
FIRM CAPACITY	TEM LNG 1	"MW"	2010	0	#N/A	MW
FIRM CAPACITY	TEM LNG 1	"MW"	2011	0	#N/A	MW
FIRM CAPACITY	TEM LNG 1	"MW"	2012	0	#N/A	MW
FIRM CAPACITY	TEM LNG 1	"MW"	2013	0	#N/A	MW
FIRM CAPACITY	TEM LNG 1	"MW"	2014	0	#N/A	MW
FIRM CAPACITY	TEM LNG 1	"MW"	2015	0	#N/A	MW
FIRM CAPACITY	TEM LNG 1	"MW"	2016	0	#N/A	MW
FIRM CAPACITY	TEM LNG 1	"MW"	2017	0	#N/A	MW
FIRM CAPACITY	TEM LNG 1	"MW"	2018	0	#N/A	MW

FIRM CAPACITY	TEM LNG	1	"MW"	2019	0	#N/A	MW
FIRM CAPACITY	TEM LNG	1	"MW"	2020	0	#N/A	MW
FIRM CAPACITY	TEM LNG	1	"MW"	2021	0	#N/A	MW
FIRM CAPACITY	TEM LNG	1	"MW"	2022	0	#N/A	MW
FIRM CAPACITY	TEM LNG	1	"MW"	2023	0	#N/A	MW
FIRM CAPACITY	TEM LNG	1	"MW"	2024	0	#N/A	MW
FIRM CAPACITY	TEM LNG	1	"MW"	2025	0	#N/A	MW
FIRM CAPACITY	TEM LNG	1	"MW"	2026	0	#N/A	MW
FIRM CAPACITY	TEM LNG	1	"MW"	2027	0	#N/A	MW
FIRM CAPACITY	TEM LNG	1	"MW"	2028	0	#N/A	MW
FIRM CAPACITY	TEM LNG	1	"MW"	2029	0	#N/A	MW
FIRM CAPACITY	TEM LNG	1	"MW"	2030	0	#N/A	MW
FIRM CAPACITY	TEM LNG	1	"MW"	2031	0	#N/A	MW
FIRM CAPACITY	TEM LNG	1	"MW"	2032	0	#N/A	MW
FIRM CAPACITY	TEM LNG	1	"MW"	2033	0	#N/A	MW
FIRM CAPACITY	TEM LNG	1	"MW"	2034	0	#N/A	MW
FIRM CAPACITY	TEM LNG	1	"MW"	2035	0	#N/A	MW
FIRM CAPACITY	RECIP	83	"MW"	2006	0	40	MW
FIRM CAPACITY	RECIP	83	"MW"	2007	0	40	MW
FIRM CAPACITY	RECIP	83	"MW"	2008	0	40	MW
FIRM CAPACITY	RECIP	83	"MW"	2009	0	40	MW
FIRM CAPACITY	RECIP	83	"MW"	2010	0	40	MW
FIRM CAPACITY	RECIP	83	"MW"	2011	0	40	MW
FIRM CAPACITY	RECIP	83	"MW"	2012	0	40	MW
FIRM CAPACITY	RECIP	83	"MW"	2013	0	40	MW
FIRM CAPACITY	RECIP	83	"MW"	2014	0	40	MW
FIRM CAPACITY	RECIP	83	"MW"	2015	0	40	MW
FIRM CAPACITY	RECIP	83	"MW"	2016	0	40	MW
FIRM CAPACITY	RECIP	83	"MW"	2017	0	40	MW
FIRM CAPACITY	RECIP	83	"MW"	2018	0	40	MW
FIRM CAPACITY	RECIP	83	"MW"	2019	0	40	MW
FIRM CAPACITY	RECIP	83	"MW"	2020	0	40	MW
FIRM CAPACITY	RECIP	83	"MW"	2021	0	40	MW
FIRM CAPACITY	RECIP	83	"MW"	2022	0	40	MW
FIRM CAPACITY	RECIP	83	"MW"	2023	0	40	MW
FIRM CAPACITY	RECIP	83	"MW"	2024	0	40	MW
FIRM CAPACITY	RECIP	83	"MW"	2025	0	40	MW
FIRM CAPACITY	RECIP	83	"MW"	2026	0	40	MW
FIRM CAPACITY	RECIP	83	"MW"	2027	0	40	MW
FIRM CAPACITY	RECIP	83	"MW"	2028	0	40	MW
FIRM CAPACITY	RECIP	83	"MW"	2029	0	40	MW
FIRM CAPACITY	RECIP	83	"MW"	2030	0	40	MW
FIRM CAPACITY	RECIP	83	"MW"	2031	0	40	MW
FIRM CAPACITY	RECIP	83	"MW"	2032	0	40	MW
FIRM CAPACITY	RECIP	83	"MW"	2033	0	40	MW
FIRM CAPACITY	RECIP	83	"MW"	2034	0	40	MW
FIRM CAPACITY	RECIP	83	"MW"	2035	40	40	MW
FIRM CAPACITY	RECIP	84	"MW"	2006	0	40	MW
FIRM CAPACITY	RECIP	84	"MW"	2007	0	40	MW
FIRM CAPACITY	RECIP	84	"MW"	2008	0	40	MW
FIRM CAPACITY	RECIP	84	"MW"	2009	0	40	MW
FIRM CAPACITY	RECIP	84	"MW"	2010	0	40	MW

FIRM CAPACITY	RECIP	84	"MW"	2011	0	40 MW
FIRM CAPACITY	RECIP	84	"MW"	2012	0	40 MW
FIRM CAPACITY	RECIP	84	"MW"	2013	0	40 MW
FIRM CAPACITY	RECIP	84	"MW"	2014	0	40 MW
FIRM CAPACITY	RECIP	84	"MW"	2015	0	40 MW
FIRM CAPACITY	RECIP	84	"MW"	2016	0	40 MW
FIRM CAPACITY	RECIP	84	"MW"	2017	0	40 MW
FIRM CAPACITY	RECIP	84	"MW"	2018	0	40 MW
FIRM CAPACITY	RECIP	84	"MW"	2019	0	40 MW
FIRM CAPACITY	RECIP	84	"MW"	2020	0	40 MW
FIRM CAPACITY	RECIP	84	"MW"	2021	0	40 MW
FIRM CAPACITY	RECIP	84	"MW"	2022	0	40 MW
FIRM CAPACITY	RECIP	84	"MW"	2023	0	40 MW
FIRM CAPACITY	RECIP	84	"MW"	2024	0	40 MW
FIRM CAPACITY	RECIP	84	"MW"	2025	0	40 MW
FIRM CAPACITY	RECIP	84	"MW"	2026	0	40 MW
FIRM CAPACITY	RECIP	84	"MW"	2027	0	40 MW
FIRM CAPACITY	RECIP	84	"MW"	2028	0	40 MW
FIRM CAPACITY	RECIP	84	"MW"	2029	0	40 MW
FIRM CAPACITY	RECIP	84	"MW"	2030	0	40 MW
FIRM CAPACITY	RECIP	84	"MW"	2031	0	40 MW
FIRM CAPACITY	RECIP	84	"MW"	2032	0	40 MW
FIRM CAPACITY	RECIP	84	"MW"	2033	40	40 MW
FIRM CAPACITY	RECIP	84	"MW"	2034	40	40 MW
FIRM CAPACITY	RECIP	84	"MW"	2035	40	40 MW
FIRM CAPACITY	CLNG	85	"MW"	2006	0	60 MW
FIRM CAPACITY	CLNG	85	"MW"	2007	0	60 MW
FIRM CAPACITY	CLNG	85	"MW"	2008	0	60 MW
FIRM CAPACITY	CLNG	85	"MW"	2009	0	60 MW
FIRM CAPACITY	CLNG	85	"MW"	2010	0	60 MW
FIRM CAPACITY	CLNG	85	"MW"	2011	0	60 MW
FIRM CAPACITY	CLNG	85	"MW"	2012	0	60 MW
FIRM CAPACITY	CLNG	85	"MW"	2013	0	60 MW
FIRM CAPACITY	CLNG	85	"MW"	2014	0	60 MW
FIRM CAPACITY	CLNG	85	"MW"	2015	0	60 MW
FIRM CAPACITY	CLNG	85	"MW"	2016	0	60 MW
FIRM CAPACITY	CLNG	85	"MW"	2017	0	60 MW
FIRM CAPACITY	CLNG	85	"MW"	2018	0	60 MW
FIRM CAPACITY	CLNG	85	"MW"	2019	0	60 MW
FIRM CAPACITY	CLNG	85	"MW"	2020	0	60 MW
FIRM CAPACITY	CLNG	85	"MW"	2021	0	60 MW
FIRM CAPACITY	CLNG	85	"MW"	2022	0	60 MW
FIRM CAPACITY	CLNG	85	"MW"	2023	0	60 MW
FIRM CAPACITY	CLNG	85	"MW"	2024	0	60 MW
FIRM CAPACITY	CLNG	85	"MW"	2025	0	60 MW
FIRM CAPACITY	CLNG	85	"MW"	2026	0	60 MW
FIRM CAPACITY	CLNG	85	"MW"	2027	0	60 MW
FIRM CAPACITY	CLNG	85	"MW"	2028	0	60 MW
FIRM CAPACITY	CLNG	85	"MW"	2029	0	60 MW
FIRM CAPACITY	CLNG	85	"MW"	2030	60	60 MW
FIRM CAPACITY	CLNG	85	"MW"	2031	60	60 MW
FIRM CAPACITY	CLNG	85	"MW"	2032	60	60 MW

FIRM CAPACITY	CLNG	85	"MW"	2033	60	60 MW
FIRM CAPACITY	CLNG	85	"MW"	2034	60	60 MW
FIRM CAPACITY	CLNG	85	"MW"	2035	60	60 MW
FIRM CAPACITY	RECIP	86	"MW"	2006	0	40 MW
FIRM CAPACITY	RECIP	86	"MW"	2007	0	40 MW
FIRM CAPACITY	RECIP	86	"MW"	2008	0	40 MW
FIRM CAPACITY	RECIP	86	"MW"	2009	0	40 MW
FIRM CAPACITY	RECIP	86	"MW"	2010	0	40 MW
FIRM CAPACITY	RECIP	86	"MW"	2011	0	40 MW
FIRM CAPACITY	RECIP	86	"MW"	2012	0	40 MW
FIRM CAPACITY	RECIP	86	"MW"	2013	0	40 MW
FIRM CAPACITY	RECIP	86	"MW"	2014	0	40 MW
FIRM CAPACITY	RECIP	86	"MW"	2015	0	40 MW
FIRM CAPACITY	RECIP	86	"MW"	2016	0	40 MW
FIRM CAPACITY	RECIP	86	"MW"	2017	0	40 MW
FIRM CAPACITY	RECIP	86	"MW"	2018	0	40 MW
FIRM CAPACITY	RECIP	86	"MW"	2019	0	40 MW
FIRM CAPACITY	RECIP	86	"MW"	2020	0	40 MW
FIRM CAPACITY	RECIP	86	"MW"	2021	0	40 MW
FIRM CAPACITY	RECIP	86	"MW"	2022	0	40 MW
FIRM CAPACITY	RECIP	86	"MW"	2023	0	40 MW
FIRM CAPACITY	RECIP	86	"MW"	2024	0	40 MW
FIRM CAPACITY	RECIP	86	"MW"	2025	0	40 MW
FIRM CAPACITY	RECIP	86	"MW"	2026	0	40 MW
FIRM CAPACITY	RECIP	86	"MW"	2027	0	40 MW
FIRM CAPACITY	RECIP	86	"MW"	2028	0	40 MW
FIRM CAPACITY	RECIP	86	"MW"	2029	40	40 MW
FIRM CAPACITY	RECIP	86	"MW"	2030	40	40 MW
FIRM CAPACITY	RECIP	86	"MW"	2031	40	40 MW
FIRM CAPACITY	RECIP	86	"MW"	2032	40	40 MW
FIRM CAPACITY	RECIP	86	"MW"	2033	40	40 MW
FIRM CAPACITY	RECIP	86	"MW"	2034	40	40 MW
FIRM CAPACITY	RECIP	86	"MW"	2035	40	40 MW
FIRM CAPACITY	RECIP	87	"MW"	2006	0	40 MW
FIRM CAPACITY	RECIP	87	"MW"	2007	0	40 MW
FIRM CAPACITY	RECIP	87	"MW"	2008	0	40 MW
FIRM CAPACITY	RECIP	87	"MW"	2009	0	40 MW
FIRM CAPACITY	RECIP	87	"MW"	2010	0	40 MW
FIRM CAPACITY	RECIP	87	"MW"	2011	0	40 MW
FIRM CAPACITY	RECIP	87	"MW"	2012	0	40 MW
FIRM CAPACITY	RECIP	87	"MW"	2013	0	40 MW
FIRM CAPACITY	RECIP	87	"MW"	2014	0	40 MW
FIRM CAPACITY	RECIP	87	"MW"	2015	0	40 MW
FIRM CAPACITY	RECIP	87	"MW"	2016	0	40 MW
FIRM CAPACITY	RECIP	87	"MW"	2017	0	40 MW
FIRM CAPACITY	RECIP	87	"MW"	2018	0	40 MW
FIRM CAPACITY	RECIP	87	"MW"	2019	0	40 MW
FIRM CAPACITY	RECIP	87	"MW"	2020	0	40 MW
FIRM CAPACITY	RECIP	87	"MW"	2021	0	40 MW
FIRM CAPACITY	RECIP	87	"MW"	2022	0	40 MW
FIRM CAPACITY	RECIP	87	"MW"	2023	0	40 MW
FIRM CAPACITY	RECIP	87	"MW"	2024	0	40 MW

FIRM CAPACITY	RECIP	87	"MW"	2025	0	40 MW
FIRM CAPACITY	RECIP	87	"MW"	2026	0	40 MW
FIRM CAPACITY	RECIP	87	"MW"	2027	0	40 MW
FIRM CAPACITY	RECIP	87	"MW"	2028	40	40 MW
FIRM CAPACITY	RECIP	87	"MW"	2029	40	40 MW
FIRM CAPACITY	RECIP	87	"MW"	2030	40	40 MW
FIRM CAPACITY	RECIP	87	"MW"	2031	40	40 MW
FIRM CAPACITY	RECIP	87	"MW"	2032	40	40 MW
FIRM CAPACITY	RECIP	87	"MW"	2033	40	40 MW
FIRM CAPACITY	RECIP	87	"MW"	2034	40	40 MW
FIRM CAPACITY	RECIP	87	"MW"	2035	40	40 MW
FIRM CAPACITY	CLNG	88	"MW"	2006	0	60 MW
FIRM CAPACITY	CLNG	88	"MW"	2007	0	60 MW
FIRM CAPACITY	CLNG	88	"MW"	2008	0	60 MW
FIRM CAPACITY	CLNG	88	"MW"	2009	0	60 MW
FIRM CAPACITY	CLNG	88	"MW"	2010	0	60 MW
FIRM CAPACITY	CLNG	88	"MW"	2011	0	60 MW
FIRM CAPACITY	CLNG	88	"MW"	2012	0	60 MW
FIRM CAPACITY	CLNG	88	"MW"	2013	0	60 MW
FIRM CAPACITY	CLNG	88	"MW"	2014	0	60 MW
FIRM CAPACITY	CLNG	88	"MW"	2015	0	60 MW
FIRM CAPACITY	CLNG	88	"MW"	2016	0	60 MW
FIRM CAPACITY	CLNG	88	"MW"	2017	0	60 MW
FIRM CAPACITY	CLNG	88	"MW"	2018	0	60 MW
FIRM CAPACITY	CLNG	88	"MW"	2019	0	60 MW
FIRM CAPACITY	CLNG	88	"MW"	2020	0	60 MW
FIRM CAPACITY	CLNG	88	"MW"	2021	0	60 MW
FIRM CAPACITY	CLNG	88	"MW"	2022	0	60 MW
FIRM CAPACITY	CLNG	88	"MW"	2023	0	60 MW
FIRM CAPACITY	CLNG	88	"MW"	2024	0	60 MW
FIRM CAPACITY	CLNG	88	"MW"	2025	0	60 MW
FIRM CAPACITY	CLNG	88	"MW"	2026	0	60 MW
FIRM CAPACITY	CLNG	88	"MW"	2027	60	60 MW
FIRM CAPACITY	CLNG	88	"MW"	2028	60	60 MW
FIRM CAPACITY	CLNG	88	"MW"	2029	60	60 MW
FIRM CAPACITY	CLNG	88	"MW"	2030	60	60 MW
FIRM CAPACITY	CLNG	88	"MW"	2031	60	60 MW
FIRM CAPACITY	CLNG	88	"MW"	2032	60	60 MW
FIRM CAPACITY	CLNG	88	"MW"	2033	60	60 MW
FIRM CAPACITY	CLNG	88	"MW"	2034	60	60 MW
FIRM CAPACITY	CLNG	88	"MW"	2035	60	60 MW
FIRM CAPACITY	RECIP	89	"MW"	2006	0	40 MW
FIRM CAPACITY	RECIP	89	"MW"	2007	0	40 MW
FIRM CAPACITY	RECIP	89	"MW"	2008	0	40 MW
FIRM CAPACITY	RECIP	89	"MW"	2009	0	40 MW
FIRM CAPACITY	RECIP	89	"MW"	2010	0	40 MW
FIRM CAPACITY	RECIP	89	"MW"	2011	0	40 MW
FIRM CAPACITY	RECIP	89	"MW"	2012	0	40 MW
FIRM CAPACITY	RECIP	89	"MW"	2013	0	40 MW
FIRM CAPACITY	RECIP	89	"MW"	2014	0	40 MW
FIRM CAPACITY	RECIP	89	"MW"	2015	0	40 MW
FIRM CAPACITY	RECIP	89	"MW"	2016	0	40 MW

FIRM CAPACITY	RECIP	89	"MW"	2017	0	40 MW
FIRM CAPACITY	RECIP	89	"MW"	2018	0	40 MW
FIRM CAPACITY	RECIP	89	"MW"	2019	0	40 MW
FIRM CAPACITY	RECIP	89	"MW"	2020	0	40 MW
FIRM CAPACITY	RECIP	89	"MW"	2021	0	40 MW
FIRM CAPACITY	RECIP	89	"MW"	2022	0	40 MW
FIRM CAPACITY	RECIP	89	"MW"	2023	0	40 MW
FIRM CAPACITY	RECIP	89	"MW"	2024	0	40 MW
FIRM CAPACITY	RECIP	89	"MW"	2025	0	40 MW
FIRM CAPACITY	RECIP	89	"MW"	2026	0	40 MW
FIRM CAPACITY	RECIP	89	"MW"	2027	40	40 MW
FIRM CAPACITY	RECIP	89	"MW"	2028	40	40 MW
FIRM CAPACITY	RECIP	89	"MW"	2029	40	40 MW
FIRM CAPACITY	RECIP	89	"MW"	2030	40	40 MW
FIRM CAPACITY	RECIP	89	"MW"	2031	40	40 MW
FIRM CAPACITY	RECIP	89	"MW"	2032	40	40 MW
FIRM CAPACITY	RECIP	89	"MW"	2033	40	40 MW
FIRM CAPACITY	RECIP	89	"MW"	2034	40	40 MW
FIRM CAPACITY	RECIP	89	"MW"	2035	40	40 MW
FIRM CAPACITY	RECIP	90	"MW"	2006	0	40 MW
FIRM CAPACITY	RECIP	90	"MW"	2007	0	40 MW
FIRM CAPACITY	RECIP	90	"MW"	2008	0	40 MW
FIRM CAPACITY	RECIP	90	"MW"	2009	0	40 MW
FIRM CAPACITY	RECIP	90	"MW"	2010	0	40 MW
FIRM CAPACITY	RECIP	90	"MW"	2011	0	40 MW
FIRM CAPACITY	RECIP	90	"MW"	2012	0	40 MW
FIRM CAPACITY	RECIP	90	"MW"	2013	0	40 MW
FIRM CAPACITY	RECIP	90	"MW"	2014	0	40 MW
FIRM CAPACITY	RECIP	90	"MW"	2015	0	40 MW
FIRM CAPACITY	RECIP	90	"MW"	2016	0	40 MW
FIRM CAPACITY	RECIP	90	"MW"	2017	0	40 MW
FIRM CAPACITY	RECIP	90	"MW"	2018	0	40 MW
FIRM CAPACITY	RECIP	90	"MW"	2019	0	40 MW
FIRM CAPACITY	RECIP	90	"MW"	2020	0	40 MW
FIRM CAPACITY	RECIP	90	"MW"	2021	0	40 MW
FIRM CAPACITY	RECIP	90	"MW"	2022	0	40 MW
FIRM CAPACITY	RECIP	90	"MW"	2023	0	40 MW
FIRM CAPACITY	RECIP	90	"MW"	2024	0	40 MW
FIRM CAPACITY	RECIP	90	"MW"	2025	40	40 MW
FIRM CAPACITY	RECIP	90	"MW"	2026	40	40 MW
FIRM CAPACITY	RECIP	90	"MW"	2027	40	40 MW
FIRM CAPACITY	RECIP	90	"MW"	2028	40	40 MW
FIRM CAPACITY	RECIP	90	"MW"	2029	40	40 MW
FIRM CAPACITY	RECIP	90	"MW"	2030	40	40 MW
FIRM CAPACITY	RECIP	90	"MW"	2031	40	40 MW
FIRM CAPACITY	RECIP	90	"MW"	2032	40	40 MW
FIRM CAPACITY	RECIP	90	"MW"	2033	40	40 MW
FIRM CAPACITY	RECIP	90	"MW"	2034	40	40 MW
FIRM CAPACITY	RECIP	90	"MW"	2035	40	40 MW
FIRM CAPACITY	CLNG	91	"MW"	2006	0	60 MW
FIRM CAPACITY	CLNG	91	"MW"	2007	0	60 MW
FIRM CAPACITY	CLNG	91	"MW"	2008	0	60 MW

FIRM CAPACITY	CLNG	91	"MW"	2009	0	60 MW
FIRM CAPACITY	CLNG	91	"MW"	2010	0	60 MW
FIRM CAPACITY	CLNG	91	"MW"	2011	0	60 MW
FIRM CAPACITY	CLNG	91	"MW"	2012	0	60 MW
FIRM CAPACITY	CLNG	91	"MW"	2013	0	60 MW
FIRM CAPACITY	CLNG	91	"MW"	2014	0	60 MW
FIRM CAPACITY	CLNG	91	"MW"	2015	0	60 MW
FIRM CAPACITY	CLNG	91	"MW"	2016	0	60 MW
FIRM CAPACITY	CLNG	91	"MW"	2017	0	60 MW
FIRM CAPACITY	CLNG	91	"MW"	2018	0	60 MW
FIRM CAPACITY	CLNG	91	"MW"	2019	0	60 MW
FIRM CAPACITY	CLNG	91	"MW"	2020	0	60 MW
FIRM CAPACITY	CLNG	91	"MW"	2021	0	60 MW
FIRM CAPACITY	CLNG	91	"MW"	2022	0	60 MW
FIRM CAPACITY	CLNG	91	"MW"	2023	0	60 MW
FIRM CAPACITY	CLNG	91	"MW"	2024	60	60 MW
FIRM CAPACITY	CLNG	91	"MW"	2025	60	60 MW
FIRM CAPACITY	CLNG	91	"MW"	2026	60	60 MW
FIRM CAPACITY	CLNG	91	"MW"	2027	60	60 MW
FIRM CAPACITY	CLNG	91	"MW"	2028	60	60 MW
FIRM CAPACITY	CLNG	91	"MW"	2029	60	60 MW
FIRM CAPACITY	CLNG	91	"MW"	2030	60	60 MW
FIRM CAPACITY	CLNG	91	"MW"	2031	60	60 MW
FIRM CAPACITY	CLNG	91	"MW"	2032	60	60 MW
FIRM CAPACITY	CLNG	91	"MW"	2033	60	60 MW
FIRM CAPACITY	CLNG	91	"MW"	2034	60	60 MW
FIRM CAPACITY	CLNG	91	"MW"	2035	60	60 MW
FIRM CAPACITY	RECIP	92	"MW"	2006	0	40 MW
FIRM CAPACITY	RECIP	92	"MW"	2007	0	40 MW
FIRM CAPACITY	RECIP	92	"MW"	2008	0	40 MW
FIRM CAPACITY	RECIP	92	"MW"	2009	0	40 MW
FIRM CAPACITY	RECIP	92	"MW"	2010	0	40 MW
FIRM CAPACITY	RECIP	92	"MW"	2011	0	40 MW
FIRM CAPACITY	RECIP	92	"MW"	2012	0	40 MW
FIRM CAPACITY	RECIP	92	"MW"	2013	0	40 MW
FIRM CAPACITY	RECIP	92	"MW"	2014	0	40 MW
FIRM CAPACITY	RECIP	92	"MW"	2015	0	40 MW
FIRM CAPACITY	RECIP	92	"MW"	2016	0	40 MW
FIRM CAPACITY	RECIP	92	"MW"	2017	0	40 MW
FIRM CAPACITY	RECIP	92	"MW"	2018	0	40 MW
FIRM CAPACITY	RECIP	92	"MW"	2019	0	40 MW
FIRM CAPACITY	RECIP	92	"MW"	2020	0	40 MW
FIRM CAPACITY	RECIP	92	"MW"	2021	0	40 MW
FIRM CAPACITY	RECIP	92	"MW"	2022	0	40 MW
FIRM CAPACITY	RECIP	92	"MW"	2023	0	40 MW
FIRM CAPACITY	RECIP	92	"MW"	2024	40	40 MW
FIRM CAPACITY	RECIP	92	"MW"	2025	40	40 MW
FIRM CAPACITY	RECIP	92	"MW"	2026	40	40 MW
FIRM CAPACITY	RECIP	92	"MW"	2027	40	40 MW
FIRM CAPACITY	RECIP	92	"MW"	2028	40	40 MW
FIRM CAPACITY	RECIP	92	"MW"	2029	40	40 MW
FIRM CAPACITY	RECIP	92	"MW"	2030	40	40 MW

FIRM CAPACITY	RECIP	92	"MW"	2031	40	40 MW
FIRM CAPACITY	RECIP	92	"MW"	2032	40	40 MW
FIRM CAPACITY	RECIP	92	"MW"	2033	40	40 MW
FIRM CAPACITY	RECIP	92	"MW"	2034	40	40 MW
FIRM CAPACITY	RECIP	92	"MW"	2035	40	40 MW
FIRM CAPACITY	CLNG	93	"MW"	2006	0	60 MW
FIRM CAPACITY	CLNG	93	"MW"	2007	0	60 MW
FIRM CAPACITY	CLNG	93	"MW"	2008	0	60 MW
FIRM CAPACITY	CLNG	93	"MW"	2009	0	60 MW
FIRM CAPACITY	CLNG	93	"MW"	2010	0	60 MW
FIRM CAPACITY	CLNG	93	"MW"	2011	0	60 MW
FIRM CAPACITY	CLNG	93	"MW"	2012	0	60 MW
FIRM CAPACITY	CLNG	93	"MW"	2013	0	60 MW
FIRM CAPACITY	CLNG	93	"MW"	2014	0	60 MW
FIRM CAPACITY	CLNG	93	"MW"	2015	0	60 MW
FIRM CAPACITY	CLNG	93	"MW"	2016	0	60 MW
FIRM CAPACITY	CLNG	93	"MW"	2017	0	60 MW
FIRM CAPACITY	CLNG	93	"MW"	2018	0	60 MW
FIRM CAPACITY	CLNG	93	"MW"	2019	0	60 MW
FIRM CAPACITY	CLNG	93	"MW"	2020	0	60 MW
FIRM CAPACITY	CLNG	93	"MW"	2021	0	60 MW
FIRM CAPACITY	CLNG	93	"MW"	2022	0	60 MW
FIRM CAPACITY	CLNG	93	"MW"	2023	60	60 MW
FIRM CAPACITY	CLNG	93	"MW"	2024	60	60 MW
FIRM CAPACITY	CLNG	93	"MW"	2025	60	60 MW
FIRM CAPACITY	CLNG	93	"MW"	2026	60	60 MW
FIRM CAPACITY	CLNG	93	"MW"	2027	60	60 MW
FIRM CAPACITY	CLNG	93	"MW"	2028	60	60 MW
FIRM CAPACITY	CLNG	93	"MW"	2029	60	60 MW
FIRM CAPACITY	CLNG	93	"MW"	2030	60	60 MW
FIRM CAPACITY	CLNG	93	"MW"	2031	60	60 MW
FIRM CAPACITY	CLNG	93	"MW"	2032	60	60 MW
FIRM CAPACITY	CLNG	93	"MW"	2033	60	60 MW
FIRM CAPACITY	CLNG	93	"MW"	2034	60	60 MW
FIRM CAPACITY	CLNG	93	"MW"	2035	60	60 MW
FIRM CAPACITY	WIND	94	"MW"	2006	0	4.8 MW
FIRM CAPACITY	WIND	94	"MW"	2007	0	4.8 MW
FIRM CAPACITY	WIND	94	"MW"	2008	0	4.8 MW
FIRM CAPACITY	WIND	94	"MW"	2009	0	4.8 MW
FIRM CAPACITY	WIND	94	"MW"	2010	0	4.8 MW
FIRM CAPACITY	WIND	94	"MW"	2011	0	4.8 MW
FIRM CAPACITY	WIND	94	"MW"	2012	0	4.8 MW
FIRM CAPACITY	WIND	94	"MW"	2013	0	4.8 MW
FIRM CAPACITY	WIND	94	"MW"	2014	0	4.8 MW
FIRM CAPACITY	WIND	94	"MW"	2015	0	4.8 MW
FIRM CAPACITY	WIND	94	"MW"	2016	0	4.8 MW
FIRM CAPACITY	WIND	94	"MW"	2017	0	4.8 MW
FIRM CAPACITY	WIND	94	"MW"	2018	0	4.8 MW
FIRM CAPACITY	WIND	94	"MW"	2019	0	4.8 MW
FIRM CAPACITY	WIND	94	"MW"	2020	4.800000191	4.8 MW
FIRM CAPACITY	WIND	94	"MW"	2021	4.800000191	4.8 MW
FIRM CAPACITY	WIND	94	"MW"	2022	4.800000191	4.8 MW

FIRM CAPACITY	WIND	94	"MW"	2023	4.800000191	4.8 MW
FIRM CAPACITY	WIND	94	"MW"	2024	4.800000191	4.8 MW
FIRM CAPACITY	WIND	94	"MW"	2025	4.800000191	4.8 MW
FIRM CAPACITY	WIND	94	"MW"	2026	4.800000191	4.8 MW
FIRM CAPACITY	WIND	94	"MW"	2027	4.800000191	4.8 MW
FIRM CAPACITY	WIND	94	"MW"	2028	4.800000191	4.8 MW
FIRM CAPACITY	WIND	94	"MW"	2029	4.800000191	4.8 MW
FIRM CAPACITY	WIND	94	"MW"	2030	4.800000191	4.8 MW
FIRM CAPACITY	WIND	94	"MW"	2031	4.800000191	4.8 MW
FIRM CAPACITY	WIND	94	"MW"	2032	4.800000191	4.8 MW
FIRM CAPACITY	WIND	94	"MW"	2033	4.800000191	4.8 MW
FIRM CAPACITY	WIND	94	"MW"	2034	4.800000191	4.8 MW
FIRM CAPACITY	WIND	94	"MW"	2035	4.800000191	4.8 MW
FIRM CAPACITY	WIND	95	"MW"	2006	0	4.8 MW
FIRM CAPACITY	WIND	95	"MW"	2007	0	4.8 MW
FIRM CAPACITY	WIND	95	"MW"	2008	0	4.8 MW
FIRM CAPACITY	WIND	95	"MW"	2009	0	4.8 MW
FIRM CAPACITY	WIND	95	"MW"	2010	0	4.8 MW
FIRM CAPACITY	WIND	95	"MW"	2011	0	4.8 MW
FIRM CAPACITY	WIND	95	"MW"	2012	0	4.8 MW
FIRM CAPACITY	WIND	95	"MW"	2013	0	4.8 MW
FIRM CAPACITY	WIND	95	"MW"	2014	0	4.8 MW
FIRM CAPACITY	WIND	95	"MW"	2015	0	4.8 MW
FIRM CAPACITY	WIND	95	"MW"	2016	0	4.8 MW
FIRM CAPACITY	WIND	95	"MW"	2017	0	4.8 MW
FIRM CAPACITY	WIND	95	"MW"	2018	0	4.8 MW
FIRM CAPACITY	WIND	95	"MW"	2019	4.800000191	4.8 MW
FIRM CAPACITY	WIND	95	"MW"	2020	4.800000191	4.8 MW
FIRM CAPACITY	WIND	95	"MW"	2021	4.800000191	4.8 MW
FIRM CAPACITY	WIND	95	"MW"	2022	4.800000191	4.8 MW
FIRM CAPACITY	WIND	95	"MW"	2023	4.800000191	4.8 MW
FIRM CAPACITY	WIND	95	"MW"	2024	4.800000191	4.8 MW
FIRM CAPACITY	WIND	95	"MW"	2025	4.800000191	4.8 MW
FIRM CAPACITY	WIND	95	"MW"	2026	4.800000191	4.8 MW
FIRM CAPACITY	WIND	95	"MW"	2027	4.800000191	4.8 MW
FIRM CAPACITY	WIND	95	"MW"	2028	4.800000191	4.8 MW
FIRM CAPACITY	WIND	95	"MW"	2029	4.800000191	4.8 MW
FIRM CAPACITY	WIND	95	"MW"	2030	4.800000191	4.8 MW
FIRM CAPACITY	WIND	95	"MW"	2031	4.800000191	4.8 MW
FIRM CAPACITY	WIND	95	"MW"	2032	4.800000191	4.8 MW
FIRM CAPACITY	WIND	95	"MW"	2033	4.800000191	4.8 MW
FIRM CAPACITY	WIND	95	"MW"	2034	4.800000191	4.8 MW
FIRM CAPACITY	WIND	95	"MW"	2035	4.800000191	4.8 MW
FIRM CAPACITY	CLNG	96	"MW"	2006	0	60 MW
FIRM CAPACITY	CLNG	96	"MW"	2007	0	60 MW
FIRM CAPACITY	CLNG	96	"MW"	2008	0	60 MW
FIRM CAPACITY	CLNG	96	"MW"	2009	0	60 MW
FIRM CAPACITY	CLNG	96	"MW"	2010	0	60 MW
FIRM CAPACITY	CLNG	96	"MW"	2011	0	60 MW
FIRM CAPACITY	CLNG	96	"MW"	2012	0	60 MW
FIRM CAPACITY	CLNG	96	"MW"	2013	0	60 MW
FIRM CAPACITY	CLNG	96	"MW"	2014	0	60 MW

FIRM CAPACITY	CLNG	96	"MW"	2015	0	60 MW
FIRM CAPACITY	CLNG	96	"MW"	2016	0	60 MW
FIRM CAPACITY	CLNG	96	"MW"	2017	0	60 MW
FIRM CAPACITY	CLNG	96	"MW"	2018	0	60 MW
FIRM CAPACITY	CLNG	96	"MW"	2019	60	60 MW
FIRM CAPACITY	CLNG	96	"MW"	2020	60	60 MW
FIRM CAPACITY	CLNG	96	"MW"	2021	60	60 MW
FIRM CAPACITY	CLNG	96	"MW"	2022	60	60 MW
FIRM CAPACITY	CLNG	96	"MW"	2023	60	60 MW
FIRM CAPACITY	CLNG	96	"MW"	2024	60	60 MW
FIRM CAPACITY	CLNG	96	"MW"	2025	60	60 MW
FIRM CAPACITY	CLNG	96	"MW"	2026	60	60 MW
FIRM CAPACITY	CLNG	96	"MW"	2027	60	60 MW
FIRM CAPACITY	CLNG	96	"MW"	2028	60	60 MW
FIRM CAPACITY	CLNG	96	"MW"	2029	60	60 MW
FIRM CAPACITY	CLNG	96	"MW"	2030	60	60 MW
FIRM CAPACITY	CLNG	96	"MW"	2031	60	60 MW
FIRM CAPACITY	CLNG	96	"MW"	2032	60	60 MW
FIRM CAPACITY	CLNG	96	"MW"	2033	60	60 MW
FIRM CAPACITY	CLNG	96	"MW"	2034	60	60 MW
FIRM CAPACITY	CLNG	96	"MW"	2035	60	60 MW
FIRM CAPACITY	WIND	97	"MW"	2006	0	4.8 MW
FIRM CAPACITY	WIND	97	"MW"	2007	0	4.8 MW
FIRM CAPACITY	WIND	97	"MW"	2008	0	4.8 MW
FIRM CAPACITY	WIND	97	"MW"	2009	0	4.8 MW
FIRM CAPACITY	WIND	97	"MW"	2010	0	4.8 MW
FIRM CAPACITY	WIND	97	"MW"	2011	0	4.8 MW
FIRM CAPACITY	WIND	97	"MW"	2012	0	4.8 MW
FIRM CAPACITY	WIND	97	"MW"	2013	0	4.8 MW
FIRM CAPACITY	WIND	97	"MW"	2014	0	4.8 MW
FIRM CAPACITY	WIND	97	"MW"	2015	0	4.8 MW
FIRM CAPACITY	WIND	97	"MW"	2016	0	4.8 MW
FIRM CAPACITY	WIND	97	"MW"	2017	0	4.8 MW
FIRM CAPACITY	WIND	97	"MW"	2018	4.800000191	4.8 MW
FIRM CAPACITY	WIND	97	"MW"	2019	4.800000191	4.8 MW
FIRM CAPACITY	WIND	97	"MW"	2020	4.800000191	4.8 MW
FIRM CAPACITY	WIND	97	"MW"	2021	4.800000191	4.8 MW
FIRM CAPACITY	WIND	97	"MW"	2022	4.800000191	4.8 MW
FIRM CAPACITY	WIND	97	"MW"	2023	4.800000191	4.8 MW
FIRM CAPACITY	WIND	97	"MW"	2024	4.800000191	4.8 MW
FIRM CAPACITY	WIND	97	"MW"	2025	4.800000191	4.8 MW
FIRM CAPACITY	WIND	97	"MW"	2026	4.800000191	4.8 MW
FIRM CAPACITY	WIND	97	"MW"	2027	4.800000191	4.8 MW
FIRM CAPACITY	WIND	97	"MW"	2028	4.800000191	4.8 MW
FIRM CAPACITY	WIND	97	"MW"	2029	4.800000191	4.8 MW
FIRM CAPACITY	WIND	97	"MW"	2030	4.800000191	4.8 MW
FIRM CAPACITY	WIND	97	"MW"	2031	4.800000191	4.8 MW
FIRM CAPACITY	WIND	97	"MW"	2032	4.800000191	4.8 MW
FIRM CAPACITY	WIND	97	"MW"	2033	4.800000191	4.8 MW
FIRM CAPACITY	WIND	97	"MW"	2034	4.800000191	4.8 MW
FIRM CAPACITY	WIND	97	"MW"	2035	4.800000191	4.8 MW
FIRM CAPACITY	WIND	98	"MW"	2006	0	4.8 MW

FIRM CAPACITY	WIND	98	"MW"	2007	0	4.8 MW
FIRM CAPACITY	WIND	98	"MW"	2008	0	4.8 MW
FIRM CAPACITY	WIND	98	"MW"	2009	0	4.8 MW
FIRM CAPACITY	WIND	98	"MW"	2010	0	4.8 MW
FIRM CAPACITY	WIND	98	"MW"	2011	0	4.8 MW
FIRM CAPACITY	WIND	98	"MW"	2012	0	4.8 MW
FIRM CAPACITY	WIND	98	"MW"	2013	0	4.8 MW
FIRM CAPACITY	WIND	98	"MW"	2014	0	4.8 MW
FIRM CAPACITY	WIND	98	"MW"	2015	0	4.8 MW
FIRM CAPACITY	WIND	98	"MW"	2016	0	4.8 MW
FIRM CAPACITY	WIND	98	"MW"	2017	4.800000191	4.8 MW
FIRM CAPACITY	WIND	98	"MW"	2018	4.800000191	4.8 MW
FIRM CAPACITY	WIND	98	"MW"	2019	4.800000191	4.8 MW
FIRM CAPACITY	WIND	98	"MW"	2020	4.800000191	4.8 MW
FIRM CAPACITY	WIND	98	"MW"	2021	4.800000191	4.8 MW
FIRM CAPACITY	WIND	98	"MW"	2022	4.800000191	4.8 MW
FIRM CAPACITY	WIND	98	"MW"	2023	4.800000191	4.8 MW
FIRM CAPACITY	WIND	98	"MW"	2024	4.800000191	4.8 MW
FIRM CAPACITY	WIND	98	"MW"	2025	4.800000191	4.8 MW
FIRM CAPACITY	WIND	98	"MW"	2026	4.800000191	4.8 MW
FIRM CAPACITY	WIND	98	"MW"	2027	4.800000191	4.8 MW
FIRM CAPACITY	WIND	98	"MW"	2028	4.800000191	4.8 MW
FIRM CAPACITY	WIND	98	"MW"	2029	4.800000191	4.8 MW
FIRM CAPACITY	WIND	98	"MW"	2030	4.800000191	4.8 MW
FIRM CAPACITY	WIND	98	"MW"	2031	4.800000191	4.8 MW
FIRM CAPACITY	WIND	98	"MW"	2032	4.800000191	4.8 MW
FIRM CAPACITY	WIND	98	"MW"	2033	4.800000191	4.8 MW
FIRM CAPACITY	WIND	98	"MW"	2034	4.800000191	4.8 MW
FIRM CAPACITY	WIND	98	"MW"	2035	4.800000191	4.8 MW
FIRM CAPACITY	RETR	99	"MW"	2006	0	60 MW
FIRM CAPACITY	RETR	99	"MW"	2007	0	60 MW
FIRM CAPACITY	RETR	99	"MW"	2008	0	60 MW
FIRM CAPACITY	RETR	99	"MW"	2009	0	60 MW
FIRM CAPACITY	RETR	99	"MW"	2010	0	60 MW
FIRM CAPACITY	RETR	99	"MW"	2011	0	60 MW
FIRM CAPACITY	RETR	99	"MW"	2012	0	60 MW
FIRM CAPACITY	RETR	99	"MW"	2013	0	60 MW
FIRM CAPACITY	RETR	99	"MW"	2014	0	60 MW
FIRM CAPACITY	RETR	99	"MW"	2015	0	60 MW
FIRM CAPACITY	RETR	99	"MW"	2016	0	60 MW
FIRM CAPACITY	RETR	99	"MW"	2017	60	60 MW
FIRM CAPACITY	RETR	99	"MW"	2018	60	60 MW
FIRM CAPACITY	RETR	99	"MW"	2019	60	60 MW
FIRM CAPACITY	RETR	99	"MW"	2020	60	60 MW
FIRM CAPACITY	RETR	99	"MW"	2021	60	60 MW
FIRM CAPACITY	RETR	99	"MW"	2022	60	60 MW
FIRM CAPACITY	RETR	99	"MW"	2023	60	60 MW
FIRM CAPACITY	RETR	99	"MW"	2024	60	60 MW
FIRM CAPACITY	RETR	99	"MW"	2025	60	60 MW
FIRM CAPACITY	RETR	99	"MW"	2026	60	60 MW
FIRM CAPACITY	RETR	99	"MW"	2027	60	60 MW
FIRM CAPACITY	RETR	99	"MW"	2028	60	60 MW

FIRM CAPACITY	RETR	99	"MW"	2029	60	60	MW
FIRM CAPACITY	RETR	99	"MW"	2030	60	60	MW
FIRM CAPACITY	RETR	99	"MW"	2031	60	60	MW
FIRM CAPACITY	RETR	99	"MW"	2032	60	60	MW
FIRM CAPACITY	RETR	99	"MW"	2033	60	60	MW
FIRM CAPACITY	RETR	99	"MW"	2034	60	60	MW
FIRM CAPACITY	RETR	99	"MW"	2035	60	60	MW
FIRM CAPACITY	WIND	100	"MW"	2006	0	4.8	MW
FIRM CAPACITY	WIND	100	"MW"	2007	0	4.8	MW
FIRM CAPACITY	WIND	100	"MW"	2008	0	4.8	MW
FIRM CAPACITY	WIND	100	"MW"	2009	0	4.8	MW
FIRM CAPACITY	WIND	100	"MW"	2010	0	4.8	MW
FIRM CAPACITY	WIND	100	"MW"	2011	0	4.8	MW
FIRM CAPACITY	WIND	100	"MW"	2012	0	4.8	MW
FIRM CAPACITY	WIND	100	"MW"	2013	0	4.8	MW
FIRM CAPACITY	WIND	100	"MW"	2014	0	4.8	MW
FIRM CAPACITY	WIND	100	"MW"	2015	0	4.8	MW
FIRM CAPACITY	WIND	100	"MW"	2016	4.800000191	4.8	MW
FIRM CAPACITY	WIND	100	"MW"	2017	4.800000191	4.8	MW
FIRM CAPACITY	WIND	100	"MW"	2018	4.800000191	4.8	MW
FIRM CAPACITY	WIND	100	"MW"	2019	4.800000191	4.8	MW
FIRM CAPACITY	WIND	100	"MW"	2020	4.800000191	4.8	MW
FIRM CAPACITY	WIND	100	"MW"	2021	4.800000191	4.8	MW
FIRM CAPACITY	WIND	100	"MW"	2022	4.800000191	4.8	MW
FIRM CAPACITY	WIND	100	"MW"	2023	4.800000191	4.8	MW
FIRM CAPACITY	WIND	100	"MW"	2024	4.800000191	4.8	MW
FIRM CAPACITY	WIND	100	"MW"	2025	4.800000191	4.8	MW
FIRM CAPACITY	WIND	100	"MW"	2026	4.800000191	4.8	MW
FIRM CAPACITY	WIND	100	"MW"	2027	4.800000191	4.8	MW
FIRM CAPACITY	WIND	100	"MW"	2028	4.800000191	4.8	MW
FIRM CAPACITY	WIND	100	"MW"	2029	4.800000191	4.8	MW
FIRM CAPACITY	WIND	100	"MW"	2030	4.800000191	4.8	MW
FIRM CAPACITY	WIND	100	"MW"	2031	4.800000191	4.8	MW
FIRM CAPACITY	WIND	100	"MW"	2032	4.800000191	4.8	MW
FIRM CAPACITY	WIND	100	"MW"	2033	4.800000191	4.8	MW
FIRM CAPACITY	WIND	100	"MW"	2034	4.800000191	4.8	MW
FIRM CAPACITY	WIND	100	"MW"	2035	4.800000191	4.8	MW
TOTAL FUEL CONSUMED	CAB ST	1	"000MBTU"	2006	3165.574219	66	000MBTU
TOTAL FUEL CONSUMED	CAB ST	1	"000MBTU"	2007	2916.960449	66	000MBTU
TOTAL FUEL CONSUMED	CAB ST	1	"000MBTU"	2008	3333.954346	66	000MBTU
TOTAL FUEL CONSUMED	CAB ST	1	"000MBTU"	2009	2961.105957	66	000MBTU
TOTAL FUEL CONSUMED	CAB ST	1	"000MBTU"	2010	3522.559814	66	000MBTU
TOTAL FUEL CONSUMED	CAB ST	1	"000MBTU"	2011	3624.448486	66	000MBTU
TOTAL FUEL CONSUMED	CAB ST	1	"000MBTU"	2012	3177.547852	66	000MBTU
TOTAL FUEL CONSUMED	CAB ST	1	"000MBTU"	2013	3793.458008	66	000MBTU
TOTAL FUEL CONSUMED	CAB ST	1	"000MBTU"	2014	3588.20752	66	000MBTU
TOTAL FUEL CONSUMED	CAB ST	1	"000MBTU"	2015	3914.626465	66	000MBTU
TOTAL FUEL CONSUMED	CAB ST	1	"000MBTU"	2016	3812.091064	66	000MBTU
TOTAL FUEL CONSUMED	CAB ST	1	"000MBTU"	2017	3726.215088	66	000MBTU
TOTAL FUEL CONSUMED	CAB ST	1	"000MBTU"	2018	3542.489014	66	000MBTU
TOTAL FUEL CONSUMED	CAB ST	1	"000MBTU"	2019	3039.528809	66	000MBTU
TOTAL FUEL CONSUMED	CAB ST	1	"000MBTU"	2020	2940.456299	66	000MBTU

TOTAL FUEL CONSUMED	CAB ST	1	"000MBTU"	2021	2835.155029	66	000MBTU
TOTAL FUEL CONSUMED	CAB ST	1	"000MBTU"	2022	2969.898926	66	000MBTU
TOTAL FUEL CONSUMED	CAB ST	1	"000MBTU"	2023	2366.476074	66	000MBTU
TOTAL FUEL CONSUMED	CAB ST	1	"000MBTU"	2024	1913.073853	66	000MBTU
TOTAL FUEL CONSUMED	CAB ST	1	"000MBTU"	2025	1881.445068	66	000MBTU
TOTAL FUEL CONSUMED	CAB ST	1	"000MBTU"	2026	1874.030151	66	000MBTU
TOTAL FUEL CONSUMED	CAB ST	1	"000MBTU"	2027	0	66	000MBTU
TOTAL FUEL CONSUMED	CAB ST	1	"000MBTU"	2028	0	66	000MBTU
TOTAL FUEL CONSUMED	CAB ST	1	"000MBTU"	2029	0	66	000MBTU
TOTAL FUEL CONSUMED	CAB ST	1	"000MBTU"	2030	0	66	000MBTU
TOTAL FUEL CONSUMED	CAB ST	1	"000MBTU"	2031	0	66	000MBTU
TOTAL FUEL CONSUMED	CAB ST	1	"000MBTU"	2032	0	66	000MBTU
TOTAL FUEL CONSUMED	CAB ST	1	"000MBTU"	2033	0	66	000MBTU
TOTAL FUEL CONSUMED	CAB ST	1	"000MBTU"	2034	0	66	000MBTU
TOTAL FUEL CONSUMED	CAB ST	1	"000MBTU"	2035	0	66	000MBTU
TOTAL FUEL CONSUMED	CAB ST	2	"000MBTU"	2006	3278.868896	66	000MBTU
TOTAL FUEL CONSUMED	CAB ST	2	"000MBTU"	2007	3315.521484	66	000MBTU
TOTAL FUEL CONSUMED	CAB ST	2	"000MBTU"	2008	3469.836914	66	000MBTU
TOTAL FUEL CONSUMED	CAB ST	2	"000MBTU"	2009	3017.567627	66	000MBTU
TOTAL FUEL CONSUMED	CAB ST	2	"000MBTU"	2010	3681.966064	66	000MBTU
TOTAL FUEL CONSUMED	CAB ST	2	"000MBTU"	2011	3809.11377	66	000MBTU
TOTAL FUEL CONSUMED	CAB ST	2	"000MBTU"	2012	3313.338379	66	000MBTU
TOTAL FUEL CONSUMED	CAB ST	2	"000MBTU"	2013	4046.415527	66	000MBTU
TOTAL FUEL CONSUMED	CAB ST	2	"000MBTU"	2014	4162.583984	66	000MBTU
TOTAL FUEL CONSUMED	CAB ST	2	"000MBTU"	2015	4167.398926	66	000MBTU
TOTAL FUEL CONSUMED	CAB ST	2	"000MBTU"	2016	4054.599609	66	000MBTU
TOTAL FUEL CONSUMED	CAB ST	2	"000MBTU"	2017	3984.479736	66	000MBTU
TOTAL FUEL CONSUMED	CAB ST	2	"000MBTU"	2018	3768.374756	66	000MBTU
TOTAL FUEL CONSUMED	CAB ST	2	"000MBTU"	2019	2806.239746	66	000MBTU
TOTAL FUEL CONSUMED	CAB ST	2	"000MBTU"	2020	2933.439209	66	000MBTU
TOTAL FUEL CONSUMED	CAB ST	2	"000MBTU"	2021	3056.787354	66	000MBTU
TOTAL FUEL CONSUMED	CAB ST	2	"000MBTU"	2022	2965.293457	66	000MBTU
TOTAL FUEL CONSUMED	CAB ST	2	"000MBTU"	2023	2231.877197	66	000MBTU
TOTAL FUEL CONSUMED	CAB ST	2	"000MBTU"	2024	1817.627808	66	000MBTU
TOTAL FUEL CONSUMED	CAB ST	2	"000MBTU"	2025	1775.579956	66	000MBTU
TOTAL FUEL CONSUMED	CAB ST	2	"000MBTU"	2026	1658.814209	66	000MBTU
TOTAL FUEL CONSUMED	CAB ST	2	"000MBTU"	2027	1751.84082	66	000MBTU
TOTAL FUEL CONSUMED	CAB ST	2	"000MBTU"	2028	0	66	000MBTU
TOTAL FUEL CONSUMED	CAB ST	2	"000MBTU"	2029	0	66	000MBTU
TOTAL FUEL CONSUMED	CAB ST	2	"000MBTU"	2030	0	66	000MBTU
TOTAL FUEL CONSUMED	CAB ST	2	"000MBTU"	2031	0	66	000MBTU
TOTAL FUEL CONSUMED	CAB ST	2	"000MBTU"	2032	0	66	000MBTU
TOTAL FUEL CONSUMED	CAB ST	2	"000MBTU"	2033	0	66	000MBTU
TOTAL FUEL CONSUMED	CAB ST	2	"000MBTU"	2034	0	66	000MBTU
TOTAL FUEL CONSUMED	CAB ST	2	"000MBTU"	2035	0	66	000MBTU
TOTAL FUEL CONSUMED	CAB SSD	3	"000MBTU"	2006	1856.640991	39.3	000MBTU
TOTAL FUEL CONSUMED	CAB SSD	3	"000MBTU"	2007	1856.71521	39.3	000MBTU
TOTAL FUEL CONSUMED	CAB SSD	3	"000MBTU"	2008	1864.083984	39.3	000MBTU
TOTAL FUEL CONSUMED	CAB SSD	3	"000MBTU"	2009	1874.772461	39.3	000MBTU
TOTAL FUEL CONSUMED	CAB SSD	3	"000MBTU"	2010	1877.863281	39.3	000MBTU
TOTAL FUEL CONSUMED	CAB SSD	3	"000MBTU"	2011	1900.608765	39.3	000MBTU
TOTAL FUEL CONSUMED	CAB SSD	3	"000MBTU"	2012	2030.888794	39.3	000MBTU

TOTAL FUEL CONSUMED	CAB SSD	3	"000MBTU"	2013	1967.001831	39.3	000MBTU
TOTAL FUEL CONSUMED	CAB SSD	3	"000MBTU"	2014	2032.848999	39.3	000MBTU
TOTAL FUEL CONSUMED	CAB SSD	3	"000MBTU"	2015	2020.40625	39.3	000MBTU
TOTAL FUEL CONSUMED	CAB SSD	3	"000MBTU"	2016	2021.454468	39.3	000MBTU
TOTAL FUEL CONSUMED	CAB SSD	3	"000MBTU"	2017	2029.320923	39.3	000MBTU
TOTAL FUEL CONSUMED	CAB SSD	3	"000MBTU"	2018	1952.974365	39.3	000MBTU
TOTAL FUEL CONSUMED	CAB SSD	3	"000MBTU"	2019	1767.675781	39.3	000MBTU
TOTAL FUEL CONSUMED	CAB SSD	3	"000MBTU"	2020	1772.917725	39.3	000MBTU
TOTAL FUEL CONSUMED	CAB SSD	3	"000MBTU"	2021	1799.15686	39.3	000MBTU
TOTAL FUEL CONSUMED	CAB SSD	3	"000MBTU"	2022	1773.405151	39.3	000MBTU
TOTAL FUEL CONSUMED	CAB SSD	3	"000MBTU"	2023	1610.263306	39.3	000MBTU
TOTAL FUEL CONSUMED	CAB SSD	3	"000MBTU"	2024	1550.058228	39.3	000MBTU
TOTAL FUEL CONSUMED	CAB SSD	3	"000MBTU"	2025	1550.017212	39.3	000MBTU
TOTAL FUEL CONSUMED	CAB SSD	3	"000MBTU"	2026	1517.312622	39.3	000MBTU
TOTAL FUEL CONSUMED	CAB SSD	3	"000MBTU"	2027	1452.584839	39.3	000MBTU
TOTAL FUEL CONSUMED	CAB SSD	3	"000MBTU"	2028	1485.602051	39.3	000MBTU
TOTAL FUEL CONSUMED	CAB SSD	3	"000MBTU"	2029	1458.846802	39.3	000MBTU
TOTAL FUEL CONSUMED	CAB SSD	3	"000MBTU"	2030	1399.628906	39.3	000MBTU
TOTAL FUEL CONSUMED	CAB SSD	3	"000MBTU"	2031	1409.089722	39.3	000MBTU
TOTAL FUEL CONSUMED	CAB SSD	3	"000MBTU"	2032	1417.683594	39.3	000MBTU
TOTAL FUEL CONSUMED	CAB SSD	3	"000MBTU"	2033	1416.972656	39.3	000MBTU
TOTAL FUEL CONSUMED	CAB SSD	3	"000MBTU"	2034	1423.282959	39.3	000MBTU
TOTAL FUEL CONSUMED	CAB SSD	3	"000MBTU"	2035	1410.449219	39.3	000MBTU
TOTAL FUEL CONSUMED	CAB SSD	4	"000MBTU"	2006	1851.244873	39.3	000MBTU
TOTAL FUEL CONSUMED	CAB SSD	4	"000MBTU"	2007	1851.355347	39.3	000MBTU
TOTAL FUEL CONSUMED	CAB SSD	4	"000MBTU"	2008	1857.85144	39.3	000MBTU
TOTAL FUEL CONSUMED	CAB SSD	4	"000MBTU"	2009	1862.842773	39.3	000MBTU
TOTAL FUEL CONSUMED	CAB SSD	4	"000MBTU"	2010	1864.806152	39.3	000MBTU
TOTAL FUEL CONSUMED	CAB SSD	4	"000MBTU"	2011	1880.693237	39.3	000MBTU
TOTAL FUEL CONSUMED	CAB SSD	4	"000MBTU"	2012	1983.535889	39.3	000MBTU
TOTAL FUEL CONSUMED	CAB SSD	4	"000MBTU"	2013	1933.525879	39.3	000MBTU
TOTAL FUEL CONSUMED	CAB SSD	4	"000MBTU"	2014	1995.675049	39.3	000MBTU
TOTAL FUEL CONSUMED	CAB SSD	4	"000MBTU"	2015	1990.962891	39.3	000MBTU
TOTAL FUEL CONSUMED	CAB SSD	4	"000MBTU"	2016	1991.518677	39.3	000MBTU
TOTAL FUEL CONSUMED	CAB SSD	4	"000MBTU"	2017	1985.611694	39.3	000MBTU
TOTAL FUEL CONSUMED	CAB SSD	4	"000MBTU"	2018	1938.534424	39.3	000MBTU
TOTAL FUEL CONSUMED	CAB SSD	4	"000MBTU"	2019	1862.514648	39.3	000MBTU
TOTAL FUEL CONSUMED	CAB SSD	4	"000MBTU"	2020	1863.327515	39.3	000MBTU
TOTAL FUEL CONSUMED	CAB SSD	4	"000MBTU"	2021	1868.032715	39.3	000MBTU
TOTAL FUEL CONSUMED	CAB SSD	4	"000MBTU"	2022	1863.595947	39.3	000MBTU
TOTAL FUEL CONSUMED	CAB SSD	4	"000MBTU"	2023	1829.866089	39.3	000MBTU
TOTAL FUEL CONSUMED	CAB SSD	4	"000MBTU"	2024	1688.790527	39.3	000MBTU
TOTAL FUEL CONSUMED	CAB SSD	4	"000MBTU"	2025	1682.720703	39.3	000MBTU
TOTAL FUEL CONSUMED	CAB SSD	4	"000MBTU"	2026	1670.573364	39.3	000MBTU
TOTAL FUEL CONSUMED	CAB SSD	4	"000MBTU"	2027	1601.255371	39.3	000MBTU
TOTAL FUEL CONSUMED	CAB SSD	4	"000MBTU"	2028	1631.386475	39.3	000MBTU
TOTAL FUEL CONSUMED	CAB SSD	4	"000MBTU"	2029	1603.310059	39.3	000MBTU
TOTAL FUEL CONSUMED	CAB SSD	4	"000MBTU"	2030	1537.064453	39.3	000MBTU
TOTAL FUEL CONSUMED	CAB SSD	4	"000MBTU"	2031	1546.829956	39.3	000MBTU
TOTAL FUEL CONSUMED	CAB SSD	4	"000MBTU"	2032	1558.043457	39.3	000MBTU
TOTAL FUEL CONSUMED	CAB SSD	4	"000MBTU"	2033	1555.269653	39.3	000MBTU
TOTAL FUEL CONSUMED	CAB SSD	4	"000MBTU"	2034	1567.176025	39.3	000MBTU

TOTAL FUEL CONSUMED	CAB SSD	4	"000MBTU"	2035	1558.757813	39.3	000MBTU
TOTAL FUEL CONSUMED	OROTE	1	"000MBTU"	2006	0.145425513	16	000MBTU
TOTAL FUEL CONSUMED	OROTE	1	"000MBTU"	2007	0	16	000MBTU
TOTAL FUEL CONSUMED	OROTE	1	"000MBTU"	2008	0	16	000MBTU
TOTAL FUEL CONSUMED	OROTE	1	"000MBTU"	2009	0	16	000MBTU
TOTAL FUEL CONSUMED	OROTE	1	"000MBTU"	2010	0	16	000MBTU
TOTAL FUEL CONSUMED	OROTE	1	"000MBTU"	2011	0	16	000MBTU
TOTAL FUEL CONSUMED	OROTE	1	"000MBTU"	2012	0	16	000MBTU
TOTAL FUEL CONSUMED	OROTE	1	"000MBTU"	2013	0	16	000MBTU
TOTAL FUEL CONSUMED	OROTE	1	"000MBTU"	2014	0	16	000MBTU
TOTAL FUEL CONSUMED	OROTE	1	"000MBTU"	2015	0	16	000MBTU
TOTAL FUEL CONSUMED	OROTE	1	"000MBTU"	2016	0	16	000MBTU
TOTAL FUEL CONSUMED	OROTE	1	"000MBTU"	2017	0	16	000MBTU
TOTAL FUEL CONSUMED	OROTE	1	"000MBTU"	2018	0	16	000MBTU
TOTAL FUEL CONSUMED	OROTE	1	"000MBTU"	2019	0	16	000MBTU
TOTAL FUEL CONSUMED	OROTE	1	"000MBTU"	2020	0	16	000MBTU
TOTAL FUEL CONSUMED	OROTE	1	"000MBTU"	2021	0	16	000MBTU
TOTAL FUEL CONSUMED	OROTE	1	"000MBTU"	2022	0	16	000MBTU
TOTAL FUEL CONSUMED	OROTE	1	"000MBTU"	2023	0	16	000MBTU
TOTAL FUEL CONSUMED	OROTE	1	"000MBTU"	2024	0	16	000MBTU
TOTAL FUEL CONSUMED	OROTE	1	"000MBTU"	2025	0	16	000MBTU
TOTAL FUEL CONSUMED	OROTE	1	"000MBTU"	2026	0	16	000MBTU
TOTAL FUEL CONSUMED	OROTE	1	"000MBTU"	2027	0	16	000MBTU
TOTAL FUEL CONSUMED	OROTE	1	"000MBTU"	2028	0	16	000MBTU
TOTAL FUEL CONSUMED	OROTE	1	"000MBTU"	2029	0	16	000MBTU
TOTAL FUEL CONSUMED	OROTE	1	"000MBTU"	2030	0	16	000MBTU
TOTAL FUEL CONSUMED	OROTE	1	"000MBTU"	2031	0	16	000MBTU
TOTAL FUEL CONSUMED	OROTE	1	"000MBTU"	2032	0	16	000MBTU
TOTAL FUEL CONSUMED	OROTE	1	"000MBTU"	2033	0	16	000MBTU
TOTAL FUEL CONSUMED	OROTE	1	"000MBTU"	2034	0	16	000MBTU
TOTAL FUEL CONSUMED	OROTE	1	"000MBTU"	2035	0	16	000MBTU
TOTAL FUEL CONSUMED	DED CT	1	"000MBTU"	2006	2.237994194	23	000MBTU
TOTAL FUEL CONSUMED	DED CT	1	"000MBTU"	2007	2.394154549	23	000MBTU
TOTAL FUEL CONSUMED	DED CT	1	"000MBTU"	2008	1.999385357	23	000MBTU
TOTAL FUEL CONSUMED	DED CT	1	"000MBTU"	2009	1.24911654	23	000MBTU
TOTAL FUEL CONSUMED	DED CT	1	"000MBTU"	2010	1.56729126	23	000MBTU
TOTAL FUEL CONSUMED	DED CT	1	"000MBTU"	2011	1.758735657	23	000MBTU
TOTAL FUEL CONSUMED	DED CT	1	"000MBTU"	2012	9.089996338	23	000MBTU
TOTAL FUEL CONSUMED	DED CT	1	"000MBTU"	2013	6.81956625	23	000MBTU
TOTAL FUEL CONSUMED	DED CT	1	"000MBTU"	2014	15.31187057	23	000MBTU
TOTAL FUEL CONSUMED	DED CT	1	"000MBTU"	2015	18.55525589	23	000MBTU
TOTAL FUEL CONSUMED	DED CT	1	"000MBTU"	2016	12.58247185	23	000MBTU
TOTAL FUEL CONSUMED	DED CT	1	"000MBTU"	2017	1.914594769	23	000MBTU
TOTAL FUEL CONSUMED	DED CT	1	"000MBTU"	2018	0.987529755	23	000MBTU
TOTAL FUEL CONSUMED	DED CT	1	"000MBTU"	2019	0.11034096	23	000MBTU
TOTAL FUEL CONSUMED	DED CT	1	"000MBTU"	2020	0.155564308	23	000MBTU
TOTAL FUEL CONSUMED	DED CT	1	"000MBTU"	2021	0.216412336	23	000MBTU
TOTAL FUEL CONSUMED	DED CT	1	"000MBTU"	2022	0.12023259	23	000MBTU
TOTAL FUEL CONSUMED	DED CT	1	"000MBTU"	2023	0	23	000MBTU
TOTAL FUEL CONSUMED	DED CT	1	"000MBTU"	2024	0	23	000MBTU
TOTAL FUEL CONSUMED	DED CT	1	"000MBTU"	2025	0	23	000MBTU
TOTAL FUEL CONSUMED	DED CT	1	"000MBTU"	2026	0	23	000MBTU

TOTAL FUEL CONSUMED	DED CT	1	"000MBTU"	2027	0	23	000MBTU
TOTAL FUEL CONSUMED	DED CT	1	"000MBTU"	2028	0	23	000MBTU
TOTAL FUEL CONSUMED	DED CT	1	"000MBTU"	2029	0	23	000MBTU
TOTAL FUEL CONSUMED	DED CT	1	"000MBTU"	2030	0	23	000MBTU
TOTAL FUEL CONSUMED	DED CT	1	"000MBTU"	2031	0	23	000MBTU
TOTAL FUEL CONSUMED	DED CT	1	"000MBTU"	2032	0	23	000MBTU
TOTAL FUEL CONSUMED	DED CT	1	"000MBTU"	2033	0	23	000MBTU
TOTAL FUEL CONSUMED	DED CT	1	"000MBTU"	2034	0	23	000MBTU
TOTAL FUEL CONSUMED	DED CT	1	"000MBTU"	2035	0	23	000MBTU
TOTAL FUEL CONSUMED	DED CT	2	"000MBTU"	2006	2.203003168	22	000MBTU
TOTAL FUEL CONSUMED	DED CT	2	"000MBTU"	2007	2.3971138	22	000MBTU
TOTAL FUEL CONSUMED	DED CT	2	"000MBTU"	2008	2.249315262	22	000MBTU
TOTAL FUEL CONSUMED	DED CT	2	"000MBTU"	2009	1.04052639	22	000MBTU
TOTAL FUEL CONSUMED	DED CT	2	"000MBTU"	2010	1.453831553	22	000MBTU
TOTAL FUEL CONSUMED	DED CT	2	"000MBTU"	2011	1.338597059	22	000MBTU
TOTAL FUEL CONSUMED	DED CT	2	"000MBTU"	2012	4.177263737	22	000MBTU
TOTAL FUEL CONSUMED	DED CT	2	"000MBTU"	2013	3.430543423	22	000MBTU
TOTAL FUEL CONSUMED	DED CT	2	"000MBTU"	2014	7.771397114	22	000MBTU
TOTAL FUEL CONSUMED	DED CT	2	"000MBTU"	2015	9.436321259	22	000MBTU
TOTAL FUEL CONSUMED	DED CT	2	"000MBTU"	2016	6.351271629	22	000MBTU
TOTAL FUEL CONSUMED	DED CT	2	"000MBTU"	2017	0.987410903	22	000MBTU
TOTAL FUEL CONSUMED	DED CT	2	"000MBTU"	2018	0.465252906	22	000MBTU
TOTAL FUEL CONSUMED	DED CT	2	"000MBTU"	2019	0.046395861	22	000MBTU
TOTAL FUEL CONSUMED	DED CT	2	"000MBTU"	2020	0.05802099	22	000MBTU
TOTAL FUEL CONSUMED	DED CT	2	"000MBTU"	2021	0.12545301	22	000MBTU
TOTAL FUEL CONSUMED	DED CT	2	"000MBTU"	2022	0.067044765	22	000MBTU
TOTAL FUEL CONSUMED	DED CT	2	"000MBTU"	2023	0.038002461	22	000MBTU
TOTAL FUEL CONSUMED	DED CT	2	"000MBTU"	2024	0.02379779	22	000MBTU
TOTAL FUEL CONSUMED	DED CT	2	"000MBTU"	2025	0	22	000MBTU
TOTAL FUEL CONSUMED	DED CT	2	"000MBTU"	2026	0	22	000MBTU
TOTAL FUEL CONSUMED	DED CT	2	"000MBTU"	2027	0	22	000MBTU
TOTAL FUEL CONSUMED	DED CT	2	"000MBTU"	2028	0	22	000MBTU
TOTAL FUEL CONSUMED	DED CT	2	"000MBTU"	2029	0	22	000MBTU
TOTAL FUEL CONSUMED	DED CT	2	"000MBTU"	2030	0	22	000MBTU
TOTAL FUEL CONSUMED	DED CT	2	"000MBTU"	2031	0	22	000MBTU
TOTAL FUEL CONSUMED	DED CT	2	"000MBTU"	2032	0	22	000MBTU
TOTAL FUEL CONSUMED	DED CT	2	"000MBTU"	2033	0	22	000MBTU
TOTAL FUEL CONSUMED	DED CT	2	"000MBTU"	2034	0	22	000MBTU
TOTAL FUEL CONSUMED	DED CT	2	"000MBTU"	2035	0	22	000MBTU
TOTAL FUEL CONSUMED	MACH CT	1	"000MBTU"	2006	1.94020772	22	000MBTU
TOTAL FUEL CONSUMED	MACH CT	1	"000MBTU"	2007	2.132183075	22	000MBTU
TOTAL FUEL CONSUMED	MACH CT	1	"000MBTU"	2008	2.070459604	22	000MBTU
TOTAL FUEL CONSUMED	MACH CT	1	"000MBTU"	2009	3.128666401	22	000MBTU
TOTAL FUEL CONSUMED	MACH CT	1	"000MBTU"	2010	2.675593138	22	000MBTU
TOTAL FUEL CONSUMED	MACH CT	1	"000MBTU"	2011	7.093446732	22	000MBTU
TOTAL FUEL CONSUMED	MACH CT	1	"000MBTU"	2012	39.09072113	22	000MBTU
TOTAL FUEL CONSUMED	MACH CT	1	"000MBTU"	2013	26.26424789	22	000MBTU
TOTAL FUEL CONSUMED	MACH CT	1	"000MBTU"	2014	57.94616318	22	000MBTU
TOTAL FUEL CONSUMED	MACH CT	1	"000MBTU"	2015	75.17624664	22	000MBTU
TOTAL FUEL CONSUMED	MACH CT	1	"000MBTU"	2016	53.28952026	22	000MBTU
TOTAL FUEL CONSUMED	MACH CT	1	"000MBTU"	2017	11.20418549	22	000MBTU
TOTAL FUEL CONSUMED	MACH CT	1	"000MBTU"	2018	6.672987461	22	000MBTU

TOTAL FUEL CONSUMED	MACH CT 1	"000MBTU"	2019	0.71421802	22 000MBTU
TOTAL FUEL CONSUMED	MACH CT 1	"000MBTU"	2020	0.795025229	22 000MBTU
TOTAL FUEL CONSUMED	MACH CT 1	"000MBTU"	2021	1.678503156	22 000MBTU
TOTAL FUEL CONSUMED	MACH CT 1	"000MBTU"	2022	1.163832784	22 000MBTU
TOTAL FUEL CONSUMED	MACH CT 1	"000MBTU"	2023	0.062090978	22 000MBTU
TOTAL FUEL CONSUMED	MACH CT 1	"000MBTU"	2024	0	22 000MBTU
TOTAL FUEL CONSUMED	MACH CT 1	"000MBTU"	2025	0	22 000MBTU
TOTAL FUEL CONSUMED	MACH CT 1	"000MBTU"	2026	0	22 000MBTU
TOTAL FUEL CONSUMED	MACH CT 1	"000MBTU"	2027	0	22 000MBTU
TOTAL FUEL CONSUMED	MACH CT 1	"000MBTU"	2028	0	22 000MBTU
TOTAL FUEL CONSUMED	MACH CT 1	"000MBTU"	2029	0	22 000MBTU
TOTAL FUEL CONSUMED	MACH CT 1	"000MBTU"	2030	0	22 000MBTU
TOTAL FUEL CONSUMED	MACH CT 1	"000MBTU"	2031	0	22 000MBTU
TOTAL FUEL CONSUMED	MACH CT 1	"000MBTU"	2032	0	22 000MBTU
TOTAL FUEL CONSUMED	MACH CT 1	"000MBTU"	2033	0	22 000MBTU
TOTAL FUEL CONSUMED	MACH CT 1	"000MBTU"	2034	0	22 000MBTU
TOTAL FUEL CONSUMED	MACH CT 1	"000MBTU"	2035	0	22 000MBTU
TOTAL FUEL CONSUMED	YIGO CT 1	"000MBTU"	2006	8.736352921	22 000MBTU
TOTAL FUEL CONSUMED	YIGO CT 1	"000MBTU"	2007	9.568943024	22 000MBTU
TOTAL FUEL CONSUMED	YIGO CT 1	"000MBTU"	2008	17.40014076	22 000MBTU
TOTAL FUEL CONSUMED	YIGO CT 1	"000MBTU"	2009	91.50534058	22 000MBTU
TOTAL FUEL CONSUMED	YIGO CT 1	"000MBTU"	2010	120.9680939	22 000MBTU
TOTAL FUEL CONSUMED	YIGO CT 1	"000MBTU"	2011	204.0505219	22 000MBTU
TOTAL FUEL CONSUMED	YIGO CT 1	"000MBTU"	2012	469.6251831	22 000MBTU
TOTAL FUEL CONSUMED	YIGO CT 1	"000MBTU"	2013	335.6377258	22 000MBTU
TOTAL FUEL CONSUMED	YIGO CT 1	"000MBTU"	2014	480.9346313	22 000MBTU
TOTAL FUEL CONSUMED	YIGO CT 1	"000MBTU"	2015	444.5788879	22 000MBTU
TOTAL FUEL CONSUMED	YIGO CT 1	"000MBTU"	2016	295.3178406	22 000MBTU
TOTAL FUEL CONSUMED	YIGO CT 1	"000MBTU"	2017	32.10727692	22 000MBTU
TOTAL FUEL CONSUMED	YIGO CT 1	"000MBTU"	2018	19.5544529	22 000MBTU
TOTAL FUEL CONSUMED	YIGO CT 1	"000MBTU"	2019	2.222404003	22 000MBTU
TOTAL FUEL CONSUMED	YIGO CT 1	"000MBTU"	2020	2.380482674	22 000MBTU
TOTAL FUEL CONSUMED	YIGO CT 1	"000MBTU"	2021	4.760860443	22 000MBTU
TOTAL FUEL CONSUMED	YIGO CT 1	"000MBTU"	2022	2.435682297	22 000MBTU
TOTAL FUEL CONSUMED	YIGO CT 1	"000MBTU"	2023	0.088874847	22 000MBTU
TOTAL FUEL CONSUMED	YIGO CT 1	"000MBTU"	2024	0	22 000MBTU
TOTAL FUEL CONSUMED	YIGO CT 1	"000MBTU"	2025	0	22 000MBTU
TOTAL FUEL CONSUMED	YIGO CT 1	"000MBTU"	2026	0	22 000MBTU
TOTAL FUEL CONSUMED	YIGO CT 1	"000MBTU"	2027	0	22 000MBTU
TOTAL FUEL CONSUMED	YIGO CT 1	"000MBTU"	2028	0	22 000MBTU
TOTAL FUEL CONSUMED	YIGO CT 1	"000MBTU"	2029	0	22 000MBTU
TOTAL FUEL CONSUMED	YIGO CT 1	"000MBTU"	2030	0	22 000MBTU
TOTAL FUEL CONSUMED	YIGO CT 1	"000MBTU"	2031	0	22 000MBTU
TOTAL FUEL CONSUMED	YIGO CT 1	"000MBTU"	2032	0	22 000MBTU
TOTAL FUEL CONSUMED	YIGO CT 1	"000MBTU"	2033	0	22 000MBTU
TOTAL FUEL CONSUMED	YIGO CT 1	"000MBTU"	2034	0	22 000MBTU
TOTAL FUEL CONSUMED	YIGO CT 1	"000MBTU"	2035	0	22 000MBTU
TOTAL FUEL CONSUMED	MARBO CT 1	"000MBTU"	2006	1.628753781	16 000MBTU
TOTAL FUEL CONSUMED	MARBO CT 1	"000MBTU"	2007	1.801262021	16 000MBTU
TOTAL FUEL CONSUMED	MARBO CT 1	"000MBTU"	2008	1.709925532	16 000MBTU
TOTAL FUEL CONSUMED	MARBO CT 1	"000MBTU"	2009	0.728556693	16 000MBTU
TOTAL FUEL CONSUMED	MARBO CT 1	"000MBTU"	2010	1.061049104	16 000MBTU

TOTAL FUEL CONSUMED	MARBO CT 1	"000MBTU"	2011	0.873704612	16 000MBTU
TOTAL FUEL CONSUMED	MARBO CT 1	"000MBTU"	2012	0.204274178	16 000MBTU
TOTAL FUEL CONSUMED	MARBO CT 1	"000MBTU"	2013	0.69496125	16 000MBTU
TOTAL FUEL CONSUMED	MARBO CT 1	"000MBTU"	2014	0.229137897	16 000MBTU
TOTAL FUEL CONSUMED	MARBO CT 1	"000MBTU"	2015	0.187602952	16 000MBTU
TOTAL FUEL CONSUMED	MARBO CT 1	"000MBTU"	2016	0.624744058	16 000MBTU
TOTAL FUEL CONSUMED	MARBO CT 1	"000MBTU"	2017	0.516768098	16 000MBTU
TOTAL FUEL CONSUMED	MARBO CT 1	"000MBTU"	2018	0.203577951	16 000MBTU
TOTAL FUEL CONSUMED	MARBO CT 1	"000MBTU"	2019	0.000669858	16 000MBTU
TOTAL FUEL CONSUMED	MARBO CT 1	"000MBTU"	2020	0.001592431	16 000MBTU
TOTAL FUEL CONSUMED	MARBO CT 1	"000MBTU"	2021	0.004886263	16 000MBTU
TOTAL FUEL CONSUMED	MARBO CT 1	"000MBTU"	2022	0.002500941	16 000MBTU
TOTAL FUEL CONSUMED	MARBO CT 1	"000MBTU"	2023	8.62636E-05	16 000MBTU
TOTAL FUEL CONSUMED	MARBO CT 1	"000MBTU"	2024	0	16 000MBTU
TOTAL FUEL CONSUMED	MARBO CT 1	"000MBTU"	2025	0	16 000MBTU
TOTAL FUEL CONSUMED	MARBO CT 1	"000MBTU"	2026	0	16 000MBTU
TOTAL FUEL CONSUMED	MARBO CT 1	"000MBTU"	2027	0	16 000MBTU
TOTAL FUEL CONSUMED	MARBO CT 1	"000MBTU"	2028	0	16 000MBTU
TOTAL FUEL CONSUMED	MARBO CT 1	"000MBTU"	2029	0	16 000MBTU
TOTAL FUEL CONSUMED	MARBO CT 1	"000MBTU"	2030	0	16 000MBTU
TOTAL FUEL CONSUMED	MARBO CT 1	"000MBTU"	2031	0	16 000MBTU
TOTAL FUEL CONSUMED	MARBO CT 1	"000MBTU"	2032	0	16 000MBTU
TOTAL FUEL CONSUMED	MARBO CT 1	"000MBTU"	2033	0	16 000MBTU
TOTAL FUEL CONSUMED	MARBO CT 1	"000MBTU"	2034	0	16 000MBTU
TOTAL FUEL CONSUMED	MARBO CT 1	"000MBTU"	2035	0	16 000MBTU
TOTAL FUEL CONSUMED	DED DSL 1	"000MBTU"	2006	0.249542311	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 1	"000MBTU"	2007	0.268213153	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 1	"000MBTU"	2008	0.251125574	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 1	"000MBTU"	2009	0.107697569	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 1	"000MBTU"	2010	0.15619646	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 1	"000MBTU"	2011	0.128787711	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 1	"000MBTU"	2012	0.029685674	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 1	"000MBTU"	2013	0.103169881	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 1	"000MBTU"	2014	0.035374153	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 1	"000MBTU"	2015	0.030120479	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 1	"000MBTU"	2016	0.095650405	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 1	"000MBTU"	2017	0	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 1	"000MBTU"	2018	0	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 1	"000MBTU"	2019	0	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 1	"000MBTU"	2020	0	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 1	"000MBTU"	2021	0	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 1	"000MBTU"	2022	0	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 1	"000MBTU"	2023	0	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 1	"000MBTU"	2024	0	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 1	"000MBTU"	2025	0	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 1	"000MBTU"	2026	0	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 1	"000MBTU"	2027	0	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 1	"000MBTU"	2028	0	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 1	"000MBTU"	2029	0	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 1	"000MBTU"	2030	0	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 1	"000MBTU"	2031	0	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 1	"000MBTU"	2032	0	2.5 000MBTU

TOTAL FUEL CONSUMED	DED DSL	1	"000MBTU"	2033	0	2.5	000MBTU
TOTAL FUEL CONSUMED	DED DSL	1	"000MBTU"	2034	0	2.5	000MBTU
TOTAL FUEL CONSUMED	DED DSL	1	"000MBTU"	2035	0	2.5	000MBTU
TOTAL FUEL CONSUMED	DED DSL	2	"000MBTU"	2006	0.247563526	2.5	000MBTU
TOTAL FUEL CONSUMED	DED DSL	2	"000MBTU"	2007	0.269165725	2.5	000MBTU
TOTAL FUEL CONSUMED	DED DSL	2	"000MBTU"	2008	0.252970606	2.5	000MBTU
TOTAL FUEL CONSUMED	DED DSL	2	"000MBTU"	2009	0.103749707	2.5	000MBTU
TOTAL FUEL CONSUMED	DED DSL	2	"000MBTU"	2010	0.155450329	2.5	000MBTU
TOTAL FUEL CONSUMED	DED DSL	2	"000MBTU"	2011	0.130508438	2.5	000MBTU
TOTAL FUEL CONSUMED	DED DSL	2	"000MBTU"	2012	0.028232438	2.5	000MBTU
TOTAL FUEL CONSUMED	DED DSL	2	"000MBTU"	2013	0.100828961	2.5	000MBTU
TOTAL FUEL CONSUMED	DED DSL	2	"000MBTU"	2014	0.032820892	2.5	000MBTU
TOTAL FUEL CONSUMED	DED DSL	2	"000MBTU"	2015	0.029746966	2.5	000MBTU
TOTAL FUEL CONSUMED	DED DSL	2	"000MBTU"	2016	0.095019028	2.5	000MBTU
TOTAL FUEL CONSUMED	DED DSL	2	"000MBTU"	2017	0	2.5	000MBTU
TOTAL FUEL CONSUMED	DED DSL	2	"000MBTU"	2018	0	2.5	000MBTU
TOTAL FUEL CONSUMED	DED DSL	2	"000MBTU"	2019	0	2.5	000MBTU
TOTAL FUEL CONSUMED	DED DSL	2	"000MBTU"	2020	0	2.5	000MBTU
TOTAL FUEL CONSUMED	DED DSL	2	"000MBTU"	2021	0	2.5	000MBTU
TOTAL FUEL CONSUMED	DED DSL	2	"000MBTU"	2022	0	2.5	000MBTU
TOTAL FUEL CONSUMED	DED DSL	2	"000MBTU"	2023	0	2.5	000MBTU
TOTAL FUEL CONSUMED	DED DSL	2	"000MBTU"	2024	0	2.5	000MBTU
TOTAL FUEL CONSUMED	DED DSL	2	"000MBTU"	2025	0	2.5	000MBTU
TOTAL FUEL CONSUMED	DED DSL	2	"000MBTU"	2026	0	2.5	000MBTU
TOTAL FUEL CONSUMED	DED DSL	2	"000MBTU"	2027	0	2.5	000MBTU
TOTAL FUEL CONSUMED	DED DSL	2	"000MBTU"	2028	0	2.5	000MBTU
TOTAL FUEL CONSUMED	DED DSL	2	"000MBTU"	2029	0	2.5	000MBTU
TOTAL FUEL CONSUMED	DED DSL	2	"000MBTU"	2030	0	2.5	000MBTU
TOTAL FUEL CONSUMED	DED DSL	2	"000MBTU"	2031	0	2.5	000MBTU
TOTAL FUEL CONSUMED	DED DSL	2	"000MBTU"	2032	0	2.5	000MBTU
TOTAL FUEL CONSUMED	DED DSL	2	"000MBTU"	2033	0	2.5	000MBTU
TOTAL FUEL CONSUMED	DED DSL	2	"000MBTU"	2034	0	2.5	000MBTU
TOTAL FUEL CONSUMED	DED DSL	2	"000MBTU"	2035	0	2.5	000MBTU
TOTAL FUEL CONSUMED	DED DSL	3	"000MBTU"	2006	0.249559745	2.5	000MBTU
TOTAL FUEL CONSUMED	DED DSL	3	"000MBTU"	2007	0.268693805	2.5	000MBTU
TOTAL FUEL CONSUMED	DED DSL	3	"000MBTU"	2008	0.252387911	2.5	000MBTU
TOTAL FUEL CONSUMED	DED DSL	3	"000MBTU"	2009	0.109504834	2.5	000MBTU
TOTAL FUEL CONSUMED	DED DSL	3	"000MBTU"	2010	0.15557988	2.5	000MBTU
TOTAL FUEL CONSUMED	DED DSL	3	"000MBTU"	2011	0.129093468	2.5	000MBTU
TOTAL FUEL CONSUMED	DED DSL	3	"000MBTU"	2012	0.030766247	2.5	000MBTU
TOTAL FUEL CONSUMED	DED DSL	3	"000MBTU"	2013	0.101165228	2.5	000MBTU
TOTAL FUEL CONSUMED	DED DSL	3	"000MBTU"	2014	0.034886528	2.5	000MBTU
TOTAL FUEL CONSUMED	DED DSL	3	"000MBTU"	2015	0.029179493	2.5	000MBTU
TOTAL FUEL CONSUMED	DED DSL	3	"000MBTU"	2016	0.091898441	2.5	000MBTU
TOTAL FUEL CONSUMED	DED DSL	3	"000MBTU"	2017	0	2.5	000MBTU
TOTAL FUEL CONSUMED	DED DSL	3	"000MBTU"	2018	0	2.5	000MBTU
TOTAL FUEL CONSUMED	DED DSL	3	"000MBTU"	2019	0	2.5	000MBTU
TOTAL FUEL CONSUMED	DED DSL	3	"000MBTU"	2020	0	2.5	000MBTU
TOTAL FUEL CONSUMED	DED DSL	3	"000MBTU"	2021	0	2.5	000MBTU
TOTAL FUEL CONSUMED	DED DSL	3	"000MBTU"	2022	0	2.5	000MBTU
TOTAL FUEL CONSUMED	DED DSL	3	"000MBTU"	2023	0	2.5	000MBTU
TOTAL FUEL CONSUMED	DED DSL	3	"000MBTU"	2024	0	2.5	000MBTU

TOTAL FUEL CONSUMED	DED DSL 3	"000MBTU"	2025	0	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 3	"000MBTU"	2026	0	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 3	"000MBTU"	2027	0	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 3	"000MBTU"	2028	0	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 3	"000MBTU"	2029	0	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 3	"000MBTU"	2030	0	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 3	"000MBTU"	2031	0	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 3	"000MBTU"	2032	0	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 3	"000MBTU"	2033	0	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 3	"000MBTU"	2034	0	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 3	"000MBTU"	2035	0	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 4	"000MBTU"	2006	0.249815375	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 4	"000MBTU"	2007	0.26801908	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 4	"000MBTU"	2008	0.25292927	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 4	"000MBTU"	2009	0.107697569	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 4	"000MBTU"	2010	0.153979167	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 4	"000MBTU"	2011	0.128085569	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 4	"000MBTU"	2012	0.02938607	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 4	"000MBTU"	2013	0.100704446	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 4	"000MBTU"	2014	0.033570647	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 4	"000MBTU"	2015	0.028703114	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 4	"000MBTU"	2016	0.092803933	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 4	"000MBTU"	2017	0	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 4	"000MBTU"	2018	0	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 4	"000MBTU"	2019	0	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 4	"000MBTU"	2020	0	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 4	"000MBTU"	2021	0	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 4	"000MBTU"	2022	0	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 4	"000MBTU"	2023	0	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 4	"000MBTU"	2024	0	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 4	"000MBTU"	2025	0	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 4	"000MBTU"	2026	0	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 4	"000MBTU"	2027	0	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 4	"000MBTU"	2028	0	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 4	"000MBTU"	2029	0	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 4	"000MBTU"	2030	0	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 4	"000MBTU"	2031	0	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 4	"000MBTU"	2032	0	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 4	"000MBTU"	2033	0	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 4	"000MBTU"	2034	0	2.5 000MBTU
TOTAL FUEL CONSUMED	DED DSL 4	"000MBTU"	2035	0	2.5 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 1	"000MBTU"	2006	6.572510719	5.3 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 1	"000MBTU"	2007	7.223890305	5.3 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 1	"000MBTU"	2008	13.00417137	5.3 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 1	"000MBTU"	2009	60.45367813	5.3 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 1	"000MBTU"	2010	1.449282169	5.3 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 1	"000MBTU"	2011	4.792804718	5.3 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 1	"000MBTU"	2012	142.9794769	5.3 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 1	"000MBTU"	2013	121.3950195	5.3 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 1	"000MBTU"	2014	145.6386261	5.3 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 1	"000MBTU"	2015	145.4339905	5.3 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 1	"000MBTU"	2016	102.5308533	5.3 000MBTU

TOTAL FUEL CONSUMED	PULANTAT 1	"000MBTU"	2017	14.11269855	5.3 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 1	"000MBTU"	2018	8.354412079	5.3 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 1	"000MBTU"	2019	1.063935637	5.3 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 1	"000MBTU"	2020	1.091697693	5.3 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 1	"000MBTU"	2021	2.075187683	5.3 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 1	"000MBTU"	2022	1.075130224	5.3 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 1	"000MBTU"	2023	0.053589392	5.3 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 1	"000MBTU"	2024	0.008755126	5.3 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 1	"000MBTU"	2025	0	5.3 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 1	"000MBTU"	2026	0	5.3 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 1	"000MBTU"	2027	0	5.3 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 1	"000MBTU"	2028	0	5.3 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 1	"000MBTU"	2029	0	5.3 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 1	"000MBTU"	2030	0	5.3 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 1	"000MBTU"	2031	0	5.3 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 1	"000MBTU"	2032	0	5.3 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 1	"000MBTU"	2033	0	5.3 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 1	"000MBTU"	2034	0	5.3 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 1	"000MBTU"	2035	0	5.3 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 2	"000MBTU"	2006	3.808642387	5.3 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 2	"000MBTU"	2007	4.237649918	5.3 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 2	"000MBTU"	2008	7.589086533	5.3 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 2	"000MBTU"	2009	38.52023697	5.3 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 2	"000MBTU"	2010	1.03927803	5.3 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 2	"000MBTU"	2011	3.806311369	5.3 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 2	"000MBTU"	2012	28.51568031	5.3 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 2	"000MBTU"	2013	44.06897354	5.3 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 2	"000MBTU"	2014	32.96003342	5.3 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 2	"000MBTU"	2015	31.8690834	5.3 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 2	"000MBTU"	2016	53.54944229	5.3 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 2	"000MBTU"	2017	11.98940849	5.3 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 2	"000MBTU"	2018	7.311131001	5.3 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 2	"000MBTU"	2019	0.901371956	5.3 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 2	"000MBTU"	2020	0.915750325	5.3 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 2	"000MBTU"	2021	1.804383755	5.3 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 2	"000MBTU"	2022	0.902771175	5.3 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 2	"000MBTU"	2023	0.048873428	5.3 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 2	"000MBTU"	2024	0.008657997	5.3 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 2	"000MBTU"	2025	0	5.3 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 2	"000MBTU"	2026	0	5.3 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 2	"000MBTU"	2027	0	5.3 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 2	"000MBTU"	2028	0	5.3 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 2	"000MBTU"	2029	0	5.3 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 2	"000MBTU"	2030	0	5.3 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 2	"000MBTU"	2031	0	5.3 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 2	"000MBTU"	2032	0	5.3 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 2	"000MBTU"	2033	0	5.3 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 2	"000MBTU"	2034	0	5.3 000MBTU
TOTAL FUEL CONSUMED	PULANTAT 2	"000MBTU"	2035	0	5.3 000MBTU
TOTAL FUEL CONSUMED	TENJO 1	"000MBTU"	2006	22.77018738	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO 1	"000MBTU"	2007	24.69833565	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO 1	"000MBTU"	2008	40.97779083	4.4 000MBTU

TOTAL FUEL CONSUMED	TENJO	1	"000MBTU"	2009	124.4657822	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	1	"000MBTU"	2010	86.47895813	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	1	"000MBTU"	2011	119.8376999	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	1	"000MBTU"	2012	200.8852539	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	1	"000MBTU"	2013	172.1067352	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	1	"000MBTU"	2014	193.7236633	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	1	"000MBTU"	2015	193.921402	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	1	"000MBTU"	2016	150.1456757	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	1	"000MBTU"	2017	46.25622177	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	1	"000MBTU"	2018	30.34363556	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	1	"000MBTU"	2019	4.816437721	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	1	"000MBTU"	2020	4.270089149	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	1	"000MBTU"	2021	7.155350685	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	1	"000MBTU"	2022	4.888757706	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	1	"000MBTU"	2023	0.254015833	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	1	"000MBTU"	2024	0	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	1	"000MBTU"	2025	0	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	1	"000MBTU"	2026	0	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	1	"000MBTU"	2027	0	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	1	"000MBTU"	2028	0	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	1	"000MBTU"	2029	0	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	1	"000MBTU"	2030	0	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	1	"000MBTU"	2031	0	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	1	"000MBTU"	2032	0	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	1	"000MBTU"	2033	0	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	1	"000MBTU"	2034	0	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	1	"000MBTU"	2035	0	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	2	"000MBTU"	2006	18.67203522	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	2	"000MBTU"	2007	20.42817497	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	2	"000MBTU"	2008	34.0615387	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	2	"000MBTU"	2009	113.4508362	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	2	"000MBTU"	2010	78.15572357	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	2	"000MBTU"	2011	108.733757	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	2	"000MBTU"	2012	191.7809448	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	2	"000MBTU"	2013	164.5840607	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	2	"000MBTU"	2014	187.30513	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	2	"000MBTU"	2015	187.1427612	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	2	"000MBTU"	2016	143.058609	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	2	"000MBTU"	2017	40.51150513	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	2	"000MBTU"	2018	26.66540146	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	2	"000MBTU"	2019	4.216200352	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	2	"000MBTU"	2020	3.621438026	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	2	"000MBTU"	2021	6.272710323	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	2	"000MBTU"	2022	4.147140503	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	2	"000MBTU"	2023	0.230280295	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	2	"000MBTU"	2024	0	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	2	"000MBTU"	2025	0	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	2	"000MBTU"	2026	0	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	2	"000MBTU"	2027	0	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	2	"000MBTU"	2028	0	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	2	"000MBTU"	2029	0	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	2	"000MBTU"	2030	0	4.4 000MBTU

TOTAL FUEL CONSUMED	TENJO	2	"000MBTU"	2031	0	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	2	"000MBTU"	2032	0	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	2	"000MBTU"	2033	0	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	2	"000MBTU"	2034	0	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	2	"000MBTU"	2035	0	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	3	"000MBTU"	2006	15.32742214	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	3	"000MBTU"	2007	16.60834503	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	3	"000MBTU"	2008	28.21426582	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	3	"000MBTU"	2009	103.5209656	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	3	"000MBTU"	2010	69.78002167	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	3	"000MBTU"	2011	99.14115143	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	3	"000MBTU"	2012	183.8762207	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	3	"000MBTU"	2013	156.7332611	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	3	"000MBTU"	2014	180.4736328	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	3	"000MBTU"	2015	179.5538635	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	3	"000MBTU"	2016	133.5036469	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	3	"000MBTU"	2017	36.12170029	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	3	"000MBTU"	2018	22.82862663	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	3	"000MBTU"	2019	3.459167242	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	3	"000MBTU"	2020	3.168288946	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	3	"000MBTU"	2021	5.537667274	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	3	"000MBTU"	2022	3.614247561	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	3	"000MBTU"	2023	0.181787595	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	3	"000MBTU"	2024	0	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	3	"000MBTU"	2025	0	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	3	"000MBTU"	2026	0	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	3	"000MBTU"	2027	0	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	3	"000MBTU"	2028	0	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	3	"000MBTU"	2029	0	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	3	"000MBTU"	2030	0	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	3	"000MBTU"	2031	0	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	3	"000MBTU"	2032	0	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	3	"000MBTU"	2033	0	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	3	"000MBTU"	2034	0	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	3	"000MBTU"	2035	0	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	4	"000MBTU"	2006	12.50742722	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	4	"000MBTU"	2007	13.6557951	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	4	"000MBTU"	2008	23.34051895	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	4	"000MBTU"	2009	91.71740723	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	4	"000MBTU"	2010	61.14850235	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	4	"000MBTU"	2011	89.75635529	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	4	"000MBTU"	2012	175.094574	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	4	"000MBTU"	2013	148.5823517	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	4	"000MBTU"	2014	173.7826538	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	4	"000MBTU"	2015	171.4516602	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	4	"000MBTU"	2016	123.6634445	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	4	"000MBTU"	2017	21.74166298	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	4	"000MBTU"	2018	12.88133144	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	4	"000MBTU"	2019	1.689772725	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	4	"000MBTU"	2020	1.638148546	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	4	"000MBTU"	2021	3.218029737	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	4	"000MBTU"	2022	1.692940712	4.4	000MBTU

TOTAL FUEL CONSUMED	TENJO	4	"000MBTU"	2023	0.066807695	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	4	"000MBTU"	2024	0	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	4	"000MBTU"	2025	0	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	4	"000MBTU"	2026	0	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	4	"000MBTU"	2027	0	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	4	"000MBTU"	2028	0	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	4	"000MBTU"	2029	0	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	4	"000MBTU"	2030	0	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	4	"000MBTU"	2031	0	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	4	"000MBTU"	2032	0	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	4	"000MBTU"	2033	0	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	4	"000MBTU"	2034	0	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	4	"000MBTU"	2035	0	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	5	"000MBTU"	2006	10.08860588	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	5	"000MBTU"	2007	10.87575817	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	5	"000MBTU"	2008	19.17077637	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	5	"000MBTU"	2009	75.94798279	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	5	"000MBTU"	2010	52.75971985	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	5	"000MBTU"	2011	80.96884918	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	5	"000MBTU"	2012	163.6254425	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	5	"000MBTU"	2013	139.6876831	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	5	"000MBTU"	2014	166.1300659	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	5	"000MBTU"	2015	163.8667603	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	5	"000MBTU"	2016	116.2037277	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	5	"000MBTU"	2017	18.45817375	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	5	"000MBTU"	2018	10.9971447	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	5	"000MBTU"	2019	1.459287882	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	5	"000MBTU"	2020	1.391330004	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	5	"000MBTU"	2021	2.683657646	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	5	"000MBTU"	2022	1.446218252	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	5	"000MBTU"	2023	0.064530857	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	5	"000MBTU"	2024	0	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	5	"000MBTU"	2025	0	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	5	"000MBTU"	2026	0	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	5	"000MBTU"	2027	0	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	5	"000MBTU"	2028	0	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	5	"000MBTU"	2029	0	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	5	"000MBTU"	2030	0	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	5	"000MBTU"	2031	0	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	5	"000MBTU"	2032	0	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	5	"000MBTU"	2033	0	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	5	"000MBTU"	2034	0	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	5	"000MBTU"	2035	0	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	6	"000MBTU"	2006	8.004940033	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	6	"000MBTU"	2007	8.764865875	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	6	"000MBTU"	2008	15.5716753	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	6	"000MBTU"	2009	66.57258606	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	6	"000MBTU"	2010	44.95599365	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	6	"000MBTU"	2011	72.29932404	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	6	"000MBTU"	2012	153.5565033	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	6	"000MBTU"	2013	130.6256104	4.4 000MBTU
TOTAL FUEL CONSUMED	TENJO	6	"000MBTU"	2014	158.0561676	4.4 000MBTU

TOTAL FUEL CONSUMED	TENJO	6	"000MBTU"	2015	155.4562378	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	6	"000MBTU"	2016	108.863739	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	6	"000MBTU"	2017	15.79853535	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	6	"000MBTU"	2018	9.414188385	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	6	"000MBTU"	2019	1.229883313	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	6	"000MBTU"	2020	1.183853745	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	6	"000MBTU"	2021	2.299305201	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	6	"000MBTU"	2022	1.234219313	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	6	"000MBTU"	2023	0.061269674	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	6	"000MBTU"	2024	0	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	6	"000MBTU"	2025	0	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	6	"000MBTU"	2026	0	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	6	"000MBTU"	2027	0	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	6	"000MBTU"	2028	0	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	6	"000MBTU"	2029	0	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	6	"000MBTU"	2030	0	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	6	"000MBTU"	2031	0	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	6	"000MBTU"	2032	0	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	6	"000MBTU"	2033	0	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	6	"000MBTU"	2034	0	4.4	000MBTU
TOTAL FUEL CONSUMED	TENJO	6	"000MBTU"	2035	0	4.4	000MBTU
TOTAL FUEL CONSUMED	TAL DSL	1	"000MBTU"	2006	32.07157898	4.4	000MBTU
TOTAL FUEL CONSUMED	TAL DSL	1	"000MBTU"	2007	33.80738068	4.4	000MBTU
TOTAL FUEL CONSUMED	TAL DSL	1	"000MBTU"	2008	54.30627441	4.4	000MBTU
TOTAL FUEL CONSUMED	TAL DSL	1	"000MBTU"	2009	134.0159454	4.4	000MBTU
TOTAL FUEL CONSUMED	TAL DSL	1	"000MBTU"	2010	99.92762756	4.4	000MBTU
TOTAL FUEL CONSUMED	TAL DSL	1	"000MBTU"	2011	132.900589	4.4	000MBTU
TOTAL FUEL CONSUMED	TAL DSL	1	"000MBTU"	2012	188.2939758	4.4	000MBTU
TOTAL FUEL CONSUMED	TAL DSL	1	"000MBTU"	2013	170.9033813	4.4	000MBTU
TOTAL FUEL CONSUMED	TAL DSL	1	"000MBTU"	2014	185.2116852	4.4	000MBTU
TOTAL FUEL CONSUMED	TAL DSL	1	"000MBTU"	2015	187.0332031	4.4	000MBTU
TOTAL FUEL CONSUMED	TAL DSL	1	"000MBTU"	2016	153.3621674	4.4	000MBTU
TOTAL FUEL CONSUMED	TAL DSL	1	"000MBTU"	2017	53.9455986	4.4	000MBTU
TOTAL FUEL CONSUMED	TAL DSL	1	"000MBTU"	2018	37.47642899	4.4	000MBTU
TOTAL FUEL CONSUMED	TAL DSL	1	"000MBTU"	2019	6.300248623	4.4	000MBTU
TOTAL FUEL CONSUMED	TAL DSL	1	"000MBTU"	2020	5.363118649	4.4	000MBTU
TOTAL FUEL CONSUMED	TAL DSL	1	"000MBTU"	2021	8.948620796	4.4	000MBTU
TOTAL FUEL CONSUMED	TAL DSL	1	"000MBTU"	2022	6.257036686	4.4	000MBTU
TOTAL FUEL CONSUMED	TAL DSL	1	"000MBTU"	2023	0.3062253	4.4	000MBTU
TOTAL FUEL CONSUMED	TAL DSL	1	"000MBTU"	2024	0	4.4	000MBTU
TOTAL FUEL CONSUMED	TAL DSL	1	"000MBTU"	2025	0	4.4	000MBTU
TOTAL FUEL CONSUMED	TAL DSL	1	"000MBTU"	2026	0	4.4	000MBTU
TOTAL FUEL CONSUMED	TAL DSL	1	"000MBTU"	2027	0	4.4	000MBTU
TOTAL FUEL CONSUMED	TAL DSL	1	"000MBTU"	2028	0	4.4	000MBTU
TOTAL FUEL CONSUMED	TAL DSL	1	"000MBTU"	2029	0	4.4	000MBTU
TOTAL FUEL CONSUMED	TAL DSL	1	"000MBTU"	2030	0	4.4	000MBTU
TOTAL FUEL CONSUMED	TAL DSL	1	"000MBTU"	2031	0	4.4	000MBTU
TOTAL FUEL CONSUMED	TAL DSL	1	"000MBTU"	2032	0	4.4	000MBTU
TOTAL FUEL CONSUMED	TAL DSL	1	"000MBTU"	2033	0	4.4	000MBTU
TOTAL FUEL CONSUMED	TAL DSL	1	"000MBTU"	2034	0	4.4	000MBTU
TOTAL FUEL CONSUMED	TAL DSL	1	"000MBTU"	2035	0	4.4	000MBTU
TOTAL FUEL CONSUMED	TAL DSL	2	"000MBTU"	2006	26.85125923	4.4	000MBTU

TOTAL FUEL CONSUMED	TAL	DSL	2	"000MBTU"	2007	28.57021904	4.4 000MBTU
TOTAL FUEL CONSUMED	TAL	DSL	2	"000MBTU"	2008	39.89648438	4.4 000MBTU
TOTAL FUEL CONSUMED	TAL	DSL	2	"000MBTU"	2009	48.39694595	4.4 000MBTU
TOTAL FUEL CONSUMED	TAL	DSL	2	"000MBTU"	2010	53.05435944	4.4 000MBTU
TOTAL FUEL CONSUMED	TAL	DSL	2	"000MBTU"	2011	57.79310989	4.4 000MBTU
TOTAL FUEL CONSUMED	TAL	DSL	2	"000MBTU"	2012	15.0008707	4.4 000MBTU
TOTAL FUEL CONSUMED	TAL	DSL	2	"000MBTU"	2013	32.26805878	4.4 000MBTU
TOTAL FUEL CONSUMED	TAL	DSL	2	"000MBTU"	2014	17.52420616	4.4 000MBTU
TOTAL FUEL CONSUMED	TAL	DSL	2	"000MBTU"	2015	15.61230659	4.4 000MBTU
TOTAL FUEL CONSUMED	TAL	DSL	2	"000MBTU"	2016	47.41465759	4.4 000MBTU
TOTAL FUEL CONSUMED	TAL	DSL	2	"000MBTU"	2017	49.28817749	4.4 000MBTU
TOTAL FUEL CONSUMED	TAL	DSL	2	"000MBTU"	2018	33.21303177	4.4 000MBTU
TOTAL FUEL CONSUMED	TAL	DSL	2	"000MBTU"	2019	5.382463932	4.4 000MBTU
TOTAL FUEL CONSUMED	TAL	DSL	2	"000MBTU"	2020	4.700635433	4.4 000MBTU
TOTAL FUEL CONSUMED	TAL	DSL	2	"000MBTU"	2021	7.900913239	4.4 000MBTU
TOTAL FUEL CONSUMED	TAL	DSL	2	"000MBTU"	2022	5.403962612	4.4 000MBTU
TOTAL FUEL CONSUMED	TAL	DSL	2	"000MBTU"	2023	0.275607347	4.4 000MBTU
TOTAL FUEL CONSUMED	TAL	DSL	2	"000MBTU"	2024	0	4.4 000MBTU
TOTAL FUEL CONSUMED	TAL	DSL	2	"000MBTU"	2025	0	4.4 000MBTU
TOTAL FUEL CONSUMED	TAL	DSL	2	"000MBTU"	2026	0	4.4 000MBTU
TOTAL FUEL CONSUMED	TAL	DSL	2	"000MBTU"	2027	0	4.4 000MBTU
TOTAL FUEL CONSUMED	TAL	DSL	2	"000MBTU"	2028	0	4.4 000MBTU
TOTAL FUEL CONSUMED	TAL	DSL	2	"000MBTU"	2029	0	4.4 000MBTU
TOTAL FUEL CONSUMED	TAL	DSL	2	"000MBTU"	2030	0	4.4 000MBTU
TOTAL FUEL CONSUMED	TAL	DSL	2	"000MBTU"	2031	0	4.4 000MBTU
TOTAL FUEL CONSUMED	TAL	DSL	2	"000MBTU"	2032	0	4.4 000MBTU
TOTAL FUEL CONSUMED	TAL	DSL	2	"000MBTU"	2033	0	4.4 000MBTU
TOTAL FUEL CONSUMED	TAL	DSL	2	"000MBTU"	2034	0	4.4 000MBTU
TOTAL FUEL CONSUMED	TAL	DSL	2	"000MBTU"	2035	0	4.4 000MBTU
TOTAL FUEL CONSUMED	TANGO		1	"000MBTU"	2006	258.789093	26.5 000MBTU
TOTAL FUEL CONSUMED	TANGO		1	"000MBTU"	2007	285.8019409	26.5 000MBTU
TOTAL FUEL CONSUMED	TANGO		1	"000MBTU"	2008	387.368042	26.5 000MBTU
TOTAL FUEL CONSUMED	TANGO		1	"000MBTU"	2009	764.6256104	26.5 000MBTU
TOTAL FUEL CONSUMED	TANGO		1	"000MBTU"	2010	618.0319824	26.5 000MBTU
TOTAL FUEL CONSUMED	TANGO		1	"000MBTU"	2011	708.6605835	26.5 000MBTU
TOTAL FUEL CONSUMED	TANGO		1	"000MBTU"	2012	981.366272	26.5 000MBTU
TOTAL FUEL CONSUMED	TANGO		1	"000MBTU"	2013	880.9530029	26.5 000MBTU
TOTAL FUEL CONSUMED	TANGO		1	"000MBTU"	2014	971.6957397	26.5 000MBTU
TOTAL FUEL CONSUMED	TANGO		1	"000MBTU"	2015	955.7246094	26.5 000MBTU
TOTAL FUEL CONSUMED	TANGO		1	"000MBTU"	2016	814.5162354	26.5 000MBTU
TOTAL FUEL CONSUMED	TANGO		1	"000MBTU"	2017	481.1260376	26.5 000MBTU
TOTAL FUEL CONSUMED	TANGO		1	"000MBTU"	2018	347.0415039	26.5 000MBTU
TOTAL FUEL CONSUMED	TANGO		1	"000MBTU"	2019	100.3927536	26.5 000MBTU
TOTAL FUEL CONSUMED	TANGO		1	"000MBTU"	2020	83.45948029	26.5 000MBTU
TOTAL FUEL CONSUMED	TANGO		1	"000MBTU"	2021	122.968689	26.5 000MBTU
TOTAL FUEL CONSUMED	TANGO		1	"000MBTU"	2022	99.11988831	26.5 000MBTU
TOTAL FUEL CONSUMED	TANGO		1	"000MBTU"	2023	7.817434311	26.5 000MBTU
TOTAL FUEL CONSUMED	TANGO		1	"000MBTU"	2024	0.062635109	26.5 000MBTU
TOTAL FUEL CONSUMED	TANGO		1	"000MBTU"	2025	0.025600076	26.5 000MBTU
TOTAL FUEL CONSUMED	TANGO		1	"000MBTU"	2026	0.0507061	26.5 000MBTU
TOTAL FUEL CONSUMED	TANGO		1	"000MBTU"	2027	0.127152041	26.5 000MBTU
TOTAL FUEL CONSUMED	TANGO		1	"000MBTU"	2028	0.123267472	26.5 000MBTU

TOTAL FUEL CONSUMED	TANGO	1	"000MBTU"	2029	0	26.5	000MBTU
TOTAL FUEL CONSUMED	TANGO	1	"000MBTU"	2030	0	26.5	000MBTU
TOTAL FUEL CONSUMED	TANGO	1	"000MBTU"	2031	0	26.5	000MBTU
TOTAL FUEL CONSUMED	TANGO	1	"000MBTU"	2032	0	26.5	000MBTU
TOTAL FUEL CONSUMED	TANGO	1	"000MBTU"	2033	0	26.5	000MBTU
TOTAL FUEL CONSUMED	TANGO	1	"000MBTU"	2034	0	26.5	000MBTU
TOTAL FUEL CONSUMED	TANGO	1	"000MBTU"	2035	0	26.5	000MBTU
TOTAL FUEL CONSUMED	TANGO	2	"000MBTU"	2006	374.4364014	26.5	000MBTU
TOTAL FUEL CONSUMED	TANGO	2	"000MBTU"	2007	396.118866	26.5	000MBTU
TOTAL FUEL CONSUMED	TANGO	2	"000MBTU"	2008	512.2165527	26.5	000MBTU
TOTAL FUEL CONSUMED	TANGO	2	"000MBTU"	2009	846.4920654	26.5	000MBTU
TOTAL FUEL CONSUMED	TANGO	2	"000MBTU"	2010	704.2670288	26.5	000MBTU
TOTAL FUEL CONSUMED	TANGO	2	"000MBTU"	2011	796.6765747	26.5	000MBTU
TOTAL FUEL CONSUMED	TANGO	2	"000MBTU"	2012	1030.106812	26.5	000MBTU
TOTAL FUEL CONSUMED	TANGO	2	"000MBTU"	2013	947.3117676	26.5	000MBTU
TOTAL FUEL CONSUMED	TANGO	2	"000MBTU"	2014	1024.557251	26.5	000MBTU
TOTAL FUEL CONSUMED	TANGO	2	"000MBTU"	2015	1006.454834	26.5	000MBTU
TOTAL FUEL CONSUMED	TANGO	2	"000MBTU"	2016	882.3301392	26.5	000MBTU
TOTAL FUEL CONSUMED	TANGO	2	"000MBTU"	2017	558.0391846	26.5	000MBTU
TOTAL FUEL CONSUMED	TANGO	2	"000MBTU"	2018	419.8969727	26.5	000MBTU
TOTAL FUEL CONSUMED	TANGO	2	"000MBTU"	2019	159.0815887	26.5	000MBTU
TOTAL FUEL CONSUMED	TANGO	2	"000MBTU"	2020	114.928299	26.5	000MBTU
TOTAL FUEL CONSUMED	TANGO	2	"000MBTU"	2021	162.2934418	26.5	000MBTU
TOTAL FUEL CONSUMED	TANGO	2	"000MBTU"	2022	135.1964722	26.5	000MBTU
TOTAL FUEL CONSUMED	TANGO	2	"000MBTU"	2023	12.91878891	26.5	000MBTU
TOTAL FUEL CONSUMED	TANGO	2	"000MBTU"	2024	0.148413166	26.5	000MBTU
TOTAL FUEL CONSUMED	TANGO	2	"000MBTU"	2025	0.066030249	26.5	000MBTU
TOTAL FUEL CONSUMED	TANGO	2	"000MBTU"	2026	0.195774928	26.5	000MBTU
TOTAL FUEL CONSUMED	TANGO	2	"000MBTU"	2027	0.136821449	26.5	000MBTU
TOTAL FUEL CONSUMED	TANGO	2	"000MBTU"	2028	0.127983853	26.5	000MBTU
TOTAL FUEL CONSUMED	TANGO	2	"000MBTU"	2029	0.135061905	26.5	000MBTU
TOTAL FUEL CONSUMED	TANGO	2	"000MBTU"	2030	0	26.5	000MBTU
TOTAL FUEL CONSUMED	TANGO	2	"000MBTU"	2031	0	26.5	000MBTU
TOTAL FUEL CONSUMED	TANGO	2	"000MBTU"	2032	0	26.5	000MBTU
TOTAL FUEL CONSUMED	TANGO	2	"000MBTU"	2033	0	26.5	000MBTU
TOTAL FUEL CONSUMED	TANGO	2	"000MBTU"	2034	0	26.5	000MBTU
TOTAL FUEL CONSUMED	TANGO	2	"000MBTU"	2035	0	26.5	000MBTU
TOTAL FUEL CONSUMED	MEC	1	"000MBTU"	2006	2794.515869	44.2	000MBTU
TOTAL FUEL CONSUMED	MEC	1	"000MBTU"	2007	2798.814209	44.2	000MBTU
TOTAL FUEL CONSUMED	MEC	1	"000MBTU"	2008	2834.365234	44.2	000MBTU
TOTAL FUEL CONSUMED	MEC	1	"000MBTU"	2009	2766.849854	44.2	000MBTU
TOTAL FUEL CONSUMED	MEC	1	"000MBTU"	2010	2844.963623	44.2	000MBTU
TOTAL FUEL CONSUMED	MEC	1	"000MBTU"	2011	2846.518311	44.2	000MBTU
TOTAL FUEL CONSUMED	MEC	1	"000MBTU"	2012	2827.510742	44.2	000MBTU
TOTAL FUEL CONSUMED	MEC	1	"000MBTU"	2013	2847.16626	44.2	000MBTU
TOTAL FUEL CONSUMED	MEC	1	"000MBTU"	2014	2847.238037	44.2	000MBTU
TOTAL FUEL CONSUMED	MEC	1	"000MBTU"	2015	2847.244629	44.2	000MBTU
TOTAL FUEL CONSUMED	MEC	1	"000MBTU"	2016	2850.607422	44.2	000MBTU
TOTAL FUEL CONSUMED	MEC	1	"000MBTU"	2017	2826.518799	44.2	000MBTU
TOTAL FUEL CONSUMED	MEC	1	"000MBTU"	2018	2766.015137	44.2	000MBTU
TOTAL FUEL CONSUMED	MEC	1	"000MBTU"	2019	2443.21875	44.2	000MBTU
TOTAL FUEL CONSUMED	MEC	1	"000MBTU"	2020	2438.686768	44.2	000MBTU

TOTAL FUEL CONSUMED	MEC	1	"000MBTU"	2021	2498.672607	44.2	000MBTU
TOTAL FUEL CONSUMED	MEC	1	"000MBTU"	2022	2433.359863	44.2	000MBTU
TOTAL FUEL CONSUMED	MEC	1	"000MBTU"	2023	1916.851074	44.2	000MBTU
TOTAL FUEL CONSUMED	MEC	1	"000MBTU"	2024	1322.321411	44.2	000MBTU
TOTAL FUEL CONSUMED	MEC	1	"000MBTU"	2025	1304.605713	44.2	000MBTU
TOTAL FUEL CONSUMED	MEC	1	"000MBTU"	2026	1261.628052	44.2	000MBTU
TOTAL FUEL CONSUMED	MEC	1	"000MBTU"	2027	1040.098999	44.2	000MBTU
TOTAL FUEL CONSUMED	MEC	1	"000MBTU"	2028	1119.880737	44.2	000MBTU
TOTAL FUEL CONSUMED	MEC	1	"000MBTU"	2029	1054.969116	44.2	000MBTU
TOTAL FUEL CONSUMED	MEC	1	"000MBTU"	2030	891.5917969	44.2	000MBTU
TOTAL FUEL CONSUMED	MEC	1	"000MBTU"	2031	915.3772583	44.2	000MBTU
TOTAL FUEL CONSUMED	MEC	1	"000MBTU"	2032	930.4595337	44.2	000MBTU
TOTAL FUEL CONSUMED	MEC	1	"000MBTU"	2033	935.619812	44.2	000MBTU
TOTAL FUEL CONSUMED	MEC	1	"000MBTU"	2034	961.1553955	44.2	000MBTU
TOTAL FUEL CONSUMED	MEC	1	"000MBTU"	2035	941.9986572	44.2	000MBTU
TOTAL FUEL CONSUMED	MEC	2	"000MBTU"	2006	2734.8479	44.2	000MBTU
TOTAL FUEL CONSUMED	MEC	2	"000MBTU"	2007	2745.531494	44.2	000MBTU
TOTAL FUEL CONSUMED	MEC	2	"000MBTU"	2008	2797.103271	44.2	000MBTU
TOTAL FUEL CONSUMED	MEC	2	"000MBTU"	2009	2709.79248	44.2	000MBTU
TOTAL FUEL CONSUMED	MEC	2	"000MBTU"	2010	2837.070557	44.2	000MBTU
TOTAL FUEL CONSUMED	MEC	2	"000MBTU"	2011	2844.434082	44.2	000MBTU
TOTAL FUEL CONSUMED	MEC	2	"000MBTU"	2012	2786.835693	44.2	000MBTU
TOTAL FUEL CONSUMED	MEC	2	"000MBTU"	2013	2846.866699	44.2	000MBTU
TOTAL FUEL CONSUMED	MEC	2	"000MBTU"	2014	2847.068359	44.2	000MBTU
TOTAL FUEL CONSUMED	MEC	2	"000MBTU"	2015	2846.962646	44.2	000MBTU
TOTAL FUEL CONSUMED	MEC	2	"000MBTU"	2016	2844.604736	44.2	000MBTU
TOTAL FUEL CONSUMED	MEC	2	"000MBTU"	2017	2815.856934	44.2	000MBTU
TOTAL FUEL CONSUMED	MEC	2	"000MBTU"	2018	2766.34668	44.2	000MBTU
TOTAL FUEL CONSUMED	MEC	2	"000MBTU"	2019	2360.933105	44.2	000MBTU
TOTAL FUEL CONSUMED	MEC	2	"000MBTU"	2020	2349.398926	44.2	000MBTU
TOTAL FUEL CONSUMED	MEC	2	"000MBTU"	2021	2419.30249	44.2	000MBTU
TOTAL FUEL CONSUMED	MEC	2	"000MBTU"	2022	2346.05835	44.2	000MBTU
TOTAL FUEL CONSUMED	MEC	2	"000MBTU"	2023	1768.048096	44.2	000MBTU
TOTAL FUEL CONSUMED	MEC	2	"000MBTU"	2024	1243.368896	44.2	000MBTU
TOTAL FUEL CONSUMED	MEC	2	"000MBTU"	2025	1247.805176	44.2	000MBTU
TOTAL FUEL CONSUMED	MEC	2	"000MBTU"	2026	1191.375854	44.2	000MBTU
TOTAL FUEL CONSUMED	MEC	2	"000MBTU"	2027	994.1588745	44.2	000MBTU
TOTAL FUEL CONSUMED	MEC	2	"000MBTU"	2028	1074.9646	44.2	000MBTU
TOTAL FUEL CONSUMED	MEC	2	"000MBTU"	2029	995.7767334	44.2	000MBTU
TOTAL FUEL CONSUMED	MEC	2	"000MBTU"	2030	866.953064	44.2	000MBTU
TOTAL FUEL CONSUMED	MEC	2	"000MBTU"	2031	886.1345215	44.2	000MBTU
TOTAL FUEL CONSUMED	MEC	2	"000MBTU"	2032	912.4022827	44.2	000MBTU
TOTAL FUEL CONSUMED	MEC	2	"000MBTU"	2033	910.836792	44.2	000MBTU
TOTAL FUEL CONSUMED	MEC	2	"000MBTU"	2034	921.3396606	44.2	000MBTU
TOTAL FUEL CONSUMED	MEC	2	"000MBTU"	2035	916.0389404	44.2	000MBTU
TOTAL FUEL CONSUMED	TEMES	1	"000MBTU"	2006	185.8274994	40	000MBTU
TOTAL FUEL CONSUMED	TEMES	1	"000MBTU"	2007	201.3851624	40	000MBTU
TOTAL FUEL CONSUMED	TEMES	1	"000MBTU"	2008	298.3029785	40	000MBTU
TOTAL FUEL CONSUMED	TEMES	1	"000MBTU"	2009	698.9435425	40	000MBTU
TOTAL FUEL CONSUMED	TEMES	1	"000MBTU"	2010	515.960083	40	000MBTU
TOTAL FUEL CONSUMED	TEMES	1	"000MBTU"	2011	635.6693115	40	000MBTU
TOTAL FUEL CONSUMED	TEMES	1	"000MBTU"	2012	909.5037231	40	000MBTU

TOTAL FUEL CONSUMED	TEMES	1	"000MBTU"	2013	794.6453857		40	000MBTU
TOTAL FUEL CONSUMED	TEMES	1	"000MBTU"	2014	876.4578857		40	000MBTU
TOTAL FUEL CONSUMED	TEMES	1	"000MBTU"	2015	870.4564819		40	000MBTU
TOTAL FUEL CONSUMED	TEMES	1	"000MBTU"	2016	567.2329712		40	000MBTU
TOTAL FUEL CONSUMED	TEMES	1	"000MBTU"	2017	0		40	000MBTU
TOTAL FUEL CONSUMED	TEMES	1	"000MBTU"	2018	0		40	000MBTU
TOTAL FUEL CONSUMED	TEMES	1	"000MBTU"	2019	0		40	000MBTU
TOTAL FUEL CONSUMED	TEMES	1	"000MBTU"	2020	0		40	000MBTU
TOTAL FUEL CONSUMED	TEMES	1	"000MBTU"	2021	0		40	000MBTU
TOTAL FUEL CONSUMED	TEMES	1	"000MBTU"	2022	0		40	000MBTU
TOTAL FUEL CONSUMED	TEMES	1	"000MBTU"	2023	0		40	000MBTU
TOTAL FUEL CONSUMED	TEMES	1	"000MBTU"	2024	0		40	000MBTU
TOTAL FUEL CONSUMED	TEMES	1	"000MBTU"	2025	0		40	000MBTU
TOTAL FUEL CONSUMED	TEMES	1	"000MBTU"	2026	0		40	000MBTU
TOTAL FUEL CONSUMED	TEMES	1	"000MBTU"	2027	0		40	000MBTU
TOTAL FUEL CONSUMED	TEMES	1	"000MBTU"	2028	0		40	000MBTU
TOTAL FUEL CONSUMED	TEMES	1	"000MBTU"	2029	0		40	000MBTU
TOTAL FUEL CONSUMED	TEMES	1	"000MBTU"	2030	0		40	000MBTU
TOTAL FUEL CONSUMED	TEMES	1	"000MBTU"	2031	0		40	000MBTU
TOTAL FUEL CONSUMED	TEMES	1	"000MBTU"	2032	0		40	000MBTU
TOTAL FUEL CONSUMED	TEMES	1	"000MBTU"	2033	0		40	000MBTU
TOTAL FUEL CONSUMED	TEMES	1	"000MBTU"	2034	0		40	000MBTU
TOTAL FUEL CONSUMED	TEMES	1	"000MBTU"	2035	0		40	000MBTU
TOTAL FUEL CONSUMED	CFB	1	"000MBTU"	2006	0	#N/A		000MBTU
TOTAL FUEL CONSUMED	CFB	1	"000MBTU"	2007	0	#N/A		000MBTU
TOTAL FUEL CONSUMED	CFB	1	"000MBTU"	2008	0	#N/A		000MBTU
TOTAL FUEL CONSUMED	CFB	1	"000MBTU"	2009	0	#N/A		000MBTU
TOTAL FUEL CONSUMED	CFB	1	"000MBTU"	2010	0	#N/A		000MBTU
TOTAL FUEL CONSUMED	CFB	1	"000MBTU"	2011	0	#N/A		000MBTU
TOTAL FUEL CONSUMED	CFB	1	"000MBTU"	2012	0	#N/A		000MBTU
TOTAL FUEL CONSUMED	CFB	1	"000MBTU"	2013	0	#N/A		000MBTU
TOTAL FUEL CONSUMED	CFB	1	"000MBTU"	2014	0	#N/A		000MBTU
TOTAL FUEL CONSUMED	CFB	1	"000MBTU"	2015	0	#N/A		000MBTU
TOTAL FUEL CONSUMED	CFB	1	"000MBTU"	2016	0	#N/A		000MBTU
TOTAL FUEL CONSUMED	CFB	1	"000MBTU"	2017	0	#N/A		000MBTU
TOTAL FUEL CONSUMED	CFB	1	"000MBTU"	2018	0	#N/A		000MBTU
TOTAL FUEL CONSUMED	CFB	1	"000MBTU"	2019	0	#N/A		000MBTU
TOTAL FUEL CONSUMED	CFB	1	"000MBTU"	2020	0	#N/A		000MBTU
TOTAL FUEL CONSUMED	CFB	1	"000MBTU"	2021	0	#N/A		000MBTU
TOTAL FUEL CONSUMED	CFB	1	"000MBTU"	2022	0	#N/A		000MBTU
TOTAL FUEL CONSUMED	CFB	1	"000MBTU"	2023	0	#N/A		000MBTU
TOTAL FUEL CONSUMED	CFB	1	"000MBTU"	2024	0	#N/A		000MBTU
TOTAL FUEL CONSUMED	CFB	1	"000MBTU"	2025	0	#N/A		000MBTU
TOTAL FUEL CONSUMED	CFB	1	"000MBTU"	2026	0	#N/A		000MBTU
TOTAL FUEL CONSUMED	CFB	1	"000MBTU"	2027	0	#N/A		000MBTU
TOTAL FUEL CONSUMED	CFB	1	"000MBTU"	2028	0	#N/A		000MBTU
TOTAL FUEL CONSUMED	CFB	1	"000MBTU"	2029	0	#N/A		000MBTU
TOTAL FUEL CONSUMED	CFB	1	"000MBTU"	2030	0	#N/A		000MBTU
TOTAL FUEL CONSUMED	CFB	1	"000MBTU"	2031	0	#N/A		000MBTU
TOTAL FUEL CONSUMED	CFB	1	"000MBTU"	2032	0	#N/A		000MBTU
TOTAL FUEL CONSUMED	CFB	1	"000MBTU"	2033	0	#N/A		000MBTU
TOTAL FUEL CONSUMED	CFB	1	"000MBTU"	2034	0	#N/A		000MBTU

TOTAL FUEL CONSUMED	CFB	1	"000MBTU"	2035	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RECIP	1	"000MBTU"	2006	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RECIP	1	"000MBTU"	2007	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RECIP	1	"000MBTU"	2008	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RECIP	1	"000MBTU"	2009	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RECIP	1	"000MBTU"	2010	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RECIP	1	"000MBTU"	2011	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RECIP	1	"000MBTU"	2012	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RECIP	1	"000MBTU"	2013	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RECIP	1	"000MBTU"	2014	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RECIP	1	"000MBTU"	2015	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RECIP	1	"000MBTU"	2016	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RECIP	1	"000MBTU"	2017	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RECIP	1	"000MBTU"	2018	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RECIP	1	"000MBTU"	2019	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RECIP	1	"000MBTU"	2020	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RECIP	1	"000MBTU"	2021	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RECIP	1	"000MBTU"	2022	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RECIP	1	"000MBTU"	2023	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RECIP	1	"000MBTU"	2024	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RECIP	1	"000MBTU"	2025	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RECIP	1	"000MBTU"	2026	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RECIP	1	"000MBTU"	2027	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RECIP	1	"000MBTU"	2028	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RECIP	1	"000MBTU"	2029	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RECIP	1	"000MBTU"	2030	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RECIP	1	"000MBTU"	2031	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RECIP	1	"000MBTU"	2032	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RECIP	1	"000MBTU"	2033	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RECIP	1	"000MBTU"	2034	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RECIP	1	"000MBTU"	2035	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MSW	1	"000MBTU"	2006	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MSW	1	"000MBTU"	2007	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MSW	1	"000MBTU"	2008	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MSW	1	"000MBTU"	2009	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MSW	1	"000MBTU"	2010	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MSW	1	"000MBTU"	2011	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MSW	1	"000MBTU"	2012	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MSW	1	"000MBTU"	2013	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MSW	1	"000MBTU"	2014	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MSW	1	"000MBTU"	2015	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MSW	1	"000MBTU"	2016	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MSW	1	"000MBTU"	2017	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MSW	1	"000MBTU"	2018	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MSW	1	"000MBTU"	2019	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MSW	1	"000MBTU"	2020	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MSW	1	"000MBTU"	2021	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MSW	1	"000MBTU"	2022	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MSW	1	"000MBTU"	2023	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MSW	1	"000MBTU"	2024	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MSW	1	"000MBTU"	2025	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MSW	1	"000MBTU"	2026	0	#N/A	000MBTU

TOTAL FUEL CONSUMED	MSW	1	"000MBTU"	2027	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MSW	1	"000MBTU"	2028	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MSW	1	"000MBTU"	2029	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MSW	1	"000MBTU"	2030	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MSW	1	"000MBTU"	2031	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MSW	1	"000MBTU"	2032	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MSW	1	"000MBTU"	2033	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MSW	1	"000MBTU"	2034	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MSW	1	"000MBTU"	2035	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RETR	1	"000MBTU"	2006	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RETR	1	"000MBTU"	2007	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RETR	1	"000MBTU"	2008	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RETR	1	"000MBTU"	2009	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RETR	1	"000MBTU"	2010	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RETR	1	"000MBTU"	2011	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RETR	1	"000MBTU"	2012	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RETR	1	"000MBTU"	2013	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RETR	1	"000MBTU"	2014	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RETR	1	"000MBTU"	2015	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RETR	1	"000MBTU"	2016	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RETR	1	"000MBTU"	2017	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RETR	1	"000MBTU"	2018	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RETR	1	"000MBTU"	2019	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RETR	1	"000MBTU"	2020	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RETR	1	"000MBTU"	2021	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RETR	1	"000MBTU"	2022	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RETR	1	"000MBTU"	2023	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RETR	1	"000MBTU"	2024	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RETR	1	"000MBTU"	2025	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RETR	1	"000MBTU"	2026	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RETR	1	"000MBTU"	2027	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RETR	1	"000MBTU"	2028	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RETR	1	"000MBTU"	2029	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RETR	1	"000MBTU"	2030	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RETR	1	"000MBTU"	2031	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RETR	1	"000MBTU"	2032	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RETR	1	"000MBTU"	2033	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RETR	1	"000MBTU"	2034	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RETR	1	"000MBTU"	2035	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CLNG	1	"000MBTU"	2006	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CLNG	1	"000MBTU"	2007	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CLNG	1	"000MBTU"	2008	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CLNG	1	"000MBTU"	2009	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CLNG	1	"000MBTU"	2010	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CLNG	1	"000MBTU"	2011	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CLNG	1	"000MBTU"	2012	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CLNG	1	"000MBTU"	2013	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CLNG	1	"000MBTU"	2014	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CLNG	1	"000MBTU"	2015	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CLNG	1	"000MBTU"	2016	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CLNG	1	"000MBTU"	2017	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CLNG	1	"000MBTU"	2018	0	#N/A	000MBTU

TOTAL FUEL CONSUMED	CLNG	1	"000MBTU"	2019	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CLNG	1	"000MBTU"	2020	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CLNG	1	"000MBTU"	2021	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CLNG	1	"000MBTU"	2022	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CLNG	1	"000MBTU"	2023	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CLNG	1	"000MBTU"	2024	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CLNG	1	"000MBTU"	2025	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CLNG	1	"000MBTU"	2026	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CLNG	1	"000MBTU"	2027	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CLNG	1	"000MBTU"	2028	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CLNG	1	"000MBTU"	2029	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CLNG	1	"000MBTU"	2030	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CLNG	1	"000MBTU"	2031	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CLNG	1	"000MBTU"	2032	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CLNG	1	"000MBTU"	2033	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CLNG	1	"000MBTU"	2034	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CLNG	1	"000MBTU"	2035	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	WIND	1	"000MBTU"	2006	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	WIND	1	"000MBTU"	2007	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	WIND	1	"000MBTU"	2008	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	WIND	1	"000MBTU"	2009	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	WIND	1	"000MBTU"	2010	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	WIND	1	"000MBTU"	2011	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	WIND	1	"000MBTU"	2012	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	WIND	1	"000MBTU"	2013	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	WIND	1	"000MBTU"	2014	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	WIND	1	"000MBTU"	2015	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	WIND	1	"000MBTU"	2016	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	WIND	1	"000MBTU"	2017	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	WIND	1	"000MBTU"	2018	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	WIND	1	"000MBTU"	2019	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	WIND	1	"000MBTU"	2020	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	WIND	1	"000MBTU"	2021	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	WIND	1	"000MBTU"	2022	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	WIND	1	"000MBTU"	2023	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	WIND	1	"000MBTU"	2024	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	WIND	1	"000MBTU"	2025	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	WIND	1	"000MBTU"	2026	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	WIND	1	"000MBTU"	2027	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	WIND	1	"000MBTU"	2028	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	WIND	1	"000MBTU"	2029	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	WIND	1	"000MBTU"	2030	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	WIND	1	"000MBTU"	2031	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	WIND	1	"000MBTU"	2032	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	WIND	1	"000MBTU"	2033	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	WIND	1	"000MBTU"	2034	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	WIND	1	"000MBTU"	2035	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CAB LNG	1	"000MBTU"	2006	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CAB LNG	1	"000MBTU"	2007	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CAB LNG	1	"000MBTU"	2008	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CAB LNG	1	"000MBTU"	2009	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CAB LNG	1	"000MBTU"	2010	0	#N/A	000MBTU

TOTAL FUEL CONSUMED	CAB LNG 1	"000MBTU"	2011	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CAB LNG 1	"000MBTU"	2012	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CAB LNG 1	"000MBTU"	2013	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CAB LNG 1	"000MBTU"	2014	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CAB LNG 1	"000MBTU"	2015	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CAB LNG 1	"000MBTU"	2016	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CAB LNG 1	"000MBTU"	2017	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CAB LNG 1	"000MBTU"	2018	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CAB LNG 1	"000MBTU"	2019	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CAB LNG 1	"000MBTU"	2020	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CAB LNG 1	"000MBTU"	2021	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CAB LNG 1	"000MBTU"	2022	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CAB LNG 1	"000MBTU"	2023	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CAB LNG 1	"000MBTU"	2024	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CAB LNG 1	"000MBTU"	2025	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CAB LNG 1	"000MBTU"	2026	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CAB LNG 1	"000MBTU"	2027	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CAB LNG 1	"000MBTU"	2028	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CAB LNG 1	"000MBTU"	2029	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CAB LNG 1	"000MBTU"	2030	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CAB LNG 1	"000MBTU"	2031	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CAB LNG 1	"000MBTU"	2032	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CAB LNG 1	"000MBTU"	2033	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CAB LNG 1	"000MBTU"	2034	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CAB LNG 1	"000MBTU"	2035	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CAB LNG 2	"000MBTU"	2006	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CAB LNG 2	"000MBTU"	2007	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CAB LNG 2	"000MBTU"	2008	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CAB LNG 2	"000MBTU"	2009	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CAB LNG 2	"000MBTU"	2010	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CAB LNG 2	"000MBTU"	2011	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CAB LNG 2	"000MBTU"	2012	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CAB LNG 2	"000MBTU"	2013	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CAB LNG 2	"000MBTU"	2014	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CAB LNG 2	"000MBTU"	2015	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CAB LNG 2	"000MBTU"	2016	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CAB LNG 2	"000MBTU"	2017	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CAB LNG 2	"000MBTU"	2018	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CAB LNG 2	"000MBTU"	2019	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CAB LNG 2	"000MBTU"	2020	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CAB LNG 2	"000MBTU"	2021	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CAB LNG 2	"000MBTU"	2022	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CAB LNG 2	"000MBTU"	2023	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CAB LNG 2	"000MBTU"	2024	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CAB LNG 2	"000MBTU"	2025	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CAB LNG 2	"000MBTU"	2026	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CAB LNG 2	"000MBTU"	2027	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CAB LNG 2	"000MBTU"	2028	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CAB LNG 2	"000MBTU"	2029	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CAB LNG 2	"000MBTU"	2030	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CAB LNG 2	"000MBTU"	2031	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CAB LNG 2	"000MBTU"	2032	0	#N/A	000MBTU

TOTAL FUEL CONSUMED	CAB LNG	2	"000MBTU"	2033	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CAB LNG	2	"000MBTU"	2034	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	CAB LNG	2	"000MBTU"	2035	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG	1	"000MBTU"	2006	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG	1	"000MBTU"	2007	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG	1	"000MBTU"	2008	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG	1	"000MBTU"	2009	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG	1	"000MBTU"	2010	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG	1	"000MBTU"	2011	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG	1	"000MBTU"	2012	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG	1	"000MBTU"	2013	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG	1	"000MBTU"	2014	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG	1	"000MBTU"	2015	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG	1	"000MBTU"	2016	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG	1	"000MBTU"	2017	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG	1	"000MBTU"	2018	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG	1	"000MBTU"	2019	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG	1	"000MBTU"	2020	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG	1	"000MBTU"	2021	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG	1	"000MBTU"	2022	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG	1	"000MBTU"	2023	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG	1	"000MBTU"	2024	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG	1	"000MBTU"	2025	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG	1	"000MBTU"	2026	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG	1	"000MBTU"	2027	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG	1	"000MBTU"	2028	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG	1	"000MBTU"	2029	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG	1	"000MBTU"	2030	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG	1	"000MBTU"	2031	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG	1	"000MBTU"	2032	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG	1	"000MBTU"	2033	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG	1	"000MBTU"	2034	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG	1	"000MBTU"	2035	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG	2	"000MBTU"	2006	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG	2	"000MBTU"	2007	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG	2	"000MBTU"	2008	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG	2	"000MBTU"	2009	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG	2	"000MBTU"	2010	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG	2	"000MBTU"	2011	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG	2	"000MBTU"	2012	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG	2	"000MBTU"	2013	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG	2	"000MBTU"	2014	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG	2	"000MBTU"	2015	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG	2	"000MBTU"	2016	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG	2	"000MBTU"	2017	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG	2	"000MBTU"	2018	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG	2	"000MBTU"	2019	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG	2	"000MBTU"	2020	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG	2	"000MBTU"	2021	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG	2	"000MBTU"	2022	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG	2	"000MBTU"	2023	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG	2	"000MBTU"	2024	0	#N/A	000MBTU

TOTAL FUEL CONSUMED	DED LNG 2	"000MBTU"	2025	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG 2	"000MBTU"	2026	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG 2	"000MBTU"	2027	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG 2	"000MBTU"	2028	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG 2	"000MBTU"	2029	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG 2	"000MBTU"	2030	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG 2	"000MBTU"	2031	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG 2	"000MBTU"	2032	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG 2	"000MBTU"	2033	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG 2	"000MBTU"	2034	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	DED LNG 2	"000MBTU"	2035	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MAC LNG 1	"000MBTU"	2006	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MAC LNG 1	"000MBTU"	2007	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MAC LNG 1	"000MBTU"	2008	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MAC LNG 1	"000MBTU"	2009	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MAC LNG 1	"000MBTU"	2010	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MAC LNG 1	"000MBTU"	2011	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MAC LNG 1	"000MBTU"	2012	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MAC LNG 1	"000MBTU"	2013	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MAC LNG 1	"000MBTU"	2014	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MAC LNG 1	"000MBTU"	2015	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MAC LNG 1	"000MBTU"	2016	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MAC LNG 1	"000MBTU"	2017	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MAC LNG 1	"000MBTU"	2018	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MAC LNG 1	"000MBTU"	2019	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MAC LNG 1	"000MBTU"	2020	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MAC LNG 1	"000MBTU"	2021	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MAC LNG 1	"000MBTU"	2022	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MAC LNG 1	"000MBTU"	2023	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MAC LNG 1	"000MBTU"	2024	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MAC LNG 1	"000MBTU"	2025	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MAC LNG 1	"000MBTU"	2026	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MAC LNG 1	"000MBTU"	2027	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MAC LNG 1	"000MBTU"	2028	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MAC LNG 1	"000MBTU"	2029	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MAC LNG 1	"000MBTU"	2030	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MAC LNG 1	"000MBTU"	2031	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MAC LNG 1	"000MBTU"	2032	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MAC LNG 1	"000MBTU"	2033	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MAC LNG 1	"000MBTU"	2034	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	MAC LNG 1	"000MBTU"	2035	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	YIG LNG 1	"000MBTU"	2006	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	YIG LNG 1	"000MBTU"	2007	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	YIG LNG 1	"000MBTU"	2008	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	YIG LNG 1	"000MBTU"	2009	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	YIG LNG 1	"000MBTU"	2010	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	YIG LNG 1	"000MBTU"	2011	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	YIG LNG 1	"000MBTU"	2012	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	YIG LNG 1	"000MBTU"	2013	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	YIG LNG 1	"000MBTU"	2014	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	YIG LNG 1	"000MBTU"	2015	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	YIG LNG 1	"000MBTU"	2016	0	#N/A	000MBTU

TOTAL FUEL CONSUMED	YIG LNG	1	"000MBTU"	2017	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	YIG LNG	1	"000MBTU"	2018	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	YIG LNG	1	"000MBTU"	2019	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	YIG LNG	1	"000MBTU"	2020	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	YIG LNG	1	"000MBTU"	2021	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	YIG LNG	1	"000MBTU"	2022	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	YIG LNG	1	"000MBTU"	2023	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	YIG LNG	1	"000MBTU"	2024	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	YIG LNG	1	"000MBTU"	2025	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	YIG LNG	1	"000MBTU"	2026	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	YIG LNG	1	"000MBTU"	2027	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	YIG LNG	1	"000MBTU"	2028	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	YIG LNG	1	"000MBTU"	2029	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	YIG LNG	1	"000MBTU"	2030	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	YIG LNG	1	"000MBTU"	2031	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	YIG LNG	1	"000MBTU"	2032	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	YIG LNG	1	"000MBTU"	2033	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	YIG LNG	1	"000MBTU"	2034	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	YIG LNG	1	"000MBTU"	2035	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TJO LNG	1	"000MBTU"	2006	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TJO LNG	1	"000MBTU"	2007	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TJO LNG	1	"000MBTU"	2008	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TJO LNG	1	"000MBTU"	2009	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TJO LNG	1	"000MBTU"	2010	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TJO LNG	1	"000MBTU"	2011	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TJO LNG	1	"000MBTU"	2012	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TJO LNG	1	"000MBTU"	2013	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TJO LNG	1	"000MBTU"	2014	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TJO LNG	1	"000MBTU"	2015	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TJO LNG	1	"000MBTU"	2016	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TJO LNG	1	"000MBTU"	2017	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TJO LNG	1	"000MBTU"	2018	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TJO LNG	1	"000MBTU"	2019	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TJO LNG	1	"000MBTU"	2020	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TJO LNG	1	"000MBTU"	2021	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TJO LNG	1	"000MBTU"	2022	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TJO LNG	1	"000MBTU"	2023	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TJO LNG	1	"000MBTU"	2024	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TJO LNG	1	"000MBTU"	2025	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TJO LNG	1	"000MBTU"	2026	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TJO LNG	1	"000MBTU"	2027	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TJO LNG	1	"000MBTU"	2028	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TJO LNG	1	"000MBTU"	2029	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TJO LNG	1	"000MBTU"	2030	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TJO LNG	1	"000MBTU"	2031	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TJO LNG	1	"000MBTU"	2032	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TJO LNG	1	"000MBTU"	2033	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TJO LNG	1	"000MBTU"	2034	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TJO LNG	1	"000MBTU"	2035	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TAN LNG	1	"000MBTU"	2006	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TAN LNG	1	"000MBTU"	2007	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TAN LNG	1	"000MBTU"	2008	0	#N/A	000MBTU

TOTAL FUEL CONSUMED	TAN LNG	1	"000MBTU"	2009	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TAN LNG	1	"000MBTU"	2010	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TAN LNG	1	"000MBTU"	2011	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TAN LNG	1	"000MBTU"	2012	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TAN LNG	1	"000MBTU"	2013	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TAN LNG	1	"000MBTU"	2014	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TAN LNG	1	"000MBTU"	2015	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TAN LNG	1	"000MBTU"	2016	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TAN LNG	1	"000MBTU"	2017	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TAN LNG	1	"000MBTU"	2018	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TAN LNG	1	"000MBTU"	2019	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TAN LNG	1	"000MBTU"	2020	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TAN LNG	1	"000MBTU"	2021	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TAN LNG	1	"000MBTU"	2022	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TAN LNG	1	"000MBTU"	2023	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TAN LNG	1	"000MBTU"	2024	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TAN LNG	1	"000MBTU"	2025	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TAN LNG	1	"000MBTU"	2026	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TAN LNG	1	"000MBTU"	2027	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TAN LNG	1	"000MBTU"	2028	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TAN LNG	1	"000MBTU"	2029	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TAN LNG	1	"000MBTU"	2030	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TAN LNG	1	"000MBTU"	2031	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TAN LNG	1	"000MBTU"	2032	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TAN LNG	1	"000MBTU"	2033	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TAN LNG	1	"000MBTU"	2034	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TAN LNG	1	"000MBTU"	2035	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TAN LNG	2	"000MBTU"	2006	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TAN LNG	2	"000MBTU"	2007	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TAN LNG	2	"000MBTU"	2008	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TAN LNG	2	"000MBTU"	2009	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TAN LNG	2	"000MBTU"	2010	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TAN LNG	2	"000MBTU"	2011	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TAN LNG	2	"000MBTU"	2012	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TAN LNG	2	"000MBTU"	2013	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TAN LNG	2	"000MBTU"	2014	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TAN LNG	2	"000MBTU"	2015	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TAN LNG	2	"000MBTU"	2016	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TAN LNG	2	"000MBTU"	2017	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TAN LNG	2	"000MBTU"	2018	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TAN LNG	2	"000MBTU"	2019	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TAN LNG	2	"000MBTU"	2020	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TAN LNG	2	"000MBTU"	2021	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TAN LNG	2	"000MBTU"	2022	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TAN LNG	2	"000MBTU"	2023	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TAN LNG	2	"000MBTU"	2024	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TAN LNG	2	"000MBTU"	2025	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TAN LNG	2	"000MBTU"	2026	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TAN LNG	2	"000MBTU"	2027	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TAN LNG	2	"000MBTU"	2028	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TAN LNG	2	"000MBTU"	2029	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TAN LNG	2	"000MBTU"	2030	0	#N/A	000MBTU

TOTAL FUEL CONSUMED	TAN LNG	2	"000MBTU"	2031	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TAN LNG	2	"000MBTU"	2032	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TAN LNG	2	"000MBTU"	2033	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TAN LNG	2	"000MBTU"	2034	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TAN LNG	2	"000MBTU"	2035	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TEM LNG	1	"000MBTU"	2006	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TEM LNG	1	"000MBTU"	2007	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TEM LNG	1	"000MBTU"	2008	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TEM LNG	1	"000MBTU"	2009	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TEM LNG	1	"000MBTU"	2010	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TEM LNG	1	"000MBTU"	2011	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TEM LNG	1	"000MBTU"	2012	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TEM LNG	1	"000MBTU"	2013	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TEM LNG	1	"000MBTU"	2014	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TEM LNG	1	"000MBTU"	2015	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TEM LNG	1	"000MBTU"	2016	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TEM LNG	1	"000MBTU"	2017	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TEM LNG	1	"000MBTU"	2018	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TEM LNG	1	"000MBTU"	2019	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TEM LNG	1	"000MBTU"	2020	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TEM LNG	1	"000MBTU"	2021	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TEM LNG	1	"000MBTU"	2022	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TEM LNG	1	"000MBTU"	2023	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TEM LNG	1	"000MBTU"	2024	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TEM LNG	1	"000MBTU"	2025	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TEM LNG	1	"000MBTU"	2026	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TEM LNG	1	"000MBTU"	2027	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TEM LNG	1	"000MBTU"	2028	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TEM LNG	1	"000MBTU"	2029	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TEM LNG	1	"000MBTU"	2030	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TEM LNG	1	"000MBTU"	2031	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TEM LNG	1	"000MBTU"	2032	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TEM LNG	1	"000MBTU"	2033	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TEM LNG	1	"000MBTU"	2034	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	TEM LNG	1	"000MBTU"	2035	0	#N/A	000MBTU
TOTAL FUEL CONSUMED	RECIP	83	"000MBTU"	2006	0	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	83	"000MBTU"	2007	0	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	83	"000MBTU"	2008	0	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	83	"000MBTU"	2009	0	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	83	"000MBTU"	2010	0	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	83	"000MBTU"	2011	0	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	83	"000MBTU"	2012	0	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	83	"000MBTU"	2013	0	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	83	"000MBTU"	2014	0	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	83	"000MBTU"	2015	0	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	83	"000MBTU"	2016	0	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	83	"000MBTU"	2017	0	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	83	"000MBTU"	2018	0	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	83	"000MBTU"	2019	0	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	83	"000MBTU"	2020	0	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	83	"000MBTU"	2021	0	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	83	"000MBTU"	2022	0	40	000MBTU

TOTAL FUEL CONSUMED	RECIP	83	"000MBTU"	2023	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	83	"000MBTU"	2024	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	83	"000MBTU"	2025	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	83	"000MBTU"	2026	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	83	"000MBTU"	2027	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	83	"000MBTU"	2028	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	83	"000MBTU"	2029	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	83	"000MBTU"	2030	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	83	"000MBTU"	2031	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	83	"000MBTU"	2032	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	83	"000MBTU"	2033	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	83	"000MBTU"	2034	125.1768723	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	83	"000MBTU"	2035	719.8648682	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	84	"000MBTU"	2006	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	84	"000MBTU"	2007	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	84	"000MBTU"	2008	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	84	"000MBTU"	2009	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	84	"000MBTU"	2010	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	84	"000MBTU"	2011	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	84	"000MBTU"	2012	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	84	"000MBTU"	2013	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	84	"000MBTU"	2014	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	84	"000MBTU"	2015	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	84	"000MBTU"	2016	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	84	"000MBTU"	2017	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	84	"000MBTU"	2018	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	84	"000MBTU"	2019	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	84	"000MBTU"	2020	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	84	"000MBTU"	2021	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	84	"000MBTU"	2022	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	84	"000MBTU"	2023	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	84	"000MBTU"	2024	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	84	"000MBTU"	2025	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	84	"000MBTU"	2026	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	84	"000MBTU"	2027	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	84	"000MBTU"	2028	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	84	"000MBTU"	2029	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	84	"000MBTU"	2030	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	84	"000MBTU"	2031	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	84	"000MBTU"	2032	120.7708664	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	84	"000MBTU"	2033	729.1038208	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	84	"000MBTU"	2034	724.8664551	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	84	"000MBTU"	2035	700.8269653	40 000MBTU
TOTAL FUEL CONSUMED	CLNG	85	"000MBTU"	2006	0	60 000MBTU
TOTAL FUEL CONSUMED	CLNG	85	"000MBTU"	2007	0	60 000MBTU
TOTAL FUEL CONSUMED	CLNG	85	"000MBTU"	2008	0	60 000MBTU
TOTAL FUEL CONSUMED	CLNG	85	"000MBTU"	2009	0	60 000MBTU
TOTAL FUEL CONSUMED	CLNG	85	"000MBTU"	2010	0	60 000MBTU
TOTAL FUEL CONSUMED	CLNG	85	"000MBTU"	2011	0	60 000MBTU
TOTAL FUEL CONSUMED	CLNG	85	"000MBTU"	2012	0	60 000MBTU
TOTAL FUEL CONSUMED	CLNG	85	"000MBTU"	2013	0	60 000MBTU
TOTAL FUEL CONSUMED	CLNG	85	"000MBTU"	2014	0	60 000MBTU

TOTAL FUEL CONSUMED	CLNG	85	"000MBTU"	2015	0	60 000MBTU
TOTAL FUEL CONSUMED	CLNG	85	"000MBTU"	2016	0	60 000MBTU
TOTAL FUEL CONSUMED	CLNG	85	"000MBTU"	2017	0	60 000MBTU
TOTAL FUEL CONSUMED	CLNG	85	"000MBTU"	2018	0	60 000MBTU
TOTAL FUEL CONSUMED	CLNG	85	"000MBTU"	2019	0	60 000MBTU
TOTAL FUEL CONSUMED	CLNG	85	"000MBTU"	2020	0	60 000MBTU
TOTAL FUEL CONSUMED	CLNG	85	"000MBTU"	2021	0	60 000MBTU
TOTAL FUEL CONSUMED	CLNG	85	"000MBTU"	2022	0	60 000MBTU
TOTAL FUEL CONSUMED	CLNG	85	"000MBTU"	2023	0	60 000MBTU
TOTAL FUEL CONSUMED	CLNG	85	"000MBTU"	2024	0	60 000MBTU
TOTAL FUEL CONSUMED	CLNG	85	"000MBTU"	2025	0	60 000MBTU
TOTAL FUEL CONSUMED	CLNG	85	"000MBTU"	2026	0	60 000MBTU
TOTAL FUEL CONSUMED	CLNG	85	"000MBTU"	2027	0	60 000MBTU
TOTAL FUEL CONSUMED	CLNG	85	"000MBTU"	2028	0	60 000MBTU
TOTAL FUEL CONSUMED	CLNG	85	"000MBTU"	2029	672.9265137	60 000MBTU
TOTAL FUEL CONSUMED	CLNG	85	"000MBTU"	2030	3378.42627	60 000MBTU
TOTAL FUEL CONSUMED	CLNG	85	"000MBTU"	2031	3420.531738	60 000MBTU
TOTAL FUEL CONSUMED	CLNG	85	"000MBTU"	2032	3452.494141	60 000MBTU
TOTAL FUEL CONSUMED	CLNG	85	"000MBTU"	2033	3444.87793	60 000MBTU
TOTAL FUEL CONSUMED	CLNG	85	"000MBTU"	2034	3475.710205	60 000MBTU
TOTAL FUEL CONSUMED	CLNG	85	"000MBTU"	2035	3424.519775	60 000MBTU
TOTAL FUEL CONSUMED	RECIP	86	"000MBTU"	2006	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	86	"000MBTU"	2007	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	86	"000MBTU"	2008	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	86	"000MBTU"	2009	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	86	"000MBTU"	2010	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	86	"000MBTU"	2011	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	86	"000MBTU"	2012	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	86	"000MBTU"	2013	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	86	"000MBTU"	2014	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	86	"000MBTU"	2015	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	86	"000MBTU"	2016	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	86	"000MBTU"	2017	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	86	"000MBTU"	2018	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	86	"000MBTU"	2019	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	86	"000MBTU"	2020	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	86	"000MBTU"	2021	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	86	"000MBTU"	2022	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	86	"000MBTU"	2023	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	86	"000MBTU"	2024	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	86	"000MBTU"	2025	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	86	"000MBTU"	2026	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	86	"000MBTU"	2027	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	86	"000MBTU"	2028	136.234436	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	86	"000MBTU"	2029	769.6311646	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	86	"000MBTU"	2030	704.3131104	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	86	"000MBTU"	2031	711.6207275	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	86	"000MBTU"	2032	719.4293213	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	86	"000MBTU"	2033	699.1971436	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	86	"000MBTU"	2034	698.9454346	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	86	"000MBTU"	2035	690.75177	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	87	"000MBTU"	2006	0	40 000MBTU

TOTAL FUEL CONSUMED	RECIP	87	"000MBTU"	2007	0	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	87	"000MBTU"	2008	0	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	87	"000MBTU"	2009	0	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	87	"000MBTU"	2010	0	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	87	"000MBTU"	2011	0	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	87	"000MBTU"	2012	0	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	87	"000MBTU"	2013	0	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	87	"000MBTU"	2014	0	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	87	"000MBTU"	2015	0	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	87	"000MBTU"	2016	0	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	87	"000MBTU"	2017	0	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	87	"000MBTU"	2018	0	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	87	"000MBTU"	2019	0	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	87	"000MBTU"	2020	0	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	87	"000MBTU"	2021	0	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	87	"000MBTU"	2022	0	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	87	"000MBTU"	2023	0	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	87	"000MBTU"	2024	0	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	87	"000MBTU"	2025	0	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	87	"000MBTU"	2026	0	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	87	"000MBTU"	2027	122.7819595	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	87	"000MBTU"	2028	783.9272461	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	87	"000MBTU"	2029	717.6951904	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	87	"000MBTU"	2030	691.6746826	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	87	"000MBTU"	2031	693.8508911	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	87	"000MBTU"	2032	698.1602173	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	87	"000MBTU"	2033	690.6079102	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	87	"000MBTU"	2034	690.6754761	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	87	"000MBTU"	2035	688.0109863	40	000MBTU
TOTAL FUEL CONSUMED	CLNG	88	"000MBTU"	2006	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	88	"000MBTU"	2007	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	88	"000MBTU"	2008	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	88	"000MBTU"	2009	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	88	"000MBTU"	2010	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	88	"000MBTU"	2011	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	88	"000MBTU"	2012	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	88	"000MBTU"	2013	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	88	"000MBTU"	2014	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	88	"000MBTU"	2015	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	88	"000MBTU"	2016	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	88	"000MBTU"	2017	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	88	"000MBTU"	2018	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	88	"000MBTU"	2019	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	88	"000MBTU"	2020	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	88	"000MBTU"	2021	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	88	"000MBTU"	2022	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	88	"000MBTU"	2023	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	88	"000MBTU"	2024	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	88	"000MBTU"	2025	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	88	"000MBTU"	2026	702.6582642	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	88	"000MBTU"	2027	3503.140869	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	88	"000MBTU"	2028	3588.721191	60	000MBTU

TOTAL FUEL CONSUMED	CLNG	88	"000MBTU"	2029	3500.370605	60 000MBTU
TOTAL FUEL CONSUMED	CLNG	88	"000MBTU"	2030	3251.275146	60 000MBTU
TOTAL FUEL CONSUMED	CLNG	88	"000MBTU"	2031	3295.521484	60 000MBTU
TOTAL FUEL CONSUMED	CLNG	88	"000MBTU"	2032	3340.346924	60 000MBTU
TOTAL FUEL CONSUMED	CLNG	88	"000MBTU"	2033	3323.124023	60 000MBTU
TOTAL FUEL CONSUMED	CLNG	88	"000MBTU"	2034	3368.174805	60 000MBTU
TOTAL FUEL CONSUMED	CLNG	88	"000MBTU"	2035	3301.166748	60 000MBTU
TOTAL FUEL CONSUMED	RECIP	89	"000MBTU"	2006	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	89	"000MBTU"	2007	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	89	"000MBTU"	2008	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	89	"000MBTU"	2009	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	89	"000MBTU"	2010	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	89	"000MBTU"	2011	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	89	"000MBTU"	2012	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	89	"000MBTU"	2013	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	89	"000MBTU"	2014	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	89	"000MBTU"	2015	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	89	"000MBTU"	2016	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	89	"000MBTU"	2017	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	89	"000MBTU"	2018	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	89	"000MBTU"	2019	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	89	"000MBTU"	2020	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	89	"000MBTU"	2021	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	89	"000MBTU"	2022	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	89	"000MBTU"	2023	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	89	"000MBTU"	2024	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	89	"000MBTU"	2025	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	89	"000MBTU"	2026	130.581665	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	89	"000MBTU"	2027	749.840332	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	89	"000MBTU"	2028	719.4423218	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	89	"000MBTU"	2029	694.3716431	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	89	"000MBTU"	2030	688.2091064	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	89	"000MBTU"	2031	688.6027832	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	89	"000MBTU"	2032	691.4393311	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	89	"000MBTU"	2033	687.8287964	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	89	"000MBTU"	2034	687.923645	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	89	"000MBTU"	2035	687.4454956	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	90	"000MBTU"	2006	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	90	"000MBTU"	2007	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	90	"000MBTU"	2008	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	90	"000MBTU"	2009	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	90	"000MBTU"	2010	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	90	"000MBTU"	2011	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	90	"000MBTU"	2012	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	90	"000MBTU"	2013	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	90	"000MBTU"	2014	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	90	"000MBTU"	2015	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	90	"000MBTU"	2016	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	90	"000MBTU"	2017	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	90	"000MBTU"	2018	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	90	"000MBTU"	2019	0	40 000MBTU
TOTAL FUEL CONSUMED	RECIP	90	"000MBTU"	2020	0	40 000MBTU

TOTAL FUEL CONSUMED	RECIP	90	"000MBTU"	2021	0	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	90	"000MBTU"	2022	0	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	90	"000MBTU"	2023	0	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	90	"000MBTU"	2024	167.4010468	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	90	"000MBTU"	2025	871.4902344	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	90	"000MBTU"	2026	843.9432983	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	90	"000MBTU"	2027	700.0998535	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	90	"000MBTU"	2028	689.9686279	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	90	"000MBTU"	2029	687.3475952	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	90	"000MBTU"	2030	687.5353394	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	90	"000MBTU"	2031	687.4362183	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	90	"000MBTU"	2032	689.5181885	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	90	"000MBTU"	2033	687.3244019	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	90	"000MBTU"	2034	687.3137817	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	90	"000MBTU"	2035	687.3469849	40	000MBTU
TOTAL FUEL CONSUMED	CLNG	91	"000MBTU"	2006	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	91	"000MBTU"	2007	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	91	"000MBTU"	2008	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	91	"000MBTU"	2009	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	91	"000MBTU"	2010	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	91	"000MBTU"	2011	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	91	"000MBTU"	2012	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	91	"000MBTU"	2013	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	91	"000MBTU"	2014	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	91	"000MBTU"	2015	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	91	"000MBTU"	2016	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	91	"000MBTU"	2017	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	91	"000MBTU"	2018	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	91	"000MBTU"	2019	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	91	"000MBTU"	2020	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	91	"000MBTU"	2021	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	91	"000MBTU"	2022	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	91	"000MBTU"	2023	725.2738647	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	91	"000MBTU"	2024	3625.791016	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	91	"000MBTU"	2025	3611.911133	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	91	"000MBTU"	2026	3582.32959	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	91	"000MBTU"	2027	3382.561279	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	91	"000MBTU"	2028	3464.680176	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	91	"000MBTU"	2029	3412.37207	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	91	"000MBTU"	2030	3128.4104	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	91	"000MBTU"	2031	3173.035889	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	91	"000MBTU"	2032	3202.798096	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	91	"000MBTU"	2033	3198.501709	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	91	"000MBTU"	2034	3234.467529	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	91	"000MBTU"	2035	3188.633301	60	000MBTU
TOTAL FUEL CONSUMED	RECIP	92	"000MBTU"	2006	0	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	92	"000MBTU"	2007	0	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	92	"000MBTU"	2008	0	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	92	"000MBTU"	2009	0	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	92	"000MBTU"	2010	0	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	92	"000MBTU"	2011	0	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	92	"000MBTU"	2012	0	40	000MBTU

TOTAL FUEL CONSUMED	RECIP	92	"000MBTU"	2013	0	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	92	"000MBTU"	2014	0	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	92	"000MBTU"	2015	0	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	92	"000MBTU"	2016	0	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	92	"000MBTU"	2017	0	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	92	"000MBTU"	2018	0	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	92	"000MBTU"	2019	0	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	92	"000MBTU"	2020	0	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	92	"000MBTU"	2021	0	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	92	"000MBTU"	2022	0	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	92	"000MBTU"	2023	192.8475189	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	92	"000MBTU"	2024	796.5291748	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	92	"000MBTU"	2025	736.4504395	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	92	"000MBTU"	2026	722.1694946	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	92	"000MBTU"	2027	689.9784546	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	92	"000MBTU"	2028	689.3363037	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	92	"000MBTU"	2029	687.2956543	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	92	"000MBTU"	2030	687.5909424	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	92	"000MBTU"	2031	687.4823608	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	92	"000MBTU"	2032	689.5199585	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	92	"000MBTU"	2033	687.3342896	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	92	"000MBTU"	2034	687.3043213	40	000MBTU
TOTAL FUEL CONSUMED	RECIP	92	"000MBTU"	2035	687.3291016	40	000MBTU
TOTAL FUEL CONSUMED	CLNG	93	"000MBTU"	2006	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	93	"000MBTU"	2007	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	93	"000MBTU"	2008	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	93	"000MBTU"	2009	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	93	"000MBTU"	2010	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	93	"000MBTU"	2011	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	93	"000MBTU"	2012	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	93	"000MBTU"	2013	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	93	"000MBTU"	2014	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	93	"000MBTU"	2015	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	93	"000MBTU"	2016	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	93	"000MBTU"	2017	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	93	"000MBTU"	2018	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	93	"000MBTU"	2019	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	93	"000MBTU"	2020	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	93	"000MBTU"	2021	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	93	"000MBTU"	2022	731.083252	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	93	"000MBTU"	2023	3709.902832	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	93	"000MBTU"	2024	3521.241699	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	93	"000MBTU"	2025	3506.036621	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	93	"000MBTU"	2026	3486.047607	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	93	"000MBTU"	2027	3247.0625	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	93	"000MBTU"	2028	3345.170166	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	93	"000MBTU"	2029	3275.283447	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	93	"000MBTU"	2030	3007.973877	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	93	"000MBTU"	2031	3049.914307	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	93	"000MBTU"	2032	3084.518555	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	93	"000MBTU"	2033	3085.949707	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	93	"000MBTU"	2034	3121.497314	60	000MBTU

TOTAL FUEL CONSUMED	CLNG	93	"000MBTU"	2035	3074.854004	60	000MBTU
TOTAL FUEL CONSUMED	WIND	94	"000MBTU"	2006	0	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	94	"000MBTU"	2007	0	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	94	"000MBTU"	2008	0	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	94	"000MBTU"	2009	0	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	94	"000MBTU"	2010	0	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	94	"000MBTU"	2011	0	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	94	"000MBTU"	2012	0	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	94	"000MBTU"	2013	0	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	94	"000MBTU"	2014	0	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	94	"000MBTU"	2015	0	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	94	"000MBTU"	2016	0	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	94	"000MBTU"	2017	0	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	94	"000MBTU"	2018	0	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	94	"000MBTU"	2019	24.39936066	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	94	"000MBTU"	2020	103.3113632	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	94	"000MBTU"	2021	103.0233612	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	94	"000MBTU"	2022	103.0233612	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	94	"000MBTU"	2023	103.0232468	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	94	"000MBTU"	2024	103.1214676	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	94	"000MBTU"	2025	102.6850662	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	94	"000MBTU"	2026	102.7457123	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	94	"000MBTU"	2027	100.9654236	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	94	"000MBTU"	2028	102.7643356	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	94	"000MBTU"	2029	101.6438904	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	94	"000MBTU"	2030	95.23790741	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	94	"000MBTU"	2031	97.31922913	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	94	"000MBTU"	2032	98.61820984	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	94	"000MBTU"	2033	97.76542664	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	94	"000MBTU"	2034	99.48832703	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	94	"000MBTU"	2035	97.03400421	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	95	"000MBTU"	2006	0	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	95	"000MBTU"	2007	0	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	95	"000MBTU"	2008	0	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	95	"000MBTU"	2009	0	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	95	"000MBTU"	2010	0	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	95	"000MBTU"	2011	0	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	95	"000MBTU"	2012	0	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	95	"000MBTU"	2013	0	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	95	"000MBTU"	2014	0	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	95	"000MBTU"	2015	0	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	95	"000MBTU"	2016	0	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	95	"000MBTU"	2017	0	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	95	"000MBTU"	2018	24.39936066	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	95	"000MBTU"	2019	103.0233612	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	95	"000MBTU"	2020	103.3113632	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	95	"000MBTU"	2021	103.0226898	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	95	"000MBTU"	2022	103.0018616	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	95	"000MBTU"	2023	102.9796219	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	95	"000MBTU"	2024	101.2243347	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	95	"000MBTU"	2025	100.9568558	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	95	"000MBTU"	2026	100.6690369	4.8	000MBTU

TOTAL FUEL CONSUMED	WIND	95	"000MBTU"	2027	96.23300934	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	95	"000MBTU"	2028	99.77478027	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	95	"000MBTU"	2029	97.40203857	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	95	"000MBTU"	2030	88.11067963	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	95	"000MBTU"	2031	90.83399963	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	95	"000MBTU"	2032	92.50312805	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	95	"000MBTU"	2033	91.87372589	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	95	"000MBTU"	2034	93.89740753	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	95	"000MBTU"	2035	90.60780334	4.8	000MBTU
TOTAL FUEL CONSUMED	CLNG	96	"000MBTU"	2006	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	96	"000MBTU"	2007	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	96	"000MBTU"	2008	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	96	"000MBTU"	2009	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	96	"000MBTU"	2010	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	96	"000MBTU"	2011	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	96	"000MBTU"	2012	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	96	"000MBTU"	2013	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	96	"000MBTU"	2014	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	96	"000MBTU"	2015	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	96	"000MBTU"	2016	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	96	"000MBTU"	2017	0	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	96	"000MBTU"	2018	744.5592041	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	96	"000MBTU"	2019	3789.27832	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	96	"000MBTU"	2020	3786.360596	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	96	"000MBTU"	2021	3784.996582	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	96	"000MBTU"	2022	3773.51416	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	96	"000MBTU"	2023	3644.254395	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	96	"000MBTU"	2024	3391.943115	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	96	"000MBTU"	2025	3381.80835	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	96	"000MBTU"	2026	3365.698975	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	96	"000MBTU"	2027	3127.602539	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	96	"000MBTU"	2028	3216.039307	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	96	"000MBTU"	2029	3137.404785	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	96	"000MBTU"	2030	2915.57959	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	96	"000MBTU"	2031	2951.966309	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	96	"000MBTU"	2032	2980.881348	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	96	"000MBTU"	2033	2983.340088	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	96	"000MBTU"	2034	3008.270752	60	000MBTU
TOTAL FUEL CONSUMED	CLNG	96	"000MBTU"	2035	2978.773438	60	000MBTU
TOTAL FUEL CONSUMED	WIND	97	"000MBTU"	2006	0	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	97	"000MBTU"	2007	0	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	97	"000MBTU"	2008	0	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	97	"000MBTU"	2009	0	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	97	"000MBTU"	2010	0	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	97	"000MBTU"	2011	0	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	97	"000MBTU"	2012	0	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	97	"000MBTU"	2013	0	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	97	"000MBTU"	2014	0	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	97	"000MBTU"	2015	0	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	97	"000MBTU"	2016	0	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	97	"000MBTU"	2017	24.39936066	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	97	"000MBTU"	2018	103.0233612	4.8	000MBTU

TOTAL FUEL CONSUMED	WIND	97	"000MBTU"	2019	103.008934	4.8 000MBTU
TOTAL FUEL CONSUMED	WIND	97	"000MBTU"	2020	103.2223892	4.8 000MBTU
TOTAL FUEL CONSUMED	WIND	97	"000MBTU"	2021	102.9745865	4.8 000MBTU
TOTAL FUEL CONSUMED	WIND	97	"000MBTU"	2022	102.8780289	4.8 000MBTU
TOTAL FUEL CONSUMED	WIND	97	"000MBTU"	2023	102.2426529	4.8 000MBTU
TOTAL FUEL CONSUMED	WIND	97	"000MBTU"	2024	97.7287674	4.8 000MBTU
TOTAL FUEL CONSUMED	WIND	97	"000MBTU"	2025	97.12879944	4.8 000MBTU
TOTAL FUEL CONSUMED	WIND	97	"000MBTU"	2026	97.0859375	4.8 000MBTU
TOTAL FUEL CONSUMED	WIND	97	"000MBTU"	2027	90.67864227	4.8 000MBTU
TOTAL FUEL CONSUMED	WIND	97	"000MBTU"	2028	95.19435883	4.8 000MBTU
TOTAL FUEL CONSUMED	WIND	97	"000MBTU"	2029	92.07860565	4.8 000MBTU
TOTAL FUEL CONSUMED	WIND	97	"000MBTU"	2030	80.9744339	4.8 000MBTU
TOTAL FUEL CONSUMED	WIND	97	"000MBTU"	2031	84.17432404	4.8 000MBTU
TOTAL FUEL CONSUMED	WIND	97	"000MBTU"	2032	86.06494141	4.8 000MBTU
TOTAL FUEL CONSUMED	WIND	97	"000MBTU"	2033	85.44548798	4.8 000MBTU
TOTAL FUEL CONSUMED	WIND	97	"000MBTU"	2034	87.92793274	4.8 000MBTU
TOTAL FUEL CONSUMED	WIND	97	"000MBTU"	2035	83.79335785	4.8 000MBTU
TOTAL FUEL CONSUMED	WIND	98	"000MBTU"	2006	0	4.8 000MBTU
TOTAL FUEL CONSUMED	WIND	98	"000MBTU"	2007	0	4.8 000MBTU
TOTAL FUEL CONSUMED	WIND	98	"000MBTU"	2008	0	4.8 000MBTU
TOTAL FUEL CONSUMED	WIND	98	"000MBTU"	2009	0	4.8 000MBTU
TOTAL FUEL CONSUMED	WIND	98	"000MBTU"	2010	0	4.8 000MBTU
TOTAL FUEL CONSUMED	WIND	98	"000MBTU"	2011	0	4.8 000MBTU
TOTAL FUEL CONSUMED	WIND	98	"000MBTU"	2012	0	4.8 000MBTU
TOTAL FUEL CONSUMED	WIND	98	"000MBTU"	2013	0	4.8 000MBTU
TOTAL FUEL CONSUMED	WIND	98	"000MBTU"	2014	0	4.8 000MBTU
TOTAL FUEL CONSUMED	WIND	98	"000MBTU"	2015	0	4.8 000MBTU
TOTAL FUEL CONSUMED	WIND	98	"000MBTU"	2016	24.39936066	4.8 000MBTU
TOTAL FUEL CONSUMED	WIND	98	"000MBTU"	2017	103.0233612	4.8 000MBTU
TOTAL FUEL CONSUMED	WIND	98	"000MBTU"	2018	103.0055466	4.8 000MBTU
TOTAL FUEL CONSUMED	WIND	98	"000MBTU"	2019	102.7664337	4.8 000MBTU
TOTAL FUEL CONSUMED	WIND	98	"000MBTU"	2020	102.7406845	4.8 000MBTU
TOTAL FUEL CONSUMED	WIND	98	"000MBTU"	2021	102.6304398	4.8 000MBTU
TOTAL FUEL CONSUMED	WIND	98	"000MBTU"	2022	102.4162216	4.8 000MBTU
TOTAL FUEL CONSUMED	WIND	98	"000MBTU"	2023	100.4361954	4.8 000MBTU
TOTAL FUEL CONSUMED	WIND	98	"000MBTU"	2024	92.83220673	4.8 000MBTU
TOTAL FUEL CONSUMED	WIND	98	"000MBTU"	2025	92.59036255	4.8 000MBTU
TOTAL FUEL CONSUMED	WIND	98	"000MBTU"	2026	91.81439209	4.8 000MBTU
TOTAL FUEL CONSUMED	WIND	98	"000MBTU"	2027	83.94683838	4.8 000MBTU
TOTAL FUEL CONSUMED	WIND	98	"000MBTU"	2028	89.50230408	4.8 000MBTU
TOTAL FUEL CONSUMED	WIND	98	"000MBTU"	2029	85.75909424	4.8 000MBTU
TOTAL FUEL CONSUMED	WIND	98	"000MBTU"	2030	73.13785553	4.8 000MBTU
TOTAL FUEL CONSUMED	WIND	98	"000MBTU"	2031	76.74212646	4.8 000MBTU
TOTAL FUEL CONSUMED	WIND	98	"000MBTU"	2032	78.98526764	4.8 000MBTU
TOTAL FUEL CONSUMED	WIND	98	"000MBTU"	2033	78.67233276	4.8 000MBTU
TOTAL FUEL CONSUMED	WIND	98	"000MBTU"	2034	81.42318726	4.8 000MBTU
TOTAL FUEL CONSUMED	WIND	98	"000MBTU"	2035	76.87942505	4.8 000MBTU
TOTAL FUEL CONSUMED	RETR	99	"000MBTU"	2006	0	60 000MBTU
TOTAL FUEL CONSUMED	RETR	99	"000MBTU"	2007	0	60 000MBTU
TOTAL FUEL CONSUMED	RETR	99	"000MBTU"	2008	0	60 000MBTU
TOTAL FUEL CONSUMED	RETR	99	"000MBTU"	2009	0	60 000MBTU
TOTAL FUEL CONSUMED	RETR	99	"000MBTU"	2010	0	60 000MBTU

TOTAL FUEL CONSUMED	RETR	99	"000MBTU"	2011	0	60	000MBTU
TOTAL FUEL CONSUMED	RETR	99	"000MBTU"	2012	0	60	000MBTU
TOTAL FUEL CONSUMED	RETR	99	"000MBTU"	2013	0	60	000MBTU
TOTAL FUEL CONSUMED	RETR	99	"000MBTU"	2014	0	60	000MBTU
TOTAL FUEL CONSUMED	RETR	99	"000MBTU"	2015	0	60	000MBTU
TOTAL FUEL CONSUMED	RETR	99	"000MBTU"	2016	468.4004211	60	000MBTU
TOTAL FUEL CONSUMED	RETR	99	"000MBTU"	2017	1893.803345	60	000MBTU
TOTAL FUEL CONSUMED	RETR	99	"000MBTU"	2018	1539.899414	60	000MBTU
TOTAL FUEL CONSUMED	RETR	99	"000MBTU"	2019	746.6625366	60	000MBTU
TOTAL FUEL CONSUMED	RETR	99	"000MBTU"	2020	593.1859741	60	000MBTU
TOTAL FUEL CONSUMED	RETR	99	"000MBTU"	2021	755.7919312	60	000MBTU
TOTAL FUEL CONSUMED	RETR	99	"000MBTU"	2022	683.5988159	60	000MBTU
TOTAL FUEL CONSUMED	RETR	99	"000MBTU"	2023	116.7293167	60	000MBTU
TOTAL FUEL CONSUMED	RETR	99	"000MBTU"	2024	2.431217194	60	000MBTU
TOTAL FUEL CONSUMED	RETR	99	"000MBTU"	2025	0.641790032	60	000MBTU
TOTAL FUEL CONSUMED	RETR	99	"000MBTU"	2026	2.550688267	60	000MBTU
TOTAL FUEL CONSUMED	RETR	99	"000MBTU"	2027	0.064199157	60	000MBTU
TOTAL FUEL CONSUMED	RETR	99	"000MBTU"	2028	14.32908344	60	000MBTU
TOTAL FUEL CONSUMED	RETR	99	"000MBTU"	2029	2.38695693	60	000MBTU
TOTAL FUEL CONSUMED	RETR	99	"000MBTU"	2030	0.802930713	60	000MBTU
TOTAL FUEL CONSUMED	RETR	99	"000MBTU"	2031	0.65880996	60	000MBTU
TOTAL FUEL CONSUMED	RETR	99	"000MBTU"	2032	0.824171841	60	000MBTU
TOTAL FUEL CONSUMED	RETR	99	"000MBTU"	2033	0.317682326	60	000MBTU
TOTAL FUEL CONSUMED	RETR	99	"000MBTU"	2034	0.286572099	60	000MBTU
TOTAL FUEL CONSUMED	RETR	99	"000MBTU"	2035	0.308597952	60	000MBTU
TOTAL FUEL CONSUMED	WIND	100	"000MBTU"	2006	0	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	100	"000MBTU"	2007	0	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	100	"000MBTU"	2008	0	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	100	"000MBTU"	2009	0	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	100	"000MBTU"	2010	0	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	100	"000MBTU"	2011	0	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	100	"000MBTU"	2012	0	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	100	"000MBTU"	2013	0	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	100	"000MBTU"	2014	0	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	100	"000MBTU"	2015	24.39936066	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	100	"000MBTU"	2016	103.3113632	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	100	"000MBTU"	2017	103.0233612	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	100	"000MBTU"	2018	102.9173203	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	100	"000MBTU"	2019	102.0330887	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	100	"000MBTU"	2020	101.64534	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	100	"000MBTU"	2021	101.8000031	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	100	"000MBTU"	2022	101.3968887	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	100	"000MBTU"	2023	97.5836792	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	100	"000MBTU"	2024	86.90519714	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	100	"000MBTU"	2025	86.72759247	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	100	"000MBTU"	2026	86.15300751	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	100	"000MBTU"	2027	77.10820007	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	100	"000MBTU"	2028	83.14096069	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	100	"000MBTU"	2029	79.1869278	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	100	"000MBTU"	2030	65.49352264	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	100	"000MBTU"	2031	69.39580536	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	100	"000MBTU"	2032	71.85830688	4.8	000MBTU

TOTAL FUEL CONSUMED	WIND	100	"000MBTU"	2033	71.62987518	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	100	"000MBTU"	2034	74.59816742	4.8	000MBTU
TOTAL FUEL CONSUMED	WIND	100	"000MBTU"	2035	69.85338593	4.8	000MBTU
TOTAL FUEL COST	CAB ST	1	"$000"	2006	24800.69336	66	$000
TOTAL FUEL COST	CAB ST	1	"$000"	2007	25578.02539	66	$000
TOTAL FUEL COST	CAB ST	1	"$000"	2008	31808.61914	66	$000
TOTAL FUEL COST	CAB ST	1	"$000"	2009	31218.38672	66	$000
TOTAL FUEL COST	CAB ST	1	"$000"	2010	40825.22266	66	$000
TOTAL FUEL COST	CAB ST	1	"$000"	2011	42092.10547	66	$000
TOTAL FUEL COST	CAB ST	1	"$000"	2012	36960.48047	66	$000
TOTAL FUEL COST	CAB ST	1	"$000"	2013	44172.91016	66	$000
TOTAL FUEL COST	CAB ST	1	"$000"	2014	41807.28906	66	$000
TOTAL FUEL COST	CAB ST	1	"$000"	2015	45612.68359	66	$000
TOTAL FUEL COST	CAB ST	1	"$000"	2016	45615.68359	66	$000
TOTAL FUEL COST	CAB ST	1	"$000"	2017	45792.84375	66	$000
TOTAL FUEL COST	CAB ST	1	"$000"	2018	44713.57031	66	$000
TOTAL FUEL COST	CAB ST	1	"$000"	2019	39405.76563	66	$000
TOTAL FUEL COST	CAB ST	1	"$000"	2020	39157.20703	66	$000
TOTAL FUEL COST	CAB ST	1	"$000"	2021	39226.75781	66	$000
TOTAL FUEL COST	CAB ST	1	"$000"	2022	42687.25391	66	$000
TOTAL FUEL COST	CAB ST	1	"$000"	2023	35330.73438	66	$000
TOTAL FUEL COST	CAB ST	1	"$000"	2024	29663.36133	66	$000
TOTAL FUEL COST	CAB ST	1	"$000"	2025	30294.41797	66	$000
TOTAL FUEL COST	CAB ST	1	"$000"	2026	31394.32031	66	$000
TOTAL FUEL COST	CAB ST	1	"$000"	2027	0	66	$000
TOTAL FUEL COST	CAB ST	1	"$000"	2028	0	66	$000
TOTAL FUEL COST	CAB ST	1	"$000"	2029	0	66	$000
TOTAL FUEL COST	CAB ST	1	"$000"	2030	0	66	$000
TOTAL FUEL COST	CAB ST	1	"$000"	2031	0	66	$000
TOTAL FUEL COST	CAB ST	1	"$000"	2032	0	66	$000
TOTAL FUEL COST	CAB ST	1	"$000"	2033	0	66	$000
TOTAL FUEL COST	CAB ST	1	"$000"	2034	0	66	$000
TOTAL FUEL COST	CAB ST	1	"$000"	2035	0	66	$000
TOTAL FUEL COST	CAB ST	2	"$000"	2006	25688.30273	66	$000
TOTAL FUEL COST	CAB ST	2	"$000"	2007	29072.89453	66	$000
TOTAL FUEL COST	CAB ST	2	"$000"	2008	33105.05078	66	$000
TOTAL FUEL COST	CAB ST	2	"$000"	2009	31813.65039	66	$000
TOTAL FUEL COST	CAB ST	2	"$000"	2010	42672.67969	66	$000
TOTAL FUEL COST	CAB ST	2	"$000"	2011	44236.69531	66	$000
TOTAL FUEL COST	CAB ST	2	"$000"	2012	38539.96484	66	$000
TOTAL FUEL COST	CAB ST	2	"$000"	2013	47118.47266	66	$000
TOTAL FUEL COST	CAB ST	2	"$000"	2014	48499.51953	66	$000
TOTAL FUEL COST	CAB ST	2	"$000"	2015	48557.95313	66	$000
TOTAL FUEL COST	CAB ST	2	"$000"	2016	48517.55078	66	$000
TOTAL FUEL COST	CAB ST	2	"$000"	2017	48966.75781	66	$000
TOTAL FUEL COST	CAB ST	2	"$000"	2018	47564.71094	66	$000
TOTAL FUEL COST	CAB ST	2	"$000"	2019	36381.30469	66	$000
TOTAL FUEL COST	CAB ST	2	"$000"	2020	39063.76953	66	$000
TOTAL FUEL COST	CAB ST	2	"$000"	2021	42293.22656	66	$000
TOTAL FUEL COST	CAB ST	2	"$000"	2022	42621.06641	66	$000
TOTAL FUEL COST	CAB ST	2	"$000"	2023	33321.21484	66	$000
TOTAL FUEL COST	CAB ST	2	"$000"	2024	28183.41406	66	$000

TOTAL FUEL COST	CAB ST	2	"$000"	2025	28589.81445	66 $000
TOTAL FUEL COST	CAB ST	2	"$000"	2026	27788.95703	66 $000
TOTAL FUEL COST	CAB ST	2	"$000"	2027	30527.74023	66 $000
TOTAL FUEL COST	CAB ST	2	"$000"	2028	0	66 $000
TOTAL FUEL COST	CAB ST	2	"$000"	2029	0	66 $000
TOTAL FUEL COST	CAB ST	2	"$000"	2030	0	66 $000
TOTAL FUEL COST	CAB ST	2	"$000"	2031	0	66 $000
TOTAL FUEL COST	CAB ST	2	"$000"	2032	0	66 $000
TOTAL FUEL COST	CAB ST	2	"$000"	2033	0	66 $000
TOTAL FUEL COST	CAB ST	2	"$000"	2034	0	66 $000
TOTAL FUEL COST	CAB ST	2	"$000"	2035	0	66 $000
TOTAL FUEL COST	CAB SSD	3	"$000"	2006	14545.85547	39.3 $000
TOTAL FUEL COST	CAB SSD	3	"$000"	2007	16281.02637	39.3 $000
TOTAL FUEL COST	CAB SSD	3	"$000"	2008	17784.86719	39.3 $000
TOTAL FUEL COST	CAB SSD	3	"$000"	2009	19765.375	39.3 $000
TOTAL FUEL COST	CAB SSD	3	"$000"	2010	21763.76953	39.3 $000
TOTAL FUEL COST	CAB SSD	3	"$000"	2011	22072.49609	39.3 $000
TOTAL FUEL COST	CAB SSD	3	"$000"	2012	23622.81641	39.3 $000
TOTAL FUEL COST	CAB SSD	3	"$000"	2013	22904.74414	39.3 $000
TOTAL FUEL COST	CAB SSD	3	"$000"	2014	23685.3418	39.3 $000
TOTAL FUEL COST	CAB SSD	3	"$000"	2015	23541.49609	39.3 $000
TOTAL FUEL COST	CAB SSD	3	"$000"	2016	24188.82813	39.3 $000
TOTAL FUEL COST	CAB SSD	3	"$000"	2017	24939.07813	39.3 $000
TOTAL FUEL COST	CAB SSD	3	"$000"	2018	24650.58789	39.3 $000
TOTAL FUEL COST	CAB SSD	3	"$000"	2019	22916.91211	39.3 $000
TOTAL FUEL COST	CAB SSD	3	"$000"	2020	23609.43555	39.3 $000
TOTAL FUEL COST	CAB SSD	3	"$000"	2021	24892.85156	39.3 $000
TOTAL FUEL COST	CAB SSD	3	"$000"	2022	25489.68555	39.3 $000
TOTAL FUEL COST	CAB SSD	3	"$000"	2023	24040.7207	39.3 $000
TOTAL FUEL COST	CAB SSD	3	"$000"	2024	24034.58398	39.3 $000
TOTAL FUEL COST	CAB SSD	3	"$000"	2025	24957.875	39.3 $000
TOTAL FUEL COST	CAB SSD	3	"$000"	2026	25418.47852	39.3 $000
TOTAL FUEL COST	CAB SSD	3	"$000"	2027	25312.875	39.3 $000
TOTAL FUEL COST	CAB SSD	3	"$000"	2028	26924.75781	39.3 $000
TOTAL FUEL COST	CAB SSD	3	"$000"	2029	27493.72461	39.3 $000
TOTAL FUEL COST	CAB SSD	3	"$000"	2030	27424.45508	39.3 $000
TOTAL FUEL COST	CAB SSD	3	"$000"	2031	28575.7793	39.3 $000
TOTAL FUEL COST	CAB SSD	3	"$000"	2032	29757.13867	39.3 $000
TOTAL FUEL COST	CAB SSD	3	"$000"	2033	30748.78125	39.3 $000
TOTAL FUEL COST	CAB SSD	3	"$000"	2034	31896.76563	39.3 $000
TOTAL FUEL COST	CAB SSD	3	"$000"	2035	32611.0957	39.3 $000
TOTAL FUEL COST	CAB SSD	4	"$000"	2006	14503.57617	39.3 $000
TOTAL FUEL COST	CAB SSD	4	"$000"	2007	16234.02734	39.3 $000
TOTAL FUEL COST	CAB SSD	4	"$000"	2008	17725.4043	39.3 $000
TOTAL FUEL COST	CAB SSD	4	"$000"	2009	19639.60156	39.3 $000
TOTAL FUEL COST	CAB SSD	4	"$000"	2010	21612.44336	39.3 $000
TOTAL FUEL COST	CAB SSD	4	"$000"	2011	21841.20898	39.3 $000
TOTAL FUEL COST	CAB SSD	4	"$000"	2012	23072.01758	39.3 $000
TOTAL FUEL COST	CAB SSD	4	"$000"	2013	22514.93359	39.3 $000
TOTAL FUEL COST	CAB SSD	4	"$000"	2014	23252.21289	39.3 $000
TOTAL FUEL COST	CAB SSD	4	"$000"	2015	23198.42578	39.3 $000
TOTAL FUEL COST	CAB SSD	4	"$000"	2016	23830.61719	39.3 $000

TOTAL FUEL COST	CAB SSD	4	"$000"	2017	24401.91992	39.3	$000
TOTAL FUEL COST	CAB SSD	4	"$000"	2018	24468.33203	39.3	$000
TOTAL FUEL COST	CAB SSD	4	"$000"	2019	24146.44336	39.3	$000
TOTAL FUEL COST	CAB SSD	4	"$000"	2020	24813.39844	39.3	$000
TOTAL FUEL COST	CAB SSD	4	"$000"	2021	25845.80664	39.3	$000
TOTAL FUEL COST	CAB SSD	4	"$000"	2022	26786.03125	39.3	$000
TOTAL FUEL COST	CAB SSD	4	"$000"	2023	27319.31445	39.3	$000
TOTAL FUEL COST	CAB SSD	4	"$000"	2024	26185.71484	39.3	$000
TOTAL FUEL COST	CAB SSD	4	"$000"	2025	27094.62109	39.3	$000
TOTAL FUEL COST	CAB SSD	4	"$000"	2026	27985.94531	39.3	$000
TOTAL FUEL COST	CAB SSD	4	"$000"	2027	27903.62695	39.3	$000
TOTAL FUEL COST	CAB SSD	4	"$000"	2028	29566.92383	39.3	$000
TOTAL FUEL COST	CAB SSD	4	"$000"	2029	30216.31055	39.3	$000
TOTAL FUEL COST	CAB SSD	4	"$000"	2030	30117.37891	39.3	$000
TOTAL FUEL COST	CAB SSD	4	"$000"	2031	31369.0918	39.3	$000
TOTAL FUEL COST	CAB SSD	4	"$000"	2032	32703.29102	39.3	$000
TOTAL FUEL COST	CAB SSD	4	"$000"	2033	33749.87891	39.3	$000
TOTAL FUEL COST	CAB SSD	4	"$000"	2034	35121.51563	39.3	$000
TOTAL FUEL COST	CAB SSD	4	"$000"	2035	36040.15234	39.3	$000
TOTAL FUEL COST	OROTE	1	"$000"	2006	1.961203218	16	$000
TOTAL FUEL COST	OROTE	1	"$000"	2007	0	16	$000
TOTAL FUEL COST	OROTE	1	"$000"	2008	0	16	$000
TOTAL FUEL COST	OROTE	1	"$000"	2009	0	16	$000
TOTAL FUEL COST	OROTE	1	"$000"	2010	0	16	$000
TOTAL FUEL COST	OROTE	1	"$000"	2011	0	16	$000
TOTAL FUEL COST	OROTE	1	"$000"	2012	0	16	$000
TOTAL FUEL COST	OROTE	1	"$000"	2013	0	16	$000
TOTAL FUEL COST	OROTE	1	"$000"	2014	0	16	$000
TOTAL FUEL COST	OROTE	1	"$000"	2015	0	16	$000
TOTAL FUEL COST	OROTE	1	"$000"	2016	0	16	$000
TOTAL FUEL COST	OROTE	1	"$000"	2017	0	16	$000
TOTAL FUEL COST	OROTE	1	"$000"	2018	0	16	$000
TOTAL FUEL COST	OROTE	1	"$000"	2019	0	16	$000
TOTAL FUEL COST	OROTE	1	"$000"	2020	0	16	$000
TOTAL FUEL COST	OROTE	1	"$000"	2021	0	16	$000
TOTAL FUEL COST	OROTE	1	"$000"	2022	0	16	$000
TOTAL FUEL COST	OROTE	1	"$000"	2023	0	16	$000
TOTAL FUEL COST	OROTE	1	"$000"	2024	0	16	$000
TOTAL FUEL COST	OROTE	1	"$000"	2025	0	16	$000
TOTAL FUEL COST	OROTE	1	"$000"	2026	0	16	$000
TOTAL FUEL COST	OROTE	1	"$000"	2027	0	16	$000
TOTAL FUEL COST	OROTE	1	"$000"	2028	0	16	$000
TOTAL FUEL COST	OROTE	1	"$000"	2029	0	16	$000
TOTAL FUEL COST	OROTE	1	"$000"	2030	0	16	$000
TOTAL FUEL COST	OROTE	1	"$000"	2031	0	16	$000
TOTAL FUEL COST	OROTE	1	"$000"	2032	0	16	$000
TOTAL FUEL COST	OROTE	1	"$000"	2033	0	16	$000
TOTAL FUEL COST	OROTE	1	"$000"	2034	0	16	$000
TOTAL FUEL COST	OROTE	1	"$000"	2035	0	16	$000
TOTAL FUEL COST	DED CT	1	"$000"	2006	30.18151093	23	$000
TOTAL FUEL COST	DED CT	1	"$000"	2007	35.59893036	23	$000
TOTAL FUEL COST	DED CT	1	"$000"	2008	31.96395874	23	$000

TOTAL FUEL COST	DED CT	1	"$000"	2009	21.82209015	23	$000
TOTAL FUEL COST	DED CT	1	"$000"	2010	29.80809784	23	$000
TOTAL FUEL COST	DED CT	1	"$000"	2011	33.51465225	23	$000
TOTAL FUEL COST	DED CT	1	"$000"	2012	173.4814911	23	$000
TOTAL FUEL COST	DED CT	1	"$000"	2013	130.2860565	23	$000
TOTAL FUEL COST	DED CT	1	"$000"	2014	292.6898804	23	$000
TOTAL FUEL COST	DED CT	1	"$000"	2015	354.6995544	23	$000
TOTAL FUEL COST	DED CT	1	"$000"	2016	246.7634735	23	$000
TOTAL FUEL COST	DED CT	1	"$000"	2017	38.52531052	23	$000
TOTAL FUEL COST	DED CT	1	"$000"	2018	20.38948059	23	$000
TOTAL FUEL COST	DED CT	1	"$000"	2019	2.337819338	23	$000
TOTAL FUEL COST	DED CT	1	"$000"	2020	3.382461071	23	$000
TOTAL FUEL COST	DED CT	1	"$000"	2021	4.8828125	23	$000
TOTAL FUEL COST	DED CT	1	"$000"	2022	2.814747334	23	$000
TOTAL FUEL COST	DED CT	1	"$000"	2023	0	23	$000
TOTAL FUEL COST	DED CT	1	"$000"	2024	0	23	$000
TOTAL FUEL COST	DED CT	1	"$000"	2025	0	23	$000
TOTAL FUEL COST	DED CT	1	"$000"	2026	0	23	$000
TOTAL FUEL COST	DED CT	1	"$000"	2027	0	23	$000
TOTAL FUEL COST	DED CT	1	"$000"	2028	0	23	$000
TOTAL FUEL COST	DED CT	1	"$000"	2029	0	23	$000
TOTAL FUEL COST	DED CT	1	"$000"	2030	0	23	$000
TOTAL FUEL COST	DED CT	1	"$000"	2031	0	23	$000
TOTAL FUEL COST	DED CT	1	"$000"	2032	0	23	$000
TOTAL FUEL COST	DED CT	1	"$000"	2033	0	23	$000
TOTAL FUEL COST	DED CT	1	"$000"	2034	0	23	$000
TOTAL FUEL COST	DED CT	1	"$000"	2035	0	23	$000
TOTAL FUEL COST	DED CT	2	"$000"	2006	29.70961952	22	$000
TOTAL FUEL COST	DED CT	2	"$000"	2007	35.64293671	22	$000
TOTAL FUEL COST	DED CT	2	"$000"	2008	35.95956421	22	$000
TOTAL FUEL COST	DED CT	2	"$000"	2009	18.17801666	22	$000
TOTAL FUEL COST	DED CT	2	"$000"	2010	27.65022278	22	$000
TOTAL FUEL COST	DED CT	2	"$000"	2011	25.50844574	22	$000
TOTAL FUEL COST	DED CT	2	"$000"	2012	79.72259521	22	$000
TOTAL FUEL COST	DED CT	2	"$000"	2013	65.53964996	22	$000
TOTAL FUEL COST	DED CT	2	"$000"	2014	148.5520172	22	$000
TOTAL FUEL COST	DED CT	2	"$000"	2015	180.3833313	22	$000
TOTAL FUEL COST	DED CT	2	"$000"	2016	124.5591354	22	$000
TOTAL FUEL COST	DED CT	2	"$000"	2017	19.86859512	22	$000
TOTAL FUEL COST	DED CT	2	"$000"	2018	9.60605526	22	$000
TOTAL FUEL COST	DED CT	2	"$000"	2019	0.982999623	22	$000
TOTAL FUEL COST	DED CT	2	"$000"	2020	1.261560321	22	$000
TOTAL FUEL COST	DED CT	2	"$000"	2021	2.830538511	22	$000
TOTAL FUEL COST	DED CT	2	"$000"	2022	1.569575191	22	$000
TOTAL FUEL COST	DED CT	2	"$000"	2023	0.923043132	22	$000
TOTAL FUEL COST	DED CT	2	"$000"	2024	0.599657774	22	$000
TOTAL FUEL COST	DED CT	2	"$000"	2025	0	22	$000
TOTAL FUEL COST	DED CT	2	"$000"	2026	0	22	$000
TOTAL FUEL COST	DED CT	2	"$000"	2027	0	22	$000
TOTAL FUEL COST	DED CT	2	"$000"	2028	0	22	$000
TOTAL FUEL COST	DED CT	2	"$000"	2029	0	22	$000
TOTAL FUEL COST	DED CT	2	"$000"	2030	0	22	$000

TOTAL FUEL COST	DED CT 2	"$000"	2031	0	22 $000
TOTAL FUEL COST	DED CT 2	"$000"	2032	0	22 $000
TOTAL FUEL COST	DED CT 2	"$000"	2033	0	22 $000
TOTAL FUEL COST	DED CT 2	"$000"	2034	0	22 $000
TOTAL FUEL COST	DED CT 2	"$000"	2035	0	22 $000
TOTAL FUEL COST	MACH CT 1	"$000"	2006	26.16557312	22 $000
TOTAL FUEL COST	MACH CT 1	"$000"	2007	31.70365143	22 $000
TOTAL FUEL COST	MACH CT 1	"$000"	2008	33.10021591	22 $000
TOTAL FUEL COST	MACH CT 1	"$000"	2009	54.65786362	22 $000
TOTAL FUEL COST	MACH CT 1	"$000"	2010	50.88674545	22 $000
TOTAL FUEL COST	MACH CT 1	"$000"	2011	135.1734924	22 $000
TOTAL FUEL COST	MACH CT 1	"$000"	2012	746.0418091	22 $000
TOTAL FUEL COST	MACH CT 1	"$000"	2013	501.771759	22 $000
TOTAL FUEL COST	MACH CT 1	"$000"	2014	1107.654297	22 $000
TOTAL FUEL COST	MACH CT 1	"$000"	2015	1437.057983	22 $000
TOTAL FUEL COST	MACH CT 1	"$000"	2016	1045.097046	22 $000
TOTAL FUEL COST	MACH CT 1	"$000"	2017	225.4496307	22 $000
TOTAL FUEL COST	MACH CT 1	"$000"	2018	137.7768707	22 $000
TOTAL FUEL COST	MACH CT 1	"$000"	2019	15.13229942	22 $000
TOTAL FUEL COST	MACH CT 1	"$000"	2020	17.28636932	22 $000
TOTAL FUEL COST	MACH CT 1	"$000"	2021	37.87129593	22 $000
TOTAL FUEL COST	MACH CT 1	"$000"	2022	27.24631882	22 $000
TOTAL FUEL COST	MACH CT 1	"$000"	2023	1.508129835	22 $000
TOTAL FUEL COST	MACH CT 1	"$000"	2024	0	22 $000
TOTAL FUEL COST	MACH CT 1	"$000"	2025	0	22 $000
TOTAL FUEL COST	MACH CT 1	"$000"	2026	0	22 $000
TOTAL FUEL COST	MACH CT 1	"$000"	2027	0	22 $000
TOTAL FUEL COST	MACH CT 1	"$000"	2028	0	22 $000
TOTAL FUEL COST	MACH CT 1	"$000"	2029	0	22 $000
TOTAL FUEL COST	MACH CT 1	"$000"	2030	0	22 $000
TOTAL FUEL COST	MACH CT 1	"$000"	2031	0	22 $000
TOTAL FUEL COST	MACH CT 1	"$000"	2032	0	22 $000
TOTAL FUEL COST	MACH CT 1	"$000"	2033	0	22 $000
TOTAL FUEL COST	MACH CT 1	"$000"	2034	0	22 $000
TOTAL FUEL COST	MACH CT 1	"$000"	2035	0	22 $000
TOTAL FUEL COST	YIGO CT 1	"$000"	2006	117.8181458	22 $000
TOTAL FUEL COST	YIGO CT 1	"$000"	2007	142.281601	22 $000
TOTAL FUEL COST	YIGO CT 1	"$000"	2008	278.1741943	22 $000
TOTAL FUEL COST	YIGO CT 1	"$000"	2009	1598.599976	22 $000
TOTAL FUEL COST	YIGO CT 1	"$000"	2010	2300.675537	22 $000
TOTAL FUEL COST	YIGO CT 1	"$000"	2011	3888.408203	22 $000
TOTAL FUEL COST	YIGO CT 1	"$000"	2012	8962.743164	22 $000
TOTAL FUEL COST	YIGO CT 1	"$000"	2013	6412.273438	22 $000
TOTAL FUEL COST	YIGO CT 1	"$000"	2014	9193.175781	22 $000
TOTAL FUEL COST	YIGO CT 1	"$000"	2015	8498.503906	22 $000
TOTAL FUEL COST	YIGO CT 1	"$000"	2016	5791.680176	22 $000
TOTAL FUEL COST	YIGO CT 1	"$000"	2017	646.0597534	22 $000
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TOTAL FUEL COST	YIGO CT 1	"$000"	2019	47.08658981	22 $000
TOTAL FUEL COST	YIGO CT 1	"$000"	2020	51.75922775	22 $000
TOTAL FUEL COST	YIGO CT 1	"$000"	2021	107.4171066	22 $000
TOTAL FUEL COST	YIGO CT 1	"$000"	2022	57.02140808	22 $000

TOTAL FUEL COST	YIGO CT 1	"$000"	2023	2.158684254	22 $000
TOTAL FUEL COST	YIGO CT 1	"$000"	2024	0	22 $000
TOTAL FUEL COST	YIGO CT 1	"$000"	2025	0	22 $000
TOTAL FUEL COST	YIGO CT 1	"$000"	2026	0	22 $000
TOTAL FUEL COST	YIGO CT 1	"$000"	2027	0	22 $000
TOTAL FUEL COST	YIGO CT 1	"$000"	2028	0	22 $000
TOTAL FUEL COST	YIGO CT 1	"$000"	2029	0	22 $000
TOTAL FUEL COST	YIGO CT 1	"$000"	2030	0	22 $000
TOTAL FUEL COST	YIGO CT 1	"$000"	2031	0	22 $000
TOTAL FUEL COST	YIGO CT 1	"$000"	2032	0	22 $000
TOTAL FUEL COST	YIGO CT 1	"$000"	2033	0	22 $000
TOTAL FUEL COST	YIGO CT 1	"$000"	2034	0	22 $000
TOTAL FUEL COST	YIGO CT 1	"$000"	2035	0	22 $000
TOTAL FUEL COST	MARBO CT 1	"$000"	2006	21.96531868	16 $000
TOTAL FUEL COST	MARBO CT 1	"$000"	2007	26.78314972	16 $000
TOTAL FUEL COST	MARBO CT 1	"$000"	2008	27.33639336	16 $000
TOTAL FUEL COST	MARBO CT 1	"$000"	2009	12.7278986	16 $000
TOTAL FUEL COST	MARBO CT 1	"$000"	2010	20.17994499	16 $000
TOTAL FUEL COST	MARBO CT 1	"$000"	2011	16.64941025	16 $000
TOTAL FUEL COST	MARBO CT 1	"$000"	2012	3.898548603	16 $000
TOTAL FUEL COST	MARBO CT 1	"$000"	2013	13.27705765	16 $000
TOTAL FUEL COST	MARBO CT 1	"$000"	2014	4.380023479	16 $000
TOTAL FUEL COST	MARBO CT 1	"$000"	2015	3.586190462	16 $000
TOTAL FUEL COST	MARBO CT 1	"$000"	2016	12.2522831	16 $000
TOTAL FUEL COST	MARBO CT 1	"$000"	2017	10.39836311	16 $000
TOTAL FUEL COST	MARBO CT 1	"$000"	2018	4.203264236	16 $000
TOTAL FUEL COST	MARBO CT 1	"$000"	2019	0.014192435	16 $000
TOTAL FUEL COST	MARBO CT 1	"$000"	2020	0.034624506	16 $000
TOTAL FUEL COST	MARBO CT 1	"$000"	2021	0.110246509	16 $000
TOTAL FUEL COST	MARBO CT 1	"$000"	2022	0.058549151	16 $000
TOTAL FUEL COST	MARBO CT 1	"$000"	2023	0.002095259	16 $000
TOTAL FUEL COST	MARBO CT 1	"$000"	2024	0	16 $000
TOTAL FUEL COST	MARBO CT 1	"$000"	2025	0	16 $000
TOTAL FUEL COST	MARBO CT 1	"$000"	2026	0	16 $000
TOTAL FUEL COST	MARBO CT 1	"$000"	2027	0	16 $000
TOTAL FUEL COST	MARBO CT 1	"$000"	2028	0	16 $000
TOTAL FUEL COST	MARBO CT 1	"$000"	2029	0	16 $000
TOTAL FUEL COST	MARBO CT 1	"$000"	2030	0	16 $000
TOTAL FUEL COST	MARBO CT 1	"$000"	2031	0	16 $000
TOTAL FUEL COST	MARBO CT 1	"$000"	2032	0	16 $000
TOTAL FUEL COST	MARBO CT 1	"$000"	2033	0	16 $000
TOTAL FUEL COST	MARBO CT 1	"$000"	2034	0	16 $000
TOTAL FUEL COST	MARBO CT 1	"$000"	2035	0	16 $000
TOTAL FUEL COST	DED DSL 1	"$000"	2006	3.365318537	2.5 $000
TOTAL FUEL COST	DED DSL 1	"$000"	2007	3.988089323	2.5 $000
TOTAL FUEL COST	DED DSL 1	"$000"	2008	4.014717579	2.5 $000
TOTAL FUEL COST	DED DSL 1	"$000"	2009	1.881478429	2.5 $000
TOTAL FUEL COST	DED DSL 1	"$000"	2010	2.970679283	2.5 $000
TOTAL FUEL COST	DED DSL 1	"$000"	2011	2.454192638	2.5 $000
TOTAL FUEL COST	DED DSL 1	"$000"	2012	0.566547632	2.5 $000
TOTAL FUEL COST	DED DSL 1	"$000"	2013	1.971034288	2.5 $000
TOTAL FUEL COST	DED DSL 1	"$000"	2014	0.676185071	2.5 $000

TOTAL FUEL COST	DED DSL 1	"$000"	2015	0.575778663	2.5 $000
TOTAL FUEL COST	DED DSL 1	"$000"	2016	1.87586534	2.5 $000
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TOTAL FUEL COST	DED DSL 1	"$000"	2018	0	2.5 $000
TOTAL FUEL COST	DED DSL 1	"$000"	2019	0	2.5 $000
TOTAL FUEL COST	DED DSL 1	"$000"	2020	0	2.5 $000
TOTAL FUEL COST	DED DSL 1	"$000"	2021	0	2.5 $000
TOTAL FUEL COST	DED DSL 1	"$000"	2022	0	2.5 $000
TOTAL FUEL COST	DED DSL 1	"$000"	2023	0	2.5 $000
TOTAL FUEL COST	DED DSL 1	"$000"	2024	0	2.5 $000
TOTAL FUEL COST	DED DSL 1	"$000"	2025	0	2.5 $000
TOTAL FUEL COST	DED DSL 1	"$000"	2026	0	2.5 $000
TOTAL FUEL COST	DED DSL 1	"$000"	2027	0	2.5 $000
TOTAL FUEL COST	DED DSL 1	"$000"	2028	0	2.5 $000
TOTAL FUEL COST	DED DSL 1	"$000"	2029	0	2.5 $000
TOTAL FUEL COST	DED DSL 1	"$000"	2030	0	2.5 $000
TOTAL FUEL COST	DED DSL 1	"$000"	2031	0	2.5 $000
TOTAL FUEL COST	DED DSL 1	"$000"	2032	0	2.5 $000
TOTAL FUEL COST	DED DSL 1	"$000"	2033	0	2.5 $000
TOTAL FUEL COST	DED DSL 1	"$000"	2034	0	2.5 $000
TOTAL FUEL COST	DED DSL 1	"$000"	2035	0	2.5 $000
TOTAL FUEL COST	DED DSL 2	"$000"	2006	3.338632584	2.5 $000
TOTAL FUEL COST	DED DSL 2	"$000"	2007	4.002253056	2.5 $000
TOTAL FUEL COST	DED DSL 2	"$000"	2008	4.044213295	2.5 $000
TOTAL FUEL COST	DED DSL 2	"$000"	2009	1.812509418	2.5 $000
TOTAL FUEL COST	DED DSL 2	"$000"	2010	2.956488848	2.5 $000
TOTAL FUEL COST	DED DSL 2	"$000"	2011	2.486982822	2.5 $000
TOTAL FUEL COST	DED DSL 2	"$000"	2012	0.538812697	2.5 $000
TOTAL FUEL COST	DED DSL 2	"$000"	2013	1.926311374	2.5 $000
TOTAL FUEL COST	DED DSL 2	"$000"	2014	0.627378821	2.5 $000
TOTAL FUEL COST	DED DSL 2	"$000"	2015	0.568638623	2.5 $000
TOTAL FUEL COST	DED DSL 2	"$000"	2016	1.863483071	2.5 $000
TOTAL FUEL COST	DED DSL 2	"$000"	2017	0	2.5 $000
TOTAL FUEL COST	DED DSL 2	"$000"	2018	0	2.5 $000
TOTAL FUEL COST	DED DSL 2	"$000"	2019	0	2.5 $000
TOTAL FUEL COST	DED DSL 2	"$000"	2020	0	2.5 $000
TOTAL FUEL COST	DED DSL 2	"$000"	2021	0	2.5 $000
TOTAL FUEL COST	DED DSL 2	"$000"	2022	0	2.5 $000
TOTAL FUEL COST	DED DSL 2	"$000"	2023	0	2.5 $000
TOTAL FUEL COST	DED DSL 2	"$000"	2024	0	2.5 $000
TOTAL FUEL COST	DED DSL 2	"$000"	2025	0	2.5 $000
TOTAL FUEL COST	DED DSL 2	"$000"	2026	0	2.5 $000
TOTAL FUEL COST	DED DSL 2	"$000"	2027	0	2.5 $000
TOTAL FUEL COST	DED DSL 2	"$000"	2028	0	2.5 $000
TOTAL FUEL COST	DED DSL 2	"$000"	2029	0	2.5 $000
TOTAL FUEL COST	DED DSL 2	"$000"	2030	0	2.5 $000
TOTAL FUEL COST	DED DSL 2	"$000"	2031	0	2.5 $000
TOTAL FUEL COST	DED DSL 2	"$000"	2032	0	2.5 $000
TOTAL FUEL COST	DED DSL 2	"$000"	2033	0	2.5 $000
TOTAL FUEL COST	DED DSL 2	"$000"	2034	0	2.5 $000
TOTAL FUEL COST	DED DSL 2	"$000"	2035	0	2.5 $000
TOTAL FUEL COST	DED DSL 3	"$000"	2006	3.365553617	2.5 $000

TOTAL FUEL COST	DED DSL 3	"$000"	2007	3.99523592	2.5 $000
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TOTAL FUEL COST	DED DSL 3	"$000"	2009	1.913051486	2.5 $000
TOTAL FUEL COST	DED DSL 3	"$000"	2010	2.958952427	2.5 $000
TOTAL FUEL COST	DED DSL 3	"$000"	2011	2.460018873	2.5 $000
TOTAL FUEL COST	DED DSL 3	"$000"	2012	0.587170184	2.5 $000
TOTAL FUEL COST	DED DSL 3	"$000"	2013	1.93273592	2.5 $000
TOTAL FUEL COST	DED DSL 3	"$000"	2014	0.666863918	2.5 $000
TOTAL FUEL COST	DED DSL 3	"$000"	2015	0.557790875	2.5 $000
TOTAL FUEL COST	DED DSL 3	"$000"	2016	1.802283049	2.5 $000
TOTAL FUEL COST	DED DSL 3	"$000"	2017	0	2.5 $000
TOTAL FUEL COST	DED DSL 3	"$000"	2018	0	2.5 $000
TOTAL FUEL COST	DED DSL 3	"$000"	2019	0	2.5 $000
TOTAL FUEL COST	DED DSL 3	"$000"	2020	0	2.5 $000
TOTAL FUEL COST	DED DSL 3	"$000"	2021	0	2.5 $000
TOTAL FUEL COST	DED DSL 3	"$000"	2022	0	2.5 $000
TOTAL FUEL COST	DED DSL 3	"$000"	2023	0	2.5 $000
TOTAL FUEL COST	DED DSL 3	"$000"	2024	0	2.5 $000
TOTAL FUEL COST	DED DSL 3	"$000"	2025	0	2.5 $000
TOTAL FUEL COST	DED DSL 3	"$000"	2026	0	2.5 $000
TOTAL FUEL COST	DED DSL 3	"$000"	2027	0	2.5 $000
TOTAL FUEL COST	DED DSL 3	"$000"	2028	0	2.5 $000
TOTAL FUEL COST	DED DSL 3	"$000"	2029	0	2.5 $000
TOTAL FUEL COST	DED DSL 3	"$000"	2030	0	2.5 $000
TOTAL FUEL COST	DED DSL 3	"$000"	2031	0	2.5 $000
TOTAL FUEL COST	DED DSL 3	"$000"	2032	0	2.5 $000
TOTAL FUEL COST	DED DSL 3	"$000"	2033	0	2.5 $000
TOTAL FUEL COST	DED DSL 3	"$000"	2034	0	2.5 $000
TOTAL FUEL COST	DED DSL 3	"$000"	2035	0	2.5 $000
TOTAL FUEL COST	DED DSL 4	"$000"	2006	3.36900115	2.5 $000
TOTAL FUEL COST	DED DSL 4	"$000"	2007	3.985203266	2.5 $000
TOTAL FUEL COST	DED DSL 4	"$000"	2008	4.043553352	2.5 $000
TOTAL FUEL COST	DED DSL 4	"$000"	2009	1.881478429	2.5 $000
TOTAL FUEL COST	DED DSL 4	"$000"	2010	2.928508759	2.5 $000
TOTAL FUEL COST	DED DSL 4	"$000"	2011	2.440812349	2.5 $000
TOTAL FUEL COST	DED DSL 4	"$000"	2012	0.560829699	2.5 $000
TOTAL FUEL COST	DED DSL 4	"$000"	2013	1.923932791	2.5 $000
TOTAL FUEL COST	DED DSL 4	"$000"	2014	0.641710579	2.5 $000
TOTAL FUEL COST	DED DSL 4	"$000"	2015	0.548684478	2.5 $000
TOTAL FUEL COST	DED DSL 4	"$000"	2016	1.820041418	2.5 $000
TOTAL FUEL COST	DED DSL 4	"$000"	2017	0	2.5 $000
TOTAL FUEL COST	DED DSL 4	"$000"	2018	0	2.5 $000
TOTAL FUEL COST	DED DSL 4	"$000"	2019	0	2.5 $000
TOTAL FUEL COST	DED DSL 4	"$000"	2020	0	2.5 $000
TOTAL FUEL COST	DED DSL 4	"$000"	2021	0	2.5 $000
TOTAL FUEL COST	DED DSL 4	"$000"	2022	0	2.5 $000
TOTAL FUEL COST	DED DSL 4	"$000"	2023	0	2.5 $000
TOTAL FUEL COST	DED DSL 4	"$000"	2024	0	2.5 $000
TOTAL FUEL COST	DED DSL 4	"$000"	2025	0	2.5 $000
TOTAL FUEL COST	DED DSL 4	"$000"	2026	0	2.5 $000
TOTAL FUEL COST	DED DSL 4	"$000"	2027	0	2.5 $000
TOTAL FUEL COST	DED DSL 4	"$000"	2028	0	2.5 $000

TOTAL FUEL COST	DED DSL 4	"$000"	2029	0	2.5 $000
TOTAL FUEL COST	DED DSL 4	"$000"	2030	0	2.5 $000
TOTAL FUEL COST	DED DSL 4	"$000"	2031	0	2.5 $000
TOTAL FUEL COST	DED DSL 4	"$000"	2032	0	2.5 $000
TOTAL FUEL COST	DED DSL 4	"$000"	2033	0	2.5 $000
TOTAL FUEL COST	DED DSL 4	"$000"	2034	0	2.5 $000
TOTAL FUEL COST	DED DSL 4	"$000"	2035	0	2.5 $000
TOTAL FUEL COST	PULANTAT 1	"$000"	2006	88.63665009	5.3 $000
TOTAL FUEL COST	PULANTAT 1	"$000"	2007	107.4127731	5.3 $000
TOTAL FUEL COST	PULANTAT 1	"$000"	2008	207.8963318	5.3 $000
TOTAL FUEL COST	PULANTAT 1	"$000"	2009	1056.127075	5.3 $000
TOTAL FUEL COST	PULANTAT 1	"$000"	2010	27.56369972	5.3 $000
TOTAL FUEL COST	PULANTAT 1	"$000"	2011	91.3321991	5.3 $000
TOTAL FUEL COST	PULANTAT 1	"$000"	2012	2728.746094	5.3 $000
TOTAL FUEL COST	PULANTAT 1	"$000"	2013	2319.220703	5.3 $000
TOTAL FUEL COST	PULANTAT 1	"$000"	2014	2783.915771	5.3 $000
TOTAL FUEL COST	PULANTAT 1	"$000"	2015	2780.094971	5.3 $000
TOTAL FUEL COST	PULANTAT 1	"$000"	2016	2010.802368	5.3 $000
TOTAL FUEL COST	PULANTAT 1	"$000"	2017	283.9744873	5.3 $000
TOTAL FUEL COST	PULANTAT 1	"$000"	2018	172.4931641	5.3 $000
TOTAL FUEL COST	PULANTAT 1	"$000"	2019	22.54184532	5.3 $000
TOTAL FUEL COST	PULANTAT 1	"$000"	2020	23.73696709	5.3 $000
TOTAL FUEL COST	PULANTAT 1	"$000"	2021	46.82151031	5.3 $000
TOTAL FUEL COST	PULANTAT 1	"$000"	2022	25.16971207	5.3 $000
TOTAL FUEL COST	PULANTAT 1	"$000"	2023	1.30163455	5.3 $000
TOTAL FUEL COST	PULANTAT 1	"$000"	2024	0.220612094	5.3 $000
TOTAL FUEL COST	PULANTAT 1	"$000"	2025	0	5.3 $000
TOTAL FUEL COST	PULANTAT 1	"$000"	2026	0	5.3 $000
TOTAL FUEL COST	PULANTAT 1	"$000"	2027	0	5.3 $000
TOTAL FUEL COST	PULANTAT 1	"$000"	2028	0	5.3 $000
TOTAL FUEL COST	PULANTAT 1	"$000"	2029	0	5.3 $000
TOTAL FUEL COST	PULANTAT 1	"$000"	2030	0	5.3 $000
TOTAL FUEL COST	PULANTAT 1	"$000"	2031	0	5.3 $000
TOTAL FUEL COST	PULANTAT 1	"$000"	2032	0	5.3 $000
TOTAL FUEL COST	PULANTAT 1	"$000"	2033	0	5.3 $000
TOTAL FUEL COST	PULANTAT 1	"$000"	2034	0	5.3 $000
TOTAL FUEL COST	PULANTAT 1	"$000"	2035	0	5.3 $000
TOTAL FUEL COST	PULANTAT 2	"$000"	2006	51.3632164	5.3 $000
TOTAL FUEL COST	PULANTAT 2	"$000"	2007	63.01005936	5.3 $000
TOTAL FUEL COST	PULANTAT 2	"$000"	2008	121.3259048	5.3 $000
TOTAL FUEL COST	PULANTAT 2	"$000"	2009	672.9492798	5.3 $000
TOTAL FUEL COST	PULANTAT 2	"$000"	2010	19.76588821	5.3 $000
TOTAL FUEL COST	PULANTAT 2	"$000"	2011	72.53347778	5.3 $000
TOTAL FUEL COST	PULANTAT 2	"$000"	2012	544.2183838	5.3 $000
TOTAL FUEL COST	PULANTAT 2	"$000"	2013	841.9265137	5.3 $000
TOTAL FUEL COST	PULANTAT 2	"$000"	2014	630.0385742	5.3 $000
TOTAL FUEL COST	PULANTAT 2	"$000"	2015	609.2047119	5.3 $000
TOTAL FUEL COST	PULANTAT 2	"$000"	2016	1050.194702	5.3 $000
TOTAL FUEL COST	PULANTAT 2	"$000"	2017	241.2498016	5.3 $000
TOTAL FUEL COST	PULANTAT 2	"$000"	2018	150.9525757	5.3 $000
TOTAL FUEL COST	PULANTAT 2	"$000"	2019	19.09757042	5.3 $000
TOTAL FUEL COST	PULANTAT 2	"$000"	2020	19.9113121	5.3 $000

TOTAL FUEL COST	PULANTAT 2	"$000"	2021	40.71147919	5.3	$000
TOTAL FUEL COST	PULANTAT 2	"$000"	2022	21.13463783	5.3	$000
TOTAL FUEL COST	PULANTAT 2	"$000"	2023	1.18708849	5.3	$000
TOTAL FUEL COST	PULANTAT 2	"$000"	2024	0.218164653	5.3	$000
TOTAL FUEL COST	PULANTAT 2	"$000"	2025	0	5.3	$000
TOTAL FUEL COST	PULANTAT 2	"$000"	2026	0	5.3	$000
TOTAL FUEL COST	PULANTAT 2	"$000"	2027	0	5.3	$000
TOTAL FUEL COST	PULANTAT 2	"$000"	2028	0	5.3	$000
TOTAL FUEL COST	PULANTAT 2	"$000"	2029	0	5.3	$000
TOTAL FUEL COST	PULANTAT 2	"$000"	2030	0	5.3	$000
TOTAL FUEL COST	PULANTAT 2	"$000"	2031	0	5.3	$000
TOTAL FUEL COST	PULANTAT 2	"$000"	2032	0	5.3	$000
TOTAL FUEL COST	PULANTAT 2	"$000"	2033	0	5.3	$000
TOTAL FUEL COST	PULANTAT 2	"$000"	2034	0	5.3	$000
TOTAL FUEL COST	PULANTAT 2	"$000"	2035	0	5.3	$000
TOTAL FUEL COST	TENJO 1	"$000"	2006	307.0779419	4.4	$000
TOTAL FUEL COST	TENJO 1	"$000"	2007	367.242157	4.4	$000
TOTAL FUEL COST	TENJO 1	"$000"	2008	655.1075439	4.4	$000
TOTAL FUEL COST	TENJO 1	"$000"	2009	2174.419434	4.4	$000
TOTAL FUEL COST	TENJO 1	"$000"	2010	1644.731445	4.4	$000
TOTAL FUEL COST	TENJO 1	"$000"	2011	2283.640137	4.4	$000
TOTAL FUEL COST	TENJO 1	"$000"	2012	3833.871826	4.4	$000
TOTAL FUEL COST	TENJO 1	"$000"	2013	3288.05542	4.4	$000
TOTAL FUEL COST	TENJO 1	"$000"	2014	3703.072021	4.4	$000
TOTAL FUEL COST	TENJO 1	"$000"	2015	3706.9729	4.4	$000
TOTAL FUEL COST	TENJO 1	"$000"	2016	2944.609375	4.4	$000
TOTAL FUEL COST	TENJO 1	"$000"	2017	930.7636108	4.4	$000
TOTAL FUEL COST	TENJO 1	"$000"	2018	626.5036621	4.4	$000
TOTAL FUEL COST	TENJO 1	"$000"	2019	102.0469437	4.4	$000
TOTAL FUEL COST	TENJO 1	"$000"	2020	92.84527588	4.4	$000
TOTAL FUEL COST	TENJO 1	"$000"	2021	161.4429016	4.4	$000
TOTAL FUEL COST	TENJO 1	"$000"	2022	114.4499741	4.4	$000
TOTAL FUEL COST	TENJO 1	"$000"	2023	6.169798851	4.4	$000
TOTAL FUEL COST	TENJO 1	"$000"	2024	0	4.4	$000
TOTAL FUEL COST	TENJO 1	"$000"	2025	0	4.4	$000
TOTAL FUEL COST	TENJO 1	"$000"	2026	0	4.4	$000
TOTAL FUEL COST	TENJO 1	"$000"	2027	0	4.4	$000
TOTAL FUEL COST	TENJO 1	"$000"	2028	0	4.4	$000
TOTAL FUEL COST	TENJO 1	"$000"	2029	0	4.4	$000
TOTAL FUEL COST	TENJO 1	"$000"	2030	0	4.4	$000
TOTAL FUEL COST	TENJO 1	"$000"	2031	0	4.4	$000
TOTAL FUEL COST	TENJO 1	"$000"	2032	0	4.4	$000
TOTAL FUEL COST	TENJO 1	"$000"	2033	0	4.4	$000
TOTAL FUEL COST	TENJO 1	"$000"	2034	0	4.4	$000
TOTAL FUEL COST	TENJO 1	"$000"	2035	0	4.4	$000
TOTAL FUEL COST	TENJO 2	"$000"	2006	251.810379	4.4	$000
TOTAL FUEL COST	TENJO 2	"$000"	2007	303.7486572	4.4	$000
TOTAL FUEL COST	TENJO 2	"$000"	2008	544.538147	4.4	$000
TOTAL FUEL COST	TENJO 2	"$000"	2009	1981.988403	4.4	$000
TOTAL FUEL COST	TENJO 2	"$000"	2010	1486.432983	4.4	$000
TOTAL FUEL COST	TENJO 2	"$000"	2011	2072.041992	4.4	$000
TOTAL FUEL COST	TENJO 2	"$000"	2012	3660.117188	4.4	$000

TOTAL FUEL COST	TENJO	2	"$000"	2013	3144.336426	4.4	$000
TOTAL FUEL COST	TENJO	2	"$000"	2014	3580.380371	4.4	$000
TOTAL FUEL COST	TENJO	2	"$000"	2015	3577.393311	4.4	$000
TOTAL FUEL COST	TENJO	2	"$000"	2016	2805.619629	4.4	$000
TOTAL FUEL COST	TENJO	2	"$000"	2017	815.1688843	4.4	$000
TOTAL FUEL COST	TENJO	2	"$000"	2018	550.5593262	4.4	$000
TOTAL FUEL COST	TENJO	2	"$000"	2019	89.3296051	4.4	$000
TOTAL FUEL COST	TENJO	2	"$000"	2020	78.74154663	4.4	$000
TOTAL FUEL COST	TENJO	2	"$000"	2021	141.5282898	4.4	$000
TOTAL FUEL COST	TENJO	2	"$000"	2022	97.08809662	4.4	$000
TOTAL FUEL COST	TENJO	2	"$000"	2023	5.593285561	4.4	$000
TOTAL FUEL COST	TENJO	2	"$000"	2024	0	4.4	$000
TOTAL FUEL COST	TENJO	2	"$000"	2025	0	4.4	$000
TOTAL FUEL COST	TENJO	2	"$000"	2026	0	4.4	$000
TOTAL FUEL COST	TENJO	2	"$000"	2027	0	4.4	$000
TOTAL FUEL COST	TENJO	2	"$000"	2028	0	4.4	$000
TOTAL FUEL COST	TENJO	2	"$000"	2029	0	4.4	$000
TOTAL FUEL COST	TENJO	2	"$000"	2030	0	4.4	$000
TOTAL FUEL COST	TENJO	2	"$000"	2031	0	4.4	$000
TOTAL FUEL COST	TENJO	2	"$000"	2032	0	4.4	$000
TOTAL FUEL COST	TENJO	2	"$000"	2033	0	4.4	$000
TOTAL FUEL COST	TENJO	2	"$000"	2034	0	4.4	$000
TOTAL FUEL COST	TENJO	2	"$000"	2035	0	4.4	$000
TOTAL FUEL COST	TENJO	3	"$000"	2006	206.7050781	4.4	$000
TOTAL FUEL COST	TENJO	3	"$000"	2007	246.9511871	4.4	$000
TOTAL FUEL COST	TENJO	3	"$000"	2008	451.0584106	4.4	$000
TOTAL FUEL COST	TENJO	3	"$000"	2009	1808.513306	4.4	$000
TOTAL FUEL COST	TENJO	3	"$000"	2010	1327.136719	4.4	$000
TOTAL FUEL COST	TENJO	3	"$000"	2011	1889.244507	4.4	$000
TOTAL FUEL COST	TENJO	3	"$000"	2012	3509.255615	4.4	$000
TOTAL FUEL COST	TENJO	3	"$000"	2013	2994.348633	4.4	$000
TOTAL FUEL COST	TENJO	3	"$000"	2014	3449.794678	4.4	$000
TOTAL FUEL COST	TENJO	3	"$000"	2015	3432.325195	4.4	$000
TOTAL FUEL COST	TENJO	3	"$000"	2016	2618.231201	4.4	$000
TOTAL FUEL COST	TENJO	3	"$000"	2017	726.8375854	4.4	$000
TOTAL FUEL COST	TENJO	3	"$000"	2018	471.3416138	4.4	$000
TOTAL FUEL COST	TENJO	3	"$000"	2019	73.29016876	4.4	$000
TOTAL FUEL COST	TENJO	3	"$000"	2020	68.88865662	4.4	$000
TOTAL FUEL COST	TENJO	3	"$000"	2021	124.9438629	4.4	$000
TOTAL FUEL COST	TENJO	3	"$000"	2022	84.61260986	4.4	$000
TOTAL FUEL COST	TENJO	3	"$000"	2023	4.415444851	4.4	$000
TOTAL FUEL COST	TENJO	3	"$000"	2024	0	4.4	$000
TOTAL FUEL COST	TENJO	3	"$000"	2025	0	4.4	$000
TOTAL FUEL COST	TENJO	3	"$000"	2026	0	4.4	$000
TOTAL FUEL COST	TENJO	3	"$000"	2027	0	4.4	$000
TOTAL FUEL COST	TENJO	3	"$000"	2028	0	4.4	$000
TOTAL FUEL COST	TENJO	3	"$000"	2029	0	4.4	$000
TOTAL FUEL COST	TENJO	3	"$000"	2030	0	4.4	$000
TOTAL FUEL COST	TENJO	3	"$000"	2031	0	4.4	$000
TOTAL FUEL COST	TENJO	3	"$000"	2032	0	4.4	$000
TOTAL FUEL COST	TENJO	3	"$000"	2033	0	4.4	$000
TOTAL FUEL COST	TENJO	3	"$000"	2034	0	4.4	$000

TOTAL FUEL COST	TENJO	3	"$000"	2035	0	4.4	$000
TOTAL FUEL COST	TENJO	4	"$000"	2006	168.6747131	4.4	$000
TOTAL FUEL COST	TENJO	4	"$000"	2007	203.0494385	4.4	$000
TOTAL FUEL COST	TENJO	4	"$000"	2008	373.1423645	4.4	$000
TOTAL FUEL COST	TENJO	4	"$000"	2009	1602.304932	4.4	$000
TOTAL FUEL COST	TENJO	4	"$000"	2010	1162.975098	4.4	$000
TOTAL FUEL COST	TENJO	4	"$000"	2011	1710.406616	4.4	$000
TOTAL FUEL COST	TENJO	4	"$000"	2012	3341.65918	4.4	$000
TOTAL FUEL COST	TENJO	4	"$000"	2013	2838.62793	4.4	$000
TOTAL FUEL COST	TENJO	4	"$000"	2014	3321.895264	4.4	$000
TOTAL FUEL COST	TENJO	4	"$000"	2015	3277.44458	4.4	$000
TOTAL FUEL COST	TENJO	4	"$000"	2016	2425.248291	4.4	$000
TOTAL FUEL COST	TENJO	4	"$000"	2017	437.4837952	4.4	$000
TOTAL FUEL COST	TENJO	4	"$000"	2018	265.9602356	4.4	$000
TOTAL FUEL COST	TENJO	4	"$000"	2019	35.80159378	4.4	$000
TOTAL FUEL COST	TENJO	4	"$000"	2020	35.61854935	4.4	$000
TOTAL FUEL COST	TENJO	4	"$000"	2021	72.60693359	4.4	$000
TOTAL FUEL COST	TENJO	4	"$000"	2022	39.63318634	4.4	$000
TOTAL FUEL COST	TENJO	4	"$000"	2023	1.622694373	4.4	$000
TOTAL FUEL COST	TENJO	4	"$000"	2024	0	4.4	$000
TOTAL FUEL COST	TENJO	4	"$000"	2025	0	4.4	$000
TOTAL FUEL COST	TENJO	4	"$000"	2026	0	4.4	$000
TOTAL FUEL COST	TENJO	4	"$000"	2027	0	4.4	$000
TOTAL FUEL COST	TENJO	4	"$000"	2028	0	4.4	$000
TOTAL FUEL COST	TENJO	4	"$000"	2029	0	4.4	$000
TOTAL FUEL COST	TENJO	4	"$000"	2030	0	4.4	$000
TOTAL FUEL COST	TENJO	4	"$000"	2031	0	4.4	$000
TOTAL FUEL COST	TENJO	4	"$000"	2032	0	4.4	$000
TOTAL FUEL COST	TENJO	4	"$000"	2033	0	4.4	$000
TOTAL FUEL COST	TENJO	4	"$000"	2034	0	4.4	$000
TOTAL FUEL COST	TENJO	4	"$000"	2035	0	4.4	$000
TOTAL FUEL COST	TENJO	5	"$000"	2006	136.0545807	4.4	$000
TOTAL FUEL COST	TENJO	5	"$000"	2007	161.7127686	4.4	$000
TOTAL FUEL COST	TENJO	5	"$000"	2008	306.4811401	4.4	$000
TOTAL FUEL COST	TENJO	5	"$000"	2009	1326.812744	4.4	$000
TOTAL FUEL COST	TENJO	5	"$000"	2010	1003.429993	4.4	$000
TOTAL FUEL COST	TENJO	5	"$000"	2011	1542.95105	4.4	$000
TOTAL FUEL COST	TENJO	5	"$000"	2012	3122.772461	4.4	$000
TOTAL FUEL COST	TENJO	5	"$000"	2013	2668.69751	4.4	$000
TOTAL FUEL COST	TENJO	5	"$000"	2014	3175.614502	4.4	$000
TOTAL FUEL COST	TENJO	5	"$000"	2015	3132.453369	4.4	$000
TOTAL FUEL COST	TENJO	5	"$000"	2016	2278.950928	4.4	$000
TOTAL FUEL COST	TENJO	5	"$000"	2017	371.4137573	4.4	$000
TOTAL FUEL COST	TENJO	5	"$000"	2018	227.0575409	4.4	$000
TOTAL FUEL COST	TENJO	5	"$000"	2019	30.91826439	4.4	$000
TOTAL FUEL COST	TENJO	5	"$000"	2020	30.25192261	4.4	$000
TOTAL FUEL COST	TENJO	5	"$000"	2021	60.55013657	4.4	$000
TOTAL FUEL COST	TENJO	5	"$000"	2022	33.85720444	4.4	$000
TOTAL FUEL COST	TENJO	5	"$000"	2023	1.567392349	4.4	$000
TOTAL FUEL COST	TENJO	5	"$000"	2024	0	4.4	$000
TOTAL FUEL COST	TENJO	5	"$000"	2025	0	4.4	$000
TOTAL FUEL COST	TENJO	5	"$000"	2026	0	4.4	$000

TOTAL FUEL COST	TENJO	5	"$000"	2027	0	4.4	$000
TOTAL FUEL COST	TENJO	5	"$000"	2028	0	4.4	$000
TOTAL FUEL COST	TENJO	5	"$000"	2029	0	4.4	$000
TOTAL FUEL COST	TENJO	5	"$000"	2030	0	4.4	$000
TOTAL FUEL COST	TENJO	5	"$000"	2031	0	4.4	$000
TOTAL FUEL COST	TENJO	5	"$000"	2032	0	4.4	$000
TOTAL FUEL COST	TENJO	5	"$000"	2033	0	4.4	$000
TOTAL FUEL COST	TENJO	5	"$000"	2034	0	4.4	$000
TOTAL FUEL COST	TENJO	5	"$000"	2035	0	4.4	$000
TOTAL FUEL COST	TENJO	6	"$000"	2006	107.9543533	4.4	$000
TOTAL FUEL COST	TENJO	6	"$000"	2007	130.3256836	4.4	$000
TOTAL FUEL COST	TENJO	6	"$000"	2008	248.9426727	4.4	$000
TOTAL FUEL COST	TENJO	6	"$000"	2009	1163.024292	4.4	$000
TOTAL FUEL COST	TENJO	6	"$000"	2010	855.0118408	4.4	$000
TOTAL FUEL COST	TENJO	6	"$000"	2011	1377.743652	4.4	$000
TOTAL FUEL COST	TENJO	6	"$000"	2012	2930.60791	4.4	$000
TOTAL FUEL COST	TENJO	6	"$000"	2013	2495.568848	4.4	$000
TOTAL FUEL COST	TENJO	6	"$000"	2014	3021.279541	4.4	$000
TOTAL FUEL COST	TENJO	6	"$000"	2015	2971.678711	4.4	$000
TOTAL FUEL COST	TENJO	6	"$000"	2016	2135.001221	4.4	$000
TOTAL FUEL COST	TENJO	6	"$000"	2017	317.896759	4.4	$000
TOTAL FUEL COST	TENJO	6	"$000"	2018	194.3742828	4.4	$000
TOTAL FUEL COST	TENJO	6	"$000"	2019	26.05781746	4.4	$000
TOTAL FUEL COST	TENJO	6	"$000"	2020	25.74073219	4.4	$000
TOTAL FUEL COST	TENJO	6	"$000"	2021	51.87817383	4.4	$000
TOTAL FUEL COST	TENJO	6	"$000"	2022	28.89412689	4.4	$000
TOTAL FUEL COST	TENJO	6	"$000"	2023	1.488181233	4.4	$000
TOTAL FUEL COST	TENJO	6	"$000"	2024	0	4.4	$000
TOTAL FUEL COST	TENJO	6	"$000"	2025	0	4.4	$000
TOTAL FUEL COST	TENJO	6	"$000"	2026	0	4.4	$000
TOTAL FUEL COST	TENJO	6	"$000"	2027	0	4.4	$000
TOTAL FUEL COST	TENJO	6	"$000"	2028	0	4.4	$000
TOTAL FUEL COST	TENJO	6	"$000"	2029	0	4.4	$000
TOTAL FUEL COST	TENJO	6	"$000"	2030	0	4.4	$000
TOTAL FUEL COST	TENJO	6	"$000"	2031	0	4.4	$000
TOTAL FUEL COST	TENJO	6	"$000"	2032	0	4.4	$000
TOTAL FUEL COST	TENJO	6	"$000"	2033	0	4.4	$000
TOTAL FUEL COST	TENJO	6	"$000"	2034	0	4.4	$000
TOTAL FUEL COST	TENJO	6	"$000"	2035	0	4.4	$000
TOTAL FUEL COST	TAL DSL	1	"$000"	2006	432.5161743	4.4	$000
TOTAL FUEL COST	TAL DSL	1	"$000"	2007	502.6854248	4.4	$000
TOTAL FUEL COST	TAL DSL	1	"$000"	2008	868.1885376	4.4	$000
TOTAL FUEL COST	TAL DSL	1	"$000"	2009	2341.260986	4.4	$000
TOTAL FUEL COST	TAL DSL	1	"$000"	2010	1900.509766	4.4	$000
TOTAL FUEL COST	TAL DSL	1	"$000"	2011	2532.567627	4.4	$000
TOTAL FUEL COST	TAL DSL	1	"$000"	2012	3593.568848	4.4	$000
TOTAL FUEL COST	TAL DSL	1	"$000"	2013	3265.06543	4.4	$000
TOTAL FUEL COST	TAL DSL	1	"$000"	2014	3540.364014	4.4	$000
TOTAL FUEL COST	TAL DSL	1	"$000"	2015	3575.298828	4.4	$000
TOTAL FUEL COST	TAL DSL	1	"$000"	2016	3007.690186	4.4	$000
TOTAL FUEL COST	TAL DSL	1	"$000"	2017	1085.488647	4.4	$000
TOTAL FUEL COST	TAL DSL	1	"$000"	2018	773.774231	4.4	$000

TOTAL FUEL COST	TAL DSL 1	"$000"	2019	133.4848022	4.4	$000
TOTAL FUEL COST	TAL DSL 1	"$000"	2020	116.6111908	4.4	$000
TOTAL FUEL COST	TAL DSL 1	"$000"	2021	201.9036255	4.4	$000
TOTAL FUEL COST	TAL DSL 1	"$000"	2022	146.4825745	4.4	$000
TOTAL FUEL COST	TAL DSL 1	"$000"	2023	7.437916756	4.4	$000
TOTAL FUEL COST	TAL DSL 1	"$000"	2024	0	4.4	$000
TOTAL FUEL COST	TAL DSL 1	"$000"	2025	0	4.4	$000
TOTAL FUEL COST	TAL DSL 1	"$000"	2026	0	4.4	$000
TOTAL FUEL COST	TAL DSL 1	"$000"	2027	0	4.4	$000
TOTAL FUEL COST	TAL DSL 1	"$000"	2028	0	4.4	$000
TOTAL FUEL COST	TAL DSL 1	"$000"	2029	0	4.4	$000
TOTAL FUEL COST	TAL DSL 1	"$000"	2030	0	4.4	$000
TOTAL FUEL COST	TAL DSL 1	"$000"	2031	0	4.4	$000
TOTAL FUEL COST	TAL DSL 1	"$000"	2032	0	4.4	$000
TOTAL FUEL COST	TAL DSL 1	"$000"	2033	0	4.4	$000
TOTAL FUEL COST	TAL DSL 1	"$000"	2034	0	4.4	$000
TOTAL FUEL COST	TAL DSL 1	"$000"	2035	0	4.4	$000
TOTAL FUEL COST	TAL DSL 2	"$000"	2006	362.1151123	4.4	$000
TOTAL FUEL COST	TAL DSL 2	"$000"	2007	424.8135681	4.4	$000
TOTAL FUEL COST	TAL DSL 2	"$000"	2008	637.8207397	4.4	$000
TOTAL FUEL COST	TAL DSL 2	"$000"	2009	845.4955444	4.4	$000
TOTAL FUEL COST	TAL DSL 2	"$000"	2010	1009.03363	4.4	$000
TOTAL FUEL COST	TAL DSL 2	"$000"	2011	1101.311768	4.4	$000
TOTAL FUEL COST	TAL DSL 2	"$000"	2012	286.289856	4.4	$000
TOTAL FUEL COST	TAL DSL 2	"$000"	2013	616.4730225	4.4	$000
TOTAL FUEL COST	TAL DSL 2	"$000"	2014	334.9792175	4.4	$000
TOTAL FUEL COST	TAL DSL 2	"$000"	2015	298.4425049	4.4	$000
TOTAL FUEL COST	TAL DSL 2	"$000"	2016	929.8812256	4.4	$000
TOTAL FUEL COST	TAL DSL 2	"$000"	2017	991.7723389	4.4	$000
TOTAL FUEL COST	TAL DSL 2	"$000"	2018	685.7478638	4.4	$000
TOTAL FUEL COST	TAL DSL 2	"$000"	2019	114.0394745	4.4	$000
TOTAL FUEL COST	TAL DSL 2	"$000"	2020	102.2067184	4.4	$000
TOTAL FUEL COST	TAL DSL 2	"$000"	2021	178.2647095	4.4	$000
TOTAL FUEL COST	TAL DSL 2	"$000"	2022	126.5113678	4.4	$000
TOTAL FUEL COST	TAL DSL 2	"$000"	2023	6.694236279	4.4	$000
TOTAL FUEL COST	TAL DSL 2	"$000"	2024	0	4.4	$000
TOTAL FUEL COST	TAL DSL 2	"$000"	2025	0	4.4	$000
TOTAL FUEL COST	TAL DSL 2	"$000"	2026	0	4.4	$000
TOTAL FUEL COST	TAL DSL 2	"$000"	2027	0	4.4	$000
TOTAL FUEL COST	TAL DSL 2	"$000"	2028	0	4.4	$000
TOTAL FUEL COST	TAL DSL 2	"$000"	2029	0	4.4	$000
TOTAL FUEL COST	TAL DSL 2	"$000"	2030	0	4.4	$000
TOTAL FUEL COST	TAL DSL 2	"$000"	2031	0	4.4	$000
TOTAL FUEL COST	TAL DSL 2	"$000"	2032	0	4.4	$000
TOTAL FUEL COST	TAL DSL 2	"$000"	2033	0	4.4	$000
TOTAL FUEL COST	TAL DSL 2	"$000"	2034	0	4.4	$000
TOTAL FUEL COST	TAL DSL 2	"$000"	2035	0	4.4	$000
TOTAL FUEL COST	TANGO 1	"$000"	2006	1967.35791	26.5	$000
TOTAL FUEL COST	TANGO 1	"$000"	2007	2439.717529	26.5	$000
TOTAL FUEL COST	TANGO 1	"$000"	2008	3605.806152	26.5	$000
TOTAL FUEL COST	TANGO 1	"$000"	2009	7883.655762	26.5	$000
TOTAL FUEL COST	TANGO 1	"$000"	2010	7019.183105	26.5	$000

TOTAL FUEL COST	TANGO	1	"$000"	2011	8065.302246	26.5	$000
TOTAL FUEL COST	TANGO	1	"$000"	2012	11187.01465	26.5	$000
TOTAL FUEL COST	TANGO	1	"$000"	2013	10053.58008	26.5	$000
TOTAL FUEL COST	TANGO	1	"$000"	2014	11095.76074	26.5	$000
TOTAL FUEL COST	TANGO	1	"$000"	2015	10913.91992	26.5	$000
TOTAL FUEL COST	TANGO	1	"$000"	2016	9557.305664	26.5	$000
TOTAL FUEL COST	TANGO	1	"$000"	2017	5800.955566	26.5	$000
TOTAL FUEL COST	TANGO	1	"$000"	2018	4299.755371	26.5	$000
TOTAL FUEL COST	TANGO	1	"$000"	2019	1278.210449	26.5	$000
TOTAL FUEL COST	TANGO	1	"$000"	2020	1092.015625	26.5	$000
TOTAL FUEL COST	TANGO	1	"$000"	2021	1672.805542	26.5	$000
TOTAL FUEL COST	TANGO	1	"$000"	2022	1401.651123	26.5	$000
TOTAL FUEL COST	TANGO	1	"$000"	2023	114.8955841	26.5	$000
TOTAL FUEL COST	TANGO	1	"$000"	2024	0.956642628	26.5	$000
TOTAL FUEL COST	TANGO	1	"$000"	2025	0.406256437	26.5	$000
TOTAL FUEL COST	TANGO	1	"$000"	2026	0.837663293	26.5	$000
TOTAL FUEL COST	TANGO	1	"$000"	2027	2.1862216	26.5	$000
TOTAL FUEL COST	TANGO	1	"$000"	2028	2.205435991	26.5	$000
TOTAL FUEL COST	TANGO	1	"$000"	2029	0	26.5	$000
TOTAL FUEL COST	TANGO	1	"$000"	2030	0	26.5	$000
TOTAL FUEL COST	TANGO	1	"$000"	2031	0	26.5	$000
TOTAL FUEL COST	TANGO	1	"$000"	2032	0	26.5	$000
TOTAL FUEL COST	TANGO	1	"$000"	2033	0	26.5	$000
TOTAL FUEL COST	TANGO	1	"$000"	2034	0	26.5	$000
TOTAL FUEL COST	TANGO	1	"$000"	2035	0	26.5	$000
TOTAL FUEL COST	TANGO	2	"$000"	2006	2846.528076	26.5	$000
TOTAL FUEL COST	TANGO	2	"$000"	2007	3381.425781	26.5	$000
TOTAL FUEL COST	TANGO	2	"$000"	2008	4767.955566	26.5	$000
TOTAL FUEL COST	TANGO	2	"$000"	2009	8727.736328	26.5	$000
TOTAL FUEL COST	TANGO	2	"$000"	2010	7998.581055	26.5	$000
TOTAL FUEL COST	TANGO	2	"$000"	2011	9067.016602	26.5	$000
TOTAL FUEL COST	TANGO	2	"$000"	2012	11742.62891	26.5	$000
TOTAL FUEL COST	TANGO	2	"$000"	2013	10810.87793	26.5	$000
TOTAL FUEL COST	TANGO	2	"$000"	2014	11699.38379	26.5	$000
TOTAL FUEL COST	TANGO	2	"$000"	2015	11493.23633	26.5	$000
TOTAL FUEL COST	TANGO	2	"$000"	2016	10353.01465	26.5	$000
TOTAL FUEL COST	TANGO	2	"$000"	2017	6728.300293	26.5	$000
TOTAL FUEL COST	TANGO	2	"$000"	2018	5202.415527	26.5	$000
TOTAL FUEL COST	TANGO	2	"$000"	2019	2025.442505	26.5	$000
TOTAL FUEL COST	TANGO	2	"$000"	2020	1503.765747	26.5	$000
TOTAL FUEL COST	TANGO	2	"$000"	2021	2207.760254	26.5	$000
TOTAL FUEL COST	TANGO	2	"$000"	2022	1911.80896	26.5	$000
TOTAL FUEL COST	TANGO	2	"$000"	2023	189.871994	26.5	$000
TOTAL FUEL COST	TANGO	2	"$000"	2024	2.266753674	26.5	$000
TOTAL FUEL COST	TANGO	2	"$000"	2025	1.047856808	26.5	$000
TOTAL FUEL COST	TANGO	2	"$000"	2026	3.234195709	26.5	$000
TOTAL FUEL COST	TANGO	2	"$000"	2027	2.352475405	26.5	$000
TOTAL FUEL COST	TANGO	2	"$000"	2028	2.289819241	26.5	$000
TOTAL FUEL COST	TANGO	2	"$000"	2029	2.514024258	26.5	$000
TOTAL FUEL COST	TANGO	2	"$000"	2030	0	26.5	$000
TOTAL FUEL COST	TANGO	2	"$000"	2031	0	26.5	$000
TOTAL FUEL COST	TANGO	2	"$000"	2032	0	26.5	$000

TOTAL FUEL COST	TANGO	2	"$000"	2033	0	26.5	$000
TOTAL FUEL COST	TANGO	2	"$000"	2034	0	26.5	$000
TOTAL FUEL COST	TANGO	2	"$000"	2035	0	26.5	$000
TOTAL FUEL COST	MEC	1	"$000"	2006	21893.63672	44.2	$000
TOTAL FUEL COST	MEC	1	"$000"	2007	24542.03516	44.2	$000
TOTAL FUEL COST	MEC	1	"$000"	2008	27042.13672	44.2	$000
TOTAL FUEL COST	MEC	1	"$000"	2009	29170.375	44.2	$000
TOTAL FUEL COST	MEC	1	"$000"	2010	32972.12109	44.2	$000
TOTAL FUEL COST	MEC	1	"$000"	2011	33057.70313	44.2	$000
TOTAL FUEL COST	MEC	1	"$000"	2012	32888.92969	44.2	$000
TOTAL FUEL COST	MEC	1	"$000"	2013	33153.82031	44.2	$000
TOTAL FUEL COST	MEC	1	"$000"	2014	33174.03516	44.2	$000
TOTAL FUEL COST	MEC	1	"$000"	2015	33175.69922	44.2	$000
TOTAL FUEL COST	MEC	1	"$000"	2016	34110.51563	44.2	$000
TOTAL FUEL COST	MEC	1	"$000"	2017	34736.13672	44.2	$000
TOTAL FUEL COST	MEC	1	"$000"	2018	34912.85547	44.2	$000
TOTAL FUEL COST	MEC	1	"$000"	2019	31674.93945	44.2	$000
TOTAL FUEL COST	MEC	1	"$000"	2020	32475.29297	44.2	$000
TOTAL FUEL COST	MEC	1	"$000"	2021	34571.24219	44.2	$000
TOTAL FUEL COST	MEC	1	"$000"	2022	34975.41797	44.2	$000
TOTAL FUEL COST	MEC	1	"$000"	2023	28617.97852	44.2	$000
TOTAL FUEL COST	MEC	1	"$000"	2024	20503.38867	44.2	$000
TOTAL FUEL COST	MEC	1	"$000"	2025	21006.33789	44.2	$000
TOTAL FUEL COST	MEC	1	"$000"	2026	21135.17383	44.2	$000
TOTAL FUEL COST	MEC	1	"$000"	2027	18124.86328	44.2	$000
TOTAL FUEL COST	MEC	1	"$000"	2028	20296.49414	44.2	$000
TOTAL FUEL COST	MEC	1	"$000"	2029	19882.1582	44.2	$000
TOTAL FUEL COST	MEC	1	"$000"	2030	17469.93359	44.2	$000
TOTAL FUEL COST	MEC	1	"$000"	2031	18563.48633	44.2	$000
TOTAL FUEL COST	MEC	1	"$000"	2032	19530.32031	44.2	$000
TOTAL FUEL COST	MEC	1	"$000"	2033	20303.26367	44.2	$000
TOTAL FUEL COST	MEC	1	"$000"	2034	21540.16406	44.2	$000
TOTAL FUEL COST	MEC	1	"$000"	2035	21780.01953	44.2	$000
TOTAL FUEL COST	MEC	2	"$000"	2006	21426.16797	44.2	$000
TOTAL FUEL COST	MEC	2	"$000"	2007	24074.81055	44.2	$000
TOTAL FUEL COST	MEC	2	"$000"	2008	26686.62695	44.2	$000
TOTAL FUEL COST	MEC	2	"$000"	2009	28568.83008	44.2	$000
TOTAL FUEL COST	MEC	2	"$000"	2010	32880.64063	44.2	$000
TOTAL FUEL COST	MEC	2	"$000"	2011	33033.49219	44.2	$000
TOTAL FUEL COST	MEC	2	"$000"	2012	32415.81055	44.2	$000
TOTAL FUEL COST	MEC	2	"$000"	2013	33150.33203	44.2	$000
TOTAL FUEL COST	MEC	2	"$000"	2014	33172.05859	44.2	$000
TOTAL FUEL COST	MEC	2	"$000"	2015	33172.41016	44.2	$000
TOTAL FUEL COST	MEC	2	"$000"	2016	34038.68359	44.2	$000
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TOTAL FUEL COST	MEC	2	"$000"	2018	34917.03906	44.2	$000
TOTAL FUEL COST	MEC	2	"$000"	2019	30608.15625	44.2	$000
TOTAL FUEL COST	MEC	2	"$000"	2020	31286.26563	44.2	$000
TOTAL FUEL COST	MEC	2	"$000"	2021	33473.08203	44.2	$000
TOTAL FUEL COST	MEC	2	"$000"	2022	33720.60938	44.2	$000
TOTAL FUEL COST	MEC	2	"$000"	2023	26396.39258	44.2	$000
TOTAL FUEL COST	MEC	2	"$000"	2024	19279.18164	44.2	$000

TOTAL FUEL COST	MEC	2	"$000"	2025	20091.75391	44.2	$000
TOTAL FUEL COST	MEC	2	"$000"	2026	19958.28906	44.2	$000
TOTAL FUEL COST	MEC	2	"$000"	2027	17324.30273	44.2	$000
TOTAL FUEL COST	MEC	2	"$000"	2028	19482.44336	44.2	$000
TOTAL FUEL COST	MEC	2	"$000"	2029	18766.60938	44.2	$000
TOTAL FUEL COST	MEC	2	"$000"	2030	16987.15625	44.2	$000
TOTAL FUEL COST	MEC	2	"$000"	2031	17970.45313	44.2	$000
TOTAL FUEL COST	MEC	2	"$000"	2032	19151.30078	44.2	$000
TOTAL FUEL COST	MEC	2	"$000"	2033	19765.46094	44.2	$000
TOTAL FUEL COST	MEC	2	"$000"	2034	20647.86914	44.2	$000
TOTAL FUEL COST	MEC	2	"$000"	2035	21179.80273	44.2	$000
TOTAL FUEL COST	TEMES	1	"$000"	2006	2506.062988	40	$000
TOTAL FUEL COST	TEMES	1	"$000"	2007	2994.416992	40	$000
TOTAL FUEL COST	TEMES	1	"$000"	2008	4768.9375	40	$000
TOTAL FUEL COST	TEMES	1	"$000"	2009	12210.55762	40	$000
TOTAL FUEL COST	TEMES	1	"$000"	2010	9812.974609	40	$000
TOTAL FUEL COST	TEMES	1	"$000"	2011	12113.38184	40	$000
TOTAL FUEL COST	TEMES	1	"$000"	2012	17357.77148	40	$000
TOTAL FUEL COST	TEMES	1	"$000"	2013	15181.49707	40	$000
TOTAL FUEL COST	TEMES	1	"$000"	2014	16753.69336	40	$000
TOTAL FUEL COST	TEMES	1	"$000"	2015	16639.51758	40	$000
TOTAL FUEL COST	TEMES	1	"$000"	2016	11124.39258	40	$000
TOTAL FUEL COST	TEMES	1	"$000"	2017	0	40	$000
TOTAL FUEL COST	TEMES	1	"$000"	2018	0	40	$000
TOTAL FUEL COST	TEMES	1	"$000"	2019	0	40	$000
TOTAL FUEL COST	TEMES	1	"$000"	2020	0	40	$000
TOTAL FUEL COST	TEMES	1	"$000"	2021	0	40	$000
TOTAL FUEL COST	TEMES	1	"$000"	2022	0	40	$000
TOTAL FUEL COST	TEMES	1	"$000"	2023	0	40	$000
TOTAL FUEL COST	TEMES	1	"$000"	2024	0	40	$000
TOTAL FUEL COST	TEMES	1	"$000"	2025	0	40	$000
TOTAL FUEL COST	TEMES	1	"$000"	2026	0	40	$000
TOTAL FUEL COST	TEMES	1	"$000"	2027	0	40	$000
TOTAL FUEL COST	TEMES	1	"$000"	2028	0	40	$000
TOTAL FUEL COST	TEMES	1	"$000"	2029	0	40	$000
TOTAL FUEL COST	TEMES	1	"$000"	2030	0	40	$000
TOTAL FUEL COST	TEMES	1	"$000"	2031	0	40	$000
TOTAL FUEL COST	TEMES	1	"$000"	2032	0	40	$000
TOTAL FUEL COST	TEMES	1	"$000"	2033	0	40	$000
TOTAL FUEL COST	TEMES	1	"$000"	2034	0	40	$000
TOTAL FUEL COST	TEMES	1	"$000"	2035	0	40	$000
TOTAL FUEL COST	CFB	1	"$000"	2006	0	#N/A	$000
TOTAL FUEL COST	CFB	1	"$000"	2007	0	#N/A	$000
TOTAL FUEL COST	CFB	1	"$000"	2008	0	#N/A	$000
TOTAL FUEL COST	CFB	1	"$000"	2009	0	#N/A	$000
TOTAL FUEL COST	CFB	1	"$000"	2010	0	#N/A	$000
TOTAL FUEL COST	CFB	1	"$000"	2011	0	#N/A	$000
TOTAL FUEL COST	CFB	1	"$000"	2012	0	#N/A	$000
TOTAL FUEL COST	CFB	1	"$000"	2013	0	#N/A	$000
TOTAL FUEL COST	CFB	1	"$000"	2014	0	#N/A	$000
TOTAL FUEL COST	CFB	1	"$000"	2015	0	#N/A	$000
TOTAL FUEL COST	CFB	1	"$000"	2016	0	#N/A	$000

TOTAL FUEL COST	CFB	1	"$000"	2017	0	#N/A	$000
TOTAL FUEL COST	CFB	1	"$000"	2018	0	#N/A	$000
TOTAL FUEL COST	CFB	1	"$000"	2019	0	#N/A	$000
TOTAL FUEL COST	CFB	1	"$000"	2020	0	#N/A	$000
TOTAL FUEL COST	CFB	1	"$000"	2021	0	#N/A	$000
TOTAL FUEL COST	CFB	1	"$000"	2022	0	#N/A	$000
TOTAL FUEL COST	CFB	1	"$000"	2023	0	#N/A	$000
TOTAL FUEL COST	CFB	1	"$000"	2024	0	#N/A	$000
TOTAL FUEL COST	CFB	1	"$000"	2025	0	#N/A	$000
TOTAL FUEL COST	CFB	1	"$000"	2026	0	#N/A	$000
TOTAL FUEL COST	CFB	1	"$000"	2027	0	#N/A	$000
TOTAL FUEL COST	CFB	1	"$000"	2028	0	#N/A	$000
TOTAL FUEL COST	CFB	1	"$000"	2029	0	#N/A	$000
TOTAL FUEL COST	CFB	1	"$000"	2030	0	#N/A	$000
TOTAL FUEL COST	CFB	1	"$000"	2031	0	#N/A	$000
TOTAL FUEL COST	CFB	1	"$000"	2032	0	#N/A	$000
TOTAL FUEL COST	CFB	1	"$000"	2033	0	#N/A	$000
TOTAL FUEL COST	CFB	1	"$000"	2034	0	#N/A	$000
TOTAL FUEL COST	CFB	1	"$000"	2035	0	#N/A	$000
TOTAL FUEL COST	RECIP	1	"$000"	2006	0	#N/A	$000
TOTAL FUEL COST	RECIP	1	"$000"	2007	0	#N/A	$000
TOTAL FUEL COST	RECIP	1	"$000"	2008	0	#N/A	$000
TOTAL FUEL COST	RECIP	1	"$000"	2009	0	#N/A	$000
TOTAL FUEL COST	RECIP	1	"$000"	2010	0	#N/A	$000
TOTAL FUEL COST	RECIP	1	"$000"	2011	0	#N/A	$000
TOTAL FUEL COST	RECIP	1	"$000"	2012	0	#N/A	$000
TOTAL FUEL COST	RECIP	1	"$000"	2013	0	#N/A	$000
TOTAL FUEL COST	RECIP	1	"$000"	2014	0	#N/A	$000
TOTAL FUEL COST	RECIP	1	"$000"	2015	0	#N/A	$000
TOTAL FUEL COST	RECIP	1	"$000"	2016	0	#N/A	$000
TOTAL FUEL COST	RECIP	1	"$000"	2017	0	#N/A	$000
TOTAL FUEL COST	RECIP	1	"$000"	2018	0	#N/A	$000
TOTAL FUEL COST	RECIP	1	"$000"	2019	0	#N/A	$000
TOTAL FUEL COST	RECIP	1	"$000"	2020	0	#N/A	$000
TOTAL FUEL COST	RECIP	1	"$000"	2021	0	#N/A	$000
TOTAL FUEL COST	RECIP	1	"$000"	2022	0	#N/A	$000
TOTAL FUEL COST	RECIP	1	"$000"	2023	0	#N/A	$000
TOTAL FUEL COST	RECIP	1	"$000"	2024	0	#N/A	$000
TOTAL FUEL COST	RECIP	1	"$000"	2025	0	#N/A	$000
TOTAL FUEL COST	RECIP	1	"$000"	2026	0	#N/A	$000
TOTAL FUEL COST	RECIP	1	"$000"	2027	0	#N/A	$000
TOTAL FUEL COST	RECIP	1	"$000"	2028	0	#N/A	$000
TOTAL FUEL COST	RECIP	1	"$000"	2029	0	#N/A	$000
TOTAL FUEL COST	RECIP	1	"$000"	2030	0	#N/A	$000
TOTAL FUEL COST	RECIP	1	"$000"	2031	0	#N/A	$000
TOTAL FUEL COST	RECIP	1	"$000"	2032	0	#N/A	$000
TOTAL FUEL COST	RECIP	1	"$000"	2033	0	#N/A	$000
TOTAL FUEL COST	RECIP	1	"$000"	2034	0	#N/A	$000
TOTAL FUEL COST	RECIP	1	"$000"	2035	0	#N/A	$000
TOTAL FUEL COST	MSW	1	"$000"	2006	0	#N/A	$000
TOTAL FUEL COST	MSW	1	"$000"	2007	0	#N/A	$000
TOTAL FUEL COST	MSW	1	"$000"	2008	0	#N/A	$000

TOTAL FUEL COST	MSW	1	"$000"	2009	0	#N/A	$000
TOTAL FUEL COST	MSW	1	"$000"	2010	0	#N/A	$000
TOTAL FUEL COST	MSW	1	"$000"	2011	0	#N/A	$000
TOTAL FUEL COST	MSW	1	"$000"	2012	0	#N/A	$000
TOTAL FUEL COST	MSW	1	"$000"	2013	0	#N/A	$000
TOTAL FUEL COST	MSW	1	"$000"	2014	0	#N/A	$000
TOTAL FUEL COST	MSW	1	"$000"	2015	0	#N/A	$000
TOTAL FUEL COST	MSW	1	"$000"	2016	0	#N/A	$000
TOTAL FUEL COST	MSW	1	"$000"	2017	0	#N/A	$000
TOTAL FUEL COST	MSW	1	"$000"	2018	0	#N/A	$000
TOTAL FUEL COST	MSW	1	"$000"	2019	0	#N/A	$000
TOTAL FUEL COST	MSW	1	"$000"	2020	0	#N/A	$000
TOTAL FUEL COST	MSW	1	"$000"	2021	0	#N/A	$000
TOTAL FUEL COST	MSW	1	"$000"	2022	0	#N/A	$000
TOTAL FUEL COST	MSW	1	"$000"	2023	0	#N/A	$000
TOTAL FUEL COST	MSW	1	"$000"	2024	0	#N/A	$000
TOTAL FUEL COST	MSW	1	"$000"	2025	0	#N/A	$000
TOTAL FUEL COST	MSW	1	"$000"	2026	0	#N/A	$000
TOTAL FUEL COST	MSW	1	"$000"	2027	0	#N/A	$000
TOTAL FUEL COST	MSW	1	"$000"	2028	0	#N/A	$000
TOTAL FUEL COST	MSW	1	"$000"	2029	0	#N/A	$000
TOTAL FUEL COST	MSW	1	"$000"	2030	0	#N/A	$000
TOTAL FUEL COST	MSW	1	"$000"	2031	0	#N/A	$000
TOTAL FUEL COST	MSW	1	"$000"	2032	0	#N/A	$000
TOTAL FUEL COST	MSW	1	"$000"	2033	0	#N/A	$000
TOTAL FUEL COST	MSW	1	"$000"	2034	0	#N/A	$000
TOTAL FUEL COST	MSW	1	"$000"	2035	0	#N/A	$000
TOTAL FUEL COST	RETR	1	"$000"	2006	0	#N/A	$000
TOTAL FUEL COST	RETR	1	"$000"	2007	0	#N/A	$000
TOTAL FUEL COST	RETR	1	"$000"	2008	0	#N/A	$000
TOTAL FUEL COST	RETR	1	"$000"	2009	0	#N/A	$000
TOTAL FUEL COST	RETR	1	"$000"	2010	0	#N/A	$000
TOTAL FUEL COST	RETR	1	"$000"	2011	0	#N/A	$000
TOTAL FUEL COST	RETR	1	"$000"	2012	0	#N/A	$000
TOTAL FUEL COST	RETR	1	"$000"	2013	0	#N/A	$000
TOTAL FUEL COST	RETR	1	"$000"	2014	0	#N/A	$000
TOTAL FUEL COST	RETR	1	"$000"	2015	0	#N/A	$000
TOTAL FUEL COST	RETR	1	"$000"	2016	0	#N/A	$000
TOTAL FUEL COST	RETR	1	"$000"	2017	0	#N/A	$000
TOTAL FUEL COST	RETR	1	"$000"	2018	0	#N/A	$000
TOTAL FUEL COST	RETR	1	"$000"	2019	0	#N/A	$000
TOTAL FUEL COST	RETR	1	"$000"	2020	0	#N/A	$000
TOTAL FUEL COST	RETR	1	"$000"	2021	0	#N/A	$000
TOTAL FUEL COST	RETR	1	"$000"	2022	0	#N/A	$000
TOTAL FUEL COST	RETR	1	"$000"	2023	0	#N/A	$000
TOTAL FUEL COST	RETR	1	"$000"	2024	0	#N/A	$000
TOTAL FUEL COST	RETR	1	"$000"	2025	0	#N/A	$000
TOTAL FUEL COST	RETR	1	"$000"	2026	0	#N/A	$000
TOTAL FUEL COST	RETR	1	"$000"	2027	0	#N/A	$000
TOTAL FUEL COST	RETR	1	"$000"	2028	0	#N/A	$000
TOTAL FUEL COST	RETR	1	"$000"	2029	0	#N/A	$000
TOTAL FUEL COST	RETR	1	"$000"	2030	0	#N/A	$000

TOTAL FUEL COST	RETR	1	"$000"	2031	0	#N/A	$000
TOTAL FUEL COST	RETR	1	"$000"	2032	0	#N/A	$000
TOTAL FUEL COST	RETR	1	"$000"	2033	0	#N/A	$000
TOTAL FUEL COST	RETR	1	"$000"	2034	0	#N/A	$000
TOTAL FUEL COST	RETR	1	"$000"	2035	0	#N/A	$000
TOTAL FUEL COST	CLNG	1	"$000"	2006	0	#N/A	$000
TOTAL FUEL COST	CLNG	1	"$000"	2007	0	#N/A	$000
TOTAL FUEL COST	CLNG	1	"$000"	2008	0	#N/A	$000
TOTAL FUEL COST	CLNG	1	"$000"	2009	0	#N/A	$000
TOTAL FUEL COST	CLNG	1	"$000"	2010	0	#N/A	$000
TOTAL FUEL COST	CLNG	1	"$000"	2011	0	#N/A	$000
TOTAL FUEL COST	CLNG	1	"$000"	2012	0	#N/A	$000
TOTAL FUEL COST	CLNG	1	"$000"	2013	0	#N/A	$000
TOTAL FUEL COST	CLNG	1	"$000"	2014	0	#N/A	$000
TOTAL FUEL COST	CLNG	1	"$000"	2015	0	#N/A	$000
TOTAL FUEL COST	CLNG	1	"$000"	2016	0	#N/A	$000
TOTAL FUEL COST	CLNG	1	"$000"	2017	0	#N/A	$000
TOTAL FUEL COST	CLNG	1	"$000"	2018	0	#N/A	$000
TOTAL FUEL COST	CLNG	1	"$000"	2019	0	#N/A	$000
TOTAL FUEL COST	CLNG	1	"$000"	2020	0	#N/A	$000
TOTAL FUEL COST	CLNG	1	"$000"	2021	0	#N/A	$000
TOTAL FUEL COST	CLNG	1	"$000"	2022	0	#N/A	$000
TOTAL FUEL COST	CLNG	1	"$000"	2023	0	#N/A	$000
TOTAL FUEL COST	CLNG	1	"$000"	2024	0	#N/A	$000
TOTAL FUEL COST	CLNG	1	"$000"	2025	0	#N/A	$000
TOTAL FUEL COST	CLNG	1	"$000"	2026	0	#N/A	$000
TOTAL FUEL COST	CLNG	1	"$000"	2027	0	#N/A	$000
TOTAL FUEL COST	CLNG	1	"$000"	2028	0	#N/A	$000
TOTAL FUEL COST	CLNG	1	"$000"	2029	0	#N/A	$000
TOTAL FUEL COST	CLNG	1	"$000"	2030	0	#N/A	$000
TOTAL FUEL COST	CLNG	1	"$000"	2031	0	#N/A	$000
TOTAL FUEL COST	CLNG	1	"$000"	2032	0	#N/A	$000
TOTAL FUEL COST	CLNG	1	"$000"	2033	0	#N/A	$000
TOTAL FUEL COST	CLNG	1	"$000"	2034	0	#N/A	$000
TOTAL FUEL COST	CLNG	1	"$000"	2035	0	#N/A	$000
TOTAL FUEL COST	WIND	1	"$000"	2006	0	#N/A	$000
TOTAL FUEL COST	WIND	1	"$000"	2007	0	#N/A	$000
TOTAL FUEL COST	WIND	1	"$000"	2008	0	#N/A	$000
TOTAL FUEL COST	WIND	1	"$000"	2009	0	#N/A	$000
TOTAL FUEL COST	WIND	1	"$000"	2010	0	#N/A	$000
TOTAL FUEL COST	WIND	1	"$000"	2011	0	#N/A	$000
TOTAL FUEL COST	WIND	1	"$000"	2012	0	#N/A	$000
TOTAL FUEL COST	WIND	1	"$000"	2013	0	#N/A	$000
TOTAL FUEL COST	WIND	1	"$000"	2014	0	#N/A	$000
TOTAL FUEL COST	WIND	1	"$000"	2015	0	#N/A	$000
TOTAL FUEL COST	WIND	1	"$000"	2016	0	#N/A	$000
TOTAL FUEL COST	WIND	1	"$000"	2017	0	#N/A	$000
TOTAL FUEL COST	WIND	1	"$000"	2018	0	#N/A	$000
TOTAL FUEL COST	WIND	1	"$000"	2019	0	#N/A	$000
TOTAL FUEL COST	WIND	1	"$000"	2020	0	#N/A	$000
TOTAL FUEL COST	WIND	1	"$000"	2021	0	#N/A	$000
TOTAL FUEL COST	WIND	1	"$000"	2022	0	#N/A	$000

TOTAL FUEL COST	WIND	1	"$000"	2023	0	#N/A	$000
TOTAL FUEL COST	WIND	1	"$000"	2024	0	#N/A	$000
TOTAL FUEL COST	WIND	1	"$000"	2025	0	#N/A	$000
TOTAL FUEL COST	WIND	1	"$000"	2026	0	#N/A	$000
TOTAL FUEL COST	WIND	1	"$000"	2027	0	#N/A	$000
TOTAL FUEL COST	WIND	1	"$000"	2028	0	#N/A	$000
TOTAL FUEL COST	WIND	1	"$000"	2029	0	#N/A	$000
TOTAL FUEL COST	WIND	1	"$000"	2030	0	#N/A	$000
TOTAL FUEL COST	WIND	1	"$000"	2031	0	#N/A	$000
TOTAL FUEL COST	WIND	1	"$000"	2032	0	#N/A	$000
TOTAL FUEL COST	WIND	1	"$000"	2033	0	#N/A	$000
TOTAL FUEL COST	WIND	1	"$000"	2034	0	#N/A	$000
TOTAL FUEL COST	WIND	1	"$000"	2035	0	#N/A	$000
TOTAL FUEL COST	CAB LNG	1	"$000"	2006	0	#N/A	$000
TOTAL FUEL COST	CAB LNG	1	"$000"	2007	0	#N/A	$000
TOTAL FUEL COST	CAB LNG	1	"$000"	2008	0	#N/A	$000
TOTAL FUEL COST	CAB LNG	1	"$000"	2009	0	#N/A	$000
TOTAL FUEL COST	CAB LNG	1	"$000"	2010	0	#N/A	$000
TOTAL FUEL COST	CAB LNG	1	"$000"	2011	0	#N/A	$000
TOTAL FUEL COST	CAB LNG	1	"$000"	2012	0	#N/A	$000
TOTAL FUEL COST	CAB LNG	1	"$000"	2013	0	#N/A	$000
TOTAL FUEL COST	CAB LNG	1	"$000"	2014	0	#N/A	$000
TOTAL FUEL COST	CAB LNG	1	"$000"	2015	0	#N/A	$000
TOTAL FUEL COST	CAB LNG	1	"$000"	2016	0	#N/A	$000
TOTAL FUEL COST	CAB LNG	1	"$000"	2017	0	#N/A	$000
TOTAL FUEL COST	CAB LNG	1	"$000"	2018	0	#N/A	$000
TOTAL FUEL COST	CAB LNG	1	"$000"	2019	0	#N/A	$000
TOTAL FUEL COST	CAB LNG	1	"$000"	2020	0	#N/A	$000
TOTAL FUEL COST	CAB LNG	1	"$000"	2021	0	#N/A	$000
TOTAL FUEL COST	CAB LNG	1	"$000"	2022	0	#N/A	$000
TOTAL FUEL COST	CAB LNG	1	"$000"	2023	0	#N/A	$000
TOTAL FUEL COST	CAB LNG	1	"$000"	2024	0	#N/A	$000
TOTAL FUEL COST	CAB LNG	1	"$000"	2025	0	#N/A	$000
TOTAL FUEL COST	CAB LNG	1	"$000"	2026	0	#N/A	$000
TOTAL FUEL COST	CAB LNG	1	"$000"	2027	0	#N/A	$000
TOTAL FUEL COST	CAB LNG	1	"$000"	2028	0	#N/A	$000
TOTAL FUEL COST	CAB LNG	1	"$000"	2029	0	#N/A	$000
TOTAL FUEL COST	CAB LNG	1	"$000"	2030	0	#N/A	$000
TOTAL FUEL COST	CAB LNG	1	"$000"	2031	0	#N/A	$000
TOTAL FUEL COST	CAB LNG	1	"$000"	2032	0	#N/A	$000
TOTAL FUEL COST	CAB LNG	1	"$000"	2033	0	#N/A	$000
TOTAL FUEL COST	CAB LNG	1	"$000"	2034	0	#N/A	$000
TOTAL FUEL COST	CAB LNG	1	"$000"	2035	0	#N/A	$000
TOTAL FUEL COST	CAB LNG	2	"$000"	2006	0	#N/A	$000
TOTAL FUEL COST	CAB LNG	2	"$000"	2007	0	#N/A	$000
TOTAL FUEL COST	CAB LNG	2	"$000"	2008	0	#N/A	$000
TOTAL FUEL COST	CAB LNG	2	"$000"	2009	0	#N/A	$000
TOTAL FUEL COST	CAB LNG	2	"$000"	2010	0	#N/A	$000
TOTAL FUEL COST	CAB LNG	2	"$000"	2011	0	#N/A	$000
TOTAL FUEL COST	CAB LNG	2	"$000"	2012	0	#N/A	$000
TOTAL FUEL COST	CAB LNG	2	"$000"	2013	0	#N/A	$000
TOTAL FUEL COST	CAB LNG	2	"$000"	2014	0	#N/A	$000

TOTAL FUEL COST	CAB LNG 2	"$000"	2015	0	#N/A	$000
TOTAL FUEL COST	CAB LNG 2	"$000"	2016	0	#N/A	$000
TOTAL FUEL COST	CAB LNG 2	"$000"	2017	0	#N/A	$000
TOTAL FUEL COST	CAB LNG 2	"$000"	2018	0	#N/A	$000
TOTAL FUEL COST	CAB LNG 2	"$000"	2019	0	#N/A	$000
TOTAL FUEL COST	CAB LNG 2	"$000"	2020	0	#N/A	$000
TOTAL FUEL COST	CAB LNG 2	"$000"	2021	0	#N/A	$000
TOTAL FUEL COST	CAB LNG 2	"$000"	2022	0	#N/A	$000
TOTAL FUEL COST	CAB LNG 2	"$000"	2023	0	#N/A	$000
TOTAL FUEL COST	CAB LNG 2	"$000"	2024	0	#N/A	$000
TOTAL FUEL COST	CAB LNG 2	"$000"	2025	0	#N/A	$000
TOTAL FUEL COST	CAB LNG 2	"$000"	2026	0	#N/A	$000
TOTAL FUEL COST	CAB LNG 2	"$000"	2027	0	#N/A	$000
TOTAL FUEL COST	CAB LNG 2	"$000"	2028	0	#N/A	$000
TOTAL FUEL COST	CAB LNG 2	"$000"	2029	0	#N/A	$000
TOTAL FUEL COST	CAB LNG 2	"$000"	2030	0	#N/A	$000
TOTAL FUEL COST	CAB LNG 2	"$000"	2031	0	#N/A	$000
TOTAL FUEL COST	CAB LNG 2	"$000"	2032	0	#N/A	$000
TOTAL FUEL COST	CAB LNG 2	"$000"	2033	0	#N/A	$000
TOTAL FUEL COST	CAB LNG 2	"$000"	2034	0	#N/A	$000
TOTAL FUEL COST	CAB LNG 2	"$000"	2035	0	#N/A	$000
TOTAL FUEL COST	DED LNG 1	"$000"	2006	0	#N/A	$000
TOTAL FUEL COST	DED LNG 1	"$000"	2007	0	#N/A	$000
TOTAL FUEL COST	DED LNG 1	"$000"	2008	0	#N/A	$000
TOTAL FUEL COST	DED LNG 1	"$000"	2009	0	#N/A	$000
TOTAL FUEL COST	DED LNG 1	"$000"	2010	0	#N/A	$000
TOTAL FUEL COST	DED LNG 1	"$000"	2011	0	#N/A	$000
TOTAL FUEL COST	DED LNG 1	"$000"	2012	0	#N/A	$000
TOTAL FUEL COST	DED LNG 1	"$000"	2013	0	#N/A	$000
TOTAL FUEL COST	DED LNG 1	"$000"	2014	0	#N/A	$000
TOTAL FUEL COST	DED LNG 1	"$000"	2015	0	#N/A	$000
TOTAL FUEL COST	DED LNG 1	"$000"	2016	0	#N/A	$000
TOTAL FUEL COST	DED LNG 1	"$000"	2017	0	#N/A	$000
TOTAL FUEL COST	DED LNG 1	"$000"	2018	0	#N/A	$000
TOTAL FUEL COST	DED LNG 1	"$000"	2019	0	#N/A	$000
TOTAL FUEL COST	DED LNG 1	"$000"	2020	0	#N/A	$000
TOTAL FUEL COST	DED LNG 1	"$000"	2021	0	#N/A	$000
TOTAL FUEL COST	DED LNG 1	"$000"	2022	0	#N/A	$000
TOTAL FUEL COST	DED LNG 1	"$000"	2023	0	#N/A	$000
TOTAL FUEL COST	DED LNG 1	"$000"	2024	0	#N/A	$000
TOTAL FUEL COST	DED LNG 1	"$000"	2025	0	#N/A	$000
TOTAL FUEL COST	DED LNG 1	"$000"	2026	0	#N/A	$000
TOTAL FUEL COST	DED LNG 1	"$000"	2027	0	#N/A	$000
TOTAL FUEL COST	DED LNG 1	"$000"	2028	0	#N/A	$000
TOTAL FUEL COST	DED LNG 1	"$000"	2029	0	#N/A	$000
TOTAL FUEL COST	DED LNG 1	"$000"	2030	0	#N/A	$000
TOTAL FUEL COST	DED LNG 1	"$000"	2031	0	#N/A	$000
TOTAL FUEL COST	DED LNG 1	"$000"	2032	0	#N/A	$000
TOTAL FUEL COST	DED LNG 1	"$000"	2033	0	#N/A	$000
TOTAL FUEL COST	DED LNG 1	"$000"	2034	0	#N/A	$000
TOTAL FUEL COST	DED LNG 1	"$000"	2035	0	#N/A	$000
TOTAL FUEL COST	DED LNG 2	"$000"	2006	0	#N/A	$000

TOTAL FUEL COST	DED LNG 2	"$000"	2007	0	#N/A	$000
TOTAL FUEL COST	DED LNG 2	"$000"	2008	0	#N/A	$000
TOTAL FUEL COST	DED LNG 2	"$000"	2009	0	#N/A	$000
TOTAL FUEL COST	DED LNG 2	"$000"	2010	0	#N/A	$000
TOTAL FUEL COST	DED LNG 2	"$000"	2011	0	#N/A	$000
TOTAL FUEL COST	DED LNG 2	"$000"	2012	0	#N/A	$000
TOTAL FUEL COST	DED LNG 2	"$000"	2013	0	#N/A	$000
TOTAL FUEL COST	DED LNG 2	"$000"	2014	0	#N/A	$000
TOTAL FUEL COST	DED LNG 2	"$000"	2015	0	#N/A	$000
TOTAL FUEL COST	DED LNG 2	"$000"	2016	0	#N/A	$000
TOTAL FUEL COST	DED LNG 2	"$000"	2017	0	#N/A	$000
TOTAL FUEL COST	DED LNG 2	"$000"	2018	0	#N/A	$000
TOTAL FUEL COST	DED LNG 2	"$000"	2019	0	#N/A	$000
TOTAL FUEL COST	DED LNG 2	"$000"	2020	0	#N/A	$000
TOTAL FUEL COST	DED LNG 2	"$000"	2021	0	#N/A	$000
TOTAL FUEL COST	DED LNG 2	"$000"	2022	0	#N/A	$000
TOTAL FUEL COST	DED LNG 2	"$000"	2023	0	#N/A	$000
TOTAL FUEL COST	DED LNG 2	"$000"	2024	0	#N/A	$000
TOTAL FUEL COST	DED LNG 2	"$000"	2025	0	#N/A	$000
TOTAL FUEL COST	DED LNG 2	"$000"	2026	0	#N/A	$000
TOTAL FUEL COST	DED LNG 2	"$000"	2027	0	#N/A	$000
TOTAL FUEL COST	DED LNG 2	"$000"	2028	0	#N/A	$000
TOTAL FUEL COST	DED LNG 2	"$000"	2029	0	#N/A	$000
TOTAL FUEL COST	DED LNG 2	"$000"	2030	0	#N/A	$000
TOTAL FUEL COST	DED LNG 2	"$000"	2031	0	#N/A	$000
TOTAL FUEL COST	DED LNG 2	"$000"	2032	0	#N/A	$000
TOTAL FUEL COST	DED LNG 2	"$000"	2033	0	#N/A	$000
TOTAL FUEL COST	DED LNG 2	"$000"	2034	0	#N/A	$000
TOTAL FUEL COST	DED LNG 2	"$000"	2035	0	#N/A	$000
TOTAL FUEL COST	MAC LNG 1	"$000"	2006	0	#N/A	$000
TOTAL FUEL COST	MAC LNG 1	"$000"	2007	0	#N/A	$000
TOTAL FUEL COST	MAC LNG 1	"$000"	2008	0	#N/A	$000
TOTAL FUEL COST	MAC LNG 1	"$000"	2009	0	#N/A	$000
TOTAL FUEL COST	MAC LNG 1	"$000"	2010	0	#N/A	$000
TOTAL FUEL COST	MAC LNG 1	"$000"	2011	0	#N/A	$000
TOTAL FUEL COST	MAC LNG 1	"$000"	2012	0	#N/A	$000
TOTAL FUEL COST	MAC LNG 1	"$000"	2013	0	#N/A	$000
TOTAL FUEL COST	MAC LNG 1	"$000"	2014	0	#N/A	$000
TOTAL FUEL COST	MAC LNG 1	"$000"	2015	0	#N/A	$000
TOTAL FUEL COST	MAC LNG 1	"$000"	2016	0	#N/A	$000
TOTAL FUEL COST	MAC LNG 1	"$000"	2017	0	#N/A	$000
TOTAL FUEL COST	MAC LNG 1	"$000"	2018	0	#N/A	$000
TOTAL FUEL COST	MAC LNG 1	"$000"	2019	0	#N/A	$000
TOTAL FUEL COST	MAC LNG 1	"$000"	2020	0	#N/A	$000
TOTAL FUEL COST	MAC LNG 1	"$000"	2021	0	#N/A	$000
TOTAL FUEL COST	MAC LNG 1	"$000"	2022	0	#N/A	$000
TOTAL FUEL COST	MAC LNG 1	"$000"	2023	0	#N/A	$000
TOTAL FUEL COST	MAC LNG 1	"$000"	2024	0	#N/A	$000
TOTAL FUEL COST	MAC LNG 1	"$000"	2025	0	#N/A	$000
TOTAL FUEL COST	MAC LNG 1	"$000"	2026	0	#N/A	$000
TOTAL FUEL COST	MAC LNG 1	"$000"	2027	0	#N/A	$000
TOTAL FUEL COST	MAC LNG 1	"$000"	2028	0	#N/A	$000

TOTAL FUEL COST	MAC LNG 1	"$000"	2029	0	#N/A	$000
TOTAL FUEL COST	MAC LNG 1	"$000"	2030	0	#N/A	$000
TOTAL FUEL COST	MAC LNG 1	"$000"	2031	0	#N/A	$000
TOTAL FUEL COST	MAC LNG 1	"$000"	2032	0	#N/A	$000
TOTAL FUEL COST	MAC LNG 1	"$000"	2033	0	#N/A	$000
TOTAL FUEL COST	MAC LNG 1	"$000"	2034	0	#N/A	$000
TOTAL FUEL COST	MAC LNG 1	"$000"	2035	0	#N/A	$000
TOTAL FUEL COST	YIG LNG 1	"$000"	2006	0	#N/A	$000
TOTAL FUEL COST	YIG LNG 1	"$000"	2007	0	#N/A	$000
TOTAL FUEL COST	YIG LNG 1	"$000"	2008	0	#N/A	$000
TOTAL FUEL COST	YIG LNG 1	"$000"	2009	0	#N/A	$000
TOTAL FUEL COST	YIG LNG 1	"$000"	2010	0	#N/A	$000
TOTAL FUEL COST	YIG LNG 1	"$000"	2011	0	#N/A	$000
TOTAL FUEL COST	YIG LNG 1	"$000"	2012	0	#N/A	$000
TOTAL FUEL COST	YIG LNG 1	"$000"	2013	0	#N/A	$000
TOTAL FUEL COST	YIG LNG 1	"$000"	2014	0	#N/A	$000
TOTAL FUEL COST	YIG LNG 1	"$000"	2015	0	#N/A	$000
TOTAL FUEL COST	YIG LNG 1	"$000"	2016	0	#N/A	$000
TOTAL FUEL COST	YIG LNG 1	"$000"	2017	0	#N/A	$000
TOTAL FUEL COST	YIG LNG 1	"$000"	2018	0	#N/A	$000
TOTAL FUEL COST	YIG LNG 1	"$000"	2019	0	#N/A	$000
TOTAL FUEL COST	YIG LNG 1	"$000"	2020	0	#N/A	$000
TOTAL FUEL COST	YIG LNG 1	"$000"	2021	0	#N/A	$000
TOTAL FUEL COST	YIG LNG 1	"$000"	2022	0	#N/A	$000
TOTAL FUEL COST	YIG LNG 1	"$000"	2023	0	#N/A	$000
TOTAL FUEL COST	YIG LNG 1	"$000"	2024	0	#N/A	$000
TOTAL FUEL COST	YIG LNG 1	"$000"	2025	0	#N/A	$000
TOTAL FUEL COST	YIG LNG 1	"$000"	2026	0	#N/A	$000
TOTAL FUEL COST	YIG LNG 1	"$000"	2027	0	#N/A	$000
TOTAL FUEL COST	YIG LNG 1	"$000"	2028	0	#N/A	$000
TOTAL FUEL COST	YIG LNG 1	"$000"	2029	0	#N/A	$000
TOTAL FUEL COST	YIG LNG 1	"$000"	2030	0	#N/A	$000
TOTAL FUEL COST	YIG LNG 1	"$000"	2031	0	#N/A	$000
TOTAL FUEL COST	YIG LNG 1	"$000"	2032	0	#N/A	$000
TOTAL FUEL COST	YIG LNG 1	"$000"	2033	0	#N/A	$000
TOTAL FUEL COST	YIG LNG 1	"$000"	2034	0	#N/A	$000
TOTAL FUEL COST	YIG LNG 1	"$000"	2035	0	#N/A	$000
TOTAL FUEL COST	TJO LNG 1	"$000"	2006	0	#N/A	$000
TOTAL FUEL COST	TJO LNG 1	"$000"	2007	0	#N/A	$000
TOTAL FUEL COST	TJO LNG 1	"$000"	2008	0	#N/A	$000
TOTAL FUEL COST	TJO LNG 1	"$000"	2009	0	#N/A	$000
TOTAL FUEL COST	TJO LNG 1	"$000"	2010	0	#N/A	$000
TOTAL FUEL COST	TJO LNG 1	"$000"	2011	0	#N/A	$000
TOTAL FUEL COST	TJO LNG 1	"$000"	2012	0	#N/A	$000
TOTAL FUEL COST	TJO LNG 1	"$000"	2013	0	#N/A	$000
TOTAL FUEL COST	TJO LNG 1	"$000"	2014	0	#N/A	$000
TOTAL FUEL COST	TJO LNG 1	"$000"	2015	0	#N/A	$000
TOTAL FUEL COST	TJO LNG 1	"$000"	2016	0	#N/A	$000
TOTAL FUEL COST	TJO LNG 1	"$000"	2017	0	#N/A	$000
TOTAL FUEL COST	TJO LNG 1	"$000"	2018	0	#N/A	$000
TOTAL FUEL COST	TJO LNG 1	"$000"	2019	0	#N/A	$000
TOTAL FUEL COST	TJO LNG 1	"$000"	2020	0	#N/A	$000

TOTAL FUEL COST	TJO LNG 1	"$000"	2021	0	#N/A	$000
TOTAL FUEL COST	TJO LNG 1	"$000"	2022	0	#N/A	$000
TOTAL FUEL COST	TJO LNG 1	"$000"	2023	0	#N/A	$000
TOTAL FUEL COST	TJO LNG 1	"$000"	2024	0	#N/A	$000
TOTAL FUEL COST	TJO LNG 1	"$000"	2025	0	#N/A	$000
TOTAL FUEL COST	TJO LNG 1	"$000"	2026	0	#N/A	$000
TOTAL FUEL COST	TJO LNG 1	"$000"	2027	0	#N/A	$000
TOTAL FUEL COST	TJO LNG 1	"$000"	2028	0	#N/A	$000
TOTAL FUEL COST	TJO LNG 1	"$000"	2029	0	#N/A	$000
TOTAL FUEL COST	TJO LNG 1	"$000"	2030	0	#N/A	$000
TOTAL FUEL COST	TJO LNG 1	"$000"	2031	0	#N/A	$000
TOTAL FUEL COST	TJO LNG 1	"$000"	2032	0	#N/A	$000
TOTAL FUEL COST	TJO LNG 1	"$000"	2033	0	#N/A	$000
TOTAL FUEL COST	TJO LNG 1	"$000"	2034	0	#N/A	$000
TOTAL FUEL COST	TJO LNG 1	"$000"	2035	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 1	"$000"	2006	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 1	"$000"	2007	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 1	"$000"	2008	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 1	"$000"	2009	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 1	"$000"	2010	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 1	"$000"	2011	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 1	"$000"	2012	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 1	"$000"	2013	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 1	"$000"	2014	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 1	"$000"	2015	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 1	"$000"	2016	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 1	"$000"	2017	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 1	"$000"	2018	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 1	"$000"	2019	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 1	"$000"	2020	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 1	"$000"	2021	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 1	"$000"	2022	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 1	"$000"	2023	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 1	"$000"	2024	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 1	"$000"	2025	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 1	"$000"	2026	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 1	"$000"	2027	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 1	"$000"	2028	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 1	"$000"	2029	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 1	"$000"	2030	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 1	"$000"	2031	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 1	"$000"	2032	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 1	"$000"	2033	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 1	"$000"	2034	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 1	"$000"	2035	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 2	"$000"	2006	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 2	"$000"	2007	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 2	"$000"	2008	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 2	"$000"	2009	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 2	"$000"	2010	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 2	"$000"	2011	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 2	"$000"	2012	0	#N/A	$000

TOTAL FUEL COST	TAN LNG 2	"$000"	2013	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 2	"$000"	2014	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 2	"$000"	2015	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 2	"$000"	2016	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 2	"$000"	2017	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 2	"$000"	2018	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 2	"$000"	2019	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 2	"$000"	2020	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 2	"$000"	2021	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 2	"$000"	2022	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 2	"$000"	2023	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 2	"$000"	2024	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 2	"$000"	2025	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 2	"$000"	2026	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 2	"$000"	2027	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 2	"$000"	2028	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 2	"$000"	2029	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 2	"$000"	2030	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 2	"$000"	2031	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 2	"$000"	2032	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 2	"$000"	2033	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 2	"$000"	2034	0	#N/A	$000
TOTAL FUEL COST	TAN LNG 2	"$000"	2035	0	#N/A	$000
TOTAL FUEL COST	TEM LNG 1	"$000"	2006	0	#N/A	$000
TOTAL FUEL COST	TEM LNG 1	"$000"	2007	0	#N/A	$000
TOTAL FUEL COST	TEM LNG 1	"$000"	2008	0	#N/A	$000
TOTAL FUEL COST	TEM LNG 1	"$000"	2009	0	#N/A	$000
TOTAL FUEL COST	TEM LNG 1	"$000"	2010	0	#N/A	$000
TOTAL FUEL COST	TEM LNG 1	"$000"	2011	0	#N/A	$000
TOTAL FUEL COST	TEM LNG 1	"$000"	2012	0	#N/A	$000
TOTAL FUEL COST	TEM LNG 1	"$000"	2013	0	#N/A	$000
TOTAL FUEL COST	TEM LNG 1	"$000"	2014	0	#N/A	$000
TOTAL FUEL COST	TEM LNG 1	"$000"	2015	0	#N/A	$000
TOTAL FUEL COST	TEM LNG 1	"$000"	2016	0	#N/A	$000
TOTAL FUEL COST	TEM LNG 1	"$000"	2017	0	#N/A	$000
TOTAL FUEL COST	TEM LNG 1	"$000"	2018	0	#N/A	$000
TOTAL FUEL COST	TEM LNG 1	"$000"	2019	0	#N/A	$000
TOTAL FUEL COST	TEM LNG 1	"$000"	2020	0	#N/A	$000
TOTAL FUEL COST	TEM LNG 1	"$000"	2021	0	#N/A	$000
TOTAL FUEL COST	TEM LNG 1	"$000"	2022	0	#N/A	$000
TOTAL FUEL COST	TEM LNG 1	"$000"	2023	0	#N/A	$000
TOTAL FUEL COST	TEM LNG 1	"$000"	2024	0	#N/A	$000
TOTAL FUEL COST	TEM LNG 1	"$000"	2025	0	#N/A	$000
TOTAL FUEL COST	TEM LNG 1	"$000"	2026	0	#N/A	$000
TOTAL FUEL COST	TEM LNG 1	"$000"	2027	0	#N/A	$000
TOTAL FUEL COST	TEM LNG 1	"$000"	2028	0	#N/A	$000
TOTAL FUEL COST	TEM LNG 1	"$000"	2029	0	#N/A	$000
TOTAL FUEL COST	TEM LNG 1	"$000"	2030	0	#N/A	$000
TOTAL FUEL COST	TEM LNG 1	"$000"	2031	0	#N/A	$000
TOTAL FUEL COST	TEM LNG 1	"$000"	2032	0	#N/A	$000
TOTAL FUEL COST	TEM LNG 1	"$000"	2033	0	#N/A	$000
TOTAL FUEL COST	TEM LNG 1	"$000"	2034	0	#N/A	$000

TOTAL FUEL COST	TEM LNG	1	"$000"	2035	0	#N/A	$000
TOTAL FUEL COST	RECIP	83	"$000"	2006	0	40	$000
TOTAL FUEL COST	RECIP	83	"$000"	2007	0	40	$000
TOTAL FUEL COST	RECIP	83	"$000"	2008	0	40	$000
TOTAL FUEL COST	RECIP	83	"$000"	2009	0	40	$000
TOTAL FUEL COST	RECIP	83	"$000"	2010	0	40	$000
TOTAL FUEL COST	RECIP	83	"$000"	2011	0	40	$000
TOTAL FUEL COST	RECIP	83	"$000"	2012	0	40	$000
TOTAL FUEL COST	RECIP	83	"$000"	2013	0	40	$000
TOTAL FUEL COST	RECIP	83	"$000"	2014	0	40	$000
TOTAL FUEL COST	RECIP	83	"$000"	2015	0	40	$000
TOTAL FUEL COST	RECIP	83	"$000"	2016	0	40	$000
TOTAL FUEL COST	RECIP	83	"$000"	2017	0	40	$000
TOTAL FUEL COST	RECIP	83	"$000"	2018	0	40	$000
TOTAL FUEL COST	RECIP	83	"$000"	2019	0	40	$000
TOTAL FUEL COST	RECIP	83	"$000"	2020	0	40	$000
TOTAL FUEL COST	RECIP	83	"$000"	2021	0	40	$000
TOTAL FUEL COST	RECIP	83	"$000"	2022	0	40	$000
TOTAL FUEL COST	RECIP	83	"$000"	2023	0	40	$000
TOTAL FUEL COST	RECIP	83	"$000"	2024	0	40	$000
TOTAL FUEL COST	RECIP	83	"$000"	2025	0	40	$000
TOTAL FUEL COST	RECIP	83	"$000"	2026	0	40	$000
TOTAL FUEL COST	RECIP	83	"$000"	2027	0	40	$000
TOTAL FUEL COST	RECIP	83	"$000"	2028	0	40	$000
TOTAL FUEL COST	RECIP	83	"$000"	2029	0	40	$000
TOTAL FUEL COST	RECIP	83	"$000"	2030	0	40	$000
TOTAL FUEL COST	RECIP	83	"$000"	2031	0	40	$000
TOTAL FUEL COST	RECIP	83	"$000"	2032	0	40	$000
TOTAL FUEL COST	RECIP	83	"$000"	2033	0	40	$000
TOTAL FUEL COST	RECIP	83	"$000"	2034	2776.218994	40	$000
TOTAL FUEL COST	RECIP	83	"$000"	2035	16476.80078	40	$000
TOTAL FUEL COST	RECIP	84	"$000"	2006	0	40	$000
TOTAL FUEL COST	RECIP	84	"$000"	2007	0	40	$000
TOTAL FUEL COST	RECIP	84	"$000"	2008	0	40	$000
TOTAL FUEL COST	RECIP	84	"$000"	2009	0	40	$000
TOTAL FUEL COST	RECIP	84	"$000"	2010	0	40	$000
TOTAL FUEL COST	RECIP	84	"$000"	2011	0	40	$000
TOTAL FUEL COST	RECIP	84	"$000"	2012	0	40	$000
TOTAL FUEL COST	RECIP	84	"$000"	2013	0	40	$000
TOTAL FUEL COST	RECIP	84	"$000"	2014	0	40	$000
TOTAL FUEL COST	RECIP	84	"$000"	2015	0	40	$000
TOTAL FUEL COST	RECIP	84	"$000"	2016	0	40	$000
TOTAL FUEL COST	RECIP	84	"$000"	2017	0	40	$000
TOTAL FUEL COST	RECIP	84	"$000"	2018	0	40	$000
TOTAL FUEL COST	RECIP	84	"$000"	2019	0	40	$000
TOTAL FUEL COST	RECIP	84	"$000"	2020	0	40	$000
TOTAL FUEL COST	RECIP	84	"$000"	2021	0	40	$000
TOTAL FUEL COST	RECIP	84	"$000"	2022	0	40	$000
TOTAL FUEL COST	RECIP	84	"$000"	2023	0	40	$000
TOTAL FUEL COST	RECIP	84	"$000"	2024	0	40	$000
TOTAL FUEL COST	RECIP	84	"$000"	2025	0	40	$000
TOTAL FUEL COST	RECIP	84	"$000"	2026	0	40	$000

