US Army Corps
of Engineers

TINIAN HARBOR MODIFICATIONS STUDY

ISLAND OF TINIAN

COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS

Interim Feasibility Report Tinian Harbor Modification Study

Prepared by:

U.S. Army Corps of Engineers

Honolulu District

4 December 2018

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Executive Summary

Introduction

The U.S. Army Corps of Engineers (USACE) in partnership with the Commonwealth of the Northern Mariana Islands (CNMI), initiated the Tinian Harbor Modification Study in December 2015 with the execution of a Feasibility Cost Share Agreement. The CNMI government serves as the non-federal sponsor and study proponent.

This study, which is comprised of an integrated feasibility study and environmental impact statement, was conducted under the authority of Section 444 of the Water Resources Development Act (WRDA) of 1996 (P.L. 104-303). Section 444 authorizes the Secretary of the Army (Secretary) to:

> *"…conduct studies in the interest of navigation in that part of the Pacific region that includes American Samoa, Guam, and the Commonwealth of the Northern Mariana Islands."*

The objectives of this *report* are two-fold: (1) to present the findings of the studies to investigate and determine whether a federal interest exists in participating in navigation improvements at Tinian Harbor, and (2) to fulfill the federal National Environmental Policy Act (NEPA) requirements to consider the environmental effects of the proposed action.

The federal interest extends only to General Navigation Features (GNF), which include primary access channels, turning basins and associated protective structures.

Study Location

The island of Tinian is located approximately 3,800 miles west of the State of Hawaii within the CNMI and has a population of 3,100. Tinian Harbor is located on the southeast coast of the island in the village of San Jose.

Problems

The protective breakwater at Tinian Harbor was originally constructed by the U.S. Navy in the mid-1940s and is currently owned by the CNMI Commonwealth Ports Authority (CPA). The breakwater is in a state of significant disrepair, potentially putting vessels calling at the harbor and port infrastructure and operations at risk from adverse wave conditions. There is no record of maintenance of the breakwater since its original construction.

The continued deterioration of the breakwater will likely worsen current navigation inefficiencies at the harbor, the cost of which, will be passed onto Tinian consumers in the form of increasing commodity prices. Based on a 5-year average, approximately 97 percent of the commodities consumed on Tinian are imported through Tinian Harbor, the only commercial harbor serving the island.

The USACE Project Delivery Team (PDT), CNMI government and project stakeholders developed a list of problems to be considered in the plan formulation process. A review of the identified problems eliminated those which were could not be confirmed, and resulted in the following list to be carried forward for further analysis:

- Insufficient protection from waves causes disruption of port operations. (port operations)
- The existing breakwater in its current state is unstable and puts harbor navigation and infrastructure at risk. (vessel delays/damages to infrastructure)
- Continued breakwater deterioration may allow increased wave energy in the harbor, increasing the risk of unexpected unsafe harbor conditions. (safety)
- Currents through the harbor impact small boat navigation. (subsistence fishing)
- When vessel calls are cancelled because of harbor conditions, the result is an increase in food costs for Tinian residents. (welfare impact, Other Social Effects (OSE))

Project Constraints

Project constraints included high construction costs due to the isolated location of the project and availability of materials, and impacts to endangered coral species, including required compensatory mitigation.

Plan Formulation and Selection Process

Plan formulation for the study used the prescribed methods described in Engineering Regulation (ER) 1105-2-100 and the USACE SMART planning process. In February 2016, project stakeholders held a planning charrette in Honolulu, Hawaii, to discuss potential alternatives to improve harbor operations. An initial array of alternatives included a No-Action Alternative, non-structural alternatives including mooring vessels offshore, use of different vessels, closing ports at times of high surge, and structural measures outlined below. Using the SMART planning screening criteria, the Project Delivery Team identified the following measures to carry forward to the evaluation process:

- Replace Existing Breakwater in Place (Figure ES-1): Replace the existing breakwater in its current footprint. Removal and disposal of approximately 4,600 ft. of sheet pile, replace with a stone or stone and concrete structure.
- Replace and Extend Existing Breakwater (Figure ES-2): Replace the existing breakwater in its current footprint and construct a 300-ft. extension.

Figure ES-1. Replace Existing Breakwater in Place

Figure ES-2. Replace and Extend Existing Breakwater in Place

Public Involvement

Following the February 2016 planning charrette, USACE published a Notice of Intent (NOI) to prepare an Integrated Feasibility/Environmental Impact Statement (EIS) to the Federal Register on July 8, 2016, informing the public about the upcoming study and soliciting public comments for scoping. The CNMI Government posted information on their social media outlets and in their local newspapers. Additionally, the USACE and the CNMI Government jointly hosted public scoping meetings on Tinian and Saipan on July 19, 2016, and July 20, 2016 The USACE and CNMI Government considered the issues raised by the local community and natural resource agencies at those meetings in the development of this study.

Environmental Consequences

The study area contains valuable marine habitat included coral reef. Although the structural footprints were designed to the minimum necessary to stabilize the structure and improve navigational capacity within the harbor, both alternatives would inevitably result in direct impacts to coral, including a species of coral listed on the Endangered Species Act as threatened. To compensate for unavoidable losses of corals, USACE proposes mitigation in the form of artificial reef balls. Quantification of anticipated project impacts, proposed mitigation and estimated costs are provided in Table ES-1. USACE will ensure compliance with all applicable environmental laws and statutes.

Alternatives	Direct Coral Impacts (acres)	Proposed Coral Mitigation (acres)	Mitigation Cost
No-Action Alternative	--	--	--
Replace Existing Breakwater in Place	14.56	4.05	$2,870,600
Replace and Extend Existing Breakwater	16.34	4.57	$3,239,100

Table ES-1 Environmental Impacts and Mitigation

Project Cost

Project first costs for each alternative were estimated based on Total Construction Costs which included all aspects of project construction and construction management i.e. real estate acquisition, environmental mitigation, dredging and dredged material management/disposal. In addition to initial construction costs, annual operation and maintenance costs were considered and separately estimated. These costs are presented in Table ES-2 and were provided in FY 2018 price levels which were annualized through the period of analysis for the average annual equivalent (AAEQ) cost calculation.

	Alternative 1	Alternative 2	Alternative 3
Project First Costs	--	$122,957,100	$188,575,800
Interest During Construction Cost	--	$1,825,339	$3,672,000
Investment Cost (Project First Cost + Interest During Construction)	--	$124,784,500	$192,247,800
Amortized Investment Cost	--	$5,008,226	$7,510,500
Annual Operation and Maintenance Cost	--	$55,414	$61,100
Average Annual Equivalent Cost	--	$5,063,640	$7,571,600

*Costs are included in Project First Costs

Table ES-2 Project First Costs for Each Alternative

National Economic Development Analysis

In evaluating the economic feasibility of a proposed project, USACE policy requires a National Economic Development (NED) analysis be conducted. The NED analysis must result in a benefit-cost ratio of equal to or exceeding 1.0 for a plan to be economically justified (USACE Deep Draft Navigation (DDN), Institute for Water Resources (IWR) NED Guidelines). In addition to the NED analysis, the economic analysis also considers Regional Economic Development, Environmental Quality, and OSE which are documented in the report.

Based on the NED analysis, the proposed project did not produce a benefit-cost ratio (BCR) equal to or greater than 1.0 for any of the plans included in the final array of alternatives (Table ES-3).

Alternatives	Average Annual Benefits	Average Annual Costs (AAC)	Total Net Benefits	Benefit-Cost Ratio
No-Action Alternative	0	0	--	--
Replace Existing Breakwater in Place	$39,500	$5,063,600	($5,022,900)	0.01
Replace and Extend Existing Breakwater	$401,400	$7,571,600	($7,157,400)	0.05

Table ES-3 NED Analysis Results

The economic feasibility of the alternatives was evaluated under the cost effectiveness/incremental cost analysis (CE/ICA). The CE/ICA determined. From the above analysis, an additional usable day for the Replace Breakwater, costs an average of $1,265,900 or each additional usable day, while the Replace & Extend Breakwater at the next level of wave and current protection costs an additional $313,500 for each additional useable day.

Alternatives	Outputs (Unusable Days)	Increase in Usable Days	Cost (AAC)
No-Action Alternative	49	--	--
Replace Existing Breakwater in Place	45	4	$5,063,600
Replace & Extend Existing Breakwater	37	12	$7,571,600

Table ES-4 CE/ICA Results

Remote and Subsistence Harbors

Section 2006 of WRDA 2007, as amended (Remote and Subsistence Harbors) provides that in conducting a study of harbor and navigation improvements, the Secretary may recommend a project without demonstrating that the improvements are justified solely by NED benefits involving remote and economically critical projects, if the Secretary determines that the improvements meet specific criteria.

The project was analyzed to determine eligibility under the Remote and Subsistence Harbors authority. Included in the analysis were impacts from cancelled vessel calls and their impact on the community, subsistence and recreational fishing, potential typhoon damage and recovery efforts, and strategic importance to U.S. national defense.

Based on the analysis described above, USACE has determined that the project met the Remote and Subsistence Harbors criteria for “Location” and “Economically Critical”. However, the project did not meet the “Long-term Viability” criterion, as the long-term viability of the community would not be threatened without the proposed navigation improvements.

Study Conclusions

The NED analysis resulted in a determination of "No Federal Interest" under Civil Works authorities because the BCR for all the alternatives were well under 1.0. It was further determined that the project did not meet the eligibility criteria for Remote and Subsistence Harbors, which would have allowed continuation of the project in lieu of a NED plan.

Study Termination

Based on evaluation of NED benefits and Remote and Subsistence Harbors criteria, USACE has determined that there is presently no federal interest in constructing harbor improvements under the USACE Civil and Public Works program at Tinian Harbor.

Accordingly, the feasibility study will be terminated and the study information made available to other parties or agencies that may be interested in pursuing a similar project. The information presented in this feasibility study is comparable to a 35% level design and cost estimate.

U.S. Department of Defense Interest

The U.S. Department of Defense (DoD) has a significant interest in assuring continuous access and port operations at Tinian Harbor to support plans for the following military initiatives on the island.

CNMI Joint Military Training: The U.S. is rebalancing military forces in the Asia-Pacific region. In support of this, the U.S. military is proposing to increase joint military training capabilities by developing live-fire ranges and training areas on the islands of Tinian and Pagan in order to reduce joint training deficiencies for military services in the Western Pacific and enable the U.S. Indo-Pacific Command (USINDOPACOM) forces to meet the Title 10 of the U.S. Code requirements to maintain, equip, and train combat and humanitarian forces in the Western Pacific. The U.S. Marine Corps is leading this joint service initiative on behalf of USINDOPACOM.

U.S. Air Force Divert Activities, Exercises Initiative: In December 2016, the U.S. Air Force selected the Tinian International Airport, as the location for the Pacific Air Forces Divert Activities, Exercise Initiative location. The purpose of the initiative is to establish additional divert options to support training activities and increase regional humanitarian assistance and disaster relief capabilities, while ensuring the ability to meet mission requirements in the event access to Andersen Air Force Base, Guam, or other western Pacific locations is limited or unavailable.

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†Sections marked with an obelisk are required content for compliance with the National Environmental Policy Act

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Acronyms

ACHP	Advisory Council on Historic Preservation
AM	Alternatives Milestone
APE	Area of Potential Effects
APPS	Act to Prevent Pollution from Ships
BCR	Benefit-Cost Ratio
BEACH	Beaches Environmental Assessment and Coastal Health Act
BECQ	Bureau of Environmental Control and Quality
BMP	Best Management Practice
CAA	Clean Air Act
CAP	Conservation Act Plans
CCA	crustose coralline algae
CE/ICA	cost-effectiveness incremental cost analysis
CEDS	Comprehensive Economic Development Strategic Plan
CELCP	Coastal and Estuarine Land Conservation Program
CEM	Coastal Engineering Manual
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CI	confidence intervals
CITES	Convention of International Trade in Endangered Species
CJMT	CNMI Joint Military Training
CMS-FLOW	Coastal Modeling System – Flow
CMS-WAVE	Coastal Modeling System – Wave
CNMI	Commonwealth of the Northern Mariana Islands
Corps/USACE	U.S. Army Corps of Engineers
CPA	Commonwealth Ports Authority
CRMO	Coastal Resources Management Office
CRTF	Coral Reef Task Force
CUC	Commonwealth Utilities Corporation
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
DAR	Division of Aquatic Resources
DCCA	Department of Community and Cultural Affairs
DEQ	Division of Environmental Quality
DFW	Division of Fish and Wildlife
DLNR	Department of Land and Natural Resources
DOFAW	Division of Forestry and Wildlife
DoD	Department of Defense
DoN	Department of the Navy
DPL	Department of Public Lands
EA	Environmental Assessment
EFH	Essential Fish Habitat

EIS	Environmental Impact Statement
ELGs	effluent limitations guidelines
EMUA	Exclusive Military Use Area
EO	Executive Order
EPA	Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
EQ	environmental quality
ESA	Endangered Species Act
F/EIS	Feasibility/Environmental Impact Statement
FCSA	Feasibility Cost Sharing Agreement
FWCA	Fish Wildlife Coordination Act
GDP	gross domestic product
gpd	gallons/day
GPS	Global Positioning System
HAR	Hawaii Administrative Rules
HEA	Habitat Equivalency Analysis
HPO	Historic Preservation Office
HRS	Hawaii Revised Statutes
HTRW	hazardous, toxic or radioactive waste
IOPP	International Oil Pollution Prevention
LBA	Lease Back Area
LERRD	lands, easements, rights-of-way, relocations and disposal areas
lpd	liters/day
MACT	maximum achievable control technology
MARPOL	International Convention for the Prevention of Pollution from Ships
MBTA	Migratory Bird Treaty Act
MITT	Mariana Islands Training and Testing
MLA	Military Lease Area
MLLW	mean lower low water
MOU	Memorandum of Understanding
MPA	Marine Protected Areas
MPRSA	Marine Protection, Research, and Sanctuaries Act
MSC	Major Subordinate Command
MSL	Mean Sea Level
NAAQS	National Ambient Air Quality Standards
NED	National Economic Development
NEPA	National Environmental Policy Act
NHO	Native Hawaiian Organization
NHPA	National Historic Preservation Act
NMC-CREES	Northern Marianas College Cooperative Research, Extension, and Education Service
NMFS	National Marine Fisheries Service
NMSA	The National Marine Sanctuaries Act

NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPL	National Priority List
NRCS	USDA Natural Resources Conservation Service
NRDA	natural resources damage assessment
NRHP	National Register of Historic Places
NOI	Notice of Intent
NSPS	new source performance standards
O&M	Operations and Maintenance
OMRR&R	operation, maintenance, repair, replacement, and rehabilitation
OSE	Other Social Effects
P&G	Principles and Guidelines
PAR	Planning Aid Report
PDT	Project Design Team
PED	planning, engineering, and design
PGN	Planning Guidance Notebook
P.L.	Public Law
RCRA	Resource Conservation and Recovery Act
RED	Regional Economic Development
RIT	Regional Integration Team
R/S	Remote & Subsistence
SARA	Superfund Amendments and Reauthorization Act
SCS	USDA Soil Conservation Service
SLA	Submerged Lands Act
SMART	Specific, Measurable, Attainable, Risk Informed, [and] Timely
SME	subject-matter expert
SOPs	Standard operating procedures
SOPEP	Shipboard Oil Pollution Emergency Plans
U.S.	United States of America
USC	United States Code
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USPACOM	U.S. Pacific Command
WIS	Wave Information Study
WQC	Water Quality Criteria
WRDA	Water Resources Development Act
WWII	World War II

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1.0 INTRODUCTION

The Northern Mariana Islands are located in the Western Pacific, approximately 3,800 miles west of Hawaii. The Commonwealth of the Northern Mariana Islands (CNMI) is composed of sixteen islands north of Guam running north-south for a distance of about 440 miles. The island of Saipan is the capital and center of population and commerce for the Northern Marianas. Tinian Island is located 14 miles south-southwest of Saipan and 120 miles north-northeast of Guam (Figure 1-1). The island is approximately 10.5 miles long and 5 miles wide. At approximately 39 square miles in size, Tinian is the second largest island in the CNMI.

Tinian Harbor is owned and operated by the Commonwealth Ports Authority (CPA). Tinian Harbor is located on the southwest coast of Tinian within a natural embayment near San Jose, the primary urban center, and it is the main point of entry for vessel passengers and commodities.

1.1 Overview of Integrated Feasibility Study/Environmental Impact Statement

The U.S. Army Corps of Engineers (USACE), Honolulu District (POH) is preparing this Interim Feasibility Report, based on a finding of "No Federal Interest" to construct harbor improvements at Tinian Harbor under the USACE Civil Works program. The study includes (1) a current and future conditions assessment of the harbor infrastructure, and (2) an analysis of a range of alternatives formulated to improve navigational risk and operational efficiency. Among the study issues being considered are the environmental effects on the abundance of biological resources, the economic factors attributed to proposed project costs, and costs affecting Tinian residents as a result of harbor problems.

The feasibility study has been combined with an Environmental Impact Statement (EIS) in this Interim Feasibility Report. The six steps of the Corps' planning process each align with a National Environmental Policy Act (NEPA) requirement. The planning steps are listed below followed by the corresponding document section and NEPA requirement (Table 1-1):

Planning Step	NEPA Requirement and Document Section
Step 1: Problems and Opportunities	Purpose and Need for Action; Section 1
Step 2: Inventory and Forecast of Conditions	Affected Environment; Section 4
Step 3: Formulate Alternative Plans	Alternatives including Proposed Action; Section 3
Step 4: Evaluate Effects of Alternative Plans	Environmental Consequences; Section 4
Step 5: Compare Alternative Plans	Alternatives including Proposed Action; Sections 3 and 4
Step 6: Select Recommended Plan	Preferred Alternative; Section 3

Table 1-1 USACE Planning Process and NEPA Correlation

1.2 Study Authority

Tinian Harbor is owned and operated by the CPA. There is currently no federal navigation project at the harbor.

The Tinian Harbor feasibility study is being conducted under the authority of Section 444 of the Water Resources and Development Act (WRDA) of 1996 (P.L. 104-303). This Act provides for the conservation and development of water and related resources, authorizes the Secretary of the Army to construct various projects for improvements to rivers and harbors of the U.S., as well as for other purposes. Section 444 specifically authorizes the Secretary to conduct studies in the interest of navigation in that part of the Pacific region that includes American Samoa, Guam, and the Commonwealth of the Northern Mariana Islands.

1.3 Study Sponsor†

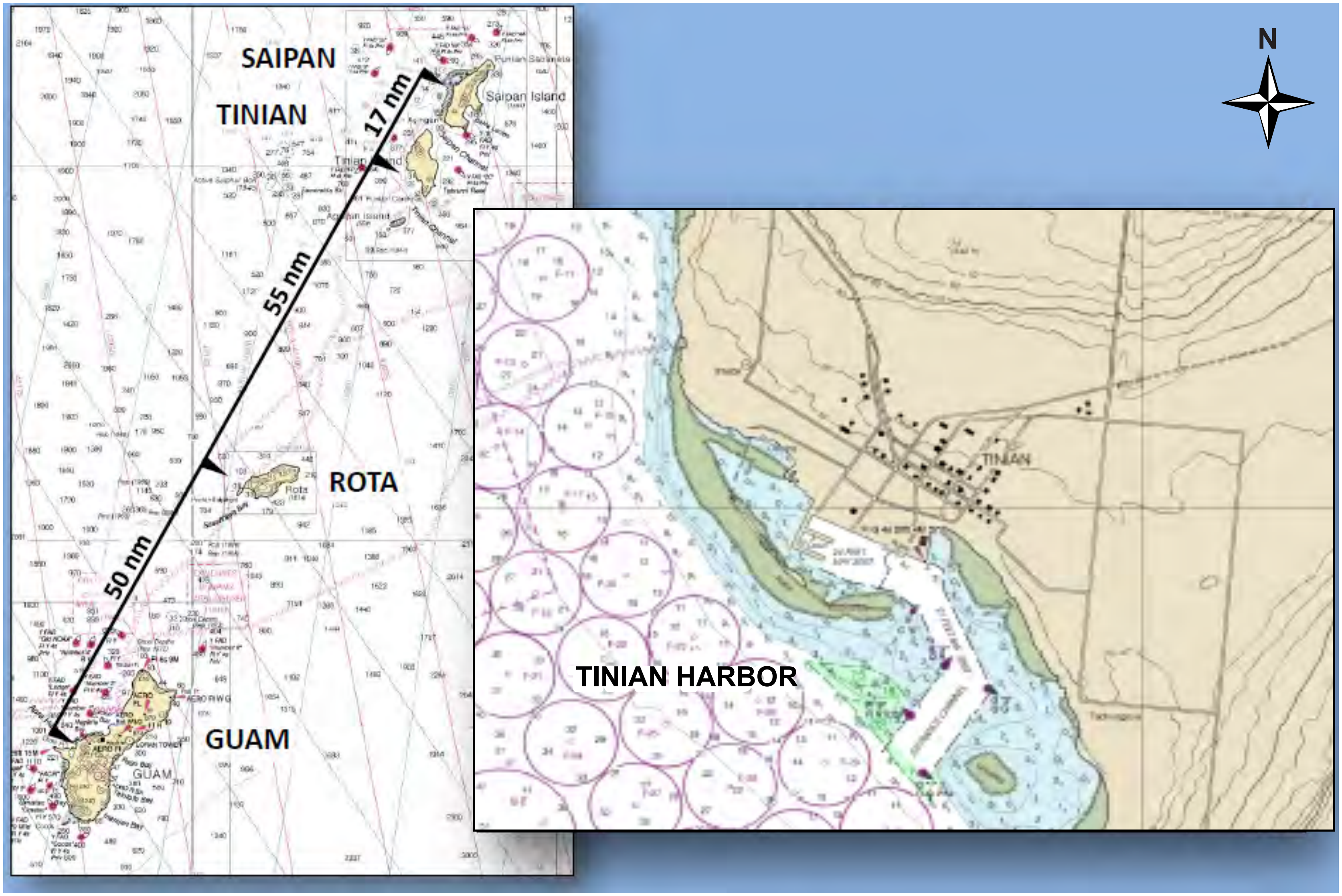
The non-federal sponsor and study proponent is the CNMI Government. A non-federal sponsor must have the legal and financial capability to fulfill the requirements of cost sharing and local cooperation. At the sponsor's request, a Section 905(b) of WRDA 1986 reconnaissance study for navigation improvements to Tinian Harbor was completed in October 2001, resulting in a recommendation to proceed with a cost-shared feasibility study. A Feasibility Cost Sharing Agreement (FCSA) was executed between the USACE and the CNMI Government on December 4, 2015.

1.4 Study Scope (Federal Interest/Proposed Federal Action)

Federal interest in water resources development is established by law. USACE's role with respect to navigation is to provide safe, reliable, and efficient waterborne transportation systems for movement of commerce, national security needs, and recreation. This study will determine whether a federal interest exists in participating in the implementation of supplemental general navigation features to improve transportation and operational efficiency at Tinian Harbor, as well as mitigating the risk of significant damage to port infrastructure consequent to the continued deterioration of the protective breakwater.

The scope of this study assesses the technical, environmental, and economic feasibility of implementing general navigation improvements at Tinian Harbor to address transportation and operational inefficiencies and navigational risk in the context of the federal interest for a 50-year period of analysis.

POH analyzed a range of structural and non-structural solutions, considering economic optimization and the least environmentally damaging practical alternative plan. The plan formulation process is described in Chapter 3.



U.S. Army Corps of Engineers
Honolulu District
Fort Shafter, Hawaii

PROJECT NAME:

Interim Feasibility Report
Tinian Harbor Modification Study
Island of Tinian
Commonwealth of the Northern Mariana Islands

FIGURE TITLE:

Vicinity and Location Maps of Tinian Island and Tinian Harbor

FIGURE NUMBER:

1-1

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1.5 Purpose and Need†

The purpose of this study is to identify a federally recommended plan to improve navigational and operational efficiency, improve harbor safety, and reduce damages to vessels and infrastructure at Tinian Harbor. The Tinian Harbor breakwater is significantly dilapidated and in need of repair. As a result, Tinian Harbor is currently experiencing some wave protection from the existing breakwater; however, its future stability is uncertain.

Due to its remoteness, the population of Tinian relies primarily on waterborne commerce (transshipped via an inter-island shuttle from Saipan) as the most economical means of importing goods and commodities. Tinian Harbor serves as a lifeline to the island's 3,100 residents. Approximately 90 percent of all goods and materials on the island are imported, of which, 90 percent enter through the harbor.

Failure of the breakwater has the potential to result in adverse impacts to commercial navigation and port operations under certain conditions. Tinian Harbor is exposed to consistent tradewind seas, seasonal open ocean swell, and relatively frequent tropical storm activity. It is somewhat protected by a shallow, fringing reef; however, the typical wind and wave activity, in combination with the deteriorated condition of the breakwater, can cause conditions in the harbor to be challenging for both small vessel transit around the finger piers and large vessel operations at the wharf. In addition, damage to the North wharf at the southeast end (Berth #4) has rendered this area unusable in recent years.

The study identifies and evaluates the feasibility of structural and non-structural navigational improvements/measures to improve the operational efficiency of commercial vessels currently calling and projected to call at Tinian Harbor. The study examines the problems and needs at the harbor in the context of existing conditions and determines whether a federal interest exists in participating in the implementation of general navigation improvements. Potential alternatives/improvements are evaluated and screened based on the SMART Planning process, and in accordance with the usage and needs of harbor users.

The EIS identifies and analyzes environmental effects of the alternatives, incorporates environmental concerns into the decision-making process, and determines whether any environmental impacts warrant mitigation.

The objectives of this report are two-fold: (1) to present the findings of an Interim Feasibility Study that was completed to investigate and determine whether there is a federal interest in providing harbor modifications to the Island of Tinian, and (2) to fulfill the federal (NEPA) requirements for environmental review of proposed actions. This document will be referred to as a Interim Feasibility Report moving forward, inclusive of both the Interim Feasibility Study and NEPA environmental review process.

1.6 Study Area†

The study area encompasses the navigational features of Tinian Harbor. The harbor entrance channel is approximately one-half mile long, by 525 feet wide, with an original project depth of 30 feet. The wharves and harbor turning basin depths range from 28 to 30 feet. The total length of the harbor breakwater is 4,805 feet. with a crest elevation of approximately 14 feet above Mean Sea Level (MSL). The 1,210 foot inner breakwater extends from the shoreline to the outer breakwater and is constructed of a single row sheet piling, much of which has deteriorated and collapsed. The 3,595 foot outer breakwater is constructed of interlocking, half-inch thick steel sheet piling in circular cell configuration. The interior of the cells are filled with quarried limestone. A 10 inch thick, unreinforced concrete slab is constructed flush with the top of the sheet piles. Other than a 900 foot reach in the middle of the breakwater that was repaired in 1979 following a tsunami, the structure is severely deteriorated, and little remains of the steel sheet pile cells. The loss of the sheet pile has resulted in the fill material being washed out and deposited along the harbor side of the breakwater. The last 300 feet of the breakwater head is significantly degraded and/or submerged. The deteriorated structure does provide some energy dissipation for typically prevailing small waves; however, it provides little or no protection against storm waves.

Interior infrastructure at the harbor consists of an approximately 2000 foot long wharf (North Wharf) with four berthing areas, an adjacent East Wharf, a set of two finger piers, and a small boat basin to the west of the finger piers. The finger piers have had little maintenance, and the small boat basin is exposed to incoming waves from the west and southwest due to the degraded and primarily submerged inner breakwater. Various structural repairs have been made to the existing inner harbor pier and wharf structures, including reconstruction of the concrete cap beams on various sections of the bulkhead walls, and most recently the installation of new fenders and mooring bollards at the Mobil fueling berth (Moffat & Nichol, 2015). Kammer Beach is a long sandy beach just east of the harbor that is frequented by tourists visiting Tinian (Figure 1-2).

Approximately 15,353 acres (or two-thirds) of Tinian is leased to the U.S. military through an arrangement known as the Military Lease Area (MLA), the main purpose of which is to support military training (CJMT Draft EIS/OEIS 2015). A section of the MLA sublet back to CNMI, known as the Lease Back Area (LBA), is used to support cattle grazing. Another 777 acres of the MLA is used by the International Broadcasting Bureau. Amphibious landings are currently authorized at several Tinian beaches and the U.S. DoD is proposing to expand these activities for future training opportunities (MITT Final EIS/OEIS 2015; CJMT Draft EIS/OEIS 2015).

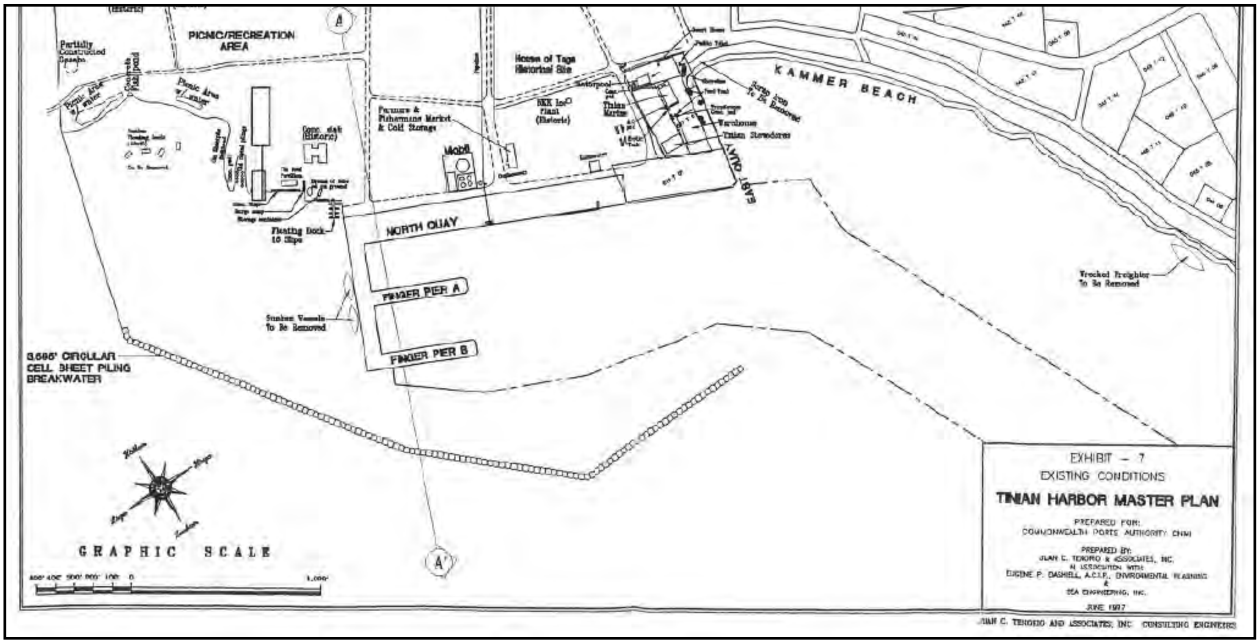

Figure 1-2 Project Map of Tinian Harbor

1.7 Study History and Background

The Tinian Harbor breakwater was constructed by the U.S. Navy in 1944-1945 during World War II. The harbor was never authorized as a federal project; therefore, the U.S. Government has never held federal interest in Tinian Harbor. The existing design of the harbor does not adequately protect the harbor facilities from severe weather, wind, waves, and current.

Since its initial construction, the breakwater has significantly deteriorated with some sections open to the outside lagoon on the west side of the harbor. Other sections are crumbling which exposes the harbor facilities to waves and currents during stormy conditions (Figure 1-3). Currents can be very strong to the point of hampering small vessel traffic in the narrow passage from the entrance channel to the commercial dock located in the main harbor area. The present condition of the harbor limits usage by supply vessels bringing goods to the island. Because ocean transportation of goods to the island is the most economical means of sustaining the island's residents, the maintenance of the harbor facility is vital to the well-being of the island community. The CPA has no record of maintenance dredging or breakwater maintenance since construction of the harbor.

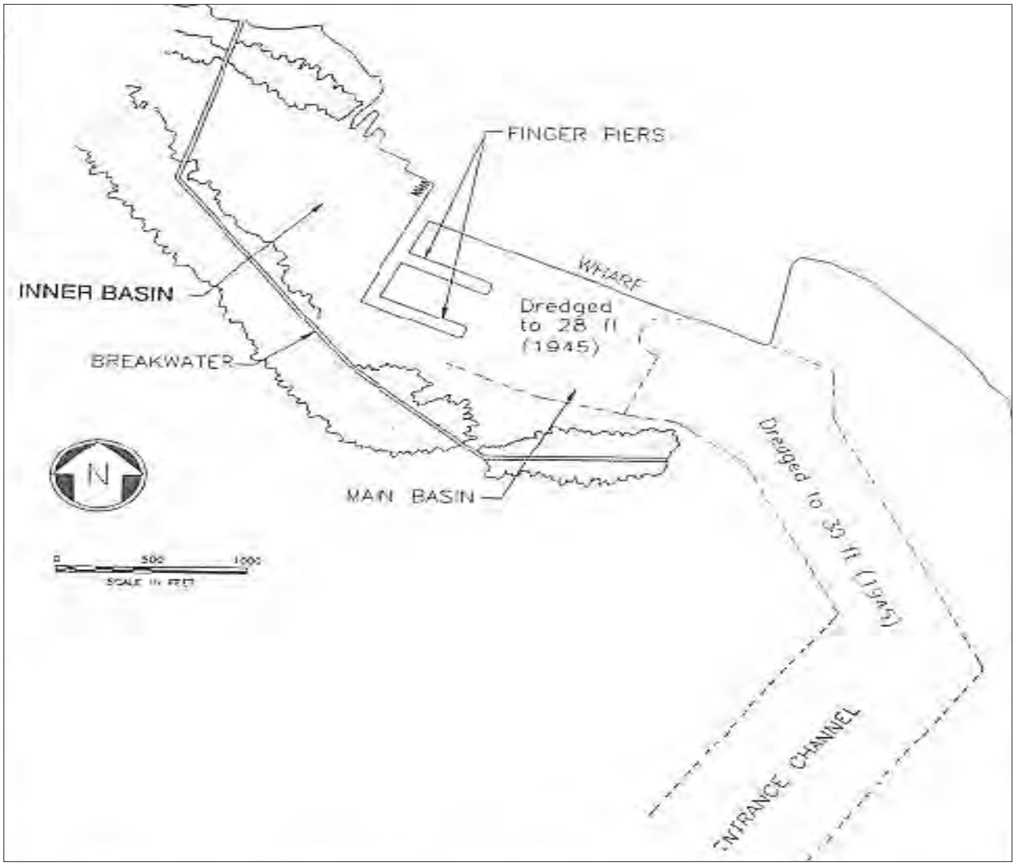

Figure 1-3 Navigation Project – Tinian Harbor

1.8 Related Projects and Activities

Prior reports and existing water projects identified by the USACE for Tinian Harbor include:

- Tinian Harbor Master Plan Update, CPA, CNMI. May 2018.
- General Investigation Report, Section 905(b) Analysis, *Navigation Improvements to Rota and Tinian Harbors*. 9 May 2002.
- *Climate Vulnerability Assessment for the Islands of Rota & Tinian, CNMI*. CNMI Bureau of Environmental and Coastal Quality Division of Coastal Resources Management. 2015.
- *Tinian Harbor Condition Assessment and Breakwater Alternatives Evaluation*, Section 22 (PAS). USACE, Honolulu District. July 2015.

Other federal and state agencies note the following in regard to related projects or studies:

- United States Fish and Wildlife Service (USFWS):

- USFWS has conducted one previous Fish and Wildlife Coordination Act (FWCA) investigation on Tinian for the U.S. Marine Corps in 2009, examining three beaches proposed for amphibious landings, as well as Tinian Harbor. A total of 14 quantitative survey transects within the Project Area were completed inside and outside the harbor (Minton, et al. 2009).

- National Marine Fisheries Service (NMFS) Pacific Science Center:
  - Coral Reef Ecosystem Program conducts periodic coral reef surveys around the island of Tinian. These surveys mostly consist of standard rapid ecological assessments, as well as tow-board diver surveys.

- U.S. DoD, U.S. Marine Corps:
  - Recently conducted a series of surveys around Tinian for proposed military training activities on the island Tinian.

- CNMI Division of Fish and Wildlife (DFW) and Bureau of Environmental Control and Quality (BECQ) conduct periodic marine surveys on Tinian.
  - Additional recent work to examine the potential resiliency of coral reefs to future climate change impacts was also conducted around Tinian (Maynard et al. 2015).

- Commonwealth Utilities Corporation (CUC):
  - The CUC is working on multiple water projects on Saipan and one each on Tinian and Rota. Water system improvements planned on Tinian include reconfiguration of piping on existing mains, installation of 650 feet of 10 inch main, and installation of 4 new pressure reducing valve (PRV) stations.

Projects in the CNMI

A variety of projects and activities either have been recently completed, are ongoing, or are planned for implementation in the CNMI. Although not all are part of the study, the scope and status of these efforts have been tracked for consideration in the planning process, conceptual design development, and impact analysis. Table 1-2 summarizes the related projects and activities that have been identified by the CNMI, and their applicability to the planning process.

The short-listed projects under this category include the rehabilitation of the Tinian Harbor. The study's importance is emphasized because of the breakwater's dilapidated condition and the reliance of the people of Tinian on its continued operation for imported goods and services. The consequences that shipping-induced inflation has on these communities significantly impacts disposable income and the ability to generate new revenues through higher spending.

EDF Short Listed Projects

	Focus on Regional Commerce	Sustainable via Private Investments	Promote Public-Private Partnerships	Environmentally Responsible	Infrastructure Improvement	Industry Innovations & Synergy	Promote New Industry/Support Current Industry
Solar Farms		X	X	X		X	X
Wind Farms		X	X	X		X	X
Waste-To-Energy		X	X	X		X	X
MBP Solar Project	X	X	X	X		X	X
Inter-island Ferry	X	X	X			X	X
Tinian Airport Renovations	X				X		X
Tinian Harbor Renovations	X				X		X
Rota Airport Fuel Storage					X		X
Rota West Harbor Rehabilitation	X				X		X
Rota Ecotourism	X			X			X
Pagan Ecotourism	X	X	X	X			X
Garapan Revitalization	X	X	X	X	X		X
Kalabera Cave Development	X			X	X		
La Fiesta Revitalization	X	X	X		X	X	X
CHC/THC/RHC Privatization		X	X	X	X	X	X

Table 1-2. Related Projects and Activities in the CNMI (CNMI Department of Commerce 2013 CNMI Economic Development Forum (EDF) Report & Recommendations)

1.9 USACE Planning Process

The USACE feasibility planning process is composed of six steps, as specified by USACE planning regulations and guidance, including Engineer Regulation (ER) 1105-2-100 “Planning Guidance Notebook (PGN)” (USACE, 2000) and the “Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (P&G)” (Water Resources Council, 1983). The PGN provides the overall direction by which Corps projects are formulated, evaluated, and selected for implementation. It contains a description of the Corps’ planning process, missions and programs, specific policies applicable to each mission and program, and analytical requirements. The P&G document outlines a set of rules and steps to be followed in assessing costs and benefits of implementation alternatives for water resource projects. These steps include (1) specification of water and related land resources problems and opportunities, (2) inventory, forecast, and analysis of water and related land resources conditions within the study area, (3) formulation of alternative plans, (4) evaluation of the effects of the alternative plans, (5) comparison of the alternative plans, and (6) identification of a tentatively selected plan based upon the comparison of the alternative plans. This process is based on a 50-year period of analysis extending from the base year (which, in the case of this study, is assumed to be 2020, per the proposed construction schedule).

Recognizing the need to modernize its planning process with an emphasis on delivering high-quality feasibility studies within shorter timeframes and at lower costs, the USACE has recently applied a SMART (Specific, Measurable, Attainable, Risk Informed, Timely) planning approach to the six-step process outlined above (USACE, 2012a). The SMART planning approach emphasizes risk-based decision making (focusing on SMART goals and decisions) and specifies three primary requirements for feasibility studies (referred to as the “3x3x3 Rule”): completion within 3 years, at a cost of no more than $3 million, and with 3 levels of vertical team alignment (including the applicable USACE District, Major Subordinate Command (MSC), and Headquarters USACE (HQUSACE)). Other key components include (1) focusing the detailed analysis and design on the tentatively selected plan, and (2) identifying the appropriate level of detail, data collection, and modeling based only on what is necessary to complete the feasibility study.

The planning process was primarily conducted by the Project Delivery Team (PDT), which comprises designated representatives from POH, the project sponsor, and POH study consultants. Additionally, project stakeholders, and local and federal resource agencies provided input into the study. Consistent with the requirements of the SMART planning process and 3x3x3 Rule, periodic reviews were held with the vertical team (comprising POH, Pacific Ocean Division (POD), and HQUSACE staff) to confirm the direction of study development relative to major milestones.

1.10 Report Organization

This report integrates into a single document the results of the USACE feasibility planning process, as well as the NEPA environmental review, analysis and disclosure of potential environmental impacts and mitigation, as needed to inform planning and decision-making. An overview of the report chapters as related to the planning process is provided below:

This report is divided into eight chapters:

- Chapter 1 – Introduction (Study Information)
- Chapter 2 – Need for and Objectives of Action
- Chapter 3 – Plan Formulation

- Chapter 4 – Affected Environment and Environmental Consequences
- Chapter 5 – Public Involvement and Agency Coordination
- Chapter 6 – Compliance with Applicable Laws, Policies, and Plans
- Chapter 7 – List of Report Preparers
- Chapter 8 – References

2.0 NEED FOR AND OBJECTIVES OF ACTION

This chapter presents the results of the first step of the planning process: the specification of harbor problems and opportunities for improvement in the study area. It describes the underlying purpose and the need to which the lead agency is responding to under the proposed action and the alternatives, in accordance with NEPA requirements. The chapter concludes with the establishment of planning objectives, planning constraints, and other evaluation criteria, which are the basis for the formulation, evaluation, comparison, and selection of alternative plans.

2.1 Problems and Opportunities

Problems and opportunities are those conditions that can be addressed through water and related land resource management of the study area and serve as the foundation for the remainder of the planning process. Based on the broadly defined goal of improving navigational and operational efficiency of the harbor, specific navigational problems and opportunities were identified for the study area. This information was compiled as part of an iterative process, based on the results of previous studies and input from the project stakeholders. The resulting list of problems and opportunities is summarized below.

Problems

- Insufficient protection from waves causes disruption to port operations.
- The existing breakwater in its current state is unstable and puts harbor navigation and infrastructure at risk.
- Continued breakwater deterioration may allow increased wave energy in the harbor, increasing the risk of unexpected unsafe harbor conditions.
- Currents through the damaged areas of the breakwater impact small boat navigation.
- When vessel calls are cancelled because of harbor conditions, the result is an increase in food costs for Tinian residents.

Insufficient protection from waves causes disruptions to port operations. As discussed in Section 1.6 the breakwater at Tinian Harbor is severely degraded, with large portions of the inner breakwater having collapsed and much of the outer breakwater sheet pile destroyed. The resulting lack of protection from waves and currents propagating into the harbor makes the harbor unusable about 49 days out of the year, based on percentages from the years 1980-2011. This number of unusable days is expected to remain constant in Future without Project (FWOP) conditions, see Appendix 1, Section 5.2 (FWOP is synonymous to the no-action alternative.

Despite the expected constancy of unusable days, the number of vessel calls, and the amount of revenue tons being delivered to Tinian is projected to increase over the 50-year study period. Without improvements to the navigation features, the supply of goods to the island could result in a shortage to the residents. Table 2-1 shows the commodity projections compared to the estimated vessel call demand. This projection is based on expected population growth of 1.4%, drawn from U.S. Census data (see Section 3.10.4).

FWOP	**Existing Condition**	**2020**	**2050**	**2069**
Annual Commodity Projections *(average based on commodity history and population projections)*	16,371	17,257	25,707	33,174
Estimated Number of Vessel Calls	51	54	62	81

Table 2-1. Commodity and Demand Projections through the Period of Analysis

The existing breakwater in its current state is unstable and puts harbor navigation and infrastructure at risk. In the past five years, the island of Tinian has spent over $1 million on pier and structural repairs (see Economics Index 4.1.2.1.1).

Continued breakwater deterioration may increase the fluctuation in wave conditions, increasing the risk of unexpected unsafe harbor conditions. In addition, it is not uncommon for “super typhoons”, defined as a typhoon exceeding the maximum wind speed of a Category 5 cyclone (175 mph), to affect this area. Between 1945 and 2015, approximately 50 storms in the western Pacific met this criteria. Based on the wave heights and storm surge experienced in historical typhoon events in this region, if Tinian were to experience a direct hit (or near miss) by a typhoon greater than Category 3, the combination of storm surge and high waves affecting the breakwater remnants would likely destroy much or all of the remaining above-water structure.

During this or subsequent high wave events, waves would propagate unimpeded into the harbor, creating dangerous conditions in the turning basin and potentially inundating the wharf area. Such an event would cause significant damage to harbor infrastructure and landside facilities. If the harbor were to be incapacitated for an extended period of time, goods such as fuel, food, and emergency supplies would increase in cost substantially.

Presently, currents prevailing through the harbor impact small boat navigation. Fishing, which is an important component of local Chamorro (indigenous population of CNMI and Guam) culture, is impossible when harbor conditions prevent small-craft navigation. Unsafe wave and current conditions in the harbor limit the availability of days to practice subsistence and recreational fishing. If conditions in the harbor continue to decline, subsistence and recreational fishing via Tinian Harbor would also decline, ultimately eliminating the social and cultural traditions upon which this community depends.

When vessel calls are cancelled due to harbor conditions, the result is an increase in food costs for Tinian residents. The correlation between cancelled vessel calls and increased food costs in the CNMI is one-to-one (linear), meaning that an increase in cancelled vessel calls increases food costs. Likewise, a decrease in cancelled vessel calls decreases food costs. Access to essential commodities relies absolutely upon the ability for vessels to enter the harbor.

Petroleum and energy supply accounts for 47 percent of all commodities that enter the harbor. Food and beverages follow at over 16 percent. Air transportation is not possible for petroleum and energy supplies, and food transport via air is much more expensive than ocean transportation. When air transportation occurs because of adverse harbor conditions, the added expense is transferred to the consumer. This shift in mode cost is expected to grow during the 50-year study period under FWOP conditions.

Opportunities

USACE and CNMI, with input from the stakeholders, considered the following opportunities or desirable future conditions to improve upon a variety of components within and near the study area as a result of the proposed navigational improvements:

- Stabilize commodity supply on Tinian/reduce economic hardship to community.
- Reduce operational delays/missed calls and transportation costs by increasing useable days.
- Reduce vessel/infrastructure damages under typical and extreme conditions.
- Improve emergency access/harbor of refuge.
- Beneficial reuse of dredged material.
- Better prepare harbor for climate change and sea level rise.
- Reduce likelihood of catastrophic damage to port during typhoons.

By protecting the harbor from a wider range of wave and current conditions, the potential outcomes of this study can increase the number of usable days at Tinian Harbor. Calculations were based on numerical modeling to determine days of harbor closure due to wave and current conditions. Increases in usable days are noted in Table 2-2.

Alternatives	Outputs (Unusable Days)	Increase in Usable Days
No-Action Alternative	49	--
Replace Existing Breakwater in Place	45	4
Replace & Extend Breakwater	37	12

Table 2-2. Increase in Usable Days

This increase will provide for additional vessel calls at the harbor, thereby reducing the use of air transport of food and basic goods. Reducing the need for air transportation will prevent increased commodity costs and avoid petroleum shortages. This will have both short- and long-term effects on the price of goods for the community.

Increased protection from wave and current action can also reduce damages to vessels and harbor infrastructure, which have grown in recent years and required repairs costing over $1 million. Damages from typical ocean conditions would be reduced by alternatives that improve breakwater function. In the event of a catastrophic storm, there would be significant dependence on the harbor to import materials and supplies needed for post-storm recovery efforts. This study therefore has the opportunity to improve emergency access to Tinian Harbor in addition to improving typical navigation activities.

2.2 Public Scoping Comments and Resources of Concern†

Scoping for the feasibility study utilized several outreach strategies including notifying local CNMI residents and local government natural resource agencies via email, letters, and verbal communication. The USACE and CNMI conducted a planning Charrette in Honolulu February 16-18, 2016 that included USFWS, the National Oceanic and Atmospheric Administration (NOAA), CNMI regulatory agencies, and other interested parties. The USACE published a Notice of Intent (NOI) to prepare an Integrated Feasibility/Environmental Impact Statement (EIS) to the Federal Register on July 8, 2016, informing the public about the upcoming study and soliciting public comment. The CNMI posted information on their social media outlets and in their local newspapers. Additionally, the USACE and CNMI jointly hosted public meetings on Tinian and Saipan on July 19, 2016 and July 20, 2016. Issues raised by the local communities and natural resources agencies at those meetings informed the scope of the study. The PDT also included issues that commonly arise during other dredging, port facility and navigation construction projects.

2.3 Planning Goal/Objectives

In general, the federal objective is not specific enough to guide the plan formulation process, rather it was considered as an overarching goal. As such, a set of focused planning objectives was developed specifically for this project. Planning objectives represent desired positive changes from the FWOP conditions and should be defined based upon the problems and opportunities identified for the study area.

The planning objectives for the Tinian Harbor Project are to:

- Improve navigation and operational efficiency.
- Reduce damages to moored vessels, pier infrastructure, and associated mooring equipment.
- Improve safe use of the harbor by small vessels.

2.4 Planning Constraints

Constraints are restrictions that limit the planning process and should be considered as part of study development. These can include resource constraints, such as limitations on schedule, budget, and/or technical knowledge, and legal constraints, such as limitations in USACE policy, as well as study-specific constraints identified by the PDT and stakeholders.

The following study-specific constraints were identified prior to developing the alternative plans for the study:

- Avoid or minimize impacts to threatened or endangered coral species identified within the study area.
- Dispose of dredged materials in accordance with all federal, state, and local regulations.
- Avoid or minimize adverse impact to water quality within the harbor.
- Avoid creating secondary adverse impacts to waves/currents in the channel/wharf areas.
- Avoid or minimize effects to adjacent shorelines.

The State of Hawaii along with CNMI, American Samoa, Guam, and other U.S. possessions in the western Pacific region, are home to abundant coral resources. Coral reefs provide a plethora of benefits to the human environment including protecting coastlines from waves and storm surge, supporting fisheries, fostering biodiversity, providing sources of sand for beaches and rock for construction, attracting people for tourism and recreation, supplying source for medicine, and are integral to island traditions, economies, and cultures. Avoiding and minimizing impacts to corals, especially threatened and endangered coral species in the study area are specific restraints of the study.

In January 2017, the USFWS produced a Draft Phase 1 Marine Habitat Characterization Planning Aid Report (PAR) for the study area. This investigation included a Phase I qualitative assessment of fish and wildlife resources within the study area, an evaluation of potential impacts associated with the proposed project components, and recommendations for fish and wildlife mitigation measures.

At the time of the USFWS survey, the proposed work for Tinian Harbor modification did not have alternatives developed; therefore, specific alternatives were not evaluated. Instead, the USACE provided a combined set of footprints for the potential areas where alternatives may be developed. The USFWS evaluated five areas within the study area as a whole and made general recommendations for each (see PAR, Appendix 2).

Dredge materials may contain contaminants that may adversely impact biological and water resources in the harbor. Construction of modification structures may change and/or amplify waves/currents in the channel/wharf areas that may cause damage to the wharf, ships, and adjacent shorelines. These constraints are evaluated and taken into consideration in developing project alternative plans.

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3.0 PLAN FORMULATION

Applying the six-step planning process described in the USACE PGN (ER-1105-2-100), plan formulation involves development and evaluation of alternative plans to address specific planning objectives. This chapter summarizes the specific plan formulation process that was conducted for the study.

3.1 Plan Formulation Strategy

Given the multiple layers of complexity and geographic remoteness of the study area, the PDT developed a strategy to guide the plan formulation process. The plan formulation strategy incorporated a methodical approach to assembling navigational management measures into alternative plans, and a multi-criteria screening process based upon existing data and available information, coordinated professional judgment, and risk-informed assumptions. Figure 3-1, Plan Formulation Approach shows the overall structure and results of the formulation process. In general, the process involved an initial grouping of conceptual navigational risk management measures based on the identified problems that were then used to compile alternative plans, narrowing the focus from broad navigational risk management concepts to a combination of site specific actions that best met the overall planning objectives/constraints. The nomenclature for the alternatives was modified over the course of this process to reflect refinements made to each alternative (e.g., after the preliminary array of alternatives were screened, final array of alternatives were renamed for simplicity). Details regarding the approach and outcome of the plan formulation process are provided in the subsequent sections.

3.2 Management Measures

In response to the identified problems and opportunities, a broad array of potential navigational risk management measures was compiled. Specifically, this included conceptual structural and non-structural measures each of which represent a different approach to navigational risk management.

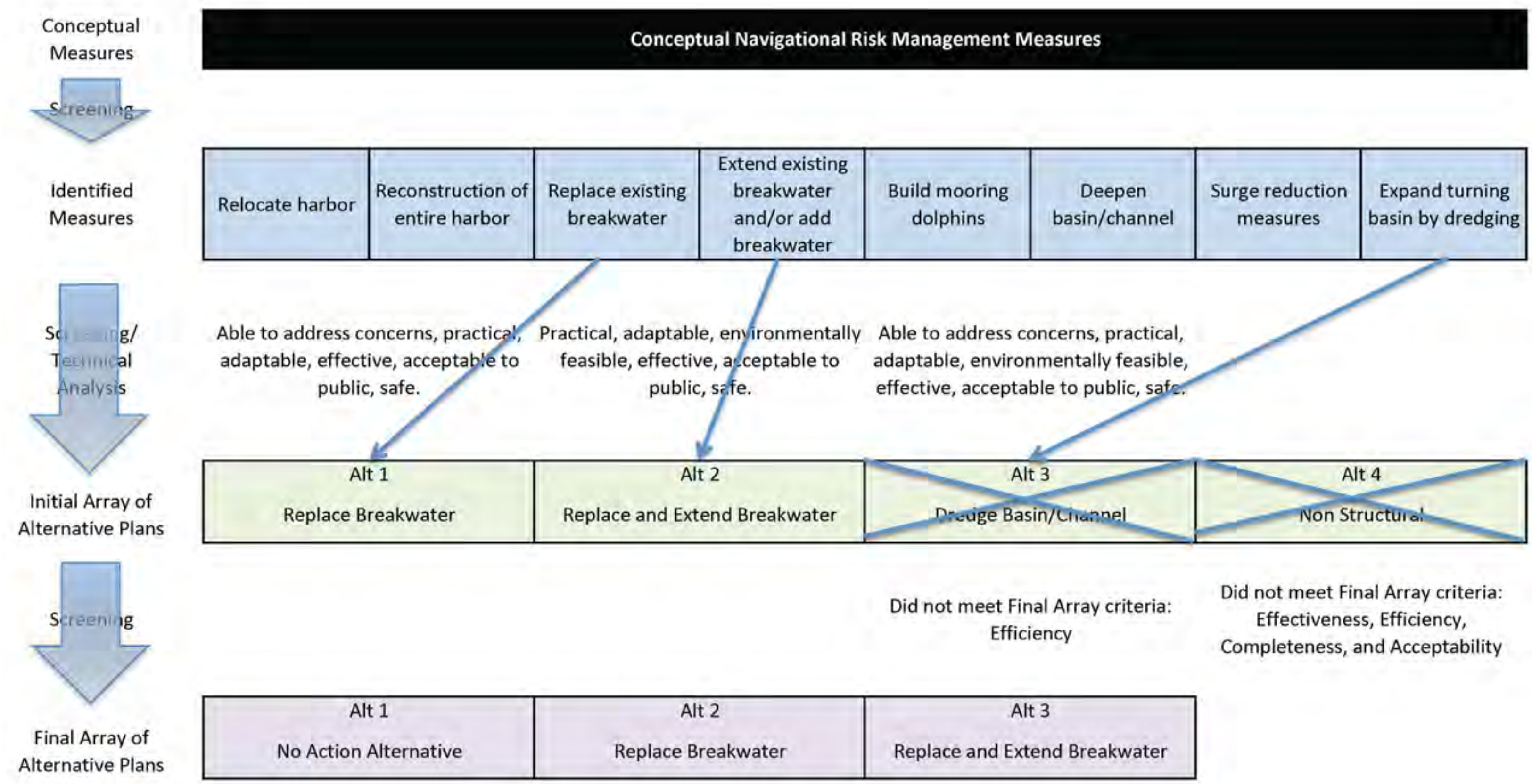
3.2.1 Preliminary List of Non-Structural Measures

Consistent with USACE policies and regulations which require equal consideration of structural and non- structural solutions, non-structural measures were formulated. In general, navigational risk management is based on a combination of probability and consequence. Non-structural measures focus on reducing the consequence of navigational impacts by modifying the characteristics of development in the proposed project area and the behavior of people living in the proposed project area (as opposed to modifying the characteristics of wave and current action). That is, they change the use of the surrounding area or accommodate existing uses of the harbor, without changing the extent and nature of the wave and current actions themselves. Non-structural solutions were considered both as a stand-alone non-structural plan, as well as in combination with structural solutions; these efforts are discussed further throughout the remainder of Section 3. A detailed description of the methods and results of the non-structural formulation process is provided in Appendix 3.

Table 3-1 lists the non-structural management measures that were considered by the PDT, and the planning objective each measure is intended to address.

	Objective(s) to be addressed by this measure		
Non-Structural Measures	Improve navigation & operational efficiency	Reduce damages to moored vessels/ equipment & pier infrastructure	Improve safety for small vessels
Moor vessels off shore and lighter cargo		x	
Use smaller vessels, more frequent trips	x		
Facilitate better surge forecasting	x		x
Add bollards		x	
Reinforce bollards		x	
Optimize operations	x		
Require harbor pilots		x	
Relocate/modify aids to navigation	x		
Close port and times of high surge		x	x
Allow 24-hour operations			
Use more tug assistance	x		
Add more accurate GPS technology in the harbor and lobby NOAA to install PORTS	x		x
Add vessels similar to MV Luta	x		
Moor vessels either offshore or deeper areas of the harbor during high wave conditions		x	
Use counterweights on vessels to dampen surge while moored		x	

Table 3-1. Non-structural Management Measures



U.S. Army Corps of Engineers
Honolulu District
Fort Shafter, Hawaii

PROJECT NAME:

Interim Feasibility Report
Tinian Harbor Modification Study
Island of Tinian
Commonwealth of the Northern Mariana Islands

FIGURE TITLE:

Plan Formulation Approach

FIGURE NUMBER:

3-1

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3.2.2 Preliminary List of Structural Measures

A preliminary array of structural alternatives which are intended to physically dissipate wave action and associated currents was generated. Table 3-2 lists the structural management measures that were considered by the PDT, and the planning objective each measure is intended to address.

Structural Measures	Objective(s) to be addressed by this measure		
	Improve navigation & operational efficiency	Reduce damages to moored vessels/ equipment & pier infrastructure	Improve safety for small vessels
Relocate harbor	x	x	x
Reconstruct entire harbor	x	x	x
Replace existing breakwater in place	x	x	X
Extend length of existing breakwater and/or add breakwater to other side of entrance	x	x	X
Build mooring dolphins		x	
Deepen basin/channel	x		
Dredge basin/channel to original depth	x		
Install surge reduction structures (wave attenuator, new breakwater, baffles, etc.)	x	x	X
Dredge and expand turning basing	x		

Table 3-2. Structural Management Measures

3.3 Screening Criteria

An increasing level of detail was used at each stage of the alternatives formulation process, as needed, to develop and refine the conceptual management measures and alternative plans, and ultimately, to provide the basis for evaluation and comparison of the final array of alternatives.

Per the USACE PGN (ER 1105-2-100), the following comprehensive set of screening criteria was developed in order to screen the initial list of non-structural and structural measures:

- Affordability – based on judgment of PDT members, would the cost of implementing the measure be so excessive that it would most likely exceed the anticipated benefits to be gained? (Yes/No)
- Completeness – Does the measure require other measures or actions to be viable? (Yes/No)

- Constructability – Given the constraints of the study area and realistic expectations of what is appropriate and reasonable, is this measure practical? (Yes/No)
- Adaptability – Can this measure be adapted if new information becomes available or conditions change? (Yes/No)
- Environmental – Is this measure environmentally feasible, based on existing knowledge of what impacts may be? (Yes/No)
- Effectiveness – Will this measure address at least one of the objectives and/or solve (or at least improve) a problem identified? (Yes/No)
- Social Effects – Based on existing knowledge of the area, will the measure be acceptable to the public? (Yes/No)
- Safety – Is the measure safe? (Yes/No)

3.4 Screening of Initial Measures

Screening of measures adhered to the following general hierarchy: 1. Remove any measure that did not meet the 'Effective' criterion, and 2. Remove any measure not meeting two or more criteria (other than affordability). Results of the screening of initial measures is provided in Tables 3-3, Non-Structural Measures and 3-4, Structural Measures. The far-right column of each table indicates whether the measure was retained or removed from further consideration. The final list of retained measures following the screening is provided in Section 3.8.

Non-Structural Measures

A number of non-structural options were considered when formulating alternatives, particularly during the study charrette held at the beginning of the planning process. The results are presented in Table 3-3 below. The three remaining non-structural measures were: 1) close ports at time of high surge, 2) add vessels similar to MV Luta, and 3) moor vessels offshore or deeper areas of the harbor during high wave conditions. These measures are described and further evaluated in Section 3.5.

Structural Measures

As a result of the initial screening (Table 3-4), only two structural measures remained: 1. Repair existing breakwater in place, and 2. Extend length of breakwater and/or add breakwater to other side of entrance. Further description of these alternatives is provided in Section 3.5, below. The second structural measure is further evaluated as two separate alternatives, extend length of existing breakwater and add additional breakwater to other side of the entrance.

Non-Structural Measures	Criteria Used to Screen Management Measures								
	Affordability	Completeness	Constructability	Adaptability	Environmental	Effectiveness	Social Effects	Safety	Keep ✓ Remove ✗
Moor vessels offshore and lighter cargo						X	X		✗
Use smaller vessels, more frequent trips	X					X			✗
Facilitate better surge forecasting						X			✗
Add bollards						X			✗
Reinforce bollards						X			✗
Optimize operations						X			✗
Require harbor pilots	X					X			✗
Relocate/modify aids to navigation						X			✗
Close port at times of high surge							X		✓
Allow 24-hour operations	X						X	X	✗
Use more tug assistance	X					X			✗
Add more accurate GPS technology in the harbor and lobby NOAA to install PORTS	X		X				X		✗
Add vessels similar to MV Luta	X								✓
Moor vessels either offshore or deeper areas of the harbor during high wave conditions							X		✓
Use counterweights on vessels to dampen surge while moored						X			✗

Table 3-3. Results of Initial Screening of Non-structural measures (X indicates measure does not meet criteria)

Structural Measures	Criteria Used to Screen Management Measures								
	Affordability	Completeness	Constructability	Adaptability	Environmental	Effectiveness	Social Effects	Safety	Keep ✓ Remove ✗
Relocate harbor	X		X		X		X		✗
Reconstruction of entire harbor	X		X		X				✗
Repair existing breakwater in place					X				✓
Extend length of existing breakwater and/or add breakwater to other side of entrance	X				X				✓
Build mooring dolphins						X		X	✗
Deepen basin/channel				X	X	X			✗
Dredge basin/channel to original depth					X	X			✗
Surge Reduction structures (wave attenuator, baffles, etc.)					X	X			✗
Expand turning basin by dredging					X	X			✗

Table 3-4. Results of Initial Screening of Structural Measures (X indicates measure does not meet criteria)

3.5 Initial Array of Alternative Plans

The following initial array of alternatives was presented to the vertical team at the Alternatives Milestone (AM), reflecting all measures retained after the initial screening:

3.5.1 AM No-Action Alternative

The "no-action" plan proposes no action to address the identified study problems. The Harbor structures, infrastructure and operations would continue to be at risk for damage by current and future climate change. Such unmitigated conditions would result in harbor closures, operational challenges, unsafe conditions for small boats, damage to existing and future infrastructure, and continued economic and social hardship for the residents of Tinian.

3.5.2 AM Alternative 1, Non Structural

NS-1: Close port at times of high surge

Objectives met: Reduce damages to moored vessels, pier infrastructure and associated mooring equipment, improve safe use of the harbor by small vessels

The non-structural measure of modifying operations to close the port at times of high waves and surge was suggested as a potential solution to reduce vessel and infrastructure damages, and to improve safety for large and small vessels. It was noted by the CPA that this measure is already implemented under current operations whereby the harbor is closed when conditions offshore exceed approximately six foot wave height. In addition, it is the discretion of harbor pilots and the U.S. Coast Guard (USCG) to determine if large/small vessels can safely navigate the channel when the harbor is open; therefore, there should be no vessels entering the harbor if safety of the vessels or passengers is at risk.

NS-3: Moor vessels either offshore or in deeper areas of the harbor during high surge

Objectives met: Reduce damages to moored vessels, pier infrastructure and associated mooring equipment, improve safe use of the harbor by small vessels

The non-structural measure of mooring large vessels either offshore, or in deeper areas of the harbor (away from the wharf and finger piers) during high wave conditions in order to reduce vessel and infrastructure damage and reduce perceived risks to vessel and passenger safety was considered.

3.5.3 AM Alternative 2, Non-Structural

NS-2: Add vessels similar to MV Luta

Objectives met: Improve navigation and operational efficiency, improve safe use of the harbor by small vessels

The MV Luta is a general cargo vessel measuring approximately 155 feet in length, with an 8.2 foot draft. The vessel was used in 2016 to deliver cargo throughout CNMI and included calls at Tinian Harbor. According to anecdotal reports by the CPA, the MV Luta was able to operate in “advisory” wave conditions of 4 to 6 feet and safely deliver cargo during conditions inaccessible to a tug and barge. However, the MV Luta has a smaller cargo capacity than a barge, consequently requiring more trips to deliver an equivalent volume of cargo, thereby increasing transportation costs. In addition, the MV Luta is no longer in service in the CNMI, and it would be the responsibility of the CPA to acquire or lease a vessel with similar capability, or to return the MV Luta into service.

3.5.4 AM Alternative 3, Structural

S-1: Repair existing breakwater in place

Objectives met: Improve navigation and operational efficiency, reduce damages to moored vessels, pier infrastructure, and associated mooring equipment, improve safe use of the harbor by small vessels

This structural alternative proposes replacement of the existing breakwater in place with additional structural stability to attenuate wave energy and protect the harbor and restore structural integrity to the dilapidated breakwater. Such repairs would address all three planning objectives. Figures 3-2, 3-3, and 3-4 depict the proposed conceptual layout of the structure, as well as typical cross-sections of the structure.

3.5.5 AM Alternative 4A, Structural

S-2: Replace and extend length of existing breakwater

Objectives met: Improve navigation and operational efficiency, reduce damages to moored vessels, pier infrastructure, and associated mooring equipment, improve safe use of the harbor by small vessels

This alternative proposes, in addition to AM Alternative 3, construction of an approximately 300 foot extension to the seaward end of the Main Breakwater, increasing the total length to approximately 4,900 feet This alternative would meet all project objectives. Figures 3-5, and 3-6 depict the proposed conceptual layout of the structure, as well as typical cross-section of the structure.

3.5.6 AM Alternative 4B, Structural

S-4B: Replace existing breakwater in place and add breakwater to other side of Harbor entrance

Objectives met: Improve navigation and operational efficiency, reduce damages to moored vessels, pier infrastructure, and associated mooring equipment, improve safe use of the harbor by small vessels

This alternative proposes, in addition to Structural Alternative 1, the construction of an additional breakwater on the east side of the existing entrance channel (Figure 3-7). This alternative would be built on the shallow reef flat that currently exists along the shoreline east of the harbor, with a cross-section similar to that shown in Figure 3-3 depicting the Northern Breakwater. The intent of this alternative is to reduce the width of the opening to the harbor, thereby reducing the wave energy entering the harbor area.

3.5.7 AM Alternative 5, Combination Non-Structural/Structural

NS-2: Add vessels similar to MV Luta (able to operate in small craft advisory)

S-1: Repair existing breakwater in place

Objectives met: Improve navigation and operational efficiency, reduce damages to moored vessels, pier infrastructure, and associated mooring equipment, improve safe use of the harbor by small vessels

This alternative combines Non-Structural Alternative 2 and Structural Alternative 1 to add vessels similar to MV Luta that exceed traditional tug-and-barge operations in the harbor under rough conditions and replace the existing breakwater in place to restore its structural integrity.

3.5.8 AM Alternative 6, Structural

S-4: Deepen basin/channel

Objectives met: Improve navigation and operational efficiency, improve safe use of the harbor by small vessels

During the planning charrette, interest in deepening the entrance channel and turning basin was expressed by the non-federal sponsor as a means to meet the project objectives. The estimated original dredge depths are 30 feet below MLLW in the entrance channel, and 28 to 30 feet below MLLW in the turning basin and wharf area.

3.6 Evaluation of Alternative Plans Presented at the AM Meeting

To further refine the initial array of AM alternatives, the following criteria were utilized.

Effectiveness:

- Wave/Current Reduction
- Reduce Damages
- Safety

Efficiency (Cost Effectiveness):

- Net Benefits
- Construction Cost

U.S. Army Corps of Engineers Honolulu District Fort Shafter, Hawaii	PROJECT NAME: Interim Feasibility Report Tinian Harbor Modification Study Island of Tinian Commonwealth of the Northern Mariana Islands	FIGURE TITLE: Conceptual Layout: Replace Existing Breakwater FIGURE NUMBER: 3-2

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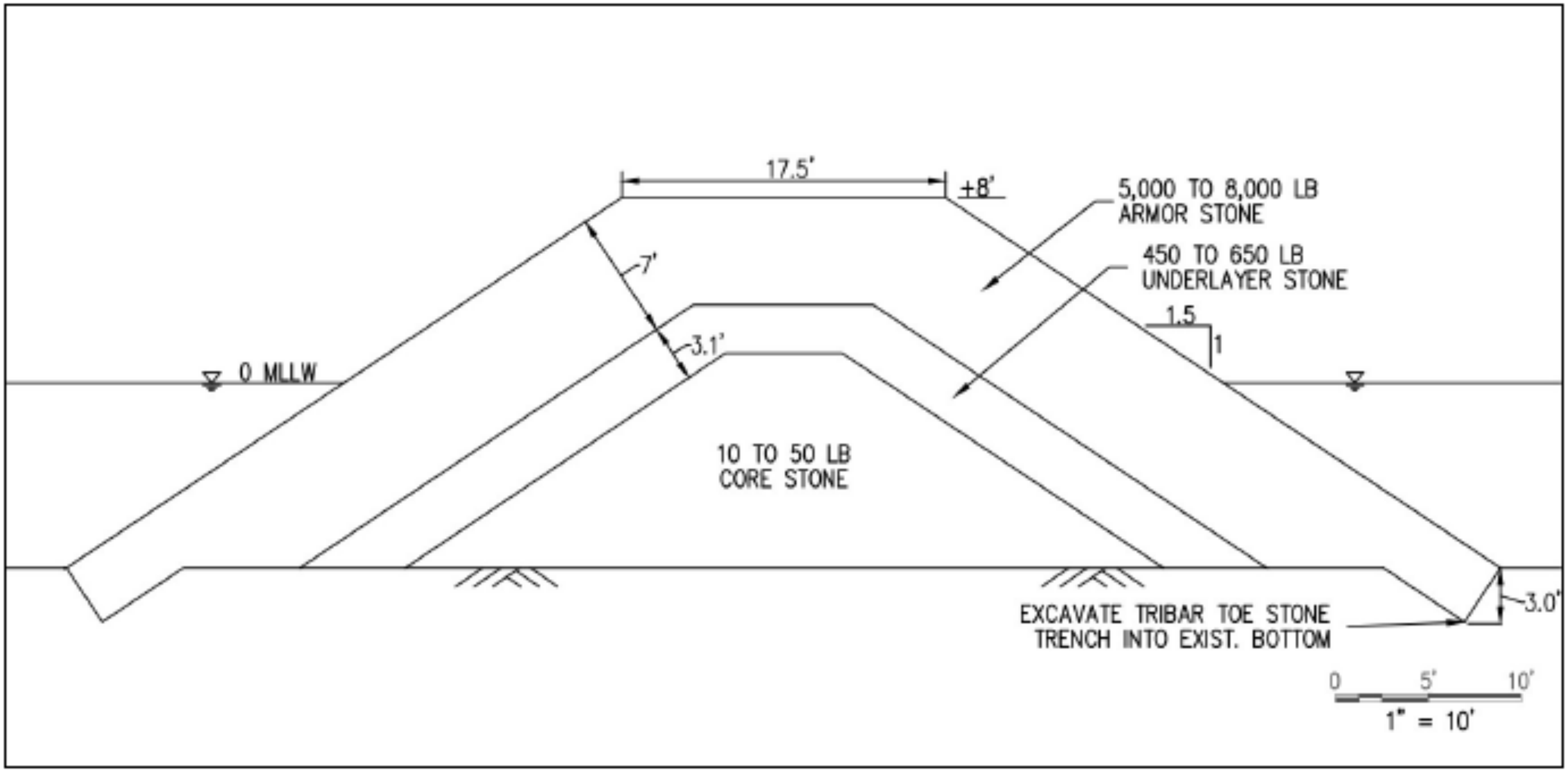

U.S. Army Corps of Engineers
Honolulu District
Fort Shafter, Hawaii

PROJECT NAME:

Feasibility Report
Tinian Harbor Modification Study
Island of Tinian
Commonwealth of the Northern Mariana Islands

FIGURE TITLE:

Typical Cross-section:
Replace Existing Breakwater (Sta 0+00 to 11+00)

FIGURE NUMBER:

3-3

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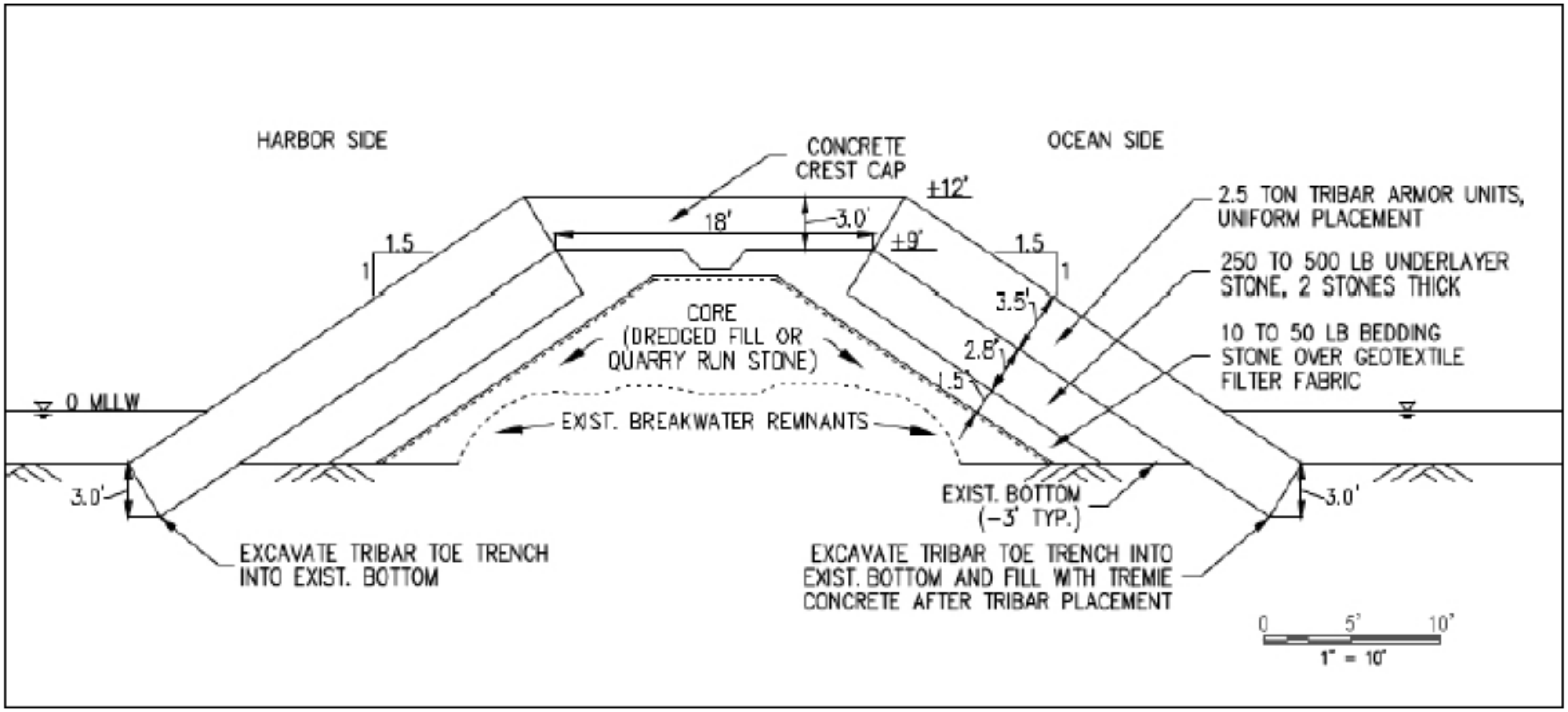

U.S. Army Corps of Engineers Honolulu District Fort Shafter, Hawaii	PROJECT NAME: Interim Feasibility Report Tinian Harbor Modification Study Island of Tinian Commonwealth of the Northern Mariana Islands	FIGURE TITLE: Typical Cross-section: Replace Existing Breakwater (Sta 11+00 to 46 +00) FIGURE NUMBER: 3-4

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U.S. Army Corps of Engineers Honolulu District Fort Shafter, Hawaii	PROJECT NAME: Interim Feasibility Report Tinian Harbor Modification Study Island of Tinian Commonwealth of the Northern Mariana Islands	FIGURE TITLE: Conceptual Layout: Replace and Extend Breakwater FIGURE NUMBER: 3-5

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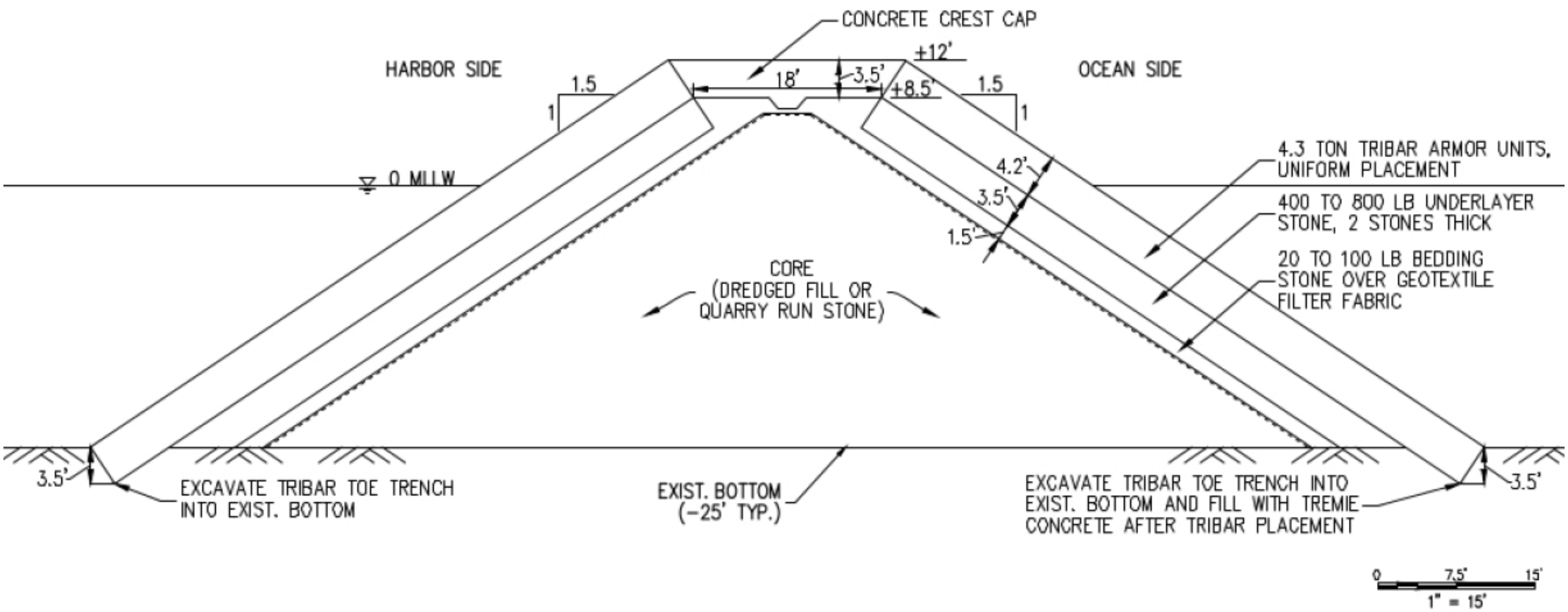

U.S. Army Corps of Engineers Honolulu District Fort Shafter, Hawaii	PROJECT NAME: Interim Feasibility Report Tinian Harbor Modification Study Island of Tinian Commonwealth of the Northern Mariana Islands	FIGURE TITLE: Typical Cross-section: Breakwater Extension FIGURE NUMBER: 3-6

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U.S. Army Corps of Engineers
Honolulu District
Fort Shafter, Hawaii

PROJECT NAME:

Interim Feasibility Report
Tinian Harbor Modification Study
Island of Tinian
Commonwealth of the Northern Mariana Islands

FIGURE TITLE:

Conceptual Layout:
Rebuild Existing Breakwater and
Add New Breakwater

FIGURE NUMBER:

3-7

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- O&M Requirements

Completeness:

- Under jurisdiction of USACE (How much reliance on other parties to implement?)
- Real Estate

Acceptability:

- Environmental Factors
- Social Effects

3.7 Screening of the AM Alternatives

Based on the reformulation and refinement criteria described above, the PDT reviewed each alternative within the context of the plan formulation strategy and overall planning objectives. Note that mitigation requirements for environmental impacts were qualitatively estimated and considered as part of the screening process. These efforts are further described in the following subsections. The results of the screening of the alternatives presented at the AM against the criteria identified in the preceding section are summarized in Table 3-5, below.

Criteria:	No Action	Alt. 1 (NS)	Alt. 2 (NS)	Alt. 3 (S)	Alt. 4A/B (S)	Alt. 5 (S)	Alt. 6 (S)	P&G Eval Criteria
1. Wave/Current Reduction	LOW	LOW	LOW	MEDIUM	HIGH	MEDIUM	LOW	Effective
2. Reduce Damages	LOW	MEDIUM	MEDIUM	HIGH	HIGH	HIGH	MEDIUM	
3. Safety	LOW	HIGH	MEDIUM	MEDIUM	HIGH	HIGH	MEDIUM	
4. Net Benefits	LOW	LOW	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	Efficient (Cost Effective)
5. Const. Cost	HIGH	HIGH	HIGH	MEDIUM	LOW	LOW	LOW	
6. O&M Requirements	HIGH	HIGH	HIGH	LOW	LOW	LOW	LOW	
7. Under USACE Control	N/A	LOW	LOW	HIGH	HIGH	MEDIUM	HIGH	Complete
8. Real Estate	HIGH	HIGH	HIGH	MEDIUM	MEDIUM	MEDIUM	MEDIUM	
9. Environmental	HIGH	HIGH	HIGH	MEDIUM	LOW	LOW	LOW	Acceptable
10. Social Effects	MEDIUM	LOW	MEDIUM	HIGH	HIGH	HIGH	HIGH	

Table 3-5. Preliminary Comparison of AM Alternatives

The following alternatives were eliminated from further consideration:

Elimination of AM Alternative 1

The non-structural measure of modifying operations to close the port at times of high waves and surge was suggested as a potential solution to reduce vessel and infrastructure damages. It was noted by the CPA that this measure is already implemented under current operations whereby the harbor is closed when conditions offshore exceed approximately 6 feet in wave height. Therefore, the risk of vessel damages is eliminated, and infrastructure damage would be unchanged except for reduction in damage to bollards/cleats since no vessels would be moored. In addition, it is the discretion of harbor pilots to determine if vessels can safely navigate the channel when the harbor is open; therefore, there should be no vessels entering the harbor if safety of the vessels or passengers is at risk. In consideration of the preceding items, this non-structural measure was eliminated from further evaluation under this study based on Effectiveness and Completeness.

Elimination of AM Alternative 2

The consideration of this alternative to replace tug and barge operations with the MV Luta or similar vessel involved discussions with the CPA and the U.S. Coast Guard (USCG). Replacement of all tug and barge operations with a vessel such as MV Luta or one that is similar would not be feasible and therefore would not meet the objective to improve operational efficiencies. However, this measure could augment the traditional delivery of cargo by tug-and-barge method during times of the year when the wave conditions are rough. Augmenting current operations with a vessel that can withstand rough seas to ensure unimpeded cargo transport has been suggested to the CPA, understanding that the decision to implement such a measure is a non-federal responsibility. In consideration of the preceding items, this non-structural alternative was removed from further evaluation under this study, based on the criteria Effectiveness and Completeness.

Elimination of AM Alternative 3

The non-structural measure of mooring large vessels either offshore, or in deeper areas of the harbor (away from the wharf and finger piers) during high wave conditions was included as a potential change to operations that could reduce vessel and infrastructure damage, and reduce perceived risks to vessel and passenger safety when transiting the channel under moderate wave conditions. Per CPA closure of the harbor when offshore wave heights exceed 6 feet, large vessels would not transit to Tinian Harbor in these conditions and would choose to omit delivery. Therefore, the risk of large vessel damages is eliminated, and infrastructure damage would be unchanged except for reduction in damage to bollards/cleats since no vessels would be moored. In addition, it is the discretion of harbor pilots to determine if vessels can safely navigate the channel when the harbor is open; therefore, there should be no vessels entering the harbor if safety of the vessels or passengers is at risk. Small vessels would not be operating in these conditions. In consideration of the preceding items, this non-structural alternative was removed from further evaluation under this study, based on the criteria Effectiveness and Completeness.

Elimination of AM Alternative 4B

The proposed replacement of the existing breakwater in place with the addition of another breakwater on the east side of the existing entrance channel was considered against the refinement criteria. Preliminary wave modeling indicated that this additional structure would not provide wave sheltering or a reduction in wave energy affecting the channel, turning basin, berthing areas, or wharf as anticipated. It also would not affect currents within the harbor. In addition, preliminary benthic surveys indicated significant environmental resources in this previously unimpacted area. In consideration of the preceding items, this non-structural alternative was removed from further evaluation under this study, based on the criteria Effectiveness and Acceptability.

Elimination of AM Alternative 5

This alternative proposed to combine both non-structural and structural measures to meet the project objectives. However, NS-2 was eliminated from further evaluation under this study based on the criteria Effectiveness and Completeness. Accordingly, for these same reasons, AM Alternative 5 was eliminated.

Elimination of AM Alternative 6

During the planning charrette, interest in deepening areas within the harbor limits was expressed by the non-federal sponsor. Tinian Harbor is not currently a federally-maintained harbor. Accordingly, limited documentation of the original construction and design depths is available.

During the course of the study, the CPA acquired a bathymetric survey of the harbor using multi-beam hydrosurvey methods. According to the October 2016 survey the majority of the channel and turning basin is at 30 feet MLLW or deeper (see Figure 3-8). There is an area within the established entrance channel limits along the eastern end of the wharf and the East Quay area exhibiting shallower depths of up to 13 feet below MLLW. Due to the orientation of the channel and location of the active berthing areas, this area is not presently used by large vessels approaching the wharf and accordingly does not pose a safety hazard to navigation.

Further discussion with the sponsor and stakeholders regarding current operational procedures as well as the existing and future vessel fleet indicated that existing depths within the channel and turning basin, in addition to the present channel width and turning basin radius, are sufficient for current and future harbor users. Dredging and/or deepening of the channel and turning basin was eliminated from further evaluation under this study based on the criteria Effectiveness. Additional detail regarding the existing/future vessel fleet can be found in the Economics Appendix.

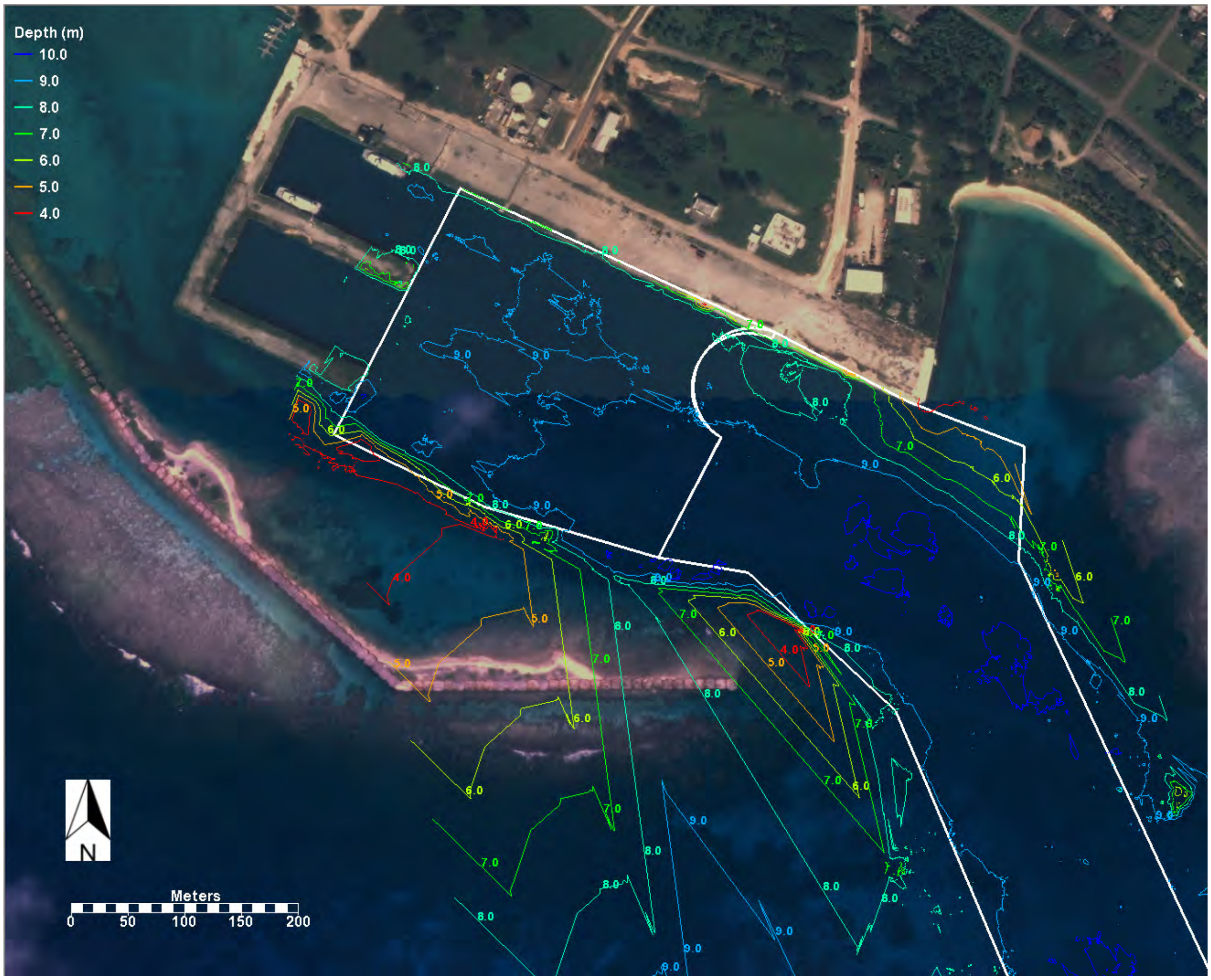

Figure 3-8 October 2016 Multibeam Hydrosurvey of Tinian Harbor Channel and Turning Basin

3.8 Final Array of Alternatives

Based on the evaluation of the reformulation and refinement screening criteria, only AM Alternatives 3 and 4A were carried forward to the final array. For clarity, the final array of alternatives were renumbered, and these three alternatives are described in detail below.

3.8.1 Alternative 1: No-Action Alternative

Environmental analysis of the No-Action Alternative is required by the CEQ NEPA implementation regulations to serve as a benchmark against which the Proposed Action can be evaluated. Under the No-Action Alternative (also known as, FWOP), the proposed modification project at Tinian Harbor would not be implemented. Under this scenario, the breakwater would continue to deteriorate, allowing increasing amounts of wave energy into the harbor, and potentially increasing currents inside the harbor. If the harbor were affected by a tsunami or typhoon that approaches near, or makes landfall on Tinian, the existing sheetpile could be damaged such that the only remaining portion of the structure is below water. This alternative would result in continued (and increasing) adverse wave and current conditions in the small boat navigation route, turning basin, and along the wharf during moderate wave events. In the future, these conditions may be exacerbated by sea level rise contributing to larger waves breaking across the reef and stronger current velocities into the harbor under higher water levels, as well as more frequent overtopping of unprotected landside infrastructure.

Should these concerns persist unmitigated, USACE anticipates continued weather-induced harbor closures, operational challenges and inefficiencies, unsafe navigation for small boats, damage to existing and future infrastructure, and potential closure of the port entirely. This would be costly to the island economy and community, as the vast majority of commodities upon which Tinian depends comes through this seaport, and would instead need to be transported by aircraft or other method. It would also limit travel dependent upon the harbor for ingress/egress and the feasibility and facilitation of future developments (i.e. casinos, hotels, construction) on Tinian. Continued deterioration of existing structures and damage to landside structures and infrastructure could cause releases, leaks, spills and pollution of the marine environment. In addition, structural pieces could dislodge, become mobilized by waves and currents and cause further physical damage to the surrounding marine and human environment.

CEQ regulations require analysis of No-Action Alternative to address any environmental consequences that may occur if the Proposed Action is not implemented, therefore, this alternative will be carried forward for further analysis in this report.

3.8.2 Alternative 2: Replace Existing Breakwater in Place (formerly AM Alternative 3, Structural)

Alternative 2 involves removal of the existing approximately 4,600 foot long cellular sheet pile breakwater, including debris, sand/silt/coral rubble, vegetation, and steel sheet piles, down to the approximate 3 foot elevation contour relative to Mean Lower Low Water (MLLW). Some of the in situ material (e.g. coral rubble) could either remain in place or be reused for the core of the new breakwater structure; however, the majority will be disposed of at a disposal site located either on Tinian or shipped to Saipan.

The new breakwater would be rebuilt along the existing structure alignment, but with varying cross-sectional area composed of either stone, or stone and concrete armor units. Figure 3-2 shows the alignment of the existing structure, as well as the conceptual footprint (not to scale) of the replacement structure. The breakwater is comprised of the Northwest Breakwater and the Main Breakwater. The Northwest Breakwater includes the section of the structure tying into land and extending approximately 1,100 feet. This section would require a smaller cross-section due to less wave exposure and can be built with a stone armor layer and underlayer. A typical cross-section for this reach is shown in Figure 3-3. The oceanside and harborside toe of the structure would be keyed into hard benthic foundation material. Existing depths in this area range from approximately 1.5 to 10.5 feet below MSL. This section would be approximately 60 feet wide and 14 feet in total height on average, with an elevation 8 feet above MLLW.

The Main Breakwater includes the remaining 3,500 feet of breakwater. This section would consist of a more robust cross-section in order to withstand head-on exposure to larger waves including those from typhoon events. A typical cross-section for this reach is shown in Figure 3-4. The Main Breakwater replacement would follow the alignment of the existing breakwater and would utilize the remnants of the existing breakwater as a portion of the core. Remnants extending above 3 feet MLLW elevation would be removed so as to not protrude into the new breakwater stone layers. A new core would be constructed around the remnants, using dredged material, quarry run stone, or other suitable material. Successive layers would be placed over the core material, consisting of a geotextile filter fabric, a 1.5 foot thick bedding layer of 10 to 50 pound stone, a two-stone thick underlayer of 250 to 500 pound stone, and a 2.5 ton tribar (or 1.8 ton Core-Loc) armor layer. A cast-in-place concrete crest cap would be used to stabilize the crest. A rubble-mound structure constructed of armor stone was considered; however, preliminary calculations indicated that this would require stone sizes of approximately 14 to 20 tons to remain stable under extreme wave conditions. This size stone is not available within the CNMI or Guam. The oceanside and harborside toe of the structure would be keyed into hard benthic foundation material and further stabilized with tremie concrete. This section would be approximately 65 feet wide and 15 feet in total height, with an elevation 12 feet above MLLW.

Alternative 2 would meet all project objectives, improve navigation and operational efficiency, reduce damages to moored vessels, pier infrastructure, and associated mooring equipment and improve safe use of the harbor by small vessels.

3.8.3 Alternative 3: Replace and Extend Existing Breakwater (formerly AM Alternative 4A, Structural)

This alternative proposes, in addition to Alternative 2, construction of an approximately 300 foot extension to the seaward end of the Main Breakwater, increasing the total length to approximately 4,900 feet. Figure 3-5 shows the alignment of the existing structure, the conceptual footprint of the replaced structure and the proposed breakwater extension. The length of the extension will be optimized based on costs relative to reduction in wave energy within the harbor. The 300 foot length depicts the maximum proposed extension due to both the location of the entrance channel and the depth contours near the end of the existing breakwater alignment. The foundation of the extended breakwater would be sited in depths ranging from 10 to 25 feet below MLLW. The breakwater extension design emulates the Main Breakwater replacement design, yet requires heavier materials and a considerably wider footprint necessary to accommodate the deeper foundation depths. A typical cross-section of the extension to the breakwater is shown in Figure 3-6.

A new core would be constructed, using salvaged breakwater material, quarry run stone, or other suitable material. Successive layers would be placed over the core material, consisting of a geotextile filter fabric, a 1.5-ft. thick bedding layer of 10 to 50 pound stone, a two-stone thick underlayer of 400 to 800 pound stone, and a 4.3-ton tribar armor layer tribar (or 3.2-ton Core-Loc). A cast-in-place concrete crest cap would be used to stabilize the crest. The oceanside and harborside toe of the structure will be keyed into hard benthic foundation material and further stabilized with tremie concrete. The section will be approximately 130 feet wide and 22 to 40 feet in total height, with an elevation 12 feet above MLLW datum.

Alternative 3 would meet all project objectives, improve navigation and operational efficiency, reduce damages to moored vessels, pier infrastructure, and associated mooring equipment and improve safe use of the harbor by small vessels.

3.9 Evaluation and Comparison of the Final Array of Alternative Plans†

Based on the principles of the SMART planning process and evaluation against screening criteria, the PDT determined that the alternative plans in the final array provided a reasonable basis for evaluation and comparison. Further evaluation of the alternative plans requires detailed engineering, economic and environmental analyses and refinements.

The USACE planning process incorporates four accounts to facilitate the display and comparison of the beneficial and adverse effects of each alternative plan. The mode of analysis, commonly referred to as the “System of Accounts,” displays the positive and negative effects of broad categories of impacts in a tabular format. The accounts include those that relate to contributions to NED, Environmental Quality (EQ), Regional Economic Development (RED), and OSE. As previously described, the NED account displays changes in the economic value of the national output of goods and services. The EQ account displays the beneficial and adverse effects of the plans on ecological, cultural, and aesthetic resources. The RED account displays changes in the distribution of regional economic activity (e.g., income and employment). The OSE account displays plan effects on social aspects such as community impacts, health and safety, and recreational opportunities.

To further refine the final array of alternatives, a variety of engineering technical analyses were also conducted. This effort incorporated numerical wave and current models to evaluate navigation/operational efficiency (i.e., useable days) in conjunction with environmental analyses (i.e., Habitat Equivalency Analysis (HEA) modeling to determine the need and extent of coral mitigation) and additional NED analysis to provide a thorough review of the cost and benefit to the nation. The engineering analysis is present in Appendix 3.

System of Accounts

Table 3-6 presents the evaluation and comparison of the final array of alternatives based on the System of Accounts, as well as other plan evaluation factors, including contributions to the planning objectives, avoidance of the planning constraints, and response to the federal evaluation criteria specified in the PGN.

3.9.1 Cost

Project costs for each alternative were provided by the Cost Engineers and are based on the Total Construction Costs. Construction costs contained all aspects of project construction and construction management including: real estate acquisition, environmental mitigation, as well as dredging and dredged material management/disposal. In addition to initial construction costs, annual operation and maintenance costs associated with maintaining the planned channel was considered and separately estimated. All costs were provided in FY 2018 price levels and annualized through the period of analysis for the average annual equivalent (AAEQ) cost calculation. See Table 3-7.

The AAEQ cost calculation used the initial investment cost required for initial construction. When the initial cost is applied to the interest during construction (IDC) cost, this is considered the Economic Investment Cost for the initial cost of construction. Economic investment costs were applied at the base year while the annual operation and maintenance (O&M) costs, including regular mitigation costs are applied each year throughout the period of analysis, as required. All costs were annualized to develop the AAEQ NED cost of the project. Costs were calculated pursuant to EM 1110-2-1304 and the Civil Works Construction Cost Index System (CWCCIS), to reflect FY18 costs and the FY18 Federal Discount rate of 2.75%.

	Alternative 1	Alternative 2	Alternative 3
Project First Costs	--	$122,957,100	$188,575,800
Interest During Construction Cost	--	$1,825,339	$3,672,000
Investment Cost (Project First Cost + Interest During Construction)	--	$124,784,500	$192,247,800
Amortized Investment Cost	--	$5,008,226	$7,510,500
Annual Operation and Maintenance Cost	--	$55,414	61,100
Average Annual Equivalent Cost	--	$5,063,640	$7,571,600

*Costs are included in Project First Costs

Table 3-6. Project First Costs for Each Alternative

	Alternative 1 No Action Alternative	Alternative 2 Replace Breakwater	Alternative 3 Replace and Extend Breakwater
PLAN DESCRIPTION			
Alternative Plan Details	The No Action Alternative and future without-project condition provides no physical project constructed by the Federal Government.	Alternative 2 consists of removing the old breakwater and constructing a new breakwater that would be built along the existing alignment. Regarding its functionality, the breakwater will not obstruct the typical navigation patterns within the harbor. When waves are broken by the breakwater, vessels are able to navigate inside the harbor more effectively, reducing the number of cancelled calls.	The extended breakwater alternative provides added protection from waves coming into the harbor by extending the breakwater by up to 300 feet. This provides the maximum protection against waves and currents within the harbor and provides the most usability in the harbor.
PLANNING ASSESSMENT			
A. National Economic Development (NED)			
1 Estimated Cost (FY2018 price level)	$0	$122,957,100	$188,575,800
2 Estimated Average Annual Cost (50 years; 2.75%)	$0	$5,063,640	$7,571,600
3 Average Annual Benefits	$0	$39,500	$401,400
4 Total Net Benefits	—	-$5,022,900	-$7,157,400
5 BCR	—	0.01	0.05
B. Environmental Quality			
1 Aquatic Habitat	The extent and quality of the aquatic habitat is expected to be commensurate with the existing condition	The construction of the offshore breakwater will have unavoidable adverse impacts on the aquatic habitat in the vicinity of the Alternative 2 site.	The construction of the offshore breakwater will have unavoidable adverse impacts on the aquatic habitat in the vicinity of the Alternative 3 site.
2 Water Quality	The extent and quality of the water quality environment is expected to be commensurate with the existing condition	Short-term impacts to water quality are anticipated during construction	Short-term impacts to water quality are anticipated during construction

3	Threatened & Endangered Species	No Impacts are anticipated to T&E species under Alternative 1.	Long-term unavoidable adverse impacts are anticipated to approximately 24.04 acres of T&E habitat	Long-term unavoidable adverse impacts are anticipated to approximately 26.93 acres of T&E habitat
4	Archaeological, Historic, and Cultural Resources	Long-term adverse impacts may occur to cultural resources if Alternative 1 is implemented.	Implementation of Alternative 2 will result in long-term beneficial impacts on archaeological, historic, and cultural resources in the project area.	Implementation of Alternative 3 will result in long-term beneficial impacts on archaeological, historic, and cultural resources in the project area.
5	Visual Resources	The extent and quality of visual resources is expected to be commensurate with the existing condition	The extent and quality of visual resources is expected to be commensurate with the existing condition	Long-term less than significant adverse impacts are expected under Alternative 3 due to construction of an additional 300 feet of the breakwater.
C. Regional Economic Development				
1	Business and Tax Revenues	Number of visitors, revenues, sales, inventories and taxes generated would all be commensurate with that of the existing conditions.	Number of visitors, revenues, sales, inventories and taxes generated could experience a faster growth trend in comparison to the existing conditions.	Number of visitors, revenues, sales, inventories and taxes generated could experience a faster growth trend in comparison to the existing conditions and of the other alternatives as it would result in an increase of vessel calls to the port.
2	Employment	Jobs and wages would be commensurate with that of the existing conditions, although they could diminish over time.	Jobs and wages could experience a faster growth trend than what would be commensurate with the existing conditions. The millions of dollars invested by the Federal and local governments in the project would have a positive short-term, if not long-term, effect on local employment as the money turns and churns through the economy.	Jobs and wages could experience a faster growth trend than what would be commensurate with the existing conditions. The millions of dollars invested by the Federal and local governments in the project would have a positive short-term, if not long-term, effect on local employment as the money turns and churns through the economy.

D. Other Social Effects (OSE)				
1	Public Health and Safety	Implementation of Alternative 1 would have an adverse effect on public health and safety as the intent of the breakwater is to reduce wave height and currents to create a safer harbor environment	Implementation of Alternative 2 would have a beneficial effect on public health and safety as the intent of the breakwater is to reduce wave height and currents to create a safer harbor environment	Implementation of Alternative 3 would have a beneficial effect on public health and safety as the intent of the breakwater is to reduce wave height and currents to create a safer harbor environment
2	Population at Risk	The local population of Tinian will be adversely impacted if Alternative 1 is implemented as unreliable delivery of goods to the island can inflate prices	Risk to the Tinian population of approximately 3,200 will be reduced under this Alternative	Risk to the Tinian population of approximately 3,200 will be reduced under this Alternative
3	Critical Infrastructure	Potential adverse impacts to harbor facilities and vessels may occur under this alternative as wave heights and currents would continue to exceed safe standards during high wind or storm conditions	Impacts to critical infrastructure would be lessened under this Alternative	Impacts to critical infrastructure would be minimized under this Alternative
4	Recreation	Implementation of Alternative 1 would have an adverse effect on recreation as the intent of the breakwater is to reduce wave height and currents to create a safer harbor environment	Implementation of Alternative 2 would have a beneficial effect on recreation as the intent of the breakwater is to reduce wave height and currents to create a safer harbor environment	Implementation of Alternative 3 would have a beneficial effect on recreation as the intent of the breakwater is to reduce wave height and currents to create a safer harbor environment
Plan Evaluation				
A. Contribution to Planning Objectives				
1	Improve harbor navigation conditions	Does not meet planning objective: continued adverse wave and current conditions in the entrance channel, turning basin, and at both wharves during moderate wave events.	Improve conditions by breaking incoming waves approaching the harbor, thereby reducing wave action within the entrance channel and at the wharves along the interior.	Improve conditions by breaking incoming waves approaching the harbor, thereby reducing wave action within the entrance channel and at the wharves along the interior.

2	Improve operational efficiency	Does not meet planning objective: operational efficiency would not improve and operations would continue to be at risk of disruption due to high wave heights and currents.	Operational efficiency would improve as the risk of disruption to operations due to high wave heights and currents would be greatly diminished.	Operational efficiency would improve as the risk of disruption to operations due to high wave heights and currents would be greatly diminished.
3	Avoid/Minimize environmental impacts	No action would be taken, no environmental impacts associated with construction of a breakwater	Alternative 2 is expected to have a significant impact on the coral habitat in the Alternative 2 area. Mitigation would not reduce impacts to less than significant in the short term, but over a 50 year period impacts are expected to be reduced to less than significant.	Alternative 3 is expected to have a significant impact on the coral habitat in the Alternative 3 area. Mitigation would not reduce impacts to less than significant in the short term, but over a 50 year period impacts are expected to be reduced to less than significant.
B. Avoidance of Planning Constraints				
1	Avoid unacceptable impacts to threatened or endangered coral species identified within the project area.	No changes are anticipated under the No Action Alternative.	Alternative 2 project area has a large number of coral species that will be impacted. Compensatory mitigation is expected to reduce impacts to less than significant over the 50 year project period. In the reasonably foreseeable future, coral impacts will be significant and unavoidable.	Alternative 3 is expected to have the greatest impact on coral habitat, as it is adding an additional 300 feet (at maximum) to the breakwater. Compensatory mitigation is expected to reduce impacts to less than significant over the 50 year project period. In the reasonably foreseeable future, coral impacts will be significant and unavoidable.
2	Do not adversely impact water quality within the harbor	No changes are anticipated under the No Action Alternative.	No long term adverse impacts to water quality within the harbor are expected.	No long term adverse impacts to water quality within the harbor are expected.
3	Avoid creating secondary adverse impacts to waves/currents in the channel/wharf areas	No changes are anticipated under the No Action Alternative.	Alternative 2 is not expected to create secondary adverse impacts to waves/currents in the harbor.	Alternative 3 is not expected to create secondary adverse impacts to waves/currents in the harbor.

4	Minimize effects to adjacent shorelines	The effect on adjacent shorelines is expected to be commensurate with the existing condition.	The effect on adjacent shorelines is expected to be commensurate with the existing condition.	The effect on adjacent shorelines is expected to be commensurate with the existing condition.
C. Response to Federal Planning Criteria				
1	Completeness	Does not meet criterion.	Meets criterion: Alternative 2 accounts for all actions necessary to achieve desired level of wave and current reduction in the harbor.	Meets criterion: Alternative 3 accounts for all actions necessary to achieve desired level of wave and current reduction in the harbor.
2	Effectiveness	Does not meet criterion: would not reduce adverse wave and current conditions in the entrance channel, turning basin, and both wharves.	Meets criterion: Alternative 2 is expected in increase vessel calls to the harbor, netting a $37,600 welfare benefit to the community.	Meets criterion: Alternative 3 is expected in increase vessel calls to the harbor, netting a $148,600 welfare benefit to the community.
3	Efficiency	Does not meet criterion	Does not meet criterion: Alternative 2 has a BCR of 0.01	Does not meet criterion: Alternative 3 has a BCR of 0.05
4	Acceptability	Does not meet criterion: project objectives for reducing adverse wave and current conditions in the harbor are not met.	Meets criterion: Technically feasible, compatible with existing laws, regulations and public policies, and reduces adverse wave and current conditions in the harbor.	Meets criterion: Technically feasible, compatible with existing laws, regulations and public policies, and reduces adverse wave and current conditions in the harbor.

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3.9.2 Economics

Consistent with the requirements of the USACE planning process, detailed economic analyses, including associated refinements were performed to ensure that an alternative plan under consideration for selection is economically justified, such that no other variation of that plan could be more economically beneficial (i.e., no other variation could better maximize the NED account). Specifically, these analyses include incremental justification to ensure that each measure included in the alternative is economically justified and optimization to ensure that the scale of each measure maximizes benefits.

As such, the evaluation and comparison process was used to identify which of the alternatives in the final array best meets the criteria for selection. Based on the outcome of this effort, detailed economic analyses were then used to refine that alternative as needed to identify the NED plan, thereby providing the basis for tentative plan selection. Following is a discussion of the economic evaluation and comparison of the final array of alternative plans. The full NED analysis is provided in Appendix 1.

NED Analysis

The NED Account is the primary account used to justify navigation projects. Measures considered in the NED Analysis were the final array of alternatives:

1. No Action Alternative
2. Replace Breakwater in Place
3. Replace and Extend Existing Breakwater

NED benefits were estimated by calculating the reduction in transportation cost for each alternative using a spreadsheet-driven economic model. It was determined that the benefits for the measures were mutually exclusive and could not be combined. For Tinian Harbor, transportation cost savings (Table 3-8) were realized by reducing the commute time from entry to exit in the harbor and reducing the number of vessels being rerouted due to harbor cancellations. Reduction in these transportation costs are included in the benefit analysis as a transportation cost savings.

	Average Number of Vessel Calls	Average Annual Transportation Costs	Additional Number of Calls	Average Annual Shift in Mode Transportation Costs	Total Transportation Costs
Alternative 1	66	$13,643,600	-	$654,400	$14,298,000
Alternative 2	67	$13,767,700	1	$490,800	$14,258,500
Alternative 3	70	$13,896,600	4	-	$13,896,600

Table 3-8. Transportation Costs

The above results are for each alternative on an average annual basis. The cost of air cargo transportation is very expensive and limited. The planes used are small planes and require multiple trips to transport the goods. Because most cargo are vessel ready, products will require re-handling costs. Food is a top priority and is typically one of the first goods that are shipped to Tinian via air cargo. To account for shift in mode costs, food is estimated at 30 percent of the total cargo, based on historical averages. Shift in Mode transportation costs are eliminated for Alternative 3, suggesting that demand is satisfied by the frequency in ocean cargo. Transportation costs do increase because vessels are added to the call list; however, with the increase in ocean cargo cost, shift in mode costs decrease.

An increase in usable days was used to compare alternative plans. A two-day transit factor was applied to the increased number of usable days to account for vessel loading and the time required to reach Tinian Harbor from other ports in the CNMI. Based on the table below, it is expected that Alternative 2, replacing the breakwater, will add one additional vessel call and Alternative 3, replacing and extending the breakwater, will add four additional calls (Table 3-9).

	Percentage of Unusable Days (A)	**Vessel Transit Factor Applied *(2*A)* (B)**	**Change in Usability Percentage (C)**	**Change in Vessel Call Frequency *((1+C)*63)* (D)**	**Additional Calls *(D-20)***
Alternative 1	13.3%	26.5%	--	66	--
Alternative 2	12.2%	24.4%	+2.1%	67	1
Alternative 3	10.0%	20.0%	+6.5%	70	4

Table 3-9. Vessel usability to additional calls per alternative

Costs for each alternative were calculated to account for initial construction, as well as planning, engineering, and design, real estate acquisition, environmental mitigation, and dredge/disposal operations. Costs were presented in Section 3.10.1.

The results of the NED analysis show negative total net benefits for each alternative considered (Table 3-10). The negative net benefits can be attributed to many factors including, the high construction cost to build a navigation feature in a remote harbor, a limited number of vessel calls in the harbor, and sustained population growth on the island for the period of analysis. The insufficient NED benefits do not justify a USACE Civil Works project to modify the harbor at Tinian.

	Average Annual Benefits	**Average Annual Costs**	**Total Net Benefits**	**Benefit-Cost Ratio (BCR)**
Alternative 1	0	0	--	--
Alternative 2	$39,500	$5,063,600	($5,022,900)	0.01
Alternative 3	$401,400	$7,571,600	($7,157,400)	0.05

Table 3-10. Benefit-to-Cost Ratio Calculation

Other Social Effects (OSE)

The account that best aligned with the problems facing the Tinian Harbor is the OSE Account. The OSE Account applies the non-monetary impacts on alternatives, utilizing an array of measures to compare alternatives. Instead of associating a monetary benefit to the improvements within the harbor, an incremental analysis is conducted to compare the costs to the added benefit to the harbor and its vessels. To distinguish impacts between alternatives, a CE/ICA is conducted. In this analysis, a factor is assigned to each of the non-monetary outputs and compared against the project's construction costs.

To justify the project, the OSE Account CE/ICA was conducted manually, following the CE/ICA IWR Report 94-PS-2, *Cost Effectiveness Analysis for Environmental Planning: Nine Easy Steps* guidance (see Economics Appendix, Section 8.1.4).

Outputs for this analysis were usable days at Tinian Harbor. These were estimated using hydraulic models of wave and current conditions in the harbor under the proposed alternatives. As discussed previously, Alternative 2, replacing the breakwater, resulted in an increase of 4 usable days, and Alternative 3, replacing and extending the breakwater, produced 12 more usable days. Table 3-11 below displays the cost and outputs for each of the alternatives listed in the final array.

	Outputs (Unusable Days)	Increase in Usable Days	Average Annual Cost
Alternative 1	49	--	--
Alternative 2	45	4	$5,063,600
Alternative 3	37	12	$7,571,600

Table 3-11. Cost/Output combinations for the preliminary array of alternatives

The increase in usable days and resulting vessel calls means that economic hardship on the local population is reduced. When cargo vessels cannot call at Tinian Harbor, air-transported food and goods are the only option for residents. These are more expensive than what shipped goods would cost. Therefore, increasing deliveries via ocean transport vessels makes food more affordable for Tinian residents.

To examine how air-transportation can adversely affect the welfare of the population, this analysis used the estimate of 30% of monthly grocery bills going towards non-perishable food items that would be subject to increased costs. Approximately 200 households on Tinian utilize the federal Supplemental Nutrition Assistance Program (SNAP), which provides vouchers of $568 per month. By taking 30% of the average monthly supplement and applying that to an income shift during times when the harbor is closed, each household has to reallocate approximately $170 of their income for food in lieu of other expenses. This $170 is considered an *income disparity factor* because it is the opportunity cost of additional food expenses.

Based on this disparity factor, it is estimated that every added vessel call would benefit each Tinian household by about $43. Table 3-12 below shows the impact to the community under the proposed alternatives:

	Additional Calls (Table 10-6) (A)	Additional Income Available (A*43) (B)	Number of Households (per 2010 Census) (C)	Community Welfare Increase (B*C) (D)	Average Annual Cost
Alternative 1	--	--	874	--	--
Alternative 2	1	$43	874	$37,600	$5,063,600
Alternative 3	4	$170	874	$148,600	$7,571,600

Table 3-12. Additional calls to welfare improvement (average annual savings to residents)

The primary justifications for the Tinian Harbor study under the Remote and Subsistence Harbor authority are the *welfare of the local population* and the *local and regional economic opportunities*. Although less critical than the local and regional economic opportunities, the social and cultural impacts also play a significant role in the community.

3.9.3 Environmental Refinement

A Phase 1 Marine Habitat Characterization Study was conducted by the USFWS in January 2017 (Appendix 2). The overall scope of the investigation was to document the existing fish and wildlife resources within the proposed project site to establish a baseline to which the impacts of the alternatives are evaluated. The FWCA is intended to ensure that fish and wildlife conservation receives equal consideration with other proposed project objectives. The FWCA PAR included a Phase I qualitative assessment of fish and wildlife resources at the currently proposed project site, an evaluation of potential impacts associated with the proposed project components, and recommendations for fish and wildlife mitigation measures. In addition, the findings and recommendations of the report may be used by the project proponent and the resource agencies for consultations required under the Essential Fish Habitat (EFH) provisions of the Magnuson-Stevens Fishery Conservation and Management Act and Section 7 of the ESA.

Tinian Harbor supports a diverse group of marine communities. The PAR describes in detail the qualitative assessment of the harbor and the areas proposed to be impacted by the alternatives considered under this study. The data provided in the PAR provides the basis for which direct and indirect impacts are calculated and the recommendations for compensatory mitigation are made. Further discussion regarding the affected environment is provide din Section 4 below.

The total proposed project area is 65.2 acres. It consists of nine different habitat zones including: 1) Back Reef, 2) Bank/ Shelf, 3) Channel, 4) Fore Reef, 5) Harbor, 6) Lagoon,

7) Land, 8) Reef Crest, and 9) Reef Flat. Over 80% of the area is dominated by Harbor, Channel, and Back Reef zones. The proposed project area consists of 4.04 acres of land, 16.76 acres of hard bottom, 9.86 acres of mixed bottom, and 34.51 acres of unconsolidated sediment. Of the unconsolidated sediment areas, the sediment type mostly consists of sand or sand/rubble mix.

The habitat structures of the Target Area consist of 1) Aggregate reef, 2) Land, 3) Pavement, 4) Pavement with Sand Channels, 5) Scattered Coral/Rock in Unconsolidated Sediment, 6) Spur and Groove, and 7) Unconsolidated Sediment. Of these, Pavement and Unconsolidated Sediment comprise majority of the area. However, the smaller areas represent high-value habitat with 2.99 acres of Aggregate Reef, 2.41 acres Pavement with Sand Channels, 4.87 acres Scattered Coral/ Rock in Unconsolidated Sediment and 2.58 acres Spur and Groove.

Two ESA-listed species are known to exist within or adjacent to the proposed project footprint and include: Green Sea Turtle (*Chelonia mydas*), endangered and *Acropora globiceps* coral, threatened. A detailed description of biological resources in the proposed project area are summarized below and provided in detail in Appendix 2.

ESA-listed Corals

NMFS has listed 15 Indo-Pacific coral species as threatened under the ESA. Of these 15 species, only 7 are known from waters of the U.S. and of these 7 only four have been documented in the Marianas Archipelago (*Acropora globiceps*, *Acropora retusa*, *Acropora speciosa*, and *Seriatopora aculeata*). Of these four species, only *A. globiceps* was observed in the study area.

Compensatory Mitigation

Compensatory mitigation requirements were further developed in compliance with Section 404(b)1 of the CWA, the FWCA PAR, and Executive Order (EO) 13089, Coral Reef Protection. This effort built upon the preliminary mitigation information that was originally incorporated into the Final Array of Alternatives; the results fall within the range of mitigation requirements and costs that were identified to allow for evaluation and comparison of the alternatives.

The PGN requires demonstration that “damages to significant ecological resources have been avoided or minimized to the extent practicable; that unavoidable damages to these resources have been compensated to the extent justified; and, that restoration opportunities for significant ecological resources have been given appropriate consideration.” The regulations further specify that mitigation requirements should be considered as an integral component of each alternative plan. Based on these requirements, and after consideration of avoidance and minimization measures, the PDT determined that compensatory mitigation would be required for unavoidable impacts to biological resources. In particular, impacts to the aquatic biological resources are anticipated in order to achieve the project objective of improving navigation (and operational) efficiency. The HEA model results that determined the extent of coral impacts and required mitigation along with a Coral Mitigation Plan for the proposed project are provided in Appendix 4. The HEA used for this study was approved by the HQ Model Certification Panel on June 13, 2017.

Compensatory mitigation is intended to replace the ecological services that are lost as a result of unavoidable impacts to resources affected by a given project. “Ecological services” refer to the services performed by a resource for the benefit of other resources or the public. The baseline for quantifying lost ecological services is the full complement of services that would have been provided absent project implementation. Lost ecological services are quantified as the reduction in the provision of services below this baseline. Compensatory mitigation must restore services commensurate with the character of lost services. The amount of compensatory mitigation needed to replace lost services depends, in part, on the ability of the affected resources to return to their baseline conditions. Factors relevant in that regard include the quantity of the affected resources and how fast and how completely they return to their baseline conditions. The amount of compensatory mitigation also depends on the ability of the selected compensatory mitigation measures to replace lost services. Relevant factors for replacement include how fast the compensatory mitigation measures become fully functional and the relative degree to which they provide additional ecological services. An HEA takes into account the above factors, and can be used to determine the appropriate quantity of compensatory mitigation.

Proposed Mitigation

The primary concerns associated with the proposed project include potential direct (loss of ecological communities and seafloor substrate) and secondary impacts (project-generated sedimentation and turbidity) within and adjacent to the proposed project area. Consultation with the Services provides technical assistance to USACE for the development of alternative project plans and/or Best Management Practices (BMP) to avoid and/or minimize adverse impacts to fish and wildlife resources.

Alternatives 2 and 3 would cause both direct and indirect impacts to corals colonizing substrate present within the proposed construction footprints of both alternatives including a 150 meter buffer representing the indirect impact area. Alternative 2 would result in 6.76 acres of direct impacts and Alternative 3 would result in 7.67 acres of direct impacts equivalent to 100% functional loss. Alternative 2 would result in 17.28 acres of direct impacts and Alternative 3 would result in 19.26 acres of direct impacts equivalent to 10% functional loss calculated in HEA. To mitigate for direct impacts resulting in 100%

functional loss and indirect impacts resulting in 10% calculated functional loss, USACE proposes installation of reef balls with coral transplantation at a 1:1 in-kind replacement of coral reef habitat in close proximity to the affected area. The proposed mitigation would take 25 years for full recovery to baseline. The reef balls are intended to compensate for coral reef habitat loss by constructing artificial substrate for coral colonization to restore ecological functions and services in the project area. Additional mitigation options evaluated for feasibility but not pursued further, including, quarried limestone boulders with coral transplantation, remove sunken vessel, development and maintenance of local in-water coral nursery and debris removal.

Mitigation Costs

The costs of any specific compensatory mitigation plan or component depends on many variables, most of which are unknown at the feasibility stage. Fully developed mitigation costs require a complete understanding of the exact impacts based on the final preferred alternative selection, quantitative measurements of the resource impacts associated with the preferred alternative, a developed mitigation plan including scale and scope of the mitigation action, and the long-term management plan to ensure success of the mitigation. Analysis of the EQ account provides an approximation of mitigation costs. At this stage in the study, USACE proposes to install reef balls transplanted with coral. Table 3-13 describes total mitigation costs per alternative.

	Environmental Impacts (Direct & Indirect) to Coral (acres)	**Mitigation Amount (acres of reef balls)**	**Mitigation Cost**
Alternative 2	24.04	4.05	$2,870,630
Alternative 3	26.93	4.57	$3,239,100

Table 3-13. Mitigation of Coral Resources

Previous projects or resource damage costs may also be used to provide insight to the scale of mitigation costs for coral reefs. Any number used will likely not directly apply to this proposed project on this island, so it must be used with appropriate caution.

USFWS provides a summary of ship grounding costs that are real costs determined as part of settlements for coral reefs impacts in the State of Hawaii. The State of Hawaii, Division of Aquatic Resources in the past developed a value matrix that ranged from $100 to $1000 per coral colony. This was used in several small vessel grounding cases. Additionally, there were grounding cases with settlements loosely based on projects designed to offset the resource losses under the Oil Pollution Act of 1990. Not all of these cases were valued in the same manner, but the value ranged from $94 to $2,244 per square meter of reef area. There are substantial differences between these cases and compensatory mitigation projects. Another comparison to use is the construction of Kilo Wharf in Guam by the U.S. Navy. Kilo Wharf was estimated to impact 4.75 direct acres and an additional 1.7 to 14.9 acres from secondary sedimentation impacts. The mitigation cost for this proposed project was $5 million and currently has yet to produce sufficient mitigation offsets many years later. How these may be applicable to Tinian Harbor modifications is uncertain. The salient point for consideration is that the scale of this proposed project may easily incur mitigation costs that exceed these comparisons unless appropriate avoidance measures are undertaken.

3.9.4 Effects on the Human Environment

The amount of cargo moving through Tinian Harbor is predicted to increase over time because there is a direct connection between population growth and commodity consumption. Using U.S. Census data from 1980 to 2010, economic analysis predicts that the population will increase 1.4% in the study period (See Appendix 1). The resulting increase in commodity cargo is expected to occur with or without navigation improvements. Without improvements, more vessels would be required to transport the increased cargo volumes that are forecasted. However, with implementation of any of the final array of alternatives, the total number of vessels could increase, and transportation costs could be reduced compared to FWOP conditions. As a result, impact to other environmental factors such as air emissions, traffic, safety, etc. could ultimately increase. The impacts have been evaluated and have been determined to be less than significant. See Section 4 of this report.

No significant construction or operational impacts to the human environment are expected. Populations of minority, juvenile, elderly, and low-income families would not experience disproportionately high and adverse effects from any of the proposed alternatives. Schools/childcare facilities and hospitals are sufficient for the existing population. Significant growth in population may require expansion of these facilities and services. No disproportionately high and adverse impacts to the population are expected in the near term.

Overall, based on the future potential of non-significant adverse, and beneficial impacts to human health, environmental health risks, and safety risk, this proposed project would not have social effects (effects on communities, children, elderly or environmental justice concerns) that would need to be mitigated.

3.9.5 Engineering Refinement

In general, the early stages of plan formulation were based on concept-level information using available information from existing studies coupled with professional judgment.

Two numerical wave models, CMS-Wave and BOUSS-2D (B2D (Table 3-14)), are often used in harbor studies. When addressing a broad range of oceanic and coastal wave modeling needs of navigation projects, the computational constraints require the use of a combination of spectral and Boussinesq-type wave models such as these (Lin and

Demirbilek, 2005 and 2012).

Model Name and Version	Brief Description of the Model and How It Will Be Applied in the Study	Approval Status
CMS- FLOW (v3.75)	CMS-Flow is a coupled hydrodynamic and sediment transport model capable of simulating depth-averaged circulation, salinity and sediment transport due to tides, wind and waves. The hydrodynamic model solves the conservative form of the shallow water equations and includes terms for the Coriolis force, wind stress, wave stress, bottom stress, vegetation flow drag, bottom and friction, and turbulent diffusion. CMS-FLOW will be applied in this study to develop currents for input into ship simulations and to evaluate harbor currents/circulation.	HH&C CoP Preferred Model
CMS-WAVE (v3.2)	Coastal Modeling System – Wave (CMS-Wave) is a spectral wave transformation model and solves the steady-state wave-action balance equation on a non- uniform Cartesian grid. It considers wind wave generation and growth, diffraction, reflection, dissipation due to bottom friction, whitecapping and breaking, wave-wave and wave-current interactions, wave run-up, wave setup, and wave transmission through structures. This model will be used to transform deep water wave conditions from the Wave Information Study (WIS) to the nearshore vicinity of the harbor and as input to the Boussinesq (BOUSS2D) wave model.	HH&C CoP Preferred Model
BOUSS2D	BOUSS2D wave model is a comprehensive numerical model for simulating the propagation and transformation of waves in coastal regions and harbors based on a time-domain solution of Boussinesq-type equations. The model can simulate most of the phenomena of interest in harbor basins including shoaling/refraction over variable topography, reflection/ diffraction near structures, energy dissipation due to wave breaking and bottom friction, cross-spectral energy transfer due to nonlinear wave-wave interactions, breaking-induced	Allowed for Use

Table 3-14. Engineering Models and Approval Status

For the evaluation and comparison of alternatives in this study, CMS-Wave, a two dimensional (2D) spectral wave model, was applied to large domains, covering deep-water offshore areas up to the shoreline. The computational efficiency of CMS-Wave permitted the simulation of a very large number of deep-water wave conditions for determining the accessibility and utilization of the harbor and proposed modifications.

B2D, a Boussinesq-type model, could be used during the detailed design of a selected alternative with small local domains in the nearshore which include details of harbors, channels and harbor infrastructure. This tandem use of two classes of wave models is necessary to thoroughly investigate waves affecting safe and efficient usage of Tinian Harbor. Because no wave data was collected in Tinian Harbor, CMS-Wave was calibrated and validated with available data during the preliminary design stage.

Wave conditions at Tinian Harbor affect currents through wave setup, and currents may also affect the waves themselves, affecting wave steepness and wave breaking, particularly in shallow water. CMS-Flow is a 2D shallow-water wave model that can be used for hydrodynamic modeling (calculation of water level and current). The combined use of CMS models (CMS-Wave and CMS-Flow) are well suited to evaluate this interaction because of their capability for inline steering (coupling) of results from one model to the other. CMS-Flow was applied using a domain identical in size, resolution and bathymetry to the local CMS-Wave grid, both for efficiency and compatibility between the two models during steering simulations.

Summary of Harbor Accessibility/Usability Analysis Based on Wave Height

Harbor accessibility and usability was evaluated for the final array of alternatives and compared to existing conditions based only on wave height and duration thresholds under operational conditions. The calculation, based on the requirement that this usability wave threshold may not be exceeded for a duration of greater than one hour, was completed based on all 32 years of WIS hindcast wave data, and averaged to determine an annual number of "unusable" days for each alternative. Analysis with the duration threshold raised to 2 consecutive hours yielded little difference in annual days per year. This is due to the typical persistence of wave events over days or weeks. In all cases, the threshold of 1 foot or less at the wharf was used as the requirement since the repair of the breakwater has little effect on conditions in the entrance channel. Since there is not a reasonable way to protect the entrance with a coastal structure due to the depth and length of the existing channel, the requirement for this criterion only at the wharf to be satisfied is appropriate.

Table 3-15 presents the average annual percentage of time and average annual number of days that the harbor is considered unusable for the final array of alternatives. The table shows that in the predicted future condition, there are an average of 49 days per year (7 weeks or 1.75 months) that the wharf may be unusable. Alternative 2 reduces this to 45 days per year, an improvement of 4 useable days. Alternative 3 reduces the unusable days to 37 days per year, an improvement of 12 useable days. Alternative 3 also achieves the Coastal Engineering Manual (CEM) design guidance stating that the mooring and access channel wave thresholds should not be exceeded more than 10 percent of the time.

Acreages (Based on 1980-2011 WIS Data)	Alternative 1	Alternative 2	Alternative 3
Percent Inaccessible/Unusable	13.4%	12.2%	10.0%
Percent Accessible/Usable	86.6%	87.8%	90.0%
Inaccessible/Unusable Days Per Year	49 days/year	45 days/year	37 days/year

Table 3-15. Summary of Harbor Usability Percentage and Days/Year

The reason for the relatively small differences in number of useable days between the FWOP condition and each alternative is that the existing reef and sediment surrounding the deteriorating sheetpile structure (which would be expected to remain even with continued breakwater deterioration in the future) provide a significant amount of wave sheltering to the harbor under operational wave conditions. Wave conditions exceeding 6 feet that would be expected during a large swell event or tropical storm would be accompanied by increased water levels due to storm surge and wave setup. This increase in water level reduces the protection provided by the shallow reef dramatically. If no breakwater (or a severely compromised breakwater) were in place during an extreme wave event, waves and currents in the harbor would be significantly larger and more damaging to harbor infrastructure and any vessels within the harbor at that time.

3.9.6 Key Assumptions: System of Accounts

Economics

Lack of available data for economics, led to the following economic study assumptions for the NED and OSE analysis:

- Linear distribution of commodity forecast was estimated based on a 20-year population trend for the NED and OSE Analysis.
- Future vessel fleet requirements used for the NED analysis were based on interviews conducted by the harbor master and vessel operators. Assumes tide is not required for the analysis.
- Future harbor improvements were not incorporated because master plans were speculative.
- Linear interpolation of model data to obtain average annual benefits (2020, 2050, 2069) (NED/OSE).
- Conducted interviews to quantify the actual change in price of air and ocean cargo from the harbor master. Because Tinian has no realized costs increases, interviewed a Rota resident to compare impacts to cost.
- To determine monthly impacts, used the family SNAP voucher to estimate monthly grocery expenditures for the Welfare Factor and the grocery survey was used to distinguish average grocery expenditures.

Cost for the alternatives were provided utilizing the following assumptions:

- Comparative level estimates were created utilizing MCACES 2nd generation software (MII). The Ponce De Leon South Jetty Extension Current Working Estimate (CWE) in MII which has been developed by the USACE Jacksonville (SAJ) district has been used as a starting point based upon similar work type, materials, etc. Quantity takeoffs have been developed by SAJ and some quantities and prices have been compared to the estimates developed for the Tinian alternatives.
- Escalation on material prices has primarily been completed in the Tinian QTO.xlsx file. Escalation of dredging prices has been applied to the direct unit price and entered as a sub bid price. General assumptions include:

  - o Sales Tax: Based upon research there appears to be no sales tax on the CNMI as a whole or Rota specifically. However, there is a 4% sales tax for Guam. Guam is a likely source of materials for this project. Therefore, 4% sales tax has been assumed.
  - o FOOH: 25% (Based upon previous PAS estimate)
  - o HOOH: 10% (Based upon previous PAS estimate)
  - o Profit: 10% (Based upon previous PAS estimate)
  - o Bond: 1% (Based upon previous PAS estimate)
  - o Price Level: 2018
- Contingency: These estimates are most closely related to a Class 4 estimate. According to ER 1110-2-1302 dated June 30, 2016 these estimates can be defined as noted below and would be sufficient for initial screening level alternative costs. 30%-40% contingency would be considered typical for Breakwaters and Seawalls Project at this stage of the planning study and the need for scope clarity and PDT review.
  - o Alternative 2: Contingency of 40% has been applied to Alternative 2 based upon the Abbreviated Risk Analysis (ARA) in the estimate backup.
  - o Alternative 3: Contingency of 77% has been applied to Alternative 3 based upon the ARA in the estimate backup
- PED costs: None applied to screening alternatives.
- S&A costs: None applied to screening alternatives.
- Site Access: Staging areas should be available either through the CNMI or through lease.
- Borrow Areas: Thought to be available on Guam for armor stone and Tinian for other stone types.
- Site Conditions: Disposal areas are assumed to be in good working condition and no restoration or dike construction has been assumed to be necessary.
- Unusual Conditions (Soil, Water, and Weather): Open water excavation and placement.
- Weather Days: Captured in unit price but not yet specifically considered for this level of estimate.
- Equipment and Labor Availability and Distance Traveled: Equipment and labor availability is a concern based upon the remote location of Tinian. The hope being that contractors with the equipment and labor resources necessary can be found on Guam or Saipan. Previously for the Tinian PAS study a contractor provided a quote for some of this work which is promising.
- Environmental Concerns during Construction: The island of Tinian contains some of the world's most pristine coral resources. This is based upon opinions of the environmental community voiced during the NEPA scoping meeting and could have huge implications during the study, design, and construction phases of the

project. The matter currently being captured in the contingency is being applied to these estimates.

Environmental

- No currently approved model for quantifying coral compensatory mitigation values
  - An HEA was developed for this study and was reviewed and approved by the HQ Model Certification Panel on June 13, 2017.
- Due to a lack of existing geotechnical information, there is uncertainty in the composition and soil properties of materials in the areas of the existing structure, and other potential structures. Whether the material is consolidated (limestone rock) or unconsolidated (sand/gravel) and whether any contaminants exist within the soil will determine the method of construction, the options for disposal (offshore/upland/beneficial use), and some environmental parameters to be followed during construction.
  - Defer geotechnical borings to PED phase due to cost and environmental permitting to mobilize a barge.
  - Do not conduct geophysical investigations (non-mechanical evaluations of subsurface conditions) in lieu of borings at feasibility phase due to cost and uncertainty in useable results.
  - Utilize SME judgment to estimate the properties of materials in potential construction areas.
- Locations and quantities of coral resources in the study area are qualitative, not quantitative. Certain alternatives may impact coral resources. The magnitude of the impact will depend upon species, size, location, quantity, and listing status. If valuable resources are impacted, it is uncertain what the scope of required mitigation would be.
  - Engage FWS early in the planning process and request Phase 1 survey be completed as soon as possible (completed).
  - A Phase II study by USFWS can provide greater detail regarding the existing environment, resources to be impacted and ultimately appropriate mitigation measures. This information will also address unresolved issues with costs. When the costs for compensatory mitigation of coral resources are better known, entire proposed project costs will be more clearly defined.
- Section 106 consultation is in progress.
- ESA Section 7 consultation is in progress.
- EFH consultation is in progress.

Engineering/Design

- Harbor usability will be defined for Tinian Harbor as both a wave threshold (less than 1 foot at mooring areas), and the duration of exceedance of these acceptable conditions.
- Alternatives can be compared based on a steady-state wave model (CMS-Wave) that may not capture fine details such as reflection and harbor seiching. A more detailed, physics-based model (B2D) that will capture these finer details should be implemented for detailed design.
- Future Sea Level Change will affect alternatives similarly, due to similarities in structure and design e.g. materials, cross-section. Adaptability of all alternatives is analogous and does not significantly distinguish them for comparison based on Sea Level Change.
- The final design has not been developed, and requires additional detailed modeling.
- Actual geotechnical conditions may be different than assumed conditions. Methods of construction, cost estimates, disposal options, and environmental requirements for alternative plans could be incorrectly estimated. Whether the material is consolidated (limestone rock) or unconsolidated (sand/gravel) and whether any contaminants exist within the soil will determine the method of construction, the options for disposal (offshore/upland/beneficial use), and some environmental parameters to be followed during construction. All of these items feed into study and proposed project construction costs.
- Construction duration is also an uncertainty. Tinian's remote location and factors such as regional typhoon activity and rough seas, make predictions of proposed project schedules and costs difficult.
- Construction should be performed when impacts to coral resources would be minimized (i.e., do not perform construction during peak coral spawning period).

3.10 Remote and Subsistence Harbors Authority

The project was evaluated under the Remote and Subsistence Harbors authority to determine federal interest (Appendix 5). This authority provides for justification under the remaining three accounts, Environmental Quality, Regional Economic Development, and Other Social Effects, to determine the best suited alternative to meet the project objectives. Under the Remote and Subsistence Harbor authorization, "the Secretary may recommend a project without demonstrating that the [harbor and navigation] improvements are justified solely by [NED] benefits, if the Secretary determines that the improvements meet the following criteria:

- *[…] the improvements would be located in the State of Hawaii, the Commonwealth of Puerto Rico, Guam, the Commonwealth of the Northern Mariana Islands, the United States Virgin Islands, or American Samoa;*
- *The harbor is economically critical such that over 80 percent of the goods transported through the harbor would be consumed within the community served by the harbor and navigation improvement; and*
- *The long-term viability of the community would be threatened without the harbor and navigation improvement.*"

Additionally, the Secretary will consider the following benefits in determining whether to recommend a project under the above criteria:

- "*public health and safety of the local community, including access to facilities designed to protect public health and safety;*
- *access to natural resources for subsistence purposes;*
- *local and regional economic opportunities;*
- *welfare of the local population; and*
- *social and cultural value to the community.*"

The project meets the first criterion in that it is located in the CNMI. The project also meets the second criterion in that the Tinian community consumes roughly 97 percent of the goods transported through Tinian Harbor. Eligibility under this criterion was analyzed comparing the total revenue tonnage with the inbound and outbound tonnage for a five-year period of analysis based on information provided by the harbor masters and not including the small boat vessels not recorded with the CPA.

The PDT considered the project's eligibility under the third criterion regarding threats to the long-term viability of the community contingent upon the harbor or navigation improvement. Tinian Island is a remote community depending predominately on ocean transport for their needs and supplies. When the harbor is not available due to adverse wave conditions, the only option for the community to import goods is via air transport. Operating costs for ocean cargo is considerably less expensive and more efficient than air cargo. When goods are transported by plane, the increased transport costs are consequently transferred to the consumer, causing financial hardship for Tinian residents. Because food and energy is required for sustainability, their income to the community is compromised.

In addition to the significant direct impacts to the residents, the region could experience secondary and tertiary effects on local businesses and communities when the harbor is underutilized. Harbor closures due to inclement weather can affect external revenue sources such as international development and tourism. For example, with its close proximity to Saipan, the island of Tinian has been a focal point for several development sites and business opportunities in the CNMI. The location of the CNMI makes it easily accessible to Asian markets and many visitors frequent the island from China and the Philippines. When the Asian economy does well, the CNMI does well. Historical population and gross domestic product data show a direct correlation between Asian economies and tourism on the island of Tinian. Impacts at the harbor could impact these commercial institutions.

While the proposed project met the first two criteria with ease, evaluation of the project's eligibility under the third criterion proved challenging. After extensive evaluation of cancelled calls, the resulting increase in food costs, the impact to community welfare, negative impacts on subsistence and recreational fishing, potential for extended disruptions of harbor services and hampered recovery efforts after a direct hit or near miss of a Category 3 or greater typhoon, the PDT determined none of these impacts were sufficient to meet the long-term viability criterion. Key determining factors included the presence of a functional airport and infrequent/periodic port closures.

3.11 Study Conclusion

The NED analysis resulted in a determination of "No Federal Interest" under Civil Works authorities because the BCR for all the alternatives were well under 1.0. It was further determined that the project did not meet the eligibility criteria for Remote and Subsistence Harbors, which would have allowed continuation of the project in lieu of a NED plan.

Based on evaluation of NED benefits and Remote and Subsistence Harbors criteria, USACE has determined that there is presently no federal interest in constructing harbor improvements under the USACE Civil and Public Works program at Tinian Harbor. Accordingly, the feasibility study will be terminated and the study information made available to other parties or agencies that may be interested in pursuing a similar project. The information presented in this feasibility study is comparable to a 35% level design and cost estimate.

4.0 AFFECTED ENVIRONMENT (EXISTING CONDITIONS) AND ENVIRONMENTAL CONSEQUENCES†

Pursuant to NEPA and its implementing regulations (40 CFR Part 1500 through Part 1508), federal agencies are required to assess the significance of their proposed actions on the human environment before making decisions. The purpose of the NEPA process is to inform decision-makers and the public of the likely environmental effects of a proposed action and its alternatives. This chapter presents information on the existing conditions of the affected environment and describes the consequences of implementing each alternative. Specific requirements and considerations for these analyses are discussed below.

Under NEPA, the federal agency documents whether a federal action has the potential to “significantly affect the quality of the human environment in an Environmental Assessment (EA). Based on the findings, the federal agency determines whether an EIS is required. The federal agency may elect to bypass the EA and proceed directly towards preparation of an EIS, beginning with an NOI. In the case of this proposed project, it was determined that an EIS was the proper form of compliance under NEPA as potential adverse impacts that could not be reduced to less than significant were anticipated.

An NOI was prepared and published in the Federal Register on July 8, 2016.

4.1 Affected Environment

Each resource within the affected environment and considered under this project is provided below. A description of the affected environment includes the existing conditions with a brief summary of historic conditions where applicable. The analysis of effects described in the subsequent Environmental Consequences section uses the Affected Environment description as the baseline to identify changes to the resource under future with- and without-project conditions. In addition to the environmental setting, this section also describes the regulatory setting, as appropriate, with the status of regulatory compliance further addressed in Section 6.0.

The Area of Concern or Region of Influence for this proposed project is defined as the primary construction limits and immediate areas around the construction footprint including the proposed construction laydown area and proposed final disposal site of construction debris (see Section 4.9 Land Use). The Region of influence for each measure are shown in Figures 3-2 and 3-5. Construction laydown and proposed final disposal site are presented in Figures 4-5 and 4-6 in Section 4.9. Environmental consequences for each area within the Region of Influence are discussed as applicable for each individual environment.

For most resources, the area of concern is generally limited to the construction limits for each measure/alternative. However, for some resources, the project-related effects must be considered within the context of the surrounding vicinity. For example, the evaluation of land use, aesthetics, noise, traffic, and socioeconomics also includes the surrounding areas. Potential effects relative to resources that occur across a broader area – climate, geology, and air quality – were considered at a regional scale.

Although environmental conditions are generally subject to some change over time, most of these resources are not expected to change significantly under the without-project condition over the period of analysis. However, any changes expected in the future-without-project condition are described in the Environmental Consequences section for the No Action alternative, as further described below.

4.2 Environmental Consequences

The evaluation of environmental consequences involves the comparison of the effects of each alternative plan relative to the No Action, (FWOP) conditions. Environmental consequences (also referred to as effects or impacts) may be adverse or beneficial, and include both direct and indirect effects. Direct effects are caused by the action and occur at the same time and place; indirect effects are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable. For those resources that may be adversely affected, measures that would be implemented to mitigate the potential impacts are described. The approach taken for mitigation follows the recommended steps set forth by the President's Council on Environmental Quality in the NEPA regulations (40 CFR Part 1508.20 [a-e]), and includes (in order of preference) avoidance, minimization, and compensation.

Criteria were identified for each resource to assist with evaluation of the potential for significant adverse effects; the criteria are based on the definitions of significance and the specific considerations identified for NEPA at 40 CFR 1508.27, as well as other standards of professional practice. Based on the significance criteria, the analysis presented for each resource concludes the degree of potential impact as one of the following:

- Beneficial. This effect would provide benefit to the environment as defined for that resource.
- No Effect. This effect would cause no discernible change in the environment as measured by the applicable significance criteria; therefore, no mitigation would be required.
- Less than Significant. This effect would cause no substantial adverse change in the environment as measured by the applicable significance criteria; in general, no compensatory mitigation would be required (but in some cases, avoidance and minimization measures may be incorporated as a best management practice or to meet other regulatory requirements).
- Significant. This effect would cause a substantial adverse change to that resource in the affected environment or as otherwise defined based on the significance criteria, taking into consideration both the intensity of the impact and the context under which the impact would occur. Effects determined to be significant fall into

one of two categories: those for which there is feasible mitigation available that would avoid or minimize the environmental effects to less-than-significant levels, and those for which there is either no feasible mitigation available or for which, even with implementation of feasible mitigation measures, there would remain a significant adverse effect on the environment. Those effects that cannot be minimized to a less-than-significant level by mitigation are identified as significant and unavoidable. For each identified impact and associated mitigation measure (if applicable), a discrete impact and mitigation number is indicated (IMP and MM, respectively); these numbers allow for a quick reference between the text and the summary of impacts (as provided in Table ES-6).

Alternatives Analyzed for Environmental Effects

The Tinian Harbor Modifications Interim Feasibility Report is intended to address USACE feasibility study requirements which includes a NEPA environmental impact review analyzing the potential impacts of the proposed project on social, natural, and economic aspects of the human environment. Additionally, all measures required for compliance with other applicable environmental statutes, including, but not limited to the Clean Air Act (CAA), the Clean Water Act (CWA), the FWCA, and the National Historic Preservation Act (NHPA) are considered under the environmental impact review process.

In this section, each of the Final Array of Alternatives described in Section 3.8 are evaluated and then compared to the baseline condition and the future No-Action Alternative condition (NEPA mandated, Alternative 1). This document also includes a provision for the No-Action Alternative and assesses resource-specific cumulative impacts for each alternative. Presented below are the definitions and assumptions of each of these conditions.

Alternative 1: No-Action Alternative

The No-Action Alternative (FWOP) represents the expected future condition if the Recommended Plan is not approved and there is no change from the current management direction or the level of management intensity. The No-Action Alternative is the NEPA benchmark for assessing environmental effects, including the cumulative impacts, of the proposed project. Essentially, the No-Action Alternative demonstrates the future consequences of not meeting the need for the Recommended Plan.

Alternative 2: Replace Existing Breakwater along Current Alignment

Alternative 2 involves removal of the existing approximately 4,600 foot long cellular sheet pile breakwater, including debris, sand/silt/coral rubble, vegetation, and steel sheet piles, down to the approximate 3 foot elevation contour relative to Mean Lower Low Water (MLLW). Some of the in situ material (e.g. coral rubble) could either remain in place or be reused for the core of the new breakwater structure; however, the majority will be disposed of at a disposal site located either on Tinian or shipped to Saipan.

The new breakwater would be rebuilt along the existing structure alignment, but with varying cross-sectional area composed of either stone, or stone and concrete armor units. Figure 3-2 shows the alignment of the existing structure, as well as the conceptual footprint (not to scale) of the replacement structure. The breakwater is comprised of the Northwest Breakwater and the Main Breakwater. The Northwest Breakwater includes the section of the structure tying into land and extending approximately 1,100 feet. This section would require a smaller cross-section due to less wave exposure and can be built with a stone armor layer and underlayer. A typical cross-section for this reach is shown in Figure 3-3. The oceanside and harborside toe of the structure would be keyed into hard benthic foundation material. Existing depths in this area range from approximately 1.5 to 10.5 feet below MSL. This section would be approximately 60 feet wide and 14 feet in total height on average, with an elevation 8 feet above MLLW.

The Main Breakwater includes the remaining 3,500 feet of breakwater. This section would consist of a more robust cross-section in order to withstand head-on exposure to larger waves including those from typhoon events. A typical cross-section for this reach is shown in Figure 3-4. The Main Breakwater replacement would follow the alignment of the existing breakwater and would utilize the remnants of the existing breakwater as a portion of the core. Remnants extending above 3 feet MLLW elevation would be removed so as to not protrude into the new breakwater stone layers. A new core would be constructed around the remnants, using dredged material, quarry run stone, or other suitable material. Successive layers would be placed over the core material, consisting of a geotextile filter fabric, a 1.5 foot thick bedding layer of 10 to 50 pound stone, a two-stone thick underlayer of 250 to 500 pound stone, and a 2.5 ton tribar (or 1.8 ton Core-Loc) armor layer. A cast-in-place concrete crest cap would be used to stabilize the crest. A rubble-mound structure constructed of armor stone was considered; however, preliminary calculations indicated that this would require stone sizes of approximately 14 to 20 tons to remain stable under extreme wave conditions. This size stone is not available within the CNMI or Guam. The oceanside and harborside toe of the structure would be keyed into hard benthic foundation material and further stabilized with tremie concrete. This section would be approximately 65 feet wide and 15 feet in total height, with an elevation 12 feet above MLLW.

Alternative 3: Replace and Extend Existing Breakwater along Current Alignment

This alternative proposes, in addition to Alternative 2, construction of an approximately 300 foot extension to the seaward end of the Main Breakwater, increasing the total length to approximately 4,900 feet. Figure 3-5 shows the alignment of the existing structure, the conceptual footprint of the replaced structure and the proposed breakwater extension. The length of the extension will be optimized based on costs relative to reduction in wave energy within the harbor. The 300 foot length depicts the maximum proposed extension due to both the location of the entrance channel and the depth contours near the end of the existing breakwater alignment. The foundation of the extended breakwater would be sited in depths ranging from 10 to 25 feet below MLLW. The breakwater extension design emulates the Main Breakwater replacement design, yet requires heavier materials and a considerably wider footprint necessary to accommodate the deeper foundation depths. A typical cross-section of the extension to the breakwater is shown in Figure 3-6.

A new core would be constructed, using salvaged breakwater material, quarry run stone, or other suitable material. Successive layers would be placed over the core material, consisting of a geotextile filter fabric, a 1.5-ft. thick bedding layer of 10 to 50 pound stone, a two-stone thick underlayer of 400 to 800 pound stone, and a 4.3-ton tribar armor layer tribar (or 3.2-ton Core-Loc). A cast-in-place concrete crest cap would be used to stabilize the crest. The oceanside and harborside toe of the structure will be keyed into hard benthic foundation material and further stabilized with tremie concrete. The section will be approximately 130 feet wide and 22 to 40 feet in total height, with an elevation 12 feet above MLLW datum.

4.3 Geology, Seismicity and Soils

4.3.1 Regulatory Framework

Regulations and policies that relate to geology, seismicity, and soils and are being considered under the environmental impact review for the proposed project include the following:

- NEPA
- Clean Water Act, Section 404
- Environmental Protection Act (2 CMC § 3101 et seq.)
- Earthmoving and Erosion Control Regulations (CNMI Administrative Code Chapter 65-30)

4.3.2 Environmental Setting

Topography

Tinian is approximately 12 miles long and 6 miles wide. Tinian consists of a series of five elevated limestone plateaus, separated by escarpments and steeply sloping areas. The surface landforms can be divided into five major physiographic areas described below.

- Southeastern Ridge: This land feature is the southernmost topographic feature on the island and includes Mount Kastiyu, the highest part of the island at 614 feet. It has steep slopes and cliffs as high as 500 feet.
- Median (Marpo) Valley: A low, broad depression located north of the Southeastern Ridge, with a maximum elevation of 150 feet. This area includes San Jose Village.
- Central Plateau: This land area extends northward from Marpo Valley and includes all of central Tinian and portions of northern Tinian. The plateau is broad and gently sloping with the majority of the vertical relief at its southern and northern

boundaries. This area includes the Tinian International Airport and portions of the Military Lease Area.

- North-Central Highland: This land area is located within the northern part of the Central Plateau and midway between the east and west coasts of the island. The maximum elevation is 545 ft. at Mount Lasso.
- North Lowland: This land area is located at the very northern part of the island. It is generally flat with an average elevation of about 100 ft., except for Lake Hagoi, where the elevation is approximately at sea level.

Geology

Tinian is an island composed mainly of coralline and algal limestone overlying volcanic rock. The volcanic rock is only observable at ground surface in two localized areas in the vicinity of Mount Lasso. The limestone is highly porous, so water easily flows through it (Gingerich 2002). The raised limestone plateaus that characterize the island are evidence of uplifting caused by movement along high-angle normal faults. The four major geologic units that comprise Tinian are explained below.

- Tinian Pyroclastic (volcanic) Rock: These fine-grained to coarse-grained ash and angular fragments represent volcanic explosive materials ejected from an ancient (extinct) volcano that forms the core of the island. These rocks are exposed on the North-Central Highland and Southeastern Ridge and cover about 2 percent (%) of the surface of the island. These materials are generally highly weathered and are altered to clay in surface exposures. Because of its texture and density, this rock unit has low permeability (i.e., water does not flow easily through it).
- Tagpochau Limestone: These rocks are exposed on approximately 15% of the island's surface, generally in the North-Central Highland and the southern part of the Southeastern Ridge. This formation reaches thicknesses of up to 600 ft. It is composed of fine to coarse-grained, partially recrystallized broken limestone fragments and approximately 5% reworked volcanic fragments and clays. This formation is very porous and water flows easily through it.
- Mariana Limestone: This formation covers approximately 80% of the island's surface, forming nearly all of the North Lowlands, the Central Plateau, and the Marpo Valley. This formation reaches thicknesses up to 450 ft. It is composed of fine to coarse-grained fragmented limestone, with some fossil and algal remains, and small amounts of clay particles. Small voids and caverns are common in surface exposures. The Mariana Limestone has a higher coral content than the Tagpochau Limestone but is similarly porous, allowing water to readily flow through it.
- Beach Deposits, Alluvium, Colluvium, and Marsh: These deposits cover less than 1% of the island's surface and reach a thickness of up to 15 ft. The deposits are made up of poorly consolidated sediments, mostly sand and gravel deposited by

waves. However, they do contain clays and silt deposited inland at Lake Hagoi and Makpo Marsh, as well as loose soil and rock material found at the base of slopes.

Coastal Geology

Most of Tinian's shoreline is comprised of sea cliffs with pocket beaches and is encircled by a narrow fringing reef. Core borings taken at Tinian Harbor's pier and wharf structures in previous studies show a foundation of hard coralline limestone up below a depth of about 25-30 ft. The limestone is covered by a surface layer of sandy limestone gravel. The fill materials behind the bulkheads generally consist of approximately 10 ft. of firm and non-cohesive sand/gravel, with no silt or clay. Native fill materials extend approximately 15 to 20 ft. below this layer, and they are also gravelly and sandy, generally dense, except for a few thin pockets of loose sand. The fill materials are not expected to liquefy during a seismic event. Beach deposits are mostly medium-to-coarse grain calcareous sands, gravels, and rubble interspersed over exposed limestone. Submarine topography is characterized by limestone with interspersed coral colonies and occasional submerged boulders. A more thorough discussion of the coral reef is presented in Section 4.11, Biological Resources.

Tinian Harbor was constructed on the southwest coast of Tinian where a shallow fringing reef offers the harbor natural protection. It was dredged from the reef during World War II by U.S. Navy Seabees. The shallow reef that wraps around from the north has water depths of 1-3 ft. on the reef flat, which is 300-500 ft. wide. The fore reef has a steep slope of about 1/14, dropping of quickly to deep water depths. Consequently, incident waves are not affected by the open ocean bathymetry until they propagate over the fringing reef and to the harbor. Waves setup over the fore reef and break at the reef crest, just before the breakwater. Breaking waves over the reef generate wave-induced currents, which can affect navigation into/out of the harbor.

Karst Geology

Karst is a distinctive landscape formed when water dissolves rocks. This creates large voids, such as sinkholes and caves, as well as smaller features characterized by rough surfaces, little soil, and small cavities known as epikarst. The epikarst commonly acts as a conduit for surface water (such as rainfall) to the underlying groundwater aquifer by percolation or channelization through connected subsurface voids or cavities.

Epikarst that is not ordinarily saturated by groundwater or surface water may provide a large amount of water storage in voids and cavities. The fast flow of water through the joints and channels of epikarst does not allow for adsorption (by soil), uptake (by plants), or microbial processes to occur that would ordinarily remove pollutants contained in surface waters before they reach groundwater (Islam 2005). Karst geology on Tinian includes epikarst, closed depressions (e.g., sinkholes), caves, and freshwater discharge features (Stafford et al. 2005). Epikarst is present in all of the limestone rock formations on Tinian and its characteristics vary based on proximity to the coast. Coastal epikarst is jagged as result of the effects of sea spray, while inland epikarst surface features become less extreme (Stafford et al. 2005). Sinkholes, a type of epikarst, can occur naturally or as a result of excavation, change in drainage patterns, or lowering of the groundwater table (Islam 2005); sinkholes can occur anywhere within the limestone formations on Tinian. Caves can form in limestone deposits in the mixing zone of the salty groundwater and fresh groundwater lens. These caves are present along portions of Tinian’s coast.

There are three main types of closed depressions on Tinian: (1) dissolutional (when water dissolves rock); (2) constructional (caused by faulting or certain rock formations); and (3) man-made or modified (e.g., excavations such as quarries, borrow pits, or landfills). Twenty closed depressions were identified during the 2005 karst survey (Stafford et al. 2005), in both inland and nearshore locations on Tinian: 7 of them were identified as dissolutional, 8 constructional, and 5 man-made or modified.

Geologic Hazards

Potential geologic hazards on Tinian include seismic activity (e.g., earthquakes along faults), liquefaction, landslides, tsunamis, and karst features (e.g., sinkholes). Additional information on these hazards is provided in the following sub-sections.

Seismic Activity

An earthquake is caused by the sudden slip of a fault that results in ground shaking and radiated seismic energy caused by the slip; volcanic or magmatic activity; or other sudden stress change in the earth’s crust (U.S. Geological Survey 2013). In addition, there are several nearby faults along the ocean floor that could potentially cause significant earthquakes felt on Tinian. There have been 13 destructive earthquakes in the Mariana Islands during the past two centuries (Mueller et al. 2013) with the majority of the recorded impacts (i.e., property damage, injuries) felt on Guam (approximately 130 miles to the south).

Liquefaction

When loose sand and silt is saturated or partially saturated with water and shaken by an earthquake it can behave like a liquid; this is known as earthquake liquefaction. The soil can lose its ability to support structures, flow down gentle slopes, and erupt to the ground surface to form sand boils (i.e., upward movement of sand). This can cause damage to buildings, roads, and pipelines. Three factors are required for liquefaction to occur: (1) loose, granular sediment is present; (2) the sediment is saturated or partially saturated by groundwater (i.e., water fills the spaces between sand and silt grains); and (3) strong shaking occurs (i.e., from a strong earthquake). Typically, liquefaction occurs in areas where there are loose soils with poor drainage. On Tinian, these conditions could be present on fill land located near the coast (e.g., Port of Tinian).

Landslides

The term landslide includes a wide range of ground movement such as rock falls, deep failure of slopes, and shallow debris flows. Earthquakes of magnitude 4.0 and greater are known to trigger landslides (U.S. Geological Survey 2013). Tinian has numerous fault scarps depicted as “fault lines”. These are related to the uplift of the limestone formations as a result of tectonic activity in the region. In general, the consolidated nature of the limestone and volcanic units reduce the potential for slope failure; however, there is a potential for slope failure to occur due to wet tropical weather on Tinian combined with weathered rock and steep cliffs along the island’s perimeter, and areas of land disturbance.

Tsunamis

A tsunami is a sea wave that can result from large-scale seafloor displacements associated with large earthquakes, major submarine landslides, or volcanic eruptions. The Mariana Islands have had recorded tsunami events dating back to 1700 (Uslu et al. 2013). Doan et al. (1960) notes that Tinian is not likely to be vulnerable to tsunamis originating from distant earthquakes or landslides due to the geographic location and the close proximity to Saipan. However, Tinian may be vulnerable to those generated by disturbances along the volcanic axis (Mariana Islands) associated with the subduction zone at the Mariana Trench. Shocks emanating from this region have the potential to generate tsunamis capable of impacting the Tinian Harbor area and the low-lying Median Valley, or other areas not protected by coastal cliffs. On March 11, 2011, evacuations were ordered for low-lying areas in the CNMI in response to the earthquake and ensuing tsunami in Japan, no damage was reported.

Karst Features

Tinian exhibits several different types of karst features including naturally formed dissolution-type closed depressions or sinkholes, human modified depressions, and limestone caves. Due to the porous nature of the limestone formations that underlie much of the island, other unmapped karst features are likely to be present. These include sinkholes, caves, recharge features (i.e., voids in the rock that allow water to seep into the subsurface), and discharge features (i.e., voids in the rock where groundwater seeps out of the subsurface).

Soils

Soil classes across Tinian were identified by the U.S. Department of Agriculture Soil Conservation Service in 1985 (Young 1989). Figure 4-1 shows the horizontal distribution of these soil classes. The soil within the affected environment (Tinian Harbor) is classified as Shioya, which is described as very deep, excessively drained, level to nearly level soils; on coastal strands. The location of this class of soil is coastal limestone sands.

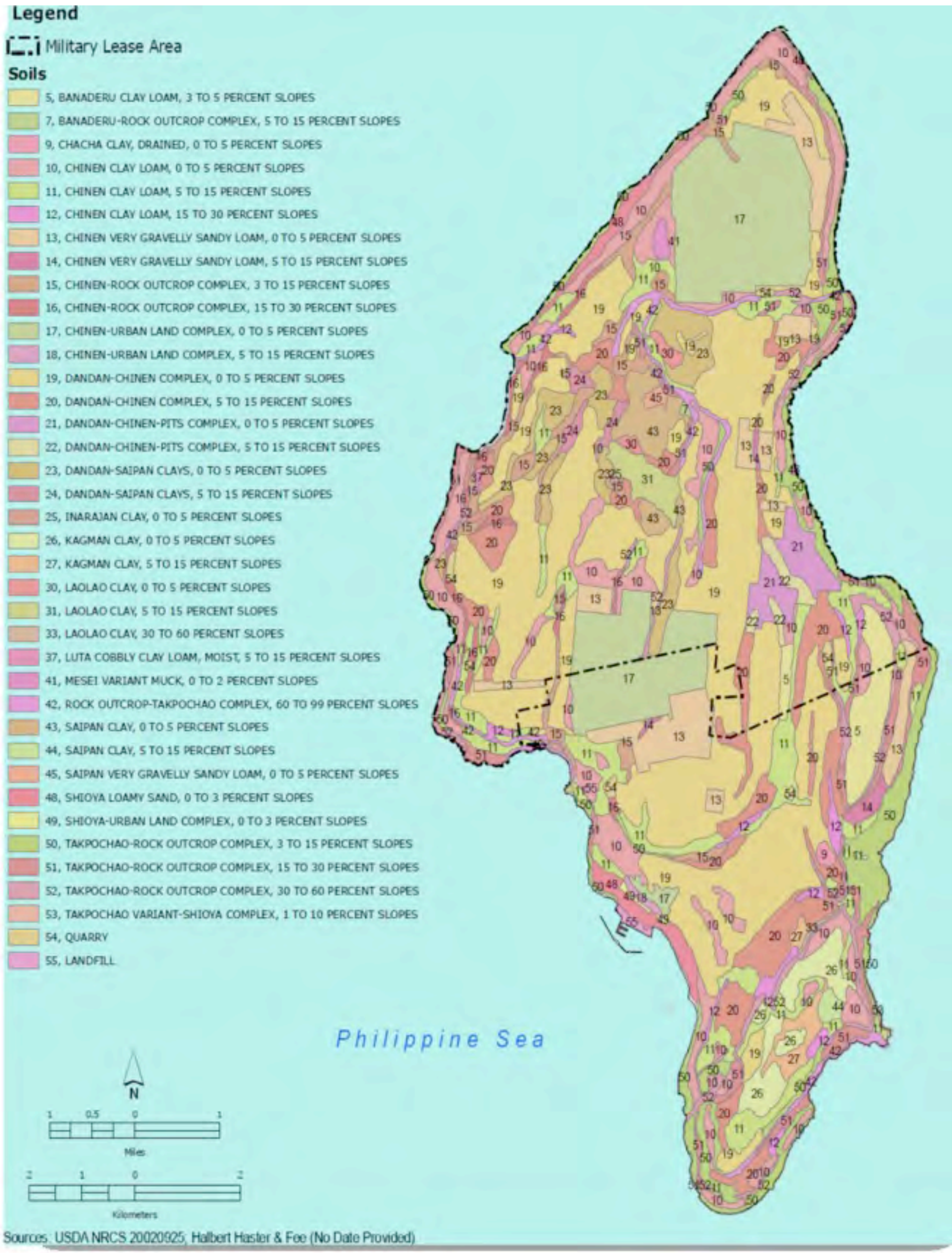
Soil types and characteristics affect the potential for soils to erode. The U.S. Department of Agriculture defines soil erosion as the "removal of material from the surface soil, which is the part of the soil having an abundance of nutrients and organic material vital to plant growth." Natural causes of soil erosion include wind and water. Human and wildlife activities can accelerate soil erosion (Muckel 2004). Soil units characterized as having the greatest susceptibility for soil erosion are generally located in areas with steep slopes. The soil units in the vicinity of the proposed action are not within this scope.

Surface Soils

The USDA Natural Resources Conservation Service (NRCS), formerly the Soil Conservation Service (SCS), has identified ten General Soil Map Units on Tinian, including two lowland soil units, two upland soil units, and six limestone plateau soil map units (Table 4-1 and Figure 4-1). General Soil Map Units are a mapping convention used to represent a general population of soils on a landscape segment. There is considerable variation within the General Soil Map Units. The percent coverage for lowland, upland and limestone plateau soils is 3, 5, and 85 percent, respectively.

Map Units	% Cover	Characteristics	General Distribution
Mesei Variant	<1	Moderately deep, very poorly drained, level soils; in depressional areas	85% Mesei soils, 10% Inarajan soils, minor areas of Laolao soils, Chinen soils, Shioya soils
Shioya	2	Very deep, excessively drained, level to nearly level soils; on coastal strands	85% Shioya soils, small areas of Urban land, Chinen soils, Takpochao soils
Upland			
Laolau-Akina	1	Moderately deep, well-drained, strongly sloping to steep soils; on volcanic uplands	Almost entirely Laolao soils
Takpochao-Chinen-Rock	4	Shallow, well-drained, strongly sloping to extremely steep soils, and Rock outcrop; on limestone escarpments and plateaus	40% Takpochao soils, 30% Chinen soils, 25% Rock outcrop, and 5% Saipan soils
Chinen-Takpochao	14	Very shallow and shallow, well drained, nearly level to strongly sloping soils; on limestone plateaus and side slopes	75% Chinen soils, 20% Takpochao soils, small areas of Saipan soils
Chinen-Urban	10	Shallow, well-drained, nearly level soils, and Urban land; on limestone plateaus	50% Chinen soils, 25% Urban land, 15% Chinen soils, 10% Dandan soils, small areas of Takpochao soils
Dandan-Chinen	51	Shallow and moderately deep, well-drained, nearly level to strongly sloping soils; on limestone plateaus	45% Dandan soils, 40% Chinen soils, small areas of Takpochao and Saipan soils
Banaderu-Rock Outcrop	2	Shallow, well-drained, nearly level to moderately steep soils, and Rock outcrop; on limestone plateaus	90% Banaderu soils, <5% Rock outcrops, small areas of Saipan soils and Takpochao soils

Table 4-1. General soil map units.



U.S. Army Corps of Engineers Honolulu District Fort Shafter, Hawaii	Interim Feasibility Report Tinian Harbor Modification Study Island of Tinian Commonwealth of the Northern Mariana Islands	FIGURE TITLE: Tinian Soil Types FIGURE NUMBER: 4-1

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4.3.3 Environmental Consequences

Effects on geology, seismicity, and soil conditions were considered to be significant if implementation of an alternative would result in any of the following:

- Substantially alter an important natural geologic feature
- Cause substantial soil erosion
- Increase exposure of people or structures to seismic-related hazards
- Substantially contribute to an increased potential for (or otherwise be affected by) an onsite or offsite landslide/debris flow, subsidence, liquefaction, or collapse.

The region of influence evaluated for geology, seismicity, and surface soil conditions included the direct footprint of the proposed project as well as the island of Tinian as a whole. The potential effects to these resources that could result from implementation of the alternatives, measures that would be conducted to mitigate those effects, and the resulting degree of impact are discussed in the following subsections.

4.3.3.1 Alternative 1: No-Action Alternative

- No impacts are anticipated to the geology, seismicity, and surface soil conditions if the No-Action Alternative is implemented.

Under the No-Action Alternative, no breakwater would be constructed, such that project-related actions would cause no discernible change in geology, seismicity, and surface soil as measured by the applicable significance criteria; therefore, no mitigation would be required.

Navigational risks are expected to persist as the existing configuration of navigational features will continue to expose the harbor and dock facilities to unsafe wave and current conditions resulting in periodic significant disruptions to navigation and port operations.

4.3.3.2 Alternative 2: Replace Existing Breakwater along Current Alignment

- During operations (following construction of the new breakwater), long-term, direct, significant beneficial impacts can be anticipated in the construction footprint area due to increased stability of the breakwater that could reduce seismic risk.
- During construction, short-term, direct, less than significant adverse impacts are anticipated at the construction laydown and disposal site areas.

Construction Footprint and Immediate Area Surrounding the Construction Footprint:

Under Alternative 2, the current 4600 ft. existing cellular sheet pile breakwater would be removed and a new breakwater would be built along the existing alignment. Material removal would include debris, sand/silt/coral rubble, vegetation, and steel sheet piles down to the approximate 3 ft. depth contour relative to MLLW elevation. Some of this in place material may either remain or be reused for the core of the new breakwater structure. The majority will need to be disposed of at a disposal site. The potential issues would be wave reflection and potentially high currents near the structure, as well as an altered approach/departure path affecting the waves/currents.

Under current conditions, there is high probability of complete failure of the breakwater during storm or seismic events. The new breakwater would reduce seismic risk and be more resilient to storm surges. These beneficial impacts would be long-term, direct and significant. The physical conditions of soil and geology within the land area of each of the proposed project site would be expected to be generally commensurate with the current onsite conditions.

Construction Laydown Area:

Short-term, less than significant, adverse impacts to geology and soil are anticipated during construction of the breakwater based on the criteria detailed above. The repairs to the breakwater will require disposal of approximately 50,000 cubic yards of sheet pile, limestone rock, and sand material. The material will be dewatered within the temporary work area located in the northwest corner of the Tinian Harbor footprint shown on Figure 4-4 of proposed project features maps. Construction activities in the laydown area could contribute to soil erosion, and as the work area is approximately 8.3 acres erosion could potentially be significant. BMPs as described in Appendix 6 would ensure that any impacts would be minimal. They include but are not limited to laying down plastic sheeting for debris stockpiling, use of berms, and adequate coverage of stockpiles. The Alternative 2 measure is not anticipated to impact geologic features, increase seismic activity or increase potential for landslides or collapse.

Construction Debris Disposal Site (Tinian Airport):

No impacts are anticipated to the geology, seismicity, and surface soil conditions of the Tinian Airport disposal site from receiving construction debris generated from implementation of Alternative 2. The final disposal location for all disposal material will be placed in a low depression area next to the Tinian airport runway. The non-federal sponsor identified disposal locations shown on Figure 4-5 of proposed project feature maps, which is approximately 48.9 acres of land. The property is an open grass area that is maintained on a regular basis. The excess sheet pile material may be placed in the Saipan landfill if the airport facility is not sufficient. All disposal locations are owned in fee by the non-federal sponsor and all land has been reported available for this proposed project. The Department of Public Work's Division of Solid Waste Management has been contacted and 50,000 cubic yards of sheet pile, limestone rock, and sand material will not put significant stress on disposal site capacity or affect geologic features in an adverse manner.

4.3.3.3 Alternative 3: Replace and Extend Existing Breakwater along Current Alignment

- During operations (following construction of the new breakwater), long-term, direct, significant beneficial impacts can be anticipated in the construction footprint area due to increased stability of the breakwater that could reduce seismic risk.
- During construction, short-term, direct, less than significant adverse impacts are anticipated at the construction laydown and disposal site areas.

Construction Footprint and Immediate Area Surrounding the Construction Footprint:

In addition to removing and replacing the current breakwater as discussed in Alternative 2, Alternative 3 extends the breakwater by approximately 300 ft. The length of the extension will be optimized based on costs and reduction to wave energy within the harbor. Impacts to the construction foot print area would be similar to those associated with Alternative 2 above.

Construction Laydown Area:

Short-term, less than significant, adverse impacts to geology and soils are anticipated during construction of the breakwater as a small construction laydown area will be required. Impacts are identical to those discussed in Alternative 2 above.

Construction Debris Disposal Site (Tinian Airport):

No impacts are anticipated to the geology, seismicity, and surface soil conditions of the Tinian Airport disposal site from receiving construction debris generated from implementation of Alternative 3. Disposal location conditions are identical to those discussed in Alternative 2 above.

4.4 Groundwater Resources

4.4.1 Regulatory Framework

Regulations and policies that relate to groundwater resources and are being considered as part of the proposed project include the following:

- NEPA
- Clean Water Act, Section 402
- Rivers and Harbors Act, Section 10
- Earthmoving and Erosion Control Regulations, Regulations (CNMI Administrative Code Chapter 65-30)
- Water Quality Standards, (CNMI Administrative Code Chapter 65-130)
- Commonwealth Groundwater Management and Protection Act of 1988 (CNMI Public Law 6-12)

4.4.2 Environmental Setting

Tinian is composed of permeable limestone that overlays a relatively impermeable volcanic foundation. Rainfall percolates rapidly downward into porous limestone rock and is the primary recharge source of fresh groundwater on Tinian (Doan et al. 1960). The average annual groundwater recharge for Tinian is estimated to be about 30 inches per year (Gingerich 2002). Groundwater is plentiful in Tinian's basal groundwater lens (lenses of fresh groundwater that floats on top of denser saltwater below) (Doan et al. 1960). Surface runoff is practically non-existent due to rapid percolation through the soils. There are no springs or perennial streams.

Most of Tinian's groundwater supply is located within the Takpochao Limestone and the Ghyben-Herzberg lens areas. This freshwater, Ghyben-Herzberg groundwater lens (fresh water that "floats" on top of saltwater forming a profile that has the appearance of a lens) is in both limestone and volcanic rocks, with the most important sources coming from limestone formations (Gingerich 2002). The interface between the freshwater and saltwater is a transition zone at a depth below sea level. The portion of the lens that is used for potable water (i.e., with chloride concentrations less than 250 parts per million) is thickest in the North-Central Highland and Central Plateau and grows increasingly thinner approaching the coastline. The freshwater lens extends from a maximum recorded 3.42 ft. above MSL to about 140 ft. below MSL at its deepest point (Gingerich 2002). The basal fresh water lens extends from 2 to 4 ft. (0.6 to 1.2 m) MSL to about 80 to 160 ft. below sea level at its deepest point (NOAA et al. 1980).

The U.S. Environmental Protection Agency has not identified a sole-source aquifer (i.e., the principal source of drinking water) underlying Tinian. Per the CNMI Wastewater Treatment and Disposal Rules and Regulations, a Class I Aquifer Recharge Area is defined as an "area contributing surface infiltration to a geologic formation, or part of a formation, that is water bearing and which currently transmits, or is believed capable of transmitting water to supply pumping wells or springs." While not formally designated, based on this definition, the CNMI Bureau of Environmental and Coastal Quality considers all of Tinian a Class I Aquifer Recharge Area per the CNMI Rules and Regulations.

Tinian utilizes shallow, Maui-type wells to skim water from the top of the freshwater lens aquifer for public use. The CUC public system extracts water from one horizontal Maui-type well (Maui Well #2) located in the Makpo sub-watershed (a Maui-type well has a horizontal collector trench constructed near the top of the water table). Before Maui Well #2 was put into service, the public system extracted water from Maui Well #1. Maui Well #1 is currently out of service due to old equipment and difficulty obtaining repair parts. In addition to pumping from Maui Well #2 for the public water system, water is currently pumped from two wells (rehabilitated by a private party) to fill containers for providing water to cattle.

Existing resources may be capable of supplying up to 7 million gallons/day (gpd) (27 million liters/day (lpd)) of potable fresh water, which can support a population of 70,000 people at an average supply rate of 100 gpd/person (379 lpd/person). Recent assessments are more conservative and estimate 30,000 people can be supported by Tinian's water resources. In 1992, water usage was estimated at 650 gpd/person (2,460 lpd/person) compared to the U.S. average of 150 gpd/person (568 lpd/person). This difference in water consumption is attributed to leaking infrastructure and poor conservation practices on Tinian (USDA/SCS 1994). The majority of households utilize municipal water, although approximately 10 percent are totally dependent on rainwater catchment (USDA/SCS 1994).

Historically, groundwater resources supported over 150,000 military personnel during WWII. Peak usage during WWII was estimated at 2.3 million gpd (8.7 million lpd). To fulfill these water requirements, approximately 40 wells were drilled at an average depth of 300 feet (70 m). Following the end of the war, most wells were abandoned (USDA/SCS 1994). It is not known if (or how) these wells were properly closed when abandoned. Some of the wells located on Tinian are used for agriculture, a total of 33 wells were used for groundwater monitoring between 1993 and 1997 by the U.S. Geological Survey. Of the 33 wells, 16 were rehabilitated and 17 were newly developed for groundwater monitoring on the island. Rehabilitation involved retrieving the original pump and pipe, re-drilling if necessary, cleaning out the hole to near the original depth, and installing new surface casings/well head features, if necessary.

Groundwater Quality

While it is not currently a problem, Tinian has the potential for high chloride levels in groundwater due to seawater intrusion into the freshwater lens from excessive pumping (Gingerich 2002). The secondary drinking water standard for chloride is set at concentrations less than or equal to 250 parts per million. Chloride concentrations at the municipal water well (i.e., Maui Well #2) range from 160 to 220 parts per million, with an average of 180 parts per million; notably close to the secondary drinking water standard (i.e., non-mandatory drinking water quality standards for aesthetic considerations, such as taste, color, and odor) (U.S. Army Corps of Engineers 2003). Table 4-2 summarizes recent data.

Well #	Year Tested	Chloride Concentrations Observed (parts per million [ppm])
Maui Well #2	2011	Mean 203, Range 195-210
	2012	Mean 196, Range 175-223
	2013	Mean 190, Range 172-217

Table 4-2. Tinian Municipal Well Water Quality

Surface activities (e.g., sewage spills, leachate from septic systems, and polluted stormwater runoff percolation) can also contaminate groundwater aquifers. As discussed in Section 4.15, Utilities, the Tinian existing solid waste facility consists of an unlined, open disposal site located about 0.5 mile (0.8 kilometer) north of San Jose on the west side of 8th Avenue. The solid waste facility is believed to have been in use since 1944 and may contain World War II-era military waste, as well as municipal solid waste generated on Tinian. No trash pickup service is available on Tinian; therefore, residents take their municipal waste to the Tinian solid waste facility for disposal. The CNMI commercial entities (administrative offices, hotels, restaurants, etc.) transport their waste to the municipal solid waste facility as well. The facility does not comply with the Resource Conservation and Recovery Act Subtitle D regulations applicable to municipal solid waste landfills (40 CFR 258) and may be a source of groundwater contamination. It is not known if groundwater in the vicinity of the solid waste facility has been contaminated, but standard contaminants for municipal waste have not been detected in groundwater extracted for municipal water supply at Maui Well #1 and #2. The CNMI government owns Maui Well #1 and Maui Well #2.

4.4.3 Environmental Consequences

Effects on groundwater resources were considered to be significant if implementation of an alternative plan would result in any of the following:

- Substantially deplete groundwater supplies
- Interfere with groundwater recharge

The region of influence evaluated for groundwater resources included the direct footprint of the proposed project as well as the groundwater formations within island of Tinian as a whole. The potential effects to groundwater supply and recharge that could result from implementation of the alternatives are discussed in the following subsections.

4.4.3.1 Alternative 1: No-Action Alternative

- No Impacts are anticipated under the No-Action Alternative based on the criteria defined above

Under the No-Action Alternative, none of the navigational risk management measures would be implemented. As no features would be constructed, there would be no project-related activities that would affect groundwater conditions. The physical conditions within each of the measure locations would be expected to be generally commensurate with the current onsite conditions.

4.4.3.2 Alternative 2: Replace Existing Breakwater along Current Alignment

- No Impacts are anticipated under Alternative 2 based on the screening criteria defined above.

Construction Footprint and Immediate Area Surrounding the Construction Footprint:

Under this alternative, the current 4600 ft. existing cellular sheet pile breakwater would be removed and a new breakwater would be built along the existing alignment. The potential issues would be wave reflection and potentially high currents near the structure, as well as an altered approach/departure path affecting the waves/currents.

Improvements to the harbor would result in reduced wave action in the channel and at wharves.

This navigational risk measure is not expected to involve disturbance of the groundwater table or other impacts to the underlying aquifer. No permanent groundwater features would be altered on land, therefore, there would be no project-related activities that would affect groundwater conditions. The physical conditions within the land area of each of the measure locations would be expected to be generally commensurate with the current onsite conditions.

Construction Laydown Area:

No adverse impacts to groundwater are anticipated during construction of the breakwater based on the criteria detailed above. BMPs as described in Appendix 6 would limit impacts to groundwater resources. These BMPs include, but are not limited to, removing debris stockpiles in a timely manner, ensuring adequate spill prevention kits, and providing primary and secondary containment for the specific volumes and chemicals that are stored on site.

Construction Debris Disposal Site (Tinian Airport):

No impacts are anticipated to the groundwater environment of the Tinian Airport disposal site from implementation of Alternative 2. Disposal of construction debris would not require alterations to groundwater features or significant use of groundwater. The Department of Public Work's Division of Solid Waste Management has been contacted and 50,000 cubic yards of sheet pile, limestone rock, and sand material will not put significant stress on disposal site capacity or affect groundwater resources in an adverse manner.

4.4.3.3 Alternative 3: Replace and Extend Existing Breakwater along Current Alignment

- No Impacts are anticipated under Alternative 3 based on the screening criteria defined above

Construction Footprint and Immediate Area Surrounding the Construction Footprint:

In addition to removing and replacing the current breakwater as described in Alternative 2, Alternative 3 extends the current breakwater by approximately 300 ft. The length of the extension will be optimized based on costs and reduction to wave energy within the harbor. Under Alternative 3, improvements to the harbor would result in reduced wave action in the channel and at wharves. As the proposed action is limited to the subtidal environment in the construction footprint area, and no surface water bodies in the vicinity of the construction area, no impacts to groundwater will occur. This navigational risk measure is not expected to involve disturbance of the groundwater table or other impacts to the underlying aquifer.

Construction Laydown Area:

No adverse impacts to groundwater are anticipated during construction of the breakwater based on the criteria detailed above. BMPs as described in Appendix 6 would limit impacts to groundwater resources. These BMPs include, but are not limited to, removing debris stockpiles in a timely manner, ensuring adequate spill prevention kits, and providing primary and secondary containment for the specific volumes and chemicals that are stored on site. No permanent groundwater features would be altered on land, therefore, there would be no project-related activities that would affect groundwater conditions. The physical conditions within the land area of each of the measure locations would be expected to be generally commensurate with the current onsite conditions.

Construction Debris Disposal Site (Tinian Airport):

No impacts are anticipated to the groundwater environment of the Tinian Airport disposal site from implementation of Alternative 3. Disposal of construction debris would not require alterations to groundwater features or significant use of groundwater. The Department of Public Work's Division of Solid Waste Management has been contacted and 50,000 cubic yards of sheet pile, limestone rock, and sand material will not put significant stress on disposal site capacity or affect groundwater resources in an adverse manner.

4.5 Surface Water Resources

Surface waters include lakes, streams, rivers, springs, and wetlands; some of these features may be considered "Waters of the U.S." Waters of the U.S. are defined under 40 CFR 230.3(s) and 33 CFR Part 328 as: "(1) all waters which are currently used, or were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters which are subject to the ebb and flow of the tide; (2) all interstate waters including interstate wetlands; (3) all other waters such as intrastate lakes, rivers, streams (including intermittent streams), mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds, the use, degradation or destruction of which could affect interstate or foreign commerce. The discussion of surface waters also incorporates the analysis of watersheds and floodplains.

Rainfall on Tinian averages 83 inches per year (Water and Environmental Research Institute 2003), 58% of which typically occurs from July to November while only 14% typically occurs during the dry season from January to April (Department of the Navy [DoN] 2010a). Much of the precipitation on Tinian evaporates, transpires, or percolates into openings in the limestone and volcanic rock beneath the thin soil surface (Gingerich 2002).

4.5.1 Regulatory Framework

The U.S. Army Corps of Engineers, the U.S. Environmental Protection Agency, and the U.S. Maritime Administration are the primary federal agencies with jurisdiction over water resources. Within the CNMI, the CNMI Bureau of Environmental and Coastal Quality is the administrative authority for the CWA and some activities under Section 10 of the Rivers and Harbors Act. Federal and local regulations that serve to protect, conserve, and manage water resources are listed below.

Federal Regulation

- Clean Water Act: Section 401, 402, and 404
- Water Pollution Control Act
- Fish and Wildlife Coordination Act
- EO 11990, Protection of Wetlands

CNMI Regulation

- CNMI Earthmoving and Erosion Control Regulations (CNMI Administrative Code Chapter 65-30)
- CNMI Wastewater Treatment and Disposal Rules and Regulations (CNMI Administrative Code Chapter 65-120)
- Water Quality Standards (CNMI Administrative Code Chapter 65-130)
- Drinking Water Regulations (CNMI Administrative Code Chapter 65- 20)
- Wastewater Treatment and Disposal (CNMI Administrative Code Chapter 65-120)

4.5.2 Environmental Setting

Surface Water Features

Tinian is formed almost entirely of permeable limestone karst, there are few springs and no perennial (permanently flowing) streams. Surface water features occur on Tinian in areas of impermeable clay that prevent infiltration of surface water, or at perched water tables (temporary pockets of groundwater located above unsaturated soil or rock, not connected to the permanent groundwater table). These areas are entirely dependent on rainfall as a water source for sustaining productivity and habitat quality. Because the entire shoreline is either limestone cliffs and rocky outcrops or sand beach, there are no mangroves or coastal wetlands present. Drainage throughout most of Tinian is underground where rainwater generally percolates downward into porous rock (Doan et al. 1960), with the exception of heavy rain events that occasionally result in stormwater runoff entering the surface and nearshore waters via short-lived ephemeral streams.

Nearshore Waters

Nearshore waters around Tinian are designated Class AA by the CNMI Bureau of Environmental and Coastal Quality, except for the nearshore waters of Tinian Harbor that are designated Class A. Class AA designation means these waters should remain in their natural pristine state with an absolute minimum of pollution or alteration of water quality from human related sources or actions. Class A designation waters under the jurisdiction of the CNMI Bureau of Environmental and Coastal Quality are protected for their recreational use and aesthetic enjoyment. Other uses of Class A waters are allowed as long as they are compatible with the protection and propagation of fish, shellfish, wildlife, and limited body contact recreation. Sewage outfalls, sewer collection overflows, sedimentation from unpaved roads and development, urban runoff, reverse osmosis brine discharges, and agriculture are the most significant stressors on the CNMI's marine water quality (Bearden et al. 2010). The Tinian municipal solid waste facility does not comply with the Resource Conservation and Recovery Act Subtitle D regulations and could be a source of nearshore water contamination. However, the solid waste facility was not identified as a source of contamination or a significant stressor to marine water quality (Bearden et al. 2012).

Beginning in 2004, the CNMI water quality for coastal waters has been assessed and reported once every 2 years in terms of water body segments based on established, named CNMI sub-watershed units (Bearden et al. 2012). As presented in Appendix I of the CNMI Bureau of Environmental and Coastal Quality's 2012 Water Quality Assessment Report (Bearden et al. 2012), the coastal waters of the Masalok, Makpo Valley, Puntan Diaplo-Lamanibot, and Puntan Tahgong sub-watersheds were listed as impaired by one or more pollutants during and the 2004, 2006, 2008, 2010, and 2012 reporting cycles. Masalok sub-watershed was reported as impaired by orthophosphate for the 2004 reporting cycle (20% of the net reporting period). Makpo Valley sub-watershed was reported as impaired by enterococci bacteria, dissolved oxygen, biocriteria, and orthophosphate for the 2004, 2006, 2010 and 2012 reporting cycles (80% of the net reporting period). Puntan Diaplo-Lamanibot sub-watershed was reported as impaired by enterococci bacteria and orthophosphate for the 2004 and 2012 reporting cycles (40% of the net reporting period). Puntan Tahgong sub-watershed was reported as impaired by biocriteria and orthophosphate for the 2004 and 2006 reporting cycles (40% of the net reporting period). Only Makpo Valley and Puntan Diaplo-Lamanibot were listed as impaired during the 2012 assessment and reporting cycle. Table 4-3 provides a summary of the impaired Tinian coastal waters.

Sub-watershed	Pollutant(s)	Source	Year Listed
Masalok	orthophosphate	unknown	2004
Makpo	enterococci, dissolved oxygen, biocriteria, orthophosphate	unknown, on-site treatment systems, urban runoff	2012 2010 2006 2004
Puntan Diaplo-Lamanibot	enterococci, orthophosphate	unknown	2012 2004
Puntan Tahgong	biocriteria, orthophosphate	unknown	2006 2004
Source: Bearden et al. 2012; APPENDIX II: Detailed 305b Listing of the CNMI Waters; Table II-5 Category 5: Coastal Waters Impaired by Pollutants (Total **Maximum Daily Load Required).**			

Table 4-3. Tinian Impaired Coastal Waters

The Makpo sub-watershed includes both Tinian's commercial harbor and its population center (San Jose). The absence of wastewater collection and treatment systems, stormwater quality treatment and erosion controls are existing concerns for the Makpo Valley sub-watershed. Makpo Valley subwatershed coastal waters have been listed as impaired based on bacterial, nutrient, dissolved oxygen, and biological criteria. The sources of pollution include on-site treatment systems and urban runoff, as well as unidentified sources.

As part of the Mariana Archipelago Reef Assessment and Monitoring Program the National Oceanic and Atmospheric Administration, National Marine Fisheries Service conducted shallow-water conductivity, temperature, and depth casts in nearshore waters surrounding Tinian in August 2003, September 2005, and May 2007. Across all sample years and locations, at a depth of 33 ft. water temperatures ranged from 82.71 to 85.86 degrees Fahrenheit (28.17 to 29.92 degrees Celsius) and salinity ranged from 34.22 to 34.60 practical salinity units. In 2003, cooler temperatures and higher salinity were recorded around the northeast end of Tinian relative to other areas of the island. In 2005 and 2007 spatial comparison suggest an east to west gradient in water properties, with warmer, more saline, and less turbid waters along the western half of the island compared to the eastern half (Brainard 2012).

In 2005 and 2007 water samples were collected to measure chlorophyll-a, total nitrogen, nitrate, and nitrite, phosphate, and silicate levels. Measures of chlorophyll-a, nitrogen, nitrate, and nitrite concentration were lower in 2007 than in 2005. Phosphate and silicate concentration were higher in 2007 than in 2005. In 2005 all measured parameters showed higher concentrations in the southwest region of the island and total nitrogen was 4 times higher in the southwest as compared to other regions of the island. Again in 2007 the highest concentration of nutrients was in the north regions of the island. However, in 2007 the highest chlorophyll-a values were in the southwest region (Brainard 2012).

Coastal

The coastal ecosystem supports valued marine and halophytic species such as sea turtles and sea grass. Some small sand beaches are present, most in northern Tinian. The coral reef systems of Tinian are categorized as fringing, patch and barrier. Fringing reefs are found along most of Tinian’s coastline in water depths of 6 in to 6 ft. (0.1 - 1.8 m) depending on the tide and can be as broad as 400 ft. (122 m). Patch reefs are small reef areas located in shallow and deep water and are not always found close to the coastline.

Wetlands

There are no officially delineated wetlands on Tinian; however, wetland/marsh ecosystems exist on Tinian. These wetland habitats are discrete areas of impermeable clay that impound rainwater. Tinian’s largest wetland is Hagoi, which is an important habitat for the endangered Mariana common moorhen (Wil Chee-Planning Inc. and AECOS Inc. 2008). At least one wetland, Hagoi, is considered jurisdictional and qualifies for official description to Army Corps of Engineers (ACOE) standards (Wil Chee-Planning

Inc. and AECOS Inc. 2008). None are designated or actively managed as protected areas.

In support of the feasibility study, all three surface water features were surveyed for wetland characteristics. Consistent with the definition of a wetland under the CWA, Lake Hagoi has hydric soils (soil which are permanently or seasonally saturated, resulting in anaerobic conditions), hydrophytic vegetation (plants adapted to life in water or waterlogged soils), and has surface water for most of the year (DoN 2013a). Vegetation within and surrounding the wetland is dominated by species native to Tinian. Based on the 2014 wetland surveys at the Mahalang Complex, one of the depressions (MD3) contains wetland vegetation and is a depressional isolated wetland. Other sites surveyed at the Mahalang Complex (MC1, M7, MC2, M10, and M11) in 2014 did not contain wetland vegetation and are ephemeral surface waters. The 2014 wetland survey documented wetland vegetation at both sites within the Bateha Isolated Wetlands. Table 4-4 provides a summary of the surface water areas determined to maintain wetland characteristics.

Watershed	Predominant INRMP Ecosystem	Acres (hectares)	Principal Uses	Attributes	Issues
Makpo Valley	Wetland, Lowland	5,980 (2,420)	Tinian government, commerce crop production	Supplies all potable and agricultural water, Makpo wetland	No sewer system, no grading erosion controls
Putan Diaplo-Lamanibot	Lowland	7,734 (3130)	Agriculture, conservation	Farming and ranching, secondary forest	Open dump is potential for groundwater contamination
Carolinas	Cliff-line	2,669 (1,080)	All public land, most leased to MDC for grazing	Limestone forest	No land clearing erosion controls, no water wells
Masalok	Lowland	4,053 (1,640)	Livestock grazing, forest, MLA	Unexploited groundwater, potable water storage tank	UXO, overgrazing, no groundwater wells
Putan Tahgong	Lowland, wetland	4,300 (1,740)	MLA	Hagoi wetland	Most disturbed watershed, groundwater highly vulnerable to surface contaminants

Table 4-4. Watershed Area Designations

Flood Zones

The Federal Emergency Management Agency (FEMA) classifies areas along coasts subject to inundation by the 100-year flood event and with storm-induced wave hazards as Flood Zone V. The entire Tinian coastline extending from approximately 400 ft. offshore to the shoreline cliff face or to the inland limit of primary flat sand beaches along open coastlines is designated as Flood Zone V and may be subject to storm-induced wave hazards.

Surface Water Quality

The CNMI Water Quality Standards establish criteria designed to protect the designated uses for each classification of waters (i.e., coastal waters, fresh waters, and wetlands). Coastal water quality is discussed in Section 4.5.2, Nearshore Waters. Designated uses of fresh surface waters include: aquatic life, fish consumption, recreation, aesthetic enjoyment, and potable water supply. The CNMI Bureau of Environmental and Coastal Quality maintains a monitoring program for water quality. However, this monitoring program on Tinian is limited to coastal waters. To date, surface water quality data has not been assessed for the three known surface water features on Tinian and the CNMI Bureau of Environmental and Coastal Quality performs no regular monitoring of surface water quality (Bearden et al. 2012).

Sub-watersheds

The U.S. Department of Agriculture identified five sub-watershed areas on Tinian in a 1994 study of island resources (Figure 4-2). The watershed area designations were based on Steering Committee concern areas, topography and principal land use (Table 4-4, above). Contamination due to human activity has the potential to impact surface water and groundwater in these sub-watersheds. Examples of existing or past human activities/land uses which have the potential to contaminate water resources include: agriculture/crop production and harvesting; auto mechanic shops; vehicle fuel stations; fuel storage; cattle ranching; pesticide storage and application; chemical storage; asphalt plant; landfill; grounds maintenance; and land disturbance/ grading/construction. The sub-watershed areas are not in close proximity to the proposed project area and are therefore not expected to affect the proposed action. Details on historic and current sites of potential environmental concern are discussed in Section 4.15.

