Palm Springs Resort

An Environmental Assessment on a proposed first class, five-star resort at Ngerur Island, Koror, Palau
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EXECUTIVE SUMMARY

On April 30, 2001, the Environmental Quality Protection Board (EQPB) issued an Earthmoving Permit (PEA 085-2001) to Morita Hotel Corporation, Incorporated for the proposed development and operation of a hotel resort project, known as the “Quest Resort” located within Ngerur Island – approximately 750m northwest of Arakebesang Island in Koror State, Republic of Palau. Quest Resort was approved by the EQPB after submission of Environmental Impact Statement (EIS) in November 2000 and series of consultations and public hearing conducted for the Project. A copy of PEA 085-2001 is shown in Appendix 1.

Due to financial problems, Morita Hotel Corporation was unable to implement the Quest Resort Project. As a result, no earthmoving activities had taken place within Ngerur Island. Earthmoving Permit PEA 085-2001 expired on March 31, 2005.

In December 2017, a new proponent, Palau Palm Springs Investment Development, Ltd, signifies its intention to develop the proposed project in accordance with the original plan and scope of work as indicated in the EQPB Permit PEA 085-2001. The project is now identified as “Palm Springs Resort.”

The main objective of the project is to provide a first class, five-star resort on Ngerur Island. PPSIDL proposes to develop an exclusive, low density, high-end resort that will encompass the entirety of the existing, uninhabited, privately-owned island of Ngerur (Ngurur) in Koror State, Republic of Palau.1

Design of physical facilities and service levels provided to the resort guests will illustrate elegant sophistication within the framework of reasonable development and responsible consideration and stewardship of the environment2. The project is aimed at developing an independently operated resort without significantly increasing the demand for public utilities in Koror and Palau whilst meeting the needs of the tourism sector and bringing additional benefits to Palau’s economy.

In summary, the project aims to:

- Run a professional, profitable and ethical company, building relationships with customers, suppliers, local government of Koror State and the national government of Palau;

- Operate a resort island, furnished and equipped to the top of standards;

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1 Final Environmental Impact Statement for Quest Resort Palau, November 2000
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- Provide complete satisfaction to clientele in terms of facilities and service standards, food and beverage and related products, at a fair price;

- Manage the resort by human resource policies which encourage and reward individual and unified effort and achievement, provide training and personal development opportunities and create a working environment in which staff can feel a real sense of job involve; and,

- Seek to comply with all statutory legislation and other external relevant authorities, define and keep under review Company policy, allowing flexibility for local requirements.

The proposed Palm Springs Resort project development encompasses the entirety of the island of Ngerur. Ngerur Island is a small island of approximately 5.2 hectares situated within Palau Lagoon. The Island extends about 350m in a north-south direction and approximately 250m in an east-west direction. A shallow fringing reef varying in width from 15 to 76m surrounds this uninhabited island.

The Ngerur Island is owned by Ngerur Island Corporation under Certificate of Title LC 355-98 particularly described as Cadastral Lot No. 029 A 01. The proponent, Palau Palm Springs Investment Development Limited, was issued with a Certificate of Approval No. 644-2018 by the Foreign Investment Board (FIB) of the Republic of Palau to construct and operate a five star resort facility at Ngerur Island. A copy of the FIB Certificate is attached in Appendix 3.

A Lease Agreement between Ngerur Island Corporation, represented by Shallum Etpison and the project proponent represented by Dong Li and Gang Zeng, was executed on January 26, 2018 for the use of Cadastral Lot 029 A 01 (Ngerur Island) as an exclusive, low-density high-end resort. Copies of the Lease Agreement and Certificate of Title are presented in Appendix 4.

The proposed Palm Springs Resort is intended for a growing number of affluent, international travelers to Palau. As envisioned, the Palm Springs Resort will be a small scale, high-end resort of 60 deluxe visitor accommodations on Ngerur Island. In its existing state, Ngerur Island is a privately owned and accessible only by boat. These conditions will remain unchanged as a result of resort development. Visitors will venture to the island resort to experience privileged seclusion in exotic tropical surroundings.

The design and master plan of the Palm Springs Resort will take full advantage of the spectacular views and existing natural environment that contribute to the remote island character of Ngerur. A proposed dive grotto on the southwest corner of the island and

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3 Final Environmental Impact Statement for Quest Resort Palau, November 2000
4 Final Environmental Impact Statement for Quest Resort Palau, November 2000
beach improvements along the western coast are additional luxuries intended to promote Ngerur Island as an exceptional destination for recreation and retreat\textsuperscript{5}.

The Palm Springs Resort will encompass 60 visitor accommodations with an overall density of approximately 12 units per hectare. The general organization of the proposed development is as follows: 58 deluxe bungalows and two (2) VIP bungalows will be situated in the northern two-thirds of the island. Forty four (44) deluxe bungalows are proposed to be accommodated in 11 two-storey buildings whereas 14 deluxe bungalows will be accommodated in seven (7) single-storey duplex buildings. Forty (40) guest bungalows will be arranged along the elevated coastline of the island and 20 bungalows will be aligned within the interior of the island.

The southern third of the island will contain the public areas used for guest arrival/departure, lobby functions, restaurants, conference room, swimming pool with outdoor bar and a fitness area including a gym, Jacuzzi pools, massage/treatment and aerobics room. Spaces for the management, housekeeping and engineering functions will also be situated in this part of the island. A harbor area including a guest dock and recreational equipment storage area will be located along the southeastern shoreline of Ngerur Island.

The total square footage of the proposed Palm Springs Resort is estimated at approximately 10,220 to 11,037 square meters (m\textsuperscript{2}). Deluxe guest bungalows will comprise approximately 72 m\textsuperscript{2}. Lanai, garden and deck areas associated with each bungalow will be roughly 43 m\textsuperscript{2}.

The proposed Palm Springs Resort will create an estimated daily water demand of 45,000 gallons per day (gpd) according to the supporting calculations. The daily flow would be approximately 20 gpm with peak flow at 60 to 80 gpm. Potable water storage for the resort including the required fire protection storage plus the peak day demand is estimated at approximately 150,000 gallons. As the Final EIS for Quest Resort Palau has been approved by the EQPB in 2001, the daily water demand calculated in the EIS was used in this EA.

Ngerur Island does not appear to have an aquifer that can sustain the average daily water demand for the proposed resort. An on-site potable water supply system will therefore include the treatment of seawater via a process of reverse osmosis (RO).

The RO system will extract the salt from the seawater through fine membranes. Concentrated waste (called brine) will be generated as a by-product of the RO system and discharge into the dredged harbor. The harbor is not intended for recreational uses (i.e., swimming, kayaking, snorkeling, etc.).

\textsuperscript{5} Final Environmental Impact Statement for Quest Resort Palau, November 2000
The wastewater generation rate for the proposed Palm Springs Resort is estimated at approximately 30,000 gpd of domestic wastewater. The wastewater generation is estimated to be 80% of the total water demand of the resort project. The wastewater generation rate from the “Final EIS for Quest Resort Palau” is used in this EA. The calculation is presented in the following table.

The on-site wastewater collection system will include 6-inch gravity sewers that convey effluent to the treatment plant located in the infrastructure building. One small sewage pump station located adjacent to the infrastructure building will serve only the kayak hut bathroom. Pumps (around 1 horsepower) and alarms indicating pump failure, high water levels, etc.) will be provided. The wet well will be slightly oversized to provide additional storage thereby allowing corrective actions to be taken prior to a spill event.

The treatment system will consist of a Jokaso wastewater treatment system. In Japan, "Jokaso" literally means "purification tank onsite wastewater treatment system" in Japanese.6

The Jokaso wastewater treatment system is currently manufactured in Japan and supplied by Fuji Clean Co., Ltd. The resort owner will order a Jokaso system to accommodate the projected design sewage flow of 30,000 gallons per day (115 m³/day). Depending on the capacity of each Jokaso unit, several units can be combined for optimal efficiency.

The effluent quality of a Jokaso wastewater treatment system is <15 mg/L of BOD and <20 mg/L of suspended solids (SS). The Jokaso effluent quality is accredited by the Building Center of Japan.

Oil/water separator will be installed to separate oils from wastewater discharge from the kitchen restaurant of the resort. The effluent from oil/water separator is discharged to the Jokaso sewage treatment plant to undergo further treatment.

Treated wastewater will be conveyed via a 6-inch HDPE pipe to a location northeast of the island and discharged approximately 100 feet (30.5 meters) below the ocean surface. Analysis using the PLUME model that was developed by the U.S. Environmental Protection Agency (EPA) indicates that "the receiving water would rapidly dilute the small volume of treated wastewater effluent generated from the Quest Resort" and "the dilution would be so rapid that all Class AA water quality criteria would be easily met within a zone of mixing 130 feet in radius around the discharge point" (Sea Engineering, Inc., 1999).8 The studies by Sea Engineering, Inc. indicate that the

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6 fujiclean.co.jp, 2018
7 Final Environmental Impact Statement for Quest Resort Palau, 2000
8 Final Environmental Impact Statement for Quest Resort Palau, 2000
discharge plume will not reach the lagoon surface because at 49 feet below sea level the plume becomes virtually indistinguishable from the receiving water with an average initial dilution ratio of over 1,000 to 1.

Runoff will be collected by an island-wide system of storm drains associated with infiltration trenches.

Solid waste generated at the Palm Springs Resort will primarily be domestic in nature (paper, plastics, packaging, waste food, etc.). Refuse collection and solid waste disposal will be contracted to a service provider and coordinated with the Bureau of Public Works (BPW) to ensure proper disposal to an operational landfill.

Solid waste will be compacted to reduce the volume of disposed waste from the island. Approximately up to 345 kg per day (760 lbs/day) of solid waste will be generated. Solid waste generation calculation in the Final EIS Report for Quest Resort Palau is adapted in this EA.

Solid waste will be transported by boat. The intent of the resort operator is to install a trash compactor within the island thereby reducing the volume of refuse. Although the weight of the waste remains the same, a reduced volume will extend the life of the landfill. The resort will institute waste separation and recycling procedures in order to take advantage of existing, and hopefully expanding, recycling facilities in Palau.

Electrical carts will be made available for the transport of all guests to their bungalows.

The proposed project is well equipped to accommodate persons with physical disabilities. Disabled guests arriving in Palau will be transported, with any assistance they need, from the airport to the Palm Springs Resort. Transport boats will include the ability to handle wheel chairs and potential other needs.

The Palm Springs Resort does not intend to tap electrical power from the Palau Public Utility Corporation (PPUC) and implement the original plan in the “Final EIS for Quest Resort Palau” to install submarine cable from a location near the Palau Pacific Resort to the island. This will therefore eliminate potential impacts to the bottom of the ocean and marine environment.

Instead, three (3) diesel generators with 1,800 kW each will be used as main power supplies for the Palm Springs Resort. Two (2) generators will be used alternately while the other generator will be used as stand-by/back up purpose. It is proposed that one variable power distribution substation and a dry-type transformer are set up within the first floor of the building. Equipment with low noise generation is selected.
Generator sets will be provided with enclosure to significantly reduce the noise generation. “Room inside the room” design concept is adopted for control. With these controls in place, the noise generation should be no more than 50 dBA.

Potable water will be used for the fire protection system consisting of fire pumps and water storage facilities. The fire storage volume of 60,000 gallons along with an emergency water storage volume of 90,000 gallons means the potable water reservoir (including the fire storage allotment) should contain, at a minimum, 150,000 gallons. This volume meets the intent of emergency and fire storage requirements. The fire pumps are proposed to be located in the basement of the main structure on Ngerur Island and be plumbed into the potable water distribution system. Two fire pumps will be installed for duty/standby operation. Each pump will have a 50 horsepower motor and be rated for 500 gpm at 100 psi.

A small harbor is proposed at the southeast corner of the island. The harbor would support the docking of vessels that carry resort guests and their luggage from Koror to Ngerur Island, vessels that would be used for water recreation activities (e.g., scuba diving, sightseeing, fishing, kayaking, etc.), and vessels that transport employees and supplies to the island.

Vessels that will dock at the proposed resort are generally expected to be powerboats ranging in size from about 7.6m (25 ft) to 15m (50 ft) in length. The proposed harbor is located in an area where a wide (30 to 61m) shallow, rock, cobble and sediment bench extends in front of the shore, as shown in Figure 2-16. The 3m (10 ft) depth is up to 122m (400 ft) offshore. This location is partially sheltered from prevailing trade winds and direct wave approaches. The sediment bench is almost daily exposed when the water level is at -0.6m (-2 ft) MSL.

Dredging for the entry channel and turning basin for the harbor is proposed to create a depth of -3.65m (-12 feet) MSL, which means that the lagoon floor will be excavated to an average of 3m (10 ft) below its existing depth. Approximately 50 percent of the area proposed to be dredged for the harbor development including the entry channel and turning basins is located on the sediment bench, thereby keeping the coral areas to be disturbed by dredging activities to a minimum.

Dock construction involves the creation of interior land. A central area of approximately 0.2 hectares between the two dock facilities will be created with dredged material and protected by a vertical cemented rock wall. The area will serve as water access for kayaks as well as provide building space for kayak storage, scuba equipment, and maintenance, etc. The calculated elevation of this area will be +1.8m (+6 ft) minimum and vary upwards depending upon the distance from the edge of the water.
It is estimated that approximately 20,000 cubic yards (CY) of bottom material will have to be removed to bring the harbor area to approximately 12 feet (3.6 meters) below sea level. Approximately 50 percent of the area proposed to be dredged for an entry channel and turning basin would occur within the area defined by the sediment bench. Approximately 65 percent of this sediment bench area will be dredged to -12 feet (3.6 meters) MSL; the remaining 35 percent will be filled to +6 feet (1.8 meters). The damage to vibrant coral areas would therefore be kept to a minimum. The dredged material is expected to be characterized as primarily volcanic breccia with pockets of sand and coral fragments. It is proposed that this material be used for construction on the island.

A small natural embayment on the southwest corner of the island will be developed into a protected saltwater pool. Creation of a rock grotto to be used primarily for SCUBA diving training will require excavation into the existing rocky nearshore area.

Wave protection will be provided by two offshore breakwaters of similar design to the rock groins used for beach stabilization. Both breakwaters will be approximately 60 feet (18.2 meters) long. These will protect the dredged pool that is 120 feet (36.4 meters) in diameter and approximately 6 to 8 feet (1.8 to 2.4 meters) deep.

Dredging in the nearshore grotto area to create adequate depths for swimming and diving is expected to remove approximately 3,500 CY of bottom material. The dredged material is expected to be characterized as primarily volcanic breccia with pockets of sand and coral fragments. It is proposed that this material be also used for construction on the island.

The proposed site for beach improvements is located along the western coast at the beginning of the northern third of the island.

Proposed stabilization structures will be rock groins constructed perpendicular to the shore at both ends of the beach. The groins will be constructed using 1,000 to 2,500 pound armor stone similar in characteristics to that occurring naturally around the island, placed over a core of 5 to 250 pound stone. The stone will be placed to form an irregular surface, and the crest elevation shall vary from +5 feet (+1.5 meters) to +7.5 feet (+2.3 meters), in order to create a more natural appearance. Cavities in the crest will be created for landscaping with salt tolerant vegetation.

The beach crest will be about 150 feet (45.6 meters) long and approximately 50 feet (15.2 meters) wide. Including the beach slope, this will result in a dry beach width of about 50 to 70 feet (15.2 to 21.2 meters) at high tide and over 100 feet (30.4 meters) at low tide. The sand fill will be stabilized by a north and south groin, each approximately 120 feet (36.4 meters) long. The relatively shallow near shore water depth at this
location necessitates constructing the beach toe at an approximate depth of minus 4 feet (1.2 meters).

The total cut volume on the island is estimated at approximately 14,200 cubic meter (m$^3$) (18,500 cubic yard (CY)) with approximately 7,000 m$^3$ (9,000 CY) or roughly 50 percent of the total cut volume attributed to the main structure of the resort. The total fill volume is projected at 2,100 m$^3$ (2,800 CY). Excess cut volume (12,000 m$^3$ or 15,700 CY) will be exported off-island and be available for sale as fill material to private customers, to the government, or to quarries for further processing.

The projected dredged volume generated by project actions is estimated at approximately 18,000 m$^3$ (23,500 CY). Roughly 20 percent of this material will be used as fill material for the marine facilities and improvements. The remaining dredged material will be exported off-island for sale as fill material.

The 6th Koror State Legislature passed on September 21, 1999, Bill No. 6-42 LDI, identified as “Rezoning of Ngerur Island”. The official Koror Zoning Map was amended to re-zone the area known as Ngerur Island from CD (Conservation) to RV (Resort Center Zone). A copy of the Rezoning Permit is presented in Appendix 6.

An amendment to the Republic of Palau Marine and Freshwater Quality Regulations, Chapter 2401-11-42 on September 19, 2000 included the “Waters extending 200m from the shoreline of Ngerur Island” as a Class B Surface Water. A copy of the signed Amendment is attached as Appendix 7.

A Memorandum of Agreement between Ngerur Corporation and the Historical Preservation Office – Bureau of Arts and Culture (HPO-BAC) was signed by both parties on April 23, 2018 and May 7, 2018 respectively. Appendix 8 provides a copy of the Historical Clearance.

The applicant proposes to commence the construction of the Palm Springs Resort by August 2018 upon securing all the required government permits and licenses including the Earthmoving Permit. It is envisaged that construction activities for the project will be undertaken within 18 months. Commissioning of the Palm Springs Resort is expected by February 2020.

The proposed Palm Springs Resort is estimated to cost approximately Sixty -Six Million US Dollars ($66,000,000.00).

Several alternatives were considered for the proposed Palm Springs Resort Project. The “No Action” Alternative is always considered an option to the proponent even before the project was conceptualized.
The alternatives considered with respect to the proposed Palm Springs Resort Project include water, wastewater, fire protection and electrical system options. An alternative maximum density resort development was also considered. Consequently, the alternatives discussed Section 3 include various infrastructure options that were considered and eliminated in favor of the proposed infrastructure systems discussed in this EA.

Baseline marine environmental survey was conducted by Pentec Environmental, Inc. on April, 1999 and results were accordingly presented in the submitted EIS for Quest Resort in November, 2000. The baseline information presented thereof will serve as reference for the assessment of NECO team of the existing conditions of the island to date.

On January 22, 2018, water samples for water quality analysis were collected using grab method at four (4) strategic point locations around the island where developments will be made based on the available conceptual plan.

Water samples were analyzed by Metiek Ngirochehol of Palau EQPB for presence of *Enterococci* using the IDEXXEnterolert Method with incubator set at 41°C. Turbidity was measured following the EPA 180.1 method using Turbidity Meter (Hach 2100P).

Result of the analysis for coliform count and water turbidity from 4 different stations shows that the water in the vicinity is free from any traces of coliform bacteria and is not considered turbid.

Effective October 6, 2000, an amendment to the Marine and Freshwater Quality Regulations, Chapter 2401-11-42 was approved specifically to classify waters extending 200 meters from the shoreline of Ngerur Island to Class B. Copy of the approved amendment is attached as Appendix 7.

On the basis of a past baseline marine environmental survey presented on the EIS for Ngerur Island, an updated baseline marine survey was conducted by Neco ECS team last January 20, 2018.

Previous baseline environmental survey from Pentec, Inc. last 1999 gathered data from areas designed to have improvements based on the conceptual plans. To monitor changes on the environmental setting, a similar transect survey was conducted on these areas with some modification.

Purpose of the marine survey was to revisit the four study areas that were selected and surveyed during the initial marine baseline survey conducted by Pentec back in 1999. The initial survey done by this company was very comprehensive and therefore should be referenced for in depth information about the site.
This present survey was more focused on the current condition of the reef in terms of coral cover. Observations during this survey show that the general condition of the area is still very much pristine. Coral community around the whole island seemed to be in good condition. There is no sign of any recently bleach coral or any sign of major physiographical change over the last two decades. Algal growth was minimal and mostly concentrated on coastal waterline. Thin layer of filamentous algae is coating basalt substrate along the whole stretch of southern side of the island making it slippery. Small patches of two species of soft coral Sarcophyton sp. and Sinularia sp. were observed on eastern side of island.

Massive corals mostly in the family of Poritidae are the dominant species around the island. Branching corals in the same family are second most common. There are other branching corals in the family of Acroporidae which was also observed outside the perimeter of study site T3 and T4 (see map). This distinct zone of branching Acropora corals runs along the east/southeast of the island but in a much deeper area which is out of reach of transect.

The survey team focused only on three biological indicators such as Fish, Invertebrate and Benthic cover. For fish species, the survey team decided to focus only on food fish, however, there were other non-food fish observed in each transect such as cardinal fish, butterfly fish, wrasses, damsels. For Invertebrate species, the team decided to include everything since there was not much in the area. For benthic survey, Line Intercept Transect (LIT) method was used to calculate the percent cover of each transect.

Two men survey team conducted the survey. Transect tape of 50 meter in length was placed along the substrate at each study site indicated by initial baseline survey team on a map. Each transect was laid as close as possible to the coast and extend perpendicular toward deeper water. Surveyors geared up with snorkeling equipment swam the length of transect enumerating fish and invertebrate within one and half meter (2.5m) on both sides of transect tape. Therefore, each transect covers an area of two hundred fifty square meter (5x50 = 250).

On February 26, 1999, a botanical survey was conducted by Dr. Derral Herbst for Ngerur Island. Results of which was gathered for the EIS prepared for then proposed Quest Resort in Ngerur.

On January 20, 2018, NECO ECS team conducted a terrestrial survey to update baseline information of the terrestrial cover of the island. An ocular survey was conducted by boat circling entirely around the island. Overlooking trees and plants were identified and noted. Four transect points were conducted at 75 – 100 meters to represent the north, east, west and south section of the island. At 5 meters interval, all
trees within 1 meter from each transect point were identified and measured. Trees on this survey mean trees measuring more than 2 meters in height.

A total of fifteen (15) species of trees were identified and noted on the four transects that were made. Of this, eleven (11) species are native to Palau, three (3) are introduced species and one (1) as endemic species.\(^9\)

The most prevalent species of tree that was noted is *Pandanus tectorius* or commonly known as Ongor or Ongor ra ked. The flowers and fruits of this tree is used during traditional first childbirth ceremonies in the country. The wood can also be used as posts for building summer houses. Another prevalent tree within the transect is *Calophyllum inophyllum* or locally known as Btaches. The wood of this tree is considered high value as this can be used for boat building, canoes, cabinet work and handicrafts.\(^10\)

An ocular survey was also done on Jan. 20, 2018 covering the entire island. This was done by encircling the island by boat and identifying plant species that can be observed from the shoreline. Below table identifies the different plant species in every directional section of the island.

The bird survey conducted followed the National Bird Monitoring Protocol developed by the Belau National Museum. The protocol requires a 15-minute count for species diversity at a central location on the site where you can simultaneously observe forest and sky.

A bird count was carried out by Ms. Heather Ketebengang of Palau Conservation Society on Jan. 20, 2018 at the proposed development site. The count was conducted in the middle of the island. This particular counting station allows a partial view of the sky, partial view of the ocean, the savannah forest and the other big tree forest.

There were a total of seven (7) birds recorded during the survey. Most of the birds that were counted, were seen or heard from the center of the proposed development site or the surrounding areas. Before the actual count, a White-tailed tropicbird was observed as well as a Palau Fruit Bat.

The negative impacts of the proposed first class high-end resort development will include soil disturbance/erosion and sedimentation, sea disturbance, damage to corals and other marine resources, dust emission, vibration and noise from heavy equipment. These impacts are typical of any type of development and can be mitigated through

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proper erosion control measures and construction management. No substantial degradation to environmental quality is foreseen.

The negative impacts identified after completion of the project construction is the possible increased volume of storm water due to removal of ground cover and paving decreasing the capacity of the area to percolate. This is expected for all development projects. Hence, it is important to properly design the project and incorporate all mitigating measures, e.g., sediment retention/catch basins, rockfill outlets, energy dissipater, etc., in the project final design.

When the resort project becomes operational, the negative impacts identified include sea disposal of brine waste from the desalination process and treated effluent from the Jokaso wastewater treatment system, solid waste and stormwater management. The project will not impact the water and sewerage infrastructures in Koror. Sewage generated by the project will be treated independently onsite and discharge to ocean in compliance with the EQPB water quality standards.

In the long-term, the Palm Springs Resort will be an income-generating activity for the property owner that results in tax benefits to the local and national government. Proposed resort development will result in the productive use of the property, the generation of revenue, the creation of employment opportunities and the provision of recreational resources and accommodations for affluent visitors to Palau. These factors are all viewed as benefits of the Palm Springs Resort project.

An Environmental Impact Statement (EIS) has been prepared for the same scope of the project in 2000. After a series of consultations and public hearing in 2000 ~ 2001, the project was approved and granted an Earthmoving Permit (PEA 085-2001, copy attached in Appendix A). No unresolved issues were identified. The project was not implemented, however, due to financial problem of the former project proponent. PEA 085-2001 expired in 2005.

This EA is prepared and submitted to support the new Earthmoving Permit application by the new project proponent, Palau Palm Springs Investment Development, Limited, to implement the same project with a new project name. The only modification is the elimination of the then approved submarine cable installation for the power supply system. All other infrastructure components of the project remain the same.

The results of this assessment are that the negative impacts that have been identified in this document shall be adequately minimized by the suggested mitigation measures. Therefore, the proposed action should not result in significant impacts on the environment.
1 INTRODUCTION

On April 30, 2001, the Environmental Quality Protection Board (EQPB) issued an Earthmoving Permit (PEA 085-2001) to Morita Hotel Corporation, Incorporated for the proposed development and operation of a hotel resort project, known as the “Quest Resort” located within Ngerur Island – approximately 750m northwest of Arakebesang Island in Koror State, Republic of Palau. Quest Resort was approved by the EQPB after submission of Environmental Impact Statement (EIS) in November 2000 and series of consultations and public hearing conducted for the Project. A copy of PEA 085-2001 is shown in Appendix 1.

Due to financial problems, Morita Hotel Corporation was unable to implement the Quest Resort Project. As a result, no earthmoving activities had taken place within Ngerur Island. Earthmoving Permit PEA 085-2001 expired on March 31, 2005.

In December 2017, a new proponent, Palau Palm Springs Investment Development, Ltd, signifies its intention to develop the proposed project in accordance with the original plan and scope of work as indicated in the EQPB Permit PEA 085-2001. The project is now identified as “Palm Springs Resort.”

This Environmental Assessment (EA) is prepared for the proposed Palm Springs Resort Project. This document provides the information (i.e., project description, existing environmental conditions, impact assessment and mitigation and supporting documentation) necessary to support the new Earthmoving Permit Application and obtain a new Earthmoving Permit /Approval from the EQPB.

The EA for the Palm Springs Resort is prepared in compliance with the EQPB Regulation 2401-61-03, which requires preparation of EA for any and all actions which propose (f) any proposed action which the Board determines may have a significant impact on the environment. As per agreement between the proponent’s representative and the EQPB staff during the Scoping Meeting held on December 1, 2017 at the EQPB Conference Room, an EA will be prepared as supplemental document to the 2001 EIS to support the EQPB Permit Application. The original EIS document is submitted to the EQPB separately.

The EA for this project covers updated baseline information of the environmental values to be impacted by the project construction, potential impacts to the environmental values and proposed mitigating measures. It is expected that all mitigation identified in this EA and recommended by the EA Preparer and the regulatory agency (EQPB), will be incorporated in the final detailed design of the Project.

The earthmoving permit applied for this project shall cover the earthmoving activities for the construction of

- 60 guest bungalows
- Restaurants
- Public recreation areas, including swimming pool, spa and other amenities
• Administrative office space
• Mechanical, storage, service and other support infrastructure, including a public water supply system and wastewater collection and treatment system
• Harbor and dock facility (dredging and filling for breakwater)
• Beach (filling)
• Dive grotto (dredging and filling for breakwater)
• Manager’s cottage and back up electric power generator.

The EQPB is advised that description of the above structures in section 2 of this EA and the Palm Springs Resort were mostly taken from the “Final Environmental Impact Statement (EIS) for Quest Resort Palau” Report. After all, the new project proponent intends to implement the project in accordance with the original plan and scope of work as indicated in the EQPB Permit PEA 085-2001 (Appendix 1).

1.1 The Project Proponent

The Applicant/Project Proponent is Palau Palm Springs Investment Development, Ltd., represented by Dong Li and Gang Zeng. The proponent is engaged in hotel developments in other countries like Four Seasons Hotel in Hong Kong and also in Shenzhen, China. A copy of the FIB Certificate is attached in Appendix 3.

Table 1-1 provides information about the project owner, address and contact information of the Applicant:

<table>
<thead>
<tr>
<th>Name of Project:</th>
<th>Palm Springs Resort</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applicant:</td>
<td>Palau Palm Springs Investment Development, Limited</td>
</tr>
<tr>
<td>Address:</td>
<td>P. O. Box 114, Koror Republic of Palau 96940</td>
</tr>
</tbody>
</table>

1.2 The Project Contractor

The proposed Palm Springs Resort will be constructed by NECO Construction Company. NECO Construction is a subsidiary arm of NECO Group of Companies.

NECO Construction emerged as the leading construction company in Palau due to its good reputation, excellent performance and integration of environmental mitigations during project implementation. Its willingness to incorporate the recommended mitigating measures at a reasonable extent during project construction/ implementation makes NECO Construction Company an environment-friendly builder in the country.

Among its projects include the Etpison Museum, NECO Plaza Building, NECO Marine/Yamaha Facilities, Airport VIP Lounge Renovation, 60 units renovation of the PPR Garden View Room, Palau Community College Three Story Library, Renovation of the Japan Embassy Building, Palau Tourism and Hospitality School of Excellence, Malakal Marine Resource Project Phase II, Palau High School 24-room Dormitory Project and New Pier Project of Palau Pacific Resort.
1.3 The Project EA Preparer

The Project Proponent has chosen and contracted NECO Environmental Consultancy Services (NECO ECS) to act as its EA Preparer and Environmental Consultant for this project.

NECO ECS is a subsidiary arm of NECO Group of Companies that aims to help investors and entrepreneurs alike in pursuing economic development in Palau as well as maintaining and protecting the pristine environment of the country.

Through its competent and efficient team, NECO ECS has been approved by the Environmental Quality Protection Board (EQPB) as a qualified EA Preparer. Since its accreditation in 2009, NECO ECS became one of the leading environmental consultants in the Republic of Palau. NECO ECS approach to assisting its clients during project planning, identifying potential impacts of the proposed development and close coordination with the EQPB during the EA process make NECO ECS a highly sought after environmental consultant in Palau. NECO ECS ensures that its environmental services to client does not end at obtaining the EQPB earthmoving permit but continuous even during the construction phase and up to completion of the project.

NECO ECS has prepared and submitted the EAs and successfully secured the EQPB Earthmoving Permits for similar projects that include:

- Palau Chief Garden Hotel located in Ngerkebesang Hamlet, Koror State, owned by Asia International Tourism Real Estate Development Group Co., Inc.
- Maryland Motel Project located in Meketii, Koror State, owned by Mr Robert Tkel;
- Six80 Apartment Project located in Malakal, Koror State owned by Mr. Bedochel Evron Sadang;
- Palau Reef Pemphis Hotel (The Presidential Hotel) located in Ngermid Hamlet, owned by Etpison Corporation;
- PPR Mountain Villas located within the Palau Pacific Resort in Ngerkebesang, Koror State, owned and operated by the Pacific Islands Development Corporation (PIDC);
- PPR Water Villas located within the Palau Pacific Resort in Ngerkebesang, Koror State, owned and operated by the Pacific Islands Development Corporation (PIDC);
- Wild Orchid Hotel Project located in Malakal Island, Koror State, owned and operated by Wild Orchid Group of Companies.

In addition to the above, NECO ECS has also assisted both government and private clienteles in preparing the required EAs and successfully secured the Earthmoving Permits for their respective projects. All the below projects were constructed in accordance with the EQPB regulations and permit conditions and are now operational:
The Project for Enhancing Coast Guard Capabilities in the Republic of Palau implemented by Japan Agency for Marine Safety (JAMS), Division of Marine Law Enforcement;

WCTC Minimart & Service Station Project in Ngeburch Hamlet, Melekeok State, owned and operated by Western Caroline Trading Company or WCTC;

Ngiwal Subdivision Project located in Tangelbad, Ngermechau Village, Ngiwal State, developed by the Ngiwal State Government, the Ngiwal State Public Lands Authority (NSPLA) and the Kiuluul Economic Development Authority;

Koksai~Ngchesar Compact Connecting Road Project in Ngatpang and Ngchesar States administered by the Bureau of Public Works – Capital Improvement Program – Design and Engineering Office (BPW-CIP-DEO), constructed by Shine Engineering Co and FR Construction Company;

National Emergency Management Office –Emergency Operation Center (NEMO-EOC) Project in Ngerusar, Airai State, administered by the Bureau of Public Works – Capital Improvement Program (BPW-CIP), funded by the European Union (EU) and constructed by Coffel Aire Industries, Incorporated;

FIDC (Airai) Fish Farm Project in Airai State owned and operated by Fortune Investment & Development Corporation (FIDC);

Ivan Rudimch Boat Channel in Ngetkib Hamlet, Airai State.

1.4 Legislative Framework

The Environmental Assessment (EA) for the Palm Springs Resort is prepared in compliance with the Environmental Quality Protection Board (EQPB) Regulation 2401-61-03, which requires preparation of EIA for any and all actions which propose (f) any proposed action which the Board determines may have a significant impact on the environment.

In most instances, an action shall be determined to have a significant effect on the environment if it:

- Involves an irrevocable commitment to loss or destruction of any natural or cultural resource;

- Curtails the range of beneficial use of the environment;

- Conflicts with the Republic of Palau's long-term environmental policies or goals and guidelines as expressed in the Environmental Quality Protection Act and any revisions thereof and amendments thereto, any regulations promulgated thereunder and relevant court decisions;

- Substantially affects the economic or social welfare of the community;

- Substantially affects public health;
- Involves a substantial secondary impacts, such as population changes or effects on public facilities or infrastructure;
- Involves a substantial degradation of environmental quality;
- Substantially affects a rare, threatened or endangered species, or its habitat;
- Detrimentally affects air or water quality or ambient noise levels; or
- Affects an environmentally sensitive area such as flood plain, erosion-prone area, geologically hazardous land, estuary, lagoon, reef area, mangrove swamp, fresh water, or coastal waters.

1.5 EA Process Documentation

The EA Process is dependent on the extent and consequence of the project involved. On this project, the EA Process Documentation was done in accordance with existing outline for environmental assessment preparation. Regular gathering and surveys were done to bring together the necessary data for the completion of the EA. With the maximum support and cooperation of the applicant, consultant and the contractor, the documentation process was made simple yet complete and accurate.

The EA Preparer noted all meetings with the Owner/Applicant, consultation with the government agencies, site visits and surveys related to the proposed hotel project. Presented in Table 1-2 are the activities performed by the EA Preparer prior to finalization and submission of EA Report to EQPB.

The scoping meeting with the EQPB resulted to identification of the main concern and issues that need to be addressed in the EA for this project.

**Table 1-2, EA Process Documentation**

<table>
<thead>
<tr>
<th>Date &amp; Time</th>
<th>Activity</th>
<th>Agenda</th>
<th>Parties Involved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nov. 29, 2017 10:00 AM</td>
<td>Initial meeting with the Applicant</td>
<td>Project Review / Site Visit</td>
<td>Applicant – NECO ECS</td>
</tr>
<tr>
<td>Dec. 1, 2017 9:00 AM</td>
<td>Scoping meeting</td>
<td>Presentation of project to EQPB; Identify the main concern/ issues that need to be addressed in the EA.</td>
<td>EQPB – NECO Architect – NECO ECS</td>
</tr>
<tr>
<td>Jan. 20, 2018</td>
<td>Terrestrial, Marine and Bird Survey</td>
<td>Ocular and Transect survey</td>
<td>EA Preparer – NECO ECS Mr. Foober Skebong – Senior Advisor, Protected Areas Network (MNRET) Mr. Collin Joseph – Manager, Coastal Management Division (Department of Conservation and Law Enforcement, Koror State Government)</td>
</tr>
</tbody>
</table>
In accordance with the EQPB Earthmoving Regulations 2401-1-06, the project developer and contractor are required to participate in a mandatory project concept meeting (otherwise referred to as “scoping meeting”) with the EQPB prior to undertaking any significant earthmoving activities that require the investment of over one hundred thousand dollars ($100,000.00) and/or require the submission of an Environmental Assessment. The purpose of the scoping meeting is to properly assess the potential impact of the project on the Republic of Palau’s environment, to ensure the applicant understand all EQPB rules and regulations, and to raise any other environmental issues relevant to the permit application.

On December 1, 2017, NECO ECS representatives met with the EQPB staff for the scoping meeting. The scoping meeting with the EQPB resulted to identification of the main concern and issues that need to be addressed in the EA for this project. Minutes of scoping meeting is attached as Appendix 2.

1.6 Methodology

In order to collect information for use in the environmental assessment, a thorough process was made to assure accuracy on the gathered data.

Terrestrial survey was undertaken to identify the plants/trees that will be removed from the site. Ocular site inspection by the team was conducted together with the quantitative survey to assess plants, birds and other wildlife in the area.

Analysis and evaluation on the design, plans and survey results generated a comprehensive mitigation measures that would complement in the protection of the underlying environment.

1.6.1 Preliminary Assessment

On November 29, 2017, the NECO ECS team went to Ngerur Island to assess the existing environmental condition. The areas for possible impacts were identified based on the project layout. Areas for biological and water quality investigation were identified based on areas on the island where developments will be constructed.

1.6.2 Marine Survey

On January 22, 2018, water samples for water quality analysis were collected using grab method at four (4) strategic point locations around the island where developments will be made based on the available conceptual plan. Water samples were analyzed by Metiek Ngirchechol of Palau EQPB for presence of Enterococci using the
IDEXX Enterolert Method with incubator set at 41°C. Turbidity was measured following the EPA 180.1 method using Turbidity Meter (Hach 2100P).

1.6.3 Terrestrial Survey

On January 20, 2018, NECO ECS team conducted a terrestrial survey to update baseline information of the terrestrial cover of the island. An ocular survey was conducted by boat circling entirely around the island. Overlooking trees and plants were identified and noted. Four transect points were conducted at 75 – 100 meters to represent the north, east, west and south section of the island. At 5 meters interval, all trees within 1 meter from each transect point were identified and measured. Trees on this survey mean trees measuring more than 2 meters in height. At 4.5 feet from the ground, tree’s circumference was measured known as circumference at breast height (CBH).

1.6.4 Bird Survey

The bird survey conducted followed the National Bird Monitoring Protocol developed by the Belau National Museum. The protocol requires a 15-minute count for species diversity at a central location on the site where you can simultaneously observe forest and sky.

A bird count was carried out by Ms. Heather Ketebengang of Palau Conservation Society on Jan. 20, 2018 at the proposed development site. The count was conducted in the middle of the island. This particular counting station allows a partial view of the sky, partial view of the ocean, the savannah forest and the other big tree forest.
2 PROJECT DESCRIPTION

2.1 Project Objectives

The Applicant “Palau Palm Springs Investment Development Limited (PPSIDL)” proposes to develop a small private island 750m northwest of Arakebesang Island in Koror State. PPSIDL identified the proposed project as “Palm Springs Resort”. The main objective of the project is to provide a first class, five-star resort on Ngerur Island. PPSIDL proposes to develop an exclusive, low density, high-end resort that will encompass the entirety of the existing, uninhabited, privately-owned island of Ngerur (Ngurur) in Koror State, Republic of Palau.¹

Design of physical facilities and service levels provided to the resort guests will illustrate elegant sophistication within the framework of reasonable development and responsible consideration and stewardship of the environment². The project is aimed at developing an independently operated resort without significantly increasing the demand for public utilities in Koror and Palau whilst meeting the needs of the tourism sector and bringing additional benefits to Palau’s economy.

In summary, the project aims to:

- Run a professional, profitable and ethical company, building relationships with customers, suppliers, local government of Koror State and the national government of Palau;
- Operate a resort island, furnished and equipped to the top of standards;
- Provide complete satisfaction to clientele in terms of facilities and service standards, food and beverage and related products, at a fair price;
- Manage the resort by human resource policies which encourage and reward individual and unified effort and achievement, provide training and personal development opportunities and create a working environment in which staff can feel a real sense of job involve; and,
- Seek to comply with all statutory legislation and other external relevant authorities, define and keep under review Company policy, allowing flexibility for local requirements.

2.2 Project Setting

The project is located in the Republic of Palau, which comprises some 340 high and low islands in the southwestern Pacific approximately 805 kilometers (km) north of the equator at latitude 7°20'N and longitude 134°28'E. The Palau archipelago is part of

¹ Final Environmental Impact Statement for Quest Resort Palau, November 2000
² Final Environmental Impact Statement for Quest Resort Palau, November 2000
Micronesia and represents the most Western group of the Caroline Islands. The nearest neighboring island groups of Papua New Guinea, the Philippines and Guam extend in a circular pattern around Palau at an approximate distance of 800km to the south, west and northeast, respectively. Figure 2-1 shows the Palm Springs Resort project setting in relation to its neighboring countries.

The main archipelago consists of an island group that spans an arc more than 160km in length in a north-south direction and 26km across at its widest point in an east-west direction. Islands in the main archipelago include Kayangel, Babeldaoob, Koror, Arakabesan (Ngerkebesang), Malakal, Ngermalk, Anguar and Peleliu. A fringing reef with a lagoon area of approximately 1,450 square kilometers (km²) encloses the archipelago. The outer slopes of the reef system are steep and are in many instances near-vertical with depths of up to 305m within a short distance. It is in these locations that some of the most well known diving spots in Palau are found.

The Republic of Palau is subdivided into 16 states. Ten (10) of these states are located on Babeldaob Island. Koror is presently the most populated state and serves as the commercial and business center for the Republic of Palau. Koror Island comprises approximately 8 km² and rises to 140m above sea level. The island of Koror is connected by bridges to three neighboring islands: (a) Ngerkebesang Island, the site of Palau’s

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second largest hamlet, Meyuns, in the eastern part of the island; (2) Malakal Island, the site of Koror’s port; and, Babeldaob Island, where Palau International Airport is located. Koror Island is connected to the Ngerkebesang and Malakal Islands via causeways while the Babeldaob Island by the Koror – Babeldaob Bridge, otherwise known as Japan-Palau Friendship Bridge.

The greater Koror area is best used as a base for trips to Babeldaob Island, Rock Islands, Peleliu, Angaur and other islands of Palau. It is a destination for visitors who want to enjoy shopping at the markets of its downtown, or to experience some of Palau’s aquatic life. Koror is home to Dolphins Pacific, the largest dolphin research facility in the world. Also in Koror is the Palau International Coral Reef Center, which is an aquarium that features local sea creatures.

2.3 Project Location

The proposed Palm Springs Resort project development encompasses the entirety of the island of Ngerur. Ngerur Island is the smallest and northernmost element of the Koror conurbation that comprises three main inhabited islands (Koror, Arakebesang and Malakal) and three uninhabited islands (Ngerur, Ngerchaol and Ngermalk). Ngerur Island is approximately 750 meters northwest of the westernmost point of Arakebesang Island. Ngerur Island is approximately 6 kilometers from the Central Business District (CBD) of Koror State. Figure 2-2 provides the location map while Figure 2-3 shows the aerial photograph of the proposed Palm Springs Resort.

![Figure 2-2, Project Location Map](source)
Figure 2-3, Aerial View of the Project Site (Ngerur Island)
2.4 Project Site Description

Ngerur Island is a small island of approximately 5.2 hectares situated within Palau Lagoon. The Island extends about 350m in a north-south direction and approximately 250m in an east-west direction as indicated in Figure 2-4. A shallow fringing reef varying in width from 15 to 76m surrounds this uninhabited island.\(^5\)

The Ngerur Island is owned by Ngerur Island Corporation under Certificate of Title LC 355-98 particularly described as Cadastral Lot No. 029 A 01. The proponent, Palau Palm Springs Investment Development Limited, was issued with a Certificate of Approval No. 644-2018 by the Foreign Investment Board (FIB) of the Republic of Palau to construct and operate a five star resort facility at Ngerur Island. A copy of the FIB Certificate is attached in Appendix 3.

A Lease Agreement between Ngerur Island Corporation, represented by Shallum Etpison and the project proponent represented by Dong Li and Gang Zeng, was executed on January 26, 2018 for the use of Cadastral Lot 029 A 01 (Ngerur Island) as an exclusive,

\(^5\) Final Environmental Impact Statement for Quest Resort Palau, November 2000
low-density high-end resort. Copies of the Lease Agreement and Certificate of Title are presented in Appendix 4.

2.5 Site Development Plan

The proposed Palm Springs Resort is intended for a growing number of affluent, international travelers to Palau. As envisioned, the Palm Springs Resort will be a small scale, high-end resort of 60 deluxe visitor accommodations on Ngerur Island. In its existing state, Ngerur Island is a privately owned and accessible only by boat. These conditions will remain unchanged as a result of resort development. Visitors will venture to the island resort to experience privileged seclusion in exotic tropical surroundings.

The design and master plan of the Palm Springs Resort will take full advantage of the spectacular views and existing natural environment that contribute to the remote island character of Ngerur. A proposed dive grotto on the southwest corner of the island and beach improvements along the western coast are additional luxuries intended to promote Ngerur Island as an exceptional destination for recreation and retreat. Figure 2-5 provides the Site Development Plan for the proposed Palm Springs Resort.

2.6 Project Features

The Palm Springs Resort will have several project features as reflected in Figures 2-6 and 2-7:

- The architecture of the Palm Springs Resort will reflect a Pacific tropical style with gracious accommodations in the very traditional and informal manner of Palau;
- Native stonewalls, earth tone materials, broad overhangs, lanais, pools, etc., are indicated in building forms and materials used throughout the site;
- Thin slate style tile in natural green color will be used for roofs;
- Walls will have rich colored plaster finish used in conjunction with local natural black rock at columns, piers and base walls;
- Natural stained hardwood such as teak or mahogany will enrich the buildings;
- Louvers will be used extensively to provide natural shading and ventilations;
- Random cut stone will be used throughout the buildings and lanais;
- Building structures will be primarily precast or cast in place concrete. Concrete masonry units (blocks) are also being considered.

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6 Final Environmental Impact Statement for Quest Resort Palau, November 2000

7 Final Environmental Impact Statement for Quest Resort Palau, November 2000
FIGURE 2-5, SITE DEVELOPMENT PLAN
FIGURE 2-6, HOTEL PERSPECTIVE

FIGURE 2-7, TYPICAL GUEST BUNGALOW

(Note: Floor Plans & Elevations/Details of Building Structures are Provided in Appendix 5 (Digital Copy Only))
2.6.1 Architectural Considerations

The Palm Springs Resort will encompass 60 visitor accommodations with an overall density of approximately 12 units per hectare. The general organization of the proposed development is as follows: 58 deluxe bungalows and two (2) VIP bungalows will be situated in the northern two-thirds of the island. Forty four (44) deluxe bungalows are proposed to be accommodated in 11 two-storey buildings whereas 14 deluxe bungalows will be accommodated in seven (7) single-storey duplex buildings. Forty (40) guest bungalows will be arranged along the elevated coastline of the island and 20 bungalows will be aligned within the interior of the island.

The southern third of the island will contain the public areas used for guest arrival/departure, lobby functions, restaurants, conference room, swimming pool with outdoor bar and a fitness area including a gym, Jacuzzi pools, massage/treatment and aerobics room. Spaces for the management, housekeeping and engineering functions will also be situated in this part of the island. A harbor area including a guest dock and recreational equipment storage area will be located along the southeastern shoreline of Ngerur Island.

The total square footage of the proposed Palm Springs Resort is estimated at approximately 10,220 to 11,037 square meters (m$^2$). Deluxe guest bungalows will comprise approximately 72 m$^2$. Lanai, garden and deck areas associated with each bungalow will be roughly 43 m$^2$. A general breakdown of the area estimates for the various spaces or functions is presented in the following table.

<table>
<thead>
<tr>
<th>Space/Function</th>
<th>Approximate Area</th>
<th>Approx. Area</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>m$^2$</td>
<td>ft$^2$</td>
</tr>
<tr>
<td>Guest bungalows</td>
<td>5,946 ~ 7,181</td>
<td>64,000 ~ 77,300</td>
</tr>
<tr>
<td>Public areas</td>
<td>771 ~ 1,068</td>
<td>8,300 ~ 11,500</td>
</tr>
<tr>
<td>Administration</td>
<td>186</td>
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</tr>
<tr>
<td>Food and beverage</td>
<td>613</td>
<td>6,600</td>
</tr>
<tr>
<td>Housekeeping</td>
<td>186 ~ 279</td>
<td>2,000 ~ 3,000</td>
</tr>
<tr>
<td>Spa/Wellness</td>
<td>297 ~ 650</td>
<td>3,200 ~ 7,000</td>
</tr>
<tr>
<td>Mechanical, storage, service</td>
<td>873 ~ 1,059</td>
<td>9,400 ~ 11,400</td>
</tr>
</tbody>
</table>

Appendix 5 (digital copy only) provides the complete set of architectural plans and sections of the proposed Palm Springs Resort.

2.6.2 Infrastructure Considerations

The proposed Palm Springs Resort will generally operate using new infrastructures to be built within the island. The required infrastructure for the resort must accommodate up to 120 guests and 110 support staff in three shifts. Equipment and facilities for water storage, reverse osmosis desalination, water treatment, wastewater treatment and pumping will be located in a dedicated building situated partially underground in the southeastern portion of the island in close proximity to the service doc area.

Infrastructure considerations are summarized as follows:
### 2.6.2.1 WATER SUPPLY SYSTEM

The proposed Palm Springs Resort will create an estimated daily water demand of 45,000 gallons per day (gpd) according to the supporting calculations (refer to Table 2-2). The daily flow would be approximately 20 gpm with peak flow at 60 to 80 gpm. Potable water storage for the resort including the required fire protection storage plus the peak day demand is estimated at approximately 150,000 gallons. As the Final EIS for Quest Resort Palau has been approved by the EQPB in 2001, the daily water demand calculated in the EIS was used in this EA.

#### TABLE 2-2, ESTIMATED WATER DEMAND, PALM SPRINGS RESORT

<table>
<thead>
<tr>
<th>Use</th>
<th>No.</th>
<th>Unit of Measure</th>
<th>Unit Rate (gpd/unit)</th>
<th>Water Demand (gpd)</th>
</tr>
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<tbody>
<tr>
<td>Guest Bungalows</td>
<td>60</td>
<td>Bungalow</td>
<td>315</td>
<td>18,900</td>
</tr>
<tr>
<td>Manager’s Cottage</td>
<td>1</td>
<td>Apartment</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td><strong>Main Structure</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lobby Lounge Level</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lobby Reception</td>
<td>7</td>
<td>Seats</td>
<td>2</td>
<td>14</td>
</tr>
<tr>
<td>Women’s Restroom</td>
<td>150</td>
<td>Flushes</td>
<td>1.5</td>
<td>225</td>
</tr>
<tr>
<td>Men’s Restroom</td>
<td>150</td>
<td>Flushes</td>
<td>1.5</td>
<td>225</td>
</tr>
<tr>
<td>Women’s Locker Room</td>
<td>50</td>
<td>Showers</td>
<td>20</td>
<td>1,000</td>
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<td>50</td>
<td>Showers</td>
<td>20</td>
<td>1,000</td>
</tr>
<tr>
<td>Staff Dining/Kitchen</td>
<td>150</td>
<td>Employees</td>
<td>10</td>
<td>1,500</td>
</tr>
<tr>
<td><strong>Restaurant Level</strong></td>
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<td></td>
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<tr>
<td>Men’s Restroom</td>
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<td>Flushes</td>
<td>1.5</td>
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<td>1.5</td>
<td>150</td>
</tr>
<tr>
<td>Main Dining</td>
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<td>Seats</td>
<td>30</td>
<td>1,800</td>
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<tr>
<td>Wine Dining</td>
<td>40</td>
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<td>30</td>
<td>1,200</td>
</tr>
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<td>Outside Dining</td>
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<td>30</td>
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</tr>
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<td>Bar Dining</td>
<td>50</td>
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<td>20</td>
<td>1,000</td>
</tr>
<tr>
<td><strong>Executive Offices</strong></td>
<td>8</td>
<td>Employees</td>
<td>11</td>
<td>88</td>
</tr>
<tr>
<td><strong>Spa/Recreation Facilities</strong></td>
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<tr>
<td>Salon</td>
<td>20</td>
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<td>200</td>
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<tr>
<td>Multi-purpose Room</td>
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<td>Units</td>
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<td>Vichy Shower</td>
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<td>(estimate)</td>
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<td>1,920</td>
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<td>Hydrotherapy Pool</td>
<td>2</td>
<td>Gal refill/day</td>
<td>77</td>
<td>154</td>
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<tr>
<td>Spa Suite</td>
<td>15</td>
<td>Uses</td>
<td>50</td>
<td>750</td>
</tr>
<tr>
<td>Swim up Pool Bar</td>
<td>18</td>
<td>Seats</td>
<td>2</td>
<td>36</td>
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<tr>
<td>Pool Bar</td>
<td>10</td>
<td>Seats</td>
<td>2</td>
<td>20</td>
</tr>
<tr>
<td><strong>Pool</strong></td>
<td>150</td>
<td>Persons</td>
<td>10</td>
<td>1,500</td>
</tr>
<tr>
<td><strong>Changing Rooms</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Toilets</td>
<td>100</td>
<td>Flushes</td>
<td>1.5</td>
<td>150</td>
</tr>
<tr>
<td>Lavatories</td>
<td>100</td>
<td>Uses</td>
<td>1.5</td>
<td>150</td>
</tr>
<tr>
<td>Cold Plunge</td>
<td>2</td>
<td>Gal refill/day</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>Jacuzzi</td>
<td>2</td>
<td>Gal refill/day</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>Washer</td>
<td>2</td>
<td>Units</td>
<td>75</td>
<td>150</td>
</tr>
<tr>
<td>Dryer</td>
<td>2</td>
<td>Units</td>
<td>75</td>
<td>150</td>
</tr>
<tr>
<td>Showers</td>
<td>4</td>
<td>(estimate)</td>
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<td>2,000</td>
</tr>
<tr>
<td>Sauna</td>
<td>2</td>
<td>Gal/day</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>Steam</td>
<td>2</td>
<td>Gal/day</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td><strong>Staff Housekeeping</strong></td>
<td>40</td>
<td>Uses</td>
<td>20</td>
<td>800</td>
</tr>
<tr>
<td><strong>Water Features</strong></td>
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<td></td>
</tr>
<tr>
<td>System 1</td>
<td>2,240</td>
<td>Sq. Footage</td>
<td>0.312</td>
<td>698</td>
</tr>
<tr>
<td>Systems 2, 3, and 4</td>
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<td>Sq. Footage</td>
<td>0.312</td>
<td>2,082</td>
</tr>
<tr>
<td>System 6</td>
<td>2,080</td>
<td>Sq. Footage</td>
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<td>486</td>
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<tr>
<td>System 7</td>
<td>5,365</td>
<td>Sq. Footage</td>
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<td>1,254</td>
</tr>
<tr>
<td>Plunge Pools</td>
<td>36</td>
<td>Gal refill/day</td>
<td>50</td>
<td>1,800</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td>43,802</td>
</tr>
<tr>
<td><strong>Total (Rounded)</strong></td>
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</tr>
<tr>
<td><strong>Average GPD/unit</strong></td>
<td></td>
<td></td>
<td></td>
<td>750</td>
</tr>
</tbody>
</table>

\[\text{4 per day at }12 \text{ gpm times }20 \text{ minutes} \]

\[\text{20 per day at }5 \text{ gpm times }5 \text{ minutes} \]
Ngerur Island does not appear to have an aquifer that can sustain the average daily water demand for the proposed resort. An on-site potable water supply system will therefore include the treatment of seawater via a process of reverse osmosis (RO).

The RO system will extract the salt from the seawater through fine membranes. Concentrated waste (called brine) will be generated as a by-product of the RO system and discharge into the dredged harbor. The harbor is not intended for recreational uses (i.e., swimming, kayaking, snorkeling, etc.).

The RO system will operate as follows:

- A submerged water intake structure will supply approximately 130,000 gallons of seawater with a total suspended solids (TSS) characteristic of 30,000 to 33,000 ppm to the system. The intake structure will be made of concrete with stainless steel bar screens on all four sides (see Figure 2-8). The bar screens will have a 2-inch by 2-inch mesh to prevent fish from entering the intake structure. The suction velocity will be less than 0.1 mph or near the equivalent of the ambient water velocity. The intake structure will be covered to prevent material from falling into it. The intake structure will take in seawater via the 12-inch diameter high density polyethylene (HDPE) pipeline (see Figure 2-9). An access hatch will be provided for the maintenance of corrosion resistant fiberglass reinforced plastic (FRP) components. The structure will be partially filled with concrete to prevent it from floating.

![Figure 2-8, Proposed Seawater Intake]
Antiscalant (at a dosage rate of 12 ppm) will be added to the collected seawater to inhibit fouling of piping/membranes.

Pretreatment will occur via a 5 micron cartridge system that removes particles.

Pressure will be increased to 1,000 pounds per square inch (psi) and the pretreated seawater will be passed through the RO membranes. The RO units (one duty with one standby) will have a recovery rate of approximately 35 to 40 percent. Each RO unit will be rated for 45,000 gpd. The two separate RO units will operate in DUTY/STANDBY mode and be alternated from on-line to off-line on a scheduled basis (per the manufacturer's recommendations).
Pretreated seawater will be recovered as purified water and treated for hardness and taste with calcium carbonate and zinc orthophosphate (at dosage rates of 10 and 12 ppm, respectively).

The purified water will be disinfected using sodium hypochlorite (at a dosage rate of approximately 10 ppm). The RO system will be sized to achieve the projected water demand of 45,000 gpd with TSS of 500 ppm.

Treated purified water will be stored in a 150,000-gallon watertight reservoir located in the infrastructure building. From the storage tank, on-island water distribution will occur via below ground piping, fire posts, distribution pumps, and a hydropneumatic tank (refer to Figure 10). The piping will be sized to accommodate the average daily flows and peak flows. For this particular project, however, a fire flow of 500 gpm with a 20 psi residual dictates that the pipeline size should be 6 inches in diameter. The pipelines will be installed beneath or near the circuitous pathways around the island at an average depth between 2.5 and 3 feet. The distribution piping will be looped to provide reliable service with minimal pressure drop. Isolation valves will be strategically located to enhance maintenance.

Distribution pumps located in the infrastructure building adjacent to the storage tanks will be part of the skid mounted packaged system that includes a hydropneumatic tank. The system will operate in LEAD/LAG/STANDBY mode. The hydropneumatic tank will provide pressurized storage to minimize pump starts and stops during low demand conditions.

Brine (with pH of 8.3, temperature of 78°F with no chlorine residue) will be returned to the harbor for dilution into surrounding waters. Approximately 85,000 gpd of brine with TSS of 50,000 to 60,000 will be discharged as a result of the RO system. The brine will be diluted to less than 35,000 ppm prior to its discharge through a perforated pipe(s) installed at the base of the harbor rip-rap embankments (refer to Figure 10).

Dilution of the brine will be accomplished for compliance with point-source discharge allowances applicable to all water classes, including Class B. To achieve the dilution, approximately 600 to 700 gpm of fresh seawater will be mixed with the brine. An intake pump station will draw the seawater from outside the harbor area. The intake will be located adjacent to the outer (or seaward) portion of the harbor breakwater whereas the perforated discharge pipe will be located near the base of the interior portion of the harbor breakwater. Dilution pumps (between 15 to 20 horsepower) will run continuously to match the continuous generation of brine by the RO units.

Water in the harbor is well circulated as a result of its open configuration. Approximately one-third of the harbor waters are flushed or exchanged with every tide cycle; therefore, the discharged brine is expected to be sufficiently circulated and diluted prior to its contact with any coral or marine life beyond the harbor.

The RO system has a self-cleaning system that can be automated or manually activated. The system will be backwashed using stored treated water.
Maintenance of the RO system will be accomplished per the manufacturer's recommendations. The pretreatment cartridge filters can be individually isolated for cleaning/replacement and multiple cartridges can be out of service without affecting the on-line treatment capacity. RO membranes will be cleaned using the integral self-cleaning system.

Water quality can be monitored in the storage reservoirs using chlorine residual analyzers and samples taken on a scheduled basis for laboratory analysis. Compliance with local regulatory agency guidelines will be achieved.

### 2.6.2.2 WASTEWATER SYSTEM

The wastewater generation rate for the proposed Palm Springs Resort is estimated at approximately 30,000 gpd of domestic wastewater. The wastewater generation is estimated to be 80% of the total water demand of the resort project (refer to Table 2-3). The wastewater generation rate from the “Final EIS for Quest Resort Palau” is used in this EA. The calculation is presented in the following table.

<table>
<thead>
<tr>
<th>Use</th>
<th>No.</th>
<th>Unit of Measure</th>
<th>Unit Rate (gpd/unit)</th>
<th>Water Demand (gpd)</th>
<th>Estimated Waste Water Generation* (gpd)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guest Bungalows</td>
<td>60</td>
<td>Bungalow</td>
<td>315</td>
<td>18,900</td>
<td>15,120</td>
</tr>
<tr>
<td>Manager's Cottage</td>
<td>1</td>
<td>Apartment</td>
<td>200</td>
<td>200</td>
<td>160</td>
</tr>
<tr>
<td>Main Structure</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lobby Lounge Level</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lobby Reception</td>
<td>7</td>
<td>Seats</td>
<td>2</td>
<td>14</td>
<td>11</td>
</tr>
<tr>
<td>Women’s Restroom</td>
<td>150</td>
<td>Flushes</td>
<td>1.5</td>
<td>225</td>
<td>180</td>
</tr>
<tr>
<td>Men’s Restroom</td>
<td>150</td>
<td>Flushes</td>
<td>1.5</td>
<td>225</td>
<td>180</td>
</tr>
<tr>
<td>Women’s Locker Room</td>
<td>50</td>
<td>Showers</td>
<td>20</td>
<td>1,000</td>
<td>800</td>
</tr>
<tr>
<td>Men’s Locker Room</td>
<td>50</td>
<td>Showers</td>
<td>20</td>
<td>1,000</td>
<td>800</td>
</tr>
<tr>
<td>Staff Dining/Kitchen</td>
<td>150</td>
<td>Employees</td>
<td>10</td>
<td>1,500</td>
<td>1,200</td>
</tr>
<tr>
<td>Restaurant Level</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men’s Restroom</td>
<td>100</td>
<td>Flushes</td>
<td>1.5</td>
<td>150</td>
<td>120</td>
</tr>
<tr>
<td>Women’s Restroom</td>
<td>100</td>
<td>Flushes</td>
<td>1.5</td>
<td>150</td>
<td>120</td>
</tr>
<tr>
<td>Main Dining</td>
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<tr>
<td>Outside Dining</td>
<td>40</td>
<td>Seats</td>
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<tr>
<td>Bar Dining</td>
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<td>1,000</td>
<td>800</td>
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<td>Executive Offices</td>
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<td>Employees</td>
<td>11</td>
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<tr>
<td>Spa/Recreation Facilities</td>
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<td>200</td>
<td>160</td>
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<td>154</td>
<td>123</td>
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<td>Uses</td>
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<td>750</td>
<td>600</td>
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<td>Swim up Pool Bar</td>
<td>18</td>
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<td>36</td>
<td>29</td>
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<tr>
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<td>Flushes</td>
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<td>Uses</td>
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<td>150</td>
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<tr>
<td>Cold Plunge</td>
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<td>80</td>
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<td>100</td>
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<tr>
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<td>120</td>
</tr>
<tr>
<td>Showers</td>
<td>4</td>
<td>(estimate)</td>
<td>500</td>
<td>2,000</td>
<td>1,600</td>
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</tbody>
</table>
The on-site wastewater collection system will include 6-inch gravity sewers that convey effluent to the treatment plant located in the infrastructure building. One small sewage pump station located adjacent to the infrastructure building will serve only the kayak hut bathroom. Pumps (around 1 horsepower) and alarms indicating pump failure, high water levels, etc.) will be provided. The wet well will be slightly oversized to provide additional storage thereby allowing corrective actions to be taken prior to a spill event.

The treatment system will consist of a Jokaso wastewater treatment system. In Japan, "Jokaso" literally means "purification tank onsite wastewater treatment system" in Japanese. A Jokaso is usually installed underground as a single compact tank. There are five functional chambers (sedimentation, anaerobic, aeration, storage and disinfection) in a tank. Although anaerobic and aerobic combined biological treatment process has been commonly employed as an onsite wastewater treatment method for over 30 years in Japan, the Jokaso technology is now greatly improved with treatment performance equivalent to that of a centralized public sewage plant. Various types and sizes are available from small residential units to large commercial units. Figure 2-10 provides the Jokaso treatment process diagram and a typical Jokaso wastewater treatment system.
FIGURE 2-10, PROPOSED (JOKASO) WASTEWATER TREATMENT SYSTEM

The Jokaso wastewater treatment system is currently manufactured in Japan and supplied by Fuji Clean Co., Ltd. The resort owner will order a Jokaso system to accommodate the projected design sewage flow of 30,000 gallons per day (115 m³/day). Depending on the capacity of each Jokaso unit, several units can be combined for optimal efficiency.

The effluent quality of a Jokaso wastewater treatment system is <15 mg/L of BOD and <20 mg/L of suspended solids (SS). The Jokaso effluent quality is accredited by the Building Center of Japan.

- **OIL WATER SEPARATOR**

Oil/water separator will be installed to separate oils from wastewater discharge from the kitchen restaurant of the resort. The effluent from oil/water separator is discharged to the Jokaso sewage treatment plant to undergo further treatment. The plan and section for a proposed oil water separator is presented in Figure 2-11.

FIGURE 2-11, OIL-WATER SEPARATOR

- **EFFLUENT DISPOSAL**

Treated wastewater will be conveyed via a 6-inch HDPE pipe to a location northeast of the island (refer to Figure 2-12) and discharged approximately 100 feet (30.5 meters) below the ocean surface (see Figure 2-12). Analysis using the PLUME model that was developed by the U.S. Environmental Protection Agency (EPA) indicates that "the receiving water would rapidly dilute the small volume of treated wastewater effluent..."
generated from the Quest Resort\textsuperscript{9} and "the dilution would be so rapid that all Class AA water quality criteria would be easily met within a zone of mixing 130 feet in radius around the discharge point" (Sea Engineering, Inc., 1999).\textsuperscript{10} The studies by Sea Engineering, Inc. (refer to Appendix 5) indicate that the discharge plume will not reach the lagoon surface because at 49 feet below sea level the plume becomes virtually indistinguishable from the receiving water (see Figure 12) with an average initial dilution ratio of over 1,000 to 1.

\textsuperscript{9} Final Environmental Impact Statement for Quest Resort Palau, 2000
\textsuperscript{10} Final Environmental Impact Statement for Quest Resort Palau, 2000
Note: The illustrated plume outfall for the discharge of approximately 30,000 gpd of effluent reflects the most conservative assumptions: 100 percent concentration levels and 10 percent currents, with a plume diameter of 260 feet and a trapping depth of -49 feet MSL. A more realistic assumption would be 75 percent concentration levels and average currents which results in a plume diameter of 165 feet and a trapping depth at -55 feet MSL.

**FIGURE 2-13, OUTFALL PROFILE AND EFFLUENT PLUME**

HDPE is recommended for the outfall pipe. This material combines cost effectiveness, ease of construction, and long life.

One of the primary construction concerns for the Ngerur outfall will be to minimize any damage to corals. During the reconnaissance diving, it was observed that many coral outcrops could be avoided by using the flexibility of the HPDE pipe.

The section of HDPE pipeline that must cross the first 100 feet from the island shoreline is proposed to be trenched into the bottom because the area supports vigorous coral growth over almost 100 percent of the bottom surface. A narrow trench will not only protect the pipeline well but would also allow the coral to recolonize the covered trench, thereby allowing the coral ecology to regenerate while locally removing the pipeline from the ecosystem.

**2.6.2.3 DRAINAGE AND IRRIGATION SYSTEM**

Runoff will be collected by an island-wide system of storm drains associated with infiltration trenches. The following elements will direct drainage:

- There is one major hardscape pavement area of porous pavement. It is located near the service building and service dock. The runoff from this area will be collected and discharged into the enclosed harbor area.
- Matting materials (i.e., filter strips) will be placed on top of all construction berms dispersed around the perimeter of the island. These berms provide a barrier to surface discharge over the island edge and contain runoff for a more controlled discharge using perforated pipe and discharge feature.

- The landward side will have a filter fabric/silt curtain with a small impoundment area drained by a buried perforated pipe, wrapped in filter fabric and installed in a gravel trench with discharge to a waterfall feature.

- Infiltration trenches will run primarily along cart service paths. Precipitation will flow on the surface of the paths and infiltrate into the grave trenches paralleling the cart paths. Perforated pipes located in these trenches will be wrapped in a filter fabric in order to minimize sediment transport. They will convey the collected surface runoff to a controlled discharge point.

- Stormwater quality inlets will be used. Filter fabric wraps will be used for entrance points into the conveyance piping. This should minimize transport of sediment through the system which eventually discharges into the surrounding ocean.

- The permanent storm drainage system will catch both surface runoff and roof downspouts. Each building will be surrounded by underground piping which includes connections to both the downspouts and surface inlets. These features will convey the water underground to a controlled discharge point.

- Existing vegetation to be removed during construction will be turned into mulch and spread on the ground in disturbed areas as a temporary ground cover in order to dissipate rain energy.

- The project does not include any retention/detention basins on the island.

Drainage and grading elements of the Palm Springs Resort are illustrated in Appendix 5.

2.6.2.4 SOLID WASTE COLLECTION AND DISPOSAL SYSTEM

Solid waste generated at the Palm Springs Resort will primarily be domestic in nature (paper, plastics, packaging, waste food, etc.). Refuse collection and solid waste disposal will be contracted to a service provider and coordinated with the Bureau of Public Works (BPW) to ensure proper disposal to an operational landfill.

Solid waste will be compacted to reduce the volume of disposed waste from the island. Approximately up to 345 kg per day (760 lbs/day) of solid waste will be generated according to the supporting calculation in Table 2-4. Solid waste generation calculation in the Final EIS Report for Quest Resort Palau is adapted in this EA.
<table>
<thead>
<tr>
<th>Use</th>
<th>No.</th>
<th>Unit of Measure</th>
<th>Unit Rate</th>
<th>Solid Waste Generation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guest Bungalows</td>
<td>60</td>
<td>Bungalow</td>
<td>3.3</td>
<td>198.0</td>
</tr>
<tr>
<td>Manager's Cottage</td>
<td>1</td>
<td>Apartment</td>
<td>3.3</td>
<td>3.3</td>
</tr>
</tbody>
</table>

### Main Structure

<table>
<thead>
<tr>
<th>Use</th>
<th>No.</th>
<th>Unit of Measure</th>
<th>Unit Rate</th>
<th>Solid Waste Generation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lobby Lounge Level</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lobby Reception</td>
<td>7</td>
<td>Seats</td>
<td>0.1</td>
<td>0.7</td>
</tr>
<tr>
<td>Women's Restroom</td>
<td>150</td>
<td>Uses</td>
<td>0.1</td>
<td>15.0</td>
</tr>
<tr>
<td>Men's Restroom</td>
<td>150</td>
<td>Uses</td>
<td>0.1</td>
<td>15.0</td>
</tr>
<tr>
<td>Women's Locker Room</td>
<td>50</td>
<td>Uses</td>
<td>0.1</td>
<td>5.0</td>
</tr>
<tr>
<td>Men's Locker Room</td>
<td>50</td>
<td>Uses</td>
<td>0.1</td>
<td>5.0</td>
</tr>
<tr>
<td>Staff Dining/Kitchen</td>
<td>150</td>
<td>Employees</td>
<td>0.5</td>
<td>75.0</td>
</tr>
</tbody>
</table>

### Restaurant Level

<table>
<thead>
<tr>
<th>Use</th>
<th>No.</th>
<th>Unit of Measure</th>
<th>Unit Rate</th>
<th>Solid Waste Generation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men's Restroom</td>
<td>100</td>
<td>Uses</td>
<td>0.1</td>
<td>10.0</td>
</tr>
<tr>
<td>Women's Restroom</td>
<td>100</td>
<td>Uses</td>
<td>0.1</td>
<td>10.0</td>
</tr>
<tr>
<td>Main Dining</td>
<td>60</td>
<td>Seats</td>
<td>1.6</td>
<td>96.0</td>
</tr>
<tr>
<td>Wine Dining</td>
<td>40</td>
<td>Seats</td>
<td>1.6</td>
<td>64.0</td>
</tr>
<tr>
<td>Outside Dining</td>
<td>40</td>
<td>Seats</td>
<td>1.6</td>
<td>64.0</td>
</tr>
<tr>
<td>Bar Dining</td>
<td>50</td>
<td>Seats</td>
<td>1.6</td>
<td>80.0</td>
</tr>
</tbody>
</table>

### Executive Offices

<table>
<thead>
<tr>
<th>Use</th>
<th>No.</th>
<th>Unit of Measure</th>
<th>Unit Rate</th>
<th>Solid Waste Generation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Executive Offices</td>
<td>8</td>
<td>Employees</td>
<td>3.7</td>
<td>29.6</td>
</tr>
</tbody>
</table>

### Spa/Recreation Facilities

<table>
<thead>
<tr>
<th>Use</th>
<th>No.</th>
<th>Unit of Measure</th>
<th>Unit Rate</th>
<th>Solid Waste Generation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salon</td>
<td>20</td>
<td>Uses</td>
<td>0.1</td>
<td>2.0</td>
</tr>
<tr>
<td>Multi-purpose Room</td>
<td>2</td>
<td>Units</td>
<td>0.1</td>
<td>0.2</td>
</tr>
<tr>
<td>Hydrotherapy</td>
<td>2</td>
<td>Units</td>
<td>0.1</td>
<td>0.2</td>
</tr>
<tr>
<td>Vichey Shower</td>
<td>2</td>
<td>Units</td>
<td>0.1</td>
<td>0.2</td>
</tr>
<tr>
<td>Hydrotherapy Pool</td>
<td>2</td>
<td>Units</td>
<td>0.1</td>
<td>0.2</td>
</tr>
<tr>
<td>Spa Suite</td>
<td>15</td>
<td>Uses</td>
<td>0.1</td>
<td>1.5</td>
</tr>
<tr>
<td>Swim up Pool Bar</td>
<td>18</td>
<td>Seats</td>
<td>1.6</td>
<td>28.8</td>
</tr>
<tr>
<td>Pool Bar</td>
<td>10</td>
<td>Seats</td>
<td>1.6</td>
<td>16.0</td>
</tr>
<tr>
<td>Pool</td>
<td>150</td>
<td>Persons</td>
<td>0.1</td>
<td>15.0</td>
</tr>
</tbody>
</table>

### Changing Rooms

<table>
<thead>
<tr>
<th>Use</th>
<th>No.</th>
<th>Unit of Measure</th>
<th>Unit Rate</th>
<th>Solid Waste Generation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toilets</td>
<td>100</td>
<td>Uses</td>
<td>0.1</td>
<td>10.0</td>
</tr>
<tr>
<td>Lavatories</td>
<td>100</td>
<td>Uses</td>
<td>0.1</td>
<td>10.0</td>
</tr>
<tr>
<td>Cold Plunge</td>
<td>2</td>
<td>Units</td>
<td>0.1</td>
<td>0.2</td>
</tr>
<tr>
<td>Jacuzzi</td>
<td>2</td>
<td>Units</td>
<td>0.1</td>
<td>0.2</td>
</tr>
<tr>
<td>Washer</td>
<td>2</td>
<td>Units</td>
<td>0.1</td>
<td>0.2</td>
</tr>
<tr>
<td>Dryer</td>
<td>2</td>
<td>Units</td>
<td>0.1</td>
<td>0.2</td>
</tr>
<tr>
<td>Showers</td>
<td>4</td>
<td>Units</td>
<td>0.1</td>
<td>0.4</td>
</tr>
<tr>
<td>Sauna</td>
<td>2</td>
<td>Units</td>
<td>0.1</td>
<td>0.2</td>
</tr>
<tr>
<td>Steam</td>
<td>2</td>
<td>Units</td>
<td>0.1</td>
<td>0.2</td>
</tr>
<tr>
<td>Staff Housekeeping</td>
<td>40</td>
<td>Uses</td>
<td>0.1</td>
<td>4.0</td>
</tr>
</tbody>
</table>

**Total** | 760.1 | 345.5 |

Solid waste will be transported by boat. The intent of the resort operator is to install a trash compactor within the island thereby reducing the volume of refuse. Although the weight of the waste remains the same, a reduced volume will extend the life of the landfill.

The resort will institute waste separation and recycling procedures in order to take advantage of existing, and hopefully expanding, recycling facilities in Palau.

### 2.6.2.5 TRANSPORTATION & ROAD NETWORK SYSTEM

The proposed road network system for the Palm Springs Resort is shown in Figure 2-14. All guest bungalows and resort facilities are accessible via this road network. Electrical carts will be made available for the transport of all guests to their bungalows.
The proposed project is well equipped to accommodate persons with physical disabilities. Disabled guests arriving in Palau will be transported, with any assistance they need, from the airport to the Palm Springs Resort. Transport boats will include the ability to handle wheelchairs and potential other needs.

Upon arrival at the resort, wheelchair access from the dock to the main area of the resort will include a ramp and an elevator. At least one such cart will be designated to accommodate the needs of a disabled guest.

The resort will offer, under current plans, special disabled facilities in two ground floor bungalows. Additionally, certain types of disabled guests can be accommodated in the regular ground floor bungalows.

2.6.2.6 ELECTRICAL AND COMMUNICATION SYSTEM

The Palm Springs Resort does not intend to tap electrical power from the Palau Public Utility Corporation (PPUC) and implement the original plan in the “Final EIS for Quest Resort Palau” to install submarine cable from a location near the Palau Pacific Resort to
the island. This will therefore eliminate potential impacts to the bottom of the ocean and marine environment.

Instead, three (3) diesel generators with 1,800 kW each will be used as main power supplies for the Palm Springs Resort. Two (2) generators will be used alternately while the other generator will be used as stand-by/back up purpose.

It is proposed that one variable power distribution substation and a dry-type transformer are set up within the first floor of the building. Equipment with low noise generation is selected.

Generator sets will be provided with enclosure to significantly reduce the noise generation. “Room inside the room” design concept is adopted for control. With these controls in place, the noise generation should be no more than 50 dBA. Figure 2-15 provides the section of the proposed generator house.

![Figure 2-15, Power Generator Room](image)

**2.6.2.7 Fire Protection System**

Potable water will be used for the fire protection system consisting of fire pumps and water storage facilities. The fire storage volume of 60,000 gallons along with an emergency water storage volume of 90,000 gallons means the potable water reservoir (including the fire storage allotment) should contain, at a minimum, 150,000 gallons. This volume meets the intent of emergency and fire storage requirements. The fire pumps are proposed to be located in the basement of the main structure on Ngerur Island and be plumbed into the potable water distribution system. Two fire pumps will be installed for duty/standby operation. Each pump will have a 50 horsepower motor and be rated for 500 gpm at 100 psi.
2.6.3 Marine Facilities and Improvements

2.6.3.1 Harbor and Dock Facility

A small harbor is proposed at the southeast corner of the island. The harbor would support the docking of vessels that carry resort guests and their luggage from Koror to Ngerur Island, vessels that would be used for water recreation activities (e.g., scuba diving, sightseeing, fishing, kayaking, etc.), and vessels that transport employees and supplies to the island.

The docking facility must be protected from wave approach to be fully functional during all reasonable wind, wave and weather conditions. The harbor must be designed to account for oceanographic conditions at the site, user vessel characteristics and use requirements. Oceanographic parameters include wind and wave conditions, nearshore bottom profiles and water depths and water level fluctuations. Vessel characteristics include length, width, draft and maneuverability. Dock usage refers to parameters such as passenger loading, cargo type and handling, and special berthing requirements.

Vessels that will dock at the proposed resort are generally expected to be powerboats ranging in size from about 7.6m (25 ft) to 15m (50 ft) in length. The proposed harbor is located in an area where a wide (30 to 61m) shallow, rock, cobble and sediment bench extends in front of the shore, as shown in Figure 2-16. The 3m (10 ft) depth is up to 122m (400 ft) offshore. This location is partially sheltered from prevailing trade winds and direct wave approaches. The sediment bench is almost daily exposed when the water level is at -0.6m (-2 ft) MSL.

Dredging for the entry channel and turning basin for the harbor is proposed to create a depth of -3.65m (-12 feet) MSL, which means that the lagoon floor will be excavated to an average of 3m (10 ft) below its existing depth. Approximately 50 percent of the area proposed to be dredged for the harbor development including the entry channel and turning basins is located on the sediment bench, thereby keeping the coral areas to be disturbed by dredging activities to a minimum.

<table>
<thead>
<tr>
<th>Table 2-5, Assumptions for Harbor Planning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Design/Typical Vessel</td>
</tr>
<tr>
<td>Length</td>
</tr>
<tr>
<td>Width</td>
</tr>
<tr>
<td>Draft</td>
</tr>
<tr>
<td>Channel &amp; Basin Depth</td>
</tr>
<tr>
<td>Vessel draft</td>
</tr>
<tr>
<td>Low tide</td>
</tr>
<tr>
<td>Vessel motion</td>
</tr>
<tr>
<td>Bottom clearance</td>
</tr>
<tr>
<td>Total</td>
</tr>
<tr>
<td>Entrance Channel width (minimum three vessel width)</td>
</tr>
<tr>
<td>3 x 18ft = 54 ft but use larger value</td>
</tr>
<tr>
<td>Turning Basin Diameter (minimum 1.5 x vessel length)</td>
</tr>
<tr>
<td>1.5 x 50 ft = 75 ft but use 100 ft</td>
</tr>
</tbody>
</table>
The conceptual dock, channel and basin, and protective structure layouts are illustrated in Figures 2-17 to 2-18. Appropriate dock design will enable comfortable loading and unloading of passengers and their luggage. The resort developer desires the docking facility to be attractive, as befits the entrance to a first-class resort.
Boats and the docking facility provide the only access to and from the resort. The docking facility must therefore be fully functional during all reasonable wind, wave and weather conditions. With the given layout, the dock would be protected from wave approach. Primary elements of the dock facility layout are summarized in Table 2-6.
**FIGURE 2-18, TYPICAL SECTION, REVETTED MOLE & BREAKWATER**

**TABLE 2-6 PRIMARY ELEMENTS OF THE DOCK FACILITY**

<table>
<thead>
<tr>
<th>Description</th>
<th>Approximate Size/ Dimension</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guest Docks (concrete floating docks with guide piles and access ramps)</td>
<td></td>
</tr>
<tr>
<td>Main landing (covered)</td>
<td>4.8 x 18.2 / 16 x 60</td>
</tr>
<tr>
<td>Tour/recreation dock, 2 sides, with an effective length of 36.5m (120ft)</td>
<td>2.4 x 18.2 / 8 x 60</td>
</tr>
<tr>
<td>Access ramps, 2 ea.</td>
<td>1.2 / 1.8 / 4 / 6</td>
</tr>
<tr>
<td>Service Docks (floating docks)</td>
<td></td>
</tr>
<tr>
<td>Solid fill wharf (concrete capped sheet pile bulkhead)</td>
<td>15.2 / 50</td>
</tr>
<tr>
<td>Floating dock, accessed by a 6 ft ramp</td>
<td>5.4 x 18.2 / 18 x 60</td>
</tr>
<tr>
<td>Entrance channel</td>
<td>18.2 / 60</td>
</tr>
<tr>
<td>Turning basins (2 areas between entrance channel and berths) - diameter</td>
<td>30.4 / 100</td>
</tr>
<tr>
<td>Protective Structures (rock rubblemound breakwaters, with crest elevation of +8 ft, 2 ea.)</td>
<td></td>
</tr>
<tr>
<td>North breakwater, length</td>
<td>125 / 413</td>
</tr>
<tr>
<td>South breakwater, length</td>
<td>124.6 / 409</td>
</tr>
</tbody>
</table>

Dock construction involves the creation of interior land. A central area of approximately 0.2 hectares between the two dock facilities will be created with dredged material and protected by a vertical cemented rock wall. The area will serve as water access for kayaks as well as provide building space for kayak storage, scuba equipment, and maintenance, etc. The calculated elevation of this area will be +1.8m (+6 ft) minimum and vary upwards depending upon the distance from the edge of the water.

It is estimated that approximately 20,000 cubic yards (CY) of bottom material will have to be removed to bring the harbor area to approximately 12 feet (3.6 meters) below sea level. Approximately 50 percent of the area proposed to be dredged for an entry channel and turning basin would occur within the area defined by the sediment bench,
Approximately 65 percent of this sediment bench area will be dredged to -12 feet (3.6 meters) MSL; the remaining 35 percent will be filled to +6 feet (1.8 meters). The damage to vibrant coral areas would therefore be kept to a minimum. The dredged material is expected to be characterized as primarily volcanic breccia with pockets of sand and coral fragments. It is proposed that this material be used for construction on the island.

2.6.3.2 DIVE GROTTO

A small natural embayment on the southwest corner of the island will be developed into a protected saltwater pool (see Figure 2-19). Creation of a rock grotto to be used primarily for SCUBA diving training will require excavation into the existing rocky nearshore area. This shallow, roughly circular rock formation is located immediately seaward of the embayment, which is exposed at low tide and barely submerged at high tide. The rock formation provides some wave protection, particularly at low tide. Additional protective structures will still be required to provide a sheltered area for swimming and SCUBA lessons. The nearshore area is shallow and requires dredging to create adequate water depth for swimming and diving.

Wave protection will be provided by two offshore breakwaters of similar design to the rock groins used for beach stabilization (refer to Figure 2-20). A breakwater crest elevation of +5 feet (1.5 meters) is calculated to provide wave protection for the grotto users during times of prevailing and moderate westerly wind conditions. The breakwaters are expected to overtop during severe storm conditions.

Both breakwaters will be approximately 60 feet (18.2 meters) long. These will protect the dredged pool that is 120 feet (36.4 meters) in diameter and approximately 6 to 8 feet (1.8 to 2.4 meters) deep. The breakwaters will be detached from land. There will be a 10-foot (3.0-meter) wide and 8-foot (2.4-meter) deep circulation channel to facilitate water exchange and provide access to deeper water for SCUBA divers.

Dredging in the nearshore grotto area to create adequate depths for swimming and diving is expected to remove approximately 3,500 CY of bottom material. The dredged material is expected to be characterized as primarily volcanic breccia with pockets of sand and coral fragments. It is proposed that this material be also used for construction on the island.
FIGURE 2-19, LAYOUT OF THE PROPOSED DIVE GROTTO

FIGURE 2-20, TYPICAL SECTION, DIVE GROTTO BREAKWATER
2.6.3.3 BEACH IMPROVEMENTS

The proposed site for beach improvements is located along the western coast at the beginning of the northern third of the island. A small natural embayment is the chosen location for the development of beach improvements (see Figure 2-22). The shape and shallow depth of the embayment provides a reasonable opportunity for beach construction. The relatively exposed nature of the shoreline, however, with little or no natural protection from storm waves, necessitates the use of beach stabilization structures. These structures will help control the beach configuration, reduce maintenance requirements and insure that the sand is not moved offshore where it could impact the marine environment.

Proposed stabilization structures will be rock groins constructed perpendicular to the shore at both ends of the beach (see Figure 2-21). The groins will be constructed using 1,000 to 2,500 pound armor stone similar in characteristics to that occurring naturally around the island, placed over a core of 5 to 250 pound stone. The stone will be placed to form an irregular surface, and the crest elevation shall vary from +5 feet (+1.5 meters) to +7.5 feet (+2.3 meters), in order to create a more natural appearance. Cavities in the crest will be created for landscaping with salt tolerant vegetation.

The beach crest will be about 150 feet (45.6 meters) long and approximately 50 feet (15.2 meters) wide. Including the beach slope, this will result in a dry beach width of about 50 to 70 feet (15.2 to 21.2 meters) at high tide and over 100 feet (30.4 meters) at low tide. The sand fill will be stabilized by a north and south groin, each approximately 120 feet (36.4 meters) long. The relatively shallow near shore water depth at this location necessitates constructing the beach toe at an approximate depth of minus 4 feet (1.2 meters).

NOTE: GROINS HAVE PLANTING CAVITIES FOR LANDSCAPING WITH TYPICAL SHORELINE VEGETATION THAT IS INDIGENOUS TO THE AREA

FIGURE 2-21, TYPICAL SECTION, BEACH BREAKWATER
Figure 2-22, Layout of the Proposed Beach Improvement
2.7 Construction Features

2.7.1 Cut and Fill Volume

The total cut volume on the island is estimated at approximately 14,200 cubic meter (m$^3$) (18,500 cubic yard (CY)) with approximately 7,000 m$^3$ (9,000 CY) or roughly 50 percent of the total cut volume attributed to the main structure of the resort. The total fill volume is projected at 2,100 m$^3$ (2,800 CY). Excess cut volume (12,000 m$^3$ or 15,700 CY) will be exported off-island and be available for sale as fill material to private customers, to the government, or to quarries for further processing.

The projected dredged volume generated by project actions is estimated at approximately 18,000 m$^3$ (23,500 CY). Roughly 20 percent of this material will be used as fill material for the marine facilities and improvements. The remaining dredged material will be exported off-island for sale as fill material.

Estimated quantities generated and required for proposed marine facilities and improvements are depicted in the following table.

<table>
<thead>
<tr>
<th>Description</th>
<th>Dredged m$^3$ (CY)</th>
<th>Required m$^3$ (CY)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harbor Construction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Breakwater armor stone</td>
<td>5,400 (7,000)</td>
<td></td>
</tr>
<tr>
<td>Breakwater underlying stone</td>
<td>2,500 (3,250)</td>
<td></td>
</tr>
<tr>
<td>Breakwater center fill (can be dredged material)</td>
<td>3,500 (4,500)</td>
<td></td>
</tr>
<tr>
<td>Grotto Improvements</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Breakwater armor stone</td>
<td>400 (500)</td>
<td></td>
</tr>
<tr>
<td>Breakwater underlying stone</td>
<td>300 (400)</td>
<td></td>
</tr>
<tr>
<td>Breakwater center fill (can be dredged material)</td>
<td>150 (200)</td>
<td></td>
</tr>
<tr>
<td>Beach Improvements</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sand fill</td>
<td>2,700 (3,500)</td>
<td></td>
</tr>
<tr>
<td>Groin armor stone</td>
<td>760 (1,000)</td>
<td></td>
</tr>
<tr>
<td>Groin underlying stone</td>
<td>600 (800)</td>
<td></td>
</tr>
<tr>
<td>Groin center fill (can be dredged material)</td>
<td>300 (400)</td>
<td></td>
</tr>
</tbody>
</table>

2.7.2 Environmental Protection Plan

Construction activities will be accomplished in an environmentally responsible manner. The environmental protection plan (EPP) includes the following elements:

a) The project contractor will provide standard 20-foot containers with proper markings as storage area for hazardous materials. This storage area will be provided for all fuel tanks, oil drums and other hazardous materials. A liner and a berm will surround the containment area.

b) All hazardous and toxic materials transported by truck or boat will be equipped with spill kits, sufficient to contain and absorb the amount of material being transported.
c) Personnel involved in handling of hazardous materials will be provided with adequate training in dealing with spill incidents.

d) If dry conditions develop creating fugitive dust emissions, sprayer or sprinklers sufficient to reduce dust, without creating runoff or erosion will be implemented.

e) All equipment operating in construction areas will be properly muffled. Work hours will be limited to between 0700 and 1800 hours on Monday through Saturday.

2.7.3 Erosion and Sedimentation Control Plan

A site specific erosion and sedimentation control plan (ESCP) will be submitted to the EQPB in fulfillment of EQPB earthmoving permit requirements as stipulated in the EQPB Earthmoving Regulations Section 2401-1-11. At a minimum, the ESCP must have the following goals:

- Minimize earth movement;
- Implement staging of earthmoving activities to best utilize site conditions;
- Avoid earthworks during heavy rains, to the extent possible.

In order to achieve the erosion and sedimentation control objectives, the contractor will strive to increase awareness among all job-site personnel with respect to the handling and disposal of materials. The contractor will hold weekly meetings to train and direct personnel. Materials will be handled appropriately to minimize spills and erosion impact to surrounding waters.

A number of proven techniques to minimize erosion impacts to the surrounding waters will be implemented. The following list of techniques will be employed at various stages of construction. The specific locations and time of implementation will be affected by factors such as the local weather, availability of material, local geological conditions and the construction schedule.

a) Site clearing will be limited to the area that will be disturbed by the construction of the hotel, swimming pool and restaurant.

b) As much vegetation as practicable will be retained since it acts as an excellent erosion control device. When vegetation is removed, mulch will be spread over the ground as much as practicable to prevent mud tracking by heavy equipment.

c) A silt fence will be installed around the site perimeter prior to commencement of any earthwork operations, e.g., grading. Silt fence will also be installed around temporary stockpiled materials (i.e., fill or excavated materials).

d) Sandbags will be installed around storm drain inlets to prevent sediments from entering permanent or temporary storm drain pipes. Sandbags may also be used as sediment barriers around swales or other drainage devices.
e) All unsuitable excavated materials, excess materials and site waste will be properly removed to an approved landfill site.

f) Fiber rolls, when available, will be installed at appropriate places to control or reduce the silts escaping the project site.

g) The contractor will monitor and maintain temporary erosion and sedimentation control devices during construction. Devices will be sequenced according to the various phases associated with site preparation, earthwork/site grading and general construction.

2.7.4 Government Permits and Clearances

An earthmoving permit application will be submitted to the EQPB. The earthmoving application will be supported by this EA document. In addition to the earthmoving permit, the following permits and clearances are required prior to construction of the proposed project:

2.7.4.1 Building and Zoning Permit from Koror State Planning Commission

The 6th Koror State Legislature passed on September 21, 1999, Bill No. 6-42 LDI, identified as “Rezoning of Ngerur Island”. The official Koror Zoning Map was amended to re-zone the area known as Ngerur Island from CD (Conservation) to RV (Resort Center Zone). A copy of the Rezoning Permit is presented in Appendix 6.

Building permit from the Koror State Government will be obtained upon re-issuance of the Earthmoving Permit.

2.7.4.2 Water Reclassification

An amendment to the Republic of Palau Marine and Freshwater Quality Regulations, Chapter 2401-11-42 on September 19, 2000 included the “Waters extending 200m from the shoreline of Ngerur Island” as a Class B Surface Water. A copy of the signed Amendment is attached as Appendix 7.

2.7.4.3 Historical Clearance from the Bureau of Arts and Culture

A Memorandum of Agreement between Ngerur Corporation and the Historical Preservation Office – Bureau of Arts and Culture (HPO-BAC) was signed by both parties on April 23, 2018 and May 7, 2018 respectively. Appendix 8 provides a copy of the Historical Clearance.

In addition to the above permits and clearances, the following clearance and permit will also need to be obtained for the Palm Springs Resort:

- Utilities Clearance from the Public Works Authority;
- Wastewater Discharge Permit from the EQPB.
2.8 Project Implementation Schedule

The applicant proposes to commence the construction of the Palm Springs Resort by August 2018 upon securing all the required government permits and licenses including the Earthmoving Permit. It is envisaged that construction activities for the project will be undertaken within 18 months. Commissioning of the Palm Springs Resort is expected by February 2020.

2.9 Project Cost

The proposed Palm Springs Resort is estimated to cost approximately Sixty-Six Million US Dollars ($66,000,000.00).
3 PROJECT ALTERNATIVES

Several alternatives were considered for the proposed Palm Springs Resort Project. The “No Action” Alternative is always considered an option to the proponent even before the project was conceptualized.

The alternatives considered with respect to the proposed Palm Springs Resort Project include water, wastewater, fire protection and electrical system options. An alternative maximum density resort development was also considered. Consequently, the alternatives discussed in this section include various infrastructure options that were considered and eliminated in favor of the proposed infrastructure systems discussed in this EA.

3.1 No Action Alternative

The selection of the “No Action” alternative would mean the discontinuation of project and result in the island being retained in its existing form. There are physical and socio-economic implications of this alternative.

As a result of the no action alternative, the island of Ngerur would remain in an undeveloped state. Short- and long-term environmental impacts, both beneficial and adverse, that are associated with the construction and operation of a resort facility would not occur. The potential impacts would be avoided as a result of no action.

Physically, the island is unlikely to undergo any major changes from its present condition. The vegetation currently present on site is unlikely to be severely affected, other than the potential for uncontrolled growth of weeds, bushes and trees introduced by avifauna, wind or other means.

The “No Action” Alternative is likely to have the greatest implications on the socio-economic environment of the area and surrounding communities. This option will consequently result in the possible loss of revenue for the applicant and the Koror State Government.

Selection of the no action alternative would result in no income generation to the property owner from resort activity on Ngerur Island. No capital resources would be expended as a result of the no action alternative despite the apparent interest of the investor to create a first-class resort project on the uninhabited island of Ngerur. The Palau Government would receive no benefits in terms of tax revenues or employment opportunities for local Palauans as a result of this alternative. The opportunity to stimulate the tourist environment in Palau would also be missed with no action. Based on the above considerations, the no action alternative has been eliminated from further consideration in this EA.

In addition, a development of this caliber will add to the Palau’s ability to market itself to visitors from markets previously under represented through previous marketing
activities. It will also fuel the growth and development of Palau’s tourism industry.

If this alternative were adopted, the investor would need to find an alternative site for the development or decide to develop the project outside of Palau.

### 3.2 The Proposed Development

This alternative would see the construction of the development as proposed by the investor, PPSIDL, and as outlined in Section 2 of this EA document. This option has good support (based on results of socio-economic survey) by the stakeholders who would be most affected by its implementation, i.e., residents of the Koror State. Series of consultations and public hearing were undertaken in 2000~2001, during the EIS Process.

This alternative will provide positive benefits to the community and Palau’s tourism product. This includes benefits such as employment opportunities, government tax earnings, increased property values and benefits to ancillary supporters/dependents of the tourism industry. If approved, construction and operation of the project will provide employment for both Palauan and non-Palauan citizens. Significant number of people are expected to be employed during the operational phase. Additionally, the multiplier effects to the construction and operation of the resort project are likely to affect a much larger number of persons.

The proposed development is being designed and built to meet or exceed local and international standards and regulations. A key benefit also is the installation of a tertiary level sewage treatment facility that will produce an effluent suitable for final release into the ocean while meeting coastal water quality standards.

### 3.3 Maximum Density Resort Development

This alternative represents resort development on a substantially larger scale as allowed by the existing Koror State zoning designation for Ngerur Island (refer to Section 5.12 for a more detailed discussion of land use considerations). Tables comparing the estimates of the daily and annual visitor load are provided below.

<table>
<thead>
<tr>
<th></th>
<th>Maximum Density Resort Development</th>
<th>Proposed Density Resort Development</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resort bungalows per acre</td>
<td>20.0 bungalows</td>
<td>4.8 bungalows</td>
</tr>
<tr>
<td>Total acreage</td>
<td>X 12.5</td>
<td>X 12.5</td>
</tr>
<tr>
<td>Total Number of resort bungalows</td>
<td>250 bungalows</td>
<td>60 bungalows</td>
</tr>
<tr>
<td>Assumed occupancy rate (75%)</td>
<td>188 bungalows</td>
<td>45 bungalows</td>
</tr>
<tr>
<td>Daily visitor load (based on 1.8 persons per room)</td>
<td>338 persons</td>
<td>81 persons</td>
</tr>
</tbody>
</table>
TABLE 3-2, COMPARISON OF ANNUAL VISITOR LOAD

<table>
<thead>
<tr>
<th></th>
<th>Maximum Density Resort Development</th>
<th>Proposed Density Resort Development</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily visitor load (based on 1.8 persons per room)</td>
<td>338 persons</td>
<td>81 persons</td>
</tr>
<tr>
<td>Assumed turn over rate</td>
<td>X 91</td>
<td>X 91</td>
</tr>
<tr>
<td>(365 days per year/4-day length of stay)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual visitor load</td>
<td>30,758 persons</td>
<td>7,371 persons</td>
</tr>
</tbody>
</table>

A large-scale resort project based on the maximum allowable density for Ngerur Island would generate substantially greater environmental impacts as compared to the proposed action due to the substantially higher (more than four times greater) annual visitor load supported by maximum density development. Infrastructure considerations would therefore encompass larger systems that can accommodate the higher potable water demand and the disposal of greater volumes of effluent and solid waste.

The alternative of a large-scale resort project on Ngerur Island would presumably function as a major revenue-source and employment center; however, the number of visitors accommodated by a maximum density resort project would also generate a substantially larger load on the natural environment whereby deleterious effects could occur. Degradation of the environment could in turn lead to a deterioration of the image of Palau as a diving paradise, thereby contributing to a reduction in the annual flow of visitors. The potential for serious long-term environmental degradation as a result of maximum density resort development led to the elimination of this alternative from further consideration.

3.4 Alternative Designs

Alternative designs presented under this sub-sections were taken from the “Final EIS Report for Quest Resort Palau.”

3.4.1 Alternative Potable Water System

Implementation of an off-site water supply system would include several components including the expansion of the existing Koror-Airai water treatment plant, installation of an underwater transmission pipeline from Arakabesan Island to Ngerur Island, and potable water purchase from the local water service provider.

The alternative of connecting to an off-site water supply system has inherent advantages since the operation and maintenance of the system would be the responsibility of the service provider. The infrastructure requirement for this option
would be primarily associated with the transbay connection to an existing system on the island of Arakabesan. The following characteristics of this option are noted:

- Multiple service providers are available on the main islands;
- Less land on Ngerur Island may be required for facilities and infrastructure;
- Less power would be required on Ngerur Island for the water supply system;
- Less manpower would be required for operation and maintenance;
- Capital expenditure may be reduced if the transbay pipeline is used for power and communications; and
- No waste products from the water treatment process would be generated or disposed with this option (as compared to the proposed action that involves seawater intake and brine disposal).

This alternative has several disadvantages related to the absence of control over the system and the dependence on the transbay pipeline for water conveyance.

- The Ngerur Island water supply would be dependent on the off-island supply;
- The Ngerur Island water supply would be dependent on the transbay pipeline;
- There would be less control over water quality and extended pipeline residence time may further deteriorate potable water quality; and
- A back-up water production system may be warranted to increase reliability.

As indicated in the above discussion, the alternative of an off-site potable water supply system implies damage to coral and marine resources along the transbay pipeline corridor. Considerable environmental analysis of off-site systems, the transbay pipeline corridor and mitigation for the irrevocable loss of marine resources would be required for the option to connect to an off-island water supply system such that it was eliminated from further consideration in favor of the proposed potable water system (with on-site supply and reverse osmosis treatment) that is more typical within the framework of an island environment.

**3.4.2 Alternative Wastewater Systems**

**3.4.2.1 Wastewater Collection via a Vacuum System**

The alternative of utilizing a vacuum system for wastewater collection implies smaller diameter collection pipes that can be installed at a shallower average depth. This option eliminates the need for pump stations since the system operates under a vacuum created by vacuum pumps located at a central collection location and through a number of pockets, valves, and clean-outs dispersed along the collection pipeline route. Collection pipelines would be 3-inches in diameter with an average depth of 3 to 5 feet. There is a limit to the amount of vacuum the system can sustain (typically not more than 15 to 25 inches of mercury (in Hg)). The lower elevations in the main structure may not be serviceable by a vacuum system such that this alternative was deemed unfeasible and subsequently dismissed in favor of the proposed wastewater collection system utilizing conventional gravity collection pipelines and pump stations.
3.4.2.2 Off-site Wastewater Treatment and Disposal

The alternative of off-site treatment and disposal involves an underwater pipeline between Ngerur Island and Arakabesan Island and conveyance of the effluent to the Malakal WWTP. The underwater pipeline would be a 8,000-foot HDPE submarine force main of 3 to 4 inches in diameter. The pipe would be of a continuous length such that it can be pulled out, sunk and hand placed between any corals encountered along the pipeline corridor. The underwater pipeline would be connected to the wet well at the public pump station on Arakabesan island and discharged into the public sewer system for conveyance to the Malakal WWTP.

Notable disadvantages of this system are as follows:

- Waste storage facilities would be required on Ngerur Island because the Malakal WWTP is at near capacity and is characterized by an inadequate conveyance system (pipelines and pump stations);
- With this option, the Quest Resort Palau would be reliant on the Malakal wastewater collection and treatment system that is prone to failure when the system is not well maintained;
- Considerable environmental concerns are associated with the underwater piping of raw wastewater and the consequences of potential failure of the system;
- This option implies dependency on an off-site service provider and associated annual costs for treatment and disposal;
- There is an increased potential for odors on Ngerur Island due to the storage of raw wastewater on the island; and
- This option implies substantial construction costs associated with the pipeline and wastewater storage facilities.

Pumping wastewater to the Arakabesan-Malakal collection system would require an in-depth analysis of the available capacity and reliability of the existing collection, treatment, and outfall facilities. Based upon data obtained from the Malakal Wastewater Master Plan (1994) and discussions with Public Works personnel, the existing collection system is approaching maximum capacity and many of the pump stations are in poor to fair condition. Untreated sewage spills are not uncommon at various locations in the collection system. Although there are plans for expansion of the Malakal WWTP, the treatment plant is operating above its rated capacity and frequently discharges wastewater into the ocean without proper secondary treatment according to applicable standards. In addition, the ocean outfall discharge for the treatment plant is only about 50 feet deep and located very close to the shore such that the effluent frequently surfaces and migrates to the shoreline. Without significant improvements to the existing Malakal system, proper conveyance, treatment, and disposal of wastewater cannot be guaranteed.

The addition of new flows to the already overburdened municipal collection and conveyance system would require substantial infrastructure improvements requiring planning studies and substantial new/rehabilitation construction. Costs are expected to be exorbitant. For example, the underwater force main alone would cost in excess of
$500,000. The cost for other required improvements is unknown but can be conservatively estimated at over $1,000,000.

In light of the above considerations, the alternative of off-site wastewater treatment and disposal has been eliminated from further consideration.

3.4.2.3 On-site Wastewater Treatment and Off-site Disposal

With this alternative, the effluent would first be treated on Ngerur before its conveyance through a submarine pipeline to Arakabesan. As with the previously evaluated alternative, the effluent would be discharged to the public collection system for ultimate treatment and disposal via the Malakal WWTP. This alternative allows for the effluent to be treated twice; however, the Quest Resort Palau would then be dependent on the public collection/conveyance and treatment system. With this option, the Quest Resort Palau would be contributing liquid inputs to a system that is characterized as unreliable because it may be already at or near capacity.

Cost for on-site wastewater treatment and off-site disposal would include the costs attributed to off-site treatment and disposal (refer to Section 3.3.2.2) in addition to the cost of constructing on-site treatment facilities. On-site treatment with off-site disposal is therefore one of the costlier options addressed in this EIS.

On-site treatment with off-site disposal is considered to be an expensive option that contributes new flows to an already overburdened municipal collection and conveyance system. For all these reasons, this option has been dismissed from further consideration.

3.4.2.4 On-site Wastewater Treatment and Disposal

Tertiary treatment (treatment beyond secondary level standards) was considered but dismissed in favor of proposed secondary treatment with UV.

- Tertiary treatment is typically utilized when the wastewater is intended for use as recycled water. Recycled water is employed in areas where water is scarce/expensive for irrigation purposes. This is not the case in Palau where the average rainfall is around 150 inches per year. Therefore, tertiary treatment for reuse is impractical and/or unnecessary.
- The tertiary treatment process involves substantial use of chemicals to coagulate suspended particles and requires filtering with disinfection for subsequent reuse in a separate distribution system. Substantially more physical space would be needed for the additional chemical storage and equipment/structures to employ their use. Space is already at a premium on Ngerur Island. The size of the structure where all treatment facilities are contained would have to increase by 100 percent to include the additional treatment components. Tertiary treatment would also entail greater cost for the treatment facilities and require the transport, storage, and use of numerous chemicals and/or fuel. Furthermore, tertiary treatment exponentially increases the complexity of the treatment process. All in all, the additional cost
(approximately $250,000 to $500,000) to treat the effluent to a tertiary level is not practical or cost effective, hence, the dismissal of this option in lieu of secondary treatment with UV (a compact, cost-effective option estimated at $25,000 that requires no chemicals) and ocean disposal via a deep outfall. The utilization of mounds/leach-fields or overland treatment was also considered and dismissed (in favor of the proposed on-site packaged WWTP).

The overland treatment was discounted due to the amount of land required, its potential for odors, and a perceived negative response of guests to a wastewater treatment process co-mingled within the public areas.

- A septic tank system employing a series of mounds and/or leach-fields was investigated but determined to be unfeasible because Ngerur Island is characterized by a thin layer of top soil underlain by a basaltic conglomerate material of unknown depth. The percolation capacity of this type of material is not favorable for a septic tank system utilizing a series of mounds and/or leach-fields. When these existing conditions are evaluated in conjunction with typical precipitation rates and the land requirement for even favorable percolation soils, the viability of such a system does not appear to be favorable.

The utilization of injection wells was also considered and dismissed (in favor of proposed disposal via ocean outfall).

- Injection wells are a common means of effluent disposal in-lieu of ocean outfalls. Due to diurnal fluctuations in the wastewater flow, the injection wells would draw from an effluent forebay to allow for more constant discharge rates. The injection wells would be drilled to a depth much greater than any extraction wells (400 to 500 feet) if such wells were used by the potable water system, in order to eliminate the potential for migration into the seawater supplying the RO system.
- Injection wells do require an additional treatment process over that required for an ocean outfall. In order to prevent fouling/clogging of the injection wells, the wastewater effluent must be filtered to reduce the number and size of particulates in the liquid being injected through the well screens.
- Advantages associated with injection wells are that facilities are small and can be contained in the WWTP area, no off-shore construction is required, and there are minimal environmental impacts with this option. The disadvantages of this system are that it requires a high power demand, requires a redundant system for reliability, and implies operational and maintenance activities on-island. The primary environmental concerns related to this option are the increased potential for noise from continuous pump activity.
- Geotechnical analysis for Ngerur Island indicated that permeability was inadequate for injection wells since at +200 feet into the subsurface the material is so compressed that no water can travel through it (refer to Appendix B-1). As a result of the analysis, the option to utilize injection wells was determined to be impracticable and was therefore dismissed from further consideration.
3.4.3 Alternative Fire Protection Systems

3.4.3.1 Seawater Fire Protection System

Implementing a seawater fire protection system would require construction of a fire pump house on the docks and a separate looped piping system. To satisfy the 500 gpm flow requirement, a 6-inch diameter piping system would be required. The advantage of the seawater system is that no fire storage is required since the ocean is the system forebay. Saltwater, however, is very aggressive on system materials. This aggressive attack translates into frequent and extensive maintenance that can result in decreased reliability. In addition, the need for a separate piping system counters the advantage of no storage requirements. Furthermore, using saltwater for the main structure sprinkler system is impractical. Lastly, in the event of a fire, saltwater would have a detrimental effect on vegetation in and around the fire. Given the above considerations, the use of seawater for fire protection was eliminated from consideration in favor of using the potable water system for fire protection.

3.4.3.2 Catchment Fire Protection System

A catchment system would likely utilize water features of the project for storage with the fire pumps drawing from those impounds. A piping system separate from the potable water system would be required since the catchment water would not be filtered or disinfected.

An advantage of using catchment water is the reduced potable water storage requirements; however, the need for a separate piping system around the island negates the potential storage reduction advantage. Moreover, if the main structure were provided with a sprinkler system, the entire structure would have to be plumbed with separate catchment piping for the sprinkler system.

The option of an independent catchment fire protection system was therefore eliminated from further consideration in favor of using the proposed potable water system for fire protection.

3.4.4 Alternative Electrical Power Systems

3.4.4.1 Palau Public Utilities Corporation (PPUC) Power Supply

This alternative will require electrical power for the Palm Springs Resort to be supplied by the Palau Public Utility Corporation (PPUC). Power will be transmitted from Arakabesan Island via a steel armored submarine cable from a location near the Palau Pacific Resort. The submarine cable will be installed in a "cut and cover" trench until deeper water is reached, where it will be laid on the ocean bottom over hard rock or coral. Anchors will be used only to the extent necessary to stabilize the submarine cable within the alignment corridor. No anchoring is required along the sandy areas that comprise approximately 75 percent of the entire alignment.

This alternative was eliminated due to the cost involved and the impacts it may cause.
on the seabed and marine life during the installation of the submarine cable.

3.4.4.2 Off-site Power Plant Facility

Obtaining power from an off-site power plant located on Arakabesan Island would require construction of a power plant on Arakabesan and installation of a transmission line such as a steel-armored submarine cable to Ngerur Island. The conduit would house power and telecommunications cables. It would have to be installed in a "cut and cover" trench until deeper water is reached where it would be laid on the lagoon bottom. Anchors would be used only to the extent necessary to stabilize the cable within the alignment corridor. No anchoring would be required along the sandy lagoon bottom areas that comprise 75 percent of the entire proposed alignment.

This alternative would require two generators each sized to handle the entire island demand. Generators would operate in a DUTY/STANDBY mode with scheduled alternation to allow for maintenance and proper exercising of the equipment. Diesel fuel would be used.

The advantages of this option are independence from the PUC power supply, less congestion on the island from equipment, no fuel transportation to and storage on the island, and reduced air and noise emissions on the island. Fewer on-island staff would be required, however, operational and maintenance staff would instead be required on Arakabesan.

The disadvantages of this alternative include the dependency on the integrity of the submarine cable, the potential line losses, and the potential need for a back-up system to increase reliability.

The alternative of an off-site facility was dismissed in favor of sourcing power supply from generators. The preferred alternative will nevertheless cause less impacts in comparison with the submarine cable installation.
4 EXISTING ENVIRONMENTAL CONDITIONS

4.1 The Land Environment

4.1.1 Geography

The stunning islands of Palau lay 1,000km (600 miles) east of the Philippines in the middle of the Pacific Ocean. Strung out like emeralds in a necklace, the archipelago stretches over 650km (400 miles) from the atoll of Kayangel in the north to the islet of Tobi in the south. The eight main islands which are inhabited make up the bulk of Palau, but the archipelago includes more than 200 islands, and is part of the larger Caroline Islands chain which also include the Federated States of Micronesia.

All of the islands are located within a single barrier reef and represent two geological formations. The largest are volcanic and rugged with interior jungle and large areas of grassed terraces. The Rock Islands, now known as the Floating Garden Islands, are of limestone formation, while Kayangel, at the northernmost tip, is a classic coral atoll.1

Koror is the state comprising the main commercial center of the Republic of Palau. Koror is located at 7°20'32" N 134°28'38" E. Besides Koror, there are 12 other hamlets in the state, namely, Meyuns, Ngermid, Ngerkeseuaol, Ngerchemai, Iyebukel, Idid, Meketii, Dngeronger, Ikela, Medalaii, Ngerbeched and Ngerkebesang. The proposed Palm Springs Resort will be located in Ngerur Island, Ngerkebesang Hamlet.

The proposed Palm Springs Resort in Ngerur Island is located approximately 750 meters northwest of the westernmost part of Arakebesang Island. Ngerur Island is approximately 6 kilometers from the Central Business District (CBD) of Koror State.

4.1.2 Topography

Ngerur island features small crescent or irregularly shaped rocky beaches around the island. The proposed site where the proposed Ngerur Island Resort will be built is featured by a relatively flat topography, roughly at 30 to 45 feet elevation. Rock formations are situated in the eastern part of the island, the highest of these formation rises to an elevation of approximately 70 feet (21 meters).2

The proposed project will take advantage of the existing topography, maximally retaining current topography and geomorphology, reducing earthwork and retaining important groups of native trees as much as possible.

4.1.3 Soil Type

According to the soil survey published by the United States Department of Agriculture, Natural Resources Conservation Service in 2009, soil type of the project area consists

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1 World Travel Guide
2 Final EIS for Quest Resort Palau, WCP , Inc 2000
of Nekken-Olei complex, 12 to 30 percent slopes (619) and Ollei-Nekken complex, 50 to 75 percent slopes (633). Figure 4-3 provides the soil map of the project site while Table 4-1 provides the properties of each type soil.