TOTAL FUEL COST	RECIP	84	"$000"	2027	0	40	$000
TOTAL FUEL COST	RECIP	84	"$000"	2028	0	40	$000
TOTAL FUEL COST	RECIP	84	"$000"	2029	0	40	$000
TOTAL FUEL COST	RECIP	84	"$000"	2030	0	40	$000
TOTAL FUEL COST	RECIP	84	"$000"	2031	0	40	$000
TOTAL FUEL COST	RECIP	84	"$000"	2032	2506.918213	40	$000
TOTAL FUEL COST	RECIP	84	"$000"	2033	15652.40039	40	$000
TOTAL FUEL COST	RECIP	84	"$000"	2034	16076.35547	40	$000
TOTAL FUEL COST	RECIP	84	"$000"	2035	16041.04785	40	$000
TOTAL FUEL COST	CLNG	85	"$000"	2006	0	60	$000
TOTAL FUEL COST	CLNG	85	"$000"	2007	0	60	$000
TOTAL FUEL COST	CLNG	85	"$000"	2008	0	60	$000
TOTAL FUEL COST	CLNG	85	"$000"	2009	0	60	$000
TOTAL FUEL COST	CLNG	85	"$000"	2010	0	60	$000
TOTAL FUEL COST	CLNG	85	"$000"	2011	0	60	$000
TOTAL FUEL COST	CLNG	85	"$000"	2012	0	60	$000
TOTAL FUEL COST	CLNG	85	"$000"	2013	0	60	$000
TOTAL FUEL COST	CLNG	85	"$000"	2014	0	60	$000
TOTAL FUEL COST	CLNG	85	"$000"	2015	0	60	$000
TOTAL FUEL COST	CLNG	85	"$000"	2016	0	60	$000
TOTAL FUEL COST	CLNG	85	"$000"	2017	0	60	$000
TOTAL FUEL COST	CLNG	85	"$000"	2018	0	60	$000
TOTAL FUEL COST	CLNG	85	"$000"	2019	0	60	$000
TOTAL FUEL COST	CLNG	85	"$000"	2020	0	60	$000
TOTAL FUEL COST	CLNG	85	"$000"	2021	0	60	$000
TOTAL FUEL COST	CLNG	85	"$000"	2022	0	60	$000
TOTAL FUEL COST	CLNG	85	"$000"	2023	0	60	$000
TOTAL FUEL COST	CLNG	85	"$000"	2024	0	60	$000
TOTAL FUEL COST	CLNG	85	"$000"	2025	0	60	$000
TOTAL FUEL COST	CLNG	85	"$000"	2026	0	60	$000
TOTAL FUEL COST	CLNG	85	"$000"	2027	0	60	$000
TOTAL FUEL COST	CLNG	85	"$000"	2028	0	60	$000
TOTAL FUEL COST	CLNG	85	"$000"	2029	9999.6875	60	$000
TOTAL FUEL COST	CLNG	85	"$000"	2030	51048.01953	60	$000
TOTAL FUEL COST	CLNG	85	"$000"	2031	52505.16797	60	$000
TOTAL FUEL COST	CLNG	85	"$000"	2032	53824.38672	60	$000
TOTAL FUEL COST	CLNG	85	"$000"	2033	54566.86719	60	$000
TOTAL FUEL COST	CLNG	85	"$000"	2034	55889.41797	60	$000
TOTAL FUEL COST	CLNG	85	"$000"	2035	55888.16016	60	$000
TOTAL FUEL COST	RECIP	86	"$000"	2006	0	40	$000
TOTAL FUEL COST	RECIP	86	"$000"	2007	0	40	$000
TOTAL FUEL COST	RECIP	86	"$000"	2008	0	40	$000
TOTAL FUEL COST	RECIP	86	"$000"	2009	0	40	$000
TOTAL FUEL COST	RECIP	86	"$000"	2010	0	40	$000
TOTAL FUEL COST	RECIP	86	"$000"	2011	0	40	$000
TOTAL FUEL COST	RECIP	86	"$000"	2012	0	40	$000
TOTAL FUEL COST	RECIP	86	"$000"	2013	0	40	$000
TOTAL FUEL COST	RECIP	86	"$000"	2014	0	40	$000
TOTAL FUEL COST	RECIP	86	"$000"	2015	0	40	$000
TOTAL FUEL COST	RECIP	86	"$000"	2016	0	40	$000
TOTAL FUEL COST	RECIP	86	"$000"	2017	0	40	$000
TOTAL FUEL COST	RECIP	86	"$000"	2018	0	40	$000

TOTAL FUEL COST	RECIP	86	"$000"	2019	0	40	$000
TOTAL FUEL COST	RECIP	86	"$000"	2020	0	40	$000
TOTAL FUEL COST	RECIP	86	"$000"	2021	0	40	$000
TOTAL FUEL COST	RECIP	86	"$000"	2022	0	40	$000
TOTAL FUEL COST	RECIP	86	"$000"	2023	0	40	$000
TOTAL FUEL COST	RECIP	86	"$000"	2024	0	40	$000
TOTAL FUEL COST	RECIP	86	"$000"	2025	0	40	$000
TOTAL FUEL COST	RECIP	86	"$000"	2026	0	40	$000
TOTAL FUEL COST	RECIP	86	"$000"	2027	0	40	$000
TOTAL FUEL COST	RECIP	86	"$000"	2028	2437.434082	40	$000
TOTAL FUEL COST	RECIP	86	"$000"	2029	14325.81348	40	$000
TOTAL FUEL COST	RECIP	86	"$000"	2030	13636.74219	40	$000
TOTAL FUEL COST	RECIP	86	"$000"	2031	14266.05078	40	$000
TOTAL FUEL COST	RECIP	86	"$000"	2032	14933.65625	40	$000
TOTAL FUEL COST	RECIP	86	"$000"	2033	15010.36426	40	$000
TOTAL FUEL COST	RECIP	86	"$000"	2034	15501.4707	40	$000
TOTAL FUEL COST	RECIP	86	"$000"	2035	15810.4375	40	$000
TOTAL FUEL COST	RECIP	87	"$000"	2006	0	40	$000
TOTAL FUEL COST	RECIP	87	"$000"	2007	0	40	$000
TOTAL FUEL COST	RECIP	87	"$000"	2008	0	40	$000
TOTAL FUEL COST	RECIP	87	"$000"	2009	0	40	$000
TOTAL FUEL COST	RECIP	87	"$000"	2010	0	40	$000
TOTAL FUEL COST	RECIP	87	"$000"	2011	0	40	$000
TOTAL FUEL COST	RECIP	87	"$000"	2012	0	40	$000
TOTAL FUEL COST	RECIP	87	"$000"	2013	0	40	$000
TOTAL FUEL COST	RECIP	87	"$000"	2014	0	40	$000
TOTAL FUEL COST	RECIP	87	"$000"	2015	0	40	$000
TOTAL FUEL COST	RECIP	87	"$000"	2016	0	40	$000
TOTAL FUEL COST	RECIP	87	"$000"	2017	0	40	$000
TOTAL FUEL COST	RECIP	87	"$000"	2018	0	40	$000
TOTAL FUEL COST	RECIP	87	"$000"	2019	0	40	$000
TOTAL FUEL COST	RECIP	87	"$000"	2020	0	40	$000
TOTAL FUEL COST	RECIP	87	"$000"	2021	0	40	$000
TOTAL FUEL COST	RECIP	87	"$000"	2022	0	40	$000
TOTAL FUEL COST	RECIP	87	"$000"	2023	0	40	$000
TOTAL FUEL COST	RECIP	87	"$000"	2024	0	40	$000
TOTAL FUEL COST	RECIP	87	"$000"	2025	0	40	$000
TOTAL FUEL COST	RECIP	87	"$000"	2026	0	40	$000
TOTAL FUEL COST	RECIP	87	"$000"	2027	2111.083496	40	$000
TOTAL FUEL COST	RECIP	87	"$000"	2028	14025.61133	40	$000
TOTAL FUEL COST	RECIP	87	"$000"	2029	13359.08691	40	$000
TOTAL FUEL COST	RECIP	87	"$000"	2030	13392.03906	40	$000
TOTAL FUEL COST	RECIP	87	"$000"	2031	13909.81738	40	$000
TOTAL FUEL COST	RECIP	87	"$000"	2032	14492.1582	40	$000
TOTAL FUEL COST	RECIP	87	"$000"	2033	14825.97168	40	$000
TOTAL FUEL COST	RECIP	87	"$000"	2034	15318.05566	40	$000
TOTAL FUEL COST	RECIP	87	"$000"	2035	15747.70605	40	$000
TOTAL FUEL COST	CLNG	88	"$000"	2006	0	60	$000
TOTAL FUEL COST	CLNG	88	"$000"	2007	0	60	$000
TOTAL FUEL COST	CLNG	88	"$000"	2008	0	60	$000
TOTAL FUEL COST	CLNG	88	"$000"	2009	0	60	$000
TOTAL FUEL COST	CLNG	88	"$000"	2010	0	60	$000

TOTAL FUEL COST	CLNG	88	"$000"	2011	0	60	$000
TOTAL FUEL COST	CLNG	88	"$000"	2012	0	60	$000
TOTAL FUEL COST	CLNG	88	"$000"	2013	0	60	$000
TOTAL FUEL COST	CLNG	88	"$000"	2014	0	60	$000
TOTAL FUEL COST	CLNG	88	"$000"	2015	0	60	$000
TOTAL FUEL COST	CLNG	88	"$000"	2016	0	60	$000
TOTAL FUEL COST	CLNG	88	"$000"	2017	0	60	$000
TOTAL FUEL COST	CLNG	88	"$000"	2018	0	60	$000
TOTAL FUEL COST	CLNG	88	"$000"	2019	0	60	$000
TOTAL FUEL COST	CLNG	88	"$000"	2020	0	60	$000
TOTAL FUEL COST	CLNG	88	"$000"	2021	0	60	$000
TOTAL FUEL COST	CLNG	88	"$000"	2022	0	60	$000
TOTAL FUEL COST	CLNG	88	"$000"	2023	0	60	$000
TOTAL FUEL COST	CLNG	88	"$000"	2024	0	60	$000
TOTAL FUEL COST	CLNG	88	"$000"	2025	0	60	$000
TOTAL FUEL COST	CLNG	88	"$000"	2026	9928.5625	60	$000
TOTAL FUEL COST	CLNG	88	"$000"	2027	50340.12891	60	$000
TOTAL FUEL COST	CLNG	88	"$000"	2028	52431.21484	60	$000
TOTAL FUEL COST	CLNG	88	"$000"	2029	52015.50781	60	$000
TOTAL FUEL COST	CLNG	88	"$000"	2030	49126.76563	60	$000
TOTAL FUEL COST	CLNG	88	"$000"	2031	50586.25391	60	$000
TOTAL FUEL COST	CLNG	88	"$000"	2032	52076.00391	60	$000
TOTAL FUEL COST	CLNG	88	"$000"	2033	52638.28516	60	$000
TOTAL FUEL COST	CLNG	88	"$000"	2034	54160.25391	60	$000
TOTAL FUEL COST	CLNG	88	"$000"	2035	53875.03516	60	$000
TOTAL FUEL COST	RECIP	89	"$000"	2006	0	40	$000
TOTAL FUEL COST	RECIP	89	"$000"	2007	0	40	$000
TOTAL FUEL COST	RECIP	89	"$000"	2008	0	40	$000
TOTAL FUEL COST	RECIP	89	"$000"	2009	0	40	$000
TOTAL FUEL COST	RECIP	89	"$000"	2010	0	40	$000
TOTAL FUEL COST	RECIP	89	"$000"	2011	0	40	$000
TOTAL FUEL COST	RECIP	89	"$000"	2012	0	40	$000
TOTAL FUEL COST	RECIP	89	"$000"	2013	0	40	$000
TOTAL FUEL COST	RECIP	89	"$000"	2014	0	40	$000
TOTAL FUEL COST	RECIP	89	"$000"	2015	0	40	$000
TOTAL FUEL COST	RECIP	89	"$000"	2016	0	40	$000
TOTAL FUEL COST	RECIP	89	"$000"	2017	0	40	$000
TOTAL FUEL COST	RECIP	89	"$000"	2018	0	40	$000
TOTAL FUEL COST	RECIP	89	"$000"	2019	0	40	$000
TOTAL FUEL COST	RECIP	89	"$000"	2020	0	40	$000
TOTAL FUEL COST	RECIP	89	"$000"	2021	0	40	$000
TOTAL FUEL COST	RECIP	89	"$000"	2022	0	40	$000
TOTAL FUEL COST	RECIP	89	"$000"	2023	0	40	$000
TOTAL FUEL COST	RECIP	89	"$000"	2024	0	40	$000
TOTAL FUEL COST	RECIP	89	"$000"	2025	0	40	$000
TOTAL FUEL COST	RECIP	89	"$000"	2026	2157.205322	40	$000
TOTAL FUEL COST	RECIP	89	"$000"	2027	12892.57617	40	$000
TOTAL FUEL COST	RECIP	89	"$000"	2028	12871.87988	40	$000
TOTAL FUEL COST	RECIP	89	"$000"	2029	12924.94238	40	$000
TOTAL FUEL COST	RECIP	89	"$000"	2030	13324.93945	40	$000
TOTAL FUEL COST	RECIP	89	"$000"	2031	13804.60547	40	$000
TOTAL FUEL COST	RECIP	89	"$000"	2032	14352.64844	40	$000

TOTAL FUEL COST	RECIP	89	"$000"	2033	14766.30859	40	$000
TOTAL FUEL COST	RECIP	89	"$000"	2034	15257.02539	40	$000
TOTAL FUEL COST	RECIP	89	"$000"	2035	15734.76172	40	$000
TOTAL FUEL COST	RECIP	90	"$000"	2006	0	40	$000
TOTAL FUEL COST	RECIP	90	"$000"	2007	0	40	$000
TOTAL FUEL COST	RECIP	90	"$000"	2008	0	40	$000
TOTAL FUEL COST	RECIP	90	"$000"	2009	0	40	$000
TOTAL FUEL COST	RECIP	90	"$000"	2010	0	40	$000
TOTAL FUEL COST	RECIP	90	"$000"	2011	0	40	$000
TOTAL FUEL COST	RECIP	90	"$000"	2012	0	40	$000
TOTAL FUEL COST	RECIP	90	"$000"	2013	0	40	$000
TOTAL FUEL COST	RECIP	90	"$000"	2014	0	40	$000
TOTAL FUEL COST	RECIP	90	"$000"	2015	0	40	$000
TOTAL FUEL COST	RECIP	90	"$000"	2016	0	40	$000
TOTAL FUEL COST	RECIP	90	"$000"	2017	0	40	$000
TOTAL FUEL COST	RECIP	90	"$000"	2018	0	40	$000
TOTAL FUEL COST	RECIP	90	"$000"	2019	0	40	$000
TOTAL FUEL COST	RECIP	90	"$000"	2020	0	40	$000
TOTAL FUEL COST	RECIP	90	"$000"	2021	0	40	$000
TOTAL FUEL COST	RECIP	90	"$000"	2022	0	40	$000
TOTAL FUEL COST	RECIP	90	"$000"	2023	0	40	$000
TOTAL FUEL COST	RECIP	90	"$000"	2024	2556.76123	40	$000
TOTAL FUEL COST	RECIP	90	"$000"	2025	13829.97363	40	$000
TOTAL FUEL COST	RECIP	90	"$000"	2026	13941.91992	40	$000
TOTAL FUEL COST	RECIP	90	"$000"	2027	12037.34863	40	$000
TOTAL FUEL COST	RECIP	90	"$000"	2028	12344.55273	40	$000
TOTAL FUEL COST	RECIP	90	"$000"	2029	12794.19922	40	$000
TOTAL FUEL COST	RECIP	90	"$000"	2030	13311.89355	40	$000
TOTAL FUEL COST	RECIP	90	"$000"	2031	13781.2168	40	$000
TOTAL FUEL COST	RECIP	90	"$000"	2032	14312.77148	40	$000
TOTAL FUEL COST	RECIP	90	"$000"	2033	14755.48145	40	$000
TOTAL FUEL COST	RECIP	90	"$000"	2034	15243.5	40	$000
TOTAL FUEL COST	RECIP	90	"$000"	2035	15732.50684	40	$000
TOTAL FUEL COST	CLNG	91	"$000"	2006	0	60	$000
TOTAL FUEL COST	CLNG	91	"$000"	2007	0	60	$000
TOTAL FUEL COST	CLNG	91	"$000"	2008	0	60	$000
TOTAL FUEL COST	CLNG	91	"$000"	2009	0	60	$000
TOTAL FUEL COST	CLNG	91	"$000"	2010	0	60	$000
TOTAL FUEL COST	CLNG	91	"$000"	2011	0	60	$000
TOTAL FUEL COST	CLNG	91	"$000"	2012	0	60	$000
TOTAL FUEL COST	CLNG	91	"$000"	2013	0	60	$000
TOTAL FUEL COST	CLNG	91	"$000"	2014	0	60	$000
TOTAL FUEL COST	CLNG	91	"$000"	2015	0	60	$000
TOTAL FUEL COST	CLNG	91	"$000"	2016	0	60	$000
TOTAL FUEL COST	CLNG	91	"$000"	2017	0	60	$000
TOTAL FUEL COST	CLNG	91	"$000"	2018	0	60	$000
TOTAL FUEL COST	CLNG	91	"$000"	2019	0	60	$000
TOTAL FUEL COST	CLNG	91	"$000"	2020	0	60	$000
TOTAL FUEL COST	CLNG	91	"$000"	2021	0	60	$000
TOTAL FUEL COST	CLNG	91	"$000"	2022	0	60	$000
TOTAL FUEL COST	CLNG	91	"$000"	2023	9754.933594	60	$000
TOTAL FUEL COST	CLNG	91	"$000"	2024	49564.5625	60	$000

TOTAL FUEL COST	CLNG	91	"$000"	2025	50205.55859	60	$000
TOTAL FUEL COST	CLNG	91	"$000"	2026	50618.31641	60	$000
TOTAL FUEL COST	CLNG	91	"$000"	2027	48607.39844	60	$000
TOTAL FUEL COST	CLNG	91	"$000"	2028	50618.97656	60	$000
TOTAL FUEL COST	CLNG	91	"$000"	2029	50707.85156	60	$000
TOTAL FUEL COST	CLNG	91	"$000"	2030	47270.27734	60	$000
TOTAL FUEL COST	CLNG	91	"$000"	2031	48706.10156	60	$000
TOTAL FUEL COST	CLNG	91	"$000"	2032	49931.625	60	$000
TOTAL FUEL COST	CLNG	91	"$000"	2033	50664.26953	60	$000
TOTAL FUEL COST	CLNG	91	"$000"	2034	52010.24219	60	$000
TOTAL FUEL COST	CLNG	91	"$000"	2035	52038.49609	60	$000
TOTAL FUEL COST	RECIP	92	"$000"	2006	0	40	$000
TOTAL FUEL COST	RECIP	92	"$000"	2007	0	40	$000
TOTAL FUEL COST	RECIP	92	"$000"	2008	0	40	$000
TOTAL FUEL COST	RECIP	92	"$000"	2009	0	40	$000
TOTAL FUEL COST	RECIP	92	"$000"	2010	0	40	$000
TOTAL FUEL COST	RECIP	92	"$000"	2011	0	40	$000
TOTAL FUEL COST	RECIP	92	"$000"	2012	0	40	$000
TOTAL FUEL COST	RECIP	92	"$000"	2013	0	40	$000
TOTAL FUEL COST	RECIP	92	"$000"	2014	0	40	$000
TOTAL FUEL COST	RECIP	92	"$000"	2015	0	40	$000
TOTAL FUEL COST	RECIP	92	"$000"	2016	0	40	$000
TOTAL FUEL COST	RECIP	92	"$000"	2017	0	40	$000
TOTAL FUEL COST	RECIP	92	"$000"	2018	0	40	$000
TOTAL FUEL COST	RECIP	92	"$000"	2019	0	40	$000
TOTAL FUEL COST	RECIP	92	"$000"	2020	0	40	$000
TOTAL FUEL COST	RECIP	92	"$000"	2021	0	40	$000
TOTAL FUEL COST	RECIP	92	"$000"	2022	0	40	$000
TOTAL FUEL COST	RECIP	92	"$000"	2023	2834.347412	40	$000
TOTAL FUEL COST	RECIP	92	"$000"	2024	12165.60449	40	$000
TOTAL FUEL COST	RECIP	92	"$000"	2025	11686.98145	40	$000
TOTAL FUEL COST	RECIP	92	"$000"	2026	11930.2168	40	$000
TOTAL FUEL COST	RECIP	92	"$000"	2027	11863.32422	40	$000
TOTAL FUEL COST	RECIP	92	"$000"	2028	12333.23926	40	$000
TOTAL FUEL COST	RECIP	92	"$000"	2029	12793.2334	40	$000
TOTAL FUEL COST	RECIP	92	"$000"	2030	13312.97266	40	$000
TOTAL FUEL COST	RECIP	92	"$000"	2031	13782.14551	40	$000
TOTAL FUEL COST	RECIP	92	"$000"	2032	14312.80859	40	$000
TOTAL FUEL COST	RECIP	92	"$000"	2033	14755.69434	40	$000
TOTAL FUEL COST	RECIP	92	"$000"	2034	15243.28809	40	$000
TOTAL FUEL COST	RECIP	92	"$000"	2035	15732.09668	40	$000
TOTAL FUEL COST	CLNG	93	"$000"	2006	0	60	$000
TOTAL FUEL COST	CLNG	93	"$000"	2007	0	60	$000
TOTAL FUEL COST	CLNG	93	"$000"	2008	0	60	$000
TOTAL FUEL COST	CLNG	93	"$000"	2009	0	60	$000
TOTAL FUEL COST	CLNG	93	"$000"	2010	0	60	$000
TOTAL FUEL COST	CLNG	93	"$000"	2011	0	60	$000
TOTAL FUEL COST	CLNG	93	"$000"	2012	0	60	$000
TOTAL FUEL COST	CLNG	93	"$000"	2013	0	60	$000
TOTAL FUEL COST	CLNG	93	"$000"	2014	0	60	$000
TOTAL FUEL COST	CLNG	93	"$000"	2015	0	60	$000
TOTAL FUEL COST	CLNG	93	"$000"	2016	0	60	$000

TOTAL FUEL COST	CLNG	93	"$000"	2017	0	60	$000
TOTAL FUEL COST	CLNG	93	"$000"	2018	0	60	$000
TOTAL FUEL COST	CLNG	93	"$000"	2019	0	60	$000
TOTAL FUEL COST	CLNG	93	"$000"	2020	0	60	$000
TOTAL FUEL COST	CLNG	93	"$000"	2021	0	60	$000
TOTAL FUEL COST	CLNG	93	"$000"	2022	9672.231445	60	$000
TOTAL FUEL COST	CLNG	93	"$000"	2023	49898.1875	60	$000
TOTAL FUEL COST	CLNG	93	"$000"	2024	48135.375	60	$000
TOTAL FUEL COST	CLNG	93	"$000"	2025	48733.90625	60	$000
TOTAL FUEL COST	CLNG	93	"$000"	2026	49257.85547	60	$000
TOTAL FUEL COST	CLNG	93	"$000"	2027	46660.28516	60	$000
TOTAL FUEL COST	CLNG	93	"$000"	2028	48872.93359	60	$000
TOTAL FUEL COST	CLNG	93	"$000"	2029	48670.71484	60	$000
TOTAL FUEL COST	CLNG	93	"$000"	2030	45450.48047	60	$000
TOTAL FUEL COST	CLNG	93	"$000"	2031	46816.18359	60	$000
TOTAL FUEL COST	CLNG	93	"$000"	2032	48087.64453	60	$000
TOTAL FUEL COST	CLNG	93	"$000"	2033	48881.44531	60	$000
TOTAL FUEL COST	CLNG	93	"$000"	2034	50193.67969	60	$000
TOTAL FUEL COST	CLNG	93	"$000"	2035	50181.62109	60	$000
TOTAL FUEL COST	WIND	94	"$000"	2006	0	4.8	$000
TOTAL FUEL COST	WIND	94	"$000"	2007	0	4.8	$000
TOTAL FUEL COST	WIND	94	"$000"	2008	0	4.8	$000
TOTAL FUEL COST	WIND	94	"$000"	2009	0	4.8	$000
TOTAL FUEL COST	WIND	94	"$000"	2010	0	4.8	$000
TOTAL FUEL COST	WIND	94	"$000"	2011	0	4.8	$000
TOTAL FUEL COST	WIND	94	"$000"	2012	0	4.8	$000
TOTAL FUEL COST	WIND	94	"$000"	2013	0	4.8	$000
TOTAL FUEL COST	WIND	94	"$000"	2014	0	4.8	$000
TOTAL FUEL COST	WIND	94	"$000"	2015	0	4.8	$000
TOTAL FUEL COST	WIND	94	"$000"	2016	0	4.8	$000
TOTAL FUEL COST	WIND	94	"$000"	2017	0	4.8	$000
TOTAL FUEL COST	WIND	94	"$000"	2018	0	4.8	$000
TOTAL FUEL COST	WIND	94	"$000"	2019	24.39936066	4.8	$000
TOTAL FUEL COST	WIND	94	"$000"	2020	103.3113632	4.8	$000
TOTAL FUEL COST	WIND	94	"$000"	2021	103.0233612	4.8	$000
TOTAL FUEL COST	WIND	94	"$000"	2022	103.0233612	4.8	$000
TOTAL FUEL COST	WIND	94	"$000"	2023	103.0232468	4.8	$000
TOTAL FUEL COST	WIND	94	"$000"	2024	103.1214676	4.8	$000
TOTAL FUEL COST	WIND	94	"$000"	2025	102.6850662	4.8	$000
TOTAL FUEL COST	WIND	94	"$000"	2026	102.7457123	4.8	$000
TOTAL FUEL COST	WIND	94	"$000"	2027	100.9654236	4.8	$000
TOTAL FUEL COST	WIND	94	"$000"	2028	102.7643356	4.8	$000
TOTAL FUEL COST	WIND	94	"$000"	2029	101.6438904	4.8	$000
TOTAL FUEL COST	WIND	94	"$000"	2030	95.23790741	4.8	$000
TOTAL FUEL COST	WIND	94	"$000"	2031	97.31922913	4.8	$000
TOTAL FUEL COST	WIND	94	"$000"	2032	98.61820984	4.8	$000
TOTAL FUEL COST	WIND	94	"$000"	2033	97.76542664	4.8	$000
TOTAL FUEL COST	WIND	94	"$000"	2034	99.48832703	4.8	$000
TOTAL FUEL COST	WIND	94	"$000"	2035	97.03400421	4.8	$000
TOTAL FUEL COST	WIND	95	"$000"	2006	0	4.8	$000
TOTAL FUEL COST	WIND	95	"$000"	2007	0	4.8	$000
TOTAL FUEL COST	WIND	95	"$000"	2008	0	4.8	$000

TOTAL FUEL COST	WIND	95	"$000"	2009	0	4.8	$000
TOTAL FUEL COST	WIND	95	"$000"	2010	0	4.8	$000
TOTAL FUEL COST	WIND	95	"$000"	2011	0	4.8	$000
TOTAL FUEL COST	WIND	95	"$000"	2012	0	4.8	$000
TOTAL FUEL COST	WIND	95	"$000"	2013	0	4.8	$000
TOTAL FUEL COST	WIND	95	"$000"	2014	0	4.8	$000
TOTAL FUEL COST	WIND	95	"$000"	2015	0	4.8	$000
TOTAL FUEL COST	WIND	95	"$000"	2016	0	4.8	$000
TOTAL FUEL COST	WIND	95	"$000"	2017	0	4.8	$000
TOTAL FUEL COST	WIND	95	"$000"	2018	24.39936066	4.8	$000
TOTAL FUEL COST	WIND	95	"$000"	2019	103.0233612	4.8	$000
TOTAL FUEL COST	WIND	95	"$000"	2020	103.3113632	4.8	$000
TOTAL FUEL COST	WIND	95	"$000"	2021	103.0226898	4.8	$000
TOTAL FUEL COST	WIND	95	"$000"	2022	103.0018616	4.8	$000
TOTAL FUEL COST	WIND	95	"$000"	2023	102.9796219	4.8	$000
TOTAL FUEL COST	WIND	95	"$000"	2024	101.2243347	4.8	$000
TOTAL FUEL COST	WIND	95	"$000"	2025	100.9568558	4.8	$000
TOTAL FUEL COST	WIND	95	"$000"	2026	100.6690369	4.8	$000
TOTAL FUEL COST	WIND	95	"$000"	2027	96.23300934	4.8	$000
TOTAL FUEL COST	WIND	95	"$000"	2028	99.77478027	4.8	$000
TOTAL FUEL COST	WIND	95	"$000"	2029	97.40203857	4.8	$000
TOTAL FUEL COST	WIND	95	"$000"	2030	88.11067963	4.8	$000
TOTAL FUEL COST	WIND	95	"$000"	2031	90.83399963	4.8	$000
TOTAL FUEL COST	WIND	95	"$000"	2032	92.50312805	4.8	$000
TOTAL FUEL COST	WIND	95	"$000"	2033	91.87372589	4.8	$000
TOTAL FUEL COST	WIND	95	"$000"	2034	93.89740753	4.8	$000
TOTAL FUEL COST	WIND	95	"$000"	2035	90.60780334	4.8	$000
TOTAL FUEL COST	CLNG	96	"$000"	2006	0	60	$000
TOTAL FUEL COST	CLNG	96	"$000"	2007	0	60	$000
TOTAL FUEL COST	CLNG	96	"$000"	2008	0	60	$000
TOTAL FUEL COST	CLNG	96	"$000"	2009	0	60	$000
TOTAL FUEL COST	CLNG	96	"$000"	2010	0	60	$000
TOTAL FUEL COST	CLNG	96	"$000"	2011	0	60	$000
TOTAL FUEL COST	CLNG	96	"$000"	2012	0	60	$000
TOTAL FUEL COST	CLNG	96	"$000"	2013	0	60	$000
TOTAL FUEL COST	CLNG	96	"$000"	2014	0	60	$000
TOTAL FUEL COST	CLNG	96	"$000"	2015	0	60	$000
TOTAL FUEL COST	CLNG	96	"$000"	2016	0	60	$000
TOTAL FUEL COST	CLNG	96	"$000"	2017	0	60	$000
TOTAL FUEL COST	CLNG	96	"$000"	2018	9232.53418	60	$000
TOTAL FUEL COST	CLNG	96	"$000"	2019	47744.90625	60	$000
TOTAL FUEL COST	CLNG	96	"$000"	2020	48503.27734	60	$000
TOTAL FUEL COST	CLNG	96	"$000"	2021	49280.66797	60	$000
TOTAL FUEL COST	CLNG	96	"$000"	2022	49923.58984	60	$000
TOTAL FUEL COST	CLNG	96	"$000"	2023	49015.21875	60	$000
TOTAL FUEL COST	CLNG	96	"$000"	2024	46367.86328	60	$000
TOTAL FUEL COST	CLNG	96	"$000"	2025	47007.13281	60	$000
TOTAL FUEL COST	CLNG	96	"$000"	2026	47557.33203	60	$000
TOTAL FUEL COST	CLNG	96	"$000"	2027	44943.65625	60	$000
TOTAL FUEL COST	CLNG	96	"$000"	2028	46986.33203	60	$000
TOTAL FUEL COST	CLNG	96	"$000"	2029	46621.83203	60	$000
TOTAL FUEL COST	CLNG	96	"$000"	2030	44054.40625	60	$000

TOTAL FUEL COST	CLNG	96	"$000"	2031	45312.68359	60	$000
TOTAL FUEL COST	CLNG	96	"$000"	2032	46471.94141	60	$000
TOTAL FUEL COST	CLNG	96	"$000"	2033	47256.10938	60	$000
TOTAL FUEL COST	CLNG	96	"$000"	2034	48372.99219	60	$000
TOTAL FUEL COST	CLNG	96	"$000"	2035	48613.57422	60	$000
TOTAL FUEL COST	WIND	97	"$000"	2006	0	4.8	$000
TOTAL FUEL COST	WIND	97	"$000"	2007	0	4.8	$000
TOTAL FUEL COST	WIND	97	"$000"	2008	0	4.8	$000
TOTAL FUEL COST	WIND	97	"$000"	2009	0	4.8	$000
TOTAL FUEL COST	WIND	97	"$000"	2010	0	4.8	$000
TOTAL FUEL COST	WIND	97	"$000"	2011	0	4.8	$000
TOTAL FUEL COST	WIND	97	"$000"	2012	0	4.8	$000
TOTAL FUEL COST	WIND	97	"$000"	2013	0	4.8	$000
TOTAL FUEL COST	WIND	97	"$000"	2014	0	4.8	$000
TOTAL FUEL COST	WIND	97	"$000"	2015	0	4.8	$000
TOTAL FUEL COST	WIND	97	"$000"	2016	0	4.8	$000
TOTAL FUEL COST	WIND	97	"$000"	2017	24.39936066	4.8	$000
TOTAL FUEL COST	WIND	97	"$000"	2018	103.0233612	4.8	$000
TOTAL FUEL COST	WIND	97	"$000"	2019	103.008934	4.8	$000
TOTAL FUEL COST	WIND	97	"$000"	2020	103.2223892	4.8	$000
TOTAL FUEL COST	WIND	97	"$000"	2021	102.9745865	4.8	$000
TOTAL FUEL COST	WIND	97	"$000"	2022	102.8780289	4.8	$000
TOTAL FUEL COST	WIND	97	"$000"	2023	102.2426529	4.8	$000
TOTAL FUEL COST	WIND	97	"$000"	2024	97.7287674	4.8	$000
TOTAL FUEL COST	WIND	97	"$000"	2025	97.12879944	4.8	$000
TOTAL FUEL COST	WIND	97	"$000"	2026	97.0859375	4.8	$000
TOTAL FUEL COST	WIND	97	"$000"	2027	90.67864227	4.8	$000
TOTAL FUEL COST	WIND	97	"$000"	2028	95.19435883	4.8	$000
TOTAL FUEL COST	WIND	97	"$000"	2029	92.07860565	4.8	$000
TOTAL FUEL COST	WIND	97	"$000"	2030	80.9744339	4.8	$000
TOTAL FUEL COST	WIND	97	"$000"	2031	84.17432404	4.8	$000
TOTAL FUEL COST	WIND	97	"$000"	2032	86.06494141	4.8	$000
TOTAL FUEL COST	WIND	97	"$000"	2033	85.44548798	4.8	$000
TOTAL FUEL COST	WIND	97	"$000"	2034	87.92793274	4.8	$000
TOTAL FUEL COST	WIND	97	"$000"	2035	83.79335785	4.8	$000
TOTAL FUEL COST	WIND	98	"$000"	2006	0	4.8	$000
TOTAL FUEL COST	WIND	98	"$000"	2007	0	4.8	$000
TOTAL FUEL COST	WIND	98	"$000"	2008	0	4.8	$000
TOTAL FUEL COST	WIND	98	"$000"	2009	0	4.8	$000
TOTAL FUEL COST	WIND	98	"$000"	2010	0	4.8	$000
TOTAL FUEL COST	WIND	98	"$000"	2011	0	4.8	$000
TOTAL FUEL COST	WIND	98	"$000"	2012	0	4.8	$000
TOTAL FUEL COST	WIND	98	"$000"	2013	0	4.8	$000
TOTAL FUEL COST	WIND	98	"$000"	2014	0	4.8	$000
TOTAL FUEL COST	WIND	98	"$000"	2015	0	4.8	$000
TOTAL FUEL COST	WIND	98	"$000"	2016	24.39936066	4.8	$000
TOTAL FUEL COST	WIND	98	"$000"	2017	103.0233612	4.8	$000
TOTAL FUEL COST	WIND	98	"$000"	2018	103.0055466	4.8	$000
TOTAL FUEL COST	WIND	98	"$000"	2019	102.7664337	4.8	$000
TOTAL FUEL COST	WIND	98	"$000"	2020	102.7406845	4.8	$000
TOTAL FUEL COST	WIND	98	"$000"	2021	102.6304398	4.8	$000
TOTAL FUEL COST	WIND	98	"$000"	2022	102.4162216	4.8	$000

TOTAL FUEL COST	WIND	98	"$000"	2023	100.4361954	4.8	$000
TOTAL FUEL COST	WIND	98	"$000"	2024	92.83220673	4.8	$000
TOTAL FUEL COST	WIND	98	"$000"	2025	92.59036255	4.8	$000
TOTAL FUEL COST	WIND	98	"$000"	2026	91.81439209	4.8	$000
TOTAL FUEL COST	WIND	98	"$000"	2027	83.94683838	4.8	$000
TOTAL FUEL COST	WIND	98	"$000"	2028	89.50230408	4.8	$000
TOTAL FUEL COST	WIND	98	"$000"	2029	85.75909424	4.8	$000
TOTAL FUEL COST	WIND	98	"$000"	2030	73.13785553	4.8	$000
TOTAL FUEL COST	WIND	98	"$000"	2031	76.74212646	4.8	$000
TOTAL FUEL COST	WIND	98	"$000"	2032	78.98526764	4.8	$000
TOTAL FUEL COST	WIND	98	"$000"	2033	78.67233276	4.8	$000
TOTAL FUEL COST	WIND	98	"$000"	2034	81.42318726	4.8	$000
TOTAL FUEL COST	WIND	98	"$000"	2035	76.87942505	4.8	$000
TOTAL FUEL COST	RETR	99	"$000"	2006	0	60	$000
TOTAL FUEL COST	RETR	99	"$000"	2007	0	60	$000
TOTAL FUEL COST	RETR	99	"$000"	2008	0	60	$000
TOTAL FUEL COST	RETR	99	"$000"	2009	0	60	$000
TOTAL FUEL COST	RETR	99	"$000"	2010	0	60	$000
TOTAL FUEL COST	RETR	99	"$000"	2011	0	60	$000
TOTAL FUEL COST	RETR	99	"$000"	2012	0	60	$000
TOTAL FUEL COST	RETR	99	"$000"	2013	0	60	$000
TOTAL FUEL COST	RETR	99	"$000"	2014	0	60	$000
TOTAL FUEL COST	RETR	99	"$000"	2015	0	60	$000
TOTAL FUEL COST	RETR	99	"$000"	2016	9186.121094	60	$000
TOTAL FUEL COST	RETR	99	"$000"	2017	38106.9375	60	$000
TOTAL FUEL COST	RETR	99	"$000"	2018	31794.23438	60	$000
TOTAL FUEL COST	RETR	99	"$000"	2019	15819.70898	60	$000
TOTAL FUEL COST	RETR	99	"$000"	2020	12897.74316	60	$000
TOTAL FUEL COST	RETR	99	"$000"	2021	17052.58594	60	$000
TOTAL FUEL COST	RETR	99	"$000"	2022	16003.63281	60	$000
TOTAL FUEL COST	RETR	99	"$000"	2023	2835.241943	60	$000
TOTAL FUEL COST	RETR	99	"$000"	2024	61.26193237	60	$000
TOTAL FUEL COST	RETR	99	"$000"	2025	16.77568054	60	$000
TOTAL FUEL COST	RETR	99	"$000"	2026	69.29161835	60	$000
TOTAL FUEL COST	RETR	99	"$000"	2027	1.812302589	60	$000
TOTAL FUEL COST	RETR	99	"$000"	2028	420.2815552	60	$000
TOTAL FUEL COST	RETR	99	"$000"	2029	72.73278809	60	$000
TOTAL FUEL COST	RETR	99	"$000"	2030	25.4139061	60	$000
TOTAL FUEL COST	RETR	99	"$000"	2031	21.56513023	60	$000
TOTAL FUEL COST	RETR	99	"$000"	2032	27.90211487	60	$000
TOTAL FUEL COST	RETR	99	"$000"	2033	11.11125851	60	$000
TOTAL FUEL COST	RETR	99	"$000"	2034	10.34447193	60	$000
TOTAL FUEL COST	RETR	99	"$000"	2035	11.48556709	60	$000
TOTAL FUEL COST	WIND	100	"$000"	2006	0	4.8	$000
TOTAL FUEL COST	WIND	100	"$000"	2007	0	4.8	$000
TOTAL FUEL COST	WIND	100	"$000"	2008	0	4.8	$000
TOTAL FUEL COST	WIND	100	"$000"	2009	0	4.8	$000
TOTAL FUEL COST	WIND	100	"$000"	2010	0	4.8	$000
TOTAL FUEL COST	WIND	100	"$000"	2011	0	4.8	$000
TOTAL FUEL COST	WIND	100	"$000"	2012	0	4.8	$000
TOTAL FUEL COST	WIND	100	"$000"	2013	0	4.8	$000
TOTAL FUEL COST	WIND	100	"$000"	2014	0	4.8	$000

TOTAL FUEL COST	WIND	100	"$000"	2015	24.39936066	4.8	$000
TOTAL FUEL COST	WIND	100	"$000"	2016	103.3113632	4.8	$000
TOTAL FUEL COST	WIND	100	"$000"	2017	103.0233612	4.8	$000
TOTAL FUEL COST	WIND	100	"$000"	2018	102.9173203	4.8	$000
TOTAL FUEL COST	WIND	100	"$000"	2019	102.0330887	4.8	$000
TOTAL FUEL COST	WIND	100	"$000"	2020	101.64534	4.8	$000
TOTAL FUEL COST	WIND	100	"$000"	2021	101.8000031	4.8	$000
TOTAL FUEL COST	WIND	100	"$000"	2022	101.3968887	4.8	$000
TOTAL FUEL COST	WIND	100	"$000"	2023	97.5836792	4.8	$000
TOTAL FUEL COST	WIND	100	"$000"	2024	86.90519714	4.8	$000
TOTAL FUEL COST	WIND	100	"$000"	2025	86.72759247	4.8	$000
TOTAL FUEL COST	WIND	100	"$000"	2026	86.15300751	4.8	$000
TOTAL FUEL COST	WIND	100	"$000"	2027	77.10820007	4.8	$000
TOTAL FUEL COST	WIND	100	"$000"	2028	83.14096069	4.8	$000
TOTAL FUEL COST	WIND	100	"$000"	2029	79.1869278	4.8	$000
TOTAL FUEL COST	WIND	100	"$000"	2030	65.49352264	4.8	$000
TOTAL FUEL COST	WIND	100	"$000"	2031	69.39580536	4.8	$000
TOTAL FUEL COST	WIND	100	"$000"	2032	71.85830688	4.8	$000
TOTAL FUEL COST	WIND	100	"$000"	2033	71.62987518	4.8	$000
TOTAL FUEL COST	WIND	100	"$000"	2034	74.59816742	4.8	$000
TOTAL FUEL COST	WIND	100	"$000"	2035	69.85338593	4.8	$000

Data		Unit	Fuel Type	Fuel Conversion Factor	Plant	000MBTU
	293.12	GWH	RFO	6.1	Cab12	
	270.25	GWH	RFO	6.1	Cab12	
	310.35	GWH	RFO	6.1	Cab12	
	278.13	GWH	RFO	6.1	Cab12	
	329.77	GWH	RFO	6.1	Cab12	
	340.10	GWH	RFO	6.1	Cab12	
	298.97	GWH	RFO	6.1	Cab12	
	356.85	GWH	RFO	6.1	Cab12	
	337.57	GWH	RFO	6.1	Cab12	
	368.25	GWH	RFO	6.1	Cab12	
	358.04	GWH	RFO	6.1	Cab12	
	349.56	GWH	RFO	6.1	Cab12	
	330.96	GWH	RFO	6.1	Cab12	
	278.22	GWH	RFO	6.1	Cab12	
	267.46	GWH	RFO	6.1	Cab12	
	259.21	GWH	RFO	6.1	Cab12	
	270.53	GWH	RFO	6.1	Cab12	
	204.25	GWH	RFO	6.1	Cab12	
	151.38	GWH	RFO	6.1	Cab12	
	147.98	GWH	RFO	6.1	Cab12	
	146.88	GWH	RFO	6.1	Cab12	
	-	GWH	RFO	6.1	Cab12	
	-	GWH	RFO	6.1	Cab12	
	-	GWH	RFO	6.1	Cab12	
	-	GWH	RFO	6.1	Cab12	
	-	GWH	RFO	6.1	Cab12	
	-	GWH	RFO	6.1	Cab12	
	-	GWH	RFO	6.1	Cab12	
	-	GWH	RFO	6.1	Cab12	
	-	GWH	RFO	6.1	Cab12	
	302.99	GWH	RFO	6.1	Cab12	
	307.07	GWH	RFO	6.1	Cab12	
	324.07	GWH	RFO	6.1	Cab12	
	285.50	GWH	RFO	6.1	Cab12	
	347.87	GWH	RFO	6.1	Cab12	
	362.03	GWH	RFO	6.1	Cab12	
	318.26	GWH	RFO	6.1	Cab12	
	388.46	GWH	RFO	6.1	Cab12	
	401.39	GWH	RFO	6.1	Cab12	
	401.93	GWH	RFO	6.1	Cab12	
	389.19	GWH	RFO	6.1	Cab12	
	381.56	GWH	RFO	6.1	Cab12	
	357.50	GWH	RFO	6.1	Cab12	
	254.23	GWH	RFO	6.1	Cab12	
	264.33	GWH	RFO	6.1	Cab12	
	278.25	GWH	RFO	6.1	Cab12	
	268.07	GWH	RFO	6.1	Cab12	
	186.39	GWH	RFO	6.1	Cab12	
	140.08	GWH	RFO	6.1	Cab12	
	135.58	GWH	RFO	6.1	Cab12	
	126.45	GWH	RFO	6.1	Cab12	

132.94	GWH	RFO	6.1	Cab12
-	GWH	RFO	6.1	Cab12
-	GWH	RFO	6.1	Cab12
-	GWH	RFO	6.1	Cab12
-	GWH	RFO	6.1	Cab12
-	GWH	RFO	6.1	Cab12
-	GWH	RFO	6.1	Cab12
-	GWH	RFO	6.1	Cab12
-	GWH	RFO	6.1	Cab12
215.18	GWH	RFO	6.1	Cab34
215.18	GWH	RFO	6.1	Cab34
216.02	GWH	RFO	6.1	Cab34
216.92	GWH	RFO	6.1	Cab34
217.39	GWH	RFO	6.1	Cab34
219.76	GWH	RFO	6.1	Cab34
233.36	GWH	RFO	6.1	Cab34
226.65	GWH	RFO	6.1	Cab34
233.49	GWH	RFO	6.1	Cab34
232.20	GWH	RFO	6.1	Cab34
232.36	GWH	RFO	6.1	Cab34
233.01	GWH	RFO	6.1	Cab34
224.50	GWH	RFO	6.1	Cab34
201.18	GWH	RFO	6.1	Cab34
201.99	GWH	RFO	6.1	Cab34
205.48	GWH	RFO	6.1	Cab34
202.00	GWH	RFO	6.1	Cab34
179.26	GWH	RFO	6.1	Cab34
170.37	GWH	RFO	6.1	Cab34
170.53	GWH	RFO	6.1	Cab34
165.76	GWH	RFO	6.1	Cab34
156.32	GWH	RFO	6.1	Cab34
160.97	GWH	RFO	6.1	Cab34
157.23	GWH	RFO	6.1	Cab34
148.59	GWH	RFO	6.1	Cab34
149.97	GWH	RFO	6.1	Cab34
151.06	GWH	RFO	6.1	Cab34
151.12	GWH	RFO	6.1	Cab34
152.05	GWH	RFO	6.1	Cab34
150.17	GWH	RFO	6.1	Cab34
217.49	GWH	RFO	6.1	Cab34
217.51	GWH	RFO	6.1	Cab34
218.25	GWH	RFO	6.1	Cab34
218.61	GWH	RFO	6.1	Cab34
218.80	GWH	RFO	6.1	Cab34
220.33	GWH	RFO	6.1	Cab34
230.36	GWH	RFO	6.1	Cab34
225.42	GWH	RFO	6.1	Cab34
231.41	GWH	RFO	6.1	Cab34
230.95	GWH	RFO	6.1	Cab34
231.13	GWH	RFO	6.1	Cab34
230.44	GWH	RFO	6.1	Cab34
225.85	GWH	RFO	6.1	Cab34

218.16	GWH	RFO	6.1	Cab34	
218.06	GWH	RFO	6.1	Cab34	
218.59	GWH	RFO	6.1	Cab34	
218.01	GWH	RFO	6.1	Cab34	
213.23	GWH	RFO	6.1	Cab34	
184.45	GWH	RFO	6.1	Cab34	
183.70	GWH	RFO	6.1	Cab34	
181.25	GWH	RFO	6.1	Cab34	
167.29	GWH	RFO	6.1	Cab34	
172.89	GWH	RFO	6.1	Cab34	
167.71	GWH	RFO	6.1	Cab34	
154.35	GWH	RFO	6.1	Cab34	
156.32	GWH	RFO	6.1	Cab34	
158.11	GWH	RFO	6.1	Cab34	
158.03	GWH	RFO	6.1	Cab34	
160.43	GWH	RFO	6.1	Cab34	
158.73	GWH	RFO	6.1	Cab34	
0.02	GWH	DSL	5.78	OROTE	1
-	GWH	DSL	5.78	OROTE	1
-	GWH	DSL	5.78	OROTE	1
-

0.13	GWH	DSL	5.78	Ded CT 12
0.57	GWH	DSL	5.78	Ded CT 12
0.44	GWH	DSL	5.78	Ded CT 12
0.96	GWH	DSL	5.78	Ded CT 12
1.16	GWH	DSL	5.78	Ded CT 12
0.80	GWH	DSL	5.78	Ded CT 12
0.13	GWH	DSL	5.78	Ded CT 12
0.07	GWH	DSL	5.78	Ded CT 12
0.01	GWH	DSL	5.78	Ded CT 12
0.01	GWH	DSL	5.78	Ded CT 12
0.01	GWH	DSL	5.78	Ded CT 12
0.01	GWH	DSL	5.78	Ded CT 12
-	GWH	DSL	5.78	Ded CT 12
-	GWH	DSL	5.78	Ded CT 12
-	GWH	DSL	5.78	Ded CT 12
-	GWH	DSL	5.78	Ded CT 12
-	GWH	DSL	5.78	Ded CT 12
-	GWH	DSL	5.78	Ded CT 12
-	GWH	DSL	5.78	Ded CT 12
-	GWH	DSL	5.78	Ded CT 12
-	GWH	DSL	5.78	Ded CT 12
-	GWH	DSL	5.78	Ded CT 12
-	GWH	DSL	5.78	Ded CT 12
-	GWH	DSL	5.78	Ded CT 12
-	GWH	DSL	5.78	Ded CT 12
0.17	GWH	DSL	5.78	Ded CT 12
0.18	GWH	DSL	5.78	Ded CT 12
0.17	GWH	DSL	5.78	Ded CT 12
0.08	GWH	DSL	5.78	Ded CT 12
0.11	GWH	DSL	5.78	Ded CT 12
0.10	GWH	DSL	5.78	Ded CT 12
0.26	GWH	DSL	5.78	Ded CT 12
0.23	GWH	DSL	5.78	Ded CT 12
0.49	GWH	DSL	5.78	Ded CT 12
0.59	GWH	DSL	5.78	Ded CT 12
0.41	GWH	DSL	5.78	Ded CT 12
0.07	GWH	DSL	5.78	Ded CT 12
0.03	GWH	DSL	5.78	Ded CT 12
0.00	GWH	DSL	5.78	Ded CT 12
0.00	GWH	DSL	5.78	Ded CT 12
0.01	GWH	DSL	5.78	Ded CT 12
0.00	GWH	DSL	5.78	Ded CT 12
0.00	GWH	DSL	5.78	Ded CT 12
0.00	GWH	DSL	5.78	Ded CT 12
-	GWH	DSL	5.78	Ded CT 12
-	GWH	DSL	5.78	Ded CT 12
-	GWH	DSL	5.78	Ded CT 12
-	GWH	DSL	5.78	Ded CT 12
-	GWH	DSL	5.78	Ded CT 12
-	GWH	DSL	5.78	Ded CT 12
-	GWH	DSL	5.78	Ded CT 12
-	GWH	DSL	5.78	Ded CT 12

-	GWH	DSL	5.78	Ded CT 12
-	GWH	DSL	5.78	Ded CT 12
-	GWH	DSL	5.78	Ded CT 12
0.20	GWH	DSL	5.78	MACH CT 1
0.22	GWH	DSL	5.78	MACH CT 1
0.21	GWH	DSL	5.78	MACH CT 1
0.30	GWH	DSL	5.78	MACH CT 1
0.26	GWH	DSL	5.78	MACH CT 1
0.67	GWH	DSL	5.78	MACH CT 1
3.72	GWH	DSL	5.78	MACH CT 1
2.50	GWH	DSL	5.78	MACH CT 1
5.53	GWH	DSL	5.78	MACH CT 1
7.14	GWH	DSL	5.78	MACH CT 1
5.02	GWH	DSL	5.78	MACH CT 1
1.03	GWH	DSL	5.78	MACH CT 1
0.61	GWH	DSL	5.78	MACH CT 1
0.07	GWH	DSL	5.78	MACH CT 1
0.07	GWH	DSL	5.78	MACH CT 1
0.15	GWH	DSL	5.78	MACH CT 1
0.11	GWH	DSL	5.78	MACH CT 1
0.01	GWH	DSL	5.78	MACH CT 1
-	GWH	DSL	5.78	MACH CT 1
-	GWH	DSL	5.78	MACH CT 1
-	GWH	DSL	5.78	MACH CT 1
-	GWH	DSL	5.78	MACH CT 1
-	GWH	DSL	5.78	MACH CT 1
-	GWH	DSL	5.78	MACH CT 1
-	GWH	DSL	5.78	MACH CT 1
-	GWH	DSL	5.78	MACH CT 1
-	GWH	DSL	5.78	MACH CT 1
-	GWH	DSL	5.78	MACH CT 1
-	GWH	DSL	5.78	MACH CT 1
-	GWH	DSL	5.78	MACH CT 1
0.82	GWH	DSL	5.78	YIGO CT 1
0.90	GWH	DSL	5.78	YIGO CT 1
1.61	GWH	DSL	5.78	YIGO CT 1
8.38	GWH	DSL	5.78	YIGO CT 1
11.08	GWH	DSL	5.78	YIGO CT 1
18.68	GWH	DSL	5.78	YIGO CT 1
43.16	GWH	DSL	5.78	YIGO CT 1
30.83	GWH	DSL	5.78	YIGO CT 1
44.31	GWH	DSL	5.78	YIGO CT 1
41.02	GWH	DSL	5.78	YIGO CT 1
27.23	GWH	DSL	5.78	YIGO CT 1
2.95	GWH	DSL	5.78	YIGO CT 1
1.79	GWH	DSL	5.78	YIGO CT 1
0.20	GWH	DSL	5.78	YIGO CT 1
0.22	GWH	DSL	5.78	YIGO CT 1
0.44	GWH	DSL	5.78	YIGO CT 1
0.22	GWH	DSL	5.78	YIGO CT 1
0.01	GWH	DSL	5.78	YIGO CT 1
-	GWH	DSL	5.78	YIGO CT 1

-	GWH	DSL	5.78	YIGO CT 1
-	GWH	DSL	5.78	YIGO CT 1
-	GWH	DSL	5.78	YIGO CT 1
-	GWH	DSL	5.78	YIGO CT 1
-	GWH	DSL	5.78	YIGO CT 1
-	GWH	DSL	5.78	YIGO CT 1
-	GWH	DSL	5.78	YIGO CT 1
-	GWH	DSL	5.78	YIGO CT 1
-	GWH	DSL	5.78	YIGO CT 1
-	GWH	DSL	5.78	YIGO CT 1
-	GWH	DSL	5.78	YIGO CT 1
0.11	GWH	DSL	5.78	MARBO CT 1
0.12	GWH	DSL	5.78	MARBO CT 1
0.12	GWH	DSL	5.78	MARBO CT 1
0.05	GWH	DSL	5.78	MARBO CT 1
0.07	GWH	DSL	5.78	MARBO CT 1
0.06	GWH	DSL	5.78	MARBO CT 1
0.01	GWH	DSL	5.78	MARBO CT 1
0.05	GWH	DSL	5.78	MARBO CT 1
0.02	GWH	DSL	5.78	MARBO CT 1
0.01	GWH	DSL	5.78	MARBO CT 1
0.04	GWH	DSL	5.78	MARBO CT 1
0.04	GWH	DSL	5.78	MARBO CT 1
0.01	GWH	DSL	5.78	MARBO CT 1
0.00	GWH	DSL	5.78	MARBO CT 1
0.00	GWH	DSL	5.78	MARBO CT 1
0.00	GWH	DSL	5.78	MARBO CT 1
0.00	GWH	DSL	5.78	MARBO CT 1
0.00	GWH	DSL	5.78	MARBO CT 1
-	GWH	DSL	5.78	MARBO CT 1
-	GWH	DSL	5.78	MARBO CT 1
-	GWH	DSL	5.78	MARBO CT 1
-	GWH	DSL	5.78	MARBO CT 1
-	GWH	DSL	5.78	MARBO CT 1
-	GWH	DSL	5.78	MARBO CT 1
-	GWH	DSL	5.78	MARBO CT 1
-	GWH	DSL	5.78	MARBO CT 1
-	GWH	DSL	5.78	MARBO CT 1
-	GWH	DSL	5.78	MARBO CT 1
-	GWH	DSL	5.78	MARBO CT 1
-	GWH	DSL	5.78	MARBO CT 1
0.02	GWH	DSL	5.78	Ded DSL 1-4
0.02	GWH	DSL	5.78	Ded DSL 1-4
0.02	GWH	DSL	5.78	Ded DSL 1-4
0.01	GWH	DSL	5.78	Ded DSL 1-4
0.01	GWH	DSL	5.78	Ded DSL 1-4
0.01	GWH	DSL	5.78	Ded DSL 1-4
0.00	GWH	DSL	5.78	Ded DSL 1-4
0.01	GWH	DSL	5.78	Ded DSL 1-4
0.00	GWH	DSL	5.78	Ded DSL 1-4
0.00	GWH	DSL	5.78	Ded DSL 1-4
0.01	GWH	DSL	5.78	Ded DSL 1-4

-	GWH	DSL	5.78	Ded DSL 1-4
-	GWH	DSL	5.78	Ded DSL 1-4
-	GWH	DSL	5.78	Ded DSL 1-4
-	GWH	DSL	5.78	Ded DSL 1-4
-	GWH	DSL	5.78	Ded DSL 1-4
-	GWH	DSL	5.78	Ded DSL 1-4
-	GWH	DSL	5.78	Ded DSL 1-4
-	GWH	DSL	5.78	Ded DSL 1-4
-	GWH	DSL	5.78	Ded DSL 1-4
-	GWH	DSL	5.78	Ded DSL 1-4
-	GWH	DSL	5.78	Ded DSL 1-4
-	GWH	DSL	5.78	Ded DSL 1-4
-	GWH	DSL	5.78	Ded DSL 1-4
-	GWH	DSL	5.78	Ded DSL 1-4
-	GWH	DSL	5.78	Ded DSL 1-4
-	GWH	DSL	5.78	Ded DSL 1-4
-	GWH	DSL	5.78	Ded DSL 1-4
-	GWH	DSL	5.78	Ded DSL 1-4
-	GWH	DSL	5.78	Ded DSL 1-4
-	GWH	DSL	5.78	Ded DSL 1-4
0.02	GWH	DSL	5.78	Ded DSL 1-4
0.02	GWH	DSL	5.78	Ded DSL 1-4
0.02	GWH	DSL	5.78	Ded DSL 1-4
0.01	GWH	DSL	5.78	Ded DSL 1-4
0.01	GWH	DSL	5.78	Ded DSL 1-4
0.01	GWH	DSL	5.78	Ded DSL 1-4
0.00	GWH	DSL	5.78	Ded DSL 1-4
0.01	GWH	DSL	5.78	Ded DSL 1-4
0.00	GWH	DSL	5.78	Ded DSL 1-4
0.00	GWH	DSL	5.78	Ded DSL 1-4
0.01	GWH	DSL	5.78	Ded DSL 1-4
-	GWH	DSL	5.78	Ded DSL 1-4
-	GWH	DSL	5.78	Ded DSL 1-4
-	GWH	DSL	5.78	Ded DSL 1-4
-	GWH	DSL	5.78	Ded DSL 1-4
-	GWH	DSL	5.78	Ded DSL 1-4
-	GWH	DSL	5.78	Ded DSL 1-4
-	GWH	DSL	5.78	Ded DSL 1-4
-	GWH	DSL	5.78	Ded DSL 1-4
-	GWH	DSL	5.78	Ded DSL 1-4
-	GWH	DSL	5.78	Ded DSL 1-4
-	GWH	DSL	5.78	Ded DSL 1-4
-	GWH	DSL	5.78	Ded DSL 1-4
-	GWH	DSL	5.78	Ded DSL 1-4
-	GWH	DSL	5.78	Ded DSL 1-4
-	GWH	DSL	5.78	Ded DSL 1-4
-	GWH	DSL	5.78	Ded DSL 1-4
-	GWH	DSL	5.78	Ded DSL 1-4
-	GWH	DSL	5.78	Ded DSL 1-4
-	GWH	DSL	5.78	Ded DSL 1-4
-	GWH	DSL	5.78	Ded DSL 1-4
-	GWH	DSL	5.78	Ded DSL 1-4
-	GWH	DSL	5.78	Ded DSL 1-4
-	GWH	DSL	5.78	Ded DSL 1-4
0.02	GWH	DSL	5.78	Ded DSL 1-4
0.02	GWH	DSL	5.78	Ded DSL 1-4
0.02	GWH	DSL	5.78	Ded DSL 1-4

0.01	GWH	DSL	5.78	Ded	DSL 1-4
0.01	GWH	DSL	5.78	Ded	DSL 1-4
0.01	GWH	DSL	5.78	Ded	DSL 1-4
0.00	GWH	DSL	5.78	Ded	DSL 1-4
0.01	GWH	DSL	5.78	Ded	DSL 1-4
0.00	GWH	DSL	5.78	Ded	DSL 1-4
0.00	GWH	DSL	5.78	Ded	DSL 1-4
0.01	GWH	DSL	5.78	Ded	DSL 1-4
-

-	GWH	DSL	5.78	Ded DSL 1-4
-	GWH	DSL	5.78	Ded DSL 1-4
-	GWH	DSL	5.78	Ded DSL 1-4
-	GWH	DSL	5.78	Ded DSL 1-4
-	GWH	DSL	5.78	Ded DSL 1-4
0.67	GWH	DSL	5.78	MDI DSL 12
0.74	GWH	DSL	5.78	MDI DSL 12
1.33	GWH	DSL	5.78	MDI DSL 12
6.17	GWH	DSL	5.78	MDI DSL 12
0.15	GWH	DSL	5.78	MDI DSL 12
0.49	GWH	DSL	5.78	MDI DSL 12
14.60	GWH	DSL	5.78	MDI DSL 12
12.40	GWH	DSL	5.78	MDI DSL 12
14.87	GWH	DSL	5.78	MDI DSL 12
14.85	GWH	DSL	5.78	MDI DSL 12
10.47	GWH	DSL	5.78	MDI DSL 12
1.44	GWH	DSL	5.78	MDI DSL 12
0.85	GWH	DSL	5.78	MDI DSL 12
0.11	GWH	DSL	5.78	MDI DSL 12
0.11	GWH	DSL	5.78	MDI DSL 12
0.21	GWH	DSL	5.78	MDI DSL 12
0.11	GWH	DSL	5.78	MDI DSL 12
0.01	GWH	DSL	5.78	MDI DSL 12
0.00	GWH	DSL	5.78	MDI DSL 12
-	GWH	DSL	5.78	MDI DSL 12
-	GWH	DSL	5.78	MDI DSL 12
-	GWH	DSL	5.78	MDI DSL 12
-	GWH	DSL	5.78	MDI DSL 12
-	GWH	DSL	5.78	MDI DSL 12
-	GWH	DSL	5.78	MDI DSL 12
-	GWH	DSL	5.78	MDI DSL 12
-	GWH	DSL	5.78	MDI DSL 12
-	GWH	DSL	5.78	MDI DSL 12
-	GWH	DSL	5.78	MDI DSL 12
-	GWH	DSL	5.78	MDI DSL 12
0.39	GWH	DSL	5.78	MDI DSL 12
0.43	GWH	DSL	5.78	MDI DSL 12
0.77	GWH	DSL	5.78	MDI DSL 12
3.93	GWH	DSL	5.78	MDI DSL 12
0.11	GWH	DSL	5.78	MDI DSL 12
0.39	GWH	DSL	5.78	MDI DSL 12
2.91	GWH	DSL	5.78	MDI DSL 12
4.50	GWH	DSL	5.78	MDI DSL 12
3.37	GWH	DSL	5.78	MDI DSL 12
3.25	GWH	DSL	5.78	MDI DSL 12
5.47	GWH	DSL	5.78	MDI DSL 12
1.22	GWH	DSL	5.78	MDI DSL 12
0.75	GWH	DSL	5.78	MDI DSL 12
0.09	GWH	DSL	5.78	MDI DSL 12
0.09	GWH	DSL	5.78	MDI DSL 12
0.18	GWH	DSL	5.78	MDI DSL 12
0.09	GWH	DSL	5.78	MDI DSL 12

0.00	GWH	DSL	5.78	MDI	DSL 12
0.00	GWH	DSL	5.78	MDI	DSL 12
-	GWH	DSL	5.78	MDI	DSL 12
-	GWH	DSL	5.78	MDI	DSL 12
-	GWH	DSL	5.78	MDI	DSL 12
-	GWH	DSL	5.78	MDI	DSL 12
-	GWH	DSL	5.78	MDI	DSL 12
-	GWH	DSL	5.78	MDI	DSL 12
-	GWH	DSL	5.78	MDI	DSL 12
-	GWH	DSL	5.78	MDI	DSL 12
-	GWH	DSL	5.78	MDI	DSL 12
-	GWH	DSL	5.78	MDI	DSL 12
-	GWH	DSL	5.78	MDI	DSL 12
2.47	GWH	DSL	5.78	TENJO	1-6
2.67	GWH	DSL	5.78	TENJO	1-6
4.44	GWH	DSL	5.78	TENJO	1-6
13.48	GWH	DSL	5.78	TENJO	1-6
9.36	GWH	DSL	5.78	TENJO	1-6
12.97	GWH	DSL	5.78	TENJO	1-6
21.75	GWH	DSL	5.78	TENJO	1-6
18.63	GWH	DSL	5.78	TENJO	1-6
20.97	GWH	DSL	5.78	TENJO	1-6
21.00	GWH	DSL	5.78	TENJO	1-6
16.26	GWH	DSL	5.78	TENJO	1-6
5.01	GWH	DSL	5.78	TENJO	1-6
3.29	GWH	DSL	5.78	TENJO	1-6
0.52	GWH	DSL	5.78	TENJO	1-6
0.46	GWH	DSL	5.78	TENJO	1-6
0.77	GWH	DSL	5.78	TENJO	1-6
0.53	GWH	DSL	5.78	TENJO	1-6
0.03	GWH	DSL	5.78	TENJO	1-6
-	GWH	DSL	5.78	TENJO	1-6
-	GWH	DSL	5.78	TENJO	1-6
-	GWH	DSL	5.78	TENJO	1-6
-	GWH	DSL	5.78	TENJO	1-6
-	GWH	DSL	5.78	TENJO	1-6
-	GWH	DSL	5.78	TENJO	1-6
-	GWH	DSL	5.78	TENJO	1-6
-	GWH	DSL	5.78	TENJO	1-6
-	GWH	DSL	5.78	TENJO	1-6
-	GWH	DSL	5.78	TENJO	1-6
-	GWH	DSL	5.78	TENJO	1-6
-	GWH	DSL	5.78	TENJO	1-6
2.02	GWH	DSL	5.78	TENJO	1-6
2.21	GWH	DSL	5.78	TENJO	1-6
3.69	GWH	DSL	5.78	TENJO	1-6
12.28	GWH	DSL	5.78	TENJO	1-6
8.46	GWH	DSL	5.78	TENJO	1-6
11.77	GWH	DSL	5.78	TENJO	1-6
20.76	GWH	DSL	5.78	TENJO	1-6
17.82	GWH	DSL	5.78	TENJO	1-6
20.28	GWH	DSL	5.78	TENJO	1-6

20.26	GWH	DSL	5.78	TENJO 1-6
15.49	GWH	DSL	5.78	TENJO 1-6
4.39	GWH	DSL	5.78	TENJO 1-6
2.89	GWH	DSL	5.78	TENJO 1-6
0.46	GWH	DSL	5.78	TENJO 1-6
0.39	GWH	DSL	5.78	TENJO 1-6
0.68	GWH	DSL	5.78	TENJO 1-6
0.45	GWH	DSL	5.78	TENJO 1-6
0.02	GWH	DSL	5.78	TENJO 1-6
-	GWH	DSL	5.78	TENJO 1-6
-	GWH	DSL	5.78	TENJO 1-6
-	GWH	DSL	5.78	TENJO 1-6
-	GWH	DSL	5.78	TENJO 1-6
-	GWH	DSL	5.78	TENJO 1-6
-	GWH	DSL	5.78	TENJO 1-6
-	GWH	DSL	5.78	TENJO 1-6
-	GWH	DSL	5.78	TENJO 1-6
-	GWH	DSL	5.78	TENJO 1-6
-	GWH	DSL	5.78	TENJO 1-6
-	GWH	DSL	5.78	TENJO 1-6
-	GWH	DSL	5.78	TENJO 1-6
1.66	GWH	DSL	5.78	TENJO 1-6
1.80	GWH	DSL	5.78	TENJO 1-6
3.05	GWH	DSL	5.78	TENJO 1-6
11.21	GWH	DSL	5.78	TENJO 1-6
7.56	GWH	DSL	5.78	TENJO 1-6
10.73	GWH	DSL	5.78	TENJO 1-6
19.91	GWH	DSL	5.78	TENJO 1-6
16.97	GWH	DSL	5.78	TENJO 1-6
19.54	GWH	DSL	5.78	TENJO 1-6
19.44	GWH	DSL	5.78	TENJO 1-6
14.45	GWH	DSL	5.78	TENJO 1-6
3.91	GWH	DSL	5.78	TENJO 1-6
2.47	GWH	DSL	5.78	TENJO 1-6
0.37	GWH	DSL	5.78	TENJO 1-6
0.34	GWH	DSL	5.78	TENJO 1-6
0.60	GWH	DSL	5.78	TENJO 1-6
0.39	GWH	DSL	5.78	TENJO 1-6
0.02	GWH	DSL	5.78	TENJO 1-6
-	GWH	DSL	5.78	TENJO 1-6
-	GWH	DSL	5.78	TENJO 1-6
-	GWH	DSL	5.78	TENJO 1-6
-	GWH	DSL	5.78	TENJO 1-6
-	GWH	DSL	5.78	TENJO 1-6
-	GWH	DSL	5.78	TENJO 1-6
-	GWH	DSL	5.78	TENJO 1-6
-	GWH	DSL	5.78	TENJO 1-6
-	GWH	DSL	5.78	TENJO 1-6
-	GWH	DSL	5.78	TENJO 1-6
-	GWH	DSL	5.78	TENJO 1-6
1.35	GWH	DSL	5.78	TENJO 1-6

1.48	GWH	DSL	5.78	TENJO 1-6
2.53	GWH	DSL	5.78	TENJO 1-6
9.93	GWH	DSL	5.78	TENJO 1-6
6.62	GWH	DSL	5.78	TENJO 1-6
9.72	GWH	DSL	5.78	TENJO 1-6
18.96	GWH	DSL	5.78	TENJO 1-6
16.09	GWH	DSL	5.78	TENJO 1-6
18.82	GWH	DSL	5.78	TENJO 1-6
18.56	GWH	DSL	5.78	TENJO 1-6
13.39	GWH	DSL	5.78	TENJO 1-6
2.35	GWH	DSL	5.78	TENJO 1-6
1.39	GWH	DSL	5.78	TENJO 1-6
0.18	GWH	DSL	5.78	TENJO 1-6
0.18	GWH	DSL	5.78	TENJO 1-6
0.35	GWH	DSL	5.78	TENJO 1-6
0.18	GWH	DSL	5.78	TENJO 1-6
0.01	GWH	DSL	5.78	TENJO 1-6
-	GWH	DSL	5.78	TENJO 1-6
-	GWH	DSL	5.78	TENJO 1-6
-	GWH	DSL	5.78	TENJO 1-6
-	GWH	DSL	5.78	TENJO 1-6
-	GWH	DSL	5.78	TENJO 1-6
-	GWH	DSL	5.78	TENJO 1-6
-	GWH	DSL	5.78	TENJO 1-6
-	GWH	DSL	5.78	TENJO 1-6
-	GWH	DSL	5.78	TENJO 1-6
-	GWH	DSL	5.78	TENJO 1-6
-	GWH	DSL	5.78	TENJO 1-6
-	GWH	DSL	5.78	TENJO 1-6
1.09	GWH	DSL	5.78	TENJO 1-6
1.18	GWH	DSL	5.78	TENJO 1-6
2.08	GWH	DSL	5.78	TENJO 1-6
8.22	GWH	DSL	5.78	TENJO 1-6
5.71	GWH	DSL	5.78	TENJO 1-6
8.77	GWH	DSL	5.78	TENJO 1-6
17.72	GWH	DSL	5.78	TENJO 1-6
15.12	GWH	DSL	5.78	TENJO 1-6
17.99	GWH	DSL	5.78	TENJO 1-6
17.74	GWH	DSL	5.78	TENJO 1-6
12.58	GWH	DSL	5.78	TENJO 1-6
2.00	GWH	DSL	5.78	TENJO 1-6
1.19	GWH	DSL	5.78	TENJO 1-6
0.16	GWH	DSL	5.78	TENJO 1-6
0.15	GWH	DSL	5.78	TENJO 1-6
0.29	GWH	DSL	5.78	TENJO 1-6
0.16	GWH	DSL	5.78	TENJO 1-6
0.01	GWH	DSL	5.78	TENJO 1-6
-	GWH	DSL	5.78	TENJO 1-6
-	GWH	DSL	5.78	TENJO 1-6
-	GWH	DSL	5.78	TENJO 1-6
-	GWH	DSL	5.78	TENJO 1-6
-	GWH	DSL	5.78	TENJO 1-6

-	GWH	DSL	5.78	TENJO 1-6
-	GWH	DSL	5.78	TENJO 1-6
-	GWH	DSL	5.78	TENJO 1-6
-	GWH	DSL	5.78	TENJO 1-6
-	GWH	DSL	5.78	TENJO 1-6
-	GWH	DSL	5.78	TENJO 1-6
-	GWH	DSL	5.78	TENJO 1-6
0.87	GWH	DSL	5.78	TENJO 1-6
0.95	GWH	DSL	5.78	TENJO 1-6
1.69	GWH	DSL	5.78	TENJO 1-6
7.21	GWH	DSL	5.78	TENJO 1-6
4.87	GWH	DSL	5.78	TENJO 1-6
7.83	GWH	DSL	5.78	TENJO 1-6
16.63	GWH	DSL	5.78	TENJO 1-6
14.14	GWH	DSL	5.78	TENJO 1-6
17.11	GWH	DSL	5.78	TENJO 1-6
16.83	GWH	DSL	5.78	TENJO 1-6
11.79	GWH	DSL	5.78	TENJO 1-6
1.71	GWH	DSL	5.78	TENJO 1-6
1.02	GWH	DSL	5.78	TENJO 1-6
0.13	GWH	DSL	5.78	TENJO 1-6
0.13	GWH	DSL	5.78	TENJO 1-6
0.25	GWH	DSL	5.78	TENJO 1-6
0.13	GWH	DSL	5.78	TENJO 1-6
0.01	GWH	DSL	5.78	TENJO 1-6
-	GWH	DSL	5.78	TENJO 1-6
-	GWH	DSL	5.78	TENJO 1-6
-	GWH	DSL	5.78	TENJO 1-6
-	GWH	DSL	5.78	TENJO 1-6
-	GWH	DSL	5.78	TENJO 1-6
-	GWH	DSL	5.78	TENJO 1-6
-	GWH	DSL	5.78	TENJO 1-6
-	GWH	DSL	5.78	TENJO 1-6
-	GWH	DSL	5.78	TENJO 1-6
-	GWH	DSL	5.78	TENJO 1-6
-	GWH	DSL	5.78	TENJO 1-6
-	GWH	DSL	5.78	TENJO 1-6
3.59	GWH	DSL	5.78	Tal DSL 12
3.78	GWH	DSL	5.78	Tal DSL 12
6.08	GWH	DSL	5.78	Tal DSL 12
15.00	GWH	DSL	5.78	Tal DSL 12
11.18	GWH	DSL	5.78	Tal DSL 12
14.87	GWH	DSL	5.78	Tal DSL 12
21.07	GWH	DSL	5.78	Tal DSL 12
19.13	GWH	DSL	5.78	Tal DSL 12
20.73	GWH	DSL	5.78	Tal DSL 12
20.93	GWH	DSL	5.78	Tal DSL 12
17.16	GWH	DSL	5.78	Tal DSL 12
6.04	GWH	DSL	5.78	Tal DSL 12
4.19	GWH	DSL	5.78	Tal DSL 12
0.71	GWH	DSL	5.78	Tal DSL 12
0.60	GWH	DSL	5.78	Tal DSL 12

1.00	GWH	DSL	5.78	Tal DSL	12
0.70	GWH	DSL	5.78	Tal DSL	12
0.03	GWH	DSL	5.78	Tal DSL	12
-	GWH	DSL	5.78	Tal DSL	12
-	GWH	DSL	5.78	Tal DSL	12
-	GWH	DSL	5.78	Tal DSL	12
-	GWH	DSL	5.78	Tal DSL	12
-	GWH	DSL	5.78	Tal DSL	12
-	GWH	DSL	5.78	Tal DSL	12
-	GWH	DSL	5.78	Tal DSL	12
-	GWH	DSL	5.78	Tal DSL	12
-	GWH	DSL	5.78	Tal DSL	12
-	GWH	DSL	5.78	Tal DSL	12
-	GWH	DSL	5.78	Tal DSL	12
-	GWH	DSL	5.78	Tal DSL	12
3.00	GWH	DSL	5.78	Tal DSL	12
3.20	GWH	DSL	5.78	Tal DSL	12
4.46	GWH	DSL	5.78	Tal DSL	12
5.42	GWH	DSL	5.78	Tal DSL	12
5.94	GWH	DSL	5.78	Tal DSL	12
6.47	GWH	DSL	5.78	Tal DSL	12
1.68	GWH	DSL	5.78	Tal DSL	12
3.61	GWH	DSL	5.78	Tal DSL	12
1.96	GWH	DSL	5.78	Tal DSL	12
1.75	GWH	DSL	5.78	Tal DSL	12
5.31	GWH	DSL	5.78	Tal DSL	12
5.52	GWH	DSL	5.78	Tal DSL	12
3.72	GWH	DSL	5.78	Tal DSL	12
0.60	GWH	DSL	5.78	Tal DSL	12
0.53	GWH	DSL	5.78	Tal DSL	12
0.88	GWH	DSL	5.78	Tal DSL	12
0.60	GWH	DSL	5.78	Tal DSL	12
0.03	GWH	DSL	5.78	Tal DSL	12
-	GWH	DSL	5.78	Tal DSL	12
-	GWH	DSL	5.78	Tal DSL	12
-	GWH	DSL	5.78	Tal DSL	12
-	GWH	DSL	5.78	Tal DSL	12
-	GWH	DSL	5.78	Tal DSL	12
-	GWH	DSL	5.78	Tal DSL	12
-	GWH	DSL	5.78	Tal DSL	12
-	GWH	DSL	5.78	Tal DSL	12
-	GWH	DSL	5.78	Tal DSL	12
-	GWH	DSL	5.78	Tal DSL	12
-	GWH	DSL	5.78	Tal DSL	12
-	GWH	DSL	5.78	Tal DSL	12
17.15	GWH	RFO	6.1	Tango	12
18.94	GWH	RFO	6.1	Tango	12
25.66	GWH	RFO	6.1	Tango	12
50.66	GWH	RFO	6.1	Tango	12
40.96	GWH	RFO	6.1	Tango	12
46.99	GWH	RFO	6.1	Tango	12
65.31	GWH	RFO	6.1	Tango	12

58.53	GWH	RFO	6.1 Tango 12
64.75	GWH	RFO	6.1 Tango 12
63.69	GWH	RFO	6.1 Tango 12
54.17	GWH	RFO	6.1 Tango 12
31.87	GWH	RFO	6.1 Tango 12
22.99	GWH	RFO	6.1 Tango 12
6.65	GWH	RFO	6.1 Tango 12
5.53	GWH	RFO	6.1 Tango 12
8.14	GWH	RFO	6.1 Tango 12
6.56	GWH	RFO	6.1 Tango 12
0.52	GWH	RFO	6.1 Tango 12
0.00	GWH	RFO	6.1 Tango 12
0.00	GWH	RFO	6.1 Tango 12
0.00	GWH	RFO	6.1 Tango 12
0.01	GWH	RFO	6.1 Tango 12
0.01	GWH	RFO	6.1 Tango 12
-	GWH	RFO	6.1 Tango 12
-	GWH	RFO	6.1 Tango 12
-	GWH	RFO	6.1 Tango 12
-	GWH	RFO	6.1 Tango 12
-	GWH	RFO	6.1 Tango 12
-	GWH	RFO	6.1 Tango 12
-	GWH	RFO	6.1 Tango 12
24.85	GWH	RFO	6.1 Tango 12
26.29	GWH	RFO	6.1 Tango 12
34.00	GWH	RFO	6.1 Tango 12
56.19	GWH	RFO	6.1 Tango 12
46.76	GWH	RFO	6.1 Tango 12
52.92	GWH	RFO	6.1 Tango 12
68.60	GWH	RFO	6.1 Tango 12
63.01	GWH	RFO	6.1 Tango 12
68.31	GWH	RFO	6.1 Tango 12
67.11	GWH	RFO	6.1 Tango 12
58.74	GWH	RFO	6.1 Tango 12
37.04	GWH	RFO	6.1 Tango 12
27.87	GWH	RFO	6.1 Tango 12
10.56	GWH	RFO	6.1 Tango 12
7.63	GWH	RFO	6.1 Tango 12
10.77	GWH	RFO	6.1 Tango 12
8.97	GWH	RFO	6.1 Tango 12
0.86	GWH	RFO	6.1 Tango 12
0.01	GWH	RFO	6.1 Tango 12
0.00	GWH	RFO	6.1 Tango 12
0.01	GWH	RFO	6.1 Tango 12
0.01	GWH	RFO	6.1 Tango 12
0.01	GWH	RFO	6.1 Tango 12
0.01	GWH	RFO	6.1 Tango 12
-	GWH	RFO	6.1 Tango 12
-	GWH	RFO	6.1 Tango 12
-	GWH	RFO	6.1 Tango 12
-	GWH	RFO	6.1 Tango 12
-	GWH	RFO	6.1 Tango 12

-	GWH	RFO	6.1	Tango 12
331.93	GWH	RFO	6.1	MEC 89
332.45	GWH	RFO	6.1	MEC 89
336.72	GWH	RFO	6.1	MEC 89
328.53	GWH	RFO	6.1	MEC 89
338.01	GWH	RFO	6.1	MEC 89
338.19	GWH	RFO	6.1	MEC 89
335.90	GWH	RFO	6.1	MEC 89
338.27	GWH	RFO	6.1	MEC 89
338.28	GWH	RFO	6.1	MEC 89
338.28	GWH	RFO	6.1	MEC 89
338.67	GWH	RFO	6.1	MEC 89
335.74	GWH	RFO	6.1	MEC 89
328.20	GWH	RFO	6.1	MEC 89
287.69	GWH	RFO	6.1	MEC 89
286.78	GWH	RFO	6.1	MEC 89
294.46	GWH	RFO	6.1	MEC 89
286.03	GWH	RFO	6.1	MEC 89
219.32	GWH	RFO	6.1	MEC 89
140.18	GWH	RFO	6.1	MEC 89
137.96	GWH	RFO	6.1	MEC 89
132.13	GWH	RFO	6.1	MEC 89
101.40	GWH	RFO	6.1	MEC 89
112.33	GWH	RFO	6.1	MEC 89
103.43	GWH	RFO	6.1	MEC 89
80.66	GWH	RFO	6.1	MEC 89
83.99	GWH	RFO	6.1	MEC 89
85.95	GWH	RFO	6.1	MEC 89
86.79	GWH	RFO	6.1	MEC 89
90.36	GWH	RFO	6.1	MEC 89
87.68	GWH	RFO	6.1	MEC 89
324.68	GWH	RFO	6.1	MEC 89
325.97	GWH	RFO	6.1	MEC 89
332.22	GWH	RFO	6.1	MEC 89
321.58	GWH	RFO	6.1	MEC 89
337.06	GWH	RFO	6.1	MEC 89
337.94	GWH	RFO	6.1	MEC 89
331.01	GWH	RFO	6.1	MEC 89
338.24	GWH	RFO	6.1	MEC 89
338.26	GWH	RFO	6.1	MEC 89
338.25	GWH	RFO	6.1	MEC 89
337.94	GWH	RFO	6.1	MEC 89
334.43	GWH	RFO	6.1	MEC 89
328.25	GWH	RFO	6.1	MEC 89
276.93	GWH	RFO	6.1	MEC 89
275.09	GWH	RFO	6.1	MEC 89
284.13	GWH	RFO	6.1	MEC 89
274.59	GWH	RFO	6.1	MEC 89
199.38	GWH	RFO	6.1	MEC 89
129.34	GWH	RFO	6.1	MEC 89
130.15	GWH	RFO	6.1	MEC 89
122.41	GWH	RFO	6.1	MEC 89

95.02	GWH	RFO		6.1	MEC 89
106.10	GWH	RFO		6.1	MEC 89
95.22	GWH	RFO		6.1	MEC 89
77.20	GWH	RFO		6.1	MEC 89
79.90	GWH	RFO		6.1	MEC 89
83.41	GWH	RFO		6.1	MEC 89
83.31	GWH	RFO		6.1	MEC 89
84.80	GWH	RFO		6.1	MEC 89
84.05	GWH	RFO		6.1	MEC 89
11.29	GWH	DSL		5.78	TEMES CT 7
12.24	GWH	DSL		5.78	TEMES CT 7
18.06	GWH	DSL		5.78	TEMES CT 7
42.12	GWH	DSL		5.78	TEMES CT 7
31.13	GWH	DSL		5.78	TEMES CT 7
38.32	GWH	DSL		5.78	TEMES CT 7
54.76	GWH	DSL		5.78	TEMES CT 7
47.88	GWH	DSL		5.78	TEMES CT 7
52.78	GWH	DSL		5.78	TEMES CT 7
52.41	GWH	DSL		5.78	TEMES CT 7
34.18	GWH	DSL		5.78	TEMES CT 7
-	GWH	DSL		5.78	TEMES CT 7
-	GWH	DSL		5.78	TEMES CT 7
-	GWH	DSL		5.78	TEMES CT 7
-	GWH	DSL		5.78	TEMES CT 7
-	GWH	DSL		5.78	TEMES CT 7
-	GWH	DSL		5.78	TEMES CT 7
-	GWH	DSL		5.78	TEMES CT 7
-	GWH	DSL		5.78	TEMES CT 7
-	GWH	DSL		5.78	TEMES CT 7
-	GWH	DSL		5.78	TEMES CT 7
-	GWH	DSL		5.78	TEMES CT 7
-	GWH	DSL		5.78	TEMES CT 7
-	GWH	DSL		5.78	TEMES CT 7
-	GWH	DSL		5.78	TEMES CT 7
-	GWH	DSL		5.78	TEMES CT 7
-	GWH	DSL		5.78	TEMES CT 7
-	GWH	DSL		5.78	TEMES CT 7
-	GWH	#N/A	#N/A		#N/A
-	GWH	#N/A	#N/A		#N/A
-	GWH	#N/A	#N/A		#N/A
-	GWH	#N/A	#N/A		#N/A
-	GWH	#N/A	#N/A		#N/A
-	GWH	#N/A	#N/A		#N/A
-	GWH	#N/A	#N/A		#N/A
-	GWH	#N/A	#N/A		#N/A
-	GWH	#N/A	#N/A		#N/A
-	GWH	#N/A	#N/A		#N/A
-	GWH	#N/A	#N/A		#N/A
-	GWH	#N/A	#N/A		#N/A
-	GWH	#N/A	#N/A		#N/A

-	GWH	#N/A	#N/A	#N/A
-	GWH	#N/A	#N/A	#N/A
-	GWH	#N/A	#N/A	#N/A

-	GWH	#N/A	#N/A	#N/A
-	GWH	#N/A	#N/A	#N/A
-	GWH	#N/A	#N/A	#N/A

-	GWH	#N/A	#N/A	#N/A
-	GWH	#N/A	#N/A	#N/A
-	GWH	#N/A	#N/A	#N/A

-	GWH	#N/A	#N/A	#N/A
-	GWH	#N/A	#N/A	#N/A
-	GWH	#N/A	#N/A	#N/A

-	GWH	#N/A	#N/A	#N/A
-	GWH	#N/A	#N/A	#N/A
-	GWH	#N/A	#N/A	#N/A

-	GWH	#N/A	#N/A	#N/A
-	GWH	#N/A	#N/A	#N/A
-	GWH	#N/A	#N/A	#N/A

-	GWH	#N/A	#N/A	#N/A
-	GWH	#N/A	#N/A	#N/A
-	GWH	#N/A	#N/A	#N/A

-	GWH	#N/A	#N/A	#N/A
-	GWH	#N/A	#N/A	#N/A
-	GWH	#N/A	#N/A	#N/A

-	GWH	#N/A	#N/A		#N/A
-	GWH	#N/A	#N/A		#N/A
-	GWH	#N/A	#N/A		#N/A

-	GWH	RFO	6.1	RECIP	83
-	GWH	RFO	6.1	RECIP	83
-	GWH	RFO	6.1	RECIP	83

-	GWH	RFO	6.1	RECIP	84
-	GWH	RFO	6.1	RECIP	84
-	GWH	RFO	6.1	RECIP	84
13.15	GWH	RFO	6.1	RECIP	84
79.58	GWH	RFO	6.1	RECIP	84
79.07	GWH	RFO	6.1	RECIP	84
76.16	GWH	RFO	6.1	RECIP	84
-	GWH	LNG	1	CLNG	85
-	GWH	LNG	1	CLNG	85
-	GWH	LNG	1	CLNG	85

-	GWH	RFO	6.1	RECIP	86
-	GWH	RFO	6.1	RECIP	86
-	GWH	RFO	6.1	RECIP	86
-	GWH	RFO	6.1	RECIP	86
-	GWH	RFO	6.1	RECIP	86
-	GWH	RFO	6.1	RECIP	86
-	GWH	RFO	6.1	RECIP	86
15.03	GWH	RFO	6.1	RECIP	86
84.49	GWH	RFO	6.1	RECIP	86
76.58	GWH	RFO	6.1	RECIP	86
77.47	GWH	RFO	6.1	RECIP	86
78.39	GWH	RFO	6.1	RECIP	86
75.96	GWH	RFO	6.1	RECIP	86
75.93	GWH	RFO	6.1	RECIP	86
74.94	GWH	RFO	6.1	RECIP	86
-	GWH	RFO	6.1	RECIP	87
-	GWH	RFO	6.1	RECIP	87
-	GWH	RFO	6.1	RECIP	87
-	GWH	RFO	6.1	RECIP	87
-	GWH	RFO	6.1	RECIP	87
-	GWH	RFO	6.1	RECIP	87
-	GWH	RFO	6.1	RECIP	87
-	GWH	RFO	6.1	RECIP	87
-	GWH	RFO	6.1	RECIP	87
-	GWH	RFO	6.1	RECIP	87
-	GWH	RFO	6.1	RECIP	87
-	GWH	RFO	6.1	RECIP	87
-	GWH	RFO	6.1	RECIP	87
-	GWH	RFO	6.1	RECIP	87
-	GWH	RFO	6.1	RECIP	87
-	GWH	RFO	6.1	RECIP	87
-	GWH	RFO	6.1	RECIP	87
-	GWH	RFO	6.1	RECIP	87
-	GWH	RFO	6.1	RECIP	87
-	GWH	RFO	6.1	RECIP	87
-	GWH	RFO	6.1	RECIP	87
-	GWH	RFO	6.1	RECIP	87
-	GWH	RFO	6.1	RECIP	87
13.40	GWH	RFO	6.1	RECIP	87
86.19	GWH	RFO	6.1	RECIP	87
78.20	GWH	RFO	6.1	RECIP	87
75.05	GWH	RFO	6.1	RECIP	87
75.31	GWH	RFO	6.1	RECIP	87
75.81	GWH	RFO	6.1	RECIP	87
74.92	GWH	RFO	6.1	RECIP	87
74.93	GWH	RFO	6.1	RECIP	87
74.61	GWH	RFO	6.1	RECIP	87
-	GWH	LNG	1	CLNG	88
-	GWH	LNG	1	CLNG	88
-	GWH	LNG	1	CLNG	88
-	GWH	LNG	1	CLNG	88
-	GWH	LNG	1	CLNG	88
-	GWH	LNG	1	CLNG	88
-	GWH	LNG	1	CLNG	88

-	GWH	LNG	1	CLNG	88
-	GWH	LNG	1	CLNG	88
-	GWH	LNG	1	CLNG	88
-	GWH	LNG	1	CLNG	88
-	GWH	LNG	1	CLNG	88
-	GWH	LNG	1	CLNG	88
-	GWH	LNG	1	CLNG	88
-	GWH	LNG	1	CLNG	88
-	GWH	LNG	1	CLNG	88
-	GWH	LNG	1	CLNG	88
-	GWH	LNG	1	CLNG	88
-	GWH	LNG	1	CLNG	88
-	GWH	LNG	1	CLNG	88
86.49	GWH	LNG	1	CLNG	88
429.56	GWH	LNG	1	CLNG	88
441.52	GWH	LNG	1	CLNG	88
429.16	GWH	LNG	1	CLNG	88
393.76	GWH	LNG	1	CLNG	88
400.05	GWH	LNG	1	CLNG	88
406.22	GWH	LNG	1	CLNG	88
403.97	GWH	LNG	1	CLNG	88
410.37	GWH	LNG	1	CLNG	88
400.85	GWH	LNG	1	CLNG	88
-	GWH	RFO	6.1	RECIP	89
-	GWH	RFO	6.1	RECIP	89
-	GWH	RFO	6.1	RECIP	89

74.54	GWH	RFO	6.1	RECIP	89
-	GWH	RFO	6.1	RECIP	90
-	GWH	RFO	6.1	RECIP	90
-	GWH	RFO	6.1	RECIP	90
-	GWH	RFO	6.1	RECIP	90
-	GWH	RFO	6.1	RECIP	90
-	GWH	RFO	6.1	RECIP	90
-	GWH	RFO	6.1	RECIP	90
-	GWH	RFO	6.1	RECIP	90
-	GWH	RFO	6.1	RECIP	90
-	GWH	RFO	6.1	RECIP	90
-	GWH	RFO	6.1	RECIP	90
-	GWH	RFO	6.1	RECIP	90
-	GWH	RFO	6.1	RECIP	90
-	GWH	RFO	6.1	RECIP	90
-	GWH	RFO	6.1	RECIP	90
-	GWH	RFO	6.1	RECIP	90
-	GWH	RFO	6.1	RECIP	90
-	GWH	RFO	6.1	RECIP	90
-	GWH	RFO	6.1	RECIP	90
18.80	GWH	RFO	6.1	RECIP	90
96.82	GWH	RFO	6.1	RECIP	90
93.49	GWH	RFO	6.1	RECIP	90
76.07	GWH	RFO	6.1	RECIP	90
74.82	GWH	RFO	6.1	RECIP	90
74.53	GWH	RFO	6.1	RECIP	90
74.55	GWH	RFO	6.1	RECIP	90
74.54	GWH	RFO	6.1	RECIP	90
74.76	GWH	RFO	6.1	RECIP	90
74.52	GWH	RFO	6.1	RECIP	90
74.52	GWH	RFO	6.1	RECIP	90
74.53	GWH	RFO	6.1	RECIP	90
-	GWH	LNG	1	CLNG	91
-	GWH	LNG	1	CLNG	91
-	GWH	LNG	1	CLNG	91
-	GWH	LNG	1	CLNG	91
-	GWH	LNG	1	CLNG	91
-	GWH	LNG	1	CLNG	91
-	GWH	LNG	1	CLNG	91
-	GWH	LNG	1	CLNG	91
-	GWH	LNG	1	CLNG	91
-	GWH	LNG	1	CLNG	91
-	GWH	LNG	1	CLNG	91
-	GWH	LNG	1	CLNG	91
-	GWH	LNG	1	CLNG	91
-	GWH	LNG	1	CLNG	91
-	GWH	LNG	1	CLNG	91
-	GWH	LNG	1	CLNG	91
-	GWH	LNG	1	CLNG	91
-	GWH	LNG	1	CLNG	91
-	GWH	LNG	1	CLNG	91
-	GWH	LNG	1	CLNG	91
-	GWH	LNG	1	CLNG	91
89.70	GWH	LNG	1	CLNG	91
446.79	GWH	LNG	1	CLNG	91
445.02	GWH	LNG	1	CLNG	91
440.81	GWH	LNG	1	CLNG	91

412.42	GWH	LNG	1	CLNG	91
423.89	GWH	LNG	1	CLNG	91
416.66	GWH	LNG	1	CLNG	91
376.30	GWH	LNG	1	CLNG	91
382.64	GWH	LNG	1	CLNG	91
386.67	GWH	LNG	1	CLNG	91
386.26	GWH	LNG	1	CLNG	91
391.37	GWH	LNG	1	CLNG	91
384.86	GWH	LNG	1	CLNG	91
-	GWH	RFO	6.1	RECIP	92
-	GWH	RFO	6.1	RECIP	92
-	GWH	RFO	6.1	RECIP	92
-	GWH	RFO	6.1	RECIP	92
-	GWH	RFO	6.1	RECIP	92
-	GWH	RFO	6.1	RECIP	92
-	GWH	RFO	6.1	RECIP	92
-	GWH	RFO	6.1	RECIP	92
-	GWH	RFO	6.1	RECIP	92
-	GWH	RFO	6.1	RECIP	92
-	GWH	RFO	6.1	RECIP	92
-	GWH	RFO	6.1	RECIP	92
-	GWH	RFO	6.1	RECIP	92
-	GWH	RFO	6.1	RECIP	92
-	GWH	RFO	6.1	RECIP	92
-	GWH	RFO	6.1	RECIP	92
-	GWH	RFO	6.1	RECIP	92
21.88	GWH	RFO	6.1	RECIP	92
87.72	GWH	RFO	6.1	RECIP	92
80.47	GWH	RFO	6.1	RECIP	92
78.74	GWH	RFO	6.1	RECIP	92
74.85	GWH	RFO	6.1	RECIP	92
74.74	GWH	RFO	6.1	RECIP	92
74.52	GWH	RFO	6.1	RECIP	92
74.56	GWH	RFO	6.1	RECIP	92
74.54	GWH	RFO	6.1	RECIP	92
74.76	GWH	RFO	6.1	RECIP	92
74.53	GWH	RFO	6.1	RECIP	92
74.52	GWH	RFO	6.1	RECIP	92
74.52	GWH	RFO	6.1	RECIP	92
-	GWH	LNG	1	CLNG	93
-	GWH	LNG	1	CLNG	93
-	GWH	LNG	1	CLNG	93
-	GWH	LNG	1	CLNG	93
-	GWH	LNG	1	CLNG	93
-	GWH	LNG	1	CLNG	93
-	GWH	LNG	1	CLNG	93
-	GWH	LNG	1	CLNG	93
-	GWH	LNG	1	CLNG	93
-	GWH	LNG	1	CLNG	93
-	GWH	LNG	1	CLNG	93
-	GWH	LNG	1	CLNG	93
-	GWH	LNG	1	CLNG	93

-	GWH	LNG	1	CLNG	93
-	GWH	LNG	1	CLNG	93
-	GWH	LNG	1	CLNG	93
90.53	GWH	LNG	1	CLNG	93
458.94	GWH	LNG	1	CLNG	93
431.93	GWH	LNG	1	CLNG	93
429.97	GWH	LNG	1	CLNG	93
427.13	GWH	LNG	1	CLNG	93
393.16	GWH	LNG	1	CLNG	93
406.90	GWH	LNG	1	CLNG	93
397.17	GWH	LNG	1	CLNG	93
359.18	GWH	LNG	1	CLNG	93
365.14	GWH	LNG	1	CLNG	93
369.86	GWH	LNG	1	CLNG	93
370.26	GWH	LNG	1	CLNG	93
375.31	GWH	LNG	1	CLNG	93
368.69	GWH	LNG	1	CLNG	93
-	GWH	WIND	1	WIND	94
-	GWH	WIND	1	WIND	94
-	GWH	WIND	1	WIND	94
-	GWH	WIND	1	WIND	94
-	GWH	WIND	1	WIND	94
-	GWH	WIND	1	WIND	94
-	GWH	WIND	1	WIND	94
-	GWH	WIND	1	WIND	94
-	GWH	WIND	1	WIND	94
-	GWH	WIND	1	WIND	94
-	GWH	WIND	1	WIND	94
-	GWH	WIND	1	WIND	94
-	GWH	WIND	1	WIND	94
24.40	GWH	WIND	1	WIND	94
103.31	GWH	WIND	1	WIND	94
103.02	GWH	WIND	1	WIND	94
103.02	GWH	WIND	1	WIND	94
103.02	GWH	WIND	1	WIND	94
103.12	GWH	WIND	1	WIND	94
102.69	GWH	WIND	1	WIND	94
102.75	GWH	WIND	1	WIND	94
100.97	GWH	WIND	1	WIND	94
102.76	GWH	WIND	1	WIND	94
101.64	GWH	WIND	1	WIND	94
95.24	GWH	WIND	1	WIND	94
97.32	GWH	WIND	1	WIND	94
98.62	GWH	WIND	1	WIND	94
97.77	GWH	WIND	1	WIND	94
99.49	GWH	WIND	1	WIND	94
97.03	GWH	WIND	1	WIND	94
-	GWH	WIND	1	WIND	95
-	GWH	WIND	1	WIND	95
-	GWH	WIND	1	WIND	95
-	GWH	WIND	1	WIND	95
-	GWH	WIND	1	WIND	95

-	GWH	WIND	1	WIND	95
-	GWH	WIND	1	WIND	95
-	GWH	WIND	1	WIND	95
-	GWH	WIND	1	WIND	95
-	GWH	WIND	1	WIND	95
-	GWH	WIND	1	WIND	95
-	GWH	WIND	1	WIND	95
24.40	GWH	WIND	1	WIND	95
103.02	GWH	WIND	1	WIND	95
103.31	GWH	WIND	1	WIND	95
103.02	GWH	WIND	1	WIND	95
103.00	GWH	WIND	1	WIND	95
102.98	GWH	WIND	1	WIND	95
101.22	GWH	WIND	1	WIND	95
100.96	GWH	WIND	1	WIND	95
100.67	GWH	WIND	1	WIND	95
96.23	GWH	WIND	1	WIND	95
99.77	GWH	WIND	1	WIND	95
97.40	GWH	WIND	1	WIND	95
88.11	GWH	WIND	1	WIND	95
90.83	GWH	WIND	1	WIND	95
92.50	GWH	WIND	1	WIND	95
91.87	GWH	WIND	1	WIND	95
93.90	GWH	WIND	1	WIND	95
90.61	GWH	WIND	1	WIND	95
-	GWH	LNG	1	CLNG	96
-	GWH	LNG	1	CLNG	96
-	GWH	LNG	1	CLNG	96
-	GWH	LNG	1	CLNG	96
-	GWH	LNG	1	CLNG	96
-	GWH	LNG	1	CLNG	96
-	GWH	LNG	1	CLNG	96
-	GWH	LNG	1	CLNG	96
-	GWH	LNG	1	CLNG	96
-	GWH	LNG	1	CLNG	96
-	GWH	LNG	1	CLNG	96
92.44	GWH	LNG	1	CLNG	96
470.22	GWH	LNG	1	CLNG	96
469.61	GWH	LNG	1	CLNG	96
469.62	GWH	LNG	1	CLNG	96
467.98	GWH	LNG	1	CLNG	96
449.61	GWH	LNG	1	CLNG	96
413.55	GWH	LNG	1	CLNG	96
412.31	GWH	LNG	1	CLNG	96
410.02	GWH	LNG	1	CLNG	96
376.18	GWH	LNG	1	CLNG	96
388.55	GWH	LNG	1	CLNG	96
377.58	GWH	LNG	1	CLNG	96
346.05	GWH	LNG	1	CLNG	96
351.22	GWH	LNG	1	CLNG	96
355.13	GWH	LNG	1	CLNG	96

355.68	GWH	LNG	1	CLNG	96
359.22	GWH	LNG	1	CLNG	96
355.03	GWH	LNG	1	CLNG	96
-	GWH	WIND	1	WIND	97
-	GWH	WIND	1	WIND	97
-	GWH	WIND	1	WIND	97
-	GWH	WIND	1	WIND	97
-	GWH	WIND	1	WIND	97
-	GWH	WIND	1	WIND	97
-	GWH	WIND	1	WIND	97
-	GWH	WIND	1	WIND	97
-	GWH	WIND	1	WIND	97
-	GWH	WIND	1	WIND	97
24.40	GWH	WIND	1	WIND	97
103.02	GWH	WIND	1	WIND	97
103.01	GWH	WIND	1	WIND	97
103.22	GWH	WIND	1	WIND	97
102.97	GWH	WIND	1	WIND	97
102.88	GWH	WIND	1	WIND	97
102.24	GWH	WIND	1	WIND	97
97.73	GWH	WIND	1	WIND	97
97.13	GWH	WIND	1	WIND	97
97.09	GWH	WIND	1	WIND	97
90.68	GWH	WIND	1	WIND	97
95.19	GWH	WIND	1	WIND	97
92.08	GWH	WIND	1	WIND	97
80.97	GWH	WIND	1	WIND	97
84.17	GWH	WIND	1	WIND	97
86.06	GWH	WIND	1	WIND	97
85.45	GWH	WIND	1	WIND	97
87.93	GWH	WIND	1	WIND	97
83.79	GWH	WIND	1	WIND	97
-	GWH	WIND	1	WIND	98
-	GWH	WIND	1	WIND	98
-	GWH	WIND	1	WIND	98
-	GWH	WIND	1	WIND	98
-	GWH	WIND	1	WIND	98
-	GWH	WIND	1	WIND	98
-	GWH	WIND	1	WIND	98
-	GWH	WIND	1	WIND	98
-	GWH	WIND	1	WIND	98
-	GWH	WIND	1	WIND	98
24.40	GWH	WIND	1	WIND	98
103.02	GWH	WIND	1	WIND	98
103.01	GWH	WIND	1	WIND	98
102.77	GWH	WIND	1	WIND	98
102.74	GWH	WIND	1	WIND	98
102.63	GWH	WIND	1	WIND	98
102.42	GWH	WIND	1	WIND	98
100.44	GWH	WIND	1	WIND	98
92.83	GWH	WIND	1	WIND	98

92.59	GWH	WIND	1	WIND	98
91.81	GWH	WIND	1	WIND	98
83.95	GWH	WIND	1	WIND	98
89.50	GWH	WIND	1	WIND	98
85.76	GWH	WIND	1	WIND	98
73.14	GWH	WIND	1	WIND	98
76.74	GWH	WIND	1	WIND	98
78.99	GWH	WIND	1	WIND	98
78.67	GWH	WIND	1	WIND	98
81.42	GWH	WIND	1	WIND	98
76.88	GWH	WIND	1	WIND	98
-	GWH	DSL	5.78	RETR	99
-	GWH	DSL	5.78	RETR	99
-	GWH	DSL	5.78	RETR	99
-	GWH	DSL	5.78	RETR	99
-	GWH	DSL	5.78	RETR	99
-	GWH	DSL	5.78	RETR	99
-	GWH	DSL	5.78	RETR	99
-	GWH	DSL	5.78	RETR	99
-	GWH	DSL	5.78	RETR	99
-	GWH	DSL	5.78	RETR	99
55.43	GWH	DSL	5.78	RETR	99
223.79	GWH	DSL	5.78	RETR	99
181.95	GWH	DSL	5.78	RETR	99
88.21	GWH	DSL	5.78	RETR	99
70.08	GWH	DSL	5.78	RETR	99
89.30	GWH	DSL	5.78	RETR	99
80.76	GWH	DSL	5.78	RETR	99
13.79	GWH	DSL	5.78	RETR	99
0.29	GWH	DSL	5.78	RETR	99
0.08	GWH	DSL	5.78	RETR	99
0.30	GWH	DSL	5.78	RETR	99
0.01	GWH	DSL	5.78	RETR	99
1.69	GWH	DSL	5.78	RETR	99
0.28	GWH	DSL	5.78	RETR	99
0.10	GWH	DSL	5.78	RETR	99
0.08	GWH	DSL	5.78	RETR	99
0.10	GWH	DSL	5.78	RETR	99
0.04	GWH	DSL	5.78	RETR	99
0.03	GWH	DSL	5.78	RETR	99
0.04	GWH	DSL	5.78	RETR	99
-	GWH	WIND	1	WIND	100
-	GWH	WIND	1	WIND	100
-	GWH	WIND	1	WIND	100
-	GWH	WIND	1	WIND	100
-	GWH	WIND	1	WIND	100
-	GWH	WIND	1	WIND	100
-	GWH	WIND	1	WIND	100
-	GWH	WIND	1	WIND	100
-	GWH	WIND	1	WIND	100
24.40	GWH	WIND	1	WIND	100
103.31	GWH	WIND	1	WIND	100

103.02	GWH	WIND	1	WIND	100
102.92	GWH	WIND	1	WIND	100
102.03	GWH	WIND	1	WIND	100
101.65	GWH	WIND	1	WIND	100
101.80	GWH	WIND	1	WIND	100
101.40	GWH	WIND	1	WIND	100
97.58	GWH	WIND	1	WIND	100
86.91	GWH	WIND	1	WIND	100
86.73	GWH	WIND	1	WIND	100
86.15	GWH	WIND	1	WIND	100
77.11	GWH	WIND	1	WIND	100
83.14	GWH	WIND	1	WIND	100
79.19	GWH	WIND	1	WIND	100
65.49	GWH	WIND	1	WIND	100
69.40	GWH	WIND	1	WIND	100
71.86	GWH	WIND	1	WIND	100
71.63	GWH	WIND	1	WIND	100
74.60	GWH	WIND	1	WIND	100
69.85	GWH	WIND	1	WIND	100
61.38	MW	RFO	6.1	Cab12	
61.38	MW	RFO	6.1	Cab12	
61.38	MW	RFO	6.1	Cab12	
61.38	MW	RFO	6.1	Cab12	
61.38	MW	RFO	6.1	Cab12	
61.38	MW	RFO	6.1	Cab12	
61.38	MW	RFO	6.1	Cab12	
61.38	MW	RFO	6.1	Cab12	
61.38	MW	RFO	6.1	Cab12	
61.38	MW	RFO	6.1	Cab12	
61.38	MW	RFO	6.1	Cab12	
61.38	MW	RFO	6.1	Cab12	
61.38	MW	RFO	6.1	Cab12	
61.38	MW	RFO	6.1	Cab12	
61.38	MW	RFO	6.1	Cab12	
61.38	MW	RFO	6.1	Cab12	
61.38	MW	RFO	6.1	Cab12	
61.38	MW	RFO	6.1	Cab12	
61.38	MW	RFO	6.1	Cab12	
61.38	MW	RFO	6.1	Cab12	
61.38	MW	RFO	6.1	Cab12	
61.38	MW	RFO	6.1	Cab12	
61.38	MW	RFO	6.1	Cab12	
61.38	MW	RFO	6.1	Cab12	
61.38	MW	RFO	6.1	Cab12	
61.38	MW	RFO	6.1	Cab12	
-	MW	RFO	6.1	Cab12	
-	MW	RFO	6.1	Cab12	
-	MW	RFO	6.1	Cab12	
-	MW	RFO	6.1	Cab12	
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-	MW	RFO	6.1	Cab12	
-	MW	RFO	6.1	Cab12	
-	MW	RFO	6.1	Cab12	
61.38	MW	RFO	6.1	Cab12	
61.38	MW	RFO	6.1	Cab12	
61.38	MW	RFO	6.1	Cab12	

61.38	MW	RFO	6.1 Cab12
61.38	MW	RFO	6.1 Cab12
61.38	MW	RFO	6.1 Cab12
61.38	MW	RFO	6.1 Cab12
61.38	MW	RFO	6.1 Cab12
61.38	MW	RFO	6.1 Cab12
61.38	MW	RFO	6.1 Cab12
61.38	MW	RFO	6.1 Cab12
61.38	MW	RFO	6.1 Cab12
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61.38	MW	RFO	6.1 Cab12
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61.38	MW	RFO	6.1 Cab12
61.38	MW	RFO	6.1 Cab12
61.38	MW	RFO	6.1 Cab12
61.38	MW	RFO	6.1 Cab12
61.38	MW	RFO	6.1 Cab12
61.38	MW	RFO	6.1 Cab12
-	MW	RFO	6.1 Cab12
-	MW	RFO	6.1 Cab12
-	MW	RFO	6.1 Cab12
-	MW	RFO	6.1 Cab12
-	MW	RFO	6.1 Cab12
-	MW	RFO	6.1 Cab12
-	MW	RFO	6.1 Cab12
-	MW	RFO	6.1 Cab12
36.94	MW	RFO	6.1 Cab34
36.94	MW	RFO	6.1 Cab34
36.94	MW	RFO	6.1 Cab34

36.94	MW	RFO	6.1	Cab34	
36.94	MW	RFO	6.1	Cab34	
36.94	MW	RFO	6.1	Cab34	
36.94	MW	RFO	6.1	Cab34	
36.94	MW	RFO	6.1	Cab34	
37.34	MW	RFO	6.1	Cab34	
37.34	MW	RFO	6.1	Cab34	
37.34

-	MW	DSL	5.78	OROTE	1
-	MW	DSL	5.78	OROTE	1
-	MW	DSL	5.78	OROTE	1
-	MW	DSL	5.78	OROTE	1
-	MW	DSL	5.78	OROTE	1
-	MW	DSL	5.78	OROTE	1
-	MW	DSL	5.78	OROTE	1
-	MW	DSL	5.78	OROTE	1
-	MW	DSL	5.78	OROTE	1
-	MW	DSL	5.78	OROTE	1
-	MW	DSL	5.78	OROTE	1
-	MW	DSL	5.78	OROTE	1
-	MW	DSL	5.78	OROTE	1
22.77	MW	DSL	5.78	Ded CT	12
22.77	MW	DSL	5.78	Ded CT	12
22.77	MW	DSL	5.78	Ded CT	12
22.77	MW	DSL	5.78	Ded CT	12
22.77	MW	DSL	5.78	Ded CT	12
22.77	MW	DSL	5.78	Ded CT	12
22.77	MW	DSL	5.78	Ded CT	12
22.77	MW	DSL	5.78	Ded CT	12
22.77	MW	DSL	5.78	Ded CT	12
22.77	MW	DSL	5.78	Ded CT	12
22.77	MW	DSL	5.78	Ded CT	12
22.77	MW	DSL	5.78	Ded CT	12
22.77	MW	DSL	5.78	Ded CT	12
22.77	MW	DSL	5.78	Ded CT	12
22.77	MW	DSL	5.78	Ded CT	12
22.77	MW	DSL	5.78	Ded CT	12
22.77	MW	DSL	5.78	Ded CT	12
-	MW	DSL	5.78	Ded CT	12
-	MW	DSL	5.78	Ded CT	12
-	MW	DSL	5.78	Ded CT	12
-	MW	DSL	5.78	Ded CT	12
-	MW	DSL	5.78	Ded CT	12
-	MW	DSL	5.78	Ded CT	12
-	MW	DSL	5.78	Ded CT	12
-	MW	DSL	5.78	Ded CT	12
-	MW	DSL	5.78	Ded CT	12
-	MW	DSL	5.78	Ded CT	12
-	MW	DSL	5.78	Ded CT	12
-	MW	DSL	5.78	Ded CT	12
22.77	MW	DSL	5.78	Ded CT	12
22.77	MW	DSL	5.78	Ded CT	12
22.77	MW	DSL	5.78	Ded CT	12
22.77	MW	DSL	5.78	Ded CT	12
22.77	MW	DSL	5.78	Ded CT	12
22.77	MW	DSL	5.78	Ded CT	12
22.77	MW	DSL	5.78	Ded CT	12
22.77	MW	DSL	5.78	Ded CT	12
22.77	MW	DSL	5.78	Ded CT	12

22.77	MW	DSL	5.78	Ded CT 12
22.77	MW	DSL	5.78	Ded CT 12
22.77	MW	DSL	5.78	Ded CT 12
22.77	MW	DSL	5.78	Ded CT 12
22.77	MW	DSL	5.78	Ded CT 12
22.77	MW	DSL	5.78	Ded CT 12
22.77	MW	DSL	5.78	Ded CT 12
22.77	MW	DSL	5.78	Ded CT 12
22.77	MW	DSL	5.78	Ded CT 12
22.77	MW	DSL	5.78	Ded CT 12
-	MW	DSL	5.78	Ded CT 12
-	MW	DSL	5.78	Ded CT 12
-	MW	DSL	5.78	Ded CT 12
-	MW	DSL	5.78	Ded CT 12
-	MW	DSL	5.78	Ded CT 12
-	MW	DSL	5.78	Ded CT 12
-	MW	DSL	5.78	Ded CT 12
-	MW	DSL	5.78	Ded CT 12
-	MW	DSL	5.78	Ded CT 12
-	MW	DSL	5.78	Ded CT 12
21.56	MW	DSL	5.78	MACH CT 1
21.56	MW	DSL	5.78	MACH CT 1
21.56	MW	DSL	5.78	MACH CT 1
21.56	MW	DSL	5.78	MACH CT 1
21.56	MW	DSL	5.78	MACH CT 1
21.56	MW	DSL	5.78	MACH CT 1
21.56	MW	DSL	5.78	MACH CT 1
21.56	MW	DSL	5.78	MACH CT 1
21.56	MW	DSL	5.78	MACH CT 1
21.56	MW	DSL	5.78	MACH CT 1
21.56	MW	DSL	5.78	MACH CT 1
21.56	MW	DSL	5.78	MACH CT 1
21.56	MW	DSL	5.78	MACH CT 1
21.56	MW	DSL	5.78	MACH CT 1
21.56	MW	DSL	5.78	MACH CT 1
21.56	MW	DSL	5.78	MACH CT 1
21.56	MW	DSL	5.78	MACH CT 1
21.56	MW	DSL	5.78	MACH CT 1
21.56	MW	DSL	5.78	MACH CT 1
21.56	MW	DSL	5.78	MACH CT 1
-	MW	DSL	5.78	MACH CT 1
-	MW	DSL	5.78	MACH CT 1
-	MW	DSL	5.78	MACH CT 1
-	MW	DSL	5.78	MACH CT 1
-	MW	DSL	5.78	MACH CT 1
-	MW	DSL	5.78	MACH CT 1
-	MW	DSL	5.78	MACH CT 1
-	MW	DSL	5.78	MACH CT 1
-	MW	DSL	5.78	MACH CT 1
-	MW	DSL	5.78	MACH CT 1
-	MW	DSL	5.78	MACH CT 1
21.56	MW	DSL	5.78	YIGO CT 1

21.56	MW	DSL	5.78	YIGO CT	1
21.56	MW	DSL	5.78	YIGO CT	1
21.56	MW	DSL	5.78	YIGO CT	1
21.56	MW	DSL	5.78	YIGO CT	1
21.56	MW	DSL	5.78	YIGO CT	1
21.56	MW	DSL	5.78	YIGO CT	1
21.56	MW	DSL	5.78	YIGO CT	1
21.56	MW	DSL	5.78	YIGO CT	1
21.56	MW	DSL	5.78	YIGO CT	1
21.56	MW	DSL	5.78	YIGO CT	1
21.56	MW	DSL	5.78	YIGO CT	1
21.56	MW	DSL	5.78	YIGO CT	1
21.56	MW	DSL	5.78	YIGO CT	1
21.56	MW	DSL	5.78	YIGO CT	1
21.56	MW	DSL	5.78	YIGO CT	1
21.56	MW	DSL	5.78	YIGO CT	1
-	MW	DSL	5.78	YIGO CT	1
-	MW	DSL	5.78	YIGO CT	1
-	MW	DSL	5.78	YIGO CT	1
-	MW	DSL	5.78	YIGO CT	1
-	MW	DSL	5.78	YIGO CT	1
-	MW	DSL	5.78	YIGO CT	1
-	MW	DSL	5.78	YIGO CT	1
-	MW	DSL	5.78	YIGO CT	1
-	MW	DSL	5.78	YIGO CT	1
-	MW	DSL	5.78	YIGO CT	1
-	MW	DSL	5.78	YIGO CT	1
15.36	MW	DSL	5.78	MARBO CT	1
15.36	MW	DSL	5.78	MARBO CT	1
15.36	MW	DSL	5.78	MARBO CT	1
15.36	MW	DSL	5.78	MARBO CT	1
15.36	MW	DSL	5.78	MARBO CT	1
15.36	MW	DSL	5.78	MARBO CT	1
15.36	MW	DSL	5.78	MARBO CT	1
15.36	MW	DSL	5.78	MARBO CT	1
15.36	MW	DSL	5.78	MARBO CT	1
15.36	MW	DSL	5.78	MARBO CT	1
15.36	MW	DSL	5.78	MARBO CT	1
15.36	MW	DSL	5.78	MARBO CT	1
15.36	MW	DSL	5.78	MARBO CT	1
15.36	MW	DSL	5.78	MARBO CT	1
15.36	MW	DSL	5.78	MARBO CT	1
15.36	MW	DSL	5.78	MARBO CT	1
15.36	MW	DSL	5.78	MARBO CT	1
15.36	MW	DSL	5.78	MARBO CT	1
15.36	MW	DSL	5.78	MARBO CT	1
15.36	MW	DSL	5.78	MARBO CT	1
15.36	MW	DSL	5.78	MARBO CT	1
15.36	MW	DSL	5.78	MARBO CT	1
15.36	MW	DSL	5.78	MARBO CT	1
15.36	MW	DSL	5.78	MARBO CT	1
15.36	MW	DSL	5.78	MARBO CT	1
15.36	MW	DSL	5.78	MARBO CT	1
15.36	MW	DSL	5.78	MARBO CT	1
15.36	MW	DSL	5.78	MARBO CT	1
-	MW	DSL	5.78	MARBO CT	1
-	MW	DSL	5.78	MARBO CT	1
-	MW	DSL	5.78	MARBO CT	1
-	MW	DSL	5.78	MARBO CT	1
-	MW	DSL	5.78	MARBO CT	1

-	MW	DSL	5.78	MARBO CT 1
-	MW	DSL	5.78	MARBO CT 1
-	MW	DSL	5.78	MARBO CT 1
-	MW	DSL	5.78	MARBO CT 1
-	MW	DSL	5.78	MARBO CT 1
-	MW	DSL	5.78	MARBO CT 1
-	MW	DSL	5.78	MARBO CT 1
2.45	MW	DSL	5.78	Ded DSL 1-4
2.45	MW	DSL	5.78	Ded DSL 1-4
2.45	MW	DSL	5.78	Ded DSL 1-4
2.45	MW	DSL	5.78	Ded DSL 1-4
2.45	MW	DSL	5.78	Ded DSL 1-4
2.45	MW	DSL	5.78	Ded DSL 1-4
2.45	MW	DSL	5.78	Ded DSL 1-4
2.45	MW	DSL	5.78	Ded DSL 1-4
2.45	MW	DSL	5.78	Ded DSL 1-4
2.45	MW	DSL	5.78	Ded DSL 1-4
2.45	MW	DSL	5.78	Ded DSL 1-4
-	MW	DSL	5.78	Ded DSL 1-4
-	MW	DSL	5.78	Ded DSL 1-4
-	MW	DSL	5.78	Ded DSL 1-4
-	MW	DSL	5.78	Ded DSL 1-4
-	MW	DSL	5.78	Ded DSL 1-4
-	MW	DSL	5.78	Ded DSL 1-4
-	MW	DSL	5.78	Ded DSL 1-4
-	MW	DSL	5.78	Ded DSL 1-4
-	MW	DSL	5.78	Ded DSL 1-4
-	MW	DSL	5.78	Ded DSL 1-4
-	MW	DSL	5.78	Ded DSL 1-4
-	MW	DSL	5.78	Ded DSL 1-4
-	MW	DSL	5.78	Ded DSL 1-4
-	MW	DSL	5.78	Ded DSL 1-4
-	MW	DSL	5.78	Ded DSL 1-4
-	MW	DSL	5.78	Ded DSL 1-4
-	MW	DSL	5.78	Ded DSL 1-4
2.45	MW	DSL	5.78	Ded DSL 1-4
2.45	MW	DSL	5.78	Ded DSL 1-4
2.45	MW	DSL	5.78	Ded DSL 1-4
2.45	MW	DSL	5.78	Ded DSL 1-4
2.45	MW	DSL	5.78	Ded DSL 1-4
2.45	MW	DSL	5.78	Ded DSL 1-4
2.45	MW	DSL	5.78	Ded DSL 1-4
2.45	MW	DSL	5.78	Ded DSL 1-4
2.45	MW	DSL	5.78	Ded DSL 1-4
2.45	MW	DSL	5.78	Ded DSL 1-4
-	MW	DSL	5.78	Ded DSL 1-4
-	MW	DSL	5.78	Ded DSL 1-4
-	MW	DSL	5.78	Ded DSL 1-4
-	MW	DSL	5.78	Ded DSL 1-4

-	MW	DSL	5.78	Ded DSL 1-4
-	MW	DSL	5.78	Ded DSL 1-4
-	MW	DSL	5.78	Ded DSL 1-4
-	MW	DSL	5.78	Ded DSL 1-4
-	MW	DSL	5.78	Ded DSL 1-4
-	MW	DSL	5.78	Ded DSL 1-4
-	MW	DSL	5.78	Ded DSL 1-4
-	MW	DSL	5.78	Ded DSL 1-4
-	MW	DSL	5.78	Ded DSL 1-4
-	MW	DSL	5.78	Ded DSL 1-4
-	MW	DSL	5.78	Ded DSL 1-4
-	MW	DSL	5.78	Ded DSL 1-4
-	MW	DSL	5.78	Ded DSL 1-4
-	MW	DSL	5.78	Ded DSL 1-4
2.45	MW	DSL	5.78	Ded DSL 1-4
2.45	MW	DSL	5.78	Ded DSL 1-4
2.45	MW	DSL	5.78	Ded DSL 1-4
2.45	MW	DSL	5.78	Ded DSL 1-4
2.45	MW	DSL	5.78	Ded DSL 1-4
2.45	MW	DSL	5.78	Ded DSL 1-4
2.45	MW	DSL	5.78	Ded DSL 1-4
2.45	MW	DSL	5.78	Ded DSL 1-4
2.45	MW	DSL	5.78	Ded DSL 1-4
2.45	MW	DSL	5.78	Ded DSL 1-4
2.45	MW	DSL	5.78	Ded DSL 1-4
-	MW	DSL	5.78	Ded DSL 1-4
-	MW	DSL	5.78	Ded DSL 1-4
-	MW	DSL	5.78	Ded DSL 1-4
-	MW	DSL	5.78	Ded DSL 1-4
-	MW	DSL	5.78	Ded DSL 1-4
-	MW	DSL	5.78	Ded DSL 1-4
-	MW	DSL	5.78	Ded DSL 1-4
-	MW	DSL	5.78	Ded DSL 1-4
-	MW	DSL	5.78	Ded DSL 1-4
-	MW	DSL	5.78	Ded DSL 1-4
-	MW	DSL	5.78	Ded DSL 1-4
-	MW	DSL	5.78	Ded DSL 1-4
-	MW	DSL	5.78	Ded DSL 1-4
-	MW	DSL	5.78	Ded DSL 1-4
-	MW	DSL	5.78	Ded DSL 1-4
-	MW	DSL	5.78	Ded DSL 1-4
-	MW	DSL	5.78	Ded DSL 1-4
-	MW	DSL	5.78	Ded DSL 1-4
-	MW	DSL	5.78	Ded DSL 1-4
-	MW	DSL	5.78	Ded DSL 1-4
-	MW	DSL	5.78	Ded DSL 1-4
-	MW	DSL	5.78	Ded DSL 1-4
-	MW	DSL	5.78	Ded DSL 1-4
2.45	MW	DSL	5.78	Ded DSL 1-4
2.45	MW	DSL	5.78	Ded DSL 1-4
2.45	MW	DSL	5.78	Ded DSL 1-4
2.45	MW	DSL	5.78	Ded DSL 1-4
2.45	MW	DSL	5.78	Ded DSL 1-4
2.45	MW	DSL	5.78	Ded DSL 1-4
2.45	MW	DSL	5.78	Ded DSL 1-4

2.45	MW	DSL	5.78	Ded	DSL 1-4
2.45	MW	DSL	5.78	Ded	DSL 1-4
2.45	MW	DSL	5.78	Ded	DSL 1-4
2.45	MW	DSL	5.78	Ded	DSL 1-4
-	MW	DSL	5.78	Ded	DSL 1-4
-	MW	DSL	5.78	Ded	DSL 1-4
-	MW	DSL	5.78	Ded	DSL 1-4
-	MW	DSL	5.78	Ded	DSL 1-4
-	MW	DSL	5.78	Ded	DSL 1-4
-	MW	DSL	5.78	Ded	DSL 1-4
-	MW	DSL	5.78	Ded	DSL 1-4
-	MW	DSL	5.78	Ded	DSL 1-4
-	MW	DSL	5.78	Ded	DSL 1-4
-	MW	DSL	5.78	Ded	DSL 1-4
-	MW	DSL	5.78	Ded	DSL 1-4
-	MW	DSL	5.78	Ded	DSL 1-4
-	MW	DSL	5.78	Ded	DSL 1-4
-	MW	DSL	5.78	Ded	DSL 1-4
-	MW	DSL	5.78	Ded	DSL 1-4
-	MW	DSL	5.78	Ded	DSL 1-4
-	MW	DSL	5.78	Ded	DSL 1-4
-	MW	DSL	5.78	Ded	DSL 1-4
-	MW	DSL	5.78	Ded	DSL 1-4
5.14	MW	DSL	5.78	MDI	DSL 12
5.14	MW	DSL	5.78	MDI	DSL 12
5.14	MW	DSL	5.78	MDI	DSL 12
5.14	MW	DSL	5.78	MDI	DSL 12
5.14	MW	DSL	5.78	MDI	DSL 12
5.14	MW	DSL	5.78	MDI	DSL 12
5.14	MW	DSL	5.78	MDI	DSL 12
5.14	MW	DSL	5.78	MDI	DSL 12
5.14	MW	DSL	5.78	MDI	DSL 12
5.14	MW	DSL	5.78	MDI	DSL 12
5.14	MW	DSL	5.78	MDI	DSL 12
5.14	MW	DSL	5.78	MDI	DSL 12
5.14	MW	DSL	5.78	MDI	DSL 12
5.14	MW	DSL	5.78	MDI	DSL 12
5.14	MW	DSL	5.78	MDI	DSL 12
5.14	MW	DSL	5.78	MDI	DSL 12
5.14	MW	DSL	5.78	MDI	DSL 12
5.14	MW	DSL	5.78	MDI	DSL 12
5.14	MW	DSL	5.78	MDI	DSL 12
5.14	MW	DSL	5.78	MDI	DSL 12
5.14	MW	DSL	5.78	MDI	DSL 12
-	MW	DSL	5.78	MDI	DSL 12
-	MW	DSL	5.78	MDI	DSL 12
-	MW	DSL	5.78	MDI	DSL 12
-	MW	DSL	5.78	MDI	DSL 12
-	MW	DSL	5.78	MDI	DSL 12
-	MW	DSL	5.78	MDI	DSL 12
-	MW	DSL	5.78	MDI	DSL 12
-	MW	DSL	5.78	MDI	DSL 12
-	MW	DSL	5.78	MDI	DSL 12
-	MW	DSL	5.78	MDI	DSL 12

-	MW	DSL	5.78	MDI	DSL 12
5.19	MW	DSL	5.78	MDI	DSL 12
5.19	MW	DSL	5.78	MDI	DSL 12
5.19	MW	DSL	5.78	MDI	DSL 12
5.19	MW	DSL	5.78	MDI	DSL 12
5.19	MW	DSL	5.78	MDI	DSL 12
5.19	MW	DSL	5.78	MDI	DSL 12
5.19	MW	DSL	5.78	MDI	DSL 12
5.19	MW	DSL	5.78	MDI	DSL 12
5.19	MW	DSL	5.78	MDI	DSL 12
5.19	MW	DSL	5.78	MDI	DSL 12
5.19	MW	DSL	5.78	MDI	DSL 12
5.19	MW	DSL	5.78	MDI	DSL 12
5.19	MW	DSL	5.78	MDI	DSL 12
5.19	MW	DSL	5.78	MDI	DSL 12
5.19	MW	DSL	5.78	MDI	DSL 12
5.19	MW	DSL	5.78	MDI	DSL 12
5.19	MW	DSL	5.78	MDI	DSL 12
5.19	MW	DSL	5.78	MDI	DSL 12
5.19	MW	DSL	5.78	MDI	DSL 12
5.19	MW	DSL	5.78	MDI	DSL 12
-	MW	DSL	5.78	MDI	DSL 12
-	MW	DSL	5.78	MDI	DSL 12
-	MW	DSL	5.78	MDI	DSL 12
-	MW	DSL	5.78	MDI	DSL 12
-	MW	DSL	5.78	MDI	DSL 12
-	MW	DSL	5.78	MDI	DSL 12
-	MW	DSL	5.78	MDI	DSL 12
-	MW	DSL	5.78	MDI	DSL 12
-	MW	DSL	5.78	MDI	DSL 12
-	MW	DSL	5.78	MDI	DSL 12
-	MW	DSL	5.78	MDI	DSL 12
4.36	MW	DSL	5.78	TENJO	1-6
4.36	MW	DSL	5.78	TENJO	1-6
4.36	MW	DSL	5.78	TENJO	1-6
4.36	MW	DSL	5.78	TENJO	1-6
4.36	MW	DSL	5.78	TENJO	1-6
4.36	MW	DSL	5.78	TENJO	1-6
4.36	MW	DSL	5.78	TENJO	1-6
4.36	MW	DSL	5.78	TENJO	1-6
4.36	MW	DSL	5.78	TENJO	1-6
4.36	MW	DSL	5.78	TENJO	1-6
4.36	MW	DSL	5.78	TENJO	1-6
4.36	MW	DSL	5.78	TENJO	1-6
4.36	MW	DSL	5.78	TENJO	1-6
4.36	MW	DSL	5.78	TENJO	1-6
4.36	MW	DSL	5.78	TENJO	1-6
4.36	MW	DSL	5.78	TENJO	1-6
4.36	MW	DSL	5.78	TENJO	1-6
4.36	MW	DSL	5.78	TENJO	1-6
4.36	MW	DSL	5.78	TENJO	1-6
-	MW	DSL	5.78	TENJO	1-6
-	MW	DSL	5.78	TENJO	1-6
-	MW	DSL	5.78	TENJO	1-6

-	MW	DSL	5.78	TENJO 1-6
-	MW	DSL	5.78	TENJO 1-6
-	MW	DSL	5.78	TENJO 1-6
-	MW	DSL	5.78	TENJO 1-6
-	MW	DSL	5.78	TENJO 1-6
-	MW	DSL	5.78	TENJO 1-6
-	MW	DSL	5.78	TENJO 1-6
-	MW	DSL	5.78	TENJO 1-6
-	MW	DSL	5.78	TENJO 1-6
4.36

4.36	MW	DSL	5.78	TENJO 1-6
4.36	MW	DSL	5.78	TENJO 1-6
4.36	MW	DSL	5.78	TENJO 1-6
4.36	MW	DSL	5.78	TENJO 1-6
4.36	MW	DSL	5.78	TENJO 1-6
-	MW	DSL	5.78	TENJO 1-6
-	MW	DSL	5.78	TENJO 1-6
-	MW	DSL	5.78	TENJO 1-6
-	MW	DSL	5.78	TENJO 1-6
-	MW	DSL	5.78	TENJO 1-6
-	MW	DSL	5.78	TENJO 1-6
-	MW	DSL	5.78	TENJO 1-6
-	MW	DSL	5.78	TENJO 1-6
-	MW	DSL	5.78	TENJO 1-6
-	MW	DSL	5.78	TENJO 1-6
-	MW	DSL	5.78	TENJO 1-6
-	MW	DSL	5.78	TENJO 1-6
4.36	MW	DSL	5.78	TENJO 1-6
4.36	MW	DSL	5.78	TENJO 1-6
4.36	MW	DSL	5.78	TENJO 1-6
4.36	MW	DSL	5.78	TENJO 1-6
4.36	MW	DSL	5.78	TENJO 1-6
4.36	MW	DSL	5.78	TENJO 1-6
4.36	MW	DSL	5.78	TENJO 1-6
4.36	MW	DSL	5.78	TENJO 1-6
4.36	MW	DSL	5.78	TENJO 1-6
4.36	MW	DSL	5.78	TENJO 1-6
4.36	MW	DSL	5.78	TENJO 1-6
4.36	MW	DSL	5.78	TENJO 1-6
4.36	MW	DSL	5.78	TENJO 1-6
4.36	MW	DSL	5.78	TENJO 1-6
4.36	MW	DSL	5.78	TENJO 1-6
4.36	MW	DSL	5.78	TENJO 1-6
4.36	MW	DSL	5.78	TENJO 1-6
4.36	MW	DSL	5.78	TENJO 1-6
4.36	MW	DSL	5.78	TENJO 1-6
4.36	MW	DSL	5.78	TENJO 1-6
-	MW	DSL	5.78	TENJO 1-6
-	MW	DSL	5.78	TENJO 1-6
-	MW	DSL	5.78	TENJO 1-6
-	MW	DSL	5.78	TENJO 1-6
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-	MW	DSL	5.78	TENJO 1-6
-	MW	DSL	5.78	TENJO 1-6
-	MW	DSL	5.78	TENJO 1-6
-	MW	DSL	5.78	TENJO 1-6
-	MW	DSL	5.78	TENJO 1-6
-	MW	DSL	5.78	TENJO 1-6
-	MW	DSL	5.78	TENJO 1-6
-	MW	DSL	5.78	TENJO 1-6
4.36	MW	DSL	5.78	TENJO 1-6
4.36	MW	DSL	5.78	TENJO 1-6
4.36	MW	DSL	5.78	TENJO 1-6
4.36	MW	DSL	5.78	TENJO 1-6
4.36	MW	DSL	5.78	TENJO 1-6

4.36	MW	DSL	5.78	TENJO 1-6

-	MW	DSL	5.78	TENJO 1-6
-	MW	DSL	5.78	TENJO 1-6
-	MW	DSL	5.78	TENJO 1-6
4.36	MW	DSL	5.78	Tal DSL 12
4.36	MW	DSL	5.78	Tal DSL 12
4.36	MW	DSL	5.78	Tal DSL 12
4.36	MW	DSL	5.78	Tal DSL 12
4.36	MW	DSL	5.78	Tal DSL 12
4.36	MW	DSL	5.78	Tal DSL 12
4.36	MW	DSL	5.78	Tal DSL 12
4.36	MW	DSL	5.78	Tal DSL 12
4.36	MW	DSL	5.78	Tal DSL 12
4.36	MW	DSL	5.78	Tal DSL 12
4.36	MW	DSL	5.78	Tal DSL 12
4.36	MW	DSL	5.78	Tal DSL 12
4.36	MW	DSL	5.78	Tal DSL 12
4.36	MW	DSL	5.78	Tal DSL 12
4.36	MW	DSL	5.78	Tal DSL 12
4.36	MW	DSL	5.78	Tal DSL 12
4.36	MW	DSL	5.78	Tal DSL 12
4.36	MW	DSL	5.78	Tal DSL 12
-	MW	DSL	5.78	Tal DSL 12
-	MW	DSL	5.78	Tal DSL 12
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4.36	MW	DSL	5.78	Tal DSL 12
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4.36	MW	DSL	5.78	Tal DSL 12
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23.85	MW	RFO	6.1	Tango 12
23.85	MW	RFO	6.1	Tango 12
23.85	MW	RFO	6.1	Tango

24.12	MW	RFO	6.1 Tango 12
24.12	MW	RFO	6.1 Tango 12
24.12	MW	RFO	6.1 Tango 12
24.12	MW	RFO	6.1 Tango 12
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42.68	MW	RFO	6.1 MEC 89
42.68	MW	RFO	6.1 MEC 89
42.68	MW	RFO	6.1 MEC 89

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42.68	MW	RFO	6.1	MEC 89
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42.68	MW	RFO	6.1	MEC 89
42.68	MW	RFO	6.1	MEC 89
42.68	MW	RFO	6.1	MEC 89
42.68	MW	RFO	6.1	MEC 89
42.68	MW	RFO	6.1	MEC 89
39.20	MW	DSL	5.78	TEMES CT 7
39.20	MW	DSL	5.78	TEMES CT 7
39.20	MW	DSL	5.78	TEMES CT 7
39.20	MW	DSL	5.78	TEMES CT 7
39.20	MW	DSL	5.78	TEMES CT 7
39.20	MW	DSL	5.78	TEMES CT 7
39.20	MW	DSL	5.78	TEMES CT 7
39.20	MW	DSL	5.78	TEMES CT 7
39.20	MW	DSL	5.78	TEMES CT 7
39.20	MW	DSL	5.78	TEMES CT 7
39.20	MW	DSL	5.78	TEMES CT 7
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-	MW	DSL	5.78	TEMES CT 7
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-	MW	DSL	5.78	TEMES CT 7
-	MW	DSL	5.78	TEMES CT 7
-	MW	DSL	5.78	TEMES CT 7
-	MW	DSL	5.78	TEMES CT 7
-	MW	DSL	5.78	TEMES CT 7
-	MW	DSL	5.78	TEMES CT 7
-	MW	DSL	5.78	TEMES CT 7
-	MW	DSL	5.78	TEMES CT 7
-	MW	DSL	5.78	TEMES CT 7

-	MW	DSL		5.78	TEMES CT 7
-	MW	DSL		5.78	TEMES CT 7
-	MW	DSL		5.78	TEMES CT 7
-	MW	DSL		5.78	TEMES CT 7
-	MW	DSL		5.78	TEMES CT 7
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-	MW	#N/A	#N/A		#N/A
-	MW	#N/A	#N/A		#N/A

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-	MW	#N/A	#N/A	#N/A

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60.00	MW	LNG	1	CLNG	93
60.00	MW	LNG	1	CLNG	93
60.00	MW	LNG	1	CLNG	93
60.00	MW	LNG	1	CLNG	93
60.00	MW	LNG	1	CLNG	93
60.00	MW	LNG	1	CLNG	93
60.00	MW	LNG	1	CLNG	93
60.00	MW	LNG	1	CLNG	93
-	MW	WIND	1	WIND	94
-	MW	WIND	1	WIND	94
-	MW	WIND	1	WIND	94
-	MW	WIND	1	WIND	94
-	MW	WIND	1	WIND	94
-	MW	WIND	1	WIND	94
-	MW	WIND	1	WIND	94
-	MW	WIND	1	WIND	94
-	MW	WIND	1	WIND	94
-	MW	WIND	1	WIND	94
-	MW	WIND	1	WIND	94
-	MW	WIND	1	WIND	94
-	MW	WIND	1	WIND	94
-	MW	WIND	1	WIND	94
-	MW	WIND	1	WIND	94
4.80	MW	WIND	1	WIND	94
4.80	MW	WIND	1	WIND	94
4.80	MW	WIND	1	WIND	94

4.80	MW	WIND	1	WIND	94
4.80	MW	WIND	1	WIND	94
4.80	MW	WIND	1	WIND	94
4.80	MW	WIND	1	WIND	94
4.80	MW	WIND	1	WIND	94
4.80	MW	WIND	1	WIND	94
4.80	MW	WIND	1	WIND	94
4.80	MW	WIND	1	WIND	94
4.80	MW	WIND	1	WIND	94
4.80	MW	WIND	1	WIND	94
4.80	MW	WIND	1	WIND	94
4.80	MW	WIND	1	WIND	94
4.80	MW	WIND	1	WIND	94
-	MW	WIND	1	WIND	95
-	MW	WIND	1	WIND	95
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-	MW	WIND	1	WIND	95
-	MW	WIND	1	WIND	95
4.80	MW	WIND	1	WIND	95
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4.80	MW	WIND	1	WIND	95
4.80	MW	WIND	1	WIND	95
4.80	MW	WIND	1	WIND	95
4.80	MW	WIND	1	WIND	95
4.80	MW	WIND	1	WIND	95
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4.80	MW	WIND	1	WIND	95
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4.80	MW	WIND	1	WIND	95
4.80	MW	WIND	1	WIND	95
4.80	MW	WIND	1	WIND	95
4.80	MW	WIND	1	WIND	95
-	MW	LNG	1	CLNG	96
-	MW	LNG	1	CLNG	96
-	MW	LNG	1	CLNG	96
-	MW	LNG	1	CLNG	96
-	MW	LNG	1	CLNG	96
-	MW	LNG	1	CLNG	96
-	MW	LNG	1	CLNG	96
-	MW	LNG	1	CLNG	96
-	MW	LNG	1	CLNG	96

-	MW	LNG	1	CLNG	96
-	MW	LNG	1	CLNG	96
-	MW	LNG	1	CLNG	96
-	MW	LNG	1	CLNG	96
60.00	MW	LNG	1	CLNG	96
60.00	MW	LNG	1	CLNG	96
60.00	MW	LNG	1	CLNG	96
60.00	MW	LNG	1	CLNG	96
60.00	MW	LNG	1	CLNG	96
60.00	MW	LNG	1	CLNG	96
60.00	MW	LNG	1	CLNG	96
60.00	MW	LNG	1	CLNG	96
60.00	MW	LNG	1	CLNG	96
60.00	MW	LNG	1	CLNG	96
60.00	MW	LNG	1	CLNG	96
60.00	MW	LNG	1	CLNG	96
60.00	MW	LNG	1	CLNG	96
60.00	MW	LNG	1	CLNG	96
60.00	MW	LNG	1	CLNG	96
60.00	MW	LNG	1	CLNG	96
60.00	MW	LNG	1	CLNG	96
-	MW	WIND	1	WIND	97
-	MW	WIND	1	WIND	97
-	MW	WIND	1	WIND	97
-	MW	WIND	1	WIND	97
-	MW	WIND	1	WIND	97
-	MW	WIND	1	WIND	97
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-	MW	WIND	1	WIND	97
-	MW	WIND	1	WIND	97
-	MW	WIND	1	WIND	97
-	MW	WIND	1	WIND	97
4.80	MW	WIND	1	WIND	97
4.80	MW	WIND	1	WIND	97
4.80	MW	WIND	1	WIND	97
4.80	MW	WIND	1	WIND	97
4.80	MW	WIND	1	WIND	97
4.80	MW	WIND	1	WIND	97
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4.80	MW	WIND	1	WIND	97
4.80	MW	WIND	1	WIND	97
4.80	MW	WIND	1	WIND	97
4.80	MW	WIND	1	WIND	97
4.80	MW	WIND	1	WIND	97
4.80	MW	WIND	1	WIND	97
-	MW	WIND	1	WIND	98

-	MW	WIND	1	WIND	98
-	MW	WIND	1	WIND	98
-	MW	WIND	1	WIND	98
-	MW	WIND	1	WIND	98
-	MW	WIND	1	WIND	98
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-	MW	WIND	1	WIND	98
-	MW	WIND	1	WIND	98
-	MW	WIND	1	WIND	98
4.80	MW	WIND	1	WIND	98
4.80	MW	WIND	1	WIND	98
4.80	MW	WIND	1	WIND	98
4.80	MW	WIND	1	WIND	98
4.80	MW	WIND	1	WIND	98
4.80	MW	WIND	1	WIND	98
4.80	MW	WIND	1	WIND	98
4.80	MW	WIND	1	WIND	98
4.80	MW	WIND	1	WIND	98
4.80	MW	WIND	1	WIND	98
4.80	MW	WIND	1	WIND	98
4.80	MW	WIND	1	WIND	98
4.80	MW	WIND	1	WIND	98
4.80	MW	WIND	1	WIND	98
4.80	MW	WIND	1	WIND	98
4.80	MW	WIND	1	WIND	98
4.80	MW	WIND	1	WIND	98
4.80	MW	WIND	1	WIND	98
-	MW	DSL	5.78	RETR	99
-	MW	DSL	5.78	RETR	99
-	MW	DSL	5.78	RETR	99
-	MW	DSL	5.78	RETR	99
-	MW	DSL	5.78	RETR	99
-	MW	DSL	5.78	RETR	99
-	MW	DSL	5.78	RETR	99
-	MW	DSL	5.78	RETR	99
-	MW	DSL	5.78	RETR	99
-	MW	DSL	5.78	RETR	99
-	MW	DSL	5.78	RETR	99
60.00	MW	DSL	5.78	RETR	99
60.00	MW	DSL	5.78	RETR	99
60.00	MW	DSL	5.78	RETR	99
60.00	MW	DSL	5.78	RETR	99
60.00	MW	DSL	5.78	RETR	99
60.00	MW	DSL	5.78	RETR	99
60.00	MW	DSL	5.78	RETR	99
60.00	MW	DSL	5.78	RETR	99
60.00	MW	DSL	5.78	RETR	99
60.00	MW	DSL	5.78	RETR	99
60.00	MW	DSL	5.78	RETR	99

60.00	MW	DSL	5.78	RETR	99	
60.00	MW	DSL	5.78	RETR	99	
60.00	MW	DSL	5.78	RETR	99	
60.00	MW	DSL	5.78	RETR	99	
60.00	MW	DSL	5.78	RETR	99	
60.00	MW	DSL	5.78	RETR	99	
60.00	MW	DSL	5.78	RETR	99	
-	MW	WIND	1	WIND	100	
-	MW	WIND	1	WIND	100	
-	MW	WIND	1	WIND	100	
-	MW	WIND	1	WIND	100	
-	MW	WIND	1	WIND	100	
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-	MW	WIND	1	WIND	100	
-	MW	WIND	1	WIND	100	
-	MW	WIND	1	WIND	100	
4.80	MW	WIND	1	WIND	100	
4.80	MW	WIND	1	WIND	100	
4.80	MW	WIND	1	WIND	100	
4.80	MW	WIND	1	WIND	100	
4.80	MW	WIND	1	WIND	100	
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4.80	MW	WIND	1	WIND	100	
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4.80	MW	WIND	1	WIND	100	
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4.80	MW	WIND	1	WIND	100	
4.80	MW	WIND	1	WIND	100	
4.80	MW	WIND	1	WIND	100	
4.80	MW	WIND	1	WIND	100	
4.80	MW	WIND	1	WIND	100	
4.80	MW	WIND	1	WIND	100	
4.80	MW	WIND	1	WIND	100	
518,946.59	BBL	RFO	6.1	Cab12		"000MBTU'
478,190.24	BBL	RFO	6.1	Cab12		
546,549.89	BBL	RFO	6.1	Cab12		
485,427.21	BBL	RFO	6.1	Cab12		
577,468.82	BBL	RFO	6.1	Cab12		
594,171.88	BBL	RFO	6.1	Cab12		
520,909.48	BBL	RFO	6.1	Cab12		
621,878.36	BBL	RFO	6.1	Cab12		
588,230.74	BBL	RFO	6.1	Cab12		
641,742.04	BBL	RFO	6.1	Cab12		
624,932.96	BBL	RFO	6.1	Cab12		
610,854.93	BBL	RFO	6.1	Cab12		
580,735.90	BBL	RFO	6.1	Cab12		
498,283.41	BBL	RFO	6.1	Cab12		
482,042.02	BBL	RFO	6.1	Cab12		

464,779.51	BBL	RFO	6.1 Cab12
486,868.68	BBL	RFO	6.1 Cab12
387,946.90	BBL	RFO	6.1 Cab12
313,618.66	BBL	RFO	6.1 Cab12
308,433.62	BBL	RFO	6.1 Cab12
307,218.06	BBL	RFO	6.1 Cab12
-	BBL	RFO	6.1 Cab12
-	BBL	RFO	6.1 Cab12
-	BBL	RFO	6.1 Cab12
-	BBL	RFO	6.1 Cab12
-	BBL	RFO	6.1 Cab12
-	BBL	RFO	6.1 Cab12
-	BBL	RFO	6.1 Cab12
-	BBL	RFO	6.1 Cab12
-	BBL	RFO	6.1 Cab12
537,519.49	BBL	RFO	6.1 Cab12
543,528.11	BBL	RFO	6.1 Cab12
568,825.72	BBL	RFO	6.1 Cab12
494,683.22	BBL	RFO	6.1 Cab12
603,600.99	BBL	RFO	6.1 Cab12
624,444.88	BBL	RFO	6.1 Cab12
543,170.23	BBL	RFO	6.1 Cab12
663,346.81	BBL	RFO	6.1 Cab12
682,390.82	BBL	RFO	6.1 Cab12
683,180.15	BBL	RFO	6.1 Cab12
664,688.46	BBL	RFO	6.1 Cab12
653,193.40	BBL	RFO	6.1 Cab12
617,766.35	BBL	RFO	6.1 Cab12
460,039.30	BBL	RFO	6.1 Cab12
480,891.67	BBL	RFO	6.1 Cab12
501,112.68	BBL	RFO	6.1 Cab12
486,113.68	BBL	RFO	6.1 Cab12
365,881.51	BBL	RFO	6.1 Cab12
297,971.77	BBL	RFO	6.1 Cab12
291,078.68	BBL	RFO	6.1 Cab12
271,936.76	BBL	RFO	6.1 Cab12
287,187.02	BBL	RFO	6.1 Cab12
-	BBL	RFO	6.1 Cab12
-	BBL	RFO	6.1 Cab12
-	BBL	RFO	6.1 Cab12
-	BBL	RFO	6.1 Cab12
-	BBL	RFO	6.1 Cab12
-	BBL	RFO	6.1 Cab12
-	BBL	RFO	6.1 Cab12
-	BBL	RFO	6.1 Cab12
304,367.38	BBL	RFO	6.1 Cab34
304,379.54	BBL	RFO	6.1 Cab34
305,587.54	BBL	RFO	6.1 Cab34
307,339.75	BBL	RFO	6.1 Cab34
307,846.44	BBL	RFO	6.1 Cab34
311,575.21	BBL	RFO	6.1 Cab34
332,932.59	BBL	RFO	6.1 Cab34

322,459.32	BBL	RFO	6.1 Cab34
333,253.93	BBL	RFO	6.1 Cab34
331,214.14	BBL	RFO	6.1 Cab34
331,385.98	BBL	RFO	6.1 Cab34
332,675.56	BBL	RFO	6.1 Cab34
320,159.73	BBL	RFO	6.1 Cab34
289,782.91	BBL	RFO	6.1 Cab34
290,642.25	BBL	RFO	6.1 Cab34
294,943.75	BBL	RFO	6.1 Cab34
290,722.16	BBL	RFO	6.1 Cab34
263,977.59	BBL	RFO	6.1 Cab34
254,107.91	BBL	RFO	6.1 Cab34
254,101.18	BBL	RFO	6.1 Cab34
248,739.77	BBL	RFO	6.1 Cab34
238,128.66	BBL	RFO	6.1 Cab34
243,541.32	BBL	RFO	6.1 Cab34
239,155.21	BBL	RFO	6.1 Cab34
229,447.36	BBL	RFO	6.1 Cab34
230,998.32	BBL	RFO	6.1 Cab34
232,407.15	BBL	RFO	6.1 Cab34
232,290.60	BBL	RFO	6.1 Cab34
233,325.08	BBL	RFO	6.1 Cab34
231,221.18	BBL	RFO	6.1 Cab34
303,482.77	BBL	RFO	6.1 Cab34
303,500.88	BBL	RFO	6.1 Cab34
304,565.81	BBL	RFO	6.1 Cab34
305,384.06	BBL	RFO	6.1 Cab34
305,705.93	BBL	RFO	6.1 Cab34
308,310.37	BBL	RFO	6.1 Cab34
325,169.82	BBL	RFO	6.1 Cab34
316,971.46	BBL	RFO	6.1 Cab34
327,159.84	BBL	RFO	6.1 Cab34
326,387.36	BBL	RFO	6.1 Cab34
326,478.47	BBL	RFO	6.1 Cab34
325,510.11	BBL	RFO	6.1 Cab34
317,792.53	BBL	RFO	6.1 Cab34
305,330.27	BBL	RFO	6.1 Cab34
305,463.53	BBL	RFO	6.1 Cab34
306,234.87	BBL	RFO	6.1 Cab34
305,507.53	BBL	RFO	6.1 Cab34
299,978.05	BBL	RFO	6.1 Cab34
276,850.91	BBL	RFO	6.1 Cab34
275,855.85	BBL	RFO	6.1 Cab34
273,864.49	BBL	RFO	6.1 Cab34
262,500.88	BBL	RFO	6.1 Cab34
267,440.41	BBL	RFO	6.1 Cab34
262,837.71	BBL	RFO	6.1 Cab34
251,977.78	BBL	RFO	6.1 Cab34
253,578.68	BBL	RFO	6.1 Cab34
255,416.96	BBL	RFO	6.1 Cab34
254,962.24	BBL	RFO	6.1 Cab34
256,914.10	BBL	RFO	6.1 Cab34

255,534.07	BBL	RFO	6.1	Cab34	
25.16	BBL	DSL	5.78	OROTE	1
-	BBL	DSL	5.78	OROTE	1
-	BBL	DSL	5.78	OROTE	1
-

-	BBL	DSL	5.78	Ded CT 12
-	BBL	DSL	5.78	Ded CT 12
-	BBL	DSL	5.78	Ded CT 12
-	BBL	DSL	5.78	Ded CT 12
-	BBL	DSL	5.78	Ded CT 12
-	BBL	DSL	5.78	Ded CT 12
-	BBL	DSL	5.78	Ded CT 12
-	BBL	DSL	5.78	Ded CT 12
-	BBL	DSL	5.78	Ded CT 12
381.14	BBL	DSL	5.78	Ded CT 12
414.73	BBL	DSL	5.78	Ded CT 12
389.15	BBL	DSL	5.78	Ded CT 12
180.02	BBL	DSL	5.78	Ded CT 12
251.53	BBL	DSL	5.78	Ded CT 12
231.59	BBL	DSL	5.78	Ded CT 12
722.71	BBL	DSL	5.78	Ded CT 12
593.52	BBL	DSL	5.78	Ded CT 12
1,344.53	BBL	DSL	5.78	Ded CT 12
1,632.58	BBL	DSL	5.78	Ded CT 12
1,098.84	BBL	DSL	5.78	Ded CT 12
170.83	BBL	DSL	5.78	Ded CT 12
80.49	BBL	DSL	5.78	Ded CT 12
8.03	BBL	DSL	5.78	Ded CT 12
10.04	BBL	DSL	5.78	Ded CT 12
21.70	BBL	DSL	5.78	Ded CT 12
11.60	BBL	DSL	5.78	Ded CT 12
6.57	BBL	DSL	5.78	Ded CT 12
4.12	BBL	DSL	5.78	Ded CT 12
-	BBL	DSL	5.78	Ded CT 12
-	BBL	DSL	5.78	Ded CT 12
-	BBL	DSL	5.78	Ded CT 12
-	BBL	DSL	5.78	Ded CT 12
-	BBL	DSL	5.78	Ded CT 12
-	BBL	DSL	5.78	Ded CT 12
-	BBL	DSL	5.78	Ded CT 12
-	BBL	DSL	5.78	Ded CT 12
-	BBL	DSL	5.78	Ded CT 12
-	BBL	DSL	5.78	Ded CT 12
-	BBL	DSL	5.78	Ded CT 12
335.68	BBL	DSL	5.78	MACH CT 1
368.89	BBL	DSL	5.78	MACH CT 1
358.21	BBL	DSL	5.78	MACH CT 1
541.29	BBL	DSL	5.78	MACH CT 1
462.91	BBL	DSL	5.78	MACH CT 1
1,227.24	BBL	DSL	5.78	MACH CT 1
6,763.10	BBL	DSL	5.78	MACH CT 1
4,543.99	BBL	DSL	5.78	MACH CT 1
10,025.29	BBL	DSL	5.78	MACH CT 1
13,006.27	BBL	DSL	5.78	MACH CT 1
9,219.64	BBL	DSL	5.78	MACH CT 1
1,938.44	BBL	DSL	5.78	MACH CT 1
1,154.50	BBL	DSL	5.78	MACH CT 1

123.57	BBL	DSL	5.78	MACH CT	1
137.55	BBL	DSL	5.78	MACH CT	1
290.40	BBL	DSL	5.78	MACH CT	1
201.36	BBL	DSL	5.78	MACH CT	1
10.74	BBL	DSL	5.78	MACH CT	1
-	BBL	DSL	5.78	MACH CT	1
-	BBL	DSL	5.78	MACH CT	1
-	BBL	DSL	5.78	MACH CT	1
-	BBL	DSL	5.78	MACH CT	1
-	BBL	DSL	5.78	MACH CT	1
-	BBL	DSL	5.78	MACH CT	1
-	BBL	DSL	5.78	MACH CT	1
-	BBL	DSL	5.78	MACH CT	1
-	BBL	DSL	5.78	MACH CT	1
-	BBL	DSL	5.78	MACH CT	1
-	BBL	DSL	5.78	MACH CT	1
-	BBL	DSL	5.78	MACH CT	1
1,511.48	BBL	DSL	5.78	YIGO CT	1
1,655.53	BBL	DSL	5.78	YIGO CT	1
3,010.40	BBL	DSL	5.78	YIGO CT	1
15,831.37	BBL	DSL	5.78	YIGO CT	1
20,928.74	BBL	DSL	5.78	YIGO CT	1
35,302.86	BBL	DSL	5.78	YIGO CT	1
81,250.03	BBL	DSL	5.78	YIGO CT	1
58,068.81	BBL	DSL	5.78	YIGO CT	1
83,206.68	BBL	DSL	5.78	YIGO CT	1
76,916.76	BBL	DSL	5.78	YIGO CT	1
51,093.05	BBL	DSL	5.78	YIGO CT	1
5,554.89	BBL	DSL	5.78	YIGO CT	1
3,383.12	BBL	DSL	5.78	YIGO CT	1
384.50	BBL	DSL	5.78	YIGO CT	1
411.85	BBL	DSL	5.78	YIGO CT	1
823.68	BBL	DSL	5.78	YIGO CT	1
421.40	BBL	DSL	5.78	YIGO CT	1
15.38	BBL	DSL	5.78	YIGO CT	1
-	BBL	DSL	5.78	YIGO CT	1
-	BBL	DSL	5.78	YIGO CT	1
-	BBL	DSL	5.78	YIGO CT	1
-	BBL	DSL	5.78	YIGO CT	1
-	BBL	DSL	5.78	YIGO CT	1
-	BBL	DSL	5.78	YIGO CT	1
-	BBL	DSL	5.78	YIGO CT	1
-	BBL	DSL	5.78	YIGO CT	1
-	BBL	DSL	5.78	YIGO CT	1
-	BBL	DSL	5.78	YIGO CT	1
-	BBL	DSL	5.78	YIGO CT	1
-	BBL	DSL	5.78	YIGO CT	1
281.79	BBL	DSL	5.78	MARBO CT	1
311.64	BBL	DSL	5.78	MARBO CT	1
295.83	BBL	DSL	5.78	MARBO CT	1
126.05	BBL	DSL	5.78	MARBO CT	1
183.57	BBL	DSL	5.78	MARBO CT	1

151.16	BBL	DSL	5.78	MARBO CT 1
35.34	BBL	DSL	5.78	MARBO CT 1
120.24	BBL	DSL	5.78	MARBO CT 1
39.64	BBL	DSL	5.78	MARBO CT 1
32.46	BBL	DSL	5.78	MARBO CT 1
108.09	BBL	DSL	5.78	MARBO CT 1
89.41	BBL	DSL	5.78	MARBO CT 1
35.22	BBL	DSL	5.78	MARBO CT 1
0.12	BBL	DSL	5.78	MARBO CT 1
0.28	BBL	DSL	5.78	MARBO CT 1
0.85	BBL	DSL	5.78	MARBO CT 1
0.43	BBL	DSL	5.78	MARBO CT 1
0.01	BBL	DSL	5.78	MARBO CT 1
-	BBL	DSL	5.78	MARBO CT 1
-	BBL	DSL	5.78	MARBO CT 1
-	BBL	DSL	5.78	MARBO CT 1
-	BBL	DSL	5.78	MARBO CT 1
-	BBL	DSL	5.78	MARBO CT 1
-	BBL	DSL	5.78	MARBO CT 1
-	BBL	DSL	5.78	MARBO CT 1
-	BBL	DSL	5.78	MARBO CT 1
-	BBL	DSL	5.78	MARBO CT 1
-	BBL	DSL	5.78	MARBO CT 1
-	BBL	DSL	5.78	MARBO CT 1
43.17	BBL	DSL	5.78	Ded DSL 1-4
46.40	BBL	DSL	5.78	Ded DSL 1-4
43.45	BBL	DSL	5.78	Ded DSL 1-4
18.63	BBL	DSL	5.78	Ded DSL 1-4
27.02	BBL	DSL	5.78	Ded DSL 1-4
22.28	BBL	DSL	5.78	Ded DSL 1-4
5.14	BBL	DSL	5.78	Ded DSL 1-4
17.85	BBL	DSL	5.78	Ded DSL 1-4
6.12	BBL	DSL	5.78	Ded DSL 1-4
5.21	BBL	DSL	5.78	Ded DSL 1-4
16.55	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4

-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
42.83	BBL	DSL	5.78	Ded DSL 1-4
46.57	BBL	DSL	5.78	Ded DSL 1-4
43.77	BBL	DSL	5.78	Ded DSL 1-4
17.95	BBL	DSL	5.78	Ded DSL 1-4
26.89	BBL	DSL	5.78	Ded DSL 1-4
22.58	BBL	DSL	5.78	Ded DSL 1-4
4.88	BBL	DSL	5.78	Ded DSL 1-4
17.44	BBL	DSL	5.78	Ded DSL 1-4
5.68	BBL	DSL	5.78	Ded DSL 1-4
5.15	BBL	DSL	5.78	Ded DSL 1-4
16.44	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
43.18	BBL	DSL	5.78	Ded DSL 1-4
46.49	BBL	DSL	5.78	Ded DSL 1-4
43.67	BBL	DSL	5.78	Ded DSL 1-4
18.95	BBL	DSL	5.78	Ded DSL 1-4
26.92	BBL	DSL	5.78	Ded DSL 1-4
22.33	BBL	DSL	5.78	Ded DSL 1-4
5.32	BBL	DSL	5.78	Ded DSL 1-4
17.50	BBL	DSL	5.78	Ded DSL 1-4
6.04	BBL	DSL	5.78	Ded DSL 1-4
5.05	BBL	DSL	5.78	Ded DSL 1-4
15.90	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4

-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
43.22	BBL	DSL	5.78	Ded DSL 1-4
46.37	BBL	DSL	5.78	Ded DSL 1-4
43.76	BBL	DSL	5.78	Ded DSL 1-4
18.63	BBL	DSL	5.78	Ded DSL 1-4
26.64	BBL	DSL	5.78	Ded DSL 1-4
22.16	BBL	DSL	5.78	Ded DSL 1-4
5.08	BBL	DSL	5.78	Ded DSL 1-4
17.42	BBL	DSL	5.78	Ded DSL 1-4
5.81	BBL	DSL	5.78	Ded DSL 1-4
4.97	BBL	DSL	5.78	Ded DSL 1-4
16.06	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
-	BBL	DSL	5.78	Ded DSL 1-4
1,137.11	BBL	DSL	5.78	MDI DSL 12
1,249.81	BBL	DSL	5.78	MDI DSL 12
2,249.86	BBL	DSL	5.78	MDI DSL 12
10,459.11	BBL	DSL	5.78	MDI DSL 12
250.74	BBL	DSL	5.78	MDI DSL 12
829.20	BBL	DSL	5.78	MDI DSL 12
24,736.93	BBL	DSL	5.78	MDI DSL 12
21,002.60	BBL	DSL	5.78	MDI DSL 12
25,196.99	BBL	DSL	5.78	MDI DSL 12
25,161.59	BBL	DSL	5.78	MDI DSL 12
17,738.90	BBL	DSL	5.78	MDI DSL 12

2,441.64	BBL	DSL	5.78	MDI DSL 12
1,445.40	BBL	DSL	5.78	MDI DSL 12
184.07	BBL	DSL	5.78	MDI DSL 12
188.88	BBL	DSL	5.78	MDI DSL 12
359.03	BBL	DSL	5.78	MDI DSL 12
186.01	BBL	DSL	5.78	MDI DSL 12
9.27	BBL	DSL	5.78	MDI DSL 12
1.51	BBL	DSL	5.78	MDI DSL 12
-	BBL	DSL	5.78	MDI DSL 12
-	BBL	DSL	5.78	MDI DSL 12
-	BBL	DSL	5.78	MDI DSL 12
-	BBL	DSL	5.78	MDI DSL 12
-	BBL	DSL	5.78	MDI DSL 12
-	BBL	DSL	5.78	MDI DSL 12
-	BBL	DSL	5.78	MDI DSL 12
-	BBL	DSL	5.78	MDI DSL 12
-	BBL	DSL	5.78	MDI DSL 12
-	BBL	DSL	5.78	MDI DSL 12
-	BBL	DSL	5.78	MDI DSL 12
658.93	BBL	DSL	5.78	MDI DSL 12
733.16	BBL	DSL	5.78	MDI DSL 12
1,312.99	BBL	DSL	5.78	MDI DSL 12
6,664.40	BBL	DSL	5.78	MDI DSL 12
179.81	BBL	DSL	5.78	MDI DSL 12
658.53	BBL	DSL	5.78	MDI DSL 12
4,933.51	BBL	DSL	5.78	MDI DSL 12
7,624.39	BBL	DSL	5.78	MDI DSL 12
5,702.43	BBL	DSL	5.78	MDI DSL 12
5,513.68	BBL	DSL	5.78	MDI DSL 12
9,264.61	BBL	DSL	5.78	MDI DSL 12
2,074.29	BBL	DSL	5.78	MDI DSL 12
1,264.90	BBL	DSL	5.78	MDI DSL 12
155.95	BBL	DSL	5.78	MDI DSL 12
158.43	BBL	DSL	5.78	MDI DSL 12
312.18	BBL	DSL	5.78	MDI DSL 12
156.19	BBL	DSL	5.78	MDI DSL 12
8.46	BBL	DSL	5.78	MDI DSL 12
1.50	BBL	DSL	5.78	MDI DSL 12
-	BBL	DSL	5.78	MDI DSL 12
-	BBL	DSL	5.78	MDI DSL 12
-	BBL	DSL	5.78	MDI DSL 12
-	BBL	DSL	5.78	MDI DSL 12
-	BBL	DSL	5.78	MDI DSL 12
-	BBL	DSL	5.78	MDI DSL 12
-	BBL	DSL	5.78	MDI DSL 12
-	BBL	DSL	5.78	MDI DSL 12
-	BBL	DSL	5.78	MDI DSL 12
-	BBL	DSL	5.78	MDI DSL 12
-	BBL	DSL	5.78	MDI DSL 12
-	BBL	DSL	5.78	MDI DSL 12
3,939.48	BBL	DSL	5.78	TENJO 1-6
4,273.07	BBL	DSL	5.78	TENJO 1-6
7,089.58	BBL	DSL	5.78	TENJO 1-6

21,533.87	BBL	DSL	5.78	TENJO 1-6
14,961.76	BBL	DSL	5.78	TENJO 1-6
20,733.17	BBL	DSL	5.78	TENJO 1-6
34,755.23	BBL	DSL	5.78	TENJO 1-6
29,776.25	BBL	DSL	5.78	TENJO 1-6
33,516.20	BBL	DSL	5.78	TENJO 1-6
33,550.42	BBL	DSL	5.78	TENJO 1-6
25,976.76	BBL	DSL	5.78	TENJO 1-6
8,002.81	BBL	DSL	5.78	TENJO 1-6
5,249.76	BBL	DSL	5.78	TENJO 1-6
833.29	BBL	DSL	5.78	TENJO 1-6
738.77	BBL	DSL	5.78	TENJO 1-6
1,237.95	BBL	DSL	5.78	TENJO 1-6
845.81	BBL	DSL	5.78	TENJO 1-6
43.95	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
3,230.46	BBL	DSL	5.78	TENJO 1-6
3,534.29	BBL	DSL	5.78	TENJO 1-6
5,893.00	BBL	DSL	5.78	TENJO 1-6
19,628.17	BBL	DSL	5.78	TENJO 1-6
13,521.75	BBL	DSL	5.78	TENJO 1-6
18,812.07	BBL	DSL	5.78	TENJO 1-6
33,180.09	BBL	DSL	5.78	TENJO 1-6
28,474.75	BBL	DSL	5.78	TENJO 1-6
32,405.73	BBL	DSL	5.78	TENJO 1-6
32,377.64	BBL	DSL	5.78	TENJO 1-6
24,750.62	BBL	DSL	5.78	TENJO 1-6
7,008.91	BBL	DSL	5.78	TENJO 1-6
4,613.39	BBL	DSL	5.78	TENJO 1-6
729.45	BBL	DSL	5.78	TENJO 1-6
626.55	BBL	DSL	5.78	TENJO 1-6
1,085.24	BBL	DSL	5.78	TENJO 1-6
717.50	BBL	DSL	5.78	TENJO 1-6
39.84	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6

-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
2,651.80	BBL	DSL	5.78	TENJO 1-6
2,873.42	BBL	DSL	5.78	TENJO 1-6
4,881.36	BBL	DSL	5.78	TENJO 1-6
17,910.20	BBL	DSL	5.78	TENJO 1-6
12,072.67	BBL	DSL	5.78	TENJO 1-6
17,152.45	BBL	DSL	5.78	TENJO 1-6
31,812.49	BBL	DSL	5.78	TENJO 1-6
27,116.48	BBL	DSL	5.78	TENJO 1-6
31,223.81	BBL	DSL	5.78	TENJO 1-6
31,064.68	BBL	DSL	5.78	TENJO 1-6
23,097.52	BBL	DSL	5.78	TENJO 1-6
6,249.43	BBL	DSL	5.78	TENJO 1-6
3,949.59	BBL	DSL	5.78	TENJO 1-6
598.47	BBL	DSL	5.78	TENJO 1-6
548.15	BBL	DSL	5.78	TENJO 1-6
958.07	BBL	DSL	5.78	TENJO 1-6
625.30	BBL	DSL	5.78	TENJO 1-6
31.45	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
2,163.91	BBL	DSL	5.78	TENJO 1-6
2,362.59	BBL	DSL	5.78	TENJO 1-6
4,038.15	BBL	DSL	5.78	TENJO 1-6
15,868.06	BBL	DSL	5.78	TENJO 1-6
10,579.33	BBL	DSL	5.78	TENJO 1-6
15,528.78	BBL	DSL	5.78	TENJO 1-6
30,293.18	BBL	DSL	5.78	TENJO 1-6
25,706.29	BBL	DSL	5.78	TENJO 1-6
30,066.20	BBL	DSL	5.78	TENJO 1-6
29,662.92	BBL	DSL	5.78	TENJO 1-6
21,395.06	BBL	DSL	5.78	TENJO 1-6
3,761.53	BBL	DSL	5.78	TENJO 1-6
2,228.60	BBL	DSL	5.78	TENJO 1-6
292.35	BBL	DSL	5.78	TENJO 1-6
283.42	BBL	DSL	5.78	TENJO 1-6
556.75	BBL	DSL	5.78	TENJO 1-6
292.90	BBL	DSL	5.78	TENJO 1-6

11.56	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
1,745.43	BBL	DSL	5.78	TENJO 1-6
1,881.62	BBL	DSL	5.78	TENJO 1-6
3,316.74	BBL	DSL	5.78	TENJO 1-6
13,139.79	BBL	DSL	5.78	TENJO 1-6
9,127.98	BBL	DSL	5.78	TENJO 1-6
14,008.45	BBL	DSL	5.78	TENJO 1-6
28,308.90	BBL	DSL	5.78	TENJO 1-6
24,167.42	BBL	DSL	5.78	TENJO 1-6
28,742.23	BBL	DSL	5.78	TENJO 1-6
28,350.65	BBL	DSL	5.78	TENJO 1-6
20,104.45	BBL	DSL	5.78	TENJO 1-6
3,193.46	BBL	DSL	5.78	TENJO 1-6
1,902.62	BBL	DSL	5.78	TENJO 1-6
252.47	BBL	DSL	5.78	TENJO 1-6
240.71	BBL	DSL	5.78	TENJO 1-6
464.30	BBL	DSL	5.78	TENJO 1-6
250.21	BBL	DSL	5.78	TENJO 1-6
11.16	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
1,384.94	BBL	DSL	5.78	TENJO 1-6
1,516.41	BBL	DSL	5.78	TENJO 1-6
2,694.06	BBL	DSL	5.78	TENJO 1-6
11,517.75	BBL	DSL	5.78	TENJO 1-6
7,777.85	BBL	DSL	5.78	TENJO 1-6
12,508.53	BBL	DSL	5.78	TENJO 1-6
26,566.87	BBL	DSL	5.78	TENJO 1-6
22,599.59	BBL	DSL	5.78	TENJO 1-6
27,345.36	BBL	DSL	5.78	TENJO 1-6

26,895.54	BBL	DSL	5.78	TENJO 1-6
18,834.56	BBL	DSL	5.78	TENJO 1-6
2,733.31	BBL	DSL	5.78	TENJO 1-6
1,628.75	BBL	DSL	5.78	TENJO 1-6
212.78	BBL	DSL	5.78	TENJO 1-6
204.82	BBL	DSL	5.78	TENJO 1-6
397.80	BBL	DSL	5.78	TENJO 1-6
213.53	BBL	DSL	5.78	TENJO 1-6
10.60	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
-	BBL	DSL	5.78	TENJO 1-6
5,548.72	BBL	DSL	5.78	Tal DSL 12
5,849.03	BBL	DSL	5.78	Tal DSL 12
9,395.55	BBL	DSL	5.78	Tal DSL 12
23,186.15	BBL	DSL	5.78	Tal DSL 12
17,288.52	BBL	DSL	5.78	Tal DSL 12
22,993.18	BBL	DSL	5.78	Tal DSL 12
32,576.81	BBL	DSL	5.78	Tal DSL 12
29,568.06	BBL	DSL	5.78	Tal DSL 12
32,043.54	BBL	DSL	5.78	Tal DSL 12
32,358.69	BBL	DSL	5.78	Tal DSL 12
26,533.25	BBL	DSL	5.78	Tal DSL 12
9,333.15	BBL	DSL	5.78	Tal DSL 12
6,483.81	BBL	DSL	5.78	Tal DSL 12
1,090.01	BBL	DSL	5.78	Tal DSL 12
927.88	BBL	DSL	5.78	Tal DSL 12
1,548.20	BBL	DSL	5.78	Tal DSL 12
1,082.53	BBL	DSL	5.78	Tal DSL 12
52.98	BBL	DSL	5.78	Tal DSL 12
-	BBL	DSL	5.78	Tal DSL 12
-	BBL	DSL	5.78	Tal DSL 12
-	BBL	DSL	5.78	Tal DSL 12
-	BBL	DSL	5.78	Tal DSL 12
-	BBL	DSL	5.78	Tal DSL 12
-	BBL	DSL	5.78	Tal DSL 12
-	BBL	DSL	5.78	Tal DSL 12
-	BBL	DSL	5.78	Tal DSL 12
-	BBL	DSL	5.78	Tal DSL 12
-	BBL	DSL	5.78	Tal DSL 12
-	BBL	DSL	5.78	Tal DSL 12
-	BBL	DSL	5.78	Tal DSL 12
4,645.55	BBL	DSL	5.78	Tal DSL 12

4,942.94	BBL	DSL	5.78	Tal DSL 12
6,902.51	BBL	DSL	5.78	Tal DSL 12
8,373.17	BBL	DSL	5.78	Tal DSL 12
9,178.95	BBL	DSL	5.78	Tal DSL 12
9,998.81	BBL	DSL	5.78	Tal DSL 12
2,595.31	BBL	DSL	5.78	Tal DSL 12
5,582.71	BBL	DSL	5.78	Tal DSL 12
3,031.87	BBL	DSL	5.78	Tal DSL 12
2,701.09	BBL	DSL	5.78	Tal DSL 12
8,203.23	BBL	DSL	5.78	Tal DSL 12
8,527.37	BBL	DSL	5.78	Tal DSL 12
5,746.20	BBL	DSL	5.78	Tal DSL 12
931.22	BBL	DSL	5.78	Tal DSL 12
813.26	BBL	DSL	5.78	Tal DSL 12
1,366.94	BBL	DSL	5.78	Tal DSL 12
934.94	BBL	DSL	5.78	Tal DSL 12
47.68	BBL	DSL	5.78	Tal DSL 12
-	BBL	DSL	5.78	Tal DSL 12
-	BBL	DSL	5.78	Tal DSL 12
-	BBL	DSL	5.78	Tal DSL 12
-	BBL	DSL	5.78	Tal DSL 12
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-	BBL	DSL	5.78	Tal DSL 12
-	BBL	DSL	5.78	Tal DSL 12
-	BBL	DSL	5.78	Tal DSL 12
-	BBL	DSL	5.78	Tal DSL 12
42,424.44	BBL	RFO	6.1	Tango 12
46,852.78	BBL	RFO	6.1	Tango 12
63,502.96	BBL	RFO	6.1	Tango 12
125,348.46	BBL	RFO	6.1	Tango 12
101,316.72	BBL	RFO	6.1	Tango 12
116,173.87	BBL	RFO	6.1	Tango 12
160,879.72	BBL	RFO	6.1	Tango 12
144,418.53	BBL	RFO	6.1	Tango 12
159,294.38	BBL	RFO	6.1	Tango 12
156,676.17	BBL	RFO	6.1	Tango 12
133,527.25	BBL	RFO	6.1	Tango 12
78,873.12	BBL	RFO	6.1	Tango 12
56,892.05	BBL	RFO	6.1	Tango 12
16,457.83	BBL	RFO	6.1	Tango 12
13,681.88	BBL	RFO	6.1	Tango 12
20,158.80	BBL	RFO	6.1	Tango 12
16,249.16	BBL	RFO	6.1	Tango 12
1,281.55	BBL	RFO	6.1	Tango 12
10.27	BBL	RFO	6.1	Tango 12
4.20	BBL	RFO	6.1	Tango 12
8.31	BBL	RFO	6.1	Tango 12
20.84	BBL	RFO	6.1	Tango 12
20.21	BBL	RFO	6.1	Tango 12

-	BBL	RFO	6.1 Tango 12
-	BBL	RFO	6.1 Tango 12
-	BBL	RFO	6.1 Tango 12
-	BBL	RFO	6.1 Tango 12
-	BBL	RFO	6.1 Tango 12
-	BBL	RFO	6.1 Tango 12
-	BBL	RFO	6.1 Tango 12
61,383.02	BBL	RFO	6.1 Tango 12
64,937.52	BBL	RFO	6.1 Tango 12
83,969.93	BBL	RFO	6.1 Tango 12
138,769.19	BBL	RFO	6.1 Tango 12
115,453.61	BBL	RFO	6.1 Tango 12
130,602.72	BBL	RFO	6.1 Tango 12
168,869.97	BBL	RFO	6.1 Tango 12
155,297.01	BBL	RFO	6.1 Tango 12
167,960.21	BBL	RFO	6.1 Tango 12
164,992.60	BBL	RFO	6.1 Tango 12
144,644.29	BBL	RFO	6.1 Tango 12
91,481.83	BBL	RFO	6.1 Tango 12
68,835.57	BBL	RFO	6.1 Tango 12
26,078.95	BBL	RFO	6.1 Tango 12
18,840.70	BBL	RFO	6.1 Tango 12
26,605.48	BBL	RFO	6.1 Tango 12
22,163.36	BBL	RFO	6.1 Tango 12
2,117.83	BBL	RFO	6.1 Tango 12
24.33	BBL	RFO	6.1 Tango 12
10.82	BBL	RFO	6.1 Tango 12
32.09	BBL	RFO	6.1 Tango 12
22.43	BBL	RFO	6.1 Tango 12
20.98	BBL	RFO	6.1 Tango 12
22.14	BBL	RFO	6.1 Tango 12
-	BBL	RFO	6.1 Tango 12
-	BBL	RFO	6.1 Tango 12
-	BBL	RFO	6.1 Tango 12
-	BBL	RFO	6.1 Tango 12
-	BBL	RFO	6.1 Tango 12
-	BBL	RFO	6.1 Tango 12
458,117.36	BBL	RFO	6.1 MEC 89
458,822.00	BBL	RFO	6.1 MEC 89
464,650.04	BBL	RFO	6.1 MEC 89
453,581.94	BBL	RFO	6.1 MEC 89
466,387.48	BBL	RFO	6.1 MEC 89
466,642.35	BBL	RFO	6.1 MEC 89
463,526.35	BBL	RFO	6.1 MEC 89
466,748.57	BBL	RFO	6.1 MEC 89
466,760.33	BBL	RFO	6.1 MEC 89
466,761.41	BBL	RFO	6.1 MEC 89
467,312.69	BBL	RFO	6.1 MEC 89
463,363.74	BBL	RFO	6.1 MEC 89
453,445.10	BBL	RFO	6.1 MEC 89
400,527.66	BBL	RFO	6.1 MEC 89
399,784.72	BBL	RFO	6.1 MEC 89

409,618.46	BBL	RFO	6.1	MEC 89
398,911.45	BBL	RFO	6.1	MEC 89
314,237.88	BBL	RFO	6.1	MEC 89
216,774.00	BBL	RFO	6.1	MEC 89
213,869.79	BBL	RFO	6.1	MEC 89
206,824.27	BBL	RFO	6.1	MEC 89
170,508.03	BBL	RFO	6.1	MEC 89
183,587.01	BBL	RFO	6.1	MEC 89
172,945.76	BBL	RFO	6.1	MEC 89
146,162.59	BBL	RFO	6.1	MEC 89
150,061.85	BBL	RFO	6.1	MEC 89
152,534.35	BBL	RFO	6.1	MEC 89
153,380.30	BBL	RFO	6.1	MEC 89
157,566.46	BBL	RFO	6.1	MEC 89
154,426.01	BBL	RFO	6.1	MEC 89
448,335.72	BBL	RFO	6.1	MEC 89
450,087.13	BBL	RFO	6.1	MEC 89
458,541.52	BBL	RFO	6.1	MEC 89
444,228.28	BBL	RFO	6.1	MEC 89
465,093.53	BBL	RFO	6.1	MEC 89
466,300.67	BBL	RFO	6.1	MEC 89
456,858.31	BBL	RFO	6.1	MEC 89
466,699.46	BBL	RFO	6.1	MEC 89
466,732.52	BBL	RFO	6.1	MEC 89
466,715.19	BBL	RFO	6.1	MEC 89
466,328.65	BBL	RFO	6.1	MEC 89
461,615.89	BBL	RFO	6.1	MEC 89
453,499.46	BBL	RFO	6.1	MEC 89
387,038.21	BBL	RFO	6.1	MEC 89
385,147.36	BBL	RFO	6.1	MEC 89
396,606.97	BBL	RFO	6.1	MEC 89
384,599.73	BBL	RFO	6.1	MEC 89
289,843.95	BBL	RFO	6.1	MEC 89
203,830.97	BBL	RFO	6.1	MEC 89
204,558.23	BBL	RFO	6.1	MEC 89
195,307.52	BBL	RFO	6.1	MEC 89
162,976.86	BBL	RFO	6.1	MEC 89
176,223.70	BBL	RFO	6.1	MEC 89
163,242.09	BBL	RFO	6.1	MEC 89
142,123.45	BBL	RFO	6.1	MEC 89
145,267.95	BBL	RFO	6.1	MEC 89
149,574.14	BBL	RFO	6.1	MEC 89
149,317.51	BBL	RFO	6.1	MEC 89
151,039.29	BBL	RFO	6.1	MEC 89
150,170.32	BBL	RFO	6.1	MEC 89
32,150.09	BBL	DSL	5.78	TEMES CT 7
34,841.72	BBL	DSL	5.78	TEMES CT 7
51,609.51	BBL	DSL	5.78	TEMES CT 7
120,924.49	BBL	DSL	5.78	TEMES CT 7
89,266.45	BBL	DSL	5.78	TEMES CT 7
109,977.39	BBL	DSL	5.78	TEMES CT 7
157,353.59	BBL	DSL	5.78	TEMES CT 7

137,481.90	BBL	DSL	5.78	TEMES CT 7
151,636.31	BBL	DSL	5.78	TEMES CT 7
150,598.01	BBL	DSL	5.78	TEMES CT 7
98,137.19	BBL	DSL	5.78	TEMES CT 7
-	BBL	DSL	5.78	TEMES CT 7
-	BBL	DSL	5.78	TEMES CT 7
-

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#N/A	#N/A	#N/A	#N/A	#N/A

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#N/A	#N/A	#N/A	#N/A	#N/A

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#N/A	#N/A	#N/A	#N/A	#N/A

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#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A

-	BBL	RFO	6.1	RECIP	83
-	BBL	RFO	6.1	RECIP	83
-	BBL	RFO	6.1	RECIP	83
-	BBL	RFO	6.1	RECIP	83
-	BBL	RFO	6.1	RECIP	83
-	BBL	RFO	6.1	RECIP	83
-	BBL	RFO	6.1	RECIP	83
-	BBL	RFO	6.1	RECIP	83
-	BBL	RFO	6.1	RECIP	83
-	BBL	RFO	6.1	RECIP	83
-	BBL	RFO	6.1	RECIP	83
20,520.80	BBL	RFO	6.1	RECIP	83
118,010.63	BBL	RFO	6.1	RECIP	83
-	BBL	RFO	6.1	RECIP	84
-	BBL	RFO	6.1	RECIP	84
-	BBL	RFO	6.1	RECIP	84

-	MCF	LNG	1	CLNG	85
-	MCF	LNG	1	CLNG	85
-	MCF	LNG	1	CLNG	85
-	MCF	LNG	1	CLNG	85
-	MCF	LNG	1	CLNG	85
-	MCF	LNG	1	CLNG	85
-	MCF	LNG	1	CLNG	85
-	MCF	LNG	1	CLNG	85
-	MCF	LNG	1	CLNG	85
-	MCF	LNG	1	CLNG	85
-	MCF	LNG	1	CLNG	85
-	MCF	LNG	1	CLNG	85
-	MCF	LNG	1	CLNG	85
-	MCF	LNG	1	CLNG	85
672,926.51	MCF	LNG	1	CLNG	85
3,378,426.27	MCF	LNG	1	CLNG	85
3,420,531.74	MCF	LNG	1	CLNG	85
3,452,494.14	MCF	LNG	1	CLNG	85
3,444,877.93	MCF	LNG	1	CLNG	85
3,475,710.21	MCF	LNG	1	CLNG	85
3,424,519.78	MCF	LNG	1	CLNG	85
-	BBL	RFO	6.1	RECIP	86
-	BBL	RFO	6.1	RECIP	86
-	BBL	RFO	6.1	RECIP	86

-	BBL	RFO	6.1	RECIP	87
-	BBL	RFO	6.1	RECIP	87
-	BBL	RFO	6.1	RECIP	87
-	BBL	RFO	6.1	RECIP	87
-	BBL	RFO	6.1	RECIP	87
-	BBL	RFO	6.1	RECIP	87
-	BBL	RFO	6.1	RECIP	87
-	BBL	RFO	6.1	RECIP	87
-	BBL	RFO	6.1	RECIP	87
-	BBL	RFO	6.1	RECIP	87
-	BBL	RFO	6.1	RECIP	87
-	BBL	RFO	6.1	RECIP	87
-	BBL	RFO	6.1	RECIP	87
-	BBL	RFO	6.1	RECIP	87
-	BBL	RFO	6.1	RECIP	87
-	BBL	RFO	6.1	RECIP	87
-	BBL	RFO	6.1	RECIP	87
-	BBL	RFO	6.1	RECIP	87
-	BBL	RFO	6.1	RECIP	87
-	BBL	RFO	6.1	RECIP	87
20,128.19	BBL	RFO	6.1	RECIP	87
128,512.66	BBL	RFO	6.1	RECIP	87
117,654.95	BBL	RFO	6.1	RECIP	87
113,389.29	BBL	RFO	6.1	RECIP	87
113,746.05	BBL	RFO	6.1	RECIP	87
114,452.49	BBL	RFO	6.1	RECIP	87
113,214.41	BBL	RFO	6.1	RECIP	87
113,225.49	BBL	RFO	6.1	RECIP	87
112,788.69	BBL	RFO	6.1	RECIP	87
-	MCF	LNG	1	CLNG	88
-	MCF	LNG	1	CLNG	88
-	MCF	LNG	1	CLNG	88
-	MCF	LNG	1	CLNG	88
-	MCF	LNG	1	CLNG	88
-	MCF	LNG	1	CLNG	88
-	MCF	LNG	1	CLNG	88
-	MCF	LNG	1	CLNG	88
-	MCF	LNG	1	CLNG	88
-	MCF	LNG	1	CLNG	88
-	MCF	LNG	1	CLNG	88
-	MCF	LNG	1	CLNG	88
-	MCF	LNG	1	CLNG	88
-	MCF	LNG	1	CLNG	88
-	MCF	LNG	1	CLNG	88
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-	MCF	LNG	1	CLNG	88
-	MCF	LNG	1	CLNG	88
-	MCF	LNG	1	CLNG	88
-	MCF	LNG	1	CLNG	88
-	MCF	LNG	1	CLNG	88
702,658.26	MCF	LNG	1	CLNG	88
3,503,140.87	MCF	LNG	1	CLNG	88
3,588,721.19	MCF	LNG	1	CLNG	88

3,500,370.61	MCF	LNG	1	CLNG	88
3,251,275.15	MCF	LNG	1	CLNG	88
3,295,521.48	MCF	LNG	1	CLNG	88
3,340,346.92	MCF	LNG	1	CLNG	88
3,323,124.02	MCF	LNG	1	CLNG	88
3,368,174.80	MCF	LNG	1	CLNG	88
3,301,166.75	MCF	LNG	1	CLNG	88
-	BBL	RFO	6.1	RECIP	89
-	BBL	RFO	6.1	RECIP	89
-	BBL	RFO	6.1	RECIP	89
-	BBL	RFO	6.1	RECIP	89
-	BBL	RFO	6.1	RECIP	89
-	BBL	RFO	6.1	RECIP	89
-	BBL	RFO	6.1	RECIP	89
-	BBL	RFO	6.1	RECIP	89
-	BBL	RFO	6.1	RECIP	89
-	BBL	RFO	6.1	RECIP	89
-	BBL	RFO	6.1	RECIP	89
-	BBL	RFO	6.1	RECIP	89
-	BBL	RFO	6.1	RECIP	89
-	BBL	RFO	6.1	RECIP	89
-	BBL	RFO	6.1	RECIP	89
-	BBL	RFO	6.1	RECIP	89
-	BBL	RFO	6.1	RECIP	89
-	BBL	RFO	6.1	RECIP	89
-	BBL	RFO	6.1	RECIP	89
-	BBL	RFO	6.1	RECIP	89
21,406.83	BBL	RFO	6.1	RECIP	89
122,924.64	BBL	RFO	6.1	RECIP	89
117,941.36	BBL	RFO	6.1	RECIP	89
113,831.42	BBL	RFO	6.1	RECIP	89
112,821.16	BBL	RFO	6.1	RECIP	89
112,885.70	BBL	RFO	6.1	RECIP	89
113,350.71	BBL	RFO	6.1	RECIP	89
112,758.82	BBL	RFO	6.1	RECIP	89
112,774.37	BBL	RFO	6.1	RECIP	89
112,695.98	BBL	RFO	6.1	RECIP	89
-	BBL	RFO	6.1	RECIP	90
-	BBL	RFO	6.1	RECIP	90
-	BBL	RFO	6.1	RECIP	90
-	BBL	RFO	6.1	RECIP	90
-	BBL	RFO	6.1	RECIP	90
-	BBL	RFO	6.1	RECIP	90
-	BBL	RFO	6.1	RECIP	90
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-	BBL	RFO	6.1	RECIP	90
-	BBL	RFO	6.1	RECIP	90
-	BBL	RFO	6.1	RECIP	90
-	BBL	RFO	6.1	RECIP	90
-	BBL	RFO	6.1	RECIP	90
-	BBL	RFO	6.1	RECIP	90
-	BBL	RFO	6.1	RECIP	90

-	BBL	RFO	6.1	RECIP	90
-	BBL	RFO	6.1	RECIP	90
-	BBL	RFO	6.1	RECIP	90
27,442.79	BBL	RFO	6.1	RECIP	90
142,867.25	BBL	RFO	6.1	RECIP	90
138,351.36	BBL	RFO	6.1	RECIP	90
114,770.47	BBL	RFO	6.1	RECIP	90
113,109.61	BBL	RFO	6.1	RECIP	90
112,679.93	BBL	RFO	6.1	RECIP	90
112,710.71	BBL	RFO	6.1	RECIP	90
112,694.46	BBL	RFO	6.1	RECIP	90
113,035.77	BBL	RFO	6.1	RECIP	90
112,676.13	BBL	RFO	6.1	RECIP	90
112,674.39	BBL	RFO	6.1	RECIP	90
112,679.83	BBL	RFO	6.1	RECIP	90
-	MCF	LNG	1	CLNG	91
-	MCF	LNG	1	CLNG	91
-	MCF	LNG	1	CLNG	91
-	MCF	LNG	1	CLNG	91
-	MCF	LNG	1	CLNG	91
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-	MCF	LNG	1	CLNG	91
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-	MCF	LNG	1	CLNG	91
-	MCF	LNG	1	CLNG	91
-	MCF	LNG	1	CLNG	91
-	MCF	LNG	1	CLNG	91
-	MCF	LNG	1	CLNG	91
725,273.86	MCF	LNG	1	CLNG	91
3,625,791.02	MCF	LNG	1	CLNG	91
3,611,911.13	MCF	LNG	1	CLNG	91
3,582,329.59	MCF	LNG	1	CLNG	91
3,382,561.28	MCF	LNG	1	CLNG	91
3,464,680.18	MCF	LNG	1	CLNG	91
3,412,372.07	MCF	LNG	1	CLNG	91
3,128,410.40	MCF	LNG	1	CLNG	91
3,173,035.89	MCF	LNG	1	CLNG	91
3,202,798.10	MCF	LNG	1	CLNG	91
3,198,501.71	MCF	LNG	1	CLNG	91
3,234,467.53	MCF	LNG	1	CLNG	91
3,188,633.30	MCF	LNG	1	CLNG	91
-	BBL	RFO	6.1	RECIP	92
-	BBL	RFO	6.1	RECIP	92
-	BBL	RFO	6.1	RECIP	92
-	BBL	RFO	6.1	RECIP	92
-	BBL	RFO	6.1	RECIP	92
-	BBL	RFO	6.1	RECIP	92
-	BBL	RFO	6.1	RECIP	92

-	BBL	RFO	6.1	RECIP	92
-	BBL	RFO	6.1	RECIP	92
-	BBL	RFO	6.1	RECIP	92
-	BBL	RFO	6.1	RECIP	92
-	BBL	RFO	6.1	RECIP	92
-	BBL	RFO	6.1	RECIP	92
-	BBL	RFO	6.1	RECIP	92
-	BBL	RFO	6.1	RECIP	92
-	BBL	RFO	6.1	RECIP	92
-	BBL	RFO	6.1	RECIP	92
31,614.35	BBL	RFO	6.1	RECIP	92
130,578.55	BBL	RFO	6.1	RECIP	92
120,729.58	BBL	RFO	6.1	RECIP	92
118,388.44	BBL	RFO	6.1	RECIP	92
113,111.22	BBL	RFO	6.1	RECIP	92
113,005.95	BBL	RFO	6.1	RECIP	92
112,671.42	BBL	RFO	6.1	RECIP	92
112,719.83	BBL	RFO	6.1	RECIP	92
112,702.03	BBL	RFO	6.1	RECIP	92
113,036.06	BBL	RFO	6.1	RECIP	92
112,677.75	BBL	RFO	6.1	RECIP	92
112,672.84	BBL	RFO	6.1	RECIP	92
112,676.90	BBL	RFO	6.1	RECIP	92
-	MCF	LNG	1	CLNG	93
-	MCF	LNG	1	CLNG	93
-	MCF	LNG	1	CLNG	93
-	MCF	LNG	1	CLNG	93
-	MCF	LNG	1	CLNG	93
-	MCF	LNG	1	CLNG	93
-	MCF	LNG	1	CLNG	93
-	MCF	LNG	1	CLNG	93
-	MCF	LNG	1	CLNG	93
-	MCF	LNG	1	CLNG	93
-	MCF	LNG	1	CLNG	93
-	MCF	LNG	1	CLNG	93
-	MCF	LNG	1	CLNG	93
-	MCF	LNG	1	CLNG	93
-	MCF	LNG	1	CLNG	93
-	MCF	LNG	1	CLNG	93
-	MCF	LNG	1	CLNG	93
-	MCF	LNG	1	CLNG	93
731,083.25	MCF	LNG	1	CLNG	93
3,709,902.83	MCF	LNG	1	CLNG	93
3,521,241.70	MCF	LNG	1	CLNG	93
3,506,036.62	MCF	LNG	1	CLNG	93
3,486,047.61	MCF	LNG	1	CLNG	93
3,247,062.50	MCF	LNG	1	CLNG	93
3,345,170.17	MCF	LNG	1	CLNG	93
3,275,283.45	MCF	LNG	1	CLNG	93
3,007,973.88	MCF	LNG	1	CLNG	93
3,049,914.31	MCF	LNG	1	CLNG	93
3,084,518.55	MCF	LNG	1	CLNG	93
3,085,949.71	MCF	LNG	1	CLNG	93
3,121,497.31	MCF	LNG	1	CLNG	93

3,074,854.00	MCF	LNG	1	CLNG	93
-	WIND	WIND	1	WIND	94
-	WIND	WIND	1	WIND	94
-	WIND	WIND	1	WIND	94
-	WIND	WIND	1	WIND	94
-	WIND	WIND	1	WIND	94
-	WIND	WIND	1	WIND	94
-	WIND	WIND	1	WIND	94
-	WIND	WIND	1	WIND	94
-	WIND	WIND	1	WIND	94
-	WIND	WIND	1	WIND	94
-	WIND	WIND	1	WIND	94
-	WIND	WIND	1	WIND	94
-	WIND	WIND	1	WIND	94
24,399.36	WIND	WIND	1	WIND	94
103,311.36	WIND	WIND	1	WIND	94
103,023.36	WIND	WIND	1	WIND	94
103,023.36	WIND	WIND	1	WIND	94
103,023.25	WIND	WIND	1	WIND	94
103,121.47	WIND	WIND	1	WIND	94
102,685.07	WIND	WIND	1	WIND	94
102,745.71	WIND	WIND	1	WIND	94
100,965.42	WIND	WIND	1	WIND	94
102,764.34	WIND	WIND	1	WIND	94
101,643.89	WIND	WIND	1	WIND	94
95,237.91	WIND	WIND	1	WIND	94
97,319.23	WIND	WIND	1	WIND	94
98,618.21	WIND	WIND	1	WIND	94
97,765.43	WIND	WIND	1	WIND	94
99,488.33	WIND	WIND	1	WIND	94
97,034.00	WIND	WIND	1	WIND	94
-	WIND	WIND	1	WIND	95
-	WIND	WIND	1	WIND	95
-	WIND	WIND	1	WIND	95
-	WIND	WIND	1	WIND	95
-	WIND	WIND	1	WIND	95
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-	WIND	WIND	1	WIND	95
-	WIND	WIND	1	WIND	95
-	WIND	WIND	1	WIND	95
-	WIND	WIND	1	WIND	95
-	WIND	WIND	1	WIND	95
-	WIND	WIND	1	WIND	95
24,399.36	WIND	WIND	1	WIND	95
103,023.36	WIND	WIND	1	WIND	95
103,311.36	WIND	WIND	1	WIND	95
103,022.69	WIND	WIND	1	WIND	95
103,001.86	WIND	WIND	1	WIND	95
102,979.62	WIND	WIND	1	WIND	95
101,224.33	WIND	WIND	1	WIND	95
100,956.86	WIND	WIND	1	WIND	95
100,669.04	WIND	WIND	1	WIND	95

96,233.01	WIND	WIND	1	WIND	95
99,774.78	WIND	WIND	1	WIND	95
97,402.04	WIND	WIND	1	WIND	95
88,110.68	WIND	WIND	1	WIND	95
90,834.00	WIND	WIND	1	WIND	95
92,503.13	WIND	WIND	1	WIND	95
91,873.73	WIND	WIND	1	WIND	95
93,897.41	WIND	WIND	1	WIND	95
90,607.80	WIND	WIND	1	WIND	95
-	MCF	LNG	1	CLNG	96
-	MCF	LNG	1	CLNG	96
-	MCF	LNG	1	CLNG	96
-	MCF	LNG	1	CLNG	96
-	MCF	LNG	1	CLNG	96
-	MCF	LNG	1	CLNG	96
-	MCF	LNG	1	CLNG	96
-	MCF	LNG	1	CLNG	96
-	MCF	LNG	1	CLNG	96
-	MCF	LNG	1	CLNG	96
-	MCF	LNG	1	CLNG	96
-	MCF	LNG	1	CLNG	96
744,559.20	MCF	LNG	1	CLNG	96
3,789,278.32	MCF	LNG	1	CLNG	96
3,786,360.60	MCF	LNG	1	CLNG	96
3,784,996.58	MCF	LNG	1	CLNG	96
3,773,514.16	MCF	LNG	1	CLNG	96
3,644,254.39	MCF	LNG	1	CLNG	96
3,391,943.12	MCF	LNG	1	CLNG	96
3,381,808.35	MCF	LNG	1	CLNG	96
3,365,698.97	MCF	LNG	1	CLNG	96
3,127,602.54	MCF	LNG	1	CLNG	96
3,216,039.31	MCF	LNG	1	CLNG	96
3,137,404.79	MCF	LNG	1	CLNG	96
2,915,579.59	MCF	LNG	1	CLNG	96
2,951,966.31	MCF	LNG	1	CLNG	96
2,980,881.35	MCF	LNG	1	CLNG	96
2,983,340.09	MCF	LNG	1	CLNG	96
3,008,270.75	MCF	LNG	1	CLNG	96
2,978,773.44	MCF	LNG	1	CLNG	96
-	WIND	WIND	1	WIND	97
-	WIND	WIND	1	WIND	97
-	WIND	WIND	1	WIND	97
-	WIND	WIND	1	WIND	97
-	WIND	WIND	1	WIND	97
-	WIND	WIND	1	WIND	97
-	WIND	WIND	1	WIND	97
-	WIND	WIND	1	WIND	97
-	WIND	WIND	1	WIND	97
-	WIND	WIND	1	WIND	97
-	WIND	WIND	1	WIND	97
24,399.36	WIND	WIND	1	WIND	97
103,023.36	WIND	WIND	1	WIND	97

103,008.93	WIND	WIND	1	WIND	97
103,222.39	WIND	WIND	1	WIND	97
102,974.59	WIND	WIND	1	WIND	97
102,878.03	WIND	WIND	1	WIND	97
102,242.65	WIND	WIND	1	WIND	97
97,728.77	WIND	WIND	1	WIND	97
97,128.80	WIND	WIND	1	WIND	97
97,085.94	WIND	WIND	1	WIND	97
90,678.64	WIND	WIND	1	WIND	97
95,194.36	WIND	WIND	1	WIND	97
92,078.61	WIND	WIND	1	WIND	97
80,974.43	WIND	WIND	1	WIND	97
84,174.32	WIND	WIND	1	WIND	97
86,064.94	WIND	WIND	1	WIND	97
85,445.49	WIND	WIND	1	WIND	97
87,927.93	WIND	WIND	1	WIND	97
83,793.36	WIND	WIND	1	WIND	97
-	WIND	WIND	1	WIND	98
-	WIND	WIND	1	WIND	98
-	WIND	WIND	1	WIND	98
-	WIND	WIND	1	WIND	98
-	WIND	WIND	1	WIND	98
-	WIND	WIND	1	WIND	98
-	WIND	WIND	1	WIND	98
-	WIND	WIND	1	WIND	98
-	WIND	WIND	1	WIND	98
-	WIND	WIND	1	WIND	98
24,399.36	WIND	WIND	1	WIND	98
103,023.36	WIND	WIND	1	WIND	98
103,005.55	WIND	WIND	1	WIND	98
102,766.43	WIND	WIND	1	WIND	98
102,740.68	WIND	WIND	1	WIND	98
102,630.44	WIND	WIND	1	WIND	98
102,416.22	WIND	WIND	1	WIND	98
100,436.20	WIND	WIND	1	WIND	98
92,832.21	WIND	WIND	1	WIND	98
92,590.36	WIND	WIND	1	WIND	98
91,814.39	WIND	WIND	1	WIND	98
83,946.84	WIND	WIND	1	WIND	98
89,502.30	WIND	WIND	1	WIND	98
85,759.09	WIND	WIND	1	WIND	98
73,137.86	WIND	WIND	1	WIND	98
76,742.13	WIND	WIND	1	WIND	98
78,985.27	WIND	WIND	1	WIND	98
78,672.33	WIND	WIND	1	WIND	98
81,423.19	WIND	WIND	1	WIND	98
76,879.43	WIND	WIND	1	WIND	98
-	BBL	DSL	5.78	RETR	99
-	BBL	DSL	5.78	RETR	99
-	BBL	DSL	5.78	RETR	99
-	BBL	DSL	5.78	RETR	99
-	BBL	DSL	5.78	RETR	99

-	BBL	DSL	5.78	RETR	99
-	BBL	DSL	5.78	RETR	99
-	BBL	DSL	5.78	RETR	99
-	BBL	DSL	5.78	RETR	99
-	BBL	DSL	5.78	RETR	99
81,038.14	BBL	DSL	5.78	RETR	99
327,647.64	BBL	DSL	5.78	RETR	99
266,418.58	BBL	DSL	5.78	RETR	99
129,180.37	BBL	DSL	5.78	RETR	99
102,627.33	BBL	DSL	5.78	RETR	99
130,759.85	BBL	DSL	5.78	RETR	99
118,269.69	BBL	DSL	5.78	RETR	99
20,195.38	BBL	DSL	5.78	RETR	99
420.63	BBL	DSL	5.78	RETR	99
111.04	BBL	DSL	5.78	RETR	99
441.30	BBL	DSL	5.78	RETR	99
11.11	BBL	DSL	5.78	RETR	99
2,479.08	BBL	DSL	5.78	RETR	99
412.97	BBL	DSL	5.78	RETR	99
138.92	BBL	DSL	5.78	RETR	99
113.98	BBL	DSL	5.78	RETR	99
142.59	BBL	DSL	5.78	RETR	99
54.96	BBL	DSL	5.78	RETR	99
49.58	BBL	DSL	5.78	RETR	99
53.39	BBL	DSL	5.78	RETR	99
-	WIND	WIND	1	WIND	100
-	WIND	WIND	1	WIND	100
-	WIND	WIND	1	WIND	100
-	WIND	WIND	1	WIND	100
-	WIND	WIND	1	WIND	100
-	WIND	WIND	1	WIND	100
-	WIND	WIND	1	WIND	100
-	WIND	WIND	1	WIND	100
-	WIND	WIND	1	WIND	100
24,399.36	WIND	WIND	1	WIND	100
103,311.36	WIND	WIND	1	WIND	100
103,023.36	WIND	WIND	1	WIND	100
102,917.32	WIND	WIND	1	WIND	100
102,033.09	WIND	WIND	1	WIND	100
101,645.34	WIND	WIND	1	WIND	100
101,800.00	WIND	WIND	1	WIND	100
101,396.89	WIND	WIND	1	WIND	100
97,583.68	WIND	WIND	1	WIND	100
86,905.20	WIND	WIND	1	WIND	100
86,727.59	WIND	WIND	1	WIND	100
86,153.01	WIND	WIND	1	WIND	100
77,108.20	WIND	WIND	1	WIND	100
83,140.96	WIND	WIND	1	WIND	100
79,186.93	WIND	WIND	1	WIND	100
65,493.52	WIND	WIND	1	WIND	100
69,395.81	WIND	WIND	1	WIND	100
71,858.31	WIND	WIND	1	WIND	100

71,629.88	WIND	WIND	1	WIND	100
74,598.17	WIND	WIND	1	WIND	100
69,853.39	WIND	WIND	1	WIND	100
24,800.69	$000	RFO	6.1	Cab12	
25,578.03	$000	RFO	6.1	Cab12	
31,808.62	$000	RFO	6.1	Cab12	
31,218.39	$000	RFO	6.1	Cab12	
40,825.22	$000	RFO	6.1	Cab12	
42,092.11	$000	RFO	6.1	Cab12	
36,960.48	$000	RFO	6.1	Cab12	
44,172.91	$000	RFO	6.1	Cab12	
41,807.29	$000	RFO	6.1	Cab12	
45,612.68	$000	RFO	6.1	Cab12	
45,615.68	$000	RFO	6.1	Cab12	
45,792.84	$000	RFO	6.1	Cab12	
44,713.57	$000	RFO	6.1	Cab12	
39,405.77	$000	RFO	6.1	Cab12	
39,157.21	$000	RFO	6.1	Cab12	
39,226.76	$000	RFO	6.1	Cab12	
42,687.25	$000	RFO	6.1	Cab12	
35,330.73	$000	RFO	6.1	Cab12	
29,663.36	$000	RFO	6.1	Cab12	
30,294.42	$000	RFO	6.1	Cab12	
31,394.32	$000	RFO	6.1	Cab12	
-	$000	RFO	6.1	Cab12	
-	$000	RFO	6.1	Cab12	
-	$000	RFO	6.1	Cab12	
-	$000	RFO	6.1	Cab12	
-	$000	RFO	6.1	Cab12	
-	$000	RFO	6.1	Cab12	
-	$000	RFO	6.1	Cab12	
-	$000	RFO	6.1	Cab12	
-	$000	RFO	6.1	Cab12	
25,688.30	$000	RFO	6.1	Cab12	
29,072.89	$000	RFO	6.1	Cab12	
33,105.05	$000	RFO	6.1	Cab12	
31,813.65	$000	RFO	6.1	Cab12	
42,672.68	$000	RFO	6.1	Cab12	
44,236.70	$000	RFO	6.1	Cab12	
38,539.96	$000	RFO	6.1	Cab12	
47,118.47	$000	RFO	6.1	Cab12	
48,499.52	$000	RFO	6.1	Cab12	
48,557.95	$000	RFO	6.1	Cab12	
48,517.55	$000	RFO	6.1	Cab12	
48,966.76	$000	RFO	6.1	Cab12	
47,564.71	$000	RFO	6.1	Cab12	
36,381.30	$000	RFO	6.1	Cab12	
39,063.77	$000	RFO	6.1	Cab12	
42,293.23	$000	RFO	6.1	Cab12	
42,621.07	$000	RFO	6.1	Cab12	
33,321.21	$000	RFO	6.1	Cab12	
28,183.41	$000	RFO	6.1	Cab12	

28,589.81	$000	RFO	6.1 Cab12
27,788.96	$000	RFO	6.1 Cab12
30,527.74	$000	RFO	6.1 Cab12
-	$000	RFO	6.1 Cab12
-	$000	RFO	6.1 Cab12
-	$000	RFO	6.1 Cab12
-	$000	RFO	6.1 Cab12
-	$000	RFO	6.1 Cab12
-	$000	RFO	6.1 Cab12
-	$000	RFO	6.1 Cab12
-	$000	RFO	6.1 Cab12
14,545.86	$000	RFO	6.1 Cab34
16,281.03	$000	RFO	6.1 Cab34
17,784.87	$000	RFO	6.1 Cab34
19,765.38	$000	RFO	6.1 Cab34
21,763.77	$000	RFO	6.1 Cab34
22,072.50	$000	RFO	6.1 Cab34
23,622.82	$000	RFO	6.1 Cab34
22,904.74	$000	RFO	6.1 Cab34
23,685.34	$000	RFO	6.1 Cab34
23,541.50	$000	RFO	6.1 Cab34
24,188.83	$000	RFO	6.1 Cab34
24,939.08	$000	RFO	6.1 Cab34
24,650.59	$000	RFO	6.1 Cab34
22,916.91	$000	RFO	6.1 Cab34
23,609.44	$000	RFO	6.1 Cab34
24,892.85	$000	RFO	6.1 Cab34
25,489.69	$000	RFO	6.1 Cab34
24,040.72	$000	RFO	6.1 Cab34
24,034.58	$000	RFO	6.1 Cab34
24,957.88	$000	RFO	6.1 Cab34
25,418.48	$000	RFO	6.1 Cab34
25,312.88	$000	RFO	6.1 Cab34
26,924.76	$000	RFO	6.1 Cab34
27,493.72	$000	RFO	6.1 Cab34
27,424.46	$000	RFO	6.1 Cab34
28,575.78	$000	RFO	6.1 Cab34
29,757.14	$000	RFO	6.1 Cab34
30,748.78	$000	RFO	6.1 Cab34
31,896.77	$000	RFO	6.1 Cab34
32,611.10	$000	RFO	6.1 Cab34
14,503.58	$000	RFO	6.1 Cab34
16,234.03	$000	RFO	6.1 Cab34
17,725.40	$000	RFO	6.1 Cab34
19,639.60	$000	RFO	6.1 Cab34
21,612.44	$000	RFO	6.1 Cab34
21,841.21	$000	RFO	6.1 Cab34
23,072.02	$000	RFO	6.1 Cab34
22,514.93	$000	RFO	6.1 Cab34
23,252.21	$000	RFO	6.1 Cab34
23,198.43	$000	RFO	6.1 Cab34
23,830.62	$000	RFO	6.1 Cab34

24,401.92	$000	RFO	6.1	Cab34		
24,468.33	$000	RFO	6.1	Cab34		
24,146.44	$000	RFO	6.1	Cab34		
24,813.40	$000	RFO	6.1	Cab34		
25,845.81	$000	RFO	6.1	Cab34		
26,786.03	$000	RFO	6.1	Cab34		
27,319.31	$000	RFO	6.1	Cab34		
26,185.71	$000	RFO	6.1	Cab34		
27,094.62	$000	RFO	6.1	Cab34		
27,985.95	$000	RFO	6.1	Cab34		
27,903.63	$000	RFO	6.1	Cab34		
29,566.92	$000	RFO	6.1	Cab34		
30,216.31	$000	RFO	6.1	Cab34		
30,117.38	$000	RFO	6.1	Cab34		
31,369.09	$000	RFO	6.1	Cab34		
32,703.29	$000	RFO	6.1	Cab34		
33,749.88	$000	RFO	6.1	Cab34		
35,121.52	$000	RFO	6.1	Cab34		
36,040.15	$000	RFO	6.1	Cab34		
1.96	$000	DSL	5.78	OROTE	1	
-	$000	DSL	5.78	OROTE	1	
-	$000	DSL	5.78	OROTE	1	
-

21.82	$000	DSL	5.78	Ded CT 12
29.81	$000	DSL	5.78	Ded CT 12
33.51	$000	DSL	5.78	Ded CT 12
173.48	$000	DSL	5.78	Ded CT 12
130.29	$000	DSL	5.78	Ded CT 12
292.69	$000	DSL	5.78	Ded CT 12
354.70	$000	DSL	5.78	Ded CT 12
246.76	$000	DSL	5.78	Ded CT 12
38.53	$000	DSL	5.78	Ded CT 12
20.39	$000	DSL	5.78	Ded CT 12
2.34	$000	DSL	5.78	Ded CT 12
3.38	$000	DSL	5.78	Ded CT 12
4.88	$000	DSL	5.78	Ded CT 12
2.81	$000	DSL	5.78	Ded CT 12
-	$000	DSL	5.78	Ded CT 12
-	$000	DSL	5.78	Ded CT 12
-	$000	DSL	5.78	Ded CT 12
-	$000	DSL	5.78	Ded CT 12
-	$000	DSL	5.78	Ded CT 12
-	$000	DSL	5.78	Ded CT 12
-	$000	DSL	5.78	Ded CT 12
-	$000	DSL	5.78	Ded CT 12
-	$000	DSL	5.78	Ded CT 12
-	$000	DSL	5.78	Ded CT 12
-	$000	DSL	5.78	Ded CT 12
-	$000	DSL	5.78	Ded CT 12
-	$000	DSL	5.78	Ded CT 12
29.71	$000	DSL	5.78	Ded CT 12
35.64	$000	DSL	5.78	Ded CT 12
35.96	$000	DSL	5.78	Ded CT 12
18.18	$000	DSL	5.78	Ded CT 12
27.65	$000	DSL	5.78	Ded CT 12
25.51	$000	DSL	5.78	Ded CT 12
79.72	$000	DSL	5.78	Ded CT 12
65.54	$000	DSL	5.78	Ded CT 12
148.55	$000	DSL	5.78	Ded CT 12
180.38	$000	DSL	5.78	Ded CT 12
124.56	$000	DSL	5.78	Ded CT 12
19.87	$000	DSL	5.78	Ded CT 12
9.61	$000	DSL	5.78	Ded CT 12
0.98	$000	DSL	5.78	Ded CT 12
1.26	$000	DSL	5.78	Ded CT 12
2.83	$000	DSL	5.78	Ded CT 12
1.57	$000	DSL	5.78	Ded CT 12
0.92	$000	DSL	5.78	Ded CT 12
0.60	$000	DSL	5.78	Ded CT 12
-	$000	DSL	5.78	Ded CT 12
-	$000	DSL	5.78	Ded CT 12
-	$000	DSL	5.78	Ded CT 12
-	$000	DSL	5.78	Ded CT 12
-	$000	DSL	5.78	Ded CT 12
-	$000	DSL	5.78	Ded CT 12

-	$000	DSL	5.78	Ded CT 12
-	$000	DSL	5.78	Ded CT 12
-	$000	DSL	5.78	Ded CT 12
-	$000	DSL	5.78	Ded CT 12
-	$000	DSL	5.78	Ded CT 12
26.17	$000	DSL	5.78	MACH CT 1
31.70	$000	DSL	5.78	MACH CT 1
33.10	$000	DSL	5.78	MACH CT 1
54.66	$000	DSL	5.78	MACH CT 1
50.89	$000	DSL	5.78	MACH CT 1
135.17	$000	DSL	5.78	MACH CT 1
746.04	$000	DSL	5.78	MACH CT 1
501.77	$000	DSL	5.78	MACH CT 1
1,107.65	$000	DSL	5.78	MACH CT 1
1,437.06	$000	DSL	5.78	MACH CT 1
1,045.10	$000	DSL	5.78	MACH CT 1
225.45	$000	DSL	5.78	MACH CT 1
137.78	$000	DSL	5.78	MACH CT 1
15.13	$000	DSL	5.78	MACH CT 1
17.29	$000	DSL	5.78	MACH CT 1
37.87	$000	DSL	5.78	MACH CT 1
27.25	$000	DSL	5.78	MACH CT 1
1.51	$000	DSL	5.78	MACH CT 1
-	$000	DSL	5.78	MACH CT 1
-	$000	DSL	5.78	MACH CT 1
-	$000	DSL	5.78	MACH CT 1
-	$000	DSL	5.78	MACH CT 1
-	$000	DSL	5.78	MACH CT 1
-	$000	DSL	5.78	MACH CT 1
-	$000	DSL	5.78	MACH CT 1
-	$000	DSL	5.78	MACH CT 1
-	$000	DSL	5.78	MACH CT 1
-	$000	DSL	5.78	MACH CT 1
-	$000	DSL	5.78	MACH CT 1
-	$000	DSL	5.78	MACH CT 1
117.82	$000	DSL	5.78	YIGO CT 1
142.28	$000	DSL	5.78	YIGO CT 1
278.17	$000	DSL	5.78	YIGO CT 1
1,598.60	$000	DSL	5.78	YIGO CT 1
2,300.68	$000	DSL	5.78	YIGO CT 1
3,888.41	$000	DSL	5.78	YIGO CT 1
8,962.74	$000	DSL	5.78	YIGO CT 1
6,412.27	$000	DSL	5.78	YIGO CT 1
9,193.18	$000	DSL	5.78	YIGO CT 1
8,498.50	$000	DSL	5.78	YIGO CT 1
5,791.68	$000	DSL	5.78	YIGO CT 1
646.06	$000	DSL	5.78	YIGO CT 1
403.74	$000	DSL	5.78	YIGO CT 1
47.09	$000	DSL	5.78	YIGO CT 1
51.76	$000	DSL	5.78	YIGO CT 1
107.42	$000	DSL	5.78	YIGO CT 1
57.02	$000	DSL	5.78	YIGO CT 1

2.16	$000	DSL	5.78	YIGO CT	1
-	$000	DSL	5.78	YIGO CT	1
-	$000	DSL	5.78	YIGO CT	1
-	$000	DSL	5.78	YIGO CT	1
-	$000	DSL	5.78	YIGO CT	1
-	$000	DSL	5.78	YIGO CT	1
-	$000	DSL	5.78	YIGO CT	1
-	$000	DSL	5.78	YIGO CT	1
-	$000	DSL	5.78	YIGO CT	1
-	$000	DSL	5.78	YIGO CT	1
-	$000	DSL	5.78	YIGO CT	1
-	$000	DSL	5.78	YIGO CT	1
-	$000	DSL	5.78	YIGO CT	1
21.97	$000	DSL	5.78	MARBO CT	1
26.78	$000	DSL	5.78	MARBO CT	1
27.34	$000	DSL	5.78	MARBO CT	1
12.73	$000	DSL	5.78	MARBO CT	1
20.18	$000	DSL	5.78	MARBO CT	1
16.65	$000	DSL	5.78	MARBO CT	1
3.90	$000	DSL	5.78	MARBO CT	1
13.28	$000	DSL	5.78	MARBO CT	1
4.38	$000	DSL	5.78	MARBO CT	1
3.59	$000	DSL	5.78	MARBO CT	1
12.25	$000	DSL	5.78	MARBO CT	1
10.40	$000	DSL	5.78	MARBO CT	1
4.20	$000	DSL	5.78	MARBO CT	1
0.01	$000	DSL	5.78	MARBO CT	1
0.03	$000	DSL	5.78	MARBO CT	1
0.11	$000	DSL	5.78	MARBO CT	1
0.06	$000	DSL	5.78	MARBO CT	1
0.00	$000	DSL	5.78	MARBO CT	1
-	$000	DSL	5.78	MARBO CT	1
-	$000	DSL	5.78	MARBO CT	1
-	$000	DSL	5.78	MARBO CT	1
-	$000	DSL	5.78	MARBO CT	1
-	$000	DSL	5.78	MARBO CT	1
-	$000	DSL	5.78	MARBO CT	1
-	$000	DSL	5.78	MARBO CT	1
-	$000	DSL	5.78	MARBO CT	1
-	$000	DSL	5.78	MARBO CT	1
-	$000	DSL	5.78	MARBO CT	1
-	$000	DSL	5.78	MARBO CT	1
-	$000	DSL	5.78	MARBO CT	1
3.37	$000	DSL	5.78	Ded DSL	1-4
3.99	$000	DSL	5.78	Ded DSL	1-4
4.01	$000	DSL	5.78	Ded DSL	1-4
1.88	$000	DSL	5.78	Ded DSL	1-4
2.97	$000	DSL	5.78	Ded DSL	1-4
2.45	$000	DSL	5.78	Ded DSL	1-4
0.57	$000	DSL	5.78	Ded DSL	1-4
1.97	$000	DSL	5.78	Ded DSL	1-4
0.68	$000	DSL	5.78	Ded DSL	1-4

0.58	$000	DSL	5.78	Ded DSL 1-4
1.88	$000	DSL	5.78	Ded DSL 1-4
-	$000	DSL	5.78	Ded DSL 1-4
-	$000	DSL	5.78	Ded DSL 1-4
-	$000	DSL	5.78	Ded DSL 1-4
-	$000	DSL	5.78	Ded DSL 1-4
-	$000	DSL	5.78	Ded DSL 1-4
-	$000	DSL	5.78	Ded DSL 1-4
-	$000	DSL	5.78	Ded DSL 1-4
-	$000	DSL	5.78	Ded DSL 1-4
-	$000	DSL	5.78	Ded DSL 1-4
-	$000	DSL	5.78	Ded DSL 1-4
-	$000	DSL	5.78	Ded DSL 1-4
-	$000	DSL	5.78	Ded DSL 1-4
-	$000	DSL	5.78	Ded DSL 1-4
-	$000	DSL	5.78	Ded DSL 1-4
-	$000	DSL	5.78	Ded DSL 1-4
-	$000	DSL	5.78	Ded DSL 1-4
-	$000	DSL	5.78	Ded DSL 1-4
-	$000	DSL	5.78	Ded DSL 1-4
-	$000	DSL	5.78	Ded DSL 1-4
-	$000	DSL	5.78	Ded DSL 1-4
-	$000	DSL	5.78	Ded DSL 1-4
-	$000	DSL	5.78	Ded DSL 1-4
-	$000	DSL	5.78	Ded DSL 1-4
3.34	$000	DSL	5.78	Ded DSL 1-4
4.00	$000	DSL	5.78	Ded DSL 1-4
4.04	$000	DSL	5.78	Ded DSL 1-4
1.81	$000	DSL	5.78	Ded DSL 1-4
2.96	$000	DSL	5.78	Ded DSL 1-4
2.49	$000	DSL	5.78	Ded DSL 1-4
0.54	$000	DSL	5.78	Ded DSL 1-4
1.93	$000	DSL	5.78	Ded DSL 1-4
0.63	$000	DSL	5.78	Ded DSL 1-4
0.57	$000	DSL	5.78	Ded DSL 1-4
1.86	$000	DSL	5.78	Ded DSL 1-4
-	$000	DSL	5.78	Ded DSL 1-4
-	$000	DSL	5.78	Ded DSL 1-4
-	$000	DSL	5.78	Ded DSL 1-4
-	$000	DSL	5.78	Ded DSL 1-4
-	$000	DSL	5.78	Ded DSL 1-4
-	$000	DSL	5.78	Ded DSL 1-4
-	$000	DSL	5.78	Ded DSL 1-4
-	$000	DSL	5.78	Ded DSL 1-4
-	$000	DSL	5.78	Ded DSL 1-4
-	$000	DSL	5.78	Ded DSL 1-4
-	$000	DSL	5.78	Ded DSL 1-4
-	$000	DSL	5.78	Ded DSL 1-4
-	$000	DSL	5.78	Ded DSL 1-4
-	$000	DSL	5.78	Ded DSL 1-4
-	$000	DSL	5.78	Ded DSL 1-4
-	$000	DSL	5.78	Ded DSL 1-4
-	$000	DSL	5.78	Ded DSL 1-4
-	$000	DSL	5.78	Ded DSL 1-4
-	$000	DSL	5.78	Ded DSL 1-4
-	$000	DSL	5.78	Ded DSL 1-4
-	$000	DSL	5.78	Ded DSL 1-4
-	$000	DSL	5.78	Ded DSL 1-4
-	$000	DSL	5.78	Ded DSL 1-4
3.37	$000	DSL	5.78	Ded DSL 1-4

4.00	$000	DSL	5.78 Ded DSL 1-4
4.03	$000	DSL	5.78 Ded DSL 1-4
1.91	$000	DSL	5.78 Ded DSL 1-4
2.96	$000	DSL	5.78 Ded DSL 1-4
2.46	$000	DSL	5.78 Ded DSL 1-4
0.59	$000	DSL	5.78 Ded DSL 1-4
1.93	$000	DSL	5.78 Ded DSL 1-4
0.67	$000	DSL	5.78 Ded DSL 1-4
0.56	$000	DSL	5.78 Ded DSL 1-4
1.80	$000	DSL	5.78 Ded DSL 1-4
-	$000	DSL	5.78 Ded DSL 1-4
-	$000	DSL	5.78 Ded DSL 1-4
-	$000	DSL	5.78 Ded DSL 1-4
-	$000	DSL	5.78 Ded DSL 1-4
-	$000	DSL	5.78 Ded DSL 1-4
-	$000	DSL	5.78 Ded DSL 1-4
-	$000	DSL	5.78 Ded DSL 1-4
-	$000	DSL	5.78 Ded DSL 1-4
-	$000	DSL	5.78 Ded DSL 1-4
-	$000	DSL	5.78 Ded DSL 1-4
-	$000	DSL	5.78 Ded DSL 1-4
-	$000	DSL	5.78 Ded DSL 1-4
-	$000	DSL	5.78 Ded DSL 1-4
-	$000	DSL	5.78 Ded DSL 1-4
-	$000	DSL	5.78 Ded DSL 1-4
-	$000	DSL	5.78 Ded DSL 1-4
-	$000	DSL	5.78 Ded DSL 1-4
-	$000	DSL	5.78 Ded DSL 1-4
-	$000	DSL	5.78 Ded DSL 1-4
-	$000	DSL	5.78 Ded DSL 1-4
3.37	$000	DSL	5.78 Ded DSL 1-4
3.99	$000	DSL	5.78 Ded DSL 1-4
4.04	$000	DSL	5.78 Ded DSL 1-4
1.88	$000	DSL	5.78 Ded DSL 1-4
2.93	$000	DSL	5.78 Ded DSL 1-4
2.44	$000	DSL	5.78 Ded DSL 1-4
0.56	$000	DSL	5.78 Ded DSL 1-4
1.92	$000	DSL	5.78 Ded DSL 1-4
0.64	$000	DSL	5.78 Ded DSL 1-4
0.55	$000	DSL	5.78 Ded DSL 1-4
1.82	$000	DSL	5.78 Ded DSL 1-4
-	$000	DSL	5.78 Ded DSL 1-4
-	$000	DSL	5.78 Ded DSL 1-4
-	$000	DSL	5.78 Ded DSL 1-4
-	$000	DSL	5.78 Ded DSL 1-4
-	$000	DSL	5.78 Ded DSL 1-4
-	$000	DSL	5.78 Ded DSL 1-4
-	$000	DSL	5.78 Ded DSL 1-4
-	$000	DSL	5.78 Ded DSL 1-4
-	$000	DSL	5.78 Ded DSL 1-4
-	$000	DSL	5.78 Ded DSL 1-4
-	$000	DSL	5.78 Ded DSL 1-4

-	$000	DSL	5.78	Ded DSL 1-4
-	$000	DSL	5.78	Ded DSL 1-4
-	$000	DSL	5.78	Ded DSL 1-4
-	$000	DSL	5.78	Ded DSL 1-4
-	$000	DSL	5.78	Ded DSL 1-4
-	$000	DSL	5.78	Ded DSL 1-4
-	$000	DSL	5.78	Ded DSL 1-4
88.64	$000	DSL	5.78	MDI DSL 12
107.41	$000	DSL	5.78	MDI DSL 12
207.90	$000	DSL	5.78	MDI DSL 12
1,056.13	$000	DSL	5.78	MDI DSL 12
27.56	$000	DSL	5.78	MDI DSL 12
91.33	$000	DSL	5.78	MDI DSL 12
2,728.75	$000	DSL	5.78	MDI DSL 12
2,319.22	$000	DSL	5.78	MDI DSL 12
2,783.92	$000	DSL	5.78	MDI DSL 12
2,780.09	$000	DSL	5.78	MDI DSL 12
2,010.80	$000	DSL	5.78	MDI DSL 12
283.97	$000	DSL	5.78	MDI DSL 12
172.49	$000	DSL	5.78	MDI DSL 12
22.54	$000	DSL	5.78	MDI DSL 12
23.74	$000	DSL	5.78	MDI DSL 12
46.82	$000	DSL	5.78	MDI DSL 12
25.17	$000	DSL	5.78	MDI DSL 12
1.30	$000	DSL	5.78	MDI DSL 12
0.22	$000	DSL	5.78	MDI DSL 12
-	$000	DSL	5.78	MDI DSL 12
-	$000	DSL	5.78	MDI DSL 12
-	$000	DSL	5.78	MDI DSL 12
-	$000	DSL	5.78	MDI DSL 12
-	$000	DSL	5.78	MDI DSL 12
-	$000	DSL	5.78	MDI DSL 12
-	$000	DSL	5.78	MDI DSL 12
-	$000	DSL	5.78	MDI DSL 12
-	$000	DSL	5.78	MDI DSL 12
-	$000	DSL	5.78	MDI DSL 12
-	$000	DSL	5.78	MDI DSL 12
51.36	$000	DSL	5.78	MDI DSL 12
63.01	$000	DSL	5.78	MDI DSL 12
121.33	$000	DSL	5.78	MDI DSL 12
672.95	$000	DSL	5.78	MDI DSL 12
19.77	$000	DSL	5.78	MDI DSL 12
72.53	$000	DSL	5.78	MDI DSL 12
544.22	$000	DSL	5.78	MDI DSL 12
841.93	$000	DSL	5.78	MDI DSL 12
630.04	$000	DSL	5.78	MDI DSL 12
609.20	$000	DSL	5.78	MDI DSL 12
1,050.19	$000	DSL	5.78	MDI DSL 12
241.25	$000	DSL	5.78	MDI DSL 12
150.95	$000	DSL	5.78	MDI DSL 12
19.10	$000	DSL	5.78	MDI DSL 12
19.91	$000	DSL	5.78	MDI DSL 12

40.71	$000	DSL	5.78	MDI DSL 12
21.13	$000	DSL	5.78	MDI DSL 12
1.19	$000	DSL	5.78	MDI DSL 12
0.22	$000	DSL	5.78	MDI DSL 12
-	$000	DSL	5.78	MDI DSL 12
-	$000	DSL	5.78	MDI DSL 12
-	$000	DSL	5.78	MDI DSL 12
-	$000	DSL	5.78	MDI DSL 12
-	$000	DSL	5.78	MDI DSL 12
-	$000	DSL	5.78	MDI DSL 12
-	$000	DSL	5.78	MDI DSL 12
-	$000	DSL	5.78	MDI DSL 12
-	$000	DSL	5.78	MDI DSL 12
-	$000	DSL	5.78	MDI DSL 12
-	$000	DSL	5.78	MDI DSL 12
307.08	$000	DSL	5.78	TENJO 1-6
367.24	$000	DSL	5.78	TENJO 1-6
655.11	$000	DSL	5.78	TENJO 1-6
2,174.42	$000	DSL	5.78	TENJO 1-6
1,644.73	$000	DSL	5.78	TENJO 1-6
2,283.64	$000	DSL	5.78	TENJO 1-6
3,833.87	$000	DSL	5.78	TENJO 1-6
3,288.06	$000	DSL	5.78	TENJO 1-6
3,703.07	$000	DSL	5.78	TENJO 1-6
3,706.97	$000	DSL	5.78	TENJO 1-6
2,944.61	$000	DSL	5.78	TENJO 1-6
930.76	$000	DSL	5.78	TENJO 1-6
626.50	$000	DSL	5.78	TENJO 1-6
102.05	$000	DSL	5.78	TENJO 1-6
92.85	$000	DSL	5.78	TENJO 1-6
161.44	$000	DSL	5.78	TENJO 1-6
114.45	$000	DSL	5.78	TENJO 1-6
6.17	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
251.81	$000	DSL	5.78	TENJO 1-6
303.75	$000	DSL	5.78	TENJO 1-6
544.54	$000	DSL	5.78	TENJO 1-6
1,981.99	$000	DSL	5.78	TENJO 1-6
1,486.43	$000	DSL	5.78	TENJO 1-6
2,072.04	$000	DSL	5.78	TENJO 1-6
3,660.12	$000	DSL	5.78	TENJO 1-6

3,144.34	$000	DSL	5.78	TENJO 1-6
3,580.38	$000	DSL	5.78	TENJO 1-6
3,577.39	$000	DSL	5.78	TENJO 1-6
2,805.62	$000	DSL	5.78	TENJO 1-6
815.17	$000	DSL	5.78	TENJO 1-6
550.56	$000	DSL	5.78	TENJO 1-6
89.33	$000	DSL	5.78	TENJO 1-6
78.74	$000	DSL	5.78	TENJO 1-6
141.53	$000	DSL	5.78	TENJO 1-6
97.09	$000	DSL	5.78	TENJO 1-6
5.59	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
206.71	$000	DSL	5.78	TENJO 1-6
246.95	$000	DSL	5.78	TENJO 1-6
451.06	$000	DSL	5.78	TENJO 1-6
1,808.51	$000	DSL	5.78	TENJO 1-6
1,327.14	$000	DSL	5.78	TENJO 1-6
1,889.24	$000	DSL	5.78	TENJO 1-6
3,509.26	$000	DSL	5.78	TENJO 1-6
2,994.35	$000	DSL	5.78	TENJO 1-6
3,449.79	$000	DSL	5.78	TENJO 1-6
3,432.33	$000	DSL	5.78	TENJO 1-6
2,618.23	$000	DSL	5.78	TENJO 1-6
726.84	$000	DSL	5.78	TENJO 1-6
471.34	$000	DSL	5.78	TENJO 1-6
73.29	$000	DSL	5.78	TENJO 1-6
68.89	$000	DSL	5.78	TENJO 1-6
124.94	$000	DSL	5.78	TENJO 1-6
84.61	$000	DSL	5.78	TENJO 1-6
4.42	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6

-	$000	DSL	5.78	TENJO 1-6
168.67	$000	DSL	5.78	TENJO 1-6
203.05	$000	DSL	5.78	TENJO 1-6
373.14	$000	DSL	5.78	TENJO 1-6
1,602.30	$000	DSL	5.78	TENJO 1-6
1,162.98	$000	DSL	5.78	TENJO 1-6
1,710.41	$000	DSL	5.78	TENJO 1-6
3,341.66	$000	DSL	5.78	TENJO 1-6
2,838.63	$000	DSL	5.78	TENJO 1-6
3,321.90	$000	DSL	5.78	TENJO 1-6
3,277.44	$000	DSL	5.78	TENJO 1-6
2,425.25	$000	DSL	5.78	TENJO 1-6
437.48	$000	DSL	5.78	TENJO 1-6
265.96	$000	DSL	5.78	TENJO 1-6
35.80	$000	DSL	5.78	TENJO 1-6
35.62	$000	DSL	5.78	TENJO 1-6
72.61	$000	DSL	5.78	TENJO 1-6
39.63	$000	DSL	5.78	TENJO 1-6
1.62	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
136.05	$000	DSL	5.78	TENJO 1-6
161.71	$000	DSL	5.78	TENJO 1-6
306.48	$000	DSL	5.78	TENJO 1-6
1,326.81	$000	DSL	5.78	TENJO 1-6
1,003.43	$000	DSL	5.78	TENJO 1-6
1,542.95	$000	DSL	5.78	TENJO 1-6
3,122.77	$000	DSL	5.78	TENJO 1-6
2,668.70	$000	DSL	5.78	TENJO 1-6
3,175.61	$000	DSL	5.78	TENJO 1-6
3,132.45	$000	DSL	5.78	TENJO 1-6
2,278.95	$000	DSL	5.78	TENJO 1-6
371.41	$000	DSL	5.78	TENJO 1-6
227.06	$000	DSL	5.78	TENJO 1-6
30.92	$000	DSL	5.78	TENJO 1-6
30.25	$000	DSL	5.78	TENJO 1-6
60.55	$000	DSL	5.78	TENJO 1-6
33.86	$000	DSL	5.78	TENJO 1-6
1.57	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6

-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
107.95	$000	DSL	5.78	TENJO 1-6
130.33	$000	DSL	5.78	TENJO 1-6
248.94	$000	DSL	5.78	TENJO 1-6
1,163.02	$000	DSL	5.78	TENJO 1-6
855.01	$000	DSL	5.78	TENJO 1-6
1,377.74	$000	DSL	5.78	TENJO 1-6
2,930.61	$000	DSL	5.78	TENJO 1-6
2,495.57	$000	DSL	5.78	TENJO 1-6
3,021.28	$000	DSL	5.78	TENJO 1-6
2,971.68	$000	DSL	5.78	TENJO 1-6
2,135.00	$000	DSL	5.78	TENJO 1-6
317.90	$000	DSL	5.78	TENJO 1-6
194.37	$000	DSL	5.78	TENJO 1-6
26.06	$000	DSL	5.78	TENJO 1-6
25.74	$000	DSL	5.78	TENJO 1-6
51.88	$000	DSL	5.78	TENJO 1-6
28.89	$000	DSL	5.78	TENJO 1-6
1.49	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
-	$000	DSL	5.78	TENJO 1-6
432.52	$000	DSL	5.78	Tal DSL 12
502.69	$000	DSL	5.78	Tal DSL 12
868.19	$000	DSL	5.78	Tal DSL 12
2,341.26	$000	DSL	5.78	Tal DSL 12
1,900.51	$000	DSL	5.78	Tal DSL 12
2,532.57	$000	DSL	5.78	Tal DSL 12
3,593.57	$000	DSL	5.78	Tal DSL 12
3,265.07	$000	DSL	5.78	Tal DSL 12
3,540.36	$000	DSL	5.78	Tal DSL 12
3,575.30	$000	DSL	5.78	Tal DSL 12
3,007.69	$000	DSL	5.78	Tal DSL 12
1,085.49	$000	DSL	5.78	Tal DSL 12
773.77	$000	DSL	5.78	Tal DSL 12

133.48	$000	DSL	5.78	Tal DSL 12
116.61	$000	DSL	5.78	Tal DSL 12
201.90	$000	DSL	5.78	Tal DSL 12
146.48	$000	DSL	5.78	Tal DSL 12
7.44	$000	DSL	5.78	Tal DSL 12
-	$000	DSL	5.78	Tal DSL 12
-	$000	DSL	5.78	Tal DSL 12
-	$000	DSL	5.78	Tal DSL 12
-	$000	DSL	5.78	Tal DSL 12
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-	$000	DSL	5.78	Tal DSL 12
-	$000	DSL	5.78	Tal DSL 12
-	$000	DSL	5.78	Tal DSL 12
-	$000	DSL	5.78	Tal DSL 12
-	$000	DSL	5.78	Tal DSL 12
-	$000	DSL	5.78	Tal DSL 12
362.12	$000	DSL	5.78	Tal DSL 12
424.81	$000	DSL	5.78	Tal DSL 12
637.82	$000	DSL	5.78	Tal DSL 12
845.50	$000	DSL	5.78	Tal DSL 12
1,009.03	$000	DSL	5.78	Tal DSL 12
1,101.31	$000	DSL	5.78	Tal DSL 12
286.29	$000	DSL	5.78	Tal DSL 12
616.47	$000	DSL	5.78	Tal DSL 12
334.98	$000	DSL	5.78	Tal DSL 12
298.44	$000	DSL	5.78	Tal DSL 12
929.88	$000	DSL	5.78	Tal DSL 12
991.77	$000	DSL	5.78	Tal DSL 12
685.75	$000	DSL	5.78	Tal DSL 12
114.04	$000	DSL	5.78	Tal DSL 12
102.21	$000	DSL	5.78	Tal DSL 12
178.26	$000	DSL	5.78	Tal DSL 12
126.51	$000	DSL	5.78	Tal DSL 12
6.69	$000	DSL	5.78	Tal DSL 12
-	$000	DSL	5.78	Tal DSL 12
-	$000	DSL	5.78	Tal DSL 12
-	$000	DSL	5.78	Tal DSL 12
-	$000	DSL	5.78	Tal DSL 12
-	$000	DSL	5.78	Tal DSL 12
-	$000	DSL	5.78	Tal DSL 12
-	$000	DSL	5.78	Tal DSL 12
-	$000	DSL	5.78	Tal DSL 12
-	$000	DSL	5.78	Tal DSL 12
-	$000	DSL	5.78	Tal DSL 12
-	$000	DSL	5.78	Tal DSL 12
-	$000	DSL	5.78	Tal DSL 12
1,967.36	$000	RFO	6.1	Tango 12
2,439.72	$000	RFO	6.1	Tango 12
3,605.81	$000	RFO	6.1	Tango 12
7,883.66	$000	RFO	6.1	Tango 12
7,019.18	$000	RFO	6.1	Tango 12

8,065.30	$000	RFO	6.1 Tango 12
11,187.01	$000	RFO	6.1 Tango 12
10,053.58	$000	RFO	6.1 Tango 12
11,095.76	$000	RFO	6.1 Tango 12
10,913.92	$000	RFO	6.1 Tango 12
9,557.31	$000	RFO	6.1 Tango 12
5,800.96	$000	RFO	6.1 Tango 12
4,299.76	$000	RFO	6.1 Tango 12
1,278.21	$000	RFO	6.1 Tango 12
1,092.02	$000	RFO	6.1 Tango 12
1,672.81	$000	RFO	6.1 Tango 12
1,401.65	$000	RFO	6.1 Tango 12
114.90	$000	RFO	6.1 Tango 12
0.96	$000	RFO	6.1 Tango 12
0.41	$000	RFO	6.1 Tango 12
0.84	$000	RFO	6.1 Tango 12
2.19	$000	RFO	6.1 Tango 12
2.21	$000	RFO	6.1 Tango 12
-	$000	RFO	6.1 Tango 12
-	$000	RFO	6.1 Tango 12
-	$000	RFO	6.1 Tango 12
-	$000	RFO	6.1 Tango 12
-	$000	RFO	6.1 Tango 12
-	$000	RFO	6.1 Tango 12
-	$000	RFO	6.1 Tango 12
2,846.53	$000	RFO	6.1 Tango 12
3,381.43	$000	RFO	6.1 Tango 12
4,767.96	$000	RFO	6.1 Tango 12
8,727.74	$000	RFO	6.1 Tango 12
7,998.58	$000	RFO	6.1 Tango 12
9,067.02	$000	RFO	6.1 Tango 12
11,742.63	$000	RFO	6.1 Tango 12
10,810.88	$000	RFO	6.1 Tango 12
11,699.38	$000	RFO	6.1 Tango 12
11,493.24	$000	RFO	6.1 Tango 12
10,353.01	$000	RFO	6.1 Tango 12
6,728.30	$000	RFO	6.1 Tango 12
5,202.42	$000	RFO	6.1 Tango 12
2,025.44	$000	RFO	6.1 Tango 12
1,503.77	$000	RFO	6.1 Tango 12
2,207.76	$000	RFO	6.1 Tango 12
1,911.81	$000	RFO	6.1 Tango 12
189.87	$000	RFO	6.1 Tango 12
2.27	$000	RFO	6.1 Tango 12
1.05	$000	RFO	6.1 Tango 12
3.23	$000	RFO	6.1 Tango 12
2.35	$000	RFO	6.1 Tango 12
2.29	$000	RFO	6.1 Tango 12
2.51	$000	RFO	6.1 Tango 12
-	$000	RFO	6.1 Tango 12
-	$000	RFO	6.1 Tango 12
-	$000	RFO	6.1 Tango 12

-	$000	RFO	6.1 Tango 12
-	$000	RFO	6.1 Tango 12
-	$000	RFO	6.1 Tango 12
21,893.64	$000	RFO	6.1 MEC 89
24,542.04	$000	RFO	6.1 MEC 89
27,042.14	$000	RFO	6.1 MEC 89
29,170.38	$000	RFO	6.1 MEC 89
32,972.12	$000	RFO	6.1 MEC 89
33,057.70	$000	RFO	6.1 MEC 89
32,888.93	$000	RFO	6.1 MEC 89
33,153.82	$000	RFO	6.1 MEC 89
33,174.04	$000	RFO	6.1 MEC 89
33,175.70	$000	RFO	6.1 MEC 89
34,110.52	$000	RFO	6.1 MEC 89
34,736.14	$000	RFO	6.1 MEC 89
34,912.86	$000	RFO	6.1 MEC 89
31,674.94	$000	RFO	6.1 MEC 89
32,475.29	$000	RFO	6.1 MEC 89
34,571.24	$000	RFO	6.1 MEC 89
34,975.42	$000	RFO	6.1 MEC 89
28,617.98	$000	RFO	6.1 MEC 89
20,503.39	$000	RFO	6.1 MEC 89
21,006.34	$000	RFO	6.1 MEC 89
21,135.17	$000	RFO	6.1 MEC 89
18,124.86	$000	RFO	6.1 MEC 89
20,296.49	$000	RFO	6.1 MEC 89
19,882.16	$000	RFO	6.1 MEC 89
17,469.93	$000	RFO	6.1 MEC 89
18,563.49	$000	RFO	6.1 MEC 89
19,530.32	$000	RFO	6.1 MEC 89
20,303.26	$000	RFO	6.1 MEC 89
21,540.16	$000	RFO	6.1 MEC 89
21,780.02	$000	RFO	6.1 MEC 89
21,426.17	$000	RFO	6.1 MEC 89
24,074.81	$000	RFO	6.1 MEC 89
26,686.63	$000	RFO	6.1 MEC 89
28,568.83	$000	RFO	6.1 MEC 89
32,880.64	$000	RFO	6.1 MEC 89
33,033.49	$000	RFO	6.1 MEC 89
32,415.81	$000	RFO	6.1 MEC 89
33,150.33	$000	RFO	6.1 MEC 89
33,172.06	$000	RFO	6.1 MEC 89
33,172.41	$000	RFO	6.1 MEC 89
34,038.68	$000	RFO	6.1 MEC 89
34,605.11	$000	RFO	6.1 MEC 89
34,917.04	$000	RFO	6.1 MEC 89
30,608.16	$000	RFO	6.1 MEC 89
31,286.27	$000	RFO	6.1 MEC 89
33,473.08	$000	RFO	6.1 MEC 89
33,720.61	$000	RFO	6.1 MEC 89
26,396.39	$000	RFO	6.1 MEC 89
19,279.18	$000	RFO	6.1 MEC 89

20,091.75	$000	RFO		6.1	MEC 89
19,958.29	$000	RFO		6.1	MEC 89
17,324.30	$000	RFO		6.1	MEC 89
19,482.44	$000	RFO		6.1	MEC 89
18,766.61	$000	RFO		6.1	MEC 89
16,987.16	$000	RFO		6.1	MEC 89
17,970.45	$000	RFO		6.1	MEC 89
19,151.30	$000	RFO		6.1	MEC 89
19,765.46	$000	RFO		6.1	MEC 89
20,647.87	$000	RFO		6.1	MEC 89
21,179.80	$000	RFO		6.1	MEC 89
2,506.06	$000	DSL		5.78	TEMES CT 7
2,994.42	$000	DSL		5.78	TEMES CT 7
4,768.94	$000	DSL		5.78	TEMES CT 7
12,210.56	$000	DSL		5.78	TEMES CT 7
9,812.97	$000	DSL		5.78	TEMES CT 7
12,113.38	$000	DSL		5.78	TEMES CT 7
17,357.77	$000	DSL		5.78	TEMES CT 7
15,181.50	$000	DSL		5.78	TEMES CT 7
16,753.69	$000	DSL		5.78	TEMES CT 7
16,639.52	$000	DSL		5.78	TEMES CT 7
11,124.39	$000	DSL		5.78	TEMES CT 7
-	$000	DSL		5.78	TEMES CT 7
-	$000	DSL		5.78	TEMES CT 7
-	$000	DSL		5.78	TEMES CT 7
-	$000	DSL		5.78	TEMES CT 7
-	$000	DSL		5.78	TEMES CT 7
-	$000	DSL		5.78	TEMES CT 7
-	$000	DSL		5.78	TEMES CT 7
-	$000	DSL		5.78	TEMES CT 7
-	$000	DSL		5.78	TEMES CT 7
-	$000	DSL		5.78	TEMES CT 7
-	$000	DSL		5.78	TEMES CT 7
-	$000	DSL		5.78	TEMES CT 7
-	$000	DSL		5.78	TEMES CT 7
-	$000	DSL		5.78	TEMES CT 7
-	$000	DSL		5.78	TEMES CT 7
-	$000	DSL		5.78	TEMES CT 7
-	$000	DSL		5.78	TEMES CT 7
-	$000	#N/A	#N/A		#N/A
-	$000	#N/A	#N/A		#N/A
-	$000	#N/A	#N/A		#N/A
-	$000	#N/A	#N/A		#N/A
-	$000	#N/A	#N/A		#N/A
-	$000	#N/A	#N/A		#N/A
-	$000	#N/A	#N/A		#N/A
-	$000	#N/A	#N/A		#N/A
-	$000	#N/A	#N/A		#N/A
-	$000	#N/A	#N/A		#N/A
-	$000	#N/A	#N/A		#N/A

-	$000	#N/A	#N/A	#N/A
-	$000	#N/A	#N/A	#N/A
-	$000	#N/A	#N/A	#N/A

-	$000	#N/A	#N/A	#N/A
-	$000	#N/A	#N/A	#N/A
-	$000	#N/A	#N/A	#N/A

-	$000	#N/A	#N/A	#N/A
-	$000	#N/A	#N/A	#N/A
-	$000	#N/A	#N/A	#N/A

-	$000	#N/A	#N/A	#N/A
-	$000	#N/A	#N/A	#N/A
-	$000	#N/A	#N/A	#N/A

-	$000	#N/A	#N/A	#N/A
-	$000	#N/A	#N/A	#N/A
-	$000	#N/A	#N/A	#N/A

-	$000	#N/A	#N/A	#N/A
-	$000	#N/A	#N/A	#N/A
-	$000	#N/A	#N/A	#N/A

-	$000	#N/A	#N/A	#N/A
-	$000	#N/A	#N/A	#N/A
-	$000	#N/A	#N/A	#N/A

-	$000	#N/A	#N/A	#N/A
-	$000	#N/A	#N/A	#N/A
-	$000	#N/A	#N/A	#N/A

-	$000	#N/A	#N/A	#N/A
-	$000	#N/A	#N/A	#N/A
-	$000	#N/A	#N/A	#N/A

-	$000	#N/A	#N/A		#N/A
-	$000	RFO		6.1 RECIP	83
-	$000	RFO		6.1 RECIP	83
-	$000	RFO		6.1 RECIP	83

-	$000	RFO	6.1	RECIP	84
-	$000	RFO	6.1	RECIP	84
-	$000	RFO	6.1	RECIP	84
-	$000	RFO	6.1	RECIP	84
-	$000	RFO	6.1	RECIP	84
2,506.92	$000	RFO	6.1	RECIP	84
15,652.40	$000	RFO	6.1	RECIP	84
16,076.36	$000	RFO	6.1	RECIP	84
16,041.05	$000	RFO	6.1	RECIP	84
-	$000	LNG	1	CLNG	85
-	$000	LNG	1	CLNG	85
-	$000	LNG	1	CLNG	85

-	$000	RFO	6.1	RECIP	86
-	$000	RFO	6.1	RECIP	86
-	$000	RFO	6.1	RECIP	86
-	$000	RFO	6.1	RECIP	86
-	$000	RFO	6.1	RECIP	86
-	$000	RFO	6.1	RECIP	86
-	$000	RFO	6.1	RECIP	86
-	$000	RFO	6.1	RECIP	86
-	$000	RFO	6.1	RECIP	86
2,437.43	$000	RFO	6.1	RECIP	86
14,325.81	$000	RFO	6.1	RECIP	86
13,636.74	$000	RFO	6.1	RECIP	86
14,266.05	$000	RFO	6.1	RECIP	86
14,933.66	$000	RFO	6.1	RECIP	86
15,010.36	$000	RFO	6.1	RECIP	86
15,501.47	$000	RFO	6.1	RECIP	86
15,810.44	$000	RFO	6.1	RECIP	86
-	$000	RFO	6.1	RECIP	87
-	$000	RFO	6.1	RECIP	87
-	$000	RFO	6.1	RECIP	87
-	$000	RFO	6.1	RECIP	87
-	$000	RFO	6.1	RECIP	87
-	$000	RFO	6.1	RECIP	87
-	$000	RFO	6.1	RECIP	87
-	$000	RFO	6.1	RECIP	87
-	$000	RFO	6.1	RECIP	87
-	$000	RFO	6.1	RECIP	87
-	$000	RFO	6.1	RECIP	87
-	$000	RFO	6.1	RECIP	87
-	$000	RFO	6.1	RECIP	87
-	$000	RFO	6.1	RECIP	87
-	$000	RFO	6.1	RECIP	87
-	$000	RFO	6.1	RECIP	87
-	$000	RFO	6.1	RECIP	87
-	$000	RFO	6.1	RECIP	87
-	$000	RFO	6.1	RECIP	87
-	$000	RFO	6.1	RECIP	87
-	$000	RFO	6.1	RECIP	87
-	$000	RFO	6.1	RECIP	87
2,111.08	$000	RFO	6.1	RECIP	87
14,025.61	$000	RFO	6.1	RECIP	87
13,359.09	$000	RFO	6.1	RECIP	87
13,392.04	$000	RFO	6.1	RECIP	87
13,909.82	$000	RFO	6.1	RECIP	87
14,492.16	$000	RFO	6.1	RECIP	87
14,825.97	$000	RFO	6.1	RECIP	87
15,318.06	$000	RFO	6.1	RECIP	87
15,747.71	$000	RFO	6.1	RECIP	87
-	$000	LNG	1	CLNG	88
-	$000	LNG	1	CLNG	88
-	$000	LNG	1	CLNG	88
-	$000	LNG	1	CLNG	88
-	$000	LNG	1	CLNG	88

-	$000	LNG	1	CLNG	88
-	$000	LNG	1	CLNG	88
-	$000	LNG	1	CLNG	88
-	$000	LNG	1	CLNG	88
-	$000	LNG	1	CLNG	88
-	$000	LNG	1	CLNG	88
-	$000	LNG	1	CLNG	88
-	$000	LNG	1	CLNG	88
-	$000	LNG	1	CLNG	88
-	$000	LNG	1	CLNG	88
-	$000	LNG	1	CLNG	88
-	$000	LNG	1	CLNG	88
-	$000	LNG	1	CLNG	88
-	$000	LNG	1	CLNG	88
-	$000	LNG	1	CLNG	88
9,928.56	$000	LNG	1	CLNG	88
50,340.13	$000	LNG	1	CLNG	88
52,431.21	$000	LNG	1	CLNG	88
52,015.51	$000	LNG	1	CLNG	88
49,126.77	$000	LNG	1	CLNG	88
50,586.25	$000	LNG	1	CLNG	88
52,076.00	$000	LNG	1	CLNG	88
52,638.29	$000	LNG	1	CLNG	88
54,160.25	$000	LNG	1	CLNG	88
53,875.04	$000	LNG	1	CLNG	88
-	$000	RFO	6.1	RECIP	89
-	$000	RFO	6.1	RECIP	89
-	$000	RFO	6.1	RECIP	89

14,766.31	$000	RFO	6.1	RECIP	89
15,257.03	$000	RFO	6.1	RECIP	89
15,734.76	$000	RFO	6.1	RECIP	89
-	$000	RFO	6.1	RECIP	90
-	$000	RFO	6.1	RECIP	90
-	$000	RFO	6.1	RECIP	90
-	$000	RFO	6.1	RECIP	90
-	$000	RFO	6.1	RECIP	90
-	$000	RFO	6.1	RECIP	90
-	$000	RFO	6.1	RECIP	90
-	$000	RFO	6.1	RECIP	90
-	$000	RFO	6.1	RECIP	90
-	$000	RFO	6.1	RECIP	90
-	$000	RFO	6.1	RECIP	90
-	$000	RFO	6.1	RECIP	90
-	$000	RFO	6.1	RECIP	90
-	$000	RFO	6.1	RECIP	90
-	$000	RFO	6.1	RECIP	90
-	$000	RFO	6.1	RECIP	90
-	$000	RFO	6.1	RECIP	90
-	$000	RFO	6.1	RECIP	90
2,556.76	$000	RFO	6.1	RECIP	90
13,829.97	$000	RFO	6.1	RECIP	90
13,941.92	$000	RFO	6.1	RECIP	90
12,037.35	$000	RFO	6.1	RECIP	90
12,344.55	$000	RFO	6.1	RECIP	90
12,794.20	$000	RFO	6.1	RECIP	90
13,311.89	$000	RFO	6.1	RECIP	90
13,781.22	$000	RFO	6.1	RECIP	90
14,312.77	$000	RFO	6.1	RECIP	90
14,755.48	$000	RFO	6.1	RECIP	90
15,243.50	$000	RFO	6.1	RECIP	90
15,732.51	$000	RFO	6.1	RECIP	90
-	$000	LNG	1	CLNG	91
-	$000	LNG	1	CLNG	91
-	$000	LNG	1	CLNG	91
-	$000	LNG	1	CLNG	91
-	$000	LNG	1	CLNG	91
-	$000	LNG	1	CLNG	91
-	$000	LNG	1	CLNG	91
-	$000	LNG	1	CLNG	91
-	$000	LNG	1	CLNG	91
-	$000	LNG	1	CLNG	91
-	$000	LNG	1	CLNG	91
-	$000	LNG	1	CLNG	91
-	$000	LNG	1	CLNG	91
-	$000	LNG	1	CLNG	91
-	$000	LNG	1	CLNG	91
-	$000	LNG	1	CLNG	91
-	$000	LNG	1	CLNG	91
-	$000	LNG	1	CLNG	91
-	$000	LNG	1	CLNG	91
9,754.93	$000	LNG	1	CLNG	91
49,564.56	$000	LNG	1	CLNG	91

50,205.56	$000	LNG	1	CLNG	91
50,618.32	$000	LNG	1	CLNG	91
48,607.40	$000	LNG	1	CLNG	91
50,618.98	$000	LNG	1	CLNG	91
50,707.85	$000	LNG	1	CLNG	91
47,270.28	$000	LNG	1	CLNG	91
48,706.10	$000	LNG	1	CLNG	91
49,931.63	$000	LNG	1	CLNG	91
50,664.27	$000	LNG	1	CLNG	91
52,010.24	$000	LNG	1	CLNG	91
52,038.50	$000	LNG	1	CLNG	91
-	$000	RFO	6.1	RECIP	92
-	$000	RFO	6.1	RECIP	92
-	$000	RFO	6.1	RECIP	92
-	$000	RFO	6.1	RECIP	92
-	$000	RFO	6.1	RECIP	92
-	$000	RFO	6.1	RECIP	92
-	$000	RFO	6.1	RECIP	92
-	$000	RFO	6.1	RECIP	92
-	$000	RFO	6.1	RECIP	92
-	$000	RFO	6.1	RECIP	92
-	$000	RFO	6.1	RECIP	92
-	$000	RFO	6.1	RECIP	92
-	$000	RFO	6.1	RECIP	92
-	$000	RFO	6.1	RECIP	92
-	$000	RFO	6.1	RECIP	92
-	$000	RFO	6.1	RECIP	92
-	$000	RFO	6.1	RECIP	92
2,834.35	$000	RFO	6.1	RECIP	92
12,165.60	$000	RFO	6.1	RECIP	92
11,686.98	$000	RFO	6.1	RECIP	92
11,930.22	$000	RFO	6.1	RECIP	92
11,863.32	$000	RFO	6.1	RECIP	92
12,333.24	$000	RFO	6.1	RECIP	92
12,793.23	$000	RFO	6.1	RECIP	92
13,312.97	$000	RFO	6.1	RECIP	92
13,782.15	$000	RFO	6.1	RECIP	92
14,312.81	$000	RFO	6.1	RECIP	92
14,755.69	$000	RFO	6.1	RECIP	92
15,243.29	$000	RFO	6.1	RECIP	92
15,732.10	$000	RFO	6.1	RECIP	92
-	$000	LNG	1	CLNG	93
-	$000	LNG	1	CLNG	93
-	$000	LNG	1	CLNG	93
-	$000	LNG	1	CLNG	93
-	$000	LNG	1	CLNG	93
-	$000	LNG	1	CLNG	93
-	$000	LNG	1	CLNG	93
-	$000	LNG	1	CLNG	93
-	$000	LNG	1	CLNG	93
-	$000	LNG	1	CLNG	93
-	$000	LNG	1	CLNG	93

-	$000	LNG	1	CLNG	93
-	$000	LNG	1	CLNG	93
-	$000	LNG	1	CLNG	93
-	$000	LNG	1	CLNG	93
-	$000	LNG	1	CLNG	93
9,672.23	$000	LNG	1	CLNG	93
49,898.19	$000	LNG	1	CLNG	93
48,135.38	$000	LNG	1	CLNG	93
48,733.91	$000	LNG	1	CLNG	93
49,257.86	$000	LNG	1	CLNG	93
46,660.29	$000	LNG	1	CLNG	93
48,872.93	$000	LNG	1	CLNG	93
48,670.71	$000	LNG	1	CLNG	93
45,450.48	$000	LNG	1	CLNG	93
46,816.18	$000	LNG	1	CLNG	93
48,087.64	$000	LNG	1	CLNG	93
48,881.45	$000	LNG	1	CLNG	93
50,193.68	$000	LNG	1	CLNG	93
50,181.62	$000	LNG	1	CLNG	93
-	$000	WIND	1	WIND	94
-	$000	WIND	1	WIND	94
-	$000	WIND	1	WIND	94
-	$000	WIND	1	WIND	94
-	$000	WIND	1	WIND	94
-	$000	WIND	1	WIND	94
-	$000	WIND	1	WIND	94
-	$000	WIND	1	WIND	94
-	$000	WIND	1	WIND	94
-	$000	WIND	1	WIND	94
-	$000	WIND	1	WIND	94
-	$000	WIND	1	WIND	94
-	$000	WIND	1	WIND	94
24.40	$000	WIND	1	WIND	94
103.31	$000	WIND	1	WIND	94
103.02	$000	WIND	1	WIND	94
103.02	$000	WIND	1	WIND	94
103.02	$000	WIND	1	WIND	94
103.12	$000	WIND	1	WIND	94
102.69	$000	WIND	1	WIND	94
102.75	$000	WIND	1	WIND	94
100.97	$000	WIND	1	WIND	94
102.76	$000	WIND	1	WIND	94
101.64	$000	WIND	1	WIND	94
95.24	$000	WIND	1	WIND	94
97.32	$000	WIND	1	WIND	94
98.62	$000	WIND	1	WIND	94
97.77	$000	WIND	1	WIND	94
99.49	$000	WIND	1	WIND	94
97.03	$000	WIND	1	WIND	94
-	$000	WIND	1	WIND	95
-	$000	WIND	1	WIND	95
-	$000	WIND	1	WIND	95

-	$000	WIND	1	WIND	95
-	$000	WIND	1	WIND	95
-	$000	WIND	1	WIND	95
-	$000	WIND	1	WIND	95
-	$000	WIND	1	WIND	95
-	$000	WIND	1	WIND	95
-	$000	WIND	1	WIND	95
-	$000	WIND	1	WIND	95
-	$000	WIND	1	WIND	95
24.40	$000	WIND	1	WIND	95
103.02	$000	WIND	1	WIND	95
103.31	$000	WIND	1	WIND	95
103.02	$000	WIND	1	WIND	95
103.00	$000	WIND	1	WIND	95
102.98	$000	WIND	1	WIND	95
101.22	$000	WIND	1	WIND	95
100.96	$000	WIND	1	WIND	95
100.67	$000	WIND	1	WIND	95
96.23	$000	WIND	1	WIND	95
99.77	$000	WIND	1	WIND	95
97.40	$000	WIND	1	WIND	95
88.11	$000	WIND	1	WIND	95
90.83	$000	WIND	1	WIND	95
92.50	$000	WIND	1	WIND	95
91.87	$000	WIND	1	WIND	95
93.90	$000	WIND	1	WIND	95
90.61	$000	WIND	1	WIND	95
-	$000	LNG	1	CLNG	96
-	$000	LNG	1	CLNG	96
-	$000	LNG	1	CLNG	96
-	$000	LNG	1	CLNG	96
-	$000	LNG	1	CLNG	96
-	$000	LNG	1	CLNG	96
-	$000	LNG	1	CLNG	96
-	$000	LNG	1	CLNG	96
-	$000	LNG	1	CLNG	96
-	$000	LNG	1	CLNG	96
-	$000	LNG	1	CLNG	96
-	$000	LNG	1	CLNG	96
9,232.53	$000	LNG	1	CLNG	96
47,744.91	$000	LNG	1	CLNG	96
48,503.28	$000	LNG	1	CLNG	96
49,280.67	$000	LNG	1	CLNG	96
49,923.59	$000	LNG	1	CLNG	96
49,015.22	$000	LNG	1	CLNG	96
46,367.86	$000	LNG	1	CLNG	96
47,007.13	$000	LNG	1	CLNG	96
47,557.33	$000	LNG	1	CLNG	96
44,943.66	$000	LNG	1	CLNG	96
46,986.33	$000	LNG	1	CLNG	96
46,621.83	$000	LNG	1	CLNG	96
44,054.41	$000	LNG	1	CLNG	96

45,312.68	$000	LNG	1	CLNG	96
46,471.94	$000	LNG	1	CLNG	96
47,256.11	$000	LNG	1	CLNG	96
48,372.99	$000	LNG	1	CLNG	96
48,613.57	$000	LNG	1	CLNG	96
-	$000	WIND	1	WIND	97
-	$000	WIND	1	WIND	97
-	$000	WIND	1	WIND	97
-	$000	WIND	1	WIND	97
-	$000	WIND	1	WIND	97
-	$000	WIND	1	WIND	97
-	$000	WIND	1	WIND	97
-	$000	WIND	1	WIND	97
-	$000	WIND	1	WIND	97
-	$000	WIND	1	WIND	97
-	$000	WIND	1	WIND	97
24.40	$000	WIND	1	WIND	97
103.02	$000	WIND	1	WIND	97
103.01	$000	WIND	1	WIND	97
103.22	$000	WIND	1	WIND	97
102.97	$000	WIND	1	WIND	97
102.88	$000	WIND	1	WIND	97
102.24	$000	WIND	1	WIND	97
97.73	$000	WIND	1	WIND	97
97.13	$000	WIND	1	WIND	97
97.09	$000	WIND	1	WIND	97
90.68	$000	WIND	1	WIND	97
95.19	$000	WIND	1	WIND	97
92.08	$000	WIND	1	WIND	97
80.97	$000	WIND	1	WIND	97
84.17	$000	WIND	1	WIND	97
86.06	$000	WIND	1	WIND	97
85.45	$000	WIND	1	WIND	97
87.93	$000	WIND	1	WIND	97
83.79	$000	WIND	1	WIND	97
-	$000	WIND	1	WIND	98
-	$000	WIND	1	WIND	98
-	$000	WIND	1	WIND	98
-	$000	WIND	1	WIND	98
-	$000	WIND	1	WIND	98
-	$000	WIND	1	WIND	98
-	$000	WIND	1	WIND	98
-	$000	WIND	1	WIND	98
-	$000	WIND	1	WIND	98
-	$000	WIND	1	WIND	98
24.40	$000	WIND	1	WIND	98
103.02	$000	WIND	1	WIND	98
103.01	$000	WIND	1	WIND	98
102.77	$000	WIND	1	WIND	98
102.74	$000	WIND	1	WIND	98
102.63	$000	WIND	1	WIND	98
102.42	$000	WIND	1	WIND	98

100.44	$000	WIND	1	WIND	98
92.83	$000	WIND	1	WIND	98
92.59	$000	WIND	1	WIND	98
91.81	$000	WIND	1	WIND	98
83.95	$000	WIND	1	WIND	98
89.50	$000	WIND	1	WIND	98
85.76	$000	WIND	1	WIND	98
73.14	$000	WIND	1	WIND	98
76.74	$000	WIND	1	WIND	98
78.99	$000	WIND	1	WIND	98
78.67	$000	WIND	1	WIND	98
81.42	$000	WIND	1	WIND	98
76.88	$000	WIND	1	WIND	98
-	$000	DSL	5.78	RETR	99
-	$000	DSL	5.78	RETR	99
-	$000	DSL	5.78	RETR	99
-	$000	DSL	5.78	RETR	99
-	$000	DSL	5.78	RETR	99
-	$000	DSL	5.78	RETR	99
-	$000	DSL	5.78	RETR	99
-	$000	DSL	5.78	RETR	99
-	$000	DSL	5.78	RETR	99
9,186.12	$000	DSL	5.78	RETR	99
38,106.94	$000	DSL	5.78	RETR	99
31,794.23	$000	DSL	5.78	RETR	99
15,819.71	$000	DSL	5.78	RETR	99
12,897.74	$000	DSL	5.78	RETR	99
17,052.59	$000	DSL	5.78	RETR	99
16,003.63	$000	DSL	5.78	RETR	99
2,835.24	$000	DSL	5.78	RETR	99
61.26	$000	DSL	5.78	RETR	99
16.78	$000	DSL	5.78	RETR	99
69.29	$000	DSL	5.78	RETR	99
1.81	$000	DSL	5.78	RETR	99
420.28	$000	DSL	5.78	RETR	99
72.73	$000	DSL	5.78	RETR	99
25.41	$000	DSL	5.78	RETR	99
21.57	$000	DSL	5.78	RETR	99
27.90	$000	DSL	5.78	RETR	99
11.11	$000	DSL	5.78	RETR	99
10.34	$000	DSL	5.78	RETR	99
11.49	$000	DSL	5.78	RETR	99
-	$000	WIND	1	WIND	100
-	$000	WIND	1	WIND	100
-	$000	WIND	1	WIND	100
-	$000	WIND	1	WIND	100
-	$000	WIND	1	WIND	100
-	$000	WIND	1	WIND	100
-	$000	WIND	1	WIND	100
-	$000	WIND	1	WIND	100
-	$000	WIND	1	WIND	100

24.40	$000	WIND	1	WIND	100
103.31	$000	WIND	1	WIND	100
103.02	$000	WIND	1	WIND	100
102.92	$000	WIND	1	WIND	100
102.03	$000	WIND	1	WIND	100
101.65	$000	WIND	1	WIND	100
101.80	$000	WIND	1	WIND	100
101.40	$000	WIND	1	WIND	100
97.58	$000	WIND	1	WIND	100
86.91	$000	WIND	1	WIND	100
86.73	$000	WIND	1	WIND	100
86.15	$000	WIND	1	WIND	100
77.11	$000	WIND	1	WIND	100
83.14	$000	WIND	1	WIND	100
79.19	$000	WIND	1	WIND	100
65.49	$000	WIND	1	WIND	100
69.40	$000	WIND	1	WIND	100
71.86	$000	WIND	1	WIND	100
71.63	$000	WIND	1	WIND	100
74.60	$000	WIND	1	WIND	100
69.85	$000	WIND	1	WIND	100

UNIT	Fuel Type	Fuel Conversion Factor (MMBTU per Fuel Unit)	Fuel Unit	**NP Rating**	**MAX Capacity (NET)**	Plant
CAB SSD 3	RFO	6.1	BBL	39.3	36.94	Cab34
CAB SSD 4	RFO	6.1	BBL	39.3	37.34	Cab34
CAB ST 1	RFO	6.1	BBL	66	61.38	Cab12
CAB ST 2	RFO	6.1	BBL	66	61.38	Cab12
CLNG 85	LNG	1	MCF	60	60	CLNG 85
CLNG 88	LNG	1	MCF	60	60	CLNG 88
CLNG 91	LNG	1	MCF	60	60	CLNG 91
CLNG 93	LNG	1	MCF	60	60	CLNG 93
CLNG 96	LNG	1	MCF	60	60	CLNG 96
DED CT 1	DSL	5.78	BBL	23	22.77	Ded CT 12
DED CT 2	DSL	5.78	BBL	22	22.77	Ded CT 12
DED DSL 1	DSL	5.78	BBL	2.5	2.45	Ded DSL 1-4
DED DSL 2	DSL	5.78	BBL	2.5	2.45	Ded DSL 1-4
DED DSL 3	DSL	5.78	BBL	2.5	2.45	Ded DSL 1-4
DED DSL 4	DSL	5.78	BBL	2.5	2.45	Ded DSL 1-4
MACH CT 1	DSL	5.78	BBL	22	21.56	MACH CT 1
MARBO CT 1	DSL	5.78	BBL	16	15.36	MARBO CT 1
MEC 1	RFO	6.1	BBL	44.2	42.68	MEC 89
MEC 2	RFO	6.1	BBL	44.2	42.68	MEC 89
OROTE 1	DSL	5.78	BBL	16	16.00	OROTE 1
PULANTAT 1	DSL	5.78	BBL	5.3	5.14	MDI DSL 12
PULANTAT 2	DSL	5.78	BBL	5.3	5.19	MDI DSL 12
RECIP 83	RFO	6.1	BBL	40	40	RECIP 83
RECIP 84	RFO	6.1	BBL	40	40	RECIP 84
RECIP 86	RFO	6.1	BBL	40	40	RECIP 86
RECIP 87	RFO	6.1	BBL	40	40	RECIP 87
RECIP 89	RFO	6.1	BBL	40	40	RECIP 89
RECIP 90	RFO	6.1	BBL	40	40	RECIP 90
RECIP 92	RFO	6.1	BBL	40	40	RECIP 92
RETR 99	DSL	5.78	BBL	60	60	RETR 99
TAL DSL 1	DSL	5.78	BBL	4.4	4.36	Tal DSL 12
TAL DSL 2	DSL	5.78	BBL	4.4	4.36	Tal DSL 12
TANGO 1	RFO	6.1	BBL	26.5	23.85	Tango 12
TANGO 2	RFO	6.1	BBL	26.5	24.12	Tango 12
TEMES 1	DSL	5.78	BBL	40	39.20	TEMES CT 7
TENJO 1	DSL	5.78	BBL	4.4	4.36	TENJO 1-6
TENJO 2	DSL	5.78	BBL	4.4	4.36	TENJO 1-6
TENJO 3	DSL	5.78	BBL	4.4	4.36	TENJO 1-6
TENJO 4	DSL	5.78	BBL	4.4	4.36	TENJO 1-6
TENJO 5	DSL	5.78	BBL	4.4	4.36	TENJO 1-6
TENJO 6	DSL	5.78	BBL	4.4	4.36	TENJO 1-6
WIND 100	WIND	1	WIND	4.8	4.8	WIND 100
WIND 94	WIND	1	WIND	4.8	4.8	WIND 94
WIND 95	WIND	1	WIND	4.8	4.8	WIND 95
WIND 97	WIND	1	WIND	4.8	4.8	WIND 97
WIND 98	WIND	1	WIND	4.8	4.8	WIND 98
YIGO CT 1	DSL	5.78	BBL	22	21.56	YIGO CT 1

CHECK:	**MAX Capacity (Yr 2021)**	**NP Rating**
	36.94	39.3
	37.34	39.3
	61.38	66
	61.38	66
	60	60
	22.77	23
	22.77	22
	21.56	22
	15.36	16
	42.68	44.2
	42.68	44.2
	5.14	5.3
	5.19	5.3
	60	60
	4.36	4.4
	4.36	4.4
	23.85	26.5
	24.12	26.5
	4.36	4.4
	4.36	4.4
	4.36	4.4
	4.36	4.4
	4.36	4.4
	4.36	4.4
	4.8	4.8
	4.8	4.8
	4.8	4.8
	4.8	4.8
	4.8	4.8
	21.56	22

YEAR	Strategist Output (Net Capacity)
2006	528.6
2007	528.6
2008	528.6
2009	528.6
2010	528.6
2011	528.6
2012	528.6
2013	528.6
2014	528.6
2015	528.6
2016	533.4
2017	549.2
2018	554
2019	618.8
2020	623.6
2021	**623.6**
2022	623.6
2023	660.83
2024	667.47
2025	674.37
2026	674.37
2027	712.99
2028	691.61
2029	707.76
2030	743.64
2031	743.64
2032	743.64
2033	783.64
2034	783.64
2035	823.64

Net	623.60	646.80	Installed
		552.80	test

Interim Report

NORTHERN DISTRICT WASTEWATER TREATMENT PLANT OUTFALL ASSESSMENT -PHASE 2-

TANGUISSON POINT, GUAM

Prepared for:

Department of the Navy
Naval Facilities Engineering Command, Pacific
Pearl Harbor, Hawaii 96860-7300

Prepared by:

Engineering Concepts, Inc.
1150 S. King Street, Suite 700
Honolulu, Hawaii 96814

September 2009

Interim Report

NORTHERN DISTRICT WASTEWATER TREATMENT PLANT OUTFALL ASSESSMENT -PHASE 2-

TANGUISSON POINT, GUAM

Prepared for:

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September 2009

EXECUTIVE SUMMARY

Note*: *This interim report presents the preliminary findings based on the initial field work conducted between August 2008 and March 2009. Additional field visits, data collection, and water quality sampling are scheduled and will be presented in subsequent reports.

This assessment of the discharge from a proposed Department of Defence (DoD) ocean outfall on the marine water environment was prepared in accordance with the Naval Facilities Engineering Command, Pacific (NAVFAC Pacific), Contract No. N62742-08-D-1920. The objective of this investigation was to evaluate the impacts to the receiving marine environment resulting from the consolidated treatment and disposal of DoD wastewater, including additional wastewater loadings associated with the relocation of the U.S. Marine Corps (USMC) from Okinawa to Guam. The results of this study are documented in this report.

The purpose of this study is to support the environmental impact statement (EIS) that will be prepared for the USMC relocation from Okinawa to Guam. According to planning documents, USMC personnel may be relocated to the Naval Computer and Telecommunications Station (NCTS) Finegayan, South Finegayan Housing area, Andersen Air Force Base (AAFB), AAFB Northwest Field, and AAFB South. These areas currently discharge wastewater to the Northern District Wastewater Treatment Plant (NDWWTP), which is owned and operated by the Guam Waterworks Authority (GWA). An assessment of the wastewater treatment and disposal options to support the USMC relocation was provided in the report, *"Guam Wastewater Utility Study Report for Proposed USMC Relocation,"* July 2008, by Earth Tech, Inc. and TEC Inc. Joint Venture (hereafter referred to as July 2008 study).

The July 2008 study evaluated nine wastewater treatment and disposal options. Three of the nine options utilized the NDWWTP outfall as the means for effluent disposal. Impacts to the receiving marine waters associated with these options were addressed in Phase 1 of this investigation. The preliminary results of these options are summarized in a report titled "Northern District Wastewater Treatment Plant Outfall Assessment, Tanguisson Point, Guam" (hereafter referred to as Phase 1 Report). This Phase 2 study evaluates the option to build a new secondary treatment plant dedicated to treat all DoD wastewater flow generated in the north, including the additional flow associated with the USMC relocation. This option is identified in the July 2008 study as Option 2. Effluent from the proposed DoD secondary treatment plant will discharge into M-2 waters through a new ocean outfall that will be located north of the new NDWWTP outfall and south of the M-1/M-2 boundary.

The results of the nearfield and farfield plume modeling performed by EKNA Services are used to assess the water quality associated with the treatment and disposal method proposed in Option 2. The environmental and biological impact assessments were performed by AECOS, Inc. This interim report contains their preliminary findings based on the initial field work conducted between August 2008 and March 2009. Parameters used to assess the environmental impacts on the receiving marine waters include:

- Comparison with the Guam Water Quality Standards (GWQS) and
- Effects to the ecological life and environment of the receiving marine waters.

Comparison with the GWQS

Initial dilution (nearfield) and farfield modeling performed in the Phase 1 study indicated that the discharge of 12 MGD of primary treated effluent from the new NDWWTP outfall will impact the receiving water quality in the vicinity of the proposed DoD outfall. For this Phase 2 study, these plume models were updated with additional ocean and wind data collected through subsequent field visits and used to develop the theoretical ambient receiving water conditions near the proposed DoD outfall. The updated initial dilution factor for the new NDWWTP outfall is 300. The resulting ambient water quality conditions at the proposed DoD outfall are summarized in **Table ES-1**.

TABLE ES-1
CALCULATED AMBIENT WATER QUALITY CONDITIONS
AT THE PROPOSED DOD OUTFALL

Water Quality Constituent	Unit	Background Concentration	NDWWTP Primary Treated Effluent Concentration	Calculated Ambient Concentration at Proposed DoD Outfall	GWQS (M-2 Waters)
Enterococci	#/100mL	0	240,000	400	104
Orthophosphate (as P)	μg P/L	5	2,620	9.4	50
Nitrate-Nitrite	μg N/L	1.1	9	1.1	200
TSS	mg/L	5.6	80	5.7	20
Turbidity	NTU	0.25	59	0.3	1
Priority Toxic Pollutants					
Lead	μg/L	0	4.94	0	8.1
Copper	μg/L	0	68.3	0.1	3.1
Zinc	μg/L	0	276	0.5	86
Additional Toxic Pollutants					
Ammonia (as N)	μg N/L	0	18,400	30.7	20
Total Sulfide	μg/L	0	140	0.2	5
Non-Regulated Constituents					
Total Nitrogen	μg N/L	151	47,600	230.1	---
Total Phosphorus	μg P/L	13	3,850	19.4	---

** Calculated ambient receiving water quality concentrations greater than the GWQS are highlighted in yellow.*

The results indicate that enterococci and ammonia in the receiving waters near the proposed DoD outfall will likely exceed the GWQS due to the primary effluent discharge plume from the NDWWTP.

The conceptual design of the proposed DoD outfall evaluated in this Phase 2 study consists of a single port outfall (no diffuser) at a depth of 150 feet. The nearfield plume model indicates that

the proposed DoD outfall will be capable of providing an average initial dilution of 251 at a design flow of 5 MGD and current speed and direction of 10 cm/sec and 15 deg true north. The plume surfaces for all runs and does not travel far horizontally before surfacing.

Utilizing the ambient water quality conditions near the proposed DoD outfall calculated in **Table ES-1**, the anticipated constituent concentrations of the discharge of secondary treated effluent from the proposed DoD outfall after initial dilution is achieved are summarized in **Table ES-2**.

TABLE ES-2
CALCULATED CONSTITUENT CONCENTRATION AFTER INITIAL DILUTION OF 251 IS ACHIEVED AT THE PROPOSED DOD OUTFALL

Water Quality Constituent	Unit	Calculated Ambient Concentration at Proposed DoD Outfall	DoD Secondary Treated Effluent Concentration	Calculated Constituent Concentration After Initial Dilution	GWQS (M-2 Waters)
Enterococci	#/100mL	400	15	398.5	104
Orthophosphate (as P)	μg P/L	9.4	1,640	15.9	50
Nitrate-Nitrite	μg N/L	1.1	14,900	60.5	200
TSS	mg/L	5.7	9	5.7	20
Turbidity	NTU	0.3	16	0.4	1
Priority Toxic Pollutants					
Lead	μg/L	0	4.43	0	8.1
Copper	μg/L	0.1	54.6	0.3	3.1
Zinc	μg/L	0.5	72.6	0.8	86
Additional Toxic Pollutants					
Ammonia (as N)	μg N/L	30.7	3,500	44.5	20
Total Sulfide	μg/L	0.2	140	0.8	5
Non-Regulated Constituents					
Total Nitrogen	μg N/L	230.1	23,950	324.6	---
Total Phosphorus	μg P/L	19.4	3,760	34.3	---

** Calculated ambient receiving water quality concentrations greater than the GWQS are highlighted in yellow.*

Due to the high levels of enterococci and ammonia in the primary effluent discharged from the new NDWWTP outfall, the resulting ambient receiving water quality in the vicinity of the proposed DoD outfall exceeds the GWQS. Although the end of pipe enterococci level present in the secondary treated discharge from the proposed DoD outfall is below the GWQS, the resulting concentration after mixing with the ambient receiving water exceeds the GWQS.

By upgrading the NDWWTP to provide secondary treatment, the reduction of pollutants in the discharge will result in the ambient receiving waters near the proposed DoD outfall to comply with the GWQS as indicated in **Table ES-3**. The anticipated constituent concentrations resulting from the discharge of secondary treated effluent from the proposed DoD outfall after initial dilution will also meet the GWQS as indicated in **Table ES-4**.

TABLE ES-3
CALCULATED AMBIENT WATER QUALITY CONDITIONS
AT THE PROPOSED DOD OUTFALL

Water Quality Constituent	Unit	Background Concentration	NDWWTP Secondary Treated Effluent Concentration	Calculated Ambient Concentration at Proposed DoD Outfall	GWQS (M-2 Waters)
Enterococci	#/100mL	0	15	0	104
Orthophosphate (as P)	μg P/L	5	1,640	7.7	50
Nitrate-Nitrite	μg N/L	1.1	14,900	25.9	200
TSS	mg/L	5.6	9	5.6	20
Turbidity	NTU	0.25	16	0.3	1
Priority Toxic Pollutants					
Lead	μg/L	0	4.43	0	8.1
Copper	μg/L	0	54.6	0.1	3.1
Zinc	μg/L	0	72.6	0.1	86
Additional Toxic Pollutants					
Ammonia (as N)	μg N/L	0	3,500	5.8	20
Total Sulfide	μg/L	0	140	0.2	5
Non-Regulated Constituents					
Total Nitrogen	μg N/L	151	23,950	190.7	---
Total Phosphorus	μg P/L	13	3,760	19.2	---

TABLE ES-4
CALCULATED CONSTITUENT CONCENTRATION AFTER INITIAL DILUTION OF 251 IS ACHIEVED AT THE PROPOSED DOD OUTFALL (Secondary Treated Effluent Discharged from NDWWTP)

Water Quality Constituent	Unit	Calculated Ambient Concentration at Proposed DoD Outfall	DoD Secondary Treated Effluent Concentration	Calculated Constituent Concentration After Initial Dilution	GWQS (M-2 Waters)
Enterococci	#/100mL	0	15	0	104
Orthophosphate (as P)	μg P/L	7.7	1,640	14.2	50
Nitrate-Nitrite	μg N/L	25.9	14,900	85.2	200
TSS	mg/L	5.6	9	5.6	20
Turbidity	NTU	0.3	16	0.3	1
Priority Toxic Pollutants					
Lead	μg/L	0	4.43	0	8.1
Copper	μg/L	0.1	54.6	0.3	3.1
Zinc	μg/L	0.1	72.6	0.4	86
Additional Toxic Pollutants					
Ammonia (as N)	μg N/L	5.8	3,500	19.8	20
Total Sulfide	μg/L	0.2	140	0.8	5
Non-Regulated Constituents					
Total Nitrogen	μg N/L	190.7	23,950	285.3	---
Total Phosphorus	μg P/L	19.2	3,760	34.1	---

Effects to the Ecological Life and Environment of the Receiving Marine Waters

The three components of sewage effluent found to be most detrimental to marine life and coral reefs are nutrients, sediments, and toxic substances. Tropical ocean waters are typically characterized as low in nutrients and particulates. Therefore, the discharge of high levels of nutrients and particulates may have detrimental impacts to the receiving marine waters.

The following assessment is derived from a review of existing studies performed by others in the vicinity of the proposed DoD outfall, supplemented by investigations performed at other marine outfalls located in Guam and Hawaii.

Water Column Impacts

The nearfield plume analysis indicates that the discharge from the diffuser rises quickly, with minimal horizontal dispersion before reaching the surface. The elapsed time for this initial

mixing and rise of the fluids is short, occurring in minutes. Therefore, there is minimum interaction with the extant assemblage of organisms in the water column.

Phytoplankton may assimilate some nutrients present in the farfield plume. Since phytoplankton requires several days to replicate and the plume will likely disperse over a wide area in a matter of hours, however, the increase in biomass is not likely to be a concern. The low phytoplankton biomass (based on the low level of chlorophyll α) also suggests that any increase resulting from phytoplankton productivity will be rapidly grazed by herbivorous zooplankters. Therefore, detectable changes in phytoplankton or herbivorous zooplankton biomass are not anticipated.

Enterococcus and ammonia in the surfacing plume will exceed the GWQS. These exceedances are attributed to the ambient receiving water quality condition resulting from the primary effluent discharged from the new NDWWTP outfall. These anticipated constituent concentrations are based on the modeling results by EKNA Services and do not take into account the degradation of constituents, die-off of organisms, or uptake of the pollutants by existing aquatic life.

Enterococcus in the discharge plume will eventually be diluted to near zero. Unfavorable conditions provided by the marine environment will likely destroy these bacteria and most others from the wastewater. Factors such as pH, temperature, solar (UV) radiation, predation, osmotic stress, nutrient deficiencies, particulate levels, turbidity, oxygen concentrations, and microbial community composition affect bacteria inactivation.

The toxicity of ammonia is dependent on pH. Dissolved in water, ammonia will react with hydrogen ions (H^+) to form non-toxic ammonium ions (NH_4^-). When mixed with the higher pH level of the receiving marine water, ammonia present in the wastewater discharge will increase in toxicity. Toxicity is still a function of concentration and, since the initial dilution of ammonia in the rising plume is around 45 μgN/L, this value is nearly two orders of magnitude (or about 1/100) of the concentration found to be toxic to most fishes (EPA, 1972).

Benthic Impacts

Benthic impacts are associated with the sedimentation of particulates entrained in the discharge plume. Sources of the particulates in the wastewater discharge plume include particulates in the effluent, particulates produced in the environment from nutrient enrichment, and natural seston.

Based on several studies performed on deep ocean outfalls off Oahu in the Hawaiian Islands, no significant impacts have been reported on the benthic faunal. Impacts to polychaete assemblage and the crustacean and soft bottom communities were found to be limited. Since the conditions off Tanguisson Point are similar to those off the Oahu deep ocean outfalls, adverse impacts to the receiving marine waters are not anticipated with the discharge of secondary treated effluent from the proposed DoD outfall.

Sewage Impacts on Coral Reef Ecosystems

The Guam nearshore environment is characterized by extensive coral bottom and coral reef areas. In the vicinity between Tanguisson Point and Falcona Beach, high coral cover and diversity exist.

Detrimental impacts to the coral reef ecosystem associated with excessive nutrient-loading, bacteria, and sediment abrasion have been documented in other studies. These impacts, however, are dependent on the flushing properties of the receiving waters and characteristics of the sediment. A 1985 report by Pastorok and Bilyard studied the impact of sewage effluent on the coral reef ecosystem. The study concluded that the discharge of sewage had little or no impact on the coral reef ecosystem in well-flushed water along open coasts.

In general, coral species located along the seaward margin of the reef are less tolerant to high sediment loadings than species found on the inner reef. However, the physical condition of the seaward margin of the reef typically prevents the accumulation of sediments. The wastewater plume models for this investigation also indicated that the plume rises to the surface quickly and then spreads out, broadening the area subject to the dissolved and particulate substances in the effluent, thus reducing the concentration of the constituents that will arrive at the reef.

The coral reef off Tanguisson Point, at its closest point, is located approximately 360 feet from the outfall. This is approximately 1,100 feet from the shoreline and roughly 820 feet from the reef margin. The results of the farfield plume analysis indicate that the average dilution along the face of the reef will be on the order of 1,000 to 2,000. Without the influence of primary treated effluent discharged through the new NDWWTP outfall, the proposed DoD discharge of secondary treated effluent will meet GWQS as the discharge plume surfaces. With the primary treated effluent discharge from the NDWWTP, the average dilution factor for the mixed plume as it surfaces and spreads to the nearby reef front is expected to be on the order of 10, reducing the ammonia concentration well below the GWQS of 20 μg N/L. The 24-hour visitation frequency for the reef area is on the order of 5 to 10 percent.

The results of the farfield plume analysis and water quality assessment indicate some impact on the nearshore reef ecosystem associated with the discharge of 12 MGD of primary treated effluent through the new NDWWTP outfall. Due to the prevailing ocean current and wind conditions, mixing and flushing capabilities, and distance from the shore, however, the biological impacts are anticipated to be inconsequential and very limited in area. This potential impact may be mitigated by improving the treatment provided at the NDWWTP to secondary levels. The addition of 5 MGD of secondary treated effluent through the proposed DoD outfall should not alter this assessment, with the exception that detectable ammonia levels (below the GWQS limits) may impinge on the reef margin.

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CHAPTER 1
INTRODUCTION

This assessment of the impacts of the discharge from a proposed Department of Defence (DoD) ocean outfall on the marine water environment was prepared in accordance with the Naval Facilities Engineering Command, Pacific (NAVFAC Pacific), Contract No. N62742-08-D-1920. The objective of this investigation was to evaluate the impacts to the receiving marine environment resulting from the consolidated treatment and disposal of DoD wastewater, including additional wastewater loadings associated with the U.S. Marine Corps (USMC) relocation from Okinawa to Guam. The results of this study are documented in this report.

1.1 Purpose of Study and Background Information

The purpose of this study is to support the environmental impact statement (EIS) that will be prepared for the relocation of the USMC from Okinawa to Guam. According to planning documents, potential locations for the relocated personnel in Guam include the Naval Computer and Telecommunications Station (NCTS) Finegayan, South Finegayan Housing area, Andersen Air Force Base (AAFB), AAFB Northwest Field, and AAFB South. These areas currently discharge their wastewater to the Northern District Wastewater Treatment Plant (NDWWTP), which is owned and operated by the Guam Waterworks Authority (GWA). An assessment of the wastewater treatment and disposal options to support the USMC relocation was provided in the report, *"Guam Wastewater Utility Study Report for Proposed USMC Relocation"* dated July 2008 prepared by Earth Tech, Inc. and TEC Inc. Joint Venture (hereafter referred to as July 2008 study).

The July 2008 study evaluated nine wastewater treatment and disposal options. Three of the nine options presented in the July 2008 study utilized the existing NDWWTP outfall as the means for effluent disposal. The impact of these three options on the marine environment was investigated in Phase 1 of this project, and the results of the study are presented in the report, "Northern District Wastewater Treatment Plant Outfall Assessment, Tanguisson Point, Guam" (hereafter referred to as Phase 1 report).

This Phase 2 investigation evaluates the option to build a new secondary treatment plant dedicated to treat all of DoD's wastewater flows generated in the north, including the additional flow associated with the USMC relocation. This option is identified in the July 2008 study as Option 2. The new treatment plant will be constructed on DoD land near the proposed USMC Finegayan development, north of the NDWWTP. A new ocean outfall will be constructed to dispose treated secondary effluent from this facility. The outfall will be located north of the existing NDWWTP outfall.

Due to the relatively close proximity of the existing and proposed outfalls, effluent discharged from the existing NDWWTP outfall will likely impact water quality of the receiving waters in the vicinity of the proposed DoD outfall. Although water quality monitoring is being performed to establish baseline values of the receiving waters, the magnitude of the current discharge from the NDWWTP is less than half the ultimate design capacity of the treatment plant. Therefore, as a conservative measure, the results of the nearfield and farfield plume analysis performed for the Phase 1 report were utilized in this investigation to predict the maximum water quality impacts associated with the ultimate design discharge from the existing NDWWTP outfall. This information was used to develop the theoretical ambient receiving water conditions for the proposed DoD outfall discharge.

1.2 Scope of Work

The scope of work for this Phase 2 investigation is to assess the environmental impacts of a new point discharge from the proposed DoD secondary treatment plant on the receiving marine waters. The proposed DoD secondary treatment plant and outfall will be located north of the existing NDWWTP and outfall.

Parameters used to assess the environmental impacts on the receiving marine waters include the following:

- Comparison with the Guam Water Quality Standards (GWQS)
- Effects to the ecological life and environment of the receiving marine waters

To conduct this assessment, a conceptual design of the proposed DoD outfall was developed. The conceptual outfall design considered the bathymetry in the area, boundaries of the M-1 and M-2 waters delineated in the GWQS, and the anticipated quality and quantity of effluent discharged from the proposed DoD secondary treatment plant. This investigation is not intended to replace an engineering report. The conceptual DoD outfall design presented in this investigation will require a follow-up detailed engineering report.

Specific tasks required for this investigation include:

- Collection of site specific data on the receiving waters
  - ⇒ Ocean current dynamics
  - ⇒ Conductivity-Temperature-Depth (CTD) and water quality data from the water column utilizing an array of stations
- Wastewater characterization of secondary treated effluent
- Analysis of the proposed DoD outfall
  - ⇒ Perform nearfield (initial dilution) plume analysis using the most recent U.S. Environmental Protection Agency (USEPA) models
  - ⇒ Perform farfield plume analysis based on industry standard practices acceptable to USEPA
- Updating the nearfield and farfield plume analysis results from the Phase I investigation to develop the theoretical ambient receiving water conditions in the vicinity of the proposed DoD outfall
- Evaluation of the impacts to ecological life and environment of the receiving marine waters based on the results of the outfall analysis performed above and anticipated fate of the effluent constituents

Field investigations for benthic ecosystem, coral, phytoplankton, fishes, and other marine life were not included in this study. Previous studies by others performed in the vicinity of the DoD outfall were used, if available, and supplemented by investigations of other marine outfalls located in Guam and Hawaii.

The scope of work is included in **Appendix 1A** for reference.

1.3 Report Organization

A project team was assembled for this study with the expertise necessary to complete the various tasks associated with this investigation. The team members and involvement in this project are as follows:

Engineering Concepts, Inc. (Project Coordinator) – Civil and Environmental/Sanitary Engineers

- Establish the basis of analysis for this investigation
- Develop future wastewater flows and characteristics used in the assessment of the DoD outfall
- Develop criteria to evaluate compliance with the GWQS

EKNA Services, Inc. – Coastal and Ocean Engineers

- Characterize existing ocean current dynamics
- Develop the conceptual design of the proposed DoD outfall
- Perform nearfield and farfield plume analysis of the DoD outfall
- Assess the dilution and concentration of the mixed effluent constituents from the NDWWTP outfall and the DoD outfall

AECOS, Inc. – Aquatic Biology and Water Quality Scientists

- Characterize baseline and theoretical "pristine" background conditions of the receiving marine waters in the vicinity of the DoD outfall
- Assess impacts on the offshore benthic and water column ecosystems under the various treatment options

A variety of information is contained in this report. To simplify the presentation of technical information, the main body of the report contains general information regarding the project, basis of developing the preliminary design of the proposed DoD outfall, and impacts to the receiving marine waters. Results of the nearfield and farfield analysis of the proposed DoD outfall and environmental and ecological impacts to the marine waters are also summarized in the main body of the report. Detailed technical information is provided in the appendices and consists of complete reports prepared by EKNA Services, Inc. and AECOS, Inc.

This report is organized in the following manner:

Chapter 1 **Introduction** presents the purpose, scope of work, and overview of this study.

Chapter 2 **Criteria and Methodology** summarizes the applicable regulatory drivers, basis of analysis, and methodology employed in this investigation to assess the potential impacts of the discharge from the proposed DoD outfall on the receiving waters. Also included in this chapter is a description of the field investigation and data collection required to obtain the information used in this assessment.

Chapter 3 **Receiving Water Conditions** establishes the physical oceanographic and water quality conditions that were used as the basis for the assessment performed in this investigation. This chapter also includes the results of the Phase 1 report and evaluates the impact of the discharge from the existing NDWWTP outfall on the receiving water quality in the vicinity of the DoD outfall.

Chapter 4 **Assessment of the Discharge from the Proposed DoD Outfall** describes the anticipated characteristics of the effluent discharged from the proposed DoD secondary treatment plant, conceptual design of the proposed DoD outfall, and the impacts on the receiving waters. This chapter includes the results of the nearfield and farfield plume analysis performed by EKNA Services and the environmental impact assessment of the receiving water performed by AECOS, Inc.

Appendices Pertinent information and data referenced in the report are presented in appendices, whose numbers correspond to the chapter for which it contains supporting information.

1.4 ACKNOWLEDGMENT

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CHAPTER 2
CRITERIA AND METHODOLOGY

The purpose of this study is to assess the impacts of a new point discharge from the proposed DoD outfall on the marine water environment. Prior to discharge, the wastewater will be treated at a proposed DoD secondary treatment plant located north of the existing NDWWTP. This DoD facility will be designed to treat all DoD wastewater flows generated in the north, including additional wastewater flows associated with the USMC relocation. This wastewater treatment and disposal option was presented in the July 2008 study as Option 2.

This chapter outlines the criteria and methodology used to assess the environmental and ecological effects to the receiving waters associated with the discharge from the proposed DoD outfall.

2.1 REQUIREMENTS AND POLICIES

The following sections summarize the applicable regulatory requirements concerning point discharges and the environmental protection standards that apply to the receiving water quality.

2.1.1 Federal Water Pollution Control Act

The Federal Water Pollution Control Act (FWPCA) and subsequent amendments, commonly referred to as the Clean Water Act (CWA), authorized the USEPA, individual states, and local governments to establish programs that would control pollution and restore and maintain the chemical, physical, and biological integrity of the nation's water. The goal of the CWA is to restore the quality of the nation's water by regulating the discharge of point sources.

The CWA considers all discharges to the nation's water unlawful, unless specifically authorized by a permit that would require the discharge to attain technology-based effluent quality limits. The National Pollutant Discharge Elimination System (NPDES) permit program was established in 1972 under the CWA. The USEPA administers the NPDES program and mandates that dischargers of point source pollutants obtain an NPDES permit. By definition, a "pollutant" includes solid waste, sewage, or sewage sludge.

Pollutants discharged to U.S. waters are federally regulated by the USEPA through the NPDES permit process prescribed in 40 CFR Part 122. EPA-approved permitting programs may be promulgated by a state or territory in lieu of the federal program. While state programs must meet the standards of the federal program, they are typically more stringent than the federal regulations. Currently, the Territory of Guam does not have an approved permitting system and relies on the federal program to regulate the discharge of pollutants to its marine waters. Guam is under the administrative jurisdiction of USEPA Region IX. Therefore, NPDES permits are issued by USEPA Region IX, while the Guam Environmental Protection Agency (GEPA), the local regulatory agency, provides input regarding the receiving water quality standards, pursuant to Section 401 of the CWA.

2.1.2 Revised Guam Water Quality Standards

The GEPA adopted standards to protect the quality of Guam's territorial waters. The intent of these standards is to eliminate the degradation of receiving waters due to point source pollution.

These water quality standards are entitled, “Guam Water Quality Standards 2001 Revision" (GWQS). A copy of the GWQS is included in **Appendix 2A** for reference.

The numeric water quality standards for each criteria regulated under the GWQS differ based on the classification of the receiving waters. Coastal waters off-shore from the mean high water mark subject to ebb and tidal flows are classified in the GWQS under three major marine water categories: M-1, M-2, and M-3. These categories are defined in the GWQS as follows:

> *M-1 marine waters - “Water in this category must be of high enough quality to protect for whole body contact recreation, and to ensure the preservation and protection of marine life, including corals and reef-dwelling organisms, fish and related fisheries resources, and enable the pursuit of marine scientific research as well as aesthetic enjoyment. This category of water shall remain substantially free from pollution attributed to domestic, commercial and industrial discharges, shipping and boating, or mariculture, construction and other activities which can reduce the waters’ quality.”*
>
> *M-2 marine waters - “Water in this category must be of sufficient quality to allow for the propagation and survival of marine organisms, particularly shellfish and other similarly harvested aquatic organisms, corals and other reef-related resources, and whole body contact recreation. Other important and intended uses include mariculture activities, aesthetic enjoyment and related activities.”*
>
> *M-3 marine waters - “Water in this category is intended for general, commercial and industrial use, while allowing for protection of aquatic life, aesthetic enjoyment and compatible recreation with limited body contact. Specific intended uses include the following: shipping, boating and berthing, industrial cooling water, and marinas.”*

The classification of Guam’s marine waters is illustrated on **Figure 2.1-1**. According to the GWQS, any new point source discharge into M-1 waters is prohibited. The proposed location of the DoD outfall will be situated in M-2 marine waters, south of the M-1/M-2 boundary as shown on **Figure 2.1-2**. The existing NDWWTP outfall is located south of the proposed DoD outfall.

In order for marine waters to meet the water quality criteria, effluent limitations are placed on discharging sources. Water quality criteria for M-2 marine waters and effluent limitations imposed by the GWQS are applicable for the proposed DoD outfall and are discussed in the following sections. Due to the close proximity of the M-1/M-2 boundary, water quality criteria for M-1 marine waters are also presented in the following sections.

2.1.2.1 Regulatory Definitions

GEPA defines the following criteria as applicable to meeting the GWQS.

- *Discharge.* The direct or indirect outflow of liquid waste or wastewater from any domestic, commercial, industrial, agricultural, or any other source onto land or into waters of Guam. The term “discharge” includes either the discharge of a single pollutant or the discharge of multiple pollutants.

- *Effluent.* The liquid waste that is discharged directly or indirectly into a waterbody, storm drain, or sewage system.

- *Industrial Waste.* Any discharge containing gaseous, solid, dissolved, or suspended material resulting from any process of industry, manufacturing, trade, or business or from the processing of any natural resource, together with such sewage as may be present which may pollute the waters of Guam.