4.5.3 Environmental Consequences

Effects on surface water features, channel stability and sediment transport were considered to be significant if implementation of an alternative would result in any of the following:

- Obstruct or otherwise change the course of a stream or canal
- Remove, fill, or substantially disturb a jurisdictional wetland or other Waters of the U.S.
- Substantially modify or otherwise adversely affect a floodplain
- Significantly increase channel and/or bank erosion, or reduce channel stability
- Substantially affect sediment transport dynamics

The region of influence evaluated for surface water conditions included the direct footprint of the proposed project as well as the island of Tinian as a whole. The potential effects to surface water features and sediment transport that could result from implementation of the alternatives, measures that would be conducted to mitigate those effects, and the resulting degree of impact are discussed in the following subsections.

4.5.3.1 Alternative 1: No-Action Alternative

- No impacts are anticipated to surface water resources if the No-Action Alternative is implemented.

Under the No-Action Alternative, no breakwater would be constructed, such that project-related actions would cause no discernible change to surface water resources as measured by the applicable significance criteria; therefore, no mitigation would be required. See Table 3. Location, ecosystem type and size of watersheds on Tinian. Source: USDA/SCS (1994).

Navigational risks are expected to persist as the existing configuration of navigational features will continue to expose the harbor and dock facilities to unsafe wave and current conditions resulting in periodic significant disruptions to navigation and port operations.

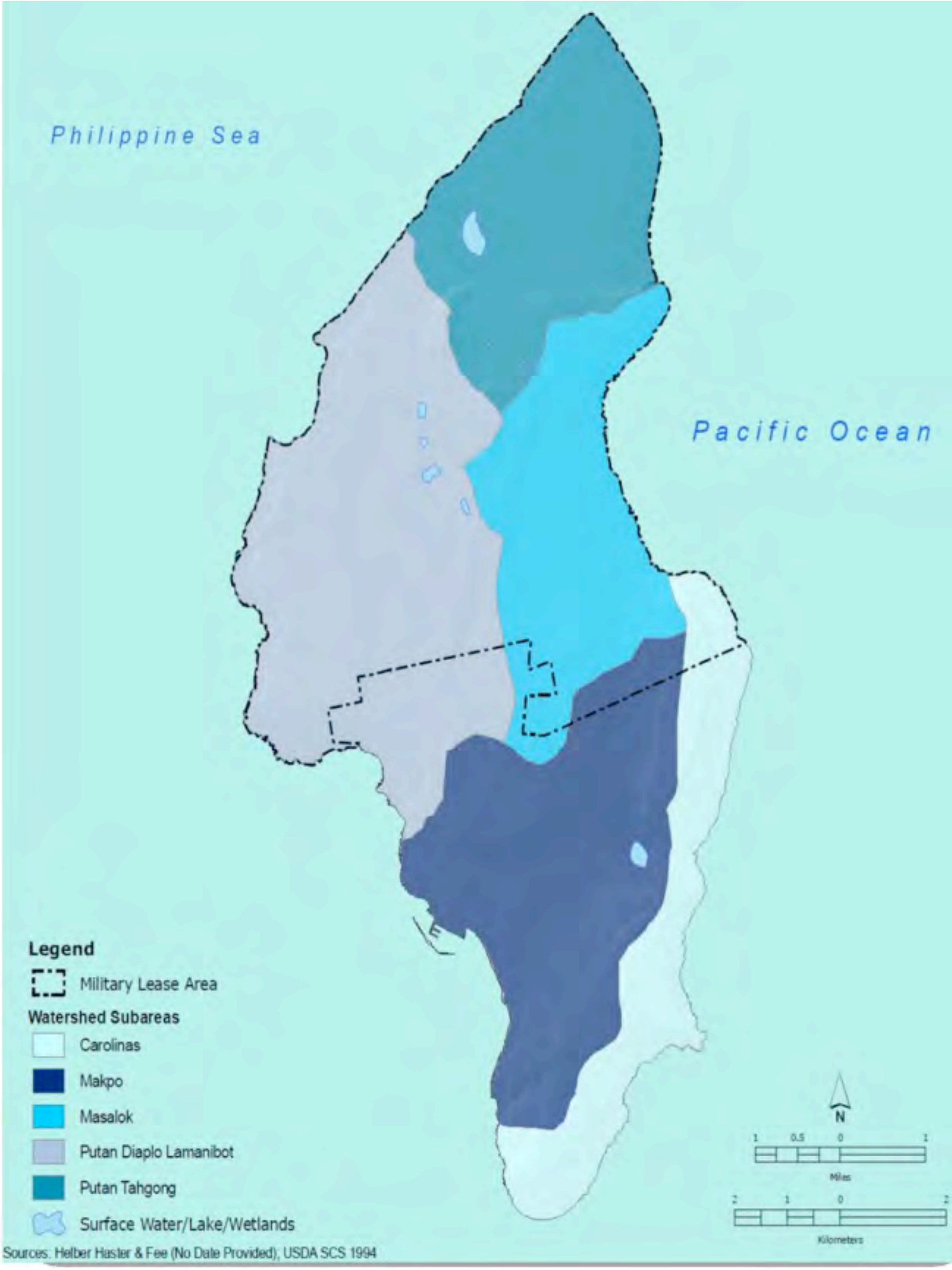
4.5.3.2 Alternative 2: Replace Existing Breakwater along Current Alignment

- Short-term, direct, significant adverse effects are anticipated to water quality of the ocean environment during construction.
- Long-term, less than significant adverse effects under operational conditions.

Construction Footprint and Immediate Area Surrounding the Construction Footprint:

Under this alternative, the current 4600 ft. existing cellular sheet pile breakwater would be removed and a new breakwater would be built along the existing alignment. The potential issues would be wave reflection and potentially high currents near the structure, as well as an altered approach/departure path affecting the waves/currents. Construction activities will affect the ocean environment; however, effects can be lessened by design elements and BMPs during construction to reduce sediment generation and prevent erosion. These BMPs include, but are not limited to, removing debris stockpiles in a timely manner, cover stockpiles to prevent erosion and implement sediment control practices. BMPs are fully described in Appendix 6.

Following construction, no adverse effects are anticipated. Impacts to the ocean environment in the immediate area surrounding the construction footprint are expected to dissipate to less than significant levels if BMPs are adhered to. As the proposed action is limited to the subtidal environment in the construction footprint area, and no surface water bodies in the vicinity of the construction area, no impacts to land-based surface water will occur. The physical conditions within the land area of each of the measure locations would be expected to be generally commensurate with the current onsite conditions.



U.S. Army Corps of Engineers Honolulu District Fort Shafter, Hawaii	Interim Feasibility Report Tinian Harbor Modification Study Island of Tinian Commonwealth of the Northern Mariana Islands	FIGURE TITLE: Location of the five sub-watershed areas on Tinian FIGURE NUMBER: 4-2

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Construction Laydown Area:

There are no surface water bodies at the construction laydown area based on the criteria detailed above. Therefore, no impacts are anticipated from receiving construction debris generated from implementation of Alternative 2. The repairs to the breakwater will require disposal of approximately 50,000 cubic yards of sheet pile, limestone rock, and sand material. The material will be dewatered within the temporary work area located in the northwest corner of the Tinian Harbor footprint shown on Figure 4-4 of proposed project features maps. The temporary work area will be used as a staging area for equipment and construction material and will not adversely impact surface water features.

Construction Debris Disposal Site (Tinian Airport):

There are no surface water bodies at Tinian Airport. Therefore, no impacts to the surface water environment of the disposal site are anticipated from receiving construction debris generated from implementation of Alternative 2. The Department of Public Work's Division of Solid Waste Management has been contacted and 50,000 cubic yards of sheet pile, limestone rock, and sand material will not put significant stress on disposal site capacity or affect geologic features in an adverse manner.

4.5.3.3 Alternative 3: Replace and Extend Existing Breakwater along Current Alignment

- Short-term, direct, significant adverse effects are anticipated to water quality of the ocean environment during construction.
- Long-term, less than significant adverse effects under operational conditions.

Construction Footprint and Immediate Area Surrounding the Construction Footprint:

In addition to removing and replacing the current breakwater, Alternative 3 extends the current breakwater by approximately 300 ft. This extension is not anticipated to substantially obstruct or change the course of the surface water environment. The length of the extension will be optimized based on costs and reduction to wave energy within the harbor. Impacts to the ocean environment in the immediate area surrounding the construction footprint are expected to dissipate to less than significant levels if the BMPs described in Alternative 2 are adhered to. Following construction, no adverse effects are anticipated.

As the proposed action is limited to the subtidal environment in the construction footprint area, and no surface water bodies in the vicinity of the construction area, no impacts to land-based surface water will occur. The physical conditions within the land area of each of the measure locations would be expected to be generally commensurate with the current onsite conditions.

Construction Laydown Area:

There are no surface water bodies at the construction laydown area based on the criteria detailed above. Therefore, no impacts are anticipated from receiving construction debris generated from implementation of Alternative 3. Similar activities (dewatering, staging) as described in Alternative 2 would apply to Alternative 3. The temporary work area will be used as a staging area for equipment and construction material and will not adversely impact surface water features.

Construction Debris Disposal Site (Tinian Airport):

There are no surface water bodies at Tinian Airport. Therefore, no impacts to the surface water environment of the disposal site are anticipated from receiving construction debris generated from implementation of Alternative 3. The Department of Public Work's Division of Solid Waste Management has been contacted and 50,000 cubic yards of sheet pile, limestone rock, and sand material will not put significant stress on disposal site capacity or affect geologic features in an adverse manner.

4.6 Air Quality

4.6.1 Regulatory Framework

Regulations and policies that relate to air quality conditions and are being considered as part of the proposed project include the following:

- Clean Air Act 42 U.S. Code § 7401 et seq.
- National Ambient Air Quality Standards
- EO 13693 (Planning for Federal Sustainability in the Next Decade)
- Air Pollution Control Regulations (CNMI Administrative Code Chapter 65-10)

The U.S. Environmental Protection Agency, under the requirements of the CAA, established National Ambient Air Quality Standards for six contaminants. These contaminants, referred to as criteria pollutants, are:

- Carbon monoxide
- Nitrogen dioxide
- Ozone
- Particulate matter
- Lead
- Sulfur dioxide

The National Ambient Air Quality Standards include primary and secondary standards. The primary standards were established to protect human health, particularly the health of sensitive populations such as asthmatics, children, and the elderly. Sensitive land uses protected by the primary air quality standards are publicly accessible areas used by these sensitive populations; including residences, hospitals, libraries, churches, parks, playgrounds, and schools. The secondary air quality standards set limits to protect the environment, including plants and animals, from adverse effects associated with pollutants in the air. In addition to the criteria pollutants that have been established by the National Ambient Air Quality Standards, greenhouse gas emissions that trap heat in the atmosphere also occur from both natural processes and human activities. Human activities are responsible for almost all of the increase in greenhouse gases in the atmosphere over the last 150 years (U.S. Environmental Protection Agency 2013). The primary long-lived greenhouse gases directly emitted by human activities are carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride.

4.6.2 Environmental Setting

This section describes the existing air quality in the region of influence for the proposed action. Air quality refers to pollutants in the air, and the health and safety aspect of those pollutants to humans and the environment, including plants and animals. Air pollution refers to chemical substances, particulates, biological materials, or other harmful materials that degrade the quality of the atmosphere. Air quality is affected by air pollutants from mobile sources such as vehicles, aircraft, ships, and construction equipment, as well as by stationary sources such as emergency generators, industrial stacks, exhaust vents, prescribed fires, and natural processes (e.g., wildfires and volcanic activity). The region of influence for air quality is Tinian's airsheds, which include the land areas and coastal waters within 3 nautical miles of the island.

Tinian has a tropical climate. Over the course of the year, the temperature varies from 76 to 88 degrees Fahrenheit (24 to 31 degrees Celsius) and is rarely below 73 degrees Fahrenheit (22 degrees Celsius) or above 90 degrees Fahrenheit (32 degrees Celsius). The probability of precipitation varies throughout the year but occurs most often around October. Wind speeds typically vary from 2 to 22 miles per hour with dominant winds originating from the east. It is anticipated that air pollutants from the island would be quickly dispersed under normal weather conditions.

The major stationary sources on Tinian include power generation units and distribution facilities that comprise the existing island-wide power system owned by the CUC. The power generation facility consists of four 2.5-megawatt diesel generators and two 5-megawatt diesel generators. These generators are the largest stationary sources of air emissions on Tinian. Given the limited human activities on the island, Tinian is considered an unclassified area and presumed to be in attainment for all criteria pollutants. In addition to the major stationary sources, facilities may have back-up generators in case of grid power failure; however, these sources are intermittent and considered minor stationary sources.

Traffic along major travel routes, such as Broadway and 8th Avenue within the San Jose area, are the dominant source of mobile source emissions. Operation of aircraft and vessels also generate emissions. The airport and seaport are located relatively far from sensitive neighborhoods, approximately 1 mile and 0.2 mile, respectively. Effects from these emission sources are negligible when compared to those from immediately adjacent roadway traffic.

4.6.3 Environmental Consequences

Effects on air quality were considered significant if implementation of an alternative plan would result in any of the following:

- Exceed air quality standards established for criteria pollutants
- Substantially contribute to an existing exceedance of an air quality standard (for pollutants in non-attainment)
- Generate greenhouse gas emissions that would significantly contribute to climate change.

As previously stated in Section 4.6.2, the region of influence for air quality is Tinian's airsheds, which include the land areas and coastal waters within 3 nautical miles of the island. The potential effects to air quality and climate change that could result from implementation of the alternatives, measures that would be conducted to mitigate those effects, and the resulting degree of impact are discussed in the following subsections.

4.6.3.1 Alternative 1: No-Action Alternative

- No Impacts are anticipated under the No-Action Alternative based on the criteria defined above.

Under the No-Action Alternative, no breakwater would be implemented in the proposed project area, such that no emissions of criteria pollutants would occur. The existing range of air pollution sources within the proposed project area would not be expected to change substantially over the period of analysis. With continuing trade wind patterns, air quality levels are expected to remain relatively constant and would continue to be in compliance with applicable standards.

4.6.3.2 Alternative 2: Replace Existing Breakwater along Current Alignment

- Short-term, direct, less than significant adverse impacts are anticipated under Alternative 2 based on the screening criteria defined above.

Construction Footprint and Immediate Area Surrounding the Construction Footprint:

Construction of the proposed project would involve a variety of ground disturbing activities, including site preparation, and dredging. Use of heavy equipment and earthmoving operations conducted as part of these activities would generate internal combustion engine emissions and fugitive dust; potential air pollutants associated with these emissions include hydrocarbons; carbon monoxide; nitrogen, carbon, and sulfur dioxide; and PM_{10} and $PM_{2.5}$. In general, these emissions would be temporary and localized in nature. The contribution to overall emissions in the region by the proposed action is relatively small; this contribution would only negligibly affect regional air quality and would not be expected to affect attainment of the ambient air quality standards. Furthermore, construction would be conducted in compliance with air pollution control regulations (§ 65-10-415) which specifies that the best practical operation or treatment be implemented such that there is not discharge of visible fugitive dust beyond the property lot line. BMPs that would be implemented to reduce construction-related impacts to air quality are expected to include use and proper maintenance of diesel power equipment, minimizing the extent of exposed soils at any given time, stabilizing soil as quickly as possible (e.g., soil binders, jute netting, and revegetation), use of water trucks or sprinkler systems to minimize dust, covering loose material hauled in trucks, and limiting number of vehicles and speed on unpaved surfaces. With implementation of these BMPs, construction-related impacts to air quality are expected to be less then significant; no mitigation would be required.

Over the long term, the proposed project would also result in air emissions from increased boat and vessel traffic to the harbor. However, these emission levels would be low, and similar to those associated with construction, would be expected to have a negligible impact on air quality. Specific to greenhouse gases, a limited amount of emissions would be associated with construction of the proposed project resulting from the use of heavy equipment. Published EPA data indicate that 22 pounds of carbon dioxide are produced for every gallon of diesel fuel burned, and 19.4 pounds are produced for every gallon of gasoline used (EPA, 2008). Given the scale of the proposed project, the total amount of emissions resulting from construction are expected to be under reporting thresholds. As such, the proposed project would be expected to have a negligible impact on greenhouse gas emissions and climate change. Thus, air quality within the land area of each of the measure locations would be expected to be generally commensurate with the current onsite conditions.

Construction Laydown Area:

Short-term, direct, less than significant adverse impacts to air quality are anticipated at the construction laydown area based on the criteria detailed above. Any fugitive dust and/or emissions generated from the use of equipment would be temporary and localized in nature, would account for a small portion of total emissions generated by the proposed project, and would only negligibly affect regional air quality. With the implementation of BMPs described above, the impact to air quality would not require mitigation. A full list of BMPs associated with the laydown area are found in Appendix 6.

Construction Debris Disposal Site (Tinian Airport):

Short-term, direct, less than significant adverse impacts to air quality are anticipated at the Tinian Airport disposal site from the implementation of Alternative 2. As described above, the handling of waste transport will result in fugitive dust and engine emissions from heavy equipment. These impacts would be removed once disposal activities cease. The Department of Public Work's Division of Solid Waste Management has been contacted and the 50,000 cubic yards of construction debris will not put significant stress on disposal site capacity or affect geologic features in an adverse manner.

4.6.3.3 Alternative 3: Replace and Extend Existing Breakwater along Current Alignment

- Short-term, direct, less than significant adverse impacts are anticipated under Alternative 3 based on the screening criteria defined above.

Air quality emissions that would occur with implementation of Alternative 3 are expected to be within the range of those described for the Alternative 2, and as such, impacts to air quality are expected to be negligible; no mitigation would be required with the implementation of BMPs.

Construction Footprint and Immediate Area Surrounding the Construction Footprint:

Under Alternative 3, construction footprint of the proposed project would involve the same process and have the same impact as described in Alternative 2. Although the breakwater is extended by approximately 300 ft., with the implementation of BMPs described above, effects on air quality would only negligibly affect regional air quality.

Construction Laydown Area:

Short-term, direct, less than significant adverse impacts to air quality are anticipated at the construction laydown area based on the criteria detailed above. Any fugitive dust and/or emissions generated from the use of equipment would be temporary and localized in nature, would account for a small portion of total emissions generated by the proposed project, and would only negligibly affect regional air quality. With the implementation of BMPs described above, the impact to air quality would not require mitigation. A full list of BMPs associated with the laydown area are found in Appendix 6.

Construction Debris Disposal Site (Tinian Airport):

Short-term, direct, less than significant adverse impacts to air quality are anticipated at the Tinian Airport disposal site. As described above, the handling of waste transport will result in fugitive dust and engine emissions from heavy equipment, similar to those described for Alternative 2. The Department of Public Work's Division of Solid Waste Management has been contacted and the 50,000 cubic yards of construction debris will not put significant stress on disposal site capacity or affect air quality in an adverse manner.

4.7 Noise

4.7.1 Regulatory Framework

Regulations and policies that oversee the Noise environment are being considered as part of the proposed project include the following:

- Noise Pollution and Abatement Act of 1972

The Noise Pollution and Abatement Act of 1972 is a statute of the U.S. initiating a federal program of regulating noise pollution with the intent of protecting human health and minimizing annoyance of noise to the general public.

The Act established mechanisms of setting emission standards for virtually every source of noise, including motor vehicles, aircraft, certain types of HVAC (heating, ventilation, and air-conditioning) equipment and major appliances. It also put local governments on notice as to their responsibilities in land-use planning to address noise mitigation. This noise regulation framework comprised a broad data base detailing the extent of noise health effects.

Congress ended funding of the federal noise control program in 1981, which curtailed development of further national regulations. Since then, starting in 1982, the primary responsibility to addressing noise pollution shifted to state and local governments. The Environmental Protection Agency (EPA) retains authority to conduct research and publish information on noise and its effects on the public, which is often included in environmental impact assessments for new developments. The initial EPA regulations and programs provided a basis for development of many state and local government noise control laws across the U.S.

This section describes noise as perceived from a human perspective. The region of influence for noise is the island of Tinian Harbor and the immediate surrounding area. Noise can also affect other resources such as biological (e.g., wildlife response), cultural (e.g., historic structures), recreational (e.g., noise intrusion on experience), and land use (e.g., incompatibility with existing land uses). This section presents baseline noise levels within the study area and focuses on the human response to those levels. Other sections in this Interim Feasibility Report use this information but in the context of their respective resource baseline and potential impact analyses. For example, the noise environment as it relates to terrestrial biological resources is presented in Sections 4.11 Biology of this Interim Feasibility Report.

Definition

Noise is generally described as unwanted sound. Sound is a physical phenomenon consisting of minute vibrations that travel through a medium, such as air or water, and are sensed by the human ear. Unwanted sound can be based on objective effects (such as hearing loss and speech interruptions) or subjective judgments (such as noise complaints and annoyance).

There are two main concepts to understand how noise is generated—sound level and frequency.

- Sound Level. Sound level or intensity is a measure of the loudness of a sound expressed in decibels. A human ear can only detect sounds that are above a certain decibel level. The other end of the spectrum is sound so loud (high decibel level) that it can cause pain, discomfort, and hearing loss.

- Frequency. Frequency is a measure of sound-wave cycles per unit of time, with higher frequency sounds dispersing more quickly than those at lower frequencies. The standard unit of measurement for sound wave frequency is cycles per second, expressed as hertz. Sound waves move outward in all directions from the source and weaken as the distance from the source increases. Sound waves (i.e., noise) can also be diminished or enhanced by wind movement, terrain, ground cover, and temperature. Human hearing can generally perceive frequencies between 20 and 20,000 hertz. The human ear cannot hear sounds above and below these frequencies.

4.7.2 Affected Environment

Most of Tinian's population and commercial activity are in San Jose near Tinian Harbor. Over half of Tinian's population resides in San Jose. The current noise environment on Tinian is typical of a rural town or small suburban area. Other residential areas include Marpo Heights, Marpo Valley, Carolinas Heights, and Carolinas village. As of the 2010 U.S. Census, total population was 3,136 people. Although infrequent, most noise-generating activities on Tinian stem from existing military aviation, marine, and ground-based training activities. This noise is imperceptible (undetectable) to Tinian Harbor and the surrounding areas near the Harbor. Other noise contributors include civil and commercial aircraft operations at Tinian International Airport, cargo vessel operations at the Port of Tinian, and aircraft activities in regional airspace. Under current conditions, all of Tinian is considered to be in Noise Zone I, except in the immediate vicinity of the airport. Under baseline conditions, one Special Use Airspace unit (Air Traffic Controlled Assigned Airspace 6) and several airport departure and arrival routes produce aircraft-generated noise around Tinian. These levels are negligible and do not perceptibly contribute to the baseline noise environment. These activities do not generate noise levels exceeding 65 decibels day-night average sound level.

Roads on Tinian currently experience very light traffic volumes. Traffic volumes this low contribute very little to the noise environment and do not exceed 65 decibels day-night average sound level. According to the 2008 CNMI Comprehensive Highway Master Plan, the largest traffic volumes were on Broadway, Canal, and Grand Streets in San Jose with annual daily trips of 1,470, 1,520, and 2,240, respectively (Commonwealth Department of Public Works 2008). Traffic volume on all other roads, including at the Port of Tinian, is well below 500 daily trips. Again, all land uses within Noise Zone I are considered compatible.

There are occasional Amphibious Assault Vehicle landings at the Port of Tinian. While these operations are rare, their noise levels are temporarily noise levels of 88 A-weighted decibels at 100 ft. These noise levels are single events and not an average noise level used for compatibility. While average noise levels exceeding 65 decibels are considered incompatible with sensitive land uses, these areas are at least 1,000 ft. from the port. Therefore, sensitive land uses are not exposed to incompatible noise levels under baseline conditions. In the waters around Tinian, small fishing and dive boats operate and a cargo vessel makes regular trips between the Saipan and Tinian ports (in 2010, ferryboat operations between Tinian and Saipan ceased operations). Fishing and dive boats, as well as the cargo vessel operations generate noise levels that are low enough to be considered compatible with adjacent land uses.

Noise zones are defined as follows:

- Zone I (<65A-weighted/<62 C-weighted/<87 decibels Peak). This noise zone includes all areas in which day-night average sound levels are less than 65 decibels A-weighted, or 62 decibels C-weighted, or the Peak sound level is below 87 decibels. This noise zone is usually compatible with all types of land use activities (e.g., residential, schools, hospitals, places of worship, commercial). A subset of Zone I is the Land Use Planning Zone contours with noise levels between 57 and 62 decibels C-weighted. These noise levels are compatible with any land use, but land use planners often use this area as a buffer around military ranges. For example, although residential areas would be compatible in these areas, permitting or zoning a high density apartment complex could invite noise complaints on days of higher than normal range activities.
- Zone II (65 to 75 A-weighted / 62 to 70 C-weighted / 87 to 104 Peak). Exposure to noise within this zone is normally considered incompatible with noise-sensitive land uses such as residences, hospitals, schools, and places of worship. Activities such as industrial, transportation, and resource production (e.g., farming, ranching, and mining) are considered compatible within this zone.
- Zone III (>75 A-weighted / >70 C-weighted / >104 Peak). Exposure to noise within this zone is considered incompatible with noise-sensitive land uses such as residences, schools, hospitals, places of worship, parks, and playgrounds but compatible with industrial, transportation, and resource production. Table 4-5 lists the noise zones in tabular format, presents the noise levels encompassed within the particular noise zone, and identifies whether sensitive land uses such as homes, schools, hospitals, places of worship are compatible with that zone (Army 2007).

Zone	Decibel A-weighted / C-weighted / Peak	Land Use Compatibility Level
I	<65 / <62 / <87	Compatible
II	65 to 75 / 62 to 70 / 87 to 104	Normally Incompatible
III	>75 / >70 / >104	Incompatible

Note: *Compatibility refers to sensitive land uses such as homes, schools, hospitals, and places of **worship. Sources: Army 2007; Army Center for Health Promotion and Preventative Medicine 2009.**

Table 4-5. Noise Zones and Sensitive Land Use Compatibility

4.7.3 Environmental Consequences

Effects related to noise were considered to be significant if implementation of an alternative plan would result in any of the following:

- Exceed maximum permissible levels established by local noise ordinances
- Cause long-term exposure of noise-sensitive receptor(s) to a substantial increase in noise levels over the ambient condition

The region of influence for noise effects include the immediate area surrounding the construction site as well as the island of Tinian as a whole. The potential effects to noise that could result from implementation of the alternatives, measures that would be conducted to mitigate those effects, and the resulting degree of impact are discussed in the following subsections.

4.7.3.1 Alternative 1: No-Action Alternative

- No Impacts will occur to the Noise Environment if the No-Action Alternative is implemented.

Navigational risks are expected to continue as the existing configuration of navigational features will continue to expose the harbor and dock facilities during periods of high wind and wind conditions, which will continue to result in significant disruption to navigation and port operations.

4.7.3.2 Alternative 2: Replace Existing Breakwater along Current Alignment

- Long-term, direct, less than significant, adverse impacts to the Noise environment will occur if Alternative 2 is implemented based on the screening criteria defined above.
- Short-term, direct, less than significant adverse impacts to the Noise environment will occur during construction of the breakwater.

Construction Footprint and Immediate Area Surrounding the Construction Footprint:

Under this alternative, the current 4600 ft. existing cellular sheet pile breakwater would be removed and a new breakwater would be built along the existing alignment. Improvements to the harbor would result in reduced wave action in the channel and at wharves, increasing the usability of the harbor, harbor facilities, and indirectly the usability of land based recreational areas. Noise is likely to increase over the long-term, but the impacts would not be significant.

As described above, no impacts are anticipated in the short or long-term to biological resources as a result of changes to the noise environment. Short-term, direct, less than significant impacts are anticipated during construction of the breakwater due to additional traffic as well as from construction equipment. Typical sound levels emitted from construction equipment range from 55 dBA from a pick-up truck to 90 dBA from a concrete saw. Table 4-6 lists sound exposure levels associated with typical equipment, in varying operating modes.

The impacts to the noise environment are unavoidable but necessary in order to achieve the benefits to safety, economics and the general well-being of the island. Mitigation will include reducing the footprint to the extent possible and using materials and design elements which blend in to the natural environment. Mitigation efforts would reduce impacts to less than significant.

Construction Laydown Area:

Short-term, direct, less than significant adverse impacts to noise are anticipated during construction of the breakwater based on the criteria detailed above. This will be due to an increase in traffic and noise from construction equipment. The temporary work area will be used as a staging area for equipment and construction materials.

Construction Debris Disposal Site (Tinian Airport):

Short-term, adverse, less than significant impacts to noise are anticipated at the Tinian Airport disposal site, which will be receiving approximately 50,000 cubic yards of construction debris (sheet pile, limestone rock, and sand material) generated from the implementation of Alternative 2. The impacts would be removed once disposal activities cease.

4.7.3.3 Alternative 3: Replace and Extend Existing Breakwater along Current Alignment

- Long-term, direct, less than significant, adverse impacts to the Noise environment will occur if Alternative 3 is implemented based on the screening criteria defined above.
- Short-term, direct, less than significant adverse impacts to the Noise environment will occur during construction of the breakwater.

Construction Footprint and Immediate Area Surrounding the Construction Footprint:

In addition to removing and replacing the current breakwater, Alternative 3 extends the current breakwater by approximately 300 ft. The length of the extension will be optimized based on costs and reduction to wave energy within the harbor. Improvements to the harbor under this breakwater alternative would include all the improvements noted under Alternative 2. Anticipated impacts are also identical to those described in Alternative 2.

Construction Laydown Area:

Short-term, adverse, less than significant impacts to noise are anticipated during construction of the breakwater based on the criteria detailed above. This will be due to an increase in traffic and noise from construction equipment.

Construction Debris Disposal Site (Tinian Airport):

Short-term, adverse, less than significant impacts to noise are anticipated at the Tinian Airport disposal site, which will be receiving approximately 50,000 cubic yards of construction debris (sheet pile, limestone rock, and sand material) generated from the implementation of Alternative 3. The impacts would be removed once disposal activities cease.

Type of Equipment[1]	Sound level (dBA)	Type of Equipment[1]	Sound level (dBA)
Backhoe	80	Excavator	85
Compactor (ground)	80	Flatbed truck	84
Concrete saw	90	Front end loader	80
Drill rig truck	84	Grader	85
Bulldozer	85	Pickup truck	55
Dump truck	84	Tractor	84
Tugboat	87	Grab dredger	112
Crane	101	Generator	63

Source: USDOT, 2006 (https://www.fhwa.dot.gov/environment/noise/construction_noise/handbook/handbook00.cfm)

[1] This is an abbreviated list for example purposes; a more complete list of construction-related equipment is available at the above-referenced source.

dBA = A-weighted decibels

Table 4-6. Typical Equipment Sound Levels

4.8 Airspace

4.8.1 Regulatory Framework

The International Civil Aviation Organization is responsible for codifying the principles and techniques of international air navigation and fostering the planning and development of international air transportation to ensure safe and orderly growth. In accordance with EO 10854, Extension of the Application of the Federal Aviation Act of 1958, both rulemaking and non-rulemaking actions that encompass airspace outside of the U.S. sovereign airspace (e.g., beyond 12 nautical miles from the U.S. coast line) require coordination with the DoD and Department of State. All EO 10854 coordination must be conducted at the Federal Aviation Administration (FAA) headquarters level by the Airspace Regulations and Air Traffic Control Procedures Group (FAA 2014c, Section 2). The FAA Western Service Area has jurisdiction for international airspace associated with this proposed action and is responsible for obtaining airspace coordination with the International Civil Aviation Organization for this proposed action. The FAA has the overall responsibility for matters involving the use of navigable airspace and handles airspace matters in accordance with FAA Order JO 7400.2K, Procedures for Handling Airspace Matters (FAA 2014c). The FAA has the same requirements under NEPA as the U.S. military (FAA Order 1050.1E, Environmental Impacts: Policies and Procedures) (FAA 2006a) and FAA Order 5050.4B, NEPA Implementing Instructions for Airport Actions (FAA 2006b). The FAA controls airspace through policies and procedures designed to ensure safe and efficient use of the airspace by all users. Like the highway system and traffic laws, FAA and International Civil Aviation Organization rules govern the Airspace System and regulations to establish how and where aircraft may fly. Collectively, the FAA uses these rules and regulations to make airspace use as safe, effective, and compatible as possible for all types of aircraft, from private propeller-driven planes to large, high-speed commercial and military jets. The U.S. military requests airspace from the FAA and schedules and uses airspace in accordance with the processes and procedures detailed in DoD Directive 5030.19, DoD Responsibilities on Federal Aviation, and FAA regulations (DoN 2013a).

4.8.2 Affected Environment

Section 4.8 describes the current condition of the airspace surrounding the island of Tinian. In the U.S. and its territories, domestic airspace includes airspace overland to 12 nautical miles from the shoreline. The proposed Special Use Airspace associated with this action would lie entirely within the Oakland Flight Information Region. International airspace begins 12 nautical miles from the shoreline and is controlled based on International Civil Aviation Organization regulations. The International Civil Aviation Organization codifies the principles and techniques of international air navigation and fosters the planning and development of international air transportation to ensure safe and orderly growth. The U.S. is one of 191 member states belonging to the International Civil Aviation Organization. They have been delegated as the Air Navigation Service Provider for the airspace associated with the CNMI (FAA 2014a, Oakland Oceanic Controlled Airspace/Flight Information Region).

The FAA is responsible for evaluating, processing and charting airspace changes. They are represented by the FAA Western Service Area (Renton, Washington) which provides guidance and control of U.S. territory airspace in the Pacific that includes the CNMI. The region of influence for the proposed action encompasses:

- Airspace within a 12-nautical mile (22-kilometer) boundary of Tinian's shore (see Section 3, Proposed Action and Alternatives).

Other Special Use Airspace in the region would not be expected to have cumulative impacts with the proposed action. The airspace surrounding Tinian is within the FAA's Guam Combined Center/Radar Approach Control Flight Information Region. Radar services are provided to high altitude aircraft operating on instrument flight rule plans en route to, transiting through, and arriving at or departing from the airports within its service area. For Tinian, air traffic control services are provided at altitudes above 3,500 ft. MSL by Guam Combined Radar/Approach Control. Air traffic control services are not available below 2,000 ft. MSL for aircraft arriving and departing Tinian International Airport. Tinian airfield requires access to the airspace within 12 nautical miles of Tinian for approaches and departures. Tinian International Airport issued by commercial, private and military aircraft.

4.8.3 Impacts and Mitigation

Effects on airspace were considered significant if implementation of an alternative plan would result in any of the following:

- Disrupts en route operations
- Impedes access to public airports
- Disrupts air traffic control services

The potential effects to airspace that could result from implementation of the alternatives, measures that would be conducted to mitigate those effects, and the resulting degree of impact are discussed in the following subsections.

4.8.3.1 Alternative 1: No-Action Alternative

- No Impacts are anticipated to air space if the No-Action Alternative is implemented.

There will be no environmental changes to air space if No Action is taken. The air space of each of the measure locations would be commensurate with current onsite conditions.

4.8.3.2 Alternative 2: Replace Existing Breakwater along Current Alignment

- No Impacts are anticipated based on the criteria defined above.

Construction Footprint and Immediate Area Surrounding the Construction Footprint:

Under this alternative, the current 4600 ft. existing cellular sheet pile breakwater would be removed and a new breakwater would be built along the existing alignment. As the proposed action is limited to the subtidal environment in the construction footprint area, no impacts to air space will occur. The airspace of each of the measure locations would be expected to be generally commensurate with the current onsite conditions.

Construction Laydown Area:

No adverse impacts to airspace are anticipated to the construction laydown area. Construction activities are in low lying areas and would not obstruct the airspace above.

Construction Debris Disposal Site (Tinian Airport):

No impacts are anticipated at the Tinian Airport disposal site, which will be receiving approximately 50,000 cubic yards of construction debris generated from the implementation of Alternative 2. The final disposal location for all disposal material will be placed in low depression areas next to the Tinian airport runway. The property is an open grass area that is maintained on a regular basis. The excess sheet pile material may be placed in the Saipan landfill if the airport facility is not sufficient. Thus, waste transport and unloading would neither disrupt air traffic operations nor impede access to the airport. Construction activities are in low lying areas and not obstructing the view of flight lines.

4.8.3.3 Alternative 3: Replace and Extend Existing Breakwater along Current Alignment

- No Impacts are anticipated to Tinian airspace if Alternative 3 is implemented.

Construction Footprint and Immediate Area Surrounding the Construction Footprint:

No adverse impacts to airspace are anticipated to the construction laydown area based on the criteria detailed above. The construction footprint area is similar to Alternative 2 and is limited to the subtidal environment. No impacts to air space will occur. The airspace of each of the measure locations would be expected to be generally commensurate with the current onsite conditions.

Construction Laydown Area:

No adverse impacts to airspace are anticipated to the construction laydown area. Similar to Alternative 2, construction activities are in low lying areas and would not obstruct the airspace above.

Construction Debris Disposal Site (Tinian Airport):

No impacts are anticipated at the Tinian Airport disposal site, which will be receiving approximately 50,000 cubic yards of construction debris generated from the implementation of Alternative 3. The final disposal location for all disposal material will be placed in low depression areas next to the Tinian airport runway. The property is an open grass area that is maintained on a regular basis. The excess sheet pile material may be placed in the Saipan landfill if the airport facility is not sufficient. Thus, waste transport and unloading would neither disrupt air traffic operations nor impede access to the airport. Construction activities are in low lying areas and not obstructing the view of flight lines.

4.9 Land and Submerged Land Use

4.9.1 Regulatory Framework

Regulations and policies that relate to land use and submerged land use being considered as part of the proposed project include the following:

Federal Regulations

- Section 216 of Flood Control Act of 1970 (Public Law 91-611)
- Coastal Zone Management Act (CZMA)
- Territorial Submerged Lands Act as amended (Senate Bill 256 and Presidential Proclamation)
- Public Lands Act (Public Law 15-2)
- Homestead Law (Public Law 16-50)
- Submerged Lands Act, as amended

4.9.2 Environmental Setting

Section 4.9 provides a summary of existing and planned land use, including submerged lands, on and adjacent to Tinian. The region of influence includes the land of Tinian and associated submerged lands, which are defined as areas within 3 nautical miles of the mean high tide.

Tinian is the second largest and topographically most level island, and therefore, has the most land remaining in the public domain. Tinian land area is approximately 25,148 acres (10,177 hectares) in size with approximately 68 miles of roads administered by the CNMI's Department of Public Works. A substantial portion of the public land is leased to the U.S. Government under the terms of the US-CNMI Covenant Agreement. A total of 10% (approximately 2,422 acres [980 hectares]) of Tinian's land is privately owned, and the remaining 90% (or 22,726 acres [9,197 hectares]) are public lands (DoN 2010), Figure 4-3.

1. Grant of Public Domain: Public lands given in fee simple (i.e., absolute title to land), with no use specified.
2. Designated Public Lands: Public lands actively managed for a particular use, such as a forest or park.
3. Leased: Public lands that require government approval (i.e., permits). If the proposed lease encompasses greater than 12.4 acres (5 hectares) it must be approved by the CNMI legislature. Areas less than 12.4 acres (5 hectares) require the CNMI Department of Public Lands approval. Permits tend to be for commercial operations, such as hotels, golf courses, and cattle grazing.
4. Technical Agreement Leased: Public lands that are leased to the military and collectively referred to as the Military Lease Area (15,148 acres [6,130 hectares]). This area encompasses the northern portion of Tinian. International Broadcasting Bureau occupies 840 acres (340 hectares) of land in the Military Lease Area. The Military Lease Area is largely undeveloped.
5. Undesignated: Undeveloped Tinian public lands without a specified use are classified as undesignated public lands.

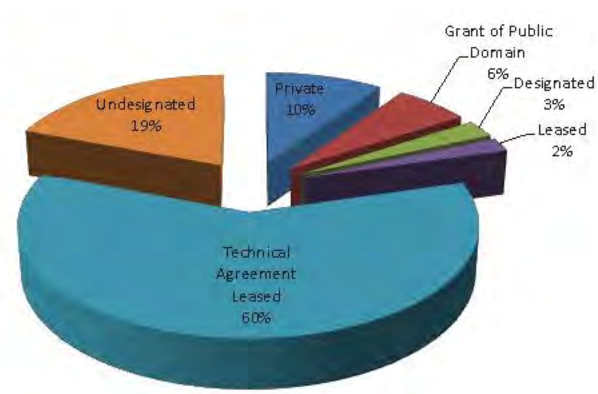

Figure 4-3 Tinian Land Jurisdictional Control

The U.S. presently leases 15,148 acres (6,130 hectares) on Tinian (approximately the northern two-thirds of Tinian) from the CNMI. The U.S. Leaseback Agreement with the CNMI for the 7,779 acres (3,148 hectares) located in the middle third of Tinian is referred to as the Lease Back Area. The U.S. Leaseback Agreement expired in 2014, and ranchers have maintained cattle grazing in the Lease Back Area on a month-to-month basis. However, the CNMI and the DoD are executing a renewal of the lease until the summer of 2016 (Zotomayor 2015). The majority of these leased lands are used for training purposes. When areas are not closed for training, the land is accessible to the public. All private land and non-Technical Agreement leased lands are located in the south part of the island. Fee interest ownership is the primary means of private land ownership (DoN 2010). Leases or easements are used for land transfer and/or management purposes.

According to the DPL Public Land Use Master Plan Update dated January 2007, planned land use in Tinian involves accommodating growth on available land. Following the recognition of garment making as a legitimate industry, this may require making CNMI an attractive and desirable regional destination again by implementing improvements in infrastructure, including resurfacing main roads and beautifying points of tourist interest, or tax incentives for investors. Other investment projects and business opportunities are available as well. This may include: agribusiness, ecotourism, foreign investment in recreational venues, healthcare, transshipment, capitalizing on natural resources, development of marine infrastructure, utilities.

The CNMI Homestead Program

The CNMI Department of Public Lands is mandated to designate public land, including land on Tinian for potential homesteads. In an effort to fulfill this mandate, the CNMI Department of Public Lands designates available and suitable land on their land use planning maps for potential village and agricultural homesteading. A person is not eligible for more than one agricultural and one village homestead. A freehold interest in the homestead is granted once the person meets specified criteria and cannot be transferred for 10 years after receipt (Fifteenth (15th) Northern Marianas Commonwealth Legislature 2007). In 2010, the CNMI enacted Public Law 16-50, a homesteading law to establish the Northern Islands Village and Agricultural Homesteading program for current or former residents of the Northern Islands or any qualified person interested in residing on the Northern Islands. The law; however, requires extensive municipal planning and infrastructure development prior to homesteading deeds being issued. There are at least two areas with fully implemented homestead programs on Tinian, Marpo Heights and the Carolinas Plateau. Homestead village areas have been noted on the Department of Public Lands' Tinian land classification map (CNMI Department of Public Lands 2013b.

The CNMI Coastal Resources Management Program

The Bureau of Environmental and Coastal Quality is responsible for the implementation of the Coastal Resources Management permit process. While the permit process is not applicable to federally leased or owned submerged lands, the Coastal Zone Management Act federal consistency determination is, and must address potential impacts to these CNMI Areas of Particular Concern, as any project wholly or partially within a CNMI Area of Particular Concern requires Coastal Resources. For example, coastal resources such as coral reefs, and reef fish habitat would be affected in this area of concern. The Bureau of Environmental and Coastal Quality has identified geographic areas with special management requirements: CNMI Areas of Particular Concern. There are five CNMI Areas of Particular Concern delineated:

1. Shoreline: The area between the mean high water mark and 150 ft. inland.
2. Lagoon and Reef: The area extending seaward from the mean high water mark to the outer slope of the reef.
3. Wetlands and Mangrove: Areas that are covered either permanently or periodically with water and where species of wetland or mangrove vegetation can be found.
4. Port and Industrial: Includes land and water areas surrounding the port of Tinian.
5. Coastal Hazards: Those areas identified as coastal flood hazard zones (V and VE) on FEMA Flood Insurance Rate Maps.

Submerged Land Control around Tinian

The Territorial Submerged Lands Act (Public Law 113-34, 27 Stat. 518) was amended to provide for the transfer of certain submerged lands around the CNMI to the CNMI government to assure parity with other insular areas. Prior to the transfer, the U.S. government had control (fee simple ownership) over submerged lands on the CNMI. The U.S. retained control over submerged lands extending to 3 nautical miles from the coast of Tinian where the U.S. government has land leases. The U.S. government has rights in, and powers over, the waters and submerged lands extending seaward of the mean high tide line. However, these submerged lands must comply with the CZMA (NOAA 1980). To ensure the protection of military training in the area, a January 2014 Presidential Proclamation did not include the transfer of submerged lands adjacent to the leased lands of Tinian to the government of the CNMI (Obama 2014). Therefore, the U.S. retains control over submerged lands extending to 3 nautical miles from the coast of Tinian where the U.S. government has land leases.

U.S. Military Land Use of Tinian Harbor

Most of Tinian's population and commercial activity are in San Jose near the Port of Tinian. The Technical Agreement (Northern Mariana Islands 1975b) between the U.S. and the CNMI governments provided for the lease back of property and joint use arrangements for the harbor and port area on Tinian; however, the lease on the harbor was terminated in the 1994 amendment. Though the harbor lease was terminated in 1994, the U.S. retains the following rights:

- Handle cargo, stage equipment, and other port related activities.

- Use the harbor as ports of entry for troops, vehicles, and equipment. There is a staging area near San Jose used for logistical support associated with major training events.
- Install, operate and maintain fuel and utility lines to support above activities.
- Moor vessels, handle cargo, stage equipment, and other port related activities
- Use the harbor as ports of entry for troops, vehicles, and equipment

Public Use of Submerged Lands around Tinian

The public use of submerged lands and the waters above include recreation, fishing, and marine transportation. See Section 4.10, Recreation and Section 4.14, Transportation, for more discussion of use of the waters around Tinian.

Tinian Land Use Plans

Per the CNMI Public Land Use Plan (Marianas Public Land Corporation 1989), planned land use on Tinian involves accommodating growth on available land, with the majority of development expected to be concentrated in the San Jose area. This may include new urban land uses and hotel-style development (i.e., a compact footprint for transient accommodations, such as guest rooms with a bed and a bath) instead of a resort-style (i.e., a sprawling land-intensive complex that often includes a hotel plus outdoor amenities, such as gardens, golf courses, etc.) to accommodate the expected increase in visitors as a result of tourism.

Sponsor's Real Estate Interests

The non-federal sponsor, the CPA, is the current fee owner of all identified land for this proposed project. All land has been under control of CPA since the original project was constructed.

Neither parcel was purchased in anticipation of the proposed project nor were federal funds provided for the acquisition.

Estates to Be Acquired

Project features consist of a breakwater, temporary work area (Figure 4-4), and disposal site (Figure 4-5). All lands identified for this proposed project are currently located within the Non-federal fee-owned property. However, if at a later date additional lands are required for disposal sites the required estate to acquire is Fee. If additional temporary work space is required the required estate is a temporary work area easement. The following estates, if found necessary at a later date, would be required for the proposed project.

Federal Projects/Ownership

The Tinian Harbor was originally constructed in 1944-1945 during World War II. The Harbor was never authorized as a federal project, there for the Government has never held federal interest in Tinian Harbor. There are no federal owned lands in the immediately vicinity.

Navigation Servitude

Lands required for the channel improvement are within navigable water of the Non-federal Sponsor and are available by navigation servitude. The proposed repairs of the breakwater structure are also within navigable water of the Non-federal sponsor and are available by navigation servitude.

PL 91-646 Relocation Benefits

Public Law (PL) 91-646, The Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended, commonly called the Uniform Act, is the primary law for acquisition and relocation activities on federal or federally assisted projects and programs. The non-federal sponsor is required to follow the guidance in this public law. The sponsor is aware of this and has experience in the Uniform Act policies.

There will be no displaced persons due to the proposed acquisitions and no PL 91-646 benefits are anticipated.

Minerals

The CNMI owns all mineral rights within the territory and there are no surface or subsurface minerals known that would impact the proposed project.

Assessment of Sponsor's Acquisition Capability

An assessment of the sponsor's acquisition capabilities to acquire the land necessary for this proposed project has not been done as of the writing of this REP. However, the local sponsors have partnered in other projects on the island. The CPA, CNMI is considered fully capable and have Eminent Domain authority. Real Estate will require the sponsor to provide an assessment of their acquisition capability and when completed, this assessment will be added to the REP.

Zoning

All lands involved in the proposed project features are currently zoned as industrial. No impacts of this proposed project will result in a taking of a real property interest due to enactment or enforcement of the zoning ordinance.

Public Utilities Relocations

There are no known public utilities that are impacted by the proposed project.

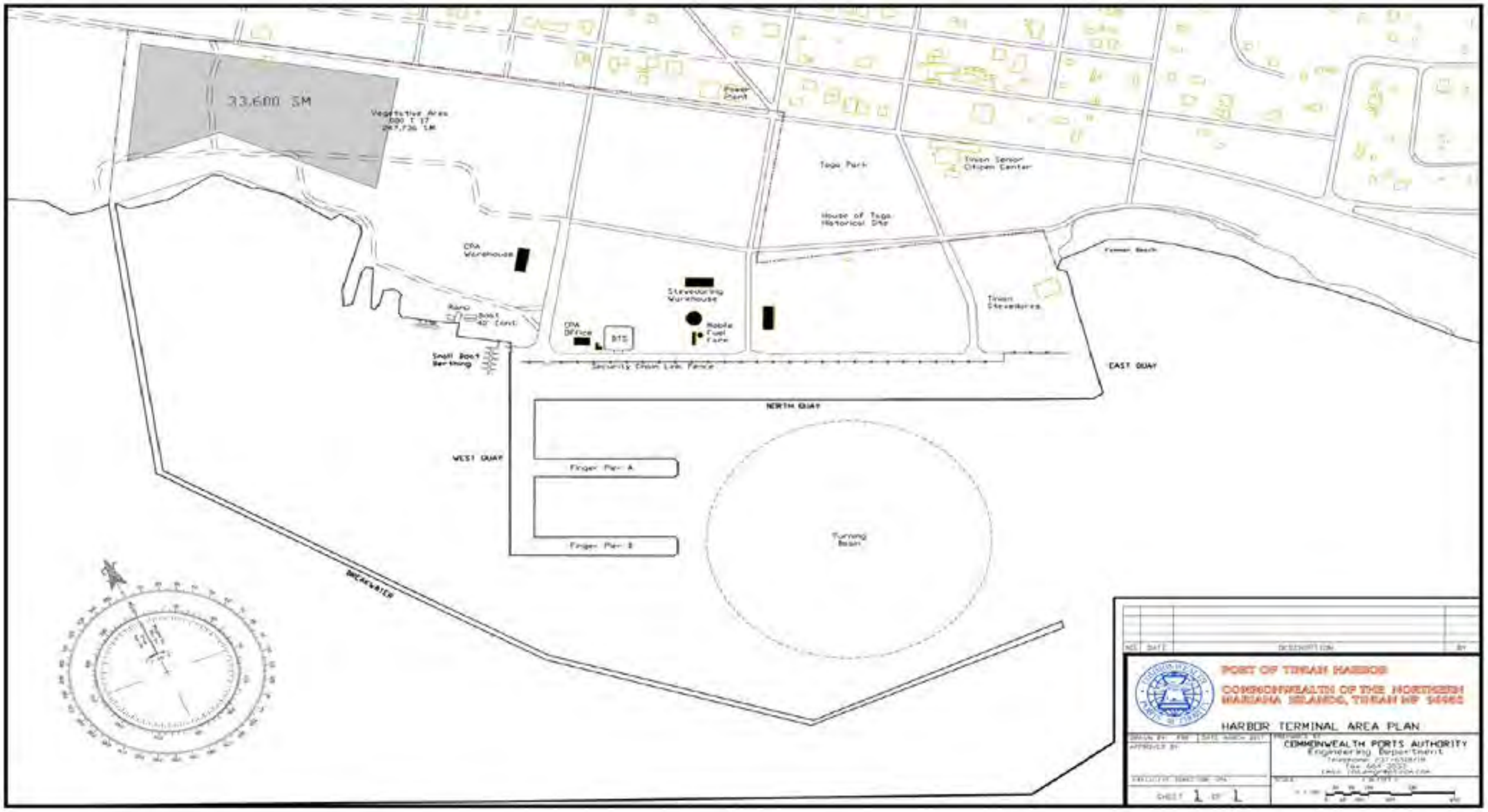

Figure source: USACE Real Estate Appendix

U.S. Army Corps of Engineers Honolulu District Fort Shafter, Hawaii	PROJECT NAME: Interim Feasibility Report Tinian Harbor Modification Study Island of Tinian Commonwealth of the Northern Mariana Islands	FIGURE TITLE: Temporary Work Areea FIGURE NUMBER: 4-4

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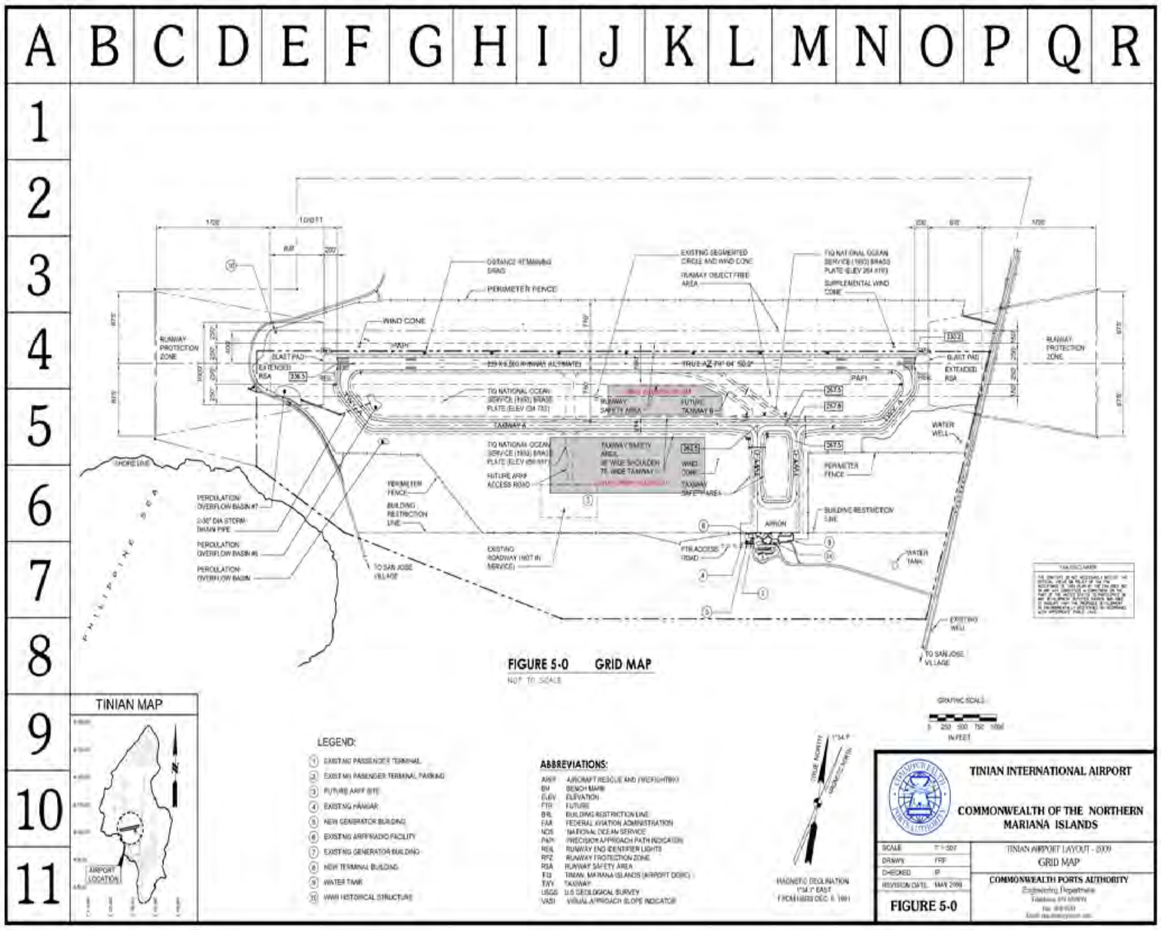

Figure 7. Plain view layout for disposal location on Tinian Island

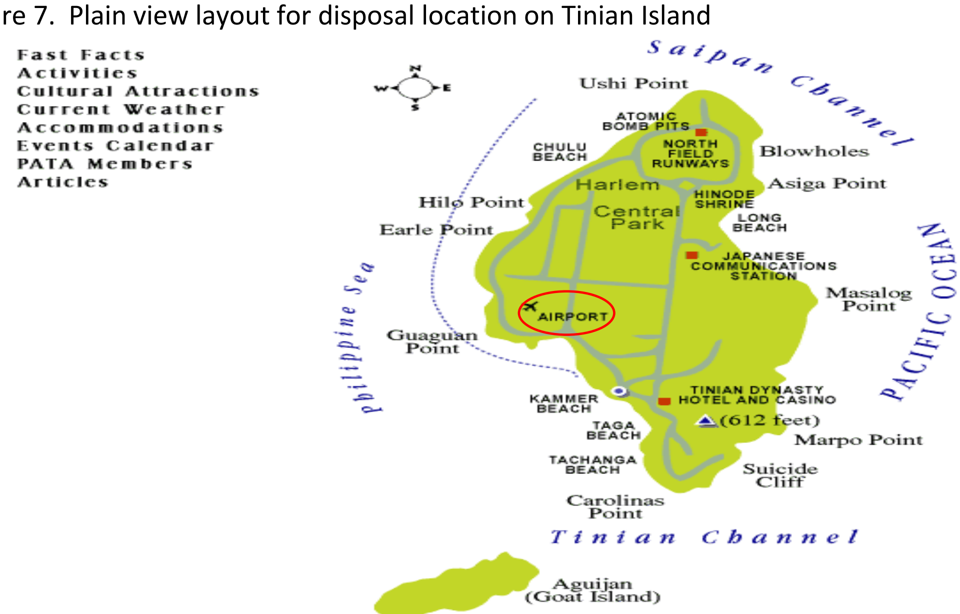

Figure source: USACE Real Estate Appendix

U.S. Army Corps of Engineers Honolulu District Fort Shafter, Hawaii	Interim Feasibility Report Tinian Harbor Modification Study Island of Tinian Commonwealth of the Northern Mariana Islands	FIGURE TITLE: Tinian Disposal Location
		FIGURE NUMBER: 4-5

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Baseline Cost Estimate for Real Estate

Fee Title	$ 0
Temporary Work Area Easement	$ 0
Improvements	$ 0
Hazard Removals	$ 0
Mineral Rights	$ 0
Damages	$ 0
Incremental real estate costs (formally known as contingencies)	$ 0
Relocations	$ 0
Uniform Relocation Assistance (PL 91-646)	$ 0
Acquisition Administrative Costs	$20,000
TOTAL COST	$20,000

Real estate acquisition is further discussed in Appendix 7.

4.9.3 Environmental Consequences

As previously described in Section 4.9.3, the region of influence includes the land of Tinian and associated submerged lands, which are defined as areas within 3 nautical miles of the mean high tide. Effects on land use were considered to be significant if implementation of an alternative plan would result in any of the following:

- Preclude use of an area for its intended purposes, or displace an existing land use;
- Substantially conflict with the objectives any applicable land use regulation, plan, or policy; or
- Directly or indirectly induce a substantial degree of development in a floodplain.
  The potential effects to land use that could result from implementation of the alternatives, measures that would be conducted to mitigate those effects, and the resulting degree of impact are discussed in the following subsections.

4.9.3.1 Alternative 1: No-Action Alternative

- No Impacts are anticipated to the Real Estate environment if the No-Action Alternative is implemented.

Under the No-Action Alternative, none of the navigational risk management measures would be implemented. As no features would be constructed, there would be no project-related activities that would affect existing real estate resources in the proposed project area. Over the 50-year period of analysis for the FWOP condition, the boundaries and intended uses of the various land use designations are expected to be maintained. In particular, no portion of the proposed project area is expected to be rezoned to allow development.

4.9.3.2 Alternative 2: Replace Existing Breakwater along Current Alignment

- Short-term, direct, less than significant adverse impacts are anticipated to the Real Estate environment if Alternative 2 is implemented.
- Long-term, indirect, less than significant adverse or beneficial impacts to the Real Estate environment may occur if implementation facilitates future economic growth that requires changes in land use.

Construction Footprint and Immediate Area Surrounding the Construction Footprint:

Under this alternative, the breakwater will be constructed within the bounds of the current breakwater and no real estate interest will be acquired due to navigation servitude. No permanent features would be constructed on land, therefore, there would be no project-related activities that would affect land use conditions.

No acquisitions are involved with the proposed action and the estimated real estate administrative costs associated with the proposed alternatives is approximately $20,000, including all LERRD and administrative fees. Long-term, indirect, less than significant adverse or beneficial impacts to the Real Estate environment may occur if implementation facilitates future economic growth that requires changes in land use. Impacts to Real Estate would include impacts during construction and operational phases.

Construction Laydown Area:

Short-term, adverse, less than significant impacts to land based real estate are anticipated during construction of the breakwater based on the criteria detailed above. The repairs to the breakwater will require disposal of approximately 50,000 cubic yards of sheet pile, limestone rock, and sand material. The material will be dewatered within the temporary work area located in the northwest corner of the Tinian Harbor footprint shown on Figure 4-4 of proposed project features maps. The temporary work area is approximately 8.3 acres of open storage space consisting of grass and gravel. The temporary work area will be used as a staging area for equipment and construction materials. This property is owned in fee by the non-federal sponsor and is located within the proposed project site. All access routes to the temporary work area and the final disposal site is owned by the non-federal sponsor and is available for the proposed project.

Construction Debris Disposal Site (Tinian Airport):

No impacts are anticipated to land and submerged land use from receiving construction debris generated from implementation of Alternative 2. The final disposal location for all disposal material will be placed in low depression areas next to the Tinian airport runway. The non-federal sponsor identified disposal locations shown on Figure 4-5 of proposed project feature maps, which is approximately 48.9 acres of land. The property is an open grass area that is maintained on a regular basis. The excess sheet pile material may be placed in the Saipan landfill if the airport facility is not sufficient. All disposal locations are owned in fee by the non-federal sponsor and all land has been reported available for this proposed project. The Department of Public Work's Division of Solid Waste Management has been contacted and 50,000 cubic yards of sheet pile, limestone rock, and sand material will not put significant stress on disposal site capacity or affect geologic features in an adverse manner.

4.9.3.3 Alternative 3: Replace and Extend Existing Breakwater along Current Alignment

- Short-term, direct, less than significant adverse impacts are anticipated to the Real Estate environment if Alternative 4 is implemented.
- Long-term, indirect, less than significant adverse or beneficial impacts to the Real Estate environment may occur if implementation facilitates future economic growth that requires changes in land use.

Construction Footprint and Immediate Area Surrounding the Construction Footprint:

This measure involves all of the same demolition and breakwater replacement methods described in Alternative 2, with the addition of an approximately 300 foot extension to the breakwater, increasing the total length to approximately 4,600 foot. The breakwater will be constructed within navigable water and no real estate interest will be acquired due to navigation servitude. No acquisitions are involved and the estimated real estate administrative costs associated with the proposed alternative is approximately $20,000, including all LERRD and administrative fees.

Construction Laydown Area:

Short-term, adverse, less than significant impacts to land based real estate are anticipated during construction of the breakwater based on the criteria detailed above. As with Alternative 2, the material will be dewatered within the temporary work area located in the northwest corner of the Tinian Harbor. The temporary work area is approximately 8.3 acres of open storage space consisting of grass and gravel. The temporary work area will be used as a staging area for equipment and construction materials. This property is owned in fee by the non-federal sponsor and is located within the proposed project site. All access routes to the temporary work area and the final disposal site is owned by the non-federal sponsor and is available for the proposed project.

Construction Debris Disposal Site (Tinian Airport):

No impacts are anticipated to land and submerged land use from receiving construction debris generated from implementation of Alternative 3. The final disposal location for all disposal material will be placed similar to Alternative 2, next to the Tinian airport runway. Any excess sheet pile material may be placed in the Saipan landfill if the airport facility is not sufficient. All disposal locations are owned in fee by the non-federal sponsor and all land has been reported available for this proposed project.

4.10 Recreation

4.10.1 Regulatory Framework

Regulations and policies that relate to recreation and are being considered as part of the proposed project include the following:

- Parks and Recreation Act of 1998 (P.L. 11-106)
- Fish, Game, and Endangered Species Act (Public Law 2-51)
- Tinian and the CNMI Mayor's Offices – The Tinian Mayor's Office maintains visitor areas on Tinian, including the historic and cultural sites in and outside of the National Historic Landmark.
- CNMI Department of Land and Natural Resources – Division of Parks and Recreation – This agency has a small presence on Tinian. The Division of Parks and Recreation is responsible for the administration of parks and recreational sports facilities in populated areas. However, this agency has no specific park management plans for Tinian.
- CNMI Bureau of Environmental and Coastal Quality – Division of Coastal Resources Management – This agency ensures consistency with the CZM Program, and manages Areas of Particular Concern (see Section 3.7, Land and Submerged Land Use), which include areas extending 150 ft. inland from shorelines, and extending seaward to the outslope of lagoons and reefs. The Division of Coastal Resources Management requires commercial recreation and tourism operators to secure a permit to operate in the shoreline jurisdiction.
- CNMI Department of Land and Natural Resources – Division of Fish and Wildlife – This agency is responsible for the protection and enhancement of natural resources, both terrestrial and ocean-based. This agency issues fishing, harvesting, and hunting permits. In addition, this agency has law enforcement responsibilities and can issue citations for violations.
- CNMI Department of Community and Cultural Affairs – Division of Sports and Recreation – This agency oversees two facilities on Tinian, both located in the village of San Jose - the gymnasium and pool/ball field complex. The division is responsible for administration of the sports complexes and associated recreation programs.

4.10.2 Environment Setting

The tourism industry is the largest industry on Tinian, with over 54,000 visitors in 2013. Figure 4-6 shows locations of various recreational resources on Tinian. The majority of the visitors to Tinian are there for the historic and cultural sites and to enjoy the warmth and the beaches (DoN 2014). Recreational resources enhance the visitor experience and help drive the local economy (DoN 2010). Most recreational facilities on Tinian are geared to visitors, and most commercial establishments catering to recreation activities are located in the village of San Jose. The most popular activities for visitors include historical

	Swimming / Wading	Snorkeling	SCUBA diving	Fishing	Picnicking	Nature viewing	Sightseeing	Walking / Hiking	Boating	Volleyball / Basketball	Marine sports	Parking	Restrooms	Palapalas (beach pavilions)	Picnic areas	Grills / Fire	Trash receptacles	Dock / Harbor	Boat ramp	Historical / Cultural site	Playground
(1) Suicide Cliff						x	x					x								x	
(2) Tachogna Beach Park	x	x			x						x	x	x	x	x		x				
(3) Taga Beach	x	x			x	x	x					x	x	x	x					x	
(4) Taga to Kammer Pathway					x	x		x							x						
(5) Kammer Beach Park	x	x			x							x	x	x	x	x					
(6) Port of Tinian									x			x						x	x		
(7) Unai Chulu (White Beach)	x			x		x						x									
(8) White Cross Memorial Point						x	x					x								x	
(9) Blow Hole						x						x									
(10) Unai Dangkulo (Long Beach)	x	x				x	x	x				x								x	
(11) Unai Masalok	x	x				x	x					x								x	

Source: Public Shoreline Access Guide for Saipan, Tinian, and Rota. 2015. BECQ

U.S. Army Corps of Engineers
Honolulu District
Fort Shafter, Hawaii

Interim Feasibility Report
Tinian Harbor Modification Study
Island of Tinian
Commonwealth of the Northern Mariana Islands

FIGURE TITLE: Tinian Recreational Areas

FIGURE NUMBER: 4-6

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island tours, snorkeling, and water sports at public beaches (Mariana Visitors Authority 2012).

Historic and Cultural Sites

Tour agencies provide packaged tours of historic and cultural sites on and around Tinian. These tours are generally windshield tours with brief stops at the sites for the tourists to take photographs (DoN 2014). One of the cultural sites near the proposed project area (east of the harbor), is The Ruins of the House of Taga, which is listed on the National Register of Historic Places. The Tinian Mayor's Office is responsible for maintaining vegetation at the House of Taga. The remnants of the house are in the village of San Jose, and belonged to the ancient Chamorro chief, Taga. This site contains the tallest set of latte stones used by the ancient Chamorros throughout the CNMI. Latte stones are pillars capped by a hemispherical stone capital with the flat side facing up that were used as building supports by the ancient Chamorro people. The stones are quarried limestone, each approximately 19 ft. in length. Of the 12 large latte structures, only one remains standing.

Beaches and Parks

Although beaches and parks are frequented by both visitors and Tinian residents, social activities of Tinian residents' center on beaches. On the weekends, residents go to the beach to barbeque and spend time with friends and family (DoN 2014). Tourists also visit the beaches, but their visits are often short as they are part of a tour group. The following sections describe the use of beaches on Tinian.

Beaches and parks (from north to south) Unai Kammer, Unai Taga, and Unai Tachogna, as described below. These beaches are the most frequented by tourists since they are located near San Jose.

Additionally, the local population frequents these beaches because they are conveniently located and have support facilities (e.g., areas for picnics, parking). These beaches are managed by the Bureau of Environmental and Coastal Quality. The Division of Parks and Recreation is responsible for the administration and maintenance of the beach parks.

- Unai Kammer is located on the southwestern side of Tinian facing the Philippine Sea near the village of San Jose. This white sand beach is surrounded by mature vegetation. Unai Kammer contains approximately six well-maintained covered picnic pavilions and a large paved parking lot. Unai Kammer is utilized by residents as well as tourists.
- The Unai Taga area is small and is accessed by a stairway system that extends to the beach and a concrete lookout area extending over the ocean where many local children enjoy diving and swimming. While the beach itself is quite small and generally frequented by residents, the site offers outstanding views to Aguijan Island and turquoise blue waters. It is a sightseeing stop for tourists.

- Unai Tachogna is located just south of Unai Taga and connected to it by a shoreline pathway. On weekends, local families and groups gather here to barbecue and picnic. It is also a popular place for snorkeling, personal watercraft, and banana boats, most of which can be rented from the beach operators. Like Unai Kammer, there are numerous covered pavilions for picnicking and socializing. The rental kiosk and covered pavilions make Unai Tachogna a popular destination for tourists.

Ocean-Based Resources

Coastal recreational activities on Tinian take place in the coastal zone and surf zone waters. Ocean-based recreational activities on Tinian include snorkeling, diving, recreational fishing, and boating.

1. Snorkeling and Diving

Tinian waters contain many World War II wrecks, coral structures, and abundant sea life. Among one of the most popular snorkel and dive spots around Tinian is "Two Corals", which is located just a short boat ride from Tinian Harbor. Two Corals consists of two adjacent coral formations. The fish life here includes varieties of parrot fish, grouper, damsel fish, and more. There are approximately six charter boats on Tinian (National Oceanic and Atmospheric Administration 2012), as well as boats on Saipan, that offer charters to Tinian dive spots (DoN 2014).

2. Recreational Fishing

Most fishing activities on Tinian are of a subsistence or artisan variety (i.e., selling fish to cover cost of fishing excursion) (DoN 2014). However, recreational fishing is popular with the tourists. There are approximately six charter boats on Tinian available for recreational fishing charters. Subsistence, artisan, and recreational fishing activities include bottom fishing and trolling for barracuda, mahi-mahi, marlin, skipjack, red sea bass, and tuna. There are also shoreline fishing areas used for recreational fishing, which are primarily located south of Dump Coke South and north of the Two Coral (Turtle Cove) diving sites on the west side of Tinian. There are several fishing events held throughout the year within the CNMI, such as the Tinian Cliff Fishing Derby and the Tinian Bottom Fishing Derby.

3. Boating

Tinian Harbor's small boat dock is north of the main wharf and finger piers. The marina contains approximately 18 small craft mooring slips. The dock and finger piers support a variety of small craft used for fishing, diving, sight-seeing, and pleasure boating. The Tinian small boat dock is operated and maintained by the Boating Access program of the CNMI Division of Fisheries and Wildlife, which is 100% federally funded by the USFWS. Vehicle access to the dock is via a paved road that services the port piers. North of the boat dock is a concrete boat ramp for launching and recovering small craft.

There are approximately six charter boats that serve tourist clientele. These charter boats are reportedly owned by non-local residents for tourists from their country of origin: Japan, China, and Korea. Although booked as charter fishing trips, these trips serve primarily as photographic opportunities for clients (National Oceanic and Atmospheric Administration 2012). Additionally, there is at least one charter boat from Saipan that conducts a Tinian boat tour (DoN 2014).

4. Annual Events

Tinian Hot Pepper Festival

In February, the Tinian Mayor's Office sponsors its annual 2-day Pika, or Hot Pepper, Festival to honor the Tinian hot pepper (Donni Sali), a small but hot native pepper. The festival is an island-style show that features different kinds of locally prepared dishes, as well as arts and crafts. One of the highlights is the hot pepper eating contest. The festival location on Tinian varies from year to year, but the festival is always held in February over President's Day weekend. The 2017 festival was held at Kammer Beach within walking distance of the seaport (Saipan Tribune 2017a).

San Jose Fiesta

The San Jose Fiesta is an annual celebration of Tinian's patron saint, which was hosted this April 2017 by the Mayor's office at the Kammer Beach Main Pavilion. The fiesta includes live band entertainment, food and game concessions, sports tournaments and competitions. Sunday starts with the San Jose Mass followed by a continuation of the games at the fiesta grounds. Camp grounds are also provided for those that wish to tent camp (Saipan Tribune 2017b).

4.10.3 Environmental Consequences

Effects on recreation were considered significant if implementation of an alternative plan would result in any of the following:

- Substantially disrupt activities that occur at an institutionally-recognized recreational facility
- Substantially reduce availability of and access to designated recreational or open space areas

The potential effects to recreation and open space that could result from implementation of the alternatives, measures that would be conducted to mitigate those effects, and the resulting degree of impact are discussed in the following subsections. The region of influence for recreational resources evaluated includes the island of Tinian and surrounding waters.

4.10.3.1 Alternative 1: No-Action Alternative

- No impacts are anticipated to the Recreational Environment if the No-Action Alternative is implemented.

Under the No-Action Alternative, none of the navigational risk management measures would be implemented. As no features would be constructed, there would be no project-related activities that would affect existing recreational activities in the proposed project area. Recreational activities would continue in the same manner as it is current conducted.

4.10.3.2 Alternative 2: Replace Existing Breakwater along Current Alignment

- Long-term, direct and indirect, significant beneficial effects are anticipated under Alternative 2 based on the screening criteria defined above.
- Short-term, direct, less than significant adverse impacts are anticipated under Alternative 2 based on the screening criteria defined above.

Construction Footprint and Immediate Area Surrounding the Construction Footprint:

Short-term, direct, less than significant adverse effects are anticipated due to construction. The potential issues would be wave reflection and potentially high currents near the structure, as well as an altered approach/departure path affecting the waves/currents.

Recreational activities described above may be affected due to temporary closure and/or other environmental effects such as noise and traffic in the proposed project area. However, long-term beneficial effects anticipated are increased usability of the harbor and harbor facilities and usability of recreational areas in the proposed project area (i.e., if water based recreational activities increase, land-based recreation is also expected to increase).

Construction Laydown Area:

Short-term, direct, less than significant adverse effects are anticipated to the construction laydown area based on the criteria detailed above. The construction laydown area would be inaccessible to the public during construction but these impacts would be removed once disposal activities cease.

Construction Debris Disposal Site (Tinian Airport):

No impacts are anticipated to the recreation environment of the Tinian Airport disposal site from receiving construction debris generated from implementation of Alternative 2.

4.10.3.3 Alternative 3: Replace and Extend Existing Breakwater along Current Alignment

- Long-term, direct and indirect, significant beneficial effects are anticipated under Alternative 3 based on the screening criteria defined above.
- Short-term, direct, less than significant adverse impacts are anticipated under Alternative 2 based on the screening criteria defined above.

Construction Footprint and Immediate Area Surrounding the Construction Footprint:

In addition to removing and replacing the current breakwater, Alternative 3 extends the current breakwater by approximately 300 ft. Impacts to the harbor under the extended breakwater alternative are identical to those in Alternative 2.

Construction Laydown Area:

Short-term, direct, less than significant adverse effects are anticipated to the construction laydown area based on the criteria detailed above. The construction laydown area would be inaccessible to the public during construction but these impacts would be removed once disposal activities cease.

Construction Debris Disposal Site (Tinian Airport):

No impacts are anticipated to the recreation environment of the Tinian Airport disposal site or Saipan Landfill from receiving construction debris generated from implementation of Alternative 3.

4.11 Biology

4.11.1 Regulatory Framework

Regulations and policies that protect biological resources and are being considered as part of the proposed project include the following:

- Federal Endangered Species Act (16 U.S. Code §§ 1531–1544, as amended)
- Magnuson-Stevens Fishery Conservation and Management Act (16 U.S. Code §§ 703–712, as amended)
- Marine Mammal Protection Act (16 U.S. Code §§1361–1421h, as amended)
- Clean Water Act, Sections 401 & 404
- EO 13089, Coral Reef Protection
- EO 13112, Invasive Species
- EO 13158, Marine Protected Areas
- EO 13547, Stewardship of the Ocean, Our Coasts, and the Great Lakes
- EO 12962, Recreational Fisheries, as amended by EO 13474, Methodology
- Migratory Bird Treaty Act
- EO 13186 – Responsibilities of Federal Agencies to Protect Migratory Birds
- EO 13112 – Invasive Species
- Threatened and Endangered Species (CNMI Administrative Code § 85-30.1-101)

In addition to these regulations, the FWCA requires federal agencies to coordinate with the U.S. Fish and Wildlife Service (USFWS) and state wildlife agencies during project planning to provide for adequate consideration of wildlife resource conservation, including minimization of adverse effects and compensation for wildlife resource losses. Coordination with USFWS and DLNR has been conducted throughout the planning process. A formal record of their recommendations has been documented in a FWCA PAR, which is included in this Interim Feasibility Report as Appendix 2. Compliance with ESA Section 7 is discussed in Section 6.4.3.

4.11.2 Environmental Setting

4.11.2.1 Terrestrial Biology

Biological resources include vegetation and wildlife, including species that are protected under federal and/or state endangered species statutes. The resources that occur within the proposed project area are generally described below. Under the ESA of 1973, as amended (Act or ESA), a species may warrant protection through listing if it is endangered or threatened throughout all or a significant portion of its range. Listing a species as an endangered or threatened species can only be completed by issuing a *rule.* Critical habitat shall be designated, to the maximum extent prudent and determinable, for any species determined to be an endangered or threatened species under the Act.

Flora

Lowland

Lowlands, the largest ecosystem on Tinian, comprise approximately half the total land area and extend between the coastal forests and the island's interior limestone cliffs. The lowlands have been heavily disturbed by historical land uses and violent typhoon weather systems that frequent the Marianas. Lowlands are characterized by secondary forests predominantly tangantangan (*Leucaena leucocephala*), crop and grazing lands, and urban development.

Cliff-line

The cliff-line ecosystem consists of isolated areas of native limestone and mixed forest that follow ridgelines. Forested areas located at the top of Mt. Lasso and around the north escarpment of Maga contain native trees, such as *Pisonia grandis*, Ficus spp., *Cynometra ramiflora*, *Guamia mariannae*, *Pandanus tectorius*, *Cerbera dilata*, and *Ochrosia mariannensis*. These species are support Mariana fruit bats and Micronesian megapodes. Cliff-line habitat is also used by the Tinian monarch. Historically, some areas of cliff-line forest (e.g., Mt. Lasso and Maga) were used for cattle grazing. However, the presence of some native species such as *Cynometra ramiflora* is not conducive to cattle grazing, resulting in limited use of the area.

Vegetation Communities

Early reports of Tinian dating from the 1700s describe the island as having predominately limestone forest. Tinian's native limestone forest was largely impacted by past activities, including widespread cultivation of non-native species (e.g., sugar cane), activities during World War II, intentional and accidental introduction of non-native plants and animals, and grazing by non-native ungulates. Native limestone forests that once dominated the island were reduced to approximately 5% of the total vegetation cover (Camp et al. 2012; DoN 2013b). Limestone forests on Tinian are important because they retain the functional ecological components of native forest that provide habitat for the majority of Tinian's native species, including ESA-listed and proposed species, and CNMI-listed species, as well as bird species protected under the Migratory Bird Treaty Act (MBTA). These forests also help maintain water quality and reduce fire risk. Non-native plant species (e.g., tangantangan) significantly alter the native forest structure, composition, and resilience of the forest to other disturbances and also provide less suitable conditions for native flora and fauna species than a native forest (Morton et al. 2000; Tang et al. 2011; DoN 2013b).

Island-wide vegetation mapping was conducted in 2006 by the U.S. Forest Service (2006), and was updated in 2009 by the U.S. Fish and Wildlife Service (Amidon 2009). The 2009 vegetation assessment of Tinian noted that since the 1980s, the coverage of open fields decreased 11.6% while secondary forest coverage increased 10.3%, likely a result of succession as open areas became reforested over the previous two decades. Smaller changes included a decrease in tangantangan and an increase in urban land cover (Amidon 2009).

Mixed Introduced Forest

Mixed introduced forest, also referred to as secondary forest, contains a mixture of introduced trees, shrubs, and dense herbaceous plants. Dominant trees common in this vegetation community include tangantangan, ironwood (*Casuarina equisetifolia*), siris tree (*Albizia lebbeck*), Formosan koa (*Acacia confusa*), flame tree (*Delonix regia*), and Madras thorn (*Pithecellobium dulce*). While not considered a native vegetation community on Tinian, the mixed introduced forest community provides habitat for the federal ESA-listed and proposed species and CNMI-listed species as well as for other native bird species, including those protected under the MBTA. Several areas of mixed introduced forest lie close to the proposed project area.

Tangantangan

This vegetation community typically occurs on limestone and is dominated by the non-native tangantangan tree. Tangantangan forests dominate much of the level and moderately sloping lowland habitat areas on Tinian, especially in the northern portions of the island. While not considered a native vegetation community on Tinian, tangantangan forest provides habitat for native bird species, including those protected under the MBTA. Several areas of tangantangan are located near the proposed project area.

Herbaceous-Scrub

This vegetation community occurs on both limestone and volcanic soils, primarily within open fields, and is dominated by grassy and low herbaceous vegetation with small thickets of native and introduced shrubs. Introduced species such as lantana (*Lantana camara*), paper rose (*Operculina ventricosa*), climbing hempweed (*Mikania scandens*), blue buffle grass (*Pennisetum polystachion*), and giant sensitive plant (*Mimosa invisa*) are common, as are small groves of trees including African tulip tree (*Spathodea campanulata*). Several areas of herbaceous scrub are located near the proposed project area.

Developed Land

Developed land includes human-occupied or otherwise highly disturbed areas that include lawns, mowed grass fields, and other landscaped areas and impervious surfaces such as buildings, roads, and parking lots. This category includes areas mapped by U.S. Forest Service (2006) as "Urban and Built-up" and "Urban Vegetation." The proposed project area is primarily on and near developed land.

Other Vegetation Communities

Of note are the vegetation communities that are not in proximity to the proposed project area. These are listed below:

- Casuarina Forest consists of forests of pure ironwood or dominated by ironwood.
- Coconut Forest describes a vegetation community dominated by coconut palms (*Cocos nucifera*).
- Beach strand vegetation communities are limited to narrow strips in coastal areas and have adapted to excessively drained soils and salt spray from the adjacent coastal waters. Strand vegetation includes beach heliotrope (*Tournefortia argentea*), bur-marigold (*Bidens pilosa*), portia tree (*Thespesia populnea*), false verbena (*Stachytarpheta spp*.), morning glory (*Ipomoea triloba*), lantana, and beach naupaka (*Scaevola taccada*). It also includes *Pemphis acidula* in rocky areas.
- Wetland vegetation communities are areas of grasses, sedges, herbs, or woody species which are specialized for growing in standing water or soils that are saturated for most of the year.
- The agricultural community is defined as those areas used for the cultivation of food crops.
- Barren, unvegetated areas of soil, sand, or rock primarily occur along Tinian's coastline.

Fauna

Tinian's native terrestrial fauna includes forest birds, water birds, seabirds, one fruit bat, eight reptiles, two land crustaceans, and one tree snail (Table 4-7). Additional fauna, such as insects and arachnids are not included.

	Common name	Genus	Species	Local Name
Birds	Rufous fantail	*Rhipidura*	*rufifrons*	Na'abak
	Micronesian starling	*Aplonis*	*opaca*	Sali
	Tinian monarch	*Monarcha*	*takatsukasae*	Chichirikan Tinian
	Micronesian honeyeater	*Myzomela*	*rubratra*	Egigi
	Bridled white-eye	*Zosterops*	*conspicillatus*	Nosa
	Mariana fruit-dove	*Ptilinopus*	*roseicapilla*	Tottot
	White-throated ground-dove	*Gallicolumba*	*xanthonura*	Paluman apaka
	Collared kingfisher	*Todiramphus*	*chloris*	Sihek
	Micronesian megapode	*Megapodius*	*laperouse laperouse*	Sasangat
	Mariana common moorhen	*Gallinula*	*chloropus guami*	Pulatatt
	Brown booby	*Sula*	*leucogaster*	Lu'ao
	Black noddy	*Anous*	*minutus*	Fahang dikiki
	Brown noddy	*Anous*	*stolidus*	Fahang
	Pacific reef-heron	*Egretta*	*sacra*	Chuchuko atilong
	White tern	*Gygis*	*alba*	Chunge'
	Yellow bittern	*Ixobrychus*	*sinensis*	Kakkak
Mammal	Mariana fruit bat	*Pteropus*	*mariannus mariannus*	Fanihi
Reptiles	Micronesian gecko	*Perochirus*	*ateles*	Guali'ek
	Oceanic snake-eyed skink	*Cryptoblepharus*	*poecilopleurus*	Guali'ek halom tano'
	Littoral skink	*Emoia*	*atrocostata*	Guali'ek halom tano'
	Mariana skink	*Emoia*	*slevini*	Halom tano
	Mutilating gecko	*Gehyra*	*mutilata*	Guali'ek
	Mourning gecko	*Lepidodactylus*	*lugubris*	Guali'ek
	Pacific blue-tailed skink	*Emoia*	*caeruleocauda*	Guali'ek halom tano'
	Brahminy blindsnake	*Ramphotyphlops*	*braminus*	
Crustaceans	Coconut crab	*Birgus*	*latro*	Ayuyu
	Hermit crab	*Coenobita*	*spp.*	Umang
Snail	Mariana Islands tree snail	*Partula*	*gibba*	Akaleha

Table 4-7. Native terrestrial fauna known from Tinian. Sources: Reichel and Glass (1991), Vogt and Williams (2004), Vogt (2008 a and b).

Birds

There are 44 native bird species reported on Tinian, of which 39 are protected under the MBTA. The Marianna common moorhen is a native bird species protected by the MBTA and the federal ESA. In addition, another native bird species, Micronesian megapode, is protected only under the federal ESA. Section 4.11.2.3, Special-status Species, further addresses bird species protected under the MBTA and the federal ESA. The remaining five native bird species that do not have a special status include:

(1) Micronesian honeyeater (*Myzomela rubratra*);
(2) Rufous fantail (*Rhipidura rufifrons uraniae*);
(3) Tinian monarch (*Monarcha takatsukasae*);
(4) Bridled white-eye (*Zosterops conspicillatus saypani*); and
(5) Micronesian starling (*Aplonis opaca guami*) (DoN 2013c, 2013d; U.S. Fish and Wildlife Service 2013).

Of the 44 bird species native to Tinian, 20 have been regularly detected in surveys conducted on Tinian between 1982 and 2013, during monthly monitoring by the DoN, and from periodic observations by the CNMI Division of Fish and Wildlife (Camp et al. 2009, 2012; DoN 2013d, 2014c). Island-wide surveys for native birds were conducted in 1982, 1996, 2008, and 2013 along a set of transects established by the U.S. Fish and Wildlife Service in 1982 (U.S. Fish and Wildlife Service 2009). Surveying of these standardized transects over time has allowed for analyses of population trends for a subset of Tinian native bird species (Camp et al. 2012; DoN 2014a)..Native bird species commonly found in forest habitats on Tinian include bridled white-eye, rufous fantail, Tinian monarch, Mariana fruit dove, white-throated ground-dove (*Gallicolumba xanthonura*), collared kingfisher (*Todiramphus chloris*), Micronesian honeyeater, and Micronesian starling. The yellow bittern (*Ixobrychus sinensis*) is a native bird species that is commonly present in open areas (DoN 2014a). All native shorebirds (e.g., sandpipers, plovers) and waterbirds (e.g., ducks) are protected under the MBTA.

Analysis of the 2013 native bird survey data was conducted by the U.S. Geological Survey to allow direct comparison to the data collection and analyses conducted for the 2008 Tinian surveys (Camp et al. 2009), as well as those done for the 1982 and 1996 surveys (Camp et al. 2012; DoN 2014a). Based on the 2013 analysis, the most abundant native bird species on Tinian were bridled white-eye, rufous fantail, and Tinian monarch (DoN 2014a). The collared kingfisher, white-throated ground-dove, and Mariana fruit dove were the least abundant. Analyses of population trends from 1982 to 2013 indicate increases in population densities for the collared kingfisher, Micronesian starling, rufous fantail, Mariana fruit dove, and white-throated ground-dove. Population densities have decreased for the Micronesian honeyeater. Population densities have remained stable for the bridled white-eye and Tinian monarch (DoN 2014a).

Mammals

The only native mammal species on Tinian is the Mariana fruit bat. The Mariana fruit bat is a medium-sized colonial flying fox. This bat is listed as threatened under the federal ESA and as threatened and endangered by the CNMI government. No permanent Mariana fruit bat colony is currently known on Tinian, although rare sightings have been reported on the island. Hunting restrictions and education on Tinian have increased public awareness; however, the Mariana fruit bat is considered a delicacy and still hunted.

In the past, the Government of Guam passed its own Endangered Species Act in 1982 (Guam Endangered Species Act, 5 GCA 63208, PL – 15-36), banning the importation of Mariana fruit bats from other islands in the archipelago. With the inclusion of Mariana fruit bats in the Convention of International Trade in Endangered Species (CITES) in 1989, all legal exportation of the species ceased (Wiles 1992).

Reptiles

There are eight native terrestrial reptile species reported on Tinian. Of these, the Micronesian gecko (*Perochirus ateles*) is a special-status species. Two native marine reptile species of sea turtle are recorded in Tinian's waters and are protected under the federal ESA and the CNMI Endangered Species Act: the threatened green sea turtle (*Chelonia mydas*), and endangered hawksbill turtle (*Eretmochelys imbricate*). Enforcement of the federal ESA for sea turtles is shared between the USFWS and the NMFS. USFWS's jurisdiction applies when listed sea turtles temporarily utilize beaches for nesting purposes and NMFS retains jurisdiction when listed sea turtles are present in the marine environment. There are no terrestrial reptiles federally listed as threatened or endangered on Tinian.

Amphibians

There are no native amphibians on Tinian.

Invertebrates

There are four native invertebrate species reported on Tinian—three crab species and one snail species. The humped tree snail (*Partula gibba*), proposed for listing as endangered under the federal ESA, is the only terrestrial invertebrate special-status species known to occur on Tinian. This species is discussed in Section 4.11.2.3, Special-status Species.

The coconut crab and two species of land crab (*Discoplax hirtipes* [previously *Cardisoma hirtipes*] and *Cardisoma carnifex*) are regulated as game species by the CNMI Division of Fish and Wildlife. A license is required for harvesting these crabs during regulated hunting seasons. The coconut crab is the largest land invertebrate in the world and can reach over 3 ft. (1 meter) in length from leg to leg. In addition to being a highly valued game species in the CNMI, it serves important ecological functions including dispersing seeds and scavenging. Although coconut crabs occur in native forests, females regularly migrate to the ocean to spawn. Coconut crab densities on Tinian have been estimated at 2 crabs/acre (5 crabs/hectare) in native forest and 0.7 crab/acre (1.8 crabs/hectares) in tangantangan (Vogt 2009).

Land crabs are a common terrestrial burrowing crab found throughout the Indo-Pacific and are generally associated with wetland or coastal habitats, although juveniles can be found further inland. Their shells can measure 4-5 inches (10-13 centimeters) across. The two species on Tinian are primarily herbivorous, eating leaves and other vegetation (Carpenter and Niem 1998).

Non-Native Wildlife

Non-native species are common on Tinian and can negatively impact native wildlife and vegetation. The non-native species on Tinian currently include at least 5 birds, 10 mammals, 6 reptiles, 1 amphibian, and 3 invertebrates (DoN 2010b, 2013a, 2013c).

Birds

Common non-native bird species include red junglefowl (or feral chicken [*Gallus gallus*]), rock dove (*Columba livia*), island collared-dove (*Streptopelia bitorquata*), Eurasian tree sparrow (*Passer montanus*), and orange-cheeked waxbill (*Estrilda melpoda*) (DoN 2013a, 2013c, 2014c). Red junglefowl are found throughout the island and are no longer exclusively associated with humans. Rock doves can be found in San Jose. The island collared-dove was introduced to the southern Mariana Islands by the Spanish from the Philippines in the 1700s and is considered common to abundant on Tinian. The most abundant non-native bird is the Eurasian tree sparrow, primarily in the vicinity of San Jose. Flocks of 30 or more orange-cheeked waxbills are seen in grasslands and roadsides (Camp et al. 2009; DoN 2013a, 2013c).

Mammals

Introduced mammals on Tinian include three rat species, the house mouse (*Mus musculus*), Asian house shrew (*Suncus murinus*), domestic cat (*Felis catus*), dog (*Canis lupus familiaris*), goat (*Capra hircus*), and cattle. Roof rats (*Rattus rattus*), Pacific rats (*Rattus exulans*) and brown rats (*Rattus norvegicus*) also occur on Tinian. Rat densities on Tinian are higher than on many other tropical Pacific islands and are likely detrimental to flora and fauna, including Tinian's bird species. Asian house or musk shrew densities are high in native and tangantangan forest. Rodents and shrews are predators of native birds, lizards, insects, and snails. The rat's diet also includes native plants, seeds, and fruit, and high rodent densities are associated with changes in forest composition (Wiewel et al. 2009).

Feral cats are extremely common on Tinian and have been observed hunting in native forest at night (DoN 2013a). Goats have been transported from Aguiguan to Tinian, and a coastal survey in October 2008 confirmed at least 20 goats at Puntan Kastiyu. There is some evidence that feral goats are creating trails, accelerating erosion, and impacting the native vegetation on Tinian (Kessler 2009).

Reptiles

Introduced reptiles include the oceanic gecko (*Gehyra oceanic*), mutilating gecko (*Gehyra mutilata*), curious skink (*Carlia fusca*), emerald skink (*Lamprolepis smaragdina*), mangrove monitor lizard (*Varanus indicus*), and green anole (*Anolis carolinensis*). Oceanic geckos were reported during the 2008 U.S. Fish and Wildlife surveys and constituted about half of the lizard biomass in limestone forest areas (Rodda et al. 2009). Mangrove monitor lizards were found throughout the island in all habitats (Rodda et al. 2009; DoN 2013a). It should be noted that recent studies indicate that mangrove monitor lizards may be native to some Mariana Islands (Pregill and Steadman 2009).

The potential establishment of the brown treesnake on Tinian is of great concern. As of 2008, nine unconfirmed brown treesnake sightings have been reported on Tinian (Brown Treesnake Technical Working Group 2009). The brown treesnake (*Boiga irregularis*) has the potential to impact the economy, human health, and island ecology in the CNMI. The brown treesnake's native range is coastal Australia, Papua New Guinea, and a large number of islands in northwestern Melanesia. This species was inadvertently introduced to Guam after World War II (Rodda and Savidge 2007). As a result of this introduction, 17 of 18 native bird species on Guam were severely impacted, and 12 of the 18 species were likely extirpated (i.e., no longer exist on Guam) (Wiles et al. 2003). Efforts to control the brown treesnake include preventing the snakes from leaving Guam by cargo, ship, or air vessels. The U.S. military has collaborated with other partners and participated in the development of brown treesnake-specific trapping techniques, detection using sniffer dogs, exclusion fence design, development of toxicants, and toxicant delivery methods. While these efforts have had success, individual brown treesnakes originating from Guam have been found in Kwajalein, Pohnpei, Hawaii (Oahu), Diego Garcia, Spain, Alaska, Texas, Oklahoma, California, and neighboring CNMI islands (Rota, Tinian, and Saipan) (Brown Treesnake Technical Working Group 2009; U.S. Department of Agriculture 2014; Kerrigan 2014).

Amphibians

The marine toad (*Bufo marinus*) is the only known amphibian on Tinian and was likely introduced in 1944, when approximately 4,000 individuals were observed in lily ponds and cisterns. By 1974, the toad was common throughout the island in mixed and limestone forest habitats (DoN 2013a). Marine toads currently occur in high densities at Lake Hagoi. The species possesses large parotid glands that excrete poison and kill potential predators. Marine toads are prolific breeders and can lay up to 70,000 eggs per year and are possibly a threat to native reptiles on Tinian (DoN 2013a).

Invertebrates

The mangrove crab (*Scylla serrata*), introduced as a potential food source, is the only introduced terrestrial crustacean on Tinian (Commander, U.S. Naval Forces Marianas 2004; DoN 2010b). The predatory manokar flatworm (*Platydemus manokwari*) was introduced to Tinian to help control the introduced giant African snail (*Achatina fulica*). The flatworm poses a serious threat to native tree snails, including the humped tree snail that is proposed for listing under the federal ESA (discussed below) (Hopper and Smith 1992; DoN 2014a).

4.11.2.2 Marine Biology

Tinian Harbor is located on the southeast coast of Tinian, in the village of San Jose. The region of influence for marine biological resources generally includes the waters surrounding Tinian from the shoreline to 3.0 nautical miles offshore. A larger region of influence of 7.3 nautical miles applies to the potential for behavioral effects to marine mammals from pile driving and extraction activities during construction.

A site investigation was performed by USFWS. The following description of the proposed project area is from the planning aid report.

Habitat Zones and Structures

Six habitat zones were observed within the proposed project site target area. They include:

- Channel – Natural channels or reef passes that often cut across several other zones (does not include artificial channels for harbors).
- Harbor – Area that is used for vessel mooring and is generally considered to be inside the outer points of the rock jetty at the mouth of the harbor entrance.
- Back Reef – Area between the seaward edge of a lagoon floor and the landward edge of a reef crest. This zone is present when a reef crest and lagoon exist.
- Reef Flat – Shallow, semi-exposed area between the shoreline intertidal zone and the reef crest of a fringing reef. This zone is protected from the high-energy waves commonly experienced on the shelf and reef crest.
- Lagoon – Shallow area (relative to the deeper water of the bank/shelf) between the shoreline intertidal zone and the back reef of a barrier island. This zone is relatively protected from the high-energy waves commonly experienced on the bank/shelf and reef crest. If no reef crest is present there is no lagoon zone.
- Back Reef – Area between the seaward edge of a lagoon floor and the landward edge of a reef crest. This zone is present when a reef crest and lagoon exist.

Five habitat structures were observed within the proposed project site target area. They include:

- Scattered Coral/Rock in Unconsolidated Sediment – Primarily unconsolidated sediment bottom with scattered rocks/boulders or small, isolated coral heads that are too small to be delineated individually (i.e. smaller than individual patch reef). (Major Structure: Mixed)
- Pavement – Flat, low-relief, and solid (carbonate or basalt substratum) bottom with coverage of macroalgae, coral, and other benthic invertebrates that are dense enough to begin to obscure the underlying surface. (Major Structure: Hard Bottom)
- Pavement with Sand Channels – Habitats of pavement with alternating sand/rubble channel formations. The sand/rubble channels of this feature have low vertical relief relative to spur and groove formations (less than 1 m). (Major Structure: Mixed)
- Spur and Groove – High vertical relief relative to pavement, and having alternating sand/rubble (groves) and reef (spurs) formations (greater than 1 m of vertical relief). (Major Structure: Mixed)
- Unconsolidated Sediment – Area comprising sand, mud, rubble, or cobble without isolated scattered coral/ rocks or large corals. See definitions of sediment terms below for sand, mud, rubble, and cobble. (Major Structure: Unconsolidated Sediment)

Based on the USFWS mitigation policy and the habitat characteristics within the Target Area, Aggregate Reef, Pavement, and Spur and Groove were considered to be the highest value habitat structures, followed by Scattered Coral/ Rock in Unconsolidated Sediment. Unconsolidated Sediment habitat is the lowest value, but still provides certain important biological functions and services to consider for resource impacts.

The reefs around Tinian are comprised of a narrow fringing reef and have been reported to have low coral cover compared to other islands in the Mariana Archipelago. The cause for the low coral cover is unknown, but it might possibly be driven by environmental factors due to the absence of modern limestone deposition and the lack of most anthropogenic stressors for corals on Tinian.

Hard shores are the most prevalent marine habitat in the CNMI, and the dominant marine habitat surrounding Tinian due to volcanic origins. Hard shores include aquatic environments that have at least 75% cover of stones, boulders, or bedrock and less than 30% vegetative cover. A diverse array of organisms is supported by the relatively stable rocky substrate provided by hard shores. Environmental gradients between hard shorelines and subtidal habitats are determined by wave action, depth, frequency of tidal inundation, and stability of substrate. Only rock outcrops may persist in areas of extreme wave energy. A mixture of rock sizes will form the intertidal zone in areas of lower energy. Boulders scattered in the intertidal and subtidal areas provide substrate for attached macroalgae and sessile (immobile) invertebrates. Plants and animals usually attach themselves to the rocky surfaces, while some animals hide in rocky crevices, under rocks, or burrow into finer substrate between boulders.

Soft shores include beaches, tidal flats, deltas, tidal rivers and estuarine systems. Soft shore habitats consist of unconsolidated substrates with less than 75% cover of stones, boulders, or bedrock and less than 30% vegetative cover other than pioneering plants. Pioneering plants are species that are the first to colonize previously disrupted or damaged ecosystems that become established during brief periods when growing conditions are favorable. The particle size of the substrate and the water regime are important factors determining the types of plant and animal present in the area. Soft shores can be irregularly exposed, regularly flooded, irregularly flooded, seasonally flooded, temporarily flooded, intermittently flooded, saturated, or artificially flooded. The distribution and composition of organisms within this habitat, particularly invertebrates, is determined by substrate particle size, the space between the substrate particles, wave action, currents, and salinity (Cowardin et al. 1979).

Hard bottom habitats in nearshore waters can include reefs and rocky bottoms colonized by dead and living sedentary invertebrates, such as coral reefs. Rocky bottoms in this habitat form as extensions of intertidal shores or isolated offshore outcrops (rock formations visible from the surface) (Cowardin et al. 1979). Colonization of this substrate can be determined by the size and shape of the rocks, but also by the depth, less than 650 ft., where there may be enough exposure to sunlight for photosynthesis to occur. This determines whether it is encrusted by algae or marine fauna, such as sponges, sea cucumbers, corals, and sea whips (DoN 2013a).

Soft bottoms include all wetland and deepwater habitats with at least 25% cover of small unconsolidated substrate particles, such as stones and sands and less than 30% vegetative cover. The distribution and composition of organisms within this habitat is determined by exposure to wave action, sunlight, and duration of being underwater, which results in variations in temperature, salinity, and pH (Cowardin et al. 1979). Soft bottom habitats include lagoons, which are semi-enclosed bays between the shoreline and a fringing or barrier reef, generally with sandy bottoms and scattered coral mounds, rubble, seagrass, and algae (DoN 2013a). Soft bottoms are inhabited by soft-sediment communities of mobile invertebrates fed by benthic algae production, chemosynthetic microorganisms, and decaying organic matter sinking through the water column. Aquatic beds include mangroves, seagrass beds and mats of floating seaweed that are generally found in the intertidal or shallow subtidal zone of nearshore waters, where the vegetation grows mainly on or below the water surface (Cowardin et al. 1979).

Aquatic bed habitats can be subtidal, irregularly exposed, regularly flooded, permanently flooded, intermittently exposed, semi-permanently flooded intermittently exposed, semi-permanently flooded, or seasonally flooded. Seagrasses are living marine resources and biotic habitats where they dominate the intertidal or shallow subtidal zone, and are therefore not covered in this chapter.

Marine Flora

Aquatic beds represent plant communities that require surface water for growth and reproduction. They are best developed in relatively permanent water or under conditions of repeated flooding. Plants are either attached to the substrate or float freely in the water above the bottom or on the surface. Aquatic beds include algae, aquatic moss, rooted vascular, and floating vascular species (Cowardin et al. 1979). This Marine Flora section will focus on macroalgae and seagrasses as these communities are found within the region of influence. Algae are photosynthetic, nonvascular plants, commonly referred to as “seaweeds.” Algae live on substrates characterized by a wide range of sediment depths and textures and occur in both the subtidal and intertidal zones up to depths of 98 ft. (Cowardin et al. 1979). In tropical regions, such as the CNMI, green algae, brown algae, and red algae are common. Algae are a main food source for sea turtles in the CNMI and within the region of influence. Seagrasses are flowering marine plants that grow entirely underwater. Seagrasses normally occur in water less than 85 ft. The distribution of seagrass is influenced by the availability of suitable soft substrates, such as sand or mud, in low wave energy areas at depths that allow sufficient light exposure (Spalding et al. 2003). Distribution and abundance of marine flora depends on several factors including light availability, water quality/clarity, salinity, type of seafloor substrate, currents, tides/water movement, and temperature (Spalding et al. 2003).

Seagrasses also provide a food source for sea turtles and habitat for fishes within the region of influence (Spalding et al. 2003). In addition, seagrasses play a major role in fisheries production and have been shown to provide protection from coastal erosion (Spalding et al. 2003).

Marine Invertebrates

Invertebrates are animals without backbones. Marine invertebrates are a large and diverse group that includes sponges, corals, snails, octopus, clams, lobsters, crabs, starfish, sea urchins, sea cucumbers, and marine worms (Eldredge 1983; DoN 2005).

True corals are categorized in the phylum *Cnidaria* which also includes fire corals, anemones, Portuguese man-o-war, jellyfish, box jellyfish and a variety of other related animals. *Cnidarians* have two basic body forms: free-swimming or floating medusa and sessile polyps. However, because many *Cnidaria* are colonial, both body forms can be found on some floating colonies such as the Portuguese man-o-war. Additionally, a single coral colony can be comprised of thousands of individual polyps, making it difficult to determine between a coral individual and a coral colony.

Corals are marine invertebrates in the class *Anthozoa* of the phylum *Cnidaria* that live individually or in colonies. Fire corals are not technically corals since they are part of the class Hydrozoa; however, fire corals are colonial marine organisms that look like true corals and are included in this discussion (DoN 2013a). Major groups of corals in the region of influence include:

- Stony corals (*Scleractinia*)
- Black and wire corals (*Antipatharia*)
- Soft corals (*Alcyonacea*, synonymous with horny corals and sea fans [*Gorgonacea*] and blue corals [*Helioporacea*])

The term “coral reef” refers to any reef, bank, or shoal comprised mostly of corals. “Reef ecosystem” includes coral and other species of reef plants and animals associated with coral reefs, and the physical environmental factors that directly affect coral reefs (Riegl and Dodge 2008; Brainard et al. 2011). Reefs are usually divided into four broad categories: barrier, bank, fringing, and patch reefs. The Mariana Islands are dominated by fringing reefs, with limited examples of barrier, bank, and patch reefs (Riegl and Dodge 2008; Brainard et al. 2011). Among the four reef types, fringing reefs are along a shoreline. Barrier, bank, and patch reefs do not require a shoreline (Riegl and Dodge 2008). Common reef morphology terms are tied to distinctive zones, which are created by differences in depth, wave action, current movement, light, temperature, and sediments along different parts of the reef. Zones are principally composed of the fore reef (adjacent to the reef crest and closer to the shore than the deep reef), reef crest (peak of the reef slope closest to the water surface and closer to the shore than the deep reef) and back reef (reef shoreward of the reef crest) (Riegl and Dodge 2008; DoN 2014a). Reef flats (shallow zone located closest to shore), lagoons, and benches may be found shoreward of the reef crest. The fore reef, is often subdivided by depth (e.g., shallow and deep fore reef) or by geomorphology (e.g., spur-and groove, apron, and sand channel). The fringing reefs of the Mariana Islands are predominately shore attached with poorly-developed reef crests (Riegl and Dodge 2008; Brainard 2012), meaning the fore reef runs up to mean low water with little or no development of a reef crest between the fore reef and the shoreline. Typical reef crests and reef flats are less than 2 ft. deep, with some grooves that are as much as 20 ft. deep, but less than 3 ft. wide (Smith 2012). In order of relative areal extent, fore reef is the most abundant habitat type in the Mariana Islands, followed by reef crest, and very small extents of reef flats (Analytical Laboratories of Hawaii 2004; National Oceanic and Atmospheric Administration, National Centers for Coastal Ocean Science 2005; Bearden et al. 2008; Riegl and Dodge 2008; Brainard et al. 2011).

<u>Fish</u>

Fish include aquatic animals with a hard bone or cartilage skull and gills, and that lack limbs or digits. Fish are not distributed uniformly throughout the region of influence; fish are closely associated with specific habitats. Fish species, such as large sharks, tuna, and billfishes, range across thousands of square miles; others, such as reef fishes, have small home ranges and restricted distributions (Helfman et al. 2009). The distribution and specific habitats of individual fish are influenced by a number of factors including its developmental stage, size, sex, and reproductive condition. This Interim Feasibility Report will focus mainly on reef fish. Fisheries, in terms of habitat requirements, are discussed under Essential Fish Habitat. Recreation and commercial fishing are also addressed in Section 4.10, Recreation.

4.11.2.3 Special-Status Species

The status and occurrence of federal ESA-listed and proposed species and CNMI listed species on Tinian are presented below. The observed locations of these special-status species within the proposed project area are presented in Table 4-8. Further descriptions of these species are presented in the following subsections.

Common Name/ Scientific Name	**Reported within Tinian Waters**
Ghost Crab (*Ocypode spp*)	No
Rock Crab (*Grapus spp*)	No
Spiny Lobster (*Panulirus spp*)	Yes
Land Hermit Crab (*Coenobita spp*)	No
Surf redfish (sea cucumber) (*Actinopyga mauritiana*)	Yes
Black teatfish (sea cucumber) (*Holothuria whitmaei*)	Yes
Sea urchin (*Toxopneustida*e)	No
Giant clam (*Tridacna spp*)*	Yes
Pectinate venus (*Gafrarium pectinatum*)	No
Common spider conch (*Lambis lambis*)	No
Horned helmet shell (*Cassis cornuta*)	No
Tapestry turban shell (*Turbo petholatus*)	No
Rough turban (*Turbo setosus*)	No
Octopus (Octopus spp)	No
Triton's trumpet shell (*Charonia tritonis*)	Yes
Note: **Tridacna spp* includes the Fluted giant clam (*Tridacna squamosa*) and the Elongate giant clam (*Tridacna maxima*). Source: Berger et al. 2005.	

Table 4-8. CNMI Marine Invertebrate Species of Special Conservation Need of Tinian

4.11.2.3.1 Sea Turtles

Both the green and the hawksbill sea turtles are known to nest on Tinian (DoN 2010a, 2011, 2012, 2013c). Green sea turtle abundance and density is highest along the island's relatively uninhabited east coast. For successful nesting, green sea turtles require deep sand beaches with open ocean exposure and minimal disturbance (DoN 2010b, 2012). On Tinian the green sea turtle is threatened by increased human presence, coastal construction, algae/seagrass/reef degradation, and illegal harvesting (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1998).

Hawksbill sea turtles use both low- and high-wave energy nesting beaches on insular and mainland sites in tropical oceans of the world. Hawksbills will nest on small pocket beaches and, because of their small body size and great agility, can traverse fringing reefs that limit access to other sea turtle species. Hawksbill sea turtles are rare on Tinian beaches. On Tinian, the hawksbill sea turtle is primarily threatened by direct takes from humans. Historically, hawksbill sea turtles have been taken for trade (e.g., tortoiseshell crafts) and, to a lesser extent, for food. Although hawksbill sea turtle eggs are readily consumed, adults are not valued as highly as green sea turtles for food. This may be due to their poor taste and sporadic fatal poisonings from their occasional toxicity (National Oceanic and Atmospheric Administration 1998).

Marine Invertebrates

Seventeen marine invertebrates have been designated by the CNMI Division of Fish and Wildlife as Species of Special Conservation Need. Five of the 17 have been reported in Tinian waters (Berger et al. 2005), see Table 4-8.

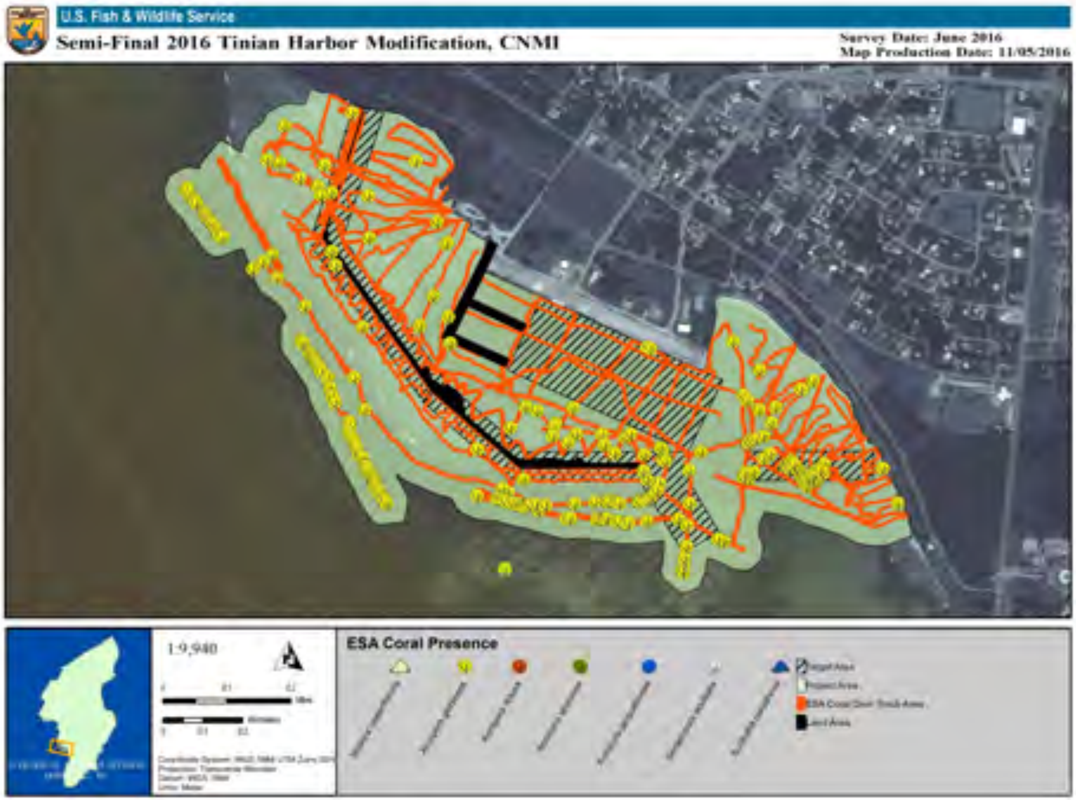
4.11.2.3.2 Coral Species

Twenty-two coral species are listed under the federal ESA; 20 of which were newly listed in August 2014. Fifteen of the newly listed species occur in the Indo-Pacific, four are likely to occur in the CNMI, *Acropora globiceps, Acropora retusa, Pavona diffluens,* and *Seriatopora aculeata* (National Marine Fisheries Service 2014a; Veron 2014), listed in Table 4-9. One protected species of coral was observed by USFWS within the proposed project area, *Acropora globiceps* (Figure 4-7). Overall coral abundance is presented in Figure 4-8.

Coral (Genus/Species)	ESA Status	Reported within Tinian Region of Influence*
Acropora globiceps	Threatened	Yes**
Acropora retusa	Threatened	No
Pavona diffluens	Threatened	No
Seriatopora aculeata	Threatened	No
The region of influence for marine biological resources includes waters surrounding Tinian from shoreline to 3 nautical miles offshore. Sources: DoN 2014a; NFMS 2014a.		

Table 4-9. Special-status Coral Species of Tinian

Acropora globiceps grow in small colonies and are usually described as digitate (having divisions arranged like those of a bird's ft. or small hand). Each of the “digits,” or branches, has varying size and appearance depending on the level of wave action and exposure; however, branches are always short and compacted closely together. Colonies are found in the intertidal zone, upper reef slopes, and reef flats in water depths shallower than 26 ft. *Acropora globiceps* can be found in areas exposed to heavy wave action (Brainard et al. 2011). *Acropora retusa* coral colonies are usually brown in color. They have a digitate morphology similar to *Acropora globiceps*, and form plates with thick short branchlets. Axial corallites are indistinct and radial corallites lay flat down the sides of branchlets (Brainard et al. 2011). The species is often confused with others in the digitate group with such as *Acropora globiceps* (Veron 2014). *Acropora retusa* occurs on upper reef slopes and tidal pools. They occur at depths ranging from 1 to 15 ft. This species provides habitat structure for organisms small enough to shelter in branches of relatively compact colonies. *Pavona diffluens* has a very narrow latitudinal and longitudinal distribution and is found in the region of the Red Sea and Arabian Gulf. It has also been reported in the Northern Mariana Islands and American Samoa; however, it is considered unlikely to occur in the CNMI (Brainard et al. 2011). *Pavona diffluens* has been reported in most reef habitats in water depths ranging from 16 ft. to 67 ft. (Brainard et al. 2011). *Seriatopora*



U.S. Army Corps of Engineers Honolulu District Fort Shafter, Hawaii	PROJECT NAME: Interim Feasibility Report Tinian Harbor Modification Study Island of Tinian Commonwealth of the Northern Mariana Islands	FIGURE TITLE: *Acropora globiceps* Observations FIGURE NUMBER: 4-7

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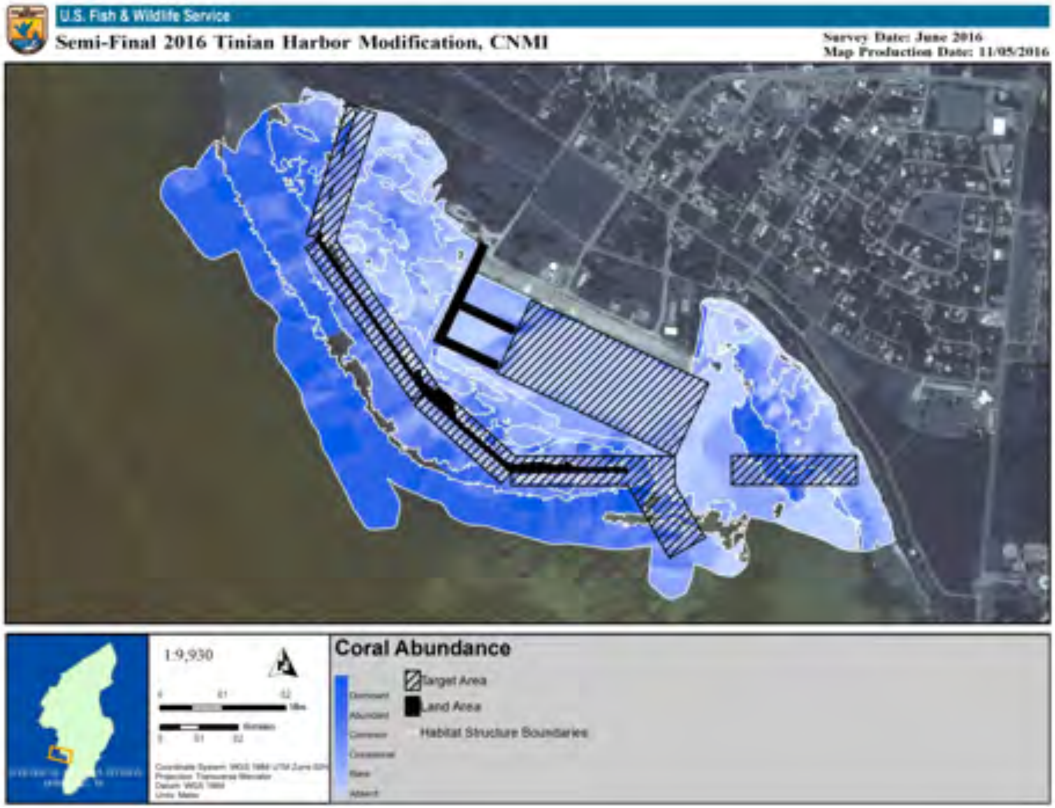

U.S. Army Corps of Engineers
Honolulu District
Fort Shafter, Hawaii

PROJECT NAME:

Interim Feasibility Report
Tinian Harbor Modification Study
Island of Tinian
Commonwealth of the Northern Mariana Islands

FIGURE TITLE:

Coral Abundance

FIGURE NUMBER:

4-8

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aculeata coral colonies have short, tapered branches, typically fused in clumps. They have irregularly distributed corallites and their tentacles are commonly extended during the day. The colonies are pink or cream, and branches are thicker than other *Seriatopora aculeata* (Brainard et al. 2011). *Seriatopora aculeata* occupies shallow reef environments ranging in depths from 10 to 131 ft. (Brainard et al. 2011). With irregular clumps of thick short branches, this species contributes to the overall reef structure and small-volume habitat.

A total of five Target Areas were identified as areas of highest priority for evaluation within the proposed project area (Figure 1-2).

<u>*Area 1*</u>

The marine habitat in the vicinity of Area 1 consists of four habitat zones (Harbor, Reef Flat, Lagoon, and Back Reef) and two geomorphological habitat structures (Scattered Coral/Rock in Unconsolidated Sediment and Pavement). The majority of this area is Pavement and its habitat complexity is low to low-medium. Various types of metal debris were observed within this area. One notable observation was a barge or landing craft sunk in the area, although this does not show on the map.

Two tracks of species identification were conducted in the Area. One track had a total of 24 species; no coral species were identified. The species richness along this transect was low to moderate relative to other transects. The second track had 48 observed species, including 16 species of cnidarians. The species richness along this transect was moderate compared to other transects. One protected species observed within this area. This observation consisted of one green sea turtle, *Chelonia mydas* swimming near the existing breakwater.

The coral abundance observed in this area ranged from absent in spots to Common, but mostly consisted of Rare abundance. In general, the abundance was greater on the outside of the existing breakwater than on the inside. The abundance was greater the further one progressed outside the Harbor and into the Lagoon. Coral morphologies were mostly lobate with some encrusting and branching colonies. The colony sizes were mostly small inside the breakwater with some mixed sizes. However, outside of the breakwater there were many large to extra-large colonies. Further into the Lagoon, extra-large microatoll colonies over 32.8 ft. in diameter were reported, with many observations of colonies in the range of 13-16 ft. Additionally, the ESA-listed coral, Ac*ropora globiceps* was found scattered through this area, with some colonies within the Target Area. However, more colonies were observed on the outside of the existing breakwater than inside the breakwater. Soft corals were observed near the breakwater, but only on the outside and none on the inside area.

Rare abundance of seagrass (species was not recorded) was observed inside the harbor, but not next to the breakwater within the Target area. The frondose algae consisted of a fairly even cover of Rare to Common abundance, but did not have any tall algal communities. CCA was Rare to Common, but generally higher on the outside of the breakwater. Filamentous algae/ Cyanobacteria were observed on the inner, inshore side of the breakwater where the water quality seemed to be poor, with high temperatures and freshwater influx.

Sea urchins (both herbivorous and rock boring) were present, but generally in low densities within this area. Sea cucumbers had a moderate density within this area, with higher densities on the inside, inshore area of the breakwater. Crown-of-Thorns sea stars were observed within this area, but mostly on the outside of the breakwater and more commonly in the Lagoon and Back Reef. Molluscs and sea stars were observed at low densities both inside and outside the breakwater. Giant clams were observed within this area, but not within the Target Area. Octopus were observed at low densities within this area, but only in distinct isolated spots away from the breakwater.

Area 2

The marine habitat in the vicinity of Area 2 consists of two habitat zones (Harbor and Back Reef) and four geomorphological habitat structures (Scattered Coral/Rock in Unconsolidated Sediment, Pavement, Unconsolidated Sediment, and Pavement with Sand Channels). The majority of this area is Scattered Coral/Rock in Unconsolidated Sediment on the inside of the existing breakwater, and Unconsolidated Sediment on the outside of the breakwater. The edge of the Target Area extent touches on Pavement with Sand Channels. The habitat complexity is low on the inside of the breakwater and low to medium on the outside. Various types of metal debris were observed within this area. One notable observation was a barge or landing craft sunk in the area.

Three tracks for species identification were conducted within this area. One track had 53 observed species, including 21 species of cnidarians. The species richness along this transect was low to moderate compared to other transects. The second track had 74 observed species, including 34 species of cnidarians. The species richness along this transect was high compared to other transects. The third track had 30 observed species, including 11 species of cnidarians. The species richness along this transect was low compared to other transects. One protected species observed within this area. This observation consisted of one green sea turtle, *Chelonia mydas* swimming near the existing breakwater.

The coral abundance observed in this area ranged from Rare to Occasional, but mostly consisted of Rare abundance. Coral abundance was similar from outside to inside the breakwater within the Target Area, but did increase on the Pavement with Sand Channel structure on the outside. On the inside of the breakwater, coral was generally Rare in abundance, but there were occasional spots with higher abundances from small staghorn coral patches. Some of these patches were dead, but one in particular was mostly alive. Coral morphologies were most lobate with some encrusting colonies. The colony sizes were mostly small inside and outside the breakwater, with occasionally large colonies on the outside. Additionally, the ESA-listed coral, *Acropora globiceps* was found sparsely scattered through this area with some colonies within the Target Area. No colonies were found inside the breakwater within the Target Area, but the species was observed at several locations outside the breakwater, but still within the Target Area. Soft corals were observed within the area, but not within the Target Area.

Rare abundance of seagrass, *Halophila* minor, was observed inside the harbor, but not next to the breakwater within the Target Area. The frondose algae consisted of a fairly even cover of Rare to Common abundance, but no tall algal communities were present. CCA was Rare to Common, but generally higher on the outside of the breakwater. Turf Algae was Rare to Common, but appeared High on the outside of the breakwater.

Sea urchins (both herbivorous and rock boring) were absent on the inside of the breakwater, but were present in low density on the outside of the breakwater. Sea cucumbers had a low to moderate density outside of the breakwater, and were absent or at low density inside the breakwater. Molluscs and sea stars were observed at low densities both inside and outside the breakwater. Giant clams were observed both inside and outside the breakwater. Giant clams outside the breakwater were within the Target Area and close to the breakwater, while the giant clams inside the breakwater were outside the Target Area. Octopus were observed at low densities outside the breakwater and within the Target Area.

Area 3

The marine habitat in the vicinity of Area 3 consists mostly of three habitat zones (Harbor, Back Reef, and Channel) and five geomorphological habitat structures (Scattered Coral/ Rock in Unconsolidated Sediment, Pavement, Unconsolidated Sediment, Pavement with Sand Channels, and Spur and Groove). This area has three sections, including the western Target Area, central Target Area, and the eastern Target Area. The western Target Area is mostly Unconsolidated Sediment and Scattered Coral/ Rock in Unconsolidated Sediment, the central Target Area is mostly Pavement and Unconsolidated Sediment, and the eastern Target Area is mostly Pavement, Unconsolidated Sediment, and Spur and Groove. The habitat complexity in the Target Area is low to low-medium for the western and central Target Area sections and low to high for the eastern Target Area section. Various types of metal debris were observed within this area.

Five tracks were conducted for species identification within this area. One track had a total of 53 species, including 21 species of cnidarians. The species richness along this transect was moderate relative to other transects. The second track had 65 observed species, including 28 species of cnidarians. The species richness along this transect was high compared to other transects. The third track had 50 observed species, including 22 species of cnidarians. The species richness along this transect was moderate compared to other transects. The fourth track had 47 observed species, including 20 species of cnidarians. The species richness along this transect was moderate compared to other transects. The fifth track had 57 observed species, including 25 species of cnidarians.

The species richness along this transect was moderate compared to other transects. There were no protected species the Target Area.

The coral abundance observed in the western Target Area section ranged from Rare to Common with a small area of Common abundance on the inside of the breakwater. The central Target Area section had Rare to Occasional coral abundance. The eastern Target Area section had Rare to Abundant coral abundance, with the highest abundance on the Spur and Groove habitat structure. In particular, the western part of the eastern Target Area section had significantly higher coral abundance than the eastern part of this area. Two areas are highlighted with squares in the map that show small areas of high coral abundance. Coral morphologies were mostly small lobate forms, with some small encrusting colonies in the western and central Target Area sections. The eastern Target Area section had mostly small lobate colonies with some mixed and extra-large lobate colonies.

Additionally, the ESA-listed coral, *Acropora globiceps* was found only sparsely through the western and central Target Area sections, but commonly throughout the eastern Target Area section. In particular, the high coral abundance area of the eastern target Area section also had many *A. globiceps*. Soft corals were observed within the eastern Target Area section, but not within the western and central Target Area sections.

Rare abundance of seagrass *Halophila* minor was observed inside the harbor and within the central Target Area section. The frondose algae consisted of a fairly even cover of Rare to Common abundance, but no tall algal communities were present. CCA was Rare to Common, and was fairly evenly distributed both inside and outside of the breakwater.

Sea urchins (both herbivorous and rock boring) were present with a low to moderate density across all the sections of Area 3. The highest density was around the eastern Target Area section near the end of the existing breakwater. Sea cucumbers had a low to moderate density, with the highest density in the eastern Target Area section near the end of the existing breakwater.

Molluscs and sea stars were observed at low densities in both the central and eastern Target Area sections. Giant clams were also observed in both in the central and eastern Target Area sections. Anemones were observed at low densities outside the breakwater and outside the Target Area. Octopus were observed at low densities inside the breakwater, but outside the Target Area.

Area 4

The marine habitat in the vicinity of Area 4 consists mostly of four habitat zones (Reef Flat, Reef Crest, Fore Reef, and Channel) and three geomorphological habitat structures (Pavement, Aggregate Reef, and Unconsolidated Sediment). The area is mostly evenly split between these three structures. The habitat complexity in the Target Area is low to high, with the Aggregate Reef having the highest complexity. Various types of metal debris were observed within this area, with the notable observation of a broken, sunken fishing vessel adjacent to the Target Area.

Five tracks were conducted for species identification within this area. One track had a total of 65 species, including 32 species of cnidarians. The species richness along this transect was high relative to other transects. The second track had 32 observed species, including 17 species of cnidarians. The species richness along this transect was low compared to other transects. The third track had 47 observed species, including 19 species of cnidarians. The species richness along this transect was moderate compared to other transects. The fourth track had 51 observed species, including 20 species of cnidarians. The species richness along this transect was moderate compared to other transects. The fifth track had 50 observed species, including 20 species of cnidarians. The species richness along this transect was moderate compared to other transects. There were two protected species the Target Area. This observation included five sea turtles, *Chelonia mydas*, swimming and two sea turtles, *C. mydas* and *Eretmochelys imbricata*, resting with four sea turtles observed within the Target Area.

The coral abundance observed in this area ranged from Rare to Abundant, but consisted of Rare to Common on the Pavement, Rare to Abundant abundance on the Aggregate Reef, and absent on the Unconsolidated Sediment. Coral morphologies were mostly lobate. The colony sizes were a combination of mixed colonies and extra-large, with the extra- large colonies only in the Aggregate Reef habitat structure. The number of extra-large colonies was notable within this area, and the extra-large colonies were the dominant size within large stretches of reef area. Additionally, the ESA-listed coral, *Acropora globiceps* was found scattered through this area, with a higher concentration within the Aggregate Reef area and within the Target Area. Zoanthids were also observed within the area.

No seagrass was observed within Area 4. The frondose algae consisted of Rare to Common abundances, with higher abundances within the Aggregate Reef area. CCA was Rare to Dominant, but generally higher on the Aggregate Reef and parts of the Pavement area.

Sea urchins (herbivorous and rock boring) were present with a low to moderate density mostly on the Pavement areas. Sea cucumbers had a low to moderate density mostly on the Pavement area. Molluscs were observed in low to moderate densities, mostly on the Pavement area. Giant clams were observed both inside and outside the breakwater. In several locations they showed a moderate density both on the Pavement and Aggregate Reef areas.

Area 5

The marine habitat in the vicinity of Area 5 consists of two habitat zones (Harbor and Channel) and one geomorphological habitat structure (Unconsolidated Sediment). The Unconsolidated Sediment is mostly sand. The habitat complexity in the Target Area is

Low to Low-medium. Various types of miscellaneous debris were observed within this area.

Four tracks were conducted for species identification within this area. One track had a total of 29 species, including 10 species of cnidarians. The species richness along this transect was low relative to other transects. The second track had 49 observed species, including 17 species of cnidarians. The species richness along this transect was moderate compared to other transects. The third track had 28 observed species, including 9 species of cnidarians. The species richness along this transect was low compared to other transects. The fourth track had 75 observed species, including 41 species of cnidarians. The species richness along this transect was high compared to other transects. One protected species observed within this area. This observation consisted of one green sea turtle, *Chelonia mydas* swimming near the existing breakwater.

The coral abundance observed in this area ranged from absent to Rare throughout the Target Area. The area occasionally had isolated colonies, but the majority of the coral within the Target Area is on the wharf face. Coral morphologies were mostly lobate. The colony sizes were a mixture of small and mixed. Additionally, the ESA-listed coral, *Acropora globiceps* occurred rarely in this area, at only two locations on the wharf face.

Rare to Common abundance of seagrass, *Halophila* minor, was observed within this area. The frondose algae consisted of Rare to Dominant abundance with tall *Halimeda* algae common through the area. CCA was Rare to Occasional, and is only found on small hard structure outcroppings around the fringe of the area.

Sea cucumbers had a low density only, in small and isolated areas. Molluscs and sea stars had a low density only, once again in small, isolated areas.

Marine Mammals

Historically, the Mariana Islands were a prominent whaling ground in the eighteenth century, with many catches of humpback whales and a lesser number of sperm whales (Townsend 1935). In the 1960s and 1970s, Japanese whaling companies conducted extensive tag (i.e., discovery tags) and recovery programs for large commercially hunted whale species in the North Pacific, including the Mariana Islands (Masaki 1972; Ohsumi and Masaki 1975). Most of the marine mammal information from this island group before 2006 comes from information attained after a marine mammal strandings/beaching, which is a relatively infrequent occurrence (Kami 1976, 1982; Donaldson 1983; Eldredge 1991, 2003; Trianni and Kessler 2002; Wiles 2005; Trianni and Tenorio 2012) and opportunistic sightings (Eldredge 1991, 2003; Miyashita et al. 1996; Wiles 2005; Jefferson et al. 2006).

A marine mammal survey (DoN 2014c) was conducted and the survey results are summarized in the following paragraphs. Earlier marine mammal surveys were limited to large-scale surveys that briefly passed through the Mariana Islands (Miyazaki and Wada 1978; Miyashita et al. 1996; Shimada and Miyashita 2001; Ohizumi et al. 2002). A few single-species surveys were directed primarily at humpback whales (Darling and Mori

1993; Yamaguchi 1995, 1996; Yamaguchi et al. 2002). Beginning in 2006, dedicated marine mammal surveys were conducted in the southern Mariana Islands (Mobley 2007; Oleson and Hill 2010; HDR 2011, 2012; Ligon et al. 2011; Hill et al. 2012, 2013). In January-April 2007 there was a large-scale, visual and acoustic line-transect survey of cetaceans and sea turtles conducted for the entire Mariana Islands Range Complex (DoN 2007). Analysis of some of the data from this Mariana Islands Sea Turtle and Cetacean Survey was later published and has provided current density estimates for some cetaceans in waters surrounding the Mariana Islands (Fulling et al. 2011; Norris et al. 2012). Several marine mammal species have been detected or observed in the nearshore environment within 3.0 nautical miles of Tinian (E. M. Oleson and Hill 2010; Fulling et al. 2011; Ligon et al. 2011; Hill et al. 2012, 2013; DoN 2014c).

According to the five-year report (Hill et al. 2014), spinner dolphins were the most frequently encountered species (54% of encounters). All of the locations where these encounters occurred were in depths less than 300 meters, and the vast majority of the locations were in depths less than 100 meters. Spinner dolphins were also encountered at offshore reefs (Marpi Reef and Rota Bank; about 11 miles from shore). Ligon et al. (2011) did not sight spinner dolphins off Tinian during a survey around the island, but did report anecdotal evidence of ferries seeing spinner dolphins off Tinian Harbor on the southwestern coast of the island. This species is highly likely to be island-associated with single groups associated with more than one island. No individuals have been documented moving between the southern islands of the CNMI and Guam or Rota Bank. Genetic evidence suggests a more diverse population than the visual data supports. Martien et al. (2014) suggest that the genetic transfer within the Marianas may be facilitated by offshore individuals that make temporary visits to nearshore populations or by males moving among the insular populations.

According to the five-year report (Hill et al. 2014), pantropical spotted dolphins were the second most frequently encountered species. The groups were encountered in the widest range of depths, as well as the deepest depths (333 meters to 3012 meters). Bottlenose dolphins ranked third highest in encounter rates. In addition, one sighting of spotted dolphins (offshore of Saipan near Malakis Reef a.k.a. Ruby Seamount) was the farthest from shore (32.8 miles) of all cetacean encounters. Four groups of bottlenose dolphins were observed during encounters with one or more other species (short-finned pilot whales, false killer whales, rough-toothed dolphins, and spinner dolphins). Their locations ranged 18-734 meters in depth and 0.2-11.6 miles from shore. Genetic analysis has indicated that bottlenose dolphins around the Mariana Islands contain genetic material common with Fraser's dolphin (*Lagenodelphis hosei*), a pelagic dolphin species. This suggests that the local population has some level of hybridization with Fraser's dolphin (Martien et al. 2014). Bottlenose dolphins would be expected to have island associated and pelagic populations. Photo-identification and telemetry data suggest that a nearshore population is distributed among the southern islands of CNMI and as far north as Sarigan in the Northern Mariana Islands (Martien et al. 2014).

According to the five-year report (Hill et al. 2014), short-finned pilot whales were the fourth most observed species by National Marine Fisheries Service. They were encountered in depths that ranged from 215 meters to 967 meters. Two groups of pilot whales were associated with bottlenose dolphins. Genetic analysis revealed significant genetic differences between individuals off Saipan, Tinian, and Aguigan (3-Islands complex) and those collected from individuals off Guam and Rota suggesting limited gene flow and interaction between the populations (Martien et al. 2014). Individuals resighted between these locations suggest that the genetic differences may be a reflection of the groups not mixing socially, that there is male-mediated gene flow, or that the 3-islands region is an area of overlap between the two populations, one population's range extending to the north and the other extending south to Guam (Martien et al. 2014). National Marine Fisheries Service false killer whale encounters occurred in depths that ranged from 88 meters to 2107 meters and distances from shore of 0.4-4.9 miles (Hill et al. 2014). Blainville’s beaked whale and Cuvier’s beaked whale may also occasionally occupy the waters near Tinian, as they have been acoustically detected; however, these species have not been confirmed within 3.0 nautical miles (3.5 miles) of shore (Baumann-Pickering et al. 2012; DoN 2014c). The humpback whale, minke whale, sei whale, pygmy killer whale, rough-toothed dolphins, short-finned pilot whale, blue whale, and fin whale are also known to occur in Tinian waters as discussed below (DoN 2014c; E. Oleson 2014; National Oceanic and Atmospheric Administration 2014). However, the blue whale and fin whale have been heard in Tinian waters; however, blue whale and fin whale calls can be heard over great distances (thousands of miles) and cannot be used to determine the presence of these species in particular areas. Sperm whales have been visually and acoustically detected near Tinian (Hill et al. 2012, 2013; Norris et al. 2012; DoN 2014c). Sperm whales were encountered three times by National Marine Fisheries Service, at depths of 374 meters, 1971 meters, and 1617 meters depth, at varying distances from land (0.7 miles, 13.7 miles and 12.1 miles, respectively (Hill et al. 2014). Evaluation of the sperm whale acoustics suggests the CNMI waters are predominantly used by females with possible social links between the eastern and western North Pacific Ocean (Hill et al. 2013). Humpback whales have been observed within 3.0 nautical miles (3.5 miles) of Tinian during the winter and spring months (Hill et al. 2012, 2013; DoN 2014c). Humpback whales currently are not considered to have island-associated populations due to their annual migrations (Hill et al. 2013; DoN 2014c; DoN 2007). Potential breeding behaviors, including singing) have been acoustically and visually documented in the nearshore waters of Tinian and Saipan (Norris et al. 2012; DoN 2014c; DoN 2007). Observed potential breeding behaviors suggest these areas may represent important wintering/breeding habitats (Fulling et al. 2011; Norris et al. 2012; DoN 2014c; DoN 2007). In addition, research indicates that there is overlap of acoustic features between humpback whales in the waters of Hawaii and the CNMI, as well as possibly with the Philippines (Norris et al. 2012). Minke whales have been acoustically detected in the proximity of the Mariana Islands during the winter and spring (DoN 2014c). Acoustic detections have originated from the waters east of Tinian and Saipan, near some of the deepest parts of the Mariana Trench (Norris et al. 2012). It is believed that these waters likely represent wintering areas for minke whales. Sei whales were visually and acoustically detected during the winter/spring surveys of Norris et al. (2012), with most sightings associated near, but not in, the deepest parts of the Mariana Trench. Previous studies have found sei whales to be a frequently sighted species (DoN 2007; Fulling et al. 2011). Melon-headed whales have been sighted within 3.0 nautical miles of the coast of Tinian (Oleson and Hill 2010; Fulling et al. 2011; Hill et al. 2012, 2013). Melon-headed whales have been encountered twice by National Marine Fisheries Service in relatively large group sizes (300-400 animals at a depth of 1,014 meters 9.4 miles from shore and approximately 100 animals at a depth of 1,975 m 4 miles from shore (Hill et al. 2014). Acoustic and visual data collected during the summer and winter-spring months documented eight marine mammal species in Tinian waters during both time periods (Hill et al. 2013). These include common bottlenose dolphins, false killer whales, pantropical spotted dolphins, pygmy killer whales, rough-toothed dolphins, short-finned pilot whales, spinner dolphins and sperm whales (DoN 2007, 2014c; Norris et al. 2012; Hill et al. 2013). Rough-toothed dolphins were encountered at depths that ranged from 260 meters to 616 meters and the distances from shore were 0.2-6.5 miles (Hill et al. 2014). In total, 14 marine mammal species have been documented in the waters surrounding Tinian, with 8 confirmed within 3.0 nautical miles of the shore (Mobley 2007; E. M. Oleson and Hill 2010; Fulling et al. 2011, 2011; Hill et al. 2012, 2013; Norris et al. 2012; Trianni and Tenorio 2012; DoN 2014c; DoN 2007).

The Marine Mammal Survey conducted (Marine Biology Technical Memo and Survey Reports) collected data about the occurrence and distribution of mammals around Tinian. The study area selected for the survey was between 0 and 3.0 nautical miles from the coast of Tinian. Data collection events were conducted on the leeward inshore waters of Tinian in 2 days. A total of 38.8 nautical miles of predetermined transect lines were completed at Tinian and no marine mammals were sighted.

4.11.2.3.3 Special-Status Fish Species

Special-status fish species documented in the CNMI include the scalloped hammerhead shark (*Sphyrna lewini*), humphead wrasse (*Cheilinus undulatus*), and gray reef shark (*Carcharhinus amblyrhynchos*). The scalloped hammerhead shark Indo-West Pacific Distinct Population Segment is listed as threatened under the federal ESA. The National Marine Fisheries Service considers the humphead wrasse a Species of Concern. This species has also been designated by the CNMI Division of Fish and Wildlife as a Species of Special Conservation Need. The CNMI also lists the gray reef shark as a Species of Special Conservation Need (Berger et al. 2005). During the various marine resources surveys conducted, fish species were also recorded and summarized in a species list report. The humphead wrasse was observed at Unai Lam. The scalloped hammerhead shark was not observed at any site on Tinian during the surveys conducted (DoN 2013b), but it has been observed within the Mariana Islands (CJMT 2015). It is possible that the federal ESA-listed scalloped hammerhead shark may be present within the vicinity of

Tinian, but it has not been documented in the nearshore environment of the CNMI. Tinian is located within the range of this migratory species, and the offshore pelagic waters, coral reefs, and turbid, nearshore waters surrounding the island of Tinian have the potential to serve as foraging, breeding, and nursery habitat for the scalloped hammerhead shark. The possibility that scalloped hammerhead sharks could occur in areas of potential impact by physical disturbance, acoustics, or indirect impacts is considered remote. Such occurrence would probably involve the transient occurrence of a small number of individuals whose most likely response would be to leave the immediate area in response to underwater noise and poor foraging conditions due to previous disturbance to the habitat.

4.11.3 Environmental Consequences

Land areas are not considered critical habitat. The construction proposed by the Alternatives for the harbor improvements do not significantly encroach on the shoreline and will have minimal permanent impact. There will be short-term impact during construction activities related to the movement and staging of construction material and machinery. The region of influence for terrestrial habitats and species are limited to those specific habitats located on the island of Tinian. The region of influence for marine biological resources generally includes the waters surrounding Tinian from the shoreline to 3.0 nautical miles offshore. A larger region of influence of 7.3 nautical miles applies to the potential for behavioral effects to marine mammals from pile driving and extraction activities during construction.

Effects on biological resources were considered significant if implementation of an alternative plan would result in any of the following:

- Result in a substantial loss of native species;
- Reduce habitat availability or degradation of habitat suitability of a magnitude and/or duration that could substantially affect a native species population;
- Substantially interfere with the movement of migratory species; or
- Introduce or contribute to the substantial spread of an invasive species. The potential effects to biological resources that could result from implementation of the alternatives, from measures that would be conducted to mitigate those effects, and from the resulting degree of impacts are discussed in the following subsections.

4.11.3.1 Alternative 1: No-Action Alternative

- No impacts are anticipated under the No-Action Alternative based on the criteria defined above.

Under the No-Action Alternative, none of the navigational risk management measures would be implemented. As no features would be constructed, there would be no project-related activities that would affect current biologic resources. The physical conditions within each of the measure locations would be expected to be generally commensurate with the current onsite conditions.

4.11.3.2 Alternative 2: Replace Existing Breakwater along Current Alignment

- Long-term, direct and indirect significant adverse impacts are anticipated under Alternative 2 based on the criteria defined above. While compensatory mitigation is expected to reduce impacts to less than significant over the 50-year project period, in the reasonably foreseeable future, coral impacts will be significant and unavoidable. Immediate mitigation measures such as design elements to minimize resource disturbance/impact, footprint reduction and BMPs during construction are not anticipated to reduce impacts to less than significant.
- Long-term, indirect, significant, adverse or beneficial secondary impacts to coral and other biological resources may occur by permanently changing the marine environment (wave action and currents) in the proposed project area and areas further removed. This could have potential beneficial effects, if changes facilitate coral growth and creates new habitat; or adverse secondary impacts, if changes reduce or destroys existing habitats in the immediate vicinity of the sea wall or locations further removed.

Construction Footprint and Immediate Area Surrounding the Construction Footprint:

The construction of a breakwater described in Alternative 2 is expected to have significant impact to coral reef communities. The abundance of biotic resources was observed to be rare to abundant and the majority of the habitat was determined to be Aggregate Reef, Pavement, and Spur and Groove, a high value habitat. The ESA-listed coral, *Acropora globiceps* was found commonly throughout the Target Areas.

Construction of the breakwater will result in loss of habitat in the proposed project footprint with additional impact from sedimentation in areas outside the construction footprint during construction and after construction due to changes in sedimentation and wave energy. A coral mitigation plan has been developed in collaboration with the USFWS, NMFS and NOAA and is provided in Appendix 4. Briefly, coral mitigation at Tinian Harbor will include a strategy of damage minimization and control wherever possible. The proposed action will avoid and minimize impacts to coral reefs and other assets via design elements and BMPs such as performing construction during the off-peak coral spawning season, and halting construction if for any unintended discovery of coral reefs. BMPs are fully described in Appendix 6. Where impacts are unavoidable, compensatory mitigation will be provided to compensate for the functions and values lost.

Coral transplantation was determined to be feasible for this site. The USACE proposes the installation of Reef Ball artificial structures for use at the mitigation site. The USFWS has surveyed the immediate vicinity and have recommended that the east area be considered as a possible coral nursery. The Reef Balls, seeded with transplanted corals from proposed project area, would serve several purposes. First, the adult corals attached to the substrate would immediately function as replacement for lost habitat by the breakwater. Second, the adult corals would provide a source for sexual recruitment of new corals, a more genetically diverse and thus more valuable solution than transplants. Third, the modular structures would provide immediate habitat for fish and invertebrates.

The mitigation plan represents a replacement service that is intended to be fully equivalent to the loss from proposed project impacts (i.e., it would be qualified at a 100% level of relative productivity, in terms of proportional equivalence). Compensation achieved under this proposed project would be a 1:1 in-kind replacement of coral reef habitat in close proximity to the area of coral loss.

Compensatory mitigation is expected to reduce impacts to less than significant over the 50-year project period. However, in the reasonably foreseeable future, coral impacts will be significant and unavoidable. Immediate mitigation measures such as design elements to minimize resource impact, footprint reduction and BMPs during construction are not anticipated to reduce impacts to less than significant.

Construction Laydown Area:

No impacts are anticipated to biologic resources of the construction laydown area based on the criteria detailed above. This is an environment generally absent of flora and fauna, and is not expected to contribute to the spread of an invasive species or substantially affect a native species population.

Construction Debris Disposal Site (Tinian Airport):

No impacts are anticipated to the biological environment of the Tinian Airport disposal site from receiving construction debris generated from implementation of Alternative 2. The final disposal location is an environment generally absent of flora and fauna

4.11.3.3 Alternative 3: Replace and Extend Existing Breakwater along Current Alignment

- Long-term, direct and indirect significant adverse impacts are anticipated under Alternative 3 based on the criteria defined above. While Compensatory mitigation is expected to reduce impacts to less than significant over the 50 year project period, in the reasonably foreseeable future, coral impacts will be significant and unavoidable. Immediate mitigation measures such as design elements to minimize resource disturbance/impact, footprint reduction and BMPs during construction are not anticipated to reduce impacts to less than significant.
- Long-term, indirect, significant, adverse or beneficial secondary impacts to coral and other biological resources may occur by permanently changing the marine environment (wave action and currents) in the proposed project area and areas further removed. This could have potential beneficial effects, if changes facilitate coral growth and creates new habitat. However, adverse secondary impacts are

likely to occur by construction activities necessary to extend the breakwater by approximately 300 ft. Improvements to the harbor under the extended breakwater alternative would include all noted under Alternative 2. Implementation of Alternative 3 will also increase the usability of the harbor, harbor facilities and indirectly the usability of the land based recreational areas (i.e., if water based recreational activities increase, land-based recreation is also expected to increase).

Construction Footprint and Immediate Area Surrounding the Construction Footprint:

This measure involves all of the same demolition and breakwater replacement methods described in Alternative 2, with the addition of approximately 300 ft. extension to the breakwater. The planned construction is expected to result in significant impact to coral reef communities, including the ESA-listed coral, *Acropora globiceps*. The coral abundance observed in this area ranged from Rare to Abundant. The majority of the area contains Aggregate Reef, Pavement, and Spur and Groove habitats which were identified as high value habitats. As with Alternative 2, construction of the breakwater will result in loss of habitat in the proposed project footprint with additional impact from sedimentation in areas outside the construction footprint. The coral mitigation plan discussed above would reduce impacts over the 50 year study period. Mitigation measures would not reduce impacts to less than significant in the reasonably foreseeable time period.

Construction Laydown Area:

No impacts are anticipated to biologic resources of the construction laydown area based on the criteria detailed above. This is an environment generally absent of flora and fauna, and is not expected to contribute to the spread of an invasive species or substantially affect a native species population.

Construction Debris Disposal Site (Tinian Airport):

No impacts are anticipated to the biological environment of the Tinian Airport disposal site from receiving construction debris generated from implementation of Alternative 3. The final disposal location is an environment generally absent of flora and fauna.

4.12 Cultural Resources

4.12.1 Framework

Regulations and policies that protect archaeological, historic, and cultural resources and are being considered as part of the proposed project include the following:

- National Historic Preservation Act (NHPA)
- CNMI Historic Preservation Act of 1982 (Public Law 3-39)
- Historic Sites Act, 16 U.S. Code § 461-467
- Protection of Historic Properties (36 CFR 800)
- Sunken Military Craft Act of 2004, 10 USC 113-118

- Abandoned Shipwreck Act, 43 USC § 2101-2106

Compliance with NHPA Section 106 is discussed in Section 6.

4.12.2 Environmental Setting

A historic property is defined under federal law (36 CFR 800.16(l)(2)) as any archaeological site, building, structure, or object included (or eligible for inclusion) on the National Register of Historic Places (NRHP). The term includes properties of traditional religious and cultural importance to a Native American tribe or Native Hawaiian organization and that meet the NRHP criteria.

As established by 36 CFR Part 60, an historical property (generally a property over 50 years of age) is eligible for listing in the NRHP if it possesses "integrity of location, design, setting, materials, workmanship, feeling, and association," and it meets at least one of four criteria:

- It is associated with events that have made a significant contribution to the broad patterns of our history; or
- It is associated with the lives of persons significant in our past; or
- It embodies the distinctive characteristics of a type, period, or method of construction, or it represents the work of a master, or it possesses high artistic values, or it represents a significant and distinguishable entity whose components may lack distinction; or

It has yielded, or may be likely to yield information important in prehistory or history. The CNMI Historic Preservation Office (HPO) was established by the passage of the CNMI Historic Preservation Act of 1982 (Public Law 3-39). The intent of Public Law 3-39 is to (1). Ensure the identification and protection of significant archaeological, historic, and cultural resources in the Commonwealth; (2). Educate the public concerning matters relating to local history, archaeology, culture and historic preservation; and (3). Develop historic and cultural properties to allow them to contribute to the cultural, social, and economic growth of our citizens. Under Public Law 3-39, the HPO is mandated to comply and take into account all federal laws and regulations governing the protection and preservation of these historic and cultural resources. The Section 106, NHPA review, as amended, and associated 36 CFR Part 800 provides the strength behind this protection and preservation regulation. A Section 106 Review must be undertaken for projects that involve a direct, indirect, or an adverse impact on a site or sites that are on or are eligible for inclusion in the National Register of Historic Places. The responsibility of initiating and completing the Section 106 Review lies with the head of any federal agency having direct or indirect jurisdiction over a proposed federal or federally assisted undertaking in any state and the head of any federal department or independent agency having authority to license any undertaking. Furthermore, the Section 106 Review must be completed prior to the approval of expenditure of any federal funds committed to the proposed project or prior to the issuance of any license.

The CNMI contains a wealth of historic and cultural properties whose preservation, study and interpretation is vital to the development of self-understanding and self-pride on the part of our people, and to the interest of the international science in understanding the history and cultures of the people and environment of the Pacific Islands. These historic and cultural properties are subject to damage and destruction by uncontrolled land-use development and once destroyed, the historical and/or archaeological value they possess will be gone forever. For this reason, it is the duty of the Historic Preservation Office to ensure the protection, preservation and regulation of historic and cultural sites pursuant to Public Law 3-39 P.L. 3-33, as amended by P.L. 10-71 to address violation matters. To carry out these duties, the Historic Preservation Office is staffed with a Historic Preservation Officer, professionals in the field of History and Archaeology, Historic Preservation Coordinators, Specialists, and Technicians. In addition, HPO is equipped with a federal grants manager, a community development specialist, and administrative assistants. The Office is under the auspices of the Department of Community and Cultural Affairs.

The heart of the HPO program is centered around the Review and Compliance section. This section ensures that developers comply with the necessary steps to meeting historic preservation requirements in order to obtain an HPO clearance. This clearance further allows the developer to obtain a Division of Environmental Quality Earthmoving permit or a Coastal Resource Management permit. Applicants or developers are required to visit the Division of Historic Preservation and fill out an “Application for Historic Preservation Review” form and turn in all needed construction plans and location maps. The HPO staff will then establish a time to inspect the proposed project site. A reconnaissance survey is usually performed, as HPO trained technicians survey on ft. to try to identify and locate any historic or archaeological sites within the proposed project area. The result of the inspection will then be compiled into a survey summary form and packaged for the review of the staff archaeologist. Once all documents are complete and certified, a clearance will be transmitted to DEQ or CRM. Site sensitivity is a huge factor in performing review and compliance activities. Certain areas, such as coastal zones, are more prevalent with pre-latte and latte associations. For this reason, monitoring conditions are stipulated in the clearance, thus equating the need for HPO personnel to be present before the commencement of any earthmoving activities. This action allows needed documentation to occur for purposes of archaeological reporting and site profiling.

A qualitative historic assessment of archaeological and historic resources, was conducted to provide an understanding of the existing resources within the proposed project area that are listed (or eligible for listing) on the NRHP.

4.12.3 Area of Potential Effects

Consistent with the requirements of NHPA Section 106, the Area of Potential Effects (APE) was defined for each of the measures that would be constructed. In consultation with the HPO, the Direct APE was defined as the area that would be directly affected by construction, and includes the measure footprint, as well as any staging areas, access roads, or other areas within the construction limits. The Indirect APE is defined to include those areas within a one-half-mile radius extending from the outer edge of the Direct APE.

As part of the assessment of archaeological resources within the proposed project area, archival research was conducted to identify the proposed project site background history, place names, traditional stories, and previously recorded archaeological sites within the area. Specifically, the archival research included a review of previous archaeological studies, cultural history documents, historic maps and photographs. This information was compiled and used to identify potential localities within the proposed project area where archaeological resources may exist, and the type and potential significance of those resources. In addition, a screening level field investigation was conducted during the USFWS Phase 1 Biological Survey to identify additional surface archaeological features.

The HPO database was queried and the agency consulted regarding potential historic sites. The HPO has the responsibility of determining if sites are highly significant, based on its uniqueness or its association with an historic event or person, and are eligible to be nominated for inclusion into the U.S. National Register of Historic Places. The National Register of Historic Places is the official list of the nation's historic places worthy of preservation. Authorized under the National Preservation Act of 1966, it is part of a national program to coordinate and support public and private efforts to identify, evaluate, and protect our historic and archaeological resources. The National Register is administered by the National Park Service under the Secretary of the Interior.

Properties listed in the National Register include districts, sites, buildings, structures, and objects that are significant in American history, architecture, archaeology, engineering, and culture. These properties include all historic areas in the National Park System, National Historic Landmarks, and properties significant to the nation, state, or community which have been nominated by the State Historic Preservation Office and approved by the National Park Service.

The National Register helps preserve these significant historic places by recognizing this irreplaceable heritage. Its primary goals are to foster a national preservation ethic; promote a greater appreciation of America's heritage; and increase and broaden the public's understanding and appreciation of historic places.

4.12.4 Previous Cultural Resource Studies and Recorded Resources

Seventeen studies have been conducted at the Port of Tinian and adjacent areas. In 2008, an architectural survey and archival study for the entire Port of Tinian, which included all structures along the wharf or quay, was conducted (Thursby 2010). Some of the port features, including the breakwater, although lacking in architectural integrity, are considered eligible for listing in the National Register of Historic Places as an archaeological site. In 2014 and 2015, archaeological surveys of the area around the port and adjacent to 6th and 8th Avenues were completed (DoN 2014a, DoN 2015). Two sites were recorded in the proposed port improvement area and consisted of Japanese tank debris from World War II, World War II-era American Administration concrete pads, and a prehistoric pottery scatter. Because the sites are so deteriorated, they are not eligible for listing in the National Register of Historic Places. Additional sites were identified along the proposed road corridors from the Port of Tinian and were eligible for listing in the National Register of Historic Places.

4.12.5 Environmental Consequences

The region of influence of cultural resources evaluated was consistent with the APE and included the area that would be directly affected by construction, and includes the measure footprint, as well as any staging areas, access roads, or other areas within the construction limits. The Indirect APE is defined to include those areas within a one-half-mile radius extending from the outer edge of the Direct APE. Effects on archaeological, historic, and cultural resources were considered to be significant if implementation of an alternative plan would result in any of the following:

- Alter, directly or indirectly, any of the characteristics of a resource that qualifies it for the NRHP or State Register of Historic Properties so that the integrity of the resource's location, design, setting, materials, workmanship, feeling, or association is diminished;
- Isolate cultural resources, practices or beliefs from their setting (or otherwise limit access to areas that support those resources, practices or beliefs); or
- Introduce elements that substantially alter the setting in which cultural resources, practices, or beliefs occur. The potential effects to archaeological, historic, and cultural resources that could result from implementation of the alternatives, measures that would be conducted to mitigate those effects, and the resulting degree of impact are discussed in the following subsections.

4.12.5.1 Alternative 1: No-Action Alternative

- Long-term, direct, adverse significant effects may occur to cultural, archaeological or historic features if the No-Action Alternative is implemented.

The population of Tinian is approximately 3,200. Any change in the cost of living, the living wage or downturn in the economy could have significant consequences on the immigration or emigration from Tinian. Cultural history and knowledge could be lost as human resources are depleted. The losses would include shared beliefs, values, customs, behaviors that are generally transmitted from generation to generation. Under the No-Action Alternative, none of the navigational risk management measures would be implemented. As no features would be constructed, there would be no project-related activities that would affect existing cultural features in the proposed project area.

Long term, direct, adverse significant effects may occur to the breakwater. The breakwater is considered eligible for listing in the National Register of Historic Places as an archaeological site, and requires Section 106 consultation. Under the No-Action Alternative, the proposed modification project at Tinian Harbor would not be implemented and the continued deterioration of the breakwater may lead to complete destruction by inclement weather conditions, such as a tropical storm or a typhoon.

4.12.5.2 Alternative 2: Replace Existing Breakwater along Current Alignment

- Long-term, direct, beneficial effects may occur to cultural, archaeological or historic features if Alternative 2 is implemented.

Construction Footprint and Immediate Area Surrounding the Construction Footprint:

Under this alternative, the structural changes may adversely impact the historical features of the breakwater as an archaeological site. However, the USACE is coordinating with NHPA to ensure that mitigation measures will sufficiently reduce many of the impacts to no adverse effect with conditions.

Implementing Alternative 2 would demolish and replace most of the existing. This would increase the efficiency of cargo operations at Tinian Harbor by blocking wave action and facilitating more reliable transportation of goods. As 97% of goods are used by residents of Tinian (most notably food supplies), the cost of living and the quality of life would be greatly improved. Reliable harbor service may also encourage economic development in aquaculture and tourism. With the loss of the garment industry and the recent closure of the Tinian Dynasty Hotel and Casino, and subsequently the depletion of jobs, many are forced to seek employment opportunities elsewhere. Consequently, the lack of human resources would lead to an invaluable loss of cultural history and knowledge.

No permanent features would be constructed on land, therefore, there would be no project-related activities that would affect cultural conditions. The physical conditions within the land area of each of the measure locations would be expected to be generally commensurate with the current onsite conditions.

Construction Laydown Area:

No impact to cultural resources are anticipated to the construction laydown area based on the criteria detailed above. This area is not designated as a historic landmark, and temporary construction activities are not expected to alter the area in which cultural practices or beliefs occur.

Construction Debris Disposal Site (Tinian Airport):

No impacts are anticipated to cultural resources of the Tinian Airport or Saipan Landfill disposal sites from receiving construction debris generated from implementation of Alternative 2. These areas are not designated as a historic landmark, and temporary construction activities are not expected to alter the area in which cultural practices or beliefs occur.

4.12.5.3 Alternative 3: Replace and Extend Existing Breakwater along Current Alignment

- Long-term, direct, beneficial effects may occur to cultural, archaeological or historic features if Alternative 3 is implemented.

Construction Footprint and Immediate Area Surrounding the Construction Footprint:

This measure involves all of the same demolition and breakwater replacement methods described in Alternative 2, with the addition of approximately 300 ft. extension to the breakwater. Implementing Alternative 3 would lead to the same benefits and impacts as described in Alternative 2. Reliable harbor service may also stimulate and strengthen the dwindling economy and discourage people from seeking employment elsewhere, which would lead to an invaluable loss of cultural history and knowledge.

The structural changes may adversely impact the historical features of the breakwater as an archaeological site. As noted in Alternative 2, USACE is coordinating with NHPA to ensure that mitigation measures will sufficiently reduce many of the impacts to no adverse effect with conditions. No permanent features would be constructed on land, therefore, there would be no project-related activities that would affect cultural conditions. The physical conditions within the land area of each of the measure locations would be expected to be generally commensurate with the current onsite conditions.

Construction Laydown Area:

No impact to cultural resources are anticipated to the construction laydown area based on the criteria detailed above. This area is not designated as a historic landmark, and temporary construction activities are not expected to alter the area in which cultural practices or beliefs occur.

Construction Debris Disposal Site (Tinian Airport):

No impacts are anticipated to cultural resources of the Tinian Airport or Saipan Landfill disposal sites from receiving construction debris generated from implementation of Alternative 2. These areas are not designated as a historic landmark, and temporary construction activities are not expected to alter the area in which cultural practices or beliefs occur.

4.12.6 NHPA Section 106 Consultation

In compliance with Section 106 of the NHPA, ongoing consultation has been conducted with HPO, (Advisory Council on Historic Preservation) ACHP, and other consulting parties, with input sought relative to definition of the APE, identification of historic properties, and determination of potential effects to those properties. Due to the historical significance of the breakwater, the USACE is coordinating with NHPA to ensure that mitigation measures will sufficiently reduce many of the impacts to no adverse effect with conditions. A Programmatic Agreement is being developed to further identify resources, determine effects and establish the process for resolving adverse effects that may arise throughout the remaining planning, design, and construction phases of the proposed project. This Programmatic Agreement will be shared with consulting parties and included as part of the Final Feasibility Report/EIS to ensure that the USACE satisfies its responsibilities under Section 106 of the NHPA and other applicable laws and regulations.

4.13 Visual Resources

4.13.1 Regulatory Framework

NEPA requires federal agencies to consider scenery and aesthetic resources in federally supported projects. Federal agencies, including the Federal Highway Administration (FHWA), the U.S. Forest Service, and the Bureau of Land Management, have developed guidance to implement NEPA with respect to the evaluation of visual resources. Regulations and policies that protect visual resources and are being considered as part of the proposed project include the following:

- Parks and Recreation Act of 1998 (Public Law 11-106)
- National Historic Preservation Act
- CZMA Sections 306/306A and 309

The CNMI DLNR is empowered to establish landscaping and beautification projects pursuant to Public Law 10-57. The Department of Lands and Natural Resources is responsible for enhancing, maintaining, and beautifying public parks. The number of public parks managed by the DLNR has increased substantially since 1979 and maintenance of the parks has become increasingly difficult without the power to charge fees, promulgate regulations, and enforce rules. The Division of Parks and Recreation within the DLNR oversees the administration of such parks and recreational sports facilities. The NHPA requires that visual aspects of historic or cultural important resources be maintained. The Coastal Management Act mandates NOAA to maintaining balance in coastal communities. It is a process that takes into consideration many factors, including development, the natural environment, coastal commerce, hazardous weather impacts, aesthetics, quality of life, water quality, erosion, and more.

4.13.2 Environmental Setting

Visual resources refer to the natural and constructed features that give a particular environment its aesthetic qualities. In undeveloped areas, landforms, water bodies, and vegetation are the primary components that characterize the landscape. These components are characterized in terms of form, color, texture, and scale. They also may be described in terms of the extent to which they are visible to surrounding viewers (i.e., whether they are considered foreground or background). In developed areas, the natural landscape often provides a background for constructed features, which are often characterized in terms of the size, form, materials, and function of buildings, structures, roadways, and associated infrastructure. The combination of these characteristics defines the overall landscape, thus determining the visual quality of an area. Attributes used to describe visual quality include significant views or vistas, landscape character, perceived aesthetic value, and uniqueness. Visual quality is also described in terms of sensitive receptors, which include areas with high scenic quality (such as designated scenic corridors or locations), areas where concentrations of people may be present (such as residential or recreation areas), and important historic or archaeological locations.

The island of Tinian is characterized by a series of limestone plateaus, steep slopes, and cliffs. The steep cliffs along the shoreline are concentrated on the southeast and northwest sides of the island and provide a dramatic visual backdrop. The central part of the island is a relatively flat plateau extending from the village of San Jose along Broadway Avenue corridor and up to the north. The same type of flat plateau is located along the 8th Avenue corridor. Both of these corridors have intermittent forested areas within grassland, and topography that provide broad views north and south on the island, with the north-central highlands area situated between the two corridors.

4.13.3 Environmental Consequences

Effects on visual resources were considered significant if implementation of an alternative plan would result in any of the following:

- Development that substantially conflicts with the surrounding landscape (i.e., a form, line, color, or texture that contrasts with the visual setting)
- Obstruction of established view plane, significant view corridor, or other public views of important environmental resources and/or landscapes
- Substantial reduction of the views or aesthetic values associated with a historic property, scenic byway, or other important landmark

The region of influence for the evaluation of visual resources included the direct area of construction and those areas within visible range of construction activities. The potential effects to visual resources that could result from implementation of the alternatives, measures that would be conducted to mitigate those effects, and the resulting degree of impact are discussed in the following subsections.

4.13.3.1 Alternative 1: No-Action Alternative

- No impacts are anticipated to the Visual Environment if the No-Action Alternative is implemented.

Navigational risks are expected to continue as the existing configuration of navigational features will continue to expose the harbor and dock facilities to extremely difficult wind, wave, and current conditions, which will continue to result in significant disruption to navigation and operational limitations. View planes would remain unchanged.

4.13.3.2 Alternative 2: Replace Existing Breakwater along Current Alignment

- Short-term, direct, less than significant adverse impacts are anticipated under Alternative 2 based on the screening criteria defined above.

Construction Footprint and Immediate Area Surrounding the Construction Footprint:

Short-term, adverse, less than significant impacts to visual resources are anticipated during construction of the breakwater based on the criteria detailed above. The location of the breakwater would not be accessible to the public but construction activities may be within public view. The impacts would be removed once reconstruction of the breakwater has been completed and materials moved to the construction laydown area.

Under Alternative 2, the current 4600 ft. existing cellular sheet pile breakwater would be removed and a new breakwater would be built along the existing alignment. Improvements to the harbor would result in reduced wave action in the channel and at wharves. The structure would rise 12 ft. above the water surface in the main section.

A brief description of the breakwater is provided below. A more detailed description is provided in the Engineering Design Appendix (Appendix 3). The new breakwater will have a varying cross-sectional area composed of either stone, or stone and concrete armor units. Figure 3-2 shows the alignment of the existing structure, as well as the conceptual footprint (not to scale) of the replaced structure, including the Northwest Breakwater and Main Breakwater sections. The Northwest Breakwater section will tie into land and extend approximately 1100 ft. This section will require a smaller cross-section due to less wave exposure, and can be built with a stone armor layer and under layer. A typical cross-section for this reach is shown in Figure 3-3. The Northwest Breakwater section will be approximately 60 ft. wide and 14 ft. in total height on average, with an elevation 8 ft. above MLLW datum.

The remaining 3500 ft. of breakwater will consist of a more robust cross-section, due to head on exposure to larger waves, including those from typhoon events. Main Breakwater would follow the alignment of the existing breakwater, and would utilize the remnants of the existing breakwater as a portion of the core. A cast-in-place concrete crest cap would be used to stabilize the crest. The oceanside and harbor side toe of the structure will be placed into a trench excavated into hard foundation material and further stabilized with tremie concrete. The section will be approximately 65 ft. wide and 15 ft. in total height, with an elevation 12 ft. above MLLW datum. A typical cross-section is shown in Figure 3-4.

Construction Laydown Area:

Short-term, adverse, less than significant impacts to visual resources are anticipated during construction of the breakwater based on the criteria detailed above. The disposal materials will be dewatered within the temporary work area located in the northwest corner of the Tinian Harbor footprint shown on Figure 4-4 of proposed project features maps. This area would not be accessible to the public but construction activities may be within public view. The impacts would be removed once disposal materials are loaded and transported to the construction disposal site at Tinian Airport.

Construction Debris Disposal Site (Tinian Airport):

Short-term, adverse, less than significant impacts to visual resources are anticipated at the Tinian Airport disposal site or Saipan Landfill site (for overflow materials). Debris may temporarily be in public view during transportation and unloading; however, visual aesthetics to the airport runway area would not be significantly impacted. Also, the impacts would be removed once disposal activities cease.

4.13.3.3 Alternative 3: Replace and Extend Existing Breakwater along Current Alignment

- Long-term, direct, less than significant adverse effects are anticipated under Alternative 3 based on the screening criteria defined above.
- Short-term, direct, less than significant adverse impacts are anticipated under Alternative 3 based on the screening criteria defined above

Construction Footprint and Immediate Area Surrounding the Construction Footprint:

This measure involves all of the same demolition and breakwater replacement methods described in Alternative 2, with the addition of approximately 300 ft. extension to the breakwater. Short-term, adverse, less than significant impacts to visual resources are anticipated during construction of the breakwater based on the criteria detailed above. The location of the breakwater would not be accessible to the public but construction activities may be within public view. The short-term impacts would be removed once reconstruction of the breakwater has been completed and materials moved to the construction laydown area. The long-term direct impacts to the visual environment under the combined breakwater alternative would be less than significant. The breakwater extension is beyond the current alignment but is not expected to substantially detract from the visual aesthetics of the breakwater, nor will it conflict with the surrounding landscape.

Construction Laydown Area:

Short-term, adverse, less than significant impacts to visual resources are anticipated during construction of the breakwater based on the criteria detailed above. Explanation of impacts are identical to those discussed in Alternative 2 above.

Construction Debris Disposal Site (Tinian Airport):

Short-term, adverse, less than significant impacts to visual resources are anticipated at the Tinian Airport disposal site, which will be receiving approximately 50,000 cubic yards of construction debris (sheet pile, limestone rock, and sand material) generated from the implementation of Alternative 2. Impacts are identical to those discussed in Alternative 2 above.

4.14 Transportation

The island of Tinian is characterized by a series of limestone plateaus, steep slopes, and cliffs. The steep cliffs along the shoreline are concentrated on the southeast and northwest sides of the island and provide a dramatic visual backdrop. The central part of the island is a relatively flat plateau extending from the village of San Jose along Broadway Avenue corridor and up to the north. The same type of flat plateau is located along the 8th Avenue corridor. Both of these corridors have intermittent forested areas within grassland, and topography that provide broad views north and south on the island, with the north-central highlands area situated between the **two corridors.**

4.14.1 Regulatory Framework

Regulations and policies that regulate traffic in the proposed action location include the following:

Ground Transportation

- CFR Title 23, Highways
- CNMI Administrative Code: Commonwealth Department of Public Works Title 155-20.1, Public Rights-of-way and Related Facilities Regulations
- American Association of State Highway and Transportation Officials. FHWA "A Policy of Geometric Design of Highways and Streets", 2011
- DoD. United Facilities Criteria 3-250-18FA, General Provisions and Geometric Design for Roads, Streets, Walks, and Open Storage Areas, 2004

Marine Transportation

- 33 CFR Part 165.1403
- 33 CFR Part 110.239
- 33 CFR Part 166
- 33 CFR Part 167 CPA Title 40-20
- CNMI Administrative Code: Commonwealth Department of Public Works Title 155-20.1, Public Rights-of-way and Related Facilities Regulations
- CPA (CNMI Administrative Code Title 40-20)

Air Transportation

Tinian International Airport is classified by the FAA as a primary commercial service airport and is designed for code D-V aircraft such as 777/747 with a single east-west runway (Runway 08/26) of 8,600 ft. (2,621 meters) long and 150 ft. (46 meters) wide. Runway 08/26 is paved and marked for precision approaches with centerline, runway designation, threshold, aiming point, touchdown zone markings, and edge stripes. The runway pavement is asphalt and is in good condition. Tinian International Airport also has two apron taxiways, connecting the aircraft parking apron to the parallel Taxiway A. Both taxiways are 75 ft. (23 meters) wide with approximately 35 ft. wide (10.5 meter) shoulders on each side. The taxiway pavement is asphalt and is in good condition. The apron is the ramp area north of the passenger terminal building. The apron area is approximately 35,000 square yards (29,000 square meters), including an apron edge taxi lane. The apron area connecting to Hangar One west of the passenger terminal building is mainly for general aviation. The existing pavement of the apron is asphalt.

Tinian International Airport is owned, managed, and operated by the CPA and is used primarily for interisland travel between the islands of Saipan, Rota, and Guam. Star Marianas Air provides passenger charters between the islands of Saipan and Tinian, and cargo charters between Guam, Rota, Tinian, and Saipan. The current fleet for Star Marianas Air consists of seven Cherokee Six aircraft and three twin-engine Navajo aircraft all based at Hangar One in Tinian International Airport. Arctic Circle Air provides air cargo services and has expanded to include passenger flights. No regularly scheduled international flights currently operate at Tinian International Airport. Arrangements for immigration and customs services at Tinian International Airport must be made in advance with Chief Immigration Saipan. In 2013, there were approximately 49,116 operations (an average of 134 flight operations per day) at Tinian International Airport (FAA 2014).

4.14.2 Environmental Setting

4.14.2.1 Road Network

Tinian has about 68 miles of roads. Most roads were designed, developed, and constructed in 1944 to accommodate heavy truck traffic when the U.S. military population on Tinian was about 150,000. Many of the existing roads throughout Tinian are now in poor condition and traffic volumes are low. There are no roads that are part of the Interstate Highway System on Tinian. Two north/south roads, Broadway Avenue and 8th Avenue, connect the village of San Jose to the Military Lease Area and areas north of the Tinian International Airport. Two east/west roads (Canal Street [Route 202] and Route 201) connect the village of San Jose to 8th Avenue and Broadway Avenue. These roads have the highest traffic volumes with about 1,520 and 2,240 vehicles per day, respectively.

Based on the analysis conducted in the CNMI Comprehensive Highway Master Plan (Commonwealth Department of Public Works 2008), all roads on Tinian are operating under capacity at acceptable Level of Service A in their existing condition, as evidenced by free flowing traffic and no traffic delays.

4.14.2.2.1 Transit Network

There is no existing transit service on Tinian due to the relatively low population density.

4.14.2.2.2 Pedestrian and Bicycle Network

Limited designated bicycle paths are located along major roads and in main tourist attractions (Commonwealth Department of Public Works 2008). Isolated sidewalks can be found along short segments of some roads within San Jose. In general, continuous sidewalks do not exist on the majority of the roads on Tinian. Typically, the outside lane or shoulder, which is generally unpaved, functions as a pedestrian/bicycle space. Bicyclists are required to share the road with vehicles on existing travel lanes, and pedestrians are required to walk on the unpaved shoulder or landscaped area off to the side of the roads.

4.14.2.3 Marine Transportation

Harbor and Port Facilities

Tinian Harbor is located near the town of San Jose and is accessible via a channel with a navigable width of 500 ft. (152 meters) and a minimum depth of 27 ft. (8 meters) (survey conducted May 2007). The harbor was constructed in 1944 to accommodate up to eight Liberty Ship cargo vessels (U.S. Commander Pacific Fleet 1999), each with a length of about 465 ft. (142 meters), a beam (maximum width) of 57 ft. (17 meters), and a draft [maximum hull depth below water] of up to 28 ft. (8 meters). The Port of Tinian consists of a main wharf, two finger piers, and a breakwater. The main wharf has a usable length of 1,600 ft. (488 meters), with depths varying between 24 and 29 ft. (7 and 9 meters). The two finger piers (Pier 1 and Pier 2) are southwest of the main wharf (Global Security 2005). A concrete boat ramp used by Amphibious Assault Vehicles is north of the finger piers and adjacent to a public dock and a public boat ramp. An adjacent grassy staging area is used for vehicles brought ashore or for staging, cleaning, and reloading (U.S. Commander Pacific Fleet 1999). A mooring buoy 2 miles from Tinian Harbor has been removed, but the anchoring system is still in place and could be used for large draft ships (DoN 2013).

The two finger piers are in a state of disrepair and are unusable. The Municipality of Tinian declared a state of emergency in October 2009 to repair these piers.

The DoN estimates that the main wharf has the capacity to process 4,500 tons (4,082 metric tons) of cargo daily. The CPA estimates that the harbor has the capacity to accommodate passenger vessels holding up to 1,500 passengers.

The main wharf has a single mobile crane with a capacity of 50 tons (45 metric tons). A tugboat and lightering barge (smaller barge to transport cargo and passengers from larger-draft vessels that cannot enter the harbor) are available on an as-needed basis at Tinian. The Port of Tinian also has a facility for biosecurity/brown treesnake (*Boiga irregularis*) control, with a capacity of four shipping containers. Current lighting at the Port of Tinian is insufficient for nighttime operations.

The harbor is used by commercial and supply barges, as well as USCG vessels and military supply shipments on Joint High Speed Vessels. Gasoline and diesel fuel can be obtained at the Mobil Oil tank compound at the Port of Tinian.

Fuel supply and regular day-to-day commodities are shipped through Tinian Harbor. Fuel is shipped by a fuel tanker on a monthly basis. The fuel tanker is berthed at the main wharf area, where its fuel is piped to storage tanks located about 300 ft. (91 meters) inland. Usual stay time for the fuel tanker is 1 day. Tinian's commodities are transported from Saipan via a privately owned SM5 Boat (Landing Craft Mechanized, Mark-6) that transits daily. The SM5 Boat is off-loaded at the shore ramp facility located near the small floating boat pier.

For larger shipments, typically once every 60 days, a tug and barge are used to bring intermodal containers from Saipan. When the larger cargo quantity is delivered, the barge is docked at the main wharf. The stay time for the barge is typically 1 day.

Marine Shipping Traffic Patterns

Shipment of cargo (to and from Saipan) typically transits to the west of Tinian due to the calmer waters. Large vessels maintain a distance of about 1 mile offshore, while smaller vessels come within 100 ft. (30 meters) of shore. There are no known restrictions to marine traffic in the vicinity of Tinian.

4.14.3 Environmental Consequences

Effects on transportation and traffic were considered to be significant if implementation of an alternative plan would result in any of the following:

- Substantially increase vessel or vehicle travel times due to increased congestion, delays in traffic movement and circulation, and/or reduced roadway capacity
- Substantially reduce availability, quality and/or safety of harbor channels, roadways or other transportation resources (e.g., sidewalks, bicycle lanes, etc.)
- Substantially decrease access to harbor facilities
- Substantially displace parking and/or cause other significant changes in parking supply

The region of influence on transportation included the island of Tinian and adjacent airspace and harbor area. The potential effects to transportation and traffic that could result from implementation of the alternatives, measures that would be conducted to mitigate those effects, and the resulting degree of impact are discussed in the following subsections.

4.14.3.1 Alternative 1: No-Action Alternative

- Long-term, direct, significant adverse impacts area anticipated to the Marine Transportation environment under the No-Action Alternative.
- No Impacts will occur to the Ground Transportation environment under the No-Action Alternative.

Navigational risks are expected to continue as the existing configuration of navigational features will continue to expose the harbor and dock facilities to extremely difficult wind, wave, and current conditions, which will continue to result in significant disruption to navigation and operational limitations. View planes would remain unchanged. There will continue to be missed vessel calls and significant delays in vessel movement. No Impacts are anticipated to ground transportation as use of the harbor will remain unchanged.

4.14.3.2 Alternative 2: Replace Existing Breakwater along Current Alignment

- Long-term, direct, significant beneficial impacts to the marine traffic environment are anticipated if Alternative 2 is implemented based on the screening criteria defined above.
- Long-term, direct, less than significant adverse impacts are anticipated to the Ground Transportation environment if Alternative 2 is implemented.
- Short-term, direct, less than significant adverse impacts are anticipated to both the marine and ground traffic environments during construction.

Construction Footprint and Immediate Area Surrounding the Construction Footprint:

Implementation of Alternative 2 will increase the usability of the harbor, harbor facilities and indirectly the usability of the land-based recreational areas. Ground traffic is anticipated to increase over the long-term as economic growth could facilitate increases in vessel calls related to the needs of the local population as well as potential increases in tourism. These impacts will be less than significant as current land based traffic is minimal.

Construction Laydown Area:

Short-term adverse impacts are anticipated to both marine and ground transportation environments during construction of the breakwater based on the criteria detailed above. Vessels may need to be diverted from the construction zone but this is not expected to result in significant delay or access to the harbor. Additional ground vehicle traffic may be generated from construction activities in laydown areas. If traffic increases impact harbor operations, it can be mitigated with the implementation of BMPs such as staggered work schedules, coordination of vessel calls and construction activities, and forethought into the location of construction laydown areas. BMPs are fully described in Appendix 6.

Construction Debris Disposal Site (Tinian Airport):

Short-term, less than significant impacts are anticipated to the environment of the Tinian Airport disposal site from receiving construction debris generated from implementation of Alternative 2.

The disposal site is not open to the public and would not result in heavy congestion and traffic delays or reduce transportation resources. However, additional ground vehicle traffic may occur in the vicinity during waste transport, but is not expected to cause significant delays or block access to the airport.

4.14.3.3 Alternative 3: Replace and Extend Existing Breakwater along Current Alignment

- Long-term, direct, significant beneficial impacts to the marine traffic environment are anticipated if Alternative 3 is implemented based on the screening criteria defined above.
- Long-term, direct, less than significant adverse impacts are anticipated to the Ground Transportation environment if Alternative 3 is implemented.
- Short-term, direct, less than significant adverse impacts are anticipated to both the marine and ground traffic environments during construction.

Construction Footprint and Immediate Area Surrounding the Construction Footprint:

This measure involves all of the same demolition and breakwater replacement methods described in Alternative 2, with the addition of an approximately 300 foot extension to the breakwater, increasing the total length to approximately 4,900 feet. Impacts and mitigation under Alternative 3 are identical to Alternative 2.

Construction Laydown Area:

Short-term adverse impacts are anticipated to both marine and ground transportation environments during construction of the breakwater based on the criteria detailed above. These impacts are outlined in Alternative 2.

Construction Debris Disposal Site (Tinian Airport):

Short-term, less than significant impacts are anticipated to the environment of the Tinian Airport disposal site from receiving construction debris generated from implementation of Alternative 3. These impacts are outlined in Alternative 2.

4.15 Public Services and Utilities

4.15.1 Regulatory Framework

The CUC is the public corporation that owns and is responsible for providing electrical power, water, and wastewater services for the CNMI. CNMI Public Law 15-35 established the Public Utilities Commission as the agency for regulatory purposes such as approval of prices, fees, charges, and terms/services for the CUC.

The CUC is subject to all applicable regulatory requirements and the CNMI Bureau of Environmental and Coastal Quality, Division of Environmental Quality administers the following programs as delegated by the U.S. Environmental Protection Agency:

- Clean Air Act (42 USC § 7401 et seq.)
- Clean Water Act (33 USC § 1251 to 1387)

- Resource Conservation and Recovery Act (42 USC § 6901 to 6992k)
- Safe Drinking Water Act (42 USC § 300f to 300j-26)
- CNMI Wastewater Treatment and Disposal Rules and Regulations (CNMI Administrative Code Chapter 65-120)
- CNMI Underground Injection Well Regulations (CNMI Administrative Code Chapter 65-90)
- CNMI Water Quality Standards (CNMI Administrative Code Chapter 65-130

The CNMI Bureau of Environmental and Coastal Quality, Division of Environmental Quality has the following responsibilities: electrical power, potable water, wastewater, stormwater, solid waste. The Federal Communications Commission regulates all commercial information technology/ communications activities in the CNMI.

4.15.2 Environmental Setting

4.15.2.1 Electrical Power

The CUC is responsible for providing electrical power on Tinian. CNMI TeleSource, Inc. has been contracted by the CUC to operate and maintain the entire electrical power infrastructure on Tinian. This contract currently extends up to year 2035 (Deposa 2014). The electrical power resource on Tinian includes generation units and distribution facilities that make up the existing island-wide power system. This includes above ground and underground transmission and distribution cables, manholes, transformers, substations, meters, and all other supporting facilities.

Supply and Demand

The electrical power available from the CUC power station totals 17.0 megawatts, as shown in Table 4-10. Current peak demand is approximately 4.5 megawatts which leaves 8 megawatts available (4.5 megawatts standby generator is kept in reserve). This peak demand can be met when one of the two largest units is down for maintenance.

Unit	Design Megawatts	Available Megawatts	Status
Diesel Engine No. 1	5.0	4.5	Operational
Diesel Engine No. 2	5.0	4.5	Standby
Diesel Engine No. 3	2.5	2.0	Standby
Diesel Engine No. 4	2.5	2.0	Standby
Diesel Engine No. 5	2.5	2.0	Standby
Diesel Engine No. 6	2.5	2.0	Standby
Totals	20.0	17.0	-

Table 4-10. Power-Generating Facility on Tinian

Generation

The power generation facility consists of the following components: diesel generators, exhaust stacks, and an above ground fuel delivery pipeline from the Port of Tinian fuel storage tank to a storage tank adjacent to the power plant facility. The power generation facility is located near the coast outside of San Jose, at 25 ft. (7.6 meters) above MSL. The power generation facility is 15 years old, and appears to be in very good condition and well maintained.

There are other private standby electrical power generators on Tinian that include the International Broadcasting Bureau facility and personal-use standby generators.

Distribution

The distribution lines are 13.8 kilovolts. A primary distribution line runs from the generation facility to the International Broadcasting Bureau via 8th Avenue. This line is above ground mounted on wooden poles except for a portion west of the airport that is underground to facilitate the clear zone for the runway. The maximum anticipated load from the International Broadcasting Bureau is 1.4 megawatts which is the peak load measured by the CUC. The power facilities at the International Broadcasting Bureau transmitting station were designed for a peak demand load of approximately 7 megawatts. Although the highest recorded load is 4 megawatts, if the International Broadcasting Bureau determines it is necessary to operate all of the transmitters simultaneously at full power using normal amplitude modulation or dynamic carrier control modulation, the station’s peak loading on the CUC power supply could approach that 7 megawatts peak design load and greatly exceed the 1.4 megawatts.

The overhead line that provides power to the International Broadcasting Bureau has capacity of up to 13.6 megawatts. However, the total additional load that can be added is limited by the drop in voltage caused by electrical losses in the transmission line. Voltage drop depends on the length of the transmission line from the power source to the electrical load and the amount of electrical load on the transmission line.

A separate 13.8-kilovolts distribution line runs from the generation facility to the airport. This line runs above ground along Broadway north to the airport access road, then runs west along this road to the airport.

Based on the characteristics of the existing distribution system and outage records from 2011, 2012, and part of 2013, the island-wide electrical power utility system is currently providing reliable service and is well positioned to keep providing an acceptable level of service into the future. The outage history from this 2.5-year period recorded 12 brief (average of 68 minutes) occurrences, only three of which were island-wide outages.

4.15.2.2 Potable Water

Tinian’s public water system is owned and operated by the CUC. It services the southern third of Tinian, where the civilian population lives. This system consists of one functioning supply well (Maui Well #2), a chlorine injection system for water treatment, pumps, three storage tanks, distribution piping (typically underground), water meters, and other supporting facilities.

Production

Currently, Maui Well #2 supplies all potable water to the CUC Tinian water system, operating three of its four pumps almost constantly (CUC 2013b). With the need to keep one pump on standby for maintenance purposes, Maui Well #2 is operating near full capacity.

Between October 2011 and August 2014, the water system produced an average of 1,056,553 gallons (3,999,488 liters) per day of potable water. The potential water production from Maui Well #2 has been estimated as at least 1 million gallons per day (3.8 million liters) of potable water in the dry season and 1.5 million gallons (5.7 million liters) per day in the wet season (Army Corps of Engineers 2003). The analysis of the potable water system assumed that a maximum average pump rate of 1,260,000 gallons (4,769,619 liters) per day was a sustainable level.

Recent water quality testing has shown chloride levels range from 172 to 217 milligrams per liter, with an average of 190 milligrams per liter. Chlorides may be associated with salt content, and the general acceptable limit of chlorides in drinking water is 250 milligrams per liter to avoid affecting the taste of drinking water. A chlorine injection system treats the water at Maui Well #2. The injection system consists of two 150-pound (68kilogram) chlorine cylinders, a vacuum regulator mounted to the top of each cylinder, and a small pressurizing pump for the chlorination circuit.

Storage

The water system includes three water storage tanks: Marpo Tank, Carolinas Tank, and Tinian Airport Tank. The Marpo Tank is a 250,000-gallon (950,000-liter) tank that serves the Marpo Valley agricultural area and Marpo Heights residential area. The largest storage tank, the Carolinas Tank is a 500,000-gallon (1.9 million-liter) tank located above the Carolinas residential area. It serves the Carolinas Heights Subdivision, San Jose, Carolinas Heights Agricultural Homesteads, and a portion of Marpo Valley. The Airport tank is a 60,000-gallon (227,000liter) tank located along the airport access road and serves only the airport facilities.

Distribution

All water transmission lines also serve as distribution lines. The waterlines between Maui Well #2 and the storage tanks also serve as distribution lines to residents. A 6-inch (150-millimeter) polyvinyl chloride water line transmits water to Marpo Tank, and an 8-inch (200-millimeter) polyvinyl chloride water line transmits water to Carolinas Tank.

The system has substantial leaks due to old galvanized and transite distribution piping, overflows at storage tanks due to lack of functioning telemetry controls, and leaks due to high pressures. The large water losses result in significantly more water being pumped from the well to make up for the losses in the system.

As of November 2013, the CUC provides the potable water for a total of 833 metered accounts, which includes residential, commercial, and government customers (CUC 2013b). Unaccounted for water is the result of leaks, unmetered uses, and unplanned overflows within the system. The typical unaccounted for water from efficient systems should be less than 25% of the water produced. The CUC has indicated that unaccounted for water (water pumped from the supply well but not billed to customers) is estimated to be approximately 75% to 80% of the water produced (CUC 2013a).

The average recorded water production in all of 2002 was 1,200,000 gallons (4,500,000 liters) per day. Over the first 7 months of 2002, a monthly average of 680,265 gallons (2,575,083 liters) per day of potable water was metered to users (Army Corps of Engineers 2003). This indicates that in 2002, approximately 641,781 gallons (2,429,405 liters) of potable water was lost within the distribution system on Tinian daily (an average unaccounted for water of 48%).

Between October 2011 and August 2014, the water system produced an average of 1,056,553 gallons (3,999,412 liters) per day of potable water (CUC 2014). The monthly average of 320,384 gallons (1,212,785 liters) per day of potable water was metered to residential, commercial and government users. This means that between 2011 and 2014, daily potable water lost within the distribution system averaged 787,031 gallons (2,979,236 liters) per day, (an average unaccounted for water of 70%).

Although the Tinian International Airport relies on the CUC system for its water source, it has its own local water distribution system. In addition, the International Broadcasting Bureau facilities are not connected to the CUC Tinian municipal water supply system. Instead, they use non-potable rainwater collection, non-potable bulk water trucked in from the CUC system, and bottled drinking water.

4.15.2.3 Wastewater

There is no centralized municipal wastewater collection and treatment system on Tinian. Decentralized collection and treatment systems on Tinian serve some residential areas, such as the housing area in San Jose, and lead to a central septic and leaching field system. Both public and private buildings on Tinian use septic tanks with leaching fields or cesspools for treatment and disposal of wastewater.

4.15.2.4 Stormwater

As discussed in Section 4-5, Water Resources, Rainfall on Tinian averages 83 inches (212 centimeters) per year (Water and Environmental Research Institute 2003), 58% of which typically occurs from July to November while only 14% typically occurs during the dry season from January to April (DoN 2010). In portions of San Jose, a few areas contain curb and gutter for stormwater conveyance. Most other areas allow stormwater to flow naturally away from the roadways.

4.15.2.5 Solid Waste

The existing solid waste facility consists of an unlined, open disposal site located about 0.5 mile (0.8 kilometer) north of San Jose and west of 8th Avenue. This disposal site receives all of the municipal solid waste generated on Tinian. The CNMI Department of Public Works operates the facility, which does not comply with the CNMI Administrative Code Chapter 65-80 Solid Waste Management Regulations or the Resource Conservation and Recovery Act Subtitle D regulations applicable to municipal solid waste landfills (40 CFR Part 258) and were issued a Cease and Desist Administrative Order, CASE NO. DEQ SWM 2010-01 in 2010. The CNMI government has initiated contracting and construction for a solid waste transfer station that would handle the solid waste generated by the civilian population.

4.15.2.6 Information Technology/Communications

The information technology/communications resources on Tinian include all telephone, internet, cable, and satellite information technology/communications infrastructure. Tinian has commercial information technology/communications services provided by IT&E, which supplies phone and internet services through overhead distribution in the southern part of Tinian. Cellular phone service is also provided by towers that serve the southern part of the island. Marianas Cable Vision Broadband provides cable television service on Tinian. The International Broadcasting Bureau has significant broadcasting facilities on the northwest portion of Tinian but is not served by commercial services. It relies instead on wireless communications with infrastructure on Saipan.

An undersea fiber optic cable links Tinian and other islands in the CNMI to the Trans-Pacific Cable hub on Guam. In addition to the undersea fiber optic cable, a microwave system between Saipan, Tinian, and Rota provides alternative connectivity and provides diverse and redundant capability for IT&E commercial communications to Tinian in the event the undersea fiber optic cable is disabled (IT&E n.d.). The IT&E Cable Landing Facility is located on Tinian near Broadway and Canal Street in San Jose.

4.15.3 Environmental Consequences

Effects on public health and safety were considered to be significant if implementation of an alternative plan would result in any of the following:

- Substantially interfere with, or increase the response time of police, fire or emergency medical services
- Permanently disrupt or decrease the level of service for any public utility
- Significantly burden any public service or utility, including the water, wastewater, or stormwater drainage system

The region of influence for public service and utilities included the island of Tinian. The potential effects to public services and utilities that could result from implementation of the alternatives, measures that would be conducted to mitigate those effects, and the resulting degree of impact are discussed in the following subsections.

4.15.3.1 Alternative 1: No-Action Alternative

- No Impacts are anticipated under the No-Action Alternative based on the criteria defined above.

Under the No-Action Alternative, the breakwater would not be constructed, and as a result, there would be no construction-related impacts to public services and utilities.

4.15.3.2 Alternative 2: Replace Existing Breakwater along Current Alignment

- No Impacts are anticipated under Alternative 2 based on the criteria defined above.

Construction Footprint and Immediate Area Surrounding the Construction Footprint:

Changes relative to public services and utilities that would occur with implementation of Alternative 2 are expected to be within the range of those described for this alternative, and as such, impacts are expected to be less than significant and/or beneficial; no mitigation would be required.