![Ngerur Island Soil Map](image)

**Figure 4-1, Soil map of the project site**
**TABLE 4-1, SOIL CHARACTERISTICS OF THE PROJECT SITE, PALM SPRINGS RESORT**

<table>
<thead>
<tr>
<th>Soil Type</th>
<th>619—Nekken-Ollei complex</th>
<th>633—Ollei-Nekken complex</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>12 to 30 percent slopes</td>
<td>50 to 75 percent slopes</td>
</tr>
<tr>
<td><strong>Major Land resource area</strong></td>
<td>193 (Volcanic Islands of Western Micronesia)</td>
<td>193 (Volcanic Islands of Western Micronesia)</td>
</tr>
<tr>
<td><strong>Elevation</strong></td>
<td>1 to 175 meters (3 to 574 feet)</td>
<td>1 to 213 meters (3 to 699 feet)</td>
</tr>
<tr>
<td><strong>Landscape</strong></td>
<td>Volcanic islands</td>
<td>Volcanic islands</td>
</tr>
<tr>
<td><strong>Aspect</strong></td>
<td>No dominant orientation</td>
<td>No dominant orientation</td>
</tr>
<tr>
<td><strong>Mean annual precipitation</strong></td>
<td>130 to 183 inches</td>
<td>130 to 183 inches</td>
</tr>
<tr>
<td><strong>Mean annual air temperature</strong></td>
<td>27 °C</td>
<td>27 °C</td>
</tr>
<tr>
<td><strong>Map Unit composition</strong></td>
<td>Nekken and similar soils – 60 percent; Ollei and similar soils – 30 percent; Minor components – 10 percent</td>
<td>Ollei and similar soils– 55 percent; Nekken and similar soils – 25 percent ; Minor components – 20 percent</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Nekken Soil</th>
<th>Ollei Soil</th>
<th>Minor Components</th>
<th>Oxyaquic Dystrudepts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Percentage Component in the map unit</strong></td>
<td>About 5 percent</td>
<td>About 3 percent</td>
<td>About 2 percent</td>
<td>About 10 percent</td>
</tr>
<tr>
<td><strong>Landform</strong></td>
<td>Coastal benches and ridges on hills</td>
<td>Coastal benches and ridges on hills</td>
<td>Hills</td>
<td>Ridges</td>
</tr>
<tr>
<td><strong>Hillslope position</strong></td>
<td>Backslopes, shoulders</td>
<td>Shoulders, backslopes</td>
<td>Summits, backslopes, footslopes, shoulders, toeslopes</td>
<td>Shoulders</td>
</tr>
<tr>
<td><strong>Geomorphic position</strong></td>
<td>Side slopes, crests</td>
<td>Side slopes, crests</td>
<td>Nose slopes, base slopes, side slopes, interfluves, crests, head slopes</td>
<td>Free faces</td>
</tr>
<tr>
<td><strong>Parent material</strong></td>
<td>Residuum derived from andesite, dacite, basaltic breccia, and tuff, the bedrock is commonly part of the Ngeremlengui Formation and to a lesser extent is the Ngardok Member of the</td>
<td>Residuum derived from andesite, dacite, basaltic breccia, and tuff, the bedrock is commonly part of the Ngeremlengui Formation and to a lesser extent is the Ngardok Member of the</td>
<td>Residuum derived from andesite, dacite, basaltic breccia, and tuff, the bedrock is commonly part of the Ngeremlengui Formation and to a lesser extent is the Ngardok Member of the</td>
<td>Residuum derived from andesite, dacite, basaltic breccia, and tuff, the bedrock is commonly part of the Ngeremlengui Formation and to a lesser extent is the Ngardok Member of the</td>
</tr>
<tr>
<td>Slope</td>
<td>12 to 30 percent</td>
<td>12 to 30 percent</td>
<td>30 to 150 percent</td>
<td>12 to 30 percent</td>
</tr>
<tr>
<td>------------------</td>
<td>-----------------</td>
<td>-----------------</td>
<td>-----------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>Slope shape</td>
<td>Convex/linear</td>
<td>Linear/concave</td>
<td>Linear/concave</td>
<td>Linear/convex</td>
</tr>
<tr>
<td>(down/</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>across)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage of</td>
<td>About 5 percent</td>
<td>About 40 percent</td>
<td>About 40 percent</td>
<td>About 5 percent</td>
</tr>
<tr>
<td>the surface</td>
<td>by angular</td>
<td>by angular</td>
<td>by angular</td>
<td>by angular</td>
</tr>
<tr>
<td>covered by rock</td>
<td>cobbles</td>
<td>gravel and 5</td>
<td>gravel and 5</td>
<td>cobbles</td>
</tr>
<tr>
<td>fragments</td>
<td></td>
<td>percent by</td>
<td>percent by</td>
<td></td>
</tr>
<tr>
<td>Slope shape</td>
<td></td>
<td>angular cobbles</td>
<td>angular gravel</td>
<td></td>
</tr>
<tr>
<td>(down/</td>
<td></td>
<td></td>
<td>and 5 percent</td>
<td></td>
</tr>
<tr>
<td>across)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depth class</td>
<td>Moderately deep</td>
<td>Very shallow</td>
<td>Very shallow</td>
<td>Moderately deep</td>
</tr>
<tr>
<td>Depth to a</td>
<td>50 to 100</td>
<td>15 to 50</td>
<td>25 to 50</td>
<td>50 to 100</td>
</tr>
<tr>
<td>restrictive</td>
<td>centimeters</td>
<td>centimeters</td>
<td>centimeters</td>
<td>centimeters</td>
</tr>
<tr>
<td>feature</td>
<td>(20 to 39</td>
<td>(9.6 to 20</td>
<td>(10 to 20</td>
<td>(20 to 39</td>
</tr>
<tr>
<td></td>
<td>inches) to</td>
<td>inches) to</td>
<td>inches) to</td>
<td>inches) to</td>
</tr>
<tr>
<td></td>
<td>lithic bedrock</td>
<td>lithic bedrock</td>
<td>lithic bedrock</td>
<td>lithic bedrock</td>
</tr>
<tr>
<td>Most limiting</td>
<td>0.360 to 3.6 cm/</td>
<td>0.360 to 3.6 cm/</td>
<td>3.6 to 36 cm/hr</td>
<td>0.360 to 3.6 cm/</td>
</tr>
<tr>
<td>permeability</td>
<td>hr (0.142 to</td>
<td>hr (0.142 to</td>
<td>(1.42 to 14.7</td>
<td>cm/hr (0.142 to</td>
</tr>
<tr>
<td>(Ksat):</td>
<td>1.42 in/hr);</td>
<td>1.42 in/hr);</td>
<td>14.7 in/hr);</td>
<td>1.42 in/hr);</td>
</tr>
<tr>
<td></td>
<td>moderately high</td>
<td>moderately high</td>
<td>high</td>
<td>high</td>
</tr>
<tr>
<td>Available water</td>
<td>About 9.6</td>
<td>About 1.9</td>
<td>About 3.5</td>
<td>About 9.3</td>
</tr>
<tr>
<td>capacity</td>
<td>centimeters</td>
<td>centimeters</td>
<td>centimeters</td>
<td>centimeters</td>
</tr>
<tr>
<td></td>
<td>(3.8 inches);</td>
<td>(0.8 inch);</td>
<td>(1.4 inches);</td>
<td>(3.7 inches);</td>
</tr>
<tr>
<td></td>
<td>low</td>
<td>very low</td>
<td>low</td>
<td>low</td>
</tr>
<tr>
<td>Shrink-swell</td>
<td>About 4 percent</td>
<td>About 2 percent</td>
<td>About 2 percent</td>
<td>About 4 percent</td>
</tr>
<tr>
<td>potential</td>
<td>(moderate)</td>
<td>(low)</td>
<td>(low)</td>
<td>(moderate)</td>
</tr>
<tr>
<td>Soil slippage</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>potential</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aluminum</td>
<td>About 5 percent</td>
<td>About 27 percent</td>
<td>About 27 percent</td>
<td>About 5 percent</td>
</tr>
<tr>
<td>saturation in the</td>
<td>(low)</td>
<td>percent (moderate)</td>
<td>percent (moderate)</td>
<td>(low)</td>
</tr>
<tr>
<td>topsoil</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aluminum</td>
<td>About 58 percent</td>
<td>About 27 percent</td>
<td>About 27 percent</td>
<td>About 58 percent</td>
</tr>
<tr>
<td>saturation in the</td>
<td>(moderate)</td>
<td>percent (moderate)</td>
<td>percent (moderate)</td>
<td>percent (moderate)</td>
</tr>
<tr>
<td>subsoil</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ponding</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Flooding</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Runoff class</td>
<td>High</td>
<td>Very high</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Drainage class</td>
<td>Well drained</td>
<td>Well drained</td>
<td>Moderately</td>
<td>Well drained</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>well drained</td>
<td></td>
</tr>
<tr>
<td>Hydrologic soil</td>
<td>C</td>
<td>D</td>
<td>D</td>
<td>C</td>
</tr>
<tr>
<td>group</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4.2 Marine and Biological Assessment

An Environmental Impact Statement prepared by WCP, Inc. from Honolulu, Hawaii was submitted to Palau EQPB last November 2000 for then proposed Quest Resort in Ngerur Island of which the same plans will be followed for this presently proposed Palm Springs Resort.

Baseline marine environmental survey was conducted by Pentec Environmental, Inc. on April, 1999 and results were accordingly presented in the submitted EIS for Quest Resort in November, 2000. The baseline information presented thereof will serve as reference for the assessment of NECO team of the existing conditions of the island to date.

4.2.1 Preliminary Assessment

On November 29, 2017, the NECO ECS team went to Ngerur Island to assess the existing environmental condition. The areas for possible impacts were identified based on the project layout. Areas for biological and water quality investigation were identified based on areas on the island where developments will be constructed.

4.2.2 Water Quality

On January 22, 2018, water samples for water quality analysis were collected using grab method at four (4) strategic point locations around the island where developments will be made based on the available conceptual plan.

![Figure 4-2: Water Quality Sampling Station Location](image-url)
Water samples were analyzed by Metiek Ngirchechol of Palau EQPB for presence of *Enterococci* using the IDEXXEnterolert Method with incubator set at 41°C. Turbidity was measured following the EPA 180.1 method using Turbidity Meter (Hach 2100P).

**FIGURE 4-3. WATER QUALITY SAMPLING RESULTS**

Result of the analysis for coliform count and water turbidity from 4 different stations shows that the water in the vicinity is free from any traces of coliform bacteria and is not considered turbid.

Coastal waters in the Republic of Palau are classified in accordance with uses to be protected in each class. Three classifications were listed for the coastal waters in the EQPB Marine and Fresh Water Quality Regulations and these include Class AA, A and B Coastal Waters.

Class AA waters are near pristine natural conditions and must be allowed full protection. Only compatible recreational, oceanic researches, subsistence fishing and other aesthetic enjoyment are allowed within these areas. No point source discharge will be permitted in these waters.

Class A waters allow swimming, bathing and other water recreational sports as well as the support and propagation of aquatic life. Only subsistence uses as fishing and recreational purposes as swimming and snorkeling are permitted in these classes of waters. It shall be kept clean of any trash, solid materials and oil, and shall not act as receiving waters for any effluent which has not received the highest degree of treatment.
Class B waters are currently used as small boat harbors, bait fishing, commercial and industrial shipping, support and propagation of aquatic life and aesthetic enjoyment. Discharge of any pollutant in this class of water shall be controlled to the maximum extent possible and that sewage and industrial effluent shall receive highest degree of treatment.

Based on the above results of water quality, it presents standards of Class AA waters mainly because of the absence of any activity within and around the island.

Effective October 6, 2000, an amendment to the Marine and Freshwater Quality Regulations, Chapter 2401-11-42 was approved specifically to classify waters extending 200 meters from the shoreline of Ngerur Island to Class B. Copy of the approved amendment is attached as Appendix 7.

4.2.3 Marine Biological Survey

On the basis of a past baseline marine environmental survey presented on the EIS for Ngerur Island, an updated baseline marine survey was conducted by Neco ECS team last January 20, 2018.

Previous baseline environmental survey from Pentec, Inc. last 1999 gathered data from areas designed to have improvements based on the conceptual plans. To monitor changes on the environmental setting, a similar transect survey was conducted on these areas with some modification. Figure 4-4A below shows the transect points conducted by Pentect, Inc. in 1999 and Figure 4-4B shows transect points conducted by Neco.
Purpose of the marine survey was to revisit the four study areas that were selected and surveyed during the initial marine baseline survey conducted by Pentec back in 1999. The initial survey done by this company was very comprehensive and therefore should be referenced for in depth information about the site.

This present survey was more focused on the current condition of the reef in terms of coral cover. Observations during this survey show that the general condition of the area is still very much pristine. Coral community around the whole island seemed to be in good condition. There is no sign of any recently bleach coral or any sign of major physiographical change over the last two decades. Algal growth was minimal and mostly concentrated on coastal waterline. Thin layer of filamentous algae is coating basalt substrate along the whole stretch of southern side of the island making it slippery. Small patches of two species of soft coral Sarcophyton sp. and Sinularia sp. were observed on eastern side of island.

Massive corals mostly in the family of Poritidae are the dominant species around the island. Branching corals in the same family are second most common. There are other branching corals in the family of Acroporidae which was also observed outside the
perimeter of study site T3 and T4 (see map). This distinct zone of branching Acropora corals runs along the east/southeast of the island but in a much deeper area which is out of reach of transect.

The survey team focused only on three biological indicators such as Fish, Invertebrate and Benthic cover. For fish species, the survey team decided to focus only on food fish, however, there were other non food fish observed in each transect such as cardinal fish, butterfly fish, wrasses, damsels. For Invertebrate species, the team decided to include everything since there was not much in the area. For benthic survey, Line Intercept Transect (LIT) method was used to calculate the percent cover of each transect.

Two men survey team conducted the survey. Transect tape of 50 meter in length was placed along the substrate at each study site indicated by initial baseline survey team on a map. Each transect was laid as close as possible to the coast and extend perpendicular toward deeper water. Surveyors geared up with snorkeling equipment swam the length of transect enumerating fish and invertebrate within one and half meter (2.5m) on both sides of transect tape. Therefore, each transect covers an area of two hundred fifty square meter (5x50 = 250).

**Table 4-2 Marine Survey Results – Transect 1A**

<table>
<thead>
<tr>
<th>Category</th>
<th>Palauan Name</th>
<th>Scientific Name</th>
<th>Quantity Observed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fish</td>
<td>Masech</td>
<td>Ctenochaetus striatus</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Reked</td>
<td>Siganus doliatus</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Belai</td>
<td>Acantharus lineatus</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Desachel</td>
<td>Sargocentron spiniferum</td>
<td>1</td>
</tr>
<tr>
<td>Invertebrate</td>
<td>Oruer</td>
<td>Tridacna crocea</td>
<td>97</td>
</tr>
<tr>
<td></td>
<td>Ribkungel</td>
<td>Tridacna squamosa</td>
<td>1</td>
</tr>
</tbody>
</table>

**Figure 4-5 Benthic Cover Result – Transect 1A**

% Benthic Cover

- Porite massive
- Porite rus
- Rubble
- Porites cylindrica
- Basalt Rock
### Table 4-3 Marine Survey Results – Transect 1B

<table>
<thead>
<tr>
<th>Category</th>
<th>Palauan Name</th>
<th>Scientific Name</th>
<th>Quantity Observed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fish</td>
<td>Masech</td>
<td>Ctenochaetus striatus</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>Reked</td>
<td>Siganus doliatus</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Ngyaoch</td>
<td>Hipposcarus longicep</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Belai</td>
<td>Acantharus lineatus</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Mellemau</td>
<td>Chlorus blekeeri</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Derringel</td>
<td>Lutjanus monostigmus</td>
<td>6</td>
</tr>
<tr>
<td>Invertebrate</td>
<td>Oruer</td>
<td>Tridacna crocea</td>
<td>69</td>
</tr>
<tr>
<td></td>
<td>Ribkungel</td>
<td>Tridacna squamosa</td>
<td>2</td>
</tr>
</tbody>
</table>

### Figure 4-6 Benthic Cover Result – Transect 1B

![Benthic Cover Bar Chart]

### Table 4-4 Marine Survey Results – Transect 1C

<table>
<thead>
<tr>
<th>Category</th>
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<th>Scientific Name</th>
<th>Quantity Observed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fish</td>
<td>Masech</td>
<td>Ctenochaetus striatus</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>Belai</td>
<td>Acantharus lineatus</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>Elas</td>
<td>Acantharus triostegus</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Reked</td>
<td>Siganus doliatus</td>
<td>9</td>
</tr>
<tr>
<td>Invertebrate</td>
<td>Oruer</td>
<td>Tridacna crocea</td>
<td>61</td>
</tr>
</tbody>
</table>
FIGURE 4-7 BENTHIC COVER RESULT – TRANSECT 1C

% Benthic Cover

![Bar chart showing benthic cover results for different categories.]

FIGURE 4-8 BENTHIC COVER RESULT – TRANSECT 2A

% Benthic Cover

![Bar chart showing benthic cover results for different categories.]

TABLE 4-5 MARINE SURVEY RESULTS – TRANSECT 2A

<table>
<thead>
<tr>
<th>Category</th>
<th>Palauan Name</th>
<th>Scientific Name</th>
<th>Quantity Observed</th>
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</thead>
<tbody>
<tr>
<td>Fish</td>
<td>Belai</td>
<td>Acantharus lineatus</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Reked</td>
<td>Siganus doliatus</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Masech</td>
<td>Ctenochaetus striatus</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>Mellemau</td>
<td>Chlorurus bleekeri</td>
<td>9</td>
</tr>
<tr>
<td>Invertebrate</td>
<td>Oruer</td>
<td>Tridacna crocea</td>
<td>61</td>
</tr>
<tr>
<td></td>
<td>Ribkungel</td>
<td>Tridacna squamosa</td>
<td></td>
</tr>
</tbody>
</table>
TABLE 4-6 MARINE SURVEY RESULTS – TRANSECT 2B

<table>
<thead>
<tr>
<th>Category</th>
<th>Palauan Name</th>
<th>Scientific Name</th>
<th>Quantity Observed</th>
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</thead>
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<td>Fish</td>
<td>Masech</td>
<td>Ctenochaetus striatus</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>Mellemau</td>
<td>Chlororus bleekeri</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Berdebed</td>
<td>Bolbometapon muricatum</td>
<td>4</td>
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<tr>
<td></td>
<td>Belai</td>
<td>Acantharus lineatus</td>
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<tr>
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<td>Elas</td>
<td>Acantharus triostegus</td>
<td>30</td>
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<td>Invertebrate</td>
<td>Oruer</td>
<td>Tridacna crocea</td>
<td>45</td>
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</table>

FIGURE 4-9 BENTHIC COVER RESULT – TRANSECT 2B

TABLE 4-7 MARINE SURVEY RESULTS – TRANSECT 2C

<table>
<thead>
<tr>
<th>Category</th>
<th>Palauan Name</th>
<th>Scientific Name</th>
<th>Quantity Observed</th>
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</thead>
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<td>Belai</td>
<td>Acantharus lineatus</td>
<td>25</td>
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<td></td>
<td>Derringel</td>
<td>Lutjanus monostigmus</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Reked</td>
<td>Siganus doliatus</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Desachel</td>
<td>Sargocentron spiniferum</td>
<td>2</td>
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<tr>
<td></td>
<td>Elas</td>
<td>Acantharus triostegus</td>
<td>29</td>
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<td>Invertebrate</td>
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<td>Tridacna crocea</td>
<td>79</td>
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<td>Ribkungel</td>
<td>Tridacna squamosa</td>
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**FIGURE 4-10 BENTHIC COVER RESULT – TRANSECT 2C**

![Graph showing benthic cover results for Transect 2C with bars for Basalt Rock, Porites massive, Porites cylindrica, and Rubble.]

**TABLE 4-8 MARINE SURVEY RESULTS – TRANSECT 3**

<table>
<thead>
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<th>Category</th>
<th>Palauan Name</th>
<th>Scientific Name</th>
<th>Quantity Observed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fish</td>
<td>Masech</td>
<td>Ctenochaetus striatus</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>Belai</td>
<td>Acantharus lineatus</td>
<td>6</td>
</tr>
<tr>
<td>Invertebrate</td>
<td>Ngimes</td>
<td>Stichopus hermanni</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Cheuas</td>
<td>Holothuria atra</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>Oruer</td>
<td>Tridacna crocea</td>
<td>58</td>
</tr>
</tbody>
</table>

**FIGURE 4-11 BENTHIC COVER RESULT – TRANSECT 3**

![Graph showing benthic cover results for Transect 3 with bars for Porites massive, Porites cylindrica, Rubble, and Sand.]

T3 - % Benthic Cover
4.2.4 Terrestrial Survey

On February 26, 1999, a botanical survey was conducted by Dr. Derral Herbst for Ngerur Island. Results of which was gathered for the EIS prepared for then proposed Quest Resort in Ngerur.

On January 20, 2018, NECO ECS team conducted a terrestrial survey to update baseline information of the terrestrial cover of the island. An ocular survey was conducted by boat circling entirely around the island. Overlooking trees and plants were identified and noted. Four transect points were conducted at 75 – 100 meters to represent the north, east, west and south section of the island. At 5 meters interval, all
trees within 1 meter from each transect point were identified and measured. Trees on this survey mean trees measuring more than 2 meters in height.

The trees were measured taking into account the height and circumference at breast height (CBH). The CBH is taken by measuring the tree circumference at 4.5 feet. This is because the 4.5 foot height is a forestry standard and is an arbitrary and convenient place for most people to measure a tree. The circumference was then converted to diameter and later was used to calculate for the tree basal area.

Wherein:

\[ BA = \pi \left( \frac{DBH}{2} \right)^2. \]

where: \( BA = \) Basal Area  
\( DBH = \) Diameter at Breast height  
\( \pi = \) pi (3.1416)
Basal area is an important forest measurement as it lets you know the forest density of the area to be affected by this project. Total basal area for transect 1 is at 30,640.42 cm², transect 2 at 77,499.35 cm², transect 3 at 2,605.01 cm² and transect 4 at 3,268.27 cm².

**TABLE 4-10 TERRESTRIAL TRANSECT SURVEY RESULTS – TRANSECT 1**

<table>
<thead>
<tr>
<th>Transect 1</th>
<th>Palauan Name</th>
<th>Scientific Name</th>
<th>Status</th>
<th>Height (m)</th>
<th>Diameter (cm)</th>
<th>Basal area (sq.cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 meters</td>
<td>Ongor</td>
<td><em>Pandanus tectorius</em></td>
<td>Native</td>
<td>4</td>
<td>10</td>
<td>78.54</td>
</tr>
<tr>
<td>5 meters</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 meters</td>
<td>Btaches</td>
<td><em>Calophyllum inophyllum</em></td>
<td>Native</td>
<td>20</td>
<td>75</td>
<td>4417.88</td>
</tr>
<tr>
<td>15 meters</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20 meters</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25 meters</td>
<td>Chebicheb</td>
<td><em>Heritiera littoralis</em></td>
<td>Native</td>
<td>10</td>
<td>30</td>
<td>706.86</td>
</tr>
<tr>
<td>30 meters</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35 meters</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40 meters</td>
<td>Chelangel</td>
<td><em>Pouteria obovate</em></td>
<td>Native</td>
<td>3</td>
<td>10</td>
<td>78.54</td>
</tr>
<tr>
<td>45 meters</td>
<td>Bedel</td>
<td><em>Heteropathe elata</em></td>
<td>Native</td>
<td>3</td>
<td>12.5</td>
<td>122.72</td>
</tr>
<tr>
<td>50 meters</td>
<td>Btaches</td>
<td><em>Calophyllum inophyllum</em></td>
<td>Native</td>
<td>15</td>
<td>67.5</td>
<td>3578.48</td>
</tr>
<tr>
<td>55 meters</td>
<td>Iedel</td>
<td><em>Magnifera indica</em></td>
<td>Introduced</td>
<td>20</td>
<td>92.5</td>
<td>6720.08</td>
</tr>
<tr>
<td>60 meters</td>
<td>Ongor</td>
<td><em>Pandanus tectorius</em></td>
<td>Native</td>
<td>3</td>
<td>17.5</td>
<td>240.53</td>
</tr>
<tr>
<td>65 meters</td>
<td>Ongor</td>
<td><em>Pandanus tectorius</em></td>
<td>Native</td>
<td>8</td>
<td>15</td>
<td>176.72</td>
</tr>
<tr>
<td>70 meters</td>
<td>Ongor</td>
<td><em>Pandanus tectorius</em></td>
<td>Native</td>
<td>4</td>
<td>22.5</td>
<td>397.61</td>
</tr>
<tr>
<td>75 meters</td>
<td>Btaches</td>
<td><em>Calophyllum inophyllum</em></td>
<td>Native</td>
<td>20</td>
<td>90</td>
<td>6361.74</td>
</tr>
<tr>
<td>80 meters</td>
<td>Chermall</td>
<td><em>Hibiscus tiliaeus</em></td>
<td>Native</td>
<td>3</td>
<td>7.5</td>
<td>44.18</td>
</tr>
<tr>
<td>85 meters</td>
<td>Chercheroi</td>
<td><em>Mussaenda philippica</em></td>
<td>Introduced</td>
<td>2.5</td>
<td>7.5</td>
<td>44.18</td>
</tr>
<tr>
<td>90 meters</td>
<td>Ongor</td>
<td><em>Pandanus tectorius</em></td>
<td>Native</td>
<td>3</td>
<td>17.5</td>
<td>240.53</td>
</tr>
<tr>
<td>95 meters</td>
<td>Iedel</td>
<td><em>Magnifera indica</em></td>
<td>Introduced</td>
<td>25</td>
<td>87.5</td>
<td>6013.22</td>
</tr>
<tr>
<td>100 meters</td>
<td>Las</td>
<td><em>Pterocarpus indicus</em></td>
<td>Native</td>
<td>5</td>
<td>42.5</td>
<td>1418.63</td>
</tr>
</tbody>
</table>

**TABLE 4-11 TERRESTRIAL TRANSECT SURVEY RESULTS – TRANSECT 2**

<table>
<thead>
<tr>
<th>Transect 2</th>
<th>Palauan Name</th>
<th>Scientific Name</th>
<th>Status</th>
<th>Height (m)</th>
<th>Diameter (cm)</th>
<th>Basal area (sq.cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 meters</td>
<td>Btaches</td>
<td><em>Calophyllum inophyllum</em></td>
<td>Native</td>
<td>18</td>
<td>95</td>
<td>7088.24</td>
</tr>
<tr>
<td>5 meters</td>
<td>Las</td>
<td><em>Pterocarpus indicus</em></td>
<td>Native</td>
<td>5</td>
<td>37.5</td>
<td>1104.47</td>
</tr>
<tr>
<td>10 meters</td>
<td>Keselingel</td>
<td><em>Morinda pedunculata</em></td>
<td>Endemic</td>
<td>3</td>
<td>12.5</td>
<td>122.72</td>
</tr>
<tr>
<td>15 meters</td>
<td>Iedel</td>
<td><em>Magnifera indica</em></td>
<td>Introduced</td>
<td>30</td>
<td>100</td>
<td>7854.00</td>
</tr>
<tr>
<td>20 meters</td>
<td>Btaches</td>
<td><em>Calophyllum inophyllum</em></td>
<td>Native</td>
<td>12</td>
<td>37.5</td>
<td>1104.47</td>
</tr>
</tbody>
</table>
### TABLE 4-12 TERRESTRIAL TRANSECT SURVEY RESULTS – TRANSECT 3

<table>
<thead>
<tr>
<th>Transect 3</th>
<th>Palauan Name</th>
<th>Scientific Name</th>
<th>Status</th>
<th>Height (m)</th>
<th>Diameter (cm)</th>
<th>Basal area (sq.cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 meters</td>
<td>Kerumes</td>
<td><em>Aidia racemos</em></td>
<td>Native</td>
<td>4</td>
<td>4</td>
<td>12.57</td>
</tr>
<tr>
<td></td>
<td>Kerumes</td>
<td><em>Aidia racemos</em></td>
<td>Native</td>
<td>3.8</td>
<td>2.5</td>
<td>4.91</td>
</tr>
<tr>
<td>5 meters</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>10 meters</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>15 meters</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>20 meters</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>25 meters</td>
<td>-l</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>30 meters</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>35 meters</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>40 meters</td>
<td>Ongor</td>
<td><em>Pandanus tectorius</em></td>
<td>Native</td>
<td>9</td>
<td>22.86</td>
<td>410.43</td>
</tr>
<tr>
<td></td>
<td>Kerumes</td>
<td><em>Aidia racemos</em></td>
<td>Native</td>
<td>4.5</td>
<td>5</td>
<td>19.64</td>
</tr>
<tr>
<td></td>
<td>Kerumes</td>
<td><em>Aidia racemos</em></td>
<td>Native</td>
<td>4</td>
<td>4</td>
<td>12.57</td>
</tr>
<tr>
<td>45 meters</td>
<td>Chermall</td>
<td><em>Hibiscus tiliaceus</em></td>
<td>Native</td>
<td>4</td>
<td>6.35</td>
<td>31.67</td>
</tr>
<tr>
<td></td>
<td>Chermall</td>
<td><em>Hibiscus tiliaceus</em></td>
<td>Native</td>
<td>3.5</td>
<td>4.45</td>
<td>-</td>
</tr>
<tr>
<td>50 meters</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>55 meters</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
A total of fifteen (15) species of trees were identified and noted on the four transects that were made. Of this, eleven (11) species are native to Palau, three (3) are introduced species and one (1) as endemic species.3

The most prevalent species of tree that was noted is *Pandanus tectorius* or commonly known as Ongor or Ongor ra ked. The flowers and fruits of this tree is used during traditional first childbirth ceremonies in the country. The wood can also be used as posts for building summer houses. Another prevalent tree within the transect is *Calophyllum inophyllum* or locally known as Btaches. The wood of this tree is

---

considered high value as this can be used for boat building, canoes, cabinet work and handicrafts.\(^4\)

An ocular survey was also done on Jan. 20, 2018 covering the entire island. This was done by encircling the island by boat and identifying plant species that can be observed from the shoreline. Below table identifies the different plant species in every directional section of the island.

**TABLE 4-14 OCULAR SURVEY RESULTS, NGERUR ISLAND**

<table>
<thead>
<tr>
<th>Section of the Island</th>
<th>Palauan Name</th>
<th>Scientific Name</th>
<th>Percent Cover</th>
</tr>
</thead>
<tbody>
<tr>
<td>East</td>
<td>Btaches</td>
<td><em>Calophyllum inophyllum</em></td>
<td>30%</td>
</tr>
<tr>
<td></td>
<td>Churur</td>
<td><em>Sonneratia alba</em></td>
<td>30%</td>
</tr>
<tr>
<td></td>
<td>Las</td>
<td><em>Pterocarpus indicus</em></td>
<td>20%</td>
</tr>
<tr>
<td></td>
<td>Miich</td>
<td><em>Terminalia catappa</em></td>
<td>10%</td>
</tr>
<tr>
<td></td>
<td>Lulk</td>
<td><em>Ficus microcarpa</em></td>
<td>5%</td>
</tr>
<tr>
<td></td>
<td>Kisaks</td>
<td><em>Millettia pinnata</em></td>
<td>5%</td>
</tr>
<tr>
<td>West</td>
<td>Chudel ra ngebei</td>
<td><em>Paspalum conjugatum</em></td>
<td>50%</td>
</tr>
<tr>
<td></td>
<td>Ongor</td>
<td><em>Pandanus tectorius</em></td>
<td>30%</td>
</tr>
<tr>
<td></td>
<td>Ngas</td>
<td><em>Casuarina equisetifolia</em></td>
<td>10%</td>
</tr>
<tr>
<td></td>
<td>Rebotel</td>
<td><em>Eugenia javanica</em></td>
<td>5%</td>
</tr>
<tr>
<td></td>
<td>Kilkuld</td>
<td><em>Dryopteris arida</em></td>
<td>2%</td>
</tr>
<tr>
<td></td>
<td>Chosem</td>
<td><em>Premna serratifolia</em></td>
<td>2%</td>
</tr>
<tr>
<td></td>
<td>Lius</td>
<td><em>Cocos nucifera</em></td>
<td>1%</td>
</tr>
<tr>
<td>North</td>
<td>Chermall</td>
<td><em>Hibiscus tiliaceus</em></td>
<td>40%</td>
</tr>
<tr>
<td></td>
<td>Ukall</td>
<td><em>Serianthes kanehirae</em></td>
<td>20%</td>
</tr>
<tr>
<td></td>
<td>Kisaks</td>
<td><em>Millettia pinnata</em></td>
<td>20%</td>
</tr>
<tr>
<td></td>
<td>Ongor</td>
<td><em>Pandanus tectorius</em></td>
<td>10%</td>
</tr>
<tr>
<td></td>
<td>Bungarauau</td>
<td><em>Portulaca oleracea</em></td>
<td>10%</td>
</tr>
<tr>
<td>South</td>
<td>Chudel ra ngebei</td>
<td><em>Paspalum conjugatum</em></td>
<td>50%</td>
</tr>
<tr>
<td></td>
<td>Ongor</td>
<td><em>Pandanus tectorius</em></td>
<td>40%</td>
</tr>
<tr>
<td></td>
<td>Chercheroi</td>
<td><em>Mussaenda philippica</em></td>
<td>10%</td>
</tr>
</tbody>
</table>

4.2.5 Bird Survey

The bird survey conducted followed the National Bird Monitoring Protocol developed by the Belau National Museum. The protocol requires a 15-minute count for species diversity at a central location on the site where you can simultaneously observe forest and sky.

A bird count was carried out by Ms. Heather Ketebengang of Palau Conservation Society on Jan. 20, 2018 at the proposed development site. The count was conducted in the middle of the island. This particular counting station allows a partial view of the sky, partial view of the ocean, the savannah forest and the other big tree forest.

There were a total of seven (7) birds recorded during the survey. Most of the birds that were counted, were seen or heard from the center of the proposed development site or the surrounding areas. Before the actual count, a White-tailed tropicbird was observed as well as a Palau Fruit Bat.
## EQPB Bird Survey Data Sheet

**Date:** January 20, 2018  
**Location:** Ngerur Island

**Start Time:** 7:33 am  
**Temperature (°C):** 25.6  
**Cloud Conditions:** partly cloudy  
**Wind (Beaufort Scale):** 0

<table>
<thead>
<tr>
<th>Species</th>
<th>Field Observations and Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palau Fruit-Dove</td>
<td>X</td>
</tr>
<tr>
<td>Palau Bush-Warbler</td>
<td></td>
</tr>
<tr>
<td>Micronesian Starling</td>
<td></td>
</tr>
<tr>
<td>Palau Swiftlet</td>
<td></td>
</tr>
<tr>
<td>Dusky White-eye</td>
<td>X</td>
</tr>
<tr>
<td>Palau Fantail</td>
<td></td>
</tr>
<tr>
<td>Palau Flycatcher</td>
<td>X</td>
</tr>
<tr>
<td>Micronesian Myzomela</td>
<td>X</td>
</tr>
<tr>
<td>Cicadabird</td>
<td></td>
</tr>
<tr>
<td>Collared Kingfisher</td>
<td>X</td>
</tr>
<tr>
<td>Micronesian Kingfisher</td>
<td></td>
</tr>
<tr>
<td>Morningbird</td>
<td>X</td>
</tr>
<tr>
<td>Micronesian Imperial-Pigeon</td>
<td></td>
</tr>
<tr>
<td>Nicobar Pigeon</td>
<td></td>
</tr>
<tr>
<td>Palau Ground Dove</td>
<td></td>
</tr>
<tr>
<td>Micronesian Megapode</td>
<td></td>
</tr>
<tr>
<td>Other:</td>
<td></td>
</tr>
<tr>
<td>Black Noddy</td>
<td>X</td>
</tr>
</tbody>
</table>

**Record the total number of species below**

**TOTAL NO. SPECIES**  7

**Name (print):** Heather Ketebengang  
**Signature:** [Signature]

**Figure 4-14, Bird Survey Results**
5 IMPACT ASSESSMENT & MITIGATIONS

An impact is any change to the existing condition of the environment caused by human activity or an external influence. Impacts therefore may be positive (beneficial) or negative (adverse), direct or indirect, long-term or short-term, and extensive or local in effect. Impacts are termed cumulative when they add incrementally to existing impacts. Both positive and adverse environmental impacts could arise during the site preparation, construction and operational phases of the Palm Springs Resort. These are discussed in this section.

The EQPB is advised that some predicted impacts discussed in this EA were taken from the “Final EIS Report for the Quest Resort Palau.” As the Project Proponent, PPSIDL, intends to follow the original project design approved by the EQPB, except for the submarine cable installation, it was deemed necessary to include the impacts and the mitigating measures presented in the Final EIS Report.

5.1 Impacts During Design & Construction of the Project

5.1.1 Potential Failure/Collapse of the Building if Not Properly Designed & Constructed

Buildings, like all structures, are designed to support certain loads without deforming excessively. The loads are the weights of people and objects, the weight of rain and the pressure of wind called “live loads” and the “dead load” of the building itself. For tall buildings consisting of many floors, the roof is a minor matter, and the support of the weight of the building itself is the main consideration. Like long bridges, tall buildings are subject to catastrophic collapse.

Structural integrity is an aspect of engineering which deals with the ability of a structure to support the designed load, i.e., both live load and dead load, without breaking, tearing apart, or collapsing, in order to prevent failures in future designs.

The following are some of the major causes of building collapse:

- The structure is not strong enough to support the load and hence it fails when it reaches a critical stress level. The structure may be weak due to its shape, size, or choice of its material.

- The instability due to geometry, design, or material choice, will cause the structure to fail from fatigue or corrosion.

- Failure may also occur due to improper selection of materials, incorrect sizing, improper heat treating, or shoddy workmanship.

- Failure may also occur from use of defective materials. The material may have been improperly manufactured, or may have been damaged from prior use.
Vandalism, sabotage, and natural disasters can overstress a structure to the point of failure. Improper training of those who use and maintain the construction can also overstress it, leading to potential failures.

**Mitigating Measures:**

- Geotechnical/Soil investigation of the site was undertaken by Geolabs, Inc. In 1999. Based on the field exploration and the proposed building designs:
  - a shallow foundation system consisting of posts-and-beams can be used to support the one to three-storey buildings planned for the proposed resort development.
  - a 16 inch octagonal precast prestressed concrete piles end-bearing can be used to support the proposed waterfront structures (harbor facilities).

- Other recommendations by the geotechnical expert provided in Appendix B-1 of the "Final EIS Report for the Quest Resort Palau" must be revisited by the resort designer and contractor.

- The structural designs must be prepared by highly qualified and experienced Structural Engineer.

- Koror State Government must ensure that the structural plans are reviewed by its Structural Engineer, or by an external structural consultants for the purpose. This will prevent faulty structural designs that may result in building failure.

- The site execution of construction work, especially with respect to the foundations and columns must be supervised by an external licensed supervising engineer appointed by the project proponent.

- The final copies of design and drawings must be kept which will become useful when any structural repairs are to be done in future.

**5.1.2 Loss of Land Use Options**

The construction of the Palm Springs Resort will involve the erection of permanent concrete structures on what used to be a conservation site. This will result in a loss of the options for alternative land use and thus represents an irreversible commitment of land resources.

In September 1999, the area was re-zoned from “CD” or “conservation” to “RV” or “Resort Center Zone” in accordance with the KSPL No. K6-102-1999. As such the proposed project is consistent with the current zoning/land use of the area.
Mitigating Measure:

- Rather than leaving the island unused, construction and operation of a permanent structure intended for tourism purposes are expected to result in positive economic impacts. Therefore, no mitigating measure for the loss of land use options in the area is recommended.

- The master plan for the Palm Springs Resort was designed to reduce the long-term stress on the environment to approximately one fourth of the impacts of the legally permitted alternative (high density hotel development). This significantly enhances the quality of the resort ambiance of the proposed project and also represents a decisive and dramatic environmental mitigation element.

5.1.3 Vegetation Removal

As indicated in the “Final EIS Report for Quest Resort Palau", the flora on Ngerur Island has the following characteristics:

- No listed threatened or endangered species were observed on Ngerur.
- A plant that can be harmful to humans (Abrus precatorius) does exist on Ngerur.
- Vegetative communities on Ngerur are neither unique nor worthy of preservation.

The removal of some existing vegetative species including a single floristic element in the form of Mangrove trees or Sonneratia alba (urur, white mangrove) at the southeastern coastline of the island is expected to occur. Due to its paucity, this element is not considered to represent a Mangrove association. Approximately 85 percent of Ngerur Island will be disturbed due to construction.

Mitigating Measures:

- The remaining undisturbed 15 percent consists of areas along the shoreline where existing vegetation will be preserved as much as possible.

- Where possible, the building and hardscape elements will be positioned so as to allow the large trees throughout the island to remain in place.

- With the exception of the buildings and hardscape areas, all of the island will be replanted with locally available species.
5.1.4 Erosion and Sedimentation

Potential erosion and sedimentation could occur as a consequence of localized alterations and land disturbing activities (grading and excavations). Bare soils will be subjected to erosion and subsequently deposited into the ocean.

Loose soils are susceptible to erosion, especially if it rains heavily during construction period. Storm water runoff from the site may carry loose soil particles into the ocean, having a detrimental effect on the water quality. Potential adverse impacts are expected to be short term and temporary.

Mitigating Measures:

- Erosion and Sedimentation Control Plan (ESCP) required by the EQPB shall be strictly implemented. These erosion control measures include silt fence, berm, sedimentation pond and silt curtains. These structures shall be installed in appropriate locations and regularly maintained throughout the duration of construction activity. A site specific ESCP will be developed in consultation with the EQPB prior to the project implementation.

- Earthmoving will not be undertaken during heavy rains.

- All erosion and sedimentation control structures in place shall be inspected regularly and observed, when safe to do so during heavy rainfall to verify efficiency and effectiveness.

- All damaged erosion control structures shall be repaired.

- Additional erosion control measures shall be implemented if found necessary.

5.1.5 Impacts to Coastal and Marine Resources

Impacts to coastal and marine resources may occur from project actions that generate runoff, siltation and pollution. Potential impacts may also occur from direct physical damage associated with activities such as dredging.

Construction of harbor, dock, dive grotto and beach will impact on the existing condition of the seabed. Dredging of the intertidal and subtidal reef flat will be necessary to construct a harbor and associated docks and mooring facilities. If not controlled, proposed dredging and filing activities may increase turbidity and sediment loads to the coral reef in the vicinity of these activities.

Sedimentation resulting directly and indirectly from shoreline earthmoving, grading, vegetation removal and related site-preparation activities could impact coastal and
marine resources and sensitive species in the vicinity of Ngerur Island. The topography of Ngerur Island is not unduly steep, with elevations generally ranging between 7 and 20 meters characterizing most of the island. There are no intermittent or permanent streams on the island. Therefore, erosion is not expected to produce any serious or long-term effect. However, Palau's high annual rainfall and the probable presence of highly erodible soils is likely to result in occasional small erosion events that will have the potential to negatively impact coastal and lagoon water quality and biota.

Heavy equipment and fuel transfer operations, and the activities of construction crews may result in an occasional accidental discharge of lubricating oil, hydraulic fluids and fuels on the project site. This could directly affect protected species and their habitats or the forage of such species.

**Mitigating Measures:**

- Silt curtains will be deployed prior to seabed disturbance. Silt curtains will be installed at appropriate place minimizing the potential impacts of pile driving.

- The implementation of Best Management Practices (BMPs) such as the deployment of silt curtains, the construction of dredged cells or dikes designed to confine and settle suspended solids help to control and/or minimize erosion and sedimentation impacts.

- "Construction of stormwater detention basins and related BMP controls should reduce the silt and sediment loading to acceptable levels in adjacent coastal waters. A properly designed and implemented drainage plan should reduce silt and sediment loading to coastal waters.

- "Development and compliance with an oil-spill prevention and control plan would reduce the opportunity for deleterious impacts upon water quality and marine biota.

- Marine areas undergoing no project-related changes should be avoided and left undisturbed.

- Dredging sites should be accessed by heavy equipment via common corridors. Erosion- and sedimentation-control plans should be developed and implemented.

- An enforceable water quality and environmental monitoring plan encompassing the potentially affected harbor environmental should be implemented.

- Dredged channel bottoms should be left uneven and irregular to provide bottom relief and vertical surfaces that can encourage recolonization of corals and other benthic and epibenthic flora and fauna.

- Natural tide and water circulation patterns should be maintained.
5.1.6 Impacts to Historical and Archaeological Resources

All archaeological features identified during the inventory survey of Ngerur Island (refer to the report by IARI, 1999) "are considered to be significant under criteria of the Palau National Code Title 19, the Palau Historical and Cultural Preservation Act. The island, Site OR-12:47, possesses integrity of location, design, setting, materials, workmanship, feeling, and association; and has yielded, or may be likely to yield, information important in prehistory or history (Criterion D).

Details of archaeological features found in Ngerur Island are discussed in Appendix B-6 of the “Final EIS Report for Quest Resort Palau.”

Mitigation requiring consultation with the Division of Cultural Affairs, the preparation of a mitigation plan, and data recovery recording and excavations in accordance with the mitigation plan had been undertaken in 2000. Efforts had been made to avoid and preserve in place as many features as possible.

The presence of buried human remains adds the element of cultural value and sensitivity to the historical importance of the site. The Treatment Plan for Burials Located on Ngerur Island, Republic of Palau (IARI, 1999b) addresses the request by the Palau Division of Cultural Affairs (DCA) to develop a plan for the ultimate disposition and long-term protection of human burial remains located on Ngerur Island. Disinterment will occur prior to the commencement of construction activities on Ngerur Island, in accordance with the stipulations in the burial treatment plan (refer to Appendix C-3).

The Division of Cultural Affairs (DCA) had reviewed the required Treatment and Monitoring Plan for Burials on Ngerur Island, Koror, Republic of Palau and given its concurrence for the implementation of the plan. On August 12, 1999, a Memorandum of Agreement was signed between DCA and Ngerur Corporation. According to this agreement, the removal and treatment of human remains and artifacts will follow DCA guidelines.

Mitigating Measures:

- Preservation of the cultural properties is preferred; however, as the planned development of the island will not be compatible with preservation, mitigation though data recovery and disinterment and reburial of human remains is an alternative.

- Mitigation of the non-burial features should be straightforward and consist of a minimal amount of work, involving more detailed recording, photography, and videotaping of the features. This work will insure the preservation of information about this important episode in Palau's history.

- The proponent shall conduct meeting with the Bureau of Arts and Culture for the proposed Palm Springs Resort. A new Historical Clearance shall be secured to
indicate the remaining mitigation measures that need to be complied with prior to implementation of the proposed project.

5.1.7 Construction Waste Disposal

Solid waste generated during site preparation and construction work would include typical construction waste (e.g. wasted concrete, steel, wooden scaffolding and forms, bags, waste earth materials, etc.). This waste would negatively impact the site and surrounding environment if not properly managed and disposed of at an approved dumpsite.

Waste materials burned onsite would generate smoke, possibly impacting negatively on ambient air quality and human health. Vegetation and solid waste, if allowed to accumulate in drainage ways, could cause localised pooling and flooding. Pooling of water, in turn, would create conditions conducive to the breeding of nuisance and health-threatening pests such as mosquitoes. Poor construction waste management constitutes a short-term, possibly long-term, negative impact.

Soil excavation in land will be required for building foundation. There may be a need to address any excess soils during construction of inland structures. A detailed engineering design and quantity take off will provide the estimated excess soil materials from the proposed project.

Mitigating Measures:

- A site waste management plan should be prepared prior to commencement of building construction. This should include the designation of appropriate waste storage areas, collection and removal schedule, identification of approved disposal site and a system for supervision and monitoring.

- Vegetation and combustible waste must not be burned on the site.

- Unusable construction waste, such as damaged pipes, formwork and other construction material, must be disposed of at an approved dumpsite.

- Excavated soils will be temporarily stockpiled within flat area and surrounded with silt fences. Excavated soils should be stockpiled away from drainage features and used for in filling where necessary.

- If in case the soil stockpile is left overnight, it will be covered by tarpaulin to prevent erosion.
5.1.8 Wastewater and Litter Management

Construction activities are expected to generate wastewater including domestic wastewater from the workers and construction wastewater (e.g., de-watering of excavations, wastewater resulting from equipment washing, etc.). All types of wastewater shall not be allowed to be discharged directly into the ocean.

Inadequate provision of toilets for use by workers can lead to ad hoc defecation in secluded areas on the site, thus creating unsanitary conditions and sources of fly infestation.

Improper disposal of food cartons and other domestic forms of construction camp garbage could lead to littering of the site and pollution of adjacent coastal waters.

**Mitigating Measures:**

- Portable toilets shall be installed at the site during construction phase of the project. Regular cleaning and/or desludging of the portable toilets shall be done.

- Wastewater from the excavations will be diverted into an excavation and allowed to settle prior to discharge, if necessary. Otherwise, the water will be left on the excavation until it dries up.

- Proper solid waste receptacles and storage containers should be provided in sufficient numbers, particularly for the disposal of lunch and drink boxes, so as to prevent littering of the site.

5.1.9 Air Pollution

Unmanaged air pollution—especially from particulate and gaseous emissions generated by construction machinery—may create nuisance and, in extreme cases, adverse health impacts and property damage. Construction will require breaking up, digging, crushing, transporting, and dumping of large quantities of dry material and will generate dust in and around construction areas.

Dust emissions may result from the excavation works while gaseous pollutant concentrations from construction vehicle activities, such as site preparation, earthmoving/grading may increase at the project site, but these impacts are largely unavoidable and temporary (short term).

This situation will be worst during the dry season and during the afternoons when the trade winds are most prevalent. High rainfall in Palau is expected to help minimize fugitive dust emission from the mentioned activities. The occurrence of dusting is periodic and short-
term, lasting for the duration of the construction activity.

Mitigating Measures:

- Enclosing construction sites;
- Access roads and exposed ground should be regularly wetted in a manner that effectively keeps down the dust;
- Maintaining moisture on construction materials;
- Stockpiles of fine materials (e.g. sand) should be wetted or covered with tarpaulin during windy conditions;
- Covering exposed soil or storage areas,
- Limiting excavation and land leveling works to rainy season, and
- Minimizing the onsite storage time of construction material.
- Workers on the site should be issued with dust masks during dry and windy conditions.

5.1.10 Noise

Noise generation is expected in any construction activity. The use of heavy equipment such as grader and excavator is expected to generate noise level in the area. However, it is expected that the noise during construction will not impact the residents of Koror due to the seclusion of Ngerur Island.

Construction noise may disturb wildlife and birds. However, the increase in noise level due to the construction activity will only be temporary (short term) and is not considered to be a significant threat to the health or well being of humans.

Mitigating Measures:

- All equipment operating within the construction area will be properly muffled.
- Construction activities that will generate disturbing sounds should be restricted to normal working hours, i.e., work hours will be limited between 7:00 AM and 6:00 PM, Monday through Saturday.
- No night time activity, that will generate noise, will be performed at the project.
Local residents should be given notice of intended noisy activities so as to reduce the degree of annoyances.

Workers operating equipment that generates noise should be equipped with noise protection gear.

Workers operating equipment generating noise levels greater than 80 dBA continuously for 8 hours or more should use earmuffs.

Workers experiencing prolonged noise levels of 70 – 80 dBA should wear earplugs.

## 5.1.11 Vibration

Vibration during construction arises not only from the excavation method, but also from other associated construction activities, some of which can be as disturbing, or more so, than the main excavation method. These include drilling, operation of construction equipment or compaction of cast in situ linings. The duration for which vibration impacts occur for these can be significantly longer than for the excavation per se, so the impacts may be potentially longer and hence more significant.

### Mitigating Measures:

- Operate earthmoving equipment on the construction area as far away from vibration-sensitive sites as possible.
- Phase earthmoving and ground-impacting operations so as not to occur in the same time period.
- Avoid nighttime activities. People are more aware of vibration in their homes during nighttime hours.
- Avoid vibratory rollers and packers near sensitive areas.

## 5.1.12 Earth Material Sourcing

Earth materials needed for construction, e.g., sand and gravel, are normally obtained from quarry and mining operations. Conscious or unwitting purchase of these materials from unlicensed operations indirectly supports, encourages and promotes
environmental degradation at the illegal quarry sites and causes medium to long-term negative impacts at source.

**Mitigating Measures:**

- Sand, gravel and other earth materials must be obtained from officially licensed and approved quarries and if imported overseas, these materials should be transported through legal channel.

### 5.1.13 Material Transportation

The various materials required for construction and building (e.g. steel, blocks, lumber, sand, asphalt, etc.) will be obtained mainly from Malakal, Koror State and transported to the site. Transportation of these materials, typically in over-laden and sometimes uncovered trucks, usually results in undue road damage. In addition, transportation of these materials in barge may potentially cause spillage and damage to the ocean bed and marine environment.

In the case of fine earth materials, dusting and spillages occur on the roadways between source and site. Dusting degrades local air quality and material spillages worsen driving conditions and increase the risk of road accidents. These occurrences represent indirect, short-term, reversible, negative impacts on public health and safety.

The transport of materials from source to site would entail use of heavy trucks, which have the potential to produce polluting gaseous emissions and dust and falling objects, depending on the material being transported.

**Mitigating Measures:**

- Trucks used for that purpose should be fitted with tailgates that close properly and with tarpaulins to cover the materials.

- Fine earth materials must be enclosed during transportation to the site to prevent spillage and dusting.

- The cleanup of spilled earth and construction material on the main roads should be the responsibility of the contractor and should be done in a timely manner (say within 2 hours) so as not to inconvenience or endanger other road users. These requirements should be included as clauses within the contracts made with relevant sub-contractors.

- The transportation of lubricants and fuel to the construction site should only be done in the appropriate vehicles and containers, i.e. fuel tankers and sealed
Transport of construction materials should be scheduled for off-peak traffic hours. This will reduce the risk of traffic congestion and of road accidents on the access roads to the site.

Appropriate traffic warning signs, informing road users of a construction site entrance ahead and instructing them to reduce speed, should be placed along the main road in the vicinity of the entrance to the Palau Portovino Hotel property.

Flagmen should be employed to control traffic and assist construction vehicles as they attempt to enter and exit the project site.

Any damaged road surfaces must be restored after completion of the building construction.

During summer, the existing road must be watered to reduce dust emission generated by the construction vehicles and trucks.

### 5.1.14 Material Stockpiling/Storage

Improper siting of stockpiles and storage of sand, gravel, cement, etc., at the construction sites could lead to fine materials being washed away, during heavy rainfall events, into the drainage system and ultimately into the adjacent marine environment. This would contribute to turbidity and sedimentation with consequent negative impacts on inshore marine water quality and ecology of the shallow marine environments, including corals.

Hazardous and flammable materials (e.g. paints, thinner, solvents, etc.) improperly stored and handled on the site are potential health hazards for construction workers and spilled chemicals would have the potential to contaminate soil and inhibit plant growth in localized areas. It is anticipated that refueling or maintenance of large vehicles will take place on the construction site and therefore there will be a requirement to store fuel and lubricants in a safe manner on the site.

**Mitigating Measures:**

- Stockpiling of construction materials should be properly controlled and managed. Sands and other fine grained materials should be stockpiled away from surface drainage channels and features.

- Sand/Fine material stockpiles should be surrounded by about 1m bund and/or covered with tarpaulin to prevent them from being washed away during rainfall.
- Safe storage areas should be identified and retaining structures put in place prior to the arrival and placement of material.

- Hazardous chemicals (e.g. fuels) should be properly stored in appropriate containers and should be safely locked away. Conspicuous warning signs (e.g. ‘No Smoking’) should be posted around hazardous waste storage and handling facilities.

### 5.1.15 Modification of Surface Water Drainage

Covered building and other structures on site will create impervious surface in the island. Add to this the surface areas of corrected roadways and it becomes apparent that the site will generate considerable volumes of runoff during the periods of prolonged rainfall.

**Mitigating Measures:**

- Storm water drainage system must be properly designed and appropriately constructed.

### 5.1.16 Employment/Income Generation

A short-term social impact associated with the proposed project may result from a construction crew of approximately 100 to 125 foreign workers that will be housed in Koror for the duration of the construction period of approximately 18 to 24 months. The number of foreign workers in Palau would therefore increase for the duration of the construction period. These levels of short-term employment opportunities would have a positive impact on the local economy and on regional unemployment.

**Mitigating Measures:**

- The project proponent shall give the residents of Koror State and Palau in general, priority in hiring construction workers, subject to qualification and experience.

- On the job training should be provided to some Palauan residents who are not qualified to do the work.

- The construction contractor will coordinate and manage a labor compound that will support the needs of the project. The contractor will provide housing facilities, a dining facility, laundry facilities, toilet facilities, refrigeration units, and various sundries and smallware to support anticipated manpower requirements. The
contractor will also handle the catering, housekeeping and maintenance of the labor compound in order to satisfy the needs of the project.

5.2 Impacts During Operation of the Project

5.2.1 Impacts from Infrastructure Facilities

5.2.1.1 Water Supply System

Completion of the Palm Springs Resort will generate no demand for the Koror water service because all potable water demands will be met by the on-site system. However, measures to conserve water would still be implemented.

The proposed Palm Springs Resort will be supplied with potable water service via an on-site water supply system. A Reverse Osmosis (RO) desalination system will remove the salinity (chloride) from the ocean water. Two self-contained skid mounted units each rated for 45,000 gpd will be used. The desalinated water will be disinfected and treated on-site prior to storage and distribution. Brine with an estimated concentration of approximately 90,000 ppm will be diluted and discharged via a perforated pipe located on the sea floor within the harbor area.

Although a salinity concentration of 90,000 ppm in large volumes can be toxic to marine life, the brine will be combined with returning cooling water from the air conditioning system such that its diluted concentration would be approximately 40,000 ppm. The volume of discharged water from the Palm Springs Resort Palau project will be small and its discharge through a perforated pipe located at the bottom of harbor means that by the time this water reaches coral areas it will have the same salinity as the surrounding waters (approximately 30,000 to 33,000 ppm).

**Mitigating Measures:**

- Water conservation shall be practiced at the resort accommodations. Each bungalow should be provided with the following water conservation devices or technologies in place.
  - Water tank in toilet will use water saving device 3/6 liters per flush.
  - Faucets will be of low water consumption.
  - Guests will be encouraged to reuse towels as part of the ecological laundry policy.

- A comprehensive potable water monitoring plan will be submitted to EQPB. Potable water quality will be monitored daily or at the very least on a weekly basis. Monitored parameters may include and not be limited to turbidity, salinity,
pH, residual chlorine, and e-coli. The RO units will be monitored for performance in accordance with the guidelines provided by the equipment manufacturer. A quarterly report that addresses water quality monitoring testing results, descriptions of performed operation and maintenance, and water use records will be filed with EQPB.

5.2.1.2 Wastewater Treatment and Disposal System

Completion of the Palm Springs Resort will generate no demand for municipal service because Ngerur Island will be served by the on-site wastewater collection, treatment and disposal systems. No mitigation is therefore proposed or considered warranted.

As indicated in the “Final EIS Report for Quest Resort Palau”, the on-site wastewater collection system will consist of gravity sewers and a single pump station. Collected effluent will be pumped to a Jokaso Wastewater Treatment System that is virtually self-contained. Treated effluent will be conveyed to discharge location that is approximately 100 feet (30.4 meters) below the ocean surface.

In order to quantify any potential impacts of discharging the treated effluent via a deep ocean outfall, a preliminary dispersion analysis was performed to ascertain the performance of such an outfall. The PLUME model developed by the EPA was used to predict the wastewater discharge plume dilution. This computerized program has become the accepted standard for modeling outfall plume behavior and is accepted by U.S. Federal regulatory agencies. The effluent characteristics initial dilution results are provided in the following table.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Ambient Receiving Water</th>
<th>Effluent Characteristics</th>
<th>Palau Standards (Class AA)</th>
<th>Concentration After Initial Dilution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature (°C)</td>
<td>30.20 (Surface) 29.42 (Bottom)</td>
<td>31.0</td>
<td>±0.9</td>
<td>29.47</td>
</tr>
<tr>
<td>Salinity (ppt)</td>
<td>32.65 (Surface) 32.78 (Bottom)</td>
<td>0</td>
<td>±10% in the range of 29-35 ppt</td>
<td>32.70</td>
</tr>
<tr>
<td>pH</td>
<td>8.16</td>
<td>8.0</td>
<td>7.7 to 8.5</td>
<td>8.16</td>
</tr>
<tr>
<td>Dissolved Oxygen (mg/L)</td>
<td>6.84</td>
<td>0</td>
<td>NLT 6.0 or Saturation</td>
<td>6.83</td>
</tr>
<tr>
<td>Total Nitrogen (mg/L)</td>
<td>0.104</td>
<td>20</td>
<td>±10% (0.014) or NTE 0.400</td>
<td>0.120</td>
</tr>
<tr>
<td>Total Phosphorus (mg/L)</td>
<td>0.010</td>
<td>8</td>
<td>±10% (0.014) or NTE 0.400</td>
<td>0.017</td>
</tr>
<tr>
<td>Fecal Coliform (per 100 ml)</td>
<td>0</td>
<td>15,000</td>
<td>70</td>
<td>9</td>
</tr>
</tbody>
</table>

Analysis by Sea Engineering, Inc. based on computer modeling using EPA’s PLUME Model
NLE = Not Less Than
NTE = Not to Exceed
The analysis indicates that the receiving water would rapidly dilute the small volume of the treated effluent generated by the proposed Quest Resort Palau project. The model indicates that the dilution will be so rapid that most Class AA water quality criteria will be met within the zone of initial dilution immediately above the discharge point; all Class AA criteria will be met within a zone of mixing with a radius of 130 feet around the discharge point.

The treated wastewater plume from the discharge would not reach the lagoon surface; at approximately 49 feet below sea level the plume would be virtually indistinguishable from the receiving water with an average dilution ratio of over 1,000 to 1. Computer analysis results indicate that there will be no significant water quality impact resulting from the discharge of this very small volume of wastewater. All the modeled water quality parameter values meet or exceed Palau standards for Class AA water within the zone of mixing.

The alignment for the marine outfall will bear northeast from the northeast side of the island. This alignment is reasonably close to the treatment facility and provides access to deep water relatively close to shore.

The outfall pipe must travel over live coral outcrops in some areas. For example, the first 100 feet (30.4 meters) off the island shoreline supports vigorous coral growth over almost 100 percent of the basin bottom. Much of this coral is finger-type that can be easily broken and/or damaged. Additionally, the bottom is uneven and not conducive to supporting the pipeline. For these reasons, the first 100 feet (30.4 meters) of the alignment for the pipeline is expected to include a narrow covered trench through the coral areas because of its advantages:

- Coral damage will be limited;
- The pipeline will not be visible;
- The pipeline will be well protected; and
- Coral can be re-colonized over the covered trench. The last point is particularly important from an environmental standpoint: coral ecology can be re-generated/re-established over the covered trench that is in effect locally removed from the ecosystem.

Increased nutrient loading from sewage and waste can cause eutrophication. Eutrophication causes changes in the original biological environment, including reducing species diversity and increasing marine floral bloom and habitation of undesirable species.

**Mitigating Measures:**

- Employ a fully qualified operator to ensure proper operation and maintenance of the STP.
- Ensure preparation and provision of a plant operations and maintenance manual.
- Undertake regular monitoring and testing of effluent to ensure compliance with EQPB sewage effluent standards and regulations.
- A comprehensive monitoring plan for wastewater effluent will be submitted to EQPB.

5.2.1.3 Drainage System

As a result of project actions, natural drainage systems on Ngerur Island will be replaced with a man-made drainage and irrigation system. No demand on municipal systems will occur as a result of the Palm Springs Resort project because the conveyance of storm runoff and the irrigation demand will be satisfied via the on-site system. No mitigation is therefore proposed or deemed warranted.

In the interior part of the island, runoff will be collected by 6-, 8- and 10-inch storm drains in infiltration trenches that are aligned parallel to the cart pathway system. On the seaward side of the guest bungalows, runoff will be collected by storm drains in infiltration trenches that are aligned along earthen dikes of native material topped with geofabric or matting. The disposal of the runoff will occur as waterfall features at individual discharge points located around the perimeter of the island. At three locations on the northeastern side of the island, sediment logs will be used in conjunction with silt curtains. The design of the drainage system does not include retention basins for storm runoff and instead the counter slopes of the extensive bermed areas will capture runoff and convey it to the surrounding waters through gravel and filter fabric. In this manner, direct surface runoff will be effectively reduced or eliminated.

Mitigating Measures:

- Adequate drainage facilities such as those described above will be implemented and maintained.

- Landscaping and the use of erosion control materials, earthen dikes with counter slopes, matting, geofabrics, and silt fences will slow the flow of sediment laden runoff to avoid erosion and sedimentation. A brief description of each feature or device is included below.
  - Sediment logs are porous fiber rolls that allow water to filter through and trap sediment, slow runoff, and reduce sheet erosion. These logs are composed of biodegradable open weave netting.
  - Earthen dikes will act as counter slopes and check dams. The ponding surface runoff trapped by the dams will be forced into perforated pipe that is part of the drainage system.
  - Silt fences are barriers of permeable fabric designed to intercept and slow sheet flow runoff.
5.2.1.4 Solid Waste Disposal System

Completion and operation of the Palm Springs Resort Palau will generate a demand for solid waste disposal service. Solid waste and wet garbage will be transported by boat for disposal at a designated landfill.

The resort operator has also expressed a desire to segregate waste in order to take advantage of existing (and hopefully expanding) recycling facilities in Palau. Conditions of the earthmoving permit will in all likelihood require the preparation of a waste minimizing plan addressing specifically aluminium can recycling and the composting of green waste.

**Mitigating Measures:**

- The intent of the resort operator is to utilize a trash compactor to reduce the volume of refuse. Although the weigh of the waste remains the same, a reduced volume will extend the life of the new landfill.
- Provisions for solid waste disposal will be coordinated with the BPW to ensure that refuse is disposed at the appropriate site.

5.2.1.5 Power Supply System

The use of generators to supply power to the entire building implies the generation of noise, vibrations, and storage of diesel fuel and the related disturbances and nuisances as well as the threat of hydrocarbon spills the ground.

**Mitigating Measures:**

- Sound proof structures will enclose the generators to prevent/minimize generation of noise and vibration.
- Fuel storage facilities will comply with suppliers’ specifications for contained storage.
- Secondary containment structures adequate to contain the maximum volume of fuel storage will be constructed.
5.2.1.6 Refrigeration/Air Conditioning Systems

The use of certain refrigerant in number of refrigeration and air conditioning systems has the potential to cause depletion of the ozone layer in the atmosphere leading to greenhouse effect. Some of these refrigerants include:

- Dichlorodifluoromethane (R-12) is a colorless gas usually sold under the brand name Freon-12, and a chlorofluorocarbon halomethane (CFC) used as a refrigerant and aerosol spray propellant. Its manufacture was universally banned in 1996, in compliance with the Montreal Protocol, due to concerns about its damaging impact to the ozone layer.

- Chlorodifluoromethane, better known as HCFC-22 or R-22 is one of the most popular refrigerant used in cooling system. R22 is the halocarbon compound named monochlorodifluoromethane with chemical formula CHClF2 and it is the hydrochlorofluorocarbon (HCFC). However, it has very high potential to exacerbate ozone-depletion. R22 is also a global warming gas. The depletion of ozone layer from the upper layers of atmosphere results in ultraviolet rays of the sun to reach the surface of the earth. This leads to high temperature on the earth and the ultraviolet ray themselves are very harmful to the skin of human beings. To avoid the long-term dangers of the R22 and other CFCs, it has been decided to phase out the use and production of R22 completely along with other CFC refrigerants.

Mitigating Measures:

- Ensure that refrigeration and air conditioning system to be used for the project do not use banned refrigerants, that include R-12.

- If the proponent opted to use R-22 as refrigerant in the cooling system, permit must be applied with the EQPB prior to importation to Palau.

- Consult with the EQPB on the proposed use of refrigerant for the project prior to importation of refrigerant to Palau.

5.2.2 Housing Demand

The Palm Springs Resort project will not impact the number of existing housing units in Palau; neither will it impact the presently existing balance between Palauan and...
non-Palauan residents. The proposed project is a resort development comprising luxury hotel guest bungalows only. The Palm Springs Resort is entirely oriented towards accommodating short-term visitors. The project does not include any condominium housing units intended for long-term residency.

The proposed project will have a short-term housing impact because the construction crew will have to be housed in Koror for the duration of the project (approximately 18 to 24 months).

**Mitigating Measures:**

- It is expected that the construction Contractor will make the necessary arrangements for a temporary worker housing compound such that no mitigation is required.
- The proponent must ensure that resort staff are provided with housing accommodations within the island resort.

### 5.2.3 Misuse of Coral Reef Resources

One of the main natural attractions that will be offered by the Ngerur Island is scuba diving and snorkeling on the famous Rock Islands and dive sites of Palau. Unless the marine resource is properly managed the increased use of the site for recreational diving could result in degradation of the habitat by damage to corals from boat anchors, souvenir collection, and poor diving practice.

**Mitigating Measures:**

- Installation of boat mooring buoys for use of dive boats and banning of anchoring directly over reef.
- Ban collection of coral reef souvenirs.
- Provision of educational and environmental sensitization material on coral reef for guests and for hotel staff.
- Institute and support coral reef monitoring programme for the Rock Islands.

### 5.2.4 Circulation and Traffic

It is the specific goal of the proposed Palm Springs Resort to be a backdrop for the experience of a luxurious exotic environment. Factors that enable this experience are the
creation of a sense of seclusion and remoteness from the day-to-day world. The identity of the resort as a special place will be enhanced by the fact that the Ngerur Island must be accessed by boat. Affluent guests will be escorted from the airport to a shuttle that will transport them to the island. All necessary shuttle services for visitors and their luggage between the airport and the island will be executed by the resort operation with Sport Utility Vehicles (SUVs) or vans. Boats will ferry these guests to the Palm Springs Resort.

Boat traffic between the Arakebesan and Ngerur Islands will increase as a result of the proposed project. Boats will transfer all visitors and their luggage. Increased traffic resulting from increased number of tourists may cause nuisance and safety risks.

An assumed four-day length of stay on Ngerur Island will generate approximately 91 exchanges per year with an average of 81 visitors per each four-day stay. A theoretical average daily exchange rate would therefore imply 20 visitors leaving and 20 visitors arriving each day.

The number of resulting boat trips will depend on the carrying capacity of the boats. Another factor that will influence boat trips is the visitors' demand for sightseeing trips.

Employees of the Palm Springs Resort and all necessary supplies and waste will also be transported by boat. With an average of 20 visitors requiring one-way shuttle transportation every day and with an assumed occupancy rate of five visitors per SUV, the average number of daily round trips between Ngerur Island and Koror Airport would therefore be four trips. This number represents a theoretical minimum of terrestrial shuttle traffic generated by the proposed project.

**Mitigating Measures:**

- Mitigation measures will include provision of a traffic management plan and close coordination between the resort management, traffic police and sea rangers for smooth execution.

- Appropriate traffic warning signs instructing the motorists to reduce speed, should be placed along the main road.

**5.2.5 Employment Generation**

The proposed project will generate employment opportunities. This aspect of the project is considered a benefit that offsets the short-term impacts generated by the importation of temporary laborers required for project construction.

At project completion, a maximum guest population of 120 persons would require 110 support staff in three shifts. Alternately, the size of the work force may be equal to
approximately 2.5 employees per bungalow or approximately 150 persons. The Palauan segment of employment opportunities within the proposed project is expected to be in the neighborhood of 80 percent.

**Mitigating Measures:**

- In accordance with the Foreign Investment Approval Certificate, the proponent shall to the maximum extent possible, employ and train citizens of the Republic of Palau in the operation of the hotel project.
- Whenever economically feasible and practical, the proponent shall favor Palauan citizens or entities as sub-contractors or concessionaires over non-Palauan individuals or entities.

5.2.6 *Income from the Project*

A positive impact of the project implementation is the income from the tourists and the annual taxes to be imposed by the Koror State Government from the operation of the Palm Springs Resort.

**Mitigating Measures:**

- Ensure that taxes imposed on the real property, income, tourism and other related taxes are correct and are properly collected.

5.3 Checklist of Environmental Impacts & Mitigation

Table 5-2 provides a summary checklist of environmental impacts and the mitigating measures proposed for this project. Other mitigating measures to be recommended by the EQPB during the permitting process and project construction shall also be implemented.
## TABLE 5-2, MATRIX OF ENVIRONMENTAL IMPACTS & MITIGATING MEASURES

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<td>1.</td>
<td>Potential failure/collapse of the building if not properly designed and constructed</td>
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<td>Recommendations by the geotechnical expert, Geolabs, Inc. must be strictly followed.</td>
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<td>Structural designs to be performed by highly qualified and experienced Structural Engineer.</td>
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<td>KSG to ensure the structural plans are reviewed by its Structural Engineer, or by an external structural consultants.</td>
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<td>Construction to be supervised by an external licensed</td>
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<td>2.</td>
<td>Loss of land use option</td>
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<td>3.</td>
<td>Vegetation removal</td>
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<td>4. Erosion and sedimentation</td>
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- Erosion and Sedimentation Control Plan (ESCP) shall be strictly implemented.
- Earthmoving will not be undertaken during heavy rains.
- All erosion control structures (silt curtains) in place shall be inspected regularly.
- Additional erosion control measures shall be implemented if found necessary.
### Palm Springs Resort
#### Environmental Assessment
NECO Group of Companies
P.O. Box 129 Koror, Palau 96940

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<td>5. Impacts to coastal and marine resources (e.g., seabed disturbance, increase in turbidity, damage to corals, fish kill, etc.)</td>
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- The implementation of Best Management Practices (BMPs) such as the deployment of silt curtains, the construction of dredged cells or dikes designed to confine and settle suspended solids help to control and/or minimize erosion and sedimentation impact.
- A properly designed and implemented drainage plan should reduce silt and sediment loading to coastal waters.
- Development and compliance with an oil-
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<td>spill prevention and control plan.</td>
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<td>▪ Marine areas undergoing no project-related changes should be avoided and left undisturbed.</td>
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<td>▪ An enforceable water quality and environmental monitoring plan should be implemented.</td>
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<td>▪ Dredged channel bottoms should be left uneven and irregular to provide bottom relief and vertical surfaces that can encourage recolonization of corals and other benthic and epibenthic flora and</td>
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- Positive
- Negative
- Short Term
- Long Term
- Localized
- Widespread
- Insignificant
- Moderate
- Severe
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<tr>
<td>6. Impacts to historical and archaeological resources</td>
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- Natural tide and water circulation patterns should be maintained.
- Preservation of the cultural properties is preferred; however, as the planned development of the island will not be compatible with preservation, mitigation though data recovery and disinterment and reburial of human remains is an alternative.
- Mitigation of the non-burial features should consist of a minimal amount of work, involving more detailed...
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<td>7. Construction waste disposal</td>
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- conduct meeting with the Bureau of Arts and Culture for the proposed Palm Springs Resort.
- A new Historical Clearance shall be secured to indicate the remaining mitigation measures that need to be complied with prior to implementation of the proposed project.
- A site waste management plan should be prepared and implemented.
- Vegetation and
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<td>Combustible waste must not be burned on the site.</td>
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<td>- Unusable construction waste, such as damaged pipes, formwork and other construction material, must be disposed of at an approved dumpsite.</td>
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<td>- Excavated soils will be temporarily stockpiled within flat area and surrounded with silt fences.</td>
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<td>- If in case the soil stockpile is left overnight, it will be covered by tarpaulin to</td>
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<td>8. Wastewater and litter management</td>
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- Portable toilets shall be installed at the site during construction. Regular cleaning and/or desludging of the portable toilets shall be done.
- Wastewater from the excavations will be diverted into an excavation and allowed to settle prior to discharge.
- Proper solid waste receptacles and storage containers should be provided in sufficient numbers, particularly for the
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<td>9. Air pollution</td>
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- Access roads and exposed ground should be regularly wetted to keep down the dust.
- Maintain moisture on construction materials.
- Stockpiles of fine materials (e.g. sand) should be wetted or covered with tarpaulin during windy conditions.
- Cover exposed soil.

- Disposal of lunch and drink boxes, so as to prevent littering of the site.
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<td>10. Noise</td>
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- Minimizing the onsite storage time of construction material.
- Workers on the site should be issued with dust masks during dry and windy conditions.
- Regular maintenance of construction vehicle.
- All equipment operating within the construction area will be muffled.
- Work hours will be limited between 7:00 AM and 6:00 PM, Monday through Saturday.
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<td>11. Vibration</td>
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<td>12. Earth material sourcing</td>
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<td>Surface Drainage Channels and Features.</td>
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<td>§ Sand/Fine material stockpiles should be surrounded by about 1m bund and/or covered with tarpaulin.</td>
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<td>§ Safe storage areas should be identified and retaining structures put in place prior to the arrival and placement of material.</td>
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<td>§ Hazardous chemicals (e.g. fuels) should be properly stored in appropriate containers and should be safely locked away. Conspicuous warning signs (e.g. ‘No Smoking’) should be posted around hazardous waste.</td>
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<td>15. Modification of surface water drainage</td>
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- In accordance with the Foreign Investment Approval Certificate, the proponent shall to the maximum extent possible, employ and train citizens of the Republic of Palau in the operation of the hotel project.

- Whenever economically feasible and practical, the proponent shall favor Palauan citizens or entities as subcontractors or concessionaires over non-Palauan individuals or entities.

- Ensure that taxes imposed on the real
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<td>17. Impacts from the water supply system (brine waste disposal)</td>
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- Water conservation shall be practiced at the resort accommodations. Each bungalow should be provided with the following water conservation devices or technologies in place.
- Water tank in toilet will use water saving device 3/6 liters per flush.
- Faucets will be of low water consumption.
- Guests will be
## Impact

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### 18. Impacts from the wastewater treatment and disposal (effluent disposal to the ocean).

|        | √                           | √                | √                   | √                   | √                  |                           |

- Encouraged to reuse towels as part of the ecological laundry policy.
  - A comprehensive potable water monitoring plan will be submitted to EQPB. Potable water quality will be monitored daily or at the very least on a weekly basis.
- Employ a fully qualified operator to ensure proper operation and maintenance of the STP.
- Ensure preparation and provision of a plant operations and maintenance manual.
- Undertake regular
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<td>19. Impacts from the drainage system (flooding, etc.)</td>
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<td>20. Impacts from solid waste collection and disposal (littering, odor, proliferation of flies, insects/vectors)</td>
<td>✓</td>
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<tr>
<td>21. Impacts from power supply system (noise, oil spill, etc.)</td>
<td>✓</td>
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<td>Pre-Construction Phase</td>
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<td>Fuel storage facilities will comply with suppliers’ specifications for contained storage.</td>
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<td>Secondary containment structures adequate to contain the maximum volume of fuel storage will be constructed.</td>
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<td>Spill prevention kits shall be maintained on site.</td>
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<td>Resort maintenance personnel shall be trained on the use of spill kits.</td>
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<td>Ensure that refrigeration and air conditioning system to be used for the project do not use banned refrigerants, that</td>
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<tr>
<td>22. Impact from refrigeration/air conditioning</td>
<td>✓</td>
<td>✓</td>
<td>Brown</td>
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### Impact Assessment Table

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- **System**: Include R-12.
  - If the proponent opted to use R-22 as refrigerant in the cooling system, permit must be applied with the EQPB prior to importation to Palau.
  - Consult with the EQPB on the proposed use of refrigerant for the project prior to importation of refrigerant to Palau.

- **23. Workers housing demand**: Include R-12.
  - It is expected that the construction Contractor will make the necessary arrangements for a temporary worker housing compound such that no mitigation is required.
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<td>24. Misuse of coral reef resources</td>
<td>✓</td>
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- The proponent must ensure that resort staff are provided with housing accommodations within the island resort.
- Installation of boat mooring buoys for use of dive boats and banning of anchoring directly over reef.
- Ban collection of coral reef souvenirs.
- Provision of educational and environmental sensitization material on coral reef for guests and for resort staff.
- Institute and support coral reef monitoring.
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25. Increase in population

- Positive: √
- Negative: √
- Short Term: √
- Long Term: √
- Localized: √
- Wide-spread: √
- Insignificant: √
- Moderate: √
- Severe: √

- Promote the use of renewable natural resources by using solar energy in the hotel.
- Coordinate with the Koror State Government, EQPB and other organizations in encouraging the local residents and tourists to conserve natural resources (water, flora and fauna, etc.).
6 CONCLUSION & RECOMMENDATIONS

6.1 Conclusion

The Island of Ngerur, which is the intended site for the proposed project is currently unutilized. If the project will push through as planned by the Proponent, the benefits are expected to outweigh the negative impacts of the Project.

The negative impacts of the proposed first class high-end resort development will include soil disturbance/erosion and sedimentation, sea disturbance, damage to corals and other marine resources, dust emission, vibration and noise from heavy equipment. These impacts are typical of any type of development and can be mitigated through proper erosion control measures and construction management. No substantial degradation to environmental quality is foreseen.

The negative impacts identified after completion of the project construction is the possible increased volume of storm water due to removal of ground cover and paving decreasing the capacity of the area to percolate. This is expected for all development projects. Hence, it is important to properly design the project and incorporate all mitigating measures, e.g., sediment retention/catch basins, rockfill outlets, energy dissipaters, etc., in the project final design.

When the resort project becomes operational, the negative impacts identified include sea disposal of brine waste from the desalination process and treated effluent from the Jokaso wastewater treatment system, solid waste and stormwater management. The project will not impact the water and sewerage infrastructures in Koror. Sewage generated by the project will be treated independently onsite and discharge to ocean in compliance with the EQPB water quality standards.

In the long-term, the Palm Springs Resort will be an income-generating activity for the property owner that results in tax benefits to the local and national government. Proposed resort development will result in the productive use of the property, the generation of revenue, the creation of employment opportunities and the provision of recreational resources and accommodations for affluent visitors to Palau. These factors are all viewed as benefits of the Palm Springs Resort project.

An Environmental Impact Statement (EIS) has been prepared for the same scope of the project in 2000. After a series of consultations and public hearing in 2000 ~ 2001, the project was approved and granted an Earthmoving Permit (PEA 085-2001, copy attached in Appendix A). No unresolved issues were identified. The project was not implemented, however, due to financial problem of the former project proponent. PEA 085-2001 expired in 2005.

This EA is prepared and submitted to support the new Earthmoving Permit application by the new project proponent, Palau Palm Springs Investment Development, Limited, to implement the same project with a new project name. The only modification is the elimination of the then approved submarine cable installation for the power supply.
system. All other infrastructure components of the project remain the same.

The results of this assessment are that the negative impacts that have been identified in this document shall be adequately minimized by the suggested mitigation measures. Therefore, the proposed action should not result in significant impacts on the environment.

6.2 Recommendations

6.2.1 Revisit the Earthmoving Permit PEA 085-2001

It is recommended that the Earthmoving Permit PEA 085-2001 conditions be reviewed and applied to this Project due to the same scope of work proposed by Palau Palm Springs Investment Development, Limited. Some modifications are proposed such as the elimination of the submarine cable installation from Arakebesang to Ngerur Island.

Other mitigating measures found to be necessary by the EQPB should be included in the permit conditions.

6.2.2 Implement Proper Erosion Control Measures

Incorporate all mitigation measures in the design that will prevent or minimize erosion during construction and operational phases. Site-specific ESCP will be developed in consultation with the EQPB prior to the project implementation. Determination of the actual and appropriate locations of the silt fences, sediment basins and other erosion control structures shall be based on actual condition of the site. The project proponent shall ensure proper implementation of the ESCP.

6.2.3 Consultation with the EQPB on the Proposed Water and Sewage Treatment Systems

It is important to establish a good relationship with the EQPB particularly in the planning, operation and management of the proposed desalination process and sewage treatment systems for the resort. More importantly, on the proposed disposal of brine waste from the RO system and treated effluent from the Jokaso system into the ocean. It is strongly recommended that the project proponent should undertake regular monitoring and testing of water and effluent to ensure compliance with EQPB sewage effluent standards and regulations.

6.2.4 Consultation with the EQPB on the Proposed Air-conditioning System

The use of certain refrigerant in number of refrigeration and air conditioning systems has the potential to cause depletion of the ozone layer in the atmosphere leading to greenhouse effect. As such, it is important to consult with the EQPB on the proposed use of refrigerant for the project prior to importation of refrigerant to Palau.
6.2.5 Develop and Implement Water Quality Monitoring Plan

An important task by the project proponent during operation of the project is the regular water quality monitoring. Therefore, a comprehensive water quality monitoring plan must be developed by the project proponent. The Plan must be developed in close coordination with the EQPB. Quarterly submission of the results of the water quality monitoring must be submitted to the EQPB and if any exceedance of water quality is identified, mitigating measures must be proposed.
REFERENCES

Environmental Quality Protection Board (EQPB), Republic of Palau, Earthmoving Regulations.


Office of the Palau Automated Land and Resource Information System (PALARIS), Ministry of Finance


World Travel Guide

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Appendix 1

PEA 085-2001
Earthmoving Permit
issued to Morita Hotel Corporation, Inc. for
Quest Resort in Ngerur Island
REPUBLIC OF PALAU
PALAU ENVIRONMENTAL QUALITY PROTECTION BOARD

EARTHMOVING PERMIT

QUEST RESORT PROJECT, NGERUR IS.

MORITA HOTEL CORPORATION INC. OF KOROR, PALAU IS HEREBY GRANTED

NAME OF APPLICANT
PLACE
PERMISSION TO CONSTRUCT AND OPERATE A HOTEL RESORT
DREDGE, LANDFILL, MOVE OR REMOVE

NGERUR ISLAND, KOROR STATE SUBJECT TO THE REQUIREMENTS OF THE
HAMLET, STATE
PALAU NATIONAL CODE AND REGULATIONS OF THE PALAU ENVIRONMENTAL
QUALITY PROTECTION BOARD AND SPECIAL CONDITIONS UNDER THIS
PERMIT, AS LISTED ON THE ATTACHED LETTER (IF ANY).

THIS PERMIT MAY BE REVOKED AT ANY TIME BY A DULY AUTHORIZED
REPRESENTATIVE OF THE BOARD, FOR NON-COMPLIANCE WITH THE PALAU
NATIONAL CODE TITLE 24 AND REGULATIONS OF THE ENVIRONMENTAL
QUALITY PROTECTION BOARD, AS PROMULGATED THEREUNDER.

8/30/2001

DATE

PAUL R. HOLM, CHAIRPERSON, EQPB (BOARD)
PALAU ENVIRONMENTAL QUALITY PROTECTION BOARD
CHAIRMAN OR HIS AUTHORIZED REPRESENTATIVE

THIS PERMIT SHALL BE POSTED FOR PUBLIC DISPLAY
VALID FROM DATE OF ISSUE UNTIL: MARCH 31, 2005
Republic Of Palau

Environmental Quality Protection Board

PERMIT CONDITIONS

PALAU ENVIRONMENTAL QUALITY PROTECTION BOARD

EARTHMOVING, CONSTRUCTION AND OPERATING PERMIT NO. PEA-085-01

QUEST RESORT PALAU PROJECT, NGERUR ISLAND, KOROR STATE

MORITA HOTEL CORPORATION, INC. (PERMITTEE)

THIS PERMIT EXPIRES ON March 31, 2005

GENERAL CONDITIONS:

1. Earthmoving operations and construction will be conducted in accordance with Palau National Code, Title 24, and Chapter 1, Earthmoving Regulations Chapter 2401-1 promulgated thereunder, and in a manner that erosion and sedimentation, siltation of surrounding reefs or pollution to fresh and marine waters will not exceed that which would occur under natural conditions.

2. Design, construction and operation of the public water supply system shall be conducted in accordance with PNC, Title 24, Chapter 1, Public Water Supply System Regulations Chapter 2401-51 promulgated thereunder, to protect public health and safety.

3. Wastewater shall be treated and disposed of in accordance with PNC, Title 24, Chapter 1, and Marine and Fresh Water Quality Regulations, Chapter 2401-11, promulgated thereunder, to minimize impacts from wastewater and to protect public health and the environment.

4. Solid and hazardous waste handling shall be conducted in accordance with PNC, Title 24, Chapter 1 and the Solid Waste Management Regulations, Chapter 2401-31 promulgated thereunder, to minimize impacts from solid and hazardous and toxic materials and to protect public health and environment.

5. The operation of stationary sources of air contaminants shall be in accordance with the PNC, Title 24, Chapter 1, and the Air Pollution Control Regulations, Chapter 2401-71 promulgated thereunder, to minimize impacts from emission of air contaminants and to protect public health and the environment.
6. Pesticide storage, handling and use shall be conducted in accordance with PNC, Title 24, Chapter 1, and the Pesticide Regulations, Chapter 2401-33 promulgated thereunder, to minimize impacts from pesticides and to protect public health and the environment.

7. This permit is issued only to Morita Hotel Corporation, Inc., their Contractor and agents as the Permittee to perform the work specified herein: To construct and operate a hotel resort located on Lot 029 A 01, property known as Ngerur Island and comprised of approximately 52,158 square meters of land as shown on Division of Land and Survey Cadastral Plat Map 029 A 00 in Koror State. The construction of the hotel resort shall consist of the following major features:

A. 60 guest bungalows (64,000 to 77,300 square feet)
B. Restaurants (6,600 square feet)
C. Public recreation areas, including swimming pool, spa and other amenities (8,300 to 11,500 square feet),
D. Administrative office space (2000 square feet)
E. Mechanical, storage, service and other support infrastructure, including a public water supply system and wastewater collection and treatment system (9,400 to 11,400 square feet).
F. Harbor and dock facility (approximately 20,000 cubic yards of dredging and 14,800 cubic yards of breakwater fill materials).
G. Beach (approximately 5,700 cubic yards of fill materials)
H. Dive grotto (approximately 3,500 cubic yards of dredging and 1,100 cubic yards of breakwater fill materials).
I. Manager’s cottage, submarine power/communications cable and back-up electric power generator

8. This permit is not transferable to other projects, firms or agencies. All work shall be completed in accordance with the EQPB regulations, permit application, project plans & specifications, and Final Environmental Impact Statement (FEIS) on file with the Palau Environmental Quality Protection Board (EQPB).

9. Conditions of this permit require the permittee to submit various reports, designs and plans for EQPB approval. These reports, designs, plans, and any conditions of EQPB’s approvals are hereby incorporated by reference and shall be considered fully enforceable conditions of this permit.

10. Certain Special Conditions in this permit pertain to facilities which will be in use during the operation phase of the permitted project after construction is completed (e.g., potable water supply systems, wastewater treatment and disposal systems, storm drainage controls, and stationary air emission sources). These permit Special Conditions remain enforceable until such time as the facilities are no longer used and are taken out of service.
11. All activities shall be conducted in accordance with the plans, specifications, terms, representations, and depictions of the approved application and FEIS as modified by the terms and conditions of this permit. Other facilities and activities not described in the permit application, project description, plans and specifications are prohibited. The FEIS mitigation measures are hereby incorporated by reference into this permit and shall be considered as fully enforceable components of this Permit. Permitee is advised to consult the FEIS and this Permit simultaneously, as certain requirements in the FEIS may not have been duplicated in this Permit.

12. This permit does not give any property rights, either in land or materials, or any exclusive privileges to permittee, and does not authorize injury to private property or invasion of private rights. This permit does not represent any opinions or representations by EQP B regarding the validity or nature of permittee’s land use rights.

13. Issuance of this permit confers no responsibility on EQP B, and EQP B assumes no liability now or later for any events associated with the planning, design, construction or performance of the permitted facilities for their intended purposes.

14. Permitee will obey and conform to all laws, regulations and rules of the Republic of Palau in performing the earthmoving activity, construction and operation of the project facilities.

15. The permittee shall conduct these earthmoving and construction activities in a manner so as to minimize any adverse impact of the work on fish, wildlife and the natural environmental.

16. No debris, petroleum products, or other deleterious materials shall be allowed to fall, flow, leach or otherwise enter any nearby body of water.

17. The Palau EQP B staff has the right to enter, photograph, inspect, review records, and collect samples at the project site at any reasonable time.

18. EQP B shall be notified 48 hours prior to beginning the construction. A copy of this earthmoving permit and its conditions shall be posted at the site for public display.
SPECIAL CONDITIONS:

Archeological and Cultural Heritage Protection

1. The permittee shall comply with all stipulations of the Memorandum of Agreement Between Ngerulmud Corporation and Division of Cultural Affairs, dated August 12, 1999, Division of Cultural Affairs.

State Permit

2. Prior to earthmoving or construction, the permittee shall submit to the EQPB office a copy of a Koror State Building Permit authorizing the project.

Erosion and Sedimentation Control

3. Prior to earthmoving or construction, the permittee shall submit to EQPB and receive approval for an Erosion and Sedimentation Control Plan (ESCP) which complies with the requirements of the EQPB Earthmoving Regulations, Chapter 2401. The overall objectives of the ESCP will be to ensure that EQPB water quality standards are not violated. Protection of the topsoil to enhance re-vegetation of cleared areas and protection of coral and other marine life during submarine construction of the sewage outfall and power cable shall also be objectives of the plan.

4. The layout and construction of the project and all temporary and permanent erosion and sedimentation controls and drainage controls shall be implemented and constructed as described in the EQPB approved ESCP required by Special Condition No 3 and the project plans and specifications. All the requirements of the ESCP, plans and specifications and the provisions listed below shall be implemented as enforceable conditions of this permit:

A. The project site shall be cleared and graded so that storm water runoff from all cleared and graded areas is directed at all times by either swales, berms, ditches, storm drains or graded surfaces with positive drainage to infiltration trenches, sediment traps, silt fences or other sediment barrier(s) prior to discharge from the property.

B. Stockpiled fill materials and excavated soils shall be placed on level areas and stabilized by covering with impermeable liner/geo-textile fabric or surrounding with silt fences or sandbags, and/or directing storm water runoff from the stockpile to a sediment trap to prevent sediments from washing off the property.

C. Existing vegetation removed during construction will be turned into mulch and spread over cleared and graded areas as protective cover to the extent practical.

D. Cut and fill slopes shall be protected with erosion control matting and/or interceptor trenches.
E. Temporary access roads shall be graded to shed water, compacted and rolled with coral aggregates.

F. Earthmoving shall be conducted in a manner designed to minimize destruction of existing vegetation. Grading beyond the areas required for construction of the permitted facilities and temporary or permanent environmental controls is prohibited.

G. Permittee shall limit the area of exposed soil during construction to the maximum extent practical. Any exposed area shall be stabilized as soon as possible after the final grade has been achieved. Whenever work stops in an area for more than fourteen (14) days, interim stabilization measures (e.g., rolling and compacting, covering, re-vegetation, capping with compacted aggregates) shall be employed.

H. All surplus excavated soils and materials shall be transported and disposed of at an EQPB permitted site.

I. Earthwork shall not be conducted during heavy rains.

J. Prior to earthmoving, the site layout and work limits shall be staked in the field and the EQPB Environmental Engineer shall be notified. Stakes shall be placed at the following locations:
   1. Grading limits for the work area,
   2. Erosion and sedimentation controls, and
   3. Drainage structures

K. Infiltration trenches, other sediment trapping devices and drainage channels/ditches shall be regularly inspected and kept free of sediment build-up. Unlined drainage ditches and storm water discharge outlets which show evidence of scouring shall be lined with erosion-resistant material (e.g., vegetation, geo-textile fabric, rock rip rap, compacted aggregates, or concrete).

L. All erosion and sedimentation controls and storm water drainage controls shall be regularly inspected for proper performance and maintained. In the event of failure of any erosion and sedimentation control or drainage control structure, the permittee shall take appropriate action (e.g., clean, repair, redesign or install additional erosion and sedimentation controls approved by EQPB) to prevent the discharge of sediment-laden storm water runoff into marine coastal waters.

M. During clearing, grading and construction, all erosion and sedimentation controls and drainage controls shall be inspected daily and after each major storm. Observations and evidence of erosion, sedimentation, blockage or damage shall be recorded on an inspection form. The inspection form shall include
recommended corrective action(s) and completion date(s). Inspection Forms shall be kept until the construction is completed and shall be provided to EQPB staff for review upon request.

N. Prior to dredging or filling in coastal waters, the permittee shall enclose the perimeter of the proposed dredge area with commercial grade silt/turbidity curtains equipped with skirt, floats, ballast and secure anchorage. Silt curtains shall be of sufficient length to extend from the water's surface to the bottom, regardless of tide, and shall be anchored properly to withstand the effects of tides and current. Silt curtains shall be installed for inspection by EQPB and receive approval prior to beginning dredging or filling operations.

O. Floating silt curtains shall be inspected daily for damage and for flow of silt/sediments outside the curtain to ensure that the curtains are properly installed and maintained in good working conditions during the work. Dredged materials shall be stockpiled and surrounded by silt fencing.

P. Prior to earthmoving or construction, the permittee shall submit to EQPB and receive approval for a nearshore water quality monitoring plan which describes sampling station locations, sampling frequencies, equipment, analytical parameters, procedures and reporting requirements. The plan shall include as a minimum monitoring for turbidity in nearshore waters to determine compliance with the applicable turbidity water quality standard. The permittee shall implement the approved water quality monitoring plan during the duration of the construction.

Q. If the water quality standard for turbidity at the site is being exceeded, the permittee shall investigate the reasons for the violation, and propose and implement corrective actions unless the permittee can demonstrate that the project construction is not contributing to the violation.

Public Drinking Water Supply System

5. Water that is intended for human consumption (e.g. potable water) for the project shall be provided by the permittee, who shall privately own and operate a "public water supply system".

6. The water supply source for the project shall be seawater pumped from a submerged intake. Water shall be treated by filtration and reverse osmosis, and disinfected with hypochlorite solution prior to human consumption. Treated water shall be stored in a reservoir that will provide 150,000 gallons of storage capacity, and shall be distributed to the consumers by a distribution system comprised of underground pipes, pumps and a hydro-pneumatic tank.

7. Components of the public water supply system shall be designed, constructed, tested and disinfected in accordance with accepted engineering and industry
practices and standards such as those of the American Water Works Association (AWWA), and the equipment manufacturer's instructions and recommendations.

8. Prior to construction of the public water supply system, the permittee shall submit to EQPB and receive approval for the finalized design plans and specifications for the water system.

9. Prior to operation of the public water supply system, the permittee shall submit to EQPB and receive approval for a drinking water quality monitoring plan to demonstrate compliance with EQPB drinking water standards, and an operation and maintenance plan for the water system. The operation and maintenance plan shall describe the training and identify qualified staff necessary to properly operate and maintain the public water supply system. Manufacturer's information on water treatment chemicals and certification by an independent testing organization such as the National Sanitation Foundation (NSF) that the chemicals are safe for treatment of potable water shall be submitted to and receive approval from EQPB.

10. New pipelines and connections to the public water supply system shall be pressure tested and leakage tested in accordance with AWWA procedures and standards. Prior to testing, the EQPB Environmental Engineer shall be notified. Test results shall be recorded and shall be provided to EQPB staff for review upon request.

11. Components of the public water system shall be disinfected in accordance with AWWA procedures and standards (maintain a minimum chlorine residual concentration of 25 mg/L for 24 hour period). Prior to disinfection of the water system components, the EQPB shall be notified and EQPB staff shall observe disinfection.

Wastewater Management and Pollutant Discharge Provisions

Sewage Discharge Conditions

12. Sewage generated by the resort project shall be collected and treated in a centralized sewage collection and treatment system located on Ngerur Island. The collection system will primarily be comprised of gravity sewers and a pumping station. The collected sewage shall receive secondary (biological) treatment by an extended aeration process "package" treatment plant and shall be disinfected using an ultraviolet system.

13. Restaurants shall be equipped with grease and oil interceptors (grease traps) to pretreat the kitchen wastewater prior to discharge to the sewage collection system. Grease and oil interceptors shall be of a type and capacity approved by EQPB and shall be properly maintained and cleaned, and shall be readily accessible for inspection.
14. Prior to construction of the sewage collection and treatment system, the final design plans and specifications shall be submitted to and receive approval by EQPB.

15. The permittee is authorized to discharge secondary treated sewage from the package plant through a deep water outfall pipe to receiving waters located approximately 480 feet offshore of Ngerur Island at a directional bearing of 31.9° north-northeast and at a depth of 105 feet MSL, in accordance with effluent limitations, monitoring requirements, and provisions set forth in permit Special Condition No. 16 and 17 and Special Conditions No. 20 through 31.

16. Treated effluent that is discharged shall be limited and monitored by the permittee as specified below:

<table>
<thead>
<tr>
<th>Effluent Characteristics</th>
<th>Discharge Limitations</th>
<th>Monitoring Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>90-Day Average(3)</td>
<td>Measurement Frequency</td>
</tr>
<tr>
<td>Flow</td>
<td>30,000 (GPD)</td>
<td>Continuous</td>
</tr>
<tr>
<td>Biological Oxygen(1) Demand (5-day)</td>
<td>30 mg/L</td>
<td>Once/week</td>
</tr>
<tr>
<td>Suspended Solids(1)</td>
<td>30 mg/L</td>
<td>Once/week</td>
</tr>
<tr>
<td>Settleable Solids</td>
<td>1 mg/mL</td>
<td>Once/week</td>
</tr>
<tr>
<td>pH(4)</td>
<td>Not less than 6.0 standard units nor greater than 9.0</td>
<td>Once/week</td>
</tr>
</tbody>
</table>

(1) Both the influent to and effluent from the treatment plant shall be monitored.

(2) Composite sample means a combination of at least 4 discrete samples taken at approximately equal time intervals for 4 hours during the higher flow period of the day, or for the duration of the discharge, whichever is shorter.

(3) Discrete grab sample means any individual sample collected in less than 15 minutes.

(4) The discharge shall not cause the pH of the receiving water to deviate from a range of 7.7 to 8.5 standard units.

17. There shall be no discharge of substances that violate the Palau EQPB Marine and Fresh Water Quality Regulation Standards for Class AA waters outside of a Zone of Mixing (ZOM). The ZOM is defined as the 260 feet diameter area extending laterally around the diffuser and vertically to a maximum height of 50 feet below Mean Sea Level.
Reverse Osmosis (RO) Brine Discharge Conditions

18. The permittee is authorized to discharge a maximum of 85,000 gallons per day of brine wastewater from the reverse osmosis water treatment system through a perforated diffuser pipe located at the base of the harbor's eastern rip rap embankment, in accordance with the effluent limitations, monitoring requirements and provisions set forth in permit Special Conditions No 19 through 31.

19. Prior to discharge, brine wastewater shall be diluted with seawater so that the effluent discharge salinity shall not deviate from a range of 29 to 35 parts per thousand. The effluent discharge shall be monitored daily for salinity.

Sewage and RO Brine Discharge Conditions

20. The receiving water shall be substantially free of visible floating materials, oils, grease, scum, and other matter attributable to sewage or brine.

21. The receiving water shall be free of materials attributable to sewage or brine that will produce visible turbidity or settle out to form deposits.

22. The receiving water shall be free from materials attributable to sewage or brine that produce objectionable color, odor or taste directly or by chemical or biological action in the water or biota.

23. The receiving water shall be free from substances attributable to sewage or brine that induce undesirable aquatic life or degrade the indigenous biota.

24. The receiving water shall be free from substances and conditions or combination thereof attributable to sewage or brine, which may be toxic or cause irritation to humans, other animals and plants, and aquatic life.

25. The discharge of sewage or brine shall not cause the temperature of the receiving water to vary by more than 1.5°F (0.9°C) from ambient conditions.

26. Prior to operation, the permittee shall submit to EQPB for approval a receiving water monitoring plan and schedule which describes sampling station locations, sampling frequencies, equipment, monitoring parameters and procedures. The monitoring plan for sewage discharge shall include as a minimum monitoring for floating materials (oils, grease, scum, etc and odor and color), fecal coliform bacteria, turbidity, salinity dissolved oxygen and pH. The monitoring plan for brine shall include as a minimum salinity.

27. Prior to operation, the permittee shall submit to EQPB for approval an operation and maintenance plan for the sewage collection and treatment system and the brine
dilution treatment system. The operation and maintenance plan shall identify the training and qualified staff necessary to properly operate the sewage collection and treatment facilities. Once approved, the plan and their schedules of actions shall become enforceable conditions of this permit.

28. The permittee shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by the permittee to achieve compliance with the special conditions of this permit for Pollutant Discharge. Proper operation and maintenance also includes adequate laboratory controls and quality assurance procedures.

29. By-pass means the intentional diversion of untreated sewage or brine from any portion of the sewage collection and treatment system. By-pass is prohibited, except if it does not cause effluent limitations to be exceeded and only if it is essential for maintenance to assure efficient operation of the treatment facilities. The permittee shall submit prior notice of an anticipated by-pass.

30. Monitoring Reports: Monitoring results obtained during the previous 3 months shall be summarized for each month. The results of all monitoring required by this permit shall be submitted in such a format as to allow direct comparison with the limitations and requirements of this permit. Unless otherwise specified, discharge flows shall be reported in terms of the average flow over each 30-day period and the maximum daily flow over that 30-day period. Monitoring reports are due each quarter (reports shall be submitted for the previous 3 months in January, April, July and October). Duplicate signed copies of these, and all other reports required herein, shall be submitted to the EQPB at the following address:

   Executive Officer, Palau Environmental Quality Protection Board
   P.O. Box 100, Koror, Republic of Palau, 96940

31. The permittee shall retain records of monitoring information, including all operation and maintenance records, copies of all reports required by this permit for at least a period of three years from the date of the monitoring information record or report.

Concrete Batch Plant Operations

32. Discharge of concrete wastewater from the project site to surface waters is prohibited without prior EQPB approval. If the Permittee is unable to recycle or dispose of onsite all concrete wastewater (zero discharge), wastewater shall be contained, tested, and approved on a case-by-case basis by EQPB prior to batch discharge. The Permittee shall contact EQPB for approval when sufficient wastewater is accumulated, and shall meet all EQPB criteria as specified in the case-by-case approval for the discharge. Effluent limitations for the wastewater to be discharged shall be as follows:
33. Any solids collected from cement wastewater shall be de-watered and disposed of and covered only at sites with valid EQPB earthmoving permits.

34. Prior to construction and operation of the concrete batch plant, the permittee shall submit to and receive approval from EQPB a report with design data, drawings, and operating procedures which demonstrates that the concrete batching operation will comply with permit Special Conditions No. 32 and 33 above. The concrete batch plant shall be inspected and approved by EQPB prior to operation.

35. The cement storage and mixing facilities shall be operated at all times with no visible dust emissions. Emissions shall be controlled by the particulate filters and by any other means required to meet the no visible emissions standard (e.g., water spray, cessation of operations during windy periods, etc.).

Solid Waste Management

Construction

36. Prior to construction, the Contractor shall submit to EQPB and receive approval for a Solid Waste Management and Minimization Plan.

37. Solid waste which is generated at the project site, shall be properly stored in appropriate containers to prevent odor and nuisance conditions from developing and transported to an EQPB permitted landfill for disposal.

Operation

38. The permittee shall install and operate a trash compactor, and shall make arrangements with a commercial refuse hauler to have solid waste generated at the project site transported to an EQPB permitted landfill for disposal.

39. No more than 90 days prior to beginning operation of the permitted facility, the permittee shall submit to EQPB and receive approval for a Solid Waste Management and Minimization Plan which describes provisions to minimize wastes through arrangements to reduce, reuse and recycle solid wastes. As a minimum the plan shall include the following elements:

A. Segregation of green wastes for reclamation (e.g., composting).
B. Segregation and transport of aluminum cans to the scrap metal recycling facility located on Malakal Island.
C. Methods of collection, storage, transport and disposal of solid wastes.
Hazardous and Toxic Materials and Chemical Waste Management

Construction

40. The Contractor shall submit to EQPB and receive approval for a Hazardous and Toxic Materials Management Plan for management of fuels and other hazardous and toxic materials and emergency response in the event of a spill of fuel or chemicals into the marine environment and must have appropriate spill response equipment available at the construction site. The hazardous materials management plans shall be submitted to and approved by the EQPB office. The plan should cover:

A. Transport, storage and handling facilities and procedures for fuels and hazardous and toxic materials that minimize risk of spill or leak to the environment,
B. Spill response procedures and equipment requirements for spill response and clean up,
C. Methods for reusing, recycling or disposing of spilt or excess materials and waste chemicals.
D. Employee training.

41. Fuel storage tanks and delivery systems shall be provided with secondary containment and shall be designed and constructed in accordance with accepted engineering and industry standards and codes approved by an independent testing organization such as the Underwriters Laboratory (UL) or equivalent for the applicable equipment uses. Design and manufacturer's data and specifications on fuel storage tank and delivery systems shall be submitted to and receive approval from EQPB.

42. Maintenance of all machinery, equipment and vehicles shall be conducted in an area isolated from rainfall (e.g. roofed) and upon an impermeable surface (e.g. concrete floor or pad area.)

43. During construction, spill prevention kits shall be maintained onsite and construction personnel shall be instructed and trained in the use of such kits in the event of accidental fuel or chemical spills. Any spill of fuel, oil, or other hazardous material shall be cleaned up immediately. Spills to the land in excess of 50 gallons or any spill with enters surface water shall be immediately reported to EQPB.

44. Engine oils, waste oils, hydraulic fluids, solvents and other hazardous or toxic materials or wastes shall be stored in containers designed to contain any leakage or spillage, shall be separated as needed for safety and compatibility, and shall be provided with secondary containment and isolated from rainfall and storm water runoff (stored inside or roofed).
45. Waste oil shall be segregated, stored and transported for use as a fuel blend at the PPUC power stations. Permittee is responsible for making arrangements with PUC for acceptance of the waste oil.

Operation

46. No later than 90 days prior to beginning operation of the permitted facility, the permittee shall submit to EQPB and receive approval for a Hazardous and Toxic Materials Management plan for the operational phase of the project which describes procedures and facilities for the handling, use and storage of hazardous and toxic materials, and provisions for reuse, recycling or disposal of any excess chemicals and wastes. The plan should propose the use of non-toxic products for cleaning, operation and maintenance, to the extent practical, as opposed to toxic products containing hazardous substances.

47. Pesticides used in maintaining turf and gardens shall be selected on the basis of the following characteristics and shall be approved by EQPB prior to use:

   A. Low toxicity to aquatic and marine organisms
   B. Low environmental mobility
   C. Rapid chemical and/or biological degradation in the environment.

48. Nutrient (fertilizer) use should be strictly controlled and application rates should be determined through soil analysis. Use of mulch and composted fertilizer and organic fertilizers should be considered in preference to chemical fertilizers.

49. Hazardous material means any substance that poses a threat to human health or the environment due to its toxicity, flammability, corrosivity, or reactivity. Hazardous Waste is as defined in Title 40 of the United States Code of Federal Regulations, Chapter 261 (40 CFR § 261), as of July 1, 1994.

Imported Plants and Materials

50. Prior to importation of landscaping plants, seeds or other plant materials into Palau from overseas, the permittee shall have authorization and quarantine clearance from Customs and the Division of Agriculture. A copy of the Division of Agriculture authorization and quarantine clearance shall be submitted to the EQPB Office.

Electrical Power and Energy Management

51. Prior to connecting to the PPUC electric power grid, the permittee shall submit to the EQPB office written confirmation from the PPUC that the permittee has complied with all PPUC mitigation measures, conditions and requirements and is authorized to connect to the power grid.
52. The project facilities shall be equipped with energy efficient lighting and switches, ventilation and air conditioning and other energy saving equipment to minimize energy use where possible without compromising the standards of the luxury resort.

Air Quality Control

53. All stationary air contaminant sources such as back-up electric power generators or boilers shall not release air pollutants that cause violations of any air quality standard in the EQPB Air Pollution Control Regulations, Chapter 2401-71.

54. All generator equipment shall be operated and maintained in accordance with the manufacturer's operation and maintenance manuals to ensure continued compliance with EQPB air quality standards. Operation and maintenance service records shall be kept at the facility for a period of two years from the date of service and shall be provided for review at the request of EQPB staff.

55. At its discretion, EQPB may require the permittee to conduct performance testing of generators or other air contaminant sources and/or ambient air impact analysis to demonstrate compliance with applicable EQPB Air Pollution Control Regulations and Standards.

56. Transportation during the operation of the project shall be provided by electric carts/vehicles to the extent practical.

57. During construction, if dry conditions develop creating visible dust emissions, water spraying shall be utilized sufficiently to control and reduce dust without creating runoff and erosion.

Noise Abatement and Traffic

58. The permittee shall use good judgement and reasonable care to transport equipment and materials and perform construction work without disturbing the public. If EQPB receives noise complaints from the public, the permittee shall transport equipment and materials from Koror to Ngerul Island during normal working hours to minimize noise related disturbance to residents along roads.

59. Normal work hours shall be between 0700 and 1800 hours. The Contractor may request a variance from normal working hours to accommodate schedule and other project constraints. Vehicles and equipment shall be fitted with proper muffling devices.

Public Services/Safety

60. Water supply for fire protection of the facilities will be provided by the potable water system, which will include pumps, distribution mains, hydrants and 150,000 gallons of water storage capacity. Facilities shall be equipped with smoke
detectors, fire extinguishers and sprinkler systems and shall have telephone and radio communication with the Bureau of Public Safety.

61. The resort will be equipped with a nursing station for first aid and over the counter medication and shall be staffed with security personnel.

Marine Protected Area Mitigation

62. The permittee shall propose to Koror State to establish a Marine Protected Area (MPA) around portions of Ngerur Island. No later than 120 days after commencement of operation of the permitted facility, the permittee shall submit to EQPB a brief letter report summarizing the results of negotiations with Koror State to adopt legislation to establish the MPA.

Ngarkebesang Channel Improvement

63. Upon the request of the Koror State Government, the permittee agrees to perform improvements to the Ngarkebesang Channel and Dock. The scope of work shall be mutually agreeable to Koror State, the Permittee, and the EQPB. The permittee shall submit to the EQPB office a permit application and supplemental environmental assessment for the proposed project. Dredging or other construction is prohibited without a separate EQPB permit authorizing the work.

Permit Renewal

64. This permit shall expire on February 28, 2005. Application for permit renewal shall be made 120 days prior to the expiration date.
MODIFICATION CHANGE OR REVOCATION OF PERMIT:

The Palau Environmental Quality Protection Board may, after taking into account any significant detrimental environmental degradation or public health threat resulting from the permitted activity, change or modify the conditions of the permit to minimize such degradation, or partially, or in whole revoke the permit should the Board determine such action to be justified and appropriate for protection of the public health and environment.

In issuing this permit, the Board has relied on the information and data which the permittee has provided in connection with his permit application. If, subsequent to the issuance of this permit, such information and data prove to be false, incomplete or inaccurate, this permit may be modified, suspended or revoked, in whole or in part.

Violation or failure to comply with the conditions of this permit may result in imposition of a civil penalty in an amount not to exceed $10,000 per day, and/or an enforcement action to cease, desist and abate all violations.

I have read and understand this permit and its conditions, and by my signature below, agree to comply with them.

[Signature]
Morita Hotel Corporation, Inc.

[Signature]
Paul R. Holm
Chairperson, EQPB

4-30-2001
Date

4/30/2001
Date
Appendix 2

Minutes of Scoping Meeting for Palm Springs Resort
I. Introduction of Members

NECO:  
Mr. John Eric Basco  
Mr. Ngelechel Etpison  
Architect Kelly Pineda

EQPB:  
Mr. Mike Blessam  
Engr. Soledad Revalo  
Ms. Lynna Thomas

II. Introduction of Client/Proponent

Mr. Ngelechel Etpison gave a brief background of the Client or Proponent of the Project. The Client is a Chinese based organization. They have developments in Hong Kong and Shenzhen, China. Their main business is hotel development like Four Seasons Hotel in Hong Kong and also in Shenzhen.

They have been in the country a month ago and would wish to develop a hotel and/or resort with an existing plan submitted through an EIS done for Ngerur in 2001. A completed and approved EIS is at hand, water reclassification and also historical documentation and burial removal was completed back in 1998. They already removed and relocated the burial sites to Ngerkebsang.

All the intensive work was done back to when Morita Corp. was interested in developing the island and is supposed to be a part of the development of Neco Marine but unfortunately Mr. Morita backed out back in 2002. All the plans, and renderings of the hotel are done and the present client would like to just mirror what Morita Corp. previously planned to do and not change anything. If there will be changes, it will be stipulated in the conditions. The permit was granted in 2001 and expired in 2005.

III. Scope of the Project.

The Scope of work will follow all the plans applied by Morita Corp. as stipulated in the EIS. It will be composed of 60 units. Water reclassification has been granted but has also an expired permit. The site development plan, architectural plans and engineering plans was shown to the EQPB staff. Since EQPB doesn’t have any documents pertaining to the EIS, NECO will provide a copy including the plans upon submission of the EA.

IV. Wastewater

They will be using a packaged type wastewater treatment plant and treated effluent will be discharged to the ocean approximately 150 meters away from the island. The effluent discharge will be passing Class A standard but since the surrounding waters have already been reclassified into Class B, so the effluent discharge even surpassed the standard.

V. Water Supply

They will be using water desalination system. Laundry facilities will not be installed. All laundry will be brought to Koror. Environmental-friendly shampoo and other products will be imported and shipped to Koror for this hotel.

VI. Power Supply
As per EIS, they plan to use a submersible cable tapped from PPR to the island. The client may change this to use generator instead but will this will have to be confirmed from the client. EQPB staff recommends the use of solar system.

VII. Socio-economic Survey
No survey needed to be done since it is a private island and no neighboring hamlets/people will be affected with the development.

VIII. Transport of Materials
Construction materials will be transported through barge and a dingy will be installed.

IX. Dredging
There are no plans to dredge.

X. Site Visit with EQPB
A site visit with EQPB will be scheduled before submission of the EA probably next year. Before construction of a project, site visit with EQPB staff will also be scheduled to discuss matters pertaining to plans that should be properly implemented.

XI. Scope of Work to be done for the new EA
- Updated Flora and Fauna on the Mixing zone
- Location of Water Discharge
- Water Quality
- Provide GPS Location of the Mixing Zone
- FIB License of the Proponent
- Updated Historical Clearance
- Update Baseline Information like bird survey and terrestrial
- Provide the RO System of the water desalination.
- Computation of the volume of discharge including the wastewater plus the reject water from the RO system.
- Specify the quality of the combined water
- Solid waste management
- Air-conditioning and refrigeration
- Design for rainwater harvesting system
- Size of tanks for the raw water and wastewater
- Fire Safety System
- Plans such as site dev. Plan, stormwater, sewer, should be enlarged and printed in A1 paper
- Countercheck all the facilities in the plans with the permitted conditions
- Updated costs and details
- Submit an electronic copy of the EIS
- Provide secondary impacts of the project like impact on the revenue of this hotel project, food supplies in the store, and others.
Appendix 3

Foreign Investment Board (FIB) Certificate
FOREIGN INVESTMENT APPROVAL CERTIFICATE NO. 644-2018

BE IT KNOWN THAT “PALAU PALM SPRINGS INVESTMENT DEVELOPMENT LIMITED” (“Grantee”) is hereby authorized by the Government of the Republic of Palau Foreign Investment Board (“Grantor”), pursuant to Title 28, Chapter 1, of the Palau National Code (the “Foreign Investment Act”) to carry on a business enterprise in the Republic of Palau subject to the following:

1. **TERM:** The term of this Certificate shall be for a period of fifty (50) years.

2. **SCOPE:** This Certificate authorizes the Grantee to engage in the following activities:
   
a. To develop, construct and operate five star resort in a property known as “Ngerur Island”, Cadastral Lot No. 029 A 01, containing an area of 52,158 square meter located in Koror State.

3. **CONDITION(S):** This Certificate is subject to the following condition(s):
   
a. Grantee shall comply with the minimum wage requirements of the Republic of Palau. The Grantee shall pay into the National Treasury of the Republic of Palau an annual fee of five hundred dollars ($500.00) for each non-citizen employed as required by 28 PNCA § 108(k)(9).

b. Pursuant to 28 PNC Section 108(k)(8), Grantee shall deposit twenty-five thousand dollars ($25,000.00) in a Palau Branch of a bank operating in the Republic of Palau within sixty (60) days after the issuance of this Certificate and shall present evidence to Grantor of same. The account shall be established jointly under the name “Foreign Investment Board and Palau Palm Springs Investment Development Limited”. Any withdrawal from this account shall require the signature of Grantee’s authorized representative and any three active members of the Grantor. This account shall be maintained throughout the term of this Certificate. Prior to establishing the joint account, Grantee shall sign both copies of the Bank Deposit Agreement and Disbursement Authorization enclosed with the FIAC and shall present one copy to the bank at which the account is established and return the other to the Foreign Investment Board.

c. Grantee shall not engage in any other business activities under this FIAC unless an amended FIAC is granted by the FIB.
d. Grantee shall provide a training program which will upgrade the skills, including managerial skills of all Palauan employees. Grantee shall use its best effort to promote qualified Palauan employees to managerial positions as soon as possible.

e. Grantee must provide written documentation to the Office of the Foreign Investment Board within six (6) months of issuance of this Certificate that the workforce of the business enterprise is comprised of at least 20% Palauan citizens as required by Section 106 of the Foreign Investment Act.

f. For each and every calendar year of the term of this certificate or portion thereof, Grantee shall submit business activities quarterly reports to the Foreign Investment Board within 30 calendar days of each of the following: March 31, June 30, September 30 and December 31.

g. Grantee shall notify the Grantor if the owner seeks to transfer some of his/her ownership interest in the Grantee.

h. Grantee shall commence its proposed business activities in the Republic of Palau consistent with the stated purpose, scope and objectives within one (1) year from the date of being granted its FIAC, or be able to demonstrate substantial progress toward obtaining all necessary licensing.

i. If Grantee fails to commence its business activities before the end of twelve (12) months, as state above, fifty percent (50%) of the required deposit under Section 3(b) of this FIAC, shall be forfeited to the Palau National Treasury.

4. **APPLICABLE LAWS:** This Certificate is granted subject to full compliance by the Grantee with all applicable Republic of Palau and State laws and regulations, including but not limited to the following:

a. **License(s):** The Grantee shall acquire and keep up to date such business license(s) required by applicable Republic of Palau and State laws and regulations governing the conduct of any business activity engaged in by the Grantee.

b. **Taxes:** The Grantee shall make timely payment of taxes lawfully levied under applicable Republic of Palau and State laws for any business activity engaged in by the Grantee.

5. **RESTRICTIONS:** This Certificate is granted subject to the following restrictions:

a. **Employment of Citizens of Palau:** The Grantee shall to the maximum extent feasible employ and train citizens of the Republic of Palau in the business activity in which it engages or may engage in the Republic of Palau.

b. **Utilization of the Republic of Palau Sub-Contractors and Concessionaires:**

   Whenever economically feasible and practical, the Grantee shall favor Palauan citizens or entities as sub-contractors or concessionaires over non-Palauan individuals or entities.
This Foreign Investment Approval Certificate No. 644-2018 shall be valid as of the date it is signed on behalf of the Foreign Investment Board, provided the following statement is signed by the Grantee’s authorized representative within 30 days of the date the Foreign Investment Approval Certificate is signed on behalf of the Foreign Investment Board. If this document is not signed by the Grantee’s authorized representative within the 30 days period, it is void and of no effect unless otherwise agreed by the Foreign Investment Board in writing.

I, ____________________________________________, hold the title of ___________________________ of "Palau Palm Springs Investment Development Limited" (the "Grantee") and am authorized to execute this statement on its behalf. I have read and understood the foregoing Foreign Investment Approval Certificate and agree on behalf of the Grantee to be bound by its provisions. I understand that this Foreign Investment Approval Certificate sets forth specific terms, conditions and restrictions relating to the conduct of the Grantee's business enterprise as established in the Republic of Palau and that the Grantee's failure to comply with any one of these provisions will render this Certificate subject to modification, suspension or revocation.

I further understand that the conduct of the Grantee's business enterprise as established in the Republic of Palau is subject to the applicable laws of the Republic of Palau and the various States, including specifically the Foreign Investment Act, 28 PNCA § 101 et. seq. In particular, I understand and am aware that the Foreign Investment Act sets forth criminal penalties for certain conduct violative of its provisions. I understand and agree on behalf of the Grantee to comply with Section 108(k)(9) of the Foreign Investment Act, which requires the Grantee to pay to the National Treasury an annual fee of $500.00 for each non-citizen it employs. Finally, I understand that in order to lawfully engage in any business activity, other than the activity authorized in this Certificate, the Grantee must either apply for an amendment to this Certificate or apply for a new Foreign Investment Approval Certificate.

______________________________  __________________________
Name of Authorized Representative  Date
Bank Deposit Agreement and Disbursement Authorization
For
PALAU PALM SPRINGS INVESTMENT DEVELOPMENT, LTD.
FIAC No. 644-2018

As a condition of the above referenced Foreign Investment Approval Certificate (the “FIAC”),
I, ________________________, the authorized representative of (the “Grantee”) understand,
acknowledge and agree as follows:

1. The Grantee is required to deposit twenty-five thousand dollars only ($25,000.00) in a jointly held
   account (the “Account”) in the Palau branch of a bank (the “Bank”) within sixty (60) days of the
   issuance of the FIAC.