- *Mixing Zone.* The area or volume of a waterbody within which effluent(s) shall become physically mixed with the receiving waters through initial dilution. Initial dilution is the process through which the wastewater immediately mixes with the receiving water due to the momentum of the waste discharge, and the difference in density between the discharge and the receiving water.

- *Point Source.* Any discernible, confined, and discrete conveyance including, but not limited to, any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container rolling stock, concentrated animal feeding operation, or vessel or other floating craft from which pollutants are, or may be, discharged. This term does not include flows from irrigated agriculture, or agricultural, storm water runoff.

- *Pollutant.* Means dredged spoil, solid waste, incinerator residue, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials, heat, wrecked, or discarded equipment, rock, sand, cellar dirt and industrial, municipal, and agricultural waste discharged into water.

2.1.2.2 Regulatory Standards

GEPA has adopted standards to conserve, protect, maintain, and improve the quality of Guam's waters for human consumption (drinking, fish and shellfish harvesting, and food processing); for the growth and propagation of aquatic life; for marine research; for the preservation of coral reefs and wilderness areas; and for domestic, agricultural, commercial, industrial, recreational, and other legitimate uses. All waters are required to meet acceptable aesthetic qualifications, be capable of supporting desirable aquatic life, and be free from substances, conditions or combinations thereof attributable to domestic, commercial, and industrial discharges or agricultural, construction and land-use practices, or other human activities that cause visible floating material, produces turbidity or deposits, result in objectionable color, odor or taste, is toxic or harmful, or induces growth of undesirable aquatic life.

The GWQS provides specific water quality criteria based on the marine water classification. Water quality criteria applicable to M-2 and M-1 waters are presented in **Table 2.1-1**.

TABLE 2.1-1
GUAM WATER QUALITY STANDARDS

Parameter	Guam Water Quality Standards	
	M-2	M-1
Enterococci	35 enterococci/100 mL (geometric mean of 5 sequential samples over a 30-day period); 104 enterococccci/100 mL (instantaneous reading)	
pH[1]	6.5 - 8.5	
Orthophosphate	0.05 mg/L	0.025 mg/L
Nitrate-Nitrogen	0.20 mg/L	0.10 mg/L
Dissolved Oxygen[2]	75% saturation (minimum)	
Salinity	≤10% increase over ambient (except due to natural conditions)	
Total Non-Filterable Suspended Solids	20 mg/L (except due to natural conditions); and ≤10% increase over ambient	5 mg/L (except due to natural conditions)
Turbidity[3]	≤1.0 NTU over ambient (except due to natural conditions)	≤0.5 NTU over ambient (except due to natural conditions)
Radioactive	strictly prohibited	
Temperature	≤1.8 degrees F variation from ambient	
Oil and Petroleum Products	visible film, or sheen, or surface discoloration with corresponding oil or petroleum product odor is unacceptable; damage to fish, invertebrates or drinking water quality is unacceptable; formation of oil deposits on shore or bottom is unacceptable	
Pesticides	reference U.S. Water Quality Criteria Guidance “Blue Book” (NAS/NAE, 1973) (US-GPO #5501-00520), “Red Book” (USEPA, 1976), “Green Book” (FWPCA, 1968) and “Gold Book” (USEPA, 1986a), which is updated periodically	
Toxic Substances	see Table 2.1-2	
Aluminum	0.20 mg/L	
Ammonia	0.02 mg/L	
Barium	0.50 mg/L	
Boron	5.00 mg/L	
Bromine	0.10 mg/L (free); 100.00 mg/L (as Bromate)	
Chlorine (total)	0.0075 mg/L	
Fluoride	1.50 mg/L	
Iron	0.05 mg/L	
Manganese	0.02 mg/L	
Molybdenum	--	
Sulfide	0.005 mg/L	
Tributyltin	0.010 µg/L (chronic); 0.356 µg/L (acute)	
Uranium[4]	0.00 mg/L	

Reference: Guam Water Quality Standards (2001 Revision)

[1]For open ocean water where the depth is substantially greater than the euphotic zone, the pH should not be changed more than 0.2 units from the naturally occurring variation, or in any case outside the range of 6.5-8.5.
[2]Where natural conditions cause lower dissolved oxygen levels, controllable water quality factors shall not cause further reductions.
[3]Marine waters exhibiting debris, rapidly settling particles, and/or true color are required to be measured by secchi disc. Secchi disc visibility shall not decrease by more than 5 meters from ambient conditions except when due to natural conditions.
[4]Naturally occurring uranium has been reported in concentrations of 0.003 mg/L, 0.00004 mg/L (river water).

In addition to receiving water quality criteria presented in **Table 2.1-1**, general effluent limitations provided in the GWQS include:

- Dilution is not acceptable as the sole means of treatment.
- All point source discharges to Guam's waters will be controlled through the federal NPDES or local GEPA permit programs.
- All sewage, including industrial waters and other wastes, shall be treated to the degree required to achieve standards of water quality prior to discharge to the waters of Guam.
- Pretreatment of toxic and hard-to-treat substances is required at the source if pass-through, interference with treatment processes, or sludge contamination results at the municipal treatment plant.
- No effluent shall, alone or in combination with other sources, cause a violation of any water quality standard.
- Measurement of pollutant concentrations to determine compliance with effluent limitations shall be made at the point immediately following final treatment before mixing with other wastes.
- Operating reports shall be submitted to GEPA.
- New and existing permitted point source discharges will promptly comply with any new or more restrictive water quality-based effluent limitations based upon adopted water quality criteria.

For secondary treatment, the GWQS provides the following minimum levels for effluent quality:

- Biochemical Oxygen Demand (5 day)
  - The arithmetic mean of the concentration for samples collected over a period of 30 consecutive days shall not exceed 30 mg/L.
  - The arithmetic mean of the concentration for samples collected over a period of 7 consecutive days shall not exceed 45 mg/L.
  - The arithmetic mean of the concentration of the effluent samples collected over a period of 30 consecutive days shall not exceed 15 percent of the arithmetic mean of the concentration of the influent samples collected over the same period (85 percent removal rate).
- Suspended Solids
  - The arithmetic mean of the concentration for samples collected over a period of 30 consecutive days shall not exceed 30 mg/L.
  - The arithmetic mean of the concentration for samples collected over a period of 7 consecutive days shall not exceed 45 mg/L.
  - The arithmetic mean of the concentration of the effluent samples collected over a period of 30 consecutive days shall not exceed 15 percent of the arithmetic mean of the concentration of the influent samples collected over the same period (85 percent removal rate).

- Microbiology
  - The appropriate GEPA microbiological indicator and standard for receiving waters classification will apply to the effluent and/or;
  - The arithmetic mean of the fecal coliform values for samples collected over a period of 30 consecutive days shall not exceed 200 per 100 mL.
  - The arithmetic mean of the fecal coliform values for samples collected over a period of 7 consecutive days shall not exceed 400 per 100 mL.

- pH
  - Effluent values for pH shall remain within the limits of 6.0 to 9.0.

Mixing zones are also regulated under the GWQS. Water quality criteria are required to be met at every boundary point of the mixing zone. In summary, the designated uses or water quality of the waters shall not be affected by the presence of the mixing zone.

2.1.3 Quality Criteria for the Receiving Water

The CWA Amendments required that USEPA establish ambient water quality criteria for pollutants expected to cause adverse effects on aquatic, marine, or human life. Not regulatory driven but based on the latest scientific research, these water quality criteria are published in “Quality Criteria for Water, 1986", also referred to as the “Gold Book”. However, certain water quality standards have been revised since 1986. The pollutants and the thresholds expected to cause observable effects on marine life and human health (carcinogens) are listed in **Table 2.1-2**, as reported in the GWQS 2001 revision.

TABLE 2.1-2
GUAM WATER QUALITY STANDARDS
NUMERICAL CRITERIA FOR PRIORITY TOXIC POLLUTANTS

CONSTITUENT	CAS NO. [11]	SALTWATER		HUMAN HEALTH (10^{-6} risk for carcinogens) FOR CONSUMPTION OF ORGANISMS ONLY (µg/L)
		CRITERION MAXIMUM CONCENTRATION [1] (µg/L)	CRITERION CONTINUOUS CONCENTRATION [2] (µg/L)	
Antimony	7440360			4,300 [3]
Arsenic	7440382	69	36	
Beryllium	7440417			[5]
Cadmium	7440439	42	9.3	[5]
Chromium (III)	16065831			[5]
Chromium (VI)	8540299	1100	50	[5]
Copper	7440508	4.8	3.1	
Lead	7439921	210	8.1	[5]
Mercury	7439976	2.1	0.025	0.051 [3]
Nickel	7440020	74	8.2	4,600 [3]
Selenium	7782492	290	71	[5]
Silver	7440224	2.3		
Thallium	7440280			6.3 [3]
Zinc	7440666	95	86	69,000
Cyanide	57125	1	1	200,000 [3,6]
Asbestos	1332214			7,000,000 fibers/L [7]
2,3,7,8-TCDD (Dioxin)	1746016			0.000000014 [4]
Acrolein	107028			780
Acrylonitrile	107131			0.66 [3,4]
Benzene	71432			71 [3,4]
Bromoform	75252			360 [3,4]
Carbon Tetrachloride	56235			4.4 [3,4]
Chlorobenzene	108907			21,000 [3,6]
Chlorodibromomethane	124481			34 [3,4]
Chloroethane	75003			
2-Chloroethylvinyl Ether	110758			
Chloroform	67663			470 [3,4]

TABLE 2.1-2 (Continued)

CONSTITUENT	CAS NO. [11]	SALTWATER		HUMAN HEALTH (10^{-6} risk for carcinogens) FOR CONSUMPTION OF ORGANISMS ONLY (µg/L)
		CRITERION MAXIMUM CONCENTRATION [1] (µg/L)	CRITERION CONTINUOUS CONCENTRATION [2] (µg/L)	
Dichlorobromomethane	75274			46 [3,4]
1,1-Dichloroethane	75343			
1,2-Dichloroethane	107062			99 [3,4]
1,1-Dichloroethylene	75354			3.2 [3,4]
1,2-Dichloropropane	78875			39 [3]
1,3-Dichloropropylene	542756			1,700 [3]
Ethylbenzene	100414			29,000 [3]
Methyl Bromide	74839			4,000 [3]
Methyl Chloride	74873			[5]
Methylene Chloride	75092			1,600 [3,4]
1,1,2,2-Tetrachloroethane	79345			11 [3,4]
Tetrachloroethylene	127184			8.85 [4]
Toluene	108883			200,0000 [3]
1,2-Trans-Dichloroethylene	156605			140,000 [3]
1,1,1-Trichloroethane	71556			[5]
1,1,2-Trichloroethane	79005			42 [3,4]
Trichloroethylene	79016			81 [4]
Vinyl Chloride	75014			525 [4]
2-Chlorophenol	95578			400 [3]
2,4-Dichlorophenol	120832			790 [3]
2,4-Dimethylphenol	105679			2,300 [3]
2-Methyl-4,6-Dinitrophenol	534521			765
2,4-Dinitrophenol	51285			14,000 [3]
2-Nitrophenol	88755			
4-Nitrophenol	100027			
3-Methyl-4-Chlorophenol	59507			

TABLE 2.1-2 (Continued)

CONSTITUENT	CAS NO. (11)	SALTWATER		HUMAN HEALTH (10^{-6} risk for carcinogens) FOR CONSUMPTION OF ORGANISMS ONLY (µg/L)
		CRITERION MAXIMUM CONCENTRATION (1) (µg/L)	CRITERION CONTINUOUS CONCENTRATION (2) (µg/L)	
Pentachlorophenol	87865	13	7.9	8.2 (3,4,6)
Phenol	108952			4,600,000 (3,6)
2,4,6-Trichlorophenol	88062			6.5 (3,4)
Acenaphthene	83329			2,700 (3)
Acenaphthylene	208968			
Anthracene	120127			110,000 (3)
Benzidene	92875			0.00054 (3,4)
Benzo(a)Anthracene	56553			0.049 (3,4)
Benzo(a)Pyrene	50328			0.049 (3,4)
Benzo(b)Fluoranthene	205992			0.049 (3,4)
Benzo(ghi)Perylene	191242			
Benzo(k)Fluoranthene	207089			0.049 (3,4)
Bis(2-Chloroethoxy) Methane	111911			1.4 (3,4)
Bis(2-Chloroethyl)Ether	111444			
Bis(2-Chloroisopropyl) Ether	108601			170,000 (3)
Bis(2-Ethylhexyl) Phthalate	117817			5.9 (3,4)
4-Bromophenyl Phenyl Ether	101553			
Butylbenzyl Phthalate	85687			5,200 (3)
2-Chloronaphthalene	91587			4,300 (3)
4-Chlorophenyl Phenyl Ether	7005723			
Chrysene	218019			0.049 (3,4)
Dibenzo(a,h)Anthracene	53703			0.049 (3,4)
1,2-Dichlorobenzene	95501			17,000 (3)
1,3-Dichlorobenzene	541731			2,600
1,4-Dichlorobenzene	106467			2,600

TABLE 2.1-2 (Continued)

CONSTITUENT	CAS NO. [11]	SALTWATER		HUMAN HEALTH (10^{-6} risk for carcinogens) FOR CONSUMPTION OF ORGANISMS ONLY (µg/L)
		CRITERION MAXIMUM CONCENTRATION [1] (µg/L)	CRITERION CONTINUOUS CONCENTRATION [2] (µg/L)	
3,3-Dichlorobenzidine	91941			0.077 [3,4]
Diethyl Phthalate	84662			120,000 [3]
Dimethyl Phthalate	131113			2,900,000
Di-n-Butyl Phthalate	84742			12,000 [3]
2,4-Dinitrotoluene	121142			9.1 [4]
2,6-Dinitrotoluene	606202			
Di-n-Octyl Phthalate	117840			
1,2-Diphenylhydrazine	122667			0.54 [3,4]
Fluoranthene	206440			370 [3]
Fluorene	86737			14,000 [3]
Hexachlorobenzene	118741			0.00077 [3,4]
Hexachlorobutadiene	87683			50 [3,4]
Hexachlorocyclopentadiene	77474			17,000 [3,6]
Hexachloroethane	67721			8.9 [3,4]
Indeno(1,2,3-cd)Pyrene	193395			0.049 [3,4]
Isophorone	78591			2,600 [4]
Naphthalene	91203			
Nitrobenzene	98953			1,900 [3,6]
N-Nitrosodimethylamine	62759			8.1 [3,4]
N-Nitrosodi-n-Propylamine	621647			1.4 [3,4] 5
N-Nitrosodiphenylamine	86306			16 [3,4]
Phenanthrene	85018			11,000 [3]
Pyrene	129000			
1,2,4-Trichlorobenzene	120821			940
Aldrin	309002	1.3 [8]		0.00014 [3,4]
alpha-BHC	319846			0.013 [3,4]
beta-BHC	319857			0.046 [3,4]

TABLE 2.1-2 (Continued)

CONSTITUENT	CAS NO. (11)	SALTWATER		HUMAN HEALTH (10^{-6} risk for carcinogens) FOR CONSUMPTION OF ORGANISMS ONLY (µg/L)
		CRITERION MAXIMUM CONCENTRATION (1) (µg/L)	CRITERION CONTINUOUS CONCENTRATION (2) (µg/L)	
gamma-BHC	58899	0.16 (8)		0.063 (4)
delta-BHC	319869			
Chlordane	57749	0.09 (8)	0.004 (8)	0.0022 (3,4)
4,4'-DDT	50293	0.13 (8)	0.001 (8)	0.00059 (3,4)
4,4'-DDE	72559			0.00059 (3,4)
4,4'-DDD	72548			0.00084 (3,4)
Dieldrin	60571	0.71 (8)	0.0019 (8)	0.00014 (3,4)
alpha-Endosulfan	959988	0.034 (8)	0.0087 (8)	240 (3)
beta-Endosulfan	33213659	0.034 (8)	0.0087 (8)	240 (3)
Endosulfan Sulfate	1031078			240 (3)
Endrin	72208	0.037(8)	0.0023 (8)	0.81 (3,6)
Endrin Aldehyde	7421934			0.81 (3,6)
Heptachlor	76448	0.053 (8)	0.0036 (8)	0.00021 (3,4)
Heptachlor Epoxide	1024573	0.053 (8)	0.0036 (8)	0.00011 (3,4)
PCBs	1336363		0.03 (8,10)	0.000171 (3,4)
Toxaphene	8001352	0.21	0.0002	0.00075 (3,4)

Reference: Guam Water Quality Standards (10 August 2001)

Notes:

(1) Criteria Maximum Concentration (CMC) is an acute concentration. It is the one (1) hour average concentration in ambient waters that should not be exceeded once every 3 years on average.

(2) Criteria Continuous Concentration (CCC) is a chronic concentration. It is the four (4) day average concentration of a pollutant in ambient water that should not be exceeded more than once every 3 years on average.

(3) Criteria revised to reflect the USEPA q_1* or RfD, as contained in the Integrated Risk Information System (IRIS) as of 1 October 1996. The fish tissue bioconcentration factor (BCF) from the 1980 documents was retained in each case.

(4) These criteria are based upon carcinogenicity of 10^{-6} risk.

(5) The Agency is not promulgating human health criteria for these contaminants. However, permit authorities should address these contaminants in NPDES permit actions using Guam's existing narrative criteria for toxics.

(6) No criteria for protection of human health from consumption of aquatic organisms (excluding water) were presented in the 1980 criteria document, or in the 1986 Quality Criteria for Water. Nevertheless, sufficient information was presented in the 1980 document to allow a calculation of a criterion, even though the results of such a calculation were not shown in the document.

(7) The criterion for asbestos is the MCL (40 CFR 141.62).

(8) Aquatic life criteria for these compounds were issued by the USEPA in 1980 utilizing the 1980 Guidelines for criteria development. The acute values shown are final acute values (FAV), which by the 1980 Guidelines are instantaneous values as contrasted with a CMC which is a short-term average.

(9) This criterion applies to total PCBs or cogener or isomer analyses.

(10) PCBs are a class of chemicals which include aroclors 1242, 1254, 1221, 1232, 1248, 1260, and 1016, CAS numbers 53469219, 11097691, 11104282, 11141165, 12672296, 11096825, and 12674112, respectively. The aquatic life criteria apply to this set of PCBs.

(11) Chemical Abstracts Service "CAS" registry number.

2.2 SUMMARY OF APPROACH

The purpose of this study is to support the EIS that will be prepared for the USMC relocation from Okinawa to Guam. An EIS is a document required under the National Environmental Policy Act to ensure that federal agencies have addressed the environmental concerns associated with their actions. The EIS identifies the environmental effects associated with a proposed action as well as the effects of other reasonable alternatives to this action.

2.2.1 Study Methodology

The proposed USMC relocation from Okinawa to Guam will increase population in the northern portion of the island. Phase 1 of this project investigated the environmental impacts to the receiving waters associated with options to treat the additional wastewater flows at the existing NDWWTP and discharge the treated effluent through the plant's outfall. The construction of a new outfall for the NDWWTP was recently completed and placed into operation on 23 January 2009. The new NDWWTP outfall replaces the old outfall that discharged seaward of the shallow reef flat. The new outfall was designed to discharge into deeper water at a 140-foot depth and to accommodate design average and peak flows of 12.0 MGD and 28.6 MGD, respectively. The diffuser system for the new outfall as shown in the original design documents has yet to be installed. For the purpose of the Phase 1 investigation, however, it was assumed that the diffuser system was installed according to the original design documents to achieve the dispersion of effluent intended. Preliminary results of the Phase 1 investigation are documented in a separate interim report dated February 2009 titled *Northern District Wastewater Treatment Plant Outfall Assessment*, hereafter referred to as the Phase 1 Report.

This Phase 2 study addresses the environmental impacts to the receiving waters associated with the option of treating all DoD wastewater flows generated in the northern district of Guam, including the additional flows associated with the USMC relocation, at a new DoD secondary treatment facility. This proposed DoD facility will be located north of the existing NDWWTP and will discharge secondary treated effluent to the Philippine Sea through a new DoD outfall. The proposed DoD outfall will be located north of both the old and new NDWWTP outfalls. The results of the Phase 1 investigation indicate that the plume from the new NDWWTP outfall generally migrates toward the north and west, in the direction of the proposed DoD outfall. This will impact the environment and ecology of the receiving waters in the vicinity of the proposed DoD outfall associated with the discharge from the new NDWWTP outfall.

The purpose of this Phase 2 investigation is to focus on the additional environmental impacts to the receiving waters associated with the proposed discharge from the DoD outfall. The primary criterion used to assess environmental impact is compliance with the GWQS. If the constituents in the treated effluent from the proposed DoD secondary treatment plant meet GWQS without dilution, then no further analysis is required. Otherwise, further evaluation is necessary to assess initial dilution and farfield transport of the constituents in the receiving waters and their biological impacts to the marine life, benthic faunal, and the coral reef ecosystems.

Assessment of the environmental and ecological impacts associated with the discharge from the proposed DoD outfall is further complicated by the following:

- There are no preliminary design plans for the proposed DoD outfall.
- The current discharge from the new NDWWTP outfall creates an altered ambient receiving water environment in the vicinity of the proposed DoD outfall, making it difficult to ascertain pristine water quality conditions without the influence of the NDWWTP discharge plume.
- The current discharge from the NDWWTP was determined to be approximately 5.1 MGD, which is less than half the design capacity of the new outfall of 12.0 MGD. The NDWWTP may utilize the entire capacity of its new outfall in the future due to civilian growth and development in the area. Therefore, current water quality sampling preformed for this investigation may not be appropriate to predict the influence of the discharge from the NDWWTP on future ambient receiving water conditions in the vicinity of the proposed DoD outfall.

To address these challenges, the following approach was undertaken in this investigation.

2.2.1.1 Conceptual DoD Outfall Design

Conceptual design of the proposed DoD outfall was performed for this investigation. The following criteria were used as the basis for the design of the proposed DoD outfall:

- Discharge an average flow of 5.0 MGD of secondary treated effluent.
- Locate within the M-2 water quality boundaries.
- Configuration to consider the existing bathymetry in the area.
- Performance based on achieving GWQS.

As presented in the Phase 1 Report, the results of the farfield plume analysis indicate that the GWQS for enterococcus and ammonia cannot be achieved in the vicinity of the proposed DoD outfall due to the primary treated effluent discharged from the new NDWWTP outfall. These constituent exceedances cannot be addressed by the proposed DoD outfall and must be corrected at the NDWWTP. Therefore, the conceptual design of the proposed DoD outfall was based on achieving the water quality levels presented in the GWQS, assuming secondary treatment will be provided at the NDWWTP to reduce the pollutants discharged.

2.2.1.2 Future Receiving Water Quality Development

Phase 2 of the investigation assessed the environmental and ecological impacts to the receiving waters associated with a new point discharge from the proposed DoD outfall. Since the discharge plume from the new NDWWTP outfall will likely migrate toward the DoD outfall, there will be preexisting environmental and ecological impacts to the receiving waters that are not associated with the proposed DoD outfall discharge. Therefore, this investigation will determine the impacts associated with the new NDWWTP outfall discharge to the receiving waters in the vicinity of the proposed DoD outfall location as well as the compounded impacts associated with the addition of a new point discharge from the proposed DoD outfall.

As a conservative approach, the future ambient water quality condition anticipated in the vicinity of the proposed DoD outfall was based on the NDWWTP discharging primary treated effluent at the full design capacity of its new outfall of 12.0 MGD. Since the current discharge from the NDWWTP is approximately 5.1 MGD, water quality sampling in the vicinity of the proposed DoD outfall cannot be used to project the modified ambient water quality of the receiving waters resulting from the discharge of 12.0 MGD from the new NDWWTP outfall. Initial dilution

analysis and farfield plume modeling performed for the new NDWWTP outfall in the Phase 1 investigation was updated in this study to estimate the future ambient water quality condition resulting from the discharge of 12.0 MGD of primary treated effluent from the new NDWWTP outfall. The methodology used for this Phase 2 investigation is summarized on **Figure 2.2-1**.

2.2.2 Outfall and Plume Modeling

Initial dilutions for the new NDWWTP and proposed DoD outfalls were developed by EKNA Services, Inc. for this investigation using the USEPA approved dilution model *Visual Plumes*. This modeling program was used to predict the initial dilution that can be achieved with various outfall configurations. The new NDWWTP outfall model was originally developed for the Phase 1 portion of this investigation and is documented in the Phase 1 Report. The proposed DoD outfall was developed for this Phase 2 investigation.

Farfield plume modeling was also performed by EKNA Services, Inc. to determine the fate of the plume beyond the diffuser location, after initial dilution has taken place. The results of this model were used to determine the environmental and ecological impacts to the areas adjacent to the outfall.

To accurately simulate the nearfield and farfield plumes, the physical characteristics of the outfall configuration, design flow, and CTD, ocean current and wind rose data were input into the computer model.

2.3 DATA COLLECTION AND GENERATION

Data collected in Phase 1 were also utilized in this Phase 2 study. This included gathering and reviewing existing information pertinent to this investigation and available from NAVFAC Pacific and GWA, such as previous design and planning reports, record drawings of the NDWWTP and outfall, laboratory analysis of the wastewater characteristics, and flow data from the plant. Assistance from NAVFAC Pacific, COMNAVMAR, and GWA in providing this information contributed substantially to this investigation.

Additional information specific to the proposed DoD outfall location was collected for this second phase of the investigation. AECOS, Inc. researched and collected data from existing reports and studies performed by others on the marine life and environment in the vicinity of the proposed DoD outfall. Supplemental information was provided through a review of reports and investigations performed on other marine outfalls located in Guam and Hawaii.

Field work for this phase of the investigation included the installation of data collecting instruments and water quality sampling in the vicinity of the proposed DoD outfall. A summary of the field instruments installed and the water quality sampling results follows.

2.3.1 Ocean Current Recorders

Site specific data on the dynamics of ocean currents are necessary for the development of nearfield and farfield plume models. The ocean current meter measurement program implemented for this investigation included a 9-month in-situ deployment of two current meters.

An illustration of the current meter mooring is presented on **Figure 2.3-1**. Two separately moored InterOcean S4 electromagnetic current meters were installed at the locations shown on **Figure 2.3-2**. This instrument measures and records current speed and direction, water depth, and water temperature. Data are continuously stored in the instrument at preset intervals to match the expected length of deployment.

This Phase 2 report is based on the first four months of data (14 August 2008 to 9 December 2008) consisting of two deployments. Deployment 1 collected ocean current data from 14 August 2008 to 7 October 2008 at stations CM1 and CM2. The data collection period for the second deployment was from 8 October 2008 to 9 December 2008. A summary of these results is presented in Chapter 3.

2.3.2 Receiving Water Quality Data

This investigation implemented a one-year water quality monitoring program to gather baseline information on current ambient conditions of the receiving waters. The water quality constituents monitored for this investigation were limited to those regulated under the GWQS and were likely to be present in the wastewater discharge in quantities that may result in a detrimental impact to the receiving marine waters. This was determined through a review of existing data provided by GWA on the NDWWTP effluent characteristics and data from other primary and secondary wastewater treatment plants located in Guam and Hawaii. In addition to the select GWQS constituents, total nitrogen, total phosphorus, and chlorophyll α were included in the limited water quality monitoring program. Total nitrogen and phosphorus represent the total nutrient source available for breakdown by phytoplankton and benthic algae, and chlorophyll α is an indicator of phytoplankton biomass in the marine water.

Water quality sampling was performed for both Phases 1 and 2 of this investigation. The Phase 1 water quality monitoring plan consisted of four sampling events that took place over the course of one year. The water quality monitoring program consisted of an array of ten sampling stations located in and around the new NDWWTP outfall, with samples collected at three depths (near surface, near bottom, and mid-depth). The Phase 2 water quality monitoring plan consisted of three sampling events that took place over a nine-month period. Eight sampling stations in and around the proposed DoD outfall were established. Preliminary results from the Phase 1 study indicated a lack of a thermocline through the water column. Samples were therefore collected only at the near surface and near bottom depths for each of the eight sampling locations in Phase 2.

The location of the sampling stations for both phases is summarized in **Table 2.3-1** and shown previously on **Figure 2.3-2**.

TABLE 2.3-1
RECEIVING WATER SAMPLING STATIONS

Phase	Station No.	Latitude (N) Deg Dec Min	Longitude (E) Deg Dec Min	Depth* Meters
1	1	13 33.21678	144 48.46404	19 / 38
	2	13 33.14590	144 48.44342	22.5 / 45
	3	13 33.11463	144 48.43620	20 / 40
	4	13 33.08166	144 48.42806	19 / 38
	5	13 33.03607	144 48.39470	19.5 / 39
	6	13 32.93168	144 48.37360	23.5 / 47
	7	13 33.12751	144 48.38585	29.5 / 59
	8	13 33.12218	144 48.40900	26 / 52
	9	13 33.10841	144 48.46130	19 / 38
	10	13 33.10339	144 48.48598	17 / 34
2	A	13 33.358	144 48.468	28
	B	13 33.358	144 48.468	40
	C	13 33.257	144 48.477	36
	D	13 33.290	144 48.430	54
	E	13 33.288	144 48.454	43
	G	13 32.285	144 48.504	30
	H	13 33.284	144 48.527	6
	J	13 33.181	144 48.453	38

**Depth of sample: Phase 1 – mid-depth and bottom, Phase 2 – bottom.*

The analysis of the samples collected is presented in **Table 2.3-2** and was conducted in accordance with standard oceanographic or EPA methods with detection limits less than the values specified in the Guam Water Quality Standards.

TABLE 2.3-2
WATER QUALITY MONITORING PROGRAM

Analyses	Hold Time	Preservation Method
pH	15 minutes	none
Dissolved Oxygen	Immediate	none
Temperature	Immediate	none
Salinity (field)	Immediate (needed for DO)	none
Salinity (by salinometer)	28 days	none
Turbidity	48 hrs	chill on ice to 4ºC
Total Suspended Solids	7 days	chill on ice to 4ºC
Nitrate + Nitrite Nitrogen	28 days	chill on ice to 4ºC , freeze
Ammonia Nitrogen	28 days	chill on ice to 4ºC , freeze
Total Nitrogen	28 days	chill on ice to 4ºC , freeze
Ortho-Phosphate	48 hrs	chill on ice to 4ºC
Total Phosphorus	28 days	chill on ice to 4ºC , freeze
Chlorophyll	---	Chill sample on ice, filter and extract as soon as possible; store frozen in dark
Enterococcus	6-8 hrs	chill on ice to 4ºC

In addition to the analyses presented in the table above, a vertical profile of conductivity, temperature, and depth (CTD) of each sampling station was collected using the Sea-Bird Electronics Seacat Profiler SBE 19.

Limited toxic substances were analyzed as part of the Phase 1 water quality monitoring program and included total sulfide, copper, lead, and zinc. Four samples were collected at each of the four sampling events (sixteen samples total).

This Phase 2 report is primarily based on the water quality results of the samples collected near the proposed DoD outfall location identified under the Phase 2 monitoring program. These results are comprised of the first two scheduled sampling events; one during 10-11 November 2008 and one during 23-24 March 2009. The old NDWWTP outfall was still in operation during the November 2008 sampling event. Discharge through the old NDWWTP outfall was discontinued in January 2009, when the new NDWWTP outfall was completed. The March 2009 water quality sampling results reflect this.

2.3.3 NDWWTP Effluent Wastewater Quality Data

The quality of the primary treated effluent discharged through the new NDWWTP outfall was previously evaluated in the Phase 1 Report. This information is still relevant for this Phase 2 study due to the influence of this discharge plume on ambient water quality of the receiving water in the vicinity of the proposed DoD outfall.

Data collected and used in the Phase 1 evaluation of the NDWWTP discharge included available discharge monitoring reports (DMR) and additional analytical testing performed by GWA on the NDWWTP influent and effluent wastewater. To supplement this information, grab samples of influent and effluent were taken at the NDWWTP on 13 October 2008 for the Phase 1 investigation and analyzed for the same water quality parameters included in the monitoring program for the receiving waters (see **Table 2.3-2**) with the exception of chlorophyll. Total sulfide, copper, lead, and zinc were also included in the analyses.

CHAPTER 3
RECEIVING WATER CONDITIONS

Primary treated wastewater currently discharges through the new NDWWTP ocean outfall at an average daily flow rate of 5.1 MGD. Phase 1 of this investigation addressed the impacts associated with the discharge of additional DoD flows through this new NDWWTP outfall. Results of the farfield plume analysis in Phase 1 indicated that the discharge from the new NDWWTP outfall will migrate in a northwesterly direction toward the proposed DoD outfall and will likely alter the marine environment in this area to less than pristine conditions.

As discussed in Chapter 2, the initial dilution analysis and farfield plume modeling results for the new NDWWTP outfall performed during Phase 1 of this investigation were updated for this Phase 2 study to predict water quality conditions of the receiving waters in the vicinity of the proposed DoD outfall. As shown schematically on Figure 2.2-1 in Chapter 2, information required to perform this task included the following:

- Discharge quantity and quality from the NDWWTP (assessed in Phase 1 study)
- Ocean current data (collected for both Phases 1 and 2 of this investigation)
- Pristine receiving water quality conditions without the influence of any wastewater discharges (utilizing results from the Phase 1 and 2 water quality monitoring plans)

This chapter presents the information utilized to form the basis for developing anticipated receiving water quality conditions in the vicinity of the proposed DoD outfall resulting from the influence of the new NDWWTP outfall discharge.

To minimize confusion in the discussions presented in the subsequent sections of this chapter and Chapter 4, the following terminology is used with respect to describing the receiving water quality conditions:

Baseline water quality refers to the results of all sampling effort in the project location. This is the current (actual) receiving water quality of the waters off Tanguisson Point and includes the influence of the existing discharge from the new NDWWTP outfall (approximate average discharge of 5.1 MGD).

Background water quality is used to characterize the water quality conditions that would exist in the absence of a wastewater discharge. In an attempt to derive average background water quality values in the waters off Tanguisson Point not influenced by the NDWWTP discharge, analytical results for select stations monitored in Phases 1 and 2 were used. Where local field measurements are either absent or not considered representative of the background water quality, historical data on similar open coastal environments were used to estimate background concentrations.

Ambient water quality is the theoretical water quality condition in the vicinity of the proposed DoD outfall determined using the initial dilution analysis and farfield plume modeling results for the new NDWWTP outfall during Phase 1 of the investigation. Although “ambient” is used in a similar sense in the GWQS, the standards consider ambient to be actual conditions, not the theoretical values determined in this Phase 2 study.

3.1 NDWWTP PRIMARY EFFLUENT QUANTITY AND QUALITY

The NDWWTP was commissioned in 1980 and was designed to provide primary treatment for an average daily flow of 12 MGD and a peak hourly flow of 28.6 MGD. Currently, all DoD wastewater flow in the north is treated at the NDWWTP. This Phase 2 study evaluates the option to construct a separate DoD treatment facility for all DoD wastewater flow in the north, including the additional wastewater loading associated with the relocation of the U.S. Marine Corps from Okinawa to Guam. Although wastewater from DoD facilities would no longer be treated at the NDWWTP under this option, this Phase 2 study assumes the entire capacity of the new outfall of 12 MGD will be utilized by future growth and development of the civilian population. Therefore, the discharge from the new NDWWTP outfall that will influence water quality conditions in the vicinity of the proposed DoD outfall is 12 MGD.

Primary treated effluent quality discharged from the NDWWTP was previously evaluated in Phase 1 of this investigation. The following discussions are excerpts from the Phase 1 Report and are used to establish effluent quality discharged from the new NDWWTP outfall.

3.1.1 GMP's 1998 Analytical Results

The *"Basis of Design for the Northern District Treatment Plant Outfall Extension"* was prepared by GMP Associates, Inc. in September 2001 for GWA and the Department of Public Works, hereafter referred to as the 2001 BOD Report. This document contained the effluent wastewater concentrations used to design the new NDWWTP outfall. Included in the 2001 BOD Report was a priority toxic pollutant scan. Of the 126 priority pollutants, five were detected, including lead, p-Dichlorobenzene, toluene, copper, and zinc. The 2001 BOD Report indicated that the concentration of lead of 2,900 μg/L was likely to be an aberration. The concentration of lead measured at other treatment plants in Guam and Hawaii was used to support this conclusion. Therefore, lead was not included in the required dilution analysis in the 2001 BOD Report. Effluent concentrations used in the 2001 BOD Report for the design of the new NDWWTP outfall are presented in **Table 3.1-1**, along with the required dilution determined in the 2001 BOD Report.

As indicated in the 2001 BOD Report, the dilution required for the new NDWWTP outfall was determined to be 200. This is based on the effluent total suspended solids (TSS) concentration of 190 mg/L relative to the ambient concentration found in the receiving waters. The required dilution for TSS was the second highest value. Enterococci required the largest dilution of 8,000. The 2001 BOD Report indicated that this dilution could not be practicably achieved by a diffuser constructed at a reasonable cost. Therefore, the new NDWWTP outfall was designed to attain the required dilution of 200.

TABLE 3.1-1

NDWWTP EFFLUENT CONCENTRATIONS AND REQUIRED DILUTION PRESENTED IN 2001 BOD REPORT

Constituent Regulated by Guam Water Quality Standards	Unit	Water Quality Standard	Effluent Concentration	Required Dilution
Enterococci	#/100mL	104	830,000*	7,981
pH		6.5 – 8.5	7.2	10
Orthophosphate	μg/L	50	4,240*	85
Nitrate-Nitrogen	μg/L	200	29	0
Dissolved Oxygen	mg/L	4.6	0	6
Salinity	ppt	+/- 10% ambient	0.8	0
Total Suspended Solids	μg/L	20,000	190,000	170
Turbidity	NTU	1 + ambient	---	---
Temperature	°C	1 + ambient	30	0
Priority Toxic Pollutants				
p-Dichlorobenzene	μg/L	2,600	1.1	0
Toluene	μg/L	5,000	1.9	0
Copper	μg/L	3.1	53	17
Zinc	μg/L	86	2,110	2
Additional Toxic Pollutants				
Ammonia	μg/L	20	1,045*	52
Sulfide	μg/L	5	110*	22
Non-regulated Chemical Constituents				
Acetone	μg/L	---	86	n/a
4-Methylphenol	μg/L	---	45	n/a

Notes:

- *Values identified with "*" are estimated from analyses of primary effluent from Oahu wastewater treatment plants.*
- *Ammonia and orthophosphate are averaged from grab samples.*
- *Application factor of 0.05 applied to total NH_3 concentration of 20.9 mg/L.*
- *Sulfide concentration is from an in-plant survey at Sand Island WWTP.*
- *Enterococci is from a five plant survey of primary effluent.*
- *Effluent total suspended solids concentration is the maximum average value recorded from January 1997 to September 1998.*
- *Required dilution for dissolved oxygen assumes 3 mg/L immediate demand.*

3.1.2 GWA's 2007-2008 Analytical Results

GWA provided DMRs for the NDWWTP for the period October 2006 to June 2007. In accordance with the NPDES permit requirements, 5-day biochemical oxygen demand (BOD_5), TSS, settleable solids, oil and grease, and pH are monitored in the effluent. BOD_5 and TSS are also monitored in the influent entering the plant. Both monthly average and daily maximum values are recorded for all parameters except pH, for which minimum and maximum values are reported. A summary of the results contained in the DMR is provided in **Table 3.1-2**.

TABLE 3.1-2
DMR SUMMARY
(October 2006 to June 2007)

Parameter	Statistical Analysis	Influent		Effluent			
		Monthly Average	Daily Maximum	Monthly Average	Monthly Average Discharge Limit	Daily Maximum	Daily Maximum Discharge Limit
BOD_5 (mg/L)	Geometric Mean	112	163	78	85	95	170
	Minimum	65	104	46		57	
	Maximum	195	274	113		141	
	90% Analysis*	153	222	101		117	
TSS (mg/L)	Geometric Mean	104	182	66	50	105	100
	Minimum	59	59	33		35	
	Maximum	428	1,332	276		844	
	90% Analysis*	141	304	85		128	
Settleable Solids (mL/L)	Geometric Mean	NA	NA	0.68	1	1.74	2
	Minimum	NA	NA	0.2		0.3	
	Maximum	NA	NA	4		20	
	90% Analysis*	NA	NA	1.6		5.4	
Oil and Grease (kg/day)	Geometric Mean	NA	NA	859	---	859	---
	Minimum	NA	NA	498		498	
	Maximum	NA	NA	1,692		1,692	
	90% Analysis*	NA	NA	1,524		1,524	
pH (Minimum and Maximum)	Geometric Mean	NA	NA	7.24	7.0	7.75	9.0
	Minimum	NA	NA	6.82		7.06	
	Maximum	NA	NA	7.65		8.32	
	90% Analysis*	NA	NA	6.9		8.1	

**Statistical analysis used to develop a value that is exceeded only 10 percent of the time.*

As indicated in the table above, the NPDES permit discharge limits for all parameters monitored were exceeded at least once during the period October 2006 to June 2007. The monthly average and daily maximum geometric mean for TSS of 66 mg/L and 105 mg/L, respectively, indicate that this parameter frequently exceeded the discharge limits. The DMR indicated that

primary treatment provided at the NDWWTP can achieve approximately 40 percent removal of BOD_5 and 39 percent removal of TSS.

GWA also provided supplemental influent and effluent wastewater quality data from January 2008 to May 2008. Daily samples were collected at the NDWWTP and analyzed at GWA's Hagatna Wastewater Treatment Plant. BOD_5, TSS, settleable solids, and pH were analyzed in both the influent and effluent samples from the NDWWTP. A summary of these results is provided in **Table 3.1-3**.

TABLE 3.1-3
SUMMARY OF HAGATNA LABORATORY RESULTS
(January 2008 to May 2008)

Parameter	Statistical Analysis	Influent (Daily Samples)	Effluent (Daily Samples)	Daily Maximum Discharge Limit	Average Percent Removal
BOD_5 (mg/L)	Geometric Mean	133.14	96.33	170	22%
	Minimum	58.00	66.30		
	Maximum	207.48	141.00		
	90% Analysis*	182.8	123.7		
TSS (mg/L)	Geometric Mean	127.08	66.53	100	44%
	Minimum	57.00	34.51		
	Maximum	346.00	110.00		
	90% Analysis*	168.2	93.1		
Settleable Solids (mL/L)	Geometric Mean	4.62	0.44	2	89%
	Minimum	0.80	0.00		
	Maximum	13.00	2.00		
	90% Analysis*	7.0	1.0		
pH (Minimum and Maximum)	Geometric Mean	7.08	6.98	7 - 9	pH reduction of 2%
	Minimum	5.99	5.96		
	Maximum	7.73	7.51		
	90% Analysis*	7.5	7.4		

**Statistical analysis used to develop a value that is exceeded only 10 percent of the time.*

The maximum TSS concentration observed between January 2008 and May 2008 was 110 mg/L, which exceeds the NPDES daily maximum discharge limit of 100 mg/L. **Table 3.1-3** also indicates that the pH level dropped below 7 during this monitoring period.

3.1.3 2008 Grab Sample Results and Temperature Monitoring

An influent and effluent wastewater grab sample was taken on 13 October 2008 from the NDWWTP to verify the wastewater characterization provided in the 2001 BOD Report. The results are summarized in **Table 3.1-4**.

TABLE 3.1-4
NDWWTP INFLUENT AND EFFLUENT GRAB SAMPLE RESULTS
(13 October 2008)

Constituent Regulated by Guam Water Quality Standards	Unit	Influent Concentration	Effluent Concentration	% Removal
Enterococci	#/100mL	> 240,000	> 240,000	---
Total Phosphorus	μg/L	4,700	3,850	18%
Orthophosphate (as P)	μg/L	2,940	2,620	11%
Total Nitrogen	μg/L	47,900	47,600	1%
Nitrate+Nitrite (as N)	μg/L	8	9	-13%
TSS	mg/L	201	80	60%
Turbidity	NTU	111	59.0	47%
Temperature	°C	28.6	29.8	-4%
Priority Toxic Pollutants				
Lead	mg/L	0.00443	0.00494	-12%
Copper	mg/L	0.0800	0.0683	15%
Zinc	mg/L	0.245	0.276	-13%
Additional Toxic Pollutants				
Ammonia (as N)	μg/L	18,400	18,400	---
Total Sulfide	mg/L	0.51	0.14	73%

A majority of the grab sample concentrations were less than those reported in the 2001 BOD Report, which was used to develop the dilution criterion for the deeper NDWWTP outfall. Considerable disparity was found with enterococci, orthophosphate, TSS, and lead.

The enterococci and orthophosphate concentrations reported in the 2001 BOD Report were 830,000 #/100 mL and 4,240 μg/L, respectively, which is significantly higher than the grab sample taken on 13 October 2008. This may be attributed to different sampling methods. The 2001 BOD Report did not elaborate on the source of the data with respect to sampling and analytical method or number of samples that comprise the values presented in the report. In addition, the enterococci and orthophosphate concentrations in the 2001 BOD Report were not taken from the NDWWTP but were extrapolated from data collected from other treatment plants on Oahu.

The TSS concentration reported in the 2001 BOD Report was 190 mg/L. This constituent was used to establish the dilution criterion of 200 for the new NDWWTP outfall. The grab sample taken on 13 October 2008 indicated a much lower concentration of 80 mg/L. Based on the DMRs and analytical tests performed by GWA (see section 3.1.2), the daily maximum concentration is approximately 110 mg/L. Based on this information, the TSS value of 190 mg/L in the 2001 BOD Report appears to be high.

As stated in the 2001 BOD Report, the lead concentration of 2,900 μg/L was likely to be an aberration and was excluded from consideration in the development of the new NDWWTP outfall design (see section 3.1.1).

3.1.4 Effluent Wastewater Characterization Summary

After reviewing the available analytical wastewater characteristic data for the NDWWTP discharge, it appears the grab sample collected on 13 October 2008 is consistent with effluent characteristics defined in the 2001 BOD Report, with the exception of enterococci, orthophosphate, TSS, and lead. The enterococci and orthophosphate concentrations presented in the 2001 BOD Report were developed from data collected at other WWTPs and may not necessarily reflect the concentrations found in the discharge from the NDWWTP. Therefore, this investigation applied the results of the 13 October 2008 grab sample instead of the 2001 BOD Report for these constituents. As previously discussed in section 3.1.3, the concentrations of TSS and lead presented in the 2001 BOD Report appeared to be high. The TSS concentration found in the grab sample is more consistent with typically effluent values and was therefore used in this investigation.

Table 3.1-5 summarizes the wastewater characteristics for the primary treated effluent discharged through the new NDWWTP outfall.

TABLE 3.1-5
PRIMARY TREATED EFFLUENT WASTEWATER CHARACTERISTICS

Constituent Regulated by Guam Water Quality Standards	Unit	Effluent Concentration
Enterococci	#/100mL	> 240,000
pH	---	7.0
Orthophosphate (as P)	μg/L	2,620
Nitrate-Nitrogen	μg/L	9
Dissolved Oxygen	mg/L	0
Salinity	ppt	0.8
TSS	μg/L	80,000
Turbidity	NTU	59.0
Temperature	°C	29.8
Priority Toxic Pollutants		
p-Dichlorobenzene	μg/L	1.1
Toluene	μg/L	1.9
Lead	μg/L	4.94
Copper	μg/L	68.3
Zinc	μg/L	276
Additional Toxic Pollutants		
Ammonia (as N)	μg/L	18,400
Total Sulfide	μg/L	140

3.2 NEW NDWWTP OUTFALL DESIGN (2005 CONSTRUCTION PLANS)

The new NDWWTP outfall was placed into operation on 23 January 2009. The diffuser system shown in the original design documents was not installed. For the purpose of both Phases 1 and 2 of this investigation, however, the initial dilution analysis and farfield plume modeling assumed the diffuser system will be installed in the future. The following discussions are excerpts from the Phase 1 Report and are used to establish the physical parameters of the new NDWWTP outfall used in the nearfield and farfield model development.

As a result of EPA's tentative denial of the renewal application for the NDWWTP, GWA decided to extend the ocean outfall into deeper waters and revised the permit application accordingly. The basis of design report (2001 BOD Report) for the new NDWWTP outfall extension was prepared by GMP Associates, Inc. in September 2001 under the Department of Public Works' Tumon Bay Infrastructure and Beautification Project. Construction plans for this new outfall were also prepared by GMP Associates, Inc. in 2005 (hereafter referred to as the 2005 Construction Plans). A copy of these construction plans is provided in **Appendix 3A**.

The new NDWWTP outfall extends approximately 1,700 feet into the ocean as measured from the shoreline, with the diffuser section discharging into deeper marine waters as shown on **Figure 3.2-1**. The diffuser section will be situated along the (-)140-foot elevation contour and will be comprised of 400 linear feet of 34-, 28-, 22-, and 20-inch piping. The design criteria for this new NDWWTP outfall are summarized in **Table 3.2-1**. The 2005 Construction Plans indicate that the resulting mixing zone is a 700-foot by 300-foot area, as shown on **Figure 3.2-2**.

Concerns regarding the design of the new NDWWTP outfall diffuser system, as shown in the 2005 Construction Plans, were identified through discussions with GWA and a preliminary hydraulic analysis performed on the system. These issues are summarized below:

- Based on a preliminary review of the 2005 Construction Plans, the tideflex check valve located at the terminus of the diffuser section will likely result in a disproportionate distribution of flow through the diffuser system. A preliminary hydraulic analysis performed by EKNA Services indicated that approximately 20 percent of the flow will be discharged through the terminus tideflex check valve. This will result in an imbalanced discharge through the diffuser system, making it difficult to attain the required dilution intended in the 2001 BOD Report for the new deeper outfall extension.

- GWA's discussions with GEPA indicated that GEPA will not allow a credit for dilution; thus requiring the discharge to meet GWQS at the end of pipe. As a result, GWA decided not to install the diffuser system until this issue is resolved.

Construction of the new deeper ocean outfall extension was recently completed without the diffuser section and placed in operation on 23 January 2009. As presented in the 2001 BOD Report, the diffuser system was designed to achieve a dilution factor of 200. However, this initial dilution cannot be attained with the open end pipe as constructed. EKNA Services determined that initial dilution from a single port outfall is 115.

Figure 3.2-1

New NDWWTP Outfall

Table 3.2-1

New NDWWTP Outfall Design Criteria*

Parameter	Criteria
Peak Hourly Flow:	28.6 MGD
Initial Dilution Ratio:	200:1
Discharge Depth:	140 feet below MLLW
Head Loss at Peak Hourly Flow at High Tide:	51 feet
Diffuser Length and Outside Diameter:	100 feet 34 inches 100 feet 28 inches 100 feet 22 inches 100 feet 20 inches
Number of Ports and Spacing:	40 at 10 feet on centers
Port:	6 inch series 35-D Tideflex Check Valve
Horizontal Direction Drilling Parameters:	
Entry Angle:	12 Degrees
Radius of Curvature:	3,400 feet
Exit Angle:	6 Degrees
Pipeline:	High Density Polyethelene 34-inch outside diameter with SR = 17

- *As presented in the construction drawings for the Tumon Infrastructure and Beautification Northern District Sewer Outfall Extension, prepared by GMP Associates, Inc., 2005.*

Figure 3.2-2

New Deeper NDWWTP Ocean Outfall Extension

For the purpose of this investigation, it was assumed that GWA will install the diffuser system. To achieve the design intent of the diffuser system as documented in the 2001 BOD Report, it was also assumed that the terminus tideflex check valve will not be installed. This modification of the outfall and diffuser system will hereafter be referred to as the "Modified Diffuser Design".

3.3 RECEIVING WATER CONDITIONS

Physical oceanographic conditions and receiving water quality were determined for both Phases 1 and 2 of this investigation. For this Phase 2 study, both baseline and background water quality characteristics were evaluated. The primary purpose for determining baseline water quality characteristics is to assess the current impact of the discharge from the new NDWWTP outfall (i.e., discharge of 5.1 MGD). Establishing background water quality characteristics in the absence of a wastewater discharge is necessary when modeling the effects of the farfield plume created by the new NDWWTP outfall operating at full capacity (i.e., discharge of 12 MGD). Interim results from Phases 1 and 2 are summarized below.

3.3.1 Physical Oceanographic Conditions

The characteristics of the discharge plume from an outfall are dependent on the site-specific dynamics of ocean currents and density of the receiving waters. EKNA Services performed the field work necessary to obtain this information to develop subsequent hydraulic plume models for the new NDWWTP and proposed DoD outfall. EKNA Services Interim Report is provided in **Appendix 3B**. A summary of the results follows.

3.3.1.1 Ocean Current Meter Measurements

Two single point moored current meters were deployed near the vicinity of the new NDWWTP outfall and the proposed DoD outfall (refer to Figure 2.3-2 in Chapter 2). The results of the initial 2-month ocean current meter deployment (14 August to 7 October 2008) conducted for Phase 1 indicated that the currents recorded from both meters were similar in speed and direction. The current direction is oriented parallel to the bathymetry contours, with a dominant northerly direction (0 to 30 ° True). The tidal currents are reversing currents; however, there is a mean net drift toward the north. The mean ocean current speed is 10 cm/sec, with a maximum speed of 50 cm/sec. The maximum ocean current speed typically lasted for one hour.

The results of the second 2-month ocean current deployment (8 October to 9 December 2008) were similar to the first deployment with respect to speed and direction. The mean current for the entire four-month period was about 10 cm/sec, with a maximum speed of 50 cm/sec. The current is typically oriented parallel to the bathymetry contours, with a dominant flow direction toward the north.

3.3.1.2 Density Profile Measurements

The nearfield effluent plume is affected by the density of the ocean waters. Ocean water density is determined by water temperature and salinity. A large density gradient through the water column can prevent the plume from reaching the surface, thereby decreasing initial dilution. Ten sampling stations around the new NDWWTP outfall and eight sampling stations around the proposed DoD outfall were sampled using a conductivity-temperature-depth (CTD) profiler. The location of these sampling stations was previously shown on Figure 2.3-2 in Chapter 2.

The results of the CTD sampling indicate that there is little variability of density throughout the water column. This may be attributed to the relatively shallow water depth and nearshore circulation, resulting in good mixing of the ocean waters at this location. There was more variability in the density profiles collected on 7 October 2008 compared to the profiles collected on 15 August 2008 and 28 January 2009, which may have been attributed to the high rainfall events during this time. The greatest variability of density occurred at stations closest to the recently decommissioned NDWWTP diffuser, which was operational prior to the January 2009 data collection period.

Due to the relative uniformity of the density of the water column, effluent discharged through the deep ocean outfall can be expected to rise rapidly to the surface. The relatively shallow water depth and nearshore circulation at this location will result in good mixing of the ocean waters.

3.3.2 Receiving Water Quality

Receiving water quality in the vicinity of the proposed DoD outfall is summarized below. Detailed analysis and results are presented in the AECOS, Inc. Interim Report provided in **Appendix 3C**.

AECOS, Inc. developed a water quality monitoring program and subsequent water quality and biology impact assessment for both Phases 1 and 2 of this investigation. The limited water quality monitoring program consisted of the analyses of 13 GWQS constituents (refer to Table 2.3-2 in Chapter 2) from samples collected at various depths. Four toxic substances (sulfide, copper, lead, and zinc) were sampled only in Phase 1 to determine their presence in the NDWWTP discharge. The water quality monitoring plan for Phase 1 consisted of ten sampling stations (refer to Figure 2.3-2 in Chapter 2) around the new NDWWTP outfall. Samples were collected at three depths (near surface, near bottom, and mid-depth). The Phase 2 water quality monitoring plan consisted of eight sampling stations around the proposed DoD outfall. Preliminary results in Phase 1 indicated that samples collected at two depths (near surface and near bottom) would be adequate.

Water quality data from Phases 1 and 2 for select stations and depths were utilized to establish the background water quality of the receiving waters around the proposed DoD outfall. Where local field measurements were either absent or not considered representative of the background water quality, historical data from similar open coastal environments were used to estimate background concentrations. The background concentrations for the receiving waters in the vicinity of the proposed DoD outfall were determined by AECOS, Inc. and are presented in **Table 3.3-1**.

TABLE 3.3-1

BACKGROUND WATER QUALITY CHARACTERISTICS OF THE RECEIVING WATERS

Water Quality Constituent	Unit	GWQS Limit	Background Concentration
Enterococci	#/100mL	104	none
Orthophosphate (as P)	μg P/L	50	5
Nitrate-Nitrite	μg N/L	200	1
TSS	mg/L	20	5.6
Turbidity	NTU	1	0.25
Priority Toxic Pollutants			
Lead	μg/L	8.1	none
Copper	μg/L	3.1	none
Zinc	μg/L	86	none
Additional Toxic Pollutants			
Ammonia (as N)	μg N/L	20	<1
Total Sulfide	μg/L	5	none
Non-Regulated Constituents			
Total Nitrogen	μg N/L	---	151
Total Phosphorus	μg P/L	---	13

The baseline water quality monitoring results for Phase 2 conducted on 10 and 11 November 2008 (old NDWWTP outfall in operation) and 23 and 24 March 2009 (new NDWWTP outfall in operation) are summarized below.

3.3.2.1 Baseline Temperature

In conjunction with salinity, temperature determines the density of the ocean water. There was little to no change in temperature with depth for samples collected in both November 2008 and March 2009. The baseline temperature measured for all samples collected at various depths during the November 2008 and March 2009 sampling events ranged from 29.5 to 29.8 °C and 28.1 to 28.5 °C, respectively. The baseline temperature did not exceed the 1.0 °C deviation stipulated in the GWQS for each sampling period.

3.3.2.2 Baseline Salinity

In conjunction with temperature, salinity determines the density of the ocean water. Like the results for temperature, there was little change in salinity across the water column. Salinity increased slightly with depth, ranging from 34.645 ppt at the surface to 34.701 ppt near the ocean bottom during the November 2008 sampling period and 35.467 ppt (surface) to 35.539 ppt (bottom) during the March 2009 sampling period. The maximum deviation of all eight sampling stations from the median concentration was less than 2 percent, which is well within the GWQS of 10 percent of the naturally occurring condition.

3.3.2.3 Baseline Dissolved Oxygen

Dissolved oxygen (DO) in marine waters is a factor of wind action at the air-sea interface, primary productivity (phytoplankton and benthic algae), and respiration. The maximum DO concentration in marine waters is a function of temperature and salinity. Similar to the temperature and salinity results, there was little change of DO saturation with depth, ranging from 91 percent to 99 percent at all stations and depths. These baseline DO saturation levels are above the GWQS minimum level of 75 percent.

3.3.2.4 Baseline pH

pH levels in marine waters may be influenced by surface water runoff, intrusion of groundwater, wastewater discharges, and excessive plant (phytoplankton and/or benthic algae) productivity. There was little variation in pH levels through the water column, indicating a well mixed environment. High pH levels are anticipated in marine surface waters as a result of higher phytoplankton productivity in this zone. However, the low presence of chlorophyll α (see section 3.3.2.12) and/or freshwater input from surface runoff may have attributed to the lower pH levels observed. At all eight sampling locations and depths, the baseline pH levels ranged from a high of 8.18 to a low of 7.95, which is within the GWQS range of 6.5 to 8.5.

3.3.2.5 Baseline Turbidity

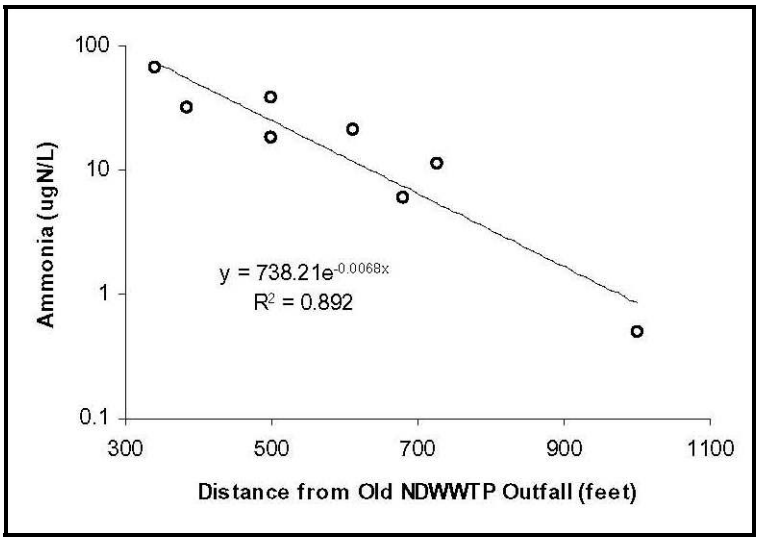
Turbidity in marine waters is influenced by surface water runoff, suspension of bottom sediments in shallow nearshore waters resulting from wave and wind action, and microscopic life naturally occurring in water. With the exception of one sample with high turbidity attributed to bottom sediment disturbance during sampling, low baseline turbidity less than 1 NTU was measured at all remaining stations and depths. This indicates a marine water environment with low levels of particulates. The GWQS stipulates that turbidity shall not increase by more than 1 NTU from ambient conditions, except under natural conditions.

3.3.2.6 Baseline TSS

Like turbidity, TSS in marine waters is influenced by surface water runoff, suspension of bottom sediments due to wave and wind action, and microscopic life naturally occurring in water. Baseline TSS levels measured during the November 2008 sampling period were nearly double those of the March 2009 sampling period. The mean surface and bottom TSS concentrations measured in November 2008 were 8.3 mg/L and 7.1 mg/L respectively. The mean surface and bottom TSS concentrations measured in March 2009 were 4.6 mg/L and 3.2 mg/L respectively. These baseline TSS concentrations are below the GWQS of 20 mg/L.

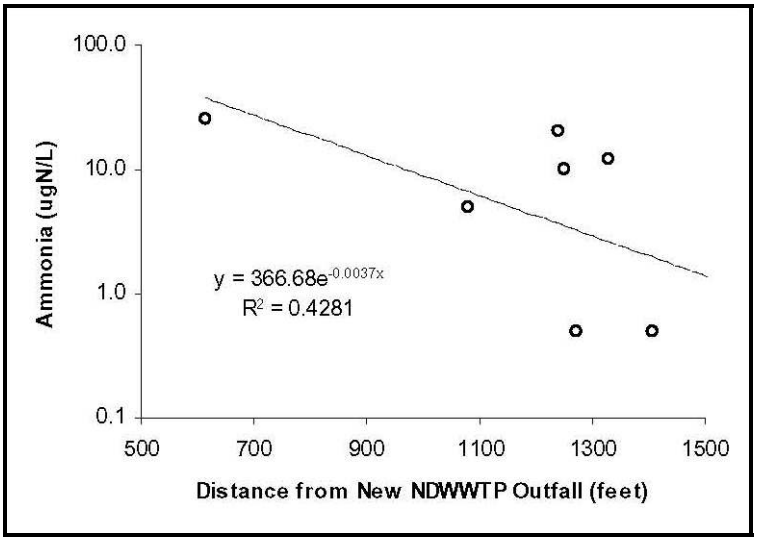
3.3.2.7 Baseline Ammonia

Ammonia is one of three major inorganic nitrogen moieties (ammonia, nitrite, and nitrate) utilized by marine phytoplankton and benthic algal populations. Ammonia is preferred over nitrite and nitrate and is typically found in very low concentrations in marine waters. Baseline ammonia levels at the stations sampled in November 2008 and March 2009 can be attributed to the discharge from the old and new NDWWTP outfalls, as shown on **Figures 3.3-1** and **3.3-2**, respectively.



SURFACE WATER AMMONIA CONCENTRATION VERSUS DISTANCE TO OLD NDWWTP OUTFALL (NOVEMBER 2008 SAMPLING EVENT)

FIGURE 3.3-1



SURFACE WATER AMMONIA CONCENTRATION VERSUS DISTANCE TO NEW NDWWTP OUTFALL (MARCH 2009 SAMPLING EVENT)

FIGURE 3.3-2

Results of the November 2008 sampling event indicated that the surface water ammonia concentration increased with proximity to the old NDWWTP outfall, which was operational at the time of sampling. Although there is less correlation with the March 2009 water samples, primarily due to proximity of the sampling stations with respect to the location of the new NDWWTP outfall, the elevated surface water ammonia levels present indicate some contribution of ammonia from the discharge of effluent through the new NDWWTP outfall.

The mean ammonia concentration measured in the November 2008 water samples is higher than the March 2009 water samples. This may be attributed to the proximity of the sampling stations with respect to the NDWWTP outfall discharge points. The mean baseline ammonia concentration present in the surface water samples collected in November 2008 was 24 μg N/L, while the mean baseline concentration present in the March 2009 samples was 1 μg N/L. It is likely that, in the absence of the NDWWTP discharge, the ammonia concentration in both the surface and bottom water samples would be undetectable in the vicinity of the proposed DoD outfall. The mean baseline ammonia concentration for both sampling events is less than the GWQS limit of 0.02 mg N/L for marine waters.

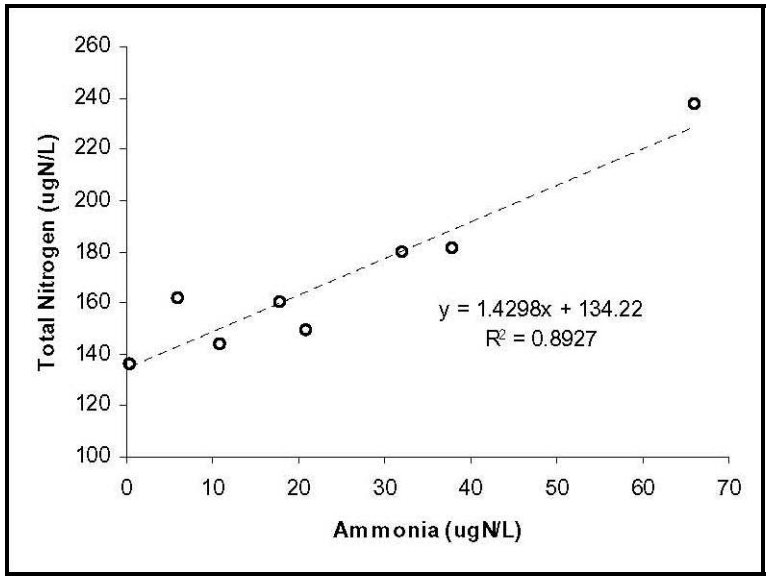
3.3.2.8 Baseline Nitrate + Nitrite

Nitrate and nitrite are two of the three major inorganic nitrogen moieties (ammonia is the third) utilized by marine phytoplankton and benthic algal populations. Due to the typically low concentration of ammonia in marine waters, this nitrogen fraction is the primary source for phytoplankton and benthic algae productivity. The baseline concentration of nitrate-nitrite present in both surface and bottom samples and both sampling events was relatively low. Like ammonia, high concentrations were present in the November 2008 samples, which may be attributed to the close proximity to the old NDWWTP discharge point. The mean baseline nitrate + nitrite concentration present in the surface water samples collected in November 2008 was 3 μg N/L, while the mean baseline concentration present in the March 2009 samples was 1 μg N/L. The GWQS stipulates that the nitrate concentration in marine water should not exceed 0.20 mg N/L. The baseline nitrate + nitrite concentration is well below this limit.

3.3.2.9 Baseline Total Nitrogen

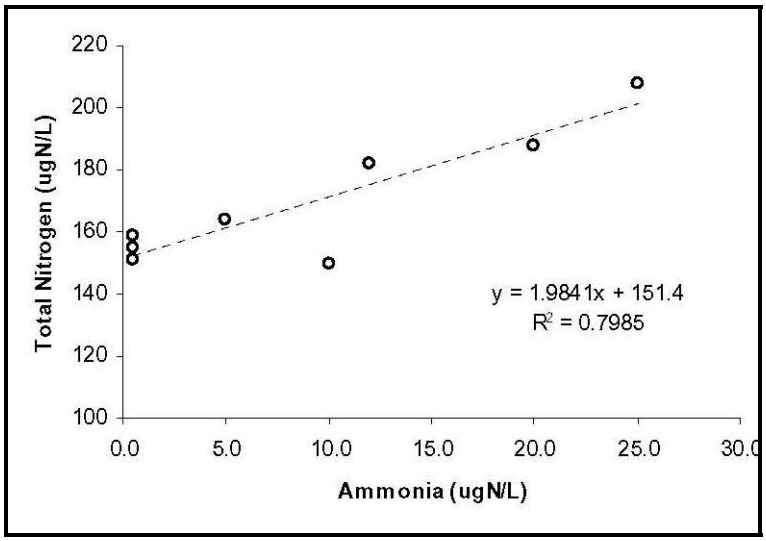
Total nitrogen represents the total quantity available for breakdown by phytoplankton and benthic algae productivity. Although no limit was established for total nitrogen in the GWQS, this parameter was monitored in this investigation to understand the fate of inorganic + organic nitrogen present in the discharge from the outfall.

The mean total nitrogen concentration present in the water samples collected for both sampling events was similar; 169 μg N/L and 170 μg N/L for the November 2008 and March 2009 samples, respectively. The corresponding mean bottom water concentration was 136 μg N/L and 144 μg N/L respectively. Sampling stations with high baseline concentrations of total nitrogen typically correlated with high baseline concentrations of ammonia in the samples. **Figures 3.3-3** and **3.3-4** show total baseline nitrogen concentration present in the surface water samples as a function of baseline ammonia concentrations for the November 2008 and March 2009 sampling events, respectively.



SURFACE WATER TOTAL NITROGEN CONCENTRATION AS A FUNCTION OF AMMONIA (NOVEMBER 2008 SAMPLING EVENT)

FIGURE 3.3-3



SURFACE WATER TOTAL NITROGEN CONCENTRATION AS A FUNCTION OF AMMONIA (MARCH 2009 SAMPLING EVENT)

FIGURE 3.3-4

The November 2008 and March 2009 sampling results indicate that the NDWWTP effluent discharge plumes from both the old and new outfalls impact nitrogen in surface water. As indicated by regression lines on **Figures 3.3-3** and **3.3-4**, in the absence of ammonia in the NDWWTP effluent discharge, background total nitrogen in the November 2008 and March 2009 samples were 136 μg N/L and 155 μg N/L, respectively. These values are similar to the mean baseline nitrogen concentration present in the bottom water samples.

3.3.2.10 Baseline Total Phosphorus

Total phosphorus represents the total quantity available for breakdown by phytoplankton and benthic algae productivity. Some total phosphorus is refractile and cannot be broken down into inorganic fractions and will not be available to primary production. Like total nitrogen, no limit for total phosphorus was established in the GWQS. This parameter was nevertheless monitored in this investigation to understand the fate of inorganic + organic phosphorus present in the discharge from the outfall.

The mean total phosphorus concentration present in the November 2008 sample indicated higher levels present in the surface (24 μg P/L) compared to the bottom (19 μg P/L), indicating the influence by surface and/or groundwater input from the island and the discharge of effluent from the NDWWTP. The March 2009 mean surface and bottom water concentrations for total phosphorus were both 16 μg P/L.

3.3.2.11 Baseline Orthophosphate

Orthophosphate is the primary inorganic form of phosphorus utilized by phytoplankton and benthic algae productivity. Orthophosphate concentrations are typically low, but detectable, in tropical marine coastal waters. Like the nitrogen moieties, a somewhat higher concentration of orthophosphate was present in the surface water samples compared to the bottom water samples. This may indicate an influence by surface and/or groundwater input from the island. The surface and bottom mean orthophosphate concentrations in the November 2008 samples were 9 μg P/L and 6 μg P/L, respectively, and 8 μg P/L and 7 μg P/L, respectively, in the March 2009 samples. The GWQS limits orthophosphate concentration in marine water to no more than 0.05 mg P/L (50 μg P/L). The baseline orthophosphate concentration is well below this limit.

3.3.2.12 Baseline Chlorophyll α

Chlorophyll α is an indicator of phytoplankton biomass in the marine water. Although no limit for chlorophyll α was established in the GWQS, this parameter was measured for this investigation to determine the potential impacts associated with the addition of elevated nitrogen and phosphorus in the wastewater discharge.

There was little variability across the water column and among the eight sampling sites for both the November 2008 and March 2009 sampling events. This indicates that phytoplankton in the water column is not being influenced by the nutrients present in the discharge from the NDWWTP. The mean baseline surface water concentration of chlorophyll α measured in November 2008 and March 2009 was 0.12 μg /L and 0.18 μg/L, respectively. The mean baseline bottom water concentration for both sampling events was 0.15 μg/L.

3.3.2.13 Baseline Enterococci

Enterococcus bacteria is found in avian and mammalian fecal matter and is an indicator of sewage contamination of the marine waters. Both the November 2008 and March 2009 samples exhibited high levels of enterococci in the surface water samples, with all but one sample collected during both sampling events exceeding the GWQS instantaneous limit for enterococci of 104 enterococci/100 mL. Enterococci were present in lower concentrations in the samples collected near the bottom.

There is a strong correlation between enterococci concentration and ammonia level at each sampling station shown on **Figures 3.3-5** and **3.3-6**, indicating that the discharge plumes from the old and new NDWWTP outfall impact water quality in the vicinity of the proposed DoD outfall. Due to the proximity of the sampling stations and the old and new NDWWTP outfalls, the mean baseline surface water concentration for enterococci was higher during the November 2008 sampling event (703 enterococci/100 mL, old NDWWTP outfall active) compared to the March 2009 sampling event (472 enterococci/100 mL, new NDWWTP outfall active).

3.3.2.14 Toxic Substances

Total sulfide, copper, lead, and zinc were analyzed in Phase 1 at a few preselected sampling sites. These constituents were analyzed in the August 2008 sampling event from samples collected at mid-depth for stations 1, 6, and 10, and near bottom depth for station 2. The concentrations found in all samples were below the detectable limits.

3.4 DIFFUSER SYSTEM PLUME ANALYSIS – NEW NDWWTP OUTFALL

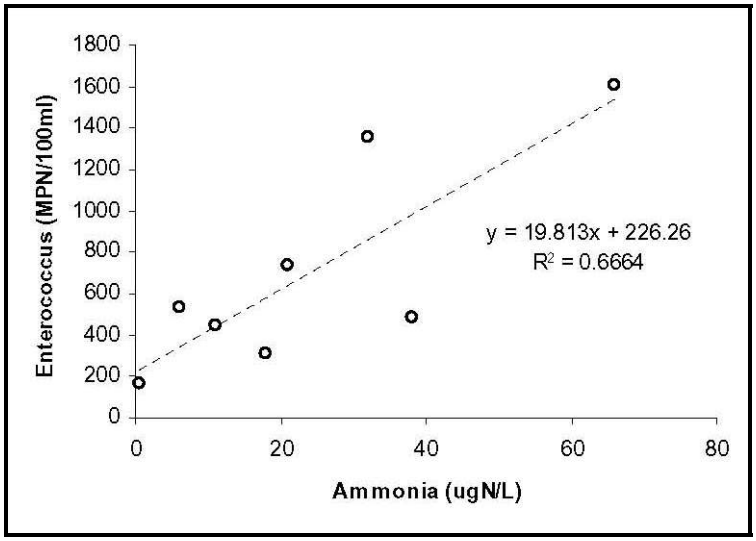
The "Modified Diffuser Design" described in section 3.2 was modeled by EKNA Services to determine the initial dilution (nearfield) and farfield plumes of the new NDWWTP outfall that will likely influence ambient receiving water quality conditions in the vicinity of the proposed DoD outfall. The following conditions were incorporated in the nearfield and farfield plume models:

Discharge Quantity: Design Average Flow = 12 MGD

Discharge Quality: Primary Treated Effluent (refer to **Table 3.1-5**)

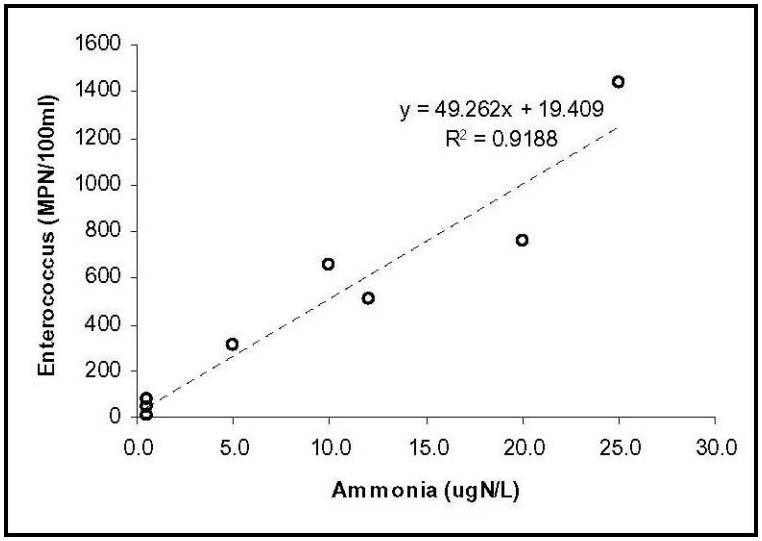
Outfall and Diffuser System Design:
"Baseline Modified Diffuser Design" (see section 3.2)
Four sections of high density polyethylene pipe (HDPE)
Each section 100 feet in length
Diameter of each section: 34", 28", 22", and 20"
40 vertical ports located 10 feet on center
Each port fitted with a 6-inch Tideflex valve

A summary of the nearfield and farfield results for the new NDWWTP outfall are presented in the following sections. Refer to EKNA Services Interim Report in **Appendix 3B** for a detailed analysis.



SURFACE WATER ENTEROCOCCUS CONCENTRATION AS A FUNCTION OF AMMONIA (NOVEMBER 2008 SAMPLING EVENT)

FIGURE 3.3-5



SURFACE WATER ENTEROCOCCUS CONCENTRATION AS A FUNCTION OF AMMONIA (MARCH 2009 SAMPLING EVENT)

FIGURE 3.3-6

3.4.1 Nearfield (Initial Dilution) Plume Modeling

The USEPA-approved dilution model, *Visual Plumes* (VP), was used to determine the initial dilutions provided under various effluent discharge flow scenarios presented in this investigation. The three-dimensional Updated Merge (UM3) model was used to simulate single and multi-port submerged discharges.

Ocean current data collected from the first four months of the monitoring period (14 August to 9 December 2008) indicate a mean current speed of 10 cm/sec at a dominant direction of 15 degrees true north. In addition to this information, CTD profiles obtained on 15 August 2008, 7 October 2008, and 28 January 2009 were used in this Phase 2 interim model run for the new NDWWTP outfall. All CTD profiles, with the exception of five inshore stations (stations 1, 2, 10, A, and H), were modeled (27 runs) and averaged to yield an average dilution value considered to be representative of the initial dilution for the given design discharge flow and current speed. CTD profiles for the five inshore stations were not used because of the likely influence of the existing NDWWTP discharge on the salinity readings at these stations.

The average dilution obtained for the new NDWWTP outfall at the design average flow of 12 MGD is 300. The plume surfaces for all runs and does not travel far horizontally before surfacing.

3.4.2 Farfield Plume Modeling

Following initial dilution, the nearfield plume remains relatively passive and is subsequently transported away from the diffuser by ocean currents. The fate of the plume beyond the diffuser is generally termed the farfield plume. To develop the farfield plume, the methodology was to utilize all the continuous time-series of ocean current measurements obtained in the field to model the transport process. Therefore, the resulting farfield plume is a cumulative representation of all plume events, providing an envelope of visitation probability of a tracer particle released into the plume after initial dilution has occurred. The probability envelope is developed by spatially tracking a tracer particle for a specified period of time. The receiving ocean water is depicted by a grid system; each grid square representing a 200 meter by 200 meter area. As a tracer particle is released into the plume after initial dilution has occurred, the incidence and time of incidence of the particle entering a grid square are recorded. The progression of the tracer particle is tracked through the grid system until the specified period of time has elapsed. Another tracer particle is released and tracked in the same manner. This analysis is performed over many thousands of trials to develop an expected visitation frequency or impact probability for each grid square. The resulting value assigned to each grid square is then used to develop the probability envelopes or contours.

In addition to determining the visitation probability of a tracer particle (representing a constituent in the wastewater) in the grid system (representing the receiving marine water), the concentration of particles associated with the visitation occurrence is of particular interest with respect to the water quality aspects of this investigation. After initial dilution, the plume is further diluted through the transport of ocean currents and entrainment of ambient ocean water. This subsequent dilution is primarily time dependent. The methodology used to extend the visitation probability analysis to include estimates of the concentration and dilution probabilities is provided in the EKNA Services Interim Report (see **Appendix 3B**).

For farfield plume modeling, initial dilution provided under average flow conditions is applicable because it represents a relatively consistent discharge flow through the outfall. Peak flow occurs intermittently and typically coincides with a rainfall event. In general, peak flows last for a period of a few hours, subsiding after the rainfall event has ended. A portion of the increased flow under this condition is also attributed to inflow and infiltration of rain water into the wastewater collection system. This addition of non-wastewater flow will dilute the concentration of constituents in the effluent prior to discharge through the outfall, reducing the dilution requirement of the diffuser system under this peak flow condition.

As indicated in the initial dilution results, the probability of the plume surfacing is 100 percent. As a result, wind patterns in conjunction with ambient ocean current will affect the fate of the farfield plume. Wind data at Guam International Airport were obtained from the National Oceanic and Atmospheric Administration (NOAA). The wind data were adjusted to reflect the lower elevation of the ocean surface with respect to the source of the data and reduced easterly (offshore) winds resulting from the sheltering effects of the cliffs.

3.4.2.1 24-Hour Visitation Frequency

The 24-hour visitation frequency was analyzed using the farfield plume model. This analysis was performed to determine the percent visitation occurrence of a tracer particle released into the plume after initial dilution had taken place, regardless of time. **Figure 3.4-1** shows the combined effect of winds and currents on the 24-hour visitation frequency of the surface plume. Due to the offshore winds and the ocean current in the predominantly northern direction, the transport of the surface plume is likely to occur in the northwesterly direction, away from Tumon Bay. As shown on **Figure 3.4-1**, the probability of the plume entering Tumon Bay is less than one percent of the time. Due to the close proximity of the new NDWWTP outfall and the proposed DoD outfall, this farfield plume analysis is applicable to both outfalls.

3.4.2.2 Farfield Dilution Factors

Average farfield dilution factors (F_{ave}) were developed in this Phase 2 study to simplify the calculation of the total dilution of any constituent based on an assumed initial dilution. Contour plots of the F_{ave} for the new NDWWTP outfall are presented on **Figure 3.4-2**. The following equation can be used to calculate total dilution based on an assumed initial dilution value:

$$S_{ave} = S_0 F_{ave}$$

where: S_{ave} = total farfield dilution for the outfall
S_0 = initial dilution for the outfall
F_{ave} = average farfield dilution factor for the outfall

Based on **Figure 3.4-2**, F_{ave} for the new NDWWTP outfall at the location of the proposed DoD outfall is about 2. Using the above equation and an initial dilution factor of 300 for the new NDWWTP outfall as determined in section 3.4.1, the total farfield dilution (S_{ave}) applied to the primary effluent discharge from the NDWWTP is 600.

Figure 3.4-1

24-Hour Visitation Frequency Impact Analysis – Surface Plume

Figure 3.4-2

Fave for New NDWWTP Outfall

3.4.2.3 Ambient Receiving Water Quality Conditions Near the Proposed DoD Outfall

The dilution required to meet a water quality standard can be calculated using the following expression (EPA Amended Section 301(h) Technical Support Document dated September 1994):

$$S_a = (C_e - C_a) / (C_s - C_a)$$

where:
- S_a = dilution
- C_e = effluent concentration
- C_s = water quality standard
- C_a = receiving water concentration

The above equation can be rearranged to solve for the resulting ambient receiving water quality parameters using the total farfield dilution for the outfall as determined in section 3.4.2.2.

- C_s = C_F = "chronic" concentration of a constituent in the receiving water
- S_a = S_{ave} = total farfield dilution for the outfall

$$C_F = C_a + (C_e - C_a) / S_{ave}$$

Ambient receiving water quality conditions in the vicinity of the proposed DoD outfall resulting from the influence of the discharge plume from the new NDWWTP outfall can be calculated using the following equation:

$$C1_F = C_a + (C1_e - C_a) / S1_{ave}$$

where:
- $C1_F$ = "chronic" concentration of a constituent in the receiving water
- C_a = background concentration of the constituent of interest in the receiving water
- $C1_e$ = concentration of the constituent of interest in the primary treated effluent discharged from the new NDWWTP outfall
- $S1_{ave}$ = total farfield dilution for the new NDWWTP outfall
  = 600 (see section 3.4.2.2)

The ambient concentration of constituents in the receiving waters at the propose DoD outfall is summarized in **Table 3.4-1**.

TABLE 3.4-1

CALCULATED AMBIENT WATER QUALITY CONDITIONS AT THE PROPOSED DOD OUTFALL ($S1_{ave}$ = 600)

Water Quality Constituent	Unit	Background Concentration (C_a)	NDWWTP Primary Treated Effluent Concentration ($C1_e$)	Calculated Ambient Concentration at Proposed DoD Outfall ($C1_F$)	GWQS (M-2 Waters)
Enterococci	#/100mL	0	240,000	400	104
Orthophosphate (as P)	μg P/L	5	2,620	9.4	50
Nitrate-Nitrite	μg N/L	1.1	9	1.1	200
TSS	mg/L	5.6	80	5.7	20
Turbidity	NTU	0.25	59	0.3	1
Priority Toxic Pollutants					
Lead	μg/L	0	4.94	0	8.1
Copper	μg/L	0	68.3	0.1	3.1
Zinc	μg/L	0	276	0.5	86
Additional Toxic Pollutants					
Ammonia (as N)	μg N/L	0	18,400	30.7	20
Total Sulfide	μg/L	0	140	0.2	5
Non-Regulated Constituents					
Total Nitrogen	μg N/L	151	47,600	230.1	---
Total Phosphorus	μg P/L	13	3,850	19.4	---

** Calculated ambient receiving water quality concentrations greater than the GWQS are highlighted in yellow.*

CHAPTER 4
ASSESSMENT OF THE DISCHARGE FROM THE PROPOSED DOD OUTFALL

Phase 2 of the study assesses the environmental and ecological impacts to the receiving waters associated with a new point discharge from the proposed DoD outfall, which is described as Option 2 in the July 2008 study. This chapter contains information on the development of the discharge quantity and quality from the proposed DoD secondary treatment plant and the conceptual design and performance of the proposed DoD outfall. Based on this information, the resulting impacts to the receiving marine waters were evaluated and summarized in this chapter.

4.1 PROPOSED DOD SECONDARY TREATMENT PLANT EFFLUENT QUANTITY AND QUALITY

As presented in the July 2008 study, the design average and peak wastewater flows for Option 2 are 4.51 and 10.92 MGD, respectively. These design flows account for all of the DoD wastewater generated in the northern district of Guam, including the additional flows associated with the relocation of the USMC.

In order to develop wastewater characteristics for secondary treated effluent, actual raw wastewater of the influent entering the NDWWTP was utilized, and typical industry standard removal efficiencies for the conventional activated sludge process were applied. The resulting constituent concentration was compared to typical secondary treated effluent wastewater concentrations found in textbooks and concentrations from existing secondary treatment facilities in Guam and Hawaii.

Table 4.1-1 summarizes the treated effluent wastewater characteristics for the discharge from the proposed DoD secondary treatment plant. DMRs for secondary treatment facilities in Guam and Hawaii were obtained for the period July 2007 to June 2008 and were reviewed for comparative purposes. This information is summarized in **Table 4.1-2**.

4.2 CONCEPTUAL DESIGN AND HYDRAULIC ANALYSIS OF THE PROPOSED DOD OUTFALL

The intent of discharging wastewater through an outfall and diffuser system is to minimize the detrimental impacts of the discharge by providing adequate dilution, dispersion, and transport of the pollutants released into the receiving marine waters. Compliance with the GWQS is one criterion used to minimize environmental and ecological impacts to the receiving waters and was used in this study as the basis for the conceptual design of the proposed DoD outfall.

TABLE 4.1-1

TREATED EFFLUENT WASTEWATER CHARACTERISTICS OF THE PROPOSED DOD SECONDARY TREATMENT PLANT

Constituent Regulated by Guam Water Quality Standards	Unit	Influent Conc.	Effluent Conc.	Comments*
Enterococci	#/100mL	> 240,000	15	Assume disinfection prior to discharge. Similar to the Apra Harbor WWTP.
pH	---	7.0	7.0	Assume no change.
Orthophosphate (as P)	μg/L	2,940	1,640	Apply textbook removal efficiency of 44%.
Nitrate-Nitrogen	μg/L	8	14,900	Calculated based on ammonia reduction (conversion of ammonia to nitrate). Comparable to Hawaii Secondary WWTPs.
Dissolved Oxygen	mg/L	---	2.0	Assume minimum DO of 2 mg/L is maintained in the activated sludge process.
Salinity	ppt	---	0.8	Assume same as Primary. No change with Secondary Treatment.
TSS	μg/L	201,000	9,000	Apply textbook removal efficiency of 96%. Comparable to the Apra Harbor WWTP with similar low TSS entering the plant.
Turbidity	NTU	111	16	Apply textbook removal efficiency of 86%. Higher than Hawaii Secondary WWTPs.
Temperature	°C	28.6	29.8	Assume same as Primary. No change with Secondary Treatment.
Priority Toxic Pollutants				
Lead	μg/L	4.43	4.43	No additional removal based on textbook information.
Copper	μg/L	80	54.6	Apply textbook removal efficiency of 32%. Higher than Guam and Oahu Secondary WWTPs.
Zinc	μg/L	245	72.6	Apply textbook removal efficiency of 70%. Higher than Guam and Oahu Secondary WWTPs.
Additional Toxic Pollutants				
Ammonia (as N)	μg/L	18,400	3,500	Apply average ammonia concentration from Hawaii Secondary WWTPs.
Total Sulfide	μg/L	510	140	Assume same as Primary. No change with Secondary Treatment.

**Note: Textbook value refers to Metcalf & Eddy, Wastewater Engineering Treatment and Reuse, Fourth Edition.*

Table 4.1-2

Summary of DMRs from Secondary WWTPs in Guam and Hawaii

Initial dilution required to meet the GWQS may be calculated using the following expression (EPA Amended Section 301(h) Technical Support Document dated September 1994):

$$Sa = \frac{(Ce - Ca)}{(Cs - Ca)}$$

Where Ce = Effluent Concentration
Cs = Water Quality Standard (GWQS)
Ca = Receiving Water Concentration
Sa = Dilution

Table 4.2-1 summarizes the required dilution to meet the GWQS for each constituent regulated. The ambient receiving water quality in the vicinity of the proposed DoD outfall will be influenced by the discharge from the new NDWWTP outfall. The resulting ambient concentrations of the constituents in the receiving waters (Ca) were previously determined in Table 3.4-1 of Chapter 3 and are used in the calculations below. The effluent concentration (Ce) anticipated with the proposed DoD secondary treatment plant was previously presented in **Table 4.1-1**.

TABLE 4.2-1
REQUIRED DILUTION FOR THE PROPOSED DOD OUTFALL

Constituent Regulated by GWQS	Unit	GWQS M-2 Water (Cs)	Ambient Receiving Water Quality ($Ca = C1_F$)	Effluent Conc. (Ce)	Required Dilution (Sa)
Enterococci	#/100mL	104	400	15	0
Orthophosphate (as P)	µg/L	50	9.4	1,640	40
Nitrate-Nitrogen	µg/L	200	1.1	14,900	75
TSS	µg/L	20,000	5,700	9,000	0
Turbidity	NTU	1	0.3	16	22
Priority Toxic Pollutants					
Lead	µg/L	8.1	0	4.43	0
Copper	µg/L	3.1	0.1	54.6	18
Zinc	µg/L	86	0.5	72.6	0
Additional Toxic Pollutants					
Ammonia (as N)	µg/L	20	30.7	3,500	**NA**
Total Sulfide	µg/L	5	0.2	140	29

Constituents that exceed the M-2 limit in the GWQS are highlighted in yellow.

As indicated in **Table 4.2-1** above, the ambient concentrations for enterococci and ammonia in the vicinity of the proposed DoD outfall are greater than the GWQS due to the influence of primary treated effluent discharged from the new NDWWTP outfall. Therefore, no amount of dilution can be provided by the proposed DoD outfall to achieve compliance with the GWQS. Improvements to the effluent discharged from the new NDWWTP outfall are necessary to reduce the ambient enterococci and ammonia concentration in the receiving water within the GWQS limits. By providing secondary treatment at the NDWWTP, ammonia concentrations

may be reduced to 3,500 μg/L, resulting in an ambient concentration of 5.8 μg/L near the proposed DoD outfall. The dilution required by the proposed DoD outfall for ammonia is 246.

Based on this information, the performance goal for the conceptual design of the proposed DoD outfall was to achieve a dilution factor of 250. Conceptual designs were developed by EKNA Services to determine whether the dilution factor of 250 can be achieved by the proposed DoD outfall based on the physical constraints of the bathymetry in the area.

Detailed description and hydraulic analysis performed for the conceptual design of the proposed DoD outfall are contained in EKNA Services Interim Report (**Appendix 3B**). The results of the nearfield and farfield plume modeling for the proposed DoD outfall are summarized below.

Four conceptual designs of the proposed DoD outfall were analyzed using the UM3 model and incorporated an open pipe outlet at varying depths without a diffuser. All CTD profiles obtained on 15 August 2008, 7 October 2008, and 28 January 2009, with the exception of five inshore stations, were used for the plume analysis. The initial dilution results for the four conceptual DoD outfall designs discharging 5 MGD are summarized in **Table 4.2-2**.

TABLE 4.2-2

INITIAL DILUTION FOR THE PROPOSED DOD OUTFALL
(Design Flow of 5 MGD, Current Speed and Direction of 10 cm/sec and 15 degT)

Conceptual Design of DoD Outfall	Range of Initial Dilution[1]	Average Initial Dilution[2]	Surfaced Plume?	Average Horizontal Distance[3]	Average Plume Diameter[4]
Single Port Outfall – 140 ft Depth	213 – 234	231	100% Yes	34 feet	61 feet
Single Port Outfall – 150 ft Depth	224 – 255	251	100% Yes	33 feet	65 feet
Dual Port Outfall – 140 ft Depth	173 – 235	229	100% Yes	47 feet	128 feet
Dual Port Outfall – 150 ft Depth	175 – 255	244	100% Yes	48 feet	132 feet

Notes: (1) Run performed for all CTD profiles conducted on 8/15/2008, 10/7/2008, and 1/28/2009, except at stations 1, 2, 10, A, H.
(2) Average initial dilution for all runs.
(3) Average horizontal excursion distance for plume (centerline) for all runs.
(4) Average diameter of the plume at the surface for all runs.
(5) Highlighted in yellow is the conceptual design scenario that met the minimum initial dilution factor of 250.

The nearfield results indicate that the initial dilution factor of 250 can be achieved with a single port outfall at a depth of 150 feet. The plume surfaces for all runs and does not travel far horizontally before surfacing.

Farfield plume modeling was performed to assess the fate of the plume beyond the diffuser location. Interim ocean current data collected for both Phases 1 and 2 of this investigation were utilized in the farfield model. As indicated in the initial dilution results, the probability of the plume surfacing is 100 percent. As a result, wind patterns in conjunction with ambient ocean current will affect the fate of the farfield plume. Wind data at Guam International Airport were obtained from the National Oceanic and Atmospheric Administration (NOAA). The data were adjusted to reflect the lower elevation of the ocean surface with respect to the source of the data and reduced easterly (offshore) winds resulting from the sheltering effects of the cliffs.

Like the analysis of the new NDWWTP outfall (see section 3.4.2.2 of Chapter 3), average farfield dilution factors (F_{ave}) were developed for the proposed DoD outfall. Contour plots of the F_{ave} values for the proposed DoD outfall are presented on **Figure 4.2-1**.

Due to the influence of the primary effluent discharged from the new NDWWTP outfall on the ambient receiving water quality conditions in the vicinity of the proposed DoD outfall, the resulting time averaged concentration of a constituent anticipated in the receiving water may be calculated using the following equation:

$$C2_F = C1_F + (C2_e - C1_F) / S2_{ave}$$

where:
- $C2_F$ = "chronic" concentration of a constituent in the receiving water due to the proposed DoD outfall discharge
- $C1_F$ = ambient receiving water quality resulting from the new NDWWTP outfall discharge of 12 MGD of primary treated effluent (see Chapter 3, section 3.4.2.2)
- $C2_e$ = concentration of the constituent of interest in the secondary treated effluent discharged from the propose DoD outfall
- $S2_{ave}$ = total farfield dilution for the proposed DoD outfall
  - = $S2_0F2_{ave}$ where $S2_0$ is the initial dilution for the proposed DoD outfall and $F2_{ave}$ is the average farfield dilution factor for the proposed DoD outfall

The above equation may also be used to specify the concentration of a constituent at the proposed DoD outfall after initial dilution by setting the average farfield dilution factor ($F2_{ave}$) to 1 as follows:

$$C2_i = C1_F + (C2_e - C1_F) / S2_0$$

Using the $C1_F$ values at the proposed DoD outfall location calculated in Table 3.4-1 of Chapter 3, the constituent concentrations resulting from the initial dilution ($C2_i$) provided by the proposed DoD outfall are summarized in **Table 4.2-3**.

Figure 4.2-1

TABLE 4.2-3

CALCULATED CONSTITUENT CONCENTRATION AFTER INITIAL DILUTION PROVIDED BY THE PROPOSED DOD OUTFALL ($S2_0$ = 251)

Water Quality Constituent	Unit	Calculated Ambient Concentration at Proposed DoD Outfall ($C1_F$)	DoD Secondary Treated Effluent Concentration ($C2_e$)	Calculated Constituent Concentration After Initial Dilution ($C2_i$)	GWQS (M-2 Waters)
Enterococci	#/100mL	400	15	398.5	104
Orthophosphate (as P)	μg P/L	9.4	1,640	15.9	50
Nitrate-Nitrite	μg N/L	1.1	14,900	60.5	200
TSS	mg/L	5.7	9	5.7	20
Turbidity	NTU	0.3	16	0.4	1
Priority Toxic Pollutants					
Lead	μg/L	0	4.43	0	8.1
Copper	μg/L	0.1	54.6	0.3	3.1
Zinc	μg/L	0.5	72.6	0.8	86
Additional Toxic Pollutants					
Ammonia (as N)	μg N/L	30.7	3,500	44.5	20
Total Sulfide	μg/L	0.2	140	0.8	5
Non-Regulated Constituents					
Total Nitrogen	μg N/L	230.1	23,950	324.6	---
Total Phosphorus	μg P/L	19.4	3,760	34.3	---

** Calculated ambient receiving water quality concentrations greater than the GWQS are highlighted in yellow.*

Due to the high level of enterococci and ammonia in the primary effluent discharged from the new NDWWTP outfall, the resulting ambient receiving water quality in the vicinity of the proposed DoD outfall exceeds the GWQS. Although the enterococci level at the end of the pipe in the secondary treated discharge from the proposed DoD outfall is below the GWQS, the concentration that results after mixing with the ambient receiving water exceeds the GWQS.

As indicated in **Table 4.2-4**, the constituent concentration that results after initial dilution is provided by the proposed DoD outfall ($C2_i$) will be able to meet the GWQS if the NDWWTP is upgraded to provide secondary treatment similar to that at the proposed DoD facility.

Constituent concentrations at the M-1 water boundary are calculated in **Table 4.2-5**. The results indicate that the GWQS can be achieved for M-1 waters for all constituents except enterococci with the secondary discharge from the proposed DoD outfall and primary discharge from the new NDWWTP outfall. Disinfection of the discharge from the NDWWTP is required to reduce enterococci in the discharge to comply with M-1 water quality.

4.3 ENVIRONMENTAL IMPACTS TO THE RECEIVING WATER

The results of the nearfield and farfield plume modeling by EKNA Services were used to assess the water quality and biological impacts on the receiving marine waters associated with a new point discharge from a proposed DoD outfall identified as Option 2 in the July 2008 study. This assessment included the effects of the modeled design discharge of 12 MGD from the new NDWWTP outfall as it mixes with the secondary treated effluent that will be discharged from the proposed DoD outfall at a design flow of 5 MGD. The water quality and biological impact assessments were performed by AECOS, Inc. This interim report contains their preliminary findings based on field work conducted for Phases 1 and 2 of this investigation.

Field investigation of benthic ecosystem, coral, phytoplankton, fishes, and other marine life was not included in the scope of this investigation. AECOS, Inc. researched and reviewed previous studies performed by others in the vicinity of the proposed DoD outfall to assess the existing benthic infaunal assemblages and coral reef ecosystem in the vicinity of Tanguisson Point and the anticipated impacts associated with the discharge of sewage effluent from an outfall. Studies on other marine outfalls located in Guam and Hawaii were also reviewed for supplemental information used in the analysis.

The results of the work performed by AECOS, Inc. are summarized below. A detailed report is provided in **Appendix 3C**.

4.3.1 Water Quality Impact Assessment

The three components of wastewater found to be most detrimental to marine life and coral reefs are nutrients, sediments, and toxic substances. Therefore, these constituents will be the focus of the following analyses. Although enterococcus is not usually considered a pathogenic organism, its presence in marine water is important since this organism is used as an indicator of wastewater contamination in recreational waters.

Constituents that may be present in the receiving water after initial dilution has been achieved were previously presented in **Table 4.2-3**. When the farfield plume from the new NDWWTP outfall (discharging primary treated effluent at 12 MGD) is mixed with the nearfield plume from the proposed DoD outfall (discharging secondary treated effluent at 5 MGD), all constituents

Table 4.2-4

Calculated Constituent Concentrations after Initial Dilution

Table 4.2-5

Calculated Constituent Concentrations at M-1 Boundary

meet the GWQS limits, with the exception of enterococcus and ammonia. Based on an analysis of the farfield plume, the GWQS will be achieved for all water quality parameters in the combined NDWWTP and DoD effluent plume within approximately 1,000 feet (for ammonia) to 1,650 feet (for enterococcus) north of the proposed DoD outfall.

4.3.2 Biological Impact Assessment

Tropical ocean waters are typically characterized as low in nutrients and particulates. The discharge of high levels of nutrients and particulates may therefore have a detrimental impact on the receiving marine water.

To minimize this impact, wastewater is treated prior to discharge to reduce the particulates present in the effluent. Secondary treatment may be utilized to further reduce the oxygen demand of the pollutants present in the discharge. Advance treatment is also available to reduce the nutrient level in the discharge. Reduction of toxic substances is best handled at the source by enforcing pretreatment and best management practices.

The following assessment is based on a review of existing studies performed by others in the vicinity of the proposed DoD outfall, supplemented by investigations performed on other marine outfalls located in Guam and Hawaii.

4.3.2.1 Water Column Impacts

As flow is discharged through an outfall, either through a diffuser or an open end pipe, wastewater and the receiving marine waters are mixed, providing the opportunity for biological substances present in the receiving water to interact with the chemical and physical properties of the discharge. The nearfield plume analysis performed by EKNA Services indicated that the discharge from the diffuser rises quickly, with minimal horizontal dispersion before reaching the surface. This initial mixing and rise of the fluids is short, occurring in minutes. Therefore, there is minimum interaction with the extant assemblage of organisms in the water column. In the immediate vicinity of the discharge, particulate organic matter (POM) can attract fishes.

Both physical mixing and uptake by marine organisms will reduce the concentration of biologically active substances in the water column. Phytoplankton may assimilate with some of the nutrients present in the farfield plume. Since phytoplankton requires several days to replicate and the plume will likely disperse over a wide area in a matter of hours, however, the increase in biomass is not likely to be a concern. The low phytoplankton biomass (based on the low level of chlorophyll α) suggests that any increase resulting from phytoplankton productivity will be rapidly grazed by herbivorous zooplankters. Therefore, detectable changes in phytoplankton or herbivorous zooplankton biomass are not anticipated.

As discussed in section 4.3.1, enterococcus and ammonia levels in the surfacing plume will exceed the GWQS. These exceedances are attributed to the ambient receiving water quality condition resulting from the primary effluent discharge from the new NDWWTP outfall. These anticipated constituent concentrations are based on the modeling results by EKNA Services and do not take into account the degradation of constituents, die-off of organisms, or uptake of the pollutants by existing aquatic life.

Enterococcus in the discharge plume will eventually be diluted to near zero. Unfavorable conditions provided by the marine environment will likely destroy these bacteria and most others from the wastewater. Factors such as pH, temperature, solar (UV) radiation, predation, osmotic stress, nutrient deficiencies, particulate levels, turbidity, oxygen concentrations, and microbial community composition affect bacteria inactivation.

The toxicity of ammonia is dependent on pH. Dissolved in water, ammonia will react with hydrogen ions (H^+) to form non-toxic ammonium ions (NH_4^-). When mixed with the higher pH level in the receiving marine water, ammonia present in the wastewater discharge will increase in toxicity. At a pH of 7.2 and a temperature of 30 °C (undiluted wastewater), 1.3 percent of the ammonia present is toxic. As pH approaches 8.2 (marine water), toxic ammonia will comprise approximately 88.6 percent of the total concentration. Toxicity is still a function of concentration and, since the initial dilution of ammonia in the rising plume is around 45 μgN/L, this value is nearly two orders of magnitude (or about 1/100) of the concentration found to be toxic to most fishes (EPA, 1972).

4.3.2.2 Benthic Impacts

Benthic impacts are associated with the sedimentation of particulates entrained in the discharge plume. Sources of particulates in the wastewater discharge plume include particulates in the effluent, particulates produced in the environment from nutrient enrichment, and natural seston (natural, very minute living and non-living particulates in water).

Based on a study performed by Bailey-Brock and Krause (2007), the benthic community in the vicinity of the NDWWTP outfall can be characterized by diverse invertebrate and polychaete assemblages, with high abundance of some taxa, typical of communities found in carbonate sand. The benthic environment at the proposed DoD outfall is anticipated to be similar.

Based on several studies performed on deep ocean outfalls off Oahu in the Hawaiian Islands, no significant impacts have been reported on the benthic faunal. Impacts to polychaete assemblages and the crustacean and soft bottom communities were found to be limited. Since the conditions off Tanguisson Point are similar to those off the Oahu deep ocean outfalls, adverse impacts to the receiving marine waters are not anticipated with the discharge of secondary treated effluent from the proposed DoD outfall.

4.3.2.3 Sewage Impacts on Coral Reef Ecosystem

The Guam nearshore environment is characterized by extensive coral bottom and coral reef areas. In the vicinity between Tanguisson Point and Falcona Beach, high coral cover and diversity exists.

Detrimental impacts to the coral reef ecosystem associated with excessive nutrient-loading, bacteria, and sediment abrasion have been documented in other studies. These impacts, however, are dependent on the flushing properties of the receiving waters and the characteristics of the sediment. A 1985 report by Pastorok and Bilyard studied the impact of sewage effluent on the coral reef ecosystem. The study concluded that the discharge of sewage had little or no impact on the coral reef ecosystem in well-flushed water along open coasts.

Increased nutrient levels tend to favor algal growth and filter-feeding invertebrates (Birkeland, 1977). A study by Smith and Smith (2006) indicated that an increase in nutrient concentration may lead to a "phase shift" in the nature of the benthic algal community from one dominated by zooxanthellae (coral symbionts) to one dominated by fleshy macro-algae.

Documented impacts of sedimentation on coral reef systems include impeded growth due to unnecessary energy expenditure used to actively reject particles that settle on them, surface abrasion due to the re-suspension of sediments, decreased light availability, and toxic effects associated with the decomposition of organic matter. In general, coral species located along the seaward margin of the reef are less tolerant to high sediment loadings than species found on the inner reef. However, the physical condition of the seaward margin of the reef typically prevents the accumulation of sediments. The wastewater plume models for this investigation also indicated that the plume rises to the surface quickly and then spreads out, broadening the area subject to the dissolved and particulate substances in the effluent, thus reducing the concentration of the constituents that will arrive at the reef.

The coral reef off Tanguisson Point, at its closest point, is located approximately 360 feet from the outfall. This is approximately 1,100 feet from the shoreline and roughly 820 feet from the reef margin. The results of the farfield plume analysis indicate that the average dilution along the face of the reef will be on the order of 1,000 to 2,000. Without the influence of primary treated effluent discharged through the new NDWWTP outfall, the proposed DoD discharge of secondary treated effluent will meet GWQS as the discharge plume surfaces. With the primary treated effluent discharge from the NDWWTP, the average dilution factor for the mixed plume as it surfaces and spreads to the nearby reef front is expected to be on the order of 10, reducing the ammonia concentration well below the GWQS of 20 μg N/L. The 24-hour visitation frequency for the reef area is on the order of 5 to 10 percent.

The results of the farfield plume analysis and water quality assessment indicate some impact on the nearshore reef ecosystem associated with the discharge of 12 MGD of primary treated effluent through the new NDWWTP outfall. Due to the prevailing ocean current and wind conditions, mixing and flushing capabilities, and distance from the shore, however, the biological impacts are anticipated to be inconsequential and very limited in area. This potential impact may be mitigated by improving the treatment provided at the NDWWTP to secondary levels. The addition of 5 MGD of secondary treated effluent through the proposed DoD outfall should not alter this assessment, with the exception that detectable ammonia levels (below the GWQS limits) may impinge on the reef margin.

TABLE 4.1-2
SUMMARY OF DMRs FROM SECONDARY WWTPs IN GUAM AND HAWAII

Parameter	Secondary Treatment							
	Apra Harbor		Waianae		Kailua Regional		Wahiawa	
	Geometric Mean	90%*	Geometric Mean	90%*	Geometric Mean	90%*	Geometric Mean	90%*
Flow (ft^3/sec)	3.5	3.8	3.3	3.4	11.8	13.2	1.9	1.8
pH	7.2 to 7.5	7.2 to 7.6	7.2 to 7.5	7.0 to 7.6	6.8 to 7.1	6.7 to 7.2	7.1 to 7.3	7.0 to 7.4
BOD5 (mg/L) - Influent	76	93	189	199	169	186	---	---
BOD5 (mg/L) - Effluent	12	17	17	18	15	18	8	11
% BOD Removal	83%		91%		91%		---	
TSS (mg/L) - Influent	177	330	153	157	237	258	---	---
TSS (mg/L) - Effluent	10	14	12	13	18	21	10	14
% TSS Removal	93%		92%		92%		---	
Turbidity (NTU)			7.4	9	9	11.5		
Enterococci (MPN/100 mL)	3.9	11.6	56,219	130,399	20,039	35,900		
Coliform, fecal general (CFU/100 mL)	4.3	14.2					3	7
Nitrogen, Total (as N) (mg/L) - Max			22.8	27.8	17	18.4	23.4	25.8
Nitrite Plus Nitrate, Total (as N) (mg/L) - Max			14.8	16.5	9.6	11.7		
Nitrogen, Ammonia (as N) (mg/L) - Max			4.7	10.6	3.9	9.3		
Ammonia & Ammonium, Total (μg/L)	37.3	156						
Phosphorus, Total (as P) (mg/L) - Max			3.8	4.4	2.8	3.4	2.1	2.9
Nickel, Total Recoverable (μg/L)	12.8	14.8						
Zinc, Total Recoverable (μg/L)	25.1	42.1						
Aluminum, Total Recoverable (μg/L)	206	361						
Copper, Total Recoverable (μg/L)	7.6	10.7						
Oil and Grease (mg/L) - Influent	---	---						
Oil and Grease (mg/L) - Effluent	1.3	2						
Chlorine, Total Residual (μg/L)	4.4	9.8					0.02	0.02
TUC STAT 1Hr Chr. Tripneustes Gratilla - Max			93.6	452.4	65.5	185.2		
TUC STAT RE 7Day Chr. Ceriodaphnia Dubia - Max			33	29.4	46.3	46.3		
% Survival Tilapia Mossambica							75	0

**Statistical analysis used to develop a value that is exceeded only 10 percent of the time.*

TABLE 4.2-4
CALCULATED CONSTITUENT CONCENTRATIONS AFTER INITIAL DILUTION ASSUMING SECONDARY TREATED EFFLUENT DISCHARGED FROM THE NDWWTP

Water Quality Constituents	Unit	Background Concentrations (C_a)	NDWWTP Secondary Treated Effluent Concentration ($C1_e$)	Initial Dilution Provided by New NDWWTP Outfall ($S1_0$)	Average Farfield Dilution Factor For the New NDWWTP Outfall at Proposed DoD Outfall Location ($F1_{ave}$)	Calculated Ambient Concentrations at Proposed DoD Outfall ($C1_F$)	DoD Secondary Treated Effluent Concentration ($C2_e$)	Initial Dilution Provided by Proposed DoD Outfall ($S2_0$)	Average Farfield Dilution Factor For the Proposed DoD Outfall Location ($F2_{ave}$)	Calculated Constituent Concentration After Initial Dilution ($C2_i$)	GWQS (M-2 Waters)
Enterococci	#/100mL	0	15	300	2	0	15	251	1	0	104
Orthophosphate (as P)	μg P/L	5	1,640	300	2	7.7	1,640	251	1	14.2	50
Nitrate-Nitrite	μg N/L	1.1	14,900	300	2	25.9	14,900	251	1	85.2	200
TSS	mg/L	5.6	9	300	2	5.6	9	251	1	5.6	20
Turbidity	NTU	0.25	16	300	2	0.3	16	251	1	0.3	1
Priority Toxic Pollutants											
Lead	μg/L	0	4.43	300	2	0	4.43	251	1	0	8.1
Copper	μg/L	0	54.6	300	2	0.1	54.6	251	1	0.3	3.1
Zinc	μg/L	0	72.6	300	2	0.1	72.6	251	1	0.4	86
Additional Toxic Pollutants											
Ammonia (as N)	μg N/L	0	3,500	300	2	5.8	3,500	251	1	19.8	20
Total Sulfide	μg/L	0	140	300	2	0.2	140	251	1	0.8	5
Non-Regulated Constituents											
Total Nitrogen	μg N/L	151	23,950	300	2	190.7	23,950	251	1	285.3	---
Total Phosphorus	μg P/L	13	3,760	300	2	19.2	3,760	251	1	34.1	---

TABLE 4.2-5
CALCULATED CONSTITUENT CONCENTRATIONS AT M-1 BOUNDARY WITH INFLUENCE OF PRIMARY EFFLUENT DISCHARGED FROM THE NDWWTP

Water Quality Constituents	Unit	Background Concentrations* (C_a)	NDWWTP Primary Treated Effluent Concentration ($C1_e$)	Initial Dilution Provided by New NDWWTP Outfall ($S1_0$)	Average Farfield Dilution Factor For the New NDWWTP Outfall at M-1 Boundary ($F1_{ave}$)	Calculated Ambient Concentrations at M-1 Boundary ($C1_F$)	DoD Secondary Treated Effluent Concentration ($C2_e$)	Initial Dilution Provided by Proposed DoD Outfall ($S2_0$)	Average Farfield Dilution Factor For the Proposed DoD Outfall at the M-1 Boundary ($F2_{ave}$)	Calculated Constituent Concentration at M-1 Boundary ($C2_F$)	GWQS (M-1 Waters)
Enterococci	#/100mL	0	240,000	300	4	200	15	251	5	200	104
Orthophosphate (as P)	μg P/L	5	2,620	300	4	7.2	1,640	251	5	8.5	25
Nitrate-Nitrite	μg N/L	1.1	9	300	4	1.1	14,900	251	5	13.0	100
TSS	mg/L	5	80	300	4	5.1	9	251	5	5	5
Turbidity	NTU	0.25	59	300	4	0.3	16	251	5	0.3	0.5
Priority Toxic Pollutants											
Lead	μg/L	0	4.43	300	4	0	4.43	251	5	0	8.1
Copper	μg/L	0	68.3	300	4	0.1	54.6	251	5	0.1	3.1
Zinc	μg/L	0	276	300	4	0.2	72.6	251	5	0.3	86
Additional Toxic Pollutants											
Ammonia (as N)	μg N/L	0	18,400	300	4	15.3	3,500	251	5	18.1	20
Total Sulfide	μg/L	0	140	300	4	0.1	140	251	5	0.2	5
Non-Regulated Constituents											
Total Nitrogen	μg N/L	151	47,600	300	4	190.5	23,950	251	5	209.5	---
Total Phosphorus	μg P/L	13	3,850	300	4	16.2	3,760	251	5	19.2	---

**Background concentration of TSS reduced from 5.4 mg/L to 5 mg/L to match GWQS for M-1 waters.*

Note: Constituents that exceed the M-1 limit in the GWQS are highlighted in yellow.

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Revised Final

Guam Wastewater Utility Study Report for Proposed USMC Relocation

May 2010

Department of the Navy
Naval Facilities Engineering Command, Pacific
258 Makalapa Drive, Suite 100
Pearl Harbor, HI 96860-3134

Contract Number N62742-06-D-1870/TO 0011

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May 2010

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The Guam Joint Military Master Plan (GJMMP) identified a planned increase in military population on Guam. Naval Computer and Telecommunications Station Finegayan, South Finegayan Housing area, Andersen Air Force Base (AFB), Andersen AFB Northwest Field, and Andersen AFB South provide potential locations for most of the proposed United States Marine Corps (USMC) relocation to Guam. Sewage from these locations is currently conveyed to the Guam Northern District Wastewater Treatment Plant (NDWWTP) for treatment and disposal. The NDWWTP is owned by Guam Waterworks Authority (GWA) and operated by Veolia Environment under contract with GWA.

The Naval Facilities Engineering Command, Pacific, under master contract number N62742-06-D-1870 issued a task order to the TEC Inc. Joint Venture to prepare Wastewater Utility Study Report and Planning Documents for the review of collection mains, pump stations, treatment and disposal system alternatives for northern Guam. This report includes evaluation of reasonable wastewater treatment alternatives to support the USMC relocation to Guam and provides sufficient and detailed information to support the environmental impact study process.

This report presents the findings of the evaluations conducted based on the information gathered during the field study; correspondence with the Guam Environmental Protection Agency, GWA, and United States Environmental Protection Agency (EPA) Region 9; search of plan files for previous studies, as-built drawings, planned sewer improvement projects, National Pollutant Discharge Elimination System, records on GWA, Air Force/Navy sewer systems; and detailed analysis of the recommended wastewater treatment options.

The following wastewater treatment alternatives are reviewed:

- **Option 1A** – Restore and upgrade existing primary treatment system at the Government of Guam (GovGuam) NDWWTP to accept the additional flow and load.
- **Option 1B** – Restore, expand, and upgrade the GovGuam NDWWTP to secondary treatment.
- **Option 2** – Build new secondary treatment plant near the proposed development on Department of Defense (DoD) land and construct new outfall.
- **Option 3** – Build new separate secondary treatment plant at GovGuam NDWWTP site to treat DoD load only.
- **Option 4** – Build a new tertiary treatment plant near the proposed development on DoD land and send effluent to a new water treatment plant (or existing water treatment plant).
- **Option 5** – Build a new secondary treatment plant and construct new outfall on eastern coastline.
- **Option 6** – Build a new tertiary treatment plant near proposed development and reuse the effluent, send the residual to the GWA outfall.
- **Option 7** – Build a new tertiary treatment plant near proposed development on DoD land and install injection wells.
- **Option 8** – Install pretreatment for DoD industrial flows in conjunction with the upgrade and expansion of the GovGuam NDWWTP.

Option 1B, upgrade the NDWWTP to secondary treatment, includes Option 1A of restoring and upgrading the primary treatment system at the NDWWTP. AECOM Technical Services, Inc. (ATS) developed a ranking system to identify the four most favorable alternatives. The ranking system used

a relative factor for regulatory agency involvement and cost of construction. The system used a factor 1 for low involvement or relative cost, 2 for medium involvement or relative cost, and 3 for high involvement or relative cost. Table 5-3 provides the total overall score and relative ranking of each alternative and Table 5-4 summarizes reasons for eliminating some of the alternatives. Based on the relative rankings, the following alternatives are considered for detailed analysis:

- Option 1A – Restore and upgrade existing primary treatment system at the GovGuam NDWWTP to accept the additional flow and load.
- Option 1B – Restore, expand, and upgrade the GovGuam NDWWTP to secondary treatment.
- Option 2 – Build new secondary treatment plant near the proposed development on DoD land and construct new outfall.
- Option 3 – Build new separate secondary treatment plant at GovGuam NDWWTP site to treat DoD load only.

The military buildup populations on Guam, including USMC relocation for the study are provided in Table ES-1. Table ES-2 provides current and future military populations in northern Guam, where the GJMMP identified the major area for future USMC relocation.

Table ES-1: Current and Future Military On-Base Populations on Guam

Service	Active Duty	Dependants	Transient	Civilian Workers [a]	Civilian Workers (Guam) [b]	Total
Baseline (FY09)						
USMC	3	2	0	1	0	6
Air Force	2,145	2,950	0	805	402	6,302
Navy	4,350	5,230	0	1,631	815	12,026
Army	30	50	0	11	5	96
USCG	140	180	0	53	26	399
Planned Increase						
USMC	8,552	9,000	2,000	1,710	855	22,117
Air Force	120	210	1,780	25	12	2,147
Navy	280	50	7,222	10	5	7,567
Army	630	950	0	126	63	1,769
USCG	81	103	0	10	5	95
Total Future Loading						
USMC	8,555	9,002	2,000	1,711	855	22,123
Air Force	2,265	3,160	1,780	830	414	8,449
Navy	4,630	5,280	7,222	1,641	820	19,593
Army	660	1,000	0	137	68	1,865
USCG	221	283	0	63	31	494

Note: Data from Navy's email dated 2/23/09.
USCG United States Coast Guard
[a] Civilian Workers – Military civilian workers (off-Island) living on the island and working on base.
[b] Civilian Workers (Guam) – On-Island residents who work on base.

Table ES-2: Current and Future Military On-Base Populations in Northern Guam

Service	Active Duty	Dependants	Transient	Civilian Workers	Civilian Workers (Guam)	Total
Baseline (FY09)						
USMC	3	2	0	1	402	6
Air Force	2,145	2,950	0	805	1130	6,302
Navy	39	66	0	1,481	5	1,586
Army	30	50	0	11	0	96
USCG	0	0	0	0	0	0
Planned Increase						
USMC	8,552	9,000	2,000	1,710	855	22,117
Air Force	120	210	1,780	25	12	2,147
Navy	0	0	0	0	0	0
Army	630	950	0	126	63	1,769
USCG	0	0	0	0	0	0
Total Future Loading						
USMC	8,555	9,002	2,000	1,711	855	22,123
Air Force	2,265	3,160	1,780	830	414	8,449
Navy	39	66	0	351	1,130	1,586
Army	660	1,000	0	137	68	1,865
USCG	0	0	0	0	0	0

Notes:
1. Assumed current USMC and Army reside in northern Guam.
2. All increased USMC and Army live in Finegayan.
3. All increased AF live in Andersen AFB.
4. Assumed no Navy and USCG population increase in northern Guam.

For detailed analysis, the projected increase in wastewater flows and existing wastewater flows to NDWWTP from both the civilian and military population are considered. Military wastewater flow includes domestic wastewater flow and industrial wastewater flow. The domestic wastewater flow is generated mainly from sanitary and general purposes and is normally estimated from a residential population. The industrial wastewater flow is generated from industrial operation processes. The following Table ES-3 provides current and future wastewater flows in northern Guam. Detailed flow analysis is provided in Section 3.

Table ES-3: Current and Future Civilian and DoD Flows in Northern Guam Region

Type of Flow	Current Wastewater Flow (Y2009) (mgd)	Projected Wastewater Flow (mgd)	Total Projected Future Wastewater Flow (Y2019) (mgd)
Civilian	5.20	1.88	7.08
Military	0.50	2.96	3.5
USMC	—	2.56	2.56
Air Force	0.36	0.20	0.56
Navy	0.12	—	0.12
Army	0.01	0.20	0.21
Total flow	5.70	4.85	10.54

mgd million gallons per day

Total planned wastewater flow generated from military facilities in northern Guam is 3.46 million gallons per day (mgd) and 7.08 mgd from civilian sources. Thus, the average daily flow to NDWWTP is forecast at 10.54 mgd upon completion of the proposed DoD buildup in the year 2019. The original design capacity for the NDWWTP is an average flow of 12.0 mgd and a peak flow of 27.0 mgd. That treatment capacity is considered for evaluating the following first viable alternative, Option 1A.

GWA has suggested future daily flows of 18.0 mgd average and 40.5 mgd peak for the NDWWTP. Those capacities are considered for evaluating the following second viable alternative, Option 1B.

A breakdown of average and future wastewater flows to NDWWTP and DoD plant are provided in Table ES-3. As shown in Table ES-3, the average future daily flow from military facilities is 3.5 mgd, and the peak future flow is 8.5 mgd. As shown in Table ES-4, the average future daily flow of 3.5 mgd, and the peak future flow of 8.5 mgd are considered for evaluating the following two viable alternatives, Option 2 and Option 3.

Table ES-4: Average and Peak Wastewater Flows Considered for Viable Alternatives

Wastewater Treatment Alternative	Average Daily Flow (mgd)	Peak Daily Flow (mgd)
Option 1A: Restore & Upgrade NDWWTP Primary Treatment	12.0	27.0
Option 1B: Restore, Expand & Upgrade NDWWTP to Secondary Treatment	18.0	40.5
Option 2: DoD Secondary Treatment on DoD Land	3.5	8.5
Option 3: Separate Secondary Treatment at NDWWTP Site to Treat DoD Load Only	3.5	8.5

The detailed analysis of the four viable alternatives is provided in Section 6. Table ES-5 provides total present capital costs and annual life cycle costs of the four viable alternatives based on year 2010 cost. Table ES-6 provides year 2010 capital costs estimated as the costs when construction starts and year 2013 capital costs estimated as mid-point costs of the construction.

In Table ES-5, both the annual life cycle cost of $664,000 (including amortized construction cost and estimated annual operation and maintenance [O&M] cost) and total capital cost of $66,121,000 for Option 1A are the lowest compared to other alternatives. The USMC's capital cost share of $20,333,000 based on USMC's portion of the wastewater flow, which is a percentage of its projected wastewater flow to the plant, is also the lowest for Option 1A. However, a secondary treatment alternative is recommended because the EPA Region 9 declared that the increased discharge from DoD activities in northern Guam would have an impact on the existing National Pollution Disposal Elimination System (NPDES) permit requirements, water quality standards, and NPDES requirements for current and any future effluent discharge would be based on EPA secondary treatment technology based requirements.

Option 1B includes all the costs of Option 1A for restoring its existing primary treatment capacity to 12 mgd and costs to upgrade the NDWWTP to an 18 mgd secondary treatment facility. Among the three secondary treatment alternatives, Option 3 has the lowest capital cost of $161,250,000 and annual life cycle cost of $13,406,000. Based on capital cost allocations, Option 1B is beneficial to Navy as the USMC share will be $55,655,000, which is the lowest of the secondary alternatives.

ATS recommended Option 1B as the best treatment alternative for both the military and Guam on-island population. Expand and upgrade the NDWWTP would improve basic island infrastructure and its surrounding water quality to the benefit of all Guam inhabitants. The study and recommended alternatives work for the planned military buildup concentrated in the Finegayan area. Significant population shifts to other locations would require further analysis to identify other collection system and treatment plant requirements and their associated construction cost. A brief summary of the recommended alternative and the other viable alternatives in the order of preference is presented in the following sections.

Table ES-5: Cost Summary on Viable Alternatives

Option:	Option 1A: Restore & Upgrade NDWWTP Primary Treatment	Option 1B: Restore, Expand & Upgrade NDWWTP to Secondary Treatment	Option 2: DoD Secondary Treatment on DoD Land	Option 3: Separate Secondary Treatment at NDWWTP Site to Treat DoD Load Only
Capital Costs				
Total Capital Cost	$66,121,000	$211,548,000	$172,375,000	$161,250,000
Amortized Capital Cost	$4,865,000	$15,566,000	$12,684,000	$11,865,000
O&M Costs				
Total Annual Cost	$664,000	$3,131,000	$1,540,000	$1,541,000
Annual Life Cycle Costs	$5,529,000	$18,697,000	$14,224,000	$13,406,000
USMC Capital Cost	*$20,333,000*	*$55,655,000*	*$127,538,000*	*$119,306,000*

Table ES-6: Capital Cost Summary on Viable Alternatives at Y2010 and Y2013

Option:	Option 1A: Restore & Upgrade NDWWTP Primary Treatment	Option 1B: Restore, Expand & Upgrade NDWWTP to Secondary Treatment	Option 2: DoD Secondary Treatment on DoD Land	Option 3: Separate Secondary Treatment at NDWWTP Site to Treat DoD Load Only
Total Capital Costs				
Y2010 Cost	$66,121,000	$211,548,000	$172,375,000	$161,250,000
Y2013 Cost	$70,168,000	$224,495,000	$182,924,000	$171,119,000
USMC Capital Costs				
Y2010 Cost	$20,333,000	$55,655,000	$127,538,000	$119,306,000
Y2013 Cost	$21,577,000	$59,061,000	$135,343,000	$126,608,000

THE RECOMMENDED ALTERNATIVE:

The recommended alternative, Option 1B, is to expand and upgrade the NDWWTP to include secondary treatment facilities to enhance removal of biodegradable organic matters (in solution or suspension) and suspended solids found in wastewater. Prior to upgrading to secondary treatment, the following short and long terms refurbishments and upgrades are required at the NDWWTP to restore its primary treatment capacity.

The short-term improvements required to restore the primary treatment capacity are as follows:

- Septage and fat/oil/grease (FOG) receiving
- Primary clarifier rehabilitation
- Sludge digester rehabilitation
- Centrifuge building replacement and one centrifuge

- Sludge-drying bed rehabilitation
- Standby power

The long-term improvements required to restore the primary treatment capacity are as follows:

- Hydraulic improvements to the chlorine contact tank
- Third digester (new)
- Second centrifuge
- Odor control
- Digester gas utilization
- Administration/laboratory, office, and workshop/storage areas rehabilitation

In addition to restoring its primary treatment capacity, the following new process components and upgrades are required to expand primary treatment capacity:

- One primary clarifier (same size as existing ones)
- Three trickling filters
- Four secondary clarifiers
- One chlorine contact tank
- Two new anaerobic digesters (same size as existing ones)
- One centrifuge solids dewatering system and odor control
- Effluent monitoring and measurement expansion
- Outfall diffuser capacity expansion

The sizes of the new process components and upgrades required for restoring, expanding and upgrading to secondary treatment are listed in Table ES-7.

A 24-inch, 7,500 foot sewer would be required to convey flow from the Finegayan area to the NDWWTP. The estimated project cost for constructing a new secondary treatment facility at the NDWWTP is $211,548,000. A summary of preliminary project cost for the recommended alternative is shown in Table ES-8.

Table ES-7: Components for Restoring, Expanding, and Upgrading the NDWWTP to Secondary Treatment

Construction Components	Refurbish (R)/Expand (E)/Upgrade (U)/NEW (N)	Unit	Dimensions/Description
Septage Receiving station	N	1	Septage storage tank, screen, two blowers, diffusers, two grinder pumps, truck unloading area
FOG receiving station	N	1	Headed grease-holding tank, heat trace system, two grinder pumps, grease truck unloading area
Headworks	U/N	2	Two fine screens
Primary clarifier	R N	2 1	130 ft diameter x 7 ft SWD 130 ft diameter x 7 ft SWD
Trickling filter pumping station	N	1	40 ft long x 25 ft wide x 16 ft high
Trickling filter	N	3	120 ft diameter x 24 ft SWD
Secondary clarifier	N	4	125 ft diameter x 16 ft SWD
Chlorine contact tank	R N	2 1	60 ft long x 40 ft wide x 8 ft SWD 60 ft long x 40 ft wide x 8 ft SWD
Anaerobic digester	R N	2 3	80 ft diameter x 18 ft SWD 80 ft diameter x 18 ft SWD
Solids dewatering centrifuges	N	3	150 gpm each
Effluent measurement	E	1	Automatic sampler
Odor control system	N	1	Locate at headworks and solids dewatering
Sludge-drying bed	R	8	Concrete repair, valves
Standby diesel generator	N	1	300-kilowatt diesel generator
Digester gas utilization	N	1	
Administration/Lab, Workshop and Storage	R	1	
Outfall capacity expansion	N	1	400 ft long multiport diffusers

ft feet or foot
gpm gallon per minute
SWD side water depth

Table ES-8: Preliminary Construction Cost for Recommended Alternative – Restore, Expand and Upgrade GovGuam NDWWTP to Secondary Treatment

Construction Categories	Cost Opinion
Septage Receiving Station	$1,317,000
FOG Receiving Station	$566,000
Headwork Expansion	$2,629,000
Primary Clarifier Expansion	$11,277,000
Pumping Station	$3,237,000
Trickling Filters	$26,067,000
Secondary Clarifiers	$31,650,000
Chlorine Contact Tanks	$5,564,000
Anaerobic Digesters	$47,057,000
Solids Dewatering Building	$8,260,000
Influent and Effluent Samplers	$318,000
Sludge Drying Bed Refurbishment	$80,000
Other Refurbishments & Upgrades	$1,540,000
Site Work and Utilities	$9,509,000
Relief Sewer	$4,181,000
Outfall Diffuser Capacity Expansion	$3,450,000
TREATMENT SUBTOTAL COST	$149,071,000
SEWER AND OUTFALL EXPANSION SUBTOTAL COST	$7,631,000
TOTAL COST	$156,702,000
PROJECT SERVICES	$54,845,000
TOTAL ESTIMATED COST	$211,548,000
TOTAL ESTIMATED PROJECT COST (ROUNDED)	**$211,548,000**
TOTAL ESTIMATED PROJECT COST FOR USMC	**$55,655,000**

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%	percent
AFB	Air Force Base
ATS	AECOM Technical Services, Inc.
BOD_5	5-day, biochemical oxygen demand
CFR	Code of Federal Regulations
CIP	Capital Improvement Program
cy	cubic yard
DoD	Department of Defense
DPW	Department of Public Works, Government of Guam
EIS	environmental impact statement
EPA	Environmental Protection Agency, United States
FOG	fat/oil/grease
ft	feet or foot
ft^2	square foot
ft^3	cubic foot
ft^3/min	cubic feet per minute
GBSPO	Guam Bureau of Statistics and Planning Office
GDAWR	Guam Department of Aquatic and Wildlife Resources
GDOA	Guam Department of Agriculture
GEPA	Guam Environmental Protection Agency
GIMDP	Guam Integrated Military Development Plan
GJMMP	Guam Joint Military Master Plan
GOJ	Government of Japan
GovGuam	Government of Guam
gpcd	gallon per capita per day
gpd	gallon per day
gpd/ft^2	gallon per day per square foot
gpm	gallon per minute
GWA	Guam Waterworks Authority
HP	horsepower
IGPBS	Integrated Global Presence and Basing Strategy
in.	inch
ISR	United States Air Force Global Intelligence, Surveillance, and Reconnaissance
lb/day	pound per day
lb/day/ft^2	pound per day per square foot
mg/L	milligram per liter
mgd	million gallons per day
MILCON	Military Construction
ml/L	milliliter per liter
MWSS	Marine Wing Support Squadron
NAVFAC	Naval Facilities Engineering Command
NCTS	Naval Computer and Telecommunications Station
NDWWTP	North District Wastewater Treatment Plant
no.	number
NPDES	National Pollution Disposal Elimination System
O&M	operation and maintenance

pH	hydrogen ion concentration
QOL	quality of life
RO	reverse osmosis
SWD	side water depth
TSS	total suspended solids
U.S.	United States
USAF	United States Air Force
USCG	United Stated Coast Guard
USG	United Stated Government
USMC	United States Marine Corps
WQS	Guam Water Quality Standards
WWTP	wastewater treatment plant

1. Introduction

1.1 PURPOSE

The purpose of this study is to identify all reasonable wastewater treatment alternatives to support the United States Marine Corps (USMC) relocation to Guam and provide sufficient and detailed information to support the environmental impact statement (EIS) process. The Naval Facilities Engineering Command (NAVFAC), Pacific, under master contract number (no.) N62742-06-D-1870 issued a task order to the TEC Inc. Joint Venture to prepare Wastewater Utility Study Report and Planning Documents for the review of collection mains, pump stations, treatment and disposal system alternatives. During the week of 23 July and 30 July, AECOM Technical Services, Inc. (ATS) visited NAVFAC Marianas facilities on Guam, and met with NAVFAC staff and several other regulatory agencies on Guam to gather information regarding the regulatory requirements and existing wastewater infrastructure for this project.

This report presents the findings of the evaluations conducted based on the information gathered during the field study; correspondence with Guam Environmental Protection Agency (GEPA), Guam Waterworks Authority (GWA), and United States (U.S.) Environmental Protection Agency (EPA) Region 9; search of plan files for previous studies, as-built drawings, planned sewer improvement projects, National Pollution Disposal Elimination System (NPDES), records on GWA, Air Force/Navy sewer systems; and detailed analysis of the recommended wastewater treatment options.

1.2 BACKGROUND INFORMATION

The island of Guam is part of the Marianas chain. Guam is a territory of the U.S. and is located approximately 3,800 miles west of Honolulu, Hawaii and 1,400 miles south of Tokyo, Japan. The island is approximately 30 miles long, ranging from 4 to 11 miles wide. The total land area is approximately 212 square miles. The current population of Guam is approximately 171,000.

The Guam Joint Military Master Plan (GJMMP) identified a planned increase in military population on Guam. Naval Computer and Telecommunications Station (NCTS) Finegayan, South Finegayan Housing area, Andersen Air Force Base (AFB), Andersen AFB Northwest Field, and Andersen AFB South provide potential locations for most of the proposed USMC relocation to Guam. Sewage from these locations is currently conveyed to the Guam Northern District Wastewater Treatment Plant (NDWWTP) for treatment and disposal. The NDWWTP is owned by Guam Waterworks Authority (GWA) and operated by Veolia Environment under contract with GWA.

Based on the findings presented in the GJMMP, NAVFAC has made the decision to perform a wastewater utility study to identify all reasonable alternatives for sewerage improvements to support the USMC relocation to Guam. This study:

- Addresses all reasonable wastewater treatment alternatives with sufficient and detailed information to support the EIS process.
- Determines wastewater collection, treatment, and disposal requirements for the Department of Defense (DoD) in northern Guam.
- Identifies and develops alternatives to support the existing and proposed DoD development as well as civilian needs.
- Provides a comparative analysis and recommendations for collection, treatment, and disposal of wastewater.

- Provides environmental impact analysis (for use in the EIS) on the most feasible treatment and disposal alternatives. The effluent disposal options include utilizing existing GWA outfall, constructing new outfall, irrigation, injecting into the ground water, and further treatment as potable water.
- Identifies and develops planning documents for projects that represent the recommended alternative for the wastewater system.

1.3 SCOPE OF WORK

This study encompasses Andersen AFB, Andersen AFB Northwest Field, Andersen AFB South, NCTS Finegayan, and South Finegayan. This study provides assessment of wastewater treatment options available in northern Guam, and covers the interceptor conveyance of sewage exiting these bases and their treatment and disposal systems.

Based on the original scope of work and information gathered during initial field investigations, the following nine wastewater treatment alternatives are reviewed. The detailed analyses of the options are provided in the following sections.

- **Option 1A** – Restore and upgrade existing primary treatment system at the Government of Guam (GovGuam) NDWWTP to accept the additional flow and load.
- **Option 1B** – Restore, expand, and upgrade the GovGuam NDWWTP to secondary treatment.
- **Option 2** – Build new secondary treatment plant near the proposed development on DoD land and construct new outfall.
- **Option 3** – Build new separate secondary treatment plant at GovGuam NDWWTP site to treat DoD load only.
- **Option 4** – Build a new tertiary treatment plant near the proposed development on DoD land and send effluent to a new water treatment plant (or existing water treatment plant).
- **Option 5** – Build a new secondary treatment plant and construct new outfall on eastern coastline.
- **Option 6** – Build a new tertiary treatment plant near proposed development and reuse the effluent, send the residual to the GWA outfall.
- **Option 7** – Build a new tertiary treatment plant near proposed development on DoD land and install injection wells.
- **Option 8** – Install pretreatment for DoD industrial flows in conjunction with the upgrade and expansion of the GovGuam NDWWTP.

2. Existing Wastewater Treatment in Northern Guam Region

The wastewater treatment in northern Guam is provided by the GWA. The GWA NDWWTP is located in the Tanguisson Point area in northern Guam. The plant has a design capacity of 12.0 million gallons per day (mgd) for primary treatment with an ocean outfall. Military wastewater flow from Andersen AFB and Finegayan area is currently conveyed to NDWWTP. The following sections provide a brief description of the wastewater systems in Andersen AFB and NCTS Finegayan, and details of the NDWWTP.

2.1 ANDERSEN AIR FORCE BASE

The existing Andersen AFB wastewater collection system consists of a network of gravity sewers, four major pump stations, and force mains located on the south side of the airfield. Two small sewage pump stations collect wastewater generated from facilities located on the north side of the airfield and convey the wastewater via force main to the gravity collection system on the south side of the airfield. The system collects wastewater generated by the industrial and residential areas on-base and discharge wastewater off-base into the GWA sewage collection system at a sewer manhole located near the Andersen AFB main gate. The wastewater is treated at the GWA NDWWTP.

2.2 NCTS FINEGAYAN

The wastewater system at NCTS Finegayan is primarily a gravity sewer system consisting of two main trunk lines. The wastewater is conveyed to NDWWTP via GWA wastewater collection system. At South Finegayan, the wastewater collection system is a gravity sewer connected to the GWA wastewater collection system. The wastewater is conveyed to NDWWTP. The average wastewater flow generated by NCTS Finegayan is approximately 0.12 mgd.

2.3 DOD FLOWS AND LOADS

The NDWWTP provides wastewater treatment for Andersen AFB under an agreement between the U.S. Air Force (USAF) and GWA. The historical average wastewater flow generated by Andersen AFB is approximately 0.36 mgd.

The Andersen AFB wastewater collection system consists of a network of gravity sewers and four major sewage pump stations and force mains located on the south side of the airfield. The existing sewer system is summarized in Table 2-1.

2.4 NDWWTP FLOWS AND LOADS

The design capacity for NDWWTP is 12 mgd average daily demand and 27 mgd peak daily demand. However, its current permit limit is 6 mgd (GWA 2007). The monthly average flows from February 2008 to June 2009 ranged from 4.5 mgd to 5.7 mgd with an overall average value of 5.2 mgd. The monthly average total suspended solids (TSS) loads from January 2009 to June 2009 ranged from 4,450 pounds per day (lb/day) to 8,330 lb/day with an average of 6,600 lb/day. The monthly average 5-day biochemical oxygen demand (BOD_5) loads from January 2009 to June 2009 ranged from 3,760 lb/day to 6,140 lb/day with an average of 5,220 lb/day. Monthly daily maximum flows during the time period exceeded the permit limit of 6 mgd. Effluent BOD_5 concentration limits, effluent BOD_5 loadings, and effluent suspended solids concentration also exceeded permit limits on a number of instances during the period of January 2009 to June 2009.

Table 2-1: Existing Sewer System

Facility 1295 Sewage Pump Station	
Area Served	Residential area bounded by Palau Loop
Type	Submersible Pump
Size (HP) and Flow (gpm)	40, flow capacity not available
Number	3
Standby generator system	Yes
Size of the Force Main (inches)	10
Length of the Force Main (ft)	Discharges into gravity sewage collection
Facility 24101 Sewage Pump Station	
Area Served	Area bound by B-52 Static display, Chicago Avenue and Arc Light Boulevard. The pump station also serves the facilities located along Arc Light Boulevard to the AMC Terminal.
Type	Horizontal Pump
Size (HP) and flow (gpm)	7.5 & 140
Head (ft)	45
Number	2
Standby generator system	Yes
Facility 24101 Sewage Pump Station (Continued)	
Wet well (ft × ft)	5 × 5
Size of the Force Main (inches)	8 inches
Length of the Force Main (ft)	1,350 [a]
Facility 1098 Sewage Pump Station	
Area Served	Serves entire main base area
Type	Vertical dry Pit Sewage Pump
Size (HP) and Flow (gpm)	150 & 2,450
Head (ft)	170
Number	3
Standby generator system	Yes
Size of the Force Main (inches)	18
Length of the Force Main (ft)	12,800 [b]
Facility 1881 Sewage Pump Station	
Area Served	Serves entire main base area
Size (HP) and Flow (gpm)	150 & 2,450 (three pumps) 150 & 3000 (one pump)
Head (ft)	170 (3 pumps), 130 (one pump)
Number	4
Standby generator system	Yes
Size of the Force Main (inches)	20
Length of the Force Main (ft)	6,300 [c]

ft feet or foot
gpm gallon per minute
HP horsepower
Head total dynamic head

[a] Discharges to a sewer manhole located along Davis Avenue.
[b] Discharges into wet well of the Facility 1881 Sewage Pump Station.
[c] Discharges into GWA sewage collection system manhole near Andersen AFB main gate.
(Source: Volume II Civil Utility Systems Report for Utility Study For Military Construction Program Projects, Andersen AFB, Guam, May 2006).

2.5 NDWWTP DESIGN CRITERIA

The NDWWTP was commissioned in 1979 and is designated Class III Wastewater Treatment Plant (WWTP). The plant is a primary treatment plant located on the northwestern coast of Guam. Location of the treatment plant is shown in Figure 2-1. NDWWTP provides services to Andersen AFB along with the local population. The WWTP contains the following unit processes:

- Comminutor
- Grit Removal
- Primary Clarifiers
- Chlorine Contact Tank
- Anaerobic Digesters
- Centrifuges
- Air Drying Bed for Solids Dewatering and Stabilization

The NDWWTP is designed for the following flows:

- Average flow 12.0 mgd
- Peak flow capacity 27.0 mgd

The NDWWTP discharges treated effluent through a 30-inch outfall into Philippines Sea. The design criteria of NDWWTP are provided in Table 2-2. The current effluent permit limitations are discussed in Section 2.8.

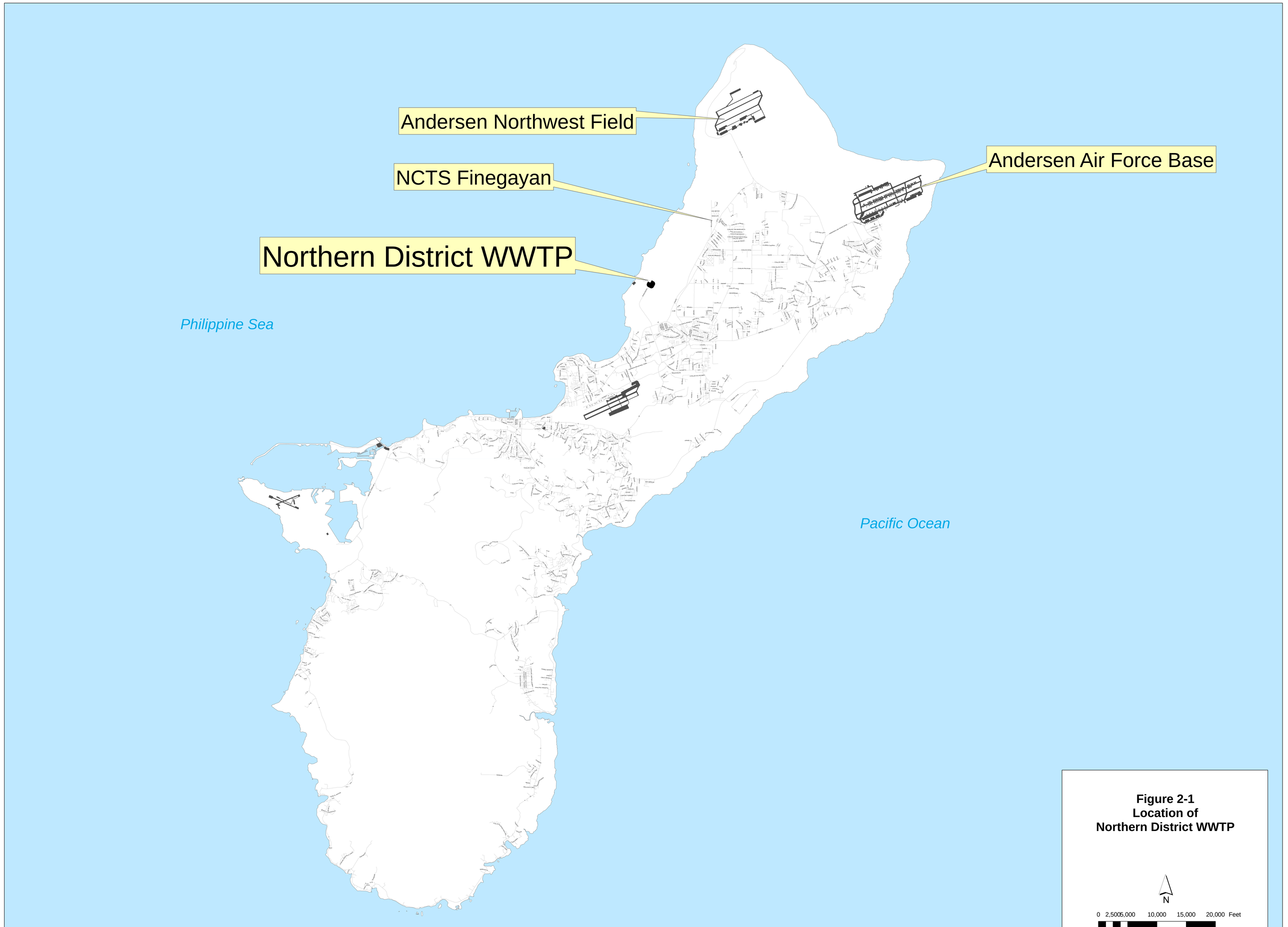
Andersen Northwest Field
NCTS Finegayan
Northern District WWTP
Andersen Air Force Base
Philippine Sea
Pacific Ocean
Figure 2-1
Location of
Northern District WWTP
N
0 2,500 5,000 10,000 15,000 20,000 Feet
C:\Projects\Guam\ArcGIS\figure6-1.mxd

Table 2-2: Existing Plant Design Summary

Item	Design Value
Comminutor	
Type	Chicago – 36A
Number	1
Diameter(ft)	Not Available
Power (HP)	3
Back Up Manual Bar Screen	
Number	1
Bar screen width (inch)	72
Bar Spacing (inch)	2
Influent Metering	
Type	Parshall Flume
Number	1
Size (inch)	36
Pre-aeration Tanks	
Number	2
Total Volume (ft^3)	18,480
Number of Air Blowers	2
Air blower Capacity (ft^3/min)	800
Grit Removal	
Number	2
Width (ft)	22
Length (ft)	54
Depth (ft)	14
Hydraulic retention time (min)	3
Total Volume (ft^3)	33,264
Primary Clarifiers	
Type	Circular
Number	2
Diameter(ft)	130
Side water depth (ft)	7
Surface Area (ft^2)	13,273
Total Volume (ft^3)	92,913
Effluent Metering	
Type	Parshall Flume
Number	1
Size (inch)	60
Disinfection	
Type	Chlorine Contact Unit
Number	2
Surface Dimension (ft × ft)	60 × 40
Side water depth (ft)	7.5
Total Volume (ft^3)	36,000
Submersible Pumps to Send Scum and Sludge from Chlorine Contact Tank to Primary Digesters	
Type	Centrifugal Pumps
Number	2
Capacity (gpm)	n/a
Head (ft)	n/a
Motor (HP)	5
Primary clarifier sludge pumps equipped with upstream grinders	
Type	Air Operated Diaphragm pump
Number	2
Capacity (gpm)	n/a
Head (ft)	n/a

Item	Design Value
Sludge Recirculation Pumps	
Type	Centrifugal
Number	2
Capacity (gpm)	450
Head (ft)	10
Motor (HP)	7.5
Primary Scum Pumps	
Type	Centrifugal Pumps
Number	2
Capacity (gpm)	n/a
Head (ft)	n/a
Primary Anaerobic Digester	
Type	Coated concrete tank with floating steel cover
Number	1
Diameter (ft)	80
Sidewall depth (ft)	21
Center depth (ft)	18
Total Active volume (ft^3)	90,478
Secondary Anaerobic Digester	
Type	
Number	1
Diameter (ft)	80
Sidewall depth (ft)	21
Center depth (ft)	18
Total Active volume (ft^3)	90,478
Heater	
Manufacturer	Cyclotherm
Capacity(Btu/hr)	500,000
Digester Sludge Recirculation Pump	
Type	Centrifugal Pump
Number	1
Capacity (gpm)	100
Head (ft)	22
Digester Sludge Transfer Pumps	
Type	Progressive Cavity Pump
Number	2
Capacity (gpm)	232
Head (ft)	10
Mechanical Dewatering	
Type	Centrifuge (Inoperative)
Number	2
Motor (HP)	75
Centrifuge Feed Pump	
Type	Progressive Cavity Pump
Number	2
Capacity (gpm)	110
Head (ft)	10
Centrifuge Polymer Feed Pumps	
Type	
Number	2
Capacity (gpm)	n/a
Head (ft)	n/a
Motor (HP)	0.5
Sludge Drying Beds	
Type	Sand

Item	Design Value
Number	8
Size – length x width (ft)	30 × 105
Total Sludge Bed Capacity (lb/day)	1,864
Depth (inches)	22
Initial Sludge Depth (inches)	8
Outfall to Philippine Sea	
Pipeline Size, each (inches)	30
Peak Hour Capacity	27 mgd
Length of the outfall from the shore	2,100 ft
Depth at which wastewater is discharged	150 ft

ft^2 square foot
ft^3 cubic foot
ft^3/min cubic foot per minute
gpd/ft^2 gallon per day per square foot
lb/day/ft^2 pound per day per square foot
n/a not available

2.6 EVALUATION OF MAJOR UNIT PROCESSES

2.6.1 Wastewater Flow

Raw wastewater influent enters the NDWWTP via a 42-inch diameter gravity line and via a 27-inch diameter forcemain from GWA's Southern Link Pump Station.

2.6.2 Preliminary Treatment

A comminutor is used to grind debris in the influent. There is one comminutor and the manufacturer is Chicago Pump. This is driven by a 3-horsepower (HP) pump. Currently, the comminutor is not in service and bar screen is used to remove debris. The screen is 72-inches wide with bar spacing of 2-inches. The screen is cleaned manually. The influent flow is measured using a Parshall flume. The Parshall flume is 36-inches wide. The flume is equipped with an ultrasonic level sensor for the flow measurement. This is currently not operational.

The flow from the Parshall flume enters two aerated grit basins. Each tank is 4,350-square feet (ft^2) equipped with an air blower with a capacity of 800-cubic feet per minute.

The influent enters flow splitter box prior to primary clarifiers. There are two clarifiers each diameter of 130 feet, side water depth of 7 feet and weir length of 471 feet. Surface area of each clarifier is 13,266 ft^2. One clarifier has a peak flow capacity of 27 mgd using a surface overflow rate of 2,000 gpd/ft^2. An aerial view of the treatment plant is shown in Figure 2-2.

2.7 SLUDGE HANDLING AND DISPOSAL

Four chopper pumps are installed as primary pumps to transfer the primary clarifier sludge to the primary anaerobic digester. Scum from the chlorine contact tanks is also pumped to the primary anaerobic digester. The stabilized sludge flows into a secondary anaerobic digester tank for thickening. These digesters are equipped with sludge heaters and gas and sludge recirculation systems. The sludge is designed to be pumped to two centrifuges for dewatering. The digesters and centrifuges are currently inoperative. The sludge from the primary clarifiers is transported to Hagatna WWTP, where it is stabilized using aerobic digesters and dewatered using centrifuges.

2.8 REGULATORY AND EFFLUENT PERMIT REQUIREMENTS

NDWWTP is considered as a Class III facility according to the GEPA. NDWWTP disposes of primary treated effluent into the Philippine Sea through an outfall.

Effluent limitations for the NDWWTP effluent are contained in NPDES permit no. GU0020141 issued on 30 June 1986 by the EPA. The NDWWTP is currently operating under 301(h) that allows discharge of primary treated effluent. This permit expired on 30 June 1991 and application for renewal has been submitted and is under review by the EPA. The original renewal received tentative denial from the EPA because of impacts to water quality and coral reef environment. The GWA revised the permit application to include a decision to extend the ocean outfall. Design of the outfall is completed and GWA is proceeding with the construction project. Table 2-3 summarizes the key effluent limits and monitoring requirements outlined in the current NPDES permit.

Table 2-3: NDWWTP NPDES Permit Requirements

	Discharge Limitations				Monitoring Requirements	
	lb/day		Other Units (specify)			
Effluent Characteristic	Average Monthly	Daily Max	Average Monthly	Daily Max	Measurement Frequency	Sample type
Flow (mgd)				6	Continuous	—
BOD_5 [a]	4,256	8,512	85 mg/L	170 mg/L	Once/week	Composite
Suspended Solids [a]	2,504	5,008	50 mg/L	100 mg/L	Once/week	Composite
Settleable Solids	—	—	1 ml/L	2 ml/L	Once/week	Discrete
Oil and Grease [b]	—	—	—	—	Once/month	Discrete
pH [c]	Not less than 7.0 standard units nor greater than 9.0 standard units					

mg/L milligram per liter
ml/L milliliter per liter
pH hydrogen ion concentration

[a] Both the influent and effluent would be monitored.

[b] Oil and grease would be monitored in the effluent on a monthly basis since many toxic organic pollutants partition into this fraction. If the level of oil and grease is found to be unacceptable, this permit would be modified to include an effluent limitation and monitoring requirement for this parameter.

[c] The discharge would not cause the pH of the receiving water to deviate more than 0.5 pH units of that which would occur naturally.

2.9 RECENT FLOWS AND LOADINGS

During the period of February 2008 and June 2009 the monthly average and daily maximum flow rate ranged from 4.5 to 5.7 mgd and from 5.3 to 7.7 mgd, respectively. Based on the permit limit of 6 mgd, the influent flow rates reported during this period are consistently above the permit limit.

The monthly average and daily maximum reported flow rate, BOD_5, TSS, settleable solids, and hydrogen ion concentration (pH) are listed in Table 2-4. The permit's mass effluent rates are based on 6 mgd flow.

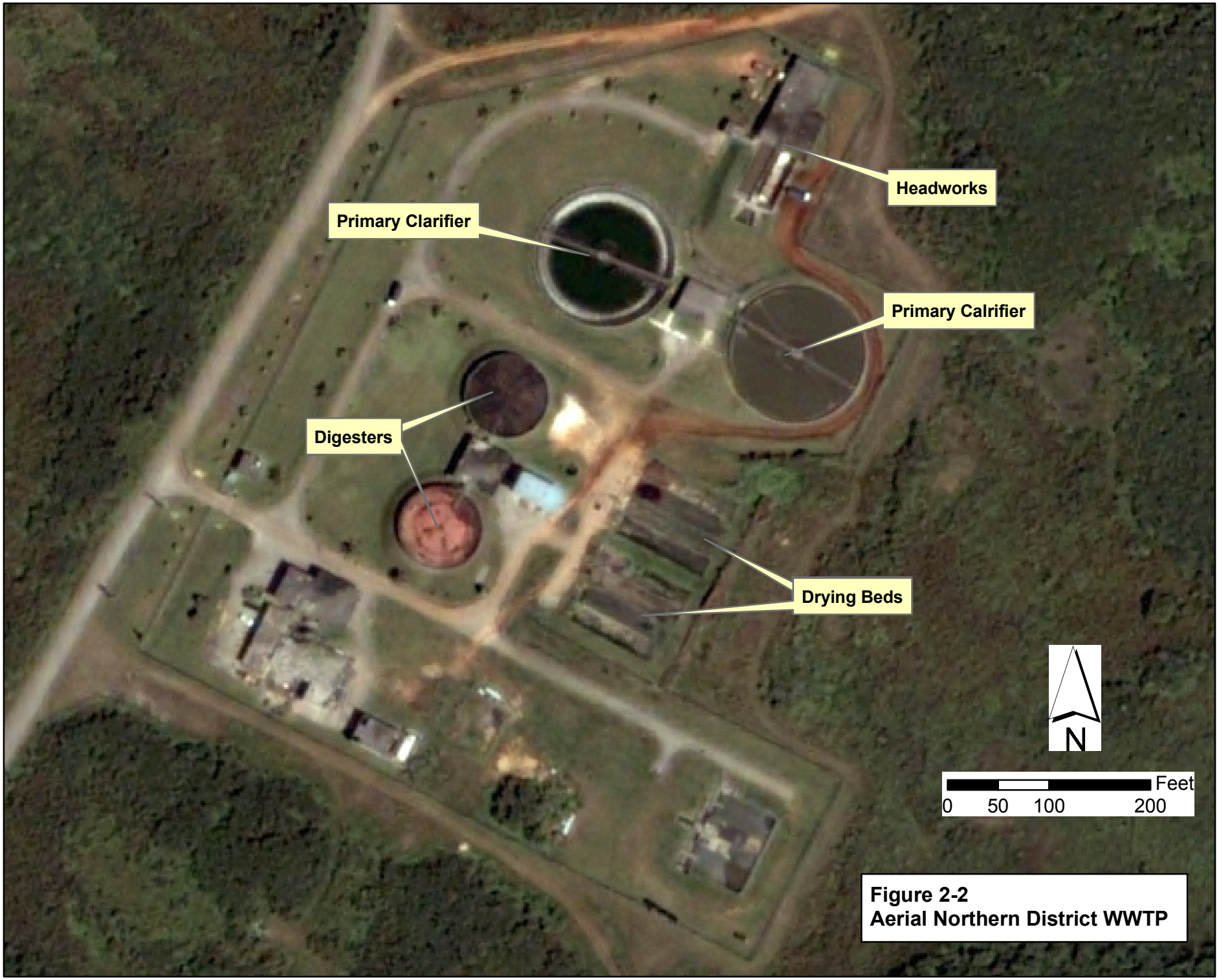

Figure 2-2
Aerial Northern District WWTP

Table 2-4: Northern District WWTP Influent and Effluent Wastewater Characteristics

Parameter	Average	Range
Flow (mgd)	5.2	4.5-5.7
Influent BOD_5 (mg/L)	120	97-183
Effluent BOD_5 (mg/L)	86.7	71-124
BOD_5 Removal Rate (%)	27.8	19.3-38.1
Influent BOD_5 (lb/day)	5,220	3,760-6,870
Effluent BOD_5 (lb/day)	3,960	2,730-5,370
Influent Suspended Solids (mg/L)	152	101-216
Effluent Suspended Solids (mg/L)	81	69-194
TSS Removal Rate (%)	46.7	10.9-62.5
Influent Suspended Solids (lb/day)	6,600	4,450-10,870
Effluent Suspended Solids (lb/day)	3,520	3,190-7,850
Effluent Settleable Solids (ml/L)	0.6	0.1-1.7
Effluent pH	7.5	6.8-8.1

% percent

2.10 POTENTIAL FUTURE PERMIT LIMITS AND REQUIREMENTS

The existing NPDES permit is based on a maximum daily flow of 6 mgd. Since both current and future maximum daily flows exceed this limit, an increased flow limit must be established. The current estimated flow is 5.7 mgd and the projected future flow by 2019 is 10.54 mgd including DoD flow from the proposed USMC relocation. Neither of these flows exceeds the original design capacity of 12.0 mgd; however, both exceed the capacity if redundancy is considered.

3. Projected Future Conditions

3.1 GUAM INTEGRATED MILITARY DEVELOPMENT

During recent years, as global events have influenced the U.S. foreign policy, the DoD has placed greater focus on stationing forces in the Pacific Region. In response to the global situation, the U.S. Pacific Command began an initiative known as Integrated Global Presence and Basing Strategy (IGPBS). A key component of this initiative is a proposed buildup of USMC, U.S. Navy, USAF, and U.S. Army elements on Guam. During the planning timeframe of Guam Integrated Military Development Plan (GIMDP), the U.S. government (USG) was conducting negotiations with the Government of Japan (GOJ) to realign U.S. forces within the country as well as relocate significant portion of USMC units in Okinawa to Guam.

The principal elements of IGPBS considered for wastewater study include:

- Relocation of USMC ground and air assets to Guam from various locations
- Development of USAF Global Intelligence, Surveillance, and Reconnaissance (ISR) and Strike hub
- Associated infrastructure, housing, and quality of life (QOL) improvements

EDAW Inc. is developing a master plan to identify the land use and facility requirements for Marine relocation. NCTS Finegayan, South Finegayan Housing area, Andersen AFB, Andersen AFB Northwest Field, and Andersen AFB South would bear the brunt of the military personnel increase on Guam. The master plan group developed several site plan concepts for the Main Base at Navy NCTS Finegayan. At this time Alternative Option 8 is the preferred alternative. Figure 3-1 provides proposed facilities to support the Marine Relocation. Table 3-1 provides the proposed facilities as identified on Figure 3-1.

Table 3-1: NCTS Finegayan Development Alternative Option 8 Proposed Building List

Map Label No.	Map Label Color Code	BFR ID	BFR ID List	Description
1	MAW	3	3, 4, 5, 6, 7, 8, 9, 10, 911	MAW ARMORY
2	Division Admin/Ops	11	11, 12, 13, 14, 15, 16, 17, 365, 575	DIV ARMORY
3	III MEF Admin/Ops	18	18, 21, 22, 19	MEF ARMORY
4	HQ Group	23	23, 24, 25, 26, 27, 28, 29, 30, 31, 686	MLG ARMORY
5	MAW	32	32, 34, 52, 53	MACG HAZ / FLAM STORAGE
6	Division Admin/Ops	35	35, 36, 511, 606	DIV HAZ / FLAM STORAGE
7	Play Fields	362	362	OUTDOOR PLAYING FIELDS HOUSING & MAIN BASE
8	III MEF Admin/Ops	37	37, 38	HAZ / FLAM STORAGE
9	MLG	40	687, 688, 40, 47, 48, 41, 545, 546	HAZ / FLAM STORAGE MLG
10	Community Support	56	56	BAND BUILDING
11	Division/III MEF HQ	57	57	OPERATIONAL TRAINER / TECG
12	Division Admin/Ops	58	58	PARACHUTE LOFT
13	MAW	70	70, 72, 73, 74	MAW AUTO MAINTENANCE SHOP
14	Division Admin/Ops	76	76, 77, 857	MOTOR TRANSPORT MAINTENANCE, H&S, RECON
15	Division Admin/Ops	78	78, 576, 577	MOTOR TRANSPORT MAINTENANCE, 12MAR / ARTY

Map Label No.	Map Label Color Code	BFR ID	BFR ID List	Description
16	III MEF Admin/Ops	79	79, 81, 82	AUTOMOTIVE MAINTENANCE
17	MLG	86	87, 694, 62, 86, 40	MT MAINTENANCE CLR-37 / 3D MED BN
18	MLG	89	89, 68, 47	ENGINEERING MAINT. SUPPORT CO CLB-5
19	MLG	90	90, 69, 48, 61, 67, 643	MT MAINTENANCE / MT CO CLR 5
20	Division Admin/Ops	146	146, 580	ARTILLERY HEAVY GUN SHOP
21	MAW	148	148, 150, 151	MACG ELECTRONIC MAINTENANCE
22	Division Admin/Ops	153	153, 154	COMM MAINTENANCE, HQ BN, RECON
23	III MEF Admin/Ops	156	156, 158, 159	COMM ELECT MAINTENANCE
24	MLG	162	162	H&S CO ELECTRONIC MAINTENANCE CLR-5
25	MLG	165	165	LS CO PARACHUTE FIELD MAINTENANCE SHOP
26	MAW	166	166, 169, 171	MACG ORGANIC STORAGE
27	MAW	167	167, 170, 51	ORGANIC STORAGE, MWHS, MWSG
28	Division Admin/Ops	173	172, 173	ORGANIC UNIT STORAGE, HQ, RECON, FAST
29	Division Admin/Ops	174	174, 581	ORGANIC UNIT STORAGE, HQ, 12 MAR
30	III MEF Admin/Ops	175	175	MHG SUPPLY WAREHOUSE
31	III MEF Admin/Ops	176	179, 176, 178, 367	ORGANIC STORAGE MEF
32	MLG	181	181, 189	ORGANIC UNIT STORAGE, MED BN
33	MLG	182	182, 695, 696, 697	ORGANIC UNIT STORAGE, CLR 37
34	MLG	183	183	ORGANIC UNIT STORAGE, CLR 35
35	MLG	186	186	ORGANIC UNIT STORAGE, CLB 5
36	MLG	188	188	SUPPLY CO, SUPPLY BN, CLR 35
37	MLG	190	190	CONTROLLED HUMIDITY WAREHOUSE CLR 35
38	MLG	191	191	CONTROLLED HUMIDITY WAREHOUSE LS CO
39	MLG	192	192	MAGTF DISTRIBUTION CENTER
40	MAW	195	195, 208	MAW HQ / MWHS OFFICE
41	Division/III MEF HQ	196	196	DIVISION HQ
42	Division/III MEF HQ	197	197	MEF HQ
43	HQ Group	198	198	MLG HQ
44	MAW	199	199	MWSG-17 HQ
45	MAW	200	200	MACG-18 HQ
46	Division/III MEF HQ	201	201	12TH MARINES RGT HQ
47	Division/III MEF HQ	202	202	MHG HQ
48	HQ Group	203	203, 257, 260, 261	CLR 37 HQ

Map Label No.	Map Label Color Code	BFR ID	BFR ID List	Description
49	MAW	204	204, 206	MWCS / MASS HQ
50	MAW	207	207, 218, 219, 209	MACS / MTACS HQ
51	Division Admin/Ops	210	513, 210	HQ / RECON BN HQ
52	III MEF Admin/Ops	211	211, 213	BN HQ, 7TH COMM, 3D INTEL
53	HQ Group	215	215, 216, 240, 243	SUPPLY BN / MAINTENANCE BN DET HQ, CLR 35
54	HQ Group	217	217, 248, 249, 250, 251, 645	CLR 5 HQ
55	Division/III MEF HQ	220	220, 221, 222, 514, 223, 224	HQ BN COMPANY OFFICES
56	Division Admin/Ops	225	225, 155	HQ BTRY, COM PLT, CNTRBTRYRAD
57	III MEF Admin/Ops	226	226, 227, 228	CO HQ / OPERATIONS, 3D INTEL
58	III MEF Admin/Ops	232	232, 233, 234, 235	CO HQ / OPERATIONS, 7TH COMM
59	III MEF Admin/Ops	236	236, 366	5TH ANGLICO / FAST CO HQ
60	HQ Group	238	237, 238, 792	3D MED BN / SURGICAL CO HQ
61	MLG	241	241, 184	MATERIAL READINESS CO, SUPPLY BN
62	MLG	242	185, 242, 42	MED LOG CO, SUPPLY BN
63	MLG	244	43, 64, 91, 244	ENGINEER MAINTENANCE CO, CLR 35
64	MLG	245	245, 44, 163	ELECTRONIC MAINTENANCE CO, CLR 35
65	MLG	246	65, 92, 246, 45	MOTOR TRANSPORT MAINT CO, CLR 35
66	MLG	247	46, 66, 93, 247	GENERAL SUPPORT MAINTENANCE, CLR 35
67	Community Support	252	252, 254, 194, 705, 164, 49	DEN HQ, CLR 35
68	HQ Group	256	256, 565, 566, 567, 568, 563, 564	9TH ESB COMPANY HQ
69	Community Support	258	258	DISBURSING OFFICE, CLR 37 / MEF
70	MLG	259	259, 147, 687, 688	COMMUNICATIONS CO DET, CLR 37
71	MLG	264	264	FUEL READY STORAGE
72	Fire/Police/Emergency Services	266	266	ALERT FORCE BUILDING
73	Community Support	270	270, 346, 341	AUDITORIUM / TRAVEL OFFICE
74	Community Support	319	319	EXCHANGE CENTRAL ADMIN
75	MLG	284	284, 288, 268.1	AUTO MAINTENANCE / MHE
76	MLG	285	285	VEHICLE HOLDING SHED
77	MLG	290	289, 290	PWC SHOP / WAREHOUSE
78	MLG	292	292	GENERAL STORAGE SHED
79	Quality of Life	294	294	MEDICAL CLINIC
80	Community Support	295.3	295.3	FACILITIES ENGINEER / ENVIRONMENTAL OFFICE

Map Label No.	Map Label Color Code	BFR ID	BFR ID List	Description
81	BEQ/BOQ	298	296, 368, 297, 369, 839, 840, 500, 515, 526, 584, 590, 596, 622, 623, 624, 625, 726, 741, 746, 501, 516, 527, 585, 591, 597, 626, 627, 628, 629, 727, 742, 747, 573, 650, 656, 677, 684, 699, 710, 796, 572, 649, 657, 676, 683, 700, 709, 795, 521, 532, 538, 711, 798, 522, 533, 539, 712, 799, 752, 757, 758, 759, 781, 786, 804, 808, 816, 819, 824, 753, 760, 761, 762, 782, 787, 805, 809, 817, 820, 825	BEQ (E1 - E3, E4 - E5)
82	Community Support	300	300, 291	DINING HALL
83	Fire/Police/Emergency Services	303	303	FIRE STATION
84	Quality of Life	304	304	ISSUE UNIFORM CENTER
85	Fire/Police/Emergency Services	305	305	BRIG
86	Fire/Police/Emergency Services	306	306, 268.2	POLICE / PMO STATION
87	Fire/Police/Emergency Services	312	312	PMO KENNEL
88	Community Support	313	313	REHABILITATION CENTER
89	MLG	314	314	RECYCLING CENTER
90	Quality of Life	315	315	RELIGIOUS MINISTRY FACILITY
91	Quality of Life	316	316	POST OFFICE
92	Quality of Life	317	317, 324, 325, 320, 323, 337	MAIN EXCHANGE
93	MLG	321.2	321.2	EXCHANGE SNACK SHOP
94	MLG	326	326	EXCHANGE MAINTENANCE SHOP
95	Quality of Life	327	327, 328	BANK / CREDIT UNION
96	Quality of Life	328	327, 328	BANK / CREDIT UNION
97	Quality of Life	329	329	TEMPORARY LODGING
98	Quality of Life	330	330, 331	COMMISARY
99	Community Support	332	332	FAMILY SERVICES CENTER
100	Quality of Life	334	334, 336, 322	EXCHANGE MAIN SERVICES STATION
101	Quality of Life	337	317, 324, 325, 320, 323, 337	MAIN EXCHANGE
102	Quality of Life	338	348, 338, 339	REC CENTER / HOBBY SHOP / EQUIP ROOM
103	Community Support	339	348, 338, 339	REC CENTER / HOBBY SHOP / EQUIP ROOM
104	Quality of Life	340	340	AUTO HOBBY SHOP
105	Quality of Life	342	342, 333	BOWLING ALLEY / AMUSEMENT CENTER
106	Quality of Life	345	345	SKATING RINK
107	Recreation	348	348, 338, 339	REC CENTER / HOBBY SHOP / EQUIP ROOM
108	Education/Community Services	349	349	YOUTH CENTER
109	Community Support	350	350	COMMISSIONED OFFICERS OPEN MESS
110	Community Support	351	351	ENLISTED CLUB

Map Label No.	Map Label Color Code	BFR ID	BFR ID List	Description
111	Quality of Life	354	354, 318.1	PACKAGE STORE / LOCATION EXCHANGE MAIN BASE
112	Education/Community Services	355	355	CHILD DEVELOPMENT CENTER
113	Quality of Life	356	356, 359	LIBRARY / EDUCATION SERVICES
114	Park - Picnic Area	357	357	RECREATION PAVILLION
115	MLG	358	358	EXCHANGE WAREHOUSE
116	Education/Community Services	359	356, 359	LIBRARY / EDUCATION SERVICES
117	Play Courts	361	361	PLAYING COURTS HOUSING & MAIN BASE
118	Quality of Life	432	432	THEATER
119	BEQ/BOQ	502	301, 302, 570, 647, 659, 674, 681, 702, 707, 793, 569, 646, 660, 673, 680, 703, 706, 855, 524, 535, 541, 714, 801, 525, 536, 542, 715, 802, 503, 518, 529, 587, 593, 599, 634, 635, 636, 637, 729, 744, 749, 504, 519, 530, 588, 594, 600, 638, 639, 640, 641, 730, 745, 750, 755, 766, 767, 768, 784, 789, 811, 822, 827, 853, 756, 785, 812, 823, 854, 842, 843	BOQ
120	Division/III MEF HQ	512	512	OPERATIONAL TRAINER FACILITY
121	MLG	544	544	GARAGE 9TH ESB
122	MLG	547	547, 548, 560, 561	9TH ESB BN WAREHOUSE
123	MLG	549	549, 558, 559, 187, 50	9TH ESB, EOD STORAGE
124	HQ Group	550	550, 791	OPERATIONAL TRAINER FACILITY
125	MLG	551	551	WOODWORKING HOP
126	MLG	553	553, 554, 552	ENGINEER / MT EQUIP MAINT SHOP 9TH ESB
127	MLG	557	557	COMM MAINTENANCE SHOP 9TH ESB
128	HQ Group	563	256, 565, 566, 567, 568, 563, 564	9TH ESB COMPANY HQ
129	Division Admin/Ops	582	582, 583	ARTILLERY BN HQ DET / CO HQ
130	Division Admin/Ops	609	609, 610, 611	CAB VEHICLE MAINTENANCE
131	Division Admin/Ops	614	614, 615	CAB COMM MAINTENANCE
132	Division Admin/Ops	616	616	CAB ORGANIC UNIT STORAGE
133	Division Admin/Ops	618	618, 619, 620, 621, 617	CAB HQ
134	MLG	644	644	MT OPEN STORAGE
135	MLG	654	654	ELECTRIC MAINT CO CLR 35
136	MLG	655	652, 653, 655	ORDNANCE MAINT CO CLR 35
137	MLG	665	88, 63, 41, 664, 665	ORGANIC MT MAINTENANCE CLR-35
138	HQ Group	679	679	CLR 35 HQ
139	MLG	690	690	CARGO STAGING AREA
140	MLG	691	691	CONTAINER OPS BUILDING
141	HQ Group	698	698, 851	LEGAL SERVICES FACILITY

Map Label No.	Map Label Color Code	BFR ID	BFR ID List	Description
142	Division Admin/Ops	717	717, 732, 602, 603, 604, 605	ARMORIES
143	Division Admin/Ops	718	718, 733	HAZ / FLAM STORAGE
144	Division Admin/Ops	719	719, 734	VEHICLE MAINTENANCE
145	Division Admin/Ops	722	722, 737	COMMUNICATION MAINTENANCE
146	Division Admin/Ops	723	723	ORGANIC STORAGE
147	Division Admin/Ops	724	724	BN HQ
148	Division Admin/Ops	725	725	CO HQ
149	Division Admin/Ops	738	738	ORGANIC STORAGE
150	Division Admin/Ops	739	739	BATTALION / SQUADRON HQ
151	Division Admin/Ops	740	740	COMPANY / BATTERY HQ
152	Division Admin/Ops	830	830	ARMORY
153	Division Admin/Ops	831	831, 836	OPERATIONAL STORAGE
154	Division Admin/Ops	832	832	AUTO SHOP
155	Division Admin/Ops	835	835	ELEC / COMM MAINTENANCE SHOP
156	Division Admin/Ops	837	837, 838	JSDF HQ
157	Community Support	845	845	PHOTOGRAPHIC BUILDING
158	Community Support	847	847	PMO ISMT
159	MLG	850	850	DSSA WAREHOUSE
160	Community Support	851	698, 851	LEGAL SERVICES FACILITY
161	MLG	901	901	CORROSION CONTROL FACILITY
162	MLG	907	907, 908	TMP / PPP
163	Community Support	909	909	PASS / ID OFFICE
164	MLG	913	913	JEMS WAREHOUSE
165	Community Support	997		
166	Quality of Life	999		
167	Existing Facility - Retained	1000		
168	MLG	29301		
169	Quality of Life	31802		
170	Quality of Life	31803		
171	Recreation	34401		
172	Quality of Life	34403		
173	Recreation	36302		
174	Elementary School			
175	Middle School			
176	High School			
177	Water / Wastewater			
178	IRP SITE			
179	BEQ/BOQ		298, 370, 571, 648, 658, 675, 682, 701, 708, 794, 523, 534, 540, 713, 800, 502, 517, 528, 586, 592, 598, 630, 631, 632, 633, 728, 743, 748, 754, 763, 764, 765, 783, 788, 806, 810, 818, 821, 826, 841	BEQ NCO (E6 - E9)

Source: EDAW Inc.

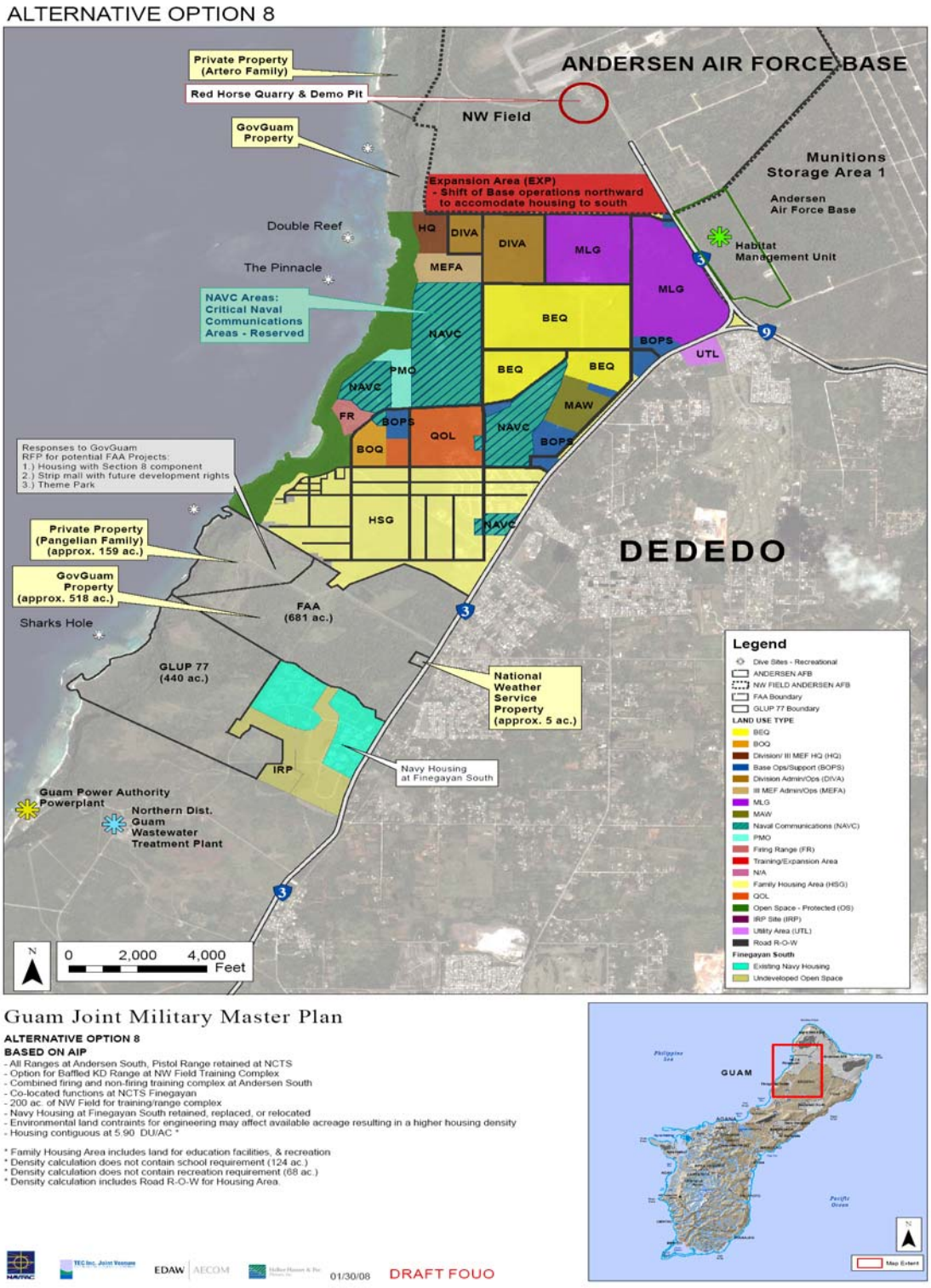

Figure 3-1
NCTS Finegayan Proposed Facilities

3.1.1 Andersen AFB

The 2001 Quadrennial Defense Review directed the Air Force to expand basing in the Pacific region with a rationally tailored, multifaceted force, able to respond quickly to defeat an adversary's military and political objectives. In response, the Air Force proposes to locate ISR, strike, and aerial refueling aircraft and personnel in the western Pacific as part of the U.S. Pacific Command's ISR/strike capability (ISR/Strike). Andersen AFB, Guam was identified as the installation to host the ISR/Strike.

EDAW Inc. is preparing a master plan to identify the facility requirements for ISR/Strike project. Several alternatives are under consideration. Alternative A is the preferred alternative. The alternative would establish the ISR/Strike capability by basing as many as 12 KC-135 aerial refueling aircraft and four Global Hawk RQ-4 unmanned aerial vehicles (Global Hawk) and support personnel at Andersen AFB. The base population would increase by as many as 2,110 personnel when combining the additional military, Air Force civilian, contractor, and dependant personnel. Facility construction, addition, and alteration projects, including 190 family housing units and associated family housing support facilities, would be constructed.

The following new mission hangars and facilities would be constructed along the South Ramp and North Ramp at Andersen AFB.

South Ramp Facilities:

- Global Hawk Maintenance Hangar
- Air and Space Expeditionary Force Support Hangar
- Fire Station
- Corrosion Control Hangar (Tanker)
- Renovated Wash Rack Hangar (Tanker, Bomber)
- General Purpose Maintenance Hangar and Aircraft Maintenance Unit (Tanker, Bomber Occasionally)
- Fuel Cell Hangar (Tanker, Bomber)

North Ramp Facilities:

- Transient Assault Echelon Fighter Hangar
- Marine Aviation Logistics Squadron Hangar
- AH-1W Hangar
- CH-53E Hangar
- HSC-25 Hangar
- Marine Aircraft Group Headquarters
- Marine Wing Support Squadron (MWSS) Headquarters
- Base Support Dining Hall
- Auto Maintenance Shop
- MWSS Organic Storage

3.1.2 NCTS Finegayan

The NCTS Finegayan parcel is the proposed location for the majority of USMC base development. The principal Marine Complex would be developed within the general NCTS Finegayan area. The South Finegayan Family Housing would be redeveloped, and two adjacent federal parcels are considered for variety of uses. The site provides approximately 2,420 acres of land, and a shoreline over 2 miles in length. Most of the land along the cliff line is considered prime limestone habitat that provides habitat for endangered plant and animal species. As a result, development in NCTS Finegayan is restricted to 1,900 to 2,000 acres. The NCTS Finegayan area is used for industrial/commercial facilities and BEQ/BOQ housing. Some of the major future proposed facilities at NCTS include: electronic maintenance shops, engineering maintenance companies, storage, warehouses, container operations buildings, cargo staging area, vehicle maintenance area, and administrative buildings. Table A-1 provides a list of facilities that support operational and training requirements for Marine Relocation. As identified in Table A-1, the administrative buildings cumulatively occupy approximately 134,000 ft^2, vehicle maintenance shops occupy 566,000 ft^2, weapon maintenance shops occupy 81,000 ft^2, and electronics and communication maintenance shops occupy 190,000 ft^2. The Army's major operation facilities would be located at NCTS Finegayan as well as field activities in other area.

3.1.3 South Finegayan

South Finegayan is proposed primarily for family housing and related QOL use for both Marine relocation and Army deployment. A total of 290 acres is proposed for family housing and QOL facilities. The proposed facilities include: family housing, bachelors housing, transient accommodation, schools, parks, fire, police, post office, library, church, child development center, auditoriums, dining facilities, play fields, and swimming pools.

Both NCTS Finegayan and South Finegayan would accommodate a total of 17,552 people that would be relocated from Japan. Of 17,552 personnel, 8,552 are active duty Marines and 9,000 are dependants. Also, South Finegayan accommodates a total of 1,580 Army personnel and their depends, and total of 2,000 military transient personnel that would be visited on Guam. Table 3-2 provides current and future military population on Guam. Table 3-3 provides current and future military populations in northern Guam.

Table 3-2: Current and Future Military Related Populations on Guam

Service	Active Duty	Dependants	Transient	Civilian Workers	Civilian Workers (Guam)	Total
Baseline (FY09)						
USMC	3	2	0	1	0	6
Air Force	2,145	2,950	0	805	402	6,302
Navy	4,350	5,230	0	1,631	815	12,026
Army	30	50	0	11	5	96
USCG	140	180	0	53	26	399
Planned Increase						
USMC	8,552	9,000	2,000	1,710	855	22,117
Air Force	120	210	1,780	25	12	2,147
Navy	280	50	7,222	10	5	7,567
Army	630	950	0	126	63	1,769
USCG	81	103	0	10	5	95

Service	Active Duty	Dependants	Transient	Civilian Workers	Civilian Workers (Guam)	Total
Total Future Loading (FY19)						
USMC	8,555	9,002	2,000	1,711	855	22,123
Air Force	2.265	3,160	1,780	830	414	8,449
Navy	4,630	5,280	7,222	1,641	820	19,593
Army	660	1,000	0	137	68	1,865
USCG	221	283	0	63	31	494

Notes:
1. Data from Socioeconomic Analysis dated 9 February 2009.
2. Civilian Workers – Military civilian workers (off-Island) living off-base and working on-base.
3. Civilian Workers (Guam) – On-Island residents who work on-base.
USCG United States Coast Guard

Table 3-3: Current and Future Military Related Populations in Northern Guam

Service	Active Duty	Dependants	Transient	Civilian Workers	Civilian Workers (Guam)	Total
Baseline (FY06)						
USMC	3	2	0	1	0	6
Air Force	2,145	2,950	0	805	402	6,302
Navy	39	66	0	1,481	1,130	1,586
Army	30	50	0	11	50	96
USCG	0	0	0	0	0	0
Planned Increase						
USMC	8,552	9,000	2,000	1,710	855	22,117
Air Force	120	210	1,780	25	12	2,147
Navy	0	0	0	0	0	0
Army	630	950	0	126	63	1,769
USCG	0	0	0	0	0	0
Total Future Loading (FY19)						
USMC	8,555	9,002	2,000	1,711	855	22,123
Air Force	2,265	3,160	1,780	830	414	8,449
Navy	39	66	0	351	1,130	1,586
Army	660	1,000	0	137	68	1,865
USCG	0	0	0	0	0	0

Notes:
1. Assumed current USMC and Army reside in northern Guam.
2. All increased USMC, and Army live in Finegayan.
3. All increased AF live in Andersen AFB.
4. Navy baseline population at NCTS Finegayan from GIMDP, 6/14/06.
5. Assumed no Navy and USCG population increase in northern Guam.

3.2 DoD and NDWWTP Wastewater Flows

The following section presents the wastewater flow estimation for the proposed facilities for the Marine relocation and improvement to the existing DoD facilities (Andersen AFB Base). Total wastewater flow contributions from domestic and industrial users are considered for this study. The domestic wastewater flow for the USMC relocation was calculated using unit flow information provided in Unified Facilities Criteria 3-240-02N, *Wastewater Treatment Systems Augmenting*

Handbook (DoD 2004). Industrial flows were calculated using unit flow information provided in Water Pollution Control Federation Manual of Practice No. FD-5. Table 3-4 lists the unit flow values used in estimating wastewater flows.

Table 3-4: Wastewater Flow Estimating Unit Values

Category	Value
Resident Population	120 gpcd
Non-Resident Population	35 gpcd
Industrial Users	15,500 gpd/acre

Notes: Resident population includes active duty and dependent personnel.
Non-Resident population includes on-base civilian personnel.
gpcd gallon per capita per day
gpd gallon per day

The current and future average daily wastewater flows from DoD facilities and off-base civilian population are summarized in Table 3-5. A total of 837,000 square feet consisting of vehicle maintenance shops, weapon maintenance shops, and electronics and communication maintenance shops are considered for industrial flow estimation. The existing and future anticipated flows from civilian population located in northern Guam contribute to NDWWTP. The civilian population includes Guam natural population growth and induced civilian population growth associated with military buildup. The population growth is based on the estimate by a socioeconomic analysis for military buildup on Guam.

Table 3-5: Current and Future Average Wastewater Flows in Northern Guam

Service	Active Duty	Dependants	Transient	On-base Civilian	Domestic Flow (mgd)	Industrial Flow (mgd)	Total Flow (mgd)
Baseline (FY06)							
Off-base Civilian							**5.20**
Military	2,217	3,068	0	1168	0.32	0.18	**0.50**
Finegayan:	72	118	0	363	0.08	0.06	**0.14**
USMC	3	2	0	1	0.00	0.00	0.00
Navy	39	66	0	351	0.06	0.06	0.12
Army	30	50	0	11	0.01	0.00	0.01
Andersen AFB:	2,145	2,950	0	805	0.24	0.12	**0.36**
Air Force	2,145	2,950	0	805	0.24	0.12	0.36
Total Northern Guam Flow							**5.70**
Notional Increase							
Off-base Civilian							**1.88**
Military	9,302	10,160	3,780	1,861	2.57	0.40	**2.96**
Finegayan:	9,532	10,580	2,000	1,836	2.46	0.30	**2.76**
USMC	8,552	9,000	2,000	1,710	2.27	0.30	2.56
Navy	0	0	0	0	0.00	0.00	0.00
Army	630	950	0	126	0.20	0.00	0.20
Andersen AFB:	120	210	1,780	25	0.10	0.10	**0.20**
Air Force	120	210	1,780	25	0.10	0.10	0.20
Total Northern Guam Flow							**4.85**

Service	Active Duty	Dependants	Transient	On-base Civilian	Domestic Flow (mgd)	Industrial Flow (mgd)	Total Flow (mgd)
Total Future Loading (FY19)							
Off-base Civilian							**7.08**
Military	11,519	13,228	3,780	3,029	2.88	0.58	**3.46**
Finegayan:	9,604	10,698	2,000	2,199	2.54	0.36	**2.90**
USMC	8,555	9,002	2,000	1,711	2.27	0.30	2.56
Navy	39	66	0	351	0.06	0.06	0.12
Army	660	1,000	0	137	0.21	0.00	0.21
Andersen AFB:	2,265	3,160	1,780	830	0.34	0.22	**0.56**
Air Force	2,265	3,160	1,780	830	0.34	0.22	0.56
Total Northern Guam Flow							**10.54**

Notes:
1. Andersen AFB and Navy industrial flows are from GIMDP, 6/14/06.
2. Existing off-base civilian flow from GWA 2008 flow measurements. Calculated by subtracting Andersen AFB & NCTAMS flows (5.7-0.36-0.14=5.20 mgd).
3. Future off-base civilian flow (FY2019) calculated per socioeconomic analysis civilian population growth and project induced population dated 9 February 2009.
4. Assumed Army lives in future Finegayan main base.

Peak factor for DoD flows was determined using the Babbit's curve in Water Pollution Control Federation Manual of Practice No. FD-5. Peak factor for off–base civilian population was based on the design criteria provided in the Guam Wastewater Master Plan. The following Table 3-6 provides future peak flows for northern Guam.

Table 3-6: Future Peak Wastewater Flows in Northern Guam

Type of Flows	Domestic Flow (mgd)	Industrial Flow (mgd)	Peak Flow Factor	Total Peak Flow (mgd)
Total Future Loading				
Off-base Civilian Flow	7.08		2.25	**15.94**
Military Flow	2.88	0.58	2.25	**7.06**
Finegayan:	2.54	0.36	2.25	**6.07**
USMC	2.27	0.30		
Navy	0.06	0.06		
Army	0.21	0.00		
Andersen AFB:	0.34	0.22	2.25	**0.99**
USAF	0.34	0.22		
Total Northern Guam Flow				**23.00**

Notes:
1. Domestic Finegayan Flow (2.54 mgd) = USMC (2,27) + Navy (0.06) + Army (0.21)
2. Domestic Military Flow (2.88 mgd) = Finegayan (2.54) + Andersen AFB (0.34)
3. Total peak flow = peak flow factor x domestic flow + industrial flow

4. Regulatory Involvement for Wastewater Treatment Alternatives

The regulatory requirements for the proposed wastewater treatment alternatives were discussed with the following regulatory agencies during the field investigations:

- Bureau of Statistics and Planning (Coastal Management)
- GEPA
- EPA Region 9
- Guam Department of Aquatic and Wildlife Resources (GDAWR)
- Department of Parks and Recreation (Historic Preservation)
- Department of Public Works
- GWA

4.1 Bureau of Statistics and Planning (Coastal Management)

The Guam Coastal Management Program was developed on Guam as a core component within the Bureau of Statistics and Plans, a staff agency within the Office of the Governor. It coordinates all the use, protection, and development of land and ocean resources within Guam's coastal zone.

ATS contacted the Bureau of Statistics and Planning to obtain the regulatory requirements for the viable wastewater alternatives discussed in Section 6. The following summarizes the discussion.

- Joint use of existing GWA outfall would have the least impact, since it already exists.
- Reef system impacts are a concern for the new DoD outfall option. The Department of Fish and Wildlife should be consulted to obtain potential mitigation requirements.
- A Habitat Equivalency Model may need to be performed as part of the planning process for a new outfall.
- Reforestation, reducing sediments, and non-point source (storm water) pollution reduction should also be considered.
- Improving the habitat for native species should be investigated.

4.2 Guam Environmental Protection Agency (GEPA)

GEPA is responsible for implementing specific local and federal statutes and regulations on environmental protection. It oversees the management and protection of Guam's drinking water, groundwater, surface and marine water resources for public water supplies and other beneficial uses. It manages and protects Guam's principal source aquifer from pollution and overdraws. It is responsible for administering a program that provides sewage treatment and related facilities for Guam, and controlling pollution from domestic wastewater. It also handles the administration of the Federal Sewer Construction Grants Program, the NPDES Program, Spill Prevention Control and Countermeasure Program, Nonpoint Source Management Program, Individual Wastewater Program, implementation and enforcement of the Guam Water Quality Standards, Guam Soil Erosion and Sediment Control Regulations, Feedlot Waste Management Regulations, Connection to Public Sewer Regulations, and Air Pollution Control.

ATS contacted the GEPA to understand the regulatory requirements for the viable wastewater alternatives that are discussed in Section 6. Following is a summary of the correspondence with GEPA staff.

The regulatory requirements for injecting effluent from the tertiary treatment plant into the groundwater. Initial research identified that the Underground Injection Control regulations provided by GEPA categorize sewage treatment effluent recharge wells as Class V wells. Current GEPA regulations prohibit Class V injection wells. The wells could only be installed with a GEPA waiver to the regulations. GEPA has mentioned that it would review the design and documents before approving the groundwater injection of treated effluent.

4.3 EPA REGION 9

EPA Region 9 is located in San Francisco. It has environmental protection responsibility in the southwestern U.S. (Arizona, California, Nevada, and the Pacific Region including Hawaii). The EPA also has a direct role in environmental protection for the U.S. territories of Guam and American Samoa, the Commonwealth of the Northern Mariana Islands, and other unincorporated U.S. Pacific possessions around south west Pacific Ocean. The Pacific Islands Office in EPA Region 9 manages the EPA's involvement and activities in the Pacific Insular areas including Guam. It regulates Guam's treated wastewater ocean outfall discharge through NPDES permit. It also guides Guam's sewage sludge disposal practice.

ATS contacted the EPA Region 9 to understand the regulator requirements for the viable wastewater alternatives that are discussed in Section 6. Following is summary of the correspondence with EPA Region 9 staff.

- NPDES requirements for current and any future effluent discharge would be based on EPA secondary treatment technology based requirements and Guam Water Quality Standards (WQS). Mixing zones may be allowed per the Guam WQS and would be subject to the approval of GEPA with concurrence from the EPA. Although the NDWWTP currently has a waiver from meeting secondary treatment requirements, waivers for newly constructed treatment plants are no longer allowed. Permittees with an existing waiver are still allowed an opportunity to seek renewal of their waiver. However, EPA Region 9 cannot predict what future permitting requirements may be; 301(h) waivers are certainly not guaranteed in the future; and changes to WQS may result in additional permitting requirements as well.
- With respect to the current NPDES permit for the NDWWTP, it is currently administratively extended until EPA issues a new permit for the facility. EPA is continuing to review information.
- EPA Region 9 envisions that if the DoD has its own treatment plant and discharges through the NDWWTP outfall that each facility would have its own NPDES permit and effluent limitations. With a joint outfall there would be shared responsibilities for receiving water impacts that could affect the NDWWTP permit conditions/requirements.
- Should DoD discharge into the NDWWTP, there is a good chance that there would be associated impacts with the increased discharge that could have an impact on the continuance of the GWA's waiver for the NDWWTP.
- As mentioned above, continuance of 301(h) waivers are uncertain and DoD may want to consider taking advantage of this opportunity (military buildup) to develop a comprehensive solution to the area's infrastructure needs with GWA which could result in cost savings for both the DoD and the GWA.

4.4 DIVISION OF AQUATIC AND WILDLIFE

GDAWR in the Guam Department of Agriculture (GDOA) is a GovGuam agency to restore, conserve, manage, and enhance the aquatic resources on Guam and to provide for the public use of

and benefits from these resources. It is responsible for endangered species recovery and conservation. It regulates, monitors, or studies the wildlife resources on Guam.

ATS met with the GDAWR staff during the field work to understand the regulatory requirements for the viable wastewater treatment alternatives that are discussed in Section 6. Following are the concerns from the Department:

- The key concerns related to installation of water and sewer facilities are options that include marine construction (such as a new outfall). These include construction impacts to coral reefs and the aquatic habitat in the area of coral reefs. Also, the long term impact of the treated effluent on the coral reef habitat is a concern.
- The water intake and brine discharge outfall for a water desalination facility would have considerations similar to the wastewater effluent outfall.
- Construction on the land is also a concern in forested or preservation areas that are populated by native species of animals and vegetation. Vacant lots that are overgrown with grass and other vegetation are not as sensitive as forested areas.
- Development in the Finegayan or NCTS area is of major concern, since it is in the vicinity of the Haputo Ecological Preserve. There may also be archaeological impacts in these areas.
- Dredging and excavation in coral reefs should be avoided. If coral reefs are disturbed, then habitat restoration plan must be developed. Tunneling or directional drilling below the coral layer may be necessary for outfall construction.
- The Pati Point Marine Preserve (Federal Listed) is located to the east of Andersen AFB. This area should be avoided as a site for an ocean outfall.
- The recent Navy Kilo Wharf Renovation in Apra Harbor required habitat restoration. Some of the restoration was actually provided in the Cetti Bay area. This project can be reviewed as an example for some potential habitat restoration alternatives.
- "Two for one" restoration is sometimes required where larger, older native plant species are removed. This is an attempt to compensate for the age and size of the habitat that is removed.
- Bringing invasive foreign species onto the island with construction materials from other regions is a big concern. Methods must be provided to verify that invasive plant and animal species are not being transported to the island with each delivery.
- Mitigation and restoration costs should be separately shown in the cost estimates.
- The GDOA and the National Oceanic Atmospheric Administration have a habitat equivalence model for identifying coral reef mitigation costs.
- Prefer to implement "direct" mitigations, not the swapping unrelated mitigations (example: planting trees as mitigation for coral that is destroyed).
- Prefer to implement "natural" mitigation, not use "fixed infrastructure" improvements as a form of mitigation.

4.5 DEPARTMENT OF PARKS AND RECREATION (HISTORIC PRESERVATION)

Historic Resources Division of Guam Department of Parks and Recreation is responsible for the Guam historic preservation program that works to help keep in place Guam's long and colorful history, and the people's heritage. It reviews new construction plans to avoid potential impact on historic sensitive area.

ATS met with the Department of Parks and Recreation staff during the field work to understand the regulatory requirements for the viable wastewater alternatives that are discussed in Section 6. Following is a summary of our correspondence with staff:

- The land adjacent to the existing plant was at one time covered with Quonset huts and then subsequently, thoroughly bladed when they were abandoned. Guam's Territorial Archaeologist is certain that there are no resources that are of concern.
- Department of Parks and Recreation would attach no requirements for historic resources investigations of the area involved in the expansion of the plant, or the construction of a tertiary-treatment plant with injection wells. However, as it is a federally funded project the Department needs to receive a letter of consultation from whichever DOD-entity owns the land or is the project initiator. The consultation letter would state "no historic properties affected" and the Department would concur with this.
- The Guam Department of Parks and Recreation houses the Historic Resources Division, State Historic Preservation Office. It is, therefore, the review agency for compliance with Federal historic resources laws for all Federal undertakings on Guam.
- This project would most likely require the participation of an archaeologist, to first survey the route, and then to conduct any testing warranted by the survey findings. If plant construction and pipeline construction are part of the same permit application then the DoD would have to place the preceding conditions on it.

4.6 DEPARTMENT OF PUBLIC WORKS

Guam Department of Public Works (DPW) is responsible for all new construction permit review and approval, highway and transportation maintenance and construction, public bus operations, and solid waste management on Guam.

ATS met with the DPW staff during the field work to understand the regulatory requirements for the viable wastewater alternatives that are discussed in Section 6. Following is a summary of the meeting:

- Construction in public right of way would require contractor to provide a performance bond to cover surface preparation, compaction, and surface restoration.
- Backfill of trenches within the road prism would require placement of flowable fill rather than compaction of native soil.
- Construction within the traveled way would be restricted to evenings.
- Ground penetrating radar should be used for utility investigations during design. Record drawings for many utilities do not exist.
- Work within the shoulder of the road can be performed during the day. However, the closure would be restricted to one lane with proper barricades and traffic control.
- The DPW may require full width overlay paving for trench cuts within roads, particularly for newer roads.
- The DPW has standard pavement restoration and trenching details that should be included in the Project Manual.
- The DPW now enforces minimum separation requirements between adjacent utilities.
- Mid-America Traffic Center guidelines are used for traffic control.

- Design submittals are reviewed by the DPW, Historical Preservation, and GEPA.
- Permit fees are based on tables in 1997 edition of Uniform Building Code.
- Erosion, dust, sediment, vehicle traffic, and storm water controls are part of the permitting process. GEPA guidelines must be observed.

4.7 GUAM WATERWORKS AUTHORITY

GWA was established by the Guam Legislature, and it is a semi autonomous, self-supporting agency. The GWA administers Guam water utility service including water treatment and distribution, sewage conveyance, treatment, and disposal. An elected, non-partisan Consolidated Commission on Utilities oversees the operations of the GWA and regulates its rates.

ATS contacted GWA to understand the regulatory requirements for the viable wastewater alternatives that are discussed in detail in Section 6. Following is a summary of our correspondence with GWA staff.

- GWA's typical wastewater charges for Navy are based on rate structure for government entities.
- GWA believes that the rate charged to the military is based on a 1980 vintage agreement. This agreement is in need of an update. GWA anticipates that this agreement would be updated as part of this development process and that it would specify a rate per 1,000 gallons that would be charged for wastewater discharged to the GWA system. The rates mentioned above can be used as anticipated guideline for estimating what the rate charged to the military would be.
- If on the other hand, the U.S. military is considering an option that would construct a wastewater treatment plant rather than discharge to the GWA system, then for planning purposes it can be anticipated that the GWA outfall would not be available for use due to implications related to its capacity and water quality impacts in the area surrounding the discharge. In this case, GWA would also expect a direct compensation for the impact of lost revenues resulting from the disconnection of NCTS and Air Force discharges into the GWA system.
- GWA has constructed a new outfall. The peak hour capacity of the outfall is 27 mgd. The limiting factor is the diffuser on the end. The outfall extends about 2100 feet from shore line to a depth of 150 feet. The EPA and GEPA have not committed to allowing a mixing zone. The GWA has pursued but received no formal response from the EPA regarding 301(h) waiver and/or requirement for secondary treatment. However, the EPA has verbally communicated this past December that 301(h) waivers may not be granted for current permit renewal regardless of any additional flows. The GWA expects to upgrade to secondary treatment within their current planning horizon of 20 years in any event.

5. Review of Wastewater Treatment Alternatives

As discussed in Section 1, the following eight alternatives are evaluated in this study:

- **Option 1A** – Restore and upgrade existing primary treatment system at the GovGuam NDWWTP to accept the additional flow and load.
- **Option 1B** – Restore, expand, and upgrade the GovGuam NDWWTP to secondary treatment.
- **Option 2** – Build new secondary treatment plant near the proposed development on DoD land and construct new outfall.
- **Option 3** – Build new separate secondary treatment plant at GovGuam NDWWTP site to treat DoD load only.
- **Option 4** – Build a new tertiary treatment plant near the proposed development on DoD land and send effluent to a new water treatment plant (or existing water treatment Plant).
- **Option 5** – Build a new secondary treatment plant and construct new outfall on eastern coastline.
- **Option 6** – Build a new tertiary treatment plant near proposed development and reuse the effluent, send the residual to the GWA outfall.
- **Option 7** – Build a new tertiary treatment plant near proposed development on DoD land and install injection wells.
- **Option 8** – Install pretreatment for DoD industrial flows in conjunction with the upgrade and expansion of the GovGuam NDWWTP.

This section provides brief description of each alternative and their advantages and disadvantages in reference to regulatory requirements and considerations, public perception, technology capability, system reliability, engineering constructability, project construction cost, project execution time, and the DoD's influence over system operation and maintenance (O&M). This section describes methodology used to identify the most viable alternatives that are evaluated in Section 6.

5.1 Restore and Upgrade Existing Primary Treatment System at GovGuam NDWWTP to Accept the Additional Flow and Load

This alternative would restore and upgrade the existing primary treatment facilities at the NDWWTP to its originally designed treatment capacity and accept the additional wastewater from USMC relocation and other future military build up in northern Guam. The projected year 2019 flow for the NDWWTP including civilian and military population increase would be 10.54 mgd, still within the designed treatment capacity of the plant (12 mgd). To accommodate the additional flow from the military buildup and its associated induced civilian population growth in northern Guam that are estimated in Table 3-4, the plant would need to restore its primary treatment capacity and apply for a new discharge permit from the EPA. The effluent discharge requirements and required level of treatment would be re-evaluated by the EPA in conjunction with the request for increased flow.

This alternative would also involve sharing the cost for expanding the NDWWTP with the GWA, and coordinating with the GWA on ongoing and planned Capital Improvement Program (CIP) projects to achieve the future required treatment capacity to accept the additional load.

The GWA sewer capacity may reach its capacity with the additional flow from anticipated civilian customers increase and future Air Force projects at Andersen AFB. As such, an independent relief

sewer would be required to convey wastewater generated from USMC relocation at Finegayan region to the NDWWTP.

The GWA requires pretreatment of industrial flows discharged from Andersen AFB and future USMC operations, which mainly come from vehicle, aircraft washing and painting, and other workshops that would have an impact on operation of the NDWWTP.

There are some potential odor issues at the NDWWTP and the interconnecting interceptors. Presently, the remote location of the current facility helps with the mitigation of these issues. However, there is a proposal to develop large scale hotels in the area adjacent to Two Lovers Point near the NDWWTP. This could have an impact on future expansion of the facility, and odor control improvements should be considered during the expansion of the plant.

5.2 RESTORE, EXPAND AND UPGRADE GOVGUAM NDWWTP TO SECONDARY TREATMENT

This alternative would restore, expand, and upgrade the NDWWTP facility to provide a secondary treatment for civilian flow and additional wastewater generated from USMC relocation, and Army and Air Force build up. This alternative would restore the NDWWTP to its original primary treatment capacity of 12 mgd, and expand and upgrade the plant to 18 mgd to provide primary and secondary treatment. Treated effluent is still discharged via existing outfall to the Philippine Sea and the NDWWTP discharge permit needs to be modified with new flow limits. The GWA sewer rates for existing non-DoD users would be increased due to the plant upgrading to the secondary treatment for non-DoD portion of the flow and the additional electrical power and sludge produced by the secondary treatment system.

This alternative would also involve coordinating with GWA on its ongoing and planned CIP projects for the NDWWTP. As discussed in Section 5.1, an independent sewer interceptor would be required to convey wastewater generated from USMC and Army relocation at Finegayan region to the NDWWTP.

As discussed in the previous section, the GWA requires pretreatment of industrial flows discharged from military users in northern Guam that would impact operations of the NDWWTP.

As discussed in Section 5.1, there are some potential odor issues at the NDWWTP and odor control improvements should be considered during the expansion of the plant.

5.3 BUILD NEW SECONDARY TREATMENT PLANT NEAR THE PROPOSED DEVELOPMENT ON DEPARTMENT OF DEFENSE (DOD) LAND AND CONSTRUCT NEW OUTFALL

This alternative would build a new secondary treatment plant adjacent to the NDWWTP on DoD-owned land, and treat only the DoD wastewater from existing sources and proposed future military buildup, including the USMC relocation in northern Guam. The final effluent from the secondary treatment plant would be discharged into Philippine Sea via a newly constructed ocean outfall and a new NPDES permit would be required for the disposal.

The existing GWA's trunk sewer conveys both Andersen AFB and civilian flow to the NDWWTP. Since it is not feasible to separate military flow from the trunk sewer or at the diversion structure upstream of the headworks, a new interceptor connecting directly to the Andersen AFB collection system would be required to convey wastewater from Andersen AFB to the new DoD WWTP. Same as in Section 5.1 and 5.2, an independent interceptor would be required to convey the DoD-generated wastewater from Finegayan region to the new DoD WWTP. The cost of interceptor sewer from

Andersen AFB is additional cost compared to the two previous options discussed in Section 5.1 and 5.2.

Although the DoD would operate the treatment plant, industrial flows generated at the DoD facilities must be pretreated before entering the sewer. As discussed in Section 5.1, there are some potential odor issues near the NDWWTP site and odor control improvements should be considered during the construction of DoD plant. The plant biosolids treatment and disposal would be managed by the DoD and would comply with the EPA's Code of Federal Regulations (CFR) 503.

5.4 BUILD NEW SEPARATE SECONDARY TREATMENT PLANT AT GOVGUAM NDWWTP SITE TO TREAT DOD LOAD ONLY

This alternative would build a new secondary treatment plant at the NDWWTP site, and treat the DoD wastewater from existing sources and proposed military build up in northern Guam including USMC relocation. The existing NDWWTP would have two separate treatment process trains. The existing primary treatment would continue to treat flow from civilian population in northern Guam. The new process train would have a separate headworks, primary treatment, secondary treatment, and sludge handling facilities to treat DoD load only. It would require jointly utilizing the existing NDWWTP ocean outfall for its treated effluent disposal. Other constraints and considerations are similar to the alternative discussed in Section 5.2. This alternative also requires new NPDES permit application.

As discussed in Section 5.3, diverting existing DoD wastewater from GWA to NDWWTP is required and would result in additional cost of constructing a new DoD owned sewer interceptor from Andersen AFB. Since new secondary treatment train would be constructed adjacent to the original treatment process at the NDWWTP site about one mile south from NCTS Finegayan area, the alternative would require construction of a longer sewer interceptor for military Finegayan activities comparing to the option discussed in Section 5.3.

Industrial flows generated at the DoD facilities must be pretreated before entering the sewer. As discussed in Section 5.1, there are some potential odor issues at the NDWWTP, and odor control improvements should be considered during the construction of plant. The plant biosolids treatment and disposal would be managed by GWA and would comply with the EPA's CFR 503 regulations.

5.5 BUILD A NEW TERTIARY TREATMENT PLANT NEAR THE PROPOSED DEVELOPMENT ON DOD LAND AND SEND EFFLUENT TO A NEW WATER TREATMENT PLANT (OR EXISTING WATER TREATMENT PLANT)

This alternative would build a new tertiary treatment plant, which includes primary treatment, secondary biological treatment and advanced tertiary treatment, near the proposed development on DoD land. It would treat the DoD wastewater from existing sources and proposed future expansions in northern Guam including USMC relocation, and inject treated effluent directly into the raw water supply immediately upstream of a new water treatment plant built in northern Guam.

This kind of treatment application falls in a category of direct potable reuse of reclaimed water, and its normal treatment practice consists of primary settlement, submersible membrane bioreactor, disinfection, reverse osmosis (RO), and advance oxidation.

While this discharge eliminates the option of building an outfall, the approach to discharge treated wastewater directly to a potable water treatment plant does not have a proven track record. Only few direct potable reuse applications have been reported worldwide (Metcalf & Eddy 2007). Even without factoring in its extremely high capital investment cost and abnormal sophisticated process

operation, it might be difficult to gain regulatory acceptance of this approach, and it is likely that community acceptance of this approach cannot be achieved. Currently, there are no direct potable reuse applications in the U.S. All reclaimed water that is treated by wastewater treatment plants has been used as potable water in an indirect way, which includes a temporal or spatial separation such as natural buffers, either a stretch of river or a ground water aquifer, between the reclaimed water introduction and its distribution to the potable water treatment plant.

In addition, brine generated from RO operation requires some kind of discharge arrangements. Typical brine disposal routes include evaporation, crystallization, deep underground injection, ocean or sewer discharge. From an economic standpoint, only the last two may be feasible for this study, and they require permission from either the EPA or GWA. Since there are no regulations available on the reclaimed water potable reuse application, the process of establishing treatment requirements and performance monitoring standards for this option would add time and cost to the project.

In addition to the construction of a new sewer interceptor to convey wastewater from NCTS Finegayan area, a new DoD-owned interceptor system as described in Section 5.3 should be constructed to convey wastewater flow from Andersen AFB. A new effluent discharge pipe should be constructed to convey the effluent to the proposed or existing water treatment facility.

The plant biosolids treatment and disposal would be managed by the DoD and would comply with the EPA's CFR 503 regulations.

5.6 BUILD A NEW SECONDARY TREATMENT PLANT AND CONSTRUCT NEW OUTFALL ON EASTERN COASTLINE

This alternative would build a new secondary treatment plant on the eastern side of the island to treat DoD wastewater from existing sources and future military build up in northern Guam including USMC proposed relocation and construct new outfall on the eastern coastline. It is feasible only when majority of USMC relocation occurs in the east side of northern Guam, and it also requires routing and diverting all existing and future USMC relocation wastewater flow to the new treatment plant. The construction of new outfall would have an adverse impact on coral reef and would likely require mitigation activities to satisfy both Guam Bureau of Statistics and Planning Office (GBSPO) and GDAWR. The entire northeast coastline around the Andersen AFB is designated as Federal Listed Pati Point Marine Preserve that would restrict this area as a site for an ocean outfall.

Guam Department of Parks and Recreation Historical Preservation also noted that there are potential historical artifacts in the area a new ocean outfall. Many of the historical sites and burial grounds are located along the coast, on the lower plateau.

NPDES permit for new outfall from the EPA would require water quality studies to identify the impact of the new outfall in the receiving water. These studies would add time and costs to the project. The DoD would be responsible for the treatment, effluent refuse, and disposal of biosolids.

Construction of the plant on a site that is located in forested or preservation areas that are populated by native species of animals and vegetation and may require mitigation activities to satisfy the GDAWR.

5.7 BUILD A NEW TERTIARY TREATMENT PLANT NEAR PROPOSED DEVELOPMENT, REUSE THE EFFLUENT, AND SEND THE RESIDUAL TO THE GWA OUTFALL

This alternative would build a new tertiary treatment plant near the proposed development on DoD land, and treat DoD wastewater from both existing sources and future proposed military build up in

northern Guam including USMC relocation. It would reuse the treated effluent from tertiary system for toilet flushing, wash water for vehicles and aircrafts, landscape irrigation, cooling water for building climate control and probably potential non-DoD end users. Excess effluent that is produced would be discharged to the existing NDWWTP outfall. A NPDES permit is required to accommodate additional flow to the outfall. To achieve treatment requirement for the above mentioned reuse practice, it requires installing a wastewater treatment process consisting of primary treatment, membrane bioreactor, disinfection, and color removal. The DoD would be responsible for the treatment, effluent reuse, and biosolids disposal with this alternative.

The total estimated reclaimed water produced by this alternative is 3.6 mgd; however, the Finegayan area lacks sustainable and reliable reclaimed water reuse demand. A study to assess the demand for reclaimed water usage and identify a sustainable reuse water rate structure is required. In addition, a separate water distribution and dual plumbing system would be required, and a cross connection risk has to be addressed for this option. This would add time and cost to the project. The installation of dual plumbing system for existing buildings may not be economically feasible. The GWA also indicated that the current sewer rate structure would be impacted since the outfall capacity is consumed without receiving the revenue from the DoD for sewage treatment.

Similar to all alternatives with the construction of the DoD wastewater treatment plant on the west side of northern Guam, a new DoD-owned interceptor system should be constructed to convey wastewater to the treatment plant. For this alternative, a new transmission line should be constructed to discharge excess reclaimed water to the NDWWTP outfall.

5.8 BUILD A NEW TERTIARY TREATMENT PLANT NEAR PROPOSED DEVELOPMENT ON DOD LAND AND INSTALL INJECTION WELLS

This alternative would build a new tertiary treatment plant near the proposed development on DoD land. It would treat DoD wastewater from existing sources and future proposed military build up in northern Guam including USMC relocation. Treated effluent would be injected into the underground aquifer for groundwater replenishment and would increase groundwater sustainability of the Northern Guam Aquifer. The DoD would be responsible for treatment, groundwater monitoring, and biosolids disposal.

Guam's Northern Lens is its sole source aquifer, and it is directly underneath the Northern Guam region. As northern Guam sets on a karst limestone plateau with high water conductivity, it results in a low retention time between injection wells and withdraw wells and a minimum soil aquifer treatment. Under these conditions, a very high degree of treatment normally beyond EPA primary drinking water standards has to be achieved. In practice, even if the treatment presented in Section 5.4 is applied for this kind of indirect potable reuse of reclaimed water, the same kind of scrutiny would be anticipated from regulatory agencies and communities. Since there are no regulations available on Guam on the application of indirect potable reuse of reclaimed water, the process of establishing treatment requirements and performance monitoring standards for this option would consume time and increase cost to the project.

In addition to the construction of a new separate DoD-owned sewer interceptor system, a new transmission line would be required to convey reclaimed water to the injection wells. The cost of the transmission line and its operation would depend on topographical condition of piping route and locations of the injection wells that are determined by underground geological structure and required set back distance between injection wells and withdraw wells.

5.9 INSTALL PRETREATMENT FOR DOD INDUSTRIAL FLOWS IN CONJUNCTION WITH THE UPGRADE AND EXPANSION OF THE GWA NDWWTP

This is not an alternative but requires installing pretreatment for DoD industrial flows in conjunction with upgrades and expansions of the NDWWTP as described in both Sections 5.1 and 5.2. The DoD industrial flows occur mainly from on-base vehicle and aircraft washing and painting operations.

Even though this option is essential for normal operation of NDWWTP, currently, there are no pretreatment units installed at DoD facilities besides a few existing obsolete oil water separators in Andersen AFB. Wastewater characteristics from each industrial stream would need to be evaluated to develop the pretreatment processes as required. GWA had indicated that Industrial Pretreatment Standards would be imposed on all industrial users on the island.

The DoD would be responsible for pretreatment, solids disposal, and discharge of treated effluent into GWA sewer. The DoD may have to file an Industrial Discharge permit identifying discharge quality agreement between the military and the GWA. The permit may require the DoD to monitor sewage for compliance with pretreatment discharge limits.

In practice, this option has to be implemented and combined into all previous discussed alternatives. To guarantee a proper treatment operation of every above reviewed alternative, this option has to be carried out first.

5.10 ADVANTAGES AND DISADVANTAGES OF TREATMENT ALTERNATIVES

The major advantages and disadvantages of each wastewater treatment alternative are provided in Table 5-1.

5.11 AGENCY INVOLVEMENT FOR TREATMENT OPTIONS

The regulatory requirements and their involvement for each wastewater treatment alternative are evaluated. Table 5-2 provides summary of regulatory and agency considerations for each alternative.

5.12 RECOMMENDED VIABLE WASTEWATER TREATMENT ALTERNATIVES

ATS developed a ranking system to identify the four most favorable alternatives. The ranking system uses a relative factor for regulatory agency involvement and cost of construction. The system uses a factor 1 for low involvement or relative cost, 2 for medium involvement or relative cost, and 3 for high involvement or relative cost. Table 5-3 provides the total overall score and relative ranking of each alternative. Based on the relative rankings, ATS recommends that the four most favorable wastewater treatment alternatives outlined in Table 5-3 should be considered for further evaluation. Table 5-4 provides the reasons for eliminating the other five alternatives for further evaluation. The four recommended alternatives considered for detailed analysis are:

- Restore and upgrade existing primary treatment system at the GovGuam NDWWTP to accept the additional flow and load.
- Restore, expand, and upgrade the GovGuam NDWWTP to secondary treatment.
- Build new secondary treatment plant near the proposed development on DoD land and construct new outfall.
- Build new separate secondary treatment plant at GovGuam NDWWTP site to treat DoD load only.

Table 5-1: Advantages and Disadvantages of Treatment Options

Wastewater Treatment Alternatives	Advantages	Disadvantages
Option 1A – Restore and upgrade existing primary treatment system at GovGuam NDWWTP to accept the additional flow and load	• GWA is responsible for treatment and disposal • GWA is responsible for NPDES permit • Standard construction schedule • Lower construction cost compared to other treatment options	• Wastewater capacity must be acquired • Need to share odor control facility cost • NDWWTP permit needs to be modified with new flow limits • Contingent on extension or re-issuance of GWA 301(h) waiver from the EPA
Option 1B – Restore, expand, and upgrade GovGuam's NDWWTP to secondary treatment	• GWA is responsible for treatment and disposal • GWA is responsible for NPDES permit • Standard construction schedule • Lower construction cost compared to other secondary treatment options (Option 2, Option 3, and Option 5)	• Wastewater capacity must be acquired • Need to share odor control facility cost • NDWWTP permit needs to be re-issued with new discharge limits • Sewer rated for DoD and non-DoD users would increase
Option 2 – Build new secondary treatment plant near the proposed development on DoD land and construct new outfall	• The DoD provides wastewater capacity • Standard construction schedule	• Require modifications to the GWA's NPDES Permit • Require GWA's outfall • Diverting existing DoD wastewater from GWA to new DoD WWTP is required and would require additional costs compared to Option 1A and Option 1B • GDAWR mitigation requirements • High construction cost compared to other secondary treatment options (Option 1B, and Option 3)
Option 3 –Build new separate secondary treatment plant at GovGuam NDWWTP site to treat DoD load only	• DoD provides wastewater capacity • Standard construction schedule	• Require modifications to GWA's NPDES permit • Require GWA's outfall • Require partnership with GWA to share treatment plant site and would result in legal issues that may delay to the project • Guam Department of Aquatic and Wildlife Resources (GDAWR) mitigation requirements • Diverting existing DoD wastewater from GWA to new DoD WWTP is required and would require additional costs compared to Option 1A and Option 1B
Option 4 – Build a new tertiary treatment plant near the proposed development on DoD land and send effluent to a new water treatment plant (or existing water treatment Plant)	• DoD provides wastewater capacity • New outfall construction is not required • Increases potable water capacity	• Diverting existing DoD wastewater from GWA to new DoD WWTP is required and would incur additional cost • Conveying the effluent to new water or existing water treatment plant is required and would incur additional cost • GDAWR mitigation requirements • Require RO brine disposal arrangement • Unproven track record • Public opinion against directly consuming reclaimed water • Longer planning effort and longer construction schedule

Wastewater Treatment Alternatives	Advantages	Disadvantages
Option 5 – Build a new secondary treatment plant and construct new outfall on eastern coastline	• DoD provides wastewater capacity	• Require new NPDES permit • Require additional studies for outfall construction • Diverting existing DoD wastewater from GWA to new DoD WWTP is required and would require additional cost • GDAWR and GBSPO mitigation requirements • Department of Parks and Recreation Historical Preservation mitigation requirements • Longer planning effort and longer construction schedule • Additional cost and time for water quality studies to identify the impact of new outfall on receiving water • High construction cost compared to other secondary treatment options (Option 1B, Option 2 and Option 3)
Option 6 – Build a new tertiary treatment plant near proposed development and reuse the effluent, send the residual to the GWA outfall	• DoD provides wastewater capacity • New outfall construction is not required • Reuse of effluent	• Require modifications to GWA's NPDES Permit • Requires partnership with GWA to utilize GWA's outfall • Diverting existing DoD wastewater from GWA to new DoD WWTP is required and would require additional cost • GDAWR mitigation requirements • Complicated permit process for treated water reuse • Longer planning effort and longer construction schedule • Limited applications for reuse water • Additional cost for construction of effluent reuse distribution system and pipe to GWA outfall to send the residual
Option 7 – Build a new tertiary treatment plant near proposed development on DoD land and install injection wells	• Increase yield of underground aquifer • Control over the availability of wastewater capacity • New outfall construction is not required	• Diverting existing DoD wastewater from GWA to new DoD WWTP is required and would require additional cost • GDAWR mitigation requirements • Groundwater discharge permit required • Longer planning effort and longer construction schedule • Additional cost for construction and maintenance of injection wells and monitoring wells • Injection over the northern aquifer is not allowed
Option 8 – Install pretreatment for DoD industrial flows in conjunction with the upgrade and expansion of the GWA NDWWTP	• Protects downstream wastewater treatment facilities from process upsets • Reduces quantities of toxic materials in effluent and biosolids produced at WWTP	None

Table 5-2: Summary of Regulatory Agency Considerations

Regulatory Agency	Relative Involvement	List of Potential Considerations
Option 1A – Restore and upgrade existing primary treatment system at GovGuam Northern District WWTP to accept the additional flow and load		
Bureau of Statistics and Planning (Coastal Management)	Low-1	Off-shore construction is not required and GWA outfall exists
GEPA	Low-1	GEPA does not regulate discharges to ocean
EPA Region 9	Moderate-2	EPA has regulatory authority to set discharge limits. Permit for 301(h) waiver already exists
GDAWR	Moderate-2	Off-shore construction is not required and GWA outfall exists Long term impact of the primary effluent on the aquatic habitat is a concern
Department of Parks and Recreation (Historic Preservation)	Low-1	No construction on undeveloped land
Department of Public Works	Moderate-2	Possible public traffic disruption for relief interceptor construction
GWA	Moderate-2	GWA operates NDWWTP Sharing construction and operation costs Coordination with ongoing CIP projects
Option 1B – Restore, expand, and upgrade GovGuam NDWWTP to secondary treatment		
Bureau of Statistics and Planning (Coastal Management)	Low-1	Off-shore construction is not required and GWA outfall exists
GEPA	Low-1	GEPA does not regulate discharges to ocean
EPA Region 9	High-3	EPA has regulatory authority to set discharge limits Existing permit needs updating for secondary treatment limits
GDAWR	Moderate-2	Off-shore construction is not required and GWA outfall exists Long term impact of the secondary effluent on the aquatic habitat is a concern
Department of Parks and Recreation (Historic Preservation)	Low-1	No construction on undeveloped land
Department of Public Works	Moderate-2	Possible public traffic disruption for relief interceptor construction
GWA	High-3	GWA operates NDWWTP Sharing construction and operation costs Coordination with ongoing CIP projects
Option 2 – Build new secondary treatment plant near the proposed development on DoD land and construct new outfall		
Bureau of Statistics and Planning (Coastal Management)	Low-1	Off-shore construction is not required and GWA outfall exists
GEPA	Low-1	GEPA does not regulate discharges to ocean
EPA Region 9	High-3	EPA has regulatory authority to set discharge limits
GDAWR	High-3	Construction on undeveloped land may be required causing habitat disruption Long term impact of the treated effluent on the coral reef habitat is a concern
Department of Parks and Recreation (Historic Preservation)	High-3	Construction site may contain historical artifacts
Department of Public Works	High-3	New sewer line construction is required for diverting DoD wastewater
Guam Waterworks Authority (GWA)	Low -1	GWA treatment revenue is reduced

Regulatory Agency	Relative Involvement	List of Potential Considerations
Option 3 – Build new separate secondary treatment plant at GovGuam NDWWTP site to treat DoD load only		
Bureau of Statistics and Planning (Coastal Management)	Low-1	Off-shore construction is not required and GWA outfall exists
GEPA	Low-1	GEPA does not regulate discharges to ocean
EPA Region 9	High-3	EPA has regulatory authority to set discharge limits Existing permit would require updating for revised limits
GDAWR	Moderate -2	Off shore construction is not required and GWA outfall exists Long term impact of the blended primary and secondary effluent on the aquatic habitat is a concern
Department of Parks and Recreation (Historic Preservation)	Low -1	No construction on undeveloped land
Department of Public Works	Low - 1	No construction on undeveloped land
GWA	High-3	GWA owns outfall GWA Operates NDWWTP GWA treatment revenue is reduced
Option 4 – Build a new tertiary treatment plant near the proposed development on DoD land and send effluent to a new water treatment plant (or existing water treatment Plant)		
Bureau of Statistics and Planning (Coastal Management)	Low-1	Off-shore construction is not required
GEPA	High-3	GEPA regulates potable water supplies
EPA Region 9	High-3	EPA sets safe drinking water limits for local agencies
GDAWR	High-3	Construction on undeveloped land may be required causing habitat disruption
Department of Parks and Recreation (Historic Preservation)	High-3	Construction site may contain historical artifacts
Department of Public Works	High-3	New sewer line construction is required for diverting DoD wastewater Construction of new water line connection is required
GWA	High-3	GWA purchases water from DoD system, and monitoring requirements would be more stringent than current condition
Option 5 – Build a new secondary treatment plant and construct new outfall on eastern coastline		
Bureau of Statistics and Planning (Coastal Management)	High-3	Off-shore construction is required
GEPA	Low-1	GEPA does not regulate discharges to ocean
EPA Region 9	High-3	EPA has regulatory authority to set discharge limits
GDAWR	High-3	Construction on undeveloped land may be required causing habitat disruption New discharge causes concern for long term impact of secondary effluent on aquatic habitat
Department of Parks and Recreation (Historic Preservation)	High-3	Construction site may contain historical artifacts
Department of Public Works	High-3	New sewer line construction is required for diverting DoD wastewater
GWA	Low-1	GWA treatment revenue is reduced

Regulatory Agency	Relative Involvement	List of Potential Considerations
Option 6 – Build a new tertiary treatment plant near proposed development and reuse the effluent, send the residual to the GWA outfall		
Bureau of Statistics and Planning (Coastal Management)	Low-1	Off-shore construction is not required and GWA outfall exists
GEPA	High-3	GEPA would regulate reclaimed water Existing permit requires updating for revised limits
EPA Region 9	High-3	EPA has regulatory authority to set outfall discharge limits
GDAWR	High-3	Construction on undeveloped land may be required causing habitat disruption Long-term impact of the blended primary and tertiary effluent on the aquatic habitat is a concern
Department of Parks and Recreation (Historic Preservation)	High-3	Construction site may contain historical artifacts
Department of Public Works	High-3	New sewer line construction is required for diverting DoD wastewater Construction of new reused water line is required
GWA	High-3	GWA owns outfall GWA treatment revenue is reduced
Option 7 – Build a new tertiary treatment plant near proposed development on DoD land and install injection wells		
Bureau of Statistics and Planning (Coastal Management)	Low-1	Off-shore construction is not required
GEPA	High-3	GEPA has regulatory authority on groundwater recharge
EPA Region 9	High -3	EPA has regulatory authority to set outfall discharge limits
GDAWR	High-3	Construction on undeveloped land may be required causing habitat disruption Long term impact of the treated effluent on the coral reef habitat is a concern
Department of Parks and Recreation (Historic Preservation)	High-3	Construction site may contain historical artifacts
Department of Public Works	High-3	New sewer line construction is required for diverting DoD wastewater
GWA	High-3	GWA potable water supply is from same aquifer GWA treatment revenue is reduced
Option 8 – Install pretreatment for DoD industrial flows in conjunction with the upgrade and expansion of the GWA NDWWTP		
Bureau of Statistics and Planning (Coastal Management)	Low-1	Off-shore construction is not required
GEPA	Low-1	GEPA does not regulate industrial discharge to sewer
EPA Region 9	Low-1	EPA does not regulate industrial discharge to sewer
GDAWR	Low-1	Construction is on the base and adjacent to the operation facility
Department of Parks and Recreation (Historic Preservation)	Low-1	Construction is on the base and adjacent to the operation facility
Department of Public Works	Low-1	Construction does not affect traffic

Regulatory Agency	Relative Involvement	List of Potential Considerations
GWA	High-3	GWA requires pretreatment of industrial discharges GWA has indicated that DoD should consider immediate implementation of pretreatment regardless of the future wastewater alternatives selected

Table 5-3: Relative Ranking of Alternatives

Wastewater Treatment Alternatives	Relative Score								Total Score (a)	Relative Ranking	Recommendation
	Bureau of Statistics and Planning	Guam EPA	EPA Region 9	Department of Aquatic and Wildlife	Department of Parks and Recreation	Department of Public Works	Guam Waterworks Authority	Construction Cost			
Option 1A – Restore and upgrade existing primary treatment system at GovGuam NDWWTP to accept the additional flow and load	Low-1	Low-1	Moderate-2	Moderate-2	Low-1	Moderate-2	Moderate-2	Low-1	12	1	Considered for Detailed Evaluation
Option 1B – Restore, expand, and upgrade GovGuam NDWWTP to secondary treatment	Low-1	Low-1	High-3	Moderate-2	Low-1	Moderate-2	High-3	Moderate-2	15	3	Considered for Detailed Evaluation
Option 2 – Build new secondary treatment plant near the proposed development on DoD land and construct new outfall	Low-1	Low-1	High-3	High-3	High-3	High-3	Low-1	High-3	18	4	Considered for Detailed Evaluation
Option 3 – Build new separate secondary treatment plant at GovGuam NDWWTP site to treat DoD load only	Low-1	Low-1	High-3	Moderate 2	Low - 1	Low -1	High-3	Moderate - 2	14	2	Considered for Detailed Evaluation
Option 4 – Build a new tertiary treatment plant near the proposed development on DoD land and send effluent to a new water treatment plant (or existing water treatment Plant)	Low-1	High-3	High-3	High-3	High-3	High-3	High-3	High-3	22	6	Eliminated
Option 5 – Build a new secondary treatment plant and construct new outfall on eastern coastline	High-3	Low-1	High-3	High-3	High-3	High-3	Low-1	High-3	20	5	Eliminated
Option 6 – Build a new tertiary treatment plant near proposed development and reuse the effluent, send the residual to the GWA outfall	Low-1	High-3	High-3	High-3	High-3	High-3	High-3	High-3	22	6	Eliminated
Option 7 – Build a new tertiary treatment plant near proposed development on DoD land and install injection wells	Low-1	High-3	High -3	High -3	High -3	High-3	High-3	High -3	22	6	Eliminated
Option 8 – Install pretreatment for DoD industrial flows in conjunction with the upgrade and expansion of the GWA NDWWTP	Low-1	Low-1	Low-1	Low-1	Low-1	Low-1	High-3	Low-1	9	NA	Project requirement for all options

Table 5-4: Factors for Elimination

Wastewater Treatment Alternatives	Recommended Option	Factors for Eliminating Alternatives
Option 1A – Restore and upgrade existing primary treatment system at GovGuam NDWWTP to accept the additional flow and load	Yes	N/A
Option 1B – Restore, expand, and Upgrade GovGuam's NDWWTP to secondary treatment	Yes	N/A
Option 2 – Build new secondary treatment plant near the proposed development on DoD land and construct new outfall	Yes	N/A
Option 3 – Build new separate secondary treatment plant at GovGuam NDWWTP site to treat DoD load only	Yes	N/A
Option 4 – Build a new tertiary treatment plant near the proposed development on DoD land and send effluent to a new water treatment plant (or existing water treatment Plant)	No	• Conveyance facilities for diverting existing DoD wastewater from GWA to new DoD WWTP • Incur additional cost for conveying the effluent to new water or existing water treatment plant • GDAWR mitigation requirements may cause project delays and additional costs to DoD • Establishing new water quality monitoring requirements may result in longer planning effort and longer construction schedule
Option 5 – Build a new secondary treatment plant and construct new outfall on eastern coastline	No	• Require new NPDES Permit. Require additional studies for outfall construction • New outfall is required • Conveyance facilities for diverting existing DoD wastewater from GWA to new DoD WWTP • DAWR and GBSPO mitigation requirements may add time and cost to project • Guam Department of Parks and Recreation Historical Preservation indicates that historical sites and burial grounds may be located along the coast on the lower plateau • Longer planning effort and longer construction schedule
Option 6 – Build a new tertiary treatment plant near proposed development and reuse the effluent, send the residual to the GWA outfall	No	• Conveyance facilities for diverting existing DoD wastewater from GWA to new DoD WWTP • GDAWR and GBSPO mitigation requirements may add time and cost to project • Complicated permit process for treated water reuse may add time and cost to the project • Construction of reclaimed water distribution network and dual plumbing systems is required

Wastewater Treatment Alternatives	Recommended Option	Factors for Eliminating Alternatives
Option 7 – Build a new tertiary treatment plant near proposed development on DoD land and install injection wells	No	• Diverting existing DoD wastewater from GWA to new DoD WWTP is required and would require additional cost • GDAWR mitigation requirements • Groundwater discharge permit required • Longer planning effort and longer construction schedule • Additional cost for construction and maintenance of injection wells and monitoring wells • Injection over the northern aquifer is not allowed • Requires construction of outfall or diversion to GWA sewer in case Injection wells are not available
Option 8 – Install pretreatment for DoD industrial flows in conjunction with the upgrade and expansion of the GWA NDWWTP	Yes	Recommended for all options

N/A not applicable

6. Viable Wastewater Treatment Alternatives

The ATS Guam Wastewater Utility Study Letter Report submitted to the NAVFAC on 31 August 2007 recommended four viable wastewater treatment alternatives for further evaluation. The four recommended viable alternatives are:

- **Option 1A** – Restore and upgrade existing primary treatment system at GovGuam Northern District WWTP to accept the additional flow and load.
- **Option 1B** – Restore, expand, and upgrade GovGuam NDWWTP to secondary treatment.
- **Option 2** – Build new secondary treatment plant near the proposed development on DoD land and construct new outfall.
- **Option 3** – Build new separate secondary treatment plant at GovGuam NDWWTP site to treat DoD load only.

In this section, all four viable wastewater treatment alternatives are discussed and their associated collection system modification issues are also evaluated. Based on the preliminary life cycle cost estimation combined with evaluation of institutional constrains and public concerns for each viable alternative, this study recommends preferred alternatives of the viable wastewater treatment ones for further Environmental Impact Study on USMC relocation to Guam initiative.

6.1 DESCRIPTION OF VIABLE ALTERNATIVES

Among four viable alternatives, Option 1A and Option 1B are both to restore and upgrade existing GovGuam NDWWTP and assumed that the Navy would coordinate with the GWA on the schedule of implementing its planned CIP to restore the existing treatment facility to its designed capacity by the time expansion of population on Guam commences and secondary treatment upgrade is started.

6.1.1 Restore and Upgrade Existing Primary Treatment System at GovGuam NDWWTP to Accept the Additional Flow and Load

As described in Section 2, the NDWWTP is the only wastewater treatment facility in northern Guam and is a primary treatment facility with comminutor and aerated grit chamber for preliminary treatment, and primary clarifiers mainly for removal of settleable organics and suspended solids. The existing plant is not operating properly and requires refurbishment to enable it to operate as designed.

Wastewater preliminary treatment removes rags, floatables, grit, and grease that may cause maintenance or operational problems to the subsequent treatment processes. For municipal applications, it normally consists of treatment, such as screening or shredding, grit removal, flow equalization, and neutralization.

Wastewater primary treatment removes a portion of the suspended solids and associated organic matter from wastewater by settling and skimming. A primary clarifier enhances solid liquid separation utilizing gravitational settling to remove suspended solids, and it normally removes 60 percent (%) suspended solids as TSS and 30% organic matter presented as BOD_5 from municipal wastewater.

The NDWWTP is a primary treatment facility. It was designed for treating an average daily flow of 12.0 mgd and a peak flow of 27.0 mgd. After restoring the existing primary treatment system, the NDWWTP should be able to treat projected wastewater flows for both DoD and civilian activities in northern Guam as presented in Table 3-5. In the year 2019, if all military wastewater generated in northern Guam is still treated by the NDWWTP, the total flow of 0.56 mgd from Andersen AFB,

with present flow of 0.36 mgd, and future flow of 0.2 mgd from the Air Force bed down military construction (MILCON) projects would all be conveyed through the existing GWA main to the NDWWTP. The GWA sewer main has adequate capacity to carry the extra flow; however, wastewater flow of 2.76 mgd generated by USMC and Army relocation at Finegayan area would have to be carried by a newly constructed relief sewer to the NDWWTP (as shown on Figure 6-1).

During the first half of 2009, average influent BOD and TSS at the NDWWTP were 125 mg/L and 155 mg/L, respectively, as reported in the plant discharge monitoring report to the EPA. ATS assumed that the future civilian and military wastewater flow would have characteristics similar to the current wastewater flow discharging to the existing NDWWTP.

The NDWWTP existing primary treatment facility is currently operating with the effluent concentration requirement as presented in Table 6-1.

Table 6-1: Current NDWWTP Effluent Pollutant Concentration Requirement

Characteristic of discharge	Unit of measurement	Daily maximum concentration	Average monthly concentration
BOD_5	mg/L	170	85
Suspended solids	mg/L	100	50
Settleable solids	ml/L	2	1
Hydrogen-ion	pH	7.0 – 9.0	

Source: GWA 2007

Based on the current plant process capacity that was evaluated in Section 2.3, to accommodate future anticipated flow and loadings while still achieving the existing effluent discharge requirement as presented in Table 6-1. GWA and ATS identified both short-term necessary improvements and long-term improvements to restore the NDWWTP primary treatment capacity. GWA identifies short-term necessary improvements, which address immediate influent flow increases, as the highest priority. Long-term improvements are those improvements required for when the influent flows approach 10 to 12 mgd.

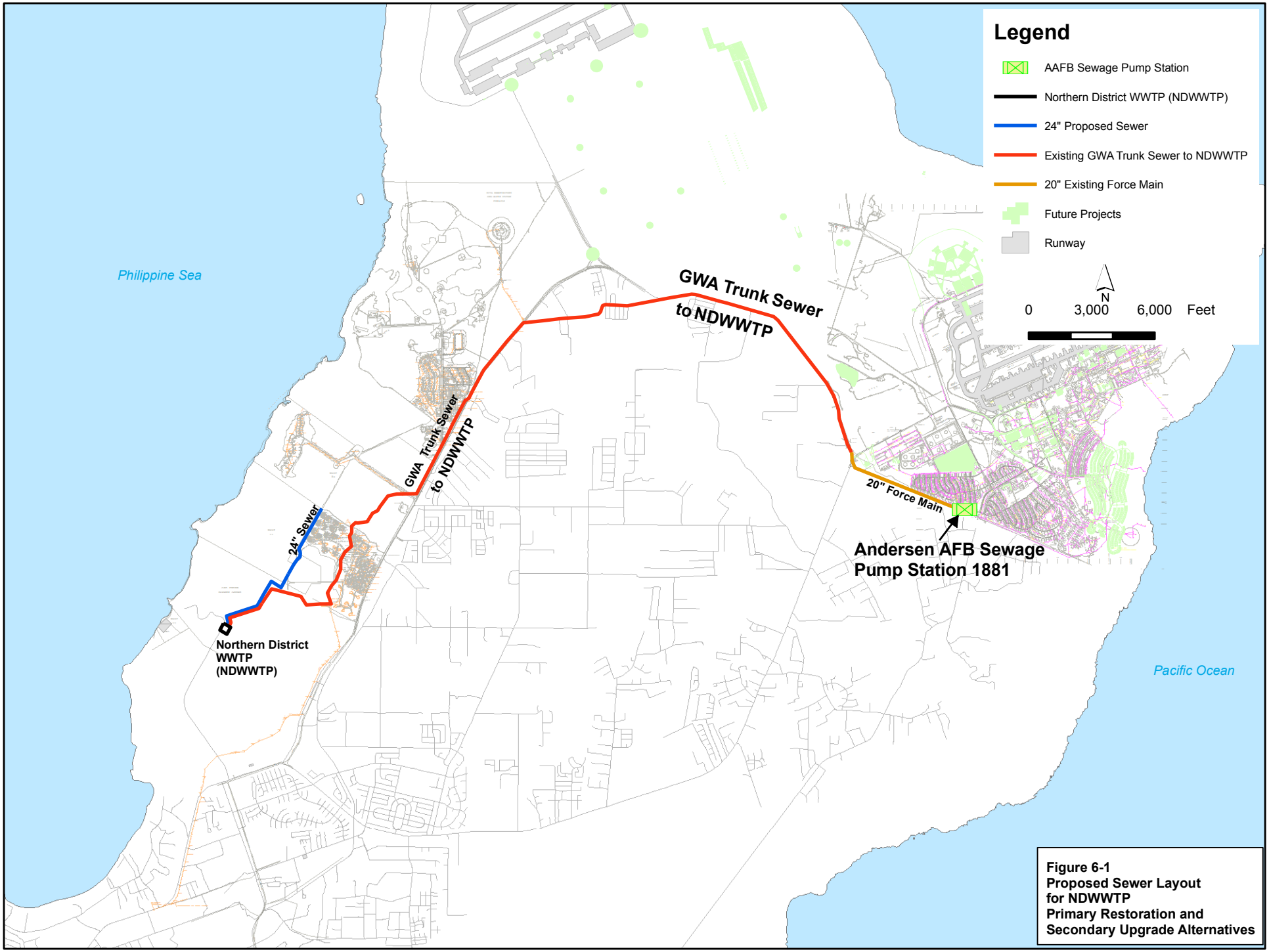

Figure 6-1
Proposed Sewer Layout for NDWWTP
Primary Restoration and Secondary Upgrade Alternatives

6.1.1.1 SHORT-TERM NECESSARY IMPROVEMENTS

The short-term necessary improvements for restoring the NDWWTP primary treatment capacity are as follows:

- Septage and fat/oil/grease (FOG) receiving
- Primary clarifier rehabilitation
- Sludge digester rehabilitation
- Centrifuge building replacement and one centrifuge
- Sludge-drying bed rehabilitation
- Standby power

A new septage receiving station would be required to receive and co-treat septage from unsewered customers. The station would consist of an unloading area, a septage storage tank, a septage screen, an aeration system, and two grinder transfer pumps. The septage storage tank would be sized for a detention time of at least 1 day. A new FOG receiving station would receive FOG generated by residential, commercial, and industrial generators, such as restaurants, grocery stores, hospitals, and food processors. The FOG receiving station would collect FOG from grease trucks and pump it into the plant anaerobic digesters, where much of the FOG would be converted into digester gas to create energy. The FOG station would consist of a grease holding tank and chopper pumps so that the FOG can be moved into the digesters. Heating would be required for the grease holding tank to maintain temperatures above 110 degrees Fahrenheit, prevent solidification of the grease, and ensure proper operation. Both the septage storage tank and the grease holding tank would be covered and would have an odor control system.

Headworks improvements would include installation of fine screens, a grit chamber retrofit, installation of a new grit pump station, installation of grit wash and dewatering units, and incorporation of flow metering. Two new mechanically cleaned fine screens would be installed to prevent the entry of large debris and coarse solids. A new flow measurement system needs to be installed to replace the malfunctioning Parshall flume. The existing Parshall flume is too close to the upstream screen channel that creates turbulence inside the flume. There is not enough space in between the screen channels and the preaeration tank to properly install a Parshall flume with the required dimensions. Without modifying the headworks structure, a meter vault would be constructed outside of the headworks building and upstream on the influent flow pipe with siphon modification to have full flow pipe. A magnetic meter would be installed for flow measurement. The grit chamber concrete surface needs to be sand blasted and coated. All air pipes and diffusers, grit removal pumps, and grit wash and dewatering units need to be replaced.

Rehabilitation of the two primary clarifiers includes concrete surface cleaning, sand blasting and coating, and replacement of the basin mechanical components with new stainless steel units. The primary clarifiers would be furnished with drive units, a walkway and drive platform, a center column, a center cage and rake arm, a feedwell, a scum removal mechanism, and fiberglass-reinforced plastic weirs and baffles. Stainless steel units are more suitable to the tropical coastal environment at the NDWWTP site.

The only element of the existing digester system that would be salvageable is its concrete tanks. The digester rehabilitation would include mixing and recirculation system, gas and scum piping, sludge recirculation and transfer pumps, gas compressors and a boiler for heating, and a waste gas flare. The

polymer dosing system, which assists with dewatering sludge and is located inside the sludge digester control building, also needs to be refurbished.

The centrifuge building needs to be replaced, and one new sludge centrifuge needs to be installed to replace the old units. A diesel generator unit needs to be installed for emergency service as a standby power source.

Implementation of the short-term necessary improvements would restore the NDWWTP to its theoretical treatment capacity and meet the immediate need for increased wastewater treatment. However, execution of identified long-term improvements would be necessary to ensure the reliability and operational flexibility of the treatment system.

6.1.1.2 LONG-TERM IMPROVEMENTS

The long-term improvements required for restoring the primary treatment capacity are as follows:

- Hydraulic improvements to the chlorine contact tank
- Third digester (new)
- Second centrifuge
- Odor control
- Digester gas utilization
- Administration/laboratory, office, and workshop/storage areas rehabilitation

In the long term, the current configuration of the chlorine contact tanks needs to be retrofitted with long, narrow channels in a serpentine pattern to improve the hydraulic characteristics. Although the current NDWWTP discharge permit does not require that the effluent be chlorinated, retrofitting the chlorine contact tanks would benefit long-term operation of the plant and simplify potential future permit-related upgrades. As part of the chlorine contact tanks reconfiguration, a new effluent Parshall flume would be installed downstream of the chlorine tanks to replace the malfunctioned existing one, which is located upstream of the chlorine tanks. The new additional anaerobic digester with concrete cover and sludge dewatering centrifuge unit would provide operational flexibility and redundant capacity for the plant sludge handling system and increase its operational reliability. A plant odor control system needs to be added to treat odor collected inside the headworks building, septage storage tank, grease-holding tank at the receiving station, and centrifuge building to improve the operator working environment and the air quality of the surrounding area.

In addition, digester gas, which consists of large quantities of methane, has to be used for heating and power generation. After corrosive and toxic gas is scrubbed off, the digester gas would be used as fuel for internal-combustion engines or gas turbines to drive air compressors, pumps, and generators for production of electricity. An engine generator, micro-turbine, or fuel cell can be installed for digester gas use. The digester gas would be a renewal source of energy for the plant, and use of the gas as fuel would reduce plant greenhouse gas emissions.

Figure 6-2 shows a process flow diagram of the refurbished and upgraded NDWWTP primary treatment. The preliminary sizes of the NDWWTP refurbishment and upgrade facilities are listed in Table 6-2.

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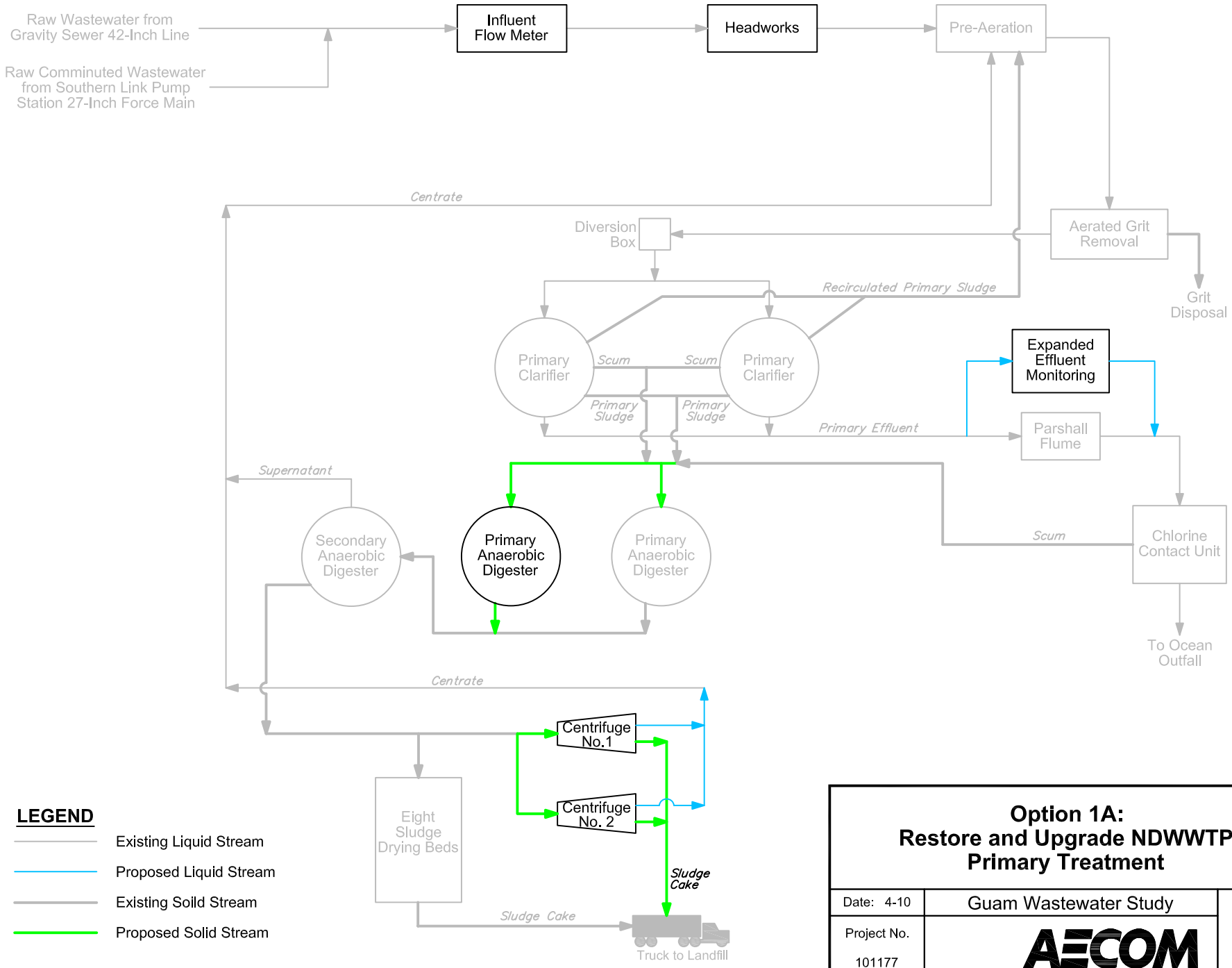

Final

Option 1A: Restore and Upgrade NDWWTP Primary Treatment

Date: 4-10	Guam Wastewater Study	Figure 6-2
Project No. 101177	AECOM	

Table 6-2: Major Components for Refurbishing and Upgrading Existing Primary Treatment System at the NDWWTP to Accept the Additional Flow and Load

Construction Components	Refurbish (R)/ Upgrade (U)/ NEW (N)	Unit	Dimensions/Description
Septage receiving station	N	1	Septage storage tank, screen, two blowers, diffusers, two grinder pumps, truck unloading area
FOG receiving station	N	1	Headed grease-holding tank, heat trace system, two grinder pumps, grease truck unloading area
Headworks	R/U/N	1	Two 6-milllimeter fine screens, grit chamber retrofit, new grit pump station, grit wash and separation, flow metering
Primary clarifier	R	2	New sludge collectors, electrical, pumps, coatings, concrete repair, 130-foot-diameter x 7-foot-SWD
Chlorine contact tank	R	2	Hydraulic improvements
Anaerobic digester	R N	2 1	80 ft diameter x 18 ft SWD (steel covered) 80 ft diameter x 18 ft SWD (concrete covered)
Solids dewatering building	N	1	Building structure replacement, two centrifuges, two feed pumps, polymer dosing system, electrical, controls, coatings, piping and valves
Influent and effluent measurement	N	2	Automatic sampler
Odor control system	N	1	Locate at headworks and solids handling
Sludge-drying bed	R	8	Concrete repair, valves
Standby diesel generator	N	1	300-kilowatt diesel generator
Digester gas utilization	N	1	
Administration/Lab, Workshop and Storage	R	1	

SWD side water depth

As described above, one wastewater stream comes into the treatment plant from the existing GWA sewer and the other from the USMC Finegayan relief sewer.

6.1.2 Restore, Expand, and Upgrade GovGuam NDWWTP to Secondary Treatment

In addition to suspended solids removal by primary treatment, a wastewater treatment facility can utilize secondary treatment to enhance removal of biodegradable organic matter (in solution or suspension) and suspended solids. Secondary treatment normally refers to a biological treatment process that utilizes microorganisms to consume organic pollutants. It can be either a suspended growth activated sludge treatment or an aerobic attached growth treatment system (such as trickling filter).

In January 2009, EPA Region 9, upon review of this new information from GWA, again issued a tentative decision to deny the Section 301 (h) secondary treatment variance for the NDWWTP, followed by a final decision to deny the variance on 30 September 2009. This final effectively requires GWA to install full secondary treatment at the NDWWTP. The national minimum secondary treatment requirements are presented in Table 6-3. To meet anticipated increased stringent EPA ocean outfall discharge requirements to Guam municipal wastewater treatment facilities, the existing primary treatment facility at the NDWWTP needs to be upgraded to provide secondary treatment. The objective of this alternative is to restore the NDWWTP to its original primary treatment capacity of 12 mgd, and upgrade and expand the plant to provide primary and secondary treatment to treat current wastewater flow, as well as additional flow from both civilian and military sources.

Table 6-3: Minimum National Standards for Secondary Treatment

Characteristic of discharge	Unit of measurement	Average 30-day concentration	Average 7-day concentration
BOD_5	mg/L	30	45
Suspended solids	mg/L	30	45
Hydrogen-ion	pH	6.0 – 9.0	

With projected wastewater flows from both DoD and GWA civilian customers, and additional future wastewater flows associated with septic conversions (connecting users to the collection system that are presently on septic systems in northern Guam), GWA suggested treatment capacity of the proposed NDWWTP secondary upgrade is 18 mgd. Using the plant originally designed peak flow factor of 2.25, peak flow for the secondary treatment system at the NDWWTP would be 40.5 mgd. During the first half of 2009, average influent BOD and TSS at the NDWWTP were 125 mg/L and 155 mg/L, respectively, as reported in the plant discharge monitoring report to the EPA. ATS assumed that the future civilian and military wastewater flow would have characteristics similar to the current wastewater flow discharging to the existing NDWWTP. Estimated influent flow and its characteristics and loadings of the NDWWTP are presented in Table 6-4.

Table 6-4: Estimated NDWWTP Influent Flow and Loading for the Secondary Treatment

Flows	Flow rate (mgd)	
Average daily flow	18.0	
Peak wet weather flow	40.5	
Parameters	Concentration (mg/L)	Loading (lbs/day)
BOD_5	125	18,765
Suspended solids	155	23,269

This option would restore the NDWWTP to its original primary treatment capacity of 12 mgd, and expand and upgrade the plant to 18 mgd to provide primary and secondary treatment. The NDWWTP could be converted to a new secondary treatment process as shown in the schematic process diagram on Figure 6-3. A trickling filter system was selected as the secondary treatment process not only because of its lower power requirement and less sludge production compared with a suspended growth system (such as Activated Sludge System), but also because of its simple and reliable operational characteristics. It is desirable to have a simple process to minimize future operation and maintenance requirements.

This alternative would require construction of a new relief sewer from the NCTS Finegayan to the NDWWTP and its sewer layout is shown on Figure 6-1.

Raw wastewater would flow through the NDWWTP restored headworks with new fine screens followed by existing rectangular aerated grit chambers into an upgraded diversion box. Grit and screenings are disposed in a sanitary landfill. Subsequently, the diversion box distributes flow evenly into one new and two existing circular primary clarifiers, while clarified primary effluent is combined and pumped to the top of the three new circular trickling filters for secondary biological treatment. Trickling filter flow is conveyed into four new circular secondary clarifiers for solid liquid separation. Clarified final effluent then flows through the effluent Parshall flume flow measurement system, and subsequently into an upgraded chlorine disinfection system for treated flow disinfection. The upgraded disinfection system with chlorination and dechlorination includes three chlorine

contact tanks with one newly constructed tank. Dechlorination is provided because residual chlorine from chlorination disinfection has adverse effects on aquatic organisms in the receiving water. The chlorine disinfected effluent flows into the 34-inch ocean outfall for final disposal. The existing NDWWTP ocean outfall needs to be upgraded with additional multiport discharge diffusers to accept additional flow. The sludge from both primary clarifiers and secondary clarifiers is collected via sludge transfer pumps to an anaerobic digestion system for pathogen control and solids reduction. Digested solids are pumped to a centrifuge dewatering system for volume reduction. Dewatered cake is hauled as Class B solids for offsite disposal.

In addition to restoring its primary treatment capacity as described in Section 6.1.1, the following new process components and upgrades are required at the NDWWTP for this alternative:

- One primary clarifier (same size as existing ones)
- Three trickling filters
- Four secondary clarifiers
- One chlorine contact tank
- Two new anaerobic digesters (same size as existing ones)
- One centrifuge solids dewatering system and odor control
- Effluent monitoring and measurement expansion
- Outfall diffuser capacity expansion

The sizes of the new process components and upgrades required at the NDWWTP for restoring, expanding, and upgrading to secondary treatment are listed in Table 6-5.

Figure 6-3 shows a process flow diagram of the upgraded NDWWTP secondary treatment. In this alternative, the preliminary and primary treatment expansion and upgrade features of the plant are exactly the same as the ones discussed in the first alternative discussed in Section 6.1.1. The primary effluent from three primary clarifiers, each 130-foot diameter and 7-foot water depth, is then pumped via a newly constructed trickling filter pump station to the top of the three new circular trickling filters for secondary biological treatment. Secondary biological treatment system includes three trickling filters and four secondary clarifiers. Each circular trickling filter is 120-foot in diameter and 24-foot water depth. Each secondary clarifier is 125-foot in diameter and 16-foot water depth. Secondary treated effluent coming out of secondary clarifier then flows through a flow measurement Parshall flume into a chlorine disinfection system. The chlorine disinfection system has two existing chlorine contact tanks and one newly constructed concrete chlorine contact tank built with common wall adjacent to the existing tanks. The new tank would have the same dimensions as the existing ones: 70-feet long and 40-feet wide with 14-foot side water depth. After expansion, the chlorine disinfection system would provide a capacity that allows one tank to be offline for maintenance. The capacity of the existing outfall is limited by its end diffusers; as the result, in this alternative, one 400-foot long multiport diffuser branch would be installed with a precast concrete junction box connected to the existing outfall pipe to increase the discharge capacity of the outfall.

Primary sludge produced by primary clarifiers and secondary biological sludge produced by secondary clarifiers are all pumped into plant solids treatment facility for sludge digestion and subsequent dewatering. Solids treatment includes five anaerobic digesters and two solids dewatering centrifuges. Each digester is 80-foot in diameter and 18-foot liquid depth. Three first-stage anaerobic digesters are operated for stabilization, and two second-stage anaerobic digesters provide liquid solids separation and thickening. The digesters are designed for a hydraulic detention time over

15 days to meet EPA Class B standards, and would operate to handle planned future sludge loadings with one digester out of service for maintenance. Anaerobic digested sludge is then pumped to three centrifuges with a capacity of 150 gallons per minute (gpm) each for the solids dewatering to reduce the volume of final disposed sludge. Dewatered cake is hauled as Class B solids for offsite disposal.

Table 6-5: Components for Restoring, Expanding, and Upgrading the NDWWTP to Secondary Treatment

Construction Components	Refurbish (R)/Expand (E)/Upgrade (U)/NEW (N)	Unit	Dimensions/Description
Septage Receiving station	N	1	Septage storage tank, screen, two blowers, diffusers, two grinder pumps, truck unloading area
FOG receiving station	N	1	Headed grease-holding tank, heat trace system, two grinder pumps, grease truck unloading area
Headworks	U/N	2	Two fine screens
Primary clarifier	R N	2 1	130 ft diameter x 7 ft SWD 130 ft diameter x 7 ft SWD
Trickling filter pumping station	N	1	40 ft long x 25 ft wide x 16 ft high
Trickling filter	N	3	120 ft diameter x 24 ft SWD
Secondary clarifier	N	4	125 ft diameter x 16 ft SWD
Chlorine contact tank	R N	2 1	60 ft long x 40 ft wide x 8 ft SWD 60 ft long x 40 ft wide x 8 ft SWD
Anaerobic digester	R N	2 3	80 ft diameter x 18 ft SWD (steel covered) 80 ft diameter x 18 ft SWD (concrete covered)
Solids dewatering centrifuges	N	3	150 gpm each
Effluent measurement	E	1	Automatic sampler
Odor control system	N	1	Locate at headworks and solids dewatering
Sludge-drying bed	R	8	Concrete repair, valves
Standby diesel generator	N	1	300-kilowatt diesel generator
Digester gas utilization	N	1	
Administration/Lab, Workshop and Storage	R	1	
Outfall capacity expansion	N	1	400 ft long multiport diffusers

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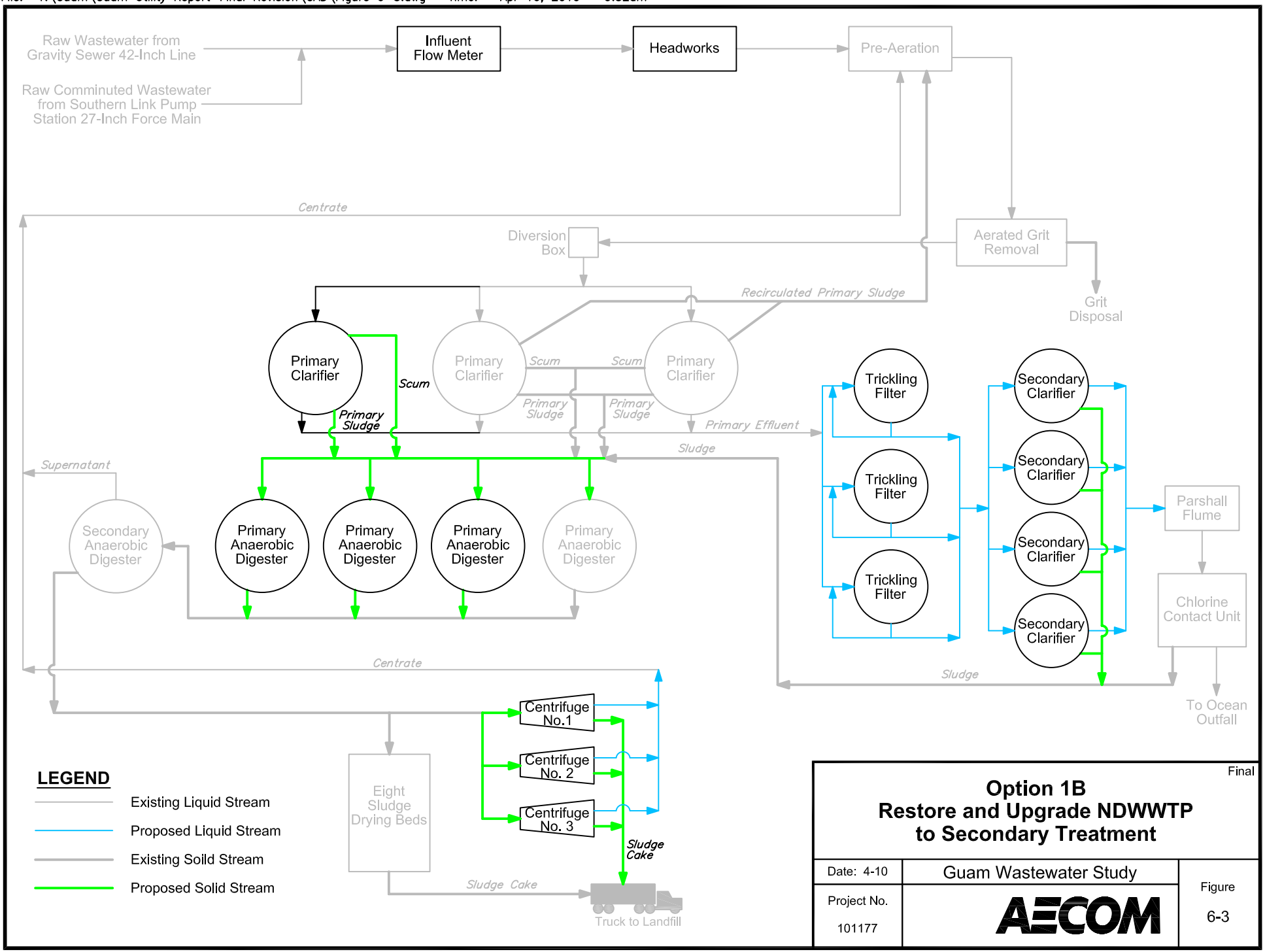

Final

Option 1B
Restore and Upgrade NDWWTP to Secondary Treatment

Date: 4-10	Guam Wastewater Study	Figure 6-3
Project No. 101177	AECOM	

6.1.3 Build New Secondary Treatment Plant near the Proposed Development on DoD Land and Construct New Outfall

This alternative considers construction of a secondary treatment plant that would be owned and operated by DoD, rather than upgrading the existing treatment plant (NDWWTP, which is owned by GWA) to secondary treatment. In this alternative, a newly constructed independent sewer main is required to convey all military generated wastewater in northern Guam to a DoD secondary treatment plant near the proposed USMC Finegayan development on DoD land (as shown on Figure 6-4). The new sewer main carries a total average daily wastewater flow of 3.46 mgd. This includes current NCTS Finegayan daily wastewater flow of 0.14 mgd, current Andersen AFB daily flow of 0.36 mgd, future Air Force bed down MILCON wastewater flow of 0.20 mgd, plus future USMC and Army wastewater flow of 2.76 mgd in the NCTS Finegayan area as indicated in Table 3-4. The treated effluent from this secondary wastewater treatment plant would be discharged via a new DoD ocean outfall into Philippine Sea. The future peak flow for the DoD secondary plant is estimated to be 10.92 mgd in Table 3-4 and its peak factor is estimated based on the served population from Babbit's curve in Water Pollution Control Federation Manual of Practice No. FD-5. ATS assumed that the future military wastewater flow would have characteristics similar to the wastewater flow discharging to the NDWWTP. Future influent wastewater flow and its characteristics and loadings to the DoD secondary plant are presented in Table 6-6.

Table 6-6: Estimated Influent Flow and Loading in 2019 for DoD Secondary Wastewater Treatment

Flows	Flow rate (mgd)	
Average daily flow	3.5	
Peak wet weather flow	8.5	
Parameters	Concentration (mg/L)	Loading (lbs/day)
BOD_5	204	5,890
Suspended solids	205	5,920

The independent sewer that connects the Andersen AFB collection system at its main gate lift station, runs along Route 3, and combines the flow generated by the relocated USMC from the Finegayan would carry wastewater into the proposed DoD secondary treatment facility at the southern end of Finegayan.

The new secondary wastewater treatment plant would consist of following components:

- Headworks (two screens and two aerated grit chambers with odor control)
- Three primary clarifiers
- Three trickling filters
- Four secondary clarifiers
- Two chlorine contact tanks
- Three anaerobic digesters
- Two centrifuge solids dewatering systems with odor control
- Effluent monitoring and measurement
- Ocean outfall

Figure 6-5 shows a process flow diagram of the new DoD secondary treatment. Preliminary treatment for this alternative includes bar racks and 3/8-inch to 1/2-inch mechanical fine screens at the headworks structure, followed by two aerated grit removal chambers. Each chamber has a 45-foot length and 12-foot width and 7-foot water depth. Grit and screenings removed are disposed in a sanitary landfill.

Primary treatment includes three primary clarifiers, each 60-foot diameter and 10-foot water depth. Secondary treatment system includes three trickling filters and three secondary clarifiers. Each circular trickling filter is 65-feet in diameter and 24-foot water depth. Each secondary clarifier is 80-feet in diameter and 13-foot water depth. Subsequently a disinfection system with two chlorine contact tanks, each 55-feet long by 25-feet wide with water depth of 14-feet, provides chlorination and dechlorination to the secondary clarifier effluent, and its effluent flows into the 30-inch ocean outfall for final discharge at Philippine Sea, west of the plant. A new ocean outfall about 5,000 feet long 30-inch effluent transmission pipe and 2,400 feet long 30-inch outfall is required for the treated effluent disposal in this alternative.

Solids treatment for both primary sludge and secondary sludge includes three anaerobic digesters and two solids dewatering centrifuges for sludge digestion and dewatering. Each digester is 80-feet in diameter and 18-foot liquid depth. Two first stage anaerobic digesters are operated for stabilization, and one second stage anaerobic digester provides liquid solids separation and thickening. The digesters are designed for a hydraulic detention time over 15 days to meet EPA Class B standards, and would operate to handle planned future sludge loadings with one digester out of service for maintenance. Anaerobic digested sludge is then pumped to two centrifuges with a capacity of 125 gpm each for the solids dewatering to reduce the volume of final disposed sludge. Dewatered cake is hauled as Class B solids for offsite disposal.

A summary of the major process components for a new DoD secondary treatment plant adjacent to the NDWWTP and a new outfall are listed in Table 6-7.

Table 6-7: Major Process Components for Building a New DoD Secondary Treatment Plant Near the Proposed Development on DoD Land and Constructing a New Outfall

Construction Components	Unit	Dimensions/Description
Headwork	1	Two mechanical fine screens and Two (2) aerated grit chambers, each 45 ft long x 12 ft wide x 7 ft SWD
Primary clarifier	3	60 ft diameter x 10 ft SWD
Trickling filter pumping station	1	40 ft long x 25 ft wide x 16 ft high
Trickling filter	3	65 ft diameter x 24 ft SWD
Secondary clarifier	3	80 ft diameter x 13 ft SWD
Chlorine contact tank	2	55 ft long x 25 ft wide x 14 ft SWD
Effluent measurement	1	Automatic sampler
Odor control system	1	Locate at headworks and solids handling
Ocean outfall & effluent transmission piping	1	30 in. diameter, 7,400 ft long
Anaerobic digesters	3	80 ft diameter x 18 ft SWD
Solids dewatering centrifuges	2	125 gpm each

in. inch

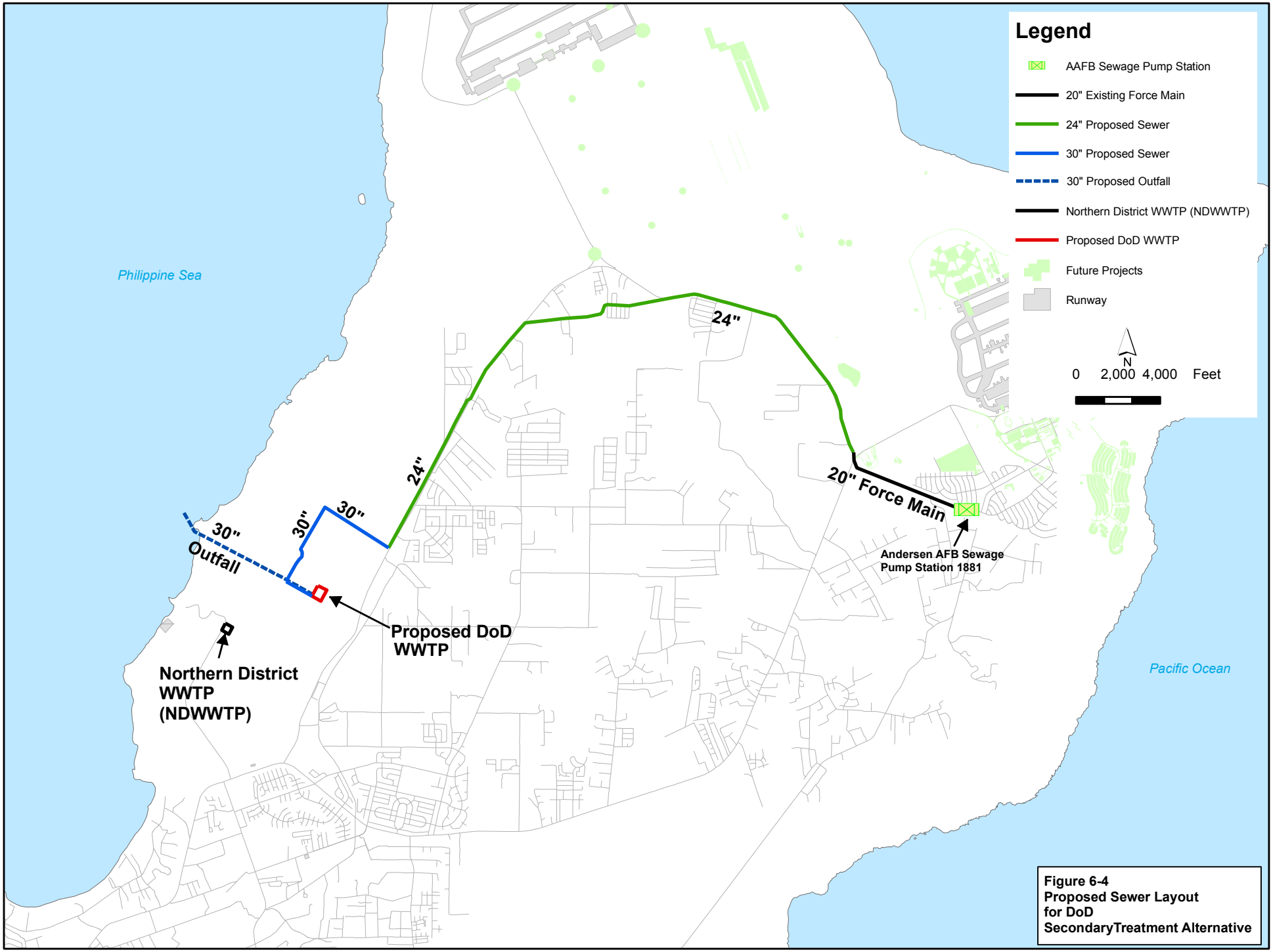

Figure 6-4
Proposed Sewer Layout for DoD SecondaryTreatment Alternative

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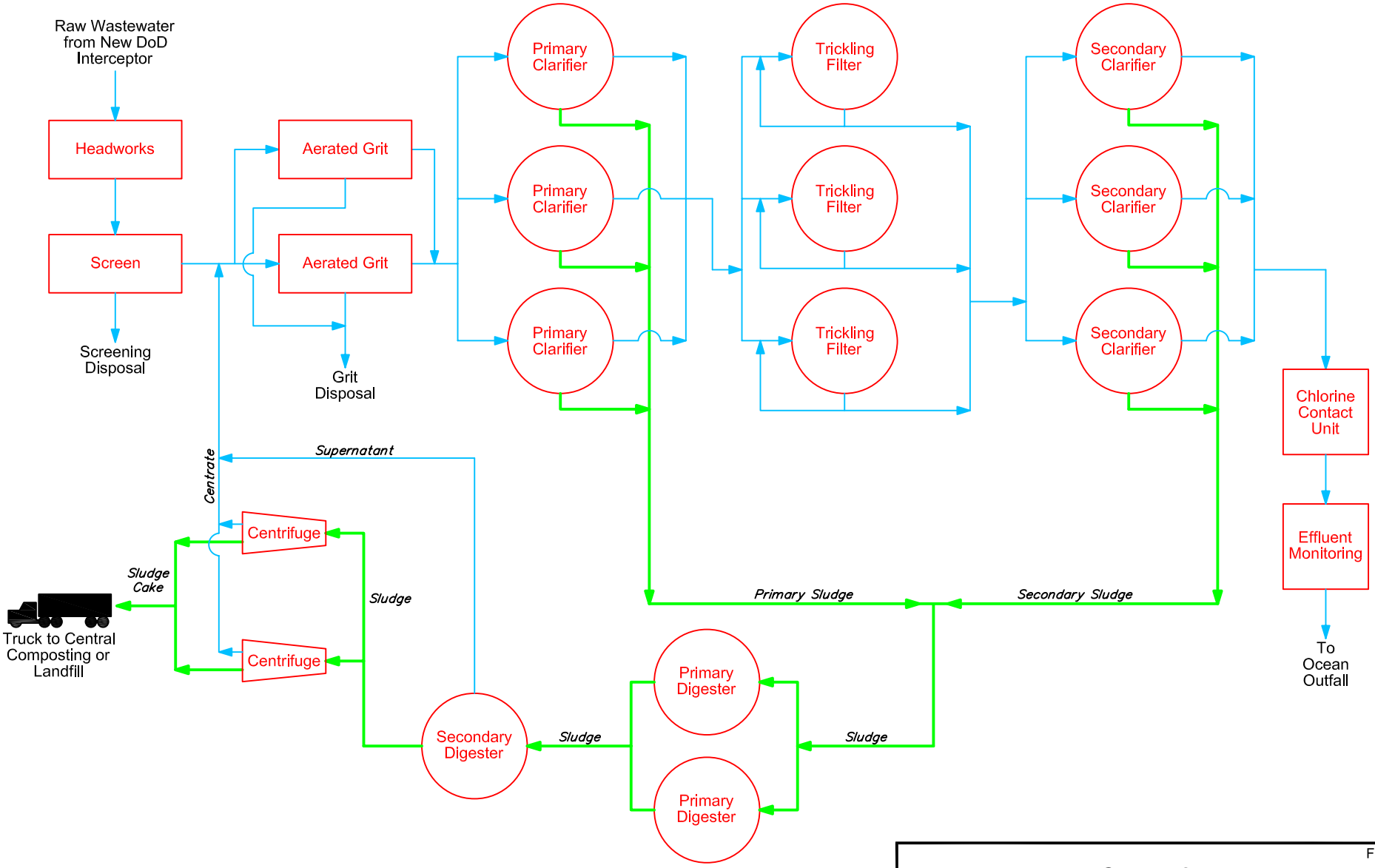

LEGEND

- Existing Liquid Stream
- Proposed Liquid Stream
- Existing Soild Stream
- Proposed Solid Stream

Final

Option 2:
Build New DoD Secondary Treatment Facility on DoD Land

Date: 4-10	Guam Wastewater Study	Figure 6-5
Project No. 101177	AECOM	

6.1.4 Build New Separate Secondary Treatment Plant at GovGuam NDWWTP Site to Treat DoD Load Only

This alternative would build a new secondary treatment plant at the NDWWTP site, and treat the DoD wastewater from the DoD facilities and proposed military buildup in northern Guam including USMC relocation. The existing NDWWTP would be upgraded to have two separate and independent treatment process trains. The existing primary treatment would continue to treat flow from civilian population in northern Guam. The new process train consists of primary and secondary treatment all the way to chlorine disinfection. The new treatment plant would have separate headworks, primary treatment, secondary treatment, chlorine disinfection, and sludge handling facilities to treat the load from DoD facilities in northern Guam. The new process train, including both liquid treatment and solids treatment, is a self-contained and complete secondary treatment system from the start to the end, and it would require jointly utilizing the existing NDWWTP ocean outfall for its secondary treated effluent disposal. This alternative requires constructing a new independent sewer main to convey all military generated wastewater in northern Guam to the NDWWTP site as shown on Figure 6-6. The independent sewer connects the Andersen AFB collection system at its main gate lift station, runs along Route 3 and combines the flow generated by the military buildup from the Finegayan area, and carries wastewater into the newly constructed secondary treatment plant located inside the NDWWTP fence about 0.8 miles south of the Southern Finegayan. The influent wastewater flow and loadings of Table 6-6 also apply to this alternative.

The new secondary wastewater treatment plant would consist of following components:

- Headworks (two screens and two aerated grit chambers with odor control)
- Three primary clarifiers
- Three trickling filters
- Three secondary clarifiers
- Two chlorine contact tanks
- Three anaerobic digesters
- Two centrifuge solids dewatering systems with odor control
- Effluent monitoring and measurement
- Outfall diffuser capacity expansion

Figure 6-7 shows a process flow diagram of the new secondary treatment plant inside NDWWTP site. Preliminary treatment for this alternative includes bar racks and 3/8-inch to 1/2-inch mechanical fine screens at the headworks structure, followed by two aerated grit removal chambers. Each chamber has a 45-foot length and 12-foot width and 7-foot water depth. Grit and screenings removed are disposed in a sanitary landfill. Primary treatment includes three primary clarifiers, each 60-foot diameter and 10-foot water depth.

Secondary treatment system includes three trickling filters and three secondary clarifiers. Each circular trickling filter is 65-foot in diameter and 24-foot water depth. Each secondary clarifier is 80-foot in diameter and 13-foot water depth. Subsequently, a disinfection system with two chlorine contact tanks, each 55-feet long by 25-feet wide with water depth of 14-feet, provides chlorination and dechlorination to the secondary clarifier effluent, and its effluent flows into the NDWWTP existing 34-inch ocean outfall for final discharge at Philippine Sea, west of the plant. The capacity of the existing outfall is limited by its end diffusers; as the result, a new ocean outfall multiport diffuser

branch would be installed with a precast concrete junction box connected to the existing outfall pipe to increase the discharge capacity of the outfall in this alternative.

Solids treatment for both primary sludge and secondary sludge includes three anaerobic digesters and two solids dewatering centrifuges for sludge digestion and dewatering. Each digester is 80-foot in diameter and 18-foot liquid depth. Two first stage anaerobic digesters are operated for stabilization, and one second stage anaerobic digester provides liquid solids separation and thickening. The digesters are designed for a hydraulic detention time over 15 days to meet EPA Class B standards, and would operate to handle planned future sludge loadings with one digester out of service for maintenance. Anaerobic digested sludge is then pumped to two centrifuges with a capacity of 225 gpm each for the solids dewatering to reduce the volume of final disposed sludge. Dewatered cake is hauled as Class B solids for offsite disposal.

All the above described treatment facilities are sized for secondarily treating DoD load only. A summary of the major process components for a new secondary treatment plant at NDWWTP site to treat DoD load only are listed in Table 6-8.

Table 6-8: Major Process Components for Building a New Secondary Treatment Plant at the NDWWTP Site to Treat DoD Load Only

Construction Components	Unit	Dimensions/Description
Headwork	1	Two mechanical fine screens and Two (2) aerated grit chambers, each 45 ft long x 12 ft wide x 7 ft SWD
Primary clarifier	3	60 ft diameter x 10 ft SWD
Trickling filter pumping station	1	40 ft long x 25 ft wide x 16 ft high
Trickling filter	3	65 ft diameter x 24 ft SWD
Secondary clarifier	3	80 ft diameter x 13 ft SWD
Chlorine contact tank	2	55 ft long x 25 ft wide x 14 ft SWD
Effluent measurement	1	Automatic sampler
Anaerobic digesters	3	80 ft diameter x 18 ft SWD
Solids dewatering centrifuges	2	125 gpm each
Outfall capacity expansion	1	Multiport diffusers

6.2 DESCRIPTION OF COLLECTION SYSTEM MODIFICATIONS

The existing sewer maps and topography maps were examined to determine how discharges from proposed facilities, identified in Section 3, would be delivered to the NDWWTP. Based on the flows identified in Section 3, the GWA's collection system connecting the Andersen AFB would have enough capacity to convey flows from Andersen AFB. However, a relief sewer is needed south of Finegayan area where flows from the proposed USMC development would be discharged.

Using projected flows identified in Section 3, a sewer collection system was developed that would convey discharges from the proposed facilities to NDWWTP. The recommended collection system is sized based on the following criteria:

- Minimum pipe size 8-inches
- At peak dry weather flow, pipe flow not to exceed 75%
- Minimum flow velocity 2 feet per second
- Pipe diameter determined using Manning's pipe friction formula
- Coefficient of roughness "n" equal to 0.013

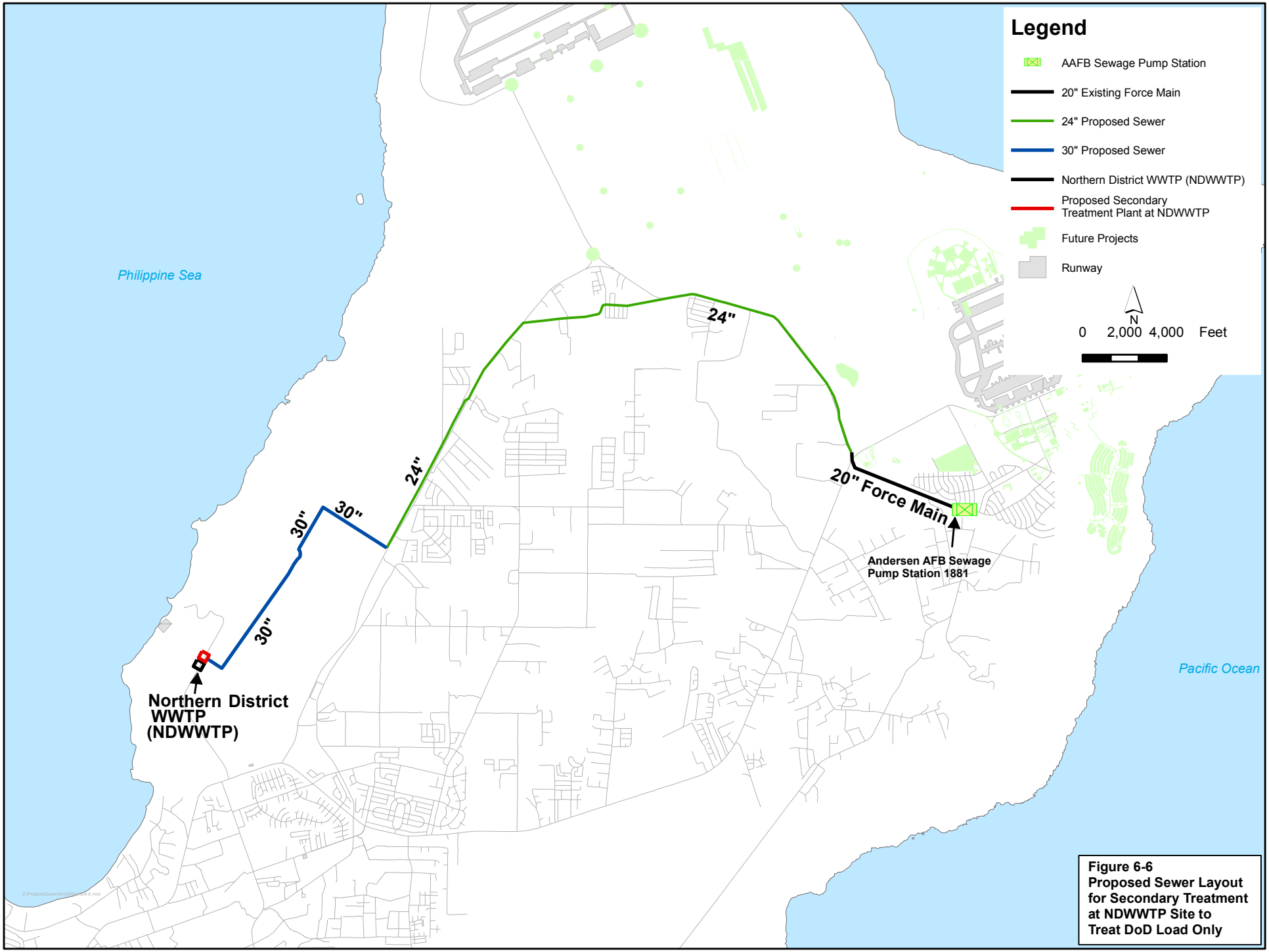

Figure 6-6
Proposed Sewer Layout for Secondary Treatment at NDWWTP Site to Treat DoD Load Only

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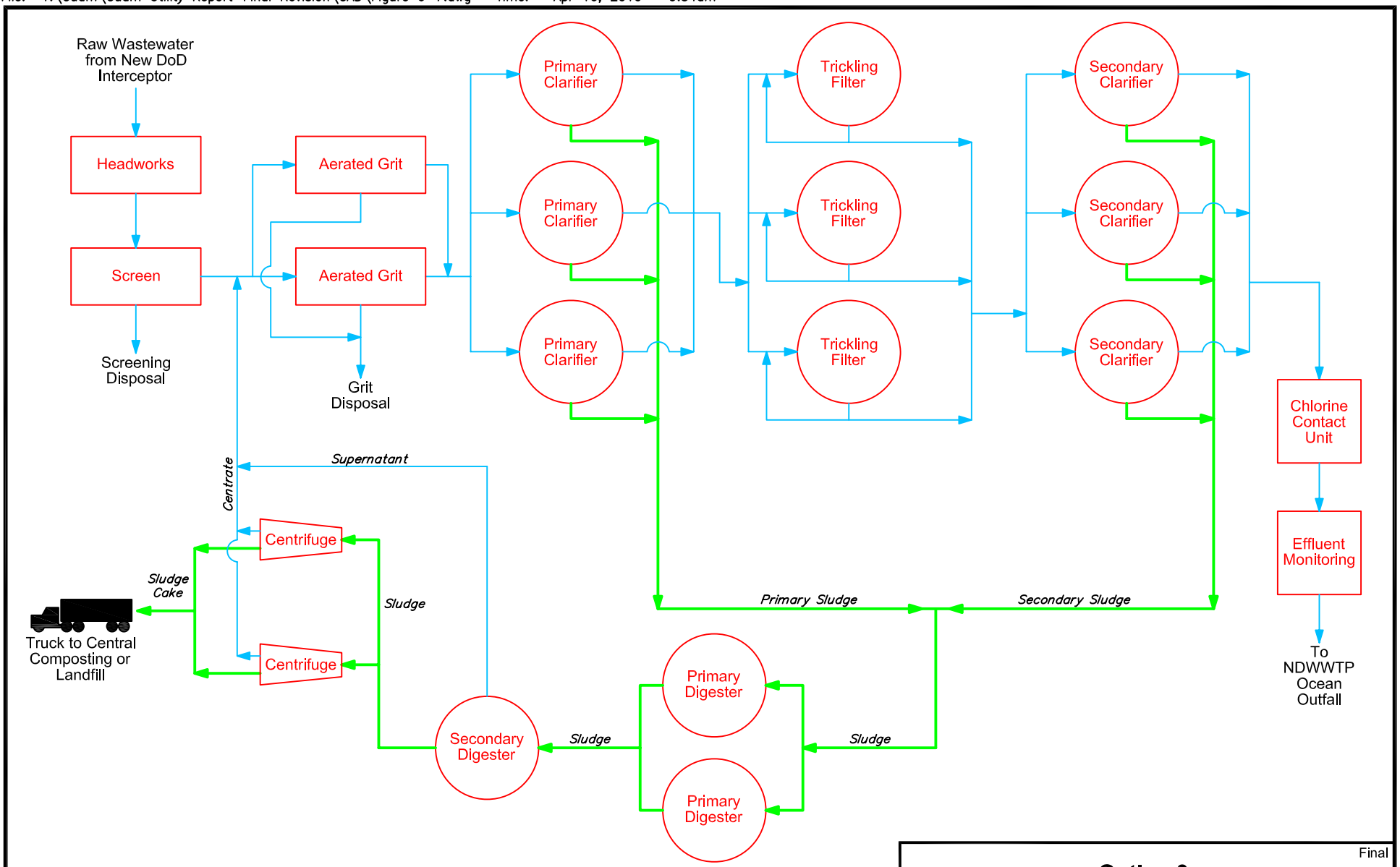

LEGEND

- Existing Liquid Stream
- Proposed Liquid Stream
- Existing Soild Stream
- Proposed Solid Stream

Final

Option 3: Build New DoD Secondary Treatment Facility at NDWWTP Site to Treat DoD Load Only

Date: 4-10	Guam Wastewater Study	Figure 6-7
Project No. 101177	AECOM	

Option 1A and Option 1B require the same set of collection system modifications. Option 2 and Option 3 require another similar set of collection system modifications. However, Option 2 has the wastewater treatment facility located within DoD land at the southeast corner of the USMC Finegayan area, while Option 3 has the wastewater treatment facility located at NDWWTP site.

Option 1A and Option 1B modifications are based on all military generated wastewater, either from the Andersen AFB or from the USMC relocation would still be carried over to the NDWWTP for treatment. All current and future military buildup at the Andersen AFB is still conveyed through the existing GWA sewer to the NDWWTP, while wastewater flow generated from the USMC relocation at Finegayan would be conveyed via a new relief sewer line to the NDWWTP.

Option 2 modifications are based on all military generated wastewater including both the Andersen AFB and the Finegayan, and would be conveyed via an independently separated sewer interceptor to the new DoD wastewater treatment facility located inside DoD land at the southeast corner of the USMC Finegayan area for treatment in the future.

Option 3 modifications are based on all military generated wastewater, including both the Andersen AFB and the Finegayan, and would be conveyed via an independently separated sewer interceptor to the new secondary wastewater treatment facility located at the NDWWTP site for treatment. The location of the secondary wastewater treatment facility in this set of modifications is different from Option 2, and it is about 0.8-mile south.

6.2.1 Construct a New Relief Sewer to Accommodate USMC Relocation Wastewater Flow

As discussed in the previous sections, after expansion and upgrading, it is anticipated that the NDWWTP would treat a total average daily flow of 10.5 mgd and peak flow of 23.7 mgd. This includes military flow generated from the Andersen AFB about 0.56 mgd (0.36 mgd existing flow and 0.20 mgd from future Air Force bed down MILCON projects), and flow of 2.96 mgd generated by the military buildup at the Finegayan area. The wastewater flow generated by the USMC relocation at the Finegayan area (that has a peak flow of 7 mgd) is required to be carried via the newly constructed relief sewer to the NDWWTP as shown on Figure 6-1.

A new gravity relief sewer would be connected from the collection system of the USMC Finegayan area on the west side of the planned USMC Finegayan development to the headworks of the NDWWTP.

As shown on Figure 6-1, a 24-inch, 7,500 foot sewer would be required to convey flow from the Finegayan area to the NDWWTP.

6.2.2 Construct a New Separate Sewer for All Military Activities in Northern Guam Region to DoD Secondary Treatment Facility Inside DoD Land

In this alternative, a newly constructed DoD-owned wastewater facility located at the southwest corner of the USMC Finegayan area requires the DoD to construct its own independent sewage interceptor to collect wastewater generated from military activities at both the Andersen AFB and the Finegayan areas. The interceptor would connect Andersen AFB collection system at its main gate lift station and would run west along Route 3, then would combine the flow generated by the USMC and Army from the Finegayan into the proposed DoD secondary treatment plant located at the southwest corner of the DoD Finegayan development (as shown on Figure 6-4). The interceptor would be designed to have a capacity for 1.5 mgd peak flow from the Andersen AFB to the beginning of the NCTS Finegayan, then 8.5 mgd peak flow from the NCTS boundary to the new DoD treatment plant.

As shown on Figure 6-4, 33,300 feet of 24-inch sewer and 8,700 feet of 30-inch sewer are required to convey flow from the Andersen AFB and the Finegayan areas to the new DoD plant.

This option would also require construction of 5,000 feet of 30-inch effluent transmission line and 2,400 feet of 30-inch outfall to discharge effluent to the Philippine Sea.

6.2.3 Construct a New Separate Sewer for All Military Activities in Northern Guam Region to Secondary Treatment Facility at the NDWWTP Site to Treat DoD Load Only

In this alternative, a DoD constructed secondary wastewater facility is planned at the NDWWTP site to treat northern Guam DoD load only. An independent sewage interceptor to collect wastewater generated from military activities both at the Andersen AFB and the Finegayan areas is required for this alternative. The interceptor connects the Andersen AFB collection system at its main gate lift station and runs along Route 3, then combines the flow from Finegayan generated by the USMC and Army to the new DoD constructed secondary treatment plant at the NDWWTP site (as shown on Figure 6-6). The interceptor prior to the connection of NCTS Finegayan is designed to have a capacity for 1.5 mgd peak flow, and the subsequent section of the interceptor all the way to the new treatment facility is required to have a capacity of 8.5 mgd.

As shown on Figure 6-6, 33,300 feet of 24-inch sewer and 13,500 feet of 30-inch sewer are required to convey flow from Andersen AFB and Finegayan to the new secondary treatment plant at the NDWWTP site.

6.3 PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST

A summary of the preliminary opinion of probable construction cost (the construction cost estimate) is outlined in this section. The quantities shown are estimates based on descriptions in this study and vendor proposals. The estimates are intended to be as comprehensive as possible at this stage, where much of the work is still at a conceptual level.

The quantities for all work items would be reviewed and updated during the detailed design. A project level allowance of 35% is added to the estimated construction cost for project services to establish the total estimated project cost. Project services include the following:

- Environmental Impact Report/Other Documents
- Design Engineering
- Construction Engineering and Contract Administration
- General and Administrative Expenses
- Contingencies

The current construction cost estimate is based on March 2010 prices (ENR_{LA} = 9,769). A summary of the preliminary construction cost for each alternative is shown in Table 6-9 through Table 6-13. An annual escalation index value of 2% is used to estimate 2013 cost from 2010. The escalation index data is obtained from Engineering News Record's cost indexes. The construction cost portion of the USMC relocation for each alternative is listed in the cost tables. A detailed construction cost allocation among the GWA, the USMC, and other relevant DoD units is presented in Table 6-15. The cost allocation is determined based on the flow portion from the respective GWA, USMC, and other DoD units. The cost is based on a percentage of projected wastewater flow from each entity to the plant. A detailed cost spreadsheet is provided in Appendix B.

As shown in Table 6-15, Option 1A has the lowest construction cost. Among the three secondary treatment options, preliminary construction cost for Option 2 and Option 3 that treat DoD load only is lower than Option 1B that treats both off-base civilian load and DoD load in northern Guam region. However, Option 1B has the lowest USMC construction share. The construction cost difference between Option 2 and 3 is because of construction of the outfall.

An estimate of the O&M costs for viable alternatives has been developed and a detailed cost spreadsheet is provided in Appendix B. The assumptions and criteria that form the basis for this estimate are presented below:

- Staffing of two expansion and upgrade alternatives (Options 1A and 1B) at the NDWWTP would be by the GWA.
- Staffing of two expansion and upgrade alternatives (Options 1A and 1B) at the NDWWTP would be similar (in terms of shift and time of day coverage by operators and sharing of maintenance with other facilities) to the current staffing at the existing NDWWTP.
- Staffing of DoD operating alternative (Options 2) would be by the DoD.
- Staffing of treating DoD load only alternative (Options 3) at the NDWWTP site would be negotiated between the GWA and DoD, but assumed similar (in terms of shift and time of day coverage by operators and sharing of maintenance with other facilities) to the DoD operating alternative (Option 2) for conservative estimation.
- Staff labor of manager at $75,000 per year including fringe benefits, operator/mechanic at $45,000 per year including fringe benefits, and administrative assistant at $30,000 per year including fringe benefits.
- Flow based on projected future value of 17.63 mgd for two expansion and upgrade alternatives (Options 1A and 1B) at the NDWWTP.
- Flow based on projected future value of 4.51 mgd for two DoD load only alternatives.
- Power cost based on $0.20 per kilowatt hour.
- Polymer cost based on $3.00 per pound.
- Sodium hypochlorite cost based on $0.85 per gallon.
- Citric acid cost based on $6.50 per gallon.
- General repair and maintenance based on $0.15% of estimated construction costs.
- Sewer line maintenance based on 0.15 per foot.
- Solids hauling and disposal based on $25 per cubic yard (cy) processing/land application fee and $285 per 20 cy truck trip for transportation.

The above viable alternatives would require a life cycle comparison for a recommended selection. An annual 4% interest was used to compare 20-year net present worth for each alternative. Table 6-14 presents an outline of annual costs for each alternative. Revenues from sewer connection fee and sale of reuse water are not included in the annual costs analysis. In addition, ATS also prepared a separate O&M cost estimate showing distribution of O&M costs between the DoD and the GWA for Option 1A and Option 1B. The costs are distributed in proportion to the flow contribution to the NDWWTP, which is 3.46 mgd of 10.54 mgd for the DoD and 7.08 mgd of 10.54 mgd for the GWA.

Table 6-16 and Table 6-17 present total O&M cost and respective cost distribution to the GWA and the DoD for Option 1A and Option 1B.