- Police, Fire Protection and Emergency Medical Services: Construction of the proposed project is not expected to affect police, fire protection or emergency medical services. Planning and coordination would be conducted with these service providers relative to construction-related road closures, detours, and other potential traffic delays, as needed to maintain adequate response times and levels of service.
- Electricity and Telecommunications: The proposed project is not expected to significantly impact public utilities. Construction of this alternative might require removal/relocation of onsite utilities, if they occur within the construction footprint and/or the immediate area surrounding the construction footprint. In general, these are expected to generally be limited to the measures located in developed portions of the harbor, if any. The specific locations of existing utility lines and detailed relocation plans would be identified as part of the design phase. In the event that utility removal/relocation is necessary, there may be some temporary interruptions in service, but the interruptions would be minimized to the extent practicable and adequate notification would be provided, such that these impacts are expected to be insignificant. The existing utilities would be replaced/relocated such that following construction, there is not expected to be any reduction in the extent or level of service provided. Planned utility relocations would be coordinated and accommodated through the final design phase, to the extent practicable. There are no utility requirements that are expected for operation and maintenance of breakwater.
- Water and Wastewater: No impacts to water or wastewater are anticipated. Some water would be needed to support construction activities (e.g., mixing concrete, providing dust control, etc.). This water would be obtained from the municipal water

supply; the required quantities are expected to be well within the current water supply. The proposed project would not involve discharge to the wastewater treatment facilities.

- Stormwater Drainage: The proposed project is not expected to affect the quantity of stormwater runoff, nor would it otherwise burden the stormwater drainage system.

Construction Laydown Area:

Impacts to public services and utilities that would occur due to the construction laydown area are expected to be commensurate to those described for the construction footprint and the surrounding area, and as such, no impacts are anticipated based on the screening criteria defined above; no mitigation would be required.

Construction Debris Disposal Site (Tinian Airport):

No impacts are anticipated to public services and utilities at the disposal site from receiving construction debris generated from implementation of Alternative 2. Construction activities will be coordinated with public services prior to any construction-related services, and minimal use of public utilities are expected for transport and unloading of debris. The final disposal location for all disposal material will be placed in a low depression areas next to the Tinian airport runway. The excess sheet pile material may be placed in the Saipan landfill if the airport facility is not sufficient. These materials are not anticipated to be hazardous and will be tested for hazardous waste constituents prior to being disposed of at the disposal site.

4.15.3.3 Alternative 3: Replace and Extend Existing Breakwater along Current Alignment

- No Impacts are anticipated under Alternative 3 based on the criteria defined above.

Construction Footprint and Immediate Area Surrounding the Construction Footprint:

Changes relative to public services and utilities that would occur with implementation of Alternative 3 are expected to be within the range of those described for the Alternative 2, and as such, impacts are expected to be less than significant and/or beneficial; no mitigation would be required.

Construction Laydown Area:

No impacts are anticipated to public utilities in the construction laydown area based on the criteria detailed above. Explanation of impacts are identical to those discussed in Alternative 2 above.

Construction Debris Disposal Site (Tinian Airport):

No impacts are anticipated to public utilities at the disposal site from receiving construction debris generated from implementation of Alternative 3. Explanation of impacts are identical to those discussed in Alternative 2 above.

4.16 Socioeconomics and Environmental Justice

Socioeconomics is generally defined as the study of the interrelation between social behavior and economics. Socioeconomic analyses typically address issues such as population, demographics, business activity, employment and income, and environmental justice. Impacts to these fundamental socioeconomic components can also influence other systemic issues such as housing, the provision of public services (e.g., emergency services, education, health services), and the general quality of life in a community.

The U.S. Environmental Protection Agency defines environmental justice as, "the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies" (U.S. Environmental Protection Agency 2012). It goes on to clarify that "no group of people should bear a disproportionate share of the negative environmental consequences resulting from industrial, governmental, and commercial operations or policies." The U.S. Environmental Protection Agency guidance states that "each federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low income populations in the U.S. and its territories, the District of Columbia, the Commonwealth of Puerto Rico, and the Commonwealth of Northern Mariana Islands."

In January 1983, the U.S. and the CNMI governments finalized a lease agreement for military use of approximately two-thirds of northern Tinian (i.e., the Military Lease Area). In 1994, the U.S military signed a lease back agreement for a portion of the land that it had leased; this Lease Back Area was made available to Tinian residents for subsistence agriculture and grazing. One-year agricultural permits were administered by the CNMI Department of Public Lands and limited to 12 acres (5 hectares). The 1994 lease back agreement has since expired but the CNMI and U.S. have continued the terms of the lease back agreement on a short-term, interim basis while negotiations continue on a long-term lease back agreement. Since the 1990s, Tinian's economy has been led by tourism and local government employment (U.S. Census Bureau 2010a, 2014).

4.16.1 Regulatory Framework

Regulations and policies that relate to socioeconomic and environmental justice and are being considered as part of the proposed project include the following:

- NEPA

- Council on Environmental Quality (40 CFR § 1508.8, 40 CFR § 1508.14)
- EO 12898: Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations
- EO 13045: Protection of Children from Environmental Health Risks and Safety Risks

The Council on Environmental Quality regulations implementing NEPA state that when economic or social effects and natural or physical environmental effects are interrelated, the EIS would discuss these effects on the human environment (40 CFR § 1508.14). The Council on Environmental Quality regulations further state that the "human environment shall be interpreted comprehensively to include the natural and physical environment and the relationship of people with that environment." In addition, 40 CFR § 1508.8 states that agencies need to assess not only direct effects, but also "aesthetic, historic, cultural, economic, social, or health" effects. Following from these regulations, the socioeconomic analysis in this Interim Feasibility Report evaluates how elements of the human environment such as population, employment, housing, and public services might be affected by the proposed action.

Two EOs deal directly with the socioeconomic conditions and concerns of potentially affected communities. EO 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations requires federal agencies to assess whether their actions could have disproportionately high and adverse environmental and health impacts on minority or low-income populations. EO 13045, Protection of Children from Environmental Health Risks and Safety Risks requires a similar analysis for children.

4.16.2 Environmental Setting

4.16.2.1 Population Characteristics

According to the 2010 Census, Saipan, Tinian, and Rota are the only three islands in the CNMI with permanent residents (U.S. Census Bureau 2010a). The CNMI population increased by 730% between 1958 and 2000 (from 8,290 to 69,221) but decreased from 2000 to 2010 by 22% (from 69,221 to 53,883).

The first major population influx was during the 1980s. During that decade, the CNMI population more than doubled from 16,780 to 43,345. The population increased substantially again during the 1990s, growing 60% from 43,345 to 69,221. The massive population influxes during the 1980s and 1990s were driven by the introduction and increasing numbers of temporary non-residents (Pacific Web 2013).

A range of projections indicates that during the time that the proposed action would be implemented, CNMI (including Tinian) population could range between 3% lower than counted in the 2010 Census and 18% higher than 2010 levels.

The racial composition of the CNMI is primarily Asian and Pacific Islander. As of 2010, 50% of the population was Asian (mostly Filipino) and 35% was Pacific Islander (mostly

Chamorro) (U.S. Census Bureau 2010a). On Tinian in 2010, 47% of the population was Asian while 39% was Pacific Islander. Of the 1,222 Pacific Islanders on Tinian in 2010, 1,183 were Chamorro (97%) (U.S. Census Bureau 2010a). On average, CNMI households had 3.26 people and a median annual income of $19,958. Of the municipalities in the CNMI, Tinian had the fewest persons per household (3.21) and the highest median household income ($24,470); Saipan had the most people per household (3.27) and the lowest median household income ($19,607) (U.S. Census Bureau 2010a).

4.16.2.2 Economic Characteristics

Employment and Income

According to the 2010 Census, the labor participation rate in the CNMI was 72%, and 11.2% of the labor force in the CNMI was unemployed (U.S. Census Bureau 2010a). In comparison to the CNMI as a whole, Tinian's unemployment rate was low, at 6.7%. Table 4-11 lists the number and percent of the labor force, employed, and unemployed in the CNMI overall and broken down into Tinian, Saipan, and Rota.

Labor Force	CNMI	Tinian	Saipan	Rota
Population 16 Years and Over	38,679	2,311	34,581	1,787
Not in Labor Force	10,711	433	9,855	423
Labor Force Participation Rate	72%	81%	71%	76%
In Civilian Labor Force	27,949	1,878	24,709	1,362
Employed	24,826	1,752	21,816	1,258
Unemployed	3,123	126	2,893	104
Unemployment Rate	11.2%	6.7%	11.7%	7.6%
Source: U.S. Census Bureau 2010a.				

Table 4-11. CNMI Labor Force, Employment, and Unemployment, 2010

Table 4-12 shows 2010 employment by industry for the CNMI and Tinian. In 2010, the industry with the highest number employed both in the CNMI and on Tinian was the arts, entertainment, recreation, accommodation and food services industry; this tourism-related industry employed 672 people on Tinian (38% of employment) and 5,519 people in the CNMI (22% of employment).

Projections indicate that during the timeframe that the proposed action would be implemented, CNMI (including Tinian) employment could range between 8.4% and 35% higher than 2010 Census levels.

In the CNMI, the average hourly wage was $9.67 in 2011, and the median hourly wage was $6.00. This is lower than the U.S. minimum wage of $7.25 per hour because the CNMI does not fall under U.S. minimum wage regulations. Average annual pay was $20,114 and the median annual pay was $12,480. The highest paying jobs were legal (average annual pay of $59,467) and healthcare practitioner (average annual pay of $48,693). The lowest paying was food preparation and service-related occupations (average annual pay of $11,606).

Industry	CNMI Overall	CNMI % of Employment	Tinian	Tinian % of Employment
Arts, entertainment, recreation, accommodation, and food services	5,519	22%	672	38%
Educational services, health care, and social assistance	3,085	12%	178	10%
Retail trade	2,645	11%	76	4%
Other services, except public administration	2,553	10%	131	7%
Public administration	2,414	10%	320	18%
Professional, scientific, management, administrative, and waste management services	1,974	8%	53	3%
Construction	1,786	7%	79	5%
Transportation and warehousing, and utilities	1,429	6%	127	7%
Finance, insurance, real estate, rental, and leasing	1,064	4%	31	2%
Wholesale Trade	700	3%	10	1%
Manufacturing	689	3%	5	0%
Information	496	2%	29	2%
Agriculture, forestry, fishing, hunting, and mining	472	2%	41	2%
Source: U.S. Census Bureau 2010a.				

Table 4-12. Employment by Industry, 2010

The trend for CNMI total employee compensation and gross domestic product over the years of 2002-2012 is that total employee compensation was greatest in 2004 ($752 million), a year before the garment manufacturing industry experienced losses. After 2004, total compensation declined every year up to 2012, reaching a low of $482 million (U.S. Bureau of Economic Analysis 2012, 2013). Projections indicate that during the timeframe that the proposed action would be implemented, due to anticipated expansion in the tourism industry and expected increases in the minimum wage, CNMI total compensation could range between 21% and 51% higher than 2012 levels.

4.16.2.3 Housing

In 2010, there were 20,850 housing units in the CNMI, most of which were in Saipan (18,683). Vacancy rates in the CNMI as a whole were 23%. Tinian was at 22%, twice the U.S. average (U.S. Census Bureau 2010b). The least expensive housing units in the CNMI were on Rota (valued at $109,900) and the most expensive were on Saipan (valued at $127,600) (U.S. Census Bureau 2010a). There were 1,118 housing units on Tinian in 2010, 874 were occupied, 244 were vacant, and 101 were for rent (U.S. Census Bureau 2010a).

The West San Jose Village Homestead, located in northwest San Jose and south of the airport, broke ground on February 5, 2014 and 170 families received homestead permits to build homes. Five other homestead sites are expected to be developed on Tinian that would house an additional 345 families (Eugenio 2014).

4.16.2.4 Tourism

CNMI Overall

From 1999 to 2011, there has been a general decline in the number of tourism visitors. There are a variety of reasons for this decline, including the exit of Japan Airlines from the CNMI market, the March 2011 Japan natural disaster, and confusion over visas for Russian and Chinese visitors (Mariana Visitors Authority 2012). From 2011 to 2013; however, the number of visitors increased, rising from 340,957 in 2011 to 438,978 in 2013.

Projections indicate that during the timeframe that the proposed action would be implemented, the number of CNMI tourism visitors could be between 25% and 56% higher than 2012 levels, due to continued growth from Chinese and Korean markets.

Commercial Agriculture

Data presented in this section were derived from the 2007 Agricultural Census (U.S. Department of Agriculture 2009) and relate to places with agricultural operations qualifying as farms according to the census definition. This included all places from which $1,000 or more of agricultural products were produced and sold during the 2007 calendar year. Data from the 2007 Agricultural Census is the most recent available as the U.S. Department of Agriculture has not conducted, and does not intend on publishing, an updated agricultural census for the CNMI (U.S. Department of Agriculture 2014).

CNMI Overall

Farms are found on all of the populated islands in the CNMI. In 2007, Saipan had the most farms (128), Rota the second most (97), and Tinian had the fewest (31) (U.S. Department of Agriculture 2009). Fruits and nuts (45%), vegetables and melons (43%), and root crops (41%) made up nearly all of the $1.85 million in agricultural product sales in the CNMI in 2007 (U.S. Department of Agriculture 2009). Additionally, CNMI farms had sales of livestock and poultry.

Tinian Farms

Based on the Census definition, a person is engaged in subsistence activities if he or she mainly produces goods for his or her own or family's use and needs, and not solely for commercial purposes (U.S. Census Bureau 2014). Table 4-13 provides information on the number of Tinian farms and the amount of land in those farms. In 2007, there were 31 farms on Tinian, an increase of 8 farms from 2002. Farms with sales over $1,000 used 2,071 acres (838 hectares) of Tinian land in 2007 (U.S. Department of Agriculture 2009).

Tinian Farms	**2002**	**2007**
Number of Farms	23	31
Land in Farms (acres)	672/272	2,071/838
Source: U.S. Department of Agriculture 2009.		

Table 4-13. Farms, Land in Farms, and Land Use by Municipality, 2002 and 2007

Of the 31 farms on Tinian in 2007, 74% were owned by individuals, 15% by a partnership, and 6% by corporations; 29% of farms were on owned land and 71% were on rented land from others; 29 of the 31 farms used unpaid labor (indicating family workers); 77% of farms were operated by Chamorros and 19% were operated by Asians; 13% of farm operators were not a U.S. citizen (U.S. Department of Agriculture 2009).

Agricultural Products

In 2007, the market value of all agricultural products sold on Tinian (including root crops, vegetables, melons, fruits, and nuts) totaled $152,537. Fruits and nuts, and vegetables and melon sales were $72,339 and $77,188, respectively (U.S. Department of Agriculture 2009).

Gathering

Multiple Tinian government agencies and other anecdotal reports indicated that hot peppers named “Donni Sali” are sometimes gathered, processed, and sold. According to the Tinian Department of Labor, pepper gathering for sale is a common source of income for community members that are not working and is a supplement to income for those who need extra money (DoN 2014).

Livestock

Approximately two-thirds of the land on Tinian is part of the Military Lease Area, therefore, the majority of agricultural grazing permits for livestock are in this area. As of 2014, the Lease Back Area (i.e., southern portion of the Military Lease Area) supported approximately 2,375 acres (961 hectares) of agricultural grazing permits. However, not all of that land was utilized. Data and research of cattle grazing on Tinian have been published in the Beef Cattle Herd Survey, 2013, by the Northern Marianas College Cooperative Research, Extension, and Education Service (NMC-CREES 2013) According to the Cattle Herd Survey, in 2013, there were 37 ranching operations that covered 1,834 acres (742.5 hectares) (NMC-CREES 2013). Of these 37 ranching operations, the Tinian Cattlemen’s Association estimates that 32 are located in the Military Lease Area (DoN 2014). Of the 1,834 acres on Tinian being used for cattle grazing, an estimated 1,010 is in the Military Lease area.

In 2012, 177 cattle were sold (with a permit) for a total of $97,350. In 2013, the herd numbered 1,043 and the live weight value, calculated based on sales in 2012, was about $547,850 (NMC-CREES 2013). According to the survey, there were about 0.6 cattle per acre (1.4 per hectare) on Tinian around the start of 2013. The Tinian Cattlemen’s Association indicated that there was no crowding of cattle, that there was more than enough space for the number of cows in the herd, and that ideally there could be more cows per acre (1 per acre or 2.5 per hectare were noted to be ideal) (NMC-CREES 2013).

Commercial Fishing

Commercial fishing occurs throughout the CNMI, mostly around Saipan and Tinian. An estimated $503,822 worth of fish were landed in the CNMI in 2010 (217,099 pounds (98,474 kilograms) at an average price of $2.32 per pound), over 90% of which were landed on Saipan (National Oceanic and Atmospheric Administration 2013a).

As of 2011, the number of fishing boats on Tinian was between 15 and 20, with the majority of those boats less than 25 ft. (8 meters) in length (National Oceanic and Atmospheric Administration 2013b). While the waters to the northwest of Tinian are used for fishing by the Saipan commercial fishing fleet, there is no evidence of a commercial fishing industry based out of Tinian. According to the Tinian Department of Land and Natural Resources and the Western Pacific Fishery Management Council, fishing boats on Tinian are not used for commercial fishing; when fish are sold, it is to cover the expenditures of fishing excursions (DoN 2014).

While the CNMI has a moratorium on gill nets, the Department of Land and Natural Resources reports gill net fishing so it is included here. The water is notably calmer on the western side of Tinian, which makes it more attractive for fishing than the eastern side. Types of fishing that require boats are almost exclusively limited to the western side of the island. According to the Tinian Department of Land and Natural Resources, waters on the eastern side are rougher and, for the most part, only good for land-based cliff-fishing (DoN 2014).

Aquaculture

Aquaculture in the CNMI is primarily land-based with major products that include tilapia and shrimp. Production in 2009 was estimated at 10 metric tons (11 tons) with a value of $56,000. Fish are sold live or fresh, usually at a size of 7-9 ounces (200-250 grams), for a price of $2-$3 per pound ($5-$6 per kilogram). As of 2011, there were eight tilapia farmers in the CNMI (five on Saipan, two on Rota, and one on Tinian) (NMC-CREES 2011). A local source with expertise in aquaculture indicated that the two farms on Rota were government-sponsored demonstration farms, four of the five Saipan farms were for subsistence, and the continued operation of the farm on Tinian was uncertain since the passing of its operator.

Commercial Hunting

Research indicated that no commercial hunting takes place in the CNMI; rather, hunting is limited to subsistence purposes only (DoN 2014).

Minerals

Through ownership in FPA Pacific Corp., Hawaiian Rock has operated a quarry and ready mix concrete plant on Tinian since 1993.

4.16.2.5 Airports and Sea Ports

The CPA operates, maintains, and is responsible for improvements of all airports and sea ports in the CNMI. Airports and sea ports are located on Tinian, Saipan, and Rota and facilitate economic activity in the CNMI. Airports facilitate the movement of tourists and goods between islands and sea ports facilitate the transportation of goods between islands. As of September 30, 2012, the CPA had 122 employees on Saipan, 25 on Tinian, and 21 on Rota (CPA, 2013).

Airports

There are three major airports in the CNMI: Saipan International Airport, Tinian International Airport, and Rota International Airport. Air taxi operations (i.e., aircraft designed to carry 60 or fewer passengers or carry up to 18,000 pounds of cargo) constituted 76% of operations at Saipan International Airport and 94% of operations at Tinian International Airport. Military operations constituted 4.1% of operations at Rota International Airport, 1% of operations at Tinian International Airport, and 0.3% of operations at Saipan International Airport.

Sea Ports

In fiscal year 2012, a total of 395,070 inbound revenue tons and 14,244 outbound revenue tons were brought in and out of CNMI ports. The Port of Tinian is located on the southwest side of the island and is currently used for fuel supply and other commodities such as food. Fuel is brought in by tanker that makes deliveries on a monthly basis (CPA, 2014). The fuel tanker docks at the port and fuel is piped to storage tanks located about 300 ft. (91 meters) inland. A tug and barge are used to bring shipping containers over from Saipan. According to the Saipan Shipping Company and Tinian Marine Stevedores Incorporated, the barge only transits about once every other month (DoN 2014). Improvements at the Port of Tinian included new fenders and bollards and repairs to the concrete cap (CPA, 2014).

Power Utility Rates

The CNMI’s electric system is owned by the CUC, which is a public corporation that is part of the CNMI government. All CNMI electricity customers pay a fuel surcharge that varies with the world price of diesel fuel; this surcharge is known as the Levelized Energy Adjustment Clause rate. One of the largest commercial electricity consumers on Tinian is the International Broadcasting Bureau.

4.16.2.6 Public Services

Education

The CNMI Public School System, created in 1988, is a state education agency for preschool, elementary, and secondary education. It also includes the Early Intervention Program for infants up to 3 years old, and Head Start for children aged 3 to 4. Public education services are funded through a mixture of CNMI and federal funds. During fiscal year 2011, the CNMI Public School System received $58,374,747 in overall federal grants (Deloitte 2013a), though much of that ($28 million) was awarded under the American Recovery and Restoration Act, which is a temporary source of funding. The CNMI Public School System comprises 12 elementary schools, 4 junior high schools, and 5 high schools. Kindergarten is offered at every elementary school, and there are 10 Head Start centers (CNMI Public School System 2013). Enrollment in elementary schools was 5,412 students, and in secondary schools it was 5,093 students (DoN 2014).

There are two accredited public schools on Tinian, an elementary school (grades kindergarten through grade 6) and a junior/senior high school (grades 7 through 12). Both schools are located in the village of San Jose. According to 2011 to 2012 school year data, published by the CNMI Public School System, Tinian elementary had 14 teachers and 260 students (student to teacher ratio of 19:1), and Tinian Junior/Senior High School had 15 teachers and 229 students (student to teacher ratio of 15:1). The overall student to teacher ratio on Tinian during the 2011 to 2012 school year was 17:1. There is one Head Start center on Tinian, and as of 2011, there were 34 children enrolled and one staff member (CNMI Public School System 2013). Representatives of the CNMI Public School System indicated that due to Tinian's declining population, Tinian schools are using less of their capacity than during previous years. The total of 489 students for the 2011 to 2012 school year is below the highest number of students that recent data show for Tinian, which was 615 students during the 2007 to 2008 school year (CNMI Public School System 2011).

Emergency Services

The Department of Public Safety provides emergency services including police, fire, and emergency medical services in the CNMI. The Department consists of four major divisions, including the Commonwealth State Police Division, the Fire Division, the Bureau of Motor Vehicles, and the Commissioner. Emergency services are funded through a mixture of CNMI and federal funds. In fiscal year 2011, the CNMI received over $2 million in grants from the U.S. Department of Justice (Deloitte 2013b).

In 2013, the CNMI Department of Public Safety handled 4,604 Emergency Medical Services incidents, 3,521 fire related incidents, and there was a total of 3,105 criminal offenses (including 1,129 burglaries/robberies/thefts, 699 disturbances, 569 violent crimes, and 316 property crimes) (CNMI Department of Public Safety 2013a).

The Tinian Department of Public Safety indicated that, as of February 2014, they were staffed by 17 police officers (a ratio of 6 officers for every 1,000 residents) and 11 firefighters (a ratio of 3.8 firefighters per 1,000 residents) (CNMI Department of Public Safety 2013a). While Tinian police officers are often responsible for a variety of tasks (for example, the same officer may be trained in boating safety and 911 call reception), the 6 officers per 1,000 residents is double the average for the U.S. as a whole, which is less than 3 officers per 1,000 residents (Bureau of Justice Statistics 2003). In addition, the ratio of 3.8 firefighters per 1,000 residents greatly exceeds the historical U.S. ratio of about 1.7. Since ratios of both officer and firefighter per 1,000 residents on Tinian are more than double of those in the U.S., Tinian emergency safety services are generally considered to have the capacity to meet the needs of the public.

The condition of the Department of Public Safety's building was noted as fair and able to accommodate current personnel and operations (DoN 2014). Additionally, the Department indicated that it has a refurbished fire engine and ambulance, and that a boating safety facility will be operational sometime in 2014 (DoN 2014). The CPA maintains firefighting capability at Tinian International Airport as a requirement for airport operations. This capability is available to the Tinian Department of Public Safety in the event of an emergency. According to the CPA, Tinian International Airport has two fire-fighting vehicles (DoN 2014).

In 2013, 86 criminal offenses were recorded in San Jose; the most common offenses included 30 thefts or burglaries, 15 incidences of disturbing the peace, and 15 assaults (CNMI Department of Public Safety 2013b). It was noted that burglary is often drug-related and domestic violence is often alcohol-related and that these crimes are also related to weak economic conditions (DoN 2014).

Health

Public health services are funded through a mixture of patient fees and CNMI and U.S. federal government funds. The Commonwealth Healthcare Corporation is an autonomous public corporation of the CNMI government. It provides hospital, primary care, and public health services to Saipan, Tinian, and Rota. There is no major trauma center in the CNMI; the closest major trauma center is on Guam.

The Tinian Health Center is the island's primary health care facility. Part of the Commonwealth Healthcare Corporation, the Health Center facility was built in 1987, currently has five holding beds, and in 2013, the Health Center accommodated 8,000 outpatient visits and 1,600 urgent care visits (DoN 2014). Information provided by staff indicates that there is one full-time physician, one nurse practitioner, four registered nurses, five licensed practical nurses, one nursing aide, and a dentist that visits periodically (DoN 2014). Medical staff explained that non-communicable diseases such as diabetes and hypertension are a major concern on Tinian, much like the rest of the CNMI (DoN 2014). Despite clearly apparent limitations necessitated by operational efficiencies in areas with small populations such as Tinian (e.g., major emergency and specialty medical cannot be provided here but in Saipan), Health Center staff did not indicate that the facility was overburdened in any way. Some concerns were expressed about available space for treatment, but expansions are underway that should alleviate those concerns (DoN 2014).

Social and Community Topics

Community and social topics are a collection of activities or goals that are important to a social group or community. Changes to community and social topics are measured in terms of changes in community character and community cohesion.

Community character is the distinctive identity of a particular place that results from the interaction of many factors that give it unique or special characteristics—built form, landscape, history, people, and activities within the place as a whole (American Planning Association 2011). The topic areas of homesteads, agriculture, fishing, and hunting in particular contribute to community character in the CNMI and are detailed in the sections below.

Community or social cohesion measures the levels of “relationship between individuals, groups, and organizations within a community” (Holdsworth 2009). In a community with strong community cohesion, high levels of characteristics such as social ties, interdependence, trust, and reciprocity exist and bind people within that community together. A lack of community cohesion occurs when there are “divisions between groups, individuals, and systems” (Stone and Hughes 2002). Again, the topic areas of homesteads, agriculture, fishing, and hunting are the characteristics within the region that allow the building of relationships between individuals, groups, and organizations within the community and are thus covered in the sections below.

CNMI Homesteads

The Northern Islands Village and Agricultural Homesteading Act of 2008 was passed by the CNMI legislature to: a) Establish the Northern Islands Village and Agricultural Homesteading program for current or former residents of the Northern Islands or any qualified person interested to reside on the Northern Islands. b) Enable residents of the Northern Islands who hold a homestead permit to borrow money to build a safe and sanitary home. c) Initiate and promote economic development on the Northern Islands through long-term commercial leases and permanent settlements. d) Provide the Department of Public Lands sufficient authority and flexibility to administer this act. e) Allow the Department of Public Lands to review homestead claims on their merits.

In addition, per Article 11 Section 5 of the CNMI constitution, some portions of public lands are to be set aside for a homestead program. In concept, one gains ownership of an unowned natural resource by performing an act of original appropriation under the program. Appropriation could be enacted by putting an unowned resource to active use (as with using it to produce a product), joining it with previously acquired property, or by marking it as owned (as with livestock branding). Eligibility requirements to receive a homestead permit, set forth in Title 2 Section 4303 of the Commonwealth Code, provide that an applicant must be of Northern Marianas descent and an applicant is eligible for a homestead permit on only one lot. Once a permit is granted, the recipient of the permit may begin to make improvements on the homestead lot. A deed of ownership of the homestead lot may be granted after a period of time if certain conditions are met, such as subdivision conditions consistent with modern planning standards (i.e., power and water utilities are present) and that a home has been built on the lot, or a minimum $10,000 investment has been made on the land.

The modern Tinian community is small and quiet with only a few stores and restaurants. Families often go to the beaches on weekends and attend barbeques. People also engage in agriculture, fishing, and hunting activities for both traditional and subsistence purposes. These agriculture, gathering, hunting, fishing, and grazing activities, when mainly conducted for a person's own or family's use and needs and not primarily for commercial purposes, are considered subsistence activities (U.S. Census Bureau 2014). The 2010 Census identified 103 Tinian residents over the age of 16 that participated in subsistence activities (U.S. Census Bureau 2010a). Of the 103 people that engaged in subsistence activity, 91 were elsewhere employed (part-time), 44 were unemployed, and 8 were not in the labor force.

Agriculture

Farming. According to Tinian and CNMI government agencies, farming is done for subsistence on Tinian. According to staff at the Tinian Health Center, Tinian is traditionally an agricultural community, but has become less so over the past several years. The trend has been away from foods that are produced locally and towards processed food that are purchased at stores (DoN 2014).

Ranching. Cattle grazing has occurred on Tinian since cattle were first introduced by the Spanish in the 16th century (NMC-CREES 2013). After the Spanish-Chamorro War, for a few hundred years, feral cattle roamed across Tinian. When Tinian was transferred from Spanish to German control, the Germans preserved the herd for food and the monetary value. The Japanese administration later oversaw a decrease in the size of the herd as sugarcane fields took over the Tinian landscape. After World War II, much of Tinian was leased to Ken Jones, a businessman who expanded the herd to include 7,000 beef cows and 1,000 milk cows; during this time, the Tinian herd was the primary source of beef and milk products consumed by residents of Tinian, Saipan, Guam, and other nearby islands. The modern herd provides local residents with fresh beef for regular consumption and for traditional cultural events (NMC-CREES 2013). Tinian beef cannot be sold commercially because slaughtering facilities do not meet U.S. federal standards (21 CFR §§ 601).

Gathering

According to multiple Tinian government agencies, people gather yams and hot peppers as a cultural tradition. It is often something that mothers and daughters do together (DoN 2014). The hot pepper is also the basis for the island's largest community event—the Pika Festival. This festival has been ongoing for more than 10 years and features song and dance performances, including performances by school groups, and events such as a crab race, a hot pepper eating contest, and a pika burger eating contest (Camacho 2014).

While the peppers have more of a cultural value than for subsistence purposes, Tinian government agency sources indicated that yams are consumed by gatherers and their families (DoN 2014).

Fishing

On April 19, 1999, the National Marine Fisheries Service officially identified the CNMI as a fishing community. The legal concept of a fishing community means "a community which is substantially dependent on, or substantially engaged in the harvest or processing of fishery resources to meet social and economic needs" (National Oceanic and Atmospheric Administration 2012). According to multiple Tinian government agencies, fishing is a cultural and traditional activity that is passed down from father to son at an early age (DoN 2014).

According to the Tinian Department of Land and Natural Resources and the Western Pacific Fishery Management Council, Tinian fishermen typically do not sell fish to earn a profit, they do so to obtain food for themselves and their family (DoN 2014). The frequency and value of subsistence fishing on Tinian is not known, but on Saipan data indicate that 90% of the catch was consumed by fishermen, family, and friends, while about 8% was sold.

Hunting

According to Tinian government agencies, hunting is a cultural and traditional activity that is passed down from father to son (DoN 2014). The Tinian Department of Land and Natural Resources indicated that wildlife that are hunted include turtledoves, coconut crabs, sea crabs, as well as feral goats and chickens (DoN 2014). While the entire island could be considered a hunting ground, the majority of hunting resources are located in the unpopulated northern two-thirds of the island, in the Military Lease Area. The reason for this in part is because there are laws against firing weapons in populated, residential areas found in the south (DoN 2014). Agencies noted that the mid-west to east part of the island is prime coconut crab area, but during the coconut crab season they can be hunted anywhere on the island, and that a prime area for sea crabs is on the northeast coast (DoN 2014).

Environmental Justice and the Protection of Children

Tinian is a small island of approximately 39 square miles in size with approximately 3,136 residents. Local residents occupy the southern one-third of the island and live generally in the villages of San Jose, Marpo, and Carolinas. The population is predominately of Pacific Islander and Asian decent with low numbers of other races. Data from the 2010 Census indicate that 98.2% of Tinian's population was comprised of minorities and 44.6% of the population was low income (U.S. Census Bureau 2010). Approximately 30% of the Tinian population is made up of children less than 18 years of age. These populations predominantly reside in San Jose and Marpo Heights.

Minority Population Areas

CNMI minority population comprised about 98% of the total population (2.1% of CNMI population was nonminority), while the Tinian population is 98.2% minority. As defined by Council on Environmental Quality guidelines, any area where 50% or more of the population is minority, is considered a minority population area. Therefore, all of Tinian is considered a minority population area. The Tinian population is further defined in the 2010 Census as 47% Asian, 39% Pacific Islander (of which 97% was Chamorro), and 12% two or more races.

Low-income Population Areas

The 2010 low-income population proportions for the CNMI overall and Tinian are presented by Census Tract. For the CNMI overall, 52% of the population was below the poverty line in 2010 (Table 4-14 and Figure 4-9). On Tinian, 43.6% of the population was below the poverty line as defined by the Bureau of Census. Therefore, the island is low income and from the perspective of EO 12898, the majority of the residents of Tinian are both minority and low income.

Age	CNMI	Tinian
Under 5 years	59%	49%
5 years	58%	48%
6 to 11 years	56%	45%
12 to 17 years	50%	36%
All Children	55%	43%
Source: U.S. Census Bureau 2010a.		

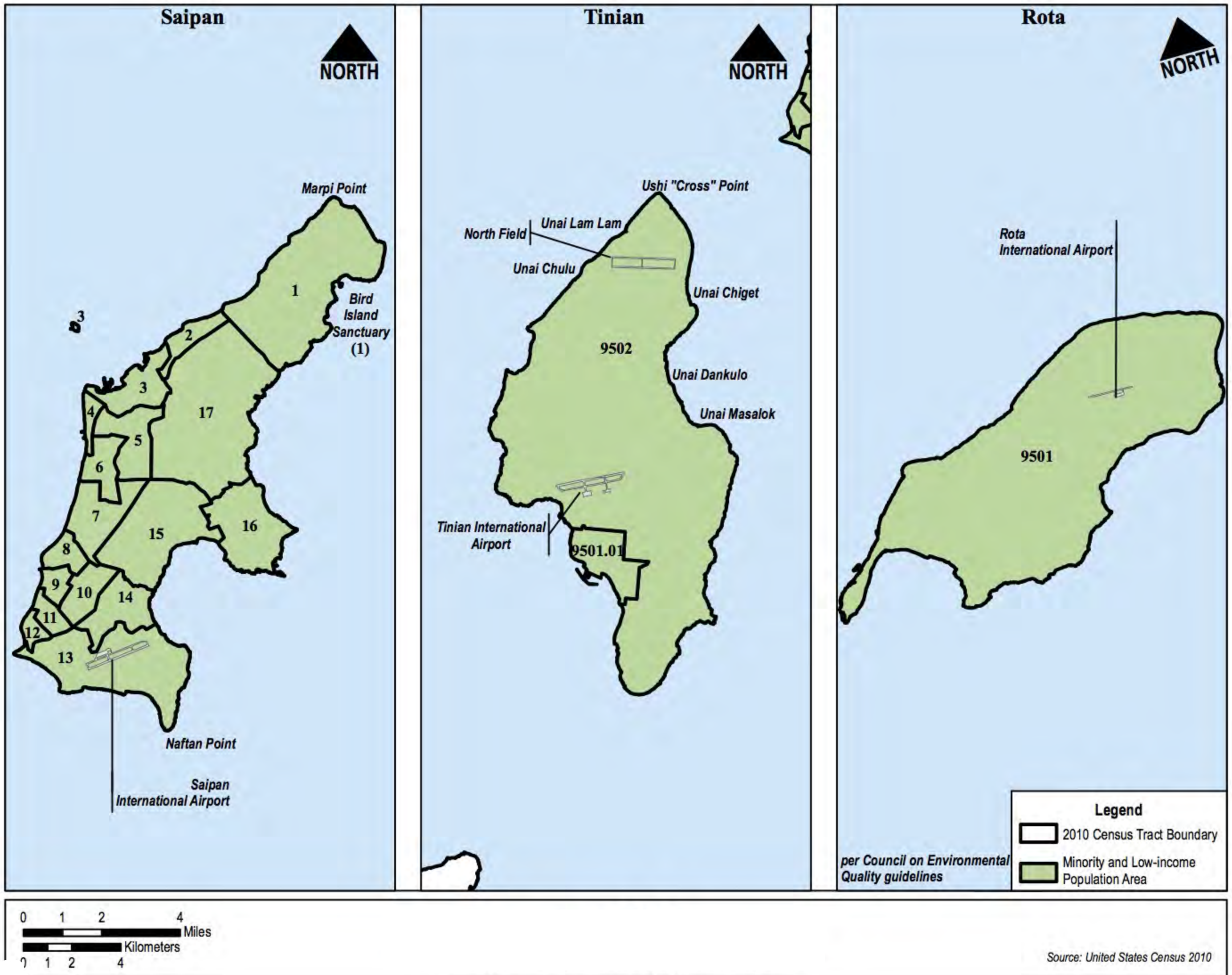
Table 4-14. Percentage of Children below the Poverty Line

The presence of children follows closely with the overall population concentrations. Within these populated areas, certain locations such as schools, parks, and playgrounds have higher concentrations of children (Figure 4-10). According the US Census Bureau, nearly 30% of the Tinian population are children. The greatest concentration of schools on Tinian is located in the village of San Jose.

4.16.3 Environmental Consequences

Effects related to socioeconomics and environmental justice were considered to be significant if implementation of an alternative plan would result in any of the following:

- Induce substantial population growth (either directly or indirectly)
- Displace substantial numbers of existing people or housing
- Substantially reduce employment opportunities or income levels in the area
- Significantly affect the social connectedness of the community
- Disproportionately affect any particular low-income or minority group
- Disproportionately endanger children in areas within or near the proposed project site



U.S. Army Corps of Engineers Honolulu District Fort Shafter, Hawaii	PROJECT NAME: Interim Feasibility Report Tinian Harbor Modification Study Island of Tinian Commonwealth of the Northern Mariana Islands	FIGURE TITLE: Minority and Low-Income Population Areas FIGURE NUMBER: 4-9

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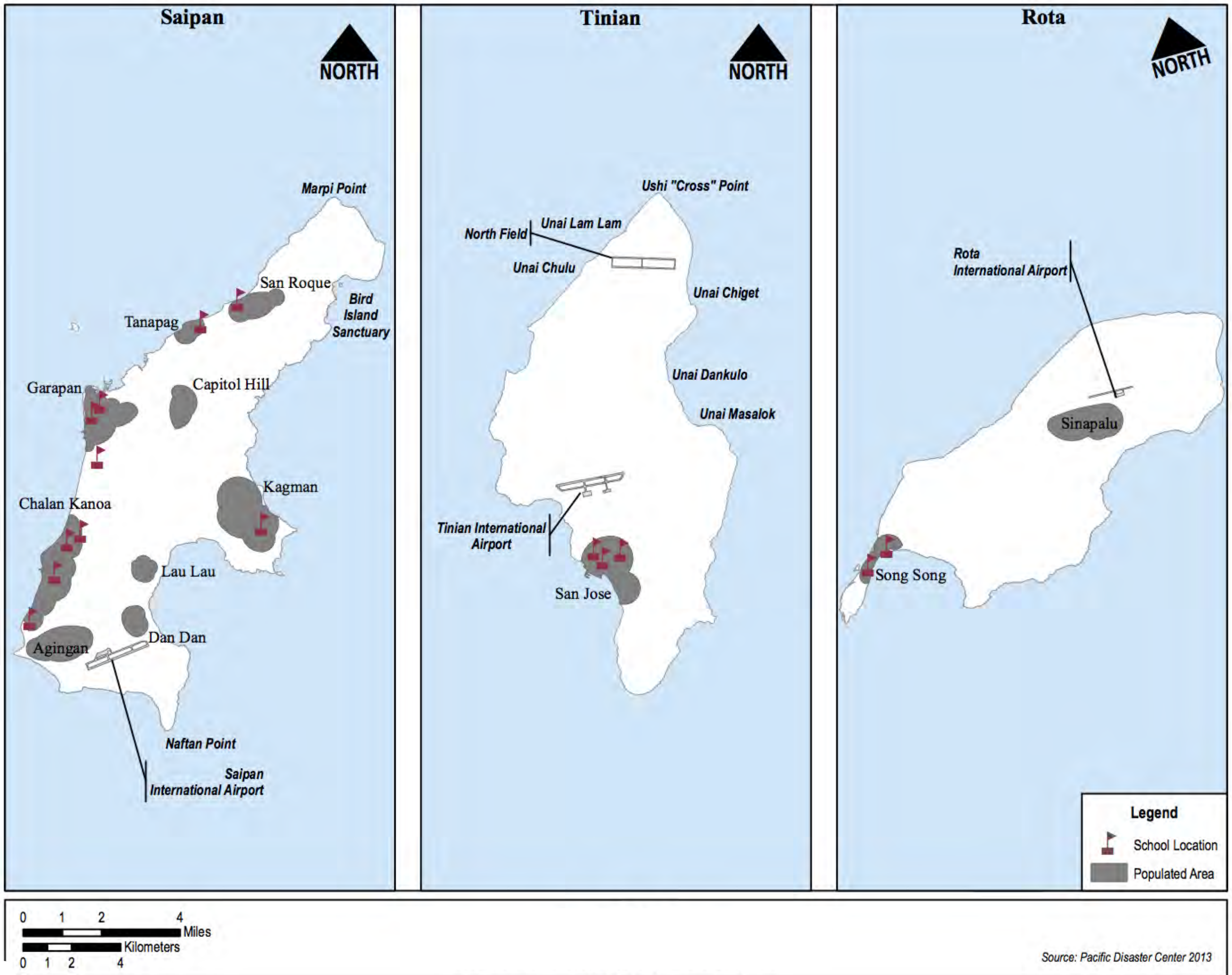

U.S. Army Corps of Engineers Honolulu District Fort Shafter, Hawaii	PROJECT NAME: Interim Feasibility Report Tinian Harbor Modification Study Island of Tinian Commonwealth of the Northern Mariana Islands	FIGURE TITLE: Schools and Highly Populated Areas FIGURE NUMBER: 4-10

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The region of influence for socioeconomic resources and environmental justice included the entire CNMI region including the islands of Tinian, Rota, and Saipan. The potential effects related to socioeconomics and environmental justice that could result from implementation of the alternatives, measures that would be conducted to mitigate those effects, and the resulting degree of impact are discussed in the following subsections.

4.16.3.1 Alternative 1: No-Action Alternative

- Long-term, direct and indirect, significant negative effects are anticipated under the No-Action Alternative based on the screening criteria defined above.

Navigational risks are expected to continue as the existing configuration of navigational features will continue to expose the harbor and dock facilities to extremely difficult wind and wave conditions, which will continue to result in significant disruption to navigation and port operations. Adverse weather conditions or closures in the harbor may limit the availability of days for subsistence fishing and recreational activities such as boating, sport fishing, sightseeing, and other social events.

4.16.3.2 Alternative 2: Replace Existing Breakwater along Current Alignment

- Long-term, direct and indirect, significant beneficial effects are anticipated under Alternative 2 based on the screening criteria defined above.
- Short-term, direct, less than significant adverse impacts are anticipated if Alternative 2 is implemented.

Construction Footprint and Immediate Area Surrounding the Construction Footprint:

This measure involves removal of the approximately 4,600 foot long existing cellular sheet pile breakwater and building a new breakwater along the existing alignment. Implementation of Alternative 2 will have the potential to increase calls to the harbor and to decrease the cost of goods that are currently being brought in under difficult circumstances due to the deterioration of the breakwater, and adding to shipping costs in the process. As the majority of goods used by residents are imported, the cost of living and the quality of life would be greatly improved by reliable harbor service and more affordable food and supplies. A more efficient harbor may also encourage economic development in aquaculture and tourism. These factors, among others, have the potential to reduce the economic burden on the population of Tinian that is living below the poverty line.

Construction Laydown Area:

Short-term, direct, less than significant, adverse impacts are anticipated to the construction laydown area. Standard operating procedures and best practice measures as listed in the construction footprint above would be implemented to mitigate adverse effects to less than significant. Therefore, Alternative 2 would not disproportionally endanger children or affect low-income or minority groups near the proposed project area. Standard operating procedures and best practice measures would be implemented to mitigate adverse effects to less than significant. BMPs as described in Appendix 6 would ensure that any impacts would be minimal. They include but are not limited to: dust control measures, water quality monitoring, spill prevention and response, biosecurity outreach, traffic management, noise abatement, notice to mariners. The Alternative 2 measure is not anticipated to substantially affect any particular minority or low-income group, endanger children, or displace people or housing.

Construction Debris Disposal Site (Tinian Airport):

No impacts are anticipated to the environment of the disposal sites from receiving construction debris generated from implementation of Alternative 2. The final location for all disposal materials will be in low depression areas next to the Tinian airport runway, as this area is unavailable for public use on a normal basis, Alternative 2 would not disproportionally endanger children or affect low-income or minority groups near the proposed project area.

4.16.3.3 Alternative 3: Replace and Extend Existing Breakwater along Current Alignment

- Long-term, direct and indirect, significant beneficial effects are anticipated under Alternative 2 based on the screening criteria defined above.
- Short-term, direct, less than significant adverse impacts are anticipated if Alternative 2 is implemented.

Construction Footprint and Immediate Area Surrounding the Construction Footprint:

This measure involves all of the same demolition and breakwater replacement methods described in Alternative 2, with the addition of an approximately 300 ft. extension to the breakwater, increasing the total length to approximately 4900 ft. Impacts and mitigation under Alternative 3 are identical to Alternative 2.

Construction Laydown Area:

Short-term, less than significant adverse impacts are anticipated during construction of the breakwater. Explanation of impacts are identical to those discussed in Alternative 2 above.

Construction Debris Disposal Site (Tinian Airport):

No impacts are anticipated to the environment of the Tinian Airport disposal site from receiving construction debris generated from implementation of Alternative 3. Explanation of impacts are identical to those discussed in Alternative 2 above.

4.17 Hazardous and Toxic Waste

4.17.1 Regulatory Framework

Hazardous substances are controlled in the U.S. primarily by laws and regulations administered by the U.S. Environmental Protection Agency, the U.S. Occupational Safety and Health Administration, and the U.S. Department of Transportation. Each agency incorporates hazardous substance controls and safeguards according to its unique Congressional mandate. U.S. Environmental Protection Agency regulations focus on the protection of human health and the environment. U.S. Occupational Safety and Health Administration regulations primarily protect employee and workplace health and safety. U.S. Department of Transportation regulations promote the safe transportation of hazardous substances used in commerce.

The CNMI oversees and administers federal environmental regulations through the CNMI Bureau of Environmental and Coastal Quality. The CNMI Bureau of Environmental and Coastal Quality, Division of Environmental Quality, Hazardous and Solid Waste Management Branch regulates hazardous waste generated within the CNMI. In 1984, the CNMI Bureau of Environmental and Coastal Quality adopted the federal hazardous waste regulations under the Resource Conservation and Recovery Act and the hazardous and solid waste amendments (CNMI Bureau of Environmental and Coastal Quality 2008). The CNMI does not have hazardous waste regulations that are more stringent than U.S. Environmental Protection Agency regulations.

The CNMI Bureau of Environmental and Coastal Quality, Division of Environmental Quality, Toxic Waste Management Branch protects human health and the environment through the enforcement and ongoing inspections of hazardous waste and emergency response. The CNMI Bureau of Environmental and Coastal Quality regulates hazardous and toxic materials through Title 65: Bureau of Environmental and Coastal Quality, Division of Environmental Quality, Chapter 65-50, Hazardous Waste Management Regulations.

All DoD operations on Tinian are required to comply with the CNMI, as well as applicable federal and DoD laws and regulations. The following federal and CNMI laws, rules, and regulations would be followed:

Federal Regulations

- Comprehensive Environmental Response, Compensation, and Liability Act
- Resource Conservation and Recovery Act
- Military Munitions Rule
- Emergency Planning and Community Right-to-Know Act
- Toxic Substances Control Act
- Oil Pollution Act
- Pollution Prevention Act

- Occupational Safety and Health Administration laws and regulations
- Department of Transportation laws and regulations, including the Transportation Safety Act
- Federal Insecticide, Fungicide, and Rodenticide Act
- Federal Environmental Pesticide Control Act
- Federal Facilities Compliance Act
- Underground Storage Tank regulations
- Ship-Borne Hazardous Substance regulations
- EO 12088, Federal Compliance with Pollution Control Standards

CNMI Regulations

- Commonwealth Environmental Protection Act
- Harmful Substance Clean Up Regulations (CNMI Administrative Code Chapter 65-40)
- Hazardous Waste Management Regulations (CNMI Administrative Code Chapter 65-50)
- Used Oil Management Rules and Regulations (CNMI Administrative Code Chapter 65-110)

4.17.2 Environmental Setting

The following provides a historical context of activities on Tinian that potentially could contribute to the use of hazardous materials, toxic substances, hazardous wastes, and/or creation of contaminated sites. Tinian was sparsely populated prior to Spanish missionaries coming to the Northern Mariana Islands in 1668 (see Section 4.12, Cultural Resources). The island was largely depopulated from approximately 1700 until the early 1920s. Large-scale sugar cane cultivation began on Tinian beginning around 1922 and continued until the U.S. takeover of the island in 1944. Military use of the island by the Japanese occurred during the early 1940s, ending with the Battle of Tinian in August 1944. The U.S. military continued operations on the island during the war with a peak population of approximately 150,000 service personnel in 1944. Following World War II, small-scale U.S. military activity continued through to the present time. Meanwhile, civilian agriculture, cattle ranching, and eventually tourist activities began to take place on the island and continue today.

The area in the vicinity of Tinian Harbor includes the storage, use, and/or management of hazardous materials. A bulk fuel storage facility owned and operated by Mobil Oil is located at the port. The plant provides Tinian with gasoline and diesel fuel, including fuel for the Commonwealth Utility Corporation power plant. Other aboveground storage tanks at the Mobil bulk fuel storage facility include a 63,000-gallon (240,000-liter) diesel tank and an approximately 30,000-gallon (100,000-liter) gasoline tank. A fuel tanker vessel delivers fuel to the tanks on a monthly basis (DoN 2014a). There is also a truck fueling facility for gasoline distribution at this facility. A 1,167-ft. (356-meter) long, single-walled, steel, aboveground pipeline delivers fuel from the Mobil bulk fuel plant to a 500,000-gallon (1,900,000-liter) aboveground diesel storage tank at the Commonwealth Utility Corporation power plant located to the northwest of the port at the corner of West Street and 6th Avenue. The pipeline is approximately 3 inches in diameter and has no secondary containment. No releases have been reported in association with the pipeline. The Commonwealth Utility Corporation has two 15,000-gallon (57,000-liter), two 7,000-gallon (26,500-liter), and one 2,000-gallon (7,600-liter) aboveground diesel fuel storage tanks. All tanks at this site are provided with secondary containment using concrete or concrete lined earthen berms. No releases have been reported at the power plant.

No radon testing has occurred on Tinian. However, radon testing on Guam resulted in a definite correlation between the type of surficial geology and radon concentrations. In almost all cases, elevated radon concentrations were found in buildings located above Barrigada and Mariana limestones but not in those located above alluvial clay deposits, beach deposits, and volcanic rocks (Burkhart et al. 1993). A large portion of the geology of Tinian consists of Mariana limestone, and therefore there is the potential for radon intrusion into structures constructed on Tinian.

Potential and Confirmed Contaminated Sites

In 1992, approximately 10,000 gallons (38,000 liters) of unleaded fuel were released at the Mobil bulk fuel storage facility (located in the vicinity of the harbor) as a result of tank bottom failure. Contamination of soils and groundwater was confirmed and remediation using a combination of in situ air sparging, free product recovery, and air stripping was implemented with quarterly groundwater monitoring.

4.17.3 Environmental Consequences

Effects relative to hazardous and toxic waste were considered to be significant if implementation of an alternative plan would result in any of the following:

- Uncover or expose an existing hazardous, toxic or radioactive waste, releasing it into the environment.
- Accidentally release a hazardous material or other contaminant.

The region of influence for hazardous, toxic, and radioactive waste included the direct area of construction and adjacent areas. The potential effects relative to hazardous, toxic or radioactive waste and that could result from implementation of the alternatives, measures that would be conducted to mitigate those effects, and the resulting degree of impact are discussed in the following subsections.

4.17.3.1 Alternative 1: No-Action Alternative

- No impacts are anticipated to the HTRW environment if the No-Action Alternative is implemented.

Under the No-Action Alternative, no breakwater would be constructed, such that no project-related actions would affect HTRW. Additional HTRW sites are not expected to be generated to a significant extent, as there are existing regulations designed to prevent future contaminant releases. As such, the number, extent and influence of HTRW sites on aquatic habitats in the harbor are not expected to significantly differ from existing conditions.

4.17.3.2 Alternative 2: Replace Existing Breakwater along Current Alignment

- Long-term, direct, less than significant adverse impacts may occur if Alternative 2 is implemented.

Construction Footprint and Immediate Area Surrounding the Construction Footprint:

Long-term, direct, less than significant adverse effects may occur on the HTRW environment if additional vessel calls are facilitated by increases in useable days and increases in economic growth. Additional vessel calls increase the potential for spills. Spill response plans already in place should minimize environmental impact.

Given that no HTRW sites are known to occur within the construction limits of the harbor, implementation of Alternative 2 is not expected to uncover or otherwise expose hazardous, toxic or radioactive waste within any of the measure locations. To confirm the absence of HTRW in the proposed project footprint, a detailed Phase I Environmental Site Assessment would be performed during the project design phase. In the event the Phase I assessment indicates the presence of HTRW, a Phase II Environmental Site Assessment would be performed, including chemical analysis for hazardous substances and/or petroleum hydrocarbons. If HTRW is detected, appropriate mitigation measures would be implemented, including proper characterization, transport and disposal in accordance with the appropriate local, state, and federal laws and regulations. In accordance with USACE regulations (ER 1165-2-132), the non-federal sponsor would be responsible for HTRW response actions as a non-project cost.

Construction and O&M activities would require the use of some hazardous materials, including fuels (e.g., gasoline and diesel fuel) and lubricants, which could adversely affect the environment if accidentally released. However, only a limited amount of these materials would be present onsite, and construction personnel would follow BMPs, including use of proper handling procedures and daily inspection of equipment for leaks, as needed to prevent spills or releases of hazardous materials during construction activities. It is expected that the permit requirements will specify effluent limitations guidelines (ELGs) and new source performance standards (NSPS) to control the discharge of pollutants from the proposed project site. With implementation of these measures, potential HTRW-related impacts are expected to be less than significant.

Construction Laydown Area:

No impacts are anticipated due to HTRW in the construction laydown area based on the criteria detailed above. The temporary work area will be used as a staging area for equipment and construction materials, some of which will include some hazardous materials, including fuels and lubricants which could adversely affect the environment if accidentally released. BMPs similar to those observed in the construction footprint area would ensure that no hazardous materials are released in the construction laydown area (Appendix 6).

Construction Debris Disposal Site (Tinian Airport):

No impacts are anticipated to the environment of the Tinian Airport disposal site from receiving construction debris generated from implementation of Alternative 2. The materials are not expected to be hazardous and will be tested for hazardous waste characteristics prior to disposal during construction.

4.17.3.3 Alternative 3: Replace and Extend Existing Breakwater along Current Alignment

- Long-term, direct, less than significant adverse impacts may occur if Alternative 3 is implemented.

Construction Footprint and Immediate Area Surrounding the Construction Footprint:

This measure involves all of the same demolition and breakwater replacement methods described in Alternative 2, with the addition of an approximately 300 ft. extension to the breakwater, increasing the total length to approximately 4900 ft. Impacts and mitigation under Alternative 3 are identical to Alternative 2.

Construction Laydown Area:

Explanation of impacts in the construction laydown area are identical to those discussed in Alternative 2 above.

Construction Debris Disposal Site (Tinian Airport):

Explanation of impacts at the disposal site are identical to those discussed in Alternative 2 above.

4.18 Public Health and Safety

4.18.1 Policies and Procedures

Standard operating procedures (SOPs) and policies pertinent to BMPs applicable to public health and safety during construction activities include the following:

- Traffic Management Plan and Work Zone Traffic Management (Refer to Traffic Section)

- Gates, Fencing, and Signs
- Public Access Plan
- Fire Management Plan
- Hazardous Materials Release Response

4.18.2 Environmental Setting

The information presented in this section focuses on the health and safety of the general public. Possible direct impacts to public health and safety during construction may result from injuries from construction related activities, traffic (Section 4.14), noise (Section 4.7), water pollution, air pollution, and hazardous material exposure. Indirect impacts may come from effects to social services (police, emergency medical services, fire department), disruption of utilities (electric, water, telecommunications, sewage), as well as the effects of the possible disruption of current shipping activities on the food and commercial goods supply to the island.

The current public safety setting has been described throughout this report. If the No-Action Alternative is implemented, the harbor will continue to pose potential safety issues to the public and harbor workers during period of high winds, waves and currents.

4.18.2.1 Ground Operations

The Tinian Department of Public Safety indicated that, as of February 2014, they were staffed by 17 police officers (a ratio of 6 officers for every 1,000 residents) and 11 firefighters (a ratio of 3.8 firefighters per 1,000 residents) (CNMI Department of Public Safety 2013a). The condition of the Department of Public Safety's building was noted as fair and able to accommodate current personnel and operations (DoN 2014). In 2013, 86 criminal offenses were recorded in San Jose; there were 30 thefts or burglaries, 15 incidences of disturbing the peace, and 15 assaults (CNMI Department of Public Safety 2013b). Descriptions of the police divisions, fire divisions, and health services are presented in Section 4.16, Socioeconomics and Environmental Justice. As described in Section 4.12, Transportation, ground transportation facilities on Tinian include the existing road network (primarily developed in 1944 to accommodate the U.S. military), with limited designated bicycle paths, and isolated sidewalks along roads within San Jose. Many of the existing roads throughout Tinian are in poor condition. The Commonwealth Department of Public Safety, Highways Safety Office develops, coordinates, and promotes safety programs and provides policy and public awareness on highway safety. Highway safety, in general terms, includes the following initiatives: reduction of traffic crashes, impaired driving traffic related injuries and fatalities, and property damages as a result of a traffic collision; and improving pedestrian and motorcycle safety, community outreach, occupant protection, child restraint, and emergency medical services. Under CNMI Public Law 3-61, §1 (§ 101), the Department of Public Safety, Police Traffic Services is the enforcement authority of all laws relating to traffic matters on the islands of Saipan, Tinian, and Rota. The Department of Public Services division on Tinian is required to submit a monthly traffic report. The report includes motor vehicle crashes, seat-belt usage, impaired driving, speeding, pedestrian, and traffic fatalities/injuries, and other data related to traffic safety. One of the five fatal collisions reported within the CNMI in 2010 occurred on Tinian. No other fatal collisions occurred on Tinian during the 5-year period from 2008 through 2012. Of the 7,332 collisions that occurred during the 5-year period, 94% resulted in property damage, 5% resulted in injury, and 1% resulted in fatality. Alcohol was a factor in 63% of the 27 fatal collisions. None of the collisions reported during the 5-year period resulted in a bicyclist or motorcyclist death.

4.18.2.2 Marine Operations

The Port of Tinian is used by the public, commercial and supply barges, as well as USCG vessels. The current port docking facilities consist of a main wharf that is approximately 2,000 ft. long with a usable length of 1,600 ft. The harbor has no fixed shore-side cranes or lighting. West of the main wharf are two finger piers, both are in complete disrepair and unusable. As described in Section 4.10, Recreation and Section 4.16 Socioeconomics and Environmental Justice, waters to the northwest of Tinian are used for fishing by the Saipan commercial fishing fleet. The water is notably calmer on the western side of Tinian, which makes it more attractive for fishing than the eastern side. Additionally, shorelines are used for recreational fishing, primarily located south of Dump Coke South and north of the Two Coral (Turtle Cove) diving sites on the west side of Tinian.

4.18.2.3 Military Activities

North of the main wharf and adjacent to the current public dock and ramps is an old concrete boat ramp that has been used by military Amphibious Assault Vehicles. This ramp has an adjacent grassy staging area suitable for storing vehicles brought ashore, or for staging, cleaning, and reloading (U.S. Commander Pacific Fleet 1999). There are no recurrent military operations within waters surrounding Tinian. There are currently no marine danger zones associated with Tinian.

4.18.2.4 Marine Vessel Accidents

The Lloyd's Maritime Information Service Casualty Register collects data on and reports vessel casualties. Vessel casualties consist of accidental groundings and shipwrecks. In 1997, the South Pacific Regional Environment Programme published a research paper which included a list of all casualties in the South Pacific between 1976 and 1996. During this 20-year period there were seven documented wrecks or groundings in the vicinity of the Northern Marianas. Four of the seven documented events involved heavy weather of typhoons. Only one vessel casualty was recorded in the waters surrounding Tinian. In August 1986, a refrigerated cargo ship carrying frozen fish stranded while entering the Tinian Harbor. The hold and engine room of the ship flooded (Preston et al. 1997). Based on a review of National Transportation Safety Board, Marine Accident Reports issued since 1996, there have been no accidents reported in the waters surrounding Tinian, during the past 18 years (National Transportation Safety Board 2014). According to a news article in saipantribune.com, dated October 5, 2016, a 36-ft. boat owned by

Huangshun Corp. and carrying 3,000-4,000 lbs. of cargo from Saipan sank at Tinian Harbor. According to the investigation the cargo boat was approaching the harbor entrance and lost propulsion, then sank due to a large hole or damage to the aft behind the captain's deck caused by breakwater metals. There were no human casualties.

4.18.3 Environmental Consequences

Potential impacts from construction related activities, environmental impacts (Noise, Air pollution, Water pollution, Hazardous materials), and impacts to social services (Police, Emergency medical services, Fire) can impact public health and safety.

The region of influence for public health and safety included the island of Tinian. Effects on public health and safety are considered to be significant if implementation of an alternative plan would result in substantially endangering the general public. The factors evaluated include the accessibility of the proposed project site, proximity of the public, system of notification, duration of the proposed project

4.18.3.1 Alternative 1: No-Action Alternative

- Long-term, direct, significant adverse impacts area anticipated to public health and safety under the No-Action Alternative.
- There would be no long-term, indirect impacts under the No-Action Alternative.

Periods of high wind and surf conditions will continue unimpeded, resulting in long-term, direct, significant risk to public health with regards to the harbor operations and recreational use of the harbor. If No Action is taken, operations of the harbor would remain unchanged. There would be no long-term indirect impacts under the No-Action Alternative.

4.18.3.2 Alternative 2: Replace Existing Breakwater along Current Alignment

- Short-term, direct, less than significant adverse impacts to public health and are anticipated if Alternative 2 is implemented based on the screening criteria defined above.
- Long-term, direct, significant, beneficial impacts are anticipated to public health and safety if Alternative 2 is implemented.
- Long-term, indirect, less than significant, adverse impact are anticipated to public health and safety if Alternative 2 is implemented.

Construction Footprint and Immediate Area Surrounding the Construction Footprint:

Under Alternative 2, improvements to the harbor would result in short-term direct, less than significant impacts of possible construction related environmental hazards (air pollution, noise pollution, hazardous materials exposure). Impacts due to accidental release of hazardous materials can be mitigated via implementation of BMPs. These include, but are not limited to ensuring adequate spill prevention kits, and providing primary and secondary containment for the specific volumes and chemicals that are stored on site. Likewise, impacts from air pollution from sources such as fugitive dust and combustion engines would be addressed through the implementation of dust control measures, and use of products that reduce emissions from equipment. BMPs are fully described in Appendix 6. Civilian access is limited and can be further restricted from any construction related location with the use of fencing, signage, and monitoring personnel. Fencing and other physical barriers to construction sites as well as signage notifying the public of construction activities would be maintained by construction personnel. Maintenance of these measures coupled with construction safety personnel monitoring construction site access points to limit unauthorized civilian entry would limit risk to public health and safety.

Long-term, direct impacts to public health and safety during construction activities are considered to be less than significant. Utility services are not expected to be impacted by construction activities and public services are not located within the proposed project area and would experience minimal impact from construction related activities at the harbor. If construction related traffic is planned that may impede normal traffic patterns in the harbor area, development and implementation of a traffic control plan and coordination with emergency services would ensure adequate response times. Impacts to social services are considered to be less than significant due to the remote locale and limited number of people at the harbor.

Long-term, direct, beneficial impacts are anticipated with the implementation of Alternative 2. The decrease in wave action would result in a safer environment for recreational activities such as boating and swimming within the harbor. Recreational use is anticipated to increase over the long-term.

Long-term, indirect, adverse impacts are anticipated with the implementation of Alternative 2. Additional ground vehicle traffic may be generated from the increase in recreational activities at the harbor. This would result in the increased risk to the general public.

Construction Laydown Area:

No adverse impacts to public health and safety are anticipated at the construction laydown area based on the criteria detailed above. Public access is limited during construction. Any risk to public health and safety will be mitigated via the implementation of BMPs, such as restricted access to the laydown area and fencing to control unauthorized personnel.

Construction Debris Disposal Site (Tinian Airport):

No impacts are anticipated to the environment of the Tinian Airport disposal site from receiving construction debris generated from implementation of Alternative 2. The risk associated with hauling construction debris to the disposal site is considered less than significant and does not require mitigation. The final disposal location for all disposal material will be placed in a low depression areas next to the Tinian airport runway, which is not expected to pose any risks to public health and safety, as it is not accessible to the public.

4.18.3.3 Alternative 3: Replace and Extend Existing Breakwater along Current Alignment

- Short-term, direct, less than significant adverse impacts to public health and are anticipated if Alternative 3 is implemented based on the screening criteria defined above.
- Long-term, direct, significant, beneficial impacts are anticipated to public health and safety if Alternative 4 is implemented.
- Long-term, indirect, less than significant, adverse impact are anticipated to public health and safety if Alternative 3 is implemented.

Construction Footprint and Immediate Area Surrounding the Construction Footprint:

This measure involves all of the same demolition and breakwater replacement methods described in Alternative 2, with the addition of an approximately 300 ft. extension to the breakwater, increasing the total length to approximately 4900 ft. Impacts and mitigation under Alternative 3 are identical to Alternative 2.

Construction Laydown Area:

Explanation of impacts in the construction laydown area are identical to those discussed in Alternative 2 above.

Construction Debris Disposal Site (Tinian Airport):

Explanation of impacts at the disposal site are identical to those discussed in Alternative 2 above.

4.19 Other Regional Analyses

Under the NEPA review processes, analysis of the significance of potential environmental effects should consider the sum of the effects on the quality of the environment; in addition to direct impacts, the analysis should also consider indirect impacts, cumulative effects, and short-term and long-term effects of the proposed action.

4.19.1 Secondary Effects

In addition to direct impacts, projects may also result in secondary and induced effects. The interrelationships and cumulative impacts of the proposed project and other related projects should also be discussed.

Secondary (or indirect) effects are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable; they may include growth inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems (40 CFR 1508.8). Potential reasonably foreseeable Secondary Effects are discussed in their individual environment sections and are reiterated below:

- Long-term, indirect, significant beneficial secondary impacts to the economy are possible - As described throughout this document, the proposed project would significantly reduce the potential for navigation risk. Reducing navigational risk may increase use of the Rota Harbor and facilitate future changes in land use and/or development patterns. The proposed project could create conditions that would induce population growth and therefore have other related indirect effects on the environment associated with that growth. While the proposed project's construction and operation expenditures would provide a direct benefit to the local economy, the amounts are relatively too small to cause significant secondary effects in the local economy.
- Long-term, indirect, significant, adverse or beneficial secondary impacts to coral and other biological resources may occur by permanently changing the marine environment (wave action and currents) in the proposed project area and areas further removed. This could have potential beneficial effects, if changes facilitate coral growth and creates new habitat, or adverse secondary impacts, if changes reduce or destroys existing habitats in the immediate vicinity of the sea wall or locations further removed.
- Long-term, indirect, significant adverse impacts to groundwater resources may occur if economic development spurs population growth and tourism. As discussed in Section 4.4, while water supply is acceptable for future growth, the island currently has inadequate artificial storage capacity of clean drinking water. Storage issues would require mitigation if demands on water resources increase.
- Long-term, indirect, adverse significant effects may occur to cultural resources, practices or beliefs if the No-Action Alternative is implemented. The population of Tinian is approximately 3,100. Any change in the cost of living, the living wage or downturn in the economy could have significant consequences on the immigration or emigration from Tinian. The cultural impacts of population changes could be real as cultural knowledge and history would be impacted.
- Long-term, indirect, less than significant adverse or beneficial impacts to the Real Estate environment may occur if implementation facilitates future economic growth that requires changes in land use.
- Long-term, indirect, significant beneficial effects to the Recreational environment if the Proposed Action is implemented. Implementation will increase the usability of the harbor, harbor facilities and indirectly the usability of the land and water-based recreational areas.
- Long-term, indirect, less than significant adverse effects may occur on the HTRW environment if additional vessel calls are facilitated by increases in useable days and increases in economic growth. Additional vessel calls increase the potential

for spills. Spill response plans already in place should minimize environmental impact.

4.19.2 Cumulative Effects

Cumulative effects are defined as “the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions” (40 CFR Section 1508.7). Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

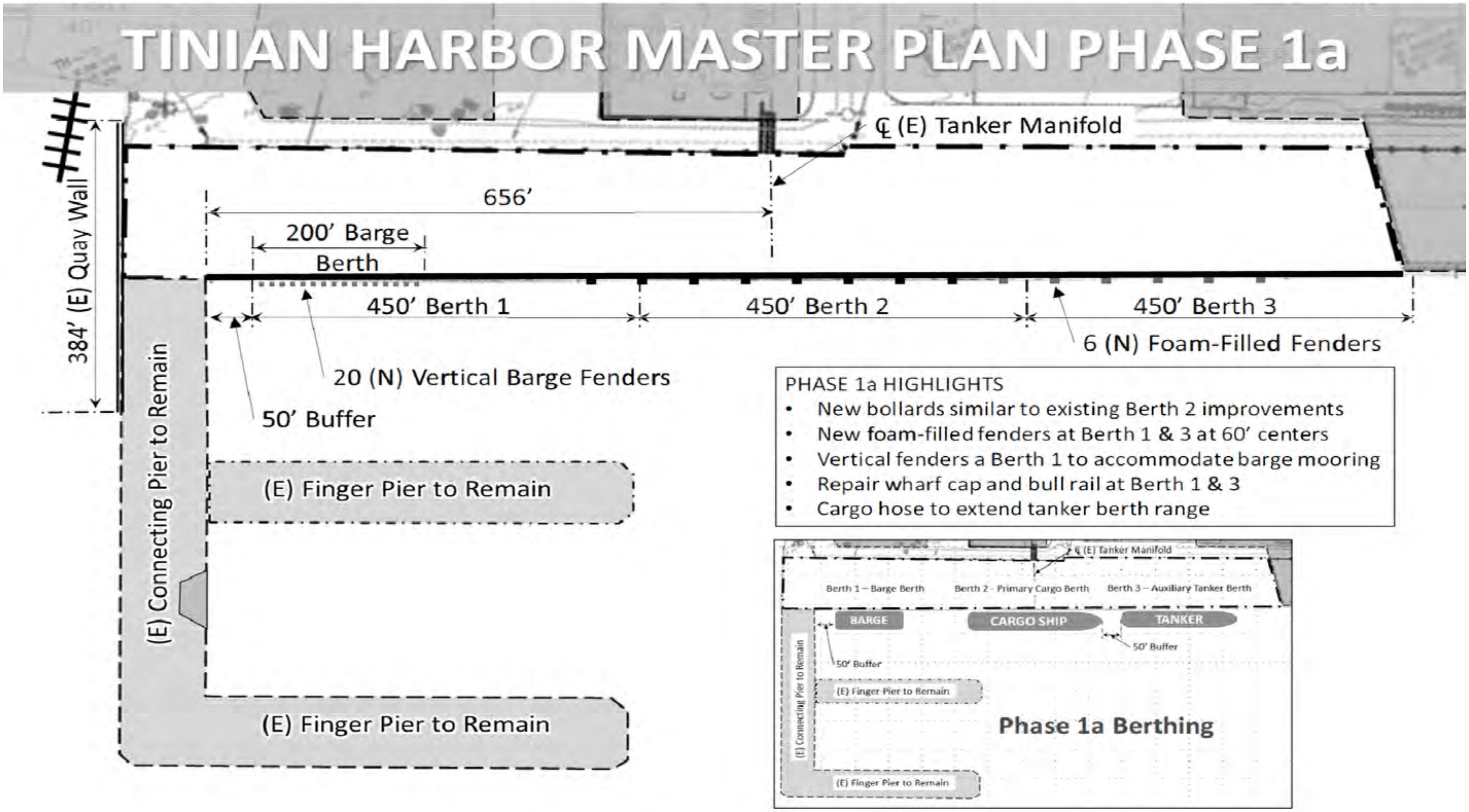
Principles of cumulative effects analysis in the CEQ guide Considering Cumulative Effects under the National Environmental Policy Act (CEQ, 1997) states: “for cumulative effects analysis to help the decision maker and inform interested parties, it must be limited through scoping to effects that can be evaluated meaningfully.” The guidance document states that cumulative analyses should only include those plans for actions which are funded or for which other NEPA analyses are being prepared. This guideline was expanded to include actions that are believed likely to occur, have an identified source of funding, and have been defined in enough detail to allow meaningful analysis, irrespective of the NEPA requirement.

The potential for cumulative impacts to the environment from the proposed action was evaluated by reviewing other projects and activities at Tinian that could directly or indirectly affect the same environmental resources as the proposed action. The analysis generally includes actions that were recently completed, are currently underway, or are programmed to occur in the foreseeable future, are directly related to the Harbor Modification Project, are located within or proximate to the proposed measure sites. The actions described below that were included in this study represent the foreseeable future actions that were identified during the current investigation. Attempts were made to determine if additional agencies planned future actions that could affect the analysis. An inquiry to the Department of Public Works has been sent regarding Office of Insular Affairs projects. A response has not yet been received. Based on a review of the potential future actions presented in the Draft Tinian Harbor Master Plan (correspondence with Moffat & Nichol 2017), this analysis incorporates the following projects and activities.

4.19.2.1 Past, Present, and Reasonably Foreseeable Activities in the Area of Cumulative Analysis

The following improvements have been evaluated for Tinian Harbor Master Plan Phase 1a (Figure 4-11):

- New bollards similar to existing Berth 2 improvements
- New foam-filled fenders at Berth 1 & 3 at 60’ centers
- Vertical fenders at Berth 1 to accommodate barge mooring



U.S. Army Corps of Engineers Honolulu District Fort Shafter, Hawaii	PROJECT NAME: Interim Feasibility Report Tinian Harbor Modification Study Island of Tinian Commonwealth of the Northern Mariana Islands	FIGURE TITLE: Tinian Harbor Master Plan Phase 1a FIGURE NUMBER: 4-11

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- Repair wharf cap and bull rail at Berth 1 & 3
- Cargo hose to extend tanker berth range

Tinian Harbor Master Plan Phase 1b includes the following changes (Figure 4-12):

- Reconstruct Berth 1-3 Quay wall
- Construct secondary tanker manifold
- Demolish and Dredge € Finger Pier A
- Excavate and revet south side of Connecting Pier
- Remove and replace € Fenders plus 5 (N) Fenders

Tinian Harbor Master Plan Phase 2 includes the following improvements (Figure 4-13):

- Reconstruct Connecting Pier Cutoff Wall
- Construct New 300' X 800" General Purpose Pier
- Develop two new berths and dredge as needed
- Provide lighting and utilities as needed

The Master Plan will allow for a multitude of both large and small vessels to utilize the harbor. These vessels would serve the community by encouraging future military activities, transporting diesel oil for power, importing much needed supplies and construction materials, providing inter-island transportation and cruises.

Air Force/Headquarters, Pacific Air Forces has potential future projects currently under study including:

Divert Activities and Exercises. The potential proposed project would involve improvements of an existing airport or airports in the Mariana Islands to support strategic requirements of U.S. forces, including Tinian International Airport. Improvements could include those to infrastructure and operations.

The DoN also has potential future projects in the region including:

- Mariana Islands Training and Testing. Potential effects could result from increases to various training activities and operations. In addition, various construction projects could occur to facilitate new training regimes.
- Mariana Islands Range Complex Airspace. This action would expand the danger zone and restricted airspace around Farallon de Medinilla and establish new warning areas south of Guam and northeast of Saipan.

The CEDS Commission has gathered a list of the major project needs on the three main islands of the CNMI (CNMI Department of Commerce 2013 CNMI Economic Development Forum Report & Recommendations). Although not currently planned for Tinian in the next future, several projects have been identified that may influence current or future impacts analyses. Detailed information such as location, size, scale, timing and impacts of these projects are unknown and therefore a detailed environmental and cumulative environmental analysis cannot be conducted. The following potential projects are provided for informational purposes only.

- Instrument Landing System for Tinian Airport
- Tinian Airport Fuel Farm
- Tinian Slaughterhouse
- Tinian Ocean View Resort and Casino (currently in dispute)
  Hong Kong-based Bridge Investment is planning a $130 million Tinian Ocean View Resort and Casino at Tinian Harbor. The casino would be situated where the former Tinian Stevedore, Customs, Immigration, Quarantine buildings, CPA warehouse and Brown Tree Snake Office were located. The project has stalled due to delays in receiving approvals from the CNMI Coastal Resources Management office, and has not received the required permits to begin construction. The CRM has stated that casino gaming is not considered a port-related activity and therefore cannot issue a permit. Additionally, the Department of Public Lands has said that the 40-year lease for the resort is in violation of its grant of public domain to the CPA because casino gaming is considered illegal on its premises. For the purposes of this report, it is assumed that the Tinian Ocean View Resort and Casino will not be built. Cumulative effects associated with the proposed Tinian Ocean View Resort and Casino are therefore not considered.

The CUC Water Sewer Infrastructure Projects include the following:

- Install 650 ft. of 10-inch main
- Install 4 new PRV stations
- Re-configure piping on existing mains

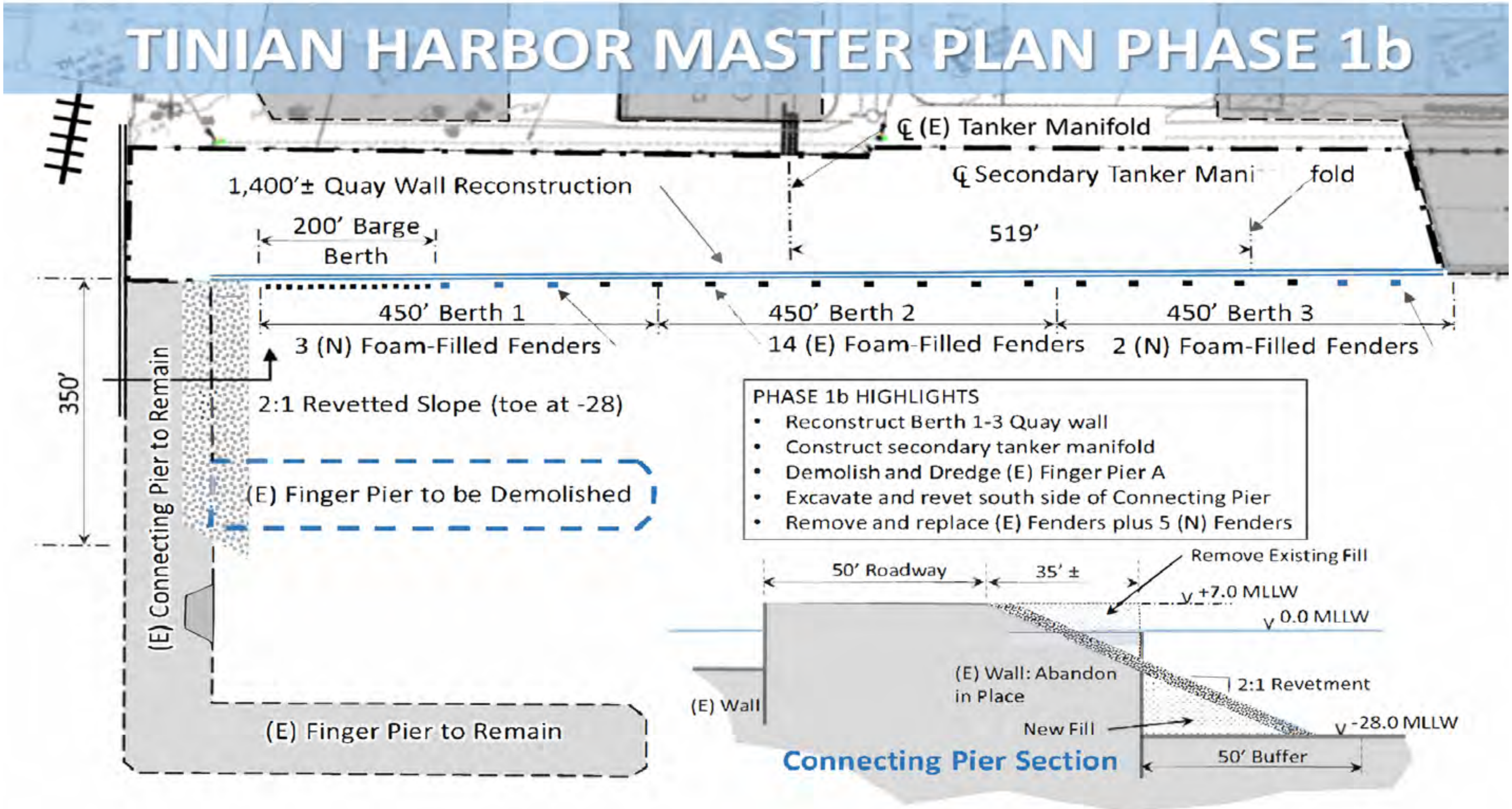
CNMI Department of Commerce (2013 CNMI Economic Development Forum Report & Recommendations):

- Tinian Airport Renovations

4.19.2.2 Evaluation of Potential Cumulative Impacts and Mitigation

4.19.2.2.1 Geology, Seismicity and Soils

Proposed project impacts to geology, seismicity and soils are fully discussed in section 4.3. Short-term, direct, less than significant, adverse impacts are anticipated to the geological environment of the laydown area based on the potential for soil erosion during construction. No cumulative effects associated with the proposed action and reasonably foreseeable future projects are anticipated as construction for these projects are likely to occur at different times. If occurring concurrently, different laydown areas would be required.



U.S. Army Corps of Engineers Honolulu District Fort Shafter, Hawaii	PROJECT NAME: Interim Feasibility Report Tinian Harbor Modification Study Island of Tinian Commonwealth of the Northern Mariana Islands	FIGURE TITLE: Tinian Harbor Master Plan Phase 1b FIGURE NUMBER: 4-12

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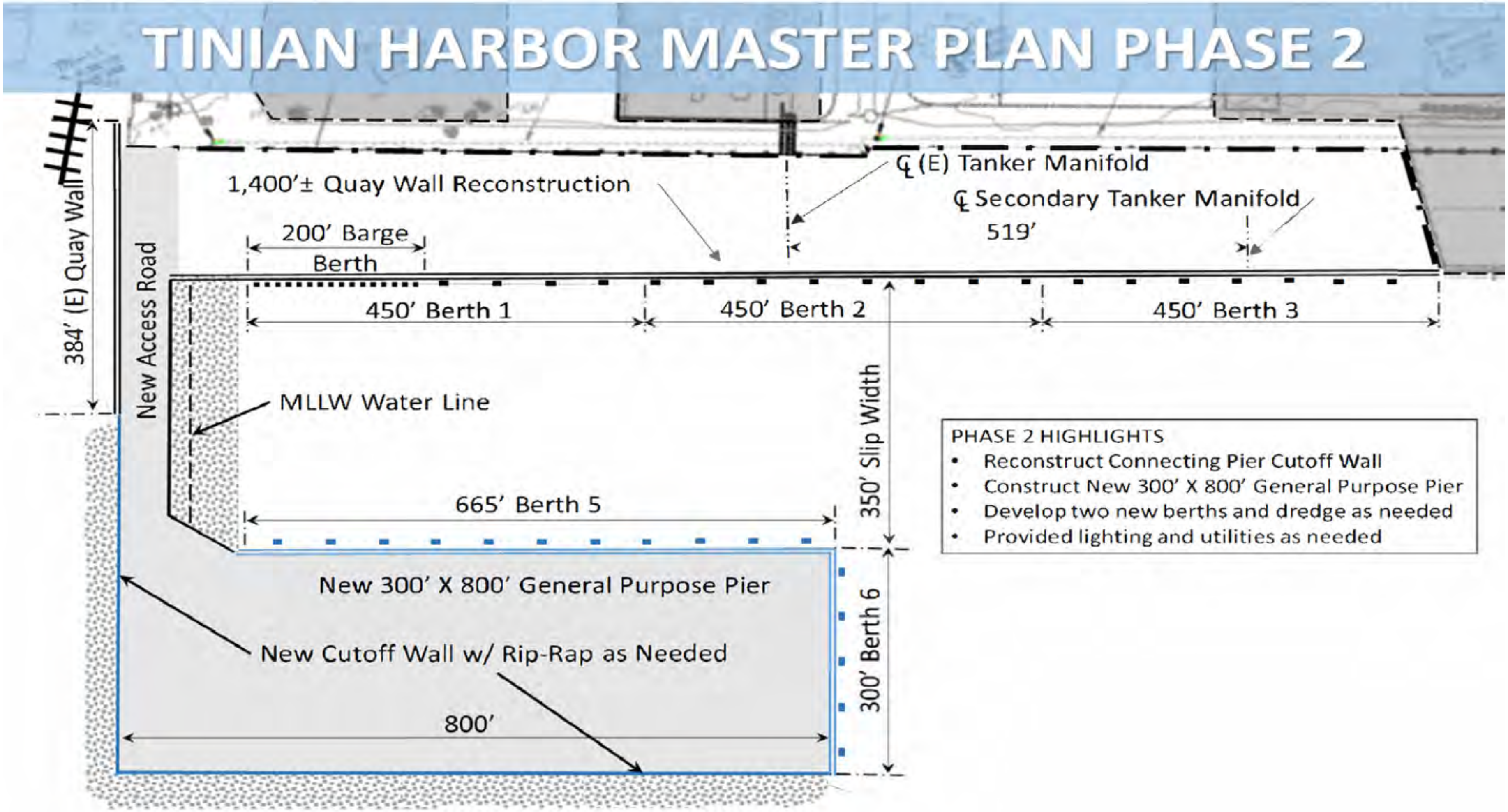

U.S. Army Corps of Engineers Honolulu District Fort Shafter, Hawaii	PROJECT NAME: Interim Feasibility Report Tinian Harbor Modification Study Island of Tinian Commonwealth of the Northern Mariana Islands	FIGURE TITLE: Tinian Harbor Master Plan Phase 2 FIGURE NUMBER: 4-13

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Seismic risks at Tinian harbor would be reduced due to construction of a new breakwater. Future improvements to the harbor are detailed in the Tinian Harbor Master Plan. As newer construction is often more conscious of seismic risks, it can be assumed that the future improvements would also have a net long-term, cumulative, beneficial impact on seismic risks for Tinian Harbor, in general. As the construction footprint, and the immediate area surrounding the construction footprint, are in the subtidal environment, no impacts to the geology and/or soils of the harbor are expected due to the construction of either alternative.

4.19.2.2.2 Groundwater Resources

There are no potential cumulative impacts to groundwater resources associated with any of the proposed project. Existing groundwater resources are capable of supplying up to 7 million gallons/day (gpd) of potable fresh water, which can support a population of 70,000 people at an average supply rate of 100 gpd/person. Recent assessments are more conservative, and estimate 30,000 people can be supported by Tinian's water resources. As such, construction activities associated with Alternatives 2 and 3 would not significantly deplete groundwater resources on Tinian, and would comply with regulatory requirements including the implementation of resource management measures.

4.19.2.2.3 Water Resources

Cumulative impacts are not anticipated to water resources assuming implementation of future projects. Impacts to sediment transport dynamics associated with construction activities will be limited to the subtidal environment in the area surrounding the construction footprint, and are expected to be less than significant and temporary during construction. No land-based surface water bodies such as canals, wetlands, or floodplains are in the vicinity of the construction area. Future improvements to the harbor detailed in the Tinian Harbor Master Plan for Phase 1b and Phase 2 replace or repair old infrastructure in the harbor, which could also have potential impacts to sediment transport dynamics. However, impacts on water resources due to the implementation of Alternative 2 or Alternative 3 in the area of the new breakwater will be limited to the duration of construction. Therefore, there would be no cumulative impacts to groundwater resources on Tinian.

4.19.2.2.4 Air Quality

Short-term, direct, less than significant adverse impacts are anticipated to the air quality environment as a result of the proposed action and future plans noted in the Tinian Harbor Master Plan Phase 1b and Phase 2 report. Impacts to Tinian air quality would primarily be related to combustion based and fugitive dust emissions during construction and operations. However, the cumulative impact on air quality on a regional or global scale would not be significant given the small scale and localized nature of the proposed project and Tinian in general. The total amount of emissions resulting from construction of the breakwater are expected to be under any reporting thresholds. In addition, prevailing winds in the area act to disperse emissions out into the ocean. Therefore, there would be no cumulative impact to the air quality of Tinian.

4.19.2.2.5 Noise

Cumulative impacts to the noise environment of the harbor due to the Proposed Action and the projects associated with the Master Plan are anticipated to have long-term, direct, less than significant, adverse effects. Direct and indirect impacts to noise are fully discussed in section 4.7. Future improvements to the harbor area are detailed in the Tinian Harbor Master Plan for Phase 1b and Phase 2 replace or repair old infrastructure in the harbor.

While noise would increase during construction, the increases would be temporary. Although not definitive (future construction schedules are not defined), it is also unlikely that construction projects will occur concurrently. Construction timing could reduce impacts on the noise environment to less than significant levels. It should be noted that there are no residences or other sensitive human receptors (e.g., hospitals or schools) in the area except those associated with harbor-related jobs.

An increase in usage of the harbor is expected to increase noise generated by people, equipment, boats, and other vehicles. However, the sound level and frequency are not anticipated to exceed the permissible levels established by local noise ordinances since they are anticipated to be temporary in nature and the harbor is considered an industrial use facility. The impacts to the noise environment are unavoidable, but necessary to achieve the benefits to safety, economics and the general well-being of the island. There would be no cumulative impacts to the noise environments to the material laydown and disposal locations after construction has ended.

4.19.2.2.6 Airspace

Long-term, indirect, less than significant beneficial impacts may occur to the Tinian airspace environment due to the implementation of Alternative 2 or Alternative 3 when considered cumulatively with other proposed projects. Implementation of the proposed action would lessen Tinian's reliance on air transportation for general goods and services. This could reduce overall cumulative impacts if potential future planned actions require and increased use of airspace (e.g. the DoD has proposed use of Tinian as a Divert Airfield). Neither alternative disrupts in-route operations of aircraft, impedes access to public airports, nor disrupts air traffic control services. Therefore, no adverse impacts are expected.

4.19.2.2.7 Land and Submerged Land Use

Direct and indirect impacts of the proposed action are detailed in Section 4.9. None of the assessed alternatives would require significant changes to land use. Short term impacts would be localized to the proposed project area, as a laydown area is required, and limited to the duration of construction. Long term impacts of the proposed action include the potential to spur economic growth due to a variety of factors discussed previously.

Proposed improvements to the harbor, as detailed in the Tinian Harbor Master Plan could have a similar impact on the economy. Cumulatively this could ultimately affect land use designations. For example, significant increases in economic growth could require conversion of land from residential or agricultural designations to industrial or commercial use depending on island needs. At this time, impacts are assumed to be long-term, indirect and less than significant as such changes in land use are anticipated by the CNMI government and specifically, the CNMI Department of Public Lands. There are currently no projects planned that would impact submerged lands, and as such, no impacts to submerged land use are expected.

4.19.2.2.8 Recreation

Cumulative impacts to recreation due to the Proposed Action and the projects associated with the Master Plan are anticipated to have short-term, direct, less than significant adverse effects during construction. Temporary adverse impacts would present as limited or restricted access to some areas of the harbor during construction. While added noise and traffic in the proposed project area are also anticipated, these impacts would be temporary and would cease following construction. Although not definitive, it is unlikely that construction projects will occur concurrently and therefore cumulative effects from these short-term impacts would be minimized.

Cumulative long-term, direct and indirect, significant beneficial effects are anticipated if there is a net increase in use of the harbor (for recreational events) due to more favorable wave and current conditions conducive to recreational activities. Land-based recreation is expected to increase concomitant with increase water-based activities.

4.19.2.2.9 Biological Resources

Cumulative impacts to the biological environment of the harbor are anticipated due to the Proposed Action and future harbor plan projects. As described in detail in Section 4.11.3, Environmental Consequences, construction of the breakwater and any extension of the breakwater will result in significant loss of coral reef, including *Acropora globiceps*, an ESA-listed coral. Long-term, indirect, significant, adverse cumulative effects may add to the direct project losses if changes in wave energy and currents facilitate increased use of the harbor that in turn could change sedimentation patterns and the HRTW environment inside and adjacent to the breakwater area.

Compensatory mitigation as described in Appendix 4 is expected to reduce impacts to less than significant over the 50-year project period. In the reasonably foreseeable future, coral impacts will be significant and unavoidable. Immediate mitigation measures such as design elements to minimize resource disturbance/impact, footprint reduction and BMPs during construction are not anticipated to reduce impacts to less than significant.

Long-term, indirect, significant, adverse or beneficial secondary impacts to coral and other biological resources may occur by permanently changing the marine environment (wave action and currents) in the proposed project area and areas further removed. This could have potential beneficial effects, if changes facilitate coral growth and creates new habitat; or adverse secondary impacts, if changes reduce or destroys existing habitats in the immediate vicinity of the sea wall or locations further removed.

4.19.2.2.10 Cultural Resources

Cumulative impacts to the cultural environment due to the Proposed Action and the projects associated with the Master Plan are anticipated to have long-term, less than significant, direct beneficial effects. The NHPA is currently evaluating the breakwater as a historical landmark. Currently the breakwater is in a dilapidated state. The Proposed Action would replace a portion of the breakwater, or alternatively extend the breakwater by 300 ft. The Proposed Action would protect the breakwater for future use. Otherwise, the breakwater is projected to be destroyed either by ongoing deterioration due to adverse wave conditions, or more than likely by a tropical storm or typhoon. Reconstruction of the breakwater is expected to have a net beneficial effect on the economy and well-being of the island. Tinian residents rely on the imported food and commodities that are traversed through the harbor as air transport can be cost prohibitive. Decreasing the cost of living while providing additional safe recreational areas that are a direct result of replacing the breakwater could improve overall quality of life. With these benefits, it is conceivable that residents would be less likely to leave Tinian, thereby preserving the traditional ways of life, culture, practices, and beliefs inherent to Tinian, which might otherwise be lost. Visual Resources

Cumulative impacts to the visual resources environment of the harbor due to the Proposed Action and the projects associated with the Master Plan are anticipated to have both short-term and long-term, less than significant, direct, adverse effects. Short-term, less than significant, direct impacts are expected during construction due to obstruction of the view plane and surrounding landscape. Construction timing may reduce these impacts if construction occurs when recreational activities at the harbor are at a low period, or the time frame of construction is shortened, such as when projects occur concurrently or completed early. These impacts will cease at the completion of construction.

Cumulative long-term, less than significant, direct, adverse effects are anticipated to visual resources as a result of the Proposed Action and proposed future projects. Although there will be an increase in vehicles/vessels due to increased activity at the harbor, it is not anticipated to substantially affect the visual aesthetics of the harbor, where the visual environment is in line with expectation. Additionally, Alternative 2, the proposed action, will not change view planes as the breakwater will remain in the current alignment. Alternative 3, if selected, would add an additional 300 ft. and will not significantly conflict with the surrounding landscape. No cumulative impacts are expected in the construction laydown area or the waste disposal site. Construction debris will be removed from the temporary laydown area upon completion of construction and the final disposal site is in low lying areas of the Tinian Airport runway.

4.19.2.2.11 Transportation and Traffic

Cumulative impacts to transportation and traffic due to the Proposed Action and the projects associated with the Master Plan are anticipated to have both long-term and short-term, less than significant, direct, adverse and beneficial effects.

Short-term, less than significant, direct, adverse effects are anticipated to marine and ground transportation at the harbor due to implementation of the Proposed Action and the projects associated with the Master Plan during construction. An increase in traffic and subsequent delays are projected to occur due to temporary closures, diversions, and the addition of construction equipment or vehicles/vessels. Although not definitive (future construction schedules are not defined), it is also unlikely that construction projects will occur concurrently. Construction timing could reduce cumulative impacts on the traffic environment.

Cumulative long-term, direct, less than significant, adverse effects are anticipated to marine and ground transportation environments post construction. An increase in usage of the harbor is expected to increase traffic, as there will be more vehicles/ vessels in the area; however, these impacts are not expected to be substantial. Well planned logistics of the area combined with knowledge of transportation schedules could reduce land and water traffic impacts to less than significant.

Cumulative long-term, indirect, less than significant, beneficial effects are projected due to an increase in harbor usage. Air cargo services are likely to decrease if the harbor provides more reliable service and if marine transportation is a more affordable option. The cost of goods would be lower and there would an overall reduction in air traffic. Public Services and Utilities

No cumulative impacts to public services and utilities are anticipated due to the Proposed Action and the projects associated with the Master Plan. Construction is not expected to require police, fire protection or emergency services. Mitigation measures such as planning and coordination would ensure that social services (such as police and fire department and other emergency services) and utilities (such as electricity, telecommunications, water, and sewage) would have adequate response times and levels of service without taxing services, supplies, or disrupting service. Refer to Section 4.15 Public Services and Utilities and Section

No cumulative impacts to public services and utilities are anticipated to the construction laydown area or to the disposal site. The debris in the laydown area will be removed after construction is completed and the final disposal site is the Tinian Airport runway. The debris, once transported, does not require any active maintenance.

4.19.2.2.12 Socioeconomic and Environmental Justice

Cumulative impacts to socioeconomic and environmental justice due to the Proposed Action and the projects associated with the Master Plan are anticipated to have both long-term and short-term effects. Short-term, direct, but less than significant adverse impacts due to construction would affect measures such as dust control, water quality, spill prevention and response, biosecurity outreach, traffic management, and noise. Standard operating procedures and best practice measures would be implemented to mitigate adverse effects to less than significant. They include but are not limited to, ensuring adequate spill prevention kits, use of berms, adequate coverage of stockpiles, and water trucks to keep dust down. BMPs are fully described in Appendix 6. These increases would be temporary. Although not definitive (future construction schedules are not defined), it is also unlikely that construction projects will occur concurrently. Construction timing could reduce impacts to less than significant levels. It should be noted that there are no residences or other community areas (e.g., hospitals or schools) in the area except those associated with harbor-related jobs.

Long-term, direct and indirect, less than significant beneficial effects are also anticipated by the potential to increase calls to the harbor and to decrease the cost of goods that are currently being brought in. The cost of living and the quality of life would be greatly improved by reliable harbor service and more affordable food and supplies. A more efficient harbor may also encourage economic development in aquaculture and tourism. These factors, among others, have the potential to reduce the economic burden on the population of Tinian that is living below the poverty line.

4.19.2.2.13 Hazardous and Toxic Waste

Cumulative impacts to the HTRW environment of the harbor due to the Proposed Action and the projects associated with the Master Plan are anticipated to have long-term, direct, less than significant adverse effects. Improved navigational conditions at the harbor is projected to increase useable days, leading to additional vessel calls. Additional vessel calls increase the potential for spills. Spill response plans already in place should minimize environmental impact to less than significant levels.

4.19.2.2.14 Public Health and Safety

Cumulative impacts to public health and safety due to the Proposed Action and the projects associated with the Master Plan are anticipated to have both long-term and short-term effects. Short-term, less than significant, direct, adverse impacts are anticipated during construction of the breakwater. Construction equipment, workers, environmental hazards (such as air and noise pollution), etc. in the proposed project footprint area could physically impede and create a dangerous environment for recreational activities as well as private and commercial vessel calls. Wave energy and currents would not be “reduced" when the breakwater is deconstructed which could also result in an unsafe environment. These impacts would be temporary and minor. Although not definitive (as future construction schedules are not defined), it is unlikely that construction projects will occur concurrently. Construction timing of future projects could reduce impacts on the public health and safety environment to less than significant levels.

Long-term, less than significant, indirect, adverse impacts are anticipated due to an increase in recreational activities at the harbor. This would likely result in an increase in ground vehicle traffic, which would increase safety risk to the public.

No cumulative impacts to public health and safety are anticipated to the construction laydown area or to the disposal site. The debris in the laydown area will be removed after construction is completed and the final disposal site, the Tinian Airport runway, is inaccessible to the public.

4.19.3 Irreversible or Irretrievable Commitments of Resources

The analysis of irreversible and irretrievable commitments of resources includes a description of the extent to which the proposed project makes use of non-renewable resources (including labor, materials, and natural and cultural resources) or irreversibly curtails the range of potential uses of the environment.

Construction and operation of the proposed project would consume non-renewable resources, such as construction labor, materials (e.g., concrete), fuel for vehicles, and electricity. Commitment of construction materials, manpower expended, and fuel/electricity consumed is considered an irreversible use of resources. In addition, the proposed project would result in unavoidable impacts to environmental resources, including habitat for native aquatic species. As described in Section 4.7, these impacts are avoided, minimized and mitigated to the extent possible; in particular, coral transplantation/compensatory mitigation has been proposed that will mitigate impacts over the long-term to offset resource and habitat loss. As such, the proposed project is not expected to substantially contribute to irreversible loss of environmental resources.

4.19.4 Unavoidable Adverse Effects

Both federal and state regulations [40 CFR 1500.2(e) and HAR Section 11-200-17(L)] require a description of probable adverse effects that cannot be avoided and the rationale for proceeding with the proposed project. Unavoidable impacts are those effects remaining after incorporation of mitigation measures that minimize, rectify, or reduce impacts of the proposed project.

Descriptions of the anticipated impacts and proposed mitigation measures have been described in this Section. Potential adverse impacts include those related to biological resources (aquatic habitat), cultural resources, recreation, and visual resources; however, measures to avoid, minimize, and mitigate these impacts have been incorporated to the extent practicable. Although some degree of impact for most environments would occur, the analysis has determined that significant, unavoidable adverse impacts would only remain for biological resources after implementation of proposed mitigation measures. Implementation of the proposed project is expected to provide significant benefits to the local economy and well-being that are expected to outweigh any remaining adverse impacts.

4.19.5 Unresolved Issues

The following summarizes unresolved issues that relate to the proposed project; it is anticipated that each of these issues can be adequately resolved before implementation of the proposed project:

- Ability to acquire all the funding needed for project implementation (considering current federal and non-federal funding climate)
- Ability to acquire some of the key land needed for flood risk management and compensatory mitigation measures
- Extent to which residual flood risk could or would be addressed by others
- Completion of the Section 106 consultation process, including execution of a Final Programmatic Agreement
- Obtaining concurrence on outstanding regulatory compliance requirements, including FWCA and ESA Section 7
- Specific environmental impacts and compensatory mitigation procedures remain unresolved. A Phase II study by USFWS can provide greater detail about mitigation measures. This information will also address unresolved issues with costs. When the costs for compensatory mitigation of coral resources are better known, entire proposed project costs will be more clearly defined.

An additional uncertainty is length of time for construction. Tinian's remote location and factors such as regional typhoon activity and rough seas, make predictions of project schedules and costs difficult.

4.19.6 Summary of Environmental Impacts

A summary of anticipated impacts resulting from the three final array of alternatives is presented in Table 4-15.

Resource	Alternative 1 No Action Alternative				Alternative 2 Replace Existing Breakwater				Alternative 3 Replace and Extend Existing Breakwater			
	Construction	Operations	Secondary	Cumulative*	Construction	Operations	Secondary	Cumulative*	Construction	Operations	Secondary	Cumulative*
Geology, Seismicity, and Soils						LT				LT		
Groundwater Quality												
Surface Water Resources					ST				ST			
Air Quality and Climate Change												
Noise					ST, U		LT		ST, U		LT	
Airspace												
Land and Submerged Land Use					ST	LT			ST	LT		
Recreation					ST	LT	LT		ST	LT	LT	
Terrestrial Biology												
Marine Biology					LT, U	LT	LT		LT, U	LT	LT	
Cultural Resources		LT			LT		LT		LT		LT	
Visual Resources									LT, U	LT, U		
Ground Transportation					ST	LT			ST	LT		
Marine Transportation		LT			ST	LT			ST	LT		
Public Service and Utiltiies												
Socioeconomic and Environmental Justice		LT	LT		ST	LT			ST	LT		
Hazardous and Toxic Waste					LT	LT			LT	LT		
Public Health and Safety					ST,U	LT	LT		ST,U	LT	LT	

NA = Not Applicable

T = Temporary Impacts
ST = Short-term Impacts
LT = Long-term Impacts
U = Unavoidable Impacts

(Red) Potentially Significant Adverse Effect
(Orange) Potentially Significant Adverse Effect Mitigable to Less Than Significant
(Yellow) Less Than Significant Adverse Effect
(White) No Effect
(Green) Beneficial Effect

Notes: * Cumulative impacts could not be determined as only general information regarding future projects on Tinian were available. A draft Tinian Master Plan is in progress, and anticipated prior to the release of the Final Feasibiltiy Study/Environmental Impact Statement. Cumulative effects analysis wil be included in the final document.

U.S. Army Corps of Engineers
Honolulu District
Fort Shafter, Hawaii

PROJECT NAME:

Interim Feasibility Report
Tinian Harbor Modification Study
Island of Tinian
Commonwealth of the Northern Mariana Islands

TABLE TITLE:

Summary of Impacts

TABLE NUMBER:

4-15

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5.0 PUBLIC INVOLVEMENT AND AGENCY COORDINATION

Public involvement activities and agency coordination are summarized in this section.

5.1 Public Involvement Process

USACE Planning Policy and NEPA emphasize public involvement in government actions affecting the environment by requiring that the benefits and risks associated with the proposed actions be assessed and publicly disclosed. In accordance with NEPA public involvement requirements (40 CFR 1506.6) and USACE Planning Policy (ER 1105-2-100), opportunities were presented for the public to provide oral or written comments on potentially affected resources, environmental issues to be considered, and the agency's approach to the analysis.

The CNMI requested a 905(b) Analysis for navigation improvements, which was completed in October 2001. NEPA legislation requires that environmental consequences of federal actions are incorporated into an agency's decision-making process. Pursuant to these requirements, a NOI was published on June 14, 2004 (69 FR 32996).

A planning charrette was held in February 2016, which included stakeholders from USACE, CNMI, and other government agencies (USFWS, NOAA, EPA). Following the planning charrette, USACE published an NOI for preparation of an Integrated Feasibility/EIS on July 8, 2016, to inform and solicit public comments on the proposed harbor improvements. The CNMI posted information on their social media outlets and in their local newspapers. Additionally, the USACE and CNMI jointly hosted public meetings on Tinian and Saipan on July 19, 2016, and July 20, 2016, to gather comments on issues of concern and to scope the feasibility study to the appropriate area and resources (Appendix 8). The USACE and CNMI based the scope of the study on issues raised by the local communities and natural resources agencies at those meetings.

5.2 Agencies and Persons Consulted†

The following list of agencies and individuals were consulted by USACE during the plan formulation and environmental review of this feasibility study.

- Saipan Government
- Rota Local Government
- Tinian Local Government
- Advisory Council on Historic Preservation
- National Park Service
- National Trust for Historic Preservation
- NOAA NMFS – Pacific Islands Regional Office
- Natural Resources Conservation Service

- Office of Insular Affairs
- U.S. Coast Guard, Sector Guam
- U.S. Coast Guard, Marianas Section
- U.S. Department of Agriculture
- U.S. Department of Agriculture, Animal and Plant Health Inspection Services
- U.S. Department of Agriculture, Animal Plant Inspection Health Service, Wildlife Services
- U.S. Department of Interior
- U.S. Department of Transportation
- U.S. Department of Transportation, Federal Highway Administration
- U.S. Department of Transportation, Maritime Administration
- EPA, Region 9
- EPA, Region 9, Environmental Review Office Communities and Ecosystems Division
- USFWS
- USFWS, Pacific Islands Office
- USFWS, Pacific Islands Refuge Complex
- CNMI BECQ
- CNMI CPA
- CNMI DLNR
- CNMI Capital Improvement Office
- CNMI Department of Public Lands
- CNMI Military Integration Management Committee
- CUC
- CNMI, Department of Community and Cultural Affairs
- CNMI, Department of Community and Cultural Affairs, HPO
- CNMI, DFW
- CNMI, Marianas Public Lands Authority
- CNMI, Marianas Visitors Authority
- CNMI, Office of Military Liaison and Veterans Affairs
- Western Pacific Region Fisheries Management Council

6.0 COMPLIANCE WITH APPLICABLE LAWS, POLICIES, AND PLANS

6.1 Regulatory Compliance

There are a variety of federal and state laws and regulations that are applicable to the proposed project, and for which compliance is required before construction. A summary of the laws and regulations (and associated permit requirements) that apply to the proposed project and the compliance status of each is provided in Table 6-1 and the following subsections.

Tinian Harbor navigational improvements would require both U.S. federal regulatory permits and local CNMI approval prior to detailed design or construction. Regulations require avoidance of impacts to sensitive biological and historical or cultural resources in the area.

Regulation	Compliance Status	
FEDERAL		
Act to Prevent Pollution from Ships (APPS)	Fully compliant	Vessels will comply with the discharge regulations set forth under the requirements of the APPS.
Beaches Environmental Assessment and Coastal Health (BEACH) Act	Fully compliant	Water quality criteria and standards for the coastal recreation waters of the CNMI have been determined for those pathogens and pathogen indicators f published criteria under section 304(a).
CAA 42 U.S. Code § 7401 et seq.	Fully compliant	The Proposed Action will comply with the CAA 42 U.S. Code § 7401 et seq.
CWA, Section 404	Fully compliant	In progress; Draft Section 404(b)(1) Evaluation
CZMA of 1982	Fully compliant	In progress; The Proposed Action is consistent to the maximum extent practicable with the Guam and CNMI Coastal Management Plans.
Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)/(Superfund) 1980	Fully compliant	All activities undertaken for the Proposed Action would be fully compliant with the CERCLA (Superfund) 1980
ESA of 1973, as amended	Fully compliant	In progress; East Harbor expansion will most likely require the completion of habitat assessments as the site contains habitat that could be used by ESA-listed species.
FWCA, as amended	Fully compliant	In progress; coordination conducted with resource agencies; input to date has been incorporated into the planning process; FWCA PAR is included
Flood Control Act of 1970	Not applicable	The Proposed Action will comply with the Flood Control Act of 1970.
Hazardous, Toxic, and Radioactive Waste Guidance for Civil Works Projects (USACE ER 1165-132)	Fully compliant	In progress; guidance will be incorporated into the planning process.

Regulation	Compliance Status	
Magnuson-Stevens Fishery Conservation and Management Act	Fully compliant	EFH Assessment Consultation with NMFS initiated.
Marine Mammal Protection Act (MMPA)	Fully compliant	This document analyzes potential effects to marine mammals, some of which are species-listed under the ESA. The Proposed Action will comply with the MMPA.
Marine Protection, Research, and Sanctuaries Act of 1972	Fully compliant	The Proposed Action will comply with the Marine Protection, Research, and Sanctuaries Act of 1972.
MBTA	Fully compliant	The Proposed Action would not have a significant impact on migratory birds and would comply with applicable requirements of the MBTA.
NEPA of 1969, as amended	Fully compliant	In progress; The Proposed Action will comply with the NEPA of 1969.
NHPA of 1966, as amended	Fully compliant	The Proposed Action will comply with the consultation and other requirements of the NHPA. The Proposed Action would not have a significant impact on cultural resources.
NHPA Act, Section 106	Fully compliant	In progress; The Proposed Action will comply with the NHPA, Section 106.
Resource Conservation and Recovery Act 1976	Fully compliant	All activities undertaken for the Proposed Action would be fully compliant with the Resource Conservation and Recovery Act.
Rivers and Harbors Act of 1962	Fully compliant	The Proposed Action will comply with the Rivers and Harbors Act of 1962.
Submerged Lands Act, as amended	Fully compliant	The Proposed Action will comply with the Submerged Lands Act.
The Antiquities Act (34 Stat. 225, 16 U.S.C. 431)	Fully compliant	The Proposed Action is in compliance with the Antiquities Act (34 Stat. 225, 16 U.S.C. 431).
The National Marine Sanctuaries Act	Fully compliant	The Proposed Action would have no effect on sanctuary resources in the offshore environment of the Study Area. Review of agency actions under Section 304 is not required.
The Sikes Act of 1960 requires military installations with significant natural resources, to prepare and implement Integrated Natural Resource Management Plans	Not applicable	The Proposed action does not involve a military installation with significant natural resources; The Proposed action is in compliance with the Sikes Act of 1960.

Regulation	Compliance Status	
EOs		
EO 11990, Protection of Wetlands	Fully compliant	The Proposed Action would not have a significant impact on wetlands.
EO 12114, Environmental Effects Abroad of Major Federal Actions	Fully compliant	EO 12114 requires environmental consideration for actions that may affect the environment outside of U.S. Territorial Waters. The Proposed Action would not result in significant harm to the environment.
EO 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations	Fully compliant	The Proposed Action would not result in disproportionately high and adverse human health or environmental effects on minority or low income populations.
EO 12962, Recreational Fisheries	Fully compliant	EO 12962 requires Agencies to fulfill certain duties with regard to promoting the health and access of the public to recreational fishing areas. The Proposed Action complies with these duties.
EO 13045, Protection of Children from Environmental Health Risks and Safety Risks	Not applicable	The Proposed Action would not result in disproportionate risks to children from environmental health risks or safety risks.
EO 13089, Coral Reef Protection	Fully compliant	EO 13089 requires federal agencies whose actions may affect U.S. coral reef ecosystems to preserve and protect the biodiversity, health, heritage, and social and economic value of U.S. coral reef ecosystems and the marine environment. This document satisfies the requirement of EO 13089 with regard to the Proposed Action.
EO 13112, Invasive Species	Fully compliant	EO 13112 requires Agencies to identify actions that may affect the status of invasive species and take measures to avoid introduction and spread of those species. This document satisfies the requirement of EO 13112 with regard to the Proposed Action.
EO 13158, Marine Protected Areas	Fully compliant	EO 13158 requires Agencies to identify any actions that affect the natural or cultural resources that are protected by MPA. Agencies shall avoid harm to the natural and cultural resources that are protected by an MPA. This document satisfies the requirement of EO 13158 with regard to the Proposed Action.
EO 13186, Protection of Migratory Birds	Fully compliant	EO 13186 directs federal agencies that take actions that either directly or indirectly effect on migratory birds to develop a Memorandum of Understanding (MOU), and to work with the U.S. Fish & Wildlife Service, and other federal agencies to promote the conservation of migratory bird populations. The Proposed Action would not have a significant impact on migratory birds.

Regulation	Compliance Status	
CNMI		
Air Pollution Control Regulations (CNMI Administrative Code Ch 65-10)	Fully compliant	The Proposed Action will comply with CNMI Administrative Code Ch 65-10.
Coastal Resources Management Act, (2 CMC § 1501 et seq.)	Fully compliant	The Proposed Action will comply with the Coastal Resources Management Act.
Commonwealth Department of Public Works (CNMI Administrative Code Title 155-20)	Fully compliant	The Proposed Action will comply with CNMI Administrative Code Title 155-20.
Commonwealth Groundwater Management and Protection Act of 1988 (CNMI Public Law 6-12)	Not applicable	The Proposed Action will comply with CNMI Administrative Public Law 6-12.
CPA (CNMI Administrative Code Title 40- 20)	Fully compliant	The Proposed Action will comply with CNMI Administrative Code Ch 40-20.
Comprehensive Wildlife Conservation Strategy	Fully compliant	The Proposed Action will comply with the Comprehensive Wildlife Conservation Strategy.
Drinking Water Regulations (CNMI Administrative Code Ch 65- 20)	Not applicable	The Proposed Action will comply with CNMI Administrative Code Ch 65-20.
Earthmoving and Erosion Control Regulations (CNMI Administrative Code Ch 65-30)	Not applicable	In progress: Permit to be obtained by non-federal sponsor before construction. The Proposed Action will comply with CNMI Administrative Code Ch 65-30.
Environmental Protection Act (2 CMC § 3101 et seq.)	Fully compliant	The Proposed Action will comply with the Environmental Protection Act (2 CMC § 3101 et seq.).
Fish, Game, and Endangered Species Act (Public Law 2-51)	Fully compliant	The Proposed Action will comply with CNMI Administrative Public Law 2-51.
Groundwater Recharge Requirements	Not applicable	The Proposed Action will comply with Groundwater Recharge Requirements.
Harmful Substance Clean Up Regulations (CNMI Administrative Code Ch65-40)	Fully compliant	The Proposed Action will comply with CNMI Administrative CNMI Administrative Code Ch 65-40.
Hazardous Waste Management Regulations (CNMI Administrative Code Ch 65-50)	Fully compliant	The Proposed Action will comply with CNMI Administrative CNMI Administrative Code Ch 65-50.
Solid Waste Management Regulations and CNMI Underground Injection Control Regulations (CNMI Administrative Code Ch 65- 80)	Fully compliant	The Proposed Action will comply with CNMI Administrative CNMI Administrative Code Ch 65-80.
Threatened and Endangered Species (CNMI Administrative Code § 85-30.1-101)	Fully compliant	The Proposed Action will comply with CNMI Administrative Code § 85-30.1-101.
Underground Injection Control Regulations (CNMI Administrative Code Ch 65-90)	Not applicable	The Proposed Action will comply with CNMI Administrative CNMI Administrative Code Ch 65-90.
Wastewater Treatment and Disposal Rules and Regulations (CNMI Administrative Code Ch 65-120)	Not applicable	The Proposed Action will comply with CNMI Administrative CNMI Administrative Code Ch 65-120.

Regulation	Compliance Status	
Water Quality Standards (CNMI Administrative Code Ch 65-130)	Fully compliant	The Proposed Action will comply with CNMI Administrative CNMI Administrative Code Ch 65-130.
Well Drilling and Well Operation Regulations (CNMI Administrative Code Ch 65-140)	Not applicable	The Proposed Action will comply with CNMI Administrative CNMI Administrative Code Ch 65-140.
Note: Fully compliant assumes USACE will be in compliance with statutes and regulations for the proposed project duration.		

Table 6-1 Regulatory Compliance Matrix

6.1.1 NEPA

The NEPA of 1969 was established to ensure that environmental consequences of federal actions are incorporated into an agency's decision making processes. Any project completed by a federal agency, using federal funding, or requiring a federal permit must comply with NEPA. A federal EA and/or EIS is required.

An initial Public EIS Scoping meeting was held on June 29, 2004. A supplemental Public EIS Scoping Meeting was held on October 21, 2008, based on the revised scope in the FCSA Amendment 1. Additional scoping opportunities were also afforded through other stakeholder outreach events, including a focus group meeting and open house meetings.

6.1.2 APPS

In the U.S., the Act to Prevent Pollution from Ships APPS enacts some of the International Convention for the Prevention of Pollution from Ships (MARPOL) regulations by establishing requirements for the following:

- Oil abatement equipment, such as oil-water separators and monitoring equipment
- Oil discharges allowed at sea
- Construction of ballast tanks, crude oil washing systems and inert gas systems
- Shipboard Oil Pollution Emergency Plans (SOPEP)

The USCG may board U.S. ships and foreign vessels in U.S. waters (in port or at offshore terminals) to verify whether the ship complies with MARPOL. If its flag state has ratified MARPOL Annex I, a foreign ship entering U.S. waters must have an International Oil Pollution Prevention (IOPP) certificate. If the flag state has not ratified the Convention, the ship must carry evidence of compliance with MARPOL.

A USCG examination may include checking the vessel's certificates (e.g., IOPP certificate), records (e.g., oil record book), documents (e.g., SOPEP) and oil transfer procedures. The examination may also include verification that the vessel is properly equipped with oily water separators.

6.1.3 BEACH Act

The BEACH Act amended the CWA in 2000. It is designed to reduce the risk of disease to users of the Nation's coastal recreation waters. The act authorizes the EPA to award program development and implementation grants to eligible states, territories, tribes, and local governments to support microbiological testing and monitoring of coastal recreational waters, including the Great Lakes and waters adjacent to beaches or similar points of access used by the public. BEACH Act grants also provide support for developing and implementing programs to notify the public of the potential for exposure to disease-causing microorganisms in coastal recreation waters. The act also authorizes EPA to provide technical assistance to states and local governments for the assessment and monitoring of floatable materials.

6.1.4 CAA 42 U.S. Code § 7401 et seq.

The CAA is the comprehensive federal law that regulates air emissions from stationary and mobile sources. Among other things, this law authorizes EPA to establish National Ambient Air Quality Standards (NAAQS) to protect public health and public welfare and to regulate emissions of hazardous air pollutants.

One of the goals of the Act was to set and achieve NAAQS in every state by 1975 in order to address the public health and welfare risks posed by certain widespread air pollutants. The setting of these pollutant standards was coupled with directing the states to develop state implementation plans, applicable to appropriate industrial sources in the state, in order to achieve these standards. The Act was amended in 1977 and 1990 primarily to set new goals (dates) for achieving attainment of NAAQS since many areas of the country had failed to meet the deadlines.

Section 112 of the CAA addresses emissions of hazardous air pollutants. Prior to 1990, CAA established a risk-based program under which only a few standards were developed. The 1990 CAA Amendments revised Section 112 to first require issuance of technology-based standards for major sources and certain area sources. "Major sources" are defined as a stationary source or group of stationary sources that emit or have the potential to emit 10 tons per year or more of a hazardous air pollutant or 25 tons per year or more of a combination of hazardous air pollutants. An "area source" is any stationary source that is not a major source.

For major sources, Section 112 requires that EPA establish emission standards that require the maximum degree of reduction in emissions of hazardous air pollutants. These emission standards are commonly referred to as "maximum achievable control technology" or "MACT" standards. Eight years after the technology-based MACT standards are issued for a source category, EPA is required to review those standards to determine whether any residual risk exists for that source category and, if necessary, revise the standards to address such risk.

6.1.5 CWA

The CWA regulates virtually all physical alterations and discharges into "waters of the U.S.," including all territorial seas three nautical miles seaward from the mean high-water mark and any waterways that physically connect to the ocean and any other wetlands. The CWA covers several waters associated issues including:

- **Section 401 WQC** provides states with ways to regulate surface water quality. The CNMI Division of Environmental Quality (DEQ) administers the state certification program for federal water-related permits including the Section 401 WQC. Expansion at East Harbor would trigger the requirement to apply for and obtain a WQC from DEQ for construction.
- **Section 402 NPDES** regulates the discharge of pollutants into waters of the US. Expansion of the East Harbor would require an individual Section 402 NPDES permit for any discharge (i.e. wastewater discharges) into near shore marine waters. The EPA has authority over the CWA Section 402 NPDES regulatory program and coordinates closely with the CNMI DEQ. Permit applications can be submitted to the USEPA Region 9, San Francisco office. However, the CNMI DEQ may administer this permit locally.
- **Section 404 of the CWA** specifically regulates the discharge of fill material into waters of the U.S. The proposed harbor improvement activities involving discharges of fill material into waters of the U.S. e.g. breakwater reconstruction or extension in Tinian Harbor, would require a Section 404 permit. The Section 404 process requires a determination as to whether there are practical alternatives having less impact and may require compensatory mitigation. The CWA Section 404 regulatory program is administered by the USACE with oversight and guidance from the USEPA. Although the CNMI is under the administrative authority of the USACE Honolulu District, the point of contact for all CNMI Section 10 and 404 regulatory issues in the USACE Guam Regulatory Office.

6.1.6 CZMA of 1982

The U.S. Congress recognized the importance of meeting the challenge of continued growth in the coastal zone by passing the CZMA in 1972. This act, administered by NOAA, provides for the management of the nation's coastal resources, including the Great Lakes. The goal is to "preserve, protect, develop, and where possible, to restore or enhance the resources of the nation's coastal zone."

The CZMA outlines three national programs, the National CZM Program, the National Estuarine Research Reserve System, and the Coastal and Estuarine Land Conservation Program (CELCP). The National CZM Program aims to balance competing land and water issues through state and territorial coastal management programs, the reserves serve as field laboratories that provide a greater understanding of estuaries and how humans impact them, and CELCP provides matching funds to state and local governments to purchase threatened coastal and estuarine lands or obtain conservation easements.

6.1.7 CERCLA (Superfund) 1980

Otherwise known as Superfund, CERCLA provides a federal "Superfund" to clean up uncontrolled or abandoned hazardous-waste sites as well as accidents, spills, and other emergency releases of pollutants and contaminants into the environment. Through CERCLA, EPA was given power to seek out those parties responsible for any release and assure their cooperation in the cleanup.

EPA cleans up orphan sites when potentially responsible parties cannot be identified or located, or when they fail to act. Through various enforcement tools, EPA obtains private party cleanup through orders, consent decrees, and other small party settlements. EPA also recovers costs from financially viable individuals and companies once a response action has been completed.

EPA is authorized to implement the Act in all 50 states and U.S. territories. Superfund site identification, monitoring, and response activities in states are coordinated through the state environmental protection or waste management agencies.

The Superfund Amendments and Reauthorization Act (SARA) of 1986 reauthorized CERCLA to continue cleanup activities around the country. Several site-specific amendments, definitions clarifications, and technical requirements were added to the legislation, including additional enforcement authorities. Also, Title III of SARA authorized the Emergency Planning and Community Right-to-Know Act (EPCRA).

6.1.8 ESA

The ESA has the purpose to conserve “the ecosystems upon which endangered and threatened species depend” and to conserve and recover species listed as Endangered or Threatened. In the marine environment, enforcement of the ESA is the responsibility of the NMFS and the USFWS.

6.1.9 FWCA

The FWCA (16 U.S.C. 661) was established to provide for the protection of fish and wildlife as part of federal water resource development projects. It requires federal agencies to coordinate with USFWS and state wildlife agencies during the planning of new projects or for modifications of existing projects so that wildlife conservation receives equal consideration with other features of such projects throughout the decision making process. Wildlife resources are conserved by minimizing adverse effects, compensating for wildlife resources losses, and enhancing wildlife resource values.

6.1.10 Flood Control Act of 1970

In 1824, Congress passed legislation charging military engineers with planning roads and canals to move goods and people. In 1850, Congress directed the USACE to engage in its first planning exercise—flood control for the lower Mississippi River. During the 1920s, Congress expanded USACE's ability to incorporate hydropower into multipurpose projects and authorized the agency to undertake comprehensive surveys to establish river-basin development plans. The modern era of federal flood control emerged with the Flood Control Act of 1936 (49 Stat. 1570), which declared flood control a "proper" federal activity in the national interest. The 1944 Flood Control Act (33 U.S.C. §708) significantly augmented the USACE's involvement in large multipurpose projects and authorized agreements for the temporary use of surplus water. The Flood Control Act of 1950 (33 U.S.C. §701n) began the USACE's emergency operations through authorization for flood preparedness and emergency operations. The Proposed Action will comply with the Flood Control Act of 1970.

6.1.11 Hazardous, Toxic, and Radioactive Waste Guidance for Civil Works Projects (USACE ER 1165-132)

The purpose of this document is to provide guidance for consideration of issues and problems associated with hazardous, toxic, and radioactive wastes which may be located within proposed project boundaries or may affect or be affected by USACE Civil Works projects. The guidance is intended to provide information on how these considerations are to be factored into project planning and implementation.

Except for dredged material and sediments beneath navigable waters proposed for dredging, for purposes of this guidance, HTRW includes any material listed as a "hazardous substance" under CERCLA. Hazardous substances regulated under CERCLA include "hazardous wastes" under Sec. 3001 of the RCRA; "hazardous substances" identified under Section 311 of the CAA, 33 U.S.C. 1321, "toxic pollutants" designated under Section 307 of the CWA, 33 U.S.C. 1317, "hazardous air pollutants" designated under Section 112 of the CAA, 42 U.S.C. 7412; and "imminently hazardous chemical substances or mixtures" on which EPA has taken action under Section 7 of the Toxic Substance Control Act, 15 U.S.C. 2606; these do not include petroleum or natural gas unless already included in the above categories.

Dredged material and sediments beneath navigable waters proposed for dredging qualify as hazardous, toxic, and radioactive wastes only if they are within the boundaries of a site designated by the EPA or a state for a response action (either a removal action or a remedial action) under CERCLA, or if they are a part of a National Priority List (NPL) site under CERCLA. Dredged material and sediments beneath the navigable waters proposed for dredging shall be tested and evaluated for their suitability for disposal in accordance with the appropriate guidelines and criteria adopted pursuant to Section 404 of the CWA and/or Section 103 of the Marine Protection Research and Sanctuaries Act and supplemented by the USACE Management Strategy for Disposal of Dredged Material: Containment Testing and Controls (or its appropriate updated version) as cited in 33 CFR 336.1.

6.1.12 Magnuson-Stevens Fishery Conservation and Management Act

The 1996 amendments to the Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. 1855(b)) establish provisions relative to EFH, in order to identify and protect important habitats for federally managed marine and anadromous fish species. Federal agencies which fund, permit, or undertake activities that may adversely affect EFH are required to consult with the National Marine Fisheries Service (NMFS) regarding the potential effects of their actions on EFH and respond to NMFS recommendations.

No portion of the proposed project area has been designated as EFH.

6.1.13 Marine Mammal Protection Act

The MMPA of 1972 prohibits the take or harassment of any marine mammals (not just protected species). Harassment can include exposure to reduced water quality or in-air and in-water noise from pile driving and dredging operations, as well as injuries or deaths from vessel strikes. NMFS provides input and guidance to USACE as part of the USACE permit process.

6.1.14 Marine Protection, Research, and Sanctuaries Act (MPRSA) of 1972

Titles I and II of the MPRSA, also referred to as the Ocean Dumping Act, generally prohibits (1) transportation of material from the U.S. for the purpose of ocean dumping; (2) transportation of material from anywhere for the purpose of ocean dumping by U.S. agencies or U.S.-flagged vessels; (3) dumping of material transported from outside the U.S. into the U.S. territorial sea. A permit is required to deviate from these prohibitions.

Under MPRSA, the standard for permit issuance is whether the dumping will "unreasonably degrade or endanger" human health, welfare, or the marine environment. EPA is charged with developing ocean dumping criteria to be used in evaluating permit applications. The MPRSA provisions administered by EPA are published in Title 33 of the U.S. Code. The MPRSA provisions that address marine sanctuaries are administered by the National Oceanic and Atmospheric Administration and are published in Title 16 of the U.S. Code. This document analyzes potential effects to marine mammals, some of which are species-listed under the ESA. The Proposed Action will comply with the MMPA.

6.1.15 Migratory Bird Treaty Act

Native migratory birds of the U.S. are protected under the MBTA of 1918, as amended (16 U.S.C. 703-712 et. seq.); the list of birds protected under MBTA implementing regulations is provided at 50 CFR 10.13. This Act states that it is unlawful to pursue, hunt, take, capture or kill; attempt to take, capture or kill; possess, offer to or sell, barter, purchase, deliver or cause to be shipped, exported, imported, transported, carried or received any migratory bird, part, nest, egg or product. “Take” is defined as “to pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to pursue, hunt, shoot, wound, kill, trap, capture, or collect (16 U.S.C. 703-712).” Consistent with the analysis provided relative to the ESA, the proposed project is not expected to adversely affect migratory species.

6.1.16 NHPA

Section 106 of the NHPA requires that federally assisted or permitted projects account for the potential effects on sites, districts, buildings, structures, or objects that are included in or eligible for inclusion in the NRHP. Section 106 review is conducted by the local CNMI Historical Preservation Officer and results in a “Determination of Effect” document. Expansion of the East Harbor would trigger Section 106 review. It was recommended that the review process be initiated early in the permit process to avoid delays in publishing a Determination of Effect.

6.1.17 Noise Pollution and Abatement Act of 1972

Inadequately controlled noise presents a growing danger to the health and welfare of the Nation's population, particularly in urban areas. The major sources of noise include transportation vehicles and equipment, machinery, appliances, and other products in commerce. The Noise Control Act of 1972 establishes a national policy to promote an environment for all Americans free from noise that jeopardizes their health and welfare. The Act also serves to (1) establish a means for effective coordination of federal research and activities in noise control; (2) authorize the establishment of federal noise emission standards for products distributed in commerce; and (3) provide information to the public respecting the noise emission and noise reduction characteristics of such products.

While primary responsibility for control of noise rests with state and local governments, federal action is essential to deal with major noise sources in commerce, control of which require national uniformity of treatment. EPA is directed by Congress to coordinate the programs of all federal agencies relating to noise research and noise control.

A detailed and independent noise study for the Tinian Harbor Modification Project was not conducted or deemed necessary because there are few if any sensitive receptors in the area that would be impacted. Land uses within and surrounding the proposed project site are harbor operations and general recreational. The area is not an essential breeding/nesting ground/habitat for threatened or endangered flora and fauna and there are no residences, schools or hospitals in the vicinity.

6.1.18 RCRA

The RCRA gives EPA the authority to control hazardous waste from the "cradle-to-grave." This includes the generation, transportation, treatment, storage, and disposal of hazardous waste. RCRA also set forth a framework for the management of non-hazardous solid wastes. The 1986 amendments to RCRA enabled EPA to address environmental problems that could result from underground tanks storing petroleum and other hazardous substances.

The Federal Hazardous and Solid Waste Amendments - are the 1984 amendments to RCRA that focused on waste minimization and phasing out land disposal of hazardous waste as well as corrective action for releases. Some of the other mandates of this law include increased enforcement authority for EPA, more stringent hazardous waste management standards, and a comprehensive underground storage tank program. All activities undertaken for the Proposed Action would be fully compliant with the Resource Conservation and Recovery Act.

6.1.19 Rivers and Harbors Act

The proposed harbor improvement activities involving work and structures in and affecting navigable waters e.g. breakwater reconstruction in Tinian Harbor, would require a permit under Section 10 of the Rivers and Harbors Act. Section 10 regulates the placement of structures, excavation of dredge, or deposition of fill material, or the accomplishment of any other work affecting the course, location, condition, or capacity in “navigable waters.” The Section 10 regulatory program is administered by the USACE Honolulu District Regulatory Branch.

6.1.20 Submerged Lands Act

The Submerged Lands Act was enacted in response to litigation that effectively transferred ownership of the first 3 miles of a state’s coastal submerged lands to the federal government. In the case of United States v. California (1947), the U.S. successfully argued that the three nautical miles seaward of California belonged to the federal government, primarily finding that the federal government’s responsibility for the defense of the marginal seas and the conduction of foreign relations outweighed the interests of the individual states.

In response, Congress adopted the SLA in 1953, granting title to the natural resources located within three miles of their coastline (three marine leagues for Texas and the Gulf coast of Florida). For purposes of the SLA, the term “natural resources” includes oil, gas, and all other minerals.

Title II addresses the rights and claims by the states to the lands and resources beneath navigable waters within their historic boundaries and provides for their development by the states. Title III preserves the control of the seabed and resources therein of the Outer

Continental Shelf beyond state boundaries and to the federal government and authorizes leasing by the Secretary of the Interior in accordance with certain specified terms and conditions.

The SLA was upheld in 1954 by the U.S. Supreme Court (Alabama v. Texas) emphasizing that Congress could relinquish to the states the federal government's property rights over the submerged lands without interfering with U.S. national sovereign interests.

6.1.21 NMSA

NMSA authorizes the Secretary of Commerce to designate and protect areas of the marine environment with special national significance due to their conservation, recreational, ecological, historical, scientific, cultural, archeological, educational or esthetic qualities as national marine sanctuaries.

Day-to-day management of national marine sanctuaries has been delegated by the Secretary of Commerce to NOAA's Office of National Marine Sanctuaries. The primary objective of the NMSA is to protect marine resources, such as coral reefs, sunken historical vessels or unique habitats.

The NMSA provides several tools for protecting designated national marine sanctuaries. For example:

- The NMSA provides the program with the authority to issue regulations for each sanctuary and the system as a whole. These regulations can, among other things, specify the types of activities that can and cannot occur within the sanctuary. [See section 308 of the NMSA.]
- The NMSA requires the program to prepare and periodically update management plans that guide day-to-day activities at each sanctuary. [See sections 304(a) and 304(e) of the NMSA.]
- The NMSA authorizes NOAA and the program to assess civil penalties (up to $130,000 per day per violation) for violations of the NMSA or its implementing regulations and damages against people that injure sanctuary resources. [See sections 306, 307 and 312 of the NMSA.]
- The NMSA requires federal agencies whose actions are “likely to destroy, cause the loss of, or injure a sanctuary resource,” to consult with the program before taking the action. The program is, in these cases, required to recommend reasonable and prudent alternatives to protect sanctuary resources.

The Proposed Action would have no effect on sanctuary resources in the offshore environment of the Study Area. Review of agency actions under Section 304 is not required.

6.1.22 The Sikes Act of 1960

President Eisenhower signed the Sikes Act into law on September 15, 1960. At its core, the Sikes Act (16 USC 670), as amended, requires and allows the Secretary of Defense to plan, develop, and maintain natural resources on U.S. military reservations.

Over the last 50 years, the Sikes Act has helped military installations protect and enhance nearly 30 million acres of land, air, and water resources while enabling troops to train in a wide array of the most realistic environmental conditions possible. These landscapes help troops prepare for combat throughout the world.

Congress originally passed the Sikes Act to ensure that the military conserved and maintained its fish and wildlife resources. Human access and development are limited on many military installations because of safety and security concerns. As a result of these restrictions, DoD installations contain some of the most significant remaining large tracts of often unique habitats in the U.S. In 1997, Congress amended the Sikes Act to require that DoD installations with significant natural resources develop and implement Integrated Natural Resources Management Plans in cooperation with the USFWS, and the appropriate state fish and wildlife agency.

The Proposed action does not involve a military installation with significant natural resources; the proposed action is in compliance with the Sikes Act of 1960.

6.2 EOs

EOs that are relevant to the proposed project and have been considered in the feasibility planning process include the following:

- **EO 11990, Protection of Wetlands**: The objective of this EO is to minimize the loss or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands. As discussed in Section 5.7 of the Draft Report, some small pockets of wetlands may exist within the limits of the channels, but no adjacent wetland features have been identified. Impacts to aquatic habitat within the stream channels will be mitigated so as to achieve no net loss of habitat function.
- **EO 12114, Environmental Effects Abroad of Major Federal Actions**: The objective of this EO is to enable responsible officials of federal agencies having ultimate responsibility for authorizing and approving actions encompassed by this Order to be informed of pertinent environmental considerations and to take such considerations into account, with other pertinent considerations of national policy, in making decisions regarding such actions.
- **EO 12898, Environmental Justice**: The objective of this EO is to make it a high priority to identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of programs, policies and activities on minority and low-income populations. As discussed in Section 5.18 of the Interim

Feasibility Report, the proposed project alternatives are not expected to have a disproportionate effect on minority or low-income populations in the proposed project area.

- **EO 12962, Recreational Fisheries**: The objective of this EO is for Agencies to fulfill certain duties with regard to promoting the health and access of the public to recreational fishing areas.
- **EO 13045, Protection of Children from Environmental Health Risks and Safety Risks**: The objective of this EO is to make it a high priority to identify and assess environmental health risks and safety risks that may disproportionately affect children. As discussed in Section 5.18 of the Interim Feasibility Report, the proposed project is not expected to involve risks that would disproportionately affect children.
- **EO 13089, Coral Reef Protection**: The objective of this EO is to preserve and protect the biodiversity, health, heritage, and social and economic value of U.S. coral reef ecosystems and the marine environment.
- **EO 13112, Invasive Species**: The objective of this EO is to prevent the introduction of invasive species, provide restoration of native species and habitat conditions in ecosystems that have been invaded, and promote public education and the means to address invasive species. The proposed project would include BMPs intended to address the introduction or spread of invasive species and would incorporate native species as part of revegetation and mitigation efforts, where practicable.
- **EO 13158, Marine Protected Areas**: The objective of this EO is to identify any actions that affect the natural or cultural resources that are protected by MPA. Agencies shall avoid harm to the natural and cultural resources that are protected by an MPA. This Interim Feasibility Report satisfies the requirement of EO 13158 with regard to the Proposed Action.
- **EO 13186, Protection of Migratory Birds**: The objective of this EO is to direct federal agencies that take actions that either directly or indirectly effect on migratory birds to develop a Memorandum of Understanding (MOU), and to work with the U.S. Fish & Wildlife Service, and other federal agencies to promote the conservation of migratory bird populations.

6.3 CNMI Regulations

The DEQ is the local environmental agency for the CNMI. The agency and was established by the Commonwealth Protection Act to “develop and administer programs ... a system of standards, permits or prohibitions, to prevent or regulate activities concerning the discharge of pollutants to the air, land, water, wetlands and submerged lands.” To protect the ground water the DEQ regulates the permitting of individual waste water disposal systems, well drilling and well operations, and above- and below-ground fuel storage tanks. In 2013 under, EO No. 2013-24, the DEQ was reorganized and merged into the Division of Environmental Quality and the Division of Coastal Resources Management Office under the newly established Bureau of Environmental and Coastal Quality. The main purpose of the merger was to enhance efficiency and collaboration through integration of services and strategic goals, sharing of resources, and elimination of overlapping responsibilities. A summary of DEQ regulations (and associated permit requirements) that apply to the proposed project and the compliance status of each is provided below.

- *Air Pollution Control Regulations (CNMI Administrative Code Chapter 65-10)*
- *Coastal Resources Management Act, (2 CMC § 1501 et seq.)*
- *Commonwealth Department of Public Works (CNMI Administrative Code Title 155-20)*
- *Commonwealth Groundwater Management and Protection Act of 1988 (CNMI Public Law 6-12)*
- *CPA (CNMI Administrative Code Title 40- 20)*
- *Comprehensive Wildlife Conservation Strategy*
- *Drinking Water Regulations (CNMI Administrative Code Chapter 65- 20)*
- *Earthmoving and Erosion Control Regulations (CNMI Administrative Code Chapter 65-30) -* Requires an Earth Moving and Erosion Control Permit by written clearance from the Historic Preservation Officer and the Division of Fish and Wildlife (DFW).
- *Environmental Protection Act (2 CMC § 3101 et seq.)*
- *Fish, Game, and Endangered Species Act (Public Law 2-51)*
- *Groundwater Recharge Requirements*
- *Harmful Substance Clean Up Regulations (CNMI Administrative Code Chapter 65-40)*
- *Hazardous Waste Management Regulations (CNMI Administrative Code Chapter 65-50)*
- *Solid Waste Management Regulations and CNMI Underground Injection Control Regulations (CNMI Administrative Code Chapter 65- 80)*
- *Threatened and Endangered Species (CNMI Administrative Code § 85-30.1-101)*
- *Underground Injection Control Regulations (CNMI Administrative Code Chapter 65-90)*
- *Wastewater Treatment and Disposal Rules and Regulations (CNMI Administrative Code Chapter 65-120) -* Govern the design of wastewater treatment and disposal systems including septic tanks and leaching fields or other treatment facilities.
- *Water Quality Standards (CNMI Administrative Code Chapter 65-130) -* Authorizes the CNMI to approve, condition, or deny water- related permits issued including the USCACE Section 404 permit, the USCACE Section 10 permit, and the USEPA Section 402 NPDES permit.
- *Well Drilling and Well Operation Regulations (CNMI Administrative Code Chapter 65-140)*

6.3.1 Other Agencies

DLNR

The DLNR, headed by an executive Board of Land and Natural Resources, is responsible for managing, administering, and exercising control over public lands, water resources, ocean waters, navigable streams, coastal areas (except commercial harbors), minerals, and all interests therein. The department's jurisdiction encompasses nearly 1.3 million acres of state lands, beaches, and coastal waters as well as 750 miles of coastline (the fourth longest in the country). It includes state parks; historical sites; forests and forest reserves; aquatic life and its sanctuaries; public fishing areas; boating, ocean recreation, and coastal programs; wildlife and its sanctuaries; game management areas; public hunting areas; and natural area reserves.

Department of Public Lands

The Department of Public Lands' overall responsibilities include the creation and implementation of a homesteading program, the commercial leasing and permitting of idle public lands, the settling of land claims (e.g., through the Land Compensation Program), and designating public land parcels to other government agencies for the fulfillment of the public purpose.

Department of Community and Cultural Affairs (DCCA)

The Department of Community and Cultural Affairs was created in 1978 with the signing of the Covenant to establish the CNMI in political union with the United States of America.

DCCA is an executive branch agency, responsible to the Governor through the Secretary.

DCCA's mission is to oversee CNMI functions in the area of human and social services, historic and landmark conservation and preservation, and activities to preserve the Chamorro and Carolinian heritages and traditions.

The Office of the Secretary oversees the operation and administration of nine divisions and programs under the Department of Community & Cultural Affairs. They are the Low-Income Home Energy Assistance Program, the Childcare Licensing Program, the Office of Aging, the Commonwealth Council for Arts and Culture, the Chamorro Carolinian Language Policy Commission, the Historic Preservation Office, the Nutrition Assistance Program, the Child Care Development Fund, and the Division of Youth Services.

HPO

The HPO was established by the passage of the CNMI Historic Preservation Act of 1982 (Public Law 3-39).

The intent of Public Law 3-39 is to (1). Ensure the identification and protection of significant archaeological, historic, and cultural resources in the Commonwealth; (2).

Educate the public concerning matters relating to local history, archaeology, culture and historic preservation; and (3). Develop historic and cultural properties to allow them to contribute to the cultural, social, and economic growth of our citizens.

CUC

CUC is a state government corporation. The CUC operates the electric power, water and wastewater services on the three main islands of the CNMI--- Saipan, Tinian, and Rota. The CNMI is one of five U.S. territories (which include Puerto Rico, U.S. Virgin Islands, Guam, and American Samoa). CUC is a semi-autonomous agency of the CNMI government. As a semiautonomous agency, the CUC should have an independent Board of Directors, appointed by the Governor, whose members serve a concurrent four-year term.

Through a transition period between U.S. Trust Territory management and after the ratification of the CNMI Covenant, in 1975, the CNMI enacted legislation creating CUC. Due to a number of delays in actual implementation, the CUC did not take over operations until October 1987, which up to that time operated under the Department of Public Works (DPW).

6.4 Permitting

Prior to construction the Corps will ensure all necessary permits, approvals or other authorizations are obtained in accordance with the regulatory statutes identified in Section 6.3.

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The primary persons responsible for contributing to, preparing, and reviewing this Interim Feasibility Report are listed in the table below. Those persons who participated as part of the PDT are indicated with an asterisk.

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Appendices

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Economics Appendix

Tinian Harbor Navigation Study

US Army Corps of Engineers

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1 Introduction

This document presents economic evaluations performed for the Tinian Island Harbor Study located within the Common Wealth of the Northern Mariana Islands. This evaluation will analyze the economic benefits to navigation improvements and ultimately its contribution to the Federal objective as described in the Principles and Guidelines. The role of the U.S. Army Corps of Engineers with respect to navigation is to reduce navigation hazards and to enable reliable and efficient waterborne transportation systems (channels, harbors and waterways) for the movement of commerce, national security needs, and recreation (U.S. Army Engineer Institute for Water Resources, 2010).

Tinian Harbor is located on the southwest coast of the island of Tinian in the Commonwealth of the Northern Mariana Islands (CNMI). The Northern Mariana Islands are located in the Western Pacific, approximately 3,800 miles west of Hawaii. The CNMI is composed of sixteen islands north of Guam running north-south for a distance of about 440 miles. The island of Saipan is the capital and center of population and commerce for the Northern Marianas. Tinian, divided by water, is located 14 miles south-southwest of Saipan and 120 miles north-northeast of Guam. The island is approximately 10.5 miles long and 5 miles wide.

1.1 Study Purpose and Scope

The purpose of this study is to evaluate problems and opportunities for improved navigation efficiency at Tinian Harbor and to identify the plan that best satisfies the environmental, economic, and engineering criteria. The purpose of these potential improvements is to increase the efficiency of cargo vessel operations on vessels that calling on the Tinian Harbor.

The scope of this feasibility study involves analysis of existing conditions and requirements, identifying opportunities for improvement, preparing economic analyses of alternatives, identifying environmental impacts, and analyzing the National Economic Development (NED) plan. In addition to the NED account for the analysis, the study will consider three other accounts of analysis. These accounts include: the Regional Economic Development (RED), Environmental Quality (EQ), and Other Social Effects (OSE) accounts.

This study identifies and evaluates alternatives that will:

- **Provide additional support to sustain the current breakwater;**

The current breakwater at Tinian Harbor is over 70 years old and provides both channel and coastal benefits to the port. The breakwater is dilapidated and in need for significant repair. The current breakwater at Tinian does provide some protection at the harbor, however, does not support significant wave activity.

- **Allow greater predictability of future cargo availability in Tinian Harbor to its residents;**

The breakwater at Tinian is very fragile and if hit by a direct typhoon, it is likely to dissipate. Not knowing when that large typhoon event will occur leaves the residents potentially vulnerable to adverse wave conditions once removed. Future cargo availability and nearshore protection is needed to sustain navigation operations within the harbor.

- **Provide the local community of Tinian with cost effective commodities that will support future income and resource needs.**

Tinian is a remote island with no land connection to any other neighboring islands. Because of this, Tinian relies heavily on ocean and air cargo for their supply of goods. With ocean cargo being the most *cost-effective way to transport goods, it is preferred over air cargo. When goods are transited in air the increased costs are passed down to the consumers and the need to keep ocean cargo available to residents is necessary.*

1.2 Authority

This study for this General Investigation study is authorized under both the Section 444 of the Water Resources and Development Act of 1996 (P.L. 104-303), which reads in part:

> *"The Secretary may conduct studies in the interest of navigation in that part of the Pacific region that includes American Samoa, Guam, and the Commonwealth of the Northern Mariana Islands."*

1.3 Background

Tinian is located at the northern group of islands within the Commonwealth of the Northern Mariana Islands, just south of Saipan. It is approximately 17 nautical miles southwest of Saipan and 55 nautical miles northeast of Tinian. Tinian is not connected to any ground transportation system and, therefore, imports all of its commodities to the island by way of air or ocean cargo.

Below is a map of Tinian and the project footprint for this analysis.

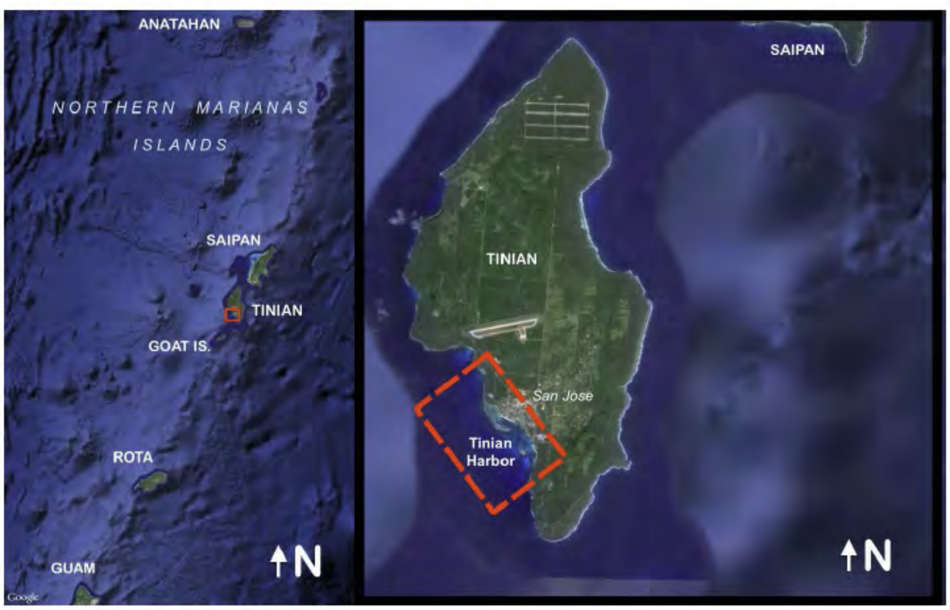


Figure 1-1 Project Location and Vicinity Map of Tinian

Ocean cargo is the most cost-effective way to transport goods and due to its remoteness, most of the goods are transported via ocean cargo. Most perishable goods are transported in air regardless of the harbor conditions, however, there have been some instances where vessels have transported frozen foods. Because of the high cost of air cargo, there is some discretion as to what goods require air cargo and which goods must wait for the next ocean cargo shipment is available.

Air cargo does pose some limitations including the size of cargo available to be transported, the quantity transported, and the type of cargo transported. When air cargo is needed, most voyages typically transport those items that are deemed necessity items, not all goods.

Figure 1-2 Tinian Island and neighboring islands graphic shows Tinian Island in relation to its neighboring islands and the remoteness of the area. Most products are transported to either Saipan or Guam in a larger vessel and then transshipped to the smaller vessels either via tug and barge or a small motor vessel.

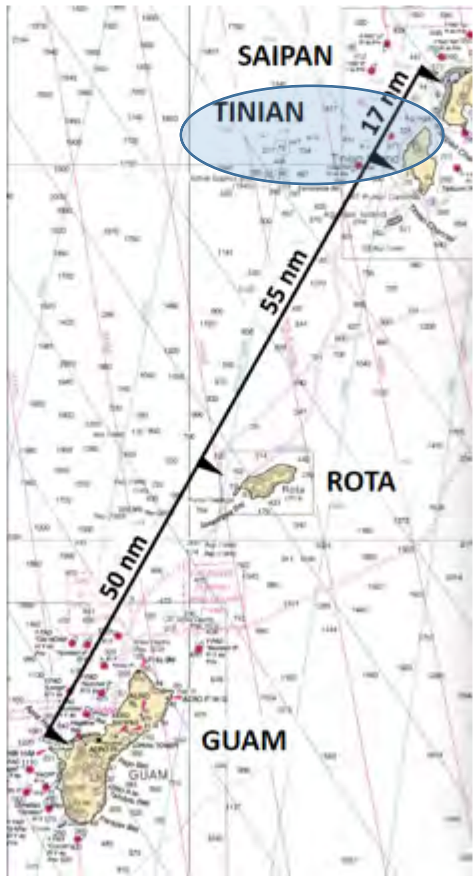


Figure 1-2 Tinian Island and neighboring islands graphic

1.4 Overview of the Economic Analysis

The Federal interest in navigable waterway improvements is derived from the commerce clause of the U.S. Constitution. Customs and court decisions that define Federal power to regulate commerce provide the linkage between the Federal interest and navigable waterway improvements. Economics is used to provide a rational and objective method for establishing the Federal Interest.

The role of the economic analysis on a navigable waterway improvement is to provide answers to the following two questions:

- Is an investment of Federal dollars in this project warranted?
- If an investment of Federal money is warranted, what is the appropriate level of investment?

The study and construction of this navigation improvement project is partially funded using Federal. Most navigation improvement projects in which the Federal government has an investment in will require an assertion that Federal dollars are utilized in the most cost-effective way and efficient way to provide a national benefit to the country. With the consideration of this project being a Federal investment, the goal of the economic analysis is to provide an economic analysis that provides a thorough review of the cost and the benefit to the nation.

An investment in a navigable waterway improvement is warranted if the project benefits exceed the costs expressed in monetary units. Project benefits are national economic development (NED) benefits and defined as a positive change in the value of the national output of goods and services. Conversely, NED costs are defined as a negative change in the value of the national output of goods and services. If it can be proven that the project causes a net positive change in NED, then the federal interest has been established subject to certain considerations.

The level of federal investment is determined based on the alternative that most reasonably maximizes net NED benefits while achieving the objective it is sought out to achieve.

1.5 Appendix Layout

The appendix layout is consistent with the development of the analysis. Section 3 provides an overview of the economic analysis while Section 4 highlights the existing conditions and what was required to model and anticipate existing conditions. Section 5 and 6 presents the NED analysis of benefits and costs while Section 7 explains the Benefit-Cost-Ratio for the NED plan.

In addition to the NED account and NED justification, the economic analysis will also review the remaining three accounts that will assist in the justification of the project. This review is contained in Sections 8 through 9. Section 10 highlights risk and uncertainty as well as presents a sensitivity analysis for the economic analysis and Section 11 concludes the analysis with a brief assessment of the completed study.

1.6 Project Study Area

Tinian Harbor is located on the southeast coast of Tinian, at San Jose, the primary urban center. There is currently no Federal navigation project at the harbor. The existing harbor was constructed in 1944-1945 during World War II. The entrance channel is about one-half mile long, approximately 525 feet wide and has been dredged to a depth of about 30 feet. The wharves and harbor turning basin were dredged to depths of 28 to 30 feet.

In addition to the construction of the channel, there was construction of a breakwater. Since its construction, there has been little to no maintenance and/or repairs to the breakwater. The below image shows the original study footprint in 1945.

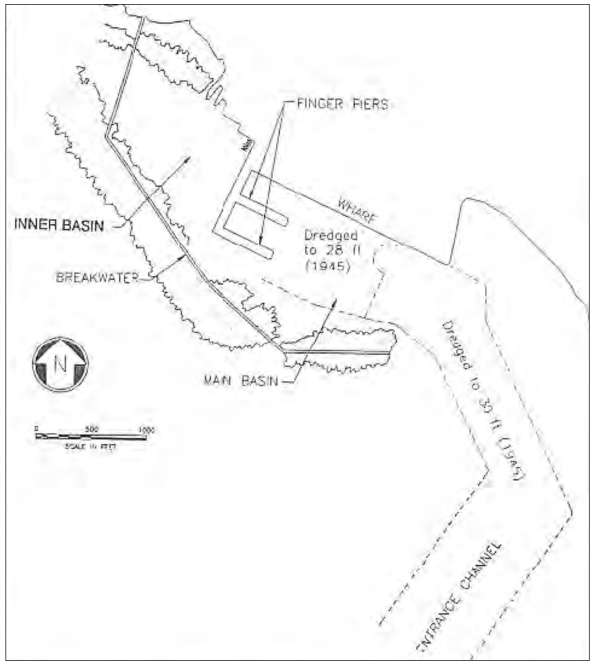


Figure 1-3 Historical Tinian Harbor 1945

The total length of the breakwater is 4,805 feet long and the crest elevation is about 14 feet above mean sea level. The inner breakwater, with a length of 1,210 feet from the shore to the outer breakwater was constructed of a single row sheet piling. Much of the sheet pile on the inner breakwater has deteriorated and collapsed. The outer breakwater, with a length of 3,595 feet, was constructed of interlocking, half-inch thick steel sheet piling in circular cell configuration. The interior of the cells was filled with quarried limestone. A 10-inch thick, unreinforced concrete slab was constructed flush with the top of the sheet piles. The steel sheet pile breakwater is almost completely deteriorated.

2 Economic Study Area (Hinterland)

2.1 Tinian Demographics

Understanding the demographics of Tinian and its location relevant to the CNMI and the Pacific is helpful in associating the need for harbor improvements. A socioeconomic analysis was conducted to provide a better understanding of the characteristics of the communities in the study area. By understanding the community supported, the culture, and the dependency of the harbor helps to explain the true the impact on residents and the community.

2.1.1 Population Demographics

Tinian is a very diverse island with visitors not only from the US and its territories, but also from Southeast-Asian countries. The total population as of the 2010 Census Report was 3,136 people. A majority of the population falls into the category of Native Hawaiian, Other Pacific Islander Origin, or Asian Descent. Tinian is a very transient area with over 80 percent of those residents born outside the CNMI moving for employment. Its close proximity to Saipan provides economic growth opportunities for both residents and non-residents.

Overall, there has been a decline in the total population in the Commonwealth of the Northern Mariana Islands, similarly Tinian. With a median age of 34, the Tinian population is aging compared to the 2000

Census report (CNMI Department of Commerce, 2012). This aging population would suggest that younger generations are leaving Tinian. Below is a table comparison of the age differentiation from the 2000 Census Report and the 2010 Census data.

Total population	2,477
Male	1,377
Female	1,100
Under 5 years	199
5 to 9 years	225
10 to 14 years	175
15 to 19 years	131
20 to 24 years	153
25 to 34 years	743
35 to 44 years	507
45 to 54 years	246
55 to 59 years	23
60 to 64 years	31
65 to 74 years	32
75 to 84 years	9
85 years and over	3

Figure 2-1 Tinian Population By Age 2000 Census Report (US Census Bureau)

Total:	**3,136**
Under 5 years	275
5 to 9 years	247
10 to 14 years	257
15 to 19 years	223
20 to 24 years	150
25 to 29 years	201
30 to 34 years	283
35 to 39 years	352
40 to 44 years	384
45 to 49 years	307
50 to 54 years	195
55 to 59 years	126
60 to 64 years	75
65 to 69 years	24
70 to 74 years	20
75 to 79 years	8
80 to 84 years	4
85 years and over	5

Figure 2-2 Tinian Population By Age 2010 Census Report (US Census Bureau)

The above figures show that the concentration of 25-34 year olds in 2000, now 35-44 year old range in 2010 Census has declined over the past 20 years. While the reason why people move to Tinian is for employment, it can be assumed that the reason Tinian residents leave the island is for employment also. The US Department of Labor predicted a population shift back in 2008 and based on the economic changes to the area, their forecasted data predictions were correct (US Department of Labor, 2008).

2.1.1.1 Economic Influences impacting the island of Tinian and the CNMI growth

While much of the population and economic decline within the CNMI, conversely Tinian, is attributed to the global financial crisis in 2007-2008, the CNMI is unique that it also suffered adverse financial and community effects from several parallel legislative actions as well. As some nations are recovering from the global financial impacts, the compounded impacts to the CNMI will require additional time and effort to recuperate.

The CNMI Department of Commerce presented several of these parallel actions affecting their economy in their *Economic Strategic Planning Report* in June of 2013. This report highlighted several legislative factors that they presumed were key contributors to the decline in the CNMI population and economy in addition to the financial crisis. Although initiated several years before the report, these actions have had lasting effects on the economy. The two most critical actions highlighted include: the US Public Law 110-28, the Fair Minimum Wage Act of 2007 (FMWA) and the US Public Law 110-229, Consolidated Natural Resources Act of 2008 (CNMI Department of Commerce, 2009).

The passing of the Fair Minimum Wage Act extended the minimum wage of the United States to several of its territorial locations including the American Samoa and the CNMI. This change was a significant in the CNMI because of the huge variance in minimum wage rate in the CNMI compared to the Federal wage rate. The minimum wage rate at the CNMI in July 2007 was at $3.55 hour and at a Federal wage rate of 7.25 per hour, there was a lot of recovery needed to fulfill this requirement (U.S. Department of Labor, 2008).

Although the new requirement implementation was gradual, it still impacted businesses located in the CNMI. When profit-constrained small businesses are required to conform to the wage requirements, ceteris paribus, their profit margins are reduced. New wage rates would essentially double the wage for the same type of worker, in some cases. For small businesses, when they have to spend more money on labor, their profits are compromised. Many businesses had to consider reducing their personnel just to remain profitable.

In addition to the FMWA, legislation was passed to align immigration regulations to the CNMI as well. The Consolidated Natural Resources Act of 2008 extended CNMI immigration control to the US Department of Homeland Security. Under this act, several immigration policies were revised to mirror those of the United States. This would include the implementation of "all laws, conventions, and treaties of the United States relating to the immigration, exclusion, deportation, expulsion, or removal of aliens" (U.S. Department of Homeland Security, 2009). Prior to the act, the CNMI was excluded from immigration regulation requirements, which gave more entrance flexibility to foreign individuals. This encouraged tourism with the CNMI and, as a result, played a significant part in the CNMI economy.

The Tinian Dynasty Hotel and Casino was one of the economic beneficiaries for Tinian during this time of economic growth within the CNMI. The casino not only provided employment for residents, but it attracted tourists and stimulated small business growth. Local CNMI residents and Asian tourists would regularly frequent the area for the hotel's amenities. As with any tourism and leisure activities, they are of the first that are reconsidered during an economic downturn. During the economic downturn, the Tinian Dynasty Hotel and Casino was severely impacted. The aggregation of the world economic crisis and the federal regulations on immigration and minimum wages forced the hotel to close its doors, significantly impairing the economic strength of the tourism industry (Camacho, 2015).

2.1.2 Economic History in Tinian

Tinian has experienced significant economic challenges over the past twenty years and efforts to stimulate the economy have not been successful in either the private or government sectors. Dating back to the 1980s, Saipan was the home to many garment manufacturers. With its geographic location relatively close to Saipan, several garment manufacturing companies were established in Tinian also. It was common for workers to move to Tinian and Saipan from their native country to work in the manufacturing industry. Although conditions did not meet US standards, many workers from China and the Philippines saw the opportunities in Saipan and Tinian as an improvement in work conditions from those in their native countries. Workers would either commute or move to Tinian for work.

As visibility increased concerning the employment conditions of its workers, working conditions were challenged, and American brands were criticized (Shenon, 1993). There was much pressure on many of the manufacturers to modify their standards and pay the workers sufficient wages. In some cases, litigation disputes were settled to compensate workers for back pay. The settlements and litigation charges drove wage up, raising production costs. The increase in production costs reduced profitability and manufacturing facilities were forced to shut down operations both in Saipan and Tinian. The garment industry provided economic growth opportunities not only to Tinian, but to the CNMI region, as a whole. This closure forced a population decline and unemployment spikes. This large shutdown affected growth and the entire industry make-up of Tinian and the CNMI.

2.1.3 Industry Analysis

Presently, the CNMI is a tourism industry. Once heavily driven by garment manufacturing, the CNMI has continued to market and attract Pacific area tourists for its biological habitat and its beaches. The CNMI is at a geographical advantage in its proximity to Asia and are able to capitalize on the international economy for much of its revenue. The Office of Insular Affairs observed in 2011 that 41.9 percent of all tourists in the CNMI were Japanese and 31.5 percent of all tourists were Korean tourists.

Tourism in the CNMI is cyclical and heavily influenced by the Asian and global markets. Based on this information impacts to the global economic crisis in 2008-2009 impacted tourism in the CNMI also. Typical consumers were hesitant on traveling and spending. After a slight recovery from the global economic crisis, the CNMI took another hit to their tourism revenue. A combination of the Japanese economic recession in 2010-2011 and the implementation of the new US immigration regulations affected the revenue significantly. With Japanese tourism making up approximately 42 percent of all tourists in the CNMI, this hurt the economy and caused a sharp decline in revenues from accommodations and amusement, driving the CNMI GDP down.

With tourism contributing to a significant share of the CNMI revenues, any shocks to the Accommodations and Amusement industry will have a substantial impact to GDP and the economy. The below table shows the comparison of the CNMI GDP from 2007 through 2014 and the main economic drivers each year.

	Line	[Millions of dollars]							
		2007	2008	2009	2010	2011	2012	2013	2014
Gross domestic product	1	**938**	**939**	**795**	**799**	**733**	**751**	**780**	**836**
Private industries	2	**717**	**727**	**586**	**589**	**540**	**563**	**581**	**632**
Manufacturing	3	174	50	18	16	15	12	11	15
Distributive Services	4	140	165	135	149	153	157	170	178
Accommodations and Amusement	5	111	122	105	110	97	114	133	147
All Other	6	291	390	328	314	274	280	268	292
Government	7	**222**	**212**	**209**	**210**	**193**	**188**	**199**	**204**
Federal	8	13	14	16	14	15	15	15	14
Territorial	9	209	197	193	196	178	173	184	189

NOTE. Detail may not add to total because of rounding.

Figure 2-3 Bureau of Economic Analysis GDP Comparison Value Added by Industry (2016)

The GDP distribution in the CNMI is very similar in Tinian, so the peaks and valleys of the CNMI economy, were most likely experienced in Tinian.

Tourism is one of Tinian's strong assets and with its close proximity to Saipan, it is convenient for tourists to travel to Tinian. There have been many efforts in reviving the casino market. In its most recent ventures, Bridge Investment Group, has planned its development of a pier-side casino, a Titanic rendition for residents and visitors. The intent is to transport goods and tourists from Saipan via ferry to attract more visitors to the island. Construction for the casino is underway and it is expected for delivery by 2020. Because the hotel and casino will be located pier-side, the need for a consistent navigable channel is necessary. Considering that one of the main sources of revenue is tourism, the CNMI government is supporting the construction and realize the need for an improved harbor. When a vessel is not able to bring in needed supplies and inventory, businesses suffer.

2.1.3.1 The role of Federal Subsidized Income

In addition to revenue sustainment from private industries, the CNMI benefits substantially from financial assistance from the United States government. The CNMI received over $13 million in government assistance for capital improvements and technical assistance. These funds are allocated throughout the CNMI, including Tinian, based on their need. These funds help to provide jobs for residents and assist where revenue is lacking to support the economy.

According to the 2014 Prevailing Wage & Workforce Assessment Study, the average wage for Tinian is approximately $16,500. With majority of the population employment in the Office and Administrative Support, Food Preparation and Serving Related, and Construction and Extraction industries, much of the employment on Tinian is supported by the government assistance provided. Additionally, there are, on average, 209 households that receive SNAP/food subsidy benefits provided in Tinian each month. This is very significant, considering the rising prices of food in the CNMI.

2.1.4 Tinian Harbor History and Department of Defense interest

The Mariana Archipelago is central and critical locations for US Military installations in the Western Pacific. Currently, Tinian is used as a Marine Islands Range Complex consisting of land training areas, ocean surface and undersea areas, and Special Use Airspace. Tinian Harbor was constructed by the United States during World War II to support military activities (U.S. Army Corps of Engineers, Honolulu District, 2012).

While the Tinian Harbor is used primarily for its residents, the harbor does have Department of Defense (DoD) interest. Now controlled by the Commonwealth Ports Authority (CPA), there is still some military use at the harbor to load and off load cargo. The DoD currently uses Tinian Harbor to deliver supplies to its military installations regularly. The importance to continue DoD efforts within the CNMI is critical to both the local and Federal government (Department of the Navy, 2013).

3 Economic Analysis Overview

The economic analysis is used to justify the Federal interest in the navigation project. The analysis will review the existing conditions and problems in effort to reduce the severity of the navigational concerns by the community of Tinian.

To conduct the analysis, four accounts are analyzed. The basis for justification of all navigation studies is the National Economic Development (NED) account. This account is based on the monetary costs and benefits for the navigation study, in particular the net benefits associated with transportation cost savings. Other accounts considered include the Other Social Effect (OSE) account, the Regional Economic Development (RED) account, and the Environmental Quality (EQ) account.

3.1 Data used to formulate economic analysis

The economic analysis uses data from several sources to estimate both existing and future conditions for the analysis. To validate future conditions, historical and existing conditions are used as the basis for the assessment. Port and vessel deployment patterns will help to determine the overarching problem in the harbor. Once this is characterized, future conditions, incorporating cargo changes and future vessel fleet operations will determine the need for the general navigation feature proposed.

3.1.1 Sources of Data

The project delivery team (PDT) held a charrette with stakeholders to understand the problems within the harbor. The information gathered in this meeting provided information regarding current harbor conditions and its affects in the harbor. The data provided in the charrette provided a basis for the analysis and helped to direct the data gathering and analysis. Data was gathered from several sources to clearly define and quantify the existing conditions and inefficiencies within the harbor.

3.1.1.1 Historical Vessel Call Data

The importance of comparing multiple sources to validate data is ideal in a navigation study, however, due to the remoteness of the harbor and limited resources, the data provided by the harbor masters was the only data available. Detailed Waterborne Commerce Statistics Center (WCSC) data was not available for Tinian because it does not fall within the geographical area covered by the WCSC. For these reasons, the vessel data used in the analysis was dependent on the data provided by the Commonwealth Ports Authority and stakeholders.

Vessel call and commodity data was provided in several formats with different information in each format. With data gaps in each format, averages and computation estimates were required to produce a complete vessel call list for the economic analysis. Detailed historical vessel call data from year 2014 to part of the year 2016 was provided by the harbor masters, but this data only included the vessel name, date, and times that the vessel was called. There were additional notes in the detailed call data that pointed out if the vessel was cancelled or was anchored. A separate data pull provided a list of monthly calls with the tonnage for each commodity, while the last data figures received provided a total of inbound and outbound tonnage each year by commodity type. Even from combining the data from each of the formats, there were several key features missing. To account for the missing data and any discrepancies, additional data collection was sought out from personal interviews.

In addition to the data received, discussions and site visits were conducted with the harbor masters to confirm and/or clarify any missing data. The harbor masters were very valuable in providing important harbor operational information including: loading and unloading procedures in the harbor, wave conditions that would limit vessel accessibility, and harbor hours. These discussions with the harbor masters were followed by interviews with two harbor pilots and two vessel operators to validate the data.

The merged vessel call data was used to validate and provide evidence of the harbor conditions as detailed in the problem statement. Information pertaining to the frequency in monthly vessel movements was used to estimate the demand of the harbor and the cargo volumes per movement. Actual impacts to the local community as it relates to the ability to provide for incoming cargo was determined using the historical data provided as the basis for the analysis.

3.1.1.2 Operational Procedures Data within the Harbor

In addition to vessel movement and vessel calls, operational procedures and requirements were needed to determine the accessibility in the harbor. These included hours of operation, movement procedures, and access conditions. Because harbor pilots are the main individuals utilizing and navigating the harbor regularly, it was important to understand their perspective on operational conditions and problems in the harbor. Interviews were conducted by several harbor pilots to understand their navigation concerns.

The harbor pilots were able to describe the harbor conditions, areas that were the most problematic for maneuverability, and typical operational procedures. Operational procedures pertinent to the analysis included: the time that it would take to enter the harbor, typical uses of tug assistance in the harbor, and wave conditions that would limit accessibility into the harbor. Although this information was provided by the harbor masters, vessel maneuvering was confirmed by the pilots as the users of the harbor.

3.1.1.3 Vessel Damages

Vessel safety and the reduction of grounded vessels were one of the concerns that were presented in the charrette conducted by the PDT. The main vessel damage concerns from the charrette pertained to the depth of the harbor and groundings to further emphasize the safety hazards and wave conditions at the harbor. Inquiries were made to the United States Coast Guard, Marine Safety Department Saipan (USCG) regarding vessel borne incidents inside the harbor for the past five years.

Incidents provided by the USCG included the vessel name, goods transported, and the cause of the incident. The incident causes help to differentiate if an event was a user error or preventable with navigation improvements. Other areas in the report that were considered were weather conditions in the harbor, which was used to help distinguish between project-condition and typhoon-event hazards. Understanding the data provided helped to determine if further analysis was required for computing vessel damages and frequencies. Based on the data received, most events were either from a user error or the event occurred during a typhoon-related storm, so quantitative vessel damages were not carried forward for the economic analysis.

3.1.1.4 Support from the non-Federal Sponsor and the local community
In addition to the data provided by the harbor master, pilots, and the USCG, qualitative impacts to the local community are crucial to assessing the true hardship on the island of Tinian. Impacts to the local community were provided by the non-Federal sponsor, through discussions held the Lieutenant Governor's Task Force. The Lieutenant Governor's Task Force was stood up specifically to address local data requirements and decision making related to the study and provided essential information regarding impacts to the harbor. Members in this taskforce include Secretary and Director-level staff from relevant CNMI government agencies that helped clarify the problem and need for the study. The taskforce was able to help the team understand the concerns from the local community, the impacts, and burden to its residents. Because they live and work in the community, the taskforce played a vital role in supplying information as it relates to the impacts to the community, both directly and indirectly.

Other sources of information provided by the non-Federal sponsor included statistical data that supported the needs and concerns provided by the taskforce. The non-Federal sponsor made available pertinent statistical data collected from the CNMI Department of Commerce, Central Statistics Division (CSD). The information provided by the CSD included information at the municipal level, not typically available in the US report database. This data helped to explain the demographics of the Tinian community and the impacts of a remote harbor on goods and price levels. Because of the remoteness of the island, data on Tinian Island is very different from typical US averages, so having current data to support the local community is significant.

3.1.1.5 National Data Used in the analysis
Due to the scarcity of the population of the island of Tinian, there were some data gaps in the historical reports. To get a better understanding of the conditions and the long-term demographic trends, US datasets from the US Census Bureau and the US Consumer Price Index were used. The disadvantage of using US Census Bureau and US Consumer Price Index is that the information is typically only provided in a regional perspective, and not at the municipal level. For long-term growth rates, this is acceptable, but for shorter term impacts to the community, the use of the CSD data was needed.

4 Existing Conditions within the Harbor
The existing conditions analysis provides the baseline of the feasibility study and helps to define current conditions and operating procedures. The existing condition formulation uses historical data to calculate to capture vessel movements and operational conditions in the harbor. Information gathered for the existing condition include quantitative historical vessel call data, pilots' data regarding vessel maneuvering times, vessel operator data for regarding frequency and use of the harbor, and the harbor infrastructure data to estimate capacity and capabilities.

To estimate the existing conditions within the harbor, the only complete years of data that represented the current call volumes were years 2014 through 2015. Averages for vessel frequency were based on these two years of data to approximate the existing condition estimates.

4.1 Elements of the Existing Conditions

4.1.1 Infrastructure and Shore-side conditions
Tinian Harbor is located on the southeast coast of Tinian, at San Jose, the primary urban center. There is currently no Federal navigation project at the harbor. The existing harbor was constructed in 1944-1945 during World War II. The entrance channel is about one-half mile long, approximately 525 feet wide and

has been dredged to a depth of about 30 feet. The wharves and harbor turning basin were dredged to depths of 28 to 30 feet. There are no permanent container loading facilities at the berthing area. Cargo containers are loaded and unloaded by a truck crane and off loaded accordingly. Figure 4-1 shows the harbor configuration and its berthing locations.

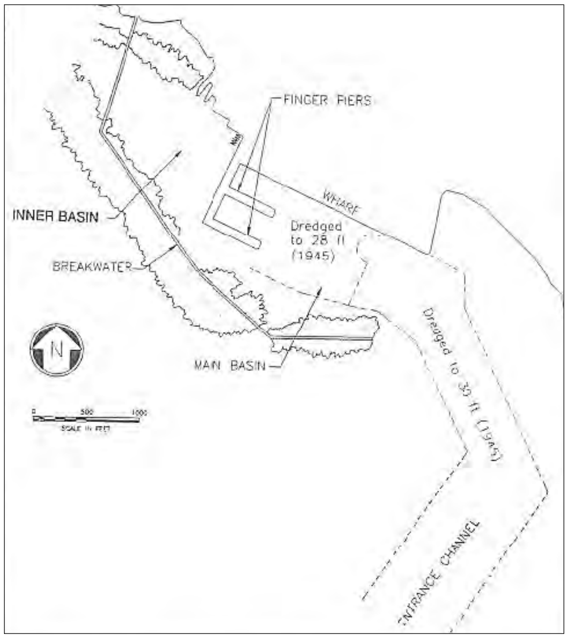


Figure 4-1 Tinian Harbor and infrastructure

The total length of the breakwater is 4,805 feet long and the crest elevation is about 14 feet above mean sea level. The inner breakwater, with a length of 1,210 feet from the shore to the outer breakwater was constructed of a single row sheet piling. Much of the sheet pile on the inner breakwater has deteriorated and collapsed. The outer breakwater, with a length of 3,595 feet, was constructed of interlocking, half-inch thick steel sheet piling in circular cell configuration. The interior of the cells was filled with quarried limestone. A 10-inch thick, unreinforced concrete slab was constructed flush with the top of the sheet piles. The steel sheet pile breakwater is almost completely deteriorated.

4.1.1.1 Harbor Operations and Conditions

The harbor operations hours on Tinian Harbor are 6:00a – 6:00p for loading and unloading cargo. These times may vary dependent on the vessel call requirements. The loading and unloading times are established because of the lighting available in the harbor. The harbor master indicated that they have considered getting additional lighting, however, current conditions are restricted to daylight operations. Typical harbor operations include, vessels arriving in the morning, unloading the cargo, and exit the harbor. There are some instances where the vessel is at the berth after unloading, but the harbor master mentioned that this was not common practice because of the variation in wave conditions.

4.1.1.1.1 Loading and Unloading

Loading and unloading times are the same for harsh and calm wave conditions. Aside from instances when unloading is interrupted for atypical weather conditions, unload times for the tug and barges are 4 to 6 hours and discharge time for the tanker vessel is 8 hours.

Loading and unloading times are similar in most conditions, however, the wharf conditions must be conducive enough to stabilize the vessel. Typical wave conditions at the wharf should be at 1’ waves or lower for safe unloading and loading conditions, however, the harbor master indicated that they try to unload most vessels that can successfully enter and dock in the harbor. Within Tinian Harbor, there have not been any instances where the harbor conditions were too harsh for loading or unloading operations to stop. This is primarily attributed to the reef and breakwater protection outside of the harbor.

4.1.1.2 Berthing area constraints within the harbor

Tinian Harbor does satisfy the needs of cargo handling in the current condition and demand requirements, however, for there are some capacity constraints for the larger vessels and DoD operational requirements. The interior infrastructure at the harbor consists of the North Wharf with four berthing areas, an adjacent East Wharf, a set of two finger piers, and a small boat basin to the west of the finger piers.

The tanker, MV Akri, and the US Marine Corps (USMC) landing vessels are the largest vessels entering in the harbor and are only able to dock at the North Warf due to its size. Because they are only able to dock there, there have been instances where the USMC landing vessel was offloading supplies and the MV Akri was approaching the harbor. In this case, the MV Akri takes precedence over the USMC vessel. The USMC vessel had to stop operations, take anchor, and wait for the Akri to discharge. There have been no confirmed plans for changes to the capacity constraints, but several suggestions proposed.

4.1.2 Wave and Current Conditions

Tinian Harbor is protected by both the deteriorating breakwater and the coral reef structure right outside of the harbor. Although wave conditions outside either structure may be harsh, vessels that are able to navigate into the harbor do receive some relief upon entering. As the protective structures deteriorate or are no longer useful, vessels will be vulnerable to the outside waves of the Pacific.

For the existing condition analysis, engineering data used historical wave and current conditions to estimate annual harbor usage. Wave and current modeling helped to form a basis of the usage by determining the number of usable days given the above criteria. When waves are too high either near the wharf or at the entrance channel, this impacts the days in which the vessels are able to utilize the harbor. Impacts on usable days is used to determine the limitation on vessel movement and also determines the shift in mode for transporting cargo.

4.1.2.1 Vessel Maneuverability

Vessel maneuverability is not as significant of a concern in the current condition, but as the breakwater continues to deteriorate, it could be problematic. Typical operational procedures for Tinian Harbor is that the harbor master will decide when and when not to allow vessels to enter into the harbor, however, it is the pilot’s ultimate decision. Vessels are typically cancelled prior to arriving at the harbor based on weather predictions. The only instance when a vessel is turned away is during a tropical storm or typhoon event approaching, which in most instances, the harbor masters and vessel operators are notified in advance.

Tug and barge vessels can enter the harbor in rough waters between 3 and 5 feet because they are sheltered by the breakwater and reef. Once vessels enter the channel, waves are typically calmer. Any waves greater than 5 feet, tug and barge vessels would typically not come in the harbor and are turned away when called. While slightly larger, this condition is applicable for the tanker vessel as well.

Ninety-five percent of the time, vessels are typically cancelled prior to leaving their last destination. This gives the operators the ability to manage their shipment and plan accordingly. During the remaining 5% of the time when wave conditions encounter a sudden change, vessel calls are cancelled while in transit. Although kept to a minimum, some vessels are even required to leave the harbor during loading and unloading procedures because of the sudden change in weather and current conditions.

4.1.2.1.1 Wave and Current impacts to the Pier structures

Intense wave and typhoon-like events impact the shore side facilities significantly. The more repeated wave action at the pier, the greater the probability for required premature maintenance on the shore structures. Historically, the breakwater at Tinian has protected the shore-side structures, however, with the continued deterioration of the breakwater, it provides less and less of protection to these structures. Within the past five years, Tinian has spent over $1 million for pier and structure repairs to the harbor facilities, partially due to the intensity of the waves. The current condition of the breakwater is delicate and there is no prediction as to when the breakwater will be completely demolished. It is expected that a direct typhoon hit would completely destroy the breakwater, leaving the shore-side structures vulnerable to high wave penetration.

4.1.3 Impacts to Tinian Island Residents

The unpredictability of the breakwater effectiveness continues to be a concern with the residents of Tinian. Understanding the hardships of its sister island, Rota, makes the need for a sustainable and reliable harbor the more necessary. Rota's exposure to wave and current conditions are very similar to Tinian, however, it is not protected by area breakwaters or reefs. When waves are significant, harbor operations are cancelled, leaving its residents with limited food and goods supply. The impacts to Rota have triggered proactive actions for Tinian and its harbor.

The CNMI government has made several efforts to improve the impacts to navigational challenges on the local community, including reducing wharfage fees to vessel operators and have sought opportunities from area professionals in developing a master plan. These considerations include deploying an inter-island ferry to help to transport people and goods to supply to the residents during turbulent waves, utilizing additional vessels, and improvements to the harbor. Any development or access improvement considerations would encourage private sector growth, and regional growth is a priority for the CNMI administration.

4.1.3.1 Harbor Dependability and Need

Tinian is a remote island located in the Commonwealth of the Northern Mariana Islands in the South Pacific. Without a land connection to the neighboring islands, it depends solely on ocean and air to transport goods to its residents. Most goods are transshipped from Saipan and/or Guam from via tug and barge service to supply the community. Since the cost of transporting goods via ocean is less expensive than air cargo, utilization of the harbor is considered the preferred method to transport goods. Transporting goods in air requires more frequent trips, increase handling costs, and limited cargo capacity.

Tinian Harbor is sheltered by both existing breakwater and reef. The breakwater is nearing its life with rusted and continuously degrading structural elements. With the significant storm and typhoon events occurring in the region, the susceptibility of the breakwater no longer protecting the harbor is a possible in the near term.

The harbor not only depends on the breakwater for navigation of vessels, but the breakwater has historically protected the shore-side facilities from the constant wave action at the pier. Over time, the deteriorated structure has provided less and less shelter for these nearside structures causing premature maintenance.

Upon complete failure of the breakwater, the harbor will be limited to its navigation capabilities. When this occurs, vessels will not be able to enter the harbor as frequently as it had done historically. This will impact the residents and the amount of cargo supplied to the residents. In those cases where the wave frequency is significant, there is a likelihood that cargo will have to be shipped via air cargo. The cost of transporting goods via air cargo versus ocean cargo is considerable. When this occurs, any increase in price is transferred to the consumer. This could have an adverse effect on food prices for the residents, potentially increasing the price of goods 50-100%.

4.1.4 Historical Data

Historical vessel call data is quantifiable data that brings the qualitative data from the residents, infrastructure conditions, and wave and current conditions together to a quantitative analysis. Vessel call frequency by month helps to associate the seasonal high wave and current months to those periods when the harbor is generally open. When the harbors are open, goods are supplied to the residents frequently to residents compared to when the harbors are closed mostly and less frequently supplied.

In addition to seasonal wave conditions, call data is also used to provide insight on changes in operator capabilities within the harbor.

The below table shows the frequency of vessel calls from October 2013 through February 2016.

Month	2013	2014	2015	2016
January		3	4	4
February		5	4	5
March		3	5	
April		4	3	
May		4	6	
June		3	5	
July		3	4	
August		5	4	
September		4	5	
October	3	5	4	
November	4	4	4	
December	5	4	5	
TOTAL	**12***	**47**	**53**	**9***

*denotes incomplete year of data

Table 4-1 Historical Vessel Frequency at Tinian Harbor

With the limited vessel data available for Tinian, it is difficult to determine any historical trends in harbor operations. However, looking at the two years of complete data, vessel calls seem to be steady month-to-month, averaging between 3 and 5 vessel calls per month. With the consistency of this information, it is implied that vessel calls, in the current condition, are able to enter and exit the harbor when needed.

4.1.5 Vessels

Most goods transported via ocean cargo to Tinian are transshipped from larger vessels by way of Guam or Saipan. These goods are brought in from a tug and barge and occasional landing crafts are used to transport vehicles. Petroleum is transshipped from the main oil facility in Saipan on a smaller tanker.

4.1.5.1 Tug and Barges

Barges are a flat-bottomed boat built mainly for shallower draft harbors to transport a large amount of cargo and heavy goods. Barges are very versatile and have the ability to carry loose and irregular cargo. Some of the goods that are transported include: frozen foods, dry goods, and general cargo. Barges are not self-propelled requires tug assistance for operations. These barges operate in a service throughout the Mariana Islands and some parts of Micronesia.

4.1.5.2 Small Boat Operations

Outside of the harbor are recreational fishing crafts. Although these crafts commute outside of the harbor, they are impacted with wind and current conditions.

4.1.5.3 MV Luta

While the MV Luta mainly services Rota, there could be a possibility for the MV Luta to service Tinian in some cases as well. The MV Luta is a retrofitted passenger and cargo vessel, was built for the CNMI, beginning service March 2016.

4.1.5.4 Tanker

Petroleum is transshipped from the main oil facility in Saipan to Tinian Harbor. The oil storage facility is located adjacent to the harbor facilities and piped in directly into the storage tank. Oil is topped off and the vessel is emptied during each trip. The vessel is only able to enter the harbor partially loaded for the supply only for Tinian. The harbor master did note that there was one instance when the vessel did come in fully loaded and was grounded. Since then, the vessel only supplies the amount of petroleum required for the island before returning to Saipan to refuel.

4.1.5.5 Design Vessel

For Tinian, largest consistent vessel calling in the harbor is a 6000 DWT tanker, one similar to the MV Akri size and dimensions. The Akri has a length overall of 325 feet, a beam of 52 feet and a design draft of 21 feet. Based on current and future consumption, Operators of Mobil Oil has not plan nor do they expect a vessel larger than this vessel to call the harbor in the future.

4.1.6 Commodities

The main commodities in the harbor include: petroleum, finished goods, frozen foods, dry goods, beverages, and vehicles. Petroleum is pumped from the birth and stored in a facility adjacent to the harbor while the other goods are off-loaded by crane. The capacity of the storage tank is expected to supply the island with maximum energy capacity for a 45-day period. The vessel transports fuel monthly and replenishes the storage tanks to provide fuel for the island. According to the harbor master, there have not been any instances where the fuel supply has been completely drained, however, the residents are concerned with the fuel availability when the vessels are not able to enter into the harbor.

In addition to the typical goods brought in from the harbor, there has been an influx of construction materials as a result of the recent investment projects, including the pier-side hotel and casino. For this project construction materials are imported to Tinian directly from the developer. Because the construction project is expected to be complete by 2018, any additional construction materials brought in are considered temporary and not included in the future cargo analysis. Aside from the atypical construction cargo, normal construction requirements remain minimal at Tinian. Below are the historical cargo volumes for 2013-2016, partial volumes for 2013 and 2016.

	POL	Const Mat	Food	Vehicles	Beverages	Cement	All Other	H Equip	Total
2013*	3080.6	180.8	765.4	349.2	7.0	14. 5	501. 6	36.5	4935.7
2014	8273.0	285.9	2462.9	816.0	0	63.1	2874.5	140.8	14916.1
2015	7116.0	4877.3	1668.0	585.8	0	47.8	2669.8	862.1	17826.6
2016*	1050.0	31.7	164.9	153.6	0	6.6	624.8	97.5	2129.2

*Partial year commodity volume

Table 4-2 Inbound Commodity Volumes (in Revenue Tons)

	POL	Const Mat	Food	Vehicles	Beverages	Cement	All other	H Equip	N/A	Total
2013*	15.456	1	0	30.4	0	0	32.4	1	0	80.218
2014	34.778	0	0	158.0	0	0	191.2	60.6	0	444.554
2015	20.658	0	0	216.7	0	0	320.9	51.3	33.3	642.872
2016*	21.83	4.6	0	28.9	0	0	35.0	4	0	94.376

*Partial year commodity volume

Table 4-3 Outbound Commodity Volumes (in Revenue Tons)

The above commodity list, although limited, shows a consistency in cargo amounts of the goods transported in the harbor annually, with the exception of construction material.

4.1.7 Trade Routes

Guam and Saipan both receive direct container vessel calls from the U.S. and Asia. Cargo is transshipped between islands by barge either from Saipan or from Guam. Saipan Shipping operates the bulk of cargo shipping services between Guam, Saipan, Tinian and Rota via a tug and barge. Tinian is on the transshipment route from both Saipan and Guam. In rare cases is cargo transferred from Tinian and Rota to the other ports on the service directly.

Saipan Shipping allocates a complete day to ship cargo to each of their locations. For example, from Tinian to Guam, it would be one day and from Guam to Tinian it would be another day. This means that at a minimum, cargo for a Tinian shipment is loaded at least three days prior to its arrival in Tinian, if using the Saipan Route, and at least four days prior to its arrival in Tinian on the Guam Route.

To estimate the roundtrip distance of the Saipan Shipping liner service, route data was calculated using distancefromto.net to estimate a complete service. Other transshipment trades between Rota, Tinian, and Micronesia utilize Matson as the vessel operator. This service is limited and serviced only 10 percent of the time. Service frequency was estimated from the call list provided and comparing the origin and destination documents from the vessel call lists. The below table lists the various trade routes to and from the CNMI based on this information as well as their estimated distance in nautical miles (nm).

	Day 1	Day 2	Day 3	Day 4	Day 5	Roundtrip Distance (nm)
Guam Route *(Saipan Shipping)*	Guam	Rota	Tinian	Guam	--	210
Saipan Route *(Saipan Shipping)*	Saipan	Tinian	Rota	Saipan	--	150
Micronesia Route *(Matson)*	Palau/Yap	Guam	Rota	Tinian	Saipan	1,860
Petroleum Service *(Mobil Oil)*	Saipan	Tinian	Saipan	--	--	35

Table 4-4 Tinian Harbor Service Routes

In addition to the service routes above, an annual petroleum transshipment route was included from Saipan to Tinian. Operators of Mobil Oil confirmed that the fuel is brought in to Saipan and then transshipped to the neighboring islands within the CNMI. From Saipan, petroleum is directly transported to Tinian, the fuel is discharged, and the vessel returns to Saipan for the next load. Mobil Oil only transports the amount of petroleum required to top off the storage container in Tinian, so it does not require additional fuel for the other islands. For the Petroleum route, a roundtrip nautical mileage was calculated at 35 nm. There was some discussion of oil transport to an auxiliary storage facility for DoD operations, however, this was not included in the analysis.

5 National Economic Development (NED) Analysis

The National Economic Development (NED) analysis is a require analysis used to evaluate and justify navigation studies within USACE. In navigation, the NED analysis takes a comprehensive approach to economic cost and benefits related to the navigation study of the project. The following sections of this chapter explain how the NED analysis was conducted.

5.1 Economic Transportation Model

The model used for the NED analysis was a spreadsheet model created by the Deep Draft Navigation Center of Expertise at USACE. This spreadsheet model provides a simplified approach to the economic evaluation of USACE deep-draft navigation studies. This model was used for this study due to the low complexity of vessel calls and transit movement. Although the model does not model vessel interactions, the risk of multiple vessel calls in one day is very low. With less than 60 vessel calls per year, the need to evaluate an event-based simulation to mimic harbor interactions were not necessary. Additionally, the availability of harbor data for the island of Tinian presented several modeling gaps in the certified deep-draft navigation model that would impair the effectiveness of the model.

5.1.1 Model Inputs

The spreadsheet model inputs include: channel controlling depth, selection of an appropriate tide station, vessel design drafts, vessel DWT, average speed vessel at sea, arrival draft, round trip voyage distance, minimum underkeel clearance, inbound and outbound cargo amounts in metric tons and the average cargo transfer rates. The use of each of these variables help to calculate transportation costs for the given modeling year.

The model uses a 50 year period of analysis with a 2020 base year. It calculates voyage costs for years 2020, 2050 and 2069 and interpolates the data to obtain a complete dataset throughout the period of analysis. Incorporating the specific model years for the analysis and interpolating the data throughout the period of analysis, average annual vessel operating costs are calculated. For each of the voyage cost years, vessel calls are promulgated based on the commodity shift.

5.2 Future Without-Project and Future With-Project Conditions

Transportation cost savings for the NED analysis are estimated by comparing transportation costs in the Future With Project (FWP) condition to the Future Without Project (FWOP) condition. The difference in the two yield benefits for the analysis. Benefits are calculated on an average annual basis and compared to average annual costs.

5.2.1 Forecast of Future Conditions

Future conditions estimate harbor needs in both the FWOP and FWP. These conditions consider the elements of the existing conditions to forecast future conditions throughout the period of analysis. For this study, the period of analysis is 50 years with the base year being 2020. All information is in FY 18 dollars using a 2.75 percent discount rate. Years modeled include 2020, 2050 and 2069, interpolating the data to achieve a full spectrum of annual transportation cost data.

5.2.1.1 Methods and Assumptions

Historical vessel call lists were requested from the CNMI, however, the data provided was limited, lacking several details required for the DDNPCX simplified model. Through email and discussions with the harbor master, the two vessel operators, and members of the Lieutenant Governor's taskforce, more data was available to support the model. Discussions with the harbor master, pilots, and terminal operators were very useful in determining vessel delays and impacts to vessel calls and movement within the harbor during adverse wave conditions. Additional statistical data was provided by the CNMI Department of Commerce to estimate population increases and commodity demand also.

5.2.1.1.1 Time Spent Waiting

Time spent waiting includes the time a pilot has to wait for a calm harbor to allow the vessel to enter the harbor. This also includes the added time required for an additional tug due to the cross currents in the harbor. The harbor master is able to determine if weather conditions in the harbor are not conducive for vessel movement up to two days prior to their service date 95 percent of the time, however, the remaining 5 percent of the time pilots may determine the wave conditions aren't calm for navigation and turn back.

Ultimately, it is the pilot's decision on whether they will enter the harbor or not and from discussions with the vessel operators, during times with high winds, pilots may wait outside the before entering upon the request of the vessel operator, however, if it is unsafe, they may turn back. On those instances, they will make 3 to 4 attempts to enter the harbor and then are called back. Failed attempts into the harbor would typically cost the shipper five hours of labor waiting and additional transit time upon return. When this does occur, vessels return with the cargo and will have to reschedule delivery for another date.

For the model, time spent waiting was estimated using the vessel operating costs provided from the vessel operator, Saipan Shipping, and estimated on an hourly basis. On average, five additional hours of commute time were added to 10 percent of the vessels calling. This was consistent with the annual average of cancelled calls for years 2014-2015. The vessels that were turned away did not bring in any cargo to the harbor, and therefore, were only incorporated to account for additional transportation cost incurred.