2. The Account will be established pursuant to section 108(k)(8) of the Foreign Investment Act and
   regulations thereunder and shall bear the following name:

   FOREIGN INVESTMENT BOARD AND PALAU PALM SPRINGS INVESTMENT DEVELOPMENT,
   LIMITED.

3. Grantee shall maintain the Account throughout the entire term of the FIAC, and at no time shall
   the balance of the Account fall below twenty-five thousand dollars only ($25,000.00) without
   prior written authorization by the Foreign Investment Board.

4. During the term of the FIAC, any withdrawal from the Account shall require the signatures of the
   grantee’s authorized representative and three active members of the Foreign Investment Board.

5. The purpose of the Account is to safeguard the interests of persons and entities doing business
   with the Grantee. Accordingly, in the event that the FIAC expires or is revoked for any reason,
   Grantee hereby authorizes the Bank to release all funds in the Account to the Foreign Investment
   Board, with the signature of three members thereof. In such case, no signature of an authorized
   representative of the Grantee shall be required for disbursement of the funds.

6. The Board shall have one year from the date of disbursement to satisfy debts and obligations of
   the Grantee. Any amount remaining after payment of such debts shall be returned to an authorized
   representative of the Grantee if any such individual can be located using reasonable efforts. If no
   authorized representative of the Grantee can be located using reasonable efforts, the remaining
   funds shall be forfeited to the National Treasury.

7. Grantee shall sign and date two Bank Deposit Agreement and Disbursement Authorizations and
   shall present one to the Bank, to be attached to the signature card of the Account. The other shall
   be returned to the Foreign Investment Board along with proof of the establishment of the Account
   and deposit therein.

Dated this __________ day of ________________________, 2018.

PALAU PALM SPRINGS IMPROVEMENT DEVELOPMENT, LTD.

By: ______________________

Authorized Representative
Appendix 4

Lease Agreement and Certificate of Title
ABSTRACT OF LEASE AGREEMENT

This is an Abstract, for recordation purposes, of that certain Lease Agreement entered into by and between NGERUR ISLAND CORPORATION Represented By SHALLUM ETPISON, a duly registered corporation with its principal address in Koror State, Palau 96940 (referred to as “Lessor”) AND MR. DONG LI AND MR. GANG ZENG of 2502-05, 25F, Harbour Road, Wanchai, Hong Kong, (hereinafter collectively referred to as "Lessee")

1. **Lease.** The parties have entered into a [Oct. 25], 2017 Lease Agreement (hereinafter “the Lease”), whereby Lessor leased to Lessee the following described real property located Koror State, Palau:

   Property known as “Ngerur Island” and referred to as Cadastral Lot No. 029 A 01; located in Koror State containing an area of 52,158 square meters, more or less, as shown on the Bureau of Lands and Surveys Cadastral Plat No. 029 A 00 and which is more particularly delineated in the Annex (hereinafter referred to as the “Premises”).

2. **Term.** The term of the Lease is fifty (50) years, with an option for forty-nine (49) years pursuant to the terms of the Lease agreement.

3. **Recordation.** This Abstract shall be recorded at the Palau Clerk of Courts and otherwise used for the purpose of giving legal notice, actual and constructive, of the above-described leasehold interests.

   In witness whereof, the Lessor have executed this Abstract on the date(s) set forth below.

[Signature]
Shum Etpison,
For and on behalf of
Ngerur Island Corp. (Lessor)

Date
Jan. 26, 2018

Sworn and Subscribed before me this 26th day of January, 2018.

Notary Public

Lease Abstract
LAND COURT
National Judiciary
Certificate of Title

This Certificate is issued pursuant to RPPL No. 4-43 Section 15. This is to certify that

Ngerur Island Corporation

is/are the owner(s) of a fee simple estate in land situated in

Land known as Ngerur Island located in Koror State

containing an area of 52,158 square meters, more or less, as shown on the Bureau of Lands and Surveys Cadastral Plat No. 029A00 dated January 04, 1994.

In accordance with RPPL No. 4-43 Section 14(a), from the date of this Certificate, all transactions involving the land described herein, except any lease or use right for a term of less than one year, shall be recorded with the Clerk of Courts.

In witness whereof, I have hereunto set my hands and caused the Land Court official seal to be affixed below this 22nd day of September, 1998.

[Signature]
Judge of the Land Court

Registered this 29th day of September 1998 in Book No. 30 at Page 05 at the Office of the Clerk of Courts, Republic of Palau.

[Signature]
Clerk of Courts, Republic of Palau

Recorded as Document No. 7867 at the Land Court on this 20th day of September 1998.

[Signature]
Land Court Registrar

Erasures on this certificate will render it null and void. If erasure occurs, owner must surrender this certificate to the Land Court and obtain a new one.

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Appendix 5

Digital Copy of Final EIS of Quest Resort
FINAL ENVIRONMENTAL IMPACT STATEMENT FOR QUEST RESORT PALAU

Island of Ngerur
State of Koror,
Republic of Palau

Prepared for:
Morita Hotel Corporation, Inc.

Accepting Authority:
Environmental Quality Protection Board
Republic of Palau

November 2000
# Final Environmental Impact Statement for Quest Resort Palau

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1.0 INTRODUCTION AND SUMMARY

1.1 Overview

This report represents one of two documents that examine the impacts of inter-related projects in Koror State that are proposed by Morita Corp Palau, Inc.: the first-class, five-star Quest Resort Palau on Ngerur Island and the Malakal Marina Village on Malakal Island. An Environmental Assessment (EA) was separately prepared to address the Malakal Marina Village project. This Environmental Impact Statement (EIS) addresses the development of the Quest Resort.

Morita Corp Palau, Inc. proposes to develop an exclusive, low-density, high-end resort that will encompass the entirety of the existing, uninhabited, privately-owned island of Ngerur (also spelled Ngurur) in Koror State, Republic of Palau. Figure 1 depicts the general project location and regional vicinity. The land owner and developer have a lease agreement in effect. Completion of the proposed resort will result in no change to the land ownership or private status of the island.

The proposed Quest Resort Palau will be carefully master-planned with an overall density of approximately five (5) units per acre. Fifty-eight (58) deluxe guest bungalows and two (2) VIP bungalows are proposed. These spacious, luxurious, guest bungalows with lanais will be for the most part situated along the topographically elevated coastline of the island. A system of walkways shall connect the bungalows that are arranged in such a manner as to benefit from both the shade of the many existing mature trees and the rich panorama of scenic landmarks viewed from across an emerald lagoon.
The resort will be accessible only by boat. An entrance pavilion at a small marina on the southern end of the island will be used as a receiving area for visitors who will be guided to the lobby, lounge and front office located near the restaurants, outdoor dining terrace, outdoor bar, swimming pool and entertainment areas. The proposed resort will also include spa facilities including a gym/aerobic area and massage rooms as part of the fitness/wellness environment.

The proposed project features a “grotto” area consisting of a natural embayment along the southwest shore of the island. This area will be transformed into a protected saltwater pool that will be used primarily for SCUBA diving training. A small indentation along the irregular shoreline on the western side of the island is the chosen location for beach improvements.

Resort operations will generate employment opportunities for local Palauans. A maximum guest population of 120 persons is estimated to require 110 support staff in three (3) shifts. Alternately, the necessary hotel work force is estimated at 2.5 employees per bungalow or approximately 150 persons. It is further estimated that local labor will constitute approximately 65 to 70 percent of the available employment opportunities resulting from resort operations. The project therefore represents a major employment center for local labor.

The Palauan government will directly benefit from the proposed project through gross tax revenues generated on an annual basis. Indirect benefits are expected to be derived from income taxation of the employed work force and the businesses associated in one form or another with the development and operation of the Quest Resort Palau.

1.2 Project Setting

The Republic of Palau comprises some 340 high and low islands in the southwestern Pacific approximately 500 miles (805 kilometers) north of the equator at latitude 7°20’N and longitude 134°28’E. The Palau archipelago is part of Micronesia and represents the most Western group of the Caroline Islands. The nearest neighboring island groups of Papua New Guinea, the Philippines and Guam extend in a circular pattern around Palau at an approximate distance of 497 miles (800 kilometers) to the south, west and northeast, respectively.¹

The main archipelago consists of an island group that spans an arc more than 100 miles (161 kilometers) in length in a north-south direction and 16 miles (26 kilometers) across at its widest point in an east-west direction (see Figure 2). Islands in the main archipelago include Kayangel, Babeldaoob, Koror, Arakabesan, Malakal, Ngermalk Anguar and Peleliu. A fringing reef with a lagoon area of approximately 560 square miles (1,450 square kilometers) encloses the archipelago. The outer slopes of the reef system are steep and are in many instances near-vertical with depths of up to 1,000 feet (305 meters) within a short distance.² It is in these locations that some of the most well known diving spots in Palau are found.

Republic of Palau jurisdiction extends beyond the fringing reef system. Kayangel and Ngeruangel are two atolls that lie north of the main island group. To the southwest of the main

¹ Sem and Underhill, 1994.
² U.S. Army, 1956.
archipelago lie a small cluster of atolls and patch reefs: Fanna, Sonsorol, Pula Anna, Merir, Hatohubei (Tobi) and Helen. The Republic of Palau also has "jurisdiction over a territorial sea (traditional baseline/0 to 3 nautical miles offshore), an Exclusive Fishery Zone (3 to 12 nautical miles offshore), and an Exclusive Economic Zone (12 to 200 nautical miles offshore)."^3

Islands within the great lagoon system represent two geomorphologically different types: the northern island group is composed of volcanic rock whereas the southern islands are composed of limestone.^4 The change from volcanic to limestone composition occurs in the Koror area.

Volcanic islands in the Koror vicinity include Koror, Arakabesan, Ngerur and southern Malakal. More than 300 coral limestone islands known as the Rock Islands extend between Koror and Peleliu. These islands have generally steep and rocky shorelines that are undercut at sea level. The resulting overhangs give the smaller islands the appearance of mushrooms. Forests that host an array of native bird life cover the heavily fractured topography.

The Republic of Palau is subdivided into 16 states (see Figure 3). Ten (10) of these states are located on Babeldaob Island. Koror is presently the most populated state and serves as the commercial and business center for the Republic of Palau. It is also the seat of the national government.

### 1.3 Project Location

The proposed development encompasses the entirety of the island of Ngerur. This island represents the smallest and northernmost element of the Koror conurbation that comprises three main inhabited islands (Koror, Arakabesan, Malakal) and three uninhabited islands (Ngerur, Ngerchaol and Ngermalk). The nearest landmass from Ngerur is Arakabesan Island. The westernmost point of Arakabesan is 2,460 feet (750 meters) southeast of Ngerur. The distance from Ngerur to the urban center of Koror is approximately 3.75 miles (6 kilometers).

Ngerur Island is geographically situated in the Palau Lagoon and away from major landmasses in the Palau archipelago. Figure 4 illustrates the project location in relation to the nearest landmasses. Its relatively unsheltered location means the island of Ngerur is exposed to prevailing winds from the northeast/east-northeast and peak gusts from the southwest.

### 1.4 Project Site Description

Ngerur Island is a small island of approximately 12.5 acres (approximately 5 hectares) situated within Palau Lagoon. The island extends about 1,150 feet (350 meters) in a north-south direction and approximately 820 feet (250 meters) in an east-west direction. A shallow fringing reef varying in width from 50 to 250 feet (15 to 76 meters) surrounds this uninhabited island.

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Both flora and fauna resources on Ngerur Island are relatively limited. The vegetation on Ngerur Island has been heavily altered and the understory cleared. Fruit bats are present on the island. An extremely high density of roof rats on the island precludes successful nesting by birds as well as any herpetofaunal recruitment or long-term survival by terrestrial crabs.

Panoramic views from the island are largely unobstructed and most often spectacular. Main vistas from the island extend in a northeastern direction toward distant Babeldaob and in a southeastern direction toward the unspoiled verdant topography of the Rock Islands. To the southwest, the horizon is defined by the closest landmass to Ngerur: Arakabesan Island.

1.5 Scope and Authority

This Environmental Impact Statement has been prepared to comply with the intent of Palau National Code (PNC) Title 24, the Environmental Quality Protection Act, and the rules and regulations promulgated thereunder. The intent of this EIS is to insure that appropriate consideration of environmental consequences in addition to economic and technical factors is provided in decision making and the processing of permit applications.

The Republic of Palau Environmental Quality Protection Board (EQPB) establishes general standards for environmental review. In the Notice of Determination (EQPB NOD No. 09-00) dated November 11, 1999, the EQPB ruled that an EIS “needs to be prepared with respect to the impacts of [the proposed] project on Palau’s environment” (EQPB, 1999).

1.6 Project Information

The proposed project as envisioned involves no public lands or funds. General project information is listed below.

| THE APPLICANT: | Morita Hotel Corporation, Inc. |
| P.O. Box 7079 |
| Koror, Palau PW 96940 |
| ATTN: Daniel J. High |

| EIS PREPARER: | WCP, Inc. |
| 1400 Rycroft Street |
| HMSA Center, Suite 928 |
| Honolulu, Hawaii 96814 |

| PROJECT LOCATION: | Ngerur Island, Koror State |
| LAND STATUS: | Private ownership |
| (leased to the present Joint Venture) |
| PARCEL AREA: | approximately 12.5 acres (5 hectares) |

Remily, 1999.
1.7 Summary of Impacts and Mitigation Measures

Project actions would result in several beneficial impacts attributed to specific topics of concern:

- **FLORA.** Project actions include landscaping with attractive native plants and the development of a nature trail.
- **FAUNA.** Project actions to eradicate rats and landscape with attractive native plants are expected to encourage the restoration of native faunal resources on the island.
- **HISTORICAL AND ARCHAEOLOGICAL RESOURCES.** Project actions include the preservation of non-burial features in accordance with the recommendations of the Division of Cultural Affairs. Methods of preservation include detailed recording, photography, and videotaping. These actions assist in the preservation of information about important episodes in Palau's history. Human remains will be reinterred in accordance with an approved burial treatment plan.
- **LAND USE CONSIDERATIONS.** The project represents a superbly master-planned, low-density, resort development. An enhanced resort ambience will provide the affluent and discriminating international traveler with the physical framework for an intimate exploration of the pristine tropical environment of Palau. The resort with its lush setting will allure guests seeking a tranquil environment for relaxation and reflection. To create the desired setting, project designers abandoned the permitted density of 20 units per acre in favor of a lower density of approximately five (5) units per acre. The proposed resort project thereby generates fewer impacts on the environment as compared to higher density resort development allowed by the existing zoning regulations.
- **AESTHETIC CONSIDERATIONS.** Landscaping and the application of an overall master plan will improve the overall aesthetic quality of the site as compared to existing site conditions.
- **SOCIO-ECONOMIC CONDITIONS.** Completion of the project will result in the generation of tax revenue to the government of Palau and the creation of employment opportunities for local Palauans. The development of a small-scale luxury resort on Ngerur Island represents the more desirable category of tourism development in Palau and will contribute to the repositioning of Palau as a more upscale destination for international travelers.
Impacts associated with the following topics of concern will be addressed by project actions that reduce or minimize effects:

- **TOPOGRAPHY.** Alterations to the topography (especially underwater areas of the proposed harbor) from earth moving, dredging and filling activities will be accomplished in an environmentally responsible manner. The construction contractor must adhere to EQPB earthmoving permit requirements and implement Best Management Practices during construction.

- **SOILS.** Disturbances to the earth and soils, erosion, soil loss, and silt runoff will be minimized with the implementation of temporary and permanent sedimentation and erosion control measures including initiatives identified in the Erosion Control Plan.

- **WATER QUALITY.** To prevent water quality concerns, wastewater generated by the resort will be treated on-island to a level equal to or better than wastewater treatment on Malakal. Treated wastewater from the Quest Resort Palau will be discharged from a deep water outfall. On-site treatment and effluent discharge via an outfall is proposed to avoid encumbering the municipal wastewater system on Malakal. The reverse osmosis water treatment system will generate brine (a concentrated seawater solution) as a by-product. Brine will be discharged into the dredged harbor in a manner that encourages mixing and circulation with the surrounding seawater. The harbor is naturally well-circulated and is not intended for recreational uses.

  As a result of the high level of treatment currently proposed, the effluent will be virtually indistinguishable from the surrounding Class AA water within approximately 100-feet of the zone of initial dilution. Generation of runoff and the possible accidental discharge of lubricating oils, hydraulic fluid or fuels will be addressed with the employment of measures to control runoff, compliance with Marine and Fresh Water Quality Regulations, and the implementation of spill prevention and containment measures.

- **AIR QUALITY.** The creation of fugitive dust and pollutant emissions will be addressed with the implementation of measures for fugitive dust control, such as the proper operation and maintenance of equipment.

- **NOISE QUALITY.** Construction noise emissions will be controlled with the utilization of noise mufflers and the proper scheduling of excessively noisy activities.

- **FLORA.** The effects of partial disturbance or removal of the existing flora will be minimized with the preservation of large specimen trees and landscaping with native plants. Harmful plants will be removed.

- **FAUNA.** Disturbances to existing fauna will be offset with the implementation of a rodent eradication and long-term control program that allows the native fauna to return to Ngerur Island.

- **COASTAL AND MARINE RESOURCES.** Unavoidable damage to or removal of marine resources will be offset with the preservation of features such as the small freshwater cave on the west side of Ngerur Island. Coral will also be transplanted into the dive grotto and on the artificial reef created by the sunken vessel west of the dive grotto. The applicant is also interested in establishing a marine sanctuary/protected area around portions of Ngerur Island after construction is
completed. Creation of a marine sanctuary/protected area will be coordinated with other interested agencies or organizations as applicable.

- **HAZARDOUS AND TOXIC MATERIALS (HTM) CONSIDERATIONS.** Potential impacts associated with the introduction of HTM (including pesticides and herbicides) to the environment will be minimized with the implementation of spill prevention features and provisions for the safe handling and storage of HTM.

- **PUBLIC SERVICES AND FACILITIES.**
  - Solid Waste Disposal. Solid waste disposal will be coordinated with the BPW for proper disposal to a designated municipal landfill.
  - Electrical Power and Communication Systems. The overall design of the project reflects a conscientious effort to provide for passive energy efficient applications within the program. The architecture of the Quest Resort Palau embodies the Pacific tropical style using earth tone materials that reduce solar heat gain. Broad overhangs at the roof lines will provide a visual transition zone while shading windows and doors. The use of louvers will provide additional shading and allow for natural ventilation. Plumbing fixtures will utilize low flow rates. Low voltage light sources and energy efficient fixtures will be used. A dimming system will allow management to dim the lights in public areas, thereby conserving energy.
  
  The Public Utility Corporation (PUC) will supply electrical power to Ngerur Island from a location near the Palau Pacific Resort on Arakabesan Island. The steel armored submarine cable supplying electrical power will be housed in an underwater conduit along with fiber optic cable for telecommunications service. Damage to corals and marine resources that lie along the alignment corridor of the underwater conduit will be minimized by adherence to an alignment of least impact upon the existing corals.

- **SOCIO-ECONOMIC CONSIDERATIONS.** Construction of the Quest Resort Palau may be accomplished with foreign labor. Manpower requirements for construction are estimated at approximately 100 to 125 persons. The contractor will provide the experience, ability, and appreciation for working with the people of Palau to minimize the social impact that imported laborers may have on the local population.
  
  The foreign worker impact reduction plan (FWIRP) will address the foreign labor force employed by any subcontractor. Responsibility for the preparation of the FWIRP rests with the general contractor. If EQPB determines that a FWIRP is a required permit condition, the applicant will include preparation and subsequent approval of the FWIRP as a contract requirement for the general contractor.

Project actions have the potential to disturb or destroy cultural resources that lie within areas that will be affected by construction activity. Mitigation for potential adverse impacts to cultural resources includes consultation with the Division of Cultural Affairs for resource preservation and strict adherence to the burial treatment plan.
1.8 Summary of Alternatives Considered

In addition to the Proposed Action, the alternatives discussion in this EIS includes the consideration of no action, the alternative of maximum density resort development, and design alternatives (an alternative potable water system, alternative wastewater systems, alternative fire protection systems, and alternative electrical power systems).

1.9 Summary of Unresolved Issues

There are no unresolved issues.

1.10 Compatibility With Land Use Plans and Policies

The proposed Quest Resort Palau is situated in the "RV" Resort Center Zone and is therefore compatible with the legal land use regulation controls of Koror State. The reduced density of 4.8 units per acre for the proposed project is well within the allowable maximum density of 20 units per acre.
2.0 PURPOSE AND NEED FOR THE PROPOSED ACTION

2.1 Purpose of the Proposed Action

The purpose of the proposed action is to provide a first class, five-star resort on Ngerur Island in the Republic of Palau. Design improvements, physical facilities and service levels provided to the public and hotel guests will illustrate elegant sophistication within the framework of reasonable development and responsible consideration and stewardship of the environment.

Completion of the Quest Resort Palau will expand the opportunities for leisure and recreation in Palau. The proposed resort is intended for a growing number of affluent, international travelers to Palau. As envisioned, the Quest Resort Palau will be a small scale, high-end resort of 60 deluxe visitor accommodations on Ngerur Island. In its existing state, Ngerur Island is privately owned and accessible only by boat; these conditions will remain unchanged as a result of resort development. Visitors will venture to the island resort to experience privileged seclusion in exotic tropical surroundings. A spectacular background of fiery sunsets on an emerald horizon will provide each guest with a memorable backdrop upon which to define and fulfill their individual quest.

Main vistas from Ngerur Island are of the large main island of Babeldaob to the northeast and the distinctive silhouette of distant Rock Islands to the southeast. To the southwest lies Arakebesan Island; it is the nearest landmass to Ngerur Island and the feature that defines the horizon. The remaining western and northern views are of the unobstructed and open lagoon and ocean waters.
The design and master plan of the Quest Resort Palau will take full advantage of the spectacular views and existing natural environment that contribute to the remote island character of Ngerur. A proposed dive grotto on the southwestern corner of the island and beach improvements along the western coast are additional luxuries intended to promote Ngerur Island as an exceptional destination for recreation and retreat.

2.2 Need for the Proposed Action

As stated in the Economic Development Plan of the Republic of Palau, the Palauan government will support the responsible growth of tourism as the leading sector of the economy as long as that growth takes place in a manner consistent with the environmental and cultural heritage of the islands. Income tax revenue generated directly or indirectly from the proposed project will benefit the Republic of Palau Government (ROPG).

Tax revenues from tourism development have to be assessed within the context of the fixed size of the natural environment, which represents the base for tourism development. The same amount of tax revenue can be generated either by a greater number of visitors procuring lower-priced accommodations or by a smaller number of visitors obtaining higher-priced accommodations. The size of the natural environment remains the same for both situations; therefore, the alternative with fewer visitors is more desirable because of its lesser impact on the environment. The proposed Quest Resort Palau is an example of the second category of development and is therefore representative of a more desirable form of tourism development in Palau. With a favorable ratio of generated government tax benefits per number of introduced yearly visitors, the proposed action is an excellent example of the kind of sustainable tourism project that is advocated in ROPG policies.

The proposed resort will further benefit the people of Palau because it will serve as a major employment source for local labor. The Palauan segment of employment opportunities within the proposed project is estimated at approximately 65 to 70 percent.
3.0 ALTERNATIVES INCLUDING THE PROPOSED ACTION

3.1 The Proposed Action

The proposed project represents an exclusive, first-class, low-density resort development. As previously stated in Section 2.1, the completed resort will provide 60 luxury visitor accommodations (58 deluxe guest bungalows and two VIP bungalows) for affluent international travelers in Palau. The proposed development encompasses the entire remote island of Ngerur and is designed to take full advantage of the spectacular views and existing tropical island environment. The successful operation of the proposed resort will promote Ngerur Island in particular and Palau in general as a premiere destination for recreation and retreat. Additionally, the Quest Resort Palau will provide employment opportunities for local labor and generate tax revenue to the government.

Access to the Quest Resort Palau will be by boat. Guests will be ferried from the Welcome Center on Malakal Island, received at a small marina on the southern end of Ngerur Island, and escorted to the lobby, lounge and front office. From there, guests and their luggage will be transported to the guest bungalows via silent electric cars. Amenities at the resort will include restaurants, the outdoor dining terrace, an outdoor bar, the swimming pool, entertainment areas, meeting space, and spa/wellness facilities. Guest bungalows will be spacious and luxurious. Interconnected walkways will lead guests to sweeping vistas around the island.

A natural embayment along the southwestern shore of Ngerur Island will be transformed into a grotto area with a protected saltwater pool to be used primarily for SCUBA diving training. Transplanted corals will enhance the attraction of this feature and at the same time introduce the divers and snorkelers to the beauty of the underwater environment around the island.
Beach improvements in the vicinity of a small indentation along the irregular shoreline on the western portion of the island will provide additional outdoor recreation opportunities for resort guests.

The proposed project is well equipped to accommodate persons with physical disabilities. Disabled guests arriving in Palau will be transported, with any assistance they need, from the airport to the Welcome Center at Malakal Marina Village. Transport boats will include the ability to handle wheel chairs and potential other needs.

Upon arrival at the resort, wheelchair access from the dock to the main area of the resort will include a ramp and an elevator. Within the resort grounds, electrical carts will be available for the transport of all guests to their bungalows; at least one such cart will be designated to accommodate the needs of a disabled guest.

The resort will offer, under current plans, special disabled facilities in two ground floor bungalows. Additionally, certain types of disabled guests can be accommodated in the regular ground floor bungalows.

3.1.1 ARCHITECTURAL CONSIDERATIONS

As currently proposed, the masterfully designed Quest Resort Palau will encompass 60 visitor accommodations with an overall density of approximately five (5) units per acre. The general organization of the proposed project is as follows: 58 deluxe bungalows and two (2) VIP bungalows will be situated in the northern two-thirds of the island (see Figures 5 and 6 and Site Plan A-10 in map pocket 1). Forty-four (44) deluxe bungalows are proposed to be accommodated in 11 two-story buildings whereas 14 deluxe bungalows will be accommodated in seven (7) single-story duplex buildings. Forty (40) guest bungalows will be arranged along the elevated coastline of the island and 20 bungalows will be aligned within the interior of the island.

The southern third of the island will contain the public areas used for guest arrival/departure, lobby functions, restaurants, a conference room, the swimming pool with outdoor bar, and a fitness area including a gym, Jacuzzi pools, massage/treatment, and aerobics room. Spaces for management, housekeeping and engineering functions will also be situated in this part of the island. A harbor area including a guest dock and recreational equipment storage area will be located along the southeastern shoreline of Ngerur Island.

The total square footage of the proposed Quest Resort Palau is estimated at approximately 110,000 to 118,800 square feet (10,220 to 11,037 square meters). Deluxe guest bungalows will comprise approximately 770 square feet (72 square meters). Lanai, garden and deck areas associated with each bungalow will be roughly 460 square feet (43 square meters). A general breakdown of the square footage estimates for the various spaces or functions is presented in the following table.

Ngerur Island
Conceptual Plan

Quest Resort Palau
Koror State
Republic of Palau
Environmental Impact Statement

No scale
### TABLE 1: SPACE ESTIMATES BY FUNCTION TYPE.

<table>
<thead>
<tr>
<th>SPACE/FUNCTION</th>
<th>SQUARE FOOTAGE ESTIMATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guest bungalows</td>
<td>64,000 - 77,300</td>
</tr>
<tr>
<td>Public Areas</td>
<td>8,300 - 11,500</td>
</tr>
<tr>
<td>Administration</td>
<td>2,000</td>
</tr>
<tr>
<td>Food and Beverage</td>
<td>6,600</td>
</tr>
<tr>
<td>Housekeeping</td>
<td>2,000 - 3,000</td>
</tr>
<tr>
<td>Spa/Wellness</td>
<td>3,200 - 7,000</td>
</tr>
<tr>
<td>Mechanical, Storage, Service</td>
<td>9,400 - 11,400</td>
</tr>
</tbody>
</table>

Design elements such as style, materials and color for the proposed Quest Resort Palau will have the following characteristics as reflected in Figures 7 and 8:

- The architecture of the Quest Resort Palau will reflect a Pacific tropical style, with graceful accommodations in the very traditional and informal manner of Palau.
- Native stonewalls, earth tone materials, broad overhangs, lanais, pools, etc., are indicated in building forms and materials used throughout the site.
- Thin slate style tile in natural green color will be used for roofs.
- Walls will have rich colored plaster finish used in conjunction with local natural black rock at columns, piers and base walls.
- Natural stained hardwood such as teak or mahogany will enrich the buildings.
- Louvers will be used extensively to provide natural shading and ventilation.
- Random cut stone will be used throughout the buildings and lanais.
- Building structures will be primarily precast or cast in place concrete. Concrete masonry units (blocks) are also being considered.
- Walls and roof framing are currently being evaluated as either galvanized metal framing or pressure treated wood.

#### 3.1.2 INFRASTRUCTURE CONSIDERATIONS

The required infrastructure for the proposed resort must accommodate up to 120 guests and 110 support staff in three shifts. Equipment and facilities for water storage, reverse osmosis desalination, water treatment, wastewater treatment and pumping will all be located in a dedicated building situated partially underground in the southeastern portion of the island in close proximity to the service dock area. Infrastructure considerations at the time of this writing are summarized in the following paragraphs.

- **WATER SYSTEM.** As shown in Table 2, the potable water demand for the Quest Resort Palau is estimated at approximately 45,000 gallons per day (gpd). The daily flow would be approximately 20 gpm with peak flow at 60 to 80 gpm. Potable water storage for the resort including the required fire protection storage plus the peak day demand is estimated at approximately 150,000 gallons.
Front Elevation

Hotel
Front Elevation

Quest Resort Palau
Koror State
Republic of Palau
Environmental Impact Statement

WCP, Inc.
13A
### TABLE 2: ESTIMATED WATER AND WASTEWATER DEMANDS.

<table>
<thead>
<tr>
<th>Measure</th>
<th>No.</th>
<th>Unit of Value</th>
<th>Value (gpd/unit)</th>
<th>Water (gpd)</th>
<th>Wastewater* (gpd)</th>
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</thead>
<tbody>
<tr>
<td>Guest Bungalows</td>
<td>60</td>
<td>Bungalow</td>
<td>315</td>
<td>18,900</td>
<td>15,120</td>
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<tr>
<td>Manager’s Cottage</td>
<td>1</td>
<td>Apartment</td>
<td>200</td>
<td>200</td>
<td>160</td>
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<td><strong>Main Structure</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basement</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lobby Lounge Level</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lobby Reception</td>
<td>7</td>
<td>Seats</td>
<td>2</td>
<td>14</td>
<td>11</td>
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<td>Women’s Restroom</td>
<td>150</td>
<td>Flushes</td>
<td>1.5</td>
<td>225</td>
<td>180</td>
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<tr>
<td>Men’s Restroom</td>
<td>150</td>
<td>Flushes</td>
<td>1.5</td>
<td>225</td>
<td>180</td>
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<td>Women’s Locker Room</td>
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<td>Showers</td>
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<td>1,000</td>
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<tr>
<td>Staff Dining/Kitchen</td>
<td>150</td>
<td>Employees</td>
<td>10</td>
<td>1,500</td>
<td>1,200</td>
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<tr>
<td><strong>Restaurant Level</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Men’s Restroom</td>
<td>100</td>
<td>Flushes</td>
<td>1.5</td>
<td>150</td>
<td>120</td>
</tr>
<tr>
<td>Women’s Restroom</td>
<td>100</td>
<td>Flushes</td>
<td>1.5</td>
<td>150</td>
<td>120</td>
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<tr>
<td>Main Dining</td>
<td>60</td>
<td>Seats</td>
<td>30</td>
<td>1,800</td>
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<tr>
<td>Wine Dining</td>
<td>40</td>
<td>Seats</td>
<td>30</td>
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<tr>
<td>Outside Dining</td>
<td>40</td>
<td>Seats</td>
<td>30</td>
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<td>Bar Dining</td>
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<td><strong>Executive Offices</strong></td>
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<td>Employees</td>
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<td><strong>Spa/Recreation Facilities</strong></td>
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<td>Salon</td>
<td>20</td>
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<td>Multi-purpose Room</td>
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<td>Units</td>
<td>75</td>
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<td>Hydrotherapy</td>
<td>2</td>
<td>Units</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Vichy Shower</td>
<td>2</td>
<td>(estimate)²</td>
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<td>1,536</td>
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<tr>
<td>Hydrotherapy Pool</td>
<td>2</td>
<td>Gal refill/day</td>
<td>77</td>
<td>154</td>
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<td>Spa Suite</td>
<td>15</td>
<td>Uses</td>
<td>50</td>
<td>750</td>
<td>600</td>
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<tr>
<td>Swim Up Pool Bar</td>
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<td>Seats</td>
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<td>36</td>
<td>29</td>
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<td>Pool Bar</td>
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<td>Seats</td>
<td>2</td>
<td>20</td>
<td>16</td>
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<tr>
<td>Pool</td>
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<td>Persons</td>
<td>10</td>
<td>1,500</td>
<td>1,200</td>
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<td><strong>Changing Rooms</strong></td>
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<td>Toilets</td>
<td>100</td>
<td>Flushes</td>
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<td>Lavatories</td>
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<td>Uses</td>
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<td>120</td>
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<td>Cold Plunge</td>
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<td>Gal refill/day</td>
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<td>80</td>
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<td>Jacuzzi</td>
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<td>Gal refill/day</td>
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<td>200</td>
<td>160</td>
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<tr>
<td>Washer</td>
<td>2</td>
<td>Units</td>
<td>75</td>
<td>150</td>
<td>120</td>
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<tr>
<td>Dryer</td>
<td>2</td>
<td>Units</td>
<td>75</td>
<td>150</td>
<td>120</td>
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<tr>
<td>Showers</td>
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<td>(estimate)²</td>
<td>500</td>
<td>2,000</td>
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<td>Sauna</td>
<td>2</td>
<td>Gal/day</td>
<td>100</td>
<td>200</td>
<td>160</td>
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<tr>
<td>Steam</td>
<td>2</td>
<td>Gal/day</td>
<td>100</td>
<td>200</td>
<td>160</td>
</tr>
<tr>
<td><strong>Staff Housekeeping</strong></td>
<td>40</td>
<td>Uses</td>
<td>20</td>
<td>800</td>
<td>640</td>
</tr>
<tr>
<td><strong>Water Features</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>System 1</td>
<td>2,240</td>
<td>Sq. Footage</td>
<td>0.312</td>
<td>698</td>
<td>-</td>
</tr>
<tr>
<td>Systems 2, 3, and 4</td>
<td>6,680</td>
<td>Sq. Footage</td>
<td>0.312</td>
<td>2,082</td>
<td>-</td>
</tr>
<tr>
<td>System 6</td>
<td>2,080</td>
<td>Sq. Footage</td>
<td>0.234</td>
<td>486</td>
<td>-</td>
</tr>
<tr>
<td>System 7</td>
<td>5,385</td>
<td>Sq. Footage</td>
<td>0.234</td>
<td>1,254</td>
<td>-</td>
</tr>
<tr>
<td>Plunge Pools</td>
<td>36</td>
<td>Gal refill/day</td>
<td>50</td>
<td>1,800</td>
<td>-</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total (Rounded)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average GPD/Unit</td>
<td>750</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Wastewater quantities equal to approximately 80% of potable water values

¹ 4 per day at 12gpm times 20 minutes

² 70 per day at 5gpm times 5 minutes
Ngerur Island does not appear to have an aquifer that can sustain the average daily water demand for the proposed resort. An on-site potable water supply system will therefore include the treatment of seawater via a process of reverse osmosis (RO). The ocean water has a salinity (chloride) concentration of approximately 30,000 to 33,000 parts per million (ppm). The RO system will extract the salt from the seawater through fine membranes. Concentrated waste (called brine) will be generated as a by-product of the RO system and discharged into the dredged harbor. The harbor is not intended for recreational uses (i.e., swimming, kayaking, snorkeling, etc.).

The RO system will operate as follows:

- A submerged water intake structure will supply approximately 130,000 gallons of seawater with a total suspended solids (TSS) characteristic of 30,000 to 33,000 ppm to the system. The intake structure will be made of concrete with stainless steel bar screens on all four sides (see Figure 9). The bar screens will have a 2-inch by 2-inch mesh to prevent fish from entering the intake structure. The suction velocity will be less than 0.1 mph or near the equivalent of the ambient water velocity. The intake structure will be covered to prevent material from falling into it. The intake structure will take in seawater via the 12-inch diameter high density polyethelene (HDPE) pipeline (see Figure 10). An access hatch will be provided for the maintenance of corrosion resistant fiberglass reinforced plastic (FRP) components. The structure will be partially filled with concrete to prevent it from floating.
- Antiscalant (at a dosage rate of 12 ppm) will be added to the collected seawater to inhibit fouling of piping/membranes.
- Pretreatment will occur via a 5 micron cartridge system that removes particles.
- Pressure will be increased to 1,000 pounds per square inch (psi) and the pretreated seawater will be passed through the RO membranes. The RO units (one duty with one standby) will have a recovery rate of approximately 35 to 40 percent. Each RO unit will be rated for 45,000 gpd. The two separate RO units will operate in DUTY/STANDBY mode and be alternated from on-line to off-line on a scheduled basis (per the manufacturer’s recommendations).
- Pretreated seawater will be recovered as purified water and treated for hardness and taste with calcium carbonate and zinc orthophosphate (at dosage rates of 10 and 12 ppm, respectively).
- The purified water will be disinfected using sodium hypochlorite (at a dosage rate of approximately 10 ppm). The RO system will be sized to achieve the projected water demand of 45,000 gpd with TSS of 500 ppm.
- Treated purified water will be stored in a 150,000-gallon watertight reservoir located in the infrastructure building. From the storage tank, on-island water distribution will occur via below ground piping, fire posts, distribution pumps, and a hydropneumatic tank (refer to Figure 10). The piping will be sized to accommodate the average daily flows and peak flows. For this particular project, however, a fire flow of 500 gpm with a 20 psi residual dictates that the pipeline size should be 6 inches in diameter. The pipelines will be installed beneath or near the circuitous pathways around the island at an average depth between 2.5 and 3 feet. The distribution piping will be looped to provide
316 STAINLESS STEEL
1/2" DIAMETER BARS
2" X 2" PATTERN
(TYPICAL EACH SIDE)

3' X 3' CORROSION RESISTANT
ACCESS HATCH (BOLTED)
DOWN W/ 316 SS BOLTS)

Water System
Water Intake Structure
Quest Resort Palau
Koror State
Republic of Palau
Environmental Impact Statement
WCP, Inc.
15A
reliable service with minimal pressure drop. Isolation valves will be strategically located to enhance maintenance.

Distribution pumps located in the infrastructure building adjacent to the storage tanks will be part of the skid mounted packaged system that includes a hydropneumatic tank. The system will operate in LEAD/LAG/STANDBY mode. The hydropneumatic tank will provide pressurized storage to minimize pump starts and stops during low demand conditions.

- Brine (with pH of 8.3, temperature of 78°F with no chlorine residue) will be returned to the harbor for dilution into surrounding waters. Approximately 85,000 gpd of brine with TSS of 50,000 to 60,000 will be discharged as a result of the RO system. The brine will be diluted to less than 35,000 ppm prior to its discharge through a perforated pipe(s) installed at the base of the harbor rip-rap embankments (refer to Figure 10).

Dilution of the brine will be accomplished for compliance with point-source discharge allowances applicable to all water classes, including Class B. To achieve the dilution, approximately 600 to 700 gpm of fresh seawater will be mixed with the brine. An intake pump station will draw the seawater from outside the harbor area. The intake will be located adjacent to the outer (or seaward) portion of the harbor breakwater whereas the perforated discharge pipe will be located near the base of the interior portion of the harbor breakwater. Dilution pumps (between 15 to 20 horsepower) will run continuously to match the continuous generation of brine by the RO units.

Water in the harbor is well circulated as a result of its open configuration. Approximately one-third of the harbor waters are flushed or exchanged with every tide cycle; therefore, the discharged brine is expected to be sufficiently circulated and diluted prior to its contact with any coral or marine life beyond the harbor.

The RO system has a self-cleaning system that can be automated or manually activated. The system will be backwashed using stored treated water.

Maintenance of the RO system will be accomplished per the manufacturer's recommendations. The pretreatment cartridge filters can be individually isolated for cleaning/replacement and multiple cartridges can be out of service without affecting the on-line treatment capacity. RO membranes will be cleaned using the integral self-cleaning system.

Water quality can be monitored in the storage reservoirs using chlorine residual analyzers and samples taken on a scheduled basis for laboratory analysis. Compliance with local regulatory agency guidelines will be achieved.

- WASTEWATER SYSTEM. The wastewater generation rate for the proposed project is estimated at approximately 30,000 gpd of domestic wastewater (refer to Table 2). This equates to an average daily flow of 20 gpm.

The on-site wastewater collection system (refer to Figure 10) will include 6-inch gravity sewers that convey effluent to the treatment plant located in the infrastructure building. One (1) small sewage pump station located adjacent to the infrastructure building will serve only the kayak hut bathroom. Pumps (around 1 horsepower) and
alarms (indicating pump failure, high water levels, etc.) will be provided. The wet well will be slightly oversized to provide additional storage thereby allowing corrective actions to be taken prior to a spill event.

The treatment system will consist of an on-site packaged wastewater treatment plant (WWTP). Packaged WWTPs are virtually self-contained with only chemical feed and storage equipment needed to supplement the treatment process. The WWTP shell is manufactured from 1/2" thick carbon steel with appropriate corrosion protection through material coatings and/or materials of construction (i.e. 316 stainless steel). Collected effluent will undergo secondary treatment via an extended aeration activated sludge process in which organic solids are biologically oxidized.

The effluent will receive secondary treatment in the extended aeration process with supplemental disinfection using an ultraviolet (UV) system. The UV disinfection method is effective and leaves no undesirable residual contaminants (as compared to chemical treatment) in the effluent. The effectiveness of UV is directly related to the dose (quantity of energy) absorbed by microorganisms. The dose is the product of the rate at which energy is delivered (intensity) and the duration of exposure to this energy. UV disinfection is expected to reduce/kill fecal coliform below typical secondary effluent levels of 15,000 per 100 ml. Effluent characteristics will meet the following minimum standards: 30 ppm TSS and 30 ppm biochemical oxygen demand (BOD). The treatment facilities will most likely exceed these standards. Average values are expected to be 20 ppm TSS and 20 BOD or less.

The UV system will be installed on the discharge side of the WWTP inside the infrastructure building. A recirculation system will be provided for continual UV lamp submergence to prevent overheating. The units will operate in DUTY/STANDBY mode with automatic switchover in the event of unit malfunction. Maintenance of the system will be performed in accordance with the manufacturer's recommendations; however, the key maintenance actions are mostly limited to lamp replacement and cleaning.

Treated wastewater will be conveyed via a 6-inch HDPE pipe to a location northeast of the island (refer to Figure 10) and discharged approximately 100 feet (30.5 meters) below the ocean surface (see Figure 11). Analysis using the PLUME model that was developed by the U.S. Environmental Protection Agency (EPA) indicates that “the receiving water would rapidly dilute the small volume of treated wastewater effluent generated from the Quest Resort” and “the dilution would be so rapid that all Class AA water quality criteria would be easily met within a zone of mixing 130 feet in radius around the discharge point” (Sea Engineering, Inc., 1999). The studies by Sea Engineering, Inc. (refer to Appendix A) indicate that the discharge plume will not reach the lagoon surface because at 49 feet below sea level the plume becomes virtually indistinguishable from the receiving water (see Figure 12) with an average initial dilution ratio of over 1,000 to 1.

HDPE is recommended for the outfall pipe. This material combines cost effectiveness, ease of construction, and long life.

One of the primary construction concerns for the Ngerur outfall will be to minimize any damage to corals. During the reconnaissance diving, it was observed that many coral outcrops could be avoided by using the flexibility of the HPDE pipe.
Note: The illustrated plume outfall for the discharge of approximately 30,000 gpd of effluent reflects the most conservative assumptions: 100 percent concentration levels and 10 percent currents, with a plume diameter of 260 feet and a trapping depth of -49 feet MSL. A more realistic assumption would be 75 percent concentration levels and average currents which results in a plume diameter of 165 feet and a trapping depth at -55 feet MSL.
The section of HDPE pipeline that must cross the first 100 feet from the island shoreline is proposed to be trenched into the bottom because the area supports vigorous coral growth over almost 100 percent of the bottom surface. A narrow trench will not only protect the pipeline well but would also allow the coral to recolonize the covered trench, thereby allowing the coral ecology to regenerate while locally removing the pipeline from the ecosystem.

- **DRAINAGE AND IRRIGATION SYSTEM.** Runoff will be collected by an island-wide system of storm drains associated with infiltration trenches. The following elements will direct drainage:
  - There is one major hardscape pavement area of Porous pavement. It is located near the service building and service dock. The runoff from this area will be collected and discharged into the enclosed harbor area.
  - Matting material (i.e., filter strips) will be placed on top of all construction berms dispersed around the perimeter of the island. These berms provide a barrier to surface discharge over the island edge and contain runoff for a more controlled discharge using perforated pipe and discharge feature. The landward side will have a filter fabric/silt curtain with a small impoundment area drained by a buried perforated pipe, wrapped in filter fabric and installed in a gravel trench with discharge to a waterfall feature.
  - Infiltration trenches will run primarily along cart service paths. Precipitation will flow on the surface of the paths and infiltrate into the gravel trenches paralleling the cart paths. Perforated pipes located in these trenches will be wrapped in a filter fabric in order to minimize sediment transport. They will convey the collected surface runoff to a controlled discharge point.
  - Stormwater quality inlets will be used. Filter fabric wraps will be used for entrance points into the conveyance piping. This should minimize transport of sediment through the system which eventually discharges into the surrounding ocean. The permanent storm drainage system will catch both surface runoff and roof downspouts. Each building will be surrounded by underground piping which includes connections to both the downspouts and surface inlets. These features will convey the water underground to a controlled discharge point.
  - Existing vegetation to be removed during construction will be turned into mulch and spread on the ground in disturbed areas as a temporary ground cover in order to dissipate rain energy.
  - The project does not include any retention/detention basins on the island.

Drainage and grading elements of the proposed project are illustrated in the Grading Plan (Drawing No. 1 in map pocket 2) and Civil Details - 3 (Drawing No. C - 13 in map pocket 3).

- **SOLID WASTE DISPOSAL SYSTEM.** According to the estimates in Table 3, the proposed Quest Resort Palau will generate approximately 760 pounds per day of solid waste.
## TABLE 3: ESTIMATED SOLID WASTE DISPOSAL REQUIREMENTS.

<table>
<thead>
<tr>
<th>Facility Type</th>
<th>No.</th>
<th>Unit of Measure</th>
<th>Solid Waste (lbs/unit)</th>
<th>Solid Waste (lbs/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guest Bungalows</td>
<td>60</td>
<td>Bungalows</td>
<td>3.3</td>
<td>198.0</td>
</tr>
<tr>
<td>Manager's Cottage</td>
<td>1</td>
<td>Apartment</td>
<td>3.3</td>
<td>3.3</td>
</tr>
<tr>
<td>Main Structure</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basement</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lobby Lounge Level</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lobby Reception</td>
<td>7</td>
<td>Seats</td>
<td>0.1</td>
<td>0.7</td>
</tr>
<tr>
<td>Women's Restroom</td>
<td>150</td>
<td>Uses</td>
<td>0.1</td>
<td>15.0</td>
</tr>
<tr>
<td>Men's Restroom</td>
<td>150</td>
<td>Uses</td>
<td>0.1</td>
<td>15.0</td>
</tr>
<tr>
<td>Women's Locker Room</td>
<td>50</td>
<td>Uses</td>
<td>0.1</td>
<td>5.0</td>
</tr>
<tr>
<td>Men's Locker Room</td>
<td>50</td>
<td>Uses</td>
<td>0.1</td>
<td>5.0</td>
</tr>
<tr>
<td>Staff Dining/Kitchen</td>
<td>150</td>
<td>Employees</td>
<td>0.5</td>
<td>75.0</td>
</tr>
<tr>
<td>Restaurant Level</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men's Restroom</td>
<td>100</td>
<td>Uses</td>
<td>0.1</td>
<td>10.0</td>
</tr>
<tr>
<td>Women's Restroom</td>
<td>100</td>
<td>Uses</td>
<td>0.1</td>
<td>10.0</td>
</tr>
<tr>
<td>Main Dining</td>
<td>60</td>
<td>Seats</td>
<td>1.6</td>
<td>96.0</td>
</tr>
<tr>
<td>Wine Dining</td>
<td>40</td>
<td>Seats</td>
<td>1.6</td>
<td>64.0</td>
</tr>
<tr>
<td>Outside Dining</td>
<td>40</td>
<td>Seats</td>
<td>1.6</td>
<td>64.0</td>
</tr>
<tr>
<td>Bar Dining</td>
<td>50</td>
<td>Seats</td>
<td>1.6</td>
<td>60.0</td>
</tr>
<tr>
<td>Executive Offices</td>
<td>8</td>
<td>Employees</td>
<td>3.7</td>
<td>29.6</td>
</tr>
<tr>
<td>Spa/Recreation Facilities</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salon</td>
<td>20</td>
<td>Uses</td>
<td>0.1</td>
<td>2.0</td>
</tr>
<tr>
<td>Multi-purpose Room</td>
<td>2</td>
<td>Units</td>
<td>0.1</td>
<td>0.2</td>
</tr>
<tr>
<td>Hydrotherapy</td>
<td>2</td>
<td>Units</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Vichy Shower</td>
<td>2</td>
<td>Units</td>
<td>0.1</td>
<td>0.2</td>
</tr>
<tr>
<td>Hydrotherapy Pool</td>
<td>2</td>
<td>Units</td>
<td>0.1</td>
<td>0.2</td>
</tr>
<tr>
<td>Spa Suite</td>
<td>15</td>
<td>Uses</td>
<td>0.1</td>
<td>1.5</td>
</tr>
<tr>
<td>Swim Up Pool Bar</td>
<td>18</td>
<td>Seats</td>
<td>1.6</td>
<td>28.8</td>
</tr>
<tr>
<td>Pool Bar</td>
<td>10</td>
<td>Seats</td>
<td>1.6</td>
<td>16.0</td>
</tr>
<tr>
<td>Pool</td>
<td>150</td>
<td>Persons</td>
<td>0.1</td>
<td>15.0</td>
</tr>
<tr>
<td>Changing Rooms</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Toilets</td>
<td>100</td>
<td>Uses</td>
<td>0.1</td>
<td>10.0</td>
</tr>
<tr>
<td>Lavatories</td>
<td>100</td>
<td>Uses</td>
<td>0.1</td>
<td>10.0</td>
</tr>
<tr>
<td>Cold Plunge</td>
<td>2</td>
<td>Units</td>
<td>0.1</td>
<td>0.2</td>
</tr>
<tr>
<td>Jacuzzi</td>
<td>2</td>
<td>Units</td>
<td>0.1</td>
<td>0.2</td>
</tr>
<tr>
<td>Washer</td>
<td>2</td>
<td>Units</td>
<td>0.1</td>
<td>0.2</td>
</tr>
<tr>
<td>Dryer</td>
<td>2</td>
<td>Units</td>
<td>0.1</td>
<td>0.2</td>
</tr>
<tr>
<td>Showers</td>
<td>4</td>
<td>Units</td>
<td>0.1</td>
<td>0.4</td>
</tr>
<tr>
<td>Sauna</td>
<td>2</td>
<td>Units</td>
<td>0.1</td>
<td>0.2</td>
</tr>
<tr>
<td>Steam</td>
<td>2</td>
<td>Units</td>
<td>0.1</td>
<td>0.2</td>
</tr>
<tr>
<td>Staff Housekeeping</td>
<td>40</td>
<td>Uses</td>
<td>0.1</td>
<td>4.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>760.1</strong></td>
</tr>
</tbody>
</table>

Solid waste will be transported by boat to the service center at the Malakal Marina Village site where it will be kept cold. By arrangement, a commercial garbage company will pick up the garbage at pre-arranged times for dumping at the landfill.

The intent of the resort operator is to install a trash compactor at the proposed project and thereby reduce the volume of refuse. Although the weight of the waste remains the same, a reduced volume will extend the life of the landfill.
The operator has also expressed a desire to segregate waste in order to take advantage of existing, and hopefully expanding, recycling facilities in Palau. Conditions of the earthmoving permit will in all likelihood require the preparation of a waste minimization plan addressing specifically aluminum can recycling and the composting of green waste.

- **ELECTRICAL AND COMMUNICATION SYSTEM.** Electrical power for the Quest Resort Palau will be supplied by the Public Utility Corporation (PUC). Power will be transmitted from Arakabesan Island via a steel armored submarine cable from a location near the Palau Pacific Resort (see Figure 13). The submarine cable will be installed in a “cut and cover” trench until deeper water is reached, where it will be laid on the ocean bottom over hard rock or coral. Anchors will be used only to the extent necessary to stabilize the submarine cable within the alignment corridor. No anchoring is required along the sandy areas that comprise approximately 75 percent of the entire alignment.

  In the event of interruption of power, a stand-by diesel generator will be used to supply power for Ngerur Island. This generator will be housed in a separate building east of the entry to the Palau Pacific Resort (PPR). From this building, the power cable will follow an alignment along the north-eastern boundary of the employee parking area of the PPR and reach the lagoon north of the PPR.

  Telecommunications service to Ngerur Island will be provided via fiber optic cable. The telecommunication cables will be housed along with the power cables in the underwater conduit.

- **FIRE PROTECTION SYSTEM.** Potable water will be used for the fire protection system consisting of fire pumps and water storage facilities. The fire storage volume of 60,000 gallons along with an emergency water storage volume of 90,000 gallons means the potable water reservoir (including the fire storage allotment) should contain, at a minimum, 150,000 gallons. This volume meets the intent of emergency and fire storage requirements. The fire pumps are proposed to be located in the basement of the main structure on Ngerur Island and be plumbed into the potable water distribution system. Two fire pumps will be installed for DUTY/STANDBY operation. Each pump will have a 50 horsepower motor and be rated for 500 gpm at 100 psi.

### 3.1.3 MARINE FACILITIES AND IMPROVEMENTS

Resort features such as harbor and dock facilities, beach improvements and the dive grotto will be designed with regard for environmental and marine engineering concerns.

- **HARBOR AND DOCK FACILITY.** A small harbor is proposed for the southeast corner of the island. The harbor would support the docking of vessels that carry resort guests and their luggage from Malakal to Ngerur Island, vessels that would be used for water recreation activities, and vessels that transport employees and supplies to
the island. The docking facility must be protected from wave approach to be fully functional during all reasonable wind, wave and weather conditions.

Proposed harbor and dock facilities will be designed to account for oceanographic conditions at the site, user vessel characteristics and use requirements. Oceanographic parameters include wind and wave conditions, nearshore bottom profiles and water depths, and water level fluctuations. Vessel characteristics include length, width, draft and maneuverability. Dock usage refers to parameters such as passenger loading, cargo type and handling, and special berthing requirements.

Vessels that will dock at the proposed resort include those used to ferry guests from Malakal to the resort, vessels used for tours and water recreation activities such as scuba diving, sightseeing, fishing, kayaking, and vessels used to transport resort workers and supplies to the island. These vessels are generally expected to be powerboats ranging in size from about 25 feet (7.6 meters) to 50 feet (15 meters) in length. Consequently, the following dimensions have been used for harbor planning.

### TABLE 4: ASSUMPTIONS FOR HARBOR PLANNING.

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>DIMENSION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Design/Typical Vessel</strong></td>
<td></td>
</tr>
<tr>
<td>Length</td>
<td>50 ft. (15.2 m.)</td>
</tr>
<tr>
<td>Width</td>
<td>18 ft. (5.5 m.)</td>
</tr>
<tr>
<td>Draft</td>
<td>4 ft. (1.2 m.)</td>
</tr>
<tr>
<td><strong>Channel and Basin Depth</strong> (as determined by four factors)</td>
<td></td>
</tr>
<tr>
<td>vessel draft</td>
<td>4 ft. (1.2 m)</td>
</tr>
<tr>
<td>low tide</td>
<td>4 ft. (1.2 m)</td>
</tr>
<tr>
<td>vessel motion</td>
<td>2 ft. (0.6 m)</td>
</tr>
<tr>
<td>bottom clearance</td>
<td>2 ft. (0.6 m)</td>
</tr>
<tr>
<td>Total</td>
<td>12 ft. (3.65 m.)</td>
</tr>
<tr>
<td><strong>Entrance channel width</strong> (minimum three vessel widths)</td>
<td></td>
</tr>
<tr>
<td>3 X 18 ft. = 54 ft. but use larger value</td>
<td>60 ft. (18.2 m.)</td>
</tr>
<tr>
<td><strong>Turning Basin Diameter</strong> (minimum 1.5 X vessel length)</td>
<td></td>
</tr>
<tr>
<td>1.5 X 50 ft. = 75 ft. (22.8 m.) but use 100 ft. (30.4 m.)</td>
<td>100 ft. (30.4 m.)</td>
</tr>
</tbody>
</table>

The proposed harbor is located in an area where a wide (100 to 200 feet or 30 to 61 meters), shallow, rock, cobble and sediment bench extends in front of the shore (see Figure 14). The 10-foot (3-meter) depth is up to 400 feet (122 meters) offshore. This location is partially sheltered from prevailing trade winds and direct wave approaches. The sediment bench is almost daily exposed when the water level is at -2 feet (-0.6 meters) MSL.

Dredging for the entry channel and turning basin for the harbor is proposed to create a depth of -12 feet (-3.65 meters) MSL, which means that the lagoon floor will be excavated to an average of 10 feet (3 meters) below its existing depth. Approximately 50 percent of the area proposed to be dredged for the harbor development including the entry channel and turning basins is located on the sediment bench, thereby keeping the coral areas to be disturbed by dredging activities to a minimum.
The harbor configuration will be very open such that the flow between the channel and the two basins is clear of any obstacles or turns. As a result of this design, there are no confined areas that could reduce circulation by trapping water. Additionally, the entrance will be large relative to the interior area.

The harbor is shallow (-12 feet or -3.65 meters MSL) relative to the average tidal prism (±2 feet or ±0.6 meters MSL) that occurs twice a day. Each tide cycle can exchange about one-third of the harbor water, and complete exchange of harbor water should occur every one and one-half to two days. In addition to water flow through the harbor entrance, the rubble mound breakwaters are somewhat permeable (particularly at high tide when the water level is up to the level of the underlayer and armor stone) whereby water will flow through the structure. Thus, flushing of the harbor and water exchange should be good, and will prevent water quality impacts such as lowered dissolved oxygen levels.

The conceptual dock, channel and basin, and protective structure layouts are illustrated in Figures 15 through 17. Appropriate dock design will enable comfortable loading and unloading of passengers and their luggage. The resort developer desires the docking facility to be attractive, as befits the entrance to a first-class resort. A further requirement is the visual and physical separateness of the service dock from the guest dock.

Boats and the docking facility provide the only access to and from the resort. The docking facility must therefore be fully functional during all reasonable wind, wave and weather conditions. With the given layout, the dock would be protected from wave approach. Primary elements of the dock facility layout are summarized in Table 5.

**TABLE 5: PRIMARY ELEMENTS OF THE DOCK FACILITY.**

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>SIZE ESTIMATE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Guest Docks</strong> (concrete floating docks with guide piles and access ramps)</td>
<td></td>
</tr>
<tr>
<td>main landing (covered)</td>
<td>16 X 60 ft. (4.8 X 18.2 m.)</td>
</tr>
<tr>
<td>tour/recreation dock, 2 sides, with an effective length of 120 ft. (36.5 m.)</td>
<td>8 X 60 ft. (2.4 X 18.2 m.)</td>
</tr>
<tr>
<td>access ramps, 2 ea.</td>
<td>4 ft. (1.2 m.) wide</td>
</tr>
<tr>
<td></td>
<td>6 ft. (1.8 m.) wide</td>
</tr>
<tr>
<td><strong>Service Docks</strong> (floating docks)</td>
<td></td>
</tr>
<tr>
<td>solid fill wharf (concrete capped sheet pile bulkhead)</td>
<td>50 ft. (15.2 m.) long</td>
</tr>
<tr>
<td>floating dock, accessed by a 6-ft. ramp</td>
<td>18 X 60 ft. (5.4 X 18.2 m.)</td>
</tr>
<tr>
<td><strong>Entrance Channel</strong></td>
<td>60 ft. (18.2 m.) wide</td>
</tr>
<tr>
<td><strong>Turning Basins</strong> (2 areas between entrance channel and berths)</td>
<td>100 ft. (30.4 m.) diameter</td>
</tr>
<tr>
<td></td>
<td>12 ft. (3.6 m.) deep</td>
</tr>
<tr>
<td><strong>Protective Structures</strong> (rock rubble mound breakwaters, with crest elevations of +8 ft., 2 ea.)</td>
<td></td>
</tr>
<tr>
<td>North breakwater</td>
<td>413 ft. (125.0 m.) long</td>
</tr>
<tr>
<td>South breakwater</td>
<td>409 ft. (124.6 m.) long</td>
</tr>
</tbody>
</table>
Ngerur Island

Hotel Entry

South Revetted Mole and Breakwater

North Revetted Mole and Breakwater

Harbor and Dock Facility Proposed Layout

Quest Resort Palau
Koror State
Republic of Palau
Environmental Impact Statement

WCP, Inc.
22A
HARBOR SIDE

CREST EL. + 9'

1,500 TO 2,500 LB ARMOR STONE,
TWO STONES THICK,
RANDOM PLACEMENT

100 TO 250 LB UNDERLAYER STONE

GEOTEXTILE FILTER FABRIC

3,000 LB (MIN) TOE STONE

EXISTING BOTTOM (VARIES)

OCEAN SIDE

150 TO 250 LB UNDERLAYER STONE

DEDGED MATERIAL

Harbor and Dock Facility
Typical Revetted Mole Section

Quest Resort Palau
Koror State
Republic of Palau
Environmental Impact Statement

WCP, Inc.
22B
HARBOR SIDE

CREST EL. + 8'

1.5 TO 2.5 ARMOR STONE, TWO STONES THICK, RANDOM PLACEMENT

100 TO 250 UNDERLAYER STONE

DREDGED MATERIAL OR QUARRY RUN STONE

2.0 MSL MATERIAL

MSL

EXISTING BOTTOM (VARIES)

OCEAN SIDE

1,500 TO 2,500 LB ARMOR STONE, TWO STONES THICK, RANDOM PLACEMENT

100 TO 250 LB UNDERLAYER STONE

GEOTEXTILE FILTER FABRIC

2.0' MATERIAL

3,000 LB (MIN) TOE STONE

GROTTO SIDE

CREST EL. + 5

2.5' TOE STONE

SPALLS TO 5 LB STONE

MSL

3,000 LB (MIN) TOE STONE

OCEAN SIDE

2,000 TO 3,000 LB ARMOR STONE, ONE STONE THICK, UNIFORM KEYED AND FIT PLACEMENT

100 TO 250 LB UNDERLAYER STONE

SPALLS TO 5 LB STONE

Breakwaters
Typical Section

Quest Resort Palau
Koror State
Republic of Palau
Environmental Impact Statement

WCP, Inc.
22C
Dock construction involves the creation of interior land. A central area of approximately 0.5 acres (0.2 hectares) between the two dock facilities will be created with dredged material and protected by a vertical cemented rock wall. The area will serve as water access for kayaks as well as provide building space for kayak storage, scuba equipment, and maintenance, etc. Landscaping will be provided. The calculated elevation of this area will be +6 feet (1.8 meters) minimum and vary upwards depending upon the distance from the edge of the water.

- **BEACH IMPROVEMENTS.** The proposed site for beach improvements is located along the western coast at the beginning of the northern third of the island. A small natural embayment is the chosen location for the development of beach improvements (see Figure 18). The shape and shallow depth of the embayment provides a reasonable opportunity for beach construction. The relatively exposed nature of the shoreline, however, with little or no natural protection from storm waves, necessitates the use of beach stabilization structures. These structures will help control the beach configuration, reduce maintenance requirements and insure that the sand is not moved offshore where it could impact the marine environment.

  Proposed stabilization structures will be rock groins constructed perpendicular to the shore at both ends of the beach (see Figure 19). The groins will be constructed using 1,000 to 2,500 pound armor stone similar in characteristics to that occurring naturally around the island, placed over a core of 5 to 250 pound stone. The stone will be placed to form an irregular surface, and the crest elevation shall vary from +5 feet (+1.5 meters) to +7.5 feet (+2.3 meters), in order to create a more natural appearance. Cavities in the crest will be created for landscaping with salt tolerant vegetation.

  The beach crest will be about 150 feet (45.6 meters) long and approximately 50 feet (15.2 meters) wide. Including the beach slope, this will result in a dry beach width of about 50 to 70 feet (15.2 to 21.2 meters) at high tide and over 100 feet (30.4 meters) at low tide. The sand fill will be stabilized by a north and south groin, each approximately 120 feet (36.4 meters) long. The relatively shallow near shore water depth at this location necessitates constructing the beach toe at an approximate depth of minus 4 feet (1.2 meters).

- **DIVE GROTTO.** A small natural embayment on the southwest corner of the island will be developed into a protected saltwater pool (see Figure 20). Creation of a rock grotto to be used primarily for SCUBA diving training will require excavation into the existing rocky nearshore area. This shallow, roughly circular rock formation is located immediately seaward of the embayment, which is exposed at low tide and barely submerged at high tide. The rock formation provides some wave protection, particularly at low tide. Additional protective structures will still be required to provide a sheltered area for swimming and SCUBA lessons. The nearshore area is shallow and requires dredging to create adequate water depth for swimming and diving.

  Wave protection will be provided by two offshore breakwaters of similar design to the rock groins used for beach stabilization (refer to Figure 19). A breakwater crest elevation of +5 feet (1.5 meters) is calculated to provide wave protection for the grotto.
1,000 TO 2,500 LB ARMOR STONE
TWO LAYERS FORMING AN
IRREGULAR SURFACE
BUT VARYING

CREST EL. VARYING
+5 TO +7.5 FT

100 TO 250 LB UNDERLAYER STONE

SPALLS TO 5 LB STONE

3,000 LB (MIN) TOE STONE

NOTE: GROINS HAVE PLANTING CAVITIES FOR LANDSCAPING WITH TYPICAL SHORELINE
VEGETATION THAT IS INDIGENOUS TO THE AREA
Dive Grotto
Proposed Layout
Quest Resort Palau
Koror State
Republic of Palau
Environmental Impact Statement
WCP, Inc.
users during times of prevailing and moderate westerly wind conditions. The breakwaters are expected to overtop during severe storm conditions. Both breakwaters will be approximately 60 feet (18.2 meters) long. These will protect the dredged pool that is 120 feet (36.4 meters) in diameter and approximately 6 to 8 feet (1.8 to 2.4 meters) deep. The breakwaters will be detached from land. There will be a 10-foot (3.0-meter) wide and 8-foot (2.4-meter) deep circulation channel to facilitate water exchange and provide access to deeper water for SCUBA divers.

DREDGING. It is estimated that approximately 20,000 cubic yards (CY) of bottom material will have to be removed to bring the harbor area to approximately 12 feet (3.6 meters) below sea level. Approximately 50 percent of the area proposed to be dredged for an entry channel and turning basin would occur within the area defined by the sediment bench. Approximately 65 percent of this sediment bench area will be dredged to -12 feet (3.6 meters) MSL; the remaining 35 percent will be filled to +6 feet (1.8 meters). The damage to vibrant coral areas would therefore be kept to a minimum. The dredged material is expected to be characterized as primarily volcanic breccia with pockets of sand and coral fragments. It is proposed that this material be used for construction on the island.

Dredging in the nearshore grotto area to create adequate depths for swimming and diving is expected to remove approximately 3,500 CY of bottom material. The dredged material is expected to be characterized as primarily volcanic breccia with pockets of sand and coral fragments. It is proposed that this material be also used for construction on the island.

Several methods may be employed to physically isolate the dredging activity from the surrounding area, prevent the spread of turbid water, and otherwise minimize sedimentation and turbidity. Dredging may involve a small barge with a backhoe and the stockpiling of materials whereby the following measures are deemed necessary.

- Confine the dredge site with the deployment of silt curtains vertically suspended from floats (see Figure 21). The floating silt curtain will be installed prior to proceeding with construction. This measure includes continuous monitoring of silt material buildup, removal of material buildup from the site, and proper disposal of silt material prior to removal of the silt curtain.
- Limit operational dredging to within confined borrow areas.
- Surround stockpiles and stored materials by a silt fence (see Figure 22). A silt fence is a temporary barrier of permeable fabric designed to intercept and slow the flow of sediment laden sheet flow runoff. Silt fencing allows runoff to settle, and releases filtered water slowly. The silt fence will be Class F geotextile, at least 16-inches in width, with a minimum of 36-inch fence posts at not more than 10 feet apart. The geotextile will be placed a minimum of 12 inches below grade.
- Situate stockpiles such that no runoff flows to reef flats.
- Situate borrow pit drainage outlets where they have the least impact to the surroundings.
Siltation Control Measures
Floating Silt Curtain

Quest Resort Project
Koror State
Republic of Palau
Environmental Impact Statement

WCP, Inc.
24A
Siltation Control Measures
Silt Fence

Quest Resort Palau
Ngerur Island, Koror State
Republic of Palau
Environmental Impact Statement

wood post 2x4 inches
woven wire fence 6x6 inches
gotextile filter fabric

min. 36 inches
min. 24 inches
min. 12 inches below ground

direction of flow
direction of flow

schematic section - not to scale
3.1.4 CONSTRUCTION FEATURES

The total cut volume on the island is estimated at approximately 18,500 CY with approximately 9,000 CY or roughly 50 percent of the total cut volume attributed to the main structure of the resort. The total fill volume is projected at 2,800 CY. Excess cut volume (15,700 CY) will be exported off-island and be available for sale as fill material to private customers, to the government, or to quarries for further processing.

The projected dredged volume generated by project actions is estimated at approximately 23,500 CY. Roughly 20 percent of this material will be used as fill material for the marine facilities and improvements. The remaining dredged material will be exported off-island for sale as fill material.

Estimated quantities generated and required for proposed marine facilities and improvements are depicted in the following table.

<table>
<thead>
<tr>
<th>TABLE 6: ESTIMATED DREDGED VOLUMES AND USAGE REQUIREMENTS.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DESCRIPTION</strong></td>
</tr>
<tr>
<td>-----------------</td>
</tr>
<tr>
<td>Harbor Creation</td>
</tr>
<tr>
<td>Breakwater armor stone</td>
</tr>
<tr>
<td>Breakwater underlying stone</td>
</tr>
<tr>
<td>Breakwater center fill (can be dredged material)</td>
</tr>
<tr>
<td>Beach Improvements</td>
</tr>
<tr>
<td>Sand fill</td>
</tr>
<tr>
<td>Groin armor stone</td>
</tr>
<tr>
<td>Groin underlying stone</td>
</tr>
<tr>
<td>Groin center fill (can be dredged material)</td>
</tr>
<tr>
<td>Grotto Improvements</td>
</tr>
<tr>
<td>Breakwater armor stone</td>
</tr>
<tr>
<td>Breakwater underlying stone</td>
</tr>
<tr>
<td>Breakwater center fill (can be dredged material)</td>
</tr>
</tbody>
</table>

Envisioned construction activities will be accomplished in an environmentally responsible manner. The following considerations will be observed.

- **ENVIRONMENTAL PROTECTION PLAN.** The environmental protection plan (EPP) includes the following elements:
  - The construction contractor will provide standard 20-foot containers with proper markings for hazardous materials. This storage area will be provided for all fuel tanks, oil drums and other hazardous material. A liner and a berm will surround the containment area.
  - All hazardous and toxic materials transported by truck or boat will be equipped with spill kits, sufficient to contain and absorb the amount of material being transported.
All gas and diesel equipment will be properly maintained to avoid smoking. If dry conditions develop creating fugitive dust emissions, sprayer or sprinklers sufficient to reduce dust, without creating runoff or erosion will be used.

All equipment operating in construction areas will be properly muffled. Work hours will be limited to between 0700 and 1800 hours on Monday through Saturday. No pile driving or other excessive noisy activities will be accomplished during the early morning and late evening periods.

**EROSION CONTROL PLAN.** The erosion control initiative for all activities incorporates several elements:

- Minimize earth movement;
- Minimize vegetation removal;
- Limit the amount of exposed areas at any one time;
- Treat completed cut and fill slopes with erosion control matting;
- Cut interceptor ditches along the top of the cut slopes;
- Sequence earthmoving activities, starting at high points and proceeding to lower points;
- Avoid earthmoving activities during heavy rains, as much as practicable;
- Incorporate water quality protection measures; and
- Focus on erosion and siltation control measures and containment of hazardous materials.

The construction contractor also proposes to implement the following management strategies to achieve the erosion control objectives:

- Employ a site superintendent who is responsible for implementing and maintaining the approved erosion control plan.
- Increase personal awareness through weekly meetings to review and discuss environmental as well as safety issues.
- Operate and maintain all equipment according to the requirements of erosion control objectives.
- Handle, store, and dispose of all material in accordance with the manufacturer’s recommendations and the erosion control objectives.
- Dispose of all packaging and waste to a permitted site (and not on Ngerur Island).
- Employ an inspection team that will monitor stormwater runoff from construction activities, keep an erosion control log, and take necessary action to correct observed deficiencies.

The construction contractor will further implement the following erosion control measures:

- Install a floating silt curtain prior to construction that confines the entire island of Ngerur including dredge sites (see Figure 23).
- Install additional silt fences around any temporary stockpiles of materials.
- Maintain sediment control devices throughout the duration of the project until such time that landscaping features (or other permanent measures) provide sufficient erosion and sedimentation control.

- Place sediment logs (i.e., porous fiber rolls that allow water to filter through fibers and trap sediment) to slow runoff and reduce sheet flow erosion in down-slope areas characterized by steep terrain (i.e., along cliff lines).

- Install earthen dikes, silt curtains, and perforated storm drain piping around each building as necessary to dam the storm or ponding surface water and force this water into the perforated pipe.

- Utilize sandbags as necessary to deter erosion during the construction phase.

LOGISTICS AND MOBILIZATION. Material, equipment and supplies will be consolidated and shipped from West Coast U.S. ports to Palau. Three ocean carriers with service originating in the U.S. provide service to Palau. Sealand Services and Matson Navigation move cargo off the West Coast of the U.S. to Guam and connect with Palau Shipping Co. in Guam. Palau Shipping moves the cargo from Guam to Koror, Palau. Sealand and Matson Navigation have weekly service from the U.S. West Coast. Sealand also connects Guam with most major Southeast Asian Ports. Palau shipping has scheduled arrivals each week in Koror. The shipping duration from a West Coast port to Koror via Guam is normally 21 days. Pacific, Micronesia and Orient (PM&O) Lines move cargo directly to Palau. PM&O Lines depart the West Coast every 21 days. Transit time from the West Coast to Palau is 28 days.

Matson Navigation and PM&O Lines will accept both breakbulk (non-containerized) cargo and containers. Sealand accepts full containers only.

Upon arrival in Koror, and after completion of customs formalities at the Customs Terminal, the cargo will proceed from the Port of Koror to a staging area at the project camp. All cargo will be received and inspected before being delivered to the Quest Resort Palau site. Cargo will be transported to Ngerur Island by a small tug and barge. Project personnel scheduled for the Quest Resort Palau site will be ferried to and from Ngerur Island by a couple of 25-passenger workboats.

LABOR HOUSING AND LABOR FORCE. The project construction managers (CM&D) estimate the manpower requirements for construction of the proposed project to be 100 to 125 persons. The applicant wants to utilize the local labor force and its existing infrastructure in order to reduce and/or mitigate impacts on the local economy and reduce overhead costs. The applicant is soliciting proposals from local general contractors, as well as encouraging local subcontractors to submit proposals to the general contractors. Additional labor and craftsmen to supplement the local workforce will be recruited outside of Palau.

The use of imported laborers (i.e., Filipinos) is expected to have a minimal impact on the local Palauan community because of the widespread practice of importing these laborers. The construction contractor is expected to provide the experience, ability and appreciation for working with the people of Palau to minimize the social impact that imported laborers may have on the local population.

The construction contractor will coordinate and manage a labor compound that will support the needs of the project. The contractor will provide housing facilities, a
dining facility, laundry facilities, toilet facilities, refrigeration units, and various sundries and smallware to support anticipated manpower requirements. The contractor will also handle the catering, housekeeping and maintenance of the labor compound in order to satisfy the needs of the project.

- **PERMITS.** Separate permit applications will need to be submitted for earthmoving activities, discharges to receiving waters, utility systems, and auxiliary facilities (i.e., workers' barracks). The responsibility for permits pertaining to new auxiliary facilities rests with the general contractor if that contractor does not use local labor forces. A general contractor has not yet been selected; therefore, the applicant has requested that the permit application for auxiliary facilities be included as a condition of the earthmoving permit. The applicant is encouraging the use of local contractors, local labor, and existing infrastructure. Appropriate supporting documentation for any proposed toilet facilities or connection to the public water system will need to be submitted to EQPB and coordinated with the BPW.

### 3.2 Maximum Density Resort Development

This alternative represents resort development on a substantially larger scale as allowed by the existing Koror State zoning designation for Ngerur Island (refer to Section 5.12 for a more detailed discussion of land use considerations). Tables comparing the estimates of the daily and annual visitor load are provided below.

**TABLE 7: COMPARISON OF THE DAILY VISITOR LOAD.**

<table>
<thead>
<tr>
<th></th>
<th>MAXIMUM DENSITY RESORT DEVELOPMENT</th>
<th>PROPOSED DENSITY RESORT DEVELOPMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resort bungalows per acre</td>
<td>20.0 bungalows</td>
<td>4.8 bungalows</td>
</tr>
<tr>
<td>Total acreage</td>
<td>X 12.5 acres</td>
<td>X 12.5 acres</td>
</tr>
<tr>
<td>Total number of resort bungalows</td>
<td>250 bungalows</td>
<td>60 bungalows</td>
</tr>
<tr>
<td>Assumed occupancy rate (75%)</td>
<td>188 bungalows</td>
<td>45 bungalows</td>
</tr>
<tr>
<td>Daily visitor load (based on 1.8 persons per room)</td>
<td>338 persons</td>
<td>81 persons</td>
</tr>
</tbody>
</table>

**TABLE 8: COMPARISON OF THE ANNUAL VISITOR LOAD.**

<table>
<thead>
<tr>
<th></th>
<th>MAXIMUM DENSITY RESORT DEVELOPMENT</th>
<th>PROPOSED DENSITY RESORT DEVELOPMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily visitor load (from Table 4)</td>
<td>338 persons</td>
<td>81 persons</td>
</tr>
<tr>
<td>Assumed turn over rate (365 days per year × 4-day length of stay)</td>
<td>X .91</td>
<td>X .91</td>
</tr>
<tr>
<td>Annual visitor load</td>
<td>30,758 persons</td>
<td>7,371 persons</td>
</tr>
</tbody>
</table>
A large-scale resort project based on the maximum allowable density for Ngerur Island would generate substantially greater environmental impacts as compared to the proposed action due to the substantially higher (more than four times greater) annual visitor load supported by maximum density development. Infrastructure considerations would therefore encompass larger systems that can accommodate the higher potable water demand and the disposal of greater volumes of effluent and solid waste.

The alternative of a large-scale resort project on Ngerur Island would presumably function as a major revenue-source and employment center; however, the number of visitors accommodated by a maximum density resort project would also generate a substantially larger load on the natural environment whereby deleterious effects could occur. Degradation of the environment could in turn lead to a deterioration of the image of Palau as a diving paradise, thereby contributing to a reduction in the annual flow of visitors. The potential for serious long-term environmental degradation as a result of maximum density resort development led to the elimination of this alternative from further consideration.

3.3 Design Alternatives

Design alternatives pertaining to water and wastewater options that would present different environmental impacts have been considered but eliminated from further consideration. The following paragraphs present the relevant discussions.

3.3.1 ALTERNATIVE POTABLE WATER SYSTEM

Implementation of an off-site water supply system would include several components including the expansion of the existing Koror-Airai water treatment plant, installation of an underwater transmission pipeline from Arakabesan Island to Ngerur Island, and potable water purchase from the local water service provider.

The alternative of connecting to an off-site water supply system has inherent advantages since the operation and maintenance of the system would be the responsibility of the service provider. The infrastructure requirement for this option would be primarily associated with the transbay connection to an existing system on the island of Arakabesan. The following characteristics of this option are noted:

- Multiple service providers are available on the main islands;
- Less land on Ngerur Island may be required for facilities and infrastructure;
- Less power would be required on Ngerur Island for the water supply system;
- Less manpower would be required for operation and maintenance;
- Capital expenditure may be reduced if the transbay pipeline is used for power and communications; and
- No waste products from the water treatment process would be generated or disposed with this option (as compared to the proposed action that involves seawater intake and brine disposal).
This alternative has several disadvantages related to the absence of control over the system and the dependence on the transbay pipeline for water conveyance.

- The Ngerur Island water supply would be dependent on the off-island supply;
- The Ngerur Island water supply would be dependent on the transbay pipeline;
- There would be less control over water quality and extended pipeline residence time may further deteriorate potable water quality; and
- A back-up water production system may be warranted to increase reliability.

As indicated in the above discussion, the alternative of an off-site potable water supply system implies damage to coral and marine resources along the transbay pipeline corridor. Considerable environmental analysis of off-site systems, the transbay pipeline corridor and mitigation for the irrevocable loss of marine resources would be required for the option to connect to an off-island water supply system such that it was eliminated from further consideration in favor of the proposed potable water system (with on-site supply and reverse osmosis treatment) that is more typical within the framework of an island environment.

3.3.2 ALTERNATIVE WASTEWATER SYSTEMS

- **WASTEWATER COLLECTION VIA A VACUUM SYSTEM.** The alternative of utilizing a vacuum system for wastewater collection implies smaller diameter collection pipes that can be installed at a shallower average depth. This option eliminates the need for pump stations since the system operates under a vacuum created by vacuum pumps located at a central collection location and through a number of pockets, valves, and clean-outs dispersed along the collection pipeline route. Collection pipelines would be 3-inches in diameter with an average depth of 3 to 5 feet. There is a limit to the amount of vacuum the system can sustain (typically not more than 15 to 25 inches of mercury (in Hg)). The lower elevations in the main structure may not be serviceable by a vacuum system such that this alternative was deemed unfeasible and subsequently dismissed in favor of the proposed wastewater collection system utilizing conventional gravity collection pipelines and pump stations.

- **OFF-SITE WASTEWATER TREATMENT AND DISPOSAL.** The alternative of off-site treatment and disposal involves an underwater pipeline between Ngerur Island and Arakabesan Island and conveyance of the effluent to the Malakal WWTP. The underwater pipeline would be a 8,000-foot HDPE submarine forcemain of 3 to 4 inches in diameter. The pipe would be of a continuous length such that it can be pulled out, sunk and hand placed between any corals encountered along the pipeline corridor. The underwater pipeline would be connected to the wet well at the public pump station on Arakabesan island and discharged into the public sewer system for conveyance to the Malakal WWTP.

Notable disadvantages of this system are as follows:

- Waste storage facilities would be required on Ngerur Island because the Malakal WWTP is at near capacity and is characterized by an inadequate conveyance system (pipelines and pump stations);
With this option, the Quest Resort Palau would be reliant on the Malakal wastewater collection and treatment system that is prone to failure when the system is not well maintained;

- Considerable environmental concerns are associated with the underwater piping of raw wastewater and the consequences of potential failure of the system;
- This option implies dependency on an off-site service provider and associated annual costs for treatment and disposal;
- There is an increased potential for odors on Ngerur Island due to the storage of raw wastewater on the island; and
- This option implies substantial construction costs associated with the pipeline and wastewater storage facilities.

Pumping wastewater to the Arakabesan-Malakal collection system would require an in-depth analysis of the available capacity and reliability of the existing collection, treatment, and outfall facilities. Based upon data obtained from the Malakal Wastewater Master Plan (1994) and discussions with Public Works personnel, the existing collection system is approaching maximum capacity and many of the pump stations are in poor to fair condition. Untreated sewage spills are not uncommon at various locations in the collection system. Although there are plans for expansion of the Malakal WWTP, the treatment plant is operating above its rated capacity and frequently discharges wastewater into the ocean without proper secondary treatment according to applicable standards. In addition, the ocean outfall discharge for the treatment plant is only about 50 feet deep and located very close to the shore such that the effluent frequently surfaces and migrates to the shoreline. Without significant improvements to the existing Malakal system, proper conveyance, treatment, and disposal of wastewater cannot be guaranteed.

The addition of new flows to the already overburdened municipal collection and conveyance system would require substantial infrastructure improvements requiring planning studies and substantial new/rehabilitation construction. Costs are expected to be exorbitant. For example, the underwater forcemain alone would cost in excess of $500,000. The cost for other required improvements is unknown but can be conservatively estimated at over $1,000,000.

In light of the above considerations, the alternative of off-site wastewater treatment and disposal has been eliminated from further consideration.

- **ON-SITE WASTEWATER TREATMENT AND OFF-SITE DISPOSAL.** With this alternative, the effluent would first be treated on Ngerur before its conveyance through a submarine pipeline to Arakabesan. As with the previously evaluated alternative, the effluent would be discharged to the public collection system for ultimate treatment and disposal via the Malakal WWTP. This alternative allows for the effluent to be treated twice; however, the Quest Resort Palau would then be dependent on the public collection/conveyance and treatment system. With this option, the Quest Resort Palau would be contributing liquid inputs to a system that is characterized as unreliable because it may be already at or near capacity.
Costs for on-site wastewater treatment and off-site disposal would include the costs attributed to off-site treatment and disposal (refer to Section 3.3.2.2) in addition to the cost of constructing on-site treatment facilities. On-site treatment with off-site disposal is therefore one of the more costly options addressed in this EIS.

On-site treatment with off-site disposal is considered to be an expensive option that contributes new flows to an already overburdened municipal collection and conveyance system. For all these reasons, this option has been dismissed from further consideration.

- **ON-SITE WASTEWATER TREATMENT AND DISPOSAL.** Tertiary treatment (treatment beyond secondary level standards) was considered but dismissed in favor of proposed secondary treatment with UV.
  - Tertiary treatment is typically utilized when the wastewater is intended for use as recycled water. Recycled water is employed in areas where water is scarce/expensive for irrigation purposes. This is not the case in Palau where the average rainfall is around 150 inches per year. Therefore, tertiary treatment for reuse is impractical and/or unnecessary.
  - The tertiary treatment process involves substantial use of chemicals to coagulate suspended particles and requires filtering with disinfection for subsequent reuse in a separate distribution system. Substantially more physical space would be needed for the additional chemical storage and equipment/structures to employ their use. Space is already at a premium on Ngerur Island. The size of the structure where all treatment facilities are contained would have to increase by 100 percent to include the additional treatment components. Tertiary treatment would also entail greater cost for the treatment facilities and require the transport, storage, and use of numerous chemicals and/or fuel. Furthermore, tertiary treatment exponentially increases the complexity of the treatment process. All in all, the additional cost (approximately $250,000 to $500,000) to treat the effluent to a tertiary level is not practical or cost effective, hence, the dismissal of this option in lieu of secondary treatment with UV (a compact, cost-effective option estimated at $25,000 that requires no chemicals) and ocean disposal via a deep outfall.

The utilization of mounds/leach-fields or overland treatment was also considered and dismissed (in favor of the proposed on-site packaged WWTP).
  - The overland treatment was discounted due to the amount of land required, its potential for odors, and a perceived negative response of guests to a wastewater treatment process co-mingled within the public areas.
  - A septic tank system employing a series of mounds and/or leach-fields was investigated but determined to be unfeasible because Ngerur Island is characterized by a thin layer of top soil underlain by a basaltic conglomerate material of unknown depth. The percolation capacity of this type of material is not favorable for a septic tank system utilizing a series of mounds and/or leach-fields. When these existing conditions are evaluated in conjunction with typical precipitation rates and the land requirement for even favorable percolation soils, the viability of such a system does not appear to be favorable.
The utilization of injection wells was also considered and dismissed (in favor of proposed disposal via ocean outfall).

- Injection wells are a common means of effluent disposal in-lieu of ocean outfalls. Due to diurnal fluctuations in the wastewater flow, the injection wells would draw from an effluent forebay to allow for more constant discharge rates. The injection wells would be drilled to a depth much greater than any extraction wells (400 to 500 feet) if such wells were used by the potable water system, in order to eliminate the potential for migration into the seawater supplying the RO system.
- Injection wells do require an additional treatment process over that required for an ocean outfall. In order to prevent fouling/clogging of the injection wells, the wastewater effluent must be filtered to reduce the number and size of particulates in the liquid being injected through the well screens.
- Advantages associated with injection wells are that facilities are small and can be contained in the WWTP area, no off-shore construction is required, and there are minimal environmental impacts with this option. The disadvantages of this system are that it requires a high power demand, requires a redundant system for reliability, and implies operational and maintenance activities on-island. The primary environmental concerns related to this option are the increased potential for noise from continuous pump activity.
- Geotechnical analysis for Ngerur Island indicated that permeability was inadequate for injection wells since at +200 feet into the subsurface the material is so compressed that no water can travel through it (refer to Appendix B-1). As a result of the analysis, the option to utilize injection wells was determined to be impracticable and was therefore dismissed from further consideration.

3.3.3 ALTERNATIVE FIRE PROTECTION SYSTEMS

- **SEAWATER FIRE PROTECTION SYSTEM.** Implementing a seawater fire protection system would require construction of a fire pump house on the docks and a separate looped piping system. To satisfy the 500 gpm flow requirement, a 6-inch diameter piping system would be required.
  
The advantage of the seawater system is that no fire storage is required since the ocean is the system forebay. Saltwater, however, is very aggressive on system materials. This aggressive attack translates into frequent and extensive maintenance that can result in decreased reliability. In addition, the need for a separate piping system counters the advantage of no storage requirements. Furthermore, using saltwater for the main structure sprinkler system is impractical. Lastly, in the event of a fire, saltwater would have a detrimental effect on vegetation in and around the fire.
  
Given the above considerations, the use of seawater for fire protection was eliminated from consideration in favor of using the potable water system for fire protection.
**CATCHMENT FIRE PROTECTION SYSTEM.** A catchment system would likely utilize water features of the project for storage with the fire pumps drawing from those impounds. A piping system separate from the potable water system would be required since the catchment water would not be filtered or disinfected.

An advantage of using catchment water is the reduced potable water storage requirements; however, the need for a separate piping system around the island negates the potential storage reduction advantage. Moreover, if the main structure were provided with a sprinkler system, the entire structure would have to be plumbed with separate catchment piping for the sprinkler system.

The option of an independent catchment fire protection system was therefore eliminated from further consideration in favor of using the proposed potable water system for fire protection.

### 3.3.4 ALTERNATIVE ELECTRICAL POWER SYSTEMS

**ON-SITE FACILITY.** Generating on-site power would require two generators each sized to handle the entire island demand. The generators would operate in a DUTY/STANDBY mode with scheduled alternation to allow for maintenance and proper exercising of the equipment. Fuel could be diesel, natural gas, or propane. Advantages of this system are that the electrical power source would be close to end users, thereby incurring less system losses. A safety critical (emergency) electrical supply is inherent to this option. Disadvantages of this alternative include the on-site land requirements, the on-site fuel storage requirements, the potential need for a redundant system to insure reliability, the generation of engine emissions and associated noise, and the on-island staffing requirements with respect to the operation and maintenance of the system. Primary environmental concerns associated with this option include the increased potential for fuel spills and the increased potential exhaust from power generation.

In light of the above considerations, this option was dismissed in favor of the proposed off-site power system with a standby emergency generator (refer to Section 3.1.2, Electrical and Communication Systems).

**OFF-SITE FACILITY.** Obtaining power from an off-site power plant located on Arakabesan Island would require construction of a power plant on Arakabesan and installation of a transmission line such as a steel-armored submarine cable to Ngerur Island. The conduit would house power and telecommunications cables. It would have to be installed in a "cut and cover" trench until deeper water is reached where it would be laid on the lagoon bottom. Anchors would be used only to the extent necessary to stabilize the cable within the alignment corridor. No anchoring would be required along the sandy lagoon bottom areas that comprise 75 percent of the entire proposed alignment.

This alternative would require two generators each sized to handle the entire island demand. Generators would operate in a DUTY/STANDBY mode with scheduled
alternation to allow for maintenance and proper exercising of the equipment. Diesel fuel would be used. The advantages of this option are independence from the PUC power supply, less congestion on the island from equipment, no fuel transportation to and storage on the island, and reduced air and noise emissions on the island. Fewer on-island staff would be required, however, operational and maintenance staff would instead be required on Arakabesan. The disadvantages of this alternative include the dependency on the integrity of the submarine cable, the potential line losses, and the potential need for a back-up system to increase reliability. The alternative of an off-site facility was dismissed in favor of obtaining power from PUC. The preferred alternative will nevertheless require that power be transmitted from Arakabesan to Ngerur Island via a submarine cable as outlined above.

3.4 No Action

As a result of the no action alternative, the island of Ngerur would remain in an undeveloped state. Short- and long-term environmental impacts, both beneficial and adverse, that are associated with the construction and operation of a resort facility would not occur. The potential impacts discussed in this EIS would be avoided as a result of no action. Selection of the no action alternative would result in no income generation to the property owner from resort activity on Ngerur Island. No capital resources would be expended as a result of the no action alternative despite the apparent interest of the investor to create a first-class resort project on the uninhabited island of Ngerur. The ROPG would receive no benefits in terms of tax revenues or employment opportunities for local Palauans as a result of this alternative. The opportunity to stimulate the tourist environment in Palau would also be missed with no action. Based on the above considerations, the no action alternative has been eliminated from further consideration in this EA.
4.0 ENVIRONMENTAL SETTING

This chapter presents the relevant resource components of the existing environment that would be affected by the alternatives under consideration if they were implemented. In other words, this chapter describes the baseline environment. The discussions presented in this chapter are necessary to understand and evaluate the effects of considered alternatives (i.e., those options that remain from Chapter 3.0).

4.1 Geography and Topography

The project site encompasses the entire island of Ngerur consisting of approximately 12.5 acres (5 hectares) within the Palau Lagoon. Arakabesan Island is the nearest landmass to the island and lies approximately 2,460 feet (750 meters) southeast of Ngerur. Koror is approximately 3.75 miles (6 kilometers) southeast of Ngerur Island.

The island is characterized by small crescent or irregularly shaped rocky beaches that occur around the perimeter of the island. Beach areas are mostly bounded by vertical to near-vertical rock escarpments and headlands. As indicated previously in Section 3.2, the remaining island topography is relatively flat at roughly 30 to 45 feet (9 to 14 meters) above sea level. A few dramatic rock formations are situated in the eastern part of the island; the highest of these formations rises to an elevation of approximately 70 feet (21 meters).
4.2. Geology and Soils

The general geology of Ngerur Island is identical with the geology of Arakabesan Island insofar as both islands consist of volcanic rocks, representing the Arakabesan member (Andesitic volcanic breccia) of the Oligocene Ngeremlengui formation. Figure 24 illustrates these existing conditions.

A shallow fringing reef varying in width from 50 to 250 feet (15 to 76 meters) surrounds Ngerur Island. In general, the nearshore bottom material is consolidated rock, with cobbles and some sediment, to a depth of approximately -4 feet (-1.2 meters) which is roughly equal to extreme low tide. Soft and hard coral growth starts at about the 4 to 5-foot depth (1.2 to 1.5 m).

The following excerpt is from the geotechnical engineering exploration report prepared by Geolabs, Inc. and dated October 28, 1999 (refer to Appendix B-1).

"In general, the Islands of Ngerur, Arak[b]esang, and the western portion of Koror are composed of the accumulation of Tertiary Epoch volcanic materials including tuff and tuffaceous breccia along the crest of the Palau Ridge structure. The geomorphology of the islands is controlled by many factors including faulting, repeated historic and submergence and emergence episodes resulting from sea level fluctuation, submarine erosion, and subaerial deep tropical weathering.

"The ground surface of the island typically consists of some thin soil cover derived from the in-situ weathering of the basaltic and andesitic parent rock. The thin soils overlie dense volcanic breccia rock with increasing depth below the ground surface. The surficial soil thickness may vary widely depending on location. Volcanic breccia may be defined as a relatively coarse-grained volcanic rock composed of various broken rock fragments (called clasts) that are welded together by heat and pressure within a generally fine-grained mineral rock matrix. Breccia rock is typically formed by volcanic eruptions and/or volcanic debris flows consisting of super-heated rock masses.

"Ngerur Island is essentially oblong in shape and generally consists of a centrally located highland that slopes down toward the perimeter shoreline. The perimeter shoreline consists of banks elevated from the coastal waters. The banks may have formed from the effects of tidal fluctuation and coastal erosion. A relatively shallow depth marine shelf surrounds the island before abruptly dropping off with increasing water depth. The shelf contains deposits of marine sediments and coral growth that may overlie volcanic rock buried at greater depths." 

Two different soil types exist on Ngerur Island. The dominant soil type that covers roughly 90 percent of the island is the Nekken-Ollei complex, 12 to 30 percent slopes (No. 410). The soil type that extends along the shore of the island from northeast counterclockwise to southwest is the Ollei-Nekken complex, 50 to 70 percent slopes (No 429). Figure 25 illustrates the soil distribution on Ngerur Island. In general, soils on Ngerur Island are very shallow. The characteristics of the two soil types found on Ngerur Island are hereby excerpted from Soil Survey of Islands of Palau, Republic of Palau (1983).

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VOLCANIC ROCKS
- Trap and indurated volcanic breccia (At or near surface)
- Weathered volcanic breccia (Extends to a depth of 10' or more)

SEDIMENTARY ROCKS
- Made land
- Coralline limestone

Source: Military Geology of the Palau Islands
Ngerur Island
Soil Map Units

Quest Resort Palau
Koror State
Republic of Palau
Environmental Impact Statement

Source: U.S. Department of Agriculture - Soil Survey of Islands of Palau
410 - NEKKEN-OLLEI COMPLEX, 12 TO 30 PERCENT SLOPE. This map unit is on low-lying foothills and ridgetops. This unit is 65 percent Nekken very gravelly silt loam and 25 percent Ollei very gravelly loam. Slopes are convex. The vegetation is mainly tropical forest. Cleared areas support savanna vegetation.

The Nekken soil is moderately deep and well drained. It formed in residuum derived dominantly from andesitic and basaltic breccia and tuff. Typically, the surface is covered with a mat of undecomposed and partially decomposed forest litter 3 centimeters thick. The surface layer is very dark brown very gravelly silt loam 20 centimeters thick. The upper 56 centimeters of the subsoil is dark yellowish brown very gravelly silty clay loam, and the lower 10 centimeters is very dark brown very gravelly silt loam. Very hard, bedded tuff is at a depth of 56 centimeters. Bedrock is at a depth of 50 to 76 centimeters. Permeability of the Nekken soil is moderate. Effective rooting depth is 50 to 76 centimeters. If the vegetation is removed, runoff is medium and the hazard of water erosion moderate.

The Ollei soil is shallow and well drained. It formed in residuum derived dominantly from hard andesitic and basaltic breccia and tuff. The surface layer is very dark brown silt loam 18 centimeters thick. The subsoil is brown very gravelly loam 10 centimeters thick. The substratum to a depth of 43 centimeters is dark yellowish brown extremely flaggy loam. Hard, bedded tuff is at a depth of 43 centimeters. Bedrock is at a depth of 25 to 51 centimeters. Permeability of the Ollei soil is moderate. Effective rooting depth is 25 to 51 centimeters. If the vegetation is removed, runoff is medium and the hazard of water erosion is moderate.

This map unit is well suited to use as pasture. Grasses and legumes grow well if adequate fertilizer is used. Proper grazing management, weed control, and fertilization are needed for maximum quality of forage.

This unit is moderately suited to use as woodland. The main concerns in producing and harvesting timber are shallow rooting depth and droughtiness of the Ollei soil.

This map unit is poorly suited to homesite development. The main limitations are slope and depth to rock. The deep cuts needed to provide essentially level building sites expose bedrock. Erosion is a hazard on the steeper slopes. Only the part of the site that is used for construction should be disturbed. Structures to divert runoff are needed if buildings and roads are constructed. Topsoil can be stockpiled and used to reclaim areas disturbed by cutting and filling.

This unit is poorly suited for use as roadfill because of the low strength of the subsoil. The bedrock underlying the soils is well suited to use as a source of rock for road construction.

This map unit is poorly suited to on-site waste disposal systems because of the shallow and moderate depth to bedrock and the steepness of slope.

429 - OLLEI NEKKEN COMPLEX, 50 TO 75 PERCENT SLOPES. This map unit is on high hills and ridge tops. This unit is 55 percent Ollei very gravelly loam and 25 percent Nekken very gravelly silt loam. Slopes are convex. The vegetation is mainly tropical forest. Cleared areas support savanna vegetation.
This map unit is poorly suited for use as roadfill because of the low strength of the subsoil. The bedrock underlying the soils is well suited to use as a source of rock for road construction.

This unit is poorly suited to on-site waste disposal systems because of the shallow and moderate depth to bedrock and the steepness of slope.

Table 9 shows the degree and kind of soil limitations that affect shallow excavations, dwellings without basement, local roads and lawns and landscaping. The limitations are considered slight, moderate or severe according to the following conditions:

- **Slight** limitations exist if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome;
- **Moderate** limitations exist if soil properties or site features are not favorable for the indicated use and special planning, design or maintenance is needed to overcome or minimize the limitations; and
- **Severe** limitations exist if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

**TABLE 9: EVALUATION OF SOIL LIMITATIONS FOR CONSTRUCTION USE.**

<table>
<thead>
<tr>
<th>SOIL TYPE</th>
<th>SHALLOW EXCAVATIONS</th>
<th>DWELLINGS WITHOUT BASEMENTS</th>
<th>SMALL COMMERCIAL BUILDINGS</th>
<th>LOCAL ROADS</th>
<th>LAWNS AND LANDSCAPING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nekken (410)</td>
<td>severe: depth to rock slope</td>
<td>severe: slope</td>
<td>severe: slope</td>
<td>severe: low strength, slope</td>
<td>severe: small stones, slope</td>
</tr>
<tr>
<td>Ollei (410)</td>
<td>severe: depth to rock slope</td>
<td>severe: slope, depth to rock</td>
<td>severe: slope, depth to rock</td>
<td>severe: depth to rock slope</td>
<td>severe: slope, thin layer</td>
</tr>
<tr>
<td>Ollei (429)</td>
<td>severe: depth to rock slope</td>
<td>severe: slope, depth to rock</td>
<td>severe: slope, depth to rock</td>
<td>severe: depth to rock slope</td>
<td>severe: slope, thin layer</td>
</tr>
<tr>
<td>Nekken (429)</td>
<td>severe: depth to rock slope</td>
<td>severe: slope</td>
<td>severe: slope</td>
<td>severe: low strength, slope</td>
<td>severe: small stones, slope</td>
</tr>
</tbody>
</table>

The following five features types are evaluated in Table 9:

- **Shallow excavations** are trenches or holes dug to a maximum depth of 150 to 180 centimeters.
- **Dwellings and small commercial buildings** are structures built on shallow foundations on undisturbed soil.
- **Local roads and streets** have an all-weather surface and carry automobile and and light truck traffic all year. They have a a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material and a flexible or rigid surface. Cuts and fills are generally limited to less than 180 centimeters.
Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. Flooding, wetness, slope, stoniness, and the amount of sand, clay or organic matter in the surface layer affect trafficability after vegetation is established.

Table 10 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated good, fair, or poor as a source of roadfill and topsoil. They are rated as a probable or improbable source of sand and gravel. Each soil is evaluated to a depth of 150 to 180 centimeters.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. Soils rated poor have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 90 centimeters thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 100 centimeters of a soil is evaluated for use as topsoil. The reclamation potential of the borrow area is also evaluated.

TABLE 10: EVALUATION OF SOIL SOURCES FOR CONSTRUCTION USES.

<table>
<thead>
<tr>
<th>SOIL TYPE</th>
<th>ROADFILL</th>
<th>SAND</th>
<th>GRAVEL</th>
<th>TOPSOIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nekken (410)</td>
<td>poor: area reclaim, low strength, thin layer</td>
<td>improbable: excess fines</td>
<td>improbable: excess fines</td>
<td>poor: small stones, slope</td>
</tr>
<tr>
<td>Ollei (410)</td>
<td>poor: area reclaim</td>
<td>improbable: excess fines, large stones</td>
<td>improbable: excess fines, large stones</td>
<td>poor: area reclaim, small stones, slope</td>
</tr>
<tr>
<td>Ollei (429)</td>
<td>poor: area reclaim, thin layer, slope</td>
<td>improbable: excess fines, large stones</td>
<td>improbable: excess fines, large stones</td>
<td>poor: area reclaim, small stones, slope</td>
</tr>
<tr>
<td>Nekken (429)</td>
<td>poor: area reclaim, low strength, thin layer</td>
<td>improbable: excess fines</td>
<td>improbable: excess fines</td>
<td>poor: small stones, slope</td>
</tr>
</tbody>
</table>

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock and toxic material.

Soils rated poor are very sandy, or clayey, have less than 50 centimeters of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a water table at or near the surface.
Information about the soils and subsurface conditions on Ngerur Island are hereby excerpted from the geotechnical investigation conducted in 1999 by Geolabs, Inc.

"The perimeter of the island generally consists of steep, near-vertical slopes with bedrock exposure. In general, there are three areas along the perimeter of the island that are underlain by soil materials with a gentle sloping terrain down to the shoreline. One of these areas may be characterized as a mangrove environment and is located at the southeastern portion of the island. The ground surface of the island is generally flat with the east side having higher elevations and the west side lower in elevations. The ground surface elevations generally range from about +66 feet MSL on the east side of the island to about +18 MSL on the west.

"The island is generally accessed by a north-south trending access trail, which connects with the equipment stand-by area at the north. Due to the high moisture content and thickness of the near-surface soils, a large portion of the island is currently not accessible by normal vehicles. Surface drainage and the infiltration characteristics of the native soils appear to be good except along the access trail, where the soils have been reworked and compacted. In these areas, potholes and standing water were observed, indicating poorly drained near-surface soil conditions.

"Other features of interest on the island include the occurrences of fault/fracture zone traces in the rock outcrops along the perimeter of the island. Most of the traces are near-vertical and trending approximately in an east-west direction. The fault/fracture zone traces are generally observed in homogeneous rock types and consist of mineral veins. In general, these fault/fracture zone traces do not appear to be active fault traces.

"The subsurface conditions at Ngerur Island were explored by drilling and sampling eight borings, designated as Boring Nos. 1 through 8, for a total footage of approximately 265 lineal feet of field exploration. Three of the eight borings (Boring Nos. 1 through 3) were drilled on the mud flats between the shoreline and the future breakwater structures. Boring Nos. 1 through 3 extended to depths of about 17 to 47 feet below the mud flat surface. The remaining five borings (Boring Nos. 4 through 8) were generally drilled for the main hotel building. The five borings extended to depths between about 13 and 47.3 feet below the existing ground surface. In addition, the subsurface conditions below the [proposed] one and two-story buildings were explored by excavating 10 test pits, designated as Test Pit Nos. 1 through 10, to a maximum depth of about 12.5 feet below the existing ground surface.

"Based on our field exploration, the island surface is generally blanketed by a mantle of soil on the order of about 3 to 5 feet below the existing ground surface. In a few areas, the surface soil layer extended to about 10 to 15 feet below the existing ground surface. The near-surface soils generally consist of stiff to very stiff clayey silts and silty clays with high moisture contents. The near-surface soils are generally the products of mechanical and chemical weathering of the underlying volcanic rock. Volcanic breccia rock formation generally underlies the surface soil horizon. In the southeastern portion of the island, the volcanic breccia rock was exposed at the ground surface. The volcanic breccia rock formation encountered generally was very dense and massive (with few fractures).
"Based on the off-shore borings (Boring Nos. 1 through 3) drilled for the proposed harbor facilities, it appears that the future harbor area enclosed within the shoreline and the proposed breakwater structures is generally underlain by dense volcanic breccia rock formation near the mud flat surface except in Boring No. 1, where the dense breccia rock was encountered at a depth of about 10 feet deep below mud flat surface."

4.3 Hydrology and Water Quality

Ngerur Island does not possess specific hydrological elements that are generally supportive of high biodiversity such as streams, ponds, freshwater marshes, and swamp forests. The following excerpt is from the geotechnical engineering exploration report for Ngerur Island prepared by Geolabs, Inc. (1999).

"Groundwater was not encountered in the test pits excavated on the island; however, a significant amount of seepage water was observed below the surface soil horizon at and around the interface between the soil and rock. However, it should be noted that groundwater (likely seepage water) was encountered in the borings drilled on the island. Due to the nature of the island location, the water levels measured in the drilled borings and excavated test pits during our field exploration were likely affected by tidal influences. In addition, the water levels at the project site may be influenced by seasonal precipitation and storm surge conditions."

Water quality standards pertaining to the marine waters of Palau are contained in the regulations by the EQPB, established pursuant to the Environmental Quality Protection Act, Chapter 1, Marine and Fresh Water Quality Standard regulations. Coastal waters are classified in accordance with uses (Chapter 2401-11-05). During the session of the Sixth Koror State Legislature, April/May 2000, a resolution was passed to recommend the waters around Ngerur Island be reclassified from Class "AA" to Class "B" (refer to Appendix B-2). Figure 26 illustrates the water quality classifications for the affected area. The draft of an Amendment to the Marine and Freshwater Quality regulations that would allow for necessary changes was endorsed by the EQPB in September 2000 and forwarded to the Office of the President for final review and approval. The President, Republic of Palau, used his authority under the law to approve the amendment as drafted (refer to Appendix B-2).

The effective date of the proposed Amendment is October 6, 2000. The current process provides the public with a 30-day comment period. The OEK has a 120-day period during which a potential repeal of the reclassification would be possible.

Water quality investigations were conducted in September 26 through 28, 1998 by PENTEC Environmental, Inc. (refer to Appendix B-3) and in October 14 through 16, 1998 by AECOS Consultants (refer to Appendix B-4). Parameters such as temperature, salinity, dissolved oxygen (DO), turbidity, pH, and nutrients were measured.

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7 Geolabs, Inc., 1999.
8 Ibid.
The findings in the water quality investigation report by PENTEC Environmental, Inc. (1999) reveal the following conditions pertaining to the waters around the perimeter of Ngerur Island:

"With the exception of temperature, water quality parameters were generally within the expected ranges for coastal lagoon waters in the equatorial western Pacific Ocean.

"Water temperatures recorded during the September 1998 survey averaged at least 1°C above normal ambient lagoon water temperatures.

"Temperature data recorded during the surveys suggest that lagoon water temperatures were still under the influence of the ongoing [El Niño Southern Oscillation or] ENSO event.

"The salinity values are somewhat lower than would normally be expected. ...prevailing ENSO drought conditions, and a presumed reduction in surface- and groundwater runoff, do not appear to have produced any corresponding increase in lagoon salinity in surface waters around Ngerur Island.

"DO concentrations were low.... Percent DO saturation...appear to reflect a range more or less typical of lagoon surface waters.

"Turbidity readings...suggest that in its undeveloped state, the vegetation cover of the island is effective in retaining silt and sediment that might otherwise run off into coastal waters.

"All 12 samples [for pH] were within Palau's water quality standards for Class AA, A and B waters."¹⁹

The investigation report by AECOS Consultants (2000) reveals the following conditions pertaining to the marine waters around Ngerur Island:

"There was little difference in temperature, salinity or pH between any of the stations around Ngerur Island,...indicating that these lagoon waters are generally well mixed. The somewhat elevated dissolved oxygen (DO) saturation levels at Station 3 indicate that there is likely a well developed coral community and/or benthic algal community in this area. Zooxanthellae (microscopic plants) which live within corals and benthic algae produce oxygen during the daytime photosynthetic process and this can result in supersaturation of DO in the water column during part of the day. Also, the slightly higher pH at Station 3...is further evidence suggesting productivity is high in this area. Carbon dioxide is consumed by plants during photosynthesis, decreasing carbonic acid in the water, and increasing pH.

"Low mean turbidity level at Station 4 seems to be due to the fact that this station was located over deeper waters (i.e., off the Ngerur reef area) and on the NW side of the island. This station was sampled only on October 16, 1998...when a morning storm was blowing out of the NW and, thus, while other stations were subject to stirring up of the shallow reef sediments, Station 3 was receiving clearer water from the deeper channel area west of Ngerur Island.

¹⁹ PENTEC Environmental, Inc., 1999.
"Nutrient levels were low in the vicinity of Ngerur Island...during the survey period and characteristic of pristine coastal tropical environments. The nitrate + nitrite levels recorded are considered to be 'growth-rate limiting.' That is, inorganic nitrogen is present in such low quantities that plant growth (phytoplankton and benthic algae) would be severely restricted at this location and, together with low turbidity levels, accounts for the pristine nature of this area."

"Water quality conditions in the vicinity of Ngerur Island were well within the standards specified by the [Republic of Palau] for the parameters measured. ...The high water quality levels that characterize this area occur for several reasons. Firstly, Ngerur Island is small relative to the surrounding marine environment (lagoon) and has little influence on this water body. There is, for example, little runoff directly into the marine environment and that which does occur...is small and probably inconsequential.... Secondly, water movement in this area is not restricted; i.e., the area is well exposed, especially to the north and west. Such exposure encourages water movement, or flushing, by wind-driven surface currents and deeper tidal movements. Such flushing maintains a steady supply of food and nutrients for the coral communities and aids in removing waste products. Finally, Ngerur Island is fairly well removed from developed areas that might contribute to water quality degradation. And even though it is close to the western side of [Arakabesan], this part of [Arakabesan] is mostly uninhabited and Ngerur Island is further isolated by a channel of some depth which separates the two islands."  

Relevant findings pertaining to the measured water quality parameters are hereby summarized from the appended investigations.  

- **TEMPERATURE.** The water temperature of samples collected in September 1998 ranged from 30.4 to 31.1°C. "A mean temperature of 30.7°C was recorded for all stations. Overall, recorded temperatures were unusually high. The normal range of water temperature is about 23.8 to 29.4°C."  
  The water temperature of samples collected in October 1999 ranged from 30.7 to 31.0°C with an overall mean of 30.8°C.  

- **SALINITY.** Salinity values of samples collected in September 1998 ranged from 30.5 to 32.0 parts per thousand (ppt). "Mean surface salinity was lowest on the south side of the island (30.6 ppt) and highest on the north side of the island (31.4 ppt). Mean midwater salinity was lowest on the west side of the island (30.7 ppt) and highest on the south and east sides of the island (31.1 ppt). A mean salinity value of 31.0 ppt was calculated for all stations."  
  "All salinity concentrations were within Palau's standard for salinity."  

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12 Ibid.  
14 PENTEC Environmental, Inc., 1999.  
15 Ibid.  
16 Ibid.
The salinity values of samples collected in October 1998 ranged from 33.44 to 33.75 ppt with a mean of 33.61 ppt.\textsuperscript{17}

\textit{Dissolved Oxygen.} DO concentrations in the September 1998 samples ranged from 4.7 to 6.1 parts per million (ppt) excluding the highest reading recorded midwater on the east side of the island on September 27, 1998.\textsuperscript{18} "The mean DO values for surface and midwater on the east side of the island were 5.1 and 5.5 ppm, respectively. The mean DO values for surface and midwater on the west side of the island were 5.2 and 5.0 ppm, respectively. There was no difference between the surface and midwater DO values for the south side of the island (5.1 ppm), or the island's north side (5.4 ppm)."\textsuperscript{19}

"DO values were influenced by the degree of wind and surface chop exposure. DO readings on the lee sides of the island (south and west) had a mean of 5.1 ppm (N = 6), whereas readings on the wind-exposed north side had a mean of 5.4 ppm (N = 6). DO saturation values ranged from 75 to 98 percent. A mean saturation value of 81.8 percent was calculated for the sampling station on the lee side, whereas a mean value of 86.1 percent characterized the windward sampling station. A mean DO value of 5.2 ppm (N = 14) was calculated for all stations.

"Measurements obtained within dark, organic, sedimentary deposits at sampling station 5 showed dissolved oxygen levels of 0.2 ppm. This site appears to be a depositional zone for organic materials transported by surface-water runoff from the island, or where lagoon-derived organic detritus is naturally deposited by water currents. Both of these mechanisms may contribute material to this area, as there is evidence of leaf litter and debris of anthropogenic origin...in the sediment. The organic deposits form a soft, unconsolidated organic slurry in an area of about 10 to 12 square meters adjacent to the vertical rock shoreline along the southeast shoreline of the island.

"Excluding Station 5, all DO concentrations met or exceeded the saturation standards... The concentration of DO is dependent on the salinity and temperature of the water. The lower-than-normal DO values can be attributed to the warmer-than-normal water temperatures. Station 5 readings are the result of unique physical or hydrological circumstances and are not relevant in terms of the regulatory standards. Samples of this material returned to the surface for closer examination indicated the strong presence of hydrogen sulfide, indicating anaerobic conditions typical of the natural degradation of organic material in this environment."\textsuperscript{20}

The DO values of samples collected in October 1998 ranged from 6.47 to 7.92 ppm with a mean of 7.07 ppm; DO saturation values ranged from 104 to 128 percent with a mean of 114 percent.\textsuperscript{21}

\textit{Turbidity.} Turbidity levels in the September 1998 samples ranged from 0.7 to 1.40 nephelometric turbidity units (NTU).\textsuperscript{22} "The highest turbidity reading was recorded on
the south side of the island. The south side also demonstrated the highest mean value (1.1 NTU). A mean value of 1.0 NTU was calculated for all stations.

All samples met Class B turbidity standards; however, Class AA and A standards were exceeded during the rainfall event on September 27, 1998.

The turbidity levels of samples collected in October 1998 ranged from 0.08 to 0.36 NTU with a mean of 0.23 NTU.

- **pH**: pH values for all the September 1998 samples ranged from 7.7 to 8.2. “The lowest reading was recorded on the west side of the island. A mean pH of 7.9 was calculated for all stations.”

“All 12 samples were within the range for Class AA, A and B waters.”

The pH levels of samples collected in October 1998 ranged from 8.17 to 8.20 with a mean of 8.18.

### 4.4 Climate

The Palau islands have a maritime tropical rainy climate that is characterized by small seasonal changes. Temperature and barometric pressure are fairly uniform throughout the year. The prevailing winds have seasonal characteristics.

The following climatological information is from climate and historical weather data compiled by the United States Department of Commerce, National Oceanic and Atmospheric Administration (NOAA) in 1991.

- **TEMPERATURE**: Both the annual and diurnal temperature ranges are small, with the annual range being smaller than the diurnal one. The mean diurnal range is 10°F (5.55°C). The mean monthly temperature is 81.7°F (27.6°C). The mean of the warmest month (May) is 82.3°F (27.9°C) and the means of the coldest months (January and February) are 81.0°F (27.2°C). Figure 27 illustrates the monthly average temperatures. Relative humidity is high throughout the year with an annual mean of 82 percent.

- **PRECIPITATION**: The mean yearly precipitation is 147.9 inches (375.6 centimeters). The mean monthly precipitation varies between 8.09 inches (20.5 centimeters) during February and 17.46 inches (44.3 centimeters) in July (see Figure 28). The driest months are from February through April when the rainfall usually is between six and eight inches (15.2 and 20.3 centimeters) per month. During the rest of the year rainfall is usually between 10 and 20 inches per month. The maximum rainfall is in July.

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24 Ibid.
26 PENTEC Environmental, Inc., 1999.
27 Ibid.
28 Ibid.
<table>
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<th>Year</th>
<th>Max (deg. F)</th>
<th>Min (deg. F)</th>
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<td>89</td>
<td>74</td>
<td>31</td>
<td>24</td>
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</tbody>
</table>

1965-1994 Monthly average temperature

Source: National Oceanic and Atmospheric Administration.
1965-1994 Mean monthly precipitation

Mean yearly precipitation: 147.97 inches 376 cm

Source: National Oceanic and Atmospheric Administration
**PREVAILING WIND DIRECTION.** The prevailing wind direction is northeast to east-northeast (see Figure 29). This is the direction of the trade winds that dominate from November to June. During May and June, east winds predominate. From July to October the prevailing winds shift to northwest, west and southwest.

**PEAK GUSTS.** The dominant direction of a recorded occurring monthly peak gusts is southwest (83 mph, November 1990). The dominant direction of monthly peak gusts with an average speed greater than 50 mph (80.4 kmph), recorded between 1985 and 1994 is northwest (1 occurrence), west (2 occurrences), southwest (3 occurrences). Figure 30 illustrates the wind conditions. The geographical location of Ngerur Island is such that the approach not only of the prevailing winds from the northeast/east-northeast sector but also of the peak gusts from southwest is over water and therefore unobstructed. Figure 31 illustrates this condition. Calms predominate an average of 18 percent of the time and reach their yearly maximum in the month of June.