Table 6-9: Preliminary Construction Cost for Option 1A– Restore and Upgrade Existing Primary Treatment System at the GovGuam NDWWTP to Accept the Additional Flow and Load, Short-Term Improvements

1. Component Navy	Guam Wastewater Utility Study		2. Date May 2010
3. Installation and Location Marine Relocation	4. Project Title Guam Wastewater Utility Study		
5. Program Element	6. Category Code	7. Project Number	8. Project Cost ($000) 35,260

9. Cost Estimates

Item	U/M	Quantity	Unit Cost	Cost ($000)
Septic Receiving Station				
Reinforced Concrete (30,000 gallon storage tank)	CY	110	$2,124	234
Earthwork	CY	900	$106	96
Septage Screen	EA	1	$557,522	558
Blowers	EA	2	$39,823	80
Coarse bubble diffusers	LS	1	$7,965	8
Transfer Pumps -Submersible Chopper	EA	2	$66,372	133
Instrumentation/SCADA	LS	1	$44,283	44
Electrical	LS	1	$166,062	166
Septic Receiving Station				
Reinforced Concrete (30,000 gallon holding tank)	CY	110	$2,124	234
Earthwork	CY	900	$106	96
Heat Trace System	EA	1	$13,274	13
Transfer Pumps -Submersible Chopper	EA	2	$66,372	133
Instrumentation/SCADA	LS	1	$19,009	19
Electrical	LS	1	$71,283	71
Headworks Upgrade				
Demolition	LS	1	$49,912	50
Reinforced Concrete for Meter Vault	LS	35	$2,124	74
Earthwork for Meter Vault	LS	400	$106	42
6mm Fine Screen Equipment	EA	2	$637,168	1,274
42 inch Mag Meter	EA	1	$111,504	112
Grit Chamber Retrofit	LS	1	$132,743	133
Grit Pump Station	LS	1	$318,584	319
Grit Wash and Separation	LS	1	$159,292	159
Piping and Valves	LS	1	$186,372	186
Instrumentation/SCADA	LS	1	$79,858	80
Electrical	LS	1	$199,646	200
Primary Clarifier Rehabilitation				
Demolition	LS	1	$79,646	80
316 SS Sludge/Scum Collector Equipment	EA	2	$1,592,920	3,186
Miscellaneous Metals	LS	1	$159,292	159
Fiberglass Reinforced Plastic Weirs	LS	1	$95,575	96
Protective Coatings & Concrete Repair	LS	1	$31,858	32
Piping and Valves	LS	1	$95,575	96
Instrumentation/SCADA	LS	1	$127,434	127
Electrical	LS	1	$318,584	319

Item	U/M	Quantity	Unit Cost	Cost ($000)
Anaerobic Digester Rehabilitation				
Demolition/Preparation	LS	1	$106,195	106
Digester Mixing and Heating Equipment	EA	2	$2,123,894	4,248
Digester Covers - Steel	LS	2	$1,991,150	3,982
Miscellaneous Metals	LS	1	$254,867	255
Roofing and Insulation	LS	1	$233,628	234
Protective Coatings & Concrete Repair	LS	1	$637,168	637
Piping and Valves	LS	1	$1,486,726	1,487
Instrumentation/SCADA	LS	1	$297,345	297
Electrical	LS	1	$637,168	637
Solids Dewatering Building Replacement				
Structure Demolition	LS	1	$66,504	67
Reinforced Concrete	CY	180	$2,124	382
Earthwork	CY	400	$106	42
Masonry Interior Walls	LS	1	$49,699	50
Miscellaneous Metals	LS	1	$45,876	46
Fiberglass Reinforced Plastic Grating	LS	1	$11,469	11
Membrane Roofing and Insulation	LS	1	$53,522	54
Doors and Windows	LS	1	$9,558	10
Protective Coatings	LS	1	$45,876	46
Building Specialties	LS	1	$7,646	8
Sludge Grinders	EA	1	$53,097	53
Sludge Feed Pumps	EA	1	$66,372	66
Polymer Feed System	EA	1	$238,938	239
Polymer Feed Pumps	EA	1	$15,929	16
Odor Control System	EA	0	$477,876	0
Centrifuges -2,000 lb/hr	EA	1	$955,752	956
Process Piping and Valves	LS	1	$239,416	239
HVAC	LS	1	$199,513	200
Plumbing	LS	1	$133,009	133
Electrical	LS	1	$665,044	665
Instrumentation/SCADA	LS	1	$146,310	146
Influent and Effluent Samplers	EA	2	$79,646	159
Sludge Drying Bed Refurbish	LS	1	$79,646	80
Emergency Diesel Generator				
Reinforced Concrete	LS	1	$79,646	80
Earthwork	LS	1	$79,646	80
Diesel Generator	EA	1	$238,938	239
Site Work and Utilities	LS	1	$1,567,312	1,567
Sub Total				26,122
Project Services 35.00%				9,143
Total Contract Cost				35,264
Total Request				35,264
Total Request (Rounded)				35,260

10. Description of Proposed Construction:
Short-term improvements are necessary improvements, which include bringing the currently inoperable process units back to service, it addresses immediate influent flow increases. It includes following constructions and refurbishments. The short-term improvements include the following:

1. New septic and FOG receiving stations
   A new septage receiving station receives and pretreats septage from unsewered customers. The station consists of an unloading area, a septage storage tank, a septage screen, an aeration system, and two grinder transfer pumps. The undergrade septage storage tank has volume of 30,000 gallons. A new FOG receiving station receives FOG generated by residential, commercial, and industrial generators, such as restaurants, grocery stores, hospitals, and food processors. The FOG receiving station collects FOG from grease trucks and pumps it into the plant anaerobic digesters for treatment. The FOG station includes a 30,000 gallon grease holding tank and chopper pumps. Both the septage storage tank and the grease holding tank would be covered and would have an odor control system.
2. Headworks upgrade
   Headworks improvements include: installation of fine screens, a grit chamber retrofit, installation of a new grit pump station, installation of grit wash and dewatering units, and incorporation of flow metering. Two new mechanically cleaned 6 milliliters (mm) fine screens would be installed to prevent the entry of large debris and coarse solids. A new flow measurement system would be installed to replace the malfunctioning Parshall flume. A meter vault would be constructed outside and upstream on the influent flow pipe with siphon modification to have full flow pipe. A magnetic meter is installed for flow measurement. The grit chamber concrete surface would be sand blasted and coated. All air pipes and diffusers, grit removal pumps, and grit wash and dewatering units would be replaced.
3. Two primary clarifier refurbish
   Rehabilitation of the two primary clarifiers includes concrete surface cleaning, sand blasting and coating, and replacement of the basin mechanical components with new stainless steel units. The primary clarifiers would be furnished with drive units, a walkway and drive platform, a center column, a center cage and rake arm, a feedwell, a scum removal mechanism, and fiberglass-reinforced plastic weirs and baffles. Stainless steel units are used for the tropical coastal environment at the NDWWTP site.
4. Sludge digester rehabilitation
   Two digester tanks would be refurbished and the digester rehabilitation would include mixing and recirculation system, gas and scum piping, sludge recirculation and transfer pumps, gas compressors and a boiler for heating, and a waste gas flare. The polymer dosing system, which assists with dewatering sludge and is located inside the sludge digester control building, also needs to be refurbished.
5. Solids dewatering building replacement
   The centrifuge building would be replaced, and one new sludge 2,000 pounds per hour (lbs/hr) centrifuge is installed to replace the old units.
6. Sludge drying beds rehabilitation
   Valves and Concrete Repair for all eight sludge drying beds.
7. New standby power
   A 300 kilowatt (kW) diesel generator unit is installed for emergency service as a standby power source.

Table 6-10: Preliminary Construction Cost for Option 1A– Restore and Upgrade Existing Primary Treatment System at the GovGuam NDWWTP to Accept the Additional Flow and Load, Long-Term Improvements

1. Component Navy	Guam Wastewater Utility Study		2. Date May 2010
3. Installation and Location Marine Relocation	4. Project Title Guam Wastewater Utility Study		
5. Program Element	6. Category Code	7. Project Number	8. Project Cost ($000) 30,860

9. COST ESTIMATES

Item	U/M	Quantity	Unit Cost	Cost ($000)
Chlorine Contact Tank (Refurbish)				
Reinforced Concrete	CY	133	$2,124	282
Earthwork	CY	260	$106	28
Demolition	LS	1	$44,602	45
Chemical Feed and Mixing Equipment	EA	2	$318,584	637
Miscellaneous Metals	LS	1	$31,858	32
Slide Gates and Weirs	LS	1	$19,115	19
Protective Coatings & Concrete Repair	LS	1	$95,575	96
Piping and Valves	LS	1	$19,115	19
Instrumentation/SCADA	LS	1	$25,487	25
Electrical	LS	1	$63,717	64
Anaerobic Digesters (New)				
Reinforced Concrete	CY	1000	$2,124	2,124
Earthwork	CY	1400	$106	149
Digester Mixing and Heating Equipment	EA	1	$2,123,894	2,124
Miscellaneous Metals	LS	1	$263,788	264
Roofing and Insulation	LS	1	$241,805	242
Protective Coatings	LS	1	$659,469	659
Piping and Valves	LS	1	$1,538,761	1,539
Instrumentation/SCADA	LS	1	$307,752	308
Electrical	LS	1	$659,469	659
New Sludge Pump Station	LS	1	$2,198,230	2,198
Digester Gas Utilization (New)				
Cogeneration System	EA	1	$1,393,805	1,394
Piping and Valves	LS	1	$487,832	488
Instrumentation/SCADA	LS	1	$97,566	98
Electrical	LS	1	$209,071	209
Centrifuge (New)				
Sludge Grinders	EA	1	$53,097	53
Sludge Feed Pumps	EA	1	$66,372	66
Polymer Feed System	EA	1	$238,938	239
Polymer Feed Pumps	EA	1	$15,929	16
Centrifuges - 2,000 lb/hr	EA	1	$955,752	956
Process Piping and Valves	LS	1	$239,416	239
HVAC	LS	1	$199,513	200
Plumbing	LS	1	$133,009	133
Electrical	LS	1	$665,044	665
Instrumentation/SCADA	LS	1	$146,310	146

Item	U/M	Quantity	Unit Cost	Cost ($000)
Plant Odor Control System	LS	1	$477,876	478
Adm/Lab/Storage (Refurbish)	LS	1	$663,717	664
Site Work and Utilities	LS	1	$1,120,581	1,121
Relief Sewer, 24"D	FT	7500	$558	4,181
Sub Total				22,858
Project Services 35.00%				8,000
Total Contract Cost				30,858
Total Request				30,858
Total Request (Rounded)				30,860

10. Description of Proposed Construction:
Long-term improvements are those improvements required when the influent flows approach 10–12 mgd. Execution of identified long-term improvements is necessary to ensure the reliability and operational flexibility of the treatment system. The long-term improvements include the following:

1. Chlorine contact tank rehabilitation
   The existing configuration of the chlorine contact tanks would be retrofitted with long, narrow channels in a serpentine pattern to improve the hydraulic characteristics. As part of the chlorine contact tanks reconfiguration, a new effluent Parshall flume would be installed downstream of the chlorine tanks to replace the malfunctioned existing one, which is located upstream of the chlorine tanks.
2. One new anaerobic digester would be added
   One digester tank same size as existing ones with diameter of 80 foot and SWD of 18 foot. New sludge mixing, heat exchangers, electrical, controls, coatings, piping and valves.
3. Digester gas utilization system would be added
   Engine generator, gas purification, compressor and gas flare system.
4. One new centrifuge would be added
   One new sludge 2,000 lbs/hr centrifuge would be installed.
5. Plant odor control system would be added
   A plant odor control system needs to be added to treat odor collected inside the headworks building, septage storage tank, grease-holding tank at the receiving station and centrifuge building to improve operator working environment and air quality of surrounding area.

Table 6-11: Preliminary Construction Cost for an Adder on Option 1A for Option 1B– Restore, Expand, and Upgrade the GovGuam NDWWTP to Secondary Treatment

1. Component xxx	Guam Wastewater Utility Study		2. Date May 2010
3. Installation and Location Marine Relocation, Guam	4. Project Title Guam Wastewater Utility Study		
5. Program Element	6. Category Code	7. Project Number	8. Project Cost ($000) 145,430

9. COST ESTIMATES

Item	U/M	Quantity	Unit Cost	Cost ($000)
Primary Clarifier				
Reinforced Concrete	CY	1300	$2,124	2,761
Earthwork	CY	6300	$106	669
Sludge and Scum Collector Equipment	EA	1	$1,592,920	1,593
Miscellaneous Metals	LS	1	$251,150	251
Frap Weirs	LS	1	$150,690	151
Protective Coatings	LS	1	$50,230	50
Piping and Valves	LS	1	$150,690	151
Instrumentation/SCADA	LS	1	$200,920	201
Electrical	LS	1	$502,301	502
Sludge Pump Station Improvements	LS	1	$853,912	854
Trickling Filter Pumping Station				
Reinforced Concrete	CY	400	$2,124	850
Earthwork	CY	1600	$106	170
Trickling Filter Influent Pump Equipment	EA	4	$238,938	956
Miscellaneous Metals	LS	1	$98,761	99
Protective Coatings	LS	1	$669,027	669
Piping and Valves	LS	1	$59,257	59
Instrumentation/SCADA	LS	1	$138,265	138
Electrical	LS	1	$296,283	296
Trickling Filters				
Reinforced Concrete	CY	5700	$2,124	12,106
Earthwork	CY	6600	$106	701
Trickling Filter Plastic Media	CY	30300	$319	9,653
Trickling Filter Influent Pump Equipment	EA	3	$477,876	1,434
Rotary Distribution Equipment	LS	1	$589,381	589
Miscellaneous Metals	LS	1	$353,628	354
Protective Coatings	LS	1	$286,726	287
Piping and Valves	LS	1	$353,628	354
Instrumentation/SCADA	LS	1	$117,876	118
Electrical	LS	1	$471,504	472

Item	U/M	Quantity	Unit Cost	Cost ($000)
Secondary Clarifier				
Reinforced Concrete	CY	6800	$2,124	14,442
Earthwork	CY	34800	$106	3,696
Sludge and Scum Collector Equipment	EA	4	$876,106	3,504
Miscellaneous Metals	LS	1	$1,082,124	1,082
Frap Weirs	LS	1	$649,274	649
Protective Coatings	LS	1	$917,310	917
Piping and Valves	LS	1	$649,274	649
Instrumentation/SCADA	LS	1	$865,699	866
Electrical	LS	1	$2,164,248	2,164
New Sludge Pump Station	LS	1	$3,679,221	3,679
Anaerobic Digesters				
Reinforced Concrete	CY	2000	$2,124	4,248
Earthwork	CY	2800	$106	297
Digester Mixing and Heating Equipment	EA	2	$2,123,894	4,248
Miscellaneous Metals	LS	1	$527,575	528
Roofing and Insulation	LS	1	$483,611	484
Protective Coatings	LS	1	$1,318,938	1,319
Piping and Valves	LS	1	$3,077,522	3,078
Instrumentation/SCADA	LS	1	$615,504	616
Electrical	LS	1	$1,318,938	1,319
New Sludge Pump Station	LS	1	$4,396,460	4,396
Solids Dewatering Building				
Reinforced Concrete	CY	130	$2,124	276
Earthwork	CY	200	$106	21
Masonry Interior Walls	LS	1	$38,655	39
Miscellaneous Metals	LS	1	$35,681	36
Fiberglass Reinforced Plastic Grating	LS	1	$8,920	9
Roofing and Insulation	LS	1	$41,628	42
Doors and Windows	LS	1	$7,434	7
Protective Coatings	LS	1	$17,841	18
Building Specialties	LS	1	$2,973	3
Sludge Grinders	EA	1	$63,717	64
Sludge Feed Pumps	EA	1	$79,646	80
Polymer Feed System	EA	1	$238,938	239
Polymer Feed Pumps	EA	1	$21,239	21
Centrifuges -2000 lb/h	EA	1	$955,752	956
Process Piping and Valves	LS	1	$53,522	54
HVAC	LS	1	$44,602	45
Plumbing	LS	1	$29,735	30
Electrical	LS	1	$148,673	149
Instrumentation/SCADA	LS	1	$32,708	33

Item	U/M	Quantity	Unit Cost	Cost ($000)
Chlorine Contact Tank				
Reinforced Concrete	CY	1000	$2,124	2,124
Earthwork	CY	4600	$106	488
Chemical Feed and Mixing Equipment	LS	2	$318,584	637
Miscellaneous Metals	LS	1	$162,478	162
Slide Gate and Weirs	LS	1	$97,487	97
Protective Coatings	LS	1	$254,867	255
Piping and Valves	LS	1	$97,487	97
Instrumentation/SCADA	LS	1	$129,982	130
Electrical	LS	1	$324,956	325
Digester Gas Utilization (New)				
Cogeneration System	EA	1	$1,393,805	1,394
Piping and Valves	LS	1	$487,832	488
Instrumentation/SCADA	LS	1	$97,566	98
Electrical	LS	1	$209,071	209
Influent and Effluent Samplers	EA	2	$79,646	159
Site Work and Utilities	LS	1	$6,821,553	6,822
Outfall Diffusers Expansion	FT	400		3,450
Treatment Cost				104,272
Sewer Cost				3,450
Sub Total				107,722
Project Services 35.00%				37,703
Total Contract Cost				145,425
Total Request				145,425
Total Request (Rounded)				145,430
Total Escalated 2010 Request (Rounded)				145,430
Total Escalated 2013 Mid-Point Construction Cost (Rounded)				154,490

10. Description of Proposed Construction:

1. A relief sewer would be constructed to convey DoD flow at Finegayan area to the NDWWTP for treatment.
2. One new Primary Clarifier is added for the extra flow.
3. Three trickling filters are added for secondary treatment.
4. Four secondary clarifiers are added for secondary treatment.
5. Two primary anaerobic digesters are added.
6. One secondary anaerobic digester is added.
7. One Centrifuge is added for solid dewatering.
8. Solids dewatering building would be upgraded.
9. Cost of Option 1B is costs from Table 6-9 + Table 6-10 + Table 6-11.

Table 6-12 Preliminary Construction Cost for Option 2– Build New Secondary Treatment Plant Near the Proposed Development on DoD Land and Construct New Outfall

1. Component xxx	Guam Wastewater Utility Study		2. Date May 2010
3. Installation and Location Marine Relocation	4. Project Title Guam Wastewater Utility Study		
5. Program Element	6. Category Code	7. Project Number	8. Project Cost ($000) 172,380

9. COST ESTIMATES

Item	U/M	Quantity	Unit Cost	Cost ($000)
Headworks Expansion				
Reinforced Concrete	CY	400	$2,124	850
Earthwork	CY	1400	$106	149
Fine Screenings Equipment	EA	2	$238,938	478
Grit Chamber Equipment	EA	2	$106,195	212
Grit Pumps Equipment	EA	2	$58,407	117
Grit Washer Equipment	EA	2	$185,841	372
Miscellaneous Metals	LS	1	$108,850	109
Frap Weirs	LS	1	$65,310	65
Protective Coatings	LS	1	$176,814	177
Piping and Valves	LS	1	$544,248	544
Instrumentation/SCADA	LS	1	$152,389	152
Electrical	LS	1	$326,549	327
Grit & Screenings Building	LS	1	$761,947	762
Primary Clarifier				
Reinforced Concrete	CY	1500	$2,124	3,186
Earthwork	CY	2200	$106	234
Sludge and Scum Collector Equipment	EA	3	$424,779	1,274
Miscellaneous Metals	LS	1	$234,690	235
Frap Weirs	LS	1	$140,814	141
Protective Coatings	LS	1	$509,735	510
Piping and Valves	LS	1	$140,814	141
Instrumentation/SCADA	LS	1	$187,752	188
Electrical	LS	1	$469,381	469
Sludge Pump Station Improvements	LS	1	$2,346,903	2,347
Trickling Filter Pumping Station				
Reinforced Concrete	CY	400	$2,124	850
Earthwork	CY	1600	$106	170
Trickling Filter Influent Pump Equipment	EA	3	$159,292	478
Miscellaneous Metals	LS	1	$74,867	75
Protective Coatings	LS	1	$334,513	335
Piping and Valves	LS	1	$44,920	45
Instrumentation/SCADA	LS	1	$104,814	105
Electrical	LS	1	$224,602	225

Item	U/M	Quantity	Unit Cost	Cost ($000)
Trickling Filters				
Reinforced Concrete	CY	2700	$2,124	5,735
Earthwork	CY	2400	$106	255
Trickling Filter Plastic Media	CY	9000	$319	2,867
Trickling Filter Influent Pump Equipment	EA	3	$265,487	796
Rotary Distribution Equipment	LS	1	$195,929	196
Miscellaneous Metals	LS	1	$117,558	118
Protective Coatings	LS	1	$557,522	558
Piping and Valves	LS	1	$274,301	274
Instrumentation/SCADA	LS	1	$39,186	39
Electrical	LS	1	$156,743	157
Secondary Clarifier				
Reinforced Concrete	CY	2400	$2,124	5,097
Earthwork	CY	12900	$106	1,370
Sludge and Scum Collector Equipment	EA	4	$557,522	2,230
Miscellaneous Metals	LS	1	$434,867	435
Frap Weirs	LS	1	$260,920	261
Protective Coatings	LS	1	$892,035	892
Piping and Valves	LS	1	$260,920	261
Instrumentation/SCADA	LS	1	$347,894	348
Electrical	LS	1	$869,735	870
Sludge Pump Station Improvements	LS	1	$1,478,549	1,479
Chlorine Contact Tanks				
Reinforced Concrete	CY	1200	$2,124	2,549
Earthwork	CY	4400	$106	467
Chemical Feed and Mixing Equipment	LS	1	$318,584	319
Miscellaneous Metals	LS	1	$166,726	167
Slide Gates and Weirs	LS	1	$100,035	100
Protective Coatings	LS	1	$127,434	127
Piping and Valves	LS	1	$100,035	100
Instrumentation/SCADA	LS	1	$133,381	133
Electrical	LS	1	$333,451	333
Anaerobic Digesters				
Reinforced Concrete	CY	3000	$2,124	6,372
Earthwork	CY	4200	$106	446
Digester Mixing and Heating Equipment	EA	3	$2,123,894	6,372
Miscellaneous Metals	LS	1	$791,363	791
Roofing and Insulation	LS	1	$725,416	725
Protective Coatings	LS	1	$1,978,407	1,978
Piping and Valves	LS	1	$4,616,283	4,616
Instrumentation/SCADA	LS	1	$923,257	923
Electrical	LS	1	$1,978,407	1,978
New Sludge Pump Station	LS	1	$6,594,690	6,595

Item	U/M	Quantity	Unit Cost	Cost ($000)
Solids Dewatering Building				
Reinforced Concrete	CY	1200	$2,124	2,549
Earthwork	CY	3200	$106	340
Masonry Interior Walls	LS	1	$375,504	376
Miscellaneous Metals	LS	1	$346,619	347
Frap Weirs	LS	1	$86,655	87
Roofing and Insulation	LS	1	$404,389	404
Doors and Windows	LS	1	$72,212	72
Protective Coatings	LS	1	$173,310	173
Building Specialties	LS	1	$28,885	29
Sludge Grinders	EA	2	$53,097	106
Sludge Feed Pumps	EA	2	$66,372	133
Polymer Feed System	EA	2	$238,938	478
Polymer Feed Pumps	EA	2	$15,929	32
Odor Control System	EA	1	$477,876	478
Centrifuges	EA	2	$955,752	1,912
Process Piping and Valves	LS	1	$519,929	520
HVAC	LS	1	$433,274	433
Plumbing	LS	1	$288,850	289
Electrical	LS	1	$1,444,248	1,444
Instrumentation/SCADA	LS	1	$317,735	318
Influent and Effluent Samplers				
Automatic Samplers	EA	2	$79,646	159
Site Work and Utilities				
Paving, Grading, and Yard Piping	LS	1	$5,972,742	5,973
Sewer Interceptor I, 24"D	FT	33300	$558	18,565
Sewer Interceptor II, 30"D	FT	8700	$664	5,774
Effluent Transmission Line, 30"D	FT	5000	$664	3,319
Ocean Outfall, 30"	FT	2400	$3,637	8,729
Treatment Cost				91,298
Sewer Cost				36,388
Sub Total				127,685
Project Services 35.00%				44,690
Total Contract Cost				172,375
Total Request				172,375
Total Request (Rounded)				172,380
Total Escalated 2013 Mid-Point Construction Cost (Rounded)				183,120

10. Description of Proposed Construction:

DoD would be constructing a new secondary treatment plant which includes:

1. Two sewer interceptors
2. Head works: Fine screening and Grit chamber
3. Primary treatment: Three primary Clarifiers
4. Secondary treatment: Three trickling Filters and Three secondary Clarifiers
5. Solid Stabilization: Two Primary Anaerobic Digesters and One Secondary Anaerobic Digester
6. Solids Dewatering: Two Centrifuges and solids dewatering building
7. Disinfection: Two Chlorine Contact Tanks
8. Ocean Outfall

Table 6-13: Preliminary Construction Cost for Option 3 – Build a New Separate Secondary Treatment Plant at GovGuam NDWWTP site to Treat DoD Load Only

1. Component xxx	Guam Wastewater Utility Study			2. Date May 2010
3. Installation and Location Marine Relocation	4. Project Title Guam Wastewater Utility Study			
5. Program Element	6. Category Code	7. Project Number	8. Project Cost ($000)	
			161,250	

9. COST ESTIMATES

Item	U/M	Quantity	Unit Cost	Cost ($000)
Headworks Expansion				
Reinforced Concrete	CY	400	$2,124	$850
Earthwork	CY	1400	$106	$149
Fine Screenings Equipment	EA	2	$238,938	$478
Grit Chamber Equipment	EA	2	$106,195	$212
Grit Pumps Equipment	EA	2	$58,407	$117
Grit Washer Equipment	EA	2	$185,841	$372
Miscellaneous Metals	LS	1	$108,850	$109
Frap Weirs	LS	1	$65,310	$65
Protective Coatings	LS	1	$176,814	$177
Piping and Valves	LS	1	$544,248	$544
Instrumentation/SCADA	LS	1	$152,389	$152
Electrical	LS	1	$326,549	$327
Grit & Screenings Building	LS	1	$761,947	$762
Primary Clarifier				
Reinforced Concrete	CY	1500	$2,124	$3,186
Earthwork	CY	2200	$106	$234
Sludge and Scum Collector Equipment	EA	3	$424,779	$1,274
Miscellaneous Metals	LS	1	$234,690	$235
Fro Weirs	LS	1	$140,814	$141
Protective Coatings	LS	1	$509,735	$510
Piping and Valves	LS	1	$140,814	$141
Instrumentation/SCADA	LS	1	$187,752	$188
Electrical	LS	1	$469,381	$469
Sludge Pump Station Improvements	LS	1	$2,346,903	$2,347
Trickling Filter Pumping Station				
Reinforced Concrete	CY	400	$2,124	$850
Earthwork	CY	1600	$106	$170
Trickling Filter Influent Pump Equipment	EA	3	$159,292	$478
Miscellaneous Metals	LS	1	$74,867	$75
Protective Coatings	LS	1	$334,513	$335
Piping and Valves	LS	1	$44,920	$45
Instrumentation/SCADA	LS	1	$104,814	$105
Electrical	LS	1	$224,602	$225
Trickling Filters				
Reinforced Concrete	CY	2700	$2,124	$5,735
Earthwork	CY	2400	$106	$255
Trickling Filter Plastic Media	CY	9000	$319	$2,867
Rotary Distribution Equipment	EA	3	$265,487	$796
Miscellaneous Metals	LS	1	$195,929	$196
Fiberglass Reinforced Plastic Weirs	LS	1	$117,558	$118
Protective Coatings	LS	1	$557,522	$558
Piping and Valves	LS	1	$274,301	$274
Instrumentation/SCADA	LS	1	$39,186	$39

Item	U/M	Quantity	Unit Cost	Cost ($000)
Secondary Clarifier				
Reinforced Concrete	CY	2400	$2,124	$5,097
Earthwork	CY	12900	$106	$1,370
Sludge and Scum Collector Equipment	EA	4	$557,522	$2,230
Miscellaneous Metals	LS	1	$434,867	$435
Fiberglass Reinforced Plastic Weirs	LS	1	$260,920	$261
Protective Coatings	LS	1	$892,035	$892
Piping and Valves	LS	1	$260,920	$261
Instrumentation/SCADA	LS	1	$347,894	$348
Electrical	LS	1	$869,735	$870
New Sludge Pump Station	LS	1	$1,478,549	$1,479
Secondary Clarifier				
Chlorine Contact Tank				
Reinforced Concrete	CY	1200	$2,124	$2,549
Earthwork	CY	4400	$106	$467
Chemical Feed Mixing Equipment	LS	1	$318,584	$319
Miscellaneous Metals	LS	1	$166,726	$167
Weirs	LS	1	$100,035	$100
Protective Coatings	LS	1	$127,434	$127
Piping and Valves	LS	1	$100,035	$100
Instrumentation/SCADA	LS	1	$133,381	$133
Electrical	LS	1	$333,451	$333
Anaerobic Digesters				
Reinforced Concrete	CY	3000	$2,124	$6,372
Earthwork	CY	4200	$106	$446
Digester Mixing and Heating Equipment	EA	3	$2,123,894	$6,372
Miscellaneous Metals	LS	1	$791,363	$791
Roofing and Insulation	LS	1	$725,416	$725
Protective Coatings	LS	1	$1,978,407	$1,978
Piping and Valves	LS	1	$4,616,283	$4,616
Instrumentation/SCADA	LS	1	$923,257	$923
Electrical	LS	1	$1,978,407	$1,978
New Sludge Pump Station	LS	1	$6,594,690	$6,595
Solids Dewatering Building				
Reinforced Concrete	CY	1200	$2,124	$2,549
Earthwork	CY	3200	$106	$340
Masonry Interior Walls	LS	1	$375,504	$376
Miscellaneous Metals	LS	1	$346,619	$347
Fiberglass Reinforced Plastic Grating	LS	1	$86,655	$87
Roofing and Insulation	LS	1	$404,389	$404
Doors and Windows	LS	1	$72,212	$72
Protective Coatings	LS	1	$173,310	$173
Building Specialties	LS	1	$28,885	$29
Sludge Grinders	EA	2	$53,097	$106
Sludge Feed Pumps	EA	2	$66,372	$133
Polymer Feed System	EA	2	$238,938	$478
Polymer Feed Pumps	EA	2	$15,929	$32
Odor Control System	EA	1	$477,876	$478
Centrifuges -125 gpm	EA	2	$955,752	$1,912
Process Piping and Valves	LS	1	$519,929	$520
HVAC	LS	1	$433,274	$433
Plumbing	LS	1	$288,850	$289
Electrical	LS	1	$1,444,248	$1,444
Influent and Effluent Samplers				
Automatic Samplers	EA	2	$79,646	$159

Item	U/M	Quantity	Unit Cost	Cost ($000)
Site Work and Utilities				
Paving, Grading, and Yard Piping	LS	1	$5,972,742	$5,973
Sewer Interceptor I, 24"D	FT	33300	$558	$18,565
Sewer Interceptor II, 30"D	FT	13500	$664	$8,960
Outfall Diffusers Expansion	FT	400		$621
Treatment Cost				$91,298
Sewer Cost				$28,147
Sub Total				119,444
Project Services 35.00%				41,806
Total Contract Cost				161,250
Total Request				161,250
Total Request (Rounded)				161,250
Total Escalated 2013 Mid-Point Construction Cost (Rounded)				171,130

10. Description of Proposed Construction:

DoD would be constructing a new secondary treatment plant which includes

1. Two sewer interceptors
2. Head works: Fine screening and Grit chamber
3. Primary treatment: Three primary Clarifiers
4. Secondary treatment: Three trickling Filters and Three secondary Clarifiers
5. Solid Stabilization: Two Primary Anaerobic Digesters and One Secondary Anaerobic Digester
6. Solids Dewatering: Two Centrifuges and solids dewatering building
7. Disinfection: Two Chlorine Contact Tanks
8. Ocean Outfall Capacity Expansion

Table 6-14: Life Cycle Cost Comparison of Wastewater Treatment Options

Item	Description	Option 1a: Restore & Upgrade NDWWTP Primary Treatment	Option 1b: Restore, Expand, & Upgrade NDWWTP to Secondary Treatment	Option 2: DoD Secondary Treatment on DoD Land	Option 3: Separate Secondary Treatment at NDWWTP Site to Treat DoD Load Only
A. Estimated Capital Cost					
1	Headworks	$2,629,000	$2,629,000	$4,313,000	$4,313,000
2	Primary Clarifiers	$4,094,000	$11,277,000	$8,724,000	$8,724,000
3	Pumping Stations	—	3,237,000	$2,281,000	$2,281,000
4	Trickling Filters	—	$26,067,000	$10,994,000	$10,994,000
5	Secondary Clarifiers	—	$31,650,000	$13,242,000	$13,242,000
6	Chlorine Contact Tanks	$1,247,000	$5,564,000	$4,296,000	$4,296,000
7	Anaerobic Digesters	$24,337,000	$47,057,000	$30,797,000	$30,797,000
8	Sludge Thickening & Dewatering System	$6,141,000	$8,260,000	$10,518,000	$10,518,000
9	Influent & Effluent Samplers	$159,000	$318,000	$159,000	$159,000
10	Other Restorations & Upgrades	$3,503,000	$3,503,000	—	—
11	Site Work & Utilities	$2,688,000	$9,509,000	$5,973,000	$5,973,000
12	Sewer Interceptors	$4,181,000	$4,181,000	$24,340,000	$27,526,000
13	Effluent Transmission Line	—	—	$3,319,000	—
14	Ocean Out Fall & Piping	—	$3,450,000	$8,729,000	$621,000
15	Project Services	$17,142,000	$54,846,000	$44,690,000	$41,806,000
	TOTAL	**$66,121,000**	**$211,548,000**	**$172,375,000**	**$161,250,000**
B. Estimated Annual O&M Cost					
1	Labor & Benefits	$45,000	$135,000	$465,000	$465,000
2	Chemicals	$173,000	$202,000	$62,000	$62,000
3	Collection	$1,000	$1,000	$8,000	$9,000
4	Contract Services	$261,000	$622,000	$260,000	$260,000
5	Maintenance	$53,000	$200,000	$251,000	$251,000
6	Utilities	$131,000	$1,971,000	$494,000	$494,000
	TOTAL	**$664,000**	**$3,131,000**	**$1,540,000**	**$1,541,000**
C. Annual Costs					
1	Amortized Capital Cost	$4,865,000	$15,566,000	$12,684,000	$11,865,000
2	Estimated Annual O&M Cost	$664,000	$3,131,000	$1,540,000	$1,541,000
	TOTAL	**$5,529,000**	**$18,697,000**	**$14,224,000**	**$13,406,000**

Table 6-15: Capital Cost Allocations between USMC and Other Relevant DoD Units

Cost Allocation	Option 1A: Restore & Upgrade NDWWTP Primary Treatment	Option 1B: Restore, Expand, & Upgrade NDWWTP to Secondary Treatment	Option 2: DoD Secondary Treatment on DoD Land	Option 3: Separate Secondary Treatment at NDWWTP Site to Treat DoD Load Only
GWA	$40,624,000	$138,311,000	—	—
USMC	$20,333,000	$55,655,000	$127,538,000	$119,306,000
Other DoD Units	$5,164,000	$17,582,000	$44,837,000	$41,944,000
Total Cost	**$66,121,000**	**$211,548,000**	**$172,375,000**	**$161,250,000**

Table 6-16: Annual O&M Cost and Cost Distribution between GWA and DoD for Option 1A– Restore and Upgrade Existing Primary Treatment System at the GovGuam NDWWTP to Accept the Additional Flow and Load

Cost Categories	Quantity	O& M Cost	GWA's O&M Cost Share	DoD's O&M Cost Share
Labor & Benefits	LS	$45,000	$30,000	$15,000
Chemicals	LS	$173,000	$116,000	$57,000
Collection	LS	$1,000	—	$1000
Contract Services	LS	$261,000	$175,000	$86,000
Maintenance	LS	$53,000	$36,000	$17,000
Utilities	LS	$131,000	$88,000	$43,000
Total Annual Operation Cost		$664,000	$445,000	$219,000

Table 6-17: Annual O&M Cost and Cost Distribution between GWA and DoD for Option 1B– Expand and Upgrade the GovGuam NDWWTP to Secondary Treatment

Cost Categories	Quantity	O& M Cost	GWA's O&M Cost Share	DoD's O&M Cost Share
Labor & Benefits	LS	135,000	91,000	44,000
Chemicals	LS	202,000	136,000	66,000
Collection	LS	$1,000	—	$1000
Contract Services	LS	622,000	418,000	204,000
Maintenance	LS	200,000	134,000	66,000
Utilities	LS	1,971,000	1,324,000	647,000
Total Annual Operation Cost		3,131,000	2,103,000	1,028,000

7. Recommended Wastewater Treatment Alternative

Based on the cost analysis discussed in Section 6, the total present capital costs and annual life cycle costs of the four viable alternatives are presented in Table 7-1.

Table 7-1: Cost Summary of Viable Alternatives

Option:	Option 1A: Restore & Upgrade NDWWTP Primary Treatment	Option 1B: Restore, Expand, & Upgrade NDWWTP to Secondary Treatment	Option 2: DoD Secondary Treatment on DoD Land	Option 3: Separate Secondary Treatment at NDWWTP Site to Treat DoD Load Only
Capital Costs				
Total Capital Cost	$66,121,000	$211,548,000	$172,375,000	$161,250,000
Amortized Capital Cost	$4,865,000	$15,566,000	$12,684,000	$11,865,000
O&M Costs				
Total Annual Cost	$664,000	$3,131,000	$1,540,000	$1,541,000
Annual Life Cycle Costs	$5,529,000	$18,697,000	$14,224,000	$13,406,000
USMC Capital Cost	***$20,333,000***	***$55,655,000***	***$127,538,000***	***$119,306,000***

Both the annual life cycle cost of $664,000 (including amortized construction cost and estimated annual operation and maintenance [O&M] cost) and total capital cost of $66,121,000 for Option 1A are the lowest compared to other alternatives. The USMC's capital cost share of $20,333,000 based on USMC's portion of the wastewater flow, which is a percentage of its projected wastewater flow to the plant, is also the lowest for Option 1A. However, a secondary treatment alternative is recommended because the EPA Region 9 declared that the increased discharge from DoD activities in northern Guam would have an impact on the existing National Pollution Disposal Elimination System (NPDES) permit requirements, water quality standards, and NPDES requirements for current and any future effluent discharge would be based on EPA secondary treatment technology based requirements.

Option 1B includes all the costs of Option 1A for restoring its existing primary treatment capacity to 12 mgd and costs to upgrade the NDWWTP to an 18 mgd secondary treatment facility. Among the three secondary treatment alternatives, Option 3 has the lowest capital cost of $161,250,000 and annual life cycle cost of $13,406,000. Based on capital cost allocations, Option 1B is beneficial to Navy as the USMC share will be $55,655,000, which is the lowest of the secondary alternatives.

ATS recommended Option 1B as the best treatment alternative for both the military and Guam on-island population. Expand and upgrade the NDWWTP would improve basic island infrastructure and its surrounding water quality to the benefit of all Guam inhabitants. The study and recommended alternatives work for the planned military buildup concentrated in the Finegayan area. Significant population shifts to other locations would require further analysis to identify other collection system and treatment plant requirements and their associated construction cost.

7.1 Description of Recommended Alternative

In this alternative the NDWWTP would be upgraded to include secondary treatment facilities to enhance removal of biodegradable organic matters (in solution or suspension) and suspended solids found in wastewater. Figure 7-1 shows the schematic process diagram of the recommended alternative. The following refurbishments and upgrades are required at the NDWWTP to restore its primary treatment capacity for this alternative.

The necessary short-term improvements to restore the primary treatment capacity are as follows:

- Septage and FOG receiving
- Primary clarifier rehabilitation
- Sludge digester rehabilitation
- Centrifuge building replacement and one centrifuge
- Sludge-drying bed rehabilitation
- Standby power

The long-term improvements required to restore the primary treatment capacity are as follows:

- Hydraulic improvements to the chlorine contact tank
- Third digester (new)
- Second centrifuge
- Odor control
- Digester gas utilization
- Administration/laboratory, office, and workshop/storage areas rehabilitation

In addition to restoring its primary treatment capacity, the following new process components and upgrades are required for this alternative:

- One primary clarifier (same size as existing ones)
- Three trickling filters
- Four secondary clarifiers
- One chlorine contact tank
- Two new anaerobic digesters (same size as existing ones)
- One centrifuge solids dewatering system and odor control
- Effluent monitoring and measurement expansion
- Outfall diffuser capacity expansion

The sizes of the new process components and upgrades required at the NDWWTP for expanding and upgrading to secondary treatment are listed in Table 7-2.

7.2 DESCRIPTION OF COLLECTION SYSTEM MODIFICATIONS

After expansion and upgrading, it is anticipated that the NDWWTP would treat a total average daily flow of 10.5 mgd and peak flow of 23.7 mgd. This total includes military flow generated from the Andersen AFB about 0.56 mgd (0.36 mgd existing flow and 0.20 mgd from future Air Force bed down MILCON projects), and flow of 2.96 mgd generated by the military buildup at the Finegayan area. The wastewater flow generated by the USMC relocation at the Finegayan area (that has a peak flow of 7 mgd) is required to be carried via the newly constructed relief sewer to the NDWWTP as shown on Figure 6-1.

A new gravity relief sewer would be connected from the collection system of the USMC Finegayan area on the west side of the planned USMC Finegayan development to the headworks of the NDWWTP.

As shown on Figure 6-1, a 24-inch, 7,500 foot sewer would be required to convey flow from the Finegayan area to the NDWWTP. The normal process of acquiring a sewer easement is required where necessary. The USG and GOJ shall determine who is responsible for obtaining the easements.

Table 7-2: Components for Expanding and Upgrading the NDWWTP to Secondary Treatment

Construction Components	Refurbish (R)/Expand (E)/Upgrade (U)/NEW (N)	Unit	Dimensions/Description
Septage Receiving station	N	1	Septage storage tank, screen, two blowers, diffusers, two grinder pumps, truck unloading area
FOG receiving station	N	1	Headed grease-holding tank, heat trace system, two grinder pumps, grease truck unloading area
Headworks	U/N	2	Two fine screens
Primary clarifier	R N	2 1	130 ft diameter x 7 ft SWD 130 ft diameter x 7 ft SWD
Trickling filter pumping station	N	1	40 ft long x 25 ft wide x 16 ft high
Trickling filter	N	3	120 ft diameter x 24 ft SWD
Secondary clarifier	N	4	125 ft diameter x 16 ft SWD
Chlorine contact tank	R N	2 1	60 ft long x 40 ft wide x 8 ft SWD 60 ft long x 40 ft wide x 8 ft SWD
Anaerobic digester	R N	2 3	80 ft diameter x 18 ft SWD 80 ft diameter x 18 ft SWD
Solids dewatering centrifuges	N	3	150 gpm each
Effluent measurement	E	1	Automatic sampler
Odor control system	N	1	Locate at headworks and solids dewatering
Sludge-drying bed	R	8	Concrete repair, valves
Standby diesel generator	N	1	300-kilowatt diesel generator
Digester gas utilization	N	1	
Administration/Lab, Workshop and Storage	R	1	
Outfall capacity expansion	N	1	400 ft long multiport diffusers

7.3 PRELIMINARY CONSTRUCTION COST

The estimated project cost for constructing a new separate secondary treatment facility at the NDWWTP site to treat DoD load only is $211,548,000. A summary of preliminary project cost for the recommended alternative is shown in Table 7-3.

7.4 PRELIMINARY CONSTRUCTION SCHEDULE

ATS anticipates that for Option 1B, constructing secondary treatment and expanding existing outfall capacity would require about 12 to 18 months to design, 5 to 6 months to bid and award, and 25 to 30 months to construct the wastewater collection and treatment facilities. It is assumed that the wastewater treatment regulatory agency permitting work would be done concurrently with the design. Therefore, the total time required is 3.5 to 4.5 years. The schedule may be compressed by 6 months to one year if “design build” or “fast track” construction methodologies are used.

Table 7-3: Preliminary Construction Cost for Recommended Alternative– Expand and Upgrade GovGuam NDWWTP to Secondary Treatment

Construction Categories	Cost Opinion
Septage Receiving Station	$1,317,000
FOG Receiving Station	$566,000
Headwork Expansion	$2,629,000
Primary Clarifier Expansion	$11,277,000
Pumping Station	$3,237,000
Trickling Filters	$26,067,000
Secondary Clarifiers	$31,650,000
Chlorine Contact Tanks	$5,564,000
Anaerobic Digesters	$47,057,000
Solids Dewatering Building	$8,260,000
Influent and Effluent Samplers	$318,000
Sludge Drying Bed Refurbishment	$80,000
Other Refurbishments & Upgrades	$1,540,000
Site Work and Utilities	$9,509,000
Relief Sewer	$4,181,000
Outfall Diffuser Capacity Expansion	$3,450,000
TREATMENT SUBTOTAL COST	$149,071,000
SEWER AND OUTFALL EXPANSION SUBTOTAL COST	$7,631,000
TOTAL COST	$156,702,000
PROJECT SERVICES	$54,845,000
TOTAL ESTIMATED COST	$211,548,000
TOTAL ESTIMATED PROJECT COST (ROUNDED)	**$211,548,000**
TOTAL ESTIMATED PROJECT COST FOR USMC	**$55,655,000**

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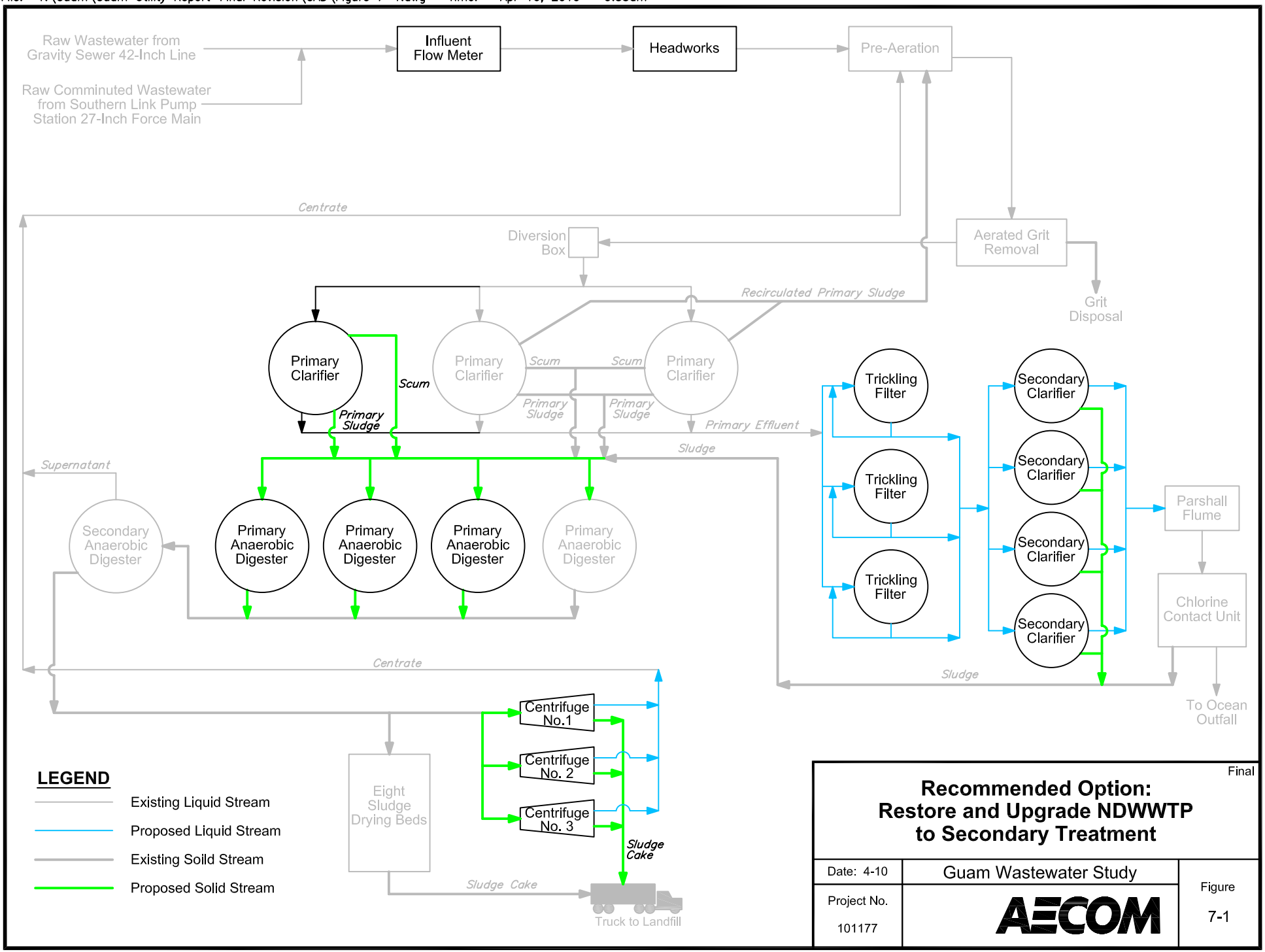

Final

Recommended Option: Restore and Upgrade NDWWTP to Secondary Treatment

Date: 4-10	Guam Wastewater Study	Figure 7-1
Project No. 101177	AECOM	

8. References

40 Code of Federal Regulations (CFR) 503. 2010. *Standards for the use or Disposal of Sewage Sludge.* 12 April.

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Appendix A
List of Facilities to Support Operational and Training Requirements for Marine Relocation

Borg

DEPARTMENT OF THE NAVY
HEADQUARTERS UNITED STATES MARINE CORPS
3000 MARINE CORPS PENTAGON
WASHINGTON, DC 20350-3000

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MEMORANDUM FOR ASSISTANT SECRETARY OF THE NAVY (INSTALLATIONS AND ENVIRONMENT)

Subj: REQUIREMENTS FOR NATIONAL ENVIRONMENTAL POLICY ACT (NEPA) ANAYLSIS OF MARINE CORPS RELOCATION FROM OKINAWA TO GUAM

Ref: (a) ASN (I&E) memo of 17 Aug 06

Encl: (1) Personnel and Units Identified for Relocation
(2) Facilities to Support Operational and Training Requirements
(3) Facilities to Support Quality of Life and Housing Requirements
(4) Training Range Requirements and Land Use Issues
(5) Development Costs

1. As requested in the reference, enclosures (1) through (4) provide estimated requirements for the 1 May 2006 Agreed Implementation Plan laydown of Marines and dependents relocating from Okinawa to Guam. The relocation effort is estimated to cost $10.27 B as outlined in enclosure (5).

2. This detail provides a solid foundation for the required National Environmental Policy Act (NEPA) analysis. However, it should be noted that as we further refine our requirements analysis, changes are inevitable. Therefore, we recommend that the NEPA analysis scope be flexible enough to support changes as they are approved. The elements normally addressed within a NEPA analysis such as environmental and socio-economic impacts should cover all relevant issues.

3. The Marine Corps looks forward to providing our input on the NEPA analysis scope of work and are also available to assist the Naval Facilities Engineering Command in its development if desired.

R. MAGNUS
Assistant Commandant
of the Marine Corps

PERSONNEL AND UNITS IDENTIFIED FOR RELOCATION

Under the 1 May Agreed Implementation Plans (AIPs), the following units will be relocated to Guam:

I. Command Element (3,046 PN)
- III Marine Expeditionary Force (MEF) Command Element and MEF Headquarters Group (MHG)
- 7th Communications Battalion
- 3d Intelligence Battalion
- III Material Handling Group (MHG)
- The MEF Band
- 5th Air Naval Gunfire Liaison Company (ANGLICO)
- Force Reconnaissance elements
- Marines assigned to the Joint Base

II. Ground Combat Element (1,100 PN)
- 3d Marine Division Headquarters
- HQ Battalion
- 12 Marine Artillery Regiment Headquarters

III. Aviation Combat Element (1,856 PN)
- 1st Marine Aircraft Wing Headquarters
- Marine Wing Headquarters Squadron-1
- Helicopter Marine Heavy (HMH) Squadron
- Marine Air Control Group (MACG) -18 HQ
- Marine Wing Communications Squadron (MWCS)-18
- Marine Air Control Squadron(MACS)-4
- Marine Air Support Squadron(MASS)-2
- Marine Tactical Air Control Squadron (MTACS)-18
- 1st Stinger Battery
- Marine Wing Support Group (MWSG)-17 Headquarters
- Marine Wing Support Squadron (MWSS) detachment

IV. Combat Service Support (2,550 PN)
- 3rd Marine Logistics Group (MLG) Headquarters
- Combat Logistics Regiment Headquarters
- Communications (Comm) Co
- Military Police (MP) Co
- Food Service Co
- 3d Material Readiness Battalion (MRB) (-)
- 3d Medical Bn (-)

ENCLOSURE(1)

- 3d Medical Bn (-)
- 3d Dental Bn (-)
- 9th Engineer Support (ESB) Bn (-)
- Transportation Det
- Combat Logistics Regiment-3 Headquarters Company (Direct Support)
- Headquarters Company

Total Personnel: 8,552 PN
Dependents: 9,000 PN

V. Transients

- 1 Infantry Battalion (Approx 800 PN)
- 1 Artillery Battery (Approx 150 PN)
- 1 Aviation Squadron (Approx 250 PN)

Beyond the above transients, there will be visiting units from USMC, DoD, and Allied countries that will train at Bi-Lateral Training area.

ENCLOSURE(1)

FACILITIES TO SUPPORT OPERATIONAL AND TRAINING REQUIREMENTS

The assigned units will require operational, maintenance, and training spaces. Facilities requirements are provided in the table below:

Unit	FAC	Description	UM	Requirement
12 Marine HQ	1164	Miscellaneous Pavement	SY	500
12 Marine HQ	2141	Vehicle Maintenance Shop	SF	25,700
12 Marine HQ	2145	Vehicle Maintenance Facility	EA	8
12 Marine HQ	2152	Weapon Maintenance Shop, Depot	SF	11,900
12 Marine HQ	2171	Electronics & Comm Maintenance Shop	SF	28,900
12 Marine HQ	4421	Covered Storage Building, Installation	SF	25,900
12 Marine HQ	6100	General Administrative Building	SF	15,700
1st Stinger Bty	2141	Vehicle Maintenance Shop	SF	5,800
1st Stinger Bty	2171	Electronics & Comm Maintenance Shop	SF	2,600
1st Stinger Bty	4421	Covered Storage Building, Installation	SF	7,900
1st Stinger Bty	6100	General Administrative Building	SF	6,700
3D Mar Div HQ	2134	Marine Maintenance Support Facility	SF	5,700
3D Mar Div HQ	2141	Vehicle Maintenance Shop	SF	9,300
3D Mar Div HQ	2152	Weapon Maintenance Shop, Depot	SF	6,600
3D Mar Div HQ	6100	General Administrative Building	SF	73,500
ANGLICO	6100	General Administrative Building	SF	26,000
Arty Bn HQ	1164	Miscellaneous Pavement	SY	200
Arty Bn HQ	2141	Vehicle Maintenance Shop	SF	8,600
Arty Bn HQ	2145	Vehicle Maintenance Facility	EA	3
Arty Bn HQ	2152	Weapon Maintenance Shop, Depot	SF	4,000
Arty Bn HQ	2171	Electronics & Comm Maintenance Shop	SF	9,700
Arty Bn HQ	4421	Covered Storage Building, Installation	SF	8,700
Arty Bn HQ	6100	General Administrative Building	SF	5,300
Base Support	1164	Miscellaneous Pavement	SY	2,200
Base Support	1231	Vehicle Fueling Facility	OL	23
Base Support	1241	Operating Fuel Storage	GA	1,581,700
Base Support	1311	Communications Building	SF	38,300
Base Support	1441	Photo Building	SF	17,100
Base Support	1442	Operations Support Lab	SF	1,400
Base Support	1443	Operations Supply Building	SF	14,200
Base Support	1444	Misc. Operations Support Building	SF	1,500
Base Support	1444	Misc. Operations Support Building	SF	2,000
Base Support	1444	Misc. Operations Support Building	SF	2,400
Base Support	1498	Security Support Facility	SF	3,100
Base Support	2141	Vehicle Maintenance Shop	SF	126,700
Base Support	2145	Vehicle Maintenance Facility	EA	36
Base Support	2171	Electronics & Comm Maintenance Shop	SF	43,400
Base Support	2191	Facility Engineer Maintenance Shop	SF	266,000
Base Support	4211	Ammunition Storage, Depot & Arsenal	SF	5,600
Base Support	4421	Covered Storage Building, Installation	SF	945,200

ENCLOSURE(2)

Base Support	4427	Small Arms Storage, Installation	SF	17,700
Base Support	6100	General Administrative Building	SF	637,300
Base Support	7220	Dining Facility	SF	52,000
Base Support	7311	Fire Station Facility	SF	61,200
Base Support	7312	Prison/Confinement Facility	SF	73,000
Base Support	7313	Police Station	SF	65,200
Base Support	7344	Postal Facility	SF	49,900
Base Support	7351	Education Center	SF	69,700
Base Support	7352	Dependent School	SF	201,125
Base Support	7361	Religious Ministry Facilities	SF	94,100
Base Support	7421	Indoor Physical Fitness Facility	SF	90,469
Base Support	7431	Auditorium & Theater Facility	SF	55,700
Base Support	7512	Outdoor Swimming Pool	EA	5
Base Support	7522	Athletic Field	EA	12
Comm Bn	1164	Miscellaneous Pavement	SY	400
Comm Bn	1443	Operations Supply Building	SF	8,100
Comm Bn	1444	Misc. Operations Support Building	SF	1,600
Comm Bn	2141	Vehicle Maintenance Shop	SF	27,800
Comm Bn	2171	Electronics & Comm Maintenance Shop	SF	66,700
Comm Bn	4421	Covered Storage Building, Installation	SF	27,800
Comm Bn	4427	Small Arms Storage, Installation	SF	6,800
Comm Bn	6100	General Administrative Building	SF	48,200
Gen Sup Det	1164	Miscellaneous Pavement	SY	1,100
Gen Sup Det	1231	Vehicle Fueling Facility	OL	3
Gen Sup Det	1443	Operations Supply Building	SF	6,700
Gen Sup Det	1444	Misc. Operations Support Building	SF	16,600
Gen Sup Det	1444	Misc. Operations Support Building	SF	30,000
Gen Sup Det	2141	Vehicle Maintenance Shop	SF	266,800
Gen Sup Det	2145	Vehicle Maintenance Facility	EA	17
Gen Sup Det	2151	Weapon Maintenance Shop	SF	15,430
Gen Sup Det	2162	Ammunition Maintenance Shop, Depot	SF	5,000
Gen Sup Det	2171	Electronics & Comm Maintenance Shop	SF	33,300
Gen Sup Det	2182	Installation Support Equipment Maint Shop	SF	21,100
Gen Sup Det	2184	Parachute & Dingy Maintenance Shop	SF	27,500
Gen Sup Det	4121	Bulk Liquid Storage, Other Than Fuel	GA	1,000
Gen Sup Det	4211	Ammunition Storage, Depot & Arsenal	SF	74,300
Gen Sup Det	4251	Open Ammunition Storage	SY	2,400
Gen Sup Det	4421	Covered Storage Building, Installation	SF	922,200
Gen Sup Det	4427	Small Arms Storage, Installation	SF	22,400
Gen Sup Det	4521	Open Storage, Installation	SY	600
Gen Sup Det	6100	General Administrative Building	SF	116,400
Intel Bn	1164	Miscellaneous Pavement	SY	300
Intel Bn	1311	Communications Building	SF	8,400
Intel Bn	2171	Electronics & Comm Maintenance Shop	SF	3,100
Intel Bn	4421	Covered Storage Building, Installation	SF	7,000
Intel Bn	6100	General Administrative Building	SF	46,400
MACG-18 HQ	2141	Vehicle Maintenance Shop	SF	14,700

ENCLOSURE(2)

MACG-18 HQ	2171	Electronics & Comm Maintenance Shop	SF	2,400
MACG-18 HQ	4421	Covered Storage Building, Installation	SF	4,300
MACG-18 HQ	4427	Small Arms Storage, Installation	SF	6,400
MACG-18 HQ	6100	General Administrative Building	SF	12,100
MACS-4	2141	Vehicle Maintenance Shop	SF	5,700
MACS-4	2171	Electronics & Comm Maintenance Shop	SF	9,300
MACS-4	4421	Covered Storage Building, Installation	SF	21,600
MACS-4	6100	General Administrative Building	SF	12,500
MACS-4	8526	Miscellaneous Paved Area	SY	5,000
MASS-2	2171	Electronics & Comm Maintenance Shop	SF	14,400
MASS-2	4421	Covered Storage Building, Installation	SF	19,300
MASS-2	6100	General Administrative Building	SF	13,100
MEF CE	1311	Communications Building	SF	5,400
MEF CE	4421	Covered Storage Building, Installation	SF	26,900
MEF CE	6100	General Administrative Building	SF	97,000
MEF CE	8526	Miscellaneous Paved Area	SY	400
MHG	1443	Operations Supply Building	SF	6,500
MHG	2141	Vehicle Maintenance Shop	SF	29,000
MHG	4421	Covered Storage Building, Installation	SF	86,800
MHG	4427	Small Arms Storage, Installation	SF	6,400
MHG	6100	General Administrative Building	SF	55,900
MHG	8526	Miscellaneous Paved Area	SY	9,500
MLG HQ	2141	Vehicle Maintenance Shop	SF	293
MLG HQ	2171	Electronics & Comm Maintenance Shop	SF	300
MLG HQ	4421	Covered Storage Building, Installation	SF	2,400
MLG HQ	4427	Small Arms Storage, Installation	SF	400
MLG HQ	6100	General Administrative Building	SF	4,100
MTACS-18	1164	Miscellaneous Pavement	SY	1,300
MTACS-18	2171	Electronics & Comm Maintenance Shop	SF	800
MTACS-18	4421	Covered Storage Building, Installation	SF	16,300
MTACS-18	6100	General Administrative Building	SF	25,800
MWCS-18	2141	Vehicle Maintenance Shop	SF	21,600
MWCS-18	2171	Electronics & Comm Maintenance Shop	SF	9,500
MWCS-18	4421	Covered Storage Building, Installation	SF	22,200
MWCS-18	4427	Small Arms Storage, Installation	SF	600
MWCS-18	6100	General Administrative Building	SF	9,100
MWCS-18	8928	Loading Platform/Ramp	EA	1
MWHS-1	2171	Electronics & Comm Maintenance Shop	SF	15,000
MWHS-1	4421	Covered Storage Building, Installation	SF	21,900
MWHS-1	4427	Small Arms Storage, Installation	SF	600
MWHS-1	6100	General Administrative Building	SF	48,800
MWSG-17 HQ	6100	General Administrative Building	SF	12,800
MWSS	1241	Operating Fuel Storage	GA	2,500
MWSS	1444	Misc. Operations Support Building	SF	1,900
MWSS	2141	Vehicle Maintenance Shop	SF	3,500
MWSS	2145	Vehicle Maintenance Facility	EA	1
MWSS	2152	Weapon Maintenance Shop, Depot	SF	2,500
MWSS	2171	Electronics & Comm Maintenance Shop	SF	600

ENCLOSURE(2)

MWSS	4111	Bulk Liquid Fuel Storage	BL	1
MWSS	4421	Covered Storage Building, Installation	SF	15,100
MWSS	4427	Small Arms Storage, Installation	SF	400
MWSS	4521	Open Storage, Installation	SY	4,400
MWSS	6100	General Administrative Building	SF	4,200
Navy		AAV Access	LS	
Navy		Wharf Improvements	LS	
Navy		Lay down/ Staging	LS	
Navy		Navy Training	LS	
Navy		"Other Impacts"	LS	
Navy		Road/Transportation Improvements	LS	
Navy		Utilities	LS	
Navy		Contingency	LS	
Recon Co	2133	Marine Maintenance Shop	SF	9,600
Recon Co	2141	Vehicle Maintenance Shop	SF	2,000
Recon Co	2171	Electronics & Comm Maintenance Shop	SF	3,400
Recon Co	2182	Installation Support Equipment Maint Shop	SF	2,900
Recon Co	2184	Parachute & Dingy Maintenance Shop	SF	3,900
Recon Co	4421	Covered Storage Building, Installation	SF	1,400
Recon Co	4427	Small Arms Storage, Installation	SF	1,000
Recon Co	6100	General Administrative Building	SF	10,000
Trnst Arty Bty	2141	Vehicle Maintenance Shop	SF	14,300
Trnst Arty Bty	4421	Covered Storage Building, Installation	SF	3,600
Trnst Arty Bty	4427	Small Arms Storage, Installation	SF	11,600
Trnst Arty Bty	6100	General Administrative Building	SF	18,200
Trnst Inf Bn	2141	Vehicle Maintenance Shop	SF	4,400
Trnst Inf Bn	2171	Electronics & Comm Maintenance Shop	SF	5,000
Trnst Inf Bn	4421	Covered Storage Building, Installation	SF	13,000
Trnst Inf Bn	6100	General Administrative Building	SF	36,800

Training Building requirements:

3D Mar Div HQ	1711	General Purpose Instruction Building	SF	11,700
Base Support	1711	General Purpose Instruction Building	SF	38,500
Comm Bn	1711	General Purpose Instruction Building	SF	1,600
Gen Sup Det	1711	General Purpose Instruction Building	SF	3,300
Intel Bn	1711	General Purpose Instruction Building	SF	600
MACG-18 HQ	1711	General Purpose Instruction Building	SF	4,700
MHG	1711	General Purpose Instruction Building	SF	25,900
MWHS-1	1711	General Purpose Instruction Building	SF	6,500
12 Marine HQ	1712	Applied Instruction Building	SF	1,600
Arty Bn HQ	1712	Applied Instruction Building	SF	600
Band	1712	Applied Instruction Building	SF	18,100
MEF CE	1712	Applied Instruction Building	SF	37,400
Trnst Inf Bn	1712	Applied Instruction Building	SF	1,800
MACS-4	1721	Flight Simulator Facility	SF	1,700
MHG	1721	Flight Simulator Facility	SF	21,000
MLG HQ	1721	Flight Simulator Facility	SF	260

ENCLOSURE(2)

Base Support	1732	Training Aids Support Building	SF	36,600
Base Support	1790	Miscellaneous Training Facility	EA	26
Base Support	7431	Auditorium & Theater Facility	SF	29,300

Training Support near a Runway:

MLG HQ	1112	Rotary Wing Landing Area, Surfaced	SY	1,100
Helo Training Sup	1131	Aircraft Apron, Surfaced	SY	37,200
MACS-4	1412	Aviation Operations Building	SF	7,400
Helo Training Sup	1444	Misc. Ops Support Building (02 space in Hangar)	SF	12,000
Helo Training Sup	2111	Aircraft Maintenance Hangar	SF	53,600
Helo Training Sup	2112	Aircraft Maintenance Shop (01 space in Hangar)	SF	12,050
Helo Training Sup (HMH)	2111	Aircraft Maintenance Hangar	SF	53,600
Helo Training Sup (HMH)	1444	Misc. Ops Support Building (02 space in Hangar)	SF	12,000
Helo Training Sup (HMH)	2112	Aircraft Maintenance Shop (01 space in Hangar)	SF	12,050

Infrastructure to support above facilities, training, and all development will include new and expansion of existing utility systems, roads, and waste facilities. These improvements are included in the total construction at a scope to be determined upon completion of additional studies.

ENCLOSURE(2)

FACILITIES TO SUPPORT QUALITY OF LIFE AND HOUSING REQUIREMENTS

The following requirements will be necessary to support family housing on Guam:

Total housing negotiated at 44% of 8,000 = 3,520 units. The anticipated split is approximately:

2,958 Units Enlisted Housing
558 Units Officer Housing
4 Units General Officer Quarters
3,520 Units

Bachelor housing Requirements:

I. Permanent Party

- Approximately 3,400 Rooms Bachelor Housing (USMC 2x0)
- Approximately 400 Bachelor Officer Rooms (1+1 Enhanced)

II. Transient Quarters to accommodate:

- 1 Infantry Battalion (800 PN)
- 1 Artillery Battery (150 PN)
- 1 Helicopter Squadron w/ 250 PN
- Visiting Officer's Quarters (100 Rooms)
- Temporary Lodging Facility (TLF w/ 70 Rooms)

Quality of Life facilities include the following:

Base Support	7314	Community Counseling Center	SF	12,700
Base Support	7333	Open Mess & Club Facility	SF	77,800
Base Support	7346	Exchange Sales Facility	SF	135,330
Base Support	7346	Exchange Sales Facility	SF	12,930
Base Support	7346	Exchange Sales Facility	SF	20,000
Base Support	7371	Nursery & Child Care Facility	SF	61,000
Base Support	7372	Family-Services-Center	SF	8,753
Base Support	7385	Public Restroom/Shower	SF	39,800
Base Support	7411	Hobby & Craft Center	SF	25,500
Base Support	7412	Automobile Craft Center	SF	33,800
Base Support	7415	Bowling Center	SF	70,200
Base Support	7416	Library	SF	55,400
Base Support	7417	Recreation Center	SF	31,200
Base Support	7417	Recreation Center	SF	32,200
Base Support	7441	Transient Lodging	SF	93,000
Base Support	7447	Miscellaneous MWR Facility	SF	30,300
Base Support	7447	Miscellaneous MWR Facility	SF	2,900
Base Support	7521	Outdoor Playing Courts	EA	42

ENCLOSURE(3)

TRAINING RANGE REQUIREMENTS AND LAND USE ISSUES

Training Requirements on Guam:

Planned Training - Facility Use	Notional location	Frequency of Use	Area Required (Size)	Land Use Issues
Guam (Notional)				
Individual combat skills (Gas chamber, land nav, survival skills, MCMAP, first aid, obstacle course, repelling course, leadership reaction course, etc.)	NCTS Finegayan	Daily, monthly, quarterly, per exercise	20 acres	Facilities, Environmental, Real Estate, Bird Migration
Small arms (9MM, M-16, 240G, 0.50 Cal, M203)	NCTS Finegayan	Daily	2 KD Small Arms ranges at 50 Firing points ea, Pistol Range at 30 Firing Points, MG range. SDZ includes over-water areas.	Facilities, Environmental, Real Estate, Bird Migration. Protection of SDZ may require closing shore and water areas during firing, by base security personnel.
Communications	NCTS Finegayan	Weekly	1 acre tract	None
Small unit patrolling and maneuver	Guam/NAV MAG	Weekly	20 acres	Environmental, Real Estate, Bird Migration
Crew Served Weapons (240G, .50 Cal)	Guam/NAV MAG	Monthly	20 acres	Clear range
MOUT	Andersen South	Quarterly	5 City blocks with roads	None
Convoy Ops	Andersen South	Monthly	7 Mile road march	Environmental mitigation
Demolition Ops	Finegayan/ Andersen South	Monthly	30ft x 30ft (bldg); range 150ft max depth of water, 400ft x 400ft	Environmental, Real Estate, Bird Migration
Equipment Operator Training/Practice	Guam	Daily	30ft x 30ft pad	None
Obstacles/Breaching	Guam	Daily	15ft x 15ft block house	None

ENCLOSURE(4)

Bridging	Guam for small bridging	Quarterly	40ft x 40ft	None
Landing beach	Guam	Quarterly	100m x 500m beach front	None
NSWU-1 CQC/Breacher House	Existing Breacher House	Weekly	On site of existing Breacher House	None

Potential Off-Island Training Requirements:

Planned Training - Facility Use	Notional location	Frequency of Use	Area Required (Size)	Land Use Issues
Tinian (Notional)				
Maneuver and tactical ops (Bn size)	Northern 2/3 of Island	Weekly	15 – 20 Sq Mi maneuver range	**Environmental issue:** NEPA applies; coral reef will require mitigation, sea turtles will require mitigation, potential archeological sites, Micronesian Megapod and Tinian Monarch may be issues, endangered wetland, R/W is Nat Historical Landmark; will be quarantine issues. **Land Issues:** Upper 2/3 of island leased from CNMI by DOD; can't buy land, have to lease from CNMI or private citizens of CNMI;
Mechanized ground (tanks, AAV/EFV)	Northern 2/3 of Island	Weekly	15 – 20 Sq Mi maneuver range	

ENCLOSURE(4)

				Other issues: Water is brackish therefore may need water treatment; power needs upgrading; airport expansion is in the works; port facilities lacking; UXO cleanup will be required.
Aguian (Notional)				
Artillery Live fire	Tinian to Goat Island	Monthly	25 Sq Mi impact area with clear live fire zones	**Aguijan**: Several environ issues; Megapods, fruit bats, swiftlets, migratory seabirds. Current enviro mitigation in progress removing goats that damage foliage birds like. **Legal/land**: Tinian Mayor controls Aguijan. Concerned entities will be CNMI, Tinian Mayor, Dept of Public lands and Federal Agencies, therefore may have to negotiate with several offices. **Additional Notes**: Will require UXO clean up; people on Tinian use Aguijan to hunt; Expect this issue to be politically and environmentally challenging.
Saipan (Notional)				
MOUT facility	Saipan	Monthly	5 city blocks	None
Aviation landing practice including NVG	Suitable expedition airfield	Daily when aviation squadrons onboard	8,000 ft airstrip	No major environmental issues. More populated. May be open to economic benefits. Infrastructure not well maintained.

ENCLOSURE(4)

FDM (Notional)				
Inert ordnance	Scored Air-Ground Target	Weekly when aviation squadrons onboard	2 acres	None
EW (portable) staging site	Northern "No-Drop" Zone	Quarterly	30ft x 30ft pad	None

SARIGAN (Notional)				
EW (portable) staging site	TBD	Quarterly	30ft x 30ft pad	None
"No Drop" Air-to-Ground range	Sarigan	Daily when aviation squadrons onboard	Navy RCD specifies two 20x20 nm land areas; airspace surface to 50,000 feet	None
Rota (Notional)				
Aviation landing practice including NVG	Suitable airfield	Daily when aviation squadrons onboard	8,000 ft strip	No significant environmental issues. May be noise issues since more highly populated. Infrastructure not well maintained.
PAGAN (Notional)				
EW (portable) staging site	Andersen, Northwest Field	Quarterly	30ft x 30ft pad	None
STOM Sea, Land, Subsurface Areas	Pagan	Monthly when MAGTF units onboard	USMC RCD specifies 739 sq nm land area; dedicated beachfront (see Landing Beach above); airspace of 50x80 nm, surface to 50,000 feet.	Environmental issues: Megapods, fruit bats, sea birds. Some cultural resources. Environmental group called "Pagan Watch" will likely oppose and use of Pagan.
Combined arms	Pagan	Weekly when MAGTF units onboard	See above	Legal/Land: Approx 20 people live in Pagan intermittently. Some families still claim land ownership. Lease price may be high due to presence of Pozolan Ash -- has mining potential.

ENCLOSURE(4)

Amphibious Assault (AAV or EFV)	Pagan	Weekly when MAGTF units onboard	See above	Other issues:Due to eruption, island has large amount of Pozolan Ash used in cement mfgr. Valued in the $Bs; Pozolan mining may become an issue.
Airspace (Notional)				
Restricted Areas (over land air-to-air)	Guam, Tinian, Saipan, FDM, Sarigan, Pagan	Daily when aviation squadrons onboard	1200 sq miles	Requires coordination with FAA; FACSFAC HI
Warning Areas (over water air-to-air)	Guam, Tinian, Saipan, FDM, Sarigan, Pagan	Daily when aviation squadrons onboard	4000 sq miles	Requires coordination with FAA; FACSFAC HI
Establish Area Control Guam	Guam, Tinian, Saipan, FDM, Sarigan, Pagan	Daily when aviation squadrons onboard	10,000 sq miles	Requires coordination with FAA; FACSFAC HI
General				
Data Backbone	Guam, Tinian, Saipan, FDM, Sarigan, Pagan	Monthly	TBD	Remote construction sites, security

* Training ranges requirement reduced when training available in deployed locations (e.g., Australia, Philippines, etc.). Deployment frequency contingent upon TEEP, sea lift, and availability of exercise related funding.

ENCLOSURE(4)

Agreed U.S.-Japan Sharing of Development Costs for USMC Relocation to Guam

All Figures: U.S. $1.0B

Priority	Description	Est. Dev. Cost	GOJ Share	USG share
I	Total op. facilities - Facilities - Assoc. Utilities - Other assoc. on-base infrastructure	4.60 3.70 0.74 0.16	Total 2.03 (44%) - Cash 1.29 - Recoverable 0.74	2.57 (56%)
II	Housing	2.55	Total 2.55 (100%) - Recoverable 2.10*	0* (0%)
III	Barracks/QOL	1.87	1.51 (81%)	0.36 (19%)
IV	Off-Base Infrastructure	0.25	0 (0%)	0.25 (100%)
V	Expeditionary Road	1.0	0 (0%)	1.0 (100%)
	Grand Total	**10.27**	**6.09 (59%) ****	**4.18 (41%)**

*Japan will finance $2.1B ($1.5B equity + .6B loan to project owner) to fund and develop 3,520 units of housing, valued at $2.55B by DOD. U.S. will provide overseas housing allowance (OHA) to USMC service members on Guam.

**Shows GOJ percentage of total development cost estimate, combining direct contributions and equity/loans to recoverable-cost projects.

ENCLOSURE(5)

Appendix B
Detailed Cost Spreadsheet

COST ESTIMATE

The cost estimate approaches of this report are described below.

I. Capital Cost

Capital costs are defined as the cost incurred to construct and install a new infrastructure facility or refurbish and rehabilitate an existing facility. Capital costs are incurred on the project services, purchase of land, buildings, equipment, construction, and pre-operating costs. Unlike operating and maintenance (O&M) costs, capital costs are one-time expenses.

1. Construction/Installation Costs

The construction costs are broken down in the detailed cost sheets in Appendix B. The cost estimates for each component were provided in 2008 dollars.

2. Project Services Cost

As indicated in Section 6.3, project services include the following:

- Environmental Impact Report/Other Documents
- Design Engineering
- Construction Engineering and Contract Administration
- General and Administrative Expenses
- Contingencies

A project level allowance of 35% is added to the estimated construction cost for project services to establish the total estimated project capital cost.

3. Escalation of Capital Costs to Mid-Point of Construction (2013)

The capital cost of year 2013 is estimated as a mid-point cost of the construction. An annual escalation index value of 2.0% was used to estimate January 2013 cost from January 2008 from ENR cost indexes, and resulted compounded escalation factor was 6.12%.

Cost in 2013 = Cost in 2010 × Escalation Factor (6.12%)

4. Total Capital Cost Amortized to Annual Capital Cost during Project Life Cycle

To compare project life cycle cost, the total capital cost (lump-sum) of the project is distributed into equal amount of annual capital cost for the duration of project life cycle time. An annual 4% interest and 20-year project life cycle were assumed in the study.

The general formula used is:

$$\text{Annual Cost} = \text{Total Cost} \times i \cdot \frac{(1+i)^n}{(1+i)^n - 1}$$

Where

i is the interest rate

n is the number of years

II. Operation and Maintenance Costs

O&M costs include the costs of labor and benefits, energy/power, chemicals, and facility/equipment repair and maintenance. The assumptions of O&M cost were described in Section 6.3.

III. Cost Allocation among the Stakeholders

For each alternative, the United States Marine Corps would share capital costs among all beneficial parties of the project. It would share the costs with Guam Waterworks Authority, Navy, Air Force, and Army in Alternative 1A and 1B, while share with Navy, Air Force, and Army in Alternative 2 and 3. The cost allocation was calculated based on a ratio of each beneficiary wastewater flow treated by the capital investment.

AECOM

PROJECT COMPUTATION SHEET

Client: NAVFEC
Project: Final Report for Utility Study on MC Relocation to Guam
Design Calculations
File Name: 101177 preliminary cost
Latest Revision: 07-May-10

Subject: Cost Estimation

Project No.:101177.06.02
Prepared By: YM
Date: 07-Nov-2007
Reviewed By:RBS

OPTION 1A: RESTORE NDWWTP PRIMARY TREATMENT CAPACITY

1. THE NDWWTP SHORT-TERM NECESSARY IMPROVEMENTS

Construction Categories	Quantity	Applicable Specifications for Cost Estimating	Cost Opinion
Septage Receiving Station (new)	1 ea	Septage storage tank, screen, two blowers,	1,317,000
FOG Receiving Station (new)	1 ea	Headed grease holding tank, heat trace	`
Headworks (refurbish)	1 ea	Two (2) 6mm fine screens, grit chamber	2,629,000
Primary Clarifier (refurbish)	2 ea	New Sludge Collectors, electrical, pumps,	4,094,000
Anaerobic Digester (refurbish)	2 ea	New sludge mixing, heat exhangers, electrical,	11,883,000
Solids Dewatering Building (replace)	1 ea	Structure replacement, one centrifuge, one	3,428,000
Influent and Effluent Samplers (new)	2 ea	Automatic samplers	159,000
Sludge Drying Bed (refurbish)	1 ea	Concrete repair, valves	80,000
Standby Diesel Generator	1 ea		398,000
Site Work and Utilities			1,567,000
TOTAL COST			$26,121,000
PROJECT SERVICES			$9,142,000
TOTAL ESTIMATED COST - GUAM			$35,263,000
TOTAL REQUEST (ROUNDED)			**$35,300,000**

2. THE NDWWTP LONG-TERM IMPROVEMENTS

Construction Categories	Quantity	Applicable Specifications for Cost Estimating	Cost Opinion
Chlorine Contact Tank (refurbish)	2 ea	New mixers, chemical feed pumps, effluent	1,247,000
Anaerobic Digester (new)	1 ea	New sludge mixing, heat exhangers, electrical,	10,266,000
Digester Gas Utilization (new)	1 ea	Engine generator, gas purification, compressor	2,188,000
Sludge Dewatering Centrifuge (new)	1 ea	2,000 lb/hr centrifuge	2,713,000
Plant Odor Control System (new)	1 ea	Odor control system	478,000
Adm/Lab, Workshop, Storage (refurb	1 ea	Adm/Lab, workshop, storage	664,000
Site Work and Utilities	1 ls		1,121,000
Relief Sewer	1 ea	7,500' 24" dia	4,181,000
TREATMENT SUBTOTAL COST			18,677,000
SEWER SUBTOTAL COST			4,181,000
TOTAL COST			$22,858,000
PROJECT SERVICES			$8,000,000
TOTAL ESTIMATED COST - GUAM			$30,858,000
TOTAL REQUEST (ROUNDED)			**$30,900,000**

AECOM

PROJECT COMPUTATION SHEET

Client: NAVFEC
Project: Final Report for Utility Study on MC Relocation to Guam Design Calculations
File Name: 101177 preliminary cost
Latest Revision: 07-May-10

Subject: Cost Estimation

Project No.:101177.06.02
Prepared By: YM
Date: 07-Nov-2007
Reviewed By:RBS

OPTION 1B: RESTORE, EXPAND & UPGRADE NDWWTP TO SECONDARY TREATMENT (Cost adder to Option 1A)

Construction Categories	Quantity	Applicable Specifications for Cost Estimating	Cost Opinion
Primary Clarifier	new 1 ea	concrete form construction 130' dia x 7'swd	7,182,903
Pumping Station	new 1 ea	concrete form construction 40' L x 25' W x 16' H	3,236,814
Trickling Filters	new 3 ea	concrete form construction 120' dia x 24'swd	26,066,549
Secondary Clarifiers	new 4 ea	concrete form construction 125' dia x 14'swd	31,649,628
Chlorine Contact Tank	new 1 ea	concrete form construction 60' L x 40' W x 8' swd	4,316,814
Anaerobic Digesters	new 2 ea	concrete form construction 80' dia x 18'swd	22,719,743
Influent and Effluent Samplers	new 2 ea		159,292
Solids Dewatering Building Expansion	1 ea	One 2,000 lb/hr centrifuge	2,119,009
Site Work and Utilities	1 ls		6,821,553
Relief Sewer	1 ea	7,500' 24" dia	0
Outfall Upgrade	1 ea	40 diffusers w/ 400' long	3,450,000
TREATMENT SUBTOTAL COST			104,272,305
SEWER & OUTFALL SUBTOTAL COST			3,450,000
TOTAL COST			$107,722,305
PROJECT SERVICES			$37,702,807
TOTAL ESTIMATED COST - GUAM			$145,425,112
TOTAL REQUEST (ROUNDED)			**$145,425,000**

AECOM

PROJECT COMPUTATION SHEET

Client: NAVFEC
Project: Final Report for Utility Study on MC Relocation to Guam
Design Calculations
File Name: 101177 preliminary cost
Latest Revision: 07-May-10

Subject: Cost Estimation

Project No.:101177.06.02
Prepared By: YM
Date: 07-Nov-2007
Reviewed By:RBS

OPTION 2: DoD SECONDARY TREATMENT on DoD LAND

Construction Categories	Quantity	Applicable Specifications for Cost Estimating	Cost Opinion
Headworks	new 1 ea	Two (2) 6mm fine screens Two (2) Aerated grit chambers, ea 45' L x 12' W x 7' SWD	4,313,097
Primary Clarifier	new 3 ea	concrete form construction 60' dia x 10'swd	8,723,894
Pumping Station	new 1 ea	concrete form construction 40' L x 25' W x 16' H	2,281,062
Trickling Filters	new 3 ea	concrete form construction 65' dia x 24'swd	10,994,336
Secondary Clarifiers	new 3 ea	concrete form construction 80' dia x 13'swd	13,242,265
Chlorine Contact Tank	new 2 ea	concrete form construction 55' L x 25' W x 14' swd	4,295,575
Anaerobic Digesters	new 3 ea	concrete form construction 80' dia x 18'swd	30,797,204
Influent and Effluent Samplers	new 2 ea		159,292
Solids Dewatering Building	2 ea	Two 125 gpm centrifuges	10,518,159
Site Work and Utilities	1 ls		5,972,742
Sewer Interceptors	1 ea	33,300' 24" dia	18,565,487
	1 ea	8,700' 30" dia	5,774,336
Effluent Transmission Line	1 ea	5,000' 30" dia	3,318,584
Ocean Out Fall & Piping	1 ea	2,400' 30" dia	8,729,204
TREATMENT SUBTOTAL COST			91,297,627
SEWER & OUTFALL SUBTOTAL COST			36,387,611
TOTAL COST			$127,685,238
PROJECT SERVICES			$44,689,833
TOTAL ESTIMATED COST - GUAM			$172,375,071
TOTAL REQUEST (ROUNDED)			**$172,375,000**

AECOM

PROJECT COMPUTATION SHEET

Client: NAVFEC
Project: Final Report for Utility Study on MC Relocation to Guam
Design Calculations
File Name: 101177 preliminary cost
Latest Revision: 07-May-10

Subject: Cost Estimation

Project No.:101177.06.02
Prepared By: YM
Date: 07-Nov-2007
Reviewed By:RBS

OPTION 3: DoD SECONDARY TREATMENT at NDWWTP to Treat DoD load Only

Construction Categories	Quantity	Applicable Specifications for Cost Estimating	Cost Opinion
Headworks	new 1 ea	Two (2) 6mm fine screens Two (2) Aerated grit chambers, ea 45' L x 12' W x 7' SWD	4,313,097
Primary Clarifier	new 3 ea	concrete form construction 60' dia x 10'swd	8,723,894
Pumping Station	new 1 ea	concrete form construction 40' L x 25' W x 16' H	2,281,062
Trickling Filters	new 3 ea	concrete form construction 65' dia x 24'swd	10,994,336
Secondary Clarifiers	new 3 ea	concrete form construction 80' dia x 13'swd	13,242,265
Chlorine Contact Tank	new 2 ea	concrete form construction 55' L x 25' W x 14' swd	4,295,575
Anaerobic Digesters	new 3 ea	concrete form construction 80' dia x 18'swd	30,797,204
Influent and Effluent Samplers	new 2 ea		159,292
Solids Dewatering Building	2 ea	Two 125 gpm centrifuges	10,518,159
Site Work and Utilities	1 ls		5,972,742
Sewer Interceptors	1 ea	33,300' 27" dia	18,565,487
	1 ea	13,500' 36" dia	8,960,177
Outfall Upgrade	1 ea	40 diffusers w/ 400' long	621,000
TREATMENT SUBTOTAL COST			91,297,627
SEWER & OUTFALL SUBTOTAL COST			28,146,664
TOTAL COST			$119,444,291
PROJECT SERVICES			$41,805,502
TOTAL ESTIMATED COST - GUAM			$161,249,792
TOTAL REQUEST (ROUNDED)			**$161,250,000**

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PROJECT COMPUTATION SHEET

Client: NAVFEC
Project: Final Report for Utility Study on MC Relocation to Guam
Design Calculations
File Name: 101177 preliminary_cost
Latest Revision: 07-May-10

Subject: Annual O&M Cost Estimation

OPTION 1A: RESTORE NDWWTP PRIMARY TREATMENT

Cost Categories	Quantity	Cost Est.	GWA Cost Est.	DoD Cost Est.
Labor & Benefits	LS	$45,000	$30,000	$15,000
Capital Improvements	LS	$0	$0	$0
Chemicals	LS	$173,000	$116,000	$57,000
Collection	LS	$1,000	$0	$1,000
Contract Services	LS	$261,000	$175,000	$86,000
Maintenance	LS	$53,000	$36,000	$17,000
Supplies	LS	$0	$0	$0
Utilities	LS	$131,000	$88,000	$43,000
TOTAL ANNUAL OPERATION COST		$664,000	$445,000	$219,000

OPTION 1B: RESTORE, EXPAND & UPGRADE NDWWTP TO SECONDARY TREATMENT

Cost Categories	Quantity	Cost Est.	GWA Cost Est.	DoD Cost Est.
Labor & Benefits	LS	135,000	91,000	44,000
Capital Improvements	LS	0	0	0
Chemicals	LS	202,000	136,000	66,000
Collection	LS	1,000	0	1,000
Contract Services	LS	622,000	418,000	204,000
Maintenance	LS	200,000	134,000	66,000
Supplies	LS	0	0	0
Utilities	LS	1,971,000	1,324,000	647,000
TOTAL ANNUAL OPERATION COST		3,131,000	2,103,000	1,028,000

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PROJECT COMPUTATION SHEET

Client: NAVFEC
Project: Final Report for Utility Study on MC Relocation to Guam
Design Calculations
File Name: 101177 preliminary_cost
Latest Revision: 07-May-10

Subject: Annual O&M Cost Estimation

OPTION 2: DOD SECONDARY TREATMENT ON DoD LAND

Cost Categories	Quantity	Cost Est.	DoD Cost Est.
Labor & Benefits	LS	465,000	465,000
Capital Improvements	LS	0	0
Chemicals	LS	62,000	62,000
Collection	LS	8,000	8,000
Contract Services	LS	260,000	260,000
Maintenance	LS	251,000	251,000
Supplies	LS	0	0
Utilities	LS	494,000	494,000
TOTAL ANNUAL OPERATION COST		1,540,000	1,540,000

OPTION 3: SECONDARY TREATMENT AT NDWWTP SITE TO TREAT DoD LOAD ONLY

Cost Categories	Quantity	Cost Est.	DoD Cost Est.
Labor & Benefits	LS	465,000	465,000
Capital Improvements	LS	0	0
Chemicals	LS	62,000	62,000
Collection	LS	9,000	9,000
Contract Services	LS	260,000	260,000
Maintenance	LS	251,000	251,000
Supplies	LS	0	0
Utilities	LS	494,000	494,000
TOTAL ANNUAL OPERATION COST		1,541,000	1,541,000

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PROJECT COMPUTATION SHEET

Client: NAVFEC
Project: Final Report for Utility Study on MC Relocation to Guam
Design Calculations
File Name: 101177 preliminary_cost
Latest Revision: 10-Jul-08

Subject: Cost Estimation

Project No.:101177.06.02
Prepared By: YM
Date: July-2008
Reviewed By: RBS

OPTION 2: DoD SECONDARY TREATMENT

Table 1: Line Item Costs

Construction Categories	Item Description	Quantity	Unit	Unit Cost	Cost Opinion	Sub. Toal Cost
Trickling Filters	Reinforced Concrete	2700	CY	$2,124	$5,734,513	$10,994,336
	Earthwork	2400	CY	$106	$254,867	
	Trickling Filter Plastic Media	9000	CY	$319	$2,867,257	
	Rotary Distribtution Equipment	3	EA	$265,487	$796,460	
	Miscellaneous Metals	1	LS	$195,929	$195,929	
	Frp Weirs	1	LS	$117,558	$117,558	
	Protective Coatings	1	LS	$557,522	$557,522	
	Piping and Valves	1	LS	$274,301	$274,301	
	Instrumentation/SCADA	1	LS	$39,186	$39,186	
	Electrical	1	LS	$156,743	$156,743	
Secondary Clarifiers	Reinforced Concrete	2400	CY	$2,124	$5,097,345	$13,242,265
	Earthwork	12900	CY	$106	$1,369,912	
	Sludge and Scum Collector Equipment	4	EA	$557,522	$2,230,088	
	Miscellaneous Metals	1	LS	$434,867	$434,867	
	Frp Weirs	1	LS	$260,920	$260,920	
	Protective Coatings	1	LS	$892,035	$892,035	
	Piping and Valves	1	LS	$260,920	$260,920	
	Instrumentation/SCADA	1	LS	$347,894	$347,894	
	Electrical	1	LS	$869,735	$869,735	
	New Sludge Pump Station	1	LS	$1,478,549	$1,478,549	
Chlorine Contact Tanks	Reinforced Concrete	1200	CY	$2,124	$2,548,673	$4,295,575
	Earthwork	4400	CY	$106	$467,257	
	Chemical Feed and Mixing Equipment	1	LS	$318,584	$318,584	
	Miscellaneous Metals	1	LS	$166,726	$166,726	
	Slide Gates and Weirs	1	LS	$100,035	$100,035	
	Protective Coatings	1	LS	$127,434	$127,434	
	Piping and Valves	1	LS	$100,035	$100,035	
	Instrumentation/SCADA	1	LS	$133,381	$133,381	
	Electrical	1	LS	$333,451	$333,451	
Anaerobic Digesters (New)	Reinforced Concrete	3000	CY	$2,124	$6,371,681	$30,797,204
	Earthwork	4200	CY	$106	$446,018	
	Digester Mixing and Heating Equipment	3	EA	$2,123,894	$6,371,681	
	Miscellaneous Metals	1	LS	$791,363	$791,363	
	Roofing and Insulation	1	LS	$725,416	$725,416	
	Protective Coatings	1	LS	$1,978,407	$1,978,407	
	Piping and Valves	1	LS	$4,616,283	$4,616,283	
	Instrumentation/SCADA	1	LS	$923,257	$923,257	
	Electrical	1	LS	$1,978,407	$1,978,407	
	New Sludge Pump Station	1	LS	$6,594,690	$6,594,690	

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PROJECT COMPUTATION SHEET

Client: NAVFEC
Project: Final Report for Utility Study on MC Relocation to Guam
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File Name: 101177 preliminary_cost
Latest Revision: 10-Jul-08

Subject: Cost Estimation

Project No.:101177.06.02
Prepared By: YM
Date: July-2008
Reviewed By: RBS

OPTION 2: DoD SECONDARY TREATMENT

Table 1: Line Item Costs

Construction Categories	Item Description	Quantity	Unit	Unit Cost	Cost Opinion	Sub. Toal Cost
Solids Dewatering Building	Reinforced Concrete	1200	CY	$2,124	$2,548,673	$10,518,159
	Earthwork	3200	CY	$106	$339,823	
	Masonry Interior Walls	1	LS	$375,504	$375,504	
	Miscellaneous Metals	1	LS	$346,619	$346,619	
	Frp Grating	1	LS	$86,655	$86,655	
	Roofing and Insulation	1	LS	$404,389	$404,389	
	Doors and Windows	1	LS	$72,212	$72,212	
	Protective Coatings	1	LS	$173,310	$173,310	
	Building Specialties	1	LS	$28,885	$28,885	
	Sludge Grinders	2	EA	$53,097	$106,195	
	Sludge Feed Pumps	2	EA	$66,372	$132,743	
	Polymer Feed System	2	EA	$238,938	$477,876	
	Polymer Feed Pumps	2	EA	$15,929	$31,858	
	Odor Control System	1	EA	$477,876	$477,876	
	Centrifuges -125 gpm	2	EA	$955,752	$1,911,504	
	Process Piping and Valves	1	LS	$519,929	$519,929	
	HVAC	1	LS	$433,274	$433,274	
	Plumbing	1	LS	$288,850	$288,850	
	Electrical	1	LS	$1,444,248	$1,444,248	
	Instrumentation/SCADA	1	LS	$317,735	$317,735	
Influent and Effluent Samplers	Automatic Samplers	2	EA	$79,646	$159,292	$159,292
Site Work and Utilities	Paving, Grading, and Yard Piping	1	LS	$5,972,742	$5,972,742	$5,972,742
Sewer Interceptor I, 24"D	Lump Sum	33300	FT	$558	$18,565,487	$18,565,487
Sewer Interceptor II, 30"D	Lump Sum	8700	FT	$664	$5,774,336	$5,774,336
Effluent Transmission Line, 30"D	Lump Sum	5,000	FT	$664	$3,318,584	$3,318,584
Ocean Out Fall, 30"	Lump Sum	2400	FT	$3,637	$8,729,204	$8,729,204
TOTAL COST						$127,685,238

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PROJECT COMPUTATION SHEET

Client: NAVFEC
Project: Final Report for Utility Study on MC Relocation to Guam
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Latest Revision: 10-Jul-08

Subject: Cost Estimation

Project No.:101177.06.02
Prepared By: YM
Date: July-2008
Reviewed By: RBS

OPTION 3: DoD SECONDARY TREATMENT at NDWWTP to Treat DoD Load Only

Table 1: Line Item Costs

Construction Categories	Item Description	Quantity	Unit	Unit Cost	Cost Opinion	Sub. Toal Cost
DoD Headworks	Reinforced Concrete	400	CY	$2,124	$849,558	$4,313,097
	Earthwork	1400	CY	$106	$148,673	
	Fine Screenings Equipment	2	EA	$238,938	$477,876	
	Grit Chamber Equipment	2	EA	$106,195	$212,389	
	Grit Pumps Equipment	2	EA	$58,407	$116,814	
	Grit Washer Equipment	2	EA	$185,841	$371,681	
	Miscellaneous Metals	1	LS	$108,850	$108,850	
	Frp Weirs	1	LS	$65,310	$65,310	
	Protective Coatings	1	LS	$176,814	$176,814	
	Piping and Valves	1	LS	$544,248	$544,248	
	Instrumentation/SCADA	1	LS	$152,389	$152,389	
	Electrical	1	LS	$326,549	$326,549	
	Grit & Screenings Building	1	LS	$761,947	$761,947	
Primary Clarifier	Reinforced Concrete	1500	CY	$2,124	$3,185,841	$8,723,894
	Earthwork	2200	CY	$106	$233,628	
	Sludge and Scum Collector Equipment	3	EA	$424,779	$1,274,336	
	Miscellaneous Metals	1	LS	$234,690	$234,690	
	Frp Weirs	1	LS	$140,814	$140,814	
	Protective Coatings	1	LS	$509,735	$509,735	
	Piping and Valves	1	LS	$140,814	$140,814	
	Instrumentation/SCADA	1	LS	$187,752	$187,752	
	Electrical	1	LS	$469,381	$469,381	
	New Sludge Pump Station	1	LS	$2,346,903	$2,346,903	
Trickling Filter Pumping Station	Reinforced Concrete	400	CY	$2,124	$849,558	$2,281,062
	Earthwork	1600	CY	$106	$169,912	
	Trickling Filter Influent Pump Equipment	3	EA	$159,292	$477,876	
	Miscellaneous Metals	1	LS	$74,867	$74,867	
	Protective Coatings	1	LS	$334,513	$334,513	
	Piping and Valves	1	LS	$44,920	$44,920	
	Instrumentation/SCADA	1	LS	$104,814	$104,814	
	Electrical	1	LS	$224,602	$224,602	

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Latest Revision: 10-Jul-08

Subject: Cost Estimation

Project No.:101177.06.02
Prepared By: YM
Date: July-2008
Reviewed By: RBS

OPTION 3: DoD SECONDARY TREATMENT at NDWWTP to Treat DoD Load Only

Table 1: Line Item Costs

Construction Categories	Item Description	Quantity	Unit	Unit Cost	Cost Opinion	Sub. Toal Cost
Trickling Filters	Reinforced Concrete	2700	CY	$2,124	$5,734,513	$10,994,336
	Earthwork	2400	CY	$106	$254,867	
	Trickling Filter Plastic Media	9000	CY	$319	$2,867,257	
	Rotary Distribtution Equipment	3	EA	$265,487	$796,460	
	Miscellaneous Metals	1	LS	$195,929	$195,929	
	Frp Weirs	1	LS	$117,558	$117,558	
	Protective Coatings	1	LS	$557,522	$557,522	
	Piping and Valves	1	LS	$274,301	$274,301	
	Instrumentation/SCADA	1	LS	$39,186	$39,186	
	Electrical	1	LS	$156,743	$156,743	
Secondary Clarifiers	Reinforced Concrete	2400	CY	$2,124	$5,097,345	$13,242,265
	Earthwork	12900	CY	$106	$1,369,912	
	Sludge and Scum Collector Equipment	4	EA	$557,522	$2,230,088	
	Miscellaneous Metals	1	LS	$434,867	$434,867	
	Frp Weirs	1	LS	$260,920	$260,920	
	Protective Coatings	1	LS	$892,035	$892,035	
	Piping and Valves	1	LS	$260,920	$260,920	
	Instrumentation/SCADA	1	LS	$347,894	$347,894	
	Electrical	1	LS	$869,735	$869,735	
	New Sludge Pump Station	1	LS	$1,478,549	$1,478,549	
Chlorine Contact Tank	Reinforced Concrete	1200	CY	$2,124	$2,548,673	$4,295,575
	Earthwork	4400	CY	$106	$467,257	
	Chemical Feed and Mixing Equipment	1	LS	$318,584	$318,584	
	Miscellaneous Metals	1	LS	$166,726	$166,726	
	Weirs	1	LS	$100,035	$100,035	
	Protective Coatings	1	LS	$127,434	$127,434	
	Piping and Valves	1	LS	$100,035	$100,035	
	Instrumentation/SCADA	1	LS	$133,381	$133,381	
	Electrical	1	LS	$333,451	$333,451	
Anaerobic Digesters (New)	Reinforced Concrete	3000	CY	$2,124	$6,371,681	$30,797,204
	Earthwork	4200	CY	$106	$446,018	
	Digester Mixing and Heating Equipment	3	EA	$2,123,894	$6,371,681	
	Miscellaneous Metals	1	LS	$791,363	$791,363	
	Roofing and Insulation	1	LS	$725,416	$725,416	
	Protective Coatings	1	LS	$1,978,407	$1,978,407	
	Piping and Valves	1	LS	$4,616,283	$4,616,283	
	Instrumentation/SCADA	1	LS	$923,257	$923,257	
	Electrical	1	LS	$1,978,407	$1,978,407	
	New Sludge Pump Station	1	LS	$6,594,690	$6,594,690	

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PROJECT COMPUTATION SHEET

Client: NAVFEC
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File Name: 101177 preliminary_cost
Latest Revision: 10-Jul-08

Subject: Cost Estimation

Project No.:101177.06.02
Prepared By: YM
Date: July-2008
Reviewed By: RBS

OPTION 3: DoD SECONDARY TREATMENT at NDWWTP to Treat DoD Load Only

Table 1: Line Item Costs

Construction Categories	Item Description	Quantity	Unit	Unit Cost	Cost Opinion	Sub. Toal Cost
Solids Dewatering Building	Reinforced Concrete	1200	CY	$2,124	$2,548,673	$10,518,159
	Earthwork	3200	CY	$106	$339,823	
	Masonry Interior Walls	1	LS	$375,504	$375,504	
	Miscellaneous Metals	1	LS	$346,619	$346,619	
	Frp Grating	1	LS	$86,655	$86,655	
	Roofing and Insulation	1	LS	$404,389	$404,389	
	Doors and Windows	1	LS	$72,212	$72,212	
	Protective Coatings	1	LS	$173,310	$173,310	
	Building Specialties	1	LS	$28,885	$28,885	
	Sludge Grinders	2	EA	$53,097	$106,195	
	Sludge Feed Pumps	2	EA	$66,372	$132,743	
	Polymer Feed System	2	EA	$238,938	$477,876	
	Polymer Feed Pumps	2	EA	$15,929	$31,858	
	Odor Control System	1	EA	$477,876	$477,876	
	Centrifuges -125 gpm	2	EA	$955,752	$1,911,504	
	Process Piping and Valves	1	LS	$519,929	$519,929	
	HVAC	1	LS	$433,274	$433,274	
	Plumbing	1	LS	$288,850	$288,850	
	Electrical	1	LS	$1,444,248	$1,444,248	
	Instrumentation/SCADA	1	LS	$317,735	$317,735	
Influent and Effluent Samplers	Automatic Samplers	2	EA	$79,646	$159,292	$159,292
Site Work and Utilities	Paving, Grading, and Yard Piping	1	LS	$5,972,742	$5,972,742	$5,972,742
Sewer Interceptor I, 24"D	Lump Sum	33300	FT	$558	$18,565,487	$18,565,487
Sewer Interceptor II, 30"D	Lump Sum	13500	FT	$664	$8,960,177	$8,960,177
Outfall Diffusers Expansion	Lump Sum	400	FT		$621,000	$621,000
TOTAL COST						$119,444,291

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PROJECT COMPUTATION SHEET

Client: NAVFEC
Project: Final Report for Utility Study on MC Relocation to Guam
Design Calculations
File Name: 101177 preliminary_cost
Latest Revision: 30-Jun-08

Subject: Annual O&M Cost Estimation

Cost Categories	Quantity	Cost Est.	GWA Cost Est.	DoD Cost Est.
Labor & Benefits	LS	$45,000	$33,000	$12,000
Capital Improvements	LS	$0	$0	$0
Chemicals	LS	$216,000	$161,000	$55,000
Collection	LS	$1,000	$0	$1,000
Contract Services	LS	$261,000	$194,000	$67,000
Maintenance	LS	$53,000	$39,000	$14,000
Supplies	LS	$0	$0	$0
Utilities	LS	$193,000	$144,000	$49,000
TOTAL ANNUAL OPERATION COST		$769,000	$571,000	$198,000

OPTION 1B: EXPAND & UPGRADE NDWWTP TO SECONDARY TREATMENT

Cost Categories	Quantity	Cost Est.	GWA Cost Est.	DoD Cost Est.
Labor & Benefits	LS	135,000	100,000	35,000
Capital Improvements	LS	0	0	0
Chemicals	LS	201,000	150,000	51,000
Collection	LS	1,000	0	1,000
Contract Services	LS	622,000	463,000	159,000
Maintenance	LS	200,000	149,000	51,000
Supplies	LS	0	0	0
Utilities	LS	1,930,000	1,436,000	494,000
TOTAL ANNUAL OPERATION COST		3,089,000	2,298,000	791,000

EarthTech
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PROJECT COMPUTATION SHEET

Client: NAVFEC
Project: Final Report for Utility Study on MC Relocation to Guam
Design Calculations
File Name: 101177 preliminary_cost
Latest Revision: 30-Jun-08

Subject: Annual O&M Cost Estimation

OPTION 2: DOD SECONDARY TREATMENT ON DoD LAND

Cost Categories	Quantity	Cost Est.	DoD Cost Est.
Labor & Benefits	LS	465,000	465,000
Capital Improvements	LS	0	0
Chemicals	LS	62,000	62,000
Collection	LS	8,000	8,000
Contract Services	LS	260,000	260,000
Maintenance	LS	251,000	251,000
Supplies	LS	0	0
Utilities	LS	494,000	494,000
TOTAL ANNUAL OPERATION COST		1,540,000	1,540,000

OPTION 3: SECONDARY TREATMENT AT NDWWTP SITE TO TREAT DoD LOAD ONLY

Cost Categories	Quantity	Cost Est.	DoD Cost Est.
Labor & Benefits	LS	465,000	465,000
Capital Improvements	LS	0	0
Chemicals	LS	62,000	62,000
Collection	LS	9,000	9,000
Contract Services	LS	260,000	260,000
Maintenance	LS	251,000	251,000
Supplies	LS	0	0
Utilities	LS	494,000	494,000
TOTAL ANNUAL OPERATION COST		1,541,000	1,541,000

Project Life (yrs) 20
Interest Rate (%) 4

LIFE CYCLE COST COMPARISON

ITEM		DESCRIPTION	OPTION 1A Expand & Upgrade NDWWTP Primary Treatment	OPTION 1B Expand & Upgrade NDWWTP to Secondary Treatment	OPTION 2 DoD Secondary Treatment Facility on DoD Land	OPTION 3 Separate Secondary Treatment Facility at NDWWTP to Treat DoD Load Only
A.		**Estimated Capital Cost**				
	1	Headworks	$1,529,000	$1,529,000	$4,313,000	$4,313,000
	2	Primary Clarifiers	$6,465,000	$6,465,000	$8,724,000	$8,724,000
	3	Pumping Stations	-	$2,759,000	$2,281,000	$2,281,000
	4	Trickling Filters	-	$26,783,000	$10,994,000	$10,994,000
	5	Secondary Clarifiers	-	$34,728,000	$13,242,000	$13,242,000
	6	Chlorine Contact Tanks	$2,596,000	$2,596,000	$4,296,000	$4,296,000
	7	Anaerobic Digesters	$10,266,000	$30,797,000	$30,797,000	$30,797,000
	8	Sludge Thickening & Dewatering System	$11,214,000	$11,214,000	$10,518,000	$10,518,000
	9	Influent & Effluent Samplers	$159,000	$159,000	$159,000	$159,000
	10	Site Work & Utilities	$2,256,000	$8,192,000	$5,973,000	$5,973,000
	11	Sewer Interceptors	$4,181,000	$4,181,000	$24,340,000	$27,526,000
	12	Effluent Transmission Line	-	-	$3,319,000	-
	13	Ocean Out Fall & Piping	$621,000	$621,000	$8,729,000	$621,000
	14	Project Services	$13,751,000	$45,509,000	$44,690,000	$41,806,000
		TOTAL	**$53,038,000**	**$175,533,000**	**$172,375,000**	**$161,250,000**
B.		**Estimated Annual O&M Cost**				
	1	Labor & Benefits	$45,000	$135,000	$465,000	$465,000
	2	Chemicals	$216,000	$201,000	$62,000	$62,000
	3	Collection	$1,000	$1,000	$8,000	$9,000
	4	Contract Services	$261,000	$622,000	$260,000	$260,000
	5	Maintenance	$53,000	$200,000	$251,000	$251,000
	6	Utilities	$193,000	$1,930,000	$494,000	$494,000
		TOTAL	**$769,000**	**$3,089,000**	**$1,540,000**	**$1,541,000**
C. Annual		**Costs**				
	1	Amortized Capital Cost	$3,903,000	$12,916,000	$12,684,000	$11,865,000
	2	Estimated Annual O&M Cost	$769,000	$3,089,000	$1,540,000	$1,541,000
		TOTAL	**$4,672,000**	**$16,005,000**	**$14,224,000**	**$13,406,000**

Appendix C
Detailed Analysis for Option 7 - Build a New Tertiary Treatment Plant near Proposed Development on DoD LAND and Install Injection Wells

Build a New Tertiary Treatment Plant near Proposed Development and Install Injection Wells

Tertiary treatment in municipal wastewater treatment practice normally refers the technologies that remove residual suspended solids, and potentially dissolved solids and trace constituents after secondary treatment, as required for specific water reuse application. For residual suspended solids removal, medium filtration, surface filtration, or membrane technology can be used. Total dissolved solids are normally removed by Reverse Osmosis (RO), and trace constituents by advanced oxidation.

This alternative includes the proposed DoD owned tertiary wastewater treatment plant at the southern end of proposed future USMC relocation site in the Finegayan area. It provides tertiary treatment for all the wastewater generated by military activities in the Northern Guam area, and treated effluent would be injected into the underground aquifer for groundwater replenishment and will increase groundwater sustainability of the Northern Guam Aquifer. With the Northern Guam Lens aquifer being designated by the EPA as a Sole Source Aquifer under the Safe Drinking Water Act, any planned groundwater recharge with reclaimed water is anticipated to be required to treat and achieve the relevant regulatory standards for indirect potable reuse, since later on it will be pumped out for potable water supply. Indirect potable reuse was defined by Metcalf & Eddy (2007) as *"The planned incorporation of reclaimed water into a raw water supply, such as in potable water storage reservoir or a groundwater aquifer, resulting in mixing, dilution, and assimilation, thus providing an environmental buffer."*

The planned DoD tertiary plant will treat the same influent flow and loading as presented in Table 6-6 of Section 6.1.3.

An independent sewer that connects the AAFB collection system at its main gate Lift Station 1881, runs along the Route 3, and combines the flow generated by USMC from Finegayan, will carry wastewater into the proposed DoD tertiary treatment plant at the southern end of Finegayan as shown on Figure C-1 attached at the end of the Appendix.

At present, there are no Federal regulations that specifically address indirect or direct potable reuse of reclaimed water. The EPA developed Guidelines for Water Reuse in 2004 and suggested the quality standard for treated municipal wastewater injection into underground potable aquifer as listed in the following Table C-1.

Table C-1: EPA Guidelines of Water Reuse for Groundwater Recharge by Injection into Potable Aquifers

Types of Reuse	Treatment	Reclaimed Water Quality	Reclaimed Water Monitoring	Setback Distances	Comments
Groundwater recharge by injection into potable aquifers	Secondary Filtration Disinfection Advanced wastewater treatment	Includes, but not limited to, the following: pH = 6.5 – 8.5 <= 2 NTU No detectable total coli/100 ml 1mg/l Cl_2 residual (minimum) <= 3 mg/L TOC <= 0.2 mg/L total toxics Nitrate N < 10 mg/L Meet drinking water standards	Includes, but not limited to the following: pH - daily Turbidity – continuous Total coliform – daily Cl_2 Residual – continuous Drinking water standards – quarterly Other – depends on constituent	2000 ft to extraction wells. May vary depending on site-specific conditions.	The reclaimed water should be retained underground for at least 9 months prior to withdrawal. Monitoring wells are necessary to detect the influence of the recharge operation on the groundwater. Recommended quality limits should be met at the point of injection. The reclaimed water should not contain measurable levels of viable pathogens after percolation through the vadose zone. A higher chlorine residual and/or a longer contact time may be necessary to assure virus and protozoa inactivation.

Source: EPA 2004
NTU nephelometric turbidity unit
TOC total organic carbon

California, Florida, and a few other states are in the forefront of developing discrete criteria relating to planned indirect potable reuse of reclaimed water. California has prepared draft criteria for groundwater recharge (the most recent being in 2004), and are shown in the Table C-2.

Table C-2: California Draft Groundwater Injection Regulations

Parameter	Requirement
Turbidity	0.2 NTU
Total nitrogen	5 mg/L
Total coliforms	2.2 total coliform/100 mL
TOC	0.5 mg/L
Set back distance	2,000 ft
Retention time underground	12 month
Drinking water standards	Meet all drinking water maximum contaminant levels (except nitrogen and new federal and state regulations as they are adopted)

Source: *Draft groundwater Recharge Regulations*, California Department of Health Services

With concerns on reliability of some unregulated trace constituents removal, and consideration of source water that meets all drinking water standards, it does not necessarily indicate that the water is safe. The above California drafted groundwater injection regulation reflects the mitigations necessary to address these concerns. In present practice, reclaimed injection into an underground potable aquifer normally has a multiple barrier protection system (such as RO and advanced oxidation process) for advanced treatment to avoid unknown potential health risks.

The northern part of Guam is set on a karst limestone high plateau, where highly porous and channelized limestone sub surface media with a high hydraulic conductivity exist. From ground surface to groundwater surface is approximately 200 feet to 350 feet. This geology provides little reliable opportunity for soil aquifer treatment, which offers additional treatment as water passes

through the soil vadose zone to an underlying aquifer. Due to limited surface area contact, flow through fractured limestone media may offer inefficient soil aquifer treatment.

Since groundwater under direct influence from surface water in the Northern Guam area has already been a concern to the GEPA, to gain public confidence on the practice of injecting reclaimed water directly into potable aquifer in a karst limestone region, the treatment processes train similar to California practice is used for this study. Groundwater recharge with reclaimed water in the Orange County Groundwater Replenishment Project, which treats secondary effluent from Orange County Sanitation District Plant # 1, employs a process including microfiltration, RO, advanced oxidation with ultraviolet (UV), and hydrogen peroxide.

A treatment process schematic flow diagram of the DoD tertiary waste water treatment plant (WWTP) is shown on Figure C-2 attached at the end of the Appendix.

Influent sewage flow will enter the treatment plant through two rotary drum fine screens at the headworks and pass through two aerated grit removal chambers. Each chamber will be approximately 45 feet long and 12 feet wide with a 7-foot water depth. Grit and screenings are disposed of in a sanitary landfill.

Primary treatment includes three primary clarifiers, each 60 feet in diameter with a 10-foot side water depth. Primary treated effluent is pumped into a flow distribution box and subsequently distributed into four rectangular membrane bioreactors each 80 feet long, 45 feet wide and 20 feet deep. Each membrane bioreactor (MBR) consists of four sections (pre-anoxic, aeration, membrane, and post-anoxic). The pre- and post-anoxic sections are used for denitrification. The aeration section degrades organic material and performs nitrification, and the membrane section provides solid and liquid separation. An inline pre-chlorination injection, followed by an inline dechlorination system destroys residual biological matter within the MBR effluent preventing biological fouling and chlorine oxidation within the RO system. Disinfected water is then fed by pumps into a RO system. The RO membranes remove a substantial portion of dissolved organic and inorganic components as well as viruses, producing permeate with low total dissolved solids (TDS) and total organic carbon (TOC) levels. RO permeate will be treated by an advanced oxidation process (AOP) with UV/hydrogen peroxide to destroy trace constituents such as synthetic organic chemicals. The purity of the permeate stream results in a water that is moderately corrosive. To stabilize the product water prior to underground injection, AOP treated water will be treated by decarbonation and lime addition. Reclaimed water is pumped out through a transmission pipeline to injection wells and recharged into the underground aquifer. The rejection water from the RO process is concentrated with constitutes such as salts and other dissolved solids. It can be discharged via a new ocean outfall or into the GWA sewer for disposal.

Membrane Bioreactor

The MBR combines biological treatment with an integrated membrane system. It can provide enhanced organics and suspended solids removal for the wastewater treatment plant. MBR achieves biological treatment to organic matter using conventional suspended growth activated sludge treatment in a bioreactor, and subsequently uses a membrane for separating treated wastewater from the active biomass in a suspended growth system. By coupling a biological reactor with a membrane system, conventional treatment operation such as gravity sedimentation and media filtration can be eliminated and it will produce an equivalent tertiary treatment effluent. The MBR requires less overall space. In this alternative, the MBR was utilized as a single one step process unit to achieve the required tertiary treatment for removing suspended and colloidal solids, including bacteria and protozoa, prior to RO treatment.

There are several types of MBRs. Figure C-3 (attached at the end of this Appendix) shows the types of MBRs available. They can be either internally immersed in the bioreactor or external to the bioreactors, including:

Flat Plate: The flat plate membrane is a submerged unit with the following operating characteristics:

- Operates with the pre-aeration basins at low dissolved oxygen (DO) concentration in the range of 0.2 milligrams per liter (mg/L) to 0.8 mg/L.
- Speed of the blowers is controlled by the measured residual DO.
- Air is cycled to maintain mixed liquor DO between 0.2 mg/L and 0.6 mg/L.
- Flat plate membranes reduce the potential for fouling.
- Reduces cleaning cycles.
- 6-log removal of bacteria and 4-log removal of viruses.
- Chemical clean in-place every 6 months with bleach.

External: External membranes are tubular membranes located on skids outside the oxidation ditch.

- Requires fine screen of 1.0 millimeter.
- External membrane skids located on a concrete slab next to the bioreactors.
- Tubular membranes, installed inside protective polyvinyl chloride vessels.

Hollow Fiber: Hollow fiber membranes are strands assembled together in a unitary rack.

- Immersed in the aeration tank.
- Available with reinforced and unreinforced membrane design.

All MBR designs offer the following advantages:

- Pretreatment requirements for subsequent reverse osmosis system for TDS control are provided.
- Secondary clarifiers and Return Activated Sludge pumping is not required.
- California Title 22 requirements, which have stringent requirements on suspended solids, bacteria and protozoa removal, are met by this process.
- Ability to remove nitrogen and phosphorus.
- Washout of solids and sludge bulking are not an issue.
- Reduced disinfection requirements

RO System

The RO system can separate a solvent, such as water, from a saline solution by using a semi-permeable membrane and hydraulic pressure. The RO membranes will remove a substantial portion of dissolved organic and inorganic components, producing permeate with low TDS and TOC.

Within the RO system, the pretreated feed will be separated into a purified permeate stream and concentrated brine stream. Based on the design water quality analyses, the RO system is normally designed for product water recoveries between 80 percent and 90 percent.

The RO membrane is a key treatment process for this integrated membrane reclaimed water plant. In practice, the selection of RO semi-permeable membranes will require pilot tests to determine the optimum continuing recovery rate and the latest low fouling membranes from various manufacturers.

The RO system will be comprised of discrete modular membrane trains housing the pressure vessels and spiral wound RO membrane elements. Wound depth type cartridge filters will be employed upstream of the RO membrane trains to protect against incidental particulate matter, which may enter the system and could potentially foul the RO membrane elements.

Each RO train will be equipped with a single, non-redundant high pressure membrane feed pump. For the selected RO train capacity, vertical turbine canned pumps will be used. Figure C-4 attached at the end of the Appendix shows a typical RO membrane system.

Advance Oxidation Process (AOP)

For reclaimed water indirect potable reuse, AOP may be used to destroy trace constituents including a variety of natural and synthetic organic carcinogens such as dioxane and N-nitrosodimethyamine (NDMA) that cannot be removed or destroyed by tertiary treatment and conventional oxidants to protect public health and the environment.

The AOP in the plant will provide an additional barrier beyond MBR/RO for the inactivation of bacteria and viruses in water reclaimed for groundwater aquifer injection.

The UV system design is based on treating 4.5 mgd of RO product water on a continuous basis for groundwater injection. Four logs of virus inactivation are required for normal operation of the UV system. Overall the MF/RO/UV treatment system will provide multiple barriers and a total of six-logs of virus removal. The UV design basis for destruction of NDMA assumes treatment of an inlet concentration of up to 150 parts per trillion (ppt) to an outlet concentration of 10 ppt. Figure C-4 attached at the end of the Appendix shows a typical UV system.

Wasted sludge from the MBR process is pumped to a Gravity Belt Thickener (GBT) system for reducing sludge water content, and two, 125 gpm GBT are included. Thickened sludge combined with primary sludge generated by primary clarifiers is pumped into a 2-stage anaerobic digestion system, which has two first-stage anaerobic digesters and one secondary anaerobic digester. Each digester has a 80-foot diameter and 18-foot side water depth. Digested sludge is subsequently dewatered by two centrifuges with a capacity of 125 gpm each. Finally, dewatered cake is hauled out as Class B solids for offsite disposal.

A summary of the major process components for a new DoD tertiary treatment plant near the proposed development and installation of injection wells are listed in Table C-3.

Table C-3: Major Process Components for Building a New DoD Tertiary Treatment Plant near Finegayan Development and Constructing New Groundwater Injection Wells

Construction Components	Unit	Dimensions/Description
Headwork	1	2 Rotary drum fine screens 2 Aerated grit chambers, each 45 ft long x 12 ft wide x 7 ft SWD
Primary clarifier	3	60 ft diameter x 10 ft SWD

Construction Components	Unit	Dimensions/Description
Membrane bioreactor	4	80 ft long x 45 ft wide x 20 ft SWD
Prechlorination / Dechlorination	1	Two 500 lbs/day chlorinators
RO system	1	75 modules each 120 gpm
Advance oxidization system	1	Two 4,500 gpm modules
Anaerobic digester	3	80 ft diameter x 18 ft SWD
Sludge gravity belt thickener	2	125 gpm each
Sludge dewatering centrifuges	2	125 gpm each
RO brine disposal line	1	30 in diameter, 7,500 ft long
Effluent transmission line	1	Approx. 7.5 miles
Injection wells	2	36 in casings
Monitoring wells	3	6 in casings

Reclaimed Water Transmission Line and Underground Injection Wells

Maximum wastewater production resulting from transfer of DoD assets to Guam is estimated at 4.1 mgd. Groundwater injection is one potential means of disposal of wastewater effluent. This option would use the highly treated wastewater effluent to recharge the freshwater lens at a location that would support the proposed new production wells on the AAFB property. Physical locations and the proposed layout of recharge wells for this scenario are shown on Figure C-1 attached at the end of the Appendix.

Under the disposal option, four recharge wells would be located parallel to Marine Drive on the southern boundary of the AAFB. The injection wells are arrayed in a line conforming to a ridge in the volcanic basement below the water bearing limestone. The ridge was chosen because the proposed production wells for the DoD expansion on Guam will be located on either side of the volcanic basement ridge allowing the injected effluent to directly recharge the portions of the aquifer that will be heavily pumped to supply water for new military and support personnel arriving on Guam. There are two injection wells proposed with approximately 1,000 feet of spacing between them. Each well would be capable of a recharge rate of approximately 1,600 gpm yielding a maximum combined injection rate of 3,200 gpm. Under non-peak loads, one to two wells would be operated allowing distribution of effluent recharge across a 2,000-foot front while enabling at least one well to be removed from service for maintenance and upkeep. The Water Utility Study provides details of the design and construction of the water injection wells.

Under this recharge option highly treated effluent is pumped from the proposed DoD WWTP facility to the injection wells. The proposed effluent pipeline runs along Route 3 (a light duty all weather road) and Marine Drive. The proposed line crosses Salisbury junction at 616 feet, just before the recharge wells. The proposed 18-inch force main is approximately 40,000 feet long.

The effluent pump station will have three vertical turbine pumps, where two pumps are in operation and one is standby. It is estimated that each pump needs to pump 1,500 gpm with a total dynamic head of 388 feet. The recommended pump is a 5-stage 15H at 1, 770 revolutions per minute with a 250 HP motor. The pumps should be provided with variable frequency drives and automated controls.

Emergency Bypass or Alternative Disposal of Effluent in Case of Non-Availability of Injection Wells

In case of plant failure or when effluent can not meet the groundwater injection standards due to process problems, two alternatives are evaluated. The first one is to discharge through a 30" ocean outfall. The second option is to discharge to GWA sewer. The constriction cost estimate included cost for these two options.

A summary of preliminary construction cost estimates for this option is provided in Table C-4.

Table C-4: Preliminary Construction Cost for Option 7 – Build a New Tertiary Treatment Plant Near Proposed Development and Install Injection Wells

1. Component xxx	Guam Wastewater Utility Study			2. Date July, 2008
3. Installation and Location Marine Relocation	4. Project Title Guam Wastewater Utility Study			
5. Program Element	6. Category Code	7. Project Number	8. Project Cost ($000)	
			294,400,	

9. COST ESTIMATES

Item	U/M	Quantity	Unit Cost	Cost ($000)
Headworks Expansion				
Reinforced Concrete	CY	400	$2,124	850
Earthwork	CY	1,400	$106	149
Fine Screenings Equipment	EA	2	$292,035	584
Grit Chamber Equipment	EA	2	$106,195	212
Grit Pumps Equipment	EA	2	$58,407	117
Grit Washer Equipment	EA	2	$185,841	372
Miscellaneous Metals	LS	1	$114,159	114
Frap Weirs	LS	1	$68,496	68
Protective Coatings	LS	1	$192,743	193
Piping and Valves	LS	1	$570,796	571
Instrumentation/SCADA	LS	1	$159,823	160
Electrical	LS	1	$342,478	342
Grit & Screenings Building	LS	1	$799,115	799
Primary Clarifier				
Reinforced Concrete	CY	1,500	$2,124	3,186
Earthwork	CY	2,200	$106	234
Sludge and Scum Collector Equipment	EA	3	$424,779	1,274
Miscellaneous Metals	LS	1	$234,690	235
Fro Weirs	LS	1	$140,814	141
Protective Coatings	LS	1	$509,735	510
Piping and Valves	LS	1	$140,814	141
Instrumentation/SCADA	LS	1	$187,752	188
Electrical	LS	1	$469,381	469
Sludge Pump Station Improvements	LS	1	$2,346,903	2,347
Membrane Bioreactors				
Reinforced Concrete	CY	4,800	$2,124	10,195
Earthwork	CY	4,400	$106	467
MBR System Equipment	EA	4	$5,575,221	22,301
Miscellaneous Metals	LS	1	$1,648,142	1,648
Fro Weirs and Gates	LS	1	$329,628	330
Protective Coatings	LS	1	$1,599,292	1,599
Piping and Valves	LS	1	$5,274,053	5,274
Instrumentation/SCADA	LS	1	$2,307,398	2,307
Electrical	LS	1	$4,944,425	4,944
MBR Pump and Blower Building	LS	1	$6,104,071	6,104

Item	U/M	Quantity	Unit Cost	Cost ($000)
Reverse Osmosis				
Reinforced Concrete	CY	500	$2,124	1,062
Earthwork	CY	600	$106	64
Reverse Osmosis System	LS	1	$13,008,850	13,009
Miscellaneous Metals	LS	1	$706,726	707
Roofing and Insulation	LS	1	$424,035	424
Protective Coatings	LS	1	$168,850	169
Piping and Valves	LS	1	$424,035	424
Instrumentation/SCADA	LS	1	$989,416	989
Electrical	LS	1	$2,120,177	2,120
Reverse Osmosis Building	LS	1	$2,402,867	2,403
Advanced Oxidation Process				
Reinforced Concrete	CY	400	$2,124	850
Earthwork	CY	600	$106	64
Ultraviolet and Peroxide Feed System	LS	1	$2,867,257	2,867
Miscellaneous Metals	LS	1	$226,832	227
Protective Coatings	LS	1	$136,991	137
Piping and Valves	LS	1	$1,323,186	1,323
Instrumentation/SCADA	LS	1	$264,637	265
Electrical	LS	1	$567,080	567
Anaerobic Digesters				
Reinforced Concrete	CY	3,000	$2,124	6,372
Earthwork	CY	4,200	$106	446
Digester Mixing and Heating Equipment	EA	3	$2,123,894	6,372
Miscellaneous Metals	LS	1	$791,363	791
Roofing and Insulation	LS	1	$725,416	725
Protective Coatings	LS	1	$1,978,407	1,978
Piping and Valves	LS	1	$4,616,283	4,616
Instrumentation/SCADA	LS	1	$923,257	923
Electrical	LS	1	$1,978,407	1,978
New Sludge Pump Station	LS	1	$6,594,690	6,595
Thickening and Dewatering Building				
Reinforced Concrete	CY	1,500	$2,124	3,186
Earthwork	CY	4,000	$106	425
Masonry Interior Walls	LS	1	$469,381	469
Miscellaneous Metals	LS	1	$433,274	433
Fro Grating	LS	1	$108,319	108
Roofing and Insulation	LS	1	$505,487	505
Doors and Windows	LS	1	$90,265	90
Protective Coatings	LS	1	$216,637	217
Building Specialties	LS	1	$36,106	36
Thickener Feed Pump	EA	2	$79,646	159
Thickener Polymer Feed System	EA	2	$238,938	478
Thickener Polymer Feed Pump	EA	2	$21,239	42
3.0 Meter Gravity Belt Thickener	EA	2	$477,876	956
Thickened Sludge Pump	EA	2	$79,646	159
Sludge Grinders	EA	2	$63,717	127
Sludge Feed Pumps	EA	2	$79,646	159
Polymer Feed System	EA	2	$238,938	478
Polymer Feed Pumps	EA	2	$21,239	42
Odor Control System	EA	1	$477,876	478
Centrifuges	EA	2	$1,274,336	2,549
Process Piping and Valves	LS	1	$649,912	650
HVAC	LS	1	$541,593	542
Plumbing	LS	1	$361,062	361
Electrical	LS	1	$1,805,310	1,805
Instrumentation/SCADA	LS	1	$397,168	397

Item	U/M	Quantity	Unit Cost	Cost ($000)
Influent and Effluent Samplers				
Automatic Samplers	EA	2	$79,646	159
Site Work and Utilities				
Paving, Grading, and Yard Piping	LS	1	$9,933,305	9,933
Sewer Interceptor (I), 24" D	FT	33,300	$558	18,565
Sewer Interceptor (II), 30" D	FT	8,700	$664	5,774
RO Brine Disposal Out Fall Line	FT	2,400	$3,637	8,729
Effluent Pumping Station	LS	1	$2,920,354	2,920
Effluent Transmission Line	FT	40,000	$478	19,115
Injection Well Heads	EA	2	$584,071	1,168
Monitoring Wells	EA	3	$159,292	478
Treatment Cost				156,404
Sewer Cost				52,184
Sub Total				208,588
Project Services 35.00%				73,006
Total Contract Cost				342,818
Total Request				342,818
Total Contract Cost				281,594
Total Request				281,594
Total Request (Rounded)				281,590
Total Escalated 2010 Request (Rounded)				294,400
Total Escalated 2013 Mid-Point Construction Cost (Rounded)				312,740
Total Request for USMC (Rounded)				157,410
Total Escalated 2010 Request for USMC (Rounded)				164,570
Total Escalated 2013 Mid-Point Construction Cost for USMC (Rounded)				174,820

10. Description of Proposed Construction:

DoD will be constructing a new tertiary treatment plant which includes

1. Two sewer interceptors
2. Head works: Fine screening and Grit chamber
3. Primary treatment: Three primary Clarifiers
4. Tertiary treatment: Four MBRs, one Reverse Osmosis, and One Advanced Oxidation Unit
5. Solid Stabilization: Two Gravity Belt Thickeners, Two Primary Anaerobic Digesters and One Secondary Anaerobic Digester
6. Solids Dewatering: Two Centrifuges and solids dewatering building
7. Effluent Transmission line to recharge wells
8. Four injection wells and three monitoring wells.

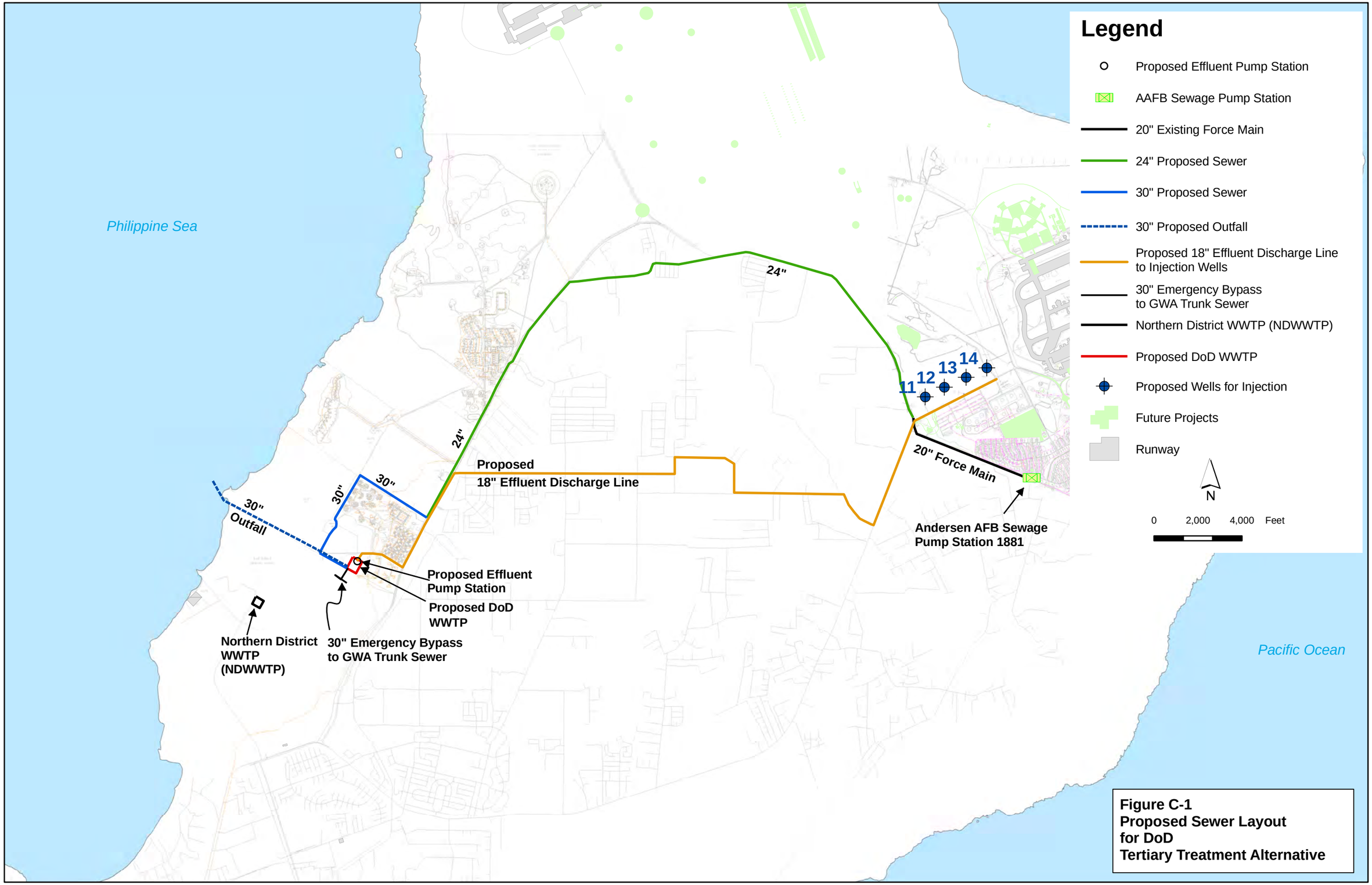

Figure C-1
Proposed Sewer Layout
for DoD
Tertiary Treatment Alternative

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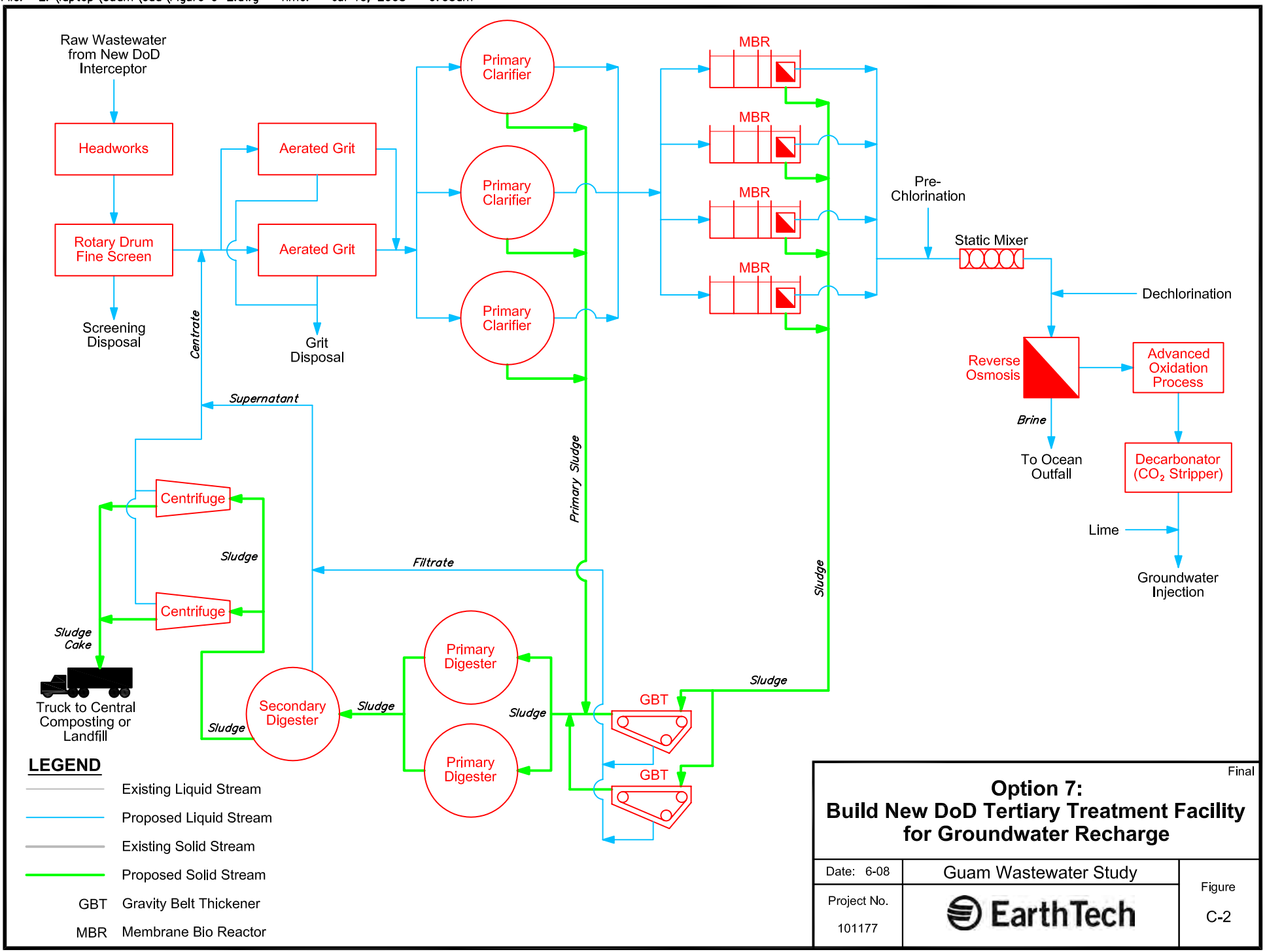

Final

Option 7: Build New DoD Tertiary Treatment Facility for Groundwater Recharge

Date: 6-08	Guam Wastewater Study	Figure C-2
Project No. 101177	EarthTech	

Flat Plate
Source: Enviroquip Inc.

External
Source: Parkson Inc

Hollow Fiber
Source: GE-Zenon

Figure C-3
Types of MBRs

Reverse Osmosis Membrane

In-Line UV System

Figure C-4
Typical RO Membrane and UV System

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Evaluation of Northern District Wastewater Treatment Plant Capacity

December 2009

Department of the Navy
Naval Facilities Engineering Command, Pacific
258 Makalapa Drive, Suite 100
Pearl Harbor, HI 96860-3134

Contract Number N62742-06-D-1870, CTO 0011

Evaluation of Northern District Wastewater Treatment Plant Capacity

December 2009

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Contract Number N62742-06-D-1870, CTO 0011

The *Guam Joint Military Master Plan* identified a planned increase in military population on Guam. Naval Computer and Telecommunications Station Finegayan, South Finegayan Housing Area, Andersen Air Force Base (AFB), Andersen AFB Northwest Field, and Andersen AFB South provide potential locations for most of the planned United States Marine Corps relocation to Guam. Sewage from these locations is conveyed to the Guam Northern District Wastewater Treatment Plant (NDWWTP) for treatment and disposal. The NDWWTP is owned and operated by the Guam Waterworks Authority (GWA).

Projected utility load growth on Guam is expected to be significant because of the current Guam Defense Policy Review Initiative (DPRI) Marine Movement. The load is also expected to sharply increase and then decrease during the construction and commissioning phases of DPRI facilities/utilities. This study would be used to determine whether existing NDWWTP capacity would be adequate to accommodate the load spurt.

Based on the findings presented in the *Guam Wastewater Utility Study for Proposed USMC Relocation* (Earth Tech 2008) and recent discussions with GWA staff, Naval Facilities Engineering Command retained AECOM to evaluate the individual unit processes and the overall capacity of the NDWWTP. This report identifies existing capacity and the improvements, along with their costs, needed to bring the NDWWTP to its full capacity as an advanced primary treatment plant.

During the week of 5 October 2009, AECOM reviewed the available plant data, reviewed the plant as-built drawings, conducted interviews with GWA plant personnel and management, and evaluated each treatment process of the plant. The following processes are evaluated in Section 3 of this document:

- Preliminary treatment
- Primary treatment
- Disinfection
- Effluent disposal
- Solids handling

Based on the as-built drawings and available data, the theoretical capacity of the NDWWTP with and without improvements was determined. The theoretical capacity of each unit treatment process is evaluated with consideration of equipment reliability/redundancy requirements. The NDWWTP is a United States Environmental Protection Agency (USEPA) Class III facility, and its reliability requirements are discussed in detail in the report. Table ES-1 provides the theoretical unit process capacity of each process at the NDWWTP for the current condition (i.e., without any improvements) and the originally designed condition (i.e., with necessary improvements).

Table ES-2 provides the overall theoretical plant capacity of the NDWWTP for the current condition and the originally designed condition.

Table ES-1: Theoretical Capacity of Unit Process at the NDWWTP without and with Improvements

Unit Process	USEPA Reliability Class	Theoretical Capacity for Current Condition (AADF-MGd)	Theoretical Capacity as Designed (AADF-MGd)
Preaeration Tanks	III	8.85	17.69
Aerated Grit Chambers	III	7.96	15.92
Primary Clarifiers	III	16.68	16.68
Chlorine Contact Tanks	III	6.13	12.26
Anaerobic Digesters	III	0.00	29.75
Sludge-Drying Beds	III	4.25	4.25
Dewatering Centrifuges	III	0.00	17.58

AADF annual average daily flow
CWA Clean Water Act
MGd million gallons per day

Table ES-2: Theoretical Capacity of the NDWWTP without and with Improvements

Overall Plant Capacity	Theoretical Capacity for Current Condition (AADF-MGd)	Theoretical Capacity as Designed (AADF-MGd)
Plant Capacity without CWA 301(h) Waiver		
with On-Site Sludge Treatment	4.25	12.26
with Off-Site Sludge Treatment	6.13	12.26
Plant Capacity with CWA 301(h) Waiver		
with On-Site Sludge Treatment	4.25	15.92
with Off-Site Sludge Treatment	7.96	15.92

A Clean Water Act (CWA) 301(h) waiver does not require chlorinated effluent. Therefore, the treatment capacity of the NDWWTP under the waiver is not limited by its chlorine disinfection facilities. Currently, primary sludge generated at the NDWWTP is hauled to GWA Hagatna Wastewater Treatment Plant for treatment as a supplementary practice to compensate for the deficient sludge-handling capacity at the NDWWTP. If the NDWWTP operates with on-site sludge handling, its overall plant capacity in terms of treating annual average daily influent flow is 4.25 million gallons per day (MGd) under current conditions and 12.26 MGd as designed. The current plant capacity is limited by the plant sludge treatment capacity, which is determined only by the sludge-drying beds; the other sludge-handling components, such as the digesters and sludge dewatering system, are obsolete. After the necessary improvements are made, the plant capacity will be determined by its liquid stream treatment capacity rather than its solids handling capacity.

Based on field evaluation, AECOM recommended both short-term improvements and long-term improvements to restore the NDWWTP primary treatment capacity. Short-term improvements are those improvements required for immediate influent flow increases, and long-term improvements are those improvements required for when the influent flows approach 10–12 MGd.

The following short-term improvements are required for the NDWWTP in descending priority based on cost, capacity enhancement, performance enhancement, and reliability enhancement:

- Primary clarifier rehabilitation
- Sludge digester rehabilitation
- Standby power
- Headworks improvements

- Centrifuge building replacement and one centrifuge
- Septage and fat/oil/grease receiving station
- Sludge-drying bed rehabilitation

The following long-term improvements are required for the NDWWTP in descending priority based on cost, capacity enhancement, performance enhancement, and reliability enhancement:

- Third digester (new)
- Hydraulic improvements to chlorine contact tank
- Second centrifuge
- Odor control
- Digester gas utilization
- Administration/laboratory, office and workshop/storage areas rehabilitation

Details of the improvements and associated costs are provided in Sections 4 and 5 of this report. Tables ES-3, ES-4, and ES-5 present summaries of cost estimates for short-term improvements, long-term improvements, and an upgrade to advanced primary treatment, respectively.

Tables ES-6 and ES-7 identify the priority of proposed short-term and long-term improvements at the NDWWTP, respectively. The improvements are prioritized based on cost, capacity enhancement, reliability/redundancy enhancement, performance enhancement, and permit compliance.

Table ES-3: Preliminary Cost for Short-Term Improvements at the NDWWTP

Construction Categories	Quantity	Cost Opinion
Septage Receiving Station (new)	1	$1,317,400
Fat/Oil/Grease Receiving Station (new)	1	$565,500
Headworks (refurbished)	1	$1,972,100
Primary Clarifier (refurbished)	2	$4,858,400
Anaerobic Digester (refurbished)	2	$7,900,900
Solids Dewatering Building (replaced)	1	$3,428,300
Influent and Effluent Samplers (new)	2	$159,300
Sludge-Drying Bed (refurbished)	8	$79,600
Standby Diesel Generator	1	$398,200
Site Work and Utilities	Lump Sum	$1,320,000
Total Cost		$21,999,800
Project Services		$7,699,900
Total Estimated Cost – Guam		**$29,699,700**
Total Request (Rounded)		**$29,700,000**

Table ES-4 Preliminary Cost for Long-Term Improvements at the NDWWTP

Construction Categories	Quantity	Cost Opinion
Chlorine Contact Tank (refurbished)	2	$1,246,700
Anaerobic Digester (new)	1	$10,265,700
Digester Gas Utilization (new)	1	$2,188,300
Sludge-Dewatering Centrifuge (new)	1	$2,713,400
Odor Control System (new)	1	$477,900
Administration/Lab, Workshop and Storage (refurbished)	1	$633,700
Site Work and Utilities	Lump Sum	$1,120,600
Total Cost		$18,676,300
Project Services		$6,536,700
Total Estimated Cost – Guam		**$25,213,000**
Total Request (Rounded)		**$25,200,000**

Lab laboratory

Table ES-5: Preliminary Cost for Upgrading the NDWWTP to Advanced Primary Treatment

Construction Categories	Quantity	Cost Opinion
Chemical Building (new)	1	1,177,100
Site Work and Utilities	Lump Sum	75,100
Total Cost		$1,252,200
Project Services		$438,300
Total Estimated Cost – Guam		**$1,690,500**
Total Request (Rounded)		**$1,700,000**

Table ES-6: Prioritized Short-Term Necessary Improvements at the NDWWTP

Priority Order	Short-Term Necessary Improvements
1	Primary clarifier rehabilitation
1	Sludge digester rehabilitation
2	Standby power
3	Headworks improvements
4	Centrifuge building replacement and one centrifuge
5	Septage and fat/oil/grease receiving
6	Sludge-drying bed rehabilitation

Table ES-7: Prioritized Long-Term Improvements at the NDWWTP

Priority Order	Long-Term Improvements
1	Third digester (new)
2	Hydraulic improvements to the chlorine contact tank
3	Second centrifuge
4	Odor control
5	Digester gas utilization
6	Administration/laboratory, office, and workshop/storage areas rehabilitation

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AADF	annual average daily flow
AFB	Air Force Base
BOD	biochemical oxygen demand
BOD_5	5-day biochemical oxygen demand
CEPT	chemically enhanced primary treatment
CWA	Clean Water Act
DPRI	Defense Policy Review Initiative
FOG	fat/oil/grease
gal/day-ft^2	gallons per day per square foot
GWA	Guam Waterworks Authority
Lab	Laboratory
lb/day	pounds per day
MCC	Motor Control Center
MGd	million gallons per day
mg/L	milligrams per liter
NAVFAC	Naval Facilities Engineering Command
NDWWTP	Northern District Wastewater Treatment Plant
No.	number
PHF	peak hourly flow
swd	side water depth
TSS	total suspended solids
U.S.	United States
USEPA	United States Environmental Protection Agency

1. Introduction

1.1 PURPOSE

The purpose of this study is to evaluate the individual unit treatment process and the overall capacity of the Guam Northern District Wastewater Treatment Plant (NDWWTP), which is owned by the Guam Waterworks Authority (GWA). The study identifies the necessary improvements and preliminary costs required to bring the NDWWTP to its full capacity as an advanced primary treatment plant. Naval Facilities Engineering Command (NAVFAC), Pacific, under Master Contract No. N62742-06-D-1870, issued a task order amendment to The Environmental Company Joint Venture to evaluate and determine the present treatment capacity of the NDWWTP without any improvements and its optimum capacity with necessary improvements. The study also involves preparing a Military Construction 1391 document for upgrading the plant to its optimum capacity as an advanced primary treatment plant. During the week of 5 October 2009, AECOM visited NDWWTP in Guam and met with GWA staff to gather information regarding the treatment plant.

This report presents the findings of the evaluations conducted based on the information gathered during the field study; from correspondence with GWA plant and management personnel; and from review of plan files from previous studies, as-built drawings, and other documents that pertain to the NDWWTP.

1.2 BACKGROUND INFORMATION

The *Guam Integrated Military Development Plan*, formerly the *Joint Guam Military Master Plan*, identified a planned increase in military population on Guam. Naval Computer and Telecommunications Station Finegayan, South Finegayan Housing Area, Andersen Air Force Base (AFB), Andersen AFB Northwest Field, and Andersen AFB South provide potential locations for most of the planned United States (U.S.) Marine Corps relocation to Guam. Sewage from these locations is conveyed to the NDWWTP for treatment and disposal. The NDWWTP is owned and operated by the GWA.

Projected utility load growth on Guam is expected to be significant because of the current Guam Defense Policy Review Initiative (DPRI) Marine Movement. The load is also expected to sharply increase and then decrease during the construction and commissioning phases of DPRI facilities/utilities. This study would be used to determine whether existing NDWWTP capacity would be adequate to accommodate the load spurt.

Based on the findings presented in the *Guam Wastewater Utility Study for Proposed USMC Relocation* (Earth Tech 2008) and recent discussions with GWA staff, NAVFAC retained AECOM to evaluate the individual unit processes and the overall capacity of the NDWWTP. This report identifies existing capacity and the improvements, along with their costs, needed to bring the NDWWTP to its full capacity as an advanced primary treatment plant.

2. NDWWTP Background Information

The NDWWTP was commissioned in 1979 and is designated a U.S. Environmental Protection Agency (USEPA) Class III wastewater treatment plant. The plant is located on a limestone plateau along the northwestern coast of Guam, just inland of the Tanguisson beach area and north of the popular Two Lovers Point landmark. The plant is a primary treatment plant and services the most populous urban centers in northern Guam, Navy Finegayan, and Andersen AFB. The location of the treatment plant and aerial view of the treatment plant is shown in Figure 2-1 and Figure 2-2. The plant elevation is approximately 300 feet above mean sea level. Raw wastewater influent enters the NDWWTP via a 42-inch-diameter gravity line and via a 27-inch-diameter force main from GWA's

Southern Link Pump Station. The design average flow rate of the plant is 12.0 million gallons per day (MGd), and design peak flow rate is 27.0 MGd. However, the NDWWTP's current permitted limit is 6 MGd maximum day monthly flow under the National Pollutant Discharge Elimination System Permit No. GU0020141. The monthly average flow based on recent flow monitoring data is 5.7 MGd. The NDWWTP discharges treated effluent through a newly constructed 34-inch-diameter outfall into the Philippine Sea, approximately 2,100 feet offshore at a depth of approximately 140 feet, near Tanguisson Point. The monthly average total suspended solids (TSS) loads during the first half of 2009 ranged from 4,400 pounds per day (lb/day) to 10,900 lb/day, with an average of 6,600 lb/day. The monthly average 5-day biochemical oxygen demand (BOD_5) loads during the first half of 2009 ranged from 3,700 lb/day to 8,100 lb/day, with an average value of 5,220 lb/day. Monthly maximum daily flows during the same period exceeded the permit limit of 6 MGd in January, February, and March. Effluent BOD_5 concentration limits, effluent BOD_5 averaged monthly loadings, and effluent suspended solids concentration also exceeded permit limits on a number of instances during the first half of 2009.

The NDWWTP was originally designed to achieve primary treatment through the following processes. The plant schematic flow diagram is presented in Figure 2-3.

- Preliminary Treatment:
  - Comminution with stand-by manual bar screen
  - Odor control (ozonation)
  - Preaeration
  - Grit removal
- Primary Treatment:
  - Primary clarification
  - Scum removal
- Disinfection:
  - Chlorine contact tank
  - Scum removal
- Effluent Disposal:
  - Ocean outfall
- Solids Handling:
  - Anaerobic digestion
  - Dewatering
  - Sludge-drying beds

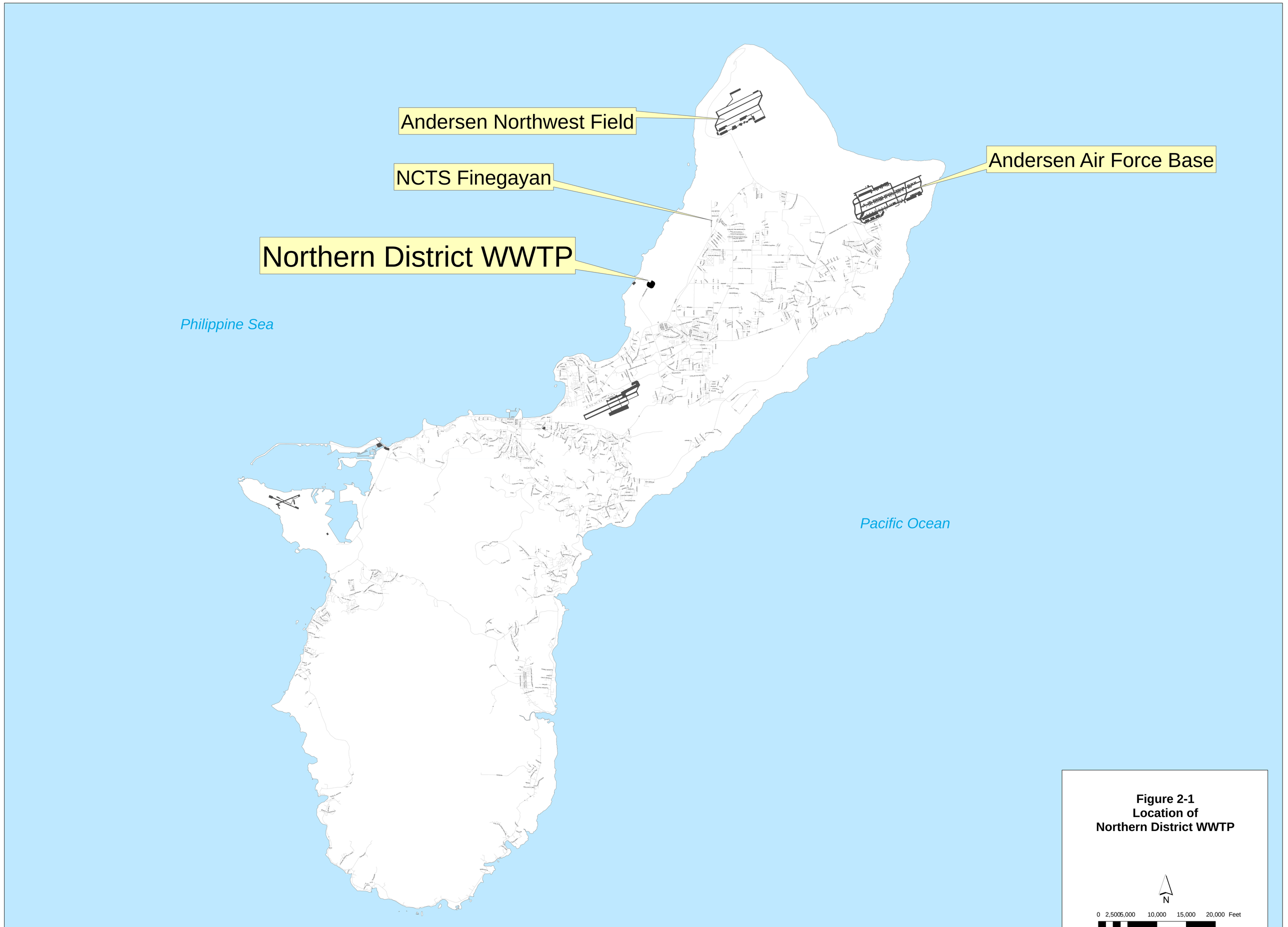
Andersen Northwest Field
NCTS Finegayan
Northern District WWTP
Andersen Air Force Base
Philippine Sea
Pacific Ocean
Figure 2-1
Location of
Northern District WWTP
N
0 2,500 5,000 10,000 15,000 20,000 Feet
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Figure 2-2
Aerial Northern District WWTP

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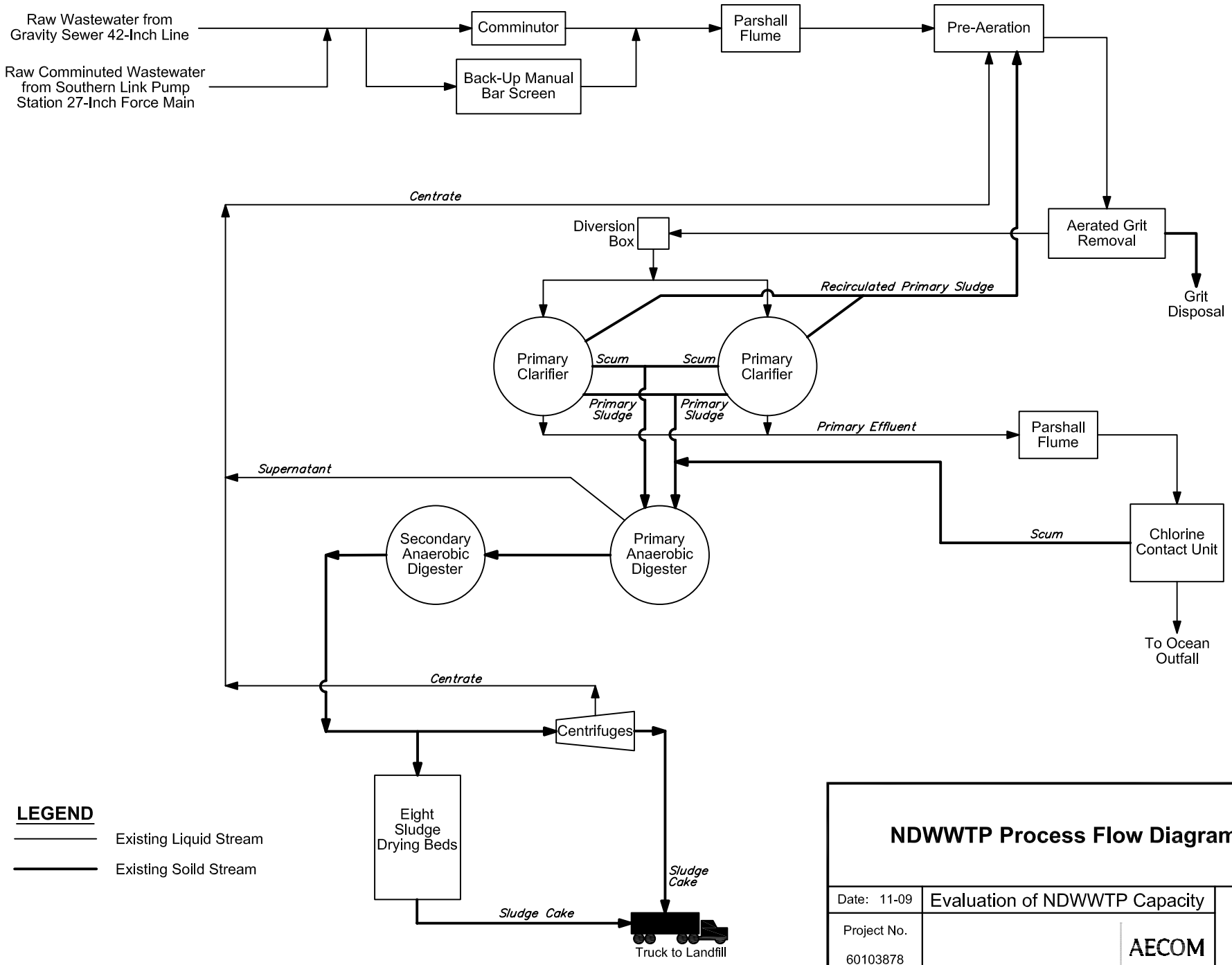

Final

NDWWTP Process Flow Diagram

Date: 11-09	Evaluation of NDWWTP Capacity	Figure 2-3
Project No. 60103878	AECOM	

3. Evaluation of Existing Facilities

3.1 ACTUAL DIMENSIONS/SIZE OF EXISTING FACILITIES

The actual dimensions of the existing treatment plant facilities were obtained from the *Comprehensive Performance Evaluation of the Northern District Sewage Treatment Plant*, March 2002; *Guam Water Resources Master Plan*, 2007; and as-built drawings of NDWWTP provided by GWA. The dimensions were confirmed during the plant visit. The actual dimensions of the existing treatment facilities of the NDWWTP are provided in Appendix A.

3.2 OBSERVATIONS OF TREATMENT PROCESS UNITS

During the week of 5 October 2009, an AECOM process engineer visited the plant, documented his observations, and took photographs of the treatment process areas. The field observations and photographs are included in Appendix B. The following sections summarize the observations made during the site visit.

3.2.1 Preliminary Treatment

The preliminary treatment and associated equipment for the NDWWTP are located at the headworks structure. Preliminary treatment as originally designed included an influent comminutor, a parallel bypass manually cleaned bar screen, preaeration tanks, and aerated grit removal chambers. The comminutor is obsolete and severely corroded and inoperable. Influent flow is diverted through the bar screen, and the slide gate in front of the comminutor is closed. The deficiency of the comminutor and the very wide openings (approximately 1.9 inches) between the bars of the bar screen reduce the effectiveness of pretreatment of the raw wastewater and allow rags and debris to pass through into the downstream processes.

Influent flow originally was measured using a Parshall flume and ultrasonic level-sensor. The level sensor is not operational, so flow is measured using manual depth readings. The Parshall flume is downstream of the communitor. Because of the way in which the influent channel upstream of the Parshall flume is configured, flow, and in particular the flow from the bypass bar screen, enters the channel from one side and causes a turbulent flow condition at the Parshall flume throat. The turbulent flow results in a water surface jump in the vicinity where depth is measured, causing inaccurate flow readings. A flow meter and a data logger are currently installed at the influent pipe manhole upstream of the plant headworks to provide temporary flow measurement.

The odor control system is disassembled and inoperable. Therefore, no odor control is provided at the headworks building. Of the two parallel preaeration tanks and aerated grit chambers, only one preaeration tank and one aerated grit chamber are inoperable. The submersible portion of the operated preaeration tank and grit chamber was not observed during the visit. The following observations were made at the preliminary treatment facility of the plant during the site visit:

- The headworks building entrance door was corroded.
- No explosion-proof lighting fixtures were present.
- Flume hydraulics were not suitable for accurate flow metering. Flow entering the flume was turbulent through the measuring zone because of poor approach geometry and high velocity through the turn in front of the flume.
- Door hardware (lockset) was missing from the door for the garden tool storage room.
- The lights and ventilation were inoperable in the blower room.

- The blowers and Motor Control Center (MCC) in the blower room appeared to be in good condition.
- The galvanized steel grating over the grit channel was severely deteriorated.
- The ventilation was inoperable in the grit channel.
- Louvers were missing from all locations.
- The entrance to the headworks was inoperable.
- The grit removal airlift system was inoperable.
- The grit screw was severely corroded and inoperable.
- The grit discharge gate was severely corroded and inoperable.
- The froth spray piping was removed. The supports for the piping were severely deteriorated.
- The air diffusers were deteriorated.
- The slide gates were misaligned and corroded.

3.2.2 Primary Treatment

Primary treatment in the NDWWTP involves using two 130-foot-diameter circular concrete primary sedimentation tanks to remove settleable and floatable solids from the raw wastewater. Settleable solids in the form of primary sludge collect at the bottom of the clarifiers and are removed. Floatable solids in the form of scum are skimmed from the water surface. Both primary clarifiers were operating during the visit; therefore, the submersible portions of the clarifiers were not observed. The following observations were made at the primary treatment facilities during the site visit:

- The scum collector was inoperative. Operation of the skimmer forces scum out of tank under baffle over weirs when it dips below the collector pipe at the walkway bridge.
- All the galvanized electrical fixtures were corroded and in poor condition.
- The walkway was corroded.
- The clarifier No. 1 drive appeared to be in good condition. The clarifier No. 2 drive appeared to be in poor condition. The scum collector actuators were corroded and inoperative in both tanks.
- All the stainless steel electrical fixtures were in good condition.
- The sludge and scum box covers were missing.
- The torque alarm is connected to local control box and not to Supervisory Control and Data Acquisition system.
- Hose bibs were corroded and leaking in some locations.
- The concrete and masonry structures were in good condition.

3.2.3 Primary Clarifier Pump Station

The primary clarifier pump station consists of four primary sludge pumps, two sludge recirculation pumps, and two scum pumps. Four centrifugal chopper primary sludge pumps move the primary sludge from the clarifiers to the anaerobic digester system. The two centrifugal chopper sludge recirculation pumps can provide recirculation of primary sludge from the clarifiers to the headworks to improve settling and assist in solids flocculation. Two centrifugal chopper scum pumps are provided to transfer scum from the scum collection box to the anaerobic digester system. All sludge

pumps were replaced and their controls were upgraded in 2006 and 2007. The following observations were made at the primary clarifier pump station during the plant visit:

- Lighting to the entrance was missing.
- Light fixtures were corroded. Seven out of 12 lights were damaged. Five out of 12 conduits were in poor condition.
- The electrical MCC in the pump room was in good condition.
- The chopper pumps and related pipe and valves appeared to be in good condition.
- Meter wiring was corroded, and the meter was not operational.
- At the time of the visit, pumps SP-1, PC-1, and PC-2 were operating. Other pumps were not operating. All pumps appeared to be in good condition.
- The pump room egress light was missing.

3.2.4 Anaerobic Digesters

The anaerobic sludge digestion process is a two-stage digester system and consists of two circular concrete digester tanks with floating steel covers and conical bottoms. Each tank has a diameter of 80 feet and side water depth of 18 feet. The capacity of each digester is 720,000 gallons. The first-stage digester tank is used for sludge digestion, and the second-stage tank is used for supernatant separation, gas storage, and digested sludge storage. The anaerobic digestion system equipment, which has deteriorated because of the coastal air and hydrogen sulfide gas emissions from the sludge, is inoperable. The following observations were made at the anaerobic digester facilities during the plant visit:

- The stairway was corroded and requires replacement.
- The gas piping was corroded and falling apart, and pieces were removed.
- Covers have sagged, and structural failure was apparent. Covers require replacement.
- The mixing system was inoperable. The system was outdated and needs to be replaced. (The system is attached to the cover that has structurally failed.)
- The concrete appeared to be in reasonably good condition for a 33-year-old structure.
- The polyvinyl chloride liner appeared to be cracking.
- Some electrical disconnects were missing, and all present were corroded.
- The gas flare has structurally failed. There were pin holes in the stack.
- The pump was missing from the pump station.
- Fire hydrants were located next to the digester, in an area of potential explosion, and should be relocated to a safe area.

3.2.5 Digester Control Building

The digester control building houses digester gas compressors, manifolds and piping, supernatant sampling lines, a sludge heater, sludge transfer and recirculation pumps, centrifuge feed pumps, and a polymer dosing system. Some of the equipment is corroded and inoperable. The following observations were made at the digester control building during the plant visit:

- The gas piping in the basement did not meet code requirements because there is no physical separation with MCC.

- The piping was extensively corroded and needs to be replaced.
- The pumps in the basement were corroded and need to be replaced.
- The gas compressors in the basement were corroded and inoperable. The location of these gas compressors did not conform to current National Fire Protection Association 820 guidelines, which require gas-handling equipment to be physically separated from electrical power and control equipment that does not have an explosion-proof rating (Class 1, Division 1, Groups C and D).
- The progressive cavity pumps used for sludge transfer/truck fill were operating but showed signs of wear and reduced capacity and therefore need to be rebuilt or replaced.
- The drives were out of date, and spare parts were unavailable; therefore, the drives need to be replaced.
- The stair supports were corroded and need to be replaced.
- The polymer system is out of date and not operational. It needs to be replaced.
- The ventilation system was corroded and inoperable and needs to be replaced.
- The rollup door was corroded and needs to be replaced.
- The MCC and lighting panels were corroded and need to be replaced.

3.2.6 Sludge Dewatering Building

The sludge dewatering building houses two centrifuges to provide mechanical dewatering for digested sludge: one operating and one on standby. The centrifuges are located on the second-floor platform in the building, which allows a truck to be parked directly below the centrifuges to discharge the sludge by gravity. The centrifuges were corroded and inoperable. One unit was partially dismantled. The following observations were made at the sludge dewatering building during the plant visit:

- The steel superstructure has structurally failed. There were holes in the roof. Beams were corroded and sagging.
- The centrifuges were outdated, corroded, and inoperable. They need to be replaced. One unit was partially disassembled.
- The monorail needs to be replaced.
- The piping was corroded and needs to be replaced. Valves were missing.
- There is no ventilation for the building.
- MCC was corroded and incorrectly located. It needs to be replaced and isolated from process equipment.
- The lighting fixtures were corroded and need to be replaced.
- The sludge cake hoppers were corroded and need to be replaced.
- The stair nosings have spalled off, which creates a safety issue (slip/trip hazard).

3.2.7 Chlorine Contact Tanks

The chlorine contact tanks consist of two rectangular concrete tanks with an upstream Parshall flume for plant effluent measurement. This system allows for use of two tanks in parallel, each baffled in a two-pass arrangement and equipped with chlorine solution diffusers. At the end of each tank is a rotating scum trough that drains into a separate scum pit. An effluent reuse pump is also installed to

pump chlorinated water for preparing chlorine solution, centrifuge flushing, and cleaning plant facilities. The chlorine dosing system was partially disassembled, corroded, and inoperable. Currently, the chlorine contact tanks are not used to disinfect effluent but are used for final scum removal before the effluent flows out to the ocean outfall. The following observations were made at the chlorine contact tanks during the plant visit:

- Flow entering the Parshall flume was supercritical and not suitable for accurate flow measurement.
- The scum trough was set too high.
- The scum pumping system was inoperable.
- There was excess scum in the contact basin because of problems noted with the primary scum system.
- The V-notch weir was operating at capacity with current flow with one tank out of service.
- There were no railings around the flume structure.
- Gratings were missing near the chlorinated effluent water pumps.
- There was a structural issue with the inlet gate support. The concrete was starting to spall off at the column.
- The interior concrete was spalling.
- The hose bibs were in poor condition and leaking.
- Yard lighting was disassembled and inoperable.

The supercritical flow, a high-speed flow, rushes out from a 42-inch primary effluent pipe and slows down inside of the downstream plant effluent Parshall flume. This creates a hydraulic jump that makes flow measurement inaccurate at the Parshall flume.

3.2.8 Administration Building

The administration building was originally designed to include an operation staff office, a shower, a laboratory, and housing for storage containers for chlorine used in the chlorine dosing system. The laboratory and chlorine dosing system are out of service. The following observations were made at the administration building during the plant visit:

- The exterior generator was not weather protected.
- The exterior main switchboard and lighting panels were severely corroded.
- Severe corrosion was noted on the monorail in the nonprocess area, which indicates that unprotected carbon steel is unsuitable material in a coastal environment.

3.2.9 Ocean Outfall

The primary treated effluent is discharged to the Philippine Sea, first through a 48-inch reinforced concrete piping that is connected to the chlorine contact tanks and then through a 30-inch ductile iron piping to a valve box at the toe of the coastline cliff. From there, the outfall, with a new 34-inch high-density polyethylene pipe, extends approximately 1,900 feet into the ocean, ending at a depth of approximately 140 feet. The new outfall was put into service at the end of 2008. The diffuser system, which consists of the last section of the originally designed new outfall, was not installed, and the diffuser system components were stored at the NDWWTP.

3.2.10 Electrical

The following observations regarding the electrical system were made during the plant visit:

- Yard lighting was disassembled and inoperable.
- The manhole covers that provide access to the electrical system were corroded.

3.2.11 Other

The following additional observation was made during the plant visit:

- Odor was noted along the road outside of the westerly fence line, downwind of the NDWWTP.

4. Evaluation of Existing System Capacity

Capacity of the NDWWTP was evaluated using data gathered during the field observations, typical design data, as-built drawings and theoretical calculations. The original design criteria provided by GWA is listed in Table A-2 of Appendix A. The unit process capacity of the existing system was evaluated assuming that the process is functional. Capacity evaluation of a nonfunctional unit process was performed through an academic exercise based on typical domestic wastewater design criteria and as-built drawings. The capacity of the major unit processes at the NDWWTP was evaluated first based on the condition of the facilities as observed during the field visit in early October 2009 (described in Section 4.1) and then based on the designed optimum condition of the facilities, along with all necessary improvements (described in Section 4.2). The following major unit process equipment was evaluated:

- Preaeration tanks
- Aerated grit chambers
- Primary clarifiers
- Chlorine contact tanks
- Anaerobic digesters
- Sludge-drying beds
- Dewatering centrifuges

The NDWWTP is a Class III wastewater treatment facility, according to the Guam Environmental Protection Agency, based on USEPA reliability classifications (GWA 2007). Reliability is a measurement of the ability of a component or system to perform its designated function without failure. USEPA provided reliability requirements for design, operation, and maintenance of wastewater treatment facilities. The three USEPA reliability classes for publicly operated wastewater treatment facilities are as follows (USEPA 1974):

- **Class I:** Works that discharge into shellfish waters or close to areas used for water contact sports
- **Class II:** Works that discharge into recreational waters
- **Class III:** Works not classified as Class I or II

The NDWWTP is considered a Class III facility because it discharges through the outfall to the open ocean (not considered shellfish, water contact, or recreational waters). Detailed USEPA reliability

classifications for each wastewater treatment unit process at the NDWWTP are summarized in Table 4-1.

Table 4-1: USEPA Reliability Classifications for Unit Process at the NDWWTP

Unit Process	USEPA Reliability Class I	USEPA Reliability Class II	USEPA Reliability Class III
Mechanically Cleaned Bar Screen	A backup bar screen shall be provided (may be manually cleaned)	Same as Class I.	Same as Class I.
Comminution Facilities	If comminution provided, an overflow bypass with bar screen shall be provided.	Same as Class I.	Same as Class I.
Pumps	A backup pump shall be provided for each set of pumps, and the capacity of the pump shall be such that with any one pump out of service, the remaining will handle the peak flow.	Same as Class I.	Same as Class I.
Preaeration Tanks	Backup components not mandatory	Same as Class I.	Same as Class I.
Aerated Grit Chambers	Backup components not mandatory	Same as Class I.	Same as Class I.
Aeration Blowers	At least two units. Design oxygen transfer will be maintained with one unit out of service.	Same as Class I.	Same as Class I.
Primary Clarifiers	There shall be sufficient number of units of a size such that the capacity of 50% of the total design flow will be maintained with the largest unit out of service.	Same as Class I.	At least two units.
Chlorine Contact Tanks	There shall be sufficient number of units of a size such that the capacity of 50% of the total design flow will be maintained with the largest unit out of service.	Same as Class I.	Same as Class I.
Anaerobic Digesters	At least two units.	Same as Class I.	Same as Class I.
Sludge-Drying Beds	Backup components not mandatory	Same as Class I.	Same as Class I.
Dewatering Centrifuges	There shall be sufficient number of units of a size such that the capacity of the design sludge flow will be maintained with the largest unit out of service.	Same as Class I.	Same as Class I.
Power Sources	A backup power source shall be provided. The backup power capacity shall be sufficient to operate all vital components, during peak flow conditions, together with critical lighting and ventilation.	Same as Class I, except that vital components used to support the secondary processes need not be included as long as treatment equivalent to sedimentation and disinfection is provided.	Sufficient to operate the screening or comminution facilities, the main wastewater pumps, the primary sedimentation basins, and the disinfection facility during peak wastewater flow condition, together with critical lighting and ventilation.

% percent

4.1 CURRENT EXISTING SYSTEM CAPACITY WITHOUT ANY IMPROVEMENTS

A detailed evaluation of the theoretical unit process capacity is presented in Appendix C. The original designed peak flow factor of 2.25 (ratio of peak hourly flow [PHF] to annual average daily flow [AADF]) was used in the evaluation, and all the unit capacities are rated in terms of influent AADF. The unit process capacities are based on the following typical industry design standards:

- Preliminary treatment

  - Preaeration time (both preaeration tanks and grit chambers) for PHF = 15 minutes
  - Hydraulic retention time of grit chamber = 10 minutes

- Primary clarifiers
  - Surface overflow rate for AADF = 900 gallons per day per square foot (gal/day-ft^2)
  - Surface overflow rate for PHF = 2,000 gal/day-ft^2
  - Hydraulic retention time for AADF = 2 hours

- Chlorine contact tanks
  - Hydraulic retention time for PHF = 15 minutes

- Anaerobic digesters
  - Hydraulic retention time for AADF = 15 days

- Sludge-drying beds
  - Sludge loading rate = 30 pounds per square foot per year (including wet season)

- Dewatering centrifuges
  - Unit centrifuge treatment = 2,000 pounds per hour

Total preaeration detention time for preliminary treatment, including time in the preaeration tanks and aerated grit chambers, was evaluated with a minimum air stripping requirement of 15 minutes for odor control. The aeration time would also improve organic matter and grease removal and the uniform distribution of suspended and floating solids. The typical detention time in an aerated grit chamber at peak flow is 3 minutes; a longer detention time of 10 minutes was used in the evaluation to provide enough preaeration. The longer preaeration time can be achieved by optimally using existing grit chamber volume.

To meet Clean Water Act (CWA) 301(h) minimum primary treatment requirements of 30 percent biochemical oxygen demand (BOD) and TSS removal, surface overflow rate for AADF at the NDWWTP should be less than 1,000 gal/day-ft^2 based on a curve of TSS removal rates versus surface overflow rates provided in *Ten States Standards* (Great Lakes-Upper Mississippi Board of State Sanitary Engineers 1978). The hydraulic retention time of a primary clarifier can be determined by influent BOD and TSS loadings and their required removal rates. Normally, a longer retention time creates a higher removal rate, but a prolonged retention time may cause tank septic. During the first half of 2009, average influent BOD and TSS at the NDWWTP were 125 milligrams per liter (mg/L) and 155 mg/L, respectively, as reported in the plant discharge monitoring report to USEPA. To achieve 30 percent removal rates on both BOD and TSS, the primary clarifier should have a hydraulic retention time of more than 2 hours based on a curve of BOD/TSS removal rates versus detention times provided in *Water Supply and Sewerage* (Steel and McGhee 1979). The primary clarifier was evaluated with surface overflow rates of 900 gal/day-ft^2 and 2,000 gal/day-ft^2 for AADF and PHF, respectively, and a hydraulic retention time of 2 hours for AADF. The evaluation procedure for the primary clarifier is provided in Appendix C, The design criteria used for the evaluation differs from the original design criteria and the variances are listed in Table A-2 in Appendix A.

Digestion time of the anaerobic digesters was evaluated based on use of high-rate digesters needed to comply with USEPA Criteria for Class B biosolids. Therefore, a typical hydraulic retention time of 15 days for high-rate anaerobic digesters was used in the evaluation.

The rest of the above-listed design criteria that were used in the capacity evaluation are all typical industrial standards. The theoretical unit process capacities at the NDWWTP during the field visit in October 2009 are summarized in Table 4-2.

The treatment capacity of the sludge-drying beds is 4.25 MGd. Since the digesters and sludge dewatering system are obsolete, the overall plant capacity is limited by sludge-drying beds. Capacity was evaluated with a yearly sludge loading rate that includes both dry and wet seasons. Currently, primary sludge generated at the NDWWTP is hauled to GWA Hagatna Wastewater Treatment Plant for treatment as a supplementary practice to compensate for the deficient sludge-handling capacity at the NDWWTP. If sludge handling is not considered, the overall plant capacity will be determined by its liquid stream treatment capacity, which is 6.13 MGd under current conditions, with one chlorine contact tank in service. Because the NDWWTP has a CWA 301(h) waiver of its current discharge permit, the effluent chlorination facilities are not required at the plant. Thus, without any improvements, current overall plant treatment capacity is 4.25 MGd with on-site sludge handling and 7.96 MGd with off-site sludge handling.

Table 4-2: Theoretical Unit Process Capacities at the NDWWTP without Any Improvement Based on Annual Average Daily Flow

Unit Process	USEPA Reliability Class	Theoretical Capacity for Current Condition (AADF-MGd)
Preaeration Tanks	III	8.85
Aerated Grit Chambers	III	7.96
Primary Clarifiers	III	16.68
Chlorine Contact Tanks	III	6.13
Anaerobic Digesters	III	0.00
Sludge-Drying Beds	III	4.25
Dewatering Centrifuges	III	0.00
Overall Plant Capacity	III	4.25
Overall Plant Capacity with CWA 301(h) Waiver	III	4.25

The capacity of interpiping between the unit processes was also evaluated. The theoretical unit process interpiping capacity at the NDWWTP during the field visit in October 2009 is summarized in Table 4-3.

Table 4-3: Theoretical Unit Process Interpiping Capacities at the NDWWTP without Any Improvement

Start of Piping	End of Piping	Theoretical Capacity for Current Condition (AADF-MGd)	Theoretical Capacity for Current Condition (PHF-MGd)
Headwork	Primary Clarifiers	22.22	50.00
Primary Clarifiers	Chlorine Contact Tanks	16.89	38.00
Chlorine Contact Tanks	Outfall	28.89	65.00
Overall Plant Liquid Stream Interpiping Capacity		16.89	38.00

The size of the interpiping used in the capacity evaluation was obtained from the plant as-built drawings and has not been field verified. All piping needs to be field verified before any future improvements at the NDWWTP are implemented. All interpiping capacities were calculated with the peak flow rate and then converted into the AADF rate. Table 4-3 shows AADF and PHF capacity of the piping between the primary clarifiers and the chlorine contact tanks. The capacity was estimated assuming the worst-case situation, with one clarifier out of service and the entire flow moving from one clarifier to the chlorine contact tanks. The piping between the clarifiers and the chlorine contact tanks is the smallest of all the interpipes in the plant but still bigger than any unit process capacities shown in Table 4-2. As a result, overall plant treatment capacity is determined by the unit process capacities.

4.2 EXISTING SYSTEM OPTIMUM CAPACITY ALONG WITH NECESSARY IMPROVEMENTS

After all necessary improvements are made to the existing treatment system, the plant should operate up to its theoretical optimum capacity. The theoretical unit process capacities were evaluated using the same typical design criteria described in Section 4.1, and the evaluation assumed that the necessary improvements would include bringing the currently inoperable process units back to service and that the units would meet USEPA Reliability Class III requirements. A detailed evaluation of the theoretical unit process capacity is presented in Appendix C, and the results are summarized in Table 4-4.

Table 4-4: Theoretical Unit Process Capacities at the NDWWTP along with Necessary Improvements Based on Annual Average Daily Flow

Unit Process	USEPA Reliability Class	Theoretical Capacity as Designed (AADF-MGd)
Preaeration Tanks	III	17.69
Aerated Grit Chambers	III	15.92
Primary Clarifiers	III	16.68
Chlorine Contact Tanks	III	12.26
Anaerobic Digesters	III	29.75
Sludge-Drying Beds	III	4.25
Dewatering Centrifuges	III	17.58
Overall Plant Capacity	III	12.26
Overall Plant Capacity with CWA 301(h) Waiver	III	15.92

With the digesters and sludge dewatering system in operation, the sludge-drying beds are used only for temporary sludge treatment when necessary. Primary sludge generated at the NDWWTP usually is digested, dewatered, and hauled to a landfill for disposal or for beneficial land use. Overall plant capacity is limited at 12.26 MGd, which is the capacity of the chlorine contact tanks. However, it can be increased to 15.92 MGd under a CWA 301(h) discharge permit waiver, which requires only 30 percent removal of influent BOD and TSS and does not require disinfection of treated effluent. The theoretical unit process interpiping capacities, along with the necessary improvements, are summarized in Table 4-5.

Table 4-5: Theoretical Unit Process Interpiping Capacities at the NDWWTP along with Necessary Improvements

Start of Piping	End of Piping	Theoretical Capacity for Design Condition (AADF-MGd)	Theoretical Capacity for Design Condition (PHF-MGd)
Headwork	Primary Clarifiers	22.22	50.00
Primary Clarifiers	Chlorine Contact Tanks	16.89	38.00
Chlorine Contact Tanks	Outfall	28.89	65.00
Overall Plant Liquid Stream Interpiping Capacity		16.89	38.00

The size of the interpiping used in the capacity evaluation was obtained from the plant as-built drawings. All interpiping capacities were calculated with the peak flow rate then converted into the AADF rate. Table 4-5 shows AADF and PHF capacity of the piping between the primary clarifiers and the chlorine contact tanks. The capacity was estimated assuming the worst-case situation, with one clarifier out of service and the entire flow moving from one clarifier to the chlorine contact tanks. The piping between the clarifiers and the chlorine contact tanks is the smallest of all the interpipes in the entire plant but still bigger than any unit process capacities in Table 4-4. As a result, overall plant treatment capacity is determined by the unit process capacities.

During the plant visit in early October 2009, GWA and AECOM identified both short-term necessary improvements and long-term improvements to restore the NDWWTP primary treatment capacity. GWA identifies short-term necessary improvements, which address immediate influent flow increases, as the highest priority. Long-term improvements are those improvements required for when the influent flows approach 10–12 MGd.

4.2.1 Short-Term Necessary Improvements

The short-term necessary improvements for the NDWWTP are as follows:

- Septage and fat/oil/grease (FOG) receiving
- Primary clarifier rehabilitation
- Sludge digester rehabilitation
- Centrifuge building replacement and one centrifuge
- Sludge-drying bed rehabilitation
- Standby power

A new septage receiving station is required to receive and cotreat septage from unsewered customers on the island. The station will consist of an unloading area, a septage storage tank, a septage screen, an aeration system, and two grinder transfer pumps. The septage storage tank will be sized for a detention time of at least 1 day. A new FOG receiving station is also required to receive FOG generated by residential, commercial, and industrial generators, such as restaurants, grocery stores, hospitals, and food processors. The FOG receiving station will collect FOG from grease trucks and pump it into the plant anaerobic digesters, where much of the FOG would be converted into digester gas to create energy. The FOG station will consist of a grease holding tank and chopper pumps so that the FOG can be moved into the digesters. Heating is required for the grease holding tank to maintain temperatures above 110 degrees Fahrenheit, prevent solidification of the grease, and ensure proper operation. Both the septage storage tank and the grease holding tank will be covered and will have an odor control system.

Headworks improvements include installation of fine screens, a grit chamber retrofit, installation of a new grit pump station, installation of grit wash and dewatering units, and incorporation of flow metering. Two new mechanically cleaned fine screens will be installed to prevent the entry of large debris and coarse solids. A new flow measurement system needs to be installed to replace the malfunctioning Parshall flume. The existing Parshall flume is too close to the upstream screen channel that creates turbulence inside the flume. There is not enough space in between the screen channels and the preaeration tank to properly install a Parshall flume with the required dimensions. Without modifying the headworks structure, a meter vault will be constructed outside of the headworks building and upstream on the influent flow pipe with siphon modification to have full flow pipe. A magnetic meter will be installed for flow measurement. The grit chamber concrete surface needs to be sand blasted and coated. All air pipes and diffusers, grit removal pumps, and grit wash and dewatering units need to be replaced.

Rehabilitation of the two primary clarifiers includes concrete surface cleaning, sand blasting and coating, and replacement of the basin mechanical components with new stainless steel units. The primary clarifiers will be furnished with drive units, a walkway and drive platform, a center column, a center cage and rake arm, a feedwell, a scum removal mechanism, and fiberglass-reinforced plastic weirs and baffles. Stainless steel units are more suitable to the tropical coastal environment at the NDWWTP site.

The only element of the existing digester system that will be salvageable is its concrete tanks. The digester rehabilitation will include mixing and recirculation system, gas and scum piping, sludge recirculation and transfer pumps, gas compressors and a boiler for heating, and a waste gas flare. The polymer dosing system, which assists with dewatering sludge and is located inside the sludge digester control building, also needs to be refurbished.

The centrifuge building needs to be replaced, and one new sludge centrifuge needs to be installed to replace the old units. A diesel generator unit needs to be installed for emergency service as a standby power source.

The short-term necessary improvements at the NDWWTP are presented in Table 4-6, listed in descending order based on cost, capacity enhancement, reliability/redundancy enhancement, performance enhancement, and permit compliance. The weighting evaluation process is described in detail in Appendix D.

Table 4-6: Prioritized Short-Term Necessary Improvements at the NDWWTP

Priority Order	Short-Term Necessary Improvements
1	Primary clarifier rehabilitation
1	Sludge digester rehabilitation
2	Standby power
3	Headworks improvements
4	Centrifuge building replacement and one centrifuge
5	Septage and fat/oil/grease receiving
6	Sludge-drying bed rehabilitation

Implementation of the short-term necessary improvements will restore the NDWWTP to its theoretical treatment capacity and meet the immediate need for increased wastewater treatment. However, execution of identified long-term improvements is necessary to ensure the reliability and operational flexibility of the treatment system.

4.2.2 Long-Term Improvements

The long-term improvements required for the NDWWTP are as follows:

- Hydraulic improvements to the chlorine contact tank
- Third digester (new)
- Second centrifuge
- Odor control
- Digester gas utilization
- Administration/laboratory, office, and workshop/storage areas rehabilitation

In the long term, the current configuration of the chlorine contact tanks needs to be retrofitted with long, narrow channels in a serpentine pattern to improve the hydraulic characteristics. Although the current NDWWTP discharge permit does not require that the effluent be chlorinated, retrofitting the chlorine contact tanks will benefit long-term operation of the plant and simplify potential future permit-related upgrades. As part of the chlorine contact tanks reconfiguration, a new effluent Parshall flume will be installed downstream of the chlorine tanks to replace the malfunctioned existing one, which is located upstream of the chlorine tanks. The new additional anaerobic digester and sludge dewatering centrifuge unit will provide operational flexibility and redundant capacity for the plant sludge handling system and increase its operational reliability. A plant odor control system needs to be added to treat odor collected inside the headworks building, septage storage tank, grease-holding tank at the receiving station and centrifuge building to improve the operator working environment and the air quality of the surrounding area.

In addition, digester gas, which consists of large quantities of methane, has to be used for heating and power generation. After corrosive and toxic gas is scrubbed off, the digester gas will be used as fuel for internal-combustion engines or gas turbines to drive air compressors, pumps, and generators for production of electricity. An engine generator, micro-turbine, or fuel cell can be installed for digester gas use. The digester gas will be a renewal source of energy for the plant, and use of the gas as fuel will reduce plant greenhouse gas emissions.

The long-term improvements at the NDWWTP are presented in Table 4-7 in descending priority based on cost, capacity enhancement, reliability/redundancy enhancement, performance enhancement, and permit compliance.

Table 4-7: Prioritized Long-Term Improvements at the NDWWTP

Priority Order	Long-Term Improvements
1	Third digester (new)
2	Hydraulic improvements to the chlorine contact tank
3	Second centrifuge
4	Odor control
5	Digester gas utilization
6	Administration/laboratory, office and workshop/storage areas rehabilitation

4.2.3 Necessary Improvements for Upgrading Existing System to an Advanced Primary Treatment System

As discussed in Section 4.2, following execution of the necessary improvements, the primary treatment system of the NDWWTP will achieve the CWA 301(h) waiver–required minimum treatment criteria of 30-percent removal rate for both BOD and TSS. However, because the influent concentration experienced at the NDWWTP is unstable, an advanced primary treatment system with a higher removal rate for BOD and TSS is evaluated for the NDWWTP upgrade.

Advanced primary treatment normally includes chemically enhanced primary treatment (CEPT) or the use of enhanced settling devices. The latter feature mostly involves retrofitting the existing primary clarifier by installing inclined-tube settlers to improve the solids removal rate. Inclined tubes are prone to develop biological growth in primary clarifiers; therefore, only CEPT is evaluated for the NDWWTP upgrade.

CEPT is the process by which chemicals, typically metal salts and/or polymers, are added to the conventional primary treatment system. Chemical precipitation enhances suspended solids settling and improves the performance of the primary settling facilities. Chemicals, usually iron salt and polymer coagulant, could be added to the aerated grit chamber at the NDWWTP for fully mixing. Upgrade to an advanced primary treatment system at the NDWWTP would involve chemical storage, chemical feeding, piping, and use of a control system. CEPT increases primary sludge production by as much as 50 percent, primarily because solids removal in the primary clarifiers is increased. The plant sludge handling system, along with the preceding long-term improvements, should have enough capacity to treat the sludge produced by the advanced primary treatment system.

CEPT adds chemicals into the wastewater during primary treatment to alter the physical state of dissolved and suspended solids and to improve their removal by sedimentation. Normally, a well-designed and well-operated conventional primary clarifier system without CEPT would have removal rates of about 50 – 65 percent for the TSS, and 25 – 35 percent for the BOD_5, However, with CEPT it is possible to remove 70 - 80 percent of the TSS, and 40 - 45 percent of the BOD_5, Facilitated by higher removal rates, a conventional primary clarifier system utilizing CEPT could treat more wastewater flow within the existing clarifiers.

By upgrading to CEPT, the existing primary clarifiers at the NDWWTP could operate with a much higher surface overflow without deteriorating their removal performance. The Manual of Practice 8 recommended average daily surface overflow for a CEPT is in the range of 1,700 – 2,000 gal/day-ft^2. Normally, CEPT has a two to three fold higher over flow rate than a conventional primary clarifier with a range of 800 – 1,200 gal/day-ft^2. With a CEPT, the existing primary treatment at the NDWWTP would have increased solids removal and generate more primary sludge as a result of solids removal improvement and addition of process associated chemical sludge. For a more precise CEPT performance estimation, pilot-scale test or jar test would need to be performed.

5. Cost Estimate for Improvements

Cost estimates have been developed for the various improvements discussed above. These opinions of conceptual cost are intended for use as budgetary guidance. The costs are based on descriptions in this study and vendor proposals. The estimates are intended to be as comprehensive as possible at the study stage although much of the work is still at a conceptual level.

The quantities for all work items will be reviewed and updated during the detailed design stage. A project-level allowance of 35 percent is added to the estimated construction cost for project services to establish the total estimated project cost. The following items are included:

- Environmental impact report/other documents
- Design engineering
- Construction engineering and contract administration
- General and administrative expenses
- Contingencies

All the costs are estimated in Guam prices.

After all necessary improvements are made to the treatment system, the plant should operate up to its theoretical optimum capacity. The improvements are classified as short-term improvements, long-term improvements, or upgrades to advanced primary treatment, which are identified in Section 4.2.1, Section 4.2.2, and Section 4.2.3, respectively. Their costs are presented in the followed sections.

5.1 ESTIMATED COSTS FOR SHORT-TERM NECESSARY IMPROVEMENTS

The short-term necessary improvements will address immediate influent flow increases at the NDWWTP and restore plant treatment capacity. Cost estimations for individual improvements are summarized in Table 5-1. The detailed, itemized costs are presented with 1391 forms in Appendix E.

5.2 ESTIMATED COSTS FOR LONG-TERM IMPROVEMENTS

The long-term improvements will provide plant operation reliability and address odor control and digester gas utilization. Cost estimations for individual long-term improvements are summarized in Table 5-2. The detailed, itemized costs are presented with 1391 forms in Appendix E.

5.3 COST ESTIMATION FOR REFURBISHING AND UPGRADING EXISTING SYSTEM TO ADVANCED PRIMARY TREATMENT PLANT

Upgrading the NDWWTP existing system to an advanced primary treatment plant would include the following improvements: chemical storage, chemical feeding, piping, and control system. Cost estimations for upgrading the system are summarized in Table 5-3. The detailed, itemized costs are presented with 1391 forms in Appendix E.

Table 5-1: Preliminary Cost for Short-Term Necessary Improvements at the NDWWTP

Construction Categories	Quantity	Applicable Specifications for Cost Estimating	Cost Opinion
Septage Receiving Station (new)	1	Septage storage tank, screen, two blowers, diffusers, two grinder pumps, truck unloading area	$1,317,400
FOG Receiving Station (new)	1	Headed grease-holding tank, heat trace system, two grinder pumps, grease truck unloading area	$565,500
Headworks (refurbished)	1	Two 6-milllimeter fine screens, grit chamber retrofit, new grit pump station, grit wash and separation, flow metering	$1,972,100
Primary Clarifier (refurbished)	2	New sludge collectors, electrical, pumps, coatings, concrete repair, 130-foot-diameter x 7-foot-swd	$4,858,400
Anaerobic Digester (refurbished)	2	New sludge mixing, heat exchangers, electrical, controls, coatings, piping and valves, concrete repair 80-foot-diameter x 18-foot-swd	$7,900,900
Solids Dewatering Building (replaced)	1	Building structure replacement, one centrifuge, one feed pump, polymer dosing system, electrical, controls, coatings, piping and valves	$3,428,300
Influent and Effluent Samplers (new)	2	Automatic samplers	$159,300
Sludge-Drying Bed (refurbished)	8	Concrete repair, valves	$79,600
Standby Diesel Generator	1	300-kilowatt diesel generator	$398,200
Site Work and Utilities	Lump Sum		$1,320,000
Total Cost			$21,999,800
Project Services			$7,699,900
Total Estimated Cost – Guam			**$29,699,700**
Total Request (Rounded)			**$29,700,000**

swd side water depth.

Table 5-2: Preliminary Cost for Long-Term Improvements at the NDWWTP

Construction Categories	Quantity	Applicable Specifications for Cost Estimating	Cost Opinion
Chlorine Contact Tank (refurbished)	2	New mixers, chemical feed pumps, electrical, coatings, concrete repair, buffer wall reconfiguration, effluent measure flume. Each chlorine tank 60 feet long x 40 feet wide x 7.5 feet swd	$1,246,700
Anaerobic Digester (new)	1	New sludge mixing, heat exchangers, electrical, controls, coatings, piping and valves, concrete repair a 80-foot-diameter x 18-foot swd digester	$10,265,700
Digester Gas Utilization (new)	1	New engine generator, gas purification, compressor	$2,188,300
Sludge Dewatering Centrifuge (new)	1	2,000 pounds per hour	$2,713,400
Odor Control System (new)	1	Odor control system	$477,900
Administration/Lab, Workshop, Storage (refurbished)	1	Administration/Lab, workshop, storage	$663,700
Site Work and Utilities	Lump Sum		$1,120,600
Total Cost			$18,676,300
Project Services			$6,536,700
Total Estimated Cost – Guam			**$25,213,000**
Total Request (Rounded)			**$25,200,000**

Lab laboratory

Table 5-3: Preliminary Cost for Upgrading the NDWWTP to Advanced Primary Treatment

Construction Categories	Quantity	Applicable Specifications for Cost Estimating	Cost Opinion
Chemical Building (new)	1	New 40-foot-long x 25-foot-wide x 12-foot-tall chemical building, chemical/polymer feed pumps, chemical storage, electrical, coatings	1,177,100
Site Work and Utilities	Lump Sum		75,100
Total Cost			$1,252,200
Project Services			$438,300
Total Estimated Cost – Guam			**$1,690,500**
Total Request (Rounded)			**$1,700,000**

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Appendix A
Existing Plant Process Unit Design Summary

Table A-1: Existing Plant Process Unit Design Summary

Item	Actual Value
Comminutor	
Type	Chicago – 36A
Number	1
Diameter(ft)	n/a
Power (HP)	3
Back Up Manual Bar Screen	
Number	1
Bar screen width (inch)	72
Bar Spacing (inch)	2
Number	1
Influent Metering	
Type	Parshall Flume
Number	1
Throat width (ft)	3
Pre-aeration Tanks	
Number	2
Length (ft)	30
Width (ft)	22
Depth (ft)	14
Total Volume (ft^3)	18,480
Number of Air Blowers	2
Air blower Capacity (ft^3/min)	800
Grit Removal	
Number	2
Width (ft)	22
Length (ft)	54
Depth (ft)	14
Total Volume (ft^3)	33,264
Primary Clarifiers	
Type	Circular
Number	2
Diameter(ft)	130
Side water depth (ft)	7
Surface Area (ft^2)	13,273
Total Volume (ft^3)	92,913
Effluent Metering	
Type	Parshall Flume
Number	1
Throat width (ft)	5
Disinfection	
Type	Chlorine Contact Tank
Number	2
Length (ft)	60
Width (ft)	40
Depth (ft)	7.5
Total Volume (ft^3)	36,000
Submersible Pumps to Send Scum and Sludge from Chlorine Contact Tank to Primary Digesters	
Type	Centrifugal Pumps
Number	2
Capacity (gpm)	n/a
Head (ft)	n/a
Power (HP)	5

Item	Actual Value
Primary clarifier sludge pumps equipped with upstream grinders	
Type	Air Operated Diaphragm pump
Number	2
Capacity (gpm)	n/a
Head (ft)	n/a
Sludge recirculation pumps	
Type	Centrifugal
Number	4
Capacity (gpm)	450
Head (ft)	10
Power (HP)	7.5
Primary Scum Pumps	
Type	Centrifugal
Number	2
Capacity (gpm)	n/a
Head (ft)	n/a
Primary Anaerobic Digester	
Type	Coated concrete tank with floating steel cover
Number	1
Diameter (ft)	80
Sidewall depth (ft)	21
Average working depth (ft)	18
Total Active volume (ft^3)	90,478
Secondary Anaerobic Digester	
Type	
Number	1
Diameter (ft)	80
Sidewall depth (ft)	21
Average working depth (ft)	18
Total Active volume (ft^3)	90,478
Heater	
Manufacturer	Cyclotherm
Capacity(Btu/hr)	0.5×10^6
Digester Sludge Recirculation Pump	
Type	Centrifugal Pump
Number	1
Capacity (gpm)	100
Head (ft)	22
Digester Sludge Transfer Pumps	
Type	Progressive Cavity Pump
Number	2
Capacity (gpm)	232
Head (psi)	10
Mechanical Dewatering	
Type	Centrifuge
Number	2
Motor (HP)	75 HP
Centrifuge Feed Pump	
Type	Progressive Cavity Pump
Number	2
Capacity (gpm)	110
Head (psi)	10
Centrifuge Polymer Feed Pumps	
Type	
Number	2

Item	Actual Value
Capacity (gpm)	n/a
Head (ft)	n/a
Power (HP)	0.5
Sludge Drying Beds	
Type	Sand
Number	8
Length (ft)	105
Width (ft)	30
Depth (inch)	22
Initial sludge depth (inches)	8
Outfall to Philippine Sea	
Pipeline Size, each (inches)	34
Peak Hour Capacity	28.6 mgd
Length of the outfall from the shore	2,100 ft
Depth at which wastewater is discharged	140 ft

ft feet
ft^3 cubic foot
ft^3/min cubic feet per minute
gpm gallons per minute
HP Horse Power
n/a not available
psi pounds per square inch

Table A-2: Existing Plant Design Data Summary

Item	Original Value	Value Used in the Analysis
Design Flow		
Average (mgd)	12	-
Peak (mgd)	27	-
Sewage Characteristics		
5 Day BOD (mg/l)	300	125
Suspended Solids (mg/l)	275	155
Pre-aeration Tanks (two)		
Volume, each (ft^3)	9,250	9,240
Air Requirement (ft^3/min)	240	-
Aerated Grit Chambers (two)		
Volume, each (ft^3)	16,650	16,630
Air Requirement (ft^3/min)	440	-
Primary Settling Tanks (two)		
Volume, each (gal)	696,000	695,000
Surface Loading @ Q_{ave} (gpd/ft^2)	455	900
Weir Overflow Rate @ Q_{ave} (gpfd)	14,700	-
Detention Time @ Q_{ave} (hrs)	2.79	2.0
Chlorination		
Average Demand – Dosage at 18 mg/l (lbs/day)	1,800	-
Peak Demand – Dosage at 18 mg/l (lbs/day)	4,050	-
Chlorine Contact Tank (one)		
Volume (gal)	296,000	287,230
Detention Time @ Q_{pk} (minutes)	16.0	15.0
Sludge Digestion Tanks (two)		
Volume, each (ft^3)	115,450	90,480
Centrifuges (two)		
Capacity@ 10% incoming sludge, each (lbs/hr)	2,100	2,000

ft	feet
ft^3	cubic foot
ft^3/min	cubic feet per minute
gpd/ft^2	gallons per day per square foot
gpfd	gallons per foot per day
hrs	hours
lbs/day	pounds per day
lbs/hr	pounds per hour

Appendix B
Field Observations and Photographs

TRIP REPORT

GUAM WATERWORKS AUTHORITY

NORTHERN DISTRICT WASTEWATER TREATMENT PLANT

OCTOBER 5 TO 7, 2009

Bob Stallings of AECOM visited the Guam Waterworks Authority (GWA) Northern District Wastewater Treatment Plant (NDWWTP) for the plant assessment on October 5, 6, and 7, 2009. The following sections will summarize the observations made during the site visits:

Primary Pump Station

- Lighting to the entrance is missing.
- Light fixtures are corroded. 7 lights out of 12 lights are damaged. 5 conduits out of 12 are in poor condition.
- Electrical MCC in pump room is in good condition.
- Chopper pumps and related pipe and valves appeared to be in good condition.
- Meter wiring is corroded and meter is not operational.
- At the time of the visit pumps SP-1, PC-1, and PC-2 were operating . Other pumps were not operating. All pumps appeared to be in good condition.
- Pump room egress light is missing.

Headworks

- Headworks building entrance door is corroded.
- Explosionproof lighting fixtures are not present.
- Flume hydraulics is not suitable for accurate flow metering. There is turbulence entering the flume through the measuring zone due to poor approach geometry and high velocity through turn in front of flume
- Door hardware (lockset) is missing at garden tool storage room.
- Lights and ventilation are inoperative in blower room.
- Blowers and MCC in blower room appear to be in good condition.
- Galvanized steel grating over grit channel is severely deteriorated.
- Ventilation is inoperative in grit channel.
- Louvers are missing in all locations.
- Door is inoperative
- Grit removal airlift system is inoperative.
- Grit screw is severely corroded and inoperative
- Grit discharge gate is severely corroded.
- Froth spray piping is removed. Supports are severely deteriorated
- Air diffusers are deteriorated
- Slide gates are misaligned and corroded.

Primary Clarifier

- Scum collector is inoperative. Operation of the skimmer forces scum out of tank under baffle over weirs when it dips below collector pipe at walkway bridge.
- All galvanized electrical are corroded and in poor condition. Walkway is corroded.
- Clarifier No. 1 drive is appears to be in good condition. Clarifier No. 2 drive is appears to be in poor condition. Scum collector actuators are corroded and inoperative in both tanks.
- All stainless steel electrical fixtures are in good condition.
- Sludge and scum box covers are missing
- Only local indication of torque alarm not to SCADA.
- Hose bibs are corroded and leaking in some locations.
- Concrete and masonry structures are in conditions for 33 year old structures.

Administration Building

- Exterior generator is not weather protected.
- Exterior main switch board and lighting panels outdoors are severely corroded.
- Severe corrosion is noted on monorail in non-process area. This indicates that steel is unsuitable material for coastal environment.

Digester Building

- Code violation with gas piping in basement. There is no physical separation with MCC.
- Piping is extensively corroded and needs replacement.
- Pumps in the basement are corroded and need replacement.
- Progressive cavity pumps used for sludge transfer/truck fill need to be rebuilt or replaced.
- Drives are out of date and need to be replaced.
- Stair supports are corroded and require replacement.
- Polymer system is out of date and not operational. It requires replacement.
- Ventilation system requires replacement.
- Rollup door is corroded and requires replacement.
- MCC and lighting panels are corroded and need replacement.

Digesters

- Stairway is corroded and requires replacement.
- Gas piping is corroded and falling apart and pieces are removed.
- Covers have sagged and there is structural failure. Covers require replacement.
- Mixing system is inoperative. The system is outdated and needs replacement (system is attached to the cover that has structurally failed).
- Concrete appears to be OK for the 33 year structure.
- PVC liner appears to be cracking.
- All electrical disconnects are corroded and some are missing.
- Gas flare is has structurally failed. There are holes in the stack.
- Pump is missing in pump station.
- Fire Hydrants are next to the Digester in area of potential explosion, should be relocated to a safe area

Sludge Dewatering

- Superstructure has structurally failed. There are holes in the roof. Beams are corroded and they are sagging.
- Centrifuges are outdated, corroded and inoperative needs replacement. One unit is partially disassembled
- Monorail needs replacement.
- Piping is corroded and needs replacement. Valves are missing.
- Ventilation is not present.
- MCC is mislocated and corroded. It needs replacement and isolation from process equipment
- Lighting is corroded and needs replacement.
- Hoppers are corroded and needs replacement.
- Stair nosing's have spalled off. This is a safety issue (slip/trip hazard)

Chlorine Contact Tank

- Flow entering the Parshall flume is supercritical and not suitable for accurate flow measurement
- Scum trough is set too high.
- Scum removal system is inoperative.
- Excess scum in contact basin due to problems noted with primary scum system.
- V-notch weir operating at capacity with current flow with one tank out of service.
- No railings around flume structure.
- Gratings are missing near chlorinated effluent water pumps.
- Structural issue is with inlet gate support. Concrete starting to spall off at the column.
- Interior concrete is spalling.
- Hose bibs are in poor condition and they are leaking.
- Yard lighting is disassembled and inoperative

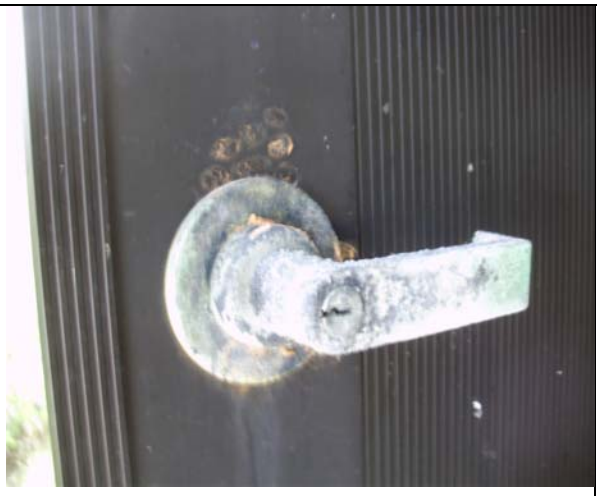
Electrical

- Yard lighting is disassembled and inoperative
- Electrical manhole covers are corroded.

Other

- Odor was noted along the road outside of westerly fenceline downwind of the NDWWTP

Headworks Photographs



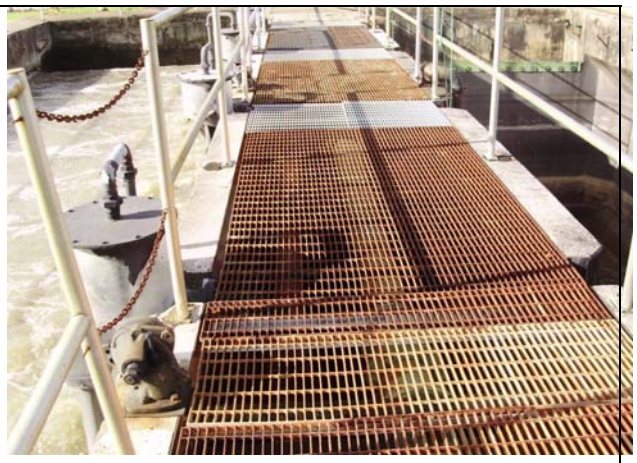
Corroded entrance door

Corroded entrance door

Inoperable Communitor	**Turbulence flow at Parshall flume**

Parshall flume	**Corroded air headers in pre-aeration tank**

Manually cleaned bar screen with bars missing



Inoperative grit removal airlift system

Broken air headers and deteriorated air diffusers at inoperable grit chamber

Inoperative and corroded grit screw

Corroded grating covers

Windows missing

Louvers missing

Inoperative ventilation

Corroded switch box

Blowers

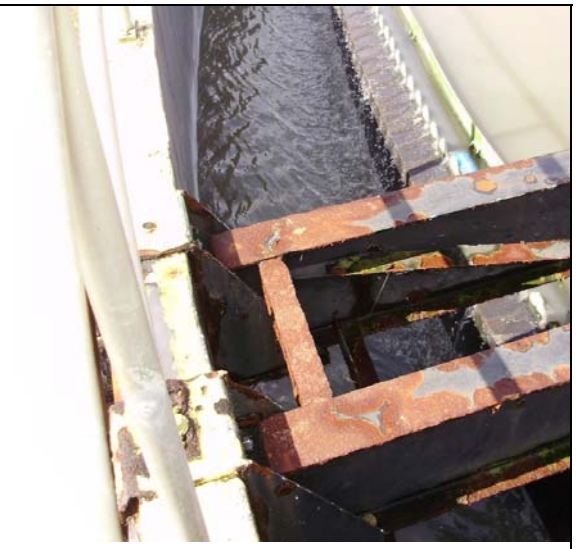
Motor Control Center

Primary Clarifiers Photographs

Primary clarifier No.1

Primary clarifier No.2

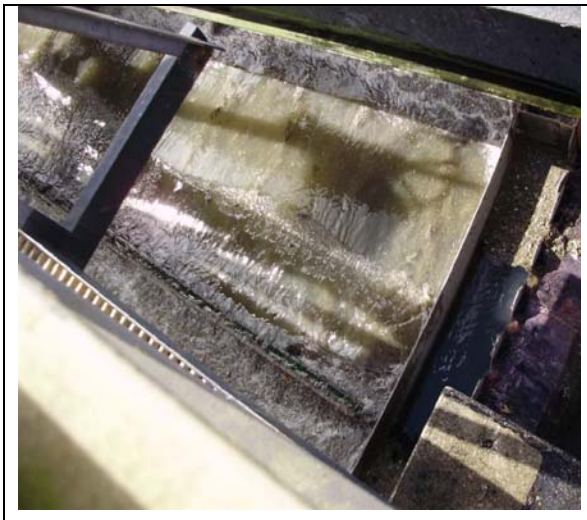
Corroded walkway supports



Corroded walkway supports

Inoperative scum pit

Driver of primary clarifier No. 2



Scum flows out of tank

Scum flows over weirs

Corroded galvanized electrical fixtures

Stainless steel electrical fixture

Corroded steel stair

Primary effluent

Primary Sludge Pump Station Photographs

Primary pump station

Primary sludge pumps

Primary pump station MCC

Piping inside primary sludge pump station

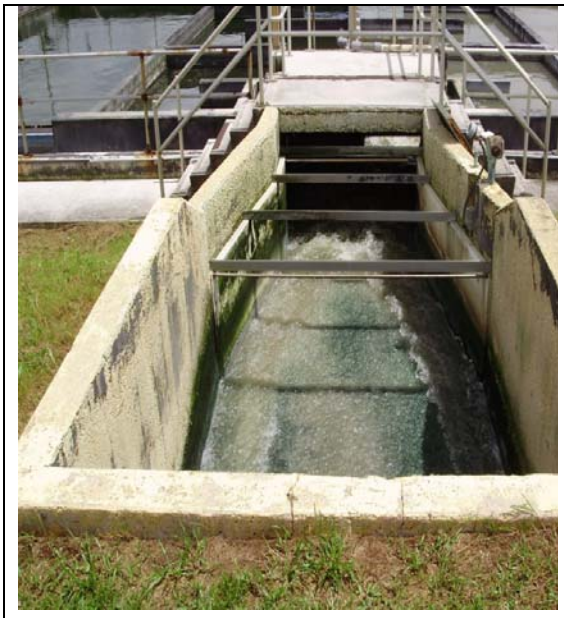
Monorail

Grating cover

Grating covers

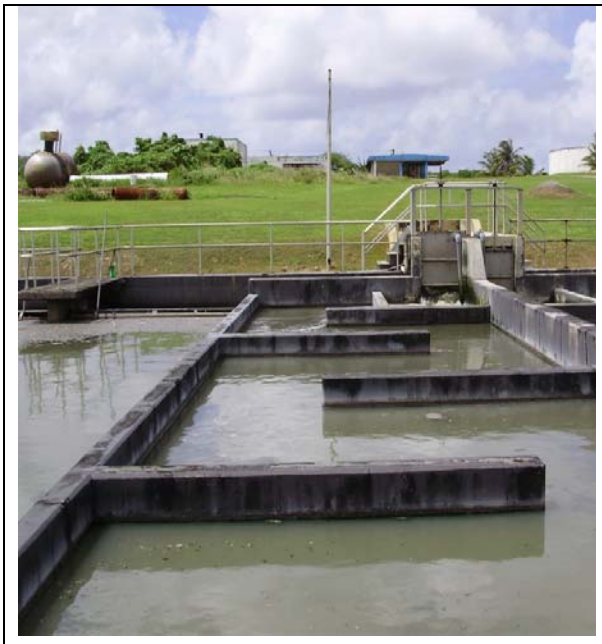
Valve vault

Chlorine Contact Tanks Photographs



Parshall flume and inlet structure

Concrete starting to spall off at inlet gate support



Baffle walls of chlorine contact tank

Excess scum in contact basin

Scum pit

Effluent over weirs

Outlet channel

Local control box

Corroded handrail

Corroded handrail

Corroded valve and pipe

Piping

Anaerobic Digesters Photographs

Anaerobic sludge digesters and control building

Anaerobic sludge digester roof

Gas piping is corroded and falling apart

Corroded stairway

Supernatant piping

Corroded electrical connectors

Digester Control Building Photographs

Corroded valves and piping

Corroded valves and piping

Gas compressor and piping

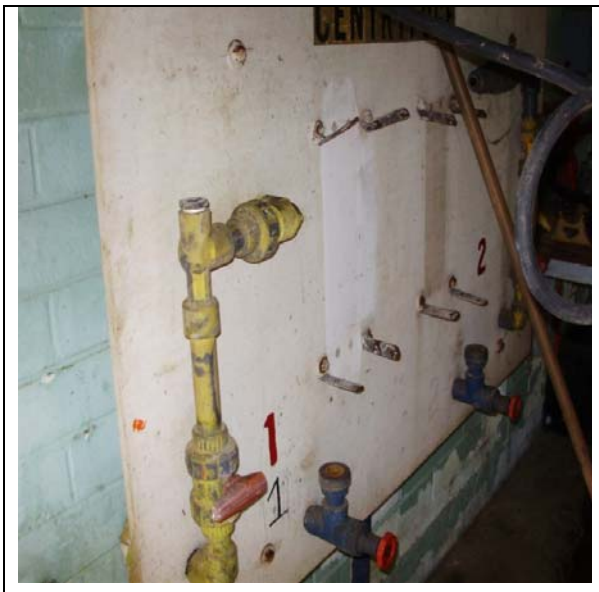
Sludge heater

Sludge transfer pumps

Centrifuge feed pumps

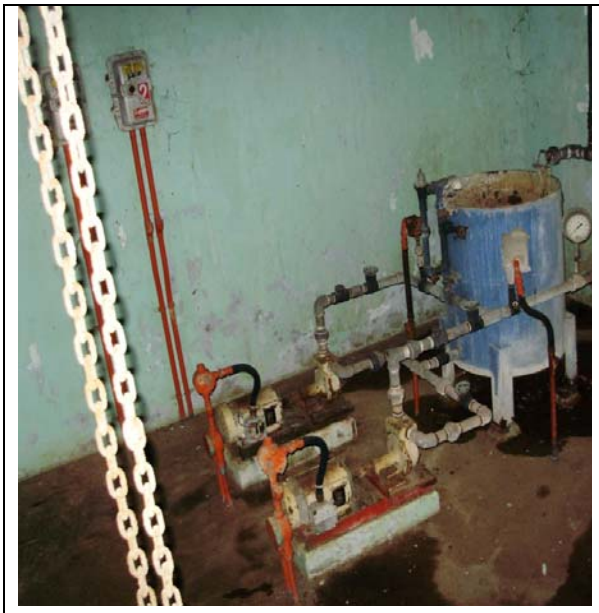
Polymer mixing tanks

Polymer feed pumps



Chemical feed piping removed

Digester gas piping



Water seal system

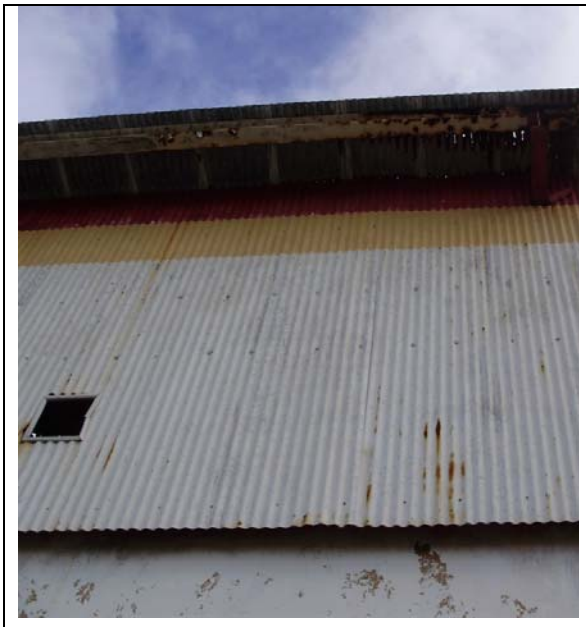
Sludge recirculation pump

MCC

Exhaust hood

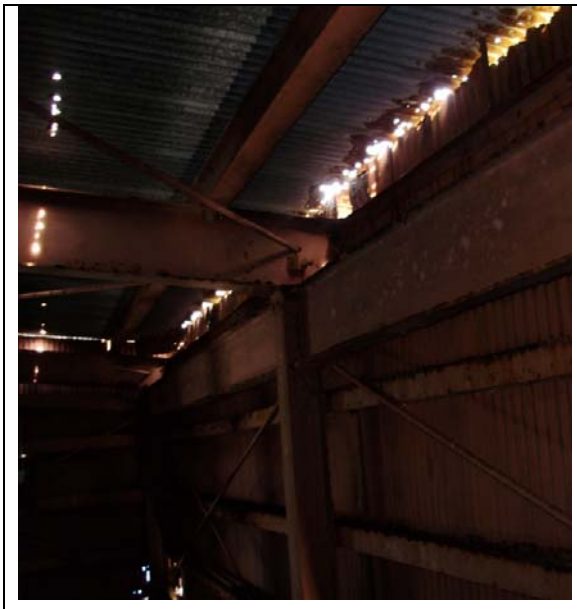
Gas flare

Sludge Dewatering Building Photographs



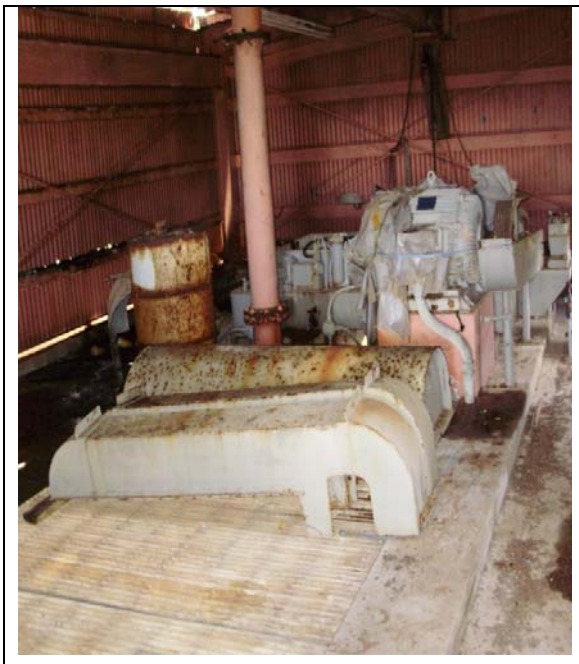
Dewatering building

Holes in the roof



Corroded corrugated steel sheets

Corroded beams



Inoperative centrifuge

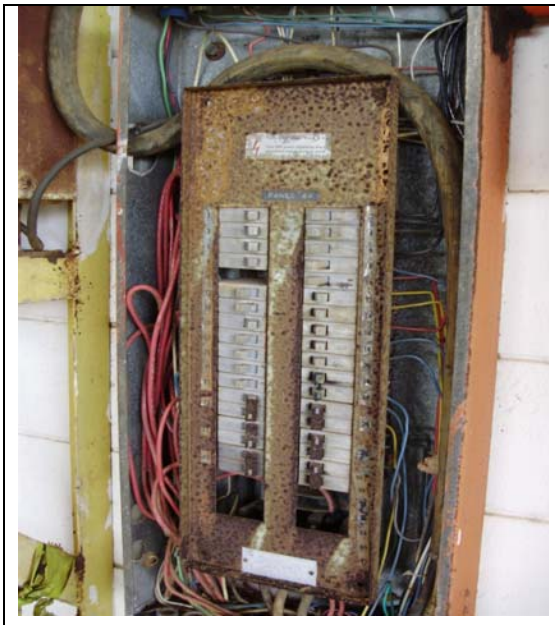
Centrifuge MCC

Centrate return pump

Administration Building Photographs

Diesel generator

Centrifuge MCC



Switch Box

Hoist

Appendix C
NDWWTP Unit Process Evaluation

North District WWTP Unit Process Evaluation

Date: 10/25/2009

Unit Process	EPA Reliability Class	Theoretical Capacity for Current Condition (AADF-MGD)	Theoretical Capacity as Designed (AADF-MGD)
Pre-Aeration Tanks	III	8.85	17.69
Aerated Grit Chambers	III	7.96	15.92
Primary Clarifiers	III	16.68	16.68
Chlorine Contact Tanks	III	6.13	12.26
Anaerobic Digesters	III	0.00	29.75
Sludge Drying Beds	III	4.25	4.25
Dewatering Centrifuges	III	0.00	17.58
Overall Plant Capacity	III	4.25	12.26
Overall Plant Capacity with CWA 301 (h) Waiver	III	4.25	15.92

*301(h) waiver doesn't require disinfection.
**Dewatered sludge can be directly disposed, then drying beds used as backup.

Design Flow Peaking Factors

Design Annual Average Daily Flow (AADF):	12.0	MGD
Design Peak Hourly Flow (PHF):	27.0	MGD
Design Peaking Factor:	2.25	

Basis of EPA Reliability Class

Class I: Works that discharge into shellfish waters or in close proximity to areas used for water contact sports.
Class II: Works that discharge into recreational waters.
Class III: Works that not classified as I or II.
The facility is considered Class III since it discharge through the outfall to the open ocean (not considered shellfish, water contact, or recreational waters)

North District WWTP Unit Process Evaluation

Date: 10/25/2009

Pre-Aeration Tanks

EPA Reliability Class:	III	
Reliability Requirements:	Backup components not mandatory.	
Volume (Each):	69,115	gallons
Tanks In Service During Visit:	1	
Total Units In Service - Design:	2	

Parameters	Units	Limits	Theoretical Capacity for Current Condition (AADF-MGD)	Theoretical Capacity as Designed (AADF-MGD)
HRT @ PHF	minutes	5.00	8.85	17.69

Total Recommended Minimum Aeration HRT@PHF =	15	minutes
HRT @ PHF in Aerated Grit Chambers =	10.00	minutes
Additional HRT Required in Pre-Aeration =	5.00	minutes

*Note: 15 minutes HRT is used for odor control and prevention of septicity (Matcalf & Eddy, 1991)

Aerated Grit Chambers

EPA Reliability Class:	III	
Reliability Requirements:	Backup components not mandatory.	
Volume (Each):	124,407	gallons
Tanks In Service During Visit:	1	
Total Units In Service - Design:	2	

Parameters	Units	Limits	Theoretical Capacity for Current Condition (AADF-MGD)	Theoretical Capacity as Designed (AADF-MGD)
HRT @ PHF	minutes	10.00	7.96	15.92

North District WWTP Unit Process Evaluation

Date: 10/25/2009

Primary Clarifiers

EPA Reliability Class:	III	
Reliability Requirements:	There shall be at least 2 sedimentation basins	
Weir Length (Each):	408	ft
Surface Area (Each):	13,273	sf
Volume (Each):	694,986	gallons
Tanks In Service During Visit:	2	
Total Units In Service - Design:	2	

Parameters	Units	Limits	Theoretical Capacity for Current Condition (AADF-MGD)	Theoretical Capacity as Designed (AADF-MGD)
SOR - AADF	gpd/sf	900	23.89	23.89
SOR - PHF	gpd/sf	2,000	23.60	23.60
HRT - AADF	hours	2.00	16.68	16.68
Minimum			16.68	16.68

*Note: Surface loading rates use middle numbers of suggested value range (Matcalf & Eddy, 1991). Surface loading rate will be lower if primary clarifier is followed by secondary treatment and co-settled with WAS sludge. With influent 125 mg/L BOD and required 30% removal, 2 hrs HRT for AADF is determined from figure shown below. Original design HRT of 2.79 hrs was derived from assigning 12 mgd average flow to the primary tankage, and CPE (Duenas, 2002) used 1 hr for PHF. Detention of PHF normally is much smaller than AADF due to diluted influent with peak wet weather flow.

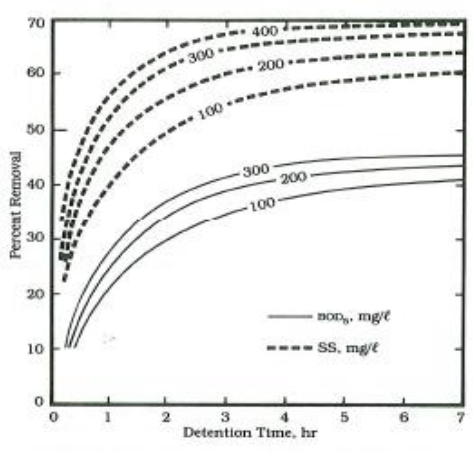


Figure C1: Percent BOD and TSS removal versus detention time for performance of primary clarifiers treating municipal wastewaters
Adapted from *Water Supply and Sewage* , 4th ed., by E. W. Steel

Chlorine Contact Tanks

EPA Reliability Class:	III	
Reliability Requirements:	Backup components not mandatory.	
Volume (Each):	143,616	gallons
Tanks In Service During Visit:	1	
Total Units In Service - Design:	2	

North District WWTP Unit Process Evaluation

Date: 10/25/2009

Parameters	Units	Limits	Theoretical Capacity for Current Condition (AADF-MGD)	Theoretical Capacity as Designed (AADF-MGD)
HRT @ PHF	minutes	15	6.13	12.26

*Note: 15 minutes HRT for PHF (Matcalf & Eddy, 1991)

Anaerobic Digesters

EPA Reliability Class:	III		
Reliability Requirements:	Backup components not mandatory.		
Active Volume (Each):	676,774	gallons	
Tanks In Service During Visit:	0		
Total Tanks In Service - Design:	2		

Parameters	Units	Limits	Theoretical Capacity for Current Condition (AADF-MGD)	Theoretical Capacity as Designed (AADF-MGD)
Average HRT	days	15	0.00	29.75

*Note: 15 days HRT for high-rate digestion (Matcalf & Eddy, 1991). CPE (Duenas, 2002) used 30 days that is for low-rate digester.

North District WWTP Unit Process Evaluation

Date: 10/25/2009

Sludge Drying Beds

EPA Reliability Class:	III	
Reliability Requirements:	Backup components not mandatory.	
Length (Each):	105	
Width (Each):	30	
Depth:	22	
Initial Sludge Depth:	30	
Beds In Service During Visit:	8	
Total Beds In Service - Design:	8	

Parameters	Units	Limits	Theoretical Capacity for Current Condition (AADF-MGD)	Theoretical Capacity as Designed (AADF-MGD)
Sludge Loading (Dry/Wet Seasons)	lbs/sf/yr	30.0	4.25	4.25

*Note: typical 30 lbs of dry solids per square foot per year for primary sludge (Matcalf & Eddy, 1991). CPE (Duenas, 2002) used dry season criteria and got higher capacity.

Dewatering Centrifuges

EPA Reliability Class:	III	
Reliability Requirements:	Remaining components handle total design loading with the largest one unit out of service.	
Capacity (Each):	2,000	lb/hr
Units In Service During Visit:	0	
Total Units In Service - Design:	2	

Parameters	Units	Limits	Theoretical Capacity for Current Condition (AADF-MGD)	Theoretical Capacity as Designed (AADF-MGD)
Average Daily	Hours/Day*	6	0.00	17.58
Operating Hours	Days/Week**	5		

*Assume 8-hr shift with 1 hour allowed for start-up and 1 hour allowed for shut-down and clean-up.
*Assume operation Monday-Friday, no operation on weekends.

*Note: same size as existing ones

PIPING CAPACITY - NDWWTP

Date: 10/25/2009

Hazen-Williams Equation: $f = 0.2083*(100/C)^{1.852} Q^{1.852} / D^{4.8655}$ *from EngineeringToolBox.com*

f = friction water head loss in ft per 100 ft of pipe

Q = volume flow (gal/min)

D = internal diameter (inches)

Assumed C = 130

1. EFFLUENT PARSHALL FLUME TO STOP GATE BOX

- with One Primary Clarifier Out of Service

Description	Flow (mgd)	Diameter (in)	Length (ft)	Flow Area (ft^2)	Velocity (fps)	$V^2/2g$	K	Slope (ft/ft)	Hm (ft)	Hf (ft)
42" OUTLET	38.00	42.00	-	9.62	6.11	0.580	0.50	-	0.29	-
375 LF 42" RCP	38.00	42.00	375	9.62	6.11	0.580	-	0.00250	-	0.94
42" 45° BEND	38.00	42.00	-	9.62	6.11	0.580	0.22	-	0.13	-
42" 45° BEND	38.00	42.00	-	9.62	6.11	0.580	0.22	-	0.13	-
42" INLET	38.00	42.00	-	9.62	6.11	0.580	0.50	-	0.29	-
								Sum	0.84	0.94
								Total Sum	1.78	

	EL. (ft)
W.S. EL 42" Pipe Outlet =	285.67
H_L =	1.78
SGB W. S. =	287.45

EL=282.17'+3.5' from NAVFAC Drawing No. 73-04-882

**SGB: Stop Gate Box*

**As-built from NAVFAC Drawing No. 73-04-844, 73-04-850, 73-04-882.

2. STOP GATE BOX TO PRIMARY CALARIFIERS

- with One Primary Clarifier Out of Service

Description	Flow (mgd)	Diameter (in)	Length (ft)	Flow Area (ft^2)	Velocity (fps)	$V^2/2g$	K	Slope (ft/ft)	Hm (ft)	Hf (ft)
42" OUTLET	38.00	42.00	-	9.62	6.11	0.580	0.50	-	0.29	-
120 LF 42" RCP	38.00	42.00	120	9.62	6.11	0.580	-	0.00250	-	0.30
42" TEE SIDE OUTLET	38.00	42.00	-	9.62	6.11	0.580	1.80	-	1.04	-
42" x 30" RED	38.00	42.00	-	9.62	6.11	0.580	0.10	-	0.06	-
60 LF 30" RCP	38.00	30.00	60	4.91	11.98	2.230	-	0.01286	-	0.77
30" TEE SIDE OUTLET	38.00	30.00	-	4.91	11.98	2.230	1.80	-	4.01	-
30" x 24" RED	19.00	30.00	-	4.91	5.99	0.558	0.10	-	0.06	-
24" x 20" RED	19.00	24.00	-	3.14	9.36	1.361	0.10	-	0.14	-
20" 45° BEND	19.00	20.00	-	2.18	13.47	2.820	0.22	-	0.62	-
20" FLEX COUPLING	19.00	20.00	-	2.18	13.47	2.820	0.05	-	0.14	-
20 LF 20" DIP	19.00	20.00	20	2.18	13.47	2.820	-	0.02561	-	0.51
20" 90° BEND	19.00	20.00	-	2.18	13.47	2.820	0.30	-	0.85	-
6 LF 20" DIP	19.00	20.00	6	2.18	13.47	2.820	-	0.02561	-	0.15
20" INLET	19.00	20.00	-	2.18	13.47	2.820	0.50	-	1.41	-
								Sum	8.62	1.74
								Total Sum	10.36	

	EL. (ft)
W.S. EL 42" Pipe Outlet =	285.67
H_L =	10.36
W.S. EL Clarifier Outlet =	296.03
EL Clarifier Outlet =	296.12
d =	-0.09
Upstream W.S. EL Clarifier Outlet =	#NUM!

downstream water depth

*As-built from NAVFAC Drawing No. 73-04-843, 73-04-844, 73-04-850, 73-04-862.

3. PRIMARY CLARIFIERS TO FLOW DIVISION STRUCTURE

- with One Primary Clarifier Out of Service

Description	Flow (mgd)	Diameter (in)	Length (ft)	Flow Area (ft^2)	Velocity (fps)	$V^2/2g$	K	Slope (ft/ft)	Hm (ft)	Hf (ft)
30" OUTLET	25.00	30.00	-	4.91	7.88	0.965	0.50	-	0.48	-
13 LF 30" DIP	25.00	30.00	13	4.91	7.88	0.965	-	0.00592	-	0.08
30" 90° BEND	25.00	30.00	-	4.91	7.88	0.965	0.30	-	0.29	-
65 LF 30" DIP	25.00	30.00	65	4.91	7.88	0.965	-	0.00592	-	0.38
63 LF 30" DIP	25.00	30.00	63	4.91	7.88	0.965	-	0.00592	-	0.37
30" INLET	25.00	30.00	-	4.91	7.88	0.965	0.50	-	0.48	-
								Sum	1.25	0.83
								Total Sum	2.08	

	EL. (ft)
Clarifier W.S. EL =	298.50
H_L =	2.08
FDS W. S. =	300.58
Weir =	301.25
Weir Flow (mgd) =	25.00
Weir Crest =	0.84
W.S. FDS Inlet =	302.09

**FDS: Flow Division Box*
Weir Lengt 15

$Q = 3.33*L*H^{3/2}$

*As-built from NAVFAC Drawing No. 73-04-843, 73-04-850, 73-04-853.

4. EFFLUENT OUTFALL

Description	Invert Elev. (ft)	Diameter (in)	Length (ft)	Manning N
STA 0+00	276.50	48		
STA 2+34.47	275.28	48	235	0.01
STA 10+00	273.40	48	389	0.01
STA 11+60	268.00	48	160	0.01

*As-built from NAVFAC Drawing No. 73-04-818 and 73-04-844.
**784 LF 48 outfall connects 30" DIP at SMH O-F-3. The SMH elev. = 267.87 ft above MSL. Flow at 48" outlet in MH freefalls.

W.S. Outfall Inlet EL. (ft)	Flow (MGD)
280.50	65
280.00	55
279.00	35
278.00	15

Appendix D
Prioritization Matrix for Proposed Improvements at NDWWTP

Table D-1: Prioritization Matrix for Proposed Improvements at NDWWTP

Rating of the Factors that Enhance Plant Performance			2	9	6	6	10	
			Capital cost	Capacity enhancement	Reliability/redundancy enhancement	Performance enhancement	Permit compliance	
No.	**Improvement Type**	**Improvements**						**Total Score**
1	**Short-term**							
2		Septage and fat/oil/grease receiving station	6	1	3	6	3	105
3		Headworks improvements	3	9	9	3	3	189
4		Primary clarifier rehabilitation	1	9	9	9	9	281
5		Sludge digester rehabilitation	1	9	9	9	9	281
6		Centrifuge building rehabilitation and one centrifuge	6	3	9	9	3	177
7		Sludge-drying bed rehabilitation	9	1	6	3	1	91
8		Standby power	3	6	9	9	9	258
9	**Long-term**							
10		Hydraulic improvements to chlorine contact tank	6	9	9	9	0	201
11		Third digester (new)	1	9	9	9	9	281
12		Second centrifuge	3	3	9	9	3	171
13		Odor control	9	1	1	1	9	129
14		Digester gas utilization	9	1	1	3	1	61
15		Adm/Lab, office and workshop/storage rehabilitation	9	1	1	1	1	49

Note: The goal of the proposed improvements at the NDWWTP is to restore its design capacity and operate efficiently without any regulatory compliance issues. The proposed improvements at the NDWWTP are prioritized based on capital cost, capacity enhancement, Reliability/redundancy enhancement, Performance enhancement and Permit compliance. A brief description of the procedure used in prioritizing the improvements is provided below:

1. *Rating of the Factors that Enhance Plant Performance*

   A scale of 1-10 was assigned to the factors: capital cost, capacity enhancement, reliability/redundancy enhancement, performance enhancement, and permit compliance that enhances NDWWTP performance. A score of 1 means the factor has little importance in achieving the enhancement and a score of 10 means the factor places ultra high importance for the enhancement. The top of the table lists all the factors and respective scoring. Out of the five factors, permit compliance is the most important for the enhancement efforts; capacity

enhancement is less important than the permit compliance; performance and reliability enhancement followed the above two in the degree of importance. The capital cost is the least important factor with respect to other factors.

2. *Ranking of each improvement with respect to enhancement factors*

   The detailed improvements at the NDWWTP are ranked by how strongly it impacts the factors such as capital cost, capacity enhancement, reliability/redundancy enhancement, performance enhancement, and permit compliance. Each improvement is assigned a number correlated to each impact factor. The correlated scores have a ranking scheme of 1 (no impact), 3 (marginal impact), 6 (strong impact), 9 (very strong impact). For example:

   - A score of 9 on capital cost means it is relatively cheaper to implement the improvement, while 0 means it is extremely expensive;
   - A score of 9 on capacity enhancement means it is crucial to the capacity enhancement, while 0 means it is noncritical to the capacity enhancement;
   - A score of 9 on reliability/redundancy enhancement means it is crucial to the reliability/redundancy enhancement, while 0 means it is noncritical;
   - A score of 9 on performance enhancement means it is crucial to the performance enhancement, while 0 means it is noncritical;
   - A score of 9 on permit compliance means it is crucial to the permit compliance, while 0 means it is noncritical.

3. *Calculation of total score for each improvement*

   Total score is obtained by multiplying each enhancement factor score (scores from Step 1) with score assigned to the correlation of improvement to the enhancement factor (scores from Step 2), and adding the individual improvement resulting scores (e.g. for item “septage and FOG receiving station” total score 105 =6×2+1×9+3×6+6×6+3×10)**.**

All the proposed improvements are prioritized based on the total score assigned to the individual improvement of the NDWWTP refurbishing project. The higher the total score, the higher the priority for improvement. (*Source: Six Sigma Cause and Effect Matrix Principles*).

Appendix E
Preliminary Cost Estimates

1. Component Navy	Northern District WWTP Short-Term Improvements			2. Date November, 2009
3. Installation and Location Northern District WWTP, Guam		4. Project Title Northern District WWTP Capacity Evaluation		
5. Program Element	6. Category Code	7. Project Number	8. Project Cost ($000) 29,700	

9. COST ESTIMATES

Item	U/M	Quantity	Unit Cost	Cost ($000)
Septic Receiving Station				
Reinforced Concrete (30,000 gallon storage tank)	CY	110	$2,124	234
Earthwork	CY	900	$106	96
Septage Screen	EA	1	$557,522	558
Blowers	LS	2	$39,823	80
Coarse bubble diffusers	LS	1	$7,965	8
Transfer Pumps -Submersible Chopper	LS	2	$66,372	133
Instrumentation/SCADA	LS	1	$44,283	44
Electrical	LS	1	$166,062	166
Septic Receiving Station				
Reinforced Concrete (30,000 gallon holding tank)	CY	110	$2,124	234
Earthwork	CY	900	$106	96
Heat Trace System	EA	1	$13,274	13
Transfer Pumps -Submersible Chopper	LS	2	$66,372	133
Instrumentation/SCADA	LS	1	$19,009	19
Electrical	LS	1	$71,283	71
Headworks Upgrade				
Demolition	LS	1	$36,770	37
Reinforced Concrete for Meter Vault	LS	35	$2,124	74
Earthwork for Meter Vault	LS	400	$106	42
6mm Fine Screen Equipment	EA	2	$637,168	1,274
Meg Meter	EA	1	$37,168	37
Grit Chamber Retrofit	LS	1	$53,097	53
Grit Pump Station	LS	1	$53,097	53
Grit Wash and Seperation	LS	1	$53,097	53
Piping and Valves	LS	1	$141,770	142
Instrumentation/SCADA	LS	1	$58,832	59
Electrical	LS	1	$147,080	147
Primary Clarifier Rehabilitation				
Demolition	LS	1	$79,646	80
316 SS Sludge/Scum Collector Equipment	EA	2	$1,592,920	3,186
Miscellaneous Metals	LS	1	$159,292	159
Fiberglass Reinforced Plastic Weirs	LS	1	$95,575	96
Protective Coatings & Concrete Repair	LS	1	$796,460	796
Piping and Valves	LS	1	$95,575	96
Instrumentation/SCADA	LS	1	$127,434	127
Electrical	LS	1	$318,584	319
Anaerobic Digester Rehabilitation				
Demolition/Preparation	LS	1	$106,195	106
Digester Mixing and Heating Equipment	EA	2	$2,123,894	4,248
Miscellaneous Metals	LS	1	$254,867	255
Roofing and Insulation	LS	1	$233,628	234
Protective Coatings & Concrete Repair	LS	1	$637,168	637
Piping and Valves	LS	1	$1,486,726	1,487
Instrumentation/SCADA	LS	1	$297,345	297
Electrical	LS	1	$637,168	637

FORM
DD 1DEC76 1391 PREVIOUS EDITIONS MAY BE USED INTERNALLY UNTIL EXHAUSTED

1. Component Navy	Northern District WWTP Short-Term Improvements			2. Date November, 2009
3. Installation and Location Northern District WWTP, Guam				
4. Project Title				7. Project Number
Item	U/M	Quantity	Unit Cost	Cost ($000)
Solids Dewatering Building Replacement				
Structure Demolition	LS	1	$66,504	67
Reinforced Concrete	CY	180	$2,124	382
Earthwork	CY	400	$106	42
Masonry Interior Walls	LS	1	$49,699	50
Miscellaneous Metals	LS	1	$45,876	46
Fiberglass Reinforced Plastic Grating	LS	1	$11,469	11
Membrane Roofing and Insulation	LS	1	$53,522	54
Doors and Windows	LS	1	$9,558	10
Protective Coatings	LS	1	$45,876	46
Building Specialties	LS	1	$7,646	8
Sludge Grinders	EA	1	$53,097	53
Sludge Feed Pumps	EA	1	$66,372	66
Polymer Feed System	EA	1	$238,938	239
Polymer Feed Pumps	EA	1	$15,929	16
Centrifuges -2,000 lb/hr	EA	1	$955,752	956
Process Piping and Valves	LS	1	$239,416	239
HVAC	LS	1	$199,513	200
Plumbing	LS	1	$133,009	133
Electrical	LS	1	$665,044	665
Instrumentation/SCADA	LS	1	$146,310	146
Influent and Effluent Samplers	EA	2	$79,646	159
Sludge Drying Bed Refurbish	LS	1	$79,646	80
Emergency Diesel Generator				
Reinforced Concrete	LS	1	$79,646	80
Earthwork	LS	1	$79,646	80
Diesel Generator	EA	1	$238,938	239
Site Work and Utilities	LS	1	$1,319,990	1,320
Sub Total				22,000
Project Services 35.00%				7,700
Total Contract Cost				29,700
Total Request				29,700
Total Request (Rounded)				29,700

10. Description of Proposed Construction:

Short-term improvements at the NDWWTP are the necessary improvements would include bringing the currently inoperable process units back to service, it addresses immediate influent flow increases. It includes following constructions and refurbishments at the NDWWTP:

1) New septic and FOG receiving stations

A new septage receiving station receives and pretreats septage from unsewered customers on the island. The station consists of an unloading area, a septage storage tank, a septage screen, an aeration system, and two grinder transfer pumps. The undergrade septage storage tank has volume of 30,000 gallons. A new FOG receiving station receives FOG generated by residential, commercial, and industrial generators, such as restaurants, grocery stores, hospitals, and food processors. The FOG receiving station collects FOG from grease trucks and pump it into the plant anaerobic digesters for treatment. The FOG station indludes a 30,000 gallon grease holding tank and chopper pumps. Both the septage storage tank and the grease holding tank will be covered and will have an odor control system.

2) Headworks upgrade

Headworks improvements include installation of fine screens, a grit chamber retrofit, installation of a new grit pump station, installation of grit wash and dewatering units, and incorporation of flow metering. Two new mechanically cleaned 6mm fine screens will be installed to prevent the entry of large debris and coarse solids. A new flow measurement system will be installed to replace the malfunctioning Parshall flume. A meter vault will be constructed outside and upstream on the influent flow pipe with siphon modification to have full flow pipe. A magnetic meter is installed for flow measurement. The grit chamber concrete surface will be sand blasted and coated. All air pipes and diffusers, grit removal pumps, and grit wash and dewatering units will be replaced.

FORM

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1. Component Navy	Northern District WWTP Short-Term Improvements	2. Date November, 2009
3. Installation and Location Northern District WWTP, Guam		
4. Project Title		7. Project Number

(…continue)

3) Two primary clarifier refurbish

Rehabilitation of the two primary clarifiers includes concrete surface cleaning, sand blasting and coating, and replacement of the basin mechanical components with new stainless steel units. The primary clarifiers will be furnished with drive units, a walkway and drive platform, a center column, a center cage and rake arm, a feedwell, a scum removal mechanism, and fiberglass-reinforced plastic weirs and baffles. Stainless steel units are used for the tropical coastal environment at the NDWWTP site.

4) Sludge digester rehabilitation

Two digester tanks will be refurbished and the digester rehabilitation will include mixing and recirculation system, gas and scum piping, sludge recirculation and transfer pumps, gas compressors and a boiler for heating, and a waste gas flare. The polymer dosing system, which assists with dewatering sludge and is located inside the sludge digester control building, also needs to be refurbished.

5) Solids dewatering building replacement

The centrifuge building will be replaced, and one new sludge 2,000 lbs/hr centrifuge is installed to replace the old units.

6) Sludge drying beds rehabilitation

Valves and Concrete Repair for all eight sludge drying beds.

7) New standby power

A 300kW diesel generator unit is installed for emergency service as a standby power source.

FORM
DD 1DEC76 1391 PREVIOUS EDITIONS MAY BE USED INTERNALLY UNTIL EXHAUSTED

1. Component Navy	Northern District WWTP Long-Term Improvements			2. Date November, 2009
3. Installation and Location Northern District WWTP, Guam		4. Project Title Northern District WWTP Capacity Evaluation		
5. Program Element	6. Category Code	7. Project Number	8. Project Cost ($000) 25,210	

9. COST ESTIMATES

Item	U/M	Quantity	Unit Cost	Cost ($000)
Chlorine Contact Tank (Refurbish)				
Reinforced Concrete	CY	133	$2,124	282
Earthwork	CY	260	$106	28
Demolition	LS	1	$44,602	45
Chemical Feed and Mixing Equipment	EA	2	$318,584	637
Miscellaneous Metals	LS	1	$31,858	32
Slide Gates and Weirs	LS	1	$19,115	19
Protective Coatings & Concrete Repair	LS	1	$95,575	96
Piping and Valves	LS	1	$19,115	19
Instrumentation/SCADA	LS	1	$25,487	25
Electrical	LS	1	$63,717	64
Anaerobic Digesters (New)				
Reinforced Concrete	CY	1000	$2,124	2,124
Earthwork	CY	1400	$106	149
Digester Mixing and Heating Equipment	EA	1	$2,123,894	2,124
Miscellaneous Metals	LS	1	$263,788	264
Roofing and Insulation	LS	1	$241,805	242
Protective Coatings	LS	1	$659,469	659
Piping and Valves	LS	1	$1,538,761	1,539
Instrumentation/SCADA	LS	1	$307,752	308
Electrical	LS	1	$659,469	659
New Sludge Pump Station	LS	1	$2,198,230	2,198
Digester Gas Uitilization (New)				
Cogeneration System	EA	1	$1,393,805	1,394
Piping and Valves	LS	1	$487,832	488
Instrumentation/SCADA	LS	1	$97,566	98
Electrical	LS	1	$209,071	209
Centrifuge (New)				
Sludge Grinders	EA	1	$53,097	53
Sludge Feed Pumps	EA	1	$66,372	66
Polymer Feed System	EA	1	$238,938	239
Polymer Feed Pumps	EA	1	$15,929	16
Centrifuges - 2,000 lb/hr	EA	1	$955,752	956
Process Piping and Valves	LS	1	$239,416	239
HVAC	LS	1	$199,513	200
Plumbing	LS	1	$133,009	133
Electrical	LS	1	$665,044	665
Instrumentation/SCADA	LS	1	$146,310	146
Plant Odor Control System	LS	1	$477,876	478
Adm/Lab/Storage (Refurbish)	LS	1	$663,717	664
Site Work and Utilities	LS	1	$1,120,581	1,121
Sub Total				18,676
Project Services 35.00%				6,537
Total Contract Cost				25,213
Total Request				25,213
Total Request (Rounded)				25,210

10. Description of Proposed Construction:

Long-term improvements at the NDWWTP are those improvements required for when the influent flows approach 10–12 mgd. Execution of identified long-term improvements is necessary to ensure the reliability and operational flexibility of the treatment system. The long-term improvements include the following:

FORM

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1. Component Navy	Northern District WWTP Long-Term Improvements	2. Date November, 2009
3. Installation and Location Northern District WWTP, Guam		
4. Project Title		7. Project Number

(…continue)

1) Chlorine contact tank rehabilitation

The existing configuration of the chlorine contact tanks will be retrofitted with long, narrow channels in a serpentine pattern to improve the hydraulic characteristics. As part of the chlorine contact tanks reconfiguration, a new effluent Parshall flume will be installed down stream of the chlorine tanks to replace the malfunctioned existing one, which is located upstream of the chlorine tanks.

2) One new anaerobic digester will be added

One digester tank same size as existing ones with diameter of 80 foot and SWD of 18 foot. New sludge mixing, heat exhangers, electrical, controls, coatings, piping and valves.

3) Digester gas utilization system will be added

Engine generator, gas purification, compressor and gas flare system.

4) One new centrifuge will be added

One new sludge 2,000 lbs/hr centrifuge will be installed.

5) Plant odor control system will be added

A plant odor control system needs to be added to treat odor collected inside the headworks building, septage storage tank, grease-holding tank at the receiving station and centrifuge building to improve operator working environment and air quality of surrounding area.

FORM
DD 1DEC76 1391 PREVIOUS EDITIONS MAY BE USED INTERNALLY UNTIL EXHAUSTED

1. Component Navy	Northern District WWTP Advanced Primary Treatment			2. Date November, 2009
3. Installation and Location Northern District WWTP, Guam	4. Project Title Northern District WWTP Capacity Evaluation			
5. Program Element	6. Category Code	7. Project Number	8. Project Cost ($000) 1,690	

9. COST ESTIMATES

Item	U/M	Quantity	Unit Cost	Cost ($000)
Chemical Building (new)				
Reinforced Concrete	CY	60	$2,124	127
Earthwork	CY	350	$106	37
Masonry Interior Walls	LS	1	$21,398	21
Miscellaneous Metals	LS	1	$19,752	20
Fiberglass Reinforced Plastic Grating	LS	1	$4,938	5
Roofing and Insulation	LS	1	$23,044	23
Doors and Windows	LS	1	$4,115	4
Protective Coatings	LS	1	$9,876	10
Building Specialties	LS	1	$1,646	2
Dry Chemical Feed System	EA	1	$132,743	133
Chemical Blending Tank	EA	2	$26,549	53
Chemical Feed Pumps	EA	2	$15,929	32
Polymer Feed System	EA	1	$238,938	239
Polymer Feed Pumps	EA	2	$13,274	27
Process Piping and Valves	LS	1	$76,938	77
HVAC	LS	1	$64,115	64
Plumbing	LS	1	$42,743	43
Electrical	LS	1	$213,717	214
Instrumentation/SCADA	LS	1	$47,018	47
Site Work and Utilities	LS	1	$75,134	75
Sub Total				1,252
Project Services 35.00%				438
Total Contract Cost				1,690
Total Request				1,690
Total Request (Rounded)				1,690

10. Description of Proposed Construction:

In order to provide a consistant treatment for unstable influent loading concentrations at the NDWWTP, an advanced primary treatment system with a higher removal rate for BOD and TSS will be installed for the NDWWTP upgrade. A chemically enhanced primary treatment (CEPT) will be installed for the NDWWTP upgrade. CEPT is the process by which chemicals, typically metal salts and/or polymers, are added to the conventional primary treatment system. Chemical precipitation enhances suspended solids settling and improves the performance of the primary settling facilities. Chemicals, usually iron salt and polymer coagulant, could be added to the aerated grit chamber at the NDWWTP for fully mixing. Upgrade to an advanced primary treatment system at the NDWWTP would involve chemical storage, chemical feeding, piping, and use of a control system. The improvements include following:

1) One 40'x25'x12' new concrete chemical building will be added
2) New dry chemical feed system
3) New polymer feed system

FORM
DD 1DEC76 1391 PREVIOUS EDITIONS MAY BE USED INTERNALLY UNTIL EXHAUSTED

Appendix F
Comments and Responses for Draft Report

Project Title: Draft Report
Evaluation of Northern District Wastewater Treatment Plant Capacity
Reviewer: Julie Shane, GWA
Date: 20 November 2009

Item	Section No.	Comment
1	Table ES.1	Provide the basis of the capacity calculation for the sludge drying beds. Clarify dry season vs. wet season.
Response: The calculations are based on dry season. Will update the report to include basis of calculations		
2	2	Before the words “Class III” add “USEPA” (as GEPA classes of plants have an entirely different meaning)
Response: Will add USEPA		
3	2	Septage is NOT currently discharged at the NDWWTP, as there is no location for discharge. All septage loads will be discharged at ND once the septage receiving station is complete.
Response: Will modify the text		
4	3.2.1	A data logger is currently in place. Although designed to be temporary, it gives far more accurate data than the Parshall flume. The blowers and MCC were installed in 2007.
Response: Will modify the text to include discussion on data logger and installation date for blowers and MCC		
5	3.2.3	Sludge pumps were replaced and controls upgraded in 2006 and 2007.
Response: Will update the text to include upgrade information for sludge pumps		
6	3.2.4	Digester capacity is not specified.
Response: Will specify the digester capacity based on the original design criteria		
7	4.1	Cite the reference for the “Industry Standards” used in all calculations.
Response: Will include the reference information		
8	4.2	Clarify that piping was field verified where possible and note that all piping must be field verified prior to work.
Response: Will clarify in the report whether the pipe was field verified or need to be field verified prior to work		
9	4.2.1	It is extremely unlikely that the centrifuge building is salvageable. It should be replaced. Administration/laboratory, office and workshop/storage area all require rehabilitation.
Response: Will modify the write-up to include a new building and modify the costs accordingly. Will add discussion on rehabilitation of Administration/laboratory, office and workshop/storage areas		
10	Appendix C	Unit Process Evaluation for Primary Clarifiers: Hydraulic Retention Time of 1.75 is reasonable for a primary clarifier that is followed by secondary treatment, however, it is low for a primary only facility. Please also provide the theoretical design AADF utilizing an HRT suitable for primary clarifiers that are not followed by secondary treatment. The basis of design for the clarifiers was an HRT of 2.79 hrs. Present data for both primary and primary followed by secondary.
Response: Design criteria for Primary Clarifiers are achieved from expected Primary removal efficiency regardless of secondary treatment followed by primary. Modified HRT of 2 hrs is obtained from Ten State Standards with 30% BOD removal from primary clarifier, it was also confirmed by clarifier vendor WesTech.		
11	Appendix C	When the Theoretical Capacity differs from that presented in the 2002 CPE or the original plant Basis of Design, provide a clarification of the differences and a justification for the data presented in the report.
Response: will add a Table to clarify the differences and justification for the data. However please confirm whether the Table I-2 attached to this sheet is the original plant basis of design. If not please provide the information		

Project Title: Draft Report
Evaluation of Northern District Wastewater Treatment Plant Capacity
Reviewer: Julie Shane, GWA
Date: 20 November 2009

Item	Section No.	Comment
12	Priority Matrices	Prioritize the projects presented in a matrix that considers cost, capacity, reliability/redundancy and performance enhancements/permit compliance.
Response: Will provide a matrix listing priority of the projects		
13	Cost Estimates	Do the cost estimates for the gas system include the engine? Numbers appear to be low.
Response: Yes the costs include the engine. We received cost from only one vendor but will reach out to more vendors and update the cost accordingly		

Project Title: Draft Report
Evaluation of Northern District Wastewater Treatment Plant Capacity
Reviewer: Travis Hylton, NAVFAC Pacific
Date: 27 November 2009

Item	Section No.	Comment
1	General	Report is well written and well presented.
Response: Thanks and appreciate your comment		
2	ES, Page v	Provide a table and discussion of existing plant capacities onsite, with off-site sludge handling, with and without the CWA 301 (h) Waiver.
Response: Will add a table listing the capacities		
3	Page 2	Statement is made that NDWWTP's current permitted capacity is 6 MGD. Provide citation (NPDES Permit), and explain if this is average daily flow or max day monthly flow.
Response: Will provide the citation and identify that it is max day monthly flow		
4	Section 3.2.7, Page 12	What improvements must be done to restore the flow regime at the Parshall flume so that it is useful for flow measurement? Alternately, should another method of flow measurement be used?
Response: Will discuss the improvement with another flow measurement method in Section 4.2.1.		
5	Section 4.0, ES, Page 14, App C	Provide a more thorough discussion of USEPA Reliability Classes. Although NDWWTP is Class III, present requirements for higher classes for each component for comparison.
Response: Will expand the discussion and present requirements for other classes		
6	Section 4.0, ES, Page 14, App C	In addition to the USEPA Reliability Requirements, provide reliability recommendations for each component to enhance operational flexibility, redundancy, and capacity.
Response: Will provide information for each component		
7	Section 4.1, Page 14, App A?	Provide the original NDWWTP Design Criteria for reference.
Response: Will provide the reference		
8	Section 4.1, Page 15	Show the evaluation procedure from Water Supply and Sewerage for the primary clarifier AADF and detention time.
Response: Will provide details of the evaluation		
9	Section 4.2, ES, Page 16	Appreciate division of improvements into short- and long- categories. Provide a further breakdown of priorities of individual improvements suitable for use in CIP programming. Prioritization should be based on cost, capacity enhancement, performance enhancement, reliability enhancement with weighting/logic as appropriate. Provide a graphic of successive capacity expansions due to individual improvements.
Response: Will provide a matrix listing priority of the projects		

Revised Final

Guam Water Utility Study Report for Proposed USMC Relocation

May 2010

Department of the Navy
Naval Facilities Engineering Command, Pacific
258 Makalapa Drive, Suite 100
Pearl Harbor, HI 96860-3134

Contract Number N62742-06-D-1870/TO 0012

Revised Final

Guam Water Utility Study Report for Proposed USMC Relocation

May 2010

Prepared for:

Department of the Navy
Naval Facilities Engineering Command, Pacific
258 Makalapa Drive, Suite 100
Pearl Harbor, HI 96860-3134

Prepared by:

AECOM Technical Services, Inc.
1001 Bishop Street, Suite 1600
Honolulu, HI 96813

Contract Number N62742-06-D-1870/TO 0012

The Guam Joint Military Master Plan identifies a planned increase in military population and activity on Guam. The Environmental Impact Statement (EIS) for this action presents several EIS Cantonment Alternatives for the United States Marine Corps (USMC). The potential site for EIS Cantonment Alternatives 1 and 2 includes the Department of Defense (DoD) base at Finegayan, Guam, and additional nearby land.

The Naval Facilities Engineering Command, Pacific, under master contract number (no.) N62742-06-D-1870 issued contract task order no. 12 to the TEC, Inc. Joint Venture to study the potable water utilities for EIS Cantonment Alternatives 1 and 2 at Finegayan, Guam. This utility study will support the preparation of the EIS for the USMC relocation to Guam with sufficient and detailed information for EIS Cantonment Alternatives 1 and 2, including the interim and long-term alternatives for the potable water utilities; the study includes site plans, cost estimates, and schedule schemes. The status of existing utilities will be considered in preparing the required alternatives. The EIS Cantonment Alternatives 1 and 2 from the September 2009 in-progress EIS were used for this analysis.

OVERVIEW

In the *Guam Water Utility Study* (Earth Tech 2008), development of groundwater resources was recommended as the primary source to serve the USMC Finegayan Base (Alternatives 1 and 2). The supply from rehabilitated wells and purchase of water from Guam Waterworks Authority (GWA) alone are not sufficient to meet USMC relocation water demand. Review of the available yield indicates that the water supply from the Northern Guam Lens Aquifer is sufficient to meet the projected demand based on the 1992 sustainable yield estimates. This report provides a detailed analysis of groundwater resource development as the primary source for the USMC Finegayan base using population information that is consistent with the Final EIS. Water supply and demand at the Navy and Air Force bases on Guam and potential impacts to the GWA water system were also reviewed.

Findings

The future water demands and supply for the DoD bases are shown in Table ES-1. Water transferred to GWA from the Navy Reservoir and Andersen Air Force Base (AFB) is also included in the demands on the DoD water systems. Components of the proposed water system are shown in Table ES-2. Wells (22) on Andersen AFB would meet the supply requirements for the USMC Finegayan water system. Groundwater would be treated prior to transmission to the base. Additional water storage capacity is required at the USMC Finegayan base. Partial replacement of the Navy island-wide water system mains is included in this option to transport water from the USMC Finegayan base to other DoD bases. Water main replacement would be phased in over time and would not be completed by 2015. This study includes the cost of transmission mains, including distribution from water storage to users. Figure ES-1 shows the planned DoD water supplies.

Life cycle costs for EIS Cantonment Alternatives 1 and 2 are shown in Table ES-3. Costs are based on year 2008 dollars and escalated to the mid-point year of construction. The present worth cost is $597 million.

Table ES-1: Proposed DoD Water Supply and Demand

Water Supply Sources (Existing and Proposed)	Water Supply (in mgd)			
	USMC Finegayan	Andersen AFB	Navy Bases	Total
Main Cantonment Alternatives 1 & 2				
Current Surface Water Supply			10.97	10.97
Current Groundwater Supply		4.73	2.21	6.94
Development of new water supply wells	11.28			11.28
Rehabilitation of existing Navy wells			1.23	1.2
Planned Supply Cantonment Alternatives 1 & 2	11.28	4.73	14.41	30.42
GWA Transfer Projected Need in 2019	0.0	0.0	4.00	4.00
Maximum Daily Demand using UFC Guidance	10.61	4.88	12.98	28.48
Maximum Daily Demand using UFC Guidance+ GWA Transfer	10.61	4.88	16.98	32.48

mgd million gallons per day
UFC Unified Facilities Criteria

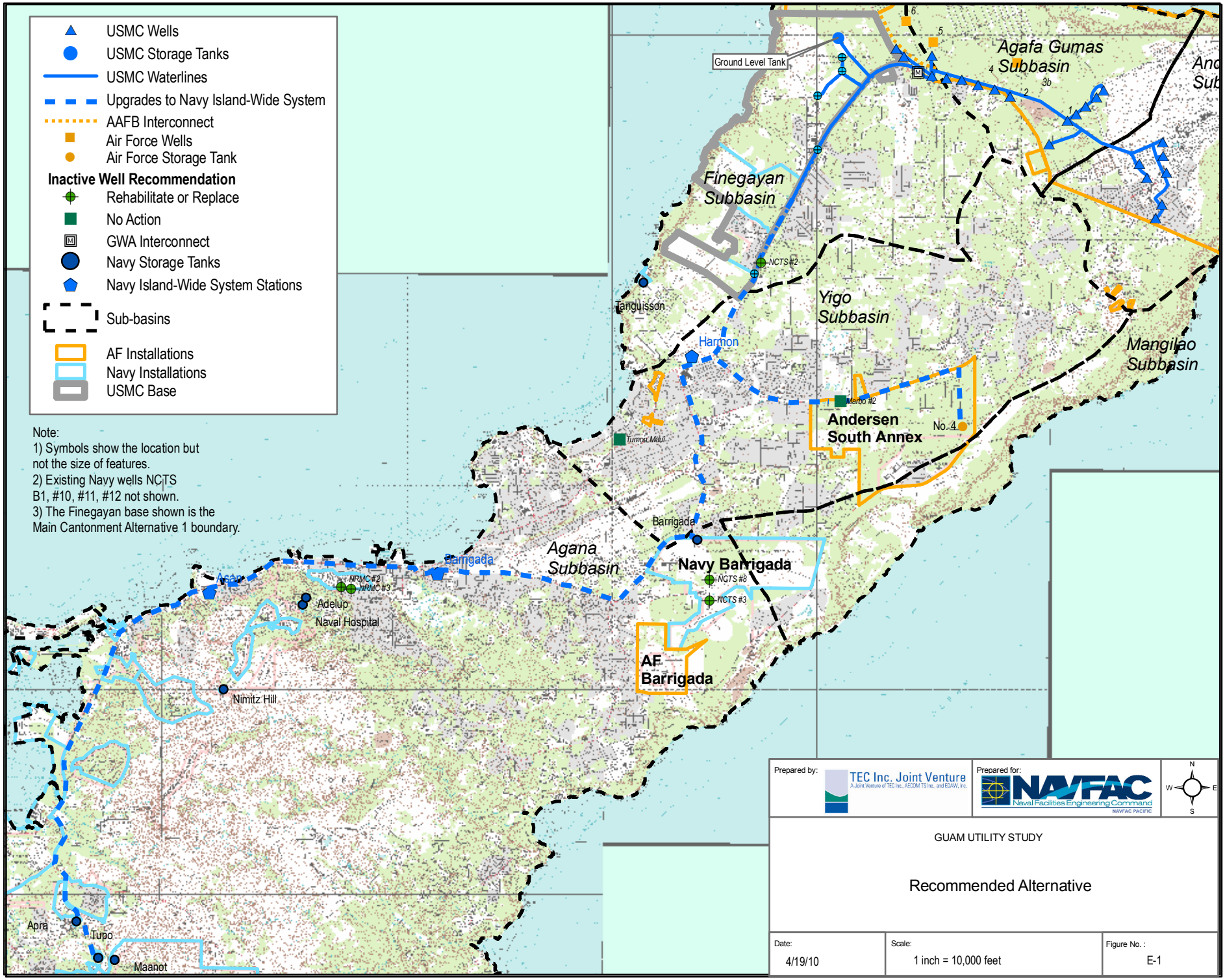
Table ES-2: Proposed Water System Components

Component	Description
Water Supply	• Development of up to 22 new water supply wells (including one contingency well) on Andersen AFB • Use of five recently installed wells at Andersen AFB • Continued use of existing Navy wells on the USMC Finegayan base • Rehabilitation of Navy wells
Water Treatment	• Disinfection and fluorination prior to transmission to the new base from the 22 new water supply wells on Andersen AFB
Water Storage	• Construction of new storage tanks on the USMC Finegayan base • Abandonment of existing Navy storage tanks on the USMC Finegayan base
Distribution System	• Waterlines to transport the water from supply wells to the ground level storage tank on USMC Finegayan base • Waterlines to distribute water throughout the USMC Finegayan base
	• An interconnect with the Navy's island-wide water system • Improvements to the Navy's island-wide water system (i.e., size pipes appropriately, replace corroded pipes, transport water to the south as well as north) • Replace water mains connecting existing Navy wells to the water system • Connections to the Air Force water system • A connection to the GWA water system

Table ES-3: Cantonment Alternatives 1 and 2 Life Cycle Costs

	Cost ($000)
Capital Costs	
1) Water Resources Development	$23,936
2) Water Treatment	$3,001
3) Distribution	$273,637
Total Construction Cost	$300,575
Contingencies (20%)	$60,115
Engineering (15%)	$45,086
Total Capital Cost	$405,776
Present Worth Guam Capital Costs	$408,959
Annual O&M Costs	
1) Water Resources Development	$402
2) Water Treatment	$1,941
3) Distribution	$4,236
Total Annual O&M Cost	$6,578
Contingency (20%)	$1,316
Total Annual O&M Cost	$7,894
Annual O&M Cost for Guam	$7,894
Present Worth of O&M Costs (25 year life)	$188,396
Present Worth of Total Costs	$597,355

% percent
O&M operation and maintenance


USMC Wells
USMC Storage Tanks
USMC Waterlines
Upgrades to Navy Island-Wide System
AAFB Interconnect
Air Force Wells
Air Force Storage Tank
Inactive Well Recommendation
Rehabilitate or Replace
No Action
GWA Interconnect
Navy Storage Tanks
Navy Island-Wide System Stations
Sub-basins
AF Installations
Navy Installations
USMC Base
Note:
1) Symbols show the location but not the size of features.
2) Existing Navy wells NCTS B1, #10, #11, #12 not shown.
3) The Finegayan base shown is the Main Cantonment Alternative 1 boundary.
Ground Level Tank
Agafa Gumas Subbasin
Finegayan Subbasin
Yigo Subbasin
Mangilao Subbasin
Agana Subbasin
NCTS #2
Tanguisson
Harmon
Marbo #2
Andersen South Annex
No. 4
Tumon Maui
Barrigada
Navy Barrigada
NCTS #8
NCTS #3
AF Barrigada
Asan
NRMC #2
NRMC #3
Adelup
Naval Hospital
Nimitz Hill
Apra
Tupo
Maanot
Prepared by:
TEC Inc. Joint Venture
Prepared for:
NAVFAC
Naval Facilities Engineering Command
GUAM UTILITY STUDY
Recommended Alternative
Date:
4/19/10
Scale:
1 inch = 10,000 feet
Figure No. :
E-1

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%	percent
°C	degree Celsius
°F	degree Fahrenheit
µg/L	microgram per liter
µmhos/cm	micromhos per centimeter
AFB	Air Force Base
ATS	AECOM Technical Services, Inc.
DEIS	Draft Environmental Impact Statement
DoD	Department of Defense
EIS	Environmental Impact Statement
EO	Executive Order
EPA	Environmental Protection Agency, United States
ESQD	explosives safe quantity distance
ESS	Explosives Safety Submission
ft	feet or foot
ft/day	feet per day
ft^2	square feet
GA	gallon
GEPA	Guam Environmental Protection Agency
GJMMP	Guam Joint Military Master Plan
gpcd	gallon per capita per day
gpd	gallon per day
gpm	gallon per minute
GWA	Guam Waterworks Authority
GWUDI	Groundwater under the direct influence of surface water
IBD	inhabited building distance
IRP	Installation Restoration Program
LF	linear foot
MARBO	Marianas Bonins Command
MCL	maximum contaminant level
MEC	munition and explosive of concern
mg/L	milligram per liter
mgd	million gallons per day
msl	mean sea level
mV	millivolt
NAVMAG	Naval Magazine
NCTAMS	Naval Computer and Telecommunications Area Master Station
NCTS	Naval Computer and Telecommunications Station
NGLA	Northern Guam Lens Aquifer
NGLS	Northern Guam Lens Study
no.	number
NOSSA	Naval Ordnance Safety and Security Activity
NRMC	Navy Regional Medical Clinic
NTU	nephelometric turbidity unit
NWF	Northwest Field
O&M	operation and maintenance
PCE	tetrachloroethene

pH	hydrogen ion concentration
SY	sustainable yield; square yard
TCE	trichloroethylene
U.S.	United States
U.S.C	United States Code
UFC	Unified Facilities Criteria
UFW	unaccounted for water
USGS	United States Geological Survey
USMC	United States Marine Corps
UXO	unexploded ordnance
VOC	volatile organic compound
WRMP	Water Resources Master Plan
WTP	water treatment plant

1. Introduction

1.1 PURPOSE

The Guam Joint Military Master Plan (GJMMP) identifies a planned increase in military population and activity on Guam. The Environmental Impact Statement (EIS) for this action presents several EIS Cantonment Alternatives for the United States (U.S.) Marine Corps (USMC). The potential site for EIS Cantonment Alternatives 1 and 2 includes the Department of Defense (DoD) base at Finegayan, Guam, and additional nearby land. The Naval Facilities Engineering Command, Pacific, under master contract number (no.) N62742-06-D-1870 issued contract task order no. 12 to the TEC, Inc. Joint Venture to study the potable water utilities for EIS Cantonment Alternatives 1 and 2 at Finegayan, Guam. This utility study will support the preparation of the EIS for the USMC relocation to Guam with sufficient and detailed information for EIS Cantonment Alternatives 1 and 2, including the interim and long-term alternatives for the potable water utilities; the study includes site plans, cost estimates, and schedule schemes. The status of existing utilities will be considered in preparing the required alternatives. The EIS Cantonment Alternatives 1 and 2 from the September 2009 in-progress EIS were used for this analysis.

1.2 BACKGROUND INFORMATION

Guam is the southernmost and largest of the Mariana Islands, a group of 15 islands located approximately 3,600 miles west of Hawaii and 1,400 miles south of Japan. The island is a territory of the U.S. The main axis of the island runs NE-SW for a total length of 30 miles and the width varies from 8 miles wide at its northern tip, to 4 miles wide near the center to 11.5 miles in the south. The total area of the island is 212 square miles. The population of Guam is estimated at 180,692 in 2010.

The Guam Integrated Military Development Plan, formerly the GJMMP, identified the planned increase in military population on Guam. Naval Computer and Telecommunications Station (NCTS) Finegayan, South Finegayan Housing area, Andersen Air Force Base (AFB), Andersen AFB Northwest Field (NWF), Andersen South, Apra Harbor and Naval Munitions would provide locations for most of the planned USMC relocation to Guam. Potable water for the Apra Harbor Naval Reservation, Andersen AFB, and other related DoD facilities are provided by separate Navy and Air Force water systems. The Navy is providing water to Guam Waterworks Authority (GWA) from its surface water reservoir to GWA's central water system. A summary of the planned USMC facilities is provided in Section 1.3.

In the *Guam Water Utility Study* (Earth Tech 2008), development of groundwater resources was recommended as the primary source to serve the USMC Finegayan base (Alternatives 1 and 2). A summary of the water resource options reviewed is provided in Section 1.4. The supply from rehabilitated wells and purchase of water from GWA alone are not sufficient to meet USMC relocation water demand. Review of the available yield indicates that the water supply from the Northern Guam Lens Aquifer (NGLA) is sufficient to meet the projected demand based on the 1992 sustainable yield estimates. This report provides a detailed analysis of groundwater resource development as the primary source for the USMC Finegayan base using population information that is consistent with the Final EIS. Water supply and demand at the Navy and Air Force bases on Guam and potential impacts to the GWA water system was also reviewed.

The DoD is considering additional water resource options to supplement the Navy water system, particularly during the dry season. Options considered include rehabilitation of the Lost River Cofferdam and dredging the Navy Reservoir to increase storage capacity to the designed level. If groundwater resources are not sufficient to meet the projected USMC demand, the DoD would

consider brackish water desalination to meet the deficit. These options are considered long-term alternatives, which require additional study and are not the subject of this report.

The Scope of Work is provided in Appendix A.

1.3 PLANNED USMC FACILITIES

A description of the planned USMC relocation is provided in Volume 2 of the Draft EIS (DEIS). The estimated current and future DoD water supply requirements are based on information from Volume 2 of the DEIS, the Guam population estimates provided in Appendix F of the DEIS, information from Alternative 1 of the Final Report of *Water, Wastewater, and Solid Waste Management Impact Assessment for GJMMP* (HPE 2006), and utility reports from the Navy and Andersen AFB. The areas which would have a future USMC presence are identified in Figure 1-1 according to Volume 2 of the DEIS. The information in the *Final U.S. Marine Corps Facility Requirements and Initial Concept Plan* (HHF 2007) is used in this document to estimate industrial water demand, but the final plan in the DEIS may differ from those used in this document. The water demand estimates do not include the added demand from non-resident military workers, such as USMC staff who would work on Andersen AFB, but the design would connect the water systems to allow the demands to be met as needed on the bases. Current and future military populations assumed for this study are presented in Table 1-1. For this study, the army is assumed to be housed at the USMC Finegayan base.

A list of facilities required for the USMC relocation from the *Final U.S. Marine Corps Facility Requirements and Initial Concept Plan* (HHF 2007) is presented in Table 1-2.

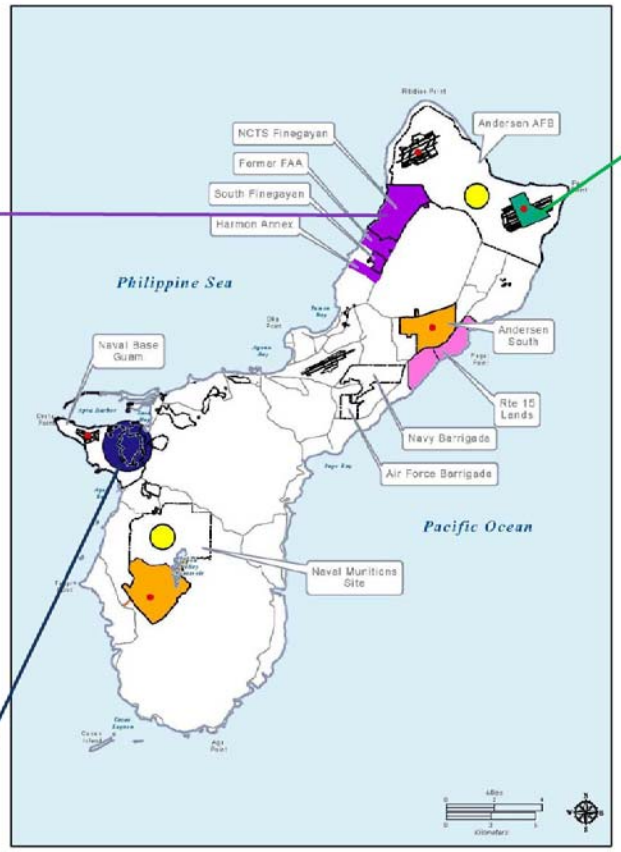
Figure 1-1: USMC Relocation Plan

Main Cantonment Functions

- Headquarters (HQ) and Administrative:
  - Administrative offices
  - Vehicle maintenance
  - Communications
  - Security
  - Warehousing
  - Armory
  - Fuel storage
  - HAZMAT, DRMO, Recycling
- Base Operations:
  - Administrative offices
  - Police/fire facilities
  - Base Access
  - Warehousing
  - Legal services, dental services, family services, and MWR support
- Bachelor's Quarters and Temporary Lodging
- Family Housing
- Educational Facilities
- Quality of Life (QOL) Functions:
  - community center, commissary, exchange, post office, theater, recreational, etc.
  - Applied instruction and auditorium
  - Services: restaurant, bank, gas station

Waterfront Functions

- Amphibious task force ship berthing
- Embarkation and cargo inspection and staging area
- LCAC/AAV laydown area
- Apra Harbor medical/dental clinic
- Relocations: Military Working Dog Kennels, USCG wharf and support facilities



Airfield Functions

- Air embarkation
- ACE beddown:
  - Hangars/aprons
  - Administrative
  - Maintenance
  - Fire and rescue

Training Functions

- Training Range Complex:
  - Live-firing ranges
  - Indoor small arms range
- Ammunition storage
- Non-firing Ranges:
  - Obstacle course
  - Hand-to hand combat
  - Gas chamber
  - Advanced motor vehicle course
  - Rappelling
  - Engineer equipment and decontamination training facility
  - Maneuver training
  - Range support buildings
- Aviation Training:
  - Marine Air Control Group (MACG) Training
  - Improved airfield
  - Landing zones
- Command, Control and Simulation:
  - Battle Staff Training
  - Combined arms training
  - Audio visual and simulation training

Table 1-1: DoD Population Increases

Population Type	Baseline	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Project-Related											
Active duty	33	535	1,220	1,220	1,220	8,602	9,182	9,182	9,182	9,182	9,182
Dependents	52	537	1,231	1,231	1,231	9,000	9,950	9,950	9,950	9,950	9,950
Transient	0	0	400	400	400	2,000	2,000	2,000	2,000	2,000	2,000
Civilian Work Force	12	102	244	244	244	1,720	1,836	1,836	1,836	1,836	1,836
USMC Finegayan Base Total	**97**	**1,174**	**3,095**	**3,095**	**3,095**	**21,322**	**22,968**	**22,968**	**22,968**	**22,968**	**22,968**
Nonproject-Related											
Active duty	2,145	80	80	80	80	120	120	120	120	120	120
Dependents	2,950	118	118	118	118	210	210	210	210	210	210
Transient	0	900	900	1,256	1,256	1,256	1,256	1,256	1,256	1,256	1,780
Civilian Work Force	805	17	17	17	17	25	25	25	25	25	25
Andersen AFB Total	**5,900**	**1115**	**1115**	**1471**	**1471**	**1611**	**1611**	**1611**	**1611**	**1611**	**2135**
Active duty	4,490	0	0	0	50	50	130	130	130	130	330
Dependents	5,410	0	0	0	30	30	80	80	80	80	80
Transient	0	0	0	0	0	0	7,222	7,222	7,222	7,222	7,222
Civilian Work Force	1,684	0	0	0	10	10	13	13	13	13	20
Navy Bases Total	**11,584**	**0**	**0**	**0**	**90**	**90**	**7,445**	**7,445**	**7,445**	**7,445**	**7,652**

Notes: Civilian Work Force lives off base.
Navy Base Transients live on visiting ships.

The USMC relocation consists of four major functional components. These components represent core capabilities and support functions within the context of the overall Marine Corps mission. The four functional components of the proposed action are:

1. *Main Cantonment Area functions*. Main cantonment military support functions (also known as base operations and support) include headquarters and administrative support, bachelor housing, family housing, supply, maintenance, open storage, community support (e.g., retail, education, recreation, medical, day care, etc.), some site-specific training functions, and open space (e.g., parade grounds, open training areas, open green space in communities, etc), as well as the utilities and infrastructure required to support the cantonment area. Figure 1-2 shows the proposed locations of the Main Cantonment and family housing for Alternatives 1 and 2, which are limited to the Finegayan area.

   Water demand associated with the USMC relocation at the Finegayan base is assumed to be the industrial and fire demands associated with the planned structures, and the domestic demand associated with the relocated Marines and their dependents, civilian support, and transients. It is assumed that the U.S. Army and their dependents may be housed at the Marine Corps Base.

2. *Training functions.* There are three subclasses of training support functions required by USMC units that would be stationed on Guam:

   – *Firing ranges* are required for live and inert munitions practice.

   – *Non-fire maneuver ranges* are required for vehicle and foot maneuver training, including urban warfare training.

   – *Aviation training areas* are either improved (paved runway) or unimproved (unpaved landing sites) used to practice landing/takeoff and air field support (including loading/unloading of fuel, munitions, cargo, and personnel).

   Training areas include Andersen South Annex and the Ordnance Annex.

   Water demands associated with the USMC relocation are the industrial and fire demands associated with the planned structures.

   No additional water demand is assumed for maneuver training.

3. *Airfield functions*. The proposed USMC relocation will include aviation units and aviation support units that require runway and hangar space and maintenance, supply and administrative facilities. There is also a need for air embarkation operations that are comparable to, compatible with, and co-located with, existing Andersen AFB operations. Air embarkation operations refer to loading and unloading cargo and passengers to and from aircraft, comparable to a civilian airport terminal.

   Water demand associated with the USMC relocation at the North Ramp Aviation Facilities is assumed to be the industrial and fire demands associated with the planned structures.

4. *Waterfront functions*. The ships and assault craft associated with the proposed USMC relocation are transient (visiting). The transient vessels support USMC operations and transient forces that presently train on Guam and in the Commonwealth of the Northern Mariana Islands. These ships would continue to support USMC requirements in the western Pacific after the proposed relocation, and would continue to require transient vessel support facilities on Guam.

   Water demand associated with the USMC relocation is assumed to be primarily the industrial and fire demands associated with the planned structures and water demand for visiting ships including air craft carriers and amphibious vessels. It is assumed that the Apra Harbor base will house additional Navy and U.S. Coast Guard personnel associated with the relocation.

Figure 1-2: Main Cantonment Area Alternatives 1 and 2

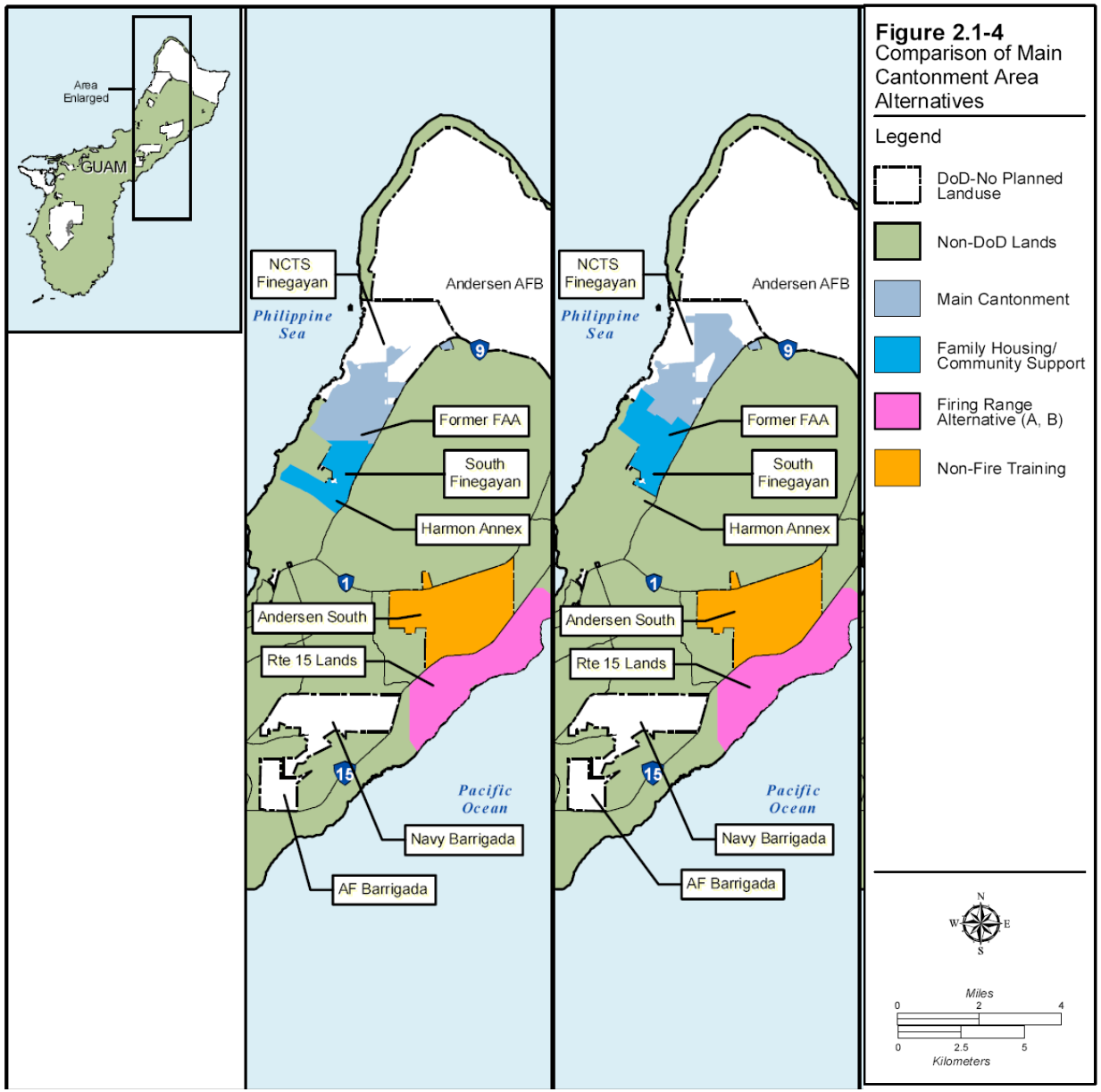


Table 1-2: USMC Facility Requirements

Description	Size	Description	Size	Description	Size
Helicopter Landing Pad	1111 SY	Maintenance Hangar OH Space	130720 ft^2	Dependent School, 1 through 6	420850 ft^2
Taxiway	9100 SY	Maintenance Hangar 01 Space	61110 ft^2	Dependent School, High	262500 ft^2
Aircraft Parking-Apron	172065 SY	Maintenance Hangar 02 Space	63706 ft^2	Personnel Weather Shelter	15300 ft^2
Aircraft Access Apron	9833 SY	Aviation Armaments Shop	5000 ft^2	Kennel	450 ft^2
Aircraft Washrack-Pavement	2250 SY	Parachute/Survival Equipment Shop	16344 ft^2	Rehab Center	45000 ft^2
Aircraft Rinse Facility	1200 SY	Engine Test Cell	2 EA	Recycling Center	1 EA
Aircraft Compass-Calibration Pad	2000 SY	Power Check Pad	1 EA	Religious Ministry Facilities	40172 ft^2
Arming-Dearming Pad	3910 SY	Boat Shop	8050 ft^2	Post Office	10701 ft^2
Line Vehicle Parking	200 SY	Amphibian Vehicle Maintenance Shop	176430 ft^2	Exchange Retail Store	37950 ft^2
Ordnance Handling Pad	2064 SY	Refueler Vehicle Shop	3230 ft^2	Location Exchange	22575 ft^2
Combat Aircraft Ordnance Loading Area	2405 SY	Vehicle Holding Shed	13440 ft^2	Exchange Central Administration	16900 ft^2
Fire & Rescue Vehicle Alert Pad	175 SY	Auto Organizational Shop	225482 ft^2	Exchange Cafeteria	24300 ft^2
Tactical Support Van Pad	2444 SY	Field Maintenance Shop	159910 ft^2	Exchange Snack Stands	1900 ft^2
Filling Station	—	Vehicle Wash Platform	65 EA	Exchange Auto Parts Store	10750 ft^2
Filling Station Building	65 SF	Grease Rack	39 EA	Exchange Food Store	3300 ft^2
Vehicle Ready Fuel Storage	138000 GA	Heavy Gun Shop	11340 ft^2	Exchange Service Outlet	28715 ft^2
Communications Center	41680 SF	Electronic/Comm Maint Shop	319437 ft^2	Exchange Dry Cleaning Shop	15050 ft^2
Visual Approach Slope Indicator	2 EA	Field Maintenance Shop, Comm/Elex	41650 ft^2	Exchange Maint Shop	2419 ft^2
Wind Direction Indicator	2 EA	Construction Weight Handling Equip Shop	5600 ft^2	Bank	6860 ft^2
Parking & Service Area Lighting	2022 LF	Battery Shop	197 EA	Credit Union	14200 ft^2
Simulated Carrier Deck Lighting	1 EA	Aviation GSE Maintenance Shop	8515 ft^2	Temporary Lodging	73188 ft^2
Taxiway Lighting	5800 LF	Aviation GSE Holding Shed	6232 ft^2	Commissary	45000 ft^2
Heliport Pad Lighting	400 LF	Dental Equipment Repair Shop	3350 ft^2	Comm Cold Storage Det	27000 ft^2
Aircraft Fire& Rescue Station	1700 ft^2	Field Maintenance Shop (Parachute)	37510 ft^2	Family Services Center	10500 ft^2
Aircraft Line Operations Building	240 ft^2	Public Works Shop	28300 ft^2	Amusement Center	6560 ft^2
Aircraft Operations Building	9760 ft^2	Public Works Storage	16000 ft^2	Exchange Service Station	6710 ft^2
Control Tower	2956 ft^2	High Explosive Magazine	30000 ft^2	Exchange Gas Station	1290 ft^2
LOX Pad	5596 ft^2	Inert Storage Building	3000 ft^2	Exchange Customer Op. Car Wash	2300 ft^2
Ordnance Operations Building	15100 ft^2	Ordnance Assembly Area	1111 SY	Thrift Shop	4300 ft^2
Armory	56968 ft^2	Cold Storage Warehouse	9200 ft^2	Hobby Shop--Arts/Crafts	17740 ft^2
Marine Barracks	4215 ft^2	Organic Unit Storage	794037 ft^2	MWR Supply/Support Facility	10080 ft^2

Description	Size	Description	Size	Description	Size
Alert Force Building	6000 ft^2	Specific Purpose Warehouse	242000 ft^2	Hobby Shop--Automotive	14790 ft^2
POL Operation/Sampling Building	4300 ft^2	Controlled Humidity Warehouse	88590 ft^2	Entertainment Center	10050 ft^2
Operational Haz/Flam Storage	30167 ft^2	General Storage Shed	18200 ft^2	Bowling Alley	15260 ft^2
Expeditionary Air Control Site	2 EA	Integrated Log. Overhaul & Outfitting	151120 ft^2	Gymnasium	63000 ft^2
Cargo Staging Area	72600 SY	Open Storage (Vehicle/Equip Parking)	124406 SY	Indoor Fitness Facility	61900 ft^2
Waterfront Transit Shed	10000 ft^2	Dental Clinic	22160 ft^2	Skating Rink	16100 ft^2
Waterfront Operations Building	6000 ft^2	Medical Clinic	47030 ft^2	Information Ticket and Travel Office	1210 ft^2
Landing Craft Ramp	2 EA	Administrative Office	106886 ft^2	Contracted Leisure Travel Agency	900 ft^2
Academic Instruction Building	630 ft^2	Division/Wing Headquarters	272410 ft^2	Recreation Center	6000 ft^2
Applied Instruction Facility	16720 ft^2	Regimental/Group Headquarters	64730 ft^2	Youth Center	29291 ft^2
General Purpose Auditorium	6000 ft^2	Battalion/Squadron Headquarters	222936 ft^2	Commissioned Officers Open Mess	25000 ft^2
Operational Trainer Facility	70230 ft^2	Company/Battery Headquarters	141080 ft^2	Enlisted Personnel Club	59400 ft^2
Indoor Arms Range	20 FP	Bachelor Enlisted Quarters E1-E3	725913 ft^2	Staff Non-Commissioned Officer Club	25000 ft^2
Maneuver/Training Area (Light)	—	Bachelor Enlisted Quarters E4-E5	498154 ft^2	Consolidated Officers/EP Open Mess	54700 ft^2
Battle Sight Zero Range	—	Bachelor Enlisted Quarters E6-E9	102935 ft^2	Package Store	10800 ft^2
Rifle Known Distance Range	—	Transient Personnel Unit Quarters E5-E6	5850 ft^2	Child Development Center	42600 ft^2
Machine Gun Field Fire Range	—	Enlisted Dining Facility	47145 ft^2	Library	20000 ft^2
Mortar Range	1 EA	Bachelor Officer Quarters, W1-O2	74745 ft^2	Recreation Pavilion	4000 ft^2
Fire and Movement Range	—	Bachelor Officer Quarters, O3 & above	30225 ft^2	Exchange Warehouse	22091 ft^2
Hand Grenade Range	8 FP	Fire Station	30170 ft^2	Educational Services Office	23100 ft^2
Engineer Range	8 FP	Issue-Uniform Center	7203 ft^2	Bathhouse	14500 ft^2
Training Course	6 EA	Brig Confinement	23220 ft^2	Playing Courts	19 EA
Combat Training Pool/Tank	65 EA	Police Station	15620 ft^2	Outdoor Playing Fields	12 EA
MOUT (Large)	1 EA	Gate/Sentry House	248 ft^2	Outdoor Swimming Pool - Installation	3 EA
Corrosion Control Hangar	13284 ft^2	Dependent School-Kindergarten	50160 ft^2	—	—

Source: HHF 2007

EA each
ft^2 square foot
GA gallon
LF linear foot
SY square yard

1.4 WATER SUPPLY ALTERNATIVES

Several water resource options were considered to meet USMC relocation water demand requirements in the *Guam Water Utility Study* (Earth Tech 2008). A summary of the evaluation is provided in Table 1-3. The evaluation of all water supply options considered for the USMC Finegayan base and a detailed review of the desalination option are provided in Appendix B.

Table 1-3: Summary of Option Evaluation for Water

Water System Alternative	Evaluation Considerations	Recommendation
Option 1 – Optimize Groundwater Resource Development within DoD Property	• Salt water intrusion/excessive aquifer draw down • Managed fully by DoD/reliable and secure • Integrated system with GWA • Sustainable yield considerations	Detailed review. Included in DoD recommended alternative.
Option 2 – Determine the Requirements for Rehabilitation, Treatment of Well Water, or Replacement of Existing Wells	• Salt water intrusion/excessive aquifer draw down • Reduced stress on aquifer from installation of new wells • Managed fully by DoD/reliable and secure • Sustainable yield considerations	Detailed review. Included in DoD recommended alternative. Insufficient supply from rehabilitated wells to meet full demand from USMC relocation.
Option 3 – Purchase Water from GWA	• New connections with DoD water systems • Upgrading systems/energy savings • No excess supply available for DoD	Detailed review. Included in DoD recommended alternative.
Option 4 – Sediment Dredging at Navy Reservoir	• Current storage capacity reduced due to sedimentation • Need to dredge to sustain long-term supply • Managed fully by DoD	Potentially viable. Additional analysis is necessary to fully evaluate.
Option 5 – Expand Naval Reservoir Storage Capacity by Raising Dam Crest	• Technical complexity of design and implementation • Relative advantages compared to other viable alternatives • Overall cost	Eliminated
Option 6 – Potable Water Reclamation through Effluent Reuse	• Negative connotations/public perception • Relative advantages compared to other viable alternatives	Eliminated
Option 7 – Non-Potable Water Reclamation through Effluent Reuse	• Requires a separate distribution system • Relative advantages compared to other viable alternatives	Eliminated
Option 8 – Desalination	• Construction of desalination plant/effluent discharge • High energy demands • Overall cost	Detailed review. Viable if freshwater resources are not sufficiently abundant to meet demand.
Option 9 – Develop a New Surface Water Source	• Complexity in identification, design and implementation • Relative advantages compared to other viable alternatives • Overall cost	Reviewed rehabilitation of Lost River cofferdam in October 2008 letter report to meet DoD demand in southern Guam.

For EIS Cantonment Alternatives 1 and 2, AECOM Technical Services, Inc. (ATS) recommended development of groundwater resources (Option 1) as the primary source to serve the USMC Finegayan base. The supply from rehabilitated wells (Option 2) and purchase of water from GWA (Option 3) are not sufficient to meet USMC relocation water demand, but are recommended as supplementary water supply to the DoD water systems. The alternative developed from these options to meet USMC demands is presented in this document.

Desalination (Option 8), rehabilitation of the Lost River cofferdam (Option 9), and sediment dredging of the Navy Reservoir (Option 5) are considered long-term alternatives, which would require follow-on analysis. Further analysis may substantially change which long-term alternatives are pursued by DoD.

1.5 PHYSICAL ENVIRONMENT

Relevant aspects of the physical environment that are important for the purposes of this study are described below. This section describes the northern Guam topography, climate, geology, and hydrogeology to support the general design for a water supply system.

1.5.1 Topography

The island is sharply divided into two distinct physiographic provinces by a NW-SE trending fault near the island's center. To the north of the fault is a low-relief limestone plateau that rises in elevation towards the northeast, with coastal cliffs standing from 200 to 600 feet above mean sea level (msl). The limestone is so permeable that normal stream drainage patterns have not been able to form; instead a gentle karst topography has developed and drainage takes place directly into the ground or through sinkholes. South of the fault is a rolling to sharply dissected terrain that consists of extrusive and pyroclastic volcanic rocks that are fringed in the east by an uplifted fossil reef limestones, which are contemporaneous with limestones in the north. A narrow band of limestone also caps the highest mountain range, which lies several miles inland and parallel to the western coast of the island. The highest peak, Mt. Lamlam, reaches 1,332 feet above msl. Two distinct drainage patterns have developed in the south: west of the high mountains drainage is by steeply sloping parallel streams; while to the east the drainage pattern is generally dendritic with some modifications imposed by faulting and other structural features. Limestone areas in the south have no distinct drainage features. Water resources in the south are predominantly from streams and a surface water reservoir, while groundwater from the limestone is the source of potable water in the north.

1.5.2 Climate

The climate on Guam is warm and humid throughout the year. Average temperatures range from 85 to 89 degrees Fahrenheit (°F) in the afternoon and 70 to 75°F in the evening. The relative humidity is 65 to 75 percent in the afternoon, and 85 to 100 percent in the evening.

The constant northeasterly trade winds result in a well-defined dry season that runs from January through May, which is broken by an occasional shower. July to November is the wet season during which trade winds are frequently interrupted by tropical storms with heavy rain. The months of June and December separate the two seasons and are transitional in nature.

The average annual rainfall on Guam is 80 to 90 inches, but is locally variable. Near Apra on the western coast the mean is 85 inches, while it averages 115 inches in the southern mountains. On the northern limestone plateau, rainfall averages between 85 and 105 inches annually. About 68 to 73 percent of the annual precipitation occurs during the wet season and 15 to 20 percent during the dry season. The remainder occurs during the transitional months.

1.5.3 Geology

The sharp division of Guam into the two distinct geologic provinces of approximate equal size is by the NE-SW trending Pago-Adelup fault. North of the fault lies a limestone plateau, while a dissected volcanic upland lies south of the fault. Volcanic units preceded limestone deposition north of the fault and the volcanic surface had been eroded before limestone emplacement such that gross unconformities separate the rock types.

The oldest rocks are Late Middle Eocene pillow basalts and basalt flows and came from a volcano located west of Guam. These rocks are overlain by Late Eocene to Early Oligocene tuffaceous shale and sandstone which is interbedded with breccia and lava flows. A second volcanic center developed to the southwest and produced extensive lavas and pyroclastic deposits until its final collapse in the Early Oligocene. Volcaniclastic sedimentation continued through the Late Oligocene to the Early Miocene, when massive reef and lagoonal limestone formation began over the volcanics.

The Miocene Bonya Limestone and the Miocene-Pliocene Alifan Limestone are found directly on top of the volcanic units in the interior highlands of southern Guam. The Alifan Limestone is also found in the northwest corner of the southern province and on the flanks of Mt. Santa Rosa in the north. The Alifan Limestone was succeeded by deposition of detrital Miocene Pliocene Barrigada Limestone, which is an extensive unit exposed in the interior of the northern plateau. This unit is a principal aquifer in that province and extends well above and below the position of the fresh-water lens. The Barrigada Limestone grades laterally and upward into the Pliocene-Pleistocene Mariana Limestone, a reef and lagoonal deposit that dominates the northern plateau. The high cliffs north of the Pago-Adelup fault are exposures of the Mariana limestone, as are the cliffs of the Orote Peninsula to the south of Apra Harbor.

The Mariana Limestone has been interpreted as a shallow-water fringing and barrier reef deposit that is thickest along the periphery of the northern peninsula. The Mariana contains large openings, voids and caverns, which are typical of massive coral growth. Inland, a lagoonal facies of the Mariana Limestone grades into the Barrigada Limestone, which is interpreted as a deep-water limestone of bank and off-reef detrital deposits. These deposits are heterogeneous and are often cemented and filled with fine calcareous mud. The Barrigada Limestone dominates the interior of the northern plateau and accounts for the greatest volume of the fresh-water lens aquifer. Most of the limestone bedrock of Guam has undergone extensive fresh-water diagenesis, resulting in significant changes in primary porosity most notably modification by karst processes. In northern Guam, infiltrating rainwater dissolves the limestone creating karst features, such as sinkholes, caves, and dissolution-widening fissures. Generally, the result is an increased hydraulic conductivity. In southern Guam, karst processes have resulted in caves and spring development.

1.5.4 Hydrogeology

Nearly all of Guam can be described in terms of two rocks types: limestone and volcanics. Generally speaking, the volcanics can be considered aquicludes when they are associated with limestone. In a strict sense, both the limestone and the volcanics are aquifers; however, aquifer properties of the limestone make it favorable for use as an exploitable fresh water source. In southern Guam, the lack of extensive limestone deposits and the unfavorable hydraulic properties of the volcanic rock typically preclude the exploitation of groundwater as a fresh water source. The primary water supply in the south is surface water in the form of the Navy Reservoir, which is supplemented to a minor degree by springs (Barrett 1994). In northern Guam, the sole water source is a limestone aquifer, which contains a freshwater body within the Mariana Limestone and the Barrigada Limestone called the NGLA (Mink 1976; CDM 1982).

Hydraulic characteristics of the limestone aquifer are highly variable in both a horizontal and vertical direction. Mink (1976) suggested that the hydraulic conductivity of limestone units, particularly the Barrigada Limestone, is “profoundly affected by the quantity of clay mixed with the limestone components” and further implied that local hydraulic properties are skewed to lower values, due to specific conditions surrounding a specific location (e.g., well, infiltration gallery), whereas regional hydraulic properties are generally higher, as they represent an average between impermeable rock and open caverns (e.g., fractures and karst features). Mink (1976) classified argillaceous limestones as those containing up to 10 percent clay content and having a local hydraulic conductivity as low as

20 feet per day (ft/day). This compares to a "clean" limestone, having low clay content and having a local conductivity of about 200 ft/day. Regional hydraulic conductivities are lowest in the more argillaceous southern portion of the NGLA, ranging from 500 to 1,500 ft/day, whereas clean limestones to the north can reach as high as 15,000 to 20,000 ft/day (CDM 1982). An average regional hydraulic conductivity of 2,000 ft/day was proposed by Mink (1976); however, modeling studies suggest that best fit simulations require a regional hydraulic conductivity of around 20,000 ft/day (Contractor 1983; Jocson et al. 2002). Based on these early studies, preliminary estimates of average hydraulic conductivity in the limestone were proposed for well productivity purposes (Mink 1976; CDM 1982):

- Clean limestone: 190 ft/day
- Probable limestone: 120 ft/day
- Argillaceous limestone: 52 ft/day
- Very argillaceous limestone: 26 ft/day

The NGLA is generally lens-shaped in cross-section and is underlain by denser seawater; however, the base is modified where it contacts the relatively impermeable basement volcanic rock. Mink (1976) proposed the term *basal zone* where the lens is underlain by seawater, and *parabasal zone* where the base of the lens is volcanic rock. Typical steady state hydraulic head in the basal zone is approximately a meter above msl; in the parabasal zone it can range from 2 to 5 meters above msl, depending on local hydraulic conductivity. Lens geometry in the parabasal zone is dependent on freshwater recharge rates, basement elevations, basement slopes, and hydraulic conductivity.

Based on basement volcanic contours the NGLA was divided into a series of six subbasins (CDM 1982). The subbasins boundaries reflect the basement topography forming hydrological divides in the subsurface. Subbasin boundaries were subsequently revised on the basis of updated basement contours. The *Northern Guam Lens Study* (NGLS) (CDM 1982) proposed guidelines that prescribed appropriate well depths and pumping rates for basal and parabasal zones of the NGLA:

Groundwater Area	Maximum Capacity (gallons per minute [gpm])	Minimum Spacing (gallons per minute [gpm])	Preferred Depth (feet)	Maximum Depth (feet below msl)
Basal				
Groundwater head <4 feet above msl	200	300	≤25	40
Groundwater head >4 feet above msl	350	300	≤35	50
Para-basal				
Southern Agana sub-basin	200[a]	300	- -	50
Upper Yigo-Tumon sub-basin	750	300	- -	50-60
Other para-basal areas	500	300	- -	50

[a] *350 gpm under special conditions*

The Guam Environmental Protection Agency (GEPA) currently uses these guidelines and bases other local regulations on the NGLS (CDM 1982).