5.2.1.1.2 Commodity Forecast

For the study, commodities were estimated to determine cargo demand throughout the period of analysis. Trends in cargo history offer insight into the port's long-term trade projections and the vessel requirements in the future. Commodity forecasts are typically derived using a number of analytical tools including the historical commodity conditions, planned demand changes, and even outsourced commodity estimates, however, due to the limited amount of data this was not achievable. With the limited range in vessel call data, commodity growth was difficult to estimate using historical cargo trends. Historic changes in commodity growth was too limited and too stochastic to determine a baseline or a trending condition. For this analysis, estimated commodity projections were based on a long-range population growth factor.

Since over 90% of the good transited support the local population, there is a direct connection between commodity growth and population growth. It is assumed that as the population changes, commodity demand with change as well. The population growth factor used to estimate the commodity demand trend was 1.4% for Tinian. This was derived using the average population growth rate for years 1980-2010. US Census data was used to determine the actual population numbers and the data for the years that the Census was not conducted was interpolated.

5.2.1.1.3 Cargo Movements & Vessel Calls

Combining historical data, information provided by the harbor master and stakeholders as well as the commodity trends, the vessel call list is derived. Contrary to a typical analysis where an increase in cargo demand increases the number of vessels calling into the harbor, the vessels at Tinian have limited navigation abilities during harsh weather and wave conditions. Commodity demands are not reflected in the future without project vessel movements, yet cargo is shifted to air cargo and increased loads for the current vessel traffic instead.

Vessel calls for the existing condition were estimated based on annual averages. Averages were used to calculate call frequencies, commodities, and to estimate vessel movement within the harbor. Deviation from the averages were made for the construction commodity because of the temporary increase due to the casino development. Future conditions incorporated an annual 1.4 percent commodity increase for the period of analysis. The commodity factor was calculated throughout the period of analysis. The below table that explains the commodities and the demanded commodities based on the current and FWOP condition.

FWOP	**Existing Cond**	**2020**	**2050**	**2069**
Annual Commodity Projections in tonnes *(average based on commodity history and population projections)*	16,371	17,257	25,707	33,174
Estimated Number of Vessel Calls	51	54	62	81

Table 5-1 Commodity and Demand Projections through the Period of Analysis

5.2.1.1.3.1 Estimated transportation costs associated with a shift in mode

To account for the discrepancy between the number of vessels needed to enter the harbor versus the actual number of vessels that are able to enter the harbor, a shift in mode cost is assigned. This is the additional cost required to transport the demanded requirement of goods using an alternative mode of transportation. For Tinian, the alternative mode of transportation is air cargo.

The cost of air cargo transportation is very expensive and limited. The planes used are small planes and require multiple trips to transport the goods. Because most cargo are vessel ready, products will require re-handling costs. Food is a top priority and is typically one of the first goods that are shipped to Tinian via air cargo. To account for shift in mode costs, food is estimated at 30 percent of the total cargo, based on historical averages.

For the shift in mode analysis, planes used are consistent with that used in the CNMI, turboprops. To estimate air cargo operational costs, the cost for a turboprop PA-32-300 is used as a guide at $650 per hour for charter. Charter services schedules and estimates were based from direct conversations with cargo handling companies and observation. The transportation time calculated for Tinian estimated a 20-minute roundtrip flight from Saipan to Tinian with an additional 30 minutes for loading. With a 50-minute flight charter, the estimate per ton is total estimate of $542.

The capacity of these planes are 6 people or 1200 pounds (Air Charter Guide, 2017). Below is a table estimating the shift in mode amounts and the requirement per displaced commodity.

	Commodity Displacement (revenue tonnage per missed call) **(A)**	**Food Commodity Amount** (30% of A) **(B)**	**Cost/revenue ton** *(Assuming a 50-minute charter/ 1.2Tons)* **(C)**	**Total Cost** *(C*B)* **(D)**
Micronesian Air Cargo Services	505	151.5	$542	$82,100

Table 5-2 Estimated Air Cargo Transportation Cost Calculation

5.2.1.1.4 Vessel Call Lists and Runs

Using the existing condition vessel call list, FWOP vessel calls were calculated for the base year, 2050, and 2070. The FWOP vessel calls were run using the DDNPCX simplified spreadsheet model. The model's calculated outputs are below:

	Number of Vessel Calls	**Annual Transportation Costs**	**Number of Vessel Calls cancelled** *(under typical weather conditions)*	**Shift in Mode Transportation Costs**
2020	54	$12,169,314	0	$0
2050	62	$13,188,971	2	$327,200
2069	78	$17,224,243	6	$981,600

Table 5-3 FWOP Condition Model Run Results

The above costs were linearly interpolated to devise average annual costs. Shift in Mode transportation costs are prevalent in the FWOP and increase throughout the period of analysis. The average annual transportation costs are $13,643,614 for the Future Without Project condition and the average annual estimated shift in mode cost for the period of analysis is $654,400.

5.2.2 Future With Project Conditions

Future With Project (FWP) conditions incorporate general navigation features that meet one or more of the objectives. These conditions help to solve the navigational problems within the harbor. These conditions can be non-structural, structural, or a combination of them both. The following subsections help to explain what alternatives were proposed, screened, and the final array of alternatives for Tinian Harbor.

5.2.2.1 Structural Alternatives Considered

5.2.2.1.1 Initial Measures Screening

Throughout the planning process, both structural and non-structural alternatives were considered. Information was gathered from stakeholders including: the non-Federal sponsor, harbor masters, pilots, terminal operators, and shipping lines to determine the specific problem and need for improved harbor conditions. There were four alternatives that were carried forward in the final array. These alternatives were modeled to determine the best alternative that would effectively meet the objective.

The initial screening measures included:

1. Replacing the existing breakwater
2. Replacing and extending the breakwater
3. Constructing a new breakwater

5.2.2.2 Non-Structural Alternatives Considered

As per ER 1105-2-100, the Planning Guidance Notebook, navigation studies must equally consider both structural and non-structural measures. Non-structural measures were considered, however, both options were dismissed due to feasibility constraints and cost. The non-structural measures considered included adding a storage facility and supplying the harbor with a vessel that would withstand wave and current conditions

Deploying a vessel that could withstand majority of the wave and current conditions was considered because of its ability to bring in cargo more frequently for the residents. This would reduce the number of cancelled vessel calls in the harbor and reduce the number of air transported cargo. With the stability of cargo movements, there would be a possibility for the vessel to transport more perishable goods by ocean cargo, reducing the cost of perishable goods also. Due the feasibility and logistical requirements to deploy and pay for the vessel, this non-structural alternative was not carried forward.

5.2.2.3 Final Array of Alternatives

After reviewing the viability of the initial array of measures, a final array of alternatives was considered to meet the objectives. The final array of alternatives includes: the no action alternative, replacing the existing breakwater, and replacing the existing breakwater and extending the breakwater.

5.2.2.3.1 Alternative 1- No Action

Under the No-Action Alternative, the breakwater would continue to deteriorate and eventually dissipate, leaving the harbor with limited navigation and coastal protection. In the future condition if there was no action taken, the community could potentially suffer from decrease vessel usability days for ocean cargo. With a vulnerable harbor, there is a greater likelihood of cancelled calls during high wave conditions and the harbor infrastructure may be compromised during a significant event. This alternative mimics the future without project condition and is the one alternative that is used to compare impacts to the navigational improvements in the harbor.

5.2.2.3.2 Alternative 2 – Replace the Existing Breakwater

Replacing the existing breakwater alternative rebuilds the current breakwater using its current footprint. Based on the ERDC wave analysis data and the 2015 Tinian Harbor Condition Assessment, the existing breakwater configuration will support help to reduce the intensity of waves during navigation and typhoon events (U.S. Army Corps of Engineers, Honolulu District, 2015). This breakwater will help to disperse the waves during intense wave activity. This would not only improve conditions within the harbor, but on the shore-side facilities as well. Regarding its functionality, the breakwater be in the same position of the existing breakwater and, therefore, will not obstruct the typical navigation patterns within the harbor. When waves are broken by the breakwater, vessels are able to navigate inside the harbor more effectively, reducing the number of cancelled calls.

5.2.2.3.3 Alternative 3 – Replace the Existing Breakwater and Extend

Similarly to Alternative 2, Alternative 3 provides protection by helping to disperse high waves during intense wave activity. This alternative will provide added protection to the east of the harbor and its shorelines. This would not only improve conditions within the harbor, but on the shore-side facilities as well. Regarding its functionality, the breakwater will not obstruct the typical navigation patterns within the harbor. When waves are broken by the breakwater, vessels are able to navigate inside the harbor more effectively, reducing the number of cancelled calls.

5.2.2.4 Benefit Calculation of Each Alternative

The benefit analysis for harbor usability was the basis for developing the vessel call lists and model calculations for each alternative. Engineering calculated usable days from a hydraulic model to determine days of harbor closures based on wave and current conditions at the wharf and in the harbor. A probability factor was placed on usable days to estimate the number of vessel calls that would be improved for each alternative and the added vessel calls were incorporated in the vessel call list.

Below is a table showing the increase in usable days for each alternative.

Alternatives	Outputs (Unusable Days)	Increase in Usable Days
No Action Alternative	49	--
Alternative 1	45	4
Alternative 2	37	12

Table 5-4 Benefit Calculations

5.2.2.4.1 Annual Vessel Call Frequency to Harbor Usability:

Using the annual vessel call frequency between 2014 and 2015, there are, on average, 54 completed calls per year. The completed calls do not include those calls that were turned away due to harbor conditions, however, it represents those calls that were complete and the goods reached the community. Considering the future demand for vessel calls, it is expected that the average annual vessel call frequency would increase to approximately 66 completed vessel calls per year. While the current number completed vessel calls do support the community, there has been some concern that the additional calls are needed to fully support the community.

To estimate the impacts on harbor improvements, harbor usability was measured. An increase in usable days will increase the number of additional vessel calls. To show impacts that are consistent with current operations, estimates were made regarding the vessel operation and vessel transit based on discussions with the vessel operators. It is estimated that preparation for each vessel call would take approximately 2 days: 1 day for cargo handling and 1 day for the commute to the harbor. As a result, a 2 day *transit factor* is applied to the unusable day percentage to account for vessel loading and transit. When the harbor master closes the harbor one to two days before, the vessel is already in transit to its destination, which suggests that the vessel is not usable during that time period.

The below table shows the actual number of calls reduced for each alternative if the tug and barge was operating efficiently in the harbor. The number of additional calls assumes that the tug and barge was operating efficiently in the harbor.

	Percentage of Unusable Days (A)	**Vessel Transit Factor Applied (2*A) (B)**	**Change in Usability Percentage (C)**	**Increase in completed Vessel Calls ((1+C)*66) (D)**	**Additional Calls *rounded* (D-66)**
No Action	13.30%	26.60%	0.00	66	-
Replace Breakwater	12.20%	24.40%	2.20%	67	1
Replace and Extend Breakwater	10.00%	20.00%	6.60%	70	4

Table 5-5 Vessel usability to additional calls per alternative

From the analysis, replacing the existing breakwater will increase the number of vessel calls by approximately 1 additional call per year and replacing and extending the breakwater will increase the number of vessel calls by approximately 4 additional calls per year.

5.2.2.5 Transportation Cost Savings Benefit Analysis

NED benefits were estimated by calculating the reduction in transportation cost for each alternative using the economic model. For the Tinian Harbor analysis, average annual transportation costs are a modeled cost reflecting a transportation cost savings realized by reducing the commute time from entry to exit in the harbor. Other transportation costs considered in the analysis include costs of vessels approaching the harbor, but rerouted due to harbor cancellations and cost associated with the vessels attempts to enter the harbor, but turned back at the pilot's discretion. Reduction in these transportation costs are included in the benefit analysis as a transportation cost saving. Average number of vessel calls is a reflection of the harbor conditions and applied to the model analysis as well. Shift in mode transportation costs show the reduction in aircraft transportation as vessel calls are increased.

	Average Number of Vessel Calls	**Average Annual Transportation Costs**	**Additional Number of Calls**	**Shift in Mode Transportation Costs** (average annual)	**Total Transportation Costs**
No Action	66	$13,643,600	-	$654,400	$14,298,000
Alternative 1	67	$13,767,700	1	$490,800	$14,258,500
Alternative 2	70	$13,896,600	4	-	$13,896,600

Table 5-6 Transportation costs analysis

The above results are for each alternative on an average annual basis. Shift in Mode transportation costs are eliminated for Alternative 2, which would suggest that the demand is supported by the frequency in ocean cargo. Transportation costs do increase because vessels are added vessels to the call list, however, with the increase in ocean cargo cost, shift in mode costs decrease.

6 Cost of Alternatives

Cost of alternatives include all economic costs to construct the proposed navigation project. Each alternative has separate features and, therefore, a different cost associated with it. Not only do cost include the project construction cost, they also include Operation and Maintenance Costs, Mitigation Costs, and Interest During Construction. Costs are in FY 18 price levels using a 2.75 discount rate and expressed in average annual equivalent (AAEQ) costs for a 50 year period of analysis.

6.1 Project First Costs

Project costs for each alternative were provided by the Cost Engineers in a Total Project Cost Summary (TPCS). Construction costs contained all aspects of project construction and construction management including: real estate acquisition, and environmental mitigation. In addition to initial construction costs, additional operation and maintenance costs associated with maintaining the planned channel was considered and separately costed. All costs were provided in FY 2018 price levels and annualized through the period of analysis for the AAEQ calculation. Contingency was derived from an abbreviated risk analysis for each alternative based on the individual features. For detailed unit cost, please refer to the Cost Appendix.

6.2 Maintenance Costs

Annual O&M Costs were given for each segment and alternative, annualized, and applied to the average annual equivalent (AAEQ) NED Costs.

6.3 Mitigation Costs

When a proposed navigation feature creates adverse effects on the area beyond current conditions, it is USACE's responsibility to mitigate for the adverse conditions. Mitigation costs are added to the total project cost as an expense to the project. These costs are incorporated into the AAEQ. In the current project, some of the alternatives considered require some mitigation for the natural resources that are disturbed. These mitigation and regular maintenance costs are included in the cost portion of this analysis.

6.4 Interest During Construction Calculation

Interest During Construction (IDC) accounts for the opportunity cost of expended funds before the benefits of the project are available and is included among the economic costs that comprise the project costs. The amount of the pre-base year cost equivalent adjustments depends on the interest rate; the construction schedule, which determines the point in time at which costs occur; and the magnitude of the costs to be adjusted. Construction period lengths are included in the IDC cost analysis.

Interest during construction was calculated considering schedule variations between the time required to obtain congressional authorization and funding. Other areas of project uncertainties include industry execution of bid and contract requirements, availability of contractors' equipment to comply with environmental windows, and delays due to unexpected weather conditions. Based on these uncertainties the construction duration for the project may vary.

6.5 Average Annual Equivalent Cost Calculation

The average annual equivalent (AAEQ) cost calculation used the initial investment cost required for initial construction. When the initial cost is applied to the interest during construction (IDC) cost, this is considered the Economic Investment Cost for the initial cost of construction. Economic investment costs are was applied at the base year while the annual operation and maintenance (O&M), including regular mitigation costs are applied each year throughout the period of analysis, as required. All costs were annualized to develop the AAEQ NED Cost of the project. Initial costs were calculated in 2017 price levels, however, they were updated using EM 1110-2-1304, Civil Works Construction Cost Index System (CWCCIS), to reflect FY18 costs and the FY18 Federal Discount rate at 2.75%.

	Alternative 1	Alternative 2	Alternative 3
Project First Costs	--	$122,957,100	$188,575,800
Interest During Construction Cost	--	$1,825,339	$3,672,000
Investment Cost (Project First Cost plus Interest During Construction)		$124,784,500	$192,247,800
Amortized Investment Cost		$5,008,226	$7,510,500
Annual Operation and Maintenance Cost	--	$55,414	61,100
Average Annual Equivalent Cost	--	$5,063,640	$7,571,600

Table 6-1 Average annual equivalent cost calculation

6.6 Cost Contingency for remoteness of the harbor

Construction in Tinian Harbor does pose some cost concerns, including the availability of resources and the costs have incurred some atypical rates and contingencies. The harbor is a remote harbor and construction materials, including additional manpower, will have to be brought in for a project of this magnitude. In addition to the higher construction costs, coral mitigation costs will require a significant amount of effort as well.

7 Benefit-Cost Ratio

The benefit-cost ratio (BCR) is the initial consideration for justifying a study under the NED account. It measures the reduction in transportation costs (benefits) to the cost of constructing and maintaining the project. The BCR compares average annual benefits (AAB) and average annual costs (AAC) to determine the appropriate benefit-to-cost ratio. The below table shows the BCR calculation for the Tinian Harbor improvements.

	Average Annual Benefits	Average Annual Costs	Total Net Benefits	BCR
No-Action Alternative	0	0	0	0
Replace Existing BW	$39,500	$5,063,600	($5,022,900)	0.01
Replace and Extend BW	$401,400	$7,571,600	($7,157,400)	0.05

Figure 7-1 Benefit-to-Cost Ratio Calculation

The results of the NED analysis show negative net benefits for each alternative considered. The negative NED can be attributed to many factors including, the high construction cost, the limited number of vessels calling in the harbor, and flattened population growth projections on the island for the period of analysis.

7.1 Harbor Dependability and Need

Tinian Harbor is the only commercial harbor on Tinian and has no direct rail or highway ling to another community. Tinian is 17 miles from Saipan and 55 miles from Rota and is only connected by ocean. Access to the island is only by air or ocean transport. Tinian consumes roughly 97 percent of its goods transported within in the harbor by the local community. This requirement was analyzed comparing the total revenue tonnage with the inbound and outbound tonnage. This revenue tonnage is based on the information represented by the harbor masters, not including the small boat vessels not recorded with the CPA.

While the impacts to the residents are significant, the region could experience secondary and tertiary effects on local businesses and communities when the harbor is underutilized. With its close proximity to Saipan, the island of Tinian has been a focal point for several development sites and business opportunities in the CNMI. The location of the CNMI makes it easily accessible to Asian markets and several visitors frequent the island from China and the Philippines. When the Asian economy does well, the CNMI does well. Historical population and GDP data show a direct correlation between Asian economies and tourism on the island of Tinian.

7.1.1.1 Cargo dependability

Tinian Island is a remote community depending on ocean and air for their needs and supplies. Operating costs for ocean cargo are considerably less expensive than air cargo. A larger vessel can transport goods much more efficiently on ocean than in the air. When the harbor is not available due to the extreme wave conditions, the only option for the community is to get their goods transported via air. When goods are transported in air, the added transportation costs are transferred to the consumer. This would cause a hardship to the local residents because it increases the cost of goods.

The breakwater is currently protecting the harbor from intense wave activity, however, when the breakwater does disintegrate, it will be prone to significant and harsh wave activity. At this time, the preferred ocean cargo method would be slightly compromised, leaving the residents with alternative ways to receive goods. This could cause a strain on small businesses because it limits their ability to sell goods to their consumers. Residents are potentially impacted because they are not able to provide their family with the necessary goods for the household, including food products.

7.1.1.1.1 Social and Cultural Value to the Community

Fishing in Tinian is very common to the local population with linkages to the ancient Chamorran traditions. Over 50 percent of the residents in Tinian are of Chamorro background and practice Chamorro culture regularly. The ancient Chamorros relied heavily on resources of the sea for their substances and the traditions are practiced by some still today (Cunningham, 1992). Wave conditions in the harbor limit ingress and egress of personal vessels to fishing grounds. Adverse wave conditions reduce the availability of days to practice subsistence and recreational fishing by Chamorrans.

7.2 Cost Effective/Incremental Cost Analysis (CE/ICA)

A cost effective/incremental cost analysis (CE/ICA) is conducted to ensure that the least cost solution is identified for each possible level of benefit output. An incremental cost analysis of the solutions is conducted to reveal changes in costs for increasing levels of outputs. In the absence of a common measurement unit for comparing the nonmonetary benefits, cost effectiveness and incremental cost analyses are valuable tools to assist in decision making.

The CE/ICA reviewed the impacts to the proposed general navigation feature alternatives, applied a measurable factor, and compared alternatives to the factor. This analysis showed the welfare impacts to the local population for the navigation improvements in the harbor using a usable day measure to compare alternatives. In addition to this analysis, the remaining two accounts will be analyzed in Section 6.4 of the appendix.

7.2.1 Method

The OSE analysis was evaluated using the CE/ICA procedure. Due to the simplicity of its measures and metrics, the CE/ICA analysis was conducted manually, however still following the CE/ICA IWR Report 94-PS-2, *Cost Effectiveness Analysis for Environmental Planning: Nine EASY Steps* guidance.

The cost effectiveness and incremental cost analysis procedures are presented in nine steps, which are grouped into four tasks listed below (U.S. Army Engineer Institute for Water Resources, 1994).

A. Formulation of Combinations
Step 1: Display outputs and costs
Step 2: Identify combinable management features
Step 3: Calculate outputs and costs of combinations

B. Cost Effectiveness Analysis
Step 4: Eliminate economically inefficient solutions
Step 5: Eliminate economically ineffective solutions

C. Development of Incremental Cost Curve
Step 6: Calculate average costs
Step 7: Recalculate average costs for additional outputs

D. Incremental Cost Analysis
Step 8: Calculate incremental costs
Step 9: Compare successive outputs and incremental costs

These steps will be followed in the latter sections to determine the final array of the incremental cost analysis.

7.2.2 Management Measures

Before beginning the analysis, information regarding management measures must be clearly defined and specified. The objectives of the navigation study are to improve *navigation/operation efficiency*, *reduce vessel and infrastructure damages*, and *improve navigation conditions*. The basis for these objectives stem from the problem of wave and current conditions impacting the navigation efficiency and the vessel's inability to commute within the harbor. The PDT has determined that the best and most effective way in achieving the objectives are by constructing a breakwater. The measures provided in the below analysis estimate impacts between several options for breakwater construction.

7.2.3 Outputs

The outputs are used to associate a like variable for alternative comparison in the analysis. Additionally, the outputs must be independent variables directly linking impacts of the selected alternatives with the study objectives.

7.2.3.1 Vessel Usability Days Output

When wave conditions are too severe, the harbor is closed, limiting its usability. There is a direct correlation to intense wave conditions and vessel usability. Vessel usability days were calculated by the Engineering Team using a CMS-Flow and CMS-Wave simulation model. This model used historical wave data to analyze annual wave patterns to develop annual wave interactions in the harbor for the with and without project conditions. Once the project was calibrated, the model could calculate results that were useful in the economic model, usability days.

The usability days were calculated based on two conditions: a maximum of one-foot waves at the pier and a maximum of three-feet waves in the harbor. If either of these conditions were not satisfied, then the harbor was not usable. These parameters were based on tug and barge operational procedures confirmed by both the harbormaster and the pilots. The usable day outputs are correlated with the number of annual vessel call cancellation. For the CE/ICA analysis, the usability output will analyze the impacts of the alternatives to usable navigation days within the harbor. Following the alternative analysis, the usability output will show the true impacts to cancelled vessel calls and its impact to the welfare of the local population. Any cancelled call will impact the residents, forcing them to ship goods by air at a higher price.

7.2.3.2 Environmental Outputs

In addition to the usability day output, environmental impacts will also be qualitatively represented within the incremental analysis. A separate analysis was used to determine the best approach for mitigation and the outputs for the environmental impacts are based on a scalability level for the analysis. Because environmental and mitigation costs associated with each alternative are already factored into the costs, the actual environmental impact will be a separate feature and not used in conjunction with the usability day output.

7.2.4 CE/ICA Procedure

The below procedure is the manual calculation nine-step process as outlined in the CE/ICA IWR Report 94-PS-2, *Cost Effectiveness Analysis for Environmental Planning: Nine EASY Steps* guidance.

7.2.4.1 Formulation of Combinations

7.2.4.1.1 Step One: Display Outputs and Costs

The Engineering Appendix measures usability days to show effects on the design and this metric is the best measure to associate the impacts to cost and design improvements for the study. Usability days is a variable output that is associated with the wave impacts of the various alternatives. What is compared in the CE/ICA analysis is costs and the incremental output. Costs are displayed as average annual costs (AAC) for the total cost of construction, operation and maintenance, and mitigation. The below table displays the cost and outputs for each of the alternatives listed in the final array.

Measures	Outputs (Unusable Days)	Cost (AAC)
No Action	49	--
Breakwater Replacement	45	$5,063,600
Replace + Extend Breakwater	37	$7,571,600

Table 7-1 Output and Cost Measures

7.2.4.1.2 Step Two: Identify Combinable Management Measures

Step Two identifies the specific measures and indicates if the measures are combinable. The below table illustrates the combinability of each of the measures analyzed.

	Can be combined with:	
Measures	Breakwater Replacement	Replace + Extend Breakwater
Breakwater Replacement	--	No; The Replace + Extend Breakwater would be located within the same site as the Breakwater Replacement, therefore, the Breakwater Replacement and the Replace + Extend Breakwater are mutually exclusive.
Replace + Extend Breakwater	No; The Replace + Extend Breakwater would be located within the same site as the Breakwater Replacement, therefore, the Breakwater Replacement and the Replace + Extend Breakwater are mutually exclusive.	--

Table 7-2 Measures Assessment

Based on the above analysis, none of the measures can be combinable and the final array of alternatives for the CE/ICA are as follows:

1. No Action Alternative
2. Replace Breakwater
3. Replace + Extend Breakwater

7.2.4.1.3 Step 3: Calculate outputs and costs of combinations

The below is the calculation of the outputs and costs for the final array of alternatives for the CE/ICA:

Alternatives	Outputs (Unusable Days)	Increase in Usable Days	Cost (AAC)
No Action Alternative	49	--	--
Replace Breakwater	45	4	$5,063,600
Replace + Extend Breakwater	37	12	$7,571,600

Table 7-3 Cost/Output Combinations for the preliminary array of alternatives

7.2.4.2 Cost effectiveness analysis

The cost-effective analysis identifies and eliminates economically irrational solutions.

7.2.4.2.1 Step 4: Eliminate economically inefficient solutions

This step identifies and eliminates inefficient solutions, which means that if you can produce a given level of output in more than one way, only the least expensive choice makes economic sense for that level of output. There were no alternatives that satisfied this requirement, so all alternatives were carried forward at this step.

7.2.4.2.2 Step 5: Eliminate economically ineffective solutions

This step identifies and eliminates ineffective solutions, which means that if you can produce a greater level of output for the same or less cost, then the only greater output choice makes economic sense. There were no alternatives that satisfied this requirement, so all alternatives were carried forward at this step.

7.2.4.3 Development of incremental cost curve:

The development of the incremental cost curve calculates the average costs of the cost-effective solutions and identifies the solution with the lowest average cost at each level. Since there is only one output measure for the current analysis, the average costs at each output level are the most cost effective. All alternatives were carried forward.

7.2.4.4 Incremental cost analysis:

The incremental cost analysis reveals and interprets changes in cost for increasing levels of environmental outputs. Step 8 and 9 can be assessed concurrently because it includes incremental costs for remaining output levels and progressively comparing successive levels of output and their incremental costs. This helps to provide decision makers with information that is useful in addressing if the additional output is worth its cost.

Alternatives	Percentage Unusable Days (1980-2011)	Outputs (# of Unusable Days)	Increase in Usable Days	Cost (AAC)	Incremental Cost	Incremental Output	Average Incremental Cost
No Action	13.25%	49	--	--	--	--	--
Replace BW	12.2%	45	4	$5,063,600	$5,063,600	4	$1,265,900
Replace + Extend BW	10.0%	37	12	$7,571,600	$2,508,000	8	$313,500

Table 7-4 CE/ICA Analysis

From the above analysis, an additional usable day for the Replace Breakwater, costs an average of $1,265,900 or each additional usable day, while the Replace + Extend Breakwater at the next level of wave and current protection costs an additional $313,500 for each additional useable day. Average incremental cost is determined by dividing the incremental output from incremental cost. For the Replace Breakwater Alternative, the difference between the No Action and Replace Breakwater calculation is the incremental cost, and the incremental addition in output is the incremental output.

7.2.5 Welfare and Local Population Impacts to Final "Best Buy" Plans

The project's objective is to increase efficiency and usability in the harbor during high wave and current periods. The best way to increase the access to the harbor is to increase the usability of the harbor. This will increase the number of vessels calling in the harbor, and therefore reducing the impacts to cancelled calls. The "Best Buy" options for the study compare usable days to the alternatives by analyzing typical wave conditions and harbor effects.

While usability days does help to screen alternatives, the true impacts on an increase in usable days is best described by the increased probability of vessels to effectively navigate within the harbor without cancelled vessel calls. The correlation between cancelled vessel calls and increased food costs is one-to-one meaning that an increase in cancelled vessel calls increases food costs and, likewise, a decrease in cancelled vessel calls, decreases food costs.

Access to essential commodities relies heavily on the ability for vessels to enter into the harbor. Petroleum and energy supply accounts for 47% of all commodities while food and beverages follow at over 16% of all commodities that enter the harbor. When calls are cancelled due to wave and current conditions, the local community experiences a hardship. This hardship comes from a delay of goods and an increase in the cost of goods, which affects the welfare of the community. Transporting commodities in air is not possible for petroleum and is much more expensive than ocean cargo. When air cargo occurs, the added expense is for transporting goods is transferred to the consumer. Reducing the need for air cargo will help to manage the cost of food and goods on the island. This will have both short and long term effects on the price of goods in the community.

7.2.5.1 Estimating impacts to the welfare of the local community between alternatives

To monetarily show the welfare and community impacts, usability days are linked to a welfare factor to demonstrate quantifiable impacts to each alternative. Tinian doesn't experience income constraints currently, however, in the future without project condition, the breakwater's performance is expected to decline. Since there are no current costs to compare, the Island of Rota, CNMI is used to calculate wage and income disparities. Given the similar climate conditions and remoteness of both islands, it is expected that income and impacts to welfare will be similar.

Consider a family of four utilizing their food supplement voucher to supply food for their family. During calm wave activity, their food is subsidized by the food allowance. However, during periods where the vessel cannot enter into the harbor and an economic shock on food occurs, they would have to supplement their food from other means. With non-perishable food items attributing to up to a 30 percent of a typical monthly grocery bill, disposable income for families is reduced ("Supermarket Sales by Department –Percent of Total Supermarket Sales", 2015). In cases where income is constrained, some individuals are forced to determine whether to buy food for their family or shelter.

Tinian Income Constraints:

While Tinian is receiving sufficient food supply currently, estimating their income constraints in the future condition will show an economic challenge to the island. According to the 2014 Prevailing Wage & Workforce Assessment Study, the average wage for Tinian is approximately $16,200 annually, or $1,350 per month. With roughly 200 households dependent on monthly Supplemental Nutrition Assistance Program (SNAP) vouchers, they are constantly torn between providing food for their family and providing other necessities for themselves during times when cargo is increased as a result of shipping goods via air.

The current Supplemental Nutrition Assistance Program (SNAP) voucher monthly supplement for Tinian is $568 per month. Based on the 2015 "Supermarket Sales by Department –Percent of Total Supermarket Sales", 30% of the monthly income is allotted for perishable goods. By taking 30% of the average monthly supplement and applying that to an income shift during times when the harbor is closed, each household has to reallocate approximately $170 of their income for food in lieu of other expenses. This $170 is considered an *income disparity factor* because it is the opportunity cost of additional food expenses.

Annual Vessel Call Frequency to Harbor Usability:
Using the average annual vessel call frequency between 2014 and 2015, there are approximately 51 calls per year. If incorporating the future need for vessel calls, it is expected that the average annual vessel call frequency would be approximately 66 vessel calls per year.

Applying the change of percentage of unusable days for each alternative will show impacts to vessel calls in the future years of the period of analysis. To obtain impacts that are consistent with current operations, estimates were made regarding the vessel operation and vessel transit based on interviews with the vessel operators. It is estimated that preparation for each vessel call would take approximately 2 days to complete: 1 day for cargo handling and 1 day for the commute to the harbor. A 2 day *transit factor* is applied to the unusable day percentage to account for vessel maneuverability. When the harbor master closes the harbor, between one to two days before, the vessel is already in transit to its destination, which suggests that the vessel is not usable during that time period.

The below table shows the actual number of calls reduced for each alternative if the tug and barge was operating efficiently in the harbor.

	Percentage of Unusable Days (A)	Vessel Transit Factor Applied (2*A) (B)	Change in Usability Percentage (C)	Change in Vessel Call Frequency ((1+C)*66) (D)	Additional Calls (D-66)
No Action	13.25%	26.5%	---	66	--
Replace Breakwater	12.2%	24.4%	+2.1%	67	1
Replace + Extend Breakwater	10.0%	20.0%	+6.5%	70	4

Table 7-5 Vessel usability to additional calls per alternative

From the analysis, construction of an Replace Breakwater will increase the number of vessel calls by approximately 1 additional call per year, while construction of the Replace and Extend Breakwater will increase the number of vessel calls by approximately 3 additional vessel calls per year.

While the increase in vessel calls seems low, if the welfare factor applied to each vessel call is very significant. Based on the call history, four calls are expected to port Tinian harbor monthly. Estimating the dollar disparity value per call, $170 (30% of the monthly SNAP voucher estimate) is divided by 4 to get a per trip estimate. Using the disparity factor estimated, it is estimated that for every added call, each household would benefit approximately $43. The below table shows the impact to the community for each additional vessel call and approximates the total impact based on number of households.

	Additional Calls (Table 10-6) (A)	Additional Income Available (A*43) (B)	Number of Households (as of 2010 Census) (C)	Community Welfare Increase (B*C) (D)	Average Annual Cost
No Action	--	--	874	--	--
Replace Breakwater	1	$43	874	$37,600	$5,063,600
Replace + Extend Breakwater	4	$170	874	$148,600	$7,571,600

Table 7-6 Additional Calls to Welfare Improvement (Average Annual Savings to Residents)

The above table shows a total increase in community welfare of $37,100 for the Replace Breakwater and $148,600 for the Replace and Extend Breakwater. An increase in additional dollars pumped back into the community could create exponential economic growth for the community. As more vessels call in the harbor, there will be less air cargo trips. This helps to manage prices, reducing economic shocks due to harbor shut downs. The additional money available to the residents could be used within the community for several things including health services, travel expenses, food industry, and many others that would benefit the local community.

7.2.5.2 Safety within the Harbor

In addition to the welfare of the local population and vessel usability, safety is also a concern. Unpredictable wave events occur often in the harbor and in some cases the harbor master is not able to stop operations and order an evacuation at the harbor in sufficient enough time. Because of this condition, although they can come in in calm conditions, vessels are still at risk to unpredictable waves during loading and unloading.

8 Other Accounts for Evaluation

USACE planning guidance establishes four accounts to facilitate and display effects of alternative plans. Previous studies have relied primarily on the use of the National Economic Development account showing the changes in economic value of the national output of goods and services. A benefit/cost ratio to show an indication of the change in net benefits is the output of the NED evaluation. Included as part of the remaining four accounts are the Environmental Quality (EQ), the Regional Economic Development (RED), and Other Social Effects (OSE) indicators.

8.1 Additional Social Effects in Tinian

Located near to the Federal channel is a docking area used for small vessels. The functionality of the small vessels ranges from small cargo movement to recreational use, i.e. recreational fishing. While the harbor does not allow for recreational fishing within the Federal channel, the area outside of the harbor is utilized by several residents for recreational and fishing purposes regularly. Fishing in Tinian is very common to the local population with linkages to the ancient Chamorran traditions.

Over 50 percent of the residents in Tinian are of Chamorro background and practice Chamorro culture regularly. Fishing is a heavily practiced cultural tradition to many of its residents. The ancient Chamorros relied heavily on resources of the sea for their substances and the traditions are practiced by some still today (Cunningham, 1992). While the number of subsistence fishing is low—less than % of the working population, many of its residents practice recreational fishing regularly (CNMI Department of Commerce, 2012). If wave conditions become a challenge for residents, there is a great possibility that there will be a decline in subsistence fishing is partially attributed to the intensity of waves.

Wave conditions in the harbor limit the availability of days to practice subsistence and recreational fishing. Conditions as these discourage residents by limiting their access to traditional and cultural practices. If conditions in the harbor decline, subsistence and recreational fishing could decline.

8.2 Environmental Quality

The environmental quality (EQ) account displays non-monetary effects on significant natural and cultural resources. The study area has a significant amount of listed coral species that are vital to the region. In both alternatives, the disturbance of the coral will impact the area. Although there will be some disruption in coral, coral mitigation plans are in effect to reduce the impact. Additionally, implementing a breakwater provides an opportunity for coral growth. Alternative 4 will require additional mitigation because of the increased the footprint of disturbed coral.

	Environmental Impacts to Coral (acres)	Mitigation Amounts (acres of reef balls)	Mitigation Cost
Alternative 2	14.56	4.05	$2,870,600
Alternative 3	16.34	4.57	$3,239,100

Table 8-1 Coral Impact and Mitigation

8.2.1 Regional Economic Development

The Regional Economic Development (RED) account is the account used in this analysis and it displays the changes in employment and income to the region as a result of the selected alternative as depicted here. When considering additional disposable income to the population, there could be secondary and tertiary effects to income added to the population. In instances where a population has to use additional disposable income to account for increases in necessary items, including, food, they are not able to use their disposable income for other items. When this occurs, the regional economy suffers. Some examples of areas that would be impacted include local small businesses and restaurants not only on the island, but on neighboring islands as well.

8.2.1.1 Harbor impacts on food prices

Food is an inelastic product, which means that as the price changes, the demand for the food remains constant. Because of its inelastic abilities and its need for the residents and the local population, people will pay the market price of the food regardless of its price. When vessels are turned away and food is flown in, the price of goods increase. Considering the inelasticity of this product, a direct relationship between vessel traffic consumer goods is realized.

From reviewing the region's CPI, it is confirmed that the residual effects of harbor conditions are indeed passed down to consumers. During times where harbor conditions do not permit vessels to enter the channel and when the harbor is shut down, the people are impacted. Food prices have been inflated as much as 4.8 percent since 2010. There is a direct correlation to food prices to the harbor availability. A large typhoon hit the island of Tinian and caused the harbor to shut down December 2013 through February. As a result, no commodities were able to be transported ocean cargo and instead were required to be sent in by way of air, Micronesia Air. During that time, the consumer price index on food products was increased by 4.8 percent.

9 Best Buy Plan Comparison

The below table shows the comparison between the No Action alternative and the two Best Buy plans and their relation to the four accounts of evaluation.

Alternative	Wave and Current Impacts	NED	RED	OSE	EQ
No Action		BCR: --	None	Community Welfare Increase: 0 Subsistence fishing to the Chamorro culture	Neutral
Breakwater Replacement	Protection from NW waves	BCR: 0.01	$148,600 Income Stimulus to residents would provide secondary and tertiary regional impacts	Additional Useable Days: 4 Subsistence fishing to the Chamorro culture	Acres of Coral Impacts: 4.05
Replace + Extend Breakwater	Protection from NW Waves Protection from N Currents	BCR: 0.06	$594,300 Income Stimulus to residents would provide secondary and tertiary regional impacts	Additional Useable Days: 12 Subsistence fishing to the Chamorro culture	Acres of Coral Impacts: 4.57

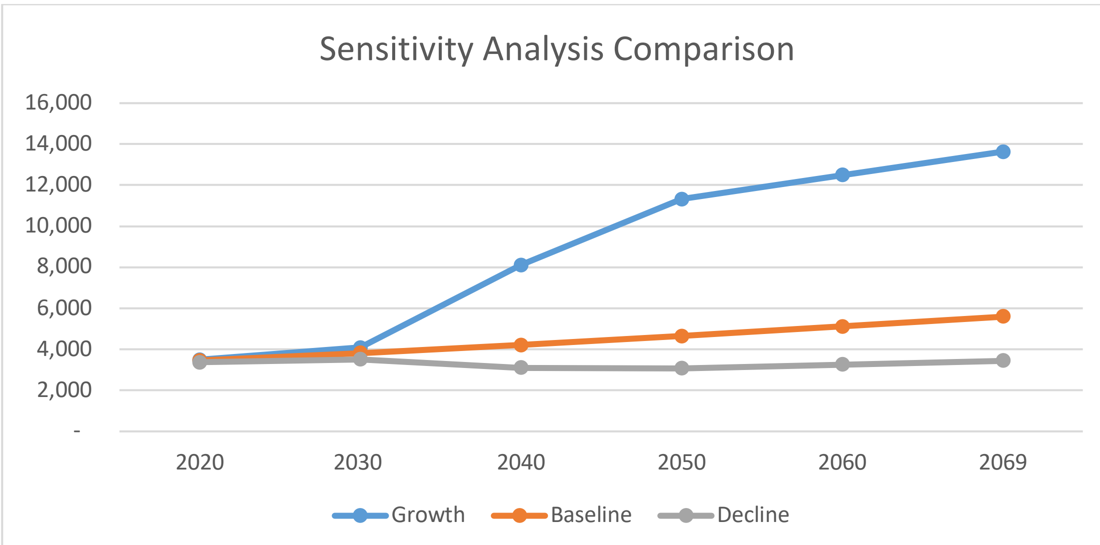
Table 9-1 Best Buy Plans - Four Accounts Comparison

10 Risk & Uncertainty

The Principles and Guidelines and its subsequent Planning Guidance Notebook, ER 1105-2-100, recognize the inherent variability to water resources planning. Navigation projects, in particular, are fraught with uncertainty about future conditions. Therefore, a sensitivity analysis, in which key quantitative assumptions and computations are modified, is required to assess their effects on the final outcome. The sensitivity analysis for this study is a repeat of the OSE analysis, substituting commodity forecasts with a range of values that were projected to be below and above the base scenario. The CE/ICA analysis used the population trend as the base of the analysis to determine changes in commodities, a key area of potential uncertainty. This sensitivity analysis presents the results of a large range of potentially different forecast of future commodity traffic at Tinian Harbor.

Tinian Harbor is in a period of development and with the uncertainties as to the future of Tinian, the economic analysis took a conservative approach based on historical population growth trends. From the recent Federal regulations and the tropical storm events, Tinian has experienced several setbacks in its economy. As a result, Tinian and the CNMI have made significant efforts to recover from these setbacks including marketing Tinian to the tourism industry. With the uncertainty of future growth in Tinian, the analysis was based on gradual economic improvements throughout the period of analysis, not economic drivers that would stimulate economic growth. Conversely, the uncertainty on future tropical storm and typhoon events that could have a negative impact on growth was not considered either.

Using population as the primary growth factor, a sensitivity analysis was conducted to compare two population scenarios: population growth stimulated by a growing economy and population decline stimulated by a tropical storm event. Historical population data was used to compare the two scenarios using event-triggered population data. For Tinian, the largest period of growth was from 1981 to 1995 with an average annual growth rate of 7.1% and the greatest decline was from 2000 to 2010 where the average annual growth rate was negative at -1.2%. To estimate a growth and decline trend that is most representative of Tinian growth/decline data, growth and/or decline is projected to begin at 2030 and incrementally changing every 15 years. At year 2020, the growth will stabilize to a steady --% rate. Population changes are most significant at the growth level because there are currently some developments planned that may influence the population size. This increase is shown at the 2030 to 2050 population estimates. Below is a graphical representation of the two scenarios of growth data.



Graph 10-1 Sensitive Analysis Population Comparison

Tinian's economy, immigration policies, and international influences are key factors to the growth and decline of its population. Because of this, the above graph was used to measure significant impacts and/or shifts. This is most important in the demand for goods and the need for additional vessel calls. As the above graph describes, any short term change in population could potentially impact the entire period of analysis. Incorporating the baseline and the two alternative scenarios, with the commodity forecast and vessel availability, the below shows the impacts of calls required to support the population.

	Vessel Calls (Baseline Condition)	Replace BW (6.6% usability)	Additional Calls	Number of Households	Additional Income per Household	Community Welfare
Population Decline	55	15	1	668	$108	$62,424
Baseline	66	67	1	874	$108	$81,500
Population Growth	108	30	2	1,658	$216	$310,824

Table 10-1 Alternative 2 Sensitivity Comparison based on population changes

The above table shows scenarios of Alternative 2 with different population considerations. This table shows that even with a decline in population, community welfare is impacted with the breakwater replacement.

	Vessel Calls (Baseline Condition)	Extend BW (6.6% usability)	Additional Calls	Number of Households	Additional Income per Household	Community Welfare
Population Decline	55	59	4	668	172	$459,900
Baseline	66	70	4	874	172	$601,300
Population Growth	108	115	7	1,658	301	$3,493,800

Table 10-2 Alternative 4 Sensitivity Comparison based on population changes

The above table of Alternative 4 shows scenarios using different populations as well. The significance in community welfare is improved in all levels of this alternative. Alternative 4 continues to improve community welfare the most in each population category. In all three of the population analyses, replacing and extending the breakwater still provides more additional calls than replacing the breakwater. This alternative also increases Community Welfare.

11 Summary and Conclusions

In summary, due to the lack of vessel calls and the increased cost of construction, Tinian Harbor was not justified under the NED analysis. While not justified under the NED analysis, the remaining accounts should be considered for justification. The results of this analysis highlight the high cost of air cargo transportation relative to ocean cargo transportation and its impacts to the residents. Although not experienced in Tinian currently, the deterioration of the breakwater, makes the harbor more prone to vessel call cancellations. When calls are cancelled and the vessels are not able to enter the harbor, food and other necessities have to be transported in air. The additional cost is transferred to consumers and residents. Added costs of goods could potentially double in cost, resulting in a community hardship.

The likelihood of the breakwater completely dismantling is high and if this occurs, under operational conditions, the harbor would still be protected by the reef. The breakwater, however, would provide protection to the port infrastructure during significant costal events. This analysis determined that the greatest increase in usable days were achieved through Alternative 3, however, replacing the breakwater would provide the needed protection for the harbor.

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Appendix 2

US Fish and Wildlife Service

Phase 1 Marine Habitat Characterization – Planning Aid Report

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Phase 1 Marine Habitat Characterization

Tinian Harbor Modification

Tinian, Commonwealth of the Northern Mariana Islands

Fish & Wildlife Coordination Act Planning Aid Report

DRAFT REPORT #2 **April 2018**

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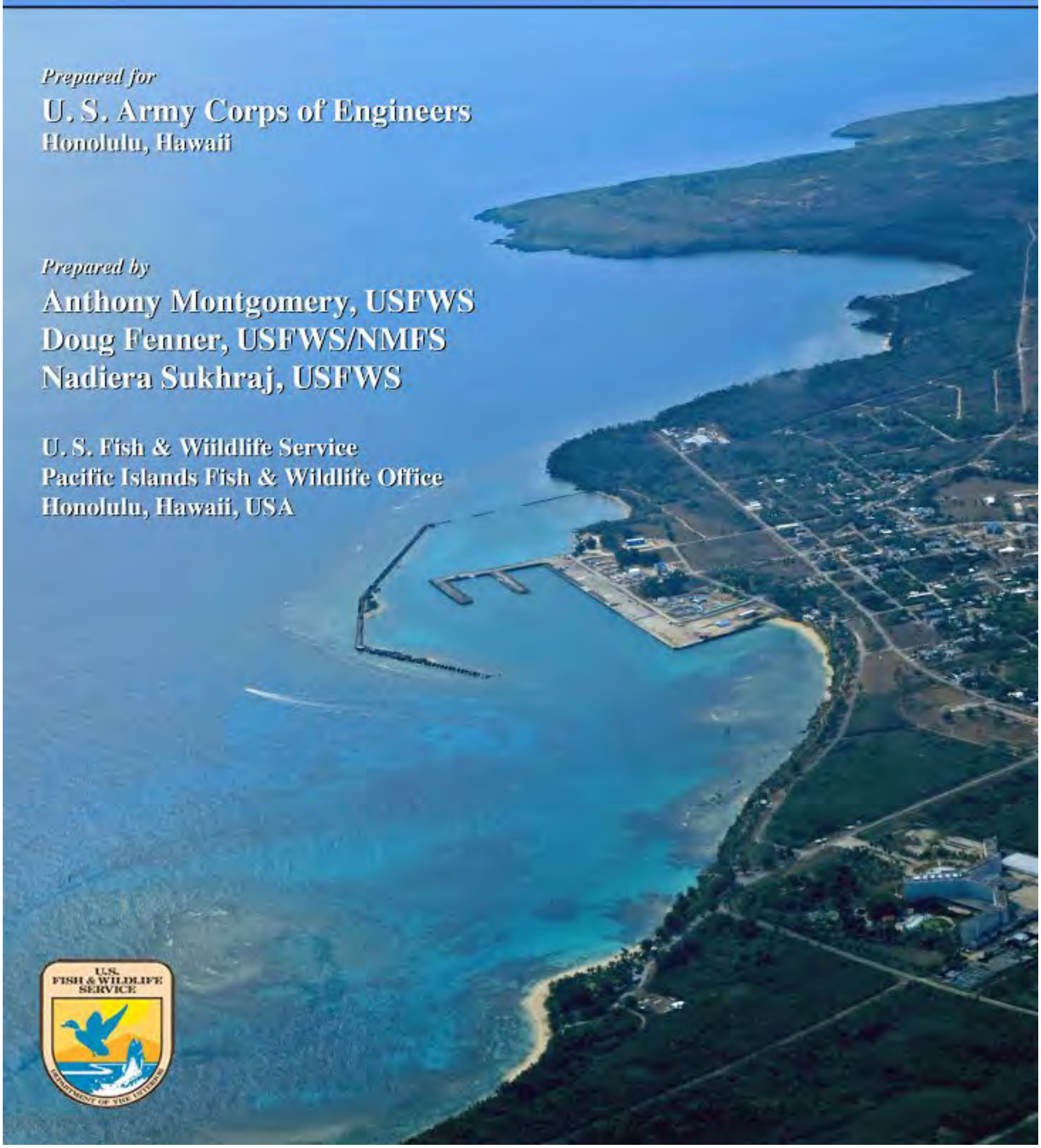

DRAFT #2
FISH AND WILDLIFE PLANNING AID REPORT

PHASE I MARINE HABITAT CHARACTERIZATION
TINIAN HARBOR MODIFICATION

TINIAN, COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS

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April 2018

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INTRODUCTION

Authority, Purpose and Scope

This Phase I report is prepared in accordance with the April 12, 2016, U.S. Fish and Wildlife Service's (Service) Planning Aid Letter (PAL) assisting the U.S. Army Corps of Engineers (USACE) with a marine resource and impact assessment associated with proposed modifications to Tinian Harbor in the Commonwealth of the Mariana Islands (CNMI). The proposed project is sponsored by the USACE at the request of CNMI's Commonwealth Port Authority (CPA). This report has been prepared under the authority of and in accordance with provisions of the Fish and Wildlife Coordination Act of 1934 [16 U.S.C. 661 *et seq*.; 48 Stat. 401], as amended (FWCA); the Clean Water Act of 1977 [33 USC 1251 *et seq*.; 91 Stat. 1566], as amended (CWA); the Endangered Species Act of 1973 [16 U.S.C. 1531 *et seq*.; 87 Stat. 884], as amended (ESA); and other authorities mandating the Service to provide technical assistance to conserve trust resources.

The FWCA provides the basic authority for the Secretary of the Interior, through the Service, and the Secretary of Commerce through the National Marine Fisheries Service (NMFS) via Reorganization Plan No. 4, to assist and cooperate with Federal, State and public or private agencies and organizations in the conservation and rehabilitation of aquatic wildlife. The NMFS provides additional assistance and cooperation for wildlife species conservation under the management responsibilities of the Department of Commerce. This Phase 1 consultation under the FWCA regarding analysis of the proposed project's impacts on marine resources was conducted by the Service, with assistance from CNMI's Department of Forestry and Wildlife (DFW) and the NMFS. The Service was the lead agency for this FWCA investigation and has the responsibility of ensuring that concerns and recommendations of the other resource agencies are considered fully in FWCA reviews. The January 2017 draft report was sent to NMFS and DFW with an invitation to join this report given their equal authority under FWCA. While NMFS has declined to be a co-lead for this report, they did participate in field operations and an informal review of the project products, the January 2017 draft report, and this current draft report. DFW staff biologists have provided informal review of early report drafts. The January 2017 draft report was also sent to CNMI's Bureau of Environmental and Coastal Quality (BECQ), the U.S. Environmental Protection Agency, and to the Resident Director of Tinian's Department of Lands and Natural Resources for review and comment. The January 2017 draft report was also sent to the USACE for review. The Service received comments from the USACE and CNMI's BECQ and these are included in Appendix G. This report reflects the incorporation of those comments to the fullest extent possible.

The CPA requested USACE to investigate modifications to existing harbors within the CNMI in 1997. By October 2001, the USACE completed a Reconnaissance Study 905(b) Analysis determining the federal interest for general navigational improvements at Rota and Tinian Harbors. In January 2016, the USACE initiated a feasibility study in regards to making improvements to both Rota and Tinian Harbors.

Tinian Harbor was constructed in 1944-1945 during World War II. The entrance channel is approximately 800 meters (m) (one-half mile) long by 160 m (525 feet [ft.]) wide and dredged to a depth of 9 meters (30 ft.). The harbor is protected by a breakwater consisting of a 1,095 m

(3,595 ft.) outer breakwater constructed of circular cell configured, interlocking sheet pile filled with quarried limestone. A 370 m (1,210 ft.) inner breakwater connects from the shore to the outer breakwater and is constructed of a single row of sheet pile. Since its initial construction, the breakwater has significantly deteriorated, with some sections open to the outside lagoon on the west side of the harbor. Other sections are crumbling, exposing the harbor facilities to waves and currents during stormy conditions. Currents can be very strong, to the point of hampering small vessel traffic in the narrow passage from the small boat harbor past the commercial dock to the main harbor area. The channel depth maintenance is also reported to limit growth of vessel traffic to the harbor (USACE 2015). As such, the present condition of the harbor limits its usage by supply vessels bringing goods to the island by sea transportation. Because ocean transportation of goods to the island is the most economical means of sustaining the island's residents, the maintenance of the harbor facility is vital to the well-being of the island.

The overall scope of the current investigation was to document the existing fish and wildlife resources within the proposed project sites and to ensure that fish and wildlife conservation receives equal consideration with other proposed project objectives as required under the FWCA. The findings and recommendations under a FWCA investigation are communicated by at least three means: (1) orally in the interactive planning process, (2) through notes and memoranda such as the planning aid letters (PAL), and (3) through formal reporting: Planning Aid Reports (PAR) or Fish and Wildlife Coordination Act Report (FWCAR/ 2(b) Report). Generally, a PAR is the appropriate reporting mechanism during a feasibility study, unless sufficient project design information and fish and wildlife survey data is available (Smalley 2004). This report includes a Phase I qualitative assessment of fish and wildlife resources at the currently proposed project site, an evaluation of potential impacts associated with the proposed project components, and recommendations for fish and wildlife mitigation measures. The Service uses a Phase I and Phase II approach in order to collect the appropriate level of data that informs decisions to avoid, minimize, or scale compensatory mitigation for a project. A Phase I survey provides valuable information for decisions on how to avoid and minimize impacts during the process of project alternative formulation. A Phase II survey provides valuable information on the exact scale of the impact associated with specific project alternatives and their secondary impacts. Phase II surveys are best suited when the project alternatives are narrowed down and there is some indication on how the project will be constructed. Compensatory mitigation planning can be incorporated into a Phase II investigation. While the details may not be available during the feasibility study, a Phase II survey can still be completed, but may require additional early planning and additional survey effort given project uncertainty. A Phase I survey is general suited for a PAR while Phase II data are needed for a FWCAR, although other considerations may be made in determining the appropriate reporting mechanism.

The findings and recommendations of this report may be useful for consultations required for Essential Fish Habitat (EFH) of the Magnuson-Stevens Fishery Conservation and Management Act and Section 7 of the Endangered Species Act (ESA) by the NMFS. However, these findings and recommendations should not be assumed to be sufficient for completing EFH or Section 7 consultations.

Prior Fish and Wildlife Service Studies and Reports

The Service has conducted one previous FWCA investigation on Tinian. This report was for the U.S. Marine Corps in 2009, and examined three beaches proposed for amphibious landings, as well as Tinian Harbor. A total of 14 quantitative transects were completed inside and outside the harbor that were within the Project Area (Minton *et al.* 2009).

Prior Studies and Reports from other agencies

NMFS's Pacific Science Center, Coral reef Ecosystem Program conducts periodic coral reef surveys around the island of Tinian. These surveys mostly consist of standard rapid ecological assessments, as well as tow-board diver surveys. There is no spatial overlap between these surveys and this proposed project, but there are transects near the harbor.

The U.S. Department of Defense, U.S. Marine Corps has recently conducted a series of surveys around Tinian for proposed military training activities on the island Tinian. There is no spatial overlap between these surveys and this proposed project.

The local CNMI agencies of DFW and Bureau of Environmental Control and Quality (BECQ) also conduct periodic marine surveys on Tinian. There is no spatial overlap between these surveys and this proposed project.

Additional recent work to examine the potential resiliency of coral reefs to future climate change impacts was also conducted around Tinian (Maynard *et al*. 2015). There is no spatial overlap between these surveys and this proposed project.

There are other marine research projects and surveys that have occurred around Tinian over time. None of these are currently known to have spatial overlap with this proposed project.

While there are no known projects that overlap with this area, previous projects may provide valuable comparative information for mitigation planning if needed. Further analysis of these datasets can be incorporated into a Phase II investigation or mitigation planning as necessary.

Coordination with Federal and Territorial Resource Agencies

USACE Planning Charrette – February 16–18, 2016

Project Planning meeting – March 24, 2016

USACE to the Service request for a PAL – April 8, 2016

Service PAL/SOW to USACE – April 12, 2016

Logistics Planning Meeting with NMFS and local agencies – May 3, 2016

Field work conducted – May 27 – June 1, 2016

Field work debriefing – June 28, 2016

Report and project recommendations update – December 14, 2016

Draft report released – January 23, 2017

USACE comments to the Service on Draft report – February 16, 2017

USACE provides refined project descriptions to the Service – February 16, 2017

CNMI's BECQ comments to the Service on Draft report – February 22, 2017

Meeting with USACE on Habitat Equivalency Analysis – March 20, 2017

Meeting with USACE, Service, and NMFS on final report – May 24, 2017

Draft Habitat Equivalency Analysis and Mitigation Plan – June 12, 2017

NMFS informal comments on January 2017 draft report – March 12, 2018

Description of Project Area

Tinian lies in the western Pacific Ocean (Figure 1), and is one of three main inhabited islands in the CNMI. It is located about 5 km southwest of Saipan, 89 km northeast of Rota, and 163 kilometers (km) northeast of Guam. The capitol of the island is San Jose at 14° 58' N latitude and 145° 37' E longitude. At approximately 100 km^2 in size, Tinian is the second largest island in the CNMI (Bearden *et al*. 2005). The population is small, consisting of approximately 3,136 people (CNMI Department of Commerce, Central Statistics Division, 2010), located primarily around San Jose village and limited to the southern third of the island. The area surrounding Tinian Harbor is the most developed area of the island, and may be prone to the most impacts (Bearden *et al.* 2005). Approximately 15,353 acres (or two-thirds) of Tinian is leased to the U.S. military through an arrangement known as the Military Lease Area (MLA). The MLA was leased to the Government of the United States on a renewable 50-year lease as part of the 1976 Covenant for $17.5 million in a property agreement that also included a small piece of property at Tanapag Harbor on Saipan and the entire island of Farallon de Medinilla Island. The main purpose of the MLA is to support military training (CJMT Draft EIS/OEIS 2015). A section of the MLA sublet back to CNMI, known as the Lease Back Area (LBA), is used to support cattle grazing. Another 777 acres of the MLB is used by the International Broadcasting Bureau. Amphibious landings are currently authorized at several Tinian beaches and the U.S. Department of Defense (DoD) is proposing to expand these activities for future training opportunities (MITT Final EIS/OEIS 2015; CJMT Draft EIS/OEIS 2015). The DoD is also proposing to expand the use of the Tinian Airport to support operations and exercises whenever Anderson Airforce base on Guam is unavailable (Department of Air Force 2016). The proposed military activities are expected to indirectly impact the harbor through increases in delivery of construction materials, equipment, personnel and fuel. Public transportation was previously available between Saipan and Tinian via ferries that ran twice each day into the harbor, predominantly to service the Tinian Dynasty hotel and casino. The ferry services stopped in 2010 and the Dynasty Hotel closed in 2015. Other large scale development projects have been proposed in recent years including Alter City Group with plans to develop a 300 room hotel and casino and 18 hole golf course, and the Bridge Investment Group with a hotel and casino that includes a replica of the *Titanic* adjacent to the port facility and within the footprint of this study. Should the Dynasty Hotel reopen or any of the proposed hotel development projects move forward then activities at the Tinian port are expected to greatly increase.

FISH AND WILDLIFE RESOURCE CONCERNS AND PLANNING OBJECTIVES

U.S. Fish and Wildlife Service Planning Objectives

The mission of the Service consists of working with others to conserve, protect, and enhance fish, wildlife, plants, and their habitats for the continuing benefit of the American people. In 2016, the Service updated its mitigation policy to better meet this mission. This policy provides guidance to Service personnel in formulating and delivering recommendations and requirements to action agencies and project proponents so that they may avoid, minimize, and compensate for action-caused impacts to species and their habitats. This policy complements the Service 's participation under the NEPA, FWCA, CWA, and other authorities of the Service. The guiding principle of this policy is to provide timely and effective recommendations when proposed actions may reduce the benefits of fish, wildlife, plants, and their habitats to the American people. To this end, it is the policy of the Service to seek to mitigate losses of fish, wildlife, plants, their habitats and their uses resulting from the proposed action. This is achieved by the following fundamental principles: 1) net conservation gain, 2) observe an appropriate mitigation sequence, 3) avoid high-value habitats, 4) use a landscape approach, 5) ensure consistency and transparency, 6) science-based mitigation, 7) durability, and 8) effective compensatory mitigation. The policy further lays out a mitigation framework that includes 1) integrating mitigation planning with conservation planning, 2) collaboration and coordination, 3) assessment, 4) evaluation species, 5) habitat valuation, 6) means and measures, 7) recommendations, 8) documentation, and 9) follow-up (USFWS, 2016).

The policy provides details on the preference of the mitigation hierarchy under the Means and Measures section as well as the characteristics for evaluation species and habitat valuation. It is the Service's policy to recommend, when feasible, to avoid and minimize impacts as opposed to providing compensatory mitigation. In this report we provide information to assist with avoidance and minimization of impacts, set in the context of evaluation species and habitat valuations. One evaluation species criterion includes species that perform a key role in ecological processes and serves as indicators of ecosystem health. While many species on coral reefs may fit this category, the Service considers reef building, stony corals as a foundational evaluation species in tropical marine ecosystems. Another important group of species the Service considers as evaluation species are seagrasses. The Service may also consider other key species as evaluation species when appropriate. Coral reefs in general are considered a high value habitat and have been defined in the CWA Section 404(b)(1) guidelines as "skeletal deposits, usually of calcareous or silicaceous materials, produced by the vital activities of anthozoan polyps or other invertebrate organisms present in growing portions of the reef." Within this broad definition and considering the detailed habitat structures described within the Evaluation Methodology section below, the Service considers hard bottom and mixed hard bottom habitat structures of coral reefs to be of the highest value.

Resource Concerns

This report is a Phase I investigation that addresses part of the Service's mitigation framework to the extent the data are sufficient. A Phase I report aims to provide broad information for avoidance and minimization, but does not include information necessary for scaling and planning a compensatory mitigation package. A subsequent Phase II investigation can address the remaining components of the Service's mitigation framework, and can also provide information for scaling and planning a compensatory mitigation package, if necessary.

The primary concerns associated with the proposed project at Tinian Harbor include potential direct and secondary impacts to the marine habitat within and adjacent to the proposed sites. The specific planning objective is to provide technical assistance to the USACE for the project alternative formulation, as well as best management practices to minimize the impact to fish and wildlife resources. To achieve this goal the we provide the following: 1) biological and habitat data for the proposed project sites; 2) analysis of potential impacts of the proposed project to fish and wildlife resources and their habitats; 3) recommendations for minimization and avoidance measures; and 4) potential mitigation opportunities for unavoidable project-related habitat losses consistent with the FWCA and our agencies' policies. Any discussed mitigation opportunities are for project planning purposes and not meant to be quantified for fully scaled projects.

EVALUATION METHODOLOGY

Field Data Collection Protocol

Two teams of three biologists using SCUBA and/or snorkel collected information on the habitats and biological communities within and adjacent to the project footprint. The survey team was equipped with digital cameras, dive watches, floated GPS units, and datasheets attached to a clipboard to record data. The time on the digital camera was synchronized with the GPS units by photographing the time of the GPS unit before entering the water. In addition, the time difference between the dive watch and GPS unit was recorded on the datasheet. The team was familiar with the proposed project area and had pre-determined starting points and areas for the initial survey. The number of survey transects was determined based on the time available and an estimated area covered.

A survey transect consisted of the team collecting habitat and biological information as described below along a swim path while towing a pair of floated GPS units. The floated GPS units were always maintained/aligned near the team to minimize spatial error between the biologists and the GPS. All survey transects were marked by a starting waypoint and an ending waypoint. GPS units were set to the local time and set to record a track log automatically at 5 second intervals.

The biologists on the survey team consisted of a habitat/coral surveyor, an algal/invertebrate surveyor, and a surveyor for ESA-listed corals. All biologists collected data on observed habitat zones, debris observations, and protected species as well as their respective biological groups. The visual observation area that was qualitatively evaluated was estimated by each biologist and recorded in meters. The estimation distance was influenced by water clarity, rugosity of habitat, complexity of habitat, water depth, and other environmental conditions that limit visual distance. One biologist was assigned as the navigator; this person followed a pre-determined compass bearing, depth contour, habitat boundary or other criteria that determined the survey transect path. Each biologist carried an underwater camera to document species and habitat types observed.

Habitat Terminology and Characterization

Habitat terminology used was modified from Battista *et al.* (2007). Although the classification of Battista *et al.* (2007) was not developed specifically for impact assessments, the terminology and characterization framework was deemed generally appropriate for the purposes of characterizing habitats for this Phase I survey. The framework described in Battista *et al.* (2007) included three data layers of habitat information, consisting of a classification of geographic zones, geomorphological structures, and biological cover. The terms for geographic zones, geomorphological structures, and major geomorphological structures are used here with slight modification. The "geographic zones" are subsequently called "habitat zones," the "geomorphological structures" are subsequently called "habitat structures," and the "major geomorphological structures" are subsequently called "major habitat structures." By contrast, the biological cover classification scheme of Battista *et al.* (2007) is not used. Instead, the biological cover classification scheme used here is modified and expanded substantially from Battista *et al.* (2007), as described below.

Habitat zones were generally determined prior to entering the water or after exiting from the water, and were recorded by the habitat/coral and algae/ invertebrate surveyors. Habitat structures were determined in the water to the best ability of the habitat/coral surveyor. Water clarity and conditions could impact the diver's ability to determine the specific habitat structure, but it was generally determined while in the water. Biologists, particularly the navigator, followed along a habitat structure boundary when appropriate in order to assist with further delineation between habitat structures. Care was taken when conducting the biological characterization along these boundaries. The biological characterization was focused on one side of the observed boundary so that it was applied appropriately to each particular habitat structure involved. This aspect was coordinated by the observers and noted on the datasheet. The boundaries between habitat structures were evaluated or refined during the data processing phase (see Habitat Map Production methods). The types of unconsolidated sediments observed were also recorded, being scored as present or absent. These included sand, mud, rubble, and cobble as described below.

In addition to characterizing the habitat structures, the habitat/coral surveyor also characterized habitat complexity. The categories of habitat complexity are the same as used by NOAA's Pacific Islands Fishery Science Center (Brainard *et al.* 2008; Brainard *et al.* 2012). As stated in Brainard *et al.* 2008, "Estimates of habitat complexity were subjective assessments of topographical diversity and complexity of the benthic habitat and were classified according to one of six categories: low, medium-low, medium, medium-high, high, and very high (Fig.

2.4.2b). As examples, low habitat complexity is often associated with flat sand plains or rubble habitats; medium habitat complexity is often associated with small to moderate spur and groove, coral or boulder habitats; and high or very high habitat complexity are often observed as high or extreme vertical relief associated with steep spur-and-groove canyons, pinnacles, and walls." These six categories were recorded on a 0-5 scale with 0 for low, 1 for medium-low, 2 for medium, 3 for medium-high, 4 for high, and 5 for very high.

Habitat Zone Term Definitions

Land – Terrestrial features above the mean high waterline.

Shoreline Intertidal – Area between the mean high waterline (or landward edge of emergent vegetation when present) and mean low lower waterline (excluding emergent segments of barrier reefs).

Vertical Wall – Area with near-vertical slope from shore to shelf or shelf escarpment. This zone is typically narrow and may not be distinguishable in remotely sensed imagery, but is included because it is recognized as a biologically important feature.

Reef Flat – Shallow, semi-exposed area between the shoreline intertidal zone and the reef crest of a fringing reef. This zone is protected from the high-energy waves commonly experienced on the shelf and reef crest.

Lagoon – Shallow area (relative to the deeper water of the bank/shelf) between the shoreline intertidal zone and the back reef of a barrier island. This zone is relatively protected from the high-energy waves commonly experienced on the bank/shelf and reef crest. If no reef crest is present there is no lagoon zone.

Back Reef – Area between the seaward edge of a lagoon floor and the landward edge of a reef crest. This zone is present when a reef crest and lagoon exist.

Reef Crest – The flattened, emergent (especially during low tides) or nearly emergent segment of a reef. This zone lies between the back reef and fore reef zones. Breaking waves will often be visible in aerial images at the seaward edge of this zone.

Fore Reef – Area from the seaward edge of the reef crest that slopes into deeper water to the landward edge of the bank/shelf platform. Features not forming an emergent reef crest but still having a seaward-facing slope that is significantly greater than the slope of the bank/shelf are also designated as fore reef.

Bank/ Shelf – Deep water area (relative to the shallow water in a lagoon) extending offshore from the seaward edge of the fore reef to the beginning of the escarpment where the insular shelf drops off into deep, oceanic water. The bank/shelf is the flattened platform between the fore reef and deep open ocean waters or between the shoreline/intertidal zone and the open ocean if no reef crest is present.

Bank/ Shelf Escarpment – The edge of the bank/shelf where depth increases rapidly into deep, oceanic water or down to another bank/shelf.

Channel – Natural channels or reef passes that often cut across several other zones (does not include artificial channels for harbors).

Harbor – Area that is used for vessel mooring and is generally considered to be inside the outer points of the rock jettie at the mouth of the harbor entrance.

Habitat Structure Term Definitions

Pavement – Flat, low-relief, and solid (carbonate or basalt substratum) bottom with coverage of macroalgae, coral, and other benthic invertebrates that are dense enough to begin to obscure the underlying surface. (Major Structure: Hard Bottom)

Pavement with Sand Channels – Habitats of pavement with alternating sand/rubble channel formations. The sand/rubble channels of this feature have low vertical relief relative to spur and groove formations (less than 1 m). (Major Structure: Mixed)

Aggregate Reef – High vertical relief relative to pavement, but lacking sand/rubble channels of spur and groove. (Major Structure: Hard Bottom)

Spur and Groove – High vertical relief relative to pavement, and having alternating sand/rubble (groves) and reef (spurs) formations (greater than 1 m of vertical relief). (Major Structure: Mixed)

Patch Reef – Coral formations that are isolated from other coral reef formations by sand, seagrass, or other habitats and that have no organized structural axis relative to the contours of the shore or shelf edge. (Major Structure: Hard Bottom)

Rock/Boulder – Continuous rocks/boulders (carbonate or basalt greater than 25 cm) with coverage of macroalgae, corals, and other benthic invertebrates. (Major Structure: Hard Bottom)

Reef Hole – An area where a depression exists in the surrounding reef area. These do not include large, expansive basin features, but smaller reef features. (Major Structure: Hard Bottom)

Scattered Coral/Rock in Unconsolidated Sediment – Primarily unconsolidated sediment bottom with scattered rocks/boulders or small, isolated coral heads that are too small to be delineated individually (i.e. smaller than individual patch reef). (Major Structure: Mixed)

Unconsolidated Sediment – Area comprising sand, mud, rubble, or cobble without isolated scattered coral/ rocks or large corals. See definitions of sediment terms below for sand, mud, rubble, and cobble. (Major Structure: Unconsolidated Sediment)

Artificial – A structure that cannot the classified as any other structure that includes harbor pilings or other harbor, development structure. (Major Structure: Hard Bottom)

Sediment Term Definitions

Sand – Defined as sediment that has a visual grain size (estimated to be 0.0625 – 10 mm)

Mud – Defined as sediment that is difficult or impossible to determine grain size

Rubble – Limestone rubble or gravel that is comprised of limestone greater than sand, but less than 25 cm in diameter

Cobble – Basalt rubble or gravel that is comprised of basalt or other non-limestone material greater than sand, but less than 25 cm in diameter (note if material is artificial).

Biotic Characterization

The biologists collected information on various biological groups/ categories and species inventoried along the survey transect. The information on the various biological groups/ categories (as described below) was recorded at a frequency of every 15 to 60 seconds depending on the habitat area and speed of swimming, but varied under different circumstances. The area that could be reasonably visually assessed was recorded at each point and varied based on water depth, water visibly, or other environmental factors. The biotic characterization included three main survey components (habitat/coral, algae/ invertebrate, and ESA corals) and each main component had multiple data collection components.

Habitat/ Coral Data

The habitat/coral surveyor (Service biologists Tony Montgomery and Nadiera Sukhraj) collected information on habitat as described above, as well as six different components of the coral population within an area. These components included the relative abundance of stony coral, stony coral growth forms observed, estimated stony coral sizes present, and presence of non-stony corals. Details for each component are given below. Each observation was collected with the specific time (hh:mm:ss) that was later converted to a GPS coordinate by the closest GPS track log coordinate within a five second window. This conversion was completed in a Microsoft Access© database. The area that could be reasonably visually assessed for coral abundance was estimated as a visual distance in meters (in terms of a radius) and recorded on the datasheet. The observer also carried an underwater camera to take photographs of representative habitats, representative coral communities, coral colonies for species identification, or any other notable feature of interest.

Component 1 – Habitat structure and sediment were classified on a continual basis and with the same frequency as other data. Habitat zone was classified at the start of the dive or when a change of zone was found.

Component 2 – Relative abundance of coral was recorded utilizing a modified DACOR method. DACOR stands for dominant (5), abundant (4), common (3), occasional (2), or rare (1), and categories were recorded on a 1-5 scale with 1 being Rare and 5 being Dominant. Zero was used for coral absence. Each category was approximated to represent a broad range of percent coral cover such as: 1 – <1% (scattered corals), 2 – <10%, 3 – 10-50%, 4 – 50-80%, and 5 – >80%.

Component 3 – The stony coral growth forms included: 1) lobate/massive, 2) conical, 3) small-branching, 4) medium-branching, 5) large-branching, 6) digitate, 7) columnar, 8) table, 9) plate, 10) foliaceous, 11) encrusting, 12) free-living, and 13) mixed. Possible mixed growth forms included forms like plates-and-column and plates-and-branched, but if other combinations existed, they were recorded. The distinction between small and medium branching colonies were made by using the approximate diameter of a pencil (< 1 cm) while the distinction between medium and large branching colonies were made by using the approximate diameter of a small wrist (< 5 cm). For data analysis, these growth forms were lumped into fewer categories including: 1) lobate, microatoll, branching, encrusting, plate-like, and free-living.

Component 4 – For each growth form observed, the sizes observed were recorded into broad size categories, including: 1) small included colonies estimated less than 50 cm, 2) large included colonies greater than 50 cm, 3) mixed included colonies of both small and large, and 4) extra-large included colonies greater than 2 m.

Component 5 – Non-stony coral groups were recorded as present or absent. The groups included: 1) soft corals, 2) zoanthids, 3) gorgonians or sea fans, and 4) black or wire corals.

Component 6 – If coral disease or bleaching were observed, it was noted in the comments section of the datasheet and recorded in the Access database. It was recorded as present or absent as coral stress, and then logged as disease, pale bleached, partial bleached, or complete bleached.

Algae/ Non-Coral Invertebrate Data

The algal/ invertebrate observer (Service biologist Kevin Foster and Service volunteer Paul Murakawa) collected information on up to eight different components. These components included relative abundances for seagrass, turf algae, coralline algae, filamentous algae, macroalgae, and several invertebrate groups. The observer also recorded observations of debris. Additionally, the observer developed an overall species list for algae and non-coral invertebrates. The details for each component are listed below. Each observation was collected with the specific time (hh:mm:ss) that was later converted to a GPS coordinate by the closest GPS track log coordinate within a five second window. This conversion was completed in a Microsoft Access© database. The area that could be reasonably assessed for algal/ invertebrate abundance was estimated as a visual distance in meters (in terms of a radius) and recorded on the datasheet. The observer also carried an underwater camera to take photographs of representative habitats, representative algal and invertebrate communities, algae and invertebrates for species identification, or any other notable feature of interest.

Component 1 – Relative abundance for seagrass was recorded on a scale of 0–3. Zero was used for seagrass absence. Category one represented seagrass abundance that consisted of isolated patches and did not have continuous coverage within an area. Category 2 represented seagrass that had a semi-continuous or continuous coverage, but had a low density of blades. Category 3 represented seagrass with a continuous coverage and had a high density of blades or a tall canopy height. The species of seagrass was recorded.

Component 2 – Relative abundance for turf algae was recorded on a scale of 0–3. Zero was used for turf algae absence. Category one represented turf algae that had sparse or patchy coverage and/or low density of turf algae. Category two represented a moderate, semi-continuous coverage and a low to moderate density of turf algae. Category three represented a continuous coverage and a high density of turf algae. Turf algae for the purpose of this assessment were sparse to thick multi-specific assemblage of diminutive and juvenile algae less than 2–3 cm in canopy height.

Component 3 – Relative abundance for coralline algae was recorded on a scale of 0–3. Zero was used for coralline algae absence. Category one represented a sparse or patchy coverage of coralline algae. Category two represented a moderate or semi-continuous coverage of coralline algae. Category three represented a continuous coverage of coralline algae. Coralline algae were assessed for readily visible corallines mostly that are red or pink on the reef surface. The observer did not look in holes or under rocks to assess the coralline algae abundance.

Component 4 – Relative abundance of filamentous algae and cyanobacteria was recorded on a scale of 0–3. Zero was used for absence of filamentous algae or cyanobacteria. Category one represented a sparse or patchy coverage of filamentous algae or cyanobacteria. Category two represented a moderate or semi-continuous coverage of filamentous algae or cyanobacteria. Category three represented a continuous coverage and a high density of filamentous algae or cyanobacteria. Filamentous algae for the purposes of this assessment was defined as hair-like plants that do not form a substantial thallus or a coherent tissue (definition modified from Huisman *et al*. 2007, page 254). Common filamentous algae that are representative of this group include *Cladophora* spp. or *Bryopsis hypnoides* (not *Bryopsis pennata*). Common cyanobacteria that are representative of this category include *Lyngbya* spp. and *Hormothamnion* sp.

Component 5 – Relative abundance of macroalgae was recorded on a scale of 0–3. Zero was used for macroalgae absence. Category one classification represented sparse or patchy (even individual plants) and a low density of macroalgae. Category two classification represented moderate, semi-continuous coverage and a low to moderate density of macroalgae. Category three represented a continuous coverage with a high density of macroalgae. In addition to recording the relative abundance, four forms of macroalgae were recorded as being present or absent and included short frondose, tall frondose, *Halimeda* algae, or invasive macroalgae. Short frondose macroalgae was defined as having a maximum canopy height of 20 cm and tall frondose macroalgae was defined as a canopy minimum canopy height of 20 cm.

Component 6 – Relative abundance for all non-coral invertebrates was recorded on a scale of 0–3. Zero was used for invertebrate absence. Category one classification represented an observation of 1–2 individuals. Category two classification represented the observation of 3–10 individuals. Category three represented the observation of more than 10 individuals. If an aggregation of significantly more than 10 individuals was observed, this was recorded in the comments section. The invertebrate groups included grazing sea urchins, rock boring sea urchins, crown-of-thorns starfish, lobsters, *Pinctada margaritifera*, giant clams, anemones, sea cucumbers, molluscs (strombids, top or turbin shells, Triton's Trumpet, helmet shells, etc.), octopus, seastars (*Linckia* sp., *Culcita* sp., or others) and, crinoids. In addition, the presence and absence (but not relative abundance of) sponges and tunicates in all forms and shapes were recorded.

Component 7 – The observation of marine debris (deb) or remnant structure underwater was recorded as present or absent. The type of structure or debris was recorded (UXO, tires, misc., etc.).

Component 8 – The final component was the compilation of an overall species list for all algae and invertebrate species observed. Species were identified to the lowest taxonomic level possible, either *in situ* or by subsequent examination of photographs taken on-site. , but it is an estimate of species richness along one transect

ESA-listed Coral Data

The ESA-listed coral surveyor (Service volunteer Douglas Fenner and NOAA biologist Steve McKagan) collected information on the presence, depth, abundance of any listed coral species (15 species within the Indo-Pacific region), approximate size class, colony condition, and a total coral species presence within the area. Details for each component are given below. Each observation was collected with the specific time (hh:mm:ss) that was later converted to a GPS coordinate by the closest GPS track log coordinate within a five second window. This conversion was completed in a Microsoft Access© database. The area that could be reasonably visually assessed for coral abundance was estimated as a visual distance in meters (in terms of a radius) and recorded on the datasheet. The observer also carried an underwater camera to take photographs of representative habitats, coral colonies for species identification, or any other notable feature of interest.

Component 1 – The surveyor would record the exact time that an ESA-listed coral colony(s) was observed. The species and the certainty of its identification were recorded. If the colony(s) showed some morphological difference from the typical species morphology that might indicate an uncertain identification, this uncertainty was recorded.

Component 2 – The depth of the observation was recorded and approximated to the nearest 1 meter.

Component 3 – The number of individual colonies observed at a single time or location was.

Component 4 – The approximate size class of the colony(s) were recorded in aggregate. Size class bins included <10 cm, <20 cm, <40 cm, <80 cm, and < 160cm. Individual colony sizes were not recorded, but only the aggregated size bins for all observations at a given location.

Component 5 – The condition of the colony(s) was recorded, and it was noted if bleaching or disease was observed. Such conditions were also recorded in a photo taken of the colony(s).

Component 6 – The surveyor also collected as much information as practical on other, non-listed coral species present. Species were identified to the lowest taxonomic level possible, either *in situ* or by subsequent examination of photographs taken on-site. The resulting species inventory should not be assumed to be a comprehensive list of all species present, but it is an estimate of species richness along one transect.

Post-Field Work Data Processing

Data Preparation

At the end of each dive day, digital images and GPS data were downloaded using appropriate software. Images were placed into daily folders and GPS data were downloaded using DNRGPS 6.0© as a tab-delimited text file (.txt). Benthic data were entered into a Microsoft Access© database. After all data were entered into the Access database, the gps data, dive data, habitat-coral data, algae-invert data, and ESA-listed coral data were validated for errors or anomalies. All errors were corrected and the data was processed for geosyncronization. The final, validated, georeferenced data were outputted as a database file (.mdb).

Data Processing

Habitat map data layers were produced with a Service custom built toolbox (Marine_Mapping_v3.tbx) using Modelbuilder in ArcGIS© 10.2.2. The toolbox consisted of multilayered models that generate final data layers used for final map production. Model A conducted a series of geoprocessing steps which prepared and initialized the data for classification. Model B consisted of a series of models that conducted a series of optional geoprocessing steps and utilized external data. The external data included NOAA's benthic classification data, a digital elevation model (DEM), a land classification layer, and a habitat classification layer produced from Feature Analyst©. NOAA's benthic classification data was incorporated into the classification layer produced from field data that provided a comparative option for the final classification. The DEM was used to provide habitat roughness and/or slope of habitat that assisted with habitat delineations. The DEM was generated from LiDAR collected by the U.S. Department of Defense around the island of Tinian. Habitat classification produced from Feature Analysts was also incorporated into the classification layer that further provided comparative options for the final classification. The habitat classification layer produced by Feature Analyst was created using a subset of the field classification data that minimized observer variability of habitat classification and WorldView-2 satellite imagery that produced a classification layer across the entire project area. After these individual datasets were processed, they were incorporated and combined into the final classification layer. This final layer was made based on comparative criteria and manual interpretation of the results. The final classification was inputted into Model C to complete the data layer processing. Model C finalized the geoprocessing steps and incorporated a series of interpolations for all the biological groups as described previously. These biotic interpolations were created with the Inverse-Distance Weight (IDW) Interpolation tool in Spatial Analysts extension.

Initial input layers used to begin the data processing included an area enclosure, target area shapefiles, land classification layer, and raw database output file. The target area shapefile represented the total, maximum area (inclusion of all potential alternatives) of the anticipated direct impact area of the proposed action. This layer was provided to the Service by the USACE. The area enclosure shapefile represented the area that bounds the total project area. The land classification layer was a layer developed prior to data collection that delineated land areas (including any dock area) from marine areas below the mean higher high waterline (MHHW) or estimated MHHW.

During the classification stage, there were set classification criteria as well as manual interpretation of the layer classifications used to make the final classification determination. The set classification criteria and manual interpretation determined the boundaries of the habitat structures by: 1) direct observation, 2) transects that were swum along habitat structure transition boundaries (i.e. scattered rock in unconsolidated sediment on one side and unconsolidated sediment-sand on the other side), 3) utilizing NOAA's Benthic Habitat Maps where deemed appropriate, or 4) other data sources as described previously (Feature Analyst outputs based on WorldView-2 imagery) that provided information on habitat structures. These boundaries may not represent the exact delineation between habitat structures, but serve as an estimate based on the available information. After the boundaries are drawn for each habitat character, the edited Theissen polygon was validated to reassure all changes are correct and complete.

The models also generated output tables that included all geodetic area calculations for each habitat major structure, habitat structure, sediment type, and habitat zones. Also, the raw number counts per transect area were also output for incorporation into the ESA-listed coral model estimations as described below.

Habitat Map Production

Once the habitat map data layers were produced and verified, the final set of formatted maps were produced with a Service custom built Python script. This script produced 36 final formatted maps that provided a complete characterization of the project. Additionally, based on the size of the project area, five additional smaller scale maps were produced to provide a close-up view of the habitat characterization. Finally, this Python script exported all of the maps and data layers into a map package, allowing for easy transfer of all electronic files for map creation as well as the generation of ArcMaps and jpeg map images.

ESA-listed Coral Estimations

Density estimates for ESA-listed corals were calculated based on the field data as described above for each habitat structure observed. Densities were estimated for the total project area using both certain and uncertain colony identifications. Density numbers were calculated for non-zero coral abundance areas to reduce the skew in the data; hence, the numbers only apply to non-zero coral abundance areas which were calculated as the percent of the transect area where corals were observed. Estimations were made with two non-parametric methods. First, a jack-knife approximation was made with 5,000 iterations with 20% of the samples randomly removed on each iteration. Second, a non-parametric bootstrap estimation of the sample median was computed with 5,000 iterations. The mean and 95% confidence intervals were computed and the bootstrapped median was calculated. However, based on the bootstrapped median still having significant skew, non-parametric BCa (bias-corrected and accelerated) confidence intervals

(DiCiccio and Efron 1996) were computed to provide a meaningful range of densities. The calculations were computed in a custom built R script using the bootstrap package (Efron and Tibshirani 1993).

The total number of colonies was estimated to be within the proposed project footprint (target area) and the two proposed alternatives (Figures 2 and 3). The densities of the colonies were calculated similarly to the colonies within the project footprint, but the source data were limited to the areas within and immediately adjacent to the target area. The area used to limit the data was an area buffering the target area. The buffer distance was calculated as the total target area divided by the area perimeter to account for varying geometries of the target area. This buffered area was used to limit transect data to provide an estimate the coral density that more accurately reflects colony density within the target area. The spatial extent of the target area was estimated between zero coral areas and non-zero coral areas to determine the percentage of area by habitat structure of non-zero coral areas. The coral densities were then extrapolated to the non-zero coral area to determine the total number of corals within the target area.

DESCRIPTION OF ALTERNATIVES UNDER CONSIDERATION

At the time of the surveys, project alternatives were not formulated, but concepts for various project components were being considered. With this understanding, the USACE provided a combined set of footprints including various project components that could be part of one or more project alternatives. This area labeled as the Target Area in Figure 4 does not represent a specific plan or design, but rather a combination of potential project components, and represented the highest priority to evaluate for this Phase I investigation. Figure 4 shows the total Project Area (total surveyed area plus project footprint) and Target Area (potential project footprint only) with the five areas highlighted for evaluation. These areas simply represent discernable sections of the project for discussion purposes only, and do not represent alternatives. The descriptions of the biological resources and habitat characteristics are broken down by each area. The entire Project Area and the corresponding 36 maps as described above are shown in Appendix A. Each specific area also has a set of 36 maps showing the habitat and resources within that particular area (Area 1 in Appendix B; Area 2 in Appendix C; Area 3; Appendix D; Area 4 in Appendix E; and Area 5 in Appendix F).

Project components include deepening the turning basin by dredging with a barge-mounted clamshell bucket. Dredged material would be evaluated for beneficial use or disposed of on land, off-site, or at a deep water ocean site (Figure 4, Area 5). Components also include repairs to the existing inner (Figure 4, Area 1) and outer breakwaters (Figure 4, Areas 2 and 3) as well as potentially modifying the outer breakwater with an extension of spur near the channel entrance (Figure 4, Area 3). Additional components also include the potential of adding new structures to address wave energy in the turning basin and berthing areas (Figure 4, Area 4). The structures may be composed of stone and/ or concrete and could be attached to the existing breakwater. The construction would be completed from land or barge as needed.

In January 2017, the USACE provided two project alternatives under consideration (Figures 2 and 3). Alternative 1 (Figure 2) represents a complete repair to the existing inner and outer breakwater structure with a 20 m (65 ft.) width, while Alternative 2 (Figure 3) includes the features of Alternative 1 with an 90 m (295 ft.) by 40 m (130 ft.) extension of the outer breakwater near the channel entrance. However, no additional information is available at this time on the construction details for these structures, which severely reduces the ability to estimate potential secondary impacts associated with the construction activities. As such, these alternatives simply represent a narrower estimation of the proposed structure, but not exact footprints, given that the exact alignment and size of the structure will likely change during the design phase of the project.

DESCRIPTION OF FISH AND WILDLIFE RESOURCES AND HABITAT

General

Appendix A contains 36 maps depicting the habitats and biological resources within and around Tinian Harbor.

- Figure A1 shows the Target Area and Project Area.
- Figures A2 and A3 show the area observed within the Project Area and the dive tracks, highlighting the area directly observed versus not observed.
- Figures A4 to A8 show the habitat zones, habitat major structures, sediment types, habitat structures, and habitat structures only within the Target Area, respectively.
- Figure A9 shows the habitat complexity.
- Figure A10 shows the location of debris.
- Figure A11 shows the location of protected species observed.
- Figures A12 to A14 show the coral abundance, coral sizes and morphologies, and ESA-listed coral locations.
- Figures A15 to A17 show the presence of soft corals, zoanthids, and gorgonians.
- Figure A18 shows the abundance of seagrass.
- Figures A19 to A22 show the abundance of frondose algae, crustose coralline algae (CCA), turf algae, and filamentous algae or cyanobacteria, respectively.
- Figures A23 to A34 show the abundance of herbivorous urchins, rock boring urchins, sea cucumbers, Crown-of-Thorns sea stars, molluscs in general, sea stars other than Crown-of-Thorns, *Pinctada margaritifera*, giant clams, anemones, lobsters, octopus, and crinoids, respectively.
- Figures A35 to A36 show the presence of sponges and tunicates, respectively.

Details for each of these maps are discussed in each respective project area, except for those pertaining to gorgonians, *Pinctada margaritifera*, lobsters, and crinoids, which were not observed during this survey.

Table 1 show the breakdown of area measurements for different habitat structures, zones, and sediment types within the Target Area (potential project footprint). The total area is 65.2 acres (263,746 m^2). It consists of nine different habitat zones including: 1) Back Reef, 2) Bank/ Shelf, 3) Channel, 4) Fore Reef, 5) Harbor, 6) Lagoon, 7) Land, 8) Reef Crest, and 9) Reef Flat. Over 80% of the area is dominated by three zones (Harbor at 50.4%, Channel at 17.4%, and Back Reef at 12.8%). The remaining 20% of the Target Area is represented by the other six zones. The Target Area consists of 4.04 acres (16,341 m^2) of Land, 16.76 acres (67,831 m^2) of hard bottom, 9.86 acres (39,908 m^2) of mixed bottom, and 34.51 acres (139,666 m^2) of unconsolidated sediment. Of the unconsolidated sediment areas, the sediment type mostly consists of sand or sand/rubble mix (~92%). The habitat structures of the Target Area consist of 1) Aggregate reef, 2) Land, 3) Pavement, 4) Pavement with Sand Channels, 5) Scattered Coral/Rock in Unconsolidated Sediment, 6) Spur and Groove, and 7) Unconsolidated Sediment. Of these, two habitat structures comprise 74.1% of the area (Pavement at 13.77 acres [55,738 m^2] and Unconsolidated Sediment at 34.51 acres [139,666 m^2]). However, the smaller areas represent high value habitat, with Aggregate Reef at 2.99 acres (12,093 m^2), Pavement with Sand Channels at 2.41 acres (9,768 m^2), Scattered Coral/ Rock in Unconsolidated Sediment at 4.87 acres (19,710 m^2), and Spur and Groove at 2.58 acres (10,430 m^2).

Based on the Service's mitigation policy, as described previously, and the habitat characteristics within the Target Area, the Service considers Aggregate Reef, Pavement, Spur and Groove, and Pavement with Sand Channels to be the highest value habitat structures, followed by Scattered Coral/ Rock in Unconsolidated Sediment. Unconsolidated Sediment habitat is the lowest value, but still provides certain important biological functions and services to consider for resource impacts.

ESA-listed Coral Density and Distribution

NMFS has listed 15 Indo-Pacific coral species as threatened under the ESA. Of these 15 species, only 7 are known from waters of the U.S. and of these 7 only 4 have been documented in the Marianas Archipelago (*Acropora globiceps*, *Acropora retusa*, *Acropora speciosa*, and *Seriatopora aculeata*). Of these four species, only *A. globiceps* was observed in the Project Area. A subset of the *A. globiceps* observations shows a broad depth distribution from 1–10 meters (Figure 5), although this does not represent the maximum depth limit of the species. This figure shows a subset of the data as depth were not collected on all dives and hence the depth distribution of the surveys was skewed to shallower depths. Recent surveys on Rota show more appropriate depth distribution for *A. globiceps* (Figure 6). The densities of colonies with a high degree of confidence in identification observed around the Project Area are shown in Table 2. Based on the BCa confidence intervals (CI), the density of *A. globiceps* ranged from 1.2 to 13.1 colonies per hectare for non-zero coral areas. The highest median density was 3.95 (CI 1.59–6.45) colonies per hectare for Aggregate Reef, and Pavement had the highest variation of median density (2.71 with CI 1.26–13.10 colonies per hectare). The densities of colonies with a lower degree of confidence in identification observed around the Project Area are shown in Table 3. Based on the BCa confidence intervals (CI), the density of *A. globiceps* ranged from 1.3–16.4 colonies per hectare for non-zero coral areas. The highest median density was 4.83 (CI 1.26-13.10) colonies per hectare for Pavement, and Aggregate Reef had the highest variation of median density (4.39 with CI 2.25–16.47 colonies per hectare). Additionally, colonies were observed on artificial structures including cables and vertical sheet piles.

Area 1

Habitat Characteristics

The marine habitat in the vicinity of Area 1 consists of four habitat zones (Harbor, Reef Flat, Lagoon, and Back Reef) (Appendix B, Figure B4) and two geomorphological habitat structures (Scattered Coral/ Rock in Unconsolidated Sediment and Pavement) (Appendix B, Figure B7). The majority of this area is Pavement and its habitat complexity is low to low-medium. Various types of metal debris were observed within this area. One notable observation was a barge or landing craft sunk in the area, although this does not show on the map (Appendix B, Figure B10).

Biological Resources

The number of species observed for each phylum within Area 1 is shown in Table 4 and the macroinvertebrate, coral, and algae species observed are listed in Table 5. Figure 7 shows the location of the transects that constitute the species inventory. The tracks within this area were 0528-4 and 0530-3. Track 0528-4 had a total of 24 species, although we did not record all coral species presence along this track, and had a low to moderate species richness relative to other transects. Track 0530-3 had 48 observed species, including 16 species of cnidarians, and had a moderate species richness compared to other transects.

Appendix B, Figure B11 shows that there was one protected species observed within this area. This observation consisted of one green sea turtle, *Chelonia mydas*, swimming near the existing breakwater.

The coral abundance observed in this area ranged from absent in spots to Common, but mostly consisted of Rare abundance (Appendix B, Figure B12). In general, the abundance was greater on the outside of the existing breakwater than on the inside. The abundance was also greater the further one progressed outside the Harbor and into the Lagoon. Coral morphologies were mostly lobate with some encrusting and branching colonies. The colony sizes were mostly small inside the breakwater with some mixed sizes (Appendix B, Figure B13). However, outside of the breakwater there were many large to extra-large colonies. Further into the Lagoon, extra-large microatoll colonies over 10 meters in diameter were reported, with many observations of colonies in the range of 4–5 meters. Additionally, the ESA-listed coral, *Acropora globiceps* was found scattered through this area, with some colonies within the Target Area. However, more colonies were observed on the outside of the existing breakwater than inside the breakwater (Appendix B, Figure B14). Soft corals were observed near the breakwater, but only on the outside, with none on the inside area (Appendix B, Figure B15).

Rare abundance of seagrass (species identification not recorded) was observed inside the harbor, but not next to the breakwater within the Target area (Appendix B, Figure B18). The frondose algae consisted of a fairly even cover of Rare to Common abundance, but did not include any tall algal communities (Appendix B, Figure B19). CCA was Rare to Common, but generally higher on the outside of the breakwater (Appendix B, Figure B20). Filamentous algae/ Cyanobacteria were observed on the inner, inshore side of the breakwater where the water quality seemed to be poor, with high temperatures and freshwater influx (Appendix B, Figure B22).

Sea urchins (both herbivorous and rock boring) were present, but generally in low densities within this area (Appendix B, Figures B23 and B24). Sea cucumbers had a moderate density within this area, with higher densities on the inside, inshore area of the breakwater (Appendix B, Figure B25). Crown-of-Thorns sea stars were observed within this area, but mostly on the outside of the breakwater and more commonly in the Lagoon and Back Reef (Appendix B, Figure B26). Molluscs and sea stars were observed at low densities both inside and outside the breakwater (Appendix B, Figures B27 and B28). Giant clams were observed within this area, but not within the Target Area (Appendix B, Figure B30). Octopus were observed at low densities within this area, but only in distinct isolated spots away from the breakwater (Appendix B, Figure B33).

Area 2

Habitat Characteristics

The marine habitat in the vicinity of Area 2 consists of two habitat zones (Harbor and Back Reef) (Appendix C, Figure C4) and four geomorphological habitat structures (Scattered Coral/ Rock in Unconsolidated Sediment, Pavement, Unconsolidated Sediment, and Pavement with Sand Channels) (Appendix C, Figure C7). The majority of this area is Scattered Coral/ Rock in Unconsolidated Sediment on the inside of the existing breakwater, and Unconsolidated Sediment on the outside of the breakwater. The edge of the Target Area extent touches on Pavement with Sand Channels (Appendix C, Figures C7 and C8). The habitat complexity is low on the inside of the breakwater and low to medium on the outside (Appendix C, Figure C9). Various types of metal debris were observed within this area. One notable observation was a barge or landing craft sunk in the area (Appendix C, Figure C10).

Biological Resources

The number of species observed for each phylum within Area 2 is shown in Table 4 and the macroinvertebrate, coral, and algae species observed are listed in Table 5. Figure 7 shows the location of the transects that constitute the species inventory. The tracks within this area were 0527-1, 0528-1, and 0529-4. Track 0527-1 had a total of 53 observed species, including 21 species of cnidarians, and had a low to moderate species richness relative to other transects. Track 0528-1 had 74 observed species, including 34 species of Cnidarians, and had a high species richness compared to other transects. Track 0529-4 had 30 observed species, including 11 species of cnidarians, and had a low species richness compared to other transects.

Appendix C, Figure C11 shows there was one protected species observed within this area. This observation consisted of one green sea turtle, *Chelonia mydas*, swimming outside, but near the existing breakwater.

The coral abundance observed in this area ranged from Rare to Occasional, but mostly consisted of Rare abundance (Appendix C, Figure C12). Coral abundance was similar from outside to inside the breakwater within the Target Area, but did increase on the Pavement with Sand Channel structure on the outside. On the inside of the breakwater, coral was generally Rare in abundance, but there were occasional spots with higher abundances due to small staghorn coral patches. Some of these patches were dead, but one in particular was mostly alive and can be seen in Appendix C, Figure C12 near the middle of the Target Area outlined in a square. Coral morphologies were mostly lobate with some encrusting colonies. The colony sizes were mostly small inside and outside the breakwater, with occasionally large colonies on the outside (Appendix C, Figure C13). Additionally, the ESA-listed coral, *Acropora globiceps* was found sparsely scattered through this area with some colonies within the Target Area. No colonies were found inside the breakwater within the Target Area, but the species was observed at several locations outside the breakwater, but still within the Target Area (Appendix C, Figure C14). Soft corals were observed within the area, but not within the Target Area (Appendix C, Figure C15).

Rare abundance of seagrass, *Halophila minor*, was observed inside the harbor, but not next to the breakwater within the Target Area (Appendix C, Figure C18). The frondose algae consisted of a fairly even cover of Rare to Common abundance, but no tall algal communities were present (Appendix C, Figure C19). CCA was Rare to Common, but generally higher on the outside of the breakwater (Appendix C, Figure C20). Turf Algae was Rare to Common, but appeared High on the outside of the breakwater (Appendix C, Figure C21).

Sea urchins (both herbivorous and rock boring) were absent on the inside of the breakwater, but were present in low density on the outside of the breakwater (Appendix C, Figures C23 and C24). Sea cucumbers had a low to moderate density outside of the breakwater, and were absent or at low density inside the breakwater (Appendix C, Figure C25). Molluscs and seastars were observed at low densities both inside and outside the breakwater (Appendix C, Figures C27 and C28). Giant clams were observed both inside and outside the breakwater. Giant clams outside the breakwater were within the Target Area and close to the breakwater, while the giant clams inside the breakwater were outside the Target Area (Appendix C, Figure C30). Octopus were observed at low densities outside the breakwater and within the Target Area (Appendix C, Figure C33).

Area 3

Habitat Characteristics

The marine habitat in the vicinity of Area 3 consists mostly of three habitat zones (Harbor, Back Reef, and Channel) (Appendix D, Figure D4) and five geomorphological habitat structures (Scattered Coral/ Rock in Unconsolidated Sediment, Pavement, Unconsolidated Sediment, Pavement with Sand Channels, and Spur and Groove). This area has three sections, including the western Target Area, central Target Area, and the eastern Target Area. The western Target Area is mostly Unconsolidated Sediment and Scattered Coral/ Rock in Unconsolidated Sediment; the central Target Area is mostly Pavement and Unconsolidated Sediment; and the eastern Target Area is mostly Pavement, Unconsolidated Sediment, and Spur and Groove (Appendix D, Figures D7 and D8). The habitat complexity in the Target Area is low to low-medium for the western and central Target Area sections and low to high for the eastern Target

Area section (Appendix D, Figure D9). Various types of metal debris were observed within this area (Appendix D, Figure D10).

Biological Resources

The number of species observed for each phylum within Area 3 is shown in Table 4 and the macroinvertebrate, coral, and algae species observed are listed in Table 5. Figure 7 shows the locations of the transects that constitute the species inventory. The tracks within this area were 0527-1, 0527-2, 0528-2, 0527-3, and 0531-1. Track 0527-1 had a total of 53 species, including 21 species of cnidarians, and had a moderate species richness relative to other transects. Track 0527-2 had 65 observed species, including 28 species of cnidarians, and had a high species richness compared to other transects. Track 0528-2 had 50 observed species, including 22 species of cnidarians, and had a moderate species richness compared to other transects. Track 0527-3 had 47 observed species, including 20 species of cnidarians, and a moderate species richness compared to other transects. Track 0531-1 had 57 observed species, including 25 species of cnidarians, and also had a moderate species richness compared to the other transects.

Appendix D, Figure D11 shows there were no protected species observed within this area.

The coral abundance observed in the western Target Area section ranged from Rare to Common with a small area of Common abundance on the inside of the breakwater. The central Target Area section had Rare to Occasional coral abundance. The eastern Target Area section had Rare to Abundant coral abundance, with the highest abundance on the Spur and Groove habitat structure. In particular, the western part of the eastern Target Area section had significantly higher coral abundance than the eastern part of this area. Two areas are highlighted with squares in the map that show small areas of high coral abundance (Appendix D, Figure D12). Coral morphologies were mostly small lobate forms, with some small encrusting colonies in the western and central Target Area sections. The eastern Target Area section had mostly small lobate colonies with some mixed and extra-large lobate colonies (Appendix D, Figure D13). Additionally, the ESA-listed coral, *Acropora globiceps* was found only sparsely through the western and central Target Area sections, but commonly throughout the eastern Target Area section. In particular, the high coral abundance area of the eastern target Area section included many colonies of *A. globiceps* (Appendix D, Figure D14). Soft corals were observed within the eastern Target Area section, but not within the western and central Target Area sections (Appendix D, Figure D15).

Rare abundance of seagrass *Halophila minor* was observed inside the harbor and within the central Target Area section (Appendix D, Figure D18). The frondose algae consisted of a fairly even cover of Rare to Common abundance, but no tall algal communities were present (Appendix D, Figure D19). CCA was Rare to Common, and was fairly evenly distributed both inside and outside of the breakwater (Appendix D, Figure D20).

Sea urchins (both herbivorous and rock boring) were present with a low to moderate density across all the sections of Area 3. The highest density was around the eastern Target Area section near the end of the existing breakwater (Appendix D, Figures D23 and D24). Sea cucumbers had a low to moderate density across all the sections of Area 1, with the highest density in the eastern

Target Area section near the end of the existing breakwater (Appendix D, Figure D25). Molluscs and seastars were observed at low densities in both the central and eastern Target Area sections (Appendix D, Figures D27 and D28). Giant clams were also observed in both in the central and eastern Target Area sections (Appendix D, Figure D30). Anemones were observed at low densities outside the breakwater and outside the Target Area (Appendix D, Figure D31). Octopus were observed at low densities inside the breakwater, but outside the Target Area (Appendix D, Figure D33).

Area 4

Habitat Characteristics

The marine habitat in the vicinity of Area 4 consists mostly of four habitat zones (Reef Flat, Reef Crest, Fore Reef, and Channel) (Appendix E, Figure E4) and three geomorphological habitat structures (Pavement, Aggregate Reef, and Unconsolidated Sediment). The area is mostly evenly split between these three structures (Appendix E, Figures E7 and E8). The habitat complexity in the Target Area is low to high, with the Aggregate Reef having the highest complexity (Appendix E, Figure E9). Various types of metal debris were observed within this area, with the notable observation of a broken, sunken fishing vessel adjacent to the Target Area (Appendix E, Figure E10).

Biological Resources

The numbers of species observed for each phylum within Area 4 are shown in Table 4 and the macroinvertebrate, coral, and algae species observed are listed in Table 4. Figure 7 shows the locations of the transects that constitute the species inventory. The tracks within this area were 0529-1, 0529-2, 0528-3, 0531-3, and 0601-3. Track 0529-1 had a total of 65 species, including 32 species of cnidarians, and had a high species richness relative to other transects. Track 0529-2 had 32 species, including 17 species of cnidarians, and had a low species richness compared to other transects. Track 0528-3 had 47 species, including 19 species of cnidarians, and had a moderate species richness compared to other transects. Track 0531-3 had 51 species, including 20 species of cnidarians, and had a moderate species richness compared to other transects. Track 0601-3 had 50 species, including 20 species of cnidarians, and had a moderate species richness compared to other transects.

Appendix E, Figure E11 shows there were seven protected species observed within this area. This observation included five sea turtles, *Chelonia mydas*, swimming and two sea turtles, *C. mydas* and *Eretmochelys imbricata*, resting with four sea turtles observed within the Target Area.

The coral abundance observed in this area ranged from Rare to Abundant, but consisted of Rare to Common on the Pavement, Rare to Abundant on the Aggregate Reef, and absent on the Unconsolidated Sediment (Appendix E, Figure E12). Coral morphologies were mostly lobate. The colony sizes were a combination of mixed colonies and extra-large, with the extra-large colonies only in the Aggregate Reef habitat structure. The number of extra-large colonies was notable within this area, and the extra-large colonies were the dominant size within large stretches of reef area (Appendix E, Figure E13). Additionally, the ESA-listed coral, *Acropora* *globiceps* was found scattered through this area, with a higher concentration within the Aggregate Reef area and within the Target Area (Appendix E, Figure E14). Zoanthids were also observed within the area (Appendix E, Figure E15).

No seagrass was observed within Area 4 (Appendix E, Figure E18). The frondose algae consisted of Rare to Common abundances, with higher abundances within the Aggregate Reef area (Appendix E, Figure E19). CCA was Rare to Dominant, but generally higher on the Aggregate Reef and parts of the Pavement area (Appendix E, Figure E20).

Sea urchins (herbivorous and rock boring) were present with a low to moderate density mostly on the Pavement areas (Appendix E, Figures E23 and E24). Sea cucumbers had a low to moderate density mostly on the Pavement area (Appendix E, Figure E25). Molluscs were observed in low to moderate densities, mostly on the Pavement area (Appendix E, Figures E27). Giant clams were observed both inside and outside the breakwater. In several locations they showed a moderate density both on the Pavement and Aggregate Reef areas (Appendix E, Figure E30).

Area 5

Habitat Characteristics

The marine habitat in the vicinity of Area 5 consists of two habitat zones (Harbor and Channel) (Appendix F, Figure F4) and one geomorphological habitat structure (Unconsolidated Sediment) (Appendix F, Figures F7 and F8). The Unconsolidated Sediment is mostly sand (Appendix F, Figure F6). The habitat complexity in the Target Area is Low to Low-medium (Appendix F, Figure F9). Various types of miscellaneous debris were observed within this area (Appendix F, Figure F10).

Biological Resources

The number of species observed for each phylum within Area 5 is shown in Table 4 and the macroinvertebrate, coral, and algae species observed are listed in Table 5. Figure 7 shows the locations of the transects that constitute the species inventory. The tracks within this area were 0529-3, 0530-1, 0530-2, and 0601-2. Track 0529-3 had a total of 29 species including, 10 species of cnidarians, and had a low species richness relative to other transects. Track 0530-1 had 49 species, including 17 species of cnidarians, and had a moderate species richness compared to other transects. Track 0530-2 had 28 species, including 9 species of cnidarians, and a low species richness compared to other transects. Track 0601-2 had 75 species, including 41 species of cnidarians, and had a high species richness compared to other transects, with this richness being concentrated on the sheetpile along the harbor dock.

Appendix F, Figure F11 shows there was one protected species observed within this area. This observation consisted of one green sea turtle, *Chelonia mydas*, swimming near the wharf.

The coral abundance observed in this area ranged from absent to Rare throughout the Target Area. The area occasionally had isolated colonies, but the majority of the coral within the Target

Area is on the wharf face (Appendix F, Figure F12). Coral morphologies were mostly lobate. The colony sizes were a mixture of small and mixed (Appendix F, Figure F13). Additionally, the ESA-listed coral, *Acropora globiceps* occurred rarely in this area, at only two locations on the wharf face (Appendix F, Figure F14).

Rare to Common abundance of seagrass, *Halophila minor,* was observed within this area (Appendix F, Figure F18). The frondose algae consisted of Rare to Dominant abundance with tall *Halimeda* algae common through the area (Appendix F, Figure F19). CCA was Rare to Occasional, and was only found on small hard structure outcroppings around the fringe of the area (Appendix F, Figure F20).

Sea cucumbers had a low density only, in small and isolated areas (Appendix F, Figure F25). Molluscs and seastars had a low density only, once again in small, isolated areas (Appendix F, Figures F27 and F28).

Alternative 1

Habitat Characteristics

Table 6 show the breakdown of area measurements for different habitat structures, zones, and sediment types within the footprint of Alternative 1. The total area is 6.8 acres (27,376 m^2). It consists of six different habitat zones including: 1) Back Reef, 2) Channel, 3) Harbor, 4) Lagoon, 5) Land, and 6) Reef Flat. Almost 90% of the area is dominated by three zones (Harbor at 29.2%, Land at 46.7%, and Reef Flat at 14.0%). The remaining 10% of Alternative 1 area is represented by the other three zones. The Alternative 1 area consists of 3.16 acres (12,798 m^2) of Land, 2.10 acres (8,503 m^2) of hard bottom, 0.59 acres (2,406 m^2) of mixed bottom, and 0.91 (3,670 m^2) acres of unconsolidated sediment. Of the unconsolidated sediment areas, the sediment type mostly consists of sand/rubble mix (97.5%). The habitat structures of Alternative 1 area consist of 1) Land, 2) Pavement, 3) Pavement with Sand Channels, 4) Scattered Coral/Rock in Unconsolidated Sediment, and 5) Unconsolidated Sediment. Of these, three habitat structures comprise 91.2% of the area (Land at 3.16 acres [12,798 m^2], Pavement at 2.10 acres [8,503 m^2] and Unconsolidated Sediment at 0.91 acres [3,670 m^2]). However, the smaller areas represent high value habitat, with Scattered Coral/ Rock in Unconsolidated Sediment at 0.59 acres (2,406 m^2) and a *de minimis* area of Pavement with Sand Channels.

Alternative 2

Habitat Characteristics

Table 7 show the breakdown of area measurements for different habitat structures, zones, and sediment types within the footprint of Alternative 2. The total area is 7.7 acres (31,054 m^2). It consists of six different habitat zones including: 1) Back Reef, 2) Channel, 3) Harbor, 4) Lagoon, 5) Land, and 6) Reef Flat. Over 90% of the area is dominated by four zones (Channel at 11.1%, Harbor at 27.0%, Land at 41.4%, and Reef Flat at 12.1%). The remaining 10% of Alternative 2 area is represented by the other two zones (most of which is Back Reef). The Alternative 2 area consists of 3.18 acres (12,867 m^2) of Land, 2.77 acres (11,198 m^2) of hard bottom, 0.73 acres

(2,965 m^2) of mixed bottom, and 0.99 (4,024 m^2) acres of unconsolidated sediment. Of the unconsolidated sediment areas, the sediment type mostly consists of sand/rubble mix (90.4%). The habitat structures of the Alternative 2 area consist of 1) Land, 2) Pavement, 3) Pavement with Sand Channels, 4) Scattered Coral/Rock in Unconsolidated Sediment, 5) Spur and Groove, and 6) Unconsolidated Sediment. Of these, two habitat structures comprise 77.5% of the area (Land at 3.18 acres [12,867 m^2] and Pavement at 2.77 acres [11,198 m^2]). However, the smaller areas represent high value habitat with Scattered Coral/ Rock in Unconsolidated Sediment at 0.73 acres (2,959 m^2) and a *de minimis* area of Pavement with Sand Channels and Spur and Groove. The remaining structure of Alternative 2 area is Unconsolidated Sediment at 0.99 acres (4,024 m^2).

PROJECT IMPACTS

Area 1

The expansion of the breakwater in this area will have impacts to the coral reef communities, depending on the specific design plans and construction method. More impacts will occur to the area outside the existing breakwater than on the inside. The majority of this area is Pavement, which, based on the Service's mitigation policy, we have determined to be a high value habitat; however, the resource abundance of the Service's evaluation species (coral and seagrass) is low to absent. If the preferred alternative is restricted to areas inside and not outside the existing breakwater, impacts to natural resources will be minimized. Furthermore, if the construction method is staged from the inside of the breakwater, impacts will also be reduced. However, it should be highlighted that the extraordinarily large coral colonies outside the area in the adjacent lagoon should be protected. Sedimentation generated from the project could impact these colonies if prudent measures are not taken.

In addition, if a new breakwater is constructed along this section and it seals off water flow across the areas that are currently open, the reduced water flow from the outside of the breakwater to inside the harbor will likely have significant impacts to the resources (both corals and seagrass) that are currently inside the harbor. If water flow can be maintained at a sufficient level, then existing resources within the harbor can continue to survive and this area may provide compensatory mitigation opportunities.

Area 2

Similar to Area 1, the expansion of the breakwater in this area will have impacts to the coral reef communities, depending on the specific design plans and construction method. More impacts will occur to the area outside the existing breakwater than on the inside. However, the majority of this area is Unconsolidated Sediment and Scattered Coral/ Rock in Unconsolidated Sediment, which, based on the Service's mitigation policy, we have determined to be lower value habitats. Also, the abundance of the Service's evaluation species (coral and seagrass) is low to absent. If the preferred alternative is restricted to areas inside and not outside the existing breakwater, impacts to natural resources will be minimized. In addition, if the construction method is staged from the inside of the breakwater, impacts will also be reduced. Furthermore, if designated staging points can be established, any sensitive resources inside the breakwater, such as the area highlighted in Appendix C, Figure C12, may be further avoided.

Area 3

Similar to Areas 1 and 2, the expansion of the breakwater in this area will have impacts to the coral reef communities, with the extent again depending on the specific design plans and construction method. More impacts will occur to the area outside the existing breakwater than on the inside. A significant part of this area is Unconsolidated Sediment and Scattered Coral/ Rock in Unconsolidated Sediment, which, based on the Service's mitigation policy, we have determined to be lower value habitats. At the same time, a large part of this area is also Pavement, which, based on the Service's mitigation policy, we have determined to be high value habitat. In addition, the abundance of the Service's evaluation species (coral and seagrass) is generally low, but with some exceptions. In particular, two areas are highlighted in Appendix D, Figure D12, showing high coral abundance areas that should be avoided if possible. The site also has a small area of seagrass that should be avoided or impacts minimized when planning the structure design or construction plan. If the preferred alternative is restricted to areas inside and not outside the existing breakwater, impacts to natural resources will be minimized. If the construction method is staged from the inside of the breakwater, impacts will also be reduced. If designated staging points can be established, impacts to sensitive resources may also be avoided or minimized.

One important consideration is that the eastern Target Area section, from the end of the existing breakwater seaward, could have significant impacts due to a high abundance of very large coral colonies. Colonies of this size may present significant challenges in developing appropriate and successful mitigation. Since this section of the project represents new construction as opposed to altering or modifying the existing breakwater, and the resources are currently less impacted from the historical construction, few opportunities exist to avoid the impacts. However, with some detailed planning in project design, there may exist some breakwater alignments that have less impact than others, particularly if the overlap with high coral density areas can be avoided or reduced in size.

Area 4

The addition of a breakwater in this area will have the most significant impacts compared to any other section of the proposed modification areas. The Target Area as presented crosses a zone of very high coral abundance with very large sized coral colonies. The loss of Aggregate Reef habitat within this Target Area will be challenging to offset, and may not be fully possible given the size and number of colonies. If a breakwater section is vital on this side of the harbor, alignments that sit outside the proposed Target Area may have less impact and may be worth considering as alternatives. For example, a breakwater that is moved south and angled 45 degrees to the existing proposed Target Area will have significantly fewer direct impacts. This will place the breakwater over the existing sunken fishing vessel.

However, the construction of a breakwater at this location, regardless of its orientation or direct impacts, may also have significant impacts to coral reef communities inshore of the breakwater.

If the breakwater reduced water flow, this might degrade water quality and increase sedimentation within the inshore Reef Flat and Aggregate Reef areas.

Area 5

The impacts to this area will be relatively minor. The entire area is Unconsolidated Sediment, but does have significant seagrass and *Halimeda* algae. If this area needs to be dredged, then avoiding the seagrass and *Halimeda* may be difficult, but with careful planning, these losses can be minimized through established transplant procedures. Significant coral colonies are growing on the wharf face and could be impacted during the dredging through accidental contact or sedimentation.

ESA-listed Corals for all Areas

The total number of *Acropora globiceps* colonies that may be impacted within the Target Area are shown in Tables 8 and 9. Colony numbers based on a high degree of confidence of identification are shown in Table 8 and are estimated to range from 45 to 193 colonies. Pavement (3-19 colonies) and Unconsolidated Sediment (18-61 colonies) habitat structures show the highest potential for impact followed by Scattered Coral/ Rock in Unconsolidated Sediment (9-34 colonies). Colony numbers based on a lower confidence of identification is shown in Table 9 and show a similar pattern, but with higher numbers. The total estimation ranges from 47 to 251 colonies with Pavement (8–69 colonies), Scattered Coral/ Rock in Unconsolidated Sediment (10–73 colonies), and Unconsolidated Sediment (18–66 colonies) having the highest number of colonies.

Alternative 1

The total number of *Acropora globiceps* colonies that may be impacted within the Alternative 1 area are shown in Tables 10 and 11. Colony numbers based on a high degree of confidence of identification are shown in Table 10 and are estimated to range from 9 to 68 colonies. Colony numbers per habitat structure include Pavement with 2–18 colonies, Scattered Coral/ Rock in Unconsolidated Sediment with 6–26 colonies, and Unconsolidated Sediment with 1–24 colonies. The Pavement with Sand Channels habitat structure did not have any *A. globiceps*. Colony numbers based on a lower confidence of identification are shown in Table 11, and exhibits identical numbers as the colony identification was straightforward within this area.

As discussed in Area 1, if a new breakwater is constructed along the inner breakwater section and it seals off water flow across the harbor basin that is currently open, the reduced water flow from the outside of the breakwater to inside the harbor will likely have significant impacts to the resources (both corals and seagrass) that are currently inside the harbor. If water flow can be maintained at a sufficient level, then existing resources within the harbor can continue to survive and this area may provide compensatory mitigation opportunities.

Additional analysis is needed on these alternatives to anticipate further potential impacts. Additional analysis is also need to assess the potential for secondary impacts from the generation of sediment as well as the staging and operation of construction equipment. This analysis was unable to be completed due to lack of information and time available.

Alternative 2

The total number of *Acropora globiceps* colonies that may be impacted within the Alternative 2 area are shown in Tables 12 and 13. Colony numbers based on a high degree of confidence of identification are shown in Table 12 and are estimated to range from 16 to 86 colonies. Colony numbers per habitat structure include Pavement with 3–10 colonies, Scattered Coral/ Rock in Unconsolidated Sediment with 12-49 colonies, and Unconsolidated Sediment with 1–27 colonies. Pavement with Sand Channels and Spur and Groove habitat structures did not have any *A. globiceps*. Colony numbers based on a lower confidence of identification are shown in Table 13, and show identical numbers as the colony identification was straightforward within this area.

As discussed in Area 1 and Alternative 1, if a new breakwater is constructed along the inner breakwater section and it seals off water flow across the harbor basin that is currently open, the reduced water flow from the outside of the breakwater to inside the harbor will likely have significant impacts to the resources (both corals and seagrass) that are currently inside the harbor. If water flow can be maintained at a sufficient level, then existing resources within the harbor can continue to survive and this area may again provide compensatory mitigation opportunities.

Additional analysis is needed on these alternatives to anticipate further potential impacts. Additional analysis is also need to assess the potential for secondary impacts from the generation of sediment as well as the staging and operation of construction equipment. This analysis could not be completed due to lack of information and time available.

EVALUATION AND COMPARISON OF ALTERNATIVES

There were no alternatives evaluated for this study since the project is in the early planning and feasibility phase. However, the USACE provided two possible alternatives after the field assessments were completed. Area estimations for habitat characteristics and estimates of the number of ESA-listed corals were produced for these alternatives, but this does not represent a complete alternatives analysis. In order to conduct a more thorough alternatives analysis, more details of the alternatives and their construction methods need to be provided. Additionally, quantitative surveys for biological resources need to be completed in order to make a thorough comparison of alternatives.

RECOMMENDATIONS

General

The Service is not providing specific BMPs at this time, given the current state of the project design. With no alternative selected or construction plan described, recommending BMPs would be premature. We can offer more specifics as the project moves forward and as details are specified on the final proposed plan. However, we would like to highlight the significant issue of turbidity control. Depending on the details of the construction, significant work may need to be done prior to construction to fully understand the impacts of turbidity. For example, understanding how sediment may move from the construction locations to areas outside the construction area requires significant consideration of the total impacts from the proposed action. Sediment modeling may need to be conducted if there appears to be a potential for significant sediment generation from the activities.

We will likely recommend the development of a turbidity control plan at later stages of the project that address the control mechanism, as well as required monitoring for sediment and any potential impacts.

Area 1

We recommend choosing a construction design that minimizes the total areal footprint, and that this footprint sit inshore of the existing breakwater. We also recommend creating less disturbance to the area outside of the existing breakwater to the extent possible and practical. For example, leaving the breakwater in place or cutting it off at the waterline would have minimal impact, but dredging a toe or other forms of substrate disruption may create additional impacts to the marine community outside of the breakwater.

We recommend the breakwater design allow water to flow from the Lagoon area to inside the Harbor area. This will allow the existing marine communities within the harbor to continue to survive, as well as maintain a potential compensatory mitigation area by allowing good environmental conditions to persist. Sealing the water flow off completely may have significant impacts across the entire area, as well as increasing sedimentation within the area. The increased sedimentation may then require periodic maintenance dredging to maintain the small boat access. Determining the appropriate flow, and design to support the flow, may require a separate hydrological study to address the question of how much flow is sufficient.

Area 2

Similar to Area 1, we recommend that the total areal footprint be minimized to the extent practical, and that the new breakwater sit inshore of the existing breakwater. We also recommend that construction plans and approaches be considered that minimize impacts to areas with coral resources that exist inside the breakwater. If specific access points can be determined or if the construction equipment can be set back far enough with minimal anchor footprints that minimize impacts along the entire inshore length of the breakwater, then fewer overall impacts will occur.

Area 3

We once again recommend that the construction along the existing breakwater follow the previous specified recommendations. As construction moves to the end of the existing breakwater, more impacts are likely to occur. We recommend considering an optimal alignment that minimizes coral impacts for the new section of breakwater, or eliminating the alternative to expand the breakwater in this area. Based on these surveys, the Service believes that unavoidable losses will occur with the expansion of this new breakwater and that this will unequivocally require compensatory mitigation. However, mitigating impacts within this section will likely be challenging.

Area 4

The construction of a new breakwater in this area poses the risk of significant impacts to coral reefs. As mentioned previously in regard to new breakwater construction, the loss of so many very large coral colonies may not be feasible to mitigate. Based on these surveys, the Service believes that unavoidable losses will occur with the expansion of this new breakwater and that this will unequivocally require compensatory mitigation. We recommend reexamining the proposed breakwater alignments or eliminating the alternative to expand the breakwater in this area. However, if a breakwater in this location is vital to the project, then there may be other alternatives that provide significantly fewer impacts, including alternatives to a fully hardened structure such as wave attenuation structures.

Additionally, if a breakwater needs to be built at this location, we recommend that further studies occur to examine the impacts to the coral reef resources inshore of this location, and to evaluate the potential impacts of reduced water flow.

Area 5

We recommend conducting seagrass and *Halimeda* transplantation before this area is dredged so as to minimize the loss of these resources. The Service has experience with working on these issues, and can provide further recommendations for developing a transplantation plan that addresses the methodology needed to evaluate locations where such transplantation may be conducted with a reasonable expectation of success.

Compensatory Mitigation

If it is determined that compensatory mitigation is needed for any section of the proposed project, the Service recommends conducting an appropriately designed Phase 2 study to quantify the resources, and to use that data to scale one or more effective and appropriate mitigation projects. Here, we provide some mitigation projects to consider, as well as considerations for proper mitigation scaling. However,in all cases, further investigation will be warranted in order to clarify the details of implementation and feasibility.

Coral Nursery and Transplanting

Corals have been transplanted with various degrees of success (Naughton and Jokiel 2001). The U.S. Coral Reef Task Force Handbook (referred to as Handbook) has provided some guidance on how this has occurred in the context of mitigation (USCRTF 2016). Corals can be relocated from the impact area or other areas of opportunity as well as a coral nursery. Nurseries can be developed on land or in-situ. The Handbook details the considerations, opportunities, and challenges with each option.

The area within the small boat harbor on the western section of the project area may present a good opportunity to develop an in-water coral nursery and associated coral transplanting project. If the water flow and water quality can be maintained within this section of the harbor, then areas may be developed to promote coral survival and growth with the appropriate approach.

Remove Sunken Vessel

The removal of derelict vessels has been used for mitigation (USCRTF 2016; Pendleton 2012), and can have long-term benefits to the surrounding reef area.

Near Area 4, there was a large fishing vessel that was reported to have run aground and sunk in the 1980s. This vessel appears to be causing damage to the immediate area based on the breakdown of the metal and the movement of metal debris. The removal of this vessel may be an opportunity to obtain mitigation credits. The coral nursery mentioned above can also supplement this option.

Removal of Debris

Marine debris removal has been conducted for mitigation in the past (Natural Resource Trustees for the M/V Casitas Grounding 2011), and this type of mitigation action can provide long-term benefits for both direct and indirect effects. While this type of mitigation has precedent, such actions create a unique challenge in determining the amount and type of credits that are produced. However, when discreet known objects are identified in advance for removal, then crediting can be more accurately determined.

Debris was observed throughout the harbor. Most importantly, there were several old sunken landing craft, potentially from WWII. The removal of such metal and other objects may provide an opportunity to obtain mitigation credits, particularly in conjunction with the development of a coral nursery, in the new locations that would be opened up for coral outplanting.

Water Quality Improvements

The alteration of water quality can produce long-term degradation of coral reef resources. The source of the degradation can be challenging to determine, but when the source of a problem is known, actions taken to rectify the problem can have beneficial results in improving resource condition. Sources can include upland terrigenous sediment, ground water nutrients from upland sources, or known point source discharges. Actions that reduce these impact sources can be achievable and practical if the source can be located.

The beach area on the eastern side of the harbor and inshore of Area 4 may provide an opportunity for mitigation credits through water quality and habitat enhancements. Filamentous algae were dominant in this area and the water quality appeared to be degraded. If a source of this degradation can be determined, such as a land-based point source amenable to remediation, then this may provide an opportunity to intervene, improve water quality, and allow the reef to recover. The coral nursery can also supplement this option as well.

Mitigation Scaling and Habitat Equivalency Analysis

The intent of this Phase 1 survey is to provide broad and general information on the resources within the area of interest that will allow the USACE to narrow, refine, or make alterations to project alternatives during the project planning stage. It is not designed to be, nor appropriate to be used as, data for scaling the losses of resources for mitigation. Phase 1 data does not quantify the resources at the appropriate detail for the purposes of mitigation planning. This is particularly true where a specific, well defined project alternative has yet to be determined.

The use of Habitat Equivalency Analysis (HEA) has been used for coral reef restoration and has been used by both the Service and NMFS in the Pacific region. It is also an acceptable model under the USACE. However, there are three main considerations regarding HEA and coral reefs. These include: 1) HEA currency, 2) mitigation loss and recovery trajectories, and 3) use of a discount rate with HEA, particularly with permanent resource loss.

HEA Currency

The currency chosen to measure the loss of resources from an action and the gain of resources from a mitigation action are of utmost importance and can be a central issue in developing appropriate scaling (or quantification) of losses to coral reef resources.

King and Adler (1991) first used HEA to develop mitigation ratio for wetland mitigation. Since then, HEA has been used for many types of resources. Milton & Dodge (2001) provide a good introductory overview of this topic. In their examples they use area of coral reef as a currency, but also highlight alternatives such as focusing on specific organism populations (also known as a Resource Equivalence Analysis, or REA, in the literature). One of the central principles of HEA is that the currency chosen between the loss and gain side of the equation must be equivalent. The equivalency principle includes more than using the same metric (acres for acres) on both sides of the equation, but also a reasonable assumption that the metric represents similar ecological functions and services.

Milton & Dodge (2001) state: "This basic approach to establishing habitat equivalency is useful for uniform landscapes with little difference in biological functions across the injured area (Mazzotta *et al.* 1994). In the coral reef setting, this approach may not realistically account for the diverse assemblage of organisms within the injured area and differences in regrowth/ growth of these organisms at the injured and replacement sites." More recently, this issue is also discussed in Scemama & Levrel (2016).

In order to use a metric such as coral reef area, one must to be able to make and defend the argument that all coral reef areas are equal to any other coral reef area. This is not a defensible assumption, given that a reef flat habitat is different than the reef crest, which is in turn different from a harbor area, and so on. In reality, the variability of coral reefs even between like habitats can still be substantial. For example, the reef flat to the east of Tinian Harbor may be substantially different than the reef flat west of the harbor. A properly designed quantitative survey can measure these differences and account for this variability in measuring the losses. This Phase 1 survey can indicate some level of variability or scale of difference, but it cannot quantify it at the appropriate level of detail.

Another currency that has been used is percent coral cover. This and some other types of non-area based metrics are further discussed in Viehman *et al.* (2009). However, the use of these metrics requires quantitative data. It should be noted that not all single metrics such as percent coral cover are appropriate to use (Minton *et al.* 2010). Previous projects in Apra Harbor Guam have proposed to use percent coral cover for mitigation against the advice of the resource agencies (U.S. Department of the Navy 2010; Peacock & Goeddeke 2007). Each of these projects used different metrics. Historically, ship grounding cases in the Pacific (Kolinski 2007; Kolinski *et al.* 2008; Montgomery *et al.* 2010) and some in the Puerto Rico (Puerto Rico Department of Natural and Environmental Resources and the National Oceanic and Atmospheric Administration 2017) have used a coral colony approach based on the size frequency distribution of individual species and colony morphologies. This approach took a single metric and split it into its components, then calculated separate HEAs in order to make an apples-to-apples comparison with a metric that is quantifiable for both loss and recovery. For example, an encrusting colony is not equal to a highly branched colony, so they are calculated separately. Although the scale of differences between individual types of corals was smaller than the difference between various coral reef areas, there was general agreement in handling these differences in losses separately. This was further facilitated by the development of a trade-off approach that can account for the value of different coral morphologies. The development of a robust trade-off analysis is still ongoing, but until such a development is complete, existing tools are available to utilize this or a similar approach. Regardless of the specific approach, quantitative data is required in order to construct an appropriate HEA that accounts for differences coral reef areas.

Mitigation Loss and Recovery Trajectories

The development of the trajectory curve can be complicated depending on type of model or data parameters used to develop the curve. Most HEA approaches use a linear trajectory that uses a maximum service provision to determine a recovery horizon. However, this does not take into consideration the composition of short lived versus long lived organisms/ individuals within a community. This may tend to underestimate the recovery of communities primarily consisting of fast growing organisms and overestimate the recovery of communities primarily consisting of slow growing organisms. If one were to use coral reef area as a metric, it is uncertain how a recovery trajectory would be estimated with data on the community composition? The details of what is in a specific acre is important and should include the organism composition, abundance, size, growth form, their growth, survival, and recruitment rates, in addition a myriad of other details for both the loss and gain calculations. If there is not data available to estimate a trajectory based on the ecological or biological features of the area, then the only way to create a trajectory is to make a guess on the time to full recovery. An additional complication with using coral reef area is applying this metric to a mitigation project. For example, if one were to do water quality enhancement to improve a coral reef, then without some specific information on what is in that particular area and is estimated to develop post-mitigation, there is no reasonable way to develop such a trajectory. In a HEA conducted without some knowledge based on quantitative data, the trajectory curve is simply a guess and as such is easily defensible. Without this type of information, the choice of currency is not important, because every HEA is the same, just with different units. The power and utility of using coral size class distributions for the development of this trajectory curve is the value of using the coral demographic information in the curve. Aspects such as growth, survival, and recruitment rates can all be critical factors in developing this curve. While other factors may need to be taken into consideration, these types of quantitative data are the foundation for developing the curve and the associated results of the HEA. Most HEA literature does not spend much time on this, because this aspect can radically change depending on the type of aquatic system or resource the HEA is being applied.

Discount Rate

We understand that it is USACE policy not to use a discount rate for HEAs or to assume a 0% discount rate. However, there are benefits to incorporating the use of a discount rate. One includes a nice mathematical way to quantify the temporal loss, which is a requirement in mitigation projects. Temporal loss is the amount of resource loss due to the differing time scales of the losses and gains. You may lose 1 acre today, but if it takes 10 years to get that acre back, then you still have an accumulated loss over time, even though you still got one acre back. The discount rate makes an assumption that a resource is more valuable today than in the future (if you use a negative value). There is a range of opinion on this, but ultimately, the use of a specific discount rate can be used to account for temporal loss, and if it is used properly, the total value of the resource is not reduced. Historically, a 3% rate (Peacock 1995; NOAA 1995) has been used that is based on the field of economics, but any value can be used that addresses the need of the HEA. The second benefit is that a discount rate used for a resource lost in perpetuity allows a finite valuation to be made. If you have a resource loss in perpetuity without a discount rate, the loss is an infinite number and cannot be mathematically placed into a HEA. If a discount rate is used, then the loss will eventually be discounted to zero allowing the loss to be enumerated and compared to the mitigation side of the equation. This should not be interpreted as meaning that the resource has no value and therefore, mitigation should end, but rather a mathematical mechanism to calculate and scale the mitigation needs. All long-term management of the mitigation project that theoretically could extend beyond the period of time the resource holds future value needs to be accounted for in the mitigation plan.

Mitigation Cost Estimation

The costs of any specific compensatory mitigation plan or component depends on many variables, most of which are unknown at this stage of the project. The development of fully developed mitigation costs requires a complete understanding of the exact impacts based on the final chosen preferred alternative, quantitative measurements of the resource impacts associated with the preferred alternative, a developed mitigation plan including scale and scope of the mitigation action, and the long-term management of the mitigation project. At this stage of the project, a reliable number cannot be determined without many other pieces of information and agency coordination. However, previous projects or resource damage costs may be used to provide insight to the scale of mitigation costs for coral reefs. Any number used will likely not directly apply to this project on this island, so it must be used with appropriate caution. Below, we provide a summary of ship grounding costs that are real costs determined as part of settlements for coral reef impacts in the State of Hawaii. How these may be applicable to Tinian Harbor modifications is uncertain.

The State of Hawaii has had a series of small and large vessel groundings throughout the islands. These vessels have ranged in size from small 10 meter vessels to larger vessels of over 150 meters. The valuations used for these groundings used different approaches, and are also different than authorities for planned construction projects that have more rigid requirements for mitigation planning. However, they do provide some initial means of quantifying the value of coral reefs in a mitigation context, based on actual precedents.

The State of Hawaii, Division of Aquatic Resources in the past developed a value matrix that ranged from $100 to $1000 per coral colony. This was used in several small vessel grounding cases. Additionally, there were grounding cases with settlements loosely based on projects designed to offset the resource losses under the Oil Pollution Act of 1990. Not all of these cases were valued in the same manner, but the value ranged from $94 to $2,244 per square meter of reef area. There are substantial differences between these cases and compensatory mitigation projects such as 1) the method of determining the value was not project or mitigation performance based, but rather a monetary value of coral; 2) the cases do not account for project management in perpetuity, which typically adds significant project maintenance costs; and, 3) these values do not account for the actual implementation of on-the-ground projects, which may vary significantly in costs. If these numbers were used for estimation purposes only, the unit area of impact should be multiplied by the area cost of reef. For example, if the above valuation metrics were applied to only the hard bottom structure class of the Target Area at Tinian Harbor, using the lowest unit rate of $94, then the value would be over $6.37 million, which does not taken into account other reef habitat such as mixed bottom, nor does it consider real mitigation costs. Including the Scattered Coral/ Rock in Unconsolidated Sediment structure with hard bottom increases the cost by $1.85 million. If these numbers are applied in the same manner to the two alternatives, then Alternative 1 area would be ~$800,000 for hard bottom with an additional $226,000 for Scattered Coral/ Rock in Unconsolidated Sediment structure and Alternative 2 area would be ~$1.05 million for hard bottom with an additional $278,000 for Scattered Coral/ Rock in Unconsolidated Sediment structure. These numbers are based on public records of case settlements and an evaluation by the Service.

Another comparison to use is the construction of Kilo Wharf in Guam by the U.S. Navy. Kilo Wharf was estimated to impact 4.75 direct acres and an additional 1.7 to 14.9 acres from secondary sedimentation impacts. The mitigation cost for this project was $5 million and currently has yet to produce sufficient mitigation offsets many years later.

The CNMI is currently conducting a seagrass and coral valuation study that might provide some monetary perspective on the value of impacts, but this valuation will not be ready until September 2018. Van Beukering et al. (2006) conducted an economic valuation for corals reefs around Saipan which concluded with an average total economic value of $800,000 per square kilometer per year with a maximum of $9,000,000 per square kilometer per year. If the average value is assumed to be reasonable for Tinian, this would value the compensatory mitigation (as compared above) at $54,000 per year for hard bottom with an additional $15,000 for Scattered Coral/ Rock in Unconsolidated Sediment structure in the Target Area, $6,800 per year for hard bottom with an additional $1,900 per year for Scattered Coral/ Rock in Unconsolidated Sediment structure in alternative 1 area, and $8,900 per year for hard bottom with an additional $2,300 per year for Scattered Coral/ Rock in Unconsolidated Sediment structure in alternative 2 area. In order to estimate the total costs, a time to recovery curve would need to develop. Depending on how the recovery curve is generate, natural recovery is often controlled by coral recruitment and growth rates and is often measured in decades depending on the circumstances.

For comparative purposes of the CNMI's economic valuation to a 2002 economic valuation in Hawaii (Cesar et al. 2002), Hawaii's reef were valued at $91 million per square kilometer per year, $3.5 million per square kilometer per year, and $730,000 per square kilometer per year for three distinct locations. These numbers also equate to $2.5 billion per square kilometer, $65 million per square kilometer, and $19 million per square kilometer in net present value (in 2002 dollars) as opposed to the $94 million per square kilometer based on historical ship grounding cases. However, an important note to considering economic values for coral reefs was reported by Cesar et al. 2002 in that "economic values and ecological values do not always go hand in hand" which can further explain the wide range in values both in Hawaii and CNMI. Under compensatory mitigation planning, we consider the costs of the ecological function which may not correlate with economic values.

The use of any of the above numbers will not necessarily directly apply to the Tinian Harbor Modification project, but they may be useful to establish the potential cost of project mitigation in a broad context. The salient point for consideration is that the scale of this project may easily incur mitigation costs that exceed these comparisons unless appropriate avoidance measures are undertaken.

Data Gaps

While this Phase I report provides useful information for alternatives planning that maximizes avoidance and minimization, there still remains a large data gap in regard to planning for or calculating impacts from any specific alternative or any proposed mitigation plan. In order to close this significant data gap, quantitative data needs to be collected within the footprints of each proposed alternative and its estimated secondary impact area, as well as from the areas proposed for each type of mitigation. Without this information, a complete understanding of the impacts and a reasonable cost of mitigation cannot be obtained. Any proposed HEA with estimates based on qualitative data or proxy data may not provide a reasonable estimate of mitigation costs, nor be considered accurate enough for appropriate planning of project feasibility. We strongly recommend that the appropriate level of quantitative data be collected in order to effectively develop and plan project alternatives and mitigation.

Next Steps

If the USACE plans on pursuing this project further, we recommend that a Phase II investigation be conducted to collect quantitative data that can more specifically detail resource impacts and further address the need for compensatory mitigation. A Phase II survey can also address aspects of compensatory mitigation planning if feasible and required. In order to move forward with a

Phase II investigation, details of the top two project alternatives and construction approach/ method will need to be provided.

SUMMARY OF POSITION

The Service provides this Phase I investigation report to assist with the development of project alternatives that maximize the avoidance and minimization of impacts to trust resources at Tinian Harbor. The greatest opportunities for impact avoidance exist in the areas where new breakwater construction is being considered. Given the coral reef resources existing in these areas, the proposed new construction may require extensive compensatory mitigation, which has the potential to dramatically and disproportionately increase the costs of the project and may not be achievable. If it is determined to move the project forward, we strongly recommend that a Phase II quantitative survey be conducted in conjunction with preliminary compensatory mitigation planning. This will allow steps to be taken that will increase the efficiency of project planning and reduce overall project costs in the long-term. If a Phase II survey is conducted, then project alternatives should be narrowed and construction methods should be defined in advance, in order to allow efficient collection the quantitative information needed. Based on the lack of Phase II data, this report cannot completely fulfill the requirement under Section 2(b) of the FWCA. Hence, this report is presented in partial fulfillment of the FWCA and does not constitute the final report of the Secretary of the Interior as required by Section 2(b) of the FWCA.

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FIGURES

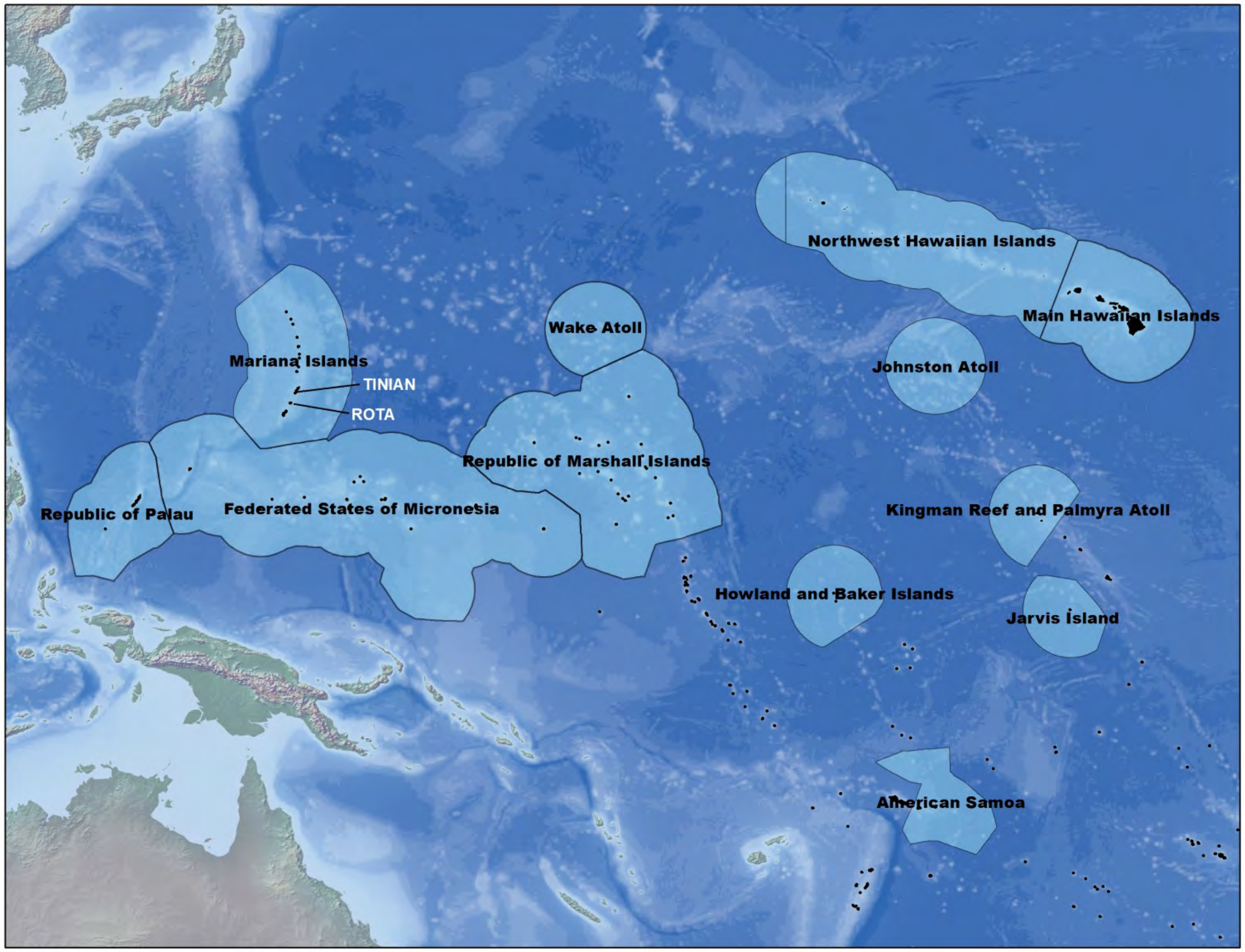

Figure 1: Pacific Ocean. Map of the Pacific Ocean showing the location of Tinian, CNMI.

Tinian Alternative 1: Replace Breakwater

Figure 2: Project Alternative 1. Map showing the location and scale of Alternative 1 that replaces the existing breakwater (Map Source: USACE).

Tinian Alternative 2: Replace and Extend Breakwater

Figure 3: Project Alternative 2. Map showing the location and scale of Alternative 2 that replaces and extends the existing breakwater (Map Source: USACE).

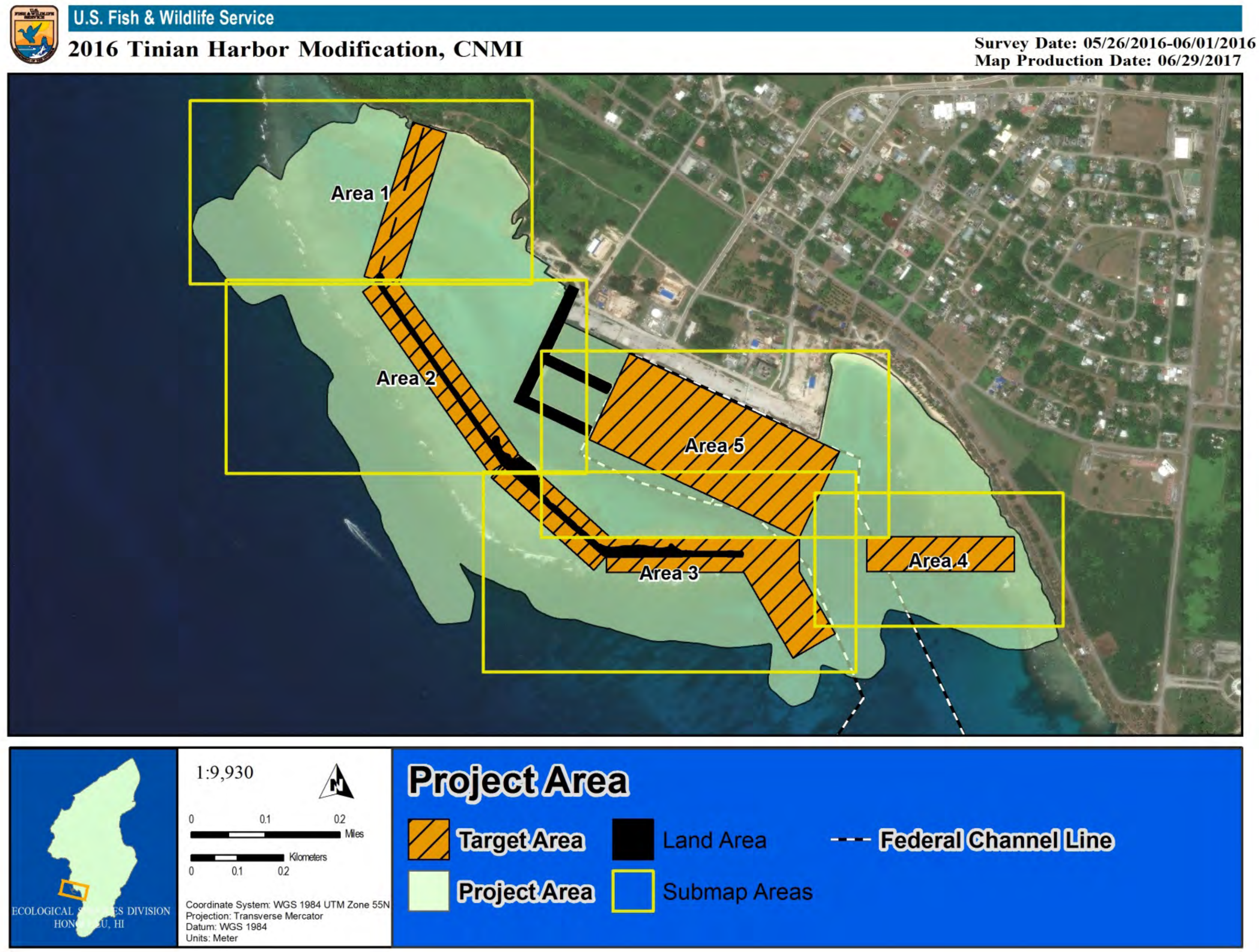

Figure 4: Subarea Map. Map showing the Tinian Harbor Modification project area with each of the five submap areas.

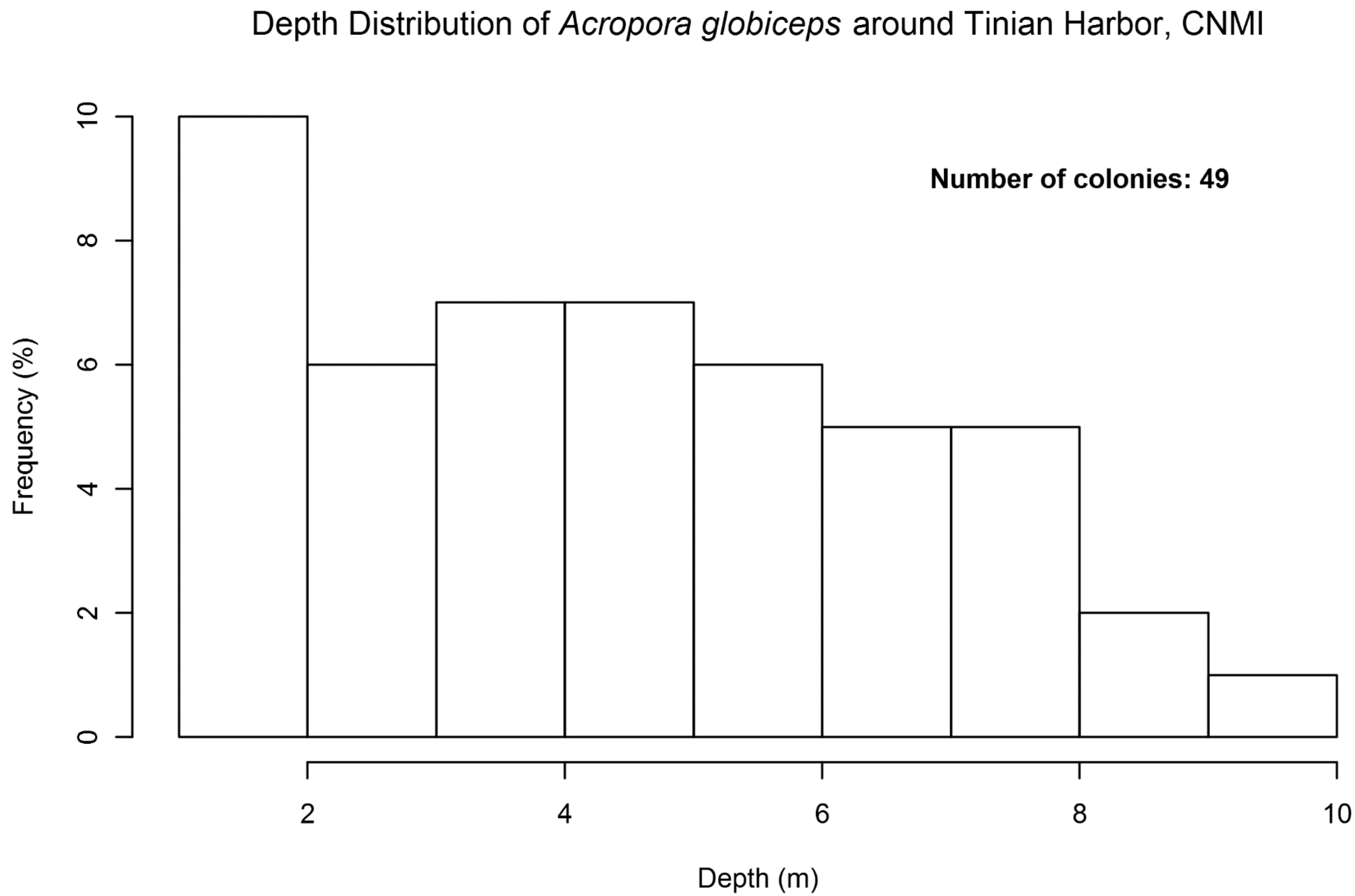

Figure 5: Tinian Depth for A. globiceps. Histogram showing the frequency of the depth distribution for a subset of the ESA-listed coral, *Acropora globiceps*, observed around Tinian Harbor.

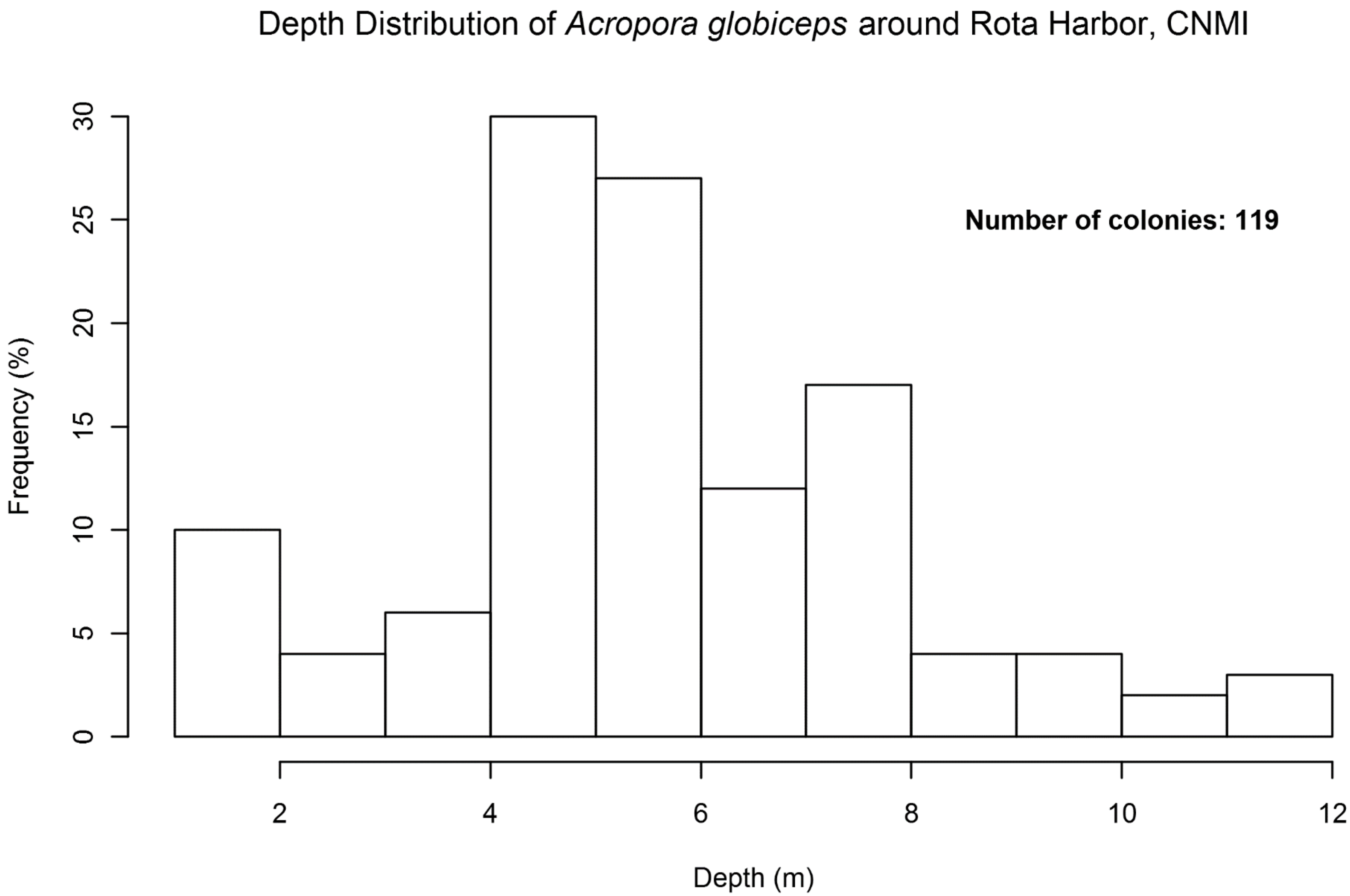

Figure 6: Rota Depth for A. globiceps. Histogram showing the frequency of the depth distribution for a subset of the ESA-listed coral, *Acropora globiceps*, observed around Rota Harbor for comparative purposes.

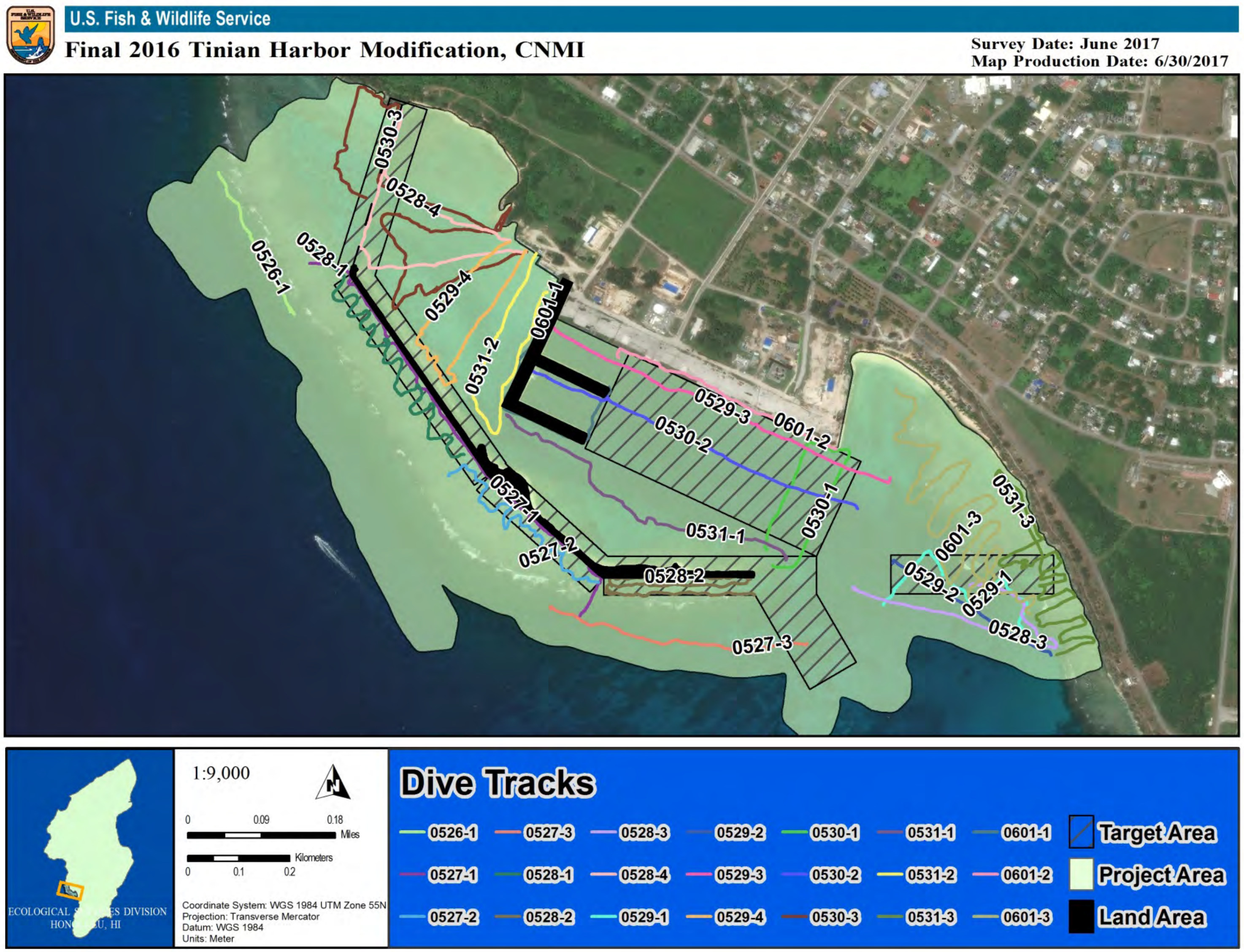

Figure 7: Species List Dive Tracks. Map showing the locations of each transect that corresponds to the species list table (Table 5), but not inclusive of all mapping transects.

TABLES

Table 1: Area Calculations. Area calculations for Habitat Zone, Major Structure, Sediment type, and Structure.

MAJOR STRUCTURE	Square Meters	Acres	Percent
Land	16,341	4.04	6.2
Hard Bottom	67,831	16.76	25.7
Mixed	39,908	9.86	15.1
Unconsolidated Sediment	139,666	34.51	53.0
Total	**263,746**	**65.2**	

SEDIMENT	Square Meters	Acres	Percent
NA	11,350	2.80	8.1
Rubble	126	0.03	0.1
Sand	81,278	20.08	58.2
Sand/ Rubble	46,912	11.59	33.6
Total	**139,665**	**34.5**	

STRUCTURE	Square Meters	Acres	Percent
Aggregate Reef	12,093	2.99	4.6
Land	16,341	4.04	6.2
Pavement	55,738	13.77	21.1
Pavement with Sand Channels	9,768	2.41	3.7
Scattered Coral Rock in Unconsolidated Sediment	19,710	4.87	7.5
Spur and Groove	10,430	2.58	4.0
Unconsolidated Sediment	139,666	34.51	53.0
Total	**263,746**	**65.2**	

HABITAT ZONE	Square Meters	Acres	Percent
Back Reef	33,728	8.33	12.8
Bank/Shelf	288	0.07	0.1
Channel	45,916	11.35	17.4
Fore Reef	12,727	3.14	4.8
Harbor	132,860	32.83	50.4
Lagoon	4,919	1.22	1.9
Land	16,340	4.04	6.2
Reef Crest	5,696	1.41	2.2
Reef Flat	11,255	2.78	4.3
Total	**263,729**	**65.2**	

Table 2: Acropora globiceps Densities (certain). Tinian Harbor estimated densities of *Acropora globiceps* for non-zero areas based on **certain** colony identification within the project area (labeled as Project Area in Appendix A, Figure A1). Three statistical approaches include a jackknife approximation, bootstrap of the median, and BCa bootstrap confidence intervals. Estimations are colonies per hectare (10,000 m^2).

Calculations based only certain identification	Jackknife Calculations					Bootstrapped Calculations					BCa Bootstrap CIs			Percent of Non-zero Area
Structure	Median	Mean	Lower CI	Upper CI	Range	Median	Mean	Lower CI	Upper CI	Range	Lower CI	Upper CI	Range	
Spur and Groove	2.02	2.00	1.99	2.00	**1.99-2.02**	2.02	2.17	2.15	2.19	**2.02-2.19**	1.24	3.35	**1.24-3.35**	**97.8**
Unconsolidated Sediment	3.00	3.04	3.03	3.06	**3.00-3.06**	3.00	3.23	3.20	3.26	**3.00-3.26**	1.67	4.80	**1.67-4.80**	**66.9**
Pavement with Sand Channels	2.85	2.62	2.61	2.63	**2.61-2.85**	2.17	2.53	2.51	2.55	**2.17-2.55**	2.07	3.64	**2.07-3.64**	**94.7**
Aggregate Reef	1.97	3.92	3.86	3.97	**1.97-3.97**	3.95	4.86	4.74	4.98	**3.95-4.98**	1.59	6.45	**1.59-6.45**	**90.8**
Scattered Coral Rock in Unconsolidated Sediment	2.50	2.60	2.59	2.61	**2.50-2.61**	2.80	2.87	2.83	2.91	**2.80-2.91**	1.43	2.89	**1.43-2.89**	**99.9**
Pavement	2.71	2.97	2.94	3.01	**2.71-3.01**	2.71	4.34	4.21	4.47	**2.71-4.47**	1.26	13.10	**1.26-13.10**	**62.9**

Table 3: Acropora globiceps Densities (uncertain). Tinian Harbor estimated densities of *Acropora globiceps* for non-zero areas based on **uncertain** colony identification directly within the project area (labeled as Project Area in Appendix A, Figure A1). Three statistical approaches include a jackknife approximation, bootstrap of the median, and BCa bootstrap confidence intervals. Estimations are colonies per hectare (10,000 m^2).

Calculation based on certain and uncertain identification	Jackknife Calculations					Bootstrapped Calculations					BCa Bootstrap CIs			Percent of Non-zero Area
Structure	Median	Mean	Lower CI	Upper CI	Range	Median	Mean	Lower CI	Upper CI	Range	Lower CI	Upper CI	Range	
Spur and Groove	2.09	2.32	2.31	2.33	**2.09-2.33**	2.09	2.58	2.55	2.61	**2.09-2.61**	1.68	4.12	**1.68-4.12**	**100**
Unconsolidated Sediment	3.99	4.15	4.14	4.16	**3.99-4.16**	3.99	4.19	4.16	4.22	**3.99-4.22**	1.67	5.46	**1.67-5.46**	**100**
Pavement with Sand Channels	2.85	2.63	2.62	2.64	**2.62-2.85**	2.17	2.54	2.52	2.56	**2.17-2.56**	2.07	3.64	**2.07-3.64**	**100**
Aggregate Reef	5.92	4.42	4.37	4.46	**4.37-5.92**	4.39	5.20	5.08	5.32	**4.39-5.32**	2.25	16.47	**2.25-16.47**	**100**
Scattered Coral Rock in Unconsolidated Sediment	2.89	3.00	3.00	3.01	**2.89-3.01**	2.89	3.22	3.20	3.25	**2.89-3.25**	2.32	4.20	**2.32-4.20**	**100**
Pavement	4.83	4.31	4.28	4.34	**4.28-4.83**	4.83	5.55	5.38	5.72	**4.83-5.72**	1.26	13.10	**1.26-13.10**	**100**

Table 4: Species Numbers. The number of species observed per Phylum on each transect. Transect numbers are shown spatially in Figure 3.

	0526-1	0527-1	0528-1	0529-1	0530-1	0531-1	0601-1	0527-2	0528-2	0529-2	0530-2	0531-2	0601-2	0527-3	0528-3	0529-3	0530-3	0531-3	0601-3	0528-4	0529-4
Animal																					
Phylum Annelida (Worms)				1			1						2	1							
Phylum Arthropoda - Subphylum Crustacea (Crabs, Shrimps, Lobsters)			1	1																	
Phylum Chordata - Subphylum Tunicata (Sea Squirts)							1						1			1					
Phylum Cnidaria (Hydroids, Jellyfish, Sea Anemones, and Corals)	22	21	34	32	17	25	29	28	22	17	9	17	41	20	19	10	16	20	20		11
Phylum Echinodermata - Subphylum Asterozoa (Sea Stars and Brittle Stars)	6	3	8	4	5	5	4	4	6	1	1	2	4	2	3		6	7	5	4	4
Phylum Mollusca (Sea Slugs, Cowries, Conchs, Clams, Scallops, Octopus, and others)	2	12	10	5	5	7	2	13	7	5	4	5	1	7	5	3	8	11	12	8	3
Phylum Porifera (Sponges)	1	2	2	2	4	4	3		1	2	1	2	7	3	5		4		1	1	
Plant																					
Phylum Chlorophyta (Green Algae)	6	5	7	10	10	7	10	10	7	4	9	4	15	5	8	11	8	6	6	6	5
Phylum Ochrophyta (Brown Algae)		4	4	2	1	1	2	4	3	1	2	1		3	1	2	2	3	2	2	2
Phylum Rhodophyta (Red Algae)	4	2	4	5	2	4	5	1	3	1		1	3	3	3	1	2	2	1	2	2
Phylum Tracheophyta (Vascular Plants)					1	1					1					1					1
Bacteria																					
Phylum Cyanobacteria (Blue-Green Bacteria)		4	4	3	4	3	2	5	1	1	1	2	1	3	3		2	2	3	1	2
Grand Total	**41**	**53**	**74**	**65**	**49**	**57**	**59**	**65**	**50**	**32**	**28**	**34**	**75**	**47**	**47**	**29**	**48**	**51**	**50**	**24**	**30**

Table 5: Species List. Species observed on each transect. Transect numbers are shown spatially in Figure 3.

	0526-1	0527-1	0528-1	0529-1	0530-1	0531-1	0601-1	0527-2	0528-2	0529-2	0530-2	0531-2	0601-2	0527-3	0528-3	0529-3	0530-3	0531-3	0601-3	0528-4	0529-4
Animal																					
Phylum Annelida (Worms)																					
Class Polychaeta (Bristle and Feather Duster Worms)																					
Order Sabellida																					
Family Serpulidae																					
Sabellastarte sp.							1						1								
Spirobranchus giganteus				1										1							
Unidentified Class																					
Unidentified Order																					
Unidentified Family																					
Tube worm sp.													1								
Phylum Arthropoda - Subphylum Crustacea (Crabs, Shrimps, Lobsters)																					
Class Malacostraca (Crabs, Shrimps, Lobsters)																					
Order Decapoda																					
Family Polybiidae																					
Portunid sp.			1	1																	
Phylum Chordata - Subphylum Tunicata (Sea Squirts)																					
Class Ascidiacea (Sea Squirts)																					
Order Phlebobranchia																					
Family Ascidiidae																					
Phalusia julinea							1						1			1					
Phylum Cnidaria (Hydroids, Jellyfish, Sea Anemones, and Corals)																					
Class Anthozoa (Corals and Sea Anemones)																					
Order Actiniaria (Sea Anemones)																					
Unidentified Family																					
Anenome sp. (white)																	1				
Family Actiniidae																					
Entacmea quadricolor												1				1					
Family Stichodactylidae																					
Heteractis sp.				1	1								1		1						
Order Corallimorpharia (Corallimorphs - Anemone-like)																					
Family Discosomidae																					
Rhodactis sp.							1						1								
Order Helioporacea																					
Family Helioporidae																					
Heliopora coerulea		1											1								
Order Scleractinia (Stony Coral)																					

Table 5. Continued: Species observed on each transect. Transect numbers are shown spatially in Figure 3.

	0526-1	0527-1	0528-1	0529-1	0530-1	0531-1	0601-1	0527-2	0528-2	0529-2	0530-2	0531-2	0601-2	0527-3	0528-3	0529-3	0530-3	0531-3	0601-3	0528-4	0529-4
Family Acroporidae																					
Acropora abrotanoides	1		1						1												
Acropora cf. smithi	1								1									1			
Acropora cophodactyla																			1		
Acropora digitifera						1		1											1		
Acropora globiceps	1	1	1	1	1	1		1	1	1		1	1	1	1	1	1	1	1		1
Acropora muricata																					1
Acropora nana	1				1													1			
Acropora ocellata	1								1												
Acropora palmerae	1								1									1			
Acropora pulchra			1			1						1					1				1
Acropora surculosa	1	1	1	1	1	1								1	1				1		
Acropora tenuis			1	1								1				1	1				
Acropora valida	1							1	1										1		
Acropora verweyi	1	1	1					1	1										1		
Astreopora cucullata										1			1								
Astreopora eliptica							1														
Astreopora gracilis							1						1								
Astreopora myriophthalma			1	1	1		1			1	1			1	1						
Astreopora randalli							1			1											
Astreopora suggesta													1								
Isopora palifera			1	1		1	1			1	1	1	1		1	1	1				
Montipora cf. grisea		1			1		1	1						1	1						
Montipora informis				1		1	1	1						1				1			
Montipora sp.				1		1							1								
Montipora turgescens			1					1					1								1
Family Agariciidae																					
Gardineroseris planulata				1											1						
Leptoseris foliosa													1								
Pavona cactus													1								
Pavona chiriquensis	1					1	1						1		1						
Pavona duerdeni								1					1	1	1			1			
Pavona explanulata													1								
Pavona frondifera			1														1		1		
Pavona maldivensis													1	1							
Pavona varians				1	1	1	1	1				1	1		1	1	1				
Pavona venosa			1	1								1	1								

Table 5. Continued: Species observed on each transect. Transect numbers are shown spatially in Figure 3.

	0526-1	0527-1	0528-1	0529-1	0530-1	0531-1	0601-1	0527-2	0528-2	0529-2	0530-2	0531-2	0601-2	0527-3	0528-3	0529-3	0530-3	0531-3	0601-3	0528-4	0529-4
Family Astrocoeniidae																					
Stylocoenia guentheri													1								
Family Coscinaraeidae																					
Coscinaraea collumna				1			1							1							
Family Euphylliidae																					
Euphyllia glabrescens					1								1		1						
Galaxea astreata													1								
Galaxea fascicularis	1	1	1	1				1	1	1				1					1		
Family Faviidae																					
Leptastrea pruinosa							1						1								
Leptastrea purpurea		1	1		1	1		1		1		1	1	1	1	1			1		1
Leptastrea transversa				1																	
Family Fungiidae																					
Fungia fungites			1			1															
Fungia scutaria						1					1										
Family Lobophylliidae																					
Acanthastrea brevis				1		1	1	1					1		1						
Lobophyllia hembrichii	1	1	1	1	1	1	1	1		1			1	1	1						
Oxypora lacera							1														
Family Merulinidae																					
Cyphastrea agazzi			1					1													
Cyphastrea sp.			1	1	1	1	1			1	1	1	1		1	1	1				
Echinopora cf. gemmifera													1	1							
Favites abdita									1										1		
Favites cf. flexuosa			1																		
Favites sp.		1				1							1						1		
Goniastrea edwardsi												1									
Goniastrea favulus													1								
Goniastrea minuta	1	1	1				1	1	1									1	1		
Goniastrea pectinata			1				1						1								
Goniastrea retiformis			1	1			1	1		1			1					1			
Goniastrea sp.				1	1		1					1	1								
Hydnophora microconos	1		1	1				1	1					1				1	1		
Leptoria phrygia	1	1	1	1	1			1	1	1			1	1			1	1			
Merulina ampliata							1														
Merulina scabricula							1														
Oulophyllia crispa				1			1						1	1							

Table 5. Continued: Species observed on each transect. Transect numbers are shown spatially in Figure 3.

	0526-1	0527-1	0528-1	0529-1	0530-1	0531-1	0601-1	0527-2	0528-2	0529-2	0530-2	0531-2	0601-2	0527-3	0528-3	0529-3	0530-3	0531-3	0601-3	0528-4	0529-4
Platygyra daedalea		1		1								1	1		1		1		1		
Platygyra pini			1	1		1	1	1		1				1			1	1			
Platygyra sp.								1													
Plerogyra sinuosa											1										
Family Montastraeidae																					
Astrea curta		1							1												
Favites valiciennesi				1		1															
Family Mussidae																					
Favia matthai								1													
Favia pallida	1	1							1												
Favia rotundata													1								
Favia sp.				1	1	1	1			1	1	1	1			1		1			1
Favia stelligera	1		1	1		1			1				1	1	1						
Family Pocilloporidae																					
Pocillopora ankeli																		1			
Pocillopora damicornis		1	1	1	1	1		1		1	1	1				1	1	1			1
Pocillopora eydouxi	1	1	1					1	1									1	1		
Pocillopora meandrina		1																			
Pocillopora setichelli									1									1	1		
Pocillopora verrucosa	1		1	1		1			1	1							1	1	1		
Stylophora pistilata		1	1	1	1			1	1			1		1	1						
Family Poritidae																					
Goniopora fruiticosa			1																		
Goniopora sp.			1																		
Porites annae									1				1								
Porites rus	1	1	1	1	1	1	1	1	1		1		1	1	1	1	1				1
Porites sp. (massive)	1	1	1	1		1	1											1	1		1
Family Psammocoridae																					
Psammocora contigua		1	1			1		1		1	1	1					1	1	1		1
Psammocora digitata							1	1		1			1								1
Psammocora nierstrazi								1	1												
Psammocora sp.												1					1				
Order Zoantharia (Zoanthids)																					
Family Sphenopidae																					
Palythoa tuberculosa																			1		
Family Zoanthidae																					
Zoanthus sp.																		1			

Table 5. Continued: Species observed on each transect. Transect numbers are shown spatially in Figure 3.

	0526-1	0527-1	0528-1	0529-1	0530-1	0531-1	0601-1	0527-2	0528-2	0529-2	0530-2	0531-2	0601-2	0527-3	0528-3	0529-3	0530-3	0531-3	0601-3	0528-4	0529-4
Class Hydrozoa (Hydrocorals, Fire Coral, and Thecate Hydroids)																					
Unidentified Order																					
Unidentified Family																					
Hydroid sp.							1														
Order Anthoathecata (Hydrocorals and Fire Coral)																					
Family Milleporidae																					
Millepora platyphylla	1													1							
Phylum Echinodermata - Subphylum Asterozoa (Sea Stars and Brittle Stars)																					
Class Asteroidea (Sea Stars)																					
Order Valvatida																					
Family Acanthasteridae																					
Acanthaster planci			1				1						1		1						
Family Ophidasteridae																					
Linckia laevigata	1	1	1	1		1	1	1				1	1		1		1	1		1	1
Linckia multifora													1								
Family Oreasteridae																					
Culcita novaeguineae							1														
Class Echinoidea (Sea Urchins)																					
Order Camarodonta (Globular Sea Urchins)																					
Family Echinometridae																					
Echinometra mathaei	1				1	1						1						1			
Echinometra matthaie																			1		
Echinometra oblonga																		1	1		
Echinostrephus aciculatus	1			1	1	1				1				1				1			
Order Diadematoida (Sea Urchins)																					
Family Diadematidae																					
Diadema savigney				1																	
Diadema setosum	1		1		1			1	1				1				1	2	1		
Class Holothuroidea (Sea Cucumbers)																					
Order Apodida																					
Family Synaptidae																					
Euapta godeffroyi			1			1	1										1			1	
Order Aspidochirotida																					
Family Holothuridae																					
Actinopyga mauritiana	1								1					1				1	1		
Bohadschia argus			1								1										
Bohadschia marmorata																				1	

Table 5. Continued: Species observed on each transect. Transect numbers are shown spatially in Figure 3.

	0526-1	0527-1	0528-1	0529-1	0530-1	0531-1	0601-1	0527-2	0528-2	0529-2	0530-2	0531-2	0601-2	0527-3	0528-3	0529-3	0530-3	0531-3	0601-3	0528-4	0529-4
Bohadschia vitiensis									1								1				1
Holothuria atra	1	1	1	1					1						1						1
Holothuria vitiensis						1															
Holothuria whitmae			1		1			1	1								1				
Family Stichopodidae																					
Stichopus chloronotus		1	1		1			1	1								1		1	1	1
Phylum Mollusca (Sea Slugs, Cowries, Conchs, Clams, Scallops, Octopus, and others)																					
Class Bivalvia (Cockles, Clams, Oysters, Scallops, and Others)																					
Order Cardiida (Giant Clams and Cockles)																					
Family Cardiidae																					
Tridacna maxima		1	1	1	1			1				1		1				1	1		1
Tridacna squamosa																	1				
Order Ostreida																					
Family Gryphaeidae																					
Hyotissa hyotis							1														
Order Venerida																					
Family Veneridae																					
Periglypta reticulata			1					1	1									1			
Class Cephalopoda (Octopus and Squid)																					
Order Octopoda (Octopus)																					
Family Octopodidae																					
Octopus cyanea		1											1								
Class Gastropoda (Sea Snails, Whelks, Sea Slugs, Cowries, Cone Shells, Conchs, and Others)																					
Order Anaspidea (Sea Slugs)																					
Family Aplysiidae																					
Aplysia dactylomela																		1	1		
Order Caenogastropoda (Ceriths)																					
Family Cerithiidae																					
Rhinoclavis sinensis			1														1				1
Family Haminoeidae																					
Haminoea cymbalum									1												
Order Littorinimorpha (Helmet Shells, Cowries, Conchs, Worm Shells, and Others)																					
Family Cassidae																					
Cassis cornuta											1										
Family Cypraeidae																					
Cypraea annulata										1											
Cypraea annulus														1						1	

Table 5. Continued: Species observed on each transect. Transect numbers are shown spatially in Figure 3.

	0526-1	0527-1	0528-1	0529-1	0530-1	0531-1	0601-1	0527-2	0528-2	0529-2	0530-2	0531-2	0601-2	0527-3	0528-3	0529-3	0530-3	0531-3	0601-3	0528-4	0529-4
Cypraea isabella						1												1			
Cypraea moneta		1	1						1										1	1	
Family Ranellidae																					
Cymatium muricinium															1				1		
Cymatium nicobaricum		1																1			
Cymatium sp.								1													
Family Strombidae																					
Lambis chiragra										1				1	1		1			1	
Lambis lambis		1	1			1		1		1	1	1			1		1		1	1	1
Lambis truncata						1		1				1					1		1		
Strombus mutabilis		1						1													
Family Vermetidae																					
Serpulorbis sp.		1					1	1							1		1			1	
Order Neogastropoda (Cone Shells and Miters)																					
Family Conidae																					
Conus ebraeus																1					
Conus chaldeus					1																
Conus distans		1																			
Conus ebraeus		1	1	1	1			1		1										1	
Conus flavidus	1	1	1	1				1	1		1	1		1	1		1	1	1		
Conus leopardus																1					
Conus lividus		1	1	1								1		1		1	1		1	2	
Conus miles			1			1								1				1	1		
Conus miliaris				1																	
Conus striatellus																		1			
Family Mitridae																					
Mitra chrysostoma								1													
Mitra mitra					1																
Family Muricidae																					
Drupa morum																		1			
Drupa ricinus	1							1	1									1	2		
Thais tuberosa																		1	1		
Family Terebridae																					
Terebra maculosa		1			1	1		1	1	1	1										
Subclass Vetigastropoda (Top and Turbin Shells)																					
Family Tegulidae																					
Tectus pyramis														1							

Table 5. Continued: Species observed on each transect. Transect numbers are shown spatially in Figure 3.

	0526-1	0527-1	0528-1	0529-1	0530-1	0531-1	0601-1	0527-2	0528-2	0529-2	0530-2	0531-2	0601-2	0527-3	0528-3	0529-3	0530-3	0531-3	0601-3	0528-4	0529-4
Family Trochidae																					
Trochus maculatus						1															
Trochus niloticus			1																		
Family Turbinidae																					
Turbo argyrostoma						1		1	1												
Phylum Porifera (Sponges)																					
Unidentified Class																					
Unidentified Order																					
Unidentified Family																					
Black sponge sp.													1								
Blue sponge sp.														1			1				
Brown sponge sp.						1									1		1				
Cream sponge sp.													1								
Green sponge sp.	1		1	1	1		1		1	1			1	1	1		1		1	1	
Grey sponge sp.															1						
Orange sponge sp. 1		1													1						
Orange sponge sp. 2		1												1	1						
Orange sponge sp. 3			1	1	1	1	1			1		1	1								
Pink sponge sp.						1															
Red sponge sp.						1															
Yellow boring sponge sp.													1								
Class Demospongiae (Siliceous Sponges)																					
Order Dictyoceratida																					
Family Dysideidae																					
Dysidea granulosa					2		1				1	1	1								
Dysidea sp.													1				1				
Plant																					
Phylum Chlorophyta (Green Algae)																					
Class Ulvophyceae																					
Order Bryopsidales																					
Family Bryopsidaceae																					
Bryopsis pennata										1											
Family Caulerpaceae																					
Caulerpa lentillifera											1										
Caulerpa racemosa	1		1				1	1	1		1					1	1			1	1
Caulerpa serrulata				1		1	1	1				1	1	1	1		1	1	1	1	
Caulerpa sertularioides					1		1				1	1	1			1	1				

Table 5. Continued: Species observed on each transect. Transect numbers are shown spatially in Figure 3.

	0526-1	0527-1	0528-1	0529-1	0530-1	0531-1	0601-1	0527-2	0528-2	0529-2	0530-2	0531-2	0601-2	0527-3	0528-3	0529-3	0530-3	0531-3	0601-3	0528-4	0529-4
Caulerpa taxifolia			1																		
Family Codiaceae																					
Codium edule													1								
Family Derbesiaceae																					
Derbesia marina		1																			
Family Dichotomosiphonaceae																					
Avrainvillea amadelpha				1	1					1	1				1	1					
Avrainvillea lacerata			1		1	1					1					1					
Avrainvillea sp.								1			1	1	2		1	1					
Family Halidedaceae																					
Haiimeda minima	1																				
Halimeda bikinensis								1													
Halimeda cylindracea						1	1								1						
Halimeda discoidea	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Halimeda gracilis				1			1				1		1	1	1						
Halimeda macroloba		1						1						1		1				1	
Halimeda micronesica				1	1	1	1						1			1		1	1	1	1
Halimeda opuntia	1			1	1		1	1	1	1			1		1	1	1	1	1	1	1
Family Rhipillaceae																					
Rhipilia sinuosa													1								
Family Udoteaceae																					
Chlorodesmis fastigiata	1	1	1	1	1			1	1						1		1	1	1		1
Tydemania expeditionis													1								
Udotea argentea													1			1					
Udotea geppii					1																
Order Dasycladales																					
Family Dasycladaceae																					
Neomeris annulata	1			1	1	1	1	1	1		1		1	1		1					
Neomeris van-bosseae						1							1								
Order Siphonocladales																					
Family Boodleaceae																					
Boodlea composita			1						1												
Family Siphonocladaceae																					
Boergesenia forbesii			1														1				
Dictyosphaeria versluysii		1	1	1	1			1	1									1			1
Family Valoniaceae																					
Valonia ventricosa				1			1						1				1		1		

Table 5. Continued: Species observed on each transect. Transect numbers are shown spatially in Figure 3.

	0526-1	0527-1	0528-1	0529-1	0530-1	0531-1	0601-1	0527-2	0528-2	0529-2	0530-2	0531-2	0601-2	0527-3	0528-3	0529-3	0530-3	0531-3	0601-3	0528-4	0529-4
Phylum Ochrophyta (Brown Algae)																					
Class Phaeophyceae																					
Order Dictyotales																					
Family Dictyotaceae																					
Dictyota acutiloba		1	1			1	1	1	1					1		1		1	1		1
Dictyota bartayresiana																		1			
Dictyota divaricata									1		1										
Dictyota friabilis		1						1						1							
Padina australis				1	1												1	1		1	
Padina sanctaecrucis		1	2	1			1		1	1	1	1		1	1	1	1		1	1	1
Order Fucales																					
Family Sargassaceae																					
Turbinaria ornata		1	1					2													
Phylum Rhodophyta (Red Algae)																					
Class Florideophyceae																					
Order Bonnemaisoniales																					
Family Bonnemaisoniaceae																					
Asparagopsis taxiformis			1	1	1	1	1		1	1		1		1	1			1			
Order Corallinales																					
Family Corallinaceae																					
Jania capillacea	1																				
Jania micrarthrodia	1	1		1					1											1	
Pololithon sp.														1							
Porolithon sp.	1								1								1			1	1
Family Sporolithaceae																					
Sporolithon sp.		1	1		1	1	1						1				1	1			1
Order Gigartinales																					
Family Cystocloniaceae																					
Hypnea spinella							1												1		
Order Nemaliales																					
Family Galaxauraceae																					
Dichotomaria marginata	1		2				1	1					1	1							
Dichotomaria obtusata						1															
Tricleocarpa cylindrica				1		1	1						1		1	1					
Tricleocarpa fragilis				1																	
Order Peyssonneliales																					
Family Peyssonneliaceae																					

Table 5. Continued: Species observed on each transect. Transect numbers are shown spatially in Figure 3.

	0526-1	0527-1	0528-1	0529-1	0530-1	0531-1	0601-1	0527-2	0528-2	0529-2	0530-2	0531-2	0601-2	0527-3	0528-3	0529-3	0530-3	0531-3	0601-3	0528-4	0529-4
Peyssonnelia sp.				1											1						
Phylum Tracheophyta (Vascular Plants)																					
Clade Monocots																					
Order Alismatales (Aquatic Herbaceous Plants)																					
Family Hydrocharitaceae																					
Halophila minor					1	1					1					1					1
Bacteria																					
Phylum Cyanobacteria (Blue-Green Bacteria)																					
Class Cyanophyceae																					
Order Nostocales																					
Family Nostocaceae																					
Hormothamnium enteromorphoides																			1		
Hormothamnium sp.		1	1					1													
Family Rivulariaceae																					
Dichothrix sp.					1		1			1		1					1				1
Order Oscillatoriales																					
Family Oscillatoriaceae																					
Lyngbya majuscula					1									1							
Lyngbya sp. 1 (yellow)		1	1	1	1	1								1	1		1	1	1		1
Lyngbya sp. 2 (red)								1													
Lyngbya sp. 3				1					1					1	1				1	1	
Family Phormidiaceae																					
Symploca sp.		1		1	1			1							1						
Family Schizotrichaceae																					
Schizothrix sp. 1			1			1		1													
Schizothrix sp. 2						1		1													
Schizothrix sp. 3		1	1				1				1	1	1					1			
Grand Total	41	53	74	65	49	57	59	65	50	32	28	34	75	47	47	29	48	51	50	24	30

Table 6: Area Calculations for Alternative 1. Area calculations for Habitat Zone, Major Structure, Sediment type, and Structure within Alternative 1 project footprint.

MAJOR STRUCTURE	Square Meters	Acres	Percent
Land	12,798	3.16	46.7
Hard Bottom	8,503	2.10	31.1
Mixed	2,406	0.59	8.8
Unconsolidated Sediment	3,670	0.91	13.4
Total	**27,376**	**6.8**	

SEDIMENT	Square Meters	Acres	Percent
NA	12	0.00	0.3
Rubble	44	0.01	1.2
Sand	37	0.01	1.0
Sand/ Rubble	3,578	0.88	97.5
Total	**3,670**	**0.9**	

STRUCTURE	Square Meters	Acres	Percent
Land	12,798	3.16	46.7
Pavement	8,503	2.10	31.1
Pavement with Sand Channels	0	0.00	0.0
Scattered Coral Rock in Unconsolidated Sediment	2,406	0.59	8.8
Unconsolidated Sediment	3,670	0.91	13.4
Total	**27,376**	**6.8**	

HABITAT ZONE	Square Meters	Acres	Percent
Back Reef	2,276	0.56	8.3
Channel	12	0.00	0.0
Harbor	7,981	1.97	29.2
Lagoon	479	0.12	1.7
Land	12,798	3.16	46.7
Reef Flat	3,830	0.95	14.0
Total	**27,376**	**6.8**	

Table 7: Area Calculations for Alternative 2. Area calculations for Habitat Zone, Major Structure, Sediment type, and Structure within Alternative 2 project footprint.

MAJOR STRUCTURE	Square Meters	Acres	Percent
Land	12,867	3.18	41.4
Hard Bottom	11,198	2.77	36.1
Mixed	2,965	0.73	9.5
Unconsolidated Sediment	4,024	0.99	13.0
Total	**31,054**	**7.7**	

SEDIMENT	Square Meters	Acres	Percent
NA	239	0.06	6.0
Rubble	41	0.01	1.0
Sand	104	0.03	2.6
Sand/ Rubble	3,639	0.90	90.4
Total	**4,023**	**1.0**	

STRUCTURE	Square Meters	Acres	Percent
Land	12,867	3.18	41.4
Pavement	11,198	2.77	36.1
Pavement with Sand Channels	0	0.00	0.0
Scattered Coral Rock in Unconsolidated Sediment	2,959	0.73	9.5
Spur and Groove	0	0.00	0.0
Unconsolidated Sediment	4,024	0.99	13.0
Total	**31,048**	**7.7**	

HABITAT ZONE	Square Meters	Acres	Percent
Back Reef	2,139	0.53	6.9
Channel	3,459	0.85	11.1
Harbor	8,375	2.07	27.0
Lagoon	438	0.11	1.4
Land	12,867	3.18	41.4
Reef Flat	3,770	0.93	12.1
Total	**31,048**	**7.7**	

Table 8: Acropora globiceps Numbers (certain). Tinian Harbor estimated number of *Acropora globiceps* based on **certain** colony identification directly within the project footprint (labeled as Target Area Appendix A, Figure A1). Three statistical approaches include a jackknife approximation, bootstrap of the median, and BCa bootstrap confidence intervals. Estimations are total colony numbers for proposed Target Area.

Calculations based only certain identification	Jackknife Calculations					Bootstrapped Calculations					BCa Bootstrap CIs		
Structure	**Median**	**Mean**	**Lower CI**	**Upper CI**	**Range**	**Median**	**Mean**	**Lower CI**	**Upper CI**	**Range**	**Lower CI**	**Upper CI**	**Range**
Aggregate Reef	5	6	6	6	**5-6**	6	8	7	8	**6-8**	3	19	**3-19**
Pavement	14	22	21	22	**14-22**	14	25	25	26	**14-26**	7	68	**7-68**
Pavement with Sand Channels	3	2	2	2	**2-3**	2	2	2	2	**2**	2	3	**2-3**
Scattered Coral Rock in Unconsolidated Sediment	19	17	17	18	**17-19**	13	20	19	20	**13-20**	9	34	**9-34**
Spur and Groove	7	7	7	7	**7-7**	7	7	7	7	**7**	6	8	**6-8**
Unconsolidated Sediment	42	41	41	41	**41-42**	42	42	42	43	**42-43**	18	61	**18-61**

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Calculation based on certain and uncertain identification	Jackknife Calculations					Bootstrapped Calculations					BCa Bootstrap CIs		
Structure	**Median**	**Mean**	**Lower CI**	**Upper CI**	**Range**	**Median**	**Mean**	**Lower CI**	**Upper CI**	**Range**	**Lower CI**	**Upper CI**	**Range**
Aggregate Reef	8	7	7	7	**7-8**	7	8	8	8	**7-8**	3	12	**2-12**
Pavement	30	32	31	32	**30-32**	30	34	34	35	**30-35**	8	69	**8-69**
Pavement with Sand Channels	3	2	2	2	**2-3**	2	2	2	2	**2-2**	2	3	**2-3**
Scattered Coral Rock in Unconsolidated Sediment	25	26	26	26	**25-26**	27	29	29	30	**27-30**	10	73	**10-73**
Spur and Groove	8	10	10	10	**8-10**	10	11	11	11	**10-11**	6	28	**6-28**
Unconsolidated Sediment	51	53	53	54	**51-54**	51	54	54	54	**51-54**	18	66	**18-66**

Table 10: Acropora globiceps Numbers (certain) for Alternative 1. Estimated number of *Acropora globiceps* based on certain colony identification directly within Alternative 1 project footprint (Figure 4 and Appendix A, Figure A1). Three statistical approaches include a jackknife approximation, bootstrap of the median, and BCa bootstrap confidence intervals. Estimations are total colony numbers for proposed Alternative 1.

Calculations based only certain identification	**Jackknife Calculations**					**Bootstrapped Calculations**					**BCa Bootstrap CIs**		
Structure	**Median**	**Mean**	**Lower CI**	**Upper CI**	**Range**	**Median**	**Mean**	**Lower CI**	**Upper CI**	**Range**	**Lower CI**	**Upper CI**	**Range**
Pavement	10	9	9	9	**9-10**	8	10	10	11	**8-11**	2	18	**2-18**
Pavement with Sand Channels	NA	NA	NA	NA	**NA**	0	0	0	0	**0**	NA	NA	**NA**
Scattered Coral Rock in Unconsolidated Sediment	18	18	18	19	**18-19**	20	20	19	20	**19-20**	6	26	**6-26**
Unconsolidated Sediment	12	9	9	10	**9-12**	3	8	8	8	**3-8**	1	24	**1-24**

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ervals.