### 4.5 Air Quality

Air pollution regulations as promulgated by EQPB have been in effect since 26 May 1996. The regulations incorporate specific ambient air quality standards with respect to pollutants such as sulfur oxides, particulate matter, carbon monoxide, photochemical oxidants, hydrocarbons and nitrogen oxides.

No major air pollutant sources exist on the uninhabited island of Ngerur or within its general vicinity. The air quality in the general project vicinity and on Ngerur Island is therefore expected to be pristine.

### 4.6 Noise Quality

No major stationary noise pollutant sources currently exist on the uninhabited island of Ngerur or within its general vicinity. Intermittent noise events may occur from motorized watercraft and overhead aircraft. Noise quality in the general project vicinity and on Ngerur Island is therefore expected to be good.

### 4.7 Flora

The following information is excerpted from the Report on the Botanical Survey of Ngerur Island, Republic of Palau (Herbst, 1998). Refer to Appendix B-5 for the botanical report.

"The vascular flora of Ngerur Island consists of 104 taxa in 51 families. Seventy-eight of the 104 taxa are believed to be native to Palau, but are common species widely distributed in the islands; another 23 taxa are adventive or naturalized, while the remaining three consist of two ornamental shrubs planted in a graveyard, and a fruit tree purposely introduced. These cultivated plants have not reproduced nor increased..."
1963 Prevailing monthly wind direction and number of occurrence

1963 Prevailing monthly wind direction by month

Source: National Oceanic and Atmospheric Administration
1965-1994
Monthly direction of peak gusts and number of occurrence

1965-1994
Monthly direction of peak gusts and average speed (mph)

Source: National Oceanic and Atmospheric Administration
NE  ) 50% of prevailing
ENE  ) monthly wind direction

SW
Direction of monthly peak gusts with greatest number of occurrence and with average speeds greater than 50 mph

Source: National Oceanic and Atmospheric Administration
in number from the original plantings. Other useful plants, such as the coconut and breadfruit, which also were introduced to the island have reproduced and spread and are therefore considered naturalized components of the island’s flora.

“The most comprehensive classification of Palauan plant communities probably is that of Cole et al. (1987). Their survey, which was designed primarily to assist foresters and land-use developers, divides the islands of Palau into four major land classes, based upon their vegetation: these are forest, agroforest, secondary vegetation, and nonforest. The four classes are further divided into vegetation types and subtypes, delineated on the basis of their drainage patterns and community structure. Variations in species composition occur within each general community type, and are influenced by site edaphic factors and disturbance history. While humans have utilized all of the vegetation communities in Palau, the last three listed are maintained by recent human activity; activities which have shaped these anthropogenic communities for thousands of years.”

Two of the five vegetation community types recognized by Muller-Dombois and Fosberg in their recently published book, Vegetation of the tropical Pacific Islands, Mueller-Dombois and Fosberg (1998), are represented on Ngerur Island: the Interior Upland Forest and the Savanna vegetation associations. A single floristic element of a third association (the Mangrove and Freshwater Swamp Forest) is also present in the form of five Sonneratia alba (urur, white mangrove) trees growing in the shallow reef waters on the eastern part of the island such that this element can not be considered a Mangrove vegetation association.

“Ngerur Island has a long history of human disturbance. At various times in the past, the island has been inhabited; it has been cleared for agricultural purposes, a chicken farm was once established on the island, and the island was used as a leper colony. As a result of the disturbance, and, additionally, perhaps the small land area of the island, the present vegetation is secondary, and a depauperate, poor example of the vegetation communities present. Many of the species...which are used to characterize the two vegetation associations are lacking.”

- Interior Upland Forest Vegetation Association. "Upland forests are restricted to the volcanic islands of Palau. Floristically, the Palauan upland forest is the most species diverse vegetation type in Micronesia. Examples of trees characteristic of this vegetation type include Maranthes corymbosa, Gmelina palauensis, Rhus taitensis, Elaeocarpus joga, Garcinia spp., Peuteria obovata, Alphitonia carolinensis, Semecarpus venenosus, Calophyllum inophyllum, Serianthes kanehirae, and Pterocarpus indicus. Perhaps the most common tree in the canopies of upland forests is Campnospermum brevipetiolata, but it usually is found on flat, lower elevation lands near streams or rivers, rather than in the drier environment of this island. Common understory species of the Upland Forest vegetation type include the palms Pinanga insignis and Heterospathe elata, Ixora casei, Osmoxylon oliveri, Alpinia spp, Symplcocos racemosa, Pandanus"
aimiriikensis, Manilkara udoido, Caesaria hirtella., Aglaia palauensis, Astronidium palauense, and Cyathea lunulata. Understories of the upland forests usually are relatively open. The vegetation on the eastern half of Negrur is most similar to the Interior Upland Forest vegetation type, but lacks many of the common, characteristic species enumerated above that are found in the more extensive examples on Babeldaob.”

SAVANNA VEGETATION ASSOCIATION. “Most, if not all, of the
grassland/savanna vegetation in Palau is the result of human activity: wildfire, land clearing, or mining. These anthropogenically maintained open uplands are also quite species-rich, although they are floristically much less diverse than the upland forests sites. Cole et al. (1987) recognize five major sub-types of the Grassland/Savanna vegetative community: Bare, Fern Lands, Grasslands, Shrubs, and Abandoned Agriculture. The sub-types are based upon former land use and the amount and type of vegetation present.”

“The western half of Ngerur supports Grassland/Savanna vegetation. Although not a particularly good example, the vegetation fits best within the parameters of Cole’s Grasslands sub-type which comprises grasses and grass-like species frequently with ferns, shrubs, and pandanus as elements of the vegetation. Common graminoid species used to characterize this vegetative sub-type include the grasses Ischaemum polystachyum var. chordatum, Paspalum orbiculare, and Dimeria chloridiformis, with Rhynchospora rubra, Sclera spp., and Fimbristylis dichotoma being common sedges. Associated ferns, fern allies, and shrubs may include Gleichenia linearis; Lygodium spp.; the club moss, Lycopodium cernuum; and shrubs, such as Melastoma malabathricum, Eurya japonica, Decaspermum fruticosum, and Wikstroemia elliptica.

“A list of threatened and endangered wildlife compiled by the government of Palau includes the following six plant taxa:

Gulubia palauensis (Becc.) Moore & Fosb. (bochela, uchreerak, esbouch, rock island palm),
Ptychosperma palauensis (Kaneh.) Moore & Fosb. (esbouch, Palau palm),
Parkia parvifolia Hosok. (kneker, parkia),
Pericopsis mooniana (Thw.) Thw. (amansis, kamanois, ngimet tree),
Cinnamomum carolinense Koidz. (ochod, Caroline cinnamon tree), and
Cinnamomum pedatinervium Meissn. (ochod, cinnamon tree).

“The two species of palms typically are members of Limestone Forest or Rock Island Forest vegetation associations, while Pericopsis usually is found in Swamp Forest communities or along sections of streams or rivers influenced by the tides. These vegetation types do not occur on Ngerur island. The other three taxa are found in Interior Upland Forest vegetation associations, and potentially could occur on Ngerur.

35 Ibid.
Island, however, none were found during the survey; all plants observed were common species widely distributed throughout the volcanic islands of Palau.

"Several plants present on Palau can be harmful to humans. Perhaps the best known of these is Semecarpus venenosus, the tonget or poison tree. Individuals allergic to relatives of this tree, which includes poison ivy, poison oak, mango, sumac, and cashew, can react painfully to exposure to its sap. Such an incident could destroy a tourist's vacation and the resort potentially could be held responsible for knowingly harboring a harmful object in their public areas. The tree was not found on Ngerur Island during this survey, however, Abrus precatorius (black-eyed Susan, rosary pea), a slender, non-native vine in the bean family is established on the island, but is not common. The hard coated, brilliant scarlet, pea-sized seed with a black spot at its point of attachment to the pod, is attractive and would attract the attention of adults and children alike; it contains the toxin abrin, a toxalbumin which inhibits protein synthesis in growing cells of the intestinal wall. Because of its hard coat, the seed is considered harmless if swallowed whole, but the ingestion of a single well-chewed seed could be fatal.36"

"The island has a history of disturbance, as a result, the vegetation is secondary; the vegetative communities on the island are neither unique nor particularly good examples of their types, and are not considered worthy of preservation."

4.8 Fauna

The following information is excerpted from the Biological and Water Quality Reconnaissance Surveys on Ngerur Island, Palau Lagoon, Republic of Palau (AECOS Consultants, 2000).

- INVERTEBRATES. The diversity of species on Ngerur Island appears to be "relatively low. ...this may be due to the island's isolation, but more significantly it is likely a result of the small range of habitats and the disturbed nature of the vegetation. Terrestrial aquatic environments (streams, swamp and marshlands, etc.) are absent, eliminating a fairly important component of terrestrial ecology in wet, tropical Palau. Vegetation types are limited (see Herbst, 1999) and therefore many habitats for insects and other small invertebrates are absent or poorly represented."38

"A number of the terrestrial molluscs (snails) collected on the Island are native species. Included are two snails (Omphalotropis cheynei and Palaua babelthuapi) that are listed in the 1994 IUCN Red List of Threatened Animals.39 Robert Cowie relates the following:

"The single species [of Assimineidae] found during the survey, Omphalotropis cheynei, was widespread, occurring at 11 of 31 terrestrial sites on Babeldaob, at the single site on Koror, where it was extremely abundant, and on both Rock Islands. It appears

highly tolerant of human disturbance, being found at some of the most disturbed sites
surveyed.

"Identification of species within the genus Palaua is tentative."40

"The results...of the taxonomic study of insects collected from Ngerur in October are
still somewhat preliminary. The collection represents mostly the common species
present on the island in October 1998. Many of these are introduced (naturalized
species). However, one member of a presumed endemic genus of beetle
(Lophothetes) was collected."41

VERTEBRATES. Despite the comparatively rich vertebrate fauna that characterizes
most areas of Palau, the island of Ngerur lacks terrestrial vertebrate biodiversity.42
Furthermore, foraging or roosting opportunities for Palauan fruit bats is limited
because the vegetation currently found on Ngerur Island [refer to Herbst, 1999] is
highly disturbed with almost no understory and few fruiting trees. Single bats were
detected on each of three mornings on site. Palauan fruit bats are known to both
forage and roost in small numbers in the forested parts of Ngerekebesang, Ngerchaol
and in large numbers on Ngeruktabel.43 "The resident sheath-tailed bat is ubiquitous
being present in almost all habitats in Palau even in the most heavily developed
industrial areas. The dominate mammalian species on Ngerur is the roof rat. Densities
encountered were extremely high. It is also likely that at least one other
species of the rat the Polynesian rat may also inhabit the Island. One other species of
muridae, the house mouse was also seen during our survey. We did not detect any
other mammalian species on the Island. Given the high densities of roof rats on the
Island it is not surprising that other vertebrate species diversity and densities were
found to be low. No trapping program was undertaken in conjunction with our
reconnaissance surveys in an attempt to ascertain any quantitative data on introduced
mammalian species. During the course of our survey we collected anecdotal
information indicating that a monkey had been reported several times from the Island.
We did not detect this animal while on island, given the coverage we gave the Island it
is unlikely that the animal is still present. The other five species of terrestrial
mammalian species known from the Republic of Palau are comensal or domesticated
farm animals. Because the Island is currently uninhabited it is not surprising that none
of these species were encountered."44

AMPHIBIANS AND REPTILES. "Unlike other area in Palau [the investigators] found
very little diversity in the terrestrial reptiles encountered. Recent surveys on
Babaldooob would suggest that most of the resident terrestrial amphibians and reptiles
found in Palau are relatively common and widely distributed throughout the Republic
of Palau.45 During the course of [the October 1999] survey [the investigators]
encountered only three of the 30 plus species of lizards previously recorded in Palau,

42 Ibid.
and only one of the [five] species of snakes. [The investigators] did not record either of the amphibian species commonly found throughout the rest of the country. The lack of understory and the high density of roof rats undoubtedly combine to limit terrestrial reptile diversity and populations to a minimum.

**AVIAN RESOURCES (BIRDS).** The avifauna currently found on Ngerur Island is depauperate when compared to that of [Arakabesan] and other surveyed areas of Palau. Forested areas on [Arakabesan] are regularly utilized by some 28 species of resident breeding birds, whereas only 12 forest bird species were detected on Ngerur, and only one was found to be nesting.\(^4^6\) “This disturbed nature of the vegetation coupled with the high density of rats currently found on Ngerur Island contributes to the limited avian diversity and population densities on the island. The avifauna found on Ngerur is dominated by native and indigenous species as is that found on other Islands located in close proximity to the Island. There is little habitat on the Island suitable for migrating shorebirds.”\(^4^7\) During the course of the survey conducted in October 1999, three such species utilizing the benthic shelf exposed at low tide were detected. Of the approximately 57 migratory and extralimital shorebirds and passerines that have been recorded in Palau, three of the more common ones were detected during this survey.

“The Lagoon and the Daerur straits separating Ngerur from Ngererbesang are utilized by a number of seabird species, most of the 13 species of resident seabirds use this area at least occasionally; in addition, 11 other species of migratory and extralimital seabirds recorded from Palau may upon occasion utilize resources within the lagoon and possibly the Daerur straits.

“There is no habitat on the Island of Ngerur suitable for the endangered Micronesian Scrubfowl. Ngerur does not support any suitable habitat for three of the other listed avian species found in Palau, these being the Pacific Black Duck, Common Moorhen, and White-breasted Woodswallow. Although there is no suitable habitat on the Island to attract or support the Nicobar Pigeon, it is likely that this species does occasionally utilize resources on the Island, and they may overfly the site on their way from roosting sites in the Rock Islands to foraging sites on Babeldaob.”\(^4^8\)

### 4.9 Coastal and Marine Resources

A bathymetric survey, accomplished during October 1998, shows that the 10-foot depth is typically reached at a distance of between 50 and 250 feet from the shore, and thereafter the bottom typically drops reasonably uniformly with a 1V:4H (25%) to 1V:5H (20%) slope. A wide (100 to 200 feet), shallow, rock, cobble and sediment bench is located on the southeast corner of the island, and the 10-foot depth is up to 400 feet offshore. On the northeast and northwest corners of the island the 100-foot depth is reached within about 500 feet off the shore. A diving reconnaissance off the north end of the island showed high relief coral coverage to

\(^{46}\) AECOS Consultants, 2000.
\(^{47}\) Ibid.
\(^{48}\) Ibid.
about the 30-foot depth, and thereafter a rock, sediment and scattered coral head bottom sloping uniformly to the 100 foot plus depth.

The following excerpt is from the report prepared by PENTEC Environmental, Inc. (1999).

"The coastal and marine habitats surrounding Ngerur Island demonstrate pristine conditions, though they do not, in general, conform to classic reef flat physiography or biological zonation patterns associated with coastal reef flats. This conclusion is supported by a nonexistent to limited intertidal and subtidal sandy reef flat and the preponderance of an intertidal basalt bench. Because of limited sand and coral rubble deposits, algal density and diversity is low. Seagrass (anthophyte) stands, often abundant in coastal mudflats and sand areas around the larger island in Palau (and occurring in high-density meadows on nearby [Arakabesan] Island), do not occur at Ngerur.

"A distinctive zone of *Porites lutea*, in both massive and micro-atoll morphologies, characterizes the reef flats around the island, as does a narrow but conspicuous soft coral zone (family *Alcyoniidae*) comprised of *Sinularia* sp. and *Sarcophyton* sp. However, an estimated 95 percent of the alcyonid corals were bleaching (yielding, in these two species, a bright yellow coloration), and moribund, and many were in an advanced stage of decomposition. A vertical and undercut basalt headland characterizes the shoreline on the south side of the island.

"Small crescent- to irregularly shaped rocky beaches occur around the perimeter of the island, though sand deposits are limited and probably experience a fugitive existence between major tropical cyclonic disturbances. Several pronounced rocky headlands protrude seaward roughly 30 meters on the west side of the island, and a massive boulder appears to have recently slumped into the intertidal zone on the east side of Ngerur.

"A massive, roughly 65-m-long basalt outcrop that partially exposes during low-tide periods forms a somewhat unusual wave-protected rocky intertidal moat on the southwest side of the island. Vertical to near-vertical rock escarpments and headlands dominate the back beach areas around most of the island, with some (on the north and west sides of the island) having steps cut into them to provide for foot access to the interior of the island from the shoreline.

"Except for a small stand of white mangrove (*Sonneratia alba*) occurring on the island’s east side, there are no wetland or estuarine plant communities occurring on or adjacent to Ngerur Island. Coastal strand and terrestrial vegetation ranges from a mixed grassland and fern understory with scattered *Pandanus* and *Cocos nucifera* palms, to dense upland forest vegetation and planted coconut groves in areas with deeper soils. Stands of the introduced tree casuarina (*Casuarina equisitifolia*) occur on some rocky, wind-exposed coastal headlands and rock outcrops where soils are thin to nonexistent.

"A small, possibly hand-dug, water-filled shoreline cave exists in the supratidal zone along the west side of the island. ...The cave may have been excavated into the near-vertical cliff face to create a source of fresh water for drinking and bathing. Despite months of drought conditions, the small cave was filled with fresh water and harbored..."
a small population of an unidentified, nearly transparent shrimp (possibly *Palaemon* sp; family *Palaemonidae*), and profuse growths of a filamentous green algae.49

After observed torrential rains, sheetflow cascades that originate between the island’s bedrock and thin soil veneer covered most of the shoreline cliff faces. Due to relatively undisturbed vegetation and soils, runoff water appeared free of significant amounts of silt.50

“Assessment of the status of coral communities (and coral-associated biota) on the subtidal habitats fronting Ngerur Island has indicated the existence of a stressed benthic community. Coral bleaching and the apparent decline in coral health appears to be the result of the 1998 ENSO event, which may have produced water temperatures debilitating and perhaps lethal to corals and other benthic species. It is uncertain at this time whether the bleached corals will survive or if overall coral diversity will be reduced, at least in the near term.

“A total of 39 coral, 72 fish, 15 algal, and 43 macroinvertebrate species were recorded in the course of baseline marine surveys conducted in inshore waters around Ngerur Island. These numbers compare with 163 corals, 66 fish, 33 algae, and 13 large, noncoral invertebrate species recorded on the reef flat and lagoon slopes in January 1976, and the then-proposed marine outfall site adjacent to the southern tip of Malakal Island.51

“The existing ENSO drought and high water temperatures may account in part for the few fish and macroinvertebrates recorded at the Ngerur Island site, though this event would not have affected the abundance or distribution of represented corals. Drought conditions and assumed low surface- and groundwater runoff could pose a limiting factor governing the presence, distribution, and abundance of algae, and directly or indirectly affect fish and other organisms depending on primary production.

“In general, coral community structure, diversity, and coverage in waters fronting the project site reflect a species composition that would be expected to occur on shallow, lagoon reef flats. These communities are dominated by hardy, robust, and relatively sediment-tolerant massive, submassive, and columnar corals, interspersed with occasional colonies of small foliaceous species.

“The impact of the warm ENSO water temperatures may eventually be reflected in the amount of live versus dead coral near Ngerur Island. Clearly, many of the hard corals were stressed and many appeared moribund. It is uncertain at this time whether these corals will survive. The fate of the soft-coral community is perhaps more precarious. An estimated 95 percent of the *Sinularia* and *Sarcophyton* appeared dead, with many colonies observed in an advanced state of decomposition.52

The following excerpt is from the report prepared by AECOS Consultants (2000).

“Two species of listed sea turtles, the green and hawksbill turtles, are known to nest in Palau. Both have been recorded nesting in small numbers on the beaches of the

49 PENTEC Environmental, Inc., 1999.
50 Ibid.
52 PENTEC Environmental, Inc., 1999.
Island of Babeldaob; however, the majority of the Palauan populations of both species nest south of Ngeruktabel. There are no extensive tidal mudflats and attendant algae and sea grass in close proximity to Ngerur to attract green sea turtles. Hawksbills, on the other hand, feed principally on sponges, crabs, sea urchins and jellyfish, thus might be more likely to be found in the waters off the Island. In talking with local residents familiar with the Ngerur area, they all stated that they very rarely saw sea turtles in close proximity to the Island.

“...the resident saltwater crocodile population has undergone a major drop in numbers due to human persecution. Messel and King estimate that at it’s height the resident population of crocodiles in Palau was close to 1,500 animals. Results from their extensive and very comprehensive survey conducted in 1991, indicate that the current population of this endangered crocodile is between 85 and 150 animals. They identified two remaining viable populations in Palau; one on Babeldaob in Ngerdok lake, and the other on Peleliu Island. They did encounter straggler animals in very small numbers in Airai, Ngeremeduu Bay, and along the west central coast on the Irur and Iwekei rivers. From their interviews with resident Palauans, Messel and King also reported that there is some movement of young crocodiles through the Rock Islands. There is no habitat on Ngerur Island suitable to support crocodiles.”

Only one of the three species of legally protected marine mammals known to occur in Palau has ever been recorded within the lagoon or close to the Island of Ngerur: the dugong (*Dugong dugon*). Both the blue whale and sperm whales are known from the oceanic regions of the Indo-Pacific area, but neither is expected to frequent the project vicinity.

“...the resident population of dugong in Palauan waters is estimated to number between 26 and 50 animals. It has been estimated that the current food supply available in Palau is sufficient to support some 2000 animals. However, given the low reproductive rate of this species and the unlikely chance of natural recruitment from other populations, this resident species is severely endangered. The principle predator of dugong are humans. If illegal poaching continues it will not be long before this species is extirpated from the Republic of Palau.

“Through most of their range dugongs spend their day in deep water, returning to shallower sea grass beds in the evening to forage. In Palau, dugongs forage in mixed seagrass beds made up of a variety of seagrass species including; *Enhalus acoroides*, *Thalassia hemprichii*, *Halophila ovata*, *Cymodocea rotundata* and *Syringodium isoetfolium*. They have also been recorded ingesting crabs, and in Palau, at least two species of sea cucumbers (*Holothuria atra* and *H. scabra*). In Palau, dugongs usually graze in lagoonal waters deeper than 7 meters which support relatively low biomass seagrass beds.

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Aerial surveys of dugong in Palau in 1978, 1983 and 1991 all found that the largest number of dugong were consistently found in the Malakal Harbor area. During the course of these same aerial surveys the closest that animals were detected to Ngerur Island, other than those recorded in the Malakal Harbor, was approximately 20 kilometers away. There are no suitable sea grass beds in close proximity to the Island; however, it is possible that animals occasionally pass close to the Island on their way to foraging areas located close to the outer reef and off of the north west coast of Babeldaob.

4.10 Historical and Archaeological Resources

During the Japanese administration, around the year 1930, a leper colony was established on Ngerur Island. Most of those banished to the island were Palauans, although a few foreigners were included. The fear associated with this disease attributed Ngerur Island a status of kapu. This fact was partially responsible for the lack of military defense installations there, despite the island's proximity (only 2 and 3 kilometers respectively) to the Arakabesan seaplane bases and strategic benefit (it would have provided control of the northern access to Malakal Harbor).

Thus Ngerur was excluded from the Japanese military build-up and avoided becoming a bombing and strafing target during U.S. air strikes launched from Aircraft Carriers on March 30 and 31, 1944 and July 25 through 27, 1944. Seaplane bases on nearby Arakabesan were destroyed during those bombing operations.

The presently remaining archaeological features on the island are almost entirely associated with the leper colony. A few of these features were presumably constructed or reconstructed after World War II when members of the Etpison family lived on the island.

Ngerur Island is practically devoid of remains of traditional Palauan culture. Eighteen (18) shovel tests placed across the island revealed no cultural deposits.

Fifty-eight (58) archaeological features with a wide range of feature-types were recorded on the island during the survey in October/November of 1998 (see Figure 32 and refer to Table 3 in Appendix B-6). The features are the result of domestic and farming activities by the leper colony established under the Japanese administration. Recorded features include a cemetery containing some 23 individuals. Additional burial sites, scattered on the island are assumed.

Ngerur Island is identified as Site OR-12:47 and is evaluated as "significant" under Criterion D of the Palau National Code, Title 19, the Palau Historical and Cultural Preservation Act. Criterion D defines significance as "possession of integrity of location, design, setting, materials, workmanship, feeling, and association and a potential to yield information important in Palau's history."

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62 Ibid.
64 Palau National Code, Title 19.
4.11 Hazardous and Toxic Materials Considerations

For the most part, Hazardous and Toxic Materials (HTM) are not yet critical issues in the Republic of Palau due to the absence of heavy industry. Areas that have not yet been touched by modern development and consumer lifestyles remain notably pristine with respect to HTM. Nevertheless, the use and disposal of HTM is expected to increase in conjunction with urban development. Potential environmental degradation may be associated with HTM misuse, illicit disposal or spills. Sources of contamination may include fueling stations and storage area, power plants, quarries, construction sites and asphalt batching plants.

The ROPG, through the Pesticide Program, undertakes use inspections, import monitoring, market surveillance, monitoring of pesticide container disposal and pesticide application testing. Currently, there are no specific HTM substance regulations other than for pesticides. EQPB currently performs limited testing for environmental contaminants.

Considerations pertaining to a potential ordnance hazard are associated with the militarization of the Palau Islands by Japan after the First World War and from military buildup during World War II. Ammunition stockpiles that were dumped into streams, thrown over cliffs or abandoned at remote storage sites continue to be discovered. Other potential ordnance sites include terrestrial and marine post-war dumpsites, reef areas and mangrove channels that were subjected to severe American bombardment during the World War II.

The absence of military use on Ngerur Island suggest that the potential for discoveries of unexploded ordnance (UXO) is low. A UXO field reconnaissance survey was conducted by Bombs Away, Inc. (refer to the appended report). The UXO Consultants "walked the perimeter of Ngerur Island and criss-crossed the island on foot using hand-held magnetometry equipment." A hydrographic survey was also accomplished in the waters around the island using divers who visually inspected the area to a depth of sixty feet.

The following information is excerpted from the UXO Survey Report, Ngerur Island, Palau (Bombs Away, Inc.). Refer to Appendix B-7 for the investigation report.

"An ordnance item was found on the shoreline. The item was a projectile. This item was brought to the island recently and it appeared to be modified. The filler is cement and perhaps the item is now used as some sort of anchor for a buoy perhaps. The item poses no hazard. Normally, this type of item would pose a high explosive threat. The island has many 'hot' rocks. This means that many of the rocks on the island have the signature of a piece of ferrous metal. This is not uncommon. Outside the rocks, no other magnetic anomalies were found."65

65 Bombs Away, Inc., (no date).
66 Ibid.
4.12 Land Use Considerations

During the session of the Sixth Koror State Legislature, July/August 1999, the Koror State Zoning Map was amended to re-zone Ngerur Island from CD “Conservation” to RV “Resort Center Zone” (refer to Appendix B-8). Figure 33 illustrates the existing land use classifications. The intent of the RV “Resort Center Zone” is intended to provide areas for integrated resort development that would include a variety of visitor-oriented uses and to encourage economic development by protecting areas particularly suited to resort use from encroachment by other uses.67

Per §3162 of the Koror Zoning Law, no building or land shall be used and no building erected except for one or more of the following specified uses in the “RV” Resort Center Zone.

- Hotels;
- Restaurants, nightclubs, bars and other similar uses; and
- Accessory buildings and uses customarily incident to the above uses.

Per §3164 of the Koror Zoning Law, area and bulk requirements are the following:

- Maximum density is 20 guest bungalows per acre;
- No minimum lot size required;
- Front yard setback is 20 feet;
- Side yard setbacks are 10 feet; and
- Rear yard setback is 10 feet.

4.13 Aesthetic Considerations

The remote island of Ngerur is situated in the Palau lagoon and away from the main islands such that panoramic views from the island are largely unobstructed and most often spectacular. Main vistas from Ngerur Island extend in a northeastern direction toward the large main island of Babeldaob; views to the southeast encompass the distinctive silhouettes of distant Rock Islands. To the southwest lies Arakebesan Island; it is the nearest landmass to Ngerur Island and the feature that defines the horizon. The remaining western and northern views are of the unobstructed and open lagoon and ocean waters.

4.14 Public Services and Facilities

4.14.1 WATER SYSTEM

In its current state, the uninhabited and undeveloped island of Ngerur has no water system and generates no demand for this service. The island is situated outside the area served by the nearest municipal water supply system.

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67 Koror Zoning Law
Sources:
Zoning Map, Koror - Koror Planning Commission 1998
KSPL No K6-102-98 (Bill No. 6-42, LD1)
The Republic of Palau Office of the Minister, Ministry of Resources and Development, Bureau of Public Works (BPW) is responsible for the operation and maintenance of the Koror-Airai water supply system. Water sources for the Koror water supply system are generated in Airai State at Ngirimel dam and Ngirikiil River. The total average discharge is 40 million gallons (150 million liters) per day. The water from these two sources is processed at the Airai Water Treatment Plant and then supplied to the consumers in the urbanized Koror-Airai areas.

Currently, an uninterrupted supply of potable water is not guaranteed by the BPW. A new water treatment plant is nearing completion, but is not expected to be fully operational until the year 2000. With its completion, an uninterrupted supply of water can be anticipated; however, the distribution system has undersized pipelines that may restrict the ability to deliver water and/or deliver at an adequate pressure.

4.14.2 WASTEWATER SYSTEM

In an undeveloped and uninhabited state, the island of Ngerur contains no wastewater system and generates no demand for this service. Ngerur Island is situated outside the area served by the nearest municipal wastewater collection and disposal system.

Koror is the only state in Palau that has a centralized wastewater collection and disposal system. The Sewer Branch of the BPW is the government agency that handles the day-to-day operations of the wastewater collection system. The primary functions of the BPW with respect to the municipal system include the operation, maintenance, repair and overhaul of the system, including sewage pump stations.

The Sewer Branch of the BPW also operates and maintains the Malakal WWTP located in the southeastern part of Malakal Island. Treated effluent is conveyed downwards via a 2,000-foot (616-meter) long sewage outfall pipe with a diameter of 18 inches (46 centimeters) to a depth of approximately 60 feet (18 meters) in Malakal Harbor. There, the effluent is discharged through two 6-inch (15-centimeter) diameter pipe diffusers and dispersed with the tidal currents.

Malakal WWTP was originally designed for a treatment capacity of one million gallons of domestic wastewater per day and put in operation in the late 1970’s. Indications are that this WWTP is presently operates only in primary treatment plant despite its design which allows for secondary treatment.

Wastewater flows received at the plant have been steadily increasing. This is expected to continue. The plant averaged about 1.3 mgd during the first three months of 1993. Flows during prolonged periods of wet weather have reached as high as 2.4 mgd. Available studies project a potential average of 1.7 mgd by the year 2000. Accordingly, the expansion of the treatment capacity of the Malakal WWTP is "one of the highest priorities of both the Palau National Government and the Koror State Government." Proposed expansion of the WWTP

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"is designed to double the capacity of the treatment facility, up from 1.0 mgd to 2.0 mgd." With the canceling of the expansion contract, the ROPG is exploring renovation of the existing plant and the subsequent implementation of a wetland treatment system. The ROPG is contemplating construction contracts and pursuing adequate funding for the improvements. Wastewater lines continue to be problematic for the collection system in areas where the full load of the collection system is concentrated (e.g., Malakal). Wastewater has surcharged the manhole lids during heavy storm events and infiltration/inflow (I/I) problems plague the system.

4.14.3 DRAINAGE AND IRRIGATION SYSTEM

The undeveloped and uninhabited island of Ngerur contains no manmade storm drainage systems at this time. Storm runoff must either percolate through the surface soils or drain by undirected sheetflow via natural drainage routes.

4.14.4 SOLID WASTE DISPOSAL SYSTEM

The undeveloped and uninhabited island of Ngerur is not currently served by an organized garbage collection system. In its current state, Ngerur Island generates no demand for solid waste disposal service and lies outside the service area. Nevertheless, numerous instances of litter presumably left by periodic visitors have been noted on the island.

The public dump site is located on a bund over reef flats adjacent to "M" Dock in central Koror. A study for the closure and relocation of this primary public disposal site was recently completed. A site selection effort for the new landfill site in the Nekken/Oisca region is presently underway by the Ad Hoc Committee on Aimeliik State Sanitation Facility. The Australian firm of Golder Associates has already been contacted to do the initial design and establish project costs. Preparation for the transfer of the landfill site would also involve excavation of materials in the old dump and their relocation for final disposal at the new site.

4.14.5 ELECTRICAL AND COMMUNICATION SYSTEMS

Ngerur Island lacks electrical and communication systems at this time. In its undeveloped and uninhabited state, Ngerur Island generates no demand for electrical or communication service. The project site lies outside the service area for electrical and communication service.

The Republic of Palau, like many Pacific Island nations, relies heavily on imported petroleum fuels to generate electricity. Electrical power generation accounted for 44 percent of petroleum consumption in 1993 and is a major sector of the economy. The ROPG in the form of the Public Utility Corporation (PUC) is the only entity to produce and sell the power as a utility service.

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Two main power-generating facilities are the 12.8-megawatt Aimeliik power plant and the 6.25-megawatt Malakal plant. Electrical power is distributed via overhead lines on concrete poles that have largely replaced wood poles. PUC is responsible for maintaining assets, retailing electric power to consumers and operating the government-owned power system.

Palau National Communication Corporation (PNCC) is a public corporation and provides and operates both domestic and international telecommunication services within the Republic of Palau. Overhead cables are being replaced with an underground copper distribution system. Fiber optics and microwave technologies are also being utilized to expand the telecommunications system.

ROPG involvement extends to cable TV service and the radio broadcasting system. Expansion of the cable TV network is occurring with the expansion of the underground fiber optic network. A privately owned and operated 175-kilowatt radio broadcasting system (KHBN) provides an alternative to the Republic of Palau-owned and operated 5-kilowatt station (WSZB).

4.14.6 CIRCULATION AND TRAFFIC

Ngerur Island is presently uninhabited and accessible only by boat. Since it is in private ownership and there are few visitors, the island lacks a landing dock for small vessels. Due to the topography of the island, there are few areas where access from boat is relatively easy. All circulation on the island is by foot.

4.14.7 DOCKING FACILITIES

The privately owned, undeveloped and uninhabited island of Ngerur contains no docking facilities at this time. The low usage of the island by the owners or their guests generates little demand for formal docking facilities at this time.

4.14.8 PUBLIC SAFETY AND FIRE PROTECTION SERVICES

Ngerur Island in its undeveloped and uninhabited state generates little demand for public safety or fire protection services. These services are administered by the national government through the Ministry of Justice. Koror has been the center for a majority of the services now under this ministry for most of the years since World War II. Limited services were extended to Airai in 1976 with the connection of the K-B Bridge and to other Babeldaob states in 1980 as roads were established. Further expansion of facilities (i.e., sub-stations) and services is being developed. Infrastructure strengthening and development to streamline and improve the information system for the Ministry is ongoing. Improvements are expected to enhance reporting and management.
4.14.9 HEALTH CARE AND EMERGENCY SERVICES

In an uninhabited state, the island of Ngerur hosts no permanent resident population requiring health care and emergency services. These services are provided by the ROPG through the Ministry of Health as mandated under Article 6 of the Constitution and 24 PNC. The government-operated Belau National Hospital (BNH) is a fairly new 80-bed facility that is situated on the island of Arakabesan. Public health services include preventive and primary health care services are provided through regular outreach services via boat and motor vehicles.

Belau Medical Clinic and the Seventh Day Adventist Clinic are private facilities staffed with physicians who have hospital privileges at BNH. The clinics provide medical and primary care services. Optical and dental services are available at the Seventh Day Adventist Clinic.

4.14.10 EDUCATIONAL SERVICES AND FACILITIES

In an undeveloped and uninhabited state, the island of Ngerur hosts no permanent resident population requiring educational services and facilities. The educational system in the Republic of Palau is generally modeled after the U.S. system in terms of goals, curricula, technology and governance. The ROPG provides free and compulsory education to all Palauan children between six and fourteen years old through an eight-year elementary program in accordance with PNC Title 22, Subchapter IV, §159.1414. The Ministry of Education budget for the 1995-1996 school year was $5,398,771, or an equivalent of $1,912 per student.70 Every child in Palau has had the opportunity to subsidized education within the proximity of his/her home for the past 50 years. The public school student/teacher ratio averages ten students to one teacher.71

There are twenty-two public and two parochial elementary schools distributed throughout the sixteen states of the Republic of Palau. Of this number, Koror has three public and two parochial schools. There are five parochial high schools and one public high school in the Republic of Palau. Of this number, three schools are located in Koror and three are on Babeldaob. Free education services are provided at the public high school to ninth to twelfth grade students who pass the high school entrance examination.

Palau Community College, formerly a trade school, is becoming a two-year college offering basic liberal arts courses. Specific courses in tourism-related and business areas are being developed to meet local needs and the increased demands of a developing economy.

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70 PRI, 1996.
71 SAGRiC International Pty. Ltd., 1996.
4.14.11 PARKS AND RECREATIONAL FACILITIES

The island of Ngerur does not contain a public park nor does it serve as a public recreation resource. In an uninhabited state, the island of Ngerur hosts no permanent resident population requiring parks or recreational facilities.

4.15 Socio-Economic Considerations

4.15.1 DEMOGRAPHICS

In its undeveloped state, the island of Ngerur contains no resident human population. The island therefore makes no contribution to the population of the Republic of Palau.

The 1990 Census indicated a population of 15,122. The median age was 25.7 years. In 1995 the total population of the Republic of Palau was estimated to be 17,408, consisting of 13,384 Palauans and 4,024 foreigners. The average growth trends during the last three decades were as follows:

<table>
<thead>
<tr>
<th>Decade</th>
<th>Annual Growth Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950's</td>
<td>3.1 percent</td>
</tr>
<tr>
<td>1960's</td>
<td>2.5 percent</td>
</tr>
<tr>
<td>1970's:</td>
<td>relatively stagnant</td>
</tr>
<tr>
<td>1980's:</td>
<td>2.4 percent</td>
</tr>
<tr>
<td>1990 to 1995:</td>
<td>2.9 percent (estimated)</td>
</tr>
</tbody>
</table>

It appears that the increased growth rate during the 1990's is due to the influx of foreign labor, 75 percent of which originates in the Philippines and 10 percent originates in Taiwan and China. Foreign workers totaled an estimated 4,300 in 1992.

The geographic distribution of Palau's population is extremely uneven, with 69 percent of the population being concentrated in the State of Koror. The next highest populated States are Airai (8 percent), Peleliu (4 percent), and Aimeliik (2.9 percent). The average of the remaining states is 1.3 percent.

Assuming a proportional growth in State population with the national trend, Koror will have a population of 14,106 by the year 2000, or 69 percent of a projected total population of 20,314.

The following table shows the population distribution for the year 1990. Slightly more than 30 percent was less than 15 years of age. At the other end the age distribution, about six percent of the population was 65 years old and over.
TABLE 11: 1990 POPULATION DISTRIBUTION.

<table>
<thead>
<tr>
<th>AGE GROUP IN 1990</th>
<th>TOTAL</th>
<th>MALE</th>
<th>FEMALE</th>
<th>TOTAL PERCENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 5</td>
<td>1,513</td>
<td>766</td>
<td>747</td>
<td>9.4</td>
</tr>
<tr>
<td>5 - 9</td>
<td>1,529</td>
<td>793</td>
<td>736</td>
<td>10.1</td>
</tr>
<tr>
<td>10 - 14</td>
<td>1,534</td>
<td>807</td>
<td>727</td>
<td>10.1</td>
</tr>
<tr>
<td>15 - 19</td>
<td>1,464</td>
<td>795</td>
<td>669</td>
<td>9.7</td>
</tr>
<tr>
<td>20 - 24</td>
<td>1,340</td>
<td>738</td>
<td>602</td>
<td>8.9</td>
</tr>
<tr>
<td>25 - 29</td>
<td>1,403</td>
<td>799</td>
<td>604</td>
<td>9.3</td>
</tr>
<tr>
<td>30 - 34</td>
<td>1,338</td>
<td>768</td>
<td>570</td>
<td>8.8</td>
</tr>
<tr>
<td>35 - 39</td>
<td>1,243</td>
<td>720</td>
<td>523</td>
<td>8.2</td>
</tr>
<tr>
<td>40 - 44</td>
<td>873</td>
<td>514</td>
<td>359</td>
<td>6.3</td>
</tr>
<tr>
<td>45 - 49</td>
<td>666</td>
<td>375</td>
<td>291</td>
<td>4.4</td>
</tr>
<tr>
<td>50 - 54</td>
<td>513</td>
<td>279</td>
<td>234</td>
<td>3.4</td>
</tr>
<tr>
<td>55 - 59</td>
<td>403</td>
<td>208</td>
<td>195</td>
<td>2.7</td>
</tr>
<tr>
<td>60 - 64</td>
<td>387</td>
<td>181</td>
<td>206</td>
<td>2.6</td>
</tr>
<tr>
<td>65 - 69</td>
<td>332</td>
<td>154</td>
<td>178</td>
<td>2.2</td>
</tr>
<tr>
<td>70 - 74</td>
<td>249</td>
<td>117</td>
<td>132</td>
<td>1.6</td>
</tr>
<tr>
<td>75 plus</td>
<td>335</td>
<td>125</td>
<td>210</td>
<td>2.2</td>
</tr>
<tr>
<td>TOTAL</td>
<td>15,122</td>
<td>8,139</td>
<td>6,983</td>
<td>100</td>
</tr>
</tbody>
</table>

Economic Development Plan population projections based trends of birth, death, and migration rates are provided below for a projection period up to the year 2020:

TABLE 12: ECONOMIC DEVELOPMENT PLAN POPULATION PROJECTIONS.

<table>
<thead>
<tr>
<th>YEAR</th>
<th>POPULATION</th>
<th>GROWTH RATE (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>20,314</td>
<td>2.609%</td>
</tr>
<tr>
<td>2005</td>
<td>22,947</td>
<td>2.262%</td>
</tr>
<tr>
<td>2010</td>
<td>25,513</td>
<td>1.95%</td>
</tr>
<tr>
<td>2015</td>
<td>27,967</td>
<td>1.720%</td>
</tr>
<tr>
<td>2020</td>
<td>30,326</td>
<td>1.543%</td>
</tr>
</tbody>
</table>

The Republic of Palau Committee on Population and Children has developed another set of population growth projections through the year 2020. This committee considered three population scenarios:

- A high growth scenario estimates the 2020 population to be 35,298;
- A moderate growth scenario estimates the 2020 population to be 25,885; and
- A sustainable growth scenario estimates the 2020 population to be 20,279.
### TABLE 13: POPULATION PROJECTIONS (HIGH GROWTH SCENARIO).

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Palauan population</td>
<td>13,120</td>
<td>14,193</td>
<td>15,222</td>
<td>16,350</td>
<td>17,445</td>
</tr>
<tr>
<td>Potential Palauan labor force</td>
<td>8,133</td>
<td>9,509</td>
<td>10,351</td>
<td>11,281</td>
<td>12,211</td>
</tr>
<tr>
<td>Labor force participation</td>
<td>62%</td>
<td>75%</td>
<td>77%</td>
<td>79%</td>
<td>80%</td>
</tr>
<tr>
<td>Palauans in the labor force</td>
<td>5,029</td>
<td>7,134</td>
<td>7,970</td>
<td>8,912</td>
<td>9,769</td>
</tr>
<tr>
<td>Workers required by economy</td>
<td>7,759</td>
<td>24,932</td>
<td>33,198</td>
<td>42,170</td>
<td>53,546</td>
</tr>
<tr>
<td>Non-Palauan workers</td>
<td>N/A</td>
<td>18,155</td>
<td>25,625</td>
<td>33,704</td>
<td>44,265</td>
</tr>
<tr>
<td>Non-Palauan population</td>
<td>4,105</td>
<td>21,105</td>
<td>30,888</td>
<td>40,068</td>
<td>52,746</td>
</tr>
<tr>
<td>TOTAL POPULATION</td>
<td>17,225</td>
<td>35,298</td>
<td>45,910</td>
<td>56,418</td>
<td>69,746</td>
</tr>
</tbody>
</table>

### TABLE 14: POPULATION PROJECTIONS (MODERATE GROWTH SCENARIO).

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
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<td>77%</td>
<td>79%</td>
<td>80%</td>
</tr>
<tr>
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<td>7,970</td>
<td>8,912</td>
<td>9,769</td>
</tr>
<tr>
<td>Workers required by economy</td>
<td>7,759</td>
<td>16,547</td>
<td>21,196</td>
<td>26,313</td>
<td>32,810</td>
</tr>
<tr>
<td>Non-Palauan workers</td>
<td>n.a.</td>
<td>9,770</td>
<td>13,624</td>
<td>17,847</td>
<td>23,529</td>
</tr>
<tr>
<td>Non-Palauan population</td>
<td>4,105</td>
<td>11,687</td>
<td>15,932</td>
<td>20,583</td>
<td>26,807</td>
</tr>
<tr>
<td>TOTAL POPULATION</td>
<td>17,225</td>
<td>25,880</td>
<td>31,154</td>
<td>36,933</td>
<td>44,252</td>
</tr>
</tbody>
</table>

### TABLE 15: POPULATION PROJECTIONS (SUSTAINABLE GROWTH SCENARIO).

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Palauan population</td>
<td>13,120</td>
<td>14,193</td>
<td>15,222</td>
<td>16,350</td>
<td>17,445</td>
</tr>
<tr>
<td>Potential Palauan labor force</td>
<td>8,133</td>
<td>9,509</td>
<td>10,351</td>
<td>11,281</td>
<td>12,211</td>
</tr>
<tr>
<td>Labor force participation</td>
<td>62%</td>
<td>75%</td>
<td>77%</td>
<td>79%</td>
<td>80%</td>
</tr>
<tr>
<td>Palauans in the labor force</td>
<td>5,029</td>
<td>7,134</td>
<td>7,970</td>
<td>8,912</td>
<td>9,769</td>
</tr>
<tr>
<td>Workers required by economy</td>
<td>7,759</td>
<td>11,492</td>
<td>13,682</td>
<td>16,147</td>
<td>19,045</td>
</tr>
<tr>
<td>Non-Palauan workers</td>
<td>n.a.</td>
<td>4,715</td>
<td>6,110</td>
<td>7,681</td>
<td>9,764</td>
</tr>
<tr>
<td>Non-Palauan population</td>
<td>4,105</td>
<td>6,086</td>
<td>7,633</td>
<td>9,373</td>
<td>11,648</td>
</tr>
<tr>
<td>TOTAL POPULATION</td>
<td>17,225</td>
<td>20,279</td>
<td>22,855</td>
<td>25,723</td>
<td>29,093</td>
</tr>
</tbody>
</table>
The Office of the President's Committee on Population Policy and Children formulated a Draft National Population Policy. Two of its main recommendations are listed below:

- That population growth be contained in balance with Palau's environment and infrastructure; and
- That an effective balance be maintained between Palauan and non-Palauan residents.

### 4.15.2 HOUSING

There is currently no resident human population on Ngerur Island resulting in no housing demand. As a result of its undeveloped and uninhabited state, the island of Ngerur makes no contribution to the available housing supply.

So far, homelessness and lack of shelter are relatively unknown in the Republic of Palau. This fact is most certainly influenced by the traditional Palauan culture and is expected to continue as long as this traditional influence remains strong.
Census data indicates that in 1990 there were 3,312 houses as compared to 2,496 in 1986. This reflects an increase of 816 houses or 33 percent. Of the total housing stock in the Republic of Palau, 63 percent or over 2,000 housing units are located in Koror State.

### 4.15.3 LABOR AND EMPLOYMENT

In an undeveloped state, the island of Ngerur contains no activities that generate employment opportunities or create a labor demand. Ngerur Island therefore makes no contribution to the labor supply and job market in the Republic of Palau.

Palau's labor force as a percentage of the total population sixteen years and older has been rising from approximately 40 percent in 1980 to approximately 60 percent in 1990. In 1990, slightly more than 50 percent of the potential Palauan work force was participating in the formal labor force.

Of the total 1990 labor force of 6,072 persons, 63.5 percent were Palauans and 31.5 percent were foreigners. Nearly four fifths of the foreigners were from the Philippines.

Palauan workers generally dominate the public sector, whereas foreign labor force increasingly dominates the private sector.

Employment projections for the year 2000 for different industry categories show that four categories are projected growing to represent more than 10 percent each of the total projected employed work force of 8,533 in that year:

- The tourist sector to 16.7 percent;
- The professional service sector to 15.0 percent;
- The construction sector to 14.6 percent; and
- The retail trade sector to 13.1 percent.

In order to assess local recruitment opportunities for employment and training in the tourist sector during the next ten years, the population figures of 1990\(^2\) were be extrapolated. The two most important age groups of 1990 in this respect are age 5 to 9 and age 10 to 14 years. The 5 to 9 year old population group of 1990 will be 15 to 19 years old in 2000. This segment of the population had a 1990 total of 1,529 persons (counting both sexes). The 10 to 14 year old population group of 1990 will be 20 to 24 years old in 2000. This group had a 1990 total of 1,534 persons (counting both sexes).

The extrapolated figures represent an important segment of the local population available to the future labor market in general and the tourist sector specifically. It is presumed that within this age group the motivation for work is very high since it might include training and prospects for career advancement.

The combined total of the two age groups described above is 3,063 persons. Experience shows that the out migration rate in this age group is approximately 14 percent or roughly 420 persons. The remaining total number is therefore 2,640 persons.

Employment of the tourist sector is projected to represent approximately 17 percent of the work force. If the same percentage of 15 to 24 year olds in the year 2000 decides to work in the tourist sector, their available work force in this sector would represent approximately 450 persons (counting both sexes) in the year 2000.

A combination of these figures with the above mentioned growth scenarios results in the following conditions:

- The sustainable growth scenario projects approximately 1,860 newly required jobs in the year 2000. By assuming that 17 percent of the labor force is in the tourist sector, the newly required work force in the tourist sector would be approximately 320. In this growth scenario the newly required work force in the tourist sector in 2000 could be supplied by the available local population growth in the 15 to 24 year old age sector.

- The moderate growth scenario projects approximately 4,400 newly required jobs in the year 2000. By assuming that 17 percent of the labor force is in the tourist sector, the newly required work force in the tourist sector would be approximately 750. In this growth scenario the newly required work force in the tourist sector in 2000 could not be fully supplied by the available local population growth in the 15 to 24 year old age group. Either local workers from other sectors, other local age groups or imported workers would have to be considered to fill the job vacancies.

The following tables illustrate the labor need in the tourist sector for the years 2000 and 2005 not only in relation to a specific age group but in relation to the whole Palauan population. The data is based on the projection numbers of the three mentioned growth scenarios furnished by Palau’s Committee on Population and Children. A continuing 17 percent labor ratio in the tourist sector is assumed.

**TABLE 17: YEAR 2000 PROJECTED LABOR FORCE IN TOURISM.**

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Total work force required</th>
<th>Required work force in tourism</th>
<th>Palauan work force in tourism</th>
<th>Required foreign work force in tourism</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Growth Scenario</td>
<td>16,345</td>
<td>2,770</td>
<td>1,033</td>
<td>1,737</td>
</tr>
<tr>
<td>Moderate Growth Scenario</td>
<td>12,153</td>
<td>2,060</td>
<td>1,033</td>
<td>1,027</td>
</tr>
<tr>
<td>Sustainable Growth Scenario</td>
<td>9,625</td>
<td>1,632</td>
<td>1,033</td>
<td>599</td>
</tr>
</tbody>
</table>
TABLE 18: YEAR 2005 PROJECTED LABOR FORCE IN TOURISM.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Total work force required</th>
<th>Required work force in tourism</th>
<th>Palauan work force in tourism</th>
<th>Required foreign work force in tourism</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Growth Scenario</td>
<td>24,932</td>
<td>4,238</td>
<td>1,212</td>
<td>3,026</td>
</tr>
<tr>
<td>Moderate Growth Scenario</td>
<td>16,547</td>
<td>2,812</td>
<td>1,212</td>
<td>1,600</td>
</tr>
<tr>
<td>Sustainable Growth Scenario</td>
<td>11,492</td>
<td>1,953</td>
<td>1,212</td>
<td>741</td>
</tr>
</tbody>
</table>

4.15.4 ECONOMIC CONDITIONS

The island of Ngerur is undeveloped such that it contains no income-generating activities. Ngerur Island therefore makes relatively no contribution to the national or local economy.

Since the basis for a self-reliant economy is to pay for its own domestic consumption and investment needs, the Palau government will pursue the course of redirecting consumption as much as feasible from imports to domestic production of both goods and services. The service sector, including government services is the predominant part of the Palauan economy. The service sector represented 60 percent of the Gross Domestic Product (GDP) in 1992, whereas government services alone accounting for 16 percent.

Hotels and restaurants represent a growing segment of this sector; however, tourism growth represents a decisive challenge insofar as it must be accomplished in a sustainable manner in order to remain a centerpiece of Palau’s market economy. This can only be achieved if the conservation and sustainable management of Palau’s unique terrestrial and aquatic resources are guaranteed in spite of invited tourism growth.

The key to the survival of Palau’s pristine environment and incomparable marine resources depends, as tourism projects in other parts of the world demonstrate, in the attraction of predominantly small scale, unique resort projects designed to attract a limited but affluent number of travelers.
5.0 ENVIRONMENTAL CONSEQUENCES

This chapter is organized according to the resources that may be affected by the proposed action. Discussions and evaluations of the environmental consequences for other alternatives and no action are unnecessary because all of the other options and no action were eliminated from further consideration (refer to Chapter 3.0).

5.1 Geography and Topography

Project actions are expected to have no effect on the geography of the project site. No mitigation with respect to the geography is therefore warranted.

Localized alteration to the topography of Ngerur Island from earth moving and land filling activities will occur as a result of construction activities such as grading and excavation for the placement of structures. Creation of the harbor will also affect the underwater topography in areas of proposed dredging. The above-mentioned activities are necessary for the development of the proposed resort and its related features.

The beneficial use of the island as a result of proposed resort development is expected to partially offset unavoidable impacts associated with construction. Specific mitigation measures that minimize impacts from erosion, runoff and sedimentation are described in subsequent sections of this document (refer to Sections 5.2 and 5.3).

Construction practices will be accomplished with best management practices (BMPs) in an environmentally responsible manner consistent with the required earthmoving permit issued by
5.2 Geology and Soils

The underlying geology of the area will be minimally affected by project actions associated with proposed resort development. No mitigation with respect to the geology is therefore proposed or considered warranted.

Potential erosion could occur as a consequence of localized alterations and land-disturbing activities (grading, excavation, the placement of fill). Exposed soils are susceptible to erosion, especially if it rains heavily during site work periods. Wind erosion is expected to cause some unavoidable soil loss, but the greater concern is silt runoff. Potential adverse impacts are expected to be short-term and temporary; however, completion and operation of the resort project is expected to result in no adverse impacts to soils. As a result of the proposed action, developed areas will consist of impermeable surfaces and bare subsoil areas that have been landscaped to generally re-establish the soil retention value of removed vegetation.

Disturbances to the ground surface will be accomplished only to the extent necessary for construction. General recommendations from the geotechnical engineering exploration report (Geolabs, Inc., 1999) are listed below; specific recommendations pertaining to shallow foundations, retaining structures, the utility building, walkway slabs, pile foundations, site grading, breakwater structures, utility trenches and drainage are included in the appended geotechnical engineering exploration report.

"...a shallow foundation system consisting of posts-and-beams may be used to support the one to three-story buildings planned for the resort development. An allowable bearing pressure of up to 3,500 pounds per square foot (psf) may be used for the design of the post footings bearing on the stiff soils and/or volcanic rock surface. The recommended bearing pressure may be increased to 10,000 psf for footings embedded into the dense volcanic breccia rock formation anticipated at shallow depths. A minimum footing embedment of 1 and 4 feet may be used for footings bearing on the dense volcanic breccia rock and the near-surface stiff soils, respectively.

"For the docking facilities and boat canopy structures planned for the proposed resort development, ...16-inch octagonal, precast prestressed concrete piles end-bearing in the dense volcanic breccia rock formation [may] be used to support the proposed structures. The driven piles may be designed based on an allowable compressive load of about 200 kips (100 tons). A preliminary pile length of up to about 30 feet may be used for the recommended pile foundation design. Installation of the driven pile foundation should be conducted after the harbor dredging operation to reduce the
potential for disturbance to the driven pile foundation and reduction in pile capacity. In order to facilitate the pile driving operation into the dense volcanic breccia rock formation, predrilling at the proposed pile location to Elevation -22 feet MSL (10 feet below the finished dredged elevation) will be required prior to pile installation. The diameter of the predrilled holes should be at least 24 inches in diameter to facilitate socketing the pile into the dense volcanic breccia rock formation and to provide the necessary lateral load resistance to the pile foundations. The annular space between the drilled hole and the pile should be grouted.

"...the proposed harbor area enclosed within the shoreline and the breakwater structure will be dredged to a depth of about Elevation -12 MSL. Based on the subsurface materials encountered in [the] borings, ...the materials encountered within the harbor area may be excavated to a slope inclination of about 2H:1V from the existing mudline down by about 5 feet to account for the sediments in the area. Below the upper 5 feet measured from the existing mudline, ...a slope inclination of 0.5H:1V may be used for the dredged excavations, which will likely expose the dense volcanic breccia rock formation.

"...the surface soils appear to be relatively porous with good percolation characteristics when the soils are left undisturbed, or in its natural state. However, drainage and infiltration characteristics will become very poor when the on-site soils are being disturbed and/or recompacted. Therefore, ...disturbance to the on-site soils should be kept to a minimum during the earthwork operations. In areas where the surface soils have been reworked or recompacted, a surface water runoff collection system may need to be incorporated into the project construction for proper drainage and erosion protection."73

Temporary and permanent erosion and sedimentation control measures will be implemented as project features. The construction Contractor will implement an Erosion Control Plan. Features of the erosion control initiative are hereby reiterated from Section 3.1.4:

- Minimize earth movement.
- Minimize vegetation removal.
- Limit the amount of exposed areas at any one time.
- Treat completed cut and fill slopes with erosion control matting.
- Cut interceptor ditches along the top of the cut slopes.
- Sequence earthmoving activities and proceed from high points to lower points.
- Avoid earthwork during heavy rains, as much as practicable.
- Incorporate water quality protection measures.
- Focus on erosion and siltation control measures and containment of HTM.
- Install 6- to 12-inch thick compacted coral subsequent to the clearing of vegetation on temporary access roads as a means to contain and seal off exposed clay materials along the routes to building sites.
- Stockpile suitable organic soils from the road and building site excavation for use as topsoil during the landscaping phase. Protect stockpiled material with tarps.

- Trench and form a sediment pit approximately 3 feet long by 3 feet wide by 3 to 4 feet deep next to each stockpile of earth/dirt. Position a silt curtain to allow the overflow from the sediment pit including fine sediments to filter through the cloth.
- Provide a trench around each building site that will drain to the lower end. Install a sediment pit and filter cloth trap at the lower end that will protect surrounding areas from sediment runoff. Install a silt curtain around each excavated area to catch any runoff that may occur in these areas. Bury the lower end of a silt fence approximately 2 feet high some 12 inches below the ground surface as a means to catch potential runoff.
- Stockpile and cover the material from sediment pits prior to its removal from the site by a dump truck.
- Install a floating silt curtain with 1-inch separation and 2-foot silt screen around the entire island of Ngerur.
- Monitor stormwater runoff from construction activities. Inspect stormwater controls and potential construction areas exposed to stormwater runoff following storm events characterized by 0.5 inches rainfall or greater in 24 hours. Annotate all deficiencies in the erosion control system on an inspection log. Take the necessary action to correct observed deficiencies.

As a result of all the measures described above that will be implemented as project features, no mitigation is proposed or considered warranted with respect to soils.

5.3 Hydrology and Water Quality

The proposed action is expected to result in no alteration to hydrological systems since no such systems presumably exist on Ngerur Island or within its general vicinity. No mitigation with respect to hydrology is warranted or proposed.

Construction activities including dredging have the potential to increase erosion events (sediment runoff) that may impact water quality in the short-term. Impervious surfaces created by pavement and development will increase localized runoff and decrease the total time of concentration since runoff (as would occur from rainfall events) will be directed to man-made drainage systems versus being allowed to percolate through the bare earth and soils. Occasional accidental discharges of lubricating oil, hydraulic fluid or fuels associated with heavy equipment operation could impact water quality in the short- and long-term according to the nature of the hydrocarbon, its toxicity and volatility, the volume of the spill and the sensitivity of the affected habitat. The accidental disposal of wastes such as sewage and garbage could also occur once the resort is operational.

The proposed action includes runoff control both during construction and on a long-term basis. General practices that should be followed during the construction period to minimize erosion are hereby excerpted from the report by AECOS Consultants (2000):

"Minimize earth movement – fit the construction to the terrain. Minimize grading."
"Minimize impervious coverage – use stepping stones or natural chips instead of concrete walkways. Keep paths as natural as possible.

"Minimize vegetation removal – preserve trees, grass and other natural vegetation in order to maintain site stability. Locate structures to minimize the need for clearing.

"Grading schedule – grading should be halted during storm events and afterwards when the soil is in a wet, saturated, muddy, or unstable condition.

"Phasing Clearance – land disturbance activities should be planned and staged so that only a small area is exposed at any one time."

Other structural controls that may be required to prevent sediment runoff into nearshore waters during the construction phase include mulch mats, sodding, siltation berms, silt fences, and/or sediment barriers. "Additional permanent structural controls may be required to retard freshwater runoff and encourage percolation once construction is completed."

Spill prevention and containment measures will be implemented as a feature of the EPP and are hereby reiterated from Section 3.1.4:

- The construction contractor will provide standard 20-foot containers with proper markings for hazardous materials. This storage area will be provided for all fuel tanks, oil drums and other hazardous material. A liner and a berm will surround the containment area.
- All hazardous and toxic materials transported by truck or boat will be equipped with spill kits, sufficient to contain and absorb the amount of material being transported.

During the operational phase of the project, treated effluent will be discharged via ocean outfall in a manner that will not degrade the water quality of receiving waters. Analysis using the PLUME model that was developed by the EPA indicates that the dilution of the treated effluent would be so rapid that all Class AA water quality criteria would be easily met within the zone of initial dilution immediately above the discharge point.

Proposed water uses, especially along the western and northern perimeter of the island will be recreational and aesthetic. It is therefore in the best interest of the applicant to maintain the highest possible level of water quality for the long-term enjoyment of resort guests.

Water quality monitoring is proposed as a project feature (see Sections 5.14.1 and 5.14.2). The testing results will be incorporated into quarterly reports that are submitted to EQPB.

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As a result of all the measures described above that will be implemented as project features, no mitigation is proposed or considered warranted with respect to water quality.

5.4 Climate

No noticeable or measurable impacts to the climate are anticipated as a result of the proposed action. Thus, no mitigation measures are warranted or proposed relative to the overall climate.

5.5 Air Quality

Short-term air quality impacts generated by the proposed action are primarily attributed to construction activity. Automotive pollutant concentrations from construction vehicle activity may increase at the project site, but these impacts are largely unavoidable and temporary. Other short-term or temporary air quality impacts are anticipated from activities (such as earth moving, grading, concrete and asphalt batching, and site preparation) that generate fugitive dust or particulate emissions; however, the high rainfall in Palau is expected to help minimize fugitive dust emission from the mentioned activities.

Heavy rains have little effect on gaseous pollutants with low solubility such as carbon monoxide, nitrogen oxides and ozone. The potential but unlikely occurrence of air pollutant buildup in the area may result from a lack of ventilation, low wind speeds and calm conditions.

In the long-term, there will be no gasoline-powered cars on the island. Transportation during the operational phase of the resort will be via electric carts.

Project features include controlling emissions from gas or diesel engines with proper maintenance and operation of the engines. Fugitive dust emissions will presumably be controlled during dry conditions through the use of sprayers or sprinklers as a feature of the EPP (refer to Section 3.1.4). As a result of these measures that will be implemented as project features, no mitigation is proposed or considered warranted with respect to air quality.

5.6 Noise Quality

Construction noise will be generated in the short-term as a result of project action. An evaluation of predicted noise levels were based on hoe ram noise measurements at 90 and 1,600 feet from the equipment (refer to Appendix C-1). "Noise from hoe ram operations will probably be audible at the northwest end of Arakabesan, and range between 42 to 58 dBA (decibels, Lmax, or maximum, A-weighted, Sound Level). Hoe ram noise, predicted to range between 30 to 40 dBA, may not be audible in the central and eastern sections of Arakabesan. Risks of adverse noise impacts from hoe ram operations (or construction activities of similar noise level), appear to be very low." 

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Long-term noise impacts may be attributed to the intermittent movement of watercraft transporting goods and/or people to and from Ngerur Island. Powered watercraft predictions are based on noise measurements at 100 and 300 feet from various watercraft. It should be noted that the closest distance between the ground track of the watercraft and any island between Ngerur and Malakal is approximately 656 feet (200 meters). “At that distance predicted maximum noise level from offshore watercraft are in the mid-50 dBA range. These levels are similar to voice conversations at 20 feet separation distance between the talker and listener. In order for the cumulative noise exposure level to exceed 55 DNL (the move conservative noise impact threshold) on an island along the transit route, over 10,000 daily trips of watercraft are required along the ground track shown between Ngerur and Malakal. Therefore, risks of adverse noise impacts from watercraft operations appear to be very low.”

In the long-term, there will be no gasoline-powered cars on the island. Transportation during the operational phase of the resort will be via electric carts.

Noise control measures are included as part of the construction Contractor’s EPP (refer to Section 3.1.4). All equipment operating in construction areas will be properly muffled. Work hours will be limited to between 0700 and 1800 hours on Monday through Saturday. No pile driving or other excessively noisy activities will be accomplished during the early morning or late evening periods. As a result of these measures, no mitigation with respect to noise quality is proposed or considered warranted.

5.7 Flora

As indicated in Section 4.7, the flora on Ngerur Island has the following characteristics:

- No listed threatened or endangered species were observed on Ngerur.
- A plant that can be harmful to humans (Abrus precatorius) does exist on Ngerur.
- Vegetative communities on Ngerur are neither unique nor worthy of preservation.

The removal of some existing vegetative species including a single floristic element in the form of five Mangrove trees or Sonneratia alba (urur, white mangrove) at the southeastern coastline of the island is expected to occur. Due to its paucity, this element is not considered to represent a Mangrove association.

Approximately 85 percent of Ngerur Island will be disturbed due to construction. The remaining undisturbed 15 percent consists of areas along the shoreline where existing vegetation will be preserved as much as possible.

Where possible, the building and hardscape elements will be positioned so as to allow the large trees throughout the island to remain in place. This includes approximately 319 trees. In addition, approximately 116 existing trees will be relocated on island. With the exception of the buildings and hardscape areas, all of the island will be replanted with locally available species.

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85 Herbst, 1999.
A listing of the plant materials that will be used is included in Appendix C-2, along with a description of proposed landscaping actions.

As a result of the findings of the botanical investigation, no mitigation with respect to the flora is proposed or considered warranted. Nevertheless, the recommendations from the botanical report (Herbst, 1999) that are expected to be incorporated in the project are listed below.

"Abrus and other harmful plants, if any are found during the landscaping and subsequent grounds maintenance phases of the resort development [should] be removed and destroyed.

"As much of the native vegetation as possible should be preserved, especially the large specimen trees.

"The landscaping should consist of native plants or, at the least, a mixture of native and exotic species. The ubiquitous ornamentals used throughout the tropical and subtropical regions of the world have been over used; employing attractive native plants would add a unique, interesting aspect to the landscaping.

"The development of a nature trail with labeled plants or a printed guide would be an additional recreational opportunity of interest to many guests of the resort."^{86}

5.8 Fauna

Pertinent findings from the Biological and Water Quality Reconnaissance Surveys on Ngerur Island, Palau Lagoon, Republic of Palau (AECOS Consultants, 2000) are hereby excerpted.

"From a terrestrial biological perspective, Ngerur Island is currently not in good shape ecologically. The vegetation has been heavily altered and the understory cleared. The extremely high density of roof rats all but precludes successful nesting by birds as well as any herpetofaunal recruitment or long term survival by terrestrial crabs."^{87}

As a result of the findings of the biological investigation, no mitigation with respect to the fauna is proposed or considered warranted. Nevertheless, pertinent recommendations with respect to the fauna that are expected to be incorporated in the project are hereby excerpted.

"The roof rat population on the Island constitutes both the major limiting factor to terrestrial vertebrate resources but also poses a human disease threat. It is recommended that efforts be launched to eliminate this population as soon as feasible. Because it will require a combination of methods, and multi-applications of all methods, it is recommended that a comprehensive rodent eradication and long term control program be developed and implemented.

"Landscaping with native and indigenous trees especially fruiting ones will help restore native faunal resources to the Island. Birds and butterflies are highly desirable

^{86} Herbst, 1999.
^{87} AECOS Consultants, 2000.
aesthetic ecological components for upscale and ecotourism clients. Many of the currently absent species commonly found on [Arakabesan] and other Islands, will rapidly re-colonize Ngerur, following the control and/or removal of rats and the replanting of the Island with more desirable plants.88

Rat eradication will involve setting up bait locations and baiting the rats with locally available, over-the-counter rat and mouse poison bait bars. This form of poison comes in solid bar pieces and is weather resistant. Unlike granular poisons, this form of poison resists erosion and therefore reduces the impact to the environment. Dead rats and unused portions of the bait are easily picked up for proper disposal. The material will be handled in accordance with the manufacturer's recommendations.

5.9 Coastal and Marine Resources

Impacts to coastal and marine resources may occur from project actions that generate runoff, siltation, and pollution. Potential impacts may also occur from direct physical damage associated with activities such as dredging. The following excerpts are from the baseline marine investigation report (PENTEC Environmental, Inc., 1999).

Dredging of the intertidal and subtidal reef flat will be necessary to construct a harbor and associated docks and mooring facilities. If not controlled, proposed dredging and filing activities may increase sediment loads to the coral reef in the vicinity of these activities. “...when sediment loads increase beyond that normally experienced, the living organisms that make up the coral reef system, especially corals, can be adversely affected.”89

"Reef flats adjacent to dredging operations and down-current areas may be impacted to some degree as a result of silt and sediment deposition.... When dredging is completed, fish and certain noncoral invertebrates normally associated with intertidal and subtidal reef flats will likely be replaced by organisms associated with deep channels, channel walls, and sandy lagoon basins. Sea cucumber populations are expected to increase in density and diversity in dredged basins in response to the availability of detrital deposits, favorable substrates, and a possible lack of competitor organisms.

"Dredging is expected to suspend silt, organically rich detrital materials and suspended solids within the water column in the immediate vicinity of active dredging operations, and temporarily increase on-site turbidity levels by at least two orders of magnitude over baseline conditions. Stockpiled materials may also contribute to siltation of adjacent waters unless controlled. Lower turbidity levels would be found at successively greater distances down-current from the dredging site. The magnitude of turbidity increases would be a function of site-specific geological conditions and prevailing water circulation patterns.

89 PENTEC Environmental, Inc., 1999.
“Sedimentation resulting directly and indirectly from shoreline earthmoving, grading, vegetation removal, and related site-preparation activities could impact coastal and marine resources and sensitive species in the vicinity of Ngerur Island. ...The topography of Ngerur Island is not unduly steep, with elevations generally ranging between 7 and 20 meters characterizing most of the island. There are no intermittent or permanent streams on the island. Therefore, erosion is not expected to produce any serious or long-term effect. However, Palau’s high annual rainfall and the probable presence of highly erodible soils is likely to result in occasional small erosion events that will have the potential to negatively impact coastal and lagoon water quality and biota.

“Construction of piers and docks in support of smallcraft operations could result in a small loss of intertidal and subtidal habitat.

“Pier and dock construction is anticipated to produce only small, localized impacts as a direct result or indirect consequence of the alterations of water circulation patterns, and minor benthic substrate and habitat changes resulting from the placement of piles or similar structures. These losses will be offset by the development of benthic communities on piles and other submerged structures, such as are found currently on existing docks and seawalls win the area (e.g., at PPR). These benthic communities are expected to attract fish and other organisms and, as a function of siting, could increase marine biodiversity over that of baseline conditions.

“Bulldozers, trucks, graders, and dredging equipment are likely to produce low-level sound waves that may be detected by protected marine mammals (e.g., dugongs) and sea turtles. Noises would be generated intermittently during the construction phase of the project. Several studies have indicated that low-level noise and vibrations generated by heavy equipment operations have no adverse affect on marine mammals.90 Sea turtles are likely to avoid locations characterized by high ambient noise levels.

“Heavy equipment and fuel transfer operations, and the activities of construction crews may result in an occasional accidental discharge of lubricating oil, hydraulic fluids, and fuels on the project site...could...directly affect protected species and their habitats, or the forage of such species. These events could produce short-term impacts as a function of the nature of the hydrocarbon, and its toxicity and volatility, the volume of the spill, and the sensitivity of the affected habitat. However, the project site is not steeply sloping and there is small likelihood that such pollutants would reach coastal waters in sufficient volume to produce any significant or long-term damage.”91

Project features intended to ensure that water quality meets or exceeds the Class B standards will be implemented such that no mitigation is proposed or considered warranted. Nevertheless, recommendations from the baseline marine investigation report (PENTEC Environmental, Inc., 1999) that are expected to be accomplished are listed below.

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91 PENTEC Environmental, Inc., 1999
The implementation of BMPs such as the deployment of silt curtains, the construction of dredged cells or dikes designed to confine and settle suspended solids help to control and/or minimize erosion and sedimentation impacts.\textsuperscript{92}

"Construction of stormwater detention basins and related BMP controls should reduce the silt and sediment loading to acceptable levels in adjacent coastal waters.

"A properly designed and implemented drainage plan should reduce silt and sediment loading to coastal waters.

"Development and compliance with an oil-spill prevention and control plan would reduce the opportunity for deleterious impacts upon water quality and marine biota."\textsuperscript{93}

Marine areas undergoing no project-related changes should be avoided and left undisturbed.

Dredging sites should be accessed by heavy equipment via common corridors.

Erosion- and sedimentation-control plans should be developed and implemented.

An enforceable water quality and environmental monitoring plan encompassing the potentially affected harbor environmental should be implemented.

Dredged channel bottoms should be left uneven and irregular to provide bottom relief and vertical surfaces that can encourage recolonization of corals and other benthic and epibenthic flora and fauna.

Natural tide and water circulation patterns should be maintained.

"The small, possibly hand-dug, freshwater cave on the island’s west side harbors at least one shrimp species and a filamentous algae that do not occur elsewhere on the island. Consideration should be given to retaining this feature, as it represents a unique (to the island) semicryptic freshwater habitat. The biota inhabiting this cave has been observed by the [investigator] in coastal springs and in small permanent and intermittent streams elsewhere in Palau. Therefore, this site feature does not appear to represent an especially uncommon or rare aquatic habitat in Palau."\textsuperscript{94}

The applicant has expressed an interest in establishing a marine sanctuary/protected area around portions of Ngerur Island after completion of construction. A marine protected area (MPA) encourages the proliferation of marine life by providing an area where fishing, shell collecting, and coral touching is prohibited. Similar areas have been designated in other resort areas like the Florida Keys and the Great Barrier Reef. The applicant intends to pursue such a designation and will explore this issue with the proper agencies and organizations.

The Palau National Government currently does not have a mechanism to establish MPAs; however, Koror State Government does. Palau Conservation Society assists villages and state governments in setting aside and establishing MPAs.

\textsuperscript{92} Ibid.

\textsuperscript{93} Ibid

\textsuperscript{94} PENTEC Environmental, Inc.. 1999.
5.10 Historical and Archaeological Resources

All archaeological features identified during the inventory survey of Ngerur Island (refer to the report by IARII, 1999) are considered to be significant under criteria of the Palau National Code Title 19, the Palau Historical and Cultural Preservation Act. The island, Site OR-12:47, possesses integrity of location, design, setting, materials, workmanship, feeling, and association; and has yielded, or may be likely to yield, information important in prehistory or history (Criterion D).  

MITIGATION: Preservation of the cultural properties is preferred; however, as the planned development of the island will not be compatible with preservation, mitigation though data recovery and disinterment and reburial of human remains is an alternative. Mitigation measures from the archaeological inventory survey report are hereby excerpted.

"Mitigation will require consultation with the Division of Cultural Affairs, the preparation of a mitigation plan, and data recovery recording and excavations in accordance with the mitigation plan. Efforts should be made to avoid and preserve in place as many features as possible.

"Mitigation of the non-burial features should be straightforward and consist of a minimal amount of work, involving more detailed recording, photography, and videotaping of the features. This work will insure the preservation of information about this important episode in Palau's history."

The following table lists the individual features identified during the archaeological inventory survey and recommendations for the mitigation of adverse impacts.

TABLE 19: MITIGATION RECOMMENDATIONS FOR IDENTIFIED FEATURES.

<table>
<thead>
<tr>
<th>RECOMMENDATIONS</th>
<th>FEATURE NO.</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>No further work</td>
<td>1, 2, 6, 10, 12, 13, 14, 16, 17, 18, 19, 20, 21, 22, 23, 24, 26, 29, 30, 31, 32, 33, 34, 35, 37, 39, 40, 41, 43, 44, 45, 46, 49, 51, 53, 54, 56, 57, 58</td>
<td>All require videotaping</td>
</tr>
<tr>
<td>More detailed recording</td>
<td>4, 15, 26, 36, 38, 52, 55</td>
<td>Feature 55 - remove portion of humerus found during survey</td>
</tr>
<tr>
<td>Test to determine if burial feature</td>
<td>3, 5, 8, 25, 27, 28, 36, 42, 47, 48, 49, 50</td>
<td>Features 27, 28, 36, 42 and 50 are likely hearth features but need positive identification</td>
</tr>
<tr>
<td>Disinter human remains</td>
<td>9</td>
<td>Feature 9 - at least 23 and possibly as many as 30 individuals buried here</td>
</tr>
</tbody>
</table>

The presence of buried human remains adds the element of cultural value and sensitivity to the historical importance of the site. The Treatment Plan for Burials Located on Ngerur Island, 

95 IARII, 1999a.
96 IARII, 1999a.
97 Ibid.
Koror, Republic of Palau (IARIU, 1999b) addresses the request by the Palau Division of Cultural Affairs (DCA) to develop a plan for the ultimate disposition and long-term protection of human burial remains located on Ngerur Island. Disinterment will occur prior to the commencement of construction activities on Ngerur Island, in accordance with the stipulations in the burial treatment plan (refer to Appendix C-3).

At the time of this writing, the Division of Cultural Affairs (DCA) had reviewed the required Treatment and Monitoring Plan for Burials on Ngerur Island, Koror, Republic of Palau and given its concurrence for the implementation of the plan. On August 12, 1999, a Memorandum of Agreement was signed between DCA and Ngerur Corporation. According to this agreement, the removal and treatment of human remains and artifacts will follow DCA guidelines. Ngerur Corporation will also secure a place for reinternment of human remains at Sakurakai cemetery in Ngerbodel, Koror State.

5.11 Hazardous and Toxic Materials Considerations

The proposed Quest Resort Palau project is expected to involve the use of HTM associated with equipment operation and boating functions whereas landscaping may involve the use of pesticides and herbicides. Impacts may occur from any potential releases to the environment.

Locally available pesticides and herbicides will be used as much as possible, if needed for the successful growth of plants on Ngerur Island. Herbicides will include locally available products such as “Roundup”, “Image”, and “Ronstar.” Minor spraying with a non-selective herbicide (such as “Image” or “Roundup”) may be required to spot control weeds. These herbicides do not have any chemicals that move beyond the immediate contact with the plant. Chemicals that are deemed restricted or unpermitted by the EQPB will not be used.

Ngerur Island “has no signs of UXO.”98 As indicated in the UXO survey report, the UXO Consultant recommends “no further action be taken as far as UXO is concerned.”99

Equipment operations and boating functions will include spill prevention features and provisions for the safe handling and storage of fuels, oils and lubricants.

A grease recovery system will be provided similar to the American Pumps System, Inc. “Low Grease Recovery Unit” on the grease waste line from the restaurant kitchen. The units mechanically remove the grease and transfer it to a container that will be located near the service level at the Hotel Pavilion. Manufacturer data indicates that the interceptors will remove up to 99 percent of the free-floating oils and grease.

As a result of the above considerations, no mitigation with respect to hazardous and toxic materials contamination is proposed or considered warranted. Nevertheless, the applicant acknowledges the need to identify hazardous substances that may be used as a result of the project. The applicant has requested that the preparation and submission of a hazardous

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98 Bombs Away, Inc. (no date).
99 Ibid.
materials management plan be made a condition of the earthmoving permit and be deliverable prior to the operation of the proposed project, as applicable.

5.12 Land Use Considerations

The project is situated in the “RV” Resort Center Zone. It is therefore compatible with the legal land use regulation controls of Koror State. No mitigation measures are warranted or proposed.

It is hereby noted that §3164 of the Koror Zoning Law allows a maximum density of 20 units per acre. If the island area of 12.5 acres were developed with an allowed maximum density of 20 guest bungalows per acre, this would result in a total of 250 guest bungalows on Ngerur Island. The resulting appearance and impacts of such a resort would be dramatically different from the proposed project. Instead, the design of the proposed project follows a master plan that includes a total of 60 guest bungalows. This results in a highly reduced density of only 4.8 units per acre.

An important aspect of the impact load of a resort development upon the environment is the average daily visitor count. Fewer visitors equates to a reduced load factor on the physical and social environment. The following discussion is reiterated from Section 4.2.

With an assumed hotel occupancy rate of 75 percent and an assumed unit occupancy rate of 1.8 persons per unit, the maximum permitted density of 20 units per acre would result in an average daily visitor count of 338 visitors. In contrast, the proposed project would result in an average daily visitor count of only 81 visitors under similar assumptions of hotel and unit occupancy rates. A comparison on a yearly basis would show the following figures: with an assumed average four-day stay, a 20-unit per acre resort development would result in approximately 30,758 yearly visitors whereas the proposed project will result in approximately 7,371 yearly visitors.

The master plan for the proposed project therefore reduces the long-term stress on the environment to approximately one fourth of the impact of the legally permitted alternative. This significantly enhances the quality of the resort ambiance of the proposed project and also represents a decisive and dramatic environmental mitigation element.

5.13 Aesthetic Considerations

The Quest Resort Palau as proposed will be a low-density master-planned development. Resulting structures on the island are expected to have no significantly adverse impact on views. The overall design and siting of permanent structures will be accomplished to take full advantage of the splendid vistas that are available from the remote location of Ngerur Island. In light of these considerations, no mitigation is warranted or proposed.

100 Koror Zoning Law, 31 PNCA.
5.14 Public Services and Facilities

5.14.1 WATER SYSTEM

Completion of the Quest Resort Palau will generate no demand for municipal water service because all potable water demands will be met by the on-site system. No mitigation is therefore proposed or considered warranted.

As indicated in Section 3.1.2, the proposed Quest Resort Palau will be supplied with potable water service via an on-site water supply system. A RO desalination system will remove the salinity (chloride) from the ocean water. Two self-contained skid mounted units each rated for 45,000 gpd will be used. The desalinated water will be disinfected and treated on-site prior to storage and distribution. Brine with an estimated concentration of approximately 90,000 ppm will be diluted and discharged via a perforated pipe located on the sea floor within the harbor area.

Although a salinity concentration of 90,000 ppm in large volumes can be toxic to marine life, the brine will be combined with returning cooling water from the air conditioning system such that its diluted concentration would be approximately 40,000 ppm. The volume of discharged water from the Quest Resort Palau project will be small and its discharge through a perforated pipe located at the bottom of harbor means that by the time this water reaches coral areas it will have the same salinity as the surrounding waters (approximately 30,000 to 33,000 ppm).

A comprehensive potable water monitoring plan will be submitted to EQPB. Potable water quality will be monitored daily or at the very least on a weekly basis. Monitored parameters may include and not be limited to turbidity, salinity, pH, residual chlorine, and e-coli. The RO units will be monitored for performance in accordance with the guidelines provided by the equipment manufacturer. A quarterly report that addresses water quality monitoring testing results, descriptions of performed operation and maintenance, and water use records will be filed with EQPB.

5.14.2 WASTEWATER SYSTEM

As indicated in Section 3.1.2, the on-site wastewater collection system will consist of gravity sewers and a single pump station. Collected effluent will be pumped to a packaged WWTP that is virtually self-contained. Disinfection of the effluent by UV leaves no residual contaminants in the treated water. Treated effluent will be conveyed to discharge location that is approximately 100 feet (30.4 meters) below the ocean surface.

In order to quantify any potential impacts of discharging the treated effluent via a deep ocean outfall, a preliminary dispersion analysis was performed to ascertain the performance of such
an outfall. The PLUME model developed by the EPA was used to predict the wastewater discharge plume dilution. This computerized program has become the accepted standard for modeling outfall plume behavior and is accepted by U.S. Federal regulatory agencies. The effluent characteristics initial dilution results are provided in the following table.

### TABLE 20: WATER QUALITY PARAMETERS AFTER INITIAL DILUTION.

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>AMBIENT RECEIVING WATER</th>
<th>EFFLUENT CHARACTERISTICS</th>
<th>PALAU STANDARDS (CLASS AA)</th>
<th>CONCENTRATION AFTER INITIAL DILUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature (°C)</td>
<td>30.20 (Surface)</td>
<td>31.0</td>
<td>±0.9</td>
<td>29.47</td>
</tr>
<tr>
<td></td>
<td>29.42 (Bottom)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salinity (ppt)</td>
<td>32.65 (Surface)</td>
<td>0</td>
<td>±10% in the range of 29-35 ppt</td>
<td>32.70</td>
</tr>
<tr>
<td></td>
<td>32.78 (Bottom)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td>8.16</td>
<td>8.0</td>
<td>7.7 to 8.5</td>
<td>8.16</td>
</tr>
<tr>
<td>Dissolved Oxygen (mg/l)</td>
<td>6.84</td>
<td>0</td>
<td>NLT 6.0 or Saturation</td>
<td>6.83</td>
</tr>
<tr>
<td>Total Nitrogen (mg/l)</td>
<td>0.104</td>
<td>20</td>
<td>±10% (0.114) or NTE 0.400</td>
<td>0.120</td>
</tr>
<tr>
<td>Total Phosphorus (mg/l)</td>
<td>0.010</td>
<td>8</td>
<td>±10% (0.011) or NTE 0.025</td>
<td>0.017</td>
</tr>
<tr>
<td>Fecal Coliform (per 100 ml)</td>
<td>0</td>
<td>15,000</td>
<td>70</td>
<td>9</td>
</tr>
</tbody>
</table>

Analysis by Sea Engineering, Inc. based on computer modeling using EPA's PLUME Model.

NLT = Not Less Than
NTE = Not To Exceed

The analysis indicates that the receiving water would rapidly dilute the small volume of the treated effluent generated by the proposed Quest Resort Palau project. The model indicates that the dilution will be so rapid that most Class AA water quality criteria will be met within the zone of initial dilution immediately above the discharge point; all Class AA criteria will be met within a zone of mixing with a radius of 130 feet around the discharge point.

The treated wastewater plume from the discharge would not reach the lagoon surface; at approximately 49 feet below sea level the plume would be virtually indistinguishable from the receiving water with an average dilution ratio of over 1,000 to 1. Computer analysis results indicate that there will be no significant water quality impact resulting from the discharge of this very small volume of wastewater. All the modeled water quality parameter values meet or exceed Palau standards for Class AA water within the zone of mixing.

The alignment for the marine outfall will bear northeast from the northeast side of the island. This alignment is reasonably close to the treatment facility and provides access to deep water relatively close to shore.
The outfall pipe must travel over live coral outcrops in some areas. For example, the first 100 feet (30.4 meters) off the island shoreline supports vigorous coral growth over almost 100 percent of the basin bottom. Much of this coral is finger-type that can be easily broken and/or damaged. Additionally, the bottom is uneven and not conducive to supporting the pipeline. For these reasons, the first 100 feet (30.4 meters) of the alignment for the pipeline is expected to include a narrow covered trench through the coral areas because of its advantages:

- Coral damage will be limited;
- The pipeline will not be visible;
- The pipeline will be well protected; and
- Coral can be re-colonized over the covered trench.

The last point is particularly important from an environmental standpoint: coral ecology can be re-generated/re-established over the covered trench that is in effect locally removed from the eco-system.

A comprehensive monitoring plan for wastewater effluent will be submitted to EQPB.

5.14.3 DRAINAGE AND IRRIGATION SYSTEM

As a result of project actions, natural drainage systems on Ngerur Island will be replaced with a man-made drainage and irrigation system. No demand on municipal systems will occur as a result of the Quest Resort Palau project because the conveyance of storm runoff and the irrigation demand will be satisfied via the on-site system. No mitigation is therefore proposed or deemed warranted.

In the interior part of the island, runoff will be collected by 6-, 8- and 10-inch storm drains in infiltration trenches that are aligned parallel to the cart pathway system. On the seaward side of the guest bungalows, runoff will be collected by storm drains in infiltration trenches that are aligned along earthen dikes of native material topped with geofabric or matting. The disposal of the runoff will occur as waterfall features at individual discharge points located around the perimeter of the island. At three locations on the northeastern side of the island, sediment logs will be used in conjunction with silt curtains. The design of the drainage system does not include retention basins for storm runoff and instead the counter slopes of the extensive bermed areas will capture runoff and convey it to the surrounding waters through gravel and filter fabric. In this manner, direct surface runoff will be effectively reduced or eliminated. No oil/water separators are anticipated since there are only electrically powered vehicles on the island.

Landscaping and the use of erosion control materials, earthen dikes with counter slopes, matting, geofabrics, and silt fences will slow the flow of sediment laden runoff to avoid erosion and sedimentation. A brief description of each feature or device is included below.
- Sediment logs are porous fiber rolls that allow water to filter through and trap sediment, slow runoff, and reduce sheet erosion. These logs are composed of biodegradable open weave netting.
- Earthen dikes will act as counter slopes and check dams. The ponding surface runoff trapped by the dams will be forced into perforated pipe that is part of the drainage system.
- Silt fences are barriers of permeable fabric designed to intercept and slow sheet flow runoff.
- The waterfall feature will be constructed as a “T.” The feature will include riprap that reduces the energy of flowing water.

Hose bibs will be provided for irrigation with potable water. Grey water irrigation is also being considered but no definite plans are available for discussion at this time.

5.14.4 SOLID WASTE DISPOSAL

Completion and operation of the Quest Resort Palau will generate a demand for solid waste disposal service. Approximately 760 pounds per day of solid waste may be generated (refer to the discussion in Section 3.1.2). Solid waste and wet garbage will be transported by boat to the service center at Malakal prior to ultimate disposal at a designated municipal landfill.

The intent of the resort operator is to utilize a trash compactor to reduce the volume of refuse. Although the weigh of the waste remains the same, a reduced volume will extend the life of the new landfill.

The resort operator has also expressed a desire to segregate waste in order to take advantage of existing (and hopefully expanding) recycling facilities in Palau. Conditions of the earthmoving permit will in all likelihood require the preparation of a waste minimizing plan addressing specifically aluminum can recycling and the composting of green waste.

Provisions for solid waste disposal will be coordinated with the BPW to ensure that refuse is disposed at the appropriate site. Coordination is especially important given that a new landfill site is being considered (refer to the discussion in Section 4.14.4). No mitigation is proposed or deemed warranted.

5.14.5 ELECTRICAL POWER AND COMMUNICATION SYSTEM

Completion and operation of the Quest Resort Palau will generate a demand for electrical power and telecommunications service. The electrical peak demand of the project is estimated at 600 to 700 kVA. As indicated in Section 3.1.2, an underwater conduit will house both electrical power and telecommunication cables.

The length of the cable is estimated at 6,500 feet or 1,900 meters. The maximum water depth of the alignment traversed by the cable is 120 feet (36.4 meters). The alignment for the
submarine cable is generally benign with the exception of some sections near the shore landings. The following paragraphs summarize the three overall sections of the alignment.

- **From the Ngerur Island shoreline to the 85-foot (25.8-meter) water depth.** For a distance of approximately 150 feet (45.6 meters) from the shoreline and to a water depth of 30-feet (9.1 meters), existing coral growth is dense. Additional protection of the cable will be necessary, either by trenching or by cast iron split pipes. Between the 30- and 70-foot (9.1- and 21.3-meter) depth, coral heads of one- to two-feet in diameter are present. These coral heads are sufficiently scattered on a smooth bottom to allow the cable to be laid between them. In water depths exceeding 70 feet (21.3 meters), the bottom areas are smooth and consist mostly of silt and sand. This represents a very benign situation for the location of the cable.

- **Mid-section between the two islands.** This section of the cable alignment covers over 70 percent of the total alignment. Water depths range from 85 to 120 feet (25.8 to 36.4 meters). The very smooth bottom consists of sand and silt. Currents and wave action in this area is minimal. No additional protection of the cable is therefore required.

- **Between the 85-foot (25.8-meter) water depth and Arakabesan Island.** Between the depths of 85 to 50 feet (25.8 to 15.2 meters) are some coral heads. These are sufficiently scattered to allow the cable to be positioned without crossing them. Between the water depths of 50 and 30 feet (15.2 to 9.1 meters), there is dense coral coverage for about 100 feet (30.4 meters). A well-defined channel is already present such that the cable can be positioned with only minor coral cutting or removing. Between 30 and 18 feet (9.1 to 5.4 meters) of water depth there is a smooth sandy bottom for 200 feet (60.8 meters). The next 300 feet (91.2 meters) of alignment towards the shoreline of Arakabesan will require some extra protection of the cable and also some removal of coral heads that are between two and five feet in diameter.

Coordination with the PUC and telecommunication providers will be accomplished for the provision of necessary services to Ngerur Island. Anchors will be used only to the extent necessary to stabilize the underwater conduit within the alignment corridor. The underwater conduit will be flexible enough to follow an alignment of least impact upon the existing coral heads. In order to reduce anchoring measures, the addition of a second armor layer will add weight to increase not only protection but also stability to the submarine cable. This action is more economical to other additional anchoring measures.

The overall design of the project reflects a conscientious effort to provide for passive energy efficient applications within the project program. The architecture of the Quest Resort Palau embodies the Pacific tropical style using earth tone materials that reduce solar heat gain. Board overhangs at the roof lines provide a visual transition zone while shading windows and doors. The use of louvers provides additional shading and allows for natural ventilation. Plumbing fixtures utilize low flow rates. Low voltage light sources and energy efficient fixtures will be used. Compact fluorescent lamps will be used wherever possible to reduce wattage. A
dimming system with presets will allow management to dim the lights in public areas, thereby conserving energy.

5.14.6 CIRCULATION AND TRAFFIC

It is the specific goal of the proposed Quest Resort Palau to be a backdrop for the experience of a luxurious exotic environment. Factors that enable this experience are the creation of a sense of seclusion and remoteness from the day-to-day world. The identity of the resort as a special place will be enhanced by the fact that the Ngerur Island must be accessed by boat. Affluent guests will be escorted from the airport to a shuttle that will transport them to the Welcome Center on Malakal Island. All necessary shuttle services for visitors and their luggage between the airport and Welcome Center on Malakal Island will be executed by the resort operation with Sport Utility Vehicles (SUVs) or vans. Boats will then ferry these guests to the Quest Resort Palau.

Boat traffic between the Welcome Center on Malakal Island and Ngerur Island will increase as a result of the proposed project. Boats will transfer all visitors and their luggage.

An assumed four-day length of stay on Ngerur Island will generate approximately 91 exchanges per year with an average of 81 visitors per each four-day stay. A theoretical average daily exchange rate would therefore imply 20 visitors leaving and 20 visitors arriving each day.

The number of resulting boat trips will depend on the carrying capacity of the boats. Another factor that will influence boat trips is the visitors' demand for sightseeing trips. This demand is expected to fluctuate and cannot be predicted at this time.

Employees of the Quest Resort Palau and all necessary supplies and waste will also be transported by boat between Malakal and Ngerur. With an average of 20 visitors requiring one-way shuttle transportation every day and with an assumed occupancy rate of five visitors per SUV, the average number of daily round trips between the Welcome Center on Malakal Island and Koror Airport would therefore be four trips. This number represents a theoretical minimum of terrestrial shuttle traffic generated by the proposed project. No mitigation is therefore proposed or deemed warranted.

5.14.7 DOCKING FACILITIES

The completion and operation of the Quest Resort Palau will result in no demand for public docking facilities since privately owned facilities on Malakal Island (at the Welcome Center) and Ngerur Island will be used. No mitigation is proposed or considered warranted.
5.14.8 PUBLIC SAFETY AND FIRE PROTECTION SERVICES

Resort security for the protection of guests' public safety will be the responsibility of the resort operator. Additionally, the project design includes a fire protection system consisting of fire pumps and water storage facilities (refer to Section 3.1.2). The resort will also have telephone and radio communication with the Bureau of Public Safety.

5.14.9 HEALTH CARE AND EMERGENCY SERVICES

The resort will include a nursing station for first aid and over-the-counter medication. No demand for public health care and emergency services will be generated as a result of the proposed project such that no mitigation is proposed or considered warranted.

5.14.10 EDUCATIONAL SERVICES AND FACILITIES

No new demand for educational services and facilities will result from the completion and operation of the Quest Resort Palau on Ngerur Island. No mitigation is deemed necessary.

5.14.11 PARKS AND RECREATIONAL FACILITIES

Ngerur Island is in private ownership and access is restricted. Resort development on this island would therefore not constitute any change in established traditional public recreational and resource gathering use patterns on public lands or lands which are presently available to the public for these purposes. Additionally, the Quest Resort Palau project would not constitute any loss of lands presently available for recreational purposes, nor any reduction in the presently available opportunities for recreational activities. Furthermore, the completion and operation of the Quest Resort Palau will result in no resident population requiring public parks and recreational facilities. No mitigation is deemed necessary.

Recreational features (e.g., a beach, dive grotto, spa, fitness center, pool, and nature trail) will be created as a result of resort development. These features are expected to be reserved for exclusive use by resort guests. Additionally, the project owner proposes to establish a Marine Sanctuary Area around Ngerur Island where no fishing is allowed.

5.15 Socio-Economic Considerations

5.15.1 DEMOGRAPHICS

Completion and operation of the Quest Resort Palau will not impact the social demographics of the project area. The proposed project is a resort development that will be entirely oriented towards accommodating short-term visitors. The resident population would therefore be unaffected by the influx of visitors such that no mitigation is warranted or proposed.
The short-term impact of foreign laborers is expected to be minimal because these workers would be live in a specific worker housing compound. The construction Contractor has the experience, ability and appreciation for working with the people of Palau to minimize the social impact that imported laborers (probably Filipinos) may have on the location population during a construction period estimated at 18 to 24 months.

5.15.2 HOUSING

The Quest Resort Palau project will not impact the number of existing housing units in Palau; neither will it impact the presently existing balance between Palauan and non-Palauan residents. The proposed project is a resort development comprising luxury hotel guest bungalows only. The Quest Resort Palau project is entirely oriented towards accommodating short-term visitors. The project does not include any condominium housing units intended for long-term residency. No mitigation is proposed or considered warranted.

The proposed project involves developing a private island that is presently uninhabited. Project actions will therefore involve no displacement of a residential population.

The proposed project will have a short-term housing impact because the construction crew will have to be housed in Koror for the duration of the project (approximately 18 to 24 months). It is expected that the construction Contractor will make the necessary arrangements for a temporary worker housing compound such that no mitigation is required.

5.15.3 LABOR AND EMPLOYMENT

The proposed project will generate employment opportunities. This aspect of the project is considered a benefit that offsets the short-term impacts generated by the importation of temporary laborers required for project construction. No mitigation is therefore proposed or considered warranted.

A short-term social impact associated with the proposed project may result from a construction crew of approximately 100 to 125 foreign workers that will be housed in Koror for the duration of the construction period of approximately 18 to 24 months. The number of foreign workers in Palau would therefore increase for the duration of the construction period.

The construction contractor will coordinate and manage a labor compound that will support the needs of the project. The contractor will provide housing facilities, a dining facility, laundry facilities, toilet facilities, refrigeration units, and various sundries and smallware to support anticipated manpower requirements. The contractor will also handle the catering, housekeeping and maintenance of the labor compound in order to satisfy the needs of the project.

At project completion, a maximum guest population of 120 persons would require 110 support staff in three shifts. Alternately, the size of the work force may be equal to approximately 2.5
employees per bungalow or approximately 150 persons. The Palauan segment of employment opportunities within the proposed project is expected to be in the neighborhood of 80 percent.

5.15.4 ECONOMIC CONDITIONS

The overall cost of the proposed Quest Resort Palau project is estimated at approximately $66 million. The project will be privately funded. No government funds will be used.

Construction could begin in the latter part of the year 2000 if all necessary EQPB approvals are granted by the fall of 2000. The construction period is estimated to be approximately 18 to 24 months. Projected completion of the project would therefore be in the latter part of the year 2002.

Through gross income taxation the government of Palau will economically benefit from the completion of the proposed Quest Resort Palau project. The government of Palau will also glean an economic benefit from income taxation of the local labor force employed by the proposed project and from local businesses associated in one form or another with the proposed project. No mitigation is proposed or considered warranted.

The Quest Resort Palau is expected to create a significantly more memorable resort experience with its reduced density. This is expected to attract more affluent and discriminating visitors as opposed to a high-density visitor development. Government income per visitor in the form of taxation is expected to be greater as a result of the proposed action as compared to a higher density resort.

For example, if the 12.5 acres Ngerur Island were developed according to the maximum density of 20 units per acre allowed in the “RV” Resort Center Zone, the total unit count would be 250. With an assumed hotel occupancy rate of 75 percent and a guest unit occupancy rate of 1.8, there would be 338 visitors per day at this higher density resort. With an assumed 4 day length of stay each unit would receive 90 occupancies per year and would generate a total yearly volume of 30,758 visitors. With an assumed daily room rate of $150, the average daily income (from bookings alone) generated by the resort would be $28,200. The yearly income (from bookings alone) would be $10,293,000 of which government revenue would be $411,720. In this scenario, the government income per yearly visitor is $13.38.

By comparison, the 60 units at the Quest Resort Palau would house an average of 81 visitors per day (with an assumed occupancy rate of 75 percent and a guest unit occupancy of 1.8). Again, with an average four day length of stay, each unit would receive 90 occupancies per year and would generate a yearly volume of 7,371 visitors. Assuming a daily room rate of $500, the Quest Resort Palau would generate a daily income (from bookings alone) of $22,500. The yearly income from room rates alone would be $8,212,500 and government revenue would be $328,500. In this scenario, the government income per visitor is $44.56.
As shown by the comparison, a high-end resort project such as the Quest Resort Palau can generate more than three times the government income per yearly visitor as compared to a high-density resort. With fewer visitors per year, the lower density, high-end resort also reduces the load on the natural and social environments of Palau.
6.0 CONCLUSIONS

6.1 Short-Term Use Versus Long-Term Productivity

In the short-term, the private landowner will not be able to use those portions of Ngerur Island that will be affected by resort development. The landowner's use of Ngerur Island for leisure activities will therefore be curtailed for the duration of proposed construction activities. Ngerur Island is not a public resource such that restrictions on its use by the public may not be attributed to proposed construction activities.

In the long-term, the Quest Resort Palau on Ngerur Island will be an income-generating activity for the property owner that results in tax benefits to the local and national government. Proposed resort development will result in the productive use of the property, the generation of revenue, the creation of employment opportunities and the provision of recreational resources and accommodations for affluent visitors to Palau. These factors are all viewed as benefits of the Quest Resort Palau project.

6.2 Irretrievable and Irreversible Resource Commitments

Proposed resort development will result in the disturbance and/or removal of existing natural resources on and marine resources around Ngerur Island. Resource commitments may also be imported specifically for the project (e.g., aggregate for concrete, steel and other building materials for structures, plants for landscaping, etc.).
6.3 Cumulative Impacts

The proposed Quest Resort Palau project, when considered with other recently completed, ongoing or planned resort projects, cumulatively increases the number and kinds of accommodations that are available to visitors to Palau. In contrast to the majority of new resort projects that provide mid-range, high-density accommodations, the Quest Resort Palau is tailored for the affluent, low-density tourist market.

Future conditions without the proposed Quest Resort Palau include the provision of additional tourist accommodations primarily on the islands of Arakabesan, Koror and Babeldaob. Environmental impacts would occur from these projects on a magnitude that is influenced by site-specific conditions and the sensitivity of the design with respect to those conditions. Disturbances to man-made systems such as utilities and traffic may be more significant if development occurs in urbanized areas or along major utility or transportation corridors. Socio-economic effects such as the increase in employment opportunities, revenue and recreational amenities would be considered benefits.

The incremental impacts of the proposed Quest Resort Palau include the provision of additional first-class tourist accommodations on the remote island of Ngerur that is physically isolated from the islands of Arakabesan, Koror and Babeldaob. Environmental impacts associated with the project are described in Chapter 6.0 of this document; the consideration of environmental conditions has been an important facet of the project. Disturbances to man-made systems such as utilities and traffic will be minimal because of the remote location of Ngerur Island and the absence of any connections to existing municipal systems at this time. The incremental development of necessary utility systems will be accomplished to provide Ngerur Island with its own separate water and wastewater service; connection to the municipal system will be necessary for electrical power and telecommunications service. Impacts to vehicular and boat traffic are expected to be minimal, again, in part to the remoteness of Ngerur Island. Beneficial socio-economic effects are anticipated from the Quest Resort Palau project.

6.4 Unresolved Issues

There are no unresolved issues.
7.0 SOURCES CITED


Remily, Jeff. 1999. (Project correspondence.)


Republic of Palau, Sixth Koror State Legislature, Tenth Special Session, April/May 2000. 2000. (A resolution to recommend to EQPB that the water classification for Ngerur Island be reclassified from Class “AA” waters to Class “B” waters to accommodate the proposed Quest Resort Palau – Resolution No. 6-41, LD1). Adopted May 10.


8.0 PREPARERS OF THE EIS

<table>
<thead>
<tr>
<th>PREPARER</th>
<th>RESPONSIBILITIES</th>
<th>AFFILIATION</th>
</tr>
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<tbody>
<tr>
<td>Chee, Wilbert</td>
<td>Production</td>
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<td>Tilgenkamp, Ivan</td>
<td>Field Manager</td>
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<tr>
<td></td>
<td>Assistant Production Manager</td>
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<td>Tom, Claire</td>
<td>Writer</td>
<td>WCP, Inc.</td>
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<td>Document Processor</td>
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<td>Production Manager</td>
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</table>
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Individuals (continued)

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Welch, David, International Archaeological Research Institute
White, Diane, Klages Carter Vail & Partners
Wong, Koichi, Republic of Palau Office of the President

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Ministry of Resources and Development
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Bureau of Public Works, Water Branch
Palau Division of Cultural Affairs

Other Organizations and Groups

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Palau Conservation Society
Palau Utilities Corporation

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Palau Conservation Society
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Demeo, Robin, USDA-NRCS
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Johanes, Gillian, Chairman, Koror Planning Commission
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Koshiba, Joshua, Senator
Kvandal, Scott, P.E., Berryman & Henigar
Lehnhoff, Curt, P.E., Berryman & Henigar
Mandranchar, Marhence, Executive Officer, Palau EQPB
Mangham, Richard, Republic of Palau Ministry of Resources and Development
Melairaei, Marcelino, Republic of Palau Ministry of Resources and Development
Ngwal, Erma
Ongidobel, Ernest
Remily, Jeff, P.E., Berryman & Henigar
Shay, Dave, U.S. Environmental Protection Agency
Smith, Don, J.A. Jones Construction
Sullivan, Scott, Sea Engineering, Inc.
Appendix A

Plume Modeling Reports

(Sea Engineering, Inc., 1999 and 2000)
PLUME MODELING FOR REVISED WASTEWATER ESTIMATES
AT QUEST RESORT, NGERUR ISLAND, REPUBLIC OF PALAU

Prepared for:
Morita Hotel Corporation, Inc.
Koror, Republic of Palau

Prepared by:
Sea Engineering, Inc.
Makai Research Park
Waimanalo, HI 96795
July 2000

Introduction
Additional information gathered since release of the Sea Engineering, Inc. (SEI) report
"Site Investigations and Plume Modeling for the Quest Resort Marine Outfall, Ngerur
Island, Republic of Palau" in December, 1999 has produced a revised estimate of the total
wastewater discharge projected for the Quest Resort. The revised total is 30,000 gallons
per day (GPD), or twice the previous estimate. The increased flow is primarily linked
to increased projections of shower use. Wastewater treatment facilities will not increase
proportionally in size as the higher usage will result in increased greywater, without a
proportional increase in biological loading.

If no new nutrient load is added to the wastewater, initial concentrations will be halved.
This is not a realistic scenario, as the greywater is likely to have some small nutrient
content. As new nutrient levels have not been clearly specified at this time, two
conservative scenarios have been chosen for modeling: 1) maintain previous nutrient
concentrations as described in the December 1999 report, and 2) use 75% of the previous
nutrient concentrations levels to reflect some dilution prior to discharge by the increase in
greywater volume.

Results
As with the previous report, effluent plume modeling was conducted using the EPA-
approved PLUMES software developed by Baumgartner, Freil, and Roberts (1993).
The results of the modeling are summarized in Table 1 for 10 percentile current speeds,
and compared with the original modeling effort with lower flow conditions.

The characteristics of the plume are the same for both scenarios, since they are functions
of the ambient water density profile and both the density and flow parameters of the
effluent. With the increased flow from the outfall pipe, the effluent plume will rise higher
in the water column before equilibrating. The plume will therefore be trapped at a depth
of 49 ft for the higher flow, versus 55 ft for the original conditions.

Because the diffuser is a single port, the geometry of the rising plume is similar for both
the original and the higher flow conditions. The diameter of the plume at its highest level
in the water column is the zone of initial dilution (ZID) diameter, and it is only slightly
increased with the new flow conditions (28 ft versus 26 ft).

After rising in the water column the effluent plume will travel with the currents and
undergo secondary dilution. This is a slower process than initial dilution in the rising
plume. For Scenario 1, using 100% of the original nutrient concentrations, water quality
standards are met when the plume has traveled a distance of 130 ft from the diffuser. The
zone of mixing (ZOM) is therefore a circle 260 ft in diameter around the diffuser, or an
increase of 37% from the original conditions. For scenario 2, less dilution is required and
the ZOM is 210 ft in diameter, or an increase of 10%.

Table 1. Comparison of Original and Revised Flow Rate and Concentration Levels
(10-Percentile Current Speeds)

<table>
<thead>
<tr>
<th></th>
<th>Original (15,000 GPD)</th>
<th>Revised, 100% Levels (30,000 GPD)</th>
<th>Revised, 75% Levels (30,000 GPD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plume Trapping</td>
<td>55</td>
<td>49</td>
<td>49</td>
</tr>
<tr>
<td>Depth (ft)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2ID Diameter (ft)</td>
<td>26</td>
<td>28</td>
<td>28</td>
</tr>
<tr>
<td>ZOM Diameter (ft)</td>
<td>130</td>
<td>260</td>
<td>210</td>
</tr>
</tbody>
</table>
Scenario 1, 100% Nutrient Concentrations

Table 2 shows nutrient concentrations in both the ambient waters and the effluent for Quest Resort. Since this scenario uses the same nutrient concentrations with a higher flow rate, this table is identical to Table 3 in the December 1999 report, and the required nutrient dilution will also be the same.

The highest required dilution factor is 7990 for total phosphorous, and it will therefore be the critical parameter. Dilution of total phosphorous in the effluent to levels that meet Palau standards will indicate that standards will have been met by all other water quality parameters.

Table 3 shows the results of plume modeling. The model was run for both the 10-percentile current level required by EPA guidelines, and also for average current velocities for better representation of actual site conditions.

The increase in water flow volume results in about a 10 ft greater rise of the effluent plume in the water column for both current regimes. The trapping level depth of the plume is 49 ft for the high flow versus 55 ft for the lower flow. The zone of initial dilution (ZID), or the plume diameter at the top of the plume rise, is about the same for both flow conditions.

The higher rise of the plume is due to the greater output of buoyant fresh water. The extra 10 ft of plume rise allows increased turbulent mixing in order for density equilibration to occur.

The initial dilution factor of 1180 (Table 3) is not sufficient to meet Palau water quality standards. Secondary dilution of the plume occurs as it moves laterally away from the top of the plume rise with the current. The plume must travel another 130 ft before the 7990 dilution factor is achieved. The zone of mixing (ZOM) diameter for this scenario is therefore defined as 260 ft.

Table 4 shows the water quality concentrations after initial dilution compared with the Palau standards. Only the nutrient and biological water quality standards (total nitrogen, total phosphorous, and fecal coliform) are affected by the new levels.

The results of plume modeling are shown in Table 6. The physical characteristics of the plume are identical to those of Scenario 1, so the dilution factor and size of the ZID are the same. However, since the required dilution of the critical parameter is less for this scenario, the required secondary dilution and travel distance by the plume from the ZID are less, and the ZOM diameter is therefore 210 ft.

Table 6 shows the parameter concentrations after initial dilution for this scenario. Again, all parameters but total nitrogen and total phosphorous meet water quality standards in the ZID, and only total phosphorous fails to meet the standard when average current velocities are used.

### Table 2. Ambient and Effluent Characteristics, and Required Dilution, 100% Nutrient Levels

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Ambient Receiving Water</th>
<th>Effluent Characteristics</th>
<th>Palau Standards (Class AA)</th>
<th>Required Dilution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature (°C)</td>
<td>30.20 (Surface) 29.42 (Bottom)</td>
<td>31.0 ± 0.9</td>
<td>± 0.9</td>
<td>1.75</td>
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<tr>
<td>Salinity (‰)</td>
<td>32.65 (Surface) 32.78 (Bottom)</td>
<td>0 ± 10% in the range of 29-35 ‰</td>
<td>9.7</td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td>8.16 8.0</td>
<td>7.7 to 8.5</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Dissolved Oxygen (mg/l)</td>
<td>6.84</td>
<td>0</td>
<td>NLT 6.0 or Saturation</td>
<td>8.1</td>
</tr>
<tr>
<td>Total Nitrogen (mg/l)</td>
<td>0.104</td>
<td>20 ± 10% (0.114), or NTE 0.400</td>
<td>1990</td>
<td></td>
</tr>
<tr>
<td>Total Phosphorus (mg/l)</td>
<td>0.010</td>
<td>8 ± 10% (0.011), or NTE 0.005</td>
<td>7990</td>
<td></td>
</tr>
<tr>
<td>Fecal Coliform (per 100 ml)</td>
<td>0</td>
<td>15,000</td>
<td>70</td>
<td>214</td>
</tr>
</tbody>
</table>
### Table 3. Comparison of Length Scales and Dilution for 10% and Average Currents

30,000 GPD, 100% Concentration Levels

<table>
<thead>
<tr>
<th></th>
<th>Depth of Plume Rise (Ft)</th>
<th>Plume Diameter (Ft)</th>
<th>Dilution Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZID</td>
<td>40</td>
<td>28</td>
<td>1180</td>
</tr>
<tr>
<td>ZOM</td>
<td>49 (Trapping Level)</td>
<td>260</td>
<td>7990</td>
</tr>
<tr>
<td>ZID</td>
<td>50 (Average Currents)</td>
<td>37</td>
<td>2217</td>
</tr>
<tr>
<td>ZOM</td>
<td>55 (Average Currents)</td>
<td>210</td>
<td>7990</td>
</tr>
</tbody>
</table>

### Table 4. Parameter Concentrations after Initial Dilution

100% Nutrient Concentration Levels

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Ambient Receiving Water</th>
<th>Effluent Characteristics</th>
<th>Palau Standards (Class AA)</th>
<th>Concentration After Initial Dilution</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10% Currents</td>
</tr>
<tr>
<td>Temperature (° C)</td>
<td>30.20 (Surface)</td>
<td>31.0</td>
<td>± 0.9</td>
<td>29.47</td>
</tr>
<tr>
<td></td>
<td>29.42 (Bottom)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salinity (o/oo)</td>
<td>32.65 (Surface)</td>
<td>0</td>
<td>± 10% in the range of 29-35 o/oo</td>
<td>32.70</td>
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<tr>
<td></td>
<td>32.78 (Bottom)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td>8.16</td>
<td>8.0</td>
<td>7.7 to 8.5</td>
<td>8.16</td>
</tr>
<tr>
<td>Dissolved Oxygen (mg/l)</td>
<td>6.84</td>
<td>0</td>
<td>NLT 6.0 or Saturating</td>
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<tr>
<td>Total Nitrogen (mg/l)</td>
<td>0.104</td>
<td>20</td>
<td>± 10% (0.114), or NTE 0.400</td>
<td>0.120</td>
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<tr>
<td>Total Phosphorus (mg/l)</td>
<td>0.010</td>
<td>8</td>
<td>± 10% (0.011), or NTE 0.025</td>
<td>0.017</td>
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<tr>
<td>Fecal Coliform (per 100 ml)</td>
<td>0</td>
<td>15,000</td>
<td>70</td>
<td>9</td>
</tr>
</tbody>
</table>

**Notes:**
Discharge Volume: 30,000GPD
Port Characteristics: Single 4-inch Port
Discharge Depth: 103 ft
Current Speed: 0.1 ft/sec
Fecal Coliform T90 = 30 minutes
DO IDOD: 5 mg/l
Initial Dilution, 10% Currents: 1180
Initial Dilution, Average Currents: 2217
Table 5. Ambient and Effluent Characteristics, and Required Dilution, 75% Nutrient Concentration Levels

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Ambient Receiving Water</th>
<th>Effluent Characteristics</th>
<th>Palau Standards (Class AA)</th>
<th>Required Dilution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature (°C)</td>
<td>30.20 (Surface) 29.42 (Bottom)</td>
<td>31.0</td>
<td>± 0.9</td>
<td>1.75</td>
</tr>
<tr>
<td>Salinity (‰)</td>
<td>32.65 (Surface) 32.78 (Bottom)</td>
<td>0</td>
<td>± 10% in the range of 29-35 ‰</td>
<td>9.7</td>
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<tr>
<td>pH</td>
<td>8.16</td>
<td>8.0</td>
<td>7.7 to 8.5</td>
<td>N/A</td>
</tr>
<tr>
<td>Dissolved Oxygen (mg/l)</td>
<td>6.84</td>
<td>0</td>
<td>NLT 6.0 or Saturation</td>
<td>8.1</td>
</tr>
<tr>
<td>Total Nitrogen (mg/l)</td>
<td>0.104</td>
<td>15</td>
<td>± 10% (0.114), or NTE 0.400</td>
<td>1490</td>
</tr>
<tr>
<td>Total Phosphorus (mg/l)</td>
<td>0.010</td>
<td>6</td>
<td>± 10% (0.011), or NTE 0.025</td>
<td>5990</td>
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<tr>
<td>Fecal Coliform (per 100 ml)</td>
<td>0</td>
<td>11,250</td>
<td>70</td>
<td>161</td>
</tr>
</tbody>
</table>

Table 6. Comparison of Length Scales and Dilution for 10% and Average Currents 30,000 GPD, 75% Concentration Levels

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Depth of Plume Rise (Ft)</th>
<th>Plume Diameter (Ft)</th>
<th>Dilution Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZID (10% Currents)</td>
<td>40</td>
<td>28</td>
<td>1180</td>
</tr>
<tr>
<td>ZOM (10% Currents)</td>
<td>49 (Trapping Level)</td>
<td>210</td>
<td>5990</td>
</tr>
<tr>
<td>ZID (Average Currents)</td>
<td>50</td>
<td>37</td>
<td>2217</td>
</tr>
<tr>
<td>ZOM (Average Currents)</td>
<td>55 (Trapping Level)</td>
<td>165</td>
<td>5990</td>
</tr>
</tbody>
</table>
Table 7. Parameter Concentrations after Initial Dilution

75% Nutrient Concentration Levels

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Ambient Receiving Water</th>
<th>Effluent Characteristics</th>
<th>Palau Standards (Class AA)</th>
<th>Concentration After Initial Dilution</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>10% Currents</td>
<td>Average Currents</td>
</tr>
<tr>
<td>Temperature (°C)</td>
<td>30.20 (Surface) 29.42 (Bottom)</td>
<td>31.0</td>
<td>± 0.9</td>
<td>29.47 29.45</td>
</tr>
<tr>
<td>Salinity (ppt)</td>
<td>32.65 (Surface) 32.78 (Bottom)</td>
<td>0</td>
<td>± 10% in the range of 29-35 ppt</td>
<td>32.70 32.72</td>
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<tr>
<td>pH</td>
<td>8.16</td>
<td>8.0</td>
<td>7.7 to 8.5</td>
<td>8.16 8.16</td>
</tr>
<tr>
<td>Dissolved Oxygen (mg/l)</td>
<td>6.84</td>
<td>0</td>
<td>NLT 6.0 or Saturation</td>
<td>6.84 6.84</td>
</tr>
<tr>
<td>Total Nitrogen (mg/l)</td>
<td>0.104</td>
<td>15</td>
<td>± 10% (0.114) or NTE 0.400</td>
<td>0.116 0.111</td>
</tr>
<tr>
<td>Total Phosphorus (mg/l)</td>
<td>0.010</td>
<td>6</td>
<td>± 10% (0.011) or NTE 0.25</td>
<td>0.015 0.013</td>
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<tr>
<td>Fecal Coliform (per 100 ml)</td>
<td>0</td>
<td>11,250</td>
<td>70</td>
<td>6 3</td>
</tr>
</tbody>
</table>

Notes:
Discharge Volume: 30,000 GPD
Port Characteristics: Single 4-inch Port
Discharge Depth: 105 ft
Current Speed: 0.1 ft/sec
Fecal Coliform 90 = 30 minutes
DO (DOD): 5 mg/l
Initial Dilution, 10% Currents: 1180
Initial Dilution, Average Currents: 2217
1. INTRODUCTION.