1.5.5 Sustainable Yield

Sustainable yield is defined as the rate at which groundwater can be continuously withdrawn from an aquifer without impairing the quality or the quantity of the pumped water. To achieve the hypothetically available sustainable yield, the means of water withdrawal must be optimized, which is usually not the case. Therefore, the full capacity of the aquifer is not available. Additionally, sustainable yield is not equal to recharge. In the case of the NGLA, leakage at the edges of the lens along the coastline must be taken into account.

There have been two published estimates of the NGLA: one by NGLS (CDM 1982), and one by Barrett Consulting with John Mink (cited herein as Barrett 1992). The NGLS estimates were based on a steady-state condition and relied on conservative assumptions such that future development and groundwater management programs could be easily implemented. The NGLS was the first to divide the aquifer into a series of six subbasins and 47 management zones. The subbasin division is based primarily on topographic expression of basement topography forming effective hydrological divides in the subsurface. Based on the position of the freshwater lens, the subbasins can be either basal (freshwater lens floating on top of salt water), or parabasal (freshwater lens bottom in contact with basement rock). Management zones are a construct to optimally manage well fields within the basin.

The second estimate of sustainable yield was prepared by Barrett (1992), which revised the simulation to a transient system rather than steady-state. Barrett argued that the NGLA is best described as a transient system, as the majority of the recharge comes during the wet season and that transient conditions best represent seasonal variations in recharge. The revised estimate using transient conditions increased sustainable yield to approximately 70 to 80 million gallons per day (mgd).

University of Guam Water and Environmental Research Institute of the Western Pacific Review of Northern Guam Lens Aquifer Sustainable Yield—*Guam Water Utility Study for Proposed USMC Relocation* (2009) provides an expert technical review of the two sustainable yield estimates for the NGLA. This study assesses the validity of the estimates in sufficient detail and objectivity to assist in obtaining public and professional acceptance of the conclusions of the study. The main conclusions of the study related to the Guam water utility studies are as follows:

- The approach and methodology used in Barrett 1992 to estimate the sustainable yield are still valid. The recommendations in Barrett 1992 are appropriate for initial planning.
- The Barrett 1992 sustainable-yield estimates should be used instead of the earlier 1982 sustainable-yield estimates (CDM 1982) because the later values are based on an additional decade of field data. The 1982 sustainable-yield estimates are excessively conservative.
- A revised analysis would be more accurate because there is currently a larger data set available on well performance, recharge, and water table response.
- A state-of-the-art model would be a useful tool for long-term management of the aquifer, but is not likely to provide a significantly different outcome for sustainable yield.
- Use of the updated basement contour maps to locate the parabasal zone for well placement provides a higher degree of confidence in the productivity of the proposed wells.
- The wells would be located or “clustered” in the parabasal zone to maximize groundwater yield and water quality:
  - In this zone the freshwater lens is most likely to be thickest, have the lowest chloride content, and be least vulnerable to saltwater intrusion.

  - The subbasins are hydrologically separate entities. Therefore, the draft on one subbasin does not affect the adjacent subbasins.
  - Additional field studies and incremental assessment of well performance as the wells are installed would increase the likelihood of optimal yield, water quality, and sustainability of the resource.
- Sustainable-yield confirmation studies should be performed.

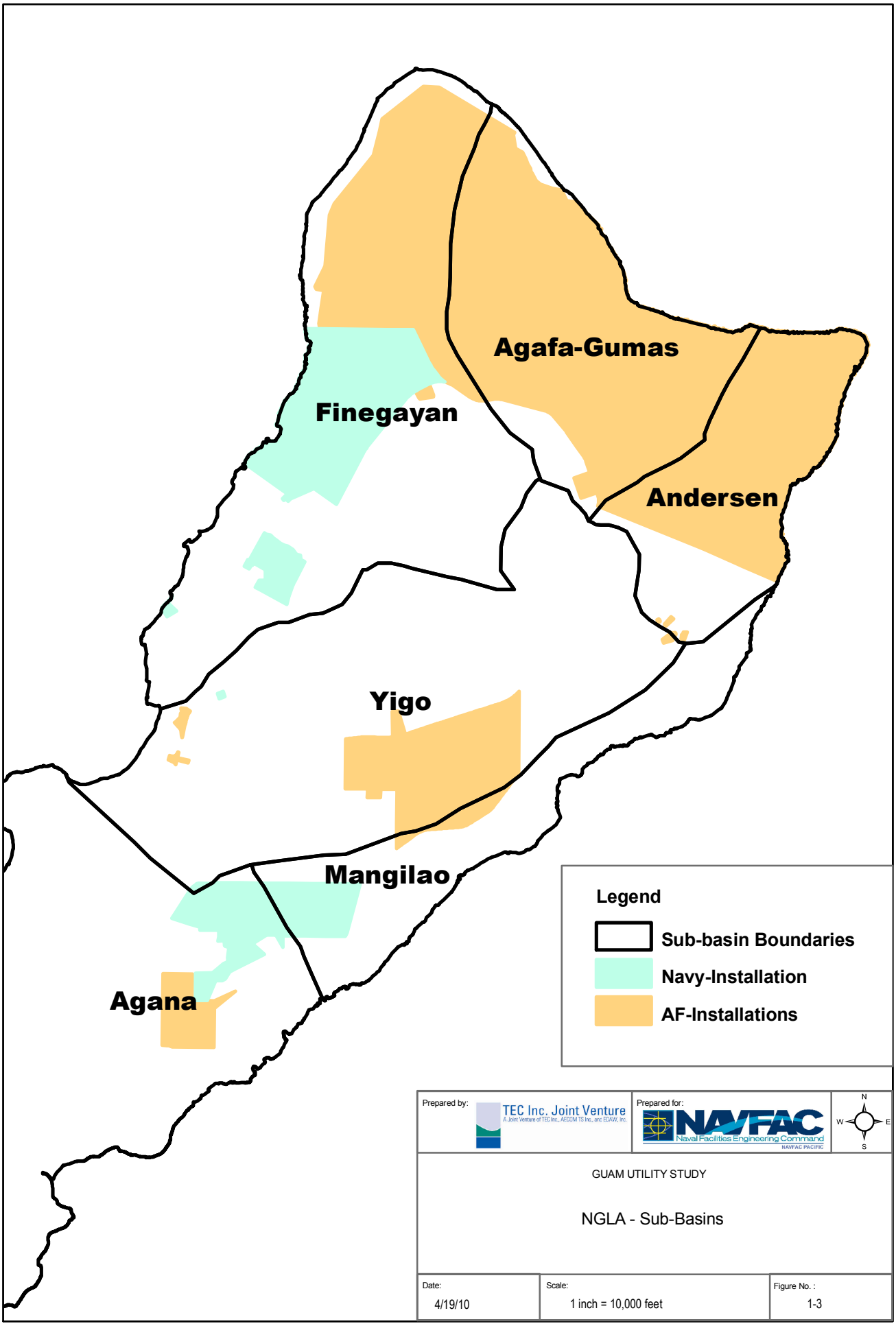
The DoD plans to support a U.S. Geological Survey study of the NGLA that would include a state-of-the-art groundwater model and verification of the sustainable yield on all relevant and available site-specific data collected to date. The study is expected to take 3 years to compete. Installation of the water system for the relocation is not expected to commence until 2011. By this time, the modeling effort would be advanced and preliminary results of this study will be reviewed by DoD and incorporated into the construction specifications, as appropriate. The model would also be used in the long-term maintenance of the NGLA groundwater resource.

Table 1-4 compares sustainable yield estimates of the NGLS (CDM 1982) and Barrett (1992) reports for each subbasin. Figure 1-3 shows the location of the subbasins. In consideration of the 2009 Water and Environmental Research Institute review of the sustainable yield estimates, the Barrett 1992 sustainable yield estimates will be used in determining the location and capacity of the wells for the Finegayan base. Current estimates of well production and available yield are presented in Table 1-4. Based on sustainable yield estimates shown in Table 1-4, it is clear that the groundwater resources within the Andersen and Agafa-Gumas subbasins are under-developed, compared to the southern subbasins with a total of 20.8 mgd available yield. Both the Andersen and Agafa-Gumas subbasins are predominated by parabasal zones, meaning that they have the potential for increased production rates. These subbasins also have the benefit of not creating a significant impact on groundwater production for civilian purposes, as the majority of these subbasins lie under DoD property and are therefore generally unavailable for civilian exploitation. An additional factor related to the selection of these two subbasins is that the Agafa-Gumas subbasin is near the proposed development area for the USMC relocation.

Table 1-4: Estimates of Sustainable and Available Yield for Subbasins in the Northern Guam Lens Aquifer

Subbasin	Current Well Production	Northern Guam Lens Study (CDM 1982)		Barrett (1992)	
		Sustainable Yield	Available Yield	Sustainable Yield	Available Yield
Agana	10.4	11.7	1.3	20.5	10.1
Mangilao	2.5	3.9	1.4	6.6	4.1
Andersen	0.7	6.2	5.5	9.8	9.1
Agafa-Gumas	0.3	10.1	9.8	12.0	11.7
Finegayan	8.9	6.4	-2.5	11.6	2.7
Yigo-Tumon	19.4	19.1	-0.3	20.0	0.6
TOTALS	**42.4**	**57.4**	**15.0**	**80.5**	**38.1**

Sources: CDM 1982, Barrett 1992, GWA 2007, Engineering Concepts 2005, and HHMI Corporation, Hawaii Pacific Engineers, and ECS, Inc. 2006.


Agafa-Gumas
Finegayan
Andersen
Yigo
Mangilao
Agana
Legend
Sub-basin Boundaries
Navy-Installation
AF-Installations
Prepared by:
TEC Inc. Joint Venture
Prepared for:
NAVFAC
Naval Facilities Engineering Command
NAVFAC PACIFIC
N
W
E
S
GUAM UTILITY STUDY
NGLA - Sub-Basins
Date:
4/19/10
Scale:
1 inch = 10,000 feet
Figure No. :
1-3

2. Existing Water Systems in Northern Guam and Current Demand

2.1 SERVICE AREAS AND WATER SYSTEMS

The existing water supply on Guam is comprised of the following three separate, but partially interconnected water systems.

- Andersen AFB Water System
- Navy Water System
- GWA Water System

The first two of the above systems are DoD water systems, while the GWA system is the primary source of water to the general public on Guam. The locations of the service areas for each system including the distribution lines are shown on Figure 2-1 and Figure 2-2. Active and inactive water supplies facilities are listed in Table 2-1.

2.1.1 Andersen Air Force Base Water System

Andersen AFB is located in northern Guam and covers approximately 24.5 square miles. The base consists of two major areas and several smaller areas called annexes. The major areas collectively known as the "main base" are North Field containing the base's active operations and NWF containing abandoned runways and landing fields. The annexes are scattered throughout northern Guam and contain base housing, communications services, and water and petroleum storage facilities. The annexes include the Marianas Bonins Command (MARBO) Annex (also known as Andersen South), the Harmon Annex, and Air Force Barrigada.

The Andersen AFB water system includes an off-base water supply, treatment, storage, and transmission systems, and an on-base water distribution system. The off-base water supply and transmission system includes nine water production wells, two booster pump stations, three reservoirs, chlorination facilities, a fluoridation facility, and approximately 80,000 feet of water lines. The existing on-base water distribution system includes a pump station, three water storage tanks, and approximately 700,000 feet of water lines.

Water is currently supplied from wells located in the Andersen South Annex, stored, disinfected, and fluoridated, and then pumped to the main base. The nine off-base production wells are located at Andersen South Annex and the Tumon area and draw water from the NGLA. Water is currently supplied to Andersen AFB from seven of the nine off-base water production wells. Andersen AFB developed plans to install 10 wells with a total capacity of 3.3 mgd on the NWF. Distribution lines and electrical components have been installed for the 10 wells. Permits were granted for all wells. To date, five of the wells have been installed and activated. Currently there are no plans to install the remaining five wells.

2.1.2 Navy Water System

The Navy system and service areas are NCTS Finegayan, South Finegayan, Navy (NCTS) Barrigada, Nimitz Hill, Naval Hospital, Ordnance Annex, and Apra Harbor Complex.

The NCTS Finegayan is situated on the northwest coast of Guam, about 9 miles north of the capital city of Hagatna, and occupies approximately 3,000 acres. NCTS Finegayan is bounded by the Andersen AFB to the north, Route 3 to the east, and the Federal Aviation Agency parcel to the south. NCTS Finegayan includes residential units for family and unaccompanied personnel, community

service facilities, administrative buildings, medical and dental clinics, support communication facilities, and mechanical shops.

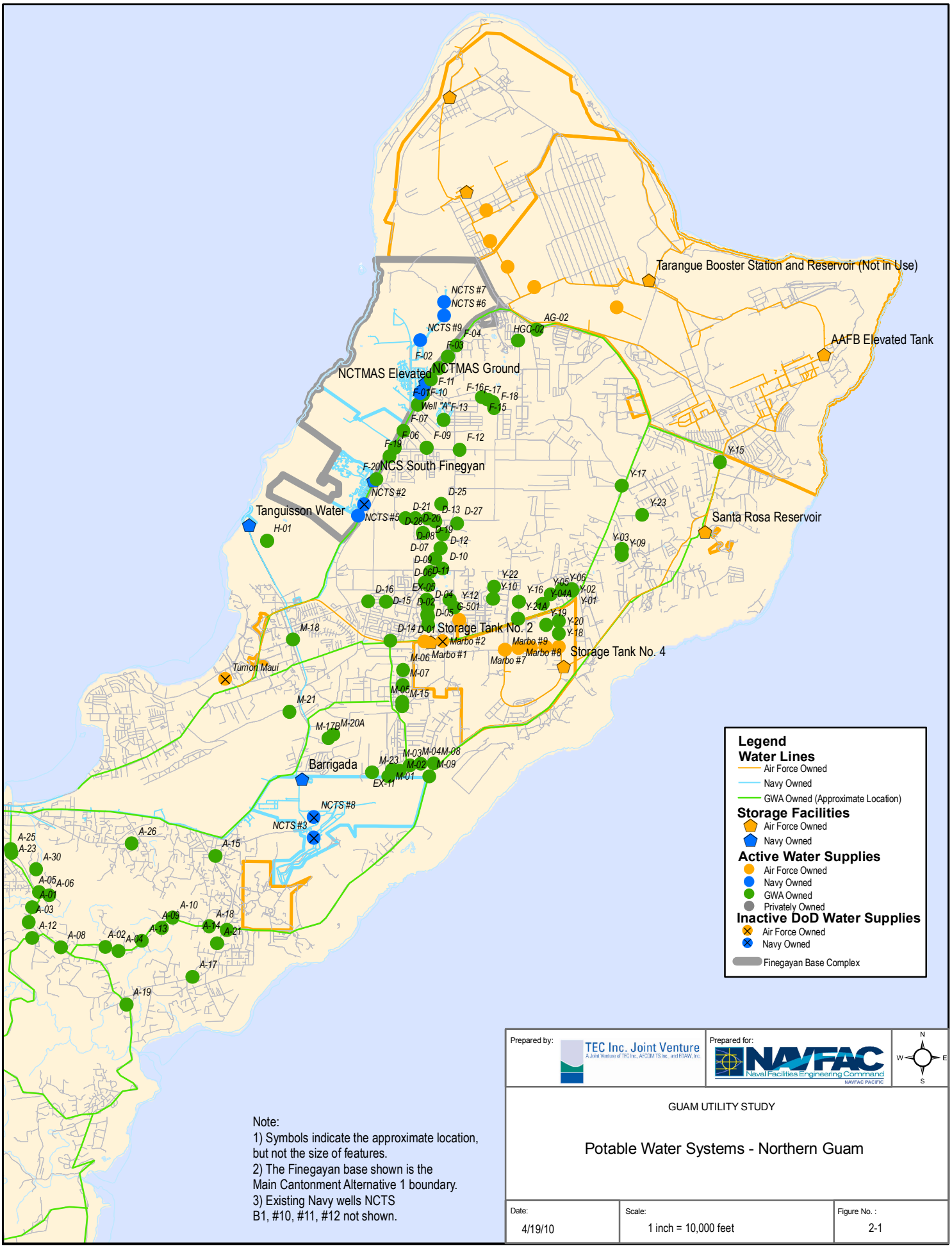
South Finegayan is located on the northwest coast of Guam, approximately 8 miles northeast of Hagatna and occupies approximately 270 acres. South Finegayan is bounded by NCTS Finegayan to the north and the Philippine Sea to the west. The area comprises family housing, an unaccompanied personnel housing unit, and a youth center.

Table 2-1: Water Supply Resources

Active Supply	Capacity (gpm)
Air Force	**Active**
Marbo #1	170
Marbo #3	210
Marbo #5	180
Marbo #6	480
Marbo #7	255
Marbo #8	490
Marbo #9	400
Wells 3a, 5, 6, 7, 8	1100
Navy	**Active**
Navy Reservoir	6260
Almagosa Spgs	928
Bona Springs	426
NCTS B1	200
NCTS #6	125
NCTS #7	235
NCTS #9	200
NCTS #10	180
NCTS #11	180
NCTS #12	180
NRMC #1	234
GWA	**Active**
Deep Wells	38
Planned Lower Production of Agana Wells with Elevated Chloride	-2
Ugum Water Treatment Plant	2.2
Santa Rita Spring	0.2

Inactive Supply	Capacity (gpm)	Reason
Air Force b	**Inactive**	
Marbo #2	320	VOC Contamination
Tumon Maui	900	VOC Contamination
Navy	**Inactive**	
NRMC #2	200	Biological Contamination
NRMC #3	178	High Chloride Levels
NCTS A	180	High Chloride Levels
NCTS #2	225	Structure/mechanical
NCTS #3	50	Structure/mechanical
NCTS #5	100	Structure/mechanical
NCTS #8	200	Structure/mechanical

Sources: Navy – measured or calculated values from Engineering Concepts (2005) and guidance from the Navy.
Air Force – measured values from HHMI Corporation, Hawaii Pacific Engineers, and ECS, Inc. (2006).
GWA – *Water Resources Master Plan* (2007).
NRMC Navy Regional Medical Clinic
[a] Several Air Force wells are permanently inactive: Tarague #4, BPM #1, and NW #4.


Tarangue Booster Station and Reservoir (Not in Use)
AAFB Elevated Tank
NCTS #7
NCTS #6
NCTS #9
AG-02
HGC-02
F-04
F-03
F-02
NCTMAS Elevated
NCTMAS Ground
F-11
F-01
F-10
F-16
F-17
F-18
Well "A"
F-13
F-15
F-07
F-06
F-09
F-12
F-19
F-20
NCS South Finegayan
NCTS #2
D-25
Tanguisson Water
NCTS #5
D-21
D-13
D-27
D-28
D-20
H-01
D-19
D-08
D-12
D-07
D-10
D-09
D-11
D-06
Y-22
Y-10
EX-05
D-16
D-15
D-04
Y-12
D-02
G-501
D-05
Storage Tank No. 2
D-14
D-01
Marbo #2
Marbo #1
M-18
M-06
Tumon Maui
M-07
M-05
M-15
M-21
M-17B
M-20A
Barrigada
M-03
M-04
M-08
M-23
M-02
M-09
M-01
EX-11
NCTS #8
NCTS #3
A-25
A-23
A-26
A-15
A-30
A-05
A-06
A-01
A-03
A-10
A-09
A-18
A-12
A-13
A-14
A-21
A-08
A-02
A-04
A-17
A-19
Y-17
Y-15
Y-23
Santa Rosa Reservoir
Y-03
Y-09
Y-16
Y-05
Y-06
Y-04A
Y-02
Y-24A
Y-01
Y-19
Y-20
Y-18
Marbo #9
Marbo #8
Marbo #7
Storage Tank No. 4
Legend
Water Lines
Air Force Owned
Navy Owned
GWA Owned (Approximate Location)
Storage Facilities
Air Force Owned
Navy Owned
Active Water Supplies
Air Force Owned
Navy Owned
GWA Owned
Privately Owned
Inactive DoD Water Supplies
Air Force Owned
Navy Owned
Finegayan Base Complex
Note:
1) Symbols indicate the approximate location, but not the size of features.
2) The Finegayan base shown is the Main Cantonment Alternative 1 boundary.
3) Existing Navy wells NCTS B1, #10, #11, #12 not shown.
Prepared by:
TEC Inc. Joint Venture
Prepared for:
NAVFAC
Naval Facilities Engineering Command
NAVFAC PACIFIC
N
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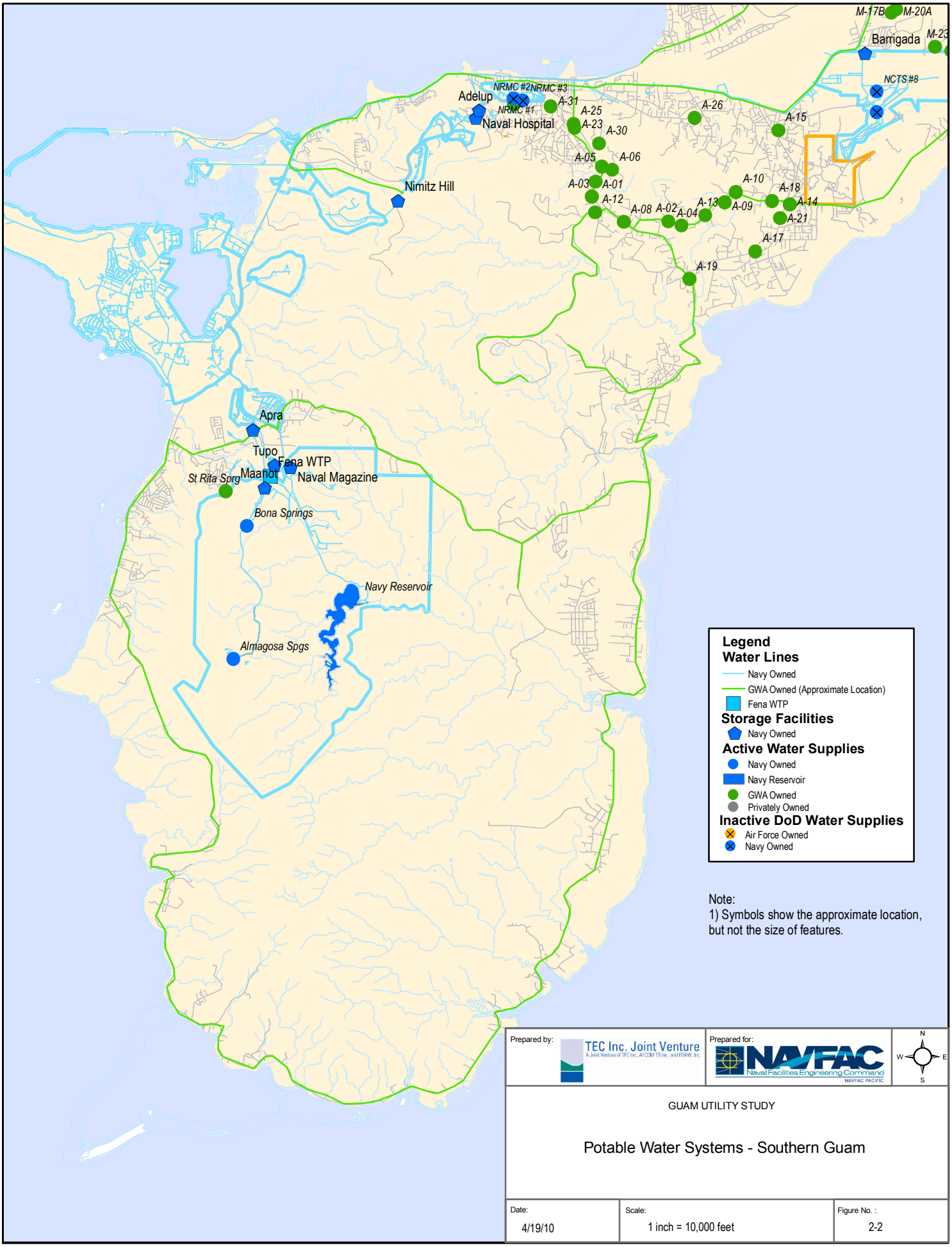
GUAM UTILITY STUDY
Potable Water Systems - Northern Guam
Date:
4/19/10
Scale:
1 inch = 10,000 feet
Figure No. :
2-1


M-17B
M-20A
Barrigada
M-23
NCTS #8
Adelup
NRMC #2
NRMC #3
NRMC #1
Naval Hospital
A-31
A-25
A-23
A-30
A-26
A-15
A-05
A-06
A-03
A-01
A-12
A-08
A-02
A-04
A-13
A-09
A-10
A-18
A-14
A-21
A-17
A-19
Nimitz Hill
Apra
Tupo
Fena WTP
Maanot
Naval Magazine
St Rita Sprg
Bona Springs
Navy Reservoir
Almagosa Spgs
Legend
Water Lines
Navy Owned
GWA Owned (Approximate Location)
Fena WTP
Storage Facilities
Navy Owned
Active Water Supplies
Navy Owned
Navy Reservoir
GWA Owned
Privately Owned
Inactive DoD Water Supplies
Air Force Owned
Navy Owned
Note:
1) Symbols show the approximate location, but not the size of features.
Prepared by:
TEC Inc. Joint Venture
Prepared for:
NAVFAC
Naval Facilities Engineering Command
NAVFAC PACIFIC
N
W
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S
GUAM UTILITY STUDY
Potable Water Systems - Southern Guam
Date:
4/19/10
Scale:
1 inch = 10,000 feet
Figure No. :
2-2

Navy Barrigada is located in the east central part of Guam, approximately 3 miles east of Hagatna and occupies approximately 1,850 acres. Navy Barrigada is bounded by the former Naval Air Station Hagatna to the west, Mount Barrigada to the north, and Air Force Barrigada to the south.

Nimitz Hill is located along the west central coast of Guam, approximately 1.5 miles south of Hagatna. It occupies about 95 acres and is bounded by Naval Hospital to the northeast and by Piti Village to the west. Naval Hospital is located northeast of Nimitz Hill along the west central coast of Guam, directly east of Hagatna. Facilities at Nimitz Hill include operations facilities, officers club, thrift shop, a federal fire station, and a high school. The main facility at Naval Hospital is a 57-bed hospital at Hagatna Heights. Other facilities include family and unaccompanied personnel housing, medical facilities, fire station, convenience stores, recreational facilities, utility plants, and a chapel.

The Apra Harbor Naval Base Complex is located on the west-central coast of Guam, approximately 8 miles southwest of Hagatna. The site encompasses a land area of 4,500 acres and a harbor of 650 acres. The Ordnance Annex is located approximately 2.5 miles southeast of Apra Harbor Naval Base Complex and encompasses approximately 8,840 acres of land most of which is used as buffer land or as watershed for the Navy Reservoir. The Apra Harbor Naval Base Complex and additional Navy areas include Orote Peninsula, Guam Economic Development Authority, Camp Covington, both new and old Apra Heights Housing Areas, Tenjo Vista, Sasa Valley, and Dry Dock Island. The Ordnance Annex has an ammunition wharf at Orote Peninsula with headquarters in the highlands above Apra Harbor Naval Base Complex along Route 5.

The existing Navy water system is an island-wide system extending from the Navy Reservoir in Southern Guam to NCTS Finegayan near the northern tip of Guam. Water for the system is primarily supplied from the Navy Water Treatment Plant (WTP). Water is distributed from the treatment plant to reservoirs designed to serve different service zones and transfer water to other Navy installations across the island. Most of the transmission mains from the reservoirs to the distribution systems are 24-inch pipelines. The Navy system is interconnected to supply water to GWA and for emergency service capability. The connection with the Andersen AFB system is out of service.

In most of the service areas, water is supplied either from onsite groundwater wells, through the Navy island-wide water system or by interconnection with the GWA. The island-wide water system comprises three primary sources, which are located at the southern region of Guam: Almagosa Springs, Bona Springs, and the Navy Reservoir surface water impoundment. Water from the above three sources are treated at the Navy WTP and distributed through a network of reservoirs, transmission mains, and booster pump stations. A brief description of the water supply sources in each of the Navy service areas is provided below.

- At NCTS Finegayan, water is primarily supplied by groundwater wells located on site and at South Finegayan. If necessary, water can also be supplied by interconnections with the GWA system or the Navy island-wide system. Groundwater wells are the primary source of potable water for this area.
- At the South Finegayan Housing area, water is primarily supplied by the groundwater wells on site and at NCTS Finegayan. If necessary, water can be supplied by interconnections with the GWA system or the Navy island-wide system.
- At Navy Barrigada, water is supplied by groundwater wells or through connection with the Navy island-wide system.
- At Naval Hospital, water can be provided from either the Navy island-wide water system or from onsite groundwater wells. Currently, two wells are operational and one well is inactive

due to high chloride levels. The three wells had tested positive for total coliform and two wells had tested positive for Escherichia coli (Engineering Concepts, Inc. 2005). Improvements were recommended to improve disinfection of the well water.

- At Apra Harbor Naval Base Complex and other Navy areas south of the Piti Power Plant, potable water is supplied entirely by the Navy WTP.

2.1.3 GWA Water System

The GWA water system comprises three public water systems known as the Northern, Central, and Southern Public Water Systems, serving the respective areas of the island with some overlaps. The Northern and Central systems are designated as 'Large' and the Southern System is designated as 'Small.' A schematic of the GWA water system is provided on Figure 2-3.

The Northern Public Water System is the largest system serving all public areas in the north and central parts of the island south of Andersen AFB. This system consists of 119 groundwater wells, 14 reservoirs (11 in use) and 10 booster pump stations (9 in use). The capacity of the GWA water supply facilities are listed in Table 2-1. GWA plans on reducing production of several wells in the Agana subbasin by a total of 2 mgd in 2012 due to consistently elevated chloride measurements. The GWA Northern Public Water System is in close proximity to the relocation areas and is primarily supplied by the NGLA. However, the Central and Southern Public Water Systems would be impacted by populations induced by the relocation and activities at Navy bases in southern Guam resulting from the relocation.

The Central Public Water System consists of 1 spring, 8 reservoirs (5 in use) and 9 booster stations (6 in use). The main source of water for this system is the Navy water system. Water is purchased through 54 metered interconnections, of which 15 are reported to be inactive. Water from the Northern System can also be fed to the Central System in the areas of Mongmong-Toto-Maite, Sinjana, Hagatna Heights, Asan, and parts of Piti. Northern water can also be supplied to Apra Heights, Santa Rita, and Agat through water mains that run along Routes 17, 5, 12, and 2.

The Southern Public Water System supplying the southern and southeastern parts of the island consists of 2 groundwater wells, 4 springs, 14 reservoirs, 16 booster stations (14 in use), and the Ugum WTP.

The baseline condition of the GWA water system is described in GWA's *Water Resources Master Plan* (WRMP). The overall condition of the water system's equipment is identified as poor in the WRMP with substantial corrosion in all infrastructure. The water system has a 50 percent unaccounted for water (UFW) rate compared to an acceptable rate of 15 percent or less. Problems with the GWA infrastructure result from the effects of natural disasters, poor maintenance, vandalism, and theft. According to the WRMP, the water system infrastructure does not meet the basic flow and pressure requirements for all customers. The water system did not consistently comply with regulatory requirements. The unreliable drinking-water delivery system resulted in frequent bacterial contamination from sewage spills, causing "boil water" notices to be sent to residents. Maintenance to improve the system has been conducted since the water system was assessed in 2005. GWA plans improvements to the distribution system principally to improve the continuity of the water supply. Improvements include a corrosion control program, pipe and equipment replacement, distribution system improvements, and improvements to the GWA Northern Public Water System's raw-water transmission line.

Figure 2-3a

GWA Water System

Legend

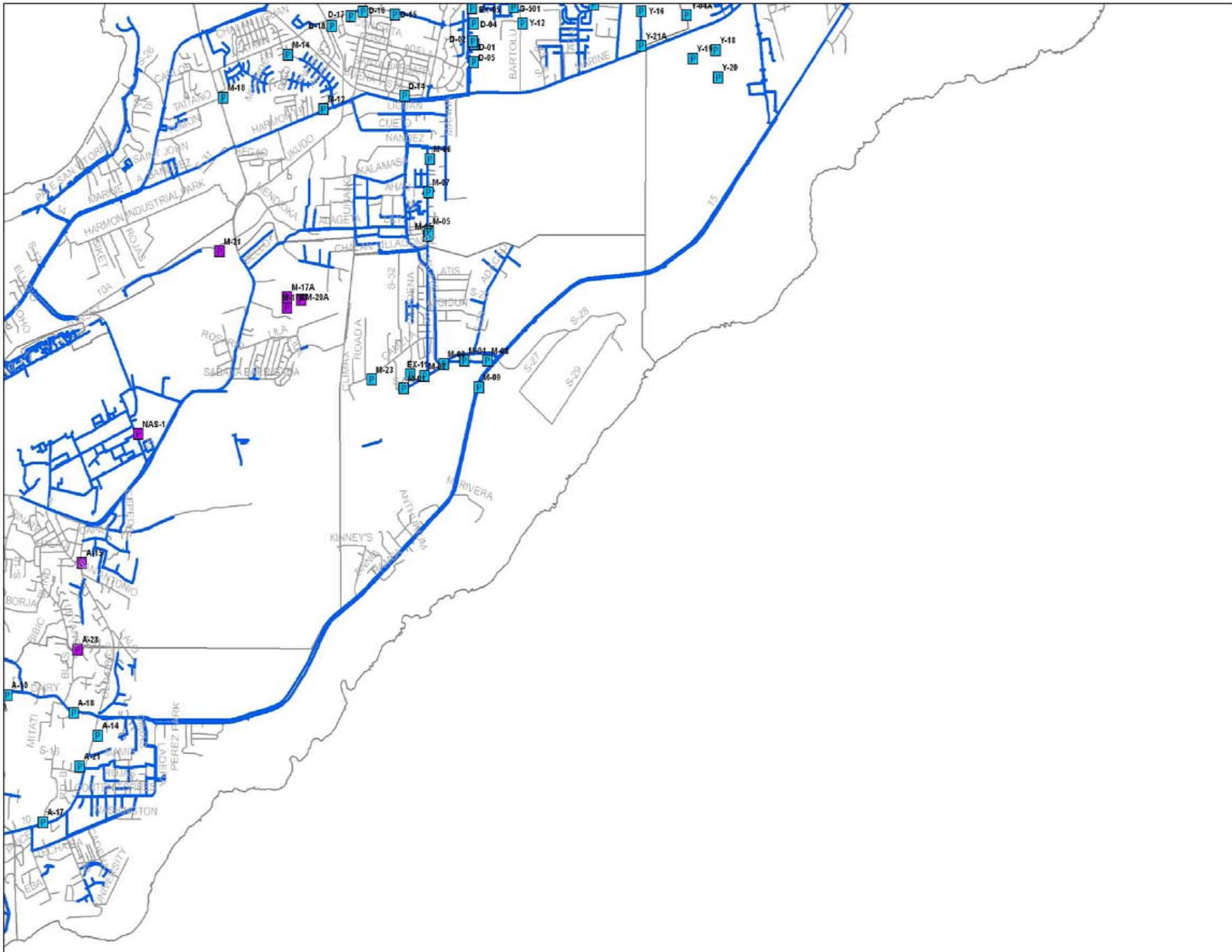
- Well (Referenced from FEMA, GPS missing)
- Well (GPS)
- Water Main

0 1,875 3,750 Feet

Reference: Adapted from Guam Water Authority. Water Resources Master Plan Volume 2, Chapter 1 Water System Description. 2007.

Figure 2-3b

GWA Water System



Reference: Adapted from Guam Water Authority. Water Resources Master Plan Volume 2, Chapter 1 Water System Description. 2007.

Figure 2-3c

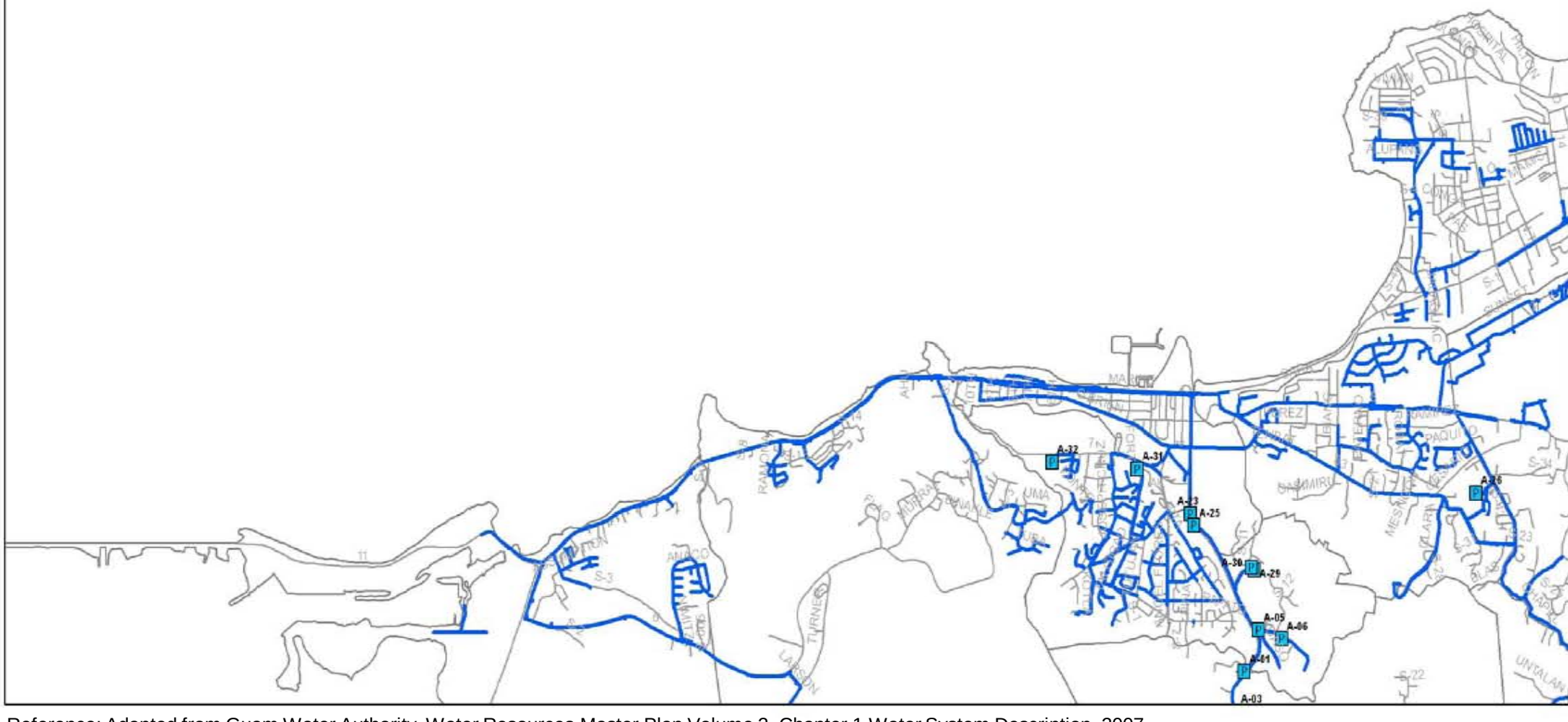
GWA Water System

Legend

Well (Referenced from FEMA, GPS missing)

Well (GPS)

Water Main



Reference: Adapted from Guam Water Authority. Water Resources Master Plan Volume 2, Chapter 1 Water System Description. 2007.

Figure 2-3d

GWA Water System

Legend

Well (Referenced from FEMA, GPS missing)

Well (GPS)

Water Main

0 1,875 3,750 Feet

Reference: Adapted from Guam Water Authority. Water Resources Master Plan Volume 2, Chapter 1 Water System Description. 2007.

Figure 2-3e

GWA Water System

Legend

Well (Referenced from FEMA, GPS missing)

Well (GPS)

Water Main

0 1,875 3,750

Feet

Reference: Adapted from Guam Water Authority. Water Resources Master Plan Volume 2, Chapter 1 Water System Description. 2007.

The U.S. Department of Justice filed a civil suit against GWA and the Government of Guam in December 2002 for failure to comply with the Safe Drinking Water Act and the Clean Water Act. The Stipulated Order for Preliminary Relief for Civil Case No. 02-0035 was negotiated in June 2003. The Stipulated Order requires GWA to improve water and wastewater conditions so that it would comply with all applicable regulations, including the National Primary Dinking Water Regulations and Maximum Contaminant Levels (MCLs) for microbiological contaminants, and to provide reliable water services to the public on Guam. Progress has been made in implementing the WRMP projects. Many major capital projects have been completed.

2.2 DoD Storage Facilities

The location of the DoD storage facilities for each system is shown on Figure 2-1. The capacity of the storage facilities are listed in Table 2-2. The storage capacity by area is shown in Table 2-3.

Table 2-2: DoD Storage Facilities

Tank	Capacity (Gallons)	Capacity (mgd)	Owner	Location	Type
Water Storage Tank	150,000	0.15	Andersen AFB	Andersen AFB, NWF	At-Grade, Steel
Water Storage Tank	150,000	0.15	Andersen AFB	Andersen AFB, NWF	Steel
Storage Tank No. 2	250,000	0.25	Andersen AFB	Andersen South	Partially buried concrete
Storage Tank No. 4	480,000	0.48	Andersen AFB	Andersen South	Partially buried concrete
Santa Rosa Reservoir	2,000,000	2.00	Andersen AFB	Andersen South	Buried concrete
Facility 19008	250,000	0.25	Andersen AFB	Andersen AFB Main Base	Ground Level concrete
Tarangue Reservoir (Not in Use)	1,000,000	1.00	Andersen AFB	Andersen AFB Main Base	not available
Naval Communication Station South Finegayan South (inoperative in 2010)	250,000	0.25	Navy	South Finegayan	Elevated
NCTAMS Elevated (inoperative in 2010)	250,000	0.25	Navy	North Finegayan	Elevated
NCTAMS Ground	200,000	0.20	Navy	North Finegayan	Ground
Barrigada	3,000,000	3.00	Navy	NCTAMS Barrigada	Reinforced Concrete covered by earth
Naval Hospital	1,000,000	1.00	Navy	Navy Hospital	Reinforced Concrete covered by earth
Nimitz Hill	1,000,000	1.00	Navy	Nimitz Hill	Reinforced Concrete covered by earth
Adelup	3,000,000	3.00	Navy	Navy Hospital/Nimitz Hill	Reinforced Concrete covered by earth
Maanot	500,000	0.50	Navy	Apra Harbor/ Ordnance Area	Reinforced Concrete at Grade
Tupo	5,000,000	5.00	Navy	Apra Harbor/ Ordnance Area	Reinforced Concrete covered by earth
Naval Magazine	700,000	0.70	Navy	Apra Harbor/ Ordnance Area	Reinforced Concrete covered by earth
Apra Heights Tank	5,000,000	5.00	Navy	Apra Harbor/ Ordnance Area	Reinforced Concrete covered by earth

NCTAMS Naval Computer and Telecommunications Area Master Station

Table 2-3: DoD Storage Capacity by Area

Area	Total Existing Capacity (million gallons)
North Finegayan	0.20
Andersen NW Field	0.30
Andersen Main Base	0.25
Andersen South	2.73
Apra Harbor/Ordnance Area	11.2
Barrigada	3.0
Navy Hospital/Nimitz Hill	5.0

2.2.1 Andersen Air Force Base

At Andersen AFB there are three on-base water storage tanks in use: a 150,000-gallon tank in the NWF, a 150,000-gallon tank further north near Ritidian Point, and a 250,000-gallon tank and booster pump station at the east end of the Andersen AFB main base area. The 150,000-gallon tank in the NWF area is a steel, at-grade storage tank. A 150,000-gallon water storage tank, Facility 825, is located north of Andersen AFB NWF. Facility 825 is owned by the Navy and formerly the Naval Communications facility at Ritidian Point. The U.S. Fish and Wildlife Service has since taken over the land and uses the tank. Although water is supplied to the tank by Andersen AFB water system, the Air Force does not draw water from the tank and does not maintain the tank. The 250,000-gallon ground level concrete storage tank was constructed around 1985 and replaced a former elevated storage tank. Water is supplied to the storage tank through a 12-inch cast iron main along Arc Light Boulevard, while the outflow is through a separate 12-inch pipeline.

The off-base reservoir includes Storage Tank No. 2, Storage Tank No. 4, and Santa Rosa Reservoir. The booster pump stations are used to transfer water from the wells to Santa Rosa Reservoir, which is Andersen AFB's primary potable water storage tank. Santa Rosa Reservoir is located on Mt. Santa Rosa approximately 1.5 miles south of Andersen AFB Santa Rosa gate. The reservoir is a buried concrete reservoir and has two 1.0-million gallon compartments for a total storage capacity of 2.0 million gallons. The inflow pipeline to Santa Rosa Reservoir is a 30-inch pipeline and the outflow is a separate 16-inch pipeline.

2.2.2 Navy Water System

At the Naval Computer and Telecommunications Area Master Station (NCTAMS), storage of potable water is provided by ground reservoir. The ground reservoir provides storage of the treated water from the water softening plant. The elevated tanks in North Finegayan and South Finegayan are no longer in service. Water in the storage tank is provided either through groundwater wells or through the Navy WTP. The Barrigada Tank is the storage facility for the NCTS Barrigada Service Area and is situated off Route 16, within and adjacent to the northern NCTAMS Barrigada boundary. The Adelup Tank serves both the Nimitz Hill and the Naval Hospital service area. Each area has a dedicated reservoir - the Nimitz Hill Tank and the Naval Hospital Tank. Booster pumps at the Adelup Tank Complex convey water from these two tanks and also serve the distribution system. The Adelup Tank has a capacity of 3.0 million gallons and an 18-inch influent line. Two sets of booster pumps (total of 5 pumps) are installed at the site of Adelup Tank. The first set of three booster pumps serves the Nimitz Hill area, while the second set of two pumps serves the Naval Hospital.

Potable water to the Apra Harbor Naval Base Complex and other Navy areas south of the Piti Power Plant is supplied entirely by the Navy WTP. The Apra Heights Tank serves a majority of Apra

Harbor Naval Base Complex, while the Tupo Tank serves the X-Ray wharf portion of Apra Harbor Naval Base Complex and area north of complex. The Maanot tank is used to supply water to the upper portion of the old Apra Heights Housing Area. The Navy WTP also supplies water to the Ordnance Annex from the Naval Magazine (NAVMAG) tank. The Navy WTP treats raw water from three primary sources: Almagosa Springs, Bona Spring, and the Navy Reservoir surface water impoundment. The Navy WTP supplies water to four main reservoirs: Apra Heights and Tupo Tanks via gravity, and NAVMAG and Maanot tanks via pumps located at the Navy WTP clearwell. The 5.0 million gallon Apra Heights Tank serves most of the Apra Harbor Naval Base Complex, including the nearby New Apra Heights housing and the lower portion of the Old Apra Heights Housing.

Water stored in the 5.0 million gallon Tupo tank is primarily transported north of the main base that includes Nimitz Hill, Naval Hospital, NCTS Barrigada, NCTS South Finegayan Housing, and NCTS Finegayan. Water for the Ordnance Annex is stored and distributed through the 0.7 million gallon NAVMAG tank through a 10-inch transmission main.

2.3 GROUNDWATER QUALITY

Historical water quality data from GWA wells are in Table 2-4. The Air Force regularly monitors the water quality at South Andersen Annex in the Yigo subbasin. A summary of data collected from the Tumon Maui and Marbo wells is provided in Table 2-5 through Table 2-8. No data is available for the Agafa-Guma subbasin. Monitoring well data related to site investigations is available for the Andersen subbasin. Data characterizing biological contamination in the groundwater is not available for this study. Some issues with the water quality from the DoD wells are:

- Groundwater from the Northern Guam Lens is typically hard, containing calcium and magnesium carbonate.
- Tumon Maui and Marbo #2 are not in service due to volatile organic contamination.
- Routine bacteriological testing at wells in the Finegayan area and Naval Hospital area has identified the presence of total coliform and Escherichia coli.
- Chloride levels rose to unacceptable levels (i.e., greater than 250 milligrams per liter [mg/L]) in some wells.
- Trichloroethylene (TCE) was detected in monitoring wells above MCLs located on the eastern side of Andersen AFB.

Table 2-4: Historical Water Quality

Constituent	MCL	Wells				H-1	M1-1
		A Series	A-9	D Series	Y Series		
pH	6.5-8.5	7.0	7.0	7.2	7.3	7.3	7.1
Residue on evap.	n/a	360	600	370	275	450	350
Total Hardness	n/a	292	360	226	242	265	380
Calcium (Ca)	n/a	113	130	78	85	88	98
Ca as CaCO3	n/a	283	325	195	213	220	245
Magnesium (Mg)	n/a	2	10	6	7	10	8
Mg as CaCO3	n/a	8	41	25	29	41	33
Chloride	250	16	140	50	17	95	30
NO3	n/a	9	9	9.5	9.3	9	4
SO4	250	2.5	13	8.0	2.0	20	4.5
Iron (Fe)	0.3	0.01	0.01	0.02	0.02	0.02	0.03

Source: Mink (1976)
Note: Units are mg/L, except pH
n/a not available
pH hydrogen ion concentration

Table 2-5: Harmon and Tumon Sampling Points Downgradient of Andersen South Annex Operating Unit

Analyte	Units	MCL	Samples Taken 1978-2007		
			Min.	Max.	Meeting or Exceeding EPA Threshold
VOCs					
PCE	µg/L	5	0.2 (est.)	22.4	5 (9/89), 9 (8/90), 8.3 (4/91), 6.1 (6/91), 7.6 (3/94), 14.6 (12/94), 11.6 (3/95), 11.6 (4/95), 12.9 (5/95), 13.1 (5/95), 13.4 (9/95), 9.4 (9/95), 11 (12/96), 11.2 (2/97), 18.2 (2/97), 19.9 (2/97), 19.5 (2/97), 22.4 (2/97), 5.2 (6/01), 5.4 (8/01), 5.0 (8/01)
TCE	µg/L	5	0.2	5.2	5.4 (6/01)
Water Quality Parameters					
Alkalinity, Bicarbonate	mg/L	n/a	154	160	
Chloride	mg/L	250	0.19	9200	

µg/L microgram per liter
n/a not available
PCE Tetrachloroethene
VOC volatile organic compounds

Table 2-6: Tumon Maui Well Groundwater Field Quality Parameters 2003-2007

Parameter	Units	MCL	Min.	Max.
pH	pH	6.5-8.5	6.7	7.46
Specific Conductivity	µmhos/cm	1600	0.756	980
Temperature	ºC	n/a	27.01	28.96
Turbidity	NTU	TT	0	9.5
Dissolved Oxygen	mg/L	n/a	3.46	16.23
Redox	mV	n/a	86	508
Chloride	mg/L	250	75.3	119

mV millivolt
n/a not available
NTU nephelometric turbidity unit
ºC degree Celsius
TT 95% of samples measured every 4 hours < 0.3 NTU
µmhos/cm micromhos per centimeter

Table 2-7: Production Well MW-2 Groundwater Analytical Results, Andersen South Annex

Analyte	Units	MCL	Samples Taken 1996-2006		
			Min.	Max.	Meeting or Exceeding EPA Threshold
VOCs					
PCE	µg/L	5	>0.1	0.2	—
TCE	µg/L	5	0.4	5.8	5 (10/96), 5.4 (10/00), 5.8 (10/01), 5.7 (5/02), 6 (10/02)
Water Quality Parameters					
Alkalinity, Bicarbonate	mg/L	n/a	210	216	—
Chloride	mg/L	250	13.8	67.2	—

n/a not available

Table 2-8: MW-2 Groundwater Field Quality Parameters, 1996-2006

Parameter	Units	MCL	Min.	Max.
pH	pH	6.5-8.5	6.44	8.31
Specific Conductivity	µmhos/cm	1600	398	686
Temperature	ºC	n/a	26.61	30.11
Turbidity	NTU	TT	0	271
Dissolved Oxygen	mg/L	n/a	0.32	9.41
Redox	mV	n/a	-175	3932
Chloride	mg/L	250	6.28	74.7

NA not available

A groundwater program is conducted for all operable units on Andersen AFB main base. Groundwater sampling at the Main Base Operable Unit has identified volatile organic compounds (VOCs), semivolatile organic compounds, polynuclear aromatic hydrocarbons, pesticides, and metals. Benzo(a)pyrene, tetrachloroethene (PCE), TCE and chromium have been detected above the MCL. Benzo(a)pyrene, PCE, and TCE are the only compounds in the long-term groundwater management program for the Main Base Operable Unit. Chromium contamination has been attributed to non-contaminant sources such as well screen corrosion. Table 2-9 lists the wells with TCE or PCE exceedances above MCLs between 1996 and 2006. The well Installation Restoration

Program (IRP)-3, IRP-39, IRP-51, United States Geological Survey (USGS)-150 and IRP-50 are located downgradient from the parabasal zone in the Andersen subbasin. Well IRP-41 with TCE concentrations ranging from nondetect to 8 micrograms per liter is located near the parabasal zone. Groundwater sampling will be conducted as part of production well installation to determine if treatment is required. Three of the wells with exceedances are located within an IRP site. Information on that site is provided in Table 2-9. Given the distance below ground surface, the TCE or PCE contamination may originate from a different location.

Table 2-9: TCE and PCE Concentration Ranges in Wells with Detections above MCLs

Well	TCE	PCE
IRP-3	49 to 169	3 to 7.3
IRP-39	15 to 28	14 to 35
IRP-51	12 to 30	<MCL
USGS-150	0.3 to 15	ND to 1
IRP-50	1.3 to 5	<MCL
IRP-41	ND to 8	<MCL

Notes: Units = ug/L
TCE MCL = 5 ug/L
PCE MCL = 5 ug/L
ND non detect

Groundwater sampling was discontinued at the Northwest Field Operable Unit and the Harmon Annex Operable Unit in 2003. Groundwater sampling is conducted at the Marbo Operable Unit for VOCs as a component of the monitored natural attenuation remedy for groundwater impacted by TCE and/or PCE. Several wells are sampled for all compounds of concern near Waste Pile 7 to monitor for potential contamination of groundwater by leachate from the capped waste pile.

2.3.1.1 NORTHERN GUAM LENS AQUIFER (NGLA) GWUDI EVALUATION

Groundwater under the direct influence of surface water (GWUDI) is groundwater with inadequate natural filtration when surface water filters through soils into the groundwater table. The inadequate filtration through soils may lead to contamination of the groundwater from bacteria or contaminants in the soils. GEPA is currently conducting a study to determine if wells extracting water from the NGLA are GWUDI. Soils in northern Guam are highly porous, and past sampling has indicated that contaminants may enter the aquifer during sewer pump station spills and rain events. If portions of the aquifer subbasins are identified as GWUDI, then treatment requirements that include filtration and disinfection may be imposed on individual wells.

The results of the GEPA study are expected in late 2010. Preliminary results of the study indicate that the NGLA would not be characterized as GWUDI, but individual wells may be designated GWUDI and require supplemental treatment. This study is developed assuming that the proposed and existing DoD wells are not subject to GWUDI.

2.4 CURRENT WATER SYSTEM DEMANDS

This section provides water demand estimates on-base for DoD and off-base for the general public.

2.4.1 On-Base Demand

The following section presents the current water demand calculation based on Unified Facilities Criteria (UFC) 3-230-19n for Water Supply Systems (DoD 2005) for the current USMC population and production or consumption data from the bases for the existing DoD facilities.

2.4.1.1 DOMESTIC USES

Domestic uses include drinking water, household uses, and household lawn irrigation. Per capita requirements are shown in Table 2-10 for permanent and temporary installation in the tropics. The per capita requirement for transients is based on the hotel domestic water allowance from Table 2-1, UFC 3-230-03A for Water Supply (DoD 2004). When on-base, transients are housed in officers or enlisted quarters, which would not require all of the water demands of a home (e.g., household lawn irrigation).

Table 2-10: Average Potable Domestic Water Requirements Gallons Per Capita Per Day

Use Category	Tropic (gpcd)
Unaccompanied Personnel Housing	155
Family Housing	180
Transients	70
Workers (per shift)	45

Source: DoD 2004, DoD 2005
gpcd gallons per capita per day

The average demand for each use category shown in Table 2-10, in gallons per day (gpd), is calculated by Equation 1:

Equation 1

Average daily domestic demand in gpd = gallon per capita per day (gpcd) x design population x growth factor

The following growth factors are used in Equation 1:

a) Large systems (5,000 population or greater), 1.25.

b) Small systems (populations less than 5,000), 1.50.

Total average domestic demand is the sum of average demand for unaccompanied personnel housing, family housing, and workers.

Other controlling demands are calculated by Equation 2:

Equation 2

Maximum daily domestic demand = average daily domestic demand in gpd x K

Using the following data (Table 2-11) for the coefficient, K.

Table 2-11: Controlling Demand Coefficients

Demand	Units of Demand	Coefficient K	
		Population <5,000	Population >5,000
Maximum Day Flow	gpd	2.25	2

Source: DoD 2005.

The average production rate for the Navy water system is currently 11.7 mgd. Current average domestic demand is estimated at 1.4 mgd by subtracting water transfer to GWA (3.6 mgd), UFW assuming 25 percent (2.9 mgd), and industrial demands (3.8 mgd) from the average production rate.

The average amount of water billed in the Andersen AFB water system was 1.4 mgd between October 2009 and April 2010. Current average domestic demand is estimated at 0.67 by subtracting the industrial demand (0.76 mgd).

Table 2-12 presents the current domestic demand for the USMC relocation. Details of the demand calculation are presented in Appendix C.

Table 2-12: Current Domestic Demand at DoD Bases

	USMC Finegayan Base	Navy Bases	Andersen AFB
Average Daily Domestic Demand (mgd)	0.016	1.4	0.67
Maximum Daily Domestic Demand (mgd)	0.035	2.8	1.3

2.4.1.2 INDUSTRIAL USES

The current industrial demands for all DoD areas and timeframes were provided by the GJMMP 2006 report and are shown in Table 2-13.

Table 2-13: Current Industrial Demands on DoD Bases

	USMC Finegayan Base	Navy Bases	Andersen AFB
Industrial Demand	0.1	3.8	0.8

2.4.1.3 FIRE PROTECTION DEMANDS

Fire protection demand includes water required for maintaining the fire protection system within the facility and is designed based on the criteria outlined under UFC 3-600-01 (DoD 2006). Requirements for fire protection water storage are based on the assumption that there would be only one fire at a time. The quantity of water required is equal to the product of the fire protection water demand and the required duration, and must be available at all times. Water supply for the domestic, industrial, and other demands is added to these requirements to determine the total amount of water required in the facility. The fire flow requirements under the *Military Handbook Fire Protection for Facilities Engineering, Design, and Construction* (UFC 3-600-01 [DoD 2006]) vary greatly based on hazard classification of the activity in the facility.

Current fire demands estimated per area are presented in Table 2-13 from the 2006 GJMMP.

Table 2-14: Current Fire Demands at DoD Bases

	USMC Finegayan Base	Navy Bases	Andersen AFB
Fire Demand	1.1	0.5	1.1

2.4.1.4 *UNACCOUNTED FOR WATER*

UFW is water that is not metered, such as water lost in leakages. UFW is derived by subtracting the amount of water measured by meters, from the water that is produced from the treatment plants and wells and net changes in water storage tank inventories. The current UFW daily demands or rates are shown in Table 2-15.

Most water utilities, policymakers, and associations, such as the American Water Works Association deem a 10 percent to 15 percent UFW loss as acceptable. However, the utility reports for the DoD facilities indicate the Navy water system may currently have higher loss rates. The GJMMP 2006 Report provided estimates for the existing UFW demand for most of the Navy facilities. The GJMMP report did not provide an estimate of the UFW for the Naval Hospital. The 1995 Naval Hospital and Nimitz Hill Utility Report estimated the UFW loss at 30 gpm. However, since this is less than 10 percent of the domestic and industrial demands, a loss rate of 10 percent was applied. It is assumed that the UFW for Navy bases is 15 percent for additional water demands. The UFW for the Andersen AFB water system is 50 percent according a study conducted at the base.

Table 2-15: Existing Unaccounted for Water from the GJMMP 2006 Report

Facility	Existing UFW	Source
Navy Finegayan	15%	Assumed high end of acceptable range
Apra Harbor	1.67 mgd	GJMMP Report
Ordnance Annex	0.072 mgd	GJMMP Report
Nimitz Hill	0.072 mgd	GJMMP Report
Naval Hospital	10%	GJMMP Report
Barrigada	0.072 mgd	GJMMP Report
Andersen AFB	50%	Information provided by Pacific Air Forces

% percent

2.4.1.5 *SUMMARY OF CALCULATED CURRENT DEMANDS*

The DoD future average and maximum daily demands are summarized in Table 2-16. The average and maximum daily demands are calculated as the sum of the domestic, industrial, and UFW demands.

Table 2-16: DoD Current Water Demands

	Navy Finegayan	Andersen AFB	Navy Bases (Remaining)
Average Daily Demand	0.13	2.1	8.1
Maximum Daily Demand	0.16	3.1	9.8

Units: mgd

2.4.2 Off-Base Demands

According to GWA, the current production from all GWA owned water resources is 42 mgd. Of this total, 18 mgd is sold, 4 mgd is leakage from the water system, and 20 mgd is unmetered or under metered. This production is assumed to serve the baseline population of 180,692 in 2010.

3. Projected Future Demands and System Requirements

This section provides future water demand estimates on-base for DoD and off-base for the general public. DoD demands are estimated assuming compliance with UFC guidance values as described in Section 2.4. An estimate of DoD demands is provided in Section 3.2 assuming sustainability practices are implemented at all bases to comply with regulatory requirements and executive orders mandating a reduction of water use at federal facilities. System requirements for the USMC Finegayan base are determined based on UFC requirements in Section 3.3. Off-base demands are estimated in Section 3.4. The amount of water in the off-base water system that is either available to or required from the DoD water system is estimated in Section 3.5. Water demand calculations are provided in Appendix C.

3.1 ON-BASE DEMANDS ASSUMING UFC CRITERIA

3.1.1 Domestic Uses

The increase in domestic demand is calculated based on the military population presented in Table 1-1 using the UFC based calculation described in Section 2.4. Transients stationed at Apra Harbor would be housed on board ships. The demand for these transients is estimated by the demand required by the ships, not per person. Visiting ships docked at Apra Harbor would be connected to the Navy island-wide water system for potable water. Potable water requirements for visiting ships are included in the domestic demand based on the requirements provided in Volume 4 of the DEIS for air craft carriers and UFC 4-150-02 (DoD 2003) for other visiting ships. The type and number of visiting ships with the potable water requirements is shown in Table 3-1.

Table 3-1: Visiting Ship Demand

	No. of Ships	Demand per ship (gpd)	Total (gpd)
Air Craft Carriers	1	235,000	235,000
LHD	1	90,000	90,000
LSD	1	24,000	24,000
LPD	1	40,000	40,000
CG-47	2	16,000	32,000
DDG	2	11,400	22,800
			443,800

Note: From DEIS Volume 2, DEIS Volume 4, and DoD 2003.

The future domestic demand is the sum of the current demand estimates shown in Table 2-12 and the increase in domestic demand resulting from the USMC relocation. Table 3-2 presents the future domestic demand for DoD bases.

Table 3-2: Future Domestic Demand

	USMC Finegayan Base	Andersen AFB	Navy Bases
Average Daily Domestic Demand	4.4	1.1	2.4
Maximum Daily Domestic Demand	8.9	2.3	4.7

Units: mgd

3.1.2 Industrial Uses

Industrial uses include air conditioning, irrigation, swimming pools, shops, laundries, dining, processing, flushing, air conditioning, and boiler makeup. The planned facilities for the USMC relocation are presented in Appendix 4 of the *Final U.S. Marine Corps Facility Requirements and Initial Concept Plan* (HHF 2007). Demands were assigned according to the values in Table 3-3 from UFC 3-230-19N (DoD 2005) for air conditioning. Other industrial demands were assigned based on the measured demands for similar existing facilities within the Navy bases on Guam. The industrial demands projects in progress are included from the GJMMP 2006 report. Demand for a 250,000 gallon ship washdown over a 5 day period at Apra Harbor was included in the Navy water system demand. Demand for power generation in northern Guam of 225 gpm was included in the USMC water system demand.

Table 3-3: Industrial Water Requirements Potable Water – Permanent Installations

Use	Unit	Requirements		
		Min	Avg	Max
Air conditioning	gpm/ton	—	0.05	0.10

Source: DOD 2005

Future industrial demands are presented in Table 3-4.

Table 3-4: Future DoD Industrial Demands

Industrial Demands (mgd)	USMC Finegayan Base	Andersen AFB	Navy Bases
Existing	0.1	0.76	3.8
USMC Relocation	0.8	0.07	0.02
Additional from Projects In Progress	0	0.17	0.73
Washdown 25,000 gallons over 5 days	0	0	0.05
225 gpm for Power Generation	0.32	0	0
Total Industrial	1.2	1	4.6

3.1.3 Fire Protection Demands

Fire protection demand includes water required for maintaining the fire protection system within the facility and is designed based on the criteria outlined in UFC Fire Protection Engineering for Facilities UFC 3-600-01 (DoD 2006). The *Final U.S. Marine Corps Facility Requirements and Initial Concept Plan* (HHF 2007) for relocation indicates four commands and 19 permanently based organizations including facilities, such as family housing, aviation operation (including hangars, maintenance shops, training facilities), command centers (including administrative offices) and facilities housing various base support operations. The fire flow requirement for each facility is determined by the hazard classification for each facility structure and operation. For the current design a maximum fire flow demand of 3,750 gpm for a minimum duration of 150 minutes is assumed. This value is referenced from Table C-1, in UFC 3-600-01(DoD 2006), and classifies the facility as “extra hazard”, which includes facilities, such as hangars, ordnance plants, and warehouses. While some of the facilities listed in the 2007 plan would fall under light or ordinary hazard category, the “extra hazard” designation is selected for the conceptual fire protection demand, assuming all the facilities listed in the relocation plan are single units. Details of the calculation are presented in Appendix C.

Fire demands estimated per area are presented in Table 3-5. Most of the USMC facilities listed in Table 1-2 are assumed to be on the USMC Finegayan base. Facilities for the Aviation Facilities at Andersen AFB North Ramp are assumed to be located at the Northern Ramp Aviation Facility. Facilities for the Embark Operations at Apra Harbor/Ordnance Annex, Fleet Anti-Terrorism Security Team Company, and Marine Expeditionary Unit are assumed to be at the Embark Operation at Apra Harbor/Ordnance Area.

Table 3-5: USMC Relocation Fire Demands by Area

Facility	Peak Fire Protection Demand (gpd)
Northern Ramp Aviation Facility	562,500
Embark Operation at Apra Harbor/ Ordnance Area	202,500
USMC Finegayan Base	562,500
Andersen South	0

3.1.4 Unaccounted for Water

A UFW of 5 percent is assumed for the new distribution system at USMC Finegayan base. It is assumed that the current UFW for Navy bases is 25 percent and that the future UFW is 15 percent of the additional demands. The current and future UFW for the Andersen AFB water system is 50 percent. The future UFW demands were calculated as the sum of the existing UFW demands and the additional UFW demands. The future UFW demands are shown in Table 3-6.

Table 3-6: Future Unaccounted for Water Demands

	USMC Finegayan Base	Andersen AFB	Navy Bases
Average UFW Demand	0.3	1.1	3.2
Maximum UFW Demand	0.5	1.6	3.7

Units: mgd

3.1.5 Summary of Calculated Demands

The DoD future average and maximum daily demands are summarized in Table 3-7. The average and maximum daily demands are calculated as the sum of the domestic, industrial, and UFW demands.

Table 3-7: DoD Future Water Demands

	USMC Finegayan Base	Andersen AFB	Navy Bases
Average Daily Demand	6.0	3.2	10.1
Maximum Daily Demand	10.6	4.9	13.0

Units: mgd

3.2 ON-BASE DEMANDS ADJUSTED TO REFLECT FEDERAL MANDATES TO REDUCE CONSUMPTION

The potable water demand assumptions presented in Section 3.1 are based on UFC (UFC 3-230-19N [DoD 2005]) that provides a conservative estimate to plan the potable water source demand for a standalone system to serve the long-term needs of a generic military base located anywhere in the world. Construction on military bases is standardized and dictated by UFC documents that provide planning, design, construction, sustainment, restoration, and modernization criteria. They are applicable to Military Departments, Defense Agencies, and DoD field activities. They were relied on in the development of project designs and would be incorporated into construction documents and permits, and operations and maintenance activities. The documents address issues, such as design standards for water systems based primarily on installation population. There is little flexibility in minimal design standards, but there is flexibility in site planning. Congressional appropriations require the incorporation of all relevant UFCs in design.

Unfortunately UFC 3-230-19N (DoD 2005) addresses the criteria to be used to define the source of water, but does not account for the fact that several federal mandates (Executive Order [EO] 13423; Congress 2005; Congress 2007; EO 13514) have been issued since the last release of UFC 3-230-19N. These federal mandates require the use of water conservation technology to achieve significant reductions in water usage. EO 13514 dated 5 October 2009 requires federal agencies to reduce their water consumption by 26 percent by 2020 as compared to the federal agency's water consumption in 2007. The disconnection between the mandated reductions in usage and the UFC, results in a design for the water source (compliant with UFC) with an amount that is greater than the actual need (based on the mandated reductions). To address this situation, in advance of an update of UFC 3-230-19N and to factor in a more realistic scenario based on Guam, it was decided to incorporated sustainability and water conservation into the water demand calculation. This approach has been endorsed by the Navy Criteria team that is responsible for updating the UFCs and is considered consistent with the spirit and intent of the UFCs. It is essential to start with UFC 3-230-19N and apply sound engineering judgment to adjust requirements to preclude the construction of a more costly system that would constrain a limited water resource and ultimately be underutilized, potentially resulting in long-term operating issues.

The reduction in on-base water demand for the new base is expected to be in the order of 22 percent for the average daily demand, and 40 percent for the maximum daily demand if conservation measures, sustainability principles, and Guam site-specific conditions are applied.

Sustainability Principals

The following directives and guidance documents address water conservation:

- EO 12902, *Energy Efficiency and Water Conservation at Federal Facilities*
- EO 13423, *Strengthening Federal Environmental, Energy, and Transportation Management*
- Energy Policy Act of 2005 Energy Independence and Security Act of 2007
- 10 United States Code (U.S.C.) 2866, *Water Conservation at Military Installations*
- 10 U.S.C. 2915, *New Construction: Use of Renewable Forms of Energy and Energy Efficient Products*
- Military Handbook 1165, *Water Conservation*, MIL-HDBK-1165 (DoD 1996)
- *Navy Water Conservation Guide For Shore Activities* (Hoffard, Magro, and Zendijas 1996)

- EO 13514, Federal Leadership In Environmental, Energy, And Economic Performance (5 October 2009)
- Leadership in Energy and Environmental Design for New Construction and Major Renovation, 2009

Additionally, the existing Navy and Air Force bases are subject to water conservation goals, such as those in EO 13423. Implementation of this order would require a reduction in water usage of 16 percent by 2015 on the existing bases. This percent reduction is included in the modified potable water demand estimates. The water conserved on the existing bases would either reduce the stress on the NGLA or be made available via interconnects to support off-base developments related to the relocation via a formal request by GWA to the Navy (Naval Facilities Engineering Command Marianas).

The DoD is in the process of developing and approving water conservation measures for the new base through equipment selection and management practices. Water consumption at the USMC Finegayan base would differ from consumption at the existing bases because, as part of the proposed action, the design and construction of the USMC Finegayan base would implement low-flow equipment and other improvements to the extent practical. Examples include the following:

- Low-flow faucets
- Ultra-low-consumption toilets/urinals with electric flush sensors
- Low-flow showerheads
- Lower flow commercial-type "Energy Star" washing machines in housing units
- Energy- and water-saving dishwashers (Energy Star)
- Water conservation education
- Use of wastewater recycling in industrial washing and rinsing of aircrafts and vehicles
  - Water-efficient cooling systems
  - Minimal landscape irrigation
  - Rainwater collection and reuse
  - Air conditioning condensate recycling

Water management practices would be implemented at the USMC Finegayan base to better control water consumption and prevent water loss. The amount of water used for lawns and landscapes would be minimized or eliminated through sustainable design. Meters would be installed at all facilities and at key locations within the water distribution system; thus, significantly improving the ability to quickly identify leaks and take corrective action. Water management operation procedures would be reviewed periodically and revised, as needed. Base residents would be educated about living responsibly on a sustainable base to create a sustainable culture through responsible actions by residents. Education programs on proper use of water would include: watering lawns sparingly or not at all, installing low flow fixtures, water reuse, full load clothes washing, etc. Metering would allow water users to have full awareness of their water usage. For housing residents, meters would support billing of water usage directly to the residents. Water conservation would be a key program that would receive command level attention and follow-up.

Site Specific Water Conservation Measures

Because the proposed USMC Finegayan base is located on Guam, some of the assumptions behind the development of the UFC guidance are not relevant. Notably, the water needed for lawn irrigation would be minimal because of Guam's climate, particularly in the rainy season. As described above, the facility design is expected to implement water conservation equipment that is likely to produce at least a 22 percent water savings compared to conventional equipment. This water savings is mandated by regulation (EO 13514). No irrigation would be utilized for housing and would be used minimally elsewhere on the base. Landscaping throughout the base would use plants that can survive with little watering. A common components manual to guide the development of the new USMC Finegayan base would address which local plants can be utilized in landscaping. Improved leak detection and extensive metering and management systems are expected to reduce the amount of UFW to a rate of 5 percent based on engineering judgment. It is noted that the UFC 3-230-19N (DoD 2005) does not address the issue of UFW. The controlling demand factor used to estimate the maximum daily demand and to size water system components would be lower for Guam because there are limited climatic changes on Guam as compared the mainland and other locations.

The potential savings from water conservation measures for Main Cantonment Alternatives 1 and 2 at Andersen AFB and Navy bases are shown below in Table 3-8.

Table 3-8: Water Demand Comparisons Using Conservation/Sustainability Measures

	Water Demand (in mgd)			
Water Demand Criteria (Existing and Proposed)	USMC Finegayan Base	Andersen AFB	Navy Bases	Total
Average Daily Demand using UFC Guidance	6.0	3.2	10.1	19.3
Average Daily Demand using Sustainability Principles	4.7	2.6	8.7	15.9
Potential Percent Reductions for Average Daily Demand	**22%**	**18%**	**14%**	**17%**
Maximum Daily Demand using UFC Guidance	10.6	4.9	13.0	28.5
Maximum Daily Demand using Sustainability Principles	6.3	3.0	9.8	19.1
Potential Percent Reductions for Maximum Daily Demand	**40%**	**39%**	**25%**	**33%**

Incorporating these assumptions, the daily demand for the USMC Finegayan base is estimated to be reduced by approximately 22 percent of the current estimated average daily demand and 40 percent of the maximum daily demand.

3.3 DESIGN CAPACITY OF SYSTEM COMPONENTS FOR THE USMC RELOCATION

3.3.1 Water Supply Sources

The water supply source would be designed to meet the military activity's quantity demands. Where there is inadequate storage between the source and the treatment plant or distribution system, the supply would provide maximum day domestic demand plus industrial use demand.

For supply wells, sufficient capacity would be included to meet the maximum day domestic demand, plus industrial use demand, with the largest well out of service.

The required future water supply for the DoD facilities is shown in Table 3-9 using the UFC requirements described in Section 3.1. The supply necessary for the USMC Finegayan base is 11.3 mgd. It is assumed that wells would be located on Andersen AFB within the Andersen and Agafa-Gumas subbasins where there is sufficient available yield (Section 1.5.5) to meet this demand.

At Navy bases, the required supply is 17.0 mgd. Including the existing supply of 13.2 mgd and well rehabilitation totaling 1.2 mgd, there is a deficit of 3.1 mgd. It is assumed that the DoD would consider long-term alternatives (Section 1.4), rehabilitate wells (e.g., Tumon Maui and Marbo #2), develop additional groundwater resources on Navy Barrigada, or use excess water from the USMC Finegayan base water supply to meet the projected deficit. There is a deficit of 0.9 mgd supply at Andersen AFB. The water demand may be lower than estimated for Andersen AFB in 2019 due to an ongoing project to rehabilitate the water mains from the Marbo wells in Andersen South Annex to the main base, which will lower the amount of UFW. The additional planned five wells on the main base may be installed. It is assumed that excess water from the USMC Finegayan base will be supplied to the Andersen AFB, if required.

Table 3-9: Required Water Supply (mgd)

	USMC Finegayan Base	Navy Bases	Andersen AFB
Minimum Required (maximum daily demand +largest well)	11.3	13.0	5.6
GWA Transfer	0	4	0
Total Supply Required (Sum Minimum Required and GWA Allotment)	11.3	17.0	5.6
Existing Supply	0.0	13.2	4.7
Additional Required	11.3	3.8	0.9
Additional Planned Capacity	11.3	1.2	0
Total Future Capacity	11.3	14.4	4.7

3.3.2 Treatment Plant

Groundwater would be treated prior to transmission to the new base by chlorination and fluorination. No water treatment plants are proposed.

3.3.3 Transmission Mains

Where the distribution is pumped from storage, transmission mains would have capacities equal to the maximum-daily demand plus industrial use demand.

3.3.4 Distribution System

The minimum capacity of the distribution system would be sufficient to meet these conditions:

- Instantaneous peak domestic and industrial flows combined.
- Maximum fire demands, plus 50 percent of average domestic demands, plus industrial demands which cannot be restricted during the fire.
- Replenishment of normal storage volume within 24 hours of average demand after a fire.

3.3.5 Storage Facilities

Reservoir capacity for the USMC relocation would be adequate to satisfy the total of the following requirements:

- Peak fire flow demand
- 50 percent of average daily consumption (domestic and industrial)

- Minimum working volume of 1 hour at average demand (domestic and industrial) for scheduling of treatment plant equipment and service pumps maintenance

The storage capacity for the facility is referenced from Section 2.3.5 of UFC 3-230-19n (DoD 2005) and is based on Equation 3:

Equation 3

$$\text{Storage} = \text{Peak Fire Flow Demand} + 50\% \text{ Average Daily Use} + 1 \text{ hour of Average Daily Use} \quad (3)$$

In the above equation, the average daily use includes both domestic and industrial.

The minimum required storage capacity for the USMC relocation areas is 4.3 million gallon. A 5 million gallon ground level tank would be installed on the main base to meet this requirement. It is assumed that all Navy existing reservoirs on the USMC Finegayan base would be demolished. New storage facilities would be required for the base.

3.4 OFF-BASE DEMANDS

Off-base water demand would be met by GWA. Population estimates are provided in Table 3-10. The population consists of the baseline growth (the expected growth in the Guam population without military relocation) in the existing population, the population induced by the Marine relocation, and the civilian workers working on-base and housed off-base. A separate estimate is provided for the population located in northern and central Guam, where the water demand is met through groundwater resources.

Table 3-10: Off-Base Population Estimates in 2019

Year	Future Population
Current Population	180,692
Baseline Growth	20,403
Civilian Workers Project	1,836
Non-Project Civilians	25
Civilian Workers Dependents Project	1,745
Induced	8,895
Total	213,596

The off-base water demand for the population increase is estimated using Equation 1, assuming 125 gpd per person (all others) plus the current billed demand of 18 mgd, 4 mgd UFW from leakage currently occurring, a UFW rate of 10 percent for additional water demands, and 20 mgd loss from unmetered or under metered usage. No other factors are included in the estimate (e.g., growth factor). The approach for estimating GWA's water demand is based on information in the GWA WRMP (GWA 2007). The future off-base water demand is 46.5 mgd. It is assumed that 81 percent of the population resides in the northern and central water system areas requiring 38 mgd water demand. Water demands from the tourist population are included in the current GWA water production. It is assumed that there is no increase in the tourist population over the current level.

3.5 OFF-BASE WATER SYSTEM CAPACITY

Table 2-1 provides the production rates for the current GWA sources. Potable water is mainly supplied to the northern system by 119 deep wells. Collectively these wells have a daily average

production rate of approximately 38 mgd. GWA plans on reducing production of several wells in the Agana subbasin which have elevated chloride levels by 2 mgd. The Navy transfers up to 4 mgd to the central water system. Total supply to the north and central water systems is 40.4 mgd. The supply in the southern water system is 2.4 mgd.

In 2019, the baseline demand would grow by 2.8 mgd for the additional 20,403 population increase. It is assumed that GWA would increase well production in the Agana or Agafa-Gumas subbasins to meet the demand resulting in a system supply capacity of up to 45.2 mgd including the Navy transfer from the Navy Reservoir. The DoD estimates that up to 1.7 mgd is currently available from the Andersen AFB water system for transfer to GWA.

The estimated GWA water demand in 2019 is 46.5 mgd. An additional supply up to 1.3 mgd from the DoD would result in a sufficient overall water supply. There are inadequate water resources in the GWA southern water system to meet the demand for the population. The water demand in southern Guam is 8.5 mgd. GWA plans to increase capacity of the Ugum water treatment plant by 1.8 mgd. Even with this increase, 4.3 mgd would need to be transferred from the central or north water system to meet demand in southern Guam. According the WRMP, the GWA water systems are interconnected, but the effectiveness of the interconnections is not known.

For this study, it is assumed that the GWA water system has no excess water available for transfer to the DoD to support the USMC relocation.

4. Expansion Alternatives for Main Cantonment Alternatives 1 and 2

This section provides a description of the water supply system components for the three options considered:

- Option 1 – Optimize groundwater resource development within DoD property
- Option 2 – Determine the requirements for rehabilitation, treatment of well water, or replacement of existing wells
- Option 3 – Purchase water from GWA

4.1 OPTION 1 - OPTIMIZE GROUNDWATER RESOURCE DEVELOPMENT WITHIN DOD PROPERTY

This section provides the rationale for potential new supply well locations, well construction, and the water supply system components.

4.1.1 Potential Well Locations

Well locations are identified on the Andersen AFB to support the USMC Finegayan base. Using the 1992 estimates of sustainable yield, sufficient groundwater is available within military reservation boundaries to meet the new required supply resulting from the transfer of USMC and other assets to Guam. Potential water supply well locations were initially sited with consideration of the following land ownership and constraints:

- Limiting well production within subbasins so that the sustainable yield would not be exceeded.
- Preferentially locating wells in parabasal zones (as opposed to basal zones) to achieve higher yield with lower chloride levels; thereby, reducing the number of wells and associated costs.
- Maintaining a 1,000-feet distance from the shoreline to avoid saltwater intrusion.
- Maintaining an approximately 800- to 1,000-feet distance from other supply wells.
- Maintaining a safe distance from potential contaminant sources.

The parabasal zones—areas where the freshwater lens bottom is in contact with basement rock—are roughly drawn on Figure 4-1. It is assumed that the parabasal zone extends seaward to a point where the top of the impermeable volcanic basement underlies the limestone aquifer at depth of approximately 131 feet below msl. A transitional parabasal/basal zone is assumed to exist in the area where the top of the impermeable volcanic basement underlies the limestone aquifer at depths between 131 and 196 feet below msl. These assumptions are based on existing GWA well locations described as parabasal or transitional that appear to meet these characteristics, according to available volcanic basement contour maps.

Some considerations for the proposed locations include:

- According to volcanic-bedrock contour mapping, a substantial portion of the available potential high-yield parabasal zone exists on or near the military reservation boundary.
- If the parabasal zone were to yield less than the proposed well production, some of the wells may need to be relocated to the basal zone on DoD property, farther from the DoD boundary, and additional wells may need to be installed. Approximately twice the number of wells would be required if wells were to be located in the basal zone.

- One of the proposed well locations falls within the inhabited building distance (IBD) explosive safety quantity distance (ESQD) arc. Because of the spatial limitations, some proposed well locations are near or within residential zones. The Air Force would review and approve facility locations at Andersen AFB. Facility design would incorporate Andersen AFB requirements.
- A significant portion of the available potential high yield parabasal zone exists on or near the military reservation boundary. Wells located along the boundary are less secure. To compensate for this, the wells would have added security, be provided with pitless adaptors, and be located within a locked structure.
- Wells near the approach to runways may need to be frangible or flush mounted. Wells located near the main base would be constructed to minimize noise and visual impact.
- Wells sited on Andersen AFB along the parabasal zone would be placed outside of the installation restoration sites and Andersen AFB facilities. Wells are placed in and near the main base housing to supply water from the Andersen subbasin. This area may be subject to impacts from the sewer lines or dry wells. Spacing between wells is approximately 1,000 feet.
- Wells are located more than 300 feet from the nearest unsewered areas outside of DoD land.
- Wells are located more than 300 feet from the nearest GWA wastewater pumping station.

Sinkholes and caves in northern Guam are shown on Figure 4-2.

Additional constraints are listed in Table 4-1.

Potential sources of contamination exist on or near Andersen AFB. These include the installation restoration sites, past hazardous activity locations, a utility corridor including a sewer line and storm water injection wells. The proposed wells would be located away from these sites, where possible. All well locations would be tested for water quality before installation. The DoD would comply with all necessary stormwater requirements. Because the primary military relocation area would not be at Andersen AFB, impacts on stormwater resulting from the relocation would be minimal. The Main Cantonment area is within the Finegayan subbasin. Design of the Marine Corps base will implement Low Impact Development to manage stormwater in a manner which is similar to the predevelopment hydrology at the site. If elevated contaminant levels were detected, the wells would be relocated or the design would be revised to include the appropriate treatment processes. A chlorinated-solvent plume containing TCE and PCE levels greater than the MCLs is identified in groundwater on Andersen AFB. Monitoring wells with elevated levels of chlorinated solvents are shown on Figure 4-1. This plume is downgradient from the wells and is not expected to affect the proposed well locations.

Unexploded ordnance (UXO) and munitions and explosives of concern (MEC) may be found at Andersen AFB. In accordance with Naval Ordnance Safety and Security Activity (NOSSA) Instruction 8020.15B, Explosives Safety Submission (ESS) documentation must be prepared that details how explosive safety standards are applied to munitions responses. The ESS also addresses how a project will comply with applicable environmental requirements related to the management of MEC and material potentially presenting an explosive hazard. At munitions response sites, no site operations may begin unless NOSSA and the DoD Explosive Safety Board have reviewed and approved the ESS. An ESS is prepared for onsite construction support where the likelihood of encountering UXO is determined to be moderate or high and where ground-disturbing or other intrusive activities, including dredging, may occur in areas known or suspected to contain UXO. The ESS outlines specific measures to be taken to ensure the safety of workers and the public.

Studies of cultural resources and sensitive habitat are ongoing. Well locations may be modified as a result of these studies.

As part of the well permitting process, GEPA would conduct a review of each well location and review site-specific data. Additionally, all federal projects proposed over the Northern Aquifer are subject to an aquifer protection review. Projects are reviewed for potential direct or indirect impacts on groundwater. Submittal of detailed site plans, plumbing plans, engineering studies, and calculations may be required.

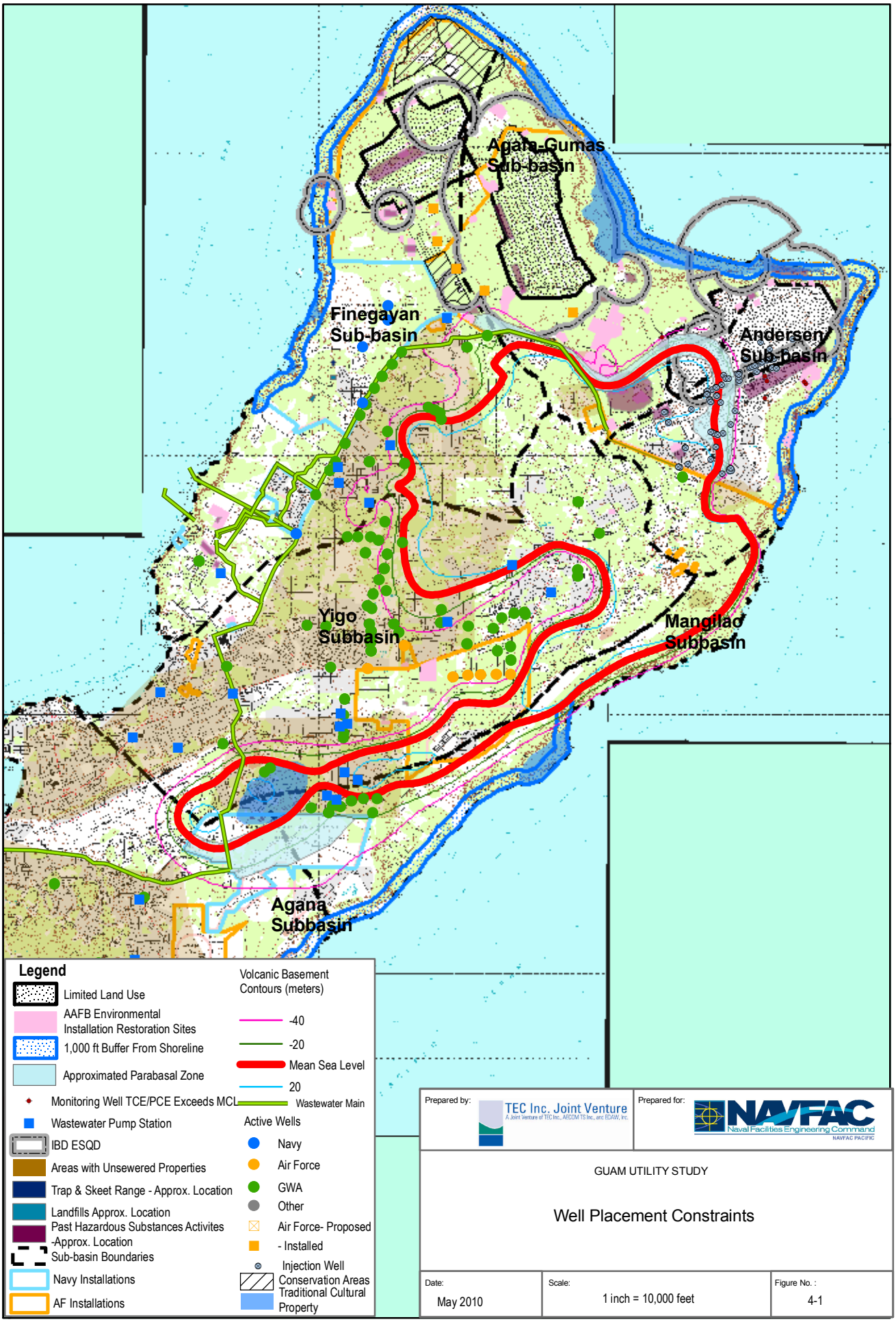
Table 4-1: Well Location Constraints

Location Constraint	Comments/Approach to Well Placement
DoD Property	Wells are located on DoD property.
Sustainable Yield	The combined capacity of the existing and planned wells is less than the 1992 sustainable yield estimate.
Parabasal/Basal Zones	Wells are clustered in the parabasal zone to maximize production of the aquifer. Lower chloride levels and higher production are anticipated for parabasal zone wells. Wells are located more than 1,000 ft from the shoreline to avoid saltwater intrusion.
Proximity to Existing and Proposed Air Force and GWA wells	Maintain an approximately 800- to 1,000-ft distance from other supply wells. Monitor for saltwater intrusion. Coordinate with GWA.
Current and Future Land Usage: - Impact on Air Force Mission and Quality of Life - Future Construction in Residential Area - Future Paving of the Utility Corridor	All facility locations would be reviewed by and require the approval of the Air Force.
ESQD	Wells are located outside all ESQD arcs, except one well that falls inside the IBD arc near the boundary.
Potential Contaminant Sources: - Fuel Pipeline in the Utility Corridor - Fuel Storage - Dry Cleaners - 78 IRP Sites including Active and Inactive Landfills - Areas of past hazardous substance activities - Landfills and target ranges on the USMC Finegayan Base - Underground Injection Control Wells in the Main Base Area - Unsewered properties	Maintain an approximately 800- to 1,000-ft distance from contaminant sources where possible. Water quality would be evaluated during the pilot hole testing and periodically during well use.
Chlorinated VOC Plumes in the Main Base Area	Monitoring wells with elevated levels of chlorinated VOCs are downgradient from the proposed well locations. Water quality would be evaluated during the pilot hole testing.
UXO/MEC	Precautions would be taken during construction for UXO/MEC.

Location Constraint	Comments/Approach to Well Placement
Sewer Main along Route 9	DoD would consider conducting a study to evaluate the integrity of sewer mains.
Runway Approach	DoD/Air Force requirements for design would be observed. Well heads would be flush with the ground or frangible.
Sinkholes and caves	Wells would be located away from known sinkholes and caves.
- Cultural Resources - Sensitive Habitat	Location specific studies are being conducted by DoD. Facility locations would be adjusted as required.

ft feet or foot

Well production rates were assigned assuming up to 450 gpm for parabasal wells and 100 to 300 gpm for transitional wells. Based on these assumptions, a minimum of 22 additional wells would be needed to meet the required supply for Main Cantonment Alternatives 1 and 2. These limits are consistent with the recommendations for supply wells presented in the 1982 NGLA study (CDM 1982). The sustainable yield estimates presented in the 1992 report (Barrett 1992) are included in this study for an assessment of well capacities by subbasin. These values are an update to the analysis presented in the 1982 NGLA study. However, the 1982 study included recommendations on the installation of supply wells that were not updated in the 1992 report. The Navy is currently implementing a study consisting of installing test wells on Andersen AFB to confirm the desired pumping capacities can be achieved.


Agana-Gumas Sub-basin
Finegayan Sub-basin
Andersen Sub-basin
Yigo Subbasin
Mangilao Subbasin
Agana Subbasin
Legend
Limited Land Use
AAFB Environmental Installation Restoration Sites
1,000 ft Buffer From Shoreline
Approximated Parabasal Zone
Monitoring Well TCE/PCE Exceeds MCL
Wastewater Pump Station
IBD ESQD
Areas with Unsewered Properties
Trap & Skeet Range - Approx. Location
Landfills Approx. Location
Past Hazardous Substances Activites -Approx. Location
Sub-basin Boundaries
Navy Installations
AF Installations
Volcanic Basement Contours (meters)
-40
-20
Mean Sea Level
20
Wastewater Main
Active Wells
Navy
Air Force
GWA
Other
Air Force- Proposed
- Installed
Injection Well
Conservation Areas
Traditional Cultural Property
Prepared by:
TEC Inc. Joint Venture
A Joint Venture of TEC Inc., AECOM TS Inc., and ESAW, Inc.
Prepared for:
NAVFAC
Naval Facilities Engineering Command
NAVFAC PACIFIC
GUAM UTILITY STUDY
Well Placement Constraints
Date:
May 2010
Scale:
1 inch = 10,000 feet
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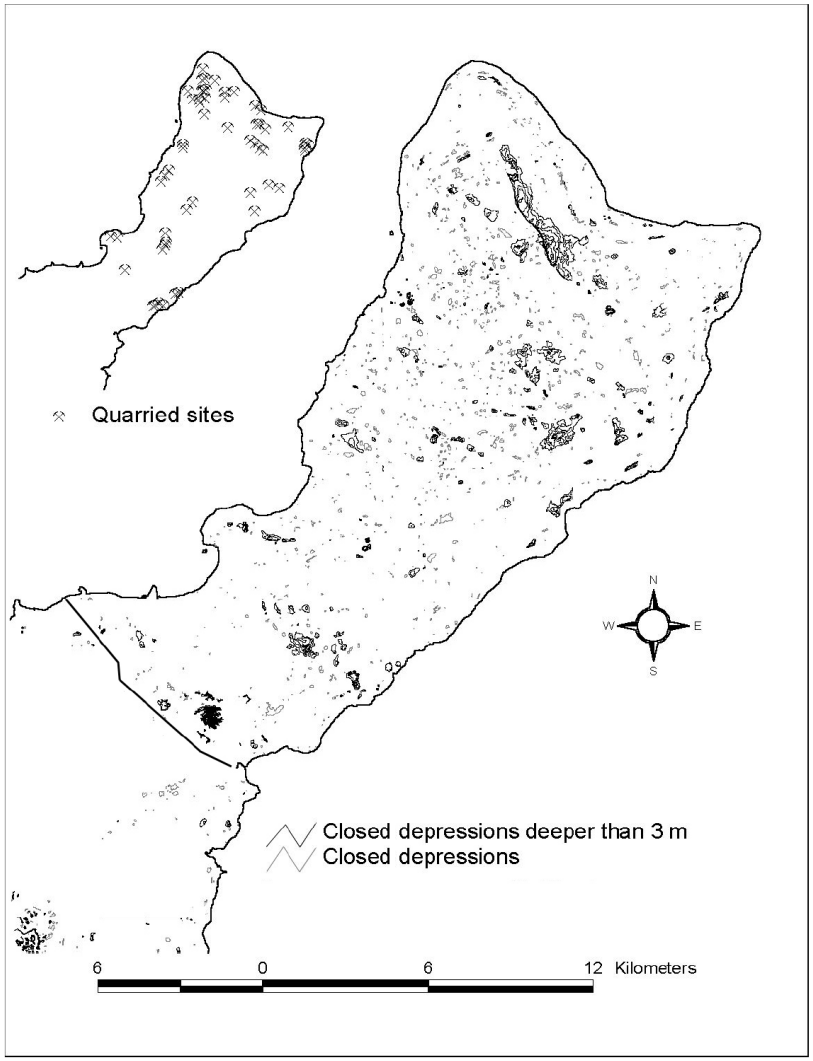
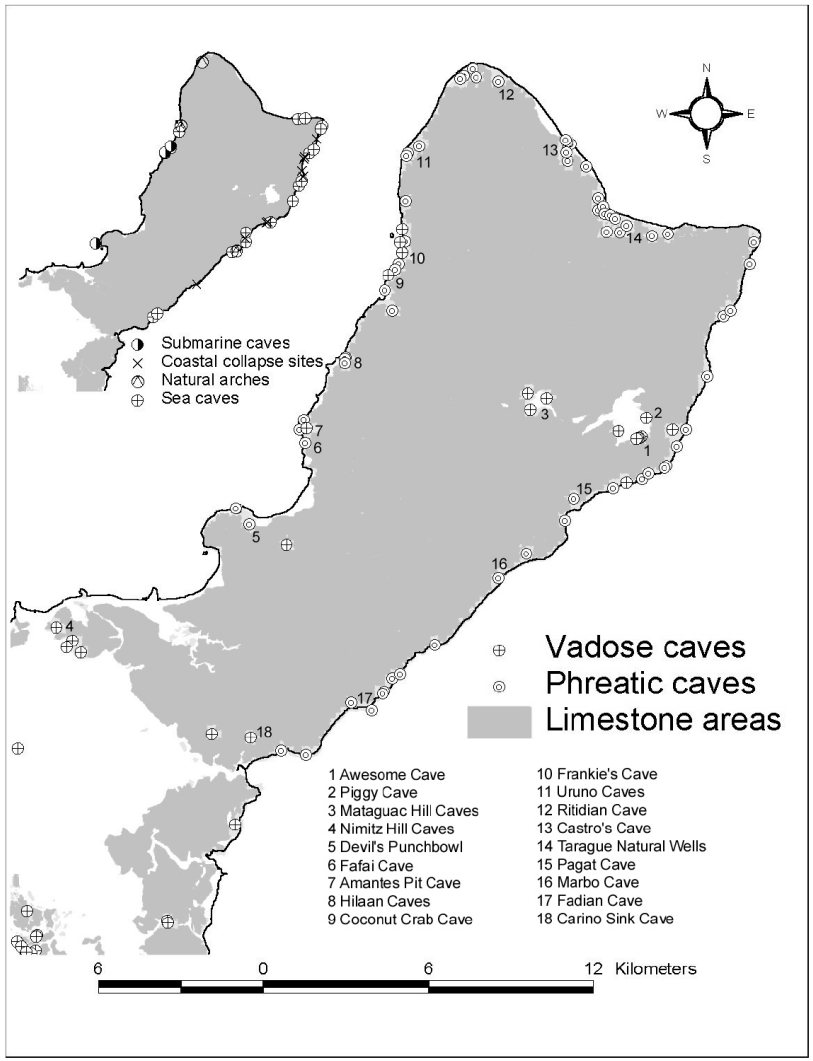
4-1





Prepared by: TEC Inc. Joint Venture

Prepared for: NAVFAC Naval Facilities Engineering Command, NAVFAC PACIFIC

GUAM UTILITY STUDY

Sinkholes and Caves in Northern Guam

Date:	Scale:	Figure No. :
4/19/10	As shown	4-2

Table 4-2 presents the well capacity and subbasin locations for potential wells needed to meet new demands resulting from transfer of DoD assets to Guam. Water system components for Option 1 are shown on Figure 4-3.

Table 4-2: Proposed Well Details

Well Number	Proposed Capacity (gpm)	Subbasin
1	450	Agafa-Gumas
2	450	Andersen
3	250	Finegayan
4	450	Agafa-Gumas
5	450	Agafa-Gumas
6	450	Agafa-Gumas
7	450	Agafa-Gumas
8	400	Finegayan
9	450	Agafa-Gumas
10	250	Andersen
11	450	Andersen
12	250	Agafa-Gumas
13	250	Andersen
14	250	Agafa-Gumas
15	250	Agafa-Gumas
16	250	Finegayan
17	450	Andersen
18	250	Andersen
19	250	Agafa-Gumas
20	375	Agafa-Gumas
21	450	Andersen
22	300	Agafa-Gumas

4.1.2 Water System Components

The water system components are described in this section. The main components are the wells, water treatment, and distribution system. The distribution system would include the water lines connecting the wells to the ground level storage tank on USMC Finegayan, distribution within the base, storage and standby generators. In addition, the water lines connecting the existing Navy wells at the USMC Finegayan base would be replaced. The USMC water lines would be connected to the Navy island-wide system and the Andersen AFB water system to distribute water between bases. The Navy island-wide system between the USMC Finegayan base and the Tupo tank would be upgraded to allow water to flow from north to south. The Navy island-wide system would be adjusted to allow 7 mgd to flow from the USMC treated waterlines to the facilities in south Guam or from south Guam to the north. Improvements to the Navy island-wide system are long-term projects/goals. Water system components are shown on Figure 4-3.

4.1.2.1 WELLS

Well Construction. Based on information in the report by McDonald and Jensen (2003) it was assumed that all wells would be constructed in limestone and a portion of the saturated interval would be screened below mean sea level. For wells in the parabasal zone, it was assumed the well

would be terminated approximately 50 feet below msl and for wells in the basal/transitional zones, well termination was assumed to be 30 feet below msl. Well construction cost estimates assume a 500 gpm well drilled in the parabasal area to a total depth of 577 feet and a 300 gpm well drilled in the transitional area to a depth of 512 feet. Well construction details and calculations of "per foot" cost for each type of well are presented in Appendix C.

Aquifer Monitoring. Periodic monitoring of the aquifer following implementation of Option 1 is recommended to optimize the system and adjust pumping rates if chloride levels show an increase. The monitoring program should be coordinated with GWA.

Well Operation and Maintenance. Proper operation and maintenance (O&M) of the supply wells is necessary so that the wells consistently meet the design capacity and achieve the design life span. Deterioration of the well system starts as soon as the well is constructed and generally occurs slowly. Given time, a critical point is reached and deterioration accelerates, resulting in substantially decreased yield, or worse yet, total failure.

4.1.2.2 WATER TREATMENT

Groundwater would be extracted, disinfected, and fluorinated prior to transmission to the new base.

4.1.2.3 DISTRIBUTION SYSTEM

Pumps at each well station would pump water from the wells to a storage tank after disinfection and fluorination. The proposed wells and water treatment plant are discussed earlier in this section of the report. Other water system components include:

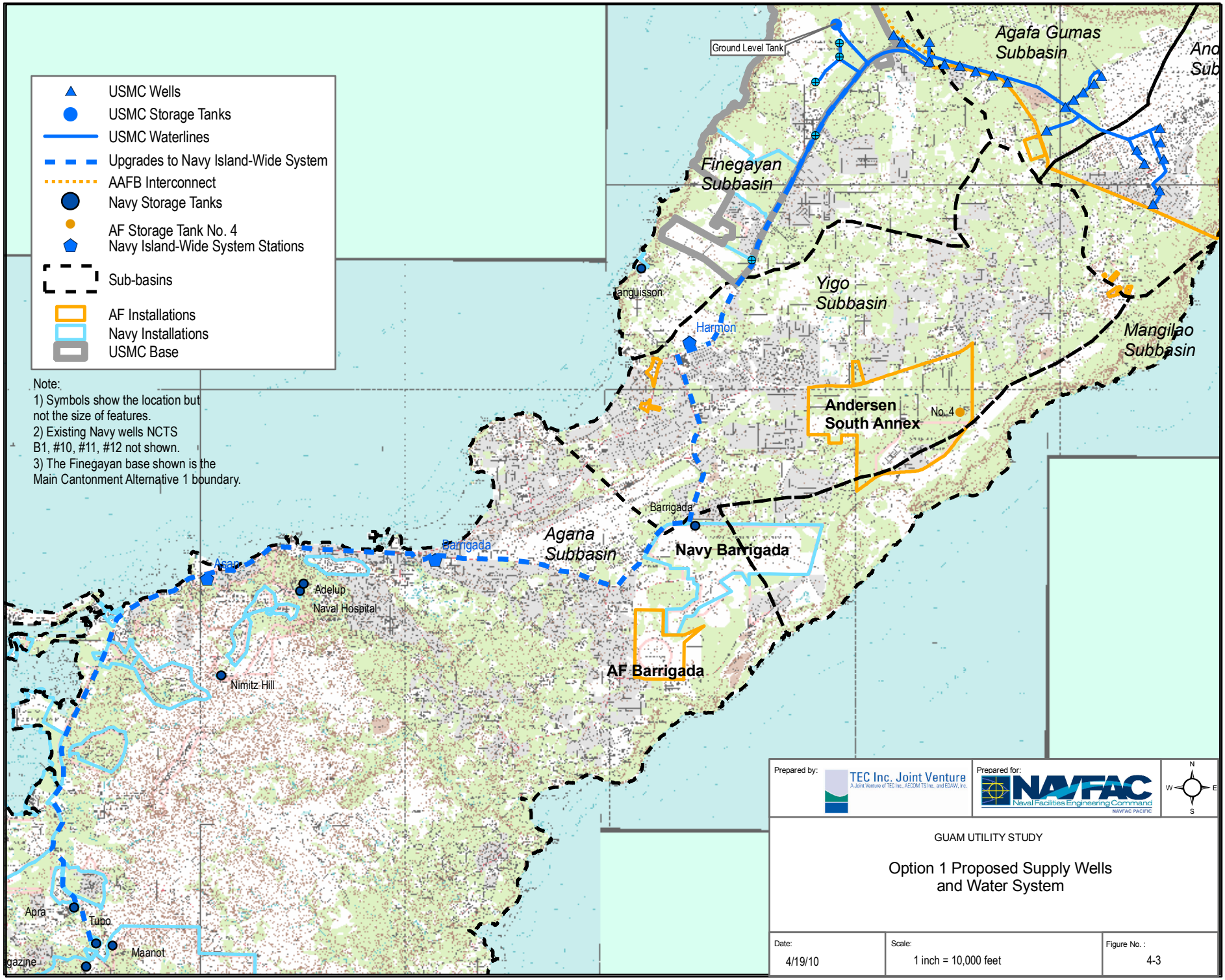
- Well pumps
- Transmission mains
- Water distribution system
- Water storage
- Andersen AFB and Navy's island-wide water system connections and upgrades

Well Pumping Stations

Well houses would be constructed to meet typhoon and local building code requirements. Sufficient standby power would be provided to ensure that the average daily demand at the new base could be met during power outages. Each well station would include a submersible well pump with an aboveground discharge pipe that would need to be protected. Wells would be installed with pitless adapters for security. The discharge pipe would have an air/vacuum relief valve, check valve, surge relief valve, and flow meter. The land area requirement for each well station is estimated to be a minimum of 1,000 square feet (93 square meters).

Transmission Mains

Transmission mains would convey water from the wells to the ground level storage tank on the USMC Finegayan base. The mains would range from 8 to 30 inches (20 to 76 centimeters) in diameter and would be sized to provide velocities less than 6 feet (2 meters) per second to minimize head losses from friction.


USMC Wells
USMC Storage Tanks
USMC Waterlines
Upgrades to Navy Island-Wide System
AAFB Interconnect
Navy Storage Tanks
AF Storage Tank No. 4
Navy Island-Wide System Stations
Sub-basins
AF Installations
Navy Installations
USMC Base
Note:
1) Symbols show the location but not the size of features.
2) Existing Navy wells NCTS B1, #10, #11, #12 not shown.
3) The Finegayan base shown is the Main Cantonment Alternative 1 boundary.
Ground Level Tank
Agafa Gumas Subbasin
Finegayan Subbasin
Yigo Subbasin
Mangilao Subbasin
Anguisson
Harmon
Andersen South Annex
No. 4
Barrigada
Agana Subbasin
Navy Barrigada
AF Barrigada
Adelup
Naval Hospital
Nimitz Hill
Apra
Tupo
Maanot
Prepared by:
TEC Inc. Joint Venture
Prepared for:
NAVFAC
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GUAM UTILITY STUDY
Option 1 Proposed Supply Wells and Water System
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4/19/10
Scale:
1 inch = 10,000 feet
Figure No. :
4-3

Water transmission mains would convey water from the wells to the distribution system. The treated water would be distributed throughout the Main Cantonment through both 8-inch (20-centimeter) and 12-inch (30-centimeter) water mains with valves and hydrants spaced at intervals of approximately 500 feet (152 meters). Interconnections with Andersen AFB would permit the transfer of water between the DoD water systems.

Water Distribution System

A network of water distribution pipes would be constructed in the Main Cantonment service area. For planning purposes, it is assumed that the pipes would follow the preliminary street layout, and pipe diameters would range between 8 and 12 inches (20 and 30 centimeters). The size and locations of distribution piping would need to be coordinated with expected land uses, estimated domestic demands, and fire flow requirements for the structures that would be constructed on the base.

Water Storage

A 5 million gallon ground storage would be located in the northern end of the Finegayan base. The tank would have a minimum of two sections to allow continuous operation during maintenance or repairs. At least one additional tank is recommended to account for extra hazard fire demand storage and peak daily demand in total storage. The additional tank may be elevated. The cost estimate for this study covers the 5 million gallon ground level storage tank.

Andersen AFB and Navy Island-wide Water System Connections and Upgrades

The U.S. Navy island-wide water system provides water to bases located throughout much of the island. The Navy's water system is capable of providing water to the limited existing developments in the Finegayan area by bringing water from the southern portions of its service area northward through a system of transmission mains, pumping stations, and reservoirs. However, DoD water demands at Finegayan are currently met by groundwater wells. Connecting the proposed USMC Finegayan water system to the Navy island-wide system and the Andersen AFB water system can provide greater flexibility in distributing drinking water around the island. To facilitate moving approximately 7 mgd of water from the proposed USMC Finegayan water system southward to the Navy island-wide system, a 24-inch main would be constructed from the USMC Finegayan water system to the Barrigada tank. Extension of the Navy island-wide system water main to Andersen South area using a 30-inch water transmission main would permit transfer of up to 10.3 mgd water to the Andersen AFB water system to interconnect the USMC, Navy, and Andersen water systems.

Additionally, extending the new transmission main from the Barrigada tank to the Tupo tank provides greater flexibility in moving water around the island. The new 24-inch and 30-inch water main would replace smaller diameter transmission mains, many of which were constructed of asbestos cement and are documented to be in deteriorating condition. Additional improvements, including replacing the Barrigada Pumping Station and Harmon Pumping Station with higher capacity pumps with variable frequency drives, would allow greater flexibility in transporting water throughout the island. Based on a review of documentation of the pumping station (Engineering Concepts, Inc. 2005), it appears the Asan Pumping Station is not used or needed, and should be abandoned.

An interconnection is proposed between the USMC Finegayan base transmission mains and the Andersen AFB water system on the main base.

Prior to constructing these additional mains, additional study and hydraulic modeling is needed to confirm the feasibility and operating conditions. Improvements to the Navy's water system can be implemented over time as part of long-term projects/goals.

4.1.3 Costs

Details of the cost estimate are provided in Appendix C.

The capital costs for Option 1 are:

Costs ($000)	Option 1
Capital Costs	
1) Water Resources Development	$20,749
2) Water Treatment	$2,607
3) Distribution	$269,371
Total Construction Cost	$292,727
Contingencies (20%)	$58,545
Engineering (15%)	$43,909
Total Capital Cost	$395,181
Present Worth Guam Capital Costs	$398,281

The O&M costs for Option 1 are:

Costs ($000)	Option 1
Annual O&M Costs	
1) Water Resources Development	$309
2) Water Treatment	$1,766
3) Distribution	$3,553
Total Annual O&M Cost	$5,629
Contingency (20%)	$1,126
Total Annual O&M Cost	$6,754
Annual O&M Cost for Guam	$6,754
Present Worth of O&M Costs (25 year life)	$161,196

The total present worth of life cycle costs for Option 1 is $559 million.

4.2 OPTION 2 - DETERMINE THE REQUIREMENTS FOR REHABILITATION, TREATMENT OF WELL WATER, OR REPLACEMENT OF EXISTING WELLS

4.2.1 Analysis

This section provides the recommended approach for inactive wells.

4.2.1.1 INACTIVE DOD WATER SUPPLY WELLS

Construction, maintenance, and operation records are not available for the Navy and Air Force water supply wells on Guam; however, several DoD wells are reported to be inactive although the reason for idling wells is not always known. Some wells have been inactivated due to a structural or mechanical failure but the specific nature of the failure is unknown.

General Recommendations

When the status of the well is permanently inactive, the well should be properly abandoned and replaced with a well of equal or greater capacity if possible. In cases where the well is pumping saline water, the standard recommendation is to reduce pumping capacity to the point where salinity is reduced to an acceptable level. When the well is contaminated, but its capacity is not diminished, the recommendation is to add the appropriate treatment to the well to remove or inactivate contaminants and continue to use the well to its design capacity. Finally, when well inactivation was a result of structural or mechanical problems, the recommendation is to investigate and identify the specific problem and determine whether well rehabilitation is technically feasible and economically justified.

Structural/mechanical problems may be a result of numerous factors including, but not limited to, biological, chemical, or sediment fouling of aquifer formation, filter pack, or well screen; mechanical failure of well casing or screen as a result of corrosion or erosion; and collapse of the borehole as a result of seismic activity or caving formation. Regardless of the cause, the first step in rehabilitation is to remove the well pump and examine the well. After pumps are removed, wells should be televised (video inspected) to observe the integrity of the well and the current depth. The video inspection would help determine the appropriate mechanical or chemical treatment to be performed.

Wells containing sediment should be bailed, then developed by pumping and surging using the well contractor's pump. If a well is fouled with iron bacteria, the well and pumping equipment should be cleaned and sanitized using both mechanical and chemical methods. The cleaning method should include a series of chemical treatments chosen to be most effective for the type of incrustation and/or iron bacteria found in the well and/or on the pumping equipment. If a well shows evidence of biofouling, it should be rehabilitated using well cleaners and super-chlorination. Jetting and high pressure air bursts are effective methods for uniform placement of cleaner and chlorine in a well.

If a well shows evidence of plugging from carbonate incrustation, it should be brushed and washed with an acid solution. Inhibitors and antifoam agents should be used; the work should be performed by trained contractors. Solutions pumped from the well should be neutralized prior to disposal. If a well has a collapsed screen, it may be possible to extract the old inner casing and well screen and install new inner casing and screen, depending on the original construction of the well. If an open borehole has collapsed, it may be possible to re-drill and develop the borehole. Each well must be evaluated on a case-by-case basis to decide the best course of action.

Specific Recommendations

Table 4-3 lists known inactive DoD wells and potential action to rehabilitate the well.

The Tumon Maui and Marbo #2 wells require modification to the VOC treatment system. These wells are part of the Andersen AFB water system. Rehabilitation is not recommended to support the USMC relocation. The DoD may consider supporting rehabilitation of the Tumon Maui and Marbo #2 wells to support off-base demands during the relocation period.

Table 4-3: Inactive DoD Wells Potential Action

Inactive Supply	Capacity (gpm)	Reason	Potential Action
Air Force			
Marbo #2	320	VOC Contamination	Modify treatment system
Tumon Maui	900	VOC Contamination	Connect wells to NIW system
Navy			
NRMC #2	200	Biological Contamination	Maintenance
NRMC #3	178	High Chloride Levels	Maintenance
NCTS A	180	High Chloride Levels	Abandon
NCTS #2	225	Structure/mechanical	Maintenance
NCTS #3	50	Structure/mechanical	Navy replacing well
NCTS #5	100	High Chloride Levels	Abandon
NCTS #8	200	Structure/mechanical	Navy replacing well

Navy Regional Medical Clinic (NRMC) #2 and NRMC #3 at the Naval Hospital should be studied to reduce coliform/chloride levels using the general recommendations provided above.

Rehabilitation or replacement of NCTS #2 is not recommended given the limited available yield in the Finegayan subbasin. For costing, it is assumed that the well is replaced.

The Navy is abandoning NCTS A and NCTS #5.

The Navy is replacing NCTS #3 and NCTS #8.

Additional Navy wells may need to be relocated to permit construction of the base and associated road-widening.

Aquifer monitoring

Installation of monitoring wells for long-term maintenance of the NGLA is recommended as part of this option on Navy Barrigada, Naval Hospital, the USMC Finegayan base, and Andersen South Annex.

4.2.2 Costs

Details of the cost estimate are provided in Appendix C.

The capital costs for Option 2 are:

Costs ($000)	Option 2
Capital Costs	
1) Water Resources Development	$3,187
2) Water Treatment	$394
3) Distribution	$2,624
Total Construction Cost	$6,205
Contingencies (20%)	$1,241
Engineering (15%)	$931
Total Capital Cost	$8,377
Present Worth Guam Capital Costs	$8,443

The O&M costs for Option 2 are:

Costs ($000)	Option 2
Annual O&M Costs	
1) Water Resources Development	$92
2) Water Treatment	$175
3) Distribution	$683
Total Annual O&M Cost	$950
Contingency (20%)	$190
Total Annual O&M Cost	$1,140
Annual O&M Cost for Guam	$1,140
Present Worth of O&M Costs (25 year life)	$27,200

The total present worth of life cycle costs for Option 2 is $36 million.

4.3 OPTION 3 – PURCHASE WATER FROM GWA

This alternative includes obtaining water with GWA either by purchasing water or through exchanging water through metered interconnections between GWA and DoD water systems. As shown in Section 3.5, the GWA water system has no excess water available for transfer to the DoD to support the USMC relocation. An interconnect is proposed to provide water to GWA from the USMC Finegayan base water supply.

A connection would be made to the GWA system near the border of Andersen AFB and USMC Finegayan base. A flow meter installed in a vault near the connection to the GWA system. An air gap would be provided to prevent backflow into the GWA system. If GWA provides water to the DoD in the future, it is assumed that the additional supply from GWA would be in place of water supply developed by the DoD. Therefore, the DoD storage capacity would not need to increase to meet the supply provided by GWA.

Details of the cost estimate are provided in Appendix C.

The capital costs for Option 3 are:

Costs ($000)	Option 3
Capital Costs	
1) Water Resources Development	$0
2) Water Treatment	$0
3) Distribution	$1,642
Total Construction Cost	$1,642
Contingencies (20%)	$328
Engineering (15%)	$246
Total Capital Cost	$2,217
Present Worth Guam Capital Costs	$2,235

There are no O&M costs for Option 3.

The total present worth of life cycle costs for Option 3 is $2.2 million.

4.4 INTERIM ALTERNATIVE

Estimated breakpoint years for the DoD water systems are shown in Table 4-4. Additional supply would be required at the USMC Finegayan base and in the Navy island-wide system during the relocation. For potable water, no distinction is made between interim and long-term alternatives. It is assumed that 10 wells on Andersen AFB would be installed to meet the interim DoD demand with housing on the USMC Finegayan base only. It is assumed that rehabilitation of Navy wells and use of the groundwater resources developed for the USMC Finegayan base would address the additional water needs for the Navy.

Table 4-4: Estimated Breakpoint Years for DoD Water System

Location	Breakpoint Year (UFC demand estimate)	Breakpoint Year (Incorporating Sustainability Measures)
Andersen AFB	2019	—
Navy Bases (including USMC Finegayan, excluding water transferred to GWA)	2011	2011
DoD Combined Resources	2011	2014

5. Recommendations and Conclusions

To accommodate the USMC relocation and meet other DoD requirements, the recommended water system includes all elements of Option 1, Option 2, and Option 3.

Option 1 alone provides sufficient water to meet the USMC relocation water demands. This option also includes improvements to the Navy island-wide water system and interconnections with the Andersen AFB water system to meet USMC demands throughout Guam.

Option 2 provides water supply to meet the estimated water demand for other DoD requirements. This option is recommended because implementation would provide additional supply to the naval facilities.

Option 3 is recommended because it would allow transfer of water from the DoD water system to GWA to meet the added demand from an induced population and civilian military workers resulting from the USMC relocation.

The components of this water system are listed in Table 5-1. Figure 5-1 shows the elements of the recommended alternative.

Table 5-1: Proposed Water System Components

Component	Description
Water Supply	• Development of up to 22 new water supply wells (including one contingency well) on Andersen AFB • Use of five recently installed wells at Andersen AFB • Continued use of existing Navy wells on the USMC Finegayan base • Rehabilitation of Navy wells
Water Treatment	• Disinfection and fluorination prior to transmission to the new base from the 22 new water supply wells on Andersen AFB
Water Storage	• Construction of new storage tanks on the USMC Finegayan base • Abandonment of existing Navy storage tanks on the USMC Finegayan base
Distribution System	• Waterlines to transport the water from supply wells to the ground level storage tank on USMC Finegayan base • Waterlines to distribute water throughout the USMC Finegayan base • An interconnect with the Navy's island-wide water system • Improvements to the Navy's island-wide water system (i.e., size pipes appropriately, replace corroded pipes, transport water to the south as well as north) • Replace water mains connecting existing Navy wells to the water system • Connections to the Air Force water system • A connection to the GWA water system

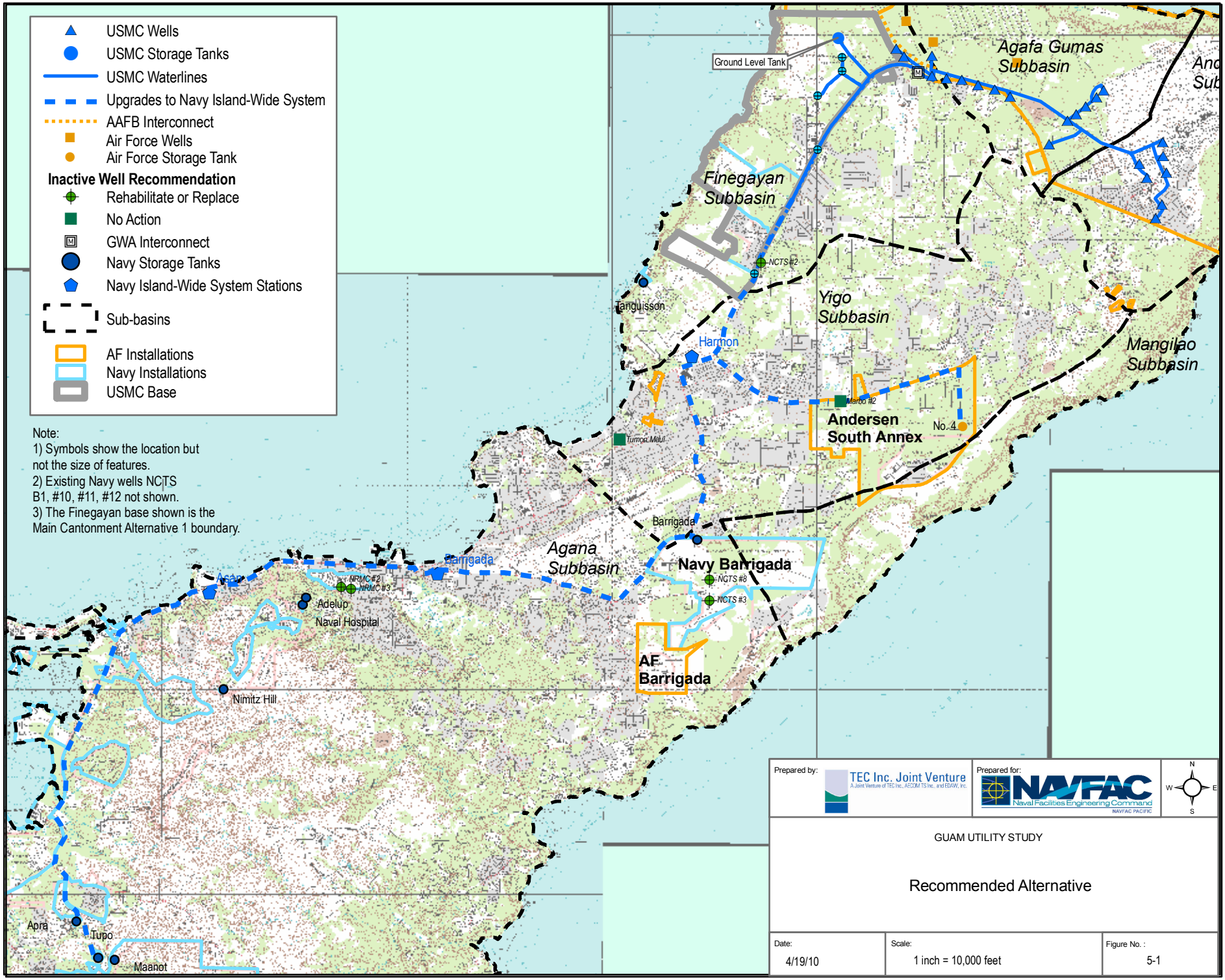
Costs for the proposed water system are presented in Table 5-2. The total present worth capital cost is $409 million. The total present worth O&M cost is $188 million assuming a 25 year life. The total present worth of life cycle costs for the recommended water system is $597 million.

ATS anticipates that implementation of the recommended water system would require about 12 to 18 months to design, 5 to 6 months to bid and award, and 25 to 30 months to construct the water supply facilities. It is assumed that the regulatory agency permitting work would be done concurrently with the design. Therefore, the total time required is approximately 5 years. Scheduling and planning the water system improvements would be important so drinking water and fire protection water would be available when and where it is needed. Prior to constructing any water system improvements, detailed water system master planning and hydraulic modeling would be

necessary. Master planning and modeling would assure that the water improvements are in the right location and of the right size for the proposed developments.

Table 5-2: Cost Summary for Proposed Water System

	Cost ($000)
Capital Costs	
1) Water Resources Development	$23,936
2) Water Treatment	$3,001
3) Distribution	$273,637
Total Construction Cost	$300,575
Contingencies (20%)	$60,115
Engineering (15%)	$45,086
Total Capital Cost	$405,776
Present Worth Guam Capital Costs	$408,959
Annual O&M Costs	
1) Water Resources Development	$402
2) Water Treatment	$1,941
3) Distribution	$4,236
Total Annual O&M Cost	$6,578
Contingency (20%)	$1,316
Total Annual O&M Cost	$7,894
Annual O&M Cost for Guam	$7,894
Present Worth of O&M Costs (25 year life)	$188,396
Present Worth of Total Costs	$597,355


USMC Wells
USMC Storage Tanks
USMC Waterlines
Upgrades to Navy Island-Wide System
AAFB Interconnect
Air Force Wells
Air Force Storage Tank
Inactive Well Recommendation
Rehabilitate or Replace
No Action
GWA Interconnect
Navy Storage Tanks
Navy Island-Wide System Stations
Sub-basins
AF Installations
Navy Installations
USMC Base
Note:
1) Symbols show the location but not the size of features.
2) Existing Navy wells NCTS B1, #10, #11, #12 not shown.
3) The Finegayan base shown is the Main Cantonment Alternative 1 boundary.
Ground Level Tank
Agafa Gumas Subbasin
Finegayan Subbasin
NCTS #2
Yigo Subbasin
Tanguisson
Harmon
Mangilao Subbasin
Marbo #2
Andersen South Annex
No. 4
Tumon Maui
Barrigada
Agana Subbasin
Navy Barrigada
NCTS #8
NCTS #3
AF Barrigada
Asan
Barrigada
NRMC #2
NRMC #3
Adelup
Naval Hospital
Nimitz Hill
Apra
Tupo
Maanot
Prepared by:
TEC Inc. Joint Venture
Prepared for:
NAVFAC
Naval Facilities Engineering Command
NAVFAC PACIFIC
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GUAM UTILITY STUDY
Recommended Alternative
Date:
4/19/10
Scale:
1 inch = 10,000 feet
Figure No. :
5-1

6. References

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Appendix A
Scope of Work

The basic Statement of Architect-Engineer Services of 12 May 2006 is amended as follows:

SCOPE OF WORK
WATER UTILITY STUDY TO SUPPORT EIS MC RELOCATION

Ref: (a) "Water, Wastewater, and Solid Waste Management Impact Assessment for JGMMP, Guam. June 14, 2006. Final Report"
(b) FY03 MCAF (AJJY023103) Replace Off-Base Water Supply System Andersen Air Force Base, Guam. July 31, 2003
(c) Volume II, Civil Utility Systems Report for Utility Study for Military Construction Program Projects, Andersen Air Force Base, Guam. May 2006.
(d) Utility Technical Study of the Potable Water Systems, PWC Guam. Jan 2005.
(e) Draft USMC Guam Master Plan, Concept of Operations and Facility Requirements, March 2007
(f) UFC 3-230-19n Water Supply Systems
(g) UFC 3-600-01 Fire Protection Engineering for Facilities
(h) UFC 3-230-02, Operation and Maintenance: Water Supply Systems, July 2001
(i) Northern Guam Lens Study, Groundwater Management Program, Aquifer Yield Report, Camp Dresser & McKee Inc. in association with Barrett, Harris & Associates, Dec 1982, GEPA
(j) Groundwater in Northern Guam: Sustainable Yield and Groundwater Development, Barrett Consulting with J. F. Mink, 1991, PUAG
(k) Surface Water Development Study, Barrett Consulting Group, 1994, PUAG.
(l) Analysis of the Dynamic Response of the Northern Guam Lens Aquifer to Sea Level Change and Recharge, Wuerch, Cruz, and Olsen, Nov 2007.
(m) E-mail, D. Loo, NAVFACPAC EV1 / R. Cababa, Earth Tech, Inc, of 8 Oct 2008

Encl: (1) SPE Water System Options Matrix, 8 March 2007

1. Introduction. The Guam Integrated Military Development Plan (GIMDP), formerly the Joint Guam Military Master Plan (JGMMP), provides the planned increase in military population on Guam. NCTC Finegayan, South Finegayan Housing area, Andersen Air Force Base (AAFB), AAFB Northwest Field, and AAFB South bear the brunt of the military personnel increase on Guam. Potable water for these bases is currently provided by separate Navy and Air Force water systems.

The U.S and Japan agreement involves in part the Special Purpose Entity (SPE), which was conceived as a business venture for the Japanese to provide family housing and utilities for the Marine relocations. Like a public and private venture, the Japanese would recoup their

investments and expenditures through housing leases and utilities service charges to U.S. Although very few details are known about the SPE, the construction of new wells and construction of a water treatment plant on DoD property is being considered by the SPE.

This engineering study will identify all reasonable alternatives for water system improvements to support the USMC relocation on Guam as well as supporting other existing and known future DoD requirements.

2. General Work Requirements. The A/E shall participate in meetings at NAVFAC Marianas, Andersen Air Force Base, Guam Environmental protection agency, and Guam Water Authority. These meetings may involve briefings to the Commanding Officer of NAVFAC Marianas and the Public Works Officer at AAFB or their designated representatives and personnel on the work to be performed. Upon completion of the field work, exit briefings shall be provided to the NAVFAC Marianas on the findings and recommendations that are known at the time of the out-brief.

All present and future potable water demands shall be based on Alternative 1 developed in reference (a), with modifications as necessary to reflect the latest master plans (reference (e)). References (b) and (c) contain pertinent information on the Andersen AFB water systems. Reference (d) contains pertinent information on the Navy water systems. All new water facilities improvements shall be based on design guidance criteria established in references (f), (g) and (h). The A-E should consult with NAVFAC Pacific Base Development for any future planning issues related to the military bases in Northern Guam. References (i), (j) and (k) provide information on groundwater and surface water resources on Guam.

This Study will determine what is needed to upgrade and integrate the DoD water systems to meet the future Marine Corps and other DoD water demands and to meet future regulatory requirements. This Study will evaluate alternative water resource options as needed to meet the future DoD water demands. This Study will develop planning documents for projects that represent the best value alternative water system improvements that will enable the DoD water systems on Guam to meet all future DoD potable water requirements.

3. Scope of Work.

(a) Evaluate and recommend water resource, water distribution, storage and treatment system improvements to Navy and Air Force water systems to meet future DoD requirements. Reference (a) recommendations may be used as a starting point. Enclosure (1) provides a subjective evaluation of potential alternative water resources that will be considered. Other more viable alternatives not included in enclosure (1) shall be considered.

(1) The following alternative water resources, identified in enclosure (1), shall be evaluated:

(A) Optimize groundwater resource development within DoD property while considering the potential impacts to neighboring wells, the estimated remaining sustainable yield, the maximum safe pumping rate from individual wells to avoid salt water intrusion and excessive draw-down, and the quality of the groundwater. For each proposed new well specify the location, diameter, depth, and production rate.

(B) Determine requirements for rehabilitation, treatment of well water, or replacement of existing wells not currently in production due to contamination, structural, and/or mechanical problems.

(C) Trade/Buy water from GWA. Establish the quantity of potable water that GWA would be agreeable to trading or selling to DoD. This quantity will determine the amount of water needed from other resources alternatives.

(D) Sediment dredging at Navy reservoir.

(E) Expand Navy reservoir storage capacity by raising the dam crest.

(F) Potable reclamation through effluent reuse. If selected as a wastewater alternative, it would reduce requirements from groundwater resources.

(G) Non-Potable reclamation through effluent reuse. If selected as a wastewater alternative, it would reduce requirements from groundwater resources.

(H) Desalination.

(I) Develop new surface water source

(2) A preliminary evaluation of the above alternatives shall be completed in order to select the most viable options for more detailed analysis in this study and for inclusion in the EIS. The results of this evaluation shall be presented to DoD representatives as a point paper per section 4 (a).

(b) Utilize information on existing Navy and Air Force water system infrastructure from previous studies, plan files and other records.

(c) Conduct field investigations and gather information on key existing water system infrastructure and site conditions for any proposed water system improvements.

(d) Gather information on Northern Guam Aquifer conditions from recent studies/reports and via interviews with GOVGUAM, USGS, and/or Water and Environmental Research Institute of the Western Pacific (WERI) personnel in order to determine available aquifer capacity on DOD property.

(e) Coordinate access to DOD facilities as needed via the appointed Station point of contact.

(f) Provide a comparative analysis of the alternatives based on life cycle costs and overall viability.

(g) Project documentation shall be of sufficient detail for the SPE to plan, design, and execute recommended water system improvement projects.

(h) Prepare an engineering report detailing the field work performed, plans, all pertinent data, and evaluation process.

(i) Computer Models. Utilize water system computer models as needed to ensure that the integrated DOD water system with proposed improvements is able to meet projected requirements. The integrated water system computer model shall be based on models developed for Navy and Air Force water systems in references (a) through (d). It is not the intention of this project to identify hydraulic deficiencies in existing water systems at Andersen AFB or existing Navy water systems with the exception that certain upgrades may be needed to store/transport the source water to new development areas. WaterCad V5.0 or compatible software shall be used for water system modeling and compatible data files shall be submitted upon request.

(j) Revision 1: Description additional effort and associated direct costs for the following work items that were not considered part of the original negotiated effort:

(1) Respond to late comments on the February 2008 (a) report submittal.

(2) Change all loading information and proposed project improvements based only on "AIP" loading. Loading shall be consistent with other utility reports.

(3) Submit a final report that incorporates, as appropriate, responses to all comments and load changes as described in 1.1 and 1.2.

(4) Expand on the discussions and analysis of the desalination alternative to address the use of brackish water sources. The analysis shall be similar in detail to the analysis of options 1 and 2 and will include the following:

A. Identification of likely areas in the northern Guam aquifer, preferably within DoD land, but not limited to DoD land, that may have suitable quantities of brackish water. Potential brackish water well locations would likely be near the outer edges of the freshwater aquifers to minimize damage caused by salt water intrusion that would result from pumping from the brackish water zones. It is also probable that fissures or other underground pathways that allow fresh water to discharge into the ocean may be found near the coastline and may be exploited with shallow or horizontal wells. **Reference (b) may be useful in**

identifying such areas. The study will also identify likely locations were "brine" water can be safely disposed underground or in ocean outfalls.

B. Development of planning level capital and life cycle costs for a desalination plant to treat brackish water within the range anticipated, and identify regulatory requirements and how those requirements would be met.

C. Provision of a scope of effort and cost estimate to conduct pilot studies to verify the best locations for brackish water wells and to estimate the quantity and quality of the brackish water supplies. The pilot study will also provide specific site locations for the plant site and appurtenant water system components.

D. This option shall be viewed as a stand alone water resource option in lieu of new well developments to meet AIP and existing DoD water demands. The brackish water desalination plant and source wells shall be designed to meet AIP water demands

(5) Submit an addendum or letter report containing the expanded discussions on desalination of brackish water sources described in 1.4.

(k) Revision 2: Per reference (m) this Amendment adds the cost of developing the Lost River to the preferred water supply alternative described in Reference (b). The revised costs will be used to develop a defensible "DoD-wide solution" for water to present to the Government of Japan for SPE funding. The data will also be used to update the Business Case Analysis. Description additional effort and associated direct costs for the following work items that were not considered part of the original negotiated effort:

(1) Add capital cost and O&M cost for Lost River (separate line item in cost estimate so can compare new cost estimate to old cost estimate)
(2) Use same cost element breakout as Appendix C, Option 1 and 2 of the Water report
(3) Show cost in present year values.
(4) At bottom of table indicate all funds needed in 2010 (because breakpoint is in 2012 and presume design-build takes two years).
(5) Indicate for each cost element if the improvement is a new DoD asset or existing DoD asset. Then at bottom of table, indicate subtotals for "new DoD assets" and for "existing DoD assets".
(6) Show USMC proportion based on loading.

(l) Revision 3: The purpose of this revision to Amendment 15 is to update the Water Utility Study to support the DEIS consistent with the utilities alternatives presented, including all of the items covered in the summary letter reports and applicable supporting studies. The following updates shall be reflected in this revision to the Water Utility Study:

(1) References to the NGLA sustainable yield verification report from UOG/WERI.

(2) LEED initiatives and deviations from UFC will be explained and justified consistently with the water letter report and the DEIS.

(3) Revised population and demands. Utility demands will be based on master plan information included in the DEIS

(4) The water well locations will be indicated on a map consistent with what is in the DEIS.

(5) Revised analyses, including demand calculations, will be provided in the appendices with summary results shown in the body of the report along with justifications. These results shall match the DEIS numbers.

4. Schedule and Submittals. The schedule for submittals and the number of copies to be provided shall be as follows:

(a) Interim Delivery Order: Point paper that summarizes preliminary evaluations of the options described in section 3(a)(1) and identifies the most viable options. Electronic copy to be submitted 45 days after award, but not later than 31 July 2007.

(b) Draft Report: Sixteen (16) hard copies 120 days after award, but not later than 30 November 2007..

(c) Revision 1: Final Report: Sixteen (16) hard copies and five (6) electronic copies on CDR by 14 July 2008. Electronic files shall include the computer model data files, AutoCAD compatible files of the water system maps, MS Office 2003 or compatible files for the main report, and complete report in pdf format.

(d) Revision 1: Final Report 30 days after GOJ comment period on submittal (c): Sixteen (16) hard copies and five (6) electronic copies on CDR**.** Electronic files shall include the computer model data files, AutoCAD compatible files of the water system maps, MS Office 2003 or compatible files for the main report, and complete report in pdf format.

(e) Revision 1: Project Completion. The project shall be completed by 30 September 2008.

(f) Revision 2: Submit a Final Letter Report in electronic format (pdf), by 30 September 2009.

(g) Revision 2: Project Completion. The project shall be completed by 30 September 2009

(h) Revion 3: Prefinal report shall include 5 hard copies and a pdf delivered electronically, by xxxxxx.

(i) Revision 3: Final report shall include 5 hard copies and 5 CDRs, including pdf and native electronic files, by xxxxxx.

5. Special Requirements.

(a) Station Liaison. Station personnel shall be apprised of all aspects of any work done on his Station. The PDE and/or a NAVFAC PAC representative will do all of the initial contacts and will participate in the initial briefings on the Station. However, A-E personnel will be working alone at the Station during most of the extended data gathering effort. Thus, the A-E, as a NAVFAC PAC Contractor, must maintain any necessary liaisons so that the Station is fully apprised on changes in the A-E's work or schedules and that there are no surprises to the Station resulting from the A-E's work on the Station.

(b) Station Regulations. All Station regulations must be followed. However, if access to restricted areas is needed, the A-E shall request assistance from the Station personnel in arranging for such access.

(c) Following award of this authorization the A-E shall prepare a proposed schedule of work per paragraph 8(a).

(d) Upon arrival at the Station the A E shall participate in meetings with Station personnel. These meetings may include:

(1) Briefing(s) to the Commanding Officer or his designated representative on work to be done on the Station and the schedule of such work.

(2) Briefing(s) to other Station personnel. Same information as above. At this briefings, the A-E will receive information on Station regulations, support, etc. which will apply to his work on the Facility.

(e) Upon completion of the fieldwork, the A-E shall provide an out brief to the Commanding Officer or his designated representative on findings and recommendations so far as is known at the time of the out brief. The PDE may not be present at this briefing.

6. Government Support and Services.

(a) The PDE and/or a NAVFAC PAC representative will participate in the initial meeting at the Station and assist the A-E in making initial contacts.

(b) The Plan Files and other records both at NAVFAC PAC and at the Station may be made available to the A-E. Government representative will indicate the general location of the information needed. The A-E will be responsible for the actual search through the files. Reproduction machines will be made available to the A-E for making copies of needed drawings and documents at Station facilities. The A-E will be given a Point Of Contact at the Station. The A-E will be responsible for establishing an account with the Station POC to compensate them for minor expenses incurred for reproduction and related costs. The Government will advise the A-E on the estimated amount for this account.

7. NAVFAC PAC Briefing. After the final submittal, the A-E shall brief NAVFAC PAC personnel of his findings and recommendations.

8. Project Management.

(a) Project Contract Specialist (PCS). The PCS assigned to this project is Ms. Valerie Mito (ACQ12), telephone (808) 471-7130, e-mail address <Valerie.mito@navy.mil>.

(b) Contracting Officers' Representative (COR). The COR assigned to this contract is Ms. **Connie Chang** (EV21) telephone (808) 472-**1395**, or e-mail address <**connie.chang**@navy.mil>. The COR will coordinate all technical matters of the contract. Keep the COR informed of contract/amendment progress and problems involved.

(c) Navy Technical Representative (NTR). The NTR that will serve as the technical representative, for this project is Mr. Kevin Oshiro (EV11) telephone (808) 472-1390, facsimile number (808) 474-5419, or e-mail address <kevin.oshiro@navy.mil>. All contacts and conferences concerning this work shall be made through the NTR. Minutes of all meetings shall be prepared by the PSC and submitted to the NTR. The PSC shall designate an individual who will be directly responsible for, and to be contacted on all matters pertaining to this project. Direct contact with other departments within NAVFAC Pacific or other commands and/or military activities may be made by the PSC only with prior notification and approval by the NTR.

Appendix B
Water Resource Option Review

5. Review of Water System Alternatives

5.1 OPTION 1 - OPTIMIZE GROUNDWATER RESOURCE DEVELOPMENT WITHIN DOD PROPERTY

5.1.1 Description

Option 1 includes the development of groundwater wells drawing water from the Guam Northern Lens Aquifer in the Navy water system and the AAFB water system. Since all the three water systems in the northern part of Guam draw water from the same aquifer with a limited sustainable yield, the development of this alternative to include new production wells must consider the impacts from wells pumping in adjacent areas and proposed additional well production from GWA. The impacts include potential salt water intrusion problems, excessive drawdown in the aquifer, and other related water quality problems. This alternative includes use of the existing Navy wells at Finegayan which produce up to 1.5 MGD (see Table 2-1). The USMC water system will be connected with both the Air Force and Navy Island-wide system to allow flexibility to meet water demands on the DoD bases in Northern Guam if housing is shifted away from the Finegayan Base Complex and in emergencies.

At present, GEPA, GWA, Water and Environmental Research Institute of the Western Pacific University of Guam, the University of North Carolina, and the DoD are negotiating a long-term study on the aquifer to determine susceptibility of the aquifer to surface water contamination. For this study, all water extracted from the Northern Lens Aquifer will be considered GWUDI, with the groundwater consolidated and treated to meet drinking water standards.

The increased water supply from implementation of Option 1 will primarily support the USMC relocation. However, Army service members will be housed at the Finegayan Base Complex, requiring approximately 9 percent of the total demand.

5.1.2 Viability

The development and implementation of this alternative can be managed by DoD, avoiding uncertainties in timely implementation through direct management. GWA currently operates 119 wells tapping the same aquifer. Coordination with GWA is important in the development of new productions wells in the DoD areas to avoid negative impacts due to over-pumping of the aquifer. Also, GWA is considering installing wells adjacent to the AAFB which could draw water away from proposed wells on DoD property.

The freshwater lens aquifer is segregated into six distinct and hydrologically separate sub-basins on the northern portion of the island. The primary sub-basin used for groundwater extraction by the Navy, Finegayan Sub-basin, is near its maximum sustainable yield. As such, water supplies for the USMC relocation would have to come from another source. Alternatively, the sub-basin being tapped by AAFB still appears to have sustainable yield available before reaching capacity. The AAFB has recently drilled five new wells in the northwest field, which are not yet on line due to problems in the construction of the water reservoir. These wells will have a positive impact on DoD water supply, once the system is operational. Based on review of the sustainable yield and current pumping capacity for existing wells, the water supply obtained from within DoD properties can meet the projected USMC demand.

5.2 OPTION 2 - DETERMINE THE REQUIREMENTS FOR REHABILITATION, TREATMENT OF WELL WATER OR REPLACEMENT OF EXISTING WELLS NOT CURRENTLY IN OPERATION

5.2.1 Description

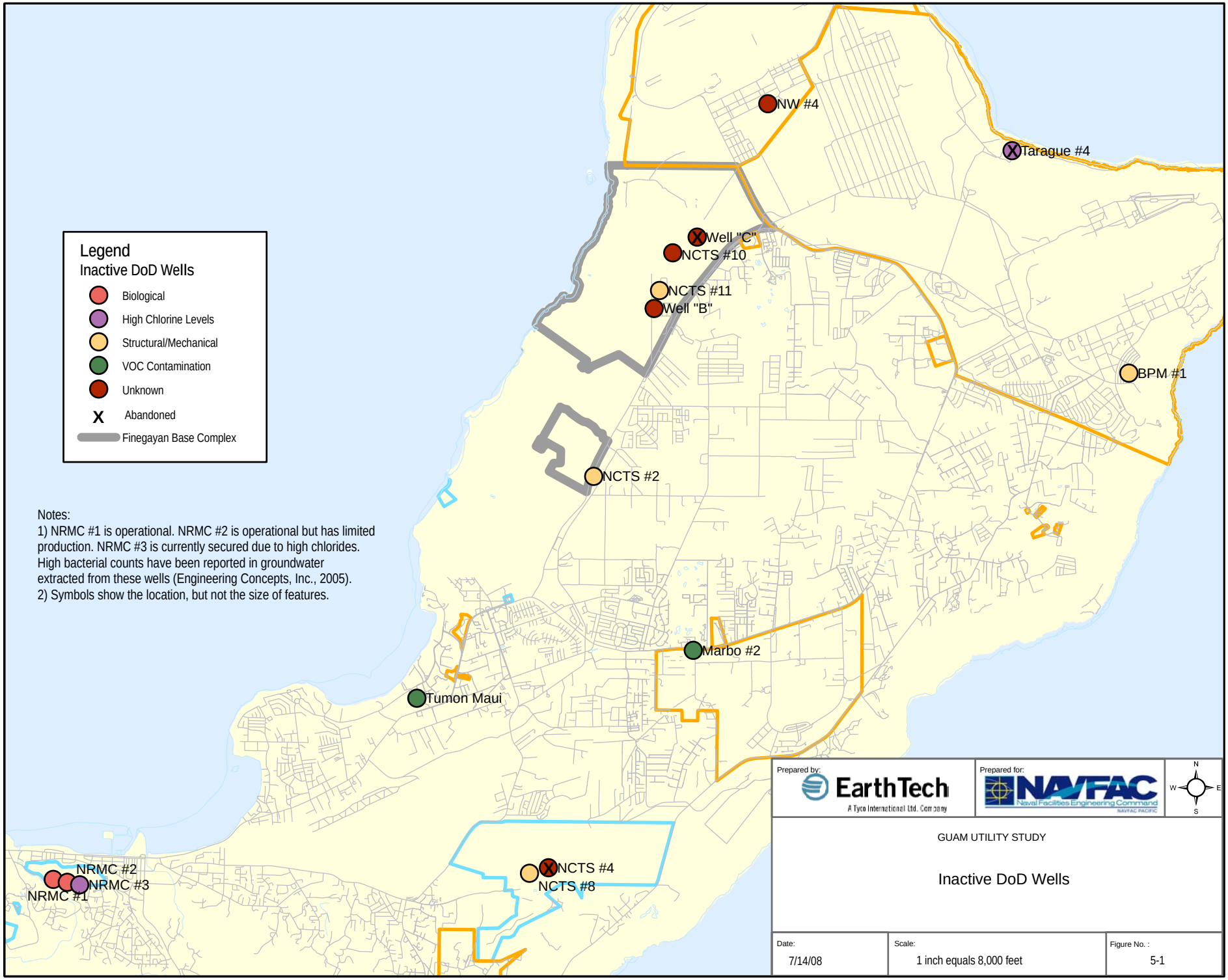
Option 2 includes the development of non-operational and underperforming existing groundwater wells drawing water from the Northern Guam Lens Aquifer in the Navy water system and the AAFB water system. Since all the three water systems in the northern part of Guam draw water from the same aquifer with a limited sustainable yield, similar to the first alternative, the development of this alternative to include rehabilitation or replacement of existing production wells also considers the impacts from wells pumping in adjacent areas. These impacts would include potential salt water intrusion problems, excessive drawdown in the aquifer and other related water quality problems. Table 5-1 provides a list of the inactive DoD wells (see also Figure 5-1). Successful rehabilitation or replacement of the inactive wells would result in approximately an additional 4 MGD if there is adequate available yield in the aquifers.

It is anticipated that the water supply from implementation of Option 1 will meet the demands of the USMC relocation. Implementation of Option 2 will provide additional supply for other DoD requirements.

Table 5-1: Inactive DoD Wells

Owner	Well	Pumping Rate (gpm)[a]	Note
VOC Contamination			
Air Force	Marbo #2	320	The pumping rate was not provided. For this assessment, the highest pumping rate from the active Marbo Wells was assumed.
Air Force	Tumon Maui	900	
Biological Contamination			
Navy	NRMC #1	234	Fully operational. According to the 2005 UTS, well has been turned off at times due to biological contamination.
Navy	NRMC #2	200	Operational but production is limited. According to the 2005 UTS, the well has been turned off at times due to biological contamination.
High Chloride Levels			
Navy	NRMC #3	178	Secured due to high chlorides. According to the 2005 UTS, the well has also been turned off at times due to biological contamination.
Structural/Mechanical			
Navy	NCTS #2	225	Not operational due to collapsed screens
Navy	NCTS #8	200	Not operational due to collapsed screens
Permanently Inactive			
Air Force	Tarague #4	NA	High chloride, not in use since 1977.
Air Force	BPM #1	NA	Well not discussed in the 2006 Civil Utility Report.
Air Force	NW #4	NA	AF drawing identified the well as abandoned.
Navy	NCTS #4	~200	These wells are identified in the Navy CADD drawing but are not discussed in the 2005 UTS study. Assumed to be abandoned.
Navy	Well C	~200	

Notes:
NA not applicable
[a] Navy pumping rates are measured or calculated values from Navy Utility Report, 2005 and the Air Force rates are measured values from AAFB Utility Report, May 2006 and Hawaii Pacific Engineers (HPE) 2003.


Legend
Inactive DoD Wells
Biological
High Chlorine Levels
Structural/Mechanical
VOC Contamination
Unknown
Abandoned
Finegayan Base Complex
Notes:
1) NRMC #1 is operational. NRMC #2 is operational but has limited production. NRMC #3 is currently secured due to high chlorides. High bacterial counts have been reported in groundwater extracted from these wells (Engineering Concepts, Inc., 2005).
2) Symbols show the location, but not the size of features.
NW #4
Tarague #4
Well "C"
NCTS #10
NCTS #11
Well "B"
BPM #1
NCTS #2
Marbo #2
Tumon Maui
NRMC #2
NRMC #3
NRMC #1
NCTS #4
NCTS #8
Prepared by:
EarthTech
A Tyco International Ltd. Company
Prepared for:
NAVFAC
Naval Facilities Engineering Command
NAVFAC PACIFIC
N
W
E
S
GUAM UTILITY STUDY
Inactive DoD Wells
Date:
7/14/08
Scale:
1 inch equals 8,000 feet
Figure No. :
5-1

5.2.2 Viability

This alternative has the potential to add to the reliability of a DoD water supply. The development and implementation of this alternative could be managed by DoD avoiding uncertainties in timely implementation through direct and proper management. Coordination with GWA is important in the development of new productions wells in the DoD areas to avoid negative impacts due to over-pumping. As discussed in Section 4.1, GWUDI will be considered to be applicable for this alternative and future planning efforts need to assume that treatment of extracted groundwater will be required.

This option is examined in detail in Section 6.3 of this report.

5.3 OPTION 3 - PURCHASE WATER FROM GWA

5.3.1 Description

This alternative includes obtaining water from GWA either by purchasing water or through exchanging water through metered interconnections between GWA and DoD water systems. There are several existing connections between the GWA and Navy water systems, although given the information currently available, none of these connections will be sufficient to supply a significant portion of the demand in the northern region without construction. The implementation of this alternative would include establishing or upgrading metered connections between the GWA and DoD water systems.

The increased water supply from implementation of Option 3 would support the USMC relocation and other DoD requirements.

5.3.2 Viability

Since the Northern Public Water System operated by GWA has an elaborate water supply system in Northern Guam with 119 well drawing water from the Guam Northern Lens Aquifer, this alternative could be considered to supplement Options 1 and 2. Additionally, this alternative could potentially result in energy cost savings by reducing the cross-island pumping of large quantities of water through the existing parallel water mains running from the north to the south.

5.4 OPTION 4 – SEDIMENT DREDGING AT THE NAVY RESERVOIR

The Navy Reservoir, located in the southern portion of Guam, is a primary source of potable water for the island and was created through impoundment of the Fena River valley by a dam. The Navy Reservoir Dam, constructed by the Navy and completed in 1951, is a zoned earth and rockfill embankment with a maximum height of 85 ft above original grade. The entire watershed impounded by the dam covers an area of 5.88 mi^2 of moderately to steeply sloped lands, and soil within the watershed is predominantly clay of volcanic origin. The slopes and soil type both contribute to rapid runoff rates and significant erosion, particularly in areas where the native vegetation has been removed. Eroded soil is ultimately transported to the reservoir itself by the runoff, and contributes to ongoing reduction of reservoir capacity due to sedimentation.

5.4.1 Description

Relevant studies investigating the reservoir in depth include “Utility Technical Study of the Potable Water Systems, PWC Guam” (Engineering Concepts, Inc. 2005) and “Maintenance Dredging Study” (Engineering Management & Planning Services Corporation [EMPSCO] 2006). The information presented for this option is primarily based on these two studies.

The utility technical study evaluated the water supply system for Guam's naval installations as a whole, and included investigations of the condition and capacity of all potable water sources, and treatment and distribution systems for naval facilities. As such, it was not focused solely on the Navy Reservoir, and did not include a specific investigation of the reservoir itself. Instead, it relied on surveys conducted by others to evaluate conditions in the reservoir.

The maintenance dredging study was focused solely on the Navy Reservoir and included reviews of prior surveys of the reservoir, as well as a new bathymetric survey conducted in 2005 for the study. Specifically, the maintenance dredging study references the pre-construction survey conducted 1949, as well as other surveys conducted in 1973, 1979, and 1990. For the new survey conducted specifically for the maintenance dredging study, the survey area was limited to a 60-acre area near the dam.

The controlling hydraulic structures that establish the maximum water elevation and minimum usable water elevations in the reservoir are the spillway and outlet structures. The spillway, which establishes the maximum water elevation in the reservoir, is a curved 179-ft long flat-crested sill at an elevation of 111.35 ft above mean lower low water (MLLW). The outlet, which establishes the lowest elevation of usable storage, consists of an intake structure at an elevation of 66.02 ft MLLW (Engineering Concepts 2005).

At full stage (i.e., a water elevation in the reservoir of 111.35 ft MLLW), the reservoir covers an area of 197 acres (roughly 0.31 mi^2) and impounds approximately 7,180 ac-ft of water, according to bathymetry collected in 1990. Approximately 6,400 ac-ft of the total impoundment is usable capacity (i.e., water stored above the outlet structure). However, both the total impoundment and usable capacity are constantly being reduced due to sedimentation within the reservoir, and the current storage capacities are not explicitly known.

5.4.1.1 Analysis of Available Bathymetric Data

In its summary of prior surveys, the maintenance dredging study notes that the anticipated total impoundment of the reservoir, based on the 1949 pre-construction survey, was 8,300 ac-ft. No estimate of the usable capacity of the reservoir was presented. The 1973 survey reported a total capacity of 7,500 ac-ft, with no estimate of the usable storage presented. The 1979 survey purportedly shows a total capacity of 7,860 ac-ft. No usable capacity estimate from the 1979 survey is identified, and the maintenance dredging study indicates that unrevised stage-capacity curves from the 1949 and 1973 surveys are presented in the report for the 1979 survey. The 1990 survey is reported to show a total capacity of about 7,180 ac-ft, of which 6,400 ac-ft is usable capacity. The storage capacity identified in the 1973 survey appears anomalous when compared to the 1979 and 1990 survey results. According to the maintenance dredging study, the 1973 survey used updated aerial photography and 500 depth soundings to determine bathymetry. Considering that this represents a sounding density on the order of 2.5 soundings per acre of water surface, the accuracy of this survey is questionable; consequently, this survey is excluded from further use in this analysis.

The 2005 survey did not cover the entire reservoir, and focuses only a 60-acre area immediately near the dam itself; as such, direct comparisons of this survey to the prior surveys to establish rates of sedimentation are not possible. Calculations comparing the 1949 and 2005 surveys indicate that approximately 800 ac-ft of sedimentation has occurred since 1949 within the 60-acre area of the 2005 survey. The estimated loss of total capacity in the reservoir between 1949 and 1990 is 1,120 ac-ft. If the rate of sedimentation is assumed to be linear, the total loss of reservoir capacity would be in excess of 1,300 ac-ft as of 2005.

5.4.1.2 DREDGING OPTIONS

The maintenance dredging study presented two distinct options for restoration of storage volume through dredging. "Level 1" dredging would restore the Navy Reservoir bathymetry to that identified in the 1949 pre-construction survey, and would require approximately 1.29 million cubic yards (MCY), or 800 ac-ft, of dredging. "Level 2" dredging would remove sediments that have accumulated since 1949 above an elevation 1 ft below the elevation of the outlet structure (66 ft MLLW; thus, sediments accumulated above 65 ft MLLW would be removed). This option entails dredging 0.29 MCY (180 ac-ft) of sediment.

5.4.2 Costs

Generally, costs for a dredging project are divided into a mobilization/demobilization fee and the dredging cost. For the Navy Reservoir dredging project, the maintenance dredging study estimated a unit dredging cost of $24/cubic yard (CY), and a handling and disposal cost of $6/CY, for a total dredging unit cost of $30/CY. As this price is reflective primarily of labor, fuel and equipment costs for workers and material actually onsite during the actual dredging work only, the location of the work in Guam is not likely to materially alter the unit price of the dredging work itself. Dredging costs are therefore estimated at $38,580,000 for Level 1 dredging, and $8,733,600 for Level 2 dredging.

The mobilization/demobilization cost, however, will reflect the difficulties of working in a relatively remote location in the form of a higher base cost. The maintenance dredging study estimated the mobilization and demobilization cost as $500,000. In light of the potential difficulties likely to be encountered in contracting for a dredge, which may increase the distance across which a dredge must be mobilized by at least a factor of 2 (as the study assumed a dredge mobilized from within 2,000 miles), this estimate is similarly scaled by a factor of 2, to a total of $1,000,000, for the life-cycle costs. Furthermore, while a mobilization for Level 1 dredging would likely entail the movement of a larger dredge to Guam than Level 2 (based on the significant difference in targeted dredge volume), it is assumed that mobilization and demobilization costs would essentially be equal, as the bulk of the cost is expected to be associated with the large distance across the equipment is being mobilized, and in the disassembly and reconstruction of the plant in Guam for overland transportation. Consequently, Level 2 dredging would be negatively impacted by elevated mobilization costs.

Based on the costing rationale described above, and assuming the remaining "incidental" items estimated in the maintenance dredging study have not changed appreciably since 2005, the total the Level 1 dredging project would remove approximately 1.29 MCY of material from Navy Reservoir at a cost of $40,580,000, while the Level 2 project would remove approximately 0.29 MCY at a cost of $10,733,600. Assuming a constant rate of sedimentation of 27.3 ac-ft per year (44,100 cy/year) based on the comparison of the 1990 and 1949 surveys, the life cycles of the Level 1 and 2 projects are approximately 29 and 6.5 years, respectively.

The increased water supply from implementation of Option 4 would serve DoD demands in south Guam. Provided water is supplied from the Northern Aquifer near the Finegayan Base Complex, water supply from implementation of this option would not support the USMC relocation, but would provide additional supply in the south that could be transported to north Guam if necessary.

5.4.3 Viability

Potential benefits of the proposed dredging alternatives are several. First, the proposed work is relatively simple in its execution, and does not present a great demand for skilled labor trades that may be difficult to procure from the limited labor pool on Guam. Secondly, the dredging alternatives do not result in the creation of new capital structures which must be operated and maintained on an

indefinite basis. The dredging alternatives also maintain the existing hydrology of the reservoir system, and do not require inundation of additional land. Finally, these alternatives do not require changes to the existing water distribution network, in that the existing discharge and bypass points are maintained in place.

Potential obstacles and drawbacks exist, as well. In particular, the potential difficulties in mobilizing a dredge to project site due to its remote location and the large mobilization distances to dredges will cause uncertainty in actual project costs. In addition, there are significant logistics difficulties in managing dredged material on Guam, as noted in the maintenance dredging study (EMPSCO 2006). While that study assumed equal dredged material management unit costs for both dredging alternatives, the lack of sufficient land area may complicate implementation of the Level 1 alternative. Dredging in the 60-acre area near the dam also does not address upland causes of decreasing reservoir capacity. Without implementation of a comprehensive watershed management plan, the rate of sedimentation will continue unabated, and may increase as climatic conditions and land development increase runoff, and therefore erosion.

Although Option 4 is a viable alternative, it cannot be sustained as a stand-alone alternative for USMC relocation. Water supplied by this option would require transportation to the north to supply the primary USMC relocation water demands, but would provide additional supply for the DoD facilities in southern Guam. It is recommended that this alternative be retained as a means of increasing the DoD water supply.

5.5 OPTION 5 - EXPAND NAVAL RESERVOIR STORAGE CAPACITY BY RAISING DAM CREST

5.5.1 Description

Option 5 involves raising the dam crest of the Navy Reservoir to increase capacity. Structural requirements for dam improvements will need to be assessed, designed and implemented building on the Surface Water Development Study (Barrett, 1994) and subsequent investigations by the Navy.

5.5.1.1 ADDITIONAL YIELD

Based on a review of topographic maps depicting the immediate vicinity of the Navy Reservoir, the topography is such that raising the elevation of the dam crest by 20 ft would not significantly change the surface area of the reservoir, which is currently 197 acres at full stage. Consequently, for the purpose of this analysis, it is assumed that a 20-ft increase in the dam crest would yield a 3,940 ac-ft, or 55 percent, increase in total reservoir capacity. The assumption that increases in surface area with rising elevation are negligible is a conservative assumption from the standpoints of estimating both safe yield (as the total impounded volume is somewhat underestimated) and capital cost per unit of water delivered (as the cost is assessed against a lower capacity, and is thus an overestimate).

The entire increase in volume would be usable storage, and would represent roughly a 62 percent increase in usable storage over the last known usable storage volume estimate of 6,400 ac-ft (based on the stage-capacity curves determined from the 1990 survey). Assuming that the watershed generates sufficient runoff to ensure reliability of this supply, the safe yield of the reservoir would therefore increase from 11.4 to 15.4 MGD (Barrett 1994), an increase of 4.0 MGD, or 35 percent. This option requires further study to determine whether the safe yield is sustainable in dryer weather.

5.5.1.2 CONCEPTUAL DESIGN FOR CAPTURING WATER

Preliminary designs for raising the dam called for a rather conventional technique involving placement of additional fill on both the upstream and downstream faces of the dam, thereby raising the crest. A significant drawback of this conventional approach, however, is the volume of fill material required. Further investigation of the existing dam's stability found that impounding

additional water using a reinforced soil system cap along the existing dam crest would be feasible (Barrett 1994).

The reinforced soil system consists of modular concrete facing panels retaining a compacted earth fill reinforced with metal strips or geogrids. Effectively, this alternative builds an extension of the dam crest in the form of a wall. The proposed construction is similar to that often used to create retained fills or reinforced embankments on highway and land development projects, and is often generically referred to as "reinforced earth." Although this alternative requires the construction of a significant quantity of new structural elements, the volume of fill required is substantially reduced, resulting in significant reductions in cost and length of construction. The actual feasibility of this alternative, however, is dependent upon additional geotechnical and structural analyses of the dam.

5.5.2 Costs

5.5.2.1 Construction Cost

Based on the estimate provided in Barrett (1994), the present worth construction cost for the reinforced earth alternative is estimated at $4,300,000, not including costs for expansion and improvement of the existing water treatment facility and distribution system. Also not included in this estimate are any operation and maintenance costs that would be associated with this alternative. While operations costs, as such, could be minimal, maintenance costs will be determined by the extent of the maintenance program, which has yet to be developed. In particular, they will be driven by the labor and material costs to perform routine inspections, as well as "typical" non-capital type repairs. These ongoing costs have not yet been established. Further analysis is necessary to validate the assessment and costing provided in Barrett (1994).

The increased water supply from implementation of Option 5 would serve DoD demands in south Guam, provided water is supplied from the Northern Aquifer near the Finegayan Base Complex.

5.5.3 Viability

The primary benefit of this alternative is that it provides a significant increase in usable storage capacity at a relatively low cost, especially as compared to other in-reservoir options (i.e., dredging). Provided that the existing watershed generates sufficient runoff to reliably supply an expanded Navy Reservoir (an assumption which must be confirmed by a detailed hydrologic analysis), this option provides increased storage and daily use capacity without altering other waterways in ways that may affect downstream ecosystems. This option can also be implemented entirely on lands currently owned by the military, and would therefore not require acquisition of privately-owned lands or displacement of existing residential or commercial land uses.

There are potential drawbacks to the expanded reservoir option, as well. As noted in Barrett (1994), fringe wetlands around the perimeter of the reservoir would be inundated as a result of raising the dam crest, and would be considered as a "fill" by the US Army Corps of Engineers. As a result of the inundation of fringe wetlands, this option would also disturb nesting areas for the moorhen, an endangered species. The swiftlet, fruit bat, giant fern, and starling are other endangered species known or suspected to exist within the project area (Barrett 1994), though it is not clear how or if implementation of this option would affect these species. Further review and analysis is necessary to determine the implementability of this option, e.g., whether this option is reasonable and safe; whether the reservoir can be used while construction is ongoing; and what modifications to the spillway might be necessary.

This alternative has the advantages of improving the DoD water supply by increasing its storage capacity in the Navy Reservoir. However, the disadvantages and uncertainties are significant and include:

- Technical complexity of design and implementation;
- Potential adverse environmental impacts;
- Uncertainties with respect to relative advantages compared to other viable alternatives;
- Studies (hydraulic, geotechnical, seismic) required;
- Potential difficulties during construction limiting use of the reservoir; and
- Overall cost may be greater than estimated.

The viability of this option is less certain than Options 1 and 2. Therefore, it is recommended that this alternative be eliminated from further evaluation.

5.6 OPTION 6 - POTABLE WATER RECLAMATION THROUGH EFFLUENT REUSE

5.6.1 Description

Wastewater collected from the Finegayan base complex is subject to tertiary treatment as described in the pre-Final Draft Wastewater Utility Study (Earth Tech 2007). The treated, potable water is returned to the main water supply for reuse. An estimated average daily flow of 8.8 MGD treated wastewater from the DoD will be available for potable water use.

While much research has been conducted in the direct potable reuse of reclaimed water, this is not a current practice within the US. However, indirect potable reuse through groundwater reinjection is developed through wastewater treatment plant (WWTP) effluent being combined with well water prior to injection. The perception of effluent reuse is an issue to be dealt with since such an option is likely to be met with significant public opposition. This indirect potable reuse alternative has a psychological advantage in that the injection of the treated effluent into groundwater reduces the perception of reclaimed water (treated effluent) used as potable water.

This alternative includes construction of a new tertiary treatment plant, providing primary treatment, secondary biological treatment, and advanced tertiary treatment, near the proposed development on DoD land. It will treat the DoD wastewater from existing sources and proposed future expansions in Northern Guam region including USMC relocation to drinking water standards.

This treatment application is categorized as direct potable reuse of reclaimed water, and normal treatment practice consists of primary settlement, submersible membrane bioreactor, disinfection, reverse osmosis (RO), and advanced oxidation.

While this discharge eliminates the option of building an outfall, discharging treated wastewater directly to a potable water treatment plant does not have a proven track record. Only few direct potable reuse applications have been reported worldwide (Metcalf & Eddy, 2007). Even without factoring in its extremely high capital investment cost and sophisticated process operation, it might be difficult to gain regulatory acceptance of this approach, and it is not likely that community acceptance of this approach can be achieved. Currently there are no direct potable reuse applications in the United States. All reclaimed water that is treated by wastewater treatment plants has been used as potable water in an indirect way which includes a temporal or spatial separation such as natural buffers, either a stretch of river or a ground water aquifer, between the reclaimed water introduction and its distribution to the potable water treatment plant.

In addition, brine generated from RO operation will need to be managed. Typical brine disposal routes include evaporation, crystallization, deep underground injection, ocean or sewer discharge. From an economic standpoint, only the last two may be feasible, and will require permission from

either the EPA or the GWA. Since there are no regulations on the reclaimed water potable reuse application, the process of establishing treatment requirements and performance monitoring standards for this option will also add time and cost to the project.

A new interceptor system would be constructed to convey wastewater flow from AAFB. A new effluent discharge pipe would be constructed to convey the effluent to the proposed or existing water treatment facility.

The plant biosolids treatment and disposal would be managed by the DoD and comply with EPA's 40 CFR Part 503 regulations.

Construction of the plant on a site that is located in forested or preservation areas that are populated by native species of animals and vegetation may require mitigation activities to satisfy the GDAWR.

The water supply provided by implementation of Option 6 would support the USMC relocation.

5.6.2 Viability

Studies have shown treated wastewater can consistently meet potable water standards, but as listed in EPA (2004), this practice is unlikely to be adopted in the U.S. because:

- Opinion surveys show the public will accept many types of nonpotable reuse but are reluctant to accept potable reuse.
- Indirect potable reuse is more acceptable to the public than direct potable reuse.
- Direct potable reuse is not often necessary.

Other disadvantages include:

- Construction of a WWTP is required.
- Conveying the effluent to new or existing water treatment plant
- GDAWR mitigation requirements
- Longer planning effort and longer construction schedule

This alternative remains viable; however, using treated effluent as potable water has certain negative connotations. It might be more acceptable if potable water supplies were less readily available. This alternative is tied directly to decisions made in the wastewater study and has been rejected as a viable alternative.

In discussions with GEPA, no opposition to this alternative was expressed. However, concern was raised about public perception on effluent reuse for potable water needs and it was noted that it was unlikely that such an option would be acceptable to the public given other viable options for water supplies.

Although this is a viable alternative, it cannot be sustained as a stand-alone alternative. The availability of other viable options doesn't justify consideration of this alternative given the potential hurdles in implementation and the likely negative public response. Therefore, it is recommended that this alternative be eliminated from further evaluation.

5.7 OPTION 7 - NON-POTABLE WATER RECLAMATION THROUGH EFFLUENT REUSE

5.7.1 Description

Non-potable water reclaimed from effluent reuse can be used to recharge the aquifer. This section addresses use of the reclaimed water to supplement the water supply. Wastewater collected from the MCB is subject to tertiary treatment as described in the Wastewater Utility Study (Earth Tech 2007). Based on the Pre-Final Draft Wastewater Utility Study, an estimated average daily flow of 8.8 MGD of treated wastewater will be available for non-potable water use during peak conditions.

Use of water reclamation for industrial uses is not considered in this section because industrial water demand consists of only 6 percent of the total water and does not justify the added complication of a dual water system.

This alternative includes construction of a new tertiary treatment plant near the proposed development on DoD land. It will treat the DoD wastewater from existing sources and future proposed military buildup in the Northern Guam region, including USMC relocation. Treated effluent would be injected into underground aquifer for groundwater recharge or to limit salt water intrusion. The DoD would be responsible for treatment, groundwater monitoring, and biosolids disposal. A separate sewer interceptor and a transmission line would be constructed to convey reclaimed water to the injection wells. The cost of the transmission line and its operation will depend on topographical condition of piping route and locations of the injection wells that are determined by underground geological structure and required set back distance between injection wells and withdraw wells.

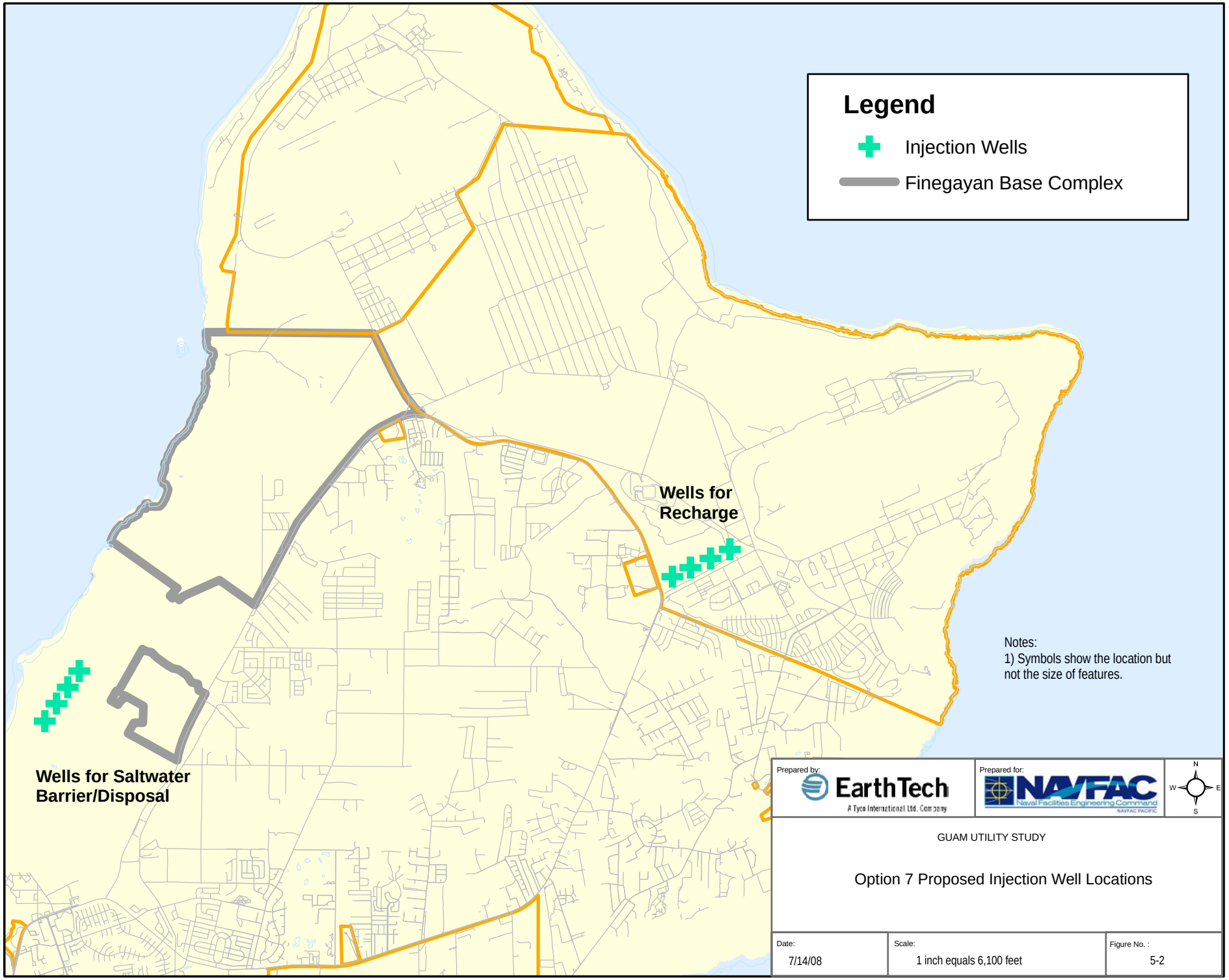
Construction of the plant on a site that is located in forested or preservation areas that are populated by native species of animals and vegetation and may require mitigation activities to satisfy the GDAWR.

The water supply provided by implementation of Option 7 would support the USMC relocation.

5.7.1.1 INJECTION OF TREATED WASTEWATER EFFLUENT

Wastewater production resulting from transfer of DoD assets to Guam is estimated at 8.8 MGD average daily flow. Groundwater injection is one potential means of disposal of wastewater effluent. Two possible injection scenarios were considered. The first is disposal by injection of treated effluent in wells approximately 1,500 to 2,000 ft inland at a location near the proposed WWTP. In this option, treated effluent is disposed in the ocean by leakage from freshwater lens underlying northern Guam, but the placement of the discharge could result in a barrier to saltwater intrusion. In the second option, the highly treated wastewater effluent is used to recharge the freshwater lens at a location that would support the proposed new production wells at AAFB. Physical locations and potential layout of injection wells for both scenarios are shown in Figure 5-2.

Under the disposal option, four injection wells would be located east of Tanguisson Point in a line approximately parallel with the coast with a separation distance between wells of approximately 1,000 ft. Each well would be capable of an injection rate of approximately 1,600 gpm yielding a maximum combined injection rate of 6,400 gpm. Under non-peak loads, two to three wells would be operated allowing distribution of effluent injection across a 4,000-ft front while enabling at least one well to be removed from service for maintenance and upkeep.


Legend
Injection Wells
Finegayan Base Complex
Wells for Recharge
Wells for Saltwater Barrier/Disposal
Notes:
1) Symbols show the location but not the size of features.
Prepared by:
EarthTech
A Tyco International Ltd. Company
Prepared for:
NAVFAC
Naval Facilities Engineering Command
NAVFAC PACIFIC
N
W
E
S
GUAM UTILITY STUDY
Option 7 Proposed Injection Well Locations
Date:
7/14/08
Scale:
1 inch equals 6,100 feet
Figure No. :
5-2

The aquifer recharge option would also include four 1,600-gpm wells with a 1,000-ft spacing. This option would allow one or more wells to be down for maintenance and upkeep during non-peak operations. The recharge option has the wells located in a 4,000-ft line parallel and to the north of Marine Drive on the southern boundary of AAFB. The injection wells are arrayed in a line conforming to a ridge in the volcanic basement below the water bearing limestone. The ridge was chosen because proposed production wells for DoD expansion on Guam are located on either side of the volcanic basement ridge allowing the injected effluent to directly recharge the portions of the aquifer that will be heavily pumped to supply water for new military and support personnel arriving on Guam.

The disposal option utilizes the freshwater lens as the receiving water for the treated wastewater effluent. Injection of the wastewater would elevate the water table surface in the disposal zone. This could have a positive effect on the potable production wells in the Finegayan sub-basin directly upgradient from the injection area. If the doming effect of the injection zone extended inland sufficiently, this could result in slightly higher capacities from the potable production wells in the affected area. However, preliminary calculations tend to indicate no increase as a result of effluent injection (see Appendix G).

Two major issues are associated with the aquifer recharge option. The first issue is transferring the treated effluent across the island to the injection point, a distance of 6 to 8 miles (depending on route) and an increase of elevation of 300 ft. The second issue is acceptance of highly treated wastewater effluent as recharge for potable production wells. This issue has two components: public perception, and technical requirements. The public may perceive that treated wastewater is used as drinking water and therefore reject the concept of aquifer recharge with treated effluent. The technical difficulty is that at the selected injection point, the recommended 9 to 12 month effluent detention time in the aquifer prior to removal could not be met.

The conceptual designs for injection wells to be used for treated wastewater effluent disposal or aquifer recharge are included in Appendix G. The injection wells are assumed to be 12-inch diameter, which readily accommodate an 8-inch conductor pipe and couplings.

At present, there are no Federal regulations that specifically address indirect or direct potable reuse of reclaimed water. The EPA developed Guidelines for Water Reuse in 2004 and suggested the quality standard for treated municipal wastewater injection into underground potable aquifer as listed in Table 5-2.

California, Florida, and a few other states are in the forefront of developing discrete criteria relating to planned indirect potable reuse of reclaimed water. California has prepared draft criteria for groundwater recharge (the most recent being in 2004), and are shown in Table 5-3.

With concerns on reliability of some unregulated trace constituents removal, and consideration of source water that meets all drinking water standards, it does not necessarily indicate that the water is safe. The California draft groundwater recharge regulations reflect the mitigation necessary to address these concerns. In present practice reclaimed injection into underground potable aquifer normally has multiple barrier protection system (such as RO and advanced oxidation process) for advanced treatment to avoid unknown potential health risks.

Table 5-2: EPA Guidelines of Water Reuse for Groundwater Recharge by Injection into Potable Aquifers

Types of Reuse	Treatment	Reclaimed Water Quality	Reclaimed Water Monitoring	Setback Distances	Comments
Groundwater recharge by injection into potable aquifers	Secondary Filtration Disinfection Advanced wastewater treatment	Includes, but not limited to, the following: pH = 6.5 – 8.5 <= 2 NTU No detectable total coli/100 ml 1mg/l chlorine residual (minimum) <= 3 mg/L total organic carbon (TOC) <= 0.2 mg/L total toxics Nitrate N < 10 mg/L Meet drinking water standards	Includes, but not limited to the following: pH - daily Turbidity – continuous Total coliform – daily chlorine residual – continuous Drinking water standards – quarterly Other – depends on constituent	2,000 ft to extraction wells. May vary depending on site-specific conditions.	The reclaimed water should be retained underground for at least 9 months prior to withdrawal. Monitoring wells are necessary to detect the influence of the recharge operation on the groundwater. Recommended quality limits should be met at the point of injection. The reclaimed water should not contain measurable levels of viable pathogens after percolation through the vadose zone. A higher chlorine residual and/or a longer contact time may be necessary to assure virus and protozoa inactivation.

Table 5-3: California Draft Groundwater Injection Regulations

Parameter	Requirement
Turbidity	0.2 NTU
Total nitrogen	5 mg/L
Total coliform	2.2 total coliform/100 mL
Total Organic Carbon	0.5 mg/L
Set back distance	2,000 ft
Retention time underground	12 month
Drinking water standards	Meet all drinking water maximum contaminant levels (except nitrogen and new federal and state regulations as they are adopted)

Source: Draft Groundwater Recharge Regulations, California Department of Health Services

The northern part of Guam is set on a karst limestone high plateau, where highly porous and channelized limestone subsurface media with a high hydraulic conductivity exist. From ground surface to groundwater surface is approximately 200 to 350 ft. This geology provides little reliable opportunity for soil aquifer treatment which offers additional treatment as water passes through the soil vadose zone to an underlying aquifer. Due to limited surface area contact, flow through fractured limestone media may offer inefficient soil aquifer treatment.

Since GWUDI in the Northern Guam area has already been a concern to the GEPA, to gain public confidence on the practice of injecting reclaimed water directly into potable aquifer in a karst limestone region, a treatment processes train similar to California practice is used for this study. Groundwater recharge with reclaimed water in the Orange County Groundwater Replenishment Project, which treats secondary effluent from Orange County Sanitation District Plant #1, employs a process including microfiltration, RO, advanced oxidation with ultraviolet (UV), and hydrogen peroxide.

5.7.1.2 HYDRAULIC FEASIBILITY OF INJECTION WELLS

When water is discharged into a well, a cone develops above the potentiometric surface in much the same way as a cone develops below the potentiometric surface when water is pumped from a well. When water is injected, the cone is reversed. In other words, it becomes a cone of impression or recharge rather than a cone of depression or discharge. This cone of impression surrounds the pumping well and can be analyzed mathematically in a very similar way as the cone of depression.

The amount of water introduced into the aquifer depends on the rate of injection, hydraulic conductivity, type of well, and potentiometric levels. However, the most important factor in any injection system is proper design of injection wells. A properly designed injection well will operate more efficiently requiring less hydraulic pressure with reduced probabilities of incrustation, thus resulting in longer well life and decreased overall operating costs.

To calculate injection pressures and water build-up in the injection wells, it was assumed that each injection well will receive 1,600 gpm continuous flow. This flow rate is well below the legally permissible injection rates under the EPA UIC regulations of 3.5 MGD (2,430 gpm) and velocity restriction of 8 fps.

It is important to determine injection pressures to ensure that there are no concerns from the engineering, economic, and regulatory points of view. Flow and pressure restrictions are imposed to protect the receiving formation from potential fracturing pressures. Fracturing pressures for limestones are approximately 600 pounds per square inch (psi). It is prudent to maintain a safety factor and maintain injection pressures in the limestone at less than 200 ft of water or below 87 psi.

Estimates of water level build-up and injection pressures were made using the Theis equation and hydraulic conductivities of 50 ft/day, 100 ft/day and 200 ft/day. Assuming a hydraulic conductivity of 200 ft/day, the head in the injection well above the top of the aquifer would be approximately 21 ft and the injection pressure head will be about 9 psi. If hydraulic conductivity is 100 ft/day, the head in the injection well above the top of the aquifer would be approximately 39 ft and the injection pressure head will be 17 psi. At the lowest hydraulic conductivity of 50 ft/day, the head in the injection well above the top of the aquifer would be approximately 74 ft and the injection pressure head will be 32 psi.

The calculated injection pressures are low and appear to have adequate safety factor for potential adverse aquifer affects that may reduce flow. The equations used are based on assumptions of perfect aquifer hydraulics and ideal water quality conditions in the aquifer; including (for example) homogeneous formation, isotropic aquifer characteristics, fully penetrating wells, and laterally extensive aquifers. Over time, injection pressure will increase as a result of screen plugging from incrustation and biological fouling. It would be important to clean and maintain the wells every few years.

5.7.2 Viability

This option will not be considered further because:

- Use of treated wastewater to recharge the aquifer is not considered a viable option because the residence time is far smaller than the EPA-recommended time of 9 months.
- Use of treated wastewater to act as a barrier to saltwater intrusion is not considered viable because calculations show the disposal of the treated water to be an ineffective barrier.

Additionally, this option may not meet regulatory approval. GEPA UIC regulations categorize sewage treatment effluent recharge wells as Class V wells. GEPA does not specify the treatment

standards and criteria for underground injecting the sewage treatment effluent to recharge the aquifer. GEPA will review the design and documents before approving the groundwater injection of treated effluent.

Additional disadvantages include:

- Existing DoD wastewater diverted from GWA to a new DoD WWTP
- WWTP construction
- GDAWR mitigation requirements
- Groundwater discharge permit
- Longer planning effort and longer construction schedule leading to increased costs

5.8 OPTION 8 – DESALINATION

Desalination is a process that removes dissolved minerals from seawater, brackish water, or treated wastewater. The water supply provided by implementation of Option 8 would support the USMC relocation.

A number of technologies have been developed for desalination, including reverse osmosis (RO), electrodialysis reversal (EDR), and distillation. In RO, feedwater is pumped at high pressure through permeable membranes, separating salts from the water. In EDR, ions are transferred through the membranes by means of direct current (DC) voltage and are removed from the feed water as the current drives the ions through the membranes. In the distillation process, feedwater is heated and then evaporated to separate out dissolved minerals.

Operating Parameters for Desalination

Desalination Process	Total Dissolved Solids (TDS) Range (mg/L)	Temperature Range (°C)
Distillation	30,000 – 500,000	35 – 120
RO	500 – 50,000	0 – 40
EDR	500 – 3,000	0 – 65

Source: CDTF 2003

It is assumed that brackish water with TDS levels ranging from about 3,000 mg/L to 4,000 mg/L will be supplied. Within this TDS range, RO is preferred. Brackish water generally requires less energy to desalinate than seawater due to its lower concentration of dissolved solids. Therefore, the desalination of brackish water is generally less expensive than desalination of seawater.

Energy costs represent about one-third to one-half of the cost of desalination, and as a result, desalination costs are relatively sensitive to the cost of energy. In addition to the energy required for the desalination process, energy is also needed to transport water to end users.

5.8.1 Description

For this option, the lowest salinity water available outside of the NGLS will be considered. Brackish water wells will be located within 1,000 ft of the shoreline to avoid impacts to the NGLS and existing wells. Sufficient brackish water will be collected from a series of wells to generate 12 MGD of potable water. Freshwater from the existing Navy wells will be sent to the same facility for water treatment assuming GWUDI. The desalination plant will be located near the Finegayan Base Complex on AAFB to be close to the location of the source and the demand. The plant includes units for pretreatment (filtration and disinfection), desalination, and post-treatment (corrosion control, remineralization and disinfection) resulting in a product of drinking water quality with TDS less than

500 mg/L. If desalination of brackish water is implemented, untreated brackish water may be used to meet fire demands requiring a separate set of non-potable waterlines and storage.

It is assumed that the brackish water will have a TDS level ranging from 3,000 mg/L to 4,000 mg/L and an oil and grease level less than 10 mg/L. In this case, RO is the preferred process. Advantages of RO plants over distillation include:

- RO plants usually have lower energy requirements;
- RO plants take up less surface area than distillation plants for the same amount of water production;
- RO plants tend to have higher recovery rates – up to about 50% for seawater;
- RO plant feedwater generally does not require heating, and the thermal impacts of discharges are lower;
- RO plants have fewer problems with corrosion.

Desalination plants produce liquid wastes that may contain some or all of the following constituents: high salt concentrations, chemicals used during defouling of plant equipment, and pretreatment residues. Liquid wastes may be discharged directly into the ocean, combined with other discharges (e.g., power plant cooling water or sewage treatment plant effluent) before ocean discharge, discharged into a sewer for treatment in a sewage treatment plant, or dried and disposed in a landfill. Combining the brine discharge with discharges from other plants serves to dilute the high salt concentrations and minimize adverse impacts associated with desalination discharges. In addition, combining with power plant cooling water helps to lower the temperature of the cooling water. Desalination plants also produce a small amount of solid waste (e.g., spent pretreatment filters and solid particles that are filtered out in the pretreatment process [California Coastal Commission 1993]).

Land disposal is not an option that is considered here, since it requires a significant amount of land and land disposal often requires the lining of evaporation ponds to minimize the effects on the surrounding aquifers (Barrett 1994). Since rainfall exceeds evaporation in Guam, the evaporation ponds would increase rather than decrease in volume. The preferred option would be to combine the discharges with those of neighboring power plant or treatment plants. Membranes that are destroyed during use will be disposed in a landfill.

5.8.2 Costs

Desalination would include similar requirements for resource development (well installation), water treatment (disinfection and filtration), and distribution (infrastructure, pumping, storage). The cost for desalination capital and O&M are additional.

5.8.3 Viability

Desalination is a viable option that results in very pure water, excellent pathogen removal, and flexible operations. The costs for this option are likely to be high relative to the water supplied by Options 1 and 2. The high power demand for desalination will need to be considered in the utility planning for electricity. The cost for desalination will also be sensitive to the level of TDS in the brackish water supply. This option is carried forward for detailed analysis because of the limited supply of freshwater in the NGLS. If water demands eventually exceed the capacity of the freshwater aquifer in the north, desalination could potentially provide a source of potable water for the DoD.

5.9 OPTION 9 - DEVELOP A NEW SURFACE WATER SOURCE

5.9.1 Description

Development of a new surface water source on Guam would require identifying a new water source, conceptualizing and designing the water source area, treatment, transmission and distribution infrastructure, and constructing the complete system to supplement the existing water systems. Such a system preferably would have to be sited within DoD lands and finding an alternate surface water source with significant capacity would likely be a major and costly initiative.

Barrett (1994) presents a detailed analysis of 30 potential surface water source alternatives in southern Guam. The analysis included estimates of the yield and reliability of the source, impacts to endangered species, habitats, and the ecosystem. Conceptual designs and screening level construction costs are included in the report. A summary of the analyses is presented in Table 5-4.

Table 5-4: Surface Water Source Development Summary Alternatives

Rank	Alt. #	Alternative	Water Quantity Diverted (MGD)[a]
1	26	Ylig Treatment Rehab.	2.00
2	18	Talofofo Diversion	2.00
3	22	Tolaeyuus Div./Lost River	0.90 (1.7-5.6[b])
4	9	Inarajan Diversion	2.00
5	7	Geus Treat. Upgrade	0.15
6	30	Tarzan Diversion	1.00
7	27	Ylig Reservoir	11.40
8	3	Navy Res. Modif. (Option 5)	4.00
9	14	Lonfit Reservoir	3.30

[a] Information from Barrett (1994)
[b] Estimate from SWCA (2007)

The Proposed Supplemental Water Supply for the Fena Reservoir System, Naval Magazine, Guam (SWCA, June 2007) report reviews five alternatives and selected pumping from the Lost River at its mouth below the Navy Reservoir as a viable alternative. Based on an extensive U.S. Geological Survey (USGS) data set, SWCA estimated that the supplemental supply from this source would have ranged from 1.7 to 5.6 MGD during the 1998 to 2001 period.

5.9.2 Costs

A summary of the screening level capital costs and yields estimated in Barrett (1994) are provided in Table 5-5. Additional study is necessary to validate these costs.

Table 5-5: Screening Level Capital Costs for Surface Water Alternatives

Alt. #	Alternative	Capital Cost Estimate- Guam (2008) $M
18	Talofofo Diversion	16
22	Tolaeyuus Div./Lost River	2
9	Inarajan Diversion	14
30	Tarzan Diversion	11
14	Lonfit Reservoir	56

Note: Costs are from Barrett (1994)

The estimated cost for supplemental water supply from the Lost River is $2,750,000 based on a SWCA (2007) conceptual plan.

The increased water supply from implementation of Option 9 would serve DoD demands in south Guam. Provided water is supplied from the Northern Aquifer near the Finegayan Base Complex, water supply from implementation of this alternative would not support the USMC relocation.

5.9.3 Viability

Additional study is necessary to fully evaluate and provide updated information on the alternatives identified in Barrett (1994). The top-ranked surface water sources are all in southern Guam, requiring significant transportation costs to meet the demand at the Finegayan Base Complex. This alternative will add more cost without having any meaningful benefits to meet the USMC relocation water needs. This option would increase the water supply to DoD facilities in southern Guam, but, with the exception of the Lost River, additional study is needed to assess the implementability and cost of the surface water sources. This option is eliminated from further consideration in this water study. However, it may be beneficial to carry forward the preliminary engineering analysis for capture of the Lost River as a means of supplementing supply to DoD in southern Guam.

5.10 SUMMARY OF OPTIONS

A summary of the options is provided in Table 5-6. Earth Tech recommends that the following options be considered for further evaluation.

- **Option 1** – Optimize groundwater resource development within DoD property.
- **Option 2** – Determine the requirements for rehabilitation, treatment of well water, or replacement of existing wells not currently in production due to contamination, structural and/or mechanical problems.
- **Option 3** – Purchase water from GWA.
- **Option 8** – Desalination.

Table 5-6: Summary of Option Evaluation

Water System Alternative	Description of Option	Evaluation Considerations	Recommendation
Option 1 – Optimize Groundwater Resource Development within DoD Property	Development of new groundwater wells in the Northern Lens Aquifer. Volume: dependent on sustainable yield and demand	• Salt water intrusion/ Excessive aquifer draw down. • Managed fully by DoD/ Reliable and secure. • Integrated System with GWA. • Sustainable yield/ GWUDI considerations.	Retained for Evaluation in Section 6

Water System Alternative	Description of Option	Evaluation Considerations	Recommendation
Option 2 – Determine the Requirements for Rehabilitation, Treatment of Well Water, or Replacement of Existing Wells	Rehabilitation or replacement of under performing wells in the Northern Lens Aquifer. Volume: 3.8 MGD (capacity of inactive wells; See Section 5.1)	• Salt water intrusion/ Excessive aquifer draw down. • Reduced stress on aquifer from installation of new wells. • Managed fully by DoD/ Reliable and secure. • Integrated system with GWA. • Sustainable yield/ GWUDI considerations.	Retained for Evaluation in Section 6
Option 3 – Purchase Water from GWA	Purchase water from GWA. Volume: subject to availability	• New connections with DoD water systems. • Upgrading systems/ energy savings.	Retained for Evaluation in Section 6
Option 4 – Sediment Dredging at Navy Reservoir	Dredge accumulated sediments Navy Reservoir thereby increasing capacity. Volume: 2.5 MGD (the additional capacity needed to return the Navy Reservoir to design capacity)	• Current storage capacity reduced due to sedimentation. • Need to dredge to sustain long-term supply • Managed fully by DoD.	Potentially viable. Additional analysis is necessary to fully evaluate.
Option 5 – Expand Naval Reservoir Storage Capacity by Raising Dam Crest	Raise the Navy Reservoir dam crest to increase capacity. Volume: 4 MGD (based on Barrett [1994])	• Technical complexity of design and implementation • Relative advantages compared to other viable alternatives • Overall cost	Eliminated
Option 6 – Potable Water Reclamation through Effluent Reuse	Wastewater treatment plant effluent is reused for human consumption. Volume: 8.8 MGD [Final Wastewater Utility Study])	• Negative connotations/ public perception. • Tied to wastewater study. • Relative advantages compared to other viable alternatives	Eliminated
Option 7 – Non-Potable Water Reclamation through Effluent Reuse	Wastewater treatment plant effluent is reused for non-potable uses Volume: 8.8 MGD [Final Wastewater Utility Study])	• Require separate distribution system. • Tied to Wastewater study. • Relative advantages compared to other viable alternatives	Eliminated
Option 8 – Desalination	Sea water or brackish water is desalinated in order to obtain fresh water suitable for human consumption. Volume: Design to meet demand	• Construction of desalination plant/Effluent discharge. • High energy demands • Overall cost.	Retained for Evaluation in Section 6

Water System Alternative	Description of Option	Evaluation Considerations	Recommendation
Option 9 – Develop a New Surface Water Source	Identify surface water source, design, construct and operate source, treatment, transmission and distribution system Volume: 9.2 MGD (based on Barrett [1994] & SWCA/Tom Nance Water Resource Engineering [2007])	• Complexity in identification, design and implementation • Relative advantages compared to other viable alternatives • Overall cost	Eliminated; Implementation of the Lost River plan described in SWCA (2007) might provide additional supply if needed in the future.

Option 4 and Option 9 (Lost River plan) are improvements to the Navy Reservoir. Development of these options may be necessary to meet the DoD-wide water needs, but additional study is needed to fully evaluate these options.

A connection will be made to the GWA system, just south of the proposed water treatment plant. A separate pipeline will convey water from the GWA system into the proposed plant, where the GWA water will discharge into the clearwell and mix with the treated water from the plant. A flow meter installed in the water treatment plant or in a vault near the connection to the GWA system will measure flow to the system for billing purposes. An air gap will be provided to prevent backflow into the GWA system. The high lift pumps, treated water transmission mains, and water storage are the same as described in Option 1. It is assumed that the additional supply from GWA would be in place of water supply developed by the DoD. Therefore, the DoD storage capacity would not need to increase to meet the supply provided by GWA.

6.4.2 Costs

Details of the cost estimate are provided in Appendix C.

Since GWA already is capable of buying substantial amounts of water from the Navy, no new connections would be needed to send water from the Navy water system to the GWA system. A new connection is required to provide water in the north from the GWA network of wells to the Finegayan Base Complex distribution system.

Capital Costs	$000
1) Water Resources Development	$0
2) Water Treatment	$0
3) Distribution	$1,642
Total Construction Cost without contingency	$1,642
Contingencies (20%)	$328
Engineering (15%)	$246
Total Capital Cost	**$2,217**
Present Worth Guam Capital Costs	$2,235

There are no O&M costs for Option 3.

The total present worth of life cycle costs for Option 3 is $2.2M.

The costs for Option 3 are primarily to accommodate the USMC relocation. However, the Finegayan Base Complex is expected to also house staff from the army and continue to be the location of the Navy communication facilities. The Basic Scenario 1 (USMC only) costs are presented in Section 7.

Discussion

There is little or no water available for purchase from the GWA in the north that is not already required for GWA customers in that region. In the future water, the purchase option may become available if the GWA system is improved to reduce the loss rate, and if expansion of the GWA northern well systems is implemented.

6.5 OPTION 8 – DESALINATION (BRACKISH WATER)

This section provides the rationale for potential new brackish water supply system components. Like Option 1, this option will provide sufficient water to meet the USMC relocation and other additional DoD water demands.

6.5.1 Potential Well Locations

Brackish water wells will be planned which supply the treatment plant with enough water to produce a total of 14 MGD of potable water. The plant will accept the 2.3 MGD of freshwater from the existing Navy wells on the Finegayan Base Complex. To supply the remaining approximately 12 MGD of potable water, it is assumed that 18 MGD of brackish water (3,000 to 4,000 mg/L TDS) will be required. The brackish water supply wells will be designed with a higher capacity, 450 gpm, since these wells will be drawing saline water. This limit is consistent with the recommendations for supply wells presented in the 1982 NGLS. To meet the supply, 28 supply wells are required. Consistent with the constraints for the freshwater wells, the brackish water supply wells will be separated by a distance of at least 1,000 ft to avoid interference and upconing. To avoid influencing existing freshwater wells, the supply wells are placed within 1,000 ft of the shoreline. Figure 6-13 shows a schematic of the subsurface. The brackish water wells will be screened within the brackish water zone.

Proposed brackish water supply well locations are shown on Figure 6-14. Most of the wells located near the northwest shoreline are within the fenced area of the military reservation. The wells located outside of the fenced area might be relocated for security. The wells along the northern shoreline are located in a limestone forest. These wells may need to be relocated due to habitat considerations. Most of the area around the Northwest Field is considered important habitat by the regulatory agencies. This area is home to the last known nesting area of the endangered Mariana Fruit Bat on the island. The area to the northeast is prime limestone forest which is important habitat for many species. It may be necessary to identify alternate well locations in areas of AAFB that are outside of the AAFB constraints shown on Figure 6-1 or other limitations to be specified by the base.

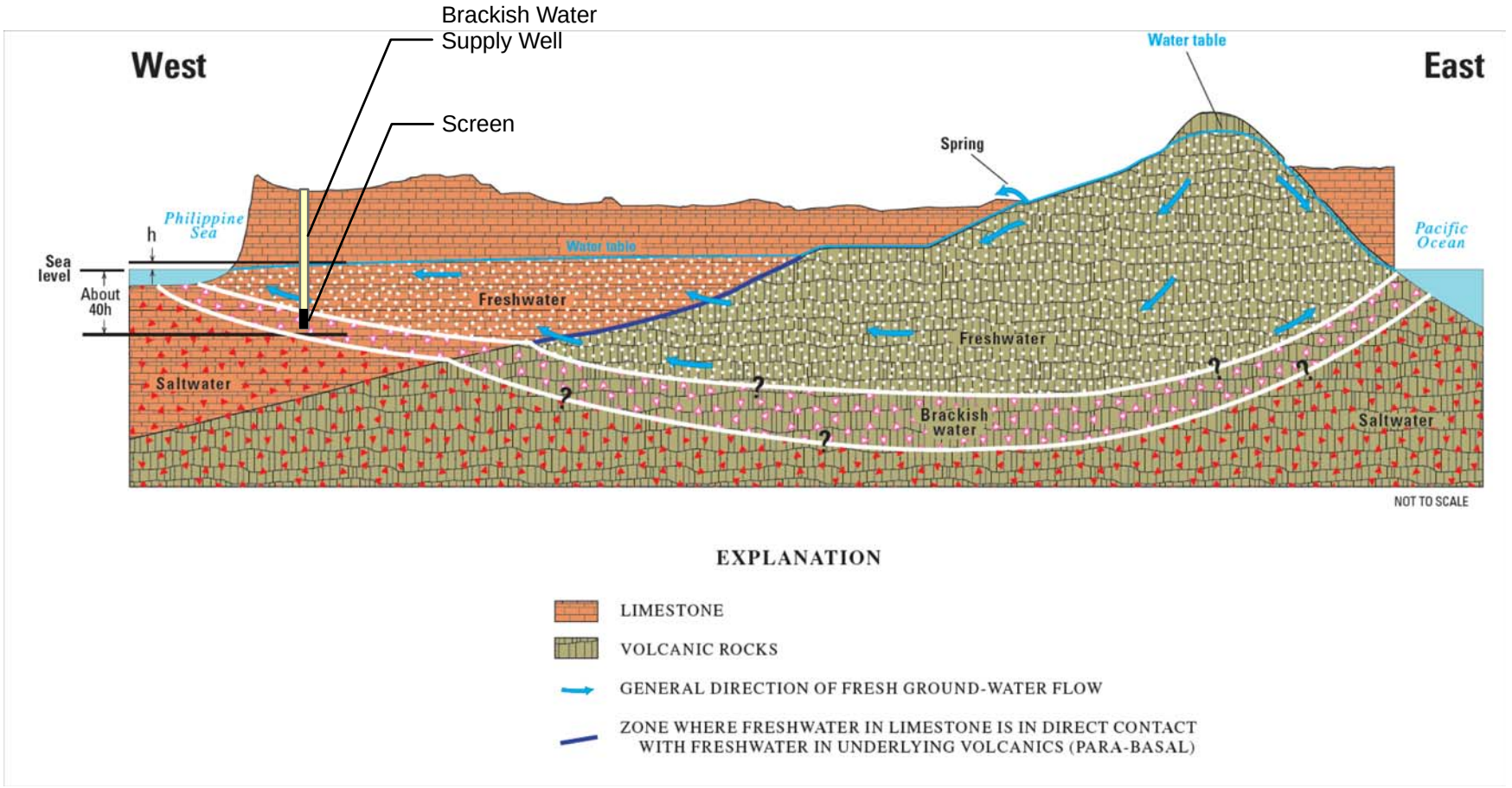
The final placement of supply wells will require additional information. The proposed locations are selected primarily in locations which are expected to produce sufficient supply to the treatment plant without harming the aquifer or influencing existing wells. Prior to installing wells, it is recommended that a pre-design study including a seismic survey, pump tests and development of a multi-layer groundwater model be conducted to support design. The study will provide data to optimize the well locations and design parameters to avoid impacts to existing wells and the aquifer.

6.5.2 Water System Components

The water system components are described in this section. The main components are the wells, water treatment plant for desalination and disinfection, and distribution system. The main components are consistent with the description provided in Section 6.2.2 for Option 1, with the exception of the desalination treatment and the location of wells and raw water lines. Option 8 includes the modifications to the existing Navy Island-wide system to add flexibility to meet water demands if alternate housing arrangements are selected.

6.5.2.1 WELLS

Well Construction. It is assumed that the well construction for the brackish water wells will be similar to the freshwater wells described in Section 6.2.2.1, but the wells will be screened in the brackish water zone.



Note: Figure taken from USGS (2003).

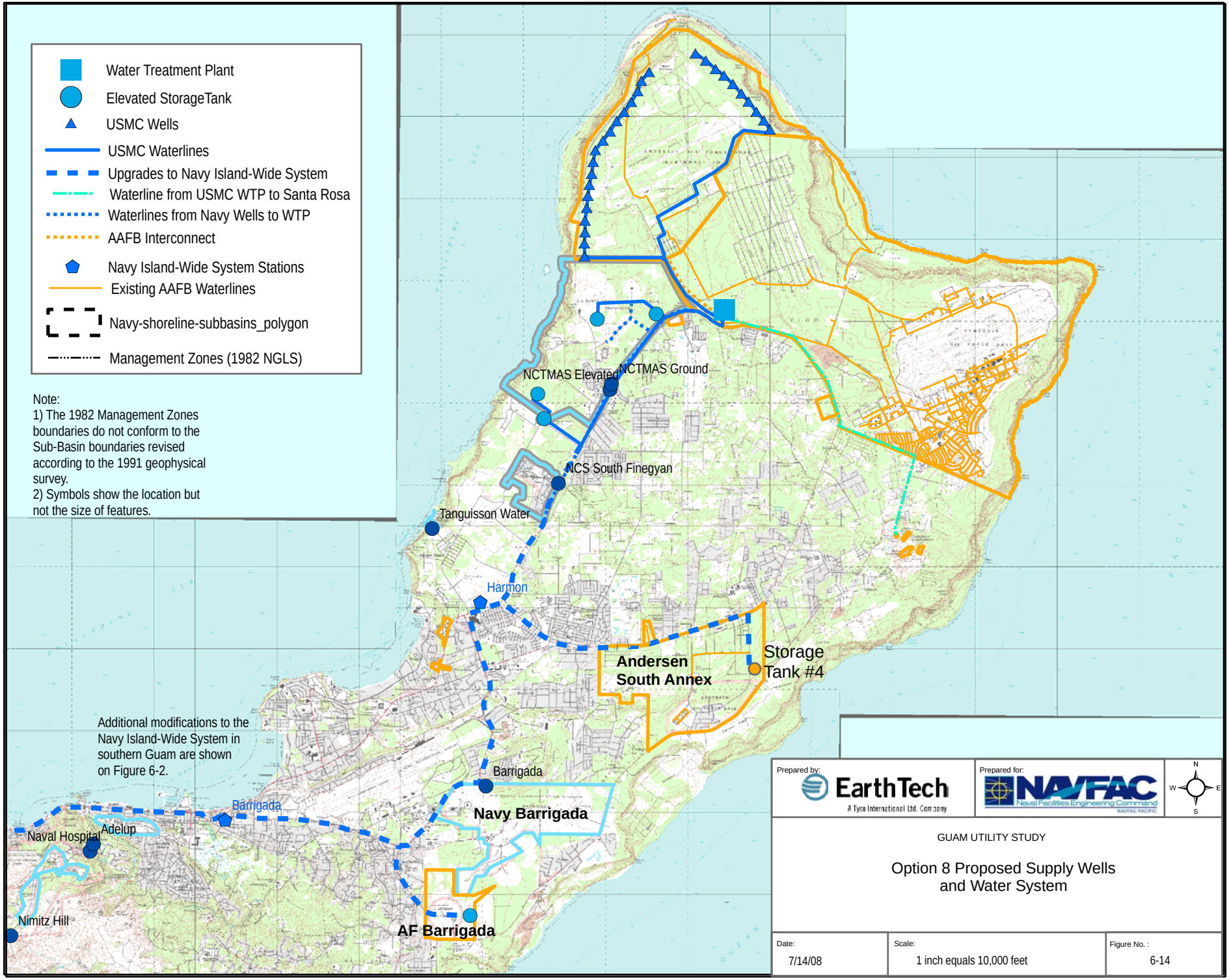
Prepared by: EarthTech, A Tyco International Ltd. Company

Prepared for: NAVFAC, Naval Facilities Engineering Command, NAVFAC PACIFIC

GUAM UTILITY STUDY

Option 8 Proposed Supply Wells
Location Constraints

Date:	Scale:	Figure No. :
7/14/08	not to scale	6-13


Water Treatment Plant
Elevated StorageTank
USMC Wells
USMC Waterlines
Upgrades to Navy Island-Wide System
Waterline from USMC WTP to Santa Rosa
Waterlines from Navy Wells to WTP
AAFB Interconnect
Navy Island-Wide System Stations
Existing AAFB Waterlines
Navy-shoreline-subbasins_polygon
Management Zones (1982 NGLS)
Note:
1) The 1982 Management Zones boundaries do not conform to the Sub-Basin boundaries revised according to the 1991 geophysical survey.
2) Symbols show the location but not the size of features.
NCTMAS Elevated
NCTMAS Ground
NCS South Finegyan
Tanguisson Water
Harmon
Andersen South Annex
Storage Tank #4
Additional modifications to the Navy Island-Wide System in southern Guam are shown on Figure 6-2.
Barrigada
Navy Barrigada
Barrigada
Naval Hospital
Adelup
Nimitz Hill
AF Barrigada
Prepared by:
EarthTech
A Tyco International Ltd. Company
Prepared for:
NAVFAC
Naval Facilities Engineering Command
NAVFAC PACIFIC
N
W
E
S
GUAM UTILITY STUDY
Option 8 Proposed Supply Wells and Water System
Date:
7/14/08
Scale:
1 inch equals 10,000 feet
Figure No. :
6-14

Pre-Design Studies. Seismic studies and test borings should be conducted at each well site as described in Sections 6.2.1 and 6.2.2.1 for the freshwater wells. It may be necessary to evaluate areas other than the notional areas shown in Figure 6-14. Given the potential for saltwater intrusion caused by the brackish water wells, it is recommended that a multi-layer groundwater model be prepared to aide in well placement and design and avert impacts to water quality in existing wells. The model will provide information to assess whether the approximately 1,000-ft spacing is adequate; to determine if there will be significant upcoming; and to identify operating parameters. Pump tests and aquifer monitoring will be needed to support the model. For planning, it is assumed that pump tests will be conducted at 10 locations and 20 monitoring wells will be installed.

Aquifer Monitoring: Long-term monitoring of the aquifer following implementation of Option 8 is recommended. TDS levels will be measured periodically from monitoring wells. If TDS levels are shown to be increasing, pumping rates may be adjusted.

6.5.2.2 CENTRAL WATER TREATMENT SYSTEM

Well water extracted from the proposed 28 new wells will be collected, desalinated and treated for water supply to the end user. This section presents a design basis for desalination, water treatment, treatment technologies and processes, and costs. The plant is designed for a peak treatment capacity of 14 MGD. Prior to design, the water quality of the brackish water should be tested to determine the optimal treatment processes. This report provides a general estimate of the approach and cost for desalination for comparison to other water utility alternatives. If desalination is selected, it is recommended that a pilot study be implemented.

The treatment plant location is shown on Figure 6-14. This location was chosen due to its proximity to the highway and the planned USMC base, and because it has sufficient space to accommodate the treatment plant and an aboveground storage tank for finished water.

Evaluation Basis and Regulatory Requirements

It is assumed that the extracted brackish groundwater in the area will have a TDS level from 3,000 to 4,000 mg/?. A RO membrane system with appropriate pretreatment will be employed to treat the brackish water. In order to maintain total residual chlorine in the distribution system, the desalinated water will need to be disinfected in the plant. To achieve these objectives, the following evaluation basis is established:

Water demand: 14 million gallons per day (MGD)

Influent and Treatment Objectives:

Parameter	Brackish Water	Treatment Objectives
TDS	3000 to 4000 mg/l	<500 mg/l
Coliform	500 counts/100 ml	Zero counts/100 ml
E. Coli	500 counts/100 ml	Zero counts/100 ml
Turbidity	1 NTU	≤0.5 NTU
Residual chlorine	NA	0.5 mg/l

Treatment Processes

The following are the major water treatment process units:

- Surge Tanks
- Desalination pretreatment unit(s)
- RO membrane units
- Wastewater Holding tanks
- Ground storage tank for finished water

Brackish well water will be extracted from the wells and transported to the desalination water treatment plant via a common pipeline and then collected in a surge tank that will also serve as a feed tank to the downstream treatment units. The treatment will provide 14 MGD (net) of potable water of which the existing Navy wells provide 2.3 MGD freshwater. For simplicity, the freshwater will be treated in the same facility. In order to obtain the remaining 12 MGD potable water, the system will treat about 18 MGD. The well water will be pumped into the pretreatment system first. If the brackish water quality is relatively good, the pretreatment process can be multimedia sand filtration followed by cartridge filtration. If the brackish water has elevated hardness, turbidity, and organics, the pretreatment process can be microfiltration (MF) or ultrafiltration (UF). After the pretreatment system, antiscalant, biocide, and acid will be added to condition the pretreated water to reduce fouling/scaling of the RO membrane. Then the conditioned water will pumped into the RO membrane system. The RO membrane unit can be one stage or two stages based on the design by the vendor and the influent water quality. The RO membrane units will remove colloids, ionic species, bacteria, and viruses and produce high quality water. The treated water will be collected and disinfected before pumping to the distribution system. A block diagram is shown in Figure 6-15.

The wastewater produced by the desalination plant will be collected in a wastewater holding tank and discharged either into an outfall to the ocean (which would require a permit) or to the GWA sewer under the appropriate discharge permits.

Equipment Sizing and Redundancy

Key process equipment items, chemical feed systems, and buildings are identified and their information presented below. Conceptual level information on the desalination system is provided herein. Specifics of the desalination system equipment will be developed during design.

Major Equipment Units:

Equipment Item	Quantity	Capacity	Notes/Comments
Surge Tank	2	460,000 Gallons	An extra unit is provided for redundancy.
Wastewater Holding Tank	2	80,000 Gallons	
Water Storage Tank	1	1.25 Million Gallons	

Chemical Feed Storage/ Feed Systems:

Equipment Item	Quantity	Capacity	Notes/Comments
Liquid Chlorine Storage Tank	2	2,000 Gallons	An extra unit is provided for redundancy.
Liquid Chlorine Feed (Pump)	2	Chlorination: 10 gph	

Buildings:

Building	Quantity	Size	Notes/Comments
Administration/Control Building	1	25' Width x 40' Length	Office and control room
Chemical Building	1	25' Width x 40' Length	Chemicals and chemical feed systems
Desalination System	1	60' Width x 100' Length	Pretreatment and RO system

Redundancy is provided in the water treatment system to avoid or minimize shutdowns due to equipment failures. All process equipment units, pumps and chemical feed pumps are provided with redundancy.

Treatment Plant Operation and Maintenance

The water treatment systems will require the operator's attention. Anticipated O&M activities are summarized below.

Routine Operation Activities:

- Prepare operation daily log sheets and record daily operation activities.
- Check the amount of the chemicals remaining in the storage tanks and order them in advance. There should be a sufficient inventory of the chemicals for water treatment.
- Respond properly in a timely fashion when alarm goes off, in accordance with the standard operations procedure.
- Follow the equipment manufacturers' operation recommendations.

Routine Maintenance:

- Prepare maintenance log sheets and record maintenance activities. Frequent maintenance is not anticipated but the moving parts of the equipment items will need periodic maintenance.
- Follow the equipment manufacturers' maintenance recommendations.

In addition, the operator should avoid any direct contact with the chemicals and must follow the health and safety plan.

The area required for installation of the proposed process units and support systems is expected to be similar to the area required for the Option 1 water treatment plant, 225,100 ft^2.

6.5.2.3 DISTRIBUTION SYSTEM

Distribution system components are incorporated into the water system using the approach discussed in Section 6.2.2.3.

- Raw Water Transmission Mains
- Well Pumping Stations
- High Lift Pumping Equipment
- Water Distribution System on the MCB
- Treated Water Transmission Mains
- Water Storage
- Andersen South Developments
- Navy Island-wide Water System Connections and Improvements

6.5.3 Costs

Details of the cost estimate are provided in Appendix C.

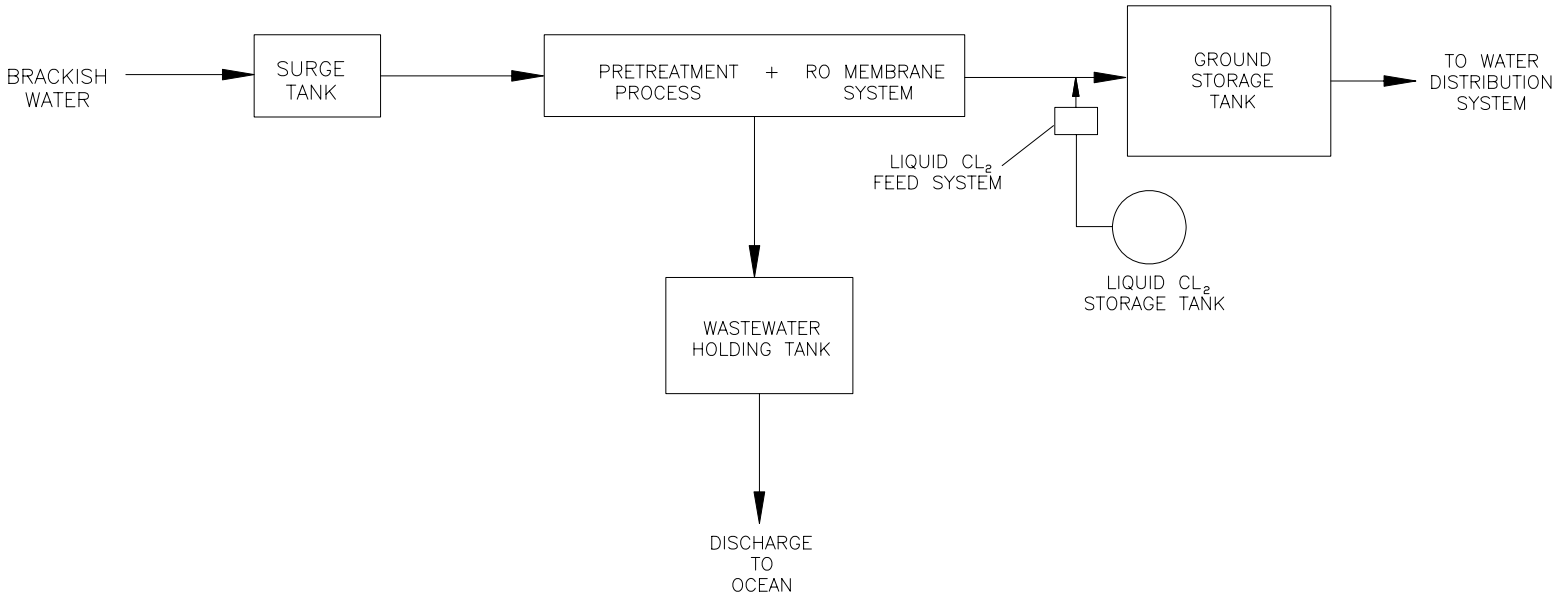
The capital costs for Option 8 are:

Capital Costs	$000
1) Water Resources Development	$34,133
2) Water Treatment	$125,360
3) Distribution	$350,434
Total Construction Cost without contingency	$509,927
Contingencies (20%)	$101,985
Engineering (15%)	$76,489
Total Capital Cost (with contingency and engineering)	**$688,401**
Present Worth Guam Capital Costs	**$693,800**

The O&M costs for Option 8 are:

O&M Costs	$000
1) Water Resources Development	$427
2) Water Treatment	$12,689
3) Distribution	$3,239
Total Annual O&M Cost without contingency	$16,355
Contingency (20%)	$3,271
Total Annual O&M Cost	**$19,626**
Present Worth of O&M Costs (25 year life)	$468,383

The total present worth of life cycle costs for Option 8 is $1.2B.



Note: Freshwater from the existing Navy wells is combined with the water from the brackish water supply wells.

Prepared by: EarthTech, A Tyco International Ltd. Company

Prepared for: NAVFAC, Naval Facilities Engineering Command, NAVFAC PACIFIC

GUAM UTILITY STUDY

Option 8 Water Treatment Process
Flow Block Diagram

Date:	Scale:	Figure No. :
7/14/08	Not to scale	6-15

6.5.4 Discussion

Desalination is technically feasible, but is more costly than use of freshwater (Option 1) and has a significant power demand. A detailed study including data collection and modeling would be necessary to identify the location of wells to minimize upcoming and influence on freshwater wells. The preferred location of the brackish water supply wells, is within 1,000 ft of shore, placing the wells in areas that may be identified as environmentally sensitive or in areas designated for future military operations. A pilot study for the desalination should be implemented prior to optimize the process and determine the best performance in terms of cost, system reliability, and water quality. Desalination is not recommended for further consideration, because the available information indicates that installation of freshwater supply wells will more cost-effectively meet the additional DoD water demands in the north with less risk to the aquifer, and there are adequate groundwater resources to meet the anticipated demand from DoD and GWA.

Appendix C
Calculations

				Feb. 2008 Population Increases										*Total 2019*
Project Relation	**Location**	**Population Type**	**Baseline**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**Total**
USMC Relocation Alt 1	Finegayan	Active duty	33	535	1,220	1,220	1,220	8,602	9,182	9,182	9,182	9,182	9,182	9,215
USMC Relocation Alt 1	Finegayan	Dependents	52	537	1,231	1,231	1,231	9,000	9,950	9,950	9,950	9,950	9,950	10,002
USMC Relocation Alt 1	Finegayan	Transient	0	0	400	400	400	2,000	2,000	2,000	2,000	2,000	2,000	2,000
USMC Relocation Alt 1	Finegayan	Civilian Work Force	12	102	244	244	244	1,720	1,836	1,836	1,836	1,836	1,836	1,848
		Finegayan Total	**97**	**1,174**	**3,095**	**3,095**	**3,095**	**21,322**	**22,968**	**22,968**	**22,968**	**22,968**	**22,968**	**23,065**
USMC Relocation Alt 3/8	Finegayan	Active duty	33	395	884	884	884	6,239	6,659	6,659	6,659	6,659	6,659	6,692
USMC Relocation Alt 3/8	Finegayan	Dependents	52	179	410	410	410	3,000	3,317	3,317	3,317	3,317	3,317	3,369
USMC Relocation Alt 3/8	Finegayan	Commuters from Barrigada	0	140	335	335	335	2,364	2,523	2,523	2,523	2,523	2,523	2,523
USMC Relocation Alt 3/8	Finegayan	Transient	0	0	400	400	400	2,000	2,000	2,000	2,000	2,000	2,000	2,000
USMC Relocation Alt 3/8	Finegayan	Civilian Work Force	12	92	220	220	220	1,548	1,653	1,653	1,653	1,653	1,653	1,665
		Finegayan Total	**97**	**806**	**2,249**	**2,249**	**2,249**	**15,151**	**16,152**	**16,152**	**16,152**	**16,152**	**16,152**	**16,249**
USMC Relocation Alt 3/8	Barrigada	Active duty	0	140	335	335	335	2,364	2,523	2,523	2,523	2,523	2,523	2,523
USMC Relocation Alt 3/8	Barrigada	Dependents	0	358	821	821	821	6,000	6,633	6,633	6,633	6,633	6,633	6,633
USMC Relocation Alt 3/8	Barrigada	Transient	0	0	0	0	0	0	0	0	0	0	0	0
USMC Relocation Alt 3/8	Barrigada	Civilian Work Force	0	10	24	24	24	172	184	184	184	184	184	184
		Barrigada Total	**0**	**508**	**1,180**	**1,180**	**1,180**	**8,536**	**9,340**	**9,340**	**9,340**	**9,340**	**9,340**	**9,340**
non-USMC Relocation	Andersen AFB	Active duty	2,145	80	80	80	80	120	120	120	120	120	120	2,265
non-USMC Relocation	Andersen AFB	Dependents	2,950	118	118	118	118	210	210	210	210	210	210	3,160
non-USMC Relocation	Andersen AFB	Transient	0	900	900	1,256	1,256	1,256	1,256	1,256	1,256	1,256	1,780	1,780
non-USMC Relocation	Andersen AFB	Civilian Work Force	805	17	17	17	17	25	25	25	25	25	25	830
		Andersen AFB Total	**5,900**	**1,115**	**1,115**	**1,471**	**1,471**	**1,611**	**1,611**	**1,611**	**1,611**	**1,611**	**2,135**	**8,035**
non-USMC Relocation	Remaining Navy	Active duty	4,490	0	0	0	50	50	130	130	130	130	330	4,820
non-USMC Relocation	Remaining Navy	Dependents	5,410	0	0	0	30	30	80	80	80	80	80	5,490
non-USMC Relocation	Remaining Navy	Transient	0	0	0	0	0	0	0	0	0	0	0	0
non-USMC Relocation	Remaining Navy	Civilian Work Force	1,684	0	0	0	10	10	13	13	13	13	20	1,704
		Remaining Navy Total	**11,584**	**0**	**0**	**0**	**90**	**90**	**223**	**223**	**223**	**223**	**430**	**12,014**

Notes:

1. CVN 7222 transients not included in water demand since housed on ships.
2. Civilian Work Force does not include construction workers
3. Finegayan transients for Alternative 3/8 include USMC commuting from Barrigada.

Population Increases Re-organized — *Total 2019*

Project Relation	Location	Population Type	Baseline	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total
USMC Relocation Alt 1	Finegayan	Family Housing	73	752	1,723	1,723	1,723	12,600	13,930	13,930	13,930	13,930	13,930	14,003
USMC Relocation Alt 1	Finegayan	Unaccompanied Resident	12	320	728	728	728	5,002	5,202	5,202	5,202	5,202	5,202	5,214
USMC Relocation Alt 1	Finegayan	Transient	0	0	400	400	400	2,000	2,000	2,000	2,000	2,000	2,000	2,000
USMC Relocation Alt 1	Finegayan	Civilian Work Force	12	102	244	244	244	1,720	1,836	1,836	1,836	1,836	1,836	1,848
		Finegayan Total	**97**	**1,174**	**3,095**	**3,095**	**3,095**	**21,322**	**22,968**	**22,968**	**22,968**	**22,968**	**22,968**	**23,065**
USMC Relocation Alt 3/8	Finegayan	Family Housing	73	251	574	574	574	4,200	4,644	4,644	4,644	4,644	4,644	4,717
USMC Relocation Alt 3/8	Finegayan	Unaccompanied Resident	12	323	720	720	720	5,039	5,332	5,332	5,332	5,332	5,332	5,344
USMC Relocation Alt 3/8	Finegayan	Transient	0	140	735	735	735	4,364	4,523	4,523	4,523	4,523	4,523	4,523
USMC Relocation Alt 3/8	Finegayan	Civilian Work Force	12	92	220	220	220	1,548	1,653	1,653	1,653	1,653	1,653	1,665
		Finegayan Total	**97**	**806**	**2,249**	**2,249**	**2,249**	**15,151**	**16,152**	**16,152**	**16,152**	**16,152**	**16,152**	**16,249**
USMC Relocation Alt 3/8	Barrigada	Family Housing	0	498	1,156	1,156	1,156	8,364	9,156	9,156	9,156	9,156	9,156	9,156
USMC Relocation Alt 3/8	Barrigada	Unaccompanied Resident	0	0	0	0	0	0	0	0	0	0	0	0
USMC Relocation Alt 3/8	Barrigada	Transient	0	0	0	0	0	0	0	0	0	0	0	0
USMC Relocation Alt 3/8	Barrigada	Civilian Work Force	0	10	24	24	24	172	184	184	184	184	184	184
		Barrigada Total	**0**	**508**	**1,180**	**1,180**	**1,180**	**8,536**	**9,340**	**9,340**	**9,340**	**9,340**	**9,340**	**9,340**
non-USMC Relocation	Andersen AFB	Family Housing	4,130	165	165	165	165	294	294	294	294	294	294	4,424
non-USMC Relocation	Andersen AFB	Unaccompanied Resident	965	33	33	33	33	36	36	36	36	36	36	1,001
non-USMC Relocation	Andersen AFB	Transient	0	900	900	1,256	1,256	1,256	1,256	1,256	1,256	1,256	1,780	1,780
non-USMC Relocation	Andersen AFB	Civilian Work Force	805	17	17	17	17	25	25	25	25	25	25	830
		Andersen AFB Total	**5,900**	**1,115**	**1,115**	**1,471**	**1,471**	**1,611**	**1,611**	**1,611**	**1,611**	**1,611**	**2,135**	**8,035**
non-USMC Relocation	Remaining Navy	Family Housing	7,574	0	0	0	42	42	112	112	112	112	112	7,686
non-USMC Relocation	Remaining Navy	Unaccompanied Resident	2,326	0	0	0	38	38	98	98	98	98	298	2,624
non-USMC Relocation	Remaining Navy	Transient	0	0	0	0	0	0	0	0	0	0	0	0
non-USMC Relocation	Remaining Navy	Civilian Work Force	1,684	0	0	0	10	10	13	13	13	13	20	1,704
		Remaining Navy Total	**11,584**	**0**	**0**	**0**	**90**	**90**	**223**	**223**	**223**	**223**	**430**	**12,014**

Total Populations

Project Relation	Location	Population Type	Baseline	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
USMC Relocation Alt 1	Finegayan	Family Housing	73	825	1,796	1,796	1,796	12,673	14,003	14,003	14,003	14,003	14,003
USMC Relocation Alt 1	Finegayan	Unaccompanied Resident	12	332	740	740	740	5,014	5,214	5,214	5,214	5,214	5,214
USMC Relocation Alt 1	Finegayan	Transient	0	0	400	400	400	2,000	2,000	2,000	2,000	2,000	2,000
USMC Relocation Alt 1	Finegayan	Civilian Work Force (on base)	12	114	256	256	256	1,732	1,848	1,848	1,848	1,848	1,848
		Finegayan Total	**97**	**1,271**	**3,192**	**3,192**	**3,192**	**21,419**	**23,065**	**23,065**	**23,065**	**23,065**	**23,065**
USMC Relocation Alt 3/8	Finegayan	Family Housing	73	323	647	647	647	4,273	4,717	4,717	4,717	4,717	4,717
USMC Relocation Alt 3/8	Finegayan	Unaccompanied Resident	12	336	732	732	732	5,051	5,344	5,344	5,344	5,344	5,344
USMC Relocation Alt 3/8	Finegayan	Transient	0	140	735	735	735	4,364	4,523	4,523	4,523	4,523	4,523
USMC Relocation Alt 3/8	Finegayan	Civilian Work Force	12	104	232	232	232	1,560	1,665	1,665	1,665	1,665	1,665
		Finegayan Total	**97**	**903**	**2,346**	**2,346**	**2,346**	**15,248**	**16,249**	**16,249**	**16,249**	**16,249**	**16,249**
USMC Relocation Alt 3/8	Barrigada	Family Housing	0	498	1,156	1,156	1,156	8,364	9,156	9,156	9,156	9,156	9,156
USMC Relocation Alt 3/8	Barrigada	Unaccompanied Resident	0	0	0	0	0	0	0	0	0	0	0
USMC Relocation Alt 3/8	Barrigada	Transient	0	0	0	0	0	0	0	0	0	0	0
USMC Relocation Alt 3/8	Barrigada	Civilian Work Force	0	10	24	24	24	172	184	184	184	184	184
		Barrigada Total	**0**	**508**	**1,180**	**1,180**	**1,180**	**8,536**	**9,340**	**9,340**	**9,340**	**9,340**	**9,340**
non-USMC Relocation	Andersen AFB	Family Housing	4,130	4,295	4,295	4,295	4,295	4,424	4,424	4,424	4,424	4,424	4,424
non-USMC Relocation	Andersen AFB	Unaccompanied Resident	965	998	998	998	998	1,001	1,001	1,001	1,001	1,001	1,001
non-USMC Relocation	Andersen AFB	Transient	0	900	900	1,256	1,256	1,256	1,256	1,256	1,256	1,256	1,780
non-USMC Relocation	Andersen AFB	Civilian Work Force	805	822	822	822	822	830	830	830	830	830	830
		Andersen AFB Total	**5,900**	**7,015**	**7,015**	**7,371**	**7,371**	**7,511**	**7,511**	**7,511**	**7,511**	**7,511**	**8,035**
non-USMC Relocation	Remaining Navy	Family Housing	7,574	7,574	7,574	7,574	7,616	7,616	7,686	7,686	7,686	7,686	7,686
non-USMC Relocation	Remaining Navy	Unaccompanied Resident	2,326	2,326	2,326	2,326	2,364	2,364	2,424	2,424	2,424	2,424	2,624
non-USMC Relocation	Remaining Navy	Transient	0	0	0	0	0	0	0	0	0	0	0
non-USMC Relocation	Remaining Navy	Civilian Work Force	1,684	1,684	1,684	1,684	1,694	1,694	1,697	1,697	1,697	1,697	1,704
		Remaining Navy Total	**11,584**	**11,584**	**11,584**	**11,584**	**11,674**	**11,674**	**11,807**	**11,807**	**11,807**	**11,807**	**12,014**

Average Daily Domestic Demand (gpd)

Location	Population Type	Require-ments (gpcd)	Additional for CVN et al (gpd)	Baseline	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019 Growth Factor	Sustain-abilty Factor	2019
Alt. 1 Finegayan	Family Housing	180		13,104	148,428	323,316	323,316	323,316	2,281,104	2,520,504	2,520,504	2,520,504	2,520,504			3,150,630
Alt. 1 Finegayan	Unaccompanied Resident	155		1,891	51,522	114,669	114,669	114,669	777,201	808,201	808,201	808,201	808,201			1,010,251
Alt. 1 Finegayan	Transient	70		0	0	28,000	28,000	28,000	140,000	140,000	140,000	140,000	140,000			175,000
Alt. 1 Finegayan	Civilian Work Force	45		540	5,130	11,520	11,520	11,520	77,940	83,160	83,160	83,160	83,160			103,950
	Finegayan Total			**15,535**	**205,080**	**477,505**	**477,505**	**477,505**	**3,276,245**	**3,551,865**	**3,551,865**	**3,551,865**	**3,551,865**	**1.25**	**0%**	**4,439,831**
Alt. 3/8 Finegayan	Family Housing	180		13,104	58,212	116,424	116,424	116,424	769,104	848,988	848,988	848,988	848,988			1,061,235
Alt. 3/8 Finegayan	Unaccompanied Resident	155		1,891	52,018	113,491	113,491	113,491	782,936	828,382	828,382	828,382	828,382			1,035,478
Alt. 3/8 Finegayan	Transient	70		0	9,800	51,450	51,450	51,450	305,480	316,610	316,610	316,610	316,610			395,763
Alt. 3/8 Finegayan	Civilian Work Force	45		540	4,680	10,440	10,440	10,440	70,200	74,925	74,925	74,925	74,925			93,656
	Finegayan Total			**15,535**	**124,710**	**291,805**	**291,805**	**291,805**	**1,927,720**	**2,068,905**	**2,068,905**	**2,068,905**	**2,068,905**	**1.25**	**0%**	**2,586,131**
Alt. 3/8 Barrigada	Family Housing	180		0	89,640	208,080	208,080	208,080	1,505,520	1,648,080	1,648,080	1,648,080	1,648,080			2,060,100
Alt. 3/8 Barrigada	Unaccompanied Resident	155		0	0	0	0	0	0	0	0	0	0			0
Alt. 3/8 Barrigada	Transient	70		0	0	0	0	0	0	0	0	0	0			0
Alt. 3/8 Barrigada	Civilian Work Force	45		0	450	1,080	1,080	1,080	7,740	8,280	8,280	8,280	8,280			10,350
	Barrigada Total			**0**	**90,090**	**209,160**	**209,160**	**209,160**	**1,513,260**	**1,656,360**	**1,656,360**	**1,656,360**	**1,656,360**	**1.25**	**0%**	**2,070,450**
Andersen AFB	Family Housing	180		743,400	773,136	773,136	773,136	773,136	796,320	796,320	796,320	796,320	796,320			995,400
Andersen AFB	Unaccompanied Resident	155		149,575	154,659	154,659	154,659	154,659	155,155	155,155	155,155	155,155	155,155			193,944
Andersen AFB	Transient	70		0	63,000	63,000	87,920	87,920	87,920	87,920	87,920	87,920	87,920			155,750
Andersen AFB	Civilian Work Force	45		36,225	36,990	36,990	36,990	36,990	37,350	37,350	37,350	37,350	37,350			46,688
	Andersen AFB Total			**929,200**	**1,027,785**	**1,027,785**	**1,052,705**	**1,052,705**	**1,076,745**	**1,076,745**	**1,076,745**	**1,076,745**	**1,076,745**	**1.25**	**0%**	**1,391,781**
Remaining Navy	Family Housing	180		1,363,320	1,363,320	1,363,320	1,363,320	1,370,880	1,370,880	1,383,480	1,383,480	1,383,480	1,383,480			1,729,350
Remaining Navy	Unaccompanied Resident	155		360,530	360,530	360,530	360,530	366,420	366,420	375,720	375,720	375,720	375,720			508,400
Remaining Navy	Transient	70	443,800	0	0	0	0	0	0	443,800	443,800	443,800	443,800			443,800
Remaining Navy	Civilian Work Force	45		75,780	75,780	75,780	75,780	76,230	76,230	76,359	76,359	76,359	76,359			95,850
	Apra Harbor Total			**1,799,630**	**1,799,630**	**1,799,630**	**1,799,630**	**1,813,530**	**1,813,530**	**2,279,359**	**2,279,359**	**2,279,359**	**2,279,359**	**1.25**	**0%**	**2,777,400**

Notes:

1. Growth Factor is only applied for 2019

Average Daily Domestic Demand (mgd)

Population Type		Baseline	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Project Alt 1	Finegayan	0.02	0.21	0.48	0.48	0.48	3.28	3.55	3.55	3.55	3.55	4.44
Project Alt 3/8	Finegayan	0.02	0.12	0.29	0.29	0.29	1.93	2.07	2.07	2.07	2.07	2.59
Project Alt 3/8	Barrigada	0.00	0.09	0.21	0.21	0.21	1.51	1.66	1.66	1.66	1.66	2.07
Non-Project	Andersen AFB	0.93	1.03	1.03	1.05	1.05	1.08	1.08	1.08	1.08	1.08	1.39
Non-Project	Remaining Navy	1.80	1.80	1.80	1.80	1.81	1.81	2.28	2.28	2.28	2.28	2.78

Industrial Daily Demands (mgd)

Population Type		Baseline	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Project Alt 1	Finegayan	0.10	0.10	0.48	0.85	1.23	1.23	1.23	1.23	1.23	1.23	1.23
Project Alt 3/8	Finegayan	0.10	0.10	0.46	0.82	1.17	1.17	1.17	1.17	1.17	1.17	1.17
Project Alt 3/8	Barrigada	0.00	0.00	0.02	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Non-Project	Andersen AFB	0.76	0.76	0.84	0.92	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Non-Project	Remaining Navy	3.80	3.80	4.06	4.33	4.60	4.60	4.60	4.60	4.60	4.60	4.60

Notes:

1. Barrigada industrial demands unrelated to the USMC relocation are included in the Remaining Navy estimates.

Average Daily Unaccounted For Water - UFW (mgd)

Population Type		Baseline	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Project Alt 1	Finegayan	0.02	0.02	0.05	0.07	0.09	0.23	0.24	0.24	0.24	0.24	0.28
Project Alt 3/8	Finegayan	0.02	0.01	0.04	0.06	0.07	0.16	0.16	0.16	0.16	0.16	0.19
Project Alt 3/8	Barrigada	0.00	0.00	0.01	0.01	0.01	0.08	0.09	0.09	0.09	0.09	0.11
Non-Project	Andersen AFB	0.84	0.89	0.93	0.98	1.02	1.04	1.04	1.04	1.04	1.04	1.19
Non-Project	Remaining Navy	1.95	1.95	1.99	2.03	2.07	2.07	2.14	2.14	2.14	2.14	2.21

Notes:

1. New systems with extensive metering and new technology are expected to reduce system leakage losses from standard 15% to 5% at USMC Relocation Areas
2. Improvements to the current systems are expected to reduce system leakage losses on new sources to the standard 15%.
3. Existing UFW from Barrigada are included in the Remaining Navy estimates.

Average Daily Demand (mgd)

Population Type		Baseline	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Project Alt 1	Finegayan	0.13	0.32	1.00	1.40	1.79	4.73	5.02	5.02	5.02	5.02	5.95
Project Alt 3/8	Finegayan	0.13	0.24	0.79	1.16	1.54	3.26	3.40	3.40	3.40	3.40	3.95
Project Alt 3/8	Barrigada	0.00	0.09	0.24	0.26	0.28	1.65	1.80	1.80	1.80	1.80	2.23
Non-Project	Andersen AFB	2.14	2.29	2.41	2.56	2.68	2.71	2.71	2.71	2.71	2.71	3.19
Non-Project	Remaining Navy	8.10	8.10	8.41	8.71	9.03	9.03	9.57	9.57	9.57	9.57	10.14

UFC Based Average Daily Demand (mgd)

Non-Project	Andersen AFB	2.53	2.68	2.80	2.95	3.07	3.11	3.11	3.11	3.11	3.11	3.58
Non-Project	Remaining Navy	7.55	7.55	7.85	8.16	8.48	8.48	9.01	9.01	9.01	9.01	9.59

UFC Based Average Daily Demand (mgd) Addition over Baseline

Non-Project	Andersen AFB	0.00	0.15	0.27	0.42	0.54	0.57	0.57	0.57	0.57	0.57	1.05
Non-Project	Remaining Navy	0.00	0.00	0.31	0.61	0.93	0.93	1.47	1.47	1.47	1.47	2.04

Maximum Day Factor - Coefficient K (mgd)

Population Type		Baseline	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Project Alt 1	Finegayan	2.25	2.25	2.25	2.25	2.25	2.00	2.00	2.00	2.00	2.00	2.00
Project Alt 3/8	Finegayan	2.25	2.25	2.25	2.25	2.25	2.00	2.00	2.00	2.00	2.00	2.00
Project Alt 3/8	Barrigada	2.25	2.25	2.25	2.25	2.25	2.00	2.00	2.00	2.00	2.00	2.00
Non-Project	Andersen AFB	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Non-Project	Apra Harbor	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00

Maximum Daily Domestic Demand (mgd)

Population Type		Baseline	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Project Alt 1	Finegayan	0.03	0.46	1.07	1.07	1.07	6.55	7.10	7.10	7.10	7.10	8.88
Project Alt 3/8	Finegayan	0.03	0.28	0.66	0.66	0.66	3.86	4.14	4.14	4.14	4.14	5.17
Project Alt 3/8	Barrigada	0.00	0.20	0.47	0.47	0.47	3.03	3.31	3.31	3.31	3.31	4.14
Non-Project	Andersen AFB	1.86	2.06	2.06	2.11	2.11	2.15	2.15	2.15	2.15	2.15	2.78
Non-Project	Remaining Navy	3.60	3.60	3.60	3.60	3.63	3.63	4.56	4.56	4.56	4.56	5.55

Maximum Daily UFW (mgd)

Population Type		Baseline	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Project Alt 1	Finegayan	0.02	0.03	0.08	0.10	0.12	0.39	0.42	0.42	0.42	0.42	0.51
Project Alt 3/8	Finegayan	0.02	0.02	0.06	0.07	0.09	0.25	0.27	0.27	0.27	0.27	0.32
Project Alt 3/8	Barrigada	0.00	0.01	0.02	0.03	0.03	0.15	0.17	0.17	0.17	0.17	0.21
Non-Project	Andersen AFB	1.31	1.41	1.45	1.51	1.55	1.57	1.57	1.57	1.57	1.57	1.89
Non-Project	Remaining Navy	1.95	1.95	1.99	2.03	2.07	2.07	2.21	2.21	2.21	2.21	2.36

Notes:

1. New systems with extensive metering and new technology are expected to reduce system leakage losses from standard 15% to 5% at USMC Relocation Areas
2. Improvements to the current systems are expected to reduce system leakage losses on new sources to the standard 15%.
3. Existing UFW from Barrigada are included in the Remaining Navy estimates.

Maximum Daily Demand (mgd)

Population Type		Baseline	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Project Alt 1	Finegayan	0.16	0.59	1.63	2.02	2.42	8.17	8.75	8.75	8.75	8.75	10.6
Project Alt 3/8	Finegayan	0.16	0.40	1.17	1.55	1.92	5.28	5.58	5.58	5.58	5.58	6.7
Project Alt 3/8	Barrigada	0.00	0.21	0.51	0.53	0.55	3.24	3.54	3.54	3.54	3.54	4.4
Non-Project	Andersen AFB	3.14	3.44	3.55	3.75	3.86	3.94	3.94	3.94	3.94	3.94	4.88
Non-Project	Remaining Navy	9.82	9.82	10.13	10.43	10.77	10.77	11.84	11.84	11.84	11.84	12.98

UFC Based Maximum Daily Demand (mgd)

Non-Project	Andersen AFB	3.93	4.22	4.34	4.53	4.65	4.72	4.72	4.72	4.72	4.72	5.7
Non-Project	Remaining Navy	9.35	9.35	9.65	9.96	10.29	10.29	11.37	11.37	11.37	11.37	12.5

UFC Based Maximum Daily Demand (mgd) Addition over Baseline

Non-Project	Andersen AFB	0.00	0.30	0.41	0.61	0.72	0.80	0.80	0.80	0.80	0.80	1.74
Non-Project	Remaining Navy	0.00	0.00	0.31	0.61	0.95	0.95	2.02	2.02	2.02	2.02	3.17

Population Type		Baseline	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
AF Average Daily Demand (mgd) - Based on Billing 10/09-4/10:							1,426,859	gpd				
Average Daily Domestic Demand		666,859										
UFW	50%	713,429										
AF Average Daily Demand (mgd)		2.14										
Navy Average Daily Demand (mgd) - Based on Avg. Production:							11.7	mgd				
Average Daily Domestic Demand		1.38				GWA	3.60					
						UFW 25%	2.93					
AF Average Daily Demand (mgd)		8.10				Industrial	3.80					
AF Maximum Daily Demand (mgd) - Based on Billing 10/09-4/10												
Maximum Daily Domestic Demand		1,333,717										
UFW	50%	1,046,859										
AF Maximum Daily Demand (mgd)		3.14										
Navy Average Daily Demand (mgd) - Based on Avg. Production												
Maximum Daily Domestic Demand		2.75										
UFW	25%	3.27										
AF Maximum Daily Demand (mgd)		9.82										

Storage Requirements 2019	Alt 1 Finegayan	Alt 3 Finegayan	Alt 3 N Barr	AAFB	Navy	Alt 3 AF Barr
Maximum Fire Demand (gpm) from JGMMP	7,500	7,500	1,125	7,500	3,000	1,125
Duration (min)	150	150	90	150	150	90
Fire Demand Storage (gal)	1,125,000	1,125,000	101,250	1,125,000	450,000	101,250
Avg Daily Demand (mgd)	6.0	3.9	2.3	3.2	10.1	1.1
50% Avg Daily Use (gpd)	2,975,940	1,973,903	1,156,570	1,593,667	5,070,344	571,378
1 hour of Average Daily Use (gal)	247,995	164,492	96,381	132,806	422,529	47,615
Minimum Storage Required (gal)	4,348,935	3,263,395	1,354,200	2,851,472	5,942,873	720,242
Minimum Storage Required (mg)	**4.3**	**3.3**	**1.4**	**2.9**	**5.9**	**0.7**

Ind N Barr	1167765	gpd
Ind AF Barr	53113.3	gpd
UFW	5%	

Storage Requirements 2010	Finegayan	AAFB	Navy
Maximum Fire Demand (gpm) from JGMMP	7,500	7,500	3,000
Duration (min)	150	150	150
Fire Demand Storage (gal)	1,125,000	1,125,000	450,000
Avg Daily Demand (mgd)	0.1	2.1	8.1
50% Avg Daily Use (gpd)	66,433	1,070,144	4,050,000
1 hour of Average Daily Use (gal)	5,536	89,179	337,500
Minimum Storage Required (gal)	1,196,969	2,284,323	4,837,500
Minimum Storage Required (mg)	**1.2**	**2.3**	**4.8**

UIC: BASE											
MEF Component: BASE											
Unit Name: MCB Guam											
							Industrial Demand		Fire Protection		
										Duration	
					For A/C	GPD	Source	Classification	Minimum Flow	Supply	Total Gallon
FAC	CCN	Nomenclature	BFR	UM	Ton			of Occupancy	GPM	Min	
1231	12310	Filling Station	6	OL		0		Hazard Group 1	1,500	120	180,000
1444	12315	Filling Station Building	65	SF	0.11	3		Hazard Group 1	1,500	120	180,000
1241	12450	Vehicle Ready Fuel Storage	88,000	GA		0		Hazard Group 1	1,500	120	180,000
1444	14320	Ordnance Operations Building	15,100	SF	25.17	755	Cal includes only A/C req and based on SF	Hazard Group 2	2,250	90	202,500
1446	14347	Alert Force Building	6,000	SF	10	300	Cal includes only A/C req and based on SF	Hazard Group 1	1,500	120	180,000
1442	14375	POL Operation/Sampling Building	4,300	SF	7.17	215	Cal includes only A/C req and based on SF	Hazard Group 1	1,500	120	180,000
1443	14378	Operation Haz Flam Material Storage	2,050	SF	3.42	102.6	Cal includes only A/C req and based on SF	Extra	3,750	150	562,500
1591	15966	Landing Craft Ramp	2	EA		0					0
7431	17125	General Purpose Auditorium	6,000	SF	10	300	Cal includes only A/C req and based on SF				0
1718	17150	Indoor Arms Range	20	FP		0					0
1741	17410	Maneuver/Training Area (Light)	1,000	AC		0					0
1751	17510	Battle Sight Zero Range	75	FP		0		Hazard Group 2	2,250	90	202,500
1755	17550	Rifle Known Distance Range	75	FP		0		Hazard Group 2	2,250	90	202,500
1758	17581	Machine Gun Field Fire Range	20	FP		0		Hazard Group 2	2,250	90	202,500
1767	17670	Mortar Range	1	EA		0		Hazard Group 2	2,250	90	202,500
1773	17730	Fire and Movement Range	14	LN		0		Hazard Group 2	2,250	90	202,500
1781	17810	Hand Grenade Range	8	FP		0		Hazard Group 2	2,250	90	202,500
1782	17820	Engineer Range	8	FP		0		Hazard Group 2	2,250	90	202,500
1790	17950	Training Course	6	EA		0		Hazard Group 2	2,250	90	202,500
1725	17955	Combat Training Pool/Tank	65	EA		325,000	Assume 5000 gpd /tank (similar to swimming pool)				0
1796	17963	MOUT (Large)	1	EA		0		Hazard Group 2	2,250	90	202,500
2118	21181	Engine Test Cell	1	EA		0		Hazard Group 2	2,250	90	202,500
2141	21420	Automotive Maintenance Shop	22,400	SF		1,400	Apra Harbor Naval Complex	Hazard Group 1	1,500	90	135,000
1444	21440	Vehicle Holding Shed	2,940	SF	4.9	147	Cal includes only A/C req and based on SF	Hazard Group 1	1,500	90	135,000
2145	21455	Vehicle Wash Platform	4	EA		0		Hazard Group 1	1,500	90	135,000
2145	21456	Vehicle Grease Rack	2	EA		0		Hazard Group 1	1,500	90	135,000
2182	21820	Construction Weight Handling Equip Shop	5,600	SF	9.33	279.9	Cal includes only A/C req and based on SF	Hazard Group 1	1,500	90	135,000
2191	21910	Public Works Shop	28,300	SF	47.17	1,415	Cal includes only A/C req and based on SF	Hazard Group 1	1,500	90	135,000

							Industrial Demand		Fire Protection		
										Duration	
					For A/C	GPD	Source	Classification	Minimum Flow	Supply	Total Gallon
FAC	CCN	Nomenclature	BFR	UM	Ton			of Occupancy	GPM	Min	
2191	21977	Public Works Storage	16,000	SF	26.67	800	Cal includes only A/C req and based on SF	Hazard Group 1	1,500	90	135,000
4311	43110	Cold Storage Warehouse	9,200	SF	15.33	460	Cal includes only A/C req and based on SF	Hazard Group 1	1,500	90	135,000
4422	44135	General Storage Shed	18,200	SF	30.33	910	Cal includes only A/C req and based on SF	Hazard Group 1	1,500	90	135,000
4521	45110	Open Storage (Vehicle/Equip Parking)	123,750	SY		0		Hazard Group 1	1,500	90	60,000
5500	55010	Medical Clinic	26,850	SF	44.75	1342.5	Cal includes only A/C req and based on SF	Light Hazard	1,125	90	101,250
6100	61010	Administrative Office	94,810	SF		4,500	Estimate based on North Finegayan	Light Hazard	1,125	90	101,250
7210	72124	Bachelor Enlisted Quarters E1-E3	709,148	SF	1181.91	35,457	Cal includes only A/C req and based on SF	Light Hazard	1,125	90	101,250
7210	72125	Bachelor Enlisted Quarters E4-E5	483,784	SF	806.31	24,189	Cal includes only A/C req and based on SF	Light Hazard	1,125	90	101,250
7210	72126	Bachelor Enlisted Quarters E6-E9	93,786	SF	156.31	4,689	Cal includes only A/C req and based on SF	Light Hazard	1,125	90	101,250
7441	72152	Transient Personnel Unit Quarters E5-E6	5,850	SF	9.75	293	Cal includes only A/C req and based on SF	Light Hazard	750	60	45,000
7220	72210	Enlisted Dining Facility	47,145	SF	78.58	2357.4	Cal includes only A/C req and based on SF	Light Hazard	750	60	45,000
7240	72411	Bachelor Officer Quarters, W1-O2	74,745	SF	124.58	3,737	Cal includes only A/C req and based on SF	Light Hazard	1,125	90	101,250
7240	72412	Bachelor Officer Quarters, O3 & above	30,225	SF	50.38	1,511	Cal includes only A/C req and based on SF	Light Hazard	750	60	45,000
7311	73010	Fire Station	30,170	SF	50.28	1508.4	Cal includes only A/C req and based on SF	Light Hazard	750	60	45,000
7343	73013	Issue-Uniform Center	7,203	SF	12.01	360	Cal includes only A/C req and based on SF	Light Hazard	750	60	45,000
7312	73015	Brig Confinement	23,220	SF	38.7	1,161	Cal includes only A/C req and based on SF	Light Hazard	750	60	45,000
7313	73020	Police Station	15,620	SF	26.03	781	Cal includes only A/C req and based on SF	Light Hazard	750	60	45,000
1498	73025	Gate/Sentry House	248	SF	0.41	12	Cal includes only A/C req and based on SF	Light Hazard	750	60	45,000
7352	73050	Dependent School-Kindergarten	50,160	SF	83.6	2508	Cal includes only A/C req and based on SF	Light Hazard	1,125	90	101,250
7352	73055	Dependent School, 1 through 6	420,850	SF	701.42	21042.6	Cal includes only A/C req and based on SF	Light Hazard	1,124	90	101,160
7352	73060	Dependent School, High	262,500	SF	437.5	13125	Cal includes only A/C req and based on SF	Light Hazard	1,125	90	101,250
7384	73066	Personnel Weather Shelter	15,300	SF	25.5	765	Cal includes only A/C req and based on SF	Light Hazard	750	60	45,000
1445	73076	Kennel	450	SF	0.75	23	Cal includes only A/C req and based on SF	Light Hazard	750	60	45,000
7314	73081	Rehab Center	45,000	SF	75	2,250	Cal includes only A/C req and based on SF	Light Hazard	750	60	45,000
8331	73082	Recycling Center	1	EA		0					
7361	73083	Religious Ministry Facilities	40,172	SF	66.95	2008.5	Cal includes only A/C req and based on SF	Light Hazard	750	60	45,000
7344	73085	Post Office	10,701	SF	17.84	535.2	Cal includes only A/C req and based on SF	Light Hazard	750	60	45,000
7346	74001	Exchange Retail Store	37,950	SF	63.25	1897.5	Cal includes only A/C req and based on SF	Light Hazard	750	60	45,000
7346	74002	Location Exchange	22,575	SF	37.63	1128.9	Cal includes only A/C req and based on SF	Light Hazard	750	60	45,000
7387	74003	Exchange Central Administration	16,900	SF	28.17	845.1	Cal includes only A/C req and based on SF	Light Hazard	750	60	45,000
7331	74004	Exchange Cafeteria	24,300	SF	40.5	1215	Cal includes only A/C req and based on SF	Light Hazard	750	60	45,000

							Industrial Demand		Fire Protection		
										Duration	
					For A/C	GPD	Source	Classification	Minimum Flow	Supply	Total Gallon
FAC	CCN	Nomenclature	BFR	UM	Ton			of Occupancy	GPM	Min	
7331	74005	Exchange Snack Stands	1,900	SF	3.17	95.1	Cal includes only A/C req and based on SF	Light Hazard	750	60	45,000
7345	74007	Exchange Auto Parts Store	10,750	SF	17.92	537.6	Cal includes only A/C req and based on SF	Light Hazard	750	60	45,000
7346	74008	Exchange Food Store	3,300	SF	5.5	165	Cal includes only A/C req and based on SF	Light Hazard	750	60	45,000
7346	74009	Exchange Service Outlet	28,715	SF	47.86	1435.8	Cal includes only A/C req and based on SF	Light Hazard	750	60	45,000
7342	74015	Exchange Dry Cleaning Shop	15,050	SF	25.08	752.4	Cal includes only A/C req and based on SF	Light Hazard	750	60	45,000
7387	74016	Exchange Maint Shop	2,419	SF	4.03	120.9	Cal includes only A/C req and based on SF	Light Hazard	750	60	45,000
7347	74018	Bank	6,860	SF	11.43	342.9	Cal includes only A/C req and based on SF	Light Hazard	750	60	45,000
7347	74019	Credit Union	14,200	SF	23.67	710.1	Cal includes only A/C req and based on SF	Light Hazard	750	60	45,000
7441	74020	Temporary Lodging	73,188	SF	121.98	3659.4	Cal includes only A/C req and based on SF	Light Hazard	1,125	90	101,250
7349	74023	Commissary	45,000	SF	75	2250	Cal includes only A/C req and based on SF	Light Hazard	750	60	45,000
4321	74024	Comm Cold Storage Det	27,000	SF	45	1,350	Cal includes only A/C req and based on SF	Hazard Group 1	1,500	120	180,000
7372	74025	Family Services Center	10,500	SF	17.5	525	Cal includes only A/C req and based on SF	Hazard Group 1	1,500	120	180,000
7417	74028	Amusement Center	6,560	SF	10.93	327.9	Cal includes only A/C req and based on SF	Light Hazard	750	60	45,000
7345	74030	Exchange Service Station	6,710	SF	11.18	335.4	Cal includes only A/C req and based on SF	Light Hazard	750	60	45,000
7345	74031	Exchange Gas Station	1,290	SF	2.15	64.5	Cal includes only A/C req and based on SF	Light Hazard	750	60	45,000
7348	74032	Exchange Customer Op. Car Wash	2,300	SF		100,000	Assume 2,000 car/day washed (20% of total car), 50gpd/car	Light Hazard	750	60	45,000
7340	74034	Thrift Shop	4,300	SF	7.17	215	Cal includes only A/C req and based on SF	Light Hazard	750	60	45,000
7411	74036	Hobby Shop--Arts/Crafts	17,740	SF	29.57	887.1	Cal includes only A/C req and based on SF	Light Hazard	750	60	45,000
7447	74037	MWR Supply/Support Facility	10,080	SF	16.8	504	Cal includes only A/C req and based on SF	Light Hazard	750	60	45,000
7412	74038	Hobby Shop--Automotive	17,790	SF	29.65	890	Cal includes only A/C req and based on SF	Light Hazard	750	60	45,000
7431	74039	Entertainment Center	10,050	SF	16.75	503	Cal includes only A/C req and based on SF	Light Hazard	750	60	45,000
7415	74040	Bowling Alley	15,260	SF	25.43	763	Cal includes only A/C req and based on SF	Hazard Group 1	1,500	120	180,000
7421	74043	Gymnasium	63,000	SF	105	3,150	Cal includes only A/C req and based on SF	Light Hazard	1,125	90	101,250
7421	74044	Indoor Fitness Facility	61,900	SF	103.17	3,095	Cal includes only A/C req and based on SF	Light Hazard	1,125	90	101,250
7418	74046	Skating Rink	16,100	SF	26.83	805	Cal includes only A/C req and based on SF	Light Hazard	750	60	45,000
7447	74047	Information Ticket and Travel Office	1,210	SF	2.02	61	Cal includes only A/C req and based on SF	Light Hazard	750	60	45,000
7447	74048	Contracted Leisure Travel Agency	900	SF	1.5	45	Cal includes only A/C req and based on SF	Hazard Group 1	1,500	120	180,000
7417	74054	Recreation Center	6,000	SF	10	300	Cal includes only A/C req and based on SF	Hazard Group 1	1,500	120	180,000
7417	74055	Youth Center	29,291	SF	48.82	1,465	Cal includes only A/C req and based on SF	Hazard Group 1	1,500	120	180,000
7333	74060	Commissioned Officers Open Mess	25,000	SF	41.67	1,250	Cal includes only A/C req and based on SF	Hazard Group 1	1,500	120	180,000

							Industrial Demand		Fire Protection		
										Duration	
					For A/C	GPD	Source	Classification	Minimum Flow	Supply	Total Gallon
FAC	CCN	Nomenclature	BFR	UM	Ton			of Occupancy	GPM	Min	
7333	74063	Enlisted Personnel Club	59,400	SF	99	2,970	Cal includes only A/C req and based on SF	Hazard Group 1	1,500	120	180,000
7333	74066	Staff NCO Club	25,000	SF	41.67	1,250	Cal includes only A/C req and based on SF	Hazard Group 1	1,500	120	180,000
7333	74067	Consolidated Officers/EP Open Mess	54,700	SF	91.17	2,735	Cal includes only A/C req and based on SF	Light Hazard	750	60	45,000
7346	74071	Package Store	10,800	SF	18	540	Cal includes only A/C req and based on SF	Light Hazard	750	60	45,000
7371	74074	Child Development Center	42,600	SF	71	2,130	Cal includes only A/C req and based on SF	Light Hazard	750	60	45,000
7416	74076	Library	20,000	SF	33.33	1,000	Cal includes only A/C req and based on SF	Hazard Group 2	2,250	90	202,500
7531	74078	Recreation Pavillion	4,000	SF	6.67	200	Cal includes only A/C req and based on SF	Hazard Group 1	1,500	120	180,000
7388	74086	Exchange Warehouse	22,091	SF	36.82	1,105	Cal includes only A/C req and based on SF	Light Hazard	750	60	45,000
7351	74088	Educational Services Office	23,100	SF	38.5	1,155	Cal includes only A/C req and based on SF	Light Hazard	750	60	45,000
7385	74089	Bathhouse	14,500	SF		8,500	Estimate based on Nimitz Hill, same as swimming pool	Light Hazard	750	60	45,000
7521	75010	Playing Courts	19	EA		4,000	same as outdoor playing field				0
7522	75020	Outdoor Playing Fields	12	EA		4,000	Apra Harbor Naval Complex				0
7512	75030	Outdoor Swimming Pool - Installation	3	EA		42,000	North Finegayan				
			Total (GPD)			659519.5		Extra	3,750	150	562,500
			Total (MGD)		Industrial	0.66		Total (MGD)	Fire Protection		0.56

UIC: M00102											
MEF Component: 1st MAW											
Unit Name: 1st Marine Air Wing Headquarter Facility											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
6100	61070	Division/Wing Headquarters	66,230	SF	110.38	3,311	Cal includes only A/C req and based on SF	Light Hazard	750	60	45,000
			Total (GPD)			3,311		Extra	750	60	45,000
			Total (MGD)		Industrial	0.0033		Total (MGD)	Fire Protection		0.05

							Industrial Demand		Fire Protection		
										Duration	
					For A/C	GPD	Source	Classification	Minimum Flow	Supply	Total Gallon
FAC	CCN	Nomenclature	BFR	UM	Ton			of Occupancy	GPM	Min	
UIC: M00109											
MEF Component: 1st MAW											
Unit Name: Marine Wing Comm Squadron 18, MACG-18											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
4427	14345	Armory	360	SF	0.6	18	Cal includes only A/C req and based on SF	Hazard Group 1	1,500	120	180,000
1443	14378	Operational Haz/Flam Storage	900	SF	1.5	45	Cal includes only A/C req and based on SF	Hazard Group 2	2,250	90	202,500
2141	21451	Auto Organizational Shop	7,640	SF	12.73	382	Cal includes only A/C req and based on SF	Hazard Group 1	1,500	120	180,000
2171	21710	Electronic/Comm Maint Shop	13,770	SF	22.95	689	Cal includes only A/C req and based on SF	Hazard Group 1	1,500	120	180,000
4421	44112	Organic Unit Storage	8,160	SF	13.6	408	Cal includes only A/C req and based on SF	Hazard Group 1	1,500	120	180,000
6102	61072	Battalion/Squadron HQ	5,950	SF	9.92	298	Cal includes only A/C req and based on SF	Hazard Group 1	1,500	120	180,000
			Total (GPD)			1,839		Hazard Group 2	2,250	90	202,500
			Total (MGD)		Industrial	0		Total (MGD)	Fire Protection		0.2
UIC: M00132											
MEF Component: 1st MAW											
Unit Name: Marine Wing Support Group, MWSG-17											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
4427	14345	Armory	310	SF	0.52	15.6	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
1443	14378	Operational Haz/Flam Storage	450	SF	0.75	23	Cal includes only A/C req and based on SF	Hazard Group 2	2250	90	202500
4421	44112	Organic Unit Storage	5,970	SF	9.95	298.5	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
6102	61071	Regimental/Group HQ	23,800	SF	39.67	1,190	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
			Total (GPD)			1,527		Hazard Group 2	2,250	90	202,500
			Total (MGD)		Industrial	0.002		Total (MGD)	Fire Protection		0.2

							Industrial Demand		Fire Protection		
										Duration	
					For A/C	GPD	Source	Classification	Minimum Flow	Supply	Total Gallon
FAC	CCN	Nomenclature	BFR	UM	Ton			of Occupancy	GPM	Min	
UIC: M00172											
MEF Component: 1st MAW											
Unit Name: Marine Wing Support Squadron, MWSG-17											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
4427	14345	Armory	1,460	SF	2.43	72.9	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
1443	14378	Operational Haz/Flam Storage	4,120	SF	6.87	206	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
2141	21451	Auto Organizational Shop	9,810	SF	16.35	490.5	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
2145	21455	Vehicle Wash Platform	2	EA		0		Hazard Group 1	1500	90	135000
2145	21456	Grease Rack	1	EA		0		Hazard Group 1	1500	90	135000
2171	21710	Electronic/Comm Maint Shop	11,710	SF	19.52	586	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
4421	44112	Organic Unit Storage	29,590	SF	49.32	1479.6	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
6102	61072	Battalion/Squadron HQ	17,200	SF	28.67	860	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
			Total (GPD)			3,695		Hazard Group 1	1,500	90	135,000
			Total (MGD)		Industrial	0.004		Total (MGD)	Fire Protection		0.14
UIC: M00618											
MEF Component: 1st MAW											
Unit Name: Marine Air Control Group 18, MACG-18											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
6102	61071	Regimental/Group HQ	8,920	SF	14.87	446	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
			Total (GPD)			446.1		Hazard Group 1	1,500	90	135,000
			Total (MGD)		Industrial	0.0004		Total (MGD)	Fire Protection		0.14

							Industrial Demand		Fire Protection		
										Duration	
					For A/C	GPD	Source	Classification	Minimum Flow	Supply	Total Gallon
FAC	CCN	Nomenclature	BFR	UM	Ton			of Occupancy	GPM	Min	

UIC: M00825											
MEF Component: 1st MAW											
Unit Name: Marine Air Support Squadron 2, MACG-18											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
4427	14345	Armory	870	SF	1.45	43.5	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
1443	14378	Operational Haz/Flam Storage	1,800	SF	3	90	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
1467	14985	Expeditionary Air Control Site	1	EA		0		Hazard Group 1	1500	90	135000
2141	21451	Auto Organizational Shop	4,500	SF	7.5	225	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
2145	21455	Vehicle Wash Platform	2	EA		0		Hazard Group 1	1500	90	135000
2145	21456	Grease Rack	1	EA		0		Hazard Group 1	1500	90	135000
2171	21710	Electronic/Comm Maint Shop	23,340	SF	38.9	1,167	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
4421	44112	Organic Unit Storage	7,860	SF	13.1	393	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
6102	61072	Battalion/Squadron HQ	40,000	SF	66.67	2,000	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
			Total (GPD)			3918.6		Hazard Group 1	1,500	90	135,000
			Total (MGD)		Industrial	0		Total (MGD)	Fire Protection		0.14

UIC: M00861											
MEF Component: 1st MAW											
Unit Name: Marine Air Control Squadron 4											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
4427	14345	Armory	430	SF	0.72	21.6	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
1443	14378	Operational Haz/Flam Storage	900	SF	1.5	45	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
1467	14985	Expeditionary Air Control Site	1	EA		0		Hazard Group 1	1500	90	135000

							Industrial Demand		Fire Protection		
										Duration	
					For A/C	GPD	Source	Classification	Minimum Flow	Supply	Total Gallon
FAC	CCN	Nomenclature	BFR	UM	Ton			of Occupancy	GPM	Min	
2141	21451	Auto Organizational Shop	7,640	SF	12.73	381.9	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
2145	21455	Vehicle Wash Platform	2	EA		0		Hazard Group 1	1500	90	135000
2145	21456	Grease Rack	1	EA		0		Hazard Group 1	1500	90	135000
6102	61072	Battalion/Squadron HQ	10,450	SF	17.42	523	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
			Total (GPD)			971.1		Hazard Group 1	1,500	90	135,000
			Total (MGD)		Industrial	0		Total (MGD)	Fire Protection		0.14

UIC: M00862											
MEF Component: 1st MAW											
Unit Name: Det A TAOC, MACS-4											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
4427	14345	Armory	570	SF	0.95	28.5	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
6101	61073	Company/Battery HQ	13,320	SF	22.2	666	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
			Total (GPD)			694.5		Hazard Group 1	1,500	90	135,000
			Total (MGD)		Industrial	0.0007		Total (MGD)	Fire Protection		0.14

UIC: M00863											
MEF Component: 1st MAW											
Unit Name: Det A ATC, MACS-4											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
6101	61073	Company/Battery HQ	9,120	SF	15.2	456	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
			Total (GPD)			456		Hazard Group 1	1,500	90	135,000

							Industrial Demand		Fire Protection		
										Duration	
					For A/C	GPD	Source	Classification	Minimum Flow	Supply	Total Gallon
FAC	CCN	Nomenclature	BFR	UM	Ton			of Occupancy	GPM	Min	
			Total (MGD)		Industrial	0		Total (MGD)	Fire Protection		0.14

UIC: M01027											
MEF Component: 1st MAW											
Unit Name: Marine Wing Headquaters Squadron 1											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
4427	14345	Armory	890	SF	1.48	44.4	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
4421	44112	Organic Unit Storage	20,190	SF	33.65	1009.5	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
6102	61072	Battalion/Squadron HQ	5,770	SF	9.62	289	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
			Total (GPD)			1342.5		Hazard Group 1	1,500	90	135,000
			Total (MGD)		Industrial	0		Total (MGD)	Fire Protection		0.14

UIC: M01143											
MEF Component: 1st MAW											
Unit Name: Marine Tactical Air Command Squadron 18, MACG-18											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
4427	14345	Armory	500	SF	0.83	24.9	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135,000
1443	14378	Operational Haz/Flam Storage	900	SF	1.5	45	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135,000
2141	21451	Auto Organizational Shop	4,500	SF	7.5	225	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135,000
2145	21455	Vehicle Wash Platform	1	EA		0		Hazard Group 1	1500	90	135,000
2145	21456	Grease Rack	1	EA		0		Hazard Group 1	1500	90	135,000
2171	21710	Electronic/Comm Maint Shop	15,270	SF	25.45	764	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135,000
4421	44112	Organic Unit Storage	5,930	SF	9.88	296.4	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135,000
6102	61072	Battalion/Squadron HQ	9,700	SF	16.17	485	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135,000

							Industrial Demand		Fire Protection		
										Duration	
					For A/C	GPD	Source	Classification	Minimum Flow	Supply	Total Gallon
FAC	CCN	Nomenclature	BFR	UM	Ton			of Occupancy	GPM	Min	
			Total (GPD)			1839.9		Hazard Group 1	1,500	90	135,000
			Total (MGD)		Industrial	0		Total (MGD)	Fire Protection		0.14

UIC: M01702											
MEF Component: 3rd MARDIV											
Unit Name: Light Armored Recon Company, 3D CAB											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
2141	21451	Auto Organizational Shop	10,690	SF	17.82	534.6	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
			Total (GPD)			534.6		Hazard Group 1	1,500	90	135,000
			Total (MGD)		Industrial	0.001		Total (MGD)	Fire Protection		0.14

UIC: M13001											
MEF Component: 3rd MARDIV											
Unit Name: H&S Company, HQ Battalion											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
2145	21455	Vehicle Wash Platform	5	EA		0		Hazard Group 1	1500	90	135000
2145	21456	Grease Rack	3	EA		0		Hazard Group 1	1500	90	135000
6100	61070	Division/Wing Headquarters	71,620	SF	119.37	3,581	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
			Total (GPD)			3581.1		Hazard Group 1	1,500	90	135,000
			Total (MGD)		Industrial	0.004		Total (MGD)	Fire Protection		0.14

							Industrial Demand		Fire Protection		
										Duration	
					For A/C	GPD	Source	Classification	Minimum Flow	Supply	Total Gallon
FAC	CCN	Nomenclature	BFR	UM	Ton			of Occupancy	GPM	Min	
UIC: M13002											
MEF Component: 3rd MARDIV											
Unit Name: HQTRS & SVC Company Headquarters											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
4427	14345	Armory	1,200	SF	2	60	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
2141	21451	Auto Organizational Shop	11,660	SF	19.43	582.9	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
4421	44112	Organic Unit Storage	22,120	SF	36.87	1106.1	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
6101	61073	Company/Battery HQ	1,470	SF	2.45	74	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
			Total (GPD)			1822.5		Hazard Group 1	1,500	90	135,000
			Total (MGD)		Industrial	0		Total (MGD)	Fire Protection		0.14

UIC: M13003											
MEF Component: 3rd MARDIV											
Unit Name: MP Company Headquarters Bn 3D											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
4427	14345	Armory	670	SF	1.12	33.6	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
6101	61073	Company/Battery HQ	1,020	SF	1.7	51	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
			Total (GPD)			84.6		Hazard Group 1	1,500	90	135,000
			Total (MGD)		Industrial	0		Total (MGD)	Fire Protection		0.14

UIC: M13006											
MEF Component: 3rd MARDIV											

							Industrial Demand		Fire Protection		
										Duration	
					For A/C	GPD	Source	Classification	Minimum Flow	Supply	Total Gallon
FAC	CCN	Nomenclature	BFR	UM	Ton			of Occupancy	GPM	Min	
Unit Name: Communication Company Headquarters Bn											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
4427	14345	Armory	810	SF	1.35	40.5	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
2171	21710	Electronic/Comm Maint Shop	27,960	SF	46.6	1,398	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
6101	61073	Company/Battery HQ	2,220	SF	3.7	111	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
			Total (GPD)			1549.5		Hazard Group 1	1,500	90	135,000
			Total (MGD)		Industrial	0		Total (MGD)	Fire Protection		0.14

UIC: M13012											
MEF Component: 3rd MARDIV											
Unit Name: H&S Company, 3rd Recon Battalion											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
4427	14345	Armory	1,840	SF	3.07	92.1	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
1443	14378	Operational Haz/Flam Storage	2,250	SF	3.75	113	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
2184	21175	Parachute/Survival Equipment Shop	11,820	SF	19.7	591	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
2133	21358	Boat Shop	8,050	SF	13.42	402.6	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
2141	21451	Auto Organizational Shop	4,500	SF	7.5	225	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
2145	21455	Vehicle Wash Platform	2	EA		0		Hazard Group 1	1500	90	135000
2145	21456	Grease Rack	2	EA		0		Hazard Group 1	1500	90	135000
2171	21710	Electronic/Comm Maint Shop	16,020	SF	26.7	801	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
4421	44112	Organic Unit Storage	8,810	SF	14.68	440.4	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
6102	61072	Battalion/Squadron HQ	8,650	SF	14.42	433	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
			Total (GPD)			3097.2		Hazard Group 1	1,500	90	135,000
			Total (MGD)		Industrial	0		Total (MGD)	Fire Protection		0.14

							Industrial Demand		Fire Protection		
										Duration	
					For A/C	GPD	Source	Classification	Minimum Flow	Supply	Total Gallon
FAC	CCN	Nomenclature	BFR	UM	Ton			of Occupancy	GPM	Min	
UIC: M13013											
MEF Component: 3rd MARDIV											
Unit Name: Distant ReconCompany, 3rd Recon Battalion											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
4427	14345	Armory	780	SF	1.3	39	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
6101	61073	Company/Battery HQ	6,720	SF	11.2	336	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
			Total (GPD)			375		Hazard Group 1	1,500	90	135,000
			Total (MGD)		Industrial	0		Total (MGD)	Fire Protection		0.14
UIC: M13013											
MEF Component: 3rd MARDIV											
Unit Name: Deep Recon Company, 3rd Recon Battalion											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
4427	14345	Armory	860	SF	1.43	42.9	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
6101	61073	Company/Battery HQ	3,270	SF	5.45	164	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
			Total (GPD)			206.4		Hazard Group 1	1,500	90	135,000
			Total (MGD)		Industrial	0		Total (MGD)	Fire Protection		0.14
UIC: M13301											
MEF Component: 3rd MARDIV											
Unit Name: Headquarters Battery 12th Marine Regiment											

							Industrial Demand		Fire Protection		
										Duration	
					For A/C	GPD	Source	Classification	Minimum Flow	Supply	Total Gallon
FAC	CCN	Nomenclature	BFR	UM	Ton			of Occupancy	GPM	Min	
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
4427	14345	Armory	1,840	SF	3.07	92.1	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
1443	14378	Operational Haz/Flam Storage	3,490	SF	5.82	175	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
2141	21451	Auto Organizational Shop	21,140	SF	35.23	1056.9	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
2145	21455	Vehicle Wash Platform	4	EA		0		Hazard Group 1	1500	90	135000
2145	21456	Grease Rack	2	EA		0		Hazard Group 1	1500	90	135000
2152	21530	Heavy Gun Shop	11,340	SF	18.9	567	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
2171	21710	Electronic/Comm Maint Shop	27,280	SF	45.47	1,364	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
4421	44112	Organic Unit Storage	24,380	SF	40.63	1218.9	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
6102	61071	Regimental/Group HQ	11,500	SF	19.17	575	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
6101	61073	Company/Battery HQ	3,220	SF	5.37	161	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
			Total (GPD)			5209.8		Hazard Group 1	1,500	90	135,000
			Total (MGD)		Industrial	0.01		Total (MGD)	Fire Protection		0.14

UIC: M20129											
MEF Component: III MEF											
Unit Name: III MEF Headqaurters Facility											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
1721	17135	Operational Trainer Facility	70,230	SF	117.05	3511.5	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
6100	61070	Division/Wing Headquarters	86,200	SF	143.67	4,310	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
			Total (GPD)			7821.6		Hazard Group 1	1,500	90	135,000
			Total (MGD)		Industrial	0.01		Total (MGD)	Fire Protection		0.14

							Industrial Demand		Fire Protection		
										Duration	
					For A/C	GPD	Source	Classification	Minimum Flow	Supply	Total Gallon
FAC	CCN	Nomenclature	BFR	UM	Ton			of Occupancy	GPM	Min	
UIC: M20381											
MEF Component: III MEF											
Unit Name: IMEF Headquarters Group (MHG)											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
4427	14345	Armory	1,780	SF	2.97	89.1	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
1712	17120	Applied Instruction Facility	16,720	SF	27.87	836.1	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
2141	21451	Auto Organizational Shop	17,050	SF	28.42	852.6	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
2145	21455	Vehicle Wash Platform	4	EA		0		Hazard Group 1	1500	90	135000
2145	21456	Grease Rack	2	EA		0		Hazard Group 1	1500	90	135000
4421	44112	Organic Unit Storage	40,690	SF	67.82	2034.6	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
6102	61071	Regimental/Group HQ	12,170	SF	20.28	608	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
			Total (GPD)			4420.8		Hazard Group 1	1,500	90	135,000
			Total (MGD)		Industrial	0		Total (MGD)	Fire Protection		0.14

UIC: M20738											
MEF Component: III MEF											
Unit Name: 3d Intel Battalion											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
4427	14345	Armory	590	SF	0.98	29.4	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
2171	21710	Electronic/Comm Maint Shop	14,300	SF	23.83	715	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
4421	44112	Organic Unit Storage	16,300	SF	27.17	815.1	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
6102	61072	Battalion/Squadron HQ	13,050	SF	21.75	653	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
			Total (GPD)			2211.9		Hazard Group 1	1,500	90	135,000
			Total (MGD)		Industrial	0		Total (MGD)	Fire Protection		0.14

							Industrial Demand		Fire Protection		
										Duration	
					For A/C	GPD	Source	Classification	Minimum Flow	Supply	Total Gallon
FAC	CCN	Nomenclature	BFR	UM	Ton			of Occupancy	GPM	Min	
UIC: M20739											
MEF Component: III MEF											
Unit Name: Headquarters Company 3rd Intel Battalion											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
6101	61073	Company/Battery HQ	1,770	SF	2.95	89	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
			Total (GPD)			88.5		Hazard Group 1	1,500	90	135,000
			Total (MGD)		Industrial	0		Total (MGD)	Fire Protection		0.14
UIC: M20782											
MEF Component: III MEF											
Unit Name: Production and Analysis Company 3rd Intel Battalion											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
6101	61073	Company/Battery HQ	12,570	SF	20.95	629	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
			Total (GPD)			628.5		Hazard Group 1	1,500	90	135,000
			Total (MGD)		Industrial	0.001		Total (MGD)	Fire Protection		0.14
UIC: M20783											
MEF Component: III MEF											
Unit Name: CI/Human Intelligence Company 3rd Intel Battalion											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						

							Industrial Demand		Fire Protection		
										Duration	
					For A/C	GPD	Source	Classification	Minimum Flow	Supply	Total Gallon
FAC	CCN	Nomenclature	BFR	UM	Ton			of Occupancy	GPM	Min	
6101	61073	Company/Battery HQ	3,420	SF	5.7	171	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
			Total (GPD)			171		Hazard Group 1	1,500	90	135,000
			Total (MGD)		Industrial	0		Total (MGD)	Fire Protection		0.14

UIC: M21541											
MEF Component: III MEF											
Unit Name: 3d Radio Battalion											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
1311	13115	Communications Center	41,680	SF	69.47	2084.1	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
4427	14345	Armory	1,060	SF	1.77	53.1	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
2141	21451	Auto Organizational Shop	9,000	SF	15	450	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
2145	21455	Vehicle Wash Platform	1	EA		0		Hazard Group 1	1500	90	135000
2145	21456	Grease Rack	1	EA		0		Hazard Group 1	1500	90	135000
2171	21710	Electronic/Comm Maint Shop	7,030	SF	11.72	352	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
4421	44112	Organic Unit Storage	8,840	SF	14.73	441.9	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
6102	61072	Battalion/Squadron HQ	6,700	SF	11.17	335	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
6101	61073	Company/Battery HQ	3,510	SF	5.85	176	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
			Total (GPD)			3891.3		Hazard Group 1	1,500	90	135,000
			Total (MGD)		Industrial	0		Total (MGD)	Fire Protection		0.14

UIC: M21631											
MEF Component: III MEF											
Unit Name: 5th ANGLICO											
					For A/C	GPD	Source				

							Industrial Demand		Fire Protection		
										Duration	
					For A/C	GPD	Source	Classification	Minimum Flow	Supply	Total Gallon
FAC	CCN	Nomenclature	BFR	UM	Ton			of Occupancy	GPM	Min	
FAC	CCN	Nomenclature	BFR	UM	Ton						
4427	14345	Armory	820	SF	1.37	41.1	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
1443	14378	Operational Haz/Flam Storage	900	SF	1.5	45	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
2141	21451	Auto Organizational Shop	4,500	SF	7.5	225	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
2145	21455	Vehicle Wash Platform	1	EA		0		Hazard Group 1	1500	90	135000
2145	21456	Grease Rack	1	EA		0		Hazard Group 1	1500	90	135000
2171	21710	Electronic/Comm Maint Shop	16,590	SF	27.65	830	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
4421	44112	Organic Unit Storage	7,660	SF	12.77	383.1	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
6101	61073	Company/Battery HQ	8,070	SF	13.45	404	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
			Total (GPD)			1927.2		Hazard Group 1	1,500	90	135,000
			Total (MGD)		Industrial	0		Total (MGD)	Fire Protection		0.14

UIC: M21634											
MEF Component: III MEF											
Unit Name: Direct Support Company (A), 7th Comm Battalion											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
6101	61073	Company/Battery HQ	2,370	SF	3.95	119	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
			Total (GPD)			118.5		Hazard Group 1	1,500	90	135,000
			Total (MGD)		Industrial	0		Total (MGD)	Fire Protection		0.14

UIC: M21636							
MEF Component: III MEF							
Unit Name: 7th Comm Battalion							
					For A/C	GPD	Source

							Industrial Demand		Fire Protection		
										Duration	
					For A/C	GPD	Source	Classification	Minimum Flow	Supply	Total Gallon
FAC	CCN	Nomenclature	BFR	UM	Ton			of Occupancy	GPM	Min	
FAC	CCN	Nomenclature	BFR	UM	Ton						
4427	14345	Armory	1,860	SF	3.1	93	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
1443	14378	Operational Haz/Flam Storage	1,800	SF	3	90	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
2141	21451	Auto Organizational Shop	11,660	SF	19.43	582.9	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
2171	21710	Electronic/Comm Maint Shop	50,420	SF	84.03	2,521	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
4421	44112	Organic Unit Storage	22,170	SF	36.95	1108.5	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
6102	61072	Battalion/Squadron HQ	12,630	SF	21.05	632	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
6101	61073	Company/Battery HQ	1,170	SF	1.95	59	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
2145	21455	Vehicle Wash Platform	4	EA		0					
2145	21456	Grease Rack	2	EA		0					
			Total (GPD)			5085.3		Hazard Group 1	1,500	90	135,000
			Total (MGD)		Industrial	0.01		Total (MGD)	Fire Protection		0.14

UIC: M21637											
MEF Component: III MEF											
Unit Name: Service Company, 7th Comm Battalion											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
6101	61073	Company/Battery HQ	1,470	SF	2.45	74	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
			Total (GPD)			73.5		Hazard Group 1	1,500	90	135,000
			Total (MGD)		Industrial	0		Total (MGD)	Fire Protection		0.14

UIC: M21638											
MEF Component: III MEF											
Unit Name: General Support Company (B), 7th Comm Battalion											

							Industrial Demand		Fire Protection		
										Duration	
					For A/C	GPD	Source	Classification	Minimum Flow	Supply	Total Gallon
FAC	CCN	Nomenclature	BFR	UM	Ton			of Occupancy	GPM	Min	
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
6101	61073	Company/Battery HQ	2,370	SF	3.95	119	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
			Total (GPD)			118.5		Hazard Group 1	1,500	90	135,000
			Total (MGD)		Industrial	0		Total (MGD)	Fire Protection		0.14

UIC: M21801											
MEF Component: 3D MARDIV											
Unit Name: H&S Company, 3d CAB											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
1443	14378	Operational Haz/Flam Storage	4,050	SF	6.75	203	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
2141	21451	Auto Organizational Shop	4,500	SF	7.5	225	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
2145	21455	Vehicle Wash Platform	4	EA		0		Hazard Group 1	1500	90	135000
2145	21456	Grease Rack	2	EA		0		Hazard Group 1	1500	90	135000
2171	21710	Electronic/Comm Maint Shop	19,400	SF	32.33	970	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
4421	44112	Organic Unit Storage	16,980	SF	28.3	849	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
			Total (GPD)			2246.4		Hazard Group 1	1,500	90	135,000
			Total (MGD)		Industrial	0.002		Total (MGD)	Fire Protection		0.14

UIC: M21804											
MEF Component: 3D MARDIV											
Unit Name: CE Company, 3d CAB											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						

							Industrial Demand		Fire Protection		
										Duration	
					For A/C	GPD	Source	Classification	Minimum Flow	Supply	Total Gallon
FAC	CCN	Nomenclature	BFR	UM	Ton			of Occupancy	GPM	Min	
2141	21451	Auto Organizational Shop	7,640	SF	12.73	381.9	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
			Total (GPD)			381.9		Hazard Group 1	1,500	90	135,000
			Total (MGD)		Industrial	0.0004		Total (MGD)	Fire Protection		0.14

UIC: M21822											
MEF Component: 3D MARDIV											
Unit Name:											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
2134	21375	Amphibian Vehicle Maintenance Shop	151,560	SF	252.6	7,578	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
2141	21451	Auto Organizational Shop	4,500	SF	7.5	225	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
2145	21455	Vehicle Wash Platform	1	EA		0		Hazard Group 1	1500	90	135000
2145	21456	Grease Rack	1	EA		0		Hazard Group 1	1500	90	135000
2171	21710	Electronic/Comm Maint Shop	13,020	SF	21.7	651	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
			Total (GPD)			8454		Hazard Group 1	1,500	90	135,000
			Total (MGD)		Industrial	0.0085		Total (MGD)	Fire Protection		0.14

UIC: M218**											
MEF Component: 3D MARDIV											
Unit Name: 3d Combat Assault Battalion											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
6102	61072	Battalion/Squadron HQ	15,550	SF	25.92	778	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
			Total (GPD)			777.6		Hazard Group 1	1,500	90	135,000

							Industrial Demand		Fire Protection		
										Duration	
					For A/C	GPD	Source	Classification	Minimum Flow	Supply	Total Gallon
FAC	CCN	Nomenclature	BFR	UM	Ton			of Occupancy	GPM	Min	
			Total (MGD)		Industrial	0.0008		Total (MGD)	Fire Protection		0.14

UIC: M28261											
MEF Component: 3D MLG											
Unit Name: Headquarters and Service Co, 3D Medical BN											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
4427	14345	Armory	760	SF	1.27	38.1	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
1443	14378	Operational Haz/Flam Storage	1,000	SF	1.67	50	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
1444	21440	Vehicle Holding Shed	840	SF	1.4	42	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
2141	21451	Auto Organizational Shop	10,220	SF	17.03	510.9	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
2145	21455	Vehicle Wash Platform	2	EA		0		Hazard Group 1	1500	90	135000
2145	21456	Grease Rack	1	EA		0		Hazard Group 1	1500	90	135000
4421	44112	Organic Unit Storage	31,330	SF	52.22	1566.6	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
4424	44120	Controlled Humidity Warehouse	7,760	SF	12.93	387.9	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
6101	61073	Company/Battery HQ	870	SF	1.45	44	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
			Total (GPD)			2639.1		Hazard Group 1	1,500	90	135,000
			Total (MGD)		Industrial	0.0026		Total (MGD)	Fire Protection		0.14

UIC: M28262											
MEF Component: 3D MLG											
Unit Name: Surgical Company B, 3D Medical BN, CLR-35											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
6101	61073	Company/Battery HQ	1,170	SF	1.95	59	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
5500	55010	Medical Clinic	20,180	SF	33.63	1,009	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000

							Industrial Demand		Fire Protection		
										Duration	
					For A/C	GPD	Source	Classification	Minimum Flow	Supply	Total Gallon
FAC	CCN	Nomenclature	BFR	UM	Ton			of Occupancy	GPM	Min	
6101	61073	Company/Battery HQ	1,170	SF	1.95	59	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
			Total (GPD)			1125.9		Hazard Group 1	1,500	90	135,000
			Total (MGD)		Industrial	0.0011		Total (MGD)	Fire Protection		0.14

UIC: M29001											
MEF Component: 3D MLG											
Unit Name: 3D Marine Logistics Group Headquarters Facility											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
6100	61070	Division/Wing Headquarters	48,360	SF	80.6	2,418	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
			Total (GPD)			2418		Hazard Group 1	1,500	90	135,000
			Total (MGD)		Industrial	0.0024		Total (MGD)	Fire Protection		0.14

UIC: M29002											
MEF Component: 3D MLG											
Unit Name:Headquarters Co, CLR-37											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
4427	14345	Armory	1,370	SF	2.28	68.4	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
2141	21451	Auto Organizational Shop	4,130	SF	6.88	206.4	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
2145	21455	Vehicle Wash Platform	1	EA		0		Hazard Group 1	1500	90	135000
2145	21456	Grease Rack	1	EA		0		Hazard Group 1	1500	90	135000
4421	44112	Organic Unit Storage	23,520	SF	39.2	1176	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
6102	61071	Regimental/Group HQ	8,340	SF	13.9	417	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
6101	61073	Company/Battery HQ	1,470	SF	2.45	74	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000

							Industrial Demand		Fire Protection		
										Duration	
					For A/C	GPD	Source	Classification	Minimum Flow	Supply	Total Gallon
FAC	CCN	Nomenclature	BFR	UM	Ton			of Occupancy	GPM	Min	
			Total (GPD)			1941.3		Hazard Group 1	1,500	90	135,000
			Total (MGD)		Industrial	0.0019		Total (MGD)	Fire Protection		0.14

UIC: M29003											
MEF Component: 3D MLG											
Unit Name:Service Company, CLR-37											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
4427	14345	Armory	430	SF	0.72	21.6	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
6101	61073	Company/Battery HQ	29,970	SF	49.95	1,499	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
			Total (GPD)			1520.1		Hazard Group 1	1,500	90	135,000
			Total (MGD)		Industrial	0.0015		Total (MGD)	Fire Protection		0.14

UIC: M29004											
MEF Component: 3D MLG											
Unit Name:Communications Company, CLR-37											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
4427	14345	Armory	540	SF	0.9	27	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
2171	21710	Electronic/Comm Maint Shop	26,960	SF	44.93	1,348	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
6101	61073	Company/Battery HQ	3,220	SF	5.37	161	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
			Total (GPD)			1536		Hazard Group 1	1,500	90	135,000
			Total (MGD)		Industrial	0.0015		Total (MGD)	Fire Protection		0.14

Industrial Demand Fire Demand Calculation by Facility
USMC Guam Relocation Plan

					Industrial Demand				Fire Protection		
										Duration	
					For A/C	GPD	Source	Classification	Minimum Flow	Supply	Total Gallon
FAC	CCN	Nomenclature	BFR	UM	Ton			of Occupancy	GPM	Min	
UIC: M29005											
MEF Component: 3D MLG											
Unit Name:MP Company, CLR-37											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
4427	14345	Armory	660	SF	1.1	33	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
6101	61073	Company/Battery HQ	2,370	SF	3.95	119	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
			Total (GPD)			151.5		Hazard Group 1	1,500	90	135,000
			Total (MGD)		Industrial	0.0002		Total (MGD)	Fire Protection		0.14

UIC: M29006											
MEF Component: 3D MLG											
Unit Name:Food Service Company, CLR-37											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
6101	61073	Company/Battery HQ	1,920	SF	3.2	96	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
			Total (GPD)			96		Hazard Group 1	1,500	90	135,000
			Total (MGD)		Industrial	0.0001		Total (MGD)	Fire Protection		0.14

UIC: M29010											
MEF Component: 3D MLG											
Unit Name:3D Supply Battalion, CLR-35											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
6102	61072	Battalion/Squadron HQ	6,970	SF	11.62	349	Cal includes only A/C req and based on SF	Hazard Group 1	1500	120	180000
			Total (GPD)			348.6		Hazard Group 1	1,500	90	135,000

							Industrial Demand		Fire Protection		
										Duration	
					For A/C	GPD	Source	Classification	Minimum Flow	Supply	Total Gallon
FAC	CCN	Nomenclature	BFR	UM	Ton			of Occupancy	GPM	Min	
			Total (MGD)		Industrial	0.0003		Total (MGD)	Fire Protection		0.14

UIC: M29011											
MEF Component: 3D MLG											
Unit Name:Headquarters and Service Co, 3D Supply BN, CLR-35											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
4427	14345	Armory	1,620	SF	2.7	81	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
1443	14378	Operational Haz/Flam Storage	200	SF	0.33	10	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
2145	21455	Vehicle Wash Platform	1	EA		0		Hazard Group 1	1500	90	135000
2145	21456	Grease Rack	1	EA		0		Hazard Group 1	1500	90	135000
4421	44112	Organic Unit Storage	41,690	SF	69.48	2084.4	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
6101	61073	Company/Battery HQ	2,370	SF	3.95	119	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
			Total (GPD)			2293.8		Hazard Group 1	1,500	90	135,000
			Total (MGD)		Industrial	0.0023		Total (MGD)	Fire Protection		0.14

UIC: M29012											
MEF Component: 3D MLG											
Unit Name:											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
4421	44112	Organic Unit Storage	131,250	SF	218.75	6562.5	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
4411	44113	Specific Purpose Warehouse	242,000	SF	403.33	12099.9	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
4424	44120	Controlled Humidity Warehouse	31,180	SF	51.97	1559.1	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
4421	44171	Integrated Log. Overhaul & Outfitting	151,120	SF		0		Hazard Group 1	1500	90	135000
6101	61073	Company/Battery HQ	1,170	SF	1.95	59	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
			Total (GPD)			20280		Hazard Group 1	1,500	90	135,000

							Industrial Demand		Fire Protection		
										Duration	
					For A/C	GPD	Source	Classification	Minimum Flow	Supply	Total Gallon
FAC	CCN	Nomenclature	BFR	UM	Ton			of Occupancy	GPM	Min	
			Total (MGD)		Industrial	0.0203		Total (MGD)	Fire Protection		0.14

UIC: M29014											
MEF Component: 3D MLG											
Unit Name:Medical Logistics Co, 3D Supply BN, CLR-35											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
1443	14378	Operational Haz/Flam Storage	200	SF	0.33	10	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
4421	44112	Organic Unit Storage	86,690	SF	144.48	4334.4	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
6101	61073	Company/Battery HQ	1,020	SF	1.7	51	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
			Total (GPD)			4395.3		Hazard Group 1	1,500	90	135,000
			Total (MGD)		Industrial	0.0044		Total (MGD)	Fire Protection		0.14

UIC: M29021											
MEF Component: 3D MLG											
Unit Name:3D Maintenance Battalion, CLR-35											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
6102	61072	Battalion/Squadron HQ	9,370	SF	15.62	469	Cal includes only A/C req and based on SF	Hazard Group 1	1500	120	180000
			Total (GPD)			468.6		Hazard Group 1	1,500	90	135,000
			Total (MGD)		Industrial	0.0005		Total (MGD)	Fire Protection		0.14

UIC: M29022											
MEF Component: 3D MLG											

							Industrial Demand		Fire Protection		
										Duration	
					For A/C	GPD	Source	Classification	Minimum Flow	Supply	Total Gallon
FAC	CCN	Nomenclature	BFR	UM	Ton			of Occupancy	GPM	Min	
Unit Name:Headquarters and Service Co, 3D Maintenance BN, CLR-35											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
4427	14345	Armory	1,790	SF	2.98	89.4	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
1444	21440	Vehicle Holding Shed	2,100	SF	3.5	105	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
2141	21451	Auto Organizational Shop	13,790	SF	22.98	689.4	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
2145	21455	Vehicle Wash Platform	2	EA		0		Hazard Group 1	1500	90	135000
2145	21456	Grease Rack	1	EA		0		Hazard Group 1	1500	90	135000
6101	61073	Company/Battery HQ	1,020	SF		4500	Estimate based on North Finegayan	Hazard Group 1	1500	90	135000
			Total (GPD)			5383.8		Hazard Group 1	1,500	90	135,000
			Total (MGD)		Industrial	0.0054		Total (MGD)	Fire Protection		0.14

UIC: M29024											
MEF Component: 3D MLG											
Unit Name:Engineer Maintenance Co, 3D Maintenance BN, CLR-35											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
1443	14378	Operational Haz/Flam Storage	200	SF	0.33	10	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
1444	21440	Vehicle Holding Shed	420	SF	0.7	21	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
2141	21453	Field Maintenance Shop	21,710	SF	36.18	1,085	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
2145	21455	Vehicle Wash Platform	1	EA		0		Hazard Group 1	1500	90	135000
2145	21456	Grease Rack	1	EA		0		Hazard Group 1	1500	90	135000
6101	61073	Company/Battery HQ	1,170	SF	1.95	59	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
			Total (GPD)			1174.8		Hazard Group 1	1,500	90	135,000

							Industrial Demand		Fire Protection		
										Duration	
					For A/C	GPD	Source	Classification	Minimum Flow	Supply	Total Gallon
FAC	CCN	Nomenclature	BFR	UM	Ton			of Occupancy	GPM	Min	
			Total (MGD)		Industrial	0.0012		Total (MGD)	Fire Protection		0.14

UIC: M29025											
MEF Component: 3D MLG											
Unit Name:Electronic Maintenance Co, 3D Maintenance BN, CLR-35											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
1443	14378	Operational Haz/Flam Storage	200	SF	0.33	10	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
2145	21455	Vehicle Wash Platform	1	EA		0		Hazard Group 1	1500	90	135000
2145	21456	Grease Rack	1	EA		0		Hazard Group 1	1500	90	135000
2171	21730	Field Maintenance Shop, Comm/Elex	41,650	SF	69.42	2,083	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
6101	61073	Company/Battery HQ	1,170	SF	1.95	59	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
			Total (GPD)			2151		Hazard Group 1	1,500	90	135,000
			Total (MGD)		Industrial	0.0022		Total (MGD)	Fire Protection		0.14

UIC: M29026											
MEF Component: 3D MLG											
Unit Name:Motor Transportation Maint Co, 3D Maintenance BN, CLR-35											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
1443	14378	Operational Haz/Flam Storage	800	SF	1.33	40	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
1444	21440	Vehicle Holding Shed	2,100	SF	3.5	105	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
2141	21453	Field Maintenance Shop	33,450	SF	55.75	1,673	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
2145	21455	Vehicle Wash Platform	2	EA		0		Hazard Group 1	1500	90	135000
2145	21456	Grease Rack	1	EA		0		Hazard Group 1	1500	90	135000
6101	61073	Company/Battery HQ	870	SF	1.45	44	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
			Total (GPD)			1860.9		Hazard Group 1	1,500	90	135,000

							Industrial Demand		Fire Protection		
										Duration	
					For A/C	GPD	Source	Classification	Minimum Flow	Supply	Total Gallon
FAC	CCN	Nomenclature	BFR	UM	Ton			of Occupancy	GPM	Min	
			Total (MGD)		Industrial	0.0019		Total (MGD)	Fire Protection		0.14

UIC: M29027											
MEF Component: 3D MLG											
Unit Name:General Support Maintenance Co, 3D Maintenance BN, CLR-35											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
1443	14378	Operational Haz/Flam Storage	200	SF	0.33	9.9	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
1444	21440	Vehicle Holding Shed	420	SF	0.7	21	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
2141	21453	Field Maintenance Shop	104,750	SF	174.58	5237.4	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
2145	21455	Vehicle Wash Platform	1	EA		0		Hazard Group 1	1500	90	135000
2145	21456	Grease Rack	1	EA		0		Hazard Group 1	1500	90	135000
6101	61073	Company/Battery HQ	1,020	SF	1.7	51	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
			Total (GPD)			5319.3		Hazard Group 1	1,500	90	135,000
			Total (MGD)		Industrial	0.0053		Total (MGD)	Fire Protection		0.14

UIC: M29040											
MEF Component: 3D MLG											
Unit Name:Combat Logistics Regiment 3											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
6102	61072	Battalion/Squadron HQ	7,270	SF	12.12	363.6	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
			Total (GPD)			363.6		Hazard Group 1	1,500	90	135,000
			Total (MGD)		Industrial	0.0004		Total (MGD)	Fire Protection		0.14

							Industrial Demand		Fire Protection		
										Duration	
					For A/C	GPD	Source	Classification	Minimum Flow	Supply	Total Gallon
FAC	CCN	Nomenclature	BFR	UM	Ton			of Occupancy	GPM	Min	
UIC: M29040											
MEF Component: 3D MLG											
Unit Name:Headquarters and Service Co, CLR-3											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
4427	14345	Armory	2,400	SF	4	120	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
1444	21440	Vehicle Holding Shed	420	SF	0.7	21	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
2145	21455	Vehicle Wash Platform	1	EA		0		Hazard Group 1	1500	90	135000
2145	21456	Grease Rack	1	EA		0		Hazard Group 1	1500	90	135000
2171	21710	Electronic/Comm Maint Shop	15,660	SF	26.1	783	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
4421	44112	Organic Unit Storage	73,310	SF	122.18	3665.4	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
6101	61073	Company/Battery HQ	1,620	SF	2.7	81	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
			Total (GPD)			4670.4		Hazard Group 1	1,500	90	135,000
			Total (MGD)		Industrial	0.0047		Total (MGD)	Fire Protection		0.14

UIC: M29042											
MEF Component: 3D MLG											
Unit Name:Support Co, CLR-3											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
1443	14378	Operational Haz/Flam Storage	200	SF	0.33	9.9	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
1444	21440	Vehicle Holding Shed	420	SF	0.7	21	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
2141	21451	Auto Organizational Shop	18,930	SF	31.55	946.5	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
2145	21455	Vehicle Wash Platform	2	EA		0		Hazard Group 1	1500	90	135000
2145	21456	Grease Rack	1	EA		0		Hazard Group 1	1500	90	135000
6101	61073	Company/Battery HQ	1,020	SF	1.7	51	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
			Total (GPD)			1028.4		Hazard Group 1	1,500	90	135,000
			Total (MGD)		Industrial	0.001		Total (MGD)	Fire Protection		0.14

							Industrial Demand		Fire Protection		
										Duration	
					For A/C	GPD	Source	Classification	Minimum Flow	Supply	Total Gallon
FAC	CCN	Nomenclature	BFR	UM	Ton			of Occupancy	GPM	Min	
UIC: M29043											
MEF Component: 3D MLG											
Unit Name:Landing Support Co, CLR-3											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
2182	21880	Field Maintenance Shop (Parachute)	37,510	SF	62.52	1875.6	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
4424	44120	Controlled Humidity Warehouse	49,650	SF	82.75	2482.5	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
6101	61073	Company/Battery HQ	1,020	SF	1.7	51	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
			Total (GPD)			4409.1		Hazard Group 1	1,500	90	135,000
			Total (MGD)		Industrial	0.0044		Total (MGD)	Fire Protection		0.14
UIC: M29044											
MEF Component: 3D MLG											
Unit Name:Motor Transportation Co, CLR-3											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
1443	14378	Operational Haz/Flam Storage	800	SF	1.33	40	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
2141	21430	Refueler Vehicle Shop	3,230	SF	5.38	161.4	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
1444	21440	Vehicle Holding Shed	3,780	SF	6.3	189	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
2141	21451	Auto Organizational Shop	16,740	SF	27.9	837	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
2145	21455	Vehicle Wash Platform	11	EA		0		Hazard Group 1	1500	90	135000
2145	21456	Grease Rack	5	EA		0		Hazard Group 1	1500	90	135000
6101	61073	Company/Battery HQ	1,020	SF	1.7	51	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
			Total (GPD)			1278.3		Hazard Group 1	1,500	90	135,000
			Total (MGD)		Industrial	0.0013		Total (MGD)	Fire Protection		0.14

							Industrial Demand		Fire Protection		
										Duration	
					For A/C	GPD	Source	Classification	Minimum Flow	Supply	Total Gallon
FAC	CCN	Nomenclature	BFR	UM	Ton			of Occupancy	GPM	Min	
UIC: M29091											
MEF Component: 3D MLG											
Unit Name:Headquarters and Service Co, 3D Dental BN											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
1443	14378	Operational Haz/Flam Storage	200	SF	0.33	9.9	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
2182	21871	Dental Equipment Repair Shop	3,350	SF	5.58	167.4	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
5400	54010	Dental Clinic	22,160	SF	36.93	1107.9	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
6101	61073	Company/Battery HQ	1,920	SF	3.2	96	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
			Total (GPD)			1381.2		Hazard Group 1	1,500	90	135,000
			Total (MGD)		Industrial	0.0014		Total (MGD)	Fire Protection		0.14

UIC: M29092											
MEF Component: 3D MLG											
Unit Name:3D Dental Co, 3D Dental BN											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
6101	61073	Company/Battery HQ	1,170	SF	1.95	58.5	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
			Total (GPD)			58.5		Hazard Group 1	1,500	90	135,000
			Total (MGD)		Industrial	0.0001		Total (MGD)	Fire Protection		0.14

UIC: M29093											
MEF Component: 3D MLG											
Unit Name:11th Dental Co, 3D Dental BN											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
6101	61073	Company/Battery HQ	1,170	SF	1.95	58.5	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000

							Industrial Demand		Fire Protection		
										Duration	
					For A/C	GPD	Source	Classification	Minimum Flow	Supply	Total Gallon
FAC	CCN	Nomenclature	BFR	UM	Ton			of Occupancy	GPM	Min	
			Total (GPD)			58.5		Hazard Group 1	1,500	90	135,000
			Total (MGD)		Industrial	0.0001		Total (MGD)	Fire Protection		0.14

UIC: M29094											
MEF Component: 3D MLG											
Unit Name:21st Dental Co, 3D Dental BN											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
6101	61073	Company/Battery HQ	1,320	SF	2.2	66	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
			Total (GPD)			66		Hazard Group 1	1,500	90	135,000
			Total (MGD)		Industrial	0.0001		Total (MGD)	Fire Protection		0.14

UIC: M29104											
MEF Component: 3D MLG											
Unit Name:9th ESB Engineer Co A, 9th Engineer Support BN											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
4427	14345	Armory	660	SF	1.1	33	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
1443	14378	Operational Haz/Flam Storage	800	SF	1.33	39.9	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
2145	21455	Vehicle Wash Platform	1	EA		0		Hazard Group 1	1500	90	135000
2145	21456	Grease Rack	1	EA		0		Hazard Group 1	1500	90	135000
4421	44112	Organic Unit Storage	32,930	SF	54.88	1646.4	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
6101	61073	Company/Battery HQ	1,020	SF	1.7	51	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
			Total (GPD)			1770.3		Hazard Group 1	1,500	90	135,000

							Industrial Demand		Fire Protection		
										Duration	
					For A/C	GPD	Source	Classification	Minimum Flow	Supply	Total Gallon
FAC	CCN	Nomenclature	BFR	UM	Ton			of Occupancy	GPM	Min	
			Total (MGD)		Industrial	0.0018		Total (MGD)	Fire Protection		0.14

UIC: MXXX4											
MEF Component:											
Unit Name:Aviation Facilities at AAFB North Ramp											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton			Hazard Group 2	2250	90	202500
1112	11120	Helicopter Landing Pad	1,111	SY		0		Special	3750	150	562500
1121	11210	Taxiway	9,100	SY		0		Hazard Group 1	1500	90	135000
1131	11320	Aircraft Parking-Apron	147,865	SY		0		Special	3750	150	562500
1131	11340	Aicraft Access Apron	9,833	SY		0		Hazard Group 1	1500	90	135000
1163	11610	Aircraft Washrack-Pavement	2,250	SY		0		Hazard Group 2	2250	90	202500
1167	11615	Aircraft Rinse Facility	1,200	SY		0		Hazard Group 1	1500	90	135000
1161	11620	Aircraft Compass-Calibration Pad	2,000	SY		0		Hazard Group 1	1500	90	135000
1131	11635	Arming-Dearming Pad	3,910	SY		0		Hazard Group 1	1500	90	135000
1164	11645	Line Vehicle Parking	200	SY		0		Hazard Group 1	1500	90	135000
1131	11655	Ordnance Handling Pad	2,064	SY		0		Special	3750	90	337500
1131	11656	Combat Aircraft Ordnance Loading Area	2,405	SY		0		Special	3750	90	337500
1164	11660	Fire&Rescue Vehicle Alert Pad	175	SY		0		Hazard Group 2	2250	90	202500
1164	11665	Tactical Support Van Pad	2,444	SY		0		Hazard Group 1	1500	90	135000
1341	13455	Visual Approach Slope Indicator	2	EA		0		Hazard Group 1	1500	120	180000
1341	13462	Wind Direction Indicator	2	EA		0		Hazard Group 1	1500	90	135000
1361	13620	Parking&Service Area Lighting	2,022	LF		0		Hazard Group 1	1500	90	135000
1362	13636	Simulated Carrier Deck Lighting	1	EA		0		Hazard Group 1	1500	90	135000
1361	13650	Taxiway Lighting	5,800	LF		0		Hazard Group 1	1500	90	135000
1361	13665	Heliport Pad Lighting	400	LF		0		Hazard Group 1	1500	90	135000
1411	14120	Aircraft Fire&Rescue Station	1,700	SF	2.83	84.9	Cal includes only A/C req and based on SF	Hazard Group 2	2250	90	202500
1412	14130	Aircraft Line Operations Building	240	SF	0.4	12	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
1412	14140	Aircraft Operations Building	9,760	SF	16.27	488.1	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000

Industrial Demand Fire Demand Calculation by Facility
USMC Guam Relocation Plan

							Industrial Demand		Fire Protection		
										Duration	
					For A/C	GPD	Source	Classification	Minimum Flow	Supply	Total Gallon
FAC	CCN	Nomenclature	BFR	UM	Ton			of Occupancy	GPM	Min	
1413	14170	Control Tower	2,956	SF	4.93	147.9	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
1444	14187	LOX Pad	5,596	SF		0		Hazard Group 1	1500	90	135000
4427	14345	Armory Small Arms Ammo	1,330	SF	2.22	66.6	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
1443	14378	Operation Haz Flam Material Storage	1,757	SF	2.93	87.9	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
1711	17110	Academic Instruction Building	630	SF	1.05	31.5	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
2113	21103	Corrosion Control Hangar	13,284	SF	22.14	664.2	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
2111	21105	Maintenance Hangar OH Space	130,720	SF		30000	3 acres, use 10,000 gpad from Mil Hdbk	Special	3750	150	562500
2112	21106	Maintenance Hangar 01 Space	61,110	SF		14000	1.4 acres, use 10,000 gpad from Mil Hdbk	Special	3750	150	562500
1444	21107	Maintenance Hangar 02 Space	63,706	SF		14624	1.4 acres, use 10,000 gpad from Mil Hdbk	Special	3750	150	562500
2112	21154	Aviation Armaments Shop	5,000	SF	8.33	249.9	Cal includes only A/C req and based on SF	Special	3750	150	562500
2184	21175	Parachute Survival Equipment Shop	4,524	SF	7.54	226.2	Cal includes only A/C req and based on SF	Hazard Group 1	1500	120	180000
2118	21181	Engine Test Cell	3,296	SF		0		Hazard Group 2	2250	90	202500
2118	21189	Power Check Pad	1	EA		0		Hazard Group 2	2250	90	202500
2145	21455	Vehicle Wash Rack	2	EA		0					
2145	21456	Vehicle Grease Rack	1	EA		0		Hazard Group 2	2250	90	202500
2181	21850	Battery Shop	197	EA		0		Hazard Group 1	1500	120	180000
2181	21860	Aviation GSE Maintenance Shop	8,515	SF	14.19	425.7	Cal includes only A/C req and based on SF	Hazard Group 1	1500	120	180000
2181	21861	Aviation GSE Holding Shed	6,232	SF	10.39	311.7	Cal includes only A/C req and based on SF	Hazard Group 1	1500	120	180000
4211	42132	Inert Storage Building	3,000	SF		0	North Finegayan, similar to warehouse	Hazard Group 2	2250	90	202500
4251	42510	Ordnance Assembly Area	1,111	SY		0		Hazard Group 2	2250	90	202500
4421	44112	Organic Unit Storage	68,489	SF	114.15	3424.5	Cal includes only A/C req and based on SF	Hazard Group 2	2250	90	202500
4521	45110	Open Storage	656	SY		0		Hazard Group 1	1500	90	135000
6100	61010	Administrative Office	12,076	SF	20.13	603.9	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
			Total (GPD)			65449		Extra	3,750	150	562,500
			Total (MGD)		Industrial	0.0654		Total (MGD)	Fire Protection		0.56

UIC: MXXX4											

							Industrial Demand		Fire Protection		
										Duration	
					For A/C	GPD	Source	Classification	Minimum Flow	Supply	Total Gallon
FAC	CCN	Nomenclature	BFR	UM	Ton			of Occupancy	GPM	Min	
MEF Component:											
Unit Name:Embark Operations at Apra Harbor/Ordnance Annex											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
1131	11320	LCAC Parking Apron	24,200	SY		0		Hazard Group 1	1500	90	135000
1241	12450	Vehicle Ready Fuel Storage	50,000	GA		0		Hazard Group 2	2250	90	202500
1531	15310	Cargo Staging Area	72,600	SY		0		Hazard Group 1	1500	90	135000
1443	15610	Waterfront Transit Shed	10,000	SF		0		Hazard Group 1	1500	90	135000
1431	15964	Waterfront Operations Building	6,000	SF	10	300	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
2134	21375	Amphibious Vehicle Maintenance Shop	2,500	SF	4.17	125.1	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
4211	42122	High Explosive Magazine	30,000	SF	50	1500	Cal includes only A/C req and based on SF	Special	3750	90	337500
			Total (GPD)			1925.1		Hazard Group 2	2,250	90	202,500
			Total (MGD)		Industrial	0.0019		Total (MGD)	Fire Protection		0.2

UIC: MXXX4											
MEF Component:											
Unit Name:FAST Company											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
4427	14345	Armory	2,108	SF	3.51	105.3	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
1446	14346	Marine Barracks	4,215	SF	7.03	210.9	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
4421	44112	Organic Unit Storage	20,000	SF	33.33	999.9	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
7210	72124	Bachelor Enlisted Quarters E1-E3	16,765	SF	27.94	838.2	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
7210	72125	Bachelor Enlisted Quarters E4-E5	14,370	SF	23.95	718.5	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
7210	72126	Bachelor Enlisted Quarters E6-E9	9,149	SF	15.25	457.5	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
			Total (GPD)			3330.3		Hazard Group 1	1,500	90	135,000
			Total (MGD)		Industrial	0.0033		Total (MGD)	Fire Protection		0.14

Industrial Demand Fire Demand Calculation by Facility
USMC Guam Relocation Plan

							Industrial Demand		Fire Protection		
										Duration	
					For A/C	GPD	Source	Classification	Minimum Flow	Supply	Total Gallon
FAC	CCN	Nomenclature	BFR	UM	Ton			of Occupancy	GPM	Min	
UIC: MXXX4											
MEF Component:											
Unit Name:MEU											
					For A/C	GPD	Source				
FAC	CCN	Nomenclature	BFR	UM	Ton						
4427	14345	Armory	23,800	SF	39.67	1190.1	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
2134	21375	Amphibian Vehicle Maintenance Shop	22,370	SF		1400	Apra Harbor Naval Complex	Hazard Group 1	1500	90	135000
2141	21451	Auto Organizational Shop	20,742	SF	34.57	1037.1	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
2171	21710	Electronic/Comm Maintenance Shop	20,707	SF		1400	Apra Harbor Naval Complex	Hazard Group 1	1500	90	135000
4421	44112	Organic Unit Storage	39,178	SF	65.3	1959	Cal includes only A/C req and based on SF	Hazard Group 1	1500	90	135000
6102	61072	Battalion/Squadron HQ	53,676	SF		4500	Estimate based on North Finegayan	Hazard Group 1	1500	90	135000
			Total (GPD)			11486.2		Hazard Group 1	1,500	90	135,000
			Total (MGD)		Industrial	0.0115		Total (MGD)	Fire Protection		0.14

Industrial (GPD)

Total	886,816
Finegayan	804,626

Notes:

1. Industrial Demand for Air Conditioning Demand assumed to be 0.05 gpm/ton (from MIL HDBK, 1005/7A)
2. Assume a 10 hour duration for A/C operation
3. Assume one ton cooling per 600 sq ft living space

1. Component	FY 2010-2014 MILITARY CONSTRUCTION PROJECT DATA			2. Date
SUMMARY OF COSTS				APR 2010
3. Installation And Location/UIC N62813		4. Project Title		
MARINE CORPS BASE GUAM		GUAM POTABLE WATER STUDY		
5. Program Element OPTION 1 - OPTIMIZE GROUNDWATER RESOURCE DEVELOPMENT WITHIN DoD	6. Category Code	7. Project Number	8. Project Cost ($000) $559,477	

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
SUMMARY OF COSTS				
CAPITAL COSTS				
1) Water Resources Development				$20,749
2) Water Treatment				$2,607
3) Distribution				$269,371
Total Construction Cost				$292,727
Contingencies (20%)				$58,545
Engineering (15%)				$43,909
Total Capital Cost				**$395,181**
Present Worth Guam Capital Costs				**$398,281**
Annual O&M Costs				
1) Water Resources Development				$309
2) Water Treatment				$1,766
3) Distribution				$3,553
Total Annual O&M Cost				$5,629
Contingency (20%)				$1,126
Total Annual O&M Cost				**$6,754**
Present Worth of O&M Costs (25 year life)				**$161,196**
Present Worth of Total Costs				**$559,477**

Guidance Cost Analysis

10. Description of Proposed Construction:
Option 1: Development of groundwater resources on DoD property. This option includes 22 water supply wells; storage facilities and within the planned Finegayan Base Complex, interconnects with the AAFB system and improvements to the Navy Island-Wide system to allow water transport south to AF Barrigada, Andersen South Annex and DoD in south Guam.