Calculation based on certain and uncertain identification	**Jackknife Calculations**					**Bootstrapped Calculations**					**BCa Bootstrap CIs**		
Structure	**Median**	**Mean**	**Lower CI**	**Upper CI**	**Range**	**Median**	**Mean**	**Lower CI**	**Upper CI**	**Range**	**Lower CI**	**Upper CI**	**Range**
Pavement	10	9	9	9	**9-10**	8	10	10	10	**8-10**	2	18	**2-18**
Pavement with Sand Channels	NA	NA	NA	NA	**NA**	0	0	0	0	**0**	NA	NA	**NA**
Scattered Coral Rock in Unconsolidated Sediment	18	18	18	19	**18-19**	20	20	19	20	**19-20**	6	26	**6-26**
Unconsolidated Sediment	12	9	9	10	**9-12**	3	8	8	8	**3-8**	1	24	**1-24**

Table 12: Acropora globiceps Numbers (certain) for Alternative 2. Estimated number of *Acropora globiceps* based on certain colony identification directly within Alternative 2 project footprint (Figure 5 and Appendix A, Figure A1). Three statistical approaches include a jackknife approximation, bootstrap of the median, and BCa bootstrap confidence intervals. Estimations are total colony numbers for proposed Alternative 2.

Calculations based only certain identification	**Jackknife Calculations**					**Bootstrapped Calculations**					**BCa Bootstrap CIs**		
Structure	**Median**	**Mean**	**Lower CI**	**Upper CI**	**Range**	**Median**	**Mean**	**Lower CI**	**Upper CI**	**Range**	**Lower CI**	**Upper CI**	**Range**
Pavement	7	7	7	7	**7**	8	8	8	8	**8**	3	10	**3-10**
Pavement with Sand Channels	NA	NA	NA	NA	**NA**	0	0	0	0	**0**	NA	NA	**NA**
Scattered Coral Rock in Unconsolidated Sediment	23	23	22	23	**23**	23	25	25	25	**23-25**	12	49	**12-49**
Spur and Groove	NA	NA	NA	NA	**NA**	0	0	0	0	**0**	NA	NA	**NA**
Unconsolidated Sediment	14	10	10	11	**10-14**	4	9	9	9	**4-9**	1	27	**1-27**

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ervals.

Calculation based on certain and uncertain identification	**Jackknife Calculations**					**Bootstrapped Calculations**					**BCa Bootstrap CIs**		
Structure	**Median**	**Mean**	**Lower CI**	**Upper CI**	**Range**	**Median**	**Mean**	**Lower CI**	**Upper CI**	**Range**	**Lower CI**	**Upper CI**	**Range**
Pavement	7	7	7	7	**7**	8	8	8	8	**8**	3	10	**3-10**
Pavement with Sand Channels	NA	NA	NA	NA	**NA**	0	0	0	0	**0**	NA	NA	**NA**
Scattered Coral Rock in Unconsolidated Sediment	23	22	22	23	**22-23**	23	25	25	26	**23-26**	12	49	**12-49**
Spur and Groove	NA	NA	NA	NA	**NA**	0	0	0	0	**0**	NA	NA	**NA**
Unconsolidated Sediment	14	11	10	11	**10-14**	4	9	9	10	**4-10**	1	27	**1-27**

APPENDIX A: Maps of Tinian Harbor Modification Project

Appendix A. Maps of Tinian Harbor Modification Project.

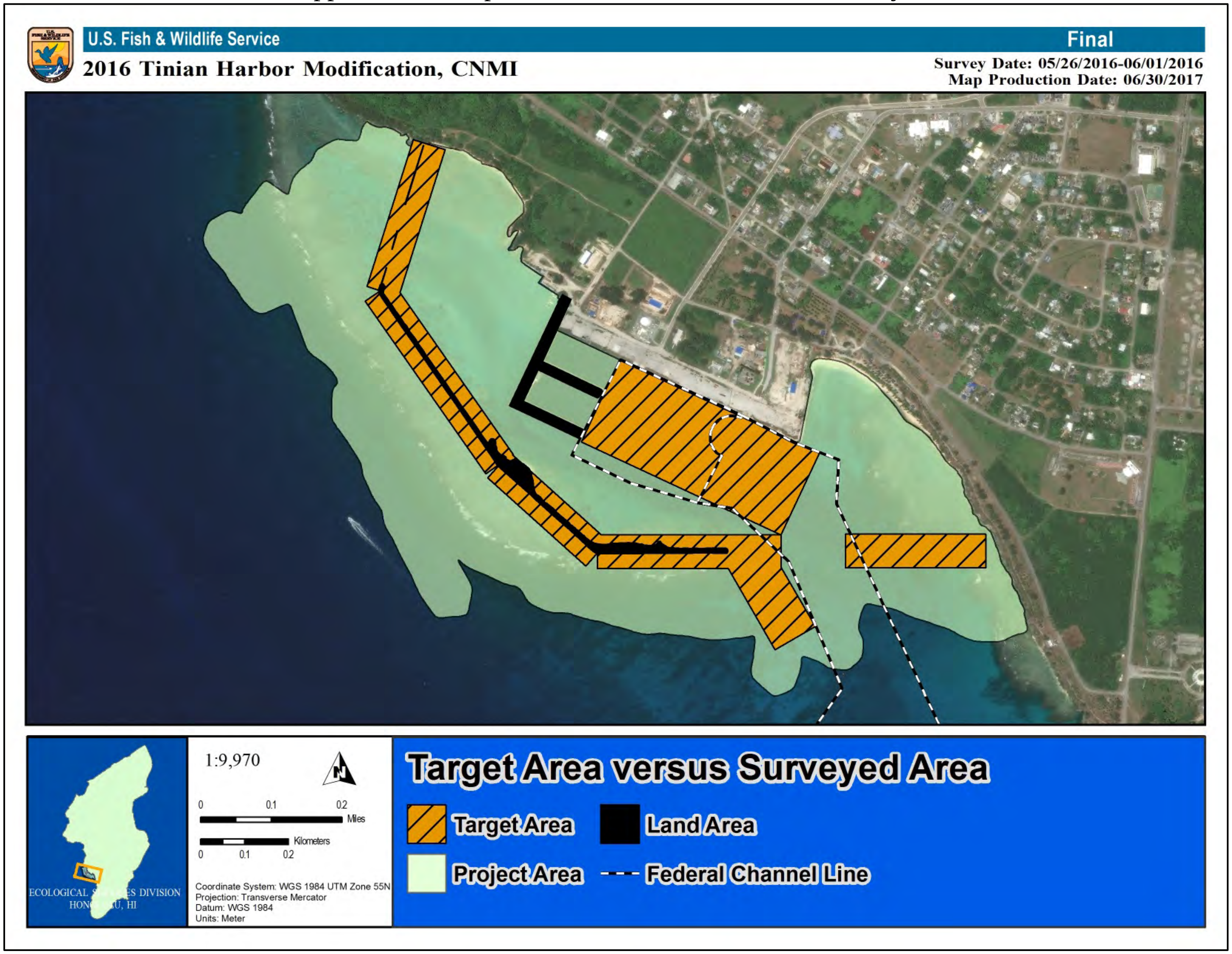

Figure A1: Target Area vs. Surveyed Area. Overview of the Project Area (total surveyed area plus project footprint) versus the Target Area (project footprint).

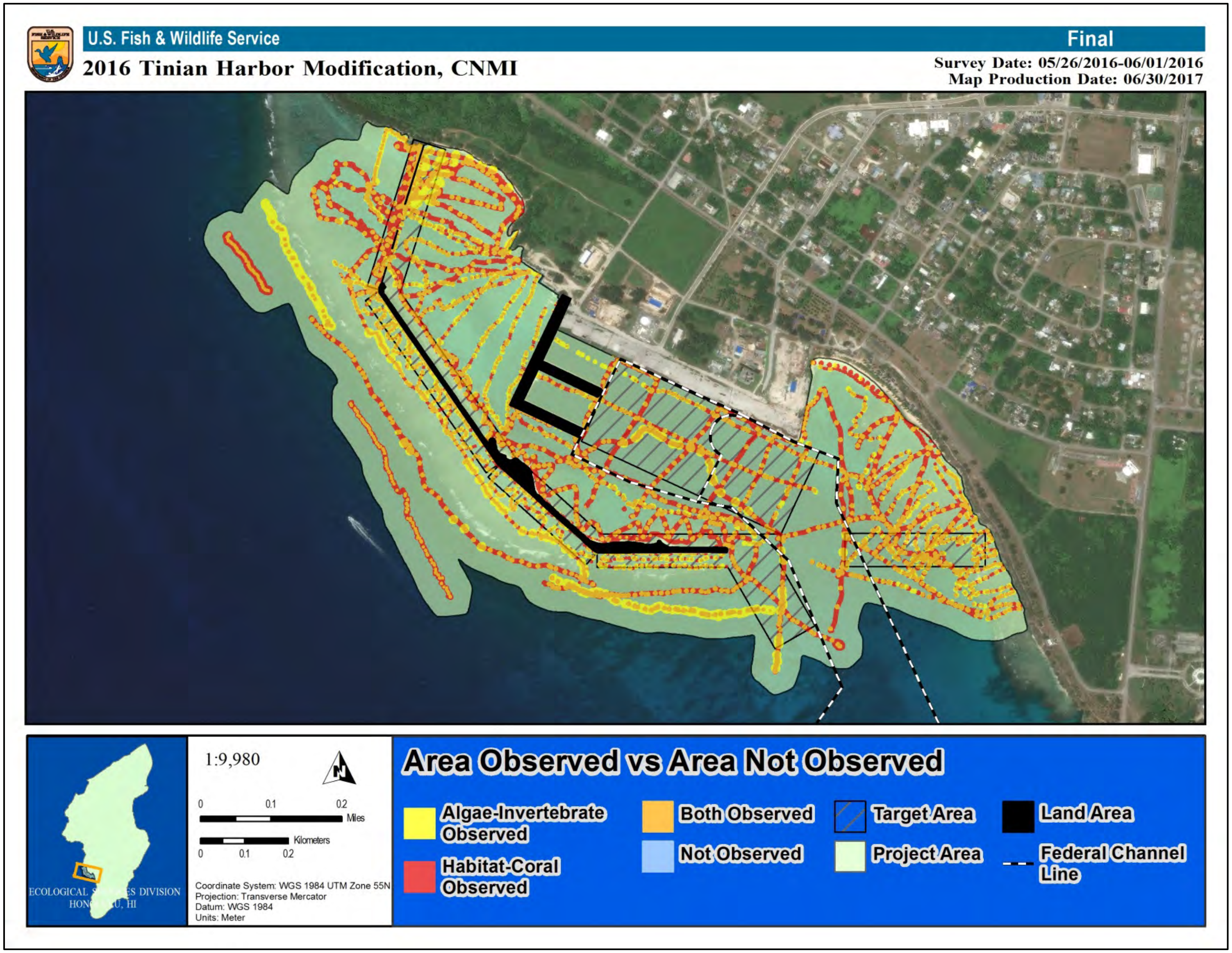

Figure A2: Area Observed. Overview of the area observed by in-water observers versus the area interpolated in all maps.

Figure A3: Dive Tracks. Overview of the dive track lines for all survey transects.

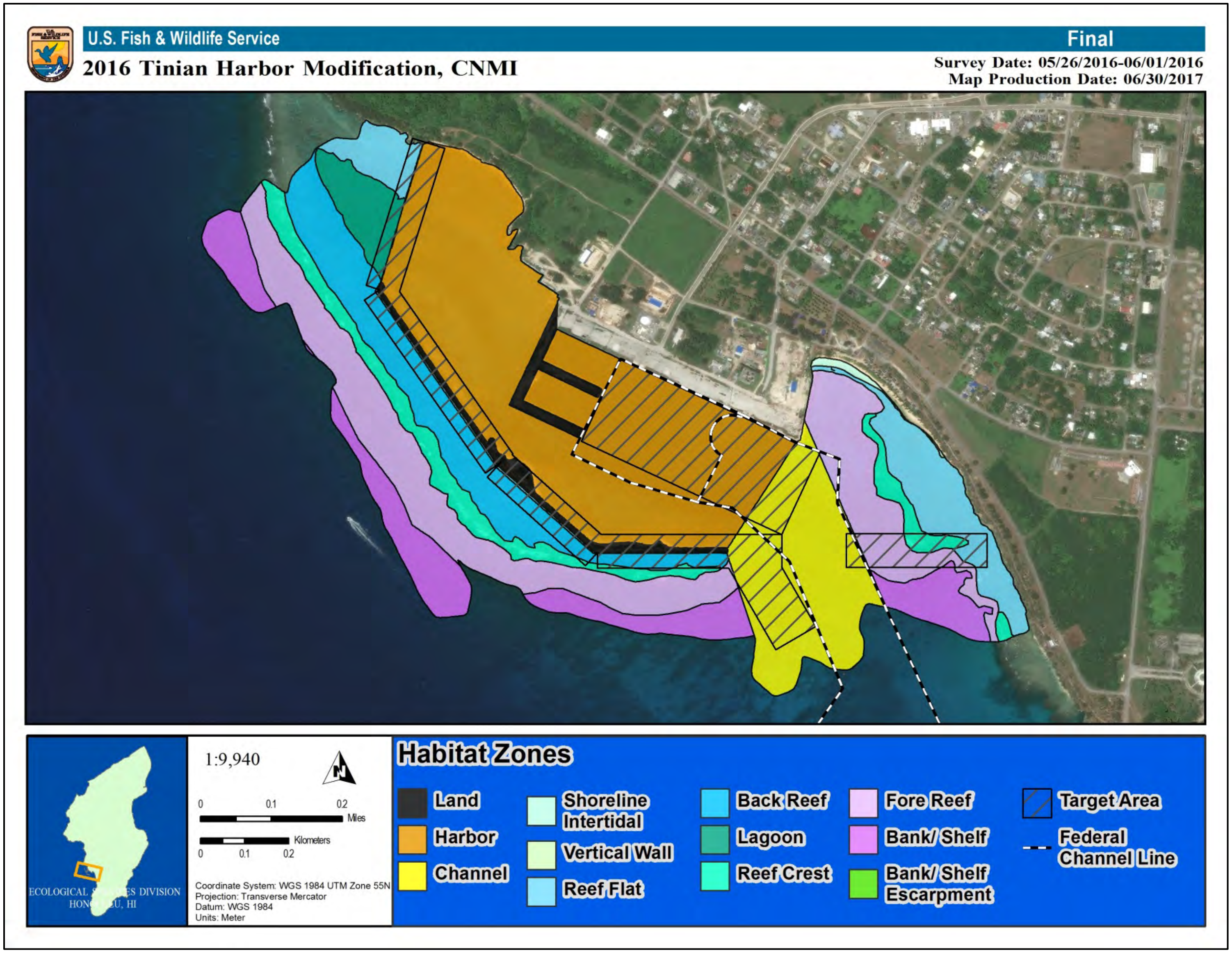

Figure A4: Habitat Zones. Overview of the various habitat zones that the project area contains.

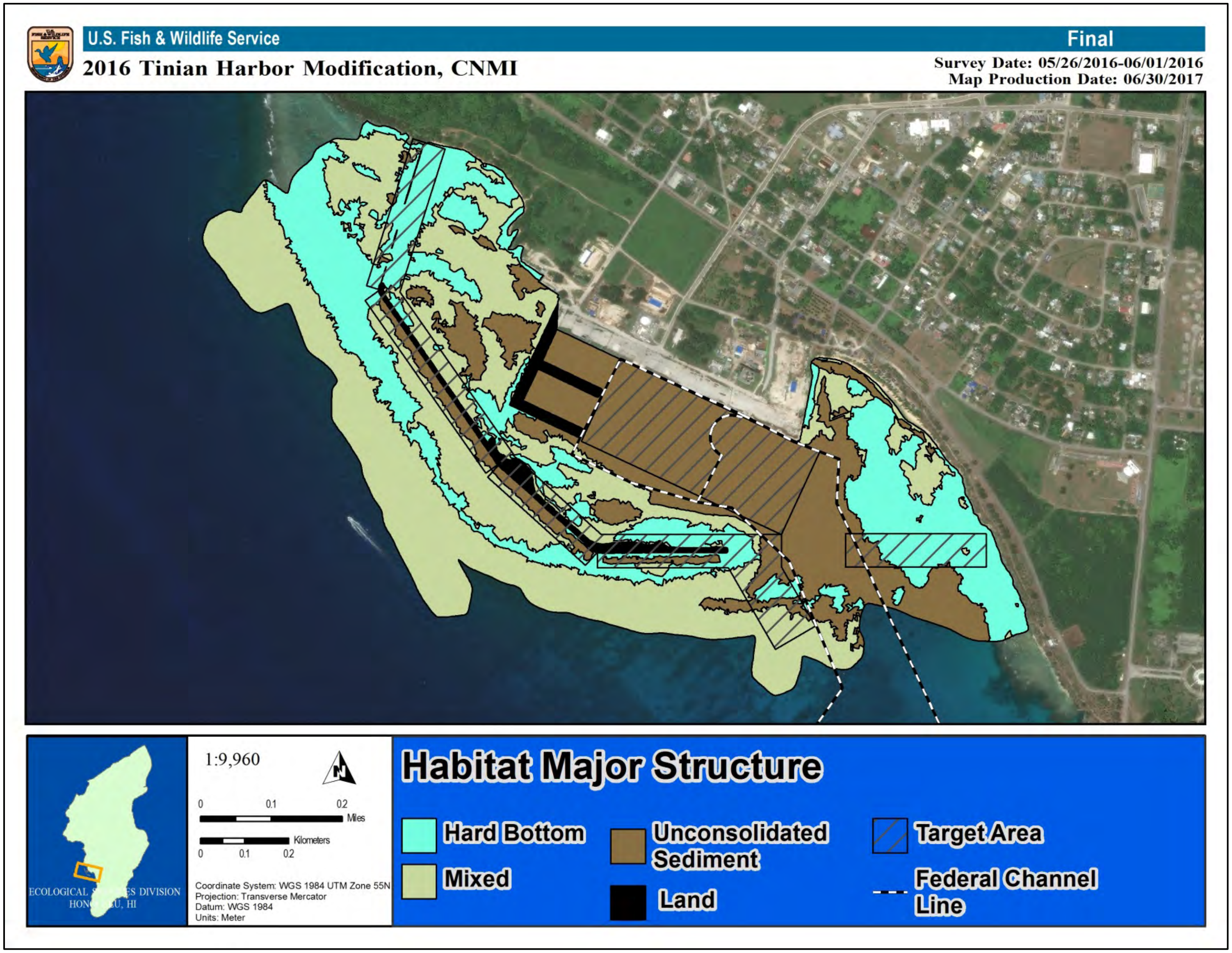

Figure A5: Habitat Major Structure. Overview of the major habitat structures that the project area contains.

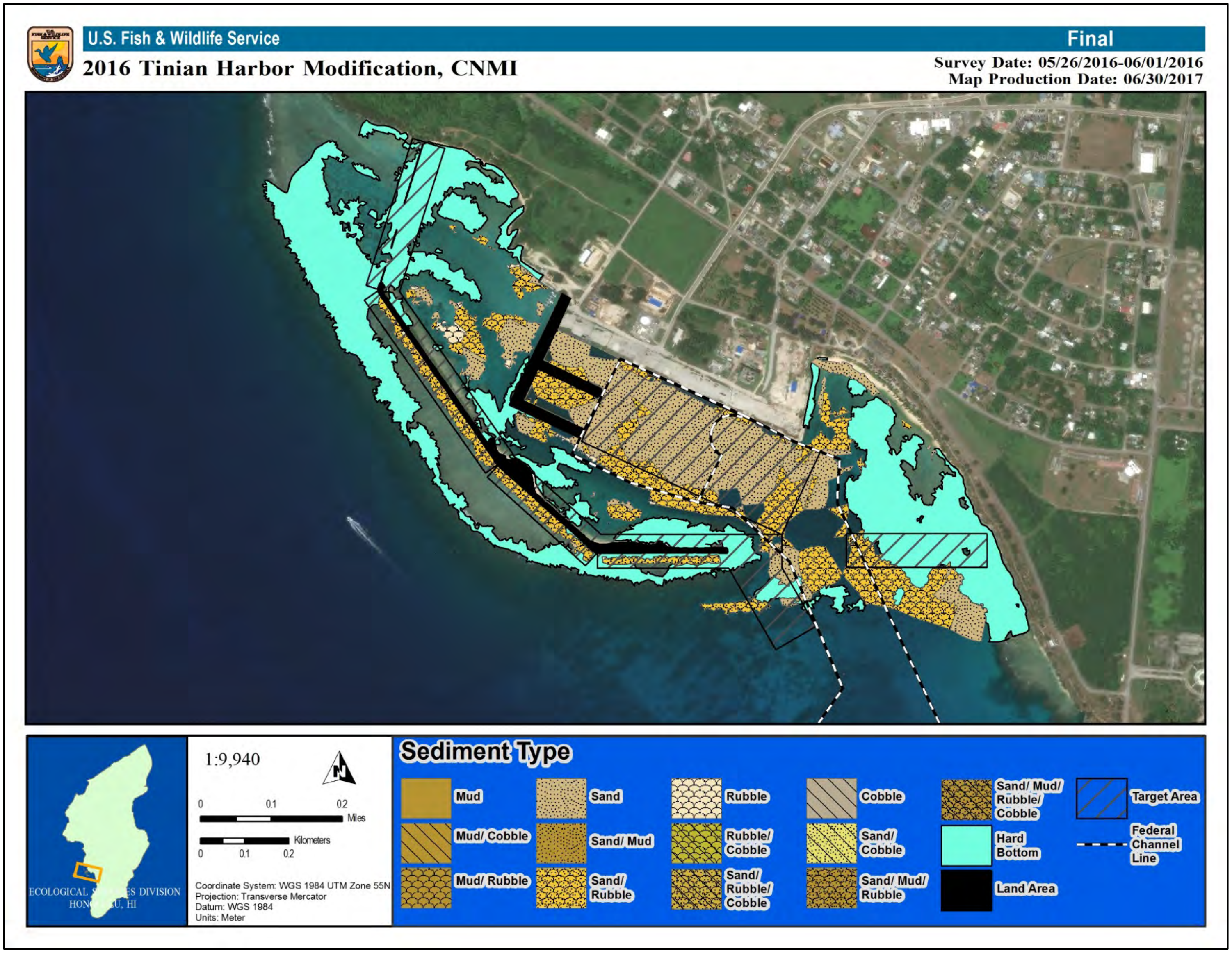

Figure A6: Sediment Type. Overview of the various sediment types that the project area contains.

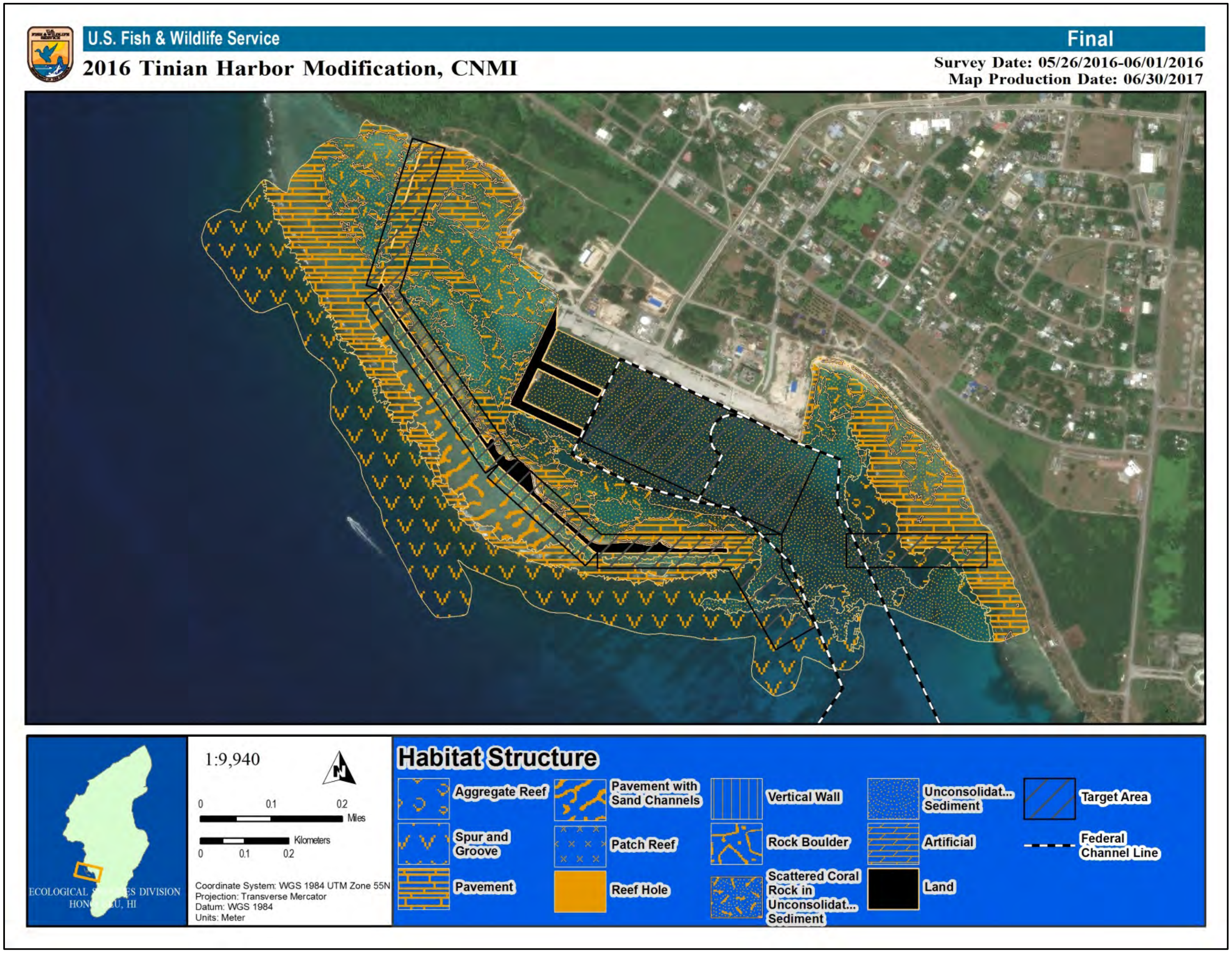

Figure A7: Habitat Structure. Overview of the habitat structures that the project area contains.

Figure A8: Habitat Structure in Target Area. Overview of the habitat structures within the project footprint (Target Area).

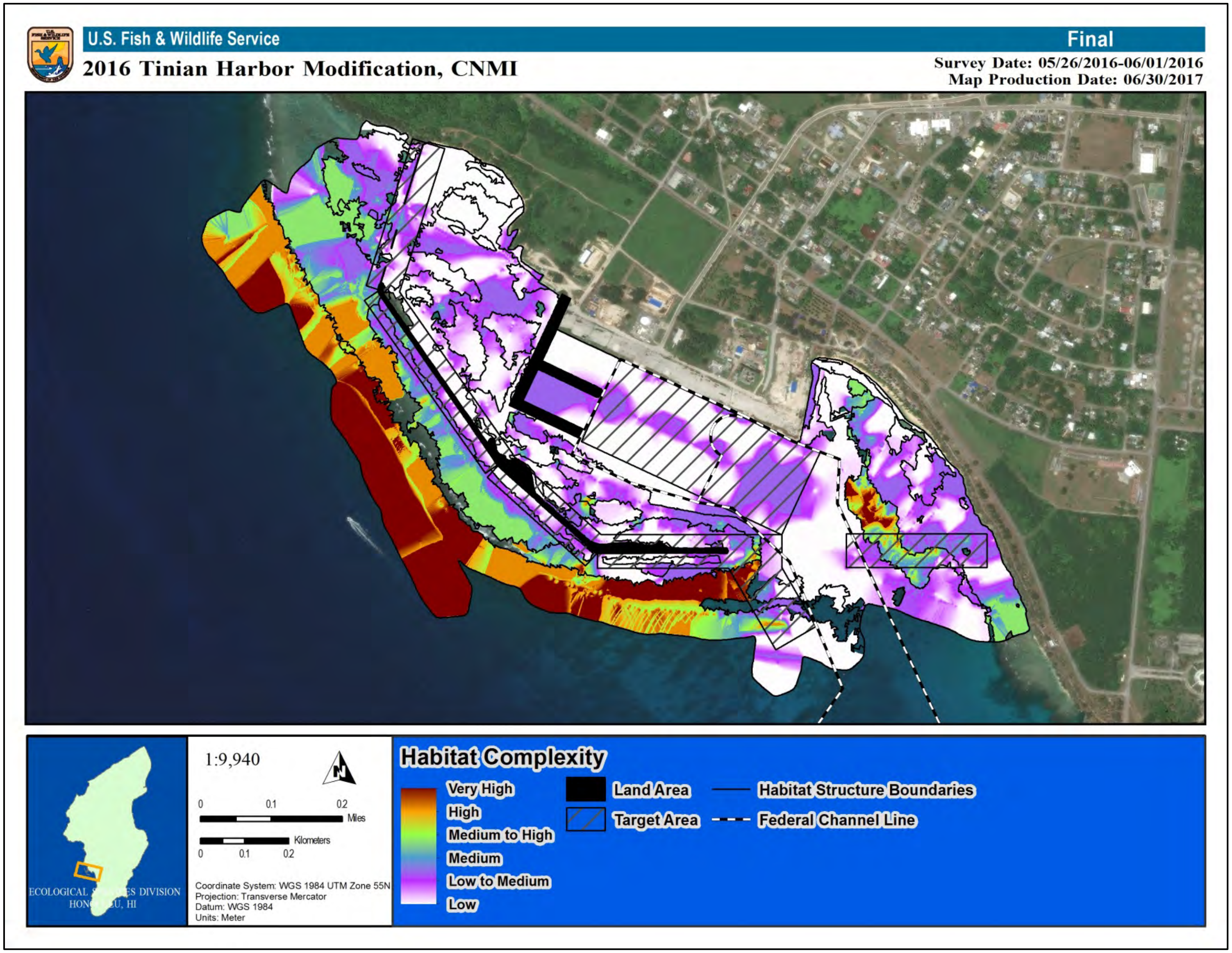

Figure A9: Habitat Complexity. Overview of the habitat complexity observed within the project area.

Figure A10: Debris. Overview of the debris observed within the project area.

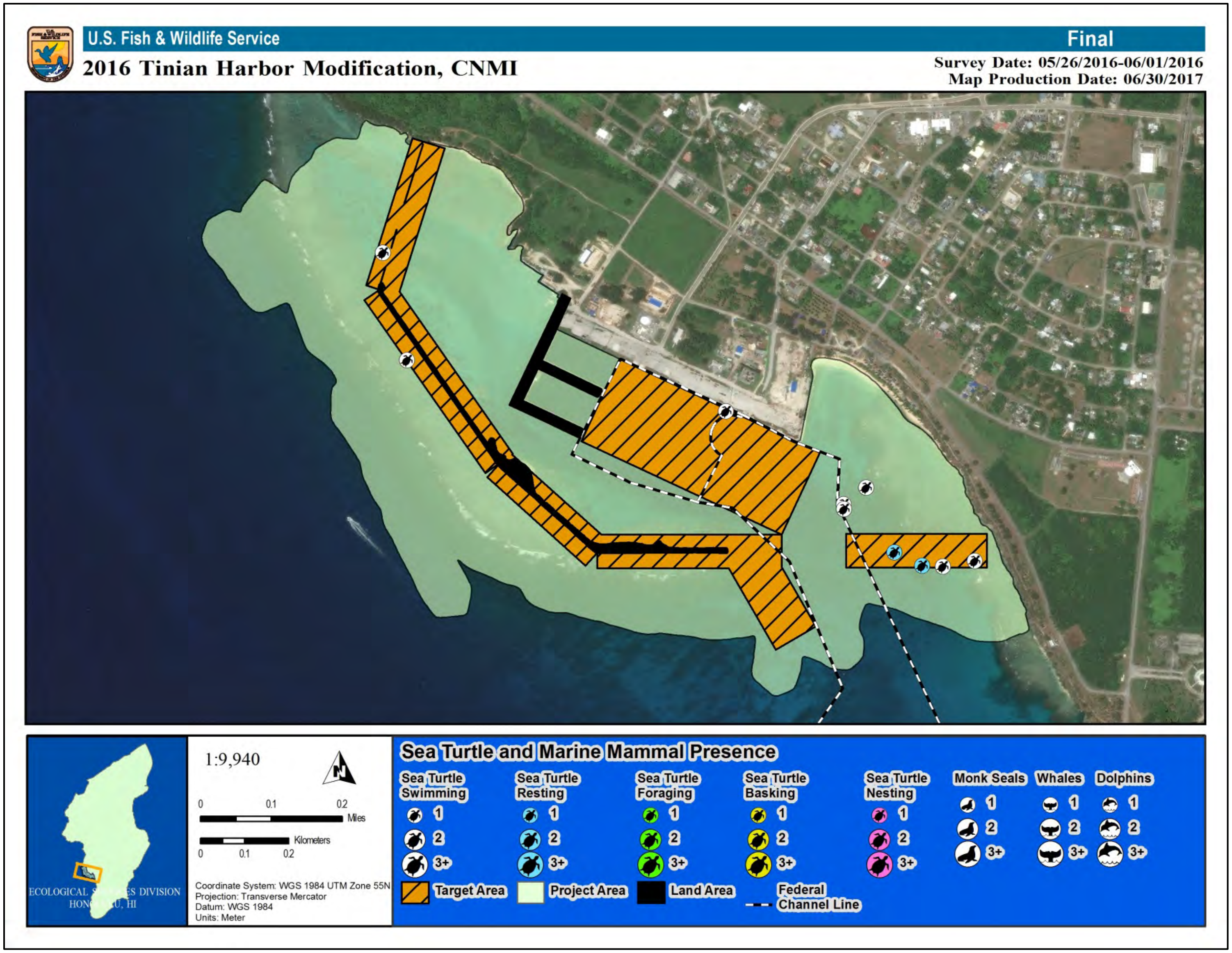

Figure A11: Protected Species. Overview of the observed protected species within the project area.

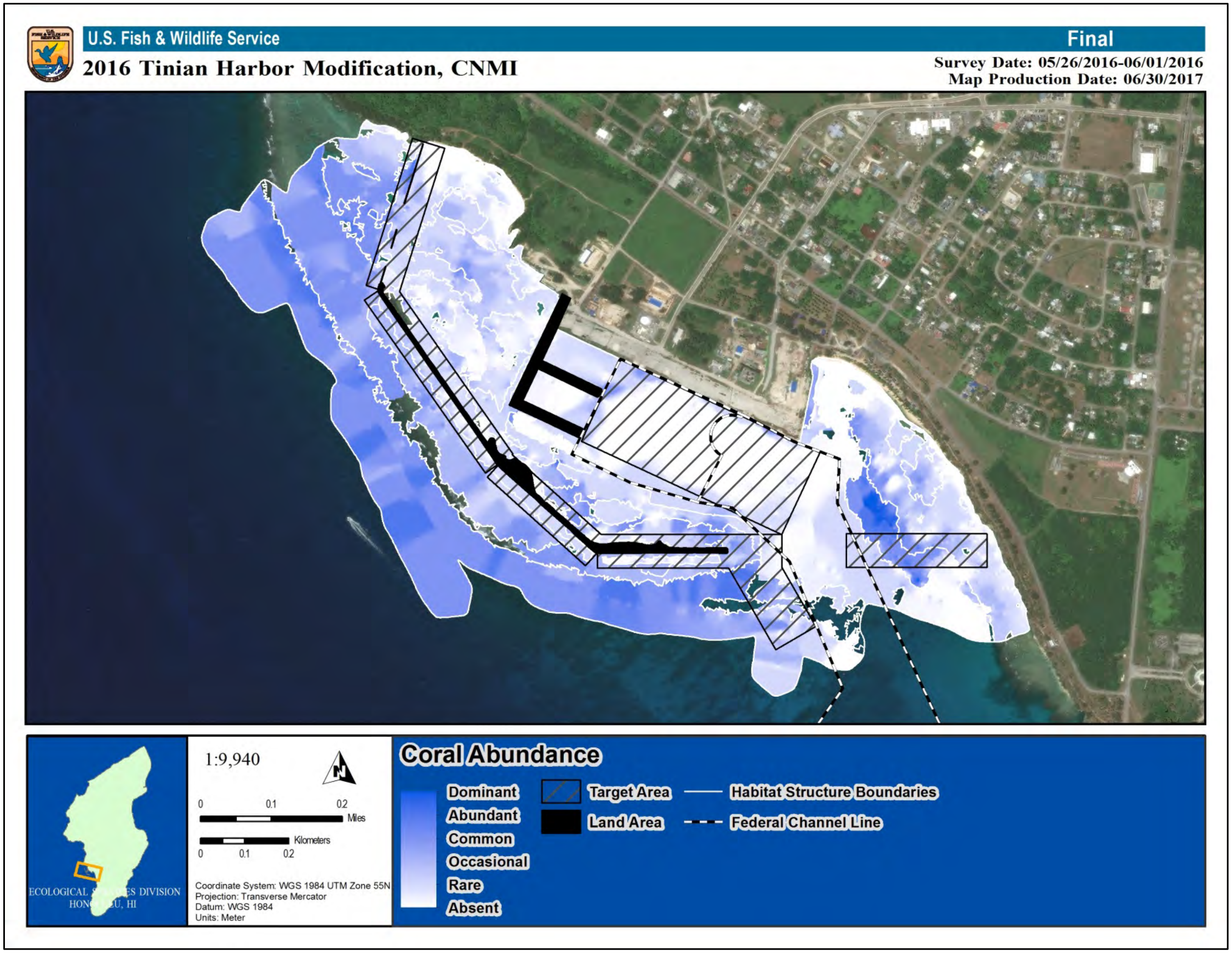

Figure A12: Coral Abundance. Overview of the coral abundance within the project.

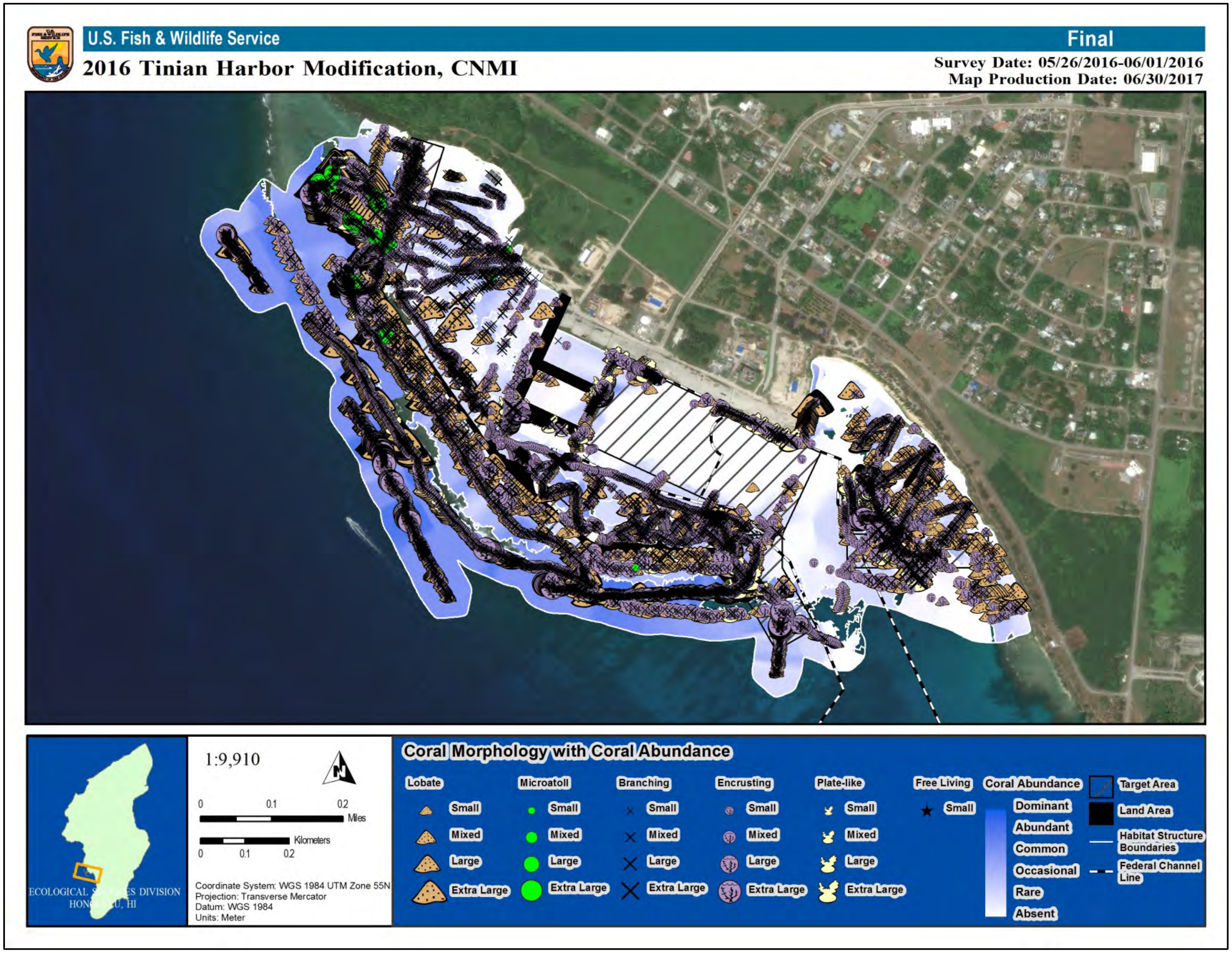

Figure A13: Coral Morphologies. Overview of the various coral morphologies and broad coral sizes observed within the project area.

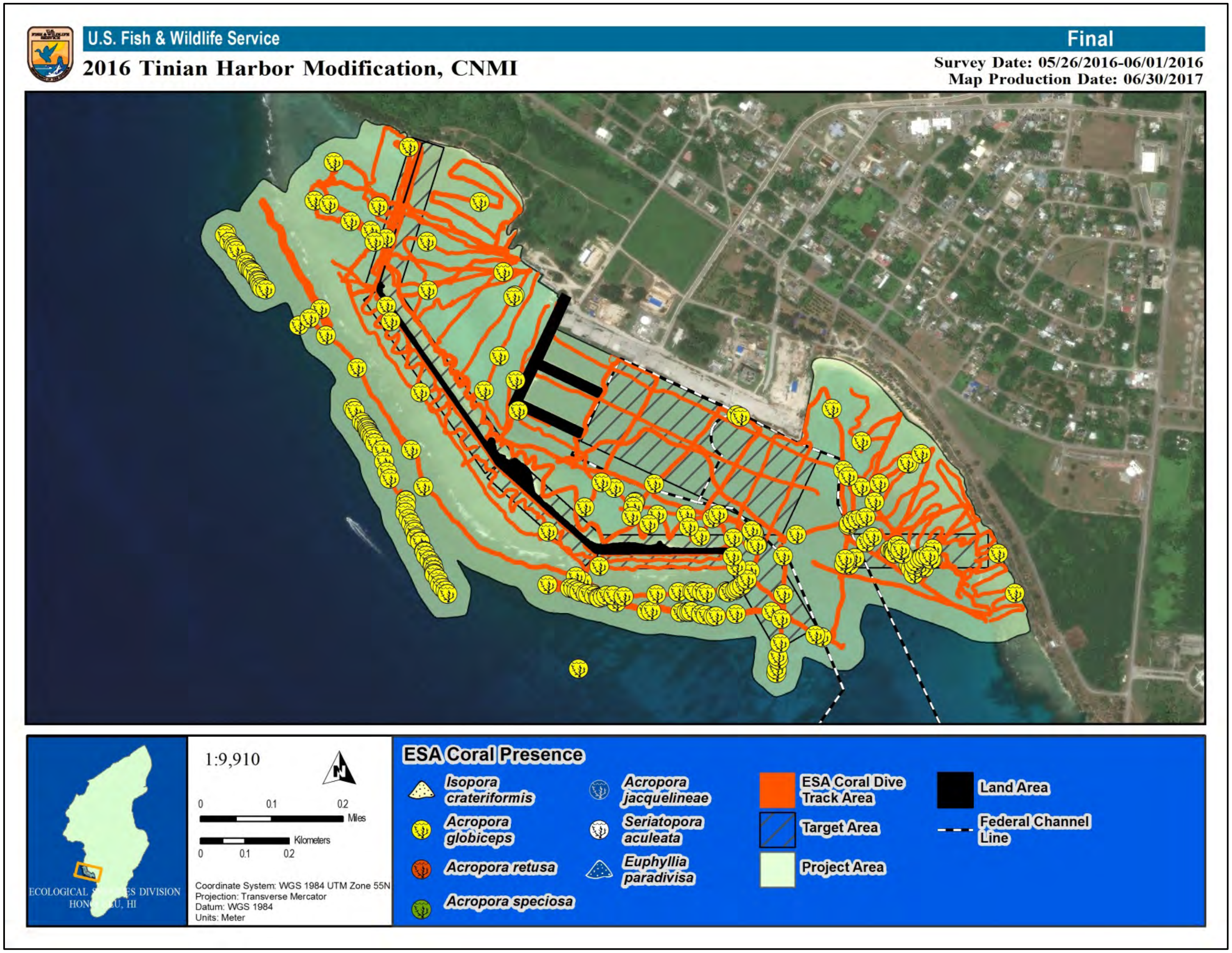

Figure A14: ESA-listed Corals. Overview of the ESA-listed coral species observed within the project area.

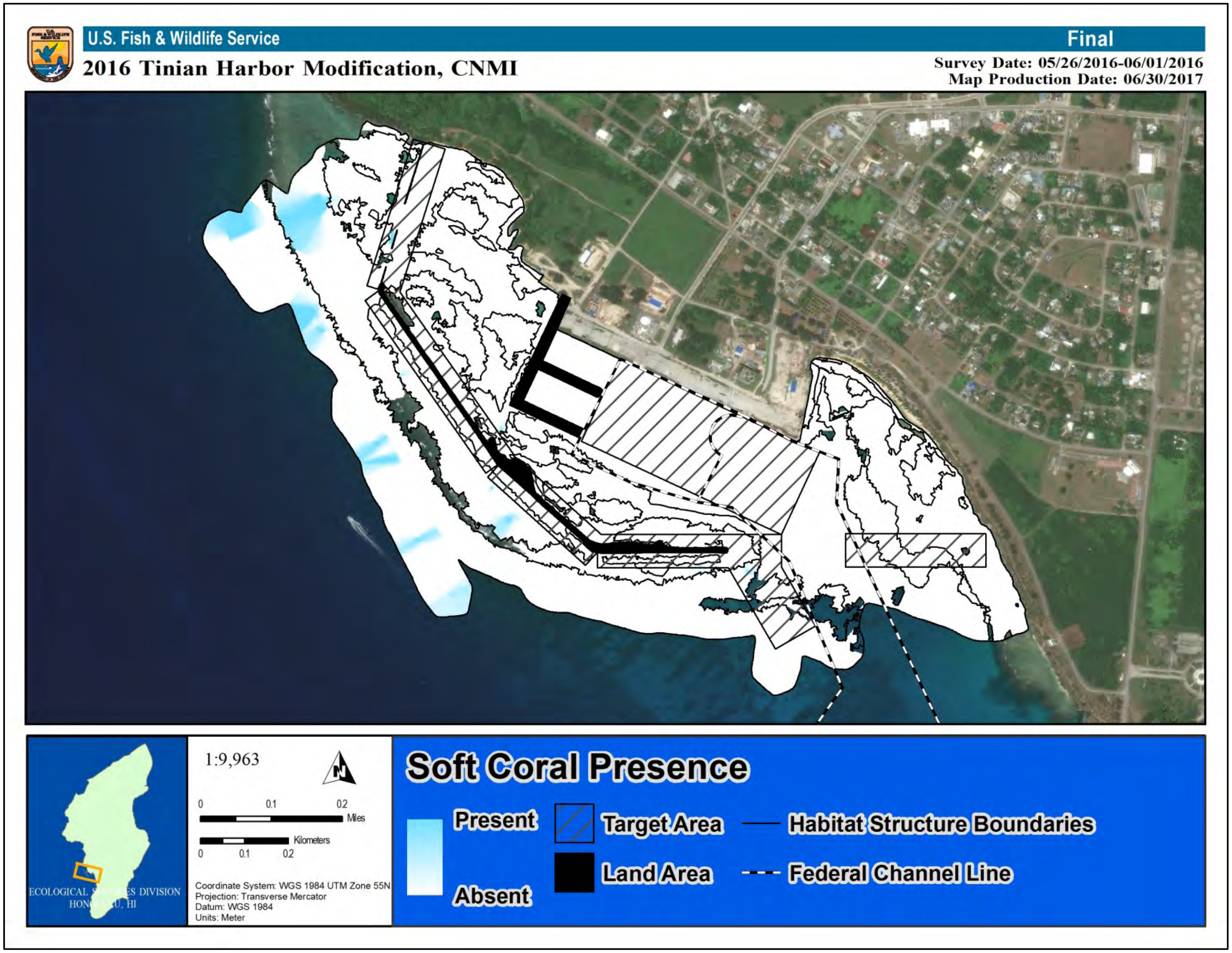

Figure A15: Soft Coral Presence. Overview of the soft coral presence within the project area.

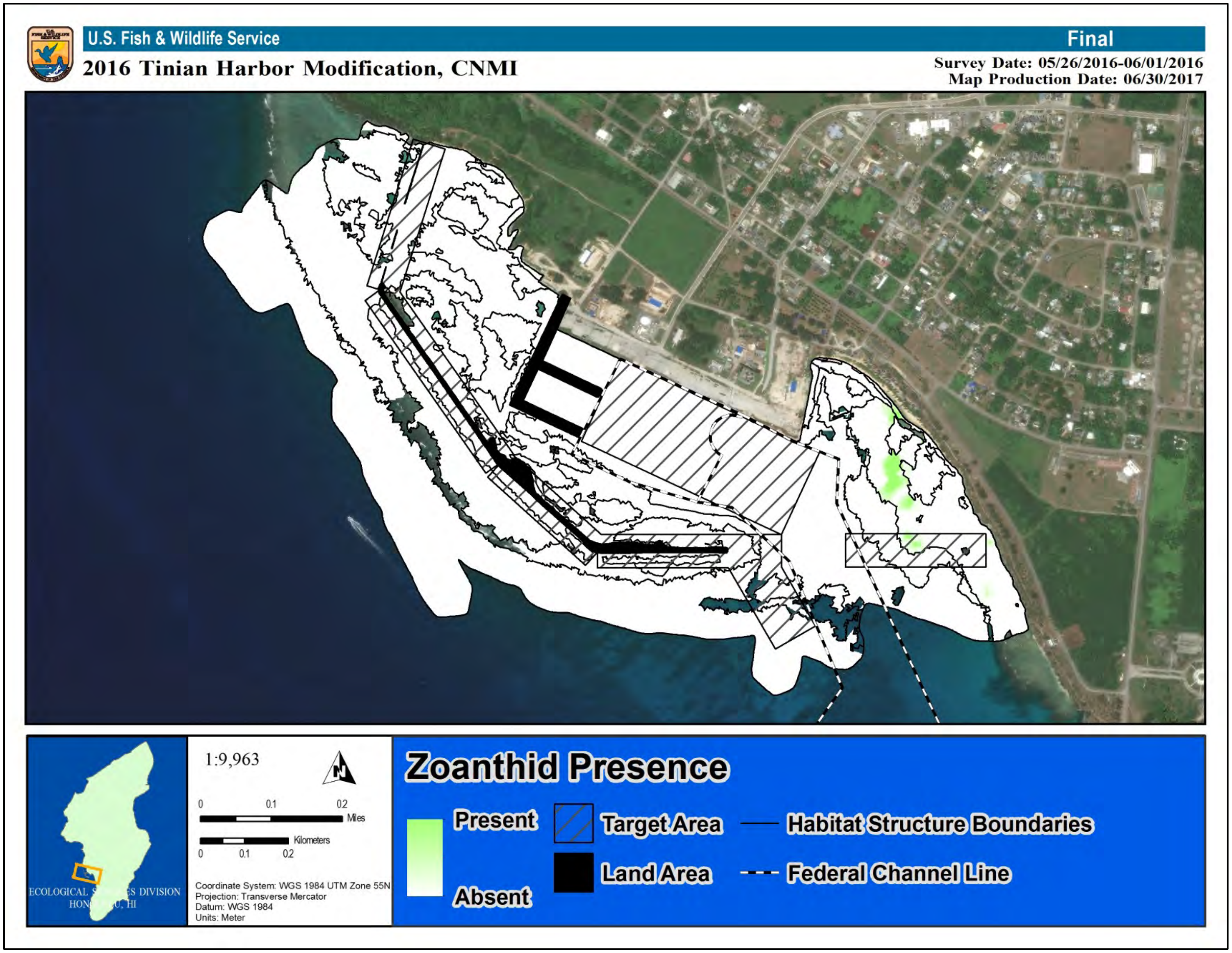

Figure A16: Zonathid Presence. Overview of the zoanthid (relative to corals) presence within the project area.

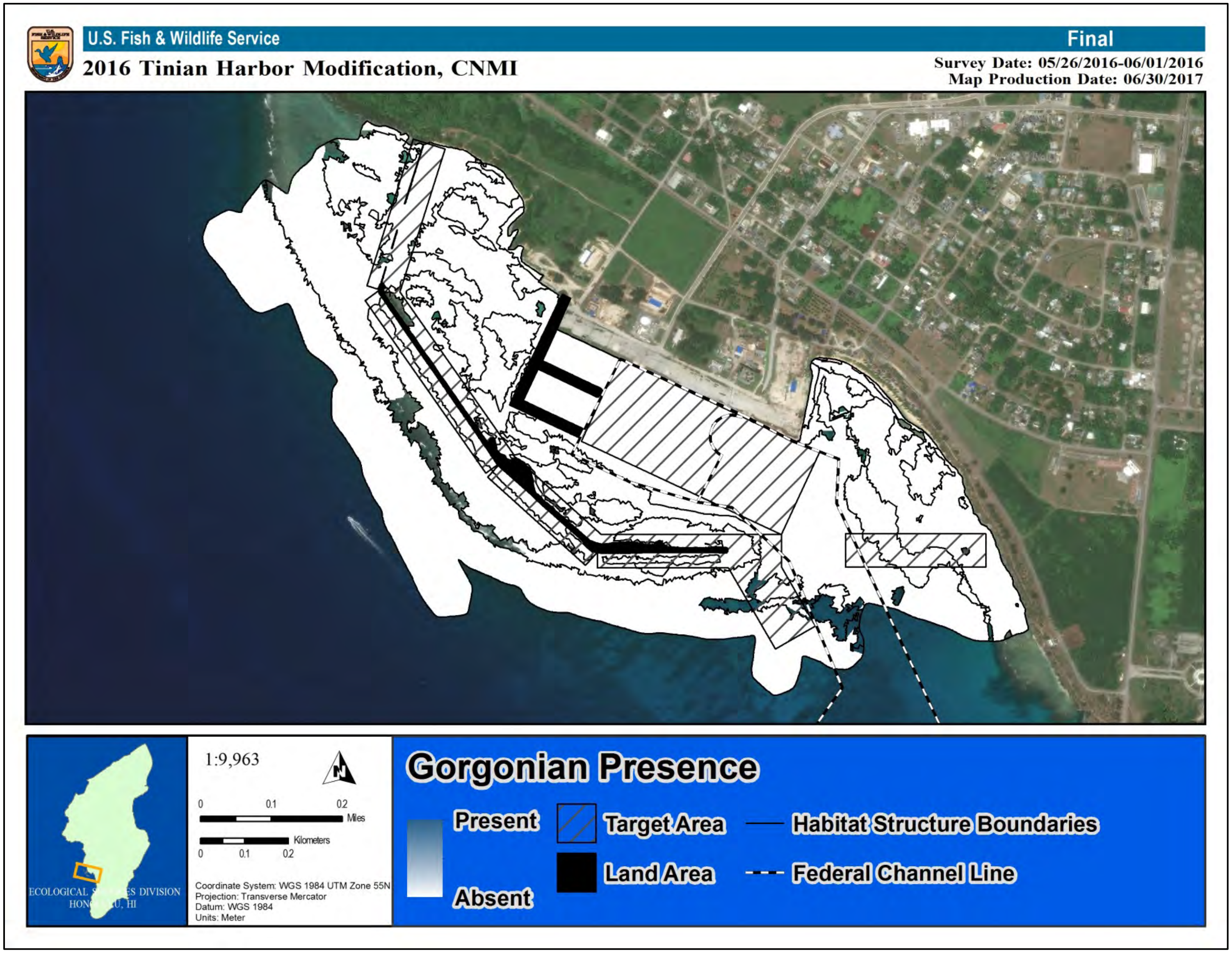

Figure A17: Gorgonian Presence. Overview of the gorgonian coral presence within the project area. Note: No gorgonians were observed.

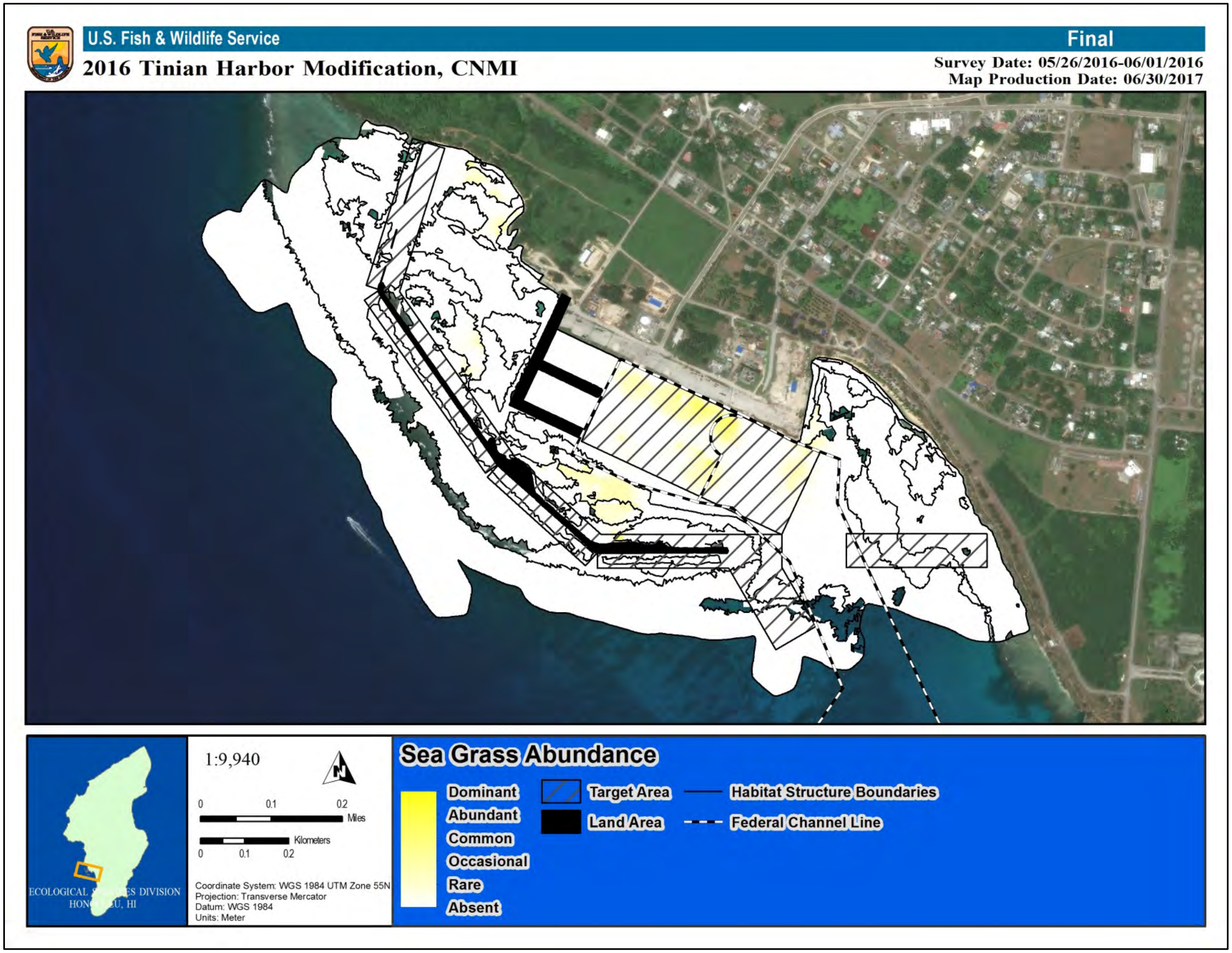

Figure A18: Sea Grass Abundance. Overview of the seagrass abundance within the project area.

Figure A19: Frondose Algae Abundance. Overview of the frondose algae (macroalgae) abundance observed within the project area.

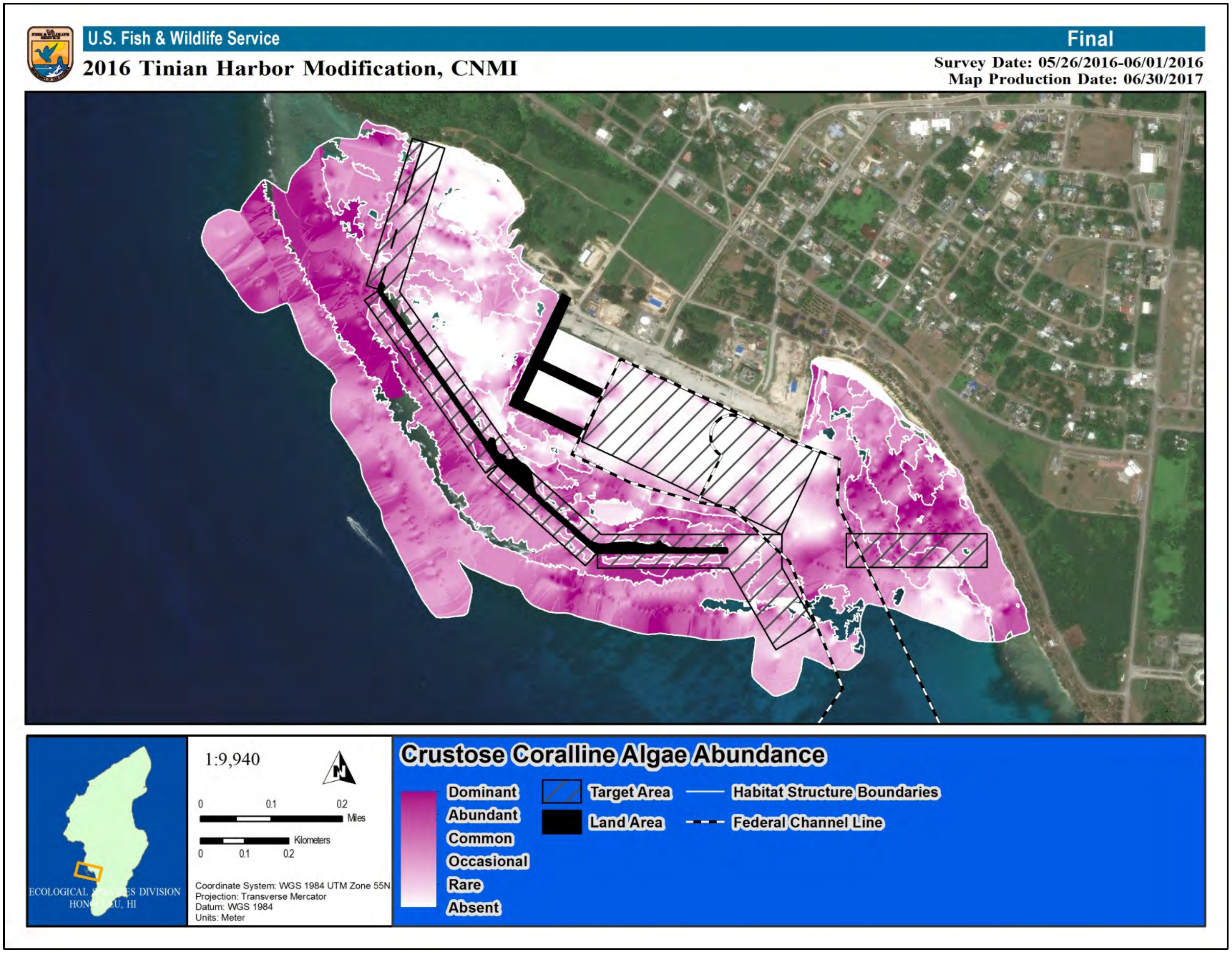

Figure A20: CCA Abundance. Overview of the crustose coralline algae abundance observed within the project area.

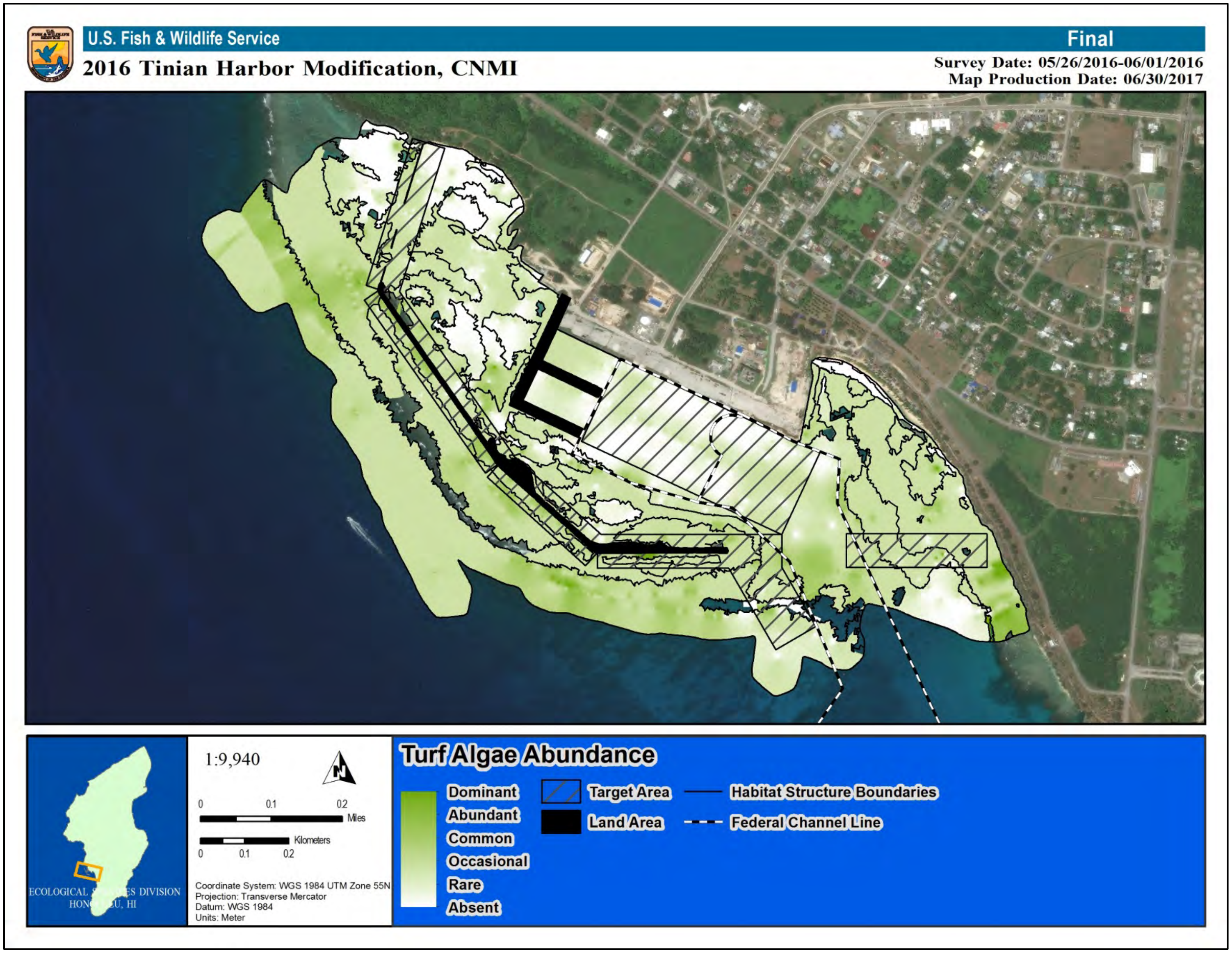

Figure A21: Turf Algae Abundance. Overview of the turf algae abundance observed within the project area.

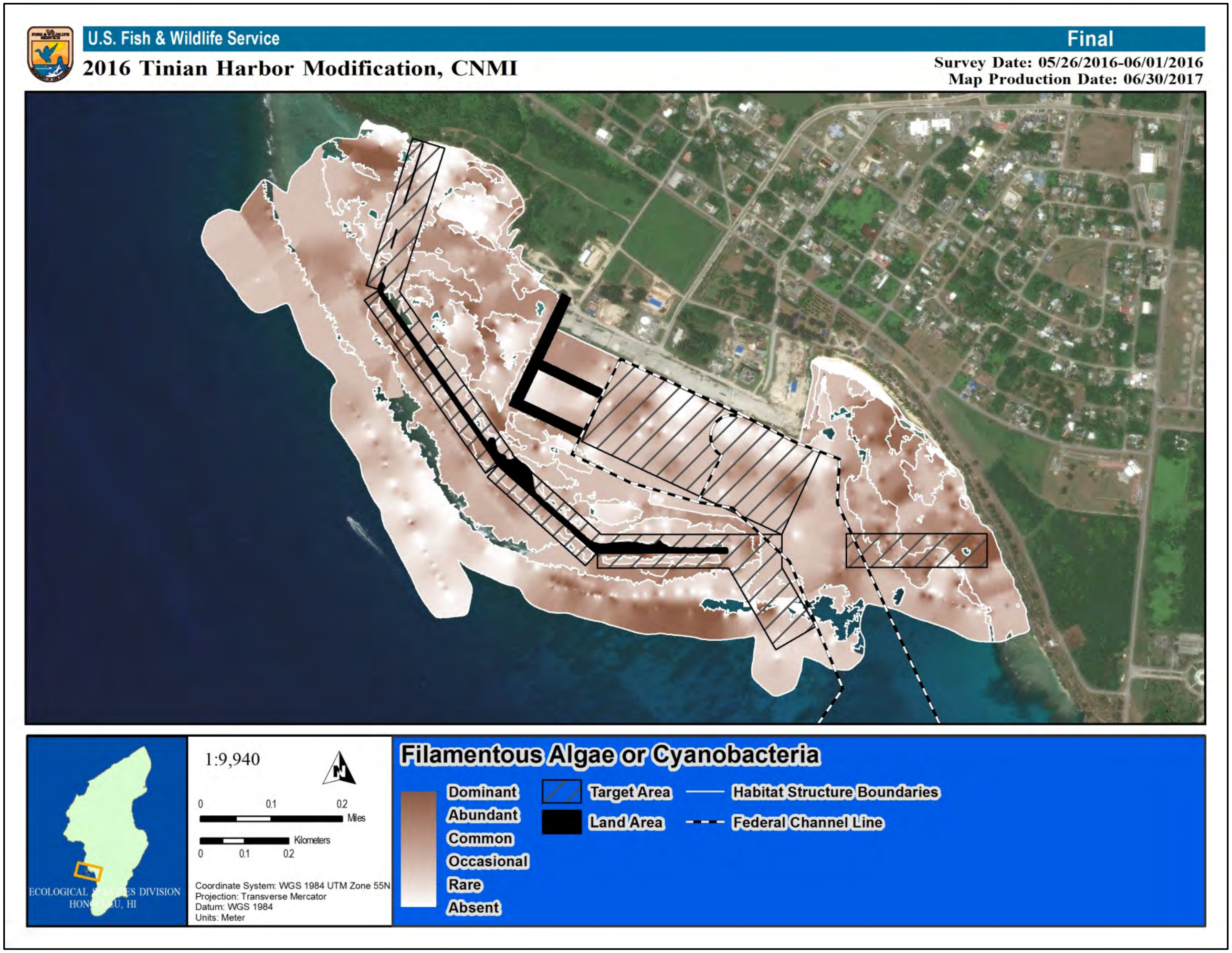

Figure A22: Filamentous Algae. Overview of the filamentous algae and cyanobacteria abundance observed within the project area.

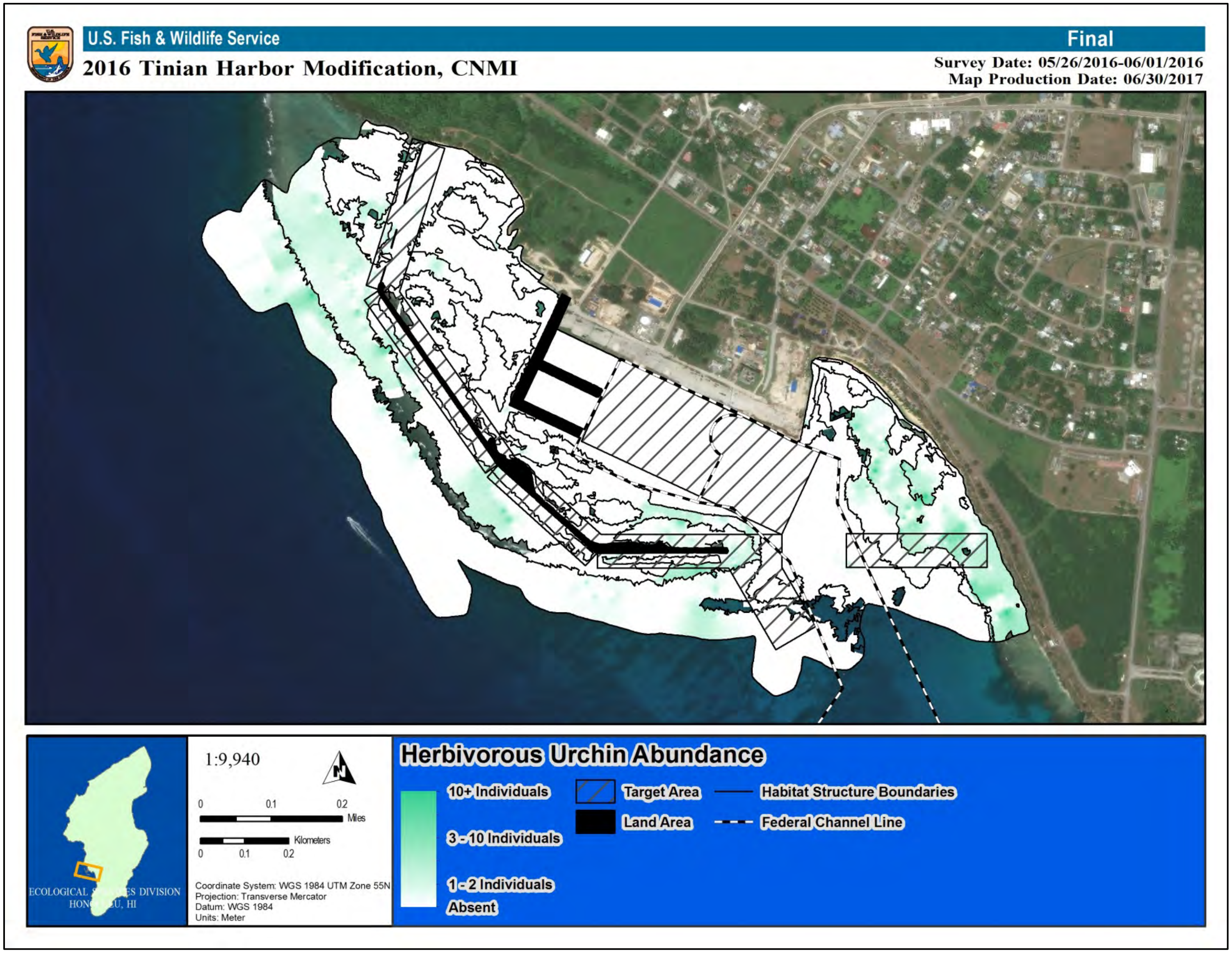

Figure A23: Herbivorous Urchin Abundance. Overview of the herbivorous urchin abundance observed within the project area.

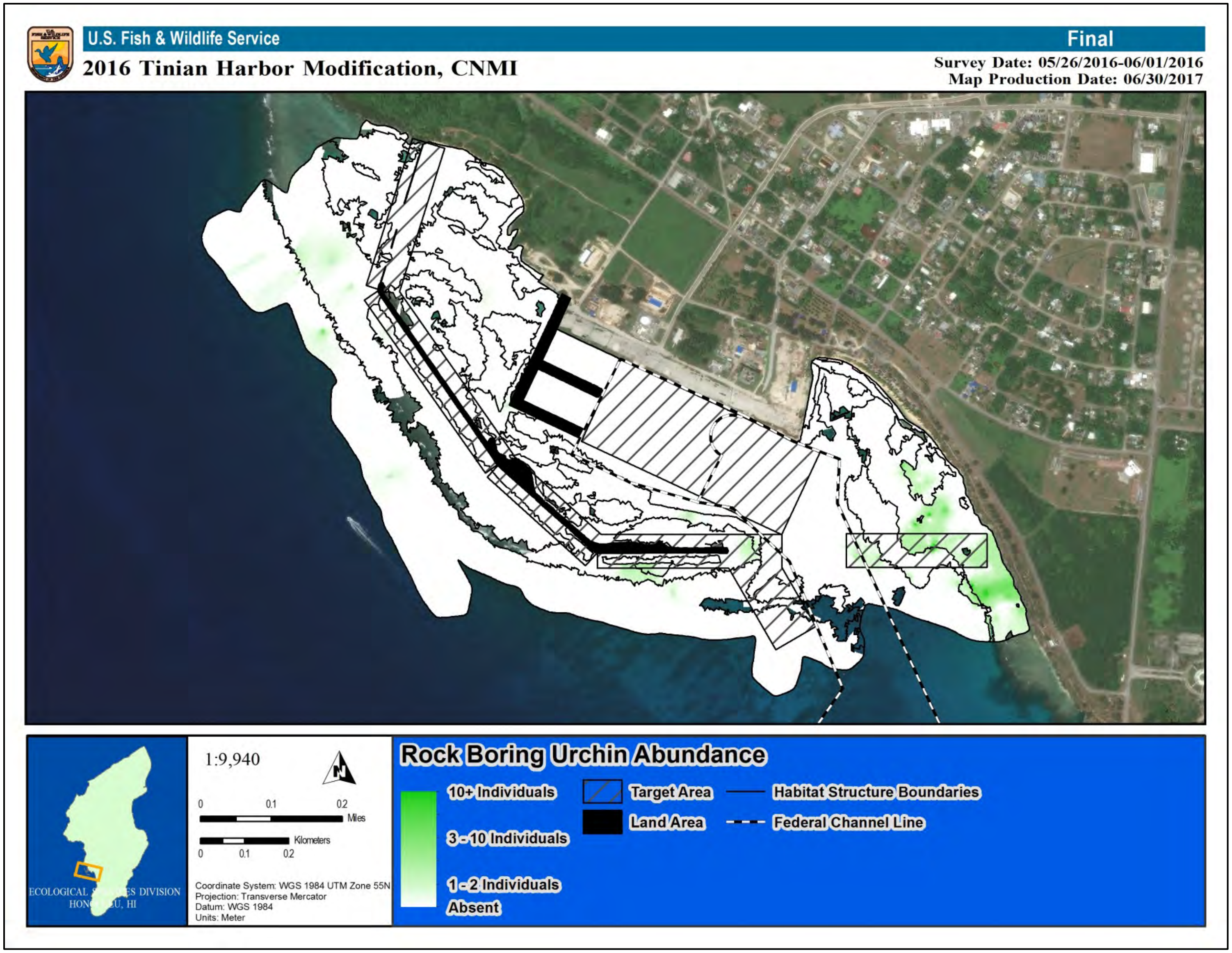

Figure A24: Rock Boring Urchin Abundance. Overview of the rock boring urchin abundance observed within the project area.

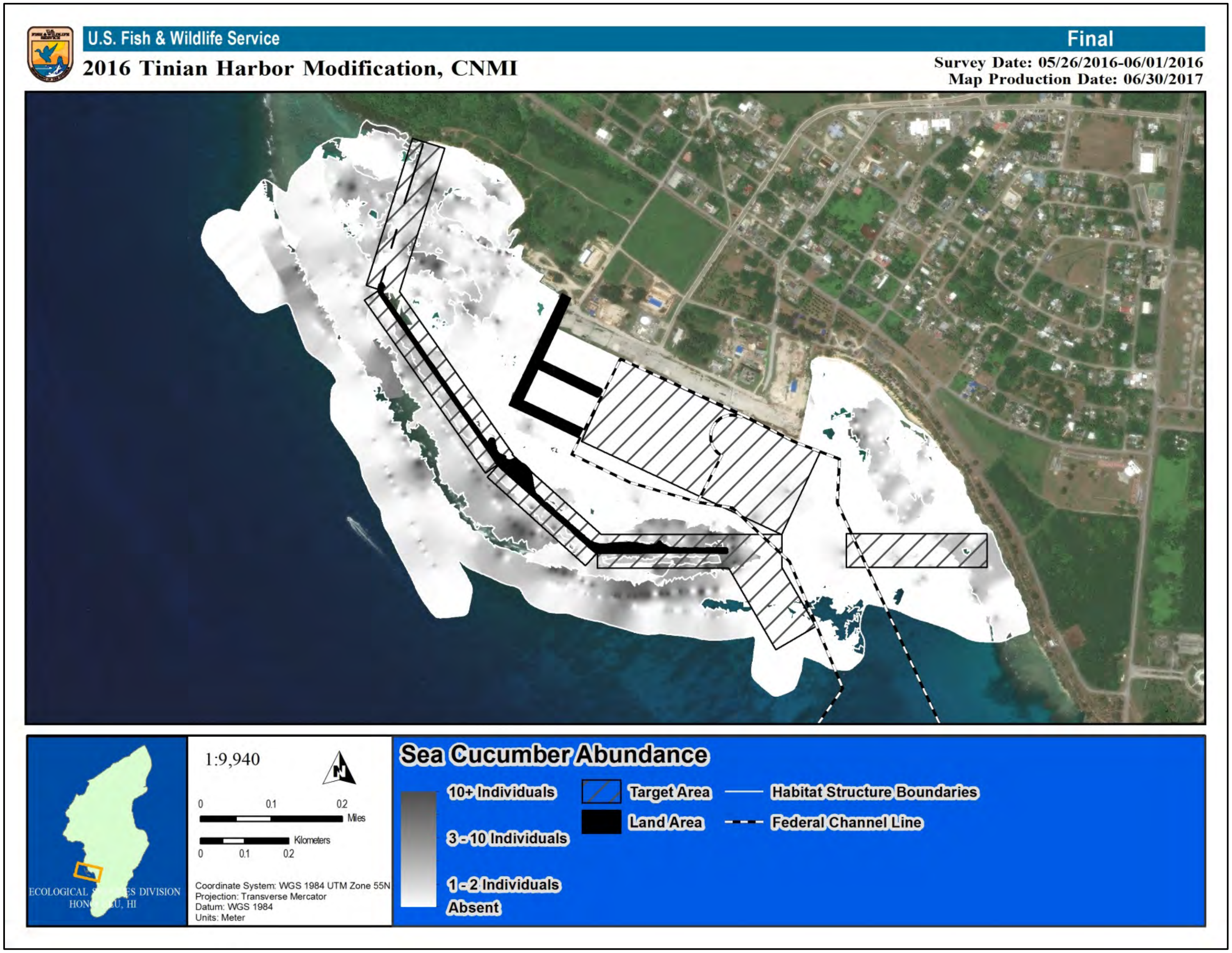

Figure A25: Sea Cucumber Abundance. Overview of the sea cucumber abundance observed within the project area.

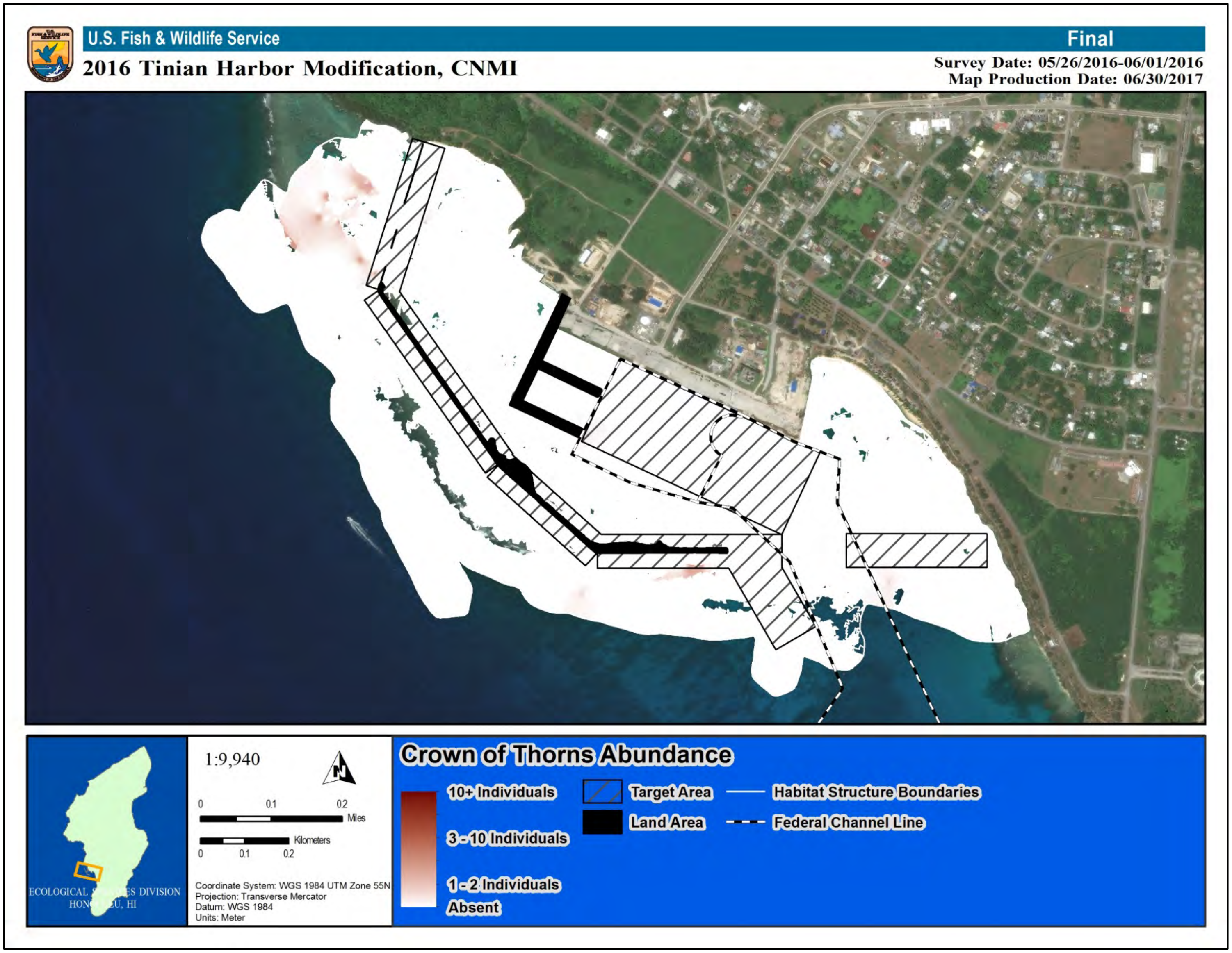

Figure A26: Crown-of-Thorns Abundance. Overview of the crown-of-thorn starfish abundance observed within the project area.

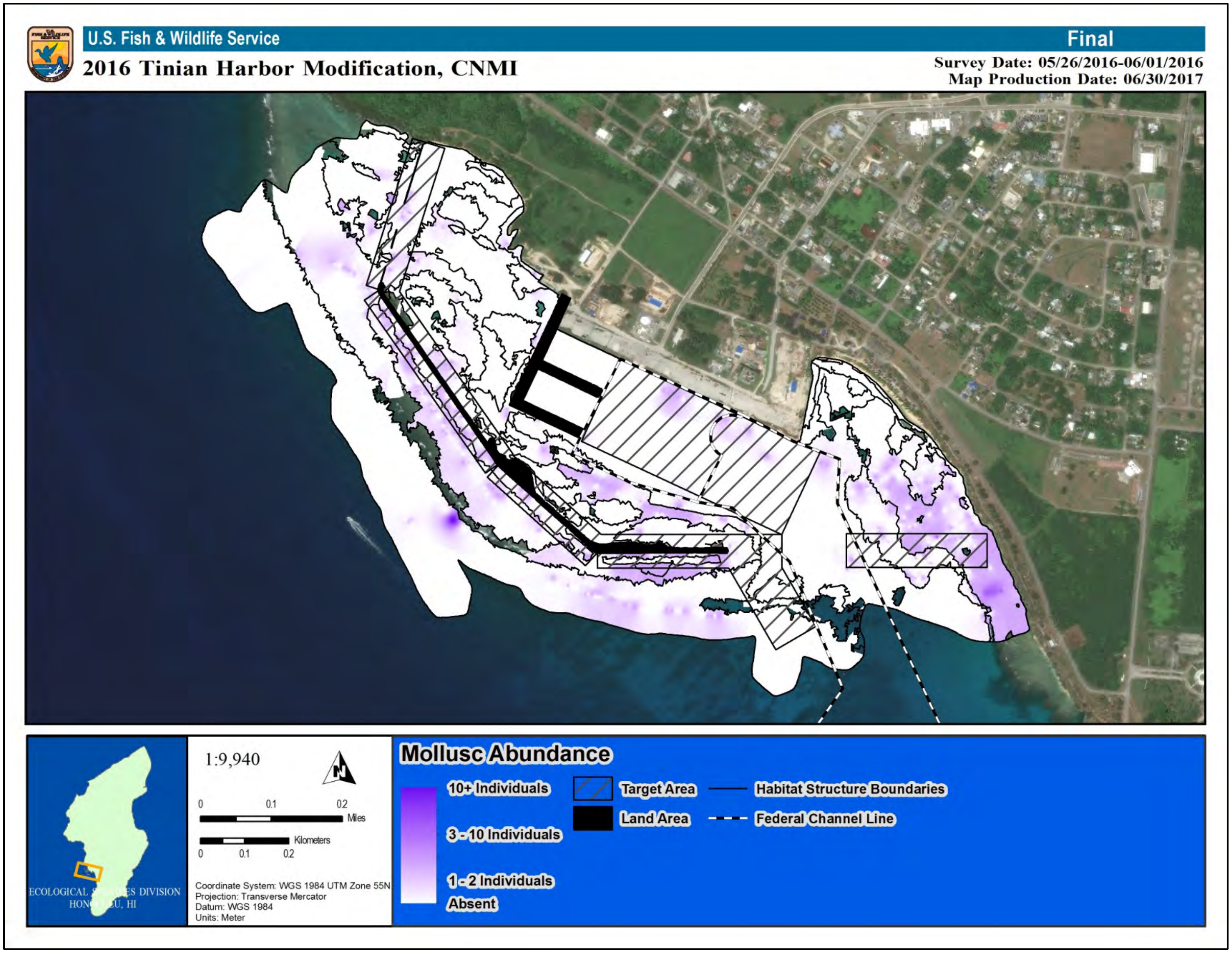

Figure A27: Mollusc Abundance. Overview of the mollusc (other than specific species shown in other maps) abundance observed within the project area.

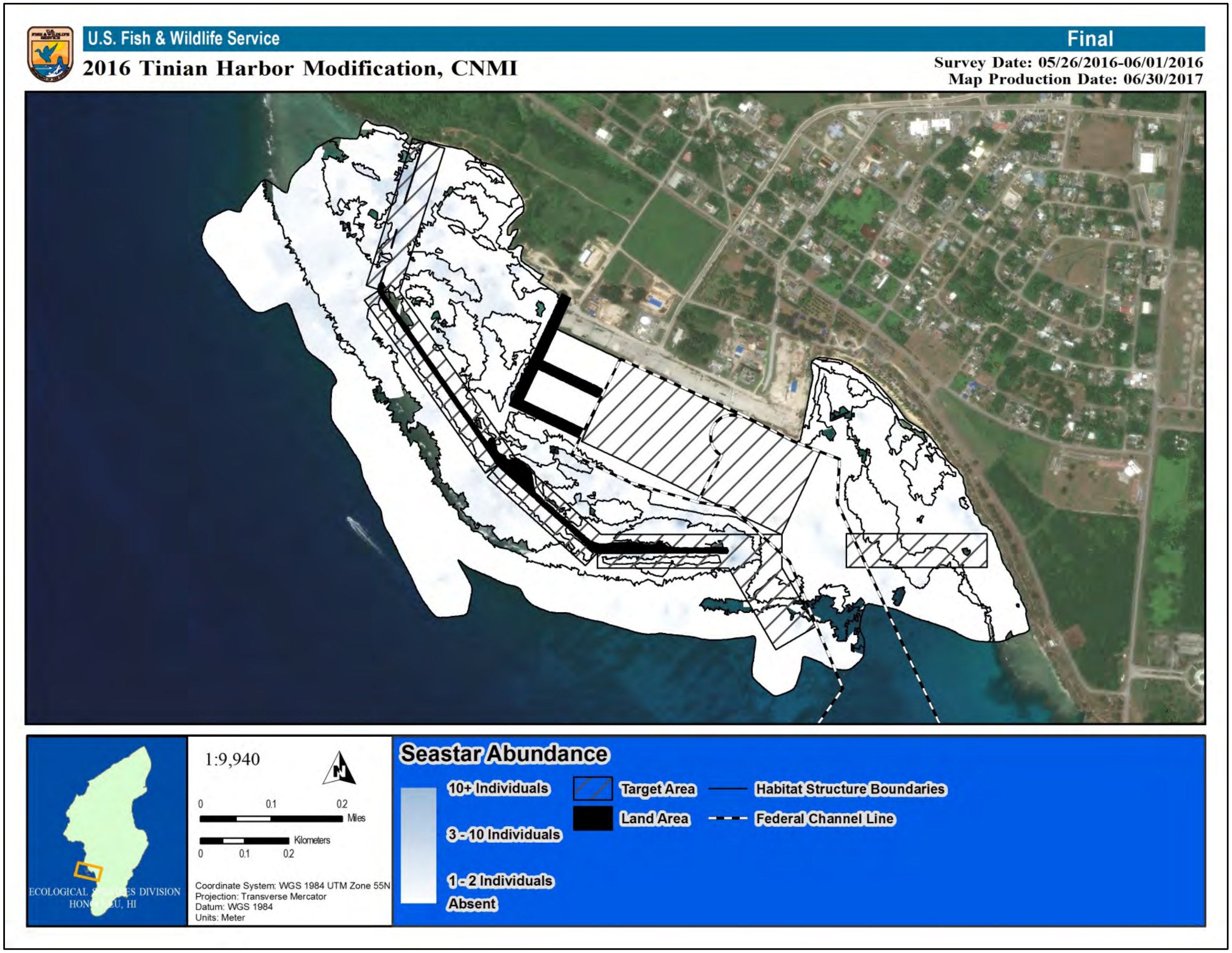

Figure A28: Seastar Abundance. Overview of the seastar abundance observed within the project area.

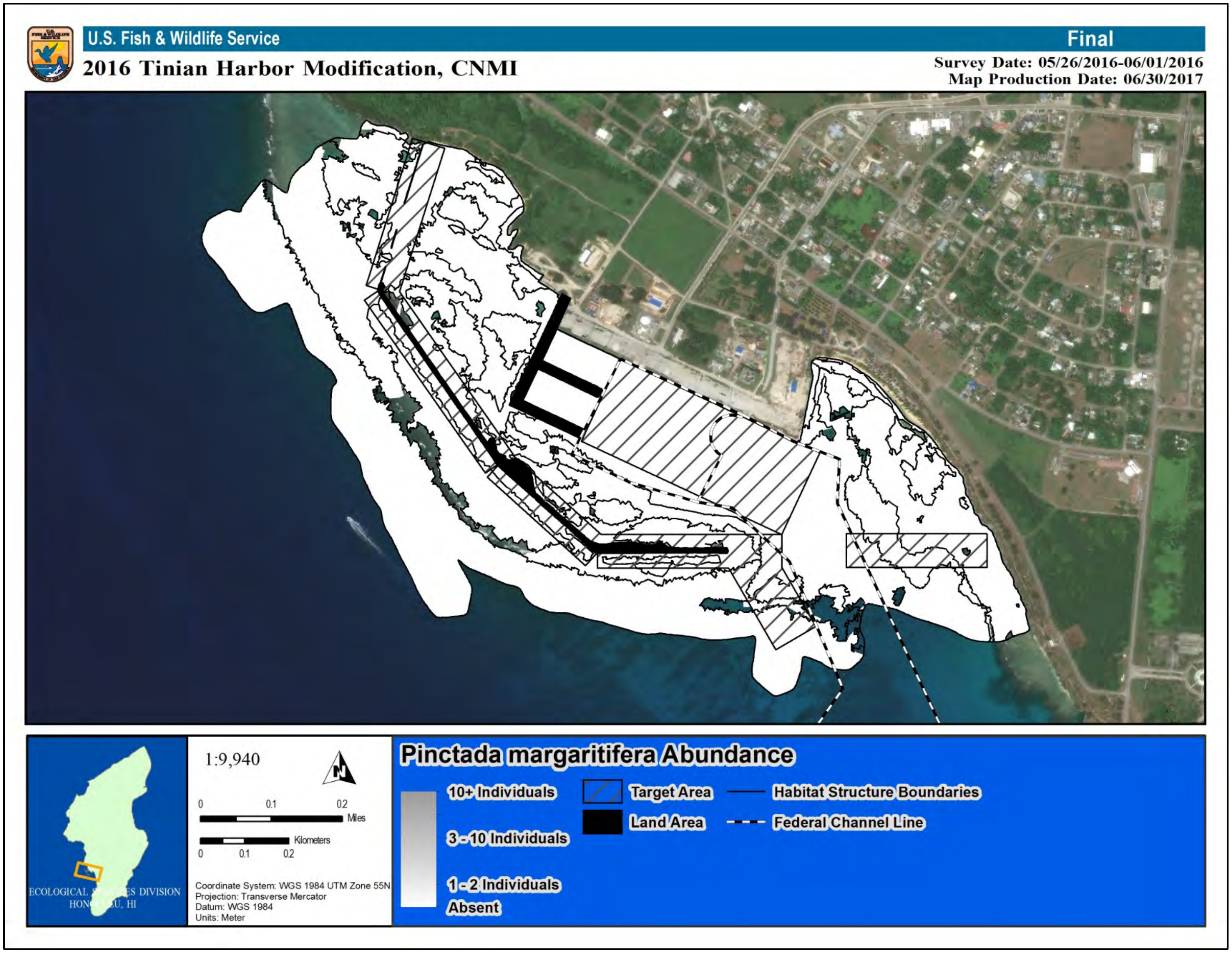

Figure A29: Pinctada Abundance. Overview of the mollusc, Pinctada margaritifera, abundance observed within the project area. Note: No Pinctada margaritifera were observed.

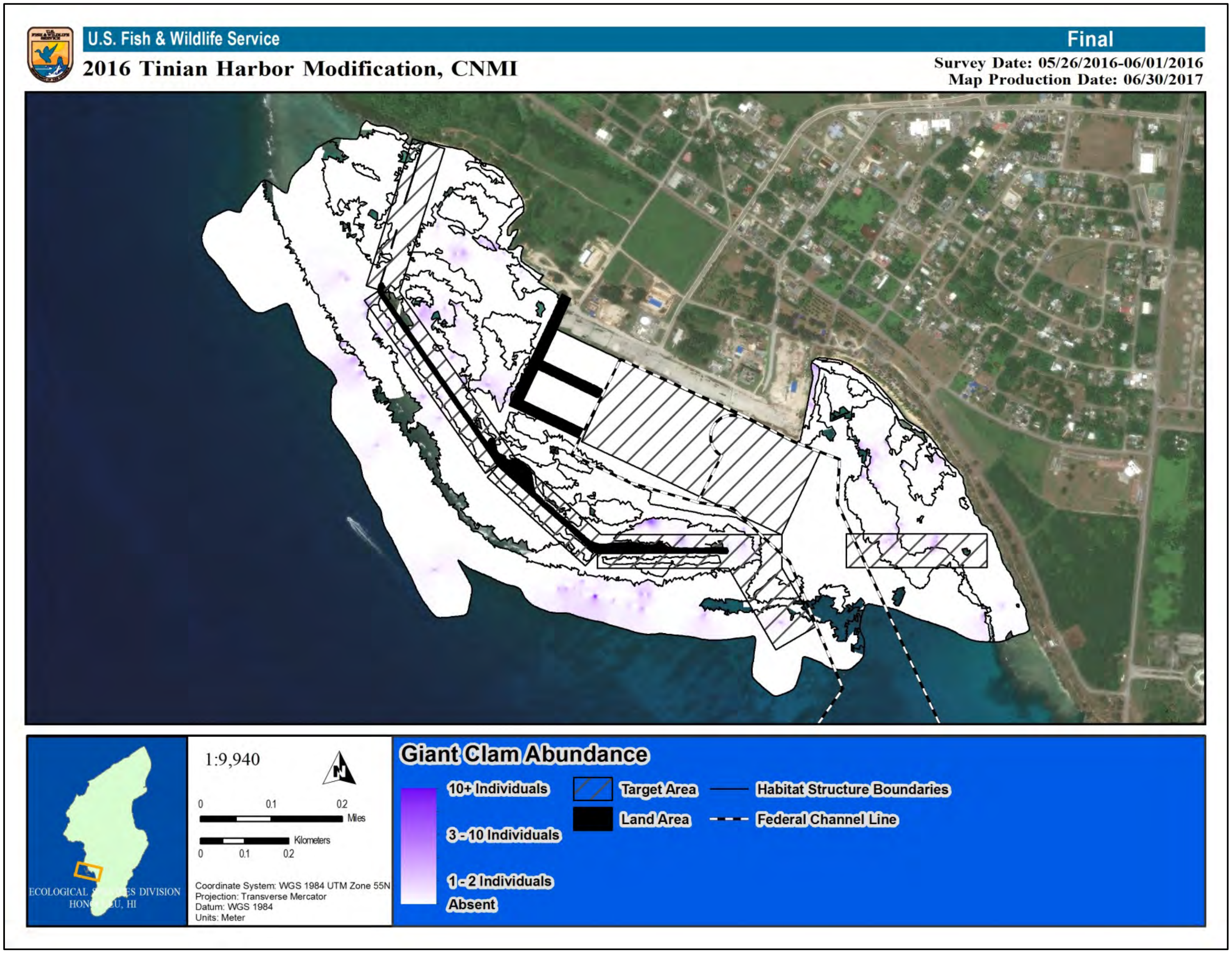

Figure A30: Giant Clam Abundance. Overview of the giant clam abundance observed within the project area.

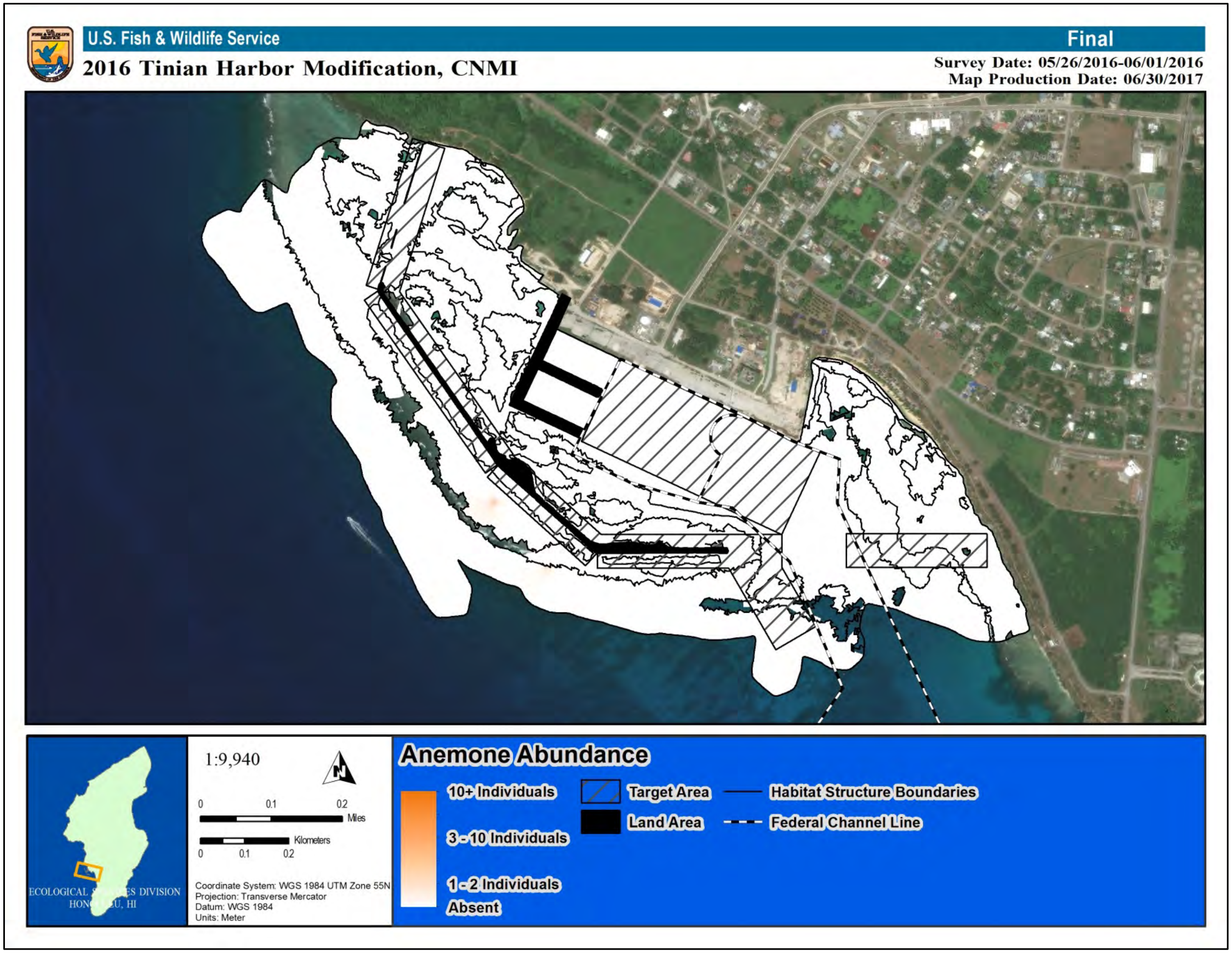

Figure A31: Anemone Abundance. Overview of the anemone abundance observed within the project area.

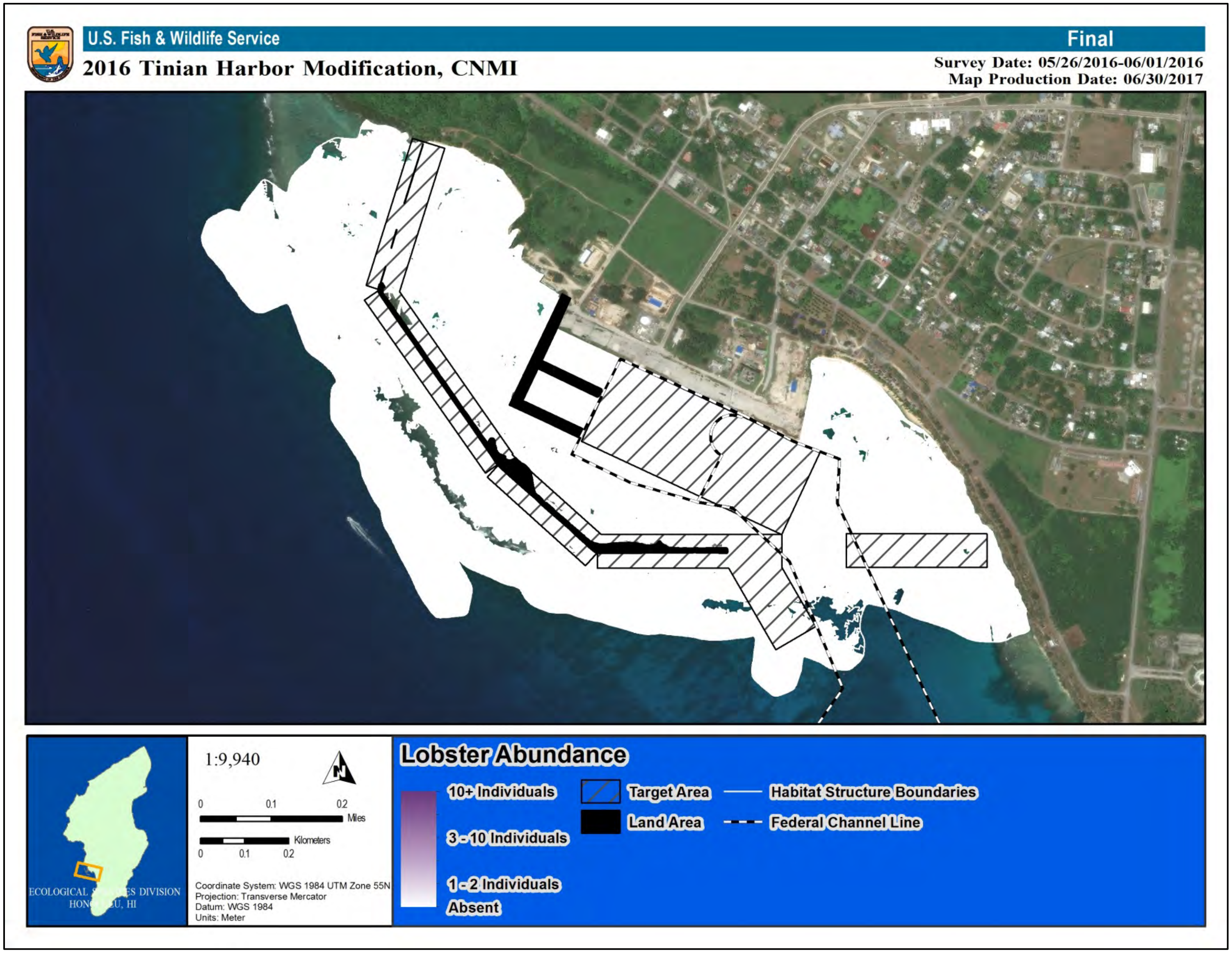

Figure A32: Lobster Abundance. Overview of the lobster abundance observed within the project area. Note: No lobsters were observed.

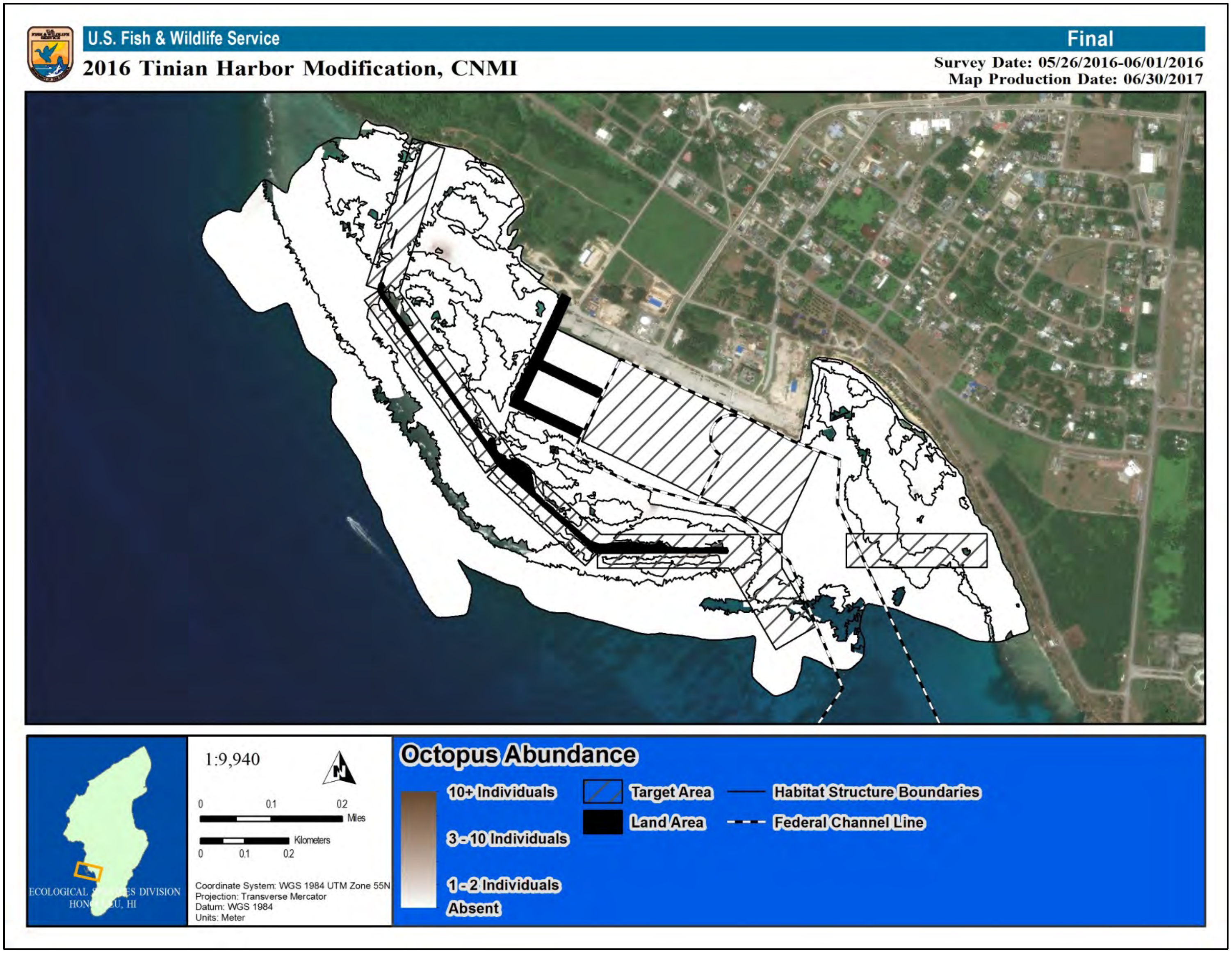

Figure A33: Octopus Abundance. Overview of the octopus abundance observed within the project area.

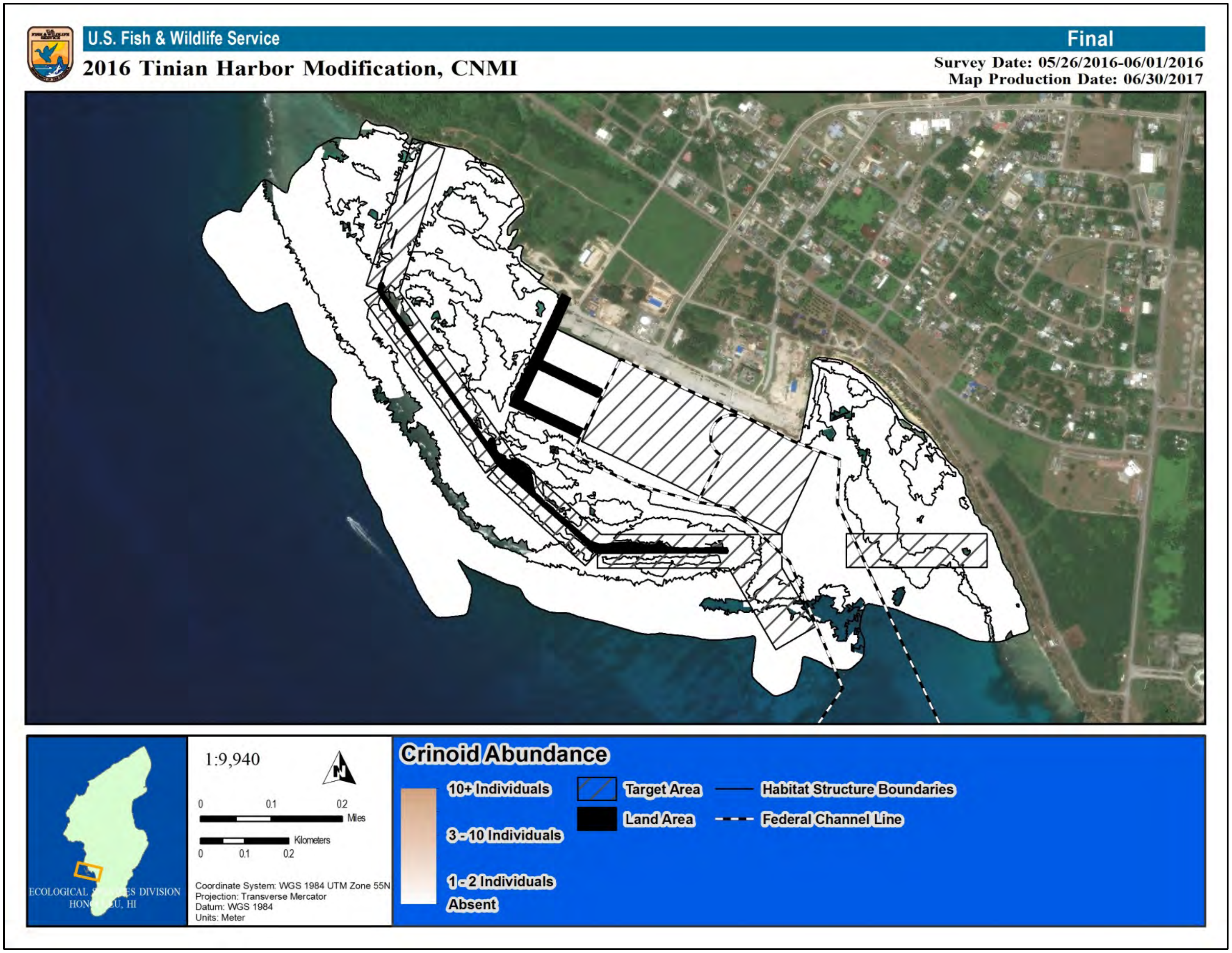

Figure A34: Crinoid Abundance. Overview of the crinoid abundance observed within the project area. Note: No crinoids were observed.

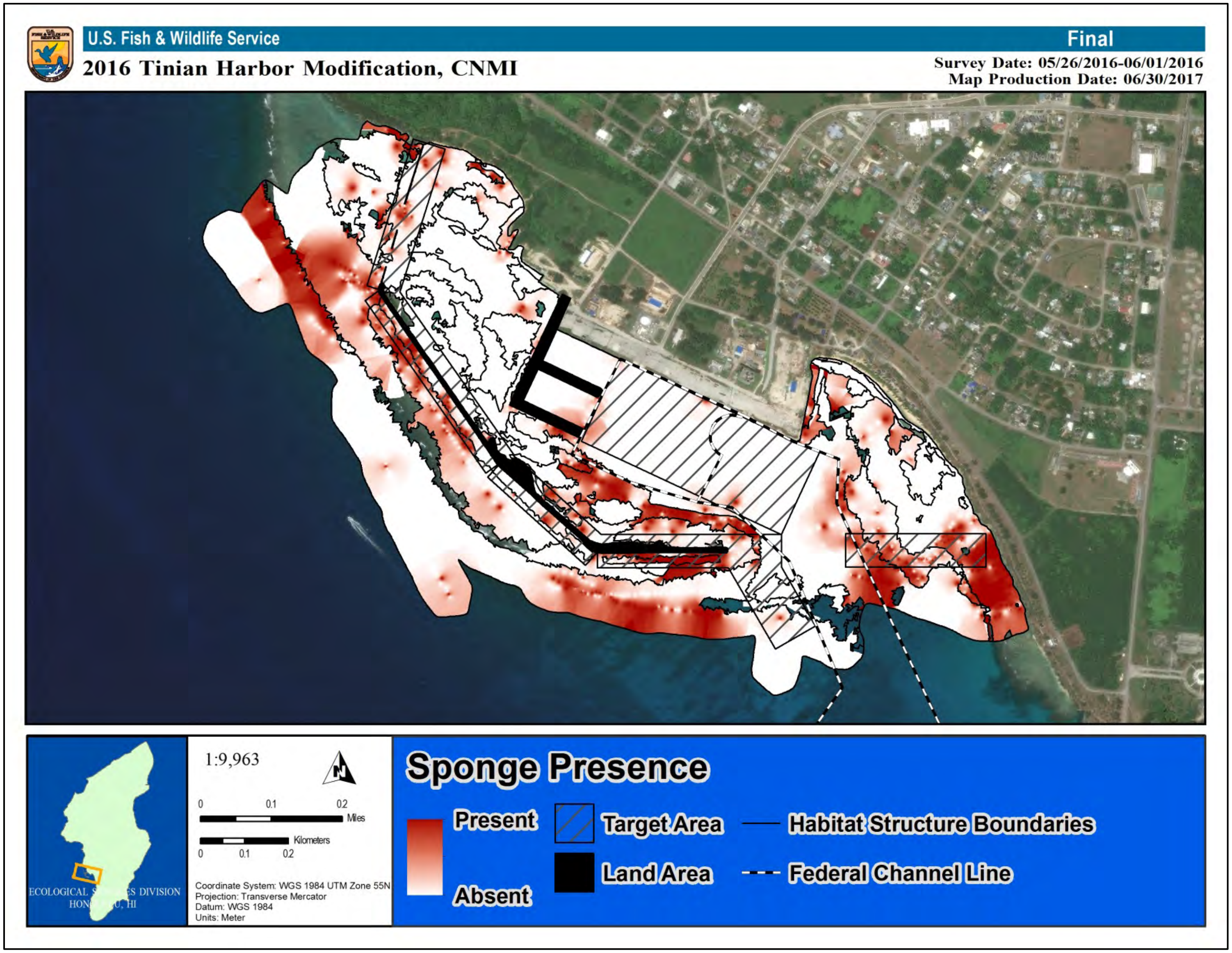

Figure A35: Sponge Presence. Overview of the sponge presence observed within the project area.

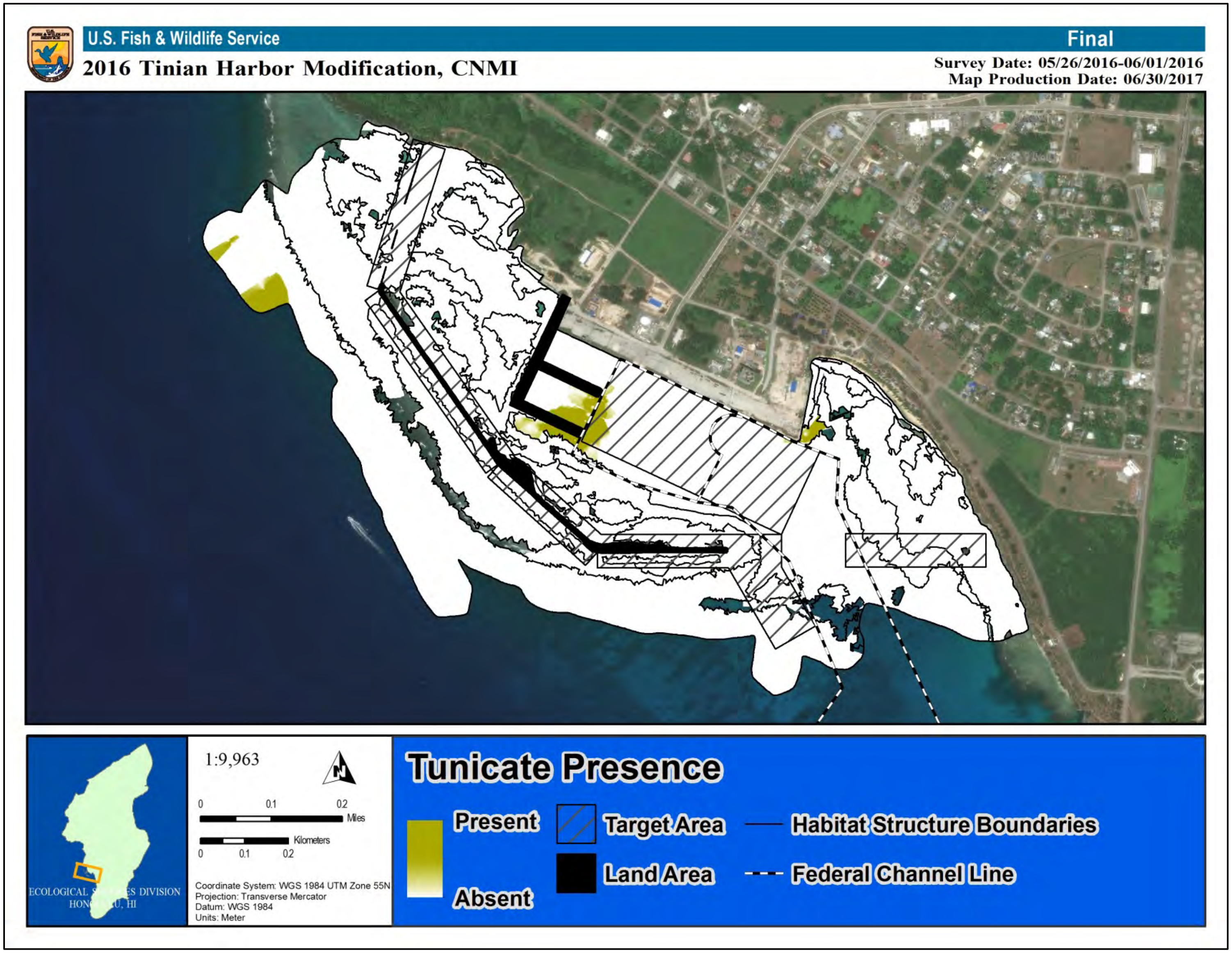

Figure A36: Tunicate Presence. Overview of the tunicate presence observed within the project area.

APPENDIX B: Maps of Tinian Harbor Modification Project (Area 1)

Appendix B. Maps of Tinian Harbor Modification Project (Area 1).

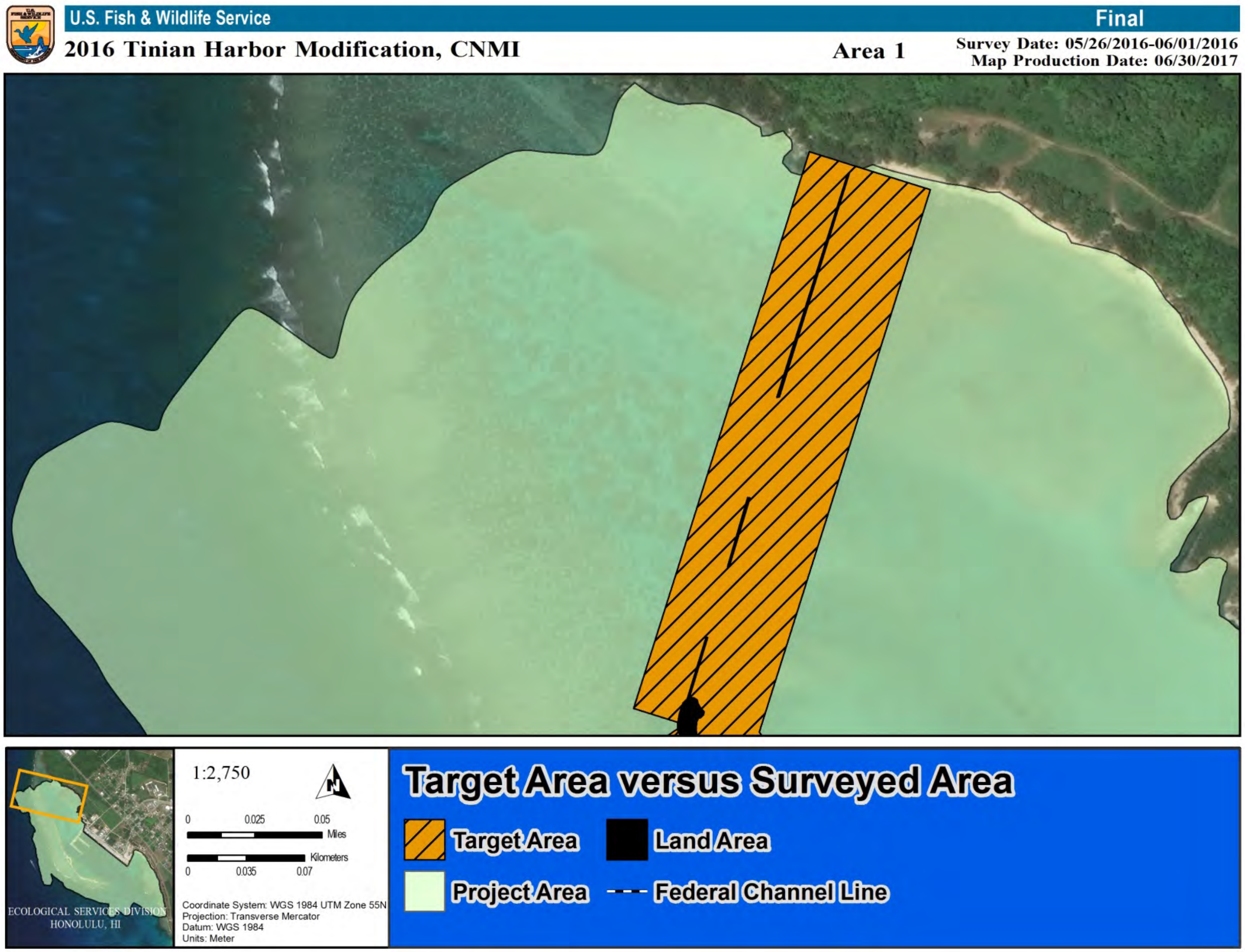

Figure B1: Target Area vs. Surveyed Area (Area 1). Overview of the Project Area (total surveyed area plus project footprint) versus the Target Area (project footprint).

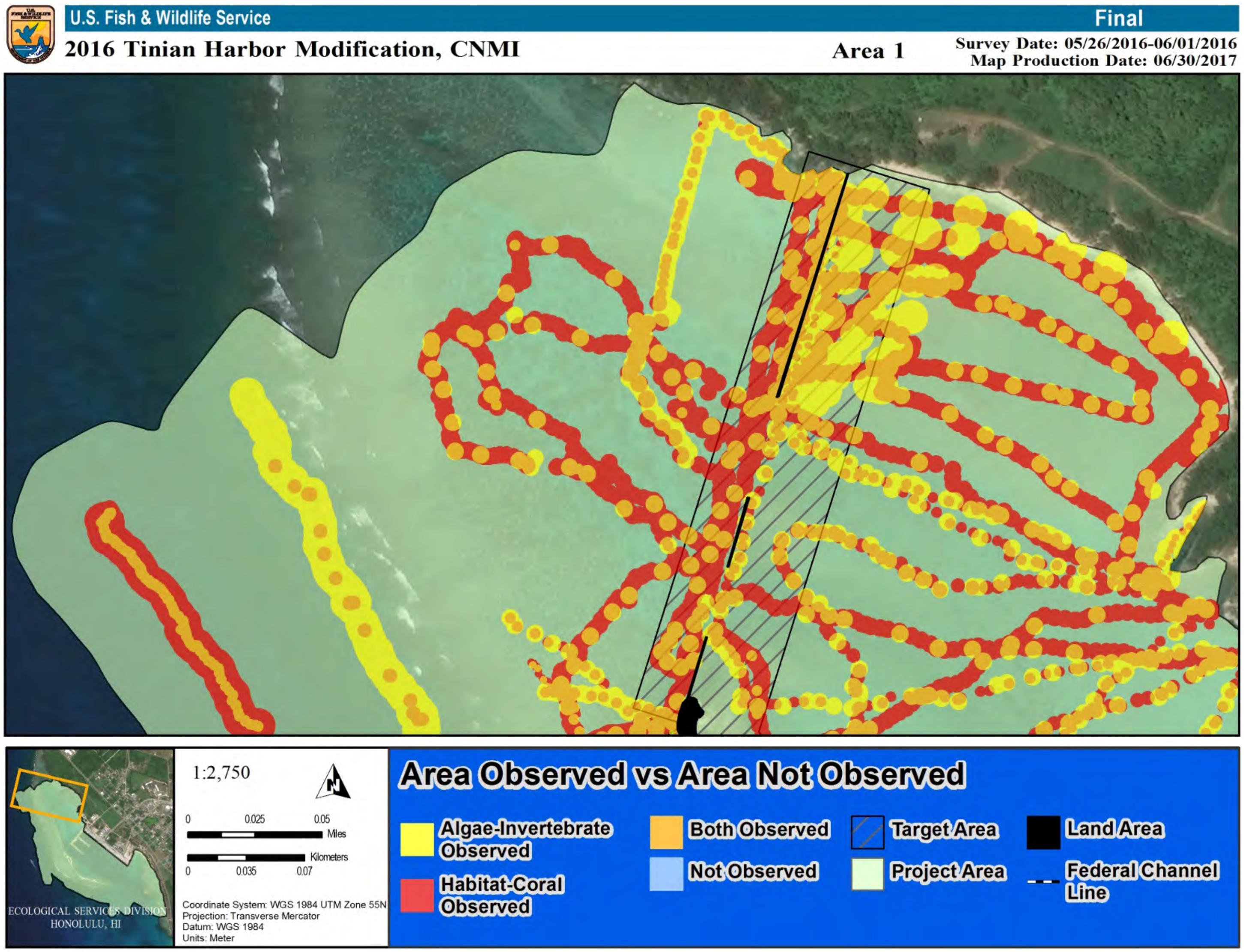

Figure B2: Area Observed (Area 1). Overview of the area observed by in-water observers versus the area interpolated in all maps.

Figure B3: Dive Tracks (Area 1). Overview of the dive track lines for all survey transects.

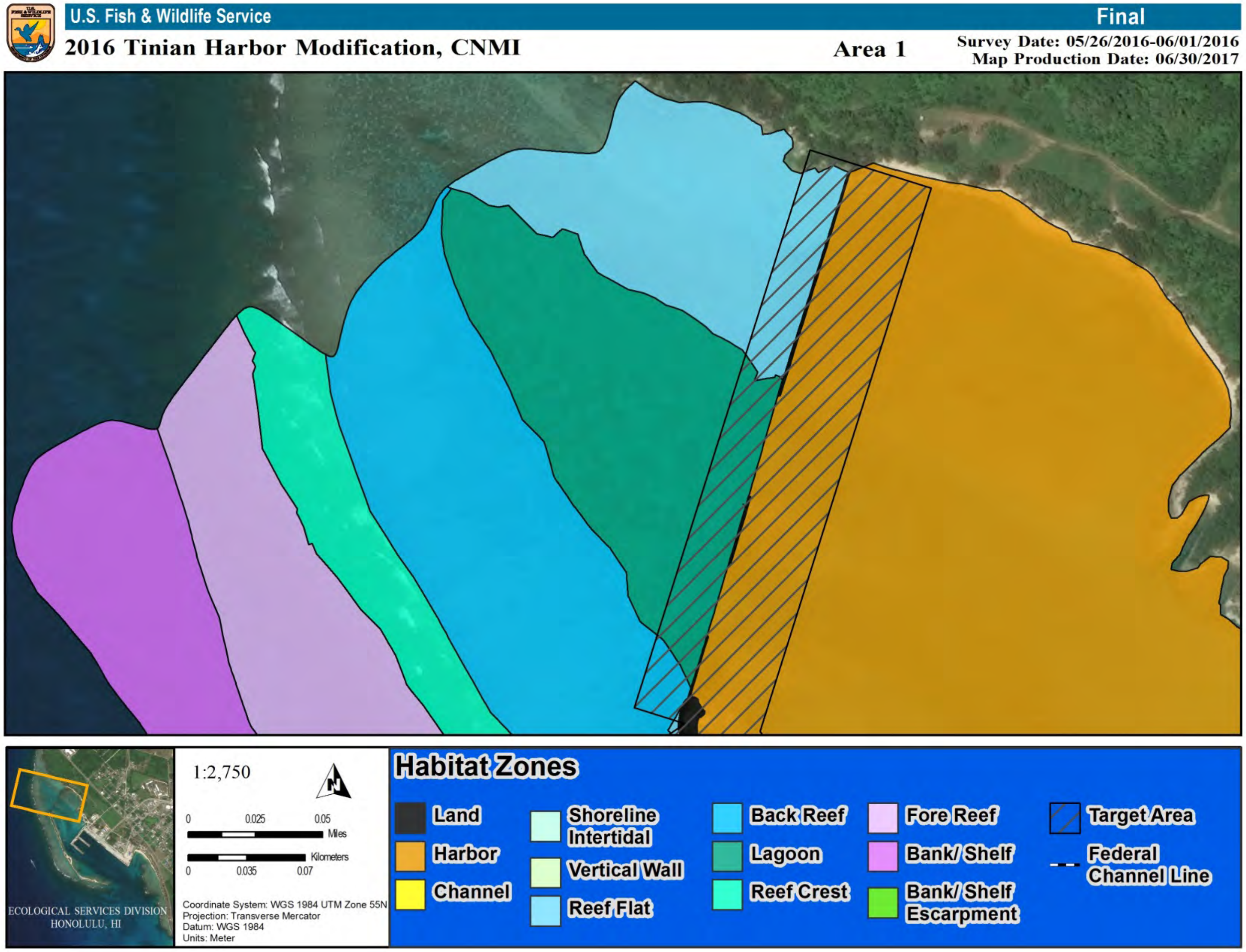

Figure B4: Habitat Zones (Area 1). Overview of the various habitat zones that the project area contains.

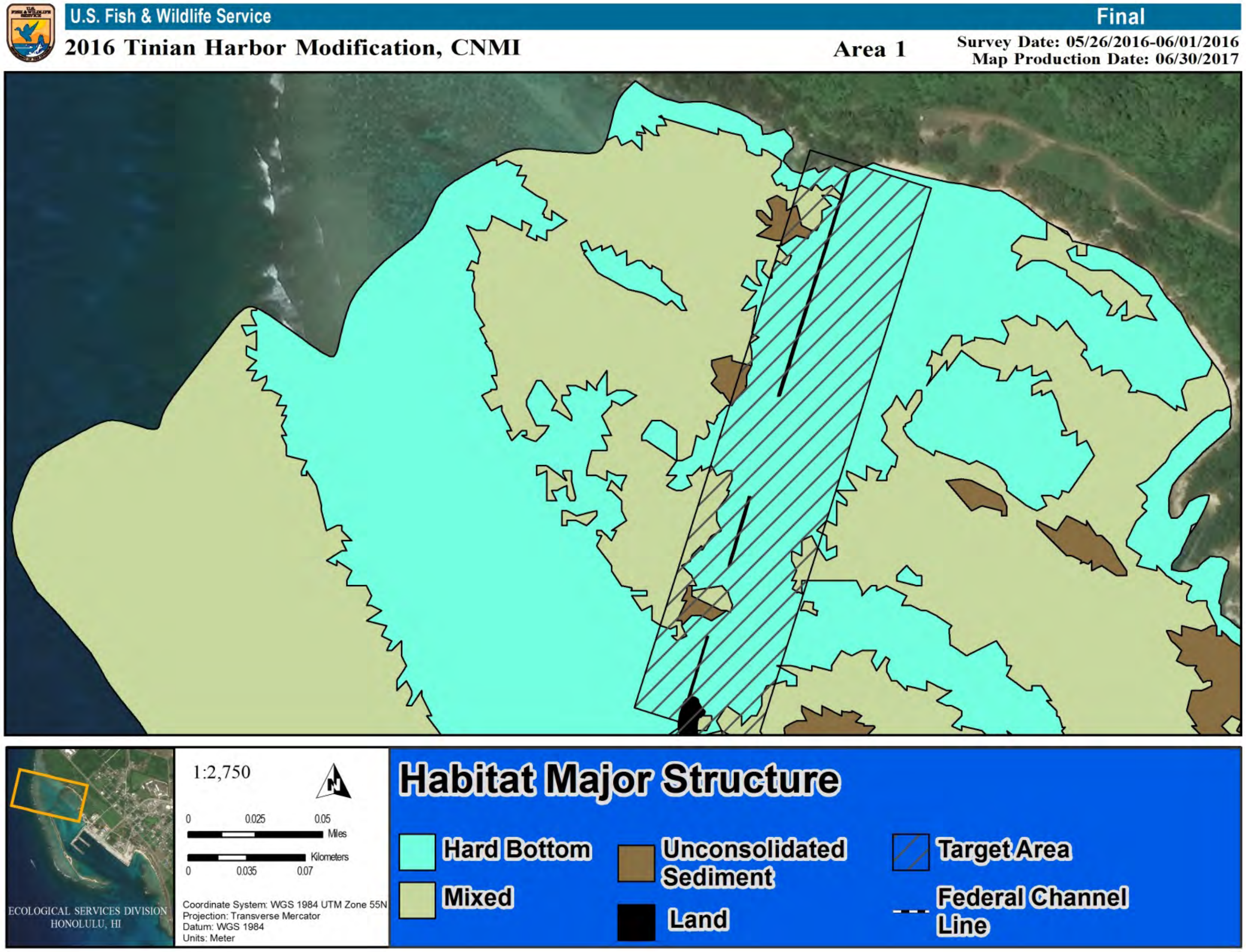

Figure B5: Habitat Major Structure (Area 1). Overview of the major habitat structures that the project area contains.

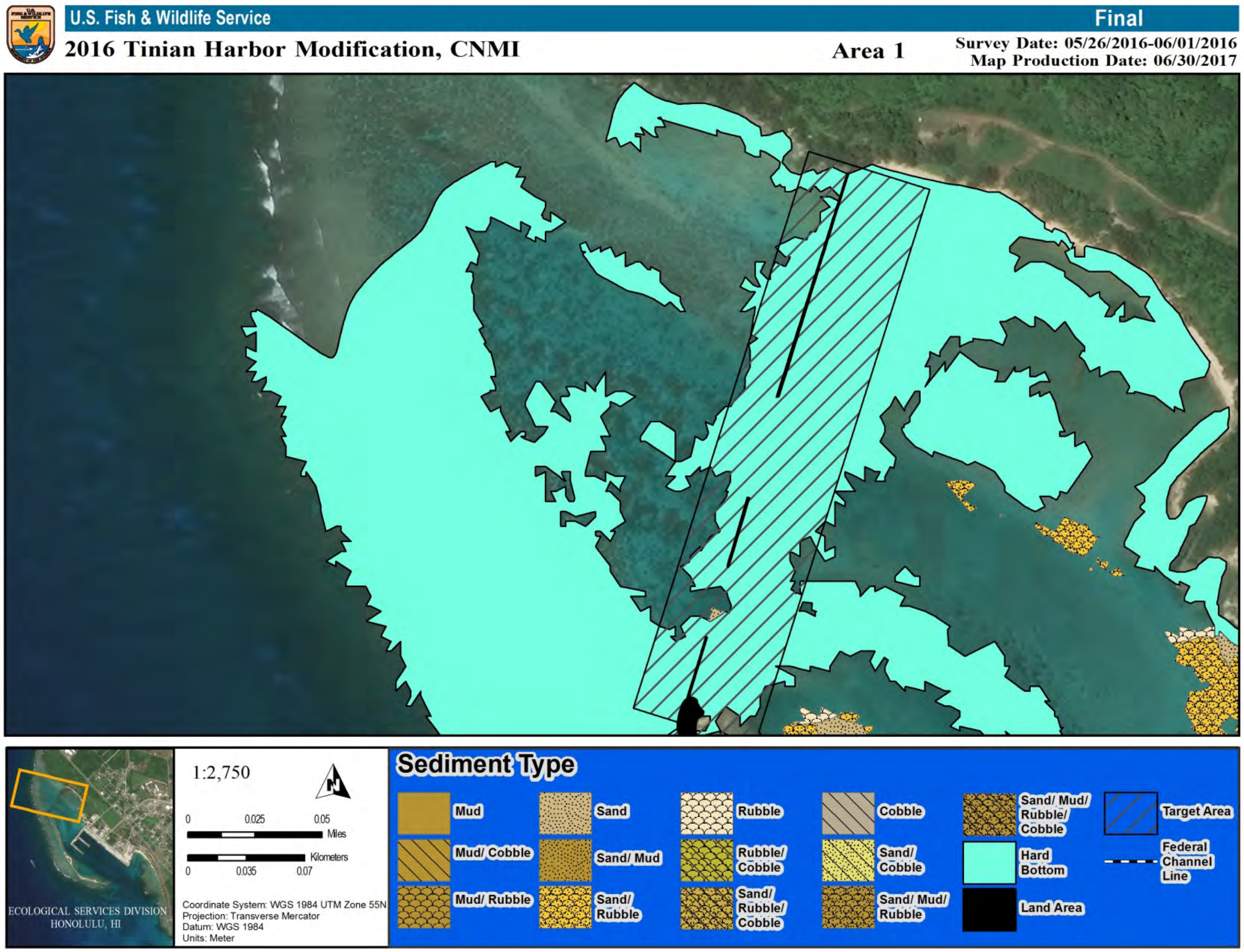

Figure B6: Sediment Type (Area 1). Overview of the various sediment types that the project area contains.

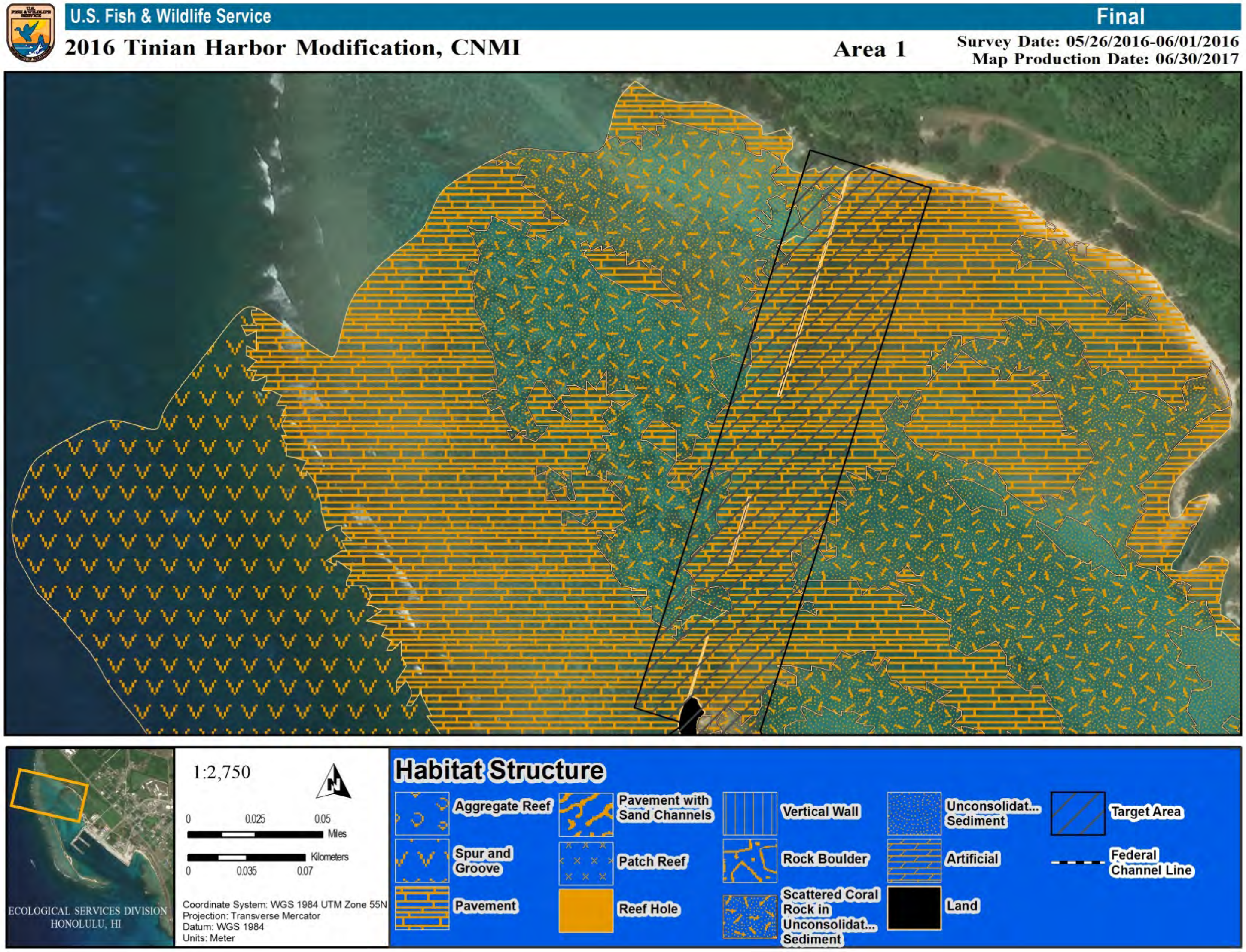

Figure B7: Habitat Structure (Area 1). Overview of the habitat structures that the project area contains.

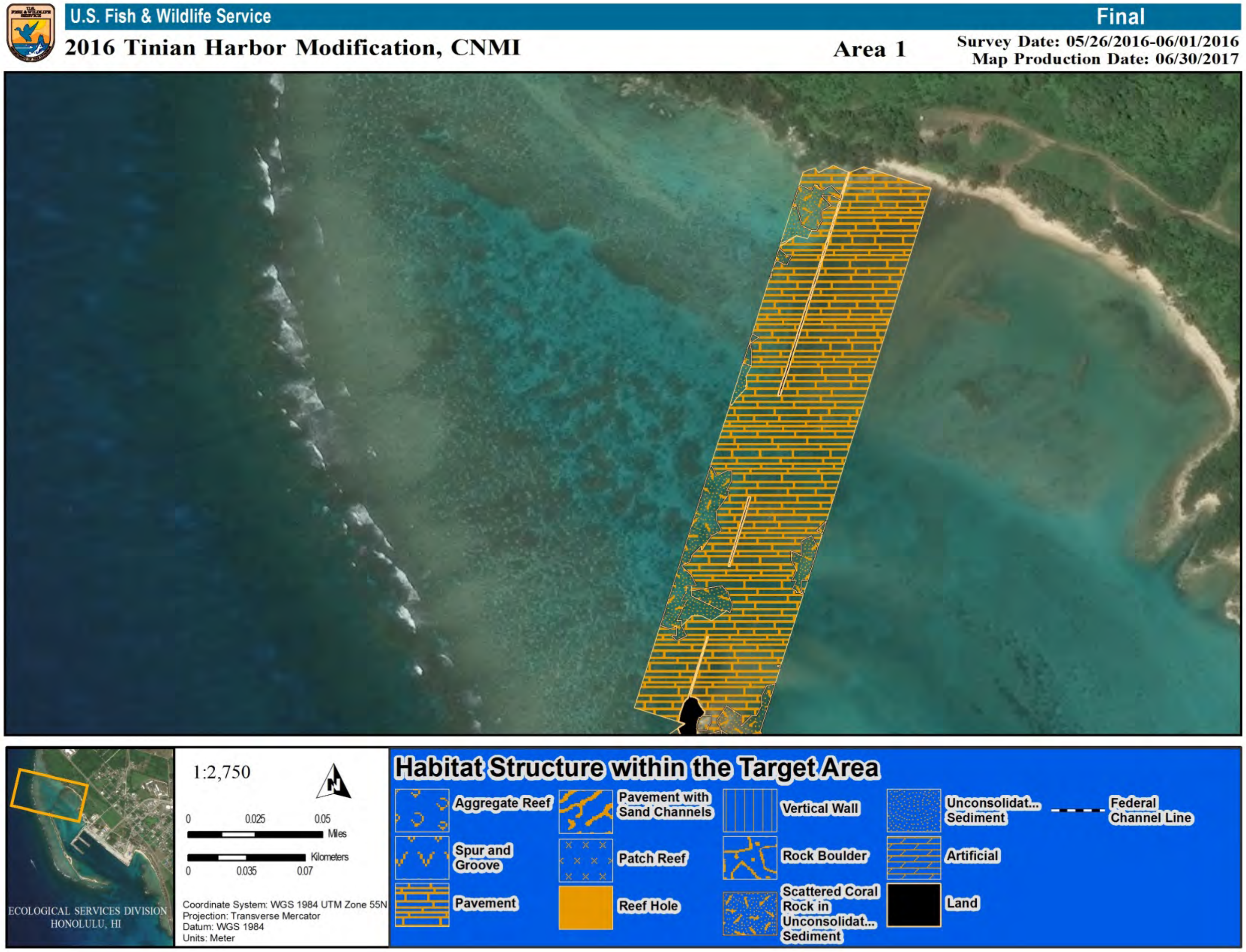

Figure B8: Habitat Structure in Target Area (Area 1). Overview of the habitat structures within the project footprint (Target Area).

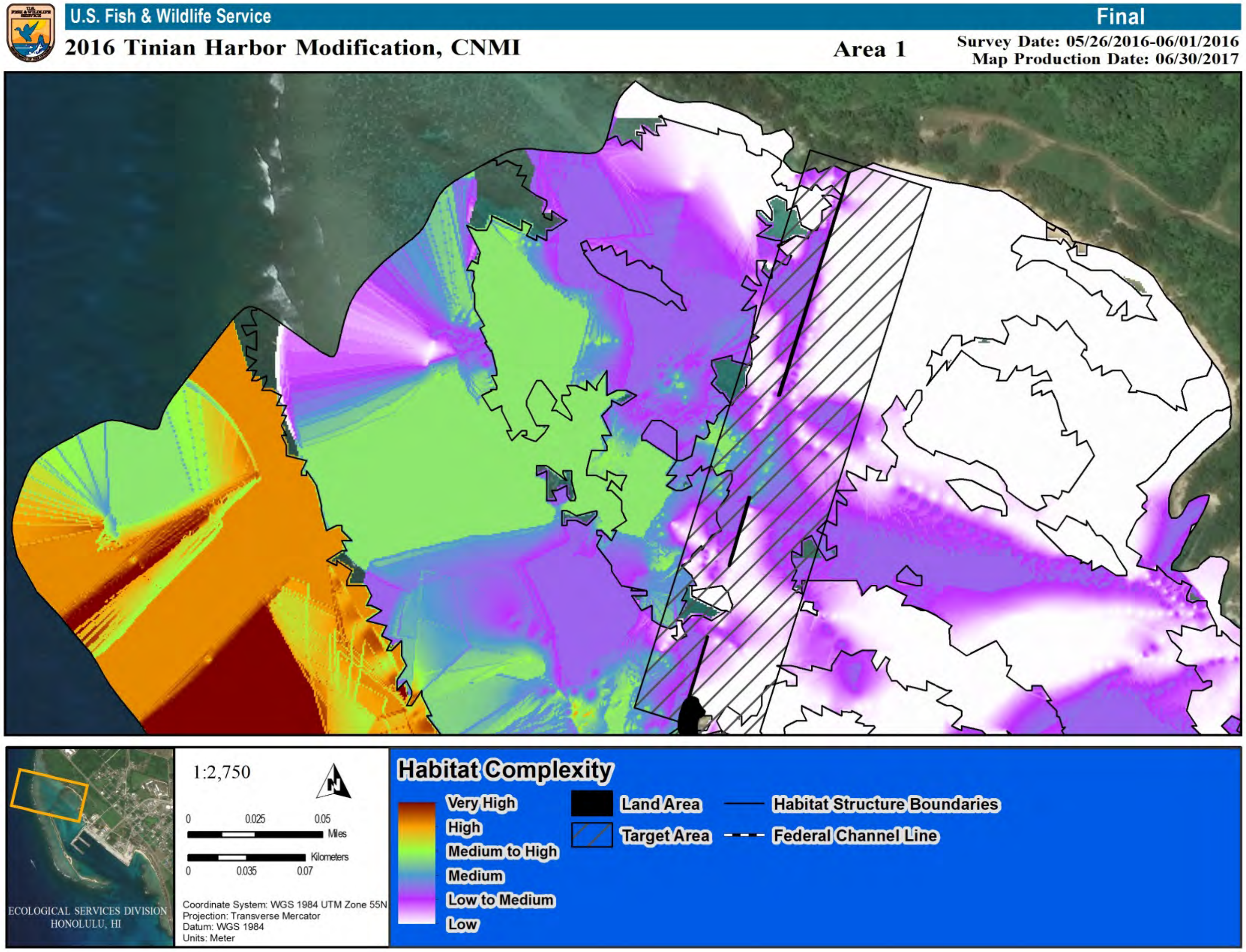

Figure B9: Habitat Complexity (Area 1). Overview of the habitat complexity observed within the project area.

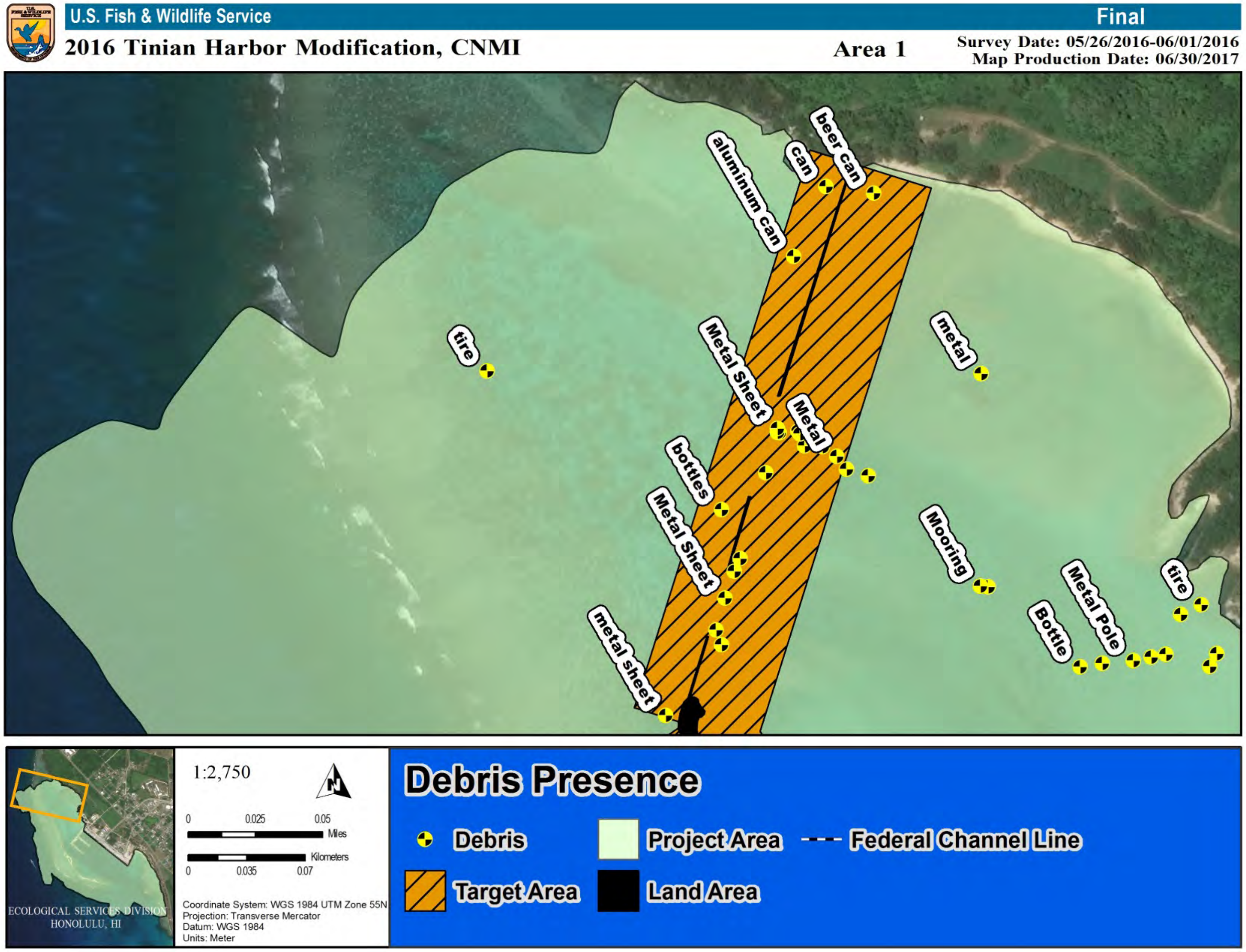

Figure B10: Debris (Area 1). Overview of the debris observed within the project area.

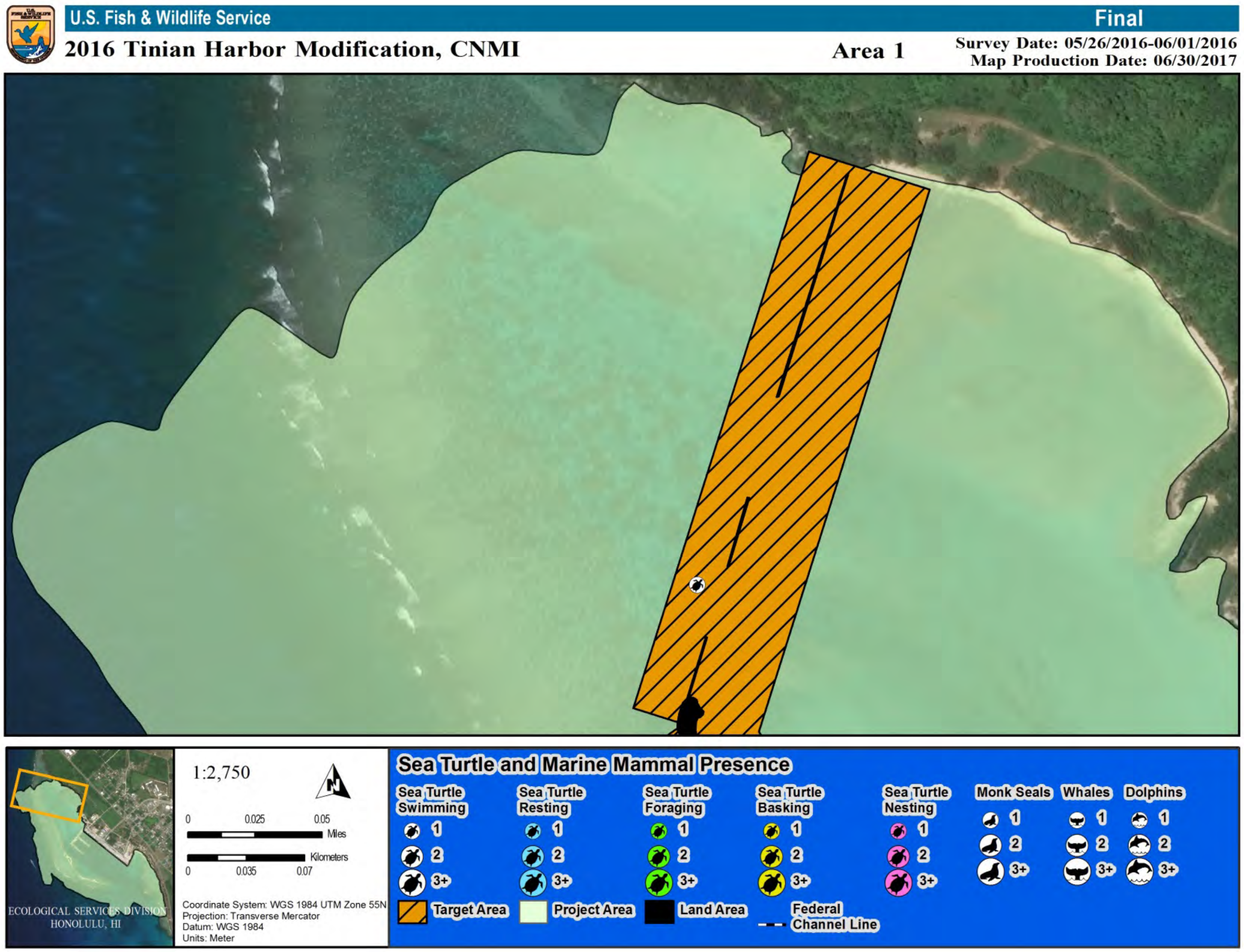

Figure B11: Protected Species (Area 1). Overview of the observed protected species within the project area.

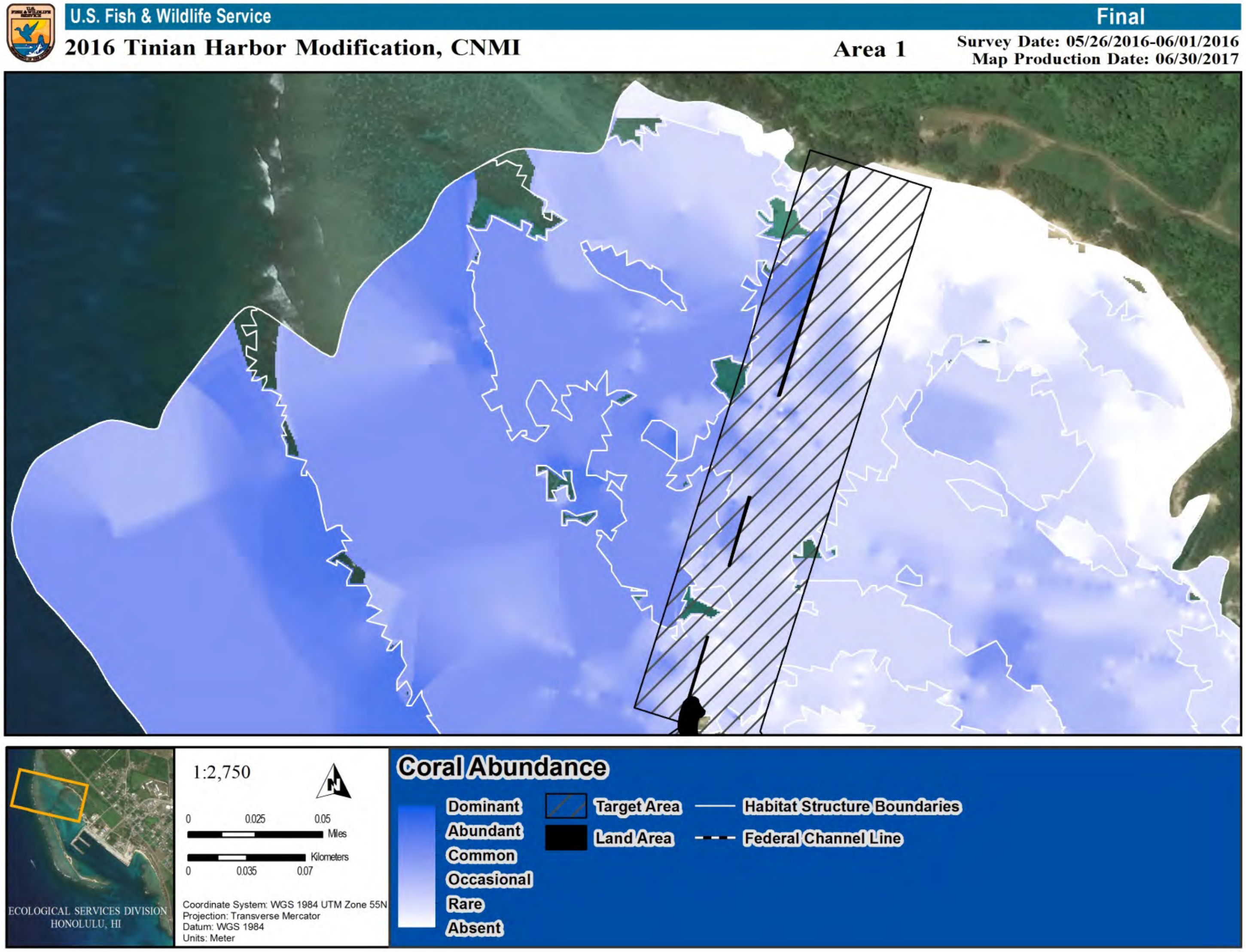

Figure B12: Coral Abundance (Area 1). Overview of the coral abundance within the project.

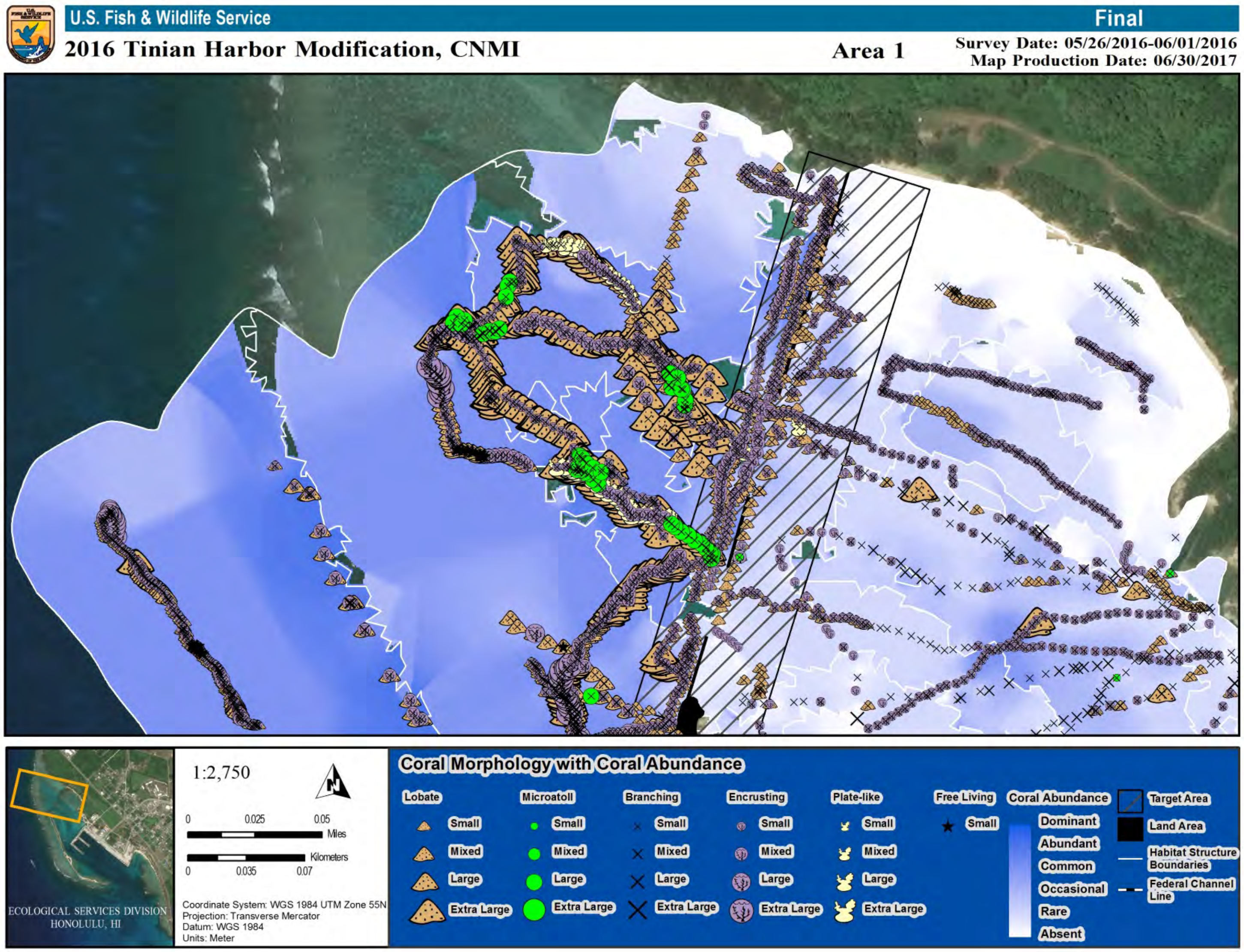

Figure B13: Coral Morphologies (Area 1). Overview of the various coral morphologies and broad coral sizes observed within the project area.

Figure B14: ESA-listed Corals (Area 1). Overview of the ESA-listed coral species observed within the project area.

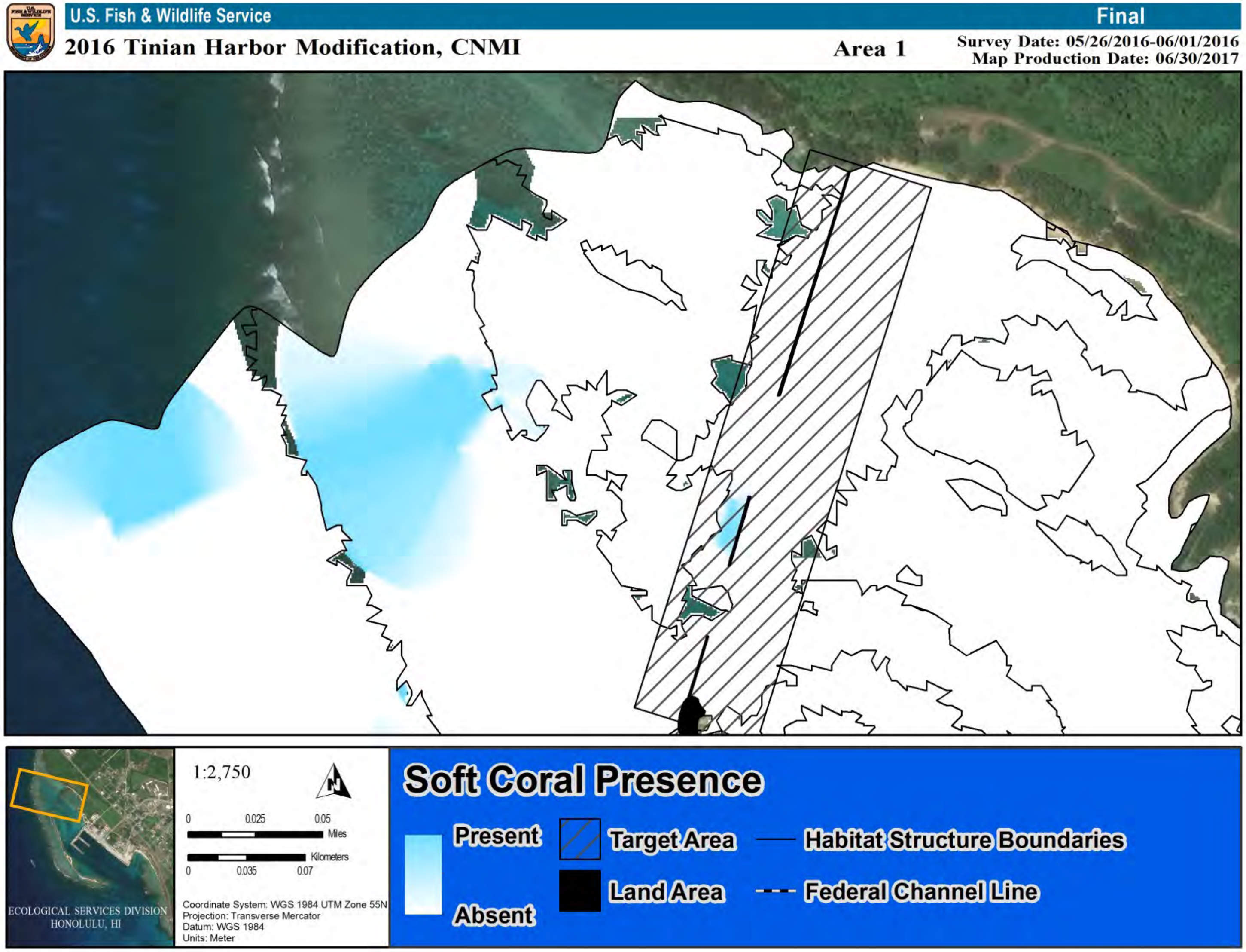

Figure B15: Soft Coral Presence (Area 1). Overview of the soft coral presence within the project area.

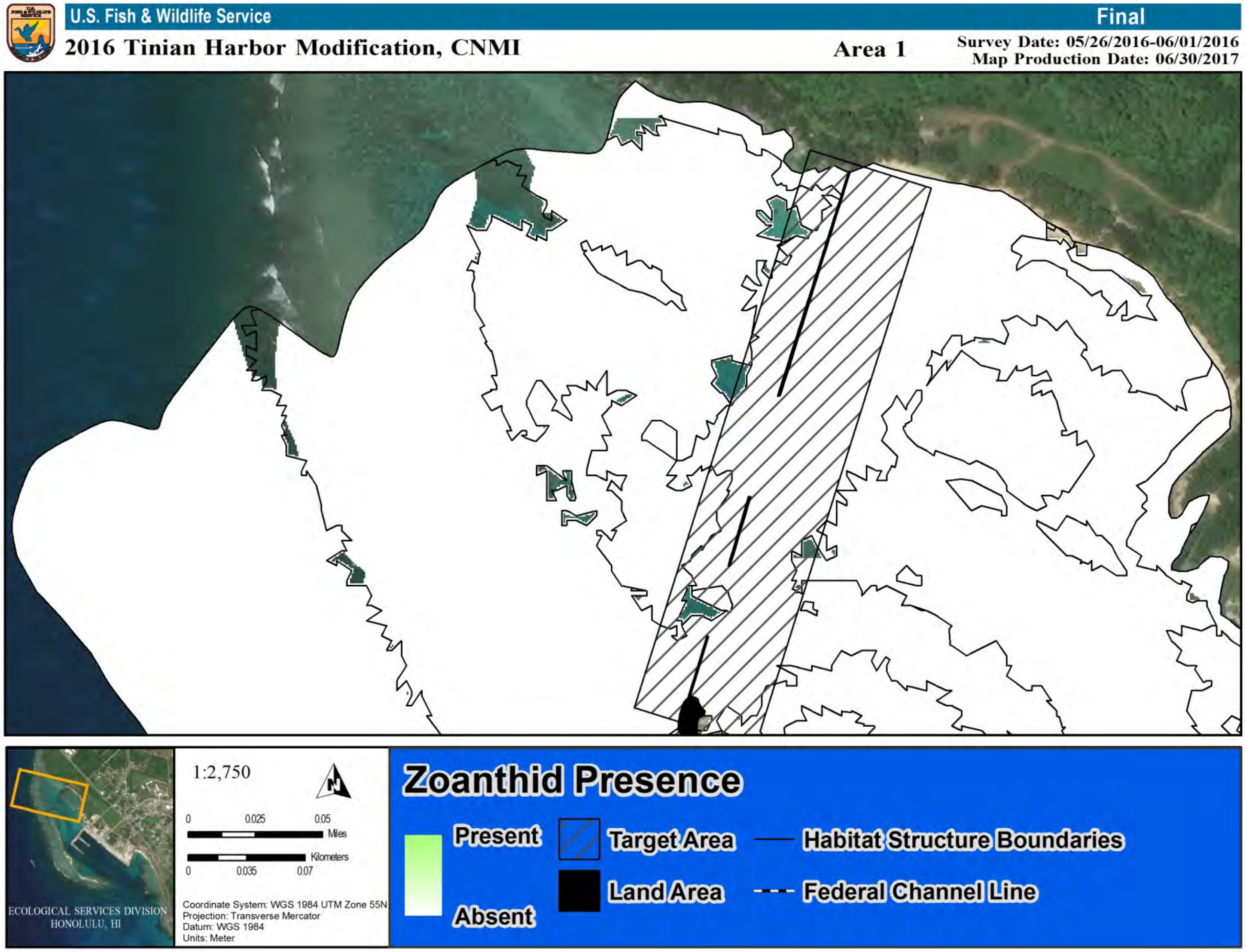

Figure B16: Zonathid Presence (Area 1). Overview of the zoanthid (relative to corals) presence within the project area. Note: No zoanthids were observed in this area.

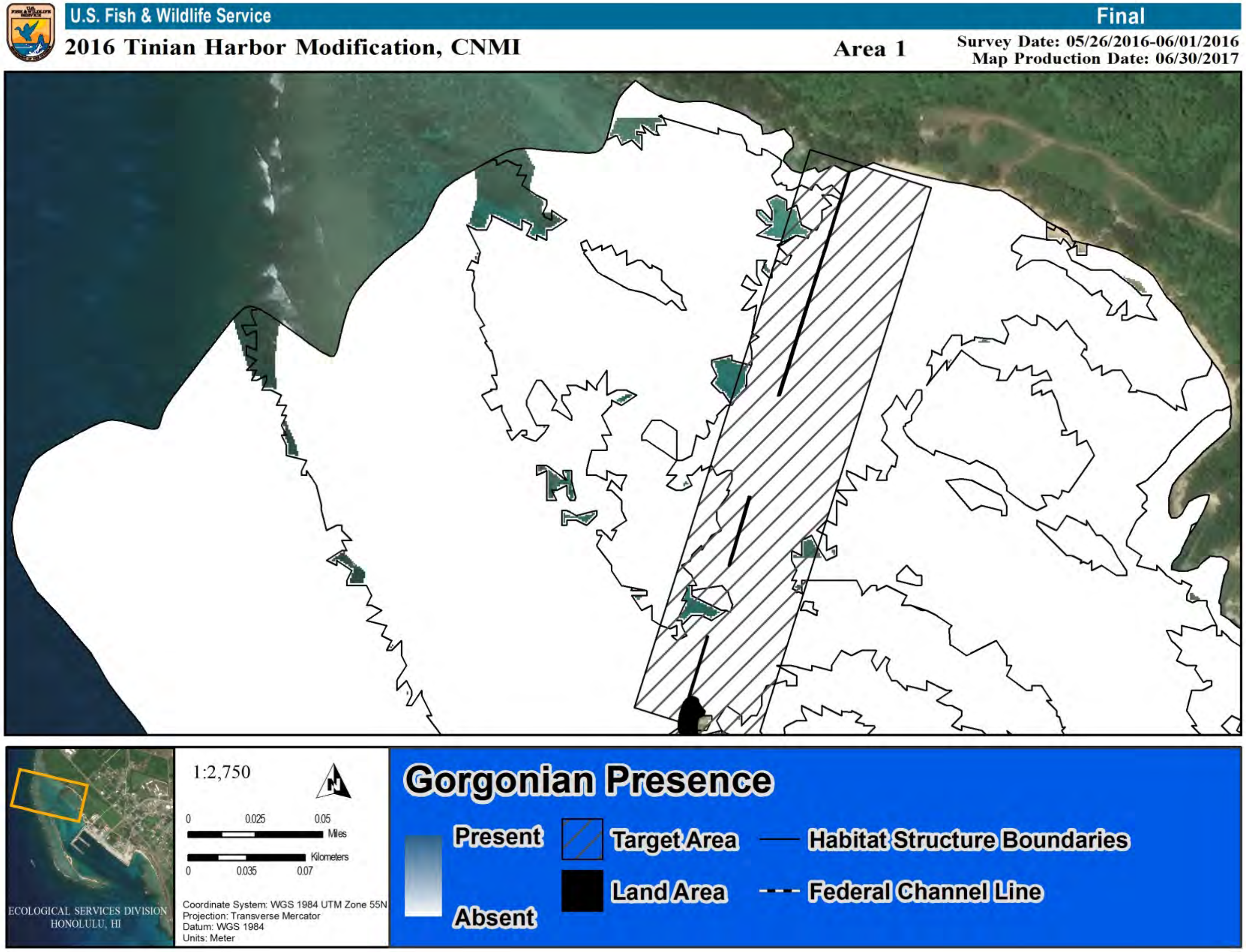

Figure B17: Gorgonian Presence (Area 1). Overview of the gorgonian coral presence within the project area. Note: No gorgonians were observed in this area.

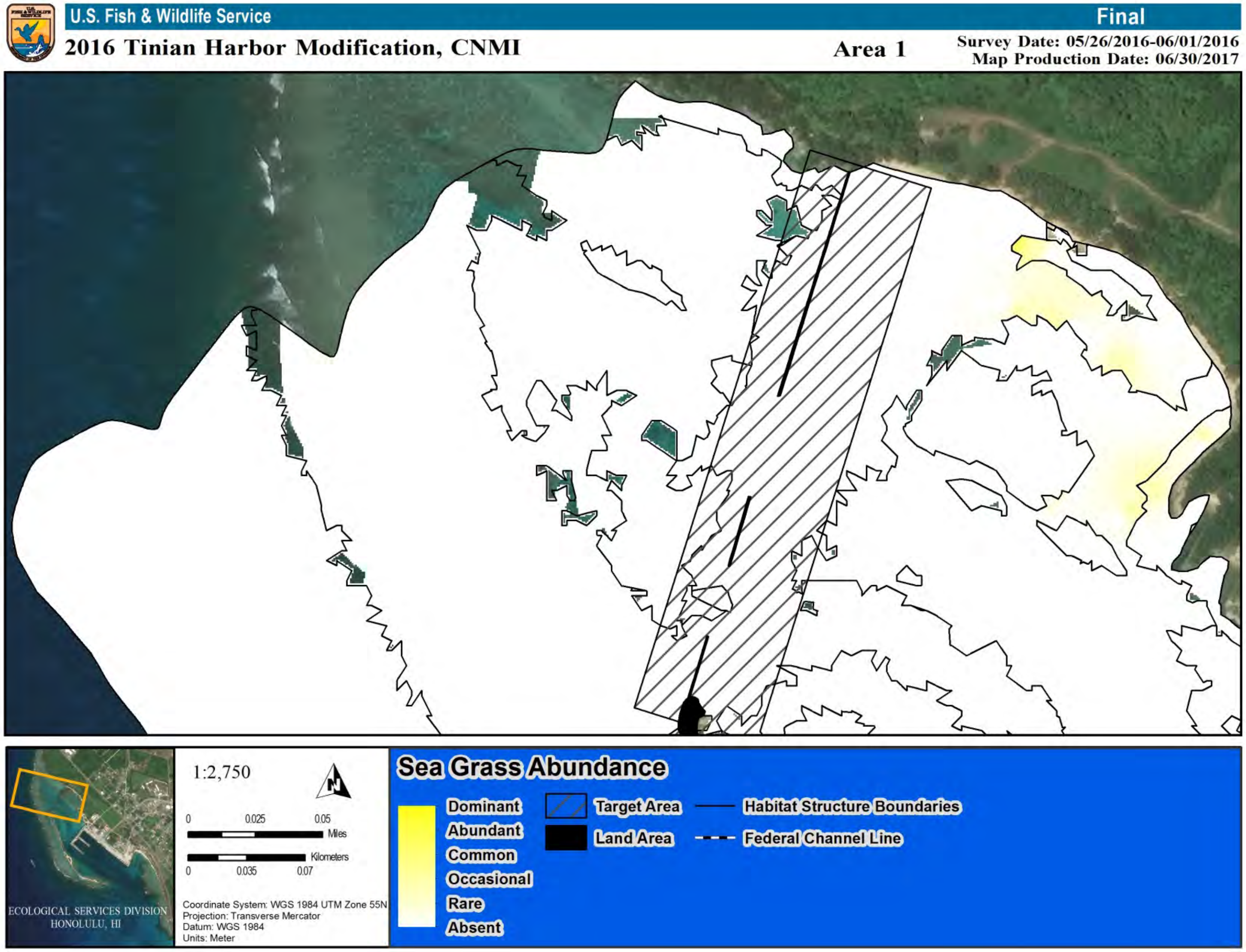

Figure B18: Sea Grass Abundance (Area 1). Overview of the seagrass abundance within the project area.

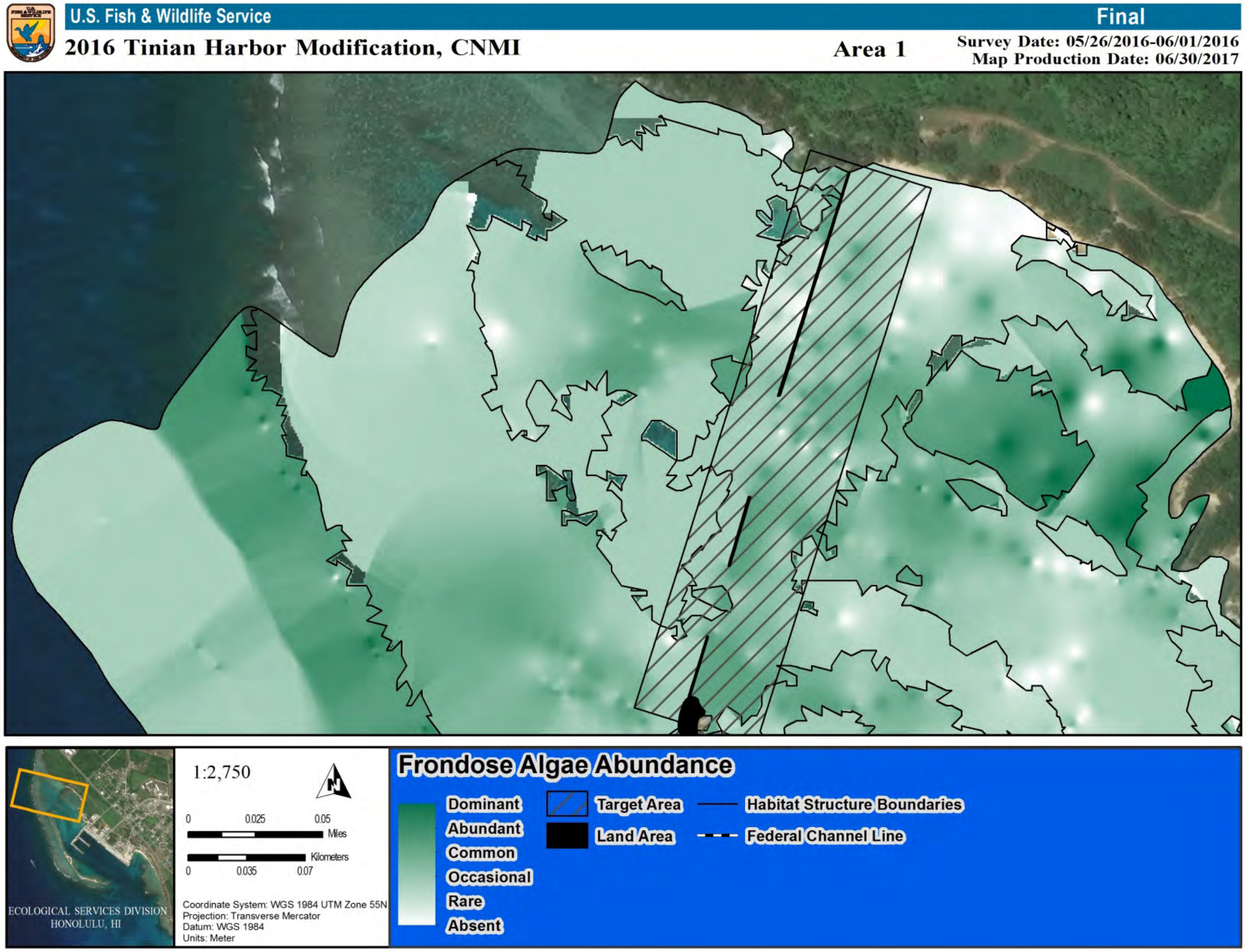

Figure B19: Frondose Algae Abundance (Area 1). Overview of the frondose algae (macroalgae) abundance observed within the project area.

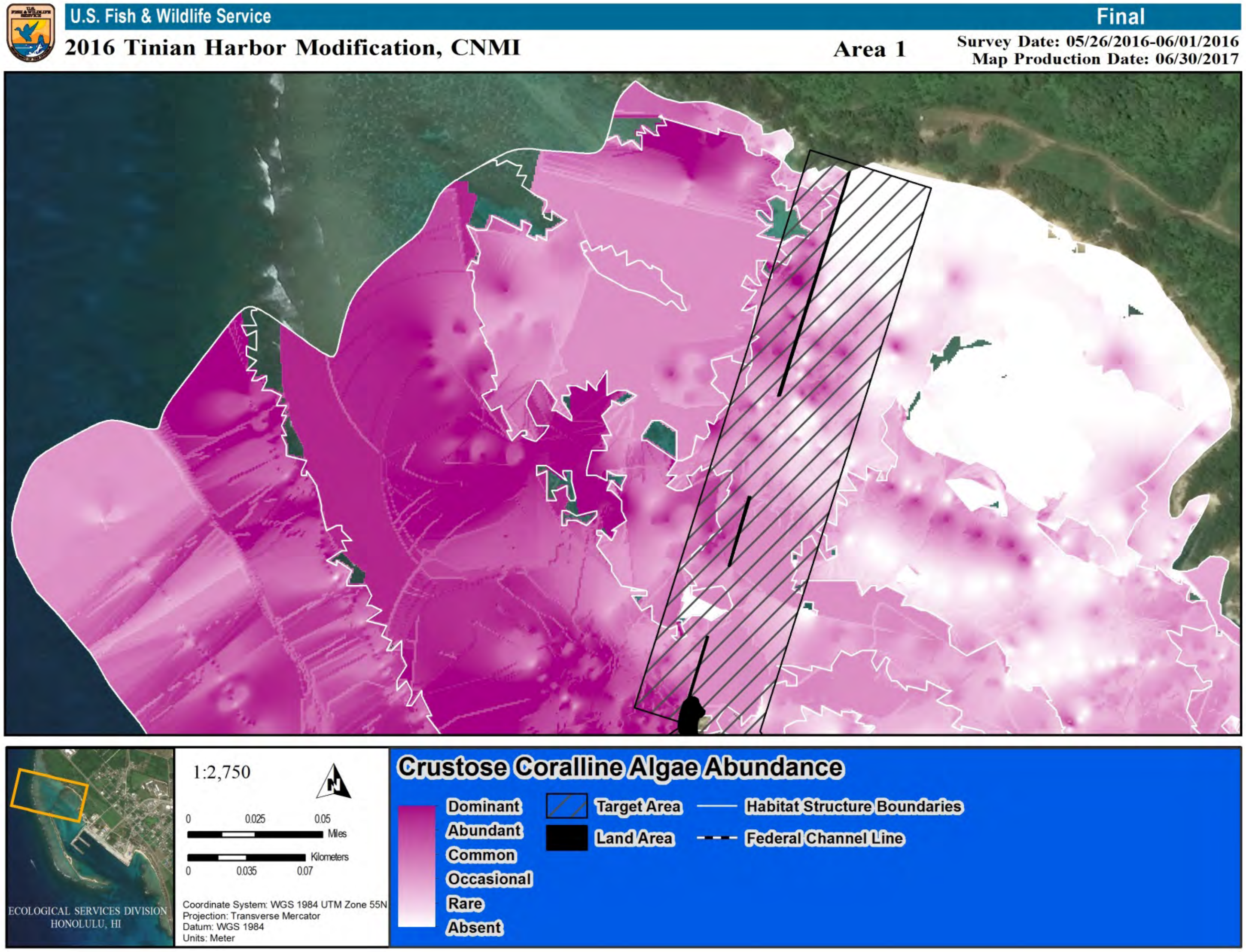

Figure B20: CCA Abundance (Area 1). Overview of the crustose coralline algae abundance observed within the project area.

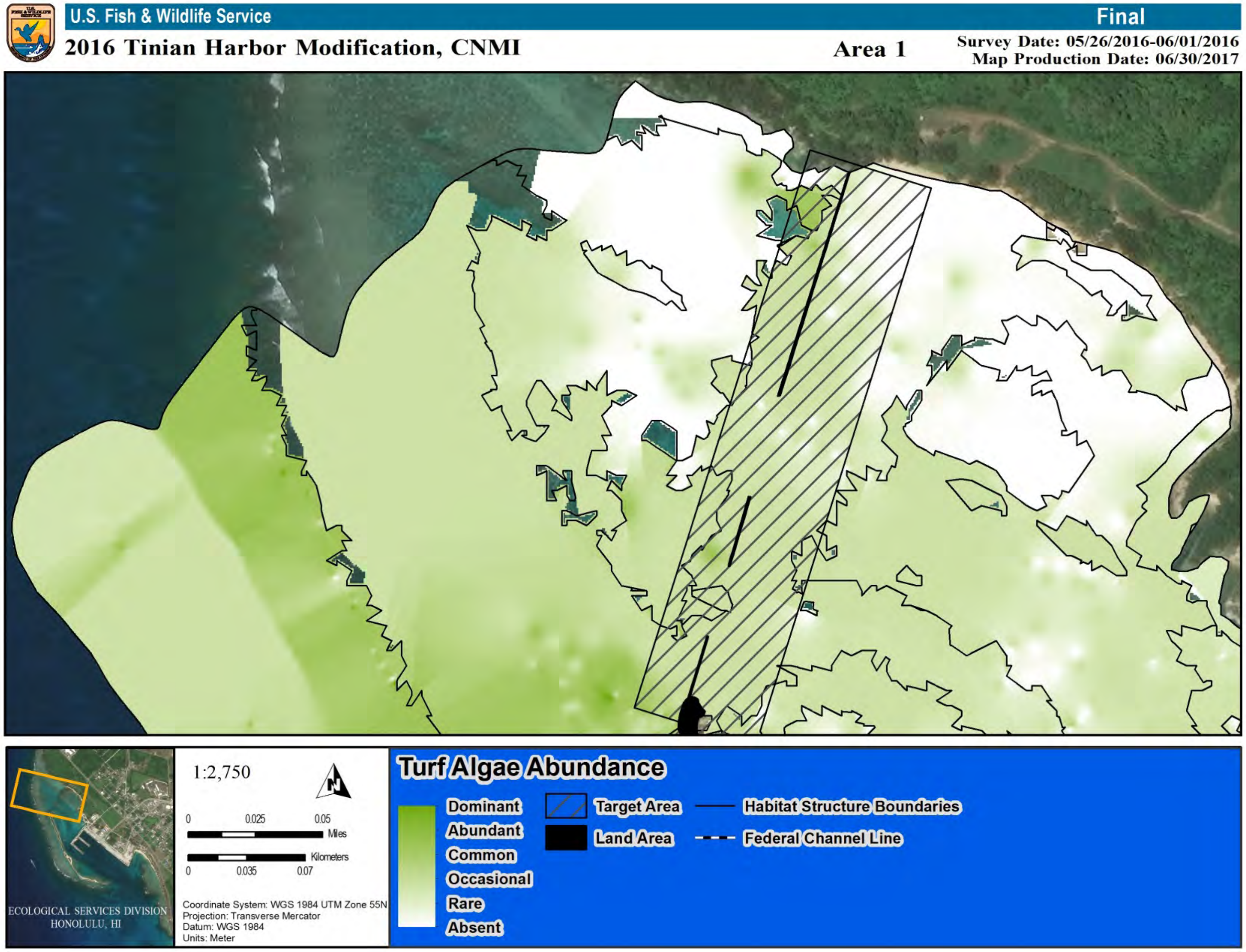

Figure B21: Turf Algae Abundance (Area 1). Overview of the turf algae abundance observed within the project area.