The Quest Resort on the island of Ngerur is projected to produce 15,000 gallons of wastewater effluent that has undergone secondary treatment. Initially, it was planned to dispose of the effluent using injection wells on the island. After investigation of the island geology, however, it became evident that the volcanic breccia that composes the island is too solid to permit injection operations. The two other options for effluent disposal are 1) to pump untreated effluent into the Arakelang-Malakal treatment system, or 2) construct a marine outfall off Ngerur Island to disperse the treated effluent in deep water.

The first option would require construction of an 8,000-ft pressurized underwater force-main to transfer the effluent off the island and into a system that is already overloaded. Additionally, the ocean outfall for the Malakal Wastewater Treatment Plant (MWWTP) discharges close to shore at a relatively shallow depth of 50 ft. In short, usage of the MWWTP would contribute to an unreliable system that has already exceeded its design capacity.

The second option would require the construction of a small diameter (4-inch) pipeline from Ngerur Island out approximately 500 ft to release the effluent in water depths of 100 ft or more. Preliminary modeling by Sea Engineering, Inc (SEI), indicated that this option would be relatively benign, with Palau Class AA water quality standards being met in the zone of initial dilution above the discharge diffuser for the pertinent water quality parameters.

This report summarizes the results of field investigations primarily conducted during November, 1999, and subsequent water quality analysis and effluent plume modeling.

2. OUTFALL ROUTE INVESTIGATIONS

2.1 General Siting and Alignment Considerations

The treatment facility on Ngerur Island will be located in the vicinity of the proposed resort small-boat harbor on the southeast face of the island (Figure 1). Primary design considerations for locating the outfall included:

- proximity to the treatment facility,
- proximity to deep water,
- minimal footprint or other impact within the resort area, and
- sensitivity to real or perceived impacts on neighboring resorts.
The west side of Ngerur island is planned to be a very active part of the resort, with plans including a dive grotto as well as a man-made beach, and was therefore excluded as a site for the outfall. Three possible alignments were considered: 1) bearing northwest from the north side of the island, 2) bearing northeast from the northeast side of the island, and 3) bearing southeast from the proposed harbor entrance. Option 1 was considered to be too far from the treatment plant. Option 3 was attractive due to the proximity of the plant and also because associated environmental damage would be minimized by using the navigation channel to cross the sensitive nearshore area. However the presence of nearby resorts on Arakebesang island make discharges on the south side of Ngerur undesirable.

Option 2 was selected as it is reasonably close to the treatment facility and has access to deep water relatively close to shore. As part of further site investigations, SEI conducted a detailed bathymetric survey and underwater route reconnaissance on the northeast side of Ngerur Island. The bathymetric survey was conducted on November 19, 1999, and the underwater route investigations were done on the following day.

### 2.2 Bathymetric Survey

The detailed bathymetric survey included the offshore area for the entire northeast coast of the island out to a depth of 120 ft. Survey lines were spaced at 25-ft intervals. Differential GPS (DGPS) with sub-meter accuracy was used for positioning, and DGPS latitudes and longitudes were transformed into the project plane coordinate system in feet. The bathymetry data were plotted and a preliminary route alignment was chosen for further inspection.

### 2.3 Route Reconnaissance

The route alignment was chosen using the detailed bathymetry coupled with visual shallow water reconnaissance. Route selection criteria included 1) minimizing impacts on local corals by using sand channels as far as practicable in the shallow water areas, and 2) reducing construction difficulties by avoiding steep rocky terrain in the deeper water.

The selected alignment is shown in Figure 2. The route is 478 ft in length from about -4 ft elevation MSL to -106 ft MSL, at an azimuth of 31.9° from true North. Route coordinates are:
There are a number of distinct topographic features that characterize the profile of the rise of the island from the depths of the lagoon (Figure 3). The lagoonal plain is flat and rather featureless, and lies at a depth of 120 ft. As the island is approached there is a rise that slopes mildly at about 8° for a distance of 100 to 175 ft and to a depth of 90 to 100 ft. The island escarpment follows, a relatively steep slope of 15° to 22° over a horizontal distance of about 200 feet up to a depth between 30 and 35 feet. Between the 60 and 90 foot water depth the slope is much steeper along some sections of the escarpment, and avoiding these sections became a major factor in choosing the route. From the edge of the escarpment to the island shoreline the slope is mild at about 9° over a distance of 200 to 300 feet. These topographically distinct zones are used in the route reconnaissance to characterize observed features along the alignment.

The route reconnaissance was conducted by laying a transect line along the route in order to establish positioning. The line was marked at 25-ft intervals, for a total distance of 600 feet, with the transect zero positioned near the island shoreline in about 4 ft of water depth. Divers using SCUBA followed the transect line from deep water to shallow. Table 1 is a summary of the physical characteristics of the route observed during the reconnaissance dive. Following the route profile (Figure 3), the route is divided into five topographically and ecologically distinct zones in the table.

From the 4-ft depth to the island shoreline the bottom is composed primarily of eroded coraline limestone and volcanic bedrock without live coral growth, as these shallow water areas are exposed during low tides.

### 3. Oceanographic Design Parameters

#### 3.1 Currents and Circulation

The current speed, direction and persistence at the proposed outfall location, and the general circulation past the island, is the single most important oceanographic consideration for ocean outfall design and evaluation. The current speed at the discharge point affects the initial effluent dilution. The speed, direction and persistence of flow is the primary determinant of secondary dispersion of the waste field as a result of transport by water currents.
### Table 1. Marine Outfall Route Description

<table>
<thead>
<tr>
<th>Offshore Distance (Feet)</th>
<th>Water Depth (Feet)</th>
<th>Slope</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>600 - 550</td>
<td>120 - 116</td>
<td>Flat</td>
<td>Zone 1; flat lagoonal plain; the bottom is composed of very fine silt permeated with burrows and other evidence of in-faunal biota.</td>
</tr>
<tr>
<td>550 - 375</td>
<td>116 - 95</td>
<td>6° - 10° (av. 8°)</td>
<td>Zone 2; rise to the island escarpment; the bottom composition changes abruptly from silt to sand. The sand is formed into small mounds 1 ft to 1.5 ft in height by in-faunal biota.</td>
</tr>
<tr>
<td>375 - 200</td>
<td>95 - 35</td>
<td>15° - 22°</td>
<td>Zone 3; island escarpment. This is the steepest part of the route. Isolated coral and rock outcrops are inter-mixed with a substrate of sand, coral cobbles, and reef detritus. The amount of coral coverage gradually increases with decreasing water depth; a maximum of about 60% coral and rock coverage occurs at the edge of the escarpment at a water depth of about 35 ft.</td>
</tr>
<tr>
<td>200 - 100</td>
<td>35 - 20</td>
<td>9°</td>
<td>Zone 4. This is the outer part of the shallow shelf around the island and is composed of banks of coral interpersed with sand channels. The amount of coral coverage decreases from the edge of the escarpment to about 30% for most of the zone.</td>
</tr>
<tr>
<td>100 - 0</td>
<td>20 - 4</td>
<td>9°</td>
<td>Zone 5. This is the inner part of the shallow shelf around the island and is distinguished by an abrupt increase to about 80% to 100% coral coverage.</td>
</tr>
</tbody>
</table>

---

**Figure 3: Route Profile**

- **ZONE 5** Inner Reef
- **ZONE 4** Outer Reef
- **ZONE 3** Island Escarpment
- **ZONE 2** Island Rise
- **ZONE 1** Lagoon Flat
- **NGERUR ISLAND** Transect Profile
- **TRANSECT PROFILE**
- **VERTICAL EXAGGERATION 2x**
- **HORIZONTAL SCALE 1 IN = 100 FT**
- **TRANSECT DISTANCE (FT)**
- **ELAVATION (FT)**
- **DIFFUSER LOCATION**

---

**Notes on the Transect Profile**

- **ZONE 1**: Lagoon flat, flat lagoonal plain; the bottom is composed of very fine silt permeated with burrows and other evidence of in-faunal biota.
- **ZONE 2**: Rise to the island escarpment; the bottom composition changes abruptly from silt to sand. The sand is formed into small mounds 1 ft to 1.5 ft in height by in-faunal biota.
- **ZONE 3**: Island escarpment. This is the steepest part of the route. Isolated coral and rock outcrops are inter-mixed with a substrate of sand, coral cobbles, and reef detritus. The amount of coral coverage gradually increases with decreasing water depth; a maximum of about 60% coral and rock coverage occurs at the edge of the escarpment at a water depth of about 35 ft.
- **ZONE 4**: This is the outer part of the shallow shelf around the island and is composed of banks of coral interspersed with sand channels. The amount of coral coverage decreases from the edge of the escarpment to about 30% for most of the zone.
- **ZONE 5**: This is the inner part of the shallow shelf around the island and is distinguished by an abrupt increase to about 80% to 100% coral coverage.
In the global circulation system the Palau Islands come under the influence of both the equatorial countercurrent and the north equatorial current. The north equatorial current is westerly and influences Palau north of about 7°N during the winter months of December through February. The rest of the year the islands lie in the east flowing equatorial countercurrent. Currents near the islands can attain rates of 1 to 1.5 knots, and tidal currents in the passages have been reported with speeds up to 4 and 5 knots. Ngerur Island, however, is within the large lagoon that is formed and protected by the barrier reef that surrounds much of Palau. The currents at the project site can therefore be expected to be much less than those in surrounding open waters outside of the barrier reef or than those in the deep constricted channels between islands.

During the course of on-site investigations and field measurements, SEI conducted measurements of currents at the project site. A General Oceanics Model 6011T current meter was deployed on a taught line mooring in 106 feet of water close to the proposed outfall discharge location (see Figure 2). The meter was placed at a depth of 50 feet from October 14 through November 20, 1999, a total of 37 days. The meter measures current speed and direction, as well as water temperature, at 10-minute intervals.

Following retrieval the current meter readings were vector averaged to obtain hourly resultant speeds and directions. The calculated hourly values were then used as the data base for subsequent computer analysis, summarized as follows:

1. The hourly data were used to construct percent frequency histograms of current speed and direction. The histogram is shown in Table 2.

2. Current rose diagrams, graphical representations of the histograms, are shown on Figure 4. The net transport (vector average of all hourly readings) was calculated and is also shown on the figures.

3. The hourly values were used to generate a time series plot of the alongshore and onshore/offshore (crossshore) flow components, as shown on Figure 5. This plot shows the long-term characteristics of the current.

The recorded current speeds are low, averaging 2.7 cm/sec (0.09 ft/sec). Maximum recorded speeds were 4.1 cm/sec (0.134 ft/sec).

The net transport is almost due west at 266°, with a slight trend for stronger currents in the 3 to 4 cm/sec range (0.10 to 0.13 ft/sec) to bear west-northwest, parallel to the trend of the bathymetry.

<table>
<thead>
<tr>
<th>Station</th>
<th>Outfall</th>
<th>Month</th>
<th>Depth</th>
<th>50 ft/106 ft</th>
<th>Deployment Period</th>
<th>Net Transport</th>
<th>STD DEV</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10/14/99 - 11/20/99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CM/NW</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>CM/NNE</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
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<td>0.0</td>
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</tr>
<tr>
<td>CM/NE</td>
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<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
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</tr>
<tr>
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<td>0.0</td>
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<tr>
<td>CM/ESE</td>
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<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
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</tr>
<tr>
<td>CM/SE</td>
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<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>CM/NE</td>
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<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
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<tr>
<td>CM/W</td>
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<td>0.0</td>
</tr>
<tr>
<td>CM/N</td>
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<td>0.0</td>
<td>0.0</td>
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<td>0.0</td>
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<td>MAX SPD</td>
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<tr>
<td>STD SPD</td>
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<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

Table 2: Current Meter Histogram
OFF QUEST RESORT OUTFALL

The recorded current speeds are low, averaging 2.7 cm/sec (0.09 ft/sec). Maximum recorded speeds were 4.1 cm/sec (0.134 ft/sec).

The net transport is almost due west at 266°, with a slight trend for stronger currents in the 3 to 4 cm/sec range (0.10 to 0.13 ft/sec) to bear west-northwest, parallel to the trend of the bathymetry.
Figure 4: Current Rose Diagram

Figure 5: Current Meter Time Series
Current drogue studies were also completed during on-site investigations and current meter deployment. Current drift drogues are designed to lock into a water mass, and subsequently move with it. Whereas current meters provide detailed measurement of flow past a fixed point, drogues move with the flow to provide information on current and circulation patterns over a larger area. The drogues used for this study were of the “window-shade” type, with a weighted “sail” approximately 48 square feet suspended at a fixed depth of 15 ft from a small surface float. Positioning was accomplished with DGPS. The results of the drogue studies are shown in Figure 6.

The drogue studies occurred during a late flood and early ebb tide with light winds blowing at 5 to 10 knots from the south-southeast. In all cases the drogues moved downwind to the northwest and north, strongly indicating that near-surface circulation is primarily wind-driven.

Although the histograms and current rose diagrams for current meter data indicate that the deep currents are also uni-directional, there is a definite semi-diurnal (twice daily) component manifest in the time-series plots that suggests a dependency on tide. Currents that are strongly influenced by the tide are usually found to be reversing, that is, they flow in two diametrically opposed directions. In cases such as this, where the circulation is primarily wind-driven or otherwise uni-directional, the effect of the tide can be to slow or speed the current, rather than cause an actual reversal.

3.2 Receiving Water Quality

Density Structure
Oceanic waters in tropical regions are typically well-mixed and homogenous in the upper regions. A CTD (Conductivity, Temperature, and Depth) profile was made near the island on 11/20/98 to measure the salinity, temperature and resulting water density. Figures 7, 8 and 9 are plots of the temperature, salinity, and density derived from the CTD data. The temperature data (Figure 7) show a 1°C temperature decrease between the surface and the 40-ft depth caused by warming of the surface water. The salinity data (Figure 8) show a sudden decrease in the first 10 feet (probably due to surface evaporation) and then a gradual increase in salinity with depth, with an overall range of about 0.2 pph. The density, a function of both temperature and salinity, shows a mild gradient between the surface and about 70 feet. Although mild, this gradient will prevent the effluent plume from surfacing.

![Diagram](image.png)
Figure 7: Temperature Profile, Ngerur Island, 11/20/99

Figure 8: Salinity Profile, Ngerur Island, 11/20/99
Water Quality and Nutrient Levels

Water quality and nutrient levels were measured by AECOS consultants between October 12 and October 16, 1998, and are contained in their report, "Biological and water quality reconnaissance surveys on Ngerur Island, Palau Lagoon, Republic of Palau" (Draft Rept. No. AC068, 8/12/99). Salinity and temperature measurements were conducted by SEI on November 20, 1999. Water quality and nutrient levels are shown in both Table 3, Section 4.4, and Table 4, Section 4.6.

Water quality standards for the Republic of Palau are contained in Chapter 2401-11 Marine and Fresh Water Quality Regulations, promulgated by the Republic of Palau Environmental Quality Protection Board (effective May 26, 1996). The coastal waters around Ngerur Island are designated Class AA Waters. The regulations state that the uses to be protected in this class of water are oceanographic research, the support and propagation of shellfish and other marine life, conservation of coral reefs and wilderness areas, compatible recreation and other aesthetic enjoyment; and that this class of waters remain as near to their natural state as possible with an absolute minimum of pollution from any source. The water quality standards applicable to Class AA Waters are contained in both Table 3, Section 4.4, and Table 4, Section 4.6. A Zone of Mixing (ZOM) for the proposed outfall will be required in accord with Sections 2401-11-30 through 2401-11-16. The ZOM defines an area in which the water quality may be expected to exceed the standards as the effluent plume mixes with the receiving water and is diluted. The ZOM includes both the Zone of Initial Dilution (ZID) in the immediate vicinity of the discharge point, as well as any required additional secondary dilution achieved during transport of the effluent plume by the prevailing currents.

4. PLUME MODELING

4.1 Wastewater Effluent Characteristics

The wastewater effluent will be treated to a secondary level using an extended aeration activated sludge process. Effluent characteristics were provided by Berryman & Henigar, Inc., and are contained in both Table 3, Section 4.4, and Table 4, Section 4.6.

4.2 Plume Behavior

The complex behavior of outfall effluent is difficult to predict without the aid of computer modeling. Mixing and dilution are functions of jet characteristics at the diffuser port.
The near field dilution of the effluent is a result of the process of initial mixing. Initial mixing occurs due to the effects of momentum and buoyancy as the plume is discharged as a jet or series of jets at the diffuser ports, and subsequent entrainment and turbulent mixing of the effluent with the receiving water as the buoyant plume rises toward the surface. The rate of dilution is quite rapid immediately after discharge, but decreases significantly after the momentum and buoyancy of the plume are dissipated. The plume rises until the mixture of the effluent and the receiving water is stable within the water column. At this point, the dilution obtained is called the initial dilution.

Following the initial dilution, the effluent plume moves with the prevailing currents and is further diluted by diffusion as a result of lateral mixing and oceanic turbulence. This secondary, or far field, dispersion is of much less magnitude than the initial dilution. While the initial dilution of a well designed diffuser is typically on the order of 100 to 1 or more and occurs in a matter of minutes, secondary mixing typically increases the additional dilution by a factor of only 5 to 10 over a matter of hours.

Initial dilution depends primarily upon the effluent discharge volume, the length and depth of the diffuser, and the prevailing currents and density stratification. At a given site, the diffuser length and depth are the primary variables controlled by the designer. Increased initial dilution can be obtained by increasing either the discharge depth or the length of the diffuser. A single port will be used for the Ngerur outfall, as the volume of flow will be so low that a multi-port diffuser would result in a significant loss of jet velocity and consequent loss in efficient initial mixing.

The density structure of the receiving water has a major effect on the behavior of the effluent plume. With a sufficiently stratified water column, a buoyant sewage plume may mix sufficiently with the more dense bottom water so that it will stay submerged and not reach the surface. However, since the initial dilution is a function of the distance traveled by the rising plume, a submerged waste field will have less initial dilution than a surfacing plume at the same site. The tropical waters of Palau are typically well-mixed and homogeneous, meaning there is little or no stratification with depth, and are normally conducive to plume surfacing. However, the deep depth of the Ngerur outfall and the low flow volume, coupled with the observed mild vertical density gradient, ensure that the plume will not surface in this case.

Although initial dilution increases with increasing ambient current speeds, higher currents increase the distance over which the initial and far field dilution takes place. For strong currents, the process can extend down-current a distance equal to multiples of the diffuser length. The scale of the subsequent far field dilution is also directly related to the current speed, because the diffusing plume is being moved at a higher speed. The EPA regulations for a waiver of secondary treatment under Section 301 (h) of the Clean Water Act (USEPA, 1982) are concerned with determining a set of receiving water and effluent conditions that would approach a worst case scenario. The EPA requires the use of the 10-percentile current speed for the calculation of the critical initial dilution value for waiver applications.

The current speeds are very low off of Ngerur Island, and the secondary dilution process will not be particularly efficient. It is therefore desirable to accomplish the required dilution during the initial dilution process, that is, during the ascent of the plume above the diffuser.

Effluent plume modeling was undertaken using the oceanographic data collected during this study to evaluate a range of outfall alternatives. Software developed for the EPA by Baumgartner, Frick, and Roberts (1993) was used for the modeling. This software has become the accepted standard for modeling outfall effluent plume behavior, and is accepted by federal regulatory agencies. PLUMES is the model interface and manager, and incorporates a variety of previous models. The model "UM" is used for initial dilution modeling. The PLUMES software also includes two far-field dilution models. One is based on Richardson's 4/3 power law for the diffusion coefficient, and the other on a constant coefficient of diffusivity. The former model is typically used for open ocean situations and was therefore used in this case.

Critical Parameter

Table 3 compares the ambient water quality parameters values measured in the receiving waters with both the Palau water quality standards and the characteristics of the effluent. The dilution required to meet the standards is also shown in the table. The required dilution for total phosphorous is greater by far than that for any other parameter. Total phosphorous is therefore considered the critical parameter, since proper dilution of phosphorous to meet the standards will ensure that the standards will be met for all other water quality parameters.

Input Parameters
Table 3: Ambient and Effluent Characteristics, and Required Dilution

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Ambient Receiving Water</th>
<th>Effluent Characteristics</th>
<th>PALU Standards (Class AA)</th>
<th>Required Dilution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature (°C)</td>
<td>30.20 (Surface) 29.42 (Bottom)</td>
<td>31.0 ± 0.9</td>
<td></td>
<td>1.75</td>
</tr>
<tr>
<td>Salinity (‰)</td>
<td>32.65 (Surface) 32.78 (Bottom)</td>
<td>0 ± 10% in the range of 29-35 0/00</td>
<td></td>
<td>9.7</td>
</tr>
<tr>
<td>pH</td>
<td>8.18</td>
<td>8.0</td>
<td>NLT 6.0 or Saturation</td>
<td>N/A</td>
</tr>
<tr>
<td>Dissolved Oxygen (mg/l)</td>
<td>6.84</td>
<td>0</td>
<td></td>
<td>8.1</td>
</tr>
<tr>
<td>Total Nitrogen (mg/l)</td>
<td>0.104</td>
<td>20 ± 10% (0.114), or NTE 0.400</td>
<td></td>
<td>1990</td>
</tr>
<tr>
<td>Total Phosphorus (mg/l)</td>
<td>0.010</td>
<td>8 ± 10% (0.011), or NTE 0.025</td>
<td></td>
<td>7990</td>
</tr>
<tr>
<td>Fecal Coliform (per 100 ml)</td>
<td>0</td>
<td>15,000</td>
<td>70</td>
<td>214</td>
</tr>
</tbody>
</table>

PLUMES requires user input which describes the receiving water body, the physical properties of the effluent, and the characteristics of the diffuser. The input parameters include effluent and receiving water temperature and salinity, from which density is calculated, effluent flow rate, current characteristics, water depth, and the diffuser port configuration.

Flow Rate: Flow rate was 15,000 gallons per day.

Density Profile: Temperature and salinity were measured at the site.

Currents: To meet the EPA worst-case scenario, 10-percenter currents were used. These were calculated from frequency distributions of current meter data collected at the site. Although the slower currents result in less initial dilution, faster current speeds result in increased far-field transport. To illustrate this, the average current speeds were also modeled. These are probably more representative of prevailing conditions at the site. The 10 percentile current speed is 0.05 ft/sec (1.5 cm/sec) and the average current speed is 0.085 ft/sec (2.6 cm/sec).

Water Depth: The water depth of the diffuser is 106 ft MSL. Deep water is close to the island and accessible.

Port Configuration: The diffuser will essentially be an open pipe consisting of one port at the nominal pipe diameter (4-inches). Construction of the port is not advisable for a small diameter pipe, and multiple ports would reduce the effluent jet velocity and consequent plume dilution.

4.5 Modeling Results

Table 4 is a comparison of the plume rise and trapping level, and also plume length scales (i.e. plume diameter for the HBD and distance traveled for the ZOM) using the required dilution of total phosphorus as the critical value for the ZOM. While EPA regulations require the use of the 10% current value to calculate the ZOM, the average currents are a better representation of actual site conditions. In both cases it should be pointed out that the current speeds are very slow and the plume is diluted primarily from the turbulent mixing associated with the buoyant rise of the plume. Secondary dilution in this case is a slow process due to the low current speeds.
Table 4. Comparison of Length Scales and Dilution for 10% and Average Currents

<table>
<thead>
<tr>
<th></th>
<th>Depth of Plume Rise (ft)</th>
<th>Plume Diameter (ZID) Plume Distance (ZOM)</th>
<th>Dilution Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZID (10% Currents)</td>
<td>59</td>
<td>26</td>
<td>1700</td>
</tr>
<tr>
<td>ZOM (10% Currents)</td>
<td>55</td>
<td>95</td>
<td>7990</td>
</tr>
<tr>
<td>ZID (Average Currents)</td>
<td>59</td>
<td>38</td>
<td>4200</td>
</tr>
<tr>
<td>ZOM (Average Currents)</td>
<td>65</td>
<td>80</td>
<td>7990</td>
</tr>
</tbody>
</table>

Using 10% current values as per EPA guidelines, the zone of mixing will extend to a radius of 95 feet around the diffuser. The trapping depth of the plume is where the plume density matches ambient conditions. In this case, the observed density gradient (see Figure 9) will ensure that the plume will remain at its trapping level and will not surface. The plume will rise slightly above the trapping level due to excess momentum from its buoyant rise, but will then fall slowly. The plume rise and trapping level is higher for the lower current speeds as there is less turbulent mixing and dilution during the rise. Figure 10 is a schematic representation of the pipeline on the seafloor with the plume rise and propagation.

4.6 Water Quality Impacts

Table 5 lists the concentrations of water quality parameters at the zone of initial dilution, or the highest rise of the plume for both 10% and average currents. All parameters except total phosphorus meet or exceed Palau water quality standards after initial dilution. Total phosphorus very nearly meets the standards at the ZID, and in fact is well within the not-to-exceed limit of 0.025 mg/l.
All parameters except dissolved oxygen (DO) and fecal coliform counts are conservative, and the concentrations were calculated by,

\[ C = \frac{(C_e - C_a)}{S} + C_a \]

where,
- \( C \) = concentration of parameter
- \( C_a \) = ambient concentration of parameter
- \( C_e \) = effluent concentration of parameter
- \( S \) = dilution at zone of mixing (ZOM) boundary (Table)

The DO concentration following initial dilution is calculated using the following equation:

\[ DO_d = DO_a + \frac{(DO_e - IDOD - DO_d)}{ID} \]

where,
- \( DO_d \) = ambient concentration
- \( DO_e \) = effluent concentration
- \( IDOD \) = immediate dissolved oxygen demand

An IDOD value of 5 mg/l is used.

The fecal coliform count is a non-conservative parameter because the bacteria are in a hostile environment and rapidly die-off. The die-off rate is expressed by the \( T_{90} \) value, or the time over which 90% of the bacteria are killed. The die-off of fecal coliform as a function of time can be expressed by,

\[ B(t) = B_A + (B_E - B_A) e^{-Kt} \]

Where,
- \( B(t) \) = coliform bacteria count as a function of travel time, \( t \)
- \( B_A \) = ambient coliform bacteria count
- \( B_E \) = effluent coliform bacteria count
- \( K \) = decay rate constant

A \( T_{90} \) of 30 minutes is used, or \( K = 4.6 \) per hour.
5. PIPELINE DESIGN AND CONSTRUCTION RECOMMENDATIONS

5.1 Overall Pipeline Material Selection

Considerations that affect the selection of the type of pipe used for the outfall include: (1) ease of construction for the given physical and environmental conditions at the project site; (2) cost effectiveness; and (3) reliability and minimum maintenance. In addition, the material selected affects the configuration of pipeline anchoring and protection.

Three types of materials are commonly used for ocean pipelines: reinforced concrete pipe with bell and spigot joints, ductile iron pipe with mechanical joints, and high-density polyethylene pipe. Concrete pipe has been extensively and successfully used for large ocean outfalls in Hawaii and other regions. The bell and spigot joints used for concrete pipe are usually joined in situ on the seafloor, a labor-intensive and therefore expensive operation. For this reason, reinforced concrete pipe is usually not used for small pipeline construction. Similarly, ductile iron pipe is mechanically joined on the seafloor with flanges or ball joints, and must be constructed section by section.

High density polyethylene is recommended for the new outfall at Ngerur. Polyethylene combines cost effectiveness, ease of construction and long life. Long sections of pipe can be pre-assembled on land, then floated into place and sunk. Its suitability has been proven in recent years by use for deep ocean intake pipes associated with Ocean Thermal Energy Conversion (OTEC) projects and the Hawaii Ocean Science and Technology Park at Kakehule Point, Island of Hawaii. Sea Engineering, Inc., has used polyethylene pipe in the design of outfalls on the Pacific islands of Roi Namur, Keore, and Sal. On the island of Rota, a polyethylene pipe is currently specified for the design of a new wastewater outfall to replace a flanged steel pipeline that was destroyed by Typhoon Karyn in 1990.

5.2 Construction Methods

Ngerur Island is located within the Palau Lagoon and is surrounded by an extensive barrier reef system that affords protection from extreme storm wave activity. The kind of protection and anchoring necessary for outfall construction on open and exposed coasts is therefore not necessary in this case. Simple methods, such as the use of concrete blocks and saddles, can be used to sink the pipe and anchor it to the substrate. If necessary, additional anchoring in the sand substrate can be achieved by strapping the pipe and using "Manu" anchors - small anchors that are burrowed into the sand. Figure 10 contains a schematic representation of the pipeline on the route profile.

One of the primary construction concerns for the Ngerur outfall will be to minimize any damage to live coral. During the reconnaissance diving, it was observed that many coral outcrops could be avoided by using the flexibility of the HDPE pipe. Other outcrops are small enough that they can be re-located by divers. However there are some areas where the outfall pipe must travel over live outcrops. In particular, the first 100 feet off the island shoreline supports vigorous coral growth over almost 100% of the bottom. Much of this coral is finger-type that can be easily broken and damaged. In addition, the bottom is uneven and not conducive to supporting the pipeline. It is recommended that the first 100 feet of the offshore pipeline be trenches into the bottom. A narrow trench through the coral areas has the following advantages:

- Coral damage will be minimized
- The pipeline will not be visible
- The pipeline will be well-protected
- Coral can be re-colonized over the covered trench.

The last point is perhaps most environmentally significant — by trenching the pipeline the coral ecology can be re-generated and the pipeline will in effect be locally removed from the eco-system.
Appendix B-1

Geotechnical Engineering Exploration Report

(GeoLabs, Inc., 1999)
DATE: November 30, 2000
TIME: 5:27 PM
TO: Wi! Chee Planning
ATTN: Mr. Wi! Chee
W.O. No.: 4168-00
SUBJECT: Quest Resort at Ngerur Island
Republic of Palau
NO. OF PAGES: 6
(Including cover sheet)
FAX NO.: 942-1851
REMARKS: As discussed over the telephone, we had to retrieve our information from the files in archives for this project. Therefore, we just got the files for review, and we are sending you the attached information.

As indicated to you, a final report was not issued for the drilling of the extraction and injection wells at the site. Although we were commissioned to drill up to five extraction and injection wells on Ngerur Island, it was mutually agreed (between the owner's representative and Geolabs) that the drilling of the wells be terminated after the results of the first well (EW-1) was drilled to about 240 feet.

The permeability tests conducted on the first well indicate that the ground was generally "impermeable" with coefficients of permeability on the order of about $10^{-7}$ to $10^{-8}$ centimeters per second. The following attachment is a communication between Geolabs and the hydrogeologist hired by the owner to evaluate the test results from the wells. Basically, the communication transmits the permeability test data (up to that time) for evaluation by the hydrogeologist. At the time of the communication, only two of the four permeability tests had been completed.

Subsequent to that memorandum, two more permeability tests were completed, and the results of the test were provided to the hydrogeologist in the field. We have included the two additional permeability tests (at depths of 200.5 feet and 240.5 feet) for your use. In general, the test results indicate that the ground at Ngerur Island down to a depth of about 240 feet may be considered to be "impermeable."

If you have questions or need additional information, please call.

xc. Mr. Stan Gamble, CM & D (545-2695)
**DATE:** June 2, 1999
**TIME:** 5:14 PM
**TO:** Earth Tech  
**FROM:** Robin M. Lim
**ATTN:** Mr. Doug Roff  
**W.O. No.:** 4168-00
**SUBJECT:** Percolation Test Results  
**NO. OF PAGES:** 3 (including cover sheet)
**FAX NO.:** 1-801-530-5920  
**FAX OPERATOR:** Cindy/Mary Ann

---

**REMARKS:** As requested, the following sheets are the results of the two injection tests conducted for the Extraction Well (EW-1) at the island. The results indicate very poor permeability, even at 200 feet, which yielded the same results. We don't have the test results to send, but they are very similar according to Yoshi. So, expect similar numbers for the test at 200 feet.

They have achieved 200 feet depth at this time and are awaiting further instructions. My thoughts are to continue coring to about 225 or 230 feet and perform another injection test to provide additional permeability data. No point in performing the pump test in these conditions. Do you agree with this?

Another note is that we need to send them more casing and HQ rods to continue the boring to 300-foot depth. I was just informed that some of the rods and casing were damaged from the offshore drilling when the barge movement sheared off some of the rods and casing. Therefore, they can get to about 230 feet only at this time until we send them more rods to continue to 300 feet.

Please let me know of your thoughts. If you have questions or need additional information, please call.

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**DATE:** June 2, 1999  
**TIME:** 5:14 PM

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**Coeff. of Permeability, k:** 6.14E-06 (cm/s)  
**1.01248E-05** (feet/min)

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**Hard Copy will be in the Mail ( )  Hard Copy will not be Sent (X)**

Please call our fax operator should any problems occur with the receipt of facsimile message.

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Coef. of Permeability, k: 1.122E-06 cm/s
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Coef. of Permeability, k: 7.325E-07 cm/s

GEOLABS-HAWAII

W.O. 4168-00 PLATE 3.4
DRAFT

Geotechnical Engineering Exploration
Quest Resort at Ngerur Island
Ngerur Island, Republic of Palau

Prepared for

MORITA CORP PALAU, INC.

Mr. Joe Hideo Morita
Morita Corp Palau, Inc.

Dear Mr. Morita:

Geolabs, Inc. is pleased to submit our report entitled "Geotechnical Engineering Exploration, Quest Resort at Ngerur Island, Ngerur Island, Republic of Palau" prepared for the design and construction of the proposed resort.

Our work was performed in general accordance with the scope of services outlined in our fee proposal of November 23, 1998.

Detailed discussion and specific design recommendations are contained in the body of this report. If there is any point that is not clear, please contact our office.

Very truly yours,

GEOLABS, INC.

DRAFT

Robin M. Lin, P.E.
Vice President

GEOLABS, INC.
Geotechnical Engineering and Drilling Services
2006 Kalihi Street • Honolulu, HI 96819

Hawaii • California • Taiwan
SUMMARY OF FINDINGS AND RECOMMENDATIONS

Based on our field exploration, the island surface is generally blanketed by a mantle of soil of the order of about 3 to 5 feet thick, with some localized areas extending to depths of about 10 to 15 feet below the existing ground surface. The near-surface soil horizon is generally underlain by volcanic breccia formation except in the southeastern portion of the Island, where the volcanic breccia rock was exposed at the ground surface. Offshore borings drilled in the proposed harbor and docking area generally encountered dense volcanic breccia rock formation near the mudflat surface.

Based on our field exploration and the current design concept, we recommend that a shallow foundation system consisting of posts-and-beams be used to support the one to three-story buildings planned for the proposed resort development. An allowable bearing pressure of up to 3,500 psf may be used for the design of the post footings bearing on the stiff soils and/or volcanic rock surface. The recommended bearing pressure may be increased to 10,000 psf for footings embedded by at least 1 foot into the dense volcanic breccia rock formation anticipated at shallow depths. A minimum footing embedment of 1 and 4 feet may be used for footings bearing on the dense volcanic breccia rock and the surface soils, respectively.

For the harbor facilities planned for the proposed resort development, we recommend that 16-inch octagonal, precast prestressed concrete piles end-bearing in the dense volcanic breccia rock formation be used to support the proposed waterfront structures. The driven piles may be designed based on an allowable compressive load capacity of about 200 kips (100 tons). A typical pile length of about 30 feet may be used for the recommended pile foundation design.

INTRODUCTION

This report presents the results of our geotechnical engineering exploration performed for the proposed Quest Resort at Ngerur Island development in the Republic of Palau. The geotechnical engineering exploration was performed in general accordance with the scope of installation of the pile foundation should be conducted after the harbor dredging operations to reduce the potential for disturbance to the driven pile foundation and reduction in pile capacity. In order to facilitate the pile installation operations into the dense volcanic breccia rock formation, predrilling at the proposed pile locations to Elevation -22 feet MSL will be required prior to pile installation. The diameter of the predrilled holes should be about 24 inches to facilitate socketing the pile into the dense volcanic breccia rock formation and to provide the lateral load resistance to the pile foundations. The annular space between the pile and the drilled hole should be grouted with tremie concrete.

The proposed harbor area between the shoreline and the breakwater structures will be dredged to a depth of about Elevation -12 feet MSL. Based on the subsurface materials encountered in our borings, we believe that the materials encountered within the harbor area may be excavated to a slope inclination of about 2H:1V from the existing mudline down by about 5 feet to account for the sediments in the area. Below the upper 5 feet measured from the existing mudline, we believe that a slope inclination of 0.5H:1V may be used for the dredged excavations, which will likely expose the dense volcanic breccia rock formation.

Our field observations indicate that the near-surface soils appear to be relatively porous with good percolation characteristics when the soils are left undisturbed or in a natural state. However, drainage became very poor when the soils have been disturbed or recompacted. Therefore, we believe that disturbance to the on-site soils should be kept to a minimum during the earthwork operations. In areas where the near-surface soils have been disturbed or recompacted, a surface water runoff collection system may need to be incorporated into the project construction for proper drainage and erosion control.

The text of this report should be referred to for detailed discussion and specific design recommendations.
The general location and vicinity of the project site are shown on the Project Location & Vicinity Map, Plate 1.

This report summarizes our findings and geotechnical engineering recommendations derived from our field exploration, laboratory testing, and engineering analyses for the proposed project. These recommendations are intended for the design of foundations, retaining structures, walkway slabs, dredge excavations, and site grading only. The findings and recommendations presented herein are subject to the limitations noted at the end of this report.

**PROJECT CONSIDERATIONS**

The proposed Quest Resort at Ngerur Island development is located on an uninhabited island in the Republic of Palau, as shown on the Project Location & Vicinity Map, Plate 1. The island is situated approximately 0.5 miles west of the westernmost point of Arakebesang Island and is about 1.5 miles from the existing Palau Pacific Resort.

Based on the information provided, we understand that 20 one and two-story buildings will be constructed for the Quest Resort at Ngerur Island development, as shown on the Site Plan, Plate 2. In addition, a two to three-story main hotel building will be constructed at the southern portion of the island. In general, we envision that the building structures will be constructed using a post-and-beam type of foundation system, which would not require substantial grading of the building areas to attain level building pads for construction.

Based on the information provided, we understand that structural loads on the post footings for the one and two-story building structures may be on the order of about 6 to 65 kips per column. Due to the sloping nature of the island, the proposed building structures will have about 7 to 10 feet of elevation differential between the opposite corners of the buildings. Therefore, we anticipate that there will be some retaining walls at the structure locations (as part of the building) to provide for grade separation.

**PURPOSE AND SCOPE**

The purpose of our geotechnical engineering exploration for the resort development was to obtain a general overview of the surface and subsurface conditions at the project site. The subsurface information obtained was utilized to develop an idealized subsurface data set for the formulation of geotechnical engineering recommendations pertinent to the design of foundations, retaining structures, walkway slabs, dredge excavations, and site grading for the proposed Quest Resort at Ngerur Island project. Our work was performed in general accordance with the scope of services outlined in our fee proposal dated November 23, 1998. The scope of our work included the following tasks and work efforts:

1. Research and review of available in-house soils and geologic information pertinent to the project site and its vicinity.
2. Mobilization and demobilization of our truck-mounted drilling equipment using a barge by International Bridge Corporation to the island and back.
3. Drilling and sampling of eight borings for a total of about 265 lineal feet of field exploration. The exploration included three offshore borings (Boring Nos. 1 through 3) extending to depths of about 17 to 47 feet below the existing mud flat surface inside the proposed harbor area, and five on-land borings (Boring Nos. 4 through 8) extending to depths of about 13 to 47.3 feet below the existing ground surface for the main hotel building.

4. Mobilization and demobilization of a rubber-tired excavator and operator for clearing access trails to the proposed boring and test pit locations.

5. Excavation of 10 test pits extending to a maximum depth of about 12.5 feet below the existing ground surface.

6. Coordination of the field exploration and logging of the borings and test pits by a geologist from our firm.

7. Laboratory testing of selected soil samples obtained during the field exploration as an aid in classifying the materials encountered and evaluating their engineering properties.

8. Analyses of the field and laboratory data for the formulation of geotechnical engineering recommendations pertinent to the design of foundations, retaining structures, walkway slabs, dredge excavations, site grading, and some other geotechnical related items for design of the proposed resort development.

9. Preparation of this report summarizing our work and presenting our findings and recommendations.

10. Coordination of our overall work on the project by an engineer from our firm.

11. Quality assurance and client-design team consultation by a principal engineer from our firm.

12. Miscellaneous work efforts such as drafting, word processing, and clerical support.

Detailed descriptions of our field exploration and Logs of Borings are presented in Appendix A of this report. The logs of the test pits excavated are presented in Appendix B. Results of the laboratory tests performed on selected soil samples are presented in Appendix C.

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Ngerur Island is essentially oblong in shape and generally consists of a centrally located highland that slopes down toward the perimeter shoreline. The perimeter shoreline consists of banks elevated from the coastal waters. The banks may have formed from the effects of tidal fluctuation and coastal erosion. A relatively shallow depth marine shelf surrounds the island before abruptly dropping off with increasing water depth. The shelf contains deposits of marine sediments and coral growth that may overlie volcanic rock buried at greater depths.

**SITE DESCRIPTION**

The project site is located on an uninhabited island, known as Ngerur Island, in Koror State in the Republic of Palau. The island is situated approximately 0.5 miles west of the westernmost point of Arakebesang Island and is about 1.5 miles from the existing Palau Pacific Resort facility. Ngerur Island is approximately 12.5 acres in size and is heavily vegetated over the entire island.

The perimeter of the island generally consists of steep, near-vertical slopes with bedrock exposure. In general, there are three areas along the perimeter of the island that are underlain by soil materials with a gentle sloping terrain down to the shoreline. One of these areas may be characterized as a mangrove environment and is located at the southeastern portion of the island. The ground surface of the island is generally flat with the east side having higher elevations and the west side lower in elevations. The ground surface elevations generally range from about +66 feet MSL on the east side of the island to about +18 feet MSL on the west.

The island is generally accessed by a north-south trending access trail, which connects with the equipment stand-by area at the north. Due to the high moisture content and thickness of the near-surface soils, a large portion of the island is currently not accessible by normal vehicles. Surface drainage and the infiltration characteristics of the native soils appear to be good except along the access trail, where the soils have been reworked and compacted. In these areas, potholes and standing water were observed, indicating poorly drained near-surface soil conditions.

Other features of interest on the island include the occurrences of fault/fracture zone traces in the rock outcrops along the perimeter of the island. Most of the traces are near-vertical and trending approximately in an east-west direction. The fault/fracture zone traces are generally observed in homogenous rock types and consist of mineral veins. In general, these fault/fracture zone traces do not appear to be active fault traces.

**SUBSURFACE CONDITIONS**

The subsurface conditions at Ngerur Island were explored by drilling and sampling eight borings, designated as Boring Nos. 1 through 8, for a total footage of approximately 265 lineal feet of field exploration. Three of the eight borings (Boring Nos. 1 through 3) were drilled on the mud flats between the shoreline and the future breakwater structures. Boring Nos. 1 through 3 extended to depths of about 17 to 47 feet below the mud flat surface. The remaining five borings (Boring Nos. 4 through 8) were generally drilled for the main hotel building. The five borings extended to depths between about 13 and 47.3 feet below the existing ground surface. In addition, the subsurface conditions below the one and two-story buildings were explored by excavating 10 test pits, designated as Test Pit Nos. 1 through 10, to a maximum depth of about 12.5 feet below the existing ground surface. The approximate locations of the borings drilled and test pits excavated are shown on the Site Plan, Plate 2.

Based on our field exploration, the island surface is generally blanketed by a mantle of soil on the order of about 3 to 5 feet below the existing ground surface. In a few areas, the surface soil layer extended to about 10 to 15 feet below the existing ground surface. The near-surface soils generally consist of stiff to very stiff clayey silts and silty clays with high moisture contents. The near-surface soils are generally the products of mechanical and chemical weathering of the underlying volcanic rock. Volcanic breccia rock formation generally underlies the surface soil horizon. In the southeastern portion of the island, the volcanic breccia rock
was exposed at the ground surface. The volcanic breccia rock formation encountered generally was very dense and massive (with few fractures).

Based on the off-shore borings (Boring Nos. 1 through 3) drilled for the proposed harbor facilities, it appears that the future harbor area enclosed within the shoreline and the proposed breakwater structures is generally underlain by dense volcanic breccia rock formation near the mud flat surface except in Boring No. 1, where the dense breccia rock was encountered at a depth of about 10 feet deep below mud flat surface.

Groundwater was not encountered in the test pits excavated on the island; however, a significant amount of seepage water was observed below the surface soil horizon at and around the interface between the soil and rock. However, it should be noted that groundwater (likely seepage water) was encountered in the borings drilled on the island. Due to the nature of the island locality, the water levels measured in the drilled borings and excavated test pits during our field exploration were likely affected by tidal influences. In addition, the water levels at the project site may be influenced by seasonal precipitation and storm surge conditions.

Detailed descriptions of the materials encountered and water levels observed are presented on the Logs of Borings, Plates A-1 through A-8 of Appendix A. Materials encountered in the test pits excavated are presented on the Logs of Test Pits, Plates B-1 through B-5 of Appendix B. Results of the laboratory tests performed on selected soil samples are presented in Appendix C.

**DISCUSSION AND RECOMMENDATIONS**

Based on our field exploration, the island surface is generally blanketed by a mantle of soil on the order of about 3 to 5 feet thick, with some localized areas extending to depths of about 10 to 15 feet below the existing ground surface. The near-surface soil horizon is generally underlain by volcanic breccia formation except in the southeastern portion of the island, where the volcanic breccia rock was exposed at the ground surface.

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live loads and may be increased by one-third for transient loads, such as those caused by wind or seismic forces. In addition, an adhesion value of 600 psf may be used for the design of the post footings, if needed. However, the frictional contribution from the upper 3 feet of soils should be neglected due to the potential for shrinkage crack development and soil disturbance resulting from construction activities.

For the post footings bearing on the stiff soils and/or volcanic rock, the bottom of the footings should be relatively free of soft and/or loose materials prior to the placement of reinforcing steel and concrete. If soft and/or loose materials are encountered at the bottom of the footings, they should be removed to expose the underlying firm materials. The bottom of footings may be extended down to the underlying competent material. The annular between the 18-inch diameter precast concrete pier and the 36-inch diameter drilled hole should be backfilled with concrete up to the finished grade. Footing excavations should be observed by a representative of Geolabs prior to placement of reinforcing steel or concrete to confirm the foundation bearing conditions and the required embedment depths.

Footings located adjacent to planned retaining walls or other below-grade structures should be embedded deep enough to avoid surcharging the retaining wall foundations or below-grade structures. If foundations are located next to utility trenches or easements, they should be embedded below a 45-degree imaginary plane extending upward from the bottom edge of the utility trench or as deep as the inverts of the utility lines. This requirement is necessary to avoid surcharging adjacent below-grade structures with additional structural loads and to reduce the potential for appreciable foundation settlement.

If the foundations are designed and constructed in accordance with our recommendations, we estimate that total settlements of footings supported on the stiff in-situ soils or dense volcanic rock formation may be on the order of about 1 inch. We estimate that the differential settlements between adjacent foundations may be on the order of about 0.5 inches.

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about 200 kips (100 tons). A preliminary pile length of up to about 30 feet may be used for the recommended pile foundation design. Installation of the driven pile foundation should be conducted after the harbor dredging operation to reduce the potential for disturbance to the driven pile foundation and reduction in pile capacity. In order to facilitate the pile driving operation into the dense volcanic breccia rock formation, predrilling at the proposed pile locations to Elevation -22 feet MSL (10 feet below the finished dredged elevation) will be required prior to pile installation. The diameter of the predrilled holes should be at least 24 inches in diameter to facilitate socketing the pile into the dense volcanic breccia rock formation and to provide the necessary lateral load resistance to the pile foundations. The annular space between the drilled hole and the pile should be grouted.

We understand that the proposed harbor area enclosed within the shoreline and the breakwater structures will be dredged to a depth of about Elevation -12 feet MSL. Based on the subsurface materials encountered in our borings, we believe that the materials encountered within the harbor area may be excavated to a slope inclination of about 2H:1V from the existing mudline down by about 5 feet to account for the sediments in the area. Below the upper 5 feet measured from the existing mudline, we believe that a slope inclination of 0.5H:1V may be used for the dredged excavations, which will likely expose the dense volcanic breccia rock formation.

Our field observations indicate that the surface soils appear to be relatively porous with good percolation characteristics when the soils are left undisturbed, or in its natural state. However, drainage and infiltration characteristics will become very poor when the on-site soils are being disturbed and/or recompacted. Therefore, we believe that disturbance to the on-site soils should be kept to a minimum during the earthwork operations. In areas where the surface soils have been reworked or recompacted, a surface water runoff collection system may need to be incorporated into the project construction for proper drainage and erosion protection. Detailed discussion of these items and our geotechnical engineering recommendations are presented in the following sections of this report.

Shallow Foundations

For the one, two, and three-story building structures, we understand that a shallow foundation system consisting of posts-and-beams will be used to transmit the building loads to the supporting soils. Based on the information provided, we understand that the post footings will generally consist of an 18-inch diameter precast concrete pier embedded into a 36-inch diameter cast-in-place concrete drilled shaft foundation.

Due to the high moisture content of the near surface soils on the island, there is potential for shrinkage cracks to develop when the building areas are covered and surface drainage is diverted around the building structures. Therefore, we strongly recommend that the building foundations be embedded deeper than normal, below the zone of potential shrinkage crack development due to potential drying out of the high moisture soils. Based on our experience, we recommend that the post footings be embedded at least 4 feet below the lowest adjacent finished grade. Where hard volcanic rock is encountered in the footing excavations at an elevation higher than the 4-foot embedment, the footings may bear directly on the hard volcanic rock surface. As a minimum, we recommend that the footings bearing on the volcanic rock be embedded a minimum of 12 inches below the lowest adjacent finished grade.

For pier footings constructed near the tops of slopes or on sloping ground conditions, the footings should be embedded deep enough to provide a minimum horizontal setback distance of 8 feet measured from the outside edge of the footings to the face of the slope. The horizontal setback distance may be reduced to a minimum of 3 feet if the footings are embedded at least 1 foot into the dense volcanic breccia rock formation.

Based on the above recommendations for foundation embedment depths, we believe that an allowable bearing pressure of up to 3,500 psf may be used for the design of footings bearing on the stiff in-situ soils and/or volcanic rock surface. If needed, the bearing pressure may be increased to 10,000 psf for footings embedded at least 1 foot into the volcanic rock formation. The bearing values recommended above are for dead plus...
Lateral Earth Pressures
Retaining structures should be designed to resist the lateral earth pressures due to the adjacent soils and surcharge effects. The recommended lateral earth pressures for design of retaining structures, expressed in equivalent fluid pressures of pounds per square foot per foot of depth (psf), are presented in the following table. The values provided in the following table generally correspond to a friction angle of 28 degrees and a moist unit weight of 110 psf.

<table>
<thead>
<tr>
<th>Backfill Condition</th>
<th>Earth Pressure Component</th>
<th>Active (psf)</th>
<th>At-Rest (psf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level Backfill</td>
<td>Horizontal</td>
<td>40</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>Vertical</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Maximum 2H:1V Sloping Backfill</td>
<td>Horizontal</td>
<td>64</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>Vertical</td>
<td>32</td>
<td>40</td>
</tr>
</tbody>
</table>

The values provided above assume that granular fill or the excavated on-site soils with a maximum particle size of 3 inches or less will be used to backfill behind the retaining structures. It is assumed that the backfill behind retaining structures will be compacted to between 90 and 95 percent relative compaction. Over-compaction of the retaining structure backfill should be avoided.

In general, an active condition may be used for gravity retaining walls and retaining structures that are free to deflect by as much as 0.5 percent of the structure height. If the tops of the structures are not free to deflect beyond this degree, or are restrained, the retaining structures should be designed for the at-rest condition. Those lateral earth pressures do not include hydrostatic pressures that might be caused by groundwater trapped behind the structures.

Surcharge stresses due to areal surcharges, line loads, and point loads within a horizontal distance equal to the depth of the retaining structures should be considered in the design. For uniform surcharge stresses imposed on the loaded side of the structure, a rectangular distribution with uniform pressure equal to 36 percent of the vertical surcharge pressure acting on the entire height of the structure, which is free to deflect (cantilever), may be used in design. For retaining structures that are restrained, a rectangular distribution equal to 54 percent of the vertical surcharge pressure acting over the entire height of the structures may be used for design. Additional analyses during design may be needed to evaluate the surcharge effects of point loads and line loads.

Drainage
Retaining structures should be well drained to reduce the build-up of hydrostatic pressures. A typical drainage system would consist of a 12-inch wide zone of permeable material, such as No. 3B Fine gravel (ASTM C 33, No. 67 gradation), immediately around a perforated pipe (perforations down) at the base of the retaining structure discharging to an appropriate outlet or weepholes. As an alternative, a prefabricated drainage product, such as MiraDrain or EnkaDrain, may be used in lieu of the drainage material. The prefabricated drainage product should also be hydraulically connected to a perforated pipe at the base of the wall.

Backfill behind the permeable drainage zone may consist of granular fill or excavated on-site soils less than 3 inches in maximum dimension. Unless covered by concrete slabs, the upper 12 inches of backfill should consist of the excavated on-site materials to reduce the potential for water infiltration behind the retaining structures.
Utility Building

Based on the information provided, we understand that a new utility building will be constructed to serve the proposed resort development. Our review of the proposed building location and its surrounding topography indicate that the new utility building will likely be constructed by excavating into the existing hillside to create a relatively level pad for the building construction. Therefore, we envision that retaining walls with concrete slabs-on-grade will be used for construction of the new utility building planned at the project site.

In general, we believe that foundations and retaining walls for the new utility building may be designed in accordance with the "Shallow Foundations" and "Retaining Structures" sections of this report. Based on the subsurface conditions encountered in our field exploration, we envision that concrete slabs-on-grade for the new utility building will likely bear on the dense volcanic breccia anticipated at shallow depths. Since the floor slab of the utility building will be subjected to vibrations from equipment loads, an 8-inch layer of aggregate subbase material or similar well-graded granular fill (structural fill) material is recommended in lieu of the normal gravel cushion and vapor barrier. The aggregate subbase or structural fill should conform to the requirements presented in the "Fill" subsection of this report and should be compacted to a minimum of 95 percent relative compaction.

We recommend that the concrete floor slab be designed by a structural engineer for the intended loads and should be reinforced as a structural slab to accommodate some amount of differential movement. For design of structural slabs, a modulus of subgrade reaction of 250 pounds per square inch per inch of deflection (pci) may be used for the compacted aggregate subbase or structural fill material. Provisions should be made for proper load transfer across the slab joints, which may be subjected to vehicular traffic. The subgrade soils beneath these slabs should be prepared in accordance with the recommendations presented in the "Site Grading" section of this report.

Walkway Slabs

We anticipate that a substantial amount of meandering concrete walkways will be provided across the island for access. We also anticipate that these walkway slabs will likely be subjected to light vehicular traffic. Therefore, we recommend that the walkway slabs be supported on a minimum of 6 inches of aggregate subbase material or similar well-graded granular fill (structural fill) material. We recognize that these types of granular fills may not be readily available on the island and will likely need to be transported to the island. Granular materials generated from the dredging operations may also be considered for use below the walkway slabs. In general, the 6-inch granular fill material below the walkway slabs should be compacted to a minimum of 95 percent relative compaction.

Crack control joints should be provided in the walkway slabs at intervals equal to the width of the walkways with expansion joints at right-angle intersections. The subgrade soils beneath the walkways should be prepared in accordance with the recommendations presented in the "Site Grading" section of this report.

Pile Foundations

Based on the current design concept, we understand that harbor facilities, such as docking structure and boat canopies, are planned at the shoreline within the breakwater structures to serve the proposed resort development. Therefore, we envision that driven pile foundations will be used to support these waterfront structures planned at the project site. Detailed information pertaining to the design grades and structural loads of these harbor facilities were not available at the time this report was prepared.

In general, we believe that 16-inch octagonal, precast prestressed concrete piles may be used to support the proposed marina facilities. As an alternative, 15-inch square, precast
Prestressed concrete piles may be used in lieu of the 16-inch octagonal, precast prestressed concrete piles. The piles would derive support principally from end-bearing on the dense volcanic breccia formation underlying the site at shallow depths, as encountered in our borings drilled for the project. An allowable compressive load of up to about 200 kips (100 tons) may be used for the recommended pile foundation design. The allowable compressive load for the piles is for dead plus live loads and may be increased by up to 50 percent for transient loads, such as for wind or seismic forces. Piles should be spaced a minimum of 4 feet center-to-center to avoid reduction in vertical capacity due to group action and to facilitate installation of piles in a group.

Based on the subsurface conditions encountered at the project site, we anticipate that a typical pile length of up to about 30 feet may be used for the recommended pile foundation. The typical pile length is based on a dredged depth of Elevation -12 feet MSL, an embedment depth of 10 feet below the dredged depth, and a top of pile of about Elevation +8 feet MSL. The estimated pile length is provided for cost estimation purposes only. The actual production pile lengths should be estimated after completion of a test pile (probe pile) program. Due to possible variation in the length of the piles, line items for add-ons, shorter piles, etc. should be included in the contract documents. Considering the relatively short pile lengths of up to about 30 feet, pile splicing should be avoided in order to utilize the bending and uplift capacities of the precast concrete piles. Therefore, we recommend that the proposed piles be cast in one piece for the proposed pile installation.

Predrilling

Our borings indicated that dense volcanic breccia rock formation would likely be encountered near the existing mud flat surface. In order to facilitate the pile installation operations and to socket the pile into the dense volcanic breccia, predrilling at the proposed pile locations to a minimum depth of 10 feet into the dense breccia rock formation would be required prior to pile installation.

The diameter of the predrilled hole should be at least 24 inches to facilitate placement of concrete grout into the annular space between the drilled hole and the pile. Detailed recommendations pertaining to predrilling would be presented after completion of the test pile program and/or submittal of the contractor's work plan for pile installation.

Uplift Load Resistance

Uplift loads imposed on the pile foundations may be resisted by a combination of the dead load of the driven pile and by shear along the pile surface and the grout. An ultimate uplift load capacity of 30 kips may be used in design of the pile foundation. The uplift load capacity includes the weight of the pile. The structural capacity of the pile member in tension should be checked by the project structural engineer.

Lateral Load Resistance

Lateral loads imposed on the harbor facilities supported on piles may be resisted by the lateral load capacity of the driven piles. Lateral load resistance for driven piles is a function of the stiffness of the surrounding material, the stiffness of the pile, allowable deflection at the top of the pile, and the induced moment in the pile. The lateral load capacities and maximum induced moments for piles, where the tops of piles are either free or fixed against rotation, based on an associated horizontal deflection of ½ inch assumed at the top of the 16-inch octagonal precast prestressed concrete pile, are presented in the following table.

A minimum pile spacing of 10 feet is required in order to utilize the full lateral load capacity shown for the single pile condition. For piles that are spaced less than 10 feet on center, additional analysis should be conducted to evaluate the effect of group action by including an efficiency factor in the direction of loading. The maximum induced moments for the fixed-head boundary condition should occur near the top of the pile. The depths at which the maximum moments occur for the free-head boundary condition are provided in the table.
LATERAL LOAD CAPACITY AND MAXIMUM INDUCED MOMENT FOR 16-INCH OCTAGONAL PRECAST CONCRETE PILES

<table>
<thead>
<tr>
<th></th>
<th>Lateral Load Capacity (kip)</th>
<th>Lateral Deflection (inches)</th>
<th>Maximum Induced Moment (kip-feet)</th>
<th>Depth to Maximum Moment (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Pile</td>
<td>1.0</td>
<td>0.5</td>
<td>18</td>
<td>19.3</td>
</tr>
<tr>
<td>Free Head</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single Pile</td>
<td>3.7</td>
<td>0.5</td>
<td>43</td>
<td>0</td>
</tr>
<tr>
<td>Fixed Head</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Pile Foundation Settlements

Settlements of pile foundations will result primarily from the elastic compression of the pile member and subgrade response. We estimate the total settlement of the pile-supported foundation to be less than one-half (½) inch with differential settlements between columns supported on piles not exceeding about one-half that amount. We believe that these settlements are essentially elastic and should occur as the loads are applied.

Site Grading

We envision that site grading for this project will consist generally of minor cuts and fills on the order of less than 3 feet thick for the one and two-story buildings. Deeper excavations are anticipated for the construction of the new utility building planned for the proposed resort development. For the new harbor area located to the southeast of the main hotel building, dredge excavations on the order of about 2 to 13 feet will be required to attain the design finished elevations in the harbor. Items of grading that are addressed in the following subsections include the following:

- Site Preparation;
- Fill Materials;
- Fill Placement and Compaction Requirements;
- Excavations;
- Cut and Fill Slopes; and
- Surface Runoff and Subdrainage.

Site grading operations should be observed by a representative of Geolabs. It is important that a representative from our office be present to observe the site preparation to evaluate whether undesirable materials are encountered during the excavation and scarification process, and whether the exposed ground conditions are similar to those encountered in our exploration.

Site Preparation

At the outset of earthwork, areas within the contract grading limits should be thoroughly cleared and grubbed. Vegetation, debris, and other unsuitable materials should be removed and disposed of properly off-site to reduce the potential for contamination of the excavated materials. If soft or wet soils are encountered during clearing and grubbing, over-excavation should be required to remove the soft or wet soils to expose firm soils.

After clearing and grubbing, subgrades designated to receive fills or improvements should be proof-rolled to a minimum of 85 percent relative compaction. Relative compaction refers to the in-place dry density of soil expressed as a percentage of the maximum dry density of the same soil determined in accordance with ASTM Test Designation D 1557-91 using the moist preparation method (wet to dry). Optimum moisture is the water content (percentage by dry weight) corresponding to the maximum dry density. Saturation and subsequent yielding of the exposed subgrade due to inclement weather and poor drainage may require over-excavation of the soft areas and replacement with compacted general fill.

Our field exploration indicated that the in-situ soils near the existing ground surface generally exists in a very moist to wet condition. Therefore, it would be very difficult to achieve the normal 90 percent relative compaction requirement without significant aeration of the in-situ soils. Since the project site is located in an area that is subjected to high rainfall throughout the year, substantial aeration of the in-situ soils may not be feasible and practical during the project construction.
a result, we believe that the compaction requirement will need to be lowered to a minimum of 85 percent relative compaction for subgrade preparation and general fill placement operations. Use of the vibratory action of a compactor should be carefully controlled to avoid inducing a pumping subgrade condition.

If the subgrade soils are pumping (or yielding) during subgrade preparation, the subgrade should be stabilized prior to fill placement and for construction of improvements. Subgrade stabilization measures may include the use of additives, such as cement or lime treatment, and/or the incorporation of ground stabilization fabrics. For pumping subgrade conditions, we recommend that a woven geotextile, such as Mirafi SQOX or equivalent, be placed on the subgrade prior to placement of fill material and/or construction of improvements.

**Fill Materials**

In general, the excavated on-site soils may be re-used as a source of general fill material (outside building and improvement areas) provided that they are free of particles (rock fragments) larger than 6 inches in maximum dimension. In addition, the general fill soils should be free of soft/wet soils and should be free of vegetation and other deleterious materials. The cut materials generated from excavations into the underlying volcanic breccia rock formation may be used as a source of structural fill materials provided that they are screened of oversized materials (greater than 3 inches in largest dimension) and processed to provide a relatively well-graded material to prevent the occurrence of voids in the compacted mass.

Boulders and oversized rock fragments generated from excavations into the underlying rock formation may be disposed of off-site or broken down to smaller-sized materials (less than 3 inches) and incorporated into the fill material. If the excavated materials do not contain sufficient fines to produce a well-graded material, off-site borrow or on-site rock crushing of large-sized rock fragments or boulders should be considered to provide the required gradation and particle size to develop a well-graded material.

---

**Aggregate subbase and structural fills required underneath the buildings and walkways should consist of crushed coral, volcanic breccia, limestone, or basalt. The material should be well graded from coarse to fine with no particles larger than 3 inches in largest dimension. In addition, the fill material should contain not more than 30 percent particles passing the No. 200 sieve. The material should have a CBR value of 20 or more and a swell value of 1 percent or less when tested in accordance with ASTM D 1883.**

Fills or backfills below the water level should consist of clean granular material, such as ASTM C 33, No. 4 gradation or ASTM C 33, No. 67 gradation up to a minimum of 12 inches above the highest anticipated water level. For backfilling operations below the water level, the excavated trenches or building footprint areas should be lined on all sides with a layer of filter fabric, such as Mirafi 180N or equivalent, prior to backfilling. This is to reduce the potential for migration of the finer adjacent soils into the open-graded clean granular fill materials resulting in future ground settlements. A layer of filter fabric should also be provided between the open-graded clean granular fill materials and the backfill above.

Where imported fill materials will be required, the imported fill materials should conform to the requirements presented above for structural fill and backfill. The materials should be tested and approved prior to delivery to the project site to confirm that the materials are suitable for the intended purpose.

**Fill Placement and Compaction Requirements**

General fills and backfills above the water table should be placed in level lifts not exceeding 8 inches in loose thickness, moisture-conditioned to above the optimum moisture content, and compacted to a minimum of 85 percent relative compaction. Relative compaction refers to the in-place dry density of soil expressed as a percentage of the maximum dry density of the same soil determined in accordance with ASTM D 1557.
with ASTM Test Designation D 1557-91 using the moist preparation method (wet to dry). Optimum moisture is the water content (percentage by dry weight) corresponding to the maximum dry density.

Aggregate subbase and structural fills should be placed in level lifts not exceeding 8 inches in loose thickness, moisture-conditioned to above the optimum moisture content, and compacted to a minimum of 95 percent relative compaction. In addition, trench backfills within 2 feet of the walkway grades should be compacted to a minimum of 90 percent relative compaction.

As previously indicated, fills or backfills below the water level should consist of free-draining granular materials, such as ASTM C 33, No. 4 gradation or ASTM C 33, No. 67 gradation, as recommended above. Mechanical compaction of these materials will not be required during placement. However, densification by pounding the material with the bucket of a backhoe or other vibratory action should be performed during placement.

**Excavations**

Our field exploration disclosed that the island is generally underlain by very dense and massive volcanic breccia rock formation at shallow depths. It is anticipated that the volcanic rock may be excavated with normal heavy excavation equipment, such as ripping with large bulldozers, where the rock is near the existing ground surface. However, excavations into the deeper formations may require the use of hoerams, chipping, or blasting.

As previously indicated, we understand that the harbor area between the shoreline and the breakwater structures will be dredged to a depth of about Elevation -12 feet MSL. Based on the subsurface materials encountered in our borings, we believe that the materials encountered within the harbor area may be excavated to a slope inclination of about two horizontal to one vertical (2H:1V) from the existing mudline down by about 5 feet to account for the sediments in the area. Below the upper 5 feet measured from the existing mudline, we believe that a slope inclination of 0.5H:1V may be used for the dredged excavations, which will likely expose the dense volcanic breccia rock formation.

**Cut and Fill Slopes**

Based on the subsurface conditions encountered in our field exploration, we believe that the planned cut slopes may consist of materials ranging from the high moisture soils near the existing ground surface to the dense volcanic breccia rock formation at shallow depths. In general, the cut slopes planned at the project site may be designed with a slope inclination of 1H:1V or flatter, with the exception of the upper 5 feet of the cut extending down from the existing natural ground surface. Because the upper 5 feet of materials is generally composed of high moisture soils, the upper 5 feet of the cut slope should be flattened to an inclination of 2H:1V to account for the less competent soil material. We envision that the cut slopes will likely expose the weathered volcanic breccia formation below a depth of 5 feet below the existing ground surface.

In certain areas where the hard volcanic breccia rock formation is near the existing ground surface, we believe that cut slopes with inclinations as steep as 0.5H:1V may be used below the upper 5 feet of near-surface materials. Where the steeper cut slope inclination is used for cut slope design in the hard rock formation, a small rock catchment area of at least 5 feet should be provided at the toe of the cut slope. We recommend that Geolabs be consulted for any planned cut slope where the steeper cut slope inclination of 0.5H:1V is desired.

Permanent fill slopes constructed using the on-site materials (or imported fill materials) may be designed with a slope inclination of 2H:1V or flatter. Fills placed on slopes steeper than 5H:1V should be keyed and benched into the existing slope to provide stability of the new fill against sliding. The filling operations should start...
at the lowest point and continue up in level horizontal compacted layers in accordance with the above fill placement recommendations. Fill slopes should be constructed by overfilling and cutting back to the design slope ratio to obtain a well-compacted slope face. In addition, slope planting should be provided as soon as possible to reduce the potential for erosion of the finished slopes.

Surface Runoff and Subdrainage

Based on our field observations conducted on Ngenur Island, it appears that the surface soils are relatively porous with good percolation characteristics when the soils are left undisturbed or in its natural state. However, the infiltration characteristics of the on-site soils appear to alter considerably when the soils are disturbed or recompacted. Drainage became very poor and generally resulted in an increase in surface water runoff. This is evident by the presence of potholes and standing water along the access trails cleared for our field exploration, where the soils have been disturbed and recompacted. Therefore, we believe that disturbance to the on-site soils should be kept to a minimum during the grading operations. Where the near-surface soils have been disturbed or recompacted, a surface water runoff collection system may need to be incorporated into the project construction for proper drainage and erosion control.

Seepage conditions may be present at localized areas across the project site as evident in some of the drilled borings conducted during our field exploration. Therefore, we recommend that provisions be incorporated into the construction documents to provide for subdrains in the following areas:

- at all springs and seepage areas observed during the course of construction;
- in other areas of the site where seepage is observed during and after grading or as recommended by the Engineer during construction.

Where needed, subdrains should consist of perforated pipes with perforations placed facing down and should be at least 4 inches in diameter. All subdrains should be surrounded and underlain by at least 4 inches of drain rock. A non-woven geotextile, such as Mirafi 180N or equivalent, should wrap around the drain rock. In general, subdrain trenches should be at least 12 inches wide and at least 2 feet deep. Subdrains should be daylighted into drainage ditches, culverts, or other drainage structures for proper drainage.

Since the project site is located in a high rainfall environment, we wish to emphasize that drainage features, such as interceptor ditches and subdrains, are critical to the stability of the cut and fill slopes and performance of the retaining structures. Excessive surface water runoff over the slope face may cause erosion of the exposed soils, thus potentially jeopardizing the long-term stability and performance of the cut and fill slopes. Accumulation of water behind the retaining structures will result in the build-up of hydrostatic pressures and may cause structural distress and potential instability. Infiltration of water below the walkway section will likely soften the silty and clayey subgrade soils, and cause premature failure of the walkway structure. Therefore, we recommend that special attention be given to the design and implementation of these drainage features at the project site.

Breakwater Structures

Based on the current design concept, two breakwater structures are planned in the proposed harbor area for protection against the erosive forces of wave action. We envision that the breakwater structures may consist of a graded stone or boulder riprap. Proper sizing of the graded stone or boulder riprap for the design of protection against wave action will be provided by others.

In general, we recommend that a layer of woven armored erosion control fabric (Mirafi 700X or equivalent) be placed underneath the graded stone or boulder riprap. The fabric serves to reduce the potential for the underlying fines or sediments from being eroded away through the voids between the graded stones or boulders. Placement of the

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woven armored erosion control fabric below the riprap should be in accordance with the manufacturer’s requirements. It is also recommended that the riprap and fabric layer be extended to appropriate depths below the level of scour potential.

Some cuts into the dredged slope may be anticipated for the construction of the breakwater structures. At the location of the breakwater structures, a bench with a horizontal distance of at least 5 feet should be maintained between the toe of the breakwater structure and the top of the dredged cut slope.

**Utility Trenches**

It is anticipated that most of the trenches for utilities on the island will be excavated in the surface soils and the underlying dense volcanic breccia rock formation, depending on the depth of the new utility trenches. In general, granular bedding consisting of 6 inches of drain rock (ASTM C 33, No., 67 gradation) is recommended under the pipes. Free-draining drain rock should also be used for the initial trench backfill up to about 12 inches above the pipes to provide adequate support around the pipes. It is critical that free-draining granular materials be used to reduce the potential for formation of voids below the haunches of pipes and to provide adequate support for the sides of the pipes. Improper backfill material and placement procedures could result in settlement of the backfill and damage to the pipes. Sand and/or well-graded granular materials may be used in lieu of drain rock materials. Where sand and/or well-graded granular materials are used for the bedding and initial trench backfill, the well-graded granular materials should be compacted to a minimum of 90 percent relative compaction.

The upper portion of the trench backfill from the level 12 inches above the pipes to the top of the subgrade or finished grade should consist of granular materials generally less than 6 inches in maximum size. The backfill material should be moisture-conditioned to above the optimum moisture, placed in maximum 8-inch level loose lifts, and mechanically compacted to not less than 90 percent relative compaction to reduce the potential for future ground subsidence. Where trenches are below walkway areas, the upper 2 feet of the trench backfill below the walkway slab subgrade should be compacted to at least 95 percent relative compaction.

Since volcanic breccia rock formation was encountered at shallow depths during our field exploration, it appears that the trench work for the utility line installation will likely involve excavation in the volcanic breccia rock formation and may require hard ripping or hoerams. Care must be exercised by the contractor to avoid over-ripping, which would disrupt the structure of the rock formation resulting in a potential loss of bearing strength for footings in the vicinity.

**Drainage**

The finished grades outside the buildings should be sloped to shed water away from foundations and to reduce the potential for ponding. It is also advised that gutter systems be installed around the buildings and that the discharge be diverted away from the foundation and slab areas. Excessive landscape watering near the foundations and slabs should also be avoided. Planters next to foundations should be avoided or have concrete bottoms and drains to reduce the potential for water infiltration into the subsoils. Drainage swales should be provided as soon as possible and maintained to drain surface water runoff away from the foundations and slabs.

**Design Review**

Final drawings and specifications for the construction of the proposed Quest Resort at Ngerur Island project should be forwarded to Geolabs, Inc. for review and written comments prior to construction. This review is needed to evaluate conformance of the plans and specifications with the intent of the foundation and earthwork recommendations provided herein. If this review is not made, Geolabs, Inc. cannot be responsible for misinterpretation of our recommendations.

**Construction Monitoring**
It is recommended that Geolabs be retained to provide geotechnical engineering services during construction of the proposed Quest Resort development project. The items of construction monitoring that are critical requiring "Special Inspection" include the following:

- observation of subgrade preparation;
- observation of building foundation excavation and preparation; and
- observation of the test pile and production pile installation.

Other aspects of earthwork construction should also be observed by a representative from Geolabs. This is to observe compliance with the intent of the design concepts, specifications, and/or recommendations, and to expedite suggestions for design changes that may be required in the event that subsurface conditions differ from those anticipated at the time this report was prepared. The recommendations presented in this report are contingent upon such observations. If the actual exposed soil conditions encountered during construction differ from those assumed or considered in this report, Geolabs should be contacted to review and/or revise the geotechnical engineering recommendations presented herein.

LIMITATIONS

The analyses and recommendations submitted in this report are based in part upon information obtained from the field borings and test pits. Variations of subsoil conditions between and beyond the field borings and test pits may occur, and the nature and extent of these variations may not become evident until construction is underway. If variations then appear evident, Geolabs should be contacted to re-evaluate the recommendations presented in this report.

The locations of the field borings and test pits indicated in this report have been staked-out in the field by a surveyor prior to our mobilization. Elevations of the field borings and test pits were estimated by interpolation from the contour lines shown on the Site Plan provided by Berryman & Henigar, Inc. on September 30, 1999. The physical locations and elevations of the field borings and test pits should be considered accurate only to the degree implied by the methods used.

The stratification lines shown on the graphic representations of the borings depict the approximate boundaries between the soil types, and as such, may denote a gradual transition. Water level data from the borings and test pits were measured at the times shown on the graphic representations and/or in the text of this report. These data have been reviewed and interpretations made in the formulation of this report. However, it must be noted that fluctuation may occur due to variation in rainfall, tides, temperatures, and other factors.

This report has been prepared for the exclusive use of Morita Corp Palau, Inc. and other project consultants for specific application to the proposed Quest Resort at Ngerur Island in accordance with generally accepted geotechnical engineering principles and practices. No warranty is expressed or implied.

This report has been prepared solely for the purpose of assisting the architect and design engineers in the design of the proposed project. Therefore, this report may not contain sufficient data, or the proper information, to serve as the basis for preparation of construction cost estimates. A contractor wishing to bid on this project should retain a competent geotechnical engineer to assist in the interpretation of this report and/or in the performance of additional site specific exploration for bid estimating purposes.

The owner/client should be aware that unanticipated soil conditions are commonly encountered. Unforeseen soil conditions, such as perched groundwater, soft deposits, hard layers, or cavities, may occur in localized areas and may require additional probing or corrections in the field (which may result in construction delays) to attain a properly constructed project. Therefore, a sufficient contingency fund is recommended to accommodate these possible extra costs.
**PLATES AND APPENDICES**

The following plates and appendices are attached and complete this report:

<table>
<thead>
<tr>
<th>Plate</th>
<th>Description</th>
</tr>
</thead>
<tbody>
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<td>Plate 1</td>
<td>Project Location &amp; Vicinity Map</td>
</tr>
<tr>
<td>Plate 2</td>
<td>Site Plan</td>
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<tr>
<td>Appendix A</td>
<td>Field Exploration</td>
</tr>
<tr>
<td>Plate A</td>
<td>Boring Log Legend</td>
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<tr>
<td>Plates A-1 thru A-8</td>
<td>Logs of Borings</td>
</tr>
<tr>
<td>Appendix B</td>
<td>Test Pit Exploration</td>
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<td>Plates B-1 thru B-8</td>
<td>Logs of Test Pits</td>
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<td>Appendix C</td>
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</tr>
<tr>
<td>Plates C-1 and C-2</td>
<td>Laboratory Test Data</td>
</tr>
</tbody>
</table>

Respectfully submitted,

GEOLABS, INC.

By ________________

Teddy S.T. Kwok, P.E.
Senior Project Engineer

By ________________

Robin M. Lim, P.E.
Vice President

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RML:TK:
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GEOLABS, INC.
Appendix A
Field Exploration

The subsurface conditions at the Quest Resort at Ngerur Island were explored by drilling and sampling eight borings, designated as Boring Nos. 1 through 8, extending to depths ranging from about 13 to 47.3 feet below the existing ground water surface. The approximate locations of the drilled borings are shown on the Site Plan, Plate 2. The borings were drilled using a truck-mounted drill rig or portable drilling equipment equipped with continuous flight augers and coring tools.

The materials encountered in the borings were classified by visual and textural examination in the field by our geologist, who monitored the drilling operations on a near-continuous basis. These classifications were further reviewed visually and by testing in the laboratory. Soils were classified in general conformance with the Unified Soil Classification System, as shown on Plate A. Graphic representations of the materials encountered in the borings are presented on the Logs of Borings, Plates A-1 through A-8.

Relatively "undisturbed" soil samples were obtained in general accordance with ASTM Test Designation D 3550-84, Ring-Mounded Barrel Sampling of Soils, by driving a 3-inch OD Modified California sampler with a 140-pound hammer falling 30 inches. In addition, some samples were obtained from the drilled borings in general accordance with ASTM Test Designation D 1586-84, Penetration Test and Split-Barrel Sampling of Soils, by driving a 2-inch OD standard penetration sampler using the same hammer and drop. The blow counts needed to drive the sampler the second and third 6 inches of an 18-inch drive are shown as the "Resilience" on the Logs of Borings at the appropriate sample depths.

Pocket penetrometer tests were performed on selected cohesive soil samples in the field. The pocket penetrometer test provides an indication of the unconfined compressive strength of the sample. Results of the pocket penetrometer tests are summarized on the Logs of Borings at the appropriate sample depths.

Core samples of rock materials encountered at the site were obtained using diamond core drilling techniques in general accordance with ASTM Standard Practice D 2113-83, Diamond Core Drilling for Site Investigation. Core drilling is a rotary drilling method, which uses a hollow bit to cut into the rock formation. The rock material left in the hollow core of the bit is mechanically recovered for examination and description.

Recovery (REC) is used as a subjective guide to the interpretation of the relative quality of rock masses. Recovery is defined as the actual length of material recovered from a coring attempt versus the length of the core attempt. For example, if 3.7 feet of material is recovered from a 5.0-foot core run, the recovery would be 74 percent and would be shown on the Logs of Borings as REC = 74%.

The Rock Quality Designation (ROD) is also a subjective guide to the relative quality of rock masses. ROD is defined as the percentage of the core run that is sound material in excess of 4 inches in length without discontinuities, discounting drilling-induced fractures or breaks. If 2.5 feet of sound material is recovered from a 5.0-foot core run, the ROD would be 50 percent and would be shown on the Logs of Borings as ROD = 50%. Generally, the following is used to describe the relative quality of the rock, based on the "Practical Handbook of Physical Properties of Rocks and Minerals."

<table>
<thead>
<tr>
<th>Rock Quality</th>
<th>ROD (%)</th>
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</thead>
<tbody>
<tr>
<td>Very Poor</td>
<td>0 - 25</td>
</tr>
<tr>
<td>Poor</td>
<td>25 - 50</td>
</tr>
<tr>
<td>Fair</td>
<td>50 - 75</td>
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<tr>
<td>Good</td>
<td>75 - 90</td>
</tr>
<tr>
<td>Excellent</td>
<td>90 - 100</td>
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</table>

The ripability of a rock mass is a function of the relative hardness of the rock, its relative quality, brittleness, and fissile characteristics. A dense rock formation with a high ROD would be very difficult to rip and would probably require more arduous methods of excavation.

W.O. 4166-00
OCTOBER 1999
UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

MAJOR DIVISIONS | USCS | TYPICAL DESCRIPTIONS
--- | --- | ---
GRAVELS | GW | CLEAN GRAVELS, WELL-GRANDED GRAVELS, MIXTURES, LITTLE OR NO FINES
MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE | GM | GRAVELS WITH FINES, SILT GRAVELS, SAND-SILT MIXTURES, LITTLE OR NO FINES
MORE THAN 50% OF MATERIAL RETAINED ON NO. 200 SIEVE | SN | SANDS WITH FINES, GRAVELY SANDS, SAND-SILT MIXTURES
SANDS WITH FINES, GRAVELY SANDS, SAND-SILT MIXTURES
SANDS | SW | CLEAN SANDS, GRAVELY SANDS, LITTLE OR NO FINES
MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE | SP | FINES GRAVELS, GRAVELY SANDS, LITTLE OR NO FINES
SANDS | SM | SILT SANDS, SAND-SILT MIXTURES
CLAYEY SANDS, SAND-CLAY MIXTURES
COARSE-BRANED SOILS | SC | CLAYEY SANDS, SAND-CLAY MIXTURES
SANDS WITH FINES, GRAVELY SANDS, SAND-SILT MIXTURES
FINE-BRANED SOILS | SILTS AND CLAYS | LIQUID LIMIT, LESS THAN 40
INORGANIC SILT AND VERY FINE SANDS, ROCK FLOCK, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY | ML | INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELY CLAYS, SANDY CLAYEY SANDS, CLAYEY CLAYEY CLAYEY CLAYEY MIXTURES
ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY | OL | INORGANIC SILTS, ORGANIC SILTS AND ORGANIC SILTY CLAYS, CLAYEY SANDS, CLAYEY CLAYEY CLAYEY CLAYEY MIXTURES
HIGHLY ORGANIC SOILS | MH | PLENTY, MUDDY, SWAMP SOILS WITH HIGH ORGANIC CONTENTS
NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

LEGEND:
- 2-INCH O.D. STANDARD PENETRATION TEST
- 2-INCH O.D. MODIFIED CALIFORNIA SAMPLE
- SHIELBY TUBE SAMPLE
- CORE SAMPLE
- REC CORE RECOVERY
- ROQ ROCK QUALITY DESIGNATION

GEO LABS, INC.
Geotechnical Engineering

WORK ORDER NO. 4168-00
Jul 99

BOURING LOG LEGEND
QUEST RESORT AT NGERUR ISLAND
NGERUR ISLAND
REPUBLIC OF PALAU

DATE: 5/7/99
LOGGED BY: Y. CHIBA
TOTAL DEPTH: 47.0 ft

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

LEGEND:
- LL | LIQUID LIMIT
- M | PLASTICITY INDEX
- TV | TORVANE SHEAR (psi)
- WC | WATER LEVEL OBSERVED IN BORING
- ROQ | ROCK QUALITY DESIGNATION

GEO LABS, INC.
Geotechnical Engineering

WORK ORDER NO. 4168-00
TSK Jul 99

LOG OF BORING 1
QUEST RESORT AT NGERUR ISLAND
NGERUR ISLAND
REPUBLIC OF PALAU

DATE: 5/7/99
LOGGED BY: Y. CHIBA
TOTAL DEPTH: 47.0 ft

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

LEGEND:
- LL | LIQUID LIMIT
- M | PLASTICITY INDEX
- TV | TORVANE SHEAR (psi)
- WC | WATER LEVEL OBSERVED IN BORING
- ROQ | ROCK QUALITY DESIGNATION

DRAFT
Drilling Method: 4" Casing, HQ Coring

Driving Energy: 140 lb. wt, 30 in. drop

Grayish green mottled with gray dense VOLCANIC BRECCIA with some voids, massive, slightly weathered, medium hard to hard

Boring terminated at 47 feet

Groundwater level at:

Depth Hours Date
2.1 ft. 1301 5/4/99
1.4 ft. 1454 5/4/99

*Elevations estimated from Site Plan provided by Berryman & Henigar, Inc. on September 30, 1999.

Approximate Surface Elevation (ft): -0.5*

Grayish green mottled with whitish gray and gray VOLCANIC BRECCIA, slightly fractured, slightly weathered, very hard (volcanic breccia formation) grades with some small voids at 3 feet grades to massive

Boring terminated at 17 feet

Groundwater level at:

Depth Hours Date
2.1 ft. 1301 5/4/99
1.4 ft. 1454 5/4/99
<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Field</th>
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</thead>
<tbody>
<tr>
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<td></td>
<td></td>
</tr>
<tr>
<td>35</td>
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</table>

**DESCRIPTION**

- Approximate Surface Elevation (ft): -2.5
- Tannish white CORAL FRAGMENTS (GW), medium hard, very moist
- Greenish gray VOLCANIC BRECCIA, massive with some voids/vesicles, slightly weathered, hard (volcanic breccia formation)
- Grades to slightly fractured
- Grades to massive with voids, medium hard
- Grades to dense, hard

Boring terminated at 31.5 feet

**Groundwater level at:**
- Depth: 2.1 ft., Hours: 1314, Date: 5/5/99
- Depth: 1.8 ft., Hours: 1430, Date: 5/6/99
**FIELD LABORATORY**

**Drilling Method:** 4' Auger, HQ Coring

**Date Started:** 6/10/99

**Date Completed:** 6/11/99

**Logged By:** Y. Chiba

**Driving Energy:** 140 lb. wt., 80 in. drop

**Total Depth:** 45.8 feet

**DESCRIPTION**

Approximate Surface Elevation (feet): 38.2

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<tbody>
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<td>Dark brown CLAYEY SILT (MH), stiff, moist (residual)</td>
</tr>
<tr>
<td>5-10</td>
<td>Bluish gray and gray VOLCANIC BRECCIA, massive, slightly weathered, very hard (volcanic breccia formation)</td>
</tr>
<tr>
<td>10-15</td>
<td>grades to slightly fractured</td>
</tr>
<tr>
<td>15-20</td>
<td>grades to massive</td>
</tr>
<tr>
<td>20-25</td>
<td></td>
</tr>
<tr>
<td>25-30</td>
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<td>65-70</td>
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<tr>
<td>70-75</td>
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</tbody>
</table>

**Boring terminated at 45.8 feet**

Groundwater level:
- Depth: 14.8 ft
  - Date: 0805 6/14/99
  - Grade to slightly fractured

**GROUNDWATER LEVEL**

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<tbody>
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<tr>
<td>25-30</td>
<td></td>
</tr>
<tr>
<td>30-35</td>
<td></td>
</tr>
<tr>
<td>35-40</td>
<td></td>
</tr>
<tr>
<td>40-45</td>
<td></td>
</tr>
<tr>
<td>45-50</td>
<td></td>
</tr>
<tr>
<td>50-55</td>
<td></td>
</tr>
<tr>
<td>55-60</td>
<td></td>
</tr>
<tr>
<td>60-65</td>
<td></td>
</tr>
<tr>
<td>65-70</td>
<td></td>
</tr>
<tr>
<td>70-75</td>
<td></td>
</tr>
</tbody>
</table>

**LOG OF BORING 4**

**REQUEST FOR QUOTATION**

**QUEST RESORT AT NGERUR ISLAND**

**NGERUR ISLAND**

**REPUBLIC OF PALAU**

**WORK ORDER NO. 4168-00**

**TSK**

**Jul 99**

**DRAFT**
**Date Started:** 6/8/99  
**Date Completed:** 6/14/99  
**Logged By:** Y. Chiba  
**Driving Energy:** 140 lb. wt., 30 in. drop

**Drill Rig:** ConcoreElL  
**Drilling Method:** 4" Auger, NX Coring

---

**Approximate Surface Elevation (ft.):** 30’

1. **RUN 1**  
   - REC: 100%  
   - RQD: 100%  
   - Description: Dark blackish brown CLAYEY SILT (MH) with roots/rootlets, stiff, moist  
   - Orangish brown mottled with dark brown, highly weathered VOLCANIC ROCK FRAGMENTS in a clayey silt matrix, medium hard, wet, (residual)  
   - Grades to highly weathered rock fragments, hard (highly weathered volcanic breccia) at 2 feet

2. **RUN 2**  
   - REC: 100%  
   - RQD: 100%  
   - Description: Dark gray and bluish light gray VOLCANIC BRECCIA, slightly fractured with some small voids, slightly weathered, hard (volcanic breccia formation)  
   - Grades to massive at 6.3 feet

---

**Groundwater level:**
- Depth: 1.3 ft.  
- Hour: 1048  
- Date: 6/8/99  
- Depth: 1.3 ft.  
- Hour: 0831  
- Date: 6/9/99 
- Depth: 1.3 ft.  
- Hour: 1450  
- Date: 6/14/99
### DESCRIPTION

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Sample</th>
<th>Density</th>
<th>Moisture</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>RUN 8</td>
<td>REC=100% RQD=100%</td>
<td></td>
<td></td>
<td>Blush gray and gray VOLCANIC BRECCIA, massive, slightly fractured, hard (volcanic breccia formation)</td>
</tr>
</tbody>
</table>

- Boring terminated at 47.3 feet
- Groundwater level at: 1.9 ft. 1458 6/14/99, 2.3 ft. 1540 6/15/99

### DESCRIPTION

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Sample</th>
<th>Density</th>
<th>Moisture</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>RUN 9</td>
<td>REC=100% RQD=100%</td>
<td></td>
<td></td>
<td>Grayish tan with multi-color motting extremely to highly weathered VOLCANIC ROCK, friable by knife, medium dense to dense (extremely to highly weathered volcanic rock)</td>
</tr>
</tbody>
</table>

- Boring terminated at 13 feet
# Log of Boring 6

**Date Started:** 6/14/99  
**Date Completed:** 6/15/99  
**Drill Rig:** Coconee 121  
**Driving Energy:** 140 lb. wt., 30 in. drop  
**Logged By:** Y. Chiba

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>Dark brown CLAYEY SILT (MH) with some gravel and organics, medium stiff, moist (residual)</td>
</tr>
<tr>
<td>1.0</td>
<td>Tannish gray highly to extremely weathered VOLCANIC ROCK FRAGMENTS in a dark brown clayey silt matrix, hard, moist (slightly to extremely weathered volcanic breccia)</td>
</tr>
<tr>
<td>1.7</td>
<td>Bushy gray and gray VOLCANIC BRECCIA, slightly fractured, slightly weathered, hard (volcanic breccia formation) grades to massive at 5.3 feet</td>
</tr>
<tr>
<td>26.6</td>
<td>Boring terminated at 26.6 feet</td>
</tr>
</tbody>
</table>

- **Groundwater level:** 7.5 ft.  
- **Date:** 6/15/99  
- **Hours:** 1305

---

# Log of Boring 7

**Date Started:** 6/11/99  
**Date Completed:** 6/14/99  
**Drill Rig:** Coconee 121  
**Driving Energy:** 140 lb. wt., 30 in. drop  
**Logged By:** Y. Chiba

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Brownish orange CLAYEY SILT (MH) with friable fragments, stiff, moist (residual) grades to multi-color motting, extremely weathered volcanic rock, friable by hand, medium hard (saprolite)</td>
</tr>
<tr>
<td>1.7</td>
<td>Blush gray and gray VOLCANIC BRECCIA, slightly fractured, slightly weathered, hard (volcanic breccia formation) grades to massive at 5.5 feet</td>
</tr>
<tr>
<td>26.6</td>
<td>Boring terminated at 26.6 feet</td>
</tr>
</tbody>
</table>

- **Groundwater level:** 7.8 ft.  
- **Date:** 6/15/99  
- **Hours:** 1545

---

**GEOLABS, INC.**  
Geotechnical Engineering  
**WORK ORDER NO. 4158-00 TSK Jul 99**  
**PLATE A-6**

---

**GEOLABS, INC.**  
Geotechnical Engineering  
**WORK ORDER NO. 4158-00 TSK Jul 99**  
**PLATE A-7.1**

---

**DRAFT**
The subsurface conditions across the project site were also explored by excavating 10 test pits, designated as Test Pit Nos. 1 through 10, extending to a maximum depth of about 12.5 feet below the existing ground surface. The approximate locations of the test pits excavated are shown on the Site Plan, Plate 2. The test pits were excavated using a rubber-tired Ford 6550 excavator.

The materials encountered in the test pits were classified by visual and textural examination in the field by our geologist, who monitored the excavation operations on a near-continuous basis. These classifications were further reviewed visually and by testing in the laboratory. Soils were classified in general conformance with the Unified Soil Classification System, as shown on Plate A of Appendix A. Logs of the materials encountered in the test pits are presented on the Logs of Test Pits, Plates B-1 through B-5.

Pocket penetrometer tests were performed on selected cohesive soil samples in the field. The pocket penetrometer test provides an indication of the unconfined compressive strength of the sample. Results of the pocket penetrometer tests are summarized on the Logs of Test Pits at the appropriate sample depths.

<table>
<thead>
<tr>
<th>Test Pit No.</th>
<th>Depth Below Surface (feet)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TP-1</td>
<td>0 - 0.5</td>
<td>Brown SILTY CLAY (CH-MH) with root/rootlets, stiff, damp. (residual) PP = 1.5 - 2.0 tsf</td>
</tr>
<tr>
<td></td>
<td>0.5 - 9.0</td>
<td>Reddish brown to brownish orange with multi-color mottling extremely weathered VOLCANIC BRECCIA. Breaks down to clayey silt with friable fragments, hard, damp. (saprolite) PP = 3.0 - 3.5 tsf</td>
</tr>
<tr>
<td></td>
<td>8.0 - 9.0</td>
<td>Grades to grayish tan with multi-color mottling. Test pit terminated at 9.0 feet of May 26, 1999. Groundwater was not encountered.</td>
</tr>
<tr>
<td>TP-2</td>
<td>0 - 0.5</td>
<td>Dark brown CLAYEY SILT (MH) with root/rootlets stiff, damp. (residual) PP = 0.5 - 1.0 tsf</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Test pit terminated at 0.5 feet on May 26, 1999. Groundwater was not encountered.</td>
</tr>
<tr>
<td>TP-3</td>
<td>0</td>
<td>VOLCANIC BRECCIA at surface. Test pit terminated at 0 feet on May 26, 1999.</td>
</tr>
<tr>
<td>Test Pit No.</td>
<td>Depth Below Surface (feet)</td>
<td>Description</td>
</tr>
<tr>
<td>-------------</td>
<td>---------------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>TP-4</td>
<td>0 – 0.5</td>
<td>Tannish brown SILTY CLAY (CH) with some gravel and root/rootlets, stiff, damp to moist. (residual) PP = 2.0 – 2.5 lsf</td>
</tr>
<tr>
<td></td>
<td>0.5 – 2.5</td>
<td>Brownish orange with multi-color mottling SILTY CLAY (CH-MH) with friable fragments, very stiff, damp. (saprolite) PP = 2.5 – 3.0 lsf</td>
</tr>
<tr>
<td></td>
<td>2.5 – 3.5</td>
<td>Grades to extremely weathered VOLCANIC BRECCIA. Breaks down to clayey silt (MH) with friable fragments, hard, moist. PP = 3.5 – 4.0 lsf</td>
</tr>
<tr>
<td></td>
<td>3.5</td>
<td>Test pit terminated at 3.5 feet on May 26, 1999 Groundwater was not encountered.</td>
</tr>
<tr>
<td>TP-5</td>
<td>0 – 1.0</td>
<td>Dark brown SILTY CLAY (CH) with some gravel and root/rootlets, stiff, moist. (residual) PP = 0.5 – 1.0 lsf</td>
</tr>
<tr>
<td></td>
<td>1.0 – 6.5</td>
<td>Bluish gray with multi-color mottling extremely to highly weathered VOLCANIC BRECCIA. Breaks down to sandy gravel/fragments with some silt, medium dense, damp to moist. (saprolite)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Test pit terminated at 6.5 feet on May 26, 1999. Groundwater was not encountered.</td>
</tr>
<tr>
<td>TP-6</td>
<td>0 – 1.0</td>
<td>Brown SILTY CLAY (CH) with roots/rootlets, stiff, moist. (residual) PP = 1.0 – 1.5 lsf</td>
</tr>
<tr>
<td></td>
<td>1.0 – 9.0</td>
<td>Orangish red with multi-color mottling extremely weathered VOLCANIC BRECCIA. Breaks down to clayey silt (MH) with friable fragments, very stiff, moist to wet. (saprolite) PP = 3.0 – 3.5 lsf</td>
</tr>
<tr>
<td></td>
<td>9.0 – 10.0</td>
<td>Grades to grayish tan with multi-color mottling. Test pit terminated at 10.0 feet on May 26, 1999. Groundwater was not encountered.</td>
</tr>
<tr>
<td>TP-7</td>
<td>0 – 0.5</td>
<td>Brown SILTY CLAY (CH) with some highly weathered volcanic rock gravel and root/rootlets, stiff, moist. (residual) PP = 1.0 – 1.5 lsf</td>
</tr>
<tr>
<td></td>
<td>0.5 – 2.5</td>
<td>Brownish orange mottled with black, tan and gray extremely weathered VOLCANIC BRECCIA. Breaks down to friable fragments in a clayey silt (MH) matrix, medium hard, moist. (saprolite) PP = 2.0 – 2.5 lsf</td>
</tr>
<tr>
<td></td>
<td>2.5 – 3.5</td>
<td>Bluish grey mottled with gray and black extremely to highly weathered VOLCANIC BRECCIA. Friable by fingers w/ some difficulty, medium hard, moist. Test pit terminated at 3.5 feet on May 26, 1999. Groundwater was not encountered.</td>
</tr>
<tr>
<td>Test Pit No.</td>
<td>Depth Below Surface (feet)</td>
<td>Description</td>
</tr>
<tr>
<td>-------------</td>
<td>---------------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>TP-8</td>
<td>0 - 0.25</td>
<td>Dark brown SILTY CLAY (CH) with some gravel and root/rootlets, stiff, moist. (residual) PP = 1.0 - 1.5 tsf</td>
</tr>
<tr>
<td>TP-9</td>
<td>0 - 0.5</td>
<td>Tannish brown SILTY CLAY (CH) with roots/rootlets, soft, wet. (residual) PP = &lt;0.5 tsf</td>
</tr>
<tr>
<td>TP-10</td>
<td>0.0 - 0.5</td>
<td>Brown SILTY CLAY (CH) with some gravel and root/rootlets, stiff, moist. (residual) PP = &lt;0.5 tsf</td>
</tr>
<tr>
<td></td>
<td>0.25 - 2.0</td>
<td>Orangish brown mottled with black SILTY CLAY (CH-MH) with some gravel and friable fragments, very stiff, moist. (residual) PP = 2.5 - 3.0 tsf</td>
</tr>
<tr>
<td></td>
<td>0.5 - 3.5</td>
<td>Orangish brown mottled with black SILTY CLAY (CH-MH) with some gravel and friable fragments, very stiff, moist. (residual) PP = 2.5 - 3.0 tsf</td>
</tr>
<tr>
<td></td>
<td>2.0 - 4.0</td>
<td>Brownish orange with multi-color mottling extremely weathered VOLCANIC BRECCIA. Breaks down to clayey silt (MH) with friable fragments, stiff, moist. (saprolite) PP = 2.5 - 3.0 tsf</td>
</tr>
<tr>
<td></td>
<td>3.5 - 6.5</td>
<td>Grayish tan with multi-color mottling highly to extremely weathered VOLCANIC BRECCIA. Friable by fingers with some difficulty, medium dense, moist. (saprolite) Test pit terminated at 6.5 feet on May 27, 1999. Groundwater was not encountered.</td>
</tr>
<tr>
<td>TP-10</td>
<td>10.0 - 12.5</td>
<td>Brown Silt CLAY (CH) with some gravel and root/rootlets, soft, wet. (residual) PP = &lt;0.5 tsf</td>
</tr>
<tr>
<td></td>
<td>10.0 - 12.5</td>
<td>Grades to extremely weathered VOLCANIC BRECCIA. Breaks down to clayey silt (MH) by hand, very stiff. (saprolite) PP = 3.0 - 3.5 tsf</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Test pit terminated at 12.5 feet on May 27, 1999. Groundwater was not encountered.</td>
</tr>
</tbody>
</table>
Laboratory Testing

Moisture content (ASTM D 2216) determinations were performed on selected samples as an aid in the classification and evaluation of soil properties. The results of these tests are presented on the Logs of Test Pits at the appropriate sample depths.

One Atterberg Limits test (ASTM D 4318) was performed on a selected soil sample to evaluate the liquid and plastic limits. Graphic presentation of the test results is provided on Plate C-1.

One sieve analysis test (ASTM C 136 & ASTM D 1140) was performed on a selected soil sample to evaluate the gradation characteristics of the soils and to aid in soil classification. Graphic presentation of the grain size distribution is provided on Plate C-2.

<table>
<thead>
<tr>
<th>Location</th>
<th>Depth (feet)</th>
<th>Description</th>
<th>LL</th>
<th>PL</th>
<th>PI</th>
</tr>
</thead>
<tbody>
<tr>
<td>TP - 8</td>
<td>1.3</td>
<td>Orangish brown CLAYEY SILT (MH) with some gravel</td>
<td>79</td>
<td>40</td>
<td>39</td>
</tr>
</tbody>
</table>

ATTERBERG LIMITS SUMMARY

GEOLABS, INC.
Geotechnical Engineering

PROJECT:
QUEST RESORT AT NGERUR ISLAND
NGERUR ISLAND
REPUBLIC OF PALAU

DATE
Oct 99

W.O.
4168-00

PLATE C - 1

DRAFT
<table>
<thead>
<tr>
<th>Location</th>
<th>Depth (feet)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TP - L</td>
<td>2.5</td>
<td>Bluish gray well-graded GRAVEL (GW-GM) w/ silt &amp; sand</td>
</tr>
</tbody>
</table>

**SIEVE ANALYSIS**

**GEOLABS, INC.**
Geotechnical Engineering

**DATE**  Oct 99   **W.O.**  4168-00

**PLATE**  C - 2  

**DRAFT**
Appendix B-2

Water Reclassification Considerations
A RESOLUTION

To recommend to EQPB that the water classification for Ngerur Island be reclassified from Class "AA" waters to Class "B" waters to accommodate the proposed "Quest Resort Palau."

THE PEOPLE OF THE STATE OF KOROR REPRESENTED IN THE STATE LEGISLATURE DO RESOLVE AS FOLLOWS,

WHEREAS, the island of Ngerur is situated in the territorial waters of the State of Koror, and is privately owned land situated within a building and zoning "Resort" zone as shown on the official Zoning Map of the State of Koror; and

WHEREAS, Morita Hotel Corporation has represented that it desires to build a world class, environmentally friendly resort facility on Ngerur Island, which includes infrastructure for related water recreation activities and support services; and

WHEREAS, Morita Hotel Corporation has caused advertisements to be placed in the local newspapers informing the public about a public meeting to discuss and learn about the project, and inviting the public to have input into the Environmental Impact Statement process; and

WHEREAS, the waters surrounding Ngerur Island are currently classified as "AA" waters, which are intended to remain in their natural state with the absolute minimal pollution from any source, and includes the preservation of the wilderness character of such areas to the greatest extent possible; and

WHEREAS, the reclassification of the waters to Class "B" waters will allow for the development of a small boat harbor and compatible recreational activities, and aesthetic enjoyment; and

WHEREAS, the reclassification of waters from "AA" to "B" would extend for 200 meters from the shore of Ngerur Island, and all other surrounding areas would be classified as "A" unless given some other specification, all under Environmental Quality Protection Board "Marine and Fresh Water Quality Regulations", section 2401-11-06; and

WHEREAS, the reclassification to Class "B" waters still requires that discharge of any
WHEREAS, the Sixth Koror State Legislature supports the proposed development of an ecologically sensitive and environmentally friendly resort development at Ngemelis Island, to the extent that such development is allowable by law, and to the extent that any pollutants of any kind be reduced to the greatest possible degree; and

WHEREAS, the Legislature desires to support the project that is environmentally friendly in order to attract similar developments to the State of Koror; and

WHEREAS, the Legislature is aware that Ngemelis Island is situated in the pristine waters of the State of Koror, and that any pollution that enters the water during construction and cleaning operations may have a significant impact on the marine life and fauna, and potentially with the health and welfare of the people of Koror; and

WHEREAS, the health and welfare of the people of Koror, and of the marine environment, is of primary concern, and prevails over any economic considerations relating to the costs of mitigation of the effects of construction and operation of the project, and whereas the safety and welfare of the people of Koror prevails over economic considerations relating to the costs and expenses of the highest degree of sewage and wastewater treatment possible under existing technology; and

WHEREAS, the Legislature supports the reclamation of the waters to the extent that sedimentation, runoff, and erosion plans will be utilized to the greatest degree and maximum extent possible, and that any sewage or other discharge of wastewater receive the highest degree of treatment possible under existing technology, regardless of any economic standard that may be in limitation under the EQPB regulations, and that all other wastes, including solid waste and

IT IS HEREBY RESOLVED that the Sixth Koror State Legislature expresses its support for the proposed Quest Resort Palau at Ngemelis Island, and requests the Environmental Quality Protection Board to reclassify waters within 200 meters of Ngemelis Island from Class "AA" to Class "B", and further, in issuing this request, that the Sixth Koror State Legislature require that all applicable laws be strictly observed, and that the effects of any potential pollution entering into the waters of the State of Koror be prevented to the greatest extent possible under existing technology, regardless of cost; and

IT IS FURTHER RESOLVED that certified copies of this Resolution shall be transmitted to the Environmental Quality Protection Board; the Honorable John C. Gibbons, Governor of the State of Koror; House of Traditional Leaders of Koror State; Speaker of the House of Delegates; the President of the Senate of the Fifth Olbil Ela Kollau; Morita Corporation; Ngemelis Island Corporation; and the Speaker of the Sixth Koror State Legislature.

ADOPTION: May 10, 2000

CERTIFIED BY:  

[Signature]

Speaker, 6th Koror State Legislature

ATTESTED TO BY:  

[Signature]

Clayton Ody, Clerk
6th Koror State Legislature
Appendix B-3

Baseline Marine Environmental Survey

(PENTEC Environmental, Inc., 1999)
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Appendix—Transect Photos
1.0 INTRODUCTION

1.1 SCOPE OF WORK

This report presents the results of baseline water quality and marine environmental surveys conducted around the perimeter of Ngerur Island, Koror State, Republic of Palau (ROP) (Figure 1).

The rationale for the surveys was based upon the need to gather both general and site-specific water quality and marine environmental data for use in the planning and conceptual siting of a proposed resort development. Preliminary conceptual design drawings suggest that the resort will feature a number of low-rise bungalows and cottages, a reception area, a restaurant, a marina and cargo handling area, a manmade sand beach, and a "coral garden" snorkeling area. To construct the project, temporary barge landing ramps and coastal revetments will be required to provide access for heavy equipment and construction materials. Minor filling, placement of submarine piles, and some coastal modifications are expected to be required. The information contained in this report is also expected to be used for scientific input into an ROP Environmental Quality Protection Board (EQPB)-required environmental assessment, and related technical reports and permit applications required by the EQPB and other national and state government agencies.

A combination of survey methods and techniques were used to gather water quality and marine biological data. Water temperature, salinity, dissolved oxygen, turbidity, and pH data were gathered using field-portable instrumentation (see Section 2.1). Marine biological data were acquired through underwater surveys, photographic documentation, and underwater video surveys conducted around Ngerur Island.

An extended drought, the result of the El Niño Southern Oscillation (ENSO), has affected Palau (and most of the central and western Pacific Ocean) for over 1 year. The effects of the
Drought may have influenced baseline water quality conditions as well as the distribution and abundance of coastal and marine biotic assemblages reported herein. Therefore, the data reported herein may be atypical of normal, “non-ENSO” conditions. Water temperature values recorded during the survey were above the normal range for Palau’s lagoon waters. The high water temperatures may have influenced the distribution and abundance of certain marine organisms in the vicinity of the project site.

1.2 REGIONAL OVERVIEW

1.2.1 Physical Environment

The Palau (Iselau) Islands are the westernmost group of the Caroline Islands and form a curving arc that extends in a north-south direction from 6°57’ north latitude to 8°12’ north latitude, and from 134°43’ to 135°08’ east longitude. The Palau Islands are located within the southern portion of the North Pacific Equatorial Current, which sets from east to west across the Pacific Ocean between latitudes of roughly 5° to 20° north. Surrounding the majority of the islands within the archipelago is an extensive barrier reef system accounting for approximately 560 square miles (mi²) (1,455 square kilometers [km²]) of protected lagoons.

Babeldaob is the largest island in the ROP, with an area exceeding 396 km², and comprises about 33 percent of all land in the Caroline Islands. Babeldaob is one of 586 large, intermediate, and small islands that compose the ROP (Maragos and Meier 1993). Between the barrier reef and main islands within Palau’s southern lagoon are many isolated and clustered groups of raised limestone islets, popularly referred to as the “Rock Islands.” These islands are characterized by their haystack shape and a deep notch cut at the intertidal zone.

Within the lagoon, numerous patch reefs reach the surface. These reefs typically range from small isolated pinnacles to linear and irregularly curved and branched reefs up to several kilometers or more in length. Curved and branched patch reefs often enclose both shallow and deep secondary lagoons. Secondary lagoons also occur on some of the lagoon fringing reefs (Maragos et al. 1994).

A diversity of marine habitats is found on the seaward and lagoon barrier reef slopes and terraces around most of the islands. These habitats include reef flat platforms, barrier reef passes, lagoon channels, lagoon patch reefs, lagoon fringing reefs, coral knolls and banks, shallow lagoons, terraces, lagoon basin floors, enclosed secondary lagoons, river estuaries, and mangrove swamps (Randall 1990).

Fringing reefs and shallow, sandy, shoreface terraces border most of the larger islands. Shorelines with developed beach sands are found at a few places on some limestone islands, but shorelines are poorly developed and patchy in distribution on the larger islands. Shoreface terraces border most of Ngerur Island (Figure 2) and sand beaches are narrow, possibly seasonal, and not well developed. The shoreline of Ngerur Island appears to be in a largely undisturbed condition. The only apparent alteration is a set of stair steps cut into the baserock at two locations to provide access to the interior of the island from the shore.

Ngerur Island is of volcanic origin and has a maximum elevation of about 20 meters (m). Total land area is some 6 hectares (ha), with the majority covered by either upland forest or shrub vegetation.

The Komebail Lagoon fronts the north and west side of Ngerur Island and immediately to the east lies Ngerekebossang (Arakabesan) Island. Around most of the island’s perimeter is a lagoon fringing reef flat that is divided into a number of habitats or biotopes reflective of changing physiographic and biological community structure.

1.2.2 Biological Environment

Due to Palau’s geographic location in the center of the Indo-Pacific basin, it hosts one of the most biologically diverse marine environments in the world. This is manifest by at least 400 species of stony (hermatypic) corals. The species and genera totals are comparable to those of the areas of highest coral diversity reported from Indonesia, Australia, and the Philippines (Maragos et al. 1994). Species diversity is highest in the lagoon surrounding Babeldaob and around some of the other large islands. Highest coral abundance and diversity are generally found in reef-slope habitats. These reef-slope habitats are found at the lagoon edge of deep passes, on lagoon patch reefs removed from areas of siltation, on deep ocean reef slopes off the western side of the barrier reef, and at semiprotected ocean walls or drop-offs (Maragos et al. 1994).

An estimated 1,357 inshore fish species occur within the Palau archipelago. Some 733 species, including about 136 new entries, were recorded during the Rapid Ecological Assessment
study conducted in 1992 (Otobed and Maiava 1994; Donaldson 1993). By comparison, the Eastern Caroline Islands is estimated to have 1,149 fish species and the Marshall Islands some 827 species. Palau also has five endemic species of marine fish (Myers 1989).

The diversity of noncoral invertebrates is similarly high in Palau, encompassing several hundred to over one thousand species. Nearly 300 species of invertebrates were recorded during a survey near Ngerukewid (Smith 1989). Sponges, pearl oysters, trochus, seven species of giant clams, mangrove crabs, lobster, deepwater shrimp, and sea cucumbers constitute some of the economically valuable marine invertebrates found in Palau.

Fifteen coastal or marine areas located in Palau have been proposed as "ecologically sensitive areas" in the Palau National Economic Development Master Plan (Maragos et al. 1994). These include the Northern Lagoon, Ngerur Island beaches, and Ngera Pass (Ngerchechelong State); Nghelbelong and Ngaraad seagrass beds; Yasuba "snake" Island, and Ngit Channel (Ngaraad State); Meteul Toachel Pass, Ngiwal seagrass beds, and Ngibital (Ngiwal State); Melekeok and Lake Ngerdok (Melekeok State); Ngetngod Pass, Toachel Suul, and Ngermeleael (Melelekel) Pass (Ngchesar State); and the Ngetngod Pass, and Ngardai and Ngeream islands and their surrounding mangrove swamp forests (Airai State). There are no proposed ecologically sensitive areas located on or adjacent to Ngerur Island.
Figure 1
Site vicinity map.
2.0 METHODS

2.1 PHYSICAL AND CHEMICAL MEASUREMENTS

The water quality parameters measured were dissolved oxygen (DO), temperature, salinity, turbidity, and pH.

Temperature and DO were measured using a Yellow Springs Instrument Co. (YSI) Model 58 DO meter. The instrument was air-calibrated at 100 percent saturation at sea level. Manufacturer-reported accuracy is ±0.02 milligrams/liter (mg/l). Temperature was measured in degrees Celsius (°C).

Salinity measurements were made using a YSI Model 33 salinity/conductivity/temperature meter. Manufacturer-reported accuracy is ±0.9 parts per thousand (ppt). The probes for each of the above measurements were positioned at approximately 20 centimeters (cm) below the surface and at roughly midwater depth at each sampling location.

Turbidity was measured using a LaMotte Model 2008 photoelectric turbidimeter. The turbidimeter was calibrated using a LaMotte AMCO standard of 5 nephelometric turbidity units (NTU). Water samples were collected at approximately 10 to 20 cm below the surface. Manufacturer-reported accuracy is ±2 percent of the reading, or ±0.05 NTU, whichever is greater. Therefore, measurement accuracy was ±0.05 NTU. However, some instrument readings may have been influenced by measurements conducted in a boat under conditions that sometimes included modest surface chop. Therefore, instrument error could exceed the range reported by the manufacturer.

pH was measured using an Oaklon pH Tstra 2 meter calibrated with a pH 7.0 reference sample. Manufacturer-reported accuracy of the pH measurements is ±0.1 pH units. Measurements were taken approximately 10 to 20 cm below the surface.

2.2 MARINE BIOLOGICAL SURVEYS

Semiquantitative coral and benthic invertebrate baseline surveys were conducted by divers using mask and snorkel apparatus along random, prepositioned underwater transect lines. Transect locations were identified on the basis of conceptual design suggestions provided by the client (e.g., candidate areas for construction of barge landing ramps, sand beaches, marina), areas potentially subject to upland runoff, and sites reflecting a representative cross-section of coastal and reef flat biotopes or habitats.

Transects were established by placing a plastic surveyor’s tape along the substrate. The surveyor’s tape was randomly placed perpendicularly to the shoreline at lengths ranging from roughly 40 to 100 m as a function of the width of the reef flat, zonation patterns (determined by analysis of aerial photographs), and bathymetry (Figure 3). The tapes were typically secured to rocks or logs within the high intertidal or supratidal zone (as determined by the presence of shoreline driftwood and jetash) to permit definition of physiographic features, biological zonation patterns, and benthic assemblages from the supratidal zone to the lagoon reef margin or slope. Once the tape was secured to the bottom (with transect interval numbers visible), an observer swam the length of the transect and recorded the physical and biological features intercepting the transect tape. At intervals of 5 to 10 m (intervals are a function of transect length) the observer took a single photograph of benthic features using an underwater camera. Although varying as a function of water depth and vertical relief, the photographs typically encompassed an area of from 0.5 to 2 m². The photographs provide a permanent data record of each transect. (See Appendix.)

Divers also conducted roving underwater surveys in the general vicinity of each transect to identify and enumerate corals and other species not recorded in the transect data. Such surveys typically averaged about 30 minutes. Some of the roving surveys were conducted by the diver being pulled behind a boat.

Underwater video surveys were also conducted along all study transects to provide additional baseline data, and to record and enumerate species that may have been overlooked during the reconnaissance surveys. A scuba-equipped diver performed the surveys, swimming along a defined compass bearing at each of the transect locations. The tapes provide a permanent record of the study area.

All underwater observations were recorded on waterproof Dura-Rite Field Notebooks. All surveys were conducted during the day. Additional species would likely have been observed had surveys also been conducted at night.
No attempt was made to identify or enumerate cryptic species or infauna dwelling within the substrate, except for certain types of large or otherwise conspicuous coral-embedding clams, mussels, and oysters. Observations were generally limited to the larger and more conspicuous invertebrates, because another consultant was to provide a detailed description of invertebrate populations.

Macrotidal algae and coral coverage was determined by visual estimates of abundance and/or percent coverage along each survey transect. Identification and enumeration of benthic invertebrates was generally limited to individuals exceeding 2 cm in body length (macroinvertebrates). Certain especially numerous, albeit smaller invertebrates were, however, occasionally recorded. Counts or population density estimates of certain benthic invertebrate populations were occasionally made using an underwater slate to roughly delineate 0.05-m² quadrats or by making density estimates.

Fish identification and abundance estimates were made by recording all species sighted within about 5 m to either side of each survey transect. In some instances, semiquantitative estimates of fish abundance were made using stationary and small plot counts (the latter technique was useful in enumerating the number of fish inhabiting single, isolated coral heads).

3.0 RESULTS

3.1 WATER QUALITY

Water quality parameters were measured on September 26-28, 1998. The results of the water quality surveys are shown in Table 1. Four sampling stations were selected in the vicinity of the project site and scattered on all sides of Ngerur Island (Figure 3). Sampling stations were located roughly 30 to 50 m from shore at each site. A fifth water quality sampling station, reflecting an area of detrital deposition, was subject to measurements on September 28 (Figure 3).

3.1.1 Temperature

Water temperatures ranged from 30.4 to 31.1°C (Table 1). The coolest temperature (30.4°C) was recorded at the west side of the island during an incoming tide on September 27, 1998. The warmest temperature (31.1°C) was recorded at the same sampling location during an incoming tide on the same day. A mean temperature of 30.7°C was calculated for all stations. Overall, recorded temperatures were unusually high. The normal range of water temperature is about 23.8 to 29.4°C.