Notes:
1. The area construction cost factor for Guam is based on Navy guidance.
2. The escalation factor for construction costs is 2.5% from ENR (May 2008).
3. The discount factor from Circular-94 Jan 2008 ranged from 2.3% (5-year) to 2.8% (30+years).
4. The construction period is assumed to be from 2010 to 2014.
5. Details are provided in Appendix E.

1. Component	FY 2010-2014 MILITARY CONSTRUCTION PROJECT DATA			2. Date
CAPITAL COSTS				APR 2010
3. Installation And Location/UIC N62813		4. Project Title		
MARINE CORPS BASE GUAM		GUAM POTABLE WATER STUDY		
5. Program Element OPTION 1 - OPTIMIZE GROUNDWATER RESOURCE DEVELOPMENT WITHIN DoD	6. Category Code	7. Project Number	8. Project Cost ($000) $559,477	

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
COST DETAILS				
CAPITAL COSTS				
1) Water Resources Development				
Well Installation/Construction Costs - 250/300 GPM Wells,				
Mobilization/Demobilization	LS	1	64,000	$64
Drill min. 17.25 in. dia. hole in unlithified and set outer temp. casing	ft	20	704	$14
Drill min. 17.25 in. dia. hole in bedrock	ft	490	512	$251
Stainless steel, wire-wrapped screen, 10-in. pipe-size dia.	ft	40	512	$20
Furnish and install steel casing, 10-in. dia.	1	472	128	$60
Furnish and install gravel pack and sand seal	LS	1	25,600	$26
Set-up grouting equipment	LS	1	12,800	$13
Circulate bentonite	bags	200	64	$13
rout annular space between 10.75-in. OD casing and 17.25-in. dia. borehole	bags	504	77	$39
Furnish and install development/test pump and appurtenances	LS	1	19,200	$19
Perform well development by pumping and surging	hr	24	768	$18
Perform step-drawdown well test	hr	8	576	$5
Perform aquifer performance test	hr	24	576	$14
Perform plumbness and alignment test	hr	1	3,840	$4
Televise well	LS	1	3,328	$3
Cost of seismic reflection study at wellsite	ea	1	25,600	$26
Total cost per 250/300 GPM well				$589
Total number of 250/300 GPM wells				11
Total cost of 250/300 GPM wells				$6,475
Well Installation/Construction Costs - 450 GPM Wells,				
Mobilization/Demobilization	LS	1	76,800	$77
Drill min. 18-in. dia. hole in unlithified and set outer temp. casing	ft	20	704	$14
Drill min. 18-in. dia. hole in bedrock	ft	557	512	$285
Stainless steel, wire-wrapped screen, 12-in. pipe-size dia.	ft	40	614	$25
Furnish and install steel casing, 12-in. dia.	1	539	166	$90
Furnish and install gravel pack and sand seal	LS	1	30,720	$31
Set-up grouting equipment	LS	1	12,800	$13
Circulate bentonite	bags	180	64	$12
Grout annular space between 12-in. dia. casing and 18-in. dia. borehole	bags	450	77	$35
Furnish and install development/test pump and appurtenances	LS	1	20,480	$20
Perform well development by pumping and surging	hr	24	768	$18
Perform step-drawdown well test	hr	8	640	$5
Perform aquifer performance test	hr	24	640	$15
Perform plumbness and alignment test	LS	1	4,480	$4
Televise well	LS	1	3,840	$4
Cost of seismic reflection study at wellsite	ea	1	25,600	$26

1. Component	FY 2010-2014 MILITARY CONSTRUCTION PROJECT DATA			2. Date
CAPITAL COSTS				APR 2010
3. Installation And Location/UIC N62813		4. Project Title		
MARINE CORPS BASE GUAM		GUAM POTABLE WATER STUDY		
5. Program Element OPTION 1 - OPTIMIZE GROUNDWATER RESOURCE DEVELOPMENT WITHIN DoD	6. Category Code	7. Project Number	8. Project Cost ($000) $559,477	

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
Total cost per 450 GPM well				$673
Total number of 450 GPM wells				11
Total cost of 450 GPM wells				$7,406
Test Borings	ea.	22	276,480	$6,083
Monitoring Wells, 400 ft at $64/f	ea	12	65,536	$786
Total Water Resources Development				**$20,749**
2) Water Treatment				
Chlorination and Flourination (200-300 gpm))	LS	11	98,594	$1,085
Chlorination and Flourination (400-450 gpm)	LS	11	138,378	$1,522
Total Water Treatment Cost				**$2,607**
3) Distribution				
Well Facilities				
250 gpm submersible pump with 50 hp motor	ea	9	153,600	$1,382
Discharge piping, valves, flow meter	ea	9	64,000	$576
Pump house	ea	9	512,000	$4,608
Security fence	ea	9	38,400	$346
Telemetry	ea	9	51,200	$461
Electrical service to site	ea	9	12,800	$115
300 gpm submersible pump with 75 hp motor	ea	2	179,200	$358
Discharge piping, valves, flow meter	ea	2	64,000	$128
Pump house	ea	2	512,000	$1,024
Security fence	ea	2	38,400	$77
Telemetry	ea	2	51,200	$102
Electrical service to site	ea	2	12,800	$26
450 gpm submersible pump with 100 hp motor	ea	11	192,000	$2,112
Discharge piping, valves, flow meter	ea	11	76,800	$845
Pump house	ea	11	512,000	$5,632
Security fence	ea	11	38,400	$422
Telemetry	ea	11	51,200	$563
Electrical service to site	ea	11	12,800	$141
Transmission Mains for New Wells				
8 inch Transmission Main Pipe and installation	ft	4700	154	$722

1. Component	FY 2010-2014 MILITARY CONSTRUCTION PROJECT DATA			2. Date
CAPITAL COSTS				APR 2010
3. Installation And Location/UIC N62813		4. Project Title		
MARINE CORPS BASE GUAM		GUAM POTABLE WATER STUDY		
5. Program Element OPTION 1 - OPTIMIZE GROUNDWATER RESOURCE DEVELOPMENT WITHIN DoD	6. Category Code	7. Project Number	8. Project Cost ($000) $559,477	

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
Restoration	ft	4700	26	$120
Valves spaced at 500 ft	ea	9	16,640	$150
Hydrants spaced at 1,000 ft	ea	5	16,896	$84
12 inch Transmission Main				
Pipe and installation	ft	11100	179	$1,989
Restoration	ft	11100	26	$284
Valves spaced at 500 ft	ea	22	25,600	$563
Hydrants spaced at 1,000 ft	ea	11	16,896	$186
16 inch Transmission Main				
Pipe and installation	ft	5600	205	$1,147
Restoration	ft	5600	26	$143
Valves spaced at 500 ft	ea	11	46,080	$507
Hydrants spaced at 1,000 ft	ea	6	16,896	$101
20 inch Transmission Main				
Pipe and installation	ft	7000	256	$1,792
Restoration	ft	7000	38	$269
Valves spaced at 500 ft	ea	14	51,200	$717
Hydrants spaced at 1,000 ft	ea	7	16,896	$118
24 inch Transmission Main				
Pipe and installation	ft	14600	307	$4,485
Restoration	ft	14600	38	$561
Valves spaced at 500 ft	ea	29	56,320	$1,633
Hydrants spaced at 1,000 ft	ea	15	16,896	$253
30 inch Transmission Main				
Pipe and installation	ft	26600	384	$10,214
Restoration	ft	26600	38	$1,021
Valves spaced at 500 ft	ea	53	64,000	$3,392
Hydrants spaced at 1,000 ft	ea	27	16,896	$456
Transmission Mains for connecting existing Navy wells at Finegayan to MCB Water System				
8 inch Transmission Main				
Pipe and installation	ft	21000	154	$3,226
Restoration	ft	21000	26	$538
Valves spaced at 500 ft	ea	42	16,640	$699
Hydrants spaced at 1,000 ft	ea	21	16,896	$355
12 inch Transmission Main				

1. Component	FY 2010-2014 MILITARY CONSTRUCTION PROJECT DATA			2. Date
CAPITAL COSTS				APR 2010
3. Installation And Location/UIC N62813		4. Project Title		
MARINE CORPS BASE GUAM		GUAM POTABLE WATER STUDY		
5. Program Element OPTION 1 - OPTIMIZE GROUNDWATER RESOURCE DEVELOPMENT WITHIN DoD	6. Category Code	7. Project Number	8. Project Cost ($000) $559,477	

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
Pipe and installation	ft	8500	179	$1,523
Restoration	ft	8500	26	$218
Valves spaced at 500 ft	ea	17	25,600	$435
Hydrants spaced at 1,000 ft	ea	9	16,896	$152
Standby Power - Generators -Central	ea	1	11,825,216	$11,825
Transmission Mains to Andersen South				
30 inch Transmission Main to Andersen South Storage Tank 2				
Pipe and installation	ft	28000	384	$10,752
Restoration	ft	28000	38	$1,075
Valves spaced at 500 ft	ea	56	64,000	$3,584
Hydrants spaced at 1,000 ft	ea	23	16,896	$389
Flow Control valve station	LS	1	512,000	$512
30 inch Transmission Main to Andersen South Storage Tank 4				
Pipe and installation	ft	15000	384	$5,760
Restoration	ft	15000	38	$576
Valves spaced at 500 ft	ea	30	64,000	$1,920
Hydrants spaced at 1,000 ft	ea	15	16,896	$253
Flow Control valve station	LS	1	512,000	$512
Connection to Navy Island-Wide System				
Connect to existing Water Main, Construct Metering Station	LS	1	512,000	$512
Replacement Mains for Navy Island Wide System				
Transmission Main to Barrigada Tank (4.1 MGD)				
24 inch Transmission Main				
Pipe and installation	ft	31000	307	$9,523
Restoration	ft	31000	38	$1,190
Valves spaced at 500 ft	ea	62	56,320	$3,492
Hydrants spaced at 1,000 ft	ea	31	16,896	$524
Flow control valve station	LS	1	512,000	$512
Between Barrigada Pump Station and Barrigada Reservoir				
30 inch Transmission Main				
Pipe and installation	ft	22000	384	$8,448
Restoration	ft	22000	38	$845
Valves spaced at 500 ft	ea	44	64,000	$2,816
Hydrants spaced at 1,000 ft	ea	22	16,896	$372
Flow control valve station	LS	1	512,000	$512

1. Component	FY 2010-2014 MILITARY CONSTRUCTION PROJECT DATA			2. Date
CAPITAL COSTS				APR 2010
3. Installation And Location/UIC N62813		4. Project Title		
MARINE CORPS BASE GUAM		GUAM POTABLE WATER STUDY		
5. Program Element OPTION 1 - OPTIMIZE GROUNDWATER RESOURCE DEVELOPMENT WITHIN DoD	6. Category Code	7. Project Number	8. Project Cost ($000) $559,477	

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
Between Asan Pump Station and Barrigada Pump Station				
30 inch Transmission Main				
Pipe and installation	ft	19000	384	$7,296
Restoration	ft	19000	38	$730
Valves spaced at 500 ft	ea	38	64,000	$2,432
Hydrants spaced at 1,000 ft	ea	19	16,896	$321
Flow control valve station	LS	0	512,000	$0
Between Tupo Reservoir and Asan Pump Station				
30 inch Transmission Main				
Pipe and installation	ft	40000	384	$15,360
Restoration	ft	40000	38	$1,536
Valves spaced at 500 ft	ea	80	64,000	$5,120
Hydrants spaced at 1,000 ft	ea	40	16,896	$676
Flow control valve station	LS	0	512,000	$0
Water Booster Pumping Station				
Replace Harmon Booster Station				
Pumps and motors	ea	2	204,800	$410
VFDs	ea	2	204,800	$410
Process piping, valves, meters	ea	1	384,000	$384
Building - 1,000 sq ft	ea	1500	640	$960
Electrical	ea	1	256,000	$256
Generator	ea	1	384,000	$384
I&C	ea	1	128,000	$128
Sitework	ea	1	128,000	$128
Demolish existing pump station	ea	1	128,000	$128
Replace Booster Station near Storage Tank 2 at Andersen South				
Pumps and motors	ea	4	128,000	$512
VFDs	ea	4	128,000	$512
Process piping, valves, meters	ea	1	512,000	$512
Building - 1,000 sq ft	ea	2000	640	$1,280
Electrical	ea	1	256,000	$256
Generator	ea	1	256,000	$256
I&C	ea	1	128,000	$128
Sitework	ea	1	204,800	$205
Demolish existing pump station	ea	1	128,000	$128
Replace Booster Station near Storage Tank 4 at Andersen South				
Pumps and motors	ea	2	128,000	$256
VFDs	ea	2	128,000	$256

1. Component	FY 2010-2014 MILITARY CONSTRUCTION PROJECT DATA			2. Date
CAPITAL COSTS				APR 2010
3. Installation And Location/UIC N62813		4. Project Title		
MARINE CORPS BASE GUAM		GUAM POTABLE WATER STUDY		
5. Program Element OPTION 1 - OPTIMIZE GROUNDWATER RESOURCE DEVELOPMENT WITHIN DoD	6. Category Code	7. Project Number	8. Project Cost ($000) $559,477	

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
Process piping, valves, meters	ea	1	256,000	$256
Building - 1,000 sq ft	ea	1000	640	$640
Electrical	ea	1	256,000	$256
Generator	ea	1	256,000	$256
I&C	ea	1	128,000	$128
Sitework	ea	1	128,000	$128
Demolish existing pump station	ea	1	128,000	$128
Replace Barrigada Booster Station				
Pumps and motors	ea	2	204,800	$410
VFDs	ea	2	204,800	$410
Process piping, valves, meters	ea	1	384,000	$384
Building - 1,000 sq ft	ea	1500	640	$960
Electrical	ea	1	256,000	$256
Generator	ea	1	384,000	$384
I&C	ea	1	128,000	$128
Sitework	ea	1	128,000	$128
Demolish existing pump station	ea	1	128,000	$128
Demolish Asan Booster Station				
Demolish booster station	ea	1	128,000	$128
Water Storage				
Concrete reservoir - 5 MG	ea	1	20,480,000	$20,480
Telemetry	ea	2	102,400	$205
Site work	ea	1	384,000	$384
Electrical service to site	ea	1	25,600	$26
Distribution within the Finegayan Base Complex				
8 inch Water Main				
Pipe and installation	ft	33400	154	$5,130
Restoration	ft	33400	26	$855
Valves spaced at 500 ft	ea	67	16,640	$1,115
Hydrants spaced at 500 ft	ea	67	16,896	$1,132
12 inch Main				
Pipe and installation	ft	84500	179	$15,142
Restoration	ft	84500	26	$2,163
Valves spaced at 500 ft	ea	169	25,600	$4,326
Hydrants spaced at 500 ft	ea	169	16,896	$2,855
Service connections	ea	3500	12,800	$44,800

1. Component	FY 2010-2014 MILITARY CONSTRUCTION PROJECT DATA			2. Date
CAPITAL COSTS				APR 2010
3. Installation And Location/UIC N62813		4. Project Title		
MARINE CORPS BASE GUAM		GUAM POTABLE WATER STUDY		
5. Program Element OPTION 1 - OPTIMIZE GROUNDWATER RESOURCE DEVELOPMENT WITHIN DoD	6. Category Code	7. Project Number	8. Project Cost ($000) $559,477	

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
AAFB Interconnect				
16- inch Transmission Main				
Pipe and installation	ft	6000	205	$1,229
Restoration	ft	6000	51	$307
Valves	ea	3	46,080	$138
Hydrants spaced at 1,000 ft	ea	6	16,896	$101
Connection to existing pipe	ea	1	12,800	$13
Flow meter at WTP	ea	1	25,600	$26
Total Distribution Cost				**$269,371**
Total Construction Cost				$292,727
Contingencies (20%)				$58,545
Engineering (15%)				$43,909
2008 Construction Costs				**$395,181**
2012 Construction Costs (2.5% Escalation)				**$436,206**
Present Worth Guam Construction Costs (2.3% discount)				**$398,281**

1. Component	FY 2010-2014 MILITARY CONSTRUCTION PROJECT DATA			2. Date
O&M COSTS				APR 2010
3. Installation And Location/UIC N62813		4. Project Title		
MARINE CORPS BASE GUAM		GUAM POTABLE WATER STUDY		
5. Program Element OPTION 1 - OPTIMIZE GROUNDWATER RESOURCE DEVELOPMENT WITHIN DoD	6. Category Code	7. Project Number	8. Project Cost ($000) $559,477	

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
O&M COSTS				
1) Water Resources Development				
Annual Maintenance Cost for Supply Wells (well cleaning)	ea	22	12,000	$264
Annual Labor Cost for Sampling MW ($25/hr with a 2.7 multiplier)	hr	672	68	$45
Total Water Resources Development				**$309**
2) Water Treatment				
Chlorination and Flourination (200-300 gpm))	ea	11	15,700	$173
Chlorination and Flourination (400-450 gpm)	ea	11	15,700	$173
Total Water Treatment				**$1,766**
3) Distribution				
Annual Electric costs				
Raw water pumps	kw-h	6609110	0.20	$1,322
Treated water pumps	kw-h	1050399	0.20	$210
Annual Pump replacement costs				
Replace Well pumps				
Pull pump from well every 10 years	ea	22	5,000	$110
Inspect and replace every 10 years	ea	22	75,000	$1,650
Annual Cost Replace Well pumps	ea	22	8,000	$176
Distribution system maintenance, flushing, etc.	ea	1	85,000	$85
Total Water Distribution				**$3,553**
Total Annual Cost				$5,629
Contingency (20%)				$1,126
Total Annual O&M Cost				$6,754
2008 O&M Cost (25 year life)				**$168,858**
Future O&M Costs (2015 to 2039)				**$274,244**
Present Worth of O&M Costs (2.4 to 2.8% Discounts)				**$161,196**

1. Component	FY 2010-2014 MILITARY CONSTRUCTION PROJECT DATA			2. Date
SUMMARY OF COSTS				APR 2010
3. Installation And Location/UIC N62813		4. Project Title		
MARINE CORPS BASE GUAM (OTHER DoD IMPROVEMENTS)		GUAM POTABLE WATER STUDY		
5. Program Element OPTION 2 - REHABILITATION, TREATMENT OF WELL WATER, OR REPLACEMENT OF	6. Category Code	7. Project Number	8. Project Cost ($000) $35,643	

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
SUMMARY OF COSTS				
CAPITAL COSTS				
1) Water Resources Development				$3,187
2) Water Treatment				$394
3) Distribution				$2,624
Total Construction Cost				$6,205
Contingencies (20%)				$1,241
Engineering (15%)				$931
Total Capital Cost				**$8,377**
Present Worth Guam Capital Costs				**$8,443**
Annual O&M Costs				
1) Water Resources Development				$92
2) Water Treatment				$175
3) Distribution				$683
Total Annual O&M Cost				$950
Contingency (20%)				$190
Total Annual O&M Cost				**$1,140**
Present Worth of O&M Costs (25 year life)				**$27,200**
Present Worth of Total Costs				**$35,643**

Guidance Cost Analysis

10. Description of Proposed Construction:
Option 2: Rehabilitate or replace inactive DoD wells. Rehabilitating two wells at the Naval Hospital; replacing one well on Finegayan base; replacing two wells on Navy Barrigada; monitoring well installation and sampling.

Notes:
1. The area construction cost factor for Guam is based on Navy guidance.
2. The escalation factor for construction costs is 2.5% from ENR (May 2008).
3. The discount factor from Circular-94 Jan 2008 ranged from 2.3% (5-year) to 2.8% (30+years).
4. The construction period is assumed to be from 2010 to 2014.
5. Details are provided in Appendix E.

1. Component	FY 2010-2014 MILITARY CONSTRUCTION PROJECT DATA	2. Date
CAPITAL COSTS		APR 2010

3. Installation And Location/UIC N62813	4. Project Title
MARINE CORPS BASE GUAM (OTHER DoD IMPROVEMENTS)	GUAM POTABLE WATER STUDY

5. Program Element	6. Category Code	7. Project Number	8. Project Cost ($000)
OPTION 2 - REHABILITATION, TREATMENT OF WELL WATER, OR REPLACEMENT OF			$35,643

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
COST DETAILS				
CAPITAL COSTS				
1) Water Resources Development				
Well Installation/Construction Costs - 100-300 GPM Wells,				
Mobilization/Demobilization	LS	1	64,000	$64
Drill min. 17.25 in. dia. hole in unlithified and set outer temp. casing	ft	20	704	$14.1
Drill min. 17.25 in. dia. hole in bedrock	ft	490	512	$251
Furnish and install stainless steel, wire-wrapped screen, 10-in. pipe-size dia.	ft	40	512	$20.5
Furnish and install steel casing, 10-in. dia.	1	472	128	$60
Furnish and install gravel pack and sand seal	LS	1	25,600	$26
Set-up grouting equipment	LS	1	12,800	$12.8
Circulate bentonite	bags	200	64	$12.8
Grout annular space between 10.75-in. OD casing and 17.25-in. dia. borehole	bags	504	77	$39
Furnish and install development/test pump and appurtenances	LS	1	19,200	$19.2
Perform well development by pumping and surging	hr	24	768	$18.4
Perform step-drawdown well test	hr	8	576	$4.6
Perform aquifer performance test	hr	24	576	$13.8
Perform plumbness and alignment test	hr	1	3,840	$3.8
Televise well	LS	1	3,328	$3.3
Cost of seismic reflection study at well site	ea	5	25,600	$128
Total cost per 200/300 GPM well				$691
Wells in Barrigada NCTS #3 and 8				2
Wells in Finegayan NCTS #2				1
Total cost of 200/300 GPM wells				$2,073
Finegayan Monitoring Wells, 400 ft at $64/ft	ea	5	65,536	$328
Barrigada Monitoring Wells, 400 ft at $64/ft	ea	5	65,536	$328
Naval Hospital Monitoring Wells, 400 ft at $64/ft	ea	2	65,536	$131
Andersen South Annex Monitoring Wells, 400 ft at $64/ft	ea	5	65,536	$328
Total Water Resources Development				**$3,187**
2) Water Treatment				
Chlorination and Flourination (NCTS #2, 3, 8 and NRMC #2)	LS	4	98,594	$394
Total Water Treatment Cost				**$394**
3) Distribution				
Well Facilities				
Replacement wells (NCTS #2,3 and 8)				
250 gpm submersible pump with 50 hp motor	ea	3	153,600	$461
Discharge piping, valves, flow meter	ea	3	64,000	$192
Pump house	ea	3	512,000	$1,536
Security fence	ea	3	38,400	$115
Telemetry	ea	3	51,200	$154
Electrical service to site	ea	3	12,800	$38
Naval Hospital Well NRMC #3				
System modifications	LS	1	128,000	$128
Total Distribution Cost				**$2,624**

1. Component	FY 2010-2014 MILITARY CONSTRUCTION PROJECT DATA			2. Date
CAPITAL COSTS				APR 2010
3. Installation And Location/UIC N62813		4. Project Title		
MARINE CORPS BASE GUAM (OTHER DoD IMPROVEMENTS)		GUAM POTABLE WATER STUDY		
5. Program Element OPTION 2 - REHABILITATION, TREATMENT OF WELL WATER, OR REPLACEMENT OF	6. Category Code	7. Project Number	8. Project Cost ($000) $35,643	

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
Total Construction Cost				$6,205
Contingencies (20%)				$1,241
Engineering (15%)				$931
2008 Construction Costs				**$8,377**
2012 Construction Costs (2.5% Escalation)				**$9,247**
Present Worth Guam Construction Costs (2.3% discount)				**$8,443**

1. Component	FY 2010-2014 MILITARY CONSTRUCTION PROJECT DATA			2. Date
O&M COSTS				APR 2010
3. Installation And Location/UIC N62813		4. Project Title		
MARINE CORPS BASE GUAM (OTHER DoD IMPROVEMENTS)		GUAM POTABLE WATER STUDY		
5. Program Element OPTION 2 - REHABILITATION, TREATMENT OF WELL WATER, OR REPLACEMENT OF	6. Category Code	7. Project Number	8. Project Cost ($000) $35,643	

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
O&M COSTS				
1) Water Resources Development				
Annual Maintenance Cost for Supply Wells (well cleaning)	ea	5	12,000	$60
Annual Labor Cost for Sampling Monitoring Wells	hr	480	68	$32
Total Water Resources Development				**$92**
2) Water Treatment				
Chlorination and Flourination (NCTS #2, 3, 8, and NRMC #2, #3)	ea	5	34,900	$175
Total Water Treatment				**$175**
3) Distribution				
Annual Electric costs				
Raw water pumps	kw-h	1214361	0.20	$243
Annual Pump replacement costs				
Replace Well pumps (NCTS #2, 3, 8, and NRMC #2, #3)				
Pull pump from well every 10 years	ea	5	5,000	$25
Inspect and replace every 10 years	ea	5	75,000	$375
Annual Cost Replace Well pumps	ea	5	8,000	$40
Total Water Distribution				**$683**
Total Annual Cost				$950
Contingency (20%)				$190
Total Annual O&M Cost				$1,140
Adjusted Annual O&M Cost for Guam (no adjustment)				$1,140
2008 O&M Cost (25 year life)				**$28,493**
Future O&M Costs (2015 to 2039)				**$46,276**
Present Worth of O&M Costs (2.4 to 2.8% Discounts)				**$27,200**

1. Component	FY 2010-2014 MILITARY CONSTRUCTION PROJECT DATA			2. Date
SUMMARY OF COSTS				APR 2010
3. Installation And Location/UIC N62813		4. Project Title		
MARINE CORPS BASE GUAM		GUAM POTABLE WATER STUDY		
5. Program Element OPTION 3 - Purchase Water From GWA	6. Category Code	7. Project Number	8. Project Cost ($000) $2,235	

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
SUMMARY OF COSTS				
CAPITAL COSTS				
1) Water Resources Development				$0
2) Water Treatment				$0
3) Distribution				$1,642
Total Construction Cost				$1,642
Contingencies (20%)				$328
Engineering (15%)				$246
Total Capital Cost				**$2,217**
Present Worth Guam Capital Costs				**$2,235**
Annual O&M Costs				
1) Water Resources Development				$0
2) Water Treatment				$0
3) Distribution				$0
Total Annual O&M Cost				$0
Contingency (20%)				$0
Total Annual O&M Cost				**$0**
Present Worth of O&M Costs (25 year life)				**$0**
Present Worth of Total Costs				**$2,235**

Guidance Cost Analysis

10. Description of Proposed Construction:
Option 3: Trade/Buy from GWA. This option includes installation of a connection between GWA and the DoD water line installed for Option 1 in the vicinity of the Option 1 water treatment plant.

Notes:
1. The area cost factor for Guam is 3.0 based on Navy guidance.
2. The escalation factor for construction costs is 2.5% from ENR (May 2008).
3. The discount factor from Circular-94 Jan 2008 is 2.3% (5-year).
4. Theconstruction period is assumed to be from 2010 to 2014.

1. Component	FY 2010-2014 MILITARY CONSTRUCTION PROJECT DATA			2. Date
CAPITAL COSTS				APR 2010
3. Installation And Location/UIC N62813		4. Project Title		
MARINE CORPS BASE GUAM		GUAM POTABLE WATER STUDY		
5. Program Element OPTION 3 - Purchase Water From GWA	6. Category Code	7. Project Number	8. Project Cost ($000)	$2,235

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
COST DETAILS				
CAPITAL COSTS				
1) Water Resources Development				
Total Water Resources Development				**$0**
2) Water Treatment				
Total Water Treatment Cost				**$0**
3) Distribution				
Connection Between GWA and DoD Waterlines				
Metering station	ea.	1	844,800	$845
Connecting water main	ea.	1	797,696	$798
Total Distribution Cost				**$1,642**
Total Construction Cost				$1,642
Contingencies (20%)				$328
Engineering (15%)				$246
2008 Guam Construction Costs				**$2,217**
2012 Construction Costs (2.5% Escalation)				**$2,448**
Present Worth Guam Construction Costs (2.3% discount)				**$2,235**

1. Component	FY 2010-2014 MILITARY CONSTRUCTION PROJECT DATA			2. Date
O&M COSTS				APR 2010
3. Installation And Location/UIC N62813		4. Project Title		
MARINE CORPS BASE GUAM		GUAM POTABLE WATER STUDY		
5. Program Element OPTION 3 - Purchase Water From GWA	6. Category Code	7. Project Number	8. Project Cost ($000)	$2,235

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
O&M COSTS				
1) Water Resources Development				
Total Water Resources Development				**$0**
2) Water Treatment				
Total Water Treatment				**$0**
3) Distribution				
Total Water Distribution				**$0**
Total Annual Cost				$0
Contingency (20%)				$0
Total Annual O&M Cost				$0
Adjusted Annual O&M Cost for Guam (no adjustment)				$0
2008 O&M Cost (25 year life)				**$0**
Future O&M Costs (2015 to 2039)				**$0**
Present Worth of O&M Costs				**$0**

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CALCULATION SHEET

PAGE ____ OF ____

PROJECT NO. _____

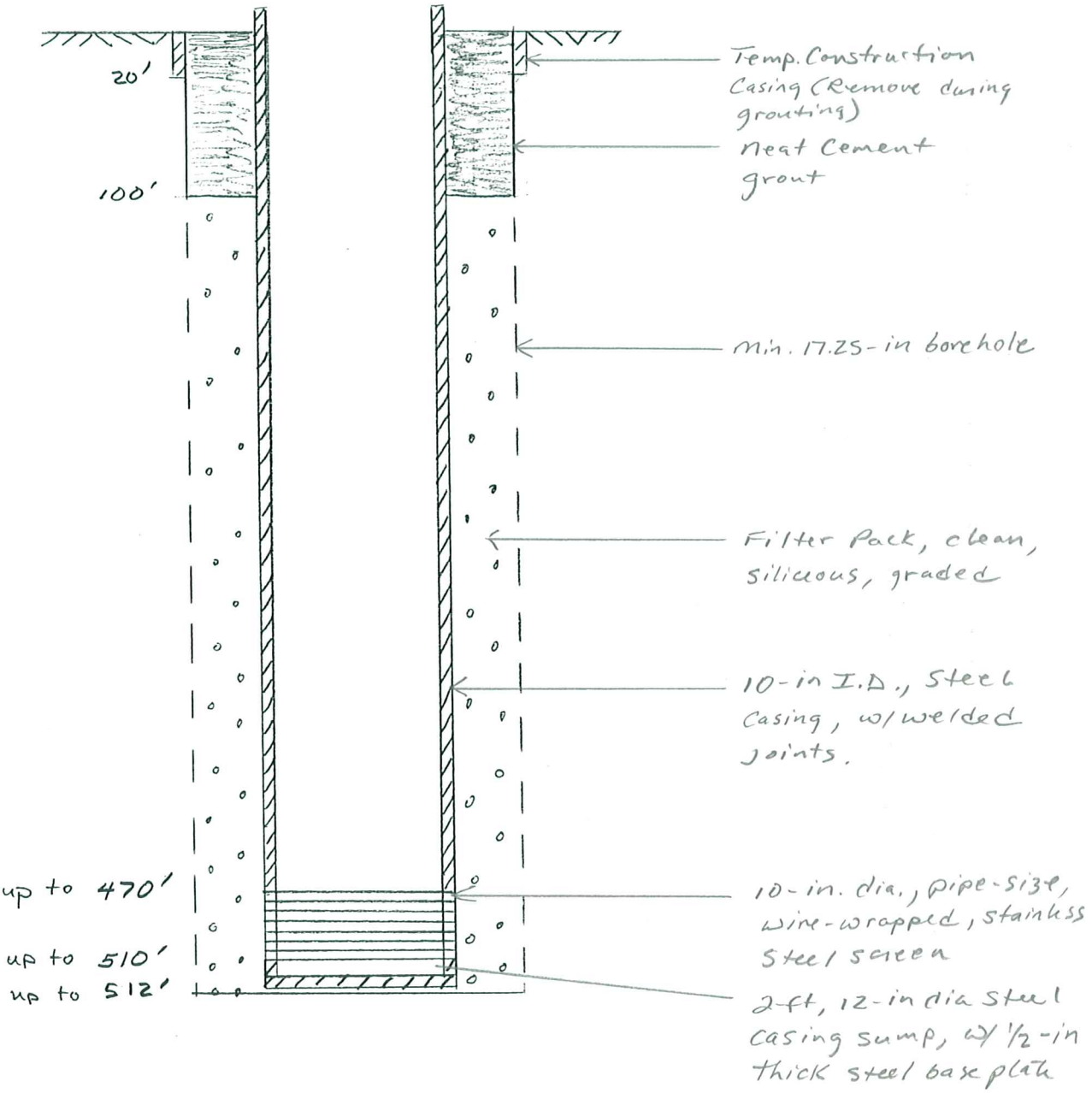
CLIENT _____ SUBJECT 10" casing/screen 17.25" Borehole

PROJECT _____

Prepared By _____ Date _____

Reviewed By _____ Date _____

Approved By _____ Date _____



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CALCULATION SHEET

PAGE ___ OF ___

PROJECT NO. ___

CLIENT ___ SUBJECT Assumptions

PROJECT ___ 10" Casing / Screen

Prepared By HRG Date 11/01/07

Reviewed By ___ Date ___

Approved By ___ Date ___

	Item	Units	Unit Price	Total
1.	Mob/Demob	1	25,000	25,000
2	Drill min 17.25 in dia hole in unlithified and set outer temp. casing (ft)	20	275	5,500
3	Drill min 17.25 in dia hole in bedrock (ft)	490	200	98,000
4.	Furnish and install stainless steel, wire-wrapped screen, 10-in., pipe-size dia (ft).	40	200	8,000
5.	Furnish and install steel casing, 10-in. dia.	472	50	23,600
6.	Furnish and install gravel pack and sand seal	1	10,000	10,000
7.	Set-up grouting equipment	1	5,000	5,000
8	Circulate bentonite (bags)	200	25	5,000
9.	Grout annular space between 10.79-in OD casing and 17.25-in dia borehole (bags)	504	30	15,120
10.	Furnish and install development /test pump and appurtenances	1	7,500	7,500

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CALCULATION SHEET

PAGE ___ OF ___

PROJECT NO. _____

CLIENT _____ SUBJECT 10" casing, 17.25" borehole

PROJECT _____

Prepared By _____ Date _____

Reviewed By _____ Date _____

Approved By _____ Date _____

(continued)

	Item	Units	Unit Price	Total
11.	Perform well development by pumping and surging	24	300	7,200
12.	Perform step-drawdown well test (Hr).	8	225	1800
13.	Perform aquifer performance test (Hr)	24	225	5400
14.	Perform plumbness and alignment test	1	1500	1500
15.	Televise well	1	1300	1300

$219,920

$$\frac{\$219,920}{512 \text{ feet}} = \$430 \text{ per foot}$$

EARTH TECH

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CALCULATION SHEET

PAGE ____ OF ____

PROJECT NO. _____

CLIENT _____ SUBJECT _____ Prepared By _____ Date _____

PROJECT _____ 10" Casing _____ Reviewed By _____ Date _____

_____ 17.25" Borehole _____ Approved By _____ Date _____

Annular Space Volume = $100\ ft\left(\left(\frac{17.25}{12}\right)^2 - \left(\frac{10.75}{12}\right)^2\right)\pi = 397\ ft^3$

Bentonite Slurry - $\frac{397\ ft^3}{3\ \frac{ft^3}{bag}}$ = 132 bags + (50%) 66 bags

= 198 bags

Say 200 bags

Grout $\frac{397\ ft^3}{1.18\ ft^3/bag}$ = 336 bags + (50%) 168 bags

= 504 bags

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CALCULATION SHEET

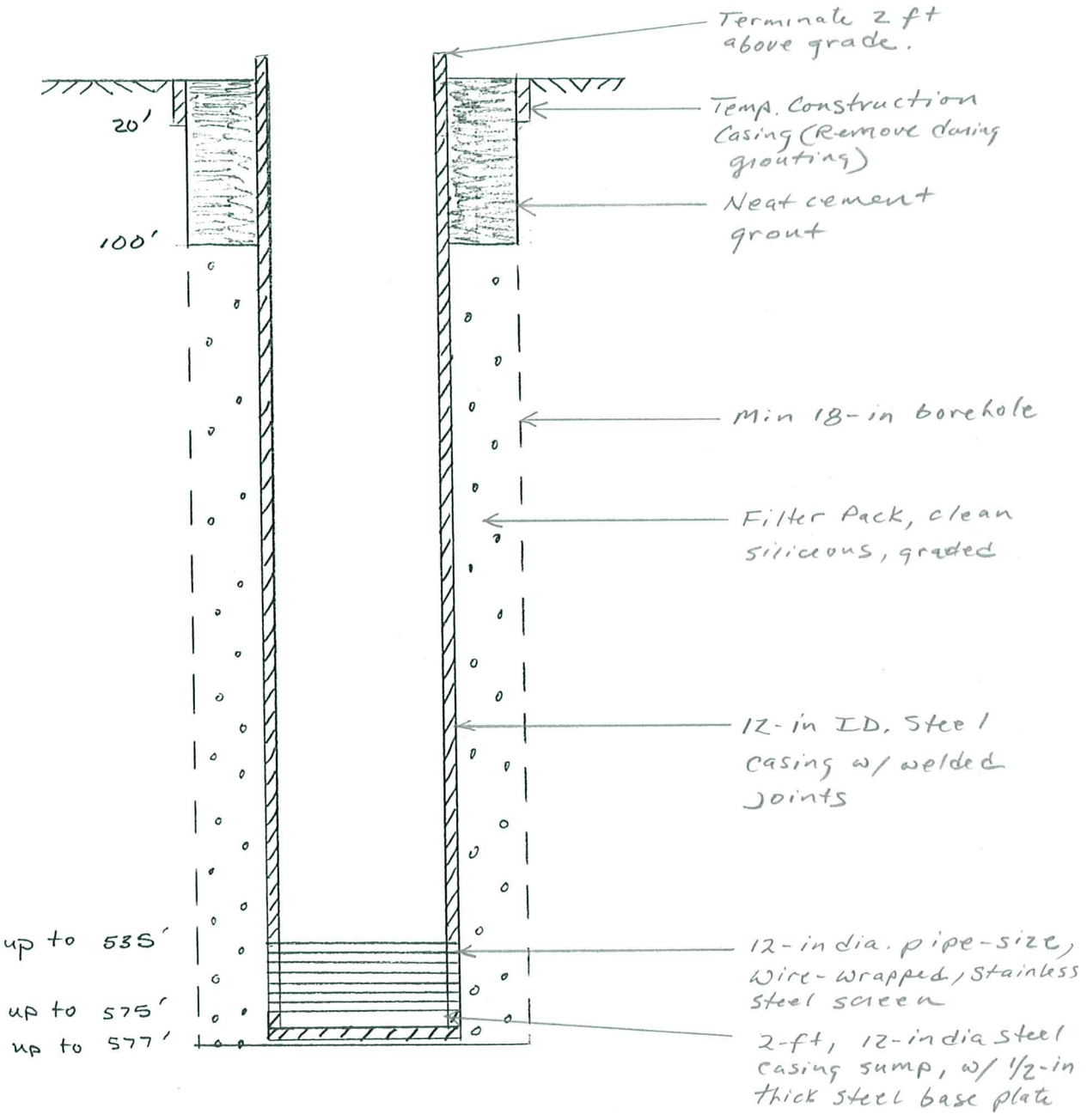
PAGE ____ OF ____

PROJECT NO. _____

CLIENT _____ SUBJECT _____ Prepared By _____ Date _____

PROJECT _____ 12" Casing/Screen Reviewed By _____ Date _____

_____ 18" Borehole Approved By _____ Date _____



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CALCULATION SHEET

PAGE ___ OF ___

PROJECT NO. ___

CLIENT ___ SUBJECT Assumptions

PROJECT ___ 12" Casing / Screen

___ 18" Borehole

Prepared By JRG Date 11/01/07

Reviewed By ___ Date ___

Approved By ___ Date ___

Item		Units	Unit Price	Total
1.	Mob / Demob	1	30,000	30,000
2.	Drill min. 18-in dia. hole in unlithified and set outer temp. casing (ft)	20	275	5,500
3.	Drill min. 18-in dia. hole in bedrock (ft)	557	200	111,400
4.	Furnish and install stainless steel, wire-wrapped screen, 12-in., Pipe-Size dia (ft).	40	240	9,600
5.	Furnish and install steel casing, 12-in dia.	539	65	35,035
6.	Furnish and install gravel pack and sand seal.	1	12,000	12,000
7.	Set-up grouting equipment	1	5,000	5,000
8.	Circulate bentonite (bags)	180	25	4,500
9.	Grout annular space between 12-in dia casing and 18-in dia. borehole (bags)	450	30	13,500
10.	Furnish and install Development / Test Pump and appurtenances	1	8,000	8,000

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CALCULATION SHEET

PAGE ___ OF ___

PROJECT NO. _____

CLIENT _____ SUBJECT _____ Prepared By _____ Date _____

PROJECT _____ 12" casing _____ Reviewed By _____ Date _____

_____ 18" borehole _____ Approved By _____ Date _____

(Continued)

Item		Units	Unit Price	Total
11.	Perform well development by pumping and surging	24	300	7,200
12.	Perform step-drawdown well test (Hr).	8	250	2,000
13.	Perform Aquifer Performance test (Hr)	24	250	6,000
14.	Perform plumbness and alignment test	1	1,750	1,750
15.	Televise Well	1	1,500	1,500

$252,985

$\frac{\$252,985}{577 \text{ feet}} = \$438$ per foot

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CALCULATION SHEET

PAGE ____ OF ____

PROJECT NO. _____

CLIENT _____ SUBJECT _____ Prepared By _____ Date _____

PROJECT _____ 12" Casing Reviewed By _____ Date _____

_____ 18" borehole Approved By _____ Date _____

Bentonite & Grout Requirements -

Annular Space Volume = $100\ ft\left(\left(\frac{18}{12}\right)^2 - \left(\frac{12.75}{12}\right)^2\right)\pi = 352\ ft^3$

Bentonite Circulation $\cong \frac{352\ ft^3}{3\ \frac{ft^3}{bag}} = 117\ bags + (50\%)\ 59\ bags$

$= 176\ bags$

Say 180 bags

Grout

wt. water = 7.87 lbs/gal.

5.7 gal. × 7.87 lbs/gal $\cong$ 45 lbs

Allow Range of 5.2 to 6.0 gal water per bag cement

Slurry density = $\frac{94\ lb\ cement + 45\ lb\ water}{1 \cdot 0.48\ \frac{ft^3}{sack} + 0.7\ ft^3\ water} = 117.8\ \frac{lbs}{ft^3}$

$\frac{94\ lb\ bag\ cement + 45\ lb\ water}{117.8\ lb/ft^3} = 1.18\ ft^3/bag\ cement$

$\frac{352\ ft^3}{1.18\ ft^3/bag} = 298\ bags + (50\%)\ 149\ bags$

$= 447\ bags$

Say 450

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CALCULATION SHEET

PAGE ___ OF ___

PROJECT NO. _____

CLIENT _____ SUBJECT Monitoring Wells Prepared By JRG Date 11/14/07

PROJECT _____ Est. Costs Water Table Reviewed By _____ Date _____

_____ and Piezometer Type Approved By _____ Date _____

$64 per ft.

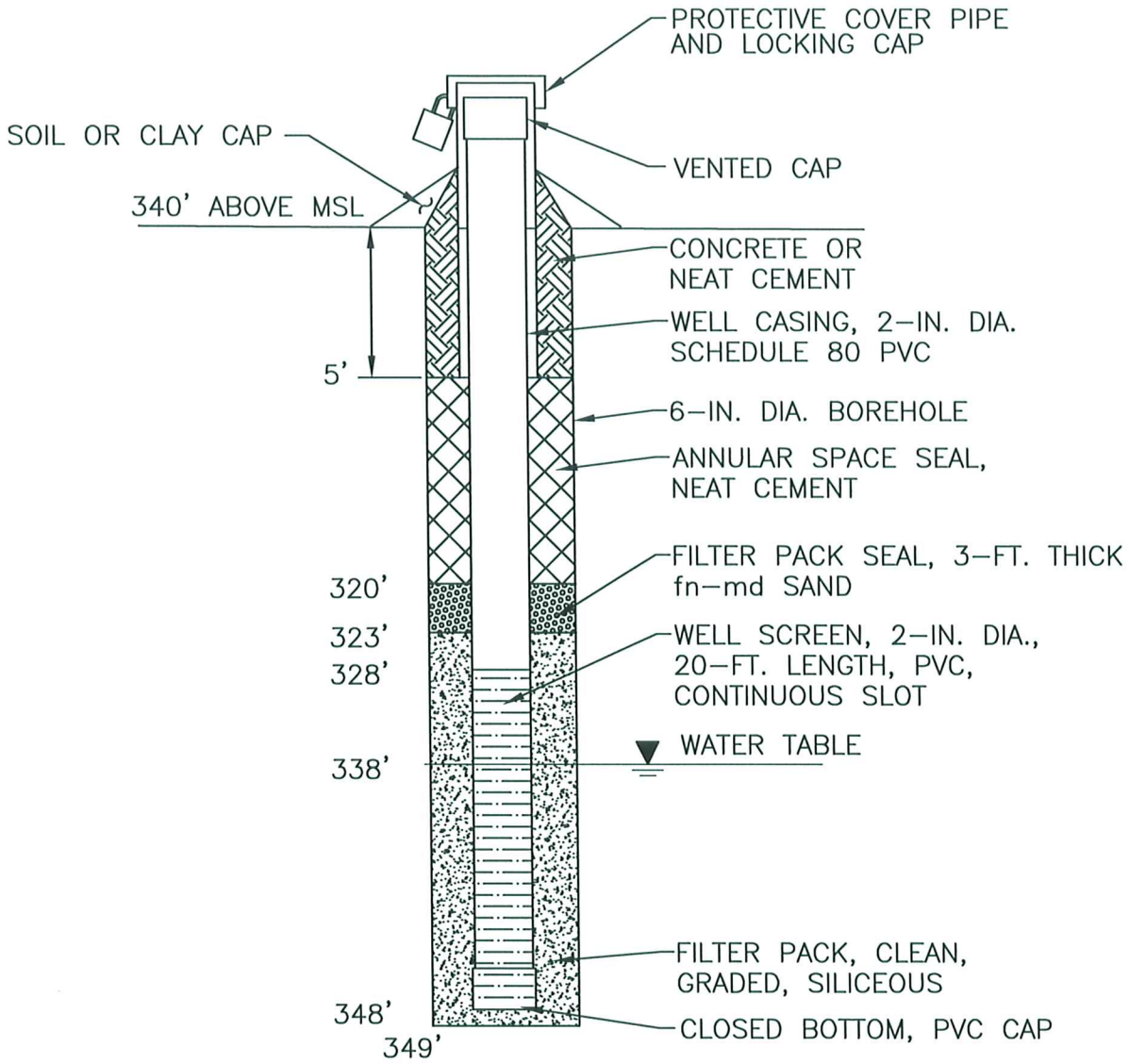
Observation Well straddling the water table

349 ft × $64 / ft = $22,336

Piezometer at mid-screen injection well

376 ft × $64 / ft = $24,064

Xrefs:
Images:



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EarthTech
A Tyco International Ltd. Company

FIGURE 1
TYPICAL OBSERVATION WELL
NEAR WWTP

NOVEMBER 2007 101296

Xrefs:
Images:
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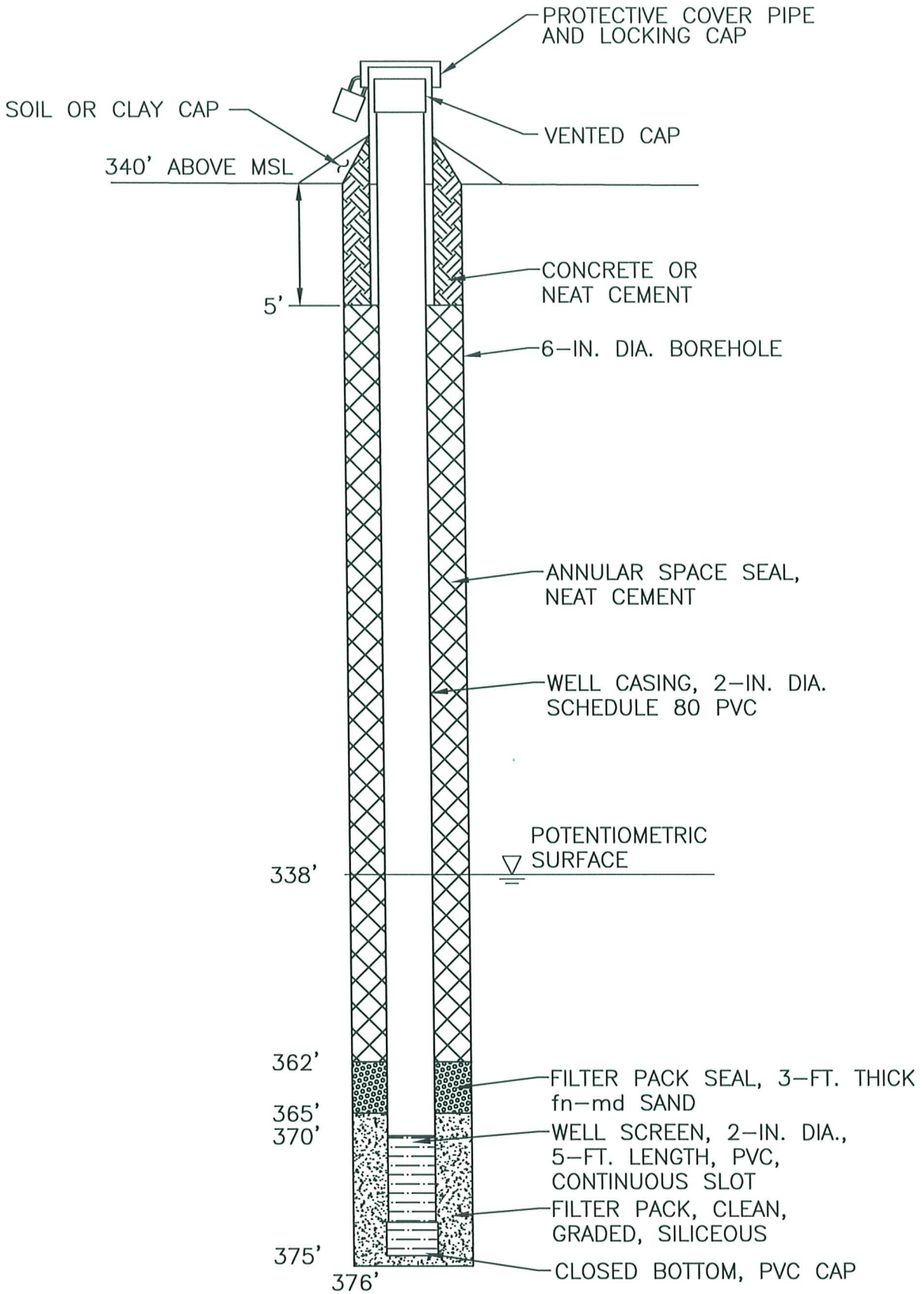

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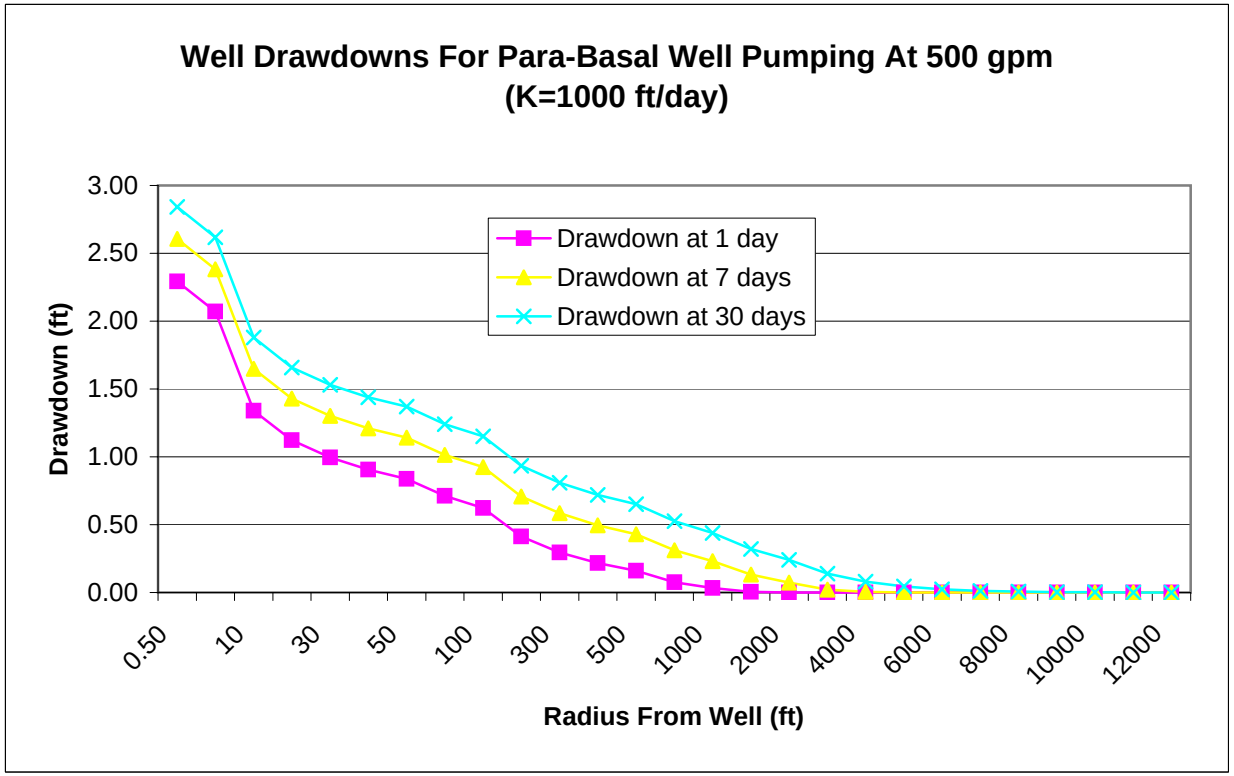
FIGURE 2
TYPICAL PIEZOMETER
NEAR WWTP

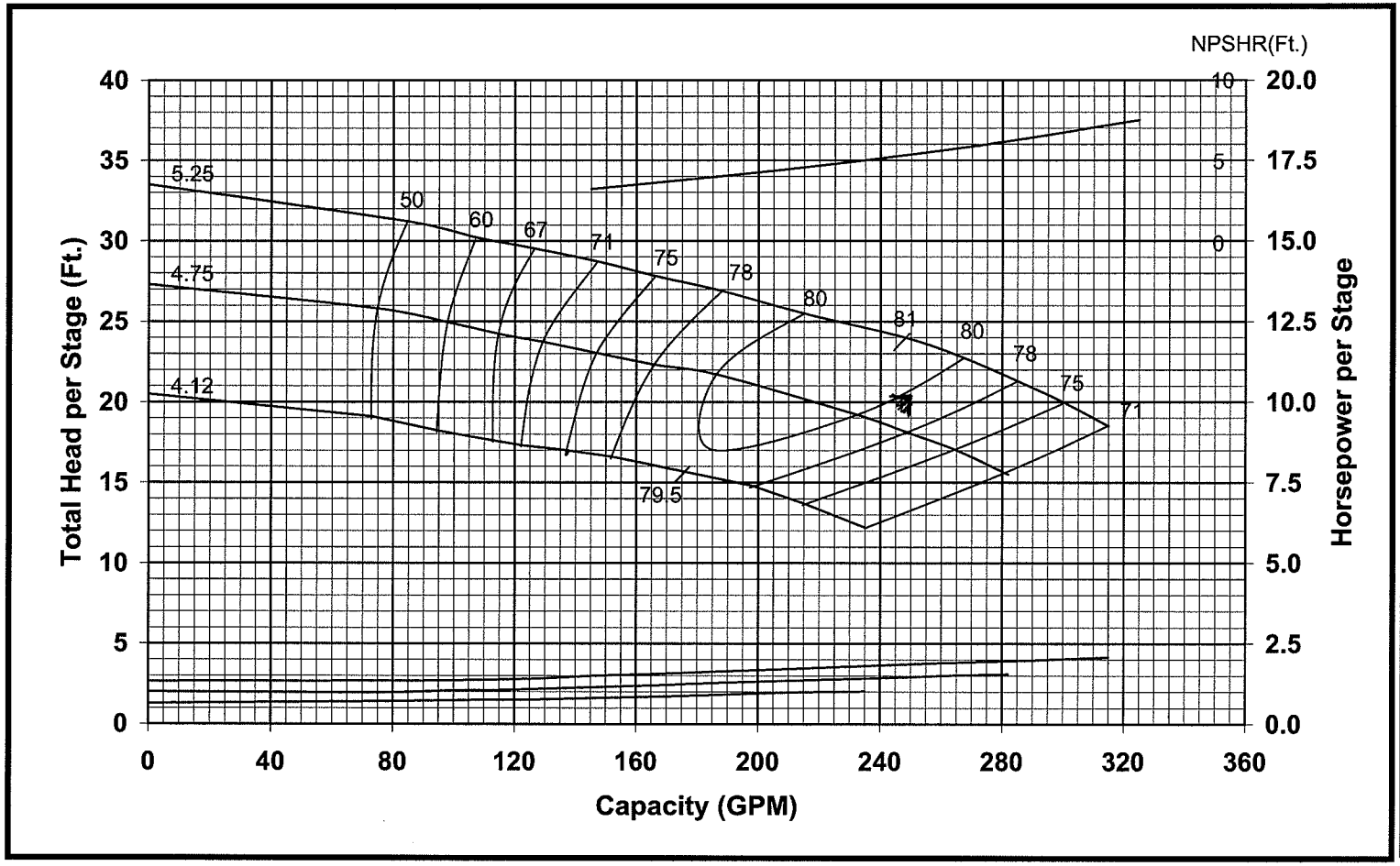
NOVEMBER 2007 101296

Radius From Well r (ft.)	Drawdown Adjusted For Dewatering at 1 day (ft.)	Drawdown Adjusted For Dewatering at 7 days (ft.)	Drawdown Adjusted For Dewatering at 30 days (ft.)
0.50	2.29	2.61	2.84
1	2.07	2.38	2.62
10	1.34	1.65	1.88
20	1.12	1.43	1.66
30	1.00	1.30	1.53
40	0.91	1.21	1.44
50	0.84	1.14	1.37
75	0.71	1.01	1.24
100	0.62	0.92	1.15
200	0.41	0.71	0.93
300	0.29	0.58	0.81
400	0.22	0.50	0.72
500	0.16	0.43	0.65
750	0.08	0.31	0.53
1000	0.03	0.23	0.44
1500	0.01	0.13	0.32
2000	0.00	0.07	0.24
3000	0.00	0.02	0.14
4000	0.00	0.01	0.08
5000	0.00	0.00	0.04
6000	0.00	0.00	0.02
7000	0.00	0.00	0.01
8000	0.00	0.00	0.01
9000	0.00	0.00	0.00
10000	0.00	0.00	0.00
11000	0.00	0.00	0.00
12000	0.00	0.00	0.00



GOULDS PROPOSAL NO.	GOULDS S.O. NO.	INQUIRY NO.	CUSTOMER P.O. NO.	P.O. DATE	ITEM NO.	CUSTOMER

PROJECT	SERVICE	GPM CAPACITY	FT. TDH	% EFFICIENCY	RPM



Curve No. E6408RFPC0	
Model	8RJLO
RPM	1760
EFFIEIENCY CORRECTION	
1-STAGE	
2-STAGE	
3-STAGE	
4-STAGE	
Impeller	OPEN
Ns =	2625
K =	5.3 LBS/FT
K(Bal.)=	N/A
Bowl O.D.	7.50"
Bowl Lateral	0.62"
Max. PSI	425
Disch Size	4", 5", 6"

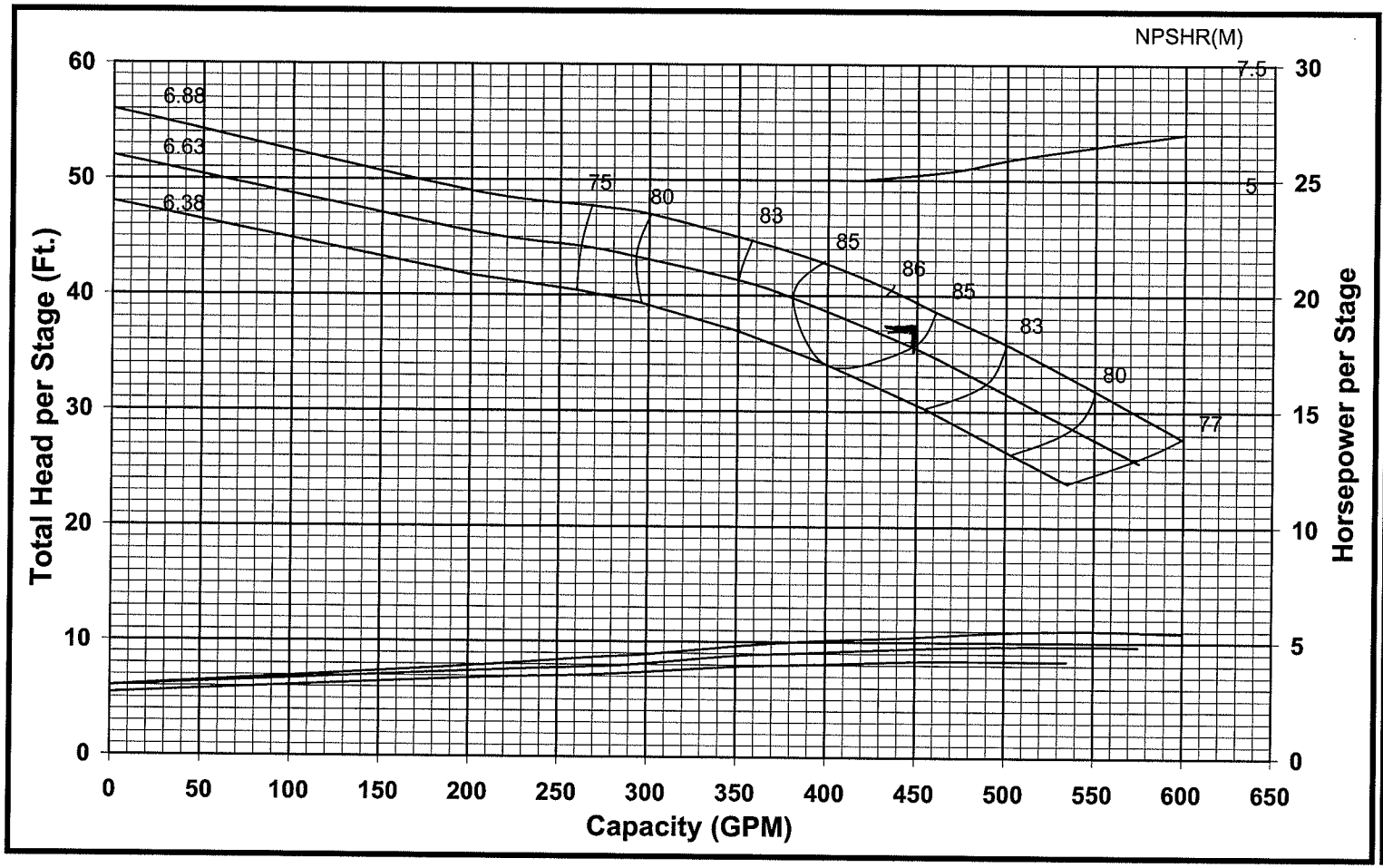
GOULDS PUMPS
TURBINE OPERATIONS
Lubbock, Texas

BOWL PERFORMANCE CURVE BASED ON PUMPING CLEAR, NON-AERATED WATER. RATED POINT ONLY IS GUARATEED. CURVES REPRESENT SINGLE STAGE PERFORMANCE BASED ON TEST OF MULTI-STAGE BOWL ASSEMBLY. EFFICIENCY CORRECTION IS REQUIRED FOR LESSER STAGES.

Design Point
250 gpm @ 525' TDH
26 stages @ 20.2 '/ stage

GOULDS PROPOSAL NO.	GOULDS S.O. NO.	INQUIRY NO.	CUSTOMER P.O. NO.	P.O. DATE	ITEM NO.	CUSTOMER

PROJECT	SERVICE	GPM CAPACITY	FT. TDH	% EFFICIENCY	RPM



Curve No.	E6409CFPC0
Model	9RCLC
RPM	1770

EFFIEIENCY CORRECTION	
1-STAGE	-2.0
2-STAGE	-1.0
3-STAGE	-0.5
4-STAGE	0.0

Impeller	ENCLOSED
Ns =	2290
K =	4.90 LBS/FT
K(Bal.)=	N/A

Bowl O.D.	9.25"
Bowl Lateral	0.88"
Max. PSI	400
Disch size	5", 6", 8"

GOULDS PUMPS

TURBINE OPERATIONS

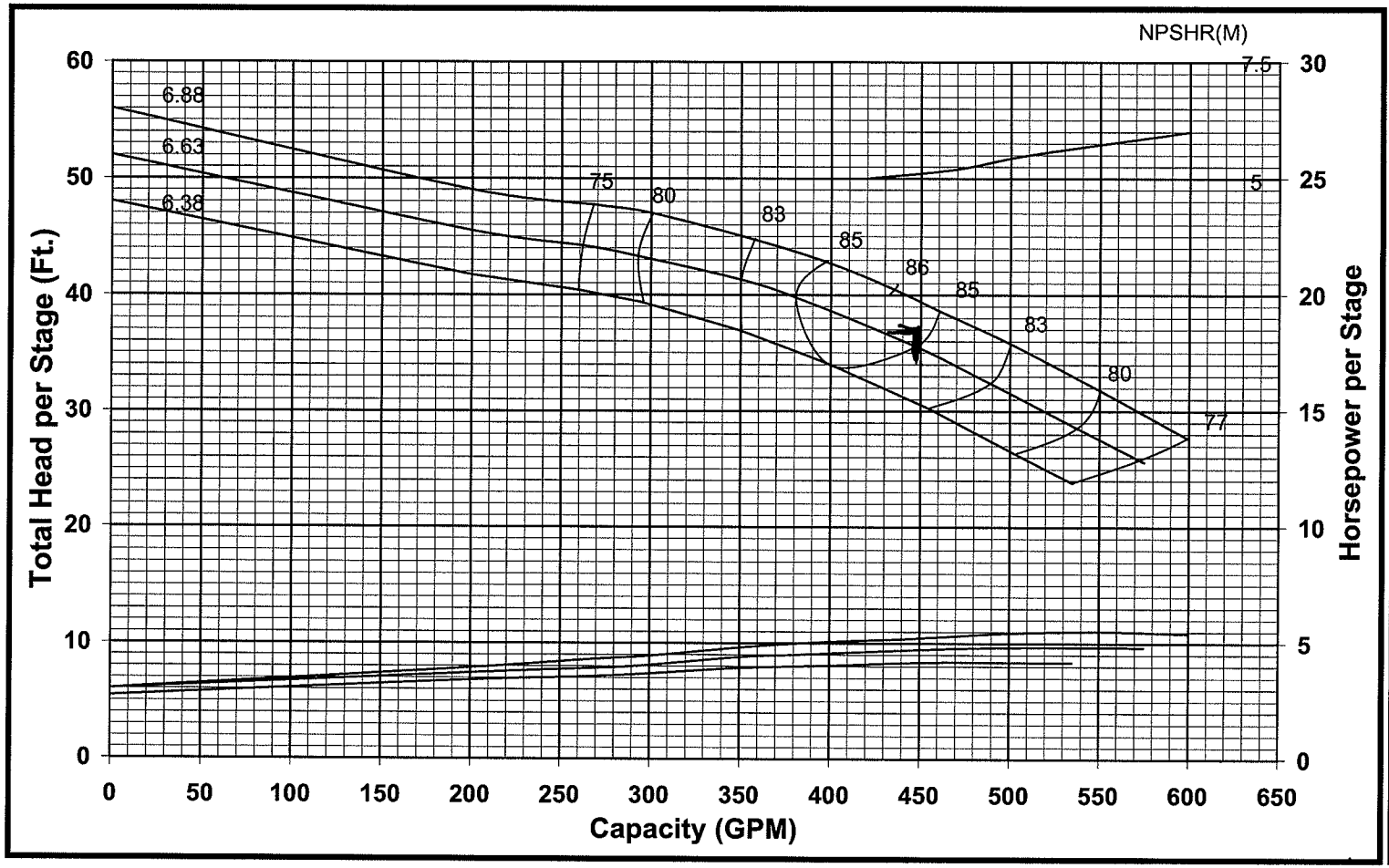
Lubbock, Texas

BOWL PERFORMANCE CURVE BASED ON PUMPING CLEAR, NON-AERATED WATER. RATED POINT ONLY IS GUARATEED. CURVES REPRESENT SINGLE STAGE PERFORMANCE BASED ON TEST OF MULTI-STAGE BOWL ASSEMBLY. EFFICIENCY CORRECTION IS REQUIRED FOR LESSER STAGES.

Design point
450 gpm @ ~ 600' TDH
16 stages at 37.5' / stage

GOULDS PROPOSAL NO.	GOULDS S.O. NO.	INQUIRY NO.	CUSTOMER P.O. NO.	P.O. DATE	ITEM NO.	CUSTOMER

PROJECT	SERVICE	GPM CAPACITY	FT. TDH	% EFFICIENCY	RPM



Curve No. E6409CFPC0

Model 9RCLC

RPM 1770

EFFIEIENCY CORRECTION	
1-STAGE	-2.0
2-STAGE	-1.0
3-STAGE	-0.5
4-STAGE	0.0

Impeller **ENCLOSED**

Ns = **2290**

K = **4.90 LBS/FT**

K(Bal.)= **N/A**

Bowl O.D.	9.25"
Bowl Lateral	0.88"
Max. PSI	400
Disch size	5", 6", 8"

GOULDS PUMPS

TURBINE OPERATIONS

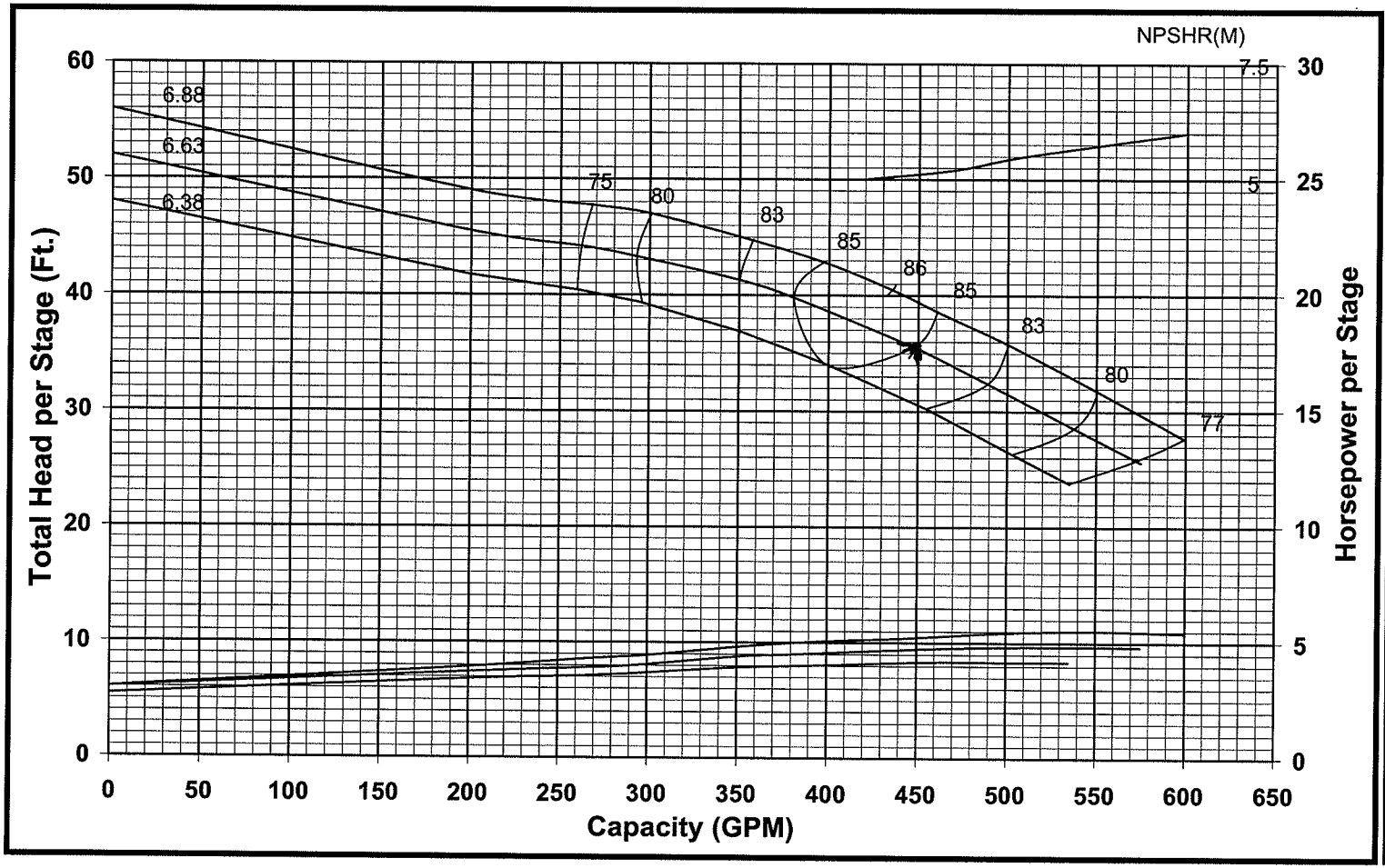
Lubbock, Texas

BOWL PERFORMANCE CURVE BASED ON PUMPING CLEAR, NON-AERATED WATER. RATED POINT ONLY IS GUARATEED. CURVES REPRESENT SINGLE STAGE PERFORMANCE BASED ON TEST OF MULTI-STAGE BOWL ASSEMBLY. EFFICIENCY CORRECTION IS REQUIRED FOR LESSER STAGES.

Design Point
450 gpm @ ~635' TDH
~17 stages @ 37.3' per stage.

GOULDS PROPOSAL NO.	GOULDS S.O. NO.	INQUIRY NO.	CUSTOMER P.O. NO.	P.O. DATE	ITEM NO.	CUSTOMER

PROJECT	SERVICE	GPM CAPACITY	FT. TDH	% EFFICIENCY	RPM



Curve No. **E6409CFPC0**

Model	**9RCLC**
RPM	**1770**

EFFIEIENCY CORRECTION	
1-STAGE	-2.0
2-STAGE	-1.0
3-STAGE	-0.5
4-STAGE	0.0

Impeller	**ENCLOSED**
Ns =	**2290**
K =	**4.90 LBS/FT**
K(Bal.)=	**N/A**
Bowl O.D.	9.25"
Bowl Lateral	0.88"
Max. PSI	400
Disch size	5", 6", 8"

GOULDS PUMPS

TURBINE OPERATIONS

Lubbock, Texas

BOWL PERFORMANCE CURVE BASED ON PUMPING CLEAR, NON-AERATED WATER. RATED POINT ONLY IS GUARATEED. CURVES REPRESENT SINGLE STAGE PERFORMANCE BASED ON TEST OF MULTI-STAGE BOWL ASSEMBLY. EFFICIENCY CORRECTION IS REQUIRED FOR LESSER STAGES.

Design Point
450 gpm @ 525' TDH
15 Stages at 35'/stage

Goulds Vertical Turbine Pumps

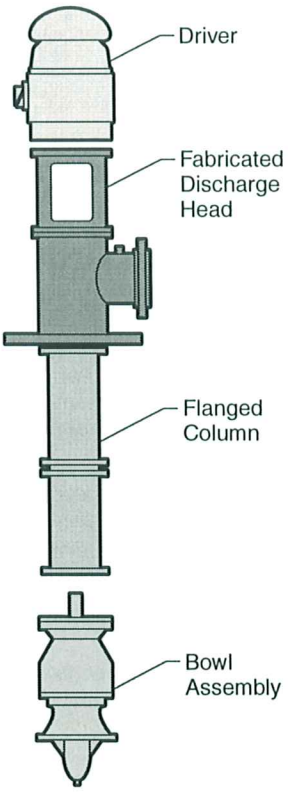
Flexibility by Design: Three Pump Models, One Common Bowl Assembly

The three different pump models in the vertical turbine line have one thing in common - the hydraulic design of the pump bowl assembly. Using state-of-the-art techniques in turbine pump design, Goulds vertical turbine line covers a wide range of hydraulic conditions to meet virtually every pumping service in the industry with optimum efficiency.

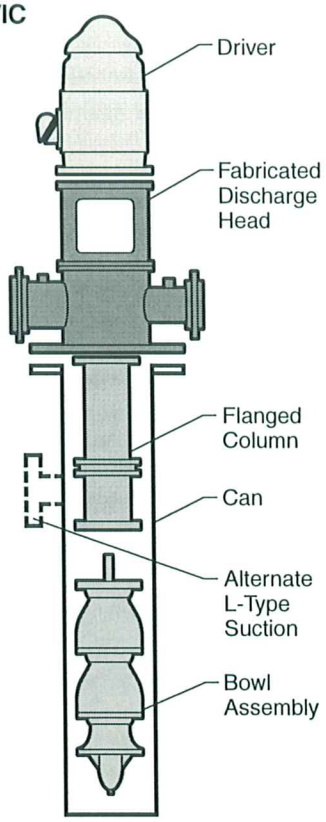
Goulds flexibility of design allows the use of a wide range of materials and design features to meet the custom requirements of the user. No matter what the requirements, whether low first cost, ease of maintenance, optimum efficiency or tough service conditions, Goulds can make the pump to best satisfy the requirements.

This bulletin is designed to assist the user in selecting the best pump for the conditions required, however, any questions will be answered promptly by calling the Goulds sales office or representative in your area.

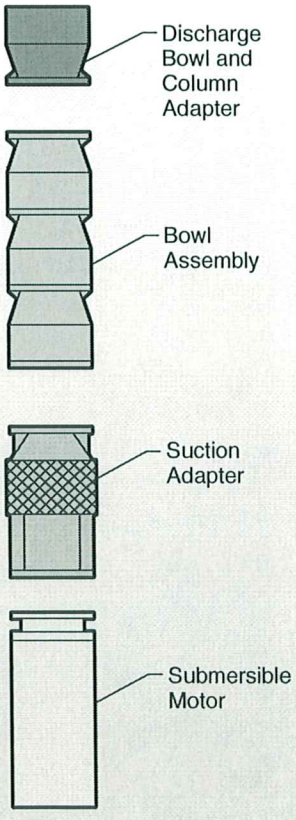
Model VIT-FF



Model VIC



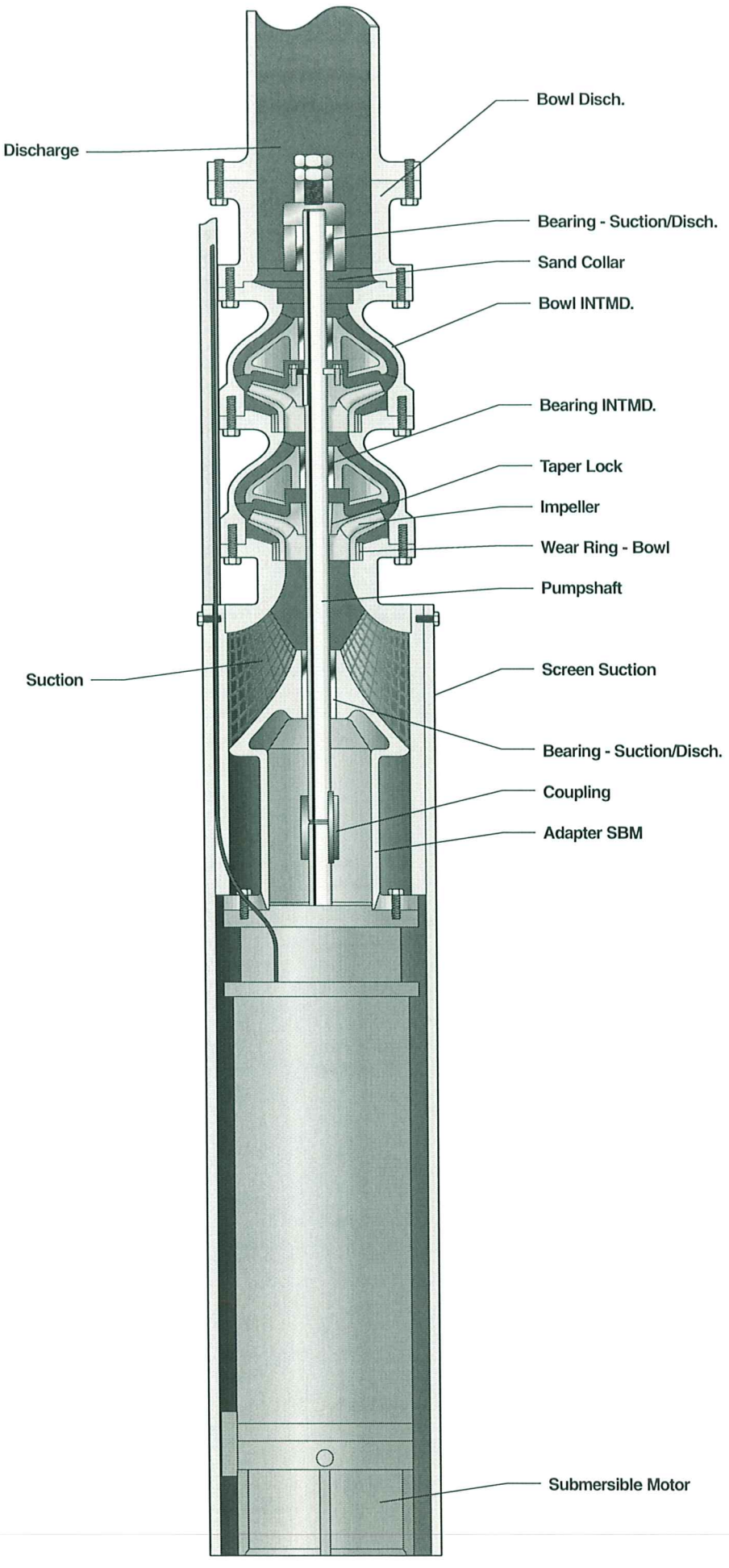
Model VIS

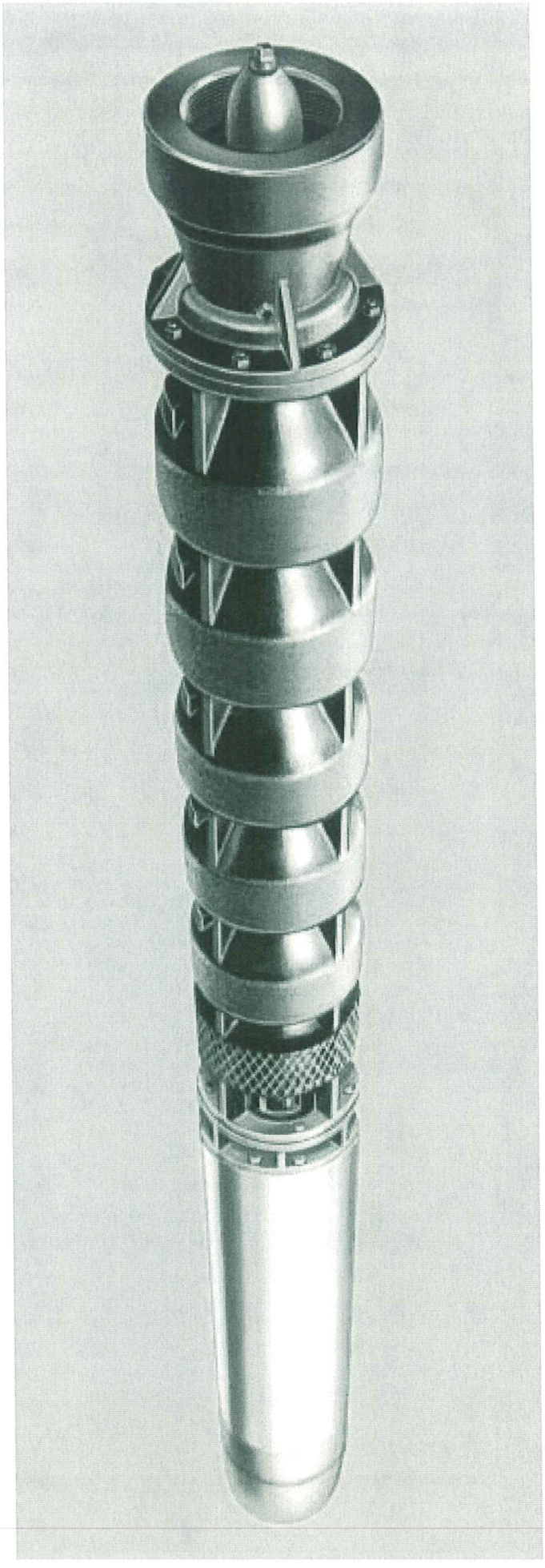


Cross Sectional
VIS

Typical Markets Served

- General Industry
- Municipal
- Hydrocarbon Processing





Model VIS

Vertical Industrial Submersible Pump

- Capacities to 4,000 GPM (908 m^3/h)
- Heads to 1,400 feet (427m)
- Bowl sizes from 6" to 20"

Design Advantages

- Ideal for deep set applications where use of lineshaft pumps is impractical.
- Complete unit is installed underground resulting in quiet operation and space saving.
- Long life/low maintenance — no lubrication, alignment.

Services

Irrigation

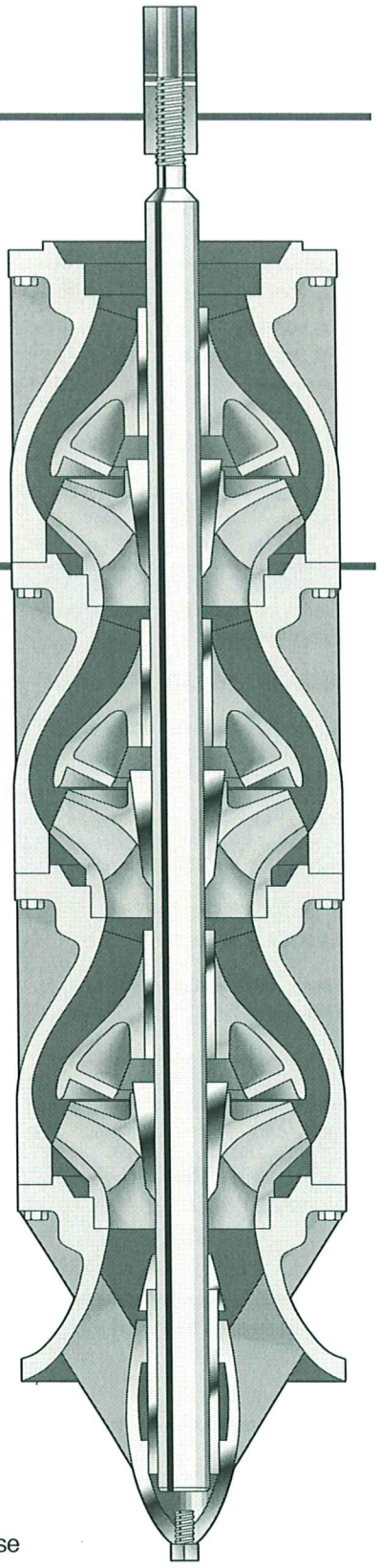
Service Water

Deep Well

Pump Bowl Assembly

The bowl assembly is the heart of the vertical turbine pump. The impeller and diffuser type casing are designed to deliver the head and capacity that your system requires in the most efficient way possible. The fact that the vertical turbine pump can be multi-staged allows maximum flexibility both in the initial pump selection and in the event that future system modifications require a change in the pump rating. Submerged impellers allow pump to be started without priming.

A variety of material options allows the selection of a pump best suited for even the most severe services. The many bowl assembly options available assure that the vertical turbine pump satisfies the users' needs for safe, efficient, reliable and maintenance-free operation.



Standard Design Features

1. **SUCTION BELL** - Allows smooth entry of liquid into impeller eye, minimizes vortex formation.
2. **SUCTION BELL BEARING** - Provided for shaft stability.
3. **SAND COLLAR** - Prevents solids from entering suction bearing.
4. **IMPELLER -** Semi-open or enclosed for appropriate service.
5. **TAPER LOCK** - Alloy steel for fastening impellers on 17" and smaller sizes.
6. **KEYED** - Impeller fastened onto the shaft by keyed split ring.
7. **PUMP SHAFT** - Heavy duty 416SS standard, available in 316SS, 17-4 PH, Monel and other alloys for strength and corrosion resistance.
8. **DIFFUSER BOWL** - Available in variety of cast materials. Glass lined cast iron standard through 18" sizes.
9. **STAGES** - Flanged and bolted together for ease of maintenance.
10. **SLEEVE TYPE BEARING** - Provided at each stage to assure stable operation away from critical speed.
11. **FLANGED BOWLS** - Registered fits assure positive alignment, ease of maintenance.

In addition to standard features and options shown here, other features are available.

A. Hydraulic balancing of impellers to reduce axial downthrust and achieve longer thrust bearing life.

B. Independent flushing of bowl bearings and wear rings for abrasive services.

C. Hard facing of shaft journals and bearings to protect against abrasion and increase interval between maintenance periods.

D. Interior coating on bowls for improved efficiency.

E. Dynamic balancing of impellers.

F. Strainers to prevent foreign objects from entering the pump.

DRAFT
For Internal Discussion Purposes Only

Legend

- New Wells
- Booster
- StorageTank
- WaterLine-New

NGLS Study Water Elevations
- <all other values>

lineDesc
- 2 ft
- 3 ft
- 4 ft
- 5 ft
- Not Water Bearing
- Exposed Volcanic Rock

CONTOUR
- 0

All-Wells-rev
- <all other values>

OWNER, STATUS
- AF, active
- AF, inactive
- AF, unknown
- Fadian Fish Hachtery, unknown
- Foremost Foods, unknown
- GWA, active
- GWA, inactive
- GWA, secured
- GWA, unknown
- HGC, unknown
- Mangilao Golf Course, unknown
- Navy, active
- Navy, inactive
- Navy, unknown
- Perez Brothers, unknown

SEGMENT I
SEGMENT H
SEGMENT G
SEGMENT F
SEGMENT E
SEGMENT D
SEGMENT C
SEGMENT J
SEGMENT B
SEGMENT A
SEGMENT K
SEGMENT L
SEGMENT M
SEGMENT N

WTP

high point ~540' msl

high point ~360' msl

N
W E
S

0 2,000 4,000 8,000 Feet

1 inch equals 4,000 feet

HYDRAULIC CALCULATIONS
OPTION 1
FRICTION LOSSES IN RAW WATER TRANSMISSION MAINS
WATER SUPPLY WELLS
GUAM
Earth Tech Project 101296

PIPE SEGMENT	PIPE DIAMETER (inches)	FLOW RATE (gpm)	VELOCITY (ft per sec)	FRICTION COEFFICIENT "C"	HEADLOSS (ft\ft)	PIPE LENGTH (ft)	HEADLOSS (ft)
				120			
B	20	2250	2.30		0.0011	7000	7.56
C	24	4500	3.19		0.0016	1800	2.89
D	24	4950	3.51		0.0019	3500	6.70
E	24	6300	4.47		0.0030	1000	2.99
F	24	6600	4.68		0.0033	1300	4.24
G	30	7050	3.20		0.0012	1300	1.62
H	30	7500	3.41		0.0014	2000	2.79
I	30	8700	3.95		0.0018	300	0.55
						18200	
TOTAL FRICTION LOSSES FROM SEGEMENT B TO WTP							29.33
A-1	12	450	1.28		0.0007	1000	0.66
A-2	16	900	1.44		0.0006	3000	1.76
A-3	16	1350	2.16		0.0012	1400	1.74
A-4	16	1800	2.87		0.0021	1000	2.12
A-5	16	2250	3.59		0.0032	1700	5.44
						8100	
TOTAL FRICTION LOSSES IN PIPE FROM WELL 10 TO SEGMENT C							11.72
B-1	12	450	1.28		0.0007	1700	1.12
B-2	12	900	2.55		0.0024	700	1.67
						2400	
TOTAL FRICTION LOSSES IN PIPE FROM WELL 11 TO SEGMENT C							2.79
J-1	12	450	1.28		0.0007	1200	0.79
J-2	12	900	2.55		0.0024	1000	2.38
J-3	12	1350	3.83		0.0050	600	3.03
						2800	
TOTAL FRICTION LOSSES IN PIPE FROM WELL 5 TO SEGMENT C							6.20
L-1	12	450	1.28		0.0007	1200	0.79
L-2	12	900	2.55		0.0024	1000	2.38
L-3	12	1350	3.83		0.0050	800	4.03
						3000	
TOTAL FRICTION LOSSES IN PIPE FROM WELL 19 TO SEGMENT E							7.21
M-1	8	250	1.60		0.0016	1500	2.40
M-2	8	500	3.19		0.0058	2000	11.55
M-3	12	950	2.70		0.0026	400	1.05
						3900	
TOTAL FRICTION LOSSES IN PIPE FROM WELL 16 TO SEGMENT I							15.00
N	8	250	1.60		0.0016	1200	1.92

THE PUBLIC UTILITY
AGENCY OF GUAM

Final Engineering Report

GROUNDWATER IN NORTHERN GUAM
Sustainable Yield and Ground Water Development

Prepared By

BARRETT CONSULTING GROUP
AGANA, GUAM

In Association With
JOHN F. MINK

GROUNDWATER IN NORTHERN GUAM

Sustainable Yield and Groundwater Development

Final Engineering Report

Prepared For The

GOVERNMENT OF GUAM

PUBLIC UTILITY AGENCY OF GUAM

May 1992

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BARRETT CONSULTING GROUP

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May 26, 1992

Mr. Joseph F. Mesa
Chief Officer
Public Utility Agency of Guam
Government of Guam
P.O. Box 3010
Agana, Guam 96910

Mr. Mesa:

In accordance with our engineering agreement dated September 24, 1990, we are pleased to submit, herewith, the final engineering report, *Groundwater In Northern Guam: Sustainable Yield and Groundwater Development*. The report represents the reevaluation by Hydrological Consultant, John F. Mink and our staff of the Northern Lens groundwater supply and proposes an overall well development program to increase the people of Guam's access to this resource.

The report presents a new basis for estimating the sustainable yield of the Northern Lens that differs significantly from the approach first applied in the 1982 *Northern Guam Lens Study* and currently used to regulate Guam's groundwater development. The proposed well development program is intended to optimize the development of groundwater resources based on this new analysis of the Northern Lens's sustainable yield and hydrodynamics.

We would like to thank PUAG, the many Government of Guam and Federal agencies whose cooperation and assistance made this report possible.

Very truly yours,

Edwin C. Pier, P.E.
Project Manager

Aziz H. Saad
Office Manager

51240E91.141/682

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CHAPTER I
EXECUTIVE SUMMARY

OBJECTIVES

The rapid increase in development and tourist population on the Island of Guam in recent years has resulted in a corresponding demand for infrastructure improvements and expansion. As a first step toward meeting some of these demands and anticipating the Island's future needs, the Public Utility Agency of Guam (PUAG) has initiated a number of water system improvement projects funded under the $53 million Capital Improvements Revenue Bond. A key factor in designing the projects, and in coordinating their implementation, is knowing how much water supply is available for development and where it is located. The groundwater of Guam's Northern Lens is known to be the most economically accessible water supply available. However, in light of the information collected and the advances in computer modelling and capabilities over the last nine years (since the Northern Guam Lens study was completed) many of the bases for characterizing the Lens' behavior and estimating its sustainable yield should be updated.

The objectives of this report therefore are: 1) to provide a preliminary updated estimate of the sustainable yield of Guam's Northern Groundwater Lens; and 2) outline a new program for well development based on the latest data and information connecting the lens. The update of the Lens' yield and hydrodynamics is based on the evaluation of available data obtained from well construction and monitoring conducted over the last ten years in addition to recent Time Domain Electromagnetic (TDEM) surveys.

CONCLUSIONS

Evaluation of well construction and monitoring data collected over the last ten years leads to two significant conclusions:

- First, it is now apparent that seasonal recovery of the groundwater lens does occur. Consequently, a more realistic method of analysis to determine the lens sustainable yield needs to be based on transient analytical computer modeling techniques rather than the static analytical techniques used in the NGLS ten years ago.

- Second, and perhaps more significantly, Guam's northern aquifer appears to be a much more continuous system than is implied by the system of discrete management zones proposed in the NGLS. The significance here is that the discrete management zone system from the NGLS is presently being used as a basis for regulating groundwater development in Guam. However, the available data now indicates that the lens has a capability to respond to significant water withdrawals in various areas, as a single resource.

As a consequence of these two conclusions, it now appears that the sustainable yield of the Northern Lens, *available to civilian development*, may be as much as 60 million gallons per day (mgd). Of this amount approximately 25 mgd is already being withdrawn by PUAG and private wells. An additional 35 mgd therefore remains to be developed.

RECOMMENDATIONS

A summary of the report's recommendations follows. A recommended program for overall groundwater development is discussed more thoroughly in Chapter V.

1. The system of discrete groundwater management zones presented in the *NGLS* and currently used to regulate groundwater development should be replaced with the concept of Aquifer Systems proposed in this report. Subsequently, the estimated sustainable yield of the new "Aquifer Systems" should be revised continually in light of data obtained from ongoing well development and monitoring.

2. Assuming the adoption and acceptance of the new Aquifer System for management of the groundwater resource, additional sustainable yield over that projected by the NGLS may be developable. It is recommended that the unused portion of the sustainable yield be developed in two increments. The first priority increment would be for a total of approximately 10 mgd from the Agafo Gumas, Yigo, Tumon, Gugagon and Ordot Aquifer Systems. The second priority increment would be for a total of approximately 5 mgd from the Mt. Santa Rosa, Sasajyan, Huchuanao and Mongmong Aquifer Systems. The results

derived from the development of the first 15 mgd should then determine the next set of priorities.

3. Redevelopment of existing wells should be considered but must be investigated on a case specific basis in response to actual conditions resulting from the increased production proposed in increments 1 and 2.

4. The conclusions, based on transient modeling and analysis of well data obtained since the *NGLS* was completed, strongly indicate that an update of the *NGLS* "Aquifer Yield Report" and groundwater management techniques are in order. Such an update would require a breadth of testing, modeling and analysis that is beyond the scope of this contract. However, the primary task should be the drilling of more monitoring wells and collection of data. Since data from additional monitoring wells would have to be collected over a period of at least 3 years for analyses to be really useful, this task should be pursued without delay. Additional study of actual evapotranspiration rates would also provide interesting data for future updates of the sustainable yield.

   At the same time, it should be recognized that any update of the Aquifer Yield Report must not be hastily conducted, if comprehensive, long-term conclusions are to be obtained.

CHAPTER II
INTRODUCTION

BACKGROUND

Groundwater in Northern Guam has been talked about, studied and evaluated as a premier water resource since 1937 when H.T. Stearns of the U.S. Geological Survey conducted a reconnaissance survey for the U.S. Navy. After World War II the Survey expanded efforts to full fledged geological mapping which became the basis for improved comprehension of the groundwater potential. Consulting engineers contributed to the solution of specific problems. Then in 1976 J.F. Mink summarized existing data and wrote an evaluation report for PUAG. The most comprehensive study of Northern Guam's water resources was made several years later and is commonly referred to as the *NGLS (Northern Guam Lens Study)*.

As the first comprehensive study of the Northern Lens, the *NGLS* was limited by the scarcity of long term hydrologic data then available. This was particularly true with regard to the behavior of the lens under stress--e.g. pumping from wells--and the lack of data on the salinity-depth relationship of groundwater storage head. As a consequence of this constraint, some of the bases for analysis and conclusions of the *NGLS* were, appropriately, conservative.

In order to provide a better data base for future analyses, the *NGLS* drilled several monitoring wells and recommended a monitoring program for all wells that was soon implemented by the Guam Environmental Protection Agency (GEPA). In the nine years since the completion of the *NGLS* a substantial number of new production wells have also been developed and monitored. As a result, considerably more data is now available for an analysis of the nature and productivity of Guam's Northern Lens than at the time of the NGLS. In particular, the increased number of production wells has provided the opportunity to observe the reaction of the Lens under increased stress due to pumping. The salinity-depth profiles obtained from monitoring these wells are also critical in evaluating the Lens's storage capacity. As discussed in Chapter 4, the salinity-depth relationship is a much more valuable tool in evaluating the hydrodynamics of Guam's Northern Lens than water table elevations which were all that was available at the time of the *NGLS*.

The additional knowledge of the Lens now available provides a basis for analyzing the Lens with a higher degree of confidence than was possible for the *NGLS* and allows current evaluations to depart from some of the *NGLS*'s more conservative assumptions. Advances in computer modelling of groundwater systems since the *NGLS* have also made available more practical and accurate methods of simulating lens behavior. A review and discussion of the steady-state and hydrologic budget model employed by the *NGLS* is given in Appendix A to this report. A similar review of the transient model employed by this report to derive an updated sustainable yield is given in Appendix B. Other key areas of the *NGLS* from which the current report deviates are the assumptions involved in estimating recharge of the lens and the system by which the Lens is subdivided into Management Zones to model and regulate groundwater development on Guam.

The *NGLS* organized and evaluated existing hydrologic data, made analyses relevant to groundwater production, and subdivided all of Northern Guam into Sub-Basins and Management Zones. This classification currently forms the basis of regulatory management decisions about the expansion of groundwater development.

In the *NGLS* only 67 square miles of the total of 100 square miles in Northern Guam were considered favorable for the production of potable water. This production area was divided into 47 Management Zones, each having an average area of somewhat more than one square mile. A primary function of these Zones was to produce an array of data points that would facilitate computer simulation of the Lens' behavior by numerical modelling. While the numerical method can be a powerful tool for modelling lens behavior—and was, perhaps, the best available at the time of the *NGLS*—it has some limitations with regards to application in Guam. These are discussed in Appendix B to this report. The outlines of the Zones proposed in the *NGLS* reflect hydrogeological and topographic features but each is too small to be uniquely identified by these parameters. Consequently, strict adherence to a Zone as a management unit inhibits flexibility in taking advantage of groundwater conditions.

To allow managers more latitude in initiating new groundwater developments and in revising existing ones, an aquifer classification scheme similar to but less restrictive than that in the

NGLS is proposed and will be explained later. The proposed divisions are congruent with the existing ones but are fewer in number.

The methodology employed to arrive at values for sustainable yield (SY) differs in important respects from that depended upon in the *NGLS*, especially in using groundwater flow computer simulations as the fundamental tool for allocating sustainable yield. In the *NGLS*, global hydrologic budgeting, not constrained by groundwater hydraulics, was the method employed (see Appendix A). For lack of better data, this budget assumed the sustainable yield was a conservative fraction of recharge. A preliminary finite element mathematical model was also devised by Dr. D. Contractor, then at the University of Guam, to suggest groundwater behavior. However, the model was not used in deriving sustainable yield for the NGLS effort because of inherent limitations imposed by a sparse data base and uncertainty of physical boundary conditions.

In the nine years since the *NGLS* was completed, data including well performance, salinity-depth profiles, water table elevations and groundwater quality have been regularly monitored and annually recorded by GEPA. This long term data base, unavailable for the *NGLS*, enables the use of a dynamic or transient model to predict behavior of the lens over seasonal changes and under different pumping scenarios. Although a groundwater hydraulics model depends on a water balance for values of recharge, sustainable yield is derived, in the current report, from the transient model rather than assigned a value as a fraction of recharge. More detailed discussions of the transient model used for deriving sustainable yield for this updated analysis of the lens are presented in Appendix B to this report.

CHAPTER III
AQUIFER CLASSIFICATION

The *NGLS* first divided the Northern Lens along geologic and hydrologic boundaries into subbasins. These subbasins were then further subdivided into Management Zones primarily to establish an array of data points that would facilitate numerical modelling of lens behavior. Given the modelling systems and extent of knowledge of lens behavior available at the time, the establishment of these Management Zones was appropriate when the *NGLS* was done. However, as discussed in Chapter 2 and Appendix B, the increased knowledge of lens behavior and advances in modelling techniques that have occurred since the *NGLS* now permit a more practical classification scheme for the management and evaluation of Northern Guam's groundwater lens.

The proposed division of Northern Guam into aquifer categories follows the methodology derived for Hawaii and other Pacific Islands. The divisional hierarchy starts with the Aquifer Sector, which is divided into Aquifer Systems, which in turn are subdivided into Aquifer Types. At this stage only the Sectors and Systems have been identified for Northern Guam.

An Aquifer Sector is a region within which exist similar hydrologic and geologic features and in which the direction of groundwater flow is to the same general discharge line (i.e., Pacific Ocean; Philippine Sea). A Sector incorporates one or more Aquifer Systems. In an Aquifer System hydraulic continuity exists among all groundwater components (e.g., parabasal; basal). The Aquifer Type (not defined in this report) describes specific hydrogeologic conditions of divisions within an Aquifer System.

In all instances the Aquifer Sectors correspond to the Sub-Basins of the *NGLS*, but the Agana Sub-Basin is further divided into the Agana and Fadian Aquifer Sectors to reflect the direction of groundwater flow (Agana Sector to the Philippine Sea; Fadian Sector to the Pacific Ocean). Aquifer Systems embrace a group of Management Zones. A System is a more flexible division for allocating water development than the much smaller Management Zone. System boundaries depend on geology (e.g., argillaceous versus clean limestone), basement configuration,

groundwater accumulation and groundwater flow direction. Figure 3-1, located at the end of this report, is a map showing Sectors and Systems.

Correspondence between the *NGLS* divisions and the proposed classification is presented in Table 3-1.

TABLE 3-1
***NGLS* AND PROPOSED AQUIFER CLASSIFICATIONS**

NGLS Sub-Div.	Aquifer Sector	Aquifer System	*NGLS* Mgmt. Zones
Agana	Agana	Ordot	Chalan Pago, Nimitz Hill, Anigua
		Mongmong	Toto, Agana Swamp
		Barrigada	Mt. Barrigada South, Barrigada
Agana	Fadian	Sabana Maagas	Sabana Maagas
Mangilao	Mangilao	Sasajyan	Mangilao South, Mangilao North, Adacao, Asbeco, Taguan, Sasajyan
		Pagat	Sabana Pagat, Janum
Andersen	Pati	Mt. Santa Rosa	Salisbury (1/4), Lupog
		Andersen	Salisbury (3/4), Tarague, Anao
Agafo Gumas	Tarague	Agafo Gumas	Agafo Gumas Central
		Northwest Field	Agafo Gumas West, Agafo gumas East, NW Field East
Finegayan	Finegayan	Gugagon	Callon Tramojo, Finegayan East, Potts
		Haputo	NW Field West, Finegayan West, NCS
Yigo	Yigo-Tumon	Yigo	Marbo South, Yigo East, Yigo West, Marbo North, Mt. Santa Rosa, Mataguac
		Tumon	Mt. Barrigada West Mogfog, Ysengsong, Dededo North, Dededo South, Macheche, Asatdos

CHAPTER IV
SUSTAINABLE YIELD

SUSTAINABLE YIELD BY AQUIFER SYSTEMS

As mentioned in the previous chapters, the *NGLS* was constrained by an absence of long-term hydrologic data and the uncertainty of physical boundary conditions from obtaining the sustainable yield of Guam's groundwater lens by computer modelling techniques then available. Instead, the *NGLS* derived the sustainable yield with a steady state model based on an overall hydrologic budget. Given the available knowledge and information at the time of the *NGLS*, these methods were adequate. With the tools and information available today, however, more accurate and realistic modelling of the lens is possible, particularly with regard to changes that occur in the lens over time.

Included in Appendix A of this report (see p. A-7) is a discussion of sustainable yield and its derivation by a steady state model as applied in the *NGLS*. Although the steady state provides a useful estimate of sustainable yield, it is based on timeless averages and therefore does not capture the profound role the seasons play in dewatering and replenishing the basal lenses. A steady state model is relatively simple to construct and does not require a long-term data base on groundwater behavior for application. The transient model (described in Appendix B of this report), which was developed subsequent to the application of the steady model, is considerably more difficult and relies on an extensive data base than was available at the time of the *NGLS*.

Determination of sustainable yield based on steady state equations for a given equilibrium head assumes average recharge and draft in combination with an initial head in the system before the commencement of pumping. This approach fits a situation where aquifers are very large and are sustained by uniform flux, such as is the case in the voluminous basal aquifers of southern Oahu, Hawaii. In Northern Guam, however, recharge is seasonal. Although the volumes of water in the basal lenses are large, data obtained since the completion of the *NGLS* indicates dewatering during the dry season significantly affects storage, causing a noticeable decline in head. During the wet season, recharge is great and results in sharp head recovery.

Seasonable changes in head can be simulated by a computer model employing the transient equations from which the steady state equations discussed above are derived. Initial conditions for head and volume of water in storage are required, and average draft and recharge must be assigned over a time interval. Based on the *NGLS*, the initial head for the basal aquifers of Northern Guam is taken as 3.0 or 3.5 feet, depending on the Aquifer System being modeled. Initial volume is calculated assuming a porosity of 10 percent, and the time interval is the month. The least sensitive parameter is initial volume.

For each simulation monthly draft is assumed to be constant. In fact, pumpage in Northern Guam is nearly uniform throughout the year at about 25 mgd. Recharge is calculated from average monthly rainfall minus evapotranspiration. Evapotranspiration is assigned a value of 3.3 inches in each month rainfall exceeds 5 inches, and a value of 0.73 times rainfall in those months (January through June) having less than 5 inches. The evapotranspiration values are estimates derived from water balances used in Hawaii.

Total average evapotranspiration for the year amounts to 35.3 inches, which is about half the pan evaporation rate. It is a realistic value which reflects the lack of opportunity for plants to have a continuous supply of moisture when rainfall is light or intermittent.

Total annual recharge is calculated as 53 inches, or about 60 percent of rainfall. This ratio is consistent with the probable hydrologic budget posed by Mink in the 1976 report to PUAG (see Appendix, p. A-2) in which runoff is ignored. It is somewhat greater than that employed in the steady state model (Appendix, p. A-8) in which both recharge and evapotranspiration rates are taken as 45 inches per year. The values in the transient model are more liberal than those employed in the *NGLS* because they reflect the complexity of the hydrological environment in which atmospheric conditions vary strongly between seasons, and soils on limestone are thin and unable to store all rainfall needed to sustain continuous evapotranspiration. Infiltration into the highly permeable limestone surface is the sole escape for rainfall not consumed by plants. The values of rainfall, evapotranspiration and recharge are listed in Table 4-1.

TABLE 4-1 NORTHERN GUAM AVERAGE WATER BALANCE			
Month	**Rain (in.)**	**Ev. Tran. (in.)**	**Recharge (in.)**
Jan	4.63	3.38	1.25
Feb	2.65	1.94	0.71
Mar	1.91	1.39	0.52
Apr	3.11	2.27	0.84
May	4.39	3.21	1.18
Jun	5.22	3.30	1.92
Jul	8.88	3.30	5.58
Aug	13.89	3.30	10.59
Sept	15.19	3.30	11.89
Oct	13.47	3.30	10.17
Nov	9.36	3.30	6.06
Dec	5.86	3.30	2.56
Annual	**88.6**	**35.3**	**53.3**

In applying the steady state model, the whole of Northern Guam is lumped in the hydrological balances and annual averages are used for recharge and evapotranspiration. But, through the application of the transient model now available for analysis the balances are determined by month for each Aquifer System. The transient model also accounts for groundwater behavior from discharge at the coastline inland to either the emergence of the basement above sea level or a groundwater divide. In a transient hydraulic model the aquifers can't be separated into non-productive coastal zones and inland producing zones as was done in the steady state model available for the *NGLS*. Groundwater is continuous and activity at one point, whether recharge or pumping, causes a reaction at all other points.

Under current average draft of 25 mgd and average conditions of rainfall, head decays during the dry season by as much as 0.5 feet, then recovers to its previous maximum during the wet season. From July through November an extraordinary volume of recharge takes place, replenishing the lens and causing a sharp increase in head.

The wet season in Guam is highly reliable. During the average five month season a total of 62.8 inches of rain falls, about 70 percent of the annual total. In the lowest wet season on record, 1973, a total of 45.2 inches fell, and in the next driest, 1966, the total was 54.6 inches. Even at these minimums substantial recharge takes place, returning head to its normal maximum.

The recoverability of the basal lenses is clearly manifested in the return of head to its annual high by October, the height of the wet season. Normally head starts to decline in December and January, sometimes as early as November, and reaches its minimum in June. The difference between the maximum and minimum heads at current draft in the principal basal lenses is 0.3 to 0.5 feet.

SALINITY-DEPTH RELATIONSHIP TO STORAGE HEAD

An even stronger manifestation of the stability of the basal lens under current operations is provided by the salinity-depth curves computed from data compiled by the U.S.G.S from monitor wells in Northern Guam starting in 1982. In a Ghyben-Herzberg lens the 40:1 ratio (40 feet of fresh water below sea level to every 1 foot above) actually applies to the depth below sea level of the middle of the transition zone, or the 50 percent sea water isochlor. Water in the lens may be fresh or brackish, but ordinarily the lens consists of a fresh water core (FWC) followed by brackish water constituting the upper limb of the transition zone (TZ). The depth of the lens water to the 50 percent isochlor is exactly 40 feet for every foot the water table stands above sea level. Below the fresh water core, the concentration versus depth curve is symmetric around the transition zone midpoint.

The midpoint rises and falls with the volume of storage in the lens. In order to depress the water table by one foot the midpoint would have to rise 40 feet. Quite obviously the midpoint is a more reliable indicator of head and volume of water in the lens than water table fluctuations. Water table measurements reflect transient perturbations, including variable recharge and pumping, which are muted or canceled before influencing the midpoint. The transition zone adjusts to long term trends rather than to the instantaneous disturbances that affect the water table.

The most reliable representation of "storage" head, defined as the head dependent on the volume of water stored in the lens, is obtained by dividing the depth below sea level to the midpoint by 40. Storage head calculated in this way is independent of broad seasonal variations in sea level because the entire lens moves in unison in response to global sea changes. Storage head as the parameter defining the status of the lens is superior to water table measurements, but monitor wells drilled through the lens are required to obtain salinity-depth curves. As a project of the *NGLS* a number of such wells were drilled, four of which continue to provide essential information about the magnitude of the lens where each is located.

Figure 4-1 is a plot of storage heads for monitor wells EX-6, EX-7, EX-10 and Ghura Dededo, all of which are located in the basal lens of the Yigo-Tumon Aquifer System. The aquifer consists of clean limestone and therefore is highly permeable. Consequently heads are less than 4.0 feet.

Storage head changes since 1982 have varied by about 0.3 feet, equivalent to a rise or fall of 12 feet at the midpoint, except at EX-7 where the data is inconsistent with the stability of the other wells. No permanent downward trend in storage head is detectable, even though lows were reached in 1984-86 at EX-6 and EX-10. Both recovered by 1988, then declined again in 1989. The midpoint of the transition zone has been remarkably stable, indicating that the present Aquifer System draft of about 11 mgd has not affected the volume of groundwater in the lens.

Figure 4-2 shows storage heads at EX-1 (Mongmong Aquifer System) and EX-4 (Fadian Aquifer System). Both wells are driven in argillaceous limestone where the hydraulic conductivity is far less than in the clean limestone of Yigo-Tumon. Storage heads are higher as a result. Water table movements in these wells may range over one foot in a year, but storage heads are stable, suggesting little impact as a result of current draft.

Figure 4-3 is a plot of storage head at EX-8 (Tarague Aquifer System) for the available data set and at EX-9 (Agana Aquifer System). These wells, like the ones in Yigo-Tumon, are in high permeability limestone. Storage heads vary over a small range but do not display a trend.

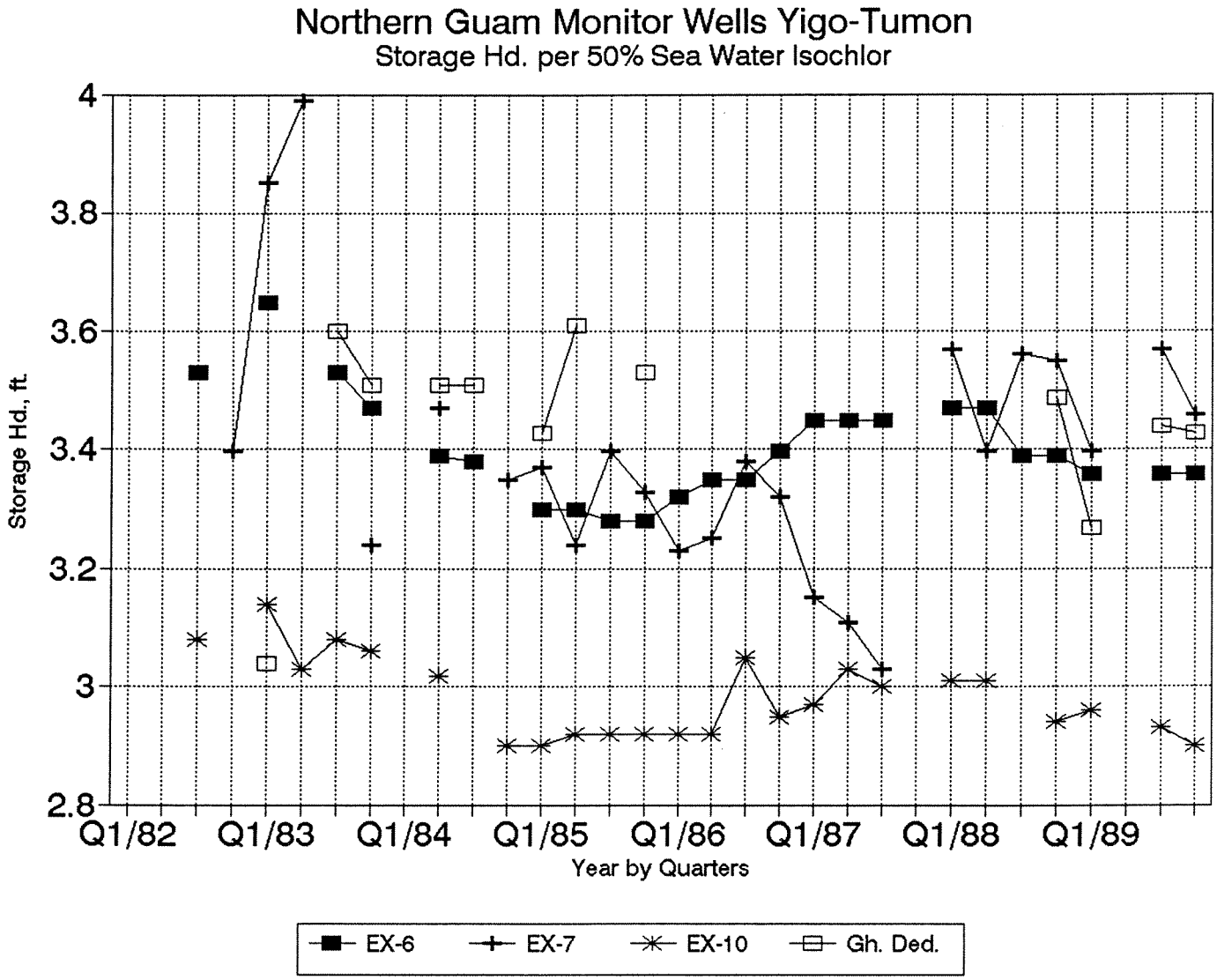


Figure 4-1
Northern Guam
Monitor Wells
Yigo-Tumon

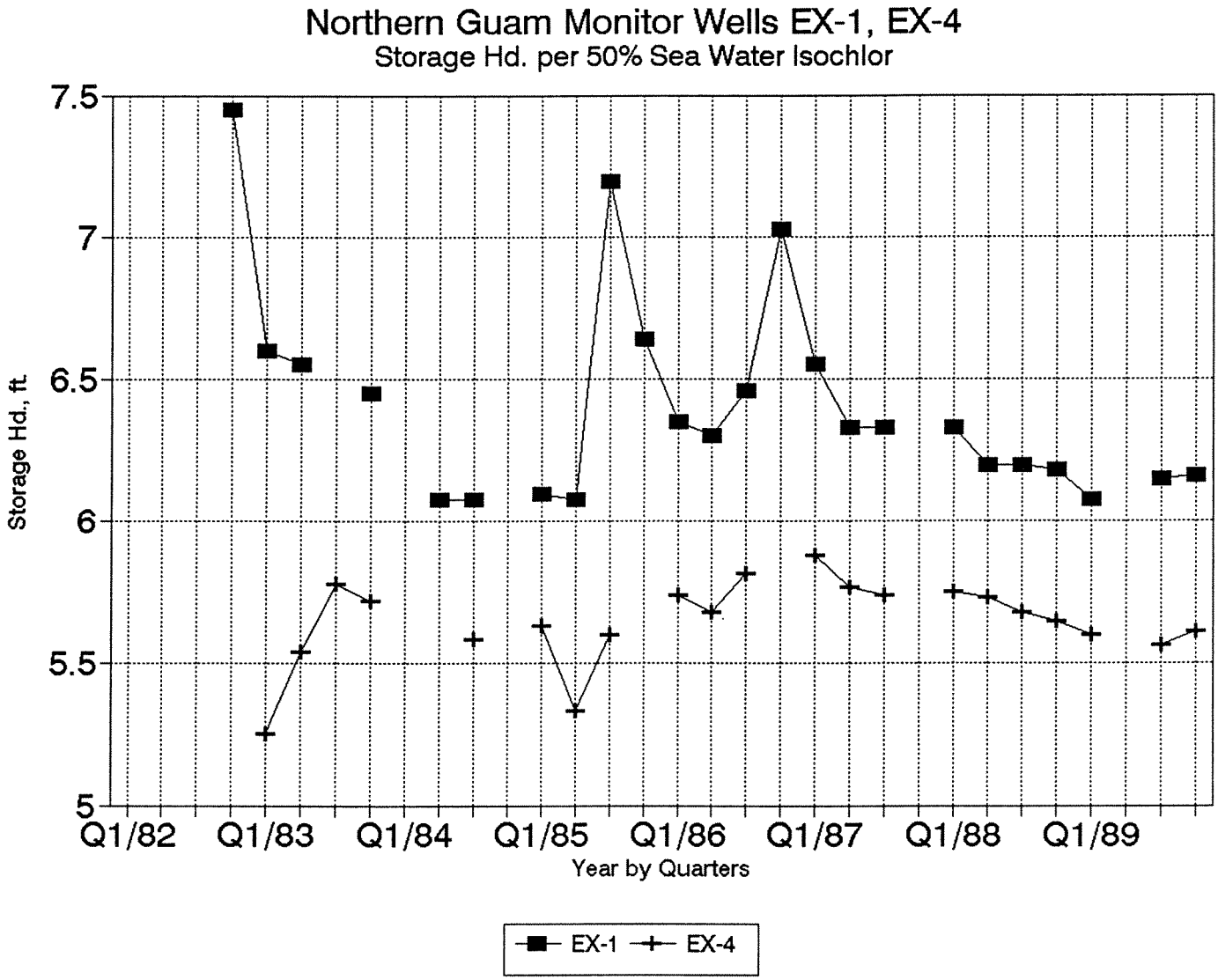


Figure 4-2
Northern Guam
Monitor Wells
EX-1, EX-4

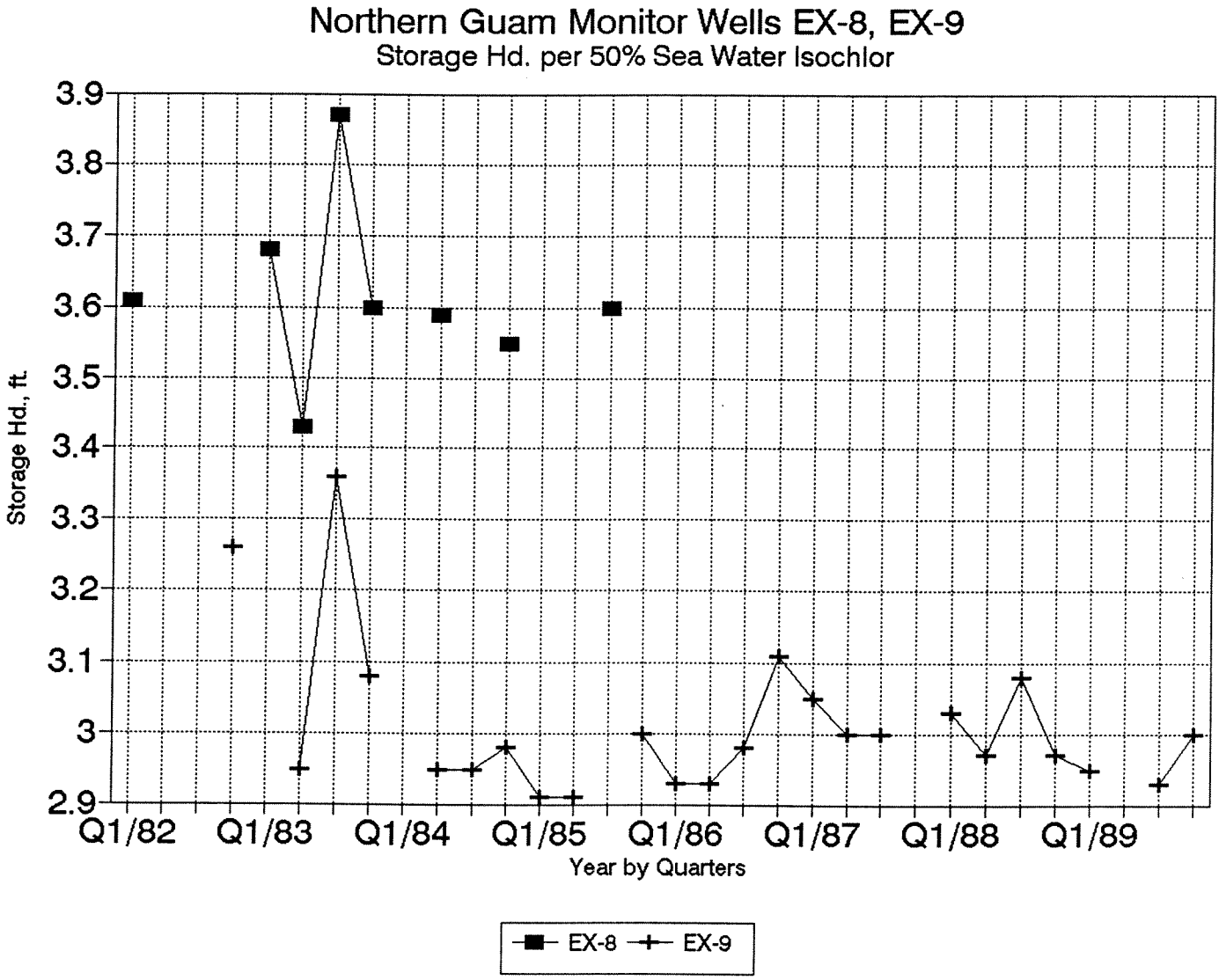


Figure 4-3
Northern Guam
Monitor Wells
EX-8, EX-9

SUSTAINABLE YIELD DETERMINED BY TRANSIENT SIMULATION

In order to test the aquifer's response to draft over time, model runs were made for two Aquifer Sectors and one Aquifer System: Yigo-Tumon Aquifer Sector; Finegayan Aquifer Sector and Ordot Aquifer System. In Yigo-Tumon and Finegayan the simulations represent behavior of the basal lenses; in Ordot parabasal water is considered.

The simulations were transient rather than steady state and are for a 12 year period at different levels of continuous average draft. The cyclical curve of head as a function of time refers to storage head. The graphs of head changes are given in Figures 4-4 through 4-7.Transient simulations do not yield single values for sustainable yield nor, for that matter, do steady state solutions. This is because sustainable yield is dependent on seasonal head change in the transient case and equilibrium head in the steady state case. A judgement must be made about an acceptable head variation for the transient simulation and a safe equilibrium head for the steady state. The annual head change or equilibrium head selected must preserve the quality and quantity of the pumped water for the given continuous average draft.

Figure 4-4 illustrates the transient case for the Finegayan Aquifer Sector. Starting with an initial head of 3.0 feet and monthly recharge rates based on Table 4-1, the head cycle for a variety of drafts to 20 mgd is simulated. As long as draft is less than recharge as an average, head will always be positive.

Head will recover each year just about to 3.0 feet if average draft is 6.0 mgd, and eventually to 2.75 feet if the average draft is 9 mgd. At a draft of 12 mgd the maximum head slips to 2.6 feet, at 15 mgd to 2.5 feet and at 20 mgd to 2.1 feet. The minimums are about 0.5 feet lower. Clearly it would be safe to pump 6 mgd from the Sector, and it is unlikely that a draft of 9 mgd would significantly affect the ability of the lens to supply good quality water. The recommended average draft is 9 mgd, but operational experience in the future may show that somewhat more draft would be allowable. The *NGLS* sustainable yield is 6.38 mgd; current draft is 3.2 mgd. An average draft of 9 mgd would account for 30 percent of the average annual recharge. The seasonal change in head is 0.5 feet.

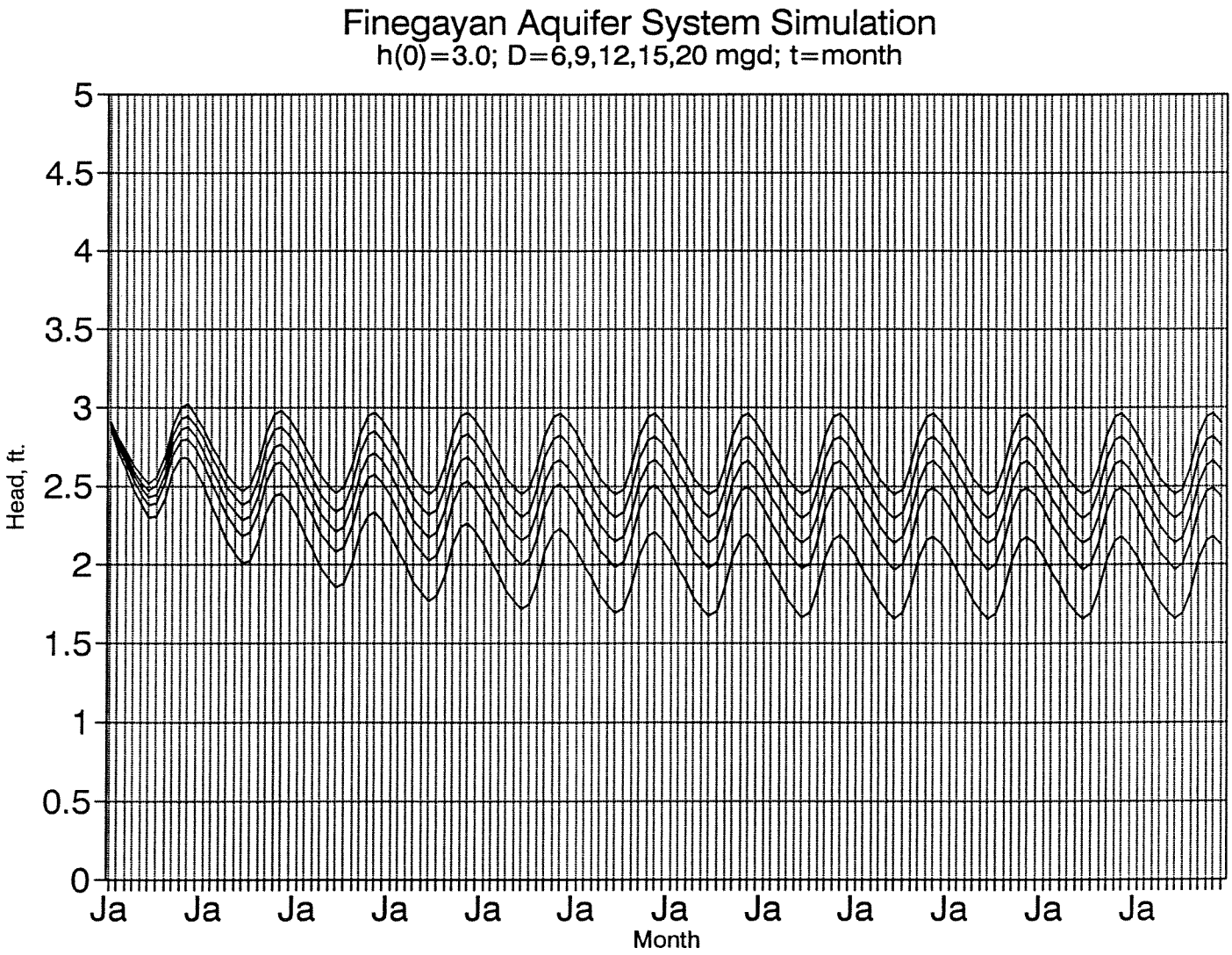


Figure 4-4
Finegayan System
Simulation

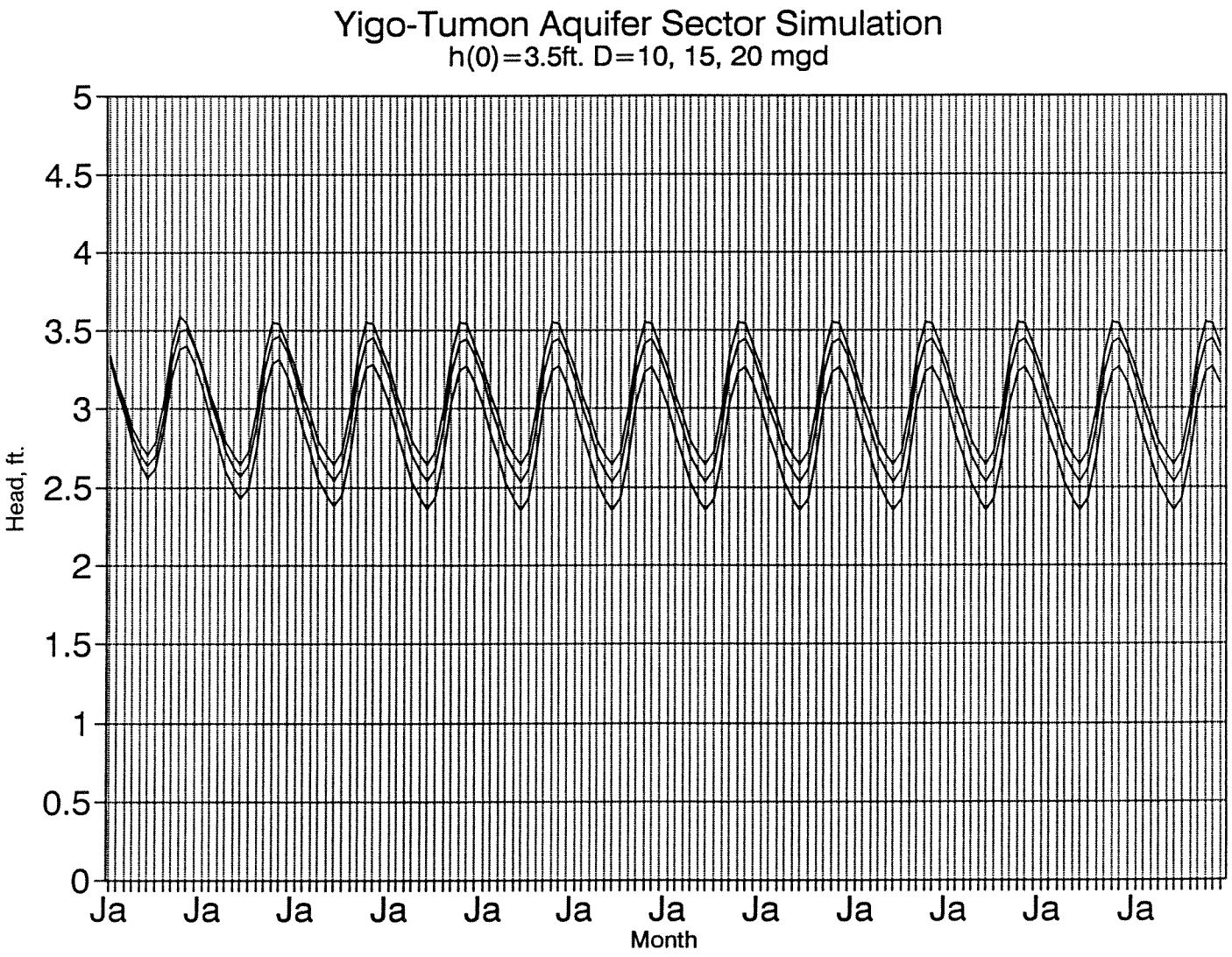


Figure 4-5
Yigo-Tumon Aquifer
Sector Simulation

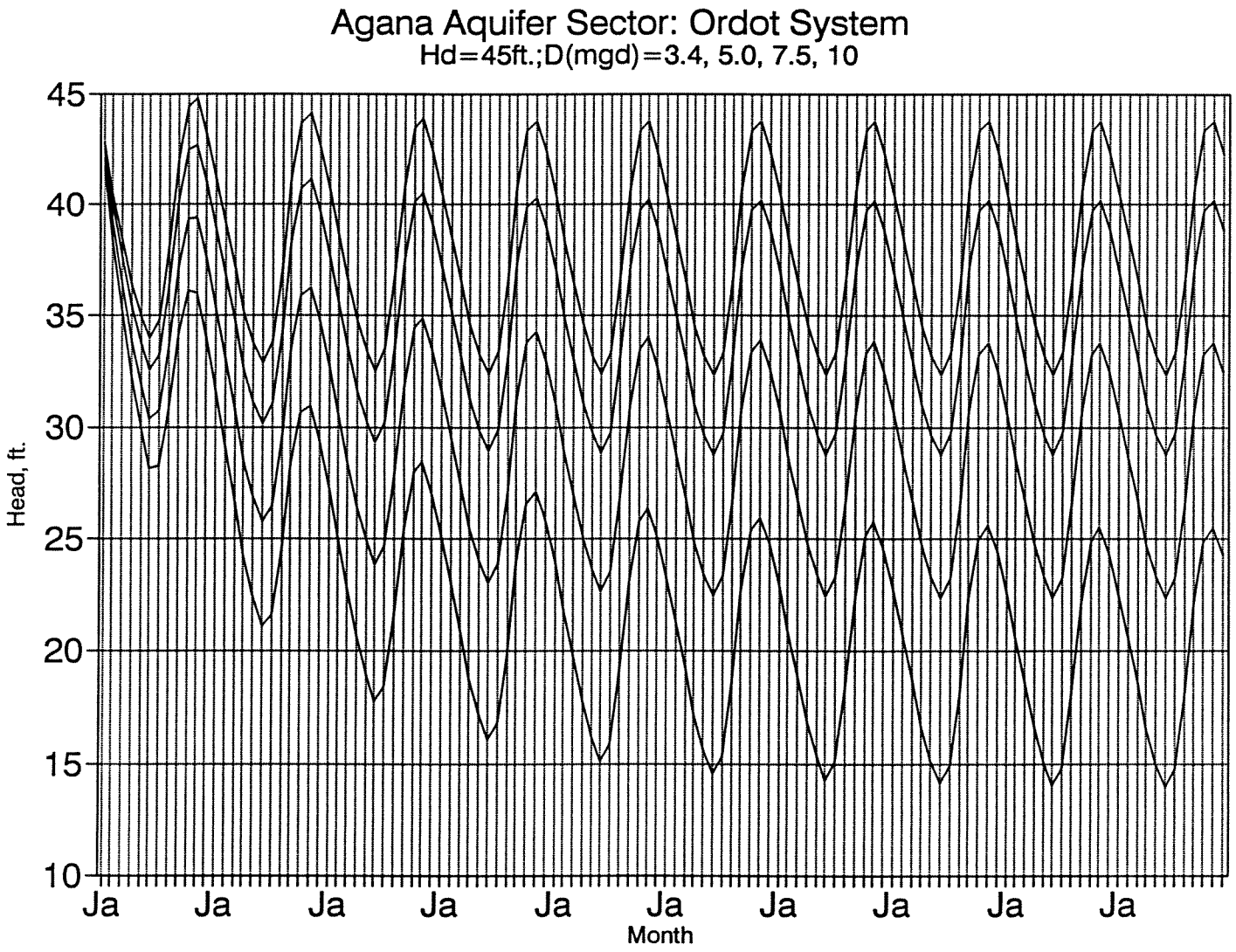


Figure 4-6
Agana Aquifer Sector:
Ordot System,
Hd = 45 Ft.

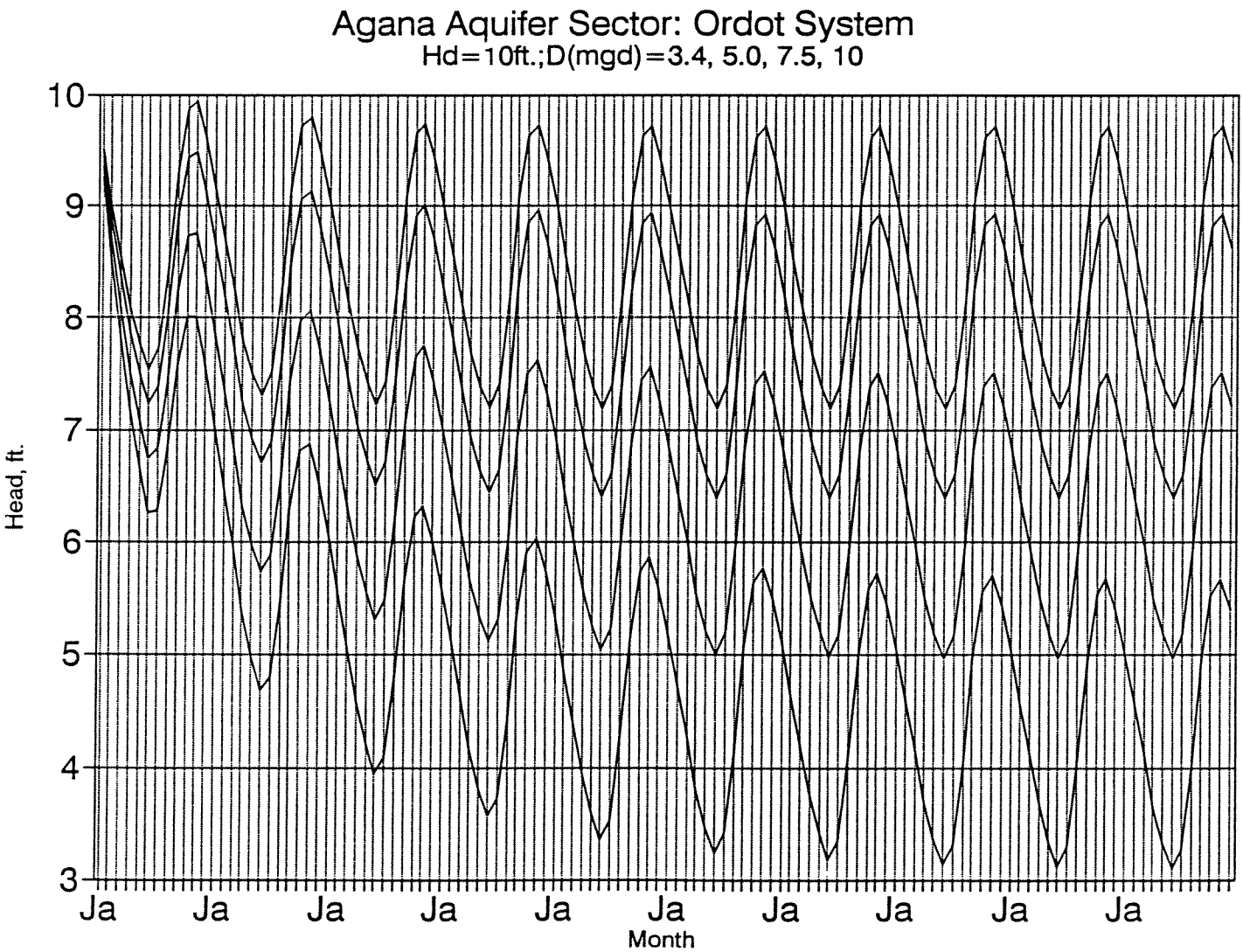


Figure 4-7
Agana Aquifer Sector:
Ordot System
Hd = 10 ft.

In Yigo-Tumon the sustainable yield of 20 mgd also amounts to 30 percent of average annual recharge. The graph in Figure 4-5 indicates that for an initial head of 3.5 feet, full recovery from a seasonal low of 2.7 feet takes place every year when draft is 10 mgd or less. At 15 mgd the low head approaches 2.5 feet and recovery peaks at 3.4 feet, while at 20 mgd the dry season minimum drops to 2.4 feet and the wet season recovery rises to 3.2 feet. Current average draft in the Sector is 11 mgd; the *NGLS* sustainable yield is 19 mgd, about the same as the recommended value.

Simulation of the parabasal groundwater in the Ordot Aquifer System is given in Figure 4-6. The head at Well A-20 is used as an index because head there has been recorded continuously for the past decade. The initial head is taken as 45 feet. The simulated yearly range is 11 feet, which matches the actual record. Decay during the dry season is similar each year unless interrupted by unusual rains. The average cycle settles at a low head of 33 feet for the average current draft of 3.4 mgd; 29.5 feet for a draft of 5 mgd; 23 feet for a draft of 7.5 mgd; and 14.5 feet for a draft of 10 mgd. In every case the head recovers by 11 feet during the wet season.

Also plotted as an Ordot graph (Figure 4-7) is the simulation for a site having an initial head of 10 feet. Because the minimum head of parabasal water is 7 feet near the margin of Agana Marsh, the sustainable yield chosen must not result in heads that would induce sea water intrusion. The simulation depicts an annual variation in head of 2.5 feet, which is characteristic of parabasal conditions where the initial head is less than about 10 feet.

The recommended sustainable yield is 7.5 mgd because at this average draft the parabasal head would be preserved even at the edge of the Marsh. The recommended sustainable yield for this parabasal situation is equal to 60 percent of average annual recharge.

RECOMMENDED AVERAGE DRAFT BY AQUIFER SECTORS AND SYSTEMS

Table 4-2, located at the end of this Chapter, summarizes the sustainable yields proposed for each Aquifer Sector and System. The model simulations for Yigo-Tumon and Finegayan Aquifer Sectors indicate that sustainable yield for a basal lens is equal to about 30 percent of recharge. This fraction is employed elsewhere in Northern Guam where basal conditions exist.

In the *NGLS* a factor of 50 percent was used but it had no basis in hydraulic analysis. Rather, it was assumed at the time as a safety factor since so little was known about the physical boundary conditions of the lens and its response under stress. Similarity among the *NGLS* and currently computed values of sustainable yield is coincidental rather than due to application of similar methodology. The *NGLS* values depend exclusively on a water budget and apply only to that portion of the island at some distance inland where groundwater is presumed to be fresh. The current approach to sustainable yield is wedded to groundwater hydraulics analysis made possible by the monitoring of wells developed since the *NGLS* and supplemented by values for recharge obtained from a water balance. In this method an entire lens is treated as a continuum. The quality of pumped water is governed by location and rate of draft. Where conditions are favorable, good water can be pumped very close to the discharge line of the lens along the coast.

Table 4-2 lists recommended sustainable yields as well as those given in the *NGLS* along with current draft. The table identifies the fraction of sustainable yield not accessible to PUAG because it is restricted to military lands. However, except in Andersen Field, where the flow path of groundwater from origin to discharge takes place in Federal property, virtually all sustainable yield can be accessed by PUAG.

The data in the table is arranged so that the Sub-basins and Management Zones of the *NGLS* correspond to the Aquifer Sectors and Systems in the proposed classification. Consistency in names for the divisions is preserved wherever possible to avoid confusion.

SUMMARY OF DRAFT AND SUSTAINABLE YIELD

The total sustainable yield for all of Northern Guam as stated in the *NGLS* is 57.44 mgd, while in the current study the recommended value for the transient model is 80 mgd and for the steady state model, 70 mgd. In the *NGLS* sustainable yield was calculated as equal to one half the average infiltration determined by hydrologic budgeting for regions lying several thousand inland of the coast. For the current evaluations the entire Northern Guam complex of aquifers, embracing 100 square miles, is considered in the hydraulic model. The complex linkage among recharge, groundwater accumulation and flow, and groundwater extraction can't be arbitrarily limited to the region of putative potable water. The entire flow system is involved.

TABLE 4-2
SUSTAINABLE YIELD
AQUIFER SYSTEMS vs. *NGLS* MANAGEMENT ZONES (mgd)

Sector	System	*NGLS* SB	*NGLS* MZ	*NGLS* SY	Revised SY	SY from Non-Federal Lands	Draft (89)	Unused SY
Agana	Ordot	Agana	Chalan Pago	1.24			1.65	
			Nimitz Hill	2.17			1.74	
			Anigua	1.17			0	
			Total	4.58	7.5	7.5	3.39	4.1
	Mongmong		Toto	0.62			0.02	
			Agana Swamp	1.25			0	
			Total	1.87	2.8	2.8	0.02	2.8
	Barrigada		Mt. Barrigada South	0.30			0	
			Barrigada	0.37			0	
			Coastal	0.45			0.99	
			Total	1.12	3.0	3.0	0.99	2.0
			TOTAL	**7.57**	**13.3**	**13.3**	**4.4**	**8.9**
Fadian	Sabana		Sabana Maagas	1.73	3.0	3.0	1.89	1.1
	Maagas							
	Huchunao		Manaca	1.67			0.15	
			Mt. Barrigada East	0.73			0	
			Total	2.40	4.2	4.2	0.15	4.0
			TOTAL	**4.13**	**7.2**	**7.2**	**2.04**	**5.1**
Mangilao	Sasajyan	Mangilao	Mangilao South	0.32			0	
			Mangilao North	0.42			1.01	
			Adacao	0.95			0.19	
			Asbeco	0.33			0	
			Taguan	0.30			0.62	
			Sasajyan	0.13			0	
			Total	2.45	3.3	3.3	1.82	1.5
	Pagat		Sabanan Pagat	0.79			0	
			Janum	0.66			0	
			Total	1.45	(3.3)	0	0	0
			TOTAL	**3.90**			**1.82**	**1.5**

* See notes at end of table.

TABLE 4-2 (Cont'd)
SUSTAINABLE YIELD
AQUIFER SYSTEMS vs. *NGLS* MANAGEMENT ZONES (mgd)

Sector	System	*NGLS* SB	*NGLS* MZ	*NGLS* SY	Revised SY	SY from Non-Federal Lands	Draft (89)	Unused SY
Pati	Mt. Santa Rosa	Andersen	Salisbury (1/4)	0.71			0	
			Lupog	1.46			0.01	
			Total	2.17	2.3	2.3	0.01	2.3
	Andersen		Salisbury (3/4)	2.14			0	
			Tarague	1.02			0	
			Anao	0.35			0	
			Andersen	0.56			0	
			Total			0	0	0
			TOTAL	**6.24**	**(9.8)**	**2.3**	**0.01**	**2.3**
Tarague	Agafo Gumas	Agafo Gumas	Agafo Gumas Central	4.20	5.0	5.0	0.54	4.5
	Northwest Field		Agafo Gumas West	0.86			0	
			Agafo Gumas East	1.63			0	
			Northwest Field East	3.40			0	
			Total	5.89	(7.0)	0	0	0
			TOTAL	**10.09**	**(12.0)**	**5.0**	**0.54**	**4.5**
Finegayan	Gugagon	Finegayan	Callon Tramojo	0.95			0.21	
			Finegayan East	1.09			0	
			Potts	0.86			0	
			Total	2.90	5.0	5.0	0.21	4.8
	Haputo		Northwest Field West	1.25			0	
			Finegayan West	0.63			2.07	
			NCS	1.60			0.72	
			Coastal				0.24	
			Total	3.48	(6.6)	4.0	3.03	1.0
			TOTAL	**6.38**	**11.6**	**9.0**	**3.2**	**5.8**

* See notes at end of table.

TABLE 4-2 (Cont'd)
SUSTAINABLE YIELD
AQUIFER SYSTEMS vs. *NGLS* MANAGEMENT ZONES (mgd)

Sector	System	*NGLS* SB	*NGLS* MZ	*NGLS* SY	Revised SY	SY from Non-Federal Lands	Draft (89)	Unused SY
Yigo-Tumon	Yigo	Yigo	Marbo South	0.65			0	
			Marbo North	0.35			0	
			Yigo East	1.08			1.05	
			Mt. Santa Rosa	0.76			0	
			Mataguac	0.88			0	
			Yigo West	1.90			1.75	
			Total	5.62	6.4	6.4	2.80	3.6
			Mt. Barrigada West	1.30			0	
			Mogfog	0.65			0	
			Ysengsong	3.00			0	
			Dededo North	1.93			1.63	
			Dededo South	3.46			5.92	
			Macheche	1.25			0	
			Asatdos	1.92			1.12	
			Coastal				1.34	
			Total	13.51	13.6	13.6	10.01	3.6
			TOTAL	**19.13**	**20.0**	**20.0**	**12.8**	**7.2**
			TOTAL			60.1	24.9	35.1

NOTES

Col.1 - Aquifer Sector: The Sector is the largest division in the proposed classification. A Sector is a region of geological and hydrological similarities.

Col.2 - Aquifer System: Each Sector contains one or more Systems. In an Aquifer System groundwater continuity exists throughout. Boundaries between Systems are related to hydrogeological features. Systems incorporate Management Zones of the *NGLS*.

Col.3 - *NGLS* Sub-Basin: The *NGLS* regional divisions corresponding to Sectors. The Agana Sub-Basin is divided into two Sectors (Agana and Fadian) along a boundary to the west of which groundwater flows toward Agana Marsh and the Philippine Sea and to the East to the Pacific Ocean. All other Sector boundaries are identical to Sub-Basin boundaries.

Col.4 - *NGLS* Management Zone: The smallest unit defined in the *NGLS*; currently the basis for allocating groundwater development. In the aquifer classification, Management Zones are subsumed in Aquifer Systems.

Col.5 - *NGLS* SY: The sustainable yield assigned to each Management Zone in the *NGLS*.

Col.6 - Revised SY: The sustainable yield derived for each Aquifer System by means of the transient simulation model. Parentheses around values means that not all of the sustainable yield is accessible by PUAG.

Col.7 - NonFed SY: Sustainable yield which is developable only in Federal lands and is presumed not accessible by PUAG.

Col.8 - Draft(89): Average 1989 pumpage by Management Zones, summed for each aquifer System.

Col.9 - Unused SY: The difference between Col.7 (NonFed SY) and Col.8 (Draft 89). The remaining undeveloped sustainable yield potentially available to PUAG.

Not all of the 80 mgd (transient model) is available to PUAG. Development of about 20 mgd falls within Federal property, leaving a total of 60 mgd accessible to PUAG. Current total draft in Northern Guam is 25 mgd (1989), and thus PUAG can add another 35 mgd to its system under prevailing conditions of land control and water development. Experience in Hawaii and Israel suggests that, with optimal well siting and development in the highly transmissible soils of Northern Guam, virtually all of the sustainable yield could be obtained. Only the development of additional production wells and their continued monitoring, however, will determine what percentage of the remaining sustainable yield can be practically retrieved.

Additional opportunities for groundwater development available to PUAG by Aquifer Sector and System along with comments about the ease of obtaining potable water are presented in Table 4-3.

TABLE 4-3
GROUNDWATER AVAILABILITY BY AQUIFER SYSTEM

Aquifer Sector	Aquifer System	Surplus SY (mgd)	Comments
Agana	Ordot	4.1	Parabasal; easy development
	Mongmong	2.8	Basal; salinity problems
	Barrigada	2.0	Basal; salinity problems
Fadian	Sabana Maagas	1.1	Basal; salinity problems
	Huchunao	4.0	Basal
Mangilao	Sasajyan	1.5	Para & basal; good
	Pagat	0	Volc. Basement ASL
Pati	Mt. Santa Rosa	2.3	Para & basal; ?
	Andersen	0	Federal property
Tarague	Agafo Gumas	4.5	Parabasal; good.
	Northwest Field	0	Federal property
Finegayan	Gugagon	4.8	Para & basal
	Haputo	1.0	Basal.
Yigo-Tumon	Yigo	3.6	Para & basal
	Tumon	3.6	Basal
Total		**35.3**	

CHAPTER V
GROUNDWATER DEVELOPMENT PROGRAM

GROUNDWATER DEVELOPMENT PRACTICES

Sustainable yields are determined for aquifer systems assuming that the extraction of groundwater is accomplished optimally. For each site the extraction unit (generally a well) must be designed and outfitted to provide potable water continuously. In locations where head is low, for example, wells must not penetrate far below sea level and pump capacities need to be modest. Frequently the cost of a low capacity well will not justify drilling. Optimal wells in argillaceous limestone differ from those in clean limestone. The largest successful wells are drilled in parabasal aquifers.

These differences must be addressed when groundwater development is planned. They haven't been considered carefully in the past because a standard well for basal groundwater (depth below sea level 35 feet; pump capacity 200 gpm) generally behaved in an acceptable way. However, in order to safely take full advantage of potential sustainable yield many existing wells should be examined and tested, and for some, depth and capacity will have to be re-adjusted. Each new well will require specifications written especially for it. The standard model is no longer adequate.

FACTORS AFFECTING WELL DESIGN AND CONSTRUCTION

The standard design for a production well in Northern Guam emerged from experience with the first wells drilled for the Government of Guam in Dededo. Tests showed that 200 gpm could be pumped from a well driven 35 to 50 feet below sea level in the basal lens. Because most drilling at that time (between 1965-1975) was concentrated in Dededo, the 200 gpm well became standard for all of northern Guam.

The Dededo well field draws from an aquifer consisting of 'clean' limestone containing a basal lens having an average head of 3.0 to 3.5 feet. Clean limestone is defined as a fossil reef association in which clay is virtually absent. The clean limestones of Northern Guam are almost

pure calcium carbonate. These limestones are extremely permeable on a global scale. However, on the local scale of a well bore, low permeability parts of the formation may control groundwater hydraulics. Because of the high regional permeability, heads are low in spite of the strong flux of groundwater. The 200 gpm well proved to be the optimal unit for this modest head basal groundwater environment.

Parabasal groundwater also occurs in the clean limestones of Northern Guam. In this instance the aquifers allow for considerably higher well capacities to take advantage of the high permeabilities of the formations and the absence of sea water intrusion. Parabasal wells in Agafo Gumas and Yigo prove that clean limestone wells can yield as much as 700 gpm. Unless constrained by unfavorable local geology, parabasal groundwater in clean limestone is the most favorable environment in Guam for large capacity wells. Therefore, 700 gpm should be set as the "target" capacity for the future drilling of all clean limestone wells in parabasal lenses. After drilling, testing of each well will determine if it meets the target capacity of 700 gpm. If not, a lower capacity well can be installed in the boring.

Not all of Northern Guam is underlain by clean limestone. About 14 square miles consist of argillaceous limestone of the Mariana formation. This area extends from the contact between the limestone of the north and the volcanics of the south to the 200 feet elevation topographic contour. The argillaceous limestone contains 5 to 10 percent clay intimately compounded with calcium carbonate along with lenses and pockets of clay interbedded in the limestone. The overall effect of the clay is to drastically reduce global permeability and to increase the probability of the occurrence of very low permeability on a local, or well boring, scale. Although groundwater head normally is higher in argillaceous limestone than in clean limestone because of the lower permeability, the standard well is not typically adaptable to this environment. Nevertheless, all of the wells drilled in basal groundwater in argillaceous limestone were designed as if the subsurface environment belonged to clean limestone. Eventually problems of salinity afflict these wells because 200 gpm is too high a pumping rate. When new pumps are required, most will have to be fitted with smaller pumps to ease the threat of increasing salinity.

Parabasal wells in argillaceous limestone can yield 200 gpm and perhaps more, but they can't really attain the production level of parabasal wells in clean limestone. The much lower permeability of the argillaceous limestone causes considerably greater drawdown than in clean limestone for the same pumping rate.

Thus the principal geologic factors affecting well capacity is the 'cleanliness' of the limestone and the position of the volcanic basement. The hydraulic factors are head, especially in basal lenses, and volume rate of groundwater flow. Head is the dominant control because it is a function of hydraulic conductivity, distance inland from the discharge front, usually the coastline, and groundwater flux.

Evaluation of operational data for wells in Guam and analogous situations in the Pacific Islands, including Hawaii, suggest that the following general rules should apply to well capacities in Northern Guam.

1. Condition: clean limestone; basal groundwater.
   a. h = 3 to 4 ft.; capacity 180 to 300 gpm.
   b. h = 2 to 3 ft.; capacity 80 to 150 gpm.

2. Condition: clean limestone; parabasal.
   a. h > 4 ft.; capacity 500 to 700 gpm.

3. Condition: argillaceous limestone; basal.
   a. h > 5 ft.; capacity 150 to 200 gpm.
   b. h = 3 to 5 ft.; capacity < 150 gpm.

4. Condition: argillaceous limestone; parabasal.
   a. h > 7 ft.; capacity 200 to 300 gpm.

WELL PRODUCTION BY AQUIFER SYSTEMS

The potential groundwater production of the Aquifer Systems is discussed in the following sections. The various Aquifer Systems are arranged by the Aquifer Sectors in which they are defined. Reference should be made to Figure 3-1 throughout the following discussions.

Agana Aquifer Sector - Within the Agana Aquifer Sector the Ordot, Mongmong and Barrigada Aquifer systems all have potential for groundwater production.

Ordot Aquifer System - All wells in the Ordot Aquifer System encounter parabasal groundwater in an argillaceous limestone aquifer. Salinity in each well never exceeds about 30 mg/l chloride and normally hovers around 20 mg/l. The wells include A-1, A-2, A-3, A-4, A-5, A-6, A-7, A-8, A-11, A-12, A-23 and A-25. Flow rates range from about 140 gpm to 260 gpm, but each well was fitted with a 40 HP pump expected to produce the standard rate of 200 gpm. Some of the wells can sustain greater rates. Operationally, the most efficient manner of determining whether a higher capacity is allowable is to perform an evaluation whenever a pump is pulled from a well.

Mongmong Aquifer System - The Mongmong System has no wells producing for PUAG. Much of the area is covered by Agana Marsh, which is a groundwater sink. The entire System is composed of argillaceous limestone containing a basal lens which, surprisingly, is not being exploited. Some old wells showed high salinities, but others suggest the possibility of obtaining potable water with modest capacity pumps.

The sustainable yield is more than 2 mgd. A number of wells can be drilled, some equipped with 200 gpm pumps but most with smaller capacities. At monitor well EX-1 the head is quite high, between 6 and 8 feet.

Barrigada Aquifer System - The Barrigada Aquifer System consists of clean limestone in which groundwater occurs in a basal lens having a maximum head of approximately 3 feet. The division between the argillaceous limestone of the Mongmong System and the

clean limestone in the Barrigada System roughly follows the trace of the 200 feet elevation contour.

PUAG uses only one well (A-15) in the System. Salinity of the pumped water is moderately good, between 150 and 175 mg/l chloride. Additional wells could be drilled to draw on an unused sustainable yield of 2 mgd.

The System has a reputation for yielding high salinity water, but wells with pump capacities between 100 and 150 gpm should ordinarily yield potable water.

Fadian Aquifer Sector - Within the Fadian Aquifer Sector the Sabana Maagas and Huchunao Aquifer Systems have potential for groundwater development.

Sabana Maagas Aquifer System - Of the seven active wells in the Sabana Maagas Aquifer System, five (A-13, A-14, A-17, A-18 and A-19) exhibit serious salinity problems. The other two (A-9 and A-10) yield water of less than 240 mg/l chloride, the recommended upper limit of potability, although they sometimes approach this limit. All of the wells evidently were expected to produce 200 gpm because they are fitted with 40 HP motors. Actual pumping rates range from about 150 gpm at A-19 to 220 gpm at A-14.

Every well encounters basal groundwater in an argillaceous limestone aquifer. Heads increase from about 3 feet at A-19 to about 4 feet in the vicinity of A-9, A-10 and A-13, the most inland sites. Clearly, installed pump capacity at each well is too large for the hydrogeological environment. Upon re-fitting, each well should be carefully assessed to select a capacity that will not provoke salinity problems. Very likely capacity should not exceed 150 gpm.

Huchunao Aquifer System - No wells produce water for PUAG in the Huchunao Aquifer System. Well A-22 was once active but is no longer used because it pumps too much air.

Virtually the entire System is underlain by a basal aquifer in clean limestone. Much of the land is under Federal control, but enough of an area can be accessed by PUAG to locate well sites. At present only Hawaiian Rock Products pumps water, one well (HRP-1) at about 600 gpm and the other (HRP-2) at about 250 gpm. The quality of the water is surprisingly good considering the high capacities of the wells and proximity to the coastline. GEPA reports that in 1989 a sample from HRP-2 contained 382 mg/l chloride and one from HRP-1 only 148 mg/l (the capacity of each well suggests that the values are reversed).

The System provides an opportunity for PUAG to develop additional supplies by means of wells having capacities between about 100 and 200 gpm.

Mangilao Aquifer Sector - Within the Mangilao Aquifer Sector the Sasajyan Aquifer System has limited potential for groundwater development and the Pagat system has negligible potential for development.

Sasajyan Aquifer System - The Sasajyan Aquifer System lies on the Pacific Ocean side of the subsurface ridge forming the western divide of the Yigo Trough. The divide runs from Ypao Peninsula to Mt. Santa Rosa. The System has a complicated hydrogeology that embraces both basal and parabasal groundwater.

Six M series wells along with EX-11 supply PUAG. Four of them (M-3, M-4, M-8 and M-9) and EX-11 are either parabasal or transitional between basal and parabasal. The wells were designed to yield 200 gpm but most average between 150 and 200 gpm.

Another 1.5 mgd can be pumped from the System by means of parabasal and basal wells. If basal, capacities will be 100 to 150 gpm; if parabasal, 300 to 500 gpm.

Pagat Aquifer System - Except for a narrow zone along the coast the volcanic basement throughout the Aquifer System lies above sea level, a condition which precludes the

accumulation of developable groundwater. At this time there is no reason to consider the System as a potential source of groundwater production.

Janum Spring flows off the subsurface contact between the limestone and the basement volcanics. Its flow cannot be intercepted by wells placed up gradient because the volcanics rise above sea level.

Pati Aquifer Sector - The Pati Aquifer Sector is divided into two Aquifer Systems, Mt. Santa Rosa and Andersen, but only Mt. Santa Rosa is available for development by PUAG. The Andersen System lies entirely in Andersen Air Force Base.

Mt. Santa Rosa Aquifer System - No producing wells are located in the Mt. Santa Rosa System. Recent TDEM surveys suggest that both parabasal and basal groundwaters exist and are developable. Exploratory wells are needed. As much as 2 mgd may be available with properly designed wells.

Andersen Aquifer System - The entire area of the System is part of Andersen AFB. The dividing line between the Andersen and Mt. Santa Rosa Systems was drawn along the property boundary for convenience. A fine opportunity exists for the Air Force to develop water within the Andersen System.

Tarague Aquifer Sector - Like the Pati Aquifer Sector, the Tarague Sector is divided into two Aquifer Systems, one of which (Agafo Gumas) is available to PUAG for development, and the other of which (Northwest Field) lies in Federal property.

Agafo Gumas Aquifer System - In most of the Agafo Gumas System the volcanic basement lies above sea level, eliminating groundwater development opportunities. However, parabasal groundwater occurs in a subsurface trough near Route 9 and is developed by well AG-2. A well across the highway, AG-1, appears to be in groundwater transitional between parabasal and basal conditions. In addition to the PUAG wells, two

golf course wells produce high quality parabasal water. These golf course wells consume an important fraction of the sustainable yield.

Wells AG-1 and AG-2 are undersized at about 200 gpm relative to the capacity of the parabasal aquifer to yield water. The golf course wells, on the other hand, successfully exploit the aquifer with 700 gpm wells. The capacity of the PUAG wells should be increased when the pumps are pulled for replacement. A capacity range of 500 to 700 gpm is justified in the parabasal area. At 10 inches in diameter, both AG-1 and AG-2 may be adequately sized to permit the desired flow of 700 gpm. However, to ensure that the diameter of the existing borings does not limit the capacity of the wells, sounding of the casings should be performed upon pulling the pumps to determine the maximum possible yield. If less than 700 gpm, the wells would need to be reamed to enlarge their diameters, then tested again to determine their increased capacities.

Details about the configuration of the volcanic basement have been revealed by recent TDEM surveys. These details will be helpful in locating exploratory and producing well sites.

Northwest Field Aquifer System - Although the Air Force does not have active wells in the Northwest Field System, opportunities for production wells exist. Both parabasal and basal groundwater may be exploited.

Finegayan Aquifer Sector - The Finegayan Sector is divided into two Aquifer Systems, Gugagon and Haputo. Both systems have potential for groundwater development although significant portions of each lie within the Andersen Air Force boundaries.

Gugagon Aquifer System - The Gugagon Aquifer System has been differentiated from the larger Haputo Aquifer System as a result of reinterpretation of the volcanic basement configuration employing original data from seismic work performed during the *NGLS* combined with recent TDEM surveys. In a large extent of the Gugagon System the basement lies above sea level, but a narrow zone evidently contains parabasal

groundwater. Also within the System is an area of basal groundwater which is continuous with the basal lens of the Haputo System.

Wells F-8 and F-9, the former definitely parabasal and the other either parabasal or transitional to it, produce water for PUAG. The average yield of each is about 150 gpm, but presumably they were drilled to give 200 gpm each. Their capacities can be increased, perhaps to as much as 500 gpm.

Exploratory wells have been recommended to test for parabasal occurrences. An additional yield of nearly 5 mgd may be obtainable.

Haputo Aquifer System - Basal groundwater occurs throughout the System and is exploited by both PUAG and the Naval Communication Station (NCS). Of the nine active PUAG wells (F-1, F-2, F-3, F-4, F-5, F-6, F-7, F-10 and F-11), three (F-4, F-6 and F-10) occasionally experience salinity in excess of the recommended limit of 240 mg/l chloride, but the others yield moderate to low salinity water. The wells apparently were designed to produce 200 gpm. Average production rates are usually less than 200 gpm except for F-1 and perhaps F-2.

Where the wells are located, head in the basal lens is about 3 feet, which is high enough to allow pump capacities of 150 to 200 gpm for production of potable water.

The NCS wells are pumped at an average rate of 150 to 200 gpm and, like the PUAG wells, apparently were developed to yield 200 gpm. One of the wells (NCS1A) sometimes exceeds the recommended salinity limit, but the other two always meet the standard.

PUAG can obtain another 1 mgd from the Haputo System even though most of its area lies inside NCS and Andersen Air Force Base.

Yigo-Tumon Aquifer Sector - The most voluminous and easily developed groundwater resources in Guam occur in the clean limestone aquifers of the subsurface trough which starts

at Yigo and discharges into Tumon Bay. The trough is a remarkably efficient collector and transporter of groundwater. Its axis follows an arc from about the center of the coastline at Tumon Bay through Dededo to closure between the exposed volcanic highlands of Mataguac and Mt. Santa Rosa. Recharge flows along the top of the basement volcanics where they rise above sea level to the trough axis and eventually to the sea coast as a basal lens.

The Sector is divided into two Aquifer Systems. The Yigo System constitutes the most inland portion of the trough where groundwater is predominantly parabasal. The Tumon System embraces the mid and coastal portions where groundwater is chiefly basal, though on the flanks of the trough some parabasal sections may exist.

The Sector is the primal source of water supply for Guam and its aquifers are the most intensively exploited in the island. Nevertheless a surplus of sustainable yield exists that can be developed easily.

Yigo Aquifer System - Of the nine wells in the Yigo Aquifer System, six are parabasal (Y-2, Y-3, Y-4, Y-6, Y-7 and Y-9) and the other two (Y-1 and Y-5) appear to be transitional between basal and parabasal. Wells Y-1 through Y-6 are pumped at rates of 200 gpm or less, consistent with their design. Wells Y-7 and Y-9 have larger pumps, with Y-9 pumping as much as 400 gpm.

The parabasal wells can yield more than 200 gpm, and when each needs to be re-equipped a larger pump size should be considered. In addition several new wells can be drilled to take advantage of the surplus sustainable yield of nearly 4 mgd in the System.

Tumon Aquifer System - The Tumon Aquifer System is being exploited by about 40 wells and one infiltration gallery, but its sustainable yield is still not fully developed. The infiltration gallery and eight wells supply water to Andersen and military activities associated with it. About 30 wells are used by PUAG, and the remaining few are private.

The first wells drilled for PUAG about 25 years ago were located in Dededo and belong to the D series. These wells have been extremely successful in providing low salinity groundwater at pumping rates of about 200 gpm from a basal aquifer having a head of 3 to 3.5 feet. They are placed near the axis of the Yigo Trough where the flux of groundwater in the highly permeable clean limestone is unusually strong. All of the D series wells follow the standard design for providing 200 gpm. Additional similar wells can be drilled to exploit the remaining surplus sustainable yield amounting to nearly 4 mgd.

The M series wells, along with EX-5A and GH-501, also yield low salinity water at pumping rates of 150 to 200 gpm. Like the D series, these wells take advantage of the strong flux of groundwater moving along the axis of the Yigo Trough.

The MW series, belonging to the Air Force, exploit the low salinity groundwater associated with a basal zone in close proximity to parabasal water. In spite of having pump capacities of 200 to 475 gpm, these wells yield low salinity water. At the terminus of the System near Tumon Bay the Air Force infiltration gallery supplies on the order of 1 mgd of low salinity basal groundwater.

The importance of the Yigo-Tumon Aquifer Sector can't be overemphasized. It is the heart of PUAG's water supply. It is already intensively developed, and of its estimated sustainable yield of 20 mgd, an average of about 13 mgd is being pumped. The reliability of this resource must be protected because of its dominating importance in supplying not only the civil economy of Guam but also Air Force activities.

WELL FAILURE AND REDEVELOPMENT

A well's inability to produce water of acceptable salinity (usually less than 150 mg/l chloride) at a feasible rate (usually more than 50 to 100 gpm) is normally manifested during initial testing following completion of drilling, but frequently failure takes place after a period of successful operation. A newly drilled well will fail if the position of the volcanic basement prevents the foundation of a saturated aquifer in limestone, or, should saturated limestone exist, the

penetration of the well bore is either too deep, inducing upconing of the transition zone, or too shallow, not allowing sufficient surface area to accommodate inflow into the well. As a general rule, near-wasted areas are not likely to yield potable water because the groundwater in the basal lens consists mainly of the transition zone.

Wells that were initially successful but begin to fail after a period of operation often may be rehabilitated by reconfiguring well construction and reducing pump capacity. Reduction in well performance may be due to: 1) the length of time required for equilibrium between pumping rate and flow lines orientation to come about; 2) clogging of screen openings by calcium carbonate precipitation, or rearrangement of particles, including the gravel pack, at the screen interface; and 3) general failure of well construction including loss of gravel pack and collapse of the casing.

For cases where equilibrium is slowly achieved, ending in higher than acceptable chloride content, the depth of penetration of the well by back-filling with grout is a possible remedy. Where clogging is the obvious problem, acidizing the screen to dissolve calcium carbonate precipitate is the usual corrective method. The standard screen is made of stainless steel, which resists corrosion.

For wells that lose efficiency or yield brackish water as a result of general failure, abandonment and replacement with a new well is often a better resolution than attempting to rescue the failed well.

As noted earlier, the standard well capacity (200 gpm) is not suitable for all hydrogeological environments in northern Guam. When a pump fails and must be replaced, the record of well behavior should be studied before deciding on replacement capacity. In fact, upon pulling a pump the well should be sounded and the casing and screen observed by means of a TV scan to ascertain whether acidizing and other actions are justified.

The range of permissible pump capacities in northern Guam is not great, and an effort should be made to have several sizes in inventory. At the high end a 700 gpm pump in a parabasal

aquifer may work, but these instances are likely to be too few to justify an inventory of extra large pumps. At the low end, however, the specification of a 100 gpm pump is likely to be frequent enough to mandate an inventory. The 200 gpm pump will continue to be the most common capacity adaptable to a wide range of conditions.

The failure of a well by no means implies the collapse in the ability of an aquifer to yield good water in reasonable amounts. The behavior of an individual well is dominated by local conditions whereas the behavior of an aquifer is a regional phenomenon. A single well in the center of a brightly productive aquifer may pump excessive salinity water if local variability promotes flow lines to travel vertically from the transition zone to the well bore, even or adjacent wells produce low salinity water. Well D-13 in the Dededo well field is a good example of this phenomenon; evidently the local permeability favors vertical movement of groundwater, perhaps by way of fractures that are not present at the other D-series wells.

Because of the dominance of local aquifer features in such a heterogeneous medium as fossil reef limestone, each well must be judged by its own performance. Adjustments are made, if needed, on this basis. Even in areas where salinity is presumed to be high because of proximity to the coast, properly designed low capacity wells often produce potable water.

ALTERNATIVE METHODS OF GROUNDWATER PRODUCTION

Except for groundwater production from the USAF Tumon Tunnel and the capture of Asan Spring flow, all potable water in Northern Guam is extracted by means of drilled wells. Asan Spring yields perched groundwater from an isolated limestone aquifer resting on volcanic rock and is not part of the Northern Guam aquifer systems. At one time several basal groundwater exposures in limestone sink holes near Tarague were tapped by the USAF. Janum and Campanaya Springs, also exposures of basal groundwater on the coastal shelf, were used by local residents. The US Navy for many years obtained a supply from parabasal groundwater springs at the margin of Agana Marsh. When the success of drilled wells was proved, spring capture was abandoned.

Basal and parabasal springs, however, are a potential source of potable water. Janum Spring in the Pagat Aquifer System has a flow estimated at 1 to 2 mgd of low salinity water. An exploratory boring was once drilled inland of the spring in an attempt to intercept groundwater but encountered the volcanic basement above sea level. The Camapanaya basal spring at the boundary of the Sasajyan and Pagat Systems was used by the Japanese occupation forces but yielded water having about 600 mg/l chloride. Better development techniques might improve output. Tarague Spring reliably provided groundwater with 300 to 350 mg/l chloride, higher than the recommended limit but indicative of an opportunity to obtain a lower salinity supply by using better techniques of withdrawal.

All of the coast of Northern Guam can be regarded as a continuum of basal springs because the lens discharges virtually at the coastline. The springs are exposures of groundwater in sink holes and caves. Where groundwater flux is strong, the "springs" yield low chloride water.

Basal groundwater springs can be created by constructing infiltration galleries. An infiltration gallery consists of tunnels and cavities excavated at about sea level. Fresh water drains into the galleries, then flows to a sump from where it is pumped. A large tunnel surface below the water table allows drainage of low salinity water from the fresh water core of the lens. The premier example of this concept, and the only infiltration gallery in use today, is the Air Force Tumon Tunnel. Its success depends on location at the terminus of the Yigo Trough where the undeveloped flux of groundwater is strong as it moves to discharge at the coast. The other infiltration gallery, the ACEORP Tunnel, is located in the Barrigada Aquifer System but is not used because of the unacceptable salinity of its pumped water. The groundwater flux passing the collection gallery is far inferior to that in the Yigo Trough.

Infiltration galleries are expensive to construct and the risk of failure is significant. They are restricted in location to coastal areas because even at short distances inland the ground surface becomes too high to permit excavation to sea level unless a deep shaft is dug. Of the few locations in Northern Guam where a successful infiltration gallery can be constructed, the most favorable is in the coastal terrace on the south side of the Tumon Aquifer System.

One more potential groundwater collecting system has merit. The Agana Marsh is sustained by groundwater from the parabasal aquifers of the Ordot Aquifer System and the basal groundwater of the Mongmong System. The parabasal groundwater was at one time developed by the US Navy at Agana Spring. Behind the Spring, drilled wells have been located to intercept a portion of the water that naturally drains to the marsh. Additional groundwater on both the parabasal (Ordot) side and the basal (Mongmong) side may be developable by means of drainage collectors.

PROPOSED WELL DEVELOPMENT PRIORITIES

The unused sustainable yield of the aquifers of northern Guam accessible by PUAG totals 35 mgd. This value is an estimate founded on the analyses discussed in the main body of the report which take into account the response of the aquifers to operation over the last decade, simulation and prediction of groundwater behavior by modeling, and TDEM surveys in some regions. Not all of the 35 mgd will be easy to develop. A portion may elude cost effectiveness and its capture may never come about. However, additional groundwater can be safely produced in the first priority increment of about 10 mgd and in the second increment, 5 mgd. When this total of 15 mgd is on line, another priority list can be established. The development of the first 15 mgd will determine the next set of priorities.

In the following table additional production is recommended by Aquifer Systems. The first priority increment includes 2 mgd from the Agafo Gumas system in the Tarague Sector; 2 mgd from the Yigo System and 1.5 mgd from the Tumon System in the Yigo-Tumon Sector; 2 mgd from the Gugagon system in the Finegayan Sector; and 2 mgd from the Ordot System in the Agana Sector. The second priority increment includes production from the Mt. Santa Rosa System in the Pati Sector, the Sasajyan System in the Mangilao Sector, the Huychunao System in the Fadian Sector and the Mongmong System in the Agana Sector. Details are listed in Table 5-1. Both first and second priority well fields are shown in Figure 5-1 at the end of this report.

TABLE 5-1
PRIORITY DEVELOPMENT BY AQUIFER SYSTEMS

Sector	System	Unused SY (mgd)	Add (mgd)	Aq. Type	Well (gpm)	No. Wells
Priority 1						
Tarague	Agafo Gumas	4.5	2.0	PB	300	5
Yigo-Tumon	Yigo	3.6	2.0	PB/B	300	5
Yigo-Tumon	Tumon	3.6	2.0	B	200	5
Finegayan	Gugagon	4.8	2.0	PB/B	200	7
Agana	Ordot	4.1	2.0	PB	250	6
			9.5			**28**
Priority 2						
Pati	Mt. Santa Rosa	2.3	1.0	PB/B	200	4
Mangilao	Sasajyan	1.5	0.5	PB/B	150	2
Fadian	Huchunao	4.0	2.0	B	150	10
Agana	Mongmong	2.8	1.0	B	150	5
			4.5			21
TOTAL			**14.0**			**49**

Notes
Col. 4 (Add mgd): Recommended additional development.
Col. 5 (Aq. Type): PB = parabasal; B = basal.
Col. 6 (Well gpm): Estimated well capacity for the aquifer type. Actual installed capacity will depend on pump testing.

APPENDIX A

Hydrologic Budgets

Sustainable Yield by Steady State Model

HYDROLOGIC BUDGET FOR NORTHERN GUAM

The goal of hydrologic budgeting is to determine a mass balance among input and output variables in the hydrologic cycle. Input variables include rainfall along with other atmospheric moisture sources, and fluxes across boundaries in the region of interest. These fluxes are surface water and groundwater. Output variables consist of direct surface runoff, evapotranspiration from vegetation, and deep percolation. Rainfall and runoff are often known to some degree of accuracy as a result of measurements. Evapotranspiration is approximated from theoretical and empirical models, and infiltration is normally solved for as the unknown variable that closes the balance equation.

Islands, with their finite terminal boundaries, are good candidates for computing hydrologic budgets on a global scale because input flows across boundaries are absent, leaving atmospheric moisture as the sole input parameter. In the case of Guam, the only atmospheric moisture component of significance is rainfall.

Guam is really composed of two different islands sutured together along a geological contact extending from Pago Bay to Agana. Each unit is about 100 square miles in area, and because of geology each may be treated as a separate global entity. In the north are the great, highly permeable limestone aquifers that are the principal sources of water supply for the whole island, while the south is dominated by poorly permeable volcanics for which the most voluminous output variable is streamflow.

Groundwater resources in the south constitute only a small fraction of the island's developable water supply, but stream flow is large. Good records of rainfall and stream flow measurements are available from which hydrological principles applicable to the whole island can be extracted. In computing hydrologic budgets, the input variable rainfall and the output variable evapotranspiration are about the same for North and South Guam, but the output variables of surface runoff and groundwater flux are vastly different.

GLOBAL HYDROLOGIC BUDGET OF NORTHERN GUAM

Hydrological mass balances for Northern Guam have been proposed by numerous investigators employing a variety of methods. The balances were attempted in order to calculate the infiltration component because in the north the only developable water resource is groundwater. In 1937, H.T. Stearns, the first to attempt a hydrologic budget, suggested that 50 to 100 mgd of groundwater could be extracted from the north (H.T. Stearns, 1937, Geology and Water Resources of the Island of Guam, Mariana Islands: Manuscript Report to U.S. Navy). Shortly after World War II a U.S. Geological Survey report concluded that 15 mgd was safely developable (Ward, P.E., Hoffard, S.H., and Davis, D.A., 1965, Hydrology of Guam, U.S. Geological Survey Professional Paper 403-H).

In a study completed in 1976 for PUAG, two hydrologic budgets were calculated, one employing evaporation as the equivalent of evapotranspiration and the other deducing evapotranspiration from the water budget for Southern Guam (Mink, J.F., 1976, Groundwater Resources of Guam: Occurrence and Development: Univ. Guam Water Resources Research Center Tech. Report 1). In the *Northern Guam Lens Study (NGLS)* (1982) a budget was derived based on a theoretical determination of evapotranspiration, and as part of the study the Water, Energy Research Institute (WERI) of the University of Guam produced a partial budget in which infiltration was computed by relating the gain in salinity in groundwater to salinity in rainfall and attributing the difference to the effects of evapotranspiration.

Each method is an approximation based on assumptions combined with a body of measured data for rainfall, pan evaporation and stream flow. The unknowns in every case are evapotranspiration and infiltration. Runoff from the northern limestones is very small and is either ignored or assigned a small value. Because groundwater is the sole resource of interest, equations are solved to yield infiltration.

The fundamental balance equation for Northern Guam is:

$$P = R + ET + I$$

in which P is average rainfall, the only input variable; R is runoff, which is close to zero because of the high infiltrability of the limestone terrain; ET is evapotranspiration, or loss of moisture to the atmosphere; and I is infiltration to groundwater. This equation is for the steady state in which input is equal to output. The change in volume of groundwater does not enter the equation until groundwater withdrawals by artificial means take place.

Rearranged to solve for I the equation is:

$$I = P - R - ET$$

P is known from rain gage records, R is either ignored or taken as 5% of P, and ET is estimated by various methods. The solution for I is singularly dependent on the value assigned to ET. The differences in computed values of I among different investigators are a result of the value given to ET by each.

Table 1 is a summary of attempts to create a global hydrologic budget for Northern Guam. The budgets taken from Mink (1976) uses a total limestone area for Northern Guam of 94.6 square miles, which is virtually the entire north half of the island. The *NGLS* (1982) budget refers to only 67.24 square miles, which is the area where it was assumed that potable water is developable. Information obtained on the Lens since the *NGLS* indicates that this restriction of area understates total input. The alternate balances were recomputed from the Mink budgets by altering some parameters and employing the total area of Northern Guam (100.3 square miles), or the area inland of a zone 0.5 miles in width from the coast, leaving an input area of 80.1 square miles.

The Mink budgets are developed and explained in detail in the 1976 report. The minimum budgets assume the most conservative conditions wherein evapotranspiration is assumed to be equivalent to pan evaporation. This, of course, is not realistic because moisture is not constantly available to plants. Much of the wet season rainfall quickly transits the thin soil to infiltrate rapidly while in the dry season insufficient rain falls to support potential evapotranspiration.

TABLE 1
NORTHERN GUAM HYDROLOGIC BUDGETS

Budget	Area (sq.mi.)	P (in/yr)	ET (in/yr)	R (in/yr)	I (mgd)
Minimum (Mink)	94.6	94.7	67.4	0	129
Minimum (Mink)	94.6	94.7	66.9	4.7	109
Probable (Mink)	94.6	94.7	42.8	0	232
Probable (Mink)	94.6	94.7	42.5	4.7	212
NGLS	67.2	94.0	59		112
Alternate 1	100.3	90.0	45	0	215
Alternate 2	100.3	90.0	45	4.5	193
Alternate 3	80.1	90.0	45	0	172
Alternate 4	80.1	90.0	45	4.5	155

Notes:
P = average annual rainfall
ET = average annual evapotranspiration
R = average annual surface runoff
I = average annual infiltration to groundwater

One of the minimum budgets assumes no runoff and the other allows for 5 percent runoff. The computed values of infiltration (129 and 109 mgd, respectively) are understated because of the excessive value assigned to evapotranspiration (67.4 in./yr.)

The "probable" budgets are a considerable improvement on the minimum budgets and are the most accurate of the postulated budgets because of the straightforward methodology employed. The balance takes advantage of the excellent USGS stream gage data for Southern Guam where 61.6 percent of rainfall leaves the land as stream flow. The stream flow is predominantly direct overland flow (about 85 percent) with the remainder derived from groundwater seepage. It is a fair assumption to equate the ratio of runoff to rainfall in the south to infiltration to rainfall in the north, leaving the balance of rain for evapotranspiration. This assumption is reasonable because only a very small quantity of groundwater escapes from the low permeability volcanic aquifers directly into the sea as seepage. Otherwise all of the output from the volcanic drainage basin is known because stream flow is accurately measured and evapotranspiration is the difference between rainfall and runoff.

The calculated evapotranspiration in the probable budget is 42.79 in./yr. This amount is consistent with values commonly assigned to humid tropical areas where average annual rainfall exceeds 60 inches (L.A. Bruijnzeel, 1990, Hydrology of Moist Tropical Forests and Effects of Conversion: A State of Knowledge Review: UNESCO Hydrology Program).

Infiltration in Northern Guam for the probable budget is 232 mgd when no allowance is made for loss by surface runoff, and 212 mgd when runoff is taken as 5 percent of the rain. These values refer to a total area of 94.6 square miles.

The *NGLS* budget limits the infiltration intake area to 67 square miles, only two thirds of the total area of Northern Guam, and assigns an evapotranspiration rate of 59 inches per year. This rate is theoretical and is calculated by the Blaney-Criddle method. Both assumptions are very conservative and restrict the estimate of infiltration to only 112 mgd. Adjusted for the entire area of Northern Guam the comparable infiltration would be 167 mgd. It will become clear later why the entire area of intake must be considered when deriving estimates of yield based on

groundwater flow hydraulics. Knowledge of the Lens obtained from monitoring wells not available at the time of the *NGLS* indicates that the aquifers are hydraulically continuous from the coast inland to their termination by the volcanic basement. The allowable rate of groundwater withdrawal depends on an equilibrium head which preserves the integrity of the resource. Head is therefore governed by input over the entire area of the aquifer, not just the area declared suitable for potable water development.

The evapotranspiration value used in the *NGLS* budget is high, about 88 percent of the pan evaporation rate employed in the "minimum" budget and 16 inches greater than the annual average used in the "probable" budget. The high evapotranspiration value was supported by the calculation for infiltration based on salinity of rain water and groundwater, but this calculation ignores the dry salt deposited on the surface of the ground which becomes entrained in the water that percolates through the soil to add another increment of salt to the groundwater.

The two alternate budgets essentially are recalculations of the "probable" budget substituting areas of either 100 square miles, the whole of Northern Guam, or 80 square miles, the envelope of land lying 0.5 miles inland of the coast. Evapotranspiration was assigned a value of 45 inches per year, slightly higher than the 43 inches in the "probable" budget. Calculated infiltration ranges from a low of 155 mgd for the 80 square miles area and 5 percent runoff to 215 mgd for 100 square miles and zero runoff.

SUMMARY OF GLOBAL HYDROLOGIC BUDGETS

In the budgets discussed above, calculated infiltration rates range from 109 mgd to 232 mgd for Northern Guam. The 109 mgd is from Mink's "minimum" budget and is similar to the conservative estimate of 112 mgd given in the *NGLS* report. Both are unreasonably low and reflect the limited data on the Lens's behavior available at the time.

More reasonable values fall in the range 155 mgd to about 215 mgd. For purposes of deriving sustainable yields, infiltration is given a low value of 175 mgd and a high value of 200 mgd. Note that sustainable yield is not equal to infiltration; it is only a fraction of it, and for the basal aquifers of Northern Guam this fraction is no more than about one third.

SUSTAINABLE YIELD

The hydrologic balances summarized above include very large values as groundwater recharge. Only a fraction of the infiltration, however, is developable as sustainable yield. In fact, for the Northern Guam aquifer system on a global scale, just 30 to 40 percent of the input is safely developable as potable water.

Sustainable yield is defined as "the average rate at which groundwater may be continuously pumped without diminishing either the quality or quantity of the pumped water." To achieve the hypothetically available sustainable yield, the means of withdrawal must be optimal. For most groundwater supply systems, production methods are sub-optimal and therefore the full value of sustainable yield is not available. These systems can be upgraded through re-development and by the careful location and design of new production units.

The sustainable yields discussed here are restricted to potable water pumpage. The production of additional non-potable but agriculturally acceptable water down gradient of the potable extraction units is permissible to some extent. Also, the sustainable yields are for basal water conditions where salinity is the major hazard accompanying over production. This constraint is necessary because eventually most of the groundwater in Northern Guam enters a basal lens before discharging along the sea coast, and the basal lenses are the most voluminous sources of groundwater.

Sustainable yield refers to the steady state condition when pumpage is in equilibrium with recharge, head, and leakage out of the system. To complete the argument, the initial system head is required. The relationship is expressed as (Mink, J.F., Chang, J.C., and Yuen, G.A., 1988, Review and Re-Evaluation of Groundwater Conditions in the Pearl Harbor Groundwater Control Area, Oahu, Hawaii: State of Hawaii Commission on Water Resources Management, Report R-78):

$$SY = I \{1 - [h(e)/h(o)]^2\}$$

in which SY is sustainable yield, I is infiltration, h(e) is equilibrium head for the groundwater system and h(o) is the initial pre-development head. In the above, sustainable yield is treated as a global variable, that is, it refers to an entire aquifer system. In the determination of sustainable yield that follows, the limestone aquifers of Northern Guam are considered a single, hydraulically connected entity.

Sustainable yield refers to production averaged over a time interval whose permissible length depends on the volume of groundwater in the aquifer system and the rate of replenishment to the system. If the volume is large and the replenishment high, wide swings in production rate are allowable over extended periods to make the average. In small groundwater systems, both the time interval of averaging and the range of pumping must be more tightly controlled.

Aquifer volume and replenishment rates in Northern Guam are substantial and thus averaging is allowable over relatively long periods of time. Total pumpage may also vary within a wide range. For example, if global sustainable yield is selected as 60 mgd, pumpage at a rate of 90 mgd for several months followed by pumpage at 30 mgd for an equal time may be permissible, so long as the average calculates to be 60 mgd. Optimal operation, however, would seek to stay as close to the average as possible.

In the steady state sustainable yield equation, values must be assigned for the initial head and the recharge rate, and an equilibrium head must be selected that will prevent degradation by salinity of the pumped water. The recharge rate is taken from hydrologic balance calculations, while the value for initial head must be extracted either from historical data or approximated. The choice of equilibrium head is somewhat arbitrary but needs to be guided by familiarity with the groundwater systems and by reference to analogous conditions elsewhere. This approach to sustainable yield, although constrained by assumptions, is far more quantitative than designating allowable draft as a fraction of infiltration rate.

The sets of values employed in the steady state equation from which the most probable range of sustainable yields could be chosen are as follows:

h(o): 3.5 ft.; 3.25 ft.; 3.0 ft.

h(e): 2.75 ft.; 2.5 ft.

I: 125 mgd; 150 mgd; 175 mgd; 200 mgd.

For infiltration values of 125 and 150 mgd, the sustainable yields are too small to be reasonable unless the equilibrium head goes to 2.0 ft. The best fit is for infiltration of 175 to 200 mgd, which is the probable range determined by hydrologic budgeting.

For infiltration of 175 mgd, the sustainable yield range is:

55 mgd < SY < 75 mgd

average 65 mgd

and for infiltration of 200 mgd,

60 mgd < SY < 80 mgd

average 70 mgd.

The calculations can be summarized as follows:

TABLE 2
SUSTAINABLE YIELDS AND EQUILIBRIUM HEADS

I (mgd)	SY (mgd)	h(o) = 3.5 h(e) ft.	h(o) = 3.25 h(e) ft.	h(o) = 3.0 h(e) ft.
175	70	2.7	2.5	2.3
175	65	2.8	2.6	2.4
200	70	2.8	2.6	2.4
200	65	2.9	2.7	2.5

The initial heads used in the calculations refer not to known maximum basal heads but to heads generally characteristic of basal groundwater far enough inland to yield potable water. Head varies seasonally by an average of about 0.3 to 0.5 feet in the clean limestone aquifers north of Agana Marsh so it is difficult to select an exact initial head. However, historical heads before the groundwater development of the last 15 years indicate that a reliable initial value is greater than 3.25 feet but less than 4.0 feet. An initial head of 3.5 feet is therefore a reasonable choice.

For sustainable yields of 65 to 70 mgd, regional equilibrium head will decay to 2.7 to 2.9 feet. These heads are high enough to support production of potable water from the basal lens using current methods (i.e., generally 200 gpm wells).

The sustainable yield values above refer to steady state conditions which come about when the groundwater system is in equilibrium with infiltration, head, draft and leakage. A long period of transient decay from the initial head takes place before equilibrium is achieved. The decay stage persists for many years. Equations of transient behavior are considerably more complicated than for the steady state, but tracking head change as a function of draft and time can be performed with a computer model.

Graphs of the average monthly heads recorded at various PUAG wells are presented in Figures 1 through 8 at the end of this appendix. The record of head change at the monitor wells since the end of the *NGLS* investigation in 1982 does not manifest a significant decay in head at the total pumping rate of 20 to 30 mgd. Illustrations of the stability of heads in basal lenses in clean limestone are graphs of average monthly heads for the period 1984 through 1988 (Figures 1 through 5). The most complete records are for 1985 and 1988.

Heads rise quickly in response to prolonged and heavy rainfall because infiltration temporarily accumulates at the top of the water table. This effect is particularly noticeable in the argillaceous limestone parabasal aquifer in the Chaot-Ordot region (Figure 6). The effect is less pronounced in the argillaceous limestone basal aquifer (Figures 7 and 8), and even less dramatic in the aquifers of clean limestone (Figures 1 through 5).

The graphs for clean limestone aquifer monitor wells EX-6 (Macheche), EX-7 (Wettengell), EX-8 (Northwest Field), EX-9 (Barrigada and EX-10 (Finegayan) show that heads during 1985 were lower than during 1988 by about 0.2 feet. This implies that there has not been a steady decline in head since 1984 as a result of pumping. The average heads for 1988 may be considered as equilibrium heads at the current rate of draft.

SUMMARY

The steady state model was the first model employed in an effort to quantitatively establish sustainable yields because of its simplicity. The steady state model lumps seasonal changes in recharge into the annual average, thus missing the cycle of head change from dry to wet to dry season. Subsequently a transient model was composed in which the time unit for averaging is the month, thereby incorporating the effects of seasonal recharge and outflow on the basal and parabasal resources. The transient model is discussed in the main text as well as Appendix B and recommended sustainable yields are taken from this model.

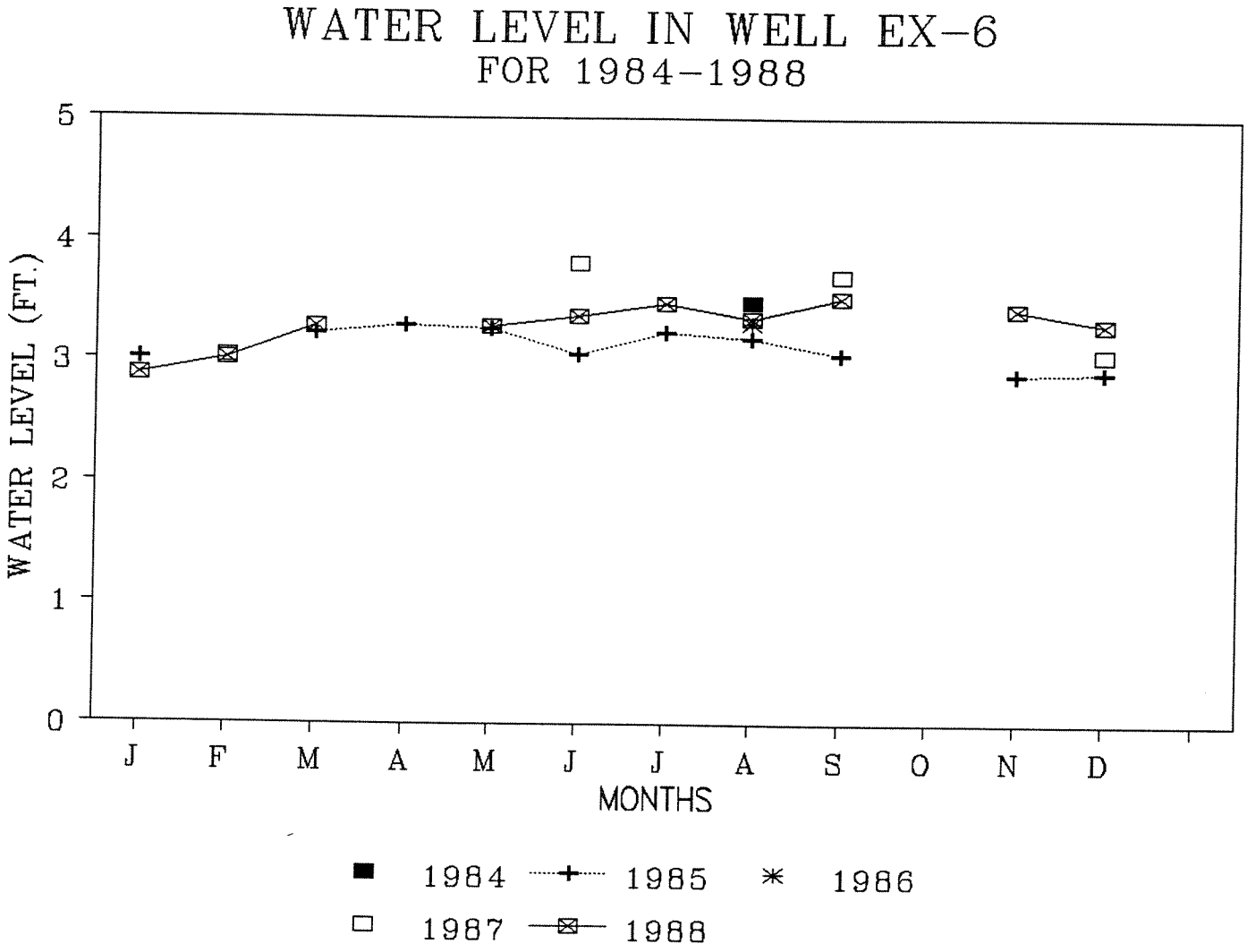


Figure 1
Average Monthly
Groundwater Elevations
Well EX-6

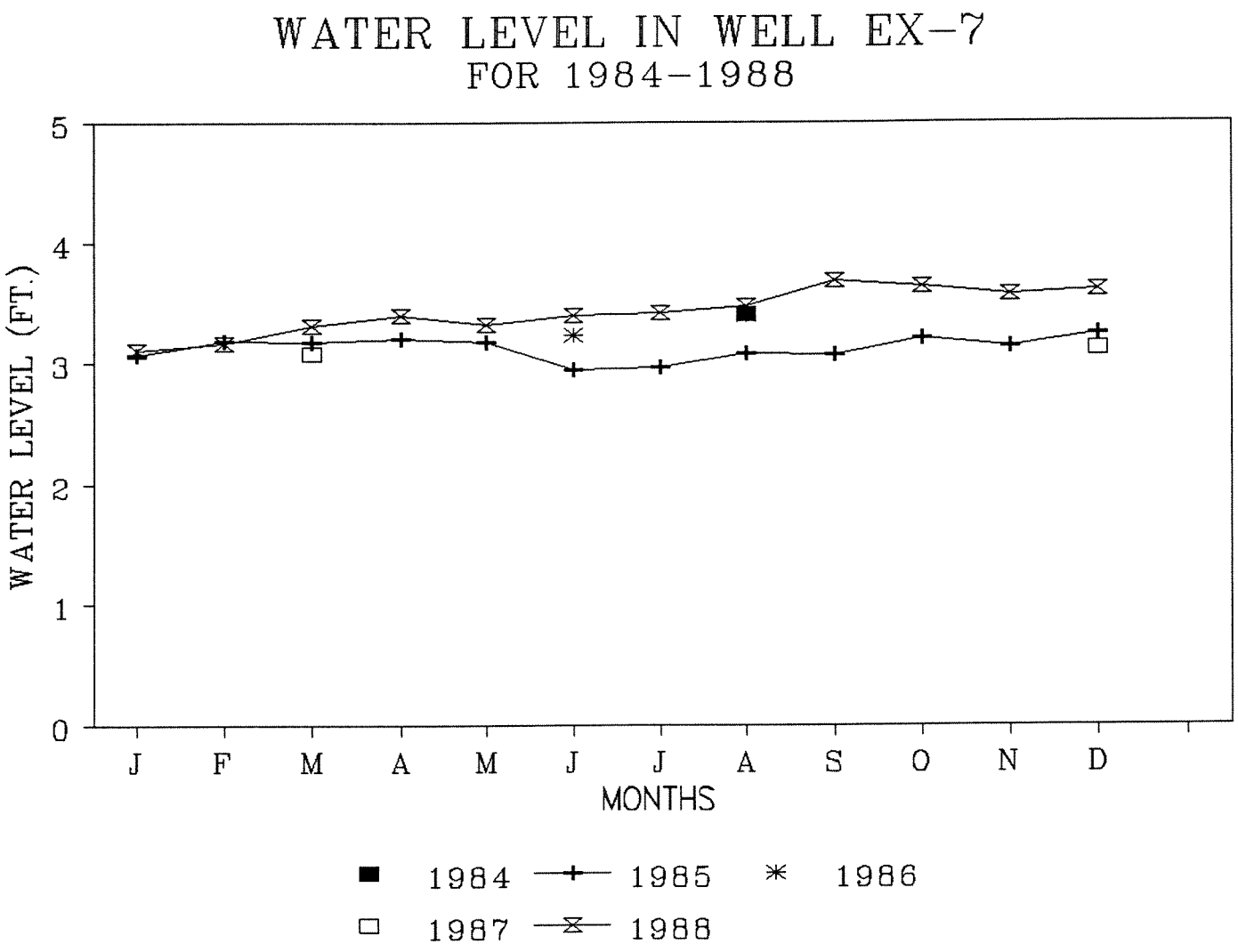


Figure 2
Average Monthly
Groundwater Elevations
Well EX-7

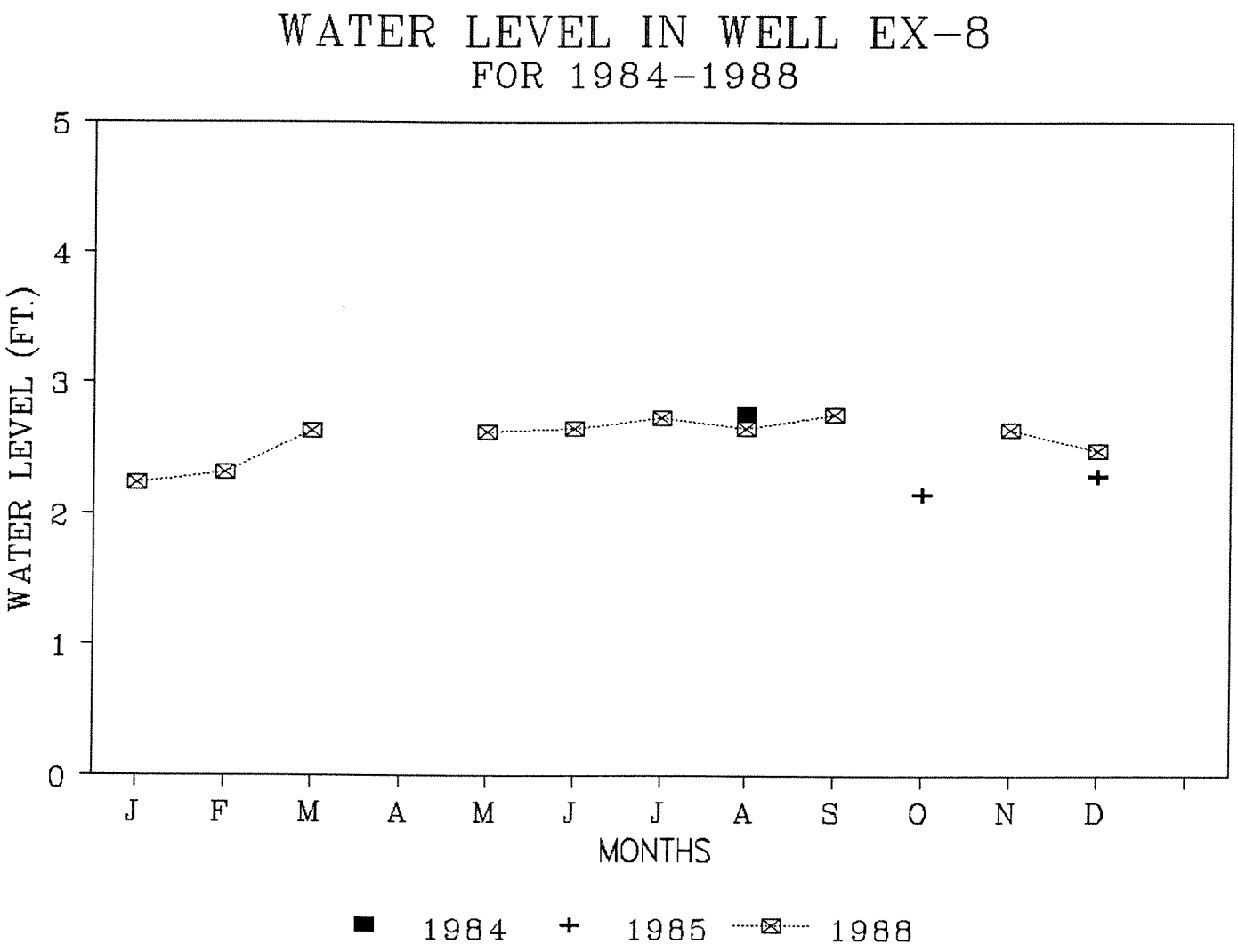


Figure 3
Average Monthly
Groundwater Elevations
Well EX-8

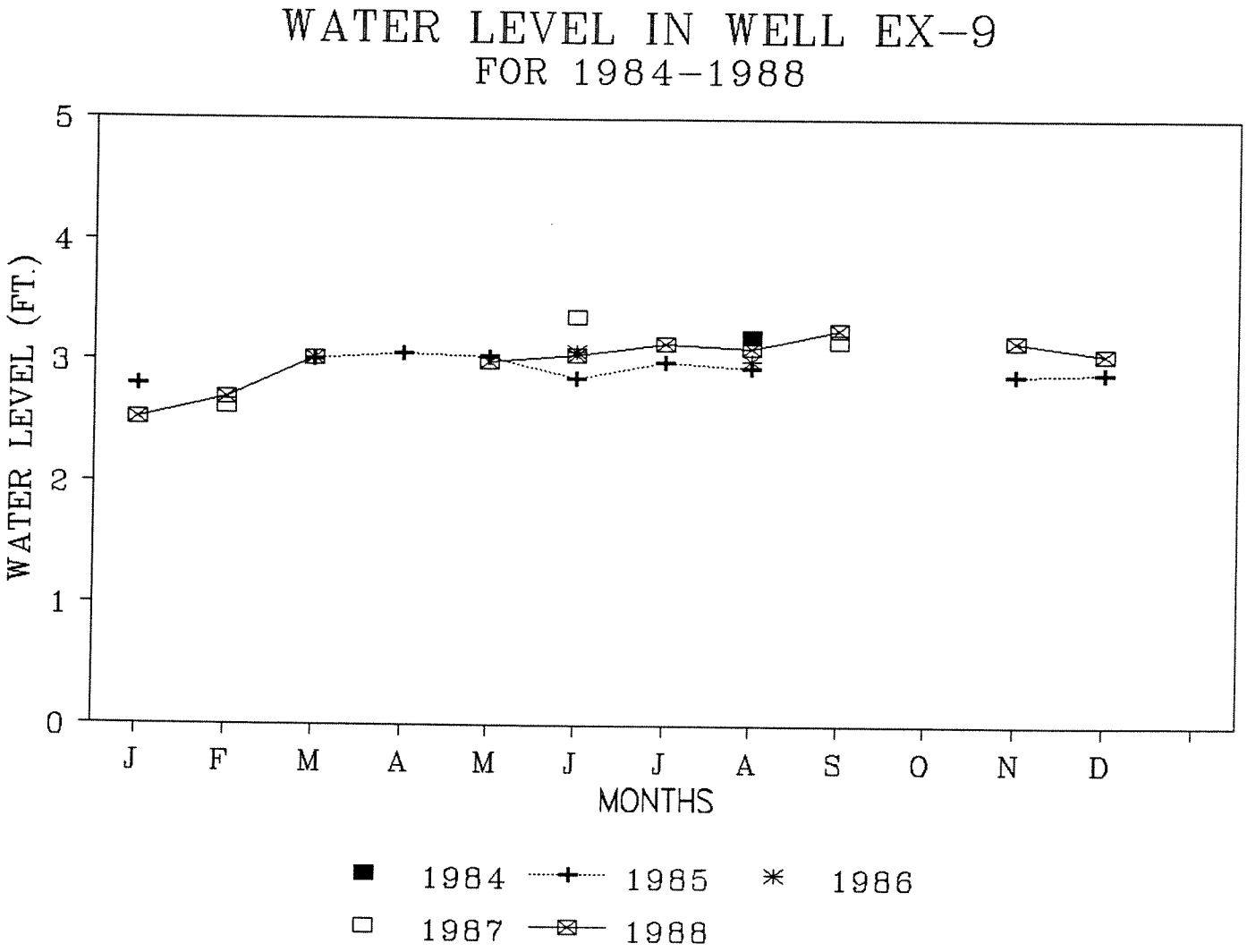


Figure 4
Average Monthly
Groundwater Elevations
Well EX-9

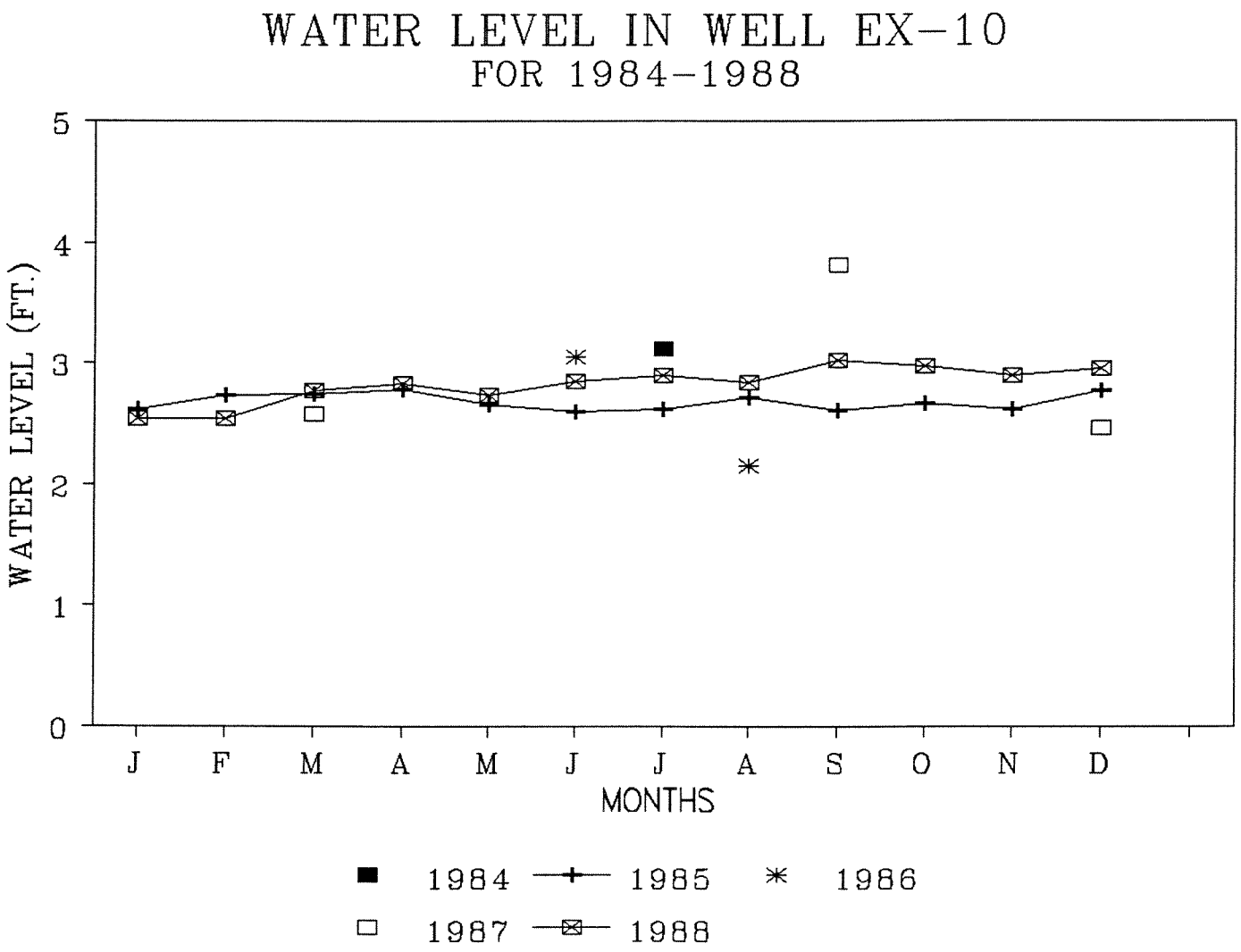


Figure 5
Average Monthly
Groundwater Elevations
Well EX-10

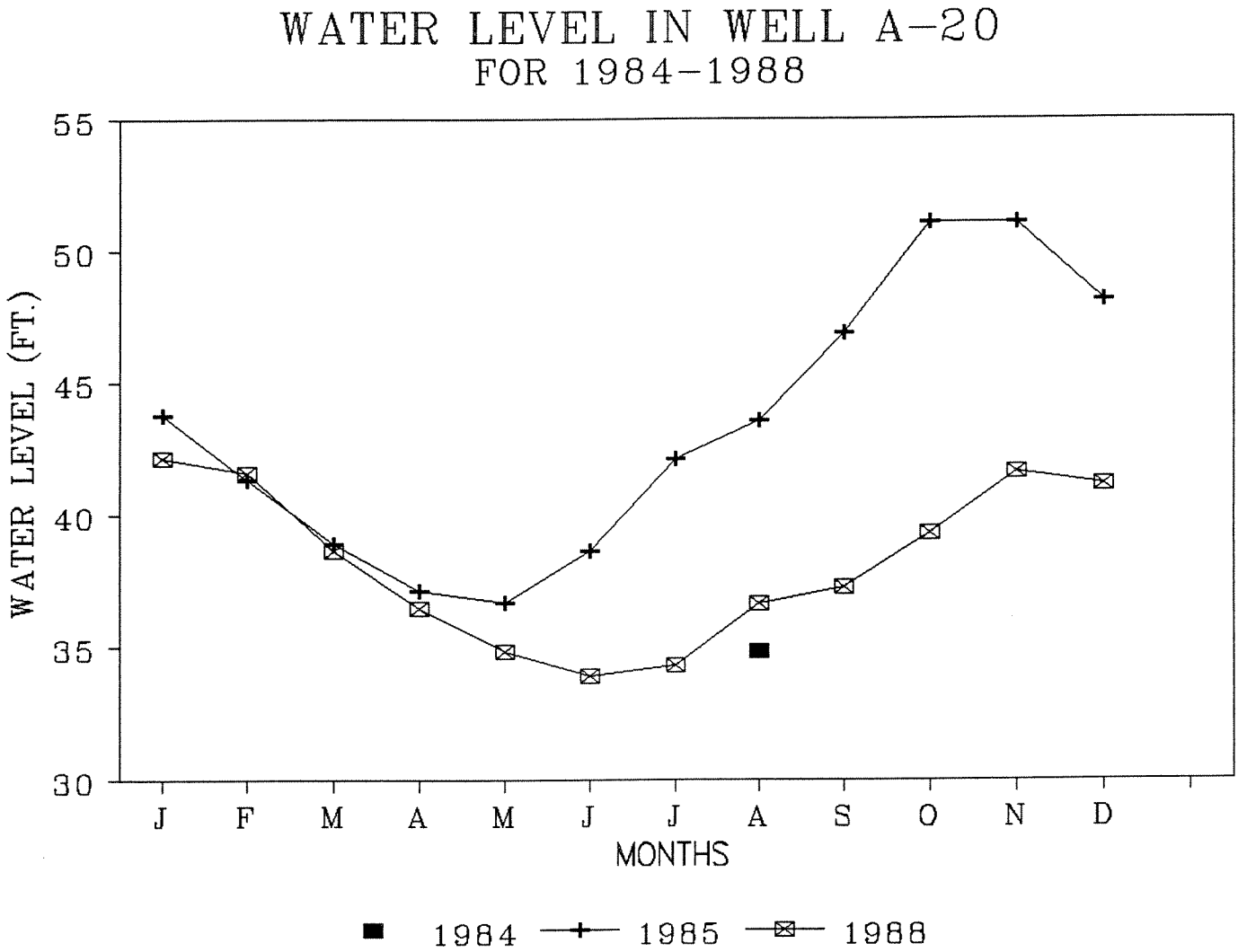


Figure 6
Average Monthly
Groundwater Elevations
Well A-20

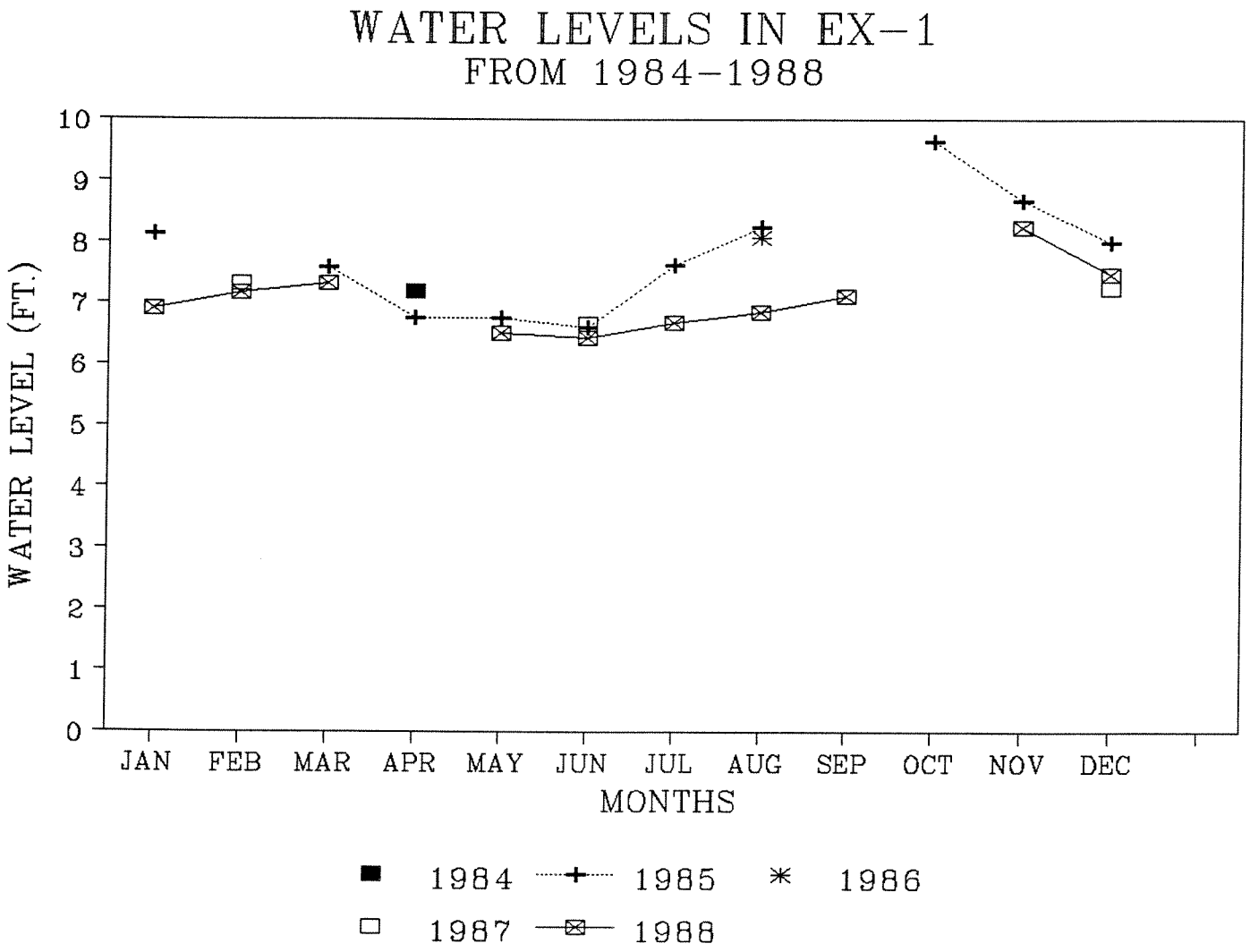


Figure 7
Average Monthly
Groundwater Elevations
Well EX-1

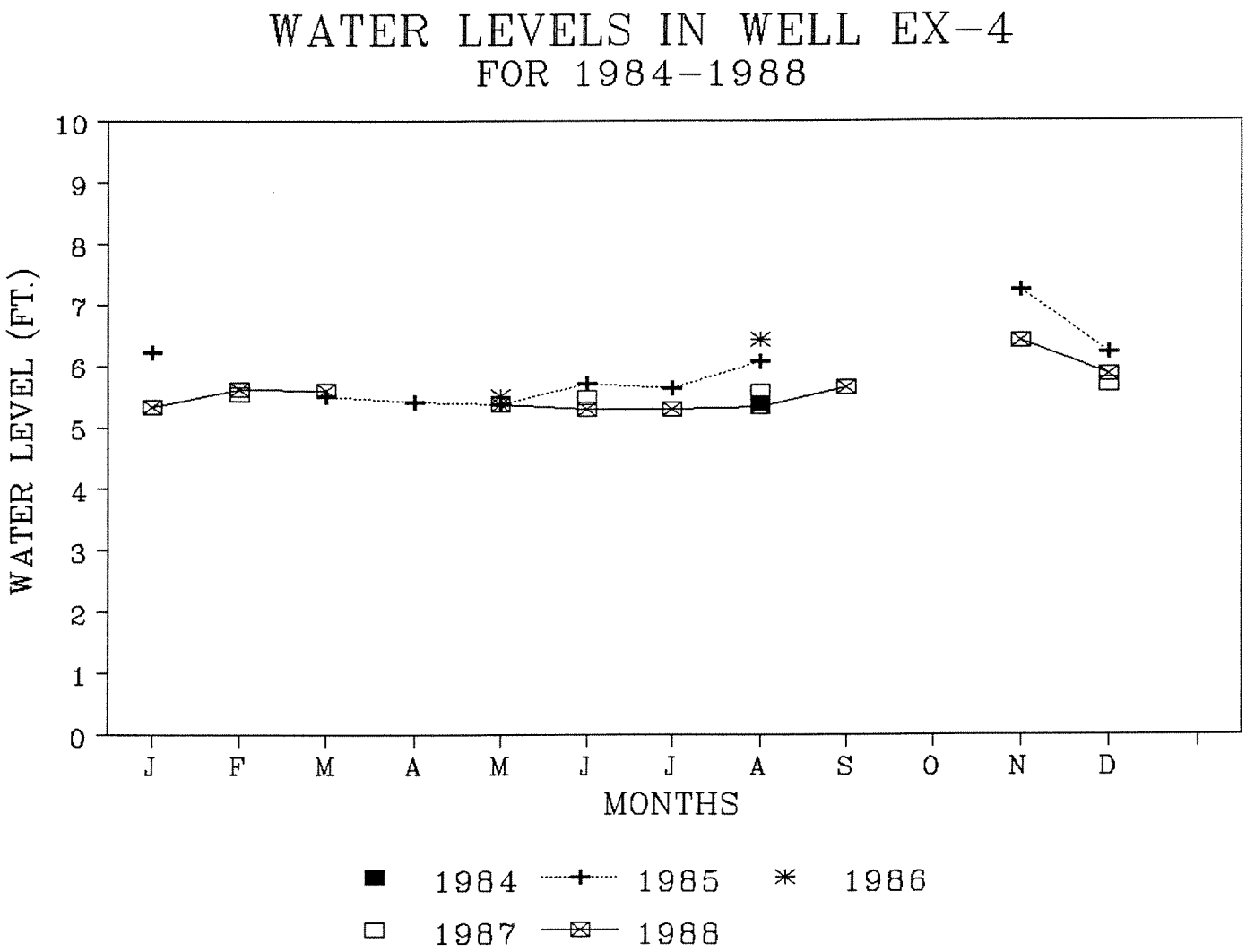


Figure 8
Average Monthly
Groundwater Elevations
Well EX-4

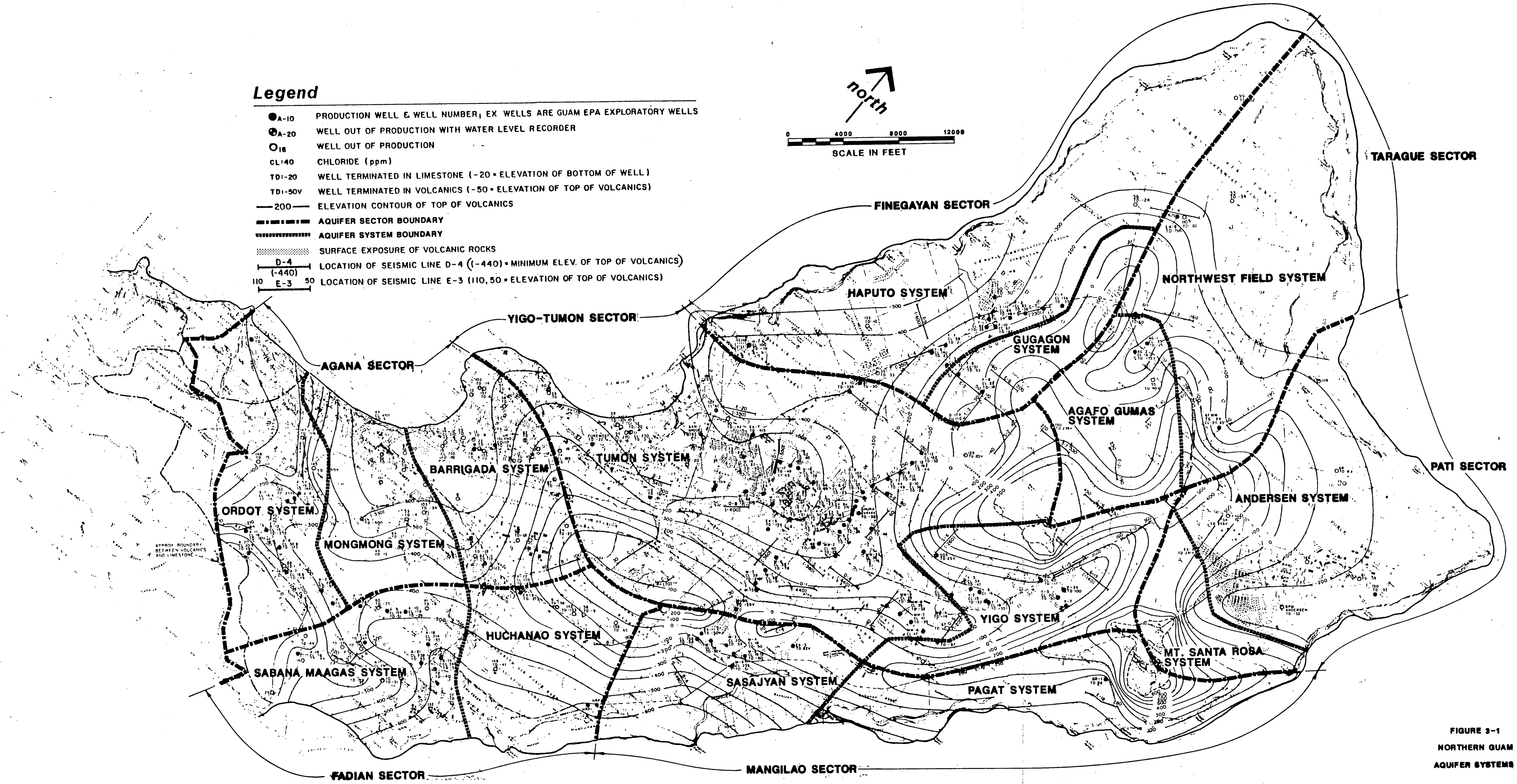


FIGURE 3-1
NORTHERN GUAM
AQUIFER SYSTEMS

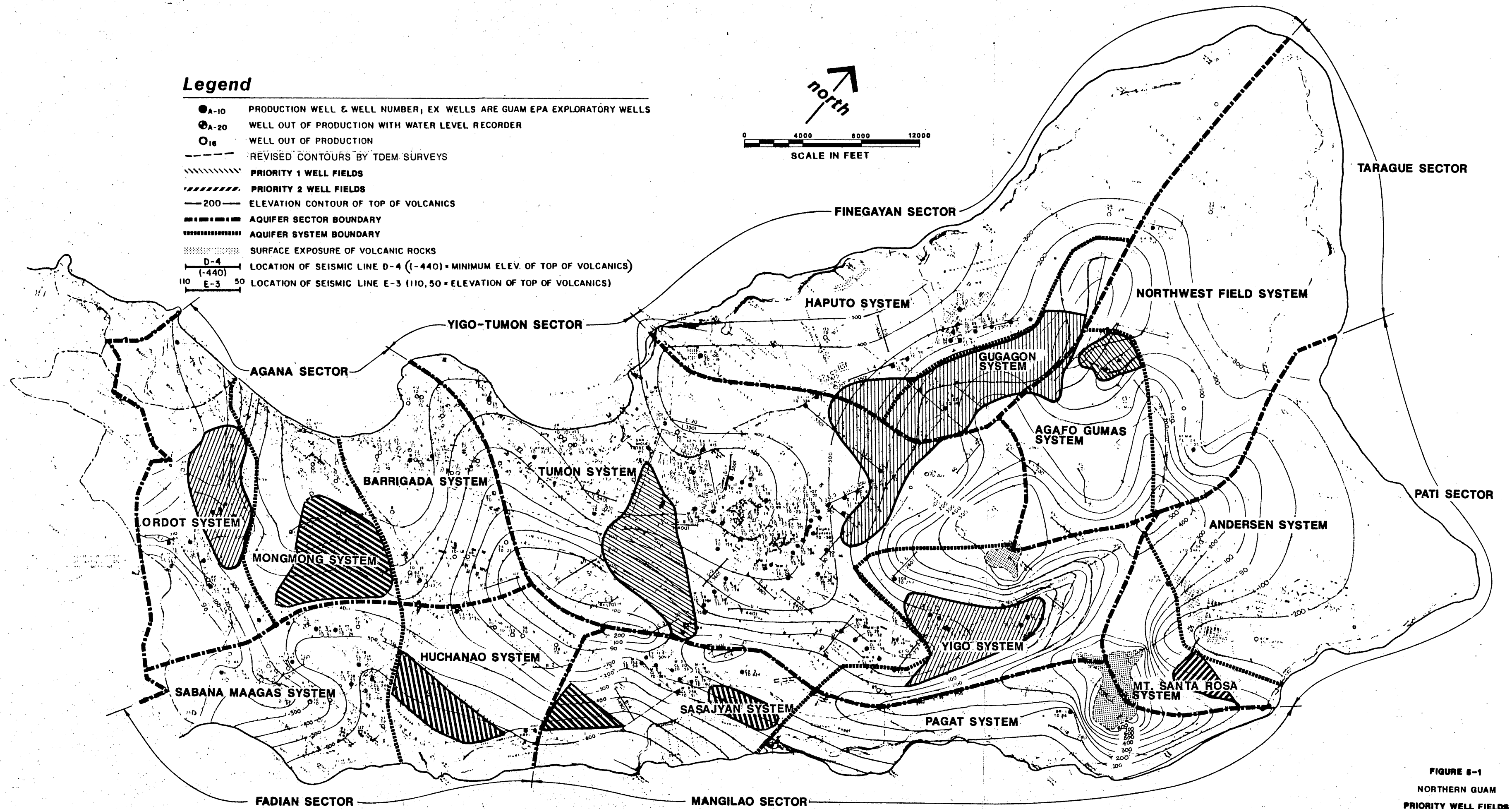


FIGURE 5-1
NORTHERN GUAM
PRIORITY WELL FIELDS

APPENDIX B

Sustainable Yield, Transient Model

SUSTAINABLE YIELD, TRANSIENT MODEL

Groundwater systems behave in complex ways that are difficult, if not impossible, to effectively describe in a classical analytical mathematical framework unless great simplifications are made. These simplifications, such as assigning well posed boundary conditions and linearizing the equations of groundwater flow, are useful in explaining particular aspects of behavior but generally fail if employed in describing the dynamics of the whole system. The analytical approach falters on the unsolvability of the second order non-linear partial differential equations defining flow in porous media, and on the heterogeneity of aquifer properties which frequently defies averaging.

To overcome the limitations of exact methods of solving the groundwater equations, physical and numerical mathematical models are commonly used. Physical models are highly constrained in simulating real aquifer behavior while numerical models can be made as flexible as computer efficiency allows. Numerical modeling is the preferred technique for explaining and predicting aquifer behavior because it accommodates heterogeneities and non-isotropism to whatever degree is economically acceptable by dividing the aquifer into an array of nodes or cells, each of which may display different properties. Numerical models, however, require a reliable data record of substantial length, which is not often available, for validation.

Several numerical models of Guam aquifers have been devised to help explain past behavior, to identify present status, and to predict future behavior for various development scenarios. The process of composing a model and testing it against the historical record requires a clear description of the groundwater system within a rational framework. The final objective of modeling is to promote optimal development of an aquifer.

GENERAL GROUNDWATER MODEL FOR NORTHERN GUAM

Groundwater movement is defined by hydraulic flow equations, the solutions of which usually require information obtained by composing the whole or portions of a hydrologic balance. The simplest balance consists of equating input and output for the natural, undeveloped condition of

the aquifer. When groundwater is emphasized, infiltration to the saturated zone is computed as the difference between rainfall, where it is the only external source of water, and losses due to evapotranspiration and direct runoff to the sea. Expressed as a balance equation, the relationship is

1. $I = P - DRO - ET$

in which I is infiltration to the aquifer, P is rainfall, DRO is direct surface runoff lost to the sea, and ET is evaporation and transpiration lost to the atmosphere. Under development, the equation is modified chiefly by introducing pumpage as an output and irrigation return as an input. The fundamental equation applies to long term averages, but it can be applied to smaller, discrete time intervals. It may also be transformed to a transient equation by including gain or loss of storage over a time interval, for which the balance equation is

2. $L = P - ET - DRO + (-) dV$

where L is leakage, equal to I at initial conditions (t=0), and dV is change in storage.

A hydrologic balance is important in mathematical modeling because it yields a value for infiltration (recharge), a critical system variable. It also defines the magnitudes of system fluxes and suggests limits to groundwater development. It is usually the first computation attempted, and quits often when carefully constructed is a model of reasonable validity.

Mathematical models are actually hydraulic flow models which combine Darcy's law of flow in porous media with a continuity equation and are subject to the constraints implicit to these laws. Analytical mathematical models provide direct solutions of aquifer behavior but are limited unless simplified because the non-linear equations of complex systems cannot be solved by exact methods. Numerical modeling avoids this handicap by decomposing the governing partial differential equations into an array of algebraic equations whose solutions give an approximate description of flow. Finite difference and finite element are the numerical techniques commonly employed. The results of numerical modeling have to be tested against a historical record to

ascertain the closeness of fit between actual and synthetic behavior before the model can be accepted as a valid representation of reality. If the simulation is good, the model is presumed to be capable of predicting future behavior for different aquifer scenarios.

Sufficient knowledge about and data for the Northern Guam aquifers now exist to justify hydraulic flow models which incorporate the buoyancy relationship of fresh water in contact with underlying sea water (Ghyben-Herzberg condition). It would be desirable, but is not yet practical on a regional scale, to combine a flow model with solute transport to track the dispersion of salt water in the fresh water lens. Important parameters necessary to support solute transport models, such as transverse and longitudinal dispersivities, are virtually impossible to measure directly. Consequently in most models a sharp interface between fresh and salt waters is assumed.

BASIC DARCY-CONTINUITY MODEL FOR THE NORTHERN GUAM AQUIFERS

Sophisticated numerical models for predicting the behavior of the Northern Guam aquifers have been attempted, yet even with an extensive data base and parameter identification, a fresh water—salt water system with two moving boundaries is difficult to simulate. All of the models assume instantaneous balance between the fresh and salt waters in response to removal or addition of water, but the preponderance of field evidence indicates that the top surface of the lens reacts quickly to transient perturbations while the bottom surface lags. This asymmetrical behavior is called the "bottom storage" phenomenon and was first elucidated by C.K. Wentworth in Hawaii fifty years ago.

In view of the uncertainties implicit in modeling a complicated fresh-salt water system, a simple yet exact lumped parameter model that provides global answers to water balances and aquifer behavior is a reasonable tool for management. A general mathematical model which assumes homogeneity and isotropism of the aquifer and changes which are averaged throughout the flow domain can be used to describe and predict global behavior. A model of this type was employed by Mink (1980) in southern Oahu. It relies on analytical solutions of the equations of groundwater flow in Ghyben-Herzberg system, yet is discretized by time intervals.

The model does not take into consideration solute transport but instead assumes a sharp interface between the fresh and sea waters. Although prescribed by limiting assumptions, it is straightforward and gives an exact accounting of water balances. Its applicability is less dependent than a numerical model on validation by simulation because fundamentally it is an analytical mathematical model. Even though it describes global rather than local behavior of an aquifer, it is useful in defining the limits of aquifer yield and in predicting the consequences of different levels of extraction. It is especially useful in aquifers where transmissivity is high, such as the limestone aquifers in Guam, because drawdown cones are shallow and extend great distances from the pumping centers.

The continuity equation for the groundwater balance may be as written as,

$$3. \quad Q\,dt = dV = AS\,dh$$

in which Q is rate of flow; dt is change in time, t; dV is change in volume, V; A is horizontal area of the flow domain; S is specific yield or effective porosity; and dh is change in head, h. For a Ghyben-Herzberg lens the above is written as

$$4. \quad Q\,dt = AS(1+g)\,dh$$

in which g is the Ghyben-Herzberg constant g(f)/g(s)-g(f), where g(f) is the specific gravity of fresh water and g(s) that of salt water.

The flow rate term, Q, can be decomposed into its balance elements to give

$$5. \quad I - L - D = AS(1+g)\,dh/dt$$

in which I is steady recharge to the aquifer, L is leakage from the aquifer, and D is draft (pumpage). for normal fresh water and sea water with specific gravities of 1.000 and 1.025, respectively, the Ghyben-Herzberg constant, g, is 40, and the constant (1+g) is 41. Hereafter this value will be used in the derivations.

Combining Darcy's law with the above produces a hydraulic flow model. Darcy's law for a basal lens with undimensional flow is written as

6. $q = 41kh\ dh/dx$

where q is unit flow through the depth of the aquifer, k is hydraulic conductivity, and x is horizontal distance along the gradient. When integrated between the limits h(1) and h(2), and x(1) and x(2) the above yields

7. $q = (41k/2)[h(2)^2-h(1)^2]/[x(2)-x(1)]$.

For simplicity let h(1), x (1) be zero, which are conditions at the hypothetical discharge front, then,

8. $q = 41kh^2/2x$

This equation is valid no matter where or what the discharge front is. The actual distance x is immaterial in the final equations because it is subsumed in a constant term along with other variables.

At initial conditions leakage is equal to total input, I, and equation 8 can be restated as

9. $I = L(0) = 41kh(0)^2/2x$

in which leakage L(0) and head h(0) are initial values. In the above, 41k/2x is a constant such that $c = 41k/2x = I/h(0)^2$. This conversion eliminates k and x from the final equations but requires that I be held constant, a condition that permits transient equations to be solved.

Restating the balance equation as amended by Darcy's law gives

10. $I - D - ch^2 = 41AS\ dh/dt$

in which I includes both vertical infiltration and underflow into the aquifer, D is net extraction (net draft), and ch^2 is leakage. Designating the constant 41SA as b, the initial volume of the lens is calculated as, V(0) = bz(0), in which z(0) = f[h(0)]. For a relatively flat groundwater table, a characteristic of high transmissivity, average initial head can be used in place of z(0), giving b = V(0)/h(0). This constant does not change over time because the relationship between V and h remains constant. specific yield is eliminated from the final equations when b is used. If initial volume is computed from parabolic curvature of the lens, a head at any fixed location can be employed in b.

Equation 10 is an ordinary differential equation readily solved by separation of variables. Integration over the limits [h(i), h(i=1)] and [t(i), t(i+1)] in which h(i) is head at the start and h(i+1) is head at the end of an interval, and t(i+1)-t(i) is the fixed length of the interval, and in which the constants c and b are replaced by initial system values, yields the following equations,

11. got I>D

$$h_{i+1} = h_0 \left[\frac{I-D}{I}\right]^{1/2} \left\{\frac{(I-D)^{1/2} + \frac{hi}{ho}(I)^{1/2} \exp\left[\frac{2t\,([I-D]\,I)^{1/2}}{V_o}\right] - (I-D)^{1/2} + \frac{hi}{ho}(I)^{1/2}}{(I-D)^{1/2} + \frac{hi}{ho}(I)^{1/2} \exp\left[\frac{2t\,([I-D]\,I)^{1/2}}{V_o}\right] + (I-D)^{1/2} - \frac{hi}{ho}(I)^{1/2}}\right\}$$

and,

12. for I<D

$$h_{i+1} = h_0 \left(\frac{D-I}{I}\right)^{1/2} \tan \left\{ aretan \frac{hi}{ho} \left(\frac{I}{D-I}\right)^{1/2} - \frac{t\,[(D-I)\,I]^{1/2}}{V_o} \right\}$$

The steady state form of equation 11 for constant D is

13. h(e) = h(0)[1-(D/I)]^1/2

in which h(e) is the equilibrium head that eventually will become established. There can be no steady state when (I<D) and I=D).

In the above equations D may vary among intervals but I is fixed. However, variations in total recharge can be accommodated by adjusting the actual draft to reflect increases or decreases of recharge without tampering with the initial value of I.

Equations 11, 12 and 13 express global water balances in terms of head and time for variable draft. Heads are "storage heads" reflecting true thickness of the lens. The Ghyben Herzberg condition is assumed to be instantaneously established at each change in output and input. Equilibrium heads, however, are not attained at the end of an interval even though the transient head, h(i+1), is in Ghyben-Herzberg balance. Equilibrium heads do not come about until leakage combined with draft exactly equals total recharge.

For Northern Guam a model based on the above equations requires the following information and data:

1. **Total recharge, I.** Obtained from hydrologic balance calculations. If the other variables are known, I can be solved for.

2. **Initial head, h(0).** The historical record is the best source, but an approximation can be extracted from sensitivity analyses.

3. **Initial volume of fresh water, V(0).** A good estimate can be made from the initial shape of the lens and an assumed value for specific yield.

4. **Ambient head, h(i), at the start of an interval.** this is storage head, best obtained by reference to the depth of the 50 percent sea water isochlor in the lens.

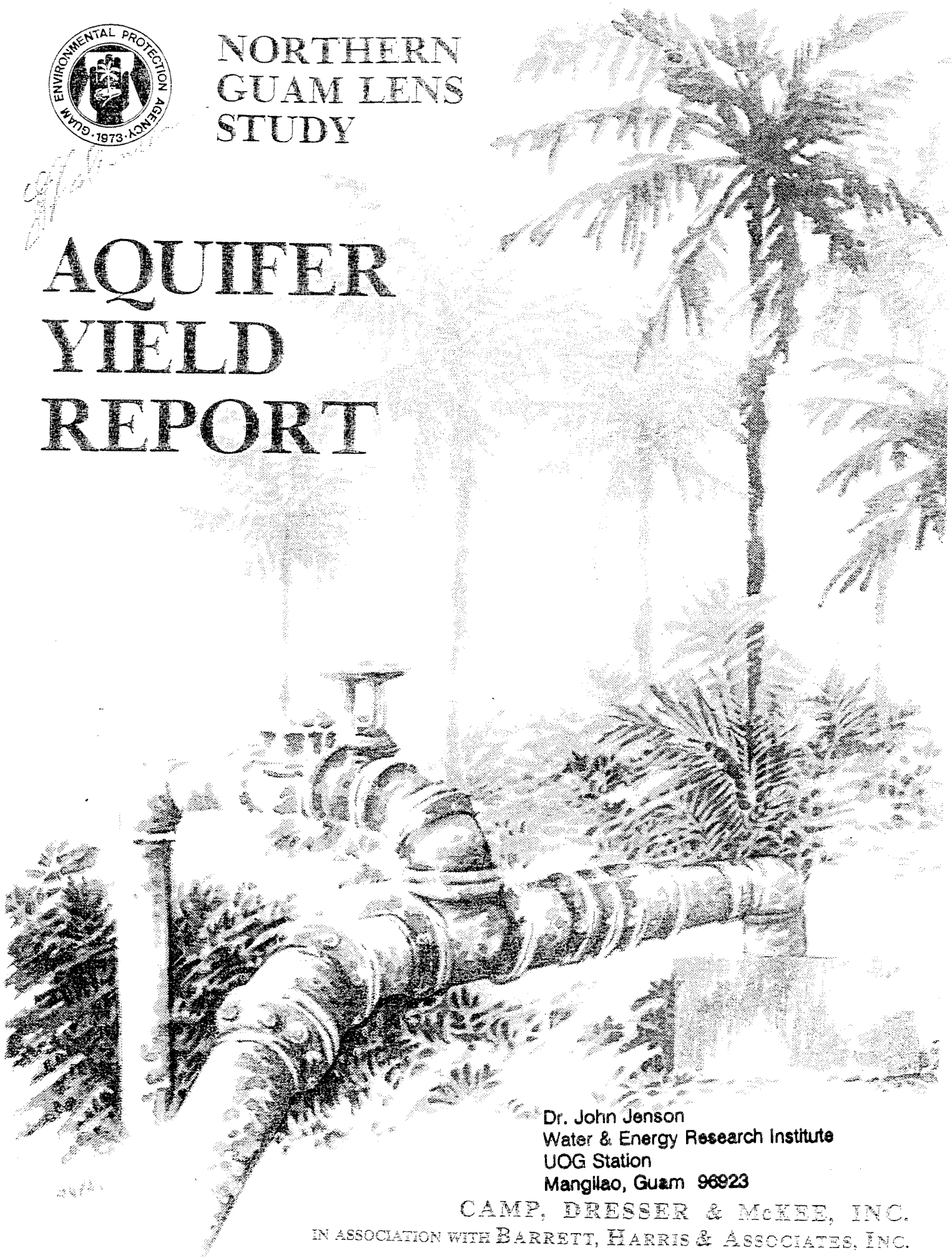
5. **Net draft, D.** Obtained from pumping records corrected for return irrigation flows.

The transient model described above, like all mathematical models so far devised, assumes instantaneous balance of the upper and lower surfaces of the lens. Unlike more sophisticated models it treats the aquifer as a homogeneous and isotropic single unit in which extractions are averaged throughout the domain, and therefore it cannot predict local water table depressions or mounds resulting from pumping and local recharge.

On the other hand, the model exactly defines water balances. It provides a good estimate of the storage state of the system even though it does not take into account the transition zone. It is especially useful for predicting the overall state of the resource for different scenarios of development. The model will provide a global sustainable yield for a given equilibrium head at controlled draft.

NORTHERN GUAM LENS STUDY

AQUIFER YIELD REPORT



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IN ASSOCIATION WITH BARRETT, HARRIS & ASSOCIATES, INC.

FINAL REPORT

NORTHERN GUAM LENS STUDY
GROUNDWATER MANAGEMENT PROGRAM
AQUIFER YIELD REPORT

Prepared for the

GOVERNMENT OF GUAM
GUAM ENVIRONMENTAL PROTECTION AGENCY

December 1982

Prepared by

Camp Dresser & McKee Inc.
in association with
Barrett, Harris & Associates, Inc.

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I

SUMMARY OF FINDINGS AND RECOMMENDATIONS

I. SUMMARY OF FINDINGS AND RECOMMENDATIONS

BACKGROUND

In 1964, the Government of Guam established a policy that the majority of its water supply would be taken from the limestone aquifers in the northern portion of the island. The fresh groundwater contained in these aquifers is collectively referred to as the Northern Lens. Because this valuable resource was insufficiently understood to insure safe, large-scale groundwater development, in 1974 the Government of Guam selected John Mink to conduct an in-depth evaluation of the long-term reliability of the Northern Lens water supply. Based on limited data, Mink (1976) estimated the sustainable yield of the Northern Lens to be at least 50 million gallons per day. Consequently, he recommended that a detailed hydrogeologic study be completed prior to extensive development of this groundwater supply. Mink's recommendation was realized in 1980 when the Guam Environmental Protection Agency (GEPA) initiated a water resource study that involved the participation of the United States Geologic Survey (USGS); the University of Guam's Water and Energy Research Institute of the Western Pacific (WERI); Barrett, Harris & Associates, Inc. (BHA); and Camp Dresser & McKee Inc. (CDM). The USGS was primarily responsible for hydrogeologic data collection. WERI was responsible for hydrogeologic data interpretation and mathematical modeling of the Northern Lens. BHA and CDM were charged with conducting an in-depth evaluation of water resources management practices in northern Guam and reevaluating the sustained yield of the Northern Lens based on new hydrogeologic data collected during the study. John Mink was given the responsibility of project director. He acted as liaison between GEPA and the study team and coordinated the technical and management studies.

SUMMARY OF FINDINGS

The aquifers of northern Guam consist of thick sequences of porous limestones that were deposited on the submarine slopes of a volcanic island.

Mount Santa Rosa and Mataguac Hill are exposed remnants of this volcanic mass. The two primary geologic formations are the Barrigada and Mariana limestones. These formations are thick and massive, and are interlaced with pores and channels that easily transmit water from the ground surface into and through the aquifers. Permeability of the aquifers varies both horizontally and vertically. Over the Northern Lens, the permeability increases from the southern part of the aquifer to the northern part, and ranges in value from under 500 feet per day in the Agana area in the south to over 12,000 feet per day in the Yigo and Finegayan areas in the north.

The Northern Lens has two primary types of groundwater conditions: basal and parabasal. In the basal portions of the lens, the fresh water floats on saline water which has intruded into the limestone formations. In the parabasal portions of the lens, the fresh water overlies the volcanic formations, but is hydraulically connected to the adjacent basal lens. Figure 1-1 illustrates the geographic distribution of the basal and parabasal lenses in northern Guam.

The average rainfall in northern Guam is 94 inches per year and ranges between 86 and 100 inches per year at the various raingaging stations over the lens. Of this rainfall, an average of approximately 35 inches per year recharges the groundwater aquifers. Sustainable yield is estimated to be approximately 40 percent of the recharge in the basal areas and about 60 percent in the parabasal areas. The difference in yield is due to the susceptibility of wells in basal aquifers to salt water intrusion (upconing).

In this study, the Northern Lens was divided into six hydrologic subbasins, which, in turn, were subdivided into 47 management zones, as shown on Figure 1-2. For each management zone, rainfall and recharge values were calculated and a sustainable yield was determined.

Table 1-1 summarizes the recharge, production, and sustainable yield of the Northern Lens as well as for each of the six hydrologic subbasins. The results are further subdivided into the basal and parabasal lenses for each subbasin. The table shows that the total recharge to the Northern Lens is

TABLE 1-1

ESTIMATES OF RECHARGE, PRODUCTION, AND SUSTAINABLE YIELD
FOR SIX HYDROLOGIC SUBBASINS
(Million Gallons Per Day)

Subbasin	Recharge	Sustainable Yield	Subbasin Production	Unused Yield
AGANA				
Parabasal	12.51	7.50	2.80	3.26
Basal	12.94	5.63	2.87	2.76
River Outflow			1.44	
Subtotals	25.45	13.13	7.11	6.02
MANGILAO				
Parabasal	5.53	3.14	0.95	2.19
Basal	1.94	0.76	0.46	0.30
Subtotals	7.47	3.90	1.41	2.49
ANDERSEN				
Parabasal	8.90	5.33	-0-	5.33
Basal	2.25	0.91	-0-	0.91
Subtotals	11.15	6.24	-0-	6.24
AGAFA GUMAS				
Parabasal	11.14	6.69	0.42	6.28
Basal	8.51	3.40	-0-	3.40
Subtotals	19.65	10.09	0.42	9.68
FINEGAYAN				
Parabasal	4.84	2.91	0.37	2.53
Basal	8.08	3.48	2.28	1.21
Subtotals	12.92	6.39	2.65	3.74
YIGO				
Parabasal	18.19	10.53	2.20	8.32
Basal	17.08	8.55	8.11	0.45
Subtotals	35.27	19.08	10.31	8.77
TOTALS	111.91	58.84	21.90*	36.94

* 20.46 MGD maximum well capacity and 21.90 MGD with additional 1.44 MGD Fonte River outflow to the ocean.

about 112 million gallons per day (MGD), of which about 59 MGD are available as sustainable yield. The combination of surface runoff to the ocean and the production capacity of existing wells is estimated to be 22 MGD, which leaves an additional 37 MGD to be developed.

RECOMMENDATIONS

The results of the hydrologic investigation of northern Guam led to the following recommendations specifically regarding the estimated sustainable yield of the Northern Lens.

1. Until the findings of the Northern Guam Lens Study (NGLS) are substantiated during expansion of groundwater production facilities, groundwater production should be limited to the sustainable yield estimated in the Aquifer Yield Report for each management zone and hydrologic subbasin.

2. For the development of basal groundwater, the following well design constraints should be imposed:

    a. In management zones where fresh water heads are less than 4 feet, wells should be limited to 200 gallons per minute (gpm) capacity and the well bottom elevation should not exceed 40 feet below mean sea level (MSL), and preferably not more than 25 feet below MSL.

    b. In management zones with fresh water heads greater than 4 feet, wells should be limited to 350 gpm capacity and the well bottom elevation should not exceed 50 feet below MSL, and preferably not more than 35 feet below MSL.

3. For the development of parabasal groundwater, wells should be designed for the maximum that the aquifer can deliver without exceeding the sustainable yield of the management zone and without exceeding 750 gpm. However, because of low permeabilities in many

parts of the Northern Lens, the following well designs are provided as guidelines for groundwater development.

a. In the southern part of the Agana Subbasin, low permeabilities will probably limit well capacities to 200 gpm, and perhaps 350 gpm under special conditions. Wells in this area should probably be drilled no deeper than 50 feet below MSL.

b. In the upper part of the Yigo Subbasin, wells will probably yield 750 gpm. Wells in this area should probably not be drilled any deeper than 50 to 60 feet below MSL.

c. Wells in all other parabasal zones should have a capacity of about 500 gpm with well bottom elevations not exceeding 50 feet below MSL.

d. Wells should not be placed any closer than 500 feet from the estimated salt water toe position in clean limestone, and 1,000 feet from the estimated salt water toe position in argillaceous limestone.

4. Wells should be placed at least 300 feet apart in both the basal and parabasal zones.

To refine the estimates of sustainable yield and to provide a method of monitoring the changes in the fresh water lens as production capacity approaches sustainable yield, the following steps are recommended in order of greatest importance.

1. Three new permanent raingaging stations should be established in northern Guam to refine the estimates of areal distribution of precipitation. These stations should be located in Ordot, Latte Heights, and Agafa Gumas.

2. To monitor the impacts of future groundwater production, water level measurements should be conducted semi-annually in all production and monitoring wells during the months of April (the end of the dry season) and October (the end of the wet season).

3. Each hydrologic subbasin should have at least one continuous water level recorder located in the basal lens to determine the impact of well production and tides on water levels and fresh water lens configuration.

4. All new data should be compiled bi-annually and the estimates of recharge, production, and sustainable yield for each subbasin should be reevaluated, refined and updated. This bi-annual re-evaluation will insure that the groundwater resource remains protected from over-development. The reevaluation should be done on an annual basis as the sustainable yield is approached or if salt water contamination of wells becomes frequent.

5. A monitoring well network should be established and expanded to complement the existing exploratory wells and the USGS observation wells. At least one monitoring well which fully penetrates the fresh water lens should be established in each major well field within the basal areas of the lens for the purpose of monitoring long-term changes in the position of the fresh water-salt water interface as groundwater production increases and approaches the sustainable yield. A major well field is an area where several wells are closely spaced such as exists in Dededo. Though existing monitoring wells may be adequate for most well fields in operation today, new monitoring wells should be drilled as new well fields are constructed.

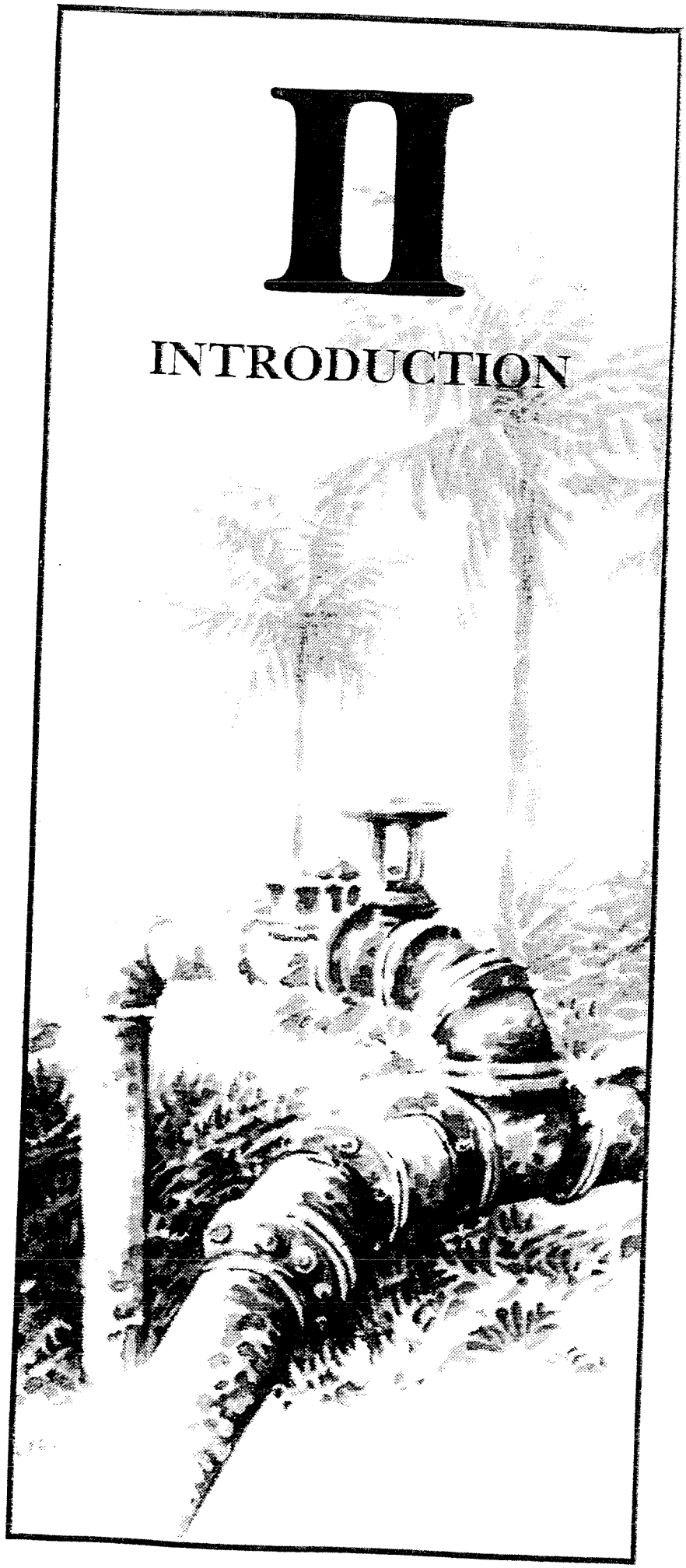
6. Lysimeters or other similar devices should be established at locations in northern Guam so that accurate evapotranspiration data can be obtained. Though these types of devices are relatively expensive to construct and maintain, the data will provide

more accurate information on the amount of rainfall that infiltrates to the groundwater system, and thus, the amount of recharge that enters the Northern Lens. This, in turn, will lead to a better assessment of sustainable yield.

7. In areas where little or conflicting data exist on where the limestone aquifer makes contact with the top of the volcanic formation, further exploratory drilling and/or seismic surveys should be conducted. Of particular concern are the northern Dededo Well Field area and the Andersen-Northwest Field areas.

II

INTRODUCTION



II. INTRODUCTION

GENERAL

The island of Guam is located in the western Pacific region, approximately half way between Japan and New Guinea (Figure 2-1), and is the largest island in the Mariana Island group. Guam has an area of about 212 square miles, is approximately 30 miles long, and ranges between 4 and 11.5 miles wide (Figure 2-2). The island has two very distinct physiographic divisions; the southern half is composed of rugged volcanic upland and the northern half is characterized by a limestone plateau. The fresh groundwater resource of northern Guam (commonly known as the Northern Lens) is the subject of this report and the Northern Guam Lens Study (NGLS).

In 1964 the Government of Guam established a policy to rely on the groundwater resources of the Northern Lens for its long-term water supply needs. The policy was adopted because of the increasing expense associated with constructing surface reservoirs and because surface reservoirs are not a long-term, reliable water supply source. Large-scale groundwater development began in Guam in 1937 and peaked during the troop build-up in World War II. Many of the wells used for the military occupation are noted on Plate I; however, and most of these are not now in use. Shortly after the war, the U.S. Geological Survey (USGS) conducted several hydrologic studies and established an ongoing surface water and groundwater data collection program. Their efforts were followed by a thorough evaluation of the long-term reliability of Guam's groundwater resources published by John Mink in 1976. In that report, Mink estimated the sustainable yield of the Northern Lens to be on the order of 50 million gallons per day (MGD). However, Mink was quick to point out that his estimates, though conservative, were rough because of the lack of detailed hydrogeologic and hydrologic data available for northern Guam. Furthermore, he recommended that prior to any extensive groundwater development of the lens, the hydrologic features of the aquifers needed to be determined. This recommendation was acted on in 1980, when the Government of Guam, with the administrative guidance of the Guam Environmental Protection Agency (GEPA), contracted the water resources

consulting firms of Barrett, Harris, and Associates, Inc. (BHA) and Camp Dresser and McKee Inc. (CDM) (hereafter jointly referred to as "the Consultant") to conduct a thorough evaluation of water resources management practices as well as a detailed reevaluation of the sustainable yield based on new hydrogeolgic data being generated for GEPA during 1980, 1981, and 1982. Concurrently, the University of Guam's Water and Energy Research Institute of the Western Pacific (WERI) and the USGS were contracted to expand the hydrogeologic understanding of the groundwater resources of the Northern Lens.

To address the need for subsurface hydrogeologic data, GEPA contracted to have seismic and gravity surveys conducted throughout Northern Guam. These surveys did more to advance the understanding of the boundary conditions of the groundwater system than any previous investigation. GEPA also contracted to have 11 exploratory wells drilled and a topographic survey conducted of all water wells in Northern Guam. The data collected from the surveys and drilling were evaluated and used by the USGS, WERI, and the Consultant to complete their assigned tasks in the NGLS.

SCOPE OF WORK

The underlying major objectives of the hydrogeologic study, as presented in this report, were to: 1) more accurately delimit the limestone aquifer of the Northern Lens, and 2) reevaluate the sustainable yield based on the newly generated hydrogeologic data.

After work started on the NGLS, the Scope of Work was modified slightly with regard to numerical modeling. That portion of the work dealing with numerical modeling (Task V-1(b)) was turned over to WERI to complete. The emphasis of the Contractor was placed on analytical analyses of the groundwater system.

ACKNOWLEDGEMENTS

The NGLS was successfully completed because of the cooperative effort of many diverse organizations now involved with the water resources of Guam.

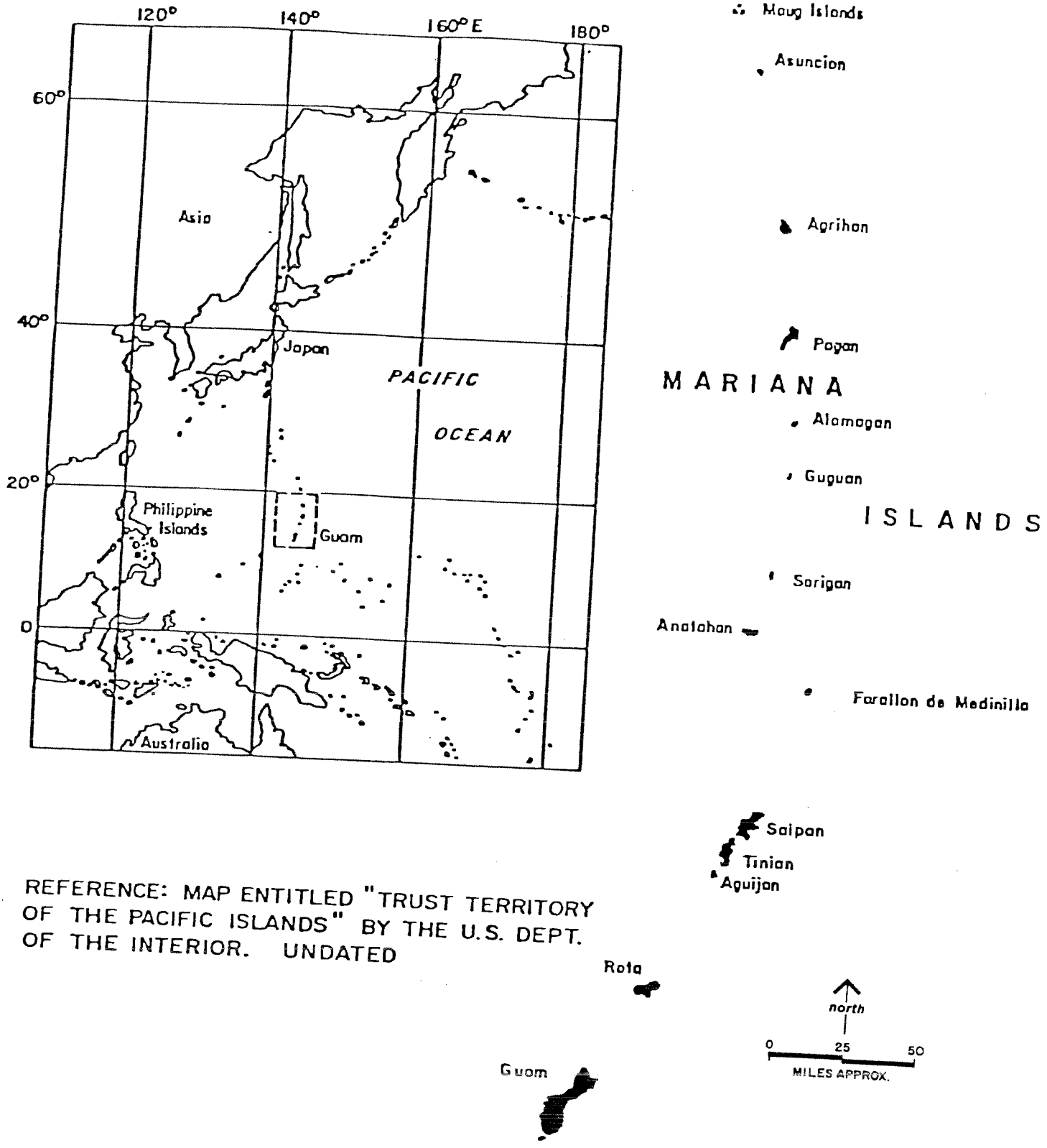


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FIGURE 2-1

LOCATION MAP

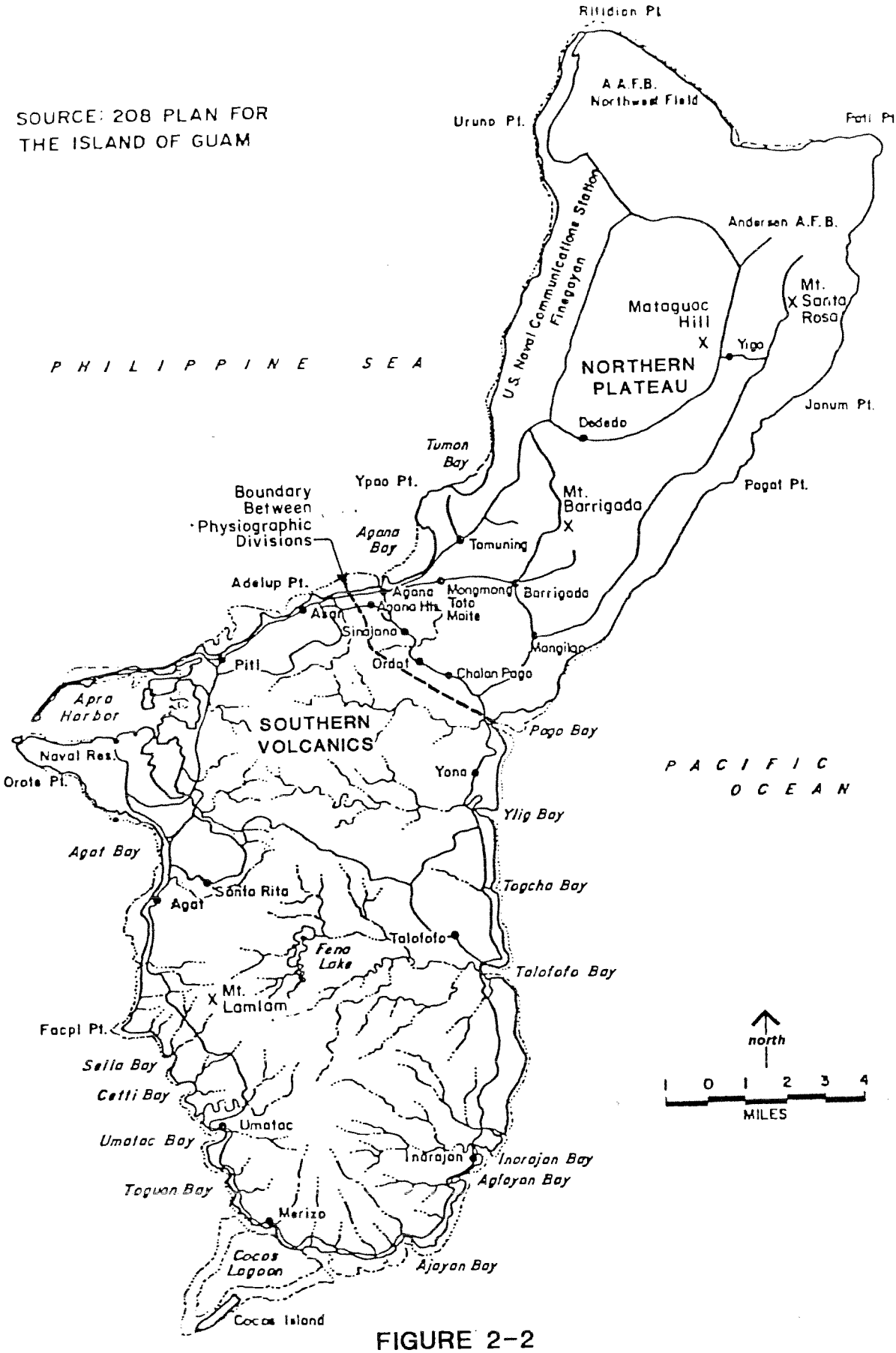


FIGURE 2-2

MAJOR PHYSIOGRAPHIC DIVISIONS OF GUAM

We are especially appreciative of Ricardo Duenas, Administrator of GEPA; James Branch, Deputy Administrator of GEPA and Project Manager of NGLS; John Mink, Project Director of the NGLS; and John Worlund, Chief Engineer of GEPA and Assistant Project Director of the NGLS. The staff of GEPA is to be commended for its efforts in providing water quality analyses and other data, office and conference room space, and assisting in the day-to-day logistics of the project. WERI provided considerable input for both hydrogeologic data interpretation and computer modeling of the Northern Lens groundwater system. Valuable data were provided by other Government of Guam agencies, in particular, the Public Utility Agency of Guam (PUAG) and the Division of Land Management. The United States Navy and United States Air Force also greatly assisted the project by supplying data as well as access to their bases. Finally, the USGS, in particular Chuck Huxel and Gregg Ikehara, are to be commended for their efforts to complete the data collection portions of the project.

REPORT FORMAT

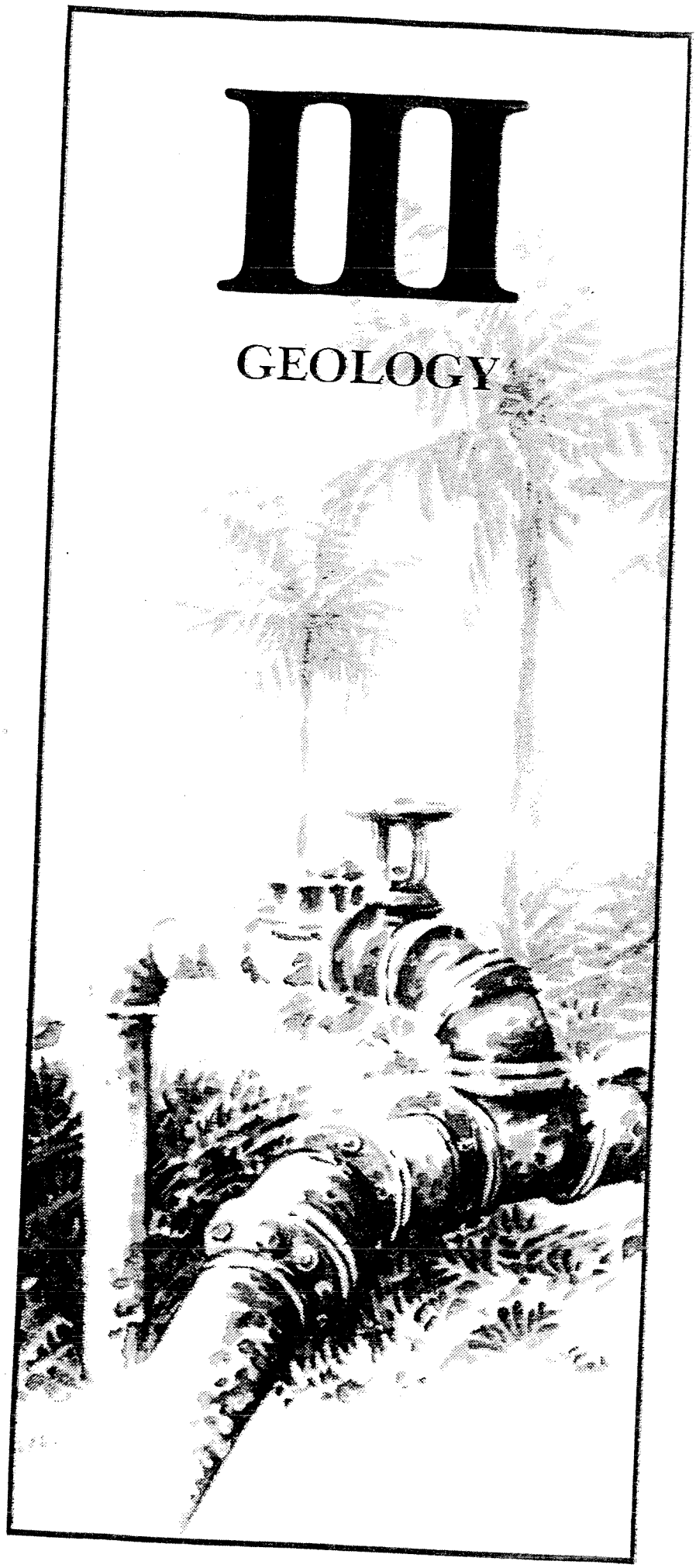
The report is divided into two major portions, the main text and technical appendices. The main text presents a summary of those topics that led to conclusions regarding sustainable yield of the Northern Lens, including geology, hydrogeology, hydrology, and groundwater quality. Information presented in this portion of the report includes reviews of work previously done which is pertinent to the study. Discussions, such as those of detailed geology, hydrogeology, and basic hydrodynamics of the fresh water-salt water system, are intentionally brief because they have been well covered in previous reports (for example, Mink, 1976 and WERI, 1982). The main text also focuses on updating and refining the results of previous studies based on new understanding of the aquifer and fresh water lens geometries.

The second part of the report consists of technical appendices which contain a summary of all data and analytical methods used to obtain aquifer and fresh water lens geometries and sustainable yield, as well as a more in-depth discussion of aquifer permeability and recharge, an analysis of transition zone geometry, and a review of analytical and numerical modeling

efforts undertaken during the investigation by various participants in the NGLS. Appendix A contains those tables from the Data Report that are referenced in the Aquifer Yield Report. The Data Report is published under separate cover and includes a compilation and summary of all data used in the preparation of this report. Appendix B summarizes the results of the geophysical surveys conducted early in the project, as well as a description of the preparation of the Volcanic Basement Contour Map (Plate 1). Appendices C, D, E, and F provide the calculations used in evaluating permeability, response of the lens to pumping, evaporation and evapotranspiration, and recharge, respectively. Appendix G summarizes the numerical modeling efforts by WERI. Appendix H provides the definitions of some of the technical terms used in this report.

III

GEOLOGY



III. GEOLOGY

PREVIOUS WORK

The following discussion of Guam's geology is a summary of the work performed by Tracey, et al, and published as USGS Professional Paper 403-A in 1964. Their work is the most complete of any geologic study done of Guam. For a more detailed consideration of Guam's geology, the reader is directed to that publication.

The first geologic observations of Guam were conducted by Agassiz in 1903. H.T. Stearns of the USGS completed a detailed geologic investigation on Guam in 1937 for the U.S. Navy. Between 1937 and 1964, a number of studies, especially by the USGS, contributed more detail to Stearns' original work. Then, in 1964, the comprehensive investigation of Guam's geology by Tracey, et al, was published by the USGS. After 1964, only a few geologic investigations, performed in localized areas of Guam, were done until the recent seismic surveys and exploratory drilling in the Northern Lens were completed for GEPA in 1981 and 1982.

GEOLOGIC SETTING

Guam is the largest and southern-most island in the Mariana Island Chain (see Figure 3-1). The island chain is located atop a large submarine ridge known as the Mariana Island Arc System, which is the boundary between subducting tectonic plates. The Mariana Trench is located east and south of the arc. Within the trench is the lowest point on the surface of the earth, the Challanger Deep, which lies about 35,760 feet below sea level.

Guam has two major physiographic divisions (see Figure 3-2). The southern half of the island is the oldest and is characterized primarily by a dissected and relatively rugged volcanic upland, on which limestones were sometimes deposited. The upland areas of the eastern part of the island are fringed by discontinuous fossil limestone reef deposits. The western

volcanic upland lies along a north-south ridge on which is the highest point of the island, Mount Lamlam, at an elevation of 1,334 feet.

The northern half of the island is characterized by a broad and gently undulating limestone plateau which slopes from Mount Santa Rosa (elevation 858 feet) on the northeast toward the Agana Swamp area (near sea level) on the southwest. The limestone plateau ends abruptly in near vertical cliffs along most of the coastline of northern Guam. Volcanic rocks are exposed at the ground surface near the tops of Mount Santa Rosa and Mataguac Hill and form the surface expressions of the volcanic backbone on which the thick sequences of limestone were deposited. Figure 3-3 illustrates the volcanic foundation below the limestone sequence. The volcanic basement is roughly circular in form in the northern part of the province and has a ridge that extends from Mount Santa Rosa on the north to Mount Barrigada on the south. The volcanic rocks of northern Guam probably formed during events that are both separate and younger than those in the south. Limestone sequences grew on the submerged volcanic surfaces as they were uplifted, and eventually connected with the southern half of the island.

MAJOR GEOLOGIC FORMATIONS

For the purposes of this report, only the major formations which occur within the northern physiographic division will be briefly discussed. For more detail regarding the lithology of any of the formations in Guam, the reader is again directed to Tracey, et al, (1964).

Alutom Formation

The Alutom Formation contains the oldest rocks exposed on Guam and is of probable Eocene to Oligocene age (approximately 40 to 60 million years old). This formation is volcanic (andesitic) and consists primarily of pyroclastics ranging in size from tuffaceous shale to coarse conglomerate and breccia, as well as flow rocks, usually in the form of pillow basalts. These deposits erupted on to the submarine floor as both flow and pyroclastic deposits and form the core or basement complex of Guam. The formation is highly folded and faulted as a result of its association with long

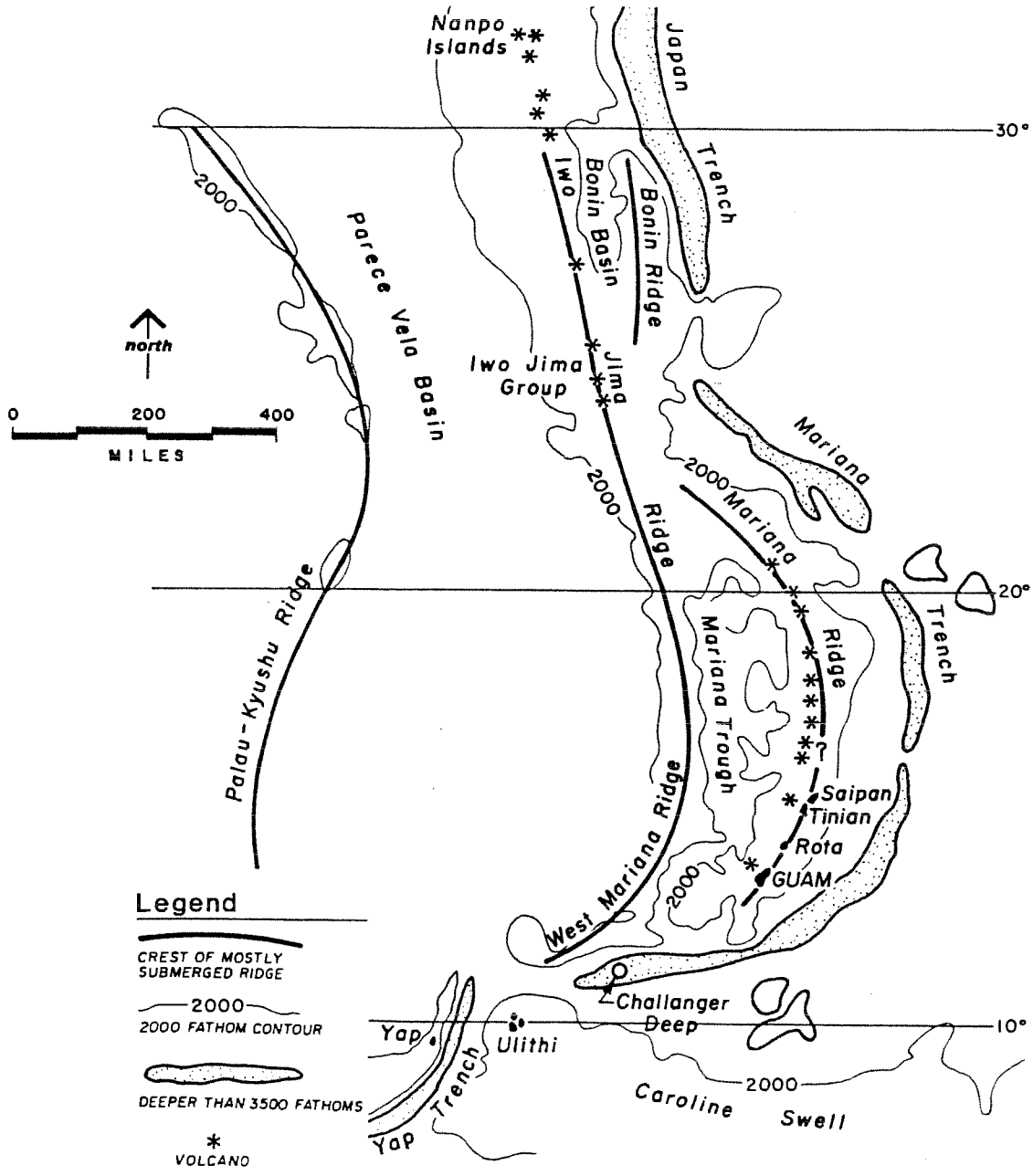


FIGURE 3-1

REGIONAL RELATIONS IN THE WESTERN NORTH PACIFIC

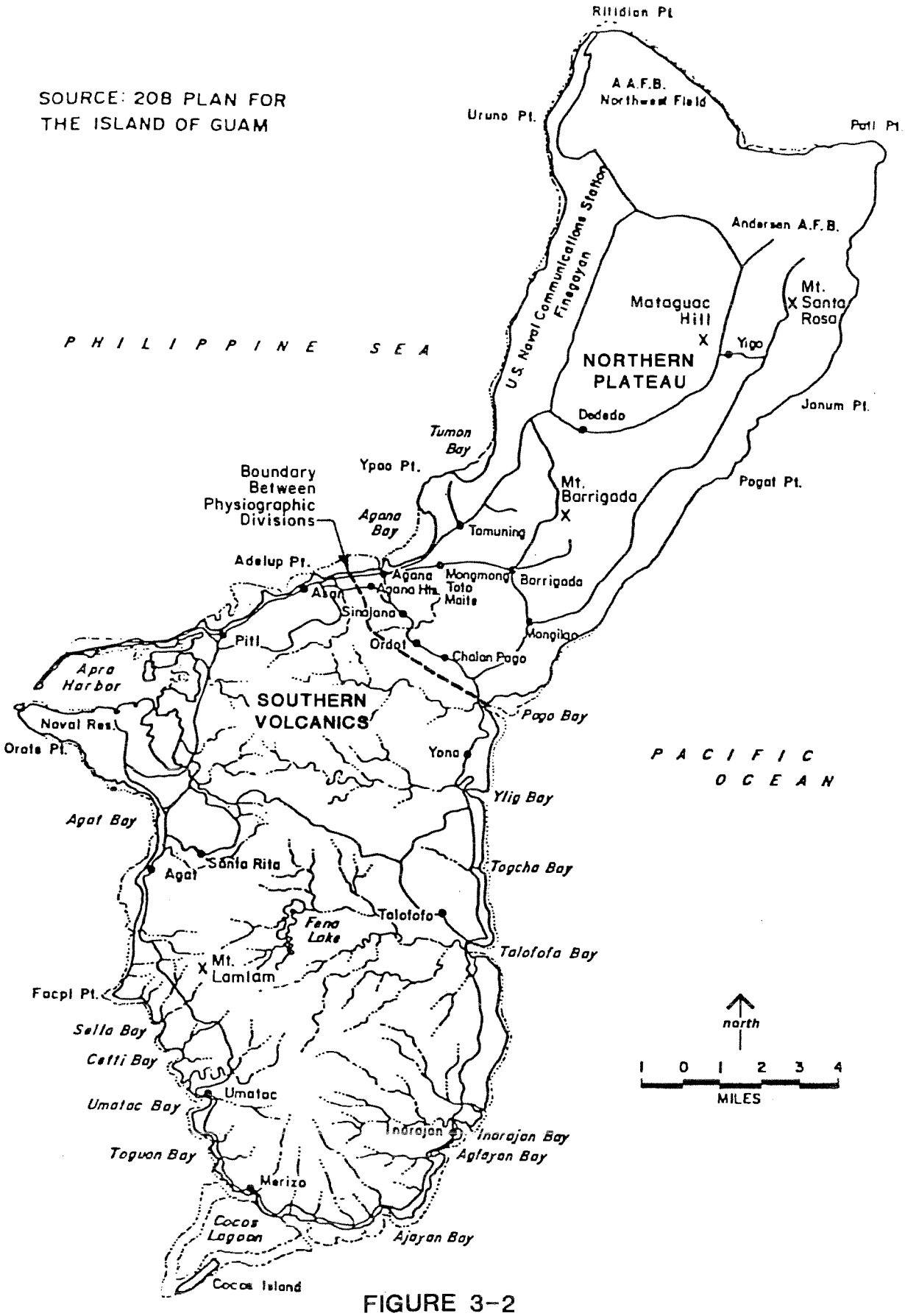


FIGURE 3-2

MAJOR PHYSIOGRAPHIC DIVISIONS OF GUAM

and very active tectonism common to those areas along tectonic plate boundaries. The Alutom Formation forms the volcanic formations exposed at Mataguac Hill and Mount Santa Rosa in central part of northern Guam (see Figure 3-4). Here the formation consists of interbedded tuffaceous shale and sandstone, lapillic tuff and conglomerate, flow breccas, and pillow basalts. These beds are cut by numerous minor joints and faults and are moderately folded. Relative to the overlying limestones, the volcanics are virtually impermeable.

The distribution of the volcanic formation beneath northern Guam was determined during the course of the NGLS by both exploratory drilling and geophysical surveys. An explanation of the drilling and geophysical surveys is described in detail in Appendix B-1. A contour map of the subsurface expression of the top of the volcanics was the final product of the exploratory work and is presented on Plate 1. The method by which Plate 1 was developed is described in Appendix B-2.

Barrigada Limestone

The Miocene (20 million years old) Barrigada limestone was deposited on the volcanic Alutom Formation in northern Guam and is exposed in the form of a ring that surrounds Mataguac Hill and Mount Santa Rosa and extends south, around, and over Mount Barrigada (see Figure 3-4). This massive detrital limestone is bright white, pure, and medium- to coarse-grained in an unweathered condition (Tracey, et al, 1964). Fossils range from abundant foraminifera near the bottom to poorly preserved mollusk and coral molds near the top. The maximum thickness of the Barrigada limestone is probably greater than 600 feet (as seen in exploratory wells EX-5 and EX-5a).

The lithology of the Barrigada limestone is somewhat different than the overlying Mariana limestone. Differentiation between the formations is generally based on fossil content, with the Barrigada containing mostly foraminifera and few mollusks and the Mariana containing mostly mollusks and corals and few foraminifera. The vertical variation in fossil content in the Barrigada limestone suggests that the lower part was deposited in

water up to 600 feet deep and the top of the formation was probably deposited in less than 200 feet of water.

Mariana Limestone

The Mariana limestone is of Plio-Pleistocene age (about 2 to 5 million years old) and constitutes about 80 percent of the exposed limestones of Guam. It onlaps the Barrigada limestone as a vertical and transgressional facies change from a deep to a shallow water depositional environment. The lithology of the Mariana limestone, though generally massive, varies significantly laterally and vertically and is associated with deposition within different reef and lagoon environments. The reef facies consists of well-cemented, crystalline coral limestone. The detrital or lagoonal facies ranges in composition from coarse, granular limestone with scattered coral heads near the reef facies to fine-grained limestone with scattered to abundant mollusk molds and shells near the paleo-shoreline. The Mariana limestone contains a facies known as the Agana Argillaceous member, which is hydrologically significant because of its relatively low permeability. This member is located below an elevation of 200 feet between Mount Barrigada and the volcanic formation to the south. It is generally yellow to tan in color and is characterized by a high content of calcareous mud associated with the near-shore environment and fine-grained detrital material contributed from the adjacent volcanic rocks.