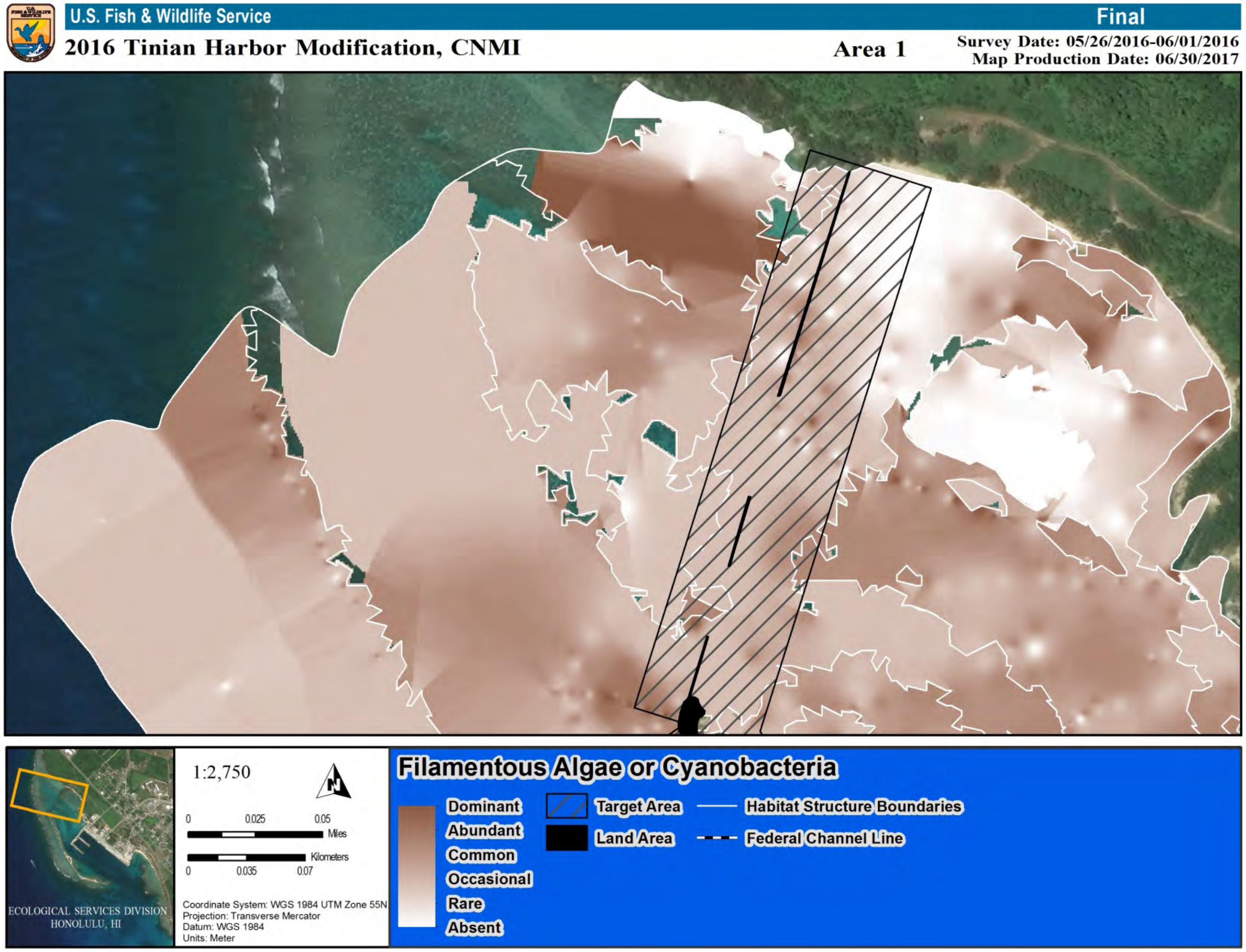

Figure B22: Filamentous Algae (Area 1). Overview of the filamentous algae and cyanobacteria abundance observed within the project area.

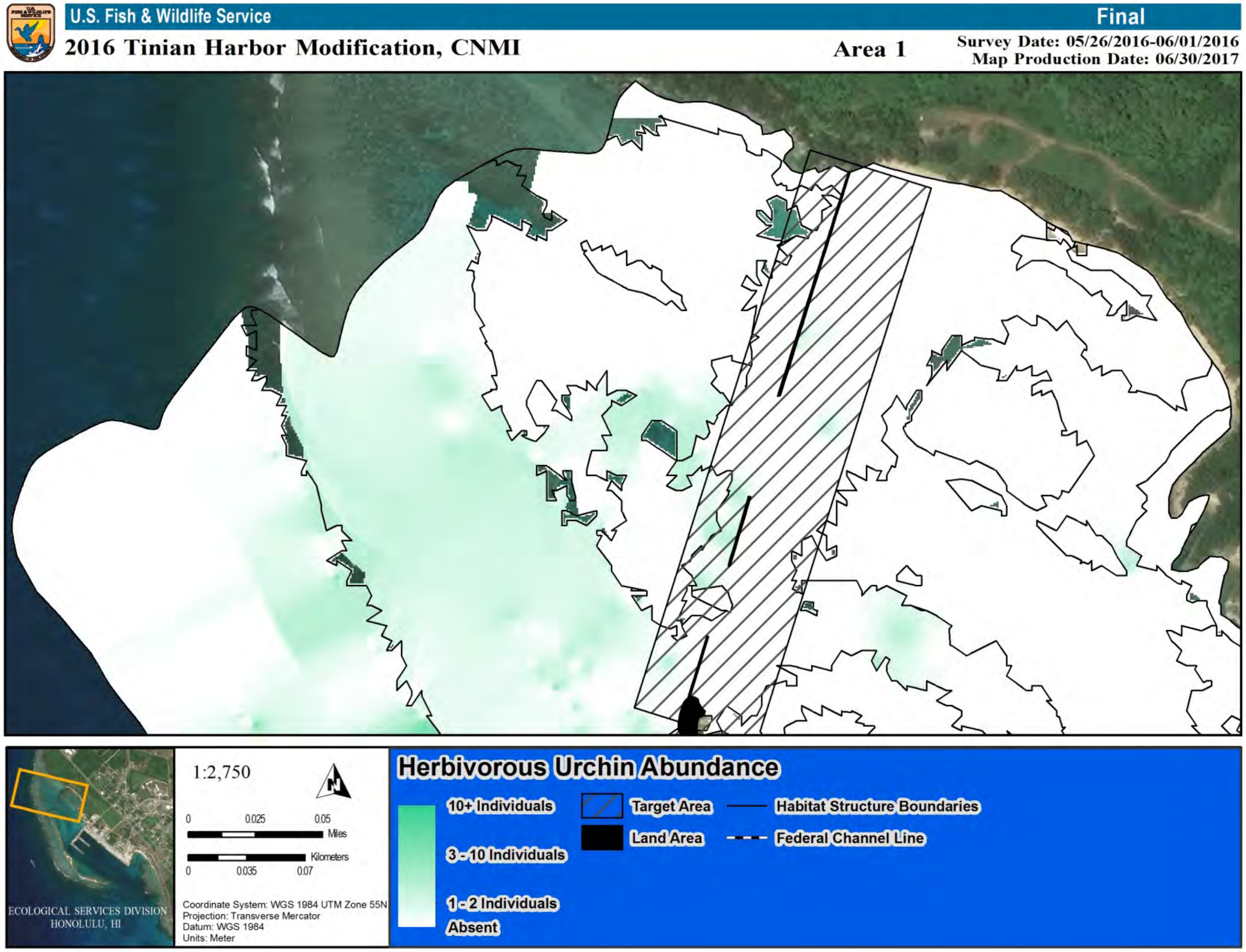

Figure B23: Herbivorous Urchin Abundance (Area 1). Overview of the herbivorous urchin abundance observed within the project area.

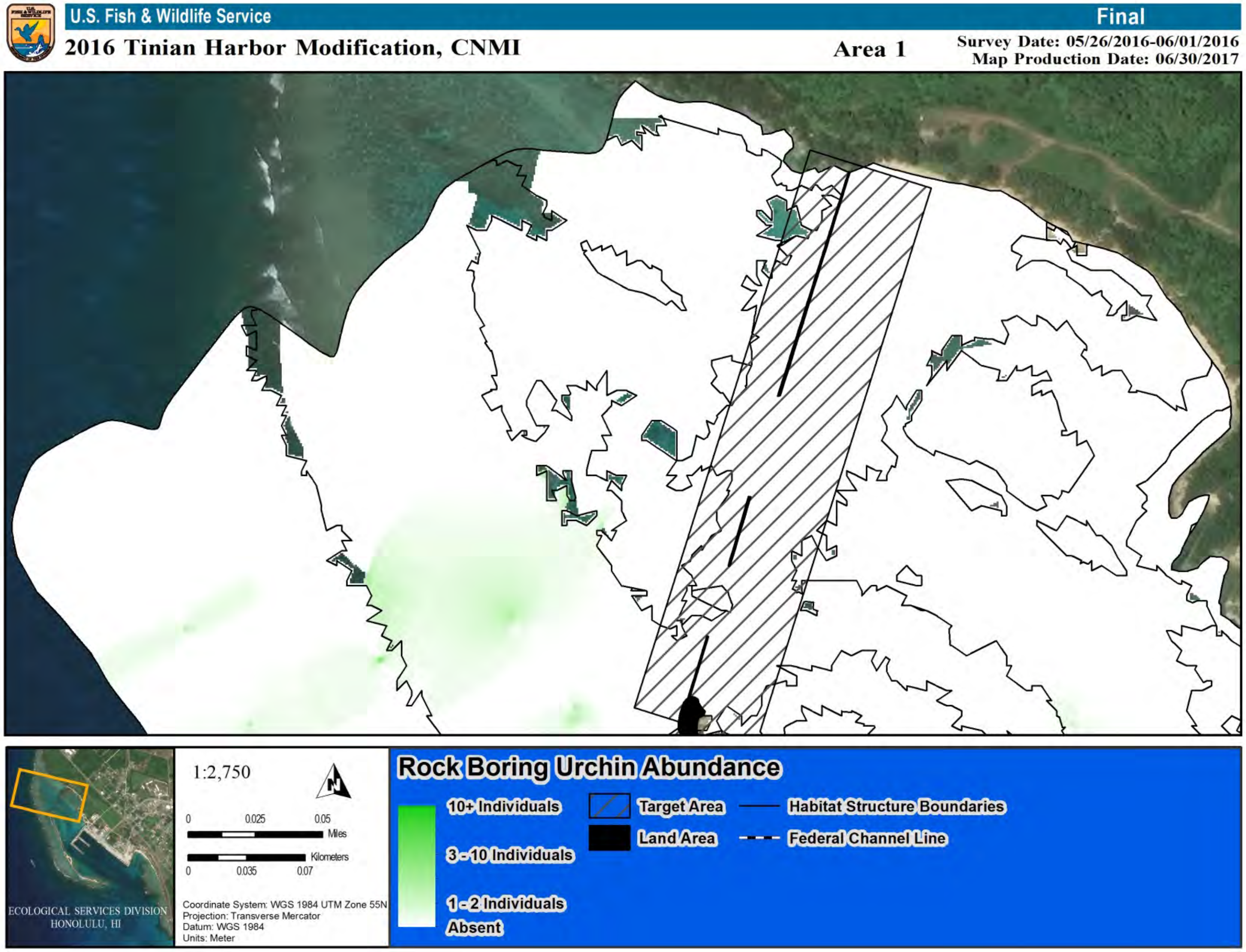

Figure B24: Rock Boring Urchin Abundance (Area 1). Overview of the rock boring urchin abundance observed within the project area.

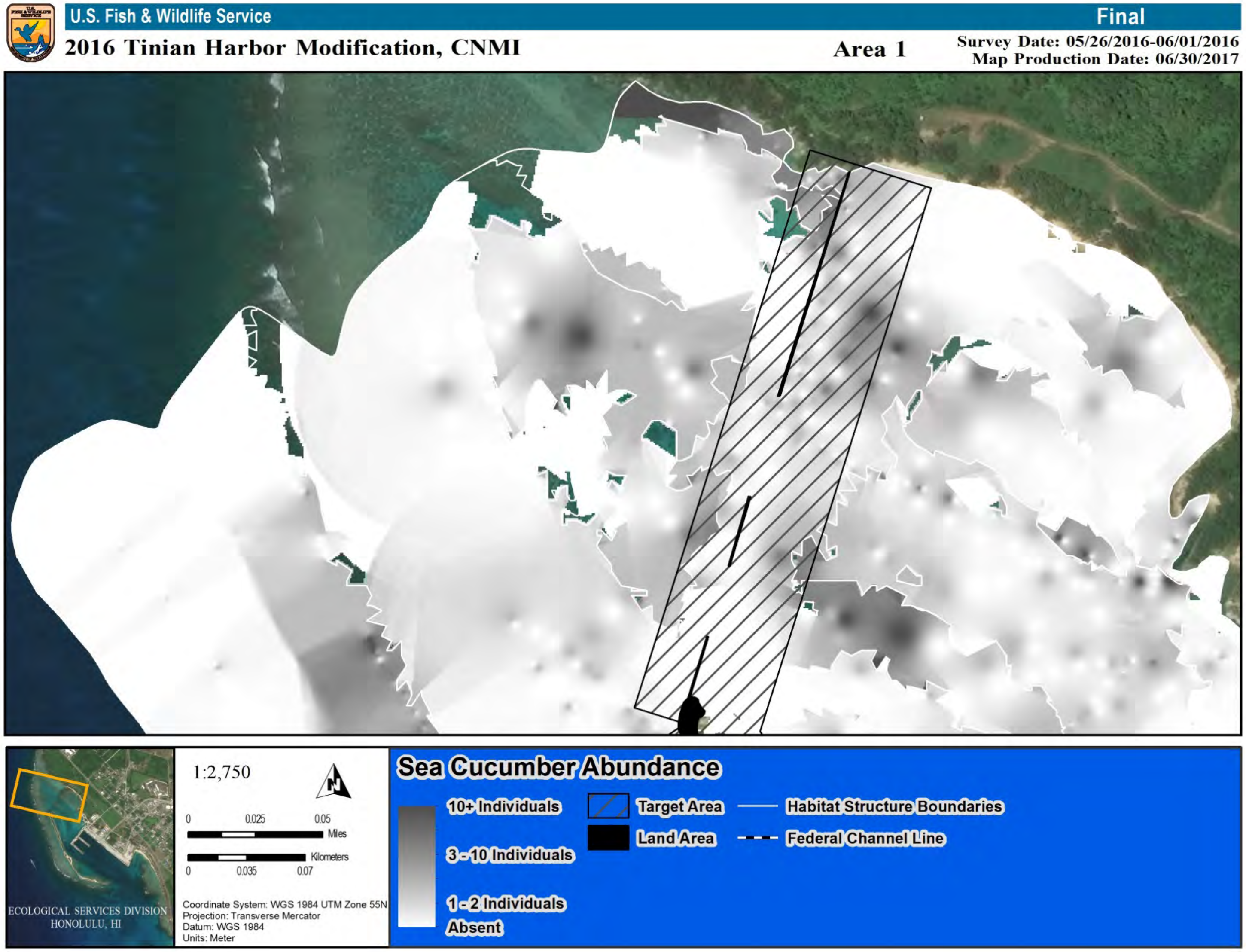

Figure B25: Sea Cucumber Abundance (Area 1). Overview of the sea cucumber abundance observed within the project area.

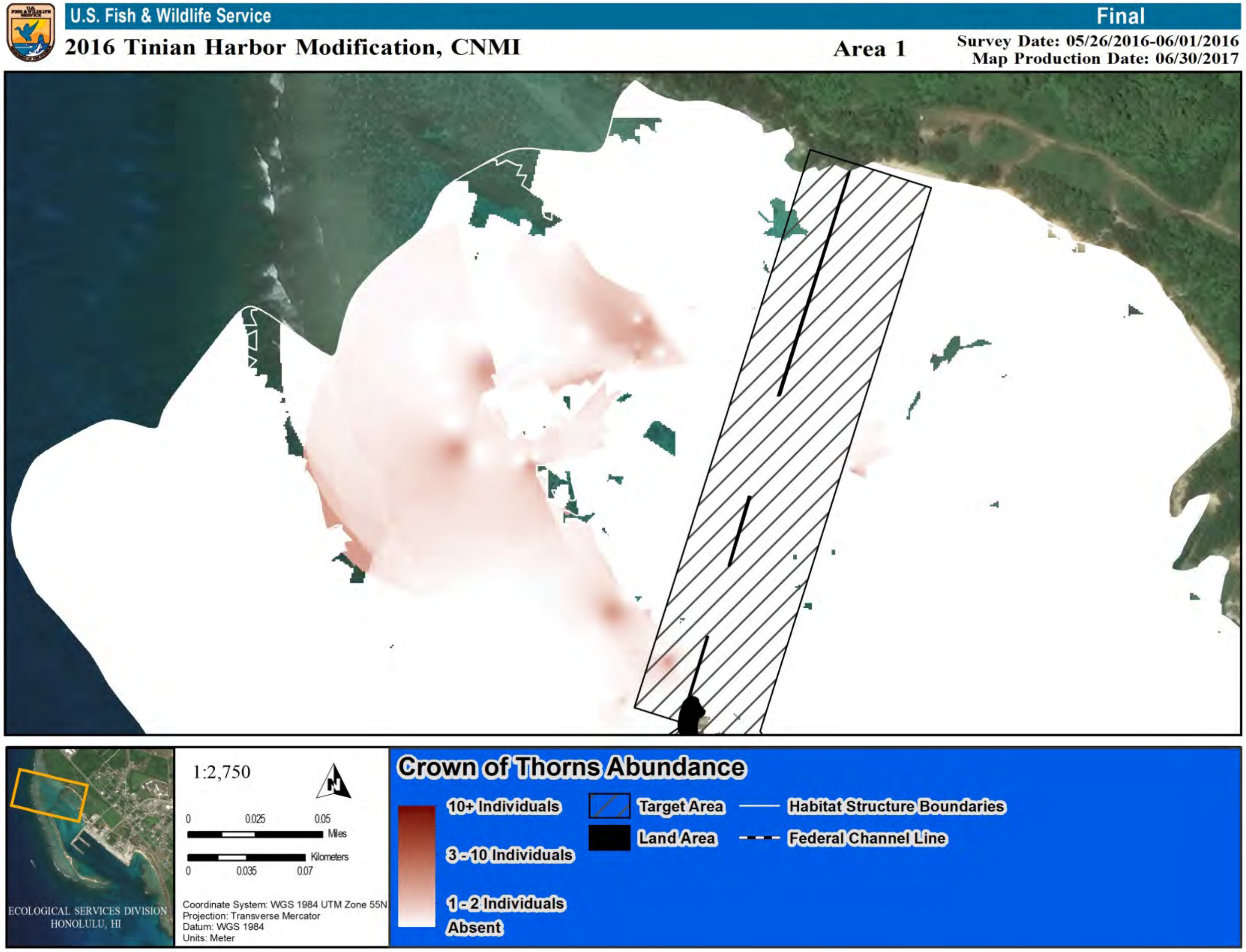

Figure B26: Crown-of-Thorns Abundance (Area 1). Overview of the crown-of-thorn starfish abundance observed within the project area.

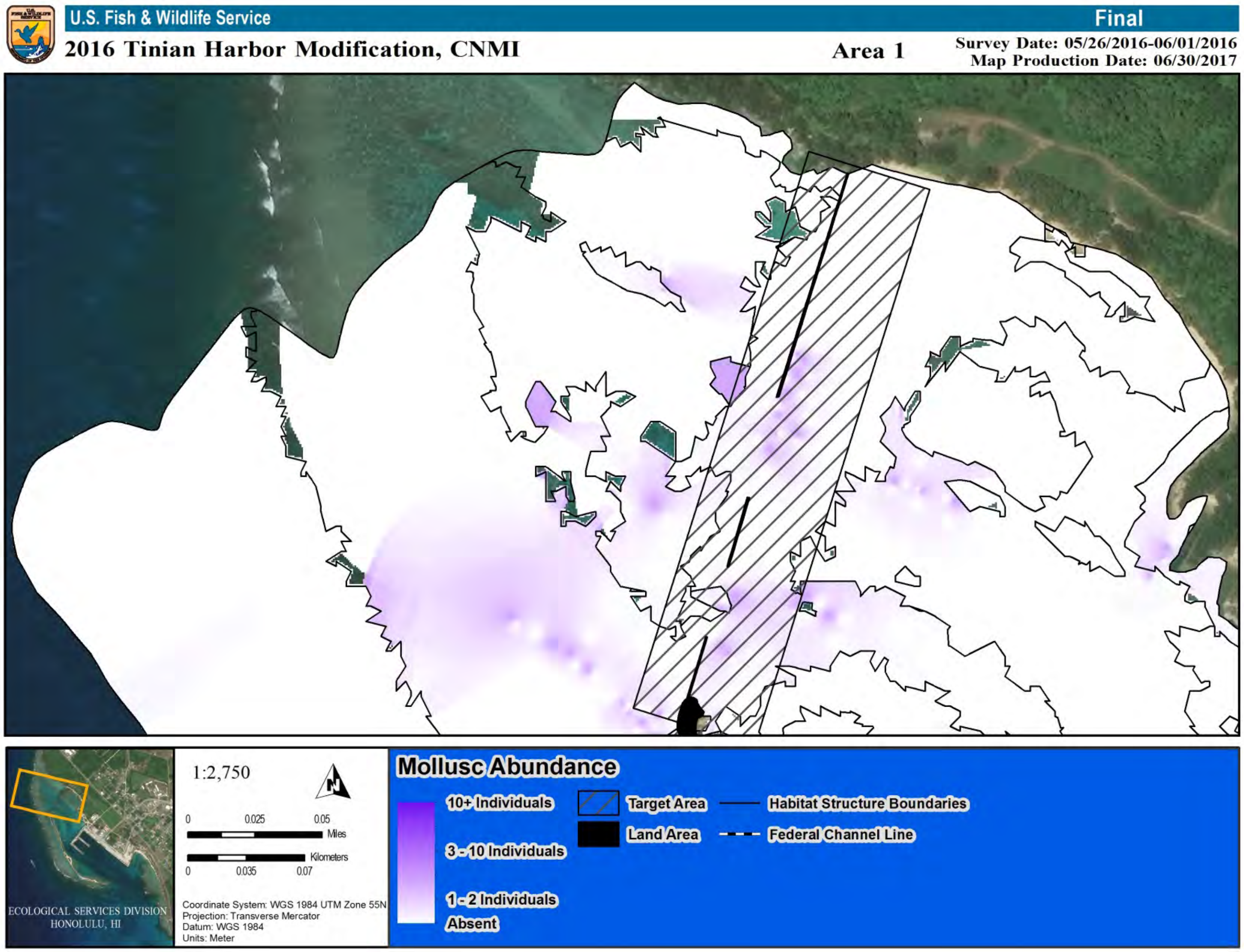

Figure B27: Mollusc Abundance (Area 1). Overview of the mollusc (other than specific species shown in other maps) abundance observed within the project area.

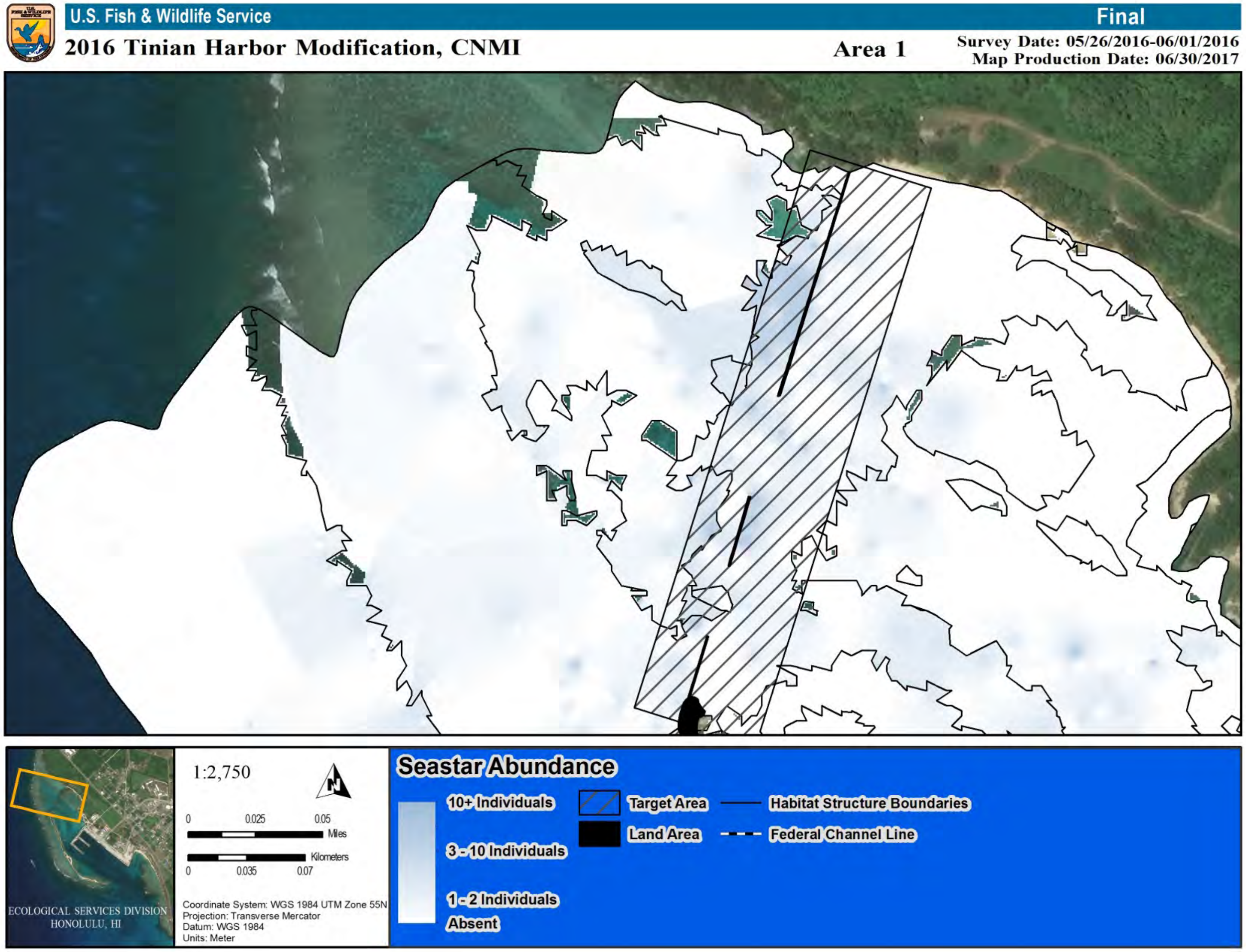

Figure B28: Seastar Abundance (Area 1). Overview of the seastar abundance observed within the project area.

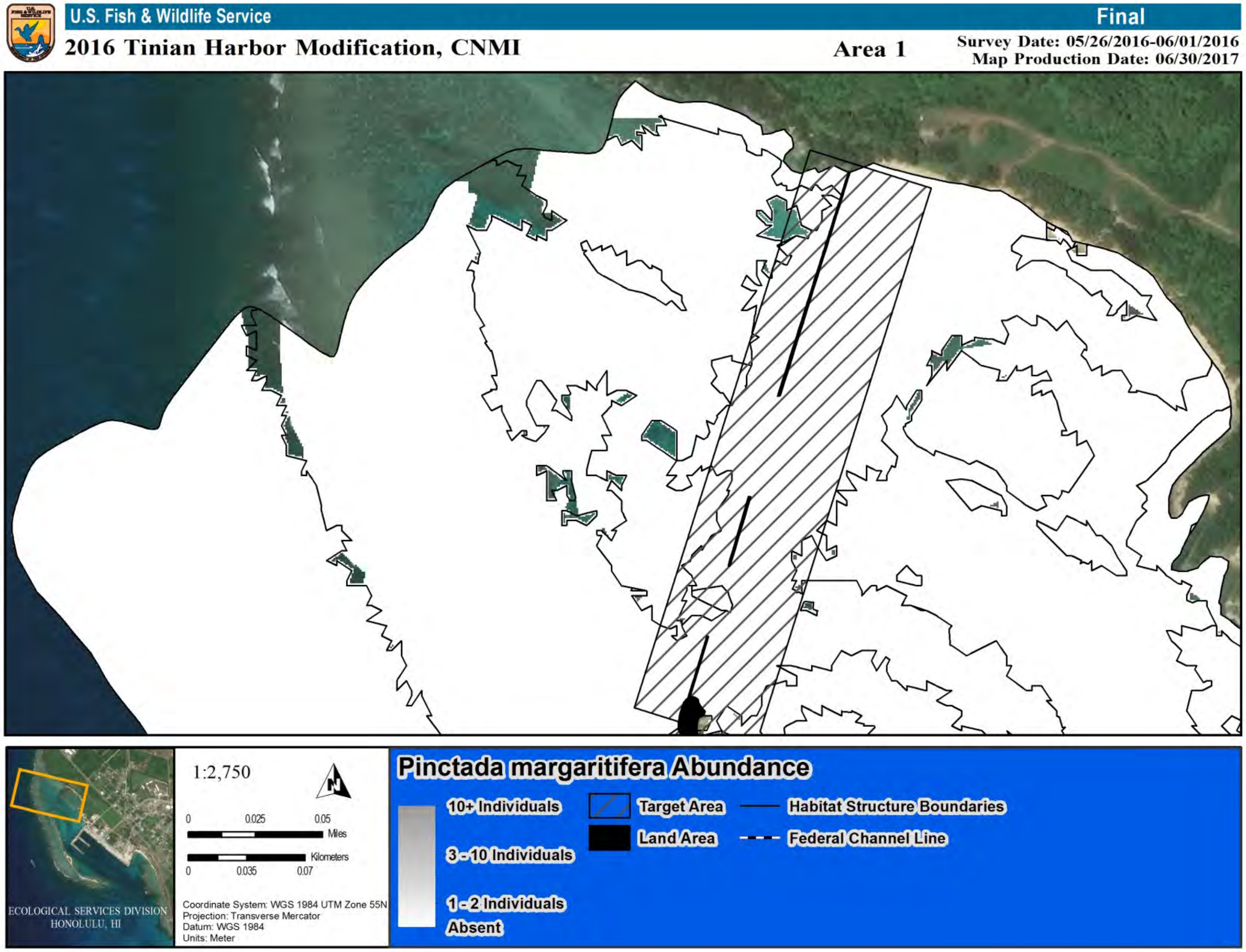

Figure B29: Pinctada Abundance (Area 1). Overview of the mollusc, Pinctada margaritifera, abundance observed within the project area.

Note: No Pinctada margaritifera were observed in this area.

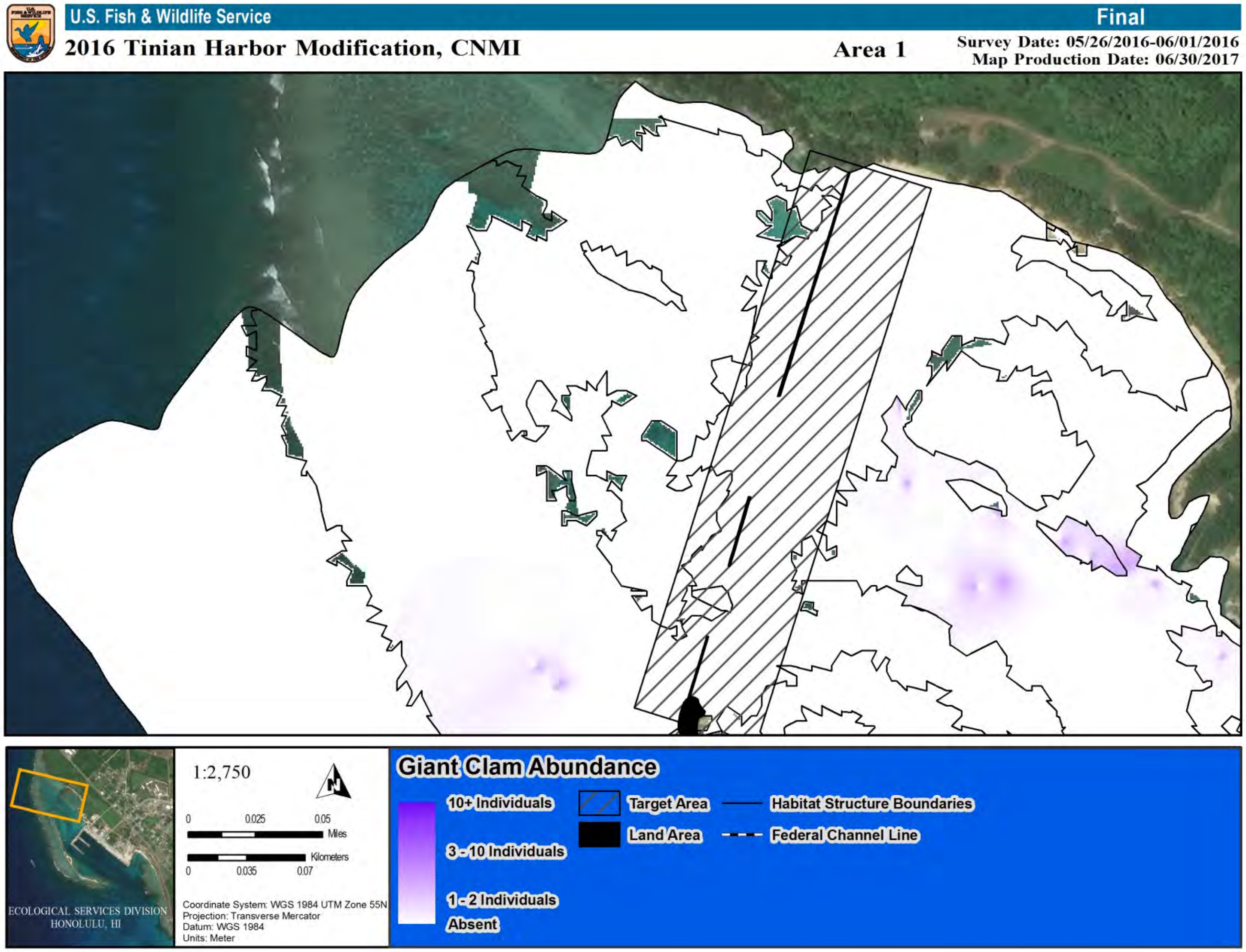

Figure B30: Giant Clam Abundance (Area 1). Overview of the giant clam abundance observed within the project area.

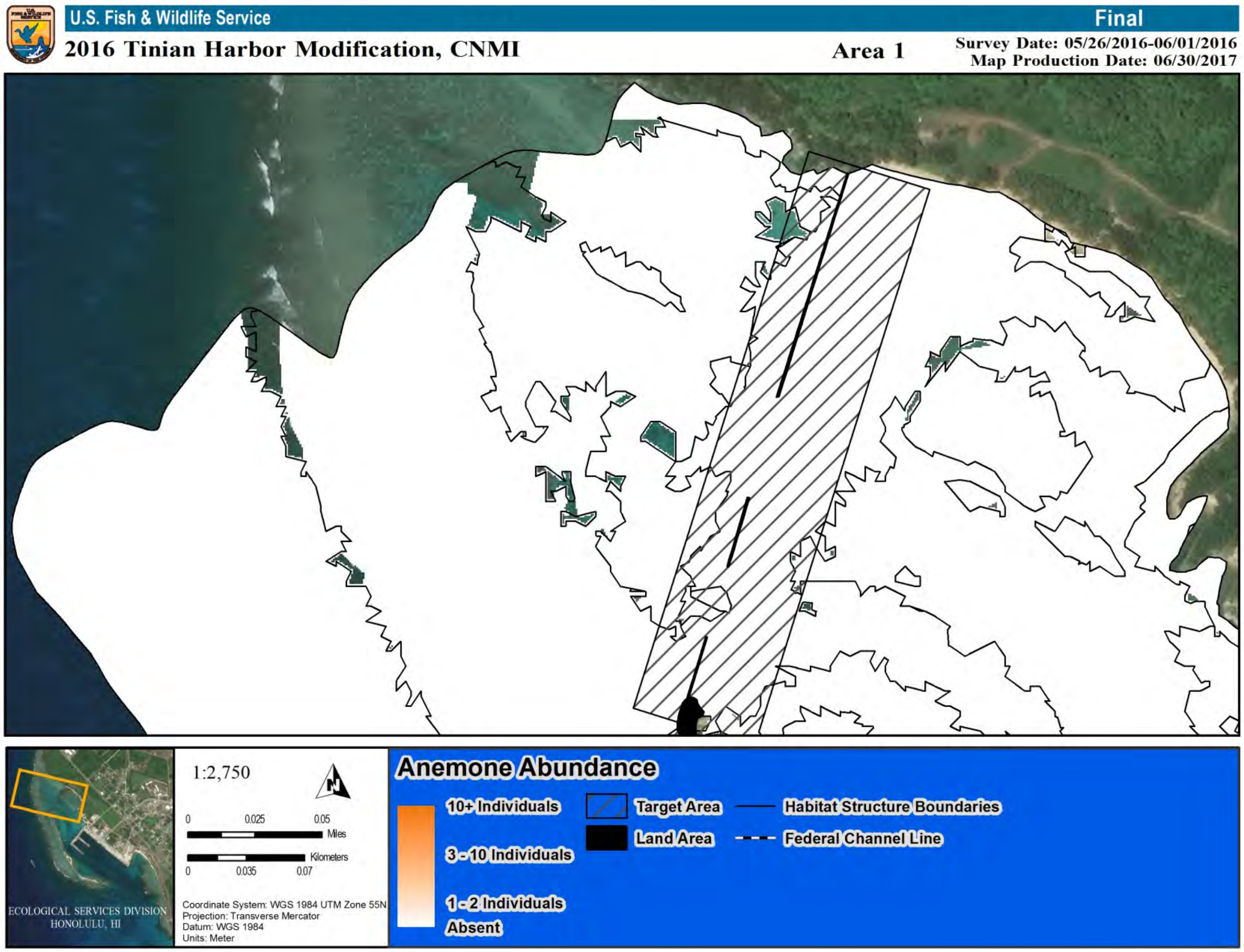

Figure B31: Anemone Abundance (Area 1). Overview of the anemone abundance observed within the project area. Note: No anemones were observed in this area.

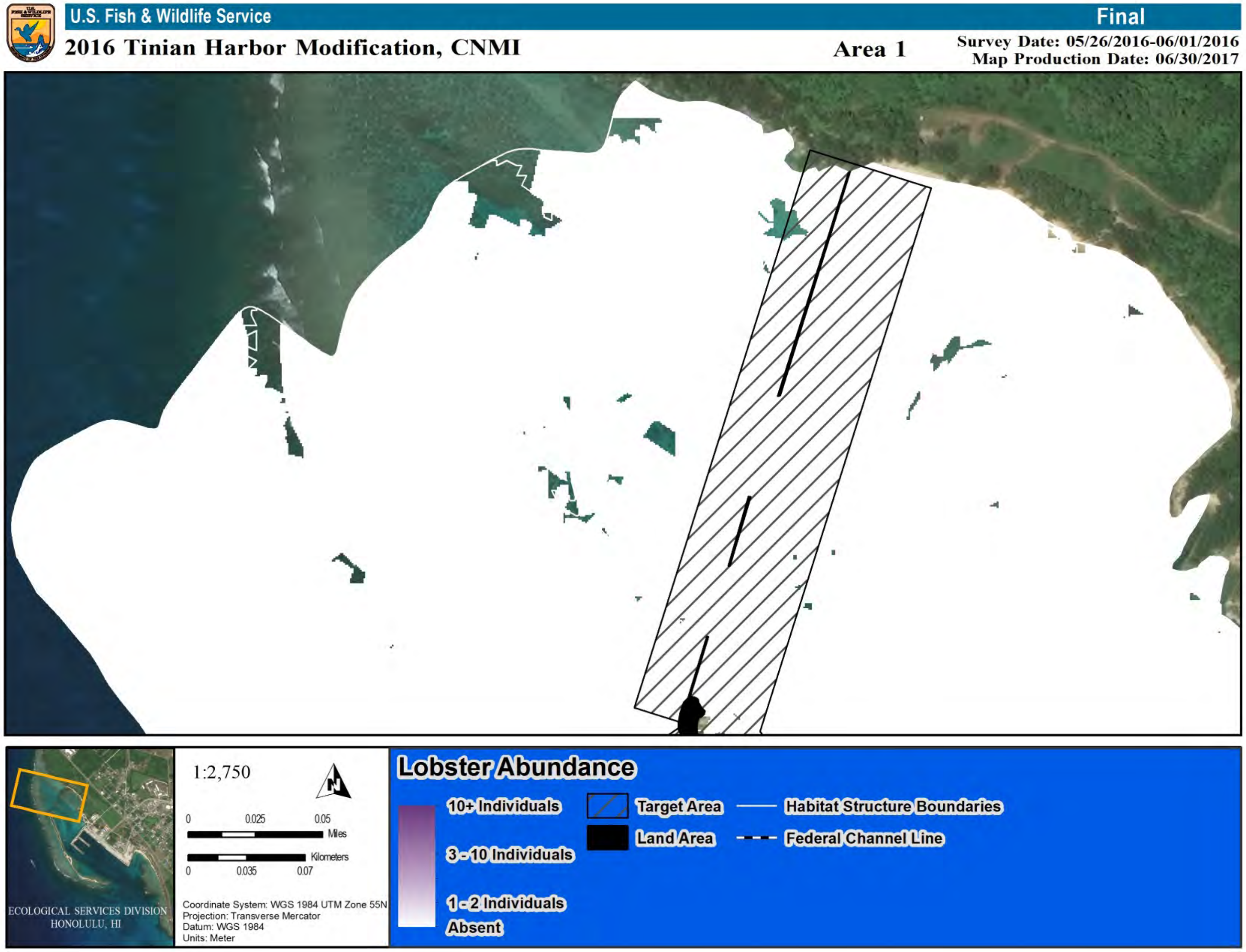

Figure B32: Lobster Abundance (Area 1). Overview of the lobster abundance observed within the project area. Note: No lobsters were observed in this area.

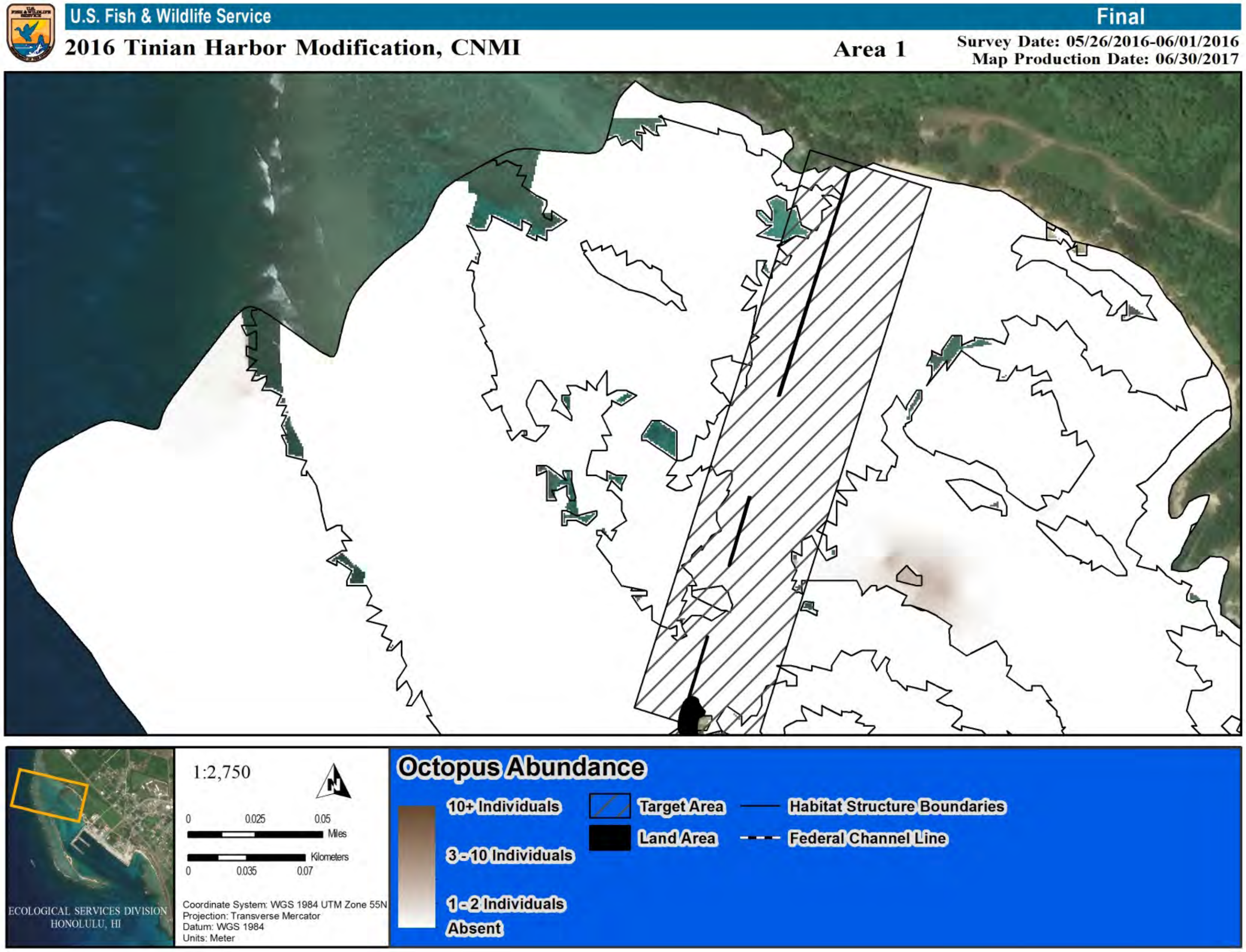

Figure B33: Octopus Abundance (Area 1). Overview of the octopus abundance observed within the project area.

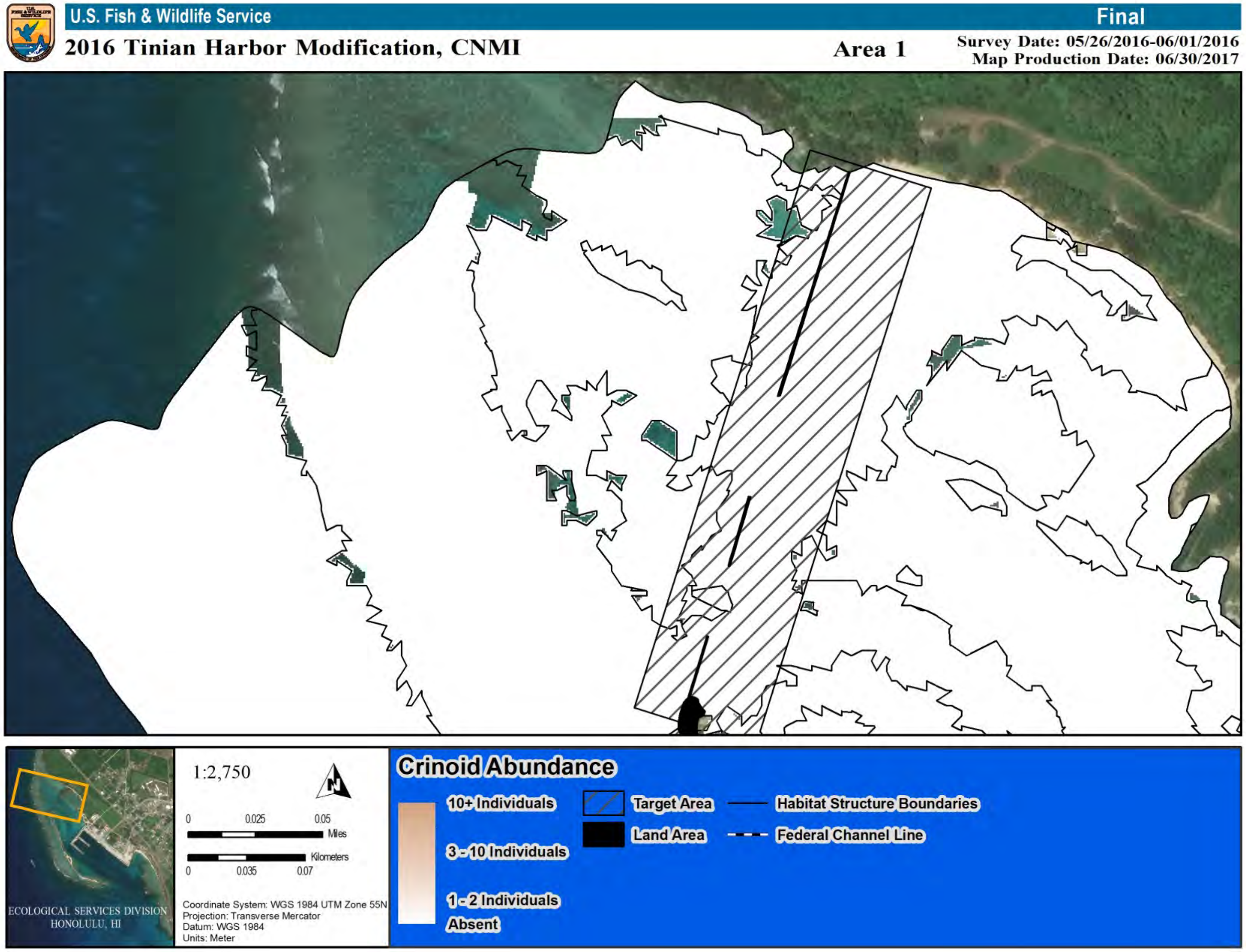

Figure B34: Crinoid Abundance (Area 1). Overview of the crinoid abundance observed within the project area. Note: No crinoids were observed in this area.

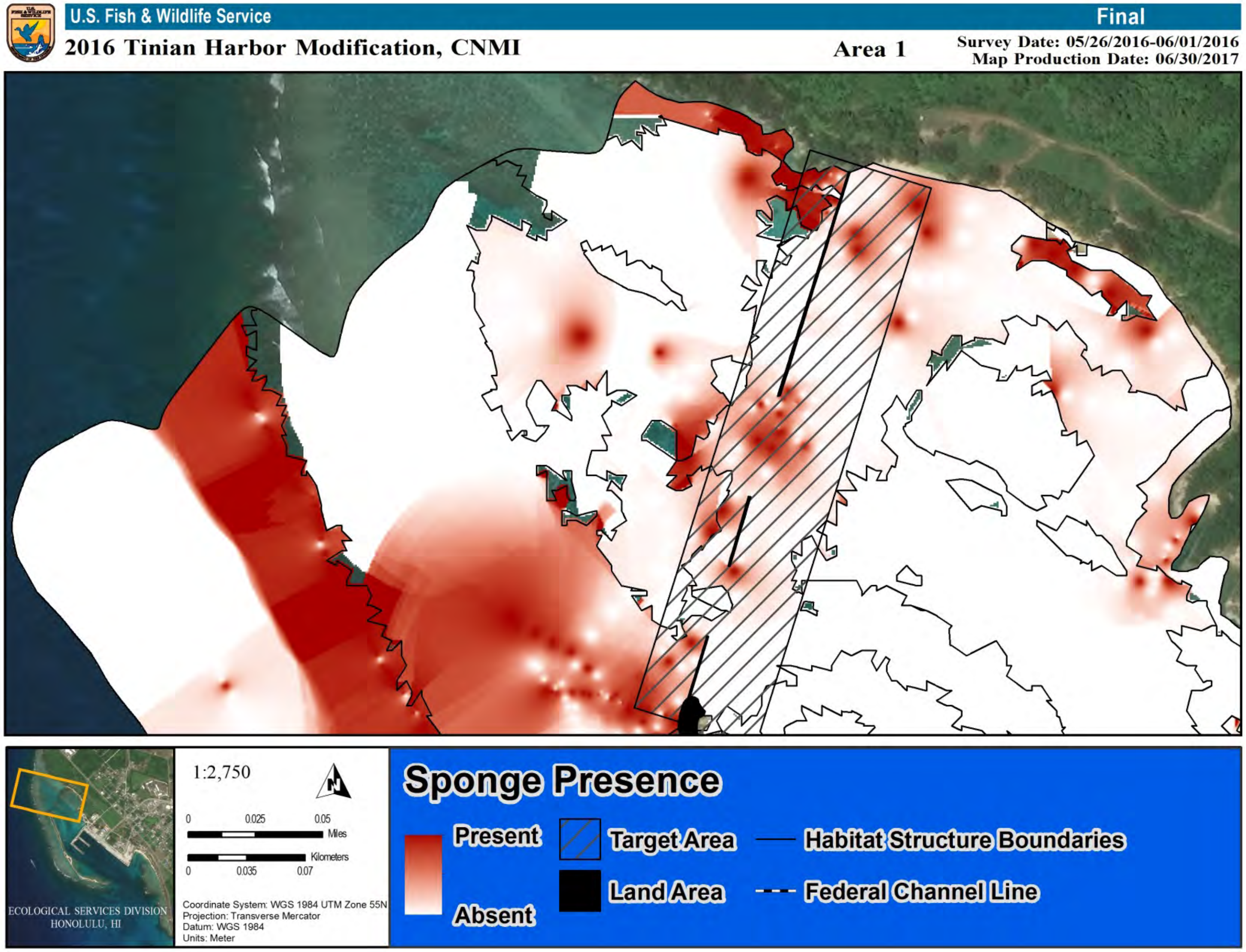

Figure B35: Sponge Presence (Area 1). Overview of the sponge presence observed within the project area.

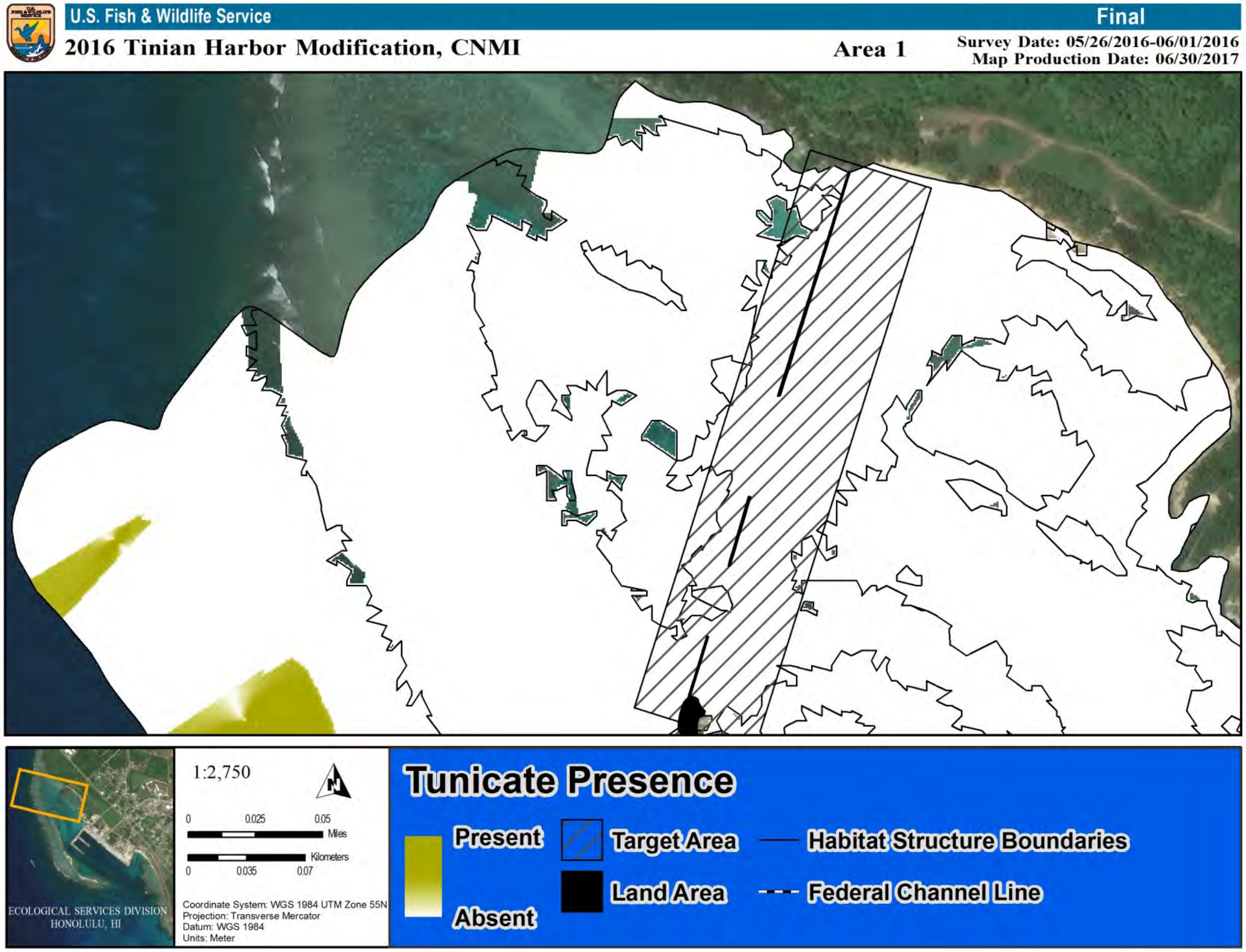

Figure B36: Tunicate Presence (Area 1). Overview of the tunicate presence observed within the project area.

APPENDIX C: Maps of Tinian Harbor Modification Project (Area 2)

Appendix C. Maps of Tinian Harbor Modification Project (Area 2).

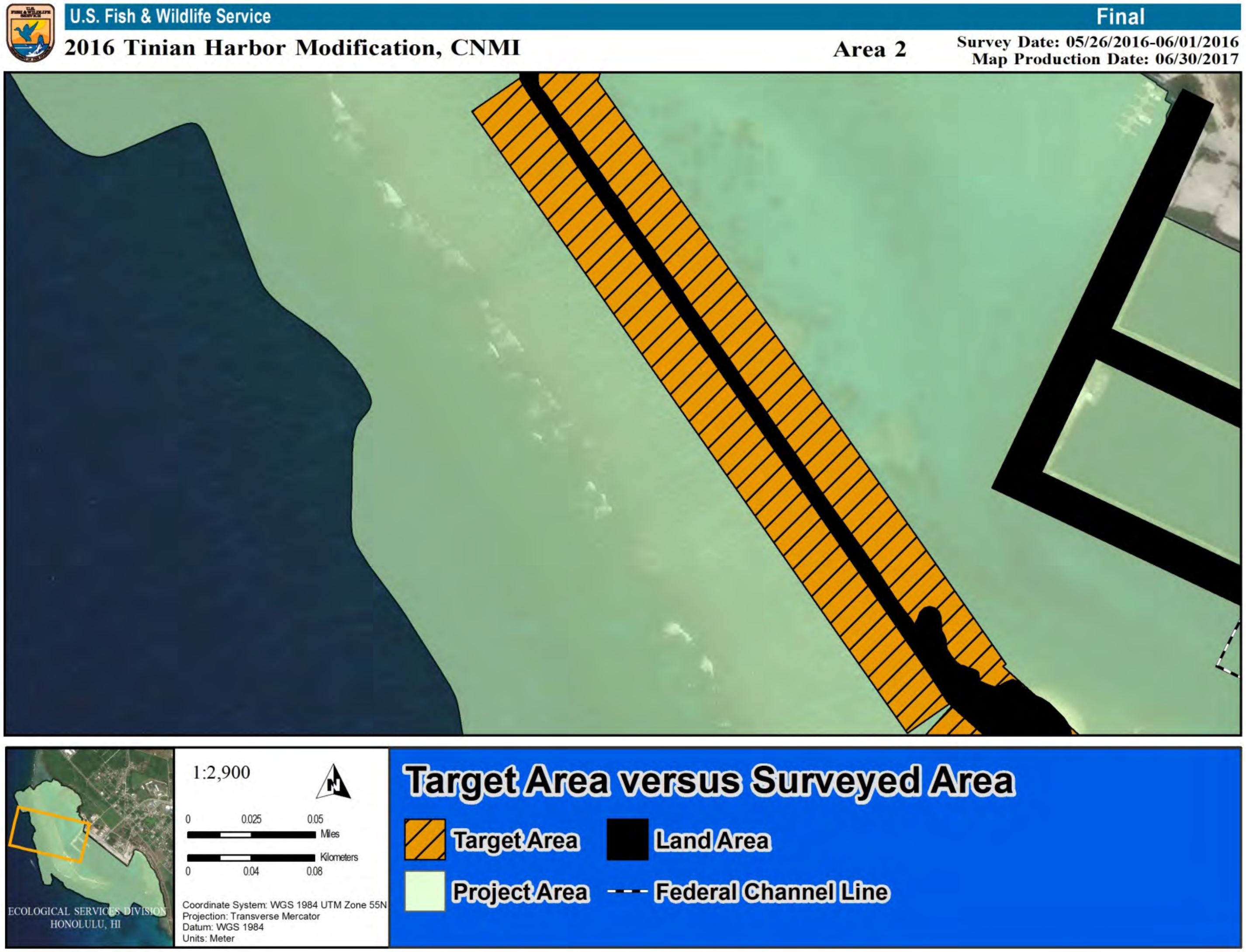

Figure C1: Target Area vs. Surveyed Area (Area 2). Overview of the Project Area (total surveyed area plus project footprint) versus the Target Area (project footprint).

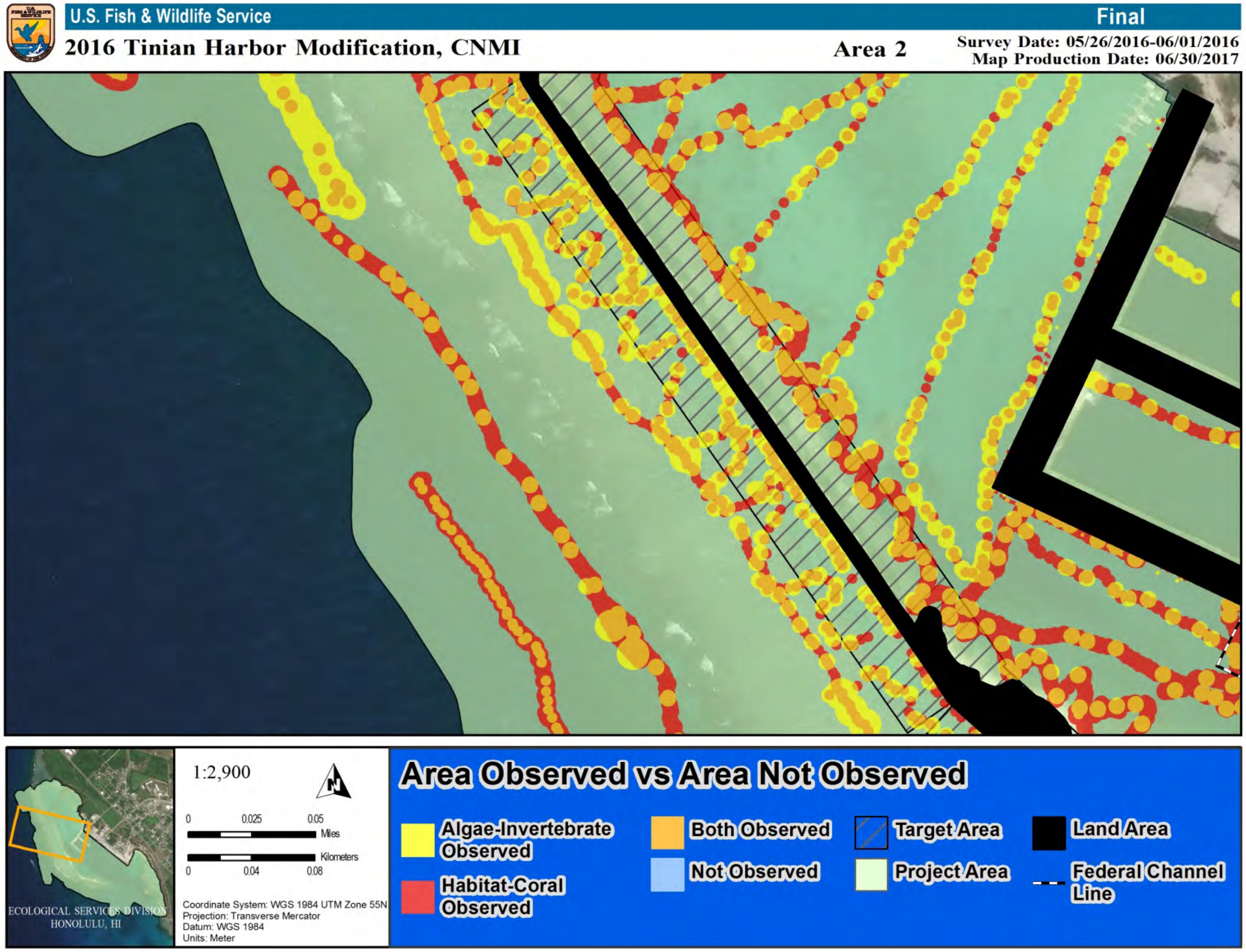

Figure C2: Area Observed (Area 2). Overview of the area observed by in-water observers versus the area interpolated in all maps.

Figure C3: Dive Tracks (Area 2). Overview of the dive track lines for all survey transects.

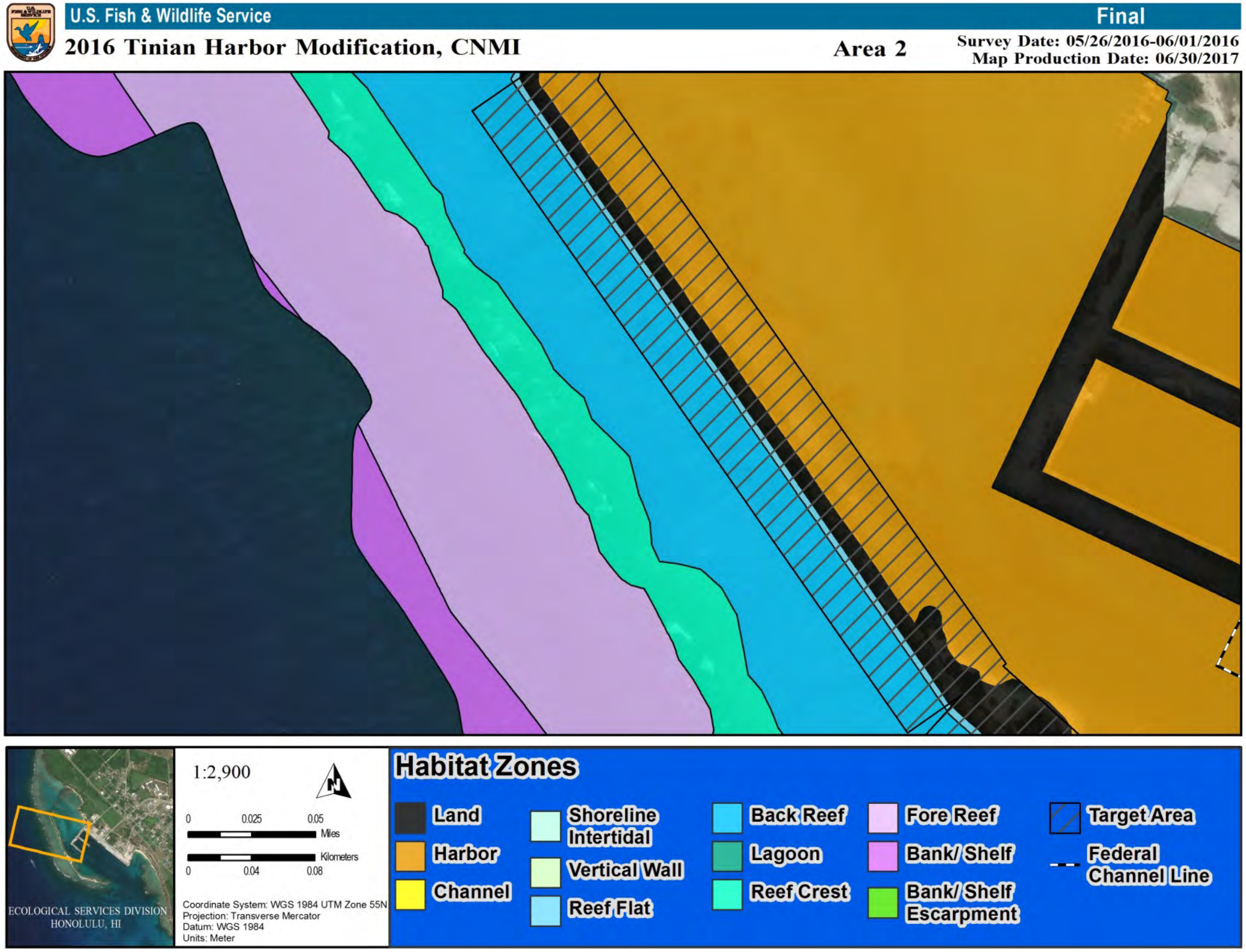

Figure C4: Habitat Zones (Area 2). Overview of the various habitat zones that the project area contains.

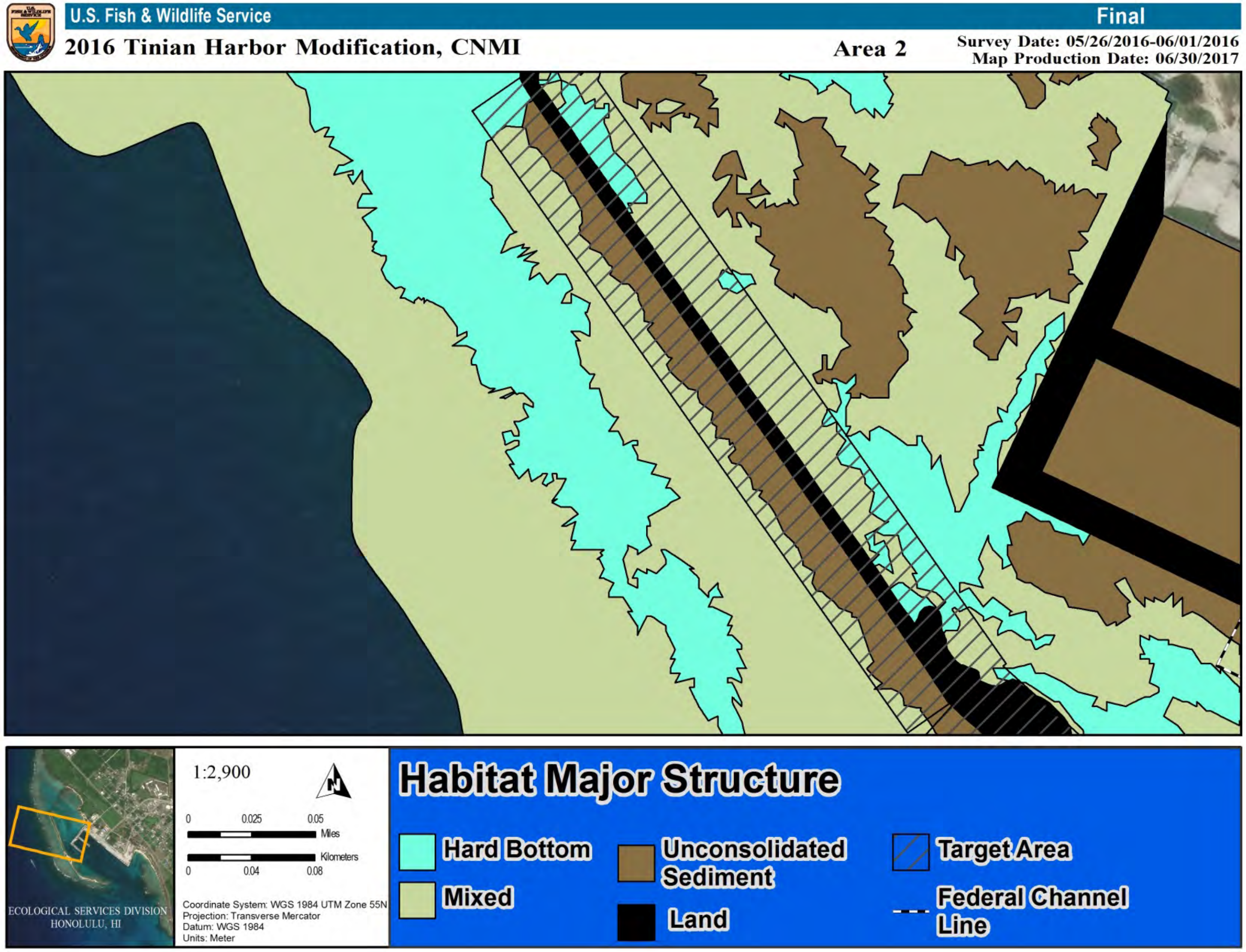

Figure C5: Habitat Major Structure (Area 2). Overview of the major habitat structures that the project area contains.

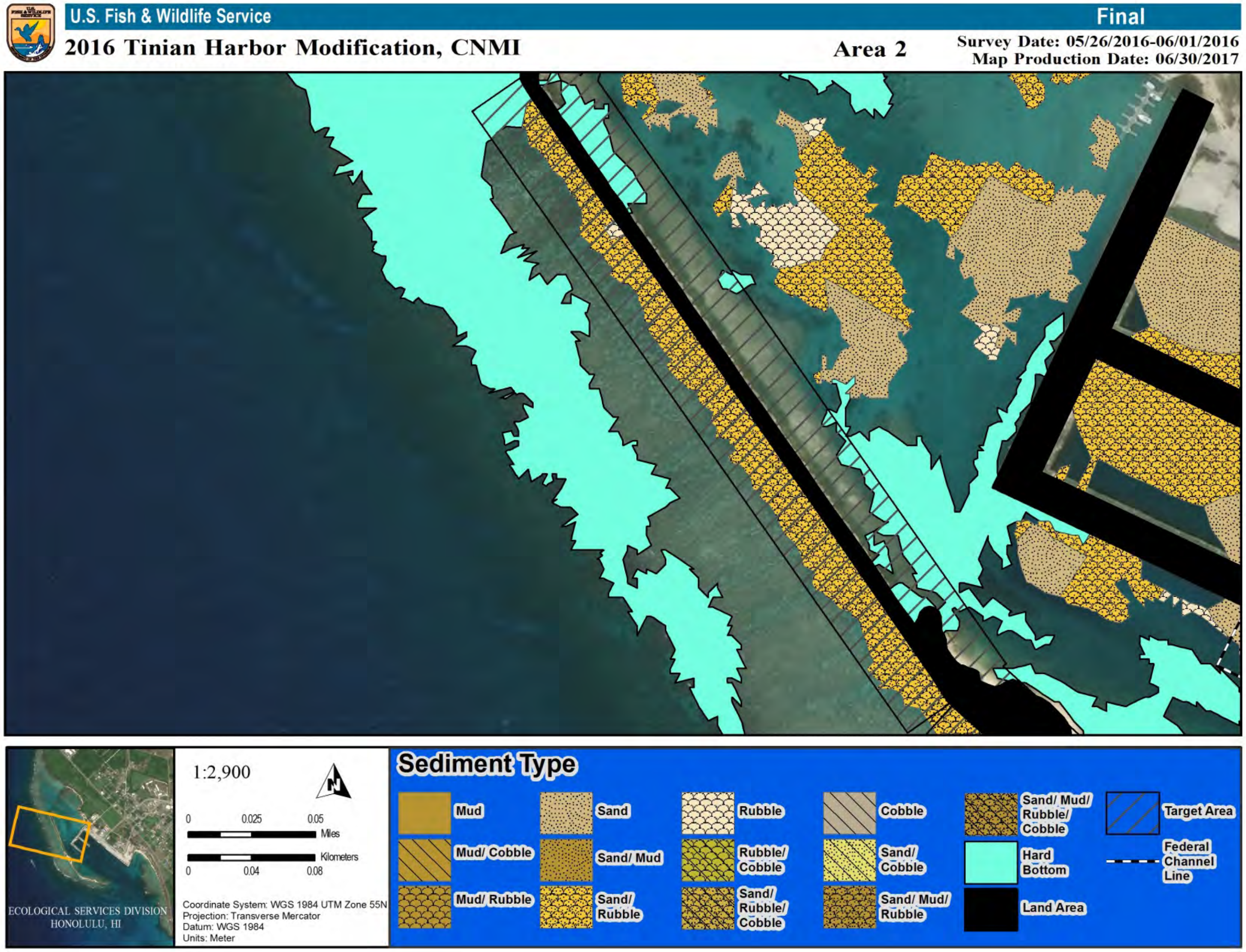

Figure C6: Sediment Type (Area 2). Overview of the various sediment types that the project area contains.

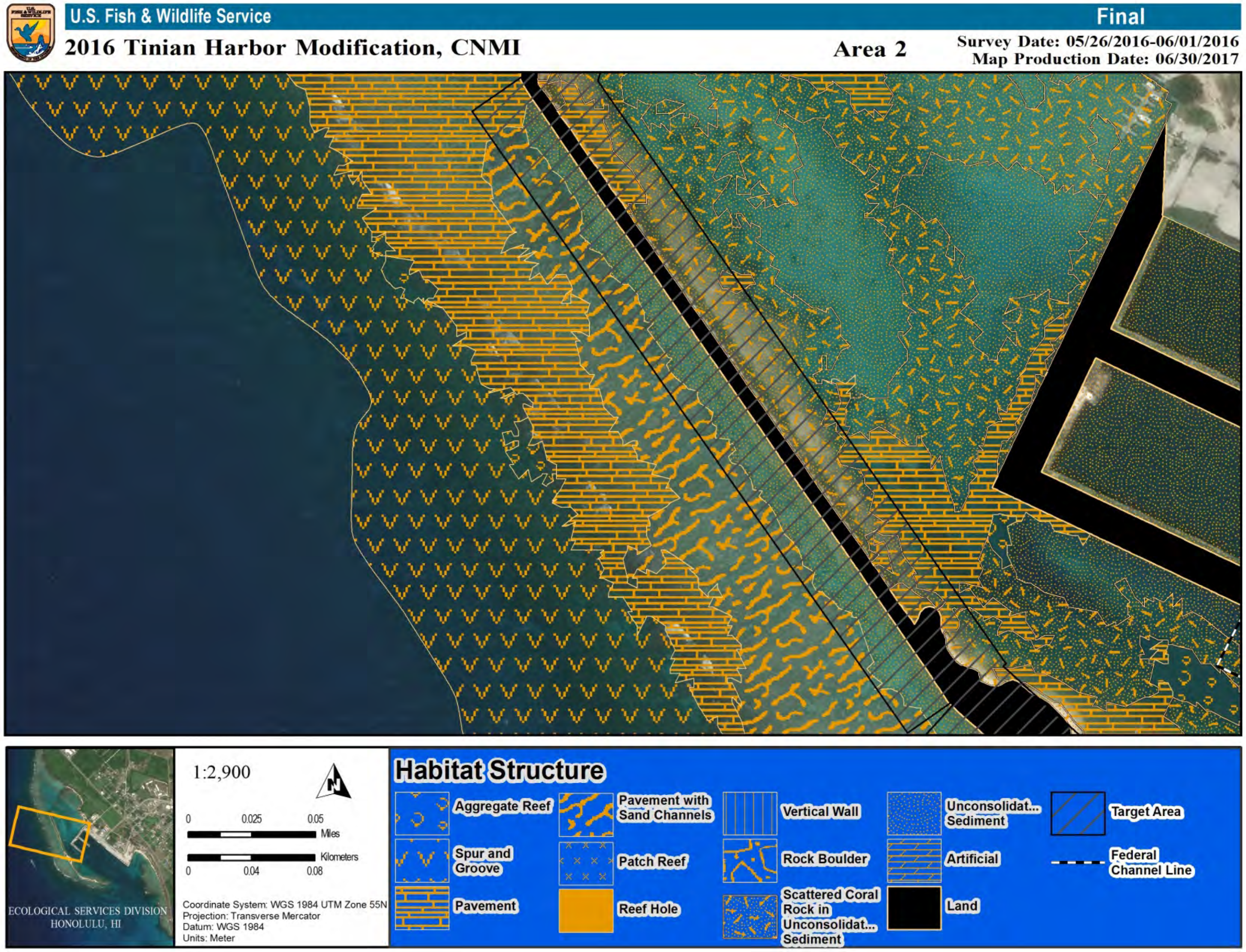

Figure C7: Habitat Structure (Area 2). Overview of the habitat structures that the project area contains.

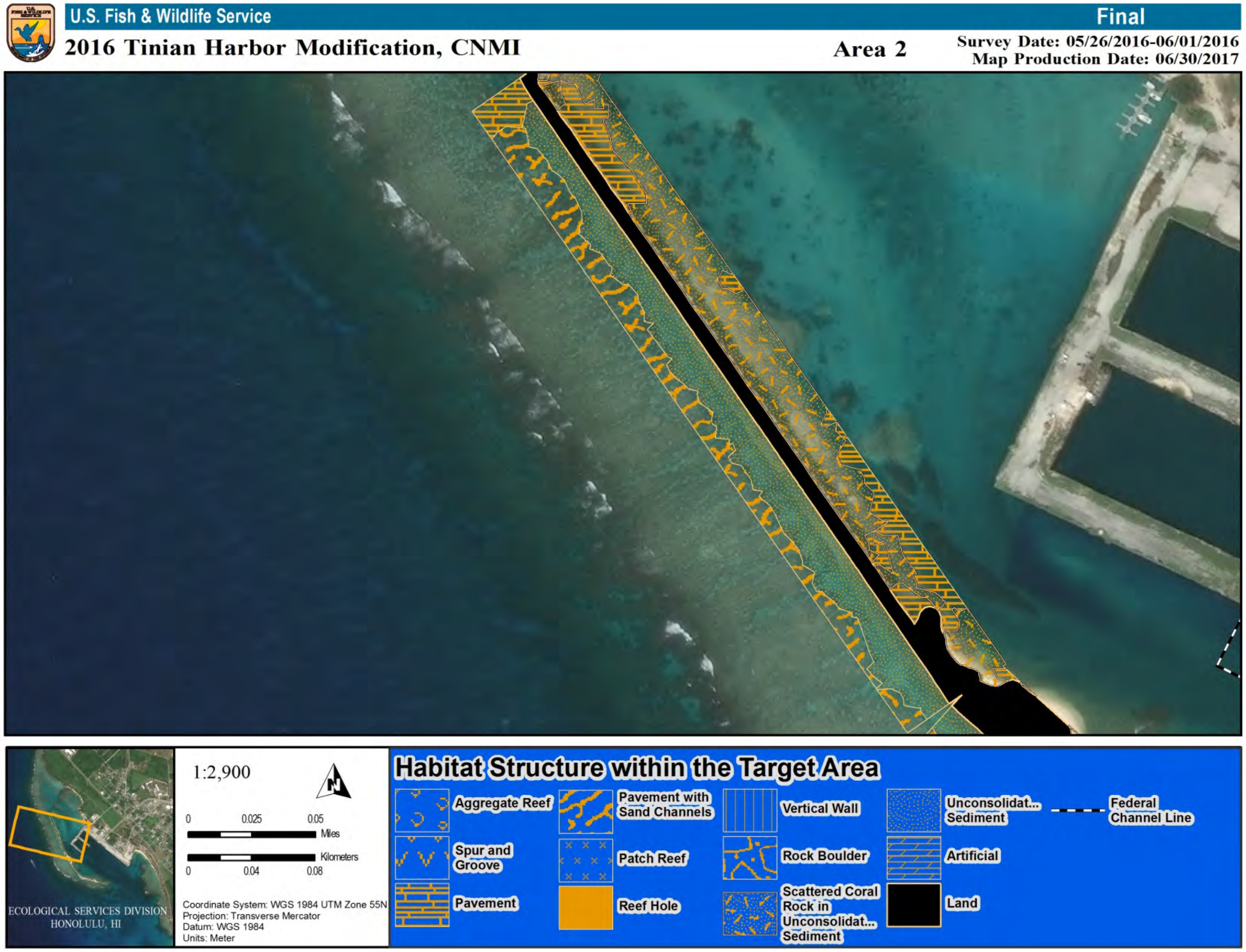

Figure C8: Habitat Structure in Target Area (Area 2). Overview of the habitat structures within the project footprint (Target Area).

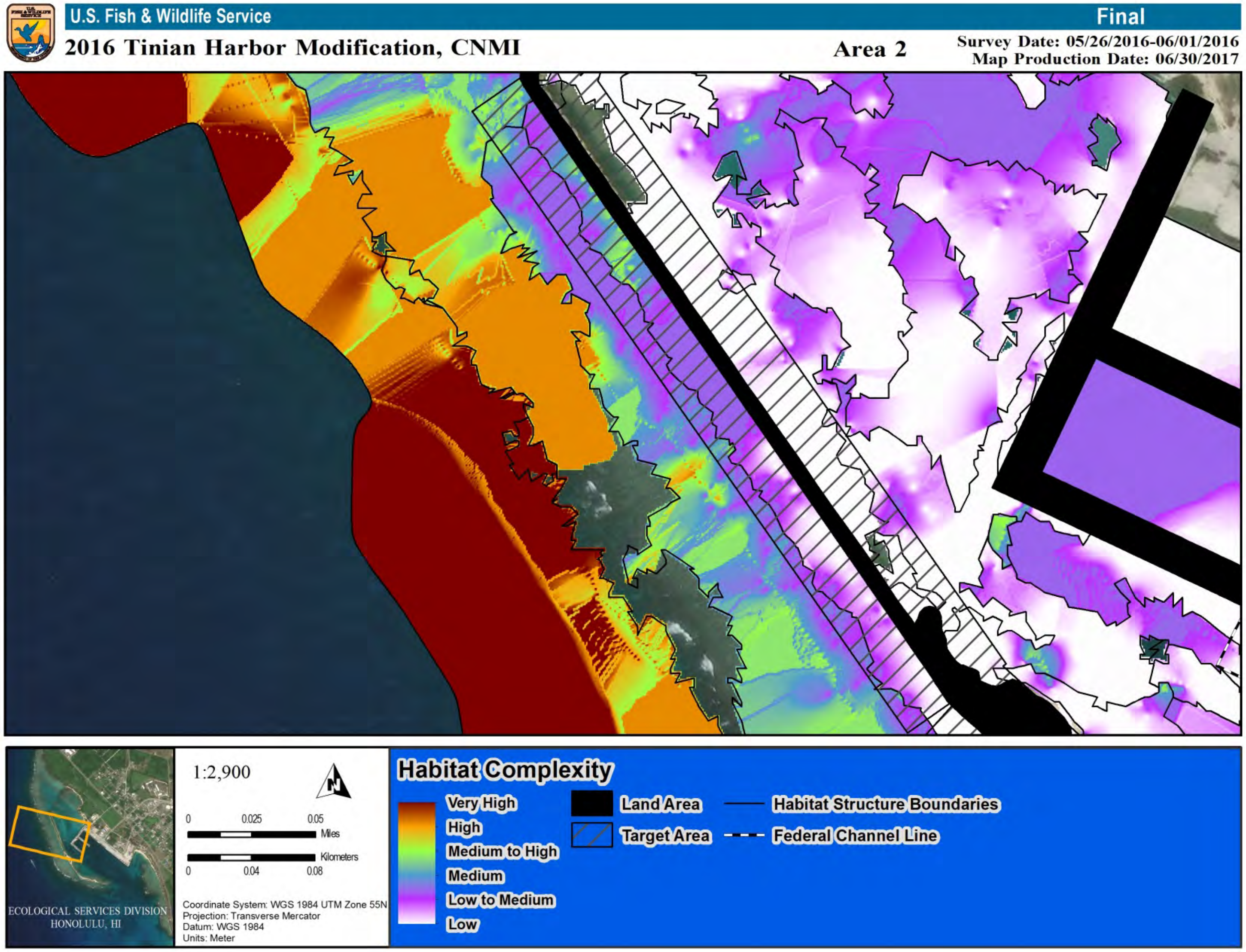

Figure C9: Habitat Complexity (Area 2). Overview of the habitat complexity observed within the project area.

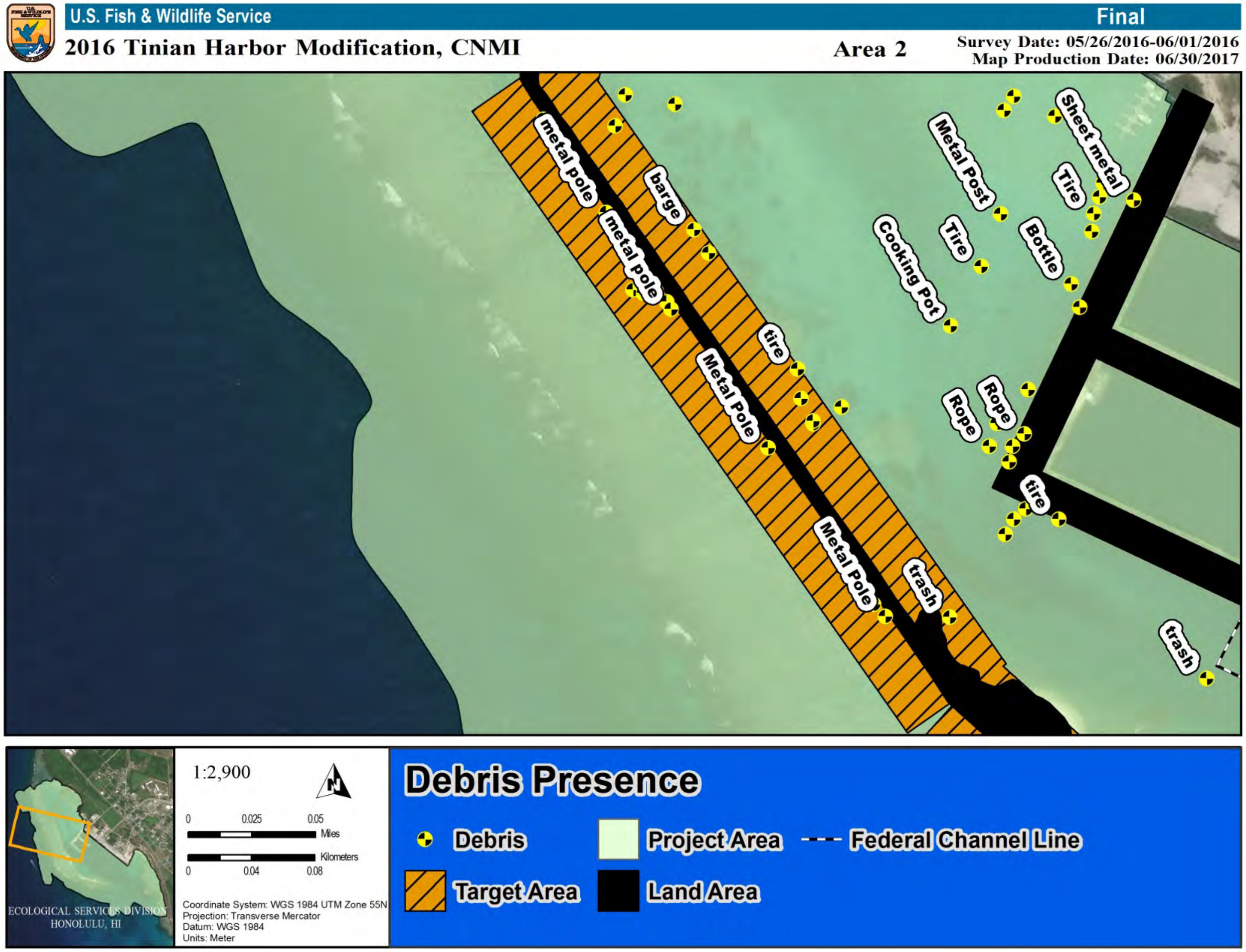

Figure C10: Debris (Area 2). Overview of the debris observed within the project area.

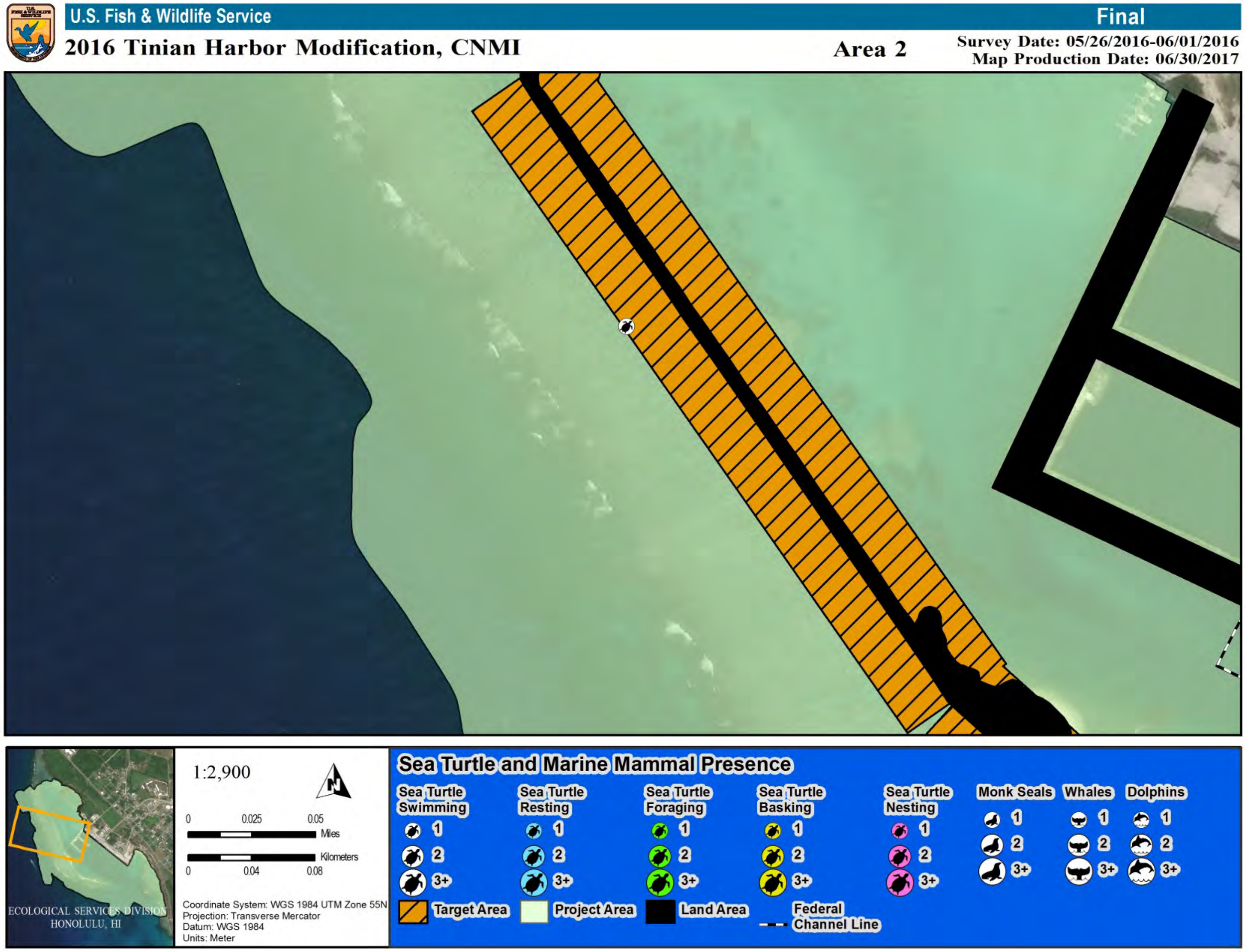

Figure C11: Protected Species (Area 2). Overview of the observed protected species within the project area.

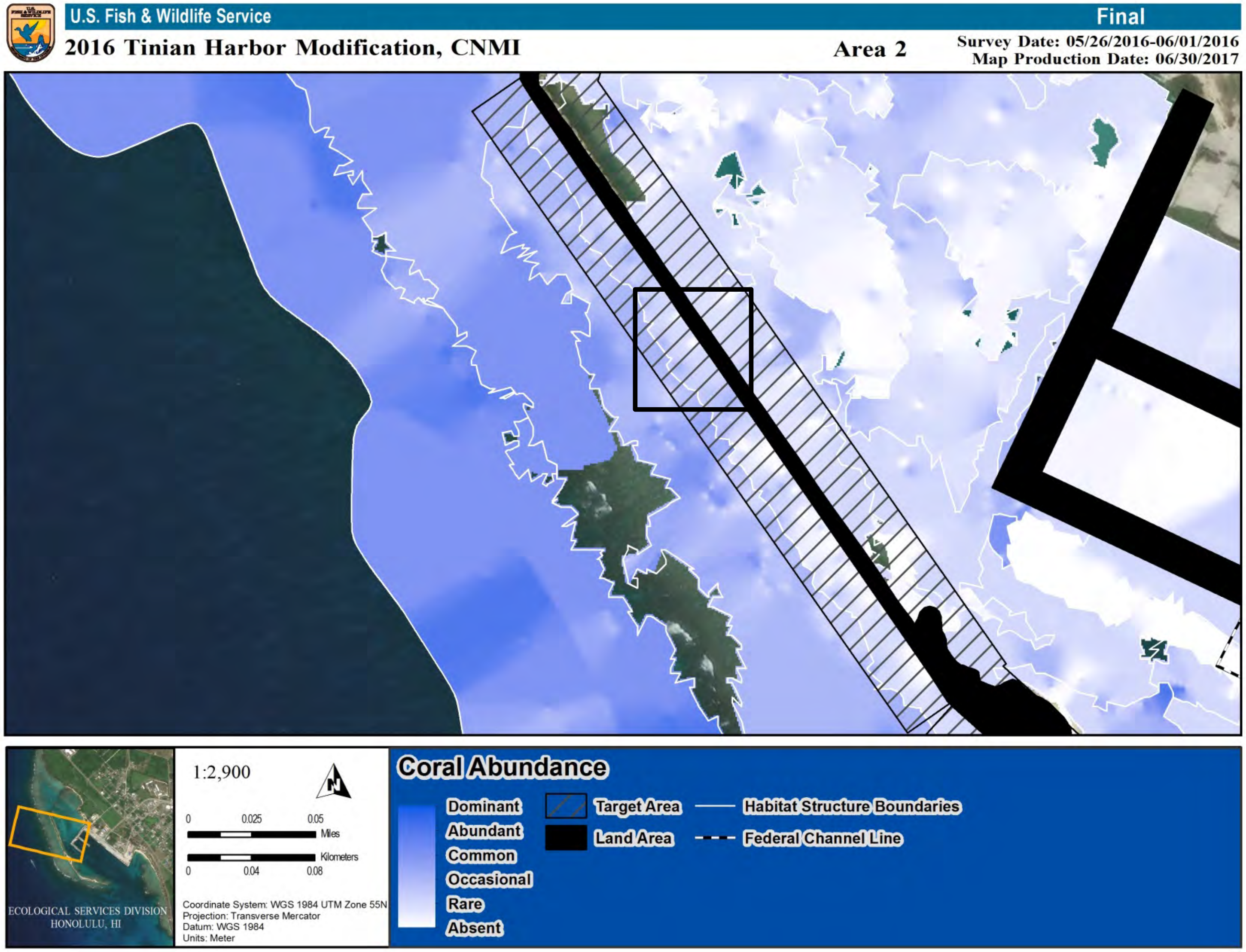

Figure C12: Coral Abundance (Area 2). Overview of the coral abundance within the project.

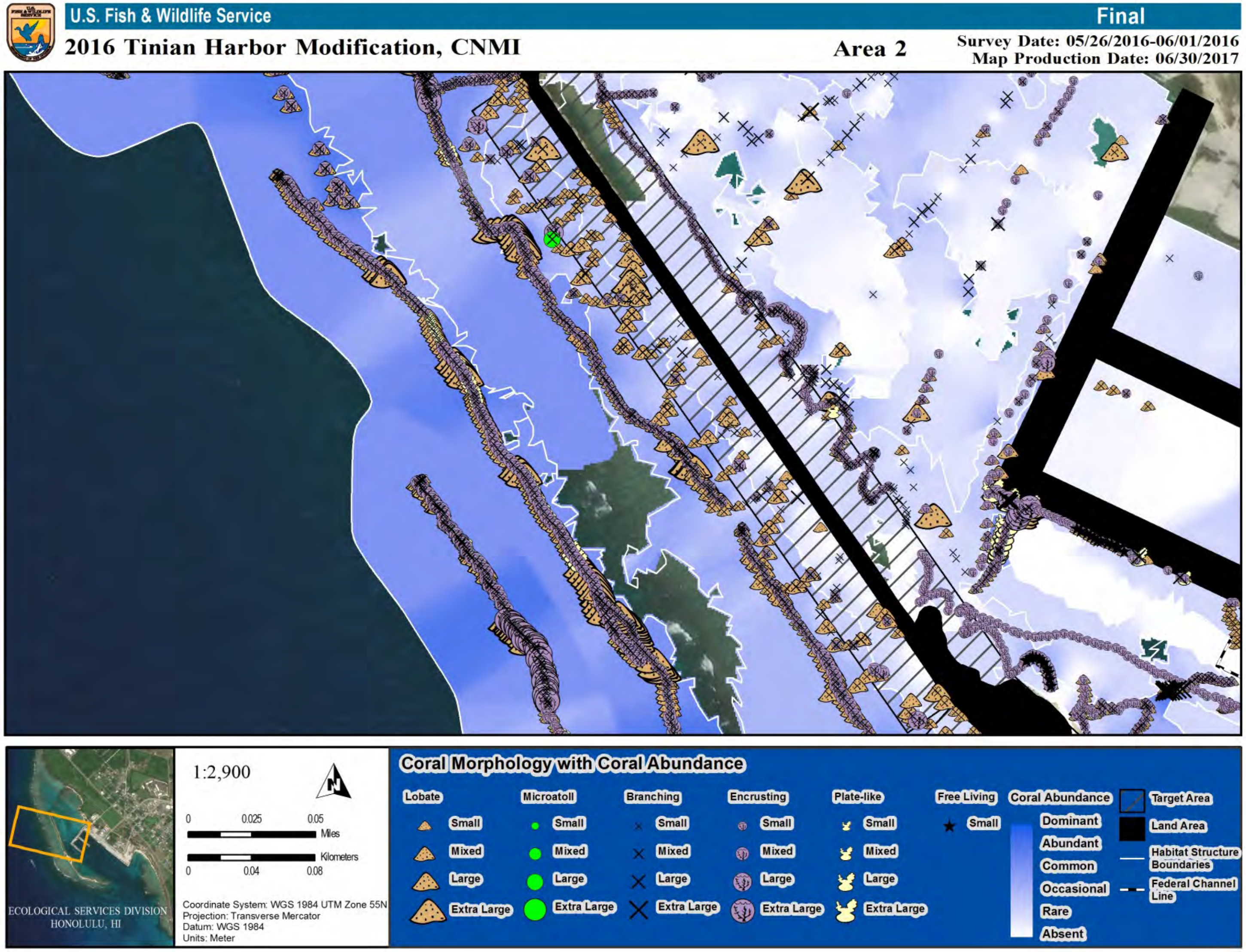

Figure C13: Coral Morphologies (Area 2). Overview of the various coral morphologies and broad coral sizes observed within the project area.

Figure C14: ESA-listed Corals (Area 2). Overview of the ESA-listed coral species observed within the project area.

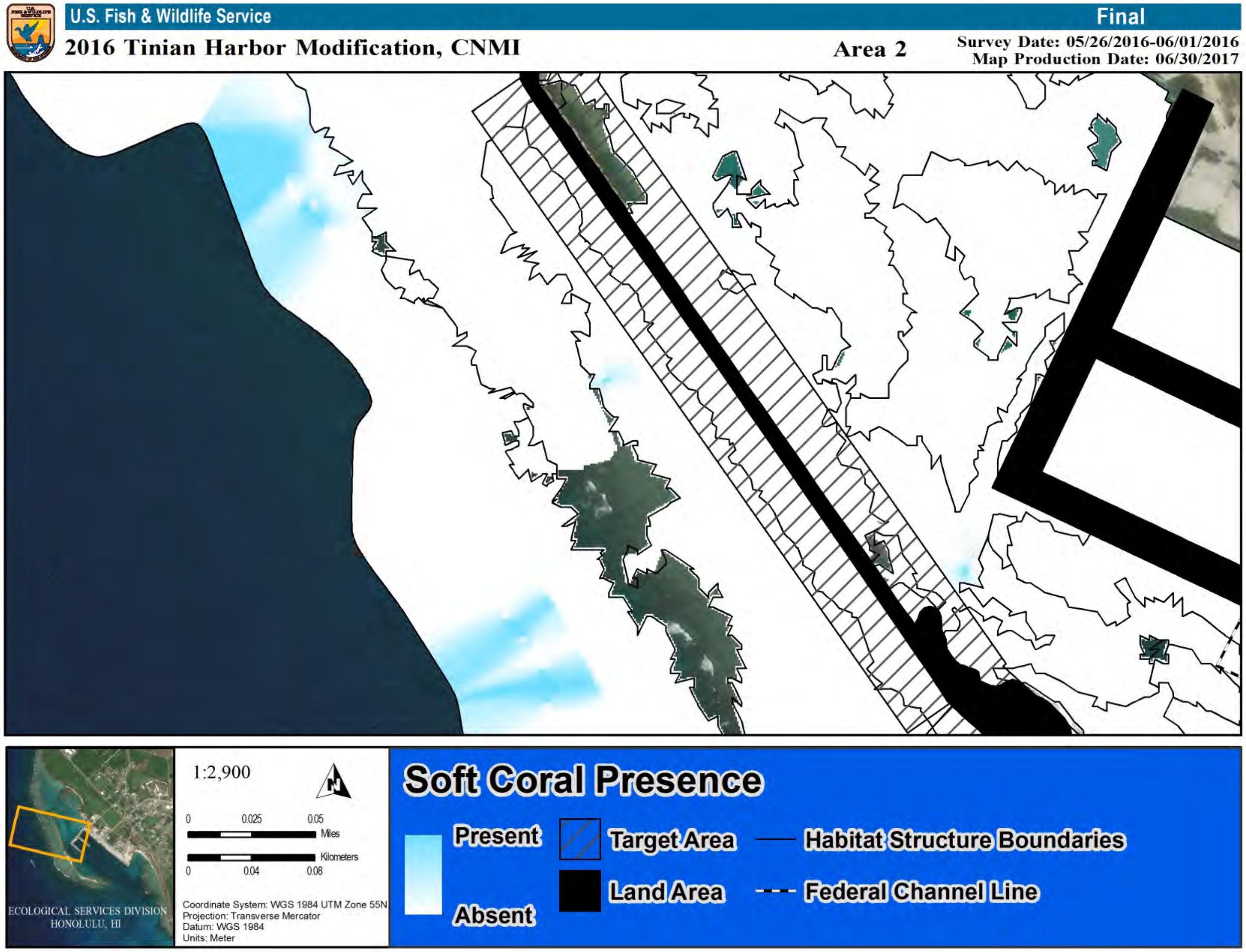

Figure C15: Soft Coral Presence (Area 2). Overview of the soft coral presence within the project area.

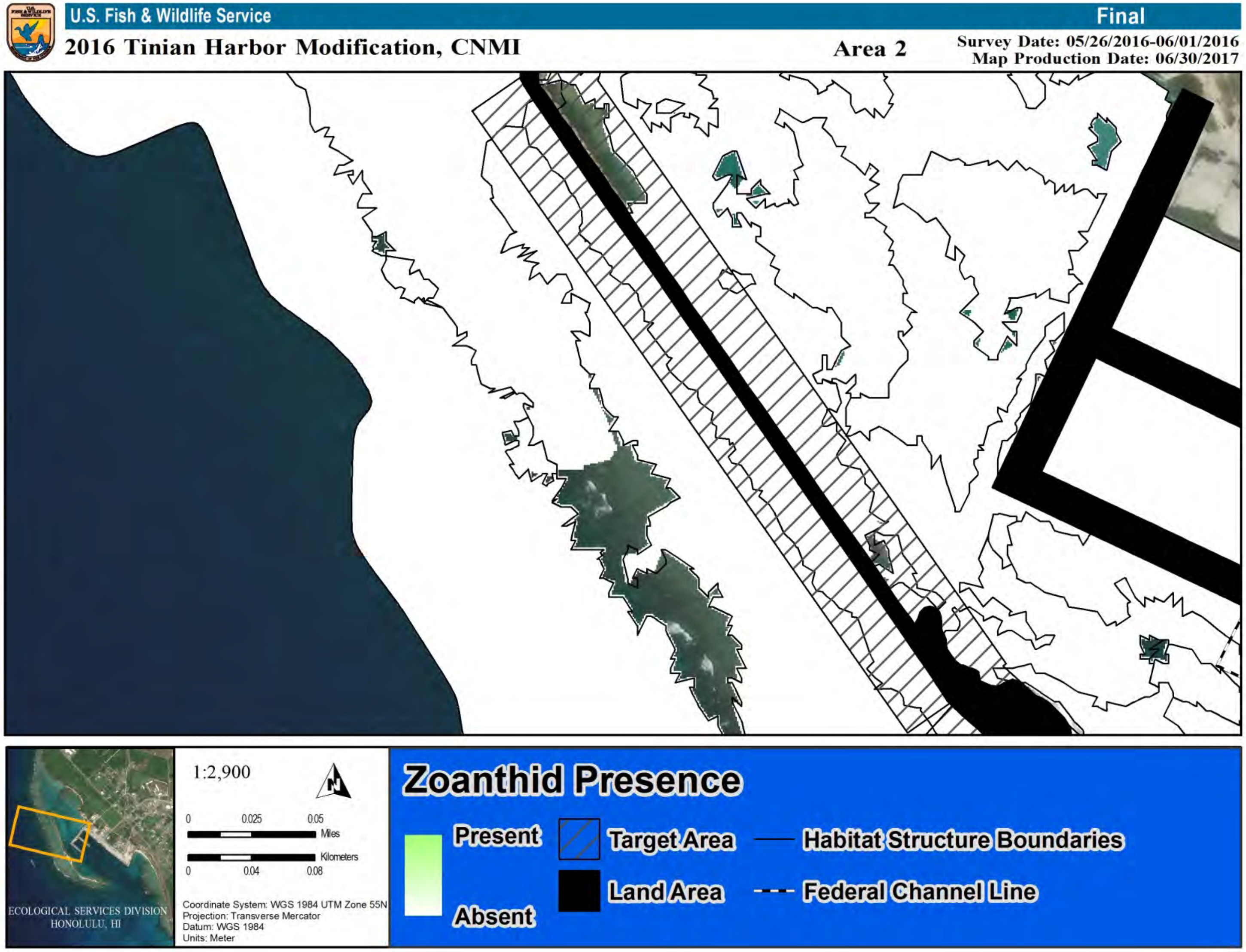

Figure C16: Zonathid Presence (Area 2). Overview of the zoanthid (relative to corals) presence within the project area. Note: No zoanthids were observed in this area.

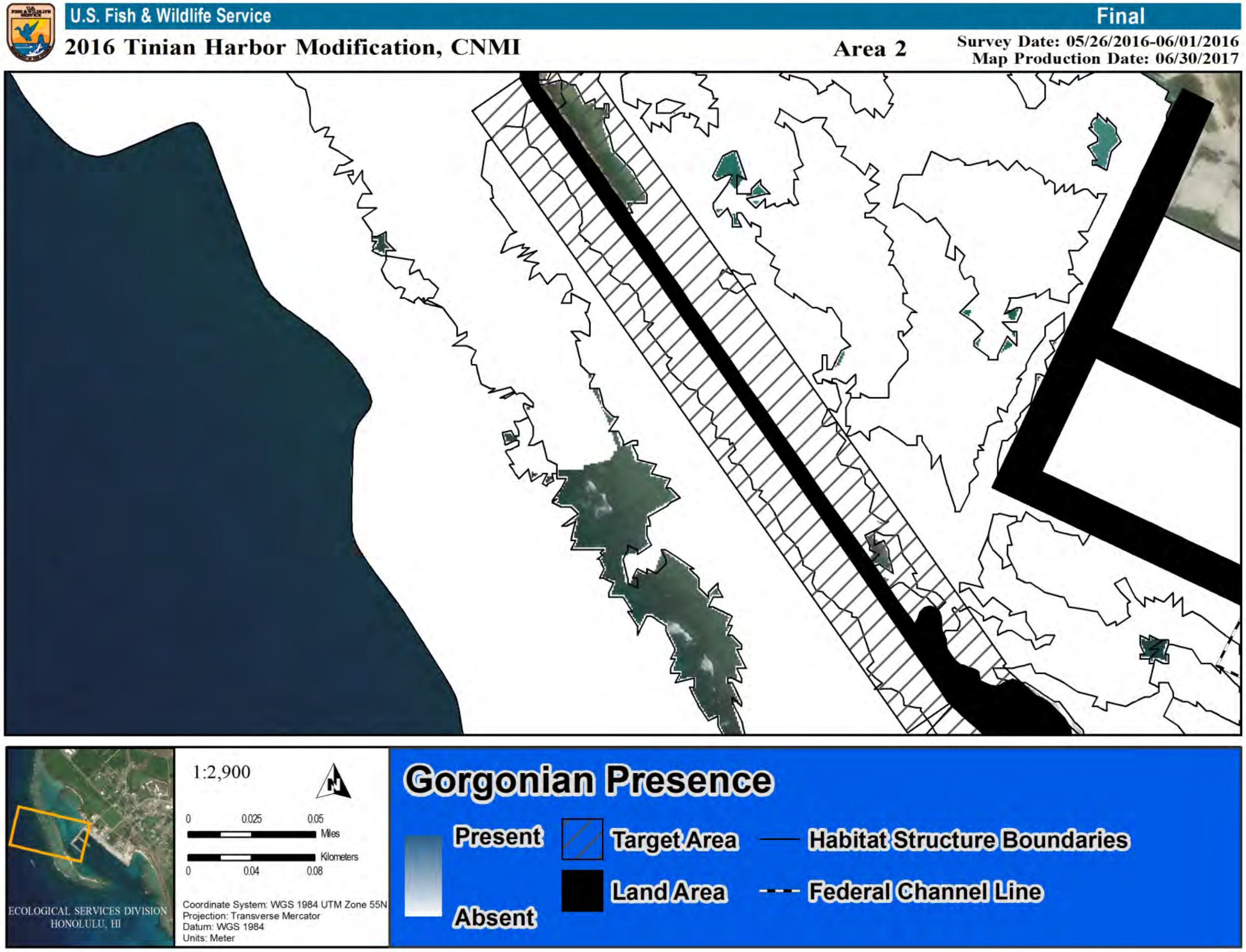

Figure C17: Gorgonian Presence (Area 2). Overview of the gorgonian coral presence within the project area. Note: No gorgonians were observed in this area.

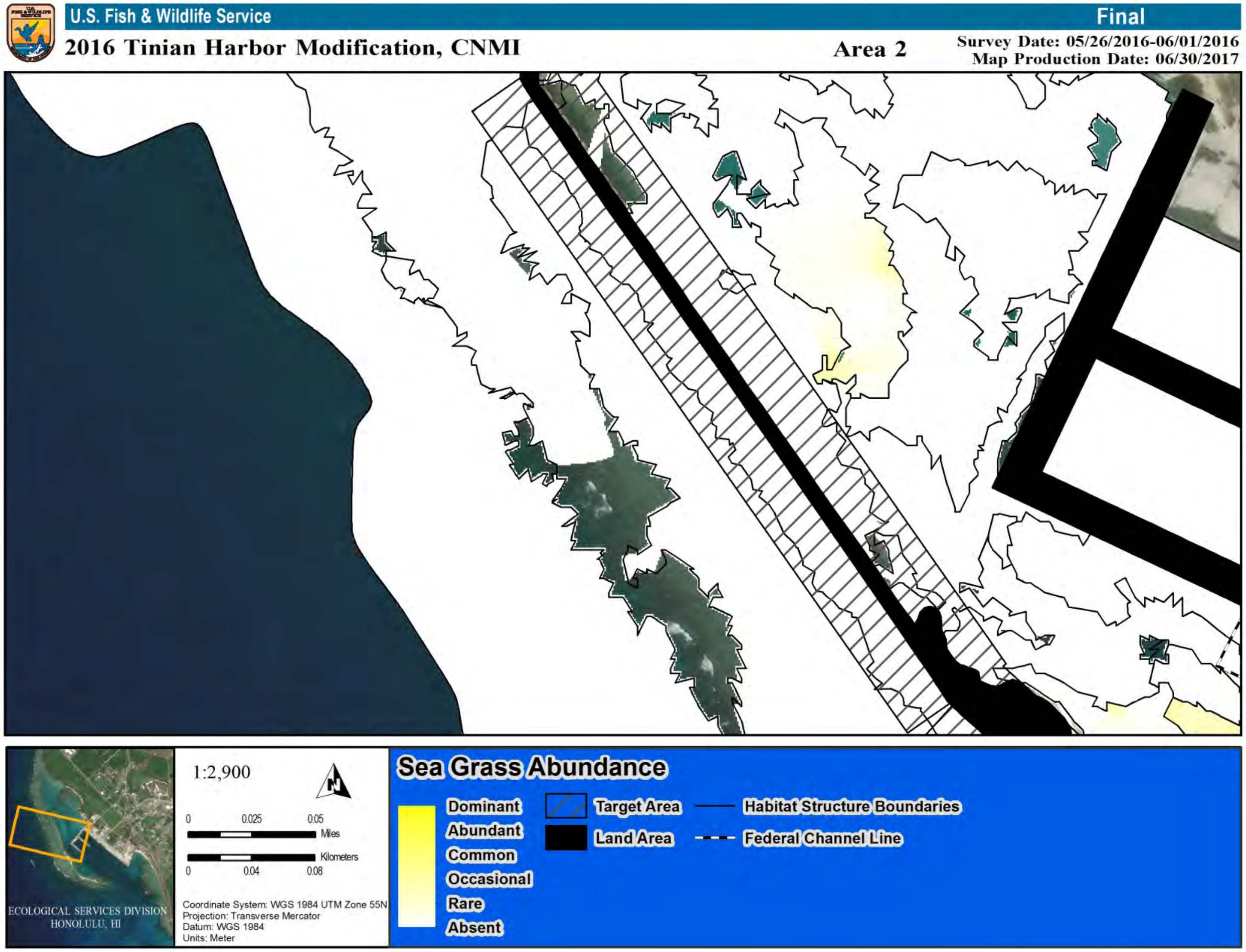

Figure C18: Sea Grass Abundance (Area 2). Overview of the seagrass abundance within the project area.

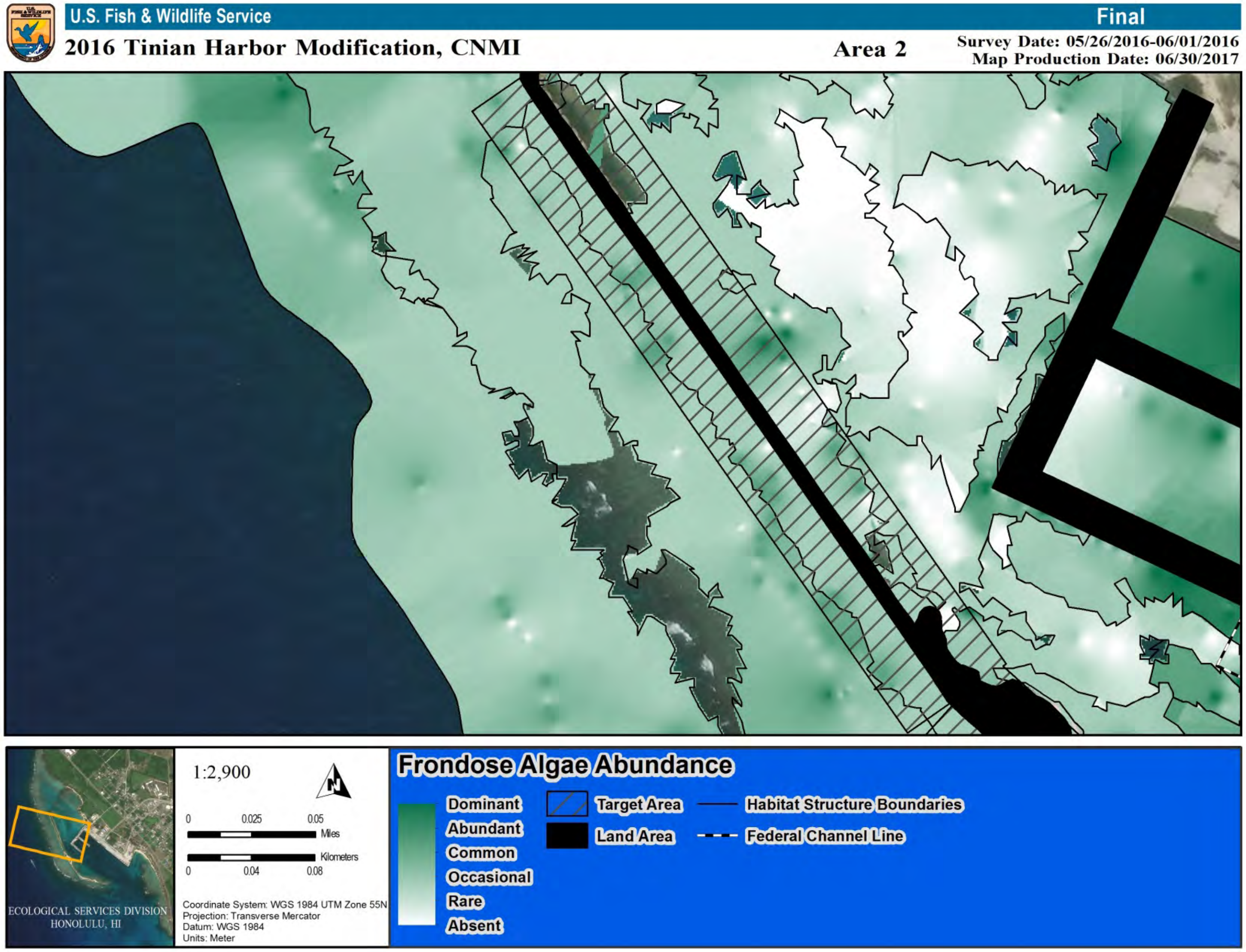

Figure C19: Frondose Algae Abundance (Area 2). Overview of the frondose algae (macroalgae) abundance observed within the project area.

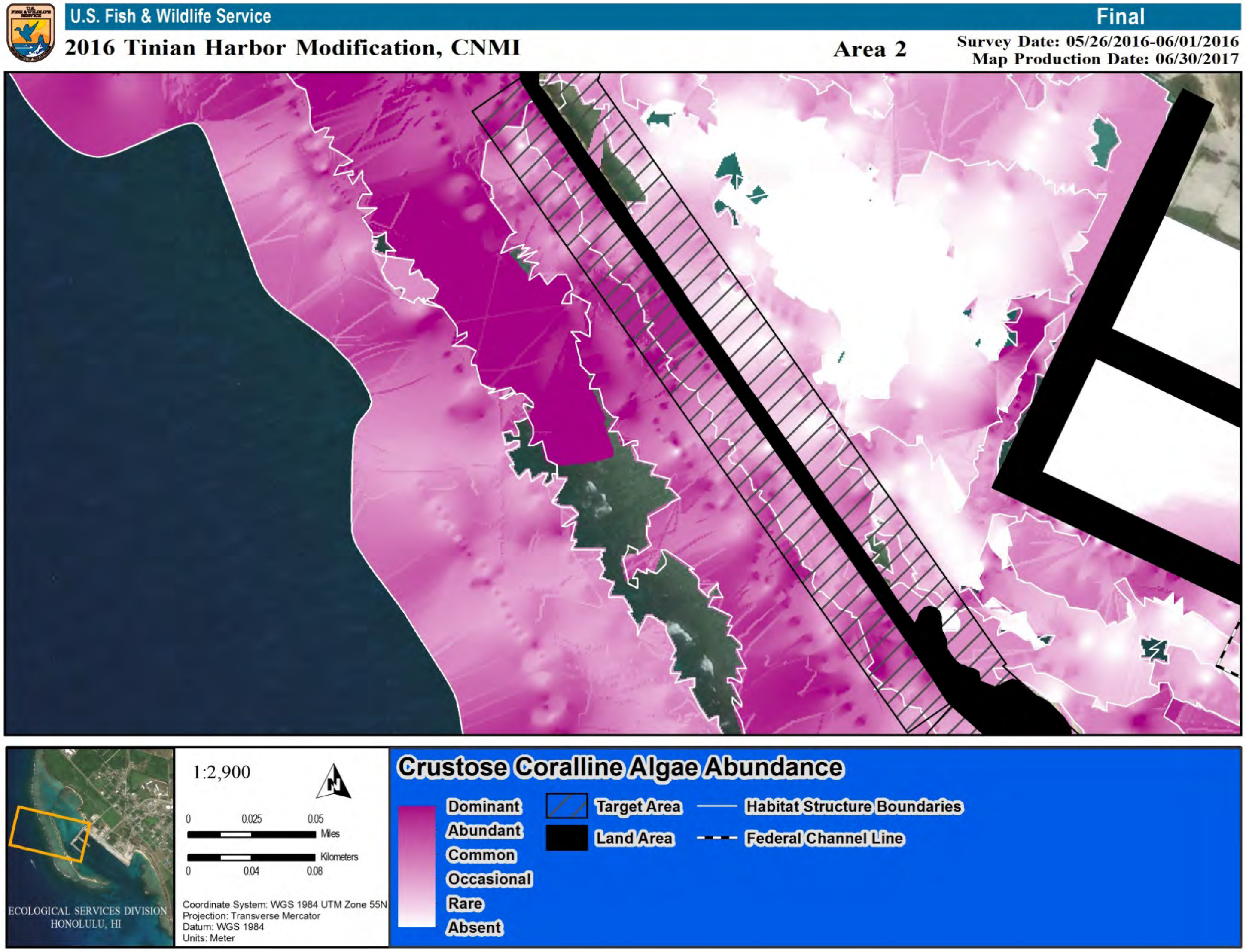

Figure C20: CCA Abundance (Area 2). Overview of the crustose coralline algae abundance observed within the project area.

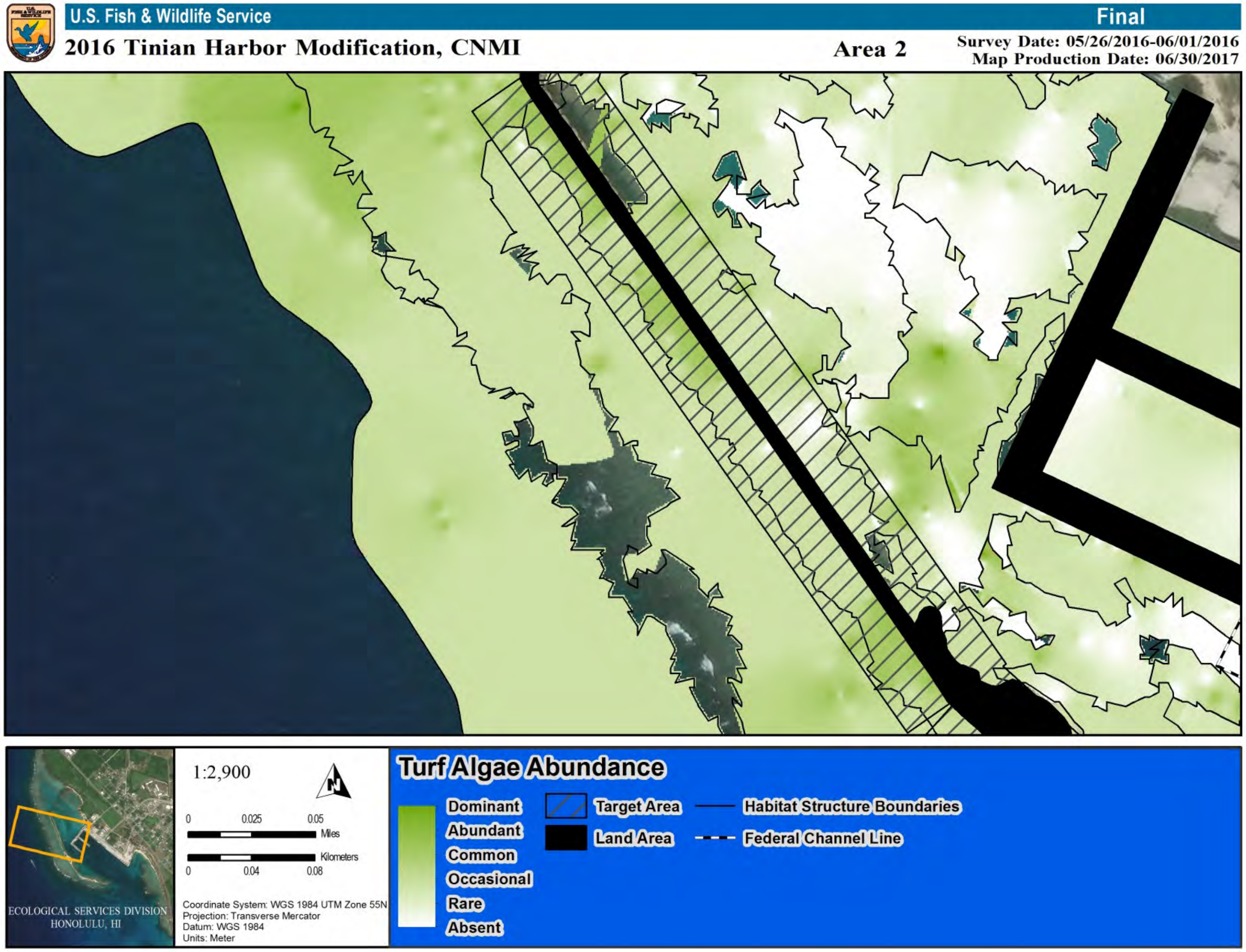

Figure C21: Turf Algae Abundance (Area 2). Overview of the turf algae abundance observed within the project area.

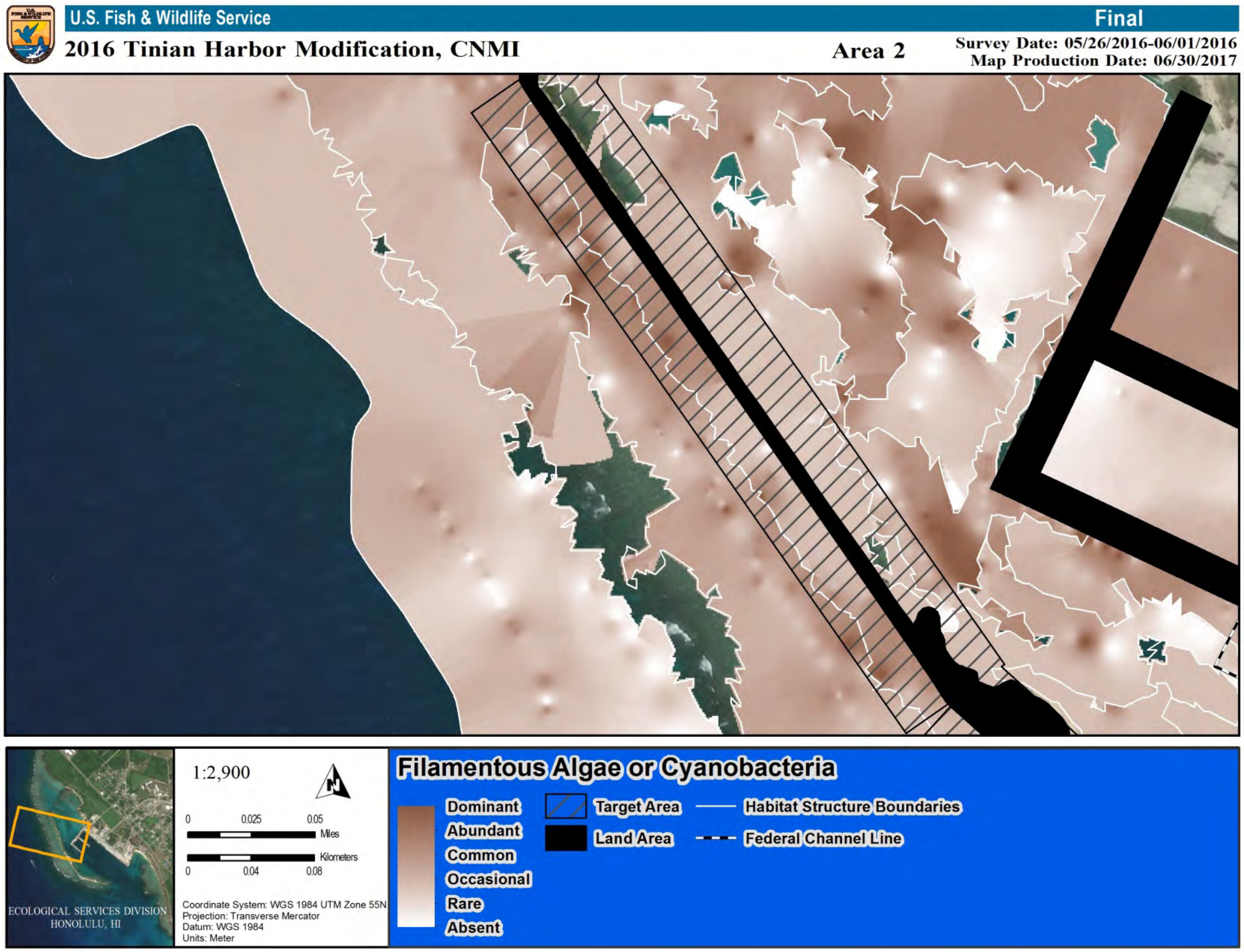

Figure C22: Filamentous Algae (Area 2). Overview of the filamentous algae and cyanobacteria abundance observed within the project area.

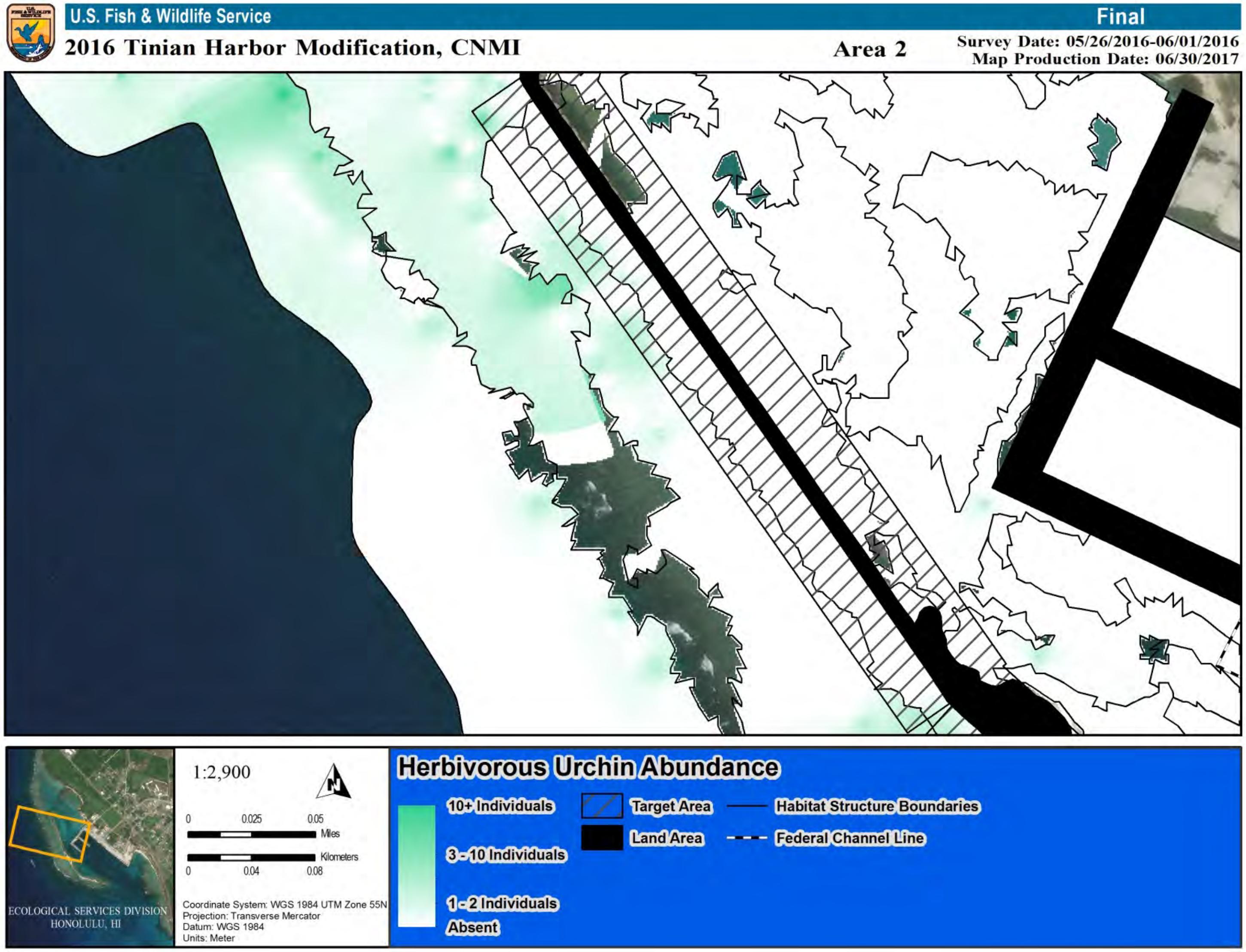

Figure C23: Herbivorous Urchin Abundance (Area 2). Overview of the herbivorous urchin abundance observed within the project area.

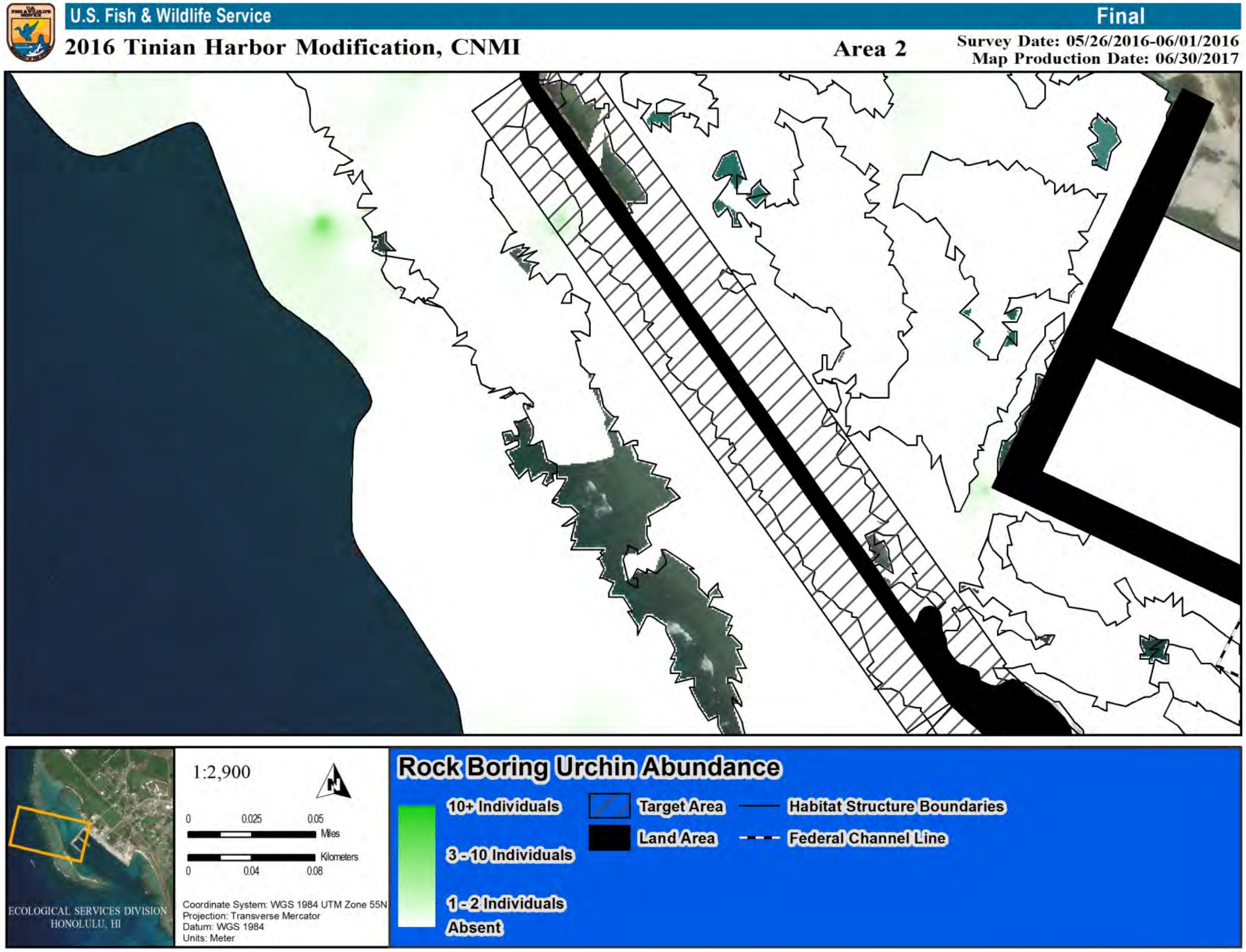

Figure C24: Rock Boring Urchin Abundance (Area 2). Overview of the rock boring urchin abundance observed within the project area.

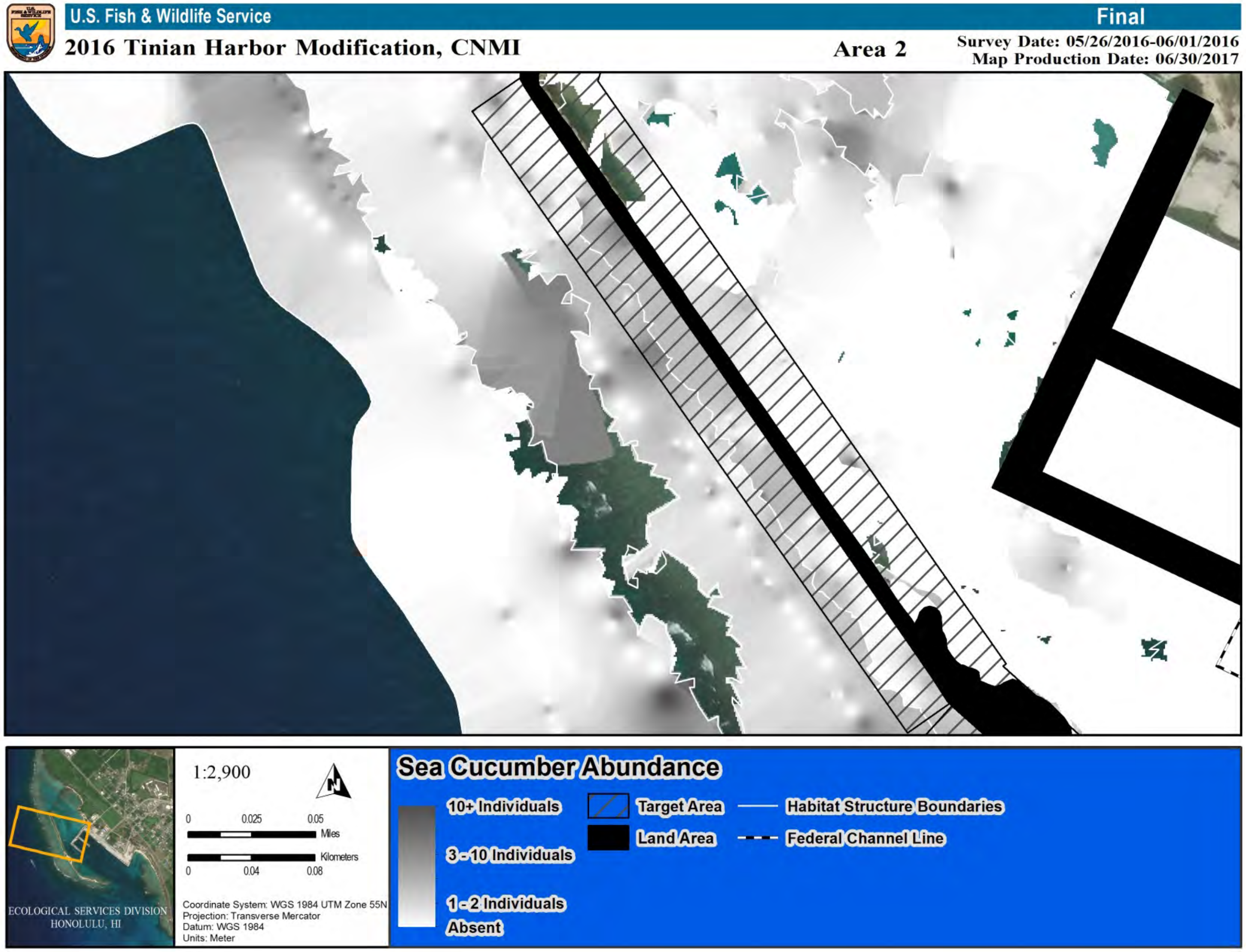

Figure C25: Sea Cucumber Abundance (Area 2). Overview of the sea cucumber abundance observed within the project area.

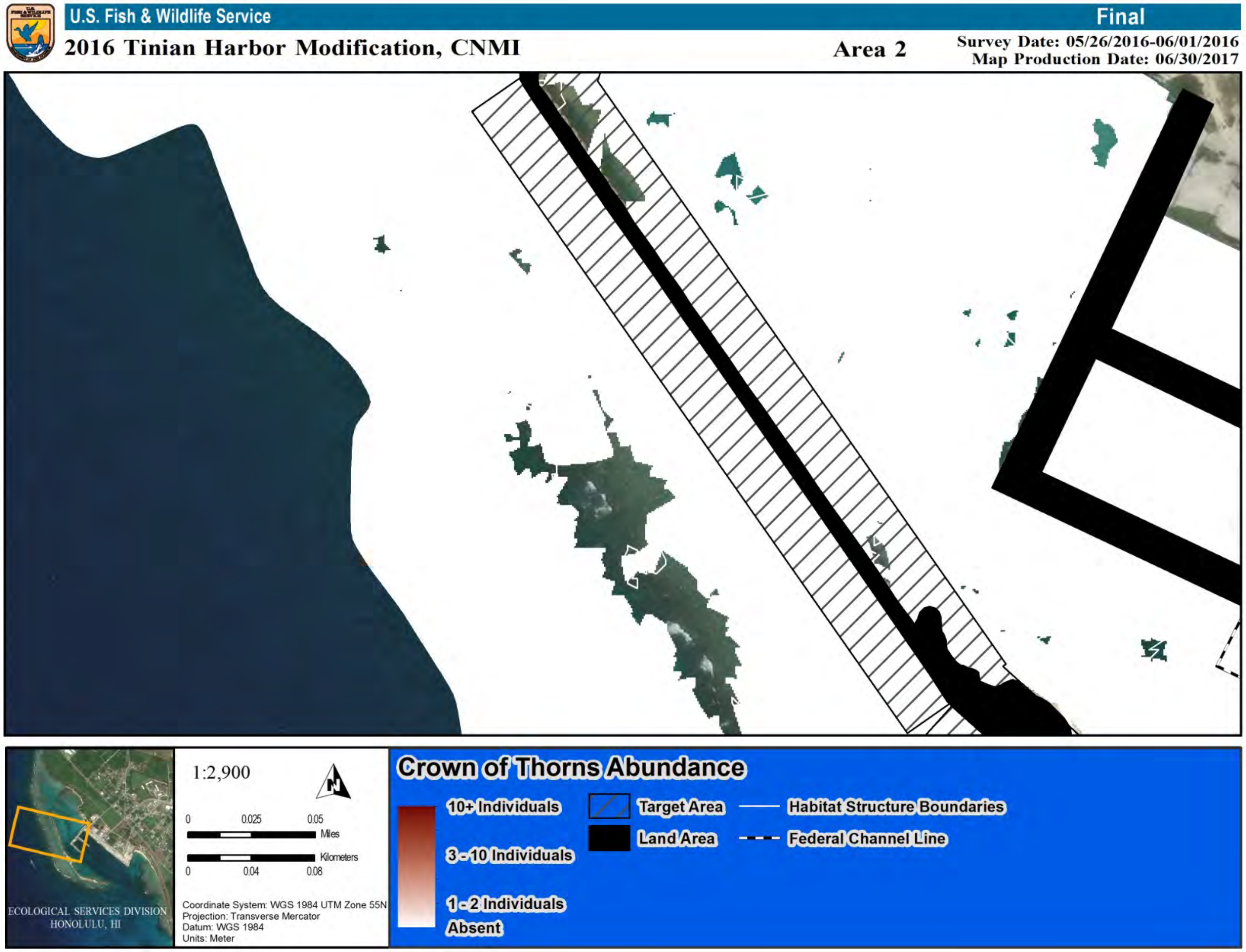

Figure C26: Crown-of-Thorns Abundance (Area 2). Overview of the crown-of-thorn starfish abundance observed within the project area.

Note: No crown-of-thorns were observed in this area.

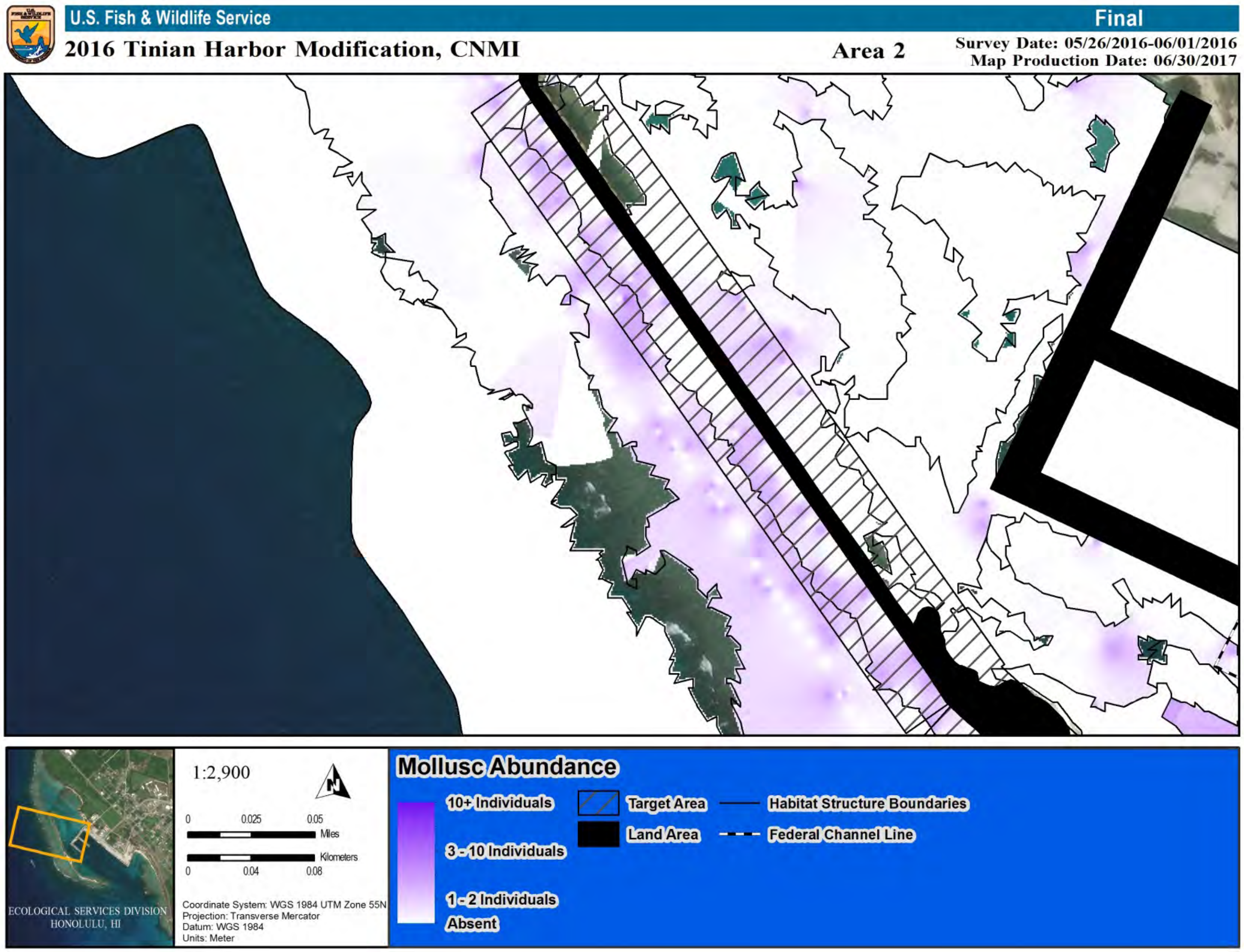

Figure C27: Mollusc Abundance (Area 2). Overview of the mollusc (other than specific species shown in other maps) abundance observed within the project area.

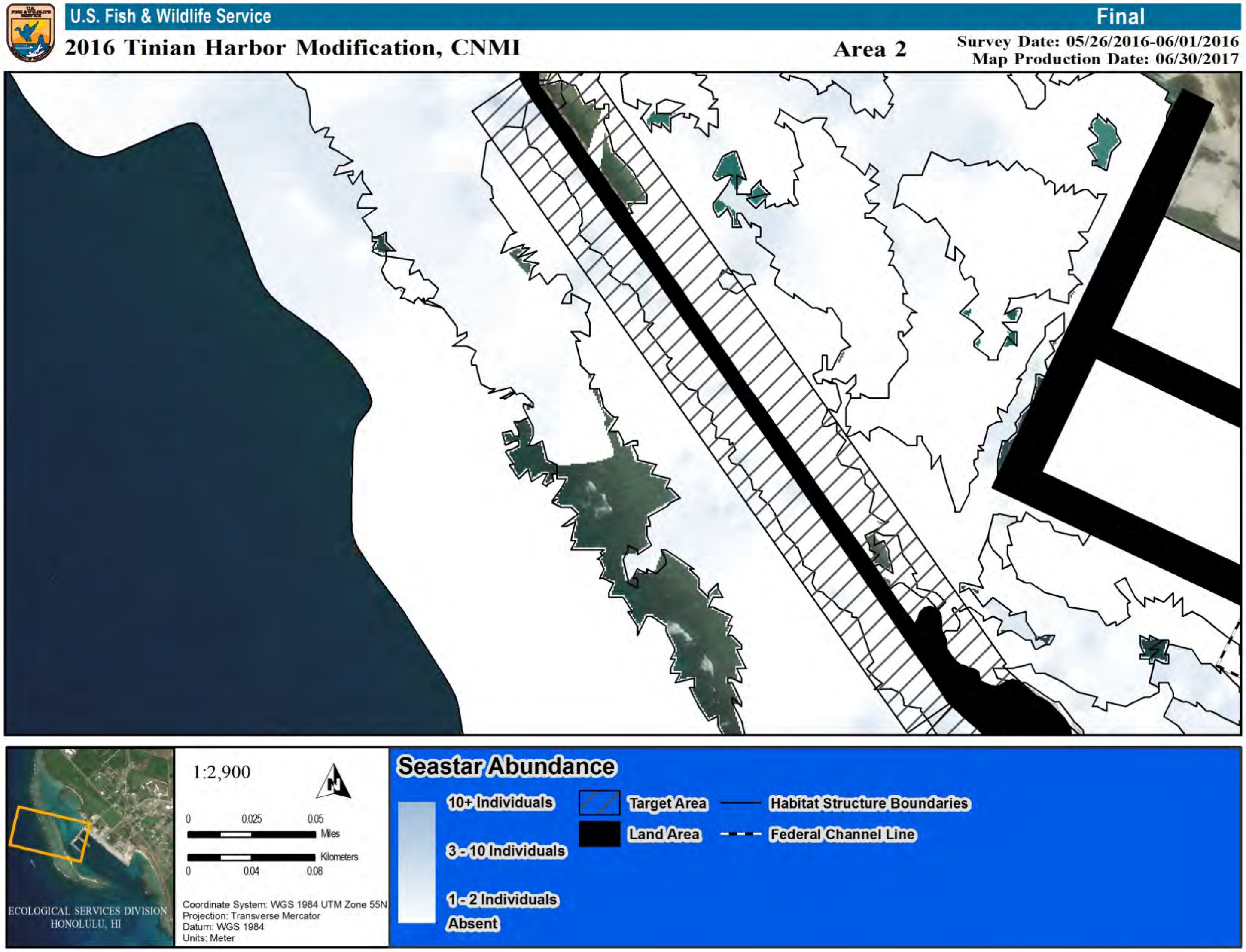

Figure C28: Seastar Abundance (Area 2). Overview of the seastar abundance observed within the project area.

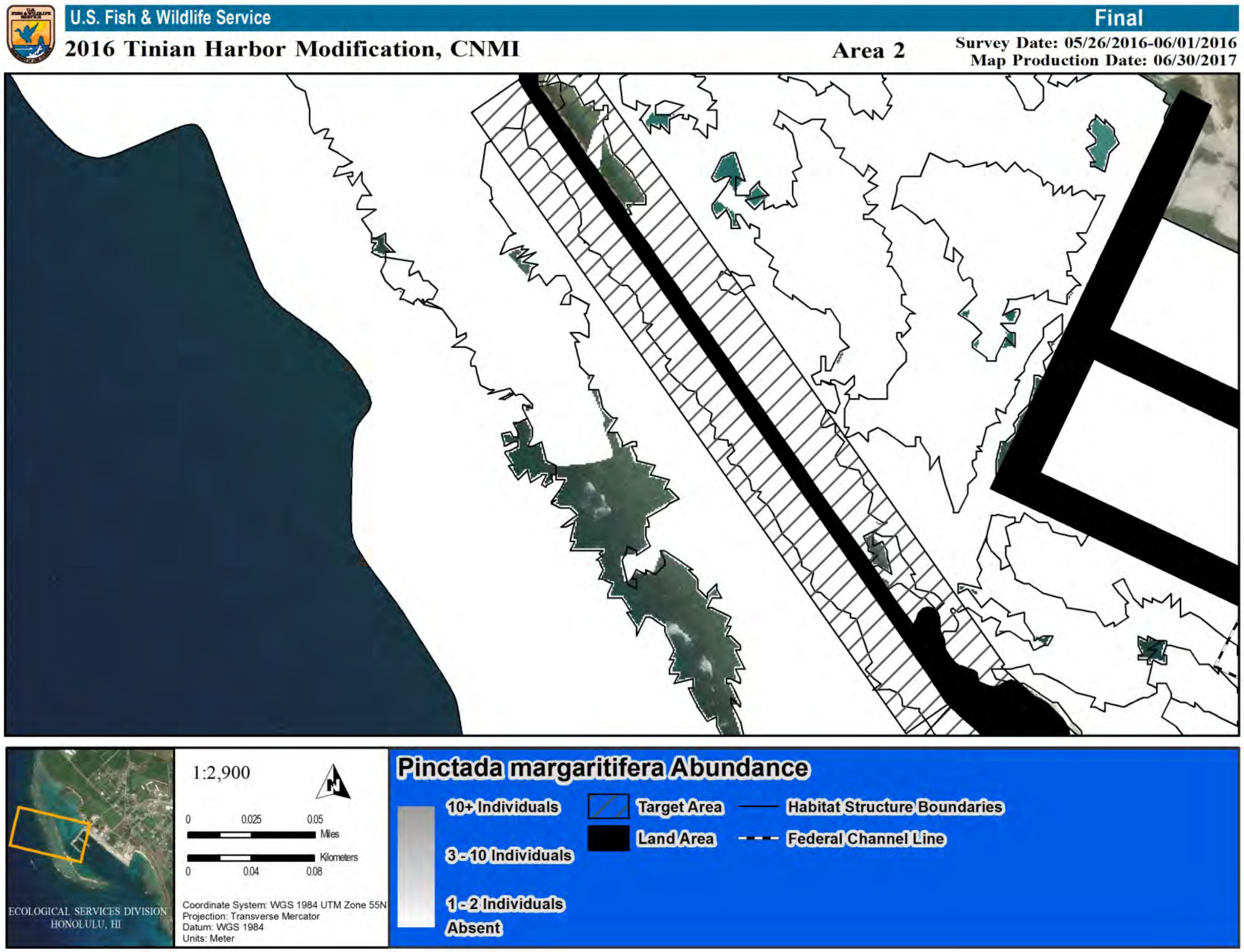

Figure C29: Pinctada Abundance (Area 2). Overview of the mollusc, Pinctada margaritifera, abundance observed within the project area.

Note: No Pinctada margaritifera were observed in this area.

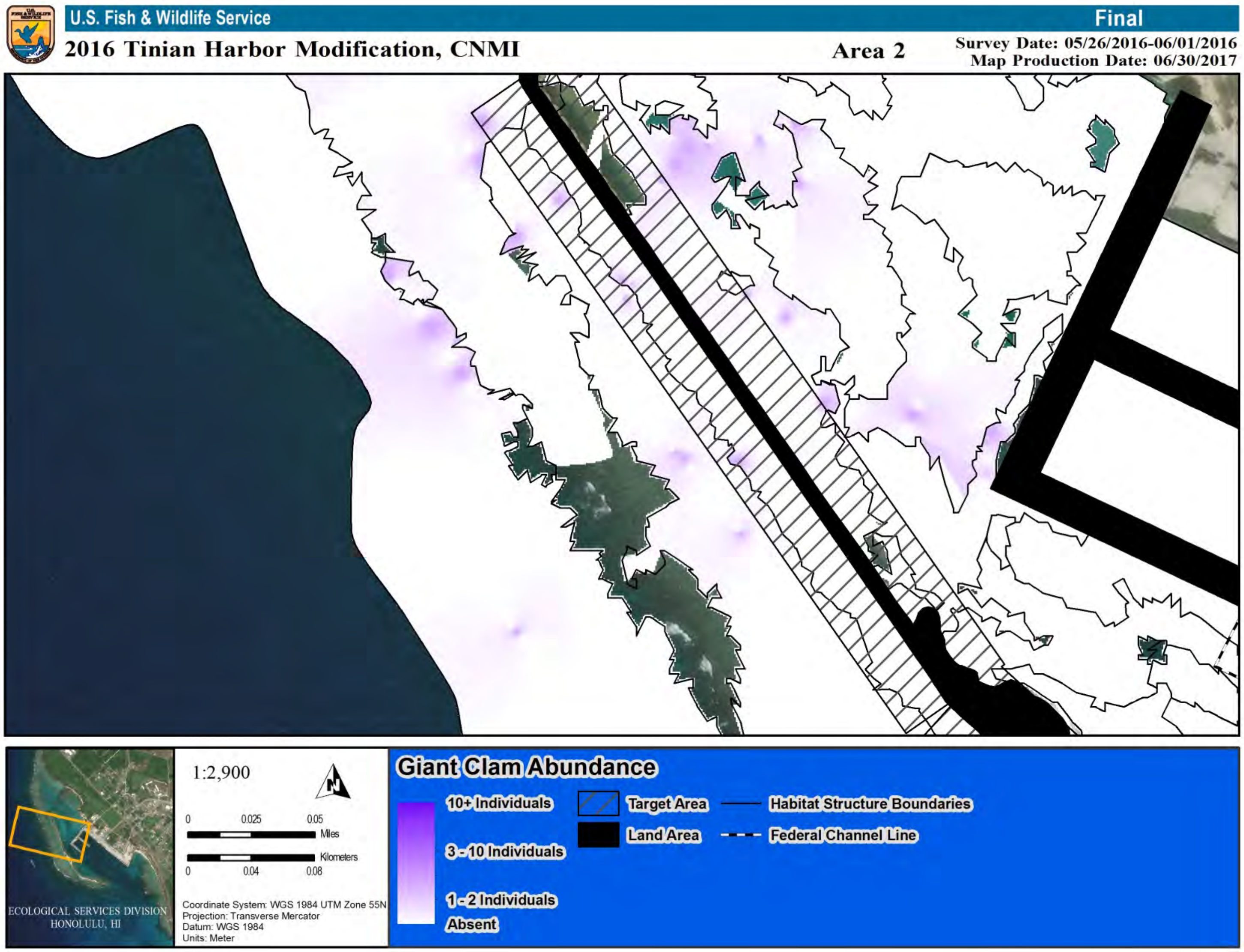

Figure C30: Giant Clam Abundance (Area 2). Overview of the giant clam abundance observed within the project area.

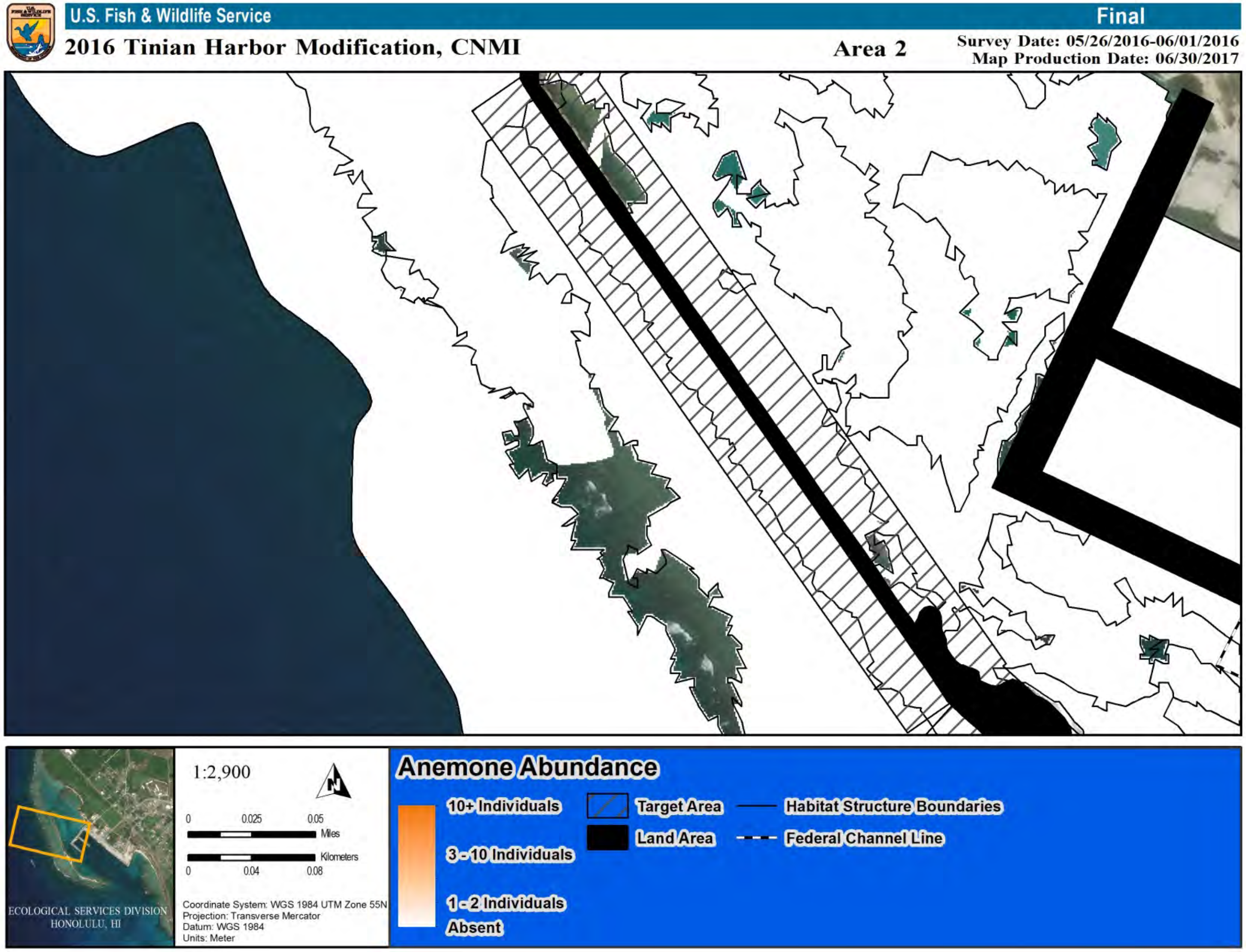

Figure C31: Anemone Abundance (Area 2). Overview of the anemone abundance observed within the project area. Note: No anemones were observed in this area.

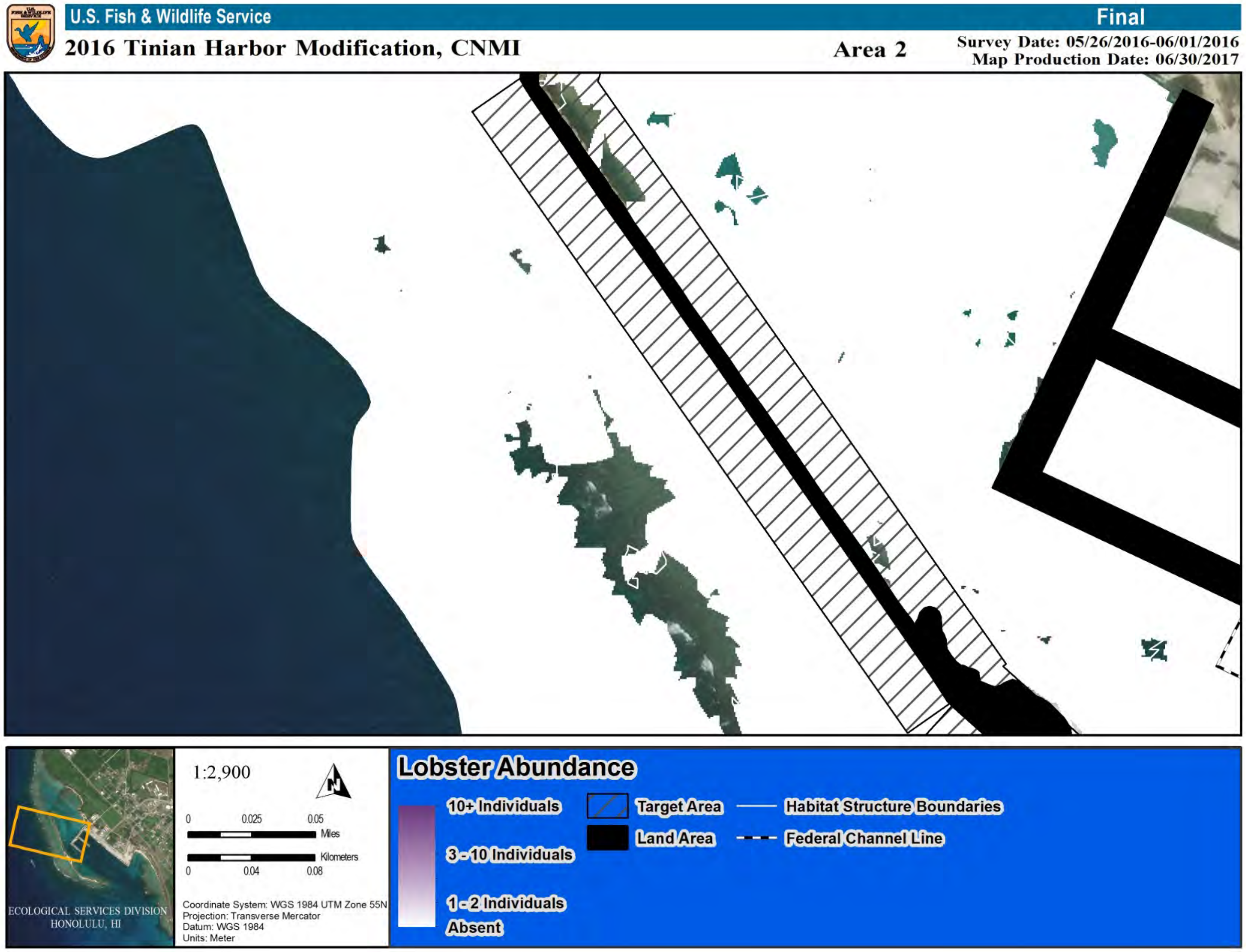

Figure C32: Lobster Abundance (Area 2). Overview of the lobster abundance observed within the project area.

Note: No lobsters were observed in this area.

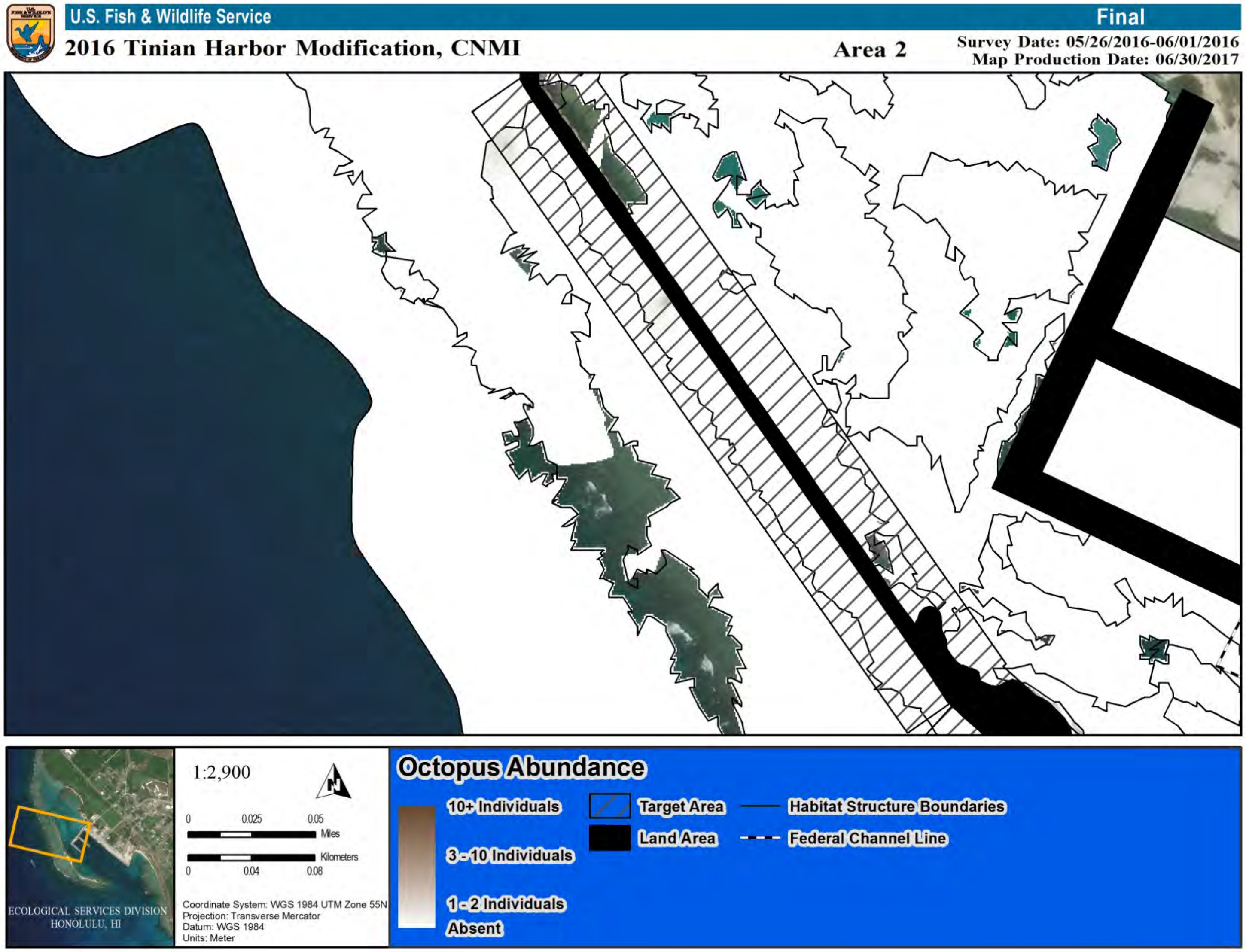

Figure C33: Octopus Abundance (Area 2). Overview of the octopus abundance observed within the project area.

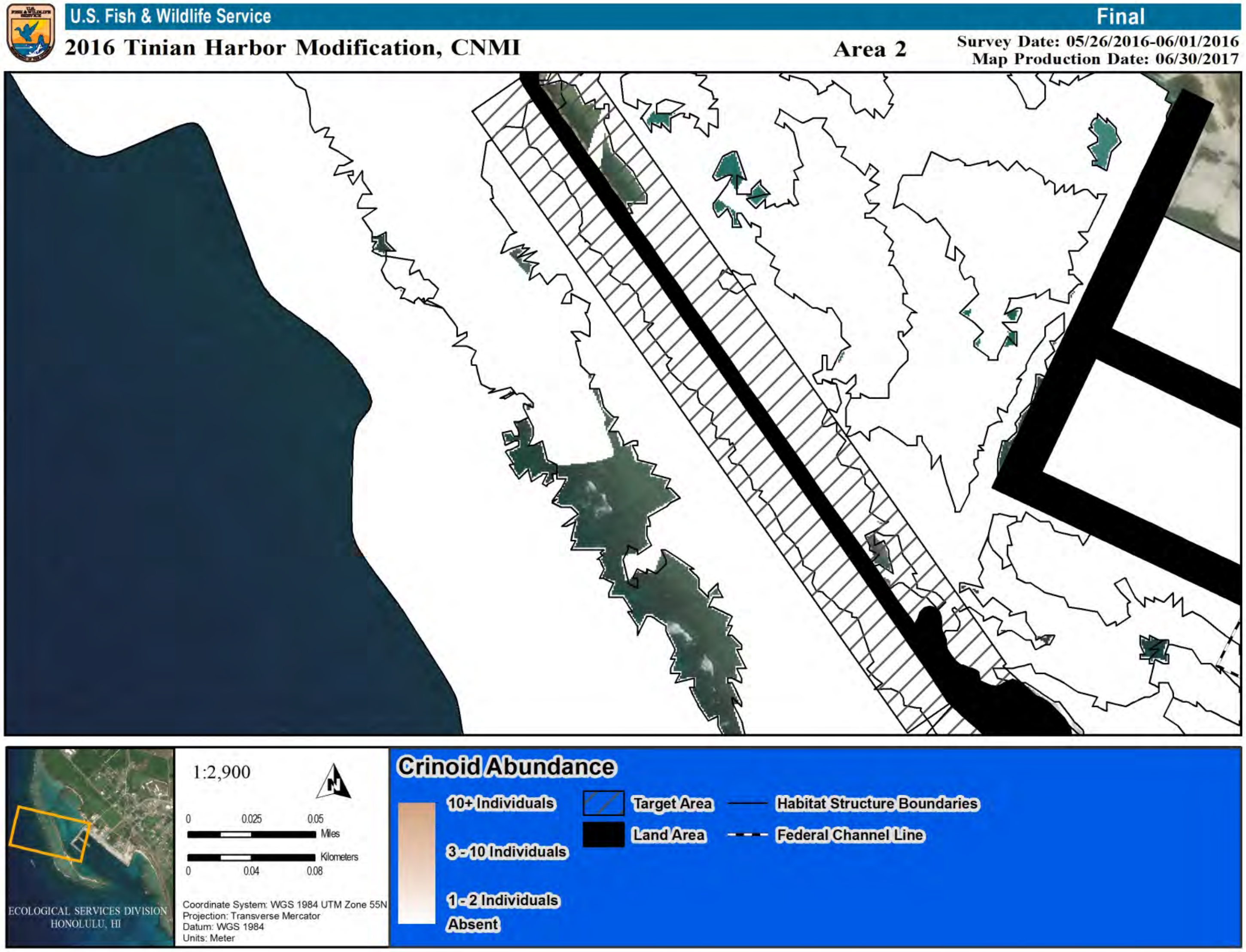

Figure C34: Crinoid Abundance (Area 2). Overview of the crinoid abundance observed within the project area. Note: No crinoids were observed in this area.

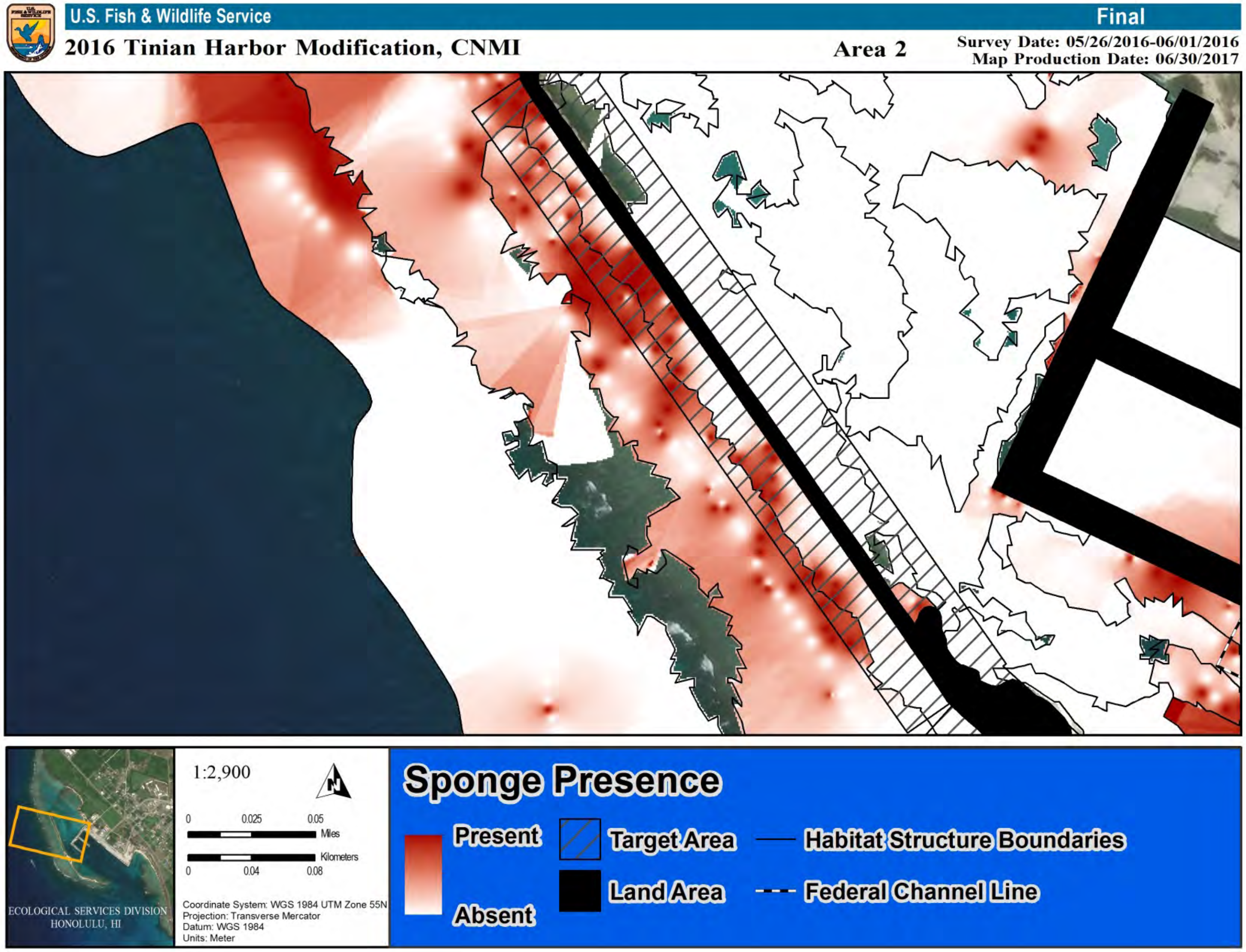

Figure C35: Sponge Presence (Area 2). Overview of the sponge presence observed within the project area.

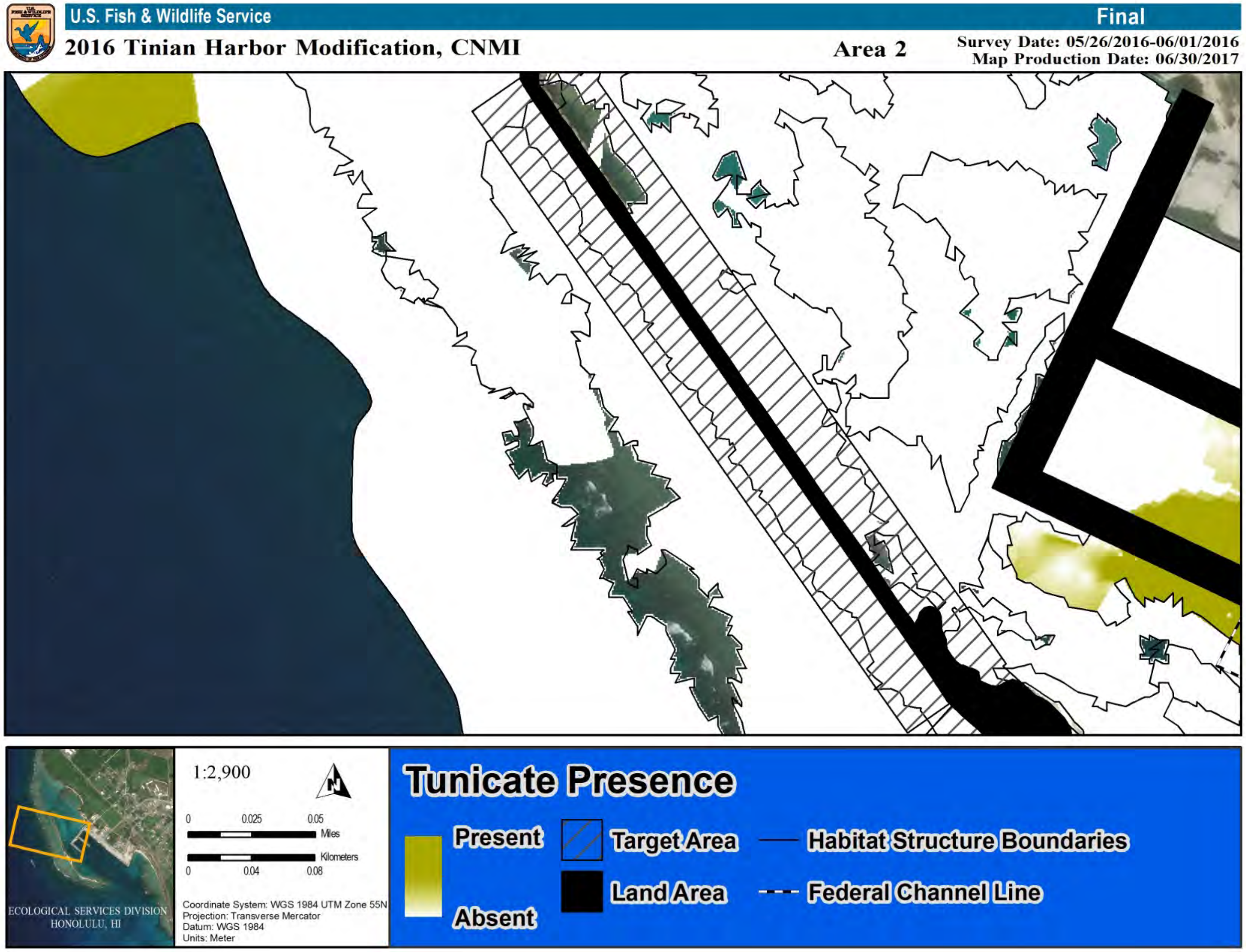

Figure C36: Tunicate Presence (Area 2). Overview of the tunicate presence observed within the project area.

APPENDIX D: Maps of Tinian Harbor Modification Project (Area 3)

Appendix D. Maps of Tinian Harbor Modification Project (Area 3).

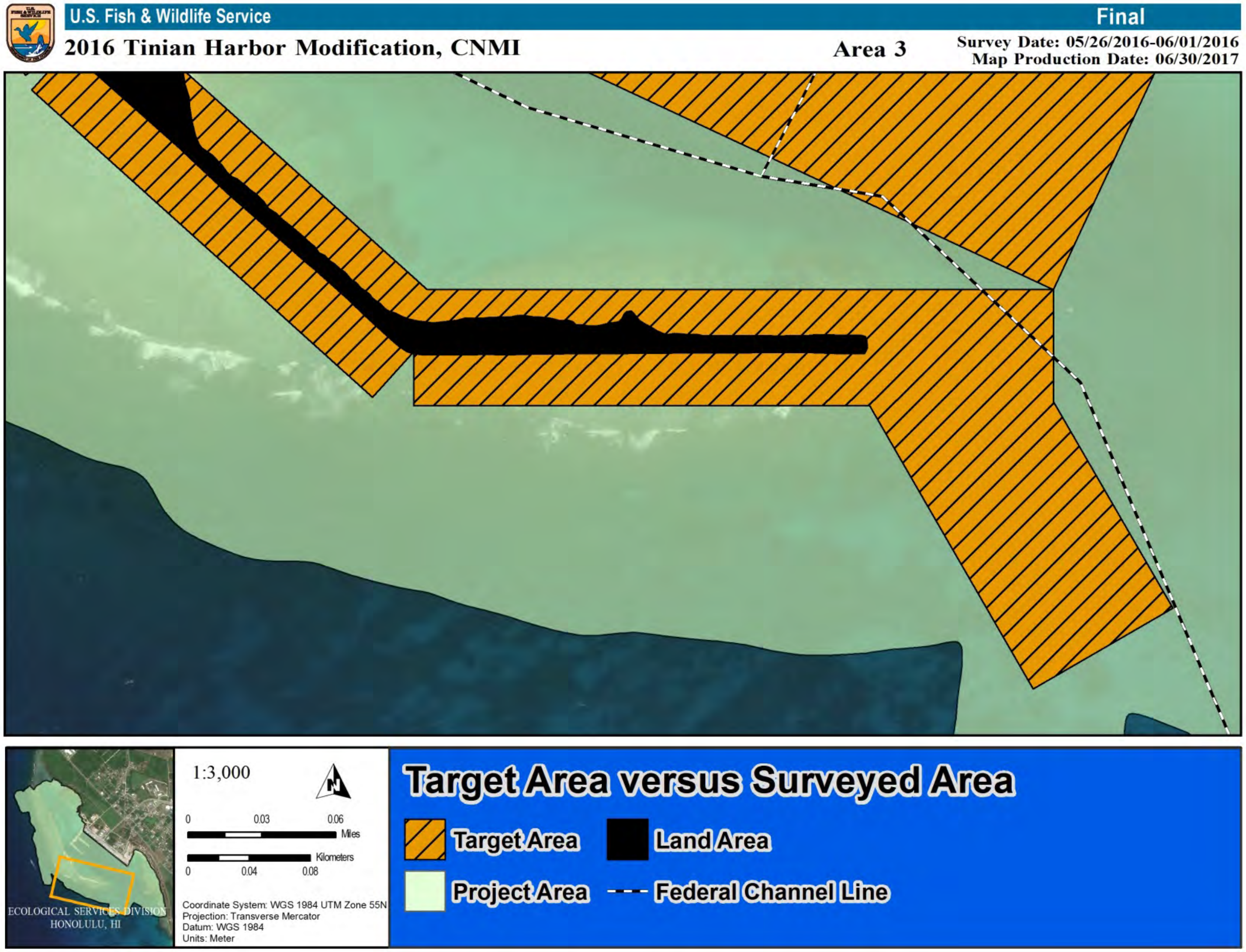

Figure D1: Target Area vs. Surveyed Area (Area 3). Overview of the Project Area (total surveyed area plus project footprint) versus the Target Area (project footprint).

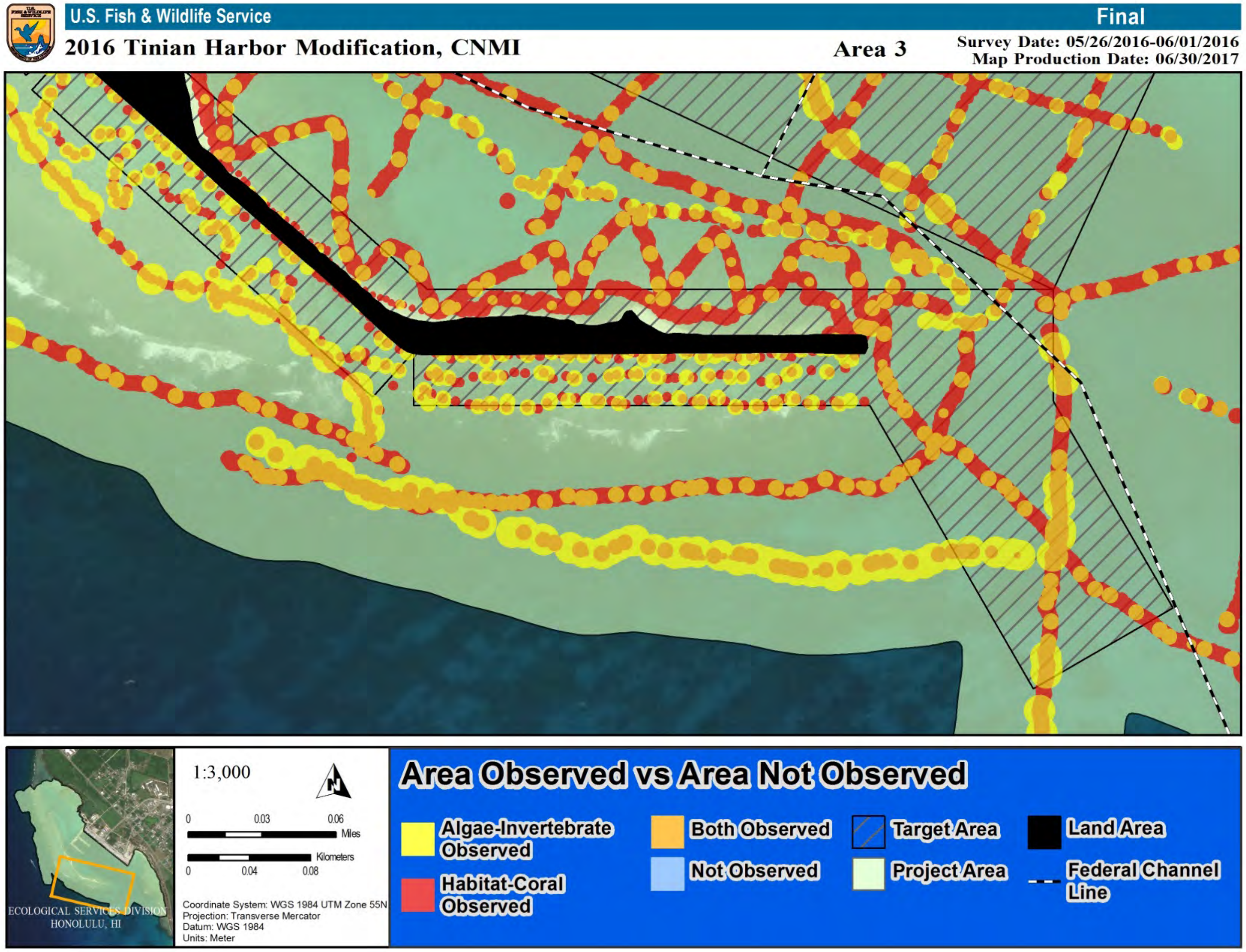

Figure D2: Area Observed (Area 3). Overview of the area observed by in-water observers versus the area interpolated in all maps.

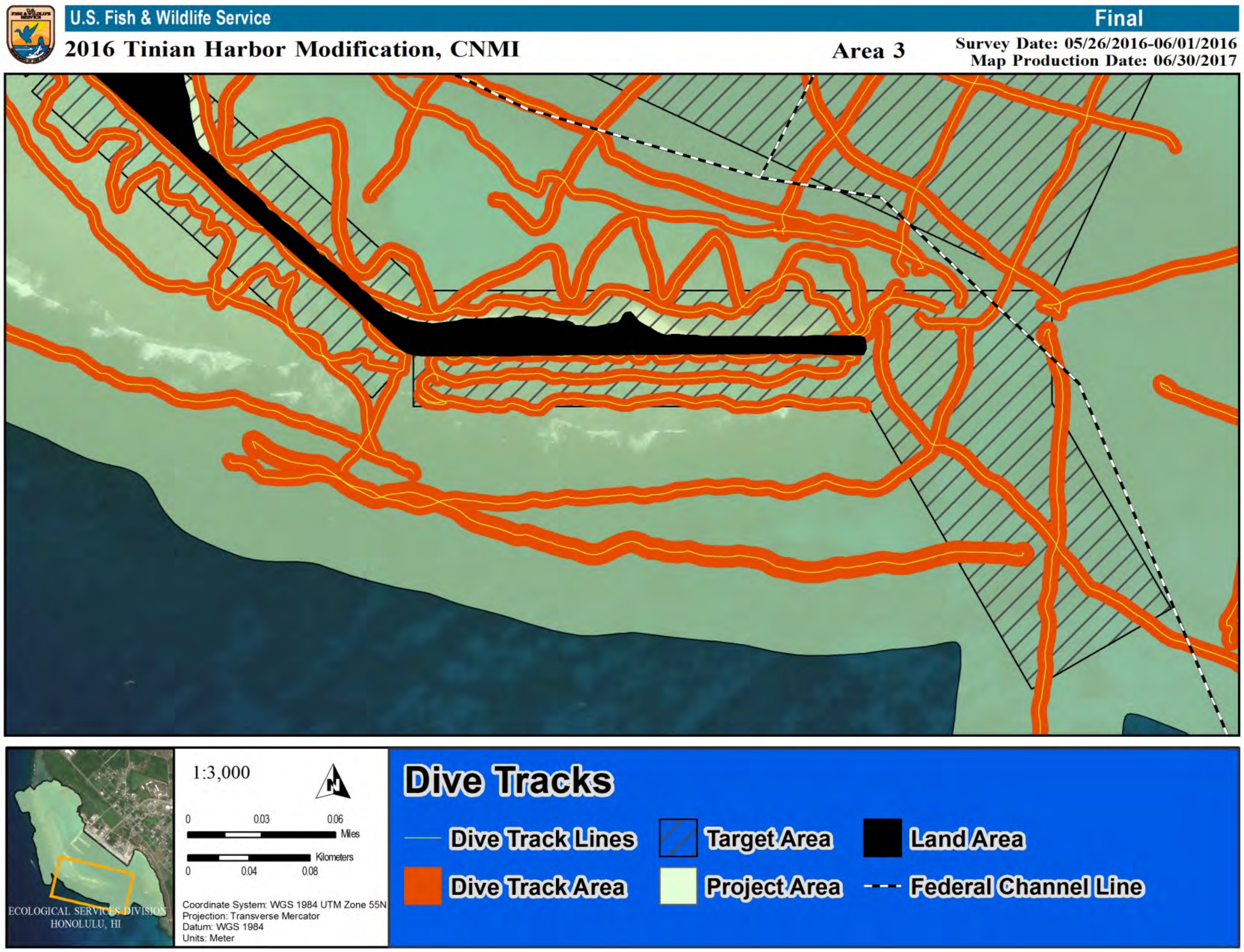

Figure D3: Dive Tracks (Area 3). Overview of the dive track lines for all survey transects.