Palau’s Marine and Fresh Water Quality Regulations (ROP 1996; Chapter 2401-11-15) defines its temperature standard as follows:

Temperature shall not vary by more than 1.5 degree Fahrenheit (0.9 degrees C) from the natural conditions in marine and fresh waters. All Waters.

The unusually high temperature measurements should not be used as a baseline temperature regime for the project site, because they no doubt originated as a result of the ongoing ENSO event.

3.1.2 Salinity

Excluding sampling station 5 (described below), salinity values ranged from 30.5 to 32.0 ppt (Table 1). Mean surface salinity was lowest on the south side of the island (30.6 ppt) and highest...
Table 1 Water quality data.

<table>
<thead>
<tr>
<th>Description</th>
<th>Date</th>
<th>Time</th>
<th>Title (ft)</th>
<th>Probe depth</th>
<th>Temp. (°C)</th>
<th>Salinity (ppt)</th>
<th>DO (ppm)</th>
<th>DO saturation (%NTU)</th>
<th>Turbidity (NTU)</th>
<th>pH</th>
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<td></td>
<td></td>
<td>9/27/98</td>
<td>8:36</td>
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<td>9/27/98</td>
<td>12:20</td>
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<td>10.8</td>
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<td>12:28</td>
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<td>11.0</td>
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<td>10.8</td>
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<td>9/25/98</td>
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<td>5.3</td>
<td>surface</td>
<td>30.7</td>
<td>10.8</td>
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<td>9/27/98</td>
<td>8:46</td>
<td>4.4</td>
<td>surface</td>
<td>30.6</td>
<td>11.1</td>
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<td>9/27/98</td>
<td>12:33</td>
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<td>30.7</td>
<td>10.0</td>
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</table>
on the north side of the island (31.4 ppt). Mean midwater salinity was lowest on the west side of the island (30.7 ppt) and highest on the south and east sides of the island (31.1 ppt). A mean salinity value of 31.0 ppt was calculated for all stations.

Station 5 salinity readings in a deposit of unconsolidated organic sediment were 22.0 to 22.5 ppt. Additional information on physical environmental conditions observed at station 5 are found in Section 3.1.3.

ROP (1996; Chapter 2401-11-12) establishes the following standard for salinity:

1. Dissolved oxygen concentrations shall not vary by more than 25% from natural conditions.
2. Dissolved oxygen concentration shall not be less than:
   a) The greater of 6.0 mg/L, 75 percent of saturation or 1 mg/L.
   b) 5.0 mg/L.

Excluding station 5, all DO concentrations met or exceeded the saturation standards; however only four times were the DO measurements at or above 6.0 mg/L. The concentration of DO is dependent on the salinity and temperature of the water. The lower-than-normal DO values can be attributed to the warmer-than-normal water temperature. Station 5 readings are the result of unique physical or hydrological circumstances and are not relevant in terms of the regulatory standards. Samples of this material returned to the surface for closer examination indicated the strong presence of hydrogen sulfide, indicating anaerobic conditions typical of the natural degradation of organic material in this environment.

3.1.4 Turbidity

Turbidity readings ranged from 0.1 to 1.10 NTU (Table 1). The highest turbidity reading was recorded on the south side of the island. The south side also demonstrated the highest mean value (1.1 NTU). A mean value of 1.0 NTU was calculated for all stations.
There were discernible differences between sampling dates. Sampling that occurred on September 26, 1998, had a mean of 1.25 NTU (N=4), whereas sampling that occurred on September 27 had a mean of 0.82 NTU (N=8). This difference was likely the result of heavy rainfall that occurred on September 26.

ROP (1996; Chapter 2401-11-16) defines its turbidity standard as follows:

Turbidity as measured by NTU shall not be:

A. greater than 1 NTU. Class AA and A waters
B. greater than 2 NTU. Class B waters
C. greater than 5% above natural conditions. Class 1 waters
D. greater than 10% above natural conditions. Class 2 waters

All turbidity measurements met Class B standards. However, the turbidity standard for Class AA and A waters was exceeded during the rainfall event on September 27, 1998.

3.1.5 pH

pH values for all samples ranged from 7.7 to 8.2 pH units (Table 1). The lowest reading was recorded on the west side of the island. A mean pH of 7.9 was calculated for all stations. Insufficient information is available to draw any significant conclusions from these data.

ROP (1996) (Chapter 2401-11-11) defines the pH standard as follows:

A. pH variation shall be within 7.7 and 8.5 units. Class AA, A, and B waters
B. pH variation shall not be greater than 0.2 pH units from natural conditions; but not lower than a pH of 6.5 or higher than a pH of 8.5 from other than natural causes. Class 1 waters
C. pH variation shall not be greater than 0.5 pH units from natural conditions; but not lower than a pH of 6.5 or higher than a pH of 8.5 from other than natural causes. Class 2 waters

All 12 samples were within the range for Class AA, A, and B waters.

3.2 MARINE BIOLOGICAL SURVEYS

The coastal and marine habitats surrounding Ngerur Island demonstrate pristine conditions, though they do not, in general, conform to classic reef flat physiography or biological zonation patterns associated with coastal reef flats. This conclusion is supported by a nonexistent to limited intertidal and subtidal sandy reef flat and the predominance of an intertidal basalt bench (Figure 4). Because of limited sand and coral rubble deposits, algal density and diversity is low. Seagrass stands, often abundant in coastal mudflats and sand areas around the larger islands in Palau (and occurring in high-density meadows on nearby Ngerekebesang Island), do not occur at Ngerur.

A distinctive zone of *Porites lutea* coral, in both massive and micro-atoll morphologies, characterizes the reef flats around the island, as does a narrow but conspicuous soft coral zone (family Alcyoniidae) comprised of *Sinularia* sp. and *Sarcophyton* sp. However, an estimated 95 percent of the acropod corals were bleached (yielding, in these two species, a bright yellow coloration), and moribund, and many were in an advanced stage of decomposition. A vertical and undercut basalt headland characterizes the shoreline on the south side of the island.

Small crescent- to irregularly shaped rocky beaches occur around the perimeter of Ngerur, though sand deposits are limited and probably experience a fugitive existence between major tropical cyclonic disturbances. Several pronounced rocky headlands protrude seaward roughly 30 m on the west side of the island, and a massive boulder appears to have recently slumped into the intertidal zone on the east side of Ngerur.

A massive, roughly 65-m-long basalt outcrop that partially exposes during low-tide periods forms a somewhat unusual wave-protected rocky intertidal mound on the southwest side of the island. Vertical to near-vertical rock escarpments and headlands dominate the back beach area around most of the island, with some (on the north and west sides of the island) having steps cut into them to provide foot access to the interior of the island from the shoreline.

Except for a small stand of white mangrove (*Sonneratia alba*) occurring on the island's east side, there are no wetland or estuarine plant communities occurring on or adjacent to Ngerur Island. Coastal strand and terrestrial vegetation ranges from a mixed grassland and fern.
understory with scattered *Pandanus* and *Cocos nucifera* palms, to dense upland forest vegetation and planted coconut groves in areas with deeper soils. Stands of the introduced tree *casuarina* (*Casuarina equisitifolia*) occur on some rocky, wind-exposed coastal headlands and rock outcrops where soils are thin to nonexistent.

A small, possibly hand-dug, water-filled shoreline cave exists in the supratidal zone along the west side of the island (adjacent to study area 1). The cave may have been excavated into the near-vertical cliff face to create a source of fresh water for drinking and bathing. Despite months of drought conditions, the small cave was filled with fresh water and harbored a small population of an unidentified, nearly transparent shrimp (possibly *Palaemon* sp; family *Palaemonidae*), and profuse growths of a filamentous green algae. Although there was evidence of small coastal springs and surface-water runoff (detected by erosion cuts into the underlying rock strata and small gullies), there was no evidence of runoff in these areas during the first two days of the survey period. However, on September 26, torrential rains associated with a 3-hour-long thunderstorm inundated the island. During this period most of the western shoreline cliff face was covered by sheetflow cascades that originated between the island's bedrock and thin soil veneer. As befitting an area with relatively undisturbed vegetation and soils, runoff water appeared free of significant amounts of sediment and coastal turbidity readings indicated only a small increase in turbidity from that associated with nonrunoff conditions (Section 3.1.4 and Table 1).

### 3.2.1 Transects 1a, 1b, and 1c

Study area 1 was located in a small, roughly 70-m-wide embayment on the west side of Ngerur Island (Figure 3). The site was selected for survey based on its potential use as a barge landing area (for heavy equipment transport) and, after the upland construction phase of the project, as a potential area for development of a manmade sand beach and swimming area.

The back beach area in study area 1 is dominated by boulders, basaltic rock, and cobbles. The intertidal zone varies between 22 m and 43 m in width, with the lagoonalward terminus located in a zone of the coral *Porites lutea*, in both micro-atoll and nodular growth forms. The intertidal zone is largely a solid rock shelf interspersed with basalt and coral rocks and cobbles. Lagoonalward of roughly the lower low water line hard corals are abundant, as are numerous...
colonies of the soft corals *Sinularia* sp. and *Sarcophyton* sp. However, an estimated 95 percent of the soft corals and an estimated 10 to 15 percent of the hard corals were bleached. The soft corals, in particular, were flaccid and appeared moribund, with many colonies showing evidence of decomposition.

Three transects were randomly laid out to cover the extreme north, south, and middle sections of the bay (Plates 2 and 3, Figure 3). As graphically depicted in Figure 4, each transect was characterized by a low-relief basalt pavement with occasional basalt outcrops or coral rubble. A thin sand veneer was evident in some places, most notably in small holes or depressions on the intertidal bench. A noticeably low, well-cropped (by herbivorous fishes) greenish to gray algal turf was evident on the intertidal basalt shelf in most areas surveyed.

### 3.2.1.1 Corals

Twenty-five species of scleractinian (hard) corals (excluding milleporids, zooanthids, and alcyoniids) were recorded along transects 1a, 1b, and 1c, or during roving surveys conducted in the vicinity of each transect (Table 2). *P. lutea*, represented by micro-atoll, massive, submassive, and nodular growth forms, was the dominant species on all transects, followed by *P. andrewsi* and *P. (*Synarea*) convexa. *P. lutea* colonies provided an indication of the approximate mean lower low water level, with numerous partial to full, albeit small (to roughly 0.5 m across the longest axis) micro-atoll growth forms evident along all three transects. Many of the *P. lutea* micro-atolls (in this bay and at all survey locations around Ngerur) are partially dead, with lumpy living portions occupying parts of their peripheral margins that remain covered by water during low tides. That single colonies exhibit both live and dead portions is not unusual. Notable, however, were numerous, bleached, massive and submassive *P. lutea* colonies, in places

---

1 The family Alcyoniidae is currently undergoing taxonomic revision, and there are a number of uncertainties regarding existing taxonomic identification. For example, distinguishing between the genera *Sinularia* and *Sarcophyton* generally involves analysis of calcareous spicules (scyrites) within their body tissues, rather than relying on colony morphology. Therefore, in this report, soft corals with a low-spreading base with upward projections that divide and subdivide to form numerous finger-like apices will be identified as *Sinularia* sp.; the generally larger, leathery, large-bladed colonies will be identified as *Sarcophyton* sp.
Table 2 (continued).

<table>
<thead>
<tr>
<th>Taxa</th>
<th>Genus/species</th>
<th>Transect no.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1a</td>
</tr>
<tr>
<td><strong>Zooanthidea</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Palythoa tuberculosa</em></td>
<td>sp. 1</td>
<td>X</td>
</tr>
<tr>
<td><em>Palythoa tuberculosa</em></td>
<td>sp. 2</td>
<td>X</td>
</tr>
<tr>
<td><strong>Stichodactylidae</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Heteraeis</em> sp. (kelly green)</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td><em>Heteraeis</em> sp. (gray/green)</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td><strong>Total species</strong></td>
<td></td>
<td>22</td>
</tr>
</tbody>
</table>

* Not observed on transect.

Accounting for as much as 10 percent surface-area coverage on the subtidal reef flat and upper lagoon slope zones.

As reported above, an estimated 95 percent of all *Sinularia* sp. and *Sarcophyton* sp. were bleached, with most appearing moribund or dead, and many demonstrating early stages of decomposition. The majority of these colonies occur in a zone about 7 to 10 m wide, with many colonies growing epiphytically on reef limestone, coral rubble, or on the nonliving parts of massive *P. lutea* colonies. However, despite the near-complete death of these species, an occasional, normally pigmented, apparently healthy colony was observed.

Other common to less-common corals recorded on all or most of the transects included *P. compressa*, *Alveopora* sp., *Montipora lobulata*, *Montipora digitata*, *Pocillopora damicornis*, various *Fungia*, *Platygyra lamellina*, and *Leptastrea purpurea*. An unidentified orange milleporeid (*Millepora* sp.) and the zooanthid *Palythoa tuberculosa* were also commonly observed throughout the study area. Overall, coral coverage ranged from 0 in the intertidal zone to an estimated 80 percent on the upper lagoon slope zone.

### 3.2.1.2 Algae

Thirteen (13) species of algae were recorded along or in the vicinity of transects 1a, 1b, and 1c (Table 3). A mixed turf composed of *Entophysalis densa*, *Microcoleus lyngbyaceus*, and *Schizothrix* sp. is common in most reaches of the intertidal zone, where it was observed to form a slippery film on reef limestone, basalt outcrops, and limestone cobbles. The filamentous green algae *Enteromorpha* sp. was also conspicuous in some areas and usually demonstrated a well-cropped appearance resulting from the apparent grazing by herbivorous fish.

Small patches of *Halimeda opuntia* and an unidentified *Halimeda* species (*Halimeda* sp.) were occasionally noted in the intertidal zone and across the outer reef flat and upper lagoon slope zones, though density was low. Other common species observed included *Valonia ventricosa*, *Turbinaria ornata*, and rarely, *Padina* sp., *Jania capillacea*, and an unidentified coralline algae (listed as *Corallinaeae* sp.). *Hydrolithon reinboldii* had a patchy distribution and was usually observed in areas exposed to wave surge.
Table 3 Checklist of algae.

<table>
<thead>
<tr>
<th>Taxa</th>
<th>Genus/species</th>
<th>Transect no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cyanophyta</td>
<td>Entophysalis deusta (black film)</td>
<td>1a  x x</td>
</tr>
<tr>
<td></td>
<td>Microcoleus lyngbyaeus</td>
<td>1b  x x x</td>
</tr>
<tr>
<td></td>
<td>Schizothrix sp.</td>
<td>2a  x x x</td>
</tr>
<tr>
<td>Chlorophyta</td>
<td>Enteromorpha clathrata</td>
<td>x  x</td>
</tr>
<tr>
<td></td>
<td>Halimeda opuntia</td>
<td>x  x x</td>
</tr>
<tr>
<td></td>
<td>Halimeda sp.</td>
<td>x  x x</td>
</tr>
<tr>
<td></td>
<td>Valonia ventricosa</td>
<td>x  x x</td>
</tr>
<tr>
<td>Chlorophyta</td>
<td>Dictyota bartayresi</td>
<td>x  x</td>
</tr>
<tr>
<td></td>
<td>Padina sp.</td>
<td>x  x x</td>
</tr>
<tr>
<td></td>
<td>Sphacelaria tribuloides</td>
<td>x  x x</td>
</tr>
<tr>
<td>Phaeophyta</td>
<td>Hydrolithion reignwellii</td>
<td>x  x</td>
</tr>
<tr>
<td></td>
<td>Total species</td>
<td>9  x x 7 x 6 7 2 3 4</td>
</tr>
</tbody>
</table>

Ngerur Island Baseline Marine Survey

3.2.1.3 Fish

Forty-nine species of fish representing 15 families were recorded on or in the vicinity of transects 1a, 1b, and 1c (Table 4). Dominant families included scatriids (surgeonfishes), apogonids (cardinalfishes), labrids (wrasses), and pomacentrids (damselfishes).

The pomacentrids dominated the fish fauna in terms of total number of species (14), with Chromis caerulea, Chrysiptera cyanea, and an unidentified yellow juvenile pomacentrid (Chromis sp. 2) abundant in areas dominated by large foliose corals. Schools composed of hundreds of individuals hovered around nearly every coral head, where they would seek refuge upon the approach of the diver. Abudelfdus coelestinus and Abudelfdus sordidus were abundant on transect 1a, but less common on transect 1b, and was not recorded along transect 1c. Two anemone-associated pomacentrids, Amphiprion melanopus and Amphiprion sp. (clownfishes), were recorded along the upper edge of the lagoon slope. Both species were associated with expansive and irregularly shaped 0.3- to 0.5-m-diameter colonies of kelly-green and gray-green anemones (Heteractis sp.).

A large school of unidentified sardines (family Clupeidae) was recorded over the upper lagoon slope at the end of transect 1a, but this species was not observed elsewhere in the bay.

Apoogonids were also abundant, but their cryptic behavior (generally residing within the branches of foliose corals) made taxonomic identification problematic and enumeration impossible. A total of seven apogonid species (including three unidentified species) were recorded. It is likely that the actual number of apogonid species could exceed that of other families. The apogonid Cheilodipterus quinquelineatus was ubiquitous along all transects.

The wrass Halichoeres hoeveni was common along all transects and Serranus bandanus was locally common in schools of 10 to 30 individuals in the vicinity of transects 1a and 1c.

A single barracuda (Sphyraena barracuda) was observed over the upper lagoon slope beyond the terminus of transect 1b. This was the largest fish observed in the study area.

Overall, fish diversity in the vicinity of transects 1a, 1b, and 1c represented a fairly typical cross-section of families and species that would be expected to occur in shallow inshore waters lacking seagrass beds. No especially rare or unusual families or species were observed.
Table 4 Checklist of fish.

<table>
<thead>
<tr>
<th>Genus/species</th>
<th>Transect no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acanthuridae (surgeonfishes)</td>
<td>1a 1b 1c 2a 2b 2c 3 4</td>
</tr>
<tr>
<td>Acanthus lineatus</td>
<td>x x x x x x</td>
</tr>
<tr>
<td>Acanthus nigrofuscus</td>
<td>x x x x x x</td>
</tr>
<tr>
<td>Acanthus tennegus</td>
<td>x</td>
</tr>
<tr>
<td>Acanthus xanthopterus</td>
<td>x x x x x</td>
</tr>
<tr>
<td>Acanthus sp. (juveniles)</td>
<td>x</td>
</tr>
<tr>
<td>Nebi litturus</td>
<td>x</td>
</tr>
<tr>
<td>Nebi unilaminis</td>
<td>x</td>
</tr>
<tr>
<td>Ctenochaetus striatus (Quoy &amp; Gaimard)</td>
<td>x x x x x</td>
</tr>
<tr>
<td>Ctenochaetus sp. (juveniles)</td>
<td>x</td>
</tr>
<tr>
<td>Apogonidae (cardinalfishes)</td>
<td>x</td>
</tr>
<tr>
<td>Chelodipterus lineatus</td>
<td>x</td>
</tr>
<tr>
<td>Chelodipterus quinquefasciatus</td>
<td>x</td>
</tr>
<tr>
<td>Niacinus nemipterus</td>
<td>x x</td>
</tr>
<tr>
<td>Unident. apogonid sp. 1</td>
<td>x</td>
</tr>
<tr>
<td>Unident. apogonid sp. 2</td>
<td>x</td>
</tr>
<tr>
<td>Unident. apogonid sp. 3 (yellow)</td>
<td>x</td>
</tr>
<tr>
<td>Atelinaeidae (silversides)</td>
<td>x</td>
</tr>
<tr>
<td>Unident. atelines</td>
<td>x x x</td>
</tr>
<tr>
<td>Balistidae (triggerfishes)</td>
<td>x</td>
</tr>
<tr>
<td>Rhinecanthus scutatus</td>
<td>x</td>
</tr>
<tr>
<td>Rhinecanthus verrucosus</td>
<td>x</td>
</tr>
<tr>
<td>Bliennidae</td>
<td>x</td>
</tr>
<tr>
<td>Cirriceps sp.</td>
<td>x</td>
</tr>
<tr>
<td>tetramichthys sp. 1 (white spot)</td>
<td>x x</td>
</tr>
<tr>
<td>Melacanthis gnomotis</td>
<td>x x x</td>
</tr>
<tr>
<td>Unident. benny sp. 1 (green/grey)</td>
<td>x</td>
</tr>
<tr>
<td>Unident. benny sp. 2 (green)</td>
<td>x x x</td>
</tr>
<tr>
<td>Unident. benny sp. 3 (blue/green)</td>
<td>x</td>
</tr>
<tr>
<td>Carangidae (jacks, trevally)</td>
<td>x</td>
</tr>
<tr>
<td>Caranx melampygus (juveniles)</td>
<td>x</td>
</tr>
<tr>
<td>Chaetodontidae (butterflyfishes)</td>
<td>x</td>
</tr>
<tr>
<td>Chaetodon ephippium</td>
<td>x x x</td>
</tr>
<tr>
<td>Chaetodon melapterus</td>
<td>x x x</td>
</tr>
<tr>
<td>Chaetodon semilarvatus</td>
<td>x</td>
</tr>
<tr>
<td>Chaetodon vagrans</td>
<td>x x</td>
</tr>
<tr>
<td>Chaetodon sp. (juveniles)</td>
<td>x x x</td>
</tr>
<tr>
<td>Cirrhitidae (jawfishes)</td>
<td>x</td>
</tr>
<tr>
<td>Paracirrhites forsteri</td>
<td>x</td>
</tr>
<tr>
<td>Cephalopholis (squirrelfishes)</td>
<td>x</td>
</tr>
<tr>
<td>Urident. sardines</td>
<td>x</td>
</tr>
<tr>
<td>Gobiidae (gobies)</td>
<td>x</td>
</tr>
<tr>
<td>Amblygobius sp.</td>
<td>x x x</td>
</tr>
<tr>
<td>Amblygobius abnormatus</td>
<td>x</td>
</tr>
</tbody>
</table>

Table 4 (continued).

<table>
<thead>
<tr>
<th>Genus/species</th>
<th>Transect no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Holocentridae (squirrelfishes)</td>
<td>1a 1b 1c 2a 2b 2c 3 4</td>
</tr>
<tr>
<td>Flammeo sammara</td>
<td>x</td>
</tr>
<tr>
<td>Unident. holocentrids</td>
<td>x</td>
</tr>
<tr>
<td>Labridae (wrasses)</td>
<td>x x x x x x</td>
</tr>
<tr>
<td>Halichoeres hortulanus</td>
<td>x</td>
</tr>
<tr>
<td>Halichoeres argenteus</td>
<td>x</td>
</tr>
<tr>
<td>Halichoeres trimaculatus</td>
<td>x</td>
</tr>
<tr>
<td>Halichoeres sp. (juveniles)</td>
<td>x</td>
</tr>
<tr>
<td>Tetraodon lineatus</td>
<td>x x x x</td>
</tr>
<tr>
<td>Tetraodon nigrovittatus</td>
<td>x x x</td>
</tr>
<tr>
<td>Totai species</td>
<td>28 31 30 31 23 16 13</td>
</tr>
</tbody>
</table>

* Not observed on transect.
3.2.1.4 Macroinvertebrates

The most conspicuous non-coral macroinvertebrate recorded in the study area was *T. crocea*, which was ubiquitous to all transects (Table 5). This coral-embedding clam inhabits the upper horizontal surfaces of massive and submassive *P. lutea* colonies, and is occasionally found in fossil reef limestone. This clam is characterized by brightly colored mantle tissue derived from symbiotic algae, often in near-fluorescent shades of blue, blue-green, and purple. Fourteen clams were counted in one large *P. lutea* colony, with a resultant estimated density of about 28/m². The mussel *SIPHONIUM BILocularis* and the oyster *Pedom spondyloideum* often occurred in the same coral head with *T. crocea*. Whereas *T. crocea* lives largely off food products produced by symbiotic zooxanthellae that reside in mantle tissue, both *S. bilocularis* and *P. spondyloideum* are filter feeders that live entirely embedded in *P. lutea* and occasionally in fossil limestone. *Lopha cristagalli*, a small, embedding oyster with a very sharp and irregular aperture, was occasionally seen in some coral heads.

Two individuals of the giant clam *Tridacna squamosa* were observed at the upper edge of the lagoon slope zone past the terminus of transect Ic. These clams represent popular local delicacies. The presence of this clam in relatively shallow water indicates that the island is not often used for reef gleaning by day picnickers.

The edible rock oyster *Saxifraga mordax* was also common throughout both the upper and mid-intertidal zones, where it lives attached to the bottom strata or on the vertical sides of boulders and rocks. Densities of between 2 and 22/m² were recorded in several 1-m² quadrats roughly laid out along transects la and lc. Numerous small snails (*Littorina* sp. and *Nerita* sp.) and an unidentified limpet (*Patella* sp.) were common on rocks and crevices in the upper intertidal and supratidal zones. Unidentified cerithiid snails (family *Cerithidae*) and snail shells occupied by unidentifiable hermit crabs composed the dominant fauna of the rocky high intertidal zone. An unidentified barnacle (family *Cirripedia*) was also common attached to rocks in the high and mid-intertidal zones.

The largest non-coral invertebrate observed in the study area was the coral-eating sea star *Acanthaster planci*. A single individual was recorded near transect Ia. This individual was approximately 0.5 m in diameter. Other sea stars recorded in the study area included *Caltia novaeguineae* (three recorded), the brilliant blue *Linckia laevigata* (two recorded), and *Linckia*. Continued.
Echinoids (sea urchins) observed in the study area included the black, long-spined Diadema savignyi, and the burrowing Echinometra mathaei.

Holothurians (sea cucumbers) were generally uncommon in the area, a finding that no doubt reflects the lack of extensive sand or coral rubble deposits in the study area. However, three species were recorded, including Holothuria atra, H. edulis, and Stichopus sp. All three species were associated with narrow, sandy troughs between coral heads and small pockets of coral rubble.

The didemnid (not an invertebrate, but a member of the Phylum Chordata, Class Asciidiacea) Diadema mola was a conspicuous feature along all transects and was abundant along the upper lagoon slope zone in the vicinity of each transect.

3.2.2 Transects 2a, 2b, and 2c

Study area 2 was located in a small, roughly 50-m-wide embayment on the southwest side of Ngerur Island (Plates 4, 5, and 6, Figure 3). The site was selected as a survey location on the basis of its potential use as a barge landing area where a ramp would be constructed to provide heavy equipment access to the island. Following land-based construction, it has been proposed that the bay's intertidal reef flat be converted into a dive "grotto." The grotto would be excavated on the intertidal reef platform to create a permanently subtidal basin within which corals and other benthic species would be planted and maintained as a resort amenity for snorkelers.

The most conspicuous physical attribute of the bay is a massive, roughly 65-m-long by 7- to 11-m-wide, elevated basalt outcrop that runs roughly parallel to the shoreline and partially exposes during low-tide periods. The exposed section of the outcrop is not populated by epibenthic organisms. During moderate to low-tide periods this somewhat linear outcrop creates a surge-protected rocky intertidal basin on its landward (east) side.

Figure 4 depicts the physical substrate encountered along transects 2a, 2b, and 2c. Despite the small size of the bay, physical and biological conditions differed between the bay's south and north sides. In particular, coral development is significantly greater along transects 2a and 2b as contrasted with transect 2c. Transects 2a and 2c were limited in length to about 46 m by the barrier imposed by the aforementioned basalt outcrop. Roving surveys were, however, conducted south (lagoonward) of the outcrop.

Table 5 (continued).

<table>
<thead>
<tr>
<th>Taxon</th>
<th>Genus/Species</th>
<th>Transect no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asterioidea (sea stars)</td>
<td></td>
<td>1a 1b 1c 2a 2b 2c 3 4</td>
</tr>
<tr>
<td>Acanthaster planulatus</td>
<td></td>
<td>x  x  x  x  x  x</td>
</tr>
<tr>
<td>Culcida novaquemae</td>
<td></td>
<td>x  x  x  x  x  x</td>
</tr>
<tr>
<td>Linckia guineae</td>
<td></td>
<td>x  x  x  x  x  x</td>
</tr>
<tr>
<td>Luckia laevigata</td>
<td></td>
<td>x  x  x  x  x  x</td>
</tr>
<tr>
<td>Echinoidae (sea urchins)</td>
<td></td>
<td>x  x  x  x  x  x</td>
</tr>
<tr>
<td>Diadema savignyi</td>
<td></td>
<td>x  x  x  x  x  x</td>
</tr>
<tr>
<td>Echinometra mola</td>
<td></td>
<td>x  x  x  x  x  x</td>
</tr>
<tr>
<td>Holothuridae (sea cucumbers)</td>
<td></td>
<td>x  x  x  x  x  x</td>
</tr>
<tr>
<td>Holothuria atra</td>
<td></td>
<td>x  x  x  x  x  x</td>
</tr>
<tr>
<td>Holothuria edulis</td>
<td></td>
<td>x  x  x  x  x  x</td>
</tr>
<tr>
<td>Holothuria chloronotus</td>
<td></td>
<td>x  x  x  x  x  x</td>
</tr>
<tr>
<td>Holothuria (Thymioscylla) hirsuta</td>
<td></td>
<td>x  x  x  x  x  x</td>
</tr>
<tr>
<td>Stichopus sp.</td>
<td></td>
<td>x  x  x  x  x  x</td>
</tr>
<tr>
<td>Ophiuridae (brittle stars)</td>
<td></td>
<td>x  x  x  x  x  x</td>
</tr>
<tr>
<td>Ophiotrix sp.</td>
<td></td>
<td>x  x  x  x  x  x</td>
</tr>
<tr>
<td>Didemnidae</td>
<td></td>
<td>x  x  x  x  x  x</td>
</tr>
<tr>
<td>Didemnum mola</td>
<td></td>
<td>x  x  x  x  x  x</td>
</tr>
<tr>
<td>Didemnum sp. 1 (orange)</td>
<td></td>
<td>x  x  x  x  x  x</td>
</tr>
<tr>
<td>Didemnum sp. 2 (olive green)</td>
<td></td>
<td>x  x  x  x  x  x</td>
</tr>
<tr>
<td>Unident. colonial ascidian</td>
<td></td>
<td>x  x  x  x  x  x</td>
</tr>
<tr>
<td>Total species</td>
<td></td>
<td>25 18 20 22 21 16 12</td>
</tr>
</tbody>
</table>

* In freshwater pool on beach, not on transect.
Ngerur Island Baseline Marine Survey

The north and south side of the bay is delimited by rocky basalt headlands. Between the headlands is a rocky beach and a vertical to near-vertical basalt cliff. The bay lacks a sand beach, though small sand deposits occur as a mostly thin veneer on or between rocks and cobbles in the intertidal zone. A large, rusted, World War II-era projectile, about 20 cm in diameter, was observed in the high intertidal zone at the south end of the bay (Plate 7). The position of the projectile atop the intertidal bench and the absence of attached organisms suggest that it may have been placed there during recent human activity on the island.

3.2.2.1 Coral

The coral community associated with transects 2a, 2b, and 2c was composed of 21 scleractinian coral species (excluding milleporids, zooanthids, and acyclonids) (Table 2). *P. lutea* was the dominant species on all transects, and was composed of micro-atoll and small nodular growth forms in the low intertidal zone, grading to massive and submassive colonies in subtidal areas and across the reef margin and lagoon slope zones. Other abundant species, often represented in expansive colonies or outcrops up to 2 m across, included *P. andreewsi*, *P. (S.) compressa*, *M. lobulata*, *M. digitata*, and *P. rus*. Coral coverage ranged from zero in the high intertidal zone, to an estimated 80 percent on the reef margin and upper lagoon slope zones.

The pocilloporid *P. damicornis* was also common along all transects, with perhaps 20 percent of the colonies demonstrating evidence of bleaching. Fungiid corals were also common, with three species, two of which were unidentified, recorded. The zooanthid *P. tuberculosa* (not a true coral) was also of common occurrence across the low intertidal zone, with densities of up to 51m² recorded on shallow, rocky substrata.

Other less common corals observed included scattered colonies of *Alveopora* sp., *Favia speciosa*, *Lobophyllia hemprichii*, and *P. lamellina*.

An estimated 95 percent of all *Sinularia* sp. and *Sarcophyton* sp. observed appeared moribund or dead, with some colonies demonstrating evidence of decomposition. The apparent death of this soft coral community is likely the result of thermal injury associated with the 1998 ENSO event.

3.2.2.2 Algae

The flora of the intertidal reef platform in study area 2 was similar in species composition to that recorded in study area 1, except that *E. deusta* and *Correllinaeaceae* sp. were not observed (Table 3). The cyanophyte community was dominated by *M. lyngbyaceus* and *Schizorhix* sp., which together created a slippery, silt-retaining film across the limestone pavement and upon basalt rocks and cobbles.

The green filamentous algae *E. clathrata* was recorded on transect 2b in small upright tufts, but was not recorded on either of the remaining two transects. This species is, however, grazed upon by herbivorous fish and invertebrates and is often difficult to discern when closely cropped. *H. opuncia* and a second unidentified *Halimeda* species were also recorded in the reef margin and upper lagoon slope zone. Both species were found in coral thickets and in areas of coral and coralline-algae rubble.

*T. ornata* was the most frequently encountered brown algae, followed by occasional patches of *Padina* sp., and *Synacyclus tribuloides*. Overall algal density was low. *T. ornata* was observed in the lower intertidal and reef margin zones. *Padina* sp. frequently demonstrated a sickly, flaccid appearance, suggesting old growths or perhaps thermal stress.

Red algae were not abundant. Represented species included *Polysiphonia scopularum* and *H. reinholdii*.

3.2.2.3 Fish

Forty-five species of fish representing 16 families were recorded along or in the vicinity of transects 2a, 2b, and 2c (Table 4). Pomacentrids accounted for the greatest number of species (11), followed by acanthurids (7), apogonids (4), chaetodontids (4), and labrids (4). As reported in Section 3.2.1.3, apogonids may represent the most diverse family, as well as the most abundant species, but their small size and cryptic behavior, combined with the near-transparency
of some species, makes them difficult to accurately identify and enumerate within dense coral thickets where they are typically found.

The pomacentrids *A. coelestes* and *A. sordidus* were abundant on all transects, as were *C. caerulea*, juvenile, *C. cyanus*, and two species of juvenile *Pomacentrus* (*Pomacentrus* sp. 1 and *Pomacentrus* sp. 2). *C. cyanus* and *Pomacentrus* sp. 1 and 2 were always recorded in assemblages of 50 to an estimated 150 individuals hovering over or atop large foliaceous corals within the reef margin and upper lagoon slope zones. Several anemone-associated clownfish (*Amphiprion* sp.) were observed within an aggregation of small anemones on the upper lagoon slope zone near transect 2c. The black-and-white-striped pomacentrid *Dasycyllus auratus* was recorded on transect 2b and was not observed elsewhere around the perimeter of the island. Eight individuals representing at least two or possibly three age classes were recorded around a single *P. damicornis* colony.

Wrasse were also abundant on all transects, with *H. hoeveni* and *S. bandanensis* recorded from the intertidal zone to well down the lagoon slope zone. Several large (200 to 300 individuals) roving schools of juvenile wrasses (*Thalassoma* sp.), all of the same age class, were recorded along each of the study transects.

At least two species of unidentified juvenile parrotfishes (scarids) were recorded in the study area. This was the only record of parrotfish observations around the Ngerur Island during this survey.

Other species recorded in the area, but not observed in other study sites, include the haistid *Rhinecanthus aculeatus*, *Cheilodipterus sp.* (dark with horizontal stripes), an unidentified blenny, *Chaetodon ephippium*, the hawkfish *Paracirrhites forsteri*, the angelfish (family Pomacentridae) *Pygoffis dusianthus*, and the pomacentrid *Pomacentrus pavo*.

### 3.2.2.4 Macroinvertebrates

A total of 30 macroinvertebrate species were recorded along transects 2a, 2b, and 2c, or during roving surveys conducted in the vicinity of the bay (Table 5). The number of species observed and enumerated was comparable between transects and was not unlike the species checklist for study area 1, which demonstrated similar physical environmental conditions (e.g., broad intertidal reef platform and a southerly exposure).
The most distinctive biological feature of study area 3 is a 20-m-wide stand of the white mangrove *Sonneratia alba*, which forms a near complete vegetative canopy, some 20 m deep, along the shoreline's supratidal zone and across portions of the intertidal zone (Plate 10). *S. alba* pneumatophores (breathing organs), averaging an estimated 30 cm in height above the rocky substratum are conspicuous features of the rocky intertidal zone and extend approximately 35 m lagoonward (east) from the shoreline cliff and about 15 m beyond the edge of the vegetative canopy. Unlike the more wind- and wave-protected coastline on the adjacent Ngerekebesang Island, water currents and small, wind-generated chop appear to minimize mangrove leaf litter deposition beneath the tree canopy. However, organic material derived from mangrove leaf litter could account for the low DO readings associated with the apparent depositional area described in section 3.1.3. Lagoon water-current patterns observed (not measured) during the survey period indicated a pronounced southerly flow that could result in the transport of leaf litter from the mangrove stand to the area where dark, anoxic, detrital deposits were observed.

A second biological feature associated with this study site is a distinct zone of alcyoniid corals, which were visible from the surface during the survey period, as well as in a color aerial photograph taken some months (date unknown) before the survey period (Figure 1). This zone occurs between 50 and 60 m east of the shoreline cliff, as measured by transect analysis. Although the undated aerial photograph depicts a distinct band of gray-colored soft corals against a contrasting white sand and coral rubble substrate, this same zone was yellow to yellowish-white during the survey period. This is believed to be the result of the apparent earlier expulsion of symbiotic zooxanthellae from the majority of the corals observed, suggesting that expulsion of zooxanthellae was recent and that coral polyps were still viable. An estimated 95 percent or more of the soft coral in this zone was dead and fragmenting, with some colonies showing evidence of being in an advanced stage of decomposition. In some areas, however, an isolated, normally pigmented, and healthy-appearing colony of either *Sinularia* sp. or *Sarcophyton* sp. was occasionally observed. The near complete destruction of these species is likely the result of above-normal water temperatures associated with the 1998 ENSO event.

As reported above, the near-total decimation of the soft coral zone, presumably the result of high water temperatures, was both interesting and disturbing. Aside from the near-total death and decay of this roughly 10-m-wide community, the majority of the soft corals found along the remainder of the 100-m transect also appeared dead, and many showed evidence of advanced decay. Coverage of dead and decaying alcyoniid corals accounted for an estimated 3 to 5 percent coverage.

Eleven species of scleractinian corals (excluding alcyoniids and zooanthids) were recorded on or around transect 3 (Table 2). Micro-atoll and nodular growth forms of *P. lutea* formed a conspicuous zone between the 60- and 80-m transect intervals, and occasionally intermixed with *P. andrewsi*, low robust colonies of *P. (S.) convexa, M. lobulata*, and sometimes expansive patches of coral rubble and sand. An estimated 15 percent of all observed *P. lutea* colonies had a bleached appearance and it was not unusual to see bleached individuals between otherwise healthy in appearance, robust, normally pigmented (yellow-green, brownish-green) colonies.

The small, foliose coral *P. damicornis* was common in scattered patches between the 70- and 90-m transect intervals, though an estimated 80 percent of all colonies recorded appeared bleached. However, there was no evidence of epiphytic algae or other fouling organisms on any of the corals observed, suggesting that expulsion of zooxanthellae was recent and that coral polyps were still viable.

Two species of fungiid corals were abundant (a total of 34 individuals recorded) in areas of coral rubble on or in the vicinity of transect 3. Both *F. echinata* and a second unidentified species (*Fungia* sp. 1) frequently displayed a yellowish-green coloration that is atypical for the genus. It is assumed that the yellow pigmentation is a direct consequence of the expulsion of zooxanthellae as a result of thermal stress. Other than the unusual pigmentation, all of the individuals appeared healthy and no evidence of epiphytic algae growth on any of the colonies was observed.

**3.2.3.2 Algae**

Algae were poorly represented on or around transect 3 (Table 3). Only two species were recorded and neither was abundant. *H. opuntia* occurred in occasional patches among areas of...
coral rubble and live coral and an unidentified coralline algae (recorded as Corallinaceae sp.) was occasionally observed between transect intervals of 55 and 70 m. The blue-green algal film characteristic of other intertidal or subtidal reef flats on the west side of the island was not observed in the vicinity of transect 3. However, this often ubiquitous mixed-species film could have been occluded by a sandy-silt veneer that was evident between the shoreline and about the 55-m transect interval.

3.2.3.3 Fish

Only 16 species of fish were recorded along transect 3 and in the course of roving surveys conducted in the general area (Table 4). Overall, the reef flat fish population could be regarded as sparse compared to similar habitats elsewhere around the perimeter of Ngerur Island, where nearly twice the number of species were recorded. Not only was the number of fishes recorded unusually small, but the population size for the represented species was also very low. A total of only 56 individual fishes were recorded in the course of diver surveys in this area.

Represented fishes included acanthurids (two species), apogonids (two species), atherinids (one species), balistids (one species), blennids (one species), chaetodontids (one species), gobiids (one species), holocentrids (two species), labrids (one species), and pomacentrids (four species).

There is no apparent or otherwise observable reason for the small number of species and individuals recorded in study area 3, other than the presence of extensive stands of decaying soft corals and bleached scleractinian corals. It is possible that the decaying soft corals, or intermediate decomposition products thereof, produce some type of toxic, inhibitory, or otherwise offensive chemical substance that reef fishes avoid by relocating, at least temporarily, elsewhere.

3.2.3.4 Macroinvertebrates

The turbinid snails Littorina sp. and Nerita sp. were common on large rocks and boulders in the high intertidal zone and were occasionally observed attached to S. alba pneumatophores (Table 5). Compared to the west side of the island, their densities were considerably lower. This observation may reflect reduced primary production resulting from tree shading across much of the supratidal and high intertidal zone in study area 3. Both Littorina sp. and Nerita sp. are herbivores and shading by S. alba could reduce the abundance of epiphytic algae upon which these small snails graze.

Coral and limestone-embedding mollusks were the dominant and largest macroinvertebrates in study area 3. T. crocea, S. bilocularis, P. spondyloideum, and L. cristagalli were abundant in many P. lutea coral heads, but often absent in other colors of the same species. Many of the T. crocea colonies demonstrated unusually pale mantle tissue, which may be the result of thermal stress or injury to the clam or to their symbiotic zooxanthellae. Zooxanthellae are responsible for imparting the fluorescent color to clam mantle tissue. This observation is qualitative and does not lend itself to quantification. Nonetheless, the difference in mantle tissue coloration was distinctive between clams observed along this transect as contrasted with clams recorded on the west side of the island.

The rock oyster S. mordax was abundant in the high and mid-intertidal zone, where it lives attached to rocks, dead coral, and bottom strata. Three dead cowries (Cypraea moneta) were also noted. This was the only record of this small cowrie around the perimeter of the island during this survey.

The sabellid worm Sabellastarte indica was recorded in two locations within coral thickets between the 80- and 85-m transect interval, as was a second unidentified sabellid.

Single individuals of the sea stars L. laevigata and L. guildingi were observed in a zone of coral rubble, as were the holothurians H. atrum, H. (Thymoscyza) hilla, and Stichopus sp.

Two ascidians were also common in coral thickets. D. molle was ubiquitous in coral areas along the transect, as was an especially common unidentified colonial ascidian that was observed growing attached to rock and dead P. lutea.

3.2.4 Transect 4

Study area 4 is located off the southeast side of Ngerur Island and is distinguished by relatively deep water and the absence of an intertidal or subtidal shelf or reef flat platform (Figure 3). This site has been conceptually identified as a proposed location for a dive master pavilion, arrival plaza, marina, and cargo operations center for the proposed resort.
Water depths during the survey period ranged from about 3 m immediately adjacent to the shoreline, to at least 20+ m deep about 120 m southeast of the shoreline. Coverage of live and dead coral is about 95 percent throughout the study area (Plates 11 and 12). Nearshore coral composition at this location was more typical of what would be expected within a lagoon reef margin community. Roving surveys conducted in the area indicated that this zone of high coral coverage extended several hundred meters south (toward the small, unnamed, rocky islet hosting a single coconut palm), forming a somewhat linear and continuous lagoon reef.

The intertidal zone at this location is composed of a vertical to undercut solid basalt wall, roughly 4 m in height, extending into unconsolidated lagoon sediment and coral outcrops dominated by massive *P. lutea* and *P.(S.) convexa*. Except for occasional, widely scattered barnacles and small patches of turf algae, the submarine cliff was mostly devoid of epibenthic biota.

### 3.2.4.1 Coral

Nine species of scleractinian corals were recorded in study area 4. The number of corals recorded is smaller than that enumerated along other study transects around Ngerur Island. However, this result is a function of the high coral density that composes the reef margin community. Coral coverage throughout the area is about 95 percent. This study area is dominated by a dense assemblage of massive corals, particularly *P. lutea*, *P.(S.) convexa*, and *P. andrewsi*, as contrasted with shallow-water subtidal communities found elsewhere along the perimeter of the island, where there is a preponderance of smaller submassive corals, *P. lutea* micro-atolls, greater vertical relief, and patches of coral rubble that can accommodate small, pioneer coral species. Thus there are fewer niches available for coral growth in this study area as contrasted with other study sites around the perimeter of Ngerur Island.

This site was also distinguished by the near-complete death of all represented alcyoniid corals and near-100 percent bleaching of all recorded *P. damicornis* colonies. Bleaching of many massive and submassive *P. lutea* colonies was evident throughout the study area, with bleached individuals accounting for an estimated 15 percent of surface-area coverage. The soft corals *Sinularia* sp. and *Sarcophyton* sp. appeared to have suffered near-complete destruction, with most individuals observed demonstrating evidence of being in an advanced stage of decomposition. Although bleached colonies of *P. damicornis* and *P. lutea* were commonly observed, none showed evidence of epiphytic algae or sponge growth on bleached tissues, suggesting that the coral polyps were alive during the study period. However, the long-term fate of the bleached corals remains uncertain.

### 3.2.4.2 Algae

Algae were uncommon and were not conspicuous in any of the areas surveyed. Small patchy growths of *H. opuntia* were occasionally noted, as was *V. ventricosa* and tufts of an unidentified whitish-pink coralline algae (identified as *Corallinaceae* sp. in Table 3).

### 3.2.4.3 Fish

Only 13 species of fish were recorded during surveys conducted in study area 4, and few of these were represented by more than a few dozen individuals (Table 4). This low census is inexplicable, given the extent of live coral coverage and the presence of otherwise diverse coral and coral rubble habitats throughout the study area.

Represented families included acanthurids (four species recorded), apogonids (one species recorded), chaetodontids (one species recorded), holocentrids (one species recorded), labrids (one species recorded), and pomacentrids (five species recorded) (Table 4). Pomacentrids were represented by *C. cyanea*, two unidentified juvenile *Chromis* sp. (*Chromis* sp. 1 and 2), *Dascyllus aruanus*, and a single school of an unidentified blue juvenile pomacentrid which was observed hovering above two separate, large-branching *Montipora* coral heads.

Acanthurids were represented by *A. lineatus*, *A. nigrofuscus*, *A. xanthopterus*, and *C. striatus*, all of which were recorded in small, roving, monotypic to sometimes mixed schools of 3 to 11 individuals.

There was no readily apparent explanation for the few fish recorded in the study area other than the presence of dead and decomposing stands of alcyoniid corals and bleached hard corals (as was previously described for study area 3).
3.2.4.4 Macroinvertebrates

Only 12 macroinvertebrate species were recorded in study area 4, or about half the number of species recorded along other transects or within other study areas around Ngerur Island (Table 5). This low diversity probably reflects both the expansiveness and morphology of the live and dead corals composing the lagoon reef margin community and the resulting low habitat diversity. Macroinvertebrates normally associated with intertidal and shallow, subtidal reef flats, sandy basins, and coral rubble habitats were therefore not represented within this expansive and mature coral community. This observation does not take into account cryptic species residing within the dense coral matrix, which are impossible to identify without destroying the coral community.

Coral-embedding mollusks were the dominant macroinvertebrates and were recorded in moderate densities of up to 11/m² in massive and submassive P. lutea coral heads, and occasionally in areas of exposed fossil reef limestone. T. crocea was conspicuous as a result of their colorful exposed mantle tissue, though in some sites the colors were subdued and atypical of the fluorescent hues that are often associated with this species. This same observation was also made in study area 3. As was reported in Section 3.2.3.4, this may be the result of thermal stress or injury, though reduced or faded coloration in clam mantle tissue was not apparent in study areas on the west side of the island. Other coral-embedding species observed included S. bilocularis, P. spondyloideum, and L. cristagalli. The rock oyster S. mordax was occasionally observed along the shoreline's vertical basalt ledge, but was not common.

Other macroinvertebrates recorded in the study area included two species of unidentified encrusting sponges, sabellid worms (family Sabellidae), the sea stars C. novaguineae and L. laevigata, the holothuroids H. atra and Stichopus sp., and the didemnid D. molle.

4.0 DISCUSSION

4.1 WATER QUALITY

With the exception of temperature, water quality parameters were generally within the expected ranges for coastal lagoon waters in the equatorial western Pacific Ocean.

Water temperatures ranged from 30.4 to 31.1°C, with a mean temperature of 30.7°C recorded for all stations. Although seasonal changes in water temperature are experienced in Palau, water temperatures are normally in the range of 27.5 to 29.9°C based on the results of water temperature analyses conducted over the past 22 years. A mean temperature of 28.3°C characterized lagoon waters on January 9, 1976, at the site of the then-proposed sewage outfall at the south side of Malakal Island (Birkeland et al. 1976). A mean temperature of 29.9°C characterized coastal marine waters on November 24, 1977, in waters fronting what is now Palau Pacific Resort (PPR) (Randall et al. 1978). A mean temperature of 29.6 and 29.8°C characterized lagoon waters fronting PPR on January 22, 1990, and September 22-23, 1992, respectively (Brewer/Brandman Associates 1990). Water temperatures recorded during the September 1998 survey averaged at least 1°C above normal ambient lagoon water temperatures.

Anecdotal reports from several sources (Coral Reef Research Foundation [CRRF] staff; Larry Sharron, Belau Aquaculture) contacted during the field survey period indicated that Palau experienced water temperatures up to 33°C (91°F) in early September 1998. This temperature was recorded in Malakal Harbor and at sites in ocean passes at depths exceeding 30 m. Temperature data recorded during the surveys suggest that lagoon water temperatures were still under the influence of the ongoing ENSO event.

Salinity values ranged from 30.5 to 32.0 ppt (excluding station 5). Salinity readings of 32.0 ppt were recorded at sampling stations on the east, north, and west sides of the island and do not appear to be location-dependent. A mean salinity value of 31.0 ppt was calculated for all stations. The salinity values are somewhat lower than would normally be expected. By comparison, a mean salinity value of 32.3 ppt was recorded on January 9, 1976, at the then-proposed site of the Malakal sewage outfall in Malakal Channel (Birkeland et al. 1976). A mean salinity value of 33.0 ppt was recorded on November 24, 1977, in coastal waters fronting what is now PPR (Randall et al. 1978). Salinity readings demonstrated a mean value of 34.0 ppt.
in lagoon waters fronting PPR on January 22, 1990, and a mean of 32.5 ppt on September 22-23, 1992 (Brewer/Brandman Associates 1990; MBA International 1992). Thus, prevailing ENSO drought conditions, and a presumed reduction in surface- and groundwater runoff, do not appear to have produced any corresponding increase in lagoon salinity in surface waters around Ngerur Island.

DO concentrations were low and ranged from 4.7 to 6.1 ppm (excluding station 5). Percent DO saturation ranged from 75 to 98 percent and appear to reflect a range more or less typical of lagoon surface waters.

As was described in the results section, a DO reading of 0.2 ppm was recorded in a confined area adjacent to the southeast side of the island. Such low readings are consistent with a depositional zone characterized by organic enrichment from terrestrial or lagoon sources.

Turbidity readings ranged from 0.7 to 140 NTU. The mean turbidity value for all stations was 1.0 NTU (N=12). Turbidity readings demonstrated a mean value of 0.3 NTU (N=4) on September 26 during a period of no rainfall, and a mean of 0.82 NTU (N=8) on September 27, a period of very heavy rainfall and rainfall runoff. These data suggest that in its undeveloped state, the vegetation cover of the island is effective in retaining silt and sediment that might otherwise run off into coastal waters.

pH values ranged from 7.7 to 8.0 pH units. All 12 samples were within Palau’s water quality standards for Class AA, A, and B waters.

4.2 BIOTA

Coral species are the most important organisms in the community structure of shallow-water habitats in tropical and subtropical oceans and lagoons worldwide. Reef-building corals (including scleractinian, octocorallian, and hydrozoan corals) are sessile organisms with potentially long life spans and distribution patterns that depend upon the particular environmental setting found from one habitat to another. Their calcium carbonate skeletons are major contributors to both in situ framework and detrital reef deposits in shallow-water fringing reef environments, the remnants of which are found in the vicinity of the proposed project site.

Characteristic coral communities develop in response to variable environmental conditions in different habitats. These conditions may range from unfavorable to optimum conditions, in which corals are the dominant organisms in the community. Corals are sensitive to many environmental variables, including suspended materials in the water column, sediment accumulation on the substrate upon which they grow, water currents, seawater dilution from surface drainage and groundwater discharge, temperature fluctuations, exposure during low tides, and pollution from toxic substances and thermal, storm drain, and sewage discharges (Randall 1990).

Assessment of the status of coral communities (and coral-associated biota) on the subtidal habitats fronting Ngerur Island has indicated the existence of a stressed benthic community. Coral bleaching and the apparent decline in coral health appears to be the result of the 1998 ENSO event, which may have produced water temperatures debilitating and perhaps lethal to corals and other benthic species. It is uncertain at this time whether the bleached corals will survive or if overall coral diversity will be reduced, at least in the near term. Future monitoring surveys should be conducted to ascertain the long-term status of the affected coral communities.

A total of 39 coral, 72 fish, 15 algal, and 43 macroinvertebrate species were recorded in the course of baseline marine surveys conducted in inshore waters around Ngerur Island. These numbers compare with 163 corals, 66 fish, 33 algae, and 13 large, noncoral invertebrate species recorded on the reef flat and lagoon slopes in January 1976, at the then-proposed marine outfall site adjacent to the southern tip of Malakal Island (Birkeland et al. 1976).

As an additional comparison, a cumulative total of 159 coral species were recorded from disturbed and undisturbed reef flat platform, channel margin, and upper channel slope zones near the Toachel Mid near Ngesal, on the east side of Koror Island (Randall 1990). Although demonstrating high coral biodiversity, physical environmental conditions in the vicinity of Ngesal are different from those at Ngerur Island, and the latter site did not have any significant seagrass or mangrove development. Any comparison of community structure or composition between these two sites would not be entirely relevant. A taxonomic inventory of the fish fauna associated with the Ngesal area accounted for at least 253 species (Myers 1991).

The existing ENSO drought and high water temperatures may account in part for the few fish and macroinvertebrates recorded at the Ngerur Island site, though this event would not have affected the abundance or distribution of represented corals. Drought conditions and assumed low surface- and groundwater runoff could pose a limiting factor governing the presence,
distribution, and abundance of algae, and directly or indirectly affect fish and other organisms depending on primary production.

In general, coral community structure, diversity, and coverage in waters fronting the project site reflect a species composition that would be expected to occur on shallow, lagoon reef flats. These communities are dominated by hardy, robust, and relatively sediment-tolerant massive, submassive, and columnar corals, interspersed with occasional colonies of small foliaceous species.

The impact of the warm ENSO water temperatures may eventually be reflected in the amount of live versus dead coral near Ngerur Island. Clearly, many of the hard corals were stressed and many appeared moribund. It is uncertain at this time whether these corals will survive. The fate of the soft-coral community is perhaps more precarious. An estimated 95 percent of the Sinularia and Sarcophyton appeared dead, with many colonies observed in an advanced state of decomposition.

4.3 DIRECT IMPACTS

4.3.1 Dredging and Filling

Potential dredging and filling activities associated with the project are likely to increase sediment loads to the coral reef in the vicinity of these activities around the project site. Although the production, storage, transport, and deposition of sediments are critically important geomorphological processes in coral reef development and maintenance, when sediment loads increase beyond that normally experienced, the living organisms that make up the coral reef system, especially corals, can be adversely affected. The extent of these effects on corals generally varies according to the following factors: (1) the source of the increase in sediment; (2) sedimentation variables of size, rate, and persistency; and (3) coral susceptibility to sediments as a function of colony morphology and rejection ability. The impacts of increased sedimentation on corals and other reef organisms can result in long-term degradation of the living resources and the existing and potential economic value of the entire reef ecosystem (Holthus 1991).

Currently, it is not known if dredging will be required at the project site. However, dredging of the intertidal and subtidal reef flat may be necessary to construct a marina and associated docks and mooring facilities. Dredging is expected to be required for the construction of the proposed "coral garden."

Dredging would likely be accomplished using a clamshell bucket from a crane positioned on a barge, or from the shoreline. Dredged materials are likely to be temporarily stockpiled on shore, on a barge, or within previously defined project staging areas (including the intertidal reef flat), where they could represent a potential silt and sediment source unless properly confined. Dredging and stockpiling of dredged spoils could each represent potential water pollution sources that could affect marine water quality and biota near Ngerur Island.

The conversion of subtidal and intertidal habitats to dredged basins and channels will change the species composition from preconstruction conditions within the affected areas. Coral, sand, and coral rubble biotopes, and many sessile benthic organisms would be directly destroyed by physical removal during dredging. Mobile organisms, such as fish, would likely flee from the site of disturbance. Displaced fish and other mobile organisms may not find suitable alternative habitats or niches not already occupied, and could ultimately be lost. Inter- and intraspecies competition for food and habitat would also increase with the potential to negatively impact both territorial and nonterritorial reef fish and other species.

Reef flats adjacent to dredging operations and down-current areas may be impacted to some degree as a result of silt and sediment deposition, and a short-term degradation in water quality is to be expected during dredging operations. When dredging is completed, fish and certain noncoral invertebrates normally associated with intertidal and subtidal reef flats will likely be replaced by organisms associated with deep channels, channel walls, and sandy lagoon basins. Sea cucumber populations are expected to increase in density and diversity in dredged basins in response to the availability of detrital deposits, favorable substrates, and a possible lack of competitor organisms.

Biological recovery in dredged areas is expected to be limited to species tolerant of unconsolidated sediments. Because of their fine consistency and possibly anaerobic conditions, the shifting, unconsolidated bottom sediments that typically persist following dredging generally provide poor habitats for most coral reef species. However, this material could be removed, if desired, and the site maintained in a manner to facilitate recolonization by corals and other species. Assuming water circulation is not unduly restricted and temperatures do not exceed the...
could be minimized through implementation and strict enforcement of BMPs. However, impacts could include clogging of filter-feeding organs in infaunal clams and crustaceans, direct habitat coverage, reduced coral growth rates, loss of coral infauna (coelobites), a reduction in sunlight penetration and photosynthetic rates, reduction in DO levels within the water column, and a decline in primary production. Dredging is expected to adversely impact a much larger area than that lost as a direct consequence of the physical removal of the substrate. However, because the amount of dredging, if any, is expected to be small, any such impacts are judged to be short-term and minor. Adjacent areas subject to only moderate silt and sediment loading are expected to incur only short-term impacts, none of which is likely to be significant.

4.3.2 Earthmoving Activities

Sedimentation resulting directly and indirectly from shoreline earthmoving, grading, vegetation removal, and related site-preparation activities could impact coastal and marine resources and sensitive species in the vicinity of Ngerur Island. Vigorous implementation and enforcement of BMPs, together with various erosion control and abatement measures, should ameliorate most impacts upon coastal water quality and biota in the vicinity of the project site. The topography of Ngerur Island is not unduly steep, with elevations of between 7 and 20 m characterizing most of the island. There are no intermittent or permanent streams on the island. Therefore, erosion is not expected to produce any serious or long-term effects. However, Palau’s high annual rainfall and the probable presence of highly erodible soils is likely to result in occasional small erosion events that will have the potential to negatively impact coastal and lagoon water quality and biota. Construction of stormwater detention basins and related BMP controls should reduce the silt and sediment loading to acceptable levels in adjacent coastal waters.

It is difficult to predict the degree of impacts, if any, and extent of any coral reef or other habitat losses that would result from an erosion event. The interplay of several physical and biological factors will likely determine the short- and long-term consequences of an erosion event on corals and associated biota. These include: (1) reef position, (2) sediment size, (3) sedimentation rate, (4) mitigating biological factors, (5) water currents, and (6) coral susceptibility to sedimentation (Holthus 1991). The rate of sediment input directly influences its accumulation on reef corals. Sedimentation rates greater than that which can be shed or rejected...
by corals may build up on horizontal surfaces, smothering them from the top down. Conversely, sediments may accumulate around the base of corals, burying them from the bottom up.

Hydrodynamic conditions, including tidal range and periodicity, episodic storms winds and waves, wind direction and strength, and wave action, will collectively determine the fate and consequences of any sediment loading on corals at or near the project site. A properly designed and implemented drainage plan should reduce silt and sediment loading to coastal waters. Overall, however, silt and sediment loading is expected to increase above baseline levels during and following project construction.

Acroporid corals (Acropora hyacinthus, A. corymbosa, and other Acropora spp.), Fungia spp., and certain Porites spp. have been found to be highly to moderately sensitive to sedimentation. Montastrea, Siderastrea, and Pocillopora spp. have demonstrated low sensitivity to sedimentation (Pastorok and Bilyard 1983). The effects of increased sediment loads upon corals can result in coral mortality or partial mortality, a reduction in growth, and bleaching caused by the death or loss of symbiotic algae (zooxanthellae) found within coral polyps (Hoitbaum 1991). P. lutea, the most common coral found around the project site, is known to be moderately sensitive to silt and sediment. However, the distribution and abundance of this species in or adjacent to chronic sources of silt and sediment loading suggest that it can, in many instances, be highly resistant to sediment effects.

The recovery or regrowth of habitats previously impacted by sediment may be slow or nonexistent. In general, coral communities experiencing high levels of sedimentation have less abundant coral cover, fewer colonies, reduced species diversity, and a dominance of branching growth forms when compared to similar areas with significantly less turbidity and sediment deposition (Randall and Birkeland 1978). The dynamics of coral communities can also be altered by increased sedimentation. Planktonic coral planula, which require clean, hard substrates to settle upon, will not colonize silt-covered reef substrate or sediment accumulations, thus possibly limiting new coral establishment in affected areas.

Sediment transported from upland areas following construction and landscaping may have attached fertilizers or pesticide chemicals or contain petroleum hydrocarbons that could increase the potential for harmful effects when these sediments settle within the marine environment. Resuspension by dredging of sediment layers containing potential harmful substances could make them again available for transport to other areas. Also, dredging-induced resuspension of sediments may result in chemical or biological oxygen demand that could result in localized oxygen depletion and die-off of certain coral reef organisms.

4.3.3 Dock and Pier Construction

Construction of piers and docks in support of small craft operations could result in a small loss of intertidal and subtidal habitat.

Piers and docks are anticipated to produce only small, localized impacts as a direct or indirect consequence of the alterations of water circulation patterns, and minor benthic substrate and habitat changes resulting from the placement of piles or similar structures. These losses will be offset by the development of benthic communities on piles and other submerged structures, such as those found currently on existing docks and seawalls in the area (e.g., at PPR). These benthic communities are expected to attract fish and other organisms and, as a function of siting, could increase marine biodiversity over that of baseline conditions.

Piers, docks, and manmade channels have the potential to interrupt natural coastal tidal and water current patterns and littoral processes, and to result in a redistribution of beach sand and other sedimentary deposits. The redistribution of coastal sedimentary deposits could indirectly impact benthic habitats via scouring or sediment deposition and result in a loss of biodiversity in localized areas. However, since the effective surface area of these proposed structures would be small, any such impacts will likely be negligible.

Hard, elevated surfaces used as seawalls, revetments, or bulkheads can enhance biodiversity in localized areas by providing solid substrate for attachment of benthic organisms such as corals, algae, and invertebrates (Maragos and Carpenter 1989). Growth of benthic and epibenthic organisms on such substrate will provide habitat and food for fish and other organisms, and will, in part, mitigate for other unavoidable habitat losses.

The construction of docks and elevated, overwater boardwalks would result in a loss of an unquantified amount of primary productivity as a result of the full or partial exclusion of sunlight from the water column. This loss in primary productivity is judged to be minor and could be partially mitigated by providing space between individual boards constructing the docks and boardwalks. Other mitigation would be in the form of the benthic and epibenthic communities...
that would colonize submerged surfaces and provide new habitats, niches, and food sources for reef fishes and other organisms.

4.3.4 Heavy Equipment and Equipment Operations

Bulldozers, trucks, graders, and dredging equipment are likely to produce low-level sound waves that may be detected by protected marine mammals (e.g., dugongs) and sea turtles. Noise would be generated intermittently during the construction phase of the project. Several studies have indicated that low-level noise and vibrations generated by heavy equipment operations have no adverse effect on marine mammals (Fraker 1981; Johnston 1983). Sea turtles are likely to avoid locations characterized by high ambient noise levels.

Heavy equipment and fuel transfer operations, and the activities of construction crews may result in an occasional accidental discharge of lubricating oil, hydraulic fluids, and fuels on the project site, thus impacting water quality. Such spills could also directly affect protected species and their habitats, or the forage of such species. These events could produce short-term impacts as a function of the nature of the hydrocarbon, and its toxicity and volatility, the volume of the spill, and the sensitivity of the affected habitat. However, the project site is not steeply sloping and there is small likelihood that such pollutants would reach coastal waters in sufficient volume to produce any significant or long-term damage. Implementation and compliance with construction-based BMPs should minimize the chance of any such event occurring during the construction phase of the project.

The impact of a hydrocarbon spill on a coral reef could be severe if such an event coincided with a minus tide, when shallow-water corals may experience subaerial exposure. Subaerial exposure would provide the opportunity for coral zooxanthellae to be coated with a hydrocarbon film that could prove injurious or lethal. The effect of such an event could also be greater in the near-term, given the bleached and stressed appearance of many corals observed during the September 1998 survey period. Potential long-term chronic effects could occur when oils mix with suspended materials and settle onto reef flats. In such instances, filter-feeding organisms, coral, and detrital feeders could be potentially subjected to long-term toxic effects. Development and compliance with an oil-spill prevention and control plan would reduce the opportunity for deleterious impacts upon water quality and marine biota.

Dredging and heavy equipment operations could result in the accidental detonation of World War II ordnance. Such an event would pose a direct hazard to construction crews and the public. Sympathetic ordnance detonation, in which shock waves from a primary detonation cause detonation of ordnance some distance away, also may occur. A “low-order” detonation, or the rupturing of an explosive shell, mortar, or canister, could result in the release of one or more chemicals into the marine environment. Such chemicals may be toxic to marine organisms in even low concentrations. Complex organic chemicals such as hexanitrodiphenylamine, picric acid, trinitrotoluene, and trinitroanisole were frequently used as explosives during World War II. Toxicity testing of an ammonium picrate-based explosive on the damselfish *Dascyllus aruanus* indicated a 48-hour TL0 (total lethal dose to 50 percent of the population) value of 1,700 mg/l and a 96-hour TL50 value of 1,000 mg/l (Jameson 1975). The potential for an explosion or release of hazardous or toxic chemicals into the marine environment is, however, thought to be low.

4.4 INDIRECT IMPACTS

4.4.1 Ciguatera Poisoning

Ciguatera poisoning is one form of ichthyosarcotoxism that occurs in certain reef and pelagic fish in the tropical and subtropical Pacific Ocean. Ciguatera poisoning is associated with ingestion of fish that have, through biological amplification, concentrated the toxin of the dinoflagellate *Gambierdiscus toxicus* within their tissues or viscera (Bagnis 1973; Banner and Helfrich 1964). Many unknown pathogenic aspects of ciguatera poisoning remain and numerous reports are based upon anecdotal evidence. However, outbreaks throughout the tropical Pacific have often been associated with dredging, filling, shipwrecks, ocean or lagoon dumping, massive stormwater runoff events, tropical cyclonic disturbances, and various construction activities on submerged lands. Such an outbreak could occur as an indirect consequence of project-related dredging or marine construction activities in the vicinity of the project site.

Bagnis (1973) identified 36 species or species groups of marine fishes known to have been implicated in ciguatera poisoning in the Mariana and Caroline islands. The source and etiology of ciguatoxin in the ROP is not well understood, but appears to be infrequent. The opportunity for ciguatera poisoning associated with relatively minor coastal construction activities is thought to be remote.
4.4.2 Crown-of-Thorns Starfish

Localized increases in the population levels of the coral-eating crown-of-thorns starfish (*Acanthaster planci*) could occur as an indirect consequence of dredging operations. Dredging operations on coral reefs may enhance the opportunity for *Acanthaster* larvae to settle and grow. A major *Acanthaster* "outbreak" occurred during the late 1960s and early 1970s in Palau and throughout many of the island groups in the central and western Pacific. It is uncertain whether this population explosion was a part of the normal ecology of Pacific coral reefs or the result of Pacific-wide changes in regional weather and water circulation patterns (e.g., ENSO) or other environmental phenomena. The opportunity for any measurable increase in local *Acanthaster* populations is remote because of the small surface area of disturbance and the limited areas of coral reef development located in the vicinity of the project site.

4.4.3 Tourism Expansion and Economic Development and Diversification

The development of a hotel, restaurant, and marina facilities is expected to contribute to an increase in tourism and related economic development activities in Malakal and Koror and elsewhere in the ROP. Such actions are consistent with the policy of the ROP government to foster economic development and diversification. Individually and collectively, such actions have the potential to negatively impact coastal and marine biological communities by contributing to increased use of and impacts upon marine resources.

An increase in commercial fishing may represent an economically beneficial consequence of the proposed project. Expansion of Palau’s commercial fishing industry has been historically impeded by geographic isolation, distance to seafood markets, cold-storage limitations, high shipping costs, and limited local markets. However, local tourist seafood demands would provide a readily available local market for many types of presently underharvested lagoon and oceanic food fishes and other high-demand marine products. The proposed project could therefore indirectly increase the use of marine resources locally and throughout the territorial waters and Exclusive Economic Zone of the ROP.

Increased tourism resulting from the proposed project is likely to create additional demand for deep-sea charter-boat fishing directed at pelagic (tunas, billfish, mahimahi) and lagoon fisheries. This likely future demand has the potential to increase annual pelagic fishery harvests in the ROP. Except for certain tuna stocks, many pelagic fisheries are thought to be largely underexploited. However, along with increased demand for charter-boat fishing would be a commensurate increase in demand for new marinas and an increase in air and water pollutants associated with boating operations. The proposed project is expected to provide facilities to handle the likely increase in demand.

Increased tourism is also expected to indirectly impact coral reef communities as a consequence of an increase in the number of sport divers visiting Palau. Although anecdotal evidence suggests that impacts have occurred by negligent divers at several popular dive sites in Palau, over 10 years of continuous beach use at PPR did not result in any discernible adverse impacts to the inshore coral community (Birkeland et al. 1990). Marine surveys conducted at PPR following the passage of Typhoon Mike on November 11, 1990, indicated that approximately 10 percent of the coral community occupying the lagoon slope zone in front of the coast was partially destroyed in the storm wave action. It is therefore unlikely that tourism-related impacts upon coral reefs would even begin to approach the severity of disturbance incurred during natural tropical cyclonic events or adverse thermal impacts associated with the existing or future ENSO events.

4.5 ENDANGERED AND THREATENED SPECIES

4.5.1 Saltwater Crocodile

4.5.1.1 Existing Conditions

The US-listed endangered estuarine or saltwater crocodile (*Crocodylus porosus*) is known to maintain a breeding population in Palau (Messel and King 1991). The Palau population represents the only island group in Oceania outside of Melanesia where crocodiles maintain breeding populations.

Historically, the saltwater crocodile is believed to have ranged throughout the main islands of Palau. However, hunting for adult crocodiles and their eggs has taken a great toll and an estimated 150 individuals are thought to remain (Cobbed and Maiava 1994). Crocodiles are known to occur in Ngeremedu Bay, in the estuarine reaches of Urumug Bay (Taoch ra Klebeang), in Aialai Bay, in several marine lakes in Palau’s southern lagoon, within the mangrove forest on the northeast side of Peleliu, and within the Taoch Ngerdorch watershed (inclusive of...
Ngerur Island Baseline Marine Survey

4.5.1 Crocodiles

A single crocodile is believed to reside within an interior lake on Angaur (Maragos et al. 1994). Crocodiles are unlikely to occur near the project site because of the absence of suitable estuarine habitat. No critical habitat designations apply to the saltwater crocodile in the ROP.

4.5.1.2 Impacts

No direct impacts on Palau's crocodile population are anticipated. Indirect, minor potential impacts, such as increased human accessibility to crocodile habitat, could accompany hotel and commercial development as a result of a greater number of tourists coming to Palau. Other forms of indirect impact, such as economic development and diversification, urbanization, and increased recreational and subsistence usage within Palau's wetlands, river systems, and coastlines, pose additional opportunities for potential long-term and cumulative adverse impacts on crocodile populations.

4.5.2 Dugongs

4.5.2.1 Existing Conditions

The dugong (Dugong dugon) is a US-listed endangered species that occurs in Palau. The dugong has a small breeding population in Palau, the only area outside of Melanesia where they are established (Marsh et al. 1992). The dugong is listed by the International Union for the Conservation of Nature (IUCN) as "vulnerable," and it is severely depleted or extinct from much of its original range (Nishiwaki and Marsh 1985).

Palau's dugong population has suffered severe declines due to years of overharvesting and poaching. The use of modern hunting gear (firearms, harpoons, and speedboats) and the decline of traditional (culturally based) controls has exacerbated hunting pressure. These factors, combined with the dugong's slow reproduction and growth rates, currently jeopardize Palau's small remaining population.

Dugongs are known to forage within seagrass beds off the northern side of Babeldaob, at Ngos Reef, and off the islands of Ngerechur and Ngerkeklau, at Kayangel (Ngcheangel) Atoll, with the highest densities generally recorded along the west side of Babeldaob's Ngerechelong peninsula and offshore of Ngaraard. Dugongs have also been recorded off Ngaroma and Aimpelik, and have been frequently sighted along the fringing reefs and lagoons offshore of central and southern Babeldaob (Marsh et al. 1992). They have also been observed in seagrass beds near Ngiaiwal, Ngcheasir, and eastern Airai Bay (Maragos et al. 1994). Dugongs have also been reported in Malakal Harbor, and one investigator considered Malakal Harbor as one of the two most important dugong habitats in Palau (Marsh et al. 1992).

Because of locally heavy boat traffic and the absence of appropriate dugong foraging areas, it is unlikely that the coastal waters surrounding Ngerur provide important feeding or resting habitat.

No critical habitat designations apply to Palau's dugong population.

4.5.2.2 Impacts

Impact on Palau's dugong population is not expected to occur because of the small scale of the proposed resort development and the projected minor, short-term disturbances to the marine environment.

Indirect impacts to the dugong population will come from expanded tourism and marine-related activities that will result in increasing development and urbanization along island shorelines, and further intrusion into dugong foraging and resting habitats.

4.5.3 Sea Turtles

4.5.3.1 Existing Conditions

Five species of sea turtles are known to occur in ocean and lagoon waters of the ROP: the US-listed threatened green sea turtle and the Pacific Ridley sea turtle (Lepidochelys olivacea), the US-listed endangered hawksbill (Eretmochelys imbricata) sea turtle, and the leatherback (Dermochelys coriacea) and loggerhead (Caretta caretta) sea turtles. Only the green and hawksbill sea turtles have established nesting populations in Palau. The International Union for the Conservation of Nature lists five of seven listed species of sea turtles as endangered (including the hawksbill) and another as "vulnerable." All species are listed in Appendix I of the
Convention on International Trade in Endangered Species of Wild Fauna and Flora, which prohibits commercial trade. Sea turtles are also protected under Title 24, Chapter 12, Subchapter I of the Palau National Code, though there is some question as to the current legal status of this subchapter.

Poaching of turtle eggs and the taking of gravid females from nesting beaches have contributed to the decline in sea turtles in the ROP. Nesting has declined or disappeared in 25 to 30 of the historically known nesting beaches. Other factors contributing to the decline in sea turtles include the encroachment of picnickers and dwellings into nesting areas, disturbance of nesting turtles or their eggs, and poaching of adults and eggs (Maragos 1992; Geermans and Honigman 1992).

Sea turtles are known to nest at Ngerechur and Ngckeklau islands off the northern coast of Babeldaob (Di Rosa 1992; Guilbeaux 1992). The southern lagoon remains as the most important hawksbill nesting area in the main Palau Islands and in Micronesia as a whole (Maragos et al. 1994). Important nesting areas include the Ngerukewid and Ngeknai islands, Ulong Island, Ngkesiil Island, and the Omekang Islands. Angaur supports several sea turtle nesting areas, though poaching of gravid females and eggs is rampant (Guilbeaux 1992).

There are no known nesting beaches on or in the vicinity of Ngerur Island (Di Rosa 1992; Guilbeaux 1992; Maragos et al. 1994). Sea turtles occur throughout Palau's lagoon and ocean waters, however, and have been observed in the vicinity of the project site.

4.5.3.2 Impacts

No significant direct impacts to green or hawksbill sea turtle populations are expected to result from the proposed project. Indirect impacts upon sea turtles are expected to increase. Noise and vibrations resulting from dredging operations and construction activities may result in turtles avoiding areas of disturbance. Any such disturbance will be largely short-term in nature, lasting only through the construction phase of the project.

Project-related dredging could impact sponge aggregations and result in a small loss of forage for the hawksbill sea turtle. However, this impact is judged to be minor because sponges are not a significant component of the nearshore ecosystem in the vicinity of the proposed project site. Any such losses would likely be offset by the provision of new piles and docks upon which sponges are likely to settle and grow.

Under the US Endangered Species Act, the green sea turtle can be taken on a subsistence basis in ROP waters, subject to certain local harvest restrictions. The hawksbill sea turtle is totally protected. ROP laws provide size restrictions for the taking of sea turtles; the removal of eggs or destruction of turtle nests is unlawful. Unfortunately, illegal poaching of adults, subadults, and eggs is widespread (Cotebed and Maiava 1994). There are no critical habitat designations that apply to any US- or ROP-listed endangered or threatened sea turtle species.

4.5.4 Whales

Five species of protected whales are known to occur within the territorial waters of Palau: sperm whale (* Physeter catodon*), blue whale (*Balaenoptera musculus*), sei whale (*B. borealis*), finback whale (*B. physalis*), and the humpback whale (*Megaptera novaeangliae*). All of the whales are US-listed endangered species. The sperm and blue whale are listed as endangered on the ROP endangered species list. However, all of the whales are oceanic species and are unlikely to be directly or indirectly affected by project actions.

There are no critical habitat designations or other special controls that apply to any US- or ROP-listed endangered whale species.

4.6 PROPOSED MITIGATION MEASURES AND RECOMMENDATIONS

Construction-related impacts from land clearing, and hotel and dock construction can be largely mitigated by using construction BMPs. Mitigation measures should include the following:

- Avoid disturbance to marine areas undergoing no project-related changes.
- Use heavy-equipment "common corridors" for accessing dredging sites.
- Develop, implement, and enforce erosion- and sediment-control plans.
Implement an enforceable water quality and environmental monitoring plan encompassing all potentially affected harbor environments.

Leave uneven and irregular dredged channel bottoms to provide bottom relief and vertical surfaces that would encourage recolonization of corals and other benthic and epibenthic flora and fauna.

Maintain natural tidal and water circulation patterns.

The small, possibly hand-dug, freshwater cave on the island's west side harbors at least one shrimp species and a filamentous algae that do not occur elsewhere on the island. Consideration should be given to retaining this site feature, as it represents a unique (to the island) semicryptic freshwater habitat. The biota inhabiting this cave has been observed by the author in coastal springs and in small permanent and intermittent streams elsewhere in Palau. Therefore, this site feature does not appear to represent an especially uncommon or rare aquatic habitat in Palau.

The *Sonneratia alba* trees occurring in the intertidal zone on the east side of the Ngerur Island should be retained as a natural site amenity, because this is the only occurrence of this mangrove tree on the island. Modest pruning could probably be undertaken if desired, without jeopardizing the health or vigor of the trees.

**5.0 REFERENCES**


Ngerur Island Baseline Marine Survey


Appendix—
Transect Photos
Area of dark detritus deposition on east side of island. Note live *Tridacna squamosa* clam in lower center between normally pigmented *Porites* colonies. Bleached *Porites* colonies are visible in lower right corner of photo.

Inter tidal basalt platform. 10-m transect interval showing silty-cyanophyte veneer on reef platform.

Sub tidal basalt platform. 40-m transect interval showing massive (left) and nodular (right center) *Porites* colonies and small foliose *Pocillopora damicornis* polyps (right).
Subtidal basalt platform. 48 m transect interval showing massive *Porites lutea* colonies (upper right and lower right) among basalt and limestone rubble.

Subtidal basalt platform. 50 m transect interval showing the colonial zoanthid *Palythoa* tuberculata (upper left) against rock strata.

Reef margin and upper lagoon slope zone demonstrating 56 percent coral coverage. Live and bleached (lower center) *Porites lutea* colonies are visible, as well as colonies of *P. (S.) convexa* and *P. andrewsi*.
Upper lagoon slope zone. 48-m transect interval showing dense *Porites* andrewsi thicket. Note bleached appearance of corall branch in center of photo.

Vertical rock cliffs in study area 2, with strand vegetation and small, rocky beach.
World War II projectile in high intertidal zone in study area 2 (camera lens cap on projectile to show relative size).

Intertidal reef flat, 30-m transect interval showing rocky intertidal platform in partially shaded area beneath stand of the coastal mangrove tree, *Sonneratia alba*.

Intertidal reef flat, 50-m transect interval showing basalt rocks atop limestone bench. Note small, embedded *Tridacna* oyster clam with blue mantle in upper center of photo.
Subtidal reef flat. 60-m transect interval showing bleached and partially fragmented colonies of alcyonid corals and small nodular *Porites* lutea (lower left).

Reef margin zone. 90-m transect interval showing live *Porites* lutea and *P. (S.) compressa* among coral rubble.

*Sonnellas* alba stand on east side of Nigeru Island.
Upper lagoon slope zone showing normally pigmented (right) and bleached (left foreground) massive colonies of Porites lutea. Note absence of fish in the photo.

Reef margin zone showing mixed assemblage of normally pigmented and bleached massive Porites lutea among P. (S.) convexe thickets. Note absence of fish in photo.

Reef margin zone showing thickset of Porites (S.) convexe approximately 5 m in diameter. Note absence of fish in the photo.

Upper lagoon slope zone showing normally pigmented (left) and bleached (right) colony of Pocillopora damicornis growing atop normally pigmented colonies of Porites lutea.
Appendix B-4

Biological and Water Quality Reconnaissance

(AECOS Consultants, 2000)
Biological and water quality reconnaissance surveys on Ngerur Island, Palau Lagoon, Republic of Palau

April 14, 2000

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Introduction

Presented herein are results of a field survey conducted on the small island of Ngerur located due west of Ngerekesheang Island in the Republic of Palau. The purpose of the field survey and report is to describe environmental resources (particularly biological resources) found on Ngerur and assess the environmental impacts potentially arising from construction of a resort proposed to substantially involve much of the land area of the island. Our survey concentrated on terrestrial environments, but included shoreline and nearshore areas as well. Supplemental to this report are additional environmental reconnaissance reports prepared by Darrel Herbst (botanist) and William Brewer (Pentec Environmental, 1999).

Methods

Water quality samples were collected from four stations around Ngerur Island (Table 1). The coordinates of each station were determined with a Magellan GPS 4000 XL. Water samples were collected from the marine environment around the island using a Niskin closing bottle at selected depths. Samples were stored in clean, pre-rinsed bottles and then stored on ice in a sealed cooler. Turbidity and pH samples were analyzed on the same day they were collected using a Hach 2100P Turbidimeter and Orion 5A 150 meter, respectively. The nutrient and salinity samples were frozen and returned to Hawaii for analysis in the AECOS laboratory on O’ahu. A Technicon AutoAnalyzer II was used for the nutrient analyses and a API Model 2100 salinometer was used to measure salinity. Water temperature and dissolved oxygen (DO) levels were measured in the field with a YSI Model 57 DO meter. An additional set of samples was obtained by Richard Stook of Wai Chee Planning in December 1998. For these samples, a measured volume of each sample was filtered through a pre-weighed Whatman® GFC filter. The filters were then stored frozen in individual sealed plastic containers for TSS analyses upon return to the AECOS Inc. laboratory in Kailua, Hawaii.

Surface drogues were deployed in the nearshore environment on several occasions to estimate the speed and direction of surface currents around Ngerur Island. Finally, some water samples were collected from springs at various locations around the island to assess ground water quality.

Terrestrial survey methods on the island consisted of several days of trekking over all parts of the land mass and along the shoreline bench, by two field zoologists. The island was visited daily between the 12th and 16th of October 1998. Due to the paucity of understory vegetation, much of which had been cleared shortly before the survey dates, we were able to easily access most of the island on foot. The entire island was searched for terrestrial vertebrates and invertebrates on a daily basis.

In addition to daily treks, at least one beginning before sunrise, the island’s avifauna (birds) was assessed using techniques described in the 1993 U. S. Fish & Wildlife Service (USFWS) survey of the forest birds of Palau. Six unlimited distance variable circular plot (VCP) bird count stations were established (Engbring 1992, Reynolds et al. 1980). These count stations were each sampled twice during the course of the field survey. Field observations were made with the aid of Leica 10 X 42 binoculars and by listening for vocalizations. When it became apparent that there was a remarkable lack of avian species on the island, we supplemented our standard survey techniques by using tape recorded playback of bird songs and calls in an attempt to find any missed species. Additionally two sets of VCP bird counts were also conducted on Ngerekesheang Island immediately across the Daerur strait from Ngerur for comparison purposes.

A running tally was kept of all vertebrate species observed and heard while on the island. The survey of both native and feral mammals was limited to visual and auditory detection, as well as observation of scat and tracks. No trapping study was conducted to obtain data on their relative abundances. Similarly, observations of amphibians and reptiles were of an incidental nature.

Table 1. Location of water quality sampling stations near Ngerur Island

<table>
<thead>
<tr>
<th>Station</th>
<th>Zone</th>
<th>Easting</th>
<th>Northing</th>
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<tbody>
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<td>Station 1</td>
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<td>04 37 061</td>
<td>08 13 320</td>
</tr>
<tr>
<td>Station 2</td>
<td>15</td>
<td>04 37 058</td>
<td>08 14 284</td>
</tr>
<tr>
<td>Station 3</td>
<td>16</td>
<td>04 36 600</td>
<td>08 14 167</td>
</tr>
</tbody>
</table>

Surface drogues were deployed in the nearshore environment on several occasions to estimate the speed and direction of surface currents around Ngerur Island.
Invertebrates were surveyed on land as well as along the shore by tape-recording field notes and, as needed for identification purposes, collecting specimens for later examination in Hawaii at the author's laboratory or by invertebrate specialists at the B. P. Bishop Museum in Honolulu. Flying insects were sampled with insect nets. Rotting logs and boulders were searched for cryptic invertebrate species. Limited (see below) terrestrial aquatic environments present were sampled with fine-mesh, hand fishing nets.

Brief underwater snorkeling surveys were made in selected areas to obtain a general understanding of the distribution of coral reef organisms (particularly corals) immediately off the shore of the island. Video tape transects were made by to document conditions of the underwater environment around the island. These efforts were meant to supplement the efforts of William Brewer, as reported in Pentec (1999). Additional marine survey work was conducted by Sea Engineering Inc. (SEI, 1999).


Description of Ngerur Island

Ngerur Island is a relatively small (ac) volcanic island located 5 km off the west end of Ngerekebesang Island, the latter being one of three main islands (in addition to Koror and Malakal) over which spreads Palau's largest town of Koror. Ngerur Island rises to an approximate maximum elevation of 20 m (60 ft) and is moderately covered by trees in the eastern aspect, but mostly having open Pandanus savannah in its western aspect (see Herbst, 1999).

Much of the Ngerur shoreline is a vertical cliff between 2 and 4 m high, making landing and accessing the more gently sloping interior somewhat difficult. A marine bench surrounds the island and this bench is exposed at low tide, so that it is possible to walk completely around the island below the shoreline cliffs. In Palau, the tidal range is typically on the order of 2 m, and cover 0.5 m deep. Although unique to the extent that no other semi-permanent (or perhaps permanent) fresh water features are to be found on the island, the circumstance of its formation is not entirely unique. At various places along the eroded shore fractures occur which have been widened out by marine action (waves). All of these features contain fresh water dripping from above. In the case of the existing "spring" some man-made (and perhaps some natural) placement of boulders, creates a deeper pool to receive input of fresh water. Also, by raising the front (exposed) edge of the pool, only storm waves could reach the pool to "contaminate" it with salt water. The "spring" is located in one of several areas and the shore notable for the fact that fresh water outflow is especially strong and persistent.

Water Quality Survey

Marine Waters

Winds were light and variable on October 14 and 15, 1998, ranging from 0-3 kts out of the W to SSE (Table 2). Surface currents near Ngerur Island on these two days were basically wind-driven flowing in a ENE to N direction with speeds ranging from 0.06 kts in the lee of Ngerur Island (winds calm) to 0.44 kts with winds at 7-8 kts. The exception to this pattern was observed at Station 2 off the SW shore of Ngerur Island where currents were diverted slightly to the west as they approached the island and flowed in WNW direction. A storm was passing through this area on the morning of October 15, 1999 and winds were from the NW at about 30 kts with 2 foot seas.
The waters off Ngerur Island were sampled primarily during rising tide conditions (see Appendix A). It is therefore not clear what influence tides might have on water quality in the Ngerur Island area. However, because Ngerur Island is relatively removed from most land masses, except Ngerakebesang Island, it is probable that tides have minimal influence on water quality in this area.

Table 2. Wind and surface current characteristics near Ngerur Island

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Station</th>
<th>Wind</th>
<th>Speed</th>
<th>Current</th>
<th>Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>14-Oct-98</td>
<td>1118</td>
<td>1</td>
<td>W</td>
<td>3</td>
<td>ENE</td>
<td>0.19</td>
</tr>
<tr>
<td>*</td>
<td>1200</td>
<td>1</td>
<td>0</td>
<td>ENE</td>
<td>0.06</td>
<td></td>
</tr>
<tr>
<td>*</td>
<td>1238</td>
<td>1</td>
<td>2</td>
<td>ENE</td>
<td>0.06</td>
<td></td>
</tr>
<tr>
<td>*</td>
<td>1315</td>
<td>1</td>
<td>SW</td>
<td>2-3</td>
<td>ENE</td>
<td>0.30</td>
</tr>
<tr>
<td>*</td>
<td>1327</td>
<td>1</td>
<td>1</td>
<td>ENE</td>
<td>0.30</td>
<td></td>
</tr>
<tr>
<td>*</td>
<td>1900</td>
<td>1</td>
<td>SSW</td>
<td>0-3</td>
<td>NNE</td>
<td>0.50</td>
</tr>
<tr>
<td>*</td>
<td>1952</td>
<td>1</td>
<td>SSW</td>
<td>0-3</td>
<td>NNE</td>
<td>0.50</td>
</tr>
<tr>
<td>15-Oct-98</td>
<td>1050</td>
<td>1</td>
<td>SSE</td>
<td>0-2</td>
<td>N</td>
<td>0.12</td>
</tr>
<tr>
<td>*</td>
<td>1130</td>
<td>1</td>
<td>SSE</td>
<td>0-3</td>
<td>N</td>
<td>0.23</td>
</tr>
<tr>
<td>16-Oct-98</td>
<td>0910</td>
<td>1</td>
<td>NW</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>*</td>
<td>1318</td>
<td>3</td>
<td>NE</td>
<td>6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Station 1 was sampled frequently to determine if: (1) there was a pattern in physical water quality related to water depth; and (2) there were notable temporal differences over the space of several days (Appendix B). As there were no notable differences or patterns, either spatially or temporally at this station, it is presumed that these waters are well mixed and adequately represented by samples from a single depth. The mean values for physical water quality parameters near Ngerur Island are shown in Table 3.

There was little difference in temperature, salinity, or pH between any of the stations around Ngerur Island, again indicating that these lagoon waters are generally well mixed. The somewhat elevated dissolved oxygen (DO) saturation levels at Station 3 indicate that there is likely a well developed coral community and/or benthic algal community in this area. Zooplankton (microscopic plants) which live within corals and benthic algae produce oxygen during the daytime photosynthetic process and this can result in supersaturation of DO in the water column during part of the day. Also, the slightly higher average pH at Station 3 (pH = 8.20) is further evidence suggesting productivity is high in this area. Carbon dioxide is consumed by plants during photosynthesis, decreasing bicarbonate in the water, and increasing pH.

Table 3. A summary of basic water quality conditions off near Ngerur Island (October 14 - 16, 1998)

<table>
<thead>
<tr>
<th>Location</th>
<th>Temp.</th>
<th>Salinity</th>
<th>DO</th>
<th>DO</th>
<th>pH</th>
<th>Turbidity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(oC)</td>
<td>(%)</td>
<td>(%)</td>
<td></td>
<td>(NTU)</td>
</tr>
<tr>
<td>Station 1</td>
<td>30.7</td>
<td>33.52</td>
<td>6.47</td>
<td>104%</td>
<td>8.18</td>
<td>0.26</td>
</tr>
<tr>
<td>Station 2</td>
<td>30.8</td>
<td>33.73</td>
<td>6.84</td>
<td>111%</td>
<td>8.15</td>
<td>0.36</td>
</tr>
<tr>
<td>Station 3</td>
<td>31.0</td>
<td>33.75</td>
<td>7.82</td>
<td>129%</td>
<td>8.20</td>
<td>0.25</td>
</tr>
<tr>
<td>Station 4</td>
<td>33.44</td>
<td>33.44</td>
<td>6.07</td>
<td>111%</td>
<td>8.18</td>
<td>0.62</td>
</tr>
</tbody>
</table>

Low mean turbidity level at Station 4 seems to be due to the fact that this station was located over deeper waters (i.e., off the Ngerur reef area) and on the NW side of the island. This station was sampled only on October 16, 1998, when a morning storm was blowing out of the NW and, thus, while other stations were subject to stirring up of the shallow reef sediments, Station 3 was receiving clearer water from the deeper channel area west of Ngerur Island.

Nutrient levels were low in the vicinity of Ngerur Island (Table 4) during the survey period and characteristic of pristine coastal tropical environments. The nitrate + nitrite levels recorded are considered to be "growth-rate limiting." That is, inorganic nitrogen is present in such low quantities that plant growth (phytoplankton and benthic algae) would be severely restricted at this location, and, together with low turbidity levels, accounts for the pristine nature of this area.

Turbidity and TSS Additional water quality samples were collected on December 5, 1999 at essentially the same four locations (Table 1) sampled in October 1998 off Ngerur Island. The purpose of these additional samples was to include, at the request of EGPB, TSS measurements not obtained during the October 1998 sampling event. On December 5, the tide was falling and near ebb condition during sample collection. Winds were out of the northeast and skies were overcast.

The samples were analyzed for total suspended solids (TSS) and turbidity. These data are presented in Table 5.
Table 5. Particulate (turbidity & TSS) levels off Ngerur Island sampled December 5, 1999.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Depth</th>
<th>Station</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSS (mg/l)</td>
<td>surface</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>bottom</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Turbidity (nT)</td>
<td>surface</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>bottom</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
</tr>
</tbody>
</table>

Turbidity and TSS levels were found to be generally low on December 5, 1999, except for TSS in the surface waters at Station 1. Since turbidity at this station was not noticeably different from the other stations where TSS was low, it is probable that the elevated TSS measured at Station 1 was caused by a piece of debris, rather than an aggregation of silt or other small particulate matter. In all cases, turbidity levels were lower than the limit of 1 nT specified for Class A waters. Presently, there is no water quality standard for TSS in the marine waters of Palau.

Turbidity and TSS levels recorded at Ngerur Island are compared in Table 6 with values from offshore (lagoon and ocean) stations around Babadan Island. Particulate levels observed off Ngerur tend to be lower than all sites listed here, with the exception of turbidity level measured at the open ocean site off Melekeok. These data indicate that the marine waters near Ngerur Island are typically low in particulate matter and represent excellent water quality conditions.

Table 6. A comparison of particulate levels in offshore waters (lagoon and ocean) around Palau (this report and AECOS Consultants, 1999).

<table>
<thead>
<tr>
<th>Location</th>
<th>NO₃-N₂O₅</th>
<th>Total N</th>
<th>Total P</th>
<th>Conductivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>station 1</td>
<td>&lt;0.001</td>
<td>0.11</td>
<td>0.006</td>
<td></td>
</tr>
<tr>
<td>station 2</td>
<td>0.001</td>
<td>0.104</td>
<td>0.110</td>
<td></td>
</tr>
<tr>
<td>station 3</td>
<td>0.000</td>
<td>0.109</td>
<td>0.012</td>
<td></td>
</tr>
<tr>
<td>station 4</td>
<td>&lt;0.001</td>
<td>0.006</td>
<td>0.011</td>
<td></td>
</tr>
<tr>
<td>grand mean</td>
<td>0.002</td>
<td>0.100</td>
<td>0.010</td>
<td></td>
</tr>
</tbody>
</table>

Terrestrial Seeps: Water samples collected from various seeps and springs on Ngerur Island typically had nutrient levels lower than the surrounding marine environment (Table 7). This is important because it means the island does not contribute significantly to the nutrient pool of the marine waters surrounding the island and this helps to maintain the high water quality conditions present in the adjacent reef areas. The single exception is an elevated nitrate + nitrite level at Spring 1. This input may be partially responsible for the high DO saturation levels at Station 3; i.e., nitrate + nitrite promotes photosynthesis which produces high DO saturation levels.

Note in Table 7 that there appears to be a trend between increasing conductivity levels and decreasing nutrient levels. It may be that runoff water which hasn't had a chance to percolate deeply into the ground (and therefore is closer to rainwater in having low conductivity) is, however, higher in nutrients — especially nitrate + nitrite. Thus, maintenance practices which encourage the percolation of rain water into the ground may help preserve low nutrient levels in the marine environment.

Table 7. Nutrient and conductivity levels from selected fresh water seeps around Ngerur Island.

<table>
<thead>
<tr>
<th>Date</th>
<th>Location</th>
<th>NO₃-N₂O₅</th>
<th>Total N</th>
<th>Total P</th>
<th>Conductivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-Oct-99</td>
<td>Spring 1</td>
<td>0.015</td>
<td>0.070</td>
<td>&lt;0.001</td>
<td>0.002</td>
</tr>
<tr>
<td></td>
<td>Spring 1A</td>
<td>&lt;0.001</td>
<td>0.030</td>
<td>&lt;0.001</td>
<td>0.003</td>
</tr>
<tr>
<td>17-Oct-99</td>
<td>Spring 1</td>
<td>&lt;0.001</td>
<td>0.018</td>
<td>&lt;0.001</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>Spring 1A</td>
<td>0.001</td>
<td>0.018</td>
<td>&lt;0.001</td>
<td>0.001</td>
</tr>
</tbody>
</table>

Invertebrate Fauna:

Appendix C lists the specimens of invertebrates identified from field observations and collections made on and around Ngerur Island. With respect to the mollusks, at least, the collection included several native (endemic) species.
Terrestrial Seeps  Fresh water that falls on Ngerur as rainfall can form temporary puddles in some areas, but mostly seeps down through the soil to the rocky subsoil layer. While fractures in rock layer certainly exist, and perhaps there is a permeable aquifer or aquiluclidean rock formations, the observed rapid response of multiple seeps around the perimeter of the island, most striking at the interface between rock and soil above, suggests that rainwater seeps through a relatively thin layer of soil.  

Internal structure focuses this subsurface flow to locations that become springs. In a few places, linear cracks collect the water and direct it to the shore near the foot of the cliff. One such formation was modeled by a small rock dam to form a permanent pool of water, mostly hidden within a cave, on the west side of the island.

The freshwater pool on the west supported (at the time of the survey) a thick growth of green, filamentous algae where the pool was exposed to sunlight. The pool was found to harbor several species of freshwater shrimp, including Macrobrachium lar and an Astid, Caridina typus. Both of these species are common in streams on Babeldaob (AECOS, 1998). Also, both species have a marine larva. Thus, it is not unusual to find these shrimp in the isolated pools on Ngerur. In fact, their presence does not even indicate a long permanence to the pool, as individuals would recruit to the pool from storm waves or by migration across the beach when after suitable habitat was available. Nonetheless, the owner indicated this particular pool has long been known as a reliable source of fresh water on the island.

Water quality measurements for the freshwater pool and other seeps/springs on the island are discussed above.

Vertebrate Fauna

The relative lack of terrestrial vertebrate biodiversity encountered on Ngerur Island is in direct contrast with the comparatively rich vertebrate faunas present in most areas of Palau. Palau's diverse vertebrate fauna is due in part to the relative close proximity of Palau to both the Philippines and New Guinea.

Amphibians and Reptiles  We did not record either of the two amphibian species currently known from Palau during the course of this survey. That neither of these common species was detected attests to the large population of roof rats on the island and the minimal aquatic habitat present. Ordinarily rats tend to avoid moisture (Bufo marinus). As with other terrestrial species the diversity and density of lizards was surprisingly low; we encountered a few species of skinks (Carlia fasciata), blue-tailed skinks (Eumeces carinatus) and several emerald tree skinks (Lamprea marinae).

We also unsecured a Philippine island snake (Ramphephiskis brevifrons) from beneath a log. No other snakes were detected — not surprising given the disturbed nature of the site. In talking with local residents familiar with the island, no one could recall ever seeing a snake on this particular island, although at least two species of snake are common on Babeldaob Island.

No crocodiles or sea turtles were seen. This is not surprising given the lack of any suitable habitat present. It is unlikely there is any significant usage of the area immediately adjacent to the island by any marine reptile species.

More than 30 species of reptiles have been recorded from Palau. These include two species of sea turtles: the green sea turtle (Chelonia mydas) and hawksbill sea turtle (Eretmochelys imbricata), the saltwater crocodile (Crocodylus porosus) and at least 5 species of snakes and more than 20 species of lizards. Two amphibian species are known from Palau: one, the Palauan tree frog (Platymantis pylaeus) is endemic; the other, the giant cane toad (Bufo marinus) is introduced. The herpetofauna of Palau is not completely known, new species continue to be discovered as research efforts are mounted. The systematics of many of the lizards and several of the snakes are currently under review, and it is expected that many of the resident reptiles will be found to be endemic (Cowle, et al., 1996; A. Allison, pers. comm.).

Of special concern is the status of both the green and hawksbill sea turtles, as well as three oceanic species: the loggerhead sea turtle (Caretta caretta), leatherback sea turtle (Dermochelys coriacea), and olive ridley sea turtle (Lepidochelys olivacea). The Palauan populations of the green sea turtle and the hawksbill sea turtle are listed as threatened and endangered respectively by USFWS. The oceanic populations of loggerhead and olive ridley sea turtles are listed as threatened by the USFWS. The leatherback sea turtle is listed as endangered. Additionally, the saltwater crocodile is also listed as endangered by the USFWS (USFWS, 1996). All 6 of the previously mentioned species are also listed on the Palauan provisional endangered species list (PNCA Section 24).

Birds  During the course of our survey we detected 19 avian species representing 13 separate families (Table 1). Twelve of these are native or indigenous forest birds, 4 were seabirds, and the remaining 3 were migratory shorebirds seen resting on the marine bench exposed at low tide. Species density was extremely low. The highly disturbed nature of the vegetation, coupled with a high density of roof rats has clearly limited both avian diversity and population densities on the island. Of interest was an active Palau Flycatcher (Myiagra parentalis) nest located in the midst of the densest remaining vegetation almost in the center of the island.

One hundred and forty two avian species representing 32 families have been recorded from Palau (Momiyama, 1922; Mayr, 1945; Marshall, 1949; Baker, 1951; Owen, 1977; Pyle & Engbring, 1985; Engbring, 1994; Wykes et al., 1999). In addition, another 12 species have been tentatively documented, and are currently considered hypothetical (Engbring, 1996; Wykes et al., 1999). One formerly established alien species has been extirpated. Nine alien species are endemic, at the species level, and at least 5 are endemic at the sub-specific level (Baker, 1951; Sibley & Monroe, 1990; Engbring, 1992; Fry et al., 1992; Clement et al., 1993; Restall, 1997).

The Palauan avifauna can be split into three major groups: Resident land birds, resident seabirds, and migratory and extramural species. Of the 35 known resident land, 25 are native
forest birds, 7 are native wetland species, and 3 are introduced species. Thirteen species of resident seabirds have been recorded from Palau. To date, 11 species of migratory and extralimital seabirds and 81 migratory and extralimital shorebirds and passerines have also been recorded (Engbring, 1992; Wiles et al., 1999).

Of special concern is the status of the Micronesian Scrubfowl (Megalopodius superciliaris), a species currently listed by both the USFWS and the Palauan Government as an endangered species (Federal Register, 1998; PNCA, Section 24). Four other Palauan endemic avian sub-species: Pacific Black Duck (Anas superciliosa pelevenis), Common Moorhen (Gallinula chloropus pelevenis), Niilirau Pigeon (Calonetta nicobarica pelevenis), and White-breasted Woodswallow (Artamus rosaceus pelevenis) are also listed on the Palauan provisional endangered species list (PNCA, Section 24). None of these sub-species is protected under U.S. statutes (Federal Register, 1996).

**Terrestrial Mammals** The only native terrestrial mammals known from Palau are two species of fruit bats (Pteropus mariannus pelevenis) and (P. pilosus) and an insectivorous sheath-tailed bat. Three fruit bats (Pteropus mariannus pelevenis) were seen during our survey; one each on three separate mornings. The bats appeared to be foraging and were not detected roosting. Several sheath-tailed bats (Emballonura sp.) were seen foraging over the Island as well as roosting both in and from Ngneror Island. Of special note was the large number of roof rats (Rattus rattus) encountered on the Island. Although no trapping program was undertaken to assess the density of rodents, some idea of the sheer numbers can be conveyed by mentioning that during one 8 minute stationary bird count we recorded 34 rats, and 2 house mice (Mus musculus). We did not detect any other mammalian species during the course of this survey.

It is currently thought that P. pilosus has been extirpated from Palau (Wiles and Engbring, 1993). The remaining mammals found in Palau have all been introduced to the Island by humans. These include four species of muridae: the roof rat, Norway rat (Rattus norvegicus), Polynesian rat (Rattus exulans), and the house mouse (Storer, 1962). One monkey species, the crab eating Macaque (Macaca fascicularis) was successfully introduced to Angaur around the turn of the century. The bulk of the macaque population is still limited to the island of Angaur; however, they are occasionally kept as pets in other locales in Palau. This has resulted in a number of escaped animals and the establishment of a small population on the Island of Koror centered around the vegetable and fruit farms in the Ngerul area (Epison, 1997). Additionally, at least five domesticated mammalian species are also found in Palau. These include dog (Canis familiaris), cat (Felis catus), pig (Sus scrofa), goat (Capra hircus), and cattle (Bos bison). These, by in large, remain in a domesticated state, although pigs are found in a feral state in the interior of Babeldoab.

**Marine Mammals** We did not detect any marine mammals. This fact is not surprising given the location of Ngner Island. Inspection of the seabed in front of the site revealed no sea grass beds. Although there is no suitable habitat within the immediate vicinity of the Island it should be borne in mind that dugongs have been regularly seen in waters to the north of the Island and in some numbers in the Malakal Harbor area.

Two whales: the blue whale (Balaenoptera musculus) and sperm whale (Physeter macrocephalus), as well as a seacow or dugong (Dugong dugon) are known from Paluan waters and are listed by the United States Fish & Wildlife Service (USFWS) as endangered species (Federal Register, 1998). All three species are also listed on the provisional endangered species list that is being proposed as part of section 24 of the Palau National Code Annotated (PNCA, Section 24).

The resident Palauan dugong population represents the most geographically isolated population of Sirenia on the planet. Recent surveys have indicated that this population is declining. The current population is estimated to number between 26 and 50 animals (Browne et al., 1981; Marsh et al., 1992, 1995).

**Discussion**

**Water Quality** Water quality standards pertaining to the marine waters of Palau are contained in The Environmental Quality Protection Act, Chapter 1, Marine and Fresh Water Quality Standards Regulations (24 PNC, Environmental Protection, 1990). The Ngeror Island area is rated as a Class AA water type which applies to waters suitable for oceanographic research, propagation of shellfish and other marine life, conservation of coral reefs and wilderness areas, compatible recreational activities, and other aesthetic enjoyment uses.

Specific water quality criteria for Class AA waters are as follows:

<table>
<thead>
<tr>
<th>Microbiology:</th>
<th>The median total or fecal coliform bacteria count shall not exceed 70 per 100 ml for any 10 consecutive samples nor shall any single sample exceed 230 per 100 ml.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enterococci count shall not exceed a geometric mean of 30 per 100 ml for any 5 samples in a given 30 day period. No single sample shall exceed 60 per 100 ml.</td>
<td></td>
</tr>
<tr>
<td>pH:</td>
<td>pH variation shall be within 7.7 and 8.5 pH units.</td>
</tr>
<tr>
<td>Nutrients:</td>
<td>The ratio of total nitrogen to total phosphorus concentration shall be within 11.1 to 27.1.</td>
</tr>
<tr>
<td>Nitrogen:</td>
<td>The concentration of total nitrogen and total phosphorus shall not vary by more than 10% from the natural conditions.</td>
</tr>
<tr>
<td></td>
<td>Except for concentrations attributable to natural causes, total P concentration shall not exceed 0.025 mg/lt.</td>
</tr>
</tbody>
</table>

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The resident Palauan dugong population represents the most geographically isolated population of Sirenia on the planet. Recent surveys have indicated that this population is declining. The current population is estimated to number between 26 and 50 animals (Browne et al., 1981; Marsh et al., 1992, 1995).

**Discussion**

**Water Quality** Water quality standards pertaining to the marine waters of Palau are contained in The Environmental Quality Protection Act, Chapter 1, Marine and Fresh Water Quality Standards Regulations (24 PNC, Environmental Protection, 1990). The Ngeror Island area is rated as a Class AA water type which applies to waters suitable for oceanographic research, propagation of shellfish and other marine life, conservation of coral reefs and wilderness areas, compatible recreational activities, and other aesthetic enjoyment uses.

Specific water quality criteria for Class AA waters are as follows:

<table>
<thead>
<tr>
<th>Microbiology:</th>
<th>The median total or fecal coliform bacteria count shall not exceed 70 per 100 ml for any 10 consecutive samples nor shall any single sample exceed 230 per 100 ml.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enterococci count shall not exceed a geometric mean of 30 per 100 ml for any 5 samples in a given 30 day period. No single sample shall exceed 60 per 100 ml.</td>
<td></td>
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<td>pH:</td>
<td>pH variation shall be within 7.7 and 8.5 pH units.</td>
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<tr>
<td>Nutrients:</td>
<td>The ratio of total nitrogen to total phosphorus concentration shall be within 11.1 to 27.1.</td>
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<tr>
<td>Nitrogen:</td>
<td>The concentration of total nitrogen and total phosphorus shall not vary by more than 10% from the natural conditions.</td>
</tr>
<tr>
<td></td>
<td>Except for concentrations attributable to natural causes, total P concentration shall not exceed 0.025 mg/lt.</td>
</tr>
</tbody>
</table>
Water quality conditions in the vicinity of Ngerur Island were well within the standards specified by the ROP for the parameters measured. (Note: of the standards specified, only bacterial determinations were not included in this survey.) The high water quality levels that characterize this area occur for several reasons. Firstly, Ngerur Island is small relative to the surrounding marine environment (lagoon) and has little influence on this water body. There is, for example, little runoff directly into the marine environment and that which does occur (such as the seeps noted above) is small and probably inconsequential, except perhaps at Spring 1. Second, water movement in this area is not restricted; i.e., the area is well exposed, especially to the north and west. Such exposure encourages water movement, or flushing, by wind-driven surface currents and deeper tidal movements. Such flushing maintains a steady supply of food and nutrients for the coral communities and aids in removing waste products. Finally, Ngerur Island is fairly well removed from developed areas that might contribute to water quality degradation. And even though it is close to the western side of Ngerekebesang, this part of Ngerekebesang is mostly uninhabited and Ngerur Island is further isolated by a channel of some depth which separates the two islands.

Invertebrates. Although work remains on identifying specimens collected from the island, the diversity of species is relatively low. In part this may be due to the island's isolation, but more significantly it is likely a result of the small range of habitats and the disturbed nature of the vegetation. Terrestrial aquatic environments (streams, swamps and marshlands, etc.) are absent, eliminating a fairly important component of terrestrial ecology in wet, tropical Palau. Vegetation types are limited (see Herbst, 1999) and therefore many habitats for insects and other small invertebrates are absent or poorly represented.

A number of the terrestrial molluscs (snails) collected on the island are native species (see Appendix C). Included are two snails (Omphalotropis cheynei and Palaua babelthuap) that are listed in the 1994 IUCN Red List of Threatened Animals (Greenbridge, 1993, cited in Cowie, et al. 1996). Robert Cowie (in Cowie et al., 1996, p. 16) relates the following:

The single species [of Assimineidae] found during the survey, Omphalotropis cheynei, was widespread, occurring at 11 of 31 terrestrial sites on Babelthuap, at the single site on Koror, where it was extremely abundant, and on both Rock Islands. It appears highly tolerant of human disturbance, being found at some of the most disturbed sites surveyed.

Identification of species within the genus Palaua is tentative (Cowie, pers. com.).

The results (Appendix C) of the taxonomic study of insects collected from Ngerur in October are still somewhat preliminary. The collection represents mostly the common species present on the island in October 1998. Many of these are introduced (naturalized species); however, one member of a presumed endemic genus of beetle (Leptophates) was collected.

Vertebrates. Unlike much of the rest of the Republic of Palau the island of Ngerur was not surveyed during the course of the systematic country wide avian and bat surveys conducted by the USEFS and cooperating agencies in 1991 (Engbring, 1992). There are no published faunal surveys of the island that we are aware of. Thus, our interpretation of the likely faunal components associated with the Island are based on our one week survey, past experiences conducting faunal surveys in the Republic of Palau, and comparison counts performed on Ngerekebesang during this survey effort.

The vegetation currently found on the Island (Herbst, 1999) is highly disturbed with almost no understory and few fruiting trees, thus does not offer much in the way of foraging or roosting opportunities for Palauan fruit bats. We detected single bats on each of three mornings on site. Palauan fruit bats are known to both forage and roost in small numbers in the forested parts of Ngerekebesang. Ngerchaol and in large numbers in Babelthuap (Engbring 1992, Wiles and Engbring 1993). The resident sheath-tailed bat is ubiquitous being present in almost all habitats in Palau even in the most heavily developed industrial areas. The dominant mammalian species on Ngerur is the house mouse. Densities encountered were extremely high. It is also likely that at least one other species of the rat-French polynesian rat may also inhabit the island. One other species of muridae, the house mouse was also seen during our survey. We did not detect any other mammalian species on the Island. Given the high densities of roof rats on the island it is not surprising that other vertebrate species diversity and densities were found to be low. No trapping program was undertaken in
conjunction with our reconnaissance surveys in an attempt to ascertain any quantitative data on introduced mammalian species. During the course of our survey we collected anecdotal information indicating that a monkey had been reported several times from the Island. We did not detect this animal while on Island, given the coverage we gave the Island it is unlikely that the animal is still present. The other five species of terrestrial mammalian species known from the Republic of Palau are commensal or domesticated farm animals. Because the Island is currently uninhabited it is not surprising that none of these species were encountered.

**Marine Mammals** Of the 3 species of legally protected marine mammals known to occur in Palau the only one that has ever been recorded within the lagoon or close to the Island of Ngerur is the dugong. Both the blue whale and sperm whales are known from the oceanic regions of the Indo-Pacific area, but neither is likely to be impacted by construction of this project.

As previously mentioned the resident population of dugong in Palauan waters is estimated to number between 26 and 50 animals (Brownell et al., 1981; Marsh et al., 1992, 1995). It has been estimated that the current food supply available in Palau is sufficient to support some 2000 animals (Heirschen et al., 1977; Anderson and Birtles, 1978 in Brownell et al., 1981). However, given the low reproductive rate of this species and the unlikely chance of natural recruitment from other populations, this resident species is severely endangered. The principle predator of dugong are humans. If illegal poaching continues it will not be long before this species is extirpated from the Republic of Palau.

Through most of their range dugongs spend their day in deep water, returning to shallower sea grass beds in the evening to forage. In Palau, dugongs forage in mixed seagrass beds made up of a variety of seagrass species including: *Halophila ovalis*, *Thalassia hemprichii*, *Halophila decipiens*, *Cymodocea rotundata* and *Syringodium isoetifolium* (Marsh et al, 1992, 1995). They have also been recorded ingesting crabs, and in Palau, at least two species of sea cucumbers (*Holothuria aenea* and *H. scabra*) (Brownell et al., 1981; Walker, 1983). In Palau, dugongs usually graze in lagoon waters deeper than 7 m that support relatively low biomass seagrass beds (Marsh et al., 1992, 1995).

Aerial surveys of dugong in Palau in 1978, 1990 and 1991 all found that the largest number of dugong were consistently found in the Malakal Harbor area (Marsh et al., 1992, 1995; Rathbun et al., 1986; Brownell et al., 1981). During the course of these same aerial surveys the closest that animals were detected to Ngerur Island, other than those recorded in the Malakal Harbor, was approximately 20 kilometers away (Marsh et al., 1992, 1995; Rathbun et al., 1986; Brownell et al., 1981). There are no suitable sea grass beds in close proximity to the Island; however, it is possible that animals occasionally pass close to the Island on their way to foraging areas located close to the outer reef and off of the north west coast of Babeldao.

**Avian Resources** The avifauna currently found on Ngerur is depauperate when compared to that of Ngerekebesang and other surveyed areas of Palau. The forest found on Ngerekebesang is regularly utilized by some 28 species of resident breeding birds, we detected only 12 forest birds species on Ngerur, and only one was found to be nesting. This difference is due to the disturbed nature of the vegetation and the high density of rats currently found on Ngerur Island. The avifauna found on Ngerur is dominated by native and indigenous species as is that found on other islands located in close proximity to the Island. There is little habitat on the Island suitable for migrating shorebirds. During the course of our survey we detected three such species utilizing the benthic shell exposed at low tide. Some 57 migratory and extralittoral shorebirds and passerines have been recorded in Palau. We detected three of the more common ones during this survey. For a more detailed discussion on the occurrence of migrant and extralittoral avian species in Palau see Pyle & Engbring (1985), Pratt et al. (1987), and Engbring (1992).

The Lagoon and the Daerur straits separating Ngerur from Ngerekebesang are utilized by a number of seabird species, most of the 13 species of resident seabirds use this area at least occasionally; in addition, 11 other species of migratory and extralittoral seabirds recorded from Palau may upon occasion utilize resources within the lagoon and possibly the Daerur straits.

There is no habitat on the Island of Ngerur suitable for the endangered Micronesian Scrubowlow. Ngerur does not support any suitable habitat for three of the other listed avian species found in Palau, these being the Pacific Black Duck, Common Moorhen, and White-breasted Woodswallow. Although there is no suitable habitat on the Island to attract or support the Nicobar Pigeon, it is likely that this species does occasionally utilize resources on the Island, and they may overfly the site on their way from nesting sites in the Rock Islands to foraging sites in Babeldao.

**Amphibians and Reptiles** We are unaware of any published surveys of the herpetofauna of the Island of Ngerur. Unlike other area in Palau we found very little diversity in the terrestrial reptiles encountered. Recent surveys on Babeldao would suggest that most of the resident terrestrial amphibians and reptiles found in Palau are relatively common and widely distributed throughout the Republic of Palau (Cowie et al., 1996; AECOS, Inc., 1998b). During the course of our survey we encountered only three of the 30 plus species of lizards previously recorded in Palau, and only one of the 5 species of snakes. We did not record either of the amphibian species commonly found throughout the rest of the country. The lack of undisturbed habitat the high density of roof rats undoubtedly combine to limit terrestrial reptile diversity and populations to a minimum.

Two species of listed sea turtles, the green and hawksbill turtles, are known to nest in Palau. Both have been recorded nesting in small numbers on the beaches of the Island of Babeldao; however, the majority of the Palauan populations of both species nest south of Ngeruktabel (Prichard, 1982). There are no extensive tidal mudflats and attendant algae and
Impacts and Recommendations

Water Quality Development of a resort on Ngerur Island could result in degradation of water quality in the nearshore environment around the island. Specifically, these impacts could include: (1) increased erosion (sediment runoff) from the island during grading and construction activities; (2) increased freshwater runoff due to constructed impervious surfaces (e.g., roofs, lanais, walkways, etc.) once construction is complete; and (3) disposal of wastes (sewage, garbage, etc.) to the marine environment when the resort is operational.