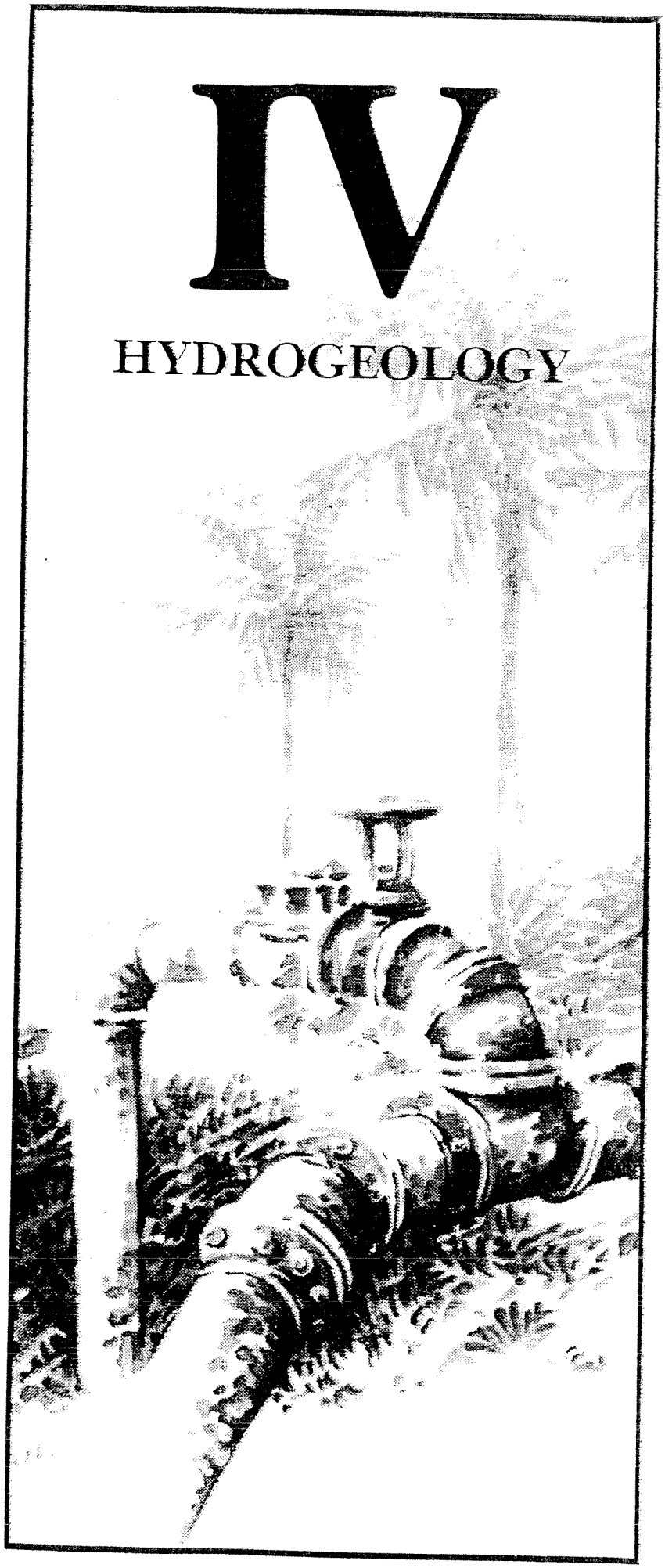
GEOLOGIC HISTORY

The volcanic formations in the southern half of Guam probably emerged in Early Miocene time as evidenced by the older limestones that were deposited on the volcanic upland. Approximately 10 to 15 million years ago, in late Miocene time, the volcanic islands of northern Guam (Mount Santa Rosa, Mataguac Hill and Mount Barrigada were submerged but came close enough to the ocean surface to support deep limestone formation. These volcanic islands could have been formed as a result of several small independent eruptions, or are the parts of a single larger volcano that subsequently collapsed, leaving remnant ridges and hills. While these volcanos were still at 600 feet below sea level, the Barrigada limestone was forming. As

the volcanic formation rose toward the ocean surface, the change in environment allowed gradual changes in limestone formation (going from foraminiferal Barrigada limestone to coral Mariana limestone associated with abundant mollusk growth). The transition from deep water limestone (Barrigada) to shallow water limestone (Mariana) was completed in Pliestocene time. The island has continued to rise sporadically to its present-day position. Long periods of quiesence were probably punctuated by periods of rapid emergence in the northern half of the island, as evidenced by the terrace formations that occur along the present coastline and along a line extending from Agana past the west side of Mount Barrigada to Yigo. Because this inland cliff slopes from Yigo (on the north) down to Agana (on the south), the northern part of the plateau appears to be rising faster than the southern part. The inland cliff feature has been interpreted by Tracey, et al, (1964) and others to be the result of normal fault activity. At this time, the island appears to be in a period of relative quiesence, with active fringing reefs being formed around the coast of northern Guam. However, because tectonic activity is still on-going in the region of the Mariana Trench, uplift of the island arc and Guam is expected to continue into the geologic future.

IV

HYDROGEOLOGY



IV. HYDROGEOLOGY

GENERAL

This chapter of the report presents a brief discussion of the hydrogeology of the Northern Lens. For the purposes of the report, hydrogeology is defined as the interrelationship between the geology of the aquifer and the fluids (both fresh water and salt water) which are stored in and move through the aquifer. The information presented includes summaries of the work done by the USGS, Mink (1976), and WERI (1982), especially that pertaining to the description of the aquifer and the hydraulic parameters associated with the aquifer. Also discussed are the water level fluctuations in the fresh water lens and an evaluation of the dynamics of the fresh water-salt water interface. Finally, additional investigations are recommended to further advance the understanding of the aquifer geometry, its hydraulic properties, and the dynamics and interrelationship of the fresh water-salt water system.

AQUIFER DESCRIPTION

The aquifer containing the Northern Lens is composed primarily of the Barrigada and Mariana limestones. As discussed in the previous chapter, the Barrigada limestone is primarily a deep water formation containing abundant foraminifera near its stratigraphic base and scattered coral and mollusk shell molds near its upper contact with the Mariana limestone. The Mariana limestone, on the other hand, was deposited in relatively shallow waters of the reef, fore reef, and lagoonal environments.

Porosity

In the aquifer section associated with the fresh water lens, porosity occurs as a result of elliptical voids in the limestone as well as continuous and discontinuous passages through the limestones. These pores range in size from microscopic openings to large, well developed cavern systems;

however, passages are generally about 1/8 to 1/4 inches in diameter. Many of the isolated openings are usually the result of the voids left by mollusk shells. Porosity in passages are formed by dissolution of the limestone by chemically aggressive fresh water which percolates through the aquifer. This latter type of opening is usually associated with fractures or small-scale lithologic differences (such as around and through coral heads) that provide the microscopic passages through which the fresh water can travel.

The Mariana limestone overlies the Barrigada limestone and is composed of a several facies that ranges from clean, fore reef limestone to clastic and calcareous detrital material deposited in a near-shore environment. The porosity of the Mariana limestone varies considerably through the different facies. Research done in Puerto Rico (FUGRO, 1974) suggested that the clean, crystalline limestones deposited in the reef and fore reef environments have higher porosities because their potential for dissolution by fresh groundwater was much higher than for argillaceous limestones. The limestones deposited in a near-shore environment contain more carbonate mud, which effectively reduces dissolution potential, thus exhibiting lower porosity. Finally, the limestones deposited immediately adjacent to subaerially exposed volcanics contain very fine-grained volcanic detrital material that washed into the limestone, significantly reducing its effective porosity (the amount of interconnected pore space available for fluid flow).

Cores from exploratory wells EX-1 and EX-5 were analyzed by WERI (1982) during the NGLS. Exploratory well EX-1 was drilled into the argillaceous limestones located in the southern part of the study area (see Figure 4-1). As was expected, porosities were low, generally less than four percent. Exploratory well EX-5 is located in the clean limestones near Dededo (see Figure 4-1). The porosities in this well ranged from three percent to 26 percent and averaged 13 percent above the water table and 21 percent below the water table.

Core analysis depict very local conditions. To gain insight into regional porosity variations, the gravity data were evaluated (see Appendix B1).

That analysis indicated a range in porosity from 13 percent to 20 percent, depending on the mineral composition of the limestone (i.e., aragonite or calcite). These regional porosity estimates compare very favorably to the results of the core analyses done for exploratory well EX-5 by WERI.

The areal variation in limestone porosities varies considerably in northern Guam. But as an overall observation, the porosity, as interpreted by water level heads, core analyses, and computer modeling efforts, increases from south to north.

Permeability

Several methods were used to estimate permeabilities in the limestones of northern Guam. These methods are discussed in detail in Appendix C and are summarized below (and in Table 4-1). The magnitude of limestone permeability is directly related to that of porosity and also increases from south to north through the Northern Lens.

Fresh water heads measured in April 1982, when related to the distances from a well to the coast and from the well to the top of the drainage divide, indicate that permeabilities increase from south to north, through the Northern Lens. In the Agana Subbasin, permeabilities deduced from head and gradiant data range from 1,500 to 3,000 ft/d. Permeabilities in the Mangilao Subbasin are about 1,500 ft/d. In the central part of the lens, permeabilities generally range from about 2,000 ft/d to about 12,000 ft/d, and in the case of Y-4, to as high as 17,590 ft/d.

Using tidal-signal attenuation data, WERI (1982) suggested that the permeability (hydraulic conductivity) ranged from 2,380 feet per day (ft/d) at the USGS monitoring well No. 72, located above Pago Bay (see Figure 4-1), to 12,400 ft/d at M-11, located near Dededo. WERI noted that these permeabilities were quite sensitive to porosity, which they assumed to be 15 percent for the permeabilities quoted on Table 4-1.

TABLE 4-1

COMPARISON OF PERMEABILITIES
(Feet Per Day)

Well No.	Method			
	Fresh Water Head and Gradient*	Tidal Attentuation (porosity=0.15)	Drawdown Recovery Test	Salt-Water Intrusion Analyses
72	2,355	2,380	-	-
H-107	3,745	5,610	-	-
M-10a	4,940	6,790	-	-
A-16	3,035	8,155	-	-
A-10	1,575	-	1,030	-
A-13	2,285	-	780	-
D-4	11,475	-	1,300	-
D-15	12,760	-	-	-
F-2	3,410	-	2,080	3,300
M-6	7,530	-	450	-
M-7	5,470	-	1,850	-
M-11	9,950	12,400	-	-
M-9	1,680	-	-	525
M-4	-	-	1,300	-
Y-4	17,590	-	-	-

*Permeabilities for other wells are provided on Table C-1 in Appendix C.

During the course of the NGLS, permeabilities were evaluated on the basis of drawdown-recovery tests conducted for several wells throughout the lens. The permeabilities range from about 780 to about 1,000 ft/d in the argillaceous limestone in the Agana Subbasin (Figure 4-1). In the clean limestones of the Mangilao and Finegayan Subbasins, permeabilities generally ranged between 1,000 and 2,000 ft/d.

Analyses of salt water intrusion using a numerical model were conducted for the Finegayan and Mangilao Subbasins. In the Mangilao Subbasin, permeability is estimated to be about 525 ft/d. In the Finegeyan and western Yigo Subbasins, the permeabilities ranged between 2,500 and 4,000 ft/d, and averaged 3,300 ft/d.

Basal and Parabasal Lenses

Figure 4-2 shows the relative distribution of the basal and parabasal lenses. A basal lens is defined as the area in which fresh groundwater is immediately underlain by salt water. A parabasal lens is in hydraulic continuity with the basal lens except that the fresh water is underlain by impermeable volcanic formations. The salt water toe is located along the line of intersection between the fresh water-salt water interface and the contact between the limestone and volcanic basement rocks. The delineation of these two lens types is important because salt water can rise vertically into a pumping well located in the basal lens (upconing), but cannot rise into a well in a parabasal lens because it is not underlain by salt water. However, if a parabasal lens is heavily pumped, salt water will intrude inland, thus causing the salt water toe (the boundary between the basal and parabasal lens) to move inland. If the toe migrates beneath a parabasal well, that well will be susceptible to upconing.

FRESH WATER-SALT WATER LENS CHARACTERISTICS

This section discusses the characteristics of the fresh water and salt water aquifers in northern Guam. Particular emphasis is given to the short-term and seasonal fluctuations in the fresh water levels, as well as

the conditions that affect the transition zone between the fresh water lens and underlying salt water.

Water Level Fluctuations in the Fresh Water Lens

Until late in the NGLS, reliable long-term and seasonal fresh water head measurements were restricted to seven USGS monitoring stations and about seven wells periodically measured by the USGS. Extensive groundwater measurement programs were undertaken in 1972 and 1973, but accurate head values were unreliable because the topographic control at the measuring points was not accurate to the degree required for the lens analysis. At the beginning of the NGLS, a detailed elevation survey was completed for all the wells in the Northern Lens for GEPA (see Appendix A). In September 1981, water levels in a few key wells were measured by the Consultant and the USGS. Then, in April 1982, the Consultant and the USGS measured water levels in nearly every municipal well in the Northern Lens (over 70). This information provided a reliable indication of the areal distribution of water levels in northern Guam. These efforts were important for three reasons:

1. They provided information on seasonal variations in water levels at various locations throughout the lens. This information augmented the data collected at the seven continuous water level recording wells established by the USGS.

2. They permitted limestone permeabilities to be estimated using the water levels in conjunction with measured distances between the observation well and the coast.

3. They allowed better estimates of the location of the salt water toe to be calculated over a wider area. These estimates are shown on Figure 4-2.

Figure 4-3 shows the April 1982 (middle of the dry season) fresh water elevation contours for the Northern Lens. As is shown on this figure, basal heads are quite high in the Agana Subbasin, ranging over 7 feet above MSL.

These high head values are the result of the low permeability of the limestone aquifer in this area (assuming that recharge is relatively constant over the region). In the northern and central parts of the lens, the heads generally range between 2.5 and 4 feet above sea level, indicating relatively high permeability for the aquifer.

Because limited water level data are available for other seasons of the year, regional water level variations can only be estimated. At Well No. A-16 (Plate 1) in the Agana Subbasin, the USGS water level recorder shows seasonal fluctuations of about 1.75 feet for water year 1977-1978, and a historic extreme fluctuation of about 3.6 feet. Water levels in September 1981 (wet season) and April 1982 (dry season) taken by the USGS and the Consultant during the NGLS at Well No. A-9 show a variation of about two feet seasonally for the 1981-82 water year (Appendix A, Table A-8). In the northern and central subbasins, where permeabilities are higher, fluctuations are lower. For example, water levels in Exploratory Well EX-7 (west of Dededo) varied about 0.35 feet between September 1981 and April 1982; EX-10 (south of Finegayan) varied about 0.20 feet between those dates (see Plate 1 for well locations).

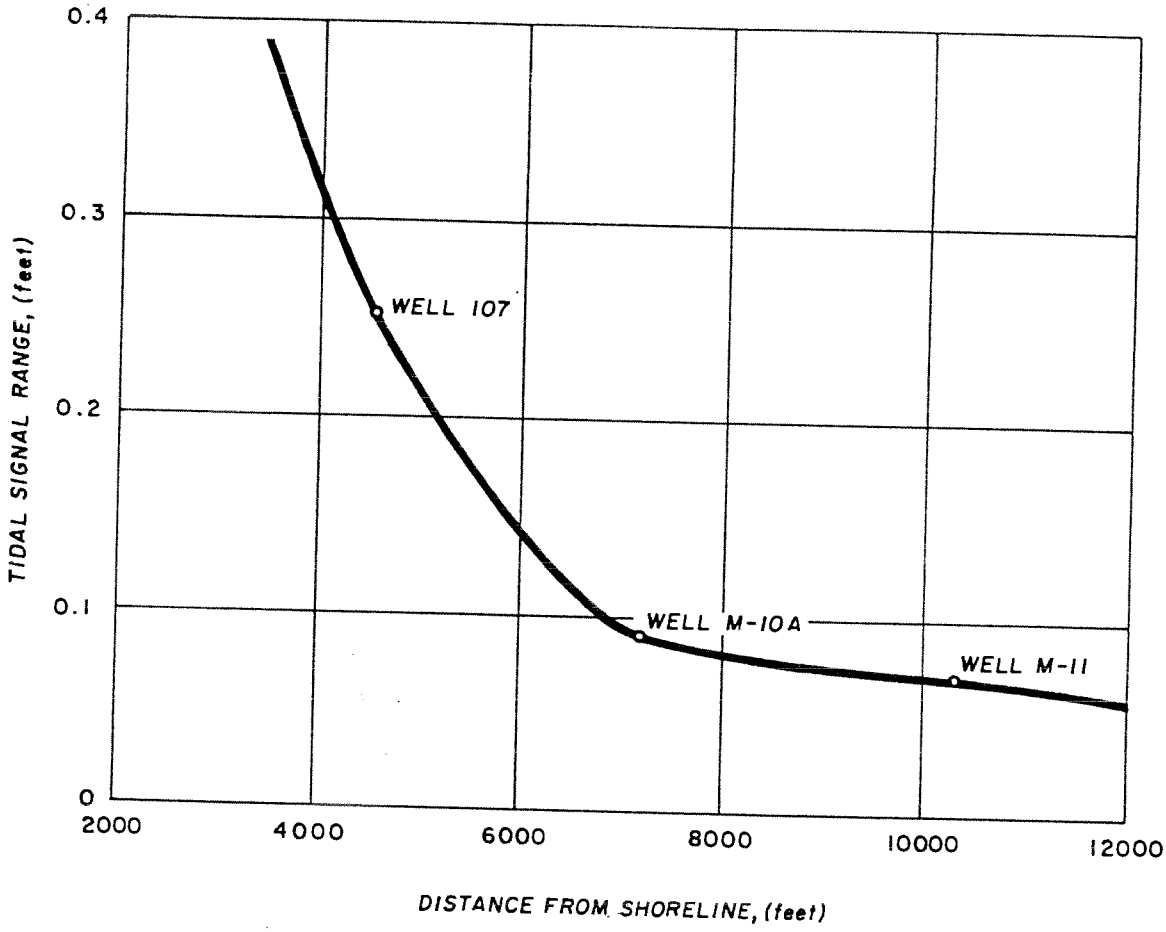
As pointed out in WERI's hydrogeologic report (1982), water level fluctuations also vary as a result of regional sea level changes and tidal influence from the nearby coast. Figure 4-4 shows that tidal effects decrease with distance from the coastline because of the dampening effect of the aquifer formation. At Well No. 107 (see Plate 1) near the coast in the Yigo Subbasin, the tidal signal range is on the order of 0.4 feet. Inland, this effect decreases to less than 0.1 feet at Wells M-10a and M-11. Regional sea level changes may account for ranges in groundwater level fluctuations on the order of one foot relative to mean sea level. Because these changes have a relatively long period (on the order of yearly), the response of the water levels is much smoother compared to the sharp diurnal and semi-diurnal changes found for tidal effects.

Transition Zone

The thickness of the fresh water lens over a salt water body is governed by the amount of head above sea level that exists at a particular location. At equilibrium, for every foot of head above sea level, 40 feet of fresh water theoretically occurs below sea level (this relationship, known as the Ghyben-Herzberg principal, is based on the density difference between fresh water and salt water). For this relationship to be entirely accurate, the boundary between the two types of water must be sharp. Actually, this boundary is gradational, resulting in a zone of varying salinity between the sea water and fresh water lens known as the transition zone. To analytically evaluate the interrelationship between the salt water and fresh water lens, the assumed boundary between the two lenses is taken to be the point where salinity is 50 percent of the salinity of sea water. A detailed description of the transition zone is provided in Appendix D; the pertinent points are discussed below.

The transition zone occurs as a result of stresses on the aquifer, such as tidal fluctuations, seasonal variations in recharge, and pumping. The thickness of the transition zone varies over the Northern Lens. The configuration of the transition zone is measured by passing a conductivity probe through the fresh water into the underlying salt water. An example of this type of survey is illustrated on Figure 4-5 for Exploratory Well No. EX-8. The relative salinity in transition from fresh water to salt water roughly follows the error function curve of normal distribution. As shown on Table 4-2, lower permeability aquifers generally have thicker transition zones than those areas of higher permeability. For example, EX-4, which is located in the argillaceous limestone, has a permeability of about 1,300 ft/d (Table C-1, Appendix C) and a transition zone thickness of 80 feet (Figure A-3, Appendix A). On the other hand, EX-10, drilled into clean limestones in the central part of the Northern Lens, has a permeability of about 6,600 ft/d (Table C-1, Appendix C) and a transition zone thickness of about 32 feet (Figure A-7, Appendix A).

The relative impact of the stimuli affecting the aquifer varies regionally. For example, in the Yigo Subbasin, fresh water head fluctuations due to



NOTE: FROM HYDROGEOLOGIC REPORT FOR THE NORTHERN GUAM LENS STUDY BY THE UNIVERSITY OF GUAM, WATER AND ENERGY RESEARCH INSTITUTE (1982).

FIGURE 4-4

TIDAL SIGNAL ATTENUATION RATE FOR INLAND WELLS

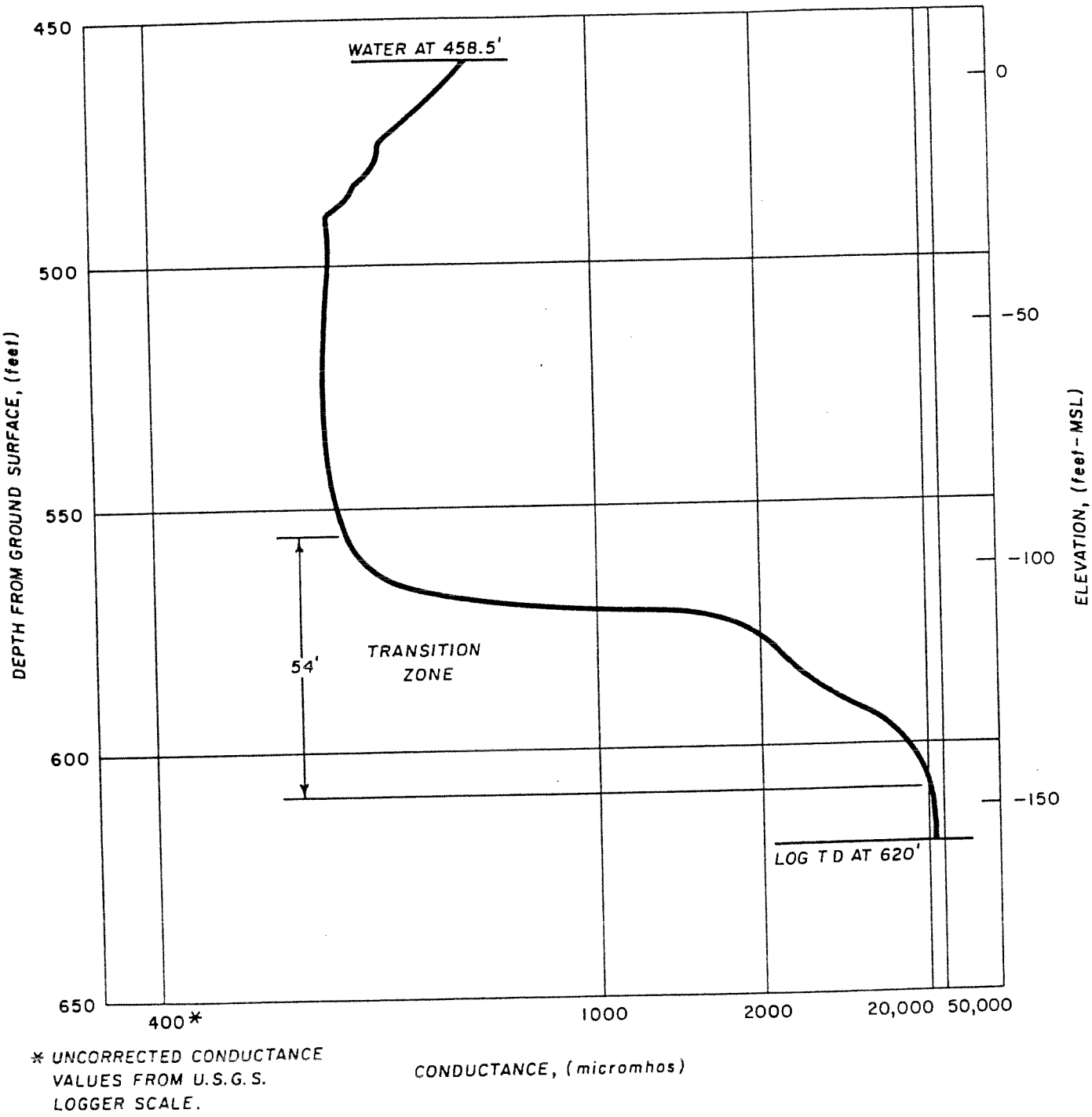


FIGURE 4-5
CONDUCTIVITY LOG - WELL EX-8
FEBRUARY 12, 1982

TABLE 4-2

COMPARISON OF PERMEABILITY AND
TRANSITION ZONE THICKNESS IN
NORTHERN GUAM

Exploratory Well Number	Transition Zone * Thickness (feet)	Permeability ** (feet/day)
EX-1	104	830
EX-4	80	1,300
EX-7	27	5,700
EX-8	54	8,500
EX-9	45	4,500
EX-10	32	6,600

* From Figures A-2 though A-8, Appendix A.
** From Table C-1, Appendix C.

tidal effects vary from 0.4 feet near the coast to less than 0.1 feet inland (see Figure 4-4). At the equilibrium condition, these fluctuations would translate into a 4- to 16-foot variation in transition zone thickness for instantaneous adjustment according to the Ghyben-Herzberg relationship. However, equilibrium conditions of the lens are never achieved instantaneously due to hydrostatic influences, so that actual movement of the interface cannot be determined directly from changes in water level elevations. In this same area, recharge causes a seasonal fluctuation of about 0.5 feet, which translates (again, at equilibrium) into a transition zone variation of 20 feet. Pumping can cause a local variation in groundwater level of about 0.3 feet, with a corresponding fluctuation in the transition zone of about 12 feet. Taken together, these stimuli theoretically create a transition zone that is on the order of 35 to 50 feet thick. In the Dededo area, measured transition zone thicknesses vary from about 27 feet at Exploratory Well No. EX-7 (see Appendix A, Figure A-4) to 47 feet at the Guam Housing and Urban Renewal Authority Monitoring Well, referred to locally as the GHURA-Dededo well (see Appendix A, Figure A-8). Therefore, the theoretical and actual transition thicknesses are comparable.

SUMMARY OF SUBBASIN HYDROGEOLOGY

The hydrogeologic characteristics of the six subbasins of northern Guam (see Figure 4-1) vary considerably. The following paragraphs summarize the hydrogeology of each subbasin.

Agana Subbasin

The aquifer in the Agana Subbasin is the Argillaceous member of the Mariana limestone. As indicated by the investigation of drilling cores by WERI (1982), porosities within the fresh water aquifer of this area are generally less than four percent. Permeabilities range from less than 500 ft/d in the southern part of the subbasin to over 3,000 ft/d near Mount Barrigada in the northern part of the subbasin (Table C-1, Appendix C); regional permeabilities probably average between 500 ft/d and 1,500 ft/d in the subbasin. The very high parabasal lens heads (20 to 30 feet) measured in the extreme southern portion of the Northern Lens suggests that permeabilities in this area are much lower than the subbasin average and are probably on the order of 10 to 100 ft/d.

Because permeabilities are low in the subbasin, water recharging the aquifer does not flow quickly toward the ocean upon reaching the water table. Because of this, the recharge waters accumulate, resulting in higher water levels relative to other areas of the Northern Lens. Basal lens water levels in the central part of the subbasin generally range between 4 and 7 feet above sea level and fluctuate 2 to 3 feet seasonally. Parabasal water levels range to over 30 feet along the southern boundary of the subbasin.

Mangilao Subbasin

The Mangilao Subbasin is located on the east side of the ridge connecting Mount Barrigada and Mount Santa Rosa. Aquifers in this subbasin are in both the Barrigada and Mariana limestones. Based on analysis of similar limestones and the estimated aquifer permeability, porosities within the

fresh water aquifer of this area are probably in the range of 10 to 20 percent. Permeabilities range from about 500 to 2,000 ft/day (Table 4-1). Water levels in the basal portion of the aquifer are around 3 feet above mean sea level. Parabasal heads measured at Well No. M-11 (near Mount Barrigada) range up to about 5 feet above mean sea level. In the northern part of the subbasin, near Janum Point, limestones are relatively thin over the volcanic formation, and as a result, water recharging this area tends to migrate as sheet flow on the volcanics that make up the east flank of Mount Santa Rosa. Flow continues to nearly the coastline, where it discharges from springs (the largest is Janum Spring). Basal groundwater does not appear to occur in this area.

Andersen Subbasin

The Andersen Subbasin is located on the northeast corner of northern Guam, beneath Andersen Air Force Base. The Mariana and Barrigada limestones form the aquifer of this subbasin. Porosities within the fresh water aquifer are estimated to be in the range of 10 to 20 percent, based on the estimated permeability of about 2,000 ft/d. Maximum basal water levels are about 3 feet. Wells are not known to penetrate the parabasal portion of the lens in this subbasin, so water levels here are unavailable. Taragüe Spring, located west of the main runway at Andersen Air Force Base occurs in cavernous Mariana limestone. The spring produced water for many years until intrusion of saline water contaminated the supply.

Agafa Gumas Subbasin

The Agafa Gumas Subbasin is located on the northwest corner of the island. The aquifer is contained within the Barrigada and Mariana limestones. Permeabilities are relatively high and probably range to over 8,000 ft/d (Table C-1, Appendix C). Judging from the magnitude of the permeabilities, porosities in the fresh water aquifer are probably also high, on the order of 15 to 25 percent. Basal water levels are highest near Agafa Gumas, with a value of 4 to 5 feet above sea level. In the larger portion of the subbasin north of Agafa Gumas, water levels are between 2.5 and 3 feet. Parabasal water levels are greater than 5 feet above sea level.

Finegayan Subbasin

The Finegayan Subbasin is located along the western flank of Mataguac Hill. The aquifer consists of the Mariana and Barrigada limestones. Permeabilities range from about 3,000 to over 4,000 ft/d in the subbasin. Porosities within the fresh water aquifer are probably correspondingly high, in the range of 15 to 20 percent. Maximum basal water levels are between 2.5 and 3.5 feet above mean sea level. Parabasal water levels have never been measured, but are probably on the order of 4 to 5 feet above sea level.

Yigo Subbasin

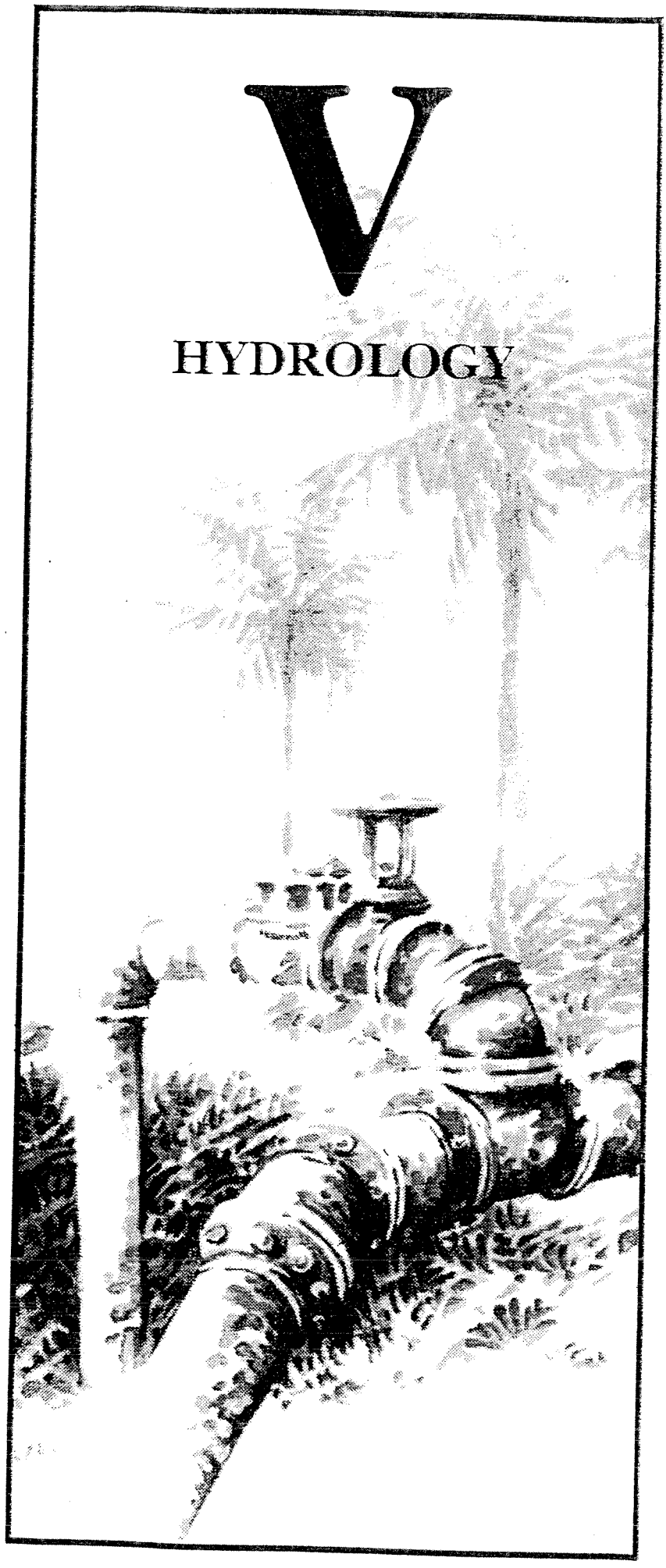
The Yigo Subbasin is the largest subbasin in northern Guam and is located on the western flank of the ridge that connects Mount Santa Rosa and Mount Barrigada. Unique among the Northern Lens subbasins, the aquifer is contained in a long, relatively narrow trough between Mataguac Hill and the Mount Barrigada-Mount Santa Rosa Ridge. The head of the trough begins between Mount Santa Rosa and Mataguac Hill and extends southwestward into Tumon Bay. The aquifer formations within the trough are the Barrigada and Mariana limestones. Permeabilities here are the highest of northern Guam's aquifers range between about 4,000 and 15,000 ft/d. The corresponding porosities are probably as much as 15 to 30 percent. Basal water levels within the subbasin range from about 3 feet near Dededo to over 4 feet near Yigo. Parabasal water levels have not been measured.

RECOMMENDED STUDIES

To refine the estimates of the limestone aquifer hydrodynamics, particular emphasis should be placed on determining the areal distribution of aquifer permeability and porosity, as well as further investigation of those areas where the geometry of the aquifer is not well known (such as at Northwest Field and Andersen Air Force Base). Much of this knowledge will automatically become available as the groundwater production facilities are expanded. Therefore, the information presented in this report should be reevaluated as new wells are drilled and tested.

V

HYDROLOGY



V. HYDROLOGY

GENERAL

This chapter of the report discusses the hydrologic aspects of the NGLS which are directly pertinent to determining the sustainable yield of the Northern Lens. Topics addressed are the determination of the amounts and areal distributions of precipitation, pan evaporation, potential evapotranspiration, recharge and leakage. Because hydrologic data are limited for the purposes of accurately determining sustainable yield, the chapter concludes with recommendations for future hydrologic data collection programs that could be used to verify these estimates.

MANAGEMENT ZONES

To make it easier to determine the hydrologic parameters and to provide maximum flexibility in implementating and managing future water supply development programs, northern Guam has been divided into six major hydrologic subbasins, which, in turn, have been subdivided into 47 management zones (see Figure 5-1). The boundaries between hydrologic subbasins have been drawn along sub-topographic divides on the top of the volcanic basement (see Plate 1). By subdividing the basins into management zones, areal variations in meteorological data can be more accurately represented. In addition, management alternatives can be easily evaluated and implemented because the magnitude of resource development is dependent upon the sustainable yield in the specific area of demand. The management zones in each subbasin are separated into areas underlain by basal and parabasal groundwater. The management zones underlain by basal groundwater do not extend any closer to the coastline than 4,000 feet to provide a fresh water barrier or buffer between the ocean and the inland areas being heavily produced. The management zones underlain by parabasal groundwater extends from the salt water toe inland to the drainage divide. However, significant amounts of groundwater cannot be produced much further inland than the zero elevation volcanic basement contour because groundwater occurs here only as a relatively thin sheet which flows on top of the volcanics. For

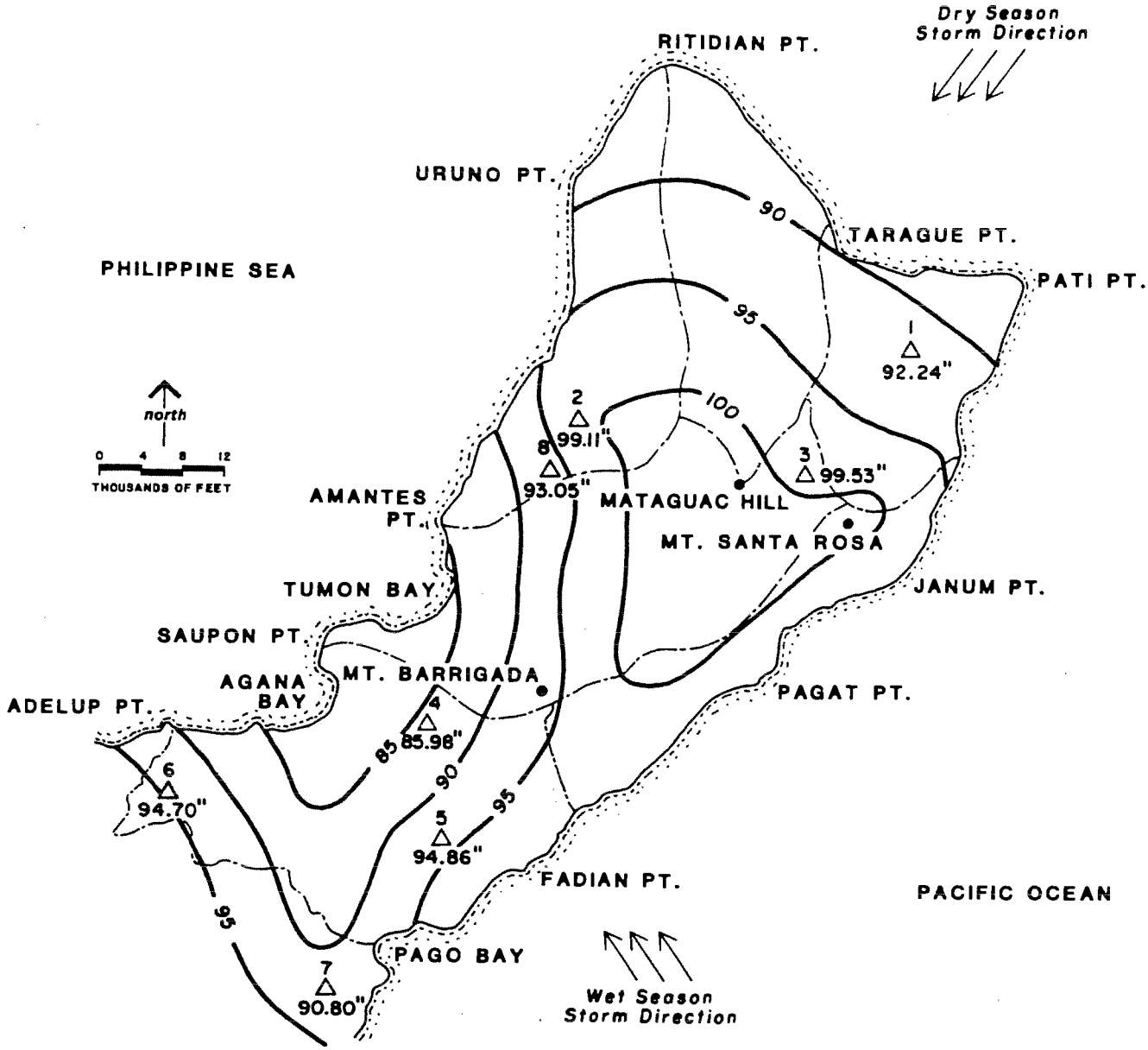
further ease, the existing well fields have been isolated in their own management zones as much as possible from those areas that are relatively undeveloped.

PRECIPITATION

The first rainfall measurements were made in Guam in 1906 at the Naval Station. Three raingages operated in Guam up until 1941 and the Japanese occupation of the island. Bewteen 1947 and 1951, Pacific Island Engineers established 13 raingages throughout the island, and in 1952, the USGS, U.S. Navy, and U.S. Air Force established about 20 stations. Most of these stations were operated for only a few years and abandoned. The long-term and most reliable raingage stations in northern Guam were installed in 1950, and from this date, the best record of rainfall for northern Guam was established. The USGS started compiling all records starting in 1951 for their own stations, as well as those stations operated by the Government of Guam, the U.S. Navy, and the U.S. Air Force. Their efforts continued through 1979. The National Oceanographic and Atmospheric Administration (NOAA) has compiled and published meteorological data for a few raingage stations in Guam since 1954. In 1980, seven raingage stations were in operation today, as shown on Figure 5-2. Appendix A (Tables A-1 through A-2h) contains a summary of northern Guam precipitation data which were used in this report for determining recharge, leakage, and sustainable yield.

The base period of record for the rainfall analyses performed during the NGLS was selected for the 31-year period from 1950 through 1980. Over that period, the Northern Lens had an average annual rainfall of about 94 inches. Average annual rainfall values ranged from 86 inches at the Naval Air Station in Tamuning to nearly 100 inches at the Yigo Agricultural Station. The areal variation in annual average rainfall is shown on the isohyetal map for northern Guam (see Figure 5-2).

Table 5-1 shows the monthly and annual average precipitation for the eight stations (as shown on Figure 5-2) used to evaluate the areal distribution



Raingage Stations

1. ANDERSEN AIR FORCE BASE
2. NATIONAL WEATHER SERVICE
3. YIGO-FINEGAYAN AG. STATION
4. NAVAL AIR STATION
5. MANGILAO
6. FLEET WEATHER CENTRAL - NIMITZ HILL
7. PAGO RIVER
8. NAVAL COMMUNICATIONS STATION

Legend

△ 93.05" — RAINGAGE STATION LOCATION & AVG. ANN. RAINFALL IN INCHES

HYDROLOGIC SUBBASIN BOUNDARY

90 — AVERAGE ANNUAL RAINFALL CONTOUR (INCHES)

FIGURE 5-2

AVERAGE ANNUAL RAINFALL
NORTHERN GUAM

TABLE 5-1

SUMMARY OF MONTHLY AND ANNUAL AVERAGE
PRECIPITATION AT SELECTED SITES IN NORTHERN GUAM*

Station Location	Average Monthly Precipitation (inches)												Average Annual Precipitation (inches)
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
Naval Air Station	4.53	3.40	2.91	3.52	5.41	5.36	9.84	12.57	13.55	11.94	8.90	4.99	85.98
Andersen Air Force Base	5.04	4.64	3.85	3.86	6.11	5.12	9.72	13.00	12.66	13.52	8.55	5.87	92.24
Yigo Agricultural Station	3.85	5.50	4.04	4.41	6.91	5.38	10.26	13.64	13.27	14.81	9.04	7.68	99.53
National Weather Service Finegayan	5.56	4.70	4.03	4.07	6.71	5.61	10.70	13.97	14.66	13.93	8.93	6.24	99.11
Mangilao	5.64	4.14	3.15	4.10	5.80	6.38	9.40	13.14	15.42	11.92	9.15	5.61	94.86
Fleet Weather Central Nimitz Hill	5.23	3.93	3.63	5.89	5.09	5.95	10.58	13.43	13.35	13.35	9.41	5.62	94.70
Naval Communications Station	5.93	3.38	3.72	3.13	6.40	6.31	9.31	14.59	12.72	13.17	8.58	5.82	93.05
Pago River	4.61	3.89	3.06	3.53	5.48	6.37	9.92	13.46	13.04	12.47	8.92	5.89	90.80
Average of Stations	5.05	4.20	3.55	3.81	5.99	5.81	9.97	13.48	13.58	13.14	8.93	5.96	93.78

* Incomplete rainfall records correlated to the Naval Air Station record which covers a 31-year base period from 1950-1980.

of rainfall in northern Guam. The longest and most complete record of these eight stations was from the Naval Air Station (NAS). The other seven stations had records that varied in length from seven years at the Mangilao station to 31 years at Andersen Air Force Base. So that rainfall estimates would be based on the entire 31 years for all stations, the record at the Naval Air Station was used to fill in the missing monthly data for the other seven stations. Date fill-in was done by performing a regression analysis for the corresponding years and months for NAS and the station in question. These expanded records are provided on Tables A-2a through A-2h in Appendix A.

The filled in rainfall record indicates distinct dry and wet seasons in Guam. The dry season runs from January through June. During this season rainfall comes from local showers. The seasonal average rainfall during the dry season is approximately 5 inches per month.

The typhoon season marks the beginning of the wet season, which runs from July through December. Rainfall during the wet season is produced from major regional storm systems. During this season, the average rainfall is about 12 inches per month. The maximum monthly rainfall generally occurs in August and September and has historically ranged to over 30 inches per month, but averages about 14 inches per month. During typhoons, rainfall intensities are extreme and can be as much as eight inches in two hours, 18 inches in 12 hours, and 24 inches in 24 hours (Tracey, et al; 1964). However, the long-term records show that monthly and annual rainfall are rather consistent on Guam, with the exception of high intensity rain generated during the occassional strong typhoons.

Northern Guam does not have a well established, incised drainage system because the limestones are so permeable that rainfall infiltrates almost immediately upon reaching the ground. An exception to this is the Fonte River which flows from the volcanic upland area of sourthern Guam toward the north and west around Nimitz Hill. The average annual flow for the Fonte River is estimated to be about 1,000 gpm (see Appendix F). In developed areas of the interior, runoff over streets is usually diverted to open trenches, such as in Liguan, or to dry wells, such as those used at

Andersen Air Force Base. Upon reaching storm water retention areas, the runoff infiltrates. Some areas near the coast have storm drains that lead to the ocean. Although this water may be relatively significant locally, the areas drained in this way generally are within the 4,000 foot buffer zone established for determining sustainable yield values, and therefore, should not significantly impact the recharge values developed.

EVAPORATION AND EVAPOTRANSPIRATION

Pan evaporation is measured in only one location in northern Guam, and that is at the National Weather Service (NWS) Station of the U.S. Weather Bureau located in Finegayan. It is measured using a standard Weather Bureau Class A evaporation pan. The average monthly pan evaporation is tabulated in Appendix A for the period from 1974 through 1981. Evaporation, like precipitation, varies seasonally, though not as drastically. During the dry season, average pan evaporation is about 7 inches per month. In the wet season, it averages about 6 inches per month. The average monthly pan evaporation is 6.85 inches and the annual average is about 82 inches.

To properly calculate recharge for the Northern Lens, potential evapotranspiration values should be used. Potential evapotranspiration (hereafter referred to as just evapotranspiration) is the combined total of evaporation and biological (plant) transpiration of water that occurs if the plant has a continuous supply of water.

Evapotranspiration rates for various types of vegetation have not been measured in Guam. However, research conducted by Chang, et al (1963) suggested that pan evaporation and evapotranspiration are roughly equivalent for tropical vegetation. Mink (1976) based his estimates of recharge in northern Guam on Chang's research results. However, because the use of evapotranspiration is more accurate in determining recharge, it is used in this report. Through the use of calculated evapotranspiration rates, this report establishes the method used to estimate recharge. When actual evapotranspiration rates have been determined for northern Guam, the actual

values can replace the calculated values. Then, using the procedures discussed in this chapter and in the Appendices, recharge can be more accurately evaluated.

To establish the procedure for calculating recharge, areal variation in evapotranspriation rates had to be estimated. Three established methods were used to estimate evapotranspiration: the Hargreaves (1956), the Thornthwaite (1944), and the Blaney-Criddle (1950) methods. These methods of determining evapotranspiration are discussed in detail in Appendix E. The calculated mean monthly evapotranspiration rate ranged from 3.40 inches (Hargreaves method) to 6.65 inches (Blaney-Criddle method). The selection of the method used for estimating recharge was based on two factors: 1) obtaining a conservative estimate of recharge and sustainable yield (until which time recharge could be reevaluated using actual evapotranspiration rate data), and 2) obtaining results that most closely correspond to Chang's and Mink's assumptions in which evapotranspriation and pan evaporation are roughly equivalent. Table 5-2 summarizes the evapotranspiration values calculated in Appendix E, as well as the measured evaporation from the NWS station in Finegayan. The Blaney-Criddle method yielded an average monthly evapotranspiration rate of about 6.65 inches, which is the most conservative for calculating recharge and which is quite close to the average monthly evaporation of 6.85 inches. For this reason, evapotranspiration rates determined by the Blaney-Criddle method were used to estimate recharge to the Northern Lens and to establish the procedure for updating the estimated recharge using actual evapotranspiration data when they become available.

RECHARGE

Recharge to the Northern Lens was evaluated by computing the rainfall-evapotranspiration relationship for northern Guam and by evaluating the rainfall-runoff characteristics of the Pago River Basin of southern Guam. These methods of estimating recharge are summarized in the following paragraphs and discussed in detail in Appendix F.

TABLE 5-2

COMPARISON OF CALCULATED EVAPOTRANSPIRATION RATES
AT THE NATIONAL WEATHER SERVICE STATION, FINEGAYAN
(inches)

Month	Evapotranspiration Rates			Pan Evaporation Rate
	Hargreaves Method	Thornthwaite Method	Blandy-Criddle Method	
JAN	3.55	4.42	6.19	6.65
FEB	3.39	4.42	5.72	6.49
MAR	3.93	4.55	6.56	8.05
APR	4.00	5.01	6.65	8.32
MAY	4.04	5.14	7.08	8.43
JUN	3.75	5.35	6.98	7.46
JULY	3.28	5.14	7.13	6.47
AUG	2.90	5.07	6.96	5.91
SEPT	2.91	5.07	6.55	5.70
OCT	2.96	5.01	6.54	6.17
NOV	2.76	5.07	6.18	6.24
DEC	3.27	4.81	6.23	6.34
Total	40.74	59.08	78.78	82.23

Very little rainfall leaves northern Guam (excluding that portion within the 4,000-foot buffer zone) except for surface runoff from the Nimitz Hill management zone via the Fonte River. Using the Pago River surface water runoff analyses (see Appendix F), average Fonte River runoff to the ocean is estimated to be about 1,000 gpm (or about 1.44 MGD). Except for this runoff, all other rainfall that remains after evapotranspiration is assumed to recharge the groundwater system. Water that infiltrates past the root zone is assumed to move vertically downward until it reaches the fresh

water lens or until it reaches the volcanic basement rocks above sea level, at which time it moves laterally until it reaches the fresh water lens. Annual recharge is calculated by subtracting the evapotranspiration rate from mean monthly precipitation and then summing these monthly recharge rates for the twelve months of the year.

During the dry season, when rainfall is low, evapotranspiration continues because the plants can extract the needed water from storage in the soil. This eventually results in a soil moisture deficiency. During these periods of little or no rainfall, the plant will also go into drought stress and will consume less water than it would if unlimited water were available. Thus, actual transpiration is generally less than potential evapotranspiration. During the next rainfall event, the soil moisture deficiency is replaced prior to any recharge to the groundwater system. Soil moisture deficiency is very difficult to estimate, so in order to estimate recharge, when evapotranspiration exceeds rainfall in any particular month, recharge is assumed to be zero.

Recharge was calculated at the eight raingage locations shown on Figure 5-2. As indicated on Table 5-3, recharge at these locations varied from 28.75 inches per year at the Naval Air Station to 37.97 inches per year at the NWS Station in Finegayan. The average recharge rate for these stations is about 32.97 inches per year for the 31-year base period.

An evaluation of recharge was also done by comparing rainfall to runoff characteristics of the Pago River Basin, located just south of the northern plateau limestone province, along its southeastern boundary (see Appendix F). A water balance was determined by correlating the stream flow data for the Pago River Basin (where groundwater base flow is minimal) for the period 1976 to 1979 to rainfall data measured in the Pago River Basin for the period 1952 to 1966 (but adjusted to the 1976 to 1979 time period using 1976 to 1979 rainfall data at the nearby Mangilao raingage station). Using this method, recharge was estimated to be between 40 and 50 percent of rainfall, or about 35 to 40 inches per year. Though these results are similar to those shown in Table 5-3, problems encountered with this method for determining recharge led to its not being used to evaluate sustainable

TABLE 5-3

AVERAGE MONTHLY RECHARGE ESTIMATES AT VARIOUS RAINGAGE STATIONS IN NORTHERN GUAM

Station Location	Months												Total (Inches)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Naval Air Station	0.82	0.58	0.14	0.48	1.65	0.50	2.96	5.63	6.94	5.76	2.92	0.37	28.75
Yigo Agricultural Station	0.19	1.08	0.55	1.10	2.52	0.49	3.20	6.61	6.83	8.19	2.90	1.88	35.54
Mangilao	1.11	0.76	0.18	0.54	1.58	0.76	2.20	6.09	8.90	5.32	3.02	0.68	31.14
Andersen Air Force Base	1.04	1.22	0.76	0.93	2.41	0.28	2.91	6.24	6.34	7.04	2.61	0.95	32.73
Naval Communications Station	1.46	0.22	0.40	0.14	2.29	1.00	2.56	7.80	6.19	6.92	2.46	0.50	31.94
Pago River	0.60	0.79	0.11	0.56	1.34	1.06	3.36	6.33	6.37	5.79	2.93	1.02	30.26
Fleet Weather Central - Nimitz Hill	1.00	0.67	0.64	0.87	0.94	0.92	5.21	6.33	7.91	6.76	3.47	0.74	35.46
National Weather Service - Finegayan	1.21	1.12	0.75	0.88	2.54	0.44	3.62	7.14	8.40	7.39	3.41	1.07	37.97
													32.97
													Northern Guam Average

yield. One problem is that the runoff characteristics between the southern volcanics and the northern limestones are quite different because of terrain, lithology, and vegetation (type and density) differences. Another problem is the major differences in soil type and thicknesses.

Average annual recharge rates on northern Guam have been estimated in several ways by researchers in the past. Mink (1976) estimated annual recharge rates of 25.62 inches at the Naval Air Station, 27.69 inches at Andersen Air Force Base, and 37.72 inches at the NWS Station in Taguac (Finegayan). These values are in the same range as developed in the NGLS. Ayers (1981) used a much different approach to calculate recharge by relating the average chloride-ion concentration of rainfall in Guam to the chloride-ion concentration observed in the parabasal groundwater areas. By this method, he estimated recharge to be about 32.68 inches per year. He reports that previous estimates by other researchers ranged from about 31 inches per year to about 53 inches per year, with most of the estimates falling between 31 and 38 inches per year. These recharge rates, determined by independent methods, suggest that the rates used in this report are realistic.

As discussed earlier, northern Guam has been subdivided into 47 management zones (shown in Figure 5-1). Each zone was assigned a recharge value based on the recharge rates calculated for nearby precipitation stations using the rainfall-evapotranspiration method developed in Appendix F. These assigned unit recharge rates are shown on Table 5-4 for the parabasal management zones and Table 5-5 for the basal management zones. To determine the recharge over the management zones, the area of each zone is multiplied by the unit recharge. As an example, the recharge in the Chalan Pago management zone is calculated as follows:

Zone area (A) = 35,748,000 sq.ft.

assigned unit recharge Ru = 34 in/yr or 0.00776 ft/day

TABLE 5-4

RECHARGE RATES FOR PARABASAL MANAGEMENT ZONES
OF THE NORTHERN LENS

SUBBASIN NAME	AREA (ft^2)	UNIT RECHARGE (in/yr)	UNIT RECHARGE (ft/day)	AREAL RECHARGE (ft^3/day)	AREAL RECHARGE (gpm)	AREAL RECHARGE (MGD)
AGANA						
Pago Bay	14,035,000	31	0.00708	99,400	520	0.74
Chalan Pago	35,748,000	34	0.00776	277,400	1,440	2.07
Nimitz Hill	97,993,000	36	0.00822	805,500	4,180	6.03
Anigua	31,700,000	36	0.00822	260,600	1,350	1.95
Mt. Barrigada South	9,798,000	30	0.00685	67,100	350	0.50
Mt. Barrigada East	22,280,000	32	0.00731	162,900	850	1.22
MANGILAO						
Mangilao South	9,222,000	34	0.00776	71,600	370	0.54
Mangilao North	11,527,000	35	0.00799	92,100	480	0.69
Adacao	25,648,000	36	0.00822	210,800	1,100	1.58
Sabanan Pagat	17,061,000	37	0.00845	144,200	750	1.08
Janum	27,608,000	35	0.00799	220,600	1,150	1.65
ANDERSEN						
Tarague	29,517,000	34	0.00776	229,100	1,190	1.71
Salisbury	79,490,000	35	0.00799	635,100	3,300	4.75
Lupog	41,960,000	34	0.00776	325,600	1,690	2.44
AGAFA GUMAS						
Agafa Gumas West	23,977,000	35	0.00799	191,600	1,000	1.43
Agafa Gumas Central	113,832,000	36	0.00822	935,700	4,860	7.00
Agafa Gumas East	45,378,000	35	0.00799	362,600	1,880	2.71

TABLE 5-4

(Continued)

SUBBASIN NAME	AREA (ft^2)	UNIT RECHARGE (in/yr)	UNIT RECHARGE (ft/day)	AREAL RECHARGE (ft^3/day)	AREAL RECHARGE (gpm)	AREAL RECHARGE (MGD)
FINEGAYAN						
Callon Tramojo	25,937,000	36	0.00822	213,200	1,110	1.60
Finegayan East	29,452,000	36	0.00822	242,100	1,260	1.81
Potts	23,977,000	35	0.00799	191,600	1,000	1.43
YIGO						
Mt. Barragada West	48,713,000	31	0.00708	344,900	1,790	2.58
Mogfog	23,631,000	32	0.00731	172,800	900	1.29
Marbo South	19,020,000	33	0.00753	143,200	740	1.07
Marbo North	9,798,000	34	0.00776	76,000	400	0.57
Yigo East	30,259,000	35	0.00799	241,800	1,260	1.81
Mt. Santa Rosa	20,634,000	36	0.00822	169,600	880	1.27
Mataguac	23,285,000	37	0.00845	196,800	1,020	1.47
Yigo West	50,287,000	37	0.00845	424,900	2,210	3.18
Y-Sengsong	80,434,000	36	0.00822	661,200	3,430	4.95
TOTALS					42,460	61.1

TABLE 5-5

RECHARGE RATES FOR BASAL MANAGEMENT ZONES
OF THE NORTHERN LENS

SUBBASIN NAME	AREA (ft^2)	UNIT RECHARGE (in/yr)	UNIT RECHARGE (ft/day)	AREAL RECHARGE (ft^3/day)	AREAL RECHARGE (gpm)	AREAL RECHARGE (MGD)
AGANA						
Barrigada	25,245,000	29	0.00662	167,100	870	1.25
Toto	32,219,000	32	0.00731	235,500	1,220	1.76
Agana Swamp	47,769,000	34	0.00776	370,700	1,930	2.77
Sabanan Maagas	65,517,000	31	0.00708	463,900	2,410	3.47
Manaca	67,343,000	32	0.00731	492,300	2,560	3.68
MANGILAO						
Asbeco	14,294,000	34	0.00776	110,900	580	0.83
Taguan	12,587,000	35	0.00799	100,600	520	0.75
Sasajyan	5,764,000	36	0.00822	47,400	250	0.35
ANDERSEN						
Anao	14,727,000	34	0.00776	114,300	590	0.85
Andersen	24,734,000	33	0.00753	186,200	970	1.39
AGAFA GUMAS						
Northwest Field East	142,301,000	35	0.00799	1,137,000	5,910	8.50
FINEGAYAN						
Northwest Field West	52,334,000	35	0.00799	418,100	2,170	3.13
Finegayan West	22,939,000	36	0.00822	188,600	980	1.41
NCS	57,637,000	36	0.00822	473,800	2,460	3.54
YIGO						
Dededo North	64,762,000	35	0.00799	517,400	2,690	3.87
Dededo South	112,406,000	36	0.00822	924,000	4,800	6.91
Macheche	55,385,000	33	0.00753	417,000	2,170	3.12
Asatdas	53,245,000	35	0.00799	425,400	2,210	3.18
TOTAL					35,290(gpm)	50.8(MGD)

Therefore, recharge = (RT) = A x Ru

= 35,748,000 x 0.00776

= 277,400 ft^3/day

= 1,440 gpm

= 2.07 MGD

The average subbasin unit recharge, as shown on Tables 5-4 and 5-5, is fairly consistent over the Northern Lens and ranges from about 33 inches per year (in/yr) in the Agana Subbasin to about 36 in/yr in the Finegayan Subbasin. As shown on Table 5-6, the 68 square miles of the Northern Lens being considered for potential production (excluding the 4,000-foot coastal buffer zone) has a total recharge of about 112 mgd, which yields an overall average recharge rate over that area of about 34.6 inches per year.

GROUNDWATER PRODUCTION

Except for a few privately owned wells on northern Guam, the production from the groundwater system is done by PUAG, the U. S. Air Force, and the U. S. Navy. There are presently over 70 municipal wells in operation in northern Guam (excluding those wells in the 4,000-foot buffer zone) which have a maximum capacity to yield about 20.46 MGD. The maximum production capacity is slightly higher than the actual amount of water extracted from wells because the wells are periodically shut down for maintenance and wells may be cycled on and off in response to reservoir level fluctuations and local demands. For example, in 1980, actual production was about 18 MGD. In addition, about 1.5 MGD leaves the Agana Subbasin as outflow to the ocean via the Fonte River.

Table 5-7 summarizes the maximum production capacity from the basal and parabasal groundwater systems in each subbasin. The Yigo Subbasin has the highest groundwater production capacity of any subbasin in northern Guam, with about 10.31 MGD. The Agana Subbasin can produce about 5.67 MGD from wells, the Finegayan Subbasin about 2.65 MGD, and the Agafa Gumas Subbasin about 1.41 MGD. The Andersen Subbasin produces only occassionally from the

TABLE 5-6

SUMMARY OF RECHARGE TO SUBBASINS OF THE NORTHERN LENS

Subbasin	Area (ft^2)	Recharge (ft^3/day)	Recharge (gpm)	Recharge (mgd)
AGANA				
Parabasal	211,554,000	1,673,200	8,690	12.51
Basal	238,093,000	1,729,500	8,990	12.94
Subtotals	449,647,000	3,402,700	17,680	25.45
MANGILAO				
Parabasal	91,066,000	739,300	3,850	5.53
Basal	32,645,000	258,900	1,350	1.94
Subtotals	123,711,000	998,200	5,200	7.47
ANDERSEN				
Parabasal	150,967,000	1,189,800	6,180	8.90
Basal	39,461,000	300,500	1,560	2.25
Subtotals	190,428,000	1,490,300	7,740	11.15
AGAFA GUMAS				
Parabasal	183,187,000	1,489,900	7,740	11.14
Basal	142,301,000	1,137,000	5,910	8.51
Subtotals	325,488,000	2,626,900	13,650	19.65
FINEGAYAN				
Parabasal	79,366,000	646,900	3,370	4.84
Basal	132,910,000	1,080,500	5,610	8.08
Subtotals	212,276,000	1,727,400	8,980	12.92
YIGO				
Parabasal	306,061,000	2,431,200	12,630	18.19
Basal	285,798,000	2,283,800	11,870	17.08
Subtotals	591,859,000	4,715,000	24,500	35.27
TOTALS	1,893,409,000	14,960,500	77,750	111.9
	or 67.92 sq. mi.			

TABLE 5-7

SUMMARY GROUNDWATER PRODUCTION CAPACITY
FOR THE NORTHERN LENS

Subbasin	Subbasin (gpm)	Production (mgd)
AGANA		
Parabasal	1,945	2.80
Basal	1,995	2.87
Subtotals	3,940	5.67
MANGILAO		
Parabasal	660	0.95
Basal	320	0.46
Subtotals	980	1.41
ANDERSEN		
Parabasal	-0-	-0-
Basal	-0-	-0-
Subtotals	-0-	-0-
AGAFA GUMAS		
Parabasal	290	0.42
Basal	-0-	-0-
Subtotals	290	0.42
FINEGAYAN		
Parabasal	260	0.37
Basal	1,580	2.28
Subtotals	1,840	2.65
YIGO		
Parabasal	1,530	2.20
Basal	5,630	8.11
Subtotals	7,160	10.31
TOTALS	14,210	20.46

well located on the Andersen Air Force Base golf course. Production from the Yigo, Agana, and Finegayan Subbasins account for over 90 percent of total pumping capacity from the Northern Lens.

LEAKAGE

Leakage from the Northern Lens aquifer is the amount of fresh water loss to the ocean that occurs around the periphery of northern Guam. In the dry season, when little or no recharge reaches the water table, leakage is derived from groundwater that is in storage in the fresh water lens. The water depleted from storage during the dry season due to loss by leakage is usually replaced during the wet season period of high recharge. Therefore, over the long-term average (steady-state) conditions, leakage can be estimated by subtracting annual groundwater production from the average annual recharge rate.

Average annual recharge to the Northern Lens is about 112 MGD in the area of potential production (68 square miles) plus about 53 MGD contributed by rainfall infilitration to the area within the 4,000-foot coastal buffer zone (33 square miles with about 34 inches per year recharge), for a total recharge of about 165 MGD. Present maximum production capacity (20.46 MGD) plus surface runoff to the ocean (1.44 MGD) in the Northern Lens is about 21.90 MGD (see Table 5-7). Therefore, average annual leakage from the Northern Lens is about 143 MGD.

RECOMMENDATIONS FOR FURTHER STUDY

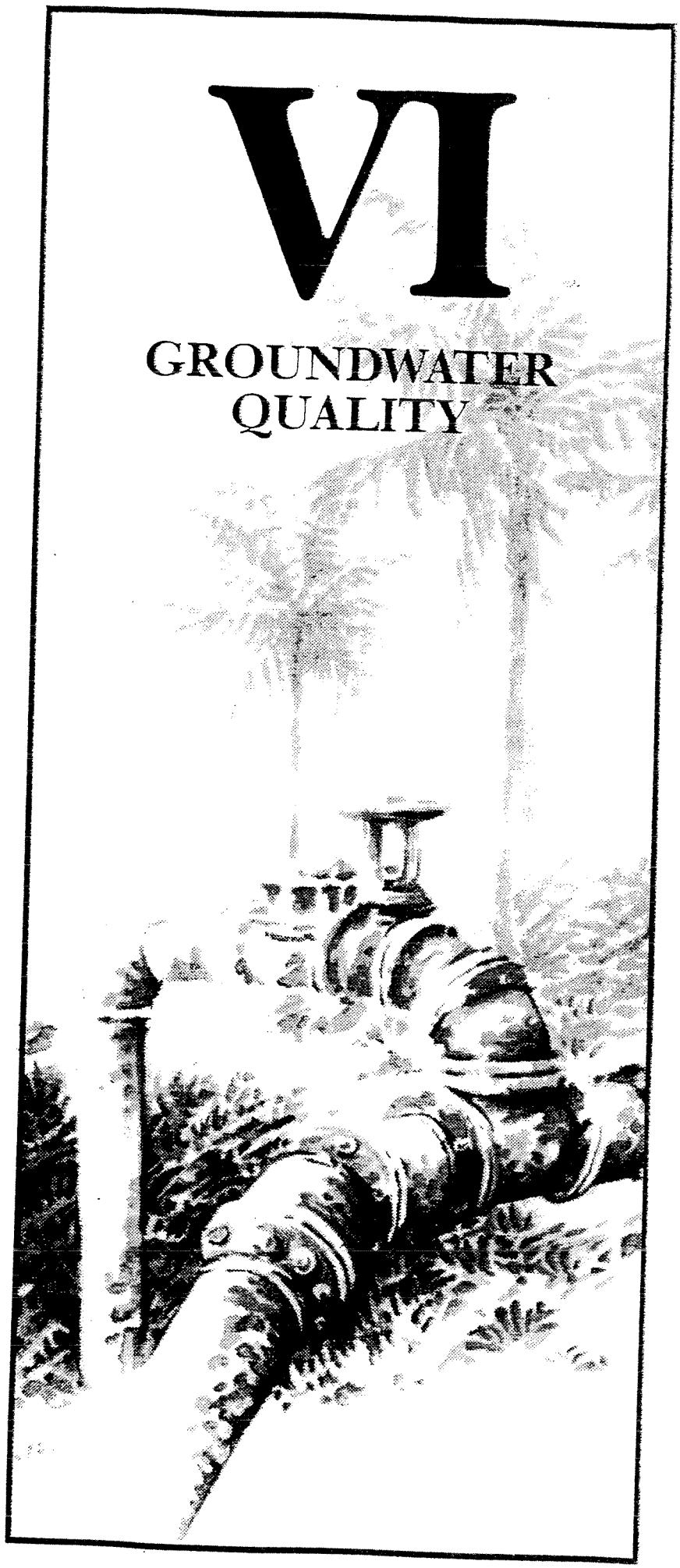
To refine the estimated recharge rates calculated in this report, two items are recommended for future consideration:

1. Raingage stations should be established in the Latte Heights area (near well M-9), in Agafa Gumas (near well AG-1), and in the Ordot area (as shown on Figure A-1 in Appendix A).

2. An investigation should be conducted in order to determine the actual evapotranspiration of vegetation in northern Guam.

VI

GROUNDWATER QUALITY



VI. GROUNDWATER QUALITY

GENERAL

This section summarizes the overall water quality of the Northern Lens. Special consideration is given to chloride and nitrate concentrations, as well as specific conductance. Table 6-1 summarizes the general water quality trends for well fields within each subbasin. The Data Report (Appendix A) summarizes the water quality trends on a well-by-well basis, usually from the time each was drilled through 1982. A more detailed discussion of groundwater quality is presented in the NGLS Groundwater Management Alternatives report and the Groundwater Management Program report.

Water quality analyses of varying detail are available for wells in northern Guam. In the past (through the early 1970's), the USGS made numerous thorough analyses. PUAG, on the other hand, has done monthly analyses on each of its wells, but has limited the analyses to chlorides, alkalinity, pH, hardness and conductivity. However, enough information is available to indicate that the main constituents of water in northern Guam are calcium and bicarbonate, which is typical of limestone aquifers.

Scattered samplings were gathered during the NGLS and were analyzed for priority pollutants designated by the U.S. EPA. These analyses indicate that northern Guam's groundwater resources are extremely clean, with only isolated minor contamination. High selenium concentrations (.013 mg/l) were noted in Well No. A-17. The U.S. EPA recommended drinking water standard is 0.010 mg/l. The source of this contaminant was not readily apparent during field investigations. In addition, Well No. M-1 showed a concentration of 0.30 mg/l of methylene chloride, which is used as a cleaning solvent for metal and electronic parts. No apparent source was evident, but it may be related to historic land use after the war.

TABLE 6-1

NORTHERN LENS SUBBASIN GROUNDWATER QUALITY SUMMARY

SUBBASIN	GENERAL CHARACTER	WATER QUALITY TRENDS CHLORIDES	NITRATES (as NO_3)	CONDUCTIVITY (micromhos)
AGANA	Calcium Bicarbonate	-Initially at 15 mg/l. -Early wells increased slightly to and steady at 20 - 40 mg/l. -Later wells from 75 to 250-300 mg/l.	-Though low have generally doubled from less then 3-5 to 6-10 mg/l.	-Steady at about 500 for earlier wells. -900 to 1300 for some later wells.
YIGO	Calcium Bicarbonate	-Initially 15-20 mg/l. -Most steady at about 50 mg/l. -D-8, 9, 13, rose to 200-400 mg/l. -Y-series wells rose from 20 to 40 mg/l and steady.	-Nitrates steady between 3 to 10 mg/l.	-Steady at 400 to 600.
FINEGAYAN	Calcium Bicarbonate	-Initially at 20 mg/l -Steady between 50 and 150 mg/l.	-Steady at 5-6 mg/l.	-Steady at 500 to 800.
AGAFO GUMAS	Calcium Bicarbonate	-Initially at 13 mg/l. -Steady between 15 and 40 mg/l.	-Steady 8 mg/l.	Steady at 450.
ANDERSEN	Calcium Bicarbonate	-Generally elevated to 400 mg/l. -BPM 35-50 mg/l.	-Less than 3 mg/l.	-BPM steady at 600. -Older wells 1000 to 2000.
MANGILAO	Calcium Bicarbonate	-Initially at 20-30 mg/l. -Generally steady at 30-50 mg/l. -M-1 150 - 250 mg/l.	-Steady at 7-9 mg/l.	-Most steady at 400 to 500. -M-1 and M-9 800 to 1000.

The results of this water quality survey are published in the Investigation of the Priority Pollutants chapter of the NGLS Groundwater Management Program report. Past significant contamination of the groundwater with such constituents as trichlorolethylene (TCE) and fuel have been mitigated naturally because of the very rapid flushing action of the highly permeable limestone aquifers.

CHLORIDES

Chloride concentrations generally indicate the success of a well in a fresh water lens which is underlain or immediately adjacent to salt water. Elevated chlorides indicate upconing or intrusion of the salt water into the fresh water lens. Based on a comparison of historic water quality (particularly chloride concentration) in Northern Lens wells and the corresponding well's location relative to estimated basal and parabasal lens areas, chloride concentrations of less than 30 mg/l probably indicate parabasal conditions in the underlying aquifer. Concentrations between 70 mg/l and 150 mg/l in wells indicate basal conditions in the underlying aquifer. Concentrations between 30 and 70 mg/l probably reflect the area overlying the salt water toe. Concentrations over 150 mg/l may indicate a critical upconing condition in the basal aquifer.

As indicated in Table 6-1, wells in most areas of the Northern Lens have operated successfully and are not experiencing severe degradation of water quality as a result of upconing. In the Andersen Subbasin and the northwest part of the Agana Subbasin, chloride concentrations are generally elevated. In the Andersen Subbasin, all wells, except for the well located at the golf course, were abandoned because they exhibited high chloride concentrations, which made them useless as a drinking water supply. This problem may have arisen because the wells were drilled too deep into the fresh water lens, which increases upconing potential. The Tumaning area between the town of Agana and the Naval Air Station has historically exhibited elevated chlorides. This may be because rainfall runoff from the airport is diverted by storm drains to Agana Bay. Diverting the water in this fashion significantly reduces recharge to the groundwater system, thus

allowing encroachment of salt water from Agana Bay toward Mount Barrigada. This area of encroachment is illustrated on Figure 5-1 (see Chapter V) by the inland positioning of the "boundary for safe pumping" beyond the established 4000-foot coastal buffer zone.

NITRATES

Nitrate concentrations are generally indicative of waste contamination. Because people live over the groundwater lens, minor contamination is expected. For the most part, nitrate levels have remained reasonably low, in the range of 2 to 10 mg/l (as NO_3). However, Mink (1976) noted that the nitrate load from on-site sewage disposal systems is not sufficient to account for the nitrate levels observed in the lens. He felt that nitrates contributed from on-site disposal systems should not be any higher than 2 mg/l in the Northern Lens. He suggested that the nitrate-fixing, tree-like shrub called tangan-tangan (Leucaena glauca), which is very common throughout northern Guam, could generate enough nitrate to account for at least 10 mg/l concentrations in the groundwater system. However, more research is needed to substantiate the magnitude of the impact that tangan-tangan has as a major nitrate source to the groundwater system.

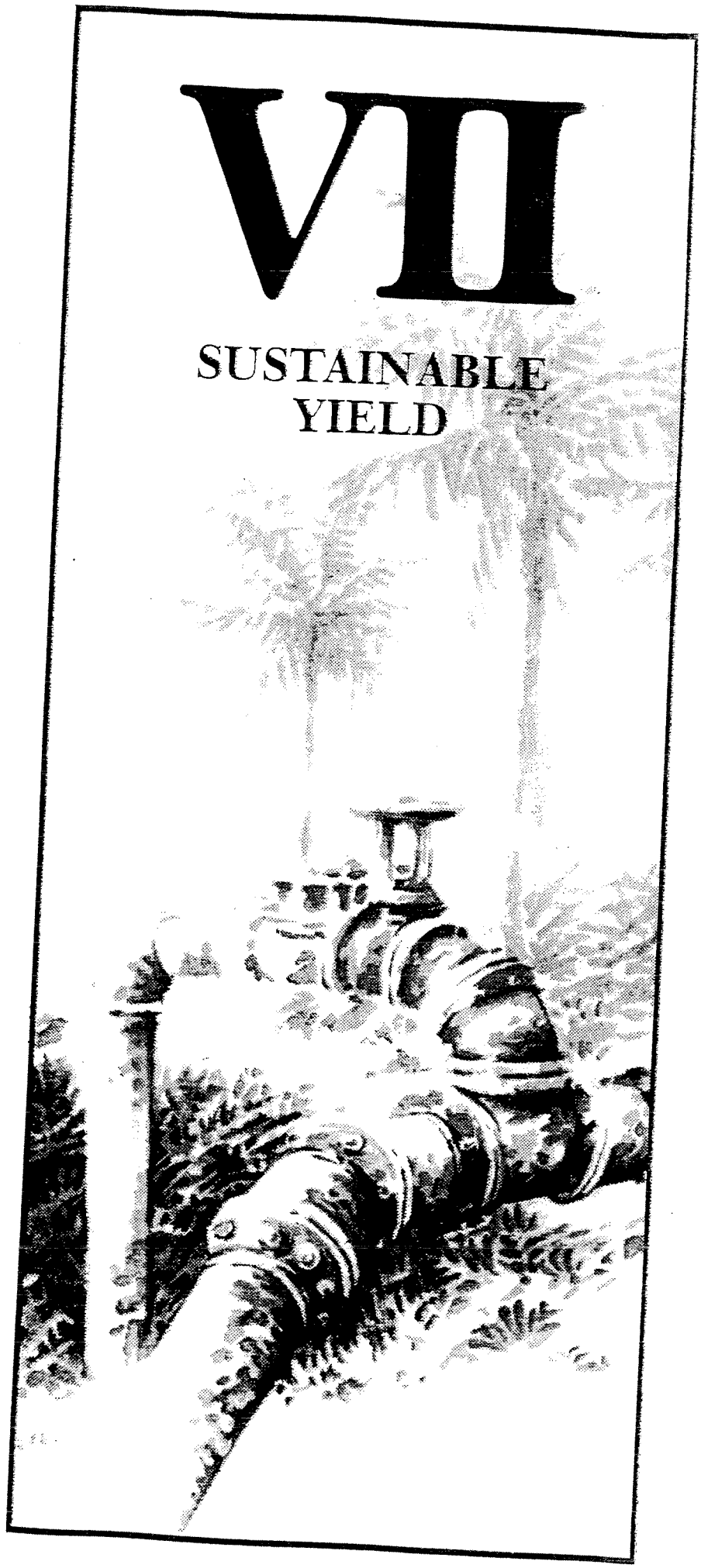
SPECIFIC CONDUCTANCE

Specific conductance, which correlates closely with total dissolved solids (TDS), is an indicator of overall water quality. Water produced from the Northern Lens exhibits specific conductance in the range between 300 and 1,300 micromhos and averages from 550 to 600 micromhos. This is equivalent to about 400 mg/l TDS. These values for specific conductance are somewhat high by drinking water standards, but, at these levels, do not constitute a health hazard. These levels are indicative of the often high chlorides associated with nearby salt water. Historically, specific conductance has usually remained steady from well to well. Those wells displaying above average specific conductance are usually the same ones that also exhibit high chloride concentrations caused by unusual hydraulic properties of the aquifer or by improper well design. If the general well design criteria that are outlined in the "Well Construction Manual" are followed, then

future wells should not exhibit unusually high specific conductance or chloride concentrations. Occassionally, wells such as Nos. D-13, A-16, and M-11 will be drilled properly yet have poor quality water probably due to extreme anisotropic aquifer conditions in which vertical permeability far exceeds horizontal permeability. This condition cannot be predicted. However, proper well design can help insure that water quality remains high.

VII

SUSTAINABLE YIELD



VII. SUSTAINABLE YIELD

GENERAL

This section presents the estimates of the sustainable yield for the Northern Lens of Guam. The information presented represents the culmination of the work presented in previous sections and the appendices of this report.

Sustainable yield is defined as the maximum amount of water that can be continuously withdrawn from the fresh water lens without impairing the integrity of the lens and the water quality. Sustainable yield is not equal to recharge, for if all water contributed by recharge were extracted, the lens would slowly dissipate because of continued leakage along the coastline.

To protect the integrity of the lens, conservative assumptions were made to determine the sustainable yield. These assumptions are:

1. The sustainable yield is calculated for each basal and parabasal management zone independent of recharge and/or production from other management zones.

2. Additional yield will not be produced in a 4,000-foot coastal buffer zone.

3. The yield available to each management zone is derived only from the infiltration of recharge to that zone from above and not from lateral inflow from an adjoining management zone.

4. Yield is a percentage of recharge based on historic head variations within a particular management zone.

MANAGEMENT ZONES

Figure 5-1 in Chapter V shows the 18 basal and 29 parabasal management zones that subdivide the six hydrologic subbasins of northern Guam. Basal management zones are differentiated from parabasal zones because wells in parabasal zones can generally yield more water than wells in basal zones without the adverse water quality effects caused by upconing (Appendix D). Under basal conditions where fresh water heads are less than four feet, present well design practices have demonstrated that wells operated at about 200 gpm have few failures due to upconing. Where fresh water heads exceed four feet in elevation, wells operated at 350 gpm in most cases should not be adversely affected by upconing. On the other hand, parabasal area wells do not have this problem, and if placed at least 500 feet away from the basal zone to avoid problems with local salt water intrusion, they should yield 500 to 750 gpm in clean limestone without causing adverse water quality changes. However, in the argillaceous limestone in the southern part of the lens, parabasal wells may only yield 350 gpm or less because of the relatively low regional aquifer permeabilities, and should not be placed any closer than 1,000 feet to the basal zone.

By subdividing the hydrologic subbasins into management zones, the groundwater resources can be easily managed because the available yield in the areas of demand is easier to identify. Also, by utilizing smaller subdivisions, areal variations in recharge can be evaluated in more detail, and areas of existing highly concentrated production, such as the Dededo and Mangilao well fields, can be isolated and excluded from consideration for future development.

A 4,000-foot wide coastal buffer zone without any new production is recommended around much of the coastline of northern Guam. Mink (1976) used a 2,000-foot wide zone that was based on low heads near the coast. The basis for expanding the zone from 2,000 feet to 4,000 feet zone is:

1. Heads are generally less than two feet above sea level in this area, and any significant production from this buffer zone will

cause more upconing than from the same amount of production further inland.

2. Tidal effects are greatest near the coast and will cause a corresponding increase in thickness within the transition zone. A thicker transition zone and lower heads near the coast significantly decreases the thickness of the fresh water lens and increases the potential for salt water upconing to wells.

3. A higher percentage of wells has been abandoned due to salt water contamination along the coast than inland. Evidence clearly shows more risk of upconing is likely along the coast.

4. Given the lower heads and thinner fresh water lens near the coast, wells placed here will probably yield less than 100 gpm safely. With higher capacity well development areas available inland, the cost per gallon of water produced would be higher along the coast.

5. Most of the commercial enterprises in northern Guam are located along the west coast, and groundwater production areas are located upstream of the commercial areas. Potential contamination of the drinking water supply can be avoided if future wells are not placed near commercial areas.

RECHARGE CONSIDERATIONS

The yield available from each management zone is assumed to occur as a result of direct infiltration of recharge within that zone with no contribution from lateral inflow from adjacent management zones. This assumption allows each management zone to be independently considered and unaffected by development in an adjacent or upstream management zone. By making this assumption, a conservative sustainable yield value can be derived, and subsequent development and management programs can be easily implemented.

The percentage of yield derived from recharge in parabasal management zones is greater than that in basal zones. Mink (1976) calculated a range of ratios for yield-to-recharge for basal aquifer areas and recommended that production of sustainable yield should not lower the head of the fresh water lens by more than one to two feet in clean limestone in order to protect the quality of water pumped from the wells. By relating production (P) from the lens to the recharge (R) and leakage (L), the percentage recharge available for sustainable yield can be developed on a regional basis.

$$L = \frac{41\ K}{2X} h_e^2 \qquad (7\text{-}1)$$

Recharge, on the other hand, is calculated at steady-state without any production from the aquifer;

where: K = permeability (ft/d)

X = distance from the coast to an inland observation point (feet)

h_e = the stable fresh water head at the observation point at full production, with $h_e < h$ (feet)

$$\text{Recharge } (R) = \frac{41\ K}{2x} h_o^2 \qquad (7\text{-}2)$$

where: h_o = initial fresh water head at the observation point prior to any pumping from the aquifer (feet)

Under steady-state conditions, the amount of water that can be developed (P) from the aquifer for a given equilibrium head, h_e, is obtained by subtracting equation (7-2) from (7-1):

$$P = R - L = \frac{41K}{2x}\left(h_o^2 - h_e^2\right) \qquad (7\text{-}3)$$

Under steady-state conditions, the fraction of recharge available for sustainable yield resulting from a drop in fresh water head from h_o to h_e is given by:

$$\frac{P}{R} = \frac{h_o^2 - h_e^2}{h_o^2} \qquad (7\text{-}4)$$

The fraction of original head that yields the equilibrium head as a result of aquifer production is:

$$\frac{h_e}{h_o} = \left(1 - \frac{P}{R}\right)^{1/2} \qquad (7\text{-}5)$$

Equation 7-5 is a powerful concept regarding the integrity of the fresh water lens under pumping conditions. For example, if production reduces recharge by 50 percent, the corresponding equilibrium head is only 70 percent of the original head.

Using the relationship described by equation (7-4) as the fraction of recharge available for sustained yield, Mink (1976) estimated that yield from basal aquifers was between 35 and 40 percent assuming a change in head between the dry season and wet season. To determine the areal distribution of percentage yield, the basal areas of each subbasin were evaluated using water level data measured in April of 1982 (Appendix A, Table A-8) and the estimated water levels during the wet season. As shown on Table 7-1, the ratio of yield to recharge ranges from 40 percent in the Dededo area to 55 percent in the eastern part of the Agana Subbasin.

In parabasal zones, establishing a percentage of recharge available for sustainable yield is somewhat arbitrary. Two items must be considered in establishing this value:

1. Production must be limited to the extent that the salt water toe does not advance inland more than about 1,000 feet due to seasonal fluctuations in recharge. As a design consideration, parabasal

TABLE 7-1

SUSTAINABLE YIELD AND EQUILIBRIUM HEADS

Subbasin Area	Initial* Head (ft)	Equilibrium** Head (ft)	$\frac{p}{R}$*** (%)	$\frac{h_e}{h_o}$**** (%)
West Agana	10.0	7.0	51.0	70
East Agana	6.0	4.0	55.6	67
Mangilao	4.0	3.0	43.8	75
Andersen	4.0	3.0	43.8	75
Northwest Field	3.0	2.25	43.8	75
Finegayan	3.5	2.5	49.9	71
Dededo	4.5	3.5	39.5	78
Yigo	5.0	3.5	51.0	70

* Estimate of wet season water levels.
** Measured in April 1982.
*** Draft (or production) divided by recharge.
**** The percentage decrease in head for a given equilibrium production.

wells should be located as far from the toe as possible, without going inland of the zero contour line of the basement complex.

2. Maximum production should be limited by how much water can be feasibly intercepted by a well field, allowing minimum flow to pass. Many small-capacity wells closely spaced, could capture most of the recharge. However, drilling, as well as operation and maintenance costs would be high when compared to similar costs of far fewer high-capacity wells spaced further apart.

Taking these items into consideration and considering that parabasal areas are not susceptible to upconing, 60 percent of the recharge was estimated to be available for sustainable yield from the parabasal lens.

DETERMINATION OF SUSTAINABLE YIELD

Recharge values were assigned to each management zone based on the estimates developed in the Hydrology Chapter and Appendix F. The values for recharge and the resulting yield from basal management zones of each subbasin are shown on Table 7-2. Similarly, the recharge values for the parabasal zones are shown on Table 7-3. On these tables, the percentage of recharge used to obtain sustainable yield are shown in parenthesis in the "Subbasin Yield" column. Table 7-4 summarizes these values for each subbasin. The following paragraphs review the subbasin yields, current production capacity, the unused yield for each subbasin, and the approximate number and capacity of wells required to produce the unused yield; these values are summarized on Tables 7-2, 7-3, and 7-4.

Agana Subbasin

The Agana Subbasin is subdivided into five basal management zones and six parabasal zones as shown on Figure 7-1. Recharge to the basal zones ranges between 29 and 34 inches per year. Recharge to the parabasal zones ranges between 30 and 36 inches per year. The amount of sustained yield is 60 percent of available recharge in the parabasal management zones and range between 30 and 50 percent in the basal zones. Maximum existing basal zone well production occurs in the Sabana management zone with about 1,560 gpm capacity. The Chalan Pago parabasal zone has an existing production capacity of 1,110 gpm.

Highest unused yield in the parabasal areas occurs in the Nimitz Hill zone (820 gpm), followed closely by Anigua (810 gpm), and Mt. Barrigada East (510 gpm). Mt. Barrigada South and Pago Bay have little unused yield remaining for future development. In the Chalan Pago management zone, production exceeds sustainable yield which means that the yield is being produced from adjacent zones and from a greater percentage of incoming recharge.

In the basal management zones, the highest unused yield occurs in the Manaca zone (1,150 gpm), followed by Agana Swamp (625 gpm) and Toto (430

TABLE 7-2

RECHARGE, PRODUCTION AND YIELD
PARABASAL AQUIFER ZONES

SUBBASIN NAME	AREA (ft^2)	UNIT RECHARGE (in/yr)	UNIT RECHARGE (ft/day)	AREAL RECHARGE (ft^3/day)	AREAL RECHARGE (gpm)	SUBBASIN YIELD (gpm)	SUBBASIN PRODUCTION (gpm)	UNUSED YIELD (gpm)
AGANA								
Pago Bay	14,035,000	31	0.00708	99,400	520	310 (60)*	145	165
Chalan Pago	35,748,000	34	0.00776	277,400	1,440	860 (60)	1,110	(250)**
Nimitz Hill	97,993,000	36	0.00822	805,500	4,180	2,510 (60)	1,690†	820
Anigua	31,700,000	36	0.00822	260,600	1,350	810 (60)	-0-	810
Mt. Barrigada So.	9,798,000	30	0.00685	67,100	350	210 (60)	-0-	210
Mt. Barrigada East	22,280,000	32	0.00731	162,900	850	510 (60)	-0-	510
MANGILAO								
Mangilao So.	9,222,000	34	0.00776	71,600	370	220 (60)	-0-	220
Mangilao No.	11,527,000	35	0.00799	92,100	480	290 (60)	660	(370)**
Adacao	25,648,000	36	0.00822	210,800	1,100	660 (60)	-0-	660
Sabanan Pagat	17,061,000	37	0.00845	144,200	750	550 (60)	-0-	550
Janum	27,608,000	35	0.00799	220,600	1,150	460 (40)	-0-	460
ANDERSEN								
Tarague	29,517,000	34	0.00776	229,100	1,190	710 (60)	-0-	710
Salisbury	79,490,000	35	0.00799	635,100	3,300	1,980 (60)	-0-	1,980
Lupog	41,960,000	34	0.00776	325,600	1,690	1,015 (60)	-0-	1,015

TABLE 7-2

(Continued)

SUBBASIN NAME	AREA (ft^2)	UNIT RECHARGE (in/yr)	UNIT RECHARGE (ft/day)	AREAL RECHARGE (ft^3/day)	AREAL RECHARGE (gpm)	SUBBASIN YIELD (gpm)	SUBBASIN PRODUCTION (gpm)	UNUSED YIELD (gpm)
AGAFA GUMAS								
Agafa Gumas West	23,977,000	35	0.00799	191,600	1,000	600 (60)*	-0-	600
Agafa Gumas Central	113,832,000	36	0.00822	935,700	4,860	2,920 (60)	290	2,630
Agafa Gumas East	45,378,000	35	0.00799	362,600	1,880	1,130 (60)	-0-	1,130
FINEGAYAN								
Callon Tramolo	25,937,000	36	0.00822	213,200	1,110	660 (60)	-0-	660
Finegayan East	29,452,000	36	0.00822	242,100	1,260	760 (60)	260	500
Potts	23,977,000	35	0.00799	191,600	1,000	600 (60)	-0-	600
YIGO								
Mt. Barragada West	48,713,000	31	0.00708	344,900	1,790	900 (50)	-0-	900
Mogfog	23,631,000	32	0.00731	172,800	900	450 (50)	-0-	450
Marbo South	19,020,000	33	0.00753	143,200	740	450 (60)	-0-	450
Marbo North	9,798,000	34	0.00776	76,000	400	240 (60)	-0-	240
Yigo East	30,259,000	35	0.00799	241,800	1,260	750 (60)	170	580

TABLE 7-2

(Continued)

SUBBASIN NAME	AREA (ft^2)	UNIT RECHARGE (in/yr)	UNIT RECHARGE (ft/day)	AREAL RECHARGE (ft^3/day)	AREAL RECHARGE (gpm)	SUBBASIN YIELD (gpm)	SUBBASIN PRODUCTION (gpm)	UNUSED YIELD (gpm)
YIGO (continued)								
Mt. Santa Rosa	20,634,000	36	0.00822	169,600	880	530 (60)	-0-	530
Mataguac	23,285,000	37	0.00845	196,800	1,020	610 (60)	-0-	610
Yigo West	50,287,000	37	0.00845	424,900	2,210	1,320 (60)	675	645
Y-Sengsong	80,434,000	36	0.00822	661,200	3,430	2,060 (60)	685	1,375
TOTALS					42,460 gpm	25,075 gpm	5,685 gpm	19,390 gpm
					61.1 MGD	36.1 MGD	8.2 MGD	27.9 MGD

* Indicates the percentage of recharge available for sustainable yield.

** Numbers in parenthesis indicate that production exceeds sustainable yield and that the deficit is being drawn from surrounding cells.

† For the Nimitz Hill Management Zone, 690 gpm is from well production and about 1000 gpm is from Fonte River outflow (average annual) to the ocean.

TABLE 7-3

RECHARGE, PRODUCTION AND YIELD
BASAL AQUIFER ZONES

SUBBASIN NAME	AREA (ft^2)	UNIT RECHARGE (in/yr)	UNIT RECHARGE (ft/day)	AREAL RECHARGE (ft^3/day)	AREAL RECHARGE (gpm)	SUBBASIN YIELD (gpm)	SUBBASIN PRODUCTION (gpm)	USED YIELD (gpm)
AGANA								
Barrigada	25,245,000	29	0.00662	167,100	870	260 (30)*	190	70
Toto	32,219,000	32	0.00731	235,500	1,220	430 (35)	-0-	430
Agana Swamp	47,769,000	34	0.00776	370,700	1,930	870 (45)	245	625
Sabanas Maagas	65,517,000	31	0.00708	463,900	2,410	1,200 (50)	1,560	(360)**
Manaca	67,343,000	32	0.00731	492,300	2,560	1,150 (45)	-0-	1,150
MANGILAO								
Asbeco	14,294,000	34	0.00776	110,900	580	230 (40)	-0-	230
Taguan	12,587,000	35	0.00799	100,600	520	210 (40)	320	(110)**
Sasajyan	5,764,000	36	0.00822	47,400	250	90 (35)	-0-	90
ANDERSEN								
Anao	14,727,000	34	0.00776	114,300	590	240 (40)	-0-	240
Andersen	24,734,000	33	0.00753	186,200	970	390 (40)	-0-	390
AGAFA GUMAS								
Northwest Field East	142,301,000	35	0.00799	1,137,000	5,910	2,360 (40)	-0-	2,360

TABLE 7-3

(Continued)

SUBBASIN NAME	AREA (ft^2)	UNIT RECHARGE (in/yr)	UNIT RECHARGE (ft/day)	AREAL RECHARGE (ft^3/day)	AREAL RECHARGE (gpm)	SUBBASIN YIELD (gpm)	SUBBASIN PRODUCTION (gpm)	USED YIELD (gpm)
FINEGAYAN								
Northwest Field West	52,334,000	35	0.00799	418,100	2,170	870 (40)*	-0-	870
Finegayan West	22,939,000	36	0.00822	188,600	980	440 (45)	1,240	(800)**
NCS	57,637,000	36	0.00822	473,800	2,460	1,110 (45)	340	770
YIGO								
Dededo No.	64,762,000	35	0.00799	517,400	2,690	1,340 (50)	600	740
Dededo So.	112,406,000	36	0.00822	924,000	4,800	2,400 (50)	3,800	(1,400)**
Macheche	55,385,000	33	0.00753	417,000	2,170	870 (40)	-0-	870
Asatdas	53,245,000	35	0.00799	425,400	2,210	1,330 (60)	1,230	100
TOTAL					35,290gpm	15,790 gpm	9,525 gpm	6,265 gpm
					50.8 MGD	22.7 MGD	13.7 MGD	9.0 MGD

* Indicates the percentage of recharge available for sustainable yield.

** Numbers in parenthesis indicate that production exceeds sustainable yield and that the deficit is being drawn from surrounding cells.

TABLE 7-4

RECHARGE, PRODUCTION, AND YIELD SUMMARY FOR NORTHERN LENS

SUBBASIN	AREA (ft^2)	RECHARGE (ft^3/day)	RECHARGE (gpm)	SUSTAINABLE YIELD (gpm)	SUBBASIN PRODUCTION (gpm)	UNUSED YIELD (gpm)
AGANA						
Parabasal	211,554,000	1,673,200	8,690	5,210	2,945	2,265
Basal	238,093,000	1,729,500	8,990	3,910	1,995	1,915
Subtotals	449,647,000	3,402,700	17,680	9,120	4,940	4,180
MANGILAO						
Parabasal	91,066,000	739,300	3,850	2,180	660	1,520
Basal	32,645,000	258,900	1,350	530	320	210
Subtotals	123,711,000	998,200	5,200	2,710	980	1,730
ANDERSEN						
Parabasal	150,967,000	1,189,800	6,180	3,705	-0-	3,705
Basal	39,461,000	300,500	1,560	630	-0-	630
Subtotals	190,428,000	1,490,300	7,740	4,335	-0-	4,335
AGAFA GUMAS						
Parabasal	183,187,000	1,489,900	7,740	4,650	290	4,360
Basal	142,301,000	1,137,000	5,910	2,360	-0-	2,360
Subtotals	325,488,000	2,626,900	13,650	7,010	290	6,720
FINEGAYAN						
Parabasal	79,366,000	646,900	3,370	2,020	260	1,760
Basal	132,910,000	1,080,500	5,610	2,420	1,580	840
Subtotals	212,276,000	1,727,400	8,980	4,440	1,840	2,600
YIGO						
Parabasal	306,061,000	2,431,200	12,630	7,310	1,530	5,780
Basal	285,798,000	2,283,800	11,870	5,940	5,630	310
Subtotals	591,859,000	4,715,000	24,500	13,250	7,160	6,090
TOTALS	1,893,409,000	14,960,500	77,750	40,865	15,210	25,655
	67.92 sq. mi.		111.9 MGD	58.8 MGD	21.9 MGD	36.9 MGD

gpm). The Barrigada management zone has little unused yield remaining. Within the Sabana zone, production exceeds yield by 360 gpm and is probably utilizing yield from adjacent management zones, which should be taken into consideration in exploiting the sustainable yield in those adjacent zones.

The parabasal management zones which are most promising for future development are the Nimitz Hill, Anigua, and Mt. Barrigada East Zones. However, because the aquifers are contained in the low peremeability argillaceous limestone, new wells will probably be limited to a productivity of 200 gpm with an occassional 350 to 500 gpm well. The basal zones that are most promising for future development are the Manaca, Agana Swamp, and Toto. Wells in these management zones should be limited in capacity to 200 gpm. As shown on Table 7-4, the Agana Subbasin is presently producing about 55 percent of its available yield.

Mangilao Subbasin

The Mangilao Subbasin is subdivided into five parabasal and three basal management zones, as shown on Figure 7-2. Recharge to these zones ranges between 34 and 37 inches per year. Maximum recharge occurs in the Janum (1,150 gpm) and Adacao (1,100 gpm) parabasal zones. The amount of sustained yield is 60 percent of available recharge in the parabasal zones and ranges between 35 and 40 percent in the basal zones. The sustained yield is limited to 2,710 gpm in the Mangilao Subbasin because of the relatively small recharge area and its proximity to the coastline.

Presently, the only production in the subbasin occurs in the Mangilao North (660 gpm) and Taguan (320 gpm) management zones. In both of these zones, production exceeds yield. The parabasal zones in which development can most favorably occur are the Janum, Adacao, and Sabanan Pagat zones. The Adacao and Sabanan Pagat zones can accommodate one 500 gpm well each. Because the limestone is fairly thin in the Janum zone, the sustainable yield would probably best be produced using infiltration galleries. Among the basal management zones, the Asbeco is the only one capable of any further production and it should be limited to one 200 gpm well.

Andersen Subbasin

The Andersen Subbasin is subdivided into three parabasal and two basal management zones, as shown on Figure 7-3. Recharge to the subbasin ranges from 33 to 35 inches per year. The highest recharge occurs in the parabasal management zones and ranges from 1,190 gpm in the Tarague zone to 3,300 gpm in the Salisbury zone. The amount of sustainable yield is 60 percent of available recharge in the parabasal zones and 40 percent in the basal zones.

At present, no water is produced from the subbasin on a continuous basis. However, the BPM well located on the Andersen Air Force Base golf course is operational. Unused yield in the parabasal zones is substantial, with 1,980 gpm available in the Salisbury management zone, 710 gpm available in the Tarague zone, and 1,015 gpm available in the Lupog zone. The parabasal zones can accommodate a total of up to 7 additional 500 gpm wells. The basal zones have some water available for production, but many of the now abandoned wells in these areas have historically had salt water upconing problems. The yield is available for one well in each management zone, but development should be done carefully.

Agafa Gumas Subbasin

The Agafa Gumas Subbasin is subdivided into three parabasal management zones and one basal zone, as shown on Figure 7-4. Recharge to the subbasin ranges between 35 and 36 inches per year. The highest recharge occurs in the Agafa Gumas Central (4,860 gpm), and Agafo Gumas East (1,880) parabasal zones, and in the Northwest Field-East (5,910 gpm) basal zone. The amount of sustainable yield is 60 percent of available recharge in the parabasal management zones and 40 percent in the basal zone.

The only production in the subbasin occurs at Well Nos. AG-1 and AG-2, which have a combined pumping capacity of about 300 gpm. Because of the very large drainage basin located upgradient from these two production zones, the subbasin can yield substantial amounts of water. Unused yield in the subbasin ranges from 2,630 gpm in the Agafa Gumas Central zone to

600 gpm in the Agafa Gumas West zone. Total unused yield in the subbasin is nearly 7,000 gpm. Because most of the recharge that enters the parabasal management zones is funnelled through a fairly narrow section of aquifer at Agafa Gumas, use of larger capacity wells may be feasible. Approximately 7 wells with capacities of 500 gpm would probably be sufficient to exploit the sustainable yield in the parabasal zone. The basal Northwest Field-East zone has an unused yield of 2,360 gpm which can be extracted by about eleven to twelve 200 gpm wells.

Finegayan Subbasin

The Finegayan Subbasin is subdivided into three basal and three parabasal management zones, as shown on Figure 7-5. Recharge to the subbasin ranges between 35 and 36 inches per year. Areal recharge to the basal zones varies between 980 gpm in the Finegayan West zone and 2,460 gpm in the NCS zone. Recharge to the parabasal zones varies between 1,000 gpm in the Potts zone and 1,260 gpm in the Finegayan East zone. The amount of sustainable yield is 60 percent of the available recharge in the parabasal management zones and 40 to 45 percent in the basal zones.

Production in the parabasal management zones is currently limited to the Finegayan East zone, which has a well capacity of about 260 gpm. Production in the basal zones occurs in the Finegayan West (1,240 gpm) and the NCS (340 gpm) zones. In the Finegayan West zone, production exceeds yield by about 800 gpm. The Northwest Field-West zone has unused yield of about 870 gpm, and the NCS zone has unused yield of 770 gpm. In the parabasal management zones, unused yield ranges between 500 gpm in the Finegayan East zone to 660 gpm in the Callon Tramolo zone. Each of the parabasal zones can accommodate about one additional 500 gpm well. However, because existing production is so high in the Finegayan West basal zone, further production in the Finegayan East zone should be done carefully. In the basal zones, the Northwest Field-West zone can accommodate about four additional 200 gpm wells, and the NCS zone can accommodate about three additional 200 gpm wells.

Yigo Subbasin

The Yigo subbasin is subdivided into nine parabasal management zones and four basal zones as shown on Figure 7-6. Recharge to the subbasin ranges between 31 and 37 inches per year, with the maximum recharge occurring in the Y-Sengsong parabasal zone (3,430 gpm) and in the Dededo South basal zone (4,800 gpm). The amount of sustainable yield varies between 50 and 60 percent of available yield in the parabasal management zones and 40 to 60 percent in the basal zones. The lower percentage recharge values in the parabasal zones have been assigned because of the rugged terrain in those areas, which would limit the ability of wells to intercept recharge. The higher values in the basal zones are assigned because of the fairly high fresh water heads that result from the long distance to the coastline.

Production capacity is quite high in the Yigo Subbasin, totalling over 7,000 gpm, with most of this production coming from the basal zones. The Dededo South zone produces up to 3,800 gpm, and the Asatdas management zone produces about 1,230 gpm. Current production in the parabasal zones is relatively limited, with most of the extractions coming from the Yigo West (675 gpm) and Y-Sengsong (685 gpm) zones. The majority of the unused yield occurs in the parabasal zones with each zone having between 240 and 1,375 gpm additional yield. Because of the high permeability of the limestone aquifer, parabasal wells should yield between 500 and 750 gpm without detriment to the fresh water lens. However, several parabasal zones may be limited to 200 and 350 gpm wells because sustainable yield is being approached.

The existing production capacity in the basal management zones is high, so additional yield is limited. The Dededo North zone has 680 gpm of unused yield, while the Macheche zone has about 920 gpm. These zones can accommodate up to three and four 200 gpm wells each, respectively. But further development in the basal zones should be done carefully because production in the Dededo South management zones greatly exceeds available yield which may impact the amount of water available for yield from adjacent zones.

SUMMARY

As shown on Table 7-4, the total recharge to the Northern Lens is about 112 MGD over about a 68 square-mile area of the Northern Lens (excluding the 4,000-foot wide coastal buffer zone). Total sustainable yield for the parabasal and basal management zones is about 59 MGD, or about 53 percent of recharge. Total subbasin runoff and production capacity is about 22 MGD, and the total unused yield is about 37 MGD.

WELL DESIGN CONSIDERATIONS

In designing the capacity of any new well or well field, the following factors should be considered:

1. The optimum well capacity is directly related to permeability; that is, the lower the permeability, the lower the well capacity that can be expected.

2. Production from a management zone should not exceed the sustainable yield of the zone. If sustainable yield is presently being exceeded in a mangement zone, then the yield from upstream zones should be correspondingly reduced.

3. If water quality in a particular management zone is being degraded to the point of becoming unuseable, any future well facility development should be halted, and sustainable yield reevaluated, even if the reported sustainable yield has not been exceeded.

4. In clean limestones with relatively high permeability, wells should be placed no closer than 300 feet from one another. In the lower permeability argillaceous limestones of the Agana Subbasin area, wells should be placed at least 500 feet apart, and preferably, 1,000 feet apart.

VIII

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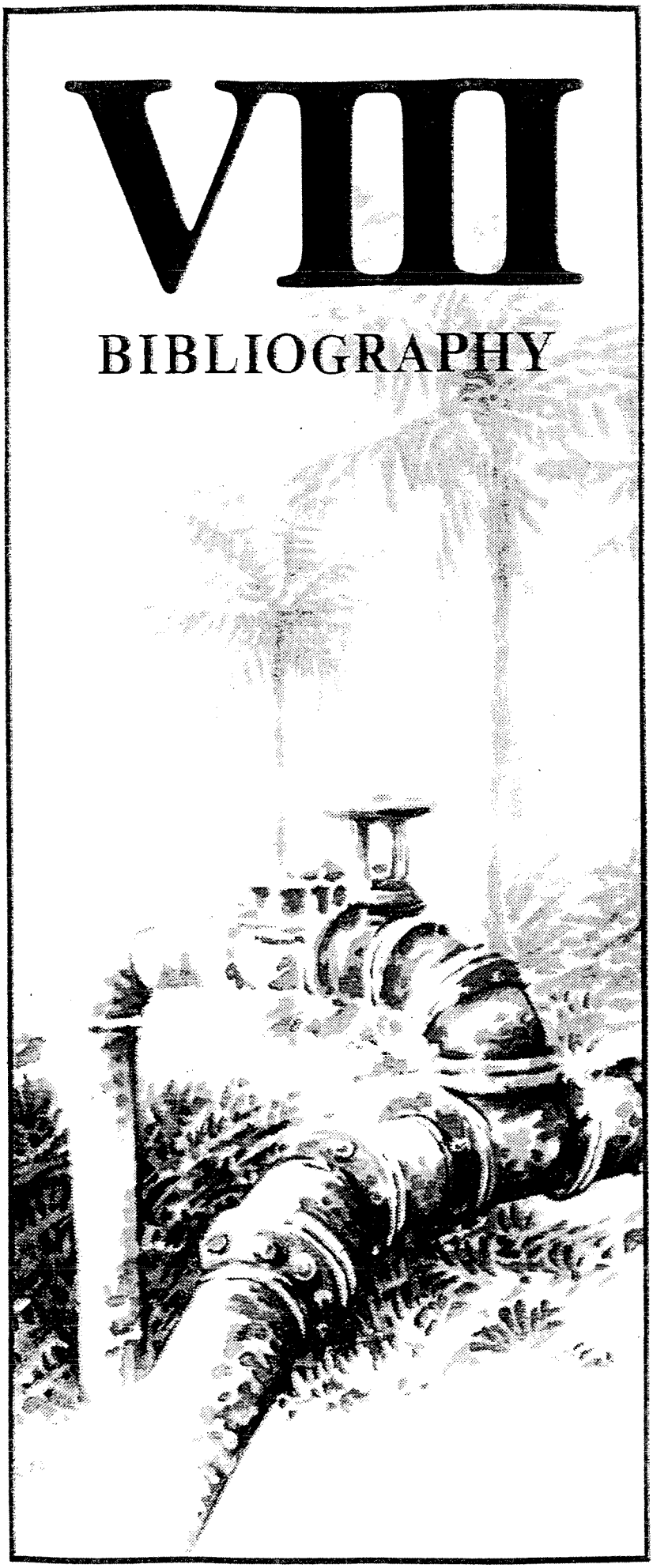

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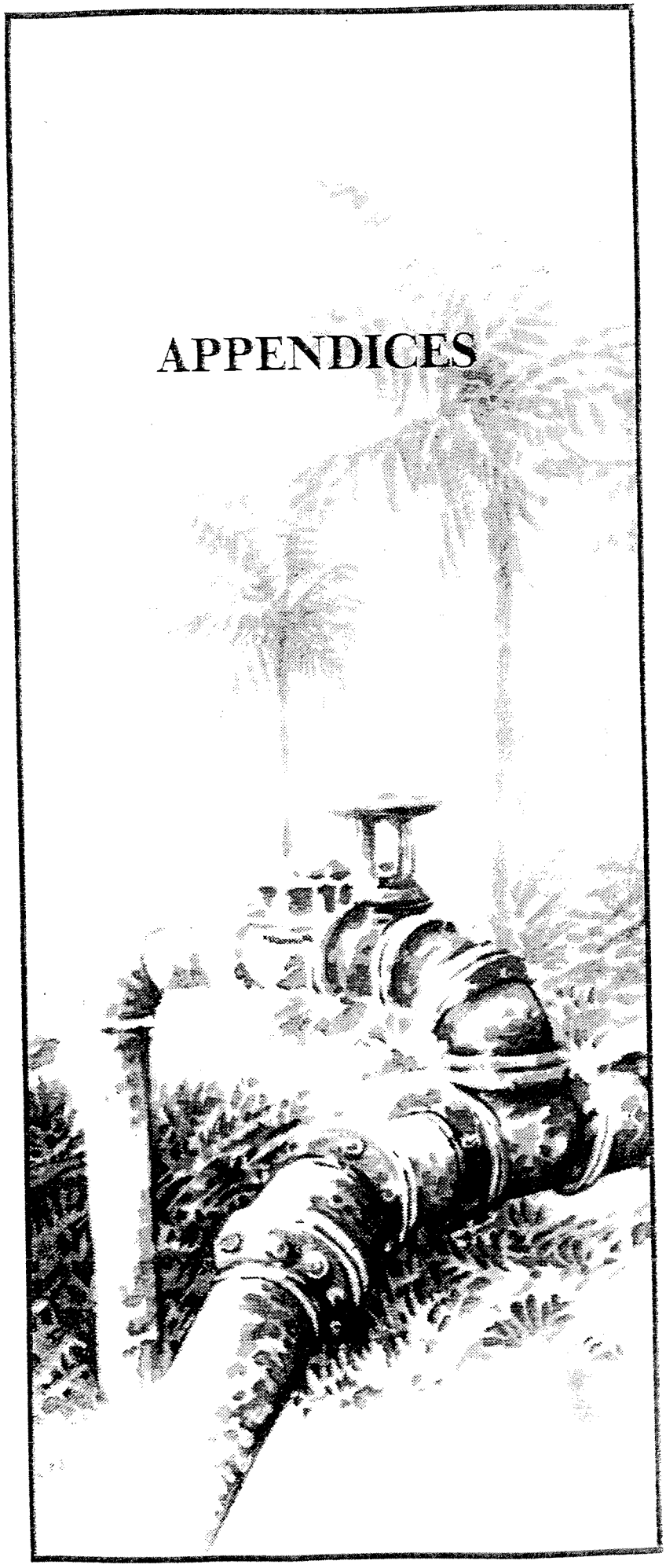
APPENDICES



APPENDIX A

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A-2c	Adjusted Monthly Precipitation, Yigo
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TABLE A-1

MEAN MONTHLY PRECIPITATION

NOAA-USGS

STATION NAME	SITE NO.	OBSERVER	NO. OF YEARS OF RECORD	MEAN MONTHLY PRECIPITATION JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVERAGE ANNUAL
Pago River (upstream)	2645100	USGS	16	4.69	3.26	2.17	3.93	4.88	5.84	8.98	13.04	13.68	12.44	9.49	6.77	89.17
Mangilao	2647550	DOA	7	6.69	5.16	4.42	4.47	5.06	7.40	9.13	13.09	13.88	12.04	10.29	4.97	96.60
Nimitz Hill (USGS)	2743440	USN	22	5.41	3.54	3.44	3.76	4.38	5.59	10.36	13.51	13.83	13.33	9.39	5.54	92.08
Fleet Weather Central (Nimitz Hill)	2743430	USN	7													
Agana Springs	2745430	USN	6	3.86	4.52	2.22	2.29	3.74	3.55	7.95	13.38	13.83	14.26	10.92	5.92	86.44
Adelup Reservoir	2843150	USN	6	2.90	2.97	1.43	1.49	2.84	3.19	7.39	13.02	15.27	14.95	9.53	4.78	79.76
Barrigada Booster School	2846201	USN	3	3.00	3.27	1.79	0.69	2.81	2.90	5.93	18.98	14.28	20.86	12.23	5.99	92.73
Tamuning (ACEORP)	2846542	USN	1	3.37	1.80	2.54	0.99	7.57	9.52	12.04	7.54	12.96	13.60	7.41	3.81	83.15
Fleet Weather Central																
NAS-A	2847501	USN	8	4.53	3.40	2.91	3.52	5.55	5.30	9.84	12.72	12.61	11.94	8.74	4.99	86.05
NAS-B	2847340	USN	23													
Tamuning (USGS)	2946051	USGS	15	4.63	2.65	1.91	3.11	4.39	5.22	8.88	13.89	15.19	13.47	9.36	5.86	88.56
Dededo	3150044	PUAG	3	5.16	9.38	5.13	4.80	7.09	7.67	13.30	17.56	18.09	22.75	8.78	9.69	129.40
Naval Communications Station	3245450	USN	10	5.27	3.01	2.64	2.23	3.70	5.14	8.46	13.87	13.47	15.13	9.37	6.01	88.30
National Weather Service	3350210	NWS	22	5.84	4.65	4.33	4.65	7.83	5.76	10.80	14.08	14.60	13.57	8.91	6.15	101.17
Yigo Agricultural Stn	3245450	USGS	6	3.57	6.56	3.57	7.32	8.85	6.23	10.06	14.32	14.31	15.90	8.94	9.45	109.08
Yigo (Animal Quar. Stn)	3253420	Gov Guam	4													
Andersen AFB-A	3355500	USAF	21	5.12	4.28	3.86	4.10	5.93	5.11	9.62	13.04	12.34	13.51	8.56	5.87	91.34
Andersen AFB-B	3455230	USAF	11													

TABLE A-2a
ADJUSTED MONTHLY PRECIPITATION
NATIONAL WEATHER SERVICE, FINEGAYAN

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1950	*3.06*	*2.81*	*2.61*	*1.12*	*11.59*	*7.21*	*12.18*	*9.12*	*23.61*	*15.75*	*8.23*	*6.47*	103.76
1951	*6.27*	*7.61*	*5.89*	*7.70*	*-0-*	*3.35*	*7.86*	*17.63*	*4.47*	*17.99*	*9.52*	*8.74*	97.03
1952	*3.61*	*1.55*	*2.44*	*1.48*	*5.74*	*4.34*	*10.75*	*12.96*	*16.78*	*14.73*	*12.22*	*8.81*	95.41
1953	*2.45*	*11.75*	*1.91*	*0.54*	*1.80*	*3.48*	*9.10*	*25.03*	*10.86*	*27.53*	*11.50*	*7.03*	112.98
1954	*6.92*	*2.80*	*1.57*	*1.93*	*1.91*	*5.27*	*8.46*	*14.14*	*20.70*	*14.50*	*13.12*	*4.65*	95.97
1955	*9.06*	*4.34*	*3.27*	*3.76*	*2.77*	*6.19*	*14.46*	*8.81*	*19.70*	*11.13*	*8.01*	*5.36*	96.86
1956	*3.39*	*4.69*	*2.95*	*2.66*	*6.55*	*4.29*	*10.16*	*8.75*	*18.09*	*10.74*	*13.15*	*9.82*	95.24
1957	*4.62*	*3.20*	*2.96*	*2.70*	*1.06*	*4.77*	*7.29*	*10.54*	*12.88*	*13.91*	*13.74*	*3.09*	80.76
1958	7.91	2.23	1.70	2.44	3.87	11.53	12.89	11.22	14.43	12.12	5.80	4.62	90.76
1959	3.48	2.30	1.93	3.22	0.90	2.27	6.15	11.56	18.39	10.76	11.71	6.31	78.98
1960	2.71	0.67	1.73	1.44	5.69	7.54	7.93	14.83	9.35	11.78	11.30	6.23	81.20
1961	7.66	2.74	4.85	4.28	5.37	5.90	8.10	16.61	15.40	19.17	5.31	4.35	99.74
1962	2.24	9.17	1.66	8.66	6.68	7.79	14.98	14.12	21.86	14.95	13.09	12.16	127.36
1963	9.33	9.47	2.40	19.55	12.56	7.11	11.25	11.85	13.47	18.06	6.88	16.19	138.12
1964	1.99	4.11	4.44	7.48	20.69	7.49	7.67	8.92	19.30	14.62	6.05	6.92	109.68
1965	10.29	1.02	0.48	0.50	1.69	5.35	15.67	3.87	22.27	6.89	6.95	3.13	78.11
1966	2.13	1.69	1.71	1.31	2.51	5.72	6.74	11.39	22.28	6.96	7.26	4.76	74.46
1967	5.26	4.45	11.28	8.97	3.76	8.37	12.62	23.07	20.28	14.20	11.75	2.51	126.52
1968	5.75	8.48	3.71	1.69	3.16	6.17	12.36	14.61	11.82	13.31	11.92	3.36	96.34
1969	2.79	1.12	0.97	1.36	2.72	1.52	13.83	9.30	6.79	25.32	10.10	10.11	85.93
1970	11.93	3.60	2.68	1.22	2.96	5.60	8.99	10.39	13.70	11.65	9.77	5.71	88.20
1971	5.25	5.78	16.94	5.74	22.68	5.06	16.06	20.92	12.21	8.63	6.75	3.14	129.16
1972	*5.10*	*4.57*	*6.12*	*1.93*	*2.29*	*5.29*	*13.92*	*16.16*	*12.97*	*6.98*	*4.55*	*4.18*	84.09
1973	2.10	2.94	1.57	1.90	3.01	4.85	9.55	6.65	9.05	17.82	2.08	5.35	66.87
1974	4.27	3.13	12.25	14.83	12.00	10.46	9.32	25.66	9.96	10.00	8.03	6.20	126.11
1975	9.68	1.15	2.25	3.67	1.33	2.46	11.13	22.57	8.86	10.68	12.33	6.42	92.53
1976	20.39	13.56	9.04	4.37	40.13	6.40	13.38	24.40	10.79	6.63	7.91	8.91	165.91
1977	3.12	3.01	4.98	2.29	6.88	5.10	7.25	6.09	17.32	16.67	12.38	2.22	87.31
1978	2.44	4.99	0.85	2.65	3.48	7.89	8.91	19.63	10.01	10.49	14.10	4.80	90.24
1979	5.60	1.85	4.20	1.89	1.48	4.28	11.83	12.75	8.34	25.79	6.78	5.67	90.46
1980	2.07	14.79	3.42	2.92	8.60	7.96	10.93	9.42	25.34	12.02	7.76	6.14	111.37
AVG.	5.56	4.70	4.03	4.07	6.71	5.61	10.70	13.97	14.88	13.93	9.36	6.24	99.76

Italicized numbers are estimated from NAS data using simple regression technique.

TABLE A-2b
ADJUSTED MONTHLY PRECIPITATION
ANDERSEN AIR FORCE BASE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1950	*2.82*	*2.51*	*2.24*	*0.67*	*10.79*	*6.60*	9.27	13.21	15.64	17.51	18.32	7.17	106.75
1951	7.96	6.40	4.81	3.58	0.77	1.21	8.97	15.35	5.64	10.00	6.93	8.09	79.71
1952	1.51	*1.09*	1.89	1.27	4.11	2.58	7.05	8.34	12.30	12.43	12.98	5.55	71.10
1953	1.84	12.37	2.31	1.17	2.46	1.42	5.92	26.28	8.55	37.09	8.83	8.22	116.46
1954	4.11	3.12	2.54	2.87	1.59	3.43	3.46	10.42	23.27	11.53	7.51	2.77	76.62
1955	6.40	3.31	3.12	3.71	1.63	4.94	10.07	6.37	16.55	8.95	4.38	4.28	73.71
1956	2.70	3.92	1.62	1.13	3.09	2.56	9.15	5.48	13.03	6.11	7.24	6.39	62.42
1957	3.69	2.17	1.84	2.50	1.67	3.12	3.00	10.47	6.69	17.71	7.86	2.10	62.82
1958	5.36	0.68	0.69	1.11	2.31	7.70	11.80	5.59	14.61	7.34	*8.14*	6.12	71.45
1959	2.15	1.30	1.62	1.92	1.41	1.40	6.13	9.12	*15.89*	8.54	6.80	6.94	63.22
1960	3.39	0.66	1.59	0.38	5.93	5.92	8.59	16.71	9.02	16.88	11.91	5.99	86.97
1961	4.79	3.73	5.04	3.20	4.37	4.09	6.45	14.95	14.51	17.88	5.97	4.43	89.41
1962	1.64	8.78	1.42	8.43	5.32	6.85	*15.28*	*17.71*	13.76	*11.92*	6.95	13.26	111.25
1963	10.92	11.06	3.35	24.00	13.97	6.93	13.25	10.77	11.56	20.24	6.71	16.90	149.66
1964	2.47	3.89	3.37	6.56	25.45	5.90	6.29	13.03	10.49	11.20	4.30	4.97	97.92
1965	9.46	0.98	0.30	*0.10*	1.10	6.49	15.78	3.99	18.41	5.36	8.68	3.37	74.02
1966	2.22	1.34	1.59	0.78	2.73	5.52	7.95	13.58	19.87	9.54	6.12	3.68	74.92
1967	5.45	4.16	10.33	8.70	3.34	7.26	15.23	16.83	22.31	13.48	*8.68*	2.15	117.92
1968	5.16	8.37	3.15	2.83	2.49	4.99	13.37	12.95	1.58	13.23	10.39	3.07	91.58
1969	2.35	1.39	1.34	0.93	2.01	2.58	9.69	8.09	8.09	27.75	6.52	6.78	77.52
1970	17.28	4.16	2.27	1.32	1.29	4.57	7.25	8.25	10.54	9.98	7.74	4.98	79.63
1971	5.47	5.50	14.66	3.95	17.56	5.63	15.39	15.31	12.95	8.17	10.28	2.99	117.80
1972	3.79	6.37	12.59	3.20	3.36	8.15	13.99	15.30	14.09	4.05	4.26	6.00	95.15
1973	1.51	2.67	2.18	1.71	3.10	4.04	8.99	13.84	10.90	20.88	2.61	6.95	79.38
1974	5.66	2.98	11.78	14.55	9.99	6.94	9.29	22.24	3.95	12.49	6.88	4.95	111.70
1975	7.83	0.71	2.30	2.92	2.07	2.92	10.67	23.88	10.03	11.70	16.75	3.93	95.71
1976	16.09	12.47	7.36	4.68	35.28	5.20	10.83	19.60	12.36	8.03	9.30	11.39	152.59
1977	3.62	3.21	4.77	2.26	3.30	7.83	6.44	5.00	15.66	14.25	10.80	1.13	78.27
1978	1.94	5.32	0.90	3.69	2.63	9.72	9.50	17.78	10.57	8.19	15.76	5.29	91.29
1979	5.34	1.19	4.40	1.35	2.48	1.77	10.36	13.25	7.52	24.59	7.42	5.59	85.26
1980	1.46	*18.09*	2.03	4.26	11.96	10.50	11.81	*9.16*	*22.10*	*11.97*	8.00	6.55	117.51
AVG.	5.04	4.64	3.85	3.86	6.11	5.12	9.72	13.00	12.66	13.52	8.55	5.87	92.24

Italicized numbers are estimated from NAS data using simple regression technique.
1950-1970 are from USGS records of Andersen AFB-A precipitation station.
1971-1981 are from USGS and NOAA records of Andersen AFB-B precipitation station.

TABLE A-2c
ADJUSTED MONTHLY PRECIPITATION
YIGO

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1950	*2.69*	*3.15*	*2.76*	*1.47*	*11.14*	*7.31*	*11.99*	*9.83*	*22.43*	*16.50*	*8.94*	*8.04*	106.25
1951	*4.17*	*9.12*	*5.74*	*8.02*	*1.24*	*1.87*	*7.01*	*16.17*	*1.73*	*17.93*	*9.86*	*11.48*	94.34
1952	*2.94*	*1.59*	*2.61*	*1.83*	*6.24*	*3.26*	*10.35*	*12.69*	*15.04*	*15.76*	*11.78*	*11.58*	95.67
1953	*2.40*	*14.28*	*2.13*	*0.89*	*2.93*	*2.06*	*8.44*	*21.68*	*8.64*	*24.27*	*11.27*	*8.87*	107.86
1954	*4.48*	*3.13*	*1.82*	*2.28*	*3.02*	*4.58*	*7.70*	*13.56*	*19.28*	*15.61*	*12.42*	*5.27*	93.15
1955	*5.47*	*5.05*	*3.36*	*4.10*	*3.74*	*5.88*	*14.62*	*9.60*	*18.20*	*13.37*	*8.79*	*6.35*	98.53
1956	*2.84*	*5.48*	*3.07*	*3.00*	*6.91*	*3.19*	*9.67*	*9.55*	*16.46*	*13.11*	*12.44*	*13.11*	98.83
1957	*3.41*	*3.63*	*3.08*	*3.04*	*2.31*	*3.87*	*6.35*	*10.89*	*10.82*	*15.21*	*12.85*	*2.91*	78.37
1958	*4.49*	*2.83*	*0.92*	*3.18*	*3.39*	*7.77*	*11.13*	*12.45*	*14.00*	*14.16*	*9.26*	*5.68*	89.26
1959	*2.91*	*2.67*	*2.53*	*2.28*	0.98	2.00	6.03	10.29	18.84	10.06	9.30	7.12	75.01
1960	3.14	1.88	1.81	1.65	4.24	4.49	4.06	12.06	8.90	11.40	11.10	15.63	80.90
1961	3.79	3.46	4.60	4.81	9.13	4.78	6.71	15.97	12.26	21.20	3.92	7.59	98.22
1962	1.43	8.69	1.78	7.32	5.88	7.57	16.60	13.04	14.04	13.57	12.67	10.60	113.19
1963	7.17	8.97	1.74	20.29	8.71	7.00	10.30	9.45	13.46	18.90	4.90	12.98	123.87
1964	2.44	3.24	2.37	10.66	22.78	4.88	8.16	9.32	13.44	*12.50*	*7.48*	*9.09*	106.36
1965	*7.04*	*2.60*	*1.24*	*0.84*	*2.54*	*4.22*	*14.44*	*6.90*	*17.69*	*11.88*	*7.87*	*8.57*	85.83
1966	*2.66*	*2.23*	*1.75*	*0.71*	*1.91*	*5.21*	*6.69*	*14.25*	*21.36*	*11.26*	*9.53*	*5.48*	83.04
1967	*4.00*	*4.60*	*10.19*	*8.35*	*5.02*	*11.20*	*11.94*	*18.33*	*20.99*	*15.90*	*9.89*	*2.79*	123.20
1968	*4.05*	*11.27*	*4.76*	*3.02*	*3.09*	*6.62*	*11.14*	*14.83*	*14.05*	*18.55*	*11.06*	*2.48*	104.92
1969	*2.79*	*3.28*	*3.76*	*3.80*	*5.23*	*1.63*	*11.89*	*11.66*	*7.28*	*18.86*	*9.94*	*13.40*	93.52
1970	*4.96*	*4.18*	*2.76*	*1.52*	*1.68*	*5.42*	*8.25*	*10.04*	*10.39*	*12.29*	*8.18*	*5.95*	75.62
1971	*3.99*	*7.86*	*9.91*	*4.86*	*19.22*	*5.32*	*14.04*	*15.48*	*7.17*	*11.74*	*8.58*	*2.93*	111.10
1972	*3.64*	*5.34*	*5.94*	*2.28*	*3.34*	*4.60*	*13.07*	*15.07*	*10.93*	*10.61*	*6.33*	*4.56*	85.71
1973	*2.31*	*3.08*	*1.51*	*1.43*	*2.27*	*3.63*	*7.35*	*11.13*	*6.61*	*17.14*	*6.30*	*11.33*	74.09
1974	*3.04*	*3.22*	*13.05*	*12.86*	*15.94*	*7.85*	*12.56*	*20.03*	*6.80*	*14.19*	*8.36*	*8.46*	126.36
1975	*5.01*	*1.56*	*2.45*	*3.26*	*1.81*	*2.34*	*10.03*	*14.89*	*6.43*	*14.86*	*10.76*	*3.81*	77.21
1976	*10.31*	*13.88*	*10.52*	*4.98*	*28.75*	*6.32*	*14.20*	*23.17*	*9.24*	*10.30*	*10.55*	*7.34*	149.56
1977	*2.62*	*3.42*	*5.25*	*1.62*	*4.92*	*4.45*	*7.20*	*7.05*	*13.32*	*17.09*	*10.02*	*2.99*	79.95
1978	*2.22*	*3.71*	*0.68*	*2.73*	*4.87*	*10.76*	9.49	22.86	17.20	13.62	13.79	5.95	107.88
1979	3.99	1.98	4.97	2.24	1.21	4.15	13.83	13.47	9.51	21.22	8.02	6.32	90.91
1980	3.02	21.00	6.29	7.34	19.80	12.49	12.77	16.34	24.92	18.65	7.80	9.37	156.79
AVG	3.85	5.50	4.04	4.41	6.91	5.38	10.26	13.64	13.27	14.81	9.04	7.68	99.53

Italicized numbers are estimated from NAS data using simple regression technique.

1959-1964 are from USGS records of Yigo Agricultural Station precipitation station.

1978-1981 are from NOAA records of Yigo precipitation station.

TABLE A-2d
ADJUSTED MONTHLY PRECIPITATION
FLEET WEATHER CENTRAL (NAS)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1950	1.97	1.76	1.95	1.13	9.17	7.45	12.11	7.79	21.62	14.57	7.46	5.21	92.19
1951	5.23	5.93	4.17	6.47	0.79	1.56	5.60	16.19	3.91	16.75	9.11	7.27	82.98
1952	2.53	0.67	1.84	1.42	5.02	3.07	9.96	11.58	15.30	13.43	12.56	7.33	84.71
1953	1.34	9.53	1.48	0.66	2.22	1.76	7.47	23.49	9.82	26.48	11.64	5.71	101.60
1954	5.90	1.75	1.25	1.79	2.30	4.49	6.50	12.74	18.93	13.19	13.71	3.55	86.10
1955	8.07	3.09	2.40	3.27	2.91	5.90	15.55	7.48	18.00	9.76	7.18	4.20	87.81
1956	2.30	3.39	2.18	2.38	5.59	2.99	9.07	7.42	16.51	9.36	13.75	8.25	83.19
1957	3.55	2.10	2.19	2.41	1.70	3.73	4.74	9.19	11.69	12.59	14.50	2.14	70.53
1958	5.92	1.54	0.58	2.52	2.61	7.95	10.98	11.26	14.41	10.97	8.03	3.80	80.57
1959	2.47	1.43	1.78	2.90	0.66	1.20	5.02	12.60	16.79	9.39	6.78	3.74	64.76
1960	2.51	0.38	1.59	1.11	5.39	4.74	6.69	11.01	10.05	10.10	9.17	7.97	70.71
1961	6.18	2.27	4.08	5.75	6.07	7.03	6.08	15.73	15.14	17.03	7.42	5.14	97.92
1962	1.63	3.93	1.59	7.35	6.11	9.38	18.03	18.06	15.09	11.27	*13.71*	7.53	113.68
1963	11.14	7.26	2.06	15.28	15.02	*7.24*	8.74	7.20	12.85	16.82	5.77	8.43	117.81
1964	1.95	2.65	1.31	8.91	14.31	4.86	10.30	8.65	12.77	9.05	4.83	5.84	85.43
1965	11.52	1.38	0.82	0.62	1.89	4.10	15.31	3.91	17.57	7.48	5.53	5.53	70.13
1966	1.92	1.12	1.20	0.51	1.36	5.18	5.18	13.65	20.71	6.53	8.52	3.68	69.56
1967	4.85	2.77	7.49	6.74	3.99	11.66	12.04	19.05	20.39	13.64	9.17	2.07	113.86
1968	4.96	7.43	3.44	2.39	2.36	6.70	11.00	14.42	14.45	17.71	11.26	1.88	98.00
1969	2.20	1.85	2.70	3.03	4.17	1.30	11.98	10.22	8.66	18.19	9.25	8.42	81.97
1970	6.96	2.48	1.95	1.17	*1.16*	5.40	7.22	8.07	11.32	8.11	6.09	3.96	63.89
1971	4.83	5.05	7.28	3.89	16.01	5.29	14.79	15.28	8.56	7.27	6.81	2.15	97.21
1972	4.05	3.29	4.32	1.79	2.57	4.52	13.52	14.74	11.78	5.53	2.75	3.13	71.99
1973	1.15	1.71	1.02	1.10	1.66	3.46	6.04	9.51	8.08	15.55	2.70	7.18	59.16
1974	2.75	1.81	9.62	10.41	13.24	8.04	12.85	21.67	8.25	11.02	6.41	5.46	111.53
1975	7.07	0.65	1.72	2.59	1.27	2.07	9.55	14.49	7.93	12.04	10.73	2.68	72.79
1976	18.69	9.25	7.73	3.99	24.08	6.38	15.00	25.47	10.33	5.06	10.35	4.79	141.12
1977	1.82	1.95	3.81	1.25	3.91	4.35	5.84	4.11	13.83	15.47	9.39	2.19	67.92
1978	0.95	2.15	0.40	2.16	3.86	11.19	10.94	16.29	9.85	10.14	16.15	3.88	87.96
1979	2.71	1.06	3.45	1.50	1.60	3.21	7.38	10.37	11.56	25.25	9.29	5.07	82.45
1980	1.21	13.74	2.74	2.77	10.34	9.90	9.69	*8.11*	23.90	11.31	5.85	6.66	106.22
AVG.	4.53	3.40	2.91	3.52	5.41	5.36	9.84	12.57	13.55	12.61	8.90	4.99	87.59

Italicized numbers are filled in using USWB, Finegayan data.

1950-1957 are from USGS records of Fleet Weather Central NAS-A precipitation station.

1958-1980 are from USGS and NOAA records of Fleet Weather Central NAS-B precipitation station.

TABLE A-2e
ADJUSTED MONTHLY PRECIPITATION
MANGILAO
NOAA

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1950	*3.04*	*2.43*	*2.22*	*1.75*	*9.21*	*8.33*	*10.69*	*9.25*	*24.96*	*12.76*	*7.98*	*5.84*	98.46
1951	*6.35*	*6.79*	*4.38*	*6.99*	*1.22*	*2.83*	*6.98*	*16.09*	*3.71*	*13.69*	*9.32*	*8.05*	86.40
1952	*3.61*	*1.29*	*2.12*	*2.03*	*5.25*	*4.24*	*9.46*	*12.34*	*17.50*	*12.27*	*12.14*	*8.11*	90.36
1953	*2.40*	*10.55*	*1.77*	*1.29*	*2.58*	*3.02*	*8.05*	*22.03*	*11.03*	*17.86*	*11.39*	*6.38*	98.34
1954	*7.03*	*2.42*	*1.54*	*2.40*	*2.66*	*5.57*	*7.49*	*13.28*	*21.78*	*12.16*	*13.08*	*4.07*	93.49
1955	*9.24*	*3.82*	*2.66*	*3.85*	*3.24*	*6.89*	*12.64*	*9.00*	*20.69*	*10.70*	*7.75*	*4.76*	95.23
1956	*3.38*	*4.13*	*2.45*	*2.98*	*5.80*	*4.17*	*8.96*	*8.95*	*18.93*	*10.52*	*13.11*	*9.10*	92.46
1957	*4.65*	*2.78*	*2.46*	*3.01*	*2.09*	*4.86*	*6.49*	*10.39*	*13.24*	*11.91*	*13.72*	*2.56*	78.15
1958	*7.05*	*2.20*	*0.89*	*3.11*	*2.95*	*8.80*	*10.04*	*12.07*	*16.45*	*11.21*	*8.44*	*4.34*	87.57
1959	*3.55*	*2.08*	*2.06*	*3.49*	*1.09*	*2.49*	*6.65*	*13.17*	*19.26*	*10.54*	*7.42*	*4.27*	106.99
1960	*3.59*	*0.99*	*1.87*	*1.73*	*5.60*	*5.80*	*7.60*	*11.87*	*11.31*	*10.84*	*9.37*	*8.80*	79.38
1961	*7.32*	*2.96*	*4.29*	*6.28*	*6.25*	*7.94*	*7.25*	*15.72*	*17.31*	*13.81*	*7.94*	*5.77*	102.85
1962	*2.70*	*4.70*	*1.87*	*7.85*	*6.29*	*10.14*	*14.06*	*17.61*	*17.25*	*11.34*	*13.08*	*8.33*	115.23
1963	*12.36*	*8.17*	*2.33*	*15.64*	*14.79*	*8.14*	*8.77*	*8.77*	*14.61*	*13.72*	*6.60*	*9.29*	123.17
1964	*3.02*	*3.36*	*1.60*	*9.39*	*14.11*	*5.91*	*9.66*	*9.95*	*14.51*	*10.39*	*5.83*	*6.52*	94.25
1965	*12.74*	*2.03*	*1.13*	*1.25*	*2.27*	*5.20*	*12.51*	*6.09*	*20.18*	*9.72*	*6.40*	*6.19*	85.70
1966	*2.99*	*1.76*	*1.50*	*1.14*	*1.76*	*6.21*	*6.74*	*14.02*	*23.88*	*9.31*	*8.84*	*4.21*	82.37
1967	*5.97*	*3.48*	*7.60*	*7.26*	*4.27*	*12.27*	*10.65*	*18.42*	*23.51*	*12.36*	*9.37*	*2.48*	117.63
1968	*6.08*	*8.35*	*3.67*	*2.99*	*2.72*	*7.63*	*10.05*	*14.65*	*16.50*	*14.10*	*11.08*	*2.28*	100.10
1969	*3.28*	*2.52*	*2.95*	*3.61*	*4.44*	*2.59*	*10.61*	*11.23*	*9.66*	*14.31*	*9.44*	*9.28*	83.92
1970	*8.11*	*3.18*	*2.22*	*1.79*	*1.57*	*6.42*	*7.90*	*9.48*	*12.80*	*9.99*	*6.86*	*4.51*	74.83
1971	*5.95*	*5.87*	*7.40*	*4.46*	*15.73*	*6.32*	*12.21*	*15.35*	*9.55*	*9.63*	*7.45*	*2.57*	102.48
1972	*5.15*	*4.03*	*4.52*	*2.40*	*2.92*	*5.60*	*11.49*	*14.91*	*13.35*	*8.88*	*4.13*	*3.62*	80.99
1973	*2.21*	*2.38*	*1.32*	*1.72*	*2.05*	*4.60*	*7.23*	*10.65*	*8.98*	*13.18*	*4.09*	*7.95*	66.37
1974	4.51	3.29	9.44	10.36	14.14	10.06	13.37	18.04	11.46	13.63	*7.12*	6.03	121.45
1975	7.57	0.64	2.41	2.74	0.43	2.52	9.22	17.06	8.37	11.89	17.24	4.68	84.76
1976	20.20	10.04	8.09	6.59	*23.42*	6.94	*12.33*	*23.65*	20.98	3.97	8.78	6.20	151.19
1977	*2.89*	2.25	3.74	*1.87*	5.34	7.51	8.59	5.51	12.00	16.41	10.84	2.77	79.72
1978	2.31	3.42	0.38	2.38	5.36	10.32	6.59	17.83	10.37	10.52	13.24	3.27	85.99
1979	3.64	1.48	4.01	1.32	1.89	3.16	6.78	12.46	4.35	14.25	6.31	2.52	62.17
1980	1.92	14.99	2.85	3.44	8.26	11.28	10.23	7.64	29.66	13.61	5.33	9.30	118.51
AVG	5.64	4.14	3.15	4.10	5.80	6.38	9.40	13.14	15.42	11.92	9.15	5.61	94.86

Italicized numbers are estimated from NAS data using simple regression technique.

TABLE A-2f
ADJUSTED MONTHLY PRECIPITATION
NIMITZ HILL

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1950	*3.01*	*2.33*	*2.24*	*1.24*	*7.59*	*8.17*	*12.93*	*10.38*	*21.89*	*14.93*	*7.92*	*5.88*	98.51
1951	4.95	*6.40*	3.85	*7.16*	*1.73*	*1.93*	*7.01*	15.87	7.63	13.13	9.36	5.99	85.01
1952	3.51	1.36	1.18	1.94	4.70	2.75	5.12	11.76	20.74	16.18	12.24	7.23	88.71
1953	6.25	10.47	2.28	1.79	0.72	3.58	9.19	16.74	11.27	19.67	14.21	6.74	102.91
1954	5.98	0.93	1.97	1.22	3.39	5.67	3.92	12.84	*19.46*	6.04	*14.37*	4.37	80.16
1955	5.78	2.36	1.78	2.52	4.43	3.36	12.57	6.02	15.74	11.81	6.37	5.09	77.83
1956	1.68	2.78	2.08	2.32	4.72	3.19	10.77	7.73	12.06	8.23	11.82	7.62	75.00
1957	3.00	2.17	2.58	0.89	2.68	2.86	4.21	10.24	11.68	19.71	13.18	3.10	76.30
1958	5.35	2.05	0.74	1.81	3.86	9.65	11.00	13.30	10.78	9.45	8.67	2.81	79.47
1959	3.14	1.47	0.93	2.91	1.55	2.25	5.80	14.88	22.81	10.02	5.80	2.88	74.44
1960	2.86	0.84	1.80	1.19	4.69	4.10	10.08	12.48	9.93	12.06	8.95	8.85	77.83
1961	8.06	2.13	4.88	2.58	*5.42*	7.69	11.23	13.27	13.02	20.43	4.81	3.23	96.75
1962	2.17	6.21	1.15	8.50	*5.45*	11.74	13.52	23.76	19.78	12.26	13.95	10.28	128.77
1963	6.80	8.62	2.37	16.44	7.59	7.05	5.53	7.92	11.91	19.33	5.71	9.90	109.17
1964	2.68	3.82	2.35	9.99	16.38	5.08	7.72	11.71	11.99	7.36	4.55	5.24	88.87
1965	12.40	2.96	1.90	0.58	1.42	5.78	16.73	7.88	16.25	6.52	4.92	2.90	80.24
1966	1.36	0.89	1.34	0.60	1.14	6.50	4.84	15.43	18.66	14.96	6.58	6.06	78.36
1967	8.08	4.50	9.68	9.28	2.84	13.40	18.58	15.88	27.20	14.30	11.75	2.32	137.81
1968	5.70	6.86	3.28	2.22	3.58	5.54	17.64	12.78	14.10	14.50	11.44	2.65	100.29
1969	1.91	1.59	1.21	0.95	3.68	1.86	9.06	11.70	7.44	17.16	10.69	14.30	81.55
1970	10.16	6.40	1.66	1.10	1.98	4.15	6.76	8.53	9.90	10.27	8.77	6.20	75.88
1971	11.26	4.64	10.15	11.70	11.45	6.03	21.23	13.83	9.59	14.56	5.46	4.25	124.15
1972	5.42	5.06	8.06	2.02	3.55	3.82	13.18	16.57	12.40	4.76	4.55	*3.91*	83.30
1973	1.45	0.90	0.72	1.33	2.81	4.14	8.97	*11.47*	13.89	11.00	3.01	7.21	66.90
1974	3.11	3.40	*13.32*	*11.53*	*10.43*	*8.79*	*13.61*	*19.20*	10.55	10.70	8.61	4.04	117.29
1975	6.04	1.37	2.43	2.56	1.81	1.95	7.21	19.14	9.41	10.82	13.26	3.85	79.85
1976	18.80	8.64	11.44	5.79	*18.00*	10.91	18.88	18.41	12.23	6.43	14.05	7.20	150.78
1977	3.86	2.03	7.73	2.08	6.58	7.90	8.77	10.27	23.42	23.30	14.01	2.75	112.70
1978	1.62	3.67	0.51	2.15	3.43	10.96	11.66	22.02	13.84	11.98	18.72	4.55	105.11
1979	3.45	0.96	3.45	1.19	1.71	2.96	9.46	13.81	8.93	29.64	7.58	5.53	88.67
1980	*2.35*	*14.03*	*3.39*	*3.05*	*8.41*	*10.76*	*10.73*	*10.58*	*23.95*	*12.30*	*6.26*	*7.26*	113.07
AVG.	5.23	3.93	3.63	3.89	5.09	5.95	10.58	13.43	13.35	13.35	9.41	5.62	94.70

Italicized numbers are estimated from NAS data using simple regression technique.

1951-1972 are from USGS records of Nimitz Hill (USGS) precipitation station.

1973-1979 are from USGS records of Fleet Weather Central (Nimitz Hill) precipitation station.

TABLE A-2g
ADJUSTED MONTHLY PRECIPITATION
NAVAL COMMUNICATION STATION
USGS

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1950	2.39	1.02	3.04	0.97	12.08	9.82	14.04	9.91	14.64	13.32	8.00	5.42	94.65
1951	11.08	*4.93*	5.46	*4.93*	2.13	*2.18*	12.17	16.97	6.24	11.65	11.01	9.26	98.01
1952	2.30	1.40	1.82	2.72	5.56	4.26	7.68	13.37	13.86	18.25	14.32	5.86	91.40
1953	3.78	7.05	3.10	1.63	2.69	2.38	5.13	30.98	6.46	33.17	12.31	9.73	118.41
1954	5.69	2.61	1.87	2.76	2.60	5.12	5.78	13.82	25.94	12.97	10.19	3.79	93.14
1955	9.44	3.28	3.73	4.53	3.58	4.81	14.77	9.99	15.34	12.50	7.56	6.15	95.68
1956	2.62	3.88	2.56	2.20	3.76	4.82	5.86	9.92	14.36	5.06	8.76	6.04	69.84
1957	6.40	2.00	2.48	0.66	0.49	3.93	3.40	13.73	12.18	18.25	7.76	2.85	74.13
1958	6.26	2.72	1.35	2.87	3.51	9.38	8.27	11.45	12.17	11.04	4.43	5.00	78.45
1959	2.75	3.15	1.03	1.69	0.59	1.73	7.51	8.56	*15.35*	*8.97*	*7.72*	*4.95*	64.00
1960	*3.70*	*1.52*	*2.19*	*1.65*	*6.16*	*5.64*	*6.97*	*12.72*	*9.90*	*9.89*	*8.68*	*7.87*	76.89
1961	*7.76*	*2.68*	*5.09*	*4.49*	*6.97*	*8.13*	*6.52*	*18.36*	*14.01*	*18.92*	*7.98*	*5.92*	106.83
1962	*2.73*	*3.70*	*2.19*	*5.47*	*7.01*	*10.69*	*15.37*	*21.15*	*13.97*	*11.42*	*10.51*	*7.57*	111.78
1963	*13.26*	*5.74*	*2.73*	*10.32*	*17.51*	*8.36*	*8.49*	*8.16*	*12.16*	*18.65*	*7.32*	*8.19*	120.89
1964	*3.08*	*2.92*	*1.86*	*6.42*	*16.67*	*5.77*	*9.65*	*9.89*	*12.09*	*8.52*	*6.94*	*6.40*	90.21
1965	*13.68*	*2.14*	*1.29*	*1.35*	*2.04*	*4.94*	*13.35*	*4.22*	*15.98*	*6.48*	*7.22*	*6.19*	78.88
1966	*3.05*	*1.98*	*1.73*	*1.28*	*1.42*	*6.12*	*5.86*	*15.87*	*18.51*	*5.24*	*8.42*	*4.91*	74.39
1967	*6.29*	*2.99*	*9.05*	*5.09*	*4.52*	*13.17*	*10.93*	*22.33*	*18.26*	*14.51*	*8.68*	*3.80*	119.62
1968	*6.41*	*5.85*	*4.34*	*2.43*	*2.60*	*7.77*	*10.16*	*16.80*	*13.45*	*19.81*	*9.52*	*3.67*	102.81
1969	*3.36*	*2.43*	*3.48*	*2.82*	*4.73*	*1.89*	*10.89*	*11.77*	*8.77*	*20.44*	*8.72*	*8.18*	87.48
1970	*8.63*	*2.81*	*2.61*	*1.68*	*1.18*	*6.36*	*7.37*	*9.20*	*10.92*	*7.30*	*7.45*	*5.11*	70.62
1971	*6.27*	*4.39*	*8.81*	*3.35*	*18.67*	*6.24*	*12.97*	*17.82*	*8.69*	*6.21*	*7.74*	*3.86*	105.02
1972	*5.41*	*3.31*	*5.36*	*2.06*	*2.84*	*5.40*	*12.03*	*17.18*	*11.29*	*3.94*	*6.11*	*4.53*	79.46
1973	*2.19*	*2.34*	*1.52*	*1.64*	*1.77*	*4.24*	*6.49*	*10.92*	*8.30*	*16.99*	*6.09*	*7.32*	69.81
1974	*3.97*	*2.40*	*11.53*	*7.34*	*15.41*	*9.23*	*11.53*	*25.47*	*8.44*	*11.09*	*7.58*	*6.14*	120.13
1975	*8.75*	*1.69*	*2.34*	*2.55*	*1.31*	*2.73*	*9.09*	*16.88*	*8.18*	*12.42*	*9.31*	*4.22*	79.47
1976	*21.62*	*6.96*	*9.33*	*3.41*	*28.18*	*7.42*	*13.12*	*30.01*	*10.12*	*3.33*	*9.16*	*5.68*	148.34
1977	*2.94*	*2.49*	*4.77*	*1.73*	*4.42*	*5.21*	*6.34*	*4.46*	*12.95*	*16.89*	*8.77*	*3.89*	74.86
1978	*1.97*	*2.61*	*0.80*	*2.29*	*4.36*	*12.66*	*10.12*	*19.03*	*9.73*	*9.95*	*11.49*	*5.05*	90.06
1979	*3.92*	*1.94*	*4.35*	*1.89*	*1.70*	*3.97*	*7.48*	*11.95*	*11.12*	*29.63*	*8.73*	*5.87*	92.55
1980	*2.26*	*9.72*	*3.53*	*2.66*	*11.99*	*11.25*	*9.19*	*9.25*	*21.09*	*11.47*	*7.35*	*6.97*	106.73
AVG	5.93	3.38	3.72	3.13	6.40	6.31	9.31	14.59	12.72	13.17	8.58	5.82	93.05

Italicized numbers are estimated from NAS data using simple regression technique.

TABLE A-2h
ADJUSTED MONTHLY PRECIPITATION
PAGO RIVER
USGS

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1950	*2.53*	*2.08*	*2.20*	*1.18*	*8.51*	*8.82*	*12.67*	*10.53*	*19.59*	*13.16*	*7.60*	*6.21*	95.08
1951	5.44	6.66	4.23	6.41	1.41	1.91	2.02	16.36	5.65	14.17	10.20	6.81	81.27
1952	3.38	1.83	1.58	2.07	3.51	3.92	7.14	10.29	19.28	7.28	11.45	5.54	77.27
1953	2.99	9.91	2.48	2.16	1.42	2.57	3.79	11.48	9.04	14.01	16.82	6.72	83.39
1954	6.72	1.13	2.37	1.70	3.60	6.63	3.88	14.76	16.16	8.11	12.41	5.71	83.18
1955	6.54	2.62	2.08	3.28	4.29	5.30	13.66	7.12	15.40	9.46	6.61	4.16	80.52
1956	1.48	3.04	2.48	2.50	5.90	3.11	10.43	6.75	11.38	13.41	11.18	10.67	82.38
1957	3.66	1.80	2.56	2.44	2.90	2.74	3.93	12.27	7.04	18.60	14.95	3.03	75.92
1958	6.23	2.67	0.79	2.99	3.72	10.66	12.01	12.87	15.44	9.24	9.34	3.45	89.41
1959	2.94	1.55	1.18	3.36	1.07	2.03	7.07	14.17	18.97	11.35	7.48	5.12	76.29
1960	3.07	1.34	1.45	1.78	5.69	5.30	8.72	13.57	9.05	11.54	10.45	12.39	84.35
1961	7.28	2.11	4.54	3.14	5.98	9.13	8.98	18.98	13.57	18.38	5.04	4.95	102.08
1962	1.96	6.06	1.70	2.78	5.26	11.72	22.84	24.78	17.66	14.26	11.94	11.34	131.90
1963	6.52	9.22	2.00	16.82	7.62	6.32	6.86	8.76	12.41	20.24	6.48	13.44	116.69
1964	2.64	3.75	2.37	10.54	19.20	5.21	8.53	9.05	14.29	7.20	4.62	5.49	92.89
1965	13.02	1.12	1.51	0.66	1.74	5.48	18.50	9.88	16.10	6.69	5.65	2.94	85.53
1966	1.22	0.68	1.35	0.61	1.23	7.44	5.36	17.50	17.49	15.13	7.22	6.54	81.77
1967	*4.87*	*3.19*	*7.12*	*6.67*	*4.12*	*13.76*	*12.59*	*17.42*	*18.59*	*12.84*	*9.17*	*2.04*	112.38
1968	*4.96*	*8.31*	*3.53*	*2.42*	*2.74*	*7.94*	*11.32*	*14.59*	*13.77*	*14.26*	*11.10*	*1.78*	96.72
1969	*2.71*	*2.18*	*2.87*	*3.04*	*4.28*	*1.61*	*12.51*	*12.02*	*9.06*	*14.42*	*9.25*	*10.47*	88.42
1970	*6.58*	*2.87*	*2.20*	*1.22*	*1.73*	*6.41*	*6.73*	*10.71*	*11.23*	*10.90*	*6.34*	*4.55*	71.47
1971	*4.85*	*5.69*	*6.94*	*3.88*	*14.30*	*6.29*	*15.93*	*15.11*	*8.98*	*10.61*	*7.00*	*2.14*	101.72
1972	*4.22*	*3.76*	*4.31*	*1.83*	*2.92*	*5.38*	*14.39*	*14.78*	*11.60*	*10.00*	*3.27*	*3.44*	79.90
1973	*1.86*	*2.02*	*1.38*	*1.15*	*2.15*	*4.14*	*5.29*	*11.59*	*8.59*	*13.50*	*3.22*	*8.83*	63.72
1974	*3.16*	*2.13*	*9.01*	*10.27*	*11.96*	*9.51*	*13.57*	*19.02*	*8.73*	*11.92*	*6.64*	*6.54*	112.46
1975	*6.67*	*0.86*	*2.00*	*2.61*	*1.82*	*2.51*	*9.56*	*14.63*	*8.47*	*12.28*	*10.61*	*2.85*	74.87
1976	*16.12*	*10.31*	*7.34*	*3.98*	*21.13*	*7.56*	*16.19*	*21.34*	*10.42*	*9.84*	*10.26*	*5.65*	140.14
1977	*2.40*	*2.29*	*3.86*	*1.30*	*4.06*	*5.18*	*5.05*	*8.29*	*13.26*	*13.47*	*9.38*	*2.19*	70.73
1978	*1.70*	*2.51*	*0.83*	*2.19*	*4.01*	*13.21*	*11.25*	*15.73*	*10.03*	*11.61*	*15.59*	*4.44*	93.10
1979	*3.13*	*1.31*	*3.54*	*1.54*	*2.10*	*3.85*	*6.92*	*12.11*	*11.42*	*16.89*	*9.28*	*5.02*	77.11
1980	*1.91*	*15.24*	*2.91*	*2.79*	*9.50*	*11.69*	*9.73*	*10.73*	*21.44*	*12.02*	*6.12*	*8.14*	112.22
AVG	4.61	3.89	3.06	3.53	5.48	6.37	9.92	13.46	13.04	12.47	8.92	5.89	90.80

Italicized numbers are estimated from NAS data using simple regression technique.

TABLE A-3

MONTHLY MEAN TEMPERATURE

NATIONAL WEATHER SERVICE, FINEGAYAN

DATE	AVERAGE MAXIMUM	AVERAGE MINIMUM	AVERAGE	DEPARTURE FROM NORMAL
1974				
Jan	83.9	70.9	77.4	0.1
Feb	84.6	72.7	78.7	1.4
Mar	82.7	72.4	77.6	-0.1
Apr	84.4	73.7	79.1	0.1
May	85.4	73.8	79.6	0.2
Jun	85.9	72.1	79.0	-0.8
Jul	85.8	71.2	78.5	-0.9
Aug	85.2	72.5	78.9	-0.2
Sept	87.0	71.1	79.1	0
Oct	86.0	73.4	79.7	0.8
Nov	85.2	73.8	79.5	0.3
Dec	83.9	73.5	78.7	0.2
1975				
Jan	83.2	72.6	77.9	0.6
Feb	84.5	70.4	77.5	0.2
Mar	85.3	69.0	77.2	-0.5
Apr	85.7	72.7	79.2	0.2
May	87.9	70.8	79.4	0
Jun	88.8	73.0	80.9	1.1
Jul	85.6	71.1	78.4	-1.0
Aug	84.0	71.9	78.0	-1.1
Sept	86.0	71.6	78.8	-0.3
Oct	85.3	72.2	78.8	-0.1
Nov	84.4	72.1	78.3	-0.9
Dec	84.2	72.2	78.2	-0.3

TABLE A-3 continued

MONTHLY MEAN TEMPERATURE - NATIONAL WEATHER SERVICE, FINEGAYAN

DATE	AVERAGE MAXIMUM	AVERAGE MINIMUM	AVERAGE	DEPARTURE FROM NORMAL
1976				
Jan	82.5	69.7	76.1	-1.2
Feb	82.1	71.1	76.6	-0.7
Mar	83.1	71.7	77.4	-0.3
Apr	84.3	72.5	78.4	-0.6
May	85.0	73.2	79.1	-0.3
Jun	85.9	73.0	79.5	-0.3
Jul	- -	- -	- -	- -
Aug	- -	- -	- -	- -
Sept	84.7	72.4	78.6	-0.5
Oct	86.5	72.4	79.5	0.6
Nov	85.3	72.2	78.8	-0.4
Dec	84.4	70.8	77.6	-0.9
1977				
Jan	83.2	69.6	76.4	-0.9
Feb	83.5	70.4	77.0	-0.3
Mar	83.8	71.5	77.7	0
Apr	85.1	71.4	78.3	-0.7
May	85.4	71.4	78.9	-0.5
Jun	86.9	73.3	80.1	0.3
Jul	86.7	73.3	80.0	0.6
Aug	87.8	72.2	80.0	0.9
Sept	85.7	72.3	79.0	-0.1
Oct	85.7	72.1	78.9	0
Nov	85.0	73.4	79.2	0
Dec	84.3	72.8	78.6	0.1

TABLE A-3 continued

MONTHLY MEAN TEMPERATURE - NATIONAL WEATHER SERVICE, FINEGAYAN

DATE	AVERAGE MAXIMUM	AVERAGE MINIMUM	AVERAGE	DEPARTURE FROM NORMAL
1978				
Jan	84.1	69.3	76.7	-0.6
Feb	82.6	70.6	76.6	-0.7
Mar	85.6	70.6	78.1	0.4
Apr	86.5	73.1	79.8	0.8
May	87.6	74.4	81.0	1.6
Jun	87.0	72.8	79.9	0.1
Jul	86.8	72.6	79.7	0.3
Aug	85.0	73.1	79.1	0
Sept	86.3	73.1	79.7	0.6
Oct	86.2	73.1	79.7	0.8
Nov	84.2	73.5	78.9	-0.3
Dec	83.8	72.3	78.1	-0.4
1979				
Jan	83.2	71.5	77.4	0.1
Feb	84.0	70.0	77.0	-0.3
Mar	84.1	71.3	77.7	0
Apr	85.1	72.7	78.9	-0.1
May	87.7	72.6	80.2	0.8
Jun	87.2	75.0	81.1	1.3
Jul	86.8	72.6	79.7	0.3
Aug	85.9	71.6	78.8	-0.3
Sept	86.5	71.2	78.9	-0.2
Oct	85.6	72.8	79.2	0.3
Nov	84.7	73.0	78.9	-0.3
Dec	83.7	72.2	78.0	-0.5

TABLE A-3 continued

MONTHLY MEAN TEMPERATURE - NATIONAL WEATHER SERVICE, FINEGAYAN

DATE	AVERAGE MAXIMUM	AVERAGE MINIMUM	AVERAGE	DEPARTURE FROM NORMAL
1980				
Jan	83.2	69.5	76.4	-0.9
Feb	82.7	72.1	77.4	0.1
Mar	83.4	71.7	77.6	-0.1
Apr	85.1	73.4	79.3	0.3
May	85.0	74.0	79.5	0.1
Jun	84.7	74.6	79.7	-0.1
Jul	86.0	73.1	79.6	0.2
Aug	86.9	73.4	80.2	1.1
Sept	85.5	73.2	79.4	0.3
Oct	85.9	73.6	79.8	0.9
Nov	86.3	74.4	80.4	1.2
Dec	85.2	70.8	78.0	-0.5
1981				
Jan	84.3	72.2	78.3	1.0
Feb	84.0	69.9	77.0	-0.3
Mar	84.9	71.1	78.0	0.3
Apr	86.0*	72.6	79.3*	0.3
May	86.8	73.4	80.1	0.7
Jun	87.0	73.2	80.1	0.3
Jul	86.4	72.4	79.4	0
Aug	85.5	72.4	79.0	-0.1
Sept	86.9	72.4	79.4	0.6
Oct	87.0	72.5	79.8	0.9
Nov	- -	- -	- -	- -
Dec	84.7	73.4	79.1	0.6
1982				
Jan	84.8	69.9	77.4	0.1
Feb	83.0	70.5	76.8	-0.5
Mar	84.5	70.3	77.4	-0.3

* estimated

TABLE A-4

MONTHLY MEAN TEMPERATURE

ANDERSEN AIR FORCE BASE - NOAA

DATE	AVERAGE MAXIMUM	AVERAGE MINIMUM	AVERAGE	DEPARTURE FROM NORMAL
1974				
Jan	82.2	75.5	78.9	0.7
Feb	83.2	75.8	79.5	1.3
Mar	81.6	74.4	78.0	-0.5
Apr	84.6	77.0	80.8	1.3
May	85.2	77.7	81.5	1.2
Jun	84.0	76.9	80.5	-0.3
Jul	84.0	77.3	80.7	0.3
Aug	83.7	76.7	80.2	0.1
Sep	83.8	76.1	80.0	0.2
Oct	84.0	77.0	80.5	0.5
Nov	84.4	77.7	81.1	0.8
Dec	83.4	77.4	80.4	1.1
1975				
Jan	82.2	76.0	79.1	0.9
Feb	83.3	75.8	79.6	1.4
Mar	83.1	75.4	79.3	0.8
Apr	83.9	76.5	80.2	0.7
May	84.9	77.6	81.3	1.0
Jun	85.6	78.4	82.0	1.2
Jul	83.4	76.0	79.7	-0.7
Aug	83.1	75.1	79.1	-1.0
Sep	85.3	76.1	80.7	0.9
Oct	85.1	76.9	81.0	1.0
Nov	83.9	77.0	80.5	0.2
Dec	82.0	76.2	79.1	-0.2

TABLE A-4 continued

MONTHLY MEAN TEMPERATURE - ANDERSEN AIR FORCE BASE

DATE	AVERAGE MAXIMUM	AVERAGE MINIMUM	AVERAGE	DEPARTURE FROM NORMAL
1976				
Jan	80.5	74.5	77.5	-0.7
Feb	79.9	74.1	77.0	-1.2
Mar	82.6	75.9	79.3	0.8
Apr	80.5	74.6	77.6	-1.9
May	81.8	75.4	78.6	-1.7
Jun	82.6	76.6	79.6	-1.2
Jul	- -	- -	- -	- -
Aug	- -	- -	- -	- -
Sep	84.0*	76.9*	80.5*	0.7
Oct	83.3	77.1	80.2	0.2
Nov	83.8	78.0	80.9	0.6
Dec	84.0	77.8	80.9	1.6
1977				
Jan	83.5	77.1	80.3	2.1
Feb	82.9	76.8	79.9	1.7
Mar	81.2	74.5	77.9	-0.6
Apr	81.4	74.5	78.0	-1.5
May	82.5	75.5	79.0	-1.3
Jun	84.0	77.2	80.6	-0.2
Jul	83.9	77.0	80.5	0.1
Aug	85.3	77.1	81.2	1.1
Sep	83.3	76.1	79.7	-0.1
Oct	83.5	76.8	80.2	0.2
Nov	83.1	77.3	80.2	-0.1
Dec	82.6	76.8	79.7	0.4

TABLE A-4 continued

MONTHLY MEAN TEMPERATURE - ANDERSEN AIR FORCE BASE

DATE	AVERAGE MAXIMUM	AVERAGE MINIMUM	AVERAGE	DEPARTURE FROM NORMAL
1978				
Jan	80.8	74.4	77.6	-0.6
Feb	79.6	72.9	76.3	-1.9
Mar	81.8	75.3	78.6	0.1
Apr	82.2	75.9	79.1	-0.4
May	83.7	76.7	80.2	-0.1
Jun	82.0	75.4	78.7	-2.1
Jul	84.8	77.2	81.0	0.6
Aug	83.1	76.6	79.9	-0.2
Sep	84.4	77.0	80.7	0.9
Oct	84.1	77.1	80.6	0.6
Nov	81.6	75.9	78.8	-1.5
Dec	81.1	75.2	78.2	-1.1
1979				
Jan	80.2	74.7	77.5	-0.7
Feb	82.1	75.7	78.9	0.7
Mar	81.4	75.8	78.6	0.1
Apr	82.2	75.4	78.8	-0.7
May	83.2	76.6	79.9	-0.4
Jun	84.8	78.4	81.6	0.8
Jul	83.7	76.7	80.2	-0.2
Aug	84.6	76.9	80.8	0.7
Sep	84.7	77.4	81.1	1.3
Oct	84.8	78.2	81.5	1.5
Nov	84.1	78.6	81.4	1.1
Dec	82.7	76.9	79.8	0.5

TABLE A-4 continued

MONTHLY MEAN TEMPERATURE - ANDERSEN AIR FORCE BASE

DATE	AVERAGE MAXIMUM	AVERAGE MINIMUM	AVERAGE	DEPARTURE FROM NORMAL
1980				
Jan	82.3	75.9	79.1	0.9
Feb	81.8	75.3	78.6	0.4
Mar	82.3	75.7	79.0	0.5
Apr	83.9	77.0	80.5	1.0
May	83.8	77.0	80.4	0.1
Jun	84.6	77.8	81.2	0.4
Jul	84.6	77.6	81.1	0.7
Aug	84.0	76.3	80.2	0.1
Sep	83.0	76.1	79.6	-0.2
Oct	85.0	78.1	81.6	1.6
Nov	85.0	78.7	81.9	1.6
Dec	84.0	77.5	80.8	1.5
1981				
Jan	- -	- -	- -	- -
Feb	82.8	76.3	79.6	1.4
Mar	83.6	75.9	79.8	1.3
Apr	- -	- -	- -	- -
May	86.6	78.7	82.7	2.4
Jun	85.0	78.1	81.6	0.8
Jul	83.8	76.8	80.3	-0.1
Aug	82.9	75.4	79.2	-0.9
Sep	84.1	77.3	80.7	0.9
Oct	84.7	77.5	81.1	1.1
Nov	- -	- -	- -	- -
Dec	81.7	76.5	79.1	-0.2

* estimated

TABLE A-5

MONTHLY MEAN TEMPERATURE

FLEET WEATHER CENTRAL NAVAL AIR STATION - NOAA

DATE	AVERAGE MAXIMUM	AVERAGE MINIMUM	AVERAGE	DEPARTURE FROM NORMAL
1974				
Jan	83.7	75.1	79.4	0
Feb	84.6	76.5	80.6	1.2
Mar	83.5	75.1	79.3	-0.7
Apr	85.2	77.8	81.5	0.7
May	84.4	78.2	81.3	0
Jun	86.5	77.8	82.2	0.4
Jul	84.7	77.0	80.9	-0.5
Aug	84.1	76.9	80.5	-0.7
Sep	86.0	79.0	82.5	1.5
Oct	87.0	79.0	83.0	2.2
Nov	84.9	79.5	82.2	1.2
Dec	85.0	79.9	82.5	2.3
1975				
Jan	84.0	78.5	81.3	1.9
Feb	83.1	76.5	79.8	0.4
Mar	83.9	76.8	80.4	0.4
Apr	84.1	77.8	81.0	0.2
May	85.7	78.5	82.1	0.8
Jun	85.4	78.8	82.1	0.3
Jul	83.7	77.4	80.6	-0.8
Aug	82.7	76.7	79.7	-1.5
Sept	83.5*	76.8*	80.2*	-1.3
Oct	84.4	76.9	80.7	-0.1
Nov	84.6	76.6	80.6	-0.4
Dec	84.9	77.4	81.2	1.0

TABLE A-5 continued

MONTHLY MEAN TEMPERATURE - FLEET WEATHER CENTRAL NAVAL AIR STATION

DATE	AVERAGE MAXIMUM	AVERAGE MINIMUM	AVERAGE	DEPARTURE FROM NORMAL
1976				
Jan	84.3	76.9	80.6	1.2
Feb	83.7	76.6	80.2	0.8
Mar	84.0	75.2	79.6	-0.4
Apr	83.6	75.9	79.8	-1.0
May	84.6	76.5	80.6	-0.7
Jun	85.5	78.0	81.8	0
Jul	- -	- -	- -	- -
Aug	- -	- -	- -	- -
Sept	86.0	77.2	81.6	0.6
Oct	88.0	78.5	83.3	2.5
Nov	86.5	77.9	82.2	1.2
Dec	85.4	76.9	81.2	1.0
1977				
Jan	84.4	75.5	80.0	0.6
Feb	84.4	75.0	79.7	0.3
Mar	84.7	76.0	80.4	0.4
Apr	85.6	76.5	81.1	0.3
May	86.7	77.5	82.1	0.8
Jun	87.3	78.4	82.9	1.1
Jul	87.8	78.5	83.2	1.8
Aug	88.9	79.1	84.0	2.8
Sept	86.8	77.6	82.2	1.2
Oct	85.8	77.2	81.5	0.7
Nov	84.8	77.1	81.0	0
Dec	83.9	76.5	80.2	0

TABLE A-5 continued

MONTHLY MEAN TEMPERATURE - FLEET WEATHER CENTRAL NAVAL AIR STATION

DATE	AVERAGE MAXIMUM	AVERAGE MINIMUM	AVERAGE	DEPARTURE FROM NORMAL
1978				
Jan	82.8	74.2	78.5	-0.9
Feb	81.8	73.1	77.0	-2.4
Mar	84.2	73.4	78.8	-1.2
Apr	86.6	77.0	81.8	1.0
May	87.8	78.5	83.2	1.9
Jun	87.3	77.7	82.5	0.7
Jul	86.5	78.0	82.3	0.9
Aug	85.4	76.9	81.2	0
Sept	87.0	76.9	82.0	1.0
Oct	86.0	78.6	82.3	1.5
Nov	84.6	77.1	80.9	-0.1
Dec	- -	- -	- -	- -
1979				
Jan	83.7	76.1	79.9	0.5
Feb	84.4	75.4	79.9	0.5
Mar	84.8	76.0	80.4	0.4
Apr	86.2	76.8	81.5	0.7
May	87.6	76.4	82.0	0.7
Jun	89.2	77.8	83.5	1.7
Jul	87.4	76.2	81.8	0.4
Aug	86.6	75.6	81.1	-0.1
Sept	89.2	76.4	82.8	1.8
Oct	88.3	76.5	82.4	1.6
Nov	86.9	76.3	81.6	0.6
Dec	- -	- -	- -	- -

TABLE A-5 continued

MONTHLY MEAN TEMPERATURE - FLEET WEATHER CENTRAL NAVAL AIR STATION

DATE	AVERAGE MAXIMUM	AVERAGE MINIMUM	AVERAGE	DEPARTURE FROM NORMAL
1980				
Jan	85.4	74.0	79.7	0.3
Feb	85.3	74.8	80.1	0.7
Mar	85.3	74.5	79.9	-0.1
Apr	86.7	77.0	81.9	1.1
May	87.3	76.9	82.1	0.8
Jun	88.1	77.9	83.0	1.2
Jul	88.9	77.0	83.0	1.6
Aug	- -	- -	- -	- -
Sept	86.7	76.1	81.4	0.4
Oct	87.3	76.5	81.9	1.1
Nov	88.1	77.5	82.8	1.8
Dec	86.4	76.3	81.4	1.2

* estimated

TABLE A-6

MEAN RELATIVE HUMIDITY-PERCENT

NATIONAL WEATHER SERVICE, FINEGAYAN

	1974	1975	1976	1977	1978	1979	1980	1981
JAN	78	81	82	79	76	79	74	83
FEB	79	75	83	78	80	76	79	73
MAR	81	76	80	80	73	77	78	77
APR	82	76	81	75	78	75	78	77
MAY	83	73	83	78	77	74	82	79
JUN	83	72	83	80	81	77	83	81
JUL	85	82	84*	81	82	81	83	84
AUG	86	86	86*	81	85	83	84	86
SEP	82	83	81	85	84	84	87	83
OCT	83	85	81	84	83	85	84	82
NOV	84	85	83	84	85	82	83	84*
DEC	82	81	81	77	80	81	82	83
ANNUAL AVERAGE	82	80	82	80	80	80	81	81

* Estimated.

TABLE A-7

MONTHLY EVAPORATION ††

NATIONAL WEATHER SERVICE, FINEGAYAN - NOAA

	1974	1975	1976	1977	1978	1979	1980	1981	AVERAGE ANNUAL
JAN	5.81	6.64*	6.27*	6.64†	7.30	7.26†	7.73	5.54	6.65
FEB	6.62	6.80	5.58	6.49	6.10	6.68	6.43†	7.22	6.49
MAR	6.90	8.08	7.22	8.20	9.46	7.76	7.85	8.94	8.05
APR	8.27	8.35	7.62	9.03	7.72	9.50	7.93	8.13†	8.32
MAY	7.21	9.01	7.37†	8.48†	8.55	10.33	8.05	8.41	8.43
JUN	5.88	9.29	7.65	7.89	6.55	8.44	6.91	7.14	7.46
JUL	6.02*	6.18	6.30*	7.83	5.90	6.44†	6.33†	6.78	6.47
AUG	5.09	5.69	5.66*	6.99	6.10†	6.34†	4.84†	6.55†	5.91
SEP	5.61†	6.14	5.47	5.24†	5.33†	5.26	5.14†	7.38	5.70
OCT	6.28	5.70	7.36	5.53†	6.32†	5.16†	5.98†	7.01†	6.17
NOV	5.73†	6.73	6.34	6.27†	5.46†	5.93	7.10	6.37*	6.24
DEC	6.93	6.39	6.56†	6.90†	5.95	6.36	6.20†	5.15	6.34
ANNUAL TOTAL	76.35	85.00	79.49	85.49	80.74	85.46	80.49	84.63	82.23

* Estimated value.

† Adjusted to a full month.

†† Measured in inches.

TABLE A-8

WATER LEVEL MEASUREMENTS - NORTHERN LENS

WELL NO.	DATE	TIME	METHOD OF MEASUREMENT	DEPTH TO WATER (ft)	ELEV. OF MEASURING POINT	ELEV. OF WATER SURFACE	CATAGORY	REMARKS
A-1	4-23-82	1435		54.86	69.97	15.11	Trans	
A-2	4-23-82	1125	S	114.79	121.44	6.65	Trans	
A-3	4-23-82	1445	E	109.40	105.28	-5.12	Parabasal	
A-4	4-23-82	1120	S	138.70	142.57	3.87	Trans	
A-5	4-23-82	1505	S	143.37	147.77	4.40	Trans	Poor Cut
A-8	4-23-82	1140	S	121.27			Trans	
A-9	4-23-82	1055	S	183.47	188.21	4.74	Basal	
	9-24-81	1055	S			6.06		
A-10	4-23-82	1020	S	186.75	191.38	4.63	Basal	
A-11	4-23-82	1520	S	141.14	172.47	31.33	Parabasal	
A-12	4-23-82	1515	S	117.74	140.02	22.28	Parabasal	
A-13	4-23-82	1025	S	128.66	133.72	4.06	Basal	
A-15	4-23-82	1600	S	195.86	199.05	3.19	Basal	
A-16	4-23-82	1555	R			3.76	Basal	
A-19	4-23-82	1415	S	133.43	136.56	3.13	Trans	
A-20	4-23-82	1400	S	103.59	141.74	38.15	Parabasal	Recorder
D-1	4-27-82	1600	S	379.55	383.10	3.55	Basal	
D-2	4-27-82	1615	S		383.03		Basal	Poor Cut
D-3	4-27-82	1645		387.40	390.18	2.78+.5	Basal	Poor Cut
D-4	4-27-82	0910	S	381.64	385.19	3.55	Basal	
D-5	4-22-82		S	378.60	379.33	0.72	Basal	Poor Cut
D-6	4-22-82		S	394.73	398.23	3.50	Trans	
D-7	4-27-82						Trans	
D-9	4-27-82	1425	S	386.10	389.65	3.55	Trans	
D-10	4-27-82	1430	E	388.39	391.28	2.89	Parabasal	
D-12	4-27-82	1520		419.36	422.86	3.50	Trans	
D-13	4-27-82	1510	S	399.78	401.63	1.85	Parabasal	Poor Cut
D-14	4-24-82					3.43	Basal	
D-15	4-24-82					2.98	Basal	
D-16	4-24-82					3.27	Basal	
D-17	4-27-82	1335	E	302.08	305.32	3.24	Basal	
D-18	4-24-82			313.55			Basal	
F-2	4-22-82		E			3.01	Basal	
F-3	4-21-82	1525	S	456.80	456.25	-.55	Basal	Poor Cut
	2-18-82	1400	S	453.12	456.25	3.13		

TABLE A-8 continued

WATER LEVEL MEASUREMENTS - NORTHERN LENS

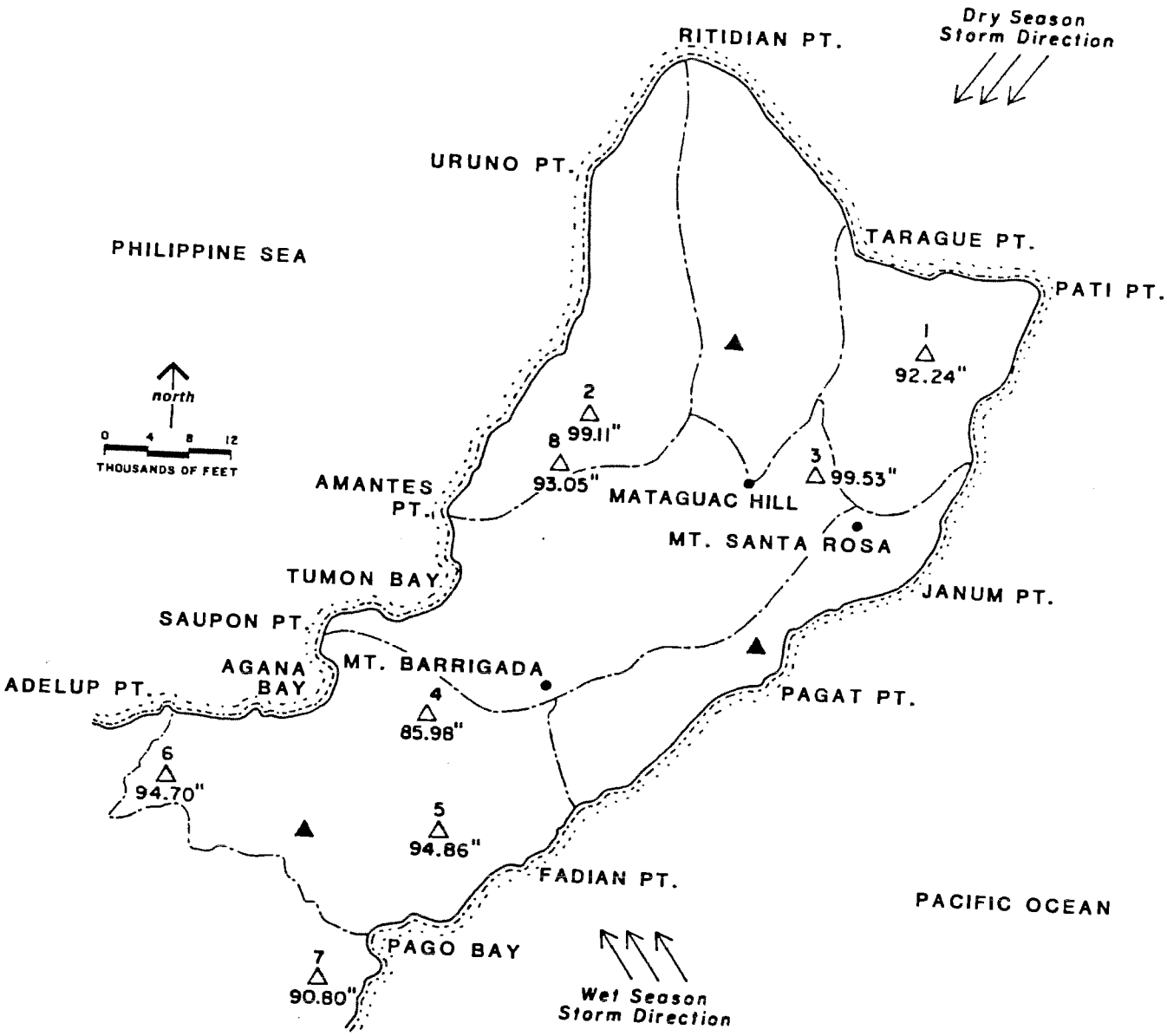
WELL NO.	DATE	TIME	METHOD OF MEASUREMENT	DEPTH TO WATER (ft)	ELEV. OF MEASURING POINT	ELEV. OF WATER SURFACE	CATAGORY	REMARKS
F-6	4-21-82	1425	S	345.03	347.74	2.71	Basal	
Y-1	4-29-82	1303	S	412.47	416.76	4.29	Parabasal	
	1-22-82	1115	S			4.39		
Y-2	4-29-82	1320	S	411.60	416.83	5.23	Parabasal	Poor Cut
Y-3	4-22-82	1630	S	413.38	417.63	4.25	Parabasal	
	1-22-82		S			10		Poor Cut
Y-4	4-29-82	1400	S	395.78	399.41	3.63	Trans	
Y-5	4-30-82	1010	E	429.90	434.14	4.23	Parabasal	
	1-22-82	1025	S			4.23		
M-3	9-25-81	1030				2.88	Trans	
M-5	4-25-82					3.59	Trans	
	9-23-81	1145				3.31		
M-6	4-25-82					3.05	Basal	
M-7	4-25-82					3.52	Basal	
	9-23-81	1040	E			3.82		
M-8	4-24-82					3.30	Trans	
M-9	4-22-82		S	448.57	451.15	2.58	Basal	
M-10a	4-27-82	0824				3.07	Basal	
M-11	4-25-82		S	292.50	295.82	3.51	Basal	Recorder
M-12	4-25-82					3.31	Basal	
M-14	4-27-82	1325	S	272.34	275.84	3.50	Basal	
MW-1	4-29-82	0755	S	344.12	347.16	3.04	Basal	
MW-2	4-29-82	0820	S	347.68	349.44	1.76	Basal	
MW-3	4-29-82	0845	S	406.69	409.17	2.48	Trans	
MW-5	4-29-82	1030	S	414.00	417.23	3.23	Trans	
	2-18-82	1000	S	414.00	418.18	4.18		
MW-6	4-29-82	1015		390.65	393.90	3.25	Trans	
MW-8	4-29-82	0945	S	353.65	357.23	3.58	Trans	
EX-1	4-23-82	0840	S	90.21	97.27	7.06	Basal	
	9-15-81	0940	S			8.67		
EX-4	4-23-82		S	148.10	153.71	5.61	Basal	
	9-24-81	1520	S			6.65		
EX-5a	4-27-82			381.80	385.16	3.37	Basal	
EX-5	9-24-81	1000	S			3.94	Basal	Poor Cut

TABLE A-8 continued

WATER LEVEL MEASUREMENTS - NORTHERN LENS

WELL NO.	DATE	TIME	METHOD OF MEASUREMENT	DEPTH TO WATER (ft)	ELEV. OF MEASURING POINT	ELEV. OF WATER SURFACE	CATAGORY	REMARKS
EX-6	4-24-82			305.83	309.41	3.58	Basal	
	1-22-82	1258				3.70		
	9-24-81	0935	S			3.75		
EX-7	4-24-82			279.86	283.31	3.45	Basal	
	1-22-82		S			3.50		
	9-25-81		S			3.1		Poor Cut
EX-8	4-24-82			459.75	462.49	2.74	Basal	
	9-22-82	1310	S			2.65		
	9-17-81	0900	S			2.70		
EX-9	4-23-82	1545				3.20	Basal	
	9-24-81	1500	S			3.17		
EX-10	4-24-82	1545		345.45		3.20	Basal	
	9-24-81	1025	S			3.02		
EX-11	1-13-82		S			5.17	Trans	
H-1	4-30-82	1045	S	291.75	293.55	1.80	Basal	
H-107	4-28-82	1230	R			3.12	Basal	
147	4-23-82	0855	S	21.98	33.22	11.24		
BPM-1 (72)	4-23-82	1535	R			2.93	Basal	
Island Equip.	4-24-82		S	79.39	81.7	2.31	Basal	
AAFB	4-29-82	1100	S	493.79	496.57	2.78	Basal	
BPM	2-18-82	0930	S	493.04	496.57	3.53		
AG-2	2-18-82	1315	E	502.94	506.2	3.08	Parabasal	
GHURA-DEDEDO	4-27-82	0855	S	391.55	393.9	2.35	Trans	
Fore-most	4-29-82	1545	S	138.66	140.41	1.75	Basal	
59	9-24-81	1545	S			8.34	Trans	

* Measurements taken by CDM and USGS
S Measured with steel tape
E Measured with electric tape
R Measured with recorder
Trans. Transitional Zone



Raingage Stations

1. ANDERSEN AIR FORCE BASE
2. NATIONAL WEATHER SERVICE
3. YIGO-FINEGAYAN AG. STATION
4. NAVAL AIR STATION
5. MANGILAO
6. FLEET WEATHER CENTRAL - NIMITZ HILL
7. PAGO RIVER
8. NAVAL COMMUNICATIONS STATION

Legend

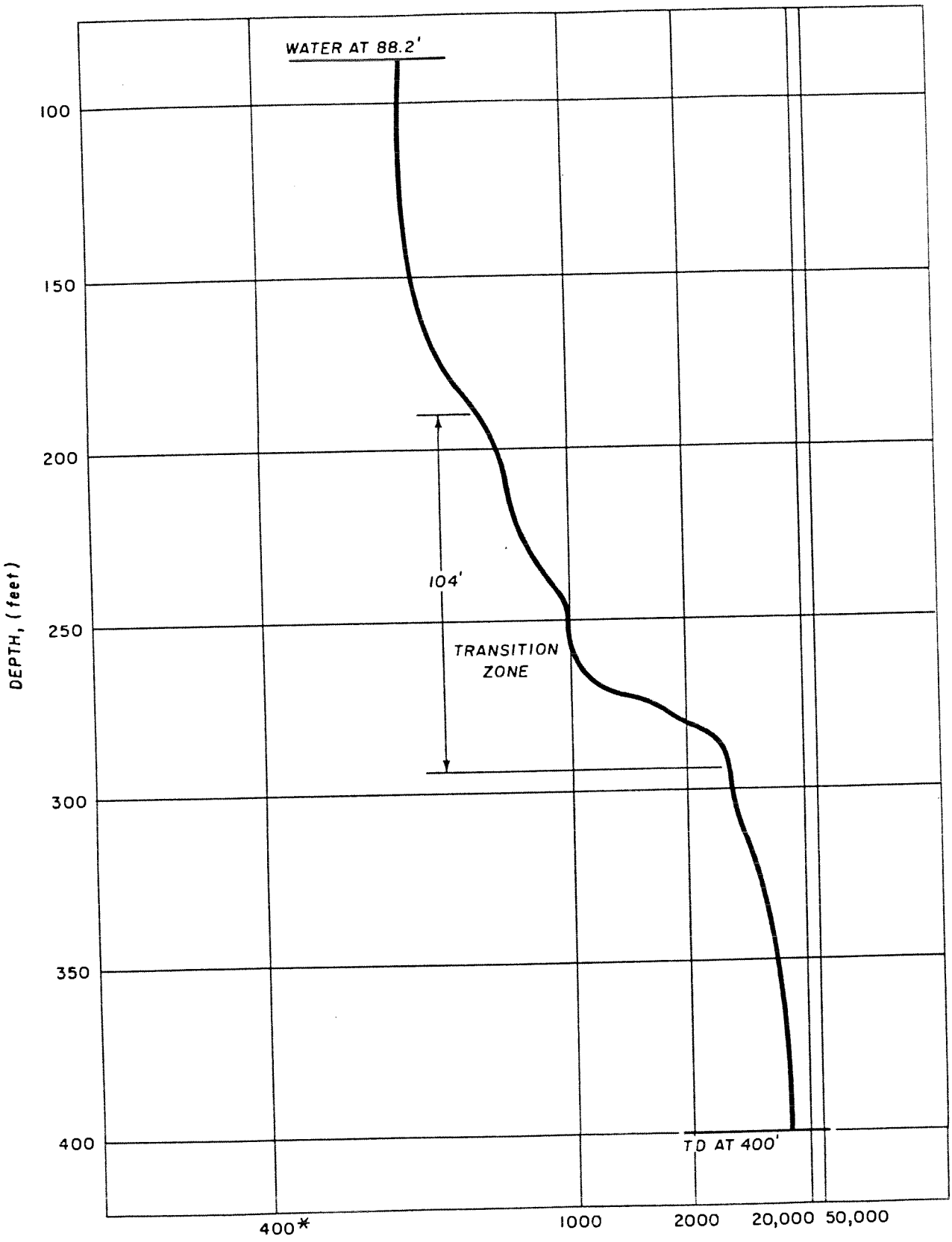
△ 93.05" — RAINGAGE STATION LOCATION & AVG. ANN. RAINFALL IN INCHES

▲ — PROPOSED RAINGAGE STATION

HYDROLOGIC SUBBASIN BOUNDARY

FIGURE A-1

RAINGAGE STATION LOCATIONS
NORTHERN GUAM



* UNCORRECTED CONDUCTANCE VALUES FROM U.S.G.S. LOGGER SCALE.

FIGURE A-2
CONDUCTIVITY LOG - WELL EX-1
FEBRUARY 24, 1982

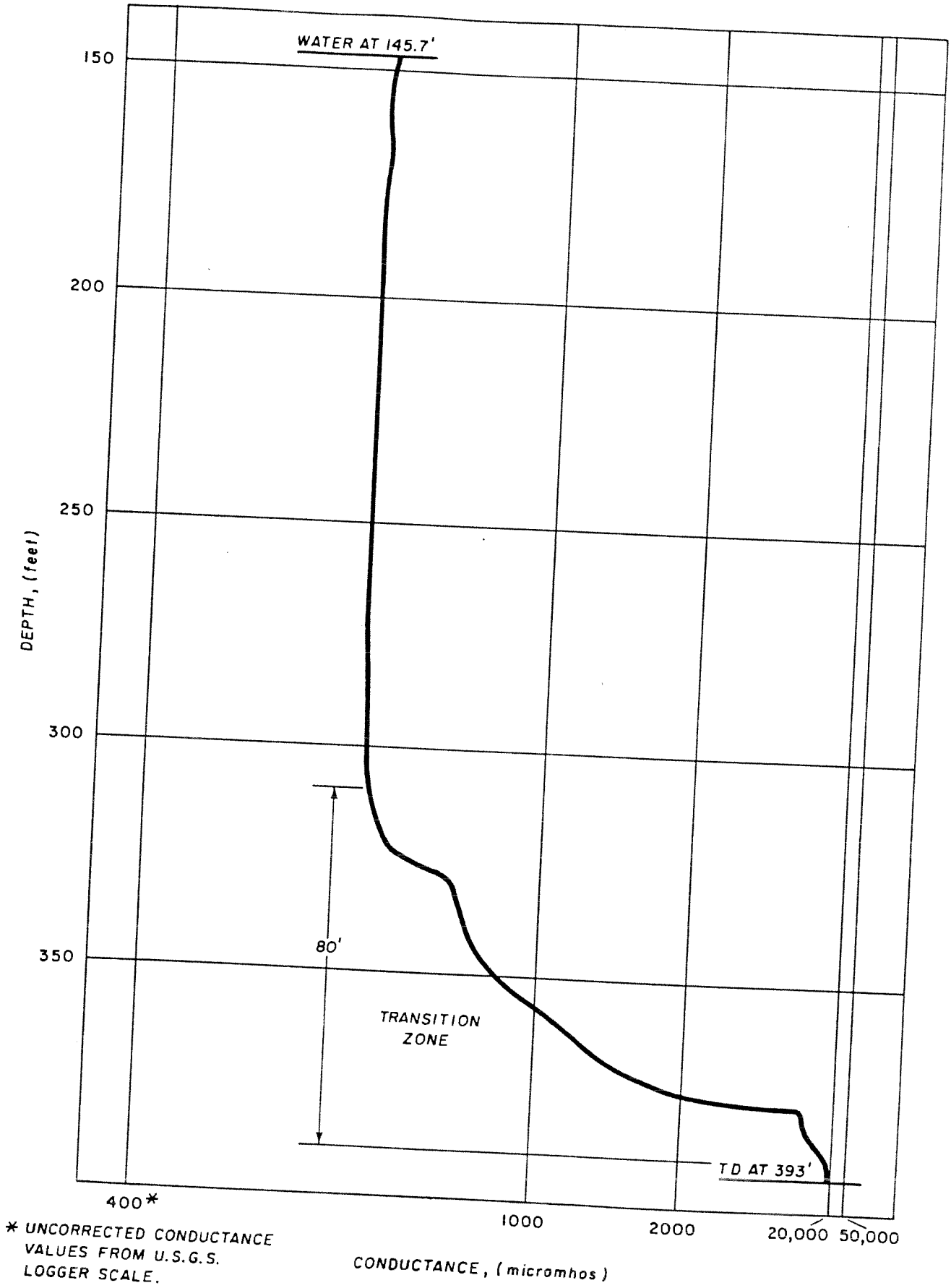


FIGURE A-3
CONDUCTIVITY LOG - WELL EX-4
FEBRUARY 12, 1982

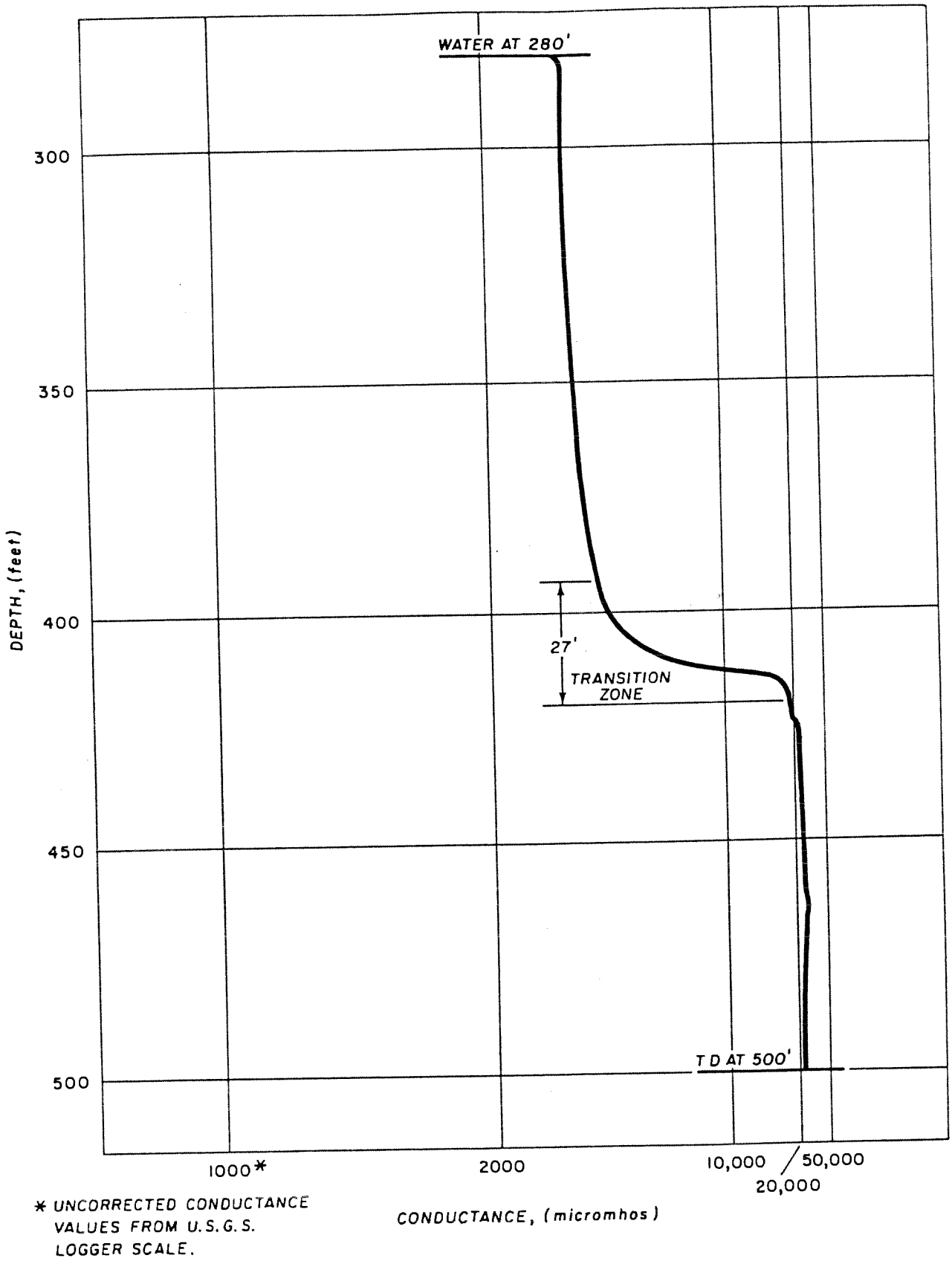


FIGURE A-4
CONDUCTIVITY LOG - WELL EX-7
FEBRUARY 10, 1982

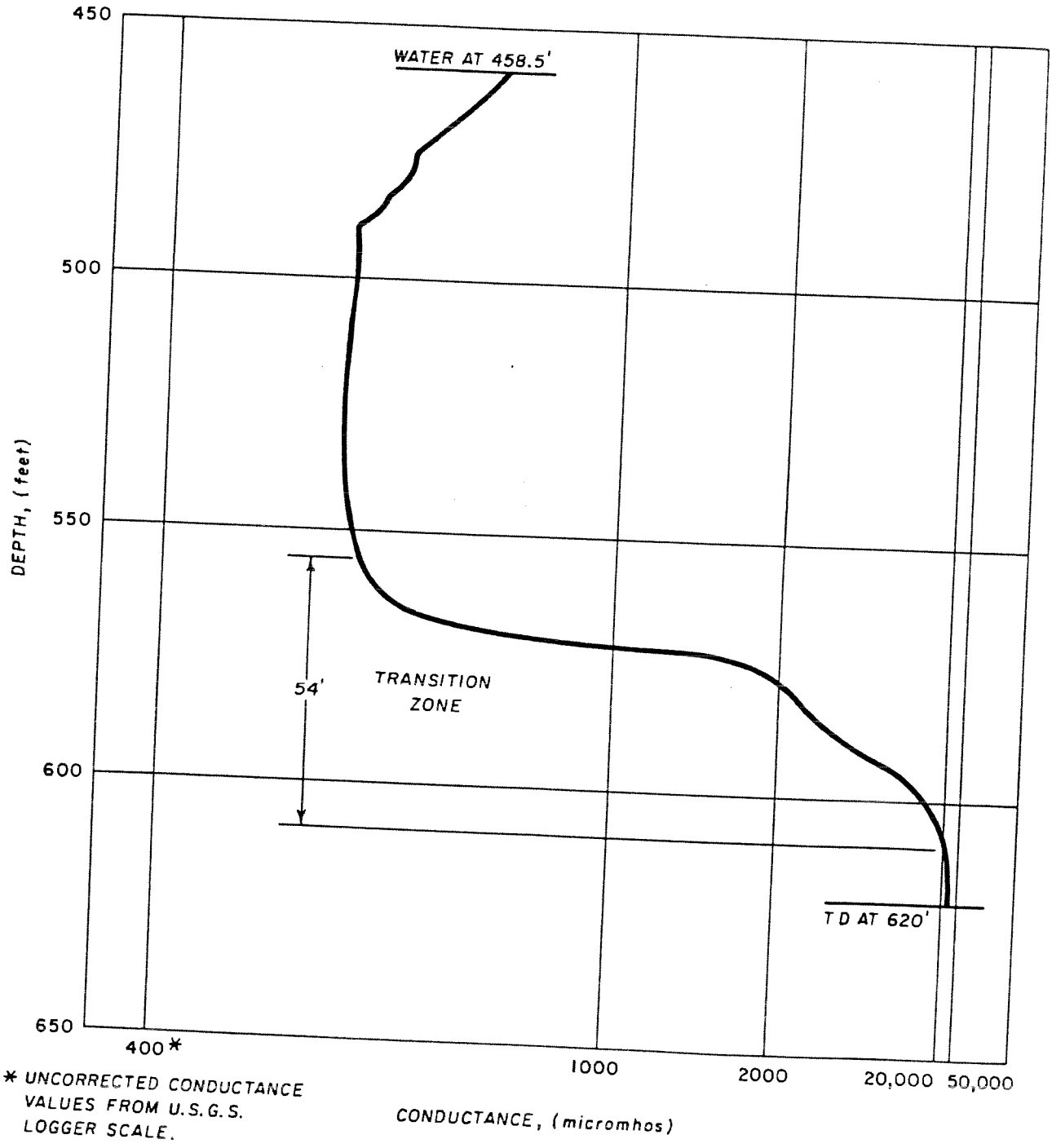


FIGURE A-5
CONDUCTIVITY LOG - WELL EX-8
FEBRUARY 12, 1982

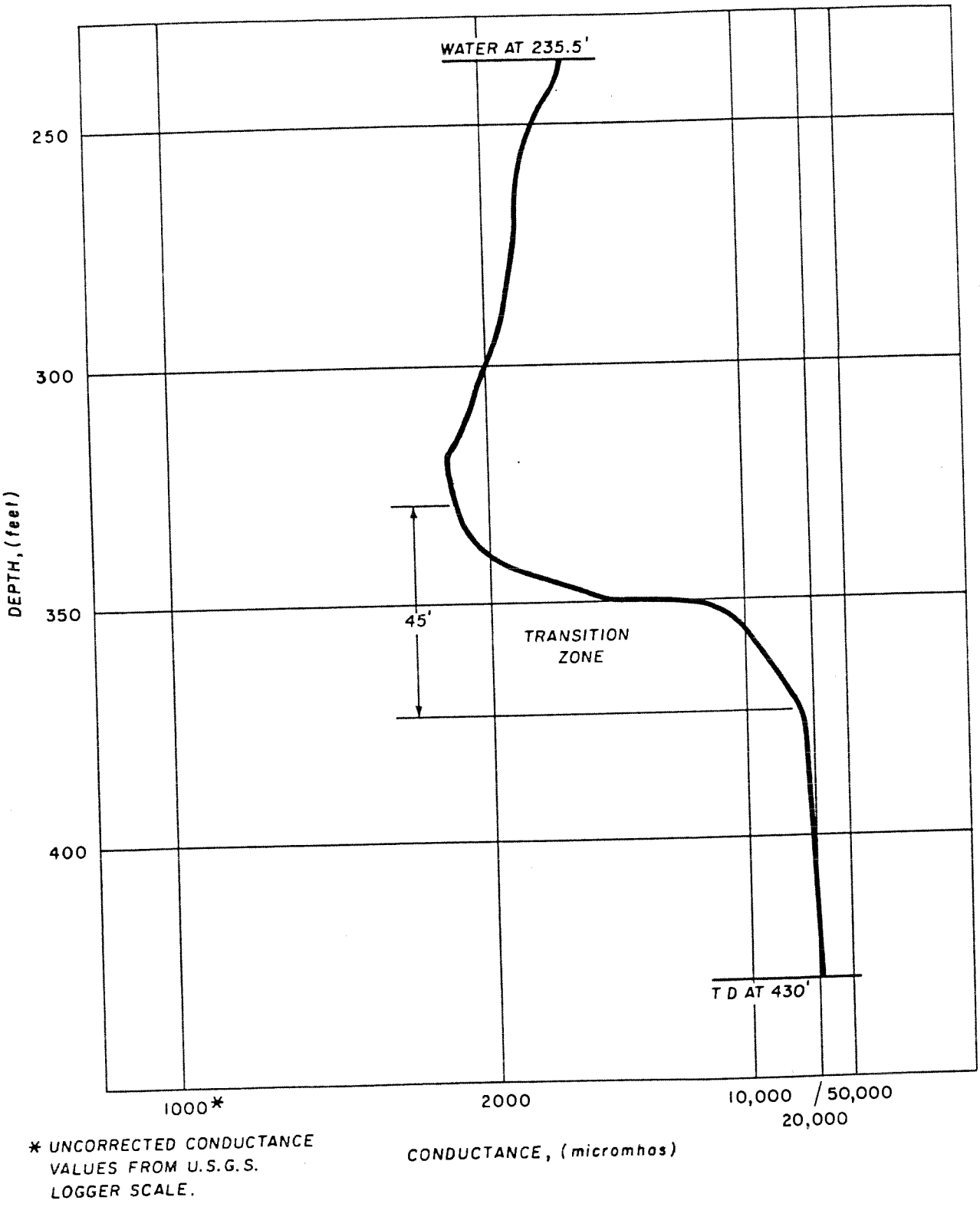


FIGURE A-6
CONDUCTIVITY LOG - WELL EX-9
FEBRUARY 26, 1982

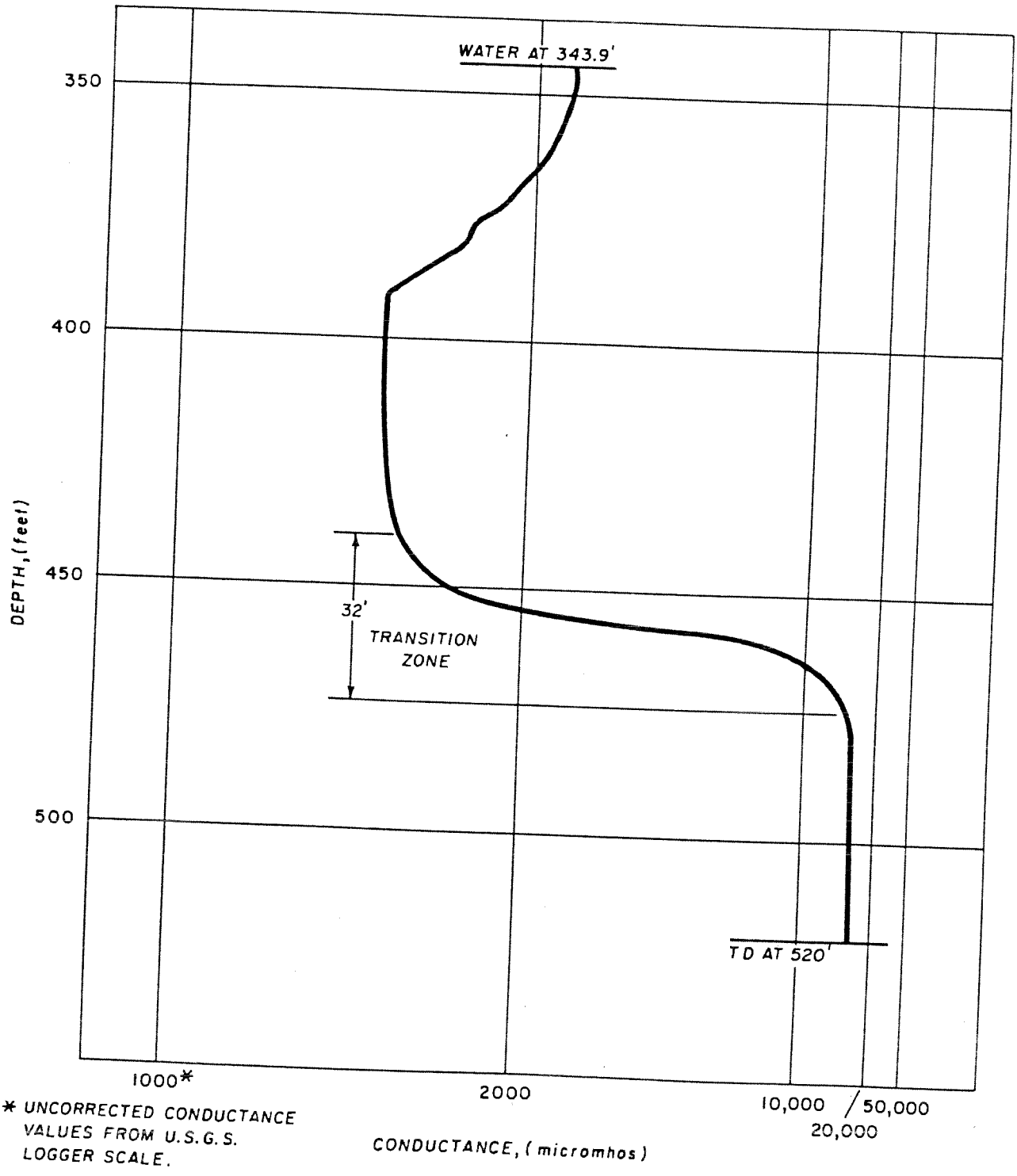


FIGURE A-7
CONDUCTIVITY LOG - WELL EX-10
FEBRUARY 16, 1982

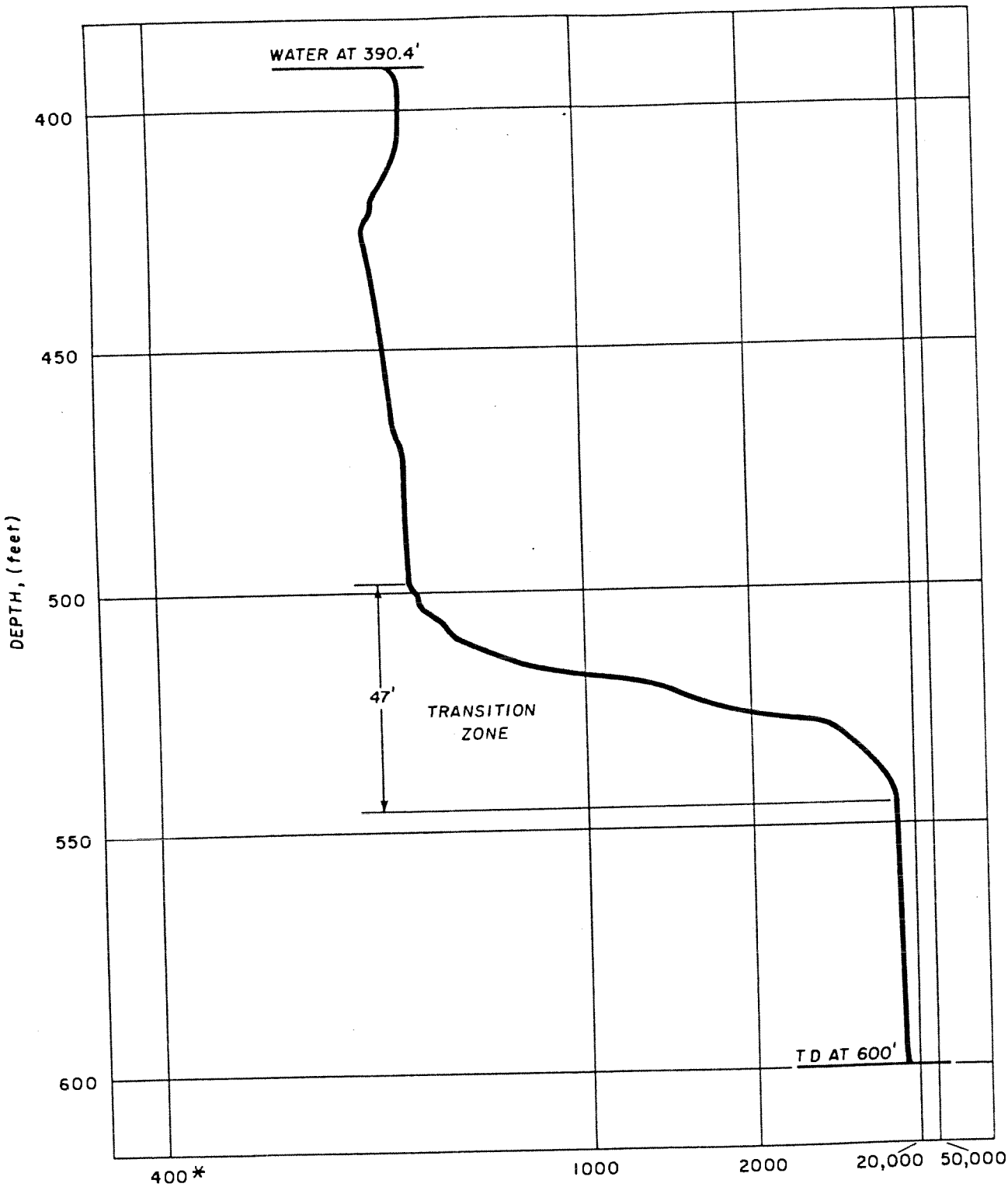


FIGURE A-8
CONDUCTIVITY LOG
GHURA - Dededo MONITORING WELL
FEBRUARY 26, 1982

APPENDIX B1

DESCRIPTION OF GEOPHYSICAL EXPLORATION METHODS

By: John F. Mink

INTRODUCTION

From the earliest hydrogeologic investigations in northern Guam, it was realized that the elevation of the volcanic basement with respect to mean sea level was extremely important in defining the groundwater flow system in the limestone aquifers. Knowledge of the basement before the start of the NGLS was obtained from a few wells that penetrated the volcanics and by extrapolation of the limestone-volcanic contact from several volcanic exposures occurring at Mataguac Hill, Palii Hill, and Mt. Santa Rosa.

Geophysical techniques had long been proposed as the means of mapping the basement on a regional scale, but only in the last few years were some of these methods employed. Seismic refraction and gravity surveys were successfully conducted, while magnetic and seismic reflection techniques were tested but discontinued. The magnetic techniques were compromised by an abundance of pipes, wires and other disturbances in most areas of the north, while the success of the refraction method eliminated a requirement for the more costly seismic reflection technique. Resistivity methods were not tried because of widespread occurrence of potentially interfering artifacts and because the lithologic succession would be masked by the occurrence of salt water. Depth to the fresh water-salt water interface was not an objective to be determined by geophysical methods.

The geophysics contract was awarded to ECOsystems Management Associates of San Diego, California. The refraction survey was organized, conducted and interpreted by Dr. Shawn Biehler, and the gravity work was under the direction of Philip Walen. The surveys were run in April, 1980 and the results and interpretations submitted the following August.

A total of 56 refraction profiles were made in the 100 square miles of northern Guam. Length of the profiles averaged 2,500 feet but varied from 2,000 to 3,500 feet. The normal geophone spacing was 100 feet. Seismic waves were generated by one to three pounds of explosives placed in holes seven to twelve feet deep. Forward and reverse shots were made. Most of the crew were locally hired and trained by Dr. Biehler.

The gravity survey was carried out during the same period as the seismic work. Measurements were made at a total of 321 stations, some of which were in the south of Guam even though this area is not included in the Lens Study. These southern readings were taken to determine the continuity of structural features exhibited by work in the north.

Details and complete data for both the seismic and gravity work is given in ECOsystem's report to Guam Environmental Protection Agency entitled, "Geophysical Investigations for the Northern Guam Lens Study," on file at the GEPA office.

SEISMIC REFRACTION SURVEY

Results of Survey

The results of the refraction survey were generally satisfactory and in some instances definitive. Not enough profiles could be run to yield unequivocal knowledge of basement configuration throughout the north, but important subsurface regional stuctures have been identified and the relationships among them illuminated. The knowledge obtained is consistent with point sources of information (wells and bedrock exposures) and with the gravity results.

In most profiles three layers of distinctively different seismic velocity were encountered: the top layer of limestone, the intermediate layer also of limestone, and the bottom layer of basement volcanic rock. The first limestone layer exhibits an unusually low velocity that clearly differentiates it from the second limestone layer. In most profiles, the volcanic basement can also be differentiated from the intermediate limestone, but in

several instances, the higher range of velocity in the limestone overlaps the lower velocity range of the volcanics so that judgement based on other factors must be exercised in selecting depth to basement. This is particularly the case in the Dededo well field area where the depth to basement rocks, as determined by seismic survey, does not coincide with well data. Here, seismic profiles indicate an elevation of volcanics on the order of 200 to 250 feet above sea level where several wells in the area penetrate limestones to elevations in excess of 50 feet below sea level. This inconsistency can be explained in two ways: the subsurface topography of the volcanics is extremely rugged, or what has been interpreted as volcanics is actually a third layer of limestone with a seismic velocity equivalent to that of volcanics. This particular area should be studied further in any future hydrogeologic investigations.

The velocities of the limestone are unexpectedly low when compared to results obtained in other limestone terrains. In fact, many of the contractors responding to the request for proposal believed that it would not be possible to discriminate between limestone and volcanic velocities and that the basement contact could not be identified by refraction techniques. The low velocities were a surprise because they were not predictable by reference to the literature of seismic studies. The generally available literature deals with the results of work on continental limestones, which are normally dense and compact, and submerged limestones of coasts and islands, which evidently are less porous than Guam limestones. On Guam, the limestones consist of fossil reefs and associated calcium carbonate deposits that have been raised above sea level, primarily by tectonic uplift and less importantly by eustatic sea levels associated with Pleistocene glaciation. The most likely explanation for the low velocities of the raised reefs of Guam is attenuation of the seismic impulse by relatively high porosity of the rock. Table B1-1 lists seismic velocities reported for limestones in islands elsewhere, showing they are about twice that of the upper limestone layer and normally appreciably more than the intermediate layer on Guam.

TABLE B1-1

SEISMIC VELOCITIES LIMESTONE ISLANDS
(velocities in feet per second)

Island	Data Source	Surface Layer	Type	Layer 1	Type	Layer 2	Type	Basement
Bikini	Dobrin and Perkins, 1954 USGS PP 260-J			7,000	Loose Calcareous	11,000	Compact Calcareous or Dolmite or Pyro-clastics	17,000
Barbados (note: raised reef)	Same			5,620	Reef			
Bermuda	Same			8,800				
Bikini and Kwajalein	Raitt 1954, USGS			8,200	Calcareous	9,840	Calcareous	
Eniwetok	Raitt 1957, USGS pp 260-S	6,298	Reef	8,000	Reef-Lagoon	10,000	Calcareous	13,616-26,543
Guam	Northern	3,000	Raised	6,700	Raised			9,000

Biehler interpreted his results to show that 27 of the 56 profiles did not encounter the basement because the limestone column was too thick for the profile length. Another interpretation into which well penetration and hydrologic information was integrated suggests that only 18 of the profiles did not refract from the basement. Where depth to basement is greater than about 500 feet, the survey could not discriminate the volcanics.

The three layer model of two limestone layers atop the volcanic basement is applicable throughout practically all of northern Guam. Table B1-2 is a summary of essential statistics of profiles separated by sectors in which geology and topography are similar. This arrangement of statistics shows that the velocity and thickness of layer 1 are quite uniform all over northern Guam and the velocity of layer 2 is similarly uniform. It also suggests that for those profiles where the volcanic basement was definitely encountered the thickness of layer 2 is also relatively uniform. In Table B(1)-2 only those basement velocities directly established by refraction were used for the statistics.

For layer 1, the highest average velocity is found in the A profiles located in the Chalan Pago-Ordot region. The Argillaceous member of the Mariana limestone covers the region. The clay layer, lens, and pocket characteristics of this limestone reduces its overall porosity, thereby increasing its seismic velocity. The velocity of the second layer in the A profiles is also higher than elsewhere and likely for the same reason. North of the argillaceous sector, the Mariana limestone is thought to be clean of clays and its porosity to be controlled by normal calcareous depositional and diagenetic processes.

Table B1-3 is a summary of velocity statistics of the three layers for all profiles without regard to location. As in Table B(1)-2, only definite basement velocities are considered. Included in the table are estimates of the outer limits of the velocity envelopes based on averages plus or minus two standard deviations. Assuming that individual values are normally distributed, these limits include 95 percent of all expected values. It appears that values for each layer have approximately normal distribution

TABLE B1-2

STATISTICS OF LAYER VELOCITY AND THICKNESS BY SECTORS
(velocities in feet per second; thickness in feet)

Profiles	Layer 1 Avg. Vel.	Standard Deviation	Layer 1 Avg. Thick.	Standard Deviation	Layer 2 Avg. Vel.	Standard Deviation	Layer 2 Avg. Thick.	Standard Deviation	Basement Avg. Vel.	Standard Deviation
A1, A2, A3, A4, A6, A7, A8	3,560	1,293	99	38.7	7,358	495	300	119	10,614	1,211
B1, B2, B3, B4, C1, C2, C3, C4	2,666	429	113	39.8	6,495	644	314	200	9,419	715
D1, D2, D3, D4, D5, D6, D7, D8, E20	3,091	823	183	86.1	6,900	701	291	187	8,773	530
E7, E8, E9, E10, E11, F1 F2, F3, F4	3,038	475	134	50.8	6,002	1,297	278	164	8,369	615
E11, E12, E13, E15, E16, E17, E18, E19, E21	2,942	469	69	44.6	6,287	880	366	201	8,664	662
S1, S2, S3, S4, S5, S6, S7, S8	3,207	408	112	52.6	6,365	516	279	153	9,696	1,725
Weighted	3,094		126		6,670		317		9,266	

TABLE B(1)-3

STATISTICS OF LAYER VELOCITY
(velocities in feet per second)

Statistic	Limestone Layer 1	Limestone Layer 2	Volcanics Layer 3
A profiles excluded			
Number in sample (N)	52	49	32
Range of velocities	2,173-4,952	5,007-8,214	7,061-13,649
Median velocity	3,024	6,643	8,990
Average velocity (V)	3,045	6,715	9,171
Standard deviation (S)	629	882	1,114
V + 2S	4,303	8,479	11,399
V - 2S	1,787	4,951	6,943
A profiles included			
Number in sample (N)	59	56	38
Range of velocities	1,781-4,988	5,007-8,214	7,061-13,649
Median velocity	3,161	7,000	9,228
Average velocity (V)	3,106	6,795	9,398
Standard deviation (S)	742	867	1,234
V + 2S	4,590	8,529	11,866
V - 2S	1,622	5,061	6,930

because the average and the median are nearly equal, a condition of normality. In the table, two sets of statistics are given, one that excludes the A profiles and the other including them. The exclusion of the A values for layers 1 and 2 may refine the statistics for the cleaner limestones but should make no difference with respect to the basement.

The statistics show that layer 1 is distinct from layer 2. The highest velocities in layer 1 are less than the lowest velocities in layer 2, which means that only in exceptional cases could the layers be confused. The (V + 2S) statistics for layer 1 is 4,303 feet per second (fps) and the (V - 2S) statistic for layer 2 is 4,951 fps, giving a large divergence between layer velocities for all but a few percent of expected values.

The clear and significant difference between layer 1 and layer 2 velocities suggests that the layers are composed of different limestones. The low velocity of layer 1 implies high porosity, essentially unaltered reef association, while the higher velocity in layer 2 suggests a more compacted lithology characteristic of deeper water calcareous deposition. In this model, the Mariana reef limestone would be the top layer.

In most profiles where an actual layer 3 velocity was recorded, the intermediate limestone is easily distinguished from the basement. However, an overlap exists between the higher velocities of layer 2 and the lower velocities of layer 3 so that in some instances the presence of the basement must be verified by supplementary information. With the A profiles included, the (V + 2S) statistic for layer 2 is 8,529 fps and the (V - 2S) statistic for layer 3 is 6,930 fps. Thus velocities between about 7,000 fps and 8,500 fps are not diagnostic of either the basement or layer 2. Where pyroclastics dominate the upper basement, velocities are apt to be similar to those of deep limestones. Nevertheless, velocities of more than 8,500 fps are almost certainly indicative of the volcanic basement.

Interpretation of the Seismic Profiles

The principal basement features having hydrologic relevance are as follows:

1. A rise exists in the basement above sea level in a roughly elliptical area of about 10 sq.mi. between Dededo and Andersen Air Force Base. Several hundred feet of limestone overlie the basement except at small volcanic outcrops at Mataguac Hill and Palii Hill. As a rule, groundwater cannot be developed where the basement is above sea level, but this area serves as a critical source of recharge for aquifers on its flanks. Several square miles of parabasal aquifers may occur just below the sea level contour. This region may be called the "Mataguac Rise".

2. A linear subsurface ridge extends from the vicinity of Mt. Santa Rosa to Barrigada. The basement rises above sea level over a 10 mile distance as a narrow ridge varying from a few tenths of a mile to more

than a mile wide. The seismic data are consistent with the occurrence along the ridge of residual positive gravity anomalies. The ridge plunges steeply on its flanks, and at its southwest nose, drops below sea level before reaching Agana Swamp. It plunges into the Yigo Trough on the west, while on the east, the sea level contour apparently coincides with Janum Springs. All of the ridge is covered by limestone, except at Mt. Santa Rosa. The ridge is profoundly important in regional hydrology because it acts as a barrier to groundwater flow. Most groundwater is forced to drain toward the west, which substantially lowers the amount of potable groundwater supplies east of the ridge. This basement feature needs a name, and an appropriate one would be the "Santa Rosa-Barrigada Rise".

3. A subsurface low between the Mataguac Rise and the Santa Rosa-Barrigada Rise has already been named the "Yigo Trough". It extends from Tumon Bay along a gentle arc to the vicinity of the south bondary of Andersen Air Force Base and has an axial length of about eight miles. In the well defined portion of the trough, width varies from 1.5 miles at Dededo-Yigo to about half a mile at Andersen. The trough rises above sea level in its northern end, as determined by Exploratory Well No. EX-2, which effectively stops groundwater drainage between Andersen Air Force Base and Yigo Trough.

   The trough is an extremely important hydrologic feature. It receives recharge from the Mataguac and Santa Rosa-Barrigada rises and channels a large volume of fresh groundwater toward Tumon Bay. This is why the Marbo Air Force wells, many of the PUAG D and M series wells, and the Air Force Tumon infiltration gallery are such excellent groundwater production sources.

The above three major basement features dominate the location and developability of the limestone aquifers. Several subsidiary features also may play a significant role. Basement ridges seem to strike toward Ritidian and Pati Points, and a secondary trough tributary to the major Yigo Trough appears to have its axis about coincident with the Dededo well field (D

series wells). Parabasal aquifers may occur on the flanks of rises where they plunge below sea level into the troughs.

Other interpretations of the seismic data may be reasonable, in particular the boundary details of the basement troughs and rises, but the four major features apparently are dominant. These features were poorly understood at the time of the writing of the last comprehensive report on the hydrology of northern Guam (Mink, 1976) but since their discovery, have greatly improved the accuracy of groundwater flow analyses for the Northern Lens. In Mink's earlier report (1976), hydrologic budget analyses assumed essentially equal groundwater flow toward the east and west coasts. The basement configuration as now known, however, indicates that at least two thirds of subsurface drainage moves toward the Philippine Sea and only one third toward the Pacific Ocean side of the island. This type of revelation, along with reasonably well defined subsurface boundaries, makes mathematical modeling of the groundwater flow system more realistic.

GRAVITY SURVEY

A gravity survey was included in the geophysical exploration program chiefly to supplement data yielded by seismic refraction. But a subsidiary purpose was to provide a reconnaissance view of gravity distribution on the island because no such survey had been done before. The normal goal of a gravity survey, which is the determination of regional gravity anomalies, was successfully accomplished. In addition, the regional bulk density of the limestone was obtained by correlating changes in free air anomalies with elevation along a linear traverse, and residual gravity values were computed by removing the regional gravity field. Bulk density of the limestone is important because, from it, an estimate of regional porosity can be calculated. The location of residual gravity anomalies trace the rise and fall of the basement.

Regional Gravity Anomalies

Over northern Guam, regional gravity varies from about 200 milligals (mgals) on the east coast to 200 mgals at the positive anomaly near Potts

Junction on Marine Drive. Although not a large gradient, it is significant. A closure of 4 to 5 mgals encircles this high in the northwest quadrant of the island. The high is not coincident with the volcanic outcrop at Mataguac Hill or the larger exposure at Mt. Santa Rosa. ECOsystems interpreted the gravity high as reflecting a deep plutonic core which is modelled as having a radius of 12,000 feet and a center of mass at a depth of 22,000 feet.

The regional gravity anomalies have not proved to be a clear guide to basement elevations, but they are indicative of primary subsurface structures. They are not as prominent as in Hawaii, where a variation of as much as 100 mgal is common, but nevertheless, ECOsystems believes they resemble the Hawaii model in reflecting concentrations of dense rock associated with volcanic rift zones. But, because Hawaiian rocks are basaltic and the rift zones radiate from calderas, while the Guam rocks are mostly andesitic with no identifiable evidence of calderas, this interpretation should be looked on as preliminary.

A second gravity high is found over Nimitz Hill. It is not as obvious as the northern one because closure is poor and incomplete. In all of Guam, the largest high lies off Facpi Point where an anomaly of 235 mgals and a closure of 5 mgals has been measured. In the vicinity of Facpi Point many dikes, which probably are part of a rift zone, have been mapped.

Determination of Bulk Density of Limestone

By correlating the change in free air gravity anomalies with differences in elevation along a line of stations, measurement of mass contained between the lowest and highest stations is made. Four traverses, mostly on Mariana limestone, resulted in density calculations ranging from 2.24 to 2.50 and averaging 2.35. From these data, approximations of the regional porosity of the limestone can be made by reference to the standard densities of solid aragonite, the mineral which calcium carbonate initially forms, and calcite, the mineral to which aragonite eventually converts. The density of aragonite is 2.930 and the density of calcite is 2.710. If all of the limestone consists of aragonite, the regional porosity would vary between

15 and 24 percent and average about 20 percent; if it consists only of calcite, regional porosity would range from 8 to 17 percent and average 13 percent. Based on gravity data, therefore, a reasonable estimate of the regional porosity of the Mariana limestone is 10 to 25 percent.

Residual Gravity Values

A technique commonly used to show relative changes in mass consists of removing the regional gravity field in order to accentuate gravity residuals. Regional separations were carried out for northern Guam and the remaining residuals computed. In many instances, the positive residuals correlate with rises in the basement and negative residuals with troughs. Not all residuals, however, follow the correlation. Interpretations of the basement configuration should be made cautiously when residuals are employed as the primary data.

APPENDIX B2

DEVELOPMENT OF THE VOLCANIC BASEMENT CONTOUR MAP

The development of the Volcanic Basement Contour Map, Plate 1, which defines the lower boundary of the limestone aquifer, has significantly increased the understanding of Guam's Northern Lens groundwater system. It provides a more precise definition of the subbasin boundaries and overall geometry of the limestone aquifer. This clearer understanding of aquifer configuration has not only enhanced the estimates of sustainable yield, but has made well site selection and design far less risky.

The contour map was constructed using: 1) lithologic logs from wells; 2) seismic refraction profiles and gravity data; 3) surface geology; 4) chloride concentrations in conjunction with groundwater level elevations; and 5) surface geomorphology.

The lithologic well logs are the most definitive information for determining the top of volcanics because the penetrated volcanic rocks are visually identifiable, thus providing an exact selection of the contact. The well logs indicate the elevation at which the well intersects the volcanics, or, if the well does not penetrate volcanics, show the maximum possible elevation of the volcanics. Prior to 1981, few wells penetrated volcanics in the northern Guam because of the design criteria which stipulated that the bottom of wells should not exceed 25 feet below sea level. As a result, very wide gaps in definitive well data were evident. GEPA realized this, and as part of the Northern Guam Lens Study, drilled 11 exploratory wells in various locations in the Lens, and of those, three penetrated volcanics. These wells not only gave positive information on where the volcanics were at these locations, but also verified the validity and interpretation of the seismic refraction data. In areas of conflicting data, such as near seismic line D-1 in the Dededo Well Field (see Plate 1), the well data were given priority over other data.

Seismic refraction profiles and gravity surveys were run by ECOsystems Management Associates, Inc. Fifty-six seismic lines were run, with the lengths of the lines varying from 2,000 feet to 3,500 feet, and with geophone spacing between 50 and 200 feet. Small dynamite blasts were used as the energy source at each end of the profile. Twenty-nine seismic refraction profiles provided top-of-volcanic surface. The map, produced by ECOsystems, represented the first generation of Plate 1, which slowly evolved as new data became available. The gravity survey data, though useful in determining anomalous subsurface features, were generally not useful in determining the break between the top of volcanics and the overlying limestone.

The previously mapped surface geology was used to identify surface exposures of the volcanics. The volcanics are exposed in northern Guam at Mount Santa Rosa, Mataguac Hill, Palii Hill, and near the southern bondary of the Northern Lens, along the Pago River.

The chloride concentrations from production wells were also used in preparing Plate 1. Data were obtained from 1982 mean chloride concentrations from PUAG and United States Air Force analyses. Chloride data, from the first drilled well in 1937, through the 1950's were used for other, older wells. The chloride ion concentrations are used to divide the groundwater basin in the Northern Lens into parabasal, basal, and transitional zones. If a particular well had a chloride concentration of less than 30 mg/l, the well was considered to be in the parabasal zone; if the concentration was less than 70 mg/l and greater than 30 mg/l, the well was probably over the transition zone between basal and parabasal zones; and if it was greater than 70 mg/l, the well was in the basal zone. Chloride concentrations used in conjunction with fresh water heads and the associated fresh water-salt water interface, which was calculated using the Ghyben-Herzberg principal (which states that the fresh water-salt water interface is located at a depth 40 times that of the groundwater surface elevation), will give an approximation of depth-to-volcanics. To use this method, first, the type of lens which a particular well penetrated must be determined (i.e. parabasal or basal). For parabasal wells, the water level is multiplied by 40

and the result is the maximum depth of the top-of-volcanics. For a basal well, the water level, multiplied by 40, is the minimum depth of the volcanics.

Finally, surface geomorphology of the Northern Lens was used to interpret subsurface volcanic landform where data was insufficient to make any other, more definitive interpretation. It was assumed that the historic geomorphology after the volcanics were deposited was relatively the same as that of today. Then, contours were drawn which reflected the suspected volcanic surface. For example, at Andersen Air Force Base, the pronounced slope of the ground surface northeast toward Patti Point, as well as the prominence of Patti Point, were interpreted as reflecting a ridge line that extends from Salisbury Junction to Patti Point.

The five types of data summarized above were used together to produce the top of volcanics contour map. As new data becomes available, the map should be refined. Areas in which questionable interpetations were made are around the Dededo Well Field, northern and eastern Agana Subbasin, Andersen Subbasin, northern Finegayan Subbasin, and the Northwest Field area. The University of Guam is obtaining instruments to conduct geophysical surveys and the NGLS consultant recommends that they conduct more detailed seismic surveys in the future in these areas to further define the volcanic subsurface. In other areas, data acquired from the drilling of future production water wells will help refine the interpretation of the volcanic map.

APPENDIX C

PERMEABILITY OF THE NORTHERN LENS LIMESTONES

GENERAL

This appendix discusses several methods used to indirectly determine permeability in Guam's Northern Lens limestone aquifer. Of all the hydraulic parameters associated with the Northern Lens limestones, permeability is probably the most important, yet the most difficult to determine. Permeability (K) is a measure of the ability of a porous medium to transmit water. Permeability is defined as the rate of flow (Q) of water at 60 degrees Farenheit through a porous media having a cross-sectional area (A) of 1 square foot under a hydraulic gradient (I) of 1 foot per foot. It is represented by the variation in the Darcy equation:

$$K = \frac{Q}{IA} \qquad \text{(C-1)}$$

In the Northern Lens limestones, regional permeabilities range over three orders of magnitude, from under 10 feet per/day (ft/d) for the most argillaceous limestones in the southern part of the lens, to over 12,000 ft/d in the northern part of the lens. However, local variations in permeability are common and extreme because of the nature of the limestone matrix structure and depositional environment. Considering the types and distribution of pore space in limestone, local permeabilities may vary from near zero to 20,000 ft/d.

This extreme variation, and especially the very high values of permeability, make its precise determination by conventional pump test methods almost impossible in northern Guam. Characteristically, drawdowns in pumping wells stabilize in a matter of a few minutes. Drawdowns measured

inside a pumping well are generally on the order of several feet, and in some instances tens of feet. However, aquifer drawdown calculations based on the high regional permeabilities are on the order of less than one foot. The difference between the in-casing drawdown and the corresponding aquifer drawdown indicates the relatively high head loss that occurs as the water passes from the aquifer through the gravel pack and well screen. Separating head loss through the aquifer from head loss through the well screen is nearly impossible for the wells now in production in the Northern Lens. If future wells are equipped with sounding tubes placed in the gravel pack outside the well casing, then a better estimate of water level drawdown in the aquifer will be available.

Because permeability is not easily determined using the more common pump test methods, several indirect methods are used to estimate local and average regional permeabilities. These include head gradient relationships, tidal attenuation, recovery tests, intrusion analyses, and numerical modeling techniques.

GENERAL PERMEABILITY CHARACTERISTICS OF LIMESTONE IN GUAM

The aquifer in northern Guam consists of limestone. Permeabilities and porosities in the limestone vary considerably, both locally and regionally, depending usually on the environment of deposition of the limestone. Limestone deposited in deep water is generally massive and crystalline, and more susceptible to chemical dissolution by fresh water (FUGRO, 1974), and thus have more pores and higher permeability. Limestones deposited in the near-shore lagoonal environment contain significant amounts of clay material (derived from the adjacent volcanic upland areas) which effectively reduce the potential for dissolution of the limestone and the formation of pores.

In the aquifer section associated with the fresh water lens, porosity occurs as a result of elliptical voids in the limestone as well as continuous and discontinuous passages through the limestones. These pores range in size from microscopic openings to large, well developed cavern systems. However, inspection of exploratory well cores and limestone

outcrops in northern Guam indicate that the passages are generally about 1/8 to 1/4 inches in diameter.

As mentioned above, the amount of clay in the limestone also affects the magnitude of the porosity, and thus, the permeability. Permeabilities vary inversely with the amount of clay contained in the limestone matrix. In the southern portion of the lens, clay contents in the limetones are significantly higher than in the limestones further north. Correspondingly, permeabilities are generally one to two orders of magnitude lower in the southern limestones. The higher clay content is probably the result of the influx of fine-grained detrital material originating from the volcanic upland area of southern Guam and deposited in the quiet waters of a near-shore lagoonal environment.

ESTIMATES OF PERMEABILITY

The magnitude of the permeabilities in the Northern Lens cannot be directly measured. In the following sections, estimates are made of permeability using various indirect methods.

Areal Variations in Fresh Water Heads

Horizontal permeability within the Northern Lens can be approximated by relating fresh water head to unit flow past an observation point (located in the basal lens) and to the distance inland to the observation point. Assuming that the head is zero at the coastline and the Ghyben-Herzberg conditions apply, the basic steady state relationship is:

$$q = -41\ Kh \frac{dh}{dX} \qquad \text{(C-2)}$$

where: q = flow per unit width of aquifer past the well (dimensional units of L^2/T)

K = horizontal permeability of the aquifer (dimensional units of L/T)

X = distance from the coast to where the head measurement (h) is made, as measured along a flow line (dimensional units of L)

h = fresh water head at X (dimensional units of L)

Aquifer unit flow (q) can be estimated by:

$$q = -R(X_1 - X) \qquad \text{(C-3)}$$

where: R = average annual unit recharge to the aquifer along the flow line that passes through the observation point (assuming no extraction along the flow line)(dimensional units of L/T)

X_1 = flow line distance from the ocean to the top of the drainage basin (dimensional units of L)

Combining equations (C-2) and (C-3) provides:

$$R(X_1 - X) = 41\ Kh\ \frac{dh}{dX} \qquad \text{(C-4)}$$

Integrating equation (C-4) with the boundary condition that when X = 0, then h = 0, yields:

$$RX_1X - \frac{RX^2}{2} = 41\ \frac{Kh^2}{2} \qquad \text{(C-5)}$$

Rearranging the variables in equation (C-5) gives the following expression for horizontal permeability in terms of fresh water head.

$$K = \frac{RX}{41}\ h^2\ (2X_1 - X) \qquad \text{(C-6)}$$

Table C-1 shows the estimates of permeability for those wells in the basal lens based on the head measurements taken in September 1981 and April 1982. Unit recharge values are those developed in Chapter 5 (Tables 5-4 and 5-5). The areal variations in permeability are similar to those calculated using other methods discussed later in this report. Regionally, permeability increases from about 500 ft/d in the southern part of the lens to over 15,000 ft/d in the central part, and then decreases to about 2,000 to 4,000 ft/d in the northern part of the lens.

Head measurements taken at wells in September 1981 yielded lower calculated permeabilities than heads measured in the same wells in April 1982. This apparent variation in permeability is the result of using transient head

TABLE C-1

PERMEABILITY DETERMINED BY
DISTANCE-HEAD-RECHARGE RELATIONSHIP

Well No.	h Head* (ft)	X Distance** (ft)	X_1-X Distance*** (ft)	R Recharge (ft/d)	K Permeability (ft/d)
A-9	4.74	11,250	2,900	.00753	1,570
A-10	4.63	10,500	3,500	.00753	1,575
A-13	4.06	12,250	2,250	.00753	2,285
A-15	3.19	12,500	1,500	.00731	3,390
A-16	3.76	8,880	9,100	.00731	3,035
A-19	3.13	3,250	4,200	.00731	689
D-1	3.55	16,250	14,200	.00799	11,225
D-4	3.55	16,250	14,700	.00799	11,475
D-12	3.50	16,000	10,800	.00799	9,575
D-14	3.43	12,900	19,300	.00799	11,000
D-15	2.98	12,500	17,000	.00799	9,560
D-16	3.27	10,750	19,000	.00799	12,760
D-17	3.24	9,500	20,240	.00799	8,820
F-2	3.01	7,500	6,500	.00822	3,410
F-6	2.71	7,800	4,900	.00822	3,750
H-1	1.80	2,500	26,000	.00799	8,200
H-107	3.12	3,500	25,000	.00799	3,745
M-6	3.05	14,600	5,000	.00799	7,530
M-7	3.52	15,250	3,800	.00799	5,470
M-9	2.58	5,000	3,250	.00799	1,680
M-10a	3.07	7,500	12,200	.00799	4,940
M-11	3.51	11,000	23,100	.00799	9,950
M-12	3.31	9,100	21,100	.00799	8,300
M-14	3.50	7,200	23,000	.00799	6,095
MW-1	3.04	15,200	16,500	.00799	15,480
Y-4	3.63	26,500	9,200	.00799	17,590
BPM-72	2.93	5,000	8,500	.00753	2,355
BPM-AAFB	2.78	3,640	10,400	.00799	2,240
EX-1	7.06	7,200	11,600	.00776	831
EX-4	5.61	8,500	8,500	.00753	1,270
EX-5a	3.37	16,000	13,500	.00799	11,800
EX-6	3.58	11,750	11,300	.00799	6,140
EX-7	3.45	6,700	22,500	.00799	5,680
EX-8	2.74	11,220	9,000	.00799	8,510
EX-9	3.20	11,400	5,100	.00753	4,430
EX-10	3.20	8,100	17,300	.00799	6,580

TABLE C-1
(Continued)

Well No.	h Head* (ft)	X Distance** (ft)	X_1-X Distance*** (ft)	R Recharge (ft/d)	K Permeability (ft/d)
Island Equip. Foremost	2.31	3,250	11,000	.00685	2,570
A-9	6.06[1]	11,250	2,900	.00753	960
M-7	3.82[1]	15,250	3,800	.00799	4,660
EX-1	8.67[1]	7,200	11,600	.00776	550
EX-4	6.65[1]	8,500	8,500	.00753	900
EX-6	3.75[1]	11,750	7,250	.00799	4,270

* April 1982 water levels.

** Distance from coastline to well along a flow line.

*** Distance from well to top of drainage basin along a flow line, which is equal to (X_1-X) in equations (C-3), (C-4), and (C-6).

1 September 1981 water levels.

values instead of average recharge values in a steady-state equation. Better estimates would be obtained if average annual head data were used in the calculation. However, in those areas of the Northern Lens where head variation is minimal, such as in the Yigo Subbasin, the permeability estimates provided in Table C-1 are relatively good.

Tidal Attenuation

WERI (1982) used equations developed by Ferris (1951) to estimate permeability based on tidal attentuation within the aquifer. Analyses were done at five wells throughout the lens using the Apra Harbor tidal gage data. Each of the wells, as well as the tidal gage, were equipped with continuous water level recorders for a period of 30 months. The equation used for the analysis was:

$$\frac{R_x}{R_o} = \exp\left[X\left(\frac{S}{Tt_o}\right)^{1/2}\right] \qquad (C\text{-}7)$$

where: R_x = tidal range in the observation well (dimensional units of L)

R_o = tidal range in the ocean (dimensional units of L)

X = inland distance of the observation well (dimensional units of L)

S = aquifer specific yield (which is approximately equal to porosity in the Northern Lens limestone)(dimensionless)

T = aquifer transmissivity (dimensional units of L^2/T)

t_o = tidal period (which is about half a day)(dimensional units of T)

Transmissivity (T) can be related to permeability (K) by the following expression:

$$K = \frac{T}{m} \qquad (C\text{-}8)$$

where m = thickness of the aquifer (dimensional units of L).

Therefore, combining equations C-7 and C-8,

$$K = \frac{S\ m}{t_o\left(X\ \mathrm{Log}\ \frac{R_x}{R_o}\right)^2} \qquad (C\text{-}9)$$

WERI (1982) calculated permeability using equation C-9 for a range of porosity values, as indicated on Table C-2. As discussed in Chapter IV, a regional average porosity in the area of the wells used for the analysis is on the order of 15 percent. Assuming a porosity of 15 percent, Table C-2 shows a range in permeabilities from 2,380 ft/d at well BPM-72, located in the Agana Subbasin (Plate 1), to 12,400 ft/d at Well No. M-11 located in the Mangilao Subbasin. The permeabilities estimated by tidal attenuation are between two and ten times higher than those calculated using variations in head discussed previously.

TABLE C-2

PERMEABILITY BASED ON
TIDAL ATTENTUATION

Well No.	Permeability (feet/day) $n^* = 0.15$	$n^* = 0.25$	$n^* = 0.40$
BPM-72	2,380	3,950	6,330
H-107	5,610	9,350	14,960
M-10a	6,790	11,330	18,130
A-16	8,155	13,590	21,750
M-11	12,400	20,670	33,075

*n = effective porosity

Recovery Tests

Although pump drawdown tests are not useful in determining permeability for the limestone aquifer, pump recovery tests can be of assistance. Figure C-1 is an example of a time-recovery curve for a test conducted at Well No. F-2. The curve is used to estimate aquifer transmissivity. The equation for determining transmissivity from the time-recovery curve is:

$$T = \frac{35.3Q}{\Delta h} \qquad \text{(C-10)}$$

where: T = transmissivity, ft^2/d

Q = discharge from the well when the well was pumping, in gpm

Δh = change in head over one log cycle of time since pumping stopped, in feet

Because the wells used for this analysis only partially penetrate the aquifer (usually the upper 25 to 50 feet), transmissivity must be corrected to reflect the entire aquifer sequence. When converting transmissivity (T)

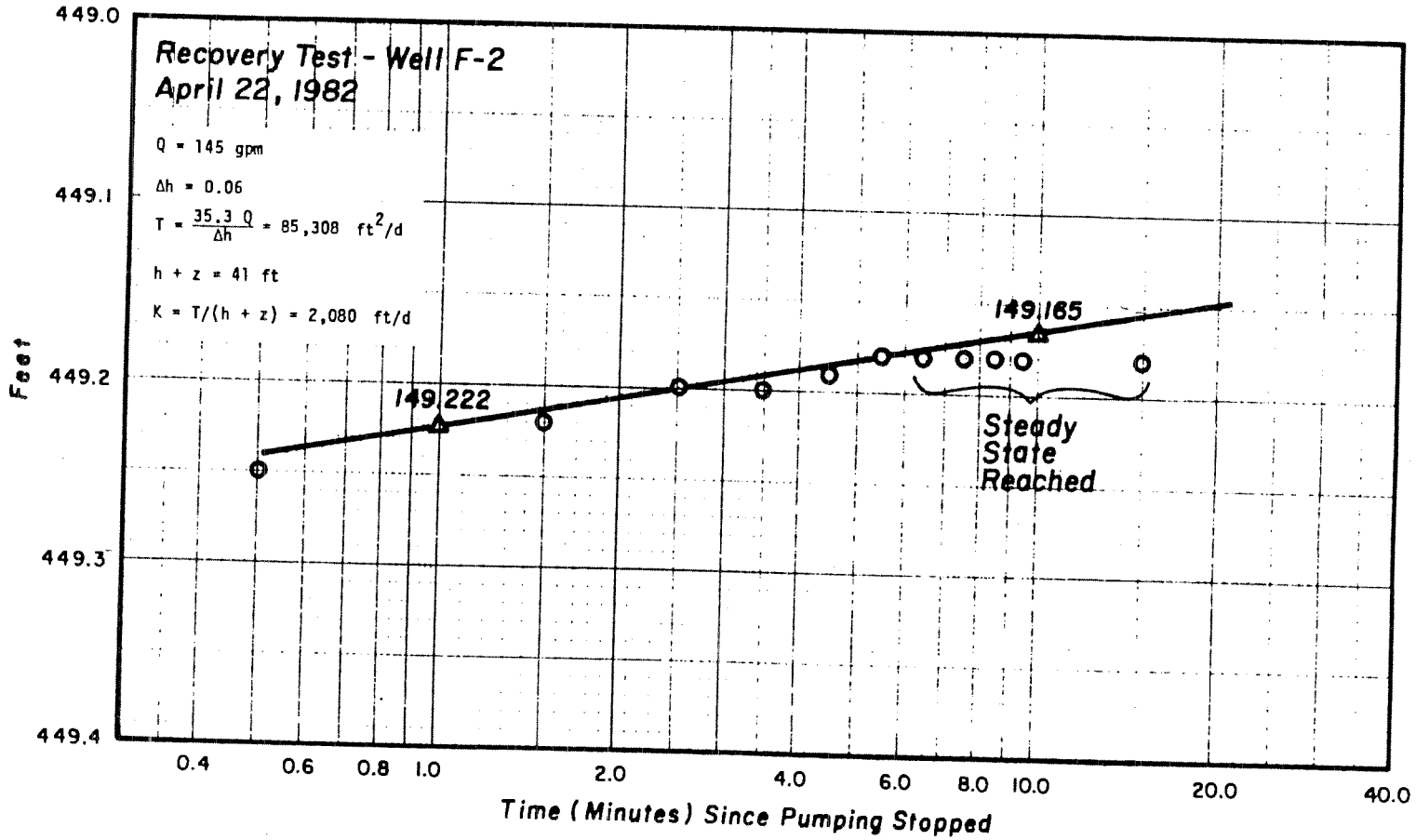


FIGURE C-1

TIME RECOVERY TEST CURVE

to permeability (K) in a fully penetrating well, T is divided by the thickness of the aquifer, as was done in equation (C-8). For a partially penetrating well, T is divided by the amount of aquifer penetrated, which equals the fresh water head (h) plus the depth of the well below sea level (z). Therefore,

$$K = T/(h+z) \qquad \text{(C-11)}$$

Table C-3 summarizes the permeabilities for each well based on the recovery test. The majority of the tests were conducted by the driller at the time of well construction prior to the initiation of the NGLS. Several tests were conducted by John Mink and CDM during the study.

TABLE C-3

PERMEABILITIES FROM
LOCAL DRAWDOWN RECOVERY TESTS

Well No.	Δh/log cycle (ft)	Q (gpm)	h (ft)	z (ft)	h+z (ft)	T (ft^2/d)	K (ft/d)
A-2	0.87	236	6.7	51	57.7	9,576	166
A-3	3.10	275	20+	306	326.0	3,131	10
A-5	0.34	225	4.4	174	178.4	23,360	131
A-7	0.69	262	10+	42	52.0	13,404	258
A-8	5.40	238	15±	173	188.0	1,556	8
A-10	0.24	215	4.6	26	30.6	31,623	1,033
A-11	12.90	164	31.3	159	190.3	449	2
A-12	3.20	252	22.3	190	212.3	2,780	13
A-13	9.50	211	4.1	194	198.1	784	4
D-4	0.16	175	3.6	26	29.6	38,609	1,304
D-11	0.31	180	3.5+	37	40.5	20,497	506
F-1	0.13	132	3.0±	35	38.0	35,843	943
F-2	0.06	145	3.0	38	41.0	85,308	2,080
M-1	0.12	194	3.0+	54	57.0	57,068	1,000
M-4	0.09	176	3.0±	50	53.0	69,031	1,300
M-5	0.10	208	3.6	131	134.6	73,424	546
M-6	0.20	194	3.1	73	76.1	34,241	450
M-7	0.08	229	3.5	51	54.5	101,046	1,850

The permeability estimates shown in Table C-3 are values for the aquifer immediately adjacent to each well, and thus, represent local permeabilities. However, the use of this method can be limited in northern Guam where aquifer permeabilities are so high. It is possible that if the permeability of the well screen and gravel pack is lower than that of the aquifer, the rise in water level within the well will lag behind the rise in the adjacent aquifer. In this case, the recovery test would be measuring the permeability of the well screen and not an accurate indication of aquifer transmissivity. If, on the other hand, the permeability of the well screen and gravel pack is higher than that of the aquifer, then the rise in water level during the test will be the same in both the aquifer and the well, thus, providing an accurate test of aquifer transmissivity. Therefore, this method of measuring permeability should be limited to those wells which do not have high in-casing drawdowns.

This method of estimating permeability shows the same areal trend and order of magnitude change over the Northern Lens as indicated by the head variation method discussed earlier in the Appendix. In the southern part of the lens, permeability ranges from 2 ft/d to 1,030 ft/day. Moving north, the permeability in the tested wells range from 450 ft/d to 2,080 ft/d.

Numerical Modeling

Two numerical groundwater models were used during the NGLS to evaluate groundwater conditions in the Northern Lens limestones. The first consisted of an intricate finite element model developed by the University of Guam. This model is described in more detail in Appendix G. The three regional permeabilities calibrated for this model were 100 ft/d in the southern part of the aquifer, 5,000 ft/d in the central part of the lens, and 10,000 ft/d in the northern part of the lens (see Appendix G).

During the NGLS, the Consultant developed a second model using a non-linear equation to determine salt water intrusion on sloping impermeable basement rock. A summary of the derivation of the basic equations of the model are provided in the following paragraphs.

Bear (1979) provides an expression which was derived by Strack (1976) for single value harmonic potential (ϕ) in the fresh water zone:

$$\phi = \frac{Q_o X}{K} + \frac{Q_i}{4\pi K} \ln \left[\frac{(X_t - x_i)^2 + Y^2}{(X_t + x_i)^2 + Y^2} \right] \qquad \text{(C-12)}$$

where: ϕ = function of head by the relationship $\phi = \frac{41\ h^2}{2}$ (dimensional units of L^2)

Q_o = unit discharge through the aquifer along a flow line (dimensional units of L^2/T)

Q_i = well discharge (dimensional units of L^3/T)

X_t = distance inland from the coast to the salt water toe (dimensional units of L)

Y = distance along the coast from origin of the coordinate system to the point where the salt water toe distance (X) is calculated (dimensional units of L)

x_i = X-coordinate of the well (dimensional units of L)

K = aquifer permeability (dimensional units of L/T)

Figure C-2 illustrates the system being described. Equation (C-12) requires modification to account for multiple wells, sloping basement rock at the base of the aquifer, and uniform recharge. To account for multiple wells, the second term on the right hand side of equation (C-12) is modified to:

$$\sum_{i=1}^{n} \left[\frac{Q_i}{4\pi K} \ln \frac{(X_t - x_i)^2 + (Y - y_i)^2}{(X_t + x_i)^2 + (Y - y_i)^2} \right] \qquad \text{(C-13)}$$

where: y_i = y-coordinate of a well (dimensional units of L)

Recharge, coming landward of the salt water toe, is introduced by modifying the first term on the right hand side of equation (C-12) as follows:

$$K\,(1+\gamma)\,h\,\frac{dh}{dX_t} = Q_o + R\,(X_1 - X_t) \qquad \text{(C-14)}$$

or

$$\begin{aligned} K\,\frac{d\phi}{dX_t} &= Q_o + R\,(X_1 - X_t) \\ &= R\,(X_1 - L) + R\,(L - X_t) \\ &= R\,(X_1 - X_t) \end{aligned} \qquad \text{(C-15)}$$

where R = unit recharge rate (dimensional units of L/T)

L = distance from the coast to the limestone/volcanics contact at an elevation equal to mean sea level (dimensional units of L)

γ = fresh water-salt water density relationship; equal to density of fresh water divided by the difference in density between fresh water and salt water (dimensionless)

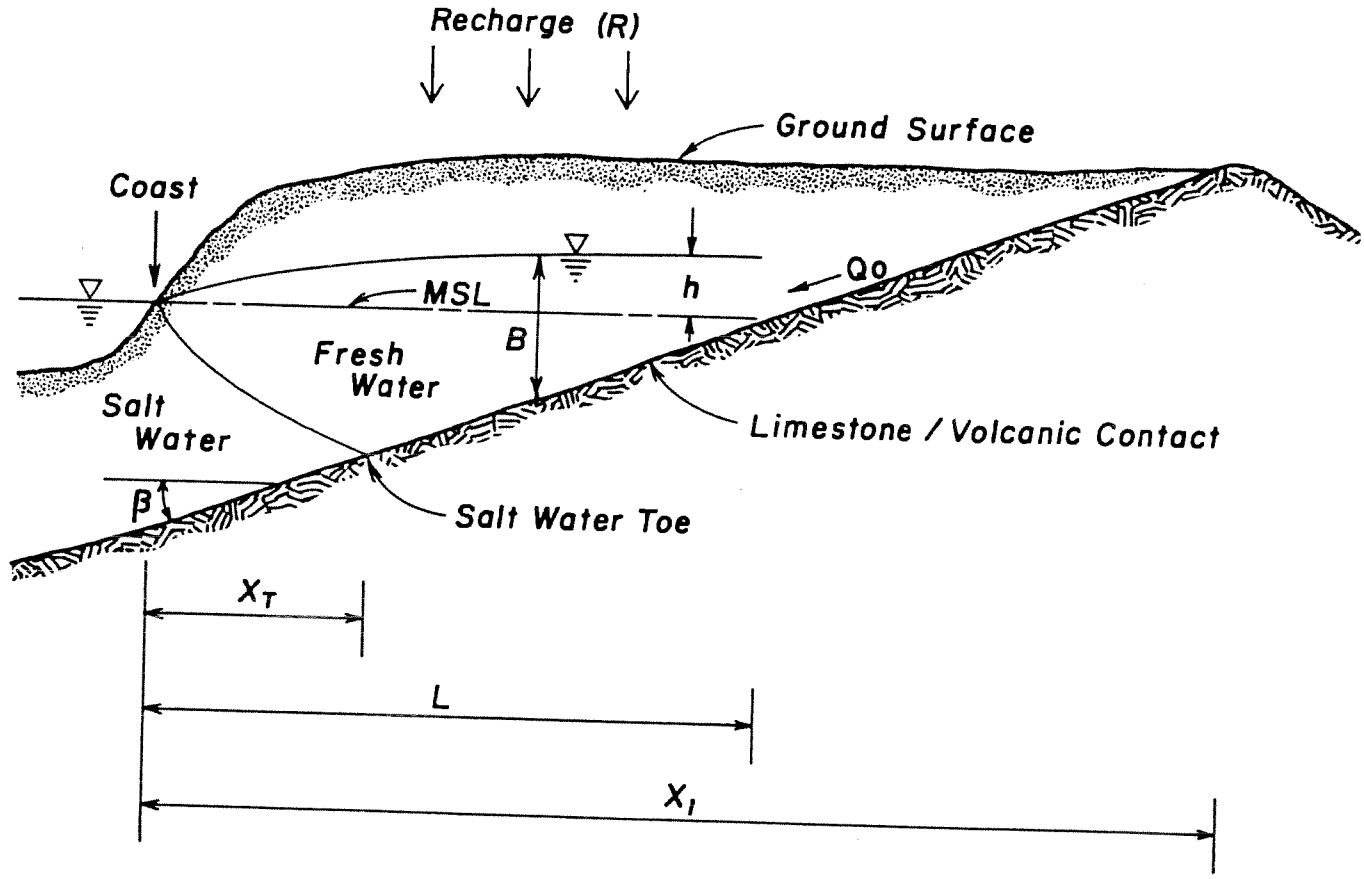
X_1 = distance from the coast to the top of the drainage basin (dimensional units of L)

Integrating the modified form of the $\frac{Q_o X_t}{K}$ term of equation (C-12) as presented in

$$\frac{Q_o X_t}{K} = \frac{R}{K} X_1 X_t - \frac{R}{2K} X_t^2 \qquad \text{(C-16)}$$

Sloping limestone/volcanic contact is addressed next. According to the analysis by Strack (1976), the potential at the fresh water-salt water interface is given by:

$$\phi = \frac{1}{2}\left(\frac{1+\gamma}{\gamma^2}\right) B^2 \qquad \text{(C-17)}$$



(NOT TO SCALE - VERTICALLY EXAGGERATED)

FIGURE C-2

HYPOTHETICAL DIAGRAM
OF THE SALT WATER TOE POSITION

where: B = thickness of the aquifer measured from the water table to the top of the volcanics. B can be modified to account for the slope of the limestone/volcanic contact by:

$$B = \beta (L - X_t)$$

Combining equations (C-17) and (C-18) gives:

$$\phi = \frac{1}{2} \left(\frac{1 + \gamma}{\gamma^2} \right) \beta^2 \left(L^2 - 2LX_t - X_t^2 \right) \qquad \text{(C-19)}$$

Modifying equation (C-12) with respect to equations (C-13) and (C-16) and equating this to equation (C-19) yields equation (C-20) for the position of the salt water toe on the sloping limestone/volcanic contact, under the influence of a well field located landward from the toe, and with uniform recharge:

$$\left(\frac{1}{2} \quad \frac{1 + \gamma}{\gamma^2} \right) \beta^2 L^2 - \left(\frac{1 + \gamma}{\gamma^2} \right) \beta^2 L^2 X_t + \frac{1}{2} \left(\frac{1 + \gamma}{\gamma^2} \right) \beta^2 X_t^2 =$$
$$\frac{RX_1 X_t}{K} - \frac{RX_t^2}{2K} + i \sum_{1}^{n} \left[\frac{Q_i}{4\pi K} \ln \left[\frac{(X_t - x_i)^2 + (Y - y_i)^2}{(X_t + x_i)^2 + (Y - y_i)^2} \right] \right] \qquad \text{(C-20)}$$

simplifying equation (C-20) in terms of X_t gives:

$$\left[\frac{1}{2} \left(\frac{1 + \gamma}{\gamma^2} \right) \beta^2 + \frac{R}{2K} \right] X_t^2 - \left[\left(\frac{1 + \gamma}{\gamma^2} \right) \beta^2 L + \frac{RX_1}{K} \right] X_t +$$
$$\left[\frac{1}{2} \left(\frac{1 + \gamma}{\gamma^2} \right) \beta^2 L^2 \right] = i \sum_{1}^{n} \left[\frac{Q_i}{4\pi K} \ln \left[\frac{(X_t - x_i)^2 + (Y - y_i)^2}{(X_t + x_i)^2 + (Y - y_i)^2} \right] \right] \qquad \text{(C-21)}$$

The regional permeability can be evaluated by estimating values for the position of the salt water toe and then calculating for K in equation (C-21). The position of the toe is estimated in the following manner:

1. Multiply by 40 (the Ghyben-Herzberg constant) the fresh water head measured in a basal well that is relatively close to the minus 200-foot contour line on Plate 1; this value is the depth below sea level of the fresh water-salt water interface.

2. Project the elevation of the interface onto the adjacent top of volcanics surface shown on Plate 1.

3. Where the interface intersects the top of volcanes is the estimated position of the toe.

For example, a basal well in Finegayan has a measured head of 3 feet and is situated over the minus 250-foot top of volcanics contour. Multiplying the head by 40 gives 120 feet, which is the approximate depth of the interface below sea level. The interface elevation (-120 feet) is projected onto the adjacent top of volcanics surface shown on Plate 1, and where the top of volcanics has a contour value, -120 feet is the approximate position of the salt water toe in that area.

The position of the salt water toe (X_t) is solved in equation (C-21) by Newton's method. The major criteria for use is that the toe, the zero elevation contour of the contact, and the top of the drainage area should be parallel to the coastline. The Finegayan and Mangilao Subbasins are the only areas in northern Guam that reasonably meet these criteria.

Assuming a volcanic bedrock slope of 0.103 ft/ft (measured from contours on Plate 1) and a recharge rate of 0.007 ft/d, the regional permeability for the Mangilao Subbasin in the vicinity of Well No. M-11 is about 525 ft/d. Assuming a volcanic bedrock slope of 0.075 ft/ft and recharge rate of 0.008 ft/d, the regional permeability in the Finegayan Subbasin near Well No. F-2 is about 3,300 ft/d. These results are in general agreement with those

determined by recovery tests and head variation methods. However, the permeability determined by the tidal attenuation method at Well No. M-11 is over an order of magnitude higher than that determined by the numerical method.

SUMMARY

Several methods for estimating horizontal permeability in the Northern Lens were discussed in this Appendix. Generally, the results of each method concurred that aquifer permeability increases over at least an order of magnitude going from the southern to the northern part of the lens. Table C-4 summarizes and compares the results of each method at coincident observation points. As shown in the table, the recovery test results provide the lowest permeability values, and the tidal attenuation results are the highest. The numerical intrusion model provides an average regional permeability for only two subbasins. The fresh water head relationship provides what appears to be an average permeability of all determinative methods used, as well as the best indication of the areal variation in permeability over the Northern Lens.

TABLE C-4

COMPARISON OF PERMEABILITIES
CALCULATED BY DIFFERENT METHODS
(units of feet per day)

Well No.	Method			
	Areal Variations in Fresh Water Heads*	Tidal Attenuation (n=0.15)	Recovery Tests	Numerical Modeling
72	2,355	2,380	-	-
H-107	3,745	5,610	-	-
M-10a	4,940	6,790	-	-
A-16	3,035	8,155	-	-
A-10	1,575	-	1,030	-
A-13	2,285	-	780	-
D-4	11,475	-	1,300	-
D-15	12,760	-	-	-
F-2	3,410	-	2,080	3,300
M-6	7,530	-	450	-
M-7	5,470	-	1,850	-
M-11	9,950	12,400	-	525
M-9	1,680	-	-	525
M-4	-	-	1,300	-
Y-4	17,590	-	-	-

*Permeabilities for other wells are provided on Table C-1 in Appendix C.

APPENDIX D

FRESH WATER-SALT WATER RELATIONSHIPS IN ISLAND AQUIFERS

GENERAL

Considerable research has been conducted on the interrelationship between fresh water and salt water bodies in island and coastal aquifers. Some of the more significant discussions on the subject are listed in the bibliography chapter of this report. The following discussion will examine the general relationship between fresh water and salt water in the island groundwater environment of the Northern Lens. The discussion will also evaluate salt water upconing and intrusion into the fresh water lens as a result of pumping from wells.

FRESH WATER-SALT WATER INTERRELATIONSHIP

By virtue of the density difference between fresh water and sea water, fresh water floats on salt water in a phreatic coastal or island aquifer such as exists in northern Guam. If the density of fresh water is 1.000 grams per cubic centimeter (g/cc) and the density of sea water is 1.025 g/cc, then the hydrostatic balance between the two waters results in the relationship:

$$\gamma = \frac{\rho_f}{\rho_s - \rho_f} = \frac{1.000}{1.025 - 1.000} = 40 \qquad \text{(D-1)}$$

where: γ = the density contrast between the two waters
ρ_f = the fresh water density
ρ_s = the sea water density

This relationship means that at equilibrium, for every foot of fresh water standing above sea level (h), 40 feet of fresh water exists below sea level (Z), below which, salt water is encountered. Thus,

$$Z = \frac{\rho_f}{\rho_s - \rho_f} h = 40h \qquad (D\text{-}2)$$

Equation (D-2) provides an estimate of the fresh water lens geometry in an island aquifer (see Figure D-1), which is commonly referred to as a Ghyben-Herzberg lens after the two men who discovered the relationship. Deviation from reality occurs near the coast where Dupuit conditions (flow everywhere is horizontal) are not approximated. But practically speaking, use of the 40:1 ratio is a powerful and accurate tool for estimating the thickness of the fresh water lens providing that corrections are made for transition zone effects.

Theoretically, the lower limit of the fresh water lens, as defined above by the distance Z, is an abrupt interface between fresh water (having a chloride concentration of about 100 mg/l) and sea water (having a chlorine concentration of about 19,500 mg/l). However, this ideal situation is never seen in the field because the hydrodynamic environment associated with the interface creates a transition zone that separates the fresh water and salt water (see Figure D-2). The thickness of this zone depends on the magnitude and variation with time of forces exerted on the lens. The major influences on the transition zone include:

1. Tidal and ocean level fluctuations.
2. Recharge to the aquifer.
3. Extractions (pumping) from the aquifer.

The following discussion provides an insight into the relative impact that each of these influences has on the transition zone when artifically isolated from the other influences.

Tidal Fluctuations

Tidal fluctuations in Guam are semidiurnal (with a mean range of 1.6 feet) and diurnal (with a mean range of 2.3 feet) (Tracey, et al, 1964). Because of the short period of the tidal fluctuations, the effects on the

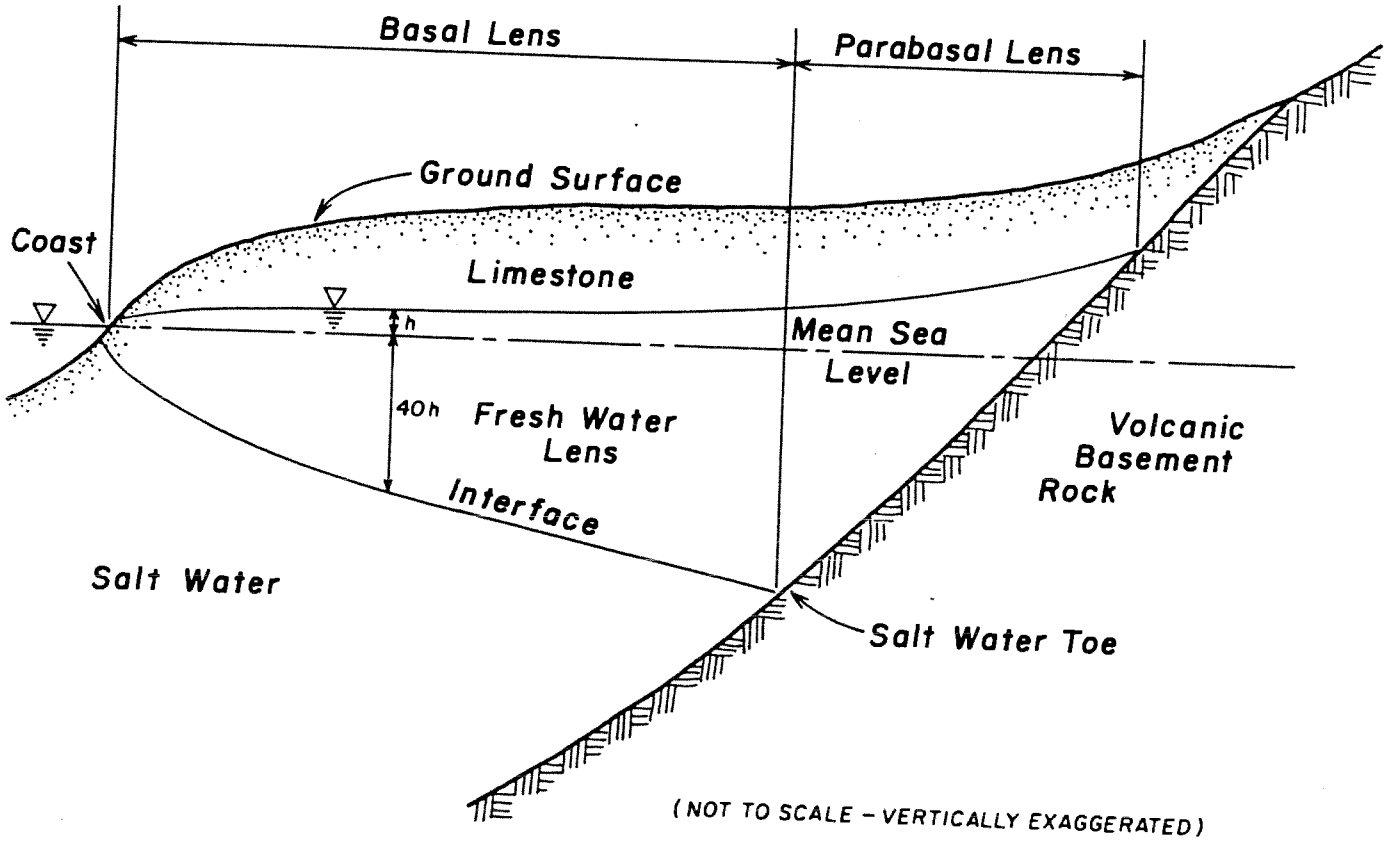


FIGURE D-1
CROSS SECTION OF FRESH WATER LENS
WITH SHARP INTERFACE
IN A COASTAL UNCONFINED AQUIFER

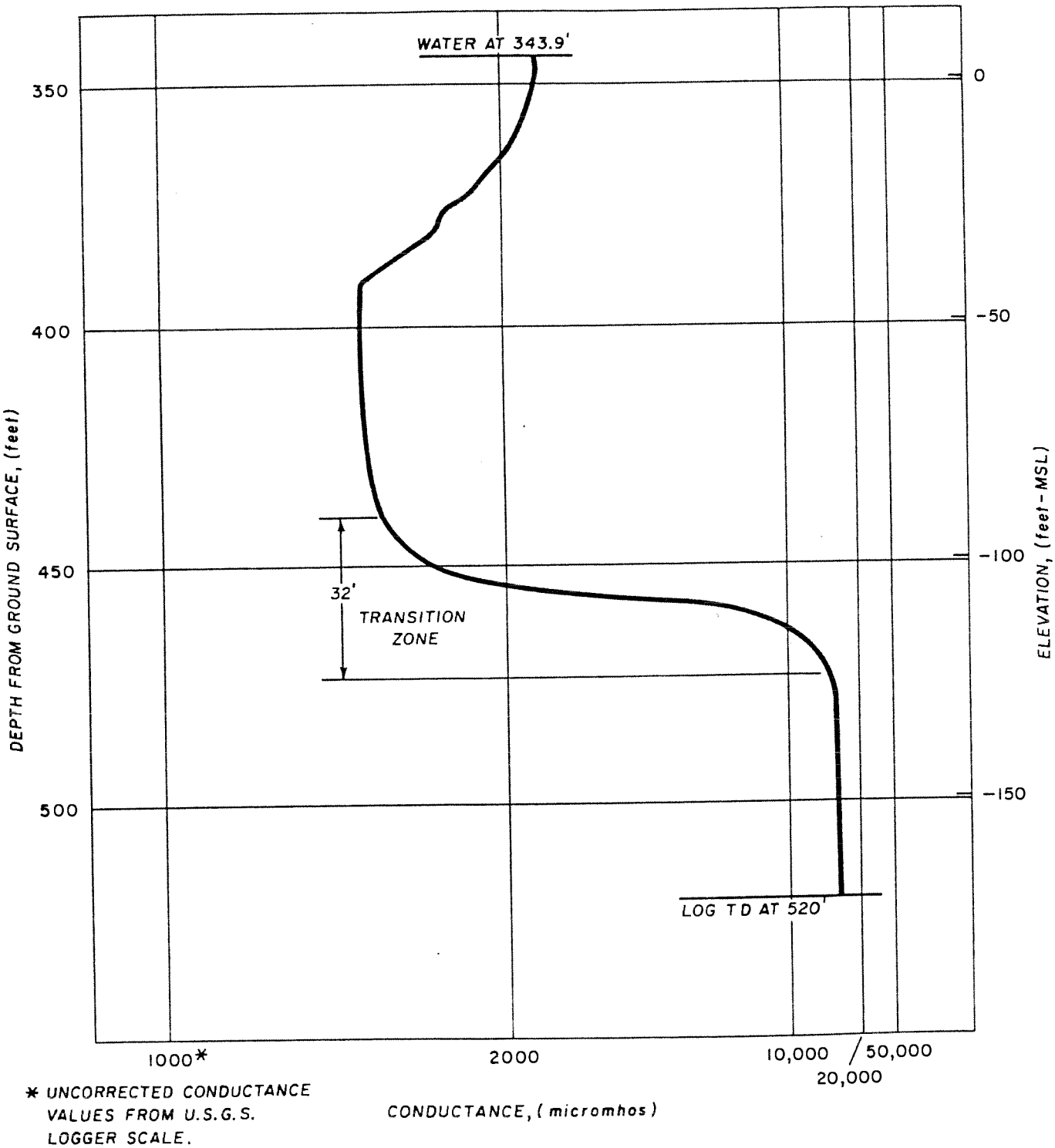


FIGURE D-2
CONDUCTIVITY LOG - WELL EX-10
FEBRUARY 16, 1982

aquifer attenuate quickly with distance inland from the coastline. Ocean level fluctuations, however, occur over a much longer period (on the order of many months) and have a range of about half a foot in Well No. 107, which is located near the coast in the Yigo Subbasin (Plate 1) (WERI, 1982). Because of the longer periods of ocean level fluctuations, their effects reach farther inland than diurnal and semidiurnal tidal effects. Ferris (1951) developed the following equation relating cyclic water level fluctuations in an open water body (e.g., the ocean) to the distance inland in a confined aquifer (WERI, 1982):

$$\frac{R_x}{R_o} = \exp \quad X \left(\frac{S}{Tt_o}\right)^{1/2} \qquad \text{(D-3)}$$

where: R_x = tidal range measured at a distance X inland from the coast,
R_o = ocean tidal range measured at the coast
S = storage coefficient of the aquifer
T = transmissivity of the aquifer
t_o = tidal period
X = distance from the coast to the observation well.

Figure D-3 is an idealized cross-section through the lens showing the relative effect on the thickness of the transition zone due to tidal and ocean level fluctuations. As shown on Figure D-3, the effect of tidal and ocean level fluctuations on the transition zone thickness decrease with distance inland.

Recharge

Seasonal variation in vertical infiltration (recharge) and lateral inflow (recharge from the adjacent parabasal areas) of rainfall to the basal fresh water lens also affects the thickness of the transition zone. WERI (1982) investigations showed that rainfall events over a 30-month period caused a water level fluctuation in Well No. 107 of about four tenths of a foot. The effect of vertical and lateral recharge on the transition is probably significant near the parabasal/basal boundary of the lens, where the inflow

of recharge is greatest, and decrease slightly toward the coast, as shown on Figure D-4.

Extractions

The effects on the transition zone of pumping from a single well in the highly permeable limestones of northern Guam are generally a local condition and felt only within a few hundred feet of the well. However, the effects caused by groundwater production from an entire well field can create broad, regional declines in fresh water heads and corresponding changes in the location of the fresh water-sea water interface. The effect on the transition zone is further accentuated by the on and off cycling of well pumps. Drawdowns within the aquifer directly adjacent to a well (not to be confused with the drawdown measured within the well, which generally has a large component of head loss through the well screens) are usually less than one foot and decrease quickly with distance from the well. The corresponding upward movement of the interface (called upconing) is proportionately less than 40 feet. Figure D-5 shows the relative impact of pumping on the transition zone.

Aquifer Hydraulic Characteristics

Areal variations in the hydraulic characteristics of the aquifer are reflected in the thickness of the transition zone. For example, the thickness of the transition zone decreases with increasing permeability. This relationship is evident when comparing the conductivity logs in exploratory wells EX-1 and EX-10, both of which are about the same distance from the coast, pumping wells, and volcanic basement rocks, and both receive about the same amount of recharge. The transition zone at EX-1 is about 104 feet thick (see Figure D-6) and the surrounding aquifer has a permeability of about 800 feet per day. The transition zone at EX-10, on the other hand, has a thickness of about 32 feet (see Figure D-2) and an aquifer permeability of about 6,500 feet per day.

The conductivity logs for Exploratory Wells EX-1 and EX-10 (see Figures D-6 and D-2) illustrate the vertical distribution of salinity (as measured by

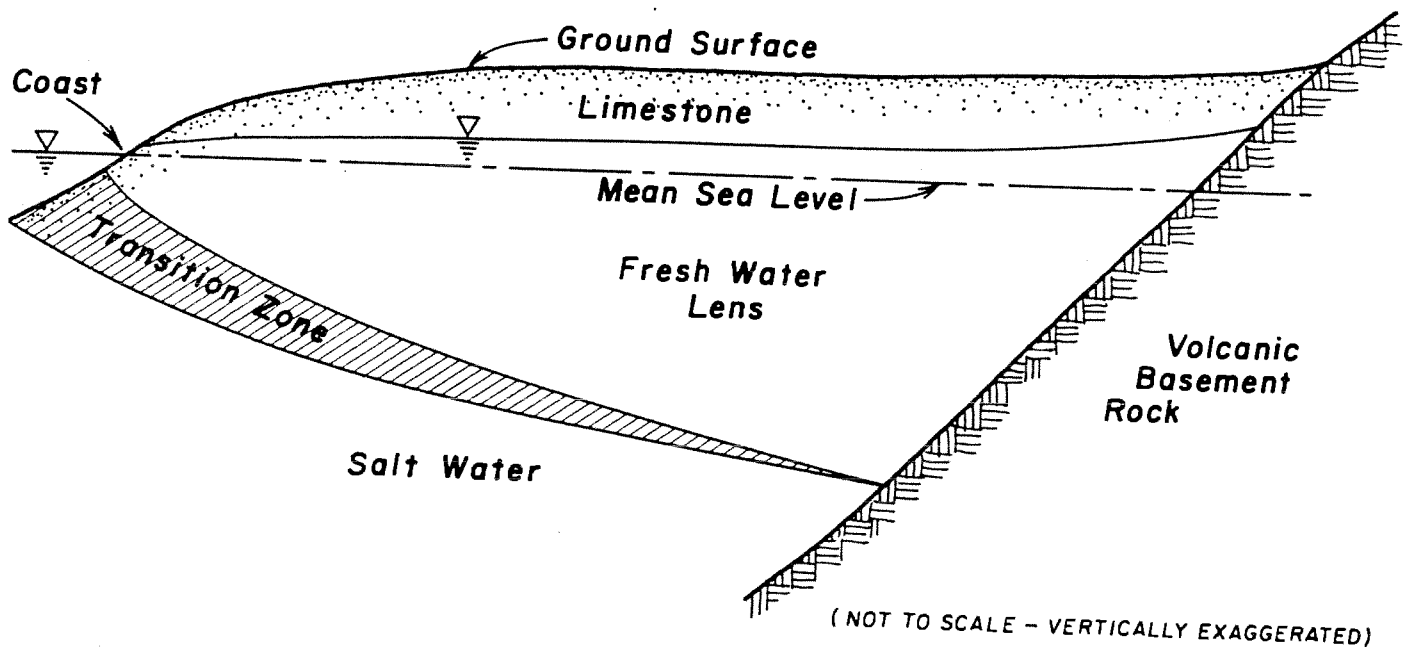


FIGURE D-3

EFFECT OF TIDAL INFLUENCES
ON THE TRANSITION ZONE

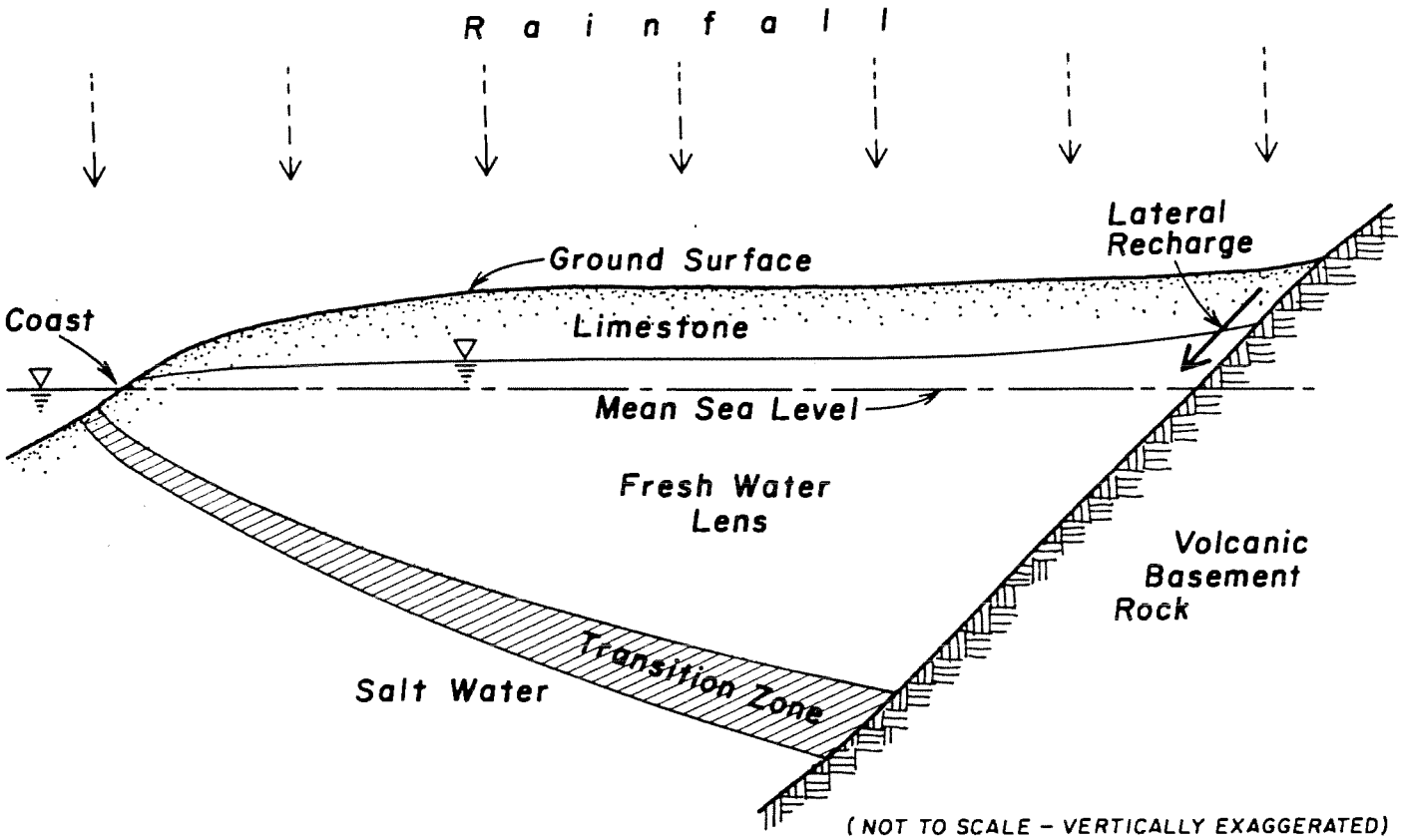


FIGURE D-4

EFFECT OF HIGH RECHARGE INFLUENCES
ON THE TRANSITION ZONE

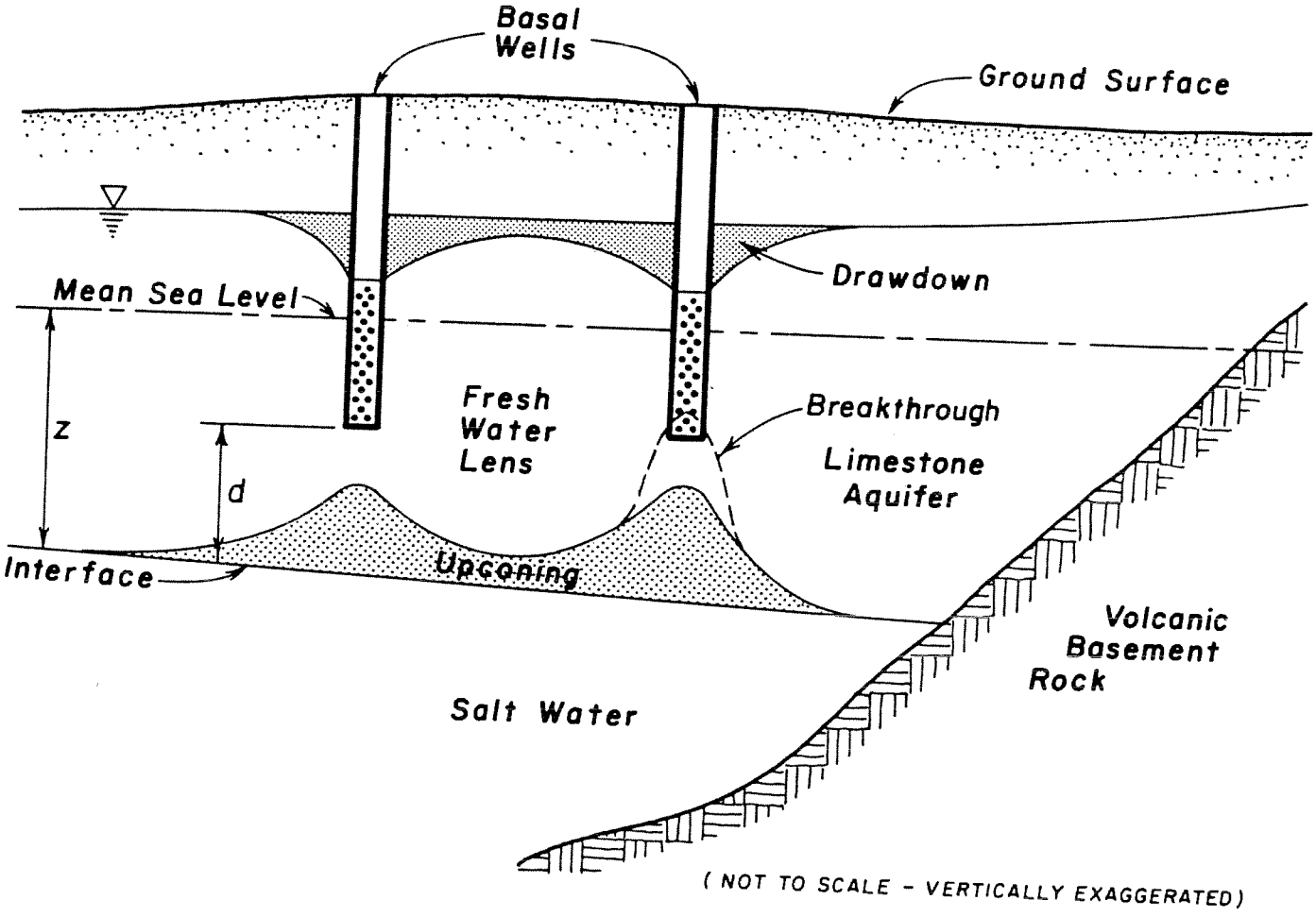
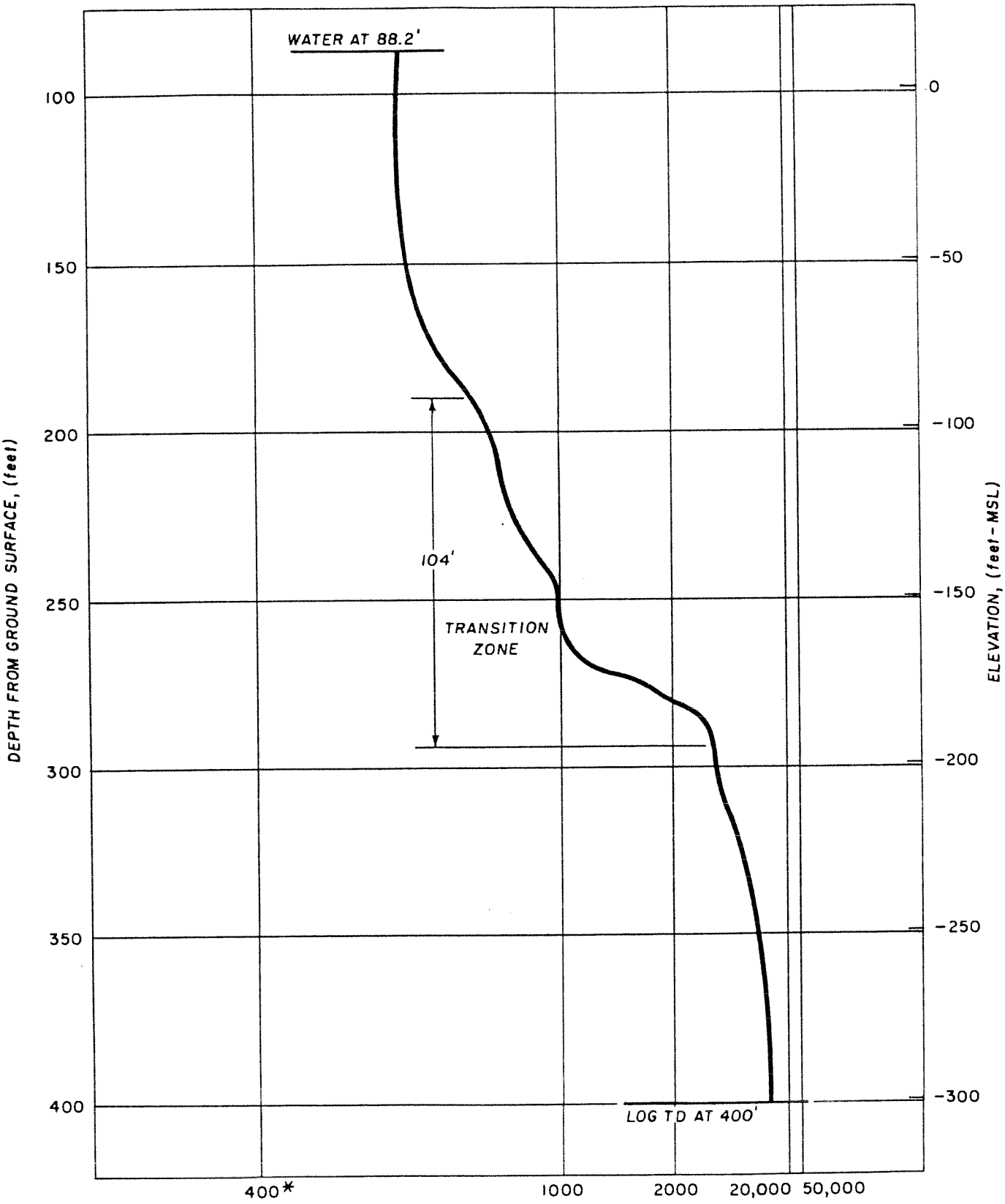


FIGURE D-5

DIAGRAM OF PUMPING INFLUENCES
ON THE TRANSITION ZONE



* UNCORRECTED CONDUCTANCE VALUES FROM U.S.G.S. LOGGER SCALE.

FIGURE D-6
CONDUCTIVITY LOG - WELL EX-1
FEBRUARY 24, 1982

conductance) through the transition zone that results from the influences described above. The transition in conductance from fresh water to salt water roughly follows a normal distribution curve with the mean value representing 50 percent sea water salinity. This point is significant because it corresponds to the lower boundary of the ideal Ghyben-Herzberg lens (i.e. where the 40:1 ratio applies).

SALT WATER UPCONING

Salt water upconing occurs when pumping-induced drawdown within the aquifer causes a corresponding rise in the fresh water-salt water interface. Under steady-state conditions, this rise would be an amount equal to about 40 times h. For example, a drawdown of 1.5 feet would cause the theoretical, steady-state interface to eventually rise upward by 60 feet. This phenomenon is schematically illustrated on Figure D-4. Because the drawdown decreases with distance from the well, the corresponding upconing of the interface also decreases.

As pumping increases, upconing also increases. At a critical pumping rate, upconing accelerates, which results in a sudden rise in salinity measured in the well. The sudden increase in upconing as the critical pumping rate is exceeded is called breakthrough (as shown on Figure D-5). The increase in salinity can render the well useless unless the pumping rate is reduced in order to reduce upconing. To help prevent breakthrough, the distance between the bottom of the well and the position of the transition zone prior to pumping should be minimized. As a general design "rule of thumb", Schmorak and Mercado (1969) recommend that:

$$Z_c/d \leq 0.5 \qquad \text{(D-4)}$$

where: Z_c = magnitude of upconing at the critical pumping rate (dimensional units of L)

d = vertical distance from the bottom of the well to the interface, prior to initiation of pumping (dimensional units of L)

The magnitude of drawdown and upconing (prior to breakthrough) in an aquifer surrounding a pumping well is dependent on both the design and pumping characteristics of the well and the hydraulic parameters of the surrounding aquifer. Bear and Dagan (1964) developed several equations describing upconing Z(r,t) under various conditions. The following equations were adapted from Bear's work for the evaluation of upconing in the Northern Lens. For the transient state in an anisotropic, but otherwise Theisian aquifer, upconing of a sharp interface at a distance r from the pumping well is calculated as follows:

$$Z\,(r,t) = \frac{Q}{2\pi\,(\rho_s - 1)\,K_x d}\left[\frac{1}{(1 + R^2)^{1/2}} - \frac{1}{((1 + \Gamma)^2 + R^2)^{1/2}}\right] \quad \text{(D-5)}$$

where: $$R = \frac{r}{d}\left(\frac{K_z}{K_x}\right)^{1/2}$$

$$\Gamma = \frac{(\rho_s - 1)K_z t}{2nd}$$

and where:

$Z_{(r,t)}$ = upconing at distance r from the pumping well at time t since pumping started (dimensional units of L)

Q = discharge from the pumping well (dimensional units of L^3/T)

ρs = specific density of salt water (gm/cc)

K_x = horizontal permeability of the aquifer (dimensional units of L/T)

K_z = vertical permeability of the aquifer (dimensional units of L/T)

d = vertical distance from the bottom of the well to the interface (middle of the transition zone) at time t = 0 (dimensional units of L)

n = porosity of the aquifer (percent)

r = horizontal distance from the well to an observation point (dimensional units of L)

t = time since pumping started (dimensional units of T)

The magnitude of upconing, as defined by equation (D-5) is computed for the theoretical interface, or for the 50 percent relative salinity level of the transition zone. However, the chloride concentration of the water at this point is on the order of 10,000 mg/1. The recommended maximum chloride concentration for drinking water is 250 mg/1, which is significantly lower than at the interface (50 percent level). Therefore, knowledge of the upconing of the 250 mg/1 isochlor would be more helpful than the location of the interface.

Schmorak and Mercado (1969) provide the basis for determining the magnitude of upconing of the 250 mg/1 isochlor. The relative salinity within the transition zone can be estimated by:

$$\varepsilon = \frac{C - C_b}{C_s - C_b} \qquad \text{(D-6)}$$

where: ε = relative salinity

C = chloride ion concentration of interest

C_b = background chloride ion concentration of the fresh water lens

C_s = the chloride ion concentration of sea water

For example, with a background chloride concentration of 20 mg/1 and a chloride concentration of salt water of 19,500 mg/1, the relative salinity of the 250 mg/1 isochlor is:

$$\varepsilon = \frac{250 - 20}{19{,}500 - 20} = 0.0118 \text{ or } 1.18\% \qquad \text{(D-7)}$$

Assuming the chloride concentration within the transition zone has a normal distribution, the thickness of the transition zone (f) from the 50 percent relative sea water salinity level to the 1.18 percent relative salinity level is:

$$f = \theta * \sigma = 2.26\ \sigma \qquad \text{(D-8)}$$

where: σ = standard deviation of the curve that represents the transition zone salinity distribution

θ = number of standard deviations between the 50 percent and the relative salinity indicated by ϵ in equation (D-6); for the example given in equation D-7, $\theta = 2.26$

The standard deviation (σ) can be estimated by plotting elevation against relative salinity within the transition zone on probability paper (see Figure D-7). From this straight line plot, the standard deviation is the change in elevation between the 50 percent and either the 84 or 16 percent relative salinity. For Well No. EX-10, as illustrated on Figure D-7, the standard deviation is about 6.5 feet. However, this standard deviation value is for static conditions and must be corrected for the effects of pumping in the following manner:

$$\sigma_\alpha = (\sigma_o^2 + (D * Z))^{1/2} \qquad \text{(D-9)}$$

where: σ_α = corrected standard deviation during pumping

σo = static condition standard deviation

D = dispersivity

$Z_{(r,t)}$ = upconing of the 50 percent salinity level calculated in equation (D-5)

Now, combining equations (D-8) and (D-9), the thickness (f) of the transition zone from the 50 relative salinity isochlor to any particular isochlor can be calculated (as long as the critical discharge is not causing breakthrough) as:

$$f = \theta \cdot \sigma_\alpha = \theta\ (\sigma^2 + (D * Z_{(r,t)}))^{1/2} \qquad \text{(D-10)}$$

For a well field, interference of upconing impacts, like drawdown, is determined by superposition. Thus, the total interface at a particular point is the sum of the individual upconing effect (calculated from equation (D-5) for each well at that point, or:

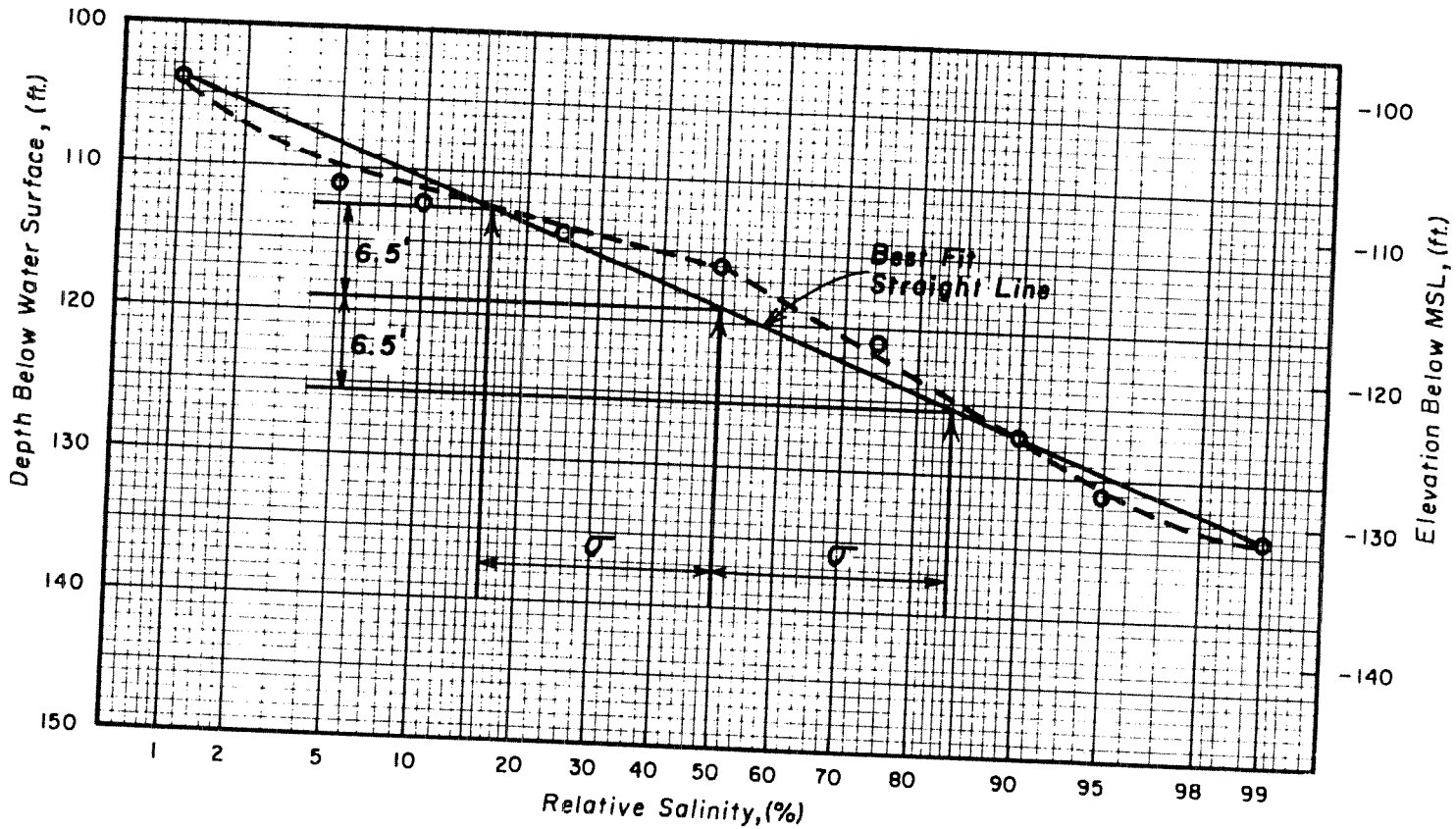


FIGURE D-7

RELATIVE SALINITY VS.
TRANSITION ZONE THICKNESS IN EX-10

$$\sum_{i=1}^{n} Z_i = Z_1 + Z_2 + Z_3 + \ldots + Z_n \qquad \text{(D-11)}$$

The total upconing (ft) for any particular isochlor caused by the pumping in a well field is:

$$f_T = \theta(\sigma^2 + (D * \sum_{i=1}^{n} Z_i))^{1/2} \qquad \text{(D-12)}$$

The upconing, as calculated using equation (D-12), will provide a very close estimate of the geometry (or change in geometry) of the fresh water lens in a well field or at an individual well. However, if breakthrough occurs in any of the wells in a well field, this analytical method becomes invalid.

SALT WATER INTRUSION

Salt water intrusion, like upconing, is a form of invasion of salt water into the fresh water lens. However, unlike upconing, which is characterized by the vertical (and usually local) movement of the interface (or transition zone), intrusion is typified by the horizontal (and regionally vertical) migration of the interface (Figure D-8). Upconing is generally the result of well or well field pumping. Intrusion, at least in northern Guam, is probably more influenced by regional and seasonal fluctuations in recharge.

The parabasal areas are most affected by horizontal intrusion. Wells located in the parabasal zone near the salt water toe can be contaminated by salt water due to the combined affect of pumping and seasonal fluctuations in recharge.

The regional position and seasonal migration of the salt water toe can be estimated using equation (C-21) in Appendix C. The relative migration of the toe can be estimated by varying the seasonal recharge rate. This

estimate will indicate the potential impact that the migrating salt water toe will have on a nearby parabasal well.

Equation (C-21) was used with varying recharge rates in the Finegayan Subbasin. The limestone aquifer in this area has relatively high permeabilities (on the order of 3,000 ft/day). The results of this analysis indicate that in order to insure that production wells remain outside the influence of the fluctuating transition zone and nearby wells, parabasal wells should (conservatively) be located at least 1,000 feet from the average toe position. In the case of a well field, where significant quantities (30 percent or more) of recharge are being intercepted, or are anticipated in future well field expansions, the wells should be located correspondingly greater than 1,000 feet away from the toe, but not more inland than the zero elevation contour of the limestone/volcanic contact. The results of this evaluation using equation (C-21) is in general agreement with the results of the regional modeling effort by WERI presented in Appendix G.