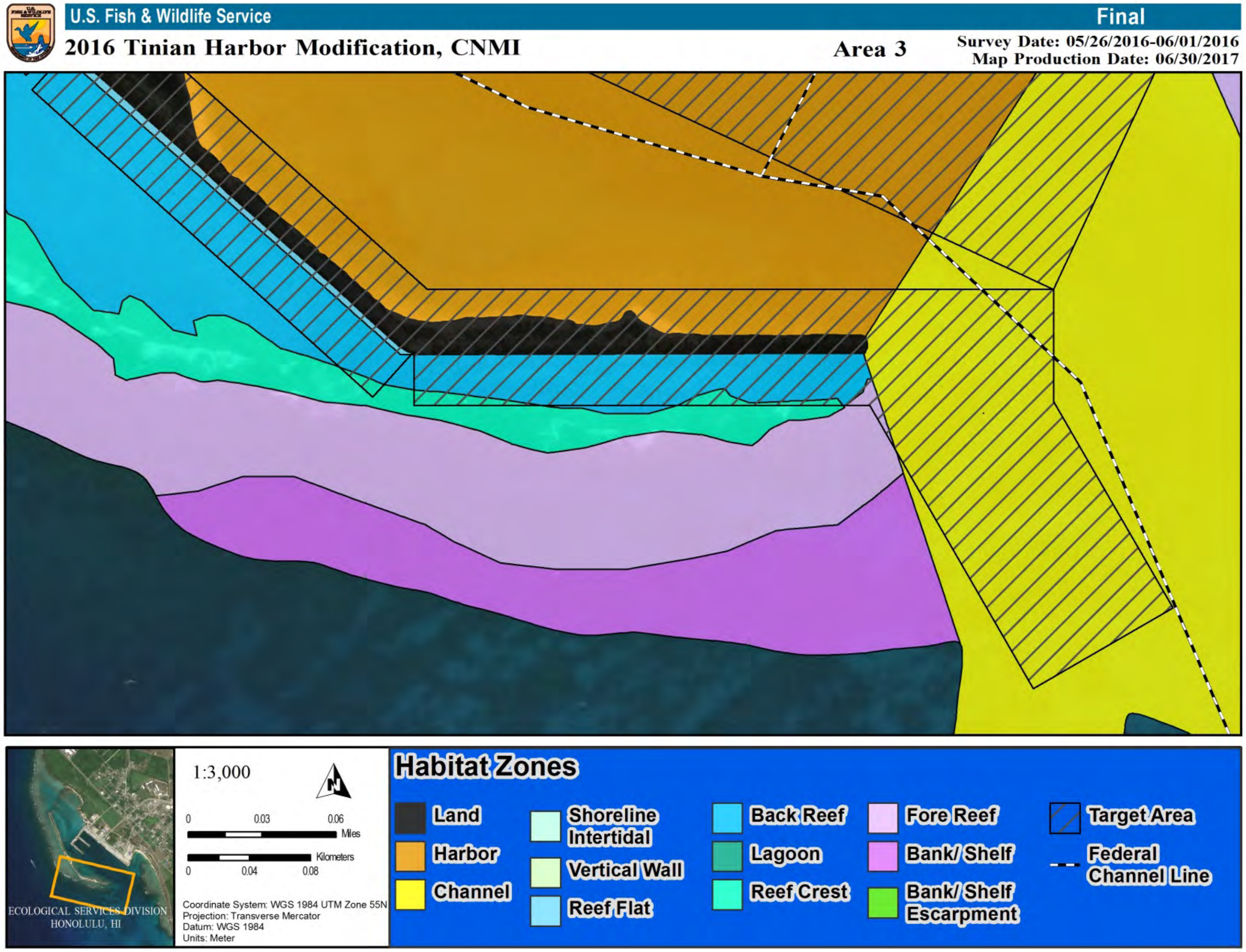

Figure D4: Habitat Zones (Area 3). Overview of the various habitat zones that the project area contains.

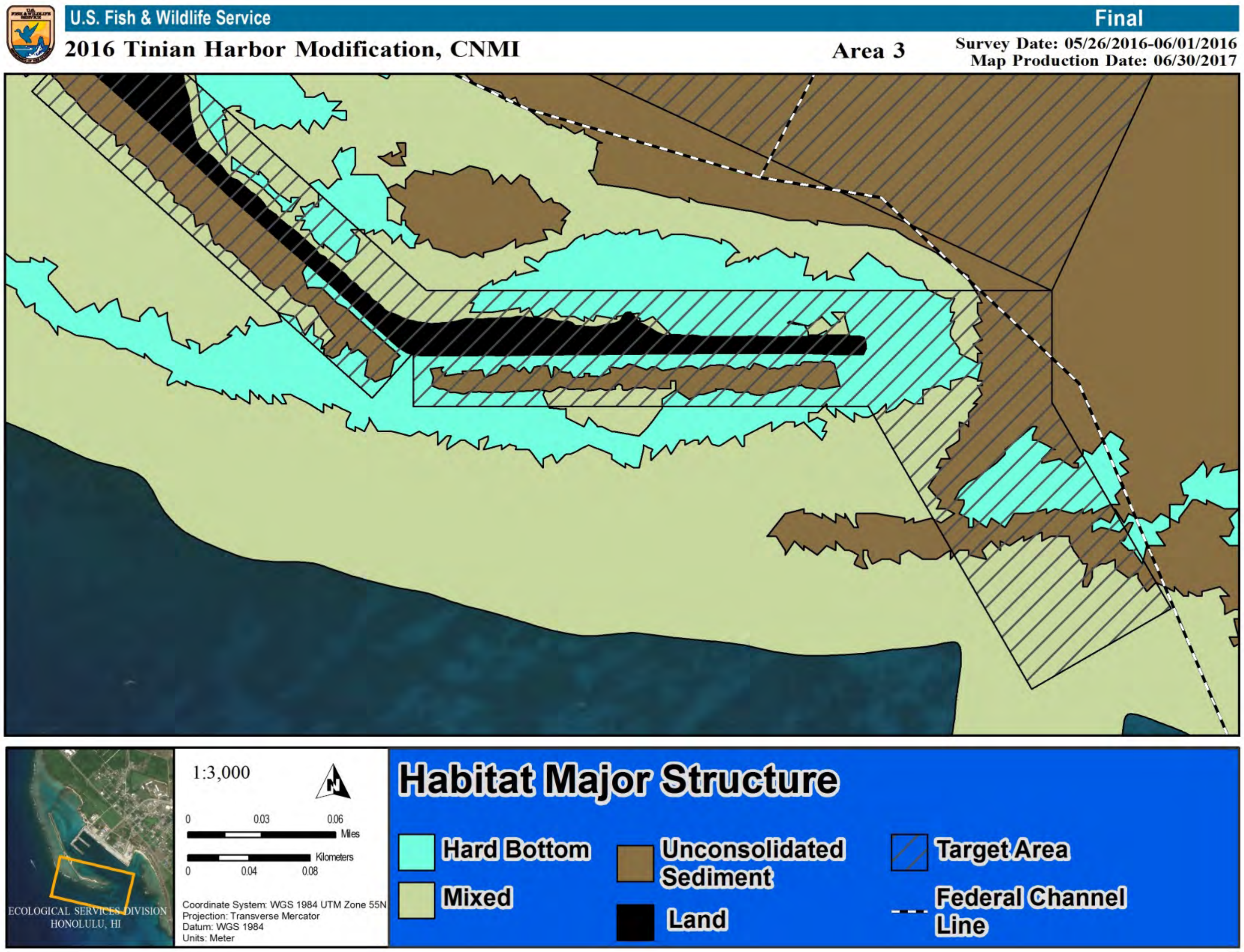

Figure D5: Habitat Major Structure (Area 3). Overview of the major habitat structures that the project area contains.

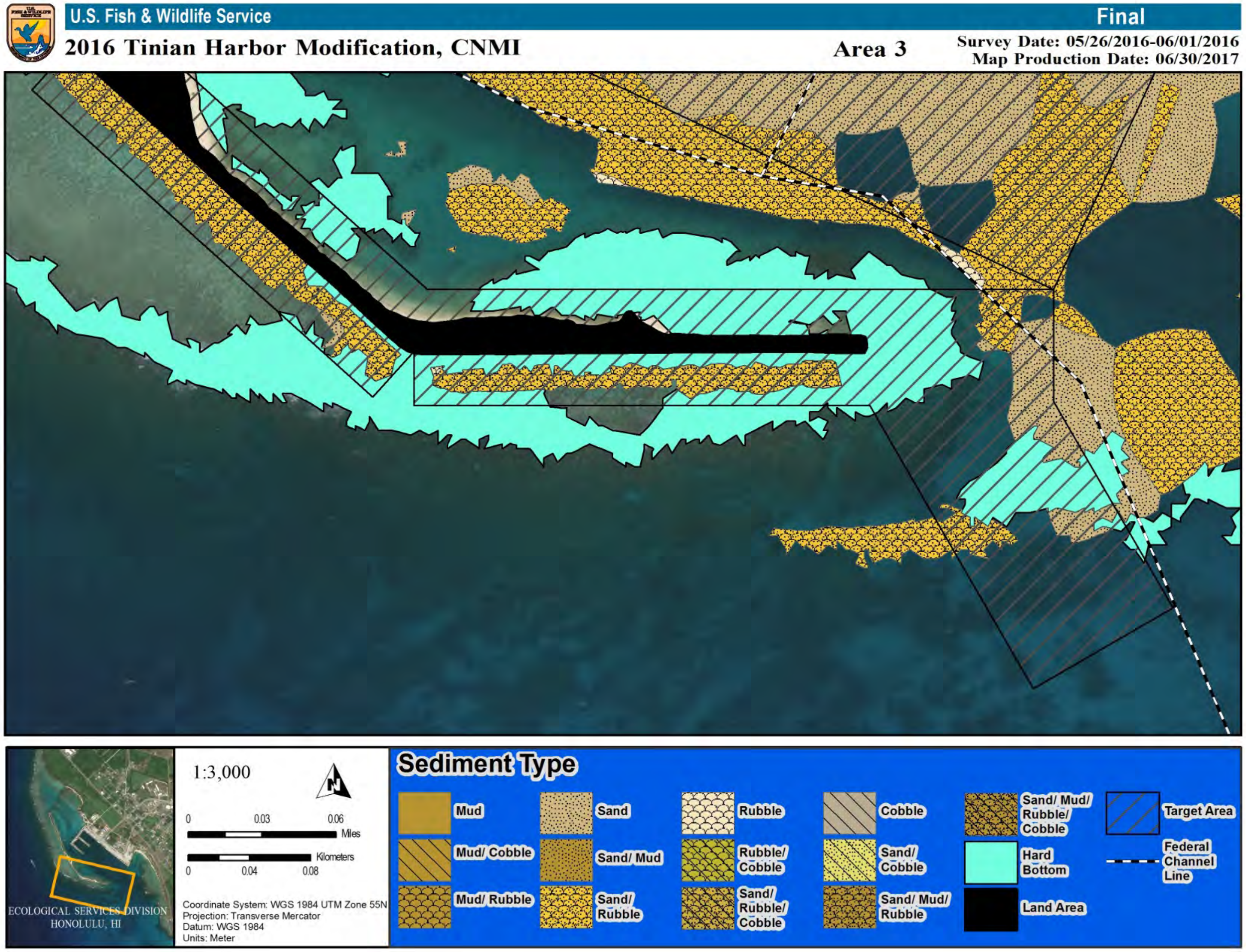

Figure D6: Sediment Type (Area 3). Overview of the various sediment types that the project area contains.

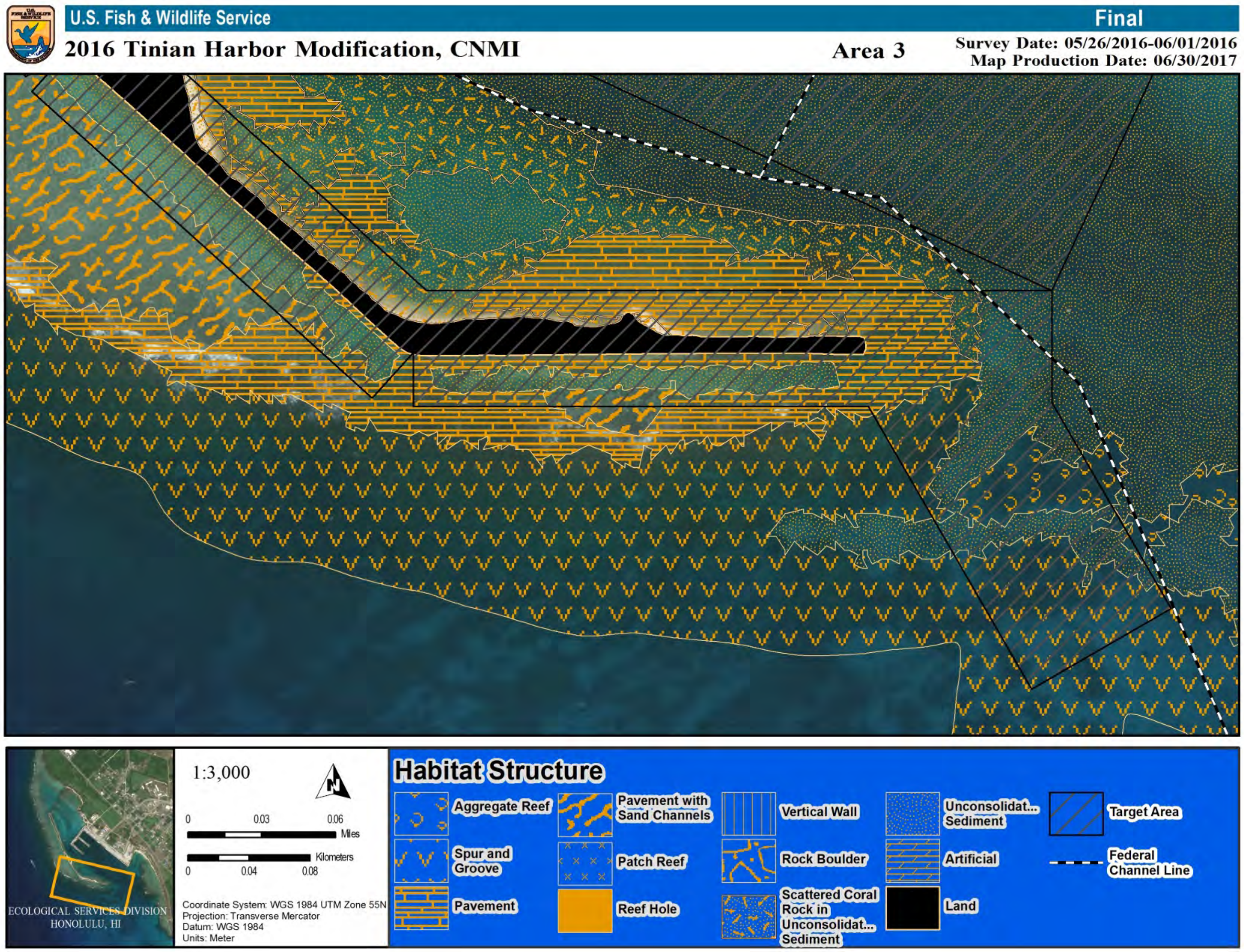

Figure D7: Habitat Structure (Area 3). Overview of the habitat structures that the project area contains.

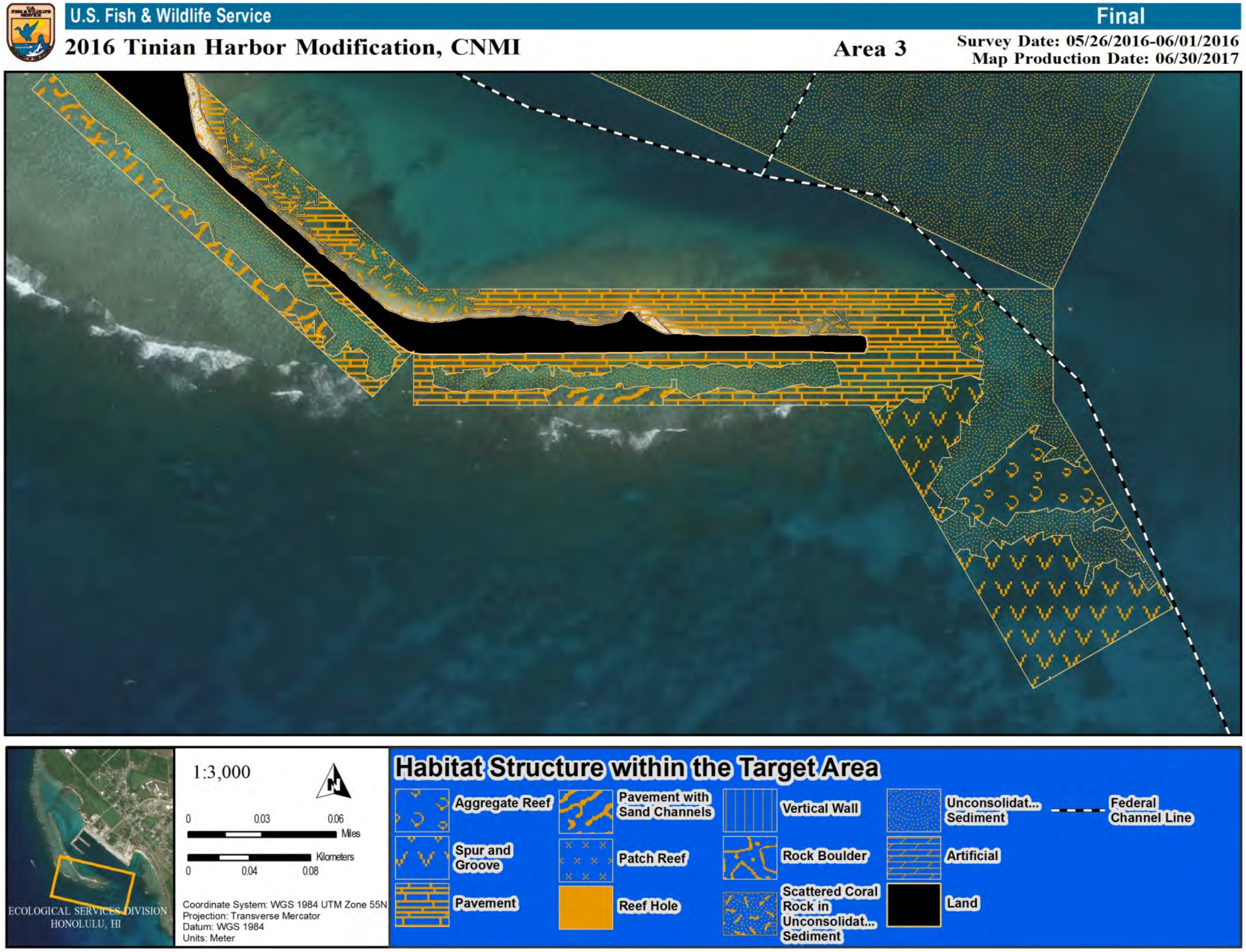

Figure D8: Habitat Structure in Target Area (Area 3). Overview of the habitat structures within the project footprint (Target Area).

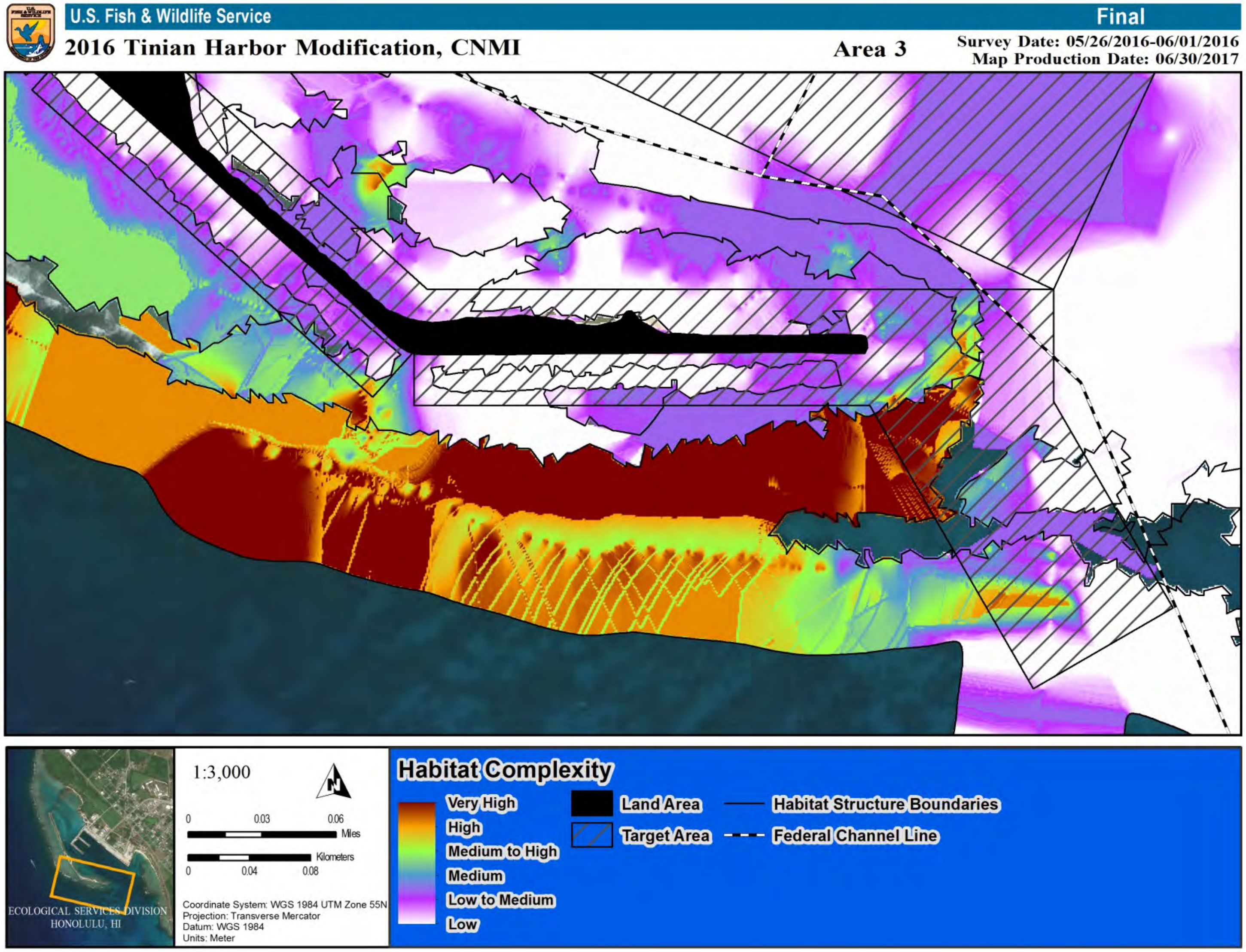

Figure D9: Habitat Complexity (Area 3). Overview of the habitat complexity observed within the project area.

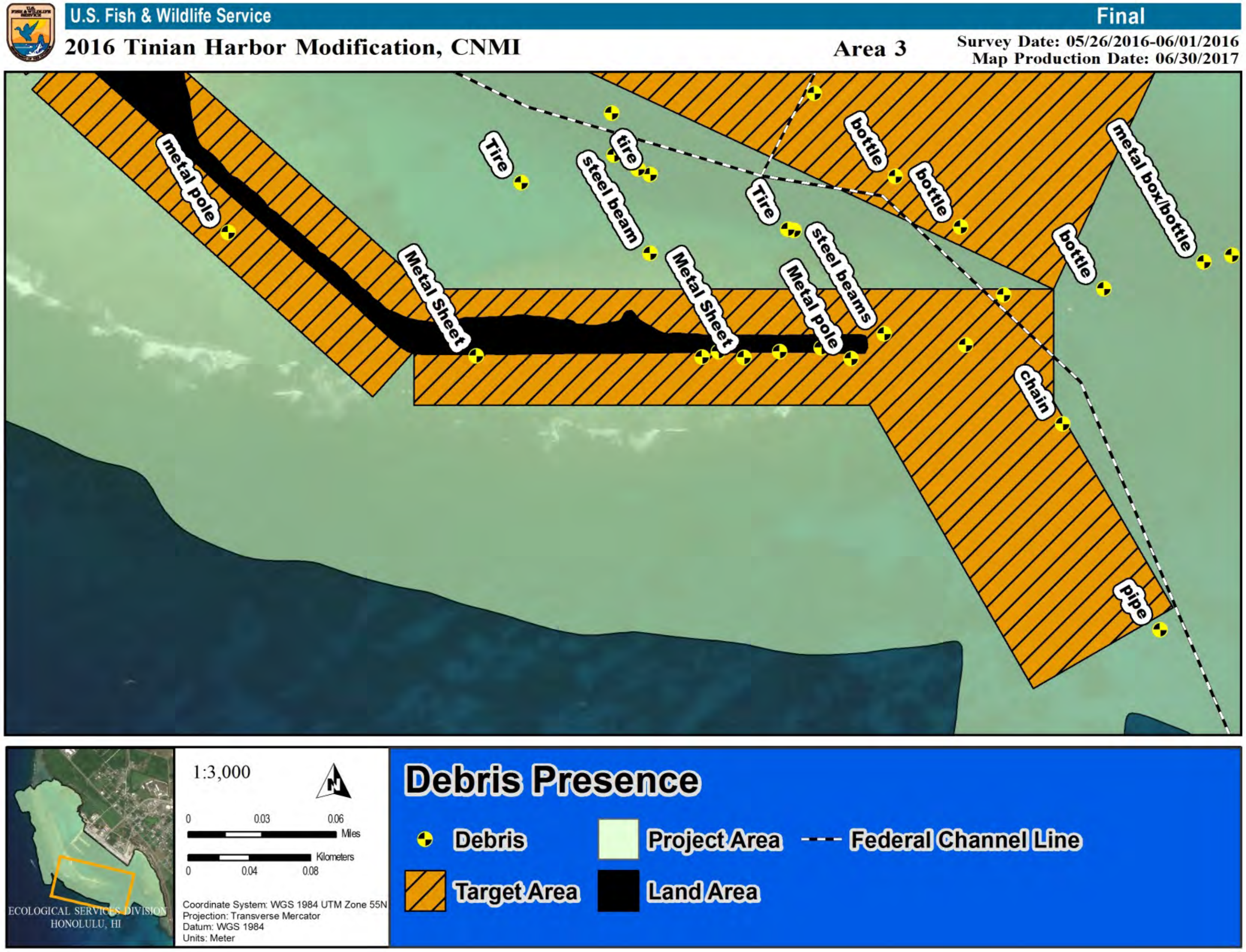

Figure D10: Debris (Area 3). Overview of the debris observed within the project area.

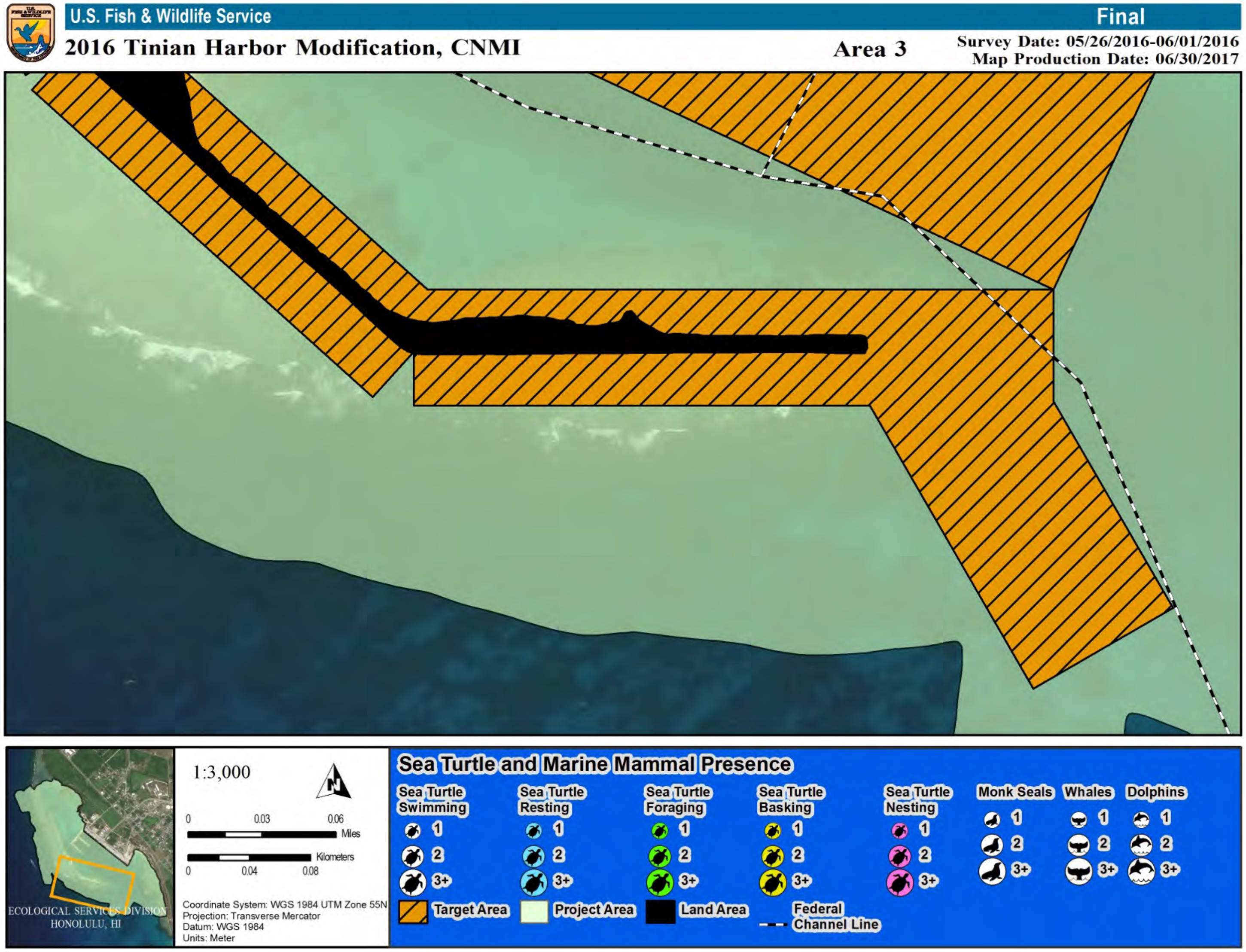

Figure D11: Protected Species (Area 3). Overview of the observed protected species within the project area.

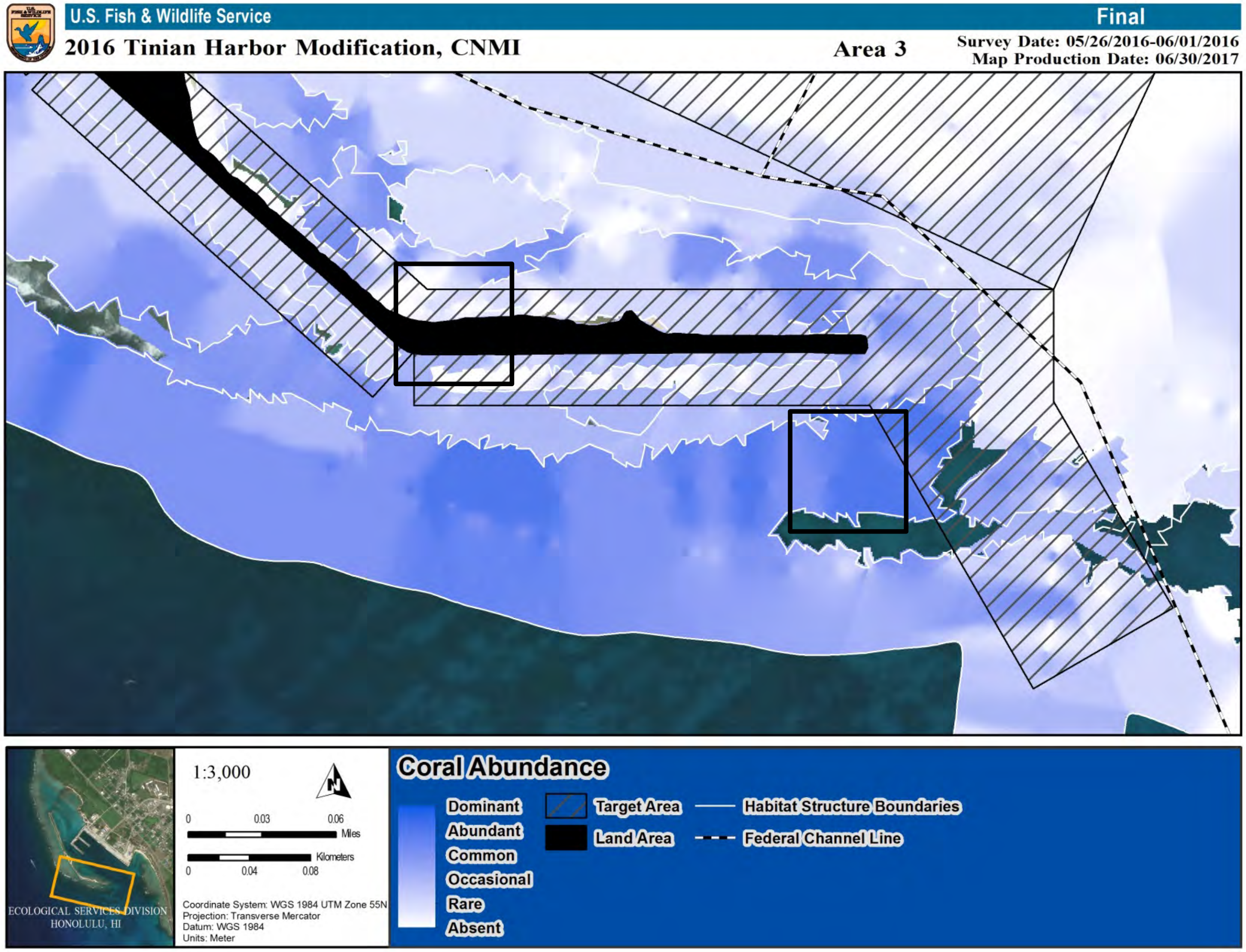

Figure D12: Coral Abundance (Area 3). Overview of the coral abundance within the project.

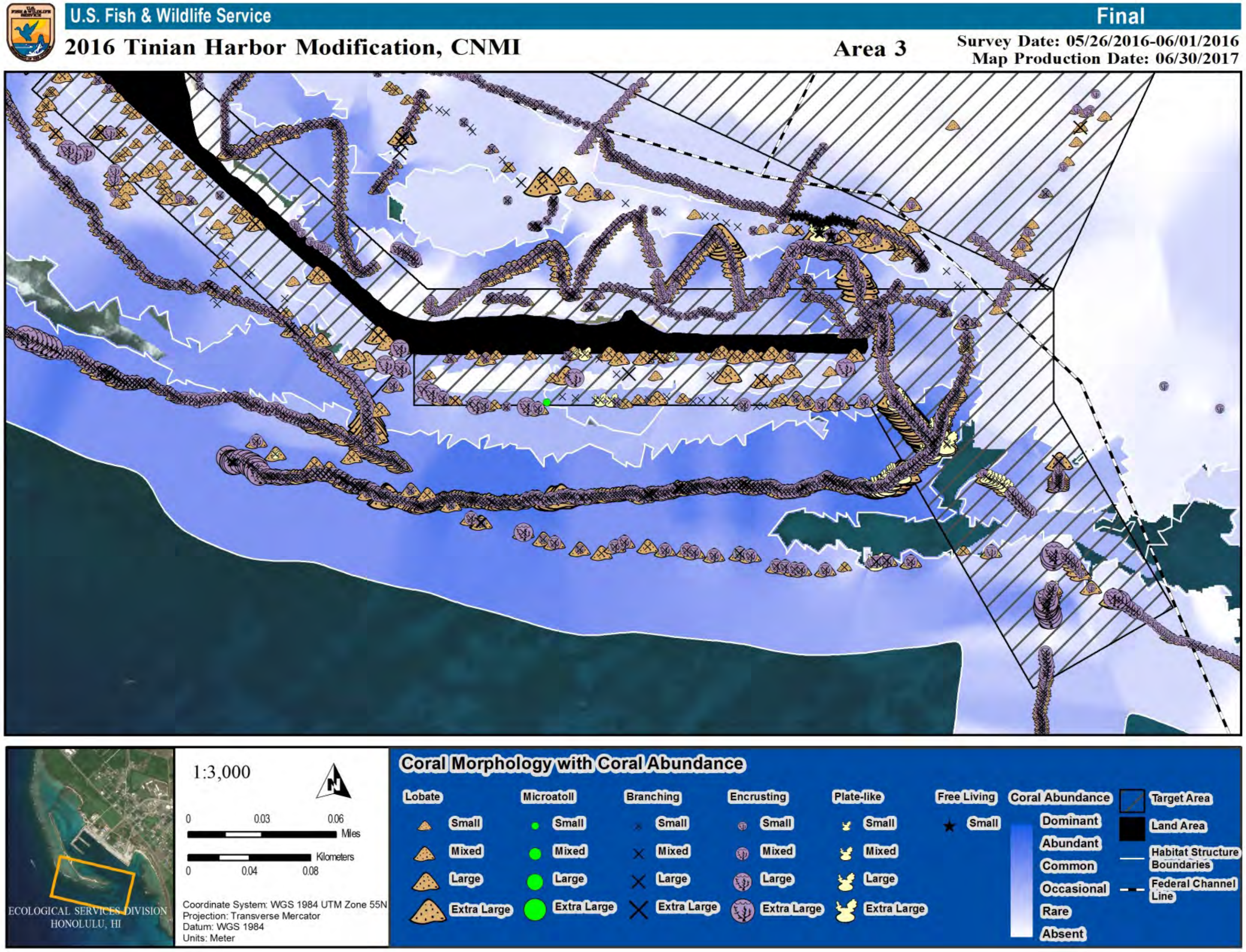

Figure D13: Coral Morphologies (Area 3). Overview of the various coral morphologies and broad coral sizes observed within the project area.

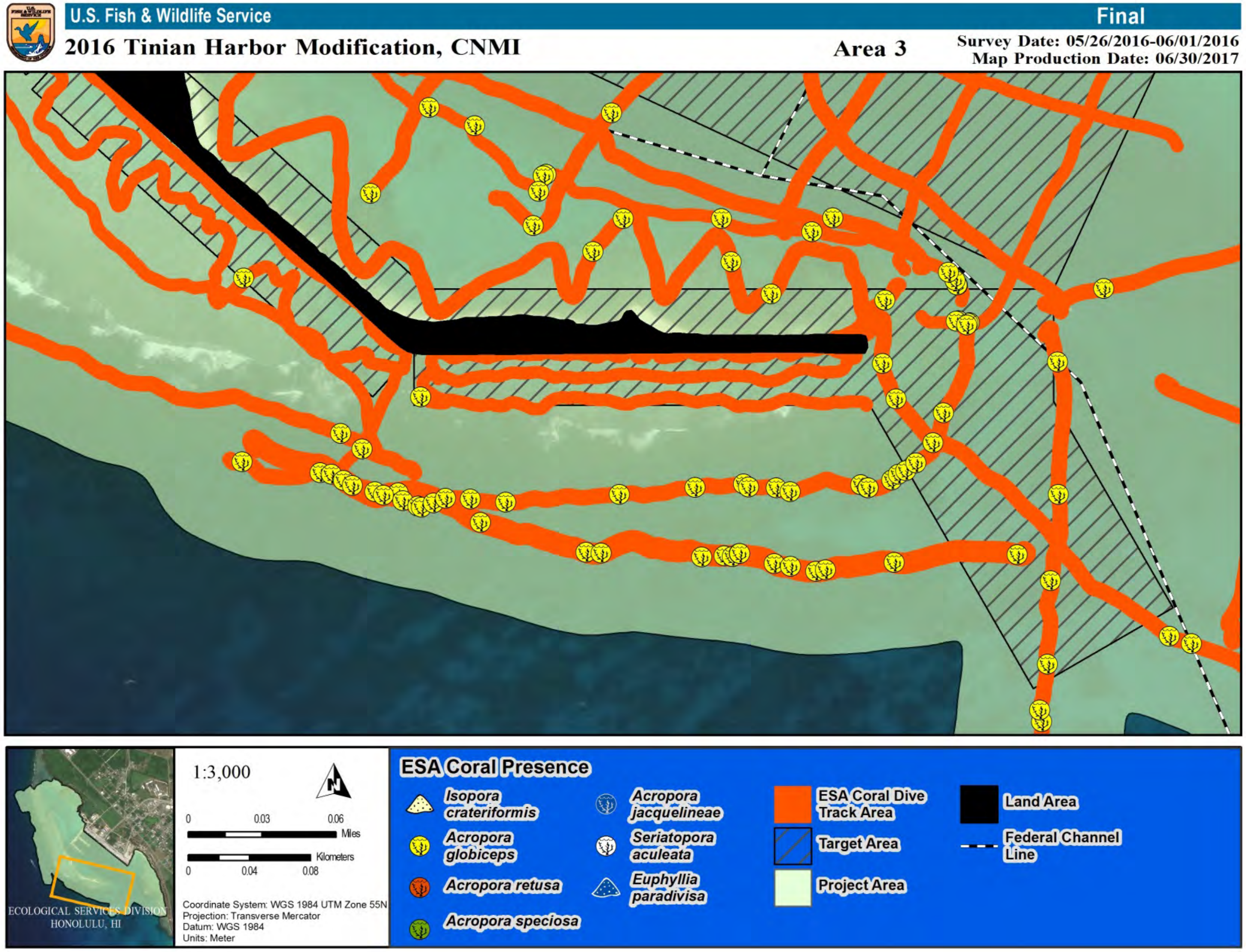

Figure D14: ESA-listed Corals (Area 3). Overview of the ESA-listed coral species observed within the project area.

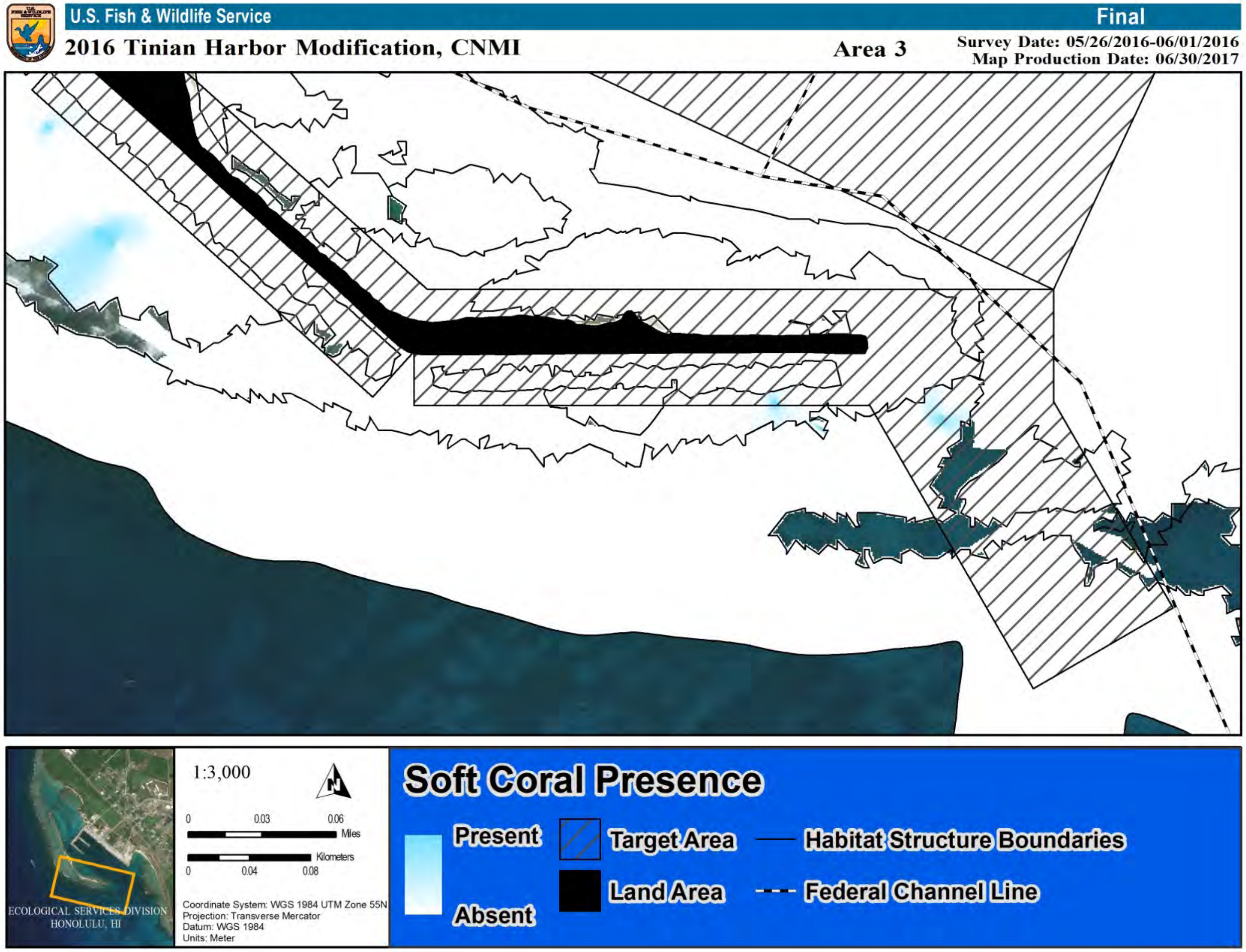

Figure D15: Soft Coral Presence (Area 3). Overview of the soft coral presence within the project area.

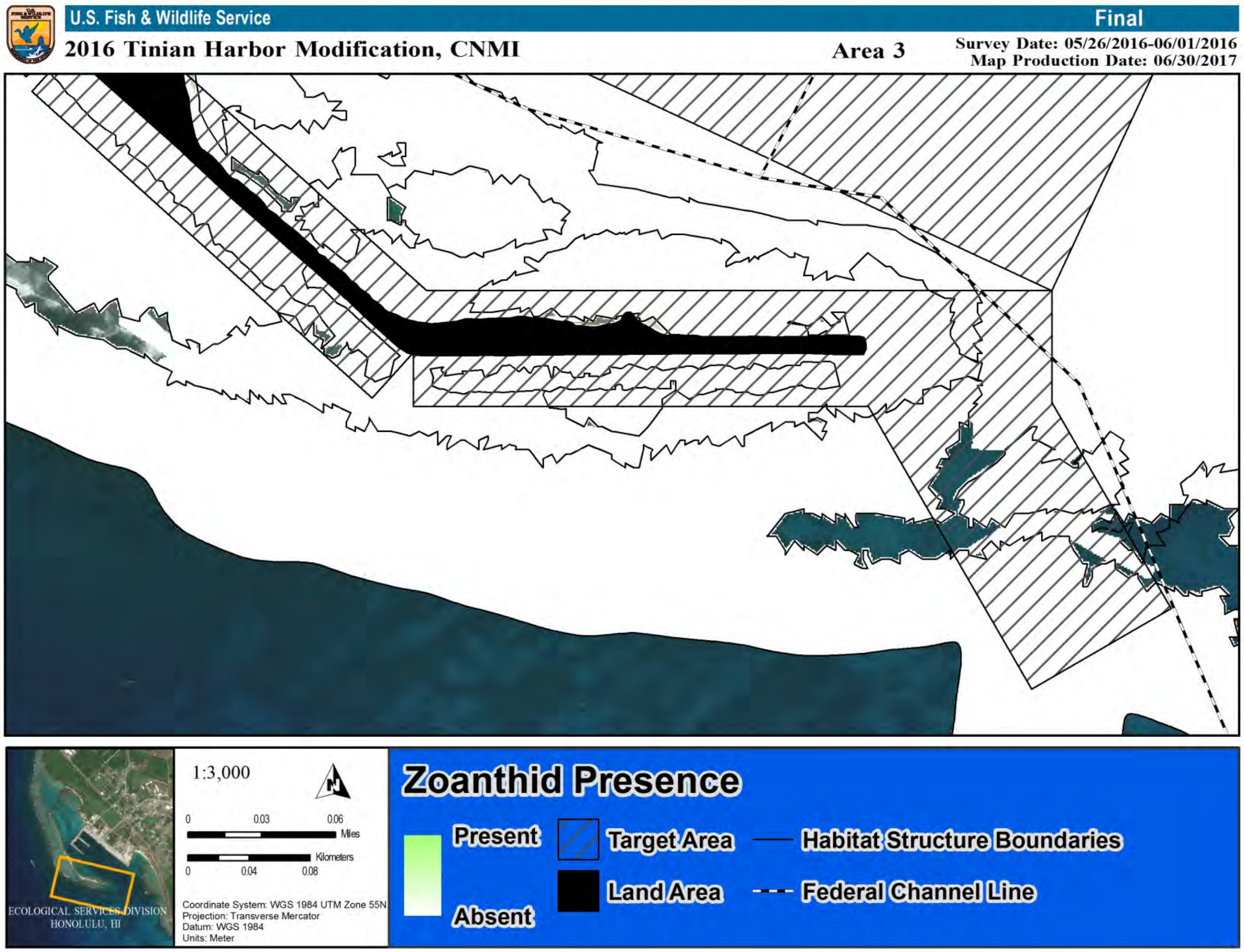

Figure D16: Zonathid Presence (Area 3). Overview of the zoanthid (relative to corals) presence within the project area. Note: No zoanthids were observed in this area.

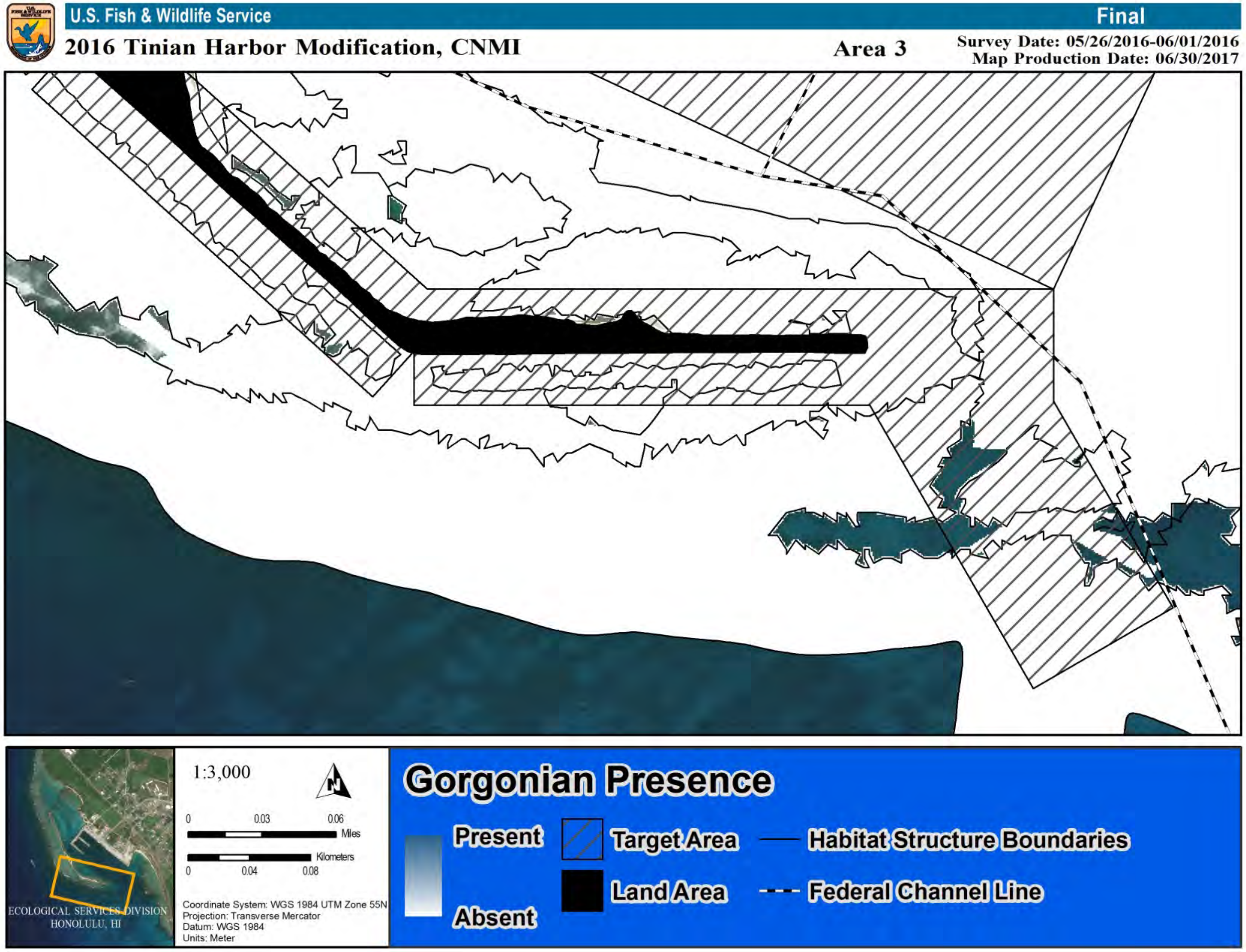

Figure D17: Gorgonian Presence (Area 3). Overview of the gorgonian coral presence within the project area. Note: No gorgonians were observed in this area.

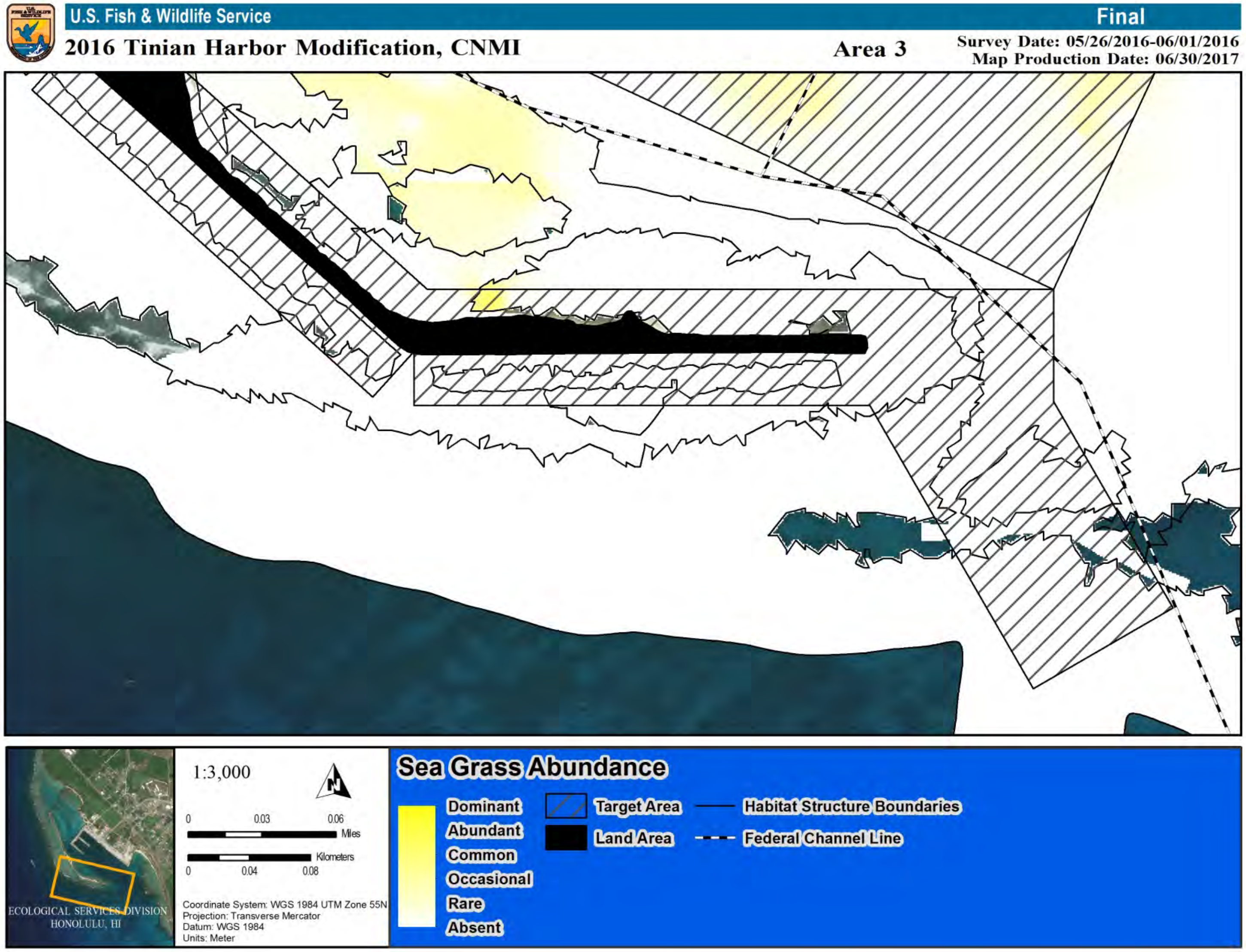

Figure D18: Sea Grass Abundance (Area 3). Overview of the seagrass abundance within the project area.

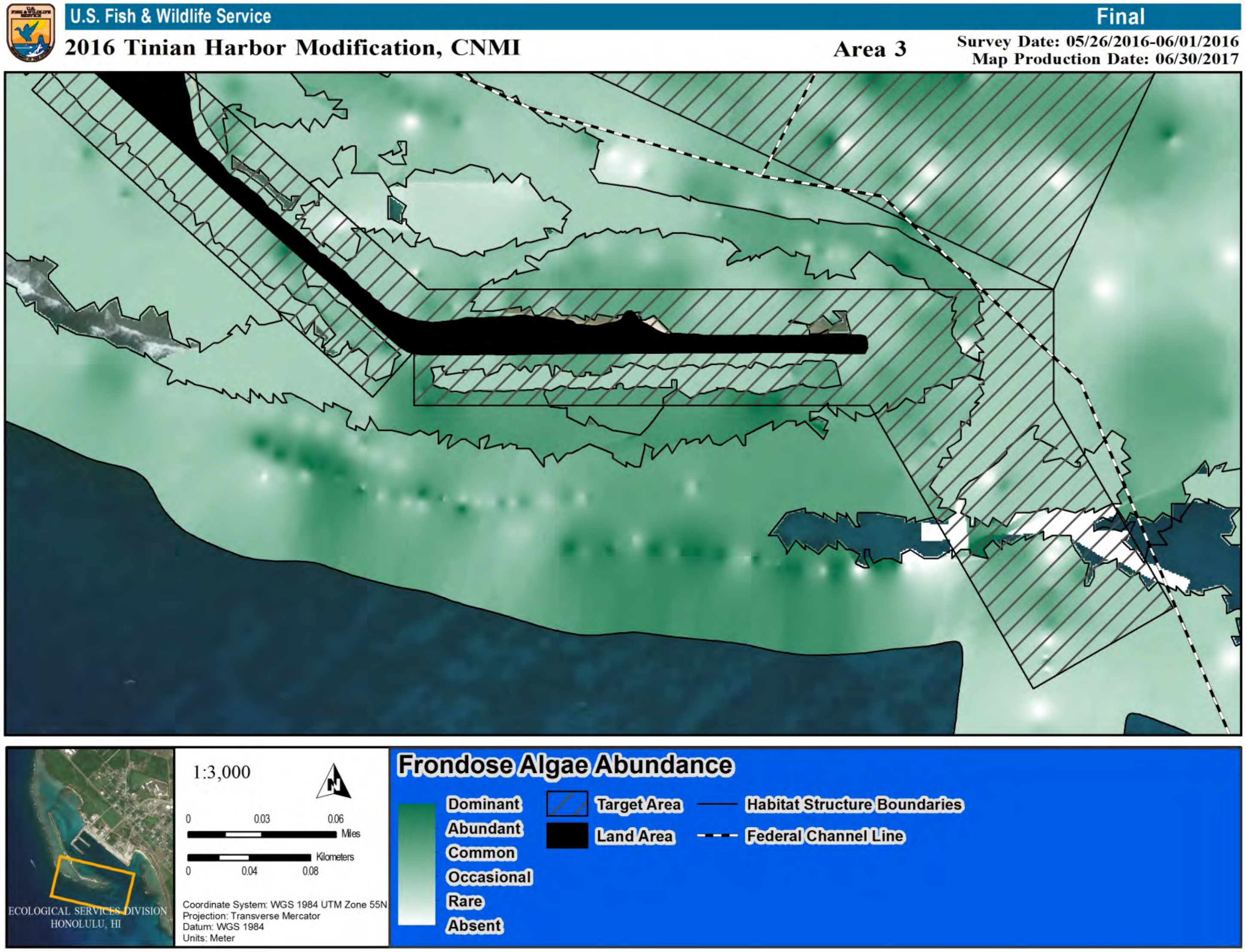

Figure D19: Frondose Algae Abundance (Area 3). Overview of the frondose algae (macroalgae) abundance observed within the project area.

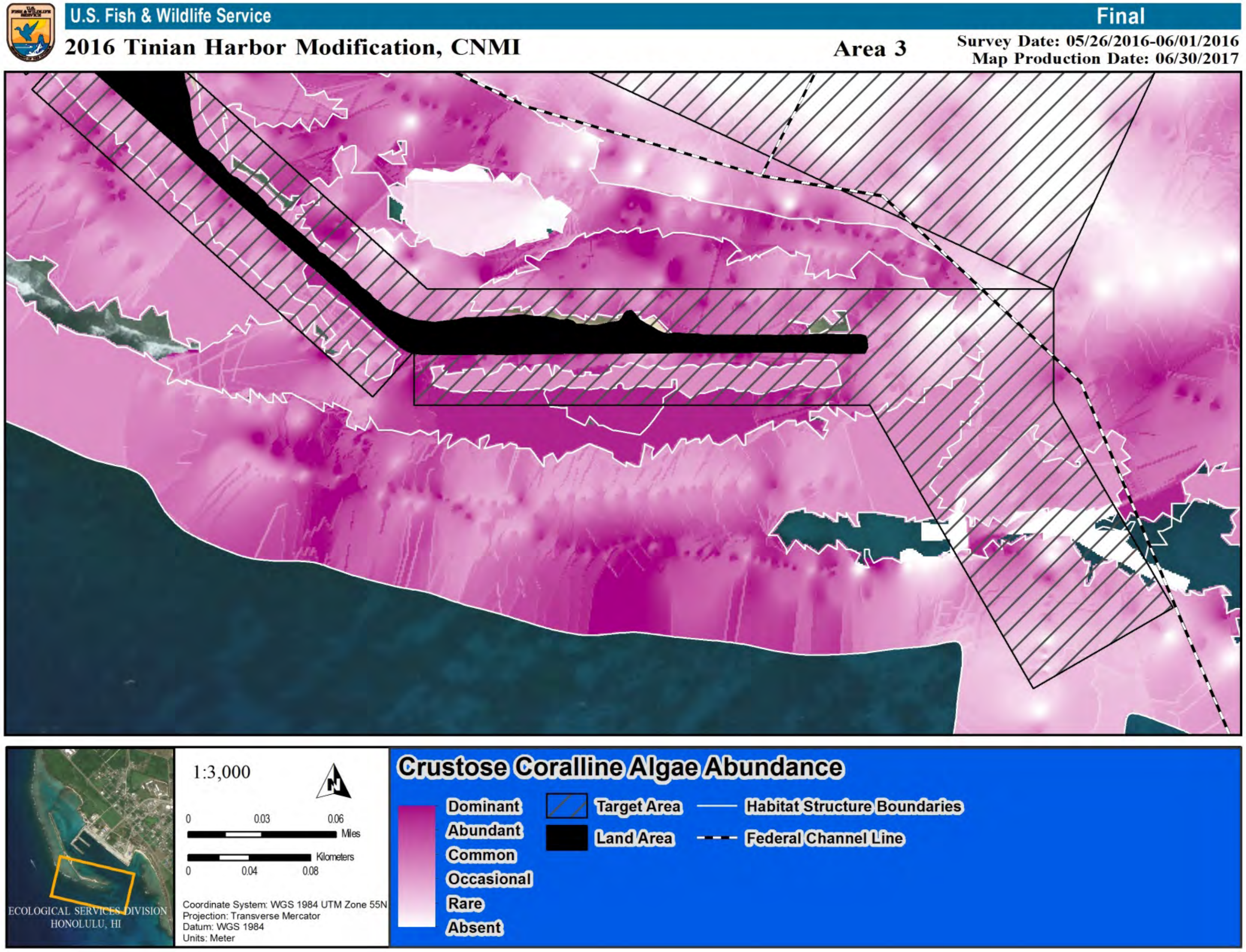

Figure D20: CCA Abundance (Area 3). Overview of the crustose coralline algae abundance observed within the project area.

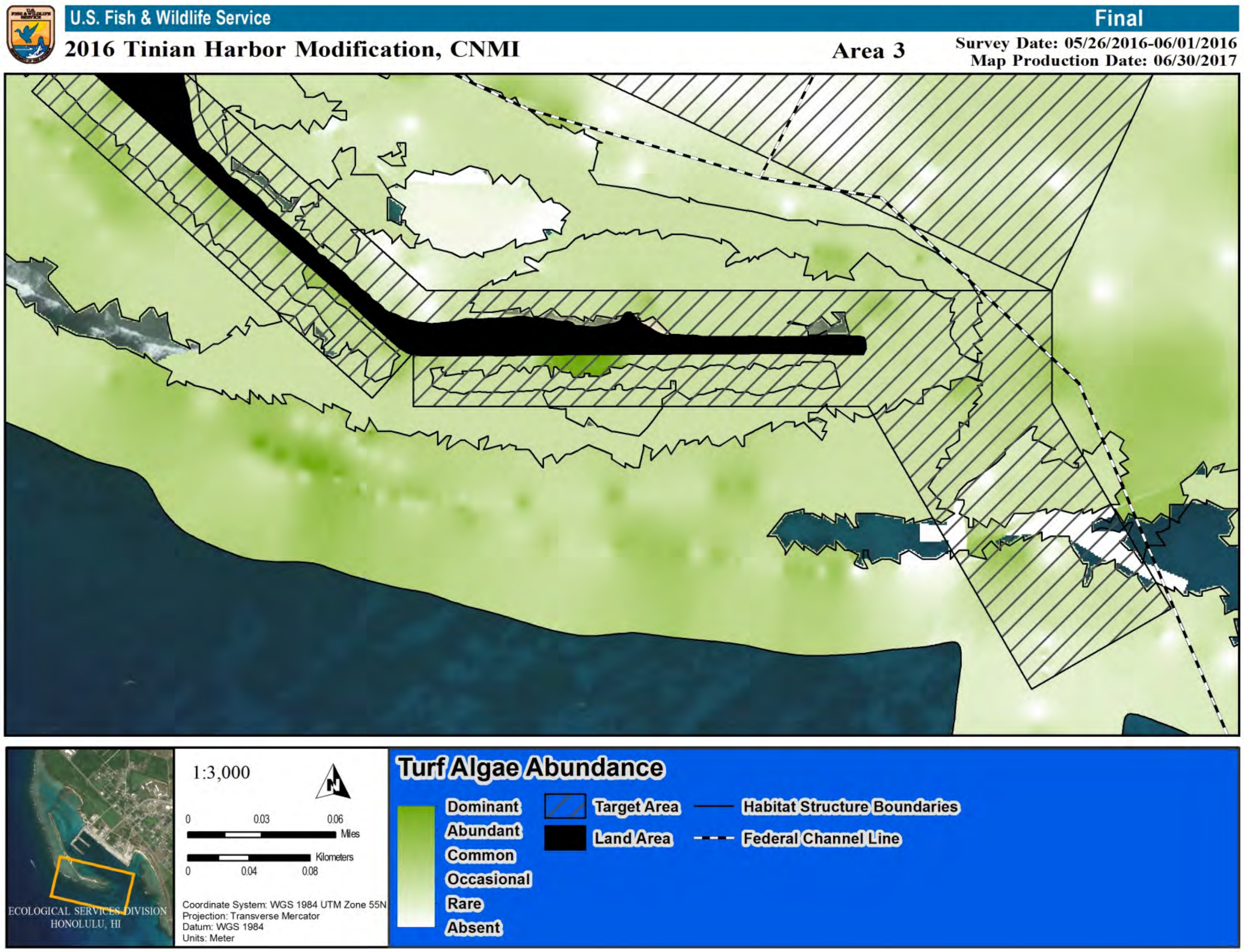

Figure D21: Turf Algae Abundance (Area 3). Overview of the turf algae abundance observed within the project area.

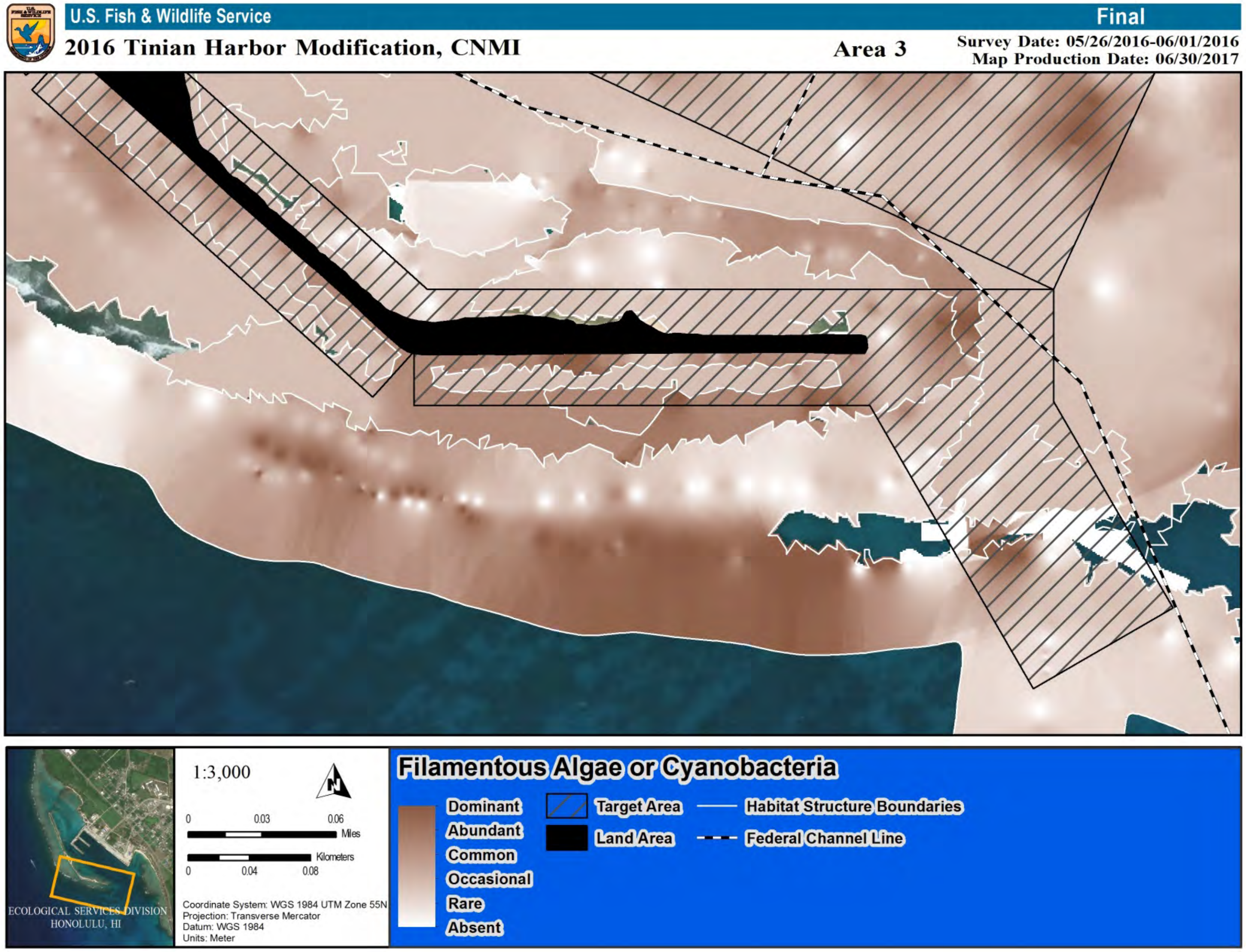

Figure D22: Filamentous Algae (Area 3). Overview of the filamentous algae and cyanobacteria abundance observed within the project area.

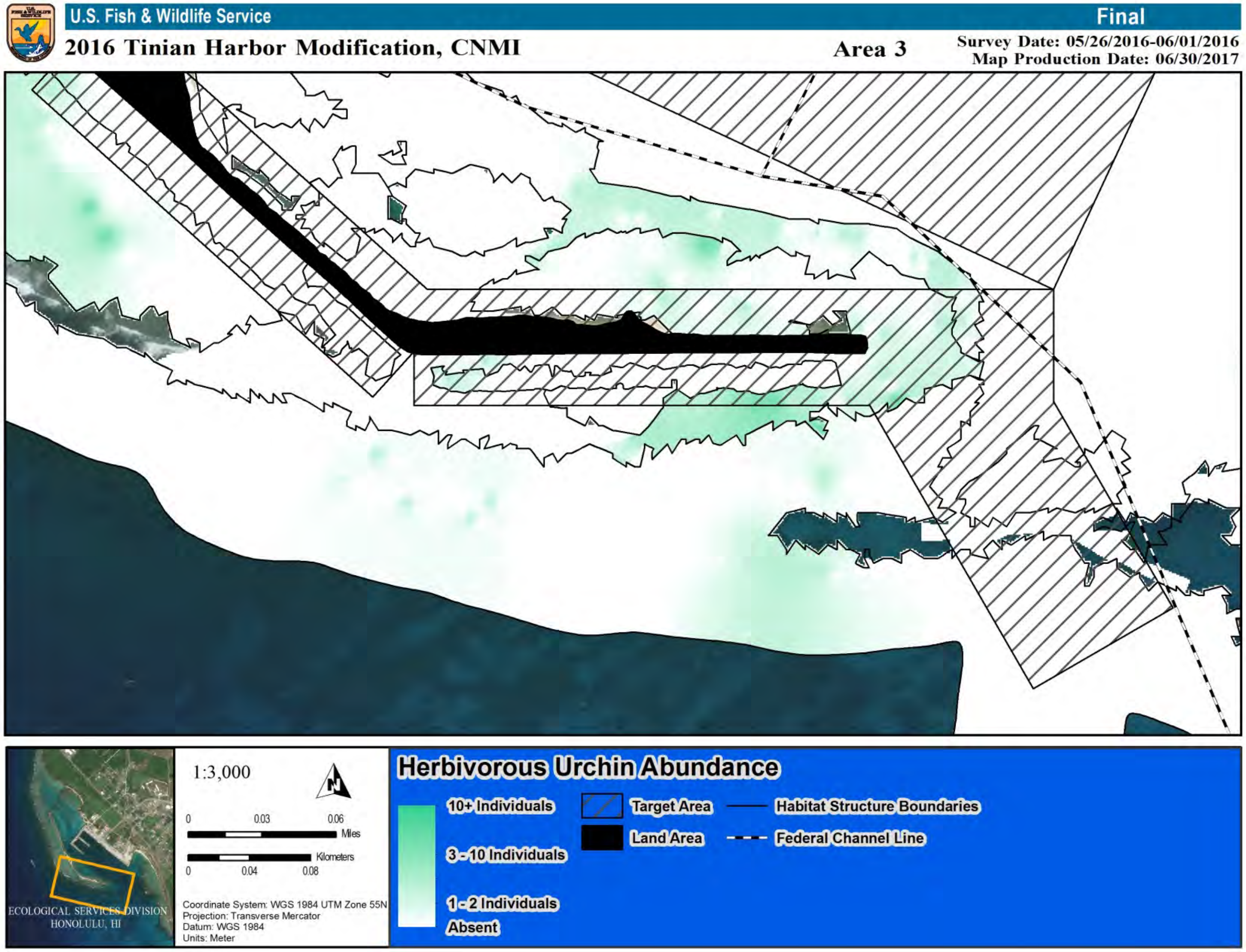

Figure D23: Herbivorous Urchin Abundance (Area 3). Overview of the herbivorous urchin abundance observed within the project area.

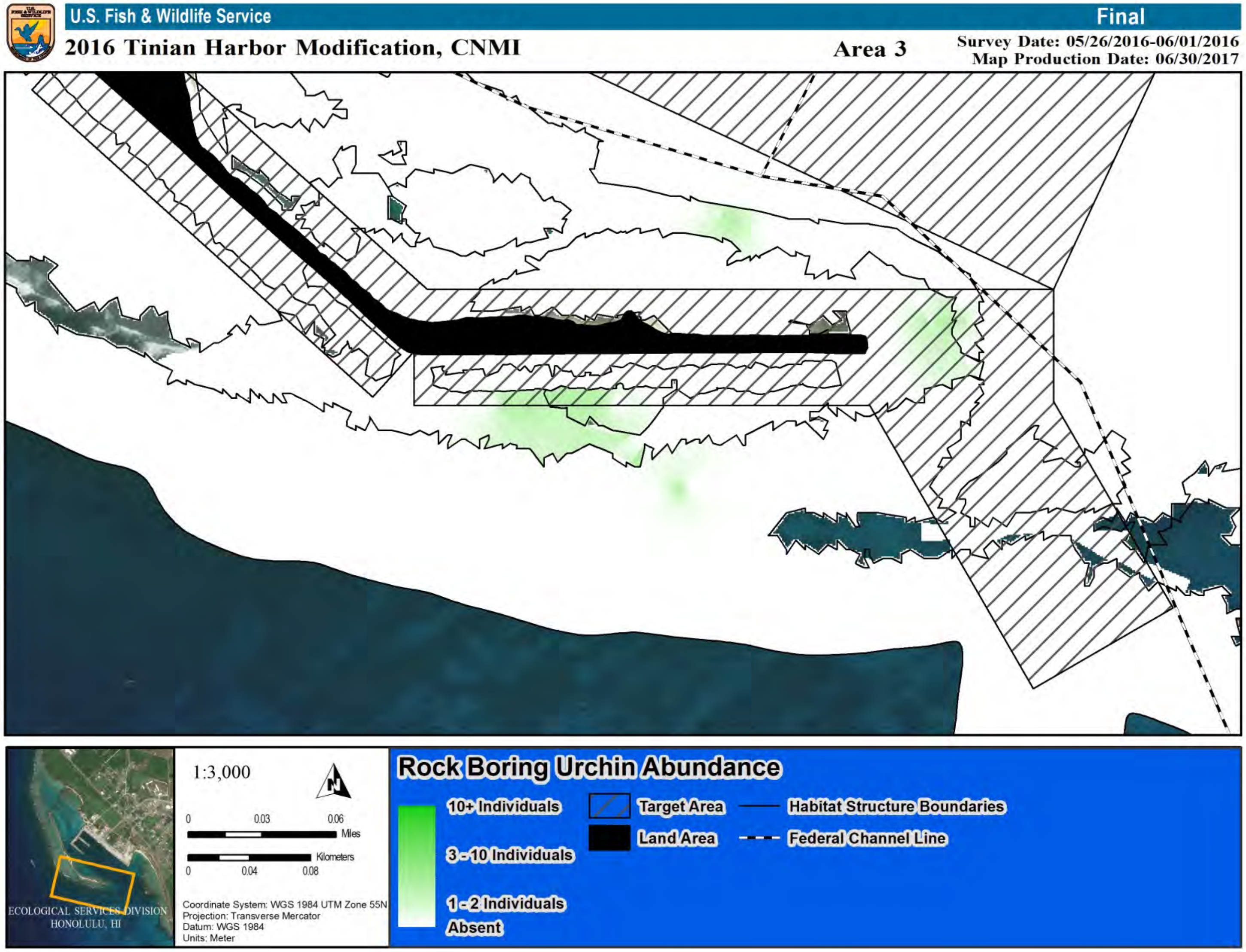

Figure D24: Rock Boring Urchin Abundance (Area 3). Overview of the rock boring urchin abundance observed within the project area.

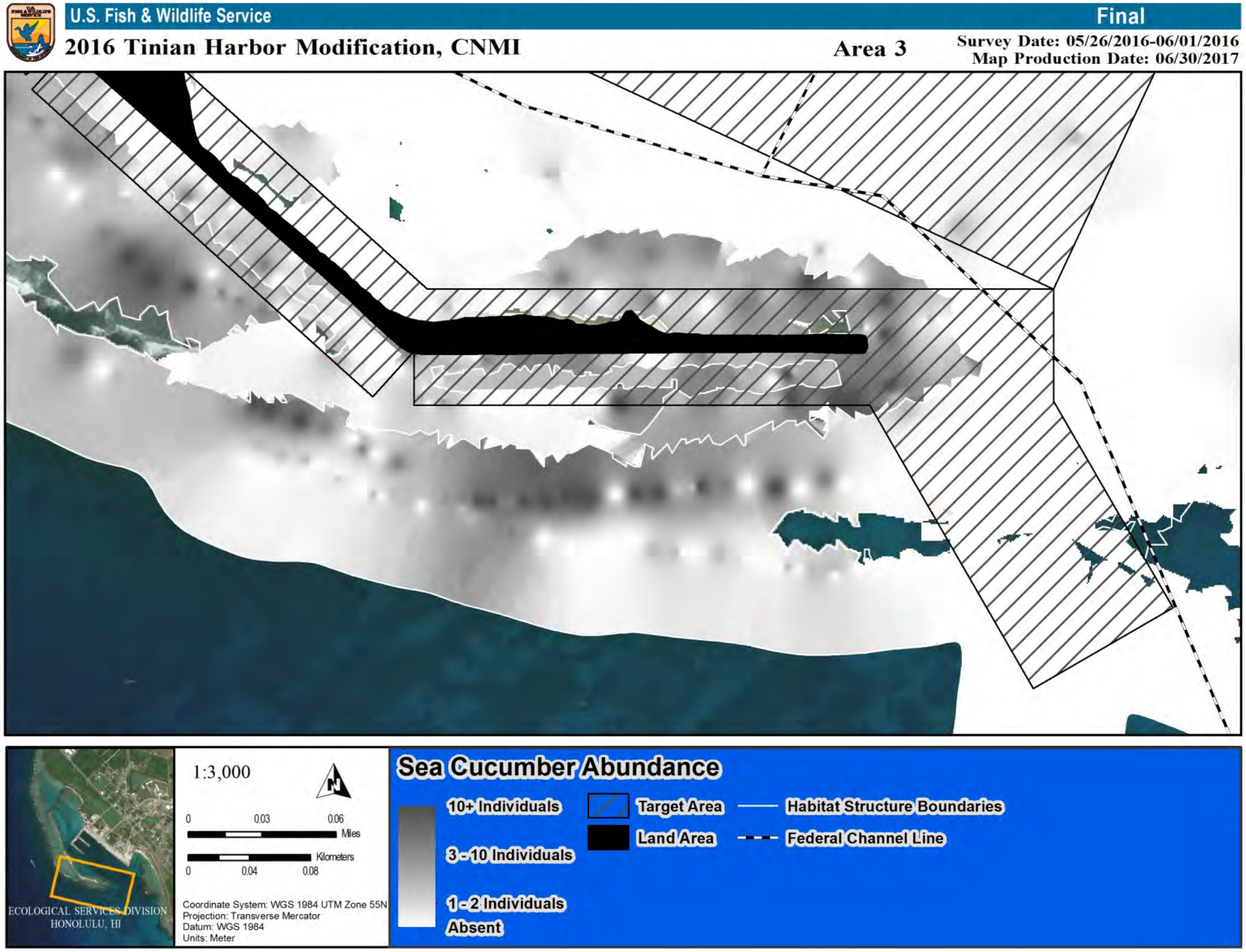

Figure D25: Sea Cucumber Abundance (Area 3). Overview of the sea cucumber abundance observed within the project area.

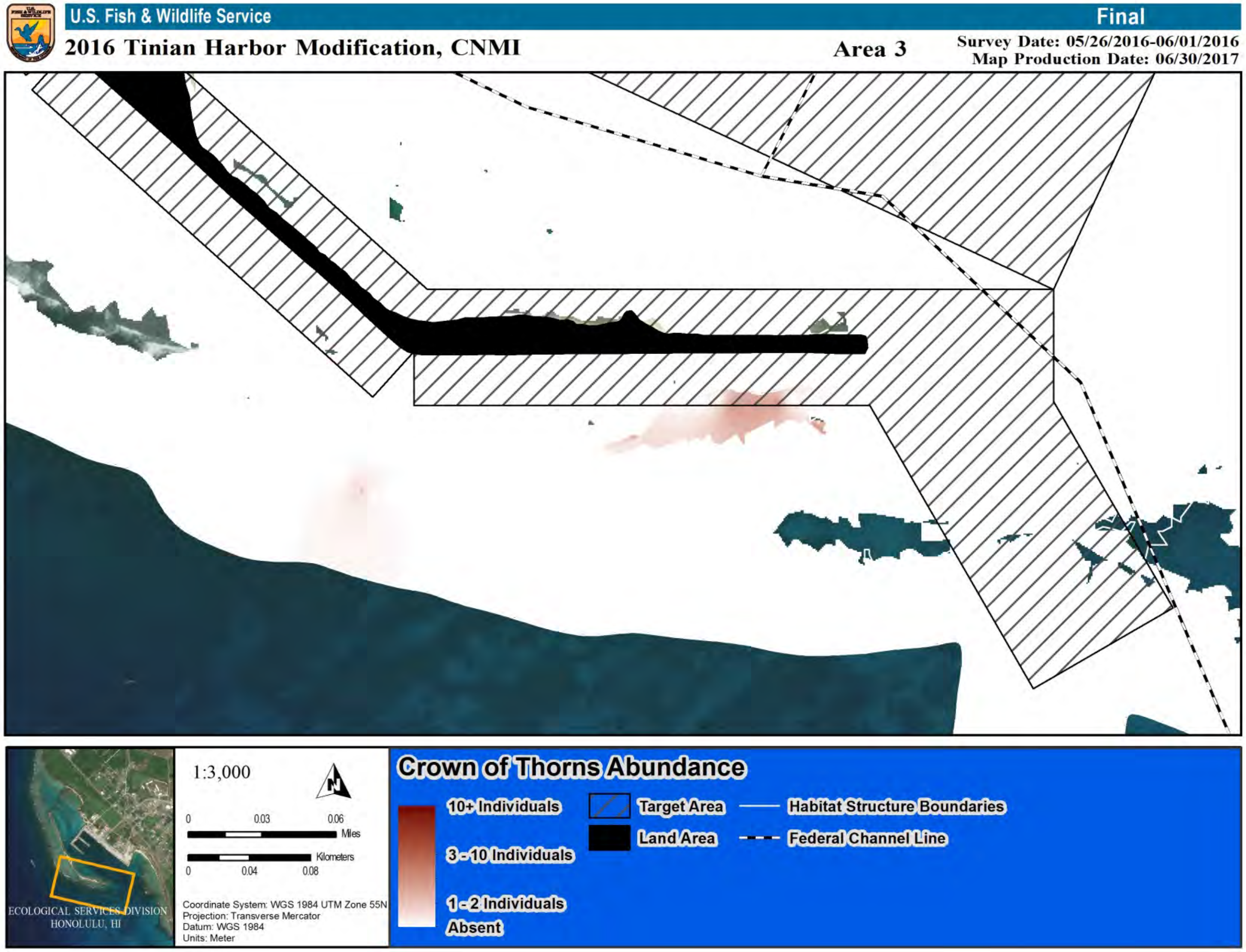

Figure D26: Crown-of-Thorns Abundance (Area 3). Overview of the crown-of-thorn starfish abundance observed within the project area.

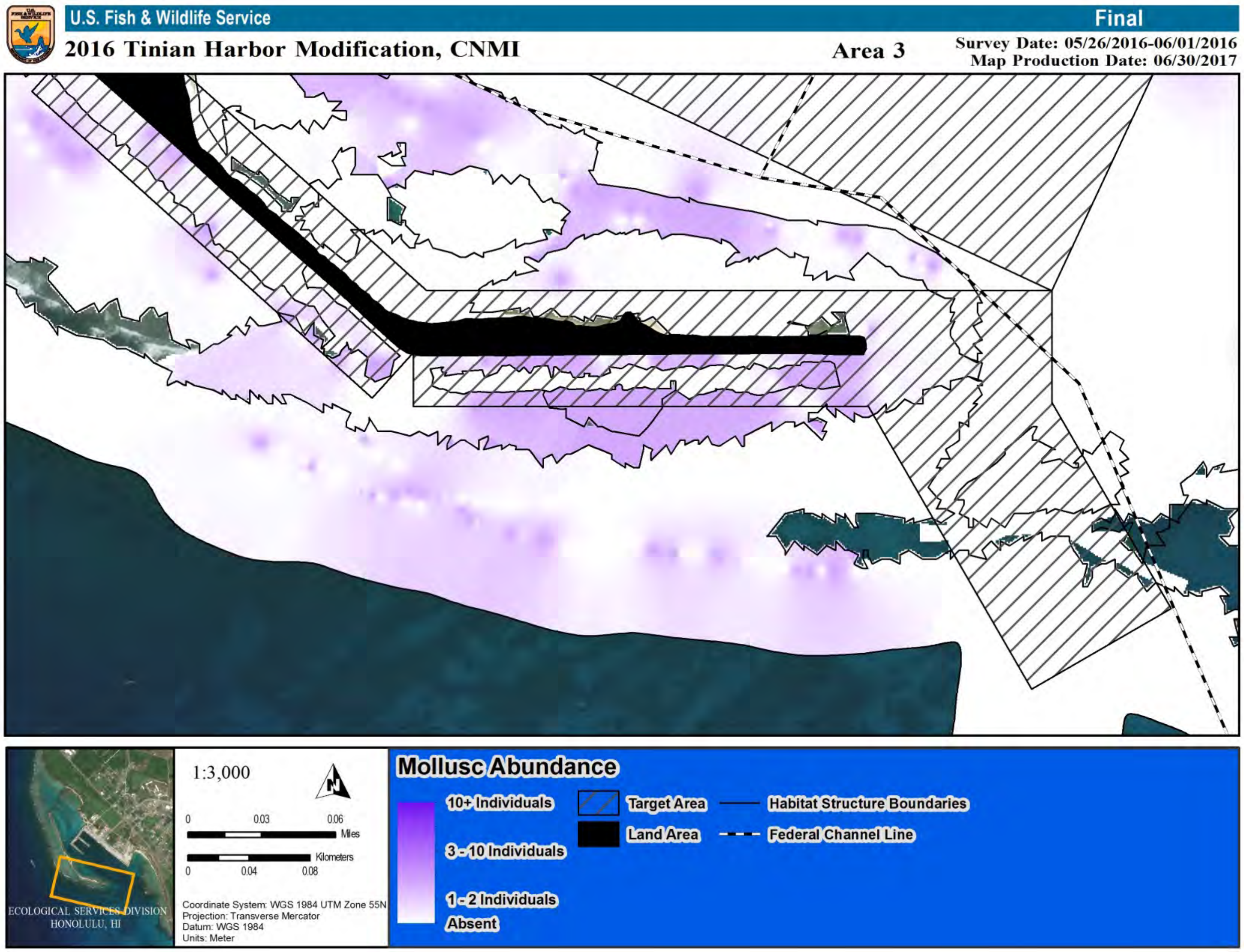

Figure D27: Mollusc Abundance (Area 3). Overview of the mollusc (other than specific species shown in other maps) abundance observed within the project area.

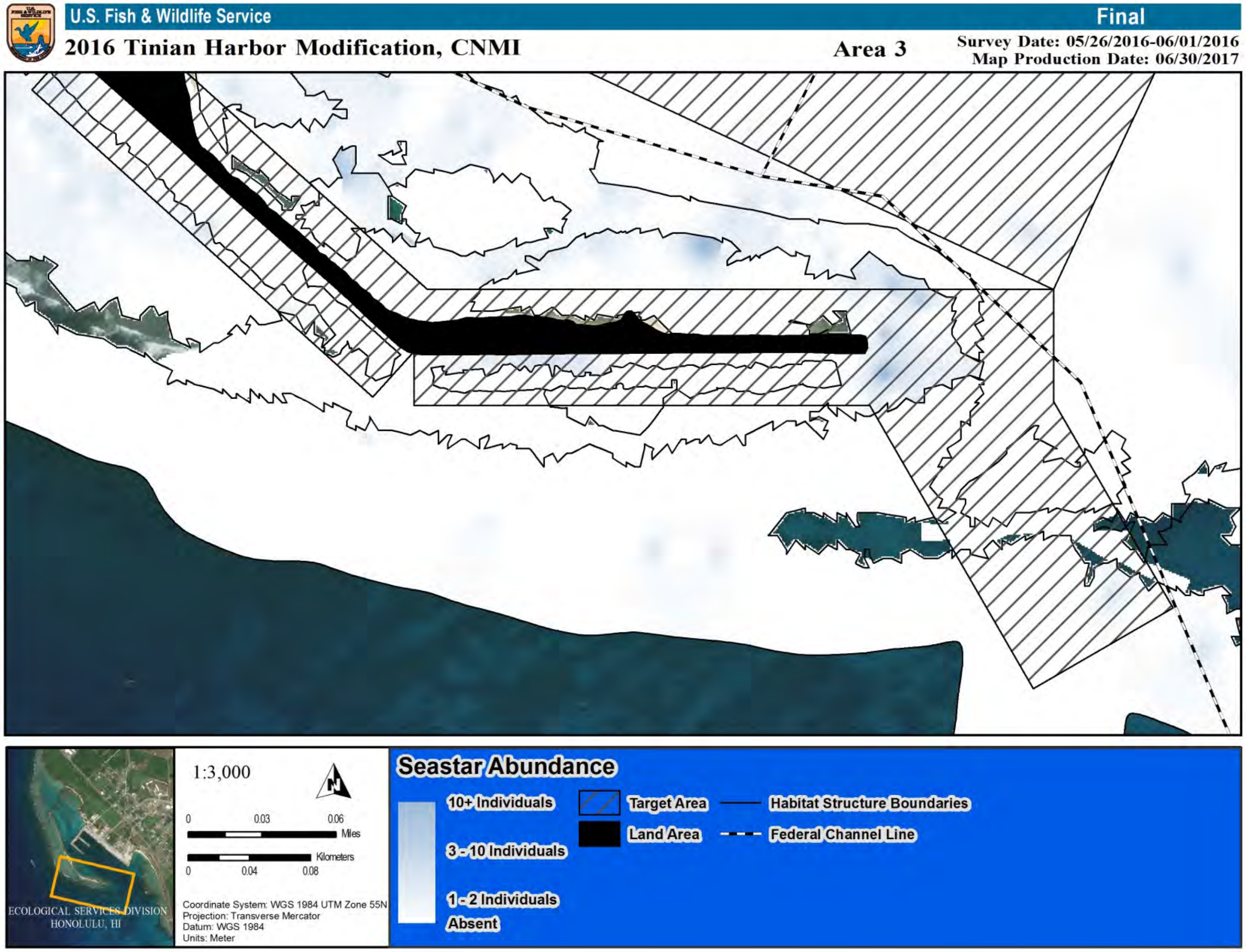

Figure D28: Seastar Abundance (Area 3). Overview of the seastar abundance observed within the project area.

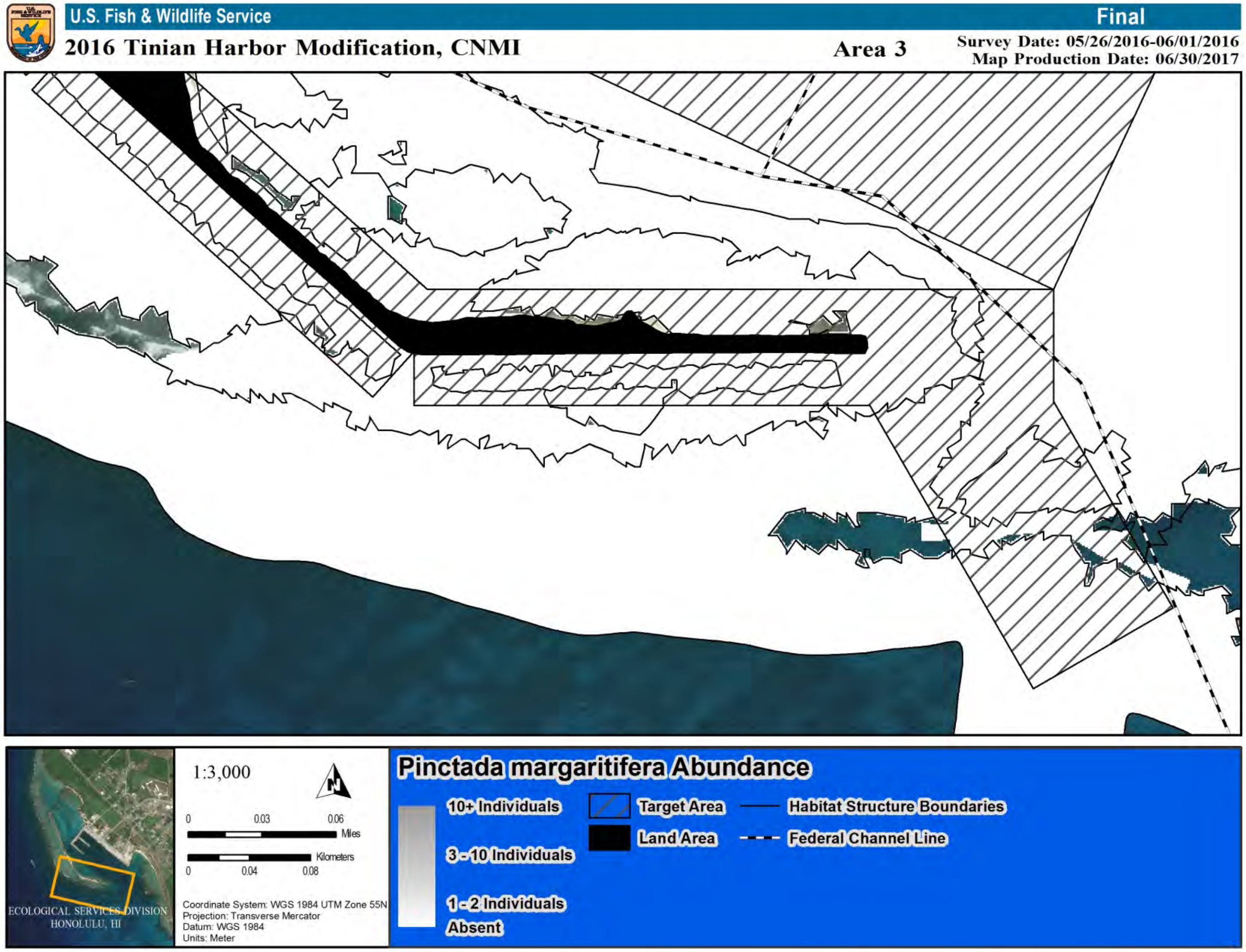

Figure D29: Pinctada Abundance (Area 3). Overview of the mollusc, Pinctada margaritifera, abundance observed within the project area.

Note: No Pinctada margaritifera were observed in this area.

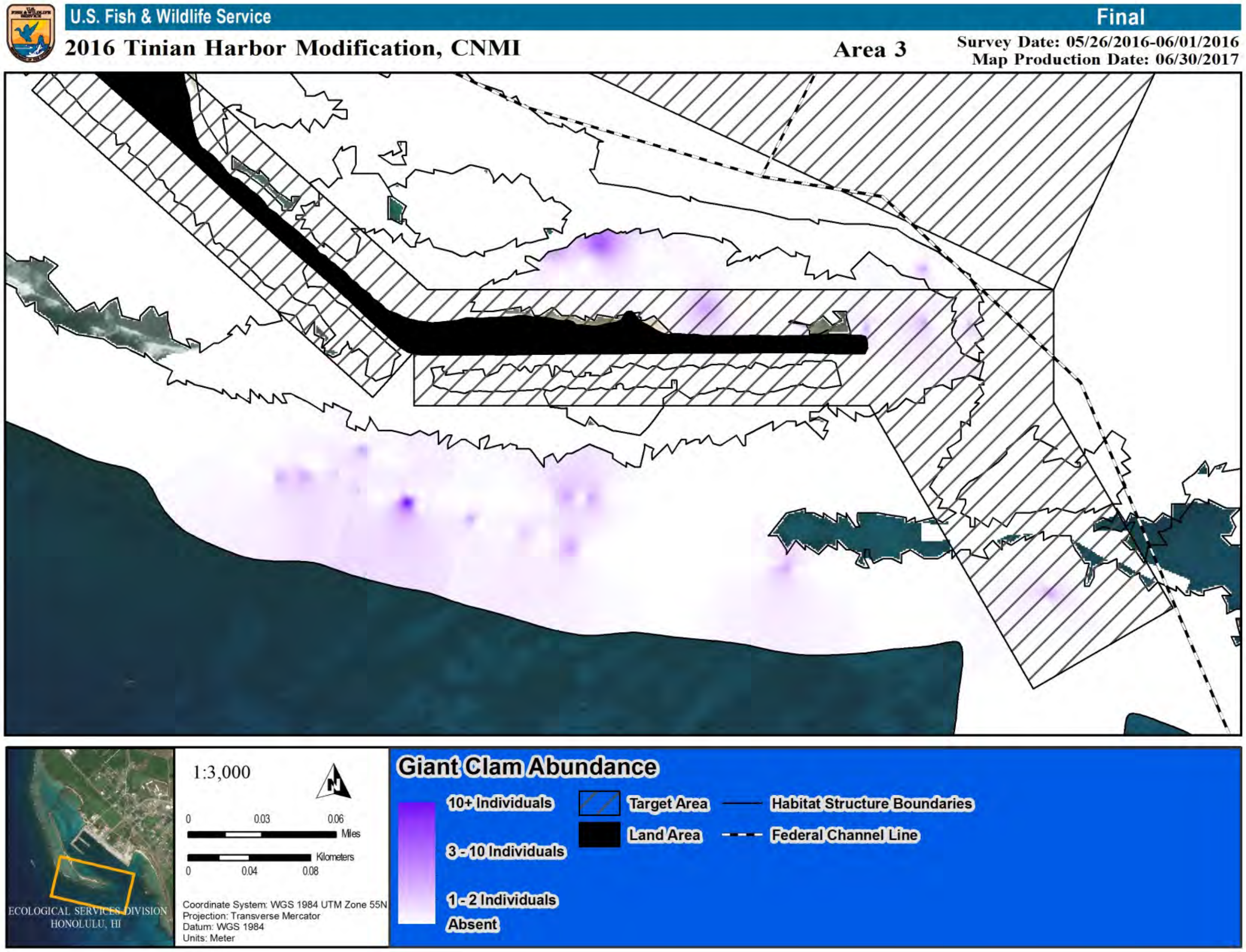

Figure D30: Giant Clam Abundance (Area 3). Overview of the giant clam abundance observed within the project area.

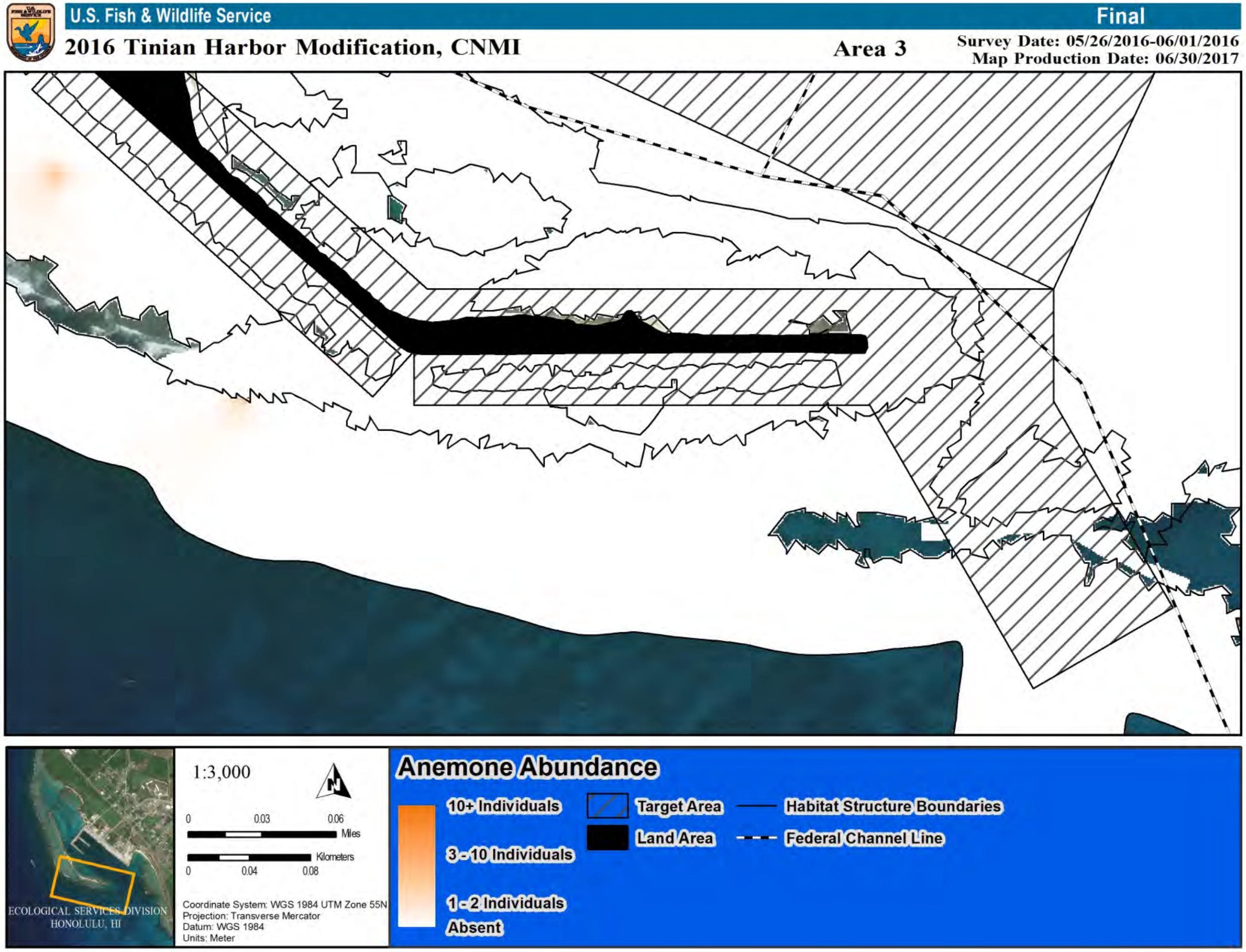

Figure D31: Anemone Abundance (Area 3). Overview of the anemone abundance observed within the project area.

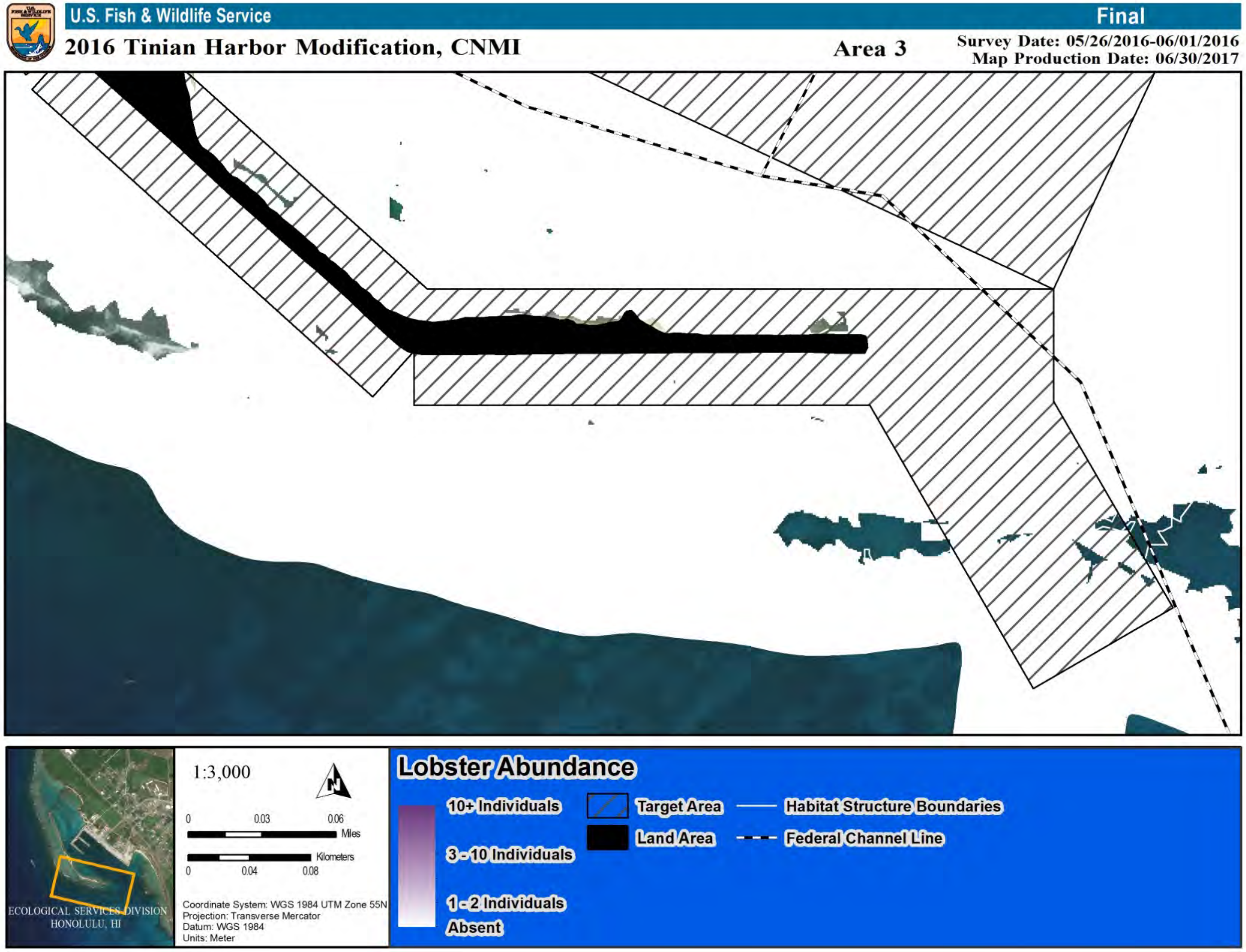

Figure D32: Lobster Abundance (Area 3). Overview of the lobster abundance observed within the project area. Note: No lobsters were observed in this area.

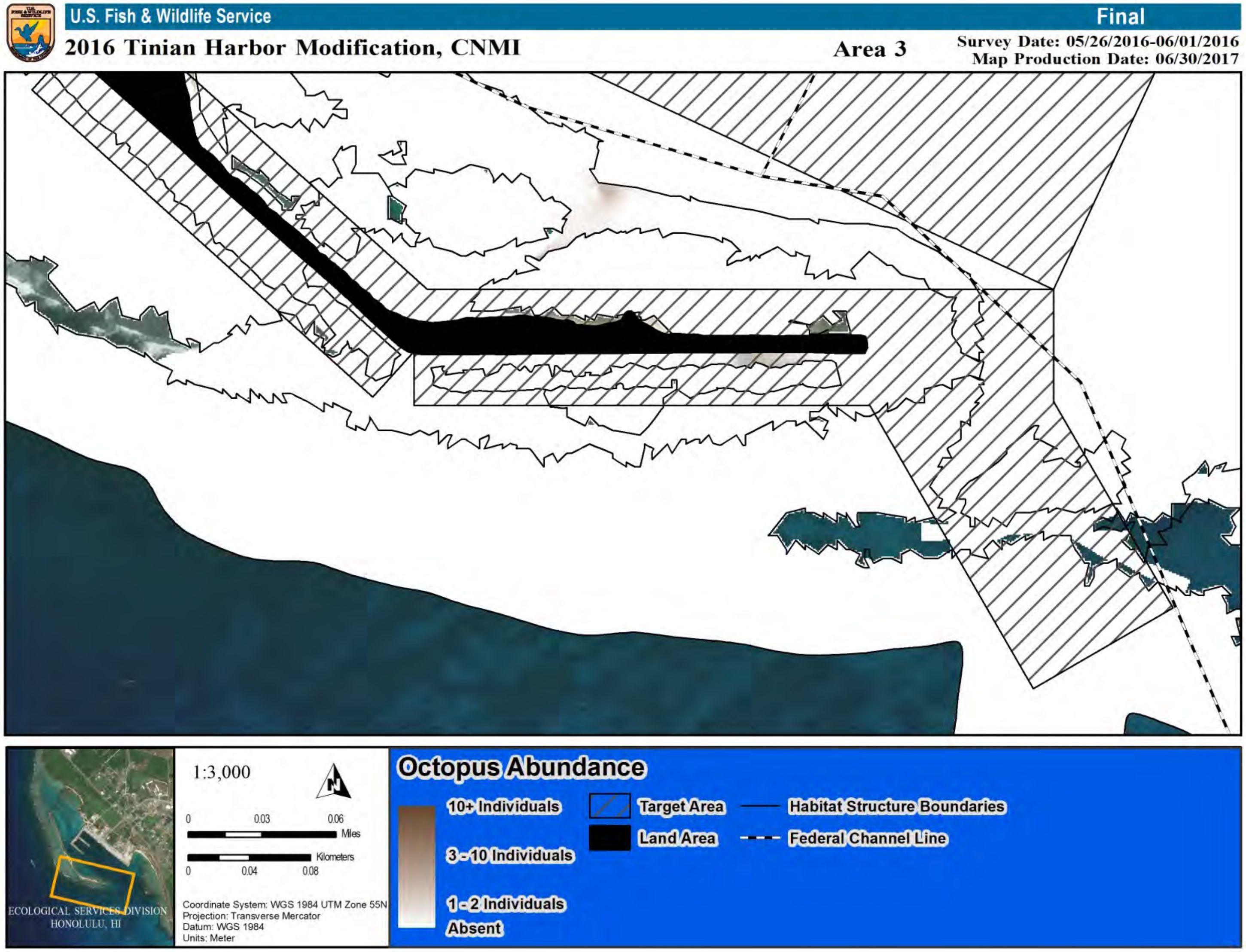

Figure D33: Octopus Abundance (Area 3). Overview of the octopus abundance observed within the project area.

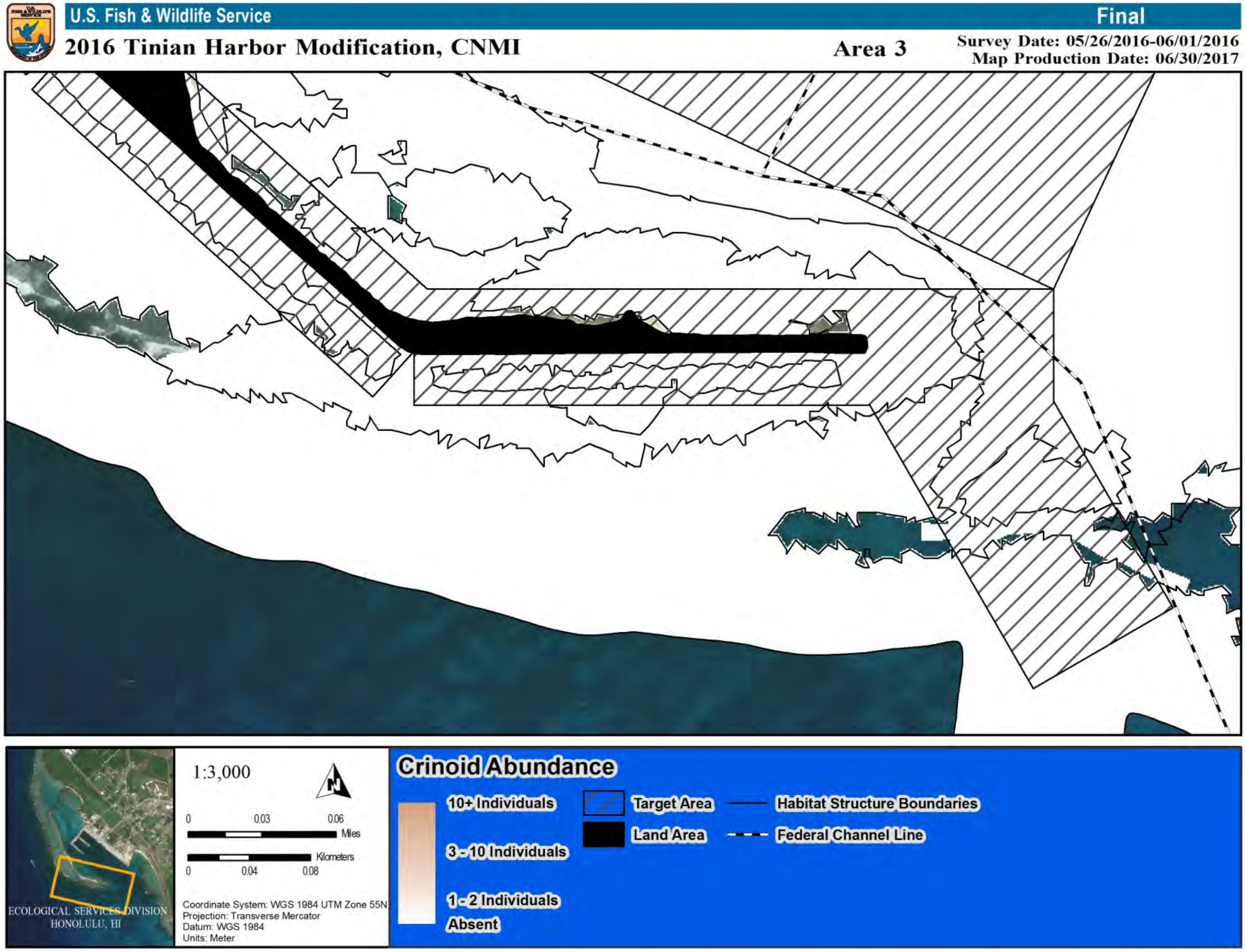

Figure D34: Crinoid Abundance (Area 3). Overview of the crinoid abundance observed within the project area. Note: No crinoids were observed in this area.

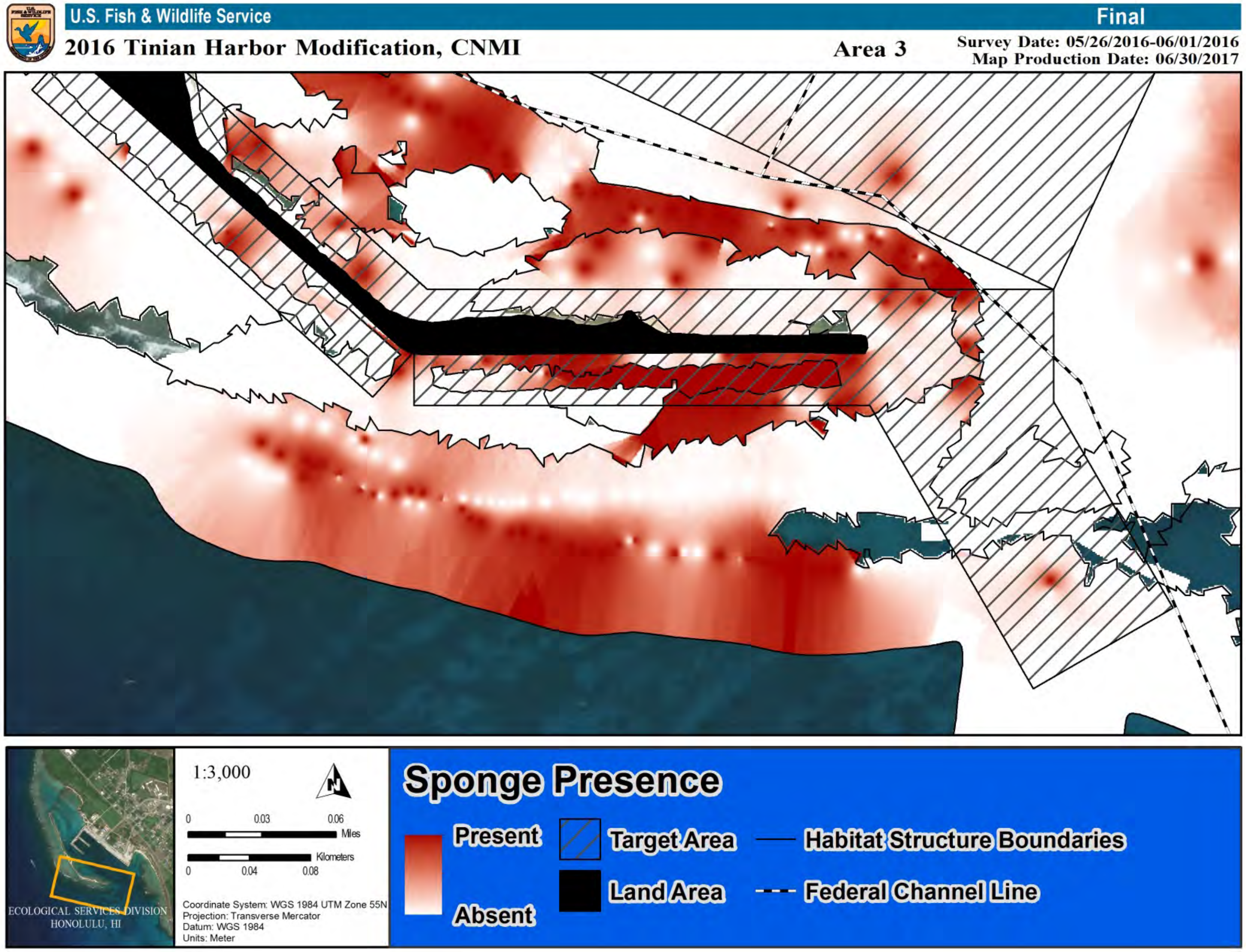

Figure D35: Sponge Presence (Area 3). Overview of the sponge presence observed within the project area.

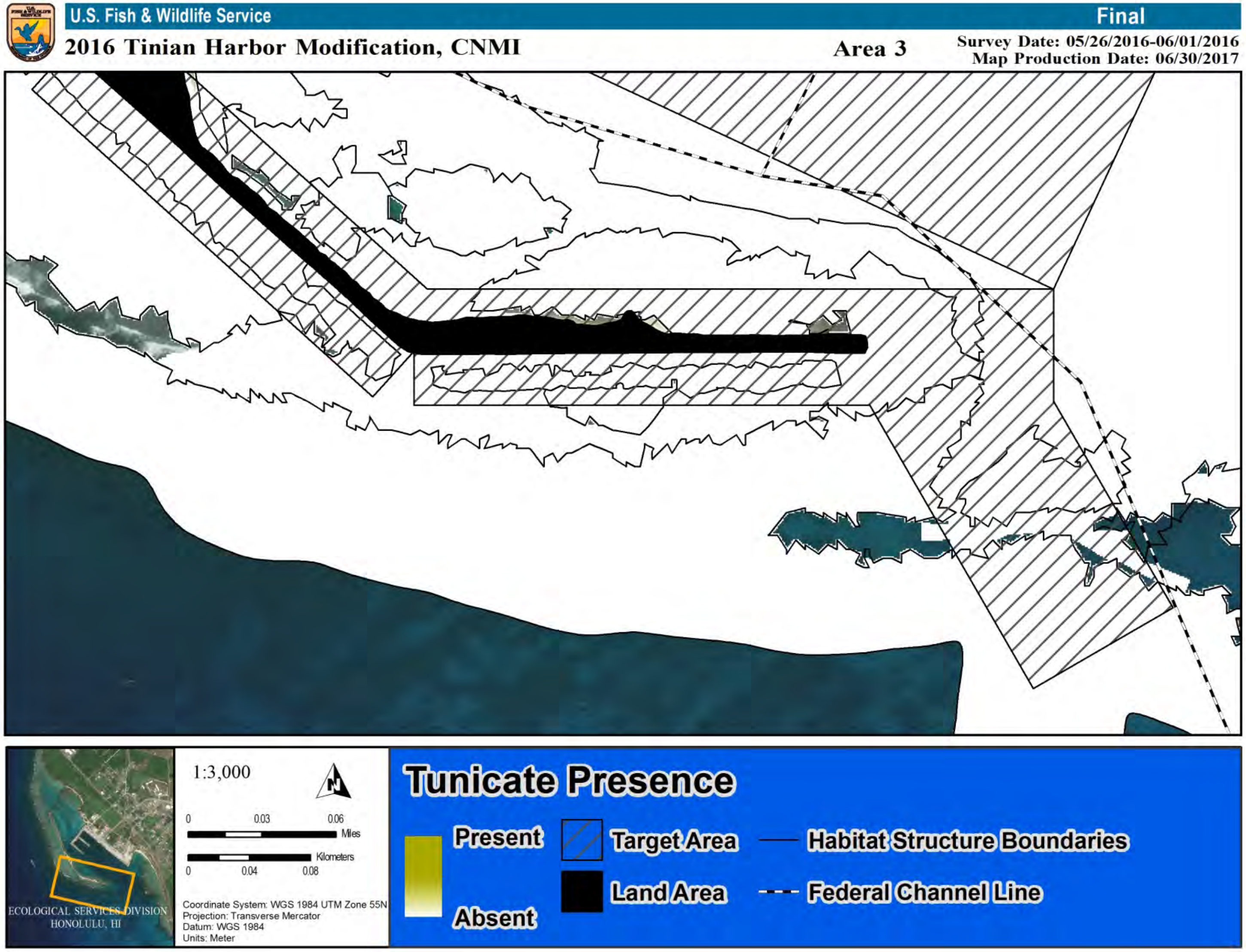

Figure D36: Tunicate Presence (Area 3). Overview of the tunicate presence observed within the project area.

APPENDIX E: Maps of Tinian Harbor Modification Project (Area 4)

Appendix E. Maps of Tinian Harbor Modification Project (Area 4).

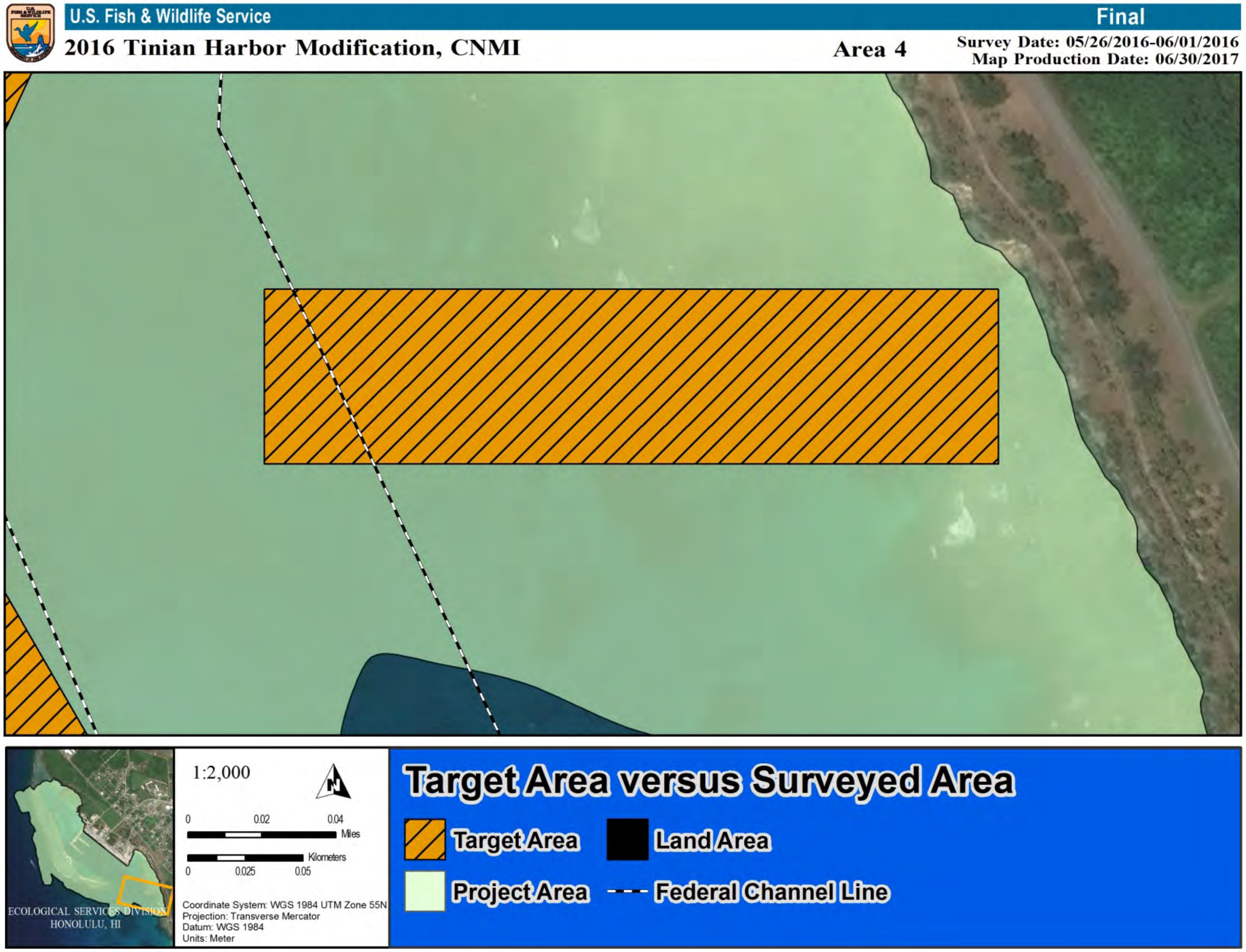

Figure E1: Target Area vs. Surveyed Area (Area 4). Overview of the Project Area (total surveyed area plus project footprint) versus the Target Area (project footprint).

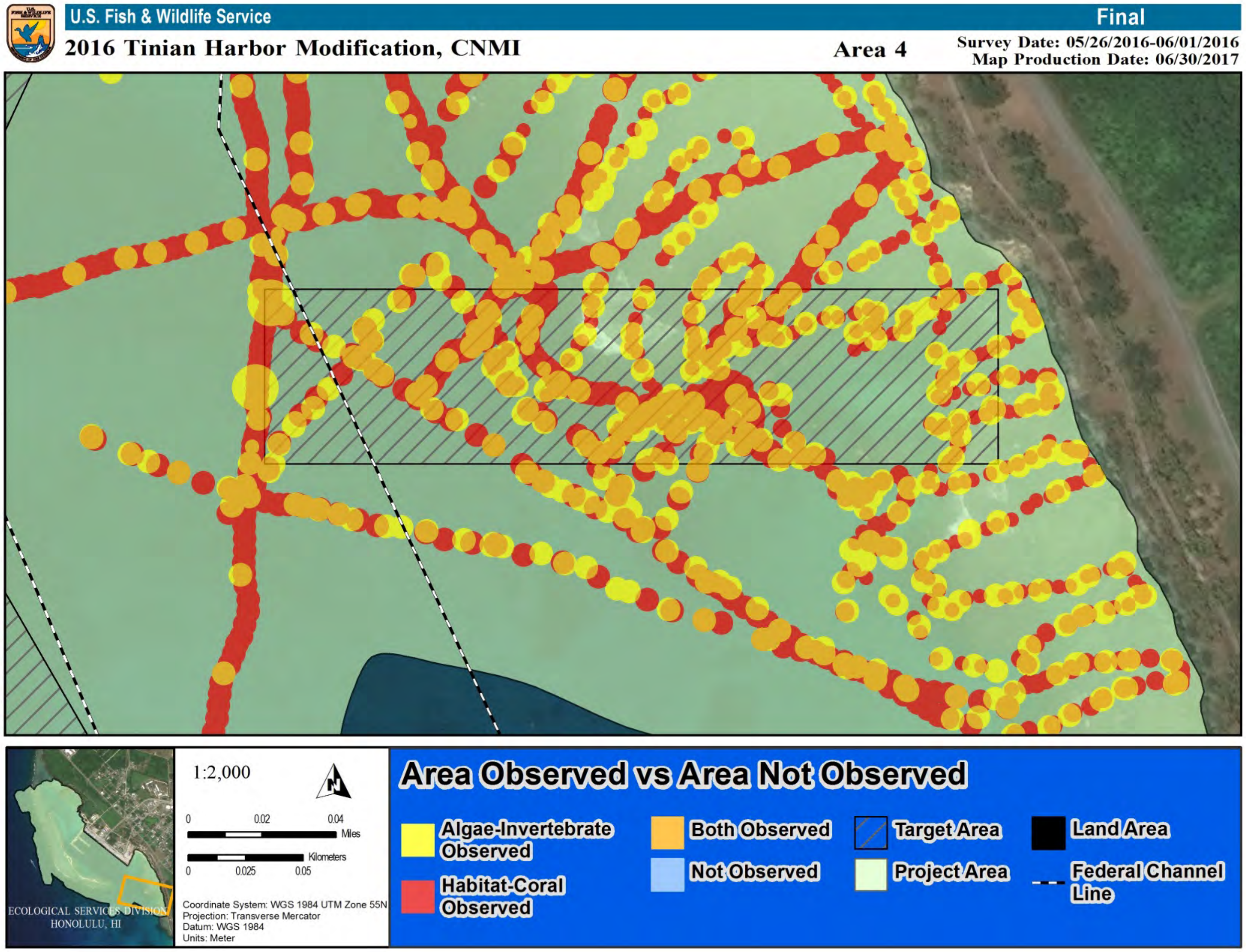

Figure E2: Area Observed (Area 4). Overview of the area observed by in-water observers versus the area interpolated in all maps.

Figure E3: Dive Tracks (Area 4). Overview of the dive track lines for all survey transects.

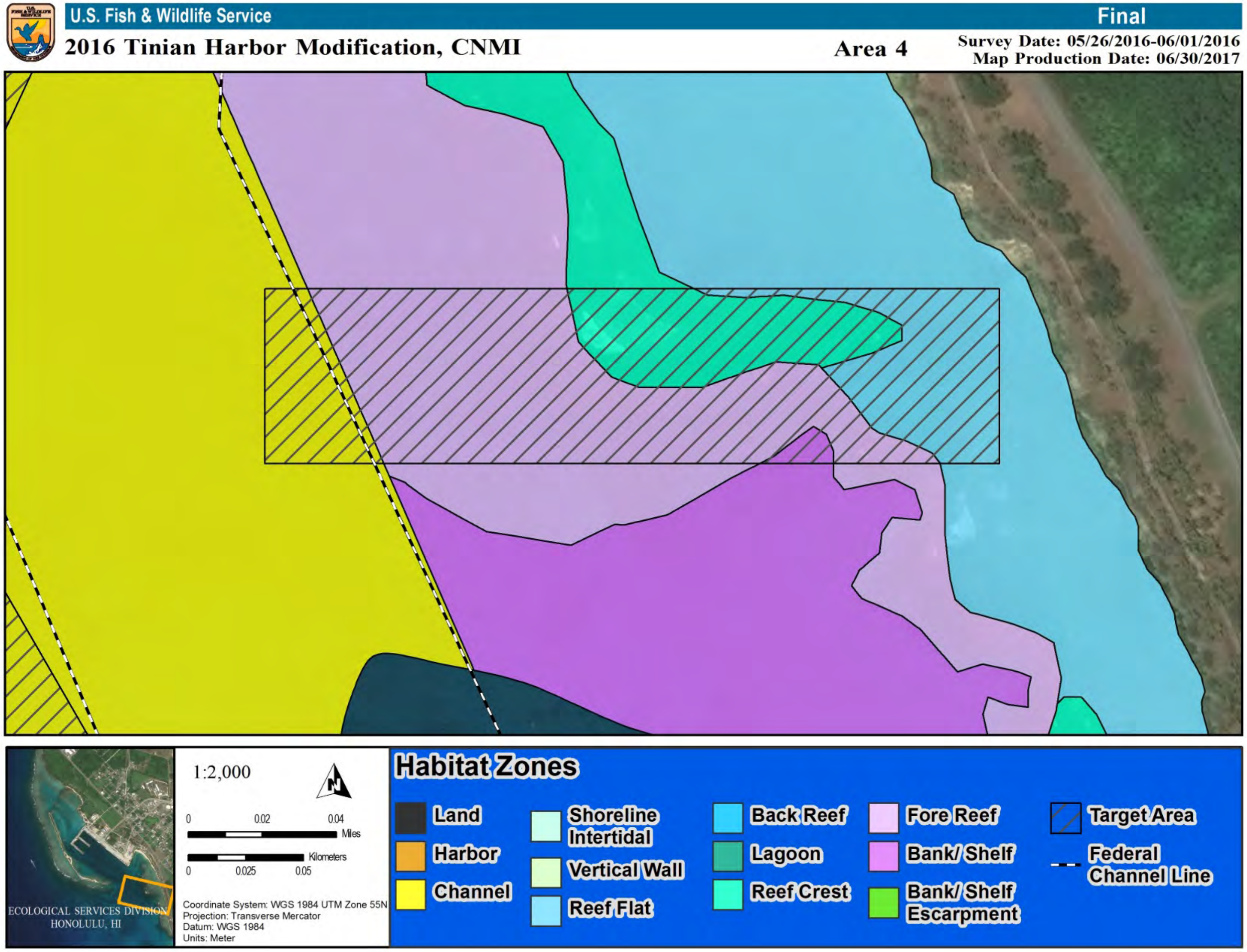

Figure E4: Habitat Zones (Area 4). Overview of the various habitat zones that the project area contains.

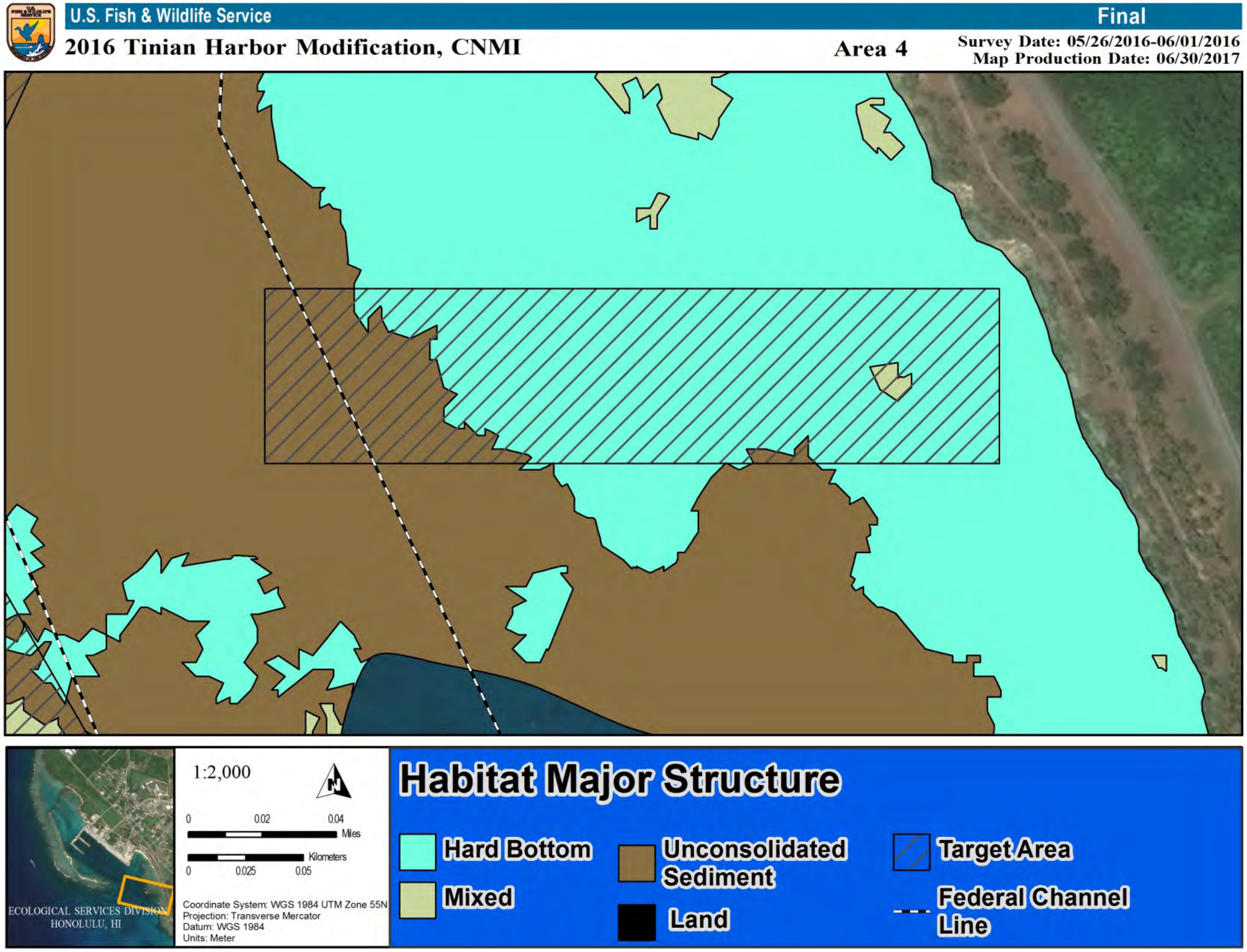

Figure E5: Habitat Major Structure (Area 4). Overview of the major habitat structures that the project area contains.

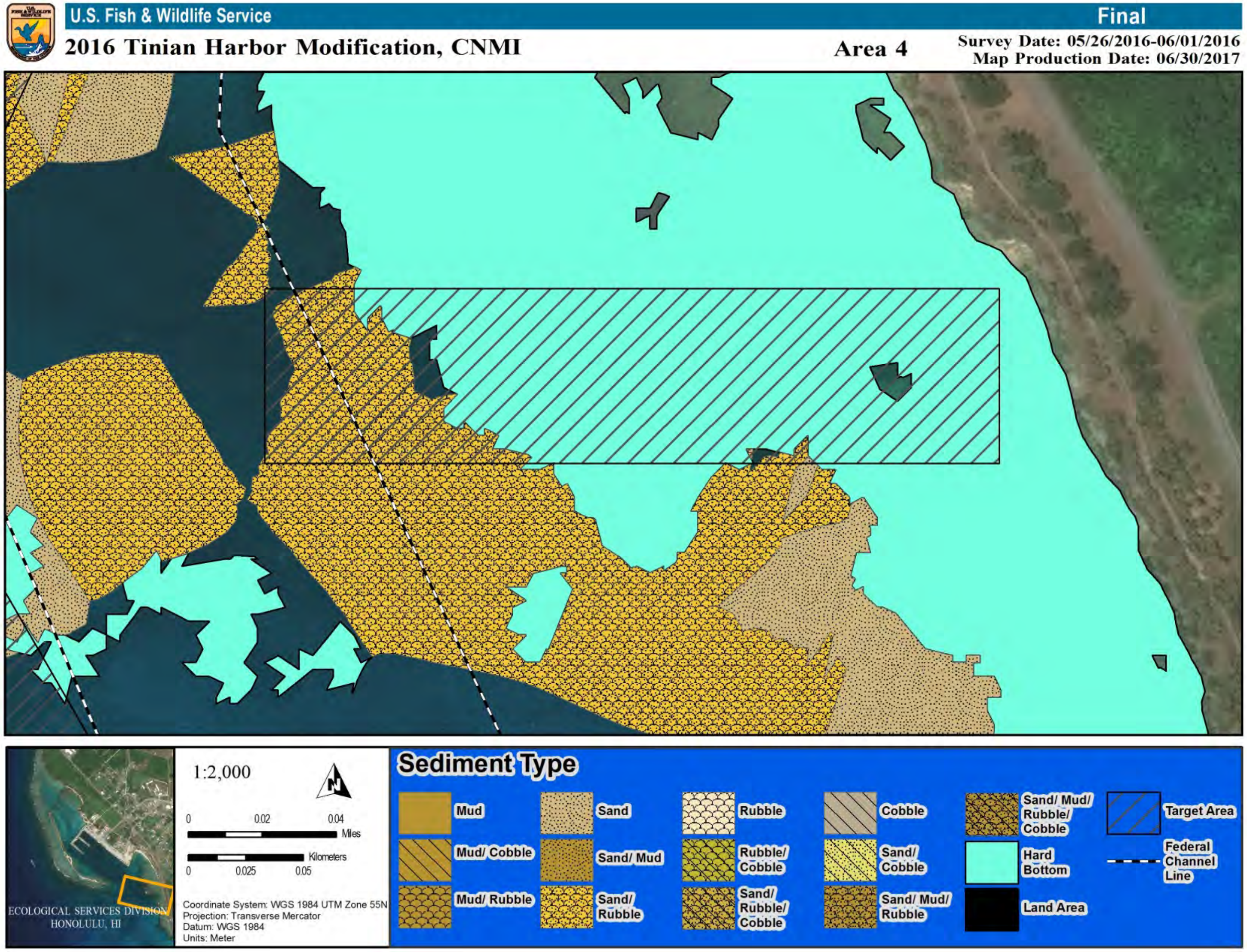

Figure E6: Sediment Type (Area 4). Overview of the various sediment types that the project area contains.

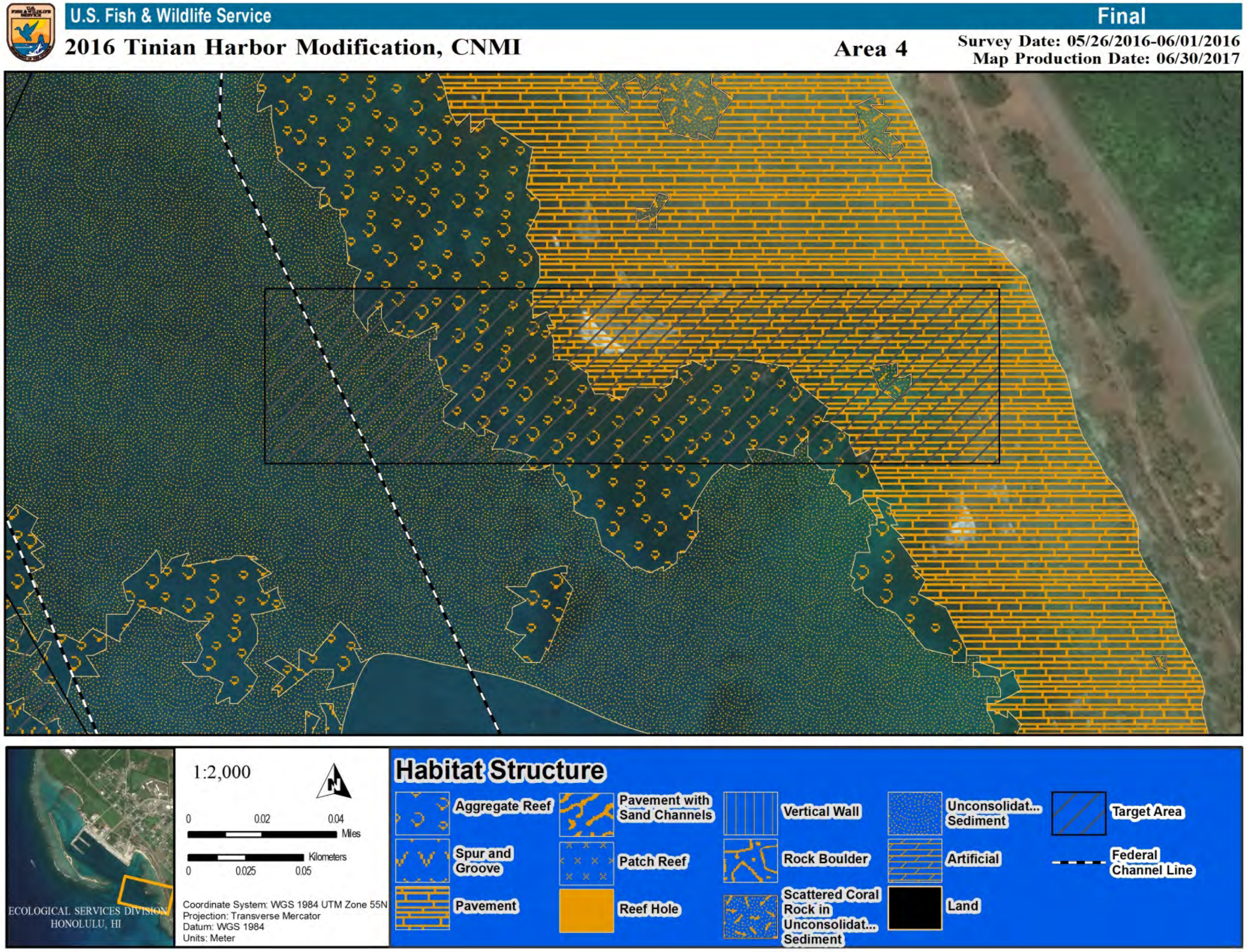

Figure E7: Habitat Structure (Area 4). Overview of the habitat structures that the project area contains.

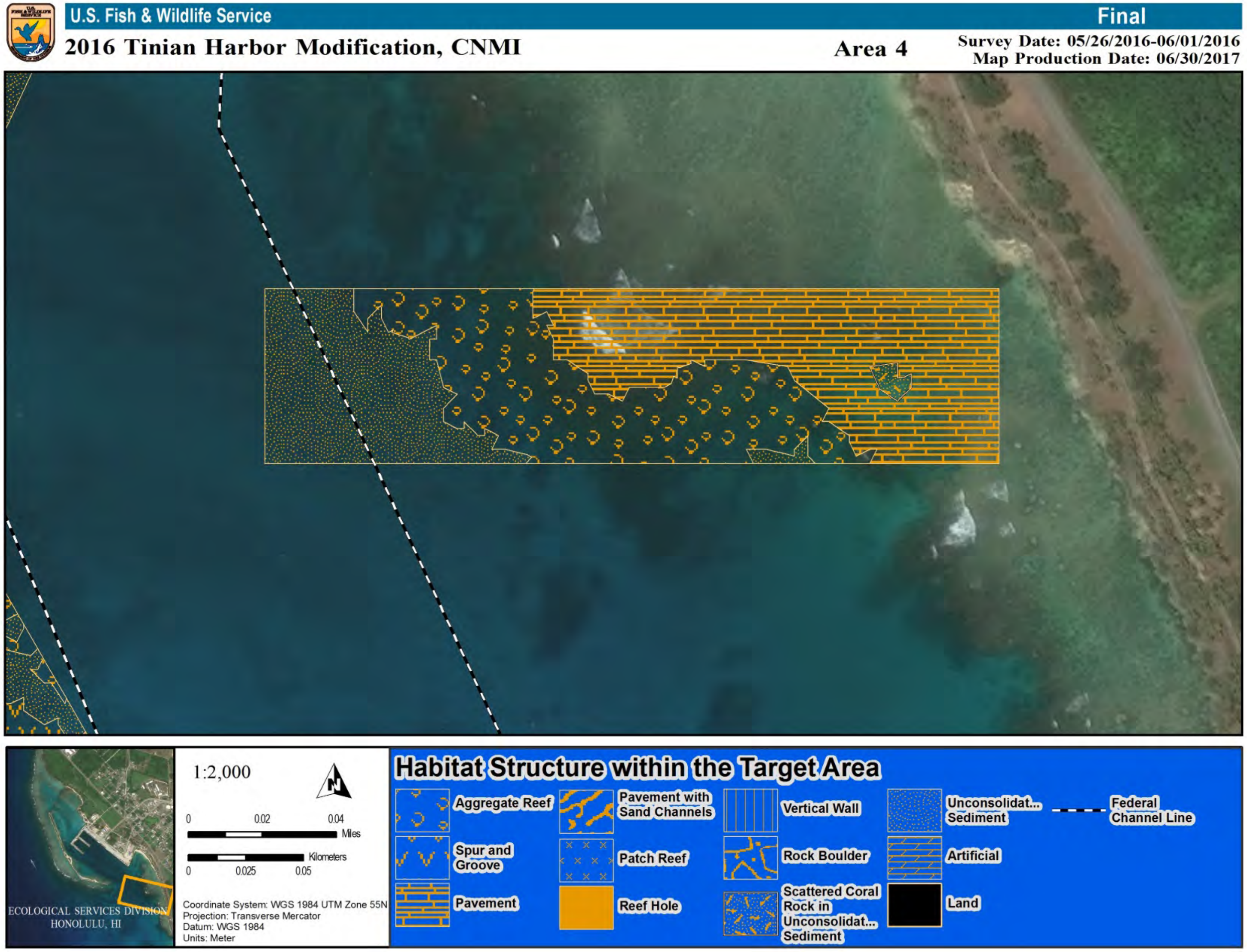

Figure E8: Habitat Structure in Target Area (Area 4). Overview of the habitat structures within the project footprint (Target Area).

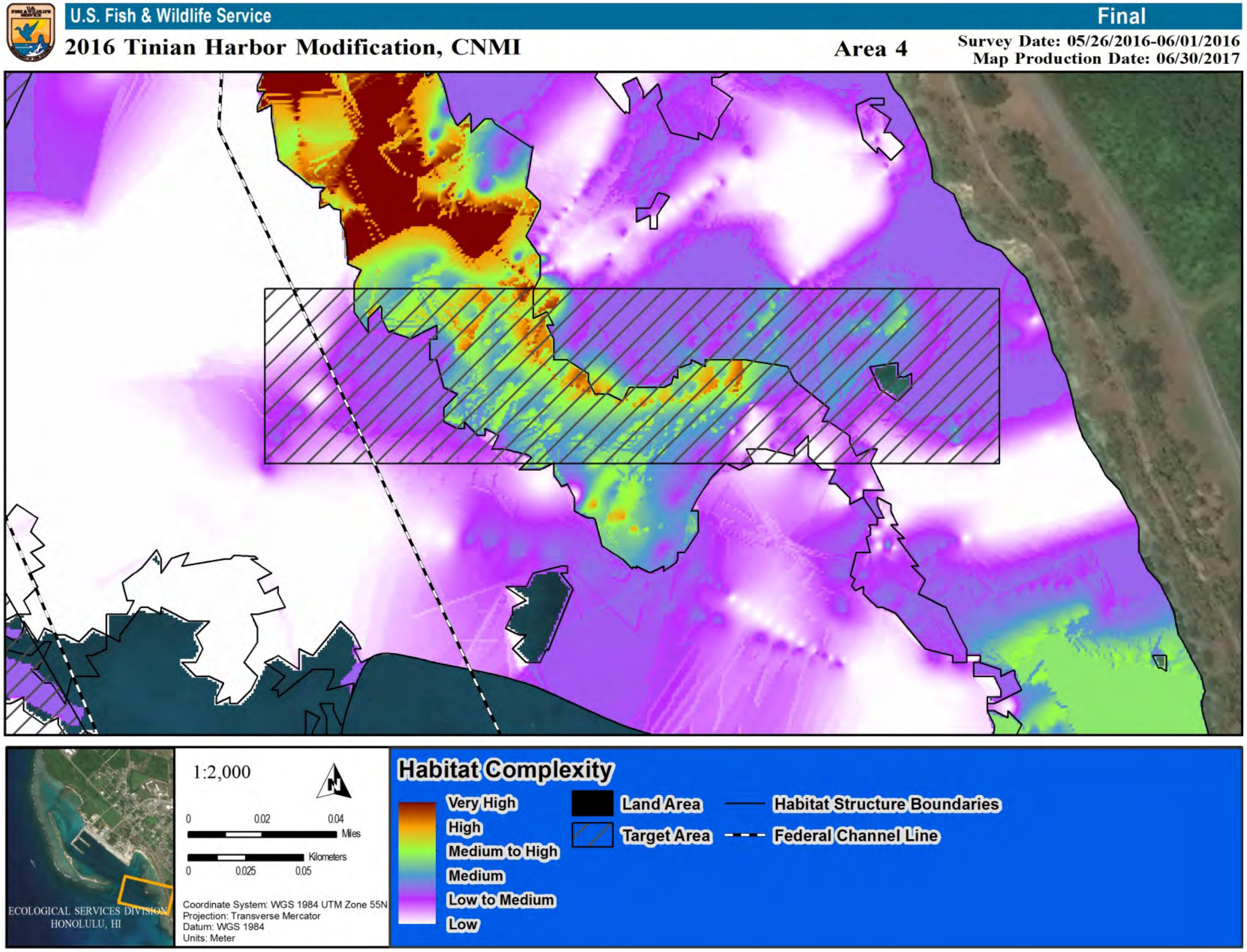

Figure E9: Habitat Complexity (Area 4). Overview of the habitat complexity observed within the project area.

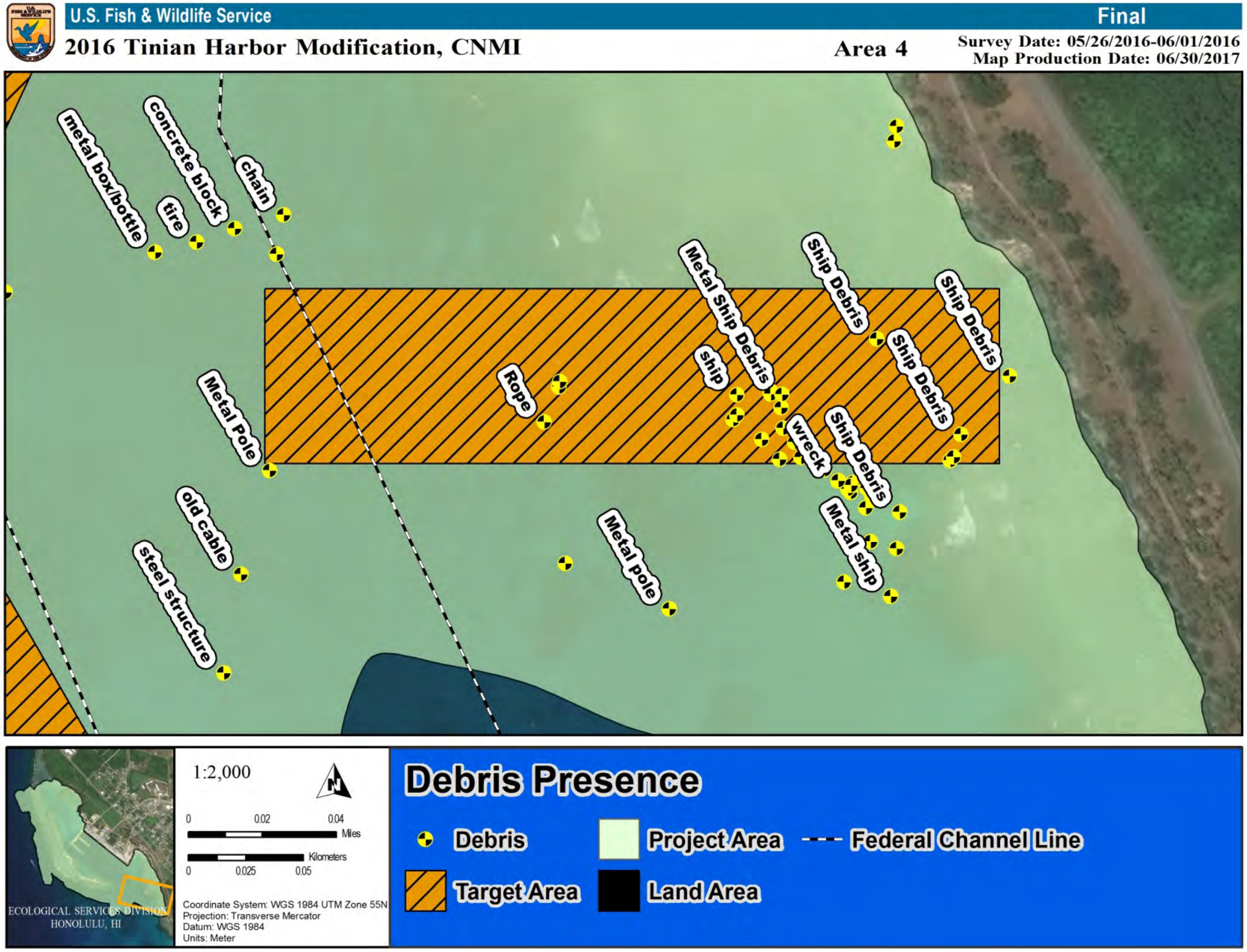

Figure E10: Debris (Area 4). Overview of the debris observed within the project area.

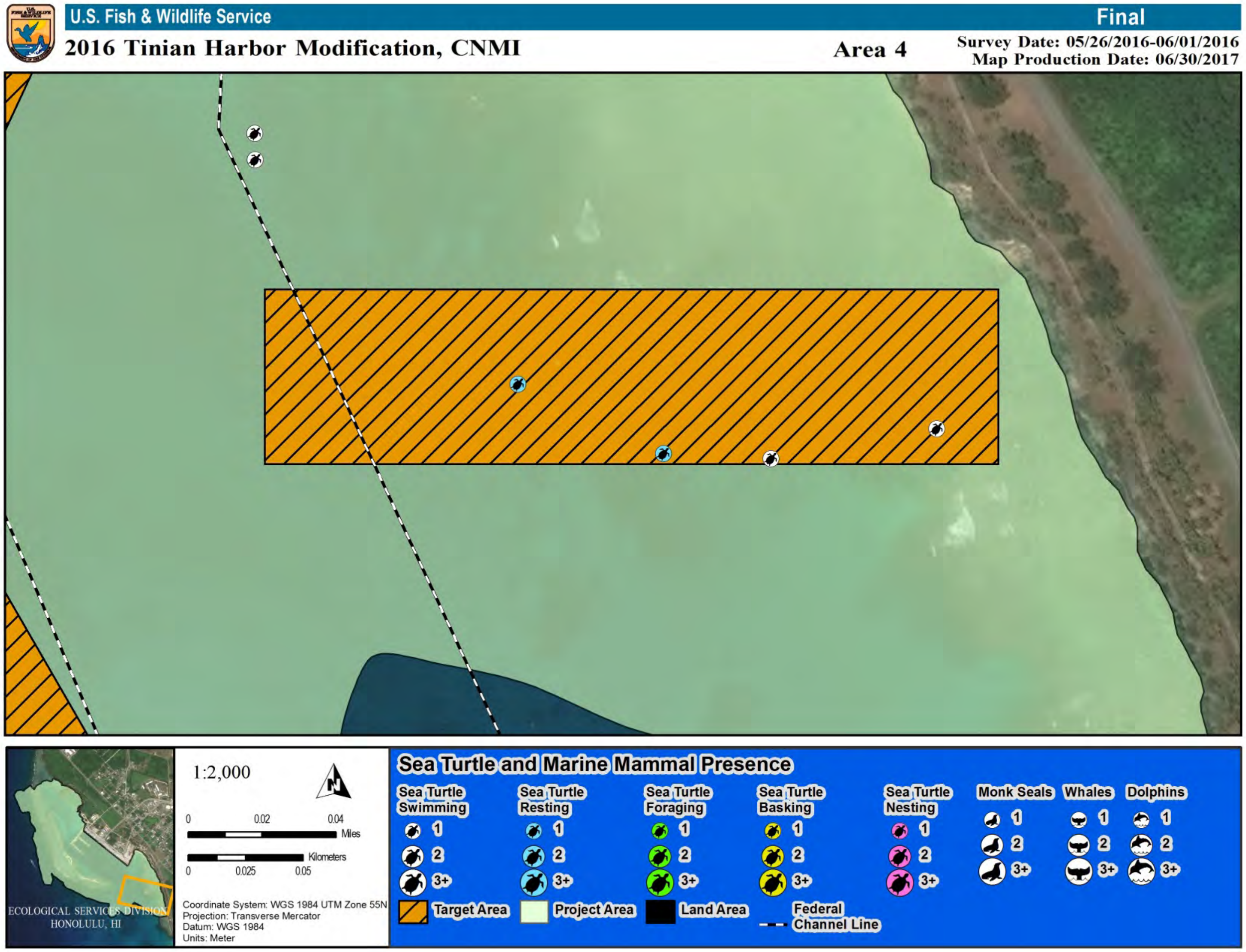

Figure E11: Protected Species (Area 4). Overview of the observed protected species within the project area.

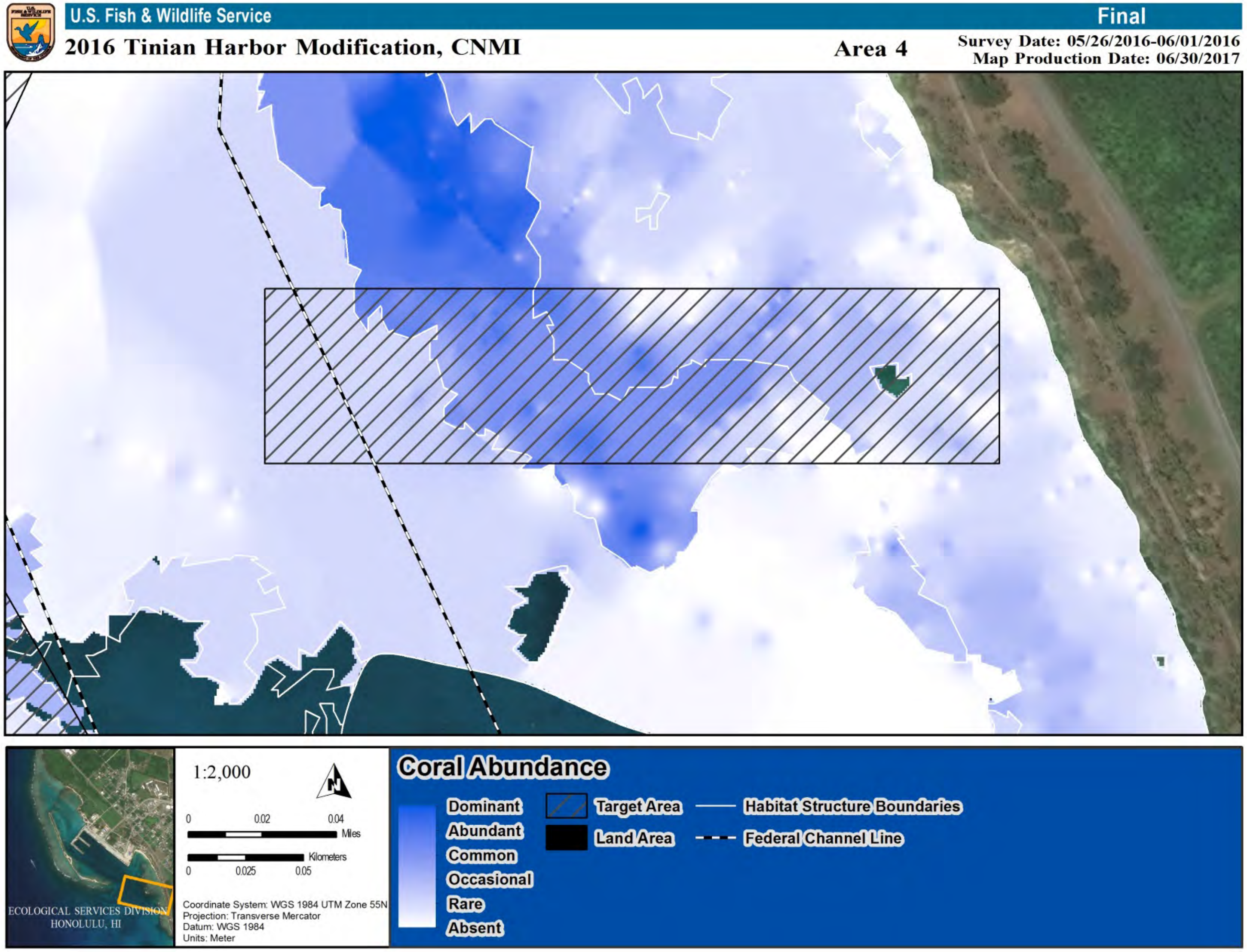

Figure E12: Coral Abundance (Area 4). Overview of the coral abundance within the project.

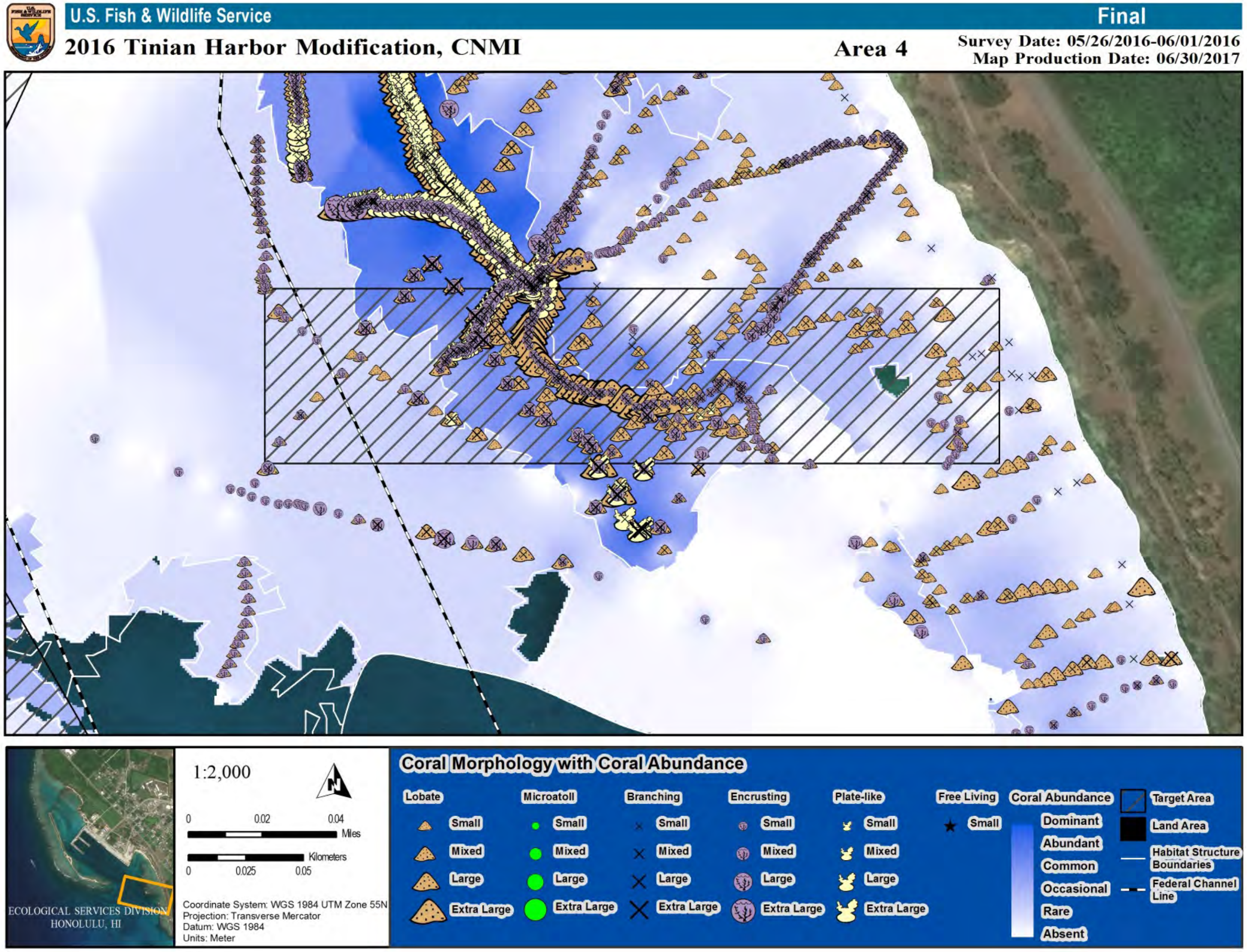

Figure E13: Coral Morphologies (Area 4). Overview of the various coral morphologies and broad coral sizes observed within the project area.

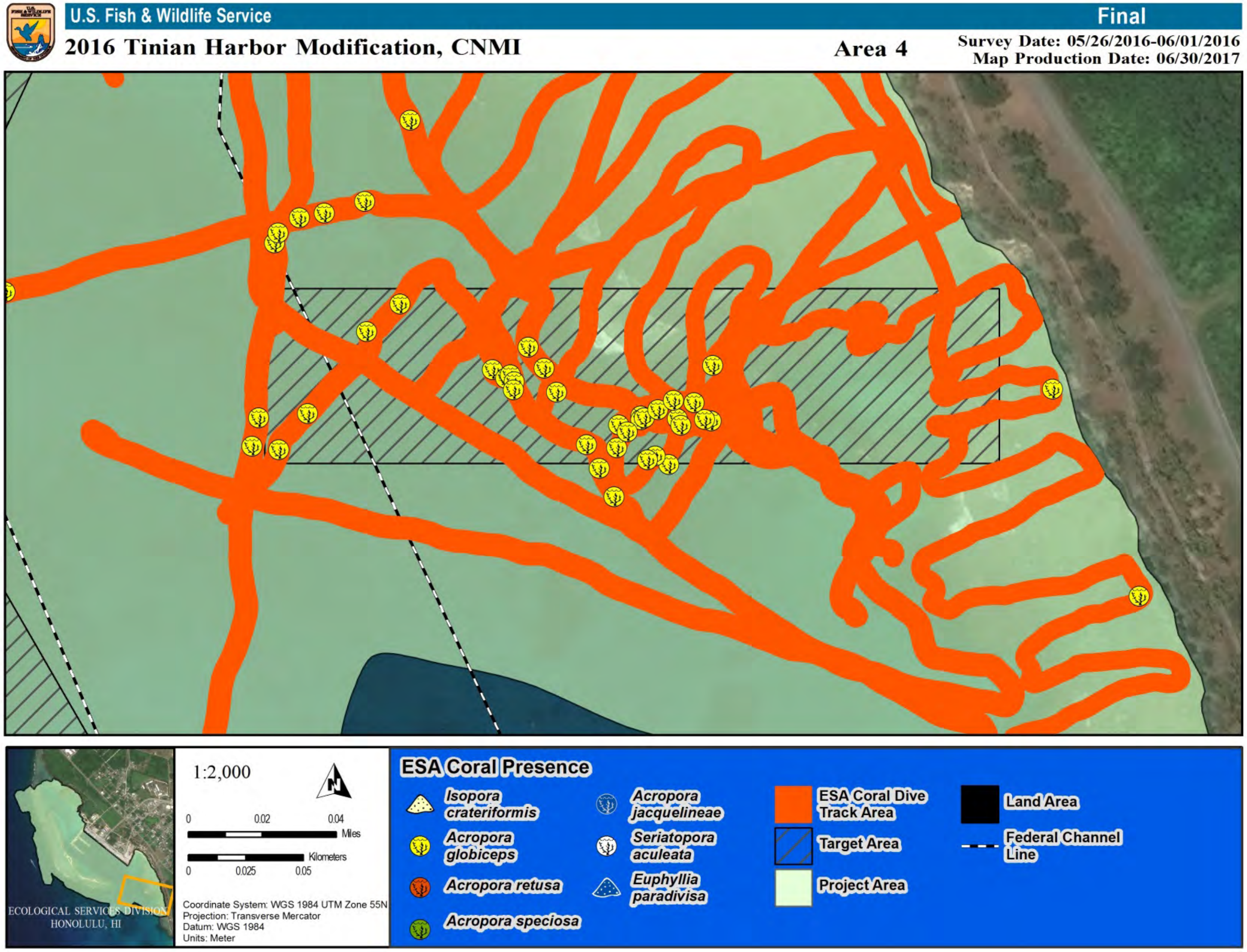

Figure E14: ESA-listed Corals (Area 4). Overview of the ESA-listed coral species observed within the project area.

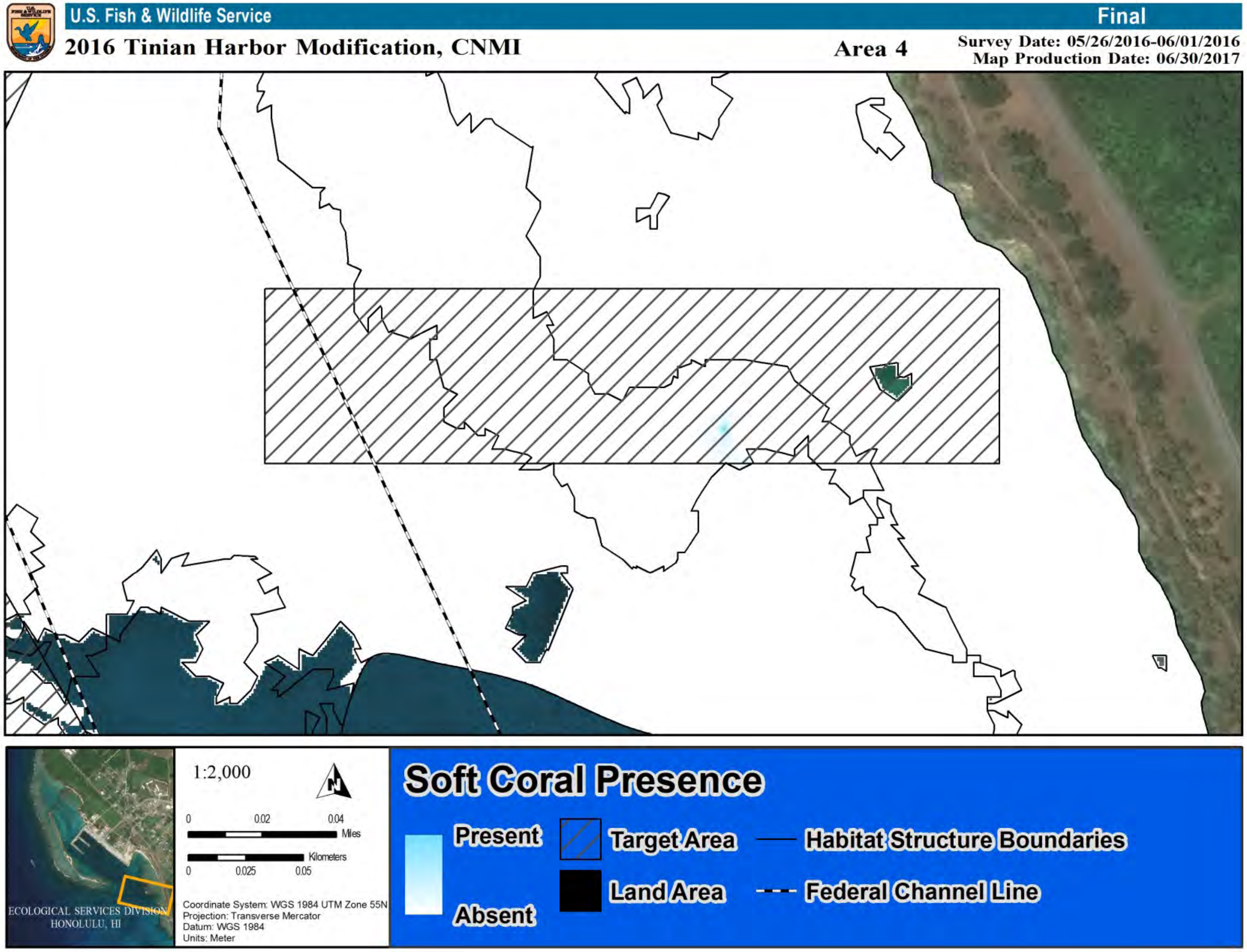

Figure E15: Soft Coral Presence (Area 4). Overview of the soft coral presence within the project area. Note: No soft corals were observed in this area.

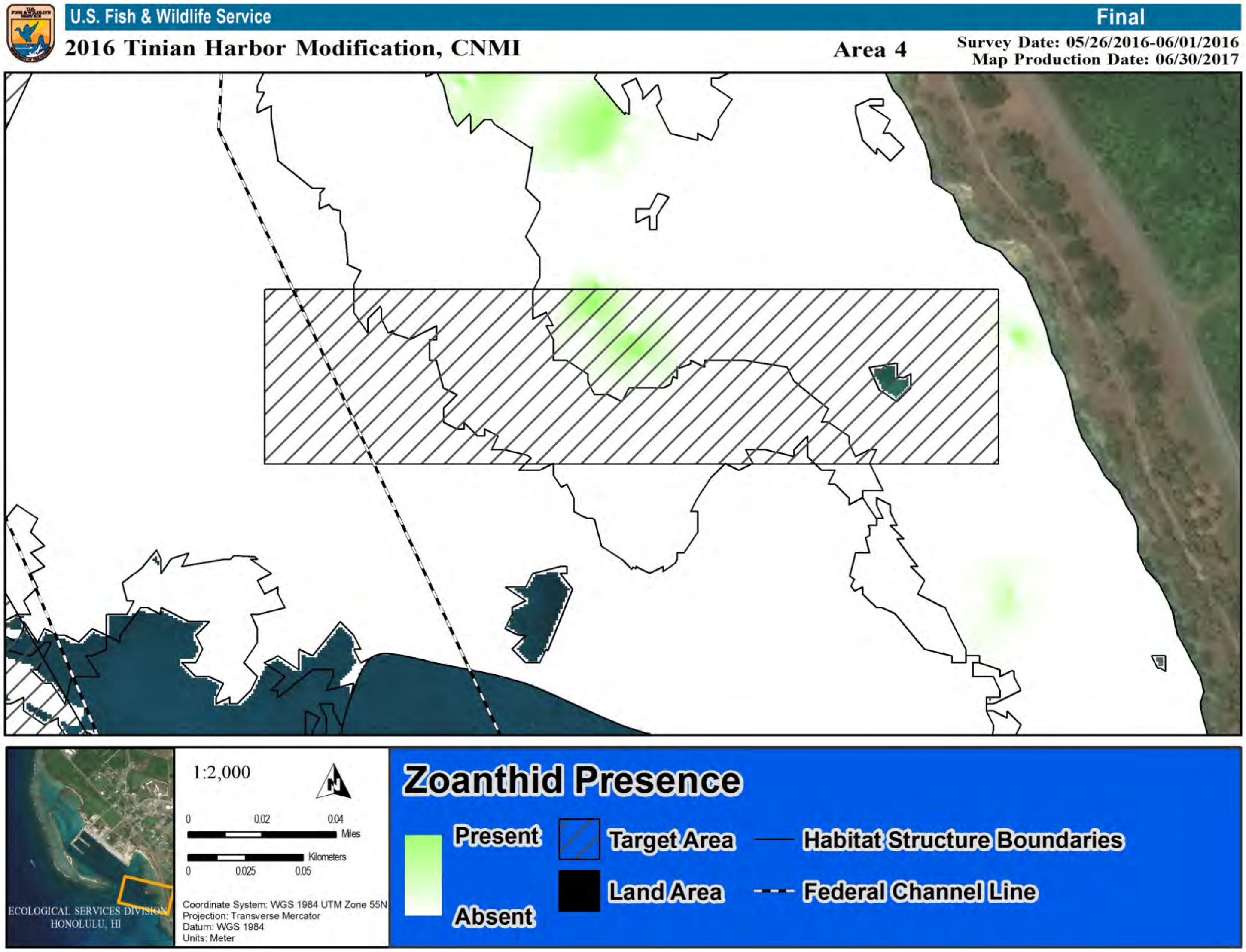

Figure E16: Zonathid Presence (Area 4). Overview of the zoanthid (relative to corals) presence within the project area.

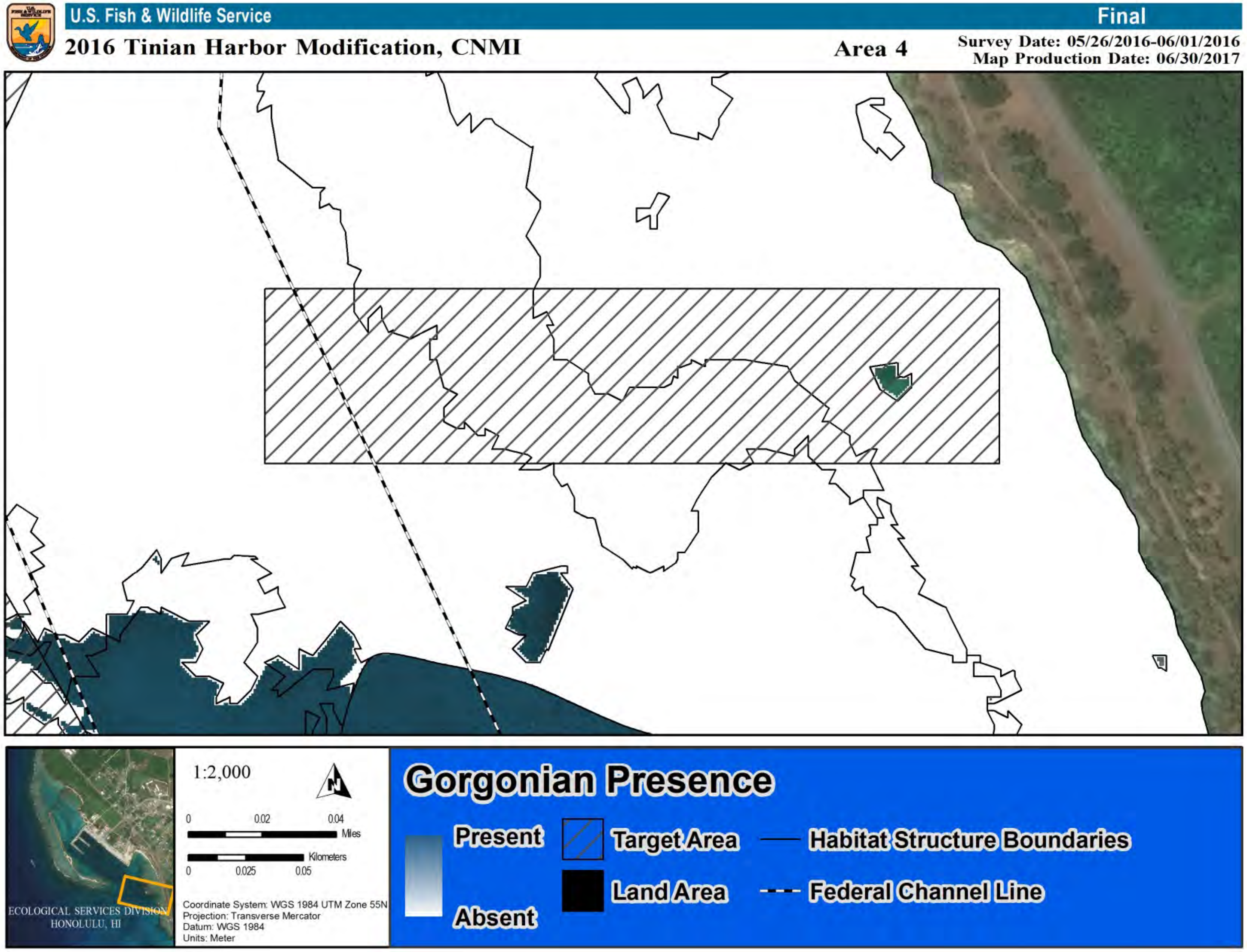

Figure E17: Gorgonian Presence (Area 4). Overview of the gorgonian coral presence within the project area. Note: No gorgonians were observed in this area.

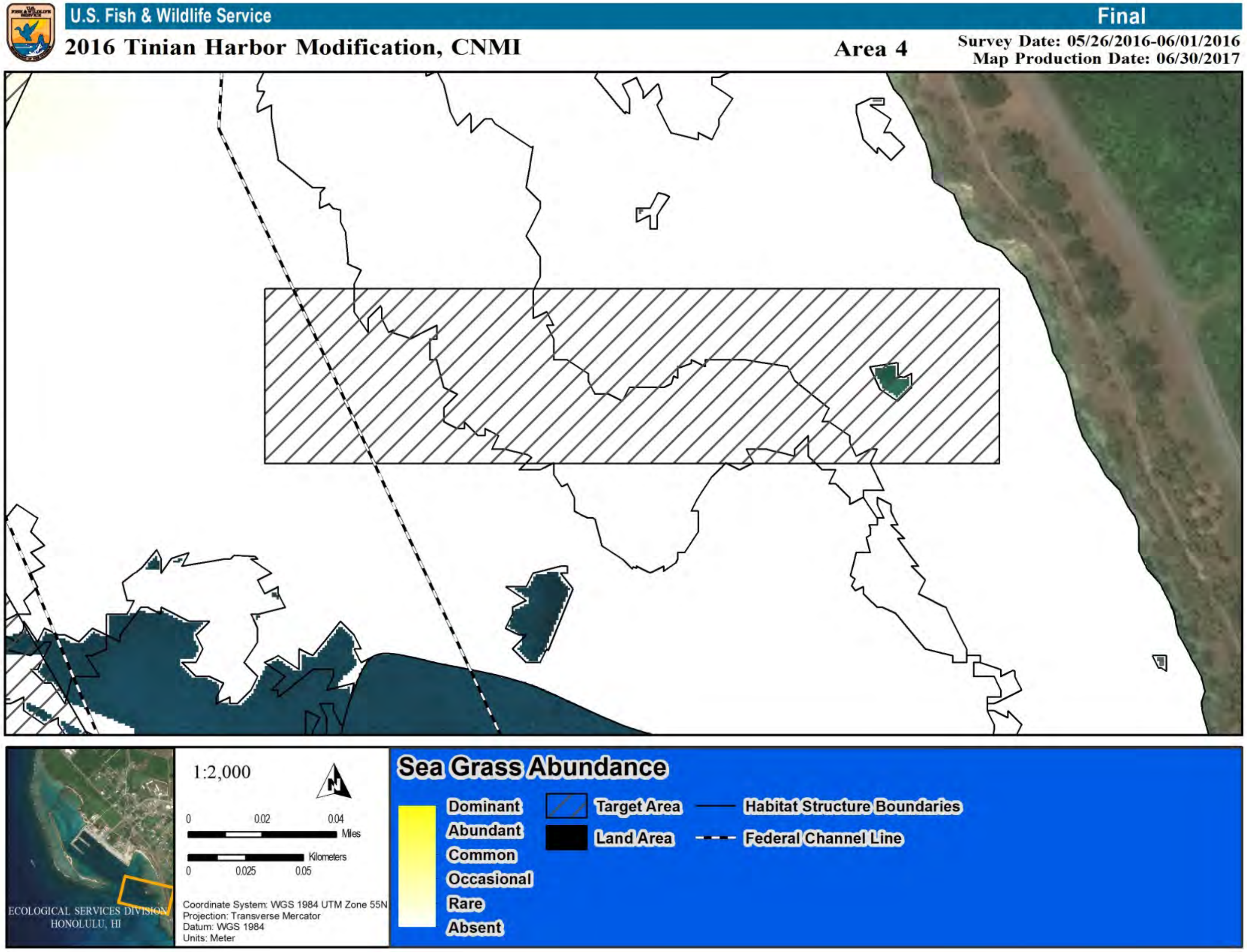

Figure E18: Sea Grass Abundance (Area 4). Overview of the seagrass abundance within the project area.

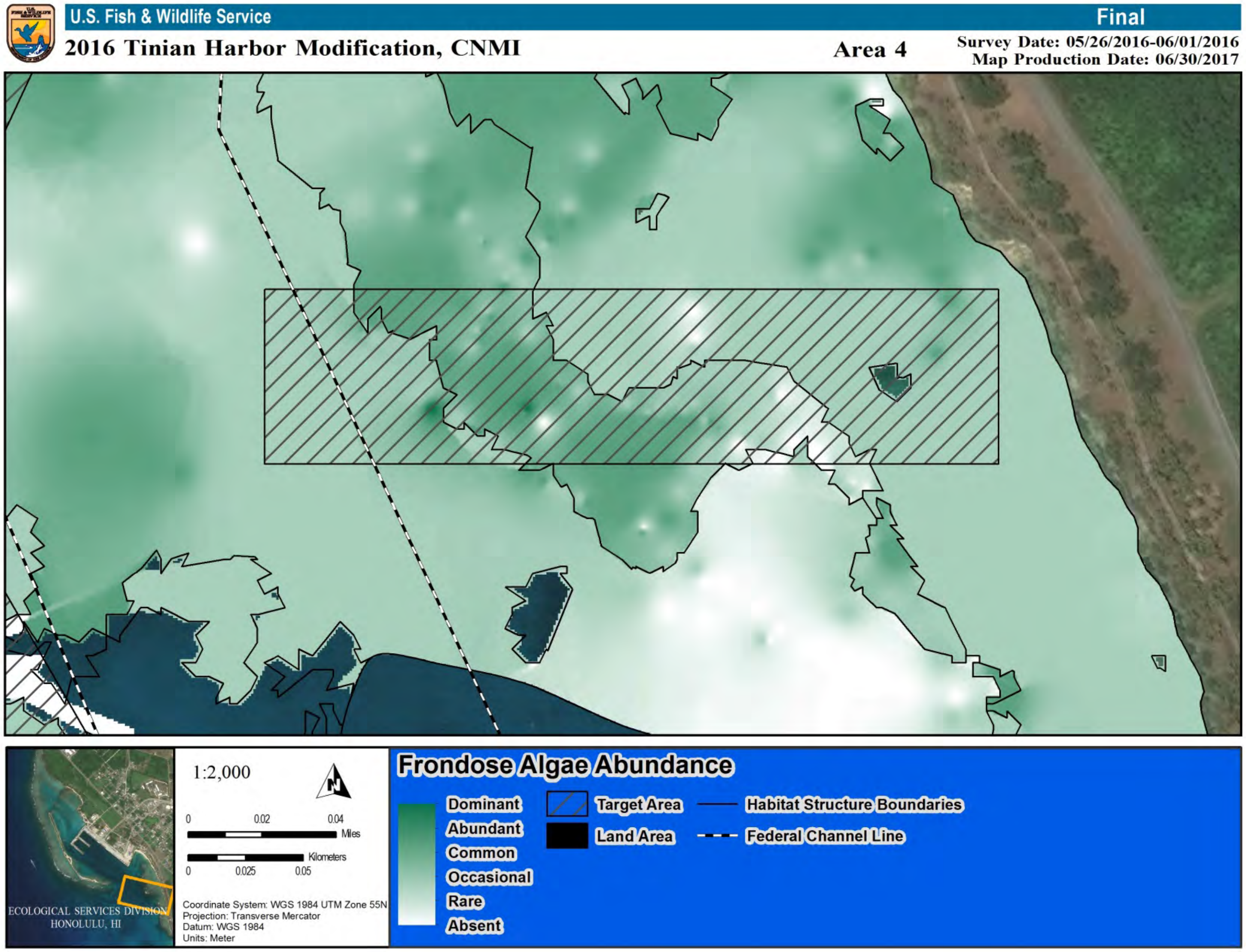

Figure E19: Frondose Algae Abundance (Area 4). Overview of the frondose algae (macroalgae) abundance observed within the project area.

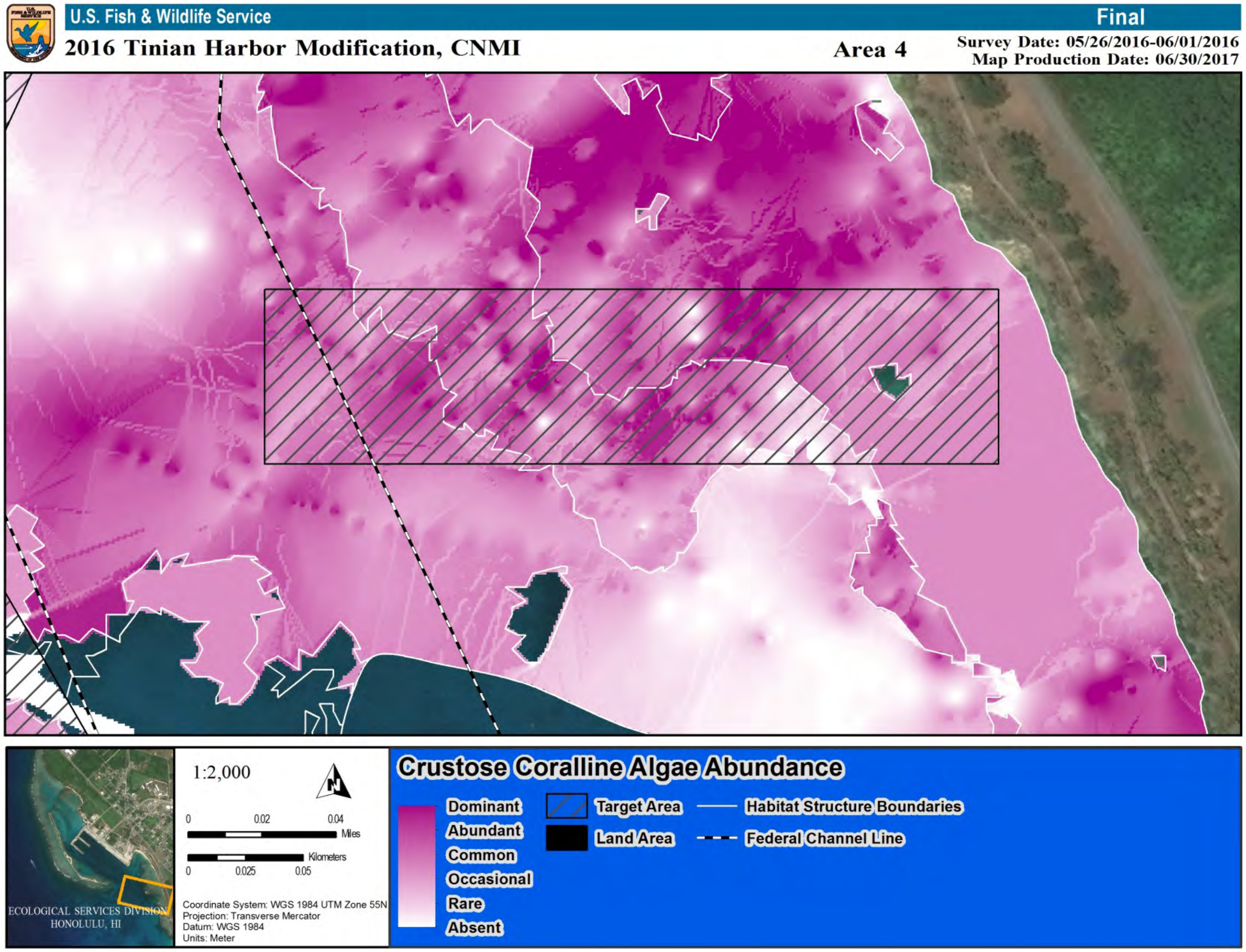

Figure E20: CCA Abundance (Area 4). Overview of the crustose coralline algae abundance observed within the project area.

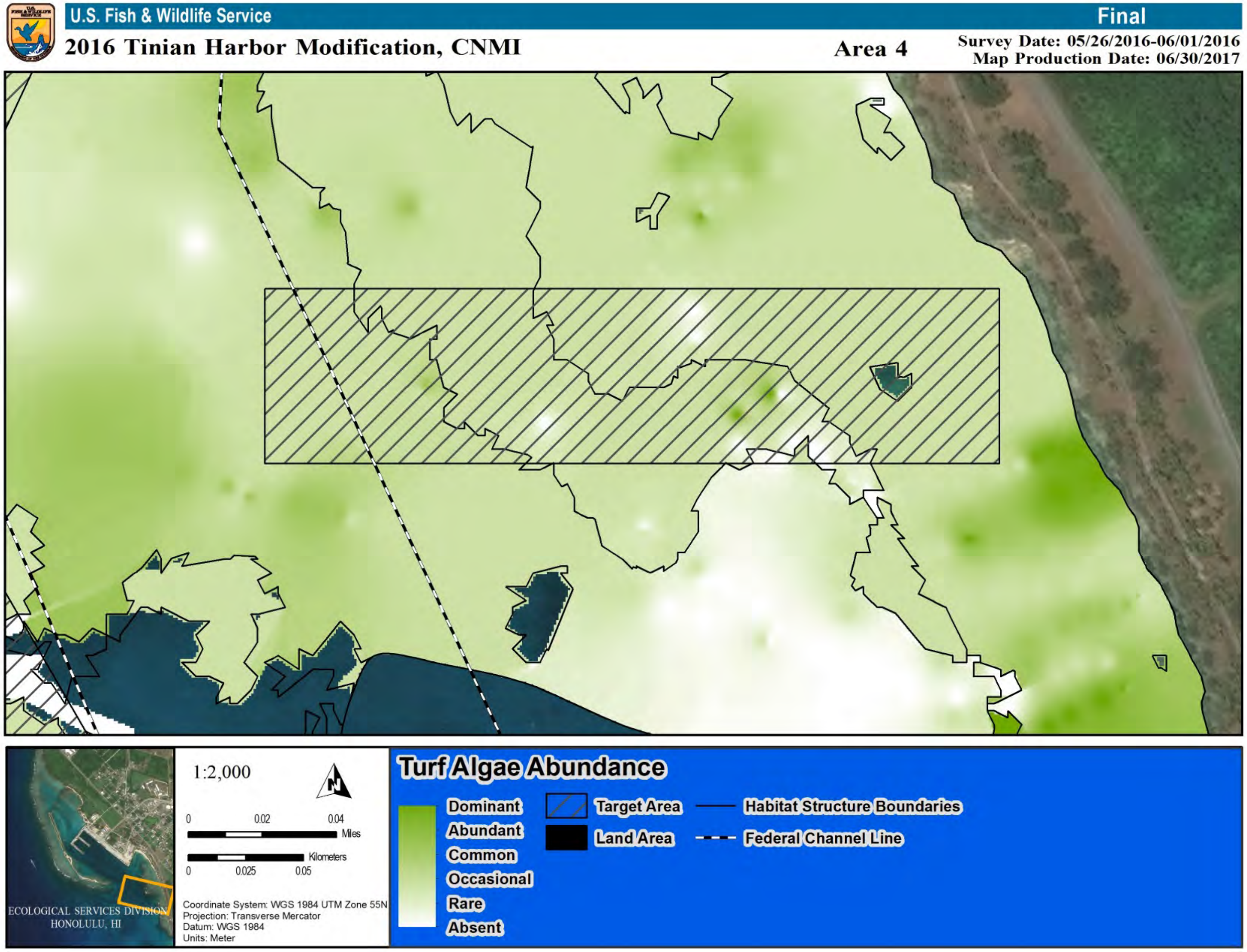

Figure E21: Turf Algae Abundance (Area 4). Overview of the turf algae abundance observed within the project area.