Because of the small size of Ngerur, careful attention must be paid to controlling runoff from this island both during construction and on an on-going basis once construction is completed. Such considerations (best management practices or BMPs) are based upon general principles for handling drainage concerns at construction sites. While site-specific BMPs must be determined by the design architects and engineers, the following is a list of general practices that should be followed during the construction period to minimize erosion (ABAG, 1995; Goldran et al. 1986; USEPA, 1993):

- Minimize earth movement - fit the construction to the terrain. Minimize grading.
- Minimize impervious coverage - use stepping stones or natural chips instead of concrete walkways. Keep paths as natural as possible.
- Minimize vegetation removal - preserve trees, grass and other natural vegetation in order to maintain site stability. Locate structures to minimize the need for clearing.

Biology From a terrestrial biological perspective, Ngerur Island is currently not in good ecological shape. The vegetation has been heavily altered and the understory cleared. The only mangrove on the Island, and mangroves are important in the life cycles of many marine organisms as well as necessary for a number of endemic avian species. The SIJlaU mangrove located on the south eastern end of the Island is important in that it is the only mangrove on the Island, and mangroves are important in the life cycles of many marine organisms as well as necessary for a number of endemic avian species. In addition mangroves can help prevent siltation of reefs and waterways, by retaining particulate matter in runoff waters.

The most significant potential impacts that the development of the Island might have on the ecosystem as a whole is to marine resources through runoff, siltation, physical damage and pollution. Extensive care should be exercised when planning and implementing the build out phase of the project, so as to ensure that as little damage as possible is done to the coral, nearshore faunal resources, and other marine organisms.

The small mangrove located on the south eastern end of the Island is important in that it is the only mangrove on the Island, and mangroves are important in the life cycles of many marine organisms as well as necessary for a number of endemic avian species. In addition mangroves can help prevent siltation of reefs and waterways, by retaining particulate matter in runoff waters.

The roof rat population on the Island constitutes both the major limiting factor to terrestrial vertebrate resources but also poses a human disease threat. It is recommended that efforts be launched to eliminate this population as soon as feasible. Because it will require a

- Grading Schedule - grading should be halted during storm events and afterwards when the soil is in a wet, saturated, muddy, or unstable condition.
- Phasing Clearance - land disturbance activities should be planned and staged so that only a small area is exposed at any one time.

Some erosion on a small site such as Ngerur is unavoidable even using the BMPs recommended above. Thus, other structural controls will likely be required to prevent sediment runoff into the nearshore marine waters during the construction phase. These might include (but not necessarily limited to) mulch/mats (NRCS, 1996; Rickson, 1994), siltation barriers (Engle and Jarrett, 1990), and/or sediment barriers (USEPA, 1993). Additional permanent structural controls may be required to retard freshwater runoff and encourage permeation once construction is completed.

Disposal of sewage wastes (and other wastewater) and garbage, once the resort is operational, is also a concern. All garbage should be removed from the Island by boat or barge and disposed of in a proper landfill area. Sewage wastes should either be removed from the Island and delivered to a sewage treatment facility, disposed of via a deep injection well on Ngerur, or treated and discharged in a manner that will not degrade water quality in the receiving waters.

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- Grading Schedule - grading should be halted during storm events and afterwards when the soil is in a wet, saturated, muddy, or unstable condition.
- Phasing Clearance - land disturbance activities should be planned and staged so that only a small area is exposed at any one time.
combination of methods, and multi-applications of all methods, it is recommended that a comprehensive rodent eradication and long term control program be developed and implemented. It is further suggested if feasible toxicants used be introduced to the Island in bait stations and that toxicants with minimal secondary toxicity characteristics be utilized, such as Diphacinone.

Landscaping with native and indigenous trees especially fruiting ones will help restore native faunal resources to the Island. Birds and butterflies are highly desirable aesthetic ecological components for upscale and ecotourism clients. Many of the currently absent species commonly found on Ngerekebesang and other Islands will rapidly re-colonize Ngerur, following the control and / or removal of rats and the replanting of the Island with more desirable plants.

Literature Cited


### Appendix A: TIDE CONDITIONS AT PALAU DURING THE NGERUR ISLAND SURVEY (OCTOBER 1998)

**Tidal Height (ft)**

| Date 1998 |

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<th>Station</th>
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<th>DO (mg/l)</th>
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**Note:** The grayed areas indicate sampling periods.

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### Appendix B: WATER QUALITY CONDITIONS AROUND NGERUR ISLAND, OCTOBER 14 - 16, 1998

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<th>Station 1</th>
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ASSIMINEIDAE
Campbelliocrinus chesmid (Dohrn & Semon)
end. 22 T

ULOBIDAE
Pythia sarraboas (L.)
ind. 22 E

HELICARIONIDAE
Pala six cf. habitihaupi Baker
end. 22 E

PUPTIDAE
Pupita difficilis Semon
ind. 22 T

SUBLINIDAE
Subulina octona (Bruguière)
nat. 22 T

SUCCINEIDAE
Succina sp.
end. 22 T

ARTHROPODA, CRUSTACEA
ISOPODA
Porcellio laevus Latreille
sow bug. 22 T

BALANIDAE
indet.

CHITJAMALIDAE
Europipho caudata
nat. 22 M

DECAPODA
ATYIDAE
Cardia typica
ind. 20 A

COENOBITIDAE
Cronchites sp.
hermit crab
Ind. 20 T

PALAEMONIDAE
Macrobrachium lar
Ind. 20 A

ARTHROPODA, SPIROBOLIDA
PACHYBOLIDAE
Trigonaquisa lumbrix
natty millipede 22 T

APPENDIX C. (continued)

ARTHROPODA, INSECTA
ORTHOPTERA
GRYLLIDAE
Cardioecystus sp.
22 T

ACRIDIDAE
Oxya hyaenica (Stål)
22 T

COLEOPTERA
CURCULIONIDAE
Lophostethus sp.
End. 22 T

DIPTERA
CALLIPHORIDAE
Calliphora vomitoria (L.)
22 T

CULICIDAE
Aedes albopictus (Skuse)

- larvae
  nat. 22 A
- adult
  nat. 22 T

DROSOPHILIDAE
Drosophila sp.
22 T

PLATYSTOMATIDAE
Schloesies bimaculata (Handl)

Plagioszomyrna sp.
22 T

TACHINIDAE
Phaenusa sp.
22 T

TIPULIDAE
Limosia sp.
22 T

HETEROPTERA (=HEMIPTERA)
NOTONECTIDAE
Indet.
20 A

VELIIDAE
Indet.
20 A

HYMENOPTERA
FORMICIDAE
Ampulex longipes Jerdon
long-legged ant
22 T

SPHECIDAE
Chalybion longuespinis (Dahlbom)
wap
23 T

TERMITIDAE
Ter Constrictipes sp.
termites
22 T

LEPIDOPTERA
CRAMIDAE
Indet.
22 T

GELECHIIDAE

AECOS Consultants (AC06b.doc) Page 27

AECOS Consultants (AC06b.doc) Page 28
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Appendix B-5

Report on the Botanical Survey
(Herbst, 1999)
REPORT ON THE BOTANICAL SURVEY
OF
NGERUR ISLAND
REPUBLIC OF PALAU
1998

Prepared for:
Wil Chee Planning, Inc.
Honolulu, Hawai‘i

Prepared by:
Derral R. Herbst, Ph.D.
Bemice P. Bishop Museum
Honolulu, Hawai‘i

February 20, 1999

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Flora .............................................................. 3
Vegetation ....................................................... 3
Findings .......................................................... 6
Recommendations ............................................... 6
Useful References ............................................... 6
Appendix 1 ...................................................... 7
Introduction

Ngerur Island is a small, relatively flat island of volcanic origin. It is about ten acres in area, and has an elevation of approximately 70 feet at its highest. The island is located approximately 0.5 miles northwest of the northwestern point of Arakabesan island. The week of October 11th, 1986, was spent surveying or collecting information on the flora and vegetation of the island. The purpose of the survey was to inventory and assess the botanical resources of the island to determine if the vegetation or any members of the flora were significant, unique, or protected by local regulations.

Methods

A walk-through, reconnaissance-level survey of the island was conducted. The island was completely circled, walking on the reef flat at low tide, to identify the plants growing on the low cliffs of the island, or over-hanging them. North/south and east/west transects on the island completed the survey. Observations concerning the flora and vegetation were recorded and a species list was prepared (Appendix 1).

Flora

The vascular flora of Ngerur Island consists of 104 taxa in 51 families. Seventy-eight of the 104 taxa are believed to be native to Palau, but are common species widely distributed in the islands; another 23 taxa are adventive or naturalized, while the remaining 3 consist of 2 ornamental shrubs planted in a graveyard, and a fruit tree purposely introduced. These cultivated plants have not reproduced nor increased in number from the original plantings. Other useful plants, such as the coconut and breadfruit, which were also introduced to the island have reproduced and spread and are therefore considered naturalized components of the island’s flora (Table 1).

<table>
<thead>
<tr>
<th>Family</th>
<th>Native</th>
<th>Adventive or naturalized</th>
<th>Cultivated or persisting</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pteridophyta</td>
<td>17 (100%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>17</td>
</tr>
<tr>
<td>Monocotyledoneae</td>
<td>22 (76%)</td>
<td>6 (21%)</td>
<td>1 (3%)</td>
<td>29</td>
</tr>
<tr>
<td>Dicotyledoneae</td>
<td>39 (70%)</td>
<td>17 (23%)</td>
<td>2 (4%)</td>
<td>58</td>
</tr>
<tr>
<td>TOTAL</td>
<td>78 (75%)</td>
<td>23 (22%)</td>
<td>3 (3%)</td>
<td>104</td>
</tr>
</tbody>
</table>

Vegetation

The most comprehensive classification of Palauan plant communities probably is that of Cole et al. (1987). Their survey, which was designed primarily to assist foresters and land-use developers, divides the islands of Palau into four major land classes, based upon their vegetation: these are forest, agroforest, secondary vegetation, and nonforest. The four classes are further divided into vegetation types and subtypes, delineated on the basis of their drainage patterns and community structure. Variations in species composition occur within each general community type, and are influenced by site edaphic factors and disturbance history. While humans have utilized all of the vegetation communities in Palau, the last three listed are maintained by recent human activity, activities which have shaped these anthropogenic communities for thousands of years.

In a recently published book, Vegetation of the tropical Pacific Islands, Mueller-Dombois and Fosberg (1988) briefly characterize the vegetation communities of Palau. The Mueller-Dombois/Fosberg system divides the vegetation on the Palauan islands with volcanic soils into five major types: Mangrove and Freshwater Swamp Forests, Strand and Lowland Vegetation, Interior Upland Forest, Ravine and Riparian Forest, and Savanna. The Mueller-Dombois/Fosberg classification is followed in this report. Of the five vegetation community types recognized by Mueller-Dombois and Fosberg, two are represented on Ngerur Island: the Interior Upland Forest and the Savanna vegetation associations, and a single floristic element of a third, the Mangrove and Freshwater Swamp Forest association. Five Sonneratia alba (urur, white mangrove) trees grow in the shallow reef waters on the eastern part of the island, but, as this is the only element of the mangrove community present, it can not be considered a Mangrove vegetation association.

A brief description of the two vegetation associations is given below. It should be remembered that Ngerur Island has a long history of human disturbance. At various times in the past, the island has been inhabited; it has been cleared for agricultural purposes, a chicken farm was once established on the island, and the island was used as a leper colony. As a result of the disturbance, and, additionally, perhaps the small land area of the island, the present vegetation is secondary, and a depauperate, poor example of the vegetation communities present. Many of the species listed below which are used to characterize the two vegetation associations are lacking. A list of the plant species present on the island is given in Appendix 1.

1. Interior Upland Forest vegetation association: upland forests are restricted to the volcanic islands of Palau. Floristically, the Palauan upland forest is the most species diverse vegetation type in Micronesia. Examples of trees characteristic of this vegetation type include Maranta comosa, Gmelina palluensis, Rhus taftensis, Elaeocarpus jaga, Gacynthia spp., Poutaria obovata, Alpinia cornifolia, Semecarpus venenosus, Calophyllum inophyllum, Serianthus kanehirae, and Pterocarpus indicus. Perhaps the most common tree in the canopies of upland forests is Campnospermum brevipetala, but it usually is found on flat, lower elevation lands near streams or rivers, rather than in the drier environment of this island. Common understory species of the Upland Forest vegetation type include the palms Pinanga insignis and Heterospatha elata, (xora cases, Osmyxylon oliveri, Alpinia spp., Symplocos racemosa, Pandanus amnibernis, Manilkara ubobo, Caesarea hirtella, Alpina palauensis, Astronium palauense, and Cynthia kunulata. Understories of the upland forests usually are relatively open. The vegetation on the eastern half of Ngerur is most similar to the Interior Upland Forest vegetation type, but lacks many of the common characteristic species enumerated above that are found in the more extensive examples on Babeldaob.

2. Savanna vegetation association: most, if not all, of the grassland/savanna vegetation in Palau is the result of human activity: wildlife, land clearing, or mining. These anthropogenically maintained open uplands are also quite species-rich, although they are floristically much less diverse than the upland forests sites. Cole et al. (1987) recognize five major sub-types of the Grassland/Savanna vegetative community. Bare, Fern Lands, Grasslands, Shrubs, and Aridland Agriculture. The sub-types are based upon former land use and the amount and type of vegetation present.
The western half of Ngerur supports Grassland/Savanna vegetation. Although not a particularly good example, the vegetation fits best within the parameters of Cole's Grasslands sub-type which comprises grasses and grass-like species frequently with ferns, shrubs, and pandanus as elements of the vegetation. Common graminoid species used to characterize this vegetative sub-type include the grasses *Ischaemum polystachyum* var. *chordatum*, *Paspalum nidiculare*, and *Dimeria chlordaniformis*; with *Rhynchospora rubra*, *Solea spp.*, and *Fimbristylis dichotoma* being common sedges. Associated ferns, fern allies, and shrubs may include *Gleichenia linearis*, *Lycopodium spp.*; the club moss, *Lycopodium cernuum*, and shrubs, such as *Melastoma malabatricum*, *Eurya japonica*, *Decaspermum fruticosum*, and *Wikstroemia elliptica*.

**Findings**

1. Threatened and endangered species: a list of threatened and endangered wildlife compiled by the government of Palau includes the following six plant taxa:

   - Gulubia palauensis (Becq.) Moore & Fosb. (combret, schrunkri, eibeukh, rock island palm)
   - Psychopoma palauensis (Kaneh.) Moore & Fosb. (esbouch, Palau palm)
   - Parkia parvifolia Hopen. (emakamer, parkia)
   - Pericopsis moorei (Thw.) Thw. (amansi, kamarok, ngimet tree)
   - Cinnamomum carolinense Meissn. (ochod, Caroline cinnamon tree)
   - Cinnamomum pedatinervium (Kaneh.) Moore & Fosb. (ochod, cinnamon tree)

   The two species of palms typically are members of Limestone Forest or Rock Island Forest vegetation associations, while *Pericopsis* usually is found in Swamp Forest communities or along sections of streams or rivers influenced by the tides. These vegetation types do not occur on Ngerur Island. The other three taxa are found in Interior Upland Forest vegetation associations, and potentially could occur on Ngerur Island, however, none were found during the survey; all plants observed were common species widely distributed throughout the volcanic islands of Palau.

2. Several plants present on Palau can be harmful to humans. Perhaps the best known of these is *Semecarpus venenosa*, the forget or poison tree. Individuals allergic to relatives of this tree, which includes poison igu, poison oak, mango, sumac, and cashew, can react painfully to exposure to its sap. Such an incident could destroy a tourist's vacation and the resort potentially could be held responsible for knowingly harboring a harmful object in their public areas. The tree was not found on Ngerur Island during this survey, however, *Abrus precatorius* (black-eyed Susan, rosary pea), a slender, non-native vine in the bean family is established on the island, but is not common. The hard-coated, brilliant scarlet, pea-sized seed with a black spot at its point of attachment to the pod, is attractive and would attract the attention of adults and children alike; it contains the toxin *abrin*, a toxalbumin which inhibits protein synthesis in growing cells of the intestinal wall. Because of its hard coat, the seed is considered harmless if swallowed whole, but the ingestion of a single well-chewed seed could be fatal (Lampe & McCann 1985).

3. The island has a history of disturbance, as a result, the vegetation is secondary: the vegetative communities on the island are neither unique nor particularly good examples of their types, and are not considered worthy of preservation.

**Recommendations**

1. *Abrus* and other harmful plants, if any, found during the landscaping and subsequent grounds maintenance phases of the resort development be removed and destroyed.

2. As much of the native vegetation as possible should be preserved, especially the large specimen trees.

3. The landscaping should consist of native plants or, at the least, a mixture of native and exotic species. The ubiquitous ornamentals used throughout the tropical and subtropical regions of the world have been over used; employing attractive native plants would add an unique, interesting aspect to the landscaping.

4. The development of a nature trail with labeled plants or a printed guide would be an additional recreational opportunity of interest to many guests of the resort.

**References**


Staples, G.W. and D.R. Herbst. (in prep.) In gardens of Hawai‘i II. Completed manuscript presently being edited at the B.P. Bishop Museum, Honolulu.
APPENDIX 1: Checklist of the Vascular Plant Species of Ngerur Island, Palau

The following checklist was compiled from observations made by Herbst on the 12th, 13th, and 15th of October 1998. The entries are arranged alphabetically under their family names and include the scientific name, the common name, the status of the species, and the host plant and habitat. With a few modifications, the nomenclature of the native and naturalized plants follows that of Fosberg, Sachet, and Amaryllidaceae (amaryllis family) Dinero (1979, 1982, 1987), except for the ferns which also are based on the taxonomy of Crabbe, et al. (1975). The cultivated plants follow the taxonomy of Staples and Herbst (in prep). The common names are taken mostly from Fosberg, et al. (1980).

### MONOCOTYLEDONAE

**Asparagaceae** (asparagus family)
- *Asparagus officinalis* L. (asparagus; uvegetable)
- *Asparagus densiflorus* L. (asparagus; asparagus)

**Amaryllidaceae** (amaryllis family)
- *Amaryllis belladonna* L. (amaryllis; dia)
- *Amaryllis belladonna* var. *hispanica* L. (amaryllis; dia)

**Agavaceae** (century plant family)
- *Agave americana* L. (century plant; uhe)
- *Agave deserti* (L.) H. Wendl. (century plant; uhe)

**Arecaceae** (palm family)
- *Areca catechu* L. (betel nut; buu)
- *Areca catechu* var. *carteri* (L.) H. Wendl. (betel nut; buu)

**Asparagaceae** (asparagus family)
- *Asparagus officinalis* L. (asparagus; uvegetable)
- *Asparagus densiflorus* L. (asparagus; asparagus)

**Pteridophytes**

**Polypodiaceae** (polypod fern family)
- *Polypodium peltatum* L. (polypod; polypod)
- *Polypodium vulgare* L. (polypod; polypod)
- *Polypodium sightings* L. (polypod; polypod)

**Ophioglossaceae** (adder's tongue family)
- *Ophioglossum vulgatum* L. (adder's tongue; adder's tongue)
- *Ophioglossum vulgatum* var. *punctatum* L. (adder's tongue; adder's tongue)

**Polypodiaceae** (polypod fern family)
- *Polypodium peltatum* L. (polypod; polypod)
- *Polypodium vulgare* L. (polypod; polypod)
- *Polypodium sightings* L. (polypod; polypod)

**Ophioglossaceae** (adder's tongue family)
- *Ophioglossum vulgatum* L. (adder's tongue; adder's tongue)
- *Ophioglossum vulgatum* var. *punctatum* L. (adder's tongue; adder's tongue)

**Zingiberaceae** (ginger family)
- *Zingiber officinale* Rosc. (ginger; ginger)
- *Zingiber zerumbet* Sm. (ginger; ginger)

**Taccaceae** (hibiscus family)
- *Taccaceae* (hibiscus family; hibiscus)
- *Taccaceae* (hibiscus family; hibiscus)

**Zingiberaceae** (ginger family)
- *Zingiber officinale* Rosc. (ginger; ginger)
- *Zingiber zerumbet* Sm. (ginger; ginger)
<table>
<thead>
<tr>
<th>1°</th>
<th>2</th>
<th>3</th>
<th>4</th>
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</thead>
<tbody>
<tr>
<td><strong>DICOTYLEDONAE</strong></td>
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</tr>
<tr>
<td>ANACARIDACEAE (tuma family)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Mangifera indica (L.) (well, mango)</td>
<td>X</td>
<td>T</td>
<td>T</td>
</tr>
<tr>
<td>Rhus taffroensis Guill (juice, sumac)</td>
<td>N</td>
<td>T</td>
<td>T</td>
</tr>
<tr>
<td>Sporodas dulcis Park. (mescaldeel)</td>
<td>X</td>
<td>T</td>
<td>T</td>
</tr>
<tr>
<td>APIACEAE (UMBELLIFERAE) (carrot family)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Centella asiatica (L.) Urb. (elisentriu)</td>
<td>N</td>
<td>H</td>
<td>T</td>
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<tr>
<td>APOCYNACEAE (dogbane family)</td>
<td></td>
<td></td>
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<tr>
<td>Cerbera manghas (L.) (remdeido)</td>
<td>N</td>
<td>T</td>
<td>T</td>
</tr>
<tr>
<td>ARALIACEAE (parsnip family)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Schottlera elliptica (Bl.) Hands. (bunganau)</td>
<td>N</td>
<td>V</td>
<td>T</td>
</tr>
<tr>
<td>CASUARINACEAE (ironwood family)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Casuarina equisetifolia (ngas: ironwood)</td>
<td>N</td>
<td>T</td>
<td>T</td>
</tr>
<tr>
<td>CELASTRACEAE (bitter-sweet family)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loxostigma macrocarpa (L.) Fosb. (paleeuea (Low,er,) Fosb. (kerangel)</td>
<td>N</td>
<td>V</td>
<td>T</td>
</tr>
<tr>
<td>CLUSIACEAE (GUTTIFERAE) (mangosteen family)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calophyllum inophyllum var. inophyllum (beaches, kanwai, portia tree)</td>
<td>N</td>
<td>T</td>
<td>T</td>
</tr>
<tr>
<td>COMBRETACEAE (combretum family)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Terminalia catappa L. (milin, tropical almond, false kamani)</td>
<td>N</td>
<td>T</td>
<td>T</td>
</tr>
<tr>
<td>CONVOLVULACEAE (morning glory family)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Murraya petallata (L.) Merr. (kebabs)</td>
<td>N</td>
<td>V</td>
<td>T</td>
</tr>
<tr>
<td>EUPHORBIACEAE (spurge family)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chamaesphele myristilza (L.) Millsp. (NCN)</td>
<td>X</td>
<td>H</td>
<td>T</td>
</tr>
<tr>
<td>Codiaeum variagatum (L.) Bl. (keesuk, kesiu or greenery, carpet)</td>
<td>X/P</td>
<td>S</td>
<td>T</td>
</tr>
<tr>
<td>Glochidion rambourii Forst. (? (NCN)</td>
<td>N</td>
<td>S</td>
<td>T</td>
</tr>
<tr>
<td>Manetanga camellifolia Voul var. carolinensis (bedal)</td>
<td>N</td>
<td>T</td>
<td>T</td>
</tr>
<tr>
<td>Phyllanthus amarus Sth. &amp; Th. (ukelila nuchel)</td>
<td>X</td>
<td>H</td>
<td>T</td>
</tr>
<tr>
<td>FABACEAE (LEGUMINOSAE) (pea family)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abrus precatorius L. (rosary bean, black-eyed susan)</td>
<td>X</td>
<td>V</td>
<td>T</td>
</tr>
<tr>
<td>Adenanthera pavonina L. (teintetuanial, fawt wilwelsi)</td>
<td>X</td>
<td>T</td>
<td>T</td>
</tr>
<tr>
<td>Aplysia vaginalis (L.) DC. (NCN)</td>
<td>X</td>
<td>H</td>
<td>T</td>
</tr>
<tr>
<td>Copaluria pallida Ait. (kantornia, rattle god)</td>
<td>X</td>
<td>H</td>
<td>T</td>
</tr>
<tr>
<td>Diospyros variabilis (L.) Bl. (derez, dub, Israf, derris root)</td>
<td>X</td>
<td>P</td>
<td>S</td>
</tr>
<tr>
<td>Deriis inflatae Lour. (kerenokem)</td>
<td>N</td>
<td>V</td>
<td>T</td>
</tr>
<tr>
<td>Dalbergia canadensis (Dentist, Prain (suit)</td>
<td>N</td>
<td>V</td>
<td>T</td>
</tr>
<tr>
<td>Desmodium retrocurvum var. oblongum var. longiflorum (okule zelu)</td>
<td>N</td>
<td>T</td>
<td>T</td>
</tr>
<tr>
<td>Desmodium wilioum (L.JOC. (olumad, peggpar's lice)</td>
<td>X</td>
<td>H</td>
<td>T</td>
</tr>
<tr>
<td>Leucaena leucocephala (Lam.) de Wit. (teletundu, kas hacle)</td>
<td>X</td>
<td>S</td>
<td>T</td>
</tr>
<tr>
<td>Pterocarpus indicus Wilt. (iis)</td>
<td>N</td>
<td>T</td>
<td>T</td>
</tr>
<tr>
<td>Sterianthes karehira Fosb. var. karehira (uwalli)</td>
<td>N</td>
<td>T</td>
<td>T</td>
</tr>
<tr>
<td>**MALVACEAE (mallow family)</td>
<td>H. Inca (hikatso L. (tefmal, bau)</td>
<td>N</td>
<td>T</td>
</tr>
<tr>
<td>**MELASTOMACEAE (melastoma family)</td>
<td></td>
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<tr>
<td>Melastoma malabathricum var. mariannum (Naud.) Fosb. &amp; Sachet (melatkiu)</td>
<td>N</td>
<td>S</td>
<td>T</td>
</tr>
<tr>
<td>**MORACEAE (mulberry family)</td>
<td></td>
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<tr>
<td>Artocarpus altilis (Park.) Fosb. (kamai, mediu, broadnail)</td>
<td>X</td>
<td>T</td>
<td>T</td>
</tr>
<tr>
<td>Ficus microcarpa L. (bulk, Chinese banana)</td>
<td>N</td>
<td>T</td>
<td>T</td>
</tr>
<tr>
<td>Ficus tinctoria Forst. (? (raeklad)</td>
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<td>T</td>
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<tr>
<td>**MYRTACEAE (myrtle family)</td>
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<tr>
<td>Eugenia reinwardiana (Bl.) DC. (kersil)</td>
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<tr>
<td>**OXALIDACEAE (wood sorrel family)</td>
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<tr>
<td>Oxalis corniculata L. (lemis, yellow wood-sorrel)</td>
<td>N</td>
<td>H</td>
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<tr>
<td>**PASSIFLORACEAE (passion flower family)</td>
<td></td>
<td></td>
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<tr>
<td>Passiflora edulis (L.) Fosb. (kudanano, passion flower)</td>
<td>X</td>
<td>V</td>
<td>T</td>
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<tr>
<td>**PIPERACEAE (pepper family)</td>
<td></td>
<td></td>
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<tr>
<td>Peperomia pellucida (L.) HBK (terilli, peperomia)</td>
<td>X</td>
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<tr>
<td>**POLYGALACEAE (milkwort family)</td>
<td></td>
<td></td>
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<tr>
<td>Polygaca paniculata L. (keskus re meekar-ng)</td>
<td>N</td>
<td>T</td>
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<tr>
<td>Salvia cordata Lours. (NCN)</td>
<td>N</td>
<td>P</td>
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<tr>
<td>**PORTULACACEAE (purslane family)</td>
<td></td>
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<tr>
<td>Portulaca oleracea L. (pulosea, purslane)</td>
<td>N</td>
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<tr>
<td>**RUBIACEAE (coffee family)</td>
<td></td>
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<tr>
<td>Hedyotis strigulosa (Bartl. ex DC.) Fosb. (red dil kelemak)</td>
<td>N</td>
<td>H</td>
<td>T</td>
</tr>
<tr>
<td>Isora casei (Hance) (kerolso, bura)</td>
<td>N</td>
<td>S</td>
<td>T</td>
</tr>
<tr>
<td>Morinda citrifolia L. var. citrifolia (nogel, Indian mulberry)</td>
<td>N</td>
<td>T</td>
<td>T</td>
</tr>
<tr>
<td>Mussaenda philippica A Richard (erechoh)</td>
<td>N</td>
<td>g</td>
<td>T</td>
</tr>
<tr>
<td>Psychotria lepidophylla var. longifolia Val. (NCN)</td>
<td>N</td>
<td>S</td>
<td>T</td>
</tr>
<tr>
<td>**RUTACEAE (rise family)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Citrus sp. (unknow)</td>
<td>X/P</td>
<td>T</td>
<td>T</td>
</tr>
<tr>
<td>**SAPOTACEAE (sapote family)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Pouteria odorata (R.B.) Baehni (clangel)</td>
<td>N</td>
<td>T</td>
<td>T</td>
</tr>
<tr>
<td>**SCROPHULARIACEAE (figwort family)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Linaria auriculata (L.) F.Muell. (iheleka)</td>
<td>N</td>
<td>H</td>
<td>T</td>
</tr>
<tr>
<td>**SOMMERERIACEAE (white mangrove family)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sonneratia alba J.E. Sm. (uruv. white mangrove)</td>
<td>N</td>
<td>T</td>
<td>M</td>
</tr>
<tr>
<td>**STERculiACEAE (cacao family)</td>
<td></td>
<td></td>
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<tr>
<td>Commersona forata L. Merr. (euramallueang)</td>
<td>N</td>
<td>S</td>
<td>T</td>
</tr>
<tr>
<td>1*</td>
<td>2</td>
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</tr>
<tr>
<td><strong>TILIACEAE</strong> (linden family)</td>
<td></td>
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<tr>
<td>Corchorus aestuans L. (NCN)</td>
<td>X</td>
<td>H</td>
<td>T</td>
</tr>
<tr>
<td>Trichospermum ledermannii Burret (elsau)</td>
<td>N</td>
<td>T</td>
<td>T</td>
</tr>
<tr>
<td><strong>TURNERACEAE</strong> (turnera family)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Piquesta ovata</em> (Belio y Esp.) Urban (NCN)</td>
<td>X</td>
<td>H</td>
<td>T</td>
</tr>
<tr>
<td><strong>VERBENACEAE</strong> (verbena family)</td>
<td></td>
<td></td>
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<tr>
<td><em>Callicarpa candicans</em> (Burm.f.) Hochr. (Dub; racheli)</td>
<td>N</td>
<td>S</td>
<td>T</td>
</tr>
<tr>
<td><em>Premna serratifolia</em> L. (osem)</td>
<td>N</td>
<td>T</td>
<td>T</td>
</tr>
<tr>
<td><em>Stachydicta urticifolia</em> Sims (touch belau, false verbena)</td>
<td>X</td>
<td>H</td>
<td>T</td>
</tr>
<tr>
<td><em>Vitex calassus</em> Reinw. ex Di. (bars; becke)</td>
<td>N</td>
<td>T</td>
<td>T</td>
</tr>
<tr>
<td><strong>VITACEAE</strong> (grape family)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Cayratia trifolia</em> (L.) Domin (bendaki)</td>
<td>N</td>
<td>V</td>
<td>T</td>
</tr>
</tbody>
</table>

*EXPLANATION OF COLUMN HEADINGS AND SYMBOLS:*

**Column 1 (CLASSIFICATION):** The information in this column relates to the classification of the plant. The first entry is the scientific name of the plant, including the authority; the second entry, in parentheses, is the common name of the plant (NCN: no common name) indicates that in Palau a common name for the plant has not been found. Some plants were neither in flower nor fruit so could not be identified to the specific level; these have the genus name, followed by "sp." meaning that the species is unknown. Column 2 (STATUS): N = native to Palau; P = planted or persisting, a native or non-native plant which was planted in its present locality and has not reproduced nor spread since; X = exotic, non-native species of accidental or deliberate introduction. Column 3 (HABIT OR GROWTH FORM): F = fern; G = grass or grass-like plant; H = herb, a plant with little or no woody growth; S = shrub, woody plants with several major stems, usually low growing; T = tree, woody plants usually with one major stem; V = vine or liana, non-woody or woody plants which can not support themselves, but sprawl or climb over the ground or on other plants. Column 4 (HABITAT OR PLACE IN THE VEGETATIVE COMMUNITY): A = aquatic, rooted, emergent, or floating in water; E = epiphyte, attached to another plant, but using that plant for support only; M = marine; T = terrestrial, rooted in relatively dry soil.
Appendix B-6

Archaeological Inventory Survey

(IARII, Inc., 1999)
Archaeological Inventory Survey
of Ngerur Island, Koror,
Republic of Palau

by
Jolie Liston, M.A.

draft prepared for
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February 1999
ABSTRACT

At the request of Wil Chee-Planning Inc., International Archaeological Research Institute, Inc. (IARI) conducted an archaeological inventory survey of Ngerur Island, Koror State, Republic of Palau. Construction of an elite resort is planned for the island. As Ngerur has been previously recorded as Site OR-12x7, the Palau Division of Cultural Affairs (DCA) requested that archaeological investigations occur prior to any proposed construction activities. The purpose of the survey was to locate and record cultural properties on the island and to provide significance evaluations and recommendations for avoidance or mitigation of these properties should construction proceed.

Fieldwork consisted of a pedestrian survey of the 4 acre parcel, recording of encountered archaeological features through verbal descriptions, photographs, and maps, and subsurface testing where warranted. Oral history documentation pertaining to the project area was conducted by Dr. Victor Yano and Jennifer Sugiyama.

Fifty-seven archaeological features were identified during fieldwork. These include concrete structures, rock mounts, rock-faced terrace platforms, earth platforms and small rectangular platforms, modified outcrops, alignments, depressions, furrows, rock shelters, trails, wells, a cemetery, a dock, a midden, a rock-circle, a rock-ring, and a utility pole. Thirteen features either contain or potentially contain human burials. Of these, five are likely hearth features but need positive identification. Twenty-three graves have been recorded in the cemetery, although it is probable that more are present.

All the cultural properties on Ngerur date to the 1930s when the island was an asylum for those with Hansen's Disease. A few of the features were reconstructed in the 1950s when members of the Episone family lived on Ngerur.

The archaeological features identified during the survey are considered to be significant under criteria established by the Palau Historical and Cultural Preservation Act. Most of these features have been sufficiently recorded during the intensive survey; a few require more detailed recording and/or testing to determine if human burials are present. It is recommended that all human remains be disinterred prior to construction activities in accordance with a Burial Treatment Plan that has been prepared for Ngerur Island (Liston 1999a).
ACKNOWLEDGMENTS

The author would like to thank the many people who assisted in the successful completion of the Ngerur Island Survey project. These include Vicky Kanai, Historic Preservation Officer for Palau; Rita Oludong, Palau Senior Archaeologist; Mandy and Shalum Etpison; and Ben and Jose at Neco Marine. The hard work and enthusiasm shown by field supervisor Vince Bilajak and field worker James Iohanes is greatly appreciated. Dr. Victor Yano and assistant Jennifer Sugiyama were diligent and enthusiastic in collecting oral histories concerning Ngerur. Their efforts in this work of vital importance are gratefully acknowledged.

Special thanks go to the people at IARII who contributed to the report construction: Roger Blackstein for all the drawings, Coral Magnuson for editing, formatting, and assistance with the photography, David Welch for editing, and Celeste LeSuer for report production.
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I. INTRODUCTION

This report presents results of an archaeological inventory survey of Ngerur Island, Koror State, Republic of Palau conducted by International Archeological Research Institute, Inc. (IARI) on behalf of Wil Chee-Planning, Inc. An elite resort is proposed for construction on the island. As Ngerur had been previously recorded as Site OR-12:47, the Palau Division of Cultural Affairs (DCA) requested that archaeological investigations occur prior to any proposed construction activities. All archaeological investigations were undertaken in accordance with the provisions of Title 19, the Palau Historical and Cultural Preservation Act. Objectives of fieldwork were to determine what cultural resources were present in the project area, evaluate these resources for significance, and recommend what further action—avoidance and/or mitigation—might be necessary to ensure that all information pertinent to the prehistory and history of the people of Palau is collected and preserved.

The planned resort will be constructed on the 4 acres of land that comprise Ngerur Island. In addition, support facilities, including a boat dock, will be constructed along a portion of the northeastern shore of Malakal Island. As this area consists only of fill and previous archaeological monitoring of trenches in the vicinity of this parcel revealed no cultural remains, no archaeological investigations were undertaken on Malakal. The project will have no adverse effect on cultural resources in this area.

Archaeological investigations undertaken for this project consisted of a pedestrian survey of the entire 4-acre island. All cultural properties encountered were recorded and photographed and detailed plan maps were prepared of the individual features. Subsurface testing was undertaken where warranted. Emphasis was placed on locating and identifying grave plots so that appropriate measures could be taken for the removal of human remains prior to construction. Oral history documentation pertaining to the project area was conducted in conjunction with the archaeological survey.

Fieldwork was carried out between 27 October and 6 November 1998 under the direction of IARI archaeologist Jolie Liston, M.A. She was assisted by field supervisor Vince Blaylock, B.A. and field workers James Johannes, Principal Investigator David J. Welch, Ph.D., visited the island on the initial day of fieldwork. Dr. Victor Yano and Jennifer Sugiyama conducted oral history interviews with people who once lived on Ngerur.

SCOPE OF WORK

Archaeological investigations were conducted in accordance with the scope of work dated April 1998. Following Title 19 guidelines, the purpose of an archaeological inventory survey is to identify and evaluate for significance any cultural resources located within the
In the inventory survey of Ngerur Island, Palau, the scope of work developed for this project called for the completion of the following tasks:

1. Complete the survey of the island, identifying all archaeological features that are present.

2. Complete the mapping, locating all the features on the island.

3. Describe and photograph each feature not previously described.

4. Conduct limited small scale test excavations. These were to be oriented toward determining the extent and depth of subsurface deposits, recovering in situ charcoal or shell that could be used for radiocarbon dating to determine the age of the deposits, and determining whether burials were present under stone features that appeared to be burial markers.

5. Conduct background research reviewing any sources of information about the history of the island, including its use by the Japanese as a leper colony and for WWII defensive purposes.

6. Conduct oral history research concerning the traditional village on the island. Because the island appears to be the site of a traditional village about which little or nothing appears in written accounts, the oral history would be important in assessing the possible historical significance of the site as well as its importance in Palauan traditions, myths, and legends.

7. Analyze excavated materials and submit samples for radiocarbon dating to assist in determining age and function of the features.

8. Prepare a report summarizing survey results, describing features on the island and their probable functions, evaluating historical significance of the island features, and making recommendations regarding the need for preservation or further mitigation work.

SUMMARY OF FIELDWORK AND RESULTS

Fifty-seven archaeological features were identified during inventory survey. These include nine rock mounds, six concrete foundations or structures, six terrace platforms, five earth platforms, five stone-lined trails, four modified outcrops, three alignments, three depressions, three sets of furrows, two stone-lined wells, two disturbed features, a set of rock shelters, a cemetery, rock, middle, rock circle, rock-cuttings, and a utility pole. In addition, five small rectangular stone platforms, two of which are located on terrace platforms, were identified. Thirteen features either contain or potentially contain human burials. Of these, five are likely hearth features but need testing for positive identification. At least 23 graves are in the cemetery, although it is probable more are present. Figure 1 shows the relative location of each cultural property on Ngerur Island. These features containing or potentially containing human burials are marked with a star.

The cultural properties on Ngerur date to the 1930s when the island was used as a leper colony. Some of these may be constructed from traditional features such as stone platforms and paths. A few of the features were reconstructed in the 1950s when members of the Epison family lived on Ngerur.

All archaeological features identified during the survey are considered to be significant under criteria of the Palau National Code Title 19, the Palau Historical and Cultural Preservation Act. The island, Site OR-12:47, possesses integrity of location, setting, materials, craftsmanship, feeling, and association; and has yielded, or may be likely to yield, information important in prehistory or history (Criterion D). Preservation of the cultural properties is preferred; however, as the planned development of the island will not be compatible with preservation, mitigation through data recovery and disinterrment and removal of human remains is an alternative.
Figure 1. Location of cultural features on Niger Island. Burial or potential burial features are marked with a star.
II. PROJECT AREA BACKGROUND

PHYSICAL SETTING AND ENVIRONMENT

Ngekur Island is part of the Palauan archipelago, a collection of over 300 islands and islets spread along a 120 km long north-south arc in the western Pacific (Fig. 2). The center of the chain, a part of the western Caroline Islands of Micronesia, is located near 7 degrees north latitude and 134 degrees east longitude, 600 km north of Borneo and 900 km east of Mindanao in the Philippines.

The geology of Palau consists chiefly of volcanic material and organic limestone (U.S. Army 1956). Babeldaob, the largest of the islands, part of the central island of Koror, and several small islands close to Koror, including Ngekur, originated from Eocene and Oligocene volcanic activity and are composed of basalt and andesite (Fig. 3). The limestone component of the archipelago consists of three types of islands: 1) high limestone, or rock islands, uplifted by tectonic forces then undercut by persistent wave action, 2) low platform islands, such as parts of Angaur and Peleliu that are moderately uplifted reef flats, and 3) classic coral atolls such as Keayangeli. A reef, partly barrier and partly fringing, encloses most of the islands from Babeldaob south to Peleliu.

Palau has a maritime tropical rainy climate with little variation in temperature or barometric pressure throughout the year (U.S. Army 1956:19). Mean temperature is 81 degrees F, with a mean temperature deviation of only 1 degree between the warmest and coldest months. The diurnal variation in temperature is about 10 degrees F. Relative humidity is high with an annual mean of 82 percent. Prevailing trade winds are from the northeast and east during winter and spring and from the southwest in summer and autumn.

Rainfall is abundant throughout the year, with an annual total of 150 inches (380 cm). The lowest precipitation (about 6 to 8 inches per month) occurs from February through April (U.S. Army 1955:20). The remaining months register between 10 to 20 inches of rain, with July typically the wettest month. Recurrence of the El Niño system in the past years has radically altered these typical weather patterns. Most rainfall occurs in the form of short but torrential storms.

Ngekur Island is located 734 m northwest of Deso'wei Point on Ngabezang Island, Koror (Fig. 4). The island comprises roughly 1.25 acres and is ca. 290 m wide, east to west, and 350 m, north to south. In the center of the island, on both the east and west sides, are small, rock-bottom inlets. There is enough seawater present in the western cove for boats to dock. Currently, the eastern cove and the southern tip of the island are too shallow, even at high tide, to allow boats entry.
Figure 3. Map of the central section of the Republic of Palau.
Ngerulmud is volcanic in origin, composed primarily of volcanic breccia, conglomerate, and tuff. The island's surface rises gently towards the center, to gain an elevation of approximately 20 m above sea level. Basalt outcrops, ca. 3 to 4 m high, frame a bench varying between 15 to 20 m wide around the south and southeast sides of Ngerulmud. A steep 1 to 4 m high cliff abuts the rocky beach surrounding the island. Fresh water is provided by several streams which flow from the side of the cliff.

The majority of the island is a lush secondary forest containing a variety of trees such as coconut (Cocos nucifera), mango (Mangifera indica), wild hibiscus (Hibiscus tiliaceus), breadfruit (Artocarpus altilis), wild taro (Colocasia esculenta), and lemon (Citrus limon). The quantity and variety of edible plants provided ample food resources for residents of the island. The west side of Ngerulmud is characterized by level sand savanna covered in grasses and screw pine (Pandanus tectorius). A small clump of mangroves borders the southern coast.

PRE-CONTACT CONTEXT

Pre-contact cultural sequences for Palau have been proposed by Osborne (1966), Masse (1989, 1990), and recently by JARRI (Wickler et al. 1998:138-143; Liston 1999b). The latter incorporates new data gathered during extensive research in support of construction of the Compact Road and expands upon Masse's 1989 sequence. This proposed sequence divides Palauan cultural history into three major periods, which has been further subdivided into seven roughly dated phases (Table 1). A brief synopsis of each of the periods is provided below.

Table 1. Pre-Contact Palauan Cultural Sequence Partly Following Wickler et al. (1998:138).

<table>
<thead>
<tr>
<th>Period</th>
<th>Phase</th>
<th>Dates</th>
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<tbody>
<tr>
<td>Terrace Period</td>
<td>Colonization</td>
<td>1800 BC-AD 1</td>
</tr>
<tr>
<td></td>
<td>Expansion</td>
<td>AD 700-1000</td>
</tr>
<tr>
<td></td>
<td>Late Phase</td>
<td>AD 900-1200</td>
</tr>
<tr>
<td>Village Period</td>
<td>Early Phase</td>
<td>AD 1200-1400</td>
</tr>
<tr>
<td></td>
<td>Intermediate</td>
<td>AD 1400-1500</td>
</tr>
<tr>
<td></td>
<td>Late Phase</td>
<td>AD 1600-1800</td>
</tr>
</tbody>
</table>

EYRAL SETTLEMENT PERIOD (CA. 1800 BC - AD 600)

Limited archaeological data are currently available which document the initial period of settlement in Palau. There are three radiocarbon dates from cultural deposits dating to the second millennium BC (Liston 1999b). These date pre-terrace cultural activity at terrace sites in Ngaiwal to 1439-1110 BC (NI-1:79, WK 5937), in Ngiangjwng to 1311-811 BC (NT-3:10, WK 5926), and in Ngeredubech village to 1410-998 BC (NT-3:9a, WK 5904). Seven charcoal samples have produced radiocarbon dates dating to the fourth millennium BC (Wickler et al. 1998; Liston et al. 1998; Liston 1999b). These assays derive from intact cultural deposits in village, terrace, and shore scatter sites, and redeposited cultural deposits in terrace sites.

All these assays were obtained by Accelerated Mass Spectrometry (AMS) from extremely small samples of scattered charcoal, a far from ideal context for the gathering of radiocarbon dating samples. The dates however, are calibrated at two sigma and associated with deposits containing pottery and flaked stone.

The collective radiocarbon evidence thus presents a clear case for settlement during the second millennium BC. The inland location of many sites suggests earlier coastal occupation, indicating initial colonization of Babeldaob occurred by at least 1800 BC.

Indirect evidence for a slightly earlier human settlement than that documented by the archaeological record were obtained from paleoenvironmental cores taken on Babeldaob (Athens and Ward 1998). Coconut (Cocos nucifera), potentially introduced by humans, initially appears in a core interval a few centimeters above a sample that yielded a radiocarbon date of 2464-2231 BC. One core shows a dramatic upsurge in both charcoal and pollen indicative of savanna during the second millennium BC, just after the initial appearance of coconut. Based on these data, humans probably settled Palau by at least 2000 BC, and possibly as much as 500 years earlier.

The expansion of settlement across Babeldaob during the first half of the first millennium AD is documented from a variety of geographical locations from which radiocarbon dates were obtained. Charcoal samples from a posthole feature and associated cultural deposit on Ngerulmud Hill, Melekeok produced a combined calibrated age range of AD 18-651 at two sigma (Liston et al. 1998). Terrace sites in Ngiangjwng (NT-2:2), Melekeok (ME-1:67), and Ngeru (NY-4:4) produced calibrated dates ranging from AD 88-789 (Wickler et al. 1998). Although each of the dates appear to be associated with cultural activity preceding the principal period of terrace construction, two of the samples are from fill layers which may be associated with the initial stages of terrace construction.

It is therefore possible that terraces were being constructed during the first half of the first millennium. Whether this is the case or not, evidence of inland occupation locations, coupled with evidence from the paleoenvironmental coring of the expansion of the savanna at this time, clearly indicate inland expansion of human settlement from AD 1-600.
TERRACE PERIOD (AD 600 - 1200)

During the Terrace Period, there is a marked increase in the number and distribution of archaeological sites with more intensive use of resources and exploitation of diverse environments throughout the archipelago. Despite this, human settlement on Palau remains poorly understood during this period.

Terrace construction expansion is emphasized since nearly all the radiocarbon dates from Babeldaob are associated with terrace sites. Terraces occur in a wide range of morphological types and are associated with a variety of artifacts and features. Some terraces appear to have served one purpose, while at others numerous activities took place. Likely they were primarily agricultural, with the absence of evidence for irrigation suggesting dryland cultivation of a crop such as taro. Terraces may have also been used for defensive purposes, habitation, rituals, and burials.

Terrace construction and use appear to have diminished and many of the massive features abandoned beginning AD 900-1200. However, this hypothesis is based on the most direct evidence for terrace abandonment. One potential cause of terrace abandonment is increased conflict after AD 1000, suggested by the construction of defensive features (trenches and embankments) on agricultural features abandoned beginning AD 900-1200. However, this hypothesis is based on the negative evidence (i.e., the lack of terrace associated dates after ca. AD 1200) rather than direct evidence for terrace abandonment. One possible factor is a shift in agricultural production from dryland taro grown on terraces to wetland taro cultivated in lower elevations. Potential explanations for this agricultural transformation include: 1) massive erosion and depletion of the agricultural soils on terraces; 2) increase in wetlands suitable for taro production as a result of geomorphological changes (e.g., transformation of embayments into marshes and swamps); and 3) increased agricultural output from intensive wetland taro production linked to population growth (Wickler et al. 1998:141).

The issues of terrace construction, function, and abandonment will need to be addressed with large-scale archaeological investigations including extensive stratigraphic trenching, aerial excavation of terrace sites, and additional paleoenvironmental coring.

There is evidence for expansion into the marginal areas of the archipelago, either for sustained habitation or short-term occupation of the rock islands from AD 600 to 900 with their decline in use by AD 900-1200 (Masse et al. 1984-88).

VILLAGE PERIOD (AD 1200-1800)

The Village Period refers to the time of village system development on Babeldaob which culminated in the traditional villages observed at European contact during the late 18th century. During this period there was a dramatic increase in the number of samples yielding radiocarbon ages which provide a more solid foundation for interpreting complexities of cultural change in Palau.

Samples were obtained from cultural deposits within the boundaries of traditional village sites. The earliest of these are suggestive of less intensive or temporary villages due to absence of buried structural remains compared with the presence of multiple features and dense midden deposits found in later village deposits (Wickler et al. 1998:142).

At least 11 sizable villages, some with defensive features, were established on the rock islands from AD 1200-1400. The development of village systems took place significantly earlier here than on Babeldaob. This may be in part due to increased conflict that forcibly displaced populations from the volcanic islands. The defensive features found in the rock island villages and terrace sites hint at this possibility.

The collapse of the rock island village systems by AD 1450 may have fueled development of traditional villages on Babeldaob (Masse et al. 1984:76). At this time, an increase in subsurface features such as postholes and refuse pits, and presence of dense middens demonstrate a more intensive habitation of the volcanic islands. It is assumed that irrigated pondfield cultivation of taro intensified in response to population growth and expansion of traditional villages. Two pondfields were readily accessible to traditional villages.

The physical and social configuration of traditional village during the Village Period was most likely in place by the 17th century. It was formed by a pattern of shifting alliances linking village federations across Babeldaob. Oral histories, lists of title holders, and first-hand accounts of Europeans add considerable depth and breadth to the picture of Palauan culture provided by the archaeological record during this phase.

CONTACT TO PRESENT DAY

Although initial European contact with Palau occurred in the 16th century, it was not until two centuries later that outside influences brought about the irrevocable transformation of Palauan culture.

Spanish explorers were the first Europeans to spot the Palau Islands. Magellan's 1521 expedition sighted the Sentaolos, in the southwest islands (Levesque 1992a:334). Englishman Francis Drake made the first recorded landing in Palau in October 1579. The ship's chaplain wrote of canoes meeting the boat, bearing men with trade items of "Cocquos, fish, Potaros, and certain fruits to small purpose" (Levesque 1992a:492). He described the Palauans as having long ears that were cut round and hung down low on their cheeks, long fingernails, and black teeth developed from the eating of "an herbce [betel], with a kind of powder [lime]". The 17th century saw only intermittent contact with Westerners, although Jesuit missionaries made a condoms but generally unsuccessful evangelical effort in the area.
Sustained European contact with Palau began after 1783 when the English schooner, the Antelope, ran aground on the reef west of Ulong Island. In exchange for the village federation of Koror helping them in reconstructing their boat, the sailors introduced the Palauans to firearms. At this time, the two most powerful village federations: Koror (Ngerekdeu) and Melekeok (Ngetelngal) were competing with one another to expand their influence. On three occasions the men of the Antelope assisted Koror in battles against their enemies (Keate 1788).

During the next century, British sea captains entering Palauan waters were commonly met by high chiefs desiring support for their military expeditions. Koror usually had the upper hand in terms of gaining support for its war since the large European ships were more likely to dock in Koror's natural harbor. As a result, the political influence of Koror rose.

Palau saw few foreign vessels during the early 19th century as the islands were too near Manila to serve as a reprovisioning port and too far from the major Pacific whaling grounds. Additionally, trading plying the Pacific were reluctant to land in the archipelago as several instances of Palauans attacking passing ships were reported. By the mid-1800s, a few foreigners had begun to harvest sea cucumbers, gather turtle shell, and produce copra on Palau. Its waters soon became over-harvested and its copra production was minimal. Besides the introduction of western crops, that probably included manioc, maize, papaya, pineapple, and possibly sweet potato, Palau was little affected by outside influences and retained its cultural traditions. Society continued to be organized around traditional villages and clans.

Although Spain claimed all the Caroline Islands, it did little in the way of administering Palau. Her nominal rule was largely ignored by Britain, Germany, and the US. Germany, envisioning the Carolines as part of its military perimeter in the Pacific, attempted to claim the islands in 1885 (Hess 1983:308). Spain opposed its claim and countersunk by sending ships into the western islands to gather information, sign treaties, and plan commercial enterprises. The dispute over who would rule Palau was settled by Pope Leo XIII in 1885. He gave Spain jurisdiction over Palau, but allowed Germany to establish a naval station, a coaling station, plantations, and other agriculturally related projects (Palau Community Action Agency [PCAA] 1976:161).

Germany bought Palau and the remainder of the Caroline archipelago from Spain at the close of the Spanish-American War in 1898. The Germans fostered mercantile enterprises and social reforms. They operated several phosphate mining companies and copra plantations, and invested public works projects such as the construction of piers and navigation beacons. Laborers for these endeavors were young Palauan men. In addition, the Germans relocated people into larger villages.

Subsequent to a period of trading in Micronesia, the Japanese acquired the German held Pacific islands in 1914, at the onset of World War I. The southwestern advancement was considered strategically important for protection of the motherland in the event of a war and the initial patriotic expansion of the Japanese empire. By the 1919 League of Nations official mandate granting Micronesia to the Japanese, a civil government was already established with a developing infrastructure, Japanese schools and hospitals, and growing commercial and industrial endeavors. Headquarters for the colonial administration, or Bureau of the South Seas (Nan'yoo-sho), was located in Koror with branches in Swin, Truk, Pohnpei, Jayu, and Yap. They were to govern for the next 30 years with the goal of creating an extension of their own culture and economy in Micronesia (Peattie 1988).

Japanese and Okinawans were encouraged to migrate to Palau to work on plantations, in phosphate and bauxite mines, and other economic enterprises. This resulted in roughly twice as many foreigners as indigenous people living in Palau. The commercial center was established in Koror, which by 1938 had grown into a substantial, primarily Japanese city. Native people were considered a source of cheap labor for these enterprises and were treated as second-class citizens. Purchase of extensive tracts of land for agricultural purposes resulted in the large-scale relocation of Palauans away from traditional villages. Substantial improvements were made in social services, including establishment of mandatory primary schools, taught in Japanese, and construction of modern water and electrical systems. Palauans at the time did not view the years of Japanese direct rule, forced acculturation, and economic exploitation as oppressive (Parmentier 1987:30).

In preparation for what appeared to be the inevitable war, Japan secretly fortified Palau, even though the League of Nations mandate explicitly prohibited such moves. Airfields, military bases, ammunition depots, coastal defense and anti-aircraft gun emplacements were constructed, and close to 60,000 troops arrived in Palau to train before deployment to New Guinea or the Solomon Islands (Bailey 1991:8; Grant 1998). By the end of 1942, the war turned against the Japanese, the Palauans began to feel the strain of the restrictions and shortages. Islanders, many of them relocated from Koror and Peleliu to Babeldaob, were forced into labor gangs to help build defenses and increase food production on the plantations.

In 1944, the brunt of the war arrived Palau as the US began intensive air strikes (Operation Desecrate One) on the islands of Peleliu and Angaur and the surrounding waters in preparation for an amphibious assault. The battles for Peleliu and Angaur were particularly bloody and bitter (Falk 1974; Grant 1995). The coraline limestone formations were aptly suited for the Japanese defensive fortresses of interlocking tunnels, bunkers, and gun positions. For 66 days, the Americans were forced to take one key defensive position after another, ultimately at the cost of an entire Marine division. This bloody experience led the US forces to bypass the 10,000 or so Japanese troops remaining on Koror and Babeldaob, as they moved on to the Philippines.

To remind the Japanese of their presence, US aircraft conducted daily harassment raids. Japanese and Palauans were driven into caves and tunnels for protection. Food supplies dwindled, and starvation and disease took a toll on the population prior to the surrender and repatriation of Japanese forces.
In 1947, the interim Naval Administration for Micronesia was replaced with an American administration under a United Nations agreement. Under the trusteeship, the US was allowed to fortify the islands for security reasons and thus focused attention and funding on military facilities on Guam and Kwajalein and nuclear testing in the northern Marshall. Palau received little in economic aid or political development until the 1960s, when the US became cognizant of its colonialism (Pannenier 1987:52). However, renewed interest may have been a direct result of a need for a strategic backup for Subic Bay and Clark Air Force Base in the Philippines, for a deep-water port, and a dumping ground for nuclear waste. The US began to provide educational and health services, promote local democracy, and supply the islands with Western commercial goods.

Although the Pan-Micronesian entity of the Federated States of Micronesia was created in 1918, Palau voted to remain independent so it could negotiate for increased capital investment, direct economic assistance and social services, and for recognition as a self-governing constitutional republic (Pannenier 1991:32). Internal negotiations were strongly factionalized however, and it was not until 1994 that Palau signed a Compact of Free Association with the US and became the independent Republic of Palau.

**PREVIOUS ARCHAEOLOGICAL RESEARCH**

Late 19th and early 20th century ethnographic accounts provide detailed descriptions of traditional ways of life on Palau (Kubary 1885; Kramer 1917; Semper 1982). Kramer also drew numerous maps of traditional villages. Archaeological investigations of Palau began during the Japanese administration when Japanese anthropologist, Hisakatsu Hijikata, studied pottery, kinship systems, and stone carvings (Hijikata 1993, 1995). Following the war, extensive archaeological research was conducted by Douglas Osborne (Osborne 1966). He systematically described numerous village and terrace sites, as well as ceramics, stone carvings, and glyphs. Upon returning to Palau in 1968, Osborne (1979) conducted a series of excavations at eight archaeological sites, from which he devised typologies of ceramics, adzes, stone carvings, and terraces.

In the mid-1970s, archaeological research in Palau was boosted by the enforcement of laws that require evaluating the impact to cultural resources of projects funded and licensed by US agencies. Compliance with these laws resulted in a decade of relatively intensive archaeological research. Much of this cultural resource management work was conducted by graduate student archaeologists from the Center for Archaeological Investigations at Southern Illinois University (SIU), under the auspices of the Micronesian Resources Study of the Micronesian Endowment for Historic Preservation, the US Trust Territory Historic Preservation Office, the US National Park Service, and DCA.

The SIU group focused their research on (Snyder and Butler 1990:2): 1) establishing the antiquity of the traditional settlement patterns and the organization of traditional villages; 2) determining age and precise function of terrace systems, as well as characterizing differences between terrace-associated villages and coastal settlements; and 3) identifying stratified, dateable archaeological contexts, which had been rare in previous excavations.

From the mid-1980s to early 1990s, much of the archaeological work in Palau has been carried out by the Palau Division of Cultural Affairs (DCA) within a cultural resources management framework and as part of an ongoing state-by-state survey program. The DCA survey teams have focused on recording surface remains and collecting oral histories. In the absence of excavation, the chronological framework for prehistoric occupation was not established in most areas. This framework was to form the basis for research designs developed by IARL for the extensive archaeological work conducted in support of the construction of the Compact Road around Babeldaob (Wickler and Welch 1996, 1997).

Ngerur Island was briefly surveyed by a team of IARL archaeologists during an inventory survey conducted in February 1998 of the northwest portion of Ngerekebesang Island (Magnuson and Liston 1998). Some of the cultural properties present on the island were recorded, photographed, and mapped at that time (Magnuson, letter dated 16 July 1998). No other archaeological research has been conducted on the property.
III. ORAL HISTORY DOCUMENTATION

Oral history documentation for Ngerur Island traces back as far as the Japanese era. Other than the distinction of being referred to as the "playground of the Devil," no stories relating to its place in prehistoric or traditional Palau were found. During the Japanese era, the island served as a leper colony. Some of the occupants of the island at that time are still alive and it is these people who provided the information presented below.

Oral history documentation was conducted in October and November 1998 by Dr. Victor Yano with the assistance of Jennifer Sugiyama. Interviews were held with informants who lived on Ngerur Island when it was a leper colony. The author utilized a combination of this oral history documentation and information from a literature review to produce the following section of the report.

The oral histories presented in this section were collected to specifically aid in interpretations and evaluations of archaeological sites. Oral history research was conducted in conjunction with archaeological investigations in preparation for proposed construction on Ngerur Island and should not be used for other purposes. Exceptions to this include research in history, archaeology, culture and tradition, and use for educational purposes.

OVERVIEW

A physician stationed on Yap provided medical care for Palauans during the German administration (PCAA 1973:369). In 1909, the doctor for the phosphate company on Angaur began making irregular trips to Koror and Babeldaob to care for the sick. By 1915, Japanese military doctors and a few civilian doctors had started to care for the sick; however, government hospitals were not opened until 1922.

Japanese improvements in public health and sanitation included subsidies for building community washing places and water tanks, streets constructed of concrete, tours to show and explain sanitary housing, and the installation of toilets on outlying islands (PCAA 1973:373). Public inoculations against preventable epidemic disease were held once a year and those working in hotels and restaurants had physicals each year. Lectures on public health were given by physicians with the assistance of film clips and magic lanterns.

During the Japanese administration, the most widespread island diseases were intestinal parasites, tuberculosis (haliaio), venereal disease (rindó), dysentery, leishmaniasis (kerdik), and leprosy (habio) (PCAA 1973:321). Severe outbreaks of plague occurred three times prior to 1930.

Hansen's Disease was prevalent in Micronesia by the time the Japanese arrived in the islands. The disease was thought to have spread from Yap where a German radio operator had introduced the disease to the population sometime before 1900 (PCAA 1973:371). There was a total of 21 cases of leprosy in Palau in 1914 and 1915 (PCAA 1973:372). According to the Navy Department (1944:104):

Leprosy has been prevalent among the aborigines for many years. In 1915, it was estimated that there were 40 lepers in the Yap district and 21 in the Palau district. In 1937 there were reported to be 27 lepers in the Yap district and 22 in the Palau district. In the same year four natives in the Yap district and two in the Palau district were reported to have died from leprosy.

Since islanders at the time were considered "unable to stand by themselves under the strenuous conditions of the modern world," policies implemented in Micronesia did not include the rapid Japanization of the local population (Japan, Ministry of Foreign Affairs in Higuchi 1964:2). However, as health and sanitation was a critical issue of the Nan'yó-cho, laws applicable to the home islands were enforced in the colonies.

One such law required the segregation of those with Hansen's Disease from the remainder of the population. The Palauans did not consider leprosy to be a contagious disease, and it was only with difficulty that the Japanese were able to segregate lepers into asylums (Navy Department 1944:104). In Palauan society, those with Hansen's Disease were accepted into the community and not ostracized. In contrast, the Japanese had such a fear of leprosy that those with any type of skin disease were isolated from society.

Island-wide health screenings were held to identify people with leprosy. Leprosy colonies were established in Saipan in 1926 (closed shortly afterwards but reopened in 1929), in Jaluit in 1928, on the island of Ngerur in Palau in 1931, and in Yap in 1932 (PCAA 1973:372). According to PCAA, between 1928 and 1951, 22 lepers were treated in Jaluit, 20 on Saipan, 18 in Palau, and 12 in Yap.

In a Spanish mission publication Father Francis Elias wrote (Etelé 1943:79-80):

There are lepers in these islands and the Japanese government has decided to isolate them. The lepers were brought to a tiny island of little more than a hectare ca. 7 kilometers from here (the church in Koror). Three Japanese style huts and a water catchment were built for them... Altogether there were about 10 or 15 lepers in this place.

In another publication Elias mentions 20 lepers on Ngerur as well as family members who are not afflicted with the disease (Etelé 1936). He visited the leper colony repeatedly from 1931 until 1933, when the Governor prohibited further visits. The priest goes on to report that (Etelé 1936):

2 Hansen's Disease is now the accepted term for Leprosy.
The kind of leprosy here is relatively mild. It makes the face wrinkled and pimply, and joints of the fingers and toes are lost, but without the repugnant sores that are sometimes associated with leprosy. Those from Sonsorol, however, are more disfigured and suffer more arthritic symptoms in their hands and feet. They have many lepers from these islands, I believe that perhaps 20% of the population is more or less afflicted. They begin to limp a little, then their legs become crooked; the feet and hands become gaunt and horrible sores appear. Tobi has less of this disease than Sonsorol. Similar to leprosy is the cancer on Sonsorol. There are two men whose nose and upper mandible was eaten away by the disease, and their nose and mouth is now one large opening.

The Japanese called Ngerur Raibyo Shima (translated to “leper island”). A 1930 photo shows some of the structures in the Ngerur leper colony (Photo 1). The 1930 date on the photograph does not correspond with the reported date of 1931 for the leper colony’s establishment.

Table 2 lists the inhabitants of Raibyo Shima, their place of origin, gender, known relatives, and whether they are buried on the island. The information was gathered from those who once lived in the colony. The table shows 33 people lived on the island, all but one having Hansen’s Disease—or, at the very least, some form of skin disease. Of these, 17 are known to be male and seven to be female. Six colonists are from Ngarembe, five from Ngardmau, three from Marshalls, two from Okikull, and one each from Ngerchelum, Ngaruman in Koror, Ngaread, Miyujin, Peleliu, and Tobi. Non-Palauean residents include two from Saipan, two from Korea, and one each from Indonesia, Japan, Okinawa, and Yap.

Accoding to the informants, 12 people are known to be buried on the island, with only half of those interred in the cemetery. Since there are at least 23 graves in the cemetery, either many of those listed in Table 2 are not buried in Ngerur are not there are people who once lived on Ngerur that are not listed.

One of the informants, Odiu Rengos, told stories of his life at Ngerur. When he was 10 years old he lived in Okikull with his adopted mother Nglodech (leredee), a widow of Ngarembe. Odiu did not feel sick but had all the asymptotic rashes similar to “ringworm” on his back, arms, and face. One day police officer Waikasang and Dr. Iseksang came to the village and brought him to Koror, where he lived with his uncle Sbal before being transferred to Ngerur for confinement.

Odiu’s mother accompanied him to the island and lived there with him until she died when he was 15 years old. Apparently, she did not suffer from any rashes but did have a non-healing ulcer in the palm of her hand. Although she traveled to Angaur for treatment, the ailment never healed. It did not debilitate her in any way and she was able to do her daily work.

At the time of his confinement, there were three other young men on the island: Mesengei, Ngirchokebai, and You Tamag from Yap. Odiu was the youngest of the four. He lived on the island for 10 to 15 years, leaving when he was between 20 and 25 years of age.

Island life was easy since the soil was fertile and food was abundant. They ate tapioca, pumpkins, taro, watermelons, and breadfruit. Canoes were carved from meduu (breadfruit, Artocarpus altilis), kele! a charm (Campnosperma brevipes), or uli! (Serianthes grandiflora) trees. Sailboats were rigged and both sailing and fishing were a favorite pastime. Others made agot and as (water and pestle). Tools were available to construct houses of wood, hamono, and match, and make caskets. The rest of the day was spent resting and recuperating.
Table 2. People Known to Have Lived on Ngirer Island While It Was a Leper Colony.

<table>
<thead>
<tr>
<th>Name</th>
<th>Origin</th>
<th>Gender</th>
<th>Buried on Island?</th>
<th>Relatives</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Francisco</td>
<td>Saipan</td>
<td>Male</td>
<td>No</td>
<td>Nepele of Oli, brother of Salaino Demk</td>
<td>Killed by Japanese soldiers in Ngirer.</td>
</tr>
<tr>
<td>Hiram Noi</td>
<td>Ngerengel</td>
<td>Male</td>
<td>No</td>
<td>Nepele of Oli, brother of Salaino Demk</td>
<td>Died from the island. After the war, he returned to Palau.</td>
</tr>
<tr>
<td>Kabun</td>
<td>Toki (Eng)</td>
<td>Female</td>
<td>Yes*</td>
<td>Nepele of Oli, brother of Salaino Demk</td>
<td>Died from skin condition that left his hand (?)</td>
</tr>
<tr>
<td>Luu</td>
<td>Saipan</td>
<td>Male</td>
<td>No</td>
<td>Nepele of Oli, brother of Salaino Demk</td>
<td>Killed by Japanese soldiers in Ngirer.</td>
</tr>
<tr>
<td>Meckuasal</td>
<td>Ngirar-i</td>
<td>Male</td>
<td>No</td>
<td>Nepele of Oli, brother of Salaino Demk</td>
<td>Betrayed when 7 months pregnant. Was in 60s when on island. Had twin daughter who did not have leprosy but died young of unknown cause.</td>
</tr>
<tr>
<td>Nguerengel</td>
<td>Ngerengel</td>
<td>Male</td>
<td>No</td>
<td>Nepele of Oli, brother of Salaino Demk</td>
<td>Had a growth on his face. Was about 75 years old when on the island.</td>
</tr>
<tr>
<td>Nguerengel /</td>
<td>Ngerengel</td>
<td>Male</td>
<td>No</td>
<td>Nepele of Oli, brother of Salaino Demk</td>
<td>Died from the island and later killed by Japanese soldiers in Oli. (Rogers and killed with others).</td>
</tr>
<tr>
<td>Nguerengel</td>
<td>Ngerengel</td>
<td>Male</td>
<td>No</td>
<td>Nepele of Oli, brother of Salaino Demk</td>
<td>Killed by Japanese soldiers in Ngirer.</td>
</tr>
<tr>
<td>Nguerengel /</td>
<td>Ngerengel</td>
<td>Male</td>
<td>No</td>
<td>Nepele of Oli, brother of Salaino Demk</td>
<td>Killed by Japanese soldiers in Ngirer.</td>
</tr>
<tr>
<td>Nguerengel</td>
<td>Ngerengel</td>
<td>Male</td>
<td>No</td>
<td>Nepele of Oli, brother of Salaino Demk</td>
<td>Was about 65 years old when on the island.</td>
</tr>
<tr>
<td>Nguerengel</td>
<td>Ngerengel</td>
<td>Male</td>
<td>No</td>
<td>Nepele of Oli, brother of Salaino Demk</td>
<td>Died from the island and later killed by Japanese soldiers in Oli. (Rogers and killed with others).</td>
</tr>
<tr>
<td>Nguerengel</td>
<td>Ngerengel</td>
<td>Male</td>
<td>No</td>
<td>Nepele of Oli, brother of Salaino Demk</td>
<td>Killed by Japanese soldiers in Ngirer.</td>
</tr>
<tr>
<td>Nguerengel</td>
<td>Ngerengel</td>
<td>Male</td>
<td>No</td>
<td>Nepele of Oli, brother of Salaino Demk</td>
<td>Killed by Japanese soldiers in Ngirer.</td>
</tr>
<tr>
<td>Nguerengel</td>
<td>Ngerengel</td>
<td>Male</td>
<td>No</td>
<td>Nepele of Oli, brother of Salaino Demk</td>
<td>First inhabitant of the island. Lived on her last.</td>
</tr>
<tr>
<td>Nguerengel</td>
<td>Ngerengel</td>
<td>Male</td>
<td>No</td>
<td>Nepele of Oli, brother of Salaino Demk</td>
<td>Died from the island and later killed by Japanese soldiers in Oli. (Rogers and killed with others).</td>
</tr>
<tr>
<td>Nguerengel</td>
<td>Ngerengel</td>
<td>Male</td>
<td>No</td>
<td>Nepele of Oli, brother of Salaino Demk</td>
<td>Killed by Japanese soldiers in Ngirer.</td>
</tr>
<tr>
<td>Nguerengel</td>
<td>Ngerengel</td>
<td>Male</td>
<td>No</td>
<td>Nepele of Oli, brother of Salaino Demk</td>
<td>Killed by Japanese soldiers in Ngirer.</td>
</tr>
<tr>
<td>Nguerengel</td>
<td>Ngerengel</td>
<td>Male</td>
<td>No</td>
<td>Nepele of Oli, brother of Salaino Demk</td>
<td>Killed by Japanese soldiers in Ngirer.</td>
</tr>
<tr>
<td>Nguerengel</td>
<td>Ngerengel</td>
<td>Male</td>
<td>No</td>
<td>Nepele of Oli, brother of Salaino Demk</td>
<td>Killed by Japanese soldiers in Ngirer.</td>
</tr>
<tr>
<td>Nguerengel</td>
<td>Ngerengel</td>
<td>Male</td>
<td>No</td>
<td>Nepele of Oli, brother of Salaino Demk</td>
<td>Killed by Japanese soldiers in Ngirer.</td>
</tr>
<tr>
<td>Nguerengel</td>
<td>Ngerengel</td>
<td>Male</td>
<td>No</td>
<td>Nepele of Oli, brother of Salaino Demk</td>
<td>Killed by Japanese soldiers in Ngirer.</td>
</tr>
<tr>
<td>Nguerengel</td>
<td>Ngerengel</td>
<td>Male</td>
<td>No</td>
<td>Nepele of Oli, brother of Salaino Demk</td>
<td>Killed by Japanese soldiers in Ngirer.</td>
</tr>
<tr>
<td>Nguerengel</td>
<td>Ngerengel</td>
<td>Male</td>
<td>No</td>
<td>Nepele of Oli, brother of Salaino Demk</td>
<td>Killed by Japanese soldiers in Ngirer.</td>
</tr>
</tbody>
</table>

Table 2. (cont.) People Known to Have Lived on Ngirer Island While It Was A Leper Colony.

<table>
<thead>
<tr>
<th>Name</th>
<th>Origin</th>
<th>Gender</th>
<th>Buried on Island?</th>
<th>Relatives</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulaek</td>
<td>Mlkeko</td>
<td>Male</td>
<td>No</td>
<td>Ngiando</td>
<td>Lived on island to accompany a relative</td>
</tr>
<tr>
<td>Rossasch</td>
<td>Ngerengel</td>
<td>Male</td>
<td>No</td>
<td>Ngiando</td>
<td>Lived on island to accompany a relative</td>
</tr>
<tr>
<td>Rongel Rensset</td>
<td>Ngerengel</td>
<td>Male</td>
<td>No</td>
<td>Ngiando</td>
<td>Lived on island to accompany a relative</td>
</tr>
<tr>
<td>Sakairyo Demk</td>
<td>Ngerengel</td>
<td>Male</td>
<td>Yes</td>
<td>Ngiando</td>
<td>Lived on island to accompany a relative</td>
</tr>
<tr>
<td>Samediar</td>
<td>Ngerengel</td>
<td>Male</td>
<td>No</td>
<td>Ngiando</td>
<td>Lived on island to accompany a relative</td>
</tr>
<tr>
<td>Schedol</td>
<td>Ngerengel in Koror</td>
<td>Male</td>
<td>Yes</td>
<td>Ngiando</td>
<td>Lived on island to accompany a relative</td>
</tr>
<tr>
<td>Tidoevoi</td>
<td>Tolieu</td>
<td>Female</td>
<td>Yes</td>
<td>Ngiando</td>
<td>Lived on island to accompany a relative</td>
</tr>
<tr>
<td>Tidoreng</td>
<td>Ngerengel</td>
<td>Female</td>
<td>Yes</td>
<td>Ngiando</td>
<td>Lived on island to accompany a relative</td>
</tr>
<tr>
<td>Tidoevoi</td>
<td>Tolieu</td>
<td>Female</td>
<td>Yes</td>
<td>Ngiando</td>
<td>Lived on island to accompany a relative</td>
</tr>
<tr>
<td>Tidoreng</td>
<td>Ngerengel</td>
<td>Female</td>
<td>Yes</td>
<td>Ngiando</td>
<td>Lived on island to accompany a relative</td>
</tr>
<tr>
<td>Yau Tamng</td>
<td>Yap</td>
<td>Male</td>
<td>No</td>
<td>Ngiando</td>
<td>Lived on island to accompany a relative</td>
</tr>
<tr>
<td>?</td>
<td></td>
<td>Male</td>
<td>Yes</td>
<td>Ngiando</td>
<td>Lived on island to accompany a relative</td>
</tr>
<tr>
<td>?</td>
<td></td>
<td>Male</td>
<td>Yes</td>
<td>Ngiando</td>
<td>Lived on island to accompany a relative</td>
</tr>
<tr>
<td>?</td>
<td></td>
<td>Male</td>
<td>Yes</td>
<td>Ngiando</td>
<td>Lived on island to accompany a relative</td>
</tr>
<tr>
<td>?</td>
<td></td>
<td>Female</td>
<td>Yes</td>
<td>Ngiando</td>
<td>Lived on island to accompany a relative</td>
</tr>
<tr>
<td>?</td>
<td></td>
<td>Male</td>
<td>Yes</td>
<td>Ngiando</td>
<td>Lived on island to accompany a relative</td>
</tr>
<tr>
<td>?</td>
<td></td>
<td>Male</td>
<td>Yes</td>
<td>Ngiando</td>
<td>Lived on island to accompany a relative</td>
</tr>
</tbody>
</table>

* lived onNgirer Island to accompany a relative
** not buried in cemetery
*** Chronic Obstructive Pulmonary Disease
Housing was organized into separate island style dwellings for those from different regions of Palau: a unit for Melekeok and Ngchesar, one for Ngaremedke, one for those from Ngardmau, and one for Koror residents. Terrace platforms such as Fas 28 and 29 are island style dwellings but the structures built on the concrete foundations (Fas 33, 34, and 35) are Japanese in design. Both types were used for housing.

A military ship (musashi) may have moored once near the island so that a medical team could disembark to obtain fluid and biopsy specimens from the lepers. One informant, however, refutes this information.

Once every two weeks, or possibly every month, a public health official—usually Dr. Iseksang and some nurses—visited the island for a few hours to perform check-ups and dispense medicine. Dr. Takao Wada was also a physician in Palau at the time but it is not known if he visited Ngerur. While some patients had tuberculosis and others had sores, none had facial deformities or limb amputations. Medications were oil based and came in a plastic container. They were administered to all and had a terrible taste. Odiu would often spit the medication out. No one improved with the treatment. Another informant says the lepers had to be fumigated with a special spray both before and after the medical team's visits.

The doctor was accompanied by Japanese coastguard (policemen) Waikasang, Rebenu, and Rechesengel, and a Palauan officer from Kayangel, Kemsong Kodep. They punished lawbreakers by whipping with a belt. Kemsong acted as an interpreter. It was on these monthly visits that supplies such as rice and cigarettes were delivered to the colonists.

Once a month requiring punishment was leaving the island, a common event for the colonists. Odiu would sail from the island to Amejiik with Secharaimul in order to transport colonists or their relatives. He rented the boat out between 7 and 8 at night so as to avoid detection of the illegal activity. One time he transported a pig from the island to Koror and had to be subdued by being whipped with a dried horse tail. He was incarcerated for 14 days as punishment for his crime.

Takasaro, a male in his late 30s from Ngiwal, often drove his boat between Koror and Ngerur transporting colonists or their relatives. He rented the boat out between 7 and 11 at night so as to avoid detection of the illegal activity. One time he transported a pig from the island to be sold by people from Ngarai. Reksid attempted to buy the animal but in the end it was sold to a buyer from Peleliu. Reksid proceeded to report the transaction to the Japanese officials who called Takasaro in for questioning. He fought with the police officer and had to be subdued by being whipped with a dried horse tail. He was incarcerated for 14 days as punishment for his crime.

Many died of causes other than leprosy. According to the informant, burial sites were not marked by stones but were generally kept in the same area, behind a large outcrop. There is a large outcrop just to the south of the cemetery but, before vandalism, a large proportion of the graves were outlined in cobblestones. Perhaps the informant does not clearly remember this, or it indicates that there are additional interments in the cemetery which are not visible on the surface.

As the Japanese were terrorized by the illness, none of them came to the island, barring the police officers and the wife of a high official. Palauan relatives, however, often visited the island and would stay on for months. None of these visitors ever contacted any form of illness. Another informant reports that only Japanese nurses came to the island to check on patients and that the three Palauan nurses, Gladine Pollar, Kany Ngori, and Faustina Uelura, working at the central hospital in Koror stayed behind.

Ngori of Ngarai captured the isolation and sadness inhabitants of Ngerur felt on New Year as they imagined the celebration in Koror and the rest of Palau in a song composed for the occasion. The song was translated by Kathy Kesolei. In the song below, the “Midori” boat refers to the Japanese boat which traveled around Palau transporting people and goods from place to place. “Arkemais” is the Palauan name for T-dock and the ochiwhu bird is an Audubon shearwater (Phaethon ochrurus).

**Ngerur**

It's New Year again, and you are all having fun,
You are all having fun, while I am here by myself and feeling lonely.

My dear friends, let me tell you about our island. Our island is small and considerably removed.

It is twilight, once again, and I am at the lookout point. While at the lookout point, I saw Midori boat.

I saw Midori boat moored at Arkemais, and we were yearning for company.

When the ochiwhu birds start to cry in the early morning, it reminds me of good times long ago.

The most cursed and shameful disease befell us on land and it has broken our hearts and spirits. Sadly there is nothing that can be done about it.

One time, a quartet started between Sechedui and Ngiraosei regarding the ownership of some firewood. It escalated into a fight where Ngiraosei speared Sechedui from the right shoulder through the chest and abdomen and the barb lodged in his right groin. When police officers Waikasang and Iseksang came to investigate the incident, Waikasang asked Sechedui if Sechedui would survive should the spear be pulled out. Iseksang replied in the negative. Sure enough, when the spear was pulled out Sechedui gasped his final breath. He was buried on the island. Ngiraosei was punished by being cuffed at the ankle to the post of his dwelling.

At the onset of WWII, the colonists fled to Babebos. Because they had Hansen's Disease, a public announcement was made asking for information as to their whereabouts. Japanese soldiers tracked some of them down and killed them. Kengi, Ngirai, Ngori and Sechedui, and two Palauans were killed in Ngatpang. Odiu and Ngiraosei in Ngirai; and Ngiraosei was killed in Melekeok. Odiu bid in caves and the local policemen kept their whereabouts a secret.
Odiu fled to Ngerodobotar where he hid with the natives of Koror during the war. He befriended Samsel, from Medonn, and often went fishing with him. Upon hearing that soldiers were looking for Odiu but lacked a way to identify him, Samsel recommended that he change his name to avoid being detained. Odiu's friend from Koror, Delulaoch, suggested that "Gibbons" be his new name. Only later, after the end of the war, did Odiu find out that "Gibbons" was the name of William Gibbons, a member of the Ngaramekerii (the Koror Council of Chiefs) and father of Charlie and James Gibbons. However, he kept the name out of fear that government officials might detain him and return him to Ngerur.

During the war, several of the colonists returned to Ngerur when food became scarce on Babeldaob. The Japanese did not want anyone on the island and soon followed You Tamag (a Yapese), Mechudengul, Kabrina, two Koreans, and an Indonesian, Japanese, and Okinawan to Ngerur to hunt them down. While trying to escape, the Indonesian jumped off the escarpment surrounding the island and broke his leg. All but You Tamag, who swam across the channel to Kuberes ngas (west passage of Malakal) and hid in the rock islands, were killed by the soldiers. These seven are buried away from the Ngerur cemetery but it is not known where on the island they were interred. Mechudengul, You's wife, was four months pregnant when she was beheaded on Ngerur. Japanese soldiers often resorted to beheading their captives in order to save their bullets. After the war, You Tamag crossed over to Omekang (one of the rock islands) and finally returned to Yap.

In 1948, during the American administration of Palau, six Palauans with Hansen's Disease were sent to the leperarium on Tinian in the Commonwealth of the Northern Marianas (Richards 1957 in Jones 1991:271). It is not known if some of these Palauans had once lived on Ngerur.

After the war, the island was bought by the Epsion family from Ngoriak for $400 US plus a jeep. The island is still owned by members of the Epsion family. Kekereldil Epsion, now 105 years old and living in Koror, lived for many years on Ngerur. During the 1960s and 1970s, her grandchildren would spend their summers and weekends with her. She lived in a house built on a stone platform (Fig. 36) with her kitchen on a set of concrete posts (Figs. 33, 34, or 35) and utilized the concrete outhouse (Fig. 30). She also kept chickens and goats in a building with a concrete slab foundation (Fig. 37) and farmed tapioca, sweet potatoes, and pumpkins. Small boats were used to commute between Koror and Ngerur. The vessels docked at one of two landings: the dock in the western cove or either the eastern cove or the dock (Fig. 44) on the southeast side of the island. Currently, there is not enough water in the eastern cove and no method of ascending from the dock on the southeast side.
IV. FIELD INVESTIGATIONS

This chapter details results of archaeological fieldwork conducted on Ngerur Island. It describes field methods, summarizes survey results, and provides detailed feature descriptions. The main objective of inventory survey was to identify, locate, and record all prehistoric and historic cultural properties on Ngerur Island, and to evaluate these resources in terms of the significance criteria of the Palau Historical and Cultural Preservation Act.

Fieldwork was conducted between 27 October and 6 November 1998 under the direction of Dr. Blayok, and field worker James Johanes. Fifty-seven archaeological features were recorded and 18 shovel tests were excavated on Ngerur Island.

FIELD METHODS

A systematic survey was conducted in areas which had not been recorded in the brief survey carried out in February 1998. The portion of the island previously documented was mapped and recorded in greater detail. Prior to current investigations, much of the undergrowth and saplings, but not the large old trees, were cleared under the direction of property owners in order to assist the work of land surveyors, archaeologists, and pre-construction crews.

Features encountered were described, photographed, and staked in plan with a tape and compass. In some instances, features were not adequately cleared of vegetation and hand clearing was necessary to delineate boundaries and expose morphological characteristics.

Subsurface testing was employed as a means to determine the presence, extent, and depth of subsurface deposits and to ascertain whether burials are present. In certain features thought to be burial markers. Testing was in the form of 50 cm square shovel tests which were dug until a septum or bedrock was reached. Recovered material was screened through 1/4 inch mesh. Stratigraphic profiles and basic soil descriptions were recorded in each test. The units were backfilled once investigations were complete.

A hindrance to the adequate documentation of cultural resources on Ngerur Island was the destruction of several archaeological features between the brief survey in February and the inventory survey in October. Upon returning to Ngerur to conduct the inventory survey, it was noted by the project director and supervisor, both of whom had been involved in the earlier work, that several of the previously recorded stone features had been destroyed. The land surveyor, also present on both occasions, noted that two stone features, which he interpreted as grave markers because of their appearance and the surrounding plants, in the north central part of the island had been completely destroyed as well. He had pinpointed their location on his February map, but archaeologists had not yet recorded those features. It is possible additional cultural properties were vandalized before being documented. On 6 November, DCA visited the island to assess the damage to the site.

The archaeologists noted five vandalized features. These include: three small stone-faced, earth-filled platforms (Fea. 27, and those on Feas. 28 and 36); two stone-faced terrace platforms (Fea. 28 and 29); a set of stone steps (part of Fea. 28); and a linear rock mound (Fea. 8), which might be one of the features noted by the land surveyor. Each feature's constituent stones had been thrown or carried ca. 15 m. The earth fill in the three small platforms had been dispersed so that none of the original form remained.

Additionally, the cemetery (Fea. 9) in the northern part of the island had been extensively damaged by the removal of grave markers consisting of a layer of stones or an outline of inverted bottles on five, and likely more, burial plots. The bottles are missing, but the stones are spread in a 20 m radius around the graves. The graves themselves do not appear to have been vandalized. A detailed map of the cemetery has yet to be drawn.

FEATURE DESCRIPTIONS

Fifty-seven archaeological features were identified during inventory survey. The range of feature types present includes: rock mounds (n=9), concrete foundations or structures (n=6), terrace platforms (n=6), stone-lined trails (n=5), modified outcrops (n=4), alignments (n=3), depositions (n=3), sets of furrows (n=3), stone-lined wells (n=2), disturbed features (n=2), a set of rock shelters, a cemetery, dock, midden, rock circles, rock ring, and a utility pole. In addition, five small rectangular stone platforms, two of which are situated on terrace platforms, were located.

Thirteen archaeological features either contain or potentially contain human burials. Of these, five features (Fea. 27, 28, 36, 42, and 50) are likely human features and need further testing for definite determination. At least 23 graves are in the cemetery (Fea. 9), although it is possible more are present.

Table 3 lists each feature, its type, function, condition, and possibility for containing human remains. Figure 1 shows the relative location of each cultural property on Ngerur Island. Those features containing or potentially containing human burials are marked with a star. Each feature is described below.

FEARure 4 is a low rock mound found close to the western cove (Fig. 5). The mound is composed of subangular to subrounded basalt cobbles and is 75 cm in diameter and 10 to 15 cm high. The feature is too small to be a conventionally sized grave site, but may be a clearing mound.
Table 3. Archaeological Features on Ngerur Island (OR-12:47), Koror.

<table>
<thead>
<tr>
<th>Feature Type</th>
<th>Feature No.</th>
<th>Function</th>
<th>Condition</th>
<th>Burial?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base of wood pole</td>
<td>19</td>
<td>utility pole</td>
<td>poor</td>
<td>-</td>
</tr>
<tr>
<td>Courtyard</td>
<td>9</td>
<td>historic burial</td>
<td>many graves recently vandalized</td>
<td>-</td>
</tr>
<tr>
<td>Concrete foundation</td>
<td>31, 34, 35</td>
<td>structural foundations</td>
<td>good</td>
<td>-</td>
</tr>
<tr>
<td>Concrete walled structure</td>
<td>30</td>
<td></td>
<td>good</td>
<td></td>
</tr>
<tr>
<td>Concrete pad</td>
<td>37</td>
<td>foundation for structure</td>
<td>good</td>
<td>-</td>
</tr>
<tr>
<td>Concrete rim</td>
<td>32</td>
<td></td>
<td>good</td>
<td>-</td>
</tr>
<tr>
<td>Depression</td>
<td>2, 17, 18</td>
<td></td>
<td>good</td>
<td>-</td>
</tr>
<tr>
<td>Disturbed feature</td>
<td>3, 4</td>
<td></td>
<td>poor</td>
<td></td>
</tr>
<tr>
<td>Each platform</td>
<td>24, 41, 50, 57, 58</td>
<td>foundation for structures; 26, 37, 38 = foundations for structures or cultivation?</td>
<td>good</td>
<td></td>
</tr>
<tr>
<td>Each terrace platform (rock-faced)</td>
<td>13, 14, 16, 18, 29, 36</td>
<td>foundations for structures; 26, 37, 38 = foundations for structures or cultivation?</td>
<td>12, 14, 16 = poor; 26, 37, 38 = good</td>
<td>-</td>
</tr>
<tr>
<td>Furrows</td>
<td>12, 13, 22</td>
<td></td>
<td>good</td>
<td>-</td>
</tr>
<tr>
<td>Modified outcrop</td>
<td>6, 11, 31, 34</td>
<td>6 = cutting or clearing area; 11, 34 = cleaning?</td>
<td>poor</td>
<td>-</td>
</tr>
<tr>
<td>Rock alignment</td>
<td>7, 49, 55</td>
<td></td>
<td>poor</td>
<td>-</td>
</tr>
<tr>
<td>Rock cluster</td>
<td>6, 22</td>
<td></td>
<td>poor</td>
<td></td>
</tr>
<tr>
<td>Rock mound</td>
<td>5, 8, 21, 23, 26, 47</td>
<td>5, 8, 25, 47 = cutting or burial; 1, 21, 26, 53 = cutting; 47 = burial</td>
<td>poor</td>
<td>-</td>
</tr>
<tr>
<td>Rock cleft</td>
<td>48, 53</td>
<td></td>
<td>good but recently utilized</td>
<td></td>
</tr>
<tr>
<td>Rock shelter</td>
<td>31 (two shelters)</td>
<td>storage or hiding place</td>
<td>poor</td>
<td>-</td>
</tr>
<tr>
<td>Shell midden</td>
<td>41</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stone bench</td>
<td>27</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stone path</td>
<td>15, 22, 39, 42, 50</td>
<td>path</td>
<td>good</td>
<td>-</td>
</tr>
<tr>
<td>Stone platform (small, rectangular)</td>
<td>37, 28, 38, 42, 50</td>
<td>kitchen platform or burial</td>
<td>all five are likely hearths but need testing</td>
<td>-</td>
</tr>
<tr>
<td>Stone well</td>
<td>40, 46</td>
<td></td>
<td>40-poor, 46-good</td>
<td>-</td>
</tr>
</tbody>
</table>
**Feature 2** is a small circular depression located along the west side of the island north of the cross-island path (Fig. 5) (see Fig. 5). The feature is 0.9 by 1.6 m wide, 0.3 m deep, and bears an azimuth of 308 degrees. It is lined with large pebbles and small cobbles. The depression may be the first stage in the construction of a foxhole, an outhouse, or a well. A Japanese brown bottle is associated with the feature.

**Feature 2** is a disturbed rock feature located on a raised soil mound next to the depression (Fig. 5). The mound is 3.5 m long, ca. 0.3 m high, and oriented at 224 degrees. The few rocks remaining on the mound almost form an alignment. Because of its shape and length, it is possible that the feature is a grave site.

**Feature 4** is a scatter of rocks in the east central part of the island (see Fig. 5). The feature, composed of subangular basalt cobbles, measures 0.9 by 1.3 m and bears an azimuth of 292 degrees. Due to considerable disturbance, the function of the feature cannot be determined.

**Feature 5** is a rock mound found in the east central part of the island (see Fig. 5). It is ca. 1.15 m in diameter. The mound is constructed of subangular to subrounded basalt pebbles and cobbles, and rises 40 cm above ground surface. Several bottles dating to the Japanese era are associated with the feature. Its shape and size suggest the feature may be a grave site.

**Feature 6** is a basalt outcrop modified to form a relatively level platform (see Fig. 5). Basalt cobbles are haphazardly placed about the outcrop. The outcrop is 3 by 5 m wide, 0.5 m high, and bears an azimuth of 22 degrees. It may have served as a clearing mound for the agricultural fields which line the northeast coast of Ngerur. Alternatively, it could have been a resting spot for the cultivators. Japanese porcelain and glass are located on the northeast side of the feature.

**Feature 7** is a rock alignment in the east central part of the island (see Fig. 5). It measures 0.5 by 4.2 m and is oriented at 337 degrees. The feature is composed of subrounded cobbles partially embedded in the earth. The alignment may be the remnants of a trail.

**Feature 8** is a linear rock mound in the north central section of the island (see Fig. 5). It is 1.5 by 7.7 m wide, 0.3 m high, and is oriented at 150 degrees. The mound is composed of medium subangular basalt cobbles. It may be a clearing mound, although its size and orientation suggest it might also be a grave site.

The feature was recorded during a reconnaissance survey in February 1998. Upon returning to the island in October 1998 to conduct the inventory survey, it was found the rock mound had been disassembled. Cobbles were spread throughout the area where the feature was once located.

**Feature 9** is a historical period cemetery located on the north side of the island (Fig. 6). Since this was the cemetery used for the leper colony, the burials probably date to the 1930s. There are at least 21 and maybe as many as 30 individuals buried here. Since the cemetery was extensively vandalized prior to the inventory survey in October, the exact burial count is not known.

During reconnaissance survey in February 1998, thick vegetation prevented delineating all the plots. Since it was reconnaissance work, the area was not cleared and the cemetery was not mapped. Upon returning to Ngerur in October 1998 to conduct the inventory survey, it was discovered that the cemetery had been heavily vandalized. All the upright bottles had been dislodged from their position around the graves and removed from the island. The stones outlining the remnants of the plots had been extracted and distributed up to 25 m away. Three burials are still in place along the cemetery's western margin and two previously disturbed ones on the row just east. The remainder of grave sites bear deep depressions at the prior locations of the stones and bottles. Most of the burials appeared to have been disturbed below ground. In addition to vandalism, a few burials are disturbed by large tree roots. Some trees have grown on top of the graves.

The cemetery is 10 by 14 m wide and is oriented at 75 degrees. It is symmetrically aligned in five rows of 10 burial plots each. However, not every plot contains a burial. Fifty centimeters separates each row and 50 to 70 cm separates each plot. One plot measures ca. 1 by 2.2 m.

At least two of the burial plots were outlined with Dai Nippon bottles embedded upside down in the earth. Another had an appendage formed by a 60 by 70 cm square outlined in bottles and filled with small basalt cobbles and a larger headstone (Photo 2). Currently, none of the bottles remain.

The burial on the southwest corner is in a 1 by 2.1 m depression filled with large cobbles and small boulders (Photo 3). Two medium boulders mark the west edge and one medium boulder marks the east edge. The grave appears to have once contained a wooden coffin which has disintegrated, causing the large rocks placed on top of the lid to drop ca. 20 cm below surface. This burial was not disturbed during the desecration of the cemetery.

The majority of remaining plots were outlined in medium subangular cobbles and earth-filled (Photo 4). A few, however, could only be distinguished by a rectangular patch of earth depressed about 10 cm below ground surface, an indicator of a disintegrated wooden coffin. One grave had an upright coral slab headstone.

Two graves on the northwest corner of the cemetery remain in situ and are in good condition. They each measure 1.1 by 2.5 m and are outlined in two courses of small subangular basalt cobbles. The lower course extends outward from the upper one to form a small apron around the plot. The stones are embedded in the ground so only 5 to 7 cm remain above surface. Within the stone rectangle, each is slightly mound-shaped; however, the current low mound could be due to erosion rather than initial construction.
Photo 2. A burial plot in the cemetery (Fea. 9) outlined in basalt cobbles. Basalt boulder and inverted bottles serve as a headstone.

Photo 3. Grave in cemetery (Fea. 9). Rocks were once on top a wooden coffin which has since disintegrated.
Figure 4. Two burial plots in the cemetery (Fea. 9) outlined in basalt cobbles.

**Feature 10** is a set of planting furrows on the northwest tip of the island. The furrows are ca. 4 m long and 0.2 m deep and run in a northeasterly direction. Furrows are found intermittently along the west side of the island between the cross-island path (Fea. 15) and Fea. 10. However, it is in the northwest corner of the island that they are most prominent. The area was likely cultivated during the time the island was a leper colony.

**Feature 11** was recorded in the October reconnaissance survey. During the February intensive survey it was documented as Fea. 48 as it was thought to be a different feature. Once it was discovered the descriptions corresponded to the same feature, it was designated Fea. 48. Feature number 11 was eliminated.

**Feature 12** is one of three small earth terrace platforms next to the western cove (Fig. 7). The platform is 5.1 by 6 m wide, 0.4 m high, and oriented parallel to the slope at 350 degrees. The edges of the feature are outlined in small subangular cobbles. A coconut tree currently grows out of the center of the platform. The feature may have been used as a resting platform for people waiting for boats to land at the cove.

Figure 7. Archaeological features on the southwest portion of Ngerur Island.
Feature 13 is a set of planting furrows located in the center of the island (see Fig. 5). The furrows are 1 m wide, 0.5 m high, and oriented at 247 degrees. A 50 cm wide depression separates each of the furrows. The once cultivated area is 6.5 by 8 m.

Feature 14 is one of three small earth terrace platforms next to the western cove (see Fig. 7). The feature is 1.5 by 3 m wide, 0.5 m high, and is oriented parallel to the slope at 350 degrees. Its edges are outlined with small cobbles. Erosion has caused the sides to slope outward. Two halves of a small Tridacna shell are associated with the feature. The platform might have been a resting platform for those waiting to board boats landing at the cove.

Feature 15 is a stone path extending from the western cove across the center of the island (see Fig. 5). Scattered coral and limestone embedded in the steep bluff are all that remain of the 22 steps leading from the cove up to the top of the island (Photo 5). Each step is 10 to 20 cm high and 40 cm wide. The top step is still in place and is constructed with three small basalt boulders. The remainder of the gravel and pebble paved path is 2.2 m wide with an outside edge delineated by rounded cobbles (Photo 6). A small ditch 30 cm wide and 10 cm deep is located on either side of the trail.

The feature extends ca. 60 m to the center of the island where it abruptly ends at a row of basalt stones lying across the width of the path. No features were encountered near where the trail terminates. It is reasonable to assume the path once continued south to the concrete structures of the leper colony as the trail is aimed in this general direction. Remnants of the path not disturbed by the heavy vegetation may likely be found between here and the concrete structures.

Feature 16 is one of three small earth terrace platforms next to the western cove (see Fig. 7). The platform measures 2.0 by 4.0 m wide and 0.4 m high. The platform, oriented true north, lies parallel to the slope. Several large coconut trees are growing on the feature. Like Feats. 12 and 14, the feature might have been a waiting platform for those ready to board vessels coming into the cove.

Feature 17 is a circular depression, 1.9 by 2.6 m wide and 0.4 m deep, located in the jungle between two earth terrace platforms (Fea. 12 and 16) (see Fig. 7). A few small cobbles are present along the feature’s sloped sides. Lack of additional rocks on the bottom of the depression argue against it once being rock-lined. The feature may be the remains of a privy hole, a trash pit, or a well.

Feature 18 is an elongated depression close to the western cove (see Fig. 7). The depression is 1.8 by 2.8 m wide, 0.6 m deep, and is oriented at 40 degrees. The sides of the feature are only very slightly eroded suggesting a more recent construction. No rocks are present in the depression. It may have functioned as a privy hole or a trash pit.

Feature 19 is the base of a wood pole located next to the embankment of the western cove (see Fig. 7). The wooden pole, 20 cm in diameter and 90 cm high, is firmly embedded directly in the ground without a concrete base. The pole likely served as a support for electric or communication utility lines.
Feature 20 is a hearth located on the plain adjacent to the south side of the western cove (see Fig. 7). The fire-ring, composed of four medium basalt cobbles, is 45 cm in diameter and rises 20 cm above ground surface. No ash is visible but recently burnt shell and pandanus keys are present in the hearth. Upon returning to the island for the inventory survey in October 1998, it was noted the fire-ring had been utilized during the five months between site visits. A shovel probe of the feature revealed no buried ash or charcoal.

Feature 21 is a rock mound on the level plain south of the western cove (see Fig. 7). It is 1.6 m in diameter and 0.5 m high. The mound is formed of small to medium basalt cobbles. The feature has been disturbed by a pandanus growing out of its center. As the surrounding landscape is devoid of rocks, it is likely the feature is a clearing mound.

Feature 22 is a stone path remnant found on the level plain south of the western cove (see Fig. 7). The feature is highly disturbed and only distinguished by a 5 m long double alignment of rocks. The alignment shifts several times from one side to the other of a level earth strip 1 m wide. Although located in the center of the plain, the path appears to continue north from the cross-island path (Feat. 15) south to the colony's garden area.

Feature 23 is a large square garden defined by mound furrows running both east-west and north-south (see Fig. 7). The garden plot lies in the northern portion of the upper cliff region on the west side of the island. It is bounded on the north, west, and south sides by a low earth berm with an alignment of medium basalt cobbles on its outer edges and is ca. 31 by 30 m and oriented at 162 degrees. Due to erosion, the berm is currently in poor condition. Documentation was completed at that time since by the end of October 1998, the platform had been disassembled. The area where the feature once stood was covered in a thick layer of recently felled small trees and brush. An exhaustive search produced no sign of the intact feature, but a large quantity of small basalt boulders and large cobbles were spread within a 15 m radius of its approximate location. As these rocks were not present in February 1998, it is highly probable they are the remains of the dismantled platform.

This structure is almost identical to Feats. 28, 36, 42, and 50. These features are all thought to be cooking hearths, although there is the slight possibility they are burials.

Feature 24 is an earth platform outlined by a small ditch (see Fig. 7). It is ca. 35 by 9 m and oriented at 80 degrees. The ditch is 50 cm wide and 15 cm deep. Beyond the ditch on the west side of the feature is a 30 cm wide, 10 cm high earthen berm. A few subangular basalt cobbles forming an alignment are eroding from the outer edge. The berm begins at the northwest corner of the platform and continues for ca. 5 m to the south. Since the platform is located next to the agricultural furrows, it likely held a farming structure.

Feature 25 is an elongated rock mound 2.3 m long by 1.8 m wide, 0.5 m high, and oriented at 180 degrees (see Fig. 7). A small piece of branch coral lies on top of the mound. The mound's shape and the presence of coral are suggestive of a burial feature, yet its placement close to a gardening area suggests it may be a clearing mound.

Feature 26 is a circular rock mound 1.5 m in diameter and 0.4 m high (see Fig. 7). It is constructed of medium basalt cobbles. Because of its location next to an area used for cultivation and its shape, the feature is likely a clearing mound.

Feature 27 is a small stone-faced, earth-filled platform just southwest of the colony's concrete structures (see Fig. 7). The rectangular shaped feature, 1 by 3.1 m wide, 0.7 m high, is oriented at 80 degrees. The platform is composed of two courses of angular to subangular basalt cobbles carefully facing an earth interior.

During the initial visit to Ngerur in February 1998, the platform was in excellent condition. Documentation was completed at that time. Since by the end of October 1998, the platform had been disassembled. The area where the feature once stood was covered in a thick layer of recently felled small trees and brush. An exhaustive search produced no sign of the intact feature, but a large quantity of small basalt boulders and large cobbles were spread within a 15 m radius of its approximate location. As these rocks were not present in February 1998, it is highly probable they are the remains of the dismantled platform.

This structure is almost identical to Feats. 26, 36, 42, and 50. These features are all thought to be cooking hearths, although there is the slight possibility they are burials.

Feature 28 is a stone-faced terrace platform placed on a 22 m wide bench between the high rock outcrop to the west and the cliff to the ocean on the east (see Fig. 7). The platform, 7.4 by 7.6 m wide, is oriented at 18 degrees. As the bench slopes slightly towards the cliff, only three sides of the feature rise above ground surface and are faced with large basalt boulders. The west side is level with the surrounding soil. The three course high east side rises ca. 50 cm above surface; both north and south sides gradually loose height until becoming level with the surrounding soil at the back of the platform. The interior of the platform is earth.

As at Fea. 36, a stone-faced earthen fill fire hearth rises ca. 50 cm above surface at the center back of the platform (Photo 7). The hearth measures 1.1 by 2.2 m and is oriented at 18 degrees. The three to four course high facing is composed of large basalt cobbles. A set of four stone steps is located on the southwest corner of the platform. This set is 2.4 m long and rises roughly 1.5 m to the west. The steps lead up to a soil slope which passes through the bedrock escarpment. Each step is one long flattened basalt cobble embedded in the soil.
Recording of the platform, hearth, and steps of Fea. 28 took place during the brief survey in February 1998. At the time of the inventory survey in October 1998, the three stone structures had been disassembled. All that remained were indentions in the soil where stones had formed the steps and platform facing. The raised hearth was leveled so that only a slightly darker soil and a few glass fragments remained to indicate its location.

Feature 29 is a stone-faced terrace platform located 12 m south and on the same bench as the Fea. 28 platform (Photo 8, Fig. 8). The feature is oriented at 32 degrees and measures 4.8 by 7.6 m. The eastern side rises 40 cm above surface and is faced with three courses of large basalt cobbles. The western side was cut 50 cm below the natural slope in order to make the platform flush with the ground surface. A few basalt and coraline limestone cobbles are scattered about the surface of the feature but the majority of the surface is leveled earth.

As with the nearby platform Fea. 28, this platform was recorded during the brief survey in February 1998 and found to have been disassembled by the time of the inventory survey in October 1998. Only an earth slope remains.

Feature 30 is a concrete latrine near the cliff circling the southeast side of the island (Fig. 8, Photo 9). The feature is 2.0 by 2.9 m wide and oriented parallel to the cliff at 36 degrees. The latrine contains three compartments distinguished only by differentially elevated concrete floors. To the south are two privies formed by 30 by 60 cm holes in the concrete. The concrete pad in this 1.2 m long section is raised 0.3 m above ground surface. Short metal rods project from the concrete at the corners and center of the pad. These likely once stabilized wooden walls around the privies. The center compartment is 14 cm lower than the its southern neighbor. This 0.8 m long concrete pad has a 1.4 m high and 0.2 m wide concrete wall along its eastern side. This section was likely the entry into the structure. The northern compartment is separated from the central section by a 10 cm high, 15 cm wide concrete partition. The concrete wall from the central section continues to form the east, north, and west sides of this 92 cm long section. A drainage hole is found in the northeast corner of the structure. This compartment may have been a shower stall. The latrine is in good condition.

In the cliff face off the southeast corner of the latrine, a large ceramic pipe hangs over the ocean after protruding from beneath a layer under concrete and earth. A basalt cobble alignment stretches from the cliff edge east past the southeast corner of the structure for 4.6 m. As the ground to the northwest of the structure rises immediately and several basalt cobbles are presently embedded in the soil, it is possible steps once led from the latrine to the two terrace platforms to the north (Fea. 28 and 29).
Feature 31 consists of rock shelters incorporated into the base of a bedrock outcrop on the bench above the stone dock (Fea. 44) (see Fig. 8). The two shelters were constructed by excavating the soil underneath the bedrock to form small cavities. Both entrances have an inward facing retaining wall constructed of two courses of basalt cobbles in order to stabilize the soil so erosion would not fill in the cavities. The northernmost shelter is 1.2 m wide by 2.5 m deep and faces the ocean at 110 degrees. The interior of the shelter descends 70 cm below surface. Entrance is gained via a 2 m long, 0.7 m wide rock-lined path leading to the northern side of the shelter. The second shelter is located 2.7 m south and is 1.7 m wide and 2.1 m deep. It is not known what the shelters were used for as the island was not occupied during WWII when such features were necessary for protection. Perhaps they were constructed by the lepers while hiding from the Japanese. The shelters are in fair condition.

Feature 32 is a concrete water catchment in the same hollow as the three structural foundations (Feas. 33, 34, and 35) (Photo 10, see Fig. 8). The 3.2 by 4.3 m wide and 1.7 m deep catchment has an axis of 20 degrees. Its walls are 25 cm thick. Metal rods projecting from the structure's four corners likely once held the roof in place. The east side of the catchment is connected to a 0.5 m high stone platform measuring 2.7 m wide and 1.9 m long. On the platform and adjacent to the catchment wall is a low 80 by 93 cm concrete step. A concrete basin 50 cm square is located in the south, 70 cm above the step. It drains into the cistern. The catchment is in excellent condition, while the stone platform has lost some of its constituent rocks on its southern side.
Photo 10. Concrete water catchment (Fea. 32).

A shallow narrow soil drainage leads from the water catchment east to the ocean 35 m away. A meter to the south of the catchment is a 9.2 m long rock alignment which makes a right angle turn at the structure’s southeast corner and continues for 3 m.

Features 33, 34, and 35 are concrete house foundations lined up northeast to southwest in a hollow below the concrete foundation (Fea. 37) to the south and the terrace platform (Fea. 36) to the north (Photo 11, see Fig. 8). They have a long axis of 202 degrees, and are separated from one another by a distance of 3.4 m. Each foundation consists of 12 rectangular posts embedded into the soil with a set of steps at either end. The posts are uniformly spaced along the 4.0 by 5.7 m feature, form three lines of four posts each. Each 27 cm square post is 80 cm high. The steps, of which there are two to each set, are 25 cm high. The base measures 60 by 150 cm and the second step measures 30 by 97 cm. The structures are in fair condition.

Feature 36 is an earth terrace platform faced on three sides with cobbles and small boulders (see Fig. 8). The subangular basalt descends from three courses on the front or south side, where it rises 67 cm, to one course along the back sides where it is 15 cm high. The platform is 9.9 by 10 m (front to back) and oriented at 336 degrees. It is constructed on a slightly sloping hill, so a 50 cm deep cut into the slope at its northeast corner creates a level surface. A set of stone steps are located in the center of the platform’s south side. A stone-faceted earth-filled hearth rises ca. 50 cm above the surface at the center back of the feature.

The 1.6 by 4.5 m hearth is oriented parallel to the width of the platform. Nearby Feas. 28 and 29 are also stone-faced terrace platforms. However, construction of their facings was not as carefully fitted as that of Fea. 36. It is therefore assumed that Fea. 36, if not of more recent construction than the others, is reconstructed. The platform may have been used while members of the Epison family lived on the island.

Six meters to the west of the feature is a 1 by 1 m and 0.7 m deep cavity in the ground which likely held garbage. On the slope above the north side of the platform is a bottle dump composed of about 10 Sakura Beer bottles, sake bottles, and several light blue bottles with “360” or “750 ml” embossed on the basal surface.

The hearth on the platform was recorded during the brief survey in February 1998. At the time of the inventory survey in October 1998, the hearth had been dismantled so that no sign of it remained. The remainder of the platform is in excellent condition.

Feature 37 is a rectangular concrete foundation on the slope above and to the south of the three structural foundations (Feas. 33, 34, and 35) (see Fig. 8). The foundation is 3.0 by 5.7 m wide, and oriented at 24 degrees. A structural wall both 25 cm thick and high encompasses all but 1.7 m of the northeastern section of the concrete pad. Here, the doorway opens onto a concrete slab poured on level basalt outcrop that once formed the porch. The steps leading from the foundation to the structural foundations below are no longer present. It is not known what was once housed in the structure. The feature is in good condition.
An elongated soil mound covered in small cobbles and measuring 1.4 by 2.1 m wide and 0.3 m high is located outside the southeast corner of the concrete foundation. A traditional 11 mm thick brick-red rim sherd with parallel sides was located on the mound. An alignment of rocks parallels the foundation 5.0 m from the east wall.

Feature 38 is a limestone-lined path leading from the top of the island downslope to the eastern cove (see Fig. 5). The shoreward side of the path is lined in flat limestone cobbles partially embedded into the surface. The inland side consists of a dirt embankment whose height is similar to the depth the path has descended. The 2.9 m wide trail proceeds at 22 degrees as it descends on a ca. 18 degree slope. The land drops 45 degrees on the shoreward side of 64 cobbles. Because of the steepness of the descent, the path turns sharply into a switchback after 12 m. A 20 cm high step composed of three flat limestone cobbles marks this turn. For the next 11 m the path bears an axis of 140 degrees and a slope of ca. 20 degrees.

The path then turns sharply towards the ocean and descends in a series of seven steps each made of five cut limestone blocks (Photo 12). Each step is 1.7 m long, 0.3 m wide, and 0.8 m high. At this point it is likely the path terminated at a wide landing platform; however, only the faintest outlines of this structure can be seen extending to the north. The remainder has been swept away by a succession of unusually high tides or storms. At this point, the cove is a shallow shelf even at high tide causing all watercraft great difficulty while docking close to the stairs.

Feature 39 is a limestone and basalt-lined path leading from the western edge of the cross-island path (Fea. 15) down to a stone-lined well (Fea. 40) adjacent to the western cove (Photo 13, see Fig. 5). The path curves slightly as it follows the contours of the cove but it generally takes a northwesterly direction. The initial 9 m of the 1.3 m wide path is lined in basalt cobbles while the final 10 m consists of only a series of single cobble steps in the center of the level path. The west side of the steep trail falls abruptly to the cove below. The dirt cliff face forms the eastern side of the trail. The feature is in fair condition.

Feature 40 is a stone-lined well in the western cove of Ngerur Island (Photo 13, see Fig. 5). The 1.4 m diameter, 0.3 m deep well is fed by a freshwater stream emerging from a crack in the cliff face to the east. A 1 m drop to the cove floor on the well’s west side is partly shored up by basalt boulders. To the south is a limestone-lined path (Fea. 39) descending down to the well from the cross-island path (Fea. 15) above. The well is in poor condition as many of the large basalt cobbles lining its interior have fallen inward.

Feature 41 is an earth platform demarcated from the surrounding topography by a shallow ditch (see Fig. 7). The platform is 4 by 7 m wide and bears an azimuth of 36 degrees. The surrounding ditch measures ca. 10 cm wide and from 20 to 40 cm deep. An additional ditch radiates from the platform’s southwest corner west for 5 m. On the platform’s east side, adjacent to the ditch, is a 60 cm high outcrop partially modified at its northern extreme (Fea. 54). The surface of the feature bears no marks such as furrows and
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In the inventory survey of Ngerur Island, Palau, it contains no rocks. It is assumed the platform served an agricultural purpose, even if only to provide the foundation for a shed, as the primary area used for cultivation by the island's inhabitants lies directly southwest.

Feature 42 is a small rectangular stone platform located on the slope ca. 26 m northwest of a terrace platform (Fea. 36) (see Fig. 8). The platform is 1.3 by 2.2 m wide, 0.5 m high, and bears an azimuth of 346 degrees. Its exterior is constructed of haphazardly placed angular basalt cobbles and an interior of earth with a scattering of rocks across the surface. A giant Tridacna shell fragment is embedded in the northeast corner of the structure and a large circular metal cooking pot lies next to its eastern side. The feature is in fair condition. Four other platforms of the same type are found on Ngerur (Feas. 27, 28, 36, and 30). Its association with a cooking pot and its affinity with those on two terrace platforms (Feas. 28 and 36) suggest the feature was a cooking hearth. However, because human burials are sometimes located in rock mounds such as this, it can not be entirely ruled out that the feature is a grave site.

Feature 43 is a shell scatter composed almost exclusively of delebekai (a class of bivalve) and a few delatangel (Nerita polita) (see Fig. 8). The area of the scatter is ca. 50 cm square and 9 cm deep. The non-deteriorated condition of the shell argues for the scatter dating to recent times, possibly post-WWII when members of the Epilson family occupied the island or even more recently.

Feature 44 is a stone dock located on the southeast side of the island below the concrete structures (Photo 14, Figs. 8 and 9). This would have been the primary docking facility for Ngerur during its use as a leper colony. The dock faces the north side of Desomel Point and by extension Koror. At low tide the ocean is 20 m away through scattered mangrove trees while at high tide water surrounds the dock.

The dock measures 3 by 8 m and is oriented due south, parallel to the cliff face. In front, the three to four courses of carefully placed basalt boulders rises 60 cm above surface. The dock's surface tapers down to the shoreline where naturally occurring beach stone converges with the structure. The feature is in fair condition with tumbled sides but the front still retaining its integrity.

It is difficult to discern where the freight and passengers of incoming vessels disembarked as the cliff rises almost sheer along this side of the island. The well (Fea. 46) and adjoining steps (Fea. 45) up to the top of the island are 15 m to the north through water at high tide. Directly behind the dock there is a narrow earth passage up through the cliff face. The passage is steep enough that the route is treacherous without stairs. No stairs currently exist, although it is possible they once were present, since erosion and tree roots have heavily disturbed the area.

Feature 45 is the remnants of a stone path likely once leading from the cistern (Fea. 32) 60 m east-southeast to the well (Fea. 46) (see Figs. 8 and 9). Flat basalt cobbles aligned from north to south are occasionally found embedded in the soil along a course between the two features. Erosion has heavily disturbed the path, as the land slopes gently towards the ocean. Steps from the top of the cliff down to the well are formed by five stones, each 6 to 12 cm in height (Photo 15). The basalt steps average 40 cm long and 25 cm wide. Large trees on the cliff edge have removed the upper steps from their original position.

Two meters south of the former path is a ditch leading from the south side of the cistern down to the cliff face where it dumps out into the ocean. The ditch measures 1.2 m wide and averages 0.2 m deep, although it descends to 0.5 m within 7 m of the cliff face. This ditch likely served as the drainage for the inhabitants of the concrete structures next to the cistern (Feas. 33, 34, and 35).

Feature 46 is a stone-lined well at the base of the cliff adjacent to the concrete structures of the leper colony (Photo 15, see Figs. 8 and 9). The 1.0 by 1.5 m wide and 0.7 m deep well is fed by a freshwater spring flowing from the cliff face. The inside and bottom of the well are carefully faced with small flattened basalt boulders. The northern facing has tumbled into the well. East of the well is a 1 m wide constructed shelf which drops 0.5 m to the floor of the inlet, to the south a carefully stacked basalt cobble retaining wall separating the well from the inlet, to the west the cliff, and to the north a constructed level area raised from 0.7 to 1.0 m above the floor of the inlet. This area measures 6.5 m from the well north.
Figure 9. Dock, well, and steps to well on southeast portion of Ngerur Island (Feas. 44, 45, and 46).

Photo 15. A stone well on a level faced platform (Fca. 46). Stone steps leading down from above are located in right background (Fca. 45).