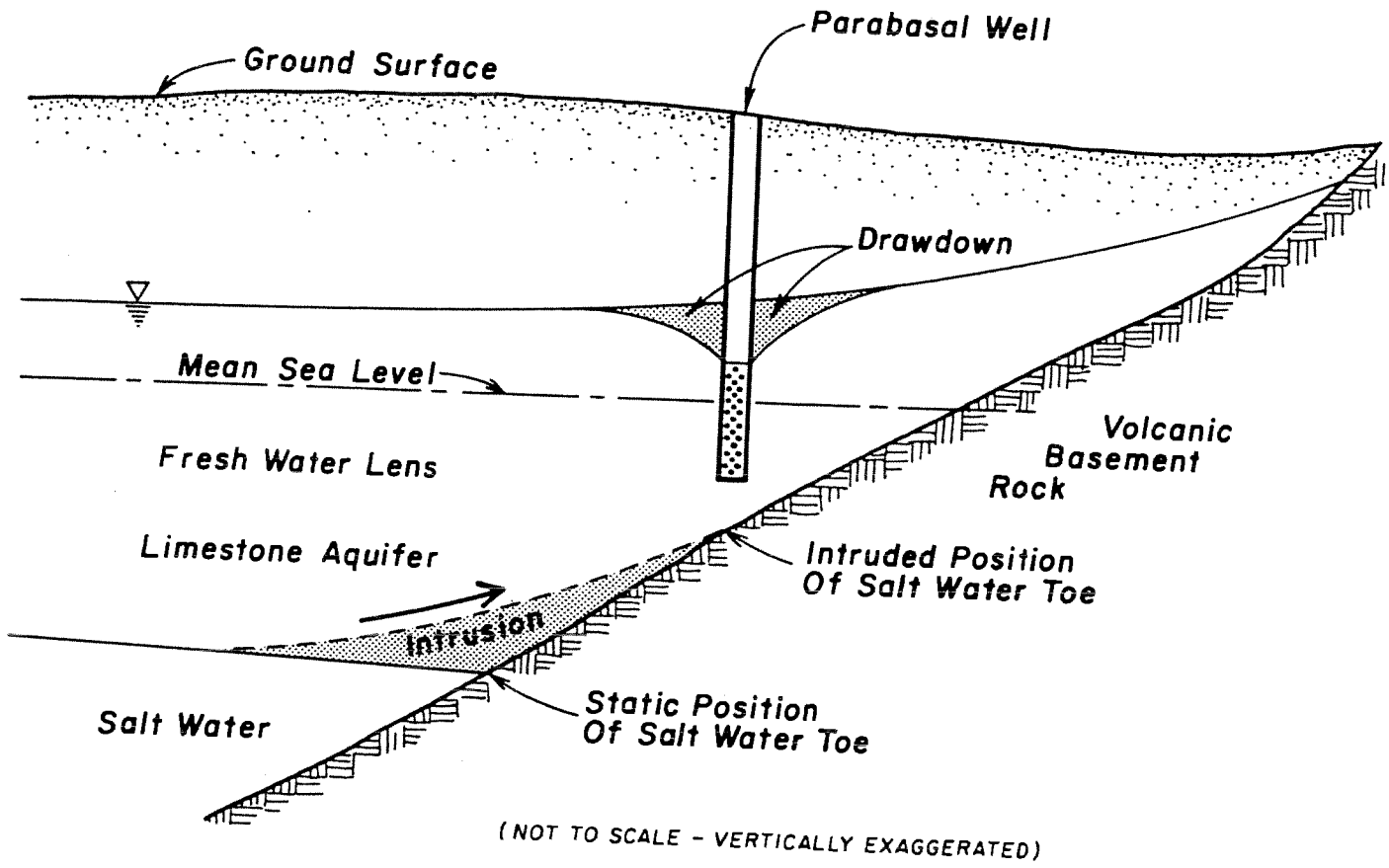


FIGURE D-8
DIAGRAM OF SALT WATER INTRUSION
TOWARD PARABASAL WELL

APPENDIX E

DETERMINATION OF EVAPOTRANSPIRATION

GENERAL

This appendix contains a discussion of the various methods used to estimate the magnitude and areal distribution of potential evapotranspiration (hereafter referred to as just evapotranspiration) in northern Guam. Evapotranspiration is probably the most important factor in determining the recharge to the Northern Lens. But, because evapotranspiration has not been directly measured for any vegetation type in Guam, it must be estimated using other measured data, such as temperature, pan evaporation, and precipitation.

The major assumption made in evaluating the different methods of estimating evapotranspiration rates in northern Guam is that for tropical vegetation, it is roughly equivalent to pan evaporation. This assumption may be an over-simplification because of the wide distribution of vegetation types and cultural influences in northern Guam. However, the assumption is probably valid because in a tropical environment such as Guam, where free moisture is continually available to plants, evapotranspiration during the most intensive period of growth (the wet season) is approximately equal to pan evaporation (Mink, 1976). Research by Chang, et al (1963) supports this assumption by showing that in Hawaii, pan evaporation is approximately equal to evapotranspiration during the maximum growth period of sugar cane. But, there are significant differences in both climatic and soil conditions between Guam and Hawaii. For this reason, more research should be conducted in Guam to measure the evapotranspiration rates and areal distribution of native vegetation. Until that research is conducted, the assumptions based on Chang's work will provide a close and conservative approximation of evapotranspiration.

The remaining part of this appendix contains an evaluation of several methods of calculating evapotranspiration. The first method discussed uses precipitation data to determine the areal variation in evapotranspiration. This method was used by Mink (1976) to estimate recharge. The second method uses temperature data and common emperical equations to estimate evapotranspiration.

EVAPOTRANSPIRATION FROM PRECIPITATION DATA

Mink (1976) suggested that pan evaporation (and thus evapotranspiration) is inversely proportional to rainfall. Using rainfall records (1956 to 1972) and evaporation data (1958 to 1973) from the National Weather Service (NWS) meteorological station at Finegayan, pan evaporation values were computed from rainfall data collected at Andersen Air Force Base (1952 to 1972) and the Guam Naval Air Station (1956 to 1972). The relationship used to compute pan evaporation is:

$$E_i = \frac{R}{R_i} E \qquad \text{(E-1)}$$

where: E_i = computed pan evaporation

R_i = measured rainfall at the station in which E_i is to be computed

E = measured pan evaporation at the NWS station in Finegayan

R = measured rainfall at the NWS station in Finegayan

Table E-1 summarizes the average monthly pan evaporation as measured at the NWS and as calculated by Mink at Andersen Air Force Base and the Naval Air Station. The measured average annual pan evaporation was 72.41 inches per year at the NWS, and the calculated average annual pan evaporation was 81.23 inches per year at Andersen Air Force Base and 85.04 inches per year at the Naval Air Station.

TABLE E-1

DETERMINATION OF EVAPORATION RATES FROM RAINFALL*
(inches)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Nat'l Weather Service (Finegayan)†													
Precipitation	5.54	4.19	4.44	4.65	6.26	6.19	11.25	13.41	15.78	13.19	9.48	6.48	100.84
Measured Evaporation	5.49	5.93	7.23	7.64	7.68	6.52	5.84	5.15	4.85	5.12	5.22	5.74	72.41
† Rainfall record 1956-1972; evaporation record 1958-1973.													
Andersen Air Force Base**													
Precipitation	5.03	4.36	3.74	4.12	5.13	4.86	9.66	11.59	13.94	13.71	8.02	5.70	89.86
Calculated Evaporation	6.05	5.70	8.58	8.62	9.37	8.30	6.80	5.96	5.49	4.93	6.05	6.53	81.23
** Rainfall record 1952-1972.													
Guam Naval Air Station††													
Precipitation	4.81	2.96	2.77	4.05	5.51	5.36	10.04	11.84	14.08	11.22	8.26	4.96	85.86
Calculated Evaporation	6.32	8.40	11.59	8.77	8.73	7.58	6.54	5.83	5.44	6.02	5.99	7.50	85.04
†† Rainfall record 1956-1972.													

* From Mink (1976), Table 2.

EVAPOTRANSPIRATION DATA FROM TEMPERATURE DATA

The more common approaches for determining evapotranspiration use monthly mean temperatures as their principal variable. The Blaney-Criddle (1950), Thornthwaite (1944), and Hargreaves (1956) methods were used to evaluate the range in ET derived by using temperature data. The results of all three methods are presented in the following paragraphs.

Hargreaves Method

The Hargreaves method uses both temperature and humidity data for determining evapotranspiration. The equation is:

$$ET = kD\,(0.38 - 0.0038H)\,(t-32) \qquad \text{(E-2)}$$

where: ET = evapotranspiration rate in inches

k = monthly consumptive use coefficient (assumed to be equal to one)

D = monthly daytime coefficient dependent on latitude

H = mean monthly relative humidity at noon in percent

t = mean monthly temperature in degrees F

The only station having both temperature and humidity data was the National Weather Service in Finegayan.

The consumptive use coefficient (k) is assumed to be equal to 1.0 based on research published by Doorenbos and Pruitt (1975). They indicate that evapotranspiration for tropical food crops, such as bananas, coffee, and sugar cane, range from .8 to 1.2 and average about 1.0. In all subsequent methods of calculating evapotranspiration, this coefficient is assumed to be equal to 1.0. The calculated monthly evapotranspiration rates at the NWS station are summarized in Table E-2. The calculated average annual evapotranspiration rate is 40.74 inches, as compared to the average annual evaporation rate of 82.23 inches at this location. To adjust the calculated evapotranspiration rate to equal the evaporation rate, the k-value

TABLE E-2

CALCULATION OF EVAPOTRANSPORATION RATES
BY THE HARGREAVES METHOD AT
THE NWS IN FINEGAYAN

Month	Temp (^{o}F)	D[1]	H[2] (%)	ET[3] (inches)	Pan Evaporation[4] (inches)
Jan	77.4	0.98	79.0	3.55	6.65
Feb	77.4	0.89	77.9	3.39	6.49
Mar	77.7	1.02	77.8	3.93	8.05
Apr	79.0	1.01	77.8	4.00	8.32
May	79.3	1.05	78.6	4.04	8.43
Jun	79.9	1.03	80.0	3.75	7.46
Jul	79.3	1.06	82.8	3.28	6.47
Aug	79.2	1.05	84.6	2.90	5.91
Sept	79.2	0.99	83.6	2.91	5.70
Oct	79.0	1.00	83.4	2.96	6.17
Nov	79.2	0.95	83.8	2.76	6.24
Dec	78.4	0.97	80.9	3.27	6.34
Total				40.74	82.23

1 D = monthly daytime coefficient dependent on latitude (for latitude 13.5^{o} N), from Chow (1964), Table 11-9.
2 H = the mean monthly relative humidity at noon, in percent.
3 ET = Evapotranspiration
4 For the period 1974 to 1981, measured at the NWS in Finegayan.

would have to be over 1.8, which seems unreasonably high when compared to k-values derived in research which are on the order of 0.5 to 1.2 (Chow, 1964, Table 11-3).

Thornthwaite Method

The Thornthwaite method uses only temperature to calculate evapotranspiration. However, it may be limited in its use for the tropics because it was developed for the temperate zone of the eastern United States. The equation is:

$$ET = 0.63 \left[\frac{10t}{TE}\right]^{a} \qquad \text{(E-3)}$$

where: $TE = \sum_{i=1}^{m} \left(\frac{t_i}{5}\right)^{1.514}$

$$a = 6.75 \times 10^{-7} (TE)^3 - 7.71 \times 10^{-5} (TE)^2 + 1.792 \times 10^{-2} (TE) + 0.49239$$

and where:

ET = evapotranspiration in inches

t_i = mean monthly temperature in degrees C

TE = temperature efficiency index

m = particular month for the given temperature data

Table E-3 shows the calculated evapotranspiration for the NWS, Andersen Air Force Base, and the Naval Air Station. The calculated average annual evapotranspiration value at the NWS is 59.08 inches as compared to the pan evaporation of 82.23 inches. As with the results of the Hargreaves method, these evapotranspiration values seem to be relatively low for tropical vegetation.

TABLE E-3

CALCULATION OF EVAPOTRANSPIRATION RATES
BY THE THORNTHWAITE METHOD

	Naval Air Station		Andersen Air Force Base		National Weather Service Station, Finegayan		
MONTH	Temp. (^{o}C)	ET* (in)	Temp. (^{o}C)	ET* (in)	Temp (^{o}C)	ET* (in)	Pan** Evap. (in)
JAN	26.3	5.04	25.7	4.69	25.2	4.42	6.65
FEB	26.3	5.04	25.7	4.69	25.2	4.42	6.49
MAR	26.7	5.35	25.8	4.75	25.4	4.55	8.05
APR	27.1	5.67	26.4	5.18	26.1	5.01	8.32
MAY	27.4	5.92	26.8	5.47	26.3	5.14	8.43
JUN	27.7	6.18	27.1	5.70	26.6	5.35	7.46
JUL	27.4	5.92	26.9	5.55	26.3	5.14	6.47
AUG	27.3	5.83	26.7	5.40	26.2	5.07	5.91
SEPT	27.2	5.75	26.6	5.32	26.2	5.07	5.70
OCT	27.1	5.67	26.7	5.40	26.1	5.01	6.17
NOV	27.2	5.75	26.8	5.47	26.2	5.07	6.24
DEC	26.8	5.43	26.3	5.10	25.8	4.81	6.34
TOTAL		67.54		62.72		59.08	82.23

* Evapotranspiration

** Pan evaporation for the period 1974 to 1981, measured at the NWS in Finegayan.

Blaney-Criddle Method

The most universally recognized method for determining evapotranspiration was developed by Blaney and Criddle (1950). Their equation is:

$$ET = \frac{kpt}{100} \qquad \text{(E-4)}$$

where: ET = evapotranspiration rate in inches per month

k = monthly consumptive use coefficient (assumed to be equal to 1)

p = percent daytime hours

t = the mean monthly temperature in degrees F

The monthly p values for latitude 13.5 degrees north are included on Table E-4. The resultant calculated average annual evapotranspiration rates for the NWS, Andersen Air Force Base and the Naval Air Station (where temperature data were available), as indicated on Table E-4, are 78.78 inches, 79.65 inches, and 80.72 inches, respectively. The calculated evapotranspiration at the NWS of 78.78 inches is relatively close to the measured pan evaporation at that station of 82.23 inches.

SELECTION OF BEST EVAPOTRANSPIRATION ESTIMATE

Using actual evapotranspiration data provides a much better estimate of recharge than calculated evaportranspiration rates. However, until actual evapotranspiration rates are measured in northern Guam, calculated rates will provide an estimate of recharge as well as illustrate the procedure for using actual evaportranspiration rates to refine recharge estimates. The best method of calculating recharge was selected based on two criteria: 1) that the method provide a conservative estimate of recharge and, subsequently, sustainable yield, until which time actual evapotranspiration rates can be used, and 2) that the method provides results which are closest to pan evapotranspiration data, which is an assumption supported by research (Chang et al, 1963).

TABLE E-4

CALCULATION OF EVAPOTRANSPIRATION
RATES BY THE BLANEY-CRIDDLE METHOD

Month	U.S. Weather Bureau, Finegayan (NOAA-NWS)			Andersen Air Force Base			Naval Air Station			
	Temp. (^{o}F)	p[1]	ET[2]	Temp. (^{o}F)	p[1]	ET[2]	Temp.	p	ET	Pan[3] Evap.
Jan	77.4	8.00	6.19	78.2	8.00	6.26	79.4	8.00	6.35	6.65
Feb	77.4	7.39	5.72	78.2	7.39	5.78	79.4	7.39	5.87	6.49
Mar	77.7	8.44	6.56	78.5	8.44	6.63	80.0	8.44	6.75	8.05
Apr	79.0	8.42	6.65	79.5	8.42	6.69	80.8	8.42	6.80	8.32
May	79.3	8.93	7.08	80.3	8.93	7.17	81.3	8.93	7.26	8.43
Jun	79.9	8.74	6.98	80.8	8.74	7.06	81.8	8.74	7.15	7.46
Jul	79.3	8.99	7.13	80.4	8.99	7.23	81.4	8.99	7.32	6.47
Aug	79.2	8.79	6.96	80.1	8.79	7.04	81.2	8.79	7.14	5.91
Sept	79.2	8.27	6.55	79.8	8.27	6.60	81.0	8.27	6.70	5.70
Oct	79.0	8.28	6.54	80.0	8.28	6.62	80.8	8.28	6.69	6.17
Nov	79.2	7.80	6.18	80.3	7.80	6.26	81.0	7.80	6.32	6.24
Dec	78.4	7.95	6.23	79.3	7.95	6.30	80.2	7.95	6.38	6.34
	TOTALS		78.78			79.65			80.72	82.23

1 p = Percent of daytime hours each month at latitude 13^{o}30' from V.T. Chow, Handbook of Applied Hydrology, 1964, Table 11-4.

2 Evapotranspiration in inches/month.

3 Evaporation data (in inches/month) from the NOAA weather station (class A pan) located at the National Weather Service Station in Finegayan.

Because the Blaney-Criddle method provides evapotranspiration values that are both the most conservative and are closest to the pan evaporation data measured at the NWS in Finegayan, it was used to estimate evapotranspiration rates in northern Guam. These evapotranspiration data were then used to estimate the recharge to the Northern Lens.

APPENDIX F

CALCULATION OF RECHARGE

GENERAL

This appendix discusses two methods used to estimate recharge to the limestone aquifer of northern Guam. Several attempts have been made over the years to determine average annual recharge to the Northern Lens. These attempts have resulted in recharge estimates that range from 21 to 53 inches per year. Peterman, et al (1945) made the first estimates and reported recharge to be about 21 inches per year. Davis (1964), using seasonal variations in precipitation, estimated recharge to be about 40 inches per year. Davis and Huxel (1968) estimated recharge to the Northern Lens to be about 53 inches per year based on rainfall-runoff records for the Pago and Ylig Rivers in southern Guam. Mink (1976) (using rainfall and evaporation data) estimated a recharge range from 26 to 38 inches per year, depending on the amount of surface runoff that is assumed. Ayers (1981) estimated recharge to the Northern Lens to be about 33 inches per year by comparing the chloride ion concentration of rain water to that found in the freshest groundwater in the Northern Lens.

Use

Because no new data were generated for the NGLS that would help in refining the results of previous recharge studies, existing data were reevaluated using two methods similar to those applied before. The first method utilized runoff data in the Pago River Basin of southern Guam to estimate recharge while the second method used evapotranspiration estimates and rainfall data to estimate recharge to the Northern Lens.

RAINFALL-RUNOFF IN THE PAGO RIVER BASIN

The Pago River drains a small basin located along the southeast boundary of the Northern Lens in the volcanic upland province of southern Guam (Plate 1) and eventually flows into Pago Bay. The USGS maintains a stream gaging

station for the Pago River near Ordot located at the contact between the volcanics and the coastal limestones. This station measures the flow from a 5.67 square-mile drainage area and has daily flow records from September 1951 to the present. Because it seemed likely that the Pago River gaging station measures essentially all of the outflow from the basin (given the small capacity for subsurface outflow over the volcanics in this part of the basin), and because the river basin is adjacent to the study area, the Pago River was used in a water balance analysis to estimate recharge.

The first step in the water balance analysis was to estimate rainfall in the Pago River basin. Included in the available precipitation data are weekly rainfall records from the USGS Pago River Station, located near the Pago River stream gage, for the period July 1951 to December 1966 (Table A-2h), and daily rainfall records at the Fleet Weather Station (NAS), located on the Northern Lens north of the Pago River Station, for the period January 1950 to December 1980 (Table A-2d).

Monthly correlations between the Naval Air Station and the Pago River Station for the 1951-1966 period were used to fill in the missing Pago River Station precipitation data and to develop a complete record for the 31-year period 1950-1980. Table A-2h reports the complete, filled-in monthly precipitation record for the Pago River Station. Table F-1 lists the 31-year monthly average precipitation values for both the dry and wet seasons of the year. Table F-1 shows an average dry season precipitation of 26.94 inches and an average wet season precipitation of 63.70 inches. The estimated average annual precipitation is 90.64 inches.

The USGS has recorded streamflow data for the Pago River near Ordot since October 1951. Table F-2 summarizes these data. Average dry season streamflow for the 29-year period is 10.60 cfs and average wet season streamflow is 41.50 cfs. Average annual streamflow is 26.17 cfs. For the 5.67 square mile drainage area above the Ordot stream gage, the average annual runoff is equivalent to 62.7 inches of precipitation.

TABLE F-1

AVERAGE MONTHLY PRECIPITATION ESTIMATES
FOR THE USGS PAGO RIVER PRECIPITATION
STATION FOR THE PERIOD 1950-1980

Dry Season Month	Average Precipitation (inches)	Wet Season Month	Average Precipitation (inches)
January	4.61	July	9.92
February	3.89	August	13.46
March	3.06	September	13.04
April	3.53	October	12.47
May	5.48	November	8.92
June	6.37	December	5.89
Total	26.94	Total	63.70

TABLE F-2

AVERAGE MONTHLY STREAMFLOWS FOR
THE PAGO RIVER NEAR ORDOT FOR THE
PERIOD OCTOBER 1951-SEPTEMBER 1980

Dry Season Month	Average Streamflow (cfs)	Wet Season Month	Average Streamflow (cfs)
January	12.63	July	25.98
February	13.51	August	49.81
March	6.59	September	59.66
April	5.49	October	56.80
May	16.56	November	37.84
June	8.87	December	19.38
Average	10.60	Average	41.50

However, the relatively thin soil cover in northern Guam and seasonal evapotranspiration rates that probably vary more pronouncely than the measured pan evaporation rate at the NWS Station at Finegayan (especially during the dry season) suggest that this basic assumption is conservative. But until more evapotranspiration information is available for northern Guam, estimating a conservative recharge rate is a prudent avenue to take in estimating the sustainable yield and developing a groundwater management plan.

Using the adjusted evaporation rates for the NWS Station, Naval Air Station, and Andersen Air Force Base developed in Appendix E (Table E-4) and the long-term monthly rainfall records provided in Appendix A, an estimate of the average recharge rate over a relatively large portion of northern Guam was derived. Eight raingaging stations were used to develop recharge estimates; they included the Naval Air Station, Yigo Agricultural Station, Mangailao Station, Andersen Air Force Base, the Naval Communications Center, the Pago River Station, Fleet Weather Central Station at Nimitz Hill Station, and the NWS Station at Finegayan. The most complete recent record was from the Naval Air Station and covered the 31 year period from 1950 to 1980.

The other seven stations had shorter periods of record, and they were filled in using monthly linear regression equations based on the longer Naval Air Station (NAS) record. These adjusted precipitation records are presented in Tables A-2a through A-2h.

Each rainfall station was assigned estimated evapotranspiration rates based on the proximity of the precipitation station to the neareat location where evapotranspiration estimates are available (NAS, NWS, and Andersen Air Force Base). Table E-4 contains the estimated monthly evapotranspiration rates. Then, for each of the eight rainfall records, monthly average recharge was calculated for the 31 years of record as follows:

$$\bar{R}_i = \frac{\sum_{j=1}^{n} \alpha \, (P_{ij} - \bar{E}_i)}{n} \qquad \text{(F-1)}$$

where: $\bar{R}_i$ = estimated average recharge (F-1) in month i (inches)

P_{ij} = precipitation in month i of year j (inches)

$\bar{E}_i$ = estimated average evapotranspiration in month i

α = 0 if $P_{ij} \geq \bar{E}$

= 1 if $P_{ij} < Ei$

i = month

j = year

n = number of years

The results of this analysis are summarized on Table F-5, which shows the average monthly recharge rate for the eight raingaging stations. The lowest recharge rate was at NAS with 28.75 inches per year; the largest rate was at the NWS Station at Finegayan with 37.97 inches per year. The average recharge rate of all eight stations was 32.97 inches per year. Recharge is seasonal, with the most amount occurring between July and December. During the dry season, recharge at the eight stations varied from 12 to 19 percent of the average monthly precipitation, and averaged 15 percent. During the wet season, recharge varied between 40 and 50 percent and averaged 45 percent.

RUNOFF FROM FONTE RIVER

For most of northern Guam, very little rainfall reaches the ocean as surface outflow. However, a notable exception is the Fonte River flow from the Nimitz Hill management zone. The river does not have a stream gage so runoff must be estimated using the stream flow data derived from the Pago River Basin. Assuming the two basins have the same outflow characteristics, then using the rainfall data from the Nimitz Hill rain gaging station, the runoff from the Fonte River Basin can be estimated, as shown on Table F-6.

TABLE F-5

AVERAGE MONTHLY RECHARGE ESTIMATES AT EIGHT RAINGAGE STATIONS IN NORTHERN GUAM (inches)

Station Location	Months												Total (Inches)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Naval Air Station	0.82	0.58	0.14	0.48	1.65	0.50	2.96	5.63	6.94	5.76	2.92	0.37	28.75
Yigo Agricultural Station	0.19	1.08	0.55	1.10	2.52	0.49	3.20	6.61	6.83	8.19	2.90	1.88	35.54
Mangilao	1.11	0.76	0.18	0.54	1.58	0.76	2.20	6.09	8.90	5.32	3.02	0.68	31.14
Andersen Air Force Base	1.04	1.22	0.76	0.93	2.41	0.28	2.91	6.24	6.34	7.04	2.61	0.95	32.73
Naval Communications Station	1.46	0.22	0.40	0.14	2.29	1.00	2.56	7.80	6.19	6.92	2.46	0.50	31.94
Pago River	0.60	0.79	0.11	0.56	1.34	1.06	3.36	6.33	6.37	5.79	2.93	1.02	30.26
Fleet Weather Central - Nimitz Hill	1.00	0.67	0.64	0.87	0.94	0.92	5.21	6.33	7.91	6.76	3.47	0.74	35.46
National Weather Service - Finegayan	1.21	1.12	0.75	0.88	2.54	0.44	3.62	7.14	8.40	7.39	3.41	1.07	37.97
											Northern Guam Average		32.97

TABLE F-6

ESTIMATED RAINFALL RUNOFF FROM FONTE RIVER

Season	Basin Rainfall* (Inches)	Runoff as a Percent of Rainfall**	Fonte River Outflow (Inches)
WET	65.74	78.6	51.67
DRY	27.72	46.8	12.97
TOTAL			64.64

* From Nimitz Hill Rain Gagin Station for base period 1950 to 1980.
** Percentages from runoff characteristics of the Pago River Basin.

The estimated average outflow for Fonte River is 64.4 inches per year. The area within the management zone covered by volcanics is about one square mile. The resulting average runoff to the limestone is about 2,160 gpm. If 50 percent of this outflow recharges the limestones prior to reaching the ocean, then roughly 1,000 gpm (or about 1.44 MGD) would be lost to the ocean.

APPENDIX G

FINITE ELEMENT MODEL OF THE NORTHERN LENS

By: D.N. Contractor

DESCRIPTION OF MODEL

This model description is intended as an introduction to solving salt water intrusion problems using the program SWIGS2D. This program and its mathematical basis have been described by Contractor (1981). A large scale application of the program to a field problem is presented in the report by Contractor, et al (1981). The model simulates an aquifer in two dimensions (plan), in which a sharp interface separates the fresh water and salt water. A finite element grid of linear triangles is used to discretize the aquifer. Appropriate boundary conditions can be specified at the nodes and along the sides of elements. Any number of pumps can be specified in the network. For these conditions, the model solves for the fresh water and salt water heads and calculates the depth of the interface, the location of the fresh water and salt water toes and the velocity in each element.

Program Capabilities

The computer program has the capacity to handle steady and unsteady flows, and analyze both confined and unconfined flows. If the aquifer is confined, the program can consider leaky and non-leaky conditions. Recharge is constant in an element but can be varied from element to element. Specified head or flow conditions can be applied at the boundaries. At a coastal boundary, a mixed or third-type boundary condition can be specified. For steady flow conditions, the salt water head can be specified to be zero along the boundary or at every node in the network. This procedure assures that the Ghyben-Herzberg condition is satisfied. The program can also be run in the unsteady mode with the Ghyben-Herzberg condition.

If the salt water head at every node in the network is specified to be much less than the anticipated fresh water head, the results of the computer program will show that the thickness of the salt water layer is equal to an arbitrarily small value. Under these conditions, the program can simulate flow in a fresh water aquifer. Use of the program to simulate fresh water aquifers is limited only by the storage capacity of the computer.

Because the heads are assumed to vary linearly across the triangular element, the velocity in each element is constant. With specific output instructions, the program will print out the velocities in the x and y directions in each element in both the fresh water and salt water layers. These velocities can then be used to calculate the flow rates across any line or boundary. The program can also determine where in the network a fresh water or salt water toe occurs. A salt water toe occurs where the interface intersects the lower impervious boundary (volcanics in the case of Guam's Northern Lens). The output provides the element number, the node numbers, and the fractional distance between the two nodes where the salt water toe occurs. The same kind of information is also provided about the fresh water toe. A fresh water toe occurs where the phreatic surface intersects the lower impervious boundary or where the interface intersects the upper impervious boundary in confined aquifers.

The program assumes that there are two independent variables at each node: the fresh water head and salt water head. After solving for the heads, the depth of the interface is determined. The location of the interface determines the thickness of the fresh water and the salt water layers. If, however, the interface is calculated to be below the lower impervious boundary, then the entire aquifer thickness will contain only fresh water and the thickness of the salt water layer should theoretically be zero. However, the program makes the salt water layer equal to an arbitrarily small value, BTOE. The permeability in the salt water thickness BTOE is made much smaller than that specified in the region where the salt water thickness is greater than BTOE. Similarly, when the phreatic surface intersects the lower impervious boundary, the fresh water layer beyond the toe is made equal to BTOE instead of zero. In the course of the program, as the interface and the phreatic surface move with respect to time, the thickness and

permeability of the salt water and fresh water regions are altered accordingly.

This program uses a weighting factor which varies between zero and one. This factor is useful in regulating the stability and accuracy of the solution. When this factor is equal to zero, the problem formulation is referred to as explicit. In this formulation, the spatial derivatives are evaluated at the known time-step, t. The time-step, delta t, necessary for stable results is very small. This results in very long execution times for the program. When the weighting factor is equal to 0.5, the problem formulation is referred to as the Crank-Nicolson approximation. This approach provides high accuracy with large values of delta t, even though the results may show some numerical instability. When the weighting factor is equal to 1.0, the formulation is known as fully implicit. This formulation provides the maximum stability at a sacrifice of some accuracy. Values of the weighting factor between 0.5 and 1.0 (e.g., 0.6, 2/3, 3/4) have been used to provide the proper balance between accuracy and stability. When steady-state results are desired, the program should be run with the weighting factor equal to 1.0 and delta t equal to a very large number (e.g. 1.0E20).

The program can be run in any set of consistent units. Thus, if feet and seconds are the length and time units, the permeability and recharge must be input in ft/sec and the pump rate in cu.ft/sec. If meters and days are the length and time units, then the permeability and recharge must be input in m/day and the pump rate in cu.m/day.

When subdividing an aquifer into triangular elements, only one side of a triangle may form a boundary. The program cannot handle triangles with boundary conditions on two of its sides. The versatility of using triangles of different sizes and orientation should be taken advantage of. Place a node wherever a pump exists or is projected to be in the future. It is, however, advisable not to let the ratio of the largest triangle to the smallest triangle become too large. It will generally be the size of the smallest triangle that determines the time step, delta t, that can be used for stable results.

APPLICATION OF A SALT WATER INTRUSION MODEL TO MANAGEMENT OF THE NORTHERN GUAM LENS

The finite element salt water intrusion model described by Contractor (1981) was calibrated for the Northern Lens of Guam using hydrologic data for 1978, 1979 and 1980. The finite element network consisted of 222 linear triangular elements and 149 nodes. The porosity was held constant at 0.25 and the permeability was calibrated for the Marianna and Barrigada limestones. The results of the calibration indicated that the Marianna limestone has a permeability in the neighborhood of 1,000 ft/day. The Barrigada limestone was found to be between 5,000 and 10,000 ft/day. For the purpose of the management runs, it was decided to use a permeability of 5,000 ft/day.

The hydrologic conditions for the management scenarios were provided by the NGLS team. The aquifer was subdivided into 29 parabasal management zones and 18 basal management zones. Recharge values were ascribed to each zone, as were the projected pumping rates. The pumping rates were distributed evenly between all the nodes within each management zone. The recharge from each zone was distributed over the months of July, August, September, October and November; the remaining months of the year were assumed to have zero recharge. Three different pumping scenarios were proposed: scenario No. 1 had a pumping rate of about 60 mgd, scenario No. 2 had 80 mgd, and scenario No. 3 had 40 mgd.

Each management scenario had to start with some initial conditions. These initial conditions were taken to be the same as the initial conditions for the calibration runs, which were obtained by a steady state analysis of the first month. Each management scenario was simulated for a year. The results at the end of the year were used as the initial conditions for simulation of a second year of the same management scenario. This process was repeated until cyclic steady-state conditions were obtained.

Results

The following number of computer runs were made:

Scenario No.	Year 1	Year 2	Year 3	Year 4	Year 5
1	X	X	X	X	X
2	X	X	-	-	-
3	X	X	-	-	-

Regrettably, a large number of runs could not be made. Each run for simulating a year required two hours of execution time on the University of Guam computer (IBM 4300 series). After the ouput was obtained, the results at the end of the last month had to be input as the initial conditions for the next run. Since the format of the output was not the same as that required for the input, considerable data manipulation was required before the next run could be made.

The output of all the runs represents a large quantity of numbers distributed over space and time. It would have been desirable to be able to plot this output in 3-D diagrams. However, such facilities were not available. Consequently, one can only present results at a point as a function of time or at a number of nodes at a given time.

Figure G-1 shows the distribution of some of the nodes in the finite element grid. This figure will help in locating the nodes at which results have been plotted. In particular, the aquifer conditions have been plotted along line No. 1 with node numbers 48, 57, 67, 76, 77, 85, 92, 95, 96, 103, 109, and 111, representing a line extending from the western shore into the Yigo trough. Because management scenario No. 1 was repeated for five years, most of the plots will be given for this scenario unless otherwise stated. Figure G-2 shows the contours of the phreatic surface at the end of the dry season (June) of the fifth year of simulation. It can be seen that during this period of no recharge and heavy pumping, there is a phreatic divide roughly along the line of node numbers 90, 82, 83, 76, 68, and 69. To the left of this divide, the water flows westward toward the

ocean. To the right of the divide, the water flows eastward toward the wells in the Dededo and Yigo areas. In the Yigo area, the phreatic surface will dip below mean sea level, to provide flow for the wells in that area. The phreatic surface is low over the entire aquifer. Because of these low levels, the volume of fresh water storage in the aquifer is a minimum. However, because of the low gradients, the leakage of fresh water to the ocean is also at a minimum.

During the wet season, when recharge to the aquifer is maximum, the phreatic levels are higher as shown in Figure G-3. In the Yigo area, the phreatic surface may be as high as 12 ft. above mean sea level. Because of the high levels during this time of year, the volume of fresh water storage in the aquifer is a maximum. However, because of the high gradients, the leakage of fresh water to the ocean is also at a maximum. Figures G-2 and G-3 show the aquifer conditions in the fifth year of simulation. Figures G-4 and G-5 show the aquifer conditions along line No. 1 for each of the five years of simulation. In Figure G-4, the phreatic surface in the first year dips only to MSL at nodes 103, 109 and 111. The reason the results are this way is because the program automatically made h_f (the fresh water piezometric head) equal to zero whenever a negative head resulted from the solution of the matrix. When the FORTRAN statement making this change was removed from the program, the heads at these and surrounding nodes dropped to negative values. It can be seen from this figure that the phreatic divide occurs at node 76. It can also be seen that the head varies so little from year to year that the differences cannot be seen on this scale. The interface, on the other hand, changes its elevation measurably from year to year. The change in elevation decreases every year. It is clear that the program needs to continue the simulation for several more years before steady cyclic conditions are reached. Figure G-5 shows the aquifer conditions at the peak of the wet season when recharge is a maximum. The phreatic surface is much higher. However, the interface elevations are not very different from those during the dry season. The difference in elevations of the phreatic surface between the wet and dry seasons represents a significant storage of fresh water, part of which will be lost to the ocean, but part of which will be pumped out during the next dry season.

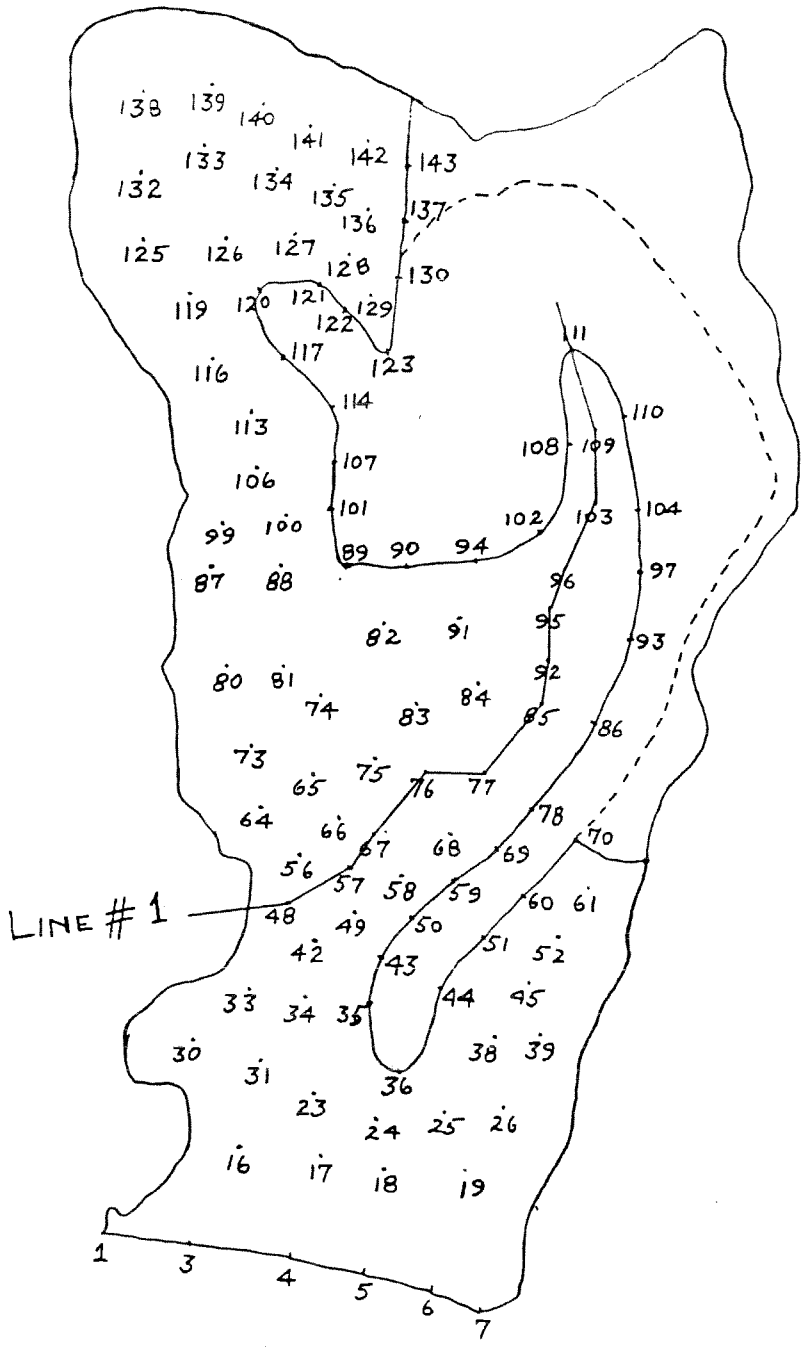


FIGURE G-1

NODE NUMBERS

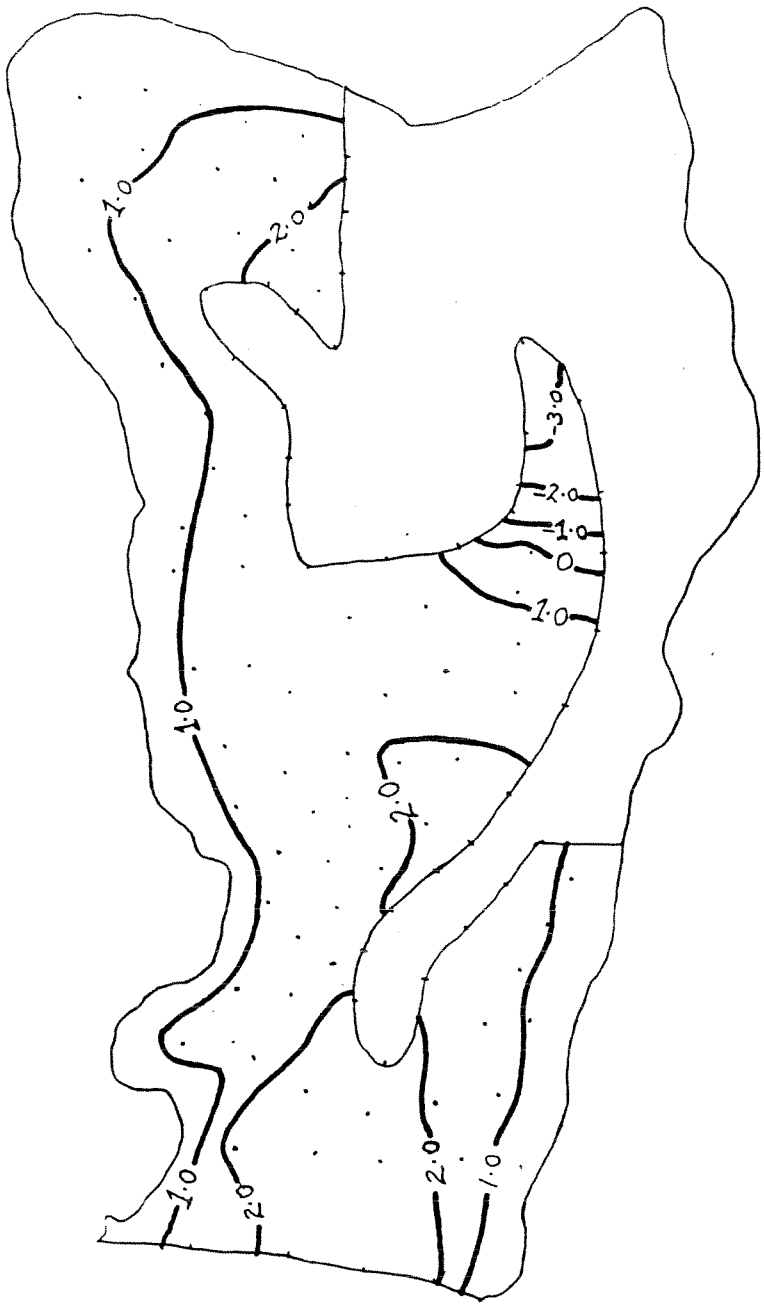


FIGURE G-2

PHREATIC CONTOURS AT END OF DRY SEASON

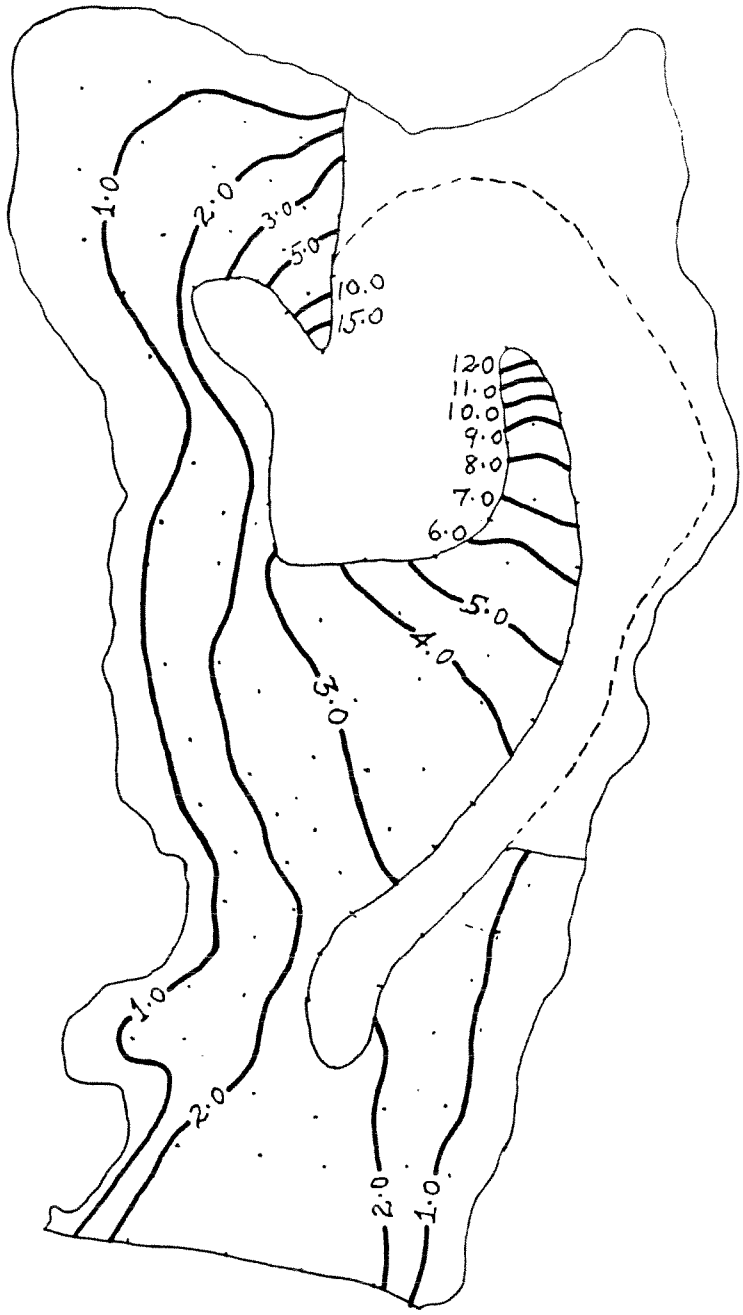


FIGURE G-3

PHREATIC CONTOURS AT END OF WET SEASON

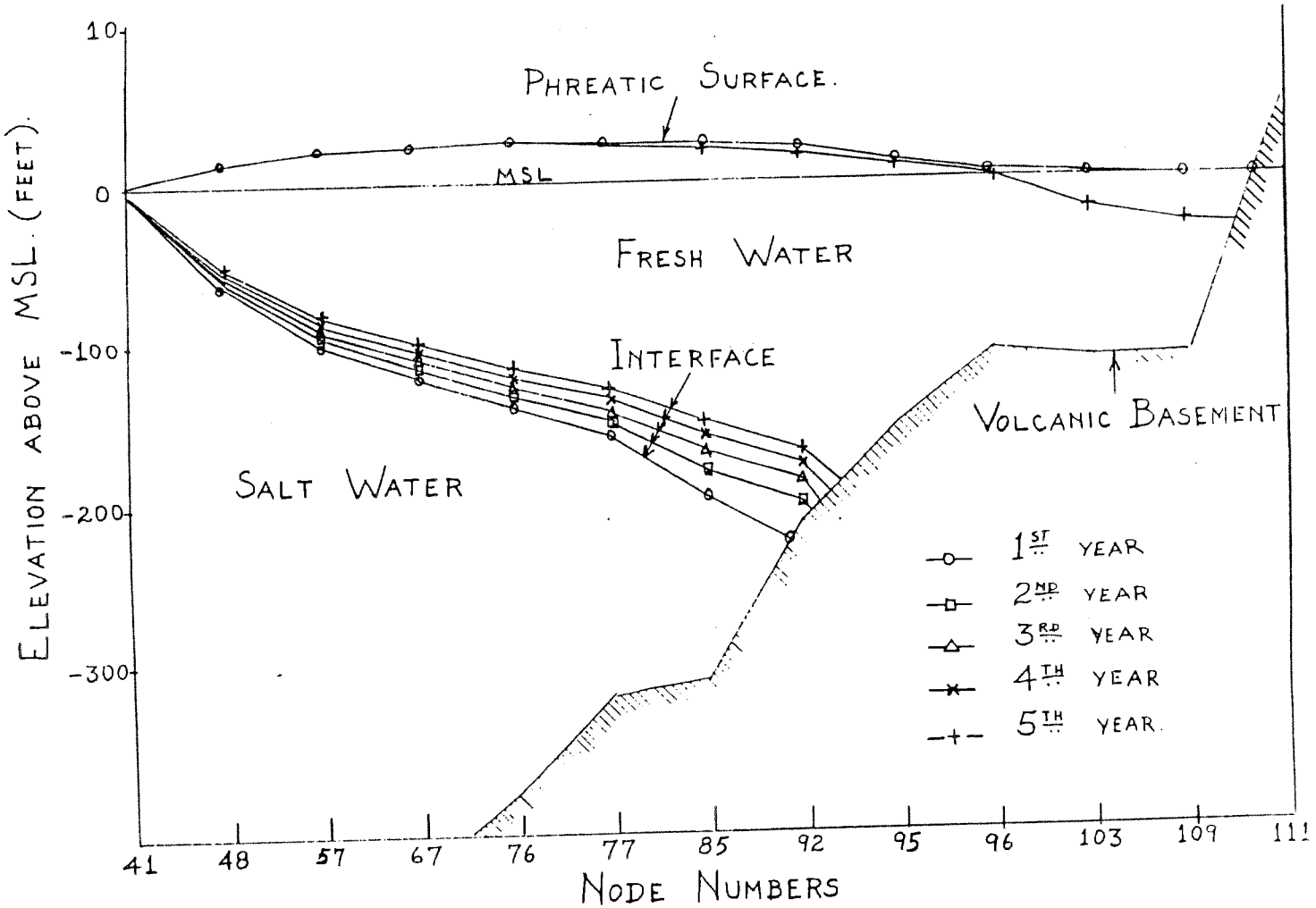


FIGURE G-4

AQUIFER CONDITIONS AT END OF DRY SEASON

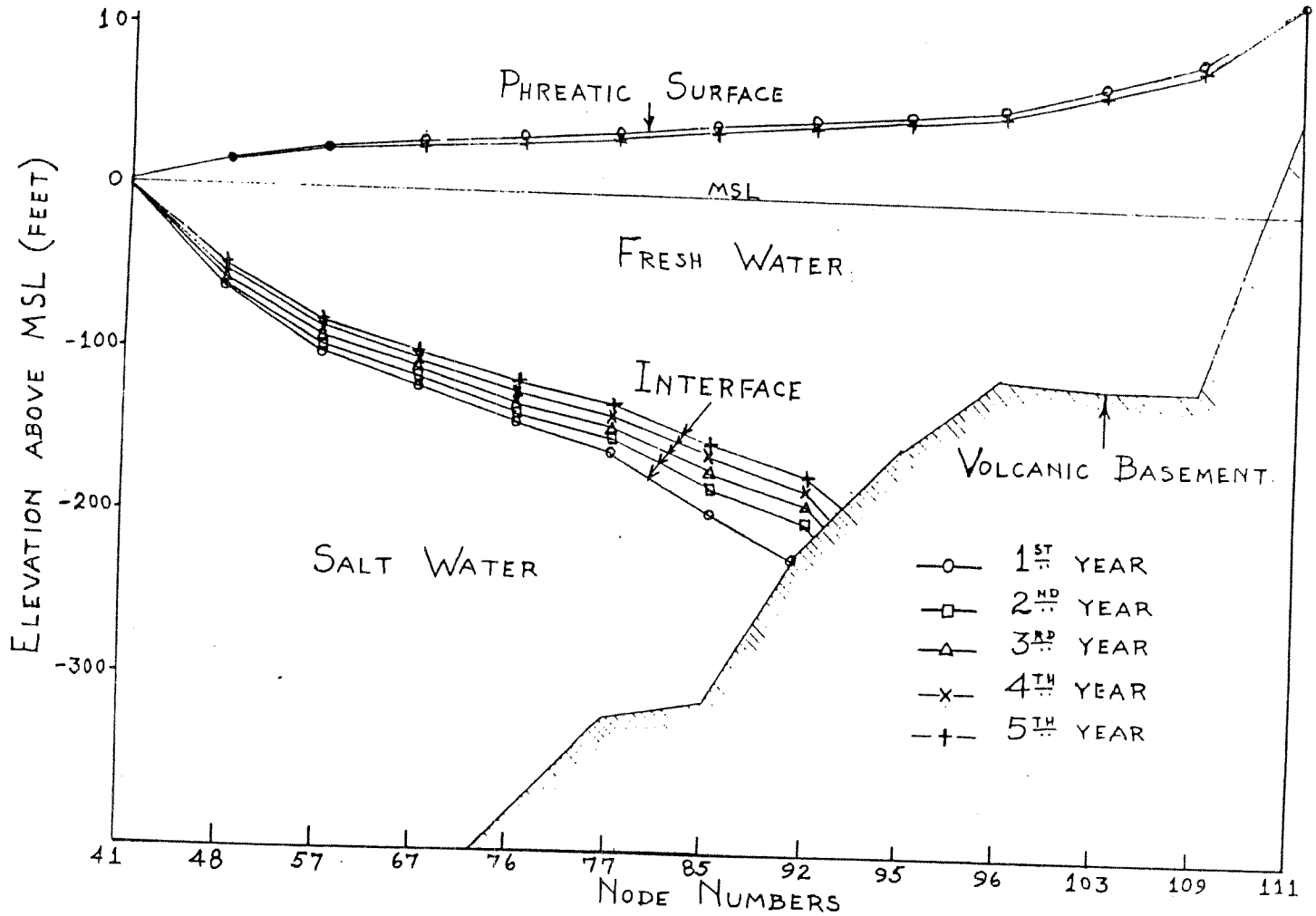


FIGURE G-5

AQUIFER CONDITIONS AT END OF WET SEASON

Figures G-6, G-7 and G-8 are plots of the elevation of the phreatic surface as a function of time at nodes 24, 76 and 95. At all three nodes, the phreatic surface rises sharply during the recharge months and drops gradually during the dry months. Over the five-year period, the head declined 0.5 feet. This decline will stop only when steady cyclic conditions prevail. The increase in elevation during the wet period is larger as one approaches the Yigo trough. Figure G-9 shows the variation of the salt water head at node 76 as a function of time. The salt water head (h_s) rose about 0.25 feet over the five year period from -1.15 feet to -0.9 feet. Because the salt water head is below mean sea level, the results show that the salt water is moving inland, which is expected. During the wet months, the fresh water head rises because of the recharge, tending to slow down the movement of the salt water inland. This can happen only when the salt water head rises during the wet season. When steady cyclic conditions are reached, the salt water head (h_s) variation during a year will be such that during the dry season, h_s will be positive, causing the same volume of salt water to move out to the ocean.

Figure G-10 shows the movement of the interface at node 76 over the period of simulation. The total rise of the interface is 35 feet. Slight variations in the elevation of the interface can be seen during a year. These variations would increase at nodes in the Yigo Trough. Because the interface is rising, the volume of fresh water in the lens will be decreasing, as shown in Figure G-11. It can be seen that the volume of fresh water in the lens has been reduced by 20 percent over five years. In general, the aquifer conditions for scenarios No. 2 and No. 3 are only slightly different from the conditions in scenario No. 1 in the first year of simulation. In the second year of simulation, some differences are observable, but are still small. The change in volume of the fresh water lens for scenario No. 2 is shown in Figure G-11. Significant changes in the aquifer conditions will occur for scenarios No. 2 and No. 3 when the simulations are continued beyond the second year. The difference in the volume of the aquifer in two consecutive months may be positive or negative. If the difference is positive, then the recharge is greater than the leakage to the ocean. If the difference is negative, then the leakage to the ocean exceeds the recharge. Figure G-12 shows the change in aquifer storage on a

monthly basis for the period of simulation. It can be seen that the leakage to the ocean exceeds the gain in aquifer storage. Consequently, the volume of the storage is continually decreasing as shown in Figure G-11. When steady cyclic conditions are reached, the gain in aquifer volume will equal the net leakage to the ocean.

The last two figures show a comparison between the measured water levels in wells M-10a and M-11 from 1978 through 1980 and the third, fourth and fifth years of simulation. It can be seen that the water levels have dropped from 0.75 to 1.0 foot. Of course, the simulated water levels will be lower when cyclic steady-state conditions are reached.

Conclusions

1. For the initial conditions assumed in the management runs, five years of simulation were insufficient to reach steady cyclic conditions. Probably another five to ten years of simulation would be required. Alternatively, one can try to obtain initial conditions that are closer to the final cyclic results.

2. Despite the fact that final, steady, cyclic conditions were not reached, the computer runs do provide insight into the aquifer behavior that one can expect under these management conditions.

3. At the end of the dry season (June), the phreatic surface will develop a divide approximately along a line with node numbers 90, 82, 83, 76, 68, and 69. To the left of this divide, the groundwater will flow westward toward the ocean, and to the right of the divide, the groundwater will flow eastward toward the wells in the Dededo and Yigo areas.

4. At the height of the wet season (October), the phreatic levels will rise sharply, especially in the Yigo Trough. These high levels represent a storage volume, part of which will drain out to the ocean and part of which will be pumped out during the next dry season.

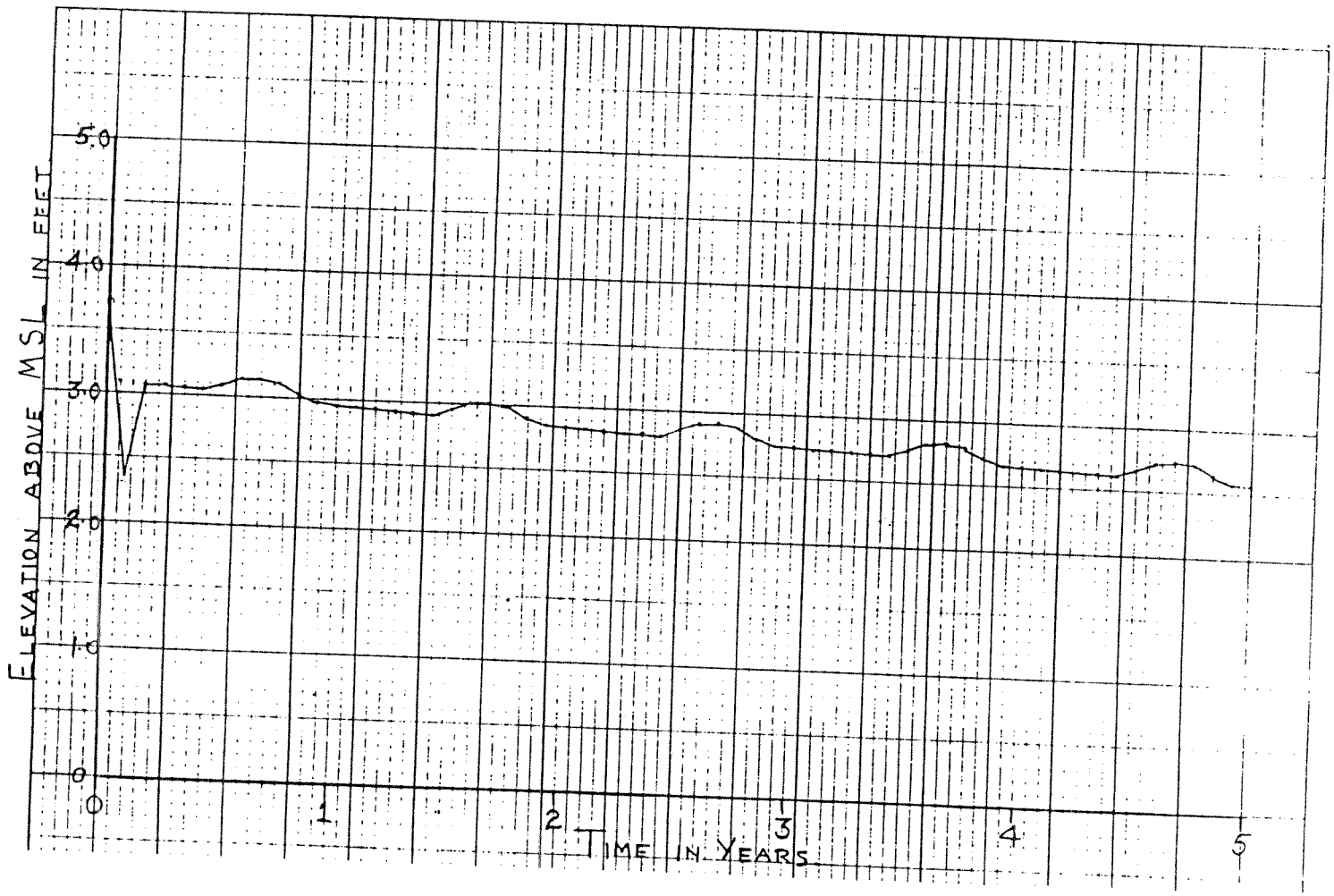


FIGURE G-6
PHREATIC SURFACE ELEVATIONS AT NODE 24

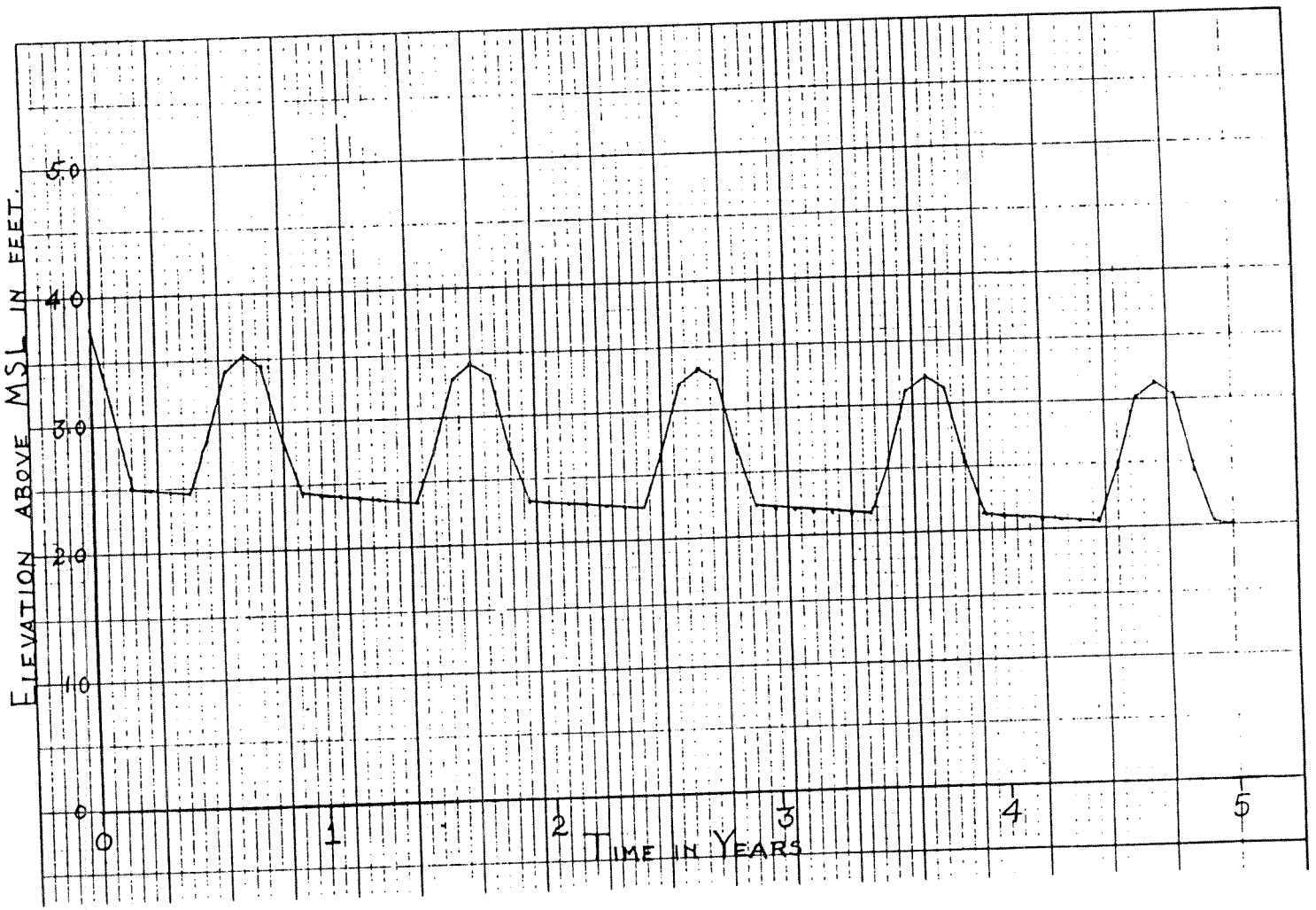


FIGURE G-7

PHREATIC SURFACE AT NODE 76

FIGURE G-8

PHREATIC SURFACE AT NODE 95

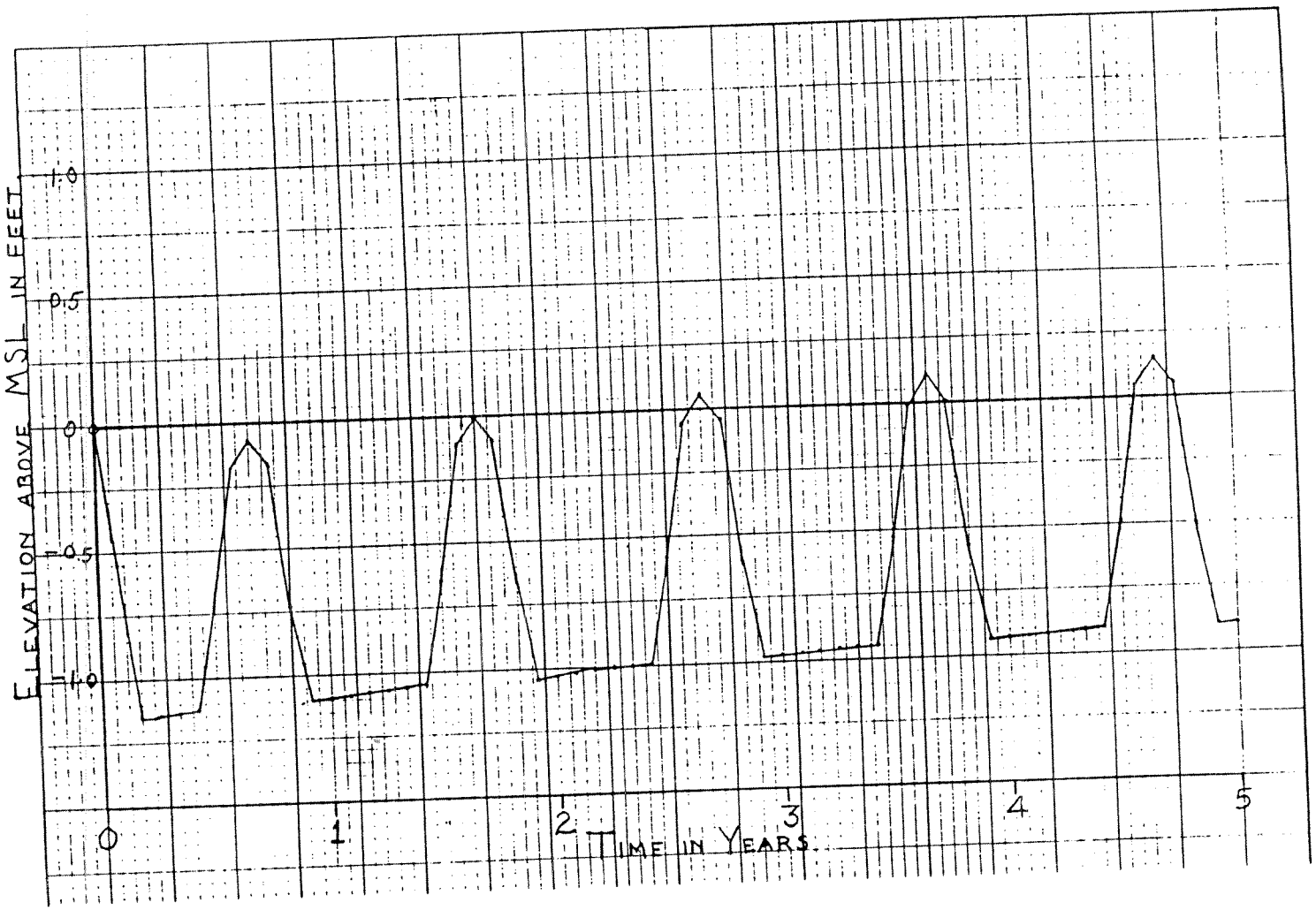


FIGURE G-9

SALTWATER HEAD AT NODE 76

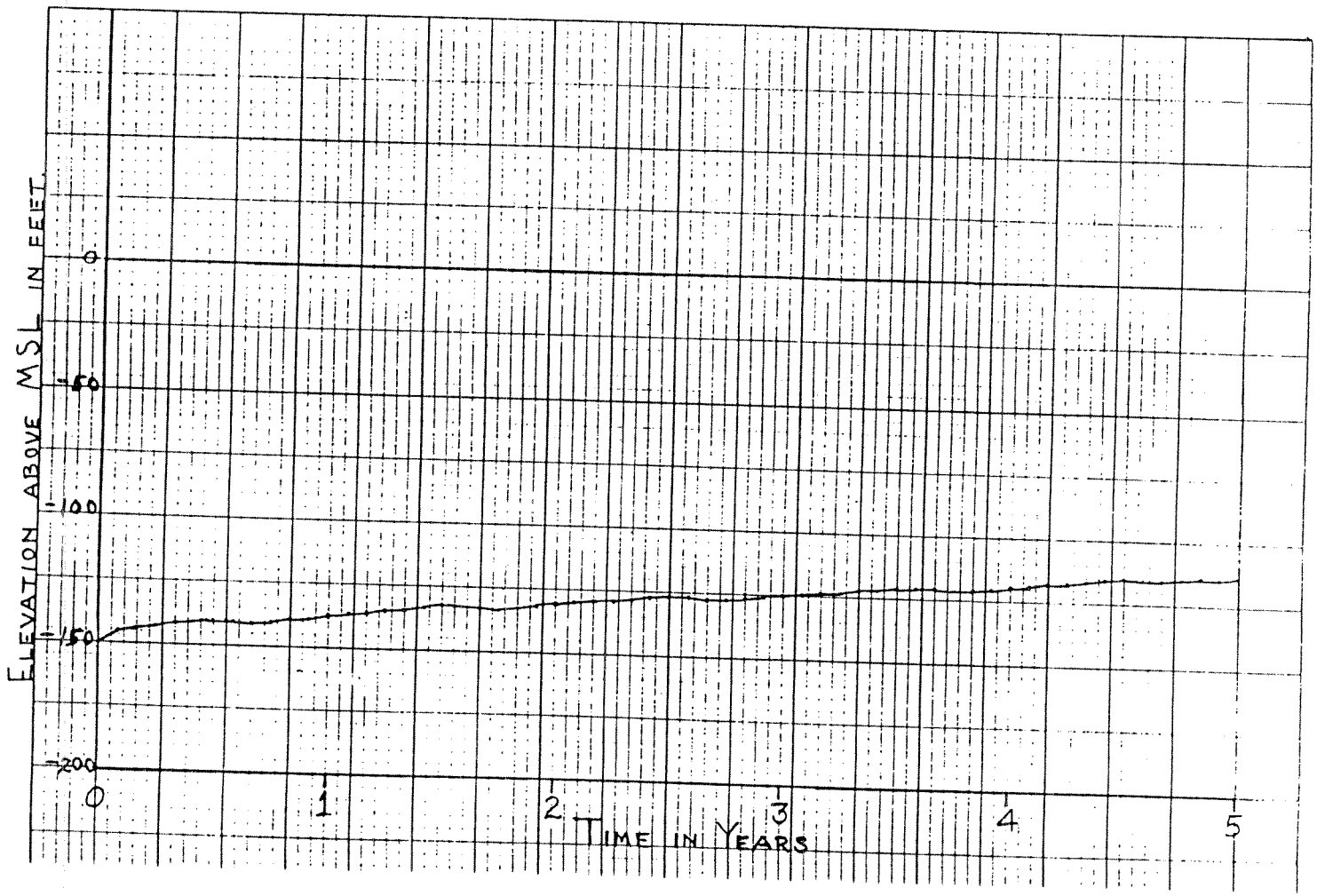


FIGURE G-10

DEPTH OF INTERFACE AT NODE 76

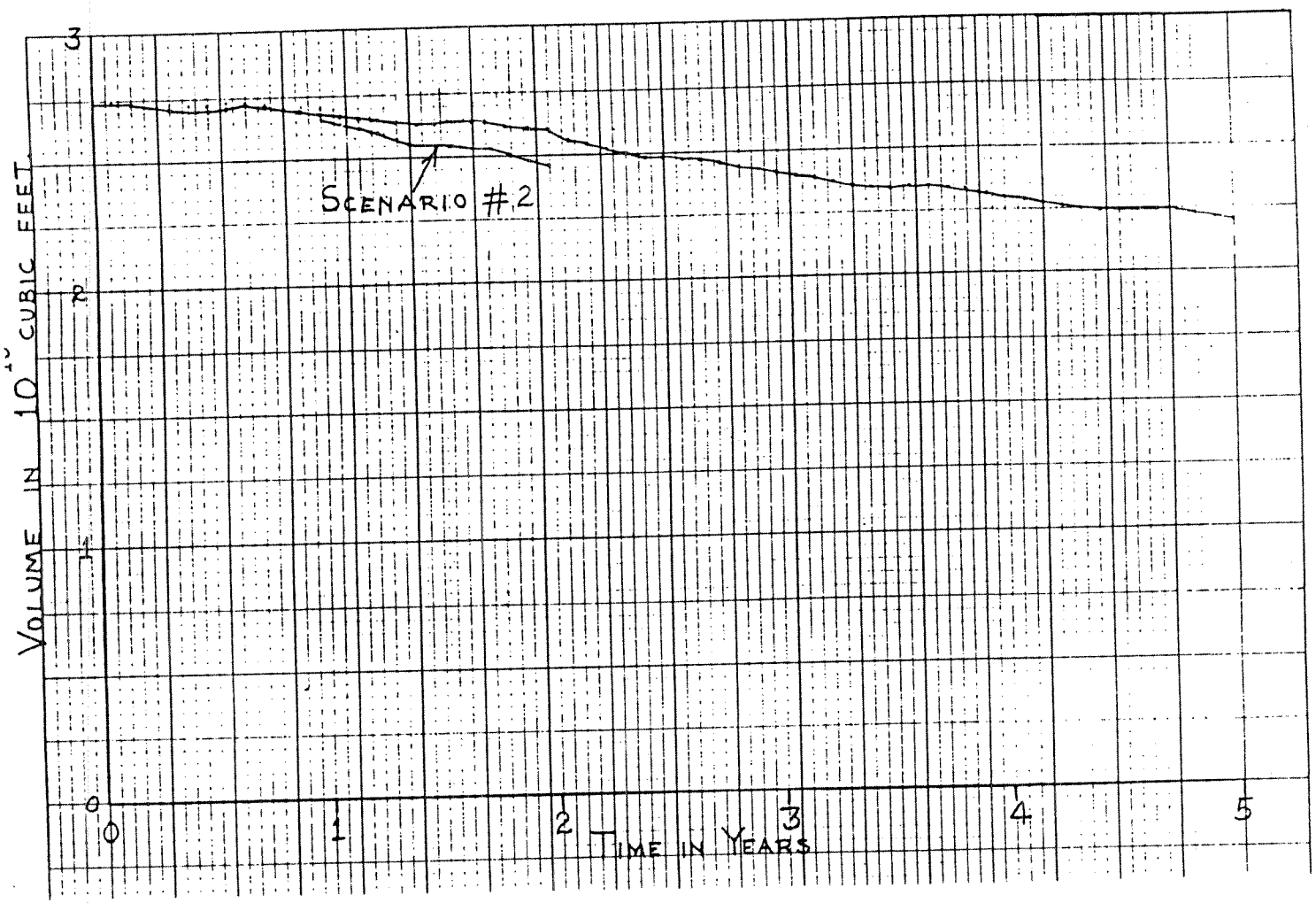


FIGURE G-11

VOLUME OF FRESH WATER STORED IN AQUIFER

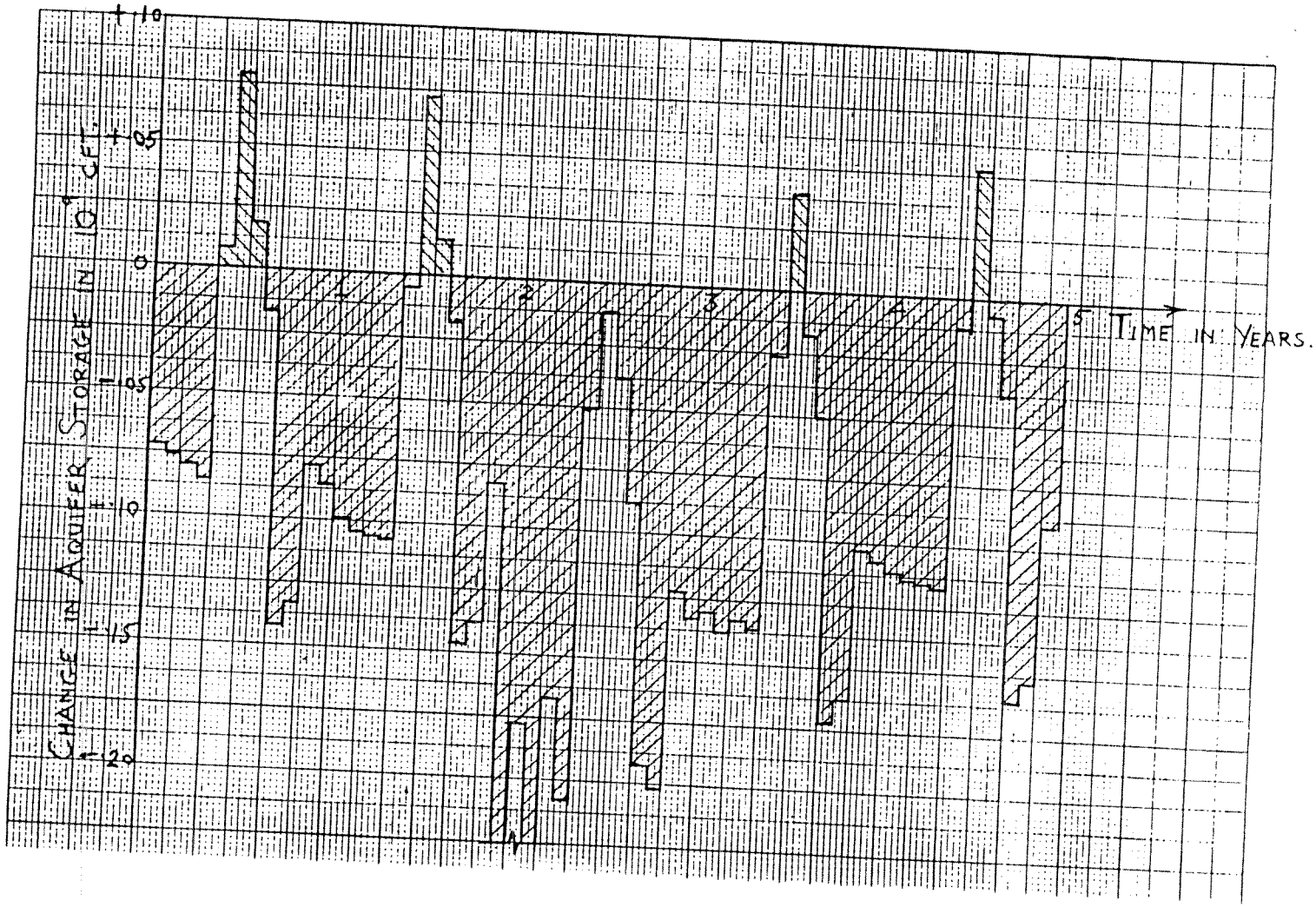


FIGURE G-12

CHANGE IN STORAGE ON A MONTHLY BASIS

5. During the five year simulation period, the fresh water lens decreased in volume by 20 percent to 2.2E10 cubic feet (5.05E5 acre-feet).

6. Management simulations for scenarios No. 2 and No. 3 were run for two years. During this period, the results were not very different from the results of scenario No. 1. With longer simulation periods, the differences would become apparent.

Suggestions for Future Work:

1. Research work should be conducted to determine ways of reducing the simulation period requird to reach steady, cyclic conditions in the aquifer. Several ideas could be explored. First, the Ghyben-Herzberg approximation, $h_s = 0$, can be used at all nodes. With this approximation, the program may reach steady, cyclic conditions sooner and then the program can be run without the Ghyben-Herzberg approximation. Second, the salt water permeability could be artifically increased tenfold and the program run until steady, cyclic conditions result, and then the permeability decreased to its normal value. The value of these ideas and the resultant computer cost savings can only be ascertained by further research.

2. Because the main area of interest is the Dededo and Yigo areas, the aquifer network could be modified to include these areas down to the western shores of the island. This will result in a smaller number of nodes and, hence, shorter execution times for the program. Alternatively, the same number of nodes may be used in this smaller area to provide better resolution of the variables.

APPENDIX H

GLOSSARY OF TECHNICAL TERMS

Aquifer.	A formation that contains sufficient saturated permeable material to yield significant quantities of water to wells and springs. In Guam the aquifer is composed of limestone.
Basal.	The zone of fresh water that floats on salt water in a groundwater environment. The delineation of the zone is estimated by the Gheyben-Herzberg Relationship.
Evapotranspiration.	The combined measure of the water vapor returned to the atmosphere as evaporation from free surfaces and from transpiration by plants.
Fresh Water Lens.	The fresh groundwater consisting of the parabasal and basal zones overlying salt water.
Ghyben-Herzberg Relationship.	Fresh groundwater floats on heavier sea water in accordance with the buoyancy principal; theoretically, 40 feet of fresh water will extend below sea level for every foot of head above sea level.
Head.	The height above a standard datum of the surface of a column of water that can be supported by the static pressure at a given point.
Management Zone.	The parabasal and basal subdivisions of the hydrologic subbasins for which recharge and sustainable yield were determined and for which management alternatives are made.

Transition Zone.	The diffuse zone of brackish water of finite thickness that separates the fresh water and saline water. This zone develops from dispersion caused by fresh water flow plus unsteady displacements of the interface by external influences such as tides, recharge, and pumping of wells.
Upconing.	When an aquifer containing an underlying body of saline water is pumped by a well, a local rise of the fresh water-salt water interface below the well occurs. If the well is pumped at too high a rate, the interface rises to the point where the well becomes unusable due to contamination by saline water.
Volcanic Basement Rock.	An impermeable volcanic formation that is the lower boundary for the limestone aquifer.

Legend

- ●A-10 — PRODUCTION WELL & WELL NUMBER; EX WELLS ARE GUAM EPA EXPLORATORY WELLS
- ⊕A-20 — WELL OUT OF PRODUCTION WITH WATER LEVEL RECORDER
- O18 — WELL OUT OF PRODUCTION
- CL:40 — CHLORIDE (ppm)
- TD:-20 — WELL TERMINATED IN LIMESTONE (-20 = ELEVATION OF BOTTOM OF WELL)
- TD:-50V — WELL TERMINATED IN VOLCANICS (-50 = ELEVATION OF TOP OF VOLCANICS)
- —200— ELEVATION CONTOUR OF TOP OF VOLCANICS
- AQUIFER SECTOR BOUNDARY
- AQUIFER SYSTEM BOUNDARY
- SURFACE EXPOSURE OF VOLCANIC ROCKS
- D-4 / (-440) — LOCATION OF SEISMIC LINE D-4 ((-440) = MINIMUM ELEV. OF TOP OF VOLCANICS)
- 110 E-3 50 — LOCATION OF SEISMIC LINE E-3 (110, 50 = ELEVATION OF TOP OF VOLCANICS)

north

0 4000 8000 12000

SCALE IN FEET

FINEGAYAN SECTOR

TARAGUE SECTOR

YIGO-TUMON SECTOR

AGANA SECTOR

HAPUTO SYSTEM

NORTHWEST FIELD SYSTEM

GUGAGON SYSTEM

AGAFO GUMAS SYSTEM

PATI SECTOR

ANDERSEN SYSTEM

BARRIGADA SYSTEM

TUMON SYSTEM

T SYSTEM

MONGMONG SYSTEM

HUCHANAO SYSTEM

YIGO SYSTEM

MT. SANTA ROSA SYSTEM

SABANA MAAGAS SYSTEM

SASAJYAN SYSTEM

PAGAT SYSTEM

MANGILAO SECTOR

FIGURE 3-1

NORTHERN GUAM

AQUIFER SYSTEMS

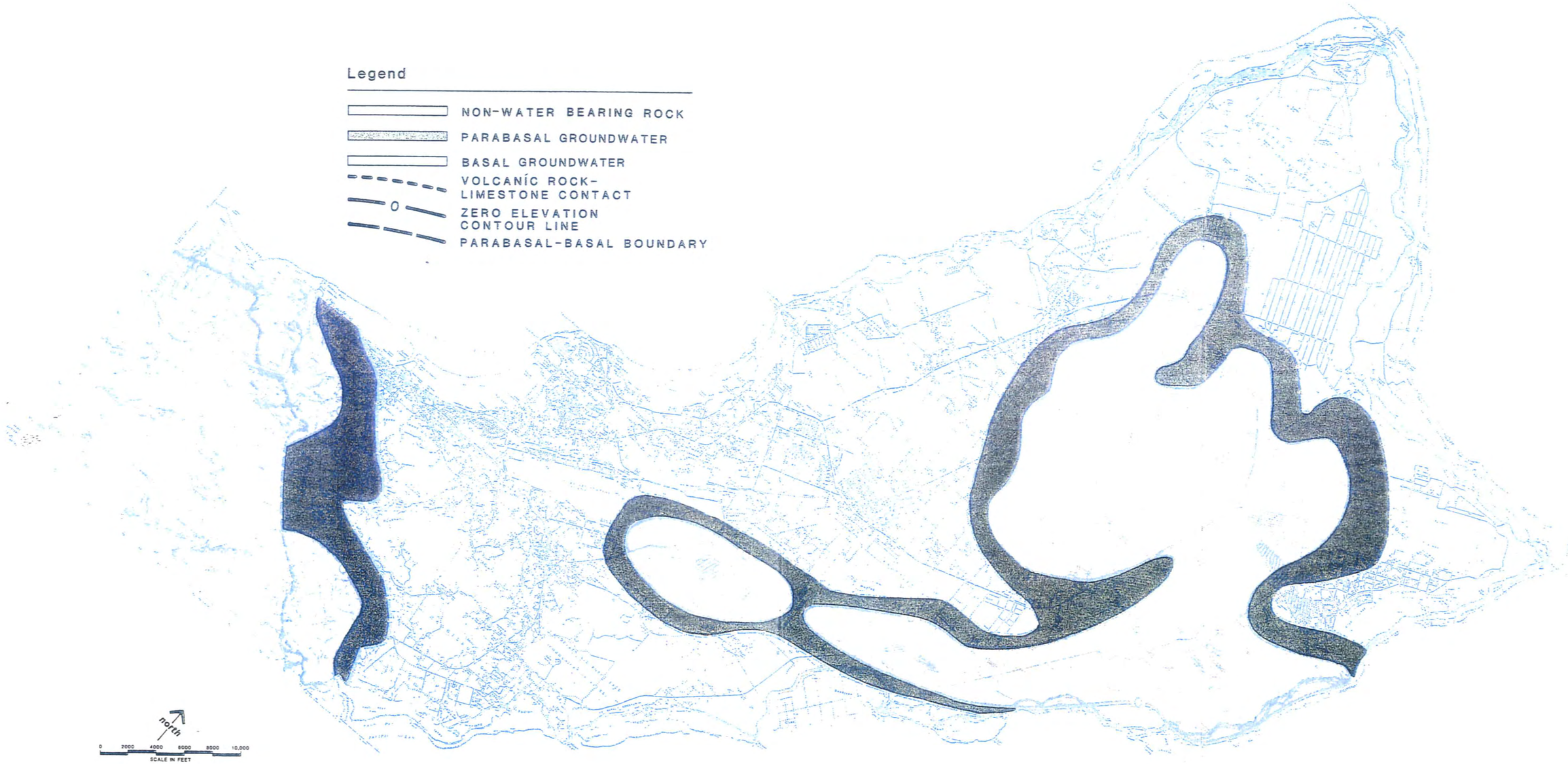


FIGURE 1-1

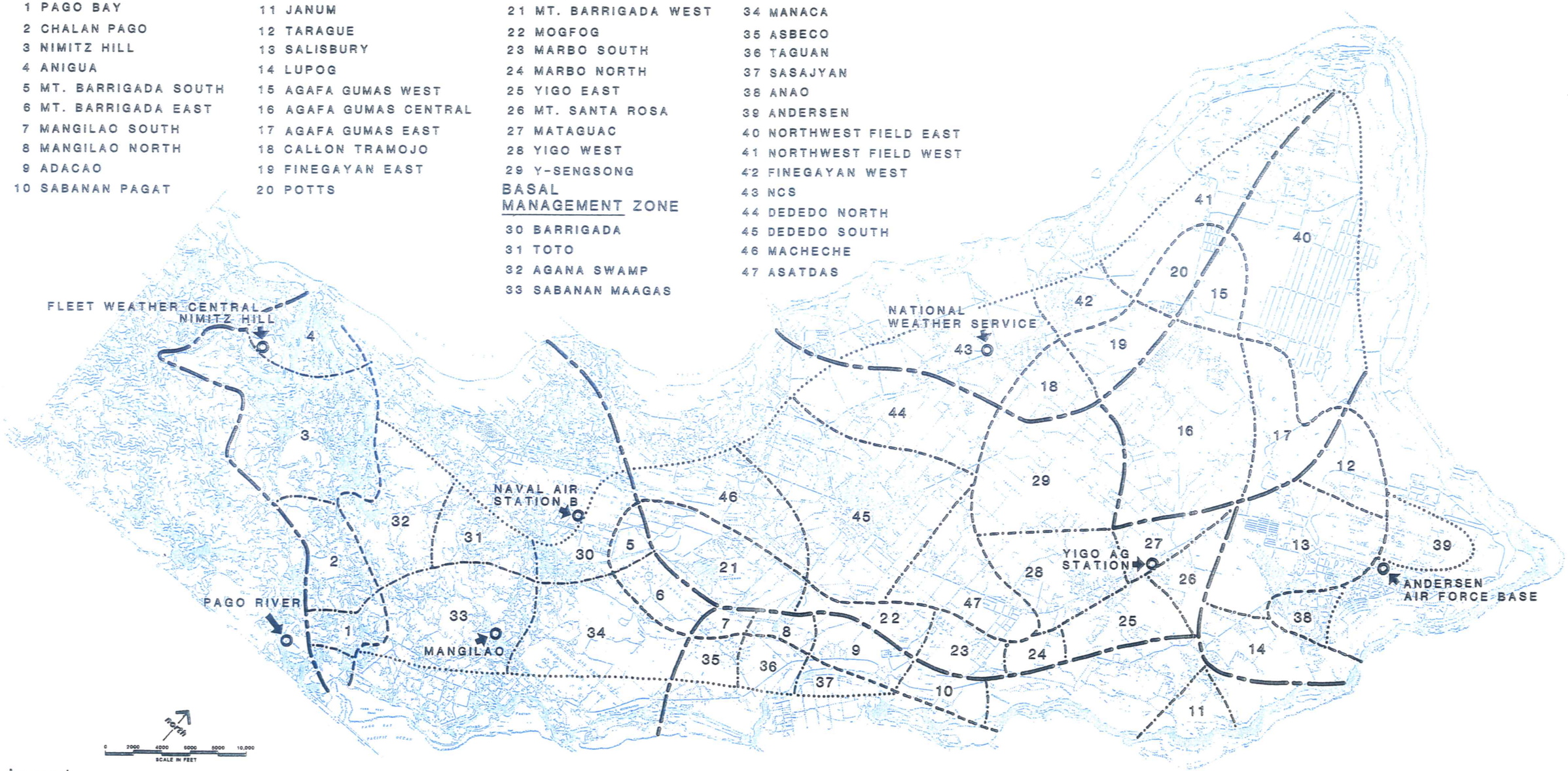
DISTRIBUTION OF
GROUNDWATER TYPES

PARABASAL
MANAGEMENT ZONE

1 PAGO BAY
2 CHALAN PAGO
3 NIMITZ HILL
4 ANIGUA
5 MT. BARRIGADA SOUTH
6 MT. BARRIGADA EAST
7 MANGILAO SOUTH
8 MANGILAO NORTH
9 ADACAO
10 SABANAN PAGAT
11 JANUM
12 TARAGUE
13 SALISBURY
14 LUPOG
15 AGAFA GUMAS WEST
16 AGAFA GUMAS CENTRAL
17 AGAFA GUMAS EAST
18 CALLON TRAMOJO
19 FINEGAYAN EAST
20 POTTS
21 MT. BARRIGADA WEST
22 MOGFOG
23 MARBO SOUTH
24 MARBO NORTH
25 YIGO EAST
26 MT. SANTA ROSA
27 MATAGUAC
28 YIGO WEST
29 Y-SENGSONG

BASAL
MANAGEMENT ZONE

30 BARRIGADA
31 TOTO
32 AGANA SWAMP
33 SABANAN MAAGAS
34 MANACA
35 ASBECO
36 TAGUAN
37 SASAJYAN
38 ANAO
39 ANDERSEN
40 NORTHWEST FIELD EAST
41 NORTHWEST FIELD WEST
42 FINEGAYAN WEST
43 NCS
44 DEDEDO NORTH
45 DEDEDO SOUTH
46 MACHECHE
47 ASATDAS



Legend

GROUNDWATER SUBBASIN BOUNDARY
PARABASAL - BASAL BOUNDARY
MANAGEMENT ZONE BOUNDARY
BOUNDARY FOR SAFE PUMPING
RAINGAGE STATION

FIGURE 1-2

GROUNDWATER MANAGEMENT ZONES
NORTHERN LENS

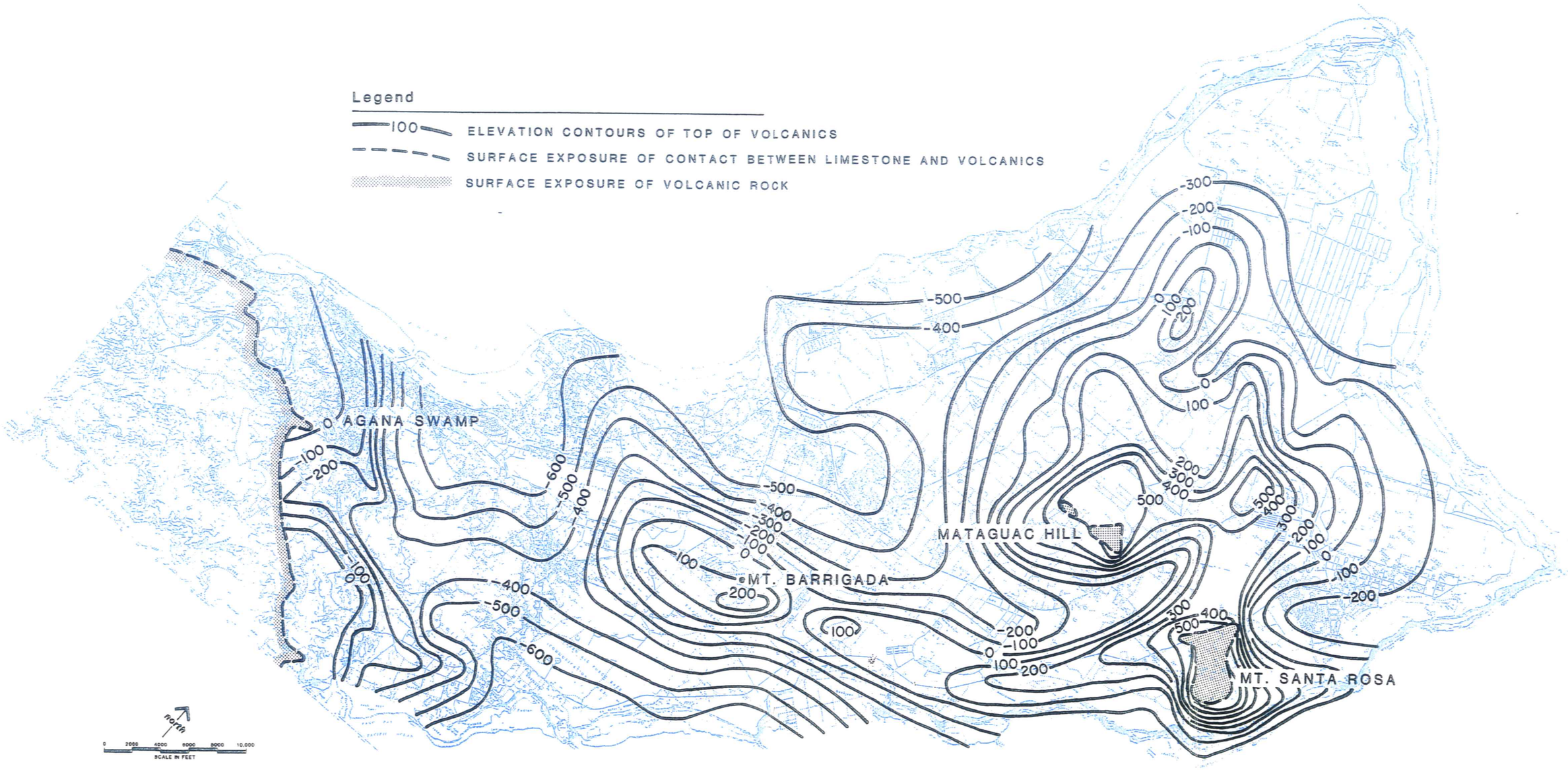


FIGURE 3-3

CONTOUR MAP
OF THE VOLCANIC BASEMENT

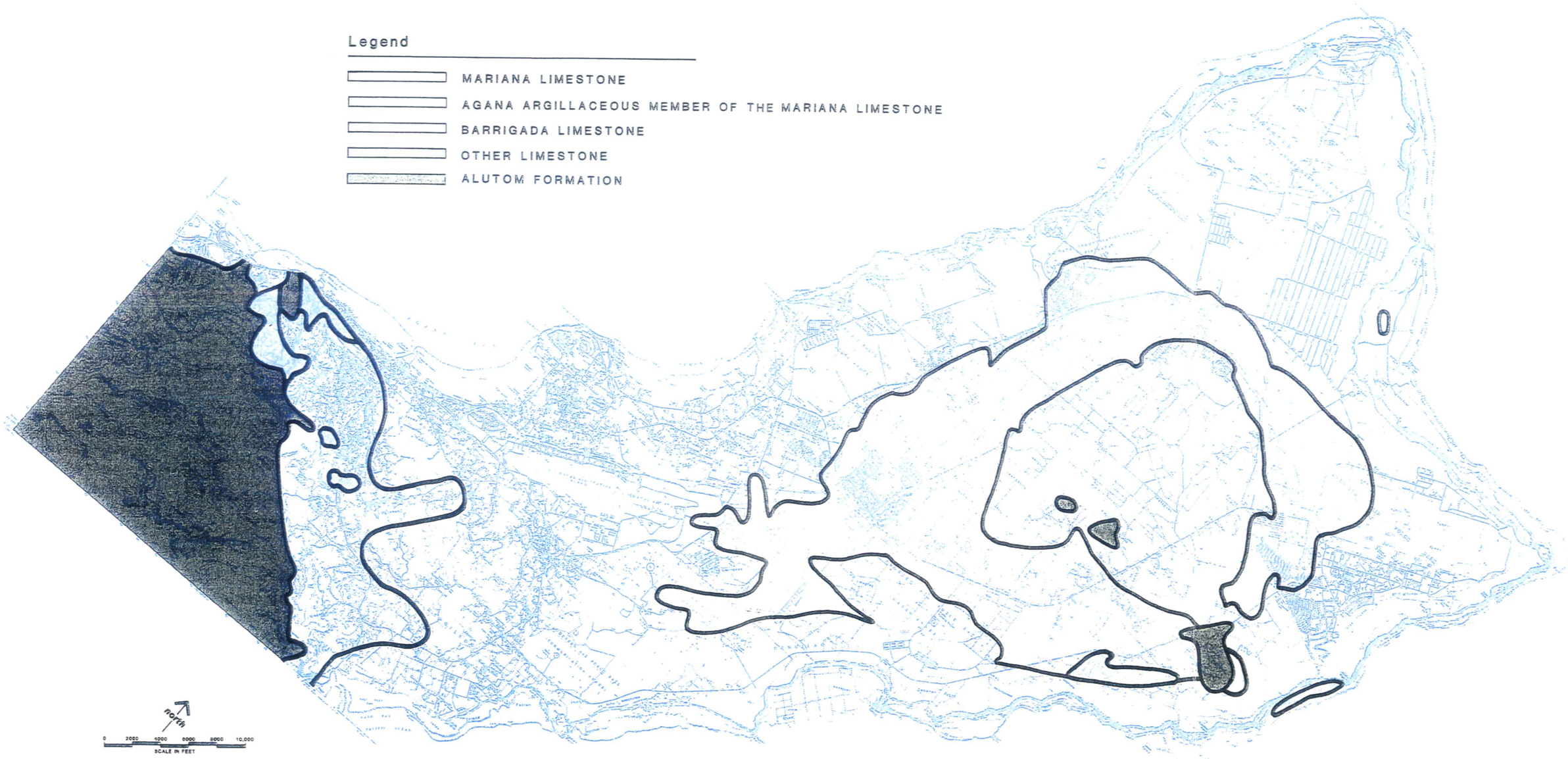
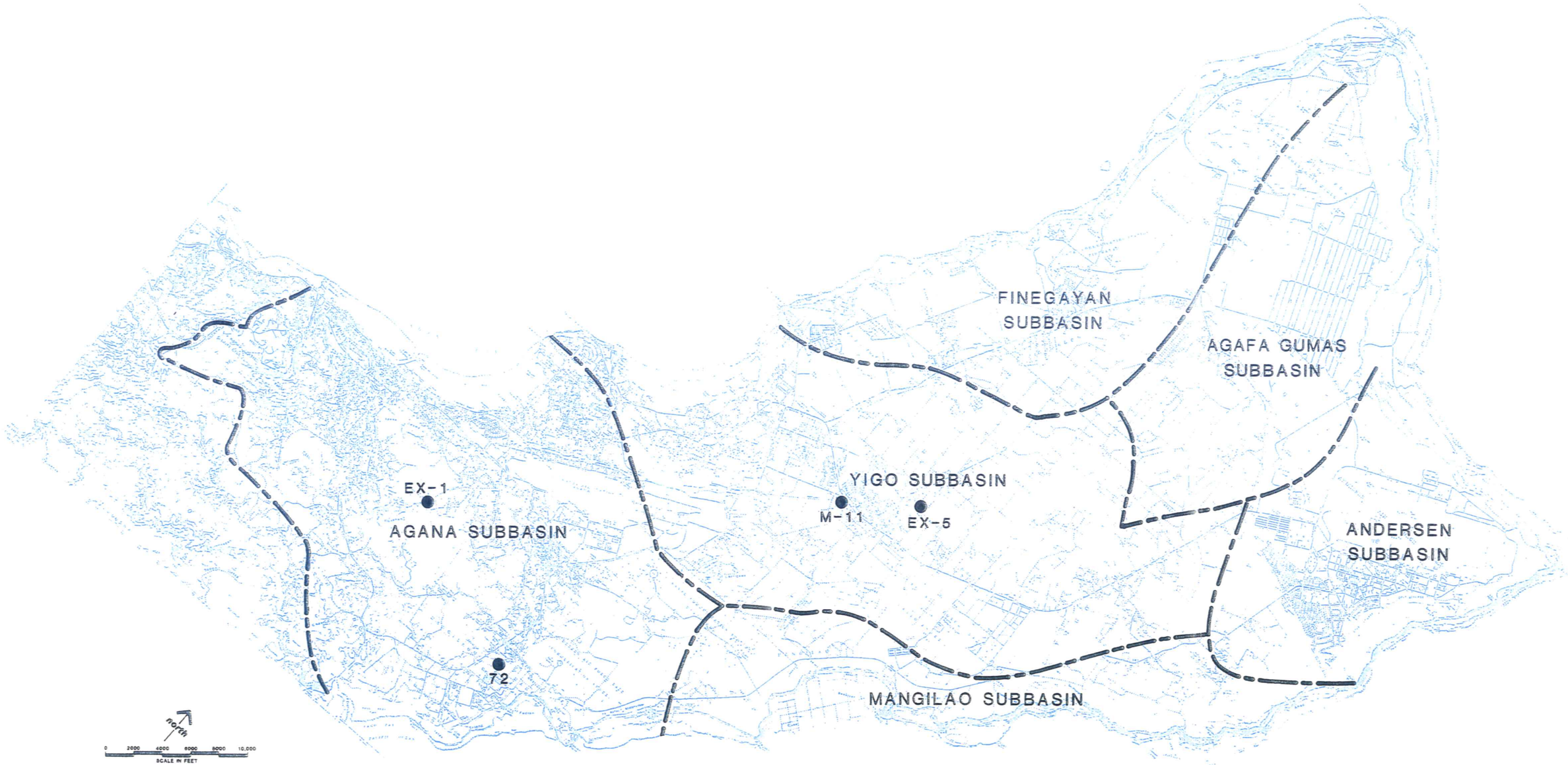


FIGURE 3-4
GENERALIZED GEOLOGY MAP



Legend

GROUNDWATER SUBBASIN BOUNDARY

72 WELL No. 72

FIGURE 4-1

SUBBASIN LOCATION MAP

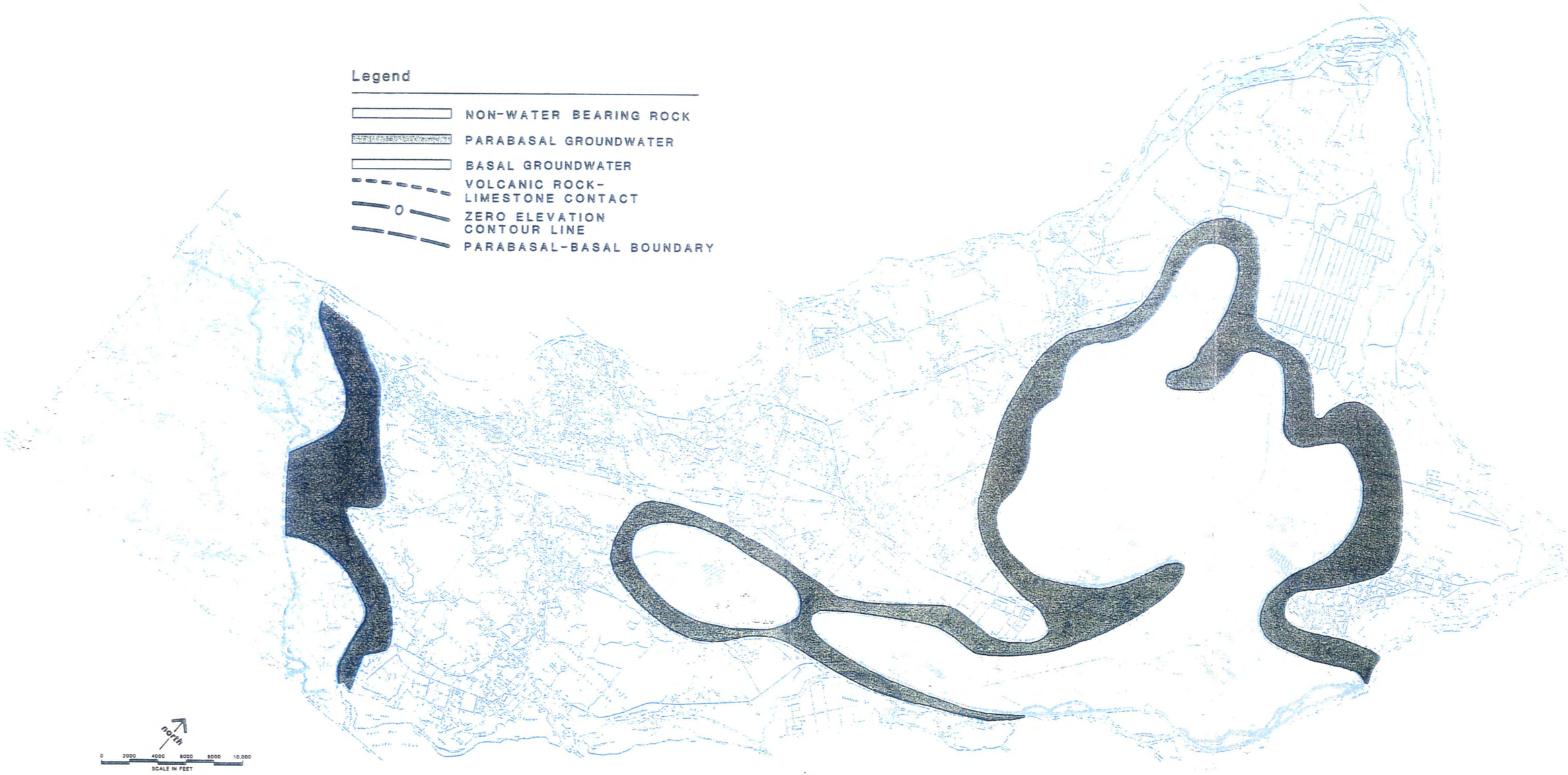


FIGURE 4-2

DISTRIBUTION OF
GROUNDWATER TYPES

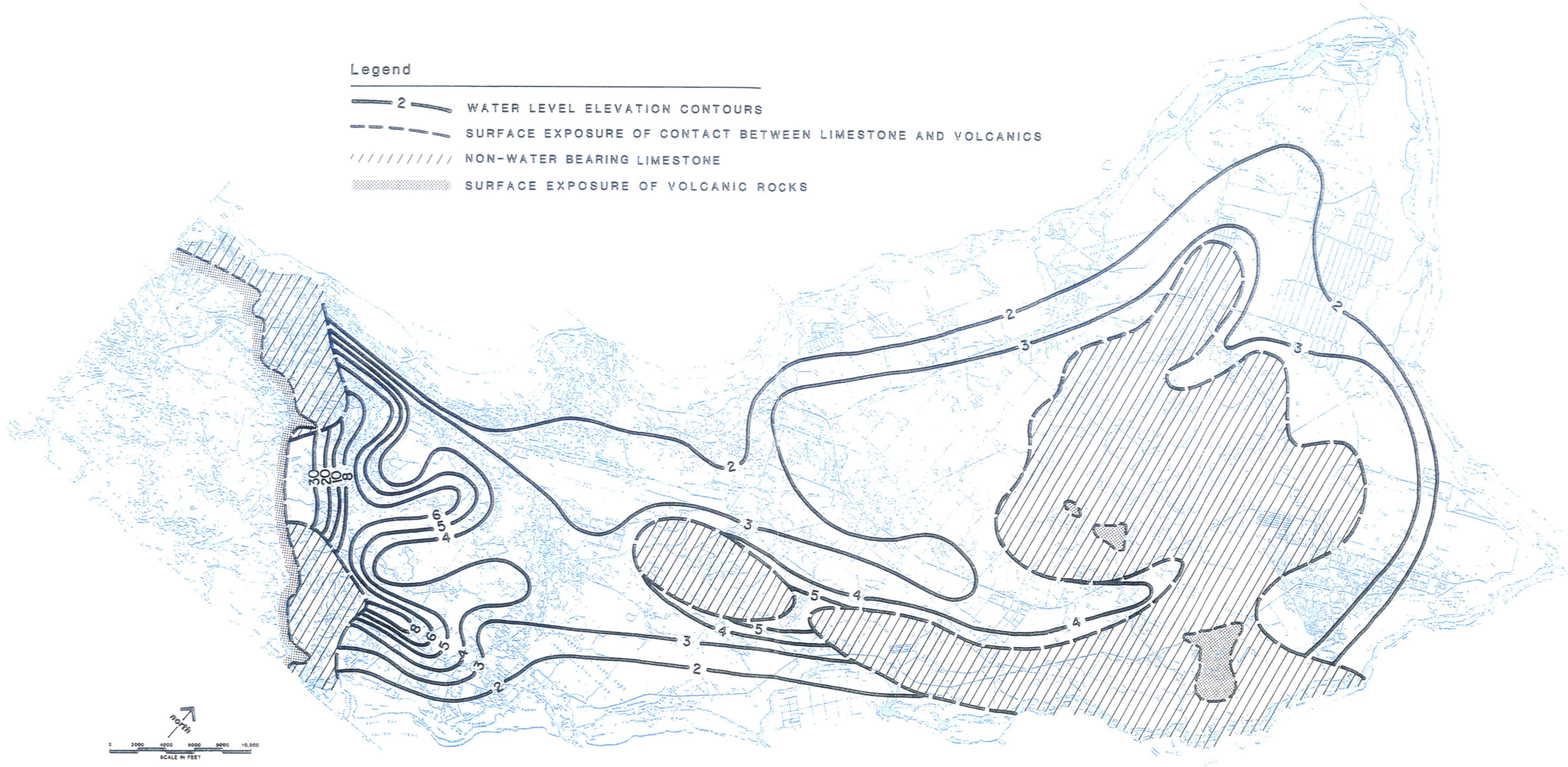


FIGURE 4-3

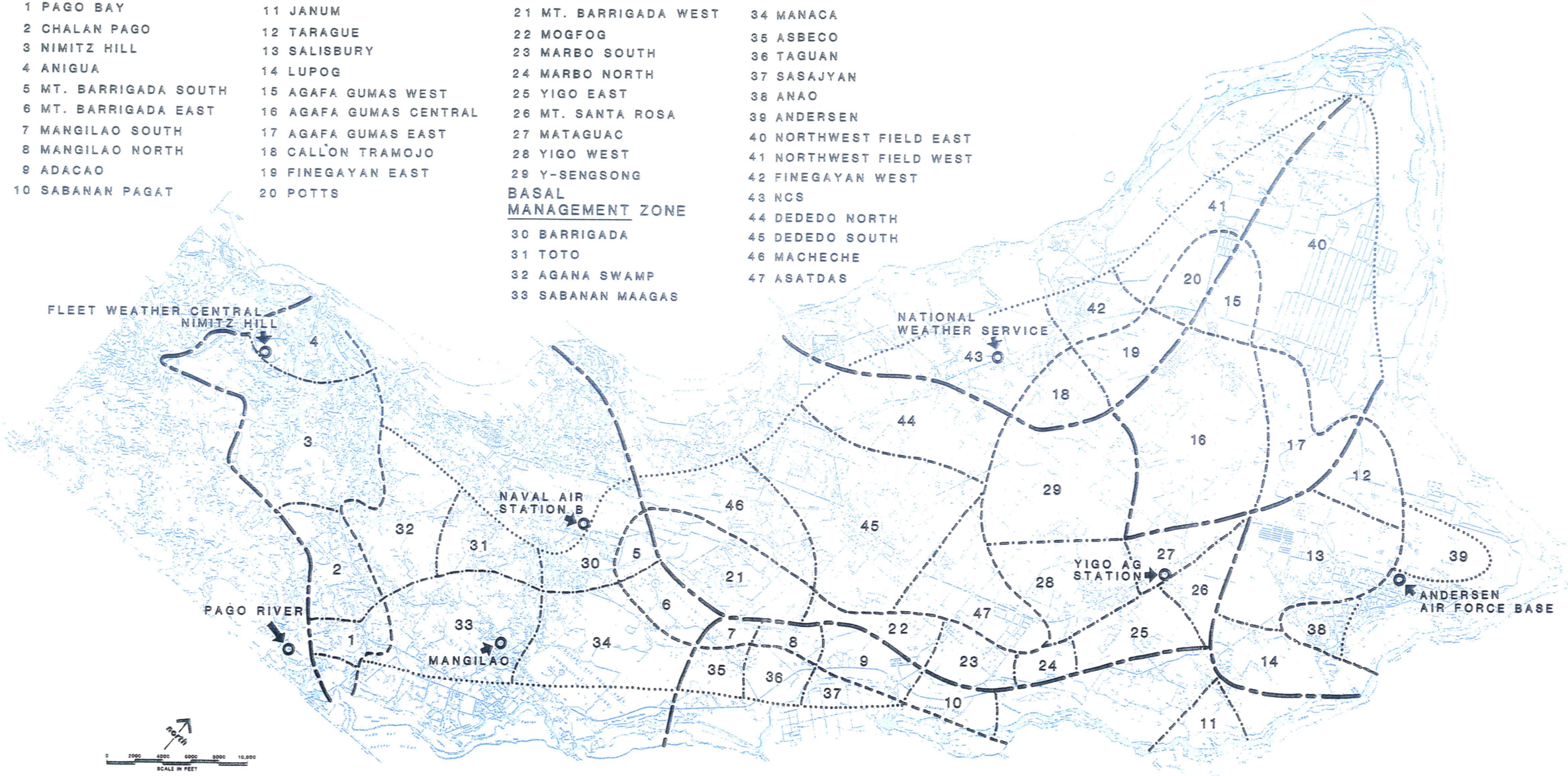
WATER LEVEL CONTOUR MAP
APRIL 1982

PARABASAL
MANAGEMENT ZONE

1 PAGO BAY
2 CHALAN PAGO
3 NIMITZ HILL
4 ANIGUA
5 MT. BARRIGADA SOUTH
6 MT. BARRIGADA EAST
7 MANGILAO SOUTH
8 MANGILAO NORTH
9 ADACAO
10 SABANAN PAGAT
11 JANUM
12 TARAGUE
13 SALISBURY
14 LUPOG
15 AGAFA GUMAS WEST
16 AGAFA GUMAS CENTRAL
17 AGAFA GUMAS EAST
18 CALLON TRAMOJO
19 FINEGAYAN EAST
20 POTTS
21 MT. BARRIGADA WEST
22 MOGFOG
23 MARBO SOUTH
24 MARBO NORTH
25 YIGO EAST
26 MT. SANTA ROSA
27 MATAGUAC
28 YIGO WEST
29 Y-SENGSONG

BASAL
MANAGEMENT ZONE

30 BARRIGADA
31 TOTO
32 AGANA SWAMP
33 SABANAN MAAGAS
34 MANACA
35 ASBECO
36 TAGUAN
37 SASAJYAN
38 ANAO
39 ANDERSEN
40 NORTHWEST FIELD EAST
41 NORTHWEST FIELD WEST
42 FINEGAYAN WEST
43 NCS
44 DEDEDO NORTH
45 DEDEDO SOUTH
46 MACHECHE
47 ASATDAS



Legend

- GROUNDWATER SUBBASIN BOUNDARY
- PARABASAL - BASAL BOUNDARY
- MANAGEMENT ZONE BOUNDARY
- BOUNDARY FOR SAFE PUMPING
- RAINGAGE STATION

FIGURE 5-1

GROUNDWATER MANAGEMENT ZONES
NORTHERN LENS

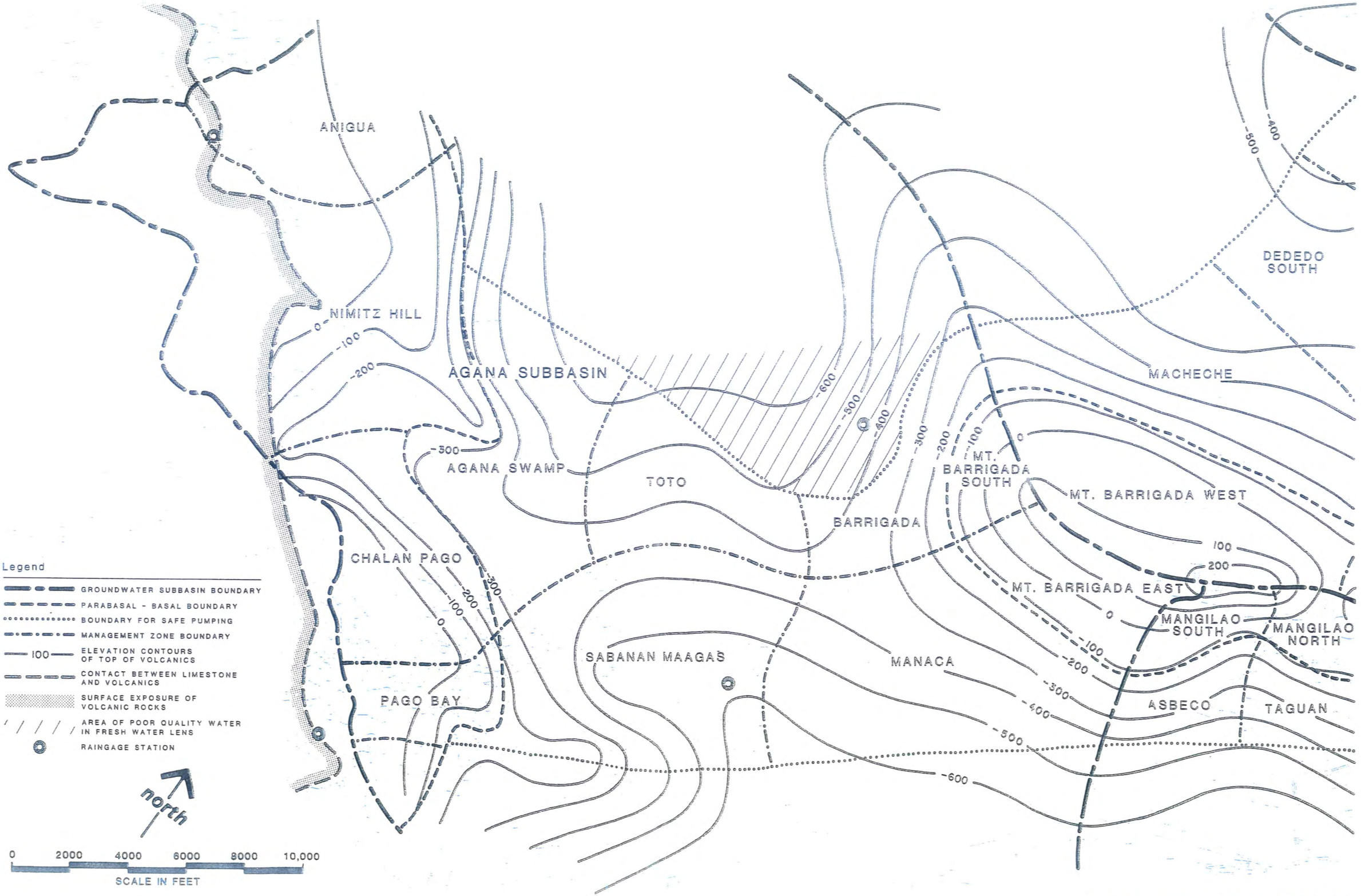


FIGURE 7-1 AGANA SUBBASIN

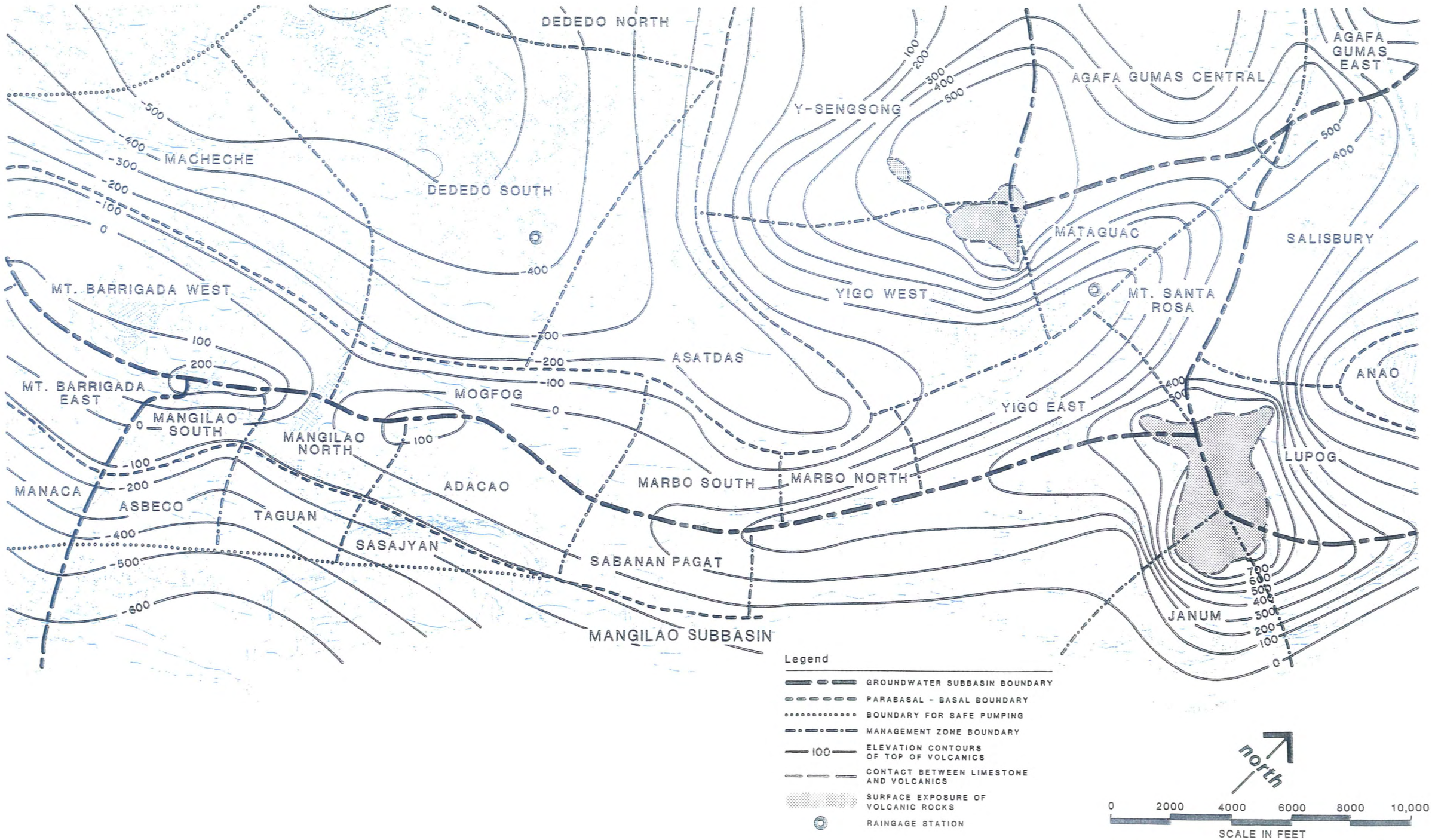


FIGURE 7-2 MANGILAO SUBBASIN

POTTS
AGAFA GUMAS WEST
NORTHWEST FIELD EAST
FINEGAYAN WEST
NCS
FINEGAYAN EAST
AGAFA GUMAS EAST
TARAGUE
CALLON TRAMOJO
AGAFA GUMAS CENTRAL
ANDERSEN
ANDERSEN SUBBASIN
Y-SENGSONG
SALISBURY
MATAGUAC
MT. SANTA ROSA
ANAO
YIGO WEST
YIGO EAST
LUPOG
ASATDAS
MARBO NORTH
MARBO SOUTH
JANUM

Legend

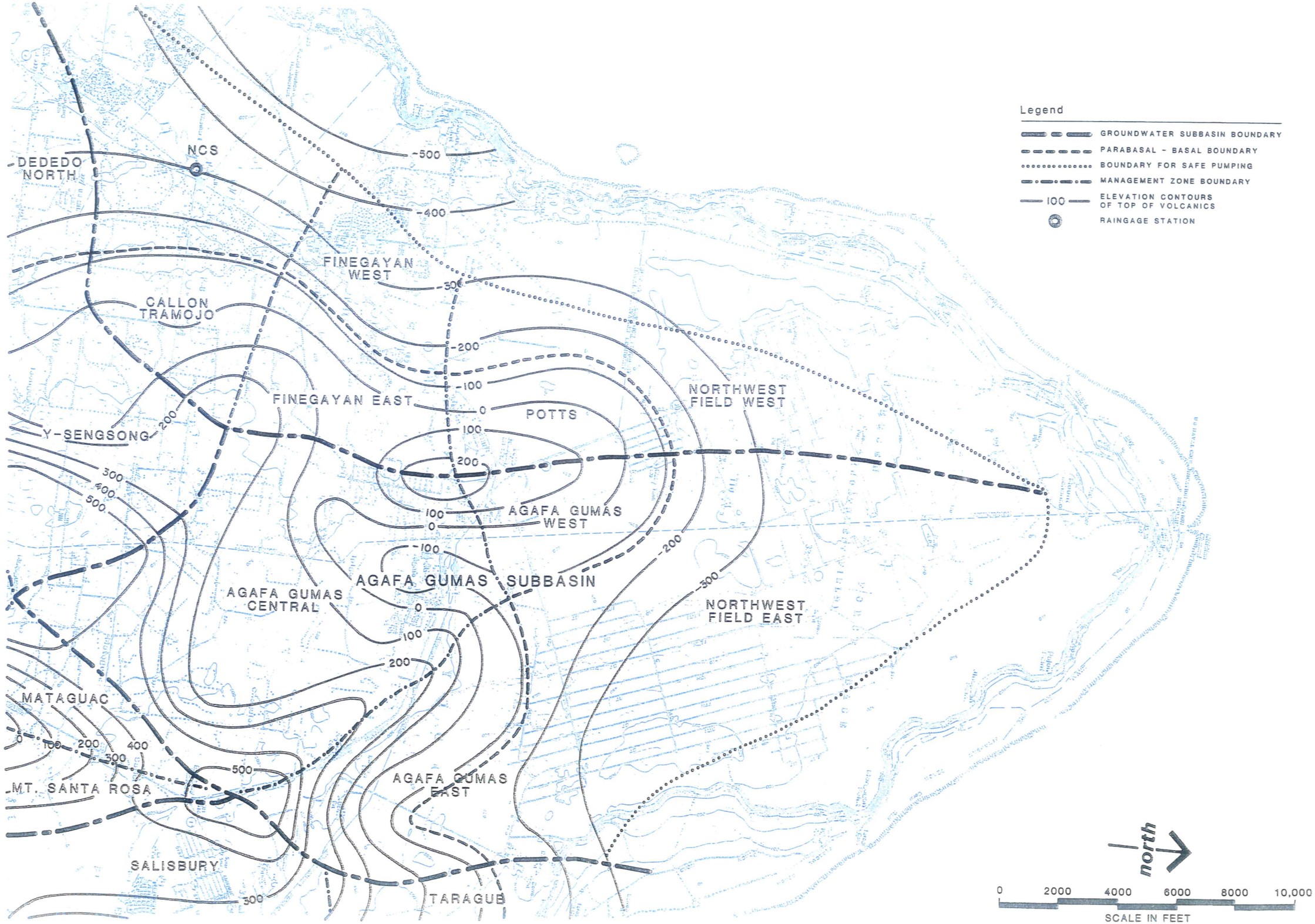
- GROUNDWATER SUBBASIN BOUNDARY
- PARABASAL - BASAL BOUNDARY
- BOUNDARY FOR SAFE PUMPING
- MANAGEMENT ZONE BOUNDARY
- 100 — ELEVATION CONTOURS OF TOP OF VOLCANICS
- CONTACT BETWEEN LIMESTONE AND VOLCANICS
- SURFACE EXPOSURE OF VOLCANIC ROCKS
- RAINGAGE STATION

north

0 2000 4000 6000 8000 10,000

SCALE IN FEET

FIGURE 7-2 ANDERSEN SUBBASIN


Legend
GROUNDWATER SUBBASIN BOUNDARY
PARABASAL - BASAL BOUNDARY
BOUNDARY FOR SAFE PUMPING
MANAGEMENT ZONE BOUNDARY
100
ELEVATION CONTOURS OF TOP OF VOLCANICS
RAINGAGE STATION
DEDEDO NORTH
NCS
FINEGAYAN WEST
CALLON TRAMOJO
FINEGAYAN EAST
Y-SENGSONG
POTTS
NORTHWEST FIELD WEST
AGAFA GUMAS WEST
AGAFA GUMAS SUBBASIN
AGAFA GUMAS CENTRAL
NORTHWEST FIELD EAST
MATAGUAC
AGAFA GUMAS EAST
MT. SANTA ROSA
SALISBURY
TARAGUB
-500
-400
-300
-200
-100
0
100
200
300
400
500
north
0 2000 4000 6000 8000 10,000
SCALE IN FEET

THE PUBLIC UTILITY
AGENCY OF GUAM

Final Engineering Report

GROUNDWATER IN NORTHERN GUAM
Sustainable Yield and Ground Water Development

Prepared By

BARRETT CONSULTING GROUP
AGANA, GUAM

In Association With
JOHN F. MINK

GROUNDWATER IN NORTHERN GUAM

Sustainable Yield and Ground Water Development

Final Engineering Report

Prepared For The

GOVERNMENT OF GUAM

PUBLIC UTILITY AGENCY OF GUAM

DECEMBER 1991

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Civil and Environmental Engineers

December 30, 1991

Mr. Joseph F. Mesa
Chief Officer
Public Utility Agency of Guam
Government of Guam
P.O. Box 3010
Agana, Guam 96910

Mr. Mesa:

In accordance with our engineering agreement dated September 24, 1990, we are pleased to submit, herewith, the final engineering report, *Groundwater In Northern Guam: Sustainable Yield and Groundwater Development*. The report represents the reevaluation by Hydrological Consultant, John F. Mink and our staff of the Northern Lens groundwater supply and proposes an overall well development program to increase the people of Guam's access to this resource.

The report presents a new basis for estimating the sustainable yield of the Northern Lens that differs significantly from the approach first applied in the 1982 *Northern Guam Lens Study* and currently used to regulate Guam's groundwater development. The proposed well development program is intended to optimize the development of groundwater resources based on this new analysis of the Northern Lens's sustainable yield and hydrodynamics.

We would like to thank PUAG, the many Government of Guam and Federal agencies whose cooperation and assistance made this report possible.

Very truly yours,

BARRETT CONSULTING GROUP

Edwin C. Pier, P.E.
Project Manager

Felix B. Limtiaco, P.E.
Principal-In-Charge

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CHAPTER I
EXECUTIVE SUMMARY

OBJECTIVES

The rapid increase in development and tourist population on the Island of Guam in recent years has resulted in a corresponding demand for infrastructure improvements and expansion. As a first step toward meeting some of these demands and anticipating the Island's future needs, the Public Utility Agency of Guam (PUAG) has initiated a number of water system improvement projects funded under the $53 million Capital Improvements Revenue Bond. A key factor in designing the projects, and in coordinating their implementation, is knowing how much water supply is available for development and where it is located. The groundwater of Guam's Northern Lens is known to be the most economically accessible water supply available. However, the bases for characterizing the Lens' behavior and estimating its sustainable yield by government regulatory agencies are dated. As a consequence, estimates of available water supply appear to be overly conservative and regulation of its development unnecessarily restrictive.

The objective of this report is to provide an updated estimate of the sustainable yield of Guam's Northern Groundwater Lens and a new program for well development. The update of the Lens' yield and hydrodynamics is based on the evaluation of available data obtained from well construction and monitoring conducted over the last ten years in addition to recent Time Domain Electromagnetic (TDEM) surveys.

CONCLUSIONS

Evaluation of well construction and monitoring data collected over the last ten years leads to two significant conclusions. The first is that, due to the significant effects of seasonal changes on Guam's groundwater system, transient analysis provides a more realistic model of the groundwater hydrodynamics than the static model available for the *Northern Guam Lens Study (NGLS)* ten years ago. The second conclusion is that Guam's northern aquifer is a much more continuous system than implied by the system of discrete management zones proposed by the *NGLS* and presently being used in regulating groundwater development.

As a consequence of these two conclusions, it now appears that the sustainable yield of the Northern Lens, *available to civilian development*, may be about 60 million gallons per day (mgd). Of this amount approximately 25 mgd is already being withdrawn by PUAG and private wells. An additional 35 mgd therefore remains to be developed.

RECOMMENDATIONS

A summary of the report's recommendations follows. A recommended program for overall groundwater development is discussed more thoroughly in Chapter V.

1. The arbitrary system of discrete groundwater management zones presented in the *NGLS* and currently used to regulate groundwater development should be replaced with the concept of Aquifer Systems proposed in this report. The estimated sustainable yield of these systems should be revised continually in light of data obtained from ongoing well development and monitoring.

2. The primary recommendation is that the unused portion of the sustainable yield be developed in two increments. The first priority increment would be for a total of approximately 10 mgd from the Agafo Gumas, Yigo, Tumon, Gugagon and Ordot Aquifer Systems. The second priority increment would be for a total of approximately 5 mgd from the Mt. Santa Rosa, Sasajyan, Huchuanao and Mongmong Aquifer Systems. The results derived from the development of the first 15 mgd will then determine the next set of priorities.

3. Redevelopment of existing wells must take place on a case specific basis in response to actual conditions resulting from the increased production proposed in increments 1 and 2.

4. The conclusions, based on dynamic transient modeling and analysis of well data obtained since the *NGLS* was completed, strongly indicate that an update of the *NGLS* "Aquifer Yield Report" and groundwater management techniques are in order. Such an update would require a breadth of testing, modeling and analysis that is beyond the scope of this contract.

CHAPTER II
INTRODUCTION

BACKGROUND

Groundwater in Northern Guam has been talked about, studied and evaluated as a premier water resource since 1937 when H.T. Stearns of the U.S. Geological Survey conducted a reconnaissance survey for the U.S. Navy. After World War II the Survey expanded efforts to full fledged geological mapping which became the basis for improved comprehension of the groundwater potential. Consulting engineers contributed to the solution of specific problems, then in 1976 J.F. Mink summarized existing data and wrote an evaluation report for PUAG. The most comprehensive study of Northern Guam's water resources was made several years later and is commonly referred to as the *NGLS (Northern Guam Lens Study)*.

The *NGLS* organized and evaluated existing hydrologic data, made analyses relevant to groundwater production, and subdivided all of Northern Guam into Sub-Basins and Management Zones. This classification forms the basis of Guam Environmental Protection Agency (GEPA) management decisions about the expansion of groundwater development.

In the *NGLS* only 67 square miles of the total of 100 square miles in Northern Guam were considered favorable for the production of potable water. This production area was divided into 47 Management Zones, each having an average area of somewhat more than one square mile. The outlines of the zones reflect hydrogeological and topographic features but each is too small to be uniquely identified by these parameters. Strict adherence to a Zone as a management unit inhibits flexibility in taking advantage of groundwater conditions.

To allow managers more latitude in initiating new groundwater developments and in revising existing ones, an aquifer classification scheme similar to but less restrictive than that in the *NGLS* is proposed and will be explained later. The proposed divisions are congruent with the existing ones but are fewer in number.

The methodology employed to arrive at values for sustainable yield (SY) differs in important respects from that depended upon in the *NGLS*, especially in using groundwater flow computer simulations as the fundamental tool for allocating sustainable yield. In the *NGLS*, global hydrologic budgeting, not constrained by groundwater hydraulics, was the method employed. Although a groundwater hydraulics model depends on a water balance for values of recharge, sustainable yield is derived from the dynamic model rather than assigned a value as an arbitrary fraction of recharge. A review and discussion of hydrologic budgeting in Northern Guam is included as an Appendix to this report.

CHAPTER III
AQUIFER CLASSIFICATION

The proposed division of Northern Guam into aquifer categories follows the methodology derived for Hawaii and other Pacific Islands. The divisional hierarchy starts with the Aquifer Sector, which is divided into Aquifer Systems, which in turn are subdivided into Aquifer Types. At this stage only the Sectors and Systems have been identified for Northern Guam.

An Aquifer Sector is a region within which exist similar hydrologic and geologic features and in which the direction of groundwater flow is to the same general discharge line (i.e., Pacific Ocean; Philippine Sea). A Sector incorporates one or more Aquifer Systems. In an Aquifer System hydraulic continuity exists among all groundwater components (e.g., parabasal; basal). The Aquifer Type (not defined in this report) describes specific hydrogeologic conditions of divisions within an Aquifer System.

In all instances the Aquifer Sectors correspond to the Sub-Basins of the *NGLS*, but the Agana Sub-Basin is further divided into the Agana and Fadian Aquifer Sectors to reflect the direction of groundwater flow (Agana Sector to the Philippine Sea; Fadian Sector to the Pacific Ocean). Aquifer Systems embrace a group of Management Zones. A System is a more flexible division for allocating water development than the much smaller Management Zone. System boundaries depend on geology (e.g., argillaceous versus clean limestone), basement configuration, groundwater accumulation and groundwater flow direction. Figure 3-1, located at the end of this report, is a map showing Sectors and Systems.

Correspondence between the *NGLS* divisions and the proposed classification is presented in Table 3-1.

TABLE 3-1
NGLS AND PROPOSED AQUIFER CLASSIFICATIONS

Aquifer Sector	*NGLS* Sub-Div.	Aquifer System	*NGLS* Mgmt. Zones
Agana	Agana	Ordot	Chalan Pago, Nimitz Hill, Anigua
		Mongmong	Toto, Agana Swamp
		Barrigada	Mt. Barrigada South, Barrigada
Fadian	Agana	Sabana Maagas	Sabana Maagas
Mangilao	Mangilao	Sasajyan	Mangilao South, Mangilao North, Adacao, Asbeco, Taguan, Sasajyan
		Pagat	Sabana Pagat, Janum
Pati	Andersen	Mt. Santa Rosa	Salisbury (1/4), Lupog
		Andersen	Salisbury (3/4), Tarague, Anao
Tarague	Agafo Gumas	Agafo Gumas	Agafo Gumas Central
		Northwest Field	Agafo Gumas West, Agafo gumas East, NW Field East
Finegayan	Finegayan	Gugagon	Callon Tramojo, Finegayan East, Potts
		Haputo	NW Field West, Finegayan West, NCS
Yigo-Tumon	Yigo	Yigo	Marbo South, Yigo East, Yigo West, Marbo North, Mt. Santa Rosa, Mataguac
		Tumon	Mt. Barrigada West Mogfog, Ysengsong, Dededo North, Dededo South, Macheche, Asatdos

CHAPTER IV
SUSTAINABLE YIELD

SUSTAINABLE YIELD BY AQUIFER SYSTEMS

Included in the Appendix of this report (see p. A-7) is a discussion of sustainable yield and its derivation by a steady state model. Although the steady state provides a useful estimate of sustainable yield, it is based on timeless averages and therefore does not capture the profound role the seasons play in dewatering and replenishing the basal lenses. A steady state model is relatively simple to construct, while a transient model, which was developed subsequent to the application of the steady model, is considerably more difficult.

Determination of sustainable yield based on steady state equations for a given equilibrium head assumes average recharge and draft in combination with an initial head in the system before the commencement of pumping. This approach fits a situation where aquifers are very large and are sustained by uniform flux, such as is the case in the voluminous basal aquifers of southern Oahu, Hawaii. In Northern Guam, however, recharge is seasonal. Although the volumes of water in the basal lenses are large, dewatering during the dry season significantly affects storage causing a noticeable decline in head, while during the wet season recharge is great and results in sharp head recovery.

Seasonable changes in head can be simulated by a computer model employing the transient equations from which the steady state equations discussed above are derived. Initial conditions for head and volume of water in storage are required, and average draft and recharge must be assigned over a time interval. Based on the *NGLS*, the initial head for the basal aquifers of Northern Guam is taken as 3.0 or 3.5 feet, depending on the Aquifer System being modeled. Initial volume is calculated assuming a porosity of 10 percent, and the time interval is the month. The least sensitive parameter is initial volume.

For each simulation monthly draft is assumed to be constant. In fact, pumpage in Northern Guam is nearly uniform throughout the year at about 25 mgd. Recharge is calculated from

average monthly rainfall minus evapotranspiration. Evapotranspiration is assigned a value of 3.3 inches in each month rainfall exceeds 5 inches, and a value of 0.73 times rainfall in those months (January through June) having less than 5 inches. The evapotranspiration values are estimates derived from water balances used in Hawaii.

Total average evapotranspiration for the year amounts to 35.3 inches, which is about half the pan evaporation rate. It is a realistic value which reflects the lack of opportunity for plants to have a continuous supply of moisture when rainfall is light or intermittent.

Total annual recharge is calculated as 53 inches, or about 60 percent of rainfall. This ratio is consistent with the probable hydrologic budget posed by Mink in the 1976 report to PUAG (see Appendix, P. A-2) in which runoff is ignored. It is somewhat greater than that employed in the steady state model (Appendix, P. A-8) in which both recharge and evapotranspiration rates are taken as 45 inches per year. The values in the transient model are more liberal than those employed in the *NGLS* because they reflect the complexity of the hydrological environment in which atmospheric conditions vary strongly between seasons, and soils on limestone are thin and unable to store all rainfall needed to sustain continuous evapotranspiration. Infiltration into the highly permeable limestone surface is the sole escape for rainfall not consumed by plants. The values of rainfall, evapotranspiration and recharge are listed in Table 4-1.

In the steady state model, the whole of Northern Guam is lumped in the hydrological balances and annual averages are used for recharge and evapotranspiration, but in the transient model the balances are determined by month for each Aquifer System. The transient model accounts for groundwater behavior from discharge at the coastline inland to either the emergence of the basement above sea level or a groundwater divide. In a hydraulic model the aquifers can't be separated into non-productive coastal zones and inland producing zones as was done in the *NGLS*. Groundwater is continuous and active, whether recharge or pumping, at one point causes a reaction at all other points.

TABLE 4-1
NORTHERN GUAM AVERAGE WATER BALANCE

Month	Rain (in.)	Ev. Tran. (in.)	Recharge (in.)
Jan	4.63	3.38	1.25
Feb	2.65	1.94	0.71
Mar	1.91	1.39	0.52
Apr	3.11	2.27	0.84
May	4.39	3.21	1.18
Jun	5.22	3.30	1.92
Jul	8.88	3.30	5.58
Aug	13.89	3.30	10.59
Sept	15.19	3.30	11.89
Oct	13.47	3.30	10.17
Nov	9.36	3.30	6.06
Dec	5.86	3.30	2.56
Annual	**88.6**	**35.3**	**53.3**

Under current average draft of 25 mgd and average conditions of rainfall, head decays during the dry season by as much as 0.5 feet, then recovers to its previous maximum during the wet season. From July through November an extraordinary volume of recharge takes place, replenishing the lens and causing a sharp increase in head.

The wet season in Guam is highly reliable. During the average five month season a total of 62.8 inches of rain falls, about 70 percent of the annual total. In the lowest wet season on record, 1973, a total of 45.2 inches fell, and in the next driest, 1966, the total was 54.6 inches. Even at these minimums substantial recharge takes place, returning head to its normal maximum.

The recoverability of the basal lenses is clearly manifested in the return of head to its annual high by October, the height of the wet season. Normally head starts to decline in December and January, sometimes as early as November, and reaches its minimum in June. The difference

between the maximum and minimum heads at current draft in the principal basal lenses is 0.3 to 0.5 feet.

SALINITY-DEPTH RELATIONSHIP TO STORAGE HEAD

An even stronger manifestation of the stability of the basal lens under current operations is provided by the salinity-depth curves computed from data compiled by the U.S.G.S from monitor wells in Northern Guam starting in 1982. In a Ghyben-Herzberg lens the 40:1 ratio (40 feet of fresh water below sea level to every 1 foot above) actually applies to the depth below sea level of the middle of the transition zone, or the 50 percent sea water isochlor. Water in the lens may be fresh or brackish, but ordinarily the lens consists of a fresh water core (FWC) followed by brackish water constituting the upper limb of the transition zone (TZ). The depth of the lens water to the 50 percent isochlor is exactly 40 feet for every foot the water table stands above sea level. Below the fresh water core, the concentration versus depth curve is symmetric around the transition zone midpoint.

The midpoint rises and falls with the volume of storage in the lens. In order to depress the water table by one foot the midpoint would have to rise 40 feet. Quite obviously the midpoint is a more reliable indicator of head and volume of water in the lens than water table fluctuations. Water table measurements reflect transient perturbations, including variable recharge and pumping, which are muted or canceled before influencing the midpoint. The transition zone adjusts to long term trends rather than to the instantaneous disturbances that affect the water table.

The most reliable representation of "storage" head, defined as the head dependent on the volume of water stored in the lens, is obtained by dividing the depth below sea level to the midpoint by 40. Storage head calculated in this way is independent of broad seasonal variations in sea level because the entire lens moves in unison in response to global sea changes. Storage head as the parameter defining the status of the lens is superior to water table measurements, but monitor wells drilled through the lens are required to obtain salinity-depth curves. As a project of the *NGLS* a number of such wells were drilled, four of which continue to provide essential information about the magnitude of the lens where each is located.

Figure 4-1 is a plot of storage heads for monitor wells EX-6, EX-7, EX-10 and Ghura Dededo, all of which are located in the basal lens of the Yigo-Tumon Aquifer System. The aquifer consists of clean limestone and therefore is highly permeable. Consequently heads are less than 4.0 feet.

Storage head changes since 1982 have varied by about 0.3 feet, equivalent to a rise or fall of 12 feet at the midpoint, except at EX-7 where the data is inconsistent with the stability of the other wells. No permanent downward trend in storage head is detectable, even though lows were reached in 1984-86 at EX-6 and EX-10. Both recovered by 1988, then declined again in 1989. The midpoint of the transition zone has been remarkably stable, indicating that the present Aquifer System draft of about 11 mgd has not affected the volume of groundwater in the lens.

Figure 4-2 shows storage heads at EX-1 (Mongmong Aquifer System) and EX-4 (Fadian Aquifer System). Both wells are driven in argillaceous limestone where the hydraulic conductivity is far less than in the clean limestone of Yigo-Tumon. Storage heads are higher as a result. Water table movements in these wells may range over one foot in a year, but storage heads are stable, suggesting little impact as a result of current draft.

Figure 4-3 is a plot of storage head at EX-8 (Tarague Aquifer System) for the available data set and at EX-9 (Agana Aquifer System). These wells, like the ones in Yigo-Tumon, are in high permeability limestone. Storage heads vary over a small range but do not display a trend.

SUSTAINABLE YIELD DETERMINED BY TRANSIENT SIMULATION

In order to test the aquifer's response to draft over time, model runs were made for two Aquifer Sectors and one Aquifer System: Yigo-Tumon Aquifer Sector; Finegayan Aquifer Sector and Ordot Aquifer System. In Yigo-Tumon and Finegayan the simulations represent behavior of the basal lenses; in Ordot parabasal water is considered.

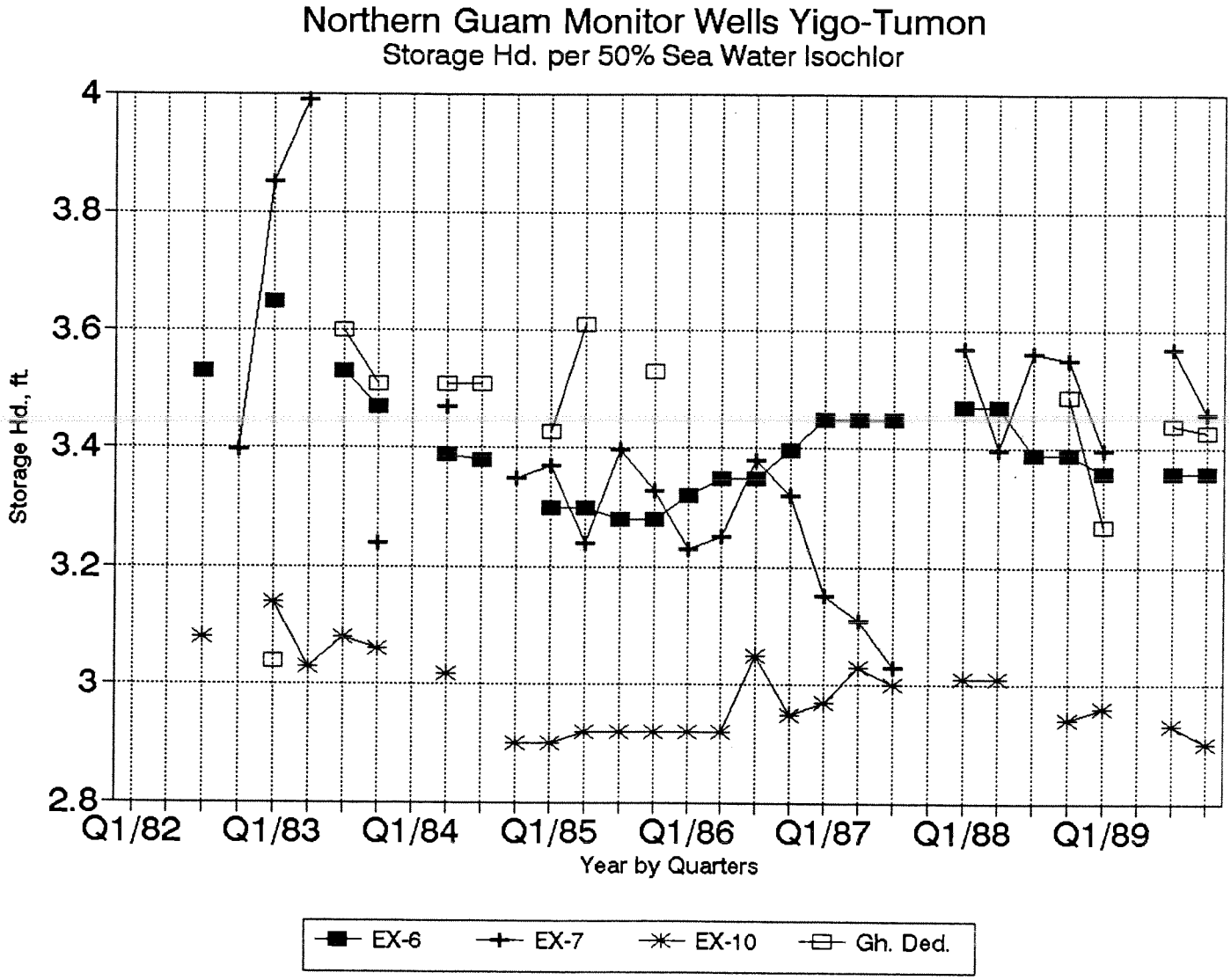


Figure 4-1
Northern Guam
Monitor Wells
Yigo-Tumon

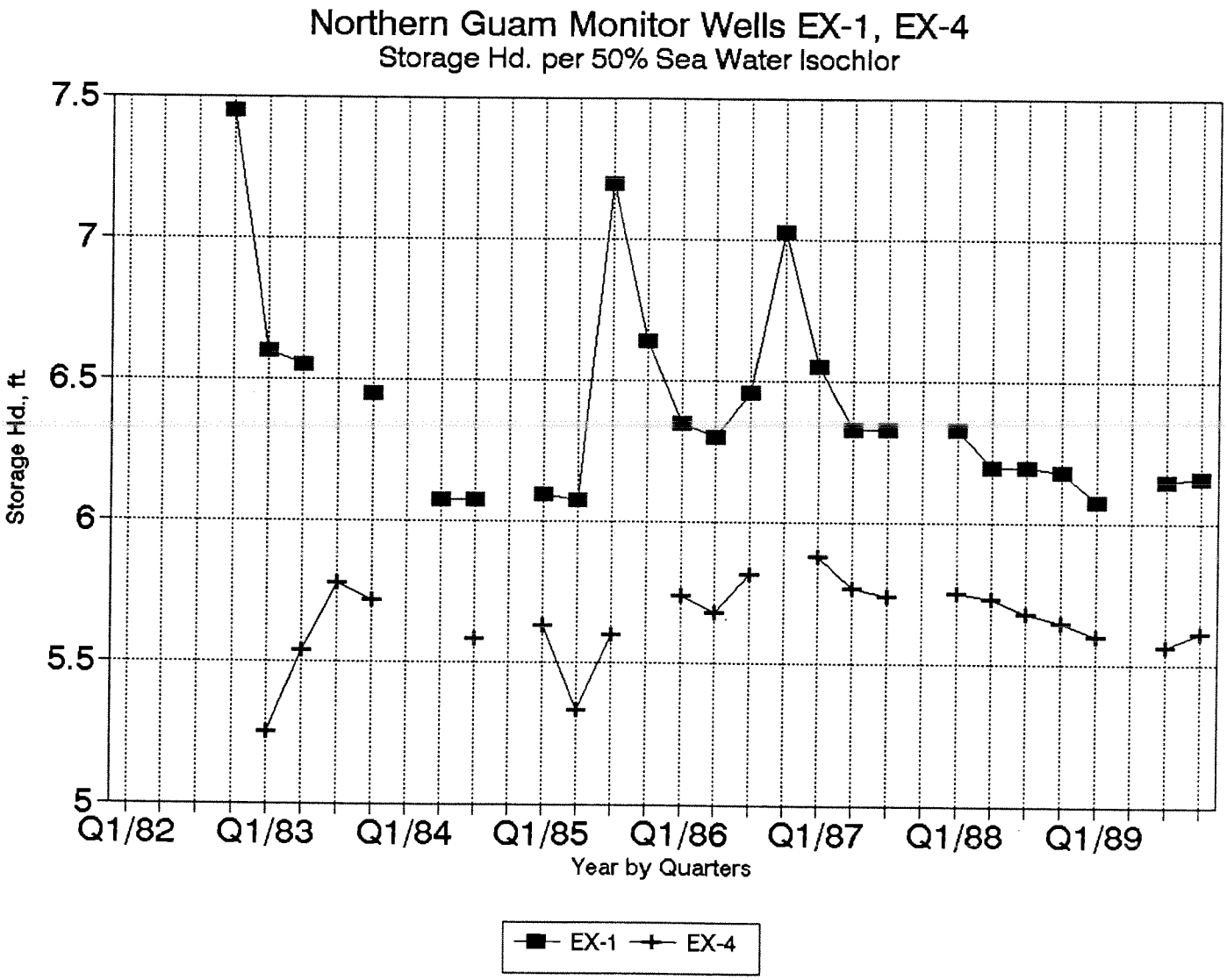


Figure 4-2
Northern Guam
Monitor Wells
EX-1, EX-4

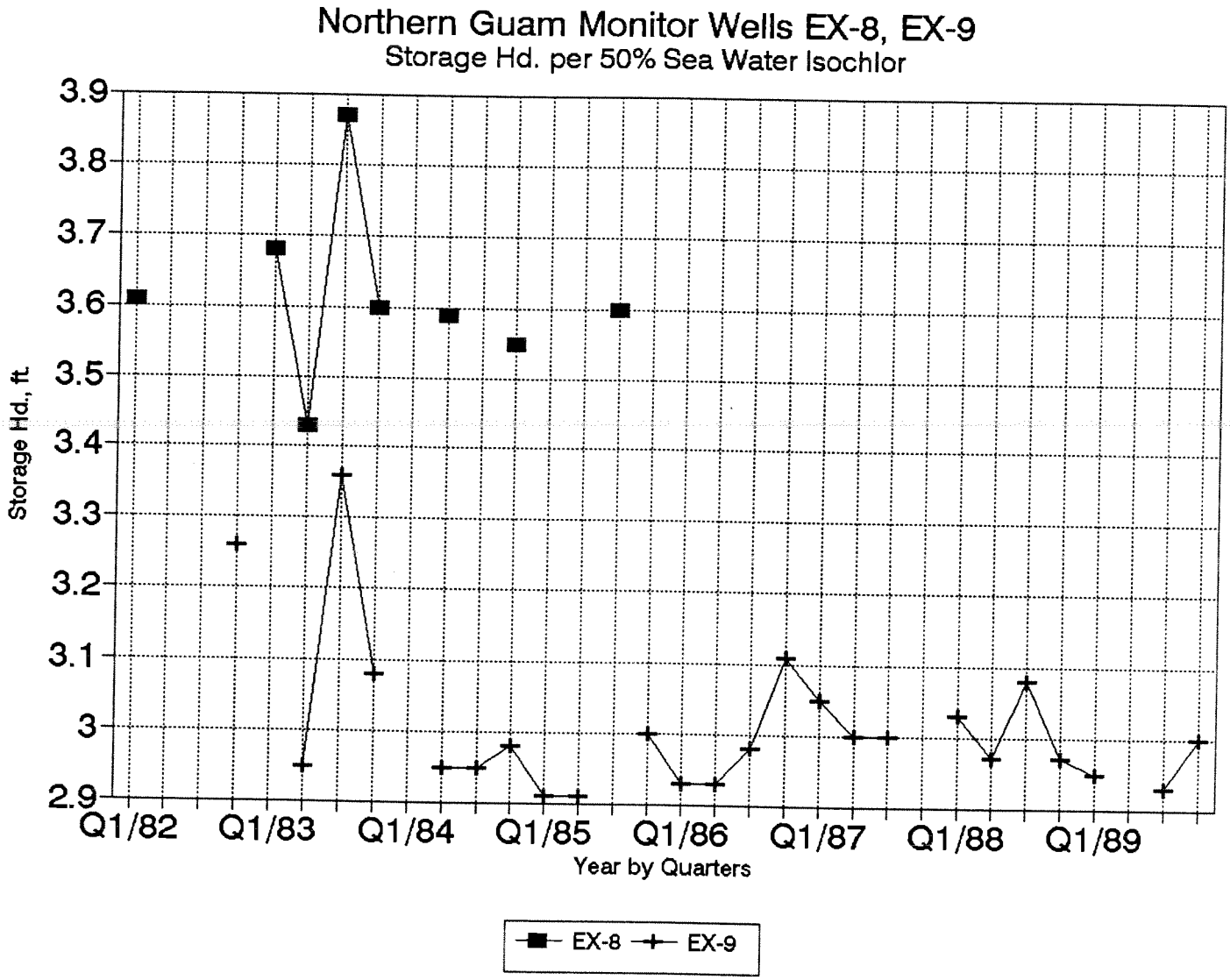


Figure 4-3
Northern Guam
Monitor Wells
EX-8, EX-9

The simulations were transient rather than steady state and are for a 12 year period at different levels of continuous average draft. The cyclical curve of head as a function of time refers to storage head. The graphs of head changes are given in Figures 4-4 through 4-7.Transient simulations do not yield single values for sustainable yield nor, for that matter, do steady state solutions. This is because sustainable yield is dependent on seasonal head change in the transient case and equilibrium head in the steady state case. A judgement must be made about an acceptable head variation for the transient simulation and a safe equilibrium head for the steady state. The annual head change or equilibrium head selected must preserve the quality and quantity of the pumped water for the given continuous average draft.

Figure 4-4 illustrates the transient case for the Finegayan Aquifer Sector. Starting with an initial head of 3.0 feet and monthly recharge rates based on Table 4-1, the head cycle for a variety of drafts to 20 mgd is simulated. As long as draft is less than recharge as an average, head will always be positive.

Head will recover each year just about to 3.0 feet if average draft is 6.0 mgd, and eventually to 2.75 feet if the average draft is 9 mgd. At a draft of 12 mgd the maximum head slips to 2.6 feet, at 15 mgd to 2.5 feet and at 20 mgd to 2.1 feet. The minimums are about 0.5 feet lower. Clearly it would be safe to pump 6 mgd from the Sector, and it is unlikely that a draft of 9 mgd would significantly affect the ability of the lens to supply good quality water. The recommended average draft is 9 mgd, but operational experience in the future may show that somewhat more draft would be allowable. The *NGLS* sustainable yield is 6.38 mgd; current draft is 3.2 mgd. An average draft of 9 mgd would account for 30 percent of the average annual recharge. The seasonal change in head is 0.5 feet.

In Yigo-Tumon the sustainable yield of 20 mgd also amounts to 30 percent of average annual recharge. The graph in Figure 4-5 indicates that for an initial head of 3.5 feet, full recovery from a seasonal low of 2.7 feet takes place every year when draft is 10 mgd or less. At 15 mgd the low head approaches 2.5 feet and recovery peaks at 3.4 feet, while at 20 mgd the dry season minimum drops to 2.4 feet and the wet season recovery rises to 3.2 feet. Current average draft in the Sector is 11 mgd; the *NGLS* sustainable yield is 19 mgd, about the same as the recommended value.

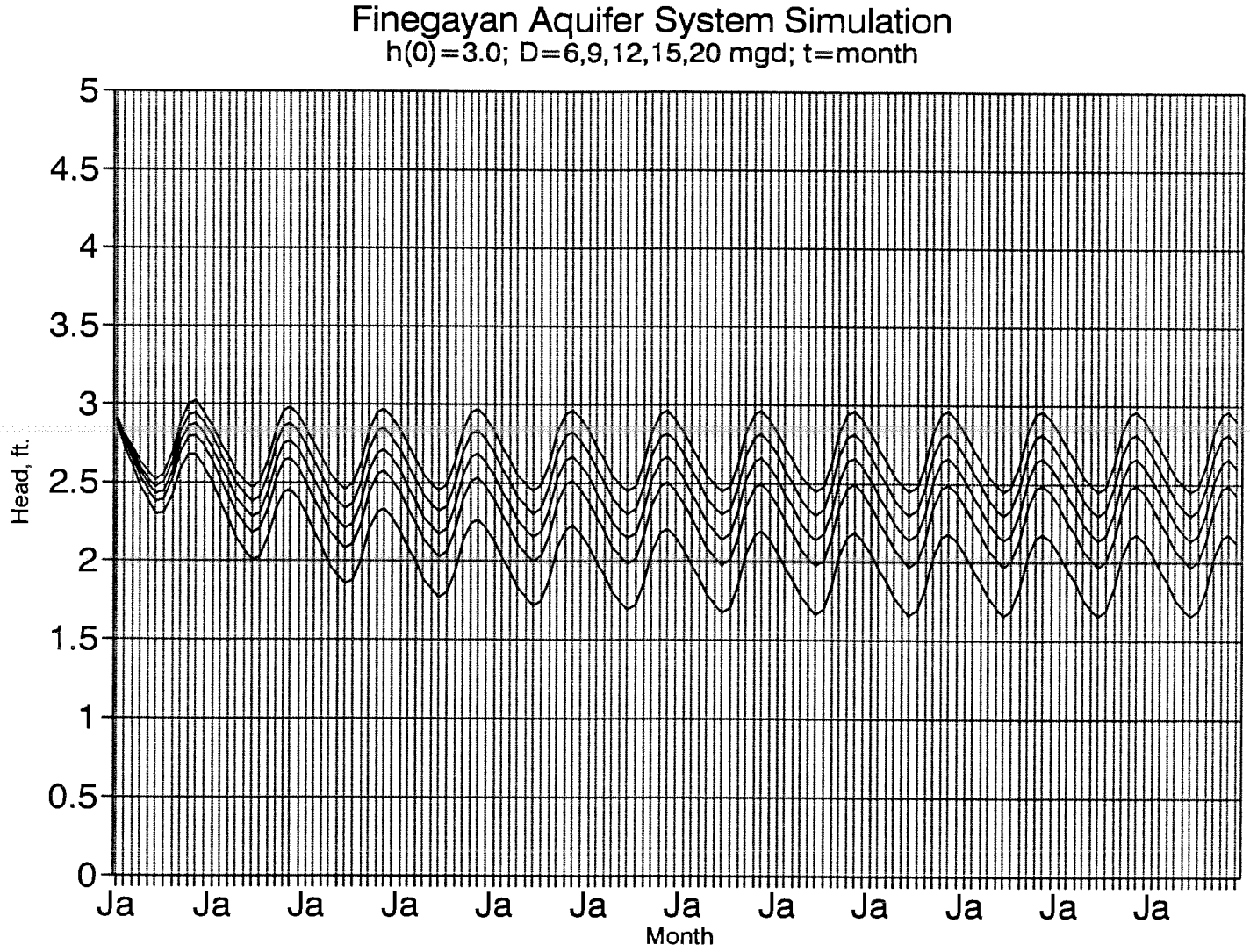


Figure 4-4
Finegayan System
Simulation

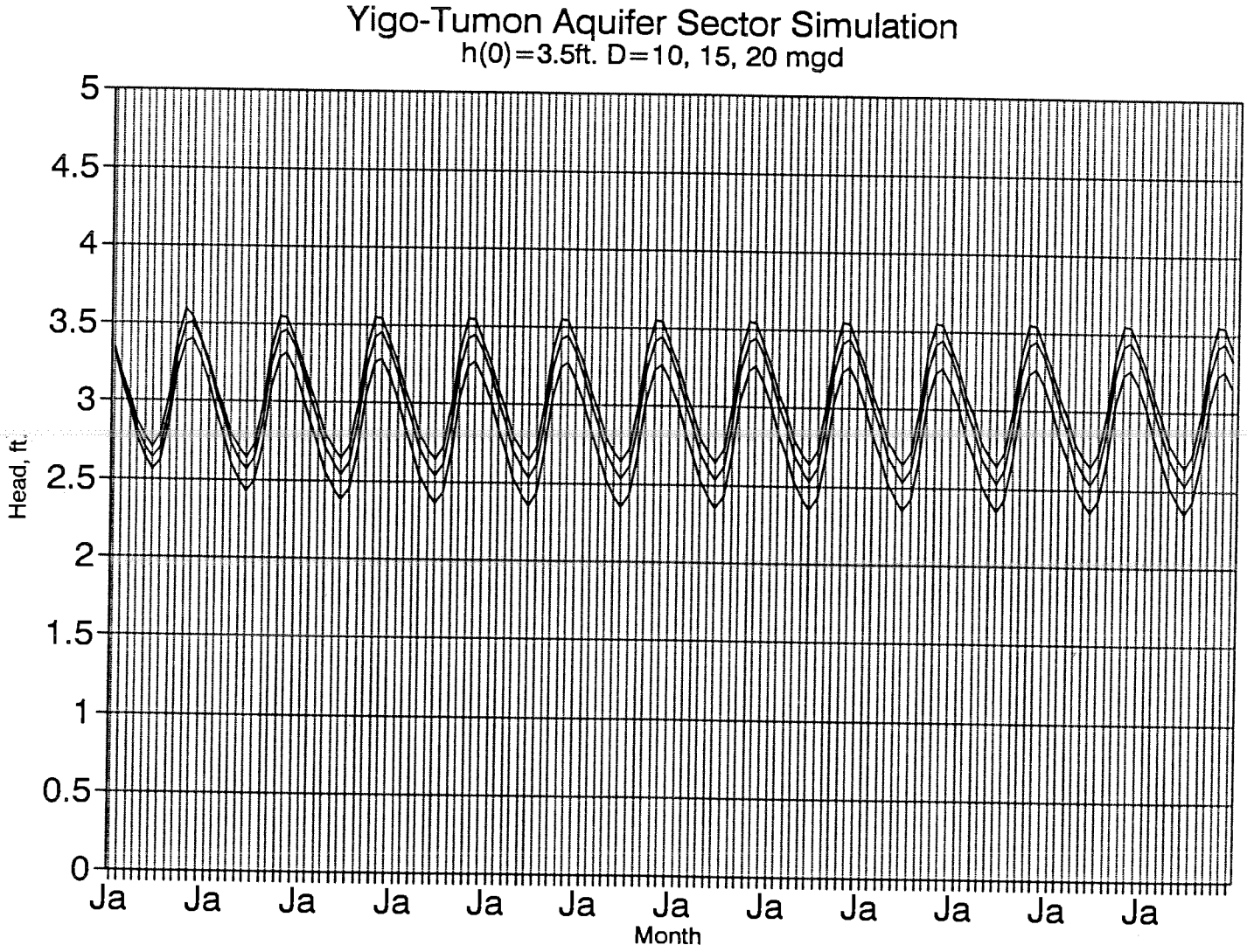


Figure 4-5
Yigo-Tumon Aquifer
Sector Simulation

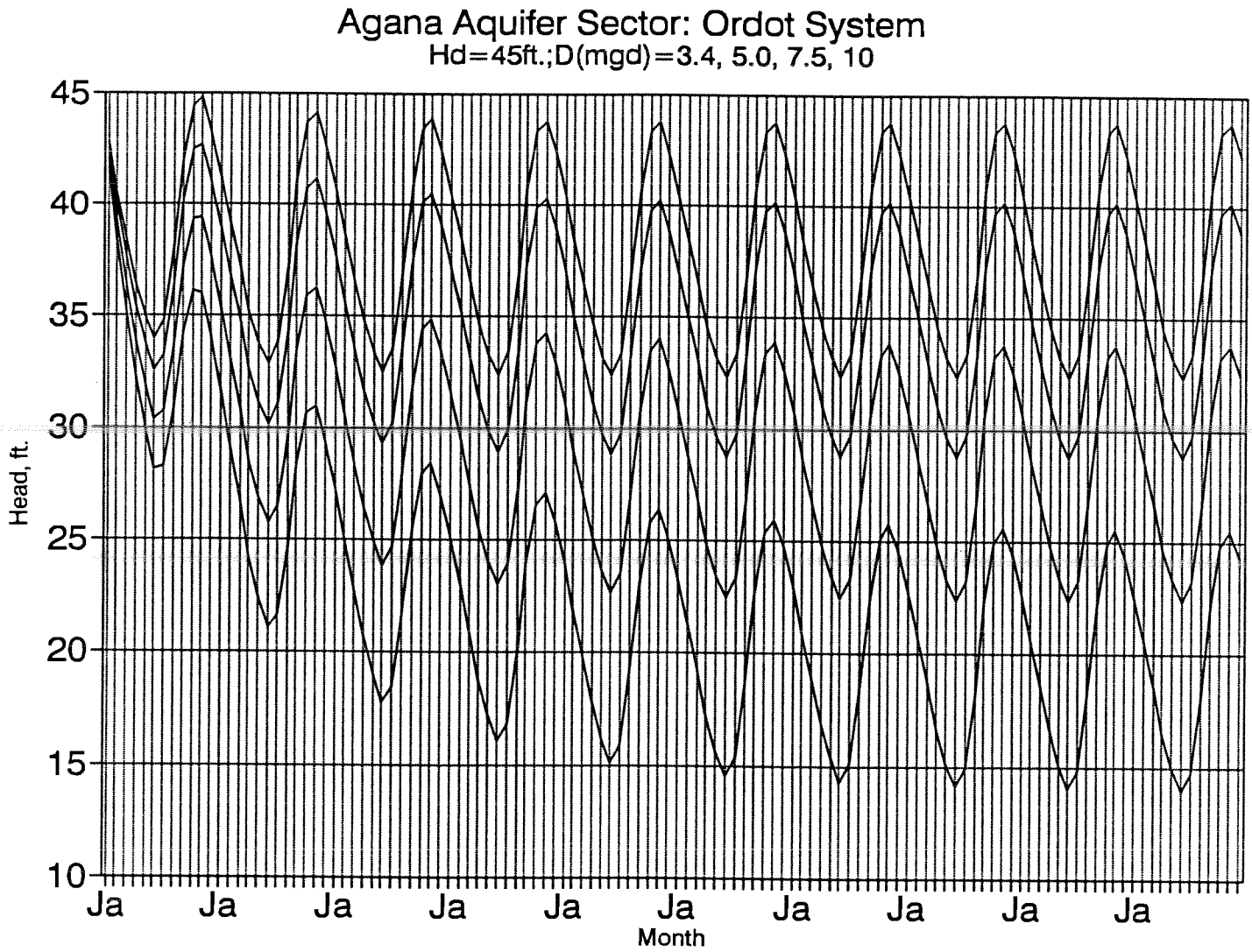


Figure 4-6
Agana Aquifer Sector:
Ordot System,
Hd = 45 Ft.

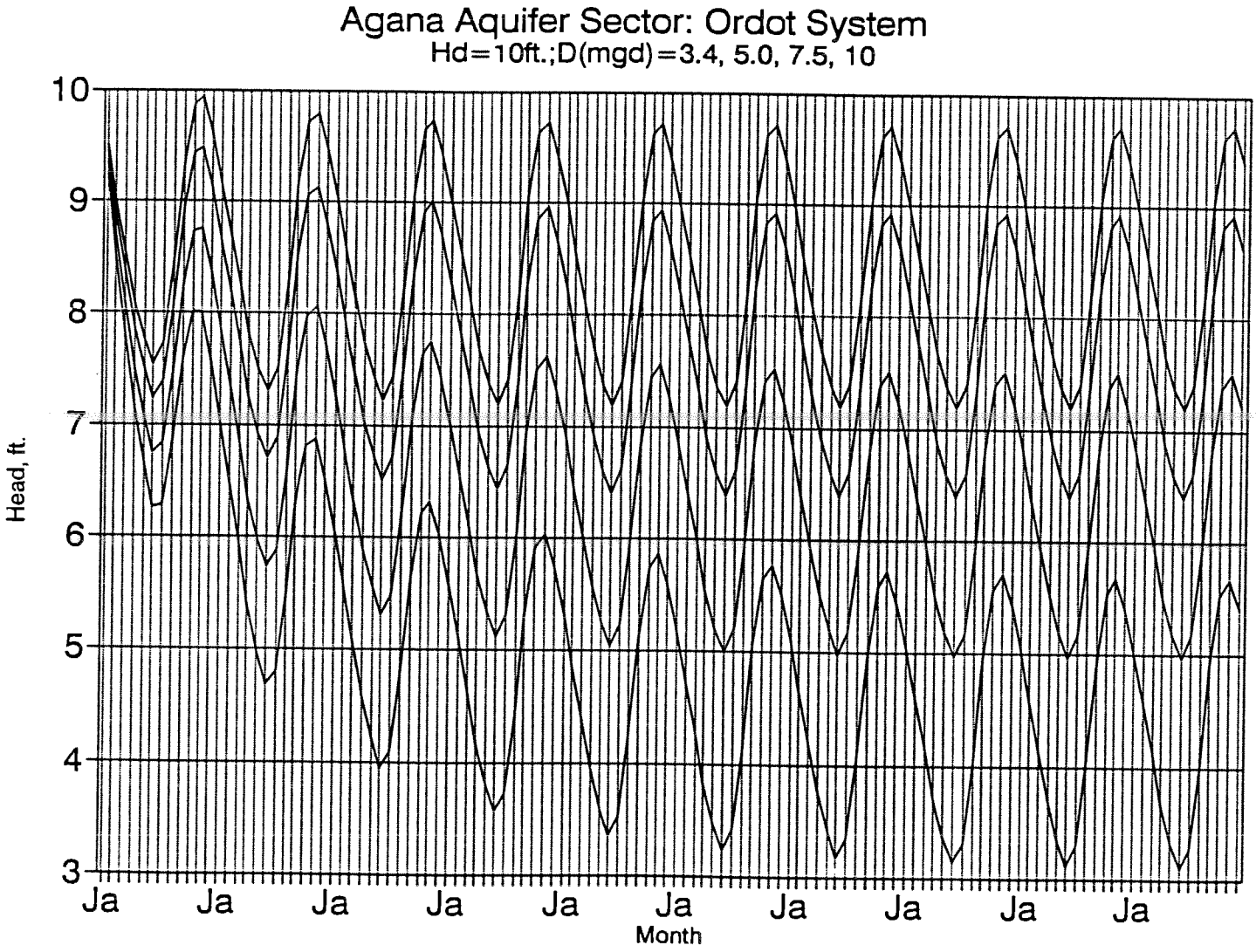


Figure 4-7
Agana Aquifer Sector:
Ordot System
Hd = 10 ft.

Simulation of the parabasal groundwater in the Ordot Aquifer System is given in Figure 4-6. The head at Well A-20 is used as an index because head there has been recorded continuously for the past decade. The initial head is taken as 45 feet. The simulated yearly range is 11 feet, which matches the actual record. Decay during the dry season is similar each year unless interrupted by unusual rains. The average cycle settles at a low head of 33 feet for the average current draft of 3.4 mgd; 29.5 feet for a draft of 5 mgd; 23 feet for a draft of 7.5 mgd; and 14.5 feet for a draft of 10 mgd. In every case the head recovers by 11 feet during the wet season.

Also plotted as an Ordot graph (Figure 4-7) is the simulation for a site having an initial head of 10 feet. Because the minimum head of parabasal water is 7 feet near the margin of Agana Marsh, the sustainable yield chosen must not result in heads that would induce sea water intrusion. The simulation depicts an annual variation in head of 2.5 feet, which is characteristic of parabasal conditions where the initial head is less than about 10 feet.

The recommended sustainable yield is 7.5 mgd because at this average draft the parabasal head would be preserved even at the edge of the Marsh. The recommended sustainable yield for this parabasal situation is equal to 60 percent of average annual recharge.

RECOMMENDED AVERAGE DRAFT BY AQUIFER SECTORS AND SYSTEMS

Table 4-2, located at the end of this Chapter, summarizes the sustainable yields proposed for each Aquifer Sector and System. The model simulations for Yigo-Tumon and Finegayan Aquifer Sectors indicate that sustainable yield for a basal lens is equal to about 30 percent of recharge. This fraction is employed elsewhere in Northern Guam where basal conditions exist.

In the *NGLS* a factor of 50 percent was used but it had no basis in hydraulic analysis. Similarity among the *NGLS* and currently computed sustainable values is coincidental rather than due to application of similar methodology. The *NGLS* values depend exclusively on a water budget and apply only to that portion of the island at some distance inland where groundwater is presumed to be fresh. The current approach to sustainable yield is wedded to groundwater hydraulics analysis supplemented by values for recharge obtained from a water balance. In this method an entire lens is treated as a continuum. The quality of pumped water is governed by location and

rate of draft. Where conditions are favorable, good water can be pumped very close to the discharge line of the lens along the coast.

Table 4-2 lists recommended sustainable yields as well as those given in the *NGLS* along with current draft. The table identifies the fraction of sustainable yield not accessible to PUAG because it is restricted to military lands. However, except in Andersen Field, where the flow path of groundwater from origin to discharge takes place in Federal property, virtually all sustainable yield can be accessed by PUAG.

The data in the table is arranged so that the Sub-basins and Management Zones of the *NGLS* correspond to the Aquifer Sectors and Systems in the proposed classification. Consistency in names for the divisions is preserved wherever possible to avoid confusion.

SUMMARY OF DRAFT AND SUSTAINABLE YIELD

The total sustainable yield for all of Northern Guam as stated in the *NGLS* is 57.44 mgd, while in the current study the recommended value for the transient model is 80 mgd and for the steady state model, 70 mgd. In the *NGLS* sustainable yield was calculated as equal to one half the average infiltration determined by hydrologic budgeting for regions lying several thousand inland of the coast. For the current evaluations the entire Northern Guam complex of aquifers, embracing 100 square miles, is considered in the hydraulic model. The complex linkage among recharge, groundwater accumulation and flow, and groundwater extraction can't be arbitrarily limited to the region of putative potable water. The entire flow system is involved.

Not all of the 80 mgd (transient model) is available to PUAG. Development of about 20 mgd falls within Federal property, leaving a total of 60 mgd accessible to PUAG. Current total draft in Northern Guam is 25 mgd (1989), and thus PUAG can add another 35 mgd to its system under prevailing conditions of land control and water development.

Additional opportunities for groundwater development available to PUAG by Aquifer Sector and System along with comments about the ease of obtaining potable water are presented in Table 4-3.

TABLE 4-2
SUSTAINABLE YIELD
AQUIFER SYSTEMS; *NGLS* MANAGEMENT ZONES: (mgd)

Sector	System	*NGLS* SB	*NGLS* MZ	*NGLS* SY	Rev. SY	Nonfed. SY	Draft (89)	Unused SY
Agana	Ordot	Agana	Chalan Pago	1.24			1.65	
			Nimitz Hill	2.17			1.74	
			Anigua	1.17			0	
			Total	4.58	7.5	7.5	3.39	4.1
	Mongmong		Toto	0.62			0.02	
			Agana Swamp	1.25			0	
			Total	1.87	2.8	2.8	0.02	2.8
	Barrigada		Mt. Barrigada South	0.30			0	
			Barrigada	0.37			0	
			Coastal	0.45			0.99	
			Total	1.12	3.0	3.0	0.99	2.0
			TOTAL	**7.57**	**13.3**	**13.3**	**4.4**	**8.9**
Fadian	Sabana Maagas		Sabana Maagas	1.73	3.0	3.0	1.89	1.1
	Huchunao		Manaca	1.67			0.15	
			Mt. Barrigada East	0.73			0	
			Total	2.40	4.2	4.2	0.15	4.0
			TOTAL	**4.13**	**7.2**	**7.2**	**2.04**	**5.1**
Mangilao	Sasajyan	Mangilao	Mangilao South	0.32			0	
			Mangilao North	0.42			1.01	
			Adacao	0.95			0.19	
			Asbeco	0.33			0	
			Taguan	0.30			0.62	
			Sasajyan	0.13			0	
			Total	2.45	3.3	3.3	1.82	1.5
	Pagat		Sabanan Pagat	0.79			0	
			Janum	0.66			0	
			Total	1.45	(3.3)	0	0	0
			TOTAL	**3.90**			**1.82**	**1.5**

TABLE 4-2
SUSTAINABLE YIELD
AQUIFER SYSTEMS; *NGLS* MANAGEMENT ZONES: (mgd)

Sector	System	*NGLS* SB	*NGLS* MZ	*NGLS* SY	Rev. SY	Nonfed. SY	Draft (89)	Unused SY
Pati	Mt. Santa Rosa	Andersen	Salisbury (1/4)	0.71			0	
			Lupog	1.46			0.01	
			Total	2.17	2.3	2.3	0.01	2.3
	Andersen		Salisbury (3/4)	2.14			0	
			Tarague	1.02			0	
			Anao	0.35			0	
			Andersen	0.56			0	
			Total			0	0	0
			TOTAL	**6.24**	**(9.8)**	**2.3**	**0.01**	**2.3**
Tarague	Agafo Gumas	Agafo Gumas	Agafo Gumas Central	4.20	5.0	5.0	0.54	4.5
	Northwest Field		Agafo Gumas West	0.86			0	
			Agafo Gumas East	1.63			0	
			Northwest Field East	3.40			0	
			Total	5.89	(7.0)	0	0	0
			TOTAL	**10.09**	**(12.0)**	**5.0**	**0.54**	**4.5**
Finegayan	Gugagon	Finegayan	Callon Tramojo	0.95			0.21	
			Finegayan East	1.09			0	
			Potts	0.86			0	
			Total	2.90	5.0	5.0	0.21	4.8
	Haputo		Northwest Field West	1.25			0	
			Finegayan West	0.63			2.07	
			NCS	1.60			0.72	
			Coastal				0.24	
			Total	3.48	(6.6)	4.0	3.03	1.0
			TOTAL	**6.38**	**11.6**	**9.0**	**3.2**	**5.8**

TABLE 4-2
SUSTAINABLE YIELD
AQUIFER SYSTEMS; *NGLS* MANAGEMENT ZONES: (mgd)

Sector	System	*NGLS* SB	*NGLS* MZ	*NGLS* SY	Rev. SY	Nonfed. SY	Draft (89)	Unused SY
Yigo-Tumon	Yigo	Yigo	Marbo South	0.65			0	
			Marbo North	0.35			0	
			Yigo East	1.08			1.05	
			Mt. Santa Rosa	0.76			0	
			Mataguac	0.88			0	
			Yigo West	1.90			1.75	
			Total	5.62	6.4	6.4	2.80	3.6
			Mt. Barrigada West	1.30			0	
			Mogfog	0.65			0	
			Ysengsong	3.00			0	
			Dededo North	1.93			1.63	
			Dededo South	3.46			5.92	
			Macheche	1.25			0	
			Asatdos	1.92			1.12	
			Coastal				1.34	
			Total	13.51	13.6	13.6	10.01	3.6
			TOTAL	**19.13**	**20.0**	**20.0**	**12.8**	**7.2**
			TOTAL			60.1	24.9	35.1

NOTES

Col.1 - Aquifer Sector: The Sector is the largest division in the proposed classification. A Sector is a region of geological and hydrological similarities.

Col.2 - Aquifer System: Each Sector contains one or more Systems. In an Aquifer System groundwater continuity exists throughout. Boundaries between Systems are related to hydrogeological features. Systems incorporate Management Zones of the *NGLS*.

Col.3 - *NGLS* Sub-Basin: The *NGLS* regional divisions corresponding to Sectors. The Agana Sub-Basin is divided into two Sectors (Agana and Fadian) along a boundary to the west of which groundwater flows toward Agana Marsh and the Philippine Sea and to the East to the Pacific Ocean. All other Sector boundaries are identical to Sub-Basin boundaries.

Col.4 - *NGLS* Management Zone: The smallest unit defined in the *NGLS*; currently the basis for allocating groundwater development. In the aquifer classification, Management Zones are subsumed in Aquifer Systems.

Col.5 - *NGLS* SY: The sustainable yield assigned to each Management Zone in the *NGLS*.

Col.6 - Revised SY: The sustainable yield derived for each Aquifer System by means of the transient simulation model. Parentheses around values means that not all of the sustainable yield is accessible by PUAG.

Col.7 - NonFed SY: Sustainable yield which is developable only in Federal lands and is presumed not accessible by PUAG.

Col.8 - Draft(89): Average 1989 pumpage by Management Zones, summed for each aquifer System.

Col.9 - Unused SY: The difference between Col.7 (NonFed SY) and Col.8 (Draft 89). The remaining undeveloped sustainable yield potentially available to PUAG.

TABLE 4-3
GROUNDWATER AVAILABILITY BY AQUIFER SYSTEM

Aquifer Sector	Aquifer System	Surplus SY (mgd)	Comments
Agana	Ordot	4.1	Parabasal; easy dev.
	Mongmong	2.8	Basal; salinity prob.
	Barrigada	2.0	Basal; salinity prob.
Fadian	Sabana Maagas	1.1	Basal; salinity prob.
	Huchunao	4.0	Basal.
Mangilao	Sasajyan	1.5	Para & basal; good.
	Pagat	0	Volc. Basement ASL
Pati	Mt. Santa Rosa	2.3	Para & basal; ?
	Andersen	0	Federal property
Tarague	Agafo Gumas	4.5	Parabasal; good.
	Northwest Field	0	Federal property
Finegayan	Gugagon	4.8	Para & basal
	Haputo	1.0	Basal.
Yigo-Tumon	Yigo	3.6	Para & basal
	Tumon	3.6	Basal
Total		**35.3**	

CHAPTER V
GROUNDWATER DEVELOPMENT PROGRAM

GROUNDWATER DEVELOPMENT PRACTICES

Sustainable yields are determined for aquifer systems assuming that the extraction of groundwater is accomplished optimally. For each site the extraction unit (generally a well) must be designed and outfitted to provide potable water continuously. In locations where head is low, for example, wells must not penetrate far below sea level and pump capacities need to be modest. Frequently the cost of a low capacity well will not justify drilling. Optimal wells in argillaceous limestone differ from those in clean limestone. The largest successful wells are drilled in parabasal aquifers.

These differences must be addressed when groundwater development is planned. They haven't been considered carefully in the past because a standard well for basal groundwater (depth below sea level 35 feet; pump capacity 200 gpm) generally behaved in an acceptable way. However, in order to safely take full advantage of potential sustainable yield many existing wells should be examined and tested, and for some, depth and capacity will have to be re-adjusted. Each new well will require specifications written especially for it. The standard model is no longer adequate.

FACTORS AFFECTING WELL DESIGN AND CONSTRUCTION

The standard design for a production well in Northern Guam emerged from experience with the first wells drilled for the Government of Guam in Dededo. Tests showed that 200 gpm could be pumped from a well driven 35 to 50 feet below sea level in the basal lens. Because most drilling at that time (between 1965-1975) was concentrated in Dededo, the 200 gpm well became standard for all of northern Guam.

The Dededo well field draws from an aquifer consisting of 'clean' limestone containing a basal lens having an average head of 3.0 to 3.5 feet. Clean limestone is defined as a fossil reef association in which clay is virtually absent. The clean limestones of Northern Guam are almost

pure calcium carbonate. These limestones are extremely permeable on a global scale. However, on the local scale of a well bore, low permeability parts of the formation may control groundwater hydraulics. Because of the high regional permeability, heads are low in spite of the strong flux of groundwater. The 200 gpm well proved to be the optimal unit for this modest head basal groundwater environment.

Parabasal groundwater also occurs in the clean limestones of Northern Guam. In this instance the aquifers allow for considerably higher well capacities to take advantage of the high permeabilities of the formations and the absence of sea water intrusion. Parabasal wells in Agafo Gumas and Yigo prove that clean limestone wells can yield as much as 700 gpm. Unless constrained by unfavorable local geology, parabasal groundwater in clean limestone is the most favorable environment in Guam for large capacity wells.

Not all of Northern Guam is underlain by clean limestone. About 14 square miles consist of argillaceous limestone of the Mariana formation. This area extends from the contact between the limestone of the north and the volcanics of the south to the 200 feet elevation topographic contour. The argillaceous limestone contains 5 to 10 percent clay intimately compounded with calcium carbonate along with lenses and pockets of clay interbedded in the limestone. The overall effect of the clay is to drastically reduce global permeability and to increase the probability of the occurrence of very low permeability on a local, or well boring, scale. Although groundwater head normally is higher in argillaceous limestone than in clean limestone because of the lower permeability, the standard well is not typically adaptable to this environment. Nevertheless, all of the wells drilled in basal groundwater in argillaceous limestone were designed as if the subsurface environment belonged to clean limestone. Eventually problems of salinity afflict these wells because 200 gpm is too high a pumping rate. When new pumps are required, most will have to be fitted with smaller pumps to ease the threat of increasing salinity.

Parabasal wells in argillaceous limestone can yield 200 gpm and perhaps more, but they can't really attain the production level of parabasal wells in clean limestone. The much lower

permeability of the argillaceous limestone causes considerably greater drawdown than in clean limestone for the same pumping rate.

Thus the principal geologic factors affecting well capacity is the 'cleanliness' of the limestone and the position of the volcanic basement. The hydraulic factors are head, especially in basal lenses, and volume rate of groundwater flow. Head is the dominant control because it is a function of hydraulic conductivity, distance inland from the discharge front, usually the coast line, and groundwater flux.

Evaluation of operational data for wells in Guam and analogous situations in the Pacific Islands, including Hawaii, suggest that the following general rules should apply to well capacities in Northern Guam.

1. Condition: clean limestone; basal groundwater.
   a. $h = 3$ to 4 ft.; capacity 180 to 300 gpm.
   b. $h = 2$ to 3 ft.; capacity 80 to 150 gpm.

2. Condition: clean limestone; parabasal.
   a. $h > 4$ ft.; capacity 500 to 700 gpm.

3. Condition: argillaceous limestone; basal.
   a. $h > 5$ ft.; capacity 150 to 200 gpm.
   b. $h = 3$ to 5 ft.; capacity < 150 gpm.

4. Condition: argillaceous limestone; parabasal.
   a. $h > 7$ ft.; capacity 200 to 300 gpm.

WELL PRODUCTION BY AQUIFER SYSTEMS

The potential groundwater production of the Aquifer Systems is discussed in the following sections. The various Aquifer Systems are arranged by the Aquifer Sectors in which they are defined. Reference should be made to Figure 3-1 throughout the following discussions.

Agana Aquifer Sector - Within the Agana Aquifer Sector the Ordot, Mongmong and Barrigada Aquifer systems all have potential for groundwater production.

Ordot Aquifer System - All wells in the Ordot Aquifer System encounter parabasal groundwater in an argillaceous limestone aquifer. Salinity in each well never exceeds about 30 mg/l chloride and normally hovers around 20 mg/l. The wells include A-1, A-2, A-3, A-4, A-5, A-6, A-7, A-8, A-11, A-12, A-23 and A-25. Flow rates range from about 140 gpm to 260 gpm, but each well was fitted with a 40 HP pump expected to produce the standard rate of 200 gpm. Some of the wells can sustain greater rates. When a pump is pulled from a well an evaluation should be made to determine whether a higher capacity is allowable.

Mongmong Aquifer System - The Mongmong System has no wells producing for PUAG. Much of the area is covered by Agana Marsh, which is a groundwater sink. The entire System is composed of argillaceous limestone containing a basal lens which, surprisingly, is not being exploited. Some old wells showed high salinities, but others suggest the possibility of obtaining potable water with modest capacity pumps.

The sustainable yield is more than 2 mgd. A number of wells can be drilled, some equipped with 200 gpm pumps but most with smaller capacities. At monitor well EX-1 the head is quite high, between 6 and 8 feet.

Barrigada Aquifer System - The Barrigada Aquifer System consists of clean limestone in which groundwater occurs in a basal lens having a maximum head of approximately 3 feet. The division between the argillaceous limestone of the Mongmong System and the clean limestone in the Barrigada System roughly follows the trace of the 200 feet elevation contour.

PUAG uses only one well (A-15) in the System. Salinity of the pumped water is moderately good, between 150 and 175 mg/l chloride. Additional wells could be drilled to draw on an unused sustainable yield of 2 mgd.

The System has a reputation for yielding high salinity water, but wells with pump capacities between 100 and 150 gpm should ordinarily yield potable water.

Fadian Aquifer Sector - Within the Fadian Aquifer Sector the Sabana Maagas and Huchunao Aquifer Systems have potential for groundwater development.

Sabana Maagas Aquifer System - Of the seven active wells in the Sabana Maagas Aquifer System, five (A-13, A-14, A-17, A-18 and A-19) exhibit serious salinity problems. The other two (A-9 and A-10) yield water of less than 240 mg/l chloride, the recommended upper limit of potability, although they sometimes approach this limit. All of the wells evidently were expected to produce 200 gpm because they are fitted with 40 HP motors. Actual pumping rates range from about 150 gpm at A-19 to 220 gpm at A-14.

Every well encounters basal groundwater in an argillaceous limestone aquifer. Heads increase from about 3 feet at A-19 to about 4 feet in the vicinity of A-9, A-10 and A-13, the most inland sites. Clearly, installed pump capacity at each well is too large for the hydrogeological environment. Upon re-fitting, each well should be carefully assessed to select a capacity that will not provoke salinity problems. Very likely capacity should not exceed 150 gpm.

Huchunao Aquifer System - No wells produce water for PUAG in the Huchunao Aquifer System. Well A-22 was once active but is no longer used because it pumps too much air.

Virtually the entire System is underlain by a basal aquifer in clean limestone. Much of the land is under Federal control, but enough of an area can be accessed by PUAG to locate well sites. At present only Hawaiian Rock Products pumps water, one well (HRP-1) at about 600 gpm and the other (HRP-2) at about 250 gpm. The quality of the water is surprisingly good considering the high capacities of the wells and proximity to the coast line. GEPA reports that in 1989 a sample from HRP-2 contained 382 mg/l chloride

and one from HRP-1 only 148 mg/l (the capacity of each well suggests that the values are reversed).

The System provides an opportunity for PUAG to develop additional supplies by means of wells having capacities between about 100 and 200 gpm.

Mangilao Aquifer Sector - Within the Mangilao Aquifer Sector the Sasajyan Aquifer System has limited potential for groundwater development and the Pagat system has negligible potential for development.

Sasajyan Aquifer System - The Sasajyan Aquifer System lies on the Pacific Ocean side of the subsurface ridge forming the western divide of the Yigo Trough. The divide runs from Ypao Peninsula to Mt. Santa Rosa. The System has a complicated hydrogeology that embraces both basal and parabasal groundwater.

Six M series wells along with EX-11 supply PUAG. Four of them (M-3, M-4, M-8 and M-9) and EX-11 are either parabasal or transitional between basal and parabasal. The wells were designed to yield 200 gpm but most average between 150 and 200 gpm.

Another 1.5 mgd can be pumped from the System by means of parabasal and basal wells. If basal, capacities will be 100 to 150 gpm; if parabasal, 300 to 500 gpm.

Pagat Aquifer System - Except for a narrow zone along the coast the volcanic basement throughout the Aquifer System lies above sea level, a condition which precludes the accumulation of developable groundwater. At this time there is no reason to consider the System as a potential source of groundwater production.

Janum Spring flows off the subsurface contact between the limestone and the basement volcanics. Its flow cannot be intercepted by wells placed up gradient because the volcanics rise above sea level.

Pati Aquifer Sector - The Pati Aquifer Sector is divided into two Aquifer Systems, Mt. Santa Rosa and Andersen, but only Mt. Santa Rosa is available for development by PUAG. The Andersen System lies entirely in Andersen Air Force Base.

Mt. Santa Rosa Aquifer System - No producing wells are located in the Mt. Santa Rosa System. Recent TDEM surveys suggest that both parabasal and basal groundwaters exist and are developable. Exploratory wells are needed. As much as 2 mgd may be available with properly designed wells.

Andersen Aquifer System - The entire area of the System is part of Andersen AFB. The dividing line between the Andersen and Mt. Santa Rosa Systems was drawn along the property boundary for convenience. A fine opportunity exists for the Air Force to develop water within the Andersen System.

Tarague Aquifer Sector - Like the Pati Aquifer Sector, the Tarague Sector is divided into two Aquifer Systems, one of which (Agafo Gumas) is available to PUAG for development, and the other of which (Northwest Field) lies in Federal property.

Agafo Gumas Aquifer System - In most of the Agafo Gumas System the volcanic basement lies above sea level, eliminating groundwater development opportunities. However, parabasal groundwater occurs in a subsurface trough near Route 9 and is developed by well AG-2. A well across the highway, AG-1, appears to be in groundwater transitional between parabasal and basal conditions. In addition to the PUAG wells, two golf course wells produce high quality parabasal water. These golf course wells consume an important fraction of the sustainable yield.

Wells AG-1 and AG-2 are undersized at about 200 gpm relative to the capacity of the parabasal aquifer to yield water. The golf course wells, on the other hand, successfully exploit the aquifer with 700 gpm wells. The capacity of the PUAG wells should be increased when the pumps are pulled for replacement. A capacity range of 500 to 700 gpm is justified in the parabasal area.

Details about the configuration of the volcanic basement have been revealed by recent TDEM surveys. These details will be helpful in locating exploratory and producing well sites.

Northwest Field Aquifer System - Although the Air Force does not have active wells in the Northwest Field System, opportunities for production wells exist. Both parabasal and basal groundwater may be exploited.

Finegayan Aquifer Sector - The Finegayan Sector is divided into two Aquifer Systems, Gugagon and Haputo. Both systems have potential for groundwater development although significant portions of each lie within the Andersen Air Force boundaries.

Gugagon Aquifer System - The Gugagon Aquifer System has been differentiated from the larger Haputo Aquifer System as a result of reinterpretation of the volcanic basement configuration employing original data from seismic work performed during the *NGLS* combined with recent TDEM surveys. In a large extent of the Gugagon System the basement lies above sea level, but a narrow zone evidently contains parabasal groundwater. Also within the System is an area of basal groundwater which is continuous with the basal lens of the Haputo System.

Wells F-8 and F-9, the former definitely parabasal and the other either parabasal or transitional to it, produce water for PUAG. The average yield of each is about 150 gpm, but presumably they were drilled to give 200 gpm each. Their capacities can be increased, perhaps to as much as 500 gpm.

Exploratory wells have been recommended to test for parabasal occurrences. An additional yield of nearly 5 mgd may be obtainable.

Haputo Aquifer System - Basal groundwater occurs throughout the System and is exploited by both PUAG and the Naval Communication Station (NCS). Of the nine active PUAG wells (F-1, F-2, F-3, F-4, F-5, F-6, F-7, F-10 and F-11), three (F-4, F-6 and

F-10) occasionally experience salinity in excess of the recommended limit of 240 mg/l chloride, but the others yield moderate to low salinity water. The wells apparently were designed to produce 200 gpm. Average production rates are usually less than 200 gpm except for F-1 and perhaps F-2.

Where the wells are located, head in the basal lens is about 3 feet, which is high enough to allow pump capacities of 150 to 200 gpm for production of potable water.

The NCS wells are pumped at an average rate of 150 to 200 gpm and, like the PUAG wells, apparently were developed to yield 200 gpm. One of the wells (NCS1A) sometimes exceeds the recommended salinity limit, but the other two always meet the standard.

PUAG can obtain another 1 mgd from the Haputo System even though most of its area lies inside NCS and Andersen Air Force Base.

Yigo-Tumon Aquifer Sector - The most voluminous and easily developed groundwater resources in Guam occur in the clean limestone aquifers of the subsurface trough which starts at Yigo and discharges into Tumon Bay. The trough is a remarkably efficient collector and transporter of groundwater. Its axis follows an arc from about the center of the coastline at Tumon Bay through Dededo to closure between the exposed volcanic highlands of Mataguac and Mt. Santa Rosa. Recharge flows along the top of the basement volcanics where they rise above sea level to the trough axis and eventually to the sea coast as a basal lens.

The Sector is divided into two Aquifer Systems. The Yigo System constitutes the most inland portion of the trough where groundwater is predominantly parabasal. The Tumon System embraces the mid and coastal portions where groundwater is chiefly basal, though on the flanks of the trough some parabasal sections may exist.

The Sector is the primal source of water supply for Guam and its aquifers are the most intensively exploited in the island. Nevertheless a surplus of sustainable yield exists that can be developed easily.

Yigo Aquifer System - Of the nine wells in the Yigo Aquifer System, six are parabasal (Y-2, Y-3, Y-4, Y-6, Y-7 and Y-9) and the other two (Y-1 and Y-5) appear to be transitional between basal and parabasal. Wells Y-1 through Y-6 are pumped at rates of 200 gpm or less, consistent with their design. Wells Y-7 and Y-9 have larger pumps, with Y-9 pumping as much as 400 gpm.

The parabasal wells can yield more than 200 gpm, and when each needs to be re-equipped a larger pump size should be considered. In addition several new wells can be drilled to take advantage of the surplus sustainable yield of nearly 4 mgd in the System.

Tumon Aquifer System - The Tumon Aquifer System is being exploited by about 40 wells and one infiltration gallery, but its sustainable yield is still not fully developed. The infiltration gallery and eight wells supply water to Andersen and military activities associated with it. About 30 wells are used by PUAG, and the remaining few are private.

The first wells drilled for PUAG about 25 years ago were located in Dededo and belong to the D series. These wells have been extremely successful in providing low salinity groundwater at pumping rates of about 200 gpm from a basal aquifer having a head of 3 to 3.5 feet. They are placed near the axis of the Yigo Trough where the flux of groundwater in the highly permeable clean limestone is unusually strong. All of the D series wells follow the standard design for providing 200 gpm. Additional similar wells can be drilled to exploit the remaining surplus sustainable yield amounting to nearly 4 mgd.

The M series wells, along with EX-5A and GH-501, also yield low salinity water at pumping rates of 150 to 200 gpm. Like the D series, these wells take advantage of the strong flux of groundwater moving along the axis of the Yigo Trough.

The MW series, belonging to the Air Force, exploit the low salinity groundwater associated with a basal zone in close proximity to parabasal water. In spite of having pump capacities of 200 to 475 gpm, these wells yield low salinity water. At the terminus

of the System near Tumon Bay the Air Force infiltration gallery supplies on the order of 1 mgd of low salinity basal groundwater.

The importance of the Yigo-Tumon Aquifer Sector can't be overemphasized. It is the heart of PUAG's water supply. It is already intensively developed, and of its estimated sustainable yield of 20 mgd, an average of about 13 mgd is being pumped. The reliability of this resource must be protected because of its dominating importance in supplying not only the civil economy of Guam but also Air Force activities.

WELL FAILURE AND REDEVELOPMENT

A well's inability to produce water of acceptable salinity (usually less than 150 mg/l chloride) at a feasible rate (usually more than 50 to 100 gpm) is normally manifested during initial testing following completion of drilling, but frequently failure takes place after a period of successful operation. A newly drilled well will fail if the position of the volcanic basement prevents the foundation of a saturated aquifer in limestone, or, should saturated limestone exist, the penetration of the well bore is either too deep, inducing upconing of the transition zone, or too shallow, not allowing sufficient surface area to accommodate inflow into the well. As a general rule, near-wasted areas are not likely to yield potable water because the groundwater in the basal lens consists mainly of the transition zone.

Wells that were initially successful but begin to fail after a period of operation often may be rehabilitated by reconfiguring well construction and reducing pump capacity. Reduction in well performance may be due to: 1) the length of time required for equilibrium between pumping rate and flow lines orientation to come about; 2) clogging of screen openings by calcium carbonate precipitation, or rearrangement of particles, including the gravel pack, at the screen interface; and 3) general failure of well construction including loss of gravel pack and collapse of the casing.

For cases where equilibrium is slowly achieved, ending in higher than acceptable chloride content, the depth of penetration of the well by back-filling with grout is a possible remedy. Where clogging is the obvious problem, acidizing the screen to dissolve calcium carbonate

precipitate is the usual corrective method. The standard screen is made of stainless steel, which resists corrosion.

For wells that lose efficiency or yield brackish water as a result of general failure, abandonment and replacement with a new well is often a better resolution than attempting to rescue the failed well.

As noted earlier, the standard well capacity (200 gpm) is not suitable for all hydrogeological environments in northern Guam. When a pump fails and must be replaced, the record of well behavior should be studied before deciding on replacement capacity. In fact, upon pulling a pump the well should be sounded and the casing and screen observed by means of a TV scan to ascertain whether acidizing and other actions are justified.

The range of permissible pump capacities in northern Guam is not great, and an effort should be made to have several sizes in inventory. At the high end a 700 gpm pump in a parabasal aquifer may work, but these instances are likely to be too few to justify an inventory of extra large pumps. At the low end, however, the specification of a 100 gpm pump is likely to be frequent enough to mandate an inventory. The 200 gpm pump will continue to be the most common capacity adaptable to a wide range of conditions.

The failure of a well by no means implies the collapse in the ability of an aquifer to yield good water in reasonable amounts. The behavior of an individual well is dominated by local conditions whereas the behavior of an aquifer is a regional phenomenon. A single well in the center of a brightly productive aquifer may pump excessive salinity water if local variability promotes flow lines to travel vertically from the transition zone to the well bore, even or adjacent wells produce low salinity water. Well D-13 in the Dededo well field is a good example of this phenomenon; evidently the local permeability favors vertical movement of groundwater, perhaps by way of fractures that are not present at the other D-series wells.

Because of the dominance of local aquifer features in such a heterogeneous medium as fossil reef limestone, each well must be judged by its own performance. Adjustments are made, if needed,

on this basis. Even in areas where salinity is presumed to be high because of proximity to the coast, properly designed low capacity wells often produce potable water.

ALTERNATIVE METHODS OF GROUNDWATER PRODUCTION

Except for groundwater production from the USAF Tumon Tunnel and the capture of Asan Spring flow, all potable water in Northern Guam is extracted by means of drilled wells. Asan Spring yields perched groundwater from an isolated limestone aquifer resting on volcanic rock and is not part of the Northern Guam aquifer systems. At one time several basal groundwater exposures in limestone sink holes near Tarague were tapped by the USAF. Janum and Campanaya Springs, also exposures of basal groundwater on the coastal shelf, were used by local residents. The US Navy for many years obtained a supply from parabasal groundwater springs at the margin of Agana Marsh. When the success of drilled wells was proved, spring capture was abandoned.

Basal and parabasal springs, however, are a potential source of potable water. Janum Spring in the Pagat Aquifer System has a flow estimated at 1 to 2 mgd of low salinity water. An exploratory boring was once drilled inland of the spring in an attempt to intercept groundwater but encountered the volcanic basement above sea level. The Camapanaya basal spring at the boundary of the Sasajyan and Pagat Systems was used by the Japanese occupation forces but yielded water having about 600 mg/l chloride. Better development techniques might improve output. Tarague Spring reliably provided groundwater with 300 to 350 mg/l chloride, higher than the recommended limit but indicative of an opportunity to obtain a lower salinity supply by using better techniques of withdrawal.

All of the coast of Northern Guam can be regarded as a continuum of basal springs because the lens discharges virtually at the coastline. The springs are exposures of groundwater in sink holes and caves. Where groundwater flux is strong, the "springs" yield low chloride water.

Basal groundwater springs can be created by constructing infiltration galleries. An infiltration gallery consists of tunnels and cavities excavated at about sea level. Fresh water drains into the galleries, then flows to a sump from where it is pumped. A large tunnel surface below the

water table allows drainage of low salinity water from the fresh water core of the lens. The premier example of this concept, and the only infiltration gallery in use today, is the Air Force Tumon Tunnel. Its success depends on location at the terminus of the Yigo Trough where the undeveloped flux of groundwater is strong as it moves to discharge at the coast. The other infiltration gallery, the ACEORP Tunnel, is located in the Barrigada Aquifer System but is not used because of the unacceptable salinity of its pumped water. The groundwater flux passing the collection gallery is far inferior to that in the Yigo Trough.

Infiltration galleries are expensive to construct and the risk of failure is significant. They are restricted in location to coastal areas because even at short distances inland the ground surface becomes too high to permit excavation to sea level unless a deep shaft is dug. Of the few locations in Northern Guam where a successful infiltration gallery can be constructed, the most favorable is in the coastal terrace on the south side of the Tumon Aquifer System.

One more potential groundwater collecting system has merit. The Agana Marsh is sustained by groundwater from the parabasal aquifers of the Ordot Aquifer System and the basal groundwater of the Mongmong System. The parabasal groundwater was at one time developed by the US Navy at Agana Spring. Behind the Spring, drilled wells have been located to intercept a portion of the water that naturally drains to the marsh. Additional groundwater on both the parabasal (Ordot) side and the basal (Mongmong) side may be developable by means of drainage collectors.

PROPOSED WELL DEVELOPMENT PRIORITIES

The unused sustainable yield of the aquifers of northern Guam accessible by PUAG totals 35 mgd. This value is an estimate founded on the analyses discussed in the main body of the report which take into account the response of the aquifers to operation over the last decade, simulation and prediction of groundwater behavior by modeling, and TDEM surveys in some regions. Not all of the 35 mgd will be easy to develop. A portion may elude cost effectiveness and its capture may never come about. However, additional groundwater can be safely produced in the first priority increment of about 10 mgd and in the second increment, 5 mgd. When this total

of 15 mgd is on line, another priority list can be established. The development of the first 15 mgd will determine the next set of priorities.

In the following table additional production is recommended by Aquifer Systems. The first priority increment includes 2 mgd from the Agafo Gumas system in the Tarague Sector; 2 mgd from the Yigo System and 1.5 mgd from the Tumon System in the Yigo-Tumon Sector; 2 mgd from the Gugagon system in the Finegayan Sector; and 2 mgd from the Ordot System in the Agana Sector. The second priority increment includes production from the Mt. Santa Rosa System in the Pati Sector, the Sasajyan System in the Mangilao Sector, the Huychunao System in the Fadian Sector and the Mongmong System in the Agana Sector. Details are listed in Table 5-1. Both first and second priority well fields are shown in Figure 5-1 at the end of this report.

TABLE 5-1
PRIORITY DEVELOPMENT BY AQUIFER SYSTEMS

Sector	System	Unused SY (mgd)	Add (mgd)	Aq. Type	Well (gpm)	No. Wells
Priority 1						
Tarague	Agafo Gumas	4.5	2.0	PB	300	5
Yigo-Tumon	Yigo	3.6	2.0	PB/B	300	5
Yigo-Tumon	Tumon	3.6	2.0	B	200	5
Finegayan	Gugagon	4.8	2.0	PB/B	200	7
Agana	Ordot	4.1	2.0	PB	250	6
			9.5			**28**
Priority 2						
Pati	Mt. Santa Rosa	2.3	1.0	PB/B	200	4
Mangilao	Sasajyan	1.5	0.5	PB/B	150	2
Fadian	Huchunao	4.0	2.0	B	150	10
Agana	Mongmong	2.8	1.0	B	150	5
			4.5			21
TOTAL			**14.0**			**49**

Notes
Col. 4 (Add mgd): Recommended additional development.
Col. 5 (Aq. Type): PB = parabasal; B = basal.
Col. 6 (Well gpm): Estimated well capacity for the aquifer type. Actual installed capacity will depend on pump testing.

HYDROLOGIC BUDGET FOR NORTHERN GUAM

The goal of hydrologic budgeting is to determine a mass balance among input and output variables in the hydrologic cycle. Input variables include rainfall along with other atmospheric moisture sources, and fluxes across boundaries in the region of interest. These fluxes are surface water and groundwater. Output variables consist of direct surface runoff, evapotranspiration from vegetation, and deep percolation. Rainfall and runoff are often known to some degree of accuracy as a result of measurements. Evapotranspiration is approximated from theoretical and empirical models, and infiltration is normally solved for as the unknown variable that closes the balance equation.

Islands, with their finite terminal boundaries, are good candidates for computing hydrologic budgets on a global scale because input flows across boundaries are absent, leaving atmospheric moisture as the sole input parameter. In the case of Guam, the only atmospheric moisture component of significance is rainfall.

Guam is really composed of two different islands sutured together along a geological contact extending from Pago Bay to Agana. Each unit is about 100 square miles in area, and because of geology each may be treated as a separate global entity. In the north are the great, highly permeable limestone aquifers that are the principal sources of water supply for the whole island, while the south is dominated by poorly permeable volcanics for which the most voluminous output variable is streamflow.

Groundwater resources in the south constitute only a small fraction of the island's developable water supply, but stream flow is large. Good records of rainfall and stream flow measurements are available from which hydrological principles applicable to the whole island can be extracted. In computing hydrologic budgets, the input variable rainfall and the output variable evapotranspiration are about the same for North and South Guam, but the output variables of surface runoff and groundwater flux are vastly different.

GLOBAL HYDROLOGIC BUDGET OF NORTHERN GUAM

Hydrological mass balances for Northern Guam have been proposed by numerous investigators employing a variety of methods. The balances were attempted in order to calculate the infiltration component because in the north the only developable water resource is groundwater. In 1937, H.T. Stearns, the first to attempt a hydrologic budget, suggested that 50 to 100 mgd of groundwater could be extracted from the north (H.T. Stearns, 1937, Geology and Water Resources of the Island of Guam, Mariana Islands: Manuscript Report to U.S. Navy). Shortly after World War II a U.S. Geological Survey report concluded that 15 mgd was safely developable (Ward, P.E., Hoffard, S.H., and Davis, D.A., 1965, Hydrology of Guam, U.S. Geological Survey Professional Paper 403-H).

In a study completed in 1976 for PUAG, two hydrologic budgets were calculated, one employing evaporation as the equivalent of evapotranspiration and the other deducing evapotranspiration from the water budget for Southern Guam (Mink, J.F., 1976, Groundwater Resources of Guam: Occurrence and Development: Univ. Guam Water Resources Research Center Tech. Report 1). In the Northern Guam Lens Study (1984) a budget was derived based on a theoretical determination of evapotranspiration, and as part of the study WERI of the University of Guam produced a partial budget in which infiltration was computed by relating the gain in salinity in groundwater to salinity in rainfall and attributing the difference to the effects of evapotranspiration.

Each method is an approximation based on assumptions combined with a body of measured data for rainfall, pan evaporation and stream flow. The unknowns in every case are evapotranspiration and infiltration. Runoff from the northern limestones is very small and is either ignored or assigned a small value. Because groundwater is the sole resource of interest, equations are solved to yield infiltration.

The fundamental balance equation for Northern Guam is:

$$P = R + ET + I$$

in which P is average rainfall, the only input variable; R is runoff, which is close to zero because of the high infiltrability of the limestone terrain; ET is evapotranspiration, or loss of moisture to the atmosphere; and I is infiltration to groundwater. This equation is for the steady state in which input is equal to output. The change in volume of groundwater does not enter the equation until groundwater withdrawals by artificial means take place.

Rearranged to solve for I the equation is:

$$I = P - R - ET$$

P is known from rain gage records, R is either ignored or taken as 5% of P, and ET is estimated by various methods. The solution for I is singularly dependent on the value assigned to ET. The differences in computed values of I among different investigators are a result of the value given to ET by each.

Table 1 is a summary of attempts to create a global hydrologic budget for Northern Guam. The budgets taken from Mink (1976) uses a total limestone area for Northern Guam of 94.6 square miles, which is virtually the entire north half of the island. The NGLS (1984) budget refers to only 67.24 square miles, which is the area where it was assumed that potable water is developable. This restriction of area understates total input. The alternate balances were recomputed from the Mink budgets by altering some parameters and employing the total area of Northern Guam (100.3 square miles), or the area inland of a zone 0.5 miles in width from the coast, leaving an input area of 80.1 square miles.

The Mink budgets are developed and explained in detail in the 1976 report. The minimum budgets assume the most conservative conditions wherein evapotranspiration is assumed to be equivalent to pan evaporation. This, of course, is not realistic because moisture is not constantly available to plants. Much of the wet season rainfall quickly transits the thin soil to infiltrate rapidly while in the dry season insufficient rain falls to support potential evapotranspiration.

TABLE 1
NORTHERN GUAM HYDROLOGIC BUDGETS

Budget	Area (sq.mi.)	P (in/yr)	ET (in/yr)	R (in/yr)	I (mgd)
Minimum (Mink)	94.6	94.7	67.4	0	129
Minimum (Mink)	94.6	94.7	66.9	4.7	109
Probable (Mink)	94.6	94.7	42.8	0	232
Probable (Mink)	94.6	94.7	42.5	4.7	212
NGLS	67.2	94.0	59		112
Alternate 1	100.3	90.0	45	0	215
Alternate 2	100.3	90.0	45	4.5	193
Alternate 3	80.1	90.0	45	0	172
Alternate 4	80.1	90.0	45	4.5	155

Notes:
P = average annual rainfall
ET = average annual evapotranspiration
R = average annual surface runoff
I = average annual infiltration to groundwater

One of the minimum budgets assumes no runoff and the other allows for 5 percent runoff. The computed values of infiltration (129 and 109 mgd, respectively) are understated because of the excessive value assigned to evapotranspiration (67.4 in./yr.)

The "probable" budgets are a considerable improvement on the minimum budgets and are the most accurate of the postulated budgets because of the straightforward methodology employed. The balance takes advantage of the excellent USGS stream gage data for Southern Guam where 61.6 percent of rainfall leaves the land as stream flow. The stream flow is predominantly direct overland flow (about 85 percent) with the remainder derived from groundwater seepage. It is a fair assumption to equate the ratio of runoff to rainfall in the south to infiltration to rainfall in the north, leaving the balance of rain for evapotranspiration. This assumption is reasonable because only a very small quantity of groundwater escapes from the low permeability volcanic aquifers directly into the sea as seepage. Otherwise all of the output from the volcanic drainage basin is known because stream flow is accurately measured and evapotranspiration is the difference between rainfall and runoff.

The calculated evapotranspiration in the probable budget is 42.79 in./yr. This amount is consistent with values commonly assigned to humid tropical areas where average annual rainfall exceeds 60 inches (L.A. Bruijnzeel, 1990, Hydrology of Moist Tropical Forests and Effects of Conversion: A State of Knowledge Review: UNESCO Hydrology Program).

Infiltration in Northern Guam for the probable budget is 232 mgd when no allowance is made for loss by surface runoff, and 212 mgd when runoff is taken as 5 percent of the rain. These values refer to a total area of 94.6 square miles.

The NGLS budget limits the infiltration intake area to 67 square miles, only two thirds of the total area of Northern Guam, and assigns an evapotranspiration rate of 59 inches per year. This rate is theoretical and is calculated by the Blaney-Criddle method. Both assumptions are very conservative and restrict the estimate of infiltration to only 112 mgd. Adjusted for the entire area of Northern Guam the comparable infiltration would be 167 mgd. It will become clear later why the entire area of intake must be considered when deriving estimates of yield based on

groundwater flow hydraulics. The aquifers are hydraulically continuous from the coast inland to their termination by the volcanic basement, and the allowable rate of groundwater withdrawal depends on an equilibrium head which preserves the integrity of the resource. Head is governed by input over the entire area of the aquifer, not just the area declared suitable for potable water development.

The evapotranspiration value used in the NGLS budget is high, about 88 percent of the pan evaporation rate employed in the "minimum" budget and 16 inches greater than the annual average used in the "probable" budget. The high evapotranspiration value was supported by the calculation for infiltration based on salinity of rain water and groundwater, but this calculation ignores the dry salt deposited on the surface of the ground which becomes entrained in the water that percolates through the soil to add another increment of salt to the groundwater.

The two alternate budgets essentially are recalculations of the "probable" budget substituting areas of either 100 square miles, the whole of Northern Guam, or 80 square miles, the envelope of land lying 0.5 miles inland of the coast. Evapotranspiration was assigned a value of 45 inches per year, slightly higher than the 43 inches in the "probable" budget. Calculated infiltration ranges from a low of 155 mgd for the 80 square miles area and 5 percent runoff to 215 mgd for 100 square miles and zero runoff.

SUMMARY OF GLOBAL HYDROLOGIC BUDGETS

In the budgets discussed above, calculated infiltration rates range from 109 mgd to 232 mgd for Northern Guam. The 109 mgd is from Mink's "minimum" budget and is similar to the conservative estimate of 112 mgd given in the NGLS report. Both are unreasonably low.

The sensible values fall in the range 155 mgd to about 215 mgd. For purposes of deriving sustainable yields, infiltration is given a low value of 175 mgd and a high value of 200 mgd. Note that sustainable yield is not equal to infiltration; it is only a fraction of it, and for the basal aquifers of Northern Guam this fraction is no more than about one third.

SUSTAINABLE YIELD

The hydrologic balances summarized above include very large values as groundwater recharge. Only a fraction of the infiltration, however, is developable as sustainable yield. In fact, for the Northern Guam aquifer system on a global scale, just 30 to 40 percent of the input is safely developable as potable water.

Sustainable yield is defined as "the average rate at which groundwater may be continuously pumped without diminishing either the quality or quantity of the pumped water." To achieve the hypothetically available sustainable yield, the means of withdrawal must be optimal. For most groundwater supply systems, production methods are sub-optimal and therefore the full value of sustainable yield is not available. These systems can be upgraded through re-development and by the careful location and design of new production units.

The sustainable yields discussed here are restricted to potable water pumpage. The production of additional non-potable but agriculturally acceptable water down gradient of the potable extraction units is permissible to some extent. Also, the sustainable yields are for basal water conditions where salinity is the major hazard accompanying over production. This constraint is necessary because eventually most of the groundwater in Northern Guam enters a basal lens before discharging along the sea coast, and the basal lenses are the most voluminous sources of groundwater.

Sustainable yield refers to the steady state condition when pumpage is in equilibrium with recharge, head, and leakage out of the system. To complete the argument, the initial system head is required. The relationship is expressed as (Mink, J.F., Chang, J.C., and Yuen, G.A., 1988, Review and Re-Evaluation of Groundwater Conditions in the Pearl Harbor Groundwater Control Area, Oahu, Hawaii: State of Hawaii Commission on Water Resources Management, Report R-78):

$$SY = I \{1 - [h(e)/h(o)]^2\}$$

in which SY is sustainable yield, I is infiltration, h(e) is equilibrium head for the groundwater system and h(o) is the initial pre-development head. In the above, sustainable yield is treated as a global variable, that is, it refers to an entire aquifer system. In the determination of sustainable yield that follows, the limestone aquifers of Northern Guam are considered a single, hydraulically connected entity.

Sustainable yield refers to production averaged over a time interval whose permissible length depends on the volume of groundwater in the aquifer system and the rate of replenishment to the system. If the volume is large and the replenishment high, wide swings in production rate are allowable over extended periods to make the average. In small groundwater systems, both the time interval of averaging and the range of pumping must be more tightly controlled.

Aquifer volume and replenishment rates in Northern Guam are substantial and thus averaging is allowable over relatively long periods of time. Total pumpage may also vary within a wide range. For example, if global sustainable yield is selected as 60 mgd, pumpage at a rate of 90 mgd for several months followed by pumpage at 30 mgd for an equal time may be permissible, so long as the average calculates to be 60 mgd. Optimal operation, however, would seek to stay as close to the average as possible.

In the steady state sustainable yield equation, values must be assigned for the initial head and the recharge rate, and an equilibrium head must be selected that will prevent degradation by salinity of the pumped water. The recharge rate is taken from hydrologic balance calculations, while the value for initial head must be extracted either from historical data or approximated. The choice of equilibrium head is somewhat arbitrary but needs to be guided by familiarity with the groundwater systems and by reference to analogous conditions elsewhere. This approach to sustainable yield, although constrained by assumptions, is far more quantitative than designating allowable draft as an arbitrary fraction of infiltration rate.

The sets of values employed in the steady state equation from which the most probable range of sustainable yields could be chosen are as follows:

h(o): 3.5 ft.; 3.25 ft.; 3.0 ft.

h(e): 2.75 ft.; 2.5 ft.

I: 125 mgd; 150 mgd; 175 mgd; 200 mgd.

For infiltration values of 125 and 150 mgd, the sustainable yields are too small to be reasonable unless the equilibrium head goes to 2.0 ft. The best fit is for infiltration of 175 to 200 mgd, which is the probable range determined by hydrologic budgeting.

For infiltration of 175 mgd, the sustainable yield range is:

55 mgd < SY < 75 mgd

average 65 mgd

and for infiltration of 200 mgd,

60 mgd < SY < 80 mgd

average 70 mgd.

The calculations can be summarized as follows:

TABLE 2
SUSTAINABLE YIELDS AND EQUILIBRIUM HEADS

I (mgd)	SY (mgd)	h(o) = 3.5 h(e) ft.	h(o) = 3.25 h(e) ft.	h(o) = 3.0 h(e) ft.
175	70	2.7	2.5	2.3
175	65	2.8	2.6	2.4
200	70	2.8	2.6	2.4
200	65	2.9	2.7	2.5

The initial heads used in the calculations refer not to known maximum basal heads but to heads generally characteristic of basal groundwater far enough inland to yield potable water. Head varies seasonally by an average of about 0.3 to 0.5 feet in the clean limestone aquifers north of Agana Marsh so it is difficult to select an exact initial head. However, historical heads before the groundwater development of the last 15 years indicate that a reliable initial value is greater than 3.25 feet but less than 4.0 feet. An initial head of 3.5 feet is therefore a reasonable choice.

For sustainable yields of 65 to 70 mgd, regional equilibrium head will decay to 2.7 to 2.9 feet. These heads are high enough to support production of potable water from the basal lens using current methods (i.e., generally 200 gpm wells).

The sustainable yield values above refer to steady state conditions which come about when the groundwater system is in equilibrium with infiltration, head, draft and leakage. A long period of transient decay from the initial head takes place before equilibrium is achieved. The decay stage persists for many years. Equations of transient behavior are considerably more complicated than for the steady state, but tracking head change as a function of draft and time can be performed with a computer model.

Graphs of the average monthly heads recorded at various PUAG wells are presented in Figures 1 through 8 at the end of this appendix. The record of head change at the monitor wells since the end of the NGLS investigation in 1982 does not manifest a significant decay in head at the total pumping rate of 20 to 30 mgd. Illustrations of the stability of heads in basal lenses in clean limestone are graphs of average monthly heads for the period 1984 through 1988 (Figures 1 through 5). The most complete records are for 1985 and 1988.

Heads rise quickly in response to prolonged and heavy rainfall because infiltration temporarily accumulates at the top of the water table. This effect is particularly noticeable in the argillaceous limestone parabasal aquifer in the Chaot-Ordot region (Figure 6). The effect is less pronounced in the argillaceous limestone basal aquifer (Figures 7 and 8), and even less dramatic in the aquifers of clean limestone (Figures 1 through 5).

The graphs for clean limestone aquifer monitor wells EX-6 (Macheche), EX-7 (Wettengell), EX-8 (Northwest Field), EX-9 (Barrigada and EX-10 (Finegayan) show that heads during 1985 were lower than during 1988 by about 0.2 feet. This implies that there has not been a steady decline in head since 1984 as a result of pumping. The average heads for 1988 may be considered as equilibrium heads at the current rate of draft.

SUMMARY

The steady state model was the first model employed in an effort to quantitatively establish sustainable yields because of its simplicity. The steady state model lumps seasonal changes in recharge into the annual average, thus missing the cycle of head change from dry to wet to dry season. Subsequently a transient model was composed in which the time unit for averaging is the month, thereby incorporating the effects of seasonal recharge and outflow on the basal and parabasal resources. The transient model is discussed in the main text, and recommended sustainable yields are taken from this model.

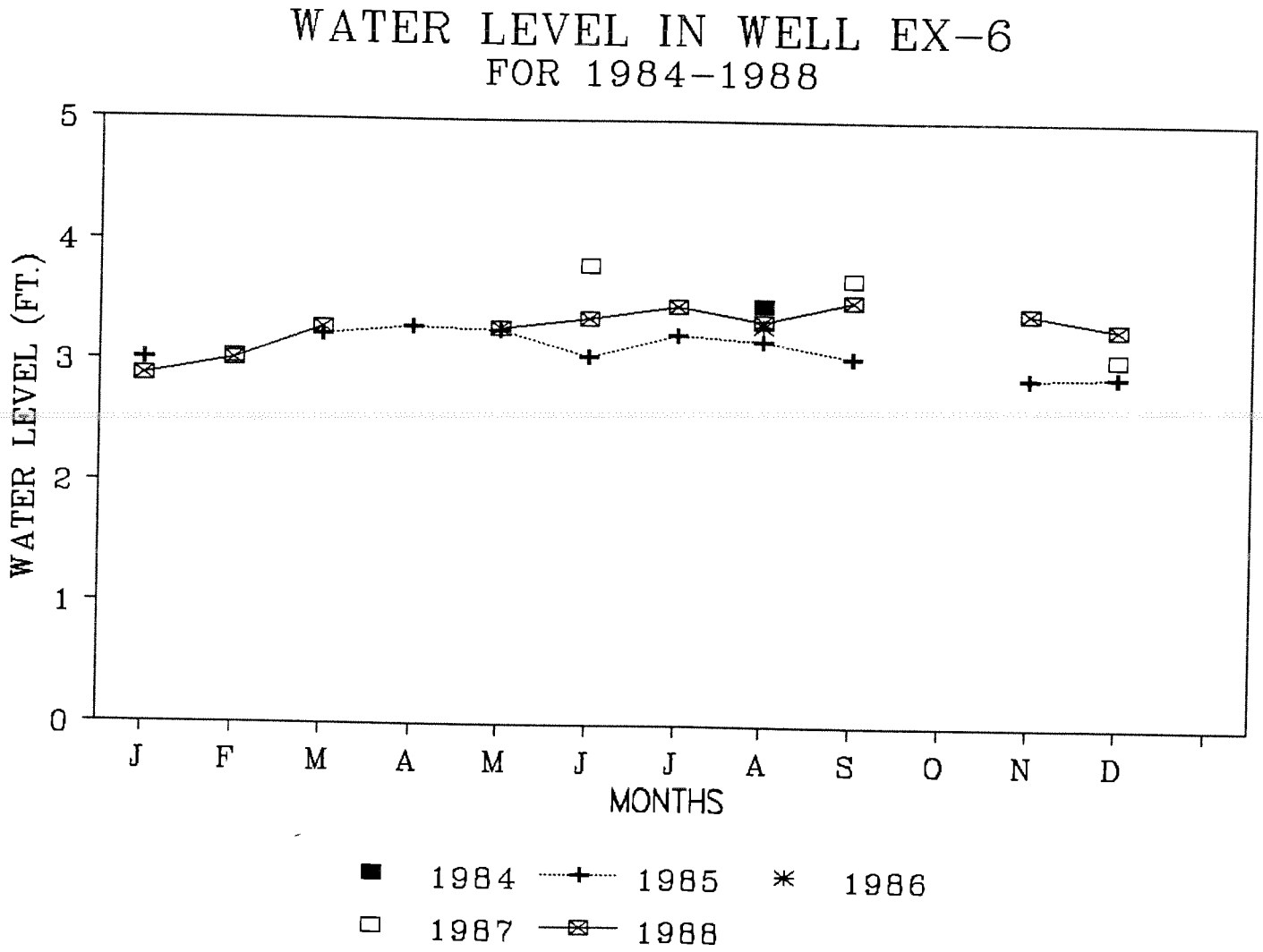


Figure 1
Average Monthly
Groundwater Elevations
Well EX-6

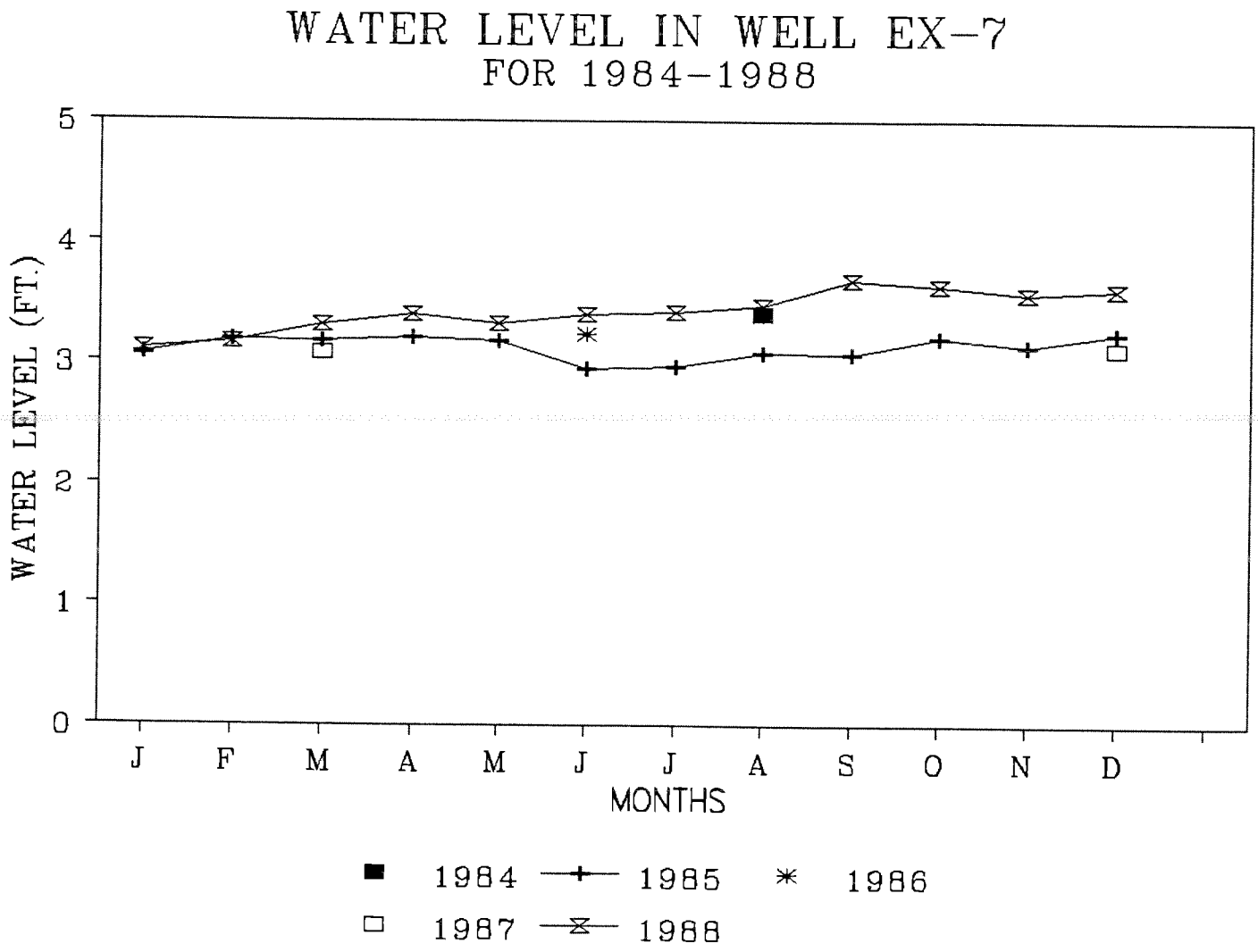


Figure 2
Average Monthly
Groundwater Elevations
Well EX-7

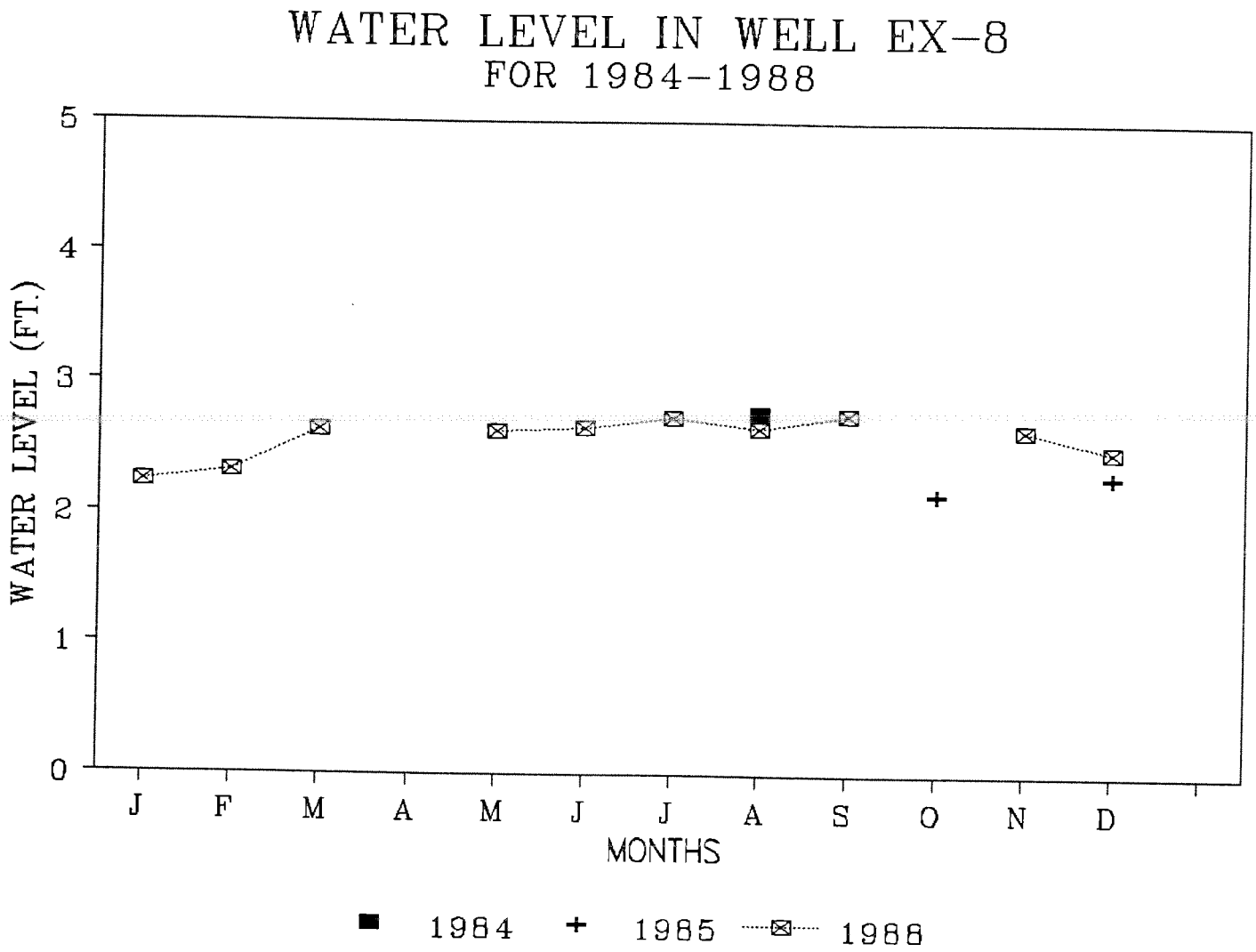


Figure 3
Average Monthly
Groundwater Elevations
Well EX-8

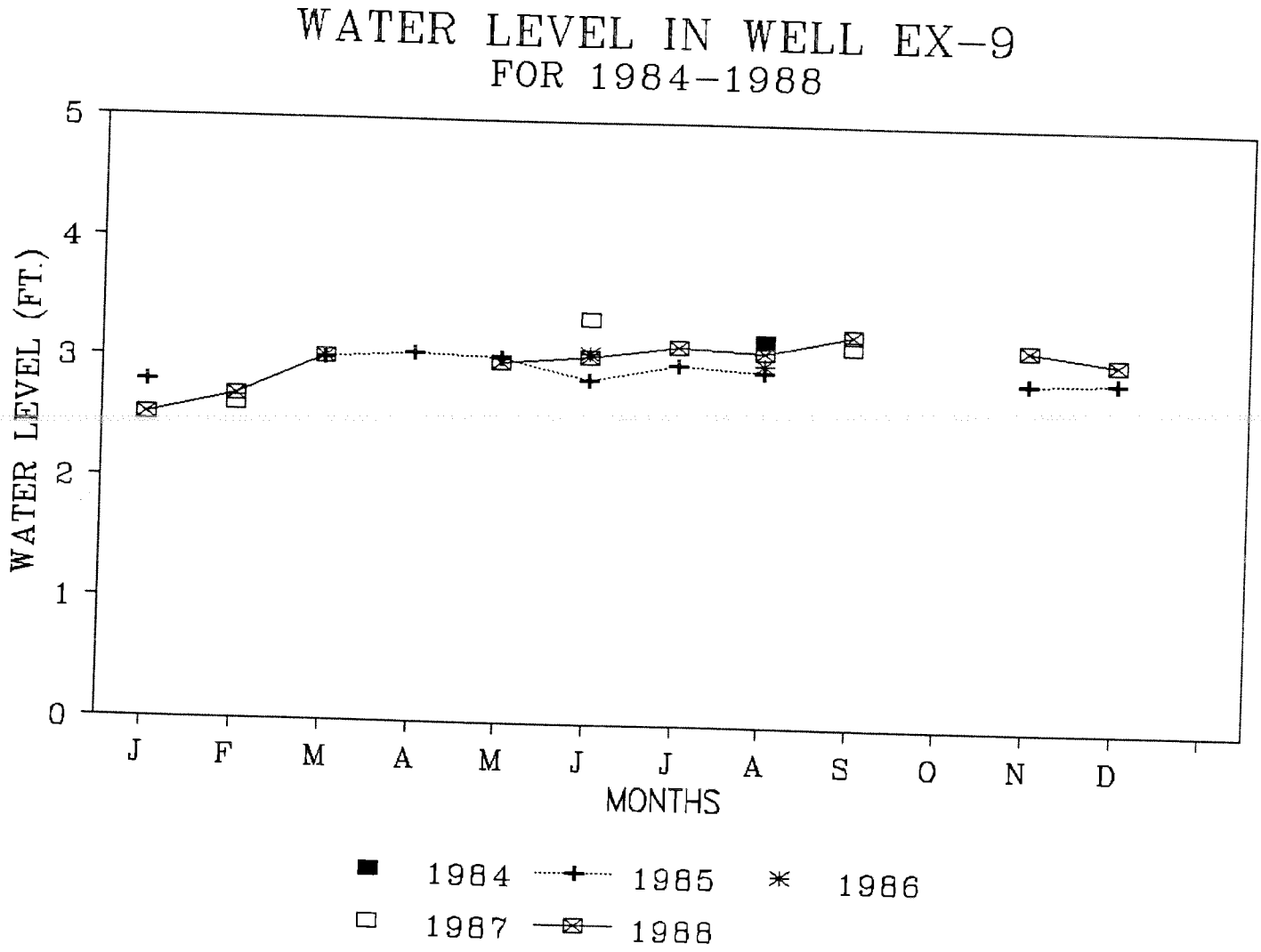


Figure 4
Average Monthly
Groundwater Elevations
Well EX-9

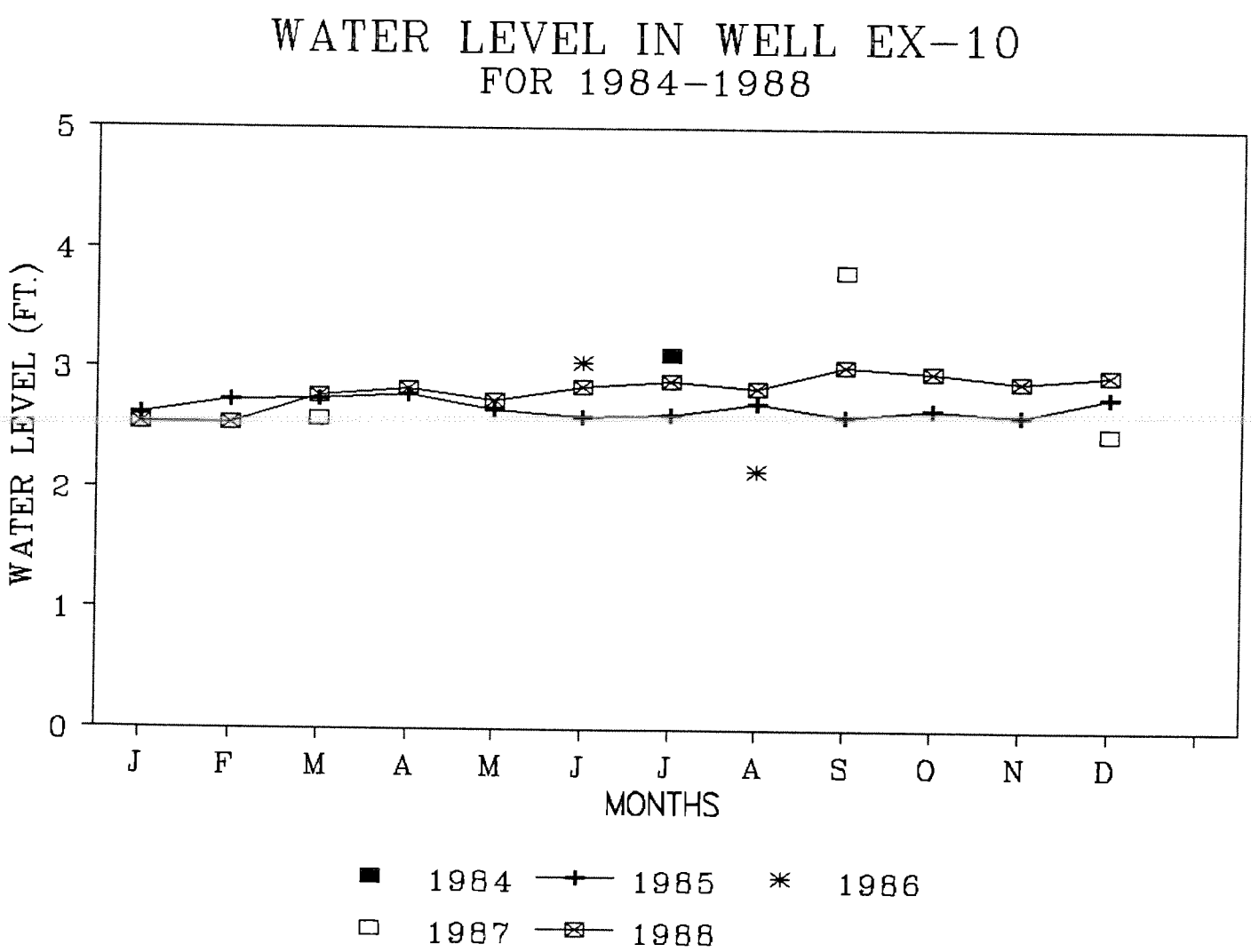


Figure 5
Average Monthly
Groundwater Elevations
Well EX-10

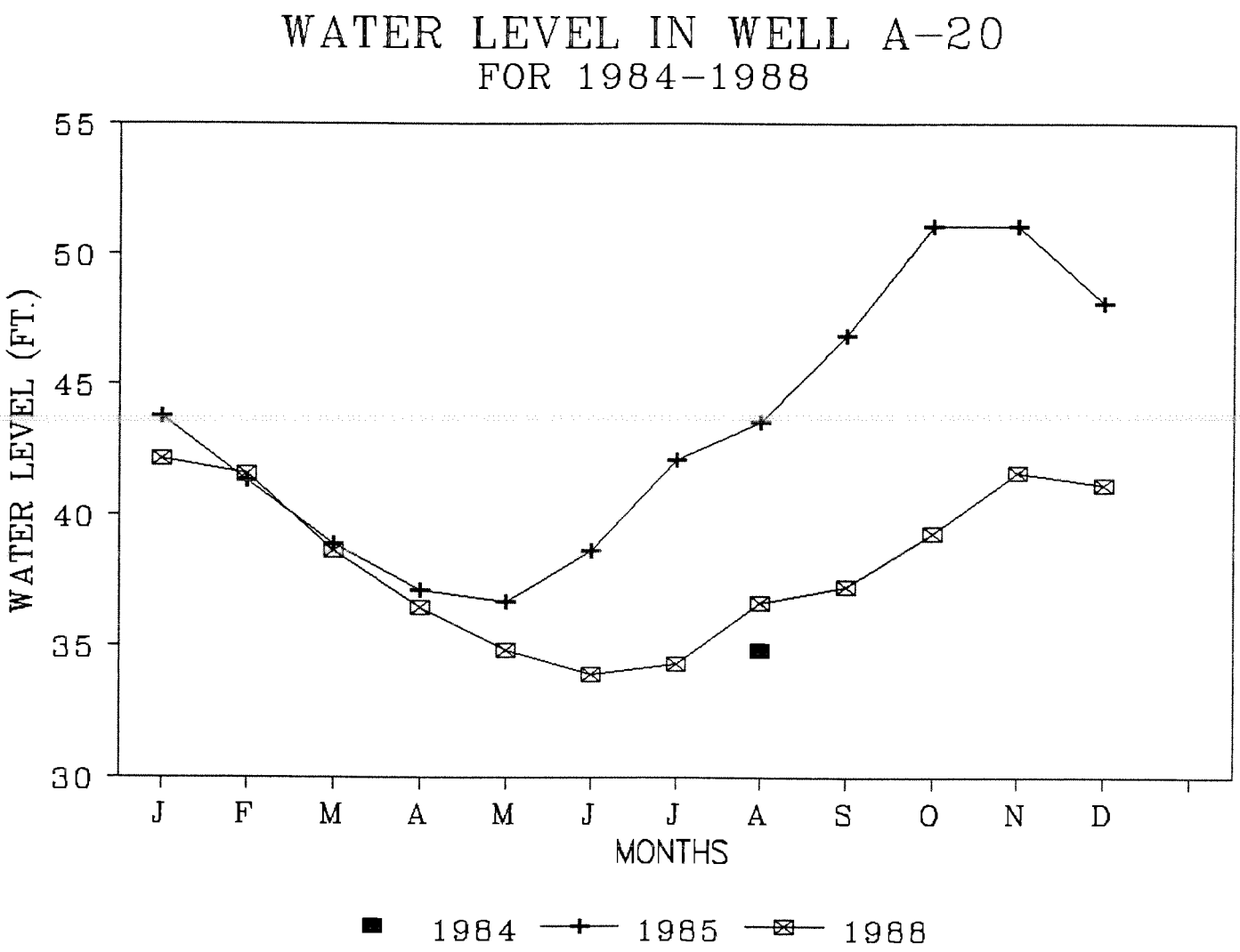


Figure 6
Average Monthly
Groundwater Elevations
Well A-20

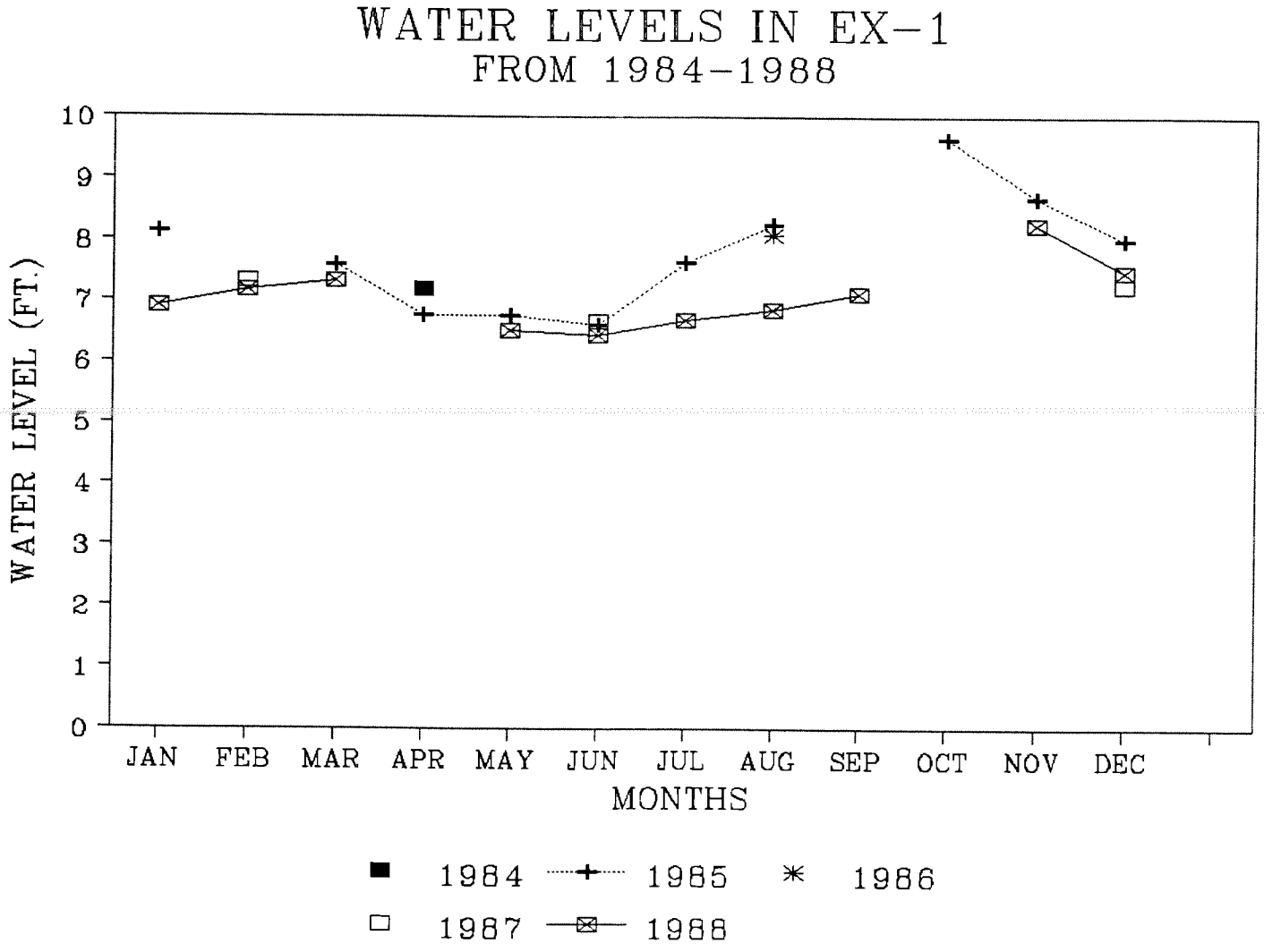


Figure 7
Average Monthly
Groundwater Elevations
Well EX-1

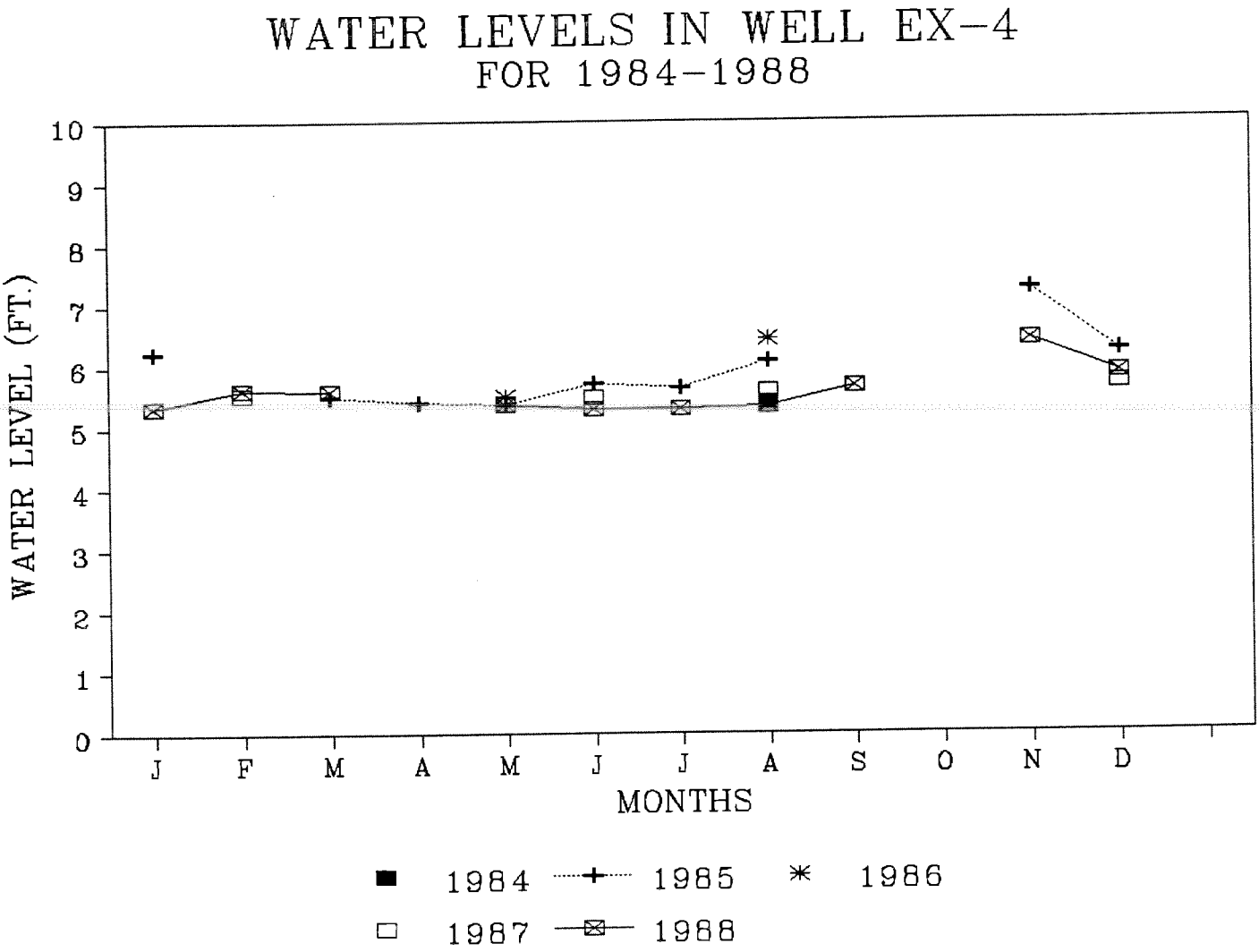


Figure 8
Average Monthly
Groundwater Elevations
Well EX-4

Legend

- ●A-10 PRODUCTION WELL & WELL NUMBER; EX WELLS ARE GUAM EPA EXPLORATORY WELLS
- ⊘A-20 WELL OUT OF PRODUCTION WITH WATER LEVEL RECORDER
- O16 WELL OUT OF PRODUCTION
- REVISED CONTOURS BY TDEM SURVEYS
- PRIORITY 1 WELL FIELDS
- PRIORITY 2 WELL FIELDS
- 200 ELEVATION CONTOUR OF TOP OF VOLCANICS
- AQUIFER SECTOR BOUNDARY
- AQUIFER SYSTEM BOUNDARY
- SURFACE EXPOSURE OF VOLCANIC ROCKS
- D-4 / (-440) LOCATION OF SEISMIC LINE D-4 ((-440) = MINIMUM ELEV. OF TOP OF VOLCANICS)
- 10 E-3 50 LOCATION OF SEISMIC LINE E-3 (10, 50 = ELEVATION OF TOP OF VOLCANICS)

north

0 4000 8000 12000

SCALE IN FEET

FINEGAYAN SECTOR

TARAGUE SECTOR

HAPUTO SYSTEM

NORTHWEST FIELD SYSTEM

YIGO-TUMON SECTOR

GUGAGON SYSTEM

AGANA SECTOR

AGAFO GUMAS SYSTEM

PATI SECTOR

BARRIGADA SYSTEM

TUMON SYSTEM

T SYSTEM

MONGMONG SYSTEM

ANDERSEN SYSTEM

YIGO SYSTEM

HUCHANAO SYSTEM

MT. SANTA ROSA SYSTEM

ABANA MAAGAS SYSTEM

SASAJYAN SYSTEM

PAGAT SYSTEM

FADIAN SECTOR

MANGILAO SECTOR

FIGURE 5-1

NORTHERN GUAM

PRIORITY WELL FIELDS

Legend

- ●A-10 — PRODUCTION WELL & WELL NUMBER; EX WELLS ARE GUAM EPA EXPLORATORY WELLS
- ⊕A-20 — WELL OUT OF PRODUCTION WITH WATER LEVEL RECORDER
- O18 — WELL OUT OF PRODUCTION
- CL:40 — CHLORIDE (ppm)
- TD:-20 — WELL TERMINATED IN LIMESTONE (-20 = ELEVATION OF BOTTOM OF WELL)
- TD:-50V — WELL TERMINATED IN VOLCANICS (-50 = ELEVATION OF TOP OF VOLCANICS)
- —200— ELEVATION CONTOUR OF TOP OF VOLCANICS
- AQUIFER SECTOR BOUNDARY
- AQUIFER SYSTEM BOUNDARY
- SURFACE EXPOSURE OF VOLCANIC ROCKS
- D-4 / (-440) — LOCATION OF SEISMIC LINE D-4 ((-440) = MINIMUM ELEV. OF TOP OF VOLCANICS)
- 110 E-3 50 — LOCATION OF SEISMIC LINE E-3 (110, 50 = ELEVATION OF TOP OF VOLCANICS)

north

0 4000 8000 12000

SCALE IN FEET

FINEGAYAN SECTOR

TARAGUE SECTOR

YIGO-TUMON SECTOR

AGANA SECTOR

HAPUTO SYSTEM

NORTHWEST FIELD SYSTEM

GUGAGON SYSTEM

AGAFO GUMAS SYSTEM

PATI SECTOR

ANDERSEN SYSTEM

BARRIGADA SYSTEM

TUMON SYSTEM

T SYSTEM

MONGMONG SYSTEM

HUCHANAO SYSTEM

YIGO SYSTEM

MT. SANTA ROSA SYSTEM

SABANA MAAGAS SYSTEM

SASAJYAN SYSTEM

PAGAT SYSTEM

MANGILAO SECTOR

FIGURE 3-1

NORTHERN GUAM

AQUIFER SYSTEMS

north

0 2000 4000 6000 8000 10,000

SCALE IN FEET

Legend

- GROUNDWATER SUBBASIN BOUNDARY
- PARABASAL - BASAL BOUNDARY
- BOUNDARY FOR SAFE PUMPING
- MANAGEMENT ZONE BOUNDARY
- 100 — ELEVATION CONTOURS OF TOP OF VOLCANICS
- RAINGAGE STATION

FINEGAYAN SUBBASIN

NORTHWEST FIELD WEST

NORTHWEST FIELD EAST

POTTS

FINEGAYAN WEST

AGAFA GUMAS WEST

NCS

FINEGAYAN EAST

DEDEDO NORTH

CALLON TRAMOJO

AGAFA GUMAS CENTRAL

AGAFA GUMAS EAST

DEDEDO SOUTH

Y-SENGSONG

TARAGUE

FIGURE 3-5 FINEGAYAN SUBBASIN

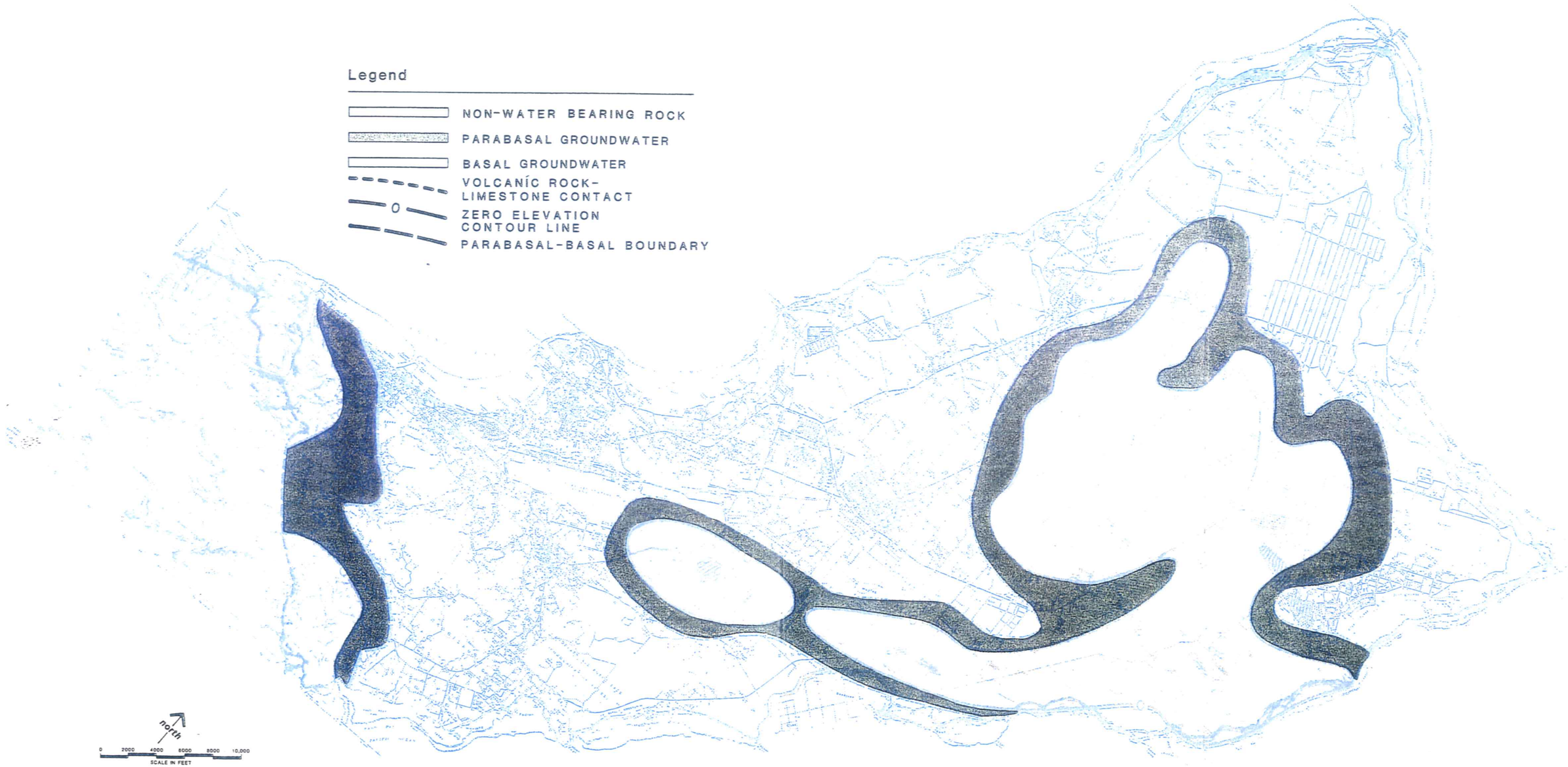


FIGURE 1-1

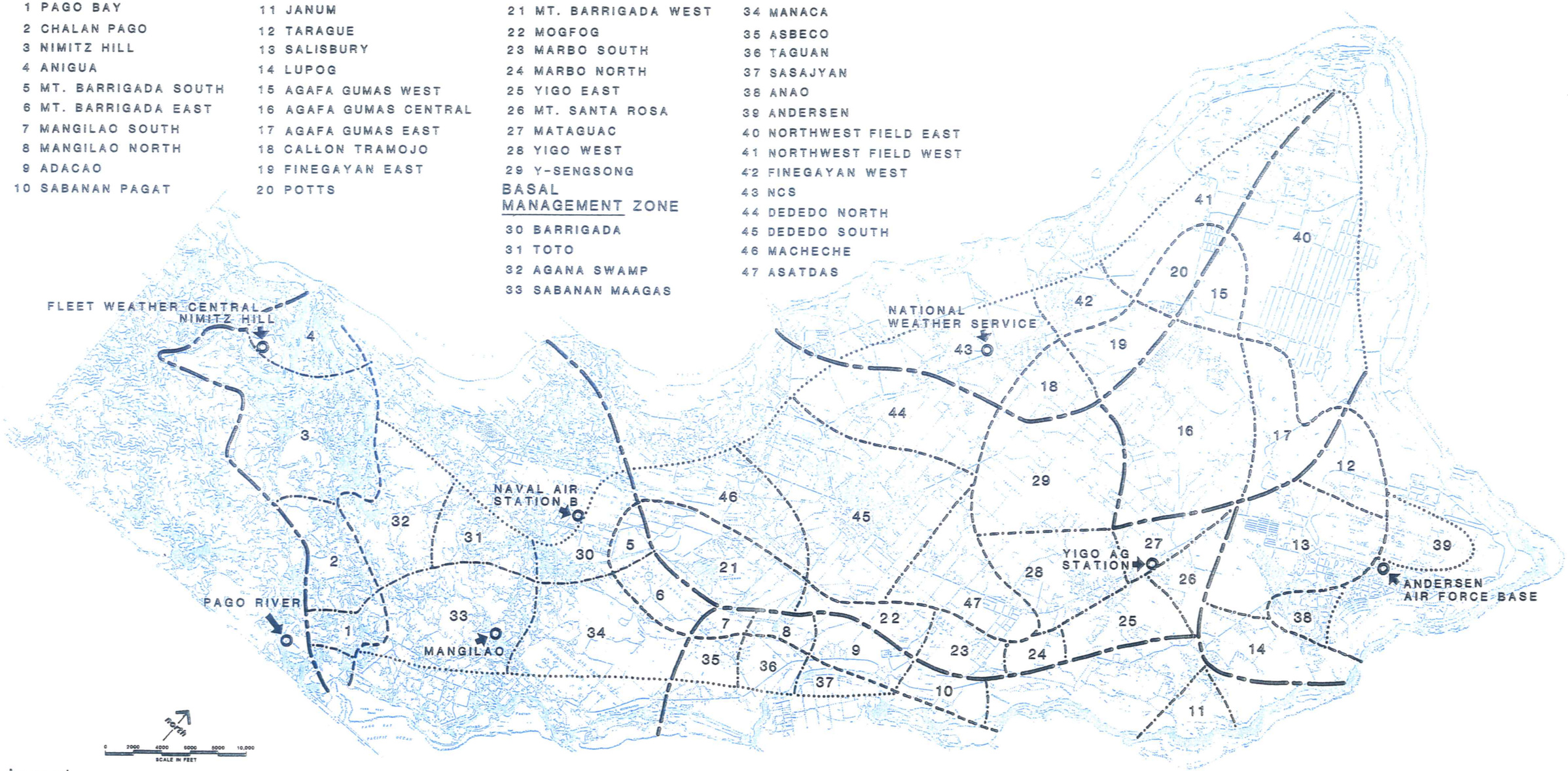
DISTRIBUTION OF
GROUNDWATER TYPES

PARABASAL
MANAGEMENT ZONE

1 PAGO BAY
2 CHALAN PAGO
3 NIMITZ HILL
4 ANIGUA
5 MT. BARRIGADA SOUTH
6 MT. BARRIGADA EAST
7 MANGILAO SOUTH
8 MANGILAO NORTH
9 ADACAO
10 SABANAN PAGAT
11 JANUM
12 TARAGUE
13 SALISBURY
14 LUPOG
15 AGAFA GUMAS WEST
16 AGAFA GUMAS CENTRAL
17 AGAFA GUMAS EAST
18 CALLON TRAMOJO
19 FINEGAYAN EAST
20 POTTS
21 MT. BARRIGADA WEST
22 MOGFOG
23 MARBO SOUTH
24 MARBO NORTH
25 YIGO EAST
26 MT. SANTA ROSA
27 MATAGUAC
28 YIGO WEST
29 Y-SENGSONG

BASAL
MANAGEMENT ZONE

30 BARRIGADA
31 TOTO
32 AGANA SWAMP
33 SABANAN MAAGAS
34 MANACA
35 ASBECO
36 TAGUAN
37 SASAJYAN
38 ANAO
39 ANDERSEN
40 NORTHWEST FIELD EAST
41 NORTHWEST FIELD WEST
42 FINEGAYAN WEST
43 NCS
44 DEDEDO NORTH
45 DEDEDO SOUTH
46 MACHECHE
47 ASATDAS



Legend

GROUNDWATER SUBBASIN BOUNDARY
PARABASAL - BASAL BOUNDARY
MANAGEMENT ZONE BOUNDARY
BOUNDARY FOR SAFE PUMPING
RAINGAGE STATION

FIGURE 1-2

GROUNDWATER MANAGEMENT ZONES
NORTHERN LENS

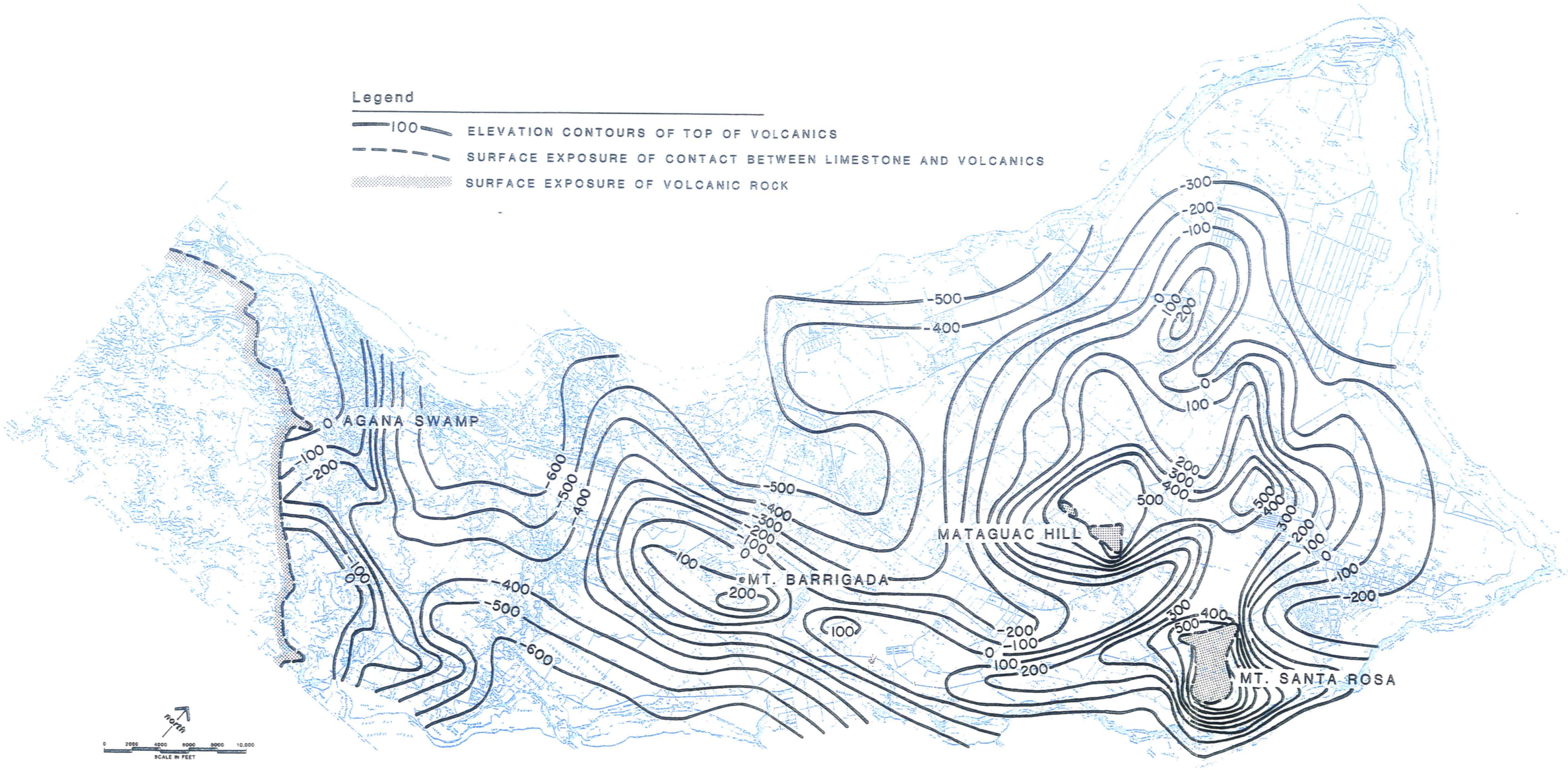


FIGURE 3-3

CONTOUR MAP
OF THE VOLCANIC BASEMENT

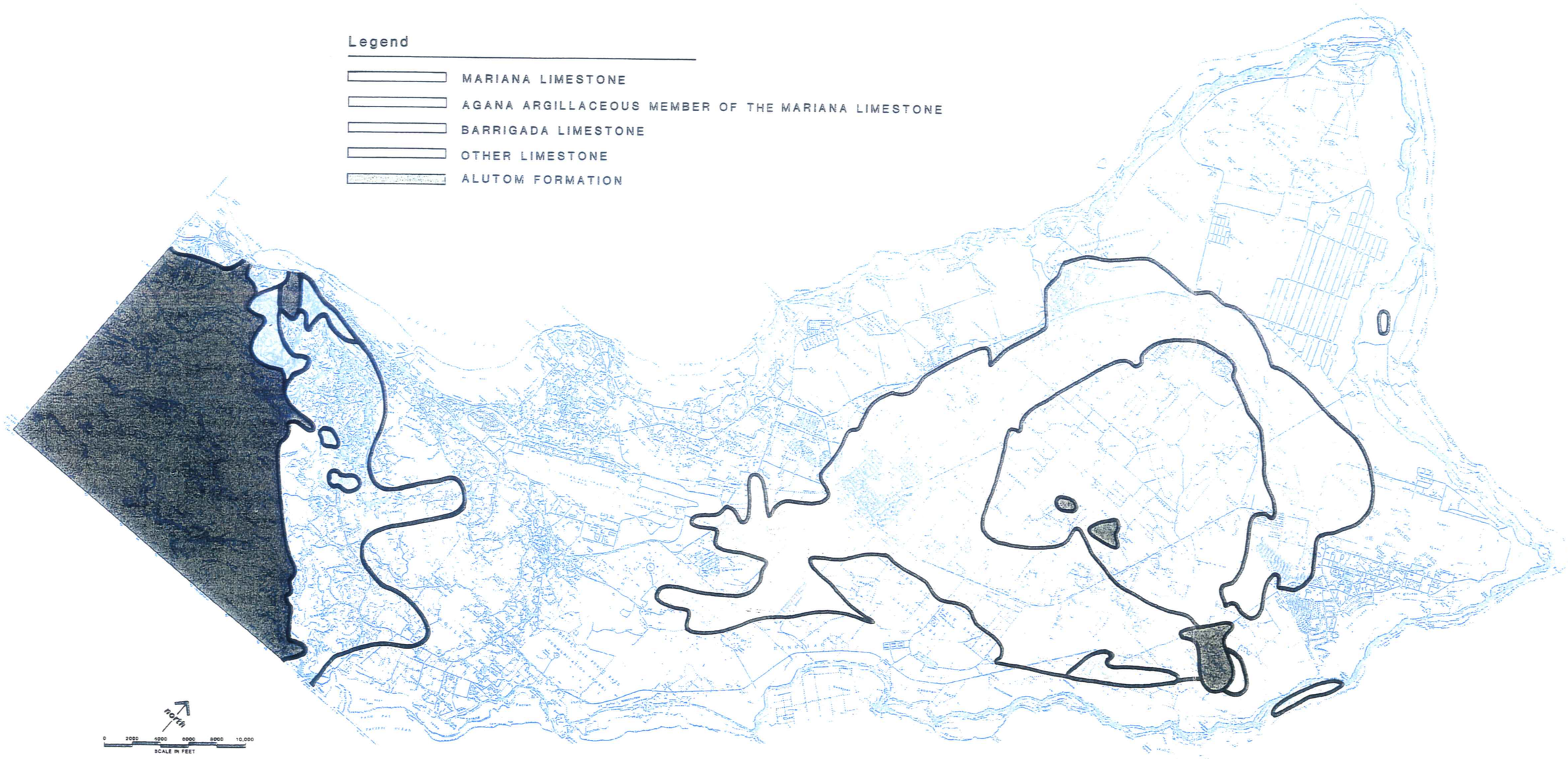
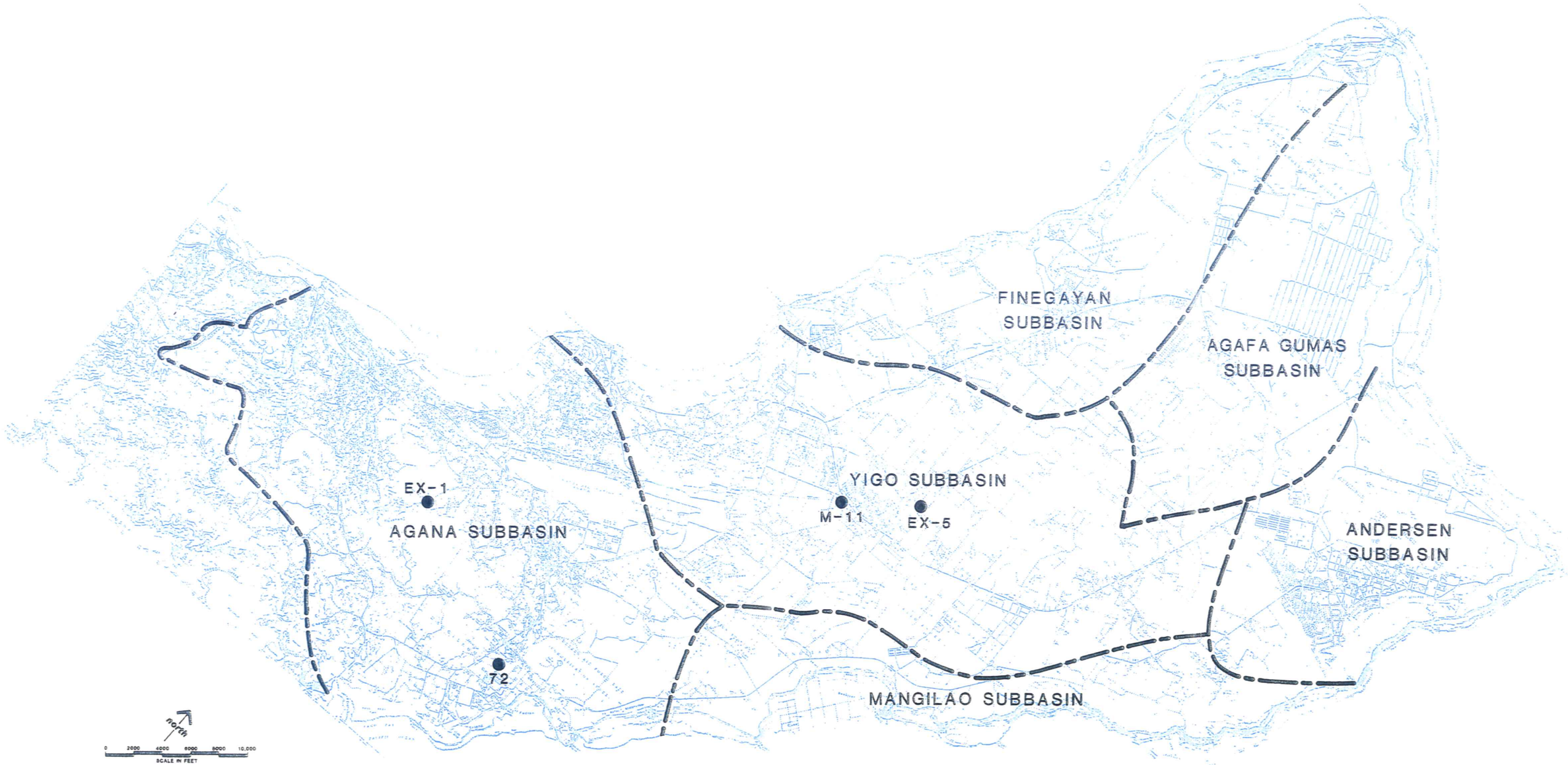


FIGURE 3-4
GENERALIZED GEOLOGY MAP



Legend

GROUNDWATER SUBBASIN BOUNDARY

72 WELL No. 72

FIGURE 4-1

SUBBASIN LOCATION MAP

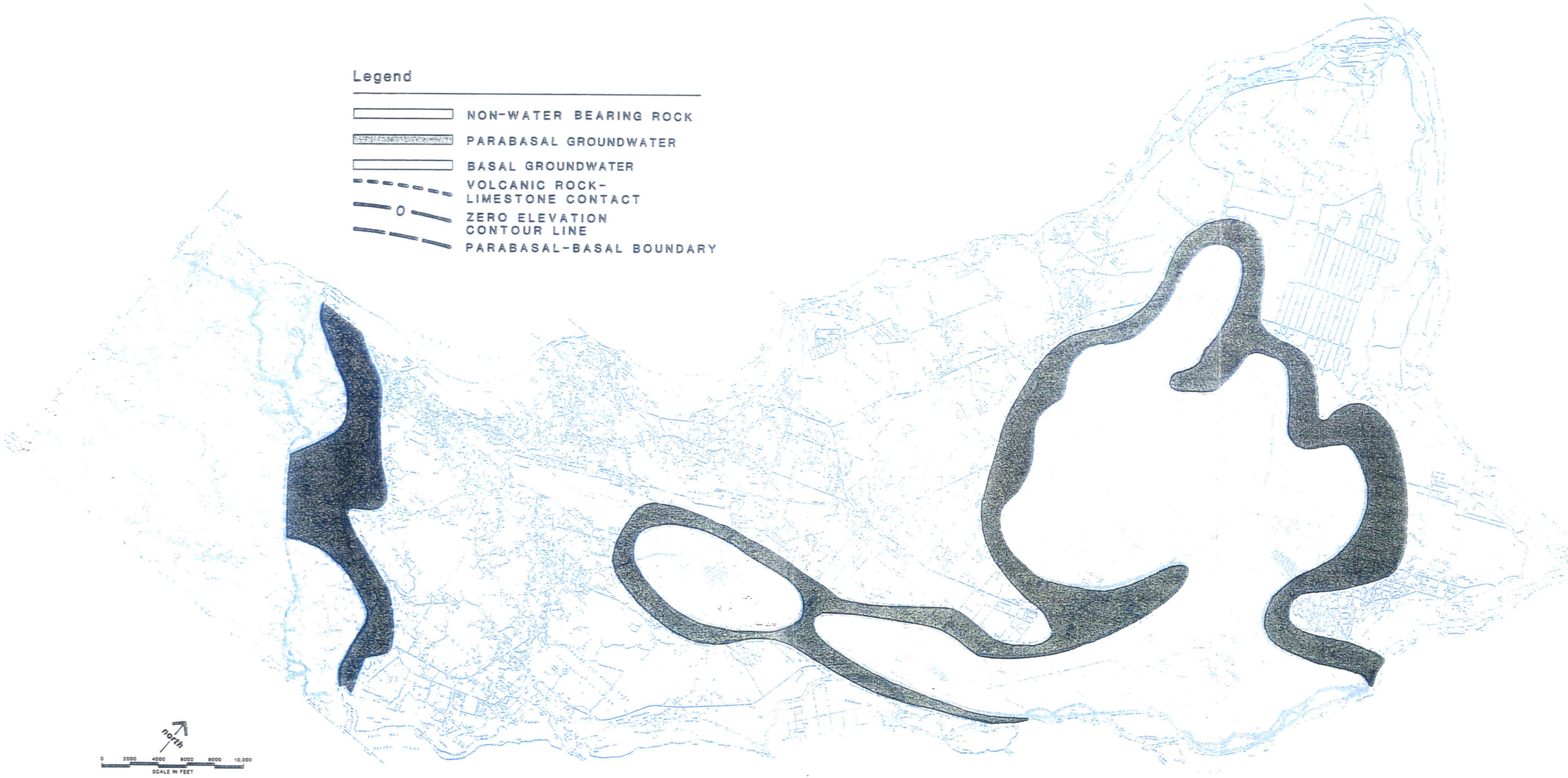


FIGURE 4-2

DISTRIBUTION OF
GROUNDWATER TYPES

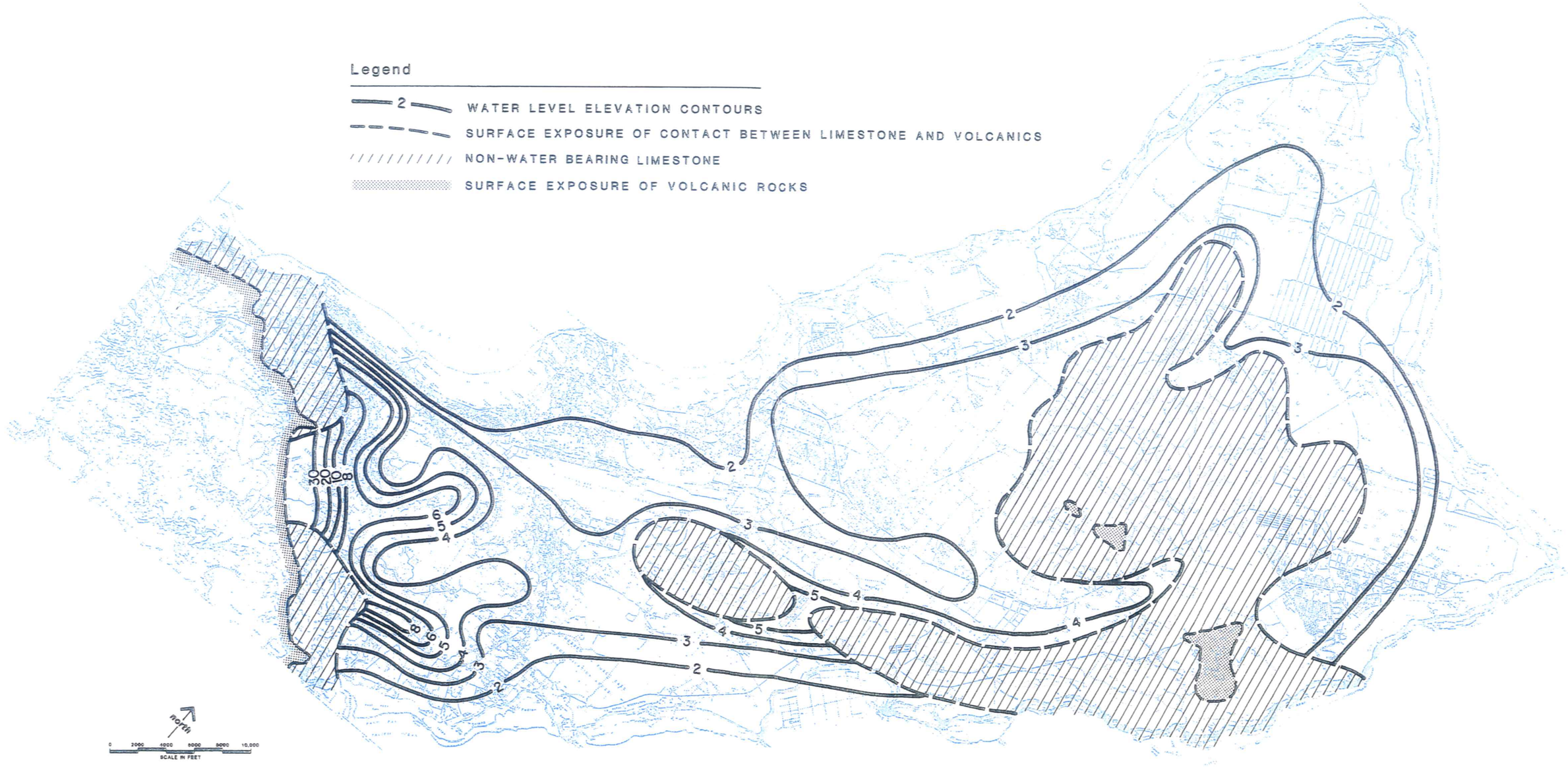


FIGURE 4-3

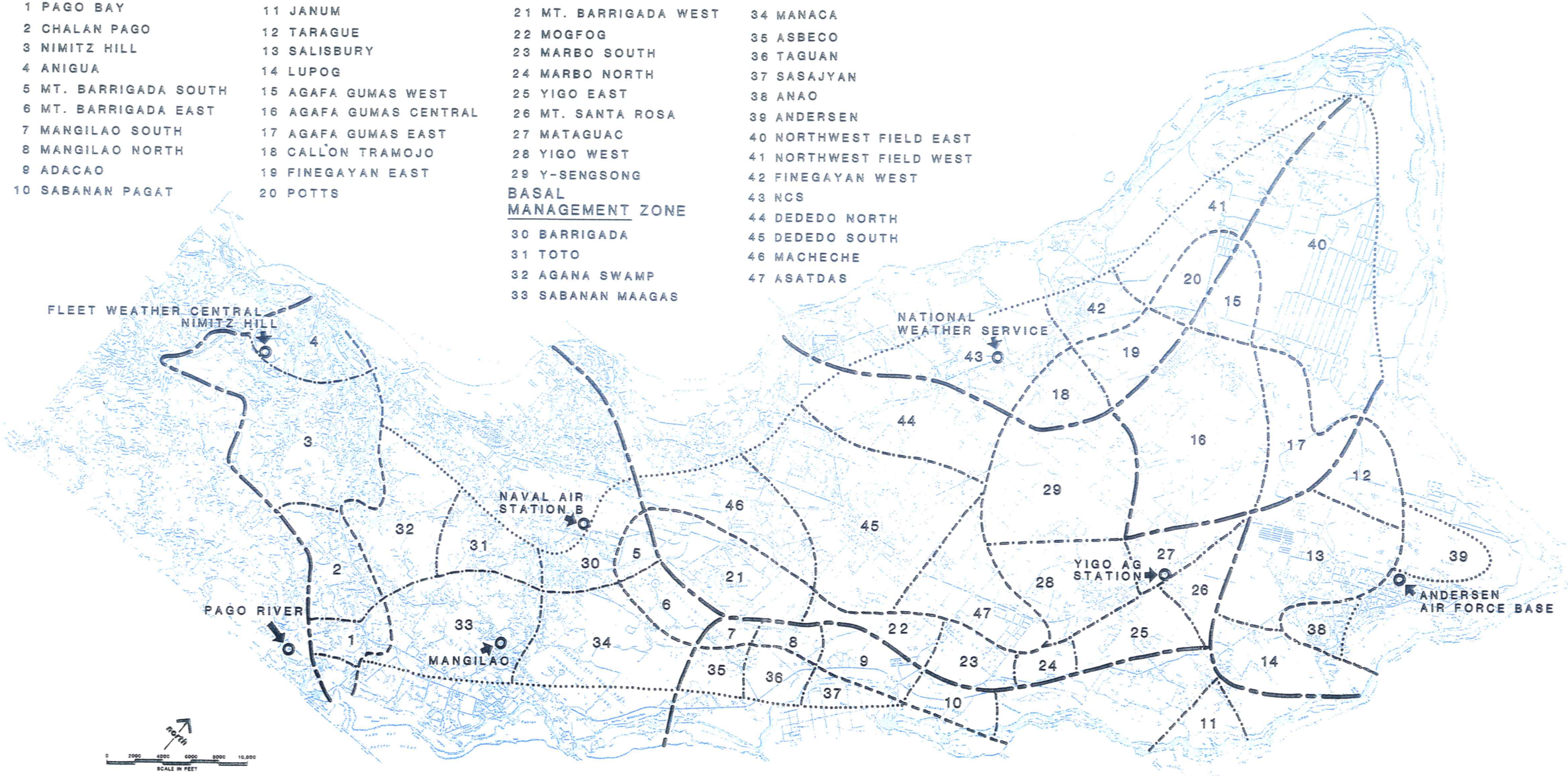
WATER LEVEL CONTOUR MAP
APRIL 1982

PARABASAL
MANAGEMENT ZONE

1 PAGO BAY
2 CHALAN PAGO
3 NIMITZ HILL
4 ANIGUA
5 MT. BARRIGADA SOUTH
6 MT. BARRIGADA EAST
7 MANGILAO SOUTH
8 MANGILAO NORTH
9 ADACAO
10 SABANAN PAGAT
11 JANUM
12 TARAGUE
13 SALISBURY
14 LUPOG
15 AGAFA GUMAS WEST
16 AGAFA GUMAS CENTRAL
17 AGAFA GUMAS EAST
18 CALLON TRAMOJO
19 FINEGAYAN EAST
20 POTTS
21 MT. BARRIGADA WEST
22 MOGFOG
23 MARBO SOUTH
24 MARBO NORTH
25 YIGO EAST
26 MT. SANTA ROSA
27 MATAGUAC
28 YIGO WEST
29 Y-SENGSONG

BASAL
MANAGEMENT ZONE

30 BARRIGADA
31 TOTO
32 AGANA SWAMP
33 SABANAN MAAGAS
34 MANACA
35 ASBECO
36 TAGUAN
37 SASAJYAN
38 ANAO
39 ANDERSEN
40 NORTHWEST FIELD EAST
41 NORTHWEST FIELD WEST
42 FINEGAYAN WEST
43 NCS
44 DEDEDO NORTH
45 DEDEDO SOUTH
46 MACHECHE
47 ASATDAS



Legend

- GROUNDWATER SUBBASIN BOUNDARY
- PARABASAL - BASAL BOUNDARY
- MANAGEMENT ZONE BOUNDARY
- BOUNDARY FOR SAFE PUMPING
- RAINGAGE STATION

FIGURE 5-1

GROUNDWATER MANAGEMENT ZONES
NORTHERN LENS

ANIGUA

NIMITZ HILL

AGANA SUBBASIN

AGANA SWAMP

TOTO

CHALAN PAGO

PAGO BAY

SABANAN MAAGAS

BARRIGADA

MANACA

DEDEDO SOUTH

MACHECHE

MT. BARRIGADA SOUTH

MT. BARRIGADA WEST

MT. BARRIGADA EAST

MANGILAO SOUTH

MANGILAO NORTH

ASBECO

TAGUAN

0 -100 -200 -300 -400 -500 -600

Legend

- GROUNDWATER SUBBASIN BOUNDARY
- PARABASAL - BASAL BOUNDARY
- BOUNDARY FOR SAFE PUMPING
- MANAGEMENT ZONE BOUNDARY
- 100 — ELEVATION CONTOURS OF TOP OF VOLCANICS
- CONTACT BETWEEN LIMESTONE AND VOLCANICS
- SURFACE EXPOSURE OF VOLCANIC ROCKS
- AREA OF POOR QUALITY WATER IN FRESH WATER LENS
- RAINGAGE STATION

north

0 2000 4000 6000 8000 10,000

SCALE IN FEET

FIGURE 7-1 AGANA SUBBASIN

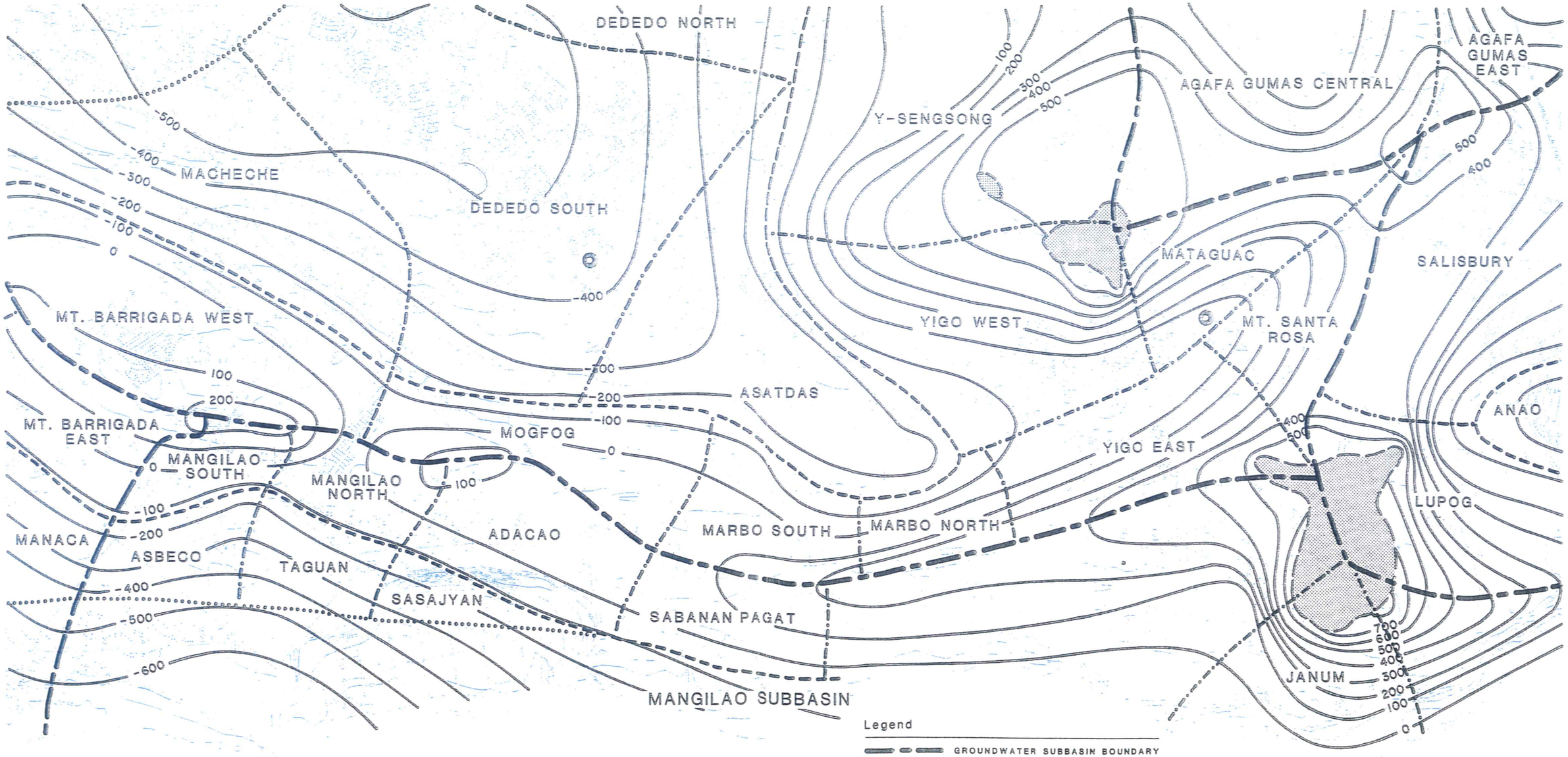


FIGURE 7-2 MANGILAO SUBBASIN

POTTS
AGAFA GUMAS WEST
NORTHWEST FIELD EAST
FINEGAYAN WEST
NCS
FINEGAYAN EAST
AGAFA GUMAS EAST
TARAGUE
CALLON TRAMOJO
AGAFA GUMAS CENTRAL
ANDERSEN
ANDERSEN SUBBASIN
Y-SENGSONG
SALISBURY
MATAGUAC
MT. SANTA ROSA
ANAO
YIGO WEST
YIGO EAST
LUPOG
ASATDAS
MARBO NORTH
MARBO SOUTH
JANUM

Legend

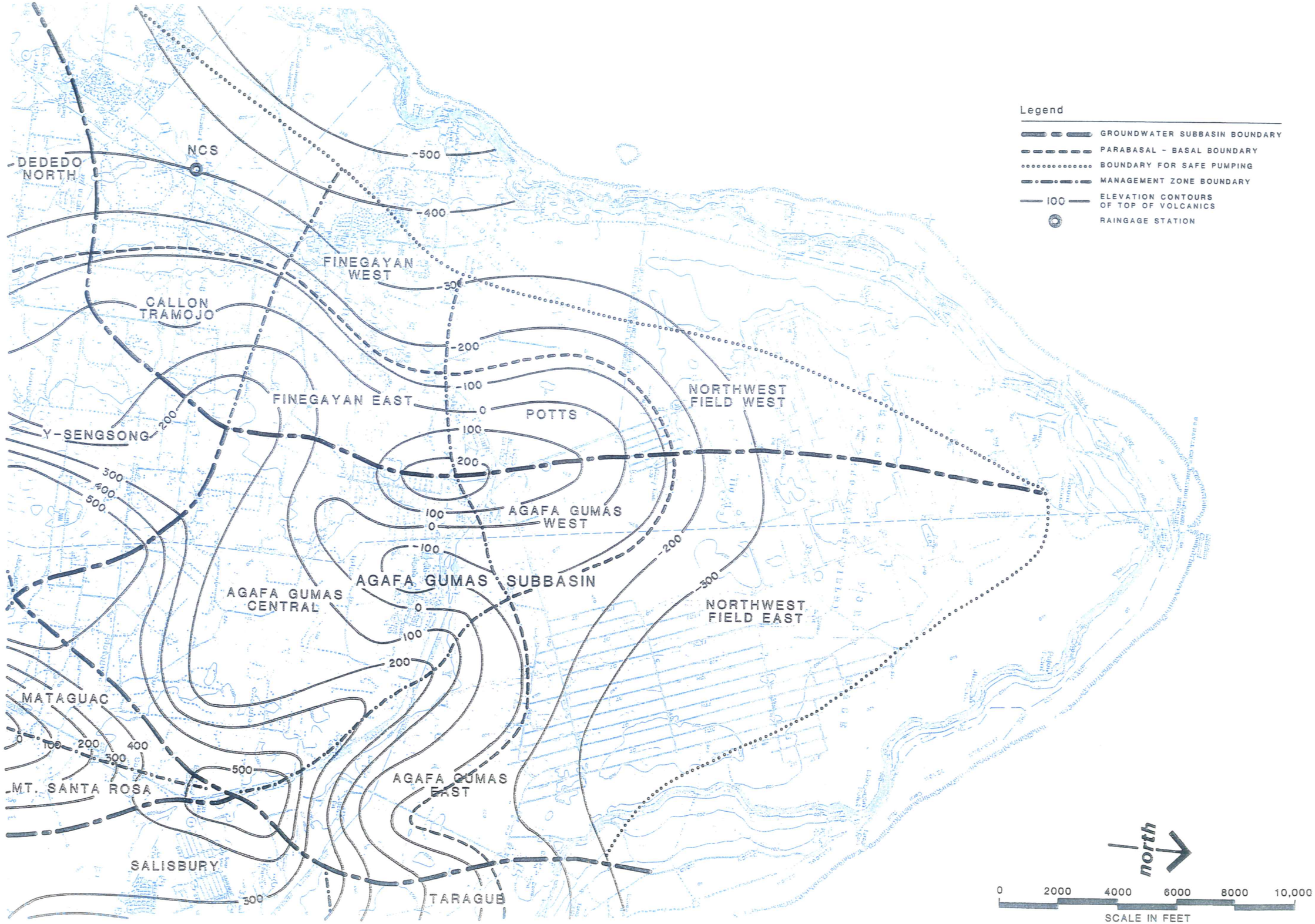
- GROUNDWATER SUBBASIN BOUNDARY
- PARABASAL - BASAL BOUNDARY
- BOUNDARY FOR SAFE PUMPING
- MANAGEMENT ZONE BOUNDARY
- 100 — ELEVATION CONTOURS OF TOP OF VOLCANICS
- CONTACT BETWEEN LIMESTONE AND VOLCANICS
- SURFACE EXPOSURE OF VOLCANIC ROCKS
- RAINGAGE STATION

north

0 2000 4000 6000 8000 10,000

SCALE IN FEET

FIGURE 7-2 ANDERSEN SUBBASIN


Legend
GROUNDWATER SUBBASIN BOUNDARY
PARABASAL - BASAL BOUNDARY
BOUNDARY FOR SAFE PUMPING
MANAGEMENT ZONE BOUNDARY
100
ELEVATION CONTOURS OF TOP OF VOLCANICS
RAINGAGE STATION
DEDEDO NORTH
NCS
FINEGAYAN WEST
CALLON TRAMOJO
FINEGAYAN EAST
Y-SENGSONG
POTTS
NORTHWEST FIELD WEST
AGAFA GUMAS WEST
AGAFA GUMAS SUBBASIN
AGAFA GUMAS CENTRAL
NORTHWEST FIELD EAST
MATAGUAC
AGAFA GUMAS EAST
MT. SANTA ROSA
SALISBURY
TARAGUB
-500
-400
-300
-200
-100
0
100
200
300
400
500
north
0 2000 4000 6000 8000 10,000
SCALE IN FEET

north

0 2000 4000 6000 8000 10,000

SCALE IN FEET

Legend

- GROUNDWATER SUBBASIN BOUNDARY
- PARABASAL - BASAL BOUNDARY
- BOUNDARY FOR SAFE PUMPING
- MANAGEMENT ZONE BOUNDARY
- 100 — ELEVATION CONTOURS OF TOP OF VOLCANICS
- RAINGAGE STATION

FINEGAYAN SUBBASIN

NORTHWEST FIELD WEST

NORTHWEST FIELD EAST

POTTS

FINEGAYAN WEST

AGAFA GUMAS WEST

NCS

FINEGAYAN EAST

DEDEDO NORTH

CALLON TRAMOJO

AGAFA GUMAS CENTRAL

AGAFA GUMAS EAST

DEDEDO SOUTH

Y-SENGSONG

TARAGUE

FIGURE 3-5 FINEGAYAN SUBBASIN