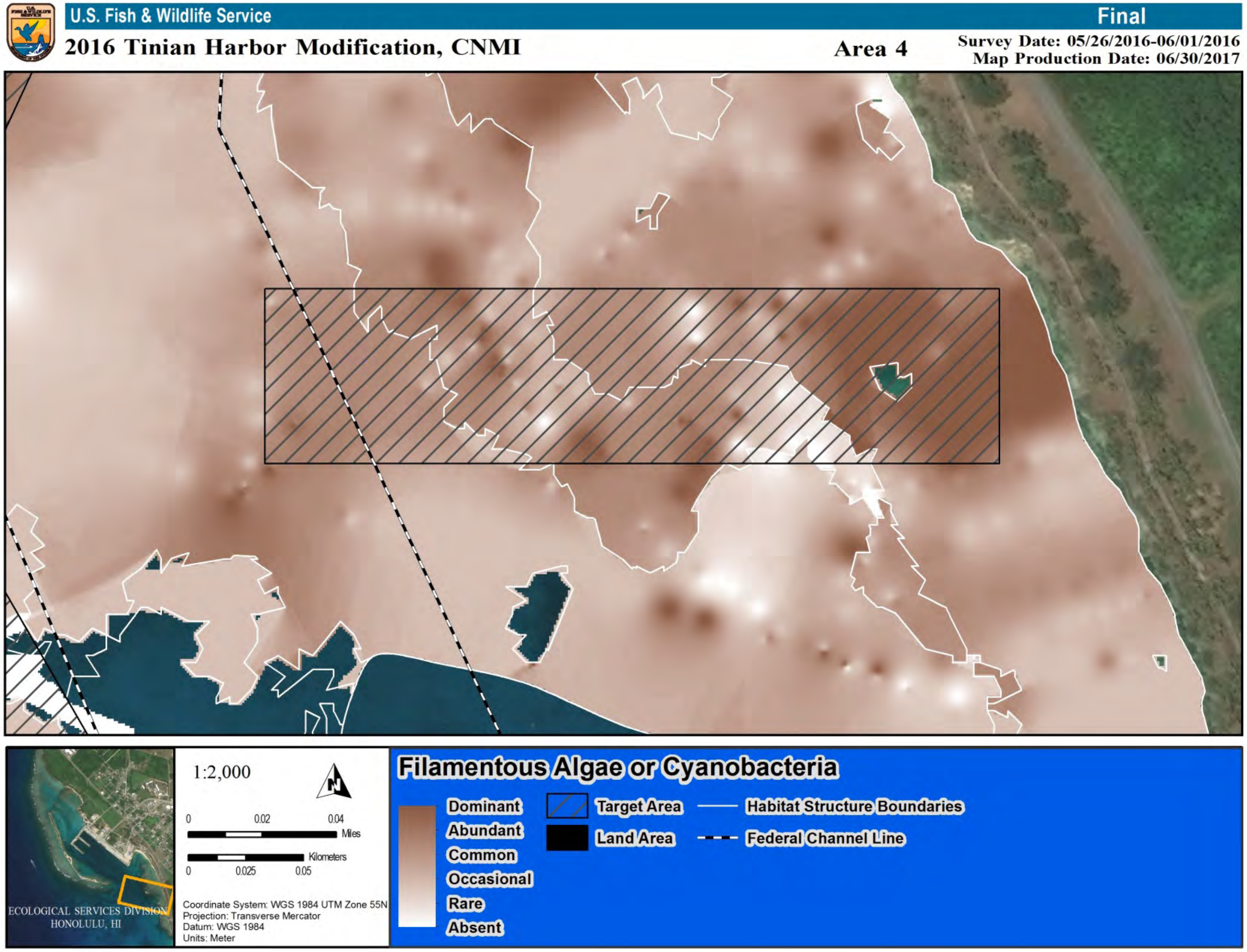

Figure E22: Filamentous Algae (Area 4). Overview of the filamentous algae and cyanobacteria abundance observed within the project area.

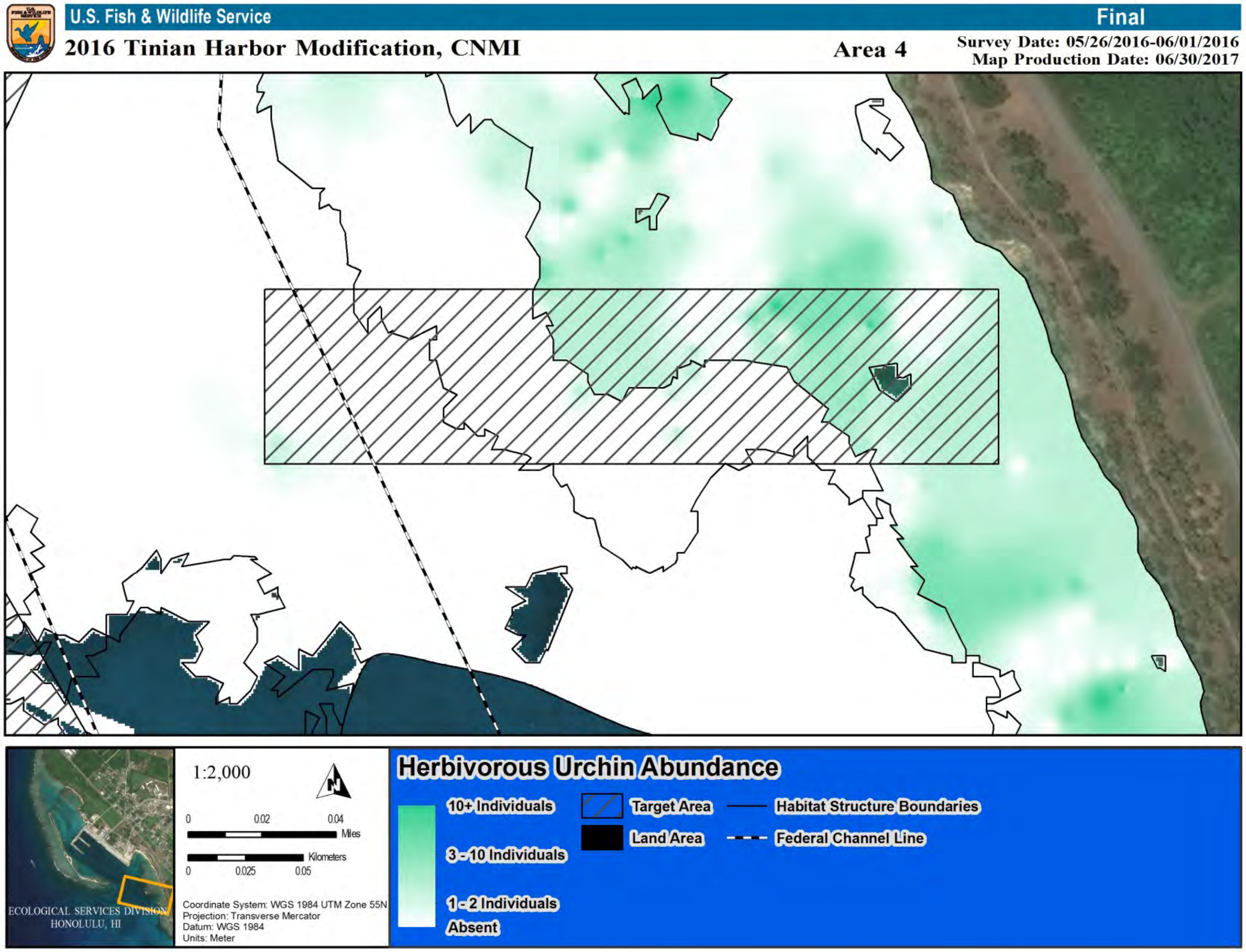

Figure E23: Herbivorous Urchin Abundance (Area 4). Overview of the herbivorous urchin abundance observed within the project area.

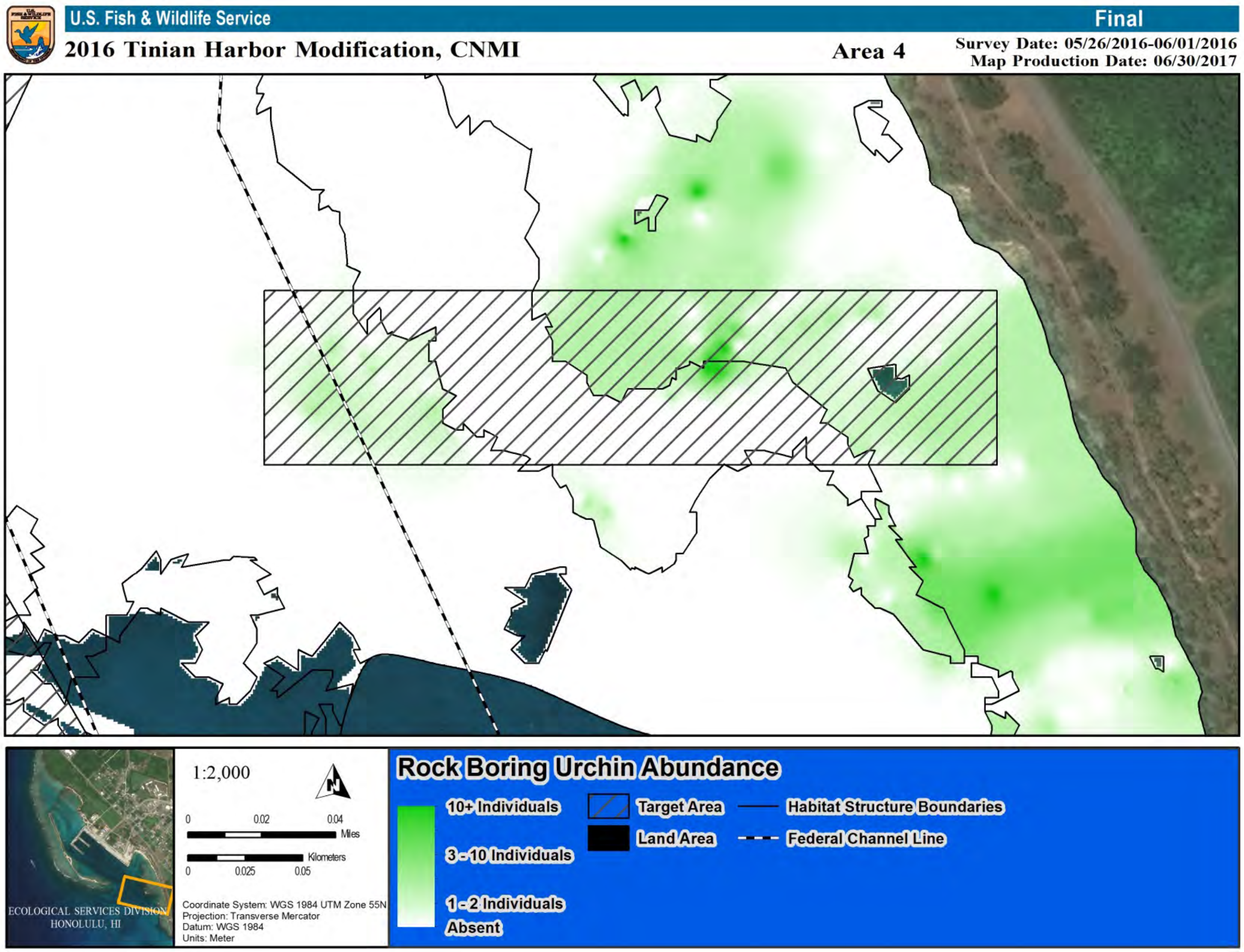

Figure E24: Rock Boring Urchin Abundance (Area 4). Overview of the rock boring urchin abundance observed within the project area.

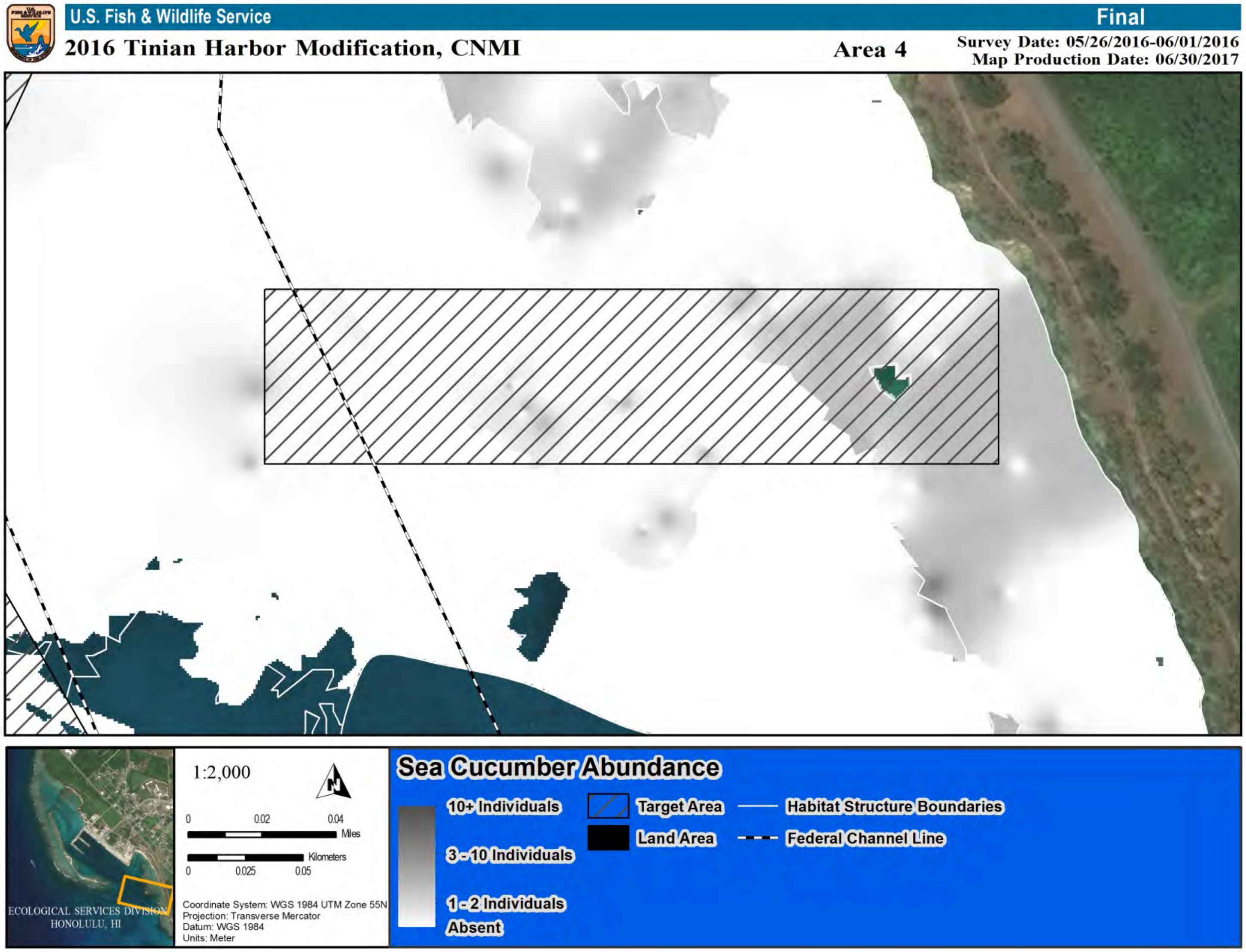

Figure E25: Sea Cucumber Abundance (Area 4). Overview of the sea cucumber abundance observed within the project area.

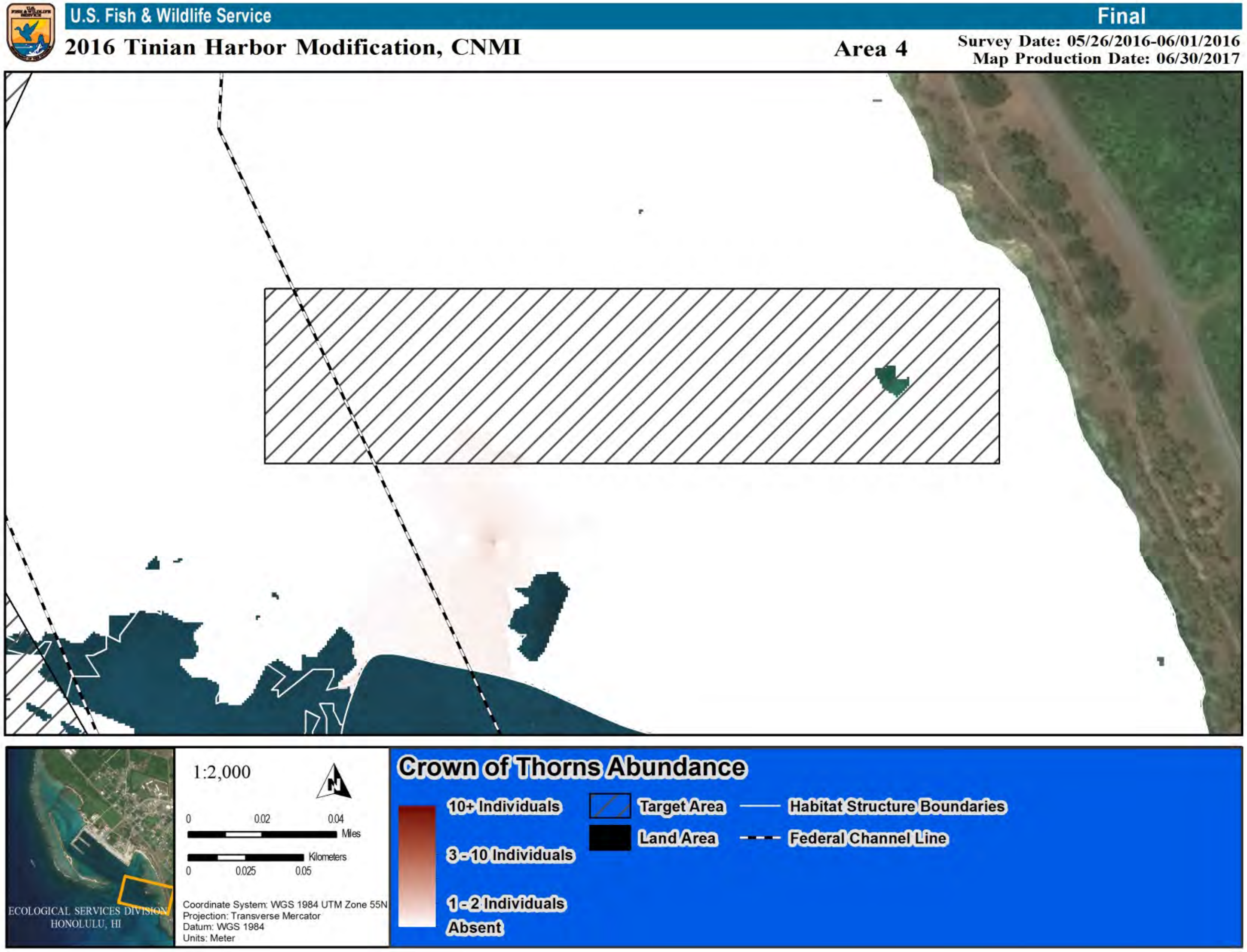

Figure E26: Crown-of-Thorns Abundance (Area 4). Overview of the crown-of-thorn starfish abundance observed within the project area.

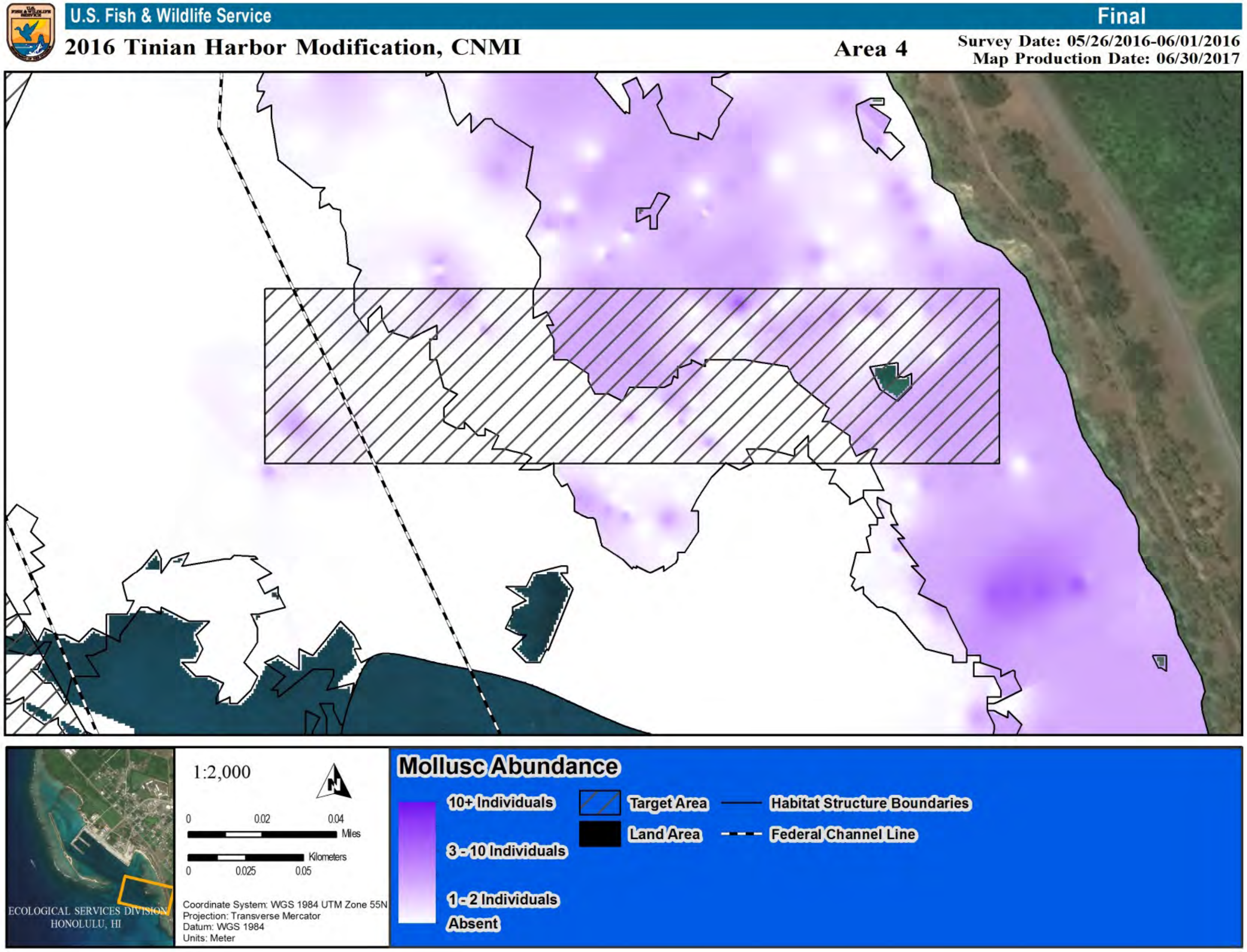

Figure E27: Mollusc Abundance (Area 4). Overview of the mollusc (other than specific species shown in other maps) abundance observed within the project area.

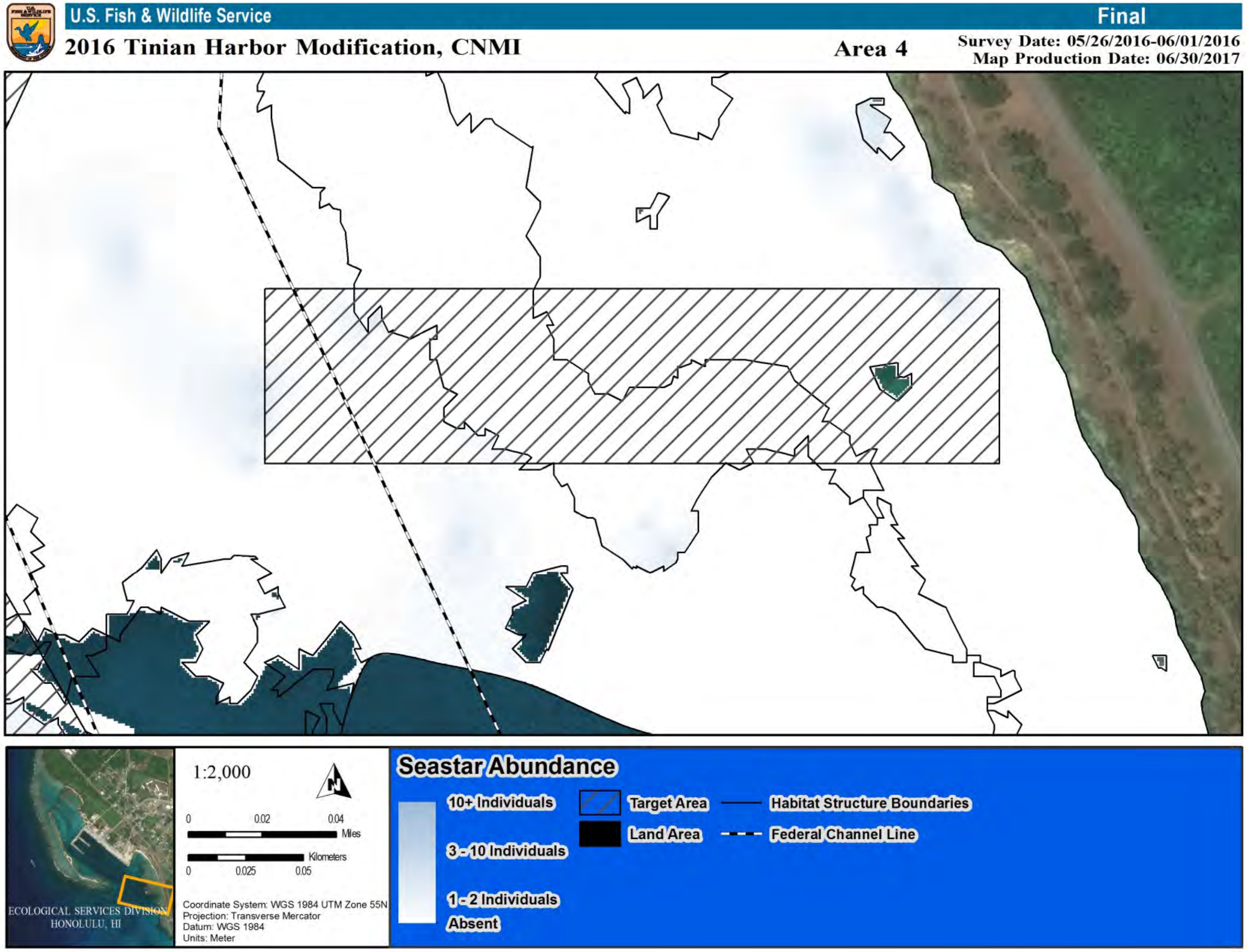

Figure E28: Seastar Abundance (Area 4). Overview of the seastar abundance observed within the project area.

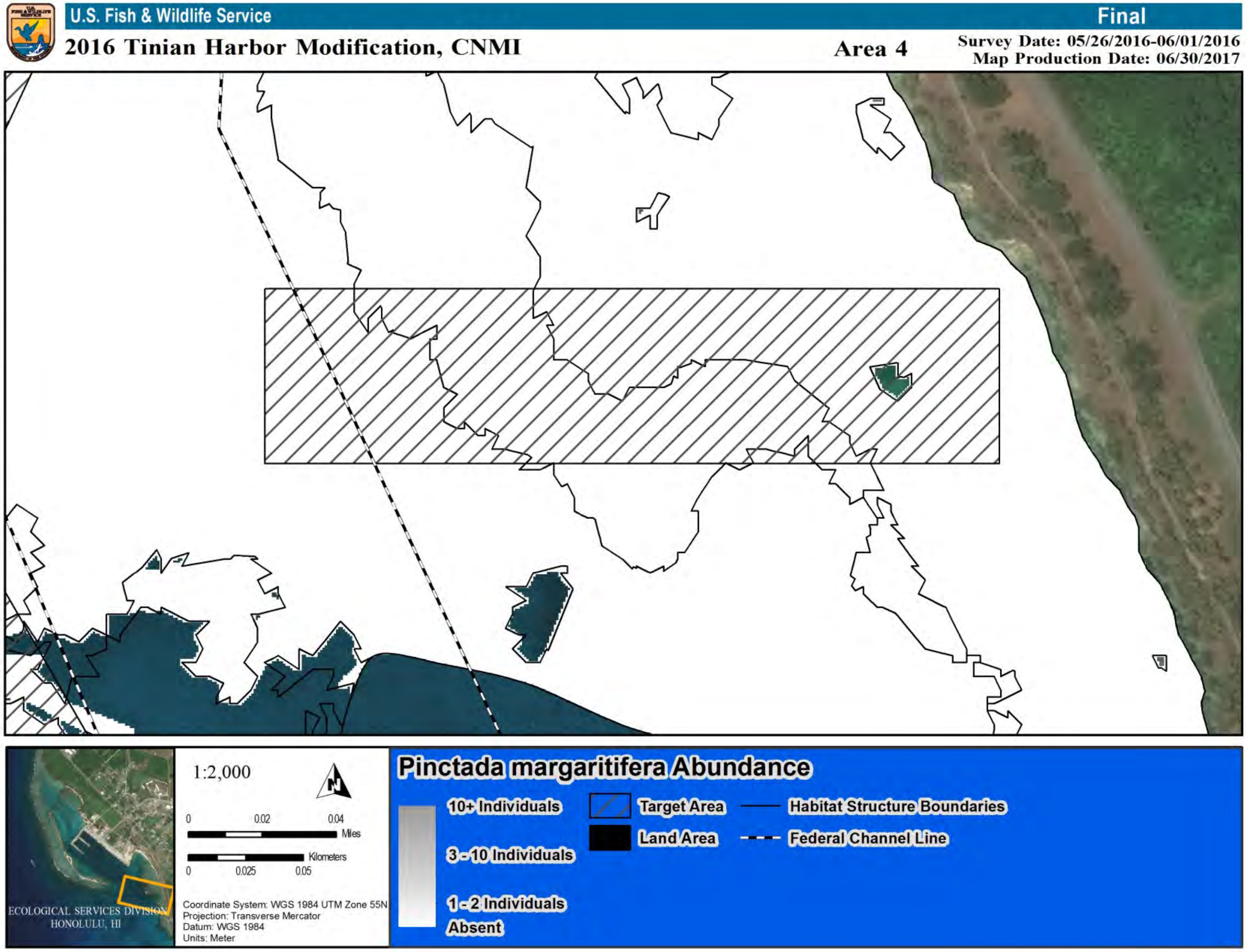

Figure E29: Pinctada Abundance (Area 4). Overview of the mollusc, Pinctada margaritifera, abundance observed within the project area.

Note: No Pinctada margaritifera were observed in this area.

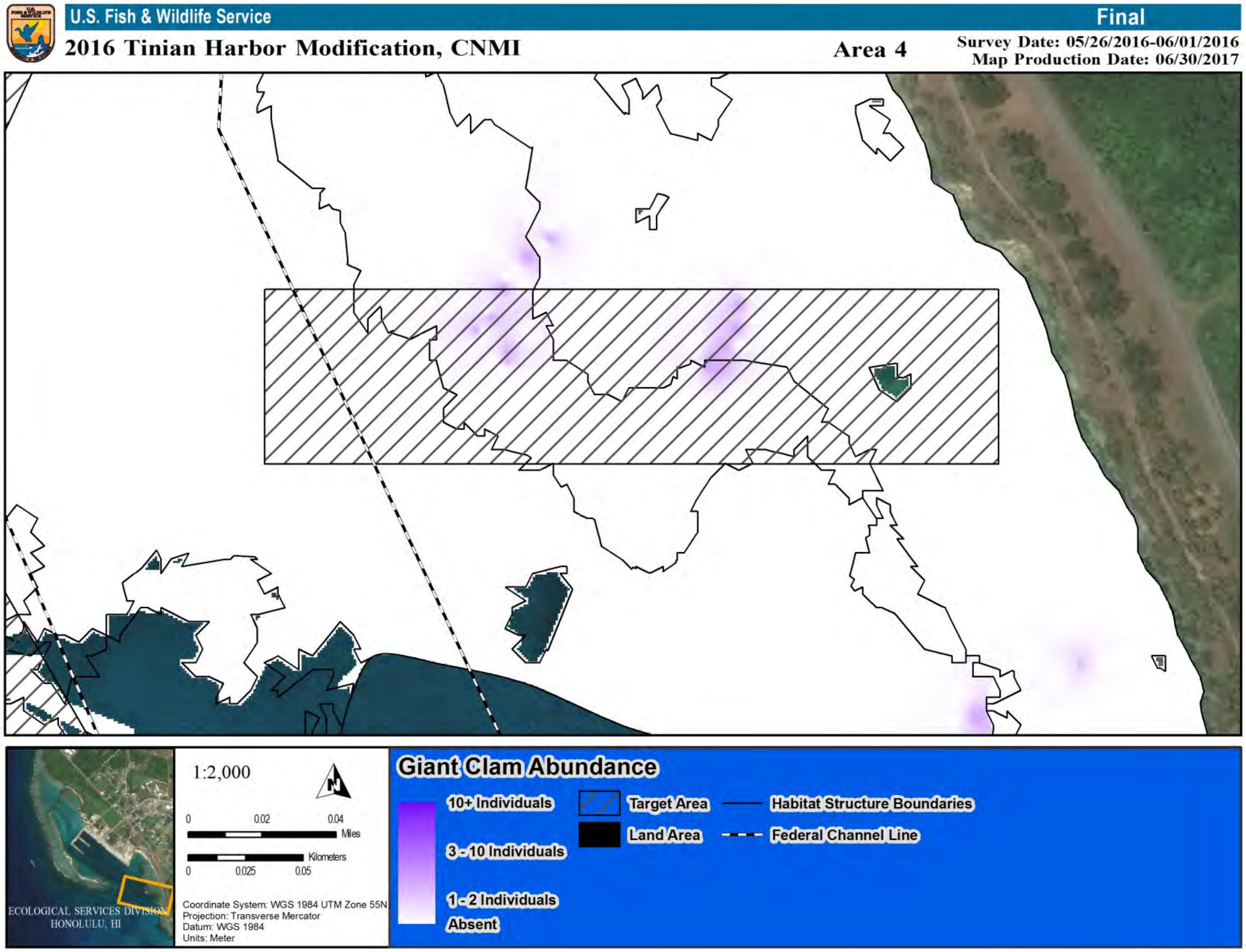

Figure E30: Giant Clam Abundance (Area 4). Overview of the giant clam abundance observed within the project area.

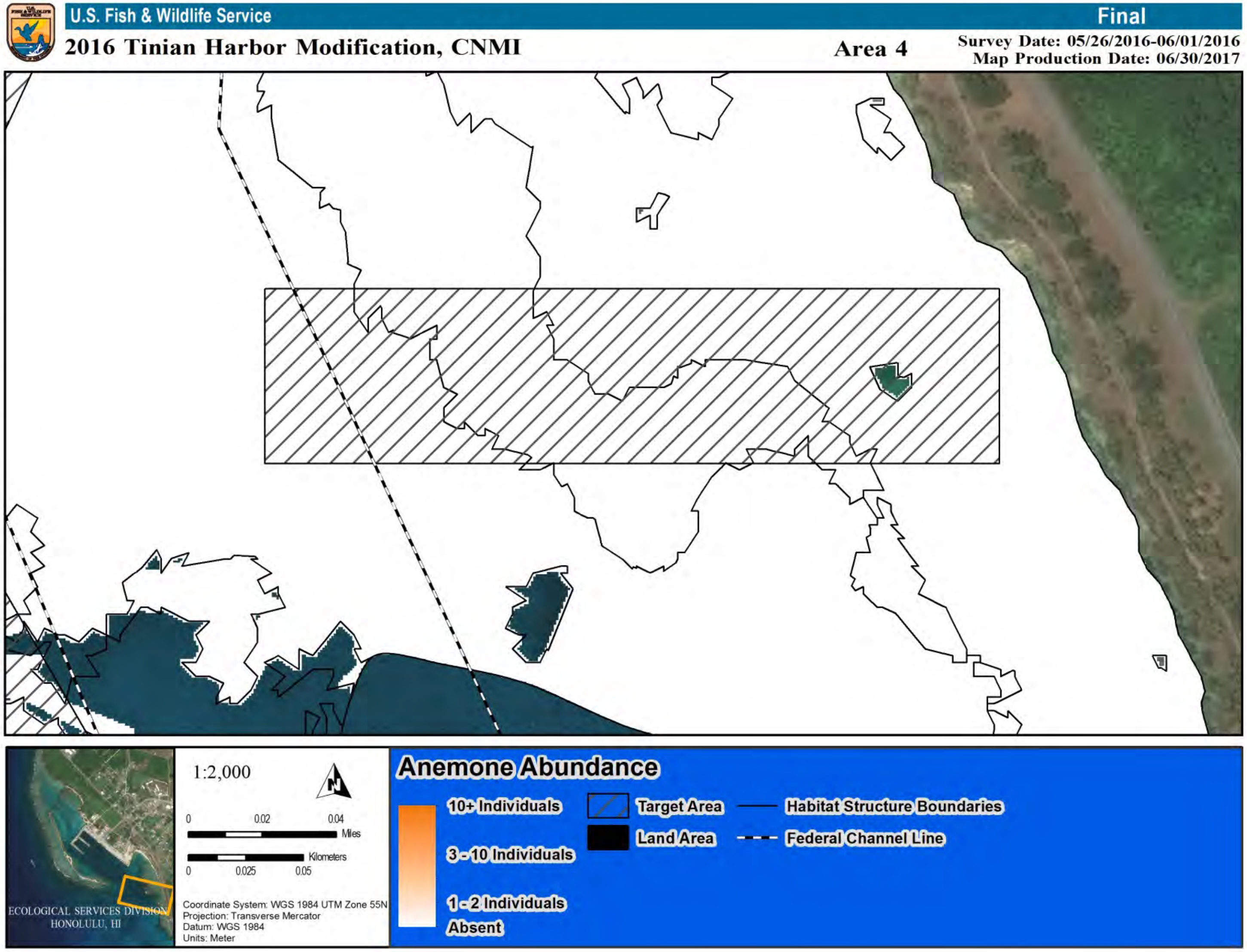

Figure E31: Anemone Abundance (Area 4). Overview of the anemone abundance observed within the project area. Note: No anemones were observed in this area.

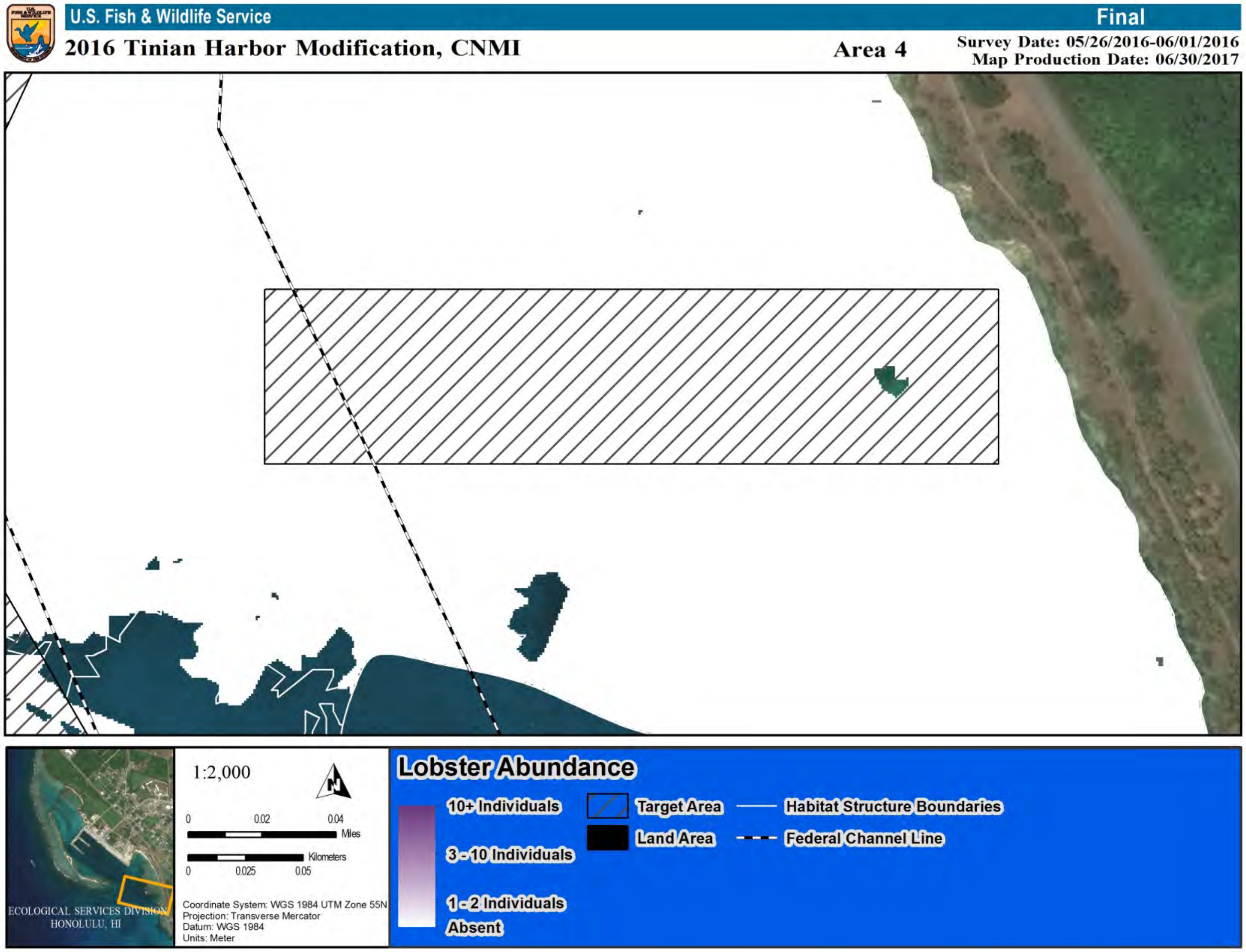

Figure E32: Lobster Abundance (Area 4). Overview of the lobster abundance observed within the project area. Note: No lobsters were observed in this area.

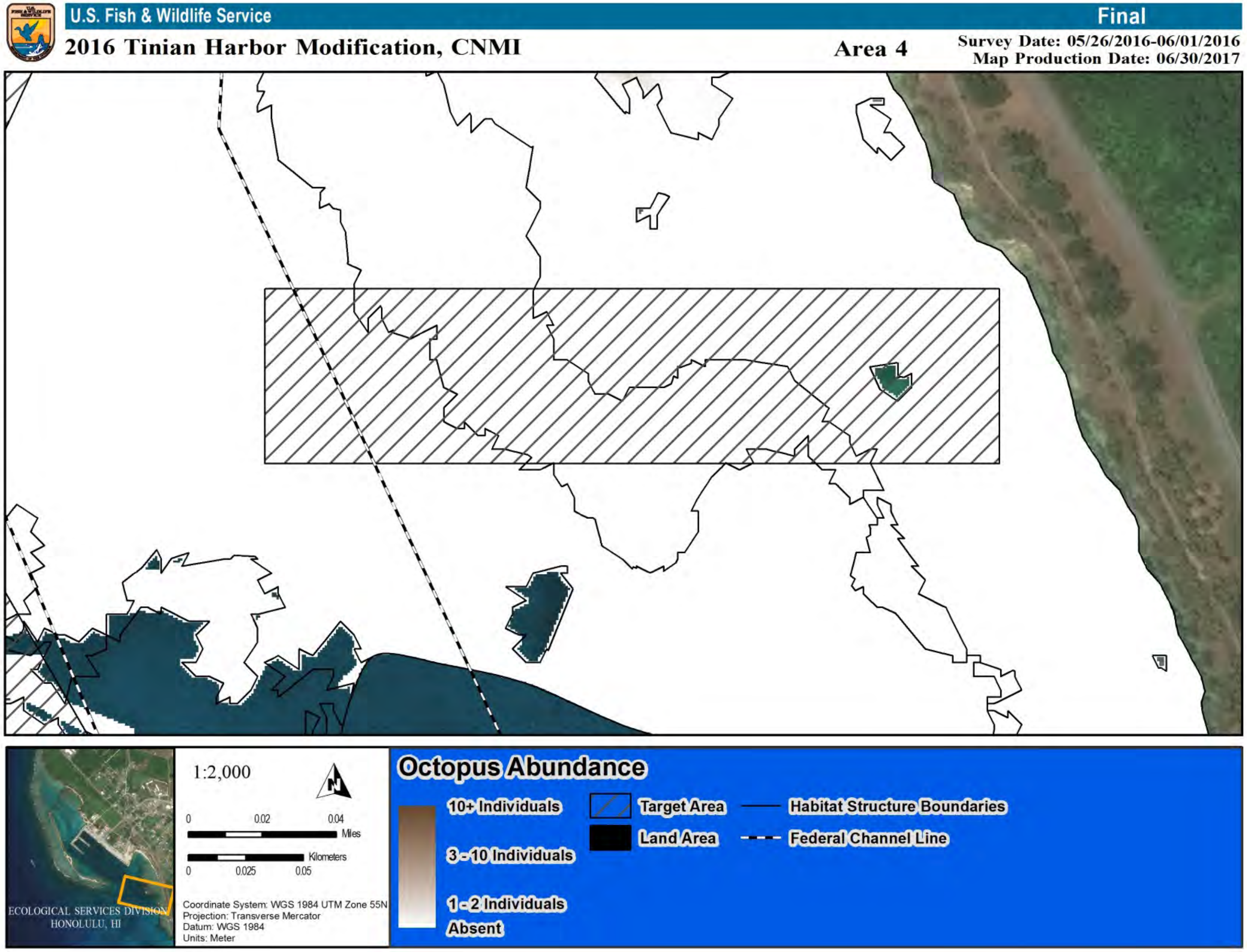

Figure E33: Octopus Abundance (Area 4). Overview of the octopus abundance observed within the project area.

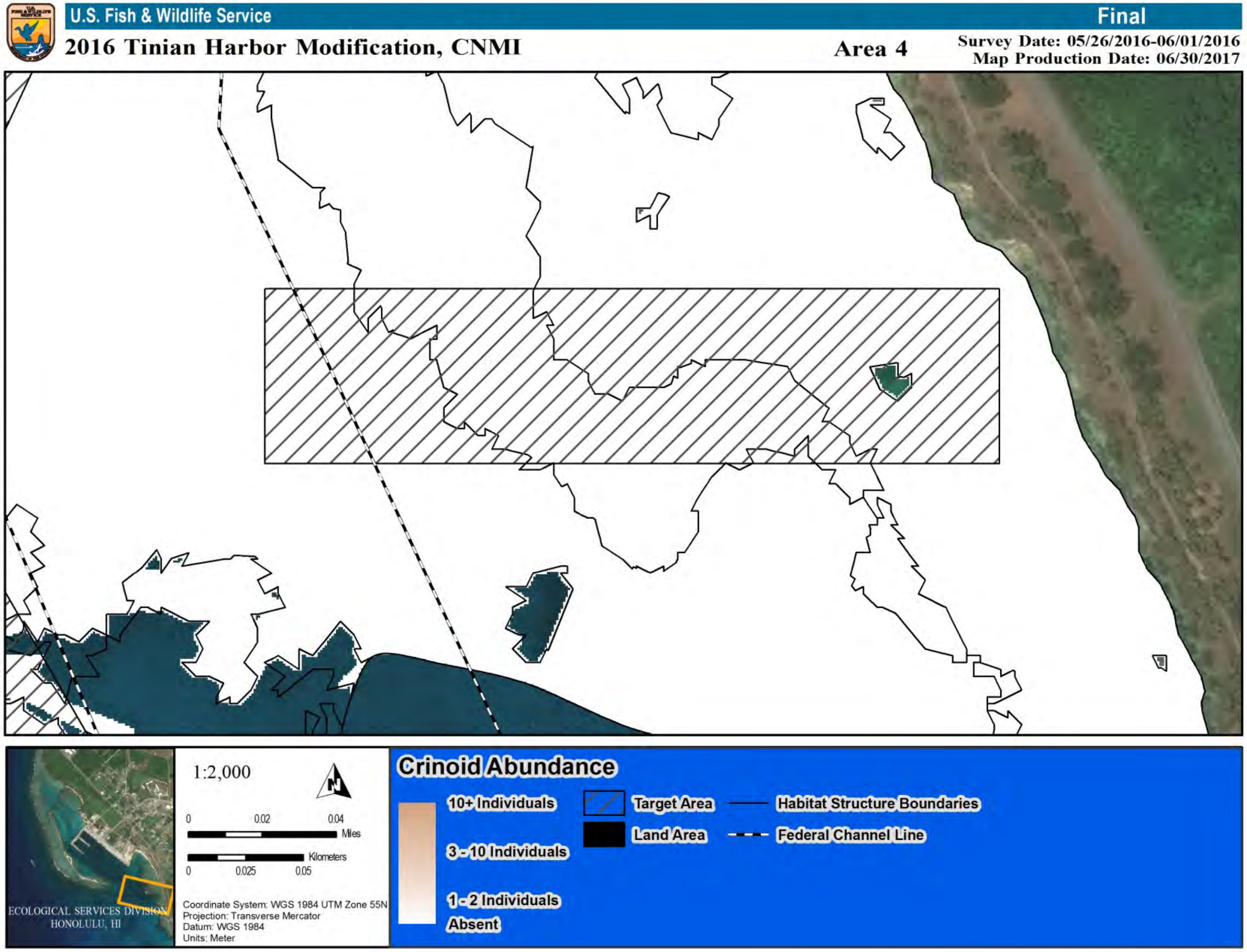

Figure E34: Crinoid Abundance (Area 4). Overview of the crinoid abundance observed within the project area. Note: No crinoids were observed in this area.

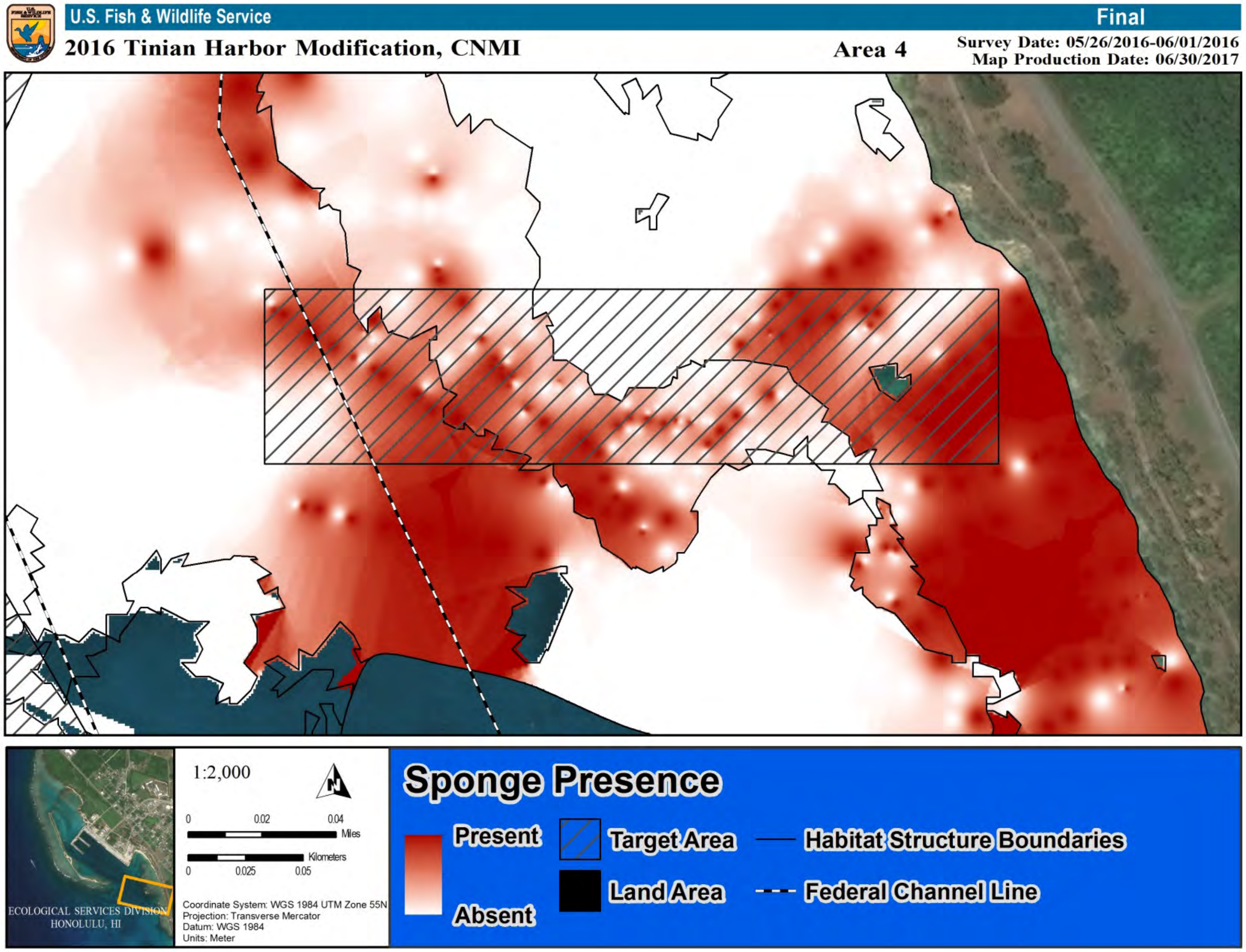

Figure E35: Sponge Presence (Area 4). Overview of the sponge presence observed within the project area.

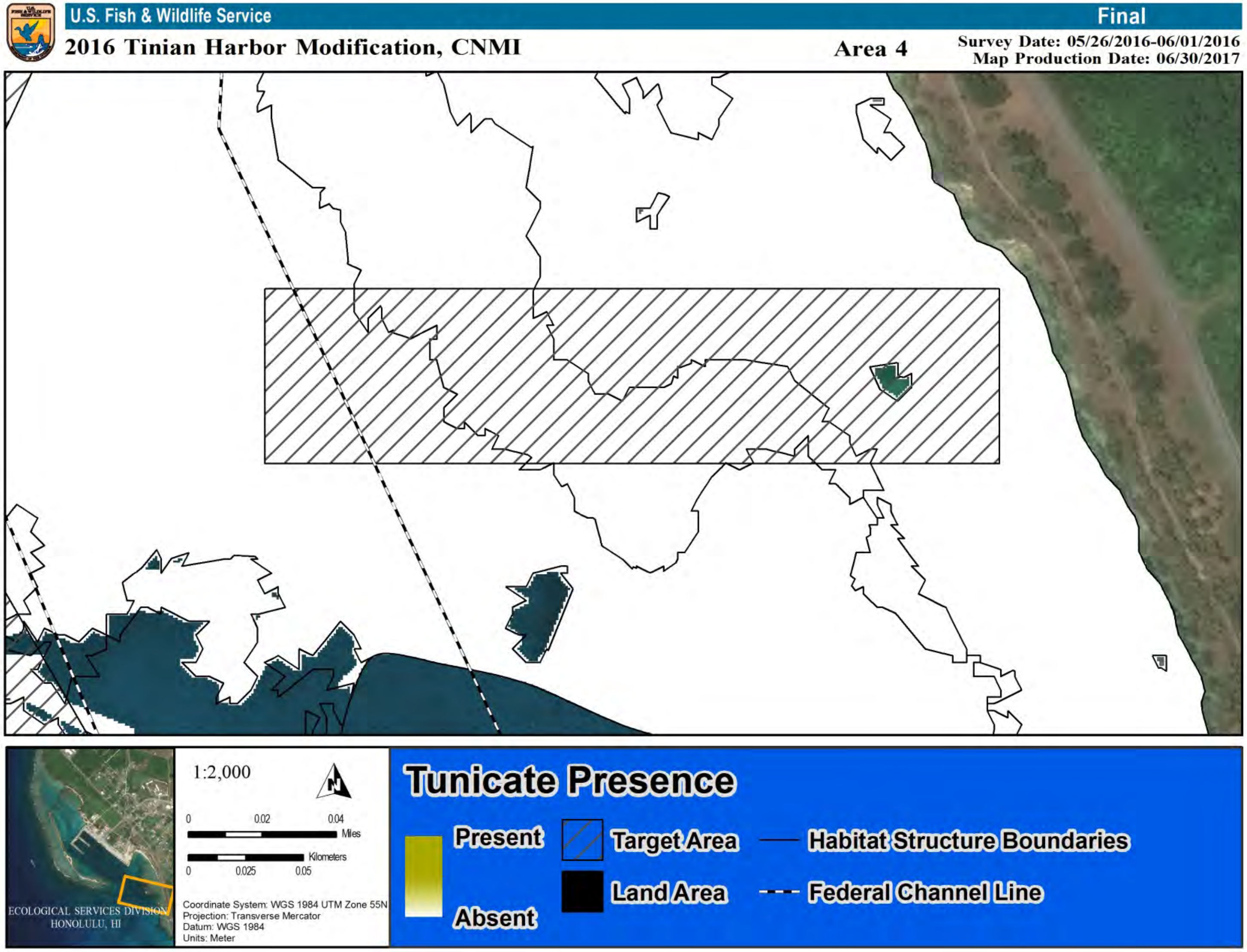

Figure E36: Tunicate Presence (Area 4). Overview of the tunicate presence observed within the project area.

APPENDIX F: Maps of Tinian Harbor Modification Project (Area 5)

Appendix F. Maps of Tinian Harbor Modification Project (Area 5).

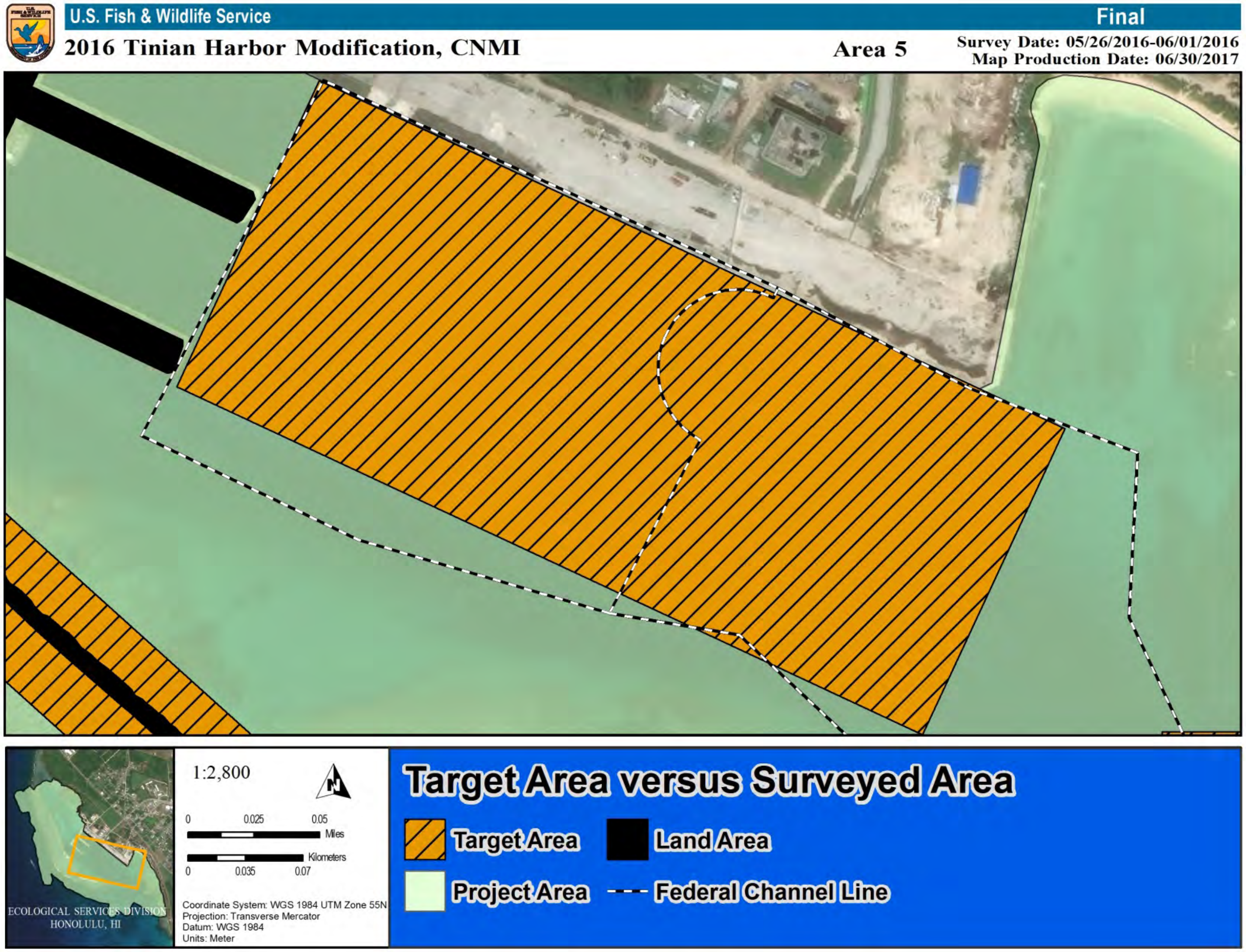

Figure F1: Target Area vs. Surveyed Area (Area 5). Overview of the Project Area (total surveyed area plus project footprint) versus the Target Area (project footprint).

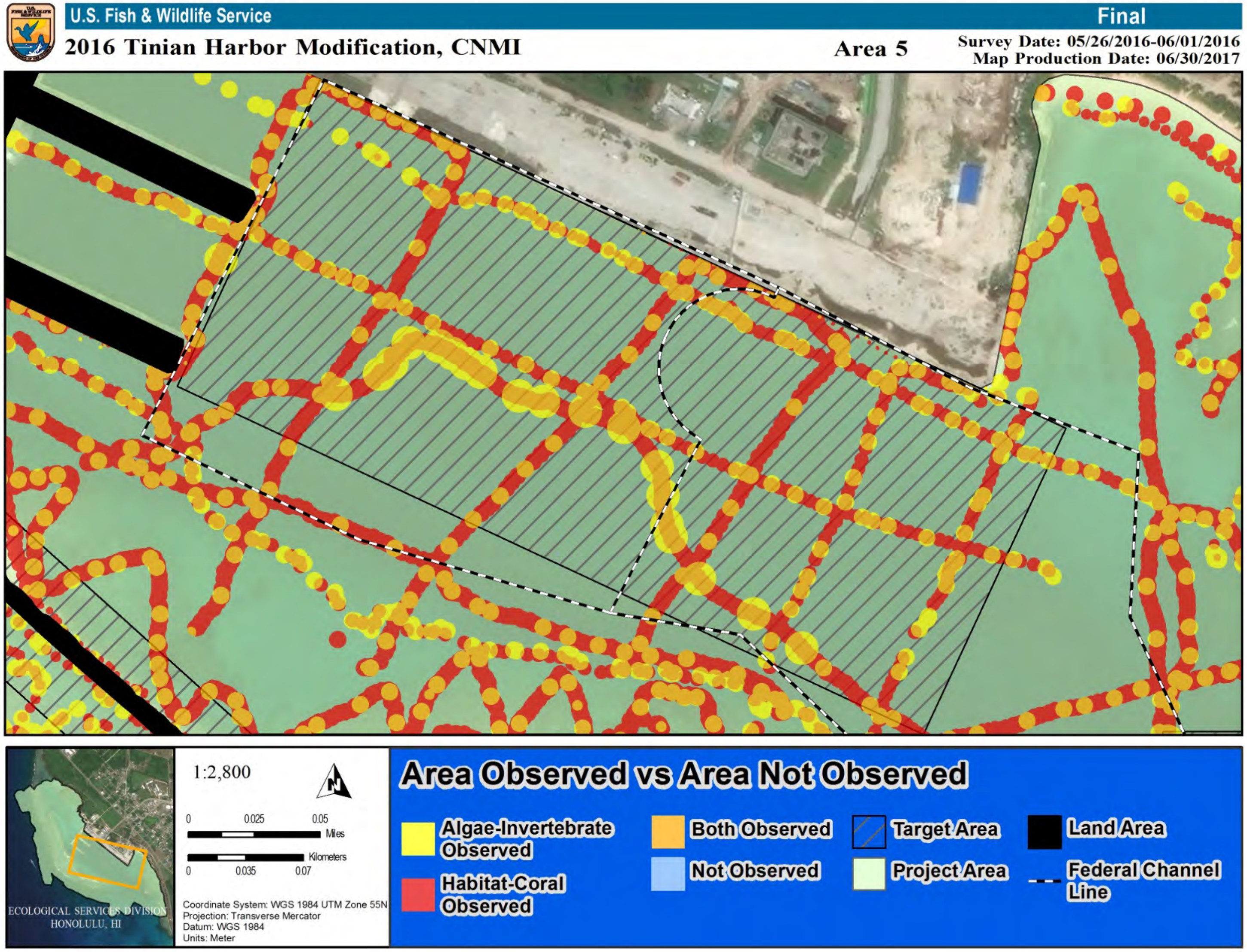

Figure F2: Area Observed (Area 5). Overview of the area observed by in-water observers versus the area interpolated in all maps.

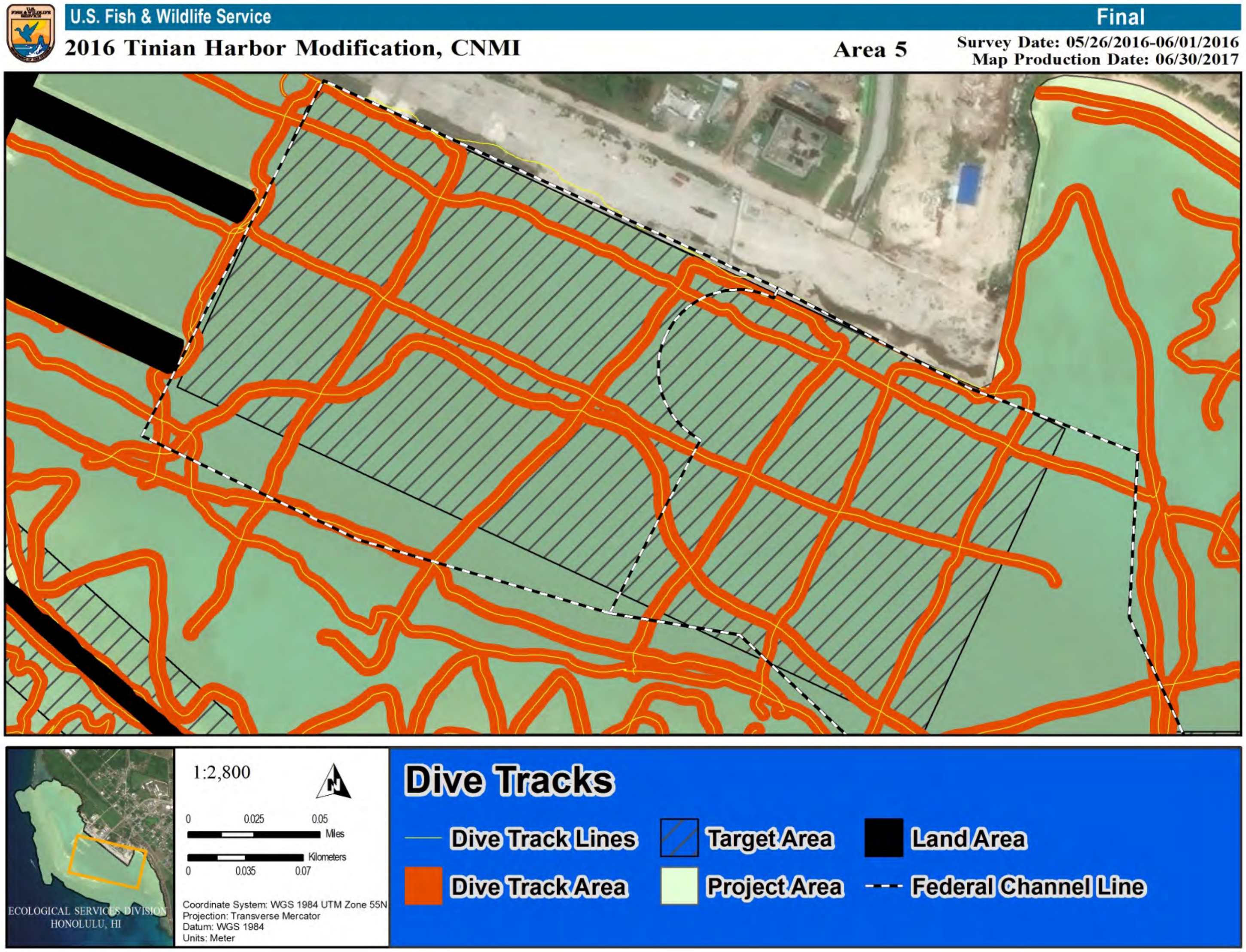

Figure F3: Dive Tracks (Area 5). Overview of the dive track lines for all survey transects.

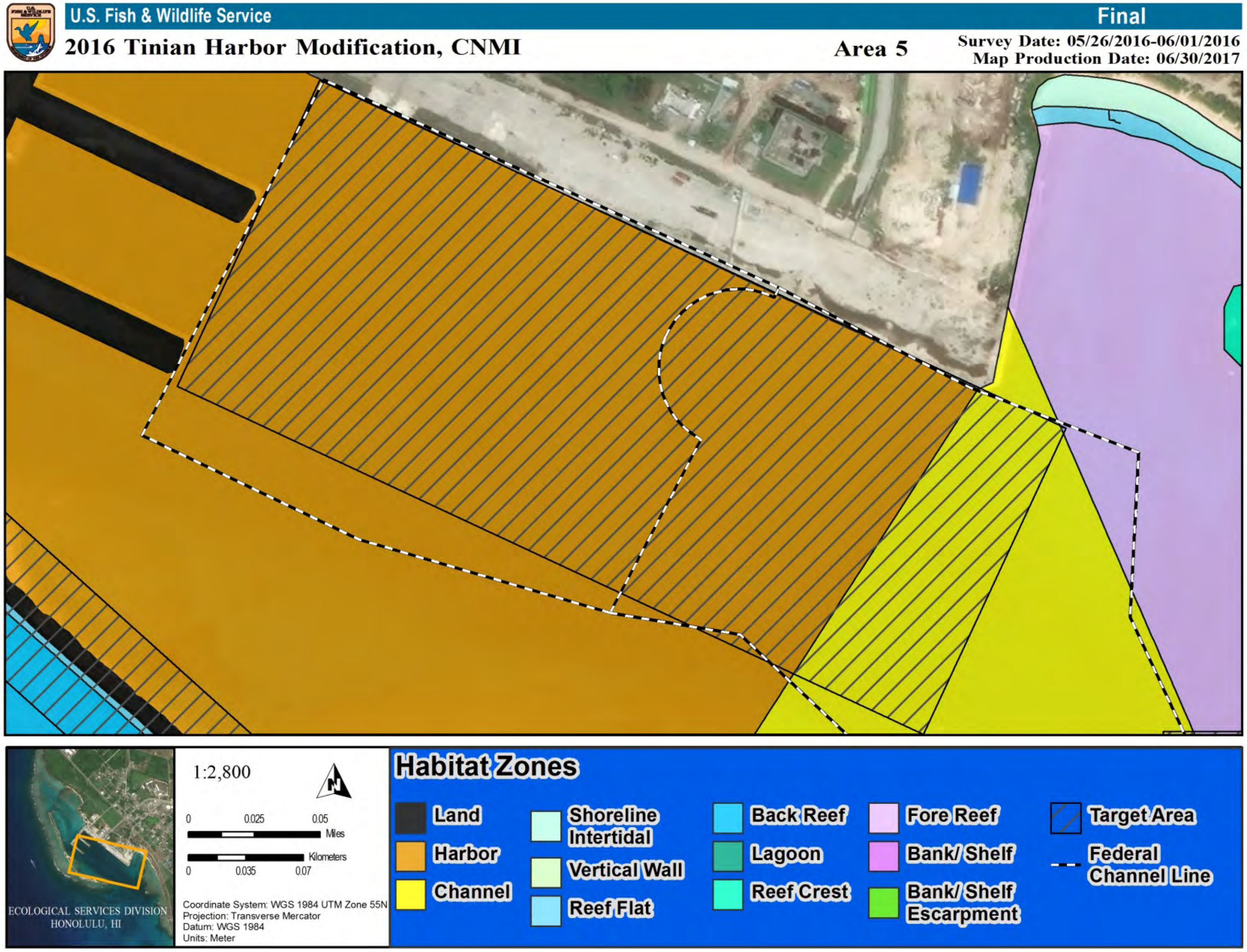

Figure F4: Habitat Zones (Area 5). Overview of the various habitat zones that the project area contains.

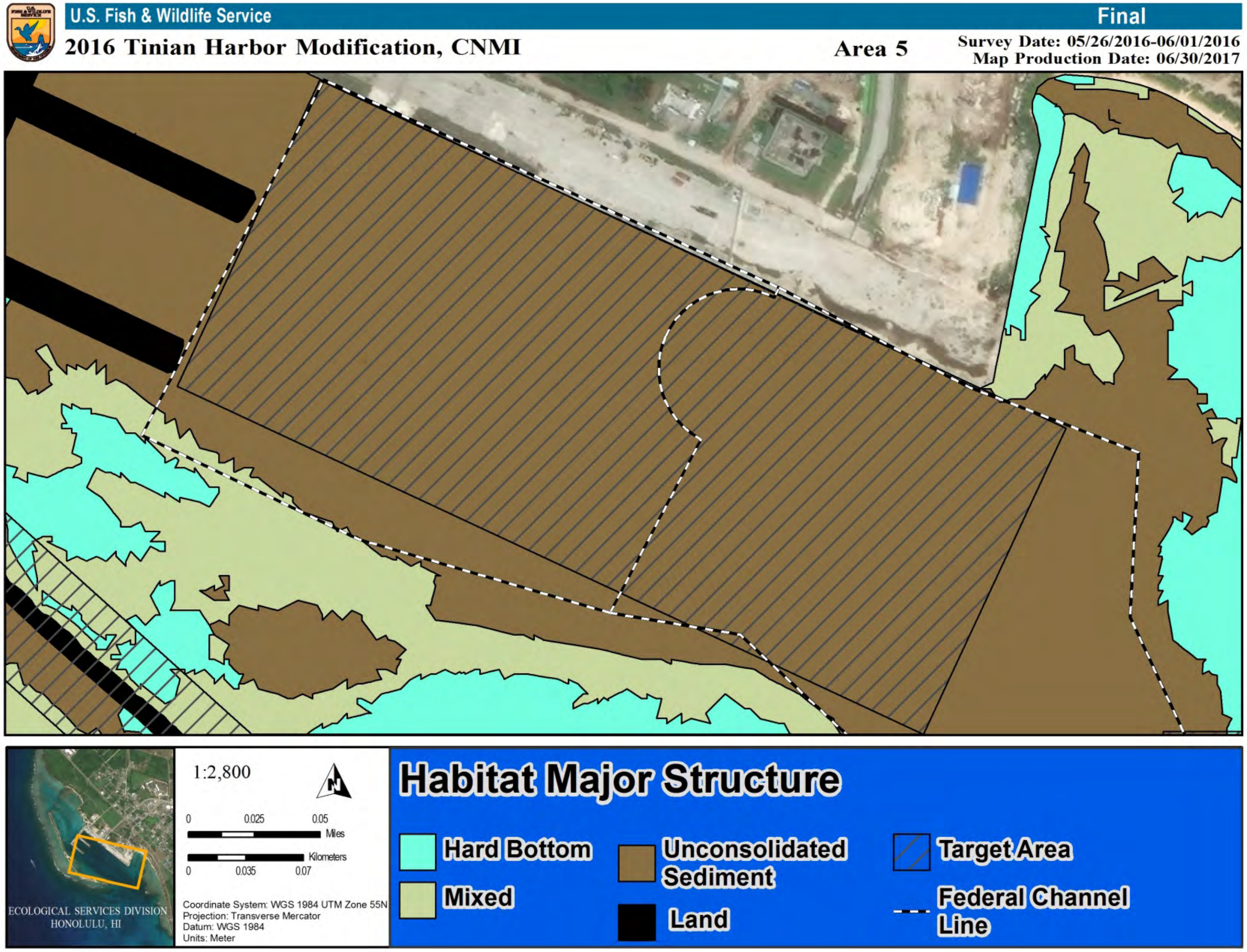

Figure F5: Habitat Major Structure (Area 5). Overview of the major habitat structures that the project area contains.

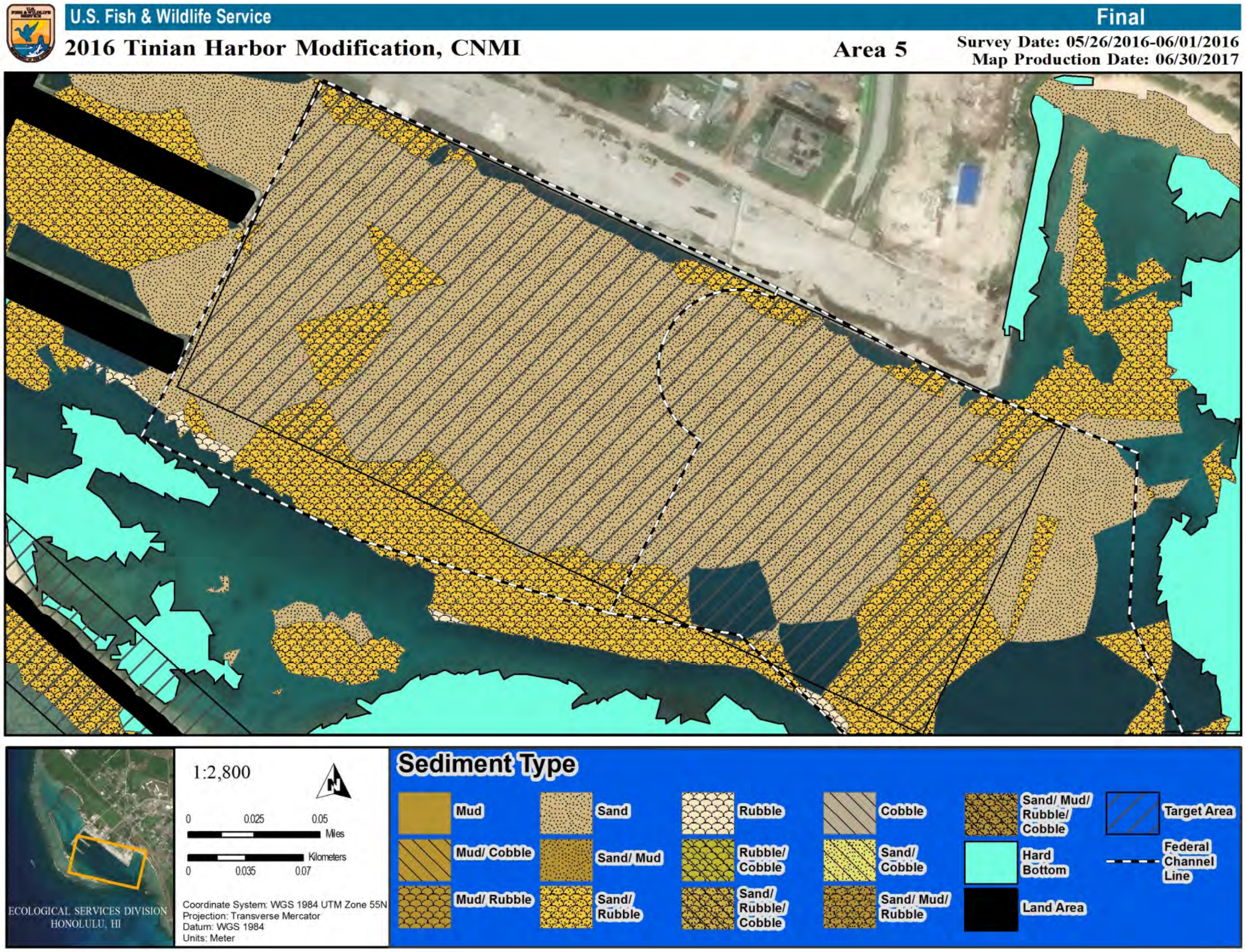

Figure F6: Sediment Type (Area 5). Overview of the various sediment types that the project area contains.

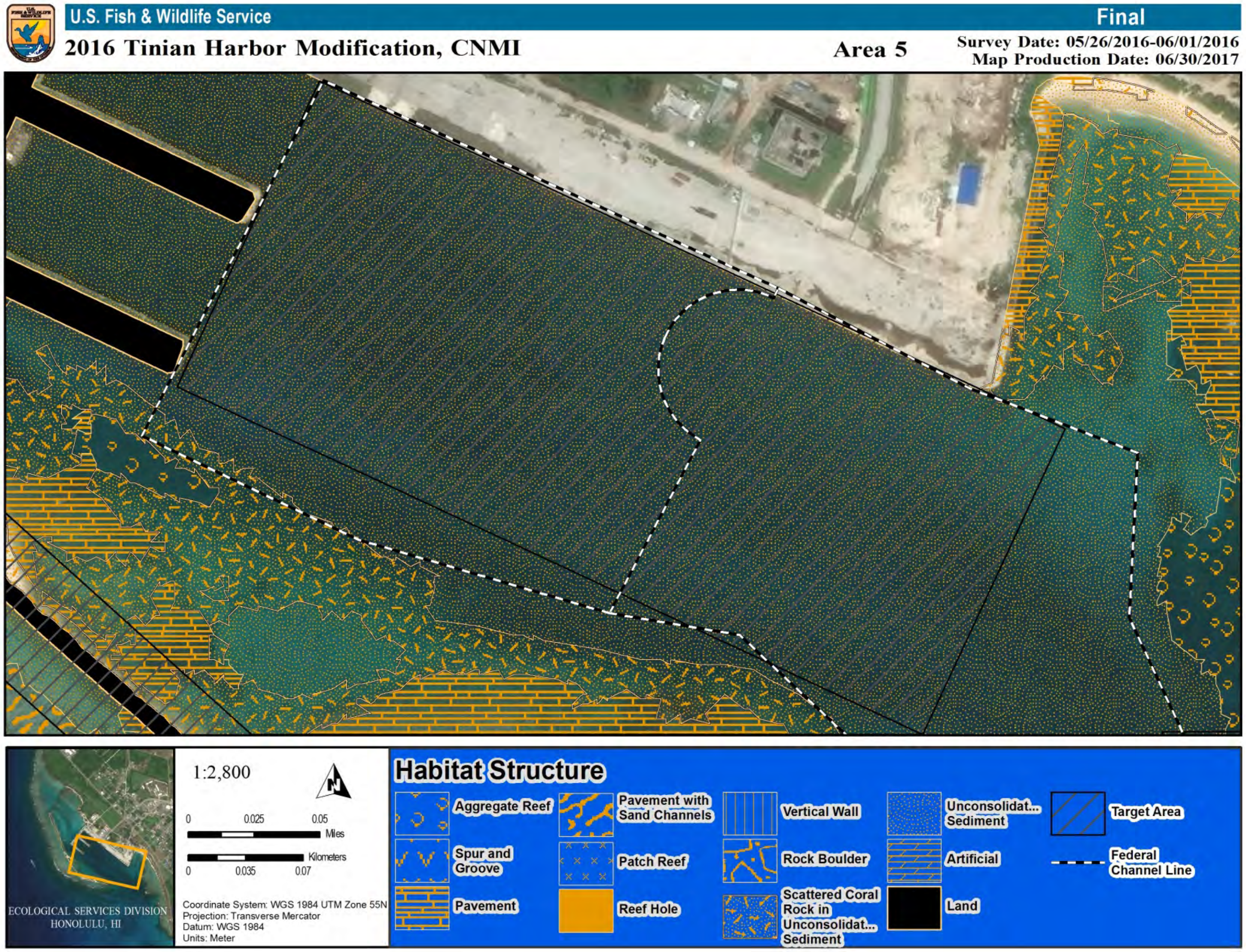

Figure F7: Habitat Structure (Area 5). Overview of the habitat structures that the project area contains.

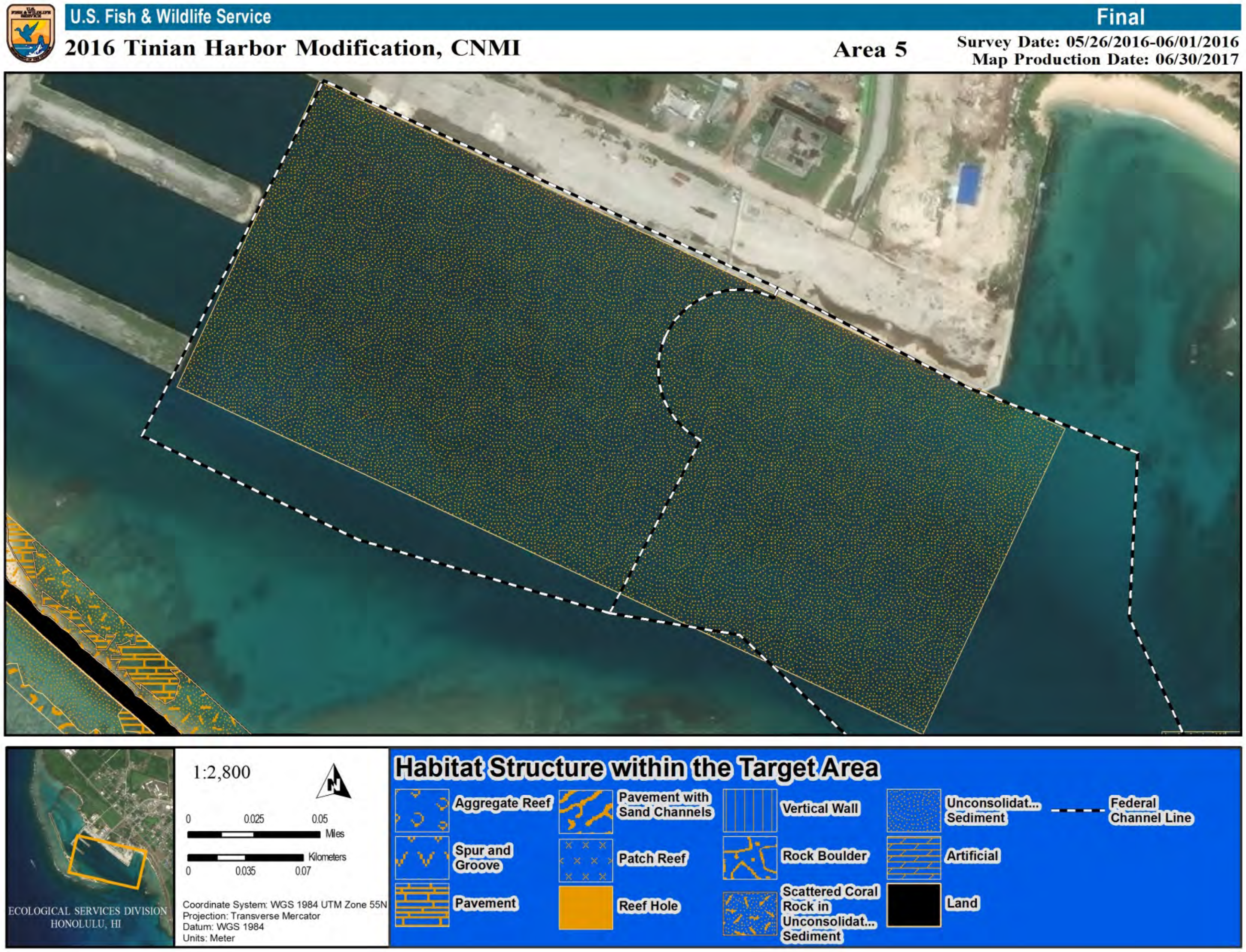

Figure F8: Habitat Structure in Target Area (Area 5). Overview of the habitat structures within the project footprint (Target Area).

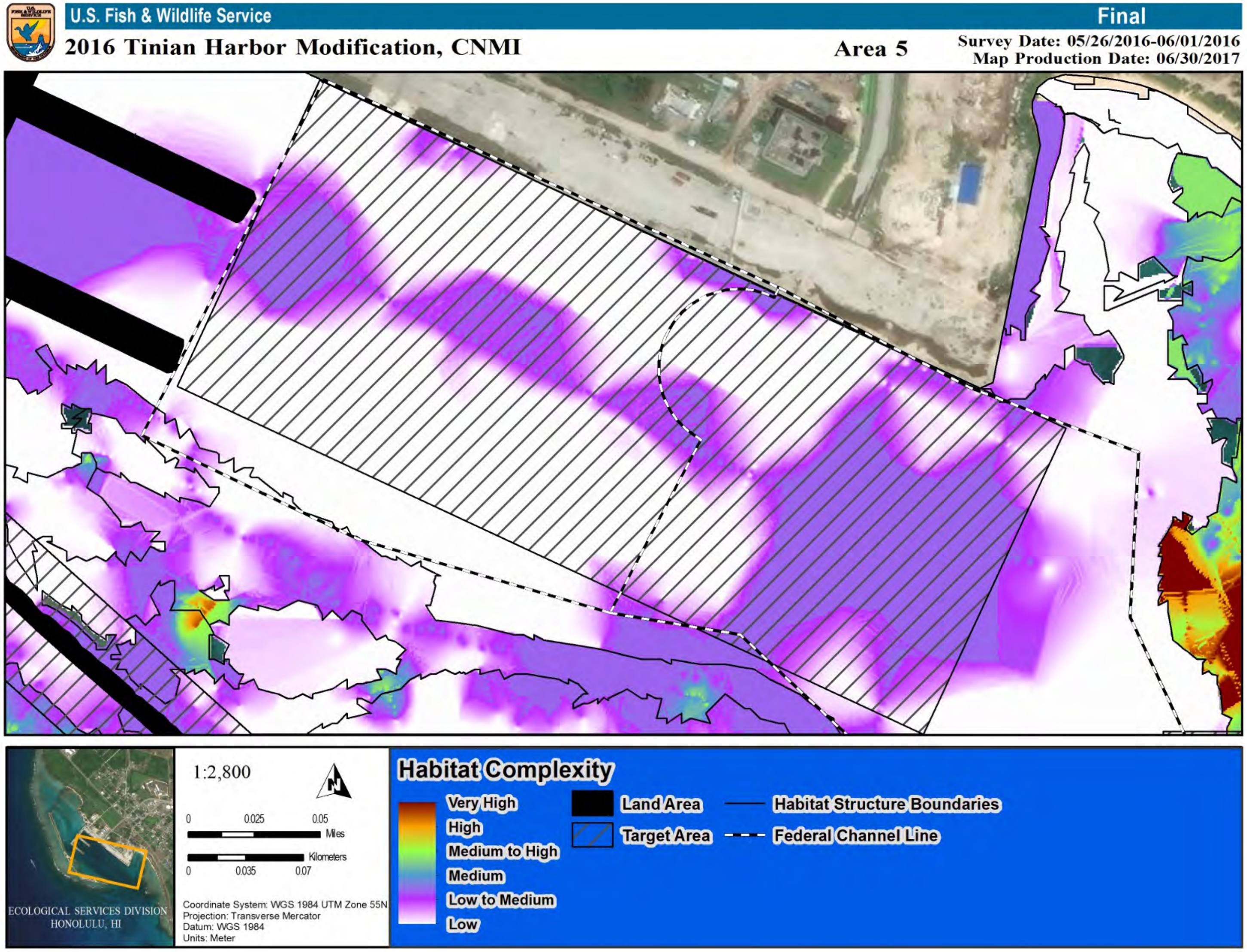

Figure F9: Habitat Complexity (Area 5). Overview of the habitat complexity observed within the project area.

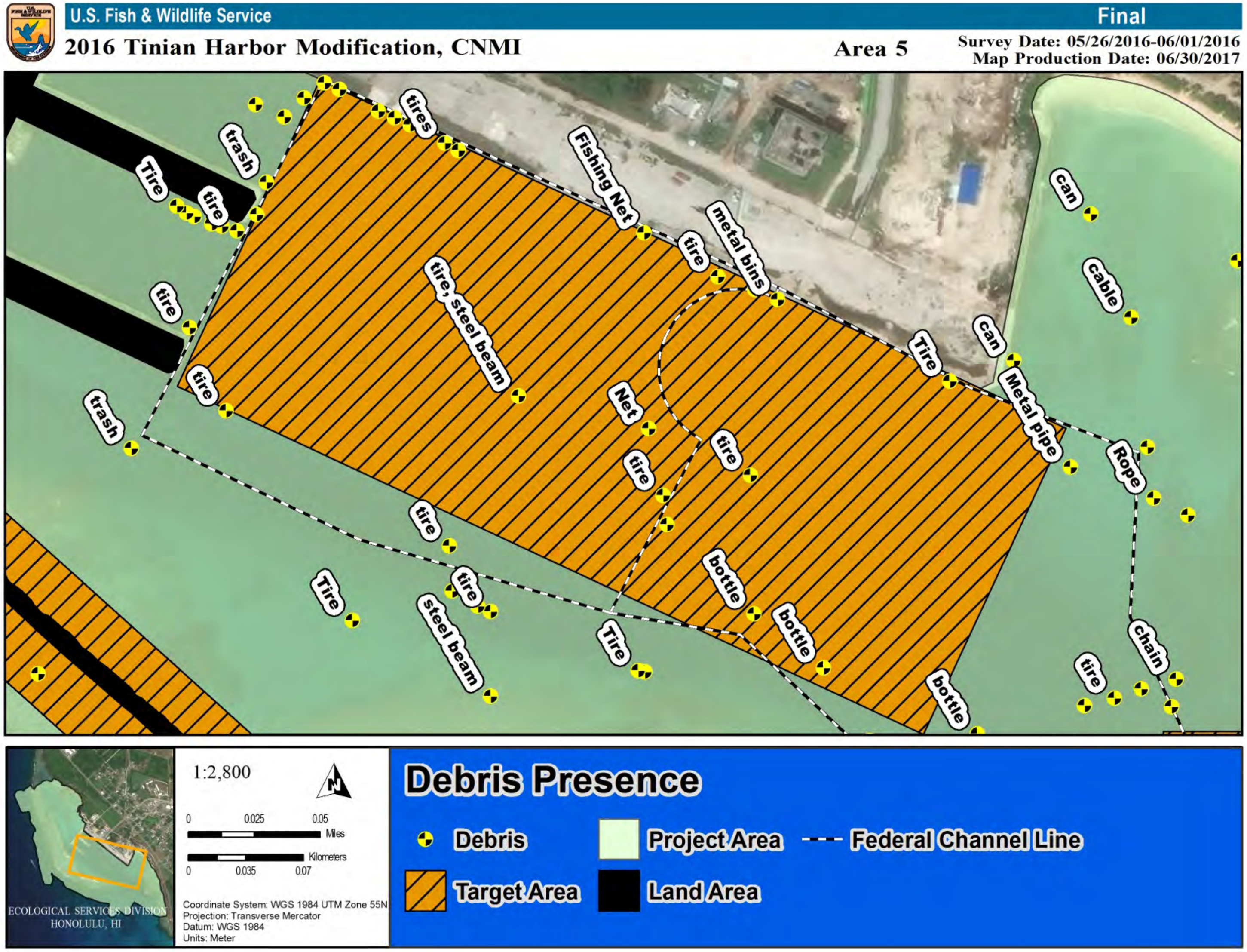

Figure F10: Debris (Area 5). Overview of the debris observed within the project area.

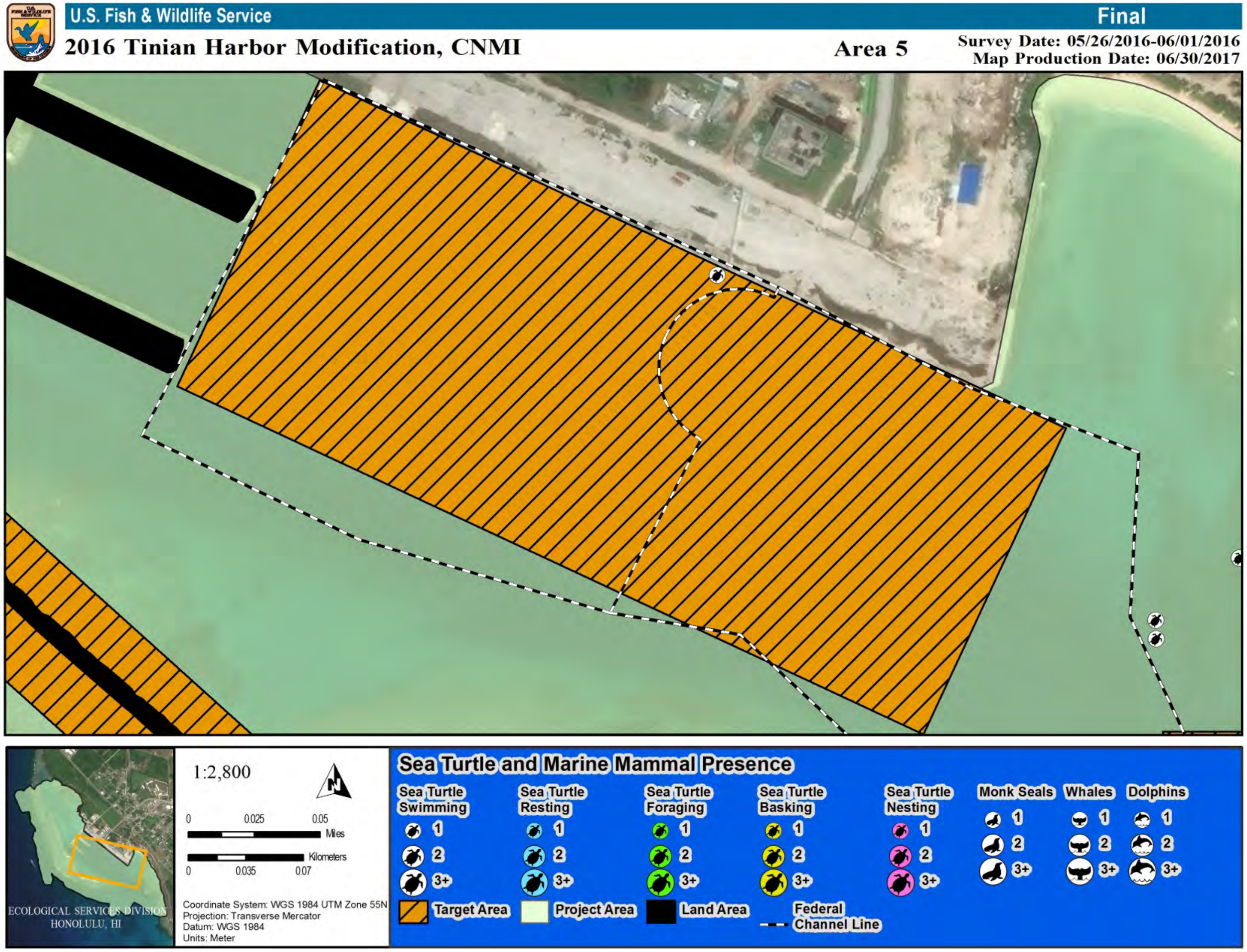

Figure F11: Protected Species (Area 5). Overview of the observed protected species within the project area.

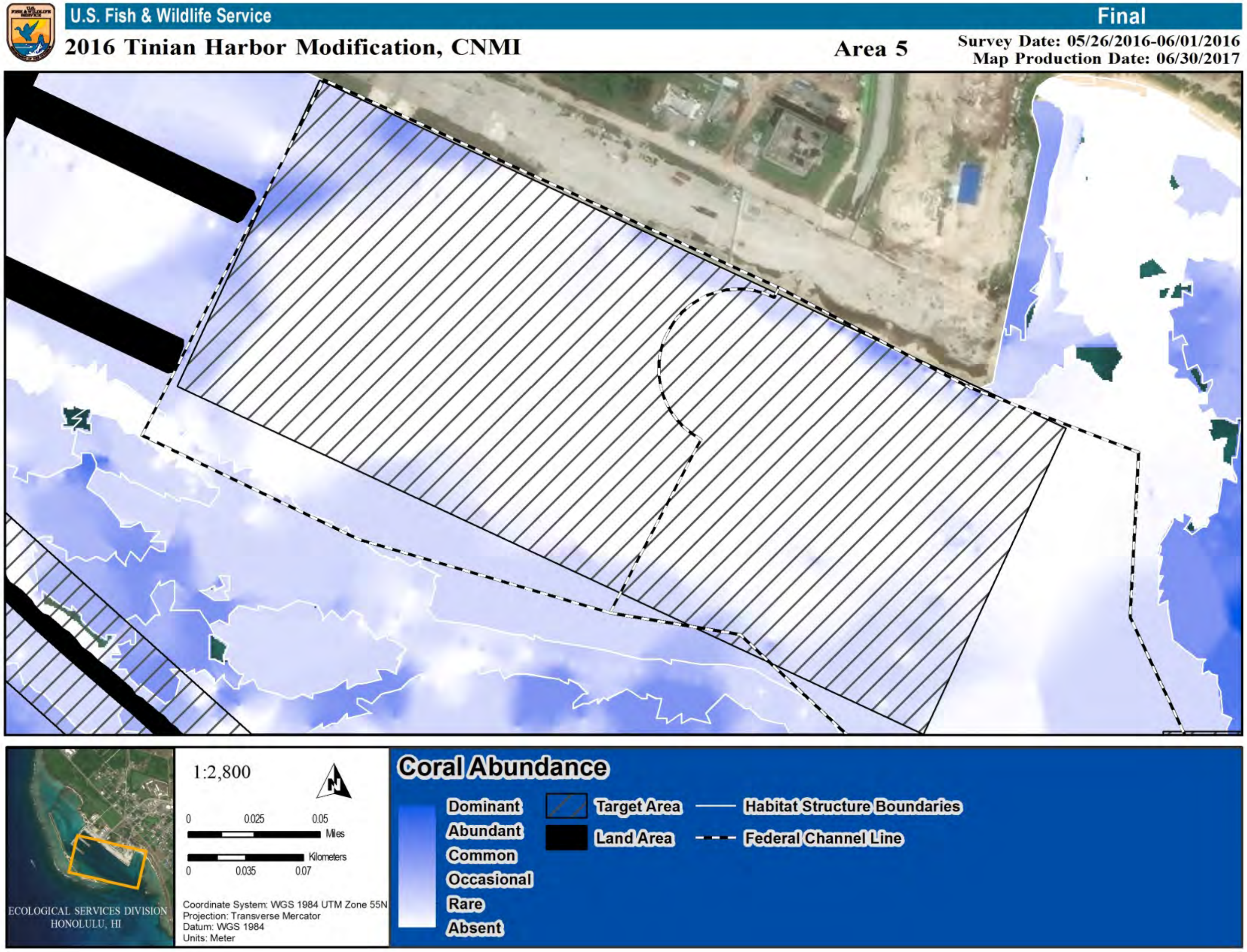

Figure F12: Coral Abundance (Area 5). Overview of the coral abundance within the project.

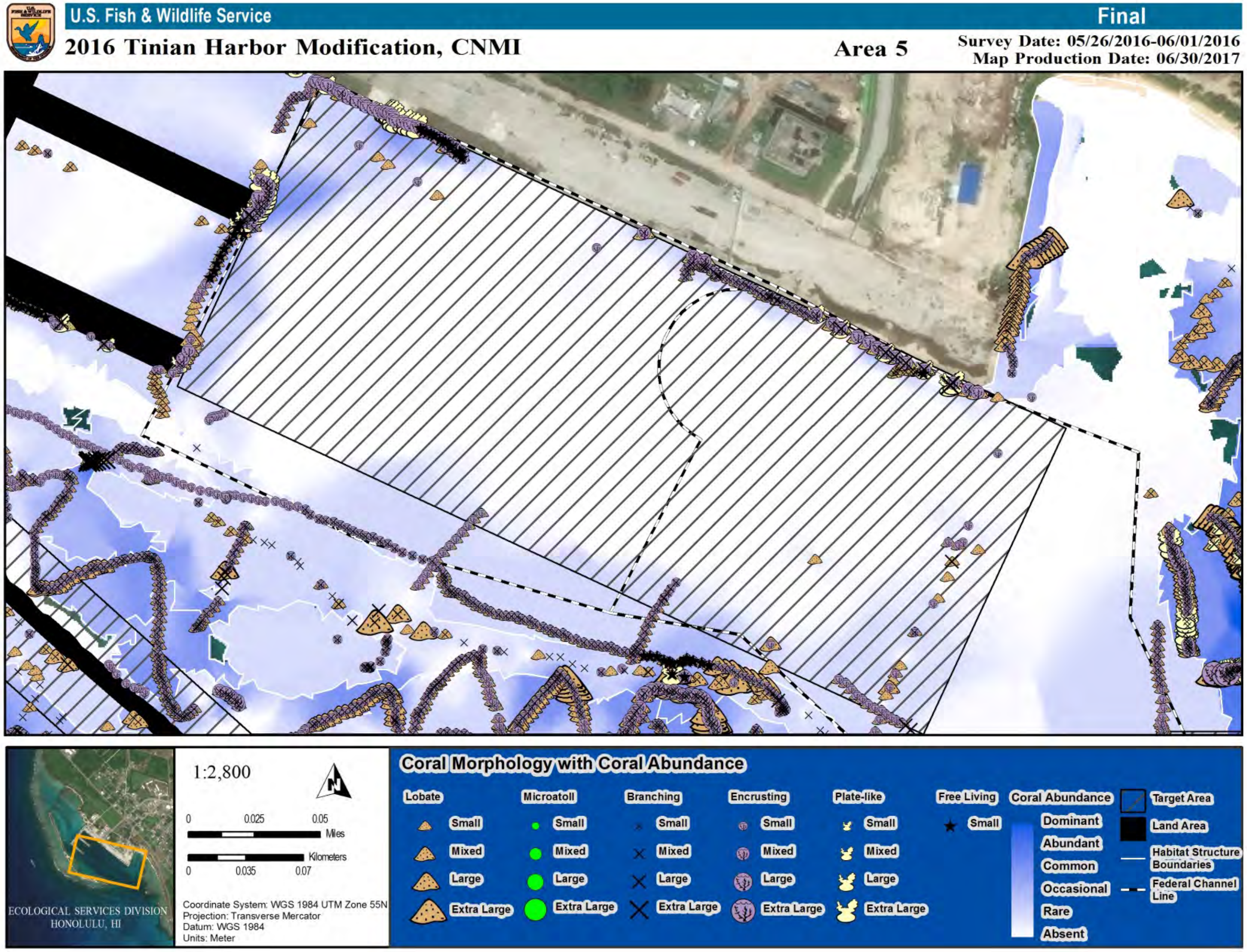

Figure F13: Coral Morphologies (Area 5). Overview of the various coral morphologies and broad coral sizes observed within the project area.

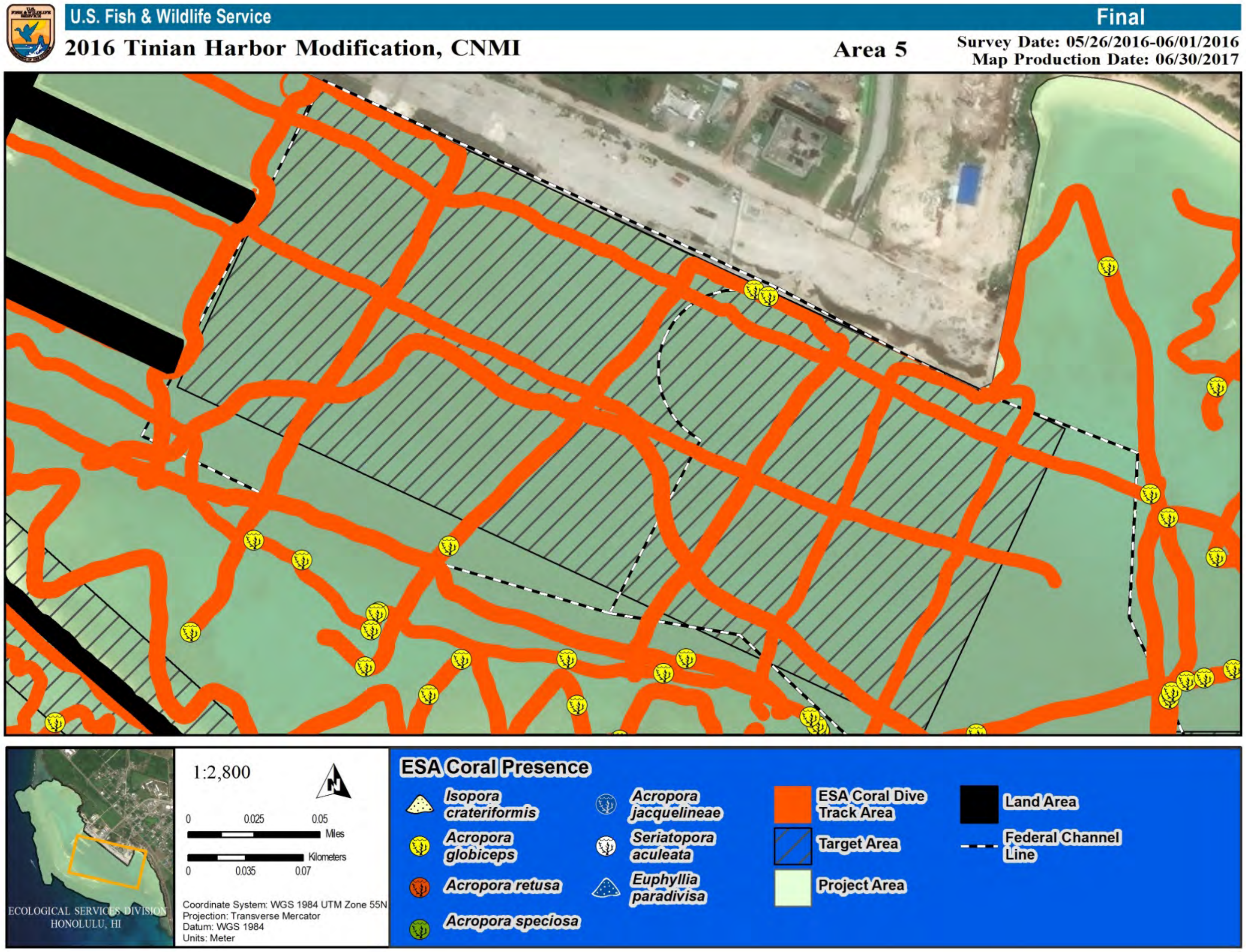

Figure F14: ESA-listed Corals (Area 5). Overview of the ESA-listed coral species observed within the project area.

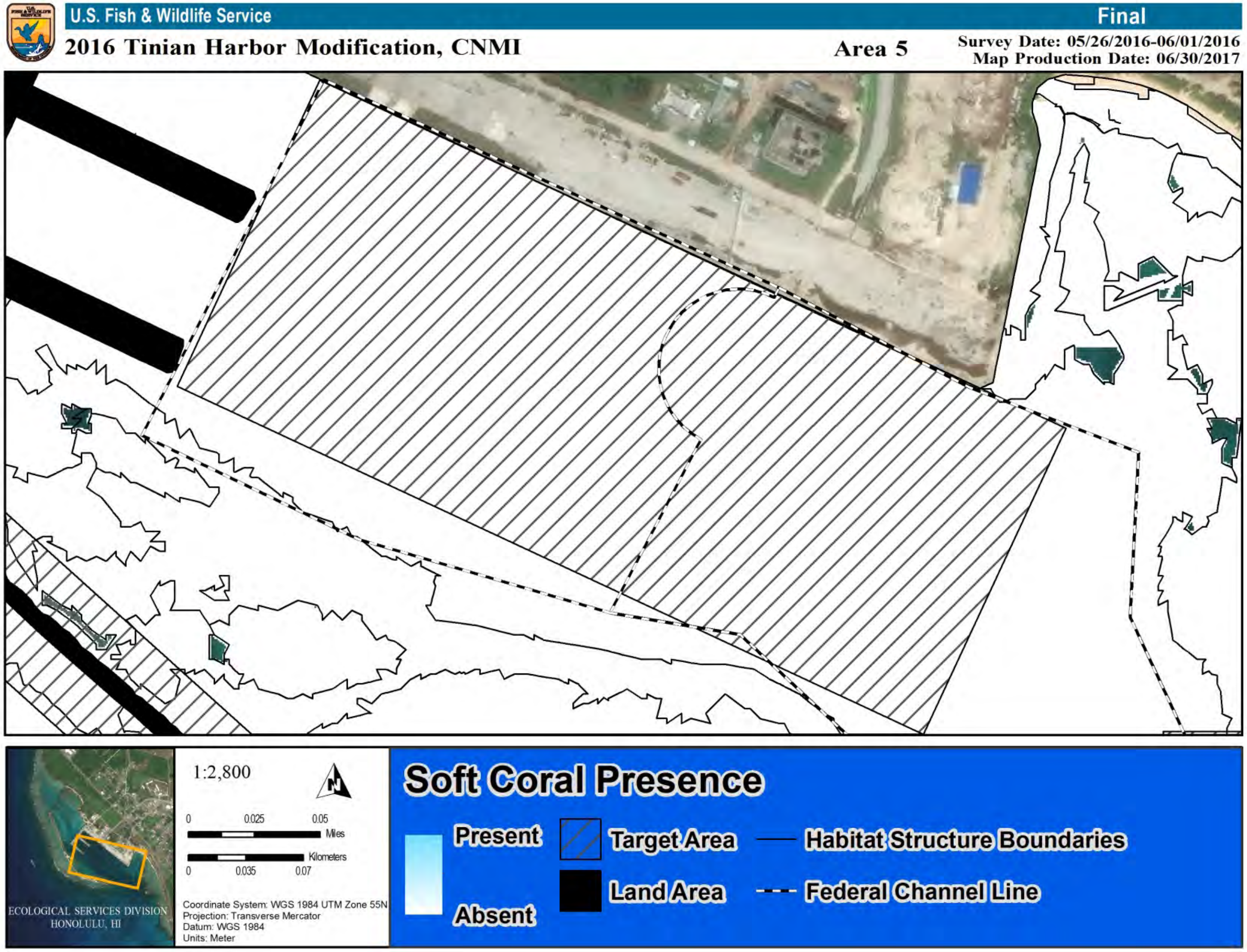

Figure F15: Soft Coral Presence (Area 5). Overview of the soft coral presence within the project area. Note: No soft corals were observed in this area.

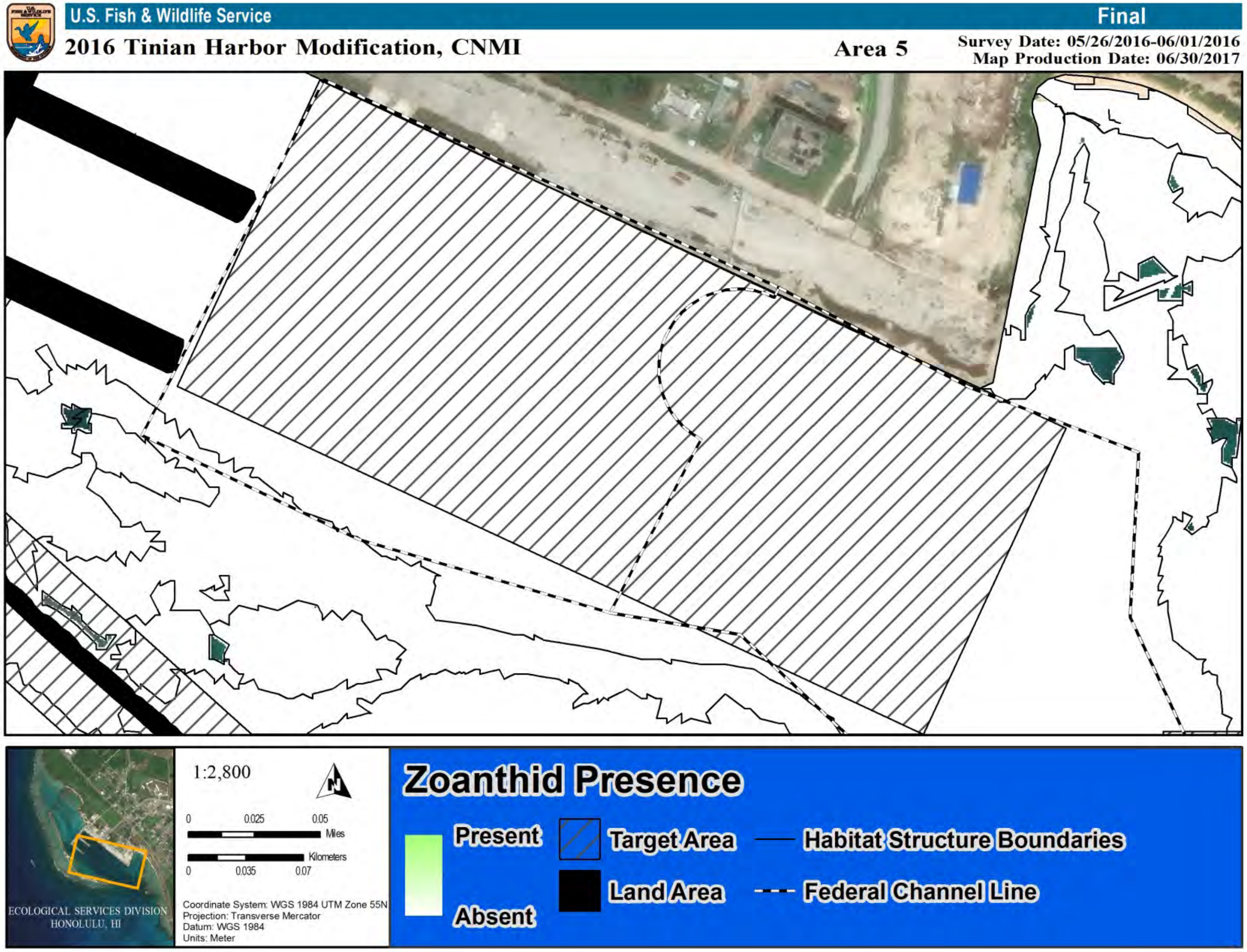

Figure F16: Zonathid Presence (Area 5). Overview of the zoanthid (relative to corals) presence within the project area. Note: No zoanthids were observed in this area.

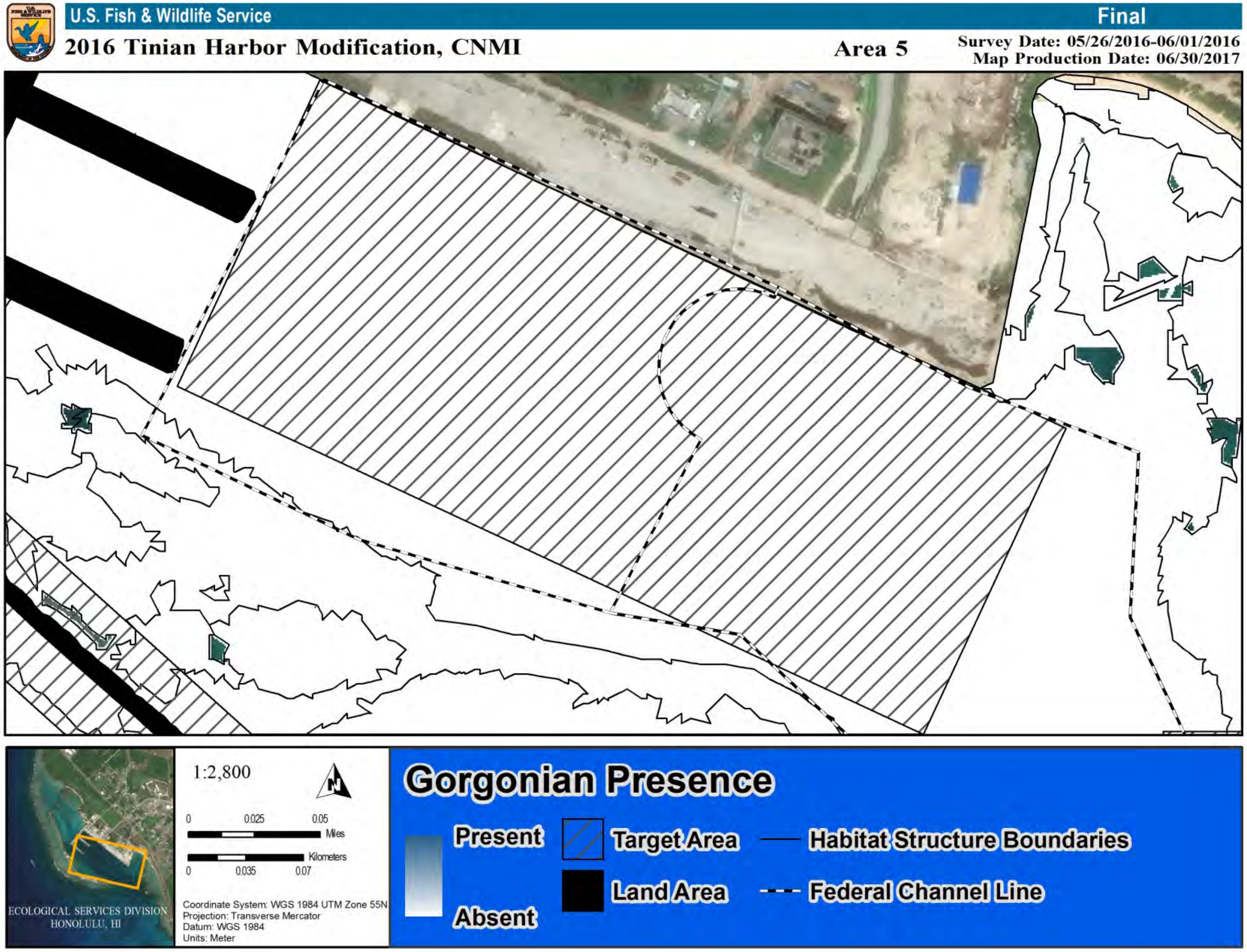

Figure F17: Gorgonian Presence (Area 5). Overview of the gorgonian coral presence within the project area. Note: No gorgonians were observed in this area.

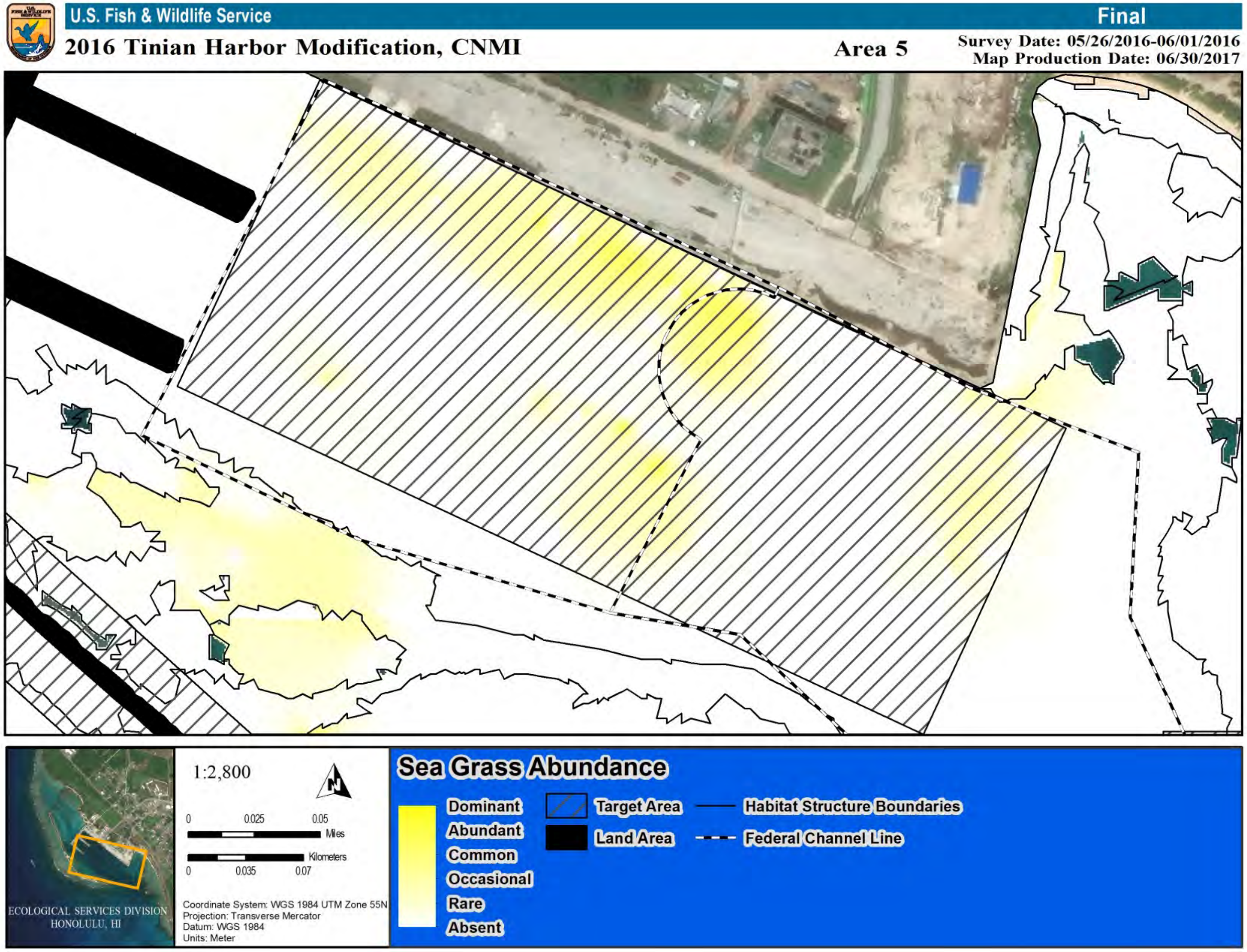

Figure F18: Sea Grass Abundance (Area 5). Overview of the seagrass abundance within the project area.

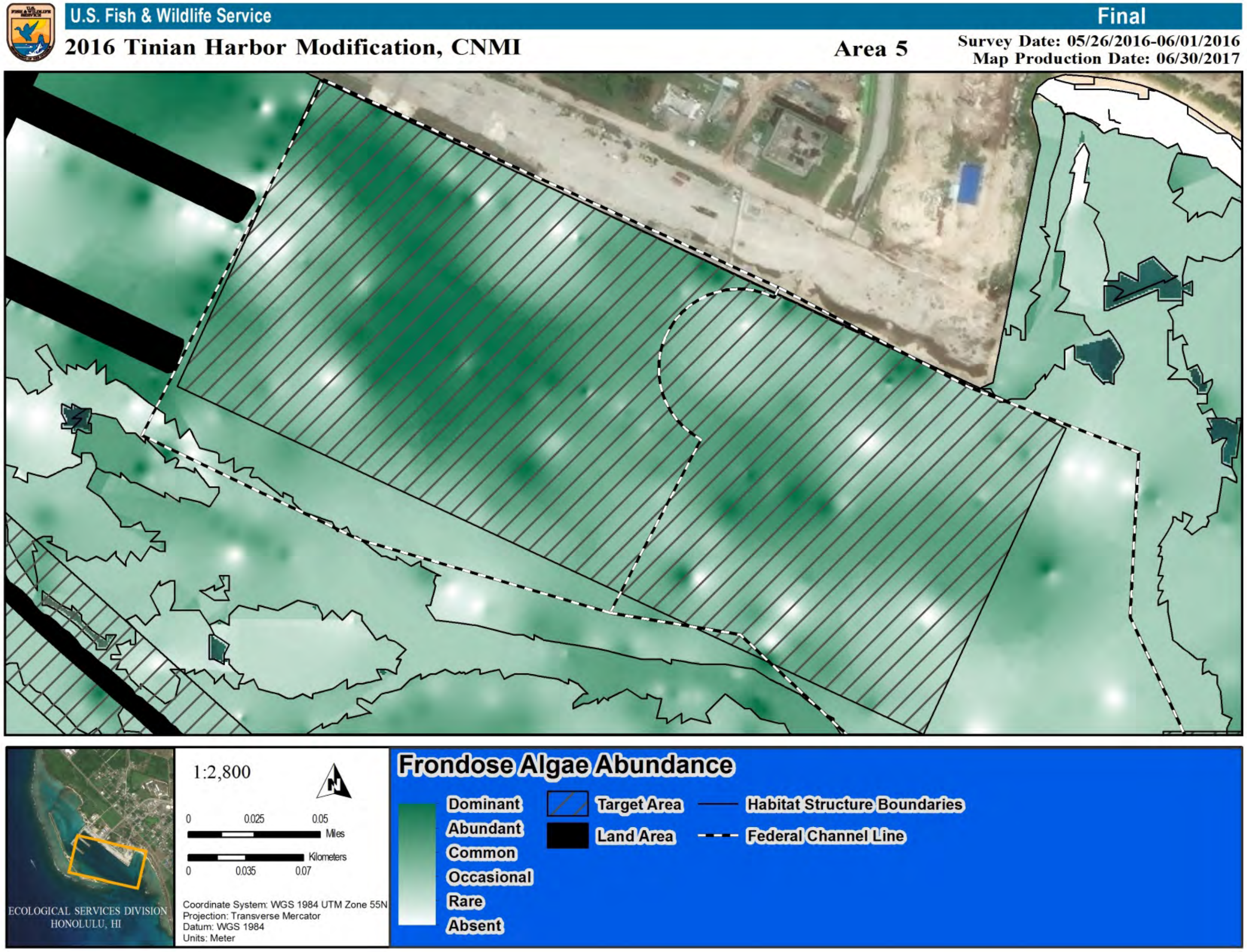

Figure F19: Frondose Algae Abundance (Area 5). Overview of the frondose algae (macroalgae) abundance observed within the project area.

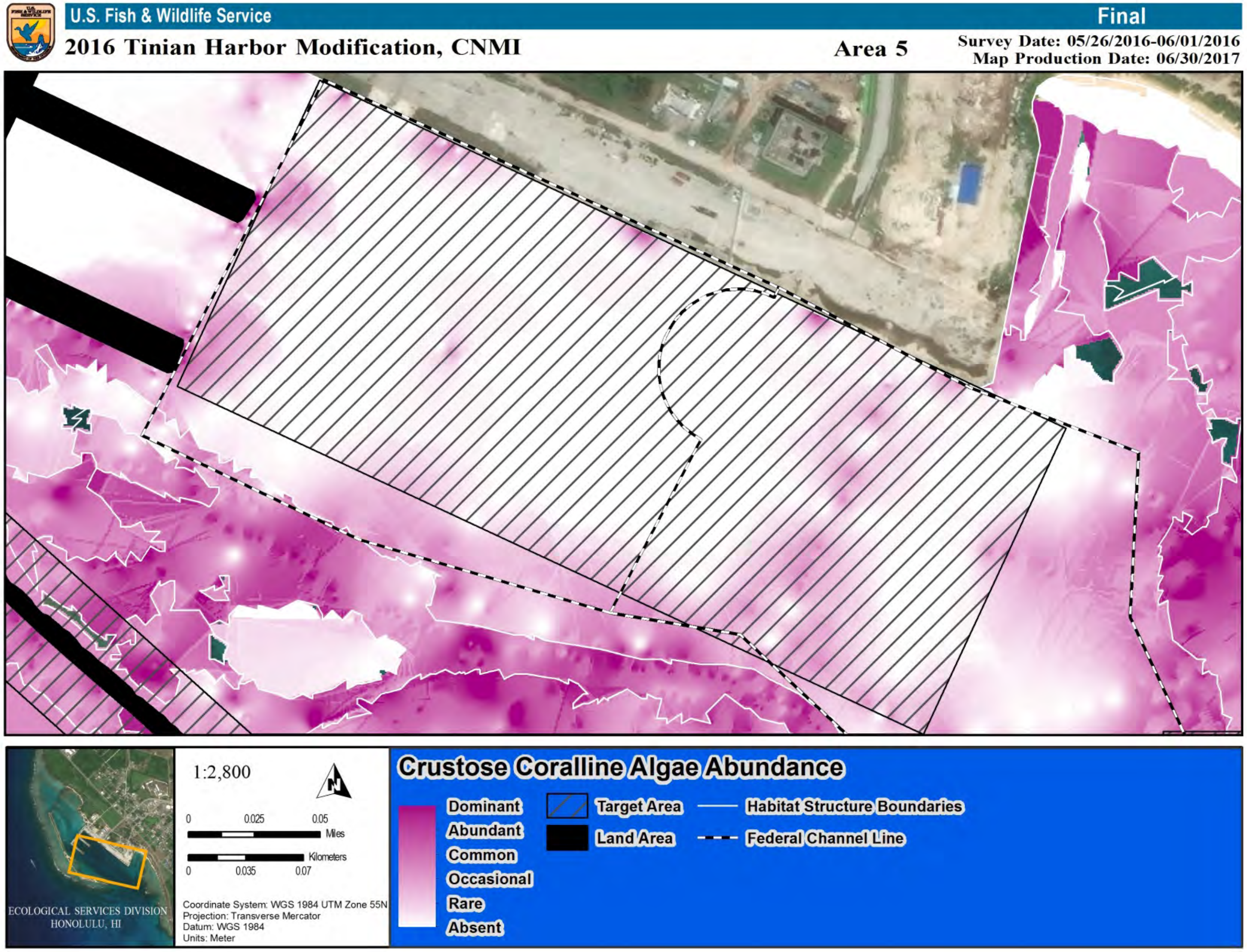

Figure F20: CCA Abundance (Area 5). Overview of the crustose coralline algae abundance observed within the project area.

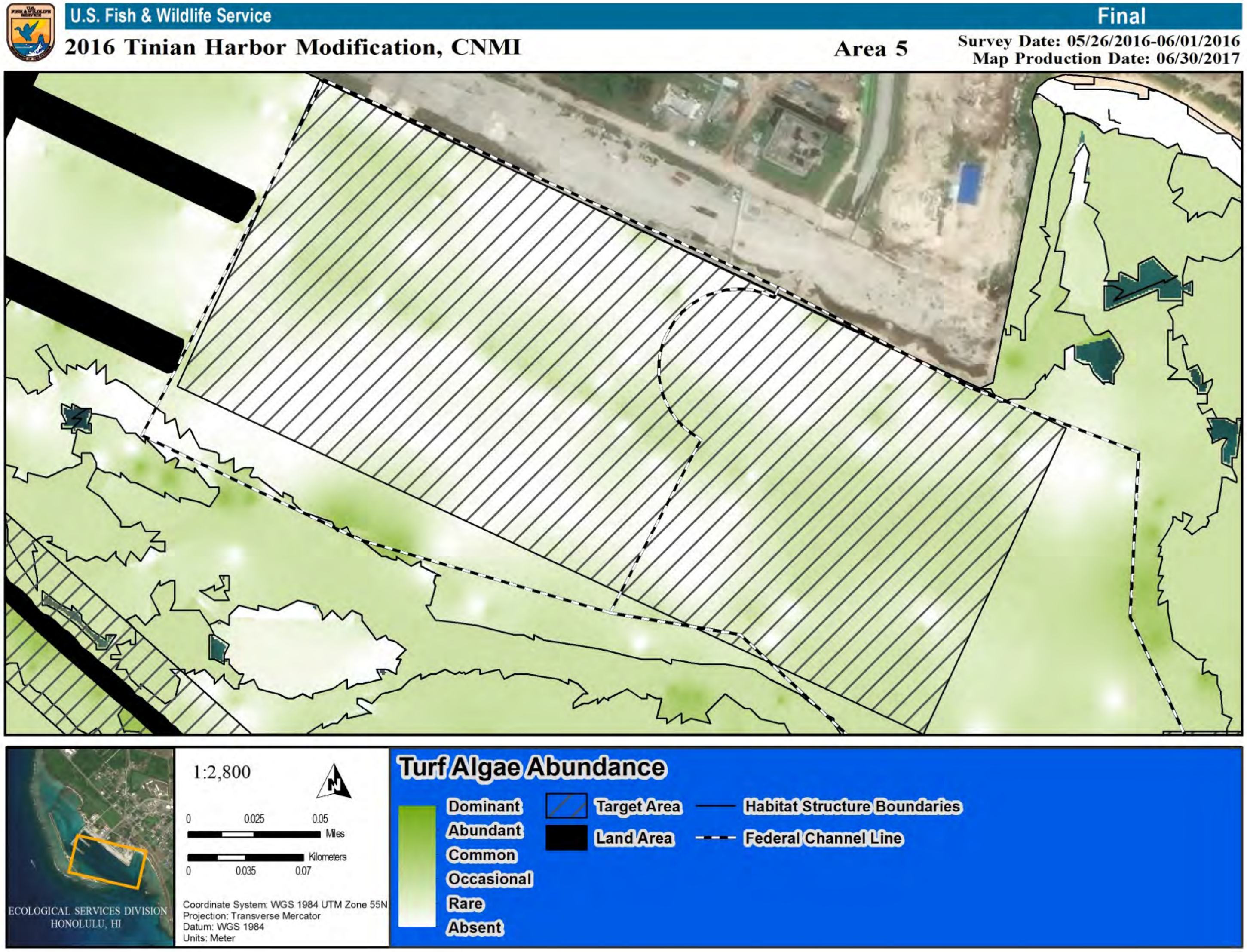

Figure F21: Turf Algae Abundance (Area 5). Overview of the turf algae abundance observed within the project area.

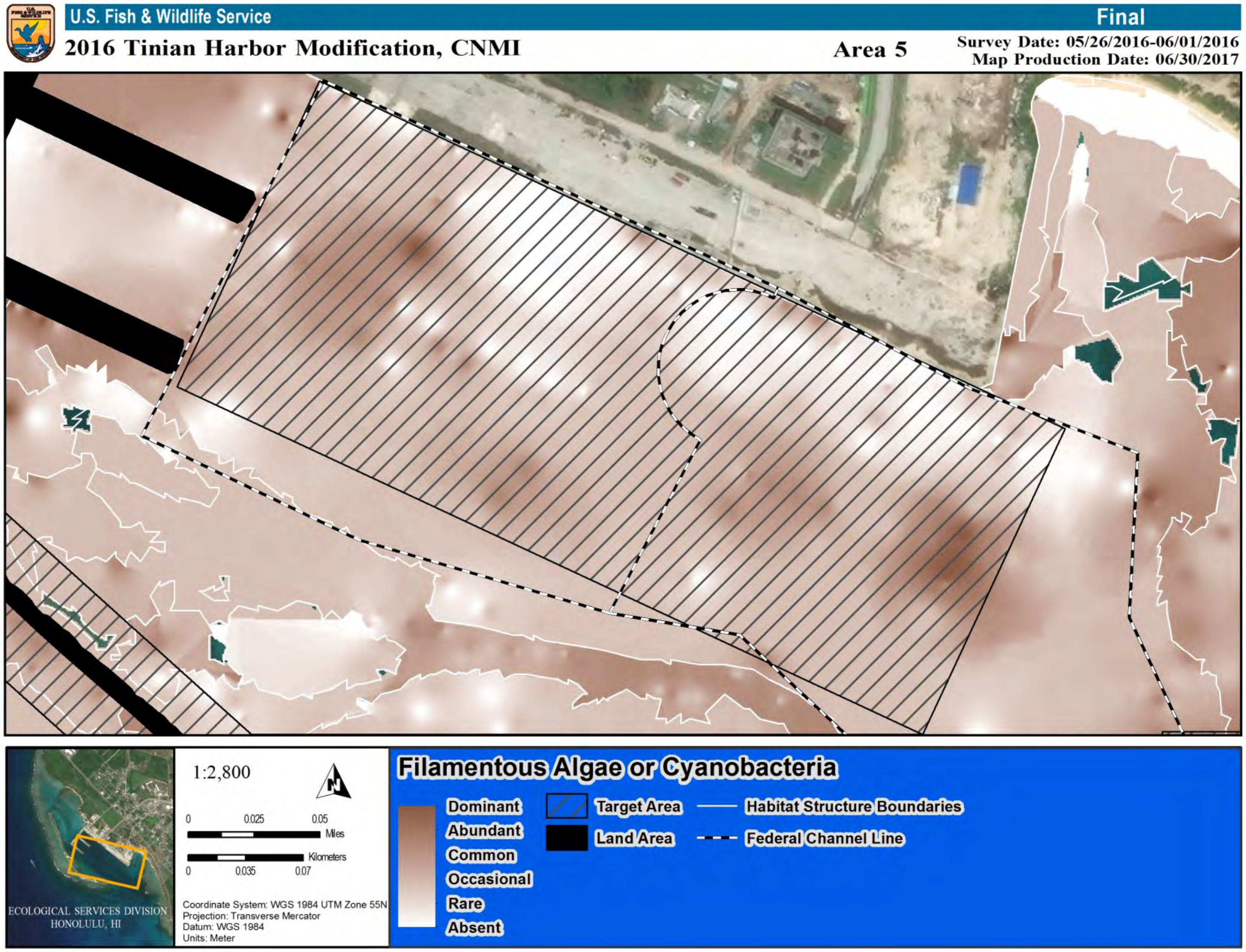

Figure F22: Filamentous Algae (Area 5). Overview of the filamentous algae and cyanobacteria abundance observed within the project area.

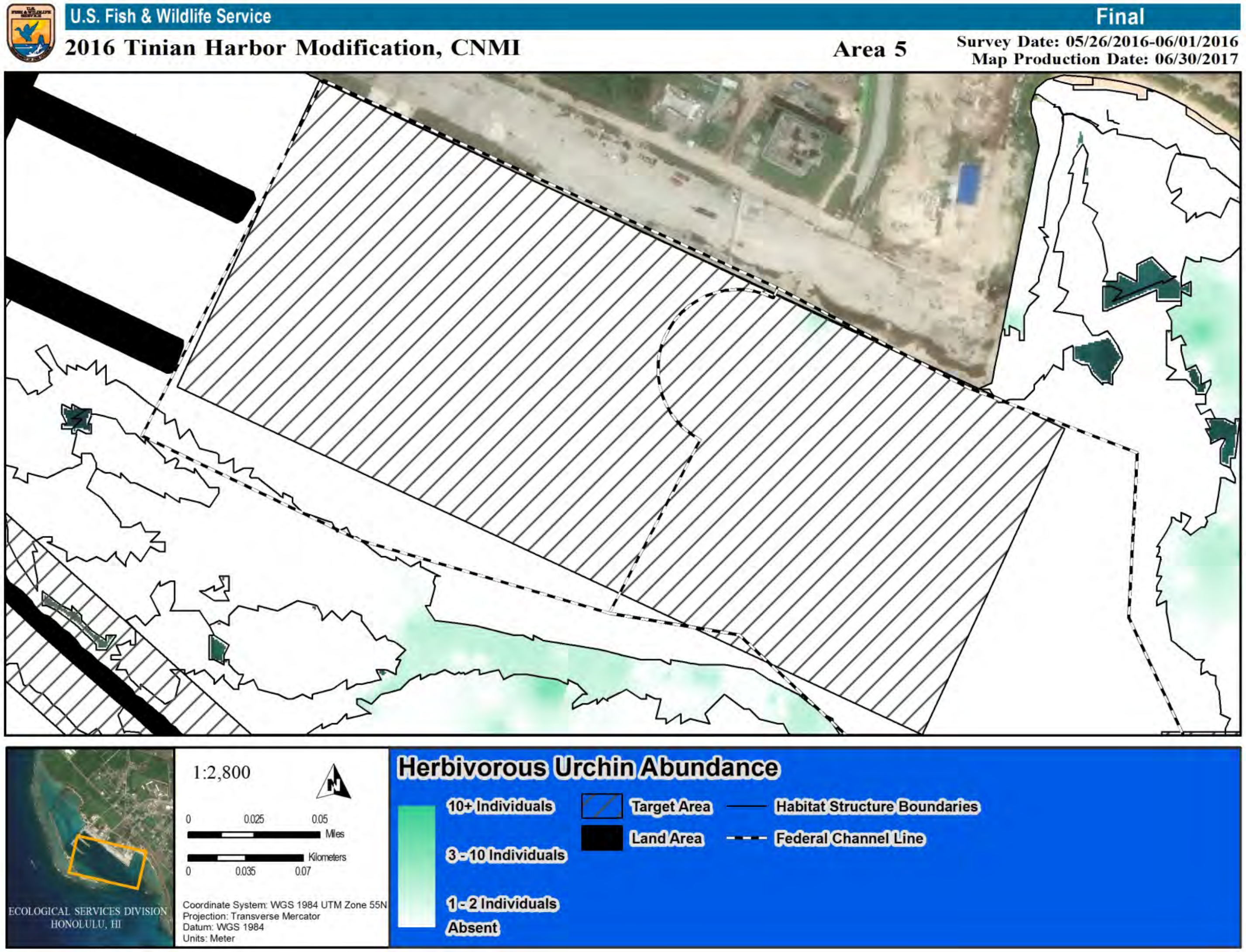

Figure F23: Herbivorous Urchin Abundance (Area 5). Overview of the herbivorous urchin abundance observed within the project area.

Note: No herbivorous urchins were observed in this area.

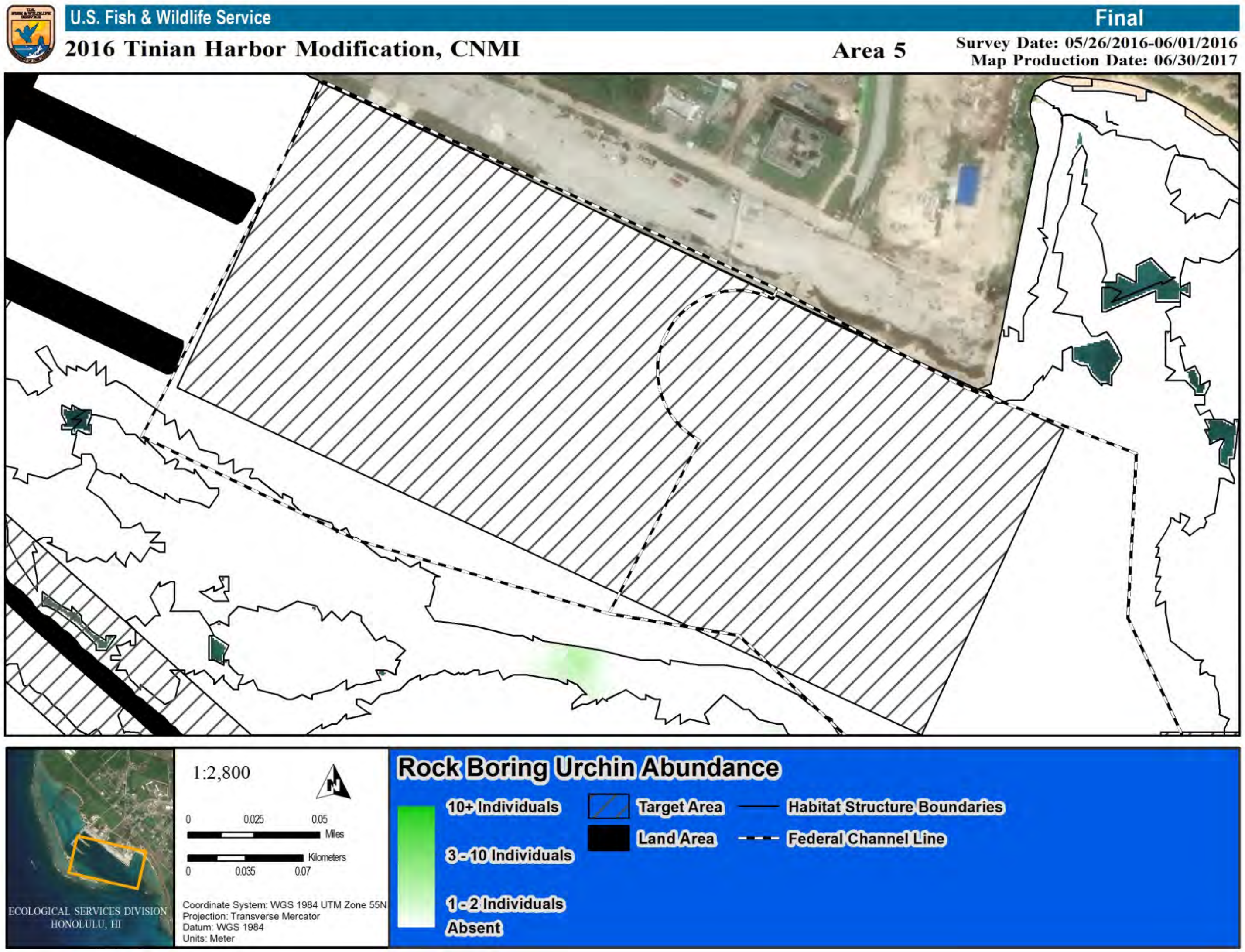

Figure F24: Rock Boring Urchin Abundance (Area 5). Overview of the rock boring urchin abundance observed within the project area.

Note: No rock boring urchins were observed in this area.

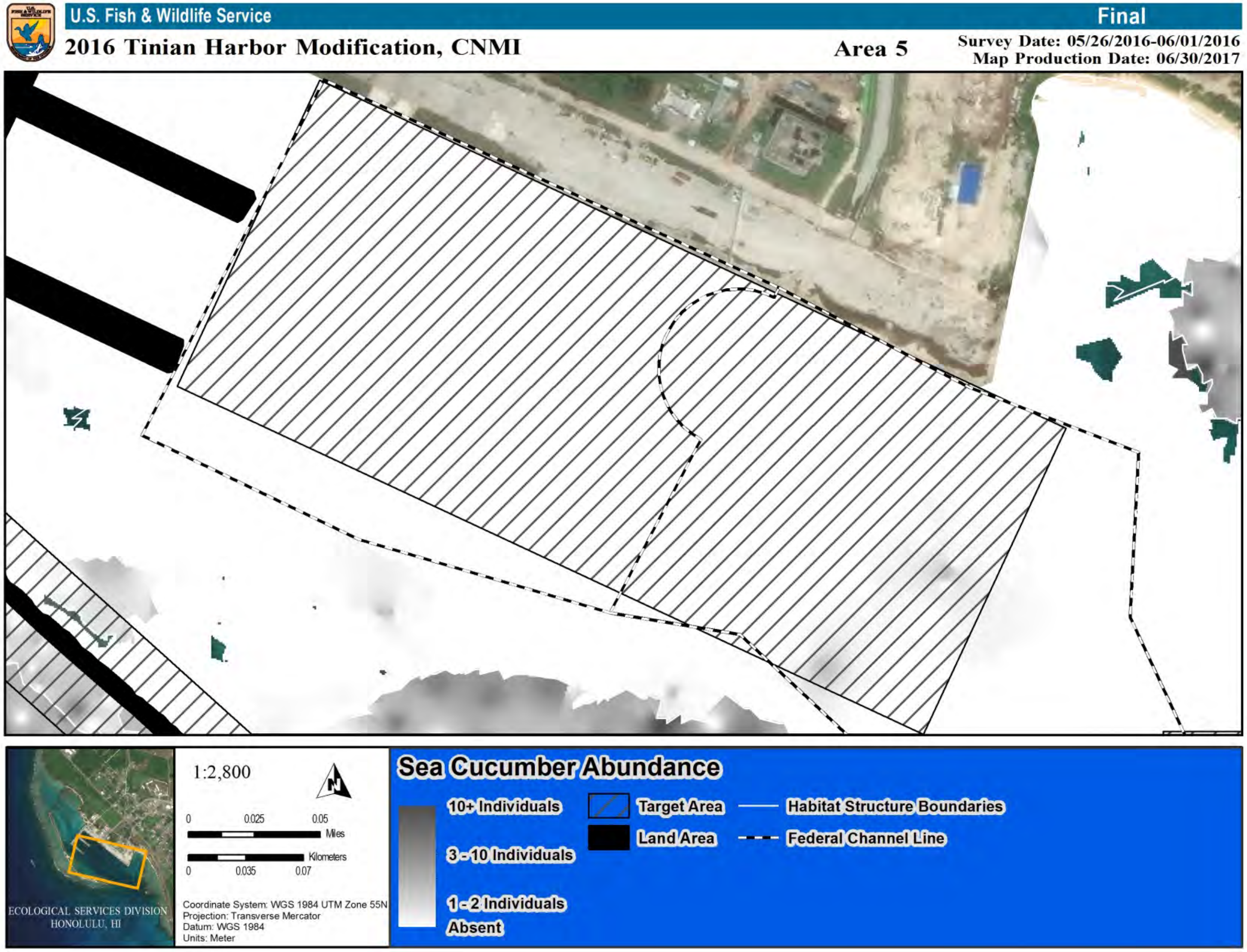

Figure F25: Sea Cucumber Abundance (Area 5). Overview of the sea cucumber abundance observed within the project area.

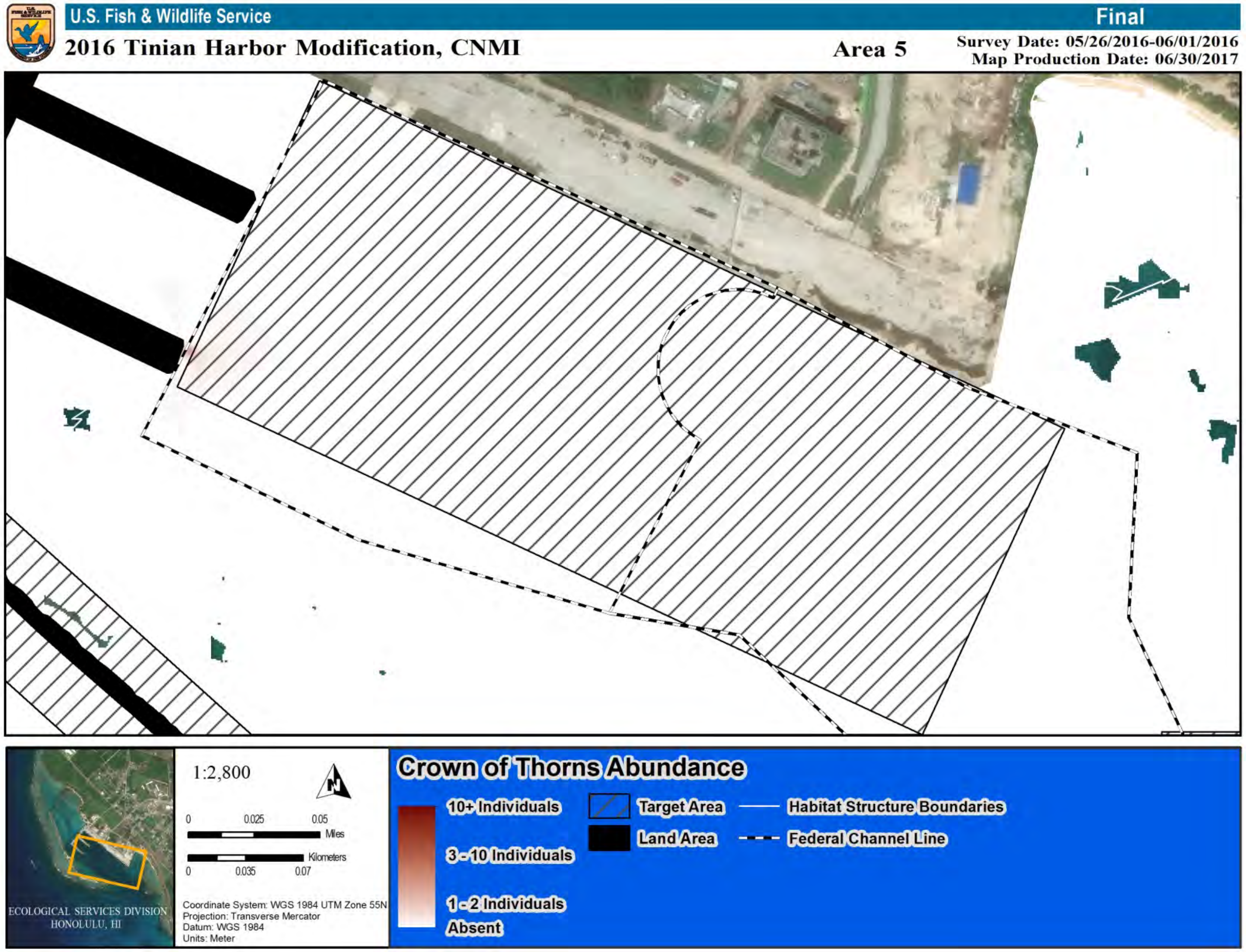

Figure F26: Crown-of-Thorns Abundance (Area 5). Overview of the crown-of-thorn starfish abundance observed within the project area.

Note: No crown-of-thorns were observed in this area.

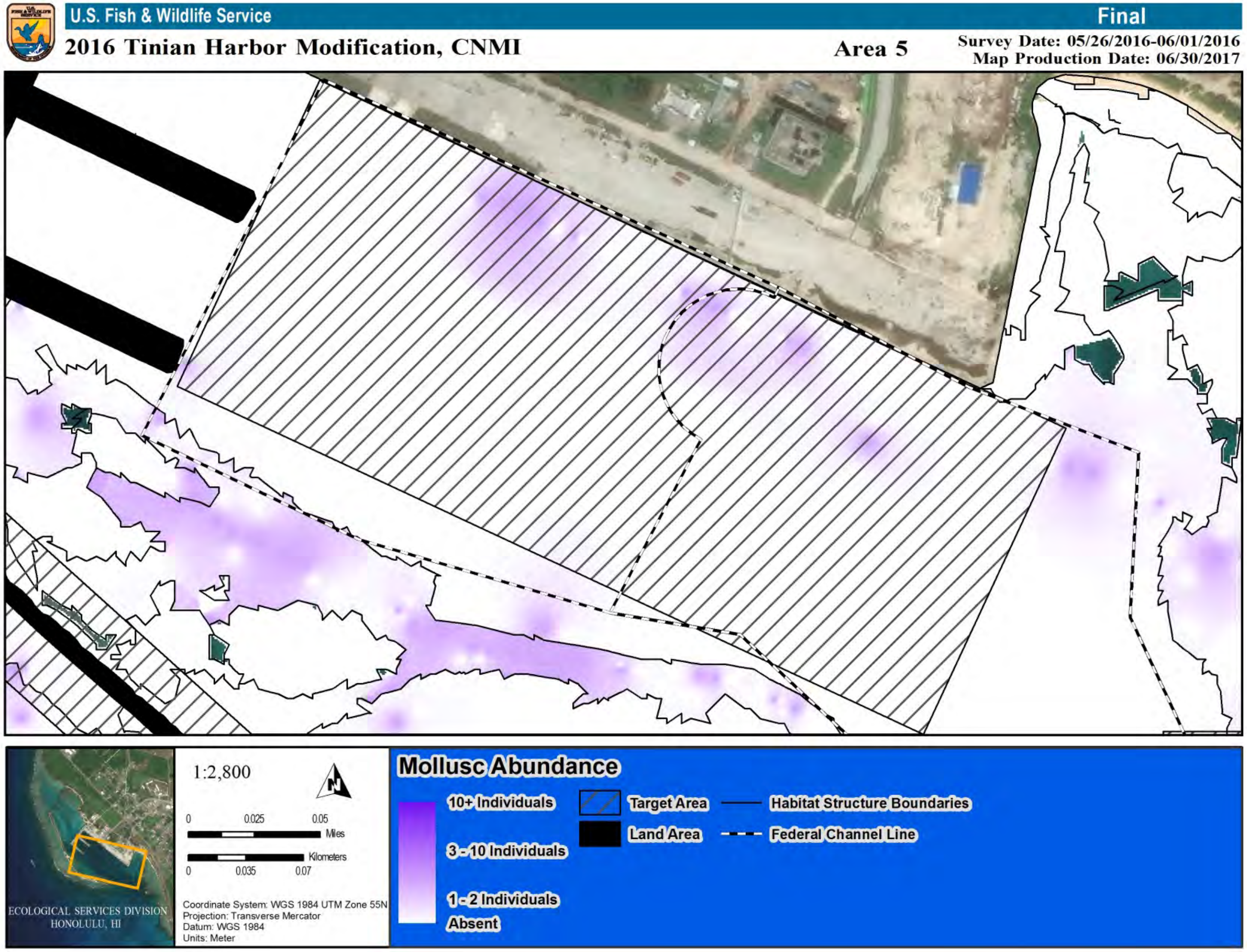

Figure F27: Mollusc Abundance (Area 5). Overview of the mollusc (other than specific species shown in other maps) abundance observed within the project area.

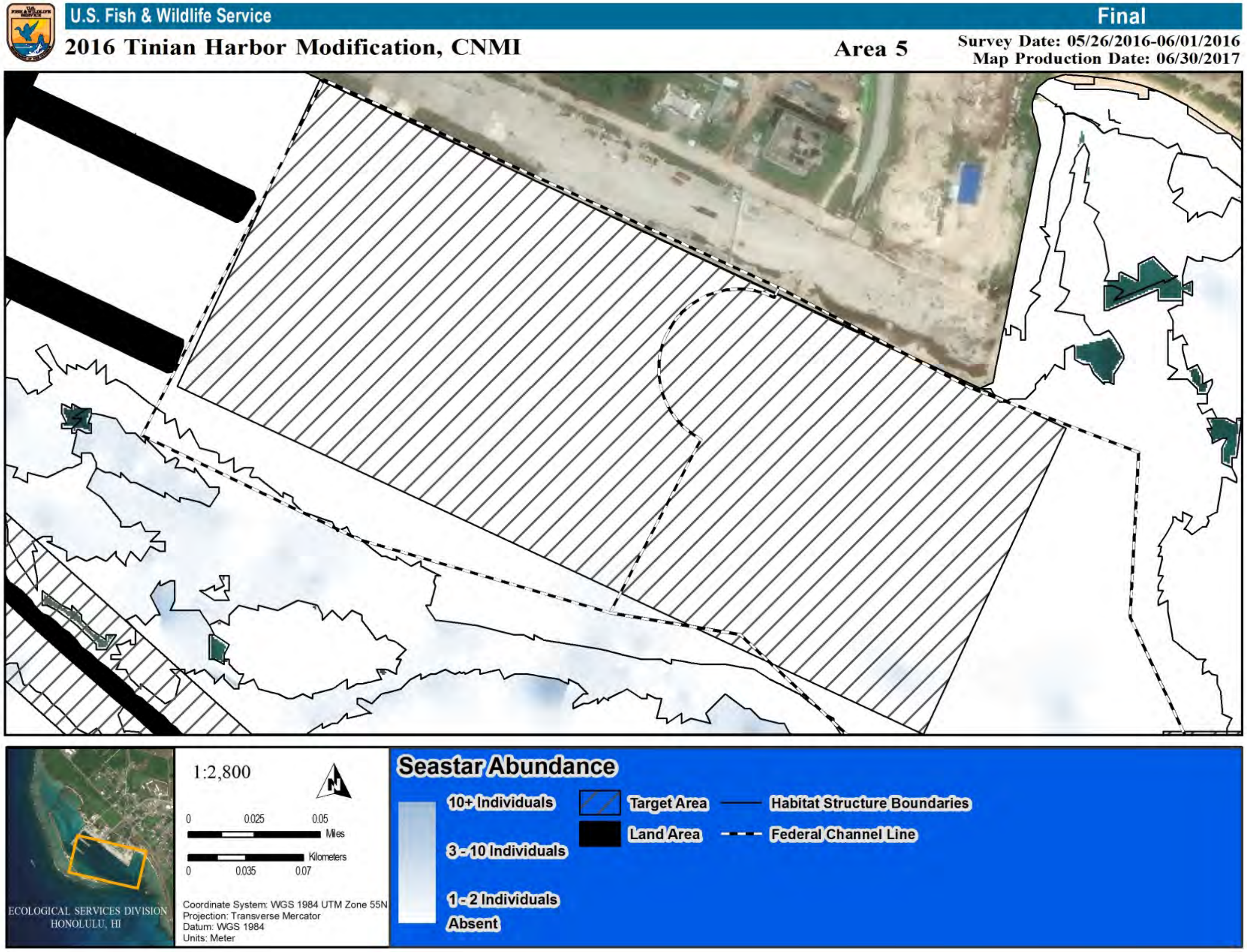

Figure F28: Seastar Abundance (Area 5). Overview of the seastar abundance observed within the project area.

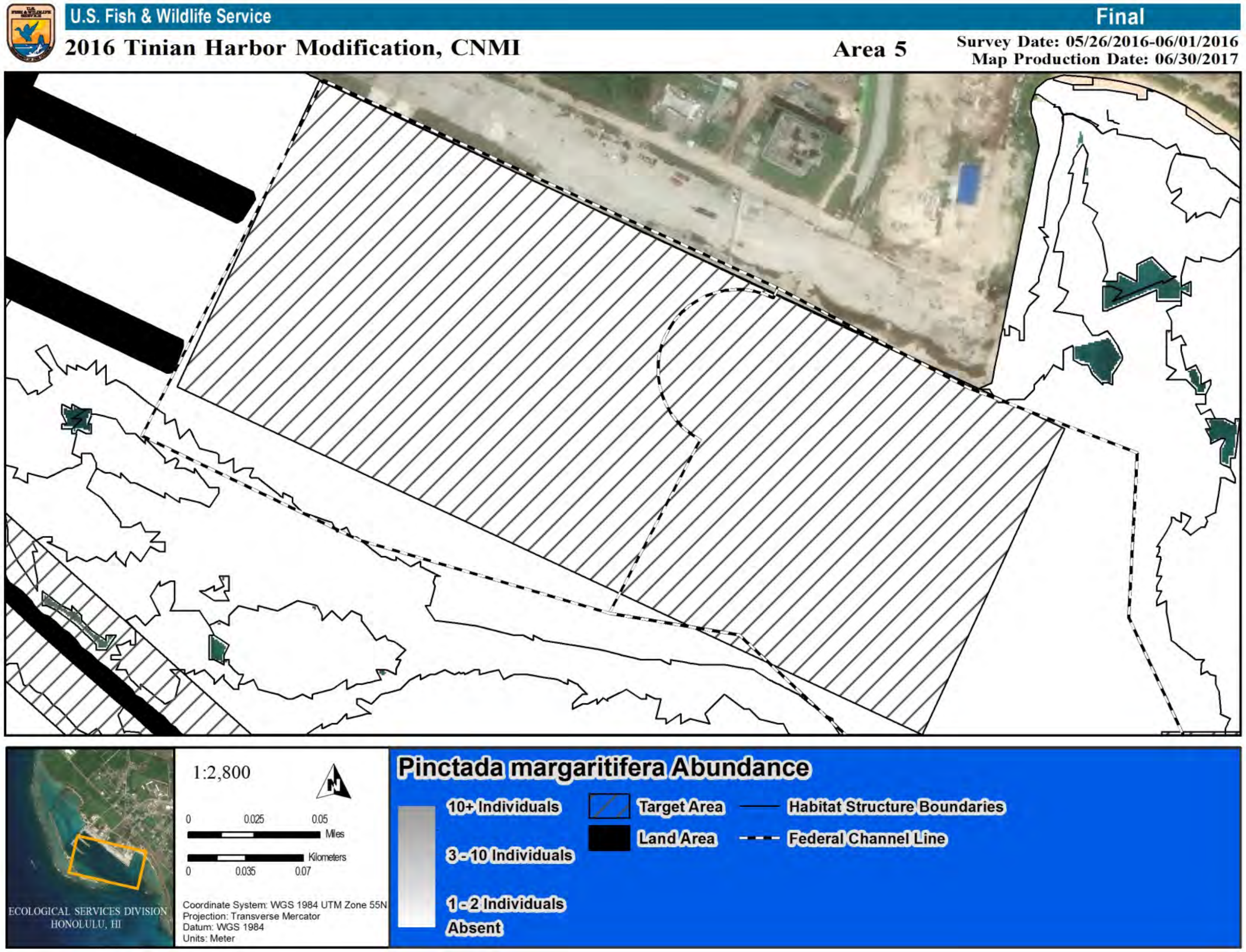

Figure F29: Pinctada Abundance (Area 5). Overview of the mollusc, Pinctada margaritifera, abundance observed within the project area.

Note: No Pinctada margaritifera were observed in this area.

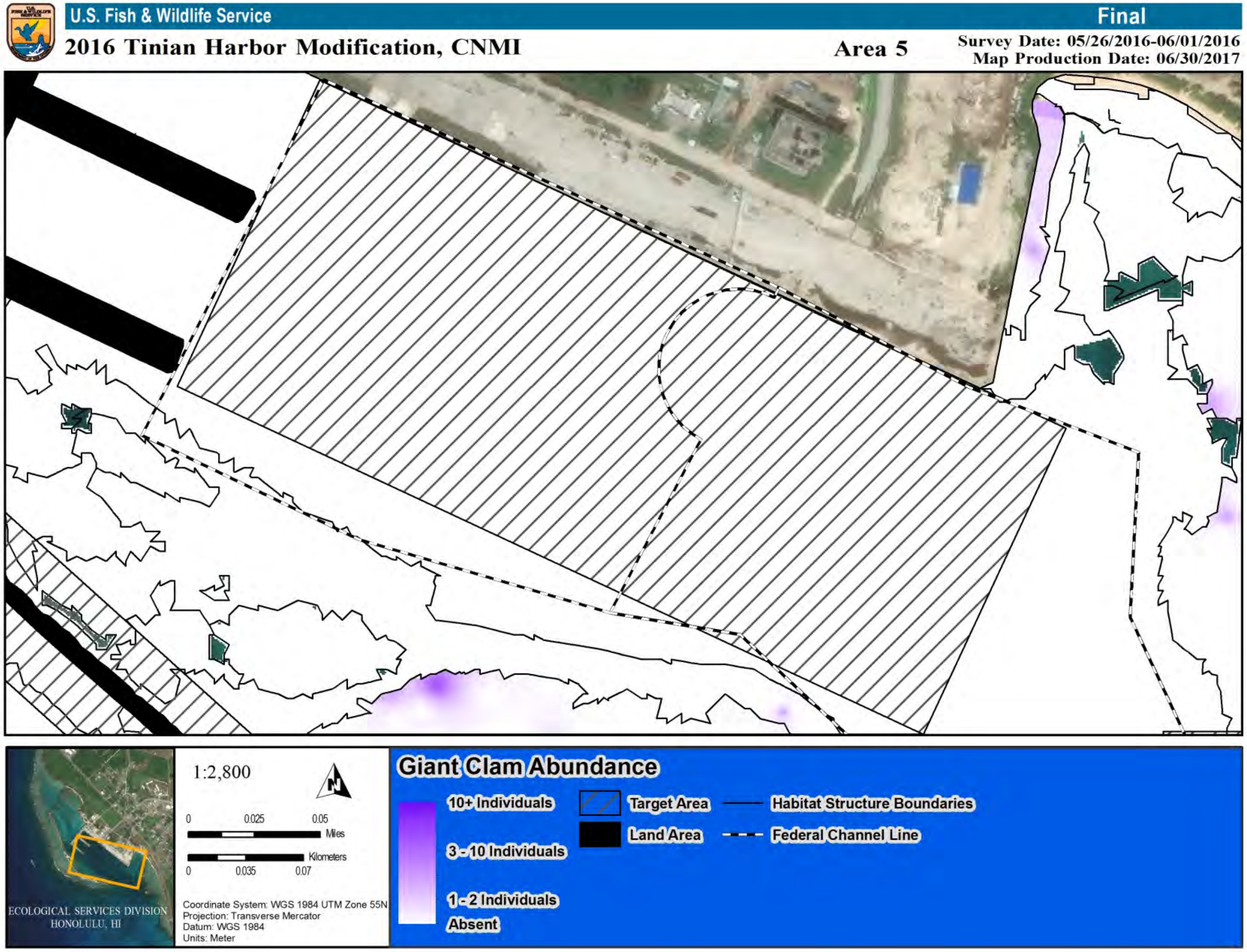

Figure F30: Giant Clam Abundance (Area 5). Overview of the giant clam abundance observed within the project area. Note: No giant clams were observed in this area.

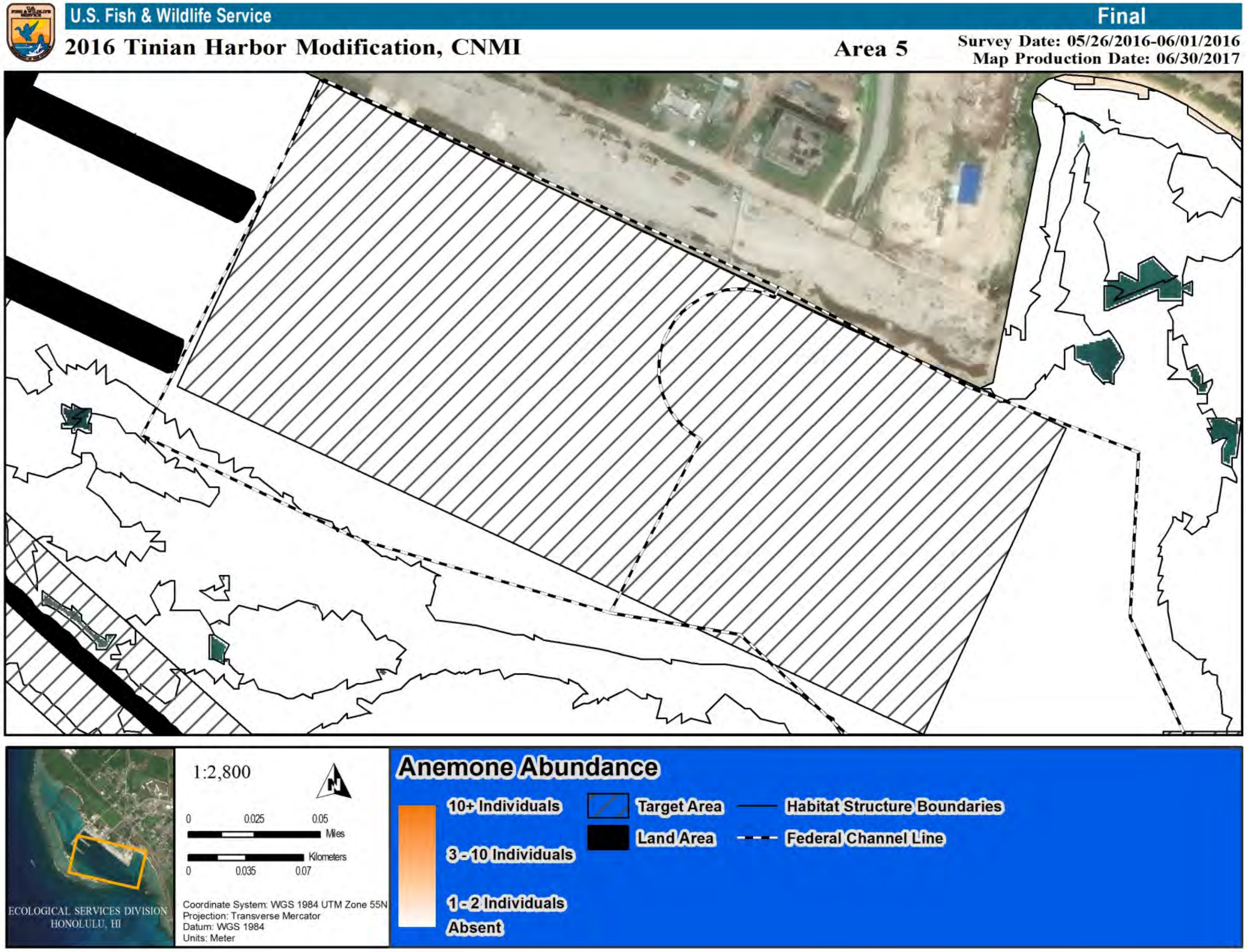

Figure F31: Anemone Abundance (Area 5). Overview of the anemone abundance observed within the project area. Note: No Anemones were observed in this area.

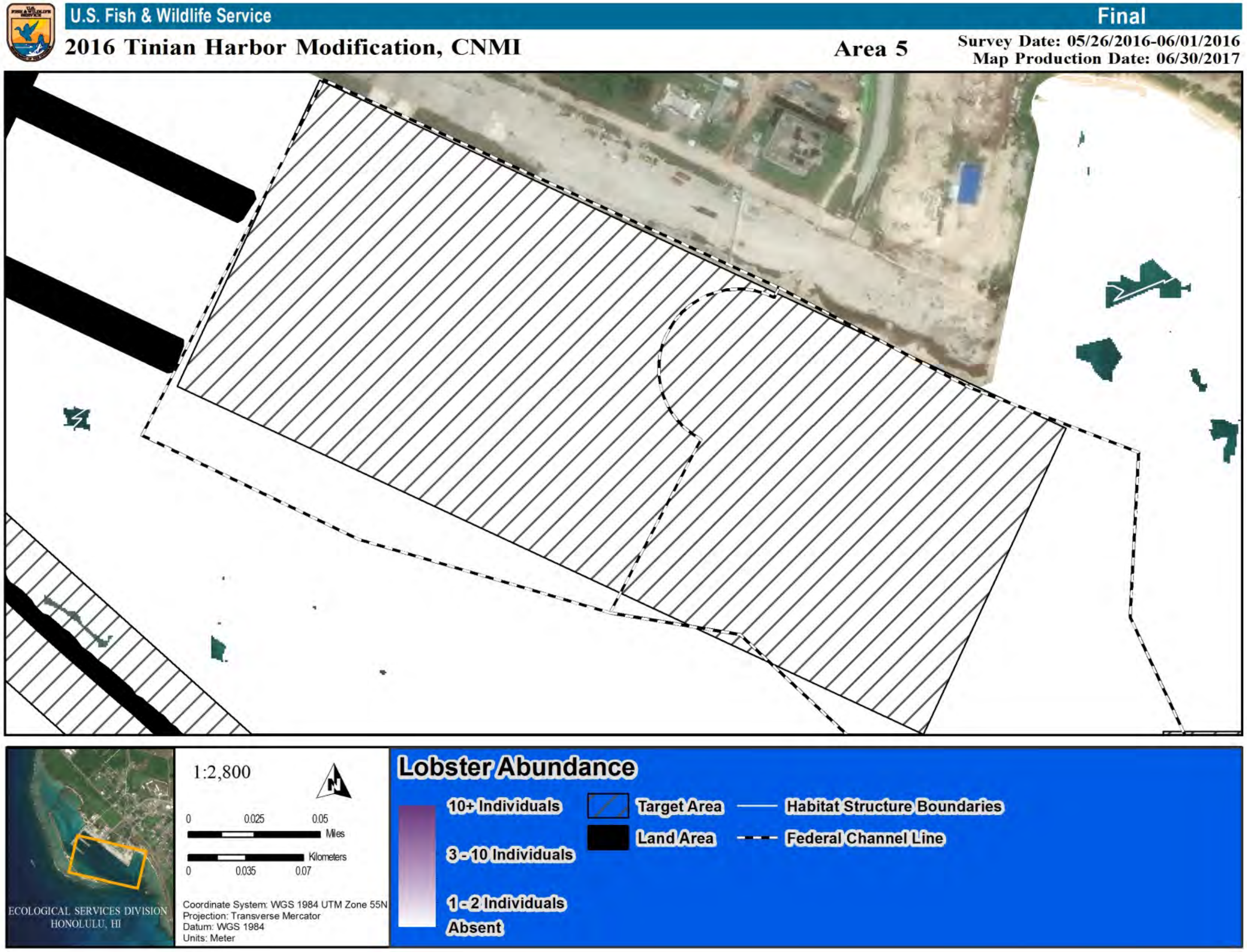

Figure F32: Lobster Abundance (Area 5). Overview of the lobster abundance observed within the project area. Note: No lobsters were observed in this area.

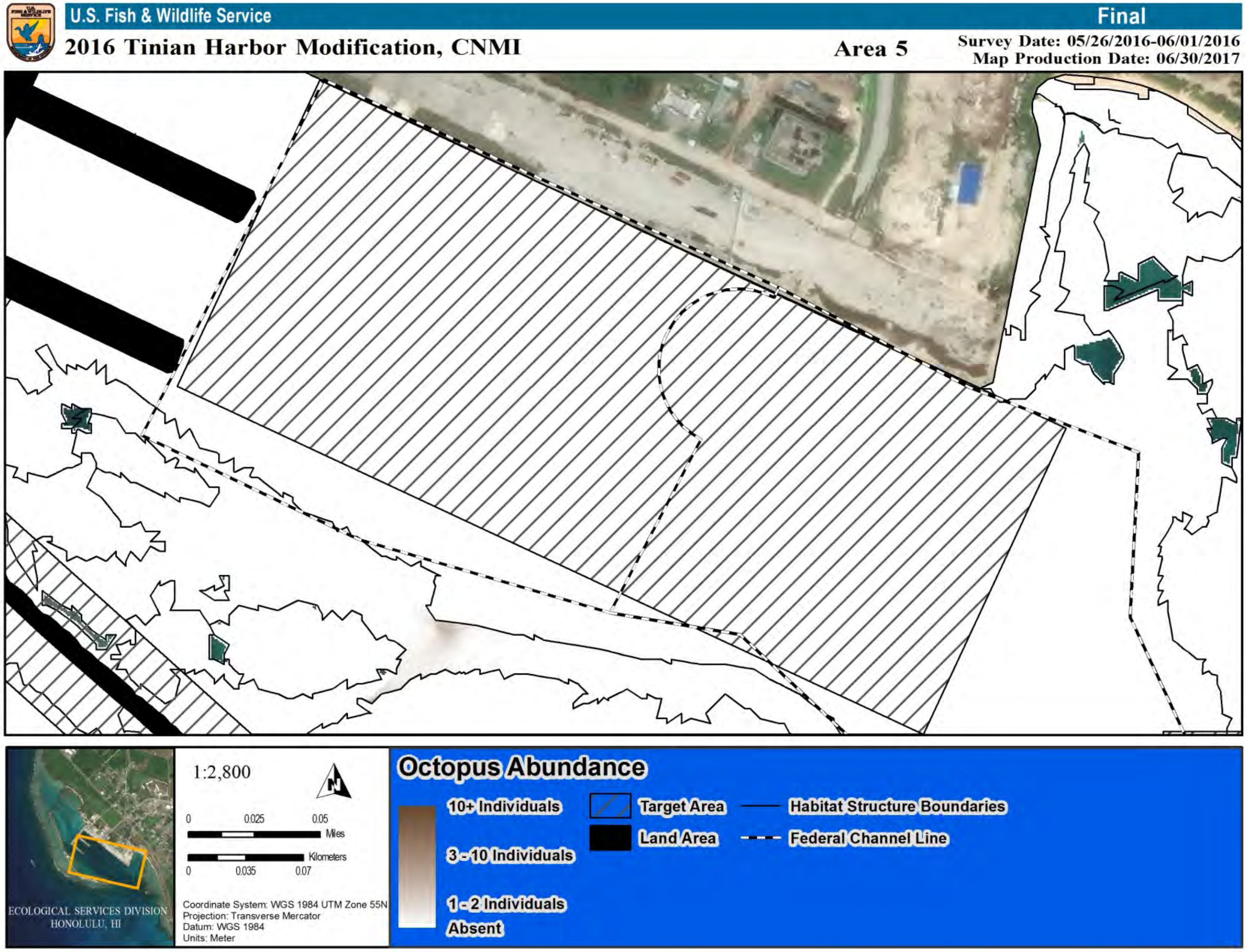

Figure F33: Octopus Abundance (Area 5). Overview of the octopus abundance observed within the project area. Note: No octopuses were observed in this area.

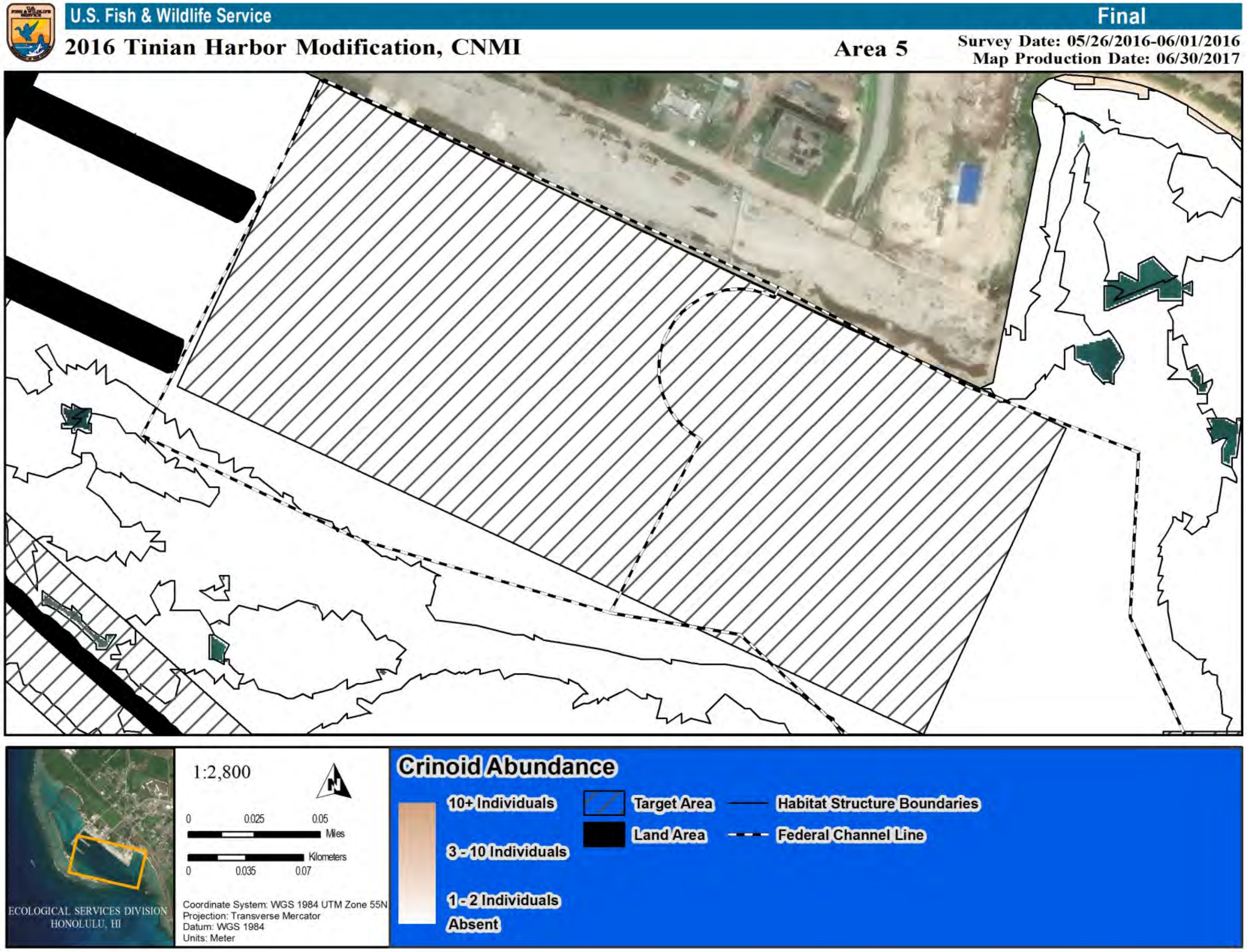

Figure F34: Crinoid Abundance (Area 5). Overview of the crinoid abundance observed within the project area. Note: No crinoids were observed in this area.

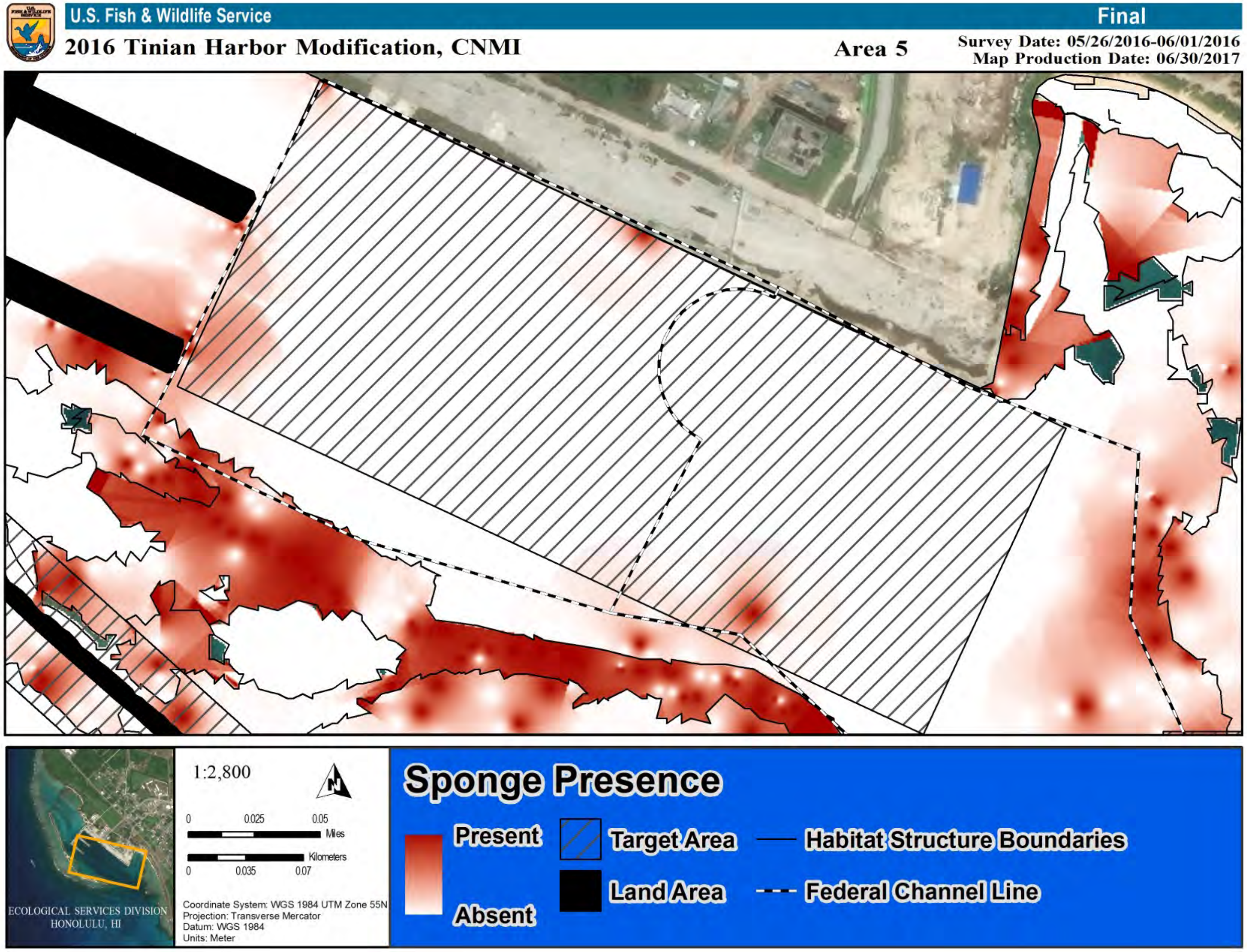

Figure F35: Sponge Presence (Area 5). Overview of the sponge presence observed within the project area.

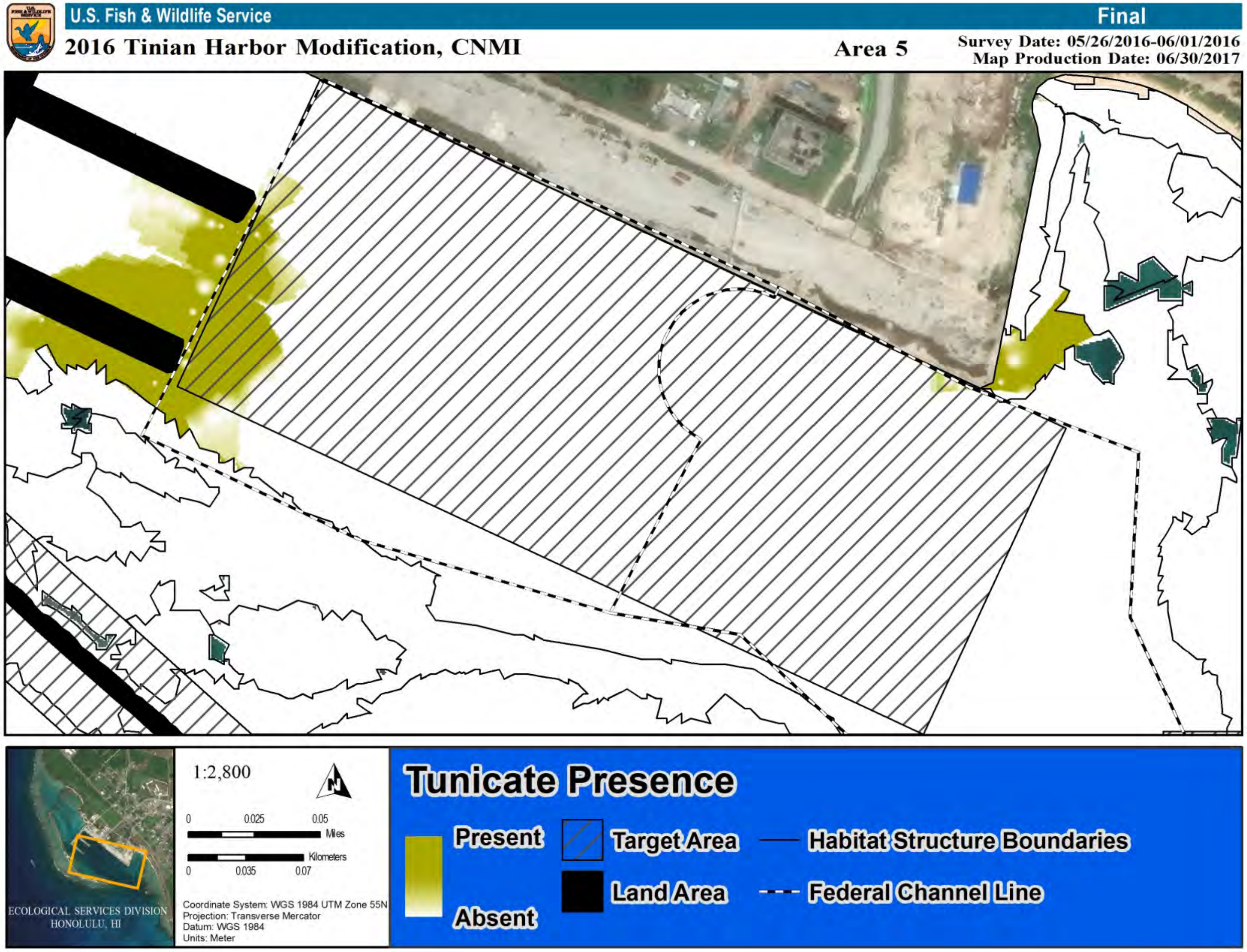

Figure F36: Tunicate Presence (Area 5). Overview of the tunicate presence observed within the project area.

APPENDIX G: Comments received on January 2017 Draft Report

Comment #1. USACE comments received February 16, 2017.

Phase 1 Marine Habitat Characterization Tinian Harbor Modification, Tinian, CNMI, Planning Aid Report, Fish & Wildlife Coordination Act 2(b) Report

January 2017

Cmt #	Page #	Line #, Figure #, or Table #	Agency Commentor	Comment	Response (To be completed by USFWS)
1.	11	Para. 4 and General	DAL	Can you please revise reference to UXO as "suspected UXO?"	Yes.
2.	14	Para. 2	JHP	"The proposed work for Tinian Harbor modification does not have alternatives developed to date; therefore, no alternatives were evaluated." We do have alternatives defined (more specifically now than at time of survey but even then there was a general idea – dredge, breakwater, etc.) If it is appropriate to include alternative evaluation in this report, we can provide additional details.	Alternatives were provided to the Service after the draft report was sent to the USACE. These alternatives will be incorporated into the final report. The project areas highlight various components of the project, but the Service was not provided alternatives to evaluate and compare prior to surveys.
3.	General	Figure 2	JHP	It's not completely clear if the "Area" limits are the same as the habitat zone limits. In Figure 2 there is a lot of overlap shown between areas – can the areas be defined better to avoid confusion?	These areas will be refined a little more narrowly to minimize overlap. These areas were chosen to segment the components of the potential impact areas for discussion purposes.
4.		Figure 2	DAL	Can you explain how you developed these Areas? Why is there overlap? We found these Areas confusing.	These areas were chosen to segment the components of the potential impact areas for discussion purposes. Overlap was create by the aspect ratio of the map area, but these areas will be refined to minimize overlap.

Page 1 of 1 Comments Due: February 8, 2017

Comment #2. CNMI's Bureau of Environmental and Coastal Quality comments received February 22, 2017.

Commonwealth of the Northern Mariana Islands
OFFICE OF THE GOVERNOR
Bureau of Environmental and Coastal Quality
Division of Coastal Resources Management

COASTAL RESOURCES MANAGEMENT

Frank M. Rabauliman
Administrator

Frances A. Castro
Director, DCRM

February 22, 2017

Mary M. Abrams, Ph.D.
Field Supervisor
United States Department of the Interior
300 Ala Moana Blvd., Room 3-122
Honolulu, HI 96850

Re: 2016-CPA-0056 Rota and Tinian Harbor Feasibility Studies

Dear Dr. Abrams,

The Division of Coastal Resources Management (DCRM) received your request for comments on the two draft reports for the Rota and Tinian Harbor feasibility studies. We appreciate this opportunity to share feedback, and understand planning efforts are still underway. In this context, we would like to provide general and site specific comments to support the harbor improvement planning and implementation efforts.

In general, DCRM would like to encourage continued coordination with CNMI resource management agencies, including the Bureau of Environmental and Coastal Quality (BECQ) and the Department of Lands and Natural Resources (DLNR) as planning and feasibility studies at the Tinian and Rota harbor sites moves forward. As acknowledged in the scoping documents, currently assessed areas do contain important coral reef assemblages, and DCRM encourages rigorous application of the mitigation hierarchy to avoid, minimize, and mitigate potential impacts. If compensatory mitigation is being proposed, such proposals should be developed with feedback from DCRM's Marine Monitoring Team. Furthermore, ongoing coordination with BECQ and other CNMI Agencies municipal representatives will support efforts to incorporate current development proposals and plans as well as other environmental considerations including updated seagrass and coral valuation information as new data becomes available.

On Tinian, project impacts discussed in Areas 1, 3, and 4 are assessed as "likely to be significant", and dredging described in Area 5 may present impacts to seagrass with indirect sedimentation impacts to coral colonies on the wharf face. Moreover, the proposed modifications considered at Area 4 will directly impact the well-developed coral reef habitat that is currently present at that site. We encourage consideration of other, potentially less impactful wave attenuation interventions, such as possible installation of jacks instead of a fully hardened breakwater to encourage coral re-growth.

Comment #2. Continued: CNMI's Bureau of Environmental and Coastal Quality comments received February 22, 2017.

On Rota, the proposed project describes four (4) areas where construction may occur, with potentially significant impacts to coral reef communities in Areas 2 and 3. Although the report qualified Area 1 as mostly