Feature 47 is a low earth and rock mound close to the eastern cove (see Fig. 5). The mound is 1.2 by 2.9 m wide, 0.2 m high, and oriented at 320 degrees. The feature is considerably eroded. Its function is unknown, but because of its shape it is postulated that it might be a grave site.

Feature 48 was recorded in the October inventory survey but was later found to correspond with Fca. 11 of the February reconnaissance survey. Feature number 48 is used in this report and feature number 11 was eliminated.

The feature is an earth and rock mound in the center of the island close to the eastern cove (see Fig. 5). The mound is 2.3 m in diameter and almost square in shape. Medium subangular basalt cobbles are placed haphazardly atop the 40 cm high mound. A piece of branch coral is on top of the feature and fragments of a soy sauce bottle, a Dai Nippon bottle, and a bottle with "750 ml" embossed on the basal surface lie off the southern edge of the mound. The center of the mound is sunken ca. 7 cm. The function of the mound is not known, but the presence of coral and the fact that decomposed coffins often cause the surface above to cave in suggests the feature might contain a burial.
Feature 49 is a square-shaped rock alignment constructed of small subangular basalt cobbles (see Fig. 5). It is located in the center of the island close to the eastern cove. The feature is 1.5 by 2.2 m wide, and oriented at 322 degrees. The earth in the center of the mound rises 7 cm above surface. The alignment outlining the eastern and northern sides of the mound is unbroken, while the other two sides have been disturbed and only half of their original structure remains. One red brick is incorporated into the alignment. Although the function of the feature is unknown, there is the possibility it could be a grave.

Feature 50 is a small stone-faced earth-filled platform in the center of the island (see Fig. 5 and 10, Photo 16). The structure is 1.3 by 2.6 m wide, 0.45 m high, and bears an azimuth of 66 degrees. The platform is composed of two to three courses of angular to subangular basalt cobbles carefully placed to face an earthen interior. Several cobbles are also located on top of the platform. A 0.6 m high earth apron extends 1 m from the north side of the platform and 0.5 m from the west and south sides. It may have also been present on the east side but vegetation has disturbed the integrity of the apron. Sections of the apron are outlined in small basalt cobbles. The feature is in good condition although portions of the north and east sides have tumbled.

Artifacts associated with the platform apron include several brown glass sherds, a 32 cm diameter cooking pot, and a white ceramic sherd. Tridacna shell fragments and a piece of coralline are incorporated into the construction of the platform.

Except for the presence of the apron, this structure is almost identical with Fae. 27, 28, 42, and 36. These features all thought to be cooking hearths although there is the slight possibility they are burials.

Feature 51 is modified outcrop located just east of an earth platform (Fae. 24) in the cultivation area (see Fig. 7). The 6 m long basalt cobble-strewn outcrop bears an azimuth of 335 degrees. The feature is a result of rock clearing in the surrounding area.

Feature 52 is a rock circle 2.1 m from the southwest corner of the earth platform (Fae. 24) in the cultivation area (see Fig. 7). The mound is 1.8 by 2.2 m wide and 0.2 m high with a prominent 0.4 m diameter area in the center lacking rocks. The feature is randomly constructed with medium subangular basalt cobbles. It is located on a slightly raised earth semi-circle which is open to the southeast. The function of the rock circle is unknown.

Feature 53 is a rock mound located north of the earth plat- form (Fae. 24) in the cultivation area (see Fig. 7). The mound is 0.8 by 1 m wide and composed of medium to large subangular basalt cobbles. The feature is a clearing mound.

Feature 54 is modified basalt outcrop located adjacent to an earth platform (Fae. 41) associated with the cultivation area (see Fig. 7). The outcrop forms an "L" shape with the longer arm adjacent to the length of the platform and the right angle at the platform's northeast corner. It is at this corner and along the 4 m short arm of the "L" that medium to
IV. Field Investigation

A large subangular basalt cobbles are randomly placed. A level area with indications of eroded furrows extends to the northeast of the outcrop, inside the crook of the "L." Because both the earth platform (Fea. 41) and the level area are free of cobbles, it is likely the modifications to the outcrop are a result of clearing within the two areas.

Feature 55 is a rock alignment bordering the southern side of three earth platforms (Feas. 56, 57, and 58) (see Fig. 6). The 10 to 15 cm long subangular basalt cobbles are placed end to end, embedded almost flush with the ground surface, and are one course high. Due to erosion, the alignment is in poor condition with only roughly one-third of its original 22 m still in place. Its eastern end forms a 90 degree angle, as if to mark the boundary of the feature, yet only two cobbles of the angle currently remain. With a long axis of 226 degrees the alignment stretches from the western edge of the cemetery (Fea. 9), parallel to the southern edge of three earth platforms (Feas. 56, 57, and 58), and terminates abruptly at the ditch marking the western boundary of the platforms. Rock outcrop to the west prevents the path from continuing further in that direction and there is no indication the alignment turned either north or south. The alignment is 20 cm high embankment bordering the southern side of the mounds.

The alignment may have served to mark the outer edge of an earth path as the terrain to the south of the feature appears artificially leveled for ca. 2 m. Although the path connects to the cemetery, it does not apparently lead anywhere. Alternatively, the alignment may have functioned to protect the adjacent earth mounds from erosion.

Shovel Tests 1 and 2 were placed in the level soil along the southern side of the alignment. Neither test contained cultural deposits. However, the proximal end of a human radius was located ca. 5 cm below surface in the western half of the alignment. The bone fragment is in good condition with only minimal weathering. It is not known from where the bone originated, although the nearby cemetery seems likely. The fragment was not collected.

Feature 56, 57, and 58 are earth platforms located near the western side of the cemetery (Fea. 5) (see Fig. 6). Each platform is delineated from the others and the surrounding ground surface by shallow ditches. Connected to one another, they stretch from east to west for 20 m and from north to south for 8 to 11 m. Forty centimeters above the ditch bordering the southern side of the platforms is a rock alignment (Fea. 55). The surface of each feature consists of level earth with no rocks or furrows present.

The platforms' sizes are mirrored by the size of their surrounding or partially surrounding ditch. Feature 56, the platform to the east, measures 4.3 by 12 m. There is no ditch marking the northern boundary of this platform. Feature 57, the center platform, is 2.0 by 9.5 m and is completely surrounded by a ditch except for a 1.3 m space at its northeast corner. Feature 58, to the west, measures ca. 10 m square. The eastern half of the platform has no northern border while the western half displays two parallel ditches separated by 1 m. The northernmost of the two is 2.5 m in length and the other is 5.5 m in length.

All ditches except for the center one measure roughly 90 cm wide and are currently 2 to 9 cm below surface. Alluvium has covered their original surfaces. The center ditch that separates Feas. 57 and 58 is 90 cm wide and 13 cm deep. Each channel tapers at its terminus. Although the first impression is that the ditches served as drainages for the platforms, the design of the channels does not follow such a pattern. Rather than having a northern terminus at the ocean, they do not extend all the way to the ocean. Also, three of them, including the widest one, continue to the west following a 90 degree turn.

Since the platforms were located close to the cemetery it is probable that additional burial plots were located within them. Furthermore, it seems unlikely that an area adjacent to a cemetery would be used for gardening or habitation. A series of 11 shovel tests placed on the earth platforms and in the ditches disclosed no clues about the function of the features.

TEST EXCAVATIONS

Eighteen shovel tests were excavated on Ngerur Island during the inventory survey. Table 4 provides locations and depths for each shovel test, along with a description of stratigraphic layers and cultural contents.

Shovel tests were placed adjacent to the west side of the cemetery (Fea. 9): two in the level area near the rock alignment (Fea. 55) and 11 in the three soil platforms (Feas. 56, 57, and 58). The goal of the tests was to determine the function of these puzzling features. Because they are located so near the cemetery it appears unlikely they would serve as house foundations or gardening areas. It was therefore posited they are an extension of the cemetery and also contained burials. However, no cultural material or human remains were encountered in these excavations.

A shovel test was placed in one of the three terrace platforms next to the western cove (Fea. 12 and 14). These platforms are more likely to have served as structural foundations than the three platforms discussed above. The tests were excavated to determine the presence, extent, and depth of subsurface deposits. In the upper 18 cm of Fea. 12, one traditional terra-cotta body sherds with a buck car was recovered. The small sherd measured 9 mm thick and 7 cm long. The test placed in the nearest terrace platform was sterile.

Sample tests were excavated in the bottom of each of the two depressions near the western cove (Feas. 17 and 18). These were dug in order to ascertain the function of the features. Feature 17 was sterile, but the water table was reached at ca. 31 cm below surface in the elongated depression. This suggests the feature once served as a well.

The final shovel test was dug in the shell midden (Fea. 43). The midden proved to be only 9 cm deep and contain two shell types: deliboten (a bivalve) and few delongote (Venus) mixed in. The shells were bleached white by the sun, but were not greatly deteriorated. It is therefore likely the shells date to relatively recent times, perhaps to the period when members of the Eppison family lived on the island.
All the tests contained the same stratigraphic layers: a dark brown loamy silt from 20 to 30 cm thick superimposed over an orange/brown B horizon. Only the test placed in the shell midden varied to a certain extent as the unit above the B horizon is only 9 cm thick.

Table 4. Shovel Tests Excavated on Ngerur Island.

<table>
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<tr>
<th>Shovel Test No.</th>
<th>Location</th>
<th>Depth (below surface)</th>
<th>Layers</th>
<th>Comments</th>
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<tr>
<td>1</td>
<td>ST 55</td>
<td>35 cm</td>
<td>I. dark brown loamy silt with roots, sterile</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>II. orange/brown B horizon</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>ST 55</td>
<td>35 cm</td>
<td>same as ST 1 sterile</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>ST 56</td>
<td>33 cm</td>
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<td></td>
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- ca. 20 cm thick
- 9 cm thick
- 30 cm thick
V. CONCLUSIONS

This chapter presents significance assessments and recommendations for mitigation of archaeological features assigned significance on Ngerur Island. Although Ngerur is recorded with one site number—OR-12-47—the 57 archaeological features composing the site possess different levels of significance and therefore require differing mitigation strategies. Recommendations are thus provided at the feature level rather than as a whole site.

SIGNIFICANCE ASSESSMENTS

Site significance is evaluated using criteria initially established by the U.S. National Register for Historic Places (NRHP), as defined in the Code of Federal Regulations, Title 36, Part 60.6 (36 CFR 60.6). These criteria have been adopted by the Republic of Palau under Palau National Code Title 19, the Palau Historical and Cultural Preservation Act. Sites are evaluated for historical significance, as follows:

The quality of significance in American history, architecture, archaeology, and culture is present in districts, sites, buildings, structures, and objects of state and local importance that possess integrity of location, design, setting, materials, workmanship, feeling, and association, and:

A. That are associated with events that have made a significant contribution to the broad patterns of our history; or
B. That are associated with the lives of persons significant in our past; or
C. That embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that have high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
D. That have yielded, or may be likely to yield, information important in prehistory of history.

Ngerur Island is evaluated as significant under Criterion D of Title 19. The island (OR-12-47) possesses integrity of location, design, setting, materials, workmanship, feeling, and association; and has yielded, or may be likely to yield, information important in Palau's history (Criterion 19). The types of cultural features present and the pattern of their distribution across the landscape augment the meager historical information available concerning the leper colony. The presence of buried human remains, some of known individuals, adds elements of cultural value and sensitivity to the historical importance of the site.

RECOMMENDATIONS

As the preferred management strategy, it is recommended that the cultural features and burials associated with OR-12-47 be left undisturbed and in place. It is our understanding, however, that the planned development of the island will not be compatible with the preservation of all the features and burials. As this will adversely impact significant cultural properties, measures to mitigate these impacts will need to be developed and implemented. While preservation is the preferred alternative, mitigation through data recovery and dismantlement and reburial of human remains is an alternative. Mitigation will require consultation with the Division of Cultural Affairs, the preparation of a mitigation plan, and data recovery recording and excavations in accordance with the mitigation plan. Efforts should be made to avoid and preserve in place as many features as possible.

Mitigation of the non-burial features should be straightforward and consist of a minimal amount of work, involving more detailed recording, photography, and videocopying of the features. This work will involve the preservation of information about this important episode in Palau's history. More extensive research will be required to test potential burial features to determine whether or not burials are present. Table 5 lists the individual features identified during inventory survey and recommendations for mitigation of adverse impacts.

Possible burial features are scattered throughout the island. Rock mound Features 3, 5, 8, 25, 47, and 49 possibly contain human remains, and a rock mound (Fig. 41) is almost certainly a burial site. Five small, rectangular, rock-faced platforms are likely kitchen hearths but there is a slight possibility they contain burials (Figs. 27, 28, 36, 37, 50).

Table 5. Mitigation Recommendations for Archaeological Features on Ngerur Island (OR-12-47), Koror

<table>
<thead>
<tr>
<th>Feature No.</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Further Work: 1, 2, 6, 10, 11, 12, 15, 14, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 29, 30, 31, 33, 34, 35, 36, 37, 38, 39, 40, 41, 43, 44, 45, 46, 51, 53, 54, 56, 57, 58</td>
<td>All require subcategorizing</td>
</tr>
<tr>
<td>More Detailed Recording: 4, 15, 28, 36, 37, 38, 55</td>
<td>Figs. 55- remove portion of a structure found during survey</td>
</tr>
<tr>
<td>Test to Determine if Burial Feature: 3, 5, 8, 22, 27, 28, 36, 42, 47, 48, 49, 50</td>
<td>Figs. 47, 48, 49, 50- likely human remains; need positive identification</td>
</tr>
<tr>
<td>Disturb Human Remains: 9</td>
<td>Figs. 9 at least 25 and possibly as many as 30 individuals buried here</td>
</tr>
</tbody>
</table>

Preservation is the preferred alternative for all archaeological features.
The removal of human burials is a sensitive issue and will require meticulous planning on the part of the applicant seeking to disinter the remains. If it is deemed necessary to remove the burials, they should be treated with the utmost respect and reinterred at a place agreed upon by all concerned. Methods to be used in the treatment of human remains must be stipulated in a burial treatment plan, which will need to be approved by DCA prior to disinterment (Liston 1999b). Careful excavation and detailed recording will be essential elements in the burial recovery process.

**DISCUSSION AND SUMMARY**

Ngeraur contains little in the way of traditional Palauan remains. An isolated pottery sherd was recovered during excavations. Also, it is possible the rounded basalt boulders used in the current structures may have once formed traditional features such as stone platforms and paths. The 18 shovel tests placed across the island revealed no cultural deposits. It is likely the island was not used as a permanent habitation area but was visited from time to time by people living on the larger nearby islands to fish, gather fruit, or relax.

After gaining control of Palau in 1914, the Japanese established a leper colony on Ngeraur around 1930 because of a profound fear of leprosy. Those banished to the island were mostly Palauan, although a few foreigners were included. The 57 archaeological features on the island today are almost all remains of the leper colony. A few of these features were probably constructed or reconstructed after WWII when members of the Epison family lived on the island.

Fifty-seven archaeological features were identified on the island during the inventory survey. The wide range of feature types present includes: rock mounds, concrete foundations or structures, terrace platforms, earth platforms, stone-lined wells, alignments, depressions, sets of furrows, modified outcrops, and disturbed features. In addition, five small rectangular stone platforms, two of which are located on terrace platforms, were located.

The cultural landscape and features of the island provide evidence of its use by the inhabitants of the leper colony for domestic activities and farming. The ploughed furrows and earth platforms testify to the farming of the land for vegetables. Fruit was gathered from the island's abundant fruit trees. A cistern and at least two wells indicate an ample supply of fresh water. The island's inhabitants slept and rested in houses constructed on terrace platforms or concrete foundations. Stone paths led from one area of the island to another. In addition, the three piers on the island assured that the monthly boat bringing fresh supplies from Koror had a place to dock.

Burials were interred in the cemetery (Fea. 9) at the northern end of Ngeraur. Some of the plots were—until recent disturbance—delineated with inverted glass bottles or stones and others were covered with a layer of cobbles. These markers, along with empty spaces between plots and depressions in the ground surface caused by decayed wooden coffins, suggest the cemetery may contain at least 23 individuals, and probably more. The cemetery may extend east of the marked plots although no markers are currently present. Shovel tests placed to the west of the cemetery on earth platform Feas. 56, 57, and 58 did not encounter human remains. However, a portion of a humerus was buried ca. 5 cm below ground surface just south of Fea. 58.

Oral historical documentation and the presence of several stone features highly reminiscent of graves indicate burials are not confined to the cemetery boundaries. An informant reports that seven people returned to Ngeraur during WWII when food became scarce on Babeldaob. Eventually they were tracked down and killed by Japanese soldiers, and buried in an area removed from the cemetery. Those burials likely had no headstones or other surface indications or possibly only simple wood markers long since washed out. Outside the cemetery, possible burial features are scattered throughout the island. Rock mound features 3, 5, 8, 25, 47, and 49 possibly contain human remains, and rock mound Feature 48 is almost certainly a burial site. Five small, rectangular, rock-faced platforms are likely kitchen hearths but there is a slight possibility they contain burials (Feas. 27, 28, 36, 42, 50).
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Wickler, Stephen K. and David J. Welch (cont.)


Wickler, Stephen J., David J. Welch, M.I. Tomonari-Tuggle, Jolie Liston, and H. David Tuggle

Appendix B-7

UXO Survey Report
(Bombs Away, Inc.)
1. Existing conditions

A. Results of literature search:

Region: Research at the Micronesia Area Research Center (MARC) and Palau National Museum, revealed Palau was the headquarters for the Japanese Navy in the southwest Pacific during World War II. Facilities included a large Japanese administrative headquarters, a major fleet anchorage and heavy defensive fortifications. Though bypassed during the island hopping campaign, the region was the scene of intensive aerial attacks by US Naval forces. On March 30 and 31, 1944 Japanese facilities in Palau were destroyed during Operation Desecrate I, the carrier raid of three US task groups of Task Force 58 under Rear Admiral Marc Mitscher. U. S. Naval forces included air assets comprising several hundred US Navy fighter and attack aircraft. All significant shore facilities were bombed. 14 Japanese support ships were sunk and defensive positions attacked with bombs, rockets and guns. The Japanese were aware the attack was coming and put up a fierce antiaircraft barrage. Repeated bombing by US Army Air Corps B24's continued in the area through the middle of 1944. A second carrier based raid was launched later in 1944 prior to the assaults on Peleliu and Angaur in the outer Palauan island chain.

Site: There are no specific records of permanent or defensive structures located at the project site. The island was used as a leper colony by the Japanese. Later, the island was a chicken farm. This is the only information on the site that we could find.

B. Summary of field reconnaissance methods:

The BOMBS AWAY UXO Consultants walked the perimeter of Ngerur island and criss-crossed the island on foot using hand-held magnetometry equipment. The Consultants also drove (in the boat) around the island several times to determine the depth of the water. After determining the depth of the water, the hydrographic survey lasted for two days. Using the boat in conjunction with the divers, the water around the island was visually inspected to a depth of sixty feet.

C. Report of field reconnaissance results:

1. Ordnance:

An ordnance item was found on the shoreline. The item was a projectile. This item was brought to the island recently and it appeared to be modified. The filler is cement and perhaps the item is now used as some sort of an anchor for a buoy perhaps. The item poses no hazard. Normally, this type of item would pose a high explosive threat. The island has many "hot" rocks. This means that
many of the rocks on the island have the signature of a piece of ferrous metal. This is not uncommon. Outside the rocks, no other magnetic anomalies were found.

D. Recommendations for future work on the island:

The island has no signs of UXO. BOMBS AWAY can only recommend that no further action be taken as far as UXO is concerned.

The UXO Consultant spent two days on the seven acre site on Malakal. Because of the existing buildings and debris, the magnetometry equipment is not accurate. The visual search found no UXO.

UXO has been found on Malakal in the past on the Mobil tank farm and the road to the rock quarry. Because of this past history, I can only recommend that a UXO Specialist be brought in to monitor the excavation on the seven-acre site. If UXO is encountered, the Specialist can take action immediately to not impede with the excavation process. The other alternative is to wait for the Palauan Government to show up. This has proved to be unreliable in the past.

EXPLOSIVE FILLER REPLACED WITH CEMENT

SIDE VIEW OF PROJECTILE

[Photo is un reproducible due to copy.]
Appendix B-8

Zoning Considerations
AN ACT

To amend the Koror State Zoning Map to re-zone the area commonly known as "Ngerur Island."

THE PEOPLE OF COROR REPRESENTED IN THE LEGISLATURE OF THE STATE OF KOROR DO ENACT AS FOLLOWS,

SECTION 1. FINDINGS. The Sixth Koror State Legislature hereby finds that the Koror State Zoning Map is outdated and requires significant adjustments to meet the ever-changing needs of Palau's growing population by creating more available spaces to allow for improved infrastructure and economic development opportunities for the State of Koror.

The Legislature further finds that, until a comprehensive zoning map is prepared to meet these demands, changes must be made regarding specific projects that are conducive to future economic development expansion. The Legislature further finds that it is in the best interests of the people of the State of Koror to re-zone the area commonly known as "Ngerur Island" to RV (Resort Center Zone).

SECTION 2. AMENDMENT OF KOROR ZONING MAP. The official Koror Zoning Map is hereby amended to re-zone the area known as "Ngerur Island" from CD ("Conservation") to RV ("Resort Center Zone"); the new zone applies to the area highlighted in red on the attached copy of the official Koror Zoning Map, and as of the effective date of this Act, the area shown in red shall be zoned RV ("Resort Center Zone").

SECTION 3. SEVERABILITY. In the event that a court of competent jurisdiction determines that any part or portion of this law is invalid, then the offending portion or portions may be stricken, and the remaining portions shall continue in full force and effect.

SECTION 4. EFFECTIVE DATE. This Act shall become effective upon its becoming law by operation of the Koror State Constitution.

PASSED September 1, 1999
Appendix C-1

Predicted Noise Levels

(Y. Ebisu and Associates, 1999)
Figure 2

Anticipated Range of Powered Boat Noise Levels vs. Distance

- **Car Horn**
  - Typical noise levels from powered boats within harbor or marina.
- **Conversational Voice**
  - Typical noise level of powered boats outside harbor.
Dear Claire:

The enclosed Figures 1 and 2 depict the predicted noise levels at various distances from hoe ram operations and powered water craft. The hoe ram predictions are based on hoe ram noise measurements at 90 and 1,600 feet from the equipment. The powered water craft predictions are based on noise measurements at 100 to 300 feet from various water craft.

**Hoe Ram Noise:** Noise from hoe ram operations will probably be audible at the northwest end of Arakabesan, and range between 42 to 58 dBA (Lmax, or maximum, A-Weighted, Sound Level). Hoe ram noise, predicted to range between 30 to 40 dBA, may not be audible in the central and easter sections of Arakabesan. Risks of adverse noise impacts from hoe ram operations (or construction activities of similar noise level), appear to be very low.

**Water Craft Noise:** The closest distance between the water crafts' ground track and any island between Ngurur and Malekal is approximately 200 meters (or 650 feet). At that distance predicted maximum noise level from offshore water craft are in the mid-50 dBA range. These levels are similar to voice conversations at 20 feet separation distance between the talker and listener. In order for the cumulative noise exposure level to exceed 65 DNL (the most conservative noise impact threshold) on an island along the transit route, over 10,000 daily trips of water craft are required along the ground track shown between Ngurur and Malekal. Therefore, risks of adverse noise impacts from water craft operations appear to be very low.

Sincerely,

Yokichi Ebisu, P.E.

encl.
Appendix C-2

Plant Materials and Landscaping Considerations

(Tongg, Clarke and McCelvey, Inc., 2000)
Landscaping Considerations

Approximately 85 percent of the island will be disturbed due to construction. The remaining undisturbed 15 percent consists of areas along the shoreline where existing vegetation will be preserved as much as possible. Where possible, the building and hardscape elements have been positioned so as to allow the large trees throughout the island to remain in place. This includes approximately 319 trees. In addition, approximately 116 existing trees will be relocated on the island. With the exception of the buildings and hardscape areas, all of the island will be replanted with locally available species (refer to the Quest Resort Plant List).

TOP SOIL. During the initial clearing and grubbing of the areas being disturbed, the existing top soil will be removed and stockpiled on the island. As part of the planting operations, this top soil will be spread throughout the planting areas and amended with organic materials (mulch, compost, etc.) to improve the water holding capacity of the soil. In addition, the green waste on the site will be chipped and placed throughout the planting beds.

FERTILIZERS. Based on the soil test, organic and chemical fertilizers will be added if required. It is not anticipated that a large amount of chemical fertilizers will be required in light of the successful growth of plants on the island.

HERBICIDES & PESTICIDES. Minor spraying with a non-selective herbicide (such as Image or Round-up) may be required to spot control weeds. These herbicides do not have any chemicals that move beyond the immediate contact with the plant. Locally available pesticides and practices will only be used as needed.

NURSERY. A temporary off site nursery is planned for the propagation of plants, shrubs, ground cover, and trees to be planted on Ngerukt Island as part of the landscape effort. The nursery will be developed during the construction phase of the project and it is expected that it will be dismantled shortly after construction is complete, once the landscaping is established at the resort. The off-site nursery will be organized into five distinct areas of operation. These areas are the shade house, the mist house, the compost area, the open nursery, and the office/storage/operation area.

- Shade House. Approximately 9,600 square feet of area covered by a simple pole, cable, and shade cloth structure would be used for the propagation and growth of shrubs and ground cover before they are moved to the open nursery. This area will be supplied with planting benches and an irrigation water supply.
- Mist House. A smaller area of approximately 4,000 square feet constructed of the same pole, cable, shade cloth material would be used for the initial propagation of cuttings and seedlings. As these become established, they will be moved to the Shade House and then into the open nursery. Planting benches and a mist irrigation system will be provided in the Mist House.

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<th>CODE</th>
<th>COMMON NAME</th>
<th>BOTANICAL NAME</th>
<th>SIZE</th>
<th>HEIGHT</th>
<th>SPD</th>
<th>CAL</th>
<th>SPACING</th>
<th>PLAN</th>
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<td>DYP LUT</td>
<td>ARECA PALM</td>
<td>CHRYSALIDOCARPUS LUTESCENS</td>
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<td>CYCAS CIRCINALIS</td>
<td>5 GAL</td>
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<td>6</td>
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<td>Pycho sperma macartthuri</td>
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<td>CAS RAI</td>
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<td></td>
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<td>CERBERA</td>
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<td>HERNANDIA</td>
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**Total - Palms:**

**Total - Trees:**
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<th>HEIGHT</th>
<th>SPD</th>
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<th>QTY.</th>
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**Total - Shrubs and Vines:**

**Ground Covers:**

| GS  | ASPARAGUS FERN       | ASPARAGUS Sprengeri          | 1 GAL | 12"    | 2'-0" O.C. | 300  | 300    |
| BM  | BACOPA               | BACOPA MONNIERI              | Plug 2" | 6'-0" O.C. | SF  | 200    | 200 SF |
## QUEST RESORT

### Plant List

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<th>CODE</th>
<th>COMMON NAME</th>
<th>BOTANICAL NAME</th>
<th>SIZE</th>
<th>HEIGHT</th>
<th>SPD</th>
<th>CAL</th>
<th>SPACING</th>
<th>PLAN QTY.</th>
<th>FILLER QTY.</th>
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**Total - Ground Covers**

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**Total - Turf Grass**

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**Total - Relocated Trees**

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**Total - Miscellaneous**

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Projects/IRP/Documents/Plant-List.xls/Plant List | Page 3 of 3
Appendix C-3

Burial Plan

(IARII, Inc., 1999)
MEMORANDUM OF AGREEMENT
BETWEEN NGERUR CORPORATION AND
DIVISION OF CULTURAL AFFAIRS

WHEREAS, an Application for a Historic Clearance was filed on August 5, 1999 by Ngerur Corporation to construct a resort on Ngerur Islands, Koror State; and

WHEREAS, Ngerur is a 4-acre of land located 734 meters northwest of Desert Point on Ngarkesenang Island, Koror State; and

WHEREAS, prior to the filing of the required application, several consultations between the Division of Cultural Affairs (DCA) and the Ngerur Corporation took place. Ngerur Corporation contracted the IAREI archaeologist to carry out an inventory of the cultural and historical resources in the island including a collection of the ethnographic information. As a result a complete report entitled Archaeological Inventory Survey of Ngerur Island, Koror, Republic of Palau was submitted to DCA for review; and

WHEREAS, based on the aforementioned report which was reviewed and concurred by DCA and DCA additional findings, Ngerur Island contains several archaeological features and human burials that will be adversely affected by the proposed project; and

WHEREAS, as a result of "adverse effect on historic properties", the required Treatment and Monitoring Plan for Burials Located on Ngerur Island, Koror, Republic of Palau was completed and submitted to DCA for review and has been concurred by DCA for implementation, and

NOW THEREFORE, the Ngerur Corporation and the DCA agree that the undertaking shall be implemented in accordance with following stipulations in order to take into account the effect of the undertaking on cultural and historic properties.

STIPULATIONS

1. Ngerur Corporation shall ensure that a professional archaeologist implements accordingly the Treatment and Monitoring Plan in Ngerur Island.

2. Ngerur Corporation shall ensure that a final report is completed and submitted to DCA as stated in the plan for review and concurrence.

3. Ngerur Corporation shall ensure that a temporary location for human remains to be collected meet all specifications as stated in the plan, and that a designated place at NFICD Marine, Malakal, Koror State, be a temporary storage for the human remains before their reinterment.

4. The removal and treatment of human remains and artifacts will follow DCA guidelines.

5. Shallum Elipson who is the President of Ngerur Corporation shall secure a place for reinterment of human remains at Sakurakai cemetery in Ngabodol Koror State. A copy of an easement letter from Koror State government of appropriate person(s) with such authority to allow the reinterment shall be sent to DCA office prior to the burials.

6. Ngerur Corporation shall inform DCA office of time and date of the reinterment.

7. Ngerur Corporation shall inform DCA office immediately of any change of plan and allow DCA office to comment.

8. If any of the signatories of this MOA believes that terms of this MOA cannot be carried out or that an amendment must be made, that party shall notify the other signatory and shall request consultation to amend this agreement. The process of amending this MOA shall be the same as that exercised in creating the original agreement.

BE IT RESOLVED THAT the execution and implementation of this MOA will satisfy the requirements of Title 19 of the Palau National Code.

NGERUR CORPORATION

Shallum Elipson
President

DIVISION OF CULTURAL AFFAIRS

Vicky N. Kann
Chief, DCA/IFO

Date

Date
TREATMENT PLAN FOR BURIALS LOCATED ON
NGERUR ISLAND, KOROR, REPUBLIC OF PALAU

by
Jolie Liston, M.A.

prepared for
Ngerur Corporation
P.O. Box 129
Koror, Republic of Palau 96940

International Archaeological Research Institute, Inc.
949 McCully Street, Suite 5
Honolulu, Hawaii 96826

January 1999
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1. Burial or Potential Burial Features on Ngerur Island (OK-12,47): 4
INTRODUCTION

This Burial Treatment Plan is prepared by International Archaeological Research Institute, Inc. (IARI) in response to a request by the Palau Division of Cultural Affairs (DCA) to develop a plan for the disposition and long-term protection of human remains located on Ngerur Island, Koror, Republic of Palau (OR-12-47). Preparation of the plan follows an archaeological inventory survey conducted as part of the environmental assessment prior to the proposed development of Ngerur into a resort property. The survey identified a historic cemetery containing at least 20 burials plus eight potential grave sites dispersed throughout the island. In addition, oral history indicates seven randomly placed graves without headstones or other surface indicators. This burial treatment plan has been prepared on behalf of the Ngerur Corporation.

The plan discusses the history of the Ngerur burials, presents the rationale for their removal, lays out the procedures for exhumation, curation, and reinvestment of the remains, and offers methods to ensure the long-term maintenance and protection of the preservation area. Creation of signage, brochures, and shrines to commemorate the Ngerur Island burials are discussed.

The burial treatment plan is intended to be used in conjunction with a data recovery plan which has yet to be prepared for Ngerur Island. All aspects of the following plan will be carried out in close consultation with the Division of Cultural Affairs.

BACKGROUND

PROPOSED DEVELOPMENT ON NGERUR ISLAND

Ngerur’s level topography, not commonly found on Palauan islands, its location neighboring Koror, and the beauty of the property have led to plans to construct an elite resort on the island. The resort design includes individual cottages dispersed across the landscape, a docking area, and a restaurant. The entire island will be utilized to accommodate the buildings and connecting pathways.

In the face of this development, two alternatives exist for the human burials on Ngerur: (1) commit to in situ preservation or (2) plan for disinterment and relocation of the remains. In either case, the proposed burial treatment will have to be approved by DCA. The recommended method of treatment of human remains is preservation in place.

In a meeting with representatives of DCA in November 1998, the property owners presented a request for the removal and relocation of the interments on Ngerur. This request was based on two factors: (1) reinvestment on the island is not possible as the soil is too shallow and (2) the presence of human graves produces a bad image for the type of development proposed for Ngerur. Thus, due to the nature of the development project, the in situ preservation alternative is not feasible. It was therefore proposed to remove the human remains from Ngerur Island and relocate them in a designated preservation area in Koror. DCA instructed the landowners to construct a burial treatment plan for the appropriate disposition of the remains. The plan would then be presented to DCA for their authorization.

DESCRIPTION OF NGERUR ISLAND

Ngerur Island is an historically and culturally significant site designated OR-12-47. It is located 744 m northwest of Desolation Point on Ngakelbesang Island, Koror. Roughly 4 acres, the island is volcanic in origin, composed primarily of volcanic breccia, conglomerate, and tuff. The surface of the island rises gently towards the middle to roughly 30 m above sea level. A steep cliff of varying heights abuts the rocky beach around the island. The soil on the island is shallow with a slightly thicker deposit in the north part of the island where the cemetery is located.

Ngerur remains little in the way of traditional Palauan remains. It is likely the island was never used as a permanent habitation area but was visited from time to time by people living on the larger nearby islands to fish, gather, or to relax.

After gaining control of Palau in 1914, the Japanese, profoundly fearful of Hansen's disease established a leper colony on Ngerur around 1930. Anyone infected with skin disease resembling leprosy was removed from Babebiando and Koror. Those banished to the island were permanently Palauan, although a few foreigners were included. The archaeological features on the island today are almost all remnants of the leper colony. A few of these features are likely constructed or reconstructed after World War II when members of the Epton family lived on the island.

Fifty-eight archaeological features were recorded on the island during the intensive survey (I series 1998). The wide range of feature types present includes: earth platforms (some rock-faced), rock mounds, concrete structures, stone walls, modified outcrops, depressions, sets of furrows, stone alignments and possible stone alignments, rectangular stone platforms, rock shelters, stone-lined wells, a cemetery, a shell midden, the base of a wood pole, a stone cist, a stone dock, and a fire hearth. Figure 1 shows the relative location of each of the cultural properties on Ngerur. These features containing or potentially containing human burials are marked with a star.

Ngerur Island is evaluated as significant under Criterion D of Palau National Code Title 19, the Palau Historical and Cultural Preservation Act. The island, Site OR-12-47, possesses integrity of location, design, setting, materials, craftsmanship, feeling, and association and has yielded, or may be likely to yield, information important in prehistory or history (Criterion D). The types of cultural features present and the pattern of their distribution across the landscape augment the making historical information available concerning the leper colony. Presence of buried human remains, some of known individuals, adds the element of cultural value and sensitivity to the historical importance of the site.
DESCRIPTION OF BURIALS

The colonizers of the leper colony were buried in the cemetery (Fig. 9) at the north end of Ngerur. Some of the plots were delineated with upside-down glass bottles or stones and others were covered in a layer of cobbles. These markers, along with empty spaces between plots and depressions in the ground surface caused by decayed wooden coffins, suggest the cemetery contains at least 20 individuals, and probably more. The cemetery may extend east of the marked plots, although no markers are currently present. Shovel tests placed to the west of the cemetery on earth mound features 56, 37, and 38 did not encounter human remains. A portion of a humerus was buried ca. 5 cm below ground surface just south of Fig. 18, however.

Oral historical documentation and the presence of several stone features highly reminiscent of graves indicate burials are not confined to the boundaries of the cemetery. An informant reports that several people returned to Ngerur during World War II when food became scarce on Babesdo. They were eventually tracked down and killed by Japanese soldiers, and then buried in an area removed from the cemetery. These burials likely had no headstones or other surface indications or possibly only simple wood markers long since rotted. Outside the cemetery, possible burial features are scattered throughout the island. Rock mound features 1, 5, 8, 21, and 47 possibly contain human remains, and rock mound feature 4 is almost certainly a burial site. The small rectangular stone platform features 17, 18, 42, and 50 may be either grave sites or kitchen platforms. Table 1 lists features where either known or potentially contain human remains.

Ngerur was briefly surveyed by a team of IARI archaeologists during an intensive survey conducted in February 1998 of the northwest portion of Ngerekebesang Island. Some of the cultural properties present on the island were recorded at that time. Upon returning to Ngerur in November of the same year to conduct an inventory survey, the project director and supervisor, both of whom had been involved in the earlier work, noted that several of the previously recorded stone features had since been destroyed.

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<td>cemetery</td>
<td>at least 20 graves, more are likely present</td>
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<td>1, 4, 5, 8</td>
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<td>Feature A probably a burial mound, but others might also</td>
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<td>56, 37, 38</td>
<td>rectangular earth platform</td>
<td>foundations for structures?</td>
<td>seems close to cemetery to function as either garden area or for placement of structures</td>
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Table 1. Burial or Potential Burial Features on Ngerur Island (NR-12:47).
Three small rectangular stone platforms (Fea. 27, and those on Feas. 28 and 29), two stone-faced terrace platforms (Fea. 28 and 29), and a set of stone steps (part of Fea. 28) had been extensively damaged and their constituent stones thrown, or carried ca. 15 m from their original location. Additionally, at least five, and likely more, burials at the cemetery (Fea. 9) had been extensively damaged by the removal of grave markers consisting of a layer of stones or an outline of upturned bottles. The removed bottles are missing, but the stones are spread in a 20 m radius around the graves. Fortunately, most of these features were previously mapped, described, and photographed. A detailed map of the cemetery had yet to be drawn. The land surveyor noted two stone features in the north central part of the island, which he interpreted as grave markers because of their appearance and the surrounding plants being those normally associated with burials. These had also been completely destroyed. He had pinpointed their location on his map constructed in February, but the archaeologists had not yet recorded these features. On 6 November, representatives of DCA visited the island to assess the damage to the site.

The total number and exact location of graves on Ngurur Island can not be determined. The cemetery (Fea. 9) is known to contain 29 graves, although more are likely. One feature (Fea. 4), a rock mound, is almost certainly a grave. Oral history indicates there are at least seven individuals buried outside the cemetery grounds. Ten possible grave sites, as indicated by rock mounds and stone platforms, are dispersed throughout the property. In addition, there may be graves in the cemetery possessing no surface indications. Thus, 28 burials are definitely located on the island. The possibility of at least an additional 10.

As the burials display no signs of disturbance—except the recent vandalism—apparent only affected the grave, and the skeletal material is presumed to be intact burials. Fragmentary remains encountered, such as the bony bone located during the inventory survey, probably represent burials that have been disturbed by erosion or rodents.

Oral history indicates that the majority of human remains on the island are Paluans who were buried 50 to 60 years ago when the island was a leper colony. In addition, an informant reports four of the burials may be foreigners from Indonesia, Japan, Korea, and China.

**RECOVERY AND CURATION OF THE REMAINS**

Disinterment will be carried out prior to the commencement of construction work on the island.

Hansen’s disease is a chronic infectious disease caused by Mycobacterium leprae. According to Dr. Bruce Clements of the Hansen’s Disease Center in Carville, Louisiana, the disease is believed to be no longer communicable 10 to 14 days after burial of an infected individual (Bruce Clements, pers. comm. December, 1998). Dr. Thomas Shennick, Branch Chief of the National Center for Infectious Disease, Tuberculosis, and Microbiologists Branch, knows of one study proving the bacterium can survive about a year in a dry open environment. Although the precise route of infection is unknown, it is believed transmission through dust and strations is the most likely method. The disease, however, is not easily transmitted (Thomas Shennick, pers. comm. December, 1998). While there have been no long-term studies of the resiliency of Mycobacterium leprae, it is improbable that the bacterium is active in the Ngurur Island burials after 50 years. However, in order protect the archaeologists removing the burials from contracting the disease, they will wear long-sleeved shirts, pants, gloves, and boots when excavating.

**PRIOR TO EXUMATION**

The undertaking will be preceded by a public announcement of the exhumation of the human remains on Ngurur Island and their relocation to a preservation area in Koror. An example of such an announcement is provided in Appendix A. A public meeting will be held in Koror following the announcement. The purpose of the meeting is to inform interested parties of the proposed treatment of the remains and to provide a public forum for discussion of these intentions. The meeting will be chaired by Shailum Eptison and attended by representatives from DCA and the developer, the Maru Corporation.

If it is appropriate, culturally specific ceremonies can be held on Ngurur Island before exhumation begins.

**EXUMATION PROCEDURES**

Disinterment of the burials will be performed by a professional team of one archaeologist and one physical anthropologist.

The graves will be systematically excavated by hand under controlled conditions. Detailed plans and profile maps will be drawn of both the grave structure and its attendant human remains. The primary goal of the meticulous hand excavation is to remove the skeletal remains intact and in a respectful manner. The secondary goal is to discover evidence of a burial pit or coffin and establish the orientation and burial position of the individual. Excavation in each grave site will cease when there is no further evidence of skeletal remains or disturbed sediments. It is likely that bedrock will be encountered just beneath the interfaces.

All remains will be documented as they are removed from the ground to determine duplication of skeletal elements or any commingling of remains. The bones will be placed in clean dry paper and carefully wrapped, recorded at to provenience and body part, and stored along with other bones from the same individual. Individuals will be curated separately.

After recovery of the large skeletal remains, the matrix surrounding the burial will be screened through 1/8 inch mesh to ensure recovery of all remains. Should grave goods be
located during the exhumations, they will be recorded and photographed, and then reinterred with the individual in the preservation area.

The decision of whether or not to conduct osteological analysis of the remains will be made by the property owners, individuals claiming ancestry to the Ngerebur burial, and OCA. If the decision for analysis is agreed upon by the interested parties, the skeletal elements will be examined to determine metric and non-metric attributes that would facilitate a determination of populational affinity. Included would be documentation of the age, sex, and cause of death of the individual. Osteological analysis is to be conducted in a laboratory by a qualified physical anthropologist.

Should the interested parties decide that osteological analysis of the remains is not called for, the remains will be moved directly from the field to the curation facility where they will remain until their reinterment.

**CURATION OF THE REMAINS**

During the period between exhumation and reburial, the remains and funerary objects are to be curated in a protected location and in a respectful manner. This temporary storage of the human skeletal material should be as close as possible to assure the protection of the bones. The location is to be large enough that the remains are not stacked atop one another but laid out by individual burial. The remains should not be exposed to the elements nor accessible to the general public and should be maintained in a secure and fire-proof room. An inventory of the remains will be available to check the completeness and condition of the exhumation upon both its delivery and removal from the exhumation site. Proposed curation locations are the concrete storage room beneath the Epturii Museum of the general hospital on Ngerekkesang Island.

**REINTERMENT OF THE REMAINS**

This section of the plan gives recommendations for ensuring that human remains from Ngerebur Island will be preserved in perpetuity. It lays out procedures and guidelines for (1) reinterment of burials; (2) location and design of the preservation area; and (3) long-term maintenance of the preservation area.

Skeletal remains disinterred from Ngerebur will be reinterred in a protected area. The preservation area will be in a cemetery in Kereru. This single reinterment site provides for a central repository that can be sealed for protection. Any burials or violent remains that may be inadvertently uncovered during development would also be interred at this preservation area.

**PROCEDURES FOR REINTERMENT**

If it is felt to be suitable, culturally appropriate services or ceremonies can be held at the reinterment location prior to reburial of the Ngerebur remains.

The individual burials are to be placed in trenches at least six feet deep. Arrangement of the burials will mimic as closely as possible that of the Ngerebur cemetery so that individuals will remain in their original placement. The burials will be covered with sand and capped with large stones that will serve as a protective layer. The reburial pit will be completely covered with loamy soil suitable for landscaping.

**PRESERVATION AREA**

If reinterment is withina specific preservation area, it is recommended that the area be raised a minimum of 18 inches above the surface of the surrounding terrain and be demarcated by a rock wall at least 3 feet high. This will create an elevated island that will help to limit pedestrian access. This raised preservation area will be landscaped with low maintenance native vegetation common to the area. If sufficiently dense, the vegetation will serve to not only accentuate the area's visual separation but will also help to further discourage pedestrian traffic across the preserve area.

If reinterment is within a cemetery, the landscaping will maintain the character of the cemetery. A stone alignment will be placed around the perimeter of the reburial location to distinguish the area from the remainder of the burial ground.

A sign indicating that this is a preservation area should be placed in a prominent location. The sign should clearly indicate that this is a burial area and should be treated respectfully. It should be attractively integrated with the landscaping. This memorial stone will be erected by the Ngerebur and Morita Corporations. An example of an epitaph is given here. The wording should be in Palaui, English, and any other appropriate language.

To remember those from Ngerebur Island.
May they rest in peace
Please be respectful.

**LONG-TERM MAINTENANCE**

As the location of the reinterred remains is a burial area it should be treated respectfully. It is imperative that the landscaping at the reinterment location be maintained and trash picked up.

To ensure that the burials are preserved in perpetuity, periodic monitoring of the burial/reburial site should be carried out. The purpose of the monitoring is to review and assess conditions to make certain that the burials have not been inadvertently or intentionally
disturbed. Should it appear that the burials have been disturbed, revised preservation guidelines will need to be developed.

Landscaping and general maintenance will be conducted by surviving family members of those interred on Ngerur. If they desire, it may be possible to gain assistance in maintenance through a custodianship program in which a local community group becomes caretaker or steward of the site.

BROCHURES AND SHRINE

After completion of fieldwork, an archaeological report will be written concerning the examination and reinterment of the burials from Ngerur Island. The report will include a background section on the history of the island and burials, maps clearly marking where each burial was located, details of the osteological analysis, and a conclusion regarding the nature and distribution of human remains on the island. Portions of this report can be extracted to compose a brochure or leaflet to be distributed at the new resort development.

A shrine commemorating those who lived and died at the leper colony will be erected on Ngerur Island by the Morita Corporation. The site of the shrine can be incorporated into the proposed landscape of the development. The shrine should bear a sign, written in Palauan and English, indicating its construction in honor of the island colonists. It should be treated with respect. Landscaping and general maintenance of the site will be carried out by the gardeners for the corporation as they fulfill their other duties on the island. Once the term of the Morita Corporation lease has expired, the Ngerur Corporation will bear responsibility for maintaining the shrine.

INADVERTENT DISCOVERY OF HUMAN REMAINS

Should additional human remains be uncovered during the construction phase of the Ngerur project, or exposed by natural processes, or found unintentionally under unusual conditions, their treatment will follow the provisions of this Burial Treatment Plan.

As at least seven unmarked graves on Ngerur are documented, it is recommended a professional archaeologist knowledgeable in human osteology be present to monitor earth-moving activities during the construction phase of the project. The monitoring archaeologist would determine if any bones unearthed are human. If so, consult with DCA concerning their disposition, and thereupon carry out the proposed course of action. Monitoring of construction activities at Ngerur requires a separate archaeological monitoring plan.
APPENDIX A.

EXAMPLE OF PUBLIC NOTICE OF DISINTERMENT OF HUMAN REMAINS

Notice is hereby given that the Ngerur Corporation may disinter, with appropriate dignity and respect, human skeletal remains from the cemetery located on Ngerur Island, Koror and from individual grave sites throughout the same island in accordance with the Burial Treatment Plan approved by the Palau Division of Cultural Affairs. The remains will be reinterred in a preservation area in Koror. The remains are almost all Palauan and date to the 1930s and early 1940s, when the island was a leper colony.

A public meeting will be held on [date and time] at [location] to present the Burial Treatment Plan for Ngerur Island to interested parties. Representatives of the Ngerur Corporation, the Morita Corporation, and the Division of Cultural Affairs will be in attendance to discuss the procedure and answer questions concerning the reinterment.
Appendix D

Comment Letters and Responses
Agencies Who Were Contacted But Had No Comment:

Bureau of Lands & Surveys, Ministry of State
Bureau of Marine and Natural Resources
Bureau of Public Utilities
Bureau of Public Works
Chamber of Commerce
Council of Chiefs
Ministry of Health Services
Palau Community Action Agency
Palau Public Utilities Corp. (consultation letter was returned)
Palau Visitor Authority
U.S. Department of Agriculture – Natural Resources Conservation Office

Organizations Who Were Contacted But Had No Comment:

Belau National Museum
Coral Reef Research Foundation
Council of Chiefs
Palau Community College
Palau Resources Institute
The Nature Conservancy
Draft EIS Comments and Responses
October 6, 2000

Mr. Manrence Madranchar, Executive Officer
Environmental Quality Protection Board
P.O. Box 100
Koror, Republic of Palau 96940

Subject: Draft Environmental Impact Statement – Quest Resort Palau Project

Mr. Madranchar:

Enclosed, please find the itemized responses to comments from the Environmental Quality Board of Palau (EQPB) excerpted from the letter addressed to Mr. Daniel J. High dated September 1, 2000. A Final Environmental Impact Statement (FEIS) that incorporates the responses to comments from EQPB is also being submitted such that a final determination regarding the project can be made.

Comments from EQPB are italicized and the corresponding responses are hereby provided.

Item 1. Section 1.7 of the EIS should identify impacts and mitigation measures associated with the sewage and brine wastewater discharges.

Acknowledged. Additional narrative will be added to the water quality discussion in Section 1.7 of the FEIS. Please also note the following information:

**Treated Wastewater Effluent Discharge.** Wastewater collected from the resort will be treated on-island to a level equal or greater than that of the wastewater treated in Malakal. Treated wastewater effluent will be discharged from a deep water outfall. On-island treatment and discharge into the harbor avoids any impacts to the existing Class AA water quality criteria would be easily met within the zone of initial dilution immediately above the discharge point (Sea Engineering, Inc., 1999).

**Brine Discharge.** A by-product of the reverse osmosis (RO) water treatment system is brine. Brines of brine wastewater will be used to dilute the brine wastewater. A characterization of the return cooling water should be provided.

The RO units have a recovery rate of 35 to 40 percent. The projected the demand of 45,000 gpd would therefore require 112,500 gpd to 130,000 gpd (or 30 to 100 gpm) of seawater for processing. Approximately 67,000 to 85,000 gpd (or 45 to 60 gpm) of brine would therefore be discharged.

Please note that design changes (e.g., return cooling water will not be used) are still being formulated. Pertinent information will be included in the FEIS.

Item 2. Discharge of waste brine is considered a point source of pollution. The estimated discharge flow of waste brine generated from the reverse osmosis process and dilution water should be provided. It is stated in Section 3.1.2 of the EIS that return cooling water will be used to dilute the brine wastewater.

The estimated discharge flow of waste brine generated from the reverse osmosis process and dilution water should be provided. It is stated in Section 3.1.2 of the EIS that return cooling water will be used to dilute the brine wastewater. A characterization of the return cooling water should be provided.

Analysis using the PLUME model that was developed by the U.S. Environmental Protection Agency (EPA) indicates that the dilution of the effluent would be so rapid that all Class AA water quality criteria would be easily met within the zone of initial dilution immediately above the discharge point (Sea Engineering, Inc., 1999).

**Marine and Fresh Water Quality Standards.** Water quality standards pertaining to the marine waters of Palau are contained in the regulations by the EQPB, established pursuant to the Environmental Quality Protection Act, Chapter 1, Marine and Freshwater Quality Standard Regulations. Coastal waters are classified in accordance with uses (Chapter 2401105). During the session of the Sixth Koror State Legislature, April-May 2000, a resolution was passed to recommend to EQPB that waters around Ngerur Island be reclassified from the existing Class AA waters to Class B waters (refer to Appendix A). The draft of an Amendment to the Marine and Freshwater Quality Regulations that would allow for necessary changes in the classification of the waters around Ngerur Island from Class AA to Class B has been endorsed by the Environmental Quality Protection Board of Palau in September 2000 and forwarded to the Office of the President for final review and approval. The President, Republic of Palau, has used his authority under the law to approve the amendment as drafted (refer to Appendix A).

The effective date of the proposed Amendment is October 6, 2000. The current process provides the public with a 30-day commenting period. The OEK has a 120-day period during which a potential repeal of this reclassification would be possible.

**Marine Sanctuary.** A marine sanctuary/protected area around portions of Ngerur Island after construction is complete. A marine sanctuary/protected area around portions of Ngerur Island after construction is complete. A marine sanctuary/protected area (MPA) encourages the proliferation of marine life by providing an area...
where fishing, shell collecting, and coral touching is prohibited. Similar areas have been designated in other resort areas like the Florida Keys and the Great Barrier Reef. Currently, Palau does not have legislation to set wide areas as a MPAs. MHC intends to pursue such a designation and will explore this issue through the proper agencies and organizations.

**Item 4.** The specifications and design data should be provided for the wastewater treatment system so that the capability of the proposed treatment system to achieve secondary effluent standards can be evaluated. Palau’s Marine and Fresh Water Quality Regulations state that mixing zones will not be granted in lieu of reasonable control measures to reduce point source pollutant discharges but will be granted to compliment the applicable controls. Moreover, the Koror State Legislature passed Resolution No. 6-41, LD131 stating that the “discharge of pollutants be controlled to the maximum extent possible and that sewage and industrial effluent receive the highest degree of treatment practical under existing technologies and economic conditions.” Alternative treatment technologies that can exceed secondary treatment standards and their associated costs must be evaluated and provided to the Board before it can make a determination regarding the wastewater discharge.

Acknowledged. Pertinent information will be included in the FEIS.

**Item 5.** From an environmental standpoint it is not desirable to have wastewater discharges into the harbor because of reduced and affected circulation patterns that may consequently lead to water quality degradation. Why was the alternative of discharging the diluted brine wastewater through the sewage deep outfall not evaluated?

The alternative of discharging the brine through the wastewater outfall was evaluated; however, the inclusion of the brine with treated sewage raises the salinity whereby the density of the effluent becomes much greater than that of the ambient receiving water. Under these conditions, the effluent plume will not rise and this severely curtails dilution of the effluent.

The more environmentally friendly option is therefore to discharge only the treated sewage through the outfall in order to maximize rapid dilution of the treated wastewater effluent. This action also minimizes impacts on receiving water quality and the size of the zone of mixing.

Acknowledged. Pertinent information will be included in the FEIS.

**Item 6.** The project will include a non-community public waste supply system as defined under the regulations. Design data and specifications should be provided for the drinking water treatment system. Information should be provided on how the system will be operated and maintained and monitored to ensure that it complies with the EQPB drinking water regulations and protects the health of the users.

Acknowledged. Pertinent information will be included in the FEIS.

**Item 7.** Design details should be provided for the water intake that will help to minimize disturbance to corals, fish and other marine organisms.

Acknowledged. The FEIS will include design details pertaining to the water intake.

**Item 8.** It is stated in Table 5 that two harbor entrances are proposed. The table is in conflict with the Figure 14 drawing which shows only one harbor entrance.

Acknowledged. Figure 14 is correct. The mention of two harbor entrances in Table 5 is erroneous. The error will be corrected in the FEIS.

**Item 9.** The harbor will be enclosed by breakwaters except for a 60 foot wide entrance according to Figure 14. Harbors are known to degrade water quality because their design geometry may cause stagnation zones leading to accumulation of petroleum products and other toxic substances, lowered dissolved oxygen levels and deterioration of other water quality standards. No provisions such as culverts to maintain adequate circulation were proposed in the harbor design, nor was analysis or modeling provided to show that adequate flushing and circulation will be maintained to avoid water quality degradation.

The proposed harbor configuration has an open character. Its geometry is such that flow between the channel and the two basins is clear of any obstacles or turns. Consequently, there are no confined areas that could reduce circulation by “trapping” water. Furthermore, the width of the entrance is large relative to the interior area.

The harbor is shallow (-12 feet MSL) relative to the average tidal prism (+4 feet) that occurs twice a day. Each tidal cycle can be expected to exchange about one-third of the harbor waters, whereby a complete exchange of harbor waters can be expected every 1.5 to 2 days. In addition to water flow both in and out of the harbor entrance, the rubble-mound breakwaters are somewhat permeable, particularly at high tide when the water level is up to the level of the underlayer and armor stone. This allows water to flow through the structure. flushing of the harbor and water exchange should therefore be good such that negative water quality impacts (e.g., lowered dissolved oxygen levels) are averted.

The applicant will recommend that standard equipment for controlling any accidental fuel spills (e.g., oil containment booms) be readily available at the harbor for immediate deployment in the event of a spill. It is in the best interest of the applicant to have effective and immediate spill containment and cleanup to avoid the disruption of harbor activities.

**Item 10.** It is stated in Section 3.1.2 of the EIS that the sewage collection system will require two to three sewage pump stations. Information should be provided on how the pump stations will be designed and operated to prevent sewage overflows (e.g., standby emergency power, telemetry, storage capacity, holding tanks, etc.).

The wastewater system requires one small sewage pump station located adjacent to the service building serving only the kayak hut bathroom. The pumps will be around 1 HP. Alarms (that indicate pump failure, high water level, etc.) will be provided. The wet well will be slightly oversized to provide extra storage to allow corrective action to be taken prior to a spill event.

**Item 11.** In the Sea Engineering Report, the dimensions for the zone of mixing (ZOM) given in Table 4 do not seem to correlate with the dimensions shown in Figure 10.

Acknowledged. Table 4 is excerpted from the Sea Engineering, Inc. report of December 1999 (which is now outdated). Figure 10 is excerpted from the Sea Engineering, Inc. report of July 2000. This figure illustrates updated information. The earlier report included the figure,
but only as a graphic illustration (not to scale) of the general plume pattern. The true dimensions of the plume will be illustrated in Figure 11 of the FEIS.

Item 12. It is stated in Section 3.1.2 of the EIS that the total wastewater generated by the project is estimated to be 30,000 gallons per day (GPD); however, an assumed wastewater flow of 15,000 GPD is used as the basis for the modeling results and conclusions contained in the Sea Engineering, Inc. report which predicts the water quality impacts associated with the effluent plume and zone of mixing.

Acknowledged. The initial/ original Sea Engineering, Inc. report submitted in December 1999 used the volume of 15,000 gpd of generated wastewater effluent. In a revised report by Sea Engineering, Inc. dated July 2000, the volume of 30,000 gpd of generated wastewater effluent was used, as shown in Table 1 on page 2 in Appendix A.

Item 13. Table 19 in the EIS includes total suspended solids (TSS) as a modeled water quality parameter; however, this parameter is not presented in Table 3 of the three modeling reports done by Sea Engineering, Inc. nor is there any discussion or analysis of suspended solids concentration after dilution. BOD oxygen demand, compliance with turbidity standards or sediment accumulation in the report.

The TSS values in Table 19 were included in error; it is not a modeled criteria. It should also be noted that the TSS concentration is not associated with a Palau Water Quality Standards criteria, or, in other words, there is no water quality standard requirement to compare with any modeled value for TSS concentration. An intuitive analysis suggests that the TSS of the effluent is low, and given the very high initial dilution rate (1180 for 10 percent currents, 2217 for average currents), impacts on water turbidity would not be significant.

BOD (oxygen demand) was addressed in the Sea Engineering, Inc. report (December 1999). This report also presented a methodology for calculating the dissolved oxygen (DO) concentration following initial dilution, assuming an immediate DO demand of 5 mg/l for the effluent (which has 0 oxygen after treatment). The analysis shows that the oxygen concentration in the receiving water will be at ambient concentration following initial dilution. In summary, the discharge will have no impact on DO in the receiving water outside of the immediate zone of initial dilution.

Item 14. It is stated in Section 5.14.2 of the EIS that the wastewater effluent may be disinfected by sodium hypochlorite. Chlorine compounds can be toxic to marine organisms; however, there was no discussion of effluent chlorine concentrations and toxicity. alternative disinfection methods or measures for de-chlorinating the effluent.

The wastewater effluent will be disinfected by UV instead of sodium hypochlorite. Pertinent information will be included in the FEIS.

Item 15. Erosion and sedimentation is identified as an adverse impact in the Draft EIS. The EIS should contain a detailed site specific erosion and sediment control plan showing all temporary and permanent controls with appropriate narrative, supporting technical data, plan and detail drawings that complies with the intent of the EQPB regulations. Instead of a conceptual description of proposed erosion and sediment control measures, a detailed Erosion and Sedimentation Control Plan (ESCP) has been prepared for the Quest Resort Palau project by a licensed civil engineering firm. MHC will submit this ESCP under separate cover as required by the earthmoving permit application. The ESCP provides additional detail and supplements the information contained in the EIS.

The ESCP is intended to be used as a guide by prospective contractors outlining the minimum requirements for erosion and sedimentation control. MHC will require that the selected contractor be responsible for the preparation, implementation, monitoring, performance, and maintenance of their own ESCP that meets the requirements of the earthmoving permit.

Item 16. In general, maps and plans were difficult to read because of their small size or lack of labeling and detail. It would be helpful to have a composite plan that shows the differences between the old topography and new topography, or grading plan, and a good legible site plan.

Acknowledged. The FEIS will include various existing plans and maps in an enlarged scale. Additional plans and maps pertaining to the reviewer's concerns would also be included in an enlarged size. The proposed size of these maps and plans is 50 percent of their original size or 15 by 21 inches. These oversized maps and plans will be provided in envelopes or map sleeves/pockets.

Item 17. Proposed cut and fill areas and volumes for the project should be estimated and calculated. The need for import of fill materials or disposal of cut surplus materials should be addressed.

The total cut requirements are 18,500 cubic yards. The on-island fill requirement is 2,800 cubic yards. The remaining 15,700 cubic yards of material will be exported off-island. Suitable excess material may be used in the marine development features. Exported material could potentially be sold as general fill material, sold to the government as landfill material, and/or sold to quarries for further processing.

Item 18. Dredge and fill areas and volumes should be calculated and tabulated for the proposed marine and shore modifications, including the beach, and supplemented as needed with appropriate drawings and diagrams.

The estimated quantities of the marine development are as follows:

<table>
<thead>
<tr>
<th>BEACH</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>sand fill</td>
<td>3,500 cubic yards</td>
</tr>
<tr>
<td>groin armor stone</td>
<td>1,000 cubic yards</td>
</tr>
<tr>
<td>groin underlying stone</td>
<td>801 cubic yards</td>
</tr>
<tr>
<td>groin center fill (dredged material can be used)</td>
<td>400 cubic yards</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>HARBOR</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>dredging</td>
<td>20,000 cubic yards</td>
</tr>
<tr>
<td>breakwater armor stone (construction material)</td>
<td>7,000 cubic yards</td>
</tr>
<tr>
<td>breakwater underlying stone (construction material)</td>
<td>3,250 cubic yards</td>
</tr>
<tr>
<td>breakwater center fill (construction material)</td>
<td>4,500 cubic yards</td>
</tr>
</tbody>
</table>
...should be preserved. There is no estimate of how much vegetation will be removed showing drainage details. The sheets will be 50 percent of original size and measure 15 by 21 inches. These will be included as permanent controls in the erosion and sedimentation control plan/grading plan.

Item 19. A drainage plan and drainage details for the project should be included in the EIS, or included as permanent controls in the erosion and sedimentation control plangrading plan.

Acknowledged. A detailed drainage plan and the pertinent details will be included in the FEIS. The plan will consist of four sheets, each detailing one-fourth of the island and showing drainage details. The sheets will be 50 percent of original size and measure 15 by 21 inches. These will be placed in envelopes or map pockets/sleeves.

Item 20. The EIS provides very little specific information about what the applicant intends to do with respect to landscaping the site beyond that "as much of the native vegetation as possible should be preserved." There is not estimate of how much vegetation will be removed and how much will be replaced with either the previously existing vegetation or new introduced vegetation and what types. Will there be a plant nursery? Will topsoil be imported?

Approximately 85 percent of the island will be disturbed due to construction. The remaining undisturbed 15 percent consists of areas along the shoreline where existing vegetation will be preserved as much as possible.

Where possible, the building and landscape elements have been positioned so as to allow the large trees throughout the island to remain in place. This includes 319 trees. An additional 116 existing trees will be relocated on the island. With the exception of the buildings and landscape areas, all of the island will be replanted with locally available species. A list of plant materials will be included in the FEIS.

TOP SOIL. During the initial clearing and grubbing of the areas being disturbed, the existing top soil will be removed and stockpiled on the island. As part of the planting operations, this top soil will be spread throughout the planting areas and amended with organic materials (mulch, compost, etc.) to improve the water holding capacity of the soil. In addition, the green waste on the site will be chipped and placed throughout the planting beds.

FERTILIZERS. Based on the soil test, organic and chemical fertilizers will be added if required. It is anticipated that a large amount of chemical fertilizers will be required in light of the successful growth of plants on the island.

HERBICIDES & PESTICIDES. Minor spraying with a non-selective herbicide (such as Imaza or Round-up) may be required to spot control weeds. These herbicides do not have any chemicals that move beyond the immediate contact with the plant. Locally available pesticides and practices will only be used as needed.

NURSERY. A temporary off-site nursery is planned for the propagation of plants, shrubs, ground cover, and trees to be planted on Ngerur Island as part of the landscape effort. The nursery will be developed during the construction phase of the project and it is expected that it will be dismantled shortly after construction is complete, once the landscaping is established at the resort. The off-site nursery will be organized into five distinct areas of operation. These areas are the shade house, the mist house, the compost area, the open nursery, and the office/storage/operation area.

- Shade House. Approximately 9,600 square feet of area covered by a simple pole, cable, and shade cloth structure would be used for the initial propagation of cuttings and seedlings. As these become established, they will be moved to the Shade House and then into the open nursery. Planting benches and a mist irrigation system will be provided in the Mist House.
- Compost Area. A 4,000-square foot area will be set aside for the composting of shredded and mulched vegetation. These materials will be used as soil conditioner and for making topsoil for use at the proposed project. This area will also be used for storing topsoil and other soil amendments that are not weather sensitive.
- Open Nursery. Approximately one to two acres will be cultivated as open nursery area. This area will be organized into areas by plant species. Trees, shrubs, ground cover, turf grass, flowers, and plants will be propagated here until time for transplantation on Ngerur Island. A simple hose bib irrigation system will be installed in the open nursery area. Native trees will provide shade.
- Office/Storage/Operation Area. A relatively small area will be needed for the office/storage/operation functions. A 200-square foot office is planned, as well as a 200-square foot secure storage container. The operations facilities will include space for a 10,000-gallon water storage tank, and water pressure system. Utilities such as water, telephone, and electricity will be provided in the office/storage/operation area. A portable, self-contained, construction-site type outhouse facility is planned for the nursery employees. A utility sink for washing tools and hands is also planned.

Item 21. In Section 5.14.8 of the EIS it is stated that the project "will result in no resident population requiring public safety protection." No reasons were given to support this conclusion or a description of what private security measures will be provided for the project.

Resort security for the protection of guests' public safety will be the responsibility of the resort operators. Additionally, the project design includes a fire protection system consisting of fire pumps and water storage facilities (refer to Section 3.1.2). The resort will also have telephone and radio communication with the Bureau of Public Safety.

Item 22. No mitigation measures were proposed to reduce energy requirements, such as energy efficient materials, equipment and operational controls.

The overall design of the project offers a conscious effort to provide for more passive energy efficient applications within the program of the project. The architecture reflects the
Pacific Tropical style using earth tone materials that reduce solar heat gain, broad overhangs at the roof lines to provide shading at windows and doors, and use of louvers to provide for both shading and allow for natural ventilation through the buildings.

The light fixtures are being selectively placed to create a non-uniform system of illumination with light on the features of the space as well as the functional areas. This helps to create drama while at the same time reduces the number of light fixtures used as the light is concentrated where it is most needed. Decorative features are used in this fashion to help provide functional light as well.

Energy efficient fixtures and sources are being used. Low voltage sources provide all the light of an incandescent light but at a reduced wattage. Compact fluorescent lamps are being used wherever possible to cut down on wattage. On the exterior, metal halide sources are being used to provide a higher quality light with better color rendering at reduced wattage consumption as compared to high pressure sodium or other typical exterior light sources.

A dimming system with presets will allow the management to dim the lights in public areas which results in saved energy. By being set at a lower level, the drama of the lighting is increased and the wattage is reduced. Also, during the day and late at night, certain fixtures can be turned off or dimmed down with the touch of a button so that lights are not on when they are not needed.

Item 23. No specific mitigation was proposed to minimize impacts from foreign workers such as training, cultural orientation, complaint/conflict resolution or a foreign worker impact reduction plan.

CM&D, the project construction managers, estimate the manpower requirement for the construction of the proposed project to be approximately 100 to 125 persons. MHC wants to take advantage of the local labor force and its existing infrastructure in order to reduce and/or mitigate impacts on the local economy and minimize overhead costs. MHC is soliciting proposals from local general contractors, as well as encouraging local subcontractors to submit proposals to the general contractors. Additional labor and craftsmen to supplement the local workforce will be recruited from outside of Palau.

A general contractor has not yet been determined. Responsibility for preparation of a foreign worker impact reduction plan (FWIRP) rests with the contractor. If it is determined by EQPB that a FWIRP is a required permit condition, MHC will include preparation and subsequent approval of the FWIRP as a contract requirement for the general contractor. The FWIRP would also address the foreign labor force employed by any subcontractor.

Item 24. Restaurants in the development will require the installation of grease/oil interceptors approved by EQPB, unless the wastewater aeration unit is designed to accommodate grease/oil loading from restaurants.

A grease recovery system will be provided similar to the American Pump System, Inc. "Lowe Grease Recovery Unit" on the grease waste line from the restaurant kitchen. The units mechanically remove grease and transfer it to a container that will be located near the service level at the Hotel Pavilion. Manufacturer data indicates that the interceptors will remove up to 99 percent of the free-floating oils and grease. Wastewater aeration will not be used.

Item 25. The Geolabs, Inc. report contained the results of a geotechnical investigation that provided data and recommendations primarily for foundation and structural design. However, Section 3.3.2.4 of the EIS states that the results of the geotechnical analysis "indicated that permeability was inadequate for injection wells since at +200 feet into the subsurface the material is so compressed that no water can travel through it." Although logical, the Geolab report contained no statements or conclusions regarding deep injection wells or permeability at depths of +200 feet; boreholes were drilled to depths of not more than approximately 47 feet.

Geolabs, Inc. was contracted to perform two separate functions at Ngerur. One function was to perform a geotechnical investigation with respect to foundations and structures (refer to Appendix B-1). The other function was to drill and install 4 wells (2 extraction wells and 2 injection wells).

Geolabs, Inc. drilled to 250 feet at boring EW-1, a proposed extraction well for the extraction of the potable water supply. A falling head test was performed and the results were so poor that the injection/extraction well program was terminated after this hole. A memorandum describing what was found at EW-1, the results of the falling head test, and the bore hole log from EW-1 will be appended to the FEIS.

Item 26. It is stated in the EIS that approximately 700 pounds of solid waste will be generated by the project. Beyond a statement that garbage will be transported by boat and disposal coordinated with the BFP, no mitigation measures were proposed to minimize, reuse and recycle solid waste.

The intent of the operator is to install a trash compactor at the proposed project site and thereby reduce the volume of refuse. Although the weight remains the same, a reduced volume will extend the life of the landfill.

The operator has also expressed a desire to segregate waste in order to take advantage of existing (and hopefully expanding) recycling facilities in Palau. MHC respectfully requests that the preparation and submission of a waste minimization plan (addressing specifically aluminum cans, recycling and composting of green wastes) be made conditions of the earthmoving permit.

Item 27. A hazardous materials management plan should be provided that describes measures to minimize reuse, recycle and disposal of hazardous wastes, both during construction and operation. Measures should be proposed for containment and storage and clean up of spills. The plan should propose the use of non-toxic products for cleaning, operation and maintenance, to the extent practical, as opposed to toxic products containing hazardous substances. Section 5.11 does not mention the use of sodium hypo-chlorite and calcium carbonate which are proposed to be used in the operation of the wastewater and water treatment systems.

MHC acknowledges the need to identify hazardous substances that will be used as a result of the project, including materials used in the water treatment system. Please note that sodium hypo-chlorite will not be used due to a design change to UV disinfection.

MHC respectfully requests that the preparation and submission of a hazardous materials management plan be made a condition of the earthmoving permit and be deliverable prior to the operation of the proposed project, as applicable.
Item 28. It is recommended in the EIS that a rat eradication program be implemented. Information will need to be provided regarding the program’s methods and materials to ensure there it poses no health or environmental threats.

MHC proposes to implement a very simple rat eradication program as recommended and currently being implemented by Palauan residents and business operators. Rat eradication will involve setting up bait locations and baiting the rats with locally available over-the-counter rat and mouse poison bait bars. Unlike granular poisons, this form of poison comes in solid bar pieces that are weather resistant and less harmful to the environment. Dead rats and unused portions of the bait may be easily picked up for proper disposal. The bait material will be handled in strict conformance with the manufacturer’s recommendations.

Item 29. Additional permits will be required for construction of any auxiliary facilities such as workers’ barracks or temporary toilet facilities.

MHC acknowledges the regulation requiring that new auxiliary facilities such as workers’ barracks require separate permits. This requirement will be the responsibility of the general contractor (not yet selected) if that contractor does not use local labor forces.

MHC respectfully requests that the application for such permits, if needed, be included as a condition of the earthmoving permit. MHC would also like to reiterate its encouragement of the use of local contractors, labor force, and existing infrastructure as described in Item 23.

Item 30. Comprehensive monitoring plans, including monitoring plans for marine water quality, wastewater effluent, drinking water and storm water runoff will need to be prepared and submitted to EQPB and receive approval before permitting and any construction can begin once a determination is made by EQPB regarding the EIS and project.

MHC acknowledges the regulation requiring submission and approval of comprehensive monitoring plans for the marine water quality, treated wastewater effluent quality, and drinking water quality. Some of these plans depend on completion of the design. Some of the plans are the responsibility of the contractor during the construction phase of the proposed project. Others are the responsibility of the resort operator during the operational phase.

MHC respectfully requests that the preparation and submission of these monitoring plans be made conditions of the earthmoving permit and be deliverable either prior to the start of construction or prior to the operation of the proposed project, as applicable.

We hope you concur with our responses. Should you have any additional questions regarding this letter of response, please feel free to contact myself, Ivan Tilgenkamp or Wil Chee by phone, fax, or email. We look forward to EQPB’s final determination regarding this project.

Sincerely,

Claire Tom
Planner
September 1, 2000
Serial No.: EQPBL-20/422
Mr. Daniel J. High, Vice President
Morita Hotel Corporation, Inc. Palau,
P.O. Box 7979
Koror, Palau 96940

RE: Comment on Draft Environmental Impact Statement:
Quest Resort Project, Ngereet Island of Koror State

Dear Mr. High:

The letter serves to notify you that EQPB reviewed the Draft Environmental Impact Statement (EIS) for Quest Resort Palau, dated July 2000. Our agency comments on the Draft EIS are provided below. EQPB has not received any comments from other interested persons, agencies and organizations; however, if late comments should come in to our office you may be required to respond to them up until the time that the Final EIS is filed and accepted. All comments must be satisfactorily responded to before the Final EIS can be considered complete and accepted by the Board.

1. Section 1.7 of the EIS should identify impacts and mitigation measures associated with the sewage and brine wastewater discharge.

2. Discharge of waste brine is considered a point source of pollution. The estimated discharge flow of waste brine generated from the reverse osmosis process and dilution water should be provided. It is stated in Section 3.1.2 of the EIS that return cooling water will be used to dilute the brine wastewater. A characterization of the return cooling water should be provided.

3. As noted in the EIS, the Ngereet Island project site is surrounded by "Class AA" designated waters under the regulations which prohibit point source discharges and destruction of coral reefs, aquatic habitats or other resources. In order to approve the EIS and permit the project, the Marine and Fresh Water Quality Regulations will need to be amended to down grade the classification of water surrounding the site from "Class AA" to "Class B." Amendment of the regulations will require a 30 day notice period and public meeting if requested by the Board or another agency, and consultation from the President and OEK.

4. The specifications and design data should be provided for the wastewater treatment system so that the capability of the proposed treatment system to achieve secondary effluent standards can be evaluated. Palau's Marine and Fresh Water Quality Regulations state that mixing zones will not be granted in lieu of reasonable control measures to reduce point source pollutant discharges but will be granted to complement the applicable controls. Moreover, the Koror State Legislature passed Resolution No. 6-41, LDI stating that the "discharge of pollutants shall be controlled to the maximum extent possible and that sewage and industrial effluent receive the highest degree of treatment practical under existing technological and economic conditions..." Alternative treatment technologies that can exceed secondary treatment standards and their associated costs must be evaluated and provided to the Board before it can make a determination regarding the wastewater discharge.

5. From an environmental standpoint it is not desirable to have wastewater discharges into the harbor because of reduced and affected circulation patterns that may consequently lead to water quality degradation. Why was the alternative of discharging the diluted brine wastewater through the sewage deep water outfall not evaluated?

6. The project will include a non-community public water supply system as defined under the regulations. Design data and specifications should be provided for the drinking water treatment system. Information should be provided on how the system will be operated and maintained and monitored to ensure that it complies with the EQPB drinking water regulations and protects the health of the users.

7. Design details should be provided for the water intake that will help to minimize disturbances to corals, fish and other marine organisms.

8. It is stated in Table 5 that two harbor entrances are proposed. The table is in conflict with the Figure 14 drawing which shows only one harbor entrance.

9. The harbor will be enclosed by breakwaters except for a 60 foot wide entrance according to Figure 14. Harbors are known to degrade water quality because their design geometry may cause stagnation zones leading to accumulation of petroleum products and other toxic substances, lowered dissolved oxygen levels and destruction of other water quality standards. No provisions such as culverts to maintain adequate circulation were proposed in the harbor design, nor was analysis or modeling provided to show that adequate flushing and circulation will be maintained to avert water quality deterioration.

10. It is stated in Section 3.1.2 of the EIS that the sewer collection system will require two to three sewage pump stations. Information should be provided on how the pump stations will be designed and operated to prevent sewage overflows (e.g., standby emergency power, telemetry, storage capacity, holding tanks, etc.).

11. In the Sea Engineering Report, the dimensions for the zone of mixing (ZOM) given in Table 5 do not seem to correlate with the dimensions shown in Figure 10.

12. It is stated in Section 3.1.2 of the EIS that the total wastewater generated by the project is estimated to be 30,000 gallons per day (GPD); however, an assumed wastewater flow of 15,000 GPD is used as the basis for the modeling results and conclusions contained in the Sea Engineering, Inc. report which predicts the water quality impacts associated with the effluent plume and zone of mixing.

13. Table 19 in the EIS includes total suspended solids (TSS) as a modeled water quality parameter, however, this parameter is not presented in Table 5 of the plume modeling report done by Sea
14. It is stated in Section 5.14.2 of the EIS that the wastewater effluent may be disinfected by sodium hypochlorite. Chlorine compounds can be toxic to marine organisms; however, there was no discussion of effluent chlorine concentrations and toxicity, alternative disinfection methods or measures for de-chlorinating the effluent.

15. Erosion and sedimentation is identified as an adverse impact in the Draft EIS. The EIS should contain a detailed site specific erosion and sediment control plan showing all temporary and permanent controls with appropriate narrative, supporting technical data, plans and detail drawings that comply with the intent of the EQPB regulations, instead of a conceptual description of proposed erosion and sediment control measures.

16. In general, maps and plans were difficult to read because of their small size or lack of labeling and detail. It would be helpful to have a composite plan that shows the differences between old topography and new topography, a grading plan, and a good legible site plan.

17. Proposed cut and fill areas and volumes for the project should be estimated and evaluated. The need for import of fill materials or disposal of cut surplus materials should be addressed.

18. Dredge and fill areas and volumes should be calculated and calculated for the proposed marine and shore modifications, including the beach, and supplemented as needed with appropriate drawings and diagrams.

19. A drainage plan and drainage details for the project should be included in the EIS, or included as permanent controls in the erosion and sediment control plan/grading plan.

20. The EIS provides very little specific information about what the applicant intends to do with respect to landscaping the site beyond that “as much of the native vegetation as possible should be preserved.” There is no estimate of how much vegetation will be removed and how much will be replaced with either the previously existing vegetation or new introduced vegetation and what types. Will there be a plant nursery? Will topsoil be imported?

21. In Section 5.14.8 of the EIS it is stated that the project “will render no resident population requiring public safety protection.” No reasons were given to support the conclusion of what private security measures will be provided for the project.

22. No mitigation measures were proposed to reduce energy requirements, such as energy efficient materials, equipment and operational controls.

23. No specific mitigation was proposed to minimize impacts from foreign workers such as training, cultural orientation, complaint/conflict resolution or a foreign worker impact reduction plan.

24. Restraints in the development will require the installation of grease/oil interceptors approved by EQPB, unless the wastewater treatment unit is designed to accommodate grease/oil loading from restaurants.

25. The Geolabs, Inc. report contained the results of a geo-technical investigation that provided data and recommendations primarily for foundation and structural design; however, Section 3.3.2.4 of the EIS states that the results of the geo-technical analysis indicated that permeability was inadequate for injection wells since at 200 feet below the surface the material is so compressed that no water can travel through it.” Although logical, the Geolabs report contained no statement or conclusion regarding deep injection wells or permeability at depths of 200 feet boreholes were called to depths of not more than approximately 47 feet.

26. It is stated in the EIS that approximately 760 pounds of solid waste will be generated by the project. Beyond a statement that garbage will be transported by boat and disposal coordinated with the BPW, no mitigation measures were proposed to minimize, reuse and recycle solid wastes.

27. A hazardous materials management plan should be provided that describes measures to minimize, recycle and dispose of hazardous wastes, both during construction and operation. Measures should be proposed for containment and storage and clean up of spills. The plan should propose the use of non-toxic products for cleaning, operation and maintenance, to the extent practical, as opposed to toxic products containing hazardous substances. Section 5.11 does not mention the use of sodium hypochlorite and calcium carbonate which are proposed to be used in the operation of the wastewater and water treatment systems.

28. It is recommended in the EIS that a wetland mitigation program be implemented. Information will need to be provided regarding the program's methods and materials to ensure that it poses no health or environmental threat.

29. Additional permits will be required for construction of any auxiliary facilities such as workers barracks or temporary toilet facilities.

30. Comprehensive monitoring plans, including monitoring plans for marine water quality, wastewater effluents, drinking water and storm water runoff will need to be prepared and reviewed by EQPB and receive approval before permitting and any construction can begin once a determination is made by the EQPB regarding the EIS and project.

If you have questions or would like to make an appointment to discuss the comments on the Draft EIS before the Final EIS is prepared, please contact me at 488-1639/3690.

Respectfully,
[Signature]
Executive Officer

[Address Application File: Chairperson & members, EQPB (Board)]
classification of the waters around Ngerur Island from Class AA to Class B has been endorsed by the Environmental Quality Protection Board of Palau in September 2000 and forwarded to the Office of the President for final review and approval. The President, Republic of Palau, has used his authority under the law to approve the amendment as drafted (refer to Appendix A).

The effective date of the proposed Amendment is October 6, 2000. The current process provides the public with a 30-day commenting period. The OEK has a 120-day period during which a potential repeal of this reclassification would be possible.

Analysis using the FLUME model that was developed by the U.S. Environmental Protection Agency (EPA) indicates that the dilution of the effluent would be so rapid that all Class AA water quality criteria would be easily met within the zone of initial dilution immediately above the discharge point (Sea Engineering, Inc., 1999).

Proposed water uses, especially along the western and northern perimeter of the island will be recreational and aesthetic. It is therefore in the best interest of the applicant to maintain the highest possible level of water quality for the long-term enjoyment of resort guests.

Morita Hotel Corporation (MHC) has expressed interest in establishing a marine sanctuary/protected area around portions of Ngerur Island after construction is complete. A marine protected area (MPA) encourages the proliferation of marine life by providing an area where fishing, shell collecting, and coral touching is prohibited. Similar areas have been designated in other resort areas like the Florida Keys and the Great Barrier Reef. Currently, Palau does not have legislation to set aside areas as a MPA. MHC intends to pursue such a designation and will explore this issue through the proper agencies and organizations.

We hope you concur with our responses. Should you have any additional questions regarding this letter of response, please feel free to contact myself, Ivan Tilgenkamp or Wil Chee by phone, fax, or email. Again, we thank you for your organization’s interest in the proposed project and your review of the Draft EIS.

Sincerely,

Claire Tom
Planner
October 6, 2000

Ms. Youlsa Bells, Executive Director
Palau Conservation Society
P.O. Box 1811
Koror, Republic of Palau 96940

Subject: Draft Environmental Impact Statement (DEIS) – Quest Resort Palau Project

Ms. Bells:

On behalf of Morita Hotel Corporation, we thank you for your organization's participation in the environmental review process. Your organization's comments are hereby acknowledged. A Final Environmental Impact Statement (FEIS) that incorporates the responses to all comments on the DEIS is currently being prepared. Your organization will be notified when the FEIS is available for review.

Comments from the letter addressed to Ms. Paula Holm, Chair, EQPB dated September 15, 2000 are italicized below. The corresponding responses are hereby provided.

Item 1. While we agree with the general erosion and sedimentation control methods proposed in Section 3.1.4, the erosion and sedimentation control plan (ESCP) should be more detailed and site specific. The EIS should refer to and include the ESCP that accompanied the permit application.

A detailed Erosion and Sedimentation Control Plan (ESCP) has been prepared for the Quest Resort Palau project by a licensed civil engineering firm. MHC will submit this ESCP under separate cover as required by the earthmoving permit application. The ESCP provides additional detail and supplements the information contained in the EIS.

The ESCP is intended to be used as a guide by prospective contractors outlining the minimum requirements for erosion and sedimentation control. MHC will require that the selected contractor be responsible for the preparation, implementation, monitoring, performance, and maintenance of their own ESCP that meets the requirements of the earthmoving permit.

Item 2. If wastewater effluent is to be treated by chlorination (Section 5.14.2), then a de-chlorination step must be included in the wastewater treatment plan.

The wastewater effluent will be disinfected by UV instead of sodium hypochlorite. Pertinent information will be included in the FEIS.

Item 3. The proposed action is expected to produce 760 pounds per day of solid waste. When evaluating environmental impacts from solid waste, the proposer should consider that it may be several years before a new national landfill is opened. Additionally, the project will produce some toxic waste such as waste oil and pesticides. The proposer should recognize also that Palau has no means or plan for the disposal of toxic waste and that any amount of toxic waste is thus a very serious problem.

The intent of the operator is to install a trash compactor at the proposed project site and thereby reduce the volume of refuse. Although the weight remains the same, a reduced volume will extend the life of the landfill.

The operator has also expressed a desire to segregate waste in order to take advantage of existing (and hopefully expanding) recycling facilities in Palau. MHC intends to prepare and submit a waste minimization plan (addressing specifically aluminum cans recycling and composting of green wastes) as part of the earthmoving permit process.

MHC acknowledges the need to identify hazardous substances that will be used as a result of the project, including materials used in the waste treatment system. Please note that sodium hypochlorite will not be used due to a design change to UV disinfection. MHC intends to prepare and submit a hazardous materials management plan as part of the earthmoving permit process.

Item 4. The reverse osmosis potable water production facility will require a point source discharge permit for the brine which is a by-product of reverse osmosis, pursuant to Section 2401-11-22 of the EQPB regulations. In addition, a notification of intent and permit will be required for the construction of a public water supply system, pursuant to Section 2401-31-06 and 2401-31-09 of the EQPB regulations. Acknowledged.

Item 5. Construction and operation of the project as designed will require a reclassification of the water around Ngerur Island from AA to B. While we recognize that some waterfront developments by the EQPB, established pursuant to the Environmental Quality Protection Act, Chapter 1, Marine and Fresh Water Quality Standard Regulations. Coastal waters are classified in accordance with 2401-11-05.

Recategorization will require the approval of the people of Palau through their elected representatives and should only occur following a clear determination that the attendant irreversible loss of natural resources will be offset by the long-term economic benefits of the project to the people of Palau.

Water quality standards pertaining to the marine waters of Palau are contained in the regulations of the EQPB. In class AA waters, individual confidentiality requests must be made to the Environmental Quality Protection Act, Chapter 1, Marine and Fresh Water Quality Standard Regulations. Coastal waters are classified in accordance with 2401-11-05.

During the session of the Sixth Koror State Legislature, April/May 2000, a resolution was passed to recommend to EQPB that waters around Ngerur Island be reclassified from the existing Class AA waters to Class B waters (refer to Appendix A). The draft of an Amendment to the Marine and Freshwater Quality Regulations that would allow for necessary changes in the
Dear Chairperson Holm:

Thank you for your review of our comments concerning the Quest Resort development proposal Draft Environmental Impact Statement (DEIS) prepared by Will Chee Planning.

The DEIS is a well-prepared and informative document, drafted by a reputable consultant with considerable knowledge of and experience in Palau. The preparation of Will Chee Planning to prepare environmental impact statements for use in Palau is commendable.

With regard to the proposed action, we recognize that this type of low volume, upscale tourism is consistent with the vision of the ROP national government as manifest in the National Master Development Plan. We also recognize that some significant environmental and social impacts are inevitable if Palau is to develop a vibrant, sustainable eco-tourism industry. We would like, however, to draw your attention to the following environmental concerns.

While we agree with the general erosion and sedimentation control methods proposed in Section 3.1.4, the erosion and sedimentation control plan (ESCP) should be more detailed and site specific. The EIS should refer to and include the ESCP that accompanied the permit application.

If wastewater effluent is to be treated by chlorination (Section 5.14.2), then a de-chlorination step must be included in the wastewater treatment plant.

The proposed action is expected to produce 760 pounds per day of solid waste. When evaluating environmental impacts from solid waste, we propose that consideration should be given to the fact that there could be severe impacts before a new national landfill is opened. Additionally, the project would produce some toxic waste such as waste oil and pesticides. The proponent should recognize also that Palau has no means or plans for the disposal of toxic waste and that any amount of toxic waste is a very serious problem.

The Palau Conservation Society would like to reiterate its support for desirable development, which includes activities promoting low volume, high-end tourism.

Thank you very much for your consideration of our comments.

Kind regards,

[Signature]

Me Paula Holm
Environmental Quality Protection Board
P.O. Box 100
Koror, PW 96940

The Palau Conservation Society would like to reiterate its support for desirable development, which includes activities promoting low volume, high-end tourism.

Thank you very much for your consideration of our comments.

Kind regards,

[Signature]

Me Paula Holm
Executive Director
Scoping Comments and Responses
June 26, 2000

Ms. Erma Ngwal
P.O. Box 961
Koror, Palau 96940

RE: Comments Pertaining to the Quest Resort Palau at Ngerur Island, Koror State

Dear Ms. Erma Ngwal:

Thank you for taking the time to express your thoughts regarding the Quest Resort Palau project. Your written comments dated April 28, 2000 pertaining to the issue of persons with disabilities deals with an area very important to Joe Morita, the person behind this project.

At his ski resort in Japan, Mr. Morita hosts the "Legends Ski Race" each year. It includes races and activities for disabled skiers, who receive strong support from Morita-san.

Disabled guests arriving in Palau will be transported, with any assistance they need, from the airport to the Welcome Center at Malakal Marine Village (now Neco Marine). Access from there, into the guest transport boats, will include the ability to handle wheel chairs, or other needs. The guest boats will have side entry, level with the dock facility.

On arrival at Quest Resort Palau, again the exit will be at dock level, through the boats side door. To go from the dock level, to the main area of the hotel, there will be a ramp, an elevator, as well as the stair access. Electric carts are available to transport all guests to their suites. This is expected to work well for disabled access. In addition, the resort will have at least one such cart, designated to accommodate the needs of a disabled guest.

Quest Resort Palau will offer disabled facilities, under current plans, in two units. Given that there are only 60 total suites and certain types of disabled guests can be accommodated in the regular ground floor suites, the developers of the project feel this is sufficient.

The swimming pool will also have shallow areas, where with staff assistance, persons with disabilities can safely enjoy that experience.

We apologize for not addressing this issue at the public hearing. Thank you for letting us address the subject now. Your valuable comments will also be addressed in the Environmental Impact Statement (EIS).

Sincerely,

Claire Tom, Planner
Wil Chee + Planning, Inc.
PUBLIC COMMENT MAIL-IN FORM

PUBLIC SCOPI NG/INFORMATION MEETING
FOR THE
QUEST RESORT PALAU AT NGERUR ISLAND, KOROR STATE

This form offers a convenient way to provide comments pertaining to the Quest Resort Palau at Ngerur Island. Write your comments, fold the form, tape, stamp and mail by May 27, 2000. Thank you!

To: Morita Hotel Corporation, Inc., Attn.: Daniel J. High, P. O. Box 7079
Koror, Palau PW. 96940

Subject: Quest Resort Palau at Ngerur Island, state of Koror, Republic of Palau

My concern is probably non-related to the EIS subject; however, statistics show that there are people on "high-ends" who have some form of disabilities and they also loves to travel and enjoy spending money. Palau unfortunately cannot accommodate this group of people maybe because we do not believe that they should enjoy the same privilege like "normal people" should. I believe that these people should be given the opportunity to enjoy what you and I can enjoy, provided that we should make available the access they need. I am pretty sure it will not be a loss to the hotel but will be very beneficial to all parties involved.

I was there at the Scoping Meeting hoping to find out if the hotel will be accessible to people with disabilities, but it was not mentioned and I'm glad I had this opportunity to reach you by this form. And by way, I do not have physical disabilities but I envisioned Palau to be able to welcome everybody of all sorts.

Signed: [Signature]
Date: April 18, 2000

Name and address (please print) Ema Newal
P. O. Box 962
Koror, Republic of Palau 96940
Phone: 488-1793 E-Mail: Patric@palaunet.com
PUBLIC COMMENT MAIL-IN FORM

PUBLIC SCOPING / INFORMATION MEETING
FOR THE
QUEST RESORT PALAU AT NGERUR ISLAND, KOROR STATE

This form offers a convenient way to provide comments pertaining to the Quest Resort Palau at Ngerur Island. Write your comments, fold the form, tape, stamp and mail by May 27, 2000. Thank you!

To: Morita Hotel Corporation, Inc., Attn: Daniel J. High, P.O. Box 7079
Koror, Palau PW 96940

Subject: Quest Resort Palau at Ngerur Island, State of Koror, Republic of Palau

Thank you for this opportunity to voice my concerns.
The main environmental concern is how the treated
around water for use, where will it come from and
oven Treatment. An a small island such as
Ngerur Island there is little or no water for drinking.
Are, poor in these any plans for potable tans?
How will these issues be addressed?

Signed: Kori Delmer Date: 4/28/2000

Name and address (please print):
USDA - NRCS
P.O. Box 6057
Koror, Palau 96940
June 26, 2000

Ms. Robin Demeo  
USDA-NRCS  
P.O. Box 6057  
Koror, Palau 96940  

RE: Comments Pertaining to the Quest Resort Palau at Ngerur Island, Koror State  

Dear Ms. Robin Demeo:  

Thank you for your written comments dated April 28, 2000 pertaining to the Quest Resort Palau project. In response to your comments, please note that the manufacture of water and the disposal of wastewater at Ngerur Island are both dependent on the latest advances in technology.

Potable water will be manufactured using reverse osmosis (RO) units because the results of exploratory geotechnical investigations consisting of drilling tests to 250 feet revealed that the sub-surface of Ngerur Island consists of solid rock, thereby preventing the intake of water, even salt water, from island wells. Instead, the project developers will use salt water intakes located in water, at least 60 feet, offshore of Ngerur Island. Additional filtration of this water prior to its introduction into the RO units will be necessary because ocean turbidity may be experienced at certain periods.

Based on research at similar tropical resorts, the project developers expect to produce approximately 600 gallons per day, per guest. The RO system will have two units to provide backup capability.

The resort will also have storage tanks for potable water on the island with a storage capacity of 100,000 gallons. Use of some catchment water from roofs, possibly to be stored in small tanks of approximately 1,500 gallons under some of the guest units, is presently being explored. This water would be used for irrigation and emergency situations.

Your question about the sewage treatment was addressed at the Public Hearing. You may recall that the possibility of bringing the island wastewater back to the Malakal Treatment Plant via underwater pipeline to an area near the PPR was discussed at that Hearing; however, since a break in the line could occur, the project developers insist that the wastewater be completely treated on the island before pumping it back to the mainland. Furthermore, once on the mainland, the existing collection system from the PPR area to the Malakal treatment plant includes at least five sewage lift stations.

Once the treated wastewater from Ngerur Island is placed into the existing sewer system and into the lift systems, it is mixed with raw, untreated wastewater from Arakabesan, Koror and Malakal areas. Once at the Malakal treatment plant, this mixed wastewater is treated again if the plant is working and then disposed via the existing system into the lagoon waters at a current depth of about 50 feet.

The plan that the developers presented as their preferred option would involve treatment on the island of all wastewater, with discharge about 478 feet offshore, on the northeast side of Ngerur Island at a depth of 100 feet. Current studies show that the treated discharge water will be carried away from Ngerur and Arakabesan. Furthermore, studies and plume models show that from a distance of 55 feet above the outfall diffuser, water quality standard of Class AA would already be met.

The project developers and officials at the Ministry of Resources and Development believe that as long as the island treatment plant meets or exceeds the treatment levels of the Malakal treatment plant, discharging into the ocean at a depth of 100 feet makes more sense than adding to the volume treated at the Malakal treatment plant, where, after treatment, the effluent is discharged at 50 feet and in a more public area near the Macao culture Center.

The project developers are also looking at the possibility of using some of the treated wastewater for irrigation needs during dry spells on the island. This practice is commonly used in resorts located in the Virgin Islands. It is also done with success in a 5-acre, 30-guest unit, bungalow style resort on an island in the Florida Keys—Little Palm Island. All of these resorts use on-site treatment systems for wastewater.

Other alternatives were considered. Septic tanks, which require leech fields and permeable soil, are not a desirable option at QRP due to the space required and the luxury nature of the resort. The use of deep injection wells for the discharge of treated wastewater was also considered, but the solid rock subsurface of Ngerur Island renders this option unfeasible.

We hope the foregoing reply is responsive to your questions. Please note that you will be informed when the Draft EIS becomes available for public review and comment. If you have additional questions, please do not hesitate to contact Dan and Debbie High, the Project Coordinators at the Morita Hotel Corporation, Inc.

Sincerely,

Claire Tom, Planner  
Wit Chee - Planning, Inc.
June 26, 2000

Senator Joshua Koshiba
P.O. Box 238
Koror, Palau 96940

RE: Comments Pertaining to the Quest Resort Palau at Ngerur Island, Koror State

Dear Senator Joshua Koshiba:

Your favorable written comments dated April 27, 2000 pertaining to the Quest Resort Palau project are most appreciated. With respect to your comments pertaining to the political nature of projects in Palau, the project developers also hope that politics do not negatively influence the Quest Resort Palau project.

For your information, the Morita Hotel Corporation, Inc. has selected Rosewood Hotels & Resorts, a firm out of Dallas, Texas, as the operator of Quest Resort Palau and Marina Village. This company is very knowledgeable of the ultra luxury market, and believes it can bring a very affluent tourist to Palau.

You can obtain an idea as to the quality level of their current resorts by checking the firm's website at www.rosewoodhotels.com. Please then click on "resorts."

We greatly appreciate your interest in the environmental review process and your response to the Public Scoping/Information Meeting. Thank you for your statement of full support for the project. You will be informed when the Draft EIS becomes available for public review and comment.

Sincerely,

Claire Tom, Planner
Wil Chee • Planning, Inc.
June 26, 2000

Mr. Ernest Ongidobel
P.O. Box 1785
Koror, Palau 96940

RE: Comments Pertaining to the Quest Resort Palau at Ngerur Island, Koror State

Dear Mr. Ernest Ongidobel:

Thank you for your attendance at the Public Hearing for the Quest Resort Palau project and for your supportive written comments dated April 27, 2000. Your comment that this project will generate substantial revenue for Koror State is definitely correct. Rosewood Hotels & Resorts has been selected by Morita Hotel Corporation, Inc. to manage both the Quest Resort Palau and Marina Village. The latter will be upgraded to a four star hotel level, although it will only have a maximum of 42 rooms.

Rosewood is a company that is very knowledgeable of the ultra-luxury guest market. The average room rate their resorts obtain is higher than either Four Seasons or Ritz Carlton. Their most recent hotel is in Saudi Arabia, and owned by the King.

The Morita Hotel Corporation, Inc. expects to start major construction in very early 2001 if all appropriate environmental permits are secured from EQPB and building permits are issued by Koror State. Work at the Marina Village site is already underway.

Thank you again for your statement of support for the Quest Resort Palau project. You will be informed when the Draft EIS becomes available for public review and comment.

Sincerely,

Claire Tom

Claire Tom, Planner
Wil Chee • Planning, Inc.
Dear Mr. Etpison:

After talking to you about your proposed projects, you made me understand you would like something in writing from me, to reassure your foreign partners, Morita Corporation, about the stable political environment and permitting process of Koror State at this time.

After reviewing your plans for the projects, a 5-star, 57-unit Island Resort on Ngerur, and a Marina village at Malakal, with 30 hotel rooms, shops and restaurants, and boat slips with power and water access for rent, I would like to comment as follows:

1) Looking at your plans, this seems to be the “high end” style tourist development with minimal environmental impact that we need for Koror and Palau in general. The development on your Malakal leasehold will be a large improvement to the existing building, as well as to provide the first real marina in Palau for people to anchor their boats. Your lease allows for a Marina, and the water around there have already been used for boat anchoring for many years by you, and are zoned “class B”.

2) If most of the retail spaces on the Malakal property will be leased out as we discussed, this also provides opportunity for local vendors, since there is always a shortage of retail space with sufficient parking available, as well as provide an additional sight seeing destination for tourism.

3) After reviewing your plans, and the opportunity you have to work with a legitimate foreign partner like Joe Morita, I would like to reassure you that as long as your proposed projects can meet all the requirements of Koror State as far as sewage disposal, minimal environmental impact, sufficient parking spaces for the development, the marina not blocking the surrounding properties or waterways, and other such concerns, we would be willing to issue you the building permits needed for these projects.

Sincerely,

[Signature]

Gillian Johnson
Chairman
Subject: Consultation on the Proposed Quest Resort on Ngurcr Island

Dear Mr. Kvandal:

Thank you for providing our office with an update as to your on-going site investigations and infrastructure development plans for the Quest Resort and the Malakal Marina Village. We are pleased with the approach and sensitivity that Morita Palau Corp is displaying on this project with regard to the protection of Palau's environment and natural resources.

Based on the briefing that you provided Ric Manglam and me in my office on October 27, 1999, it is our understanding that the alternative for injecting treated wastewater into deep wells on Ngurcr Island will not be feasible due to the results of the exploratory well drilling. Consequently, we understand that you are exploring the following two alternatives for wastewater treatment and disposal:

1. Conveying the wastewater via a submarine pipeline from Ngurcr Island to Arakebesang Island for ultimate treatment at the Malakal Wastewater Treatment Plant (WWTP) and disposal through the existing outfall off Malakal Island.
2. Providing secondary wastewater treatment on Ngurcr Island and disposal of the treated effluent through a deep ocean outfall (100-foot depth) located off the northern part of Ngurcr Island.

We understand that you are currently collecting additional oceanographic data to confirm your preliminary plume modeling results.

Based on the information that you have presented to us to date, we believe that the preferred method to be the second of the alternatives, as indicated above, for the following reasons. First, the level of treatment as you discussed will equal or exceed the level of treatment at the proposed upgrade to the Malakal WWTP. Second, the wastewater flow generated from the proposed Quest Resort development is quite small and will immediately be mixed at the point of discharge (with no zone of mixing required) meeting Class AA water quality standards at the point of discharge. Finally, there would be no additional “stress” placed on our existing wastewater pump stations and collection sewers.

We look forward to discussing the project further as your design proceeds. Thank you again for sharing the proposed development plans with us during your design process so that we can provide our input into the project. Based on what we have seen to date, it appears that this represents the type of development that is good for Palau.

Please contact me if you have any questions on the information above.

Sincerely,

[Signature]
Minister of Resources and Development

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Subject: Consultation on Proposed Ngurcr Island Resort and Marina Village Projects

Dear Mr. Chee:

Thank you for your letter of April 1999 concerning the proposed Ngurcr Island Resort and Marina Village Projects. It was a pleasure meeting with you the following week to discuss these developments.

In regard to your concern over Koror’s wastewater treatment plant capacity, as I mentioned in our recent meeting, the Republic of Palau is committed to expanding the capacity, as well as improving the level of treatment of the Malakal Wastewater Treatment Plant which serves the capital. As you know, the plant is currently overloaded, but it is one of the highest priorities of both the Palau National Government and the Koror State Government to expand and improve this facility. Obviously, proper treatment of wastewater is one of the most critical items in protecting Palau’s unique and fragile environment and laying the foundation for a strong tourist industry that our nation will rely upon.

I might also bring to your attention that the Palau Environmental Quality Protection Board (EQQP) is currently considering and negotiating certain “impact fees” with developers such as us to assist the government in its task of maintaining our basic infrastructure upon which such new developments have an effect. We are working with EPQPB to make sure that any “impact fees” assigned to a project are actually targeted toward our infrastructure operations and maintenance. You may have already contacted the EPQPB to commence discussion on this matter.

Please contact me if you have any questions or comments on the information above. Thank you.

Sincerely,

[Signature]
Minister of Resources and Development
May 14, 1999

Mr. Wilbert C.F. Chee
President
Wil Chee-Planning, Inc.
1400 Ryecoff Street
Suite # 928
Honolulu, Hawaii 96814

Dear Mr. Chee;

Reference is made to the consultation meeting held in my office in the late morning of May 11, 1999, relative to potential environmental impact that could result from the development of the proposed Ngerur Island Resort and the Marina Village projects. I appreciate the effort of the developer of subject projects for aiming at the high-end of the tourism trade by developing high class facilities. The selection of the firm of Wil Chee-Planning, Inc., a firm highly qualified to undertake the required environmental studies on the project sites is an assurance that the potential adverse impact that may be caused by construction activities will be clearly identified/quantified and mitigation measures will be outlined in the resulting EA and EIS and implemented during construction phase to prevent and/or minimized such impacts.

As I stated in our meeting, I believe that the development of the Marina Village project will have minor impact on the environment only during the construction phase. In fact, the development of the site will actually improve the environment as the runoff will be relatively clean water compared to the present situation. Plans call for substantial part of the area to be beautifully landscaped and planted. Other areas will be paved for parking areas and the rest under buildings. Construction activities in the water such as dredging, construction of structures for docking and mooring facilities (Marina facilities) will be easily controlled by conventional mitigation measures and will not have detrimental impact in the marine part (offshore areas) of the site.

As far as wastewater is concerned, in a recent meeting with representatives of Koror State, EQPB and the Minister of Resources and Development, an agreement was reached whereby Minister Melaiti was to immediately award the contract for the expansion of the Malakal Wastewater treatment plant as designed. The expansion of the treatment plant is designed to double the capacity of the treatment facility, up from 1MGD to 2MGD. Wastewater emanating from the proposed Marina Village project could be pumped to a nearby existing sewer main, and therefore will flow by gravity and by pumping to the expanded Malakal wastewater treatment plant for treatment and disposal.

In short, it is my opinion that a full blown Environment Impact Statement is not necessary for the development of the proposed Marina Village project. Only an Environmental Assessment should suffice.

As far as Ngerur Island Resort project is concerned, the development of which entails much dredging activities, the island being rather exposed to winds and strong currents, development of its own waste water collection, treatment and disposal and possible substantial earthmoving, an Environmental Impact Statement for the project is in order.

Thank you for your concern, interest, and participation in projects to enhance the economic advancement of the Republic of Palau.

Sincerely yours,

(Kach L. Wong)
National Planner
September 21, 1999

The Honorable Salvador Tellames  
Speaker, 6th Koror State Legislature  
P.O. Box 116  
Koror, Palau 96940  

Re: Bill No. 6-42, LD1; Rezoning of Ngerur Island  

Dear Mr. Speaker:

Transmitted herewith is a copy of Bill No. 6-42, LD1 which was submitted to the House of Traditional Leaders for action. By this letter, I am informing you that the HOTL passed this Bill on September 20, 1999 by unanimous vote.

Sincerely,

Ibedul Yutaka M. Gibbons  
Chairman, HOTL

KSPL NO. K46 – 102-99  
ibeditr9.doc
AN ACT

To amend the Koror State Zoning Map to re-zone the area commonly known as “Ngerur Island.”

THE PEOPLE OF KOROR REPRESENTED IN THE LEGISLATURE OF THE STATE OF KOROR DO ENACT AS FOLLOWS:

SECTION 1. FINDINGS. The Sixth Koror State Legislature hereby finds that the Koror State Zoning Map is outdated and requires significant adjustments to meet the ever-changing needs of Palau’s growing population by creating more available spaces to allow for improved infrastructure and economic development opportunities for the State of Koror.

The Legislature further finds that until a comprehensive zoning map is prepared to meet these demands, changes must be made regarding specific projects that are conducive to future economic development expansion. The Legislature further finds that it is in the best interests of the people of the State of Koror to re-zone the area commonly known as “Ngerur Island” to RV (Resort Center Zone).

SECTION 2. AMENDMENT OF KOROR ZONING MAP. The official Koror Zoning Map is hereby amended to re-zone the area known as “Ngerur Island” from CD (“Conservation”) to RV (“Resort Center Zone”); the new zone applies to the area highlighted in red on the attached copy of the official Koror Zoning Map, and as of the effective date of this Act, the area shown in red shall be zoned RV (“Resort Center Zone”).

SECTION 3. SEVERABILITY. In the event that a court of competent jurisdiction determines that any part or portion of this law is invalid, then the offending portion or portions may be stricken, and the remaining portions shall continue in full force and effect.

SECTION 4. EFFECTIVE DATE. This Act shall become effective upon its becoming law by operation of the Koror State Constitution.

PASSED: September 1, 1999
SIXTH KOROR STATE LEGISLATURE
Fourth Regular Session, July-August 1999

CERTIFIED BY:

Salvador Tellames, Speaker
6th Koror State Legislature

ATTESTED TO BY:

Charlyle Ung, Clerk
6th Koror State Legislature

APPROVED THIS _____ DAY OF __________, 1999.

John C. Gibbons
Governor, Koror State

APPROVED THIS 20 DAY OF _________, 1999

Ibedul Y. M. Gibbons
Chairman, House of Traditional Leaders
KENGEI PERMIT

Reference: Building and Zoning Permit
Application No.

URSOR:
Project: QUEST RESORT PALAU (NGERUR)

BASIO: (Hang) (Rael)
Location (Hamlet) NGERUR ISLAND (Street) NGERUR

OKKALOU:
Owner: MORITA HOTEL CORPORATION, INC.

ADRESS:
Address: KOROR, ROP 96940

Tial longit ra kengei ra okedcharul a blai ma llechul omekedcheraol el nor tial mal meiung ehab el lurroor, el lomesodal a ngar sel ongit ra okedcharul a blai ma llechul omekedcheraol, a mla mekengei:

The application for a Building and Zoning Permit for the above stated project, as defined on the Building and Zoning Application Form, has been approved:

Lobengkel aikel teletael a blalotobed ar edal a Koror Planning Commission
with the enclosed conditions as imposed by the Koror Planning Commission
e diak a kuk bebil ra teletael lobengkel.

/XX/without additional conditions

Tial kengei a ngarnijii a klisichel el lenul (2) rak, e motobed loyak a klodkengei el kro, a Building and Zoning Official ra Official ra Koror Municipality malechub eng kel lometehei renjii’l chad a mosebechel loddingel ra urror ra ngidil taem el molterkokl ma urror a olitrakl aikel mla meiung e mekengei luluasu, ea uspechnej malechub eng delengchokl ra blai a diak bol molterkokl el dumereko lebornijii sel kwal uziul we sa otebedel sel babier (certificate of Occupancy) loleterkokl ra uspechnej malechub eng delengchokl ra blai.

This permit is valid for a period of TWO YEARS, and is given with the understanding that the Building and Zoning Official of Koror Municipality or his designee may visit the project site from time to time to insure compliance with the approved plans, and that occupancy will not take place until Final Inspection and the issuance of a Certificate of Occupancy.

TIAL KENGEI A MODIAR A KLISICHEL RA: Of. 31, 2003

This permit Expires:

BUILDING AND ZONING OFFICIAL

11/05/01 09:58 TX/RX NO.9330 P.003
Koror State Government

KENGEI

PERMIT NO. 5496-01

Morita Hotel Corp.
Ngerur Is., Koror

Building and Zoning Official

Quest Resort Palau
Appendix 7

Signed Amendment and Water Reclassification
September 20, 2000
Serial No.:EQPBltr.20-454

Mr. Daniel J. High
Morita Hotel Corporation, Inc.
P.O. Box 7079
Koror, Palau 96940

Re: Marine Water Quality Reclassification Around Ngerur Island, Koror State

Dear Mr. High:

We are pleased to acknowledge with thanks receipt of your letter of September 13 regarding public comments on the plans for development of a luxury resort hotel in Ngerur Island of Koror State. We believe that the EIS is a helpful process that should be carefully observed if Palau is to allow economic and social development to proceed in an manner that is both environmentally sound and sustainable.

As mentioned during our discussion over the phone, the Board has already initiated efforts to change water classification around Ngerur Island from Class AA to Class B. The graft of the amendment that would allow for necessary changes in the classification has been endorsed by the Board and forwarded to the Office of the President for final review and approval. At any rate, we should note that the current process provide the public with a 30 days commenting period.

The President, ROP, has used his authority under the law to go ahead and approved the amendment as is. A copy of the approved amendment is attached for your information. The effective date of the proposed Amendment to the Marine and Freshwater Quality Regulations amendment is 06 October this year. The resolution by Koror State Legislature that you referred to in your letter did, however, create a proper opportunity for the Board to proceed with the reclassification process.

Again, we appreciate your company's interest in the Republic. Please feel free to contact either Robert Marek or myself if you wish to be updated of the progress or the status of the EIS process.

Sincerely,

[Signature]

Executive Officer

Enclosures: as stated

xc: Chairperson & Members-EQPB(BOARD)
Mr. Shullum Etison-NECO
Delegate Alan R. Seid-MIDCORP
AMENDMENT TO REPUBLIC OF PALU MARINE AND FRESHWATER
QUALITY REGULATIONS, CHAPTER 2401-11-42*

WATER USE AREAS: CLASSIFICATION AND ESTABLISHMENT

2401-11-42 Surface Waters

The following classification of water uses shall apply to the following areas:

* * * *

(B) Koror

* * * *

(3) Class B

(a) Malakal (Ngemelachell) Harbor;
(b) M-Dock (Singhatoba) including S.E. of Ngerbeched Shore;
(c) Kemangel Toachel, excluding T-Dock (Ngerkemais);
(d) Metukerdemul to the E. side of old Japanese Dock (Derrmel);
(e) Ngeraksong;
(f) Nikko (Iwayama) Bay from the Nikko pier to a shoreline boundary approximately 1200 feet
    N.W. of the Nikko pier and an additional 300 feet of offshore reef flat to the N.W. of the
    shoreline boundary.
(g) Waters extending 200 meters from the shoreline of Ngerur Island.

Effective Date: October 06, 2000

Certification Of Adoption: [Signature]
Paula R. Holm, Chairperson
Environmental Quality Protection Board

Adoption Date: 9/7/2000

Presidential Approval: [Signature] 9-19-00
The Honorable Kunwo Nakamura President
Republic of Palau

Approval Date: 9-19-2000

*Changes to the regulation are in bold.
MEMORANDUM OF AGREEMENT BETWEEN
NGERUR CORPORATION, REPRESENTED BY MR. SHALLUM ETPISON AND
BUREAU OF CULTURAL AND HISTORICAL PRESERVATION/PALAU HISTORIC
PRESERVATION OFFICE (BCHP) REGARDING THE CONSTRUCTION PROJECT
OF QUEST RESORT PALAU AT NGERUR ISLAND IN NGEREKEBESANG,
KOROR STATE, REPUBLIC OF PALAU

WHEREAS, Ngerur Corporation, represented by Mr. Shallum Etpison (Applicant) has filed an
application for a Historic Clearance on February 06, 2018 to engage in a construction of a Quest
Resort Palau at Ngerur Island in Ngerekebesang, Koror State; and

WHEREAS, BCHP staff reviewed archival materials and found that the proposed project was
issued a historical permit in 2001 where both archaeological survey and data recovery of the
whole Ngerur Island was completed; and

WHEREAS, on February 12, 2018, a consultation meeting was held at MCC1A conference room
at the National Capitol Building in Ngerulmud between the applicant and BCHP in regards to the
detail of the proposed project and what are needed. On February 21, 2018, a new plan of the
proposed project was delivered to BCHP by the applicant contact person (Ngelechel Etpison);
and

WHEREAS, BCHP reviewed both the archaeological survey and data recovery of Ngerur Island
and will follow the recommendations in those two reports; and

WHEREAS, pursuant to Title 19 of PNC and BCHP regulations, Bureau of Cultural and
Historical Preservation (BCHP) is responsible for the protection and preservation of historic
properties and maintaining a cultural and historical database for the whole Palau was consulted
by the applicant; and

NOW THEREFORE, Mr. Shallum Etpison, Representing Ngerur Corporation (applicant) and
Bureau of Cultural and Historical Preservation/Palau Historic Preservation Office has taken into
consideration the effect of the project to cultural and historic property and to satisfy Title 19
Chapter 1 of PNC, BCHP regulations through the following stipulations to ensure that all the
cultural and historical properties on the area are not needlessly disturbed, altered, and or
destroyed without proper documentation, preservation, and or protection.
STIPULATIONS

1. Mr. Shallum Etpison, representing Ngerur Corporation (applicant) shall ensure that all activities of the project must follow exactly what was stated in the project proposal and all measures and stipulations within this MOA.

2. Mr. Shallum Etpison, representing Ngerur Corporation (applicant) shall ensure that all activities of the Palau Quest Resort Palau project must stay within the proximity of the proposed project.

3. Mr. Shallum Etpison, representing Ngerur Corporation (applicant) shall report to BCHP for consultation on any changes of plan that is not stated within the Quest Resort Palau proposal before any action is taken.

4. Mr. Shallum Etpison, representing Ngerur Corporation (applicant) shall ensure that any human remains encountered or unearthed during the field work or the actual earthmoving and construction, the activities must stop and the Bureau of Cultural and Historical Preservation must be notified for assessment. BCHP regulation entitled, “Regulations Regarding the treatment and Disposition of Human Remains and Burial Furnishing” and “Agreement for the Disposition of Human Remains” must be followed. It shall be noted that all remains found in the Republic of Palau are considered Palauan until proven otherwise.

5. Mr. Shallum Etpison, representing Ngerur Corporation (applicant) shall ensure that any artifacts encountered during the field work or the actual earthmoving must be fully documented in detail, mapped, photographed and be left in situ. It must be reported to BCHP for consultation and shall follow the BCHP regulation entitled; “Regulations Regarding Palau Cultural and Historical Artifacts” and “Agreement for the Temporary Curation of Artifacts and Records”. It shall be noted that all artifacts found in the Republic of Palau are considered Palauan until proven otherwise.

6. Mr. Shallum Etpison, representing Ngerur Corporation (applicant) shall ensure that any unusual finds that was not recorded during the archaeological field survey and data recovery unearthed or exposed during the actual clearing, earthmoving and construction, the project must stop and BCHP must be notified for assessment.

7. Mr. Shallum Etpison, representing Etpison Corporation (applicant) shall ensure that BCHP staff has access to conduct monitoring, with prior notice to applicant, of the project on a systematic basis to ensure all stipulations are followed during the course of the project.

8. Should any of the signatories find that any part of this MOA cannot be met or find it necessary to make amendment, that signatory shall initiate a consultation with other signatory. The amendment of this MOA shall follow the same process as the execution of this MOA.

Oncherreu, Omechelius, Mengeluolu, e Ketek a Putele a Cherechar er a Belau

BCHP Initial
The execution of this MOA and implementation of its term of reference as evidence that Mr. Shallum Etpison, representing Ngerur Corporation (applicant) has afforded Bureau of Cultural and Historical Preservation/Palau Historic Preservation Office an opportunity to comment on a study of the project area and its effects on a cultural and historical property and has taken into account the effect of the undertaking on historic property.

Ngerur Corporation (Applicant)

[Signature]

Mr. Shallum Etpison
Representing Ngerur Corporation
P. O. Box 129
Koror, Palau 96040

4/23/18
Date

Bureau of Cultural and Historical Preservation/Palau Historic Preservation Office

[Signature]

Sunny O. Ngirmang
Director/HPO
BCHP

5/07/18
Date

Cc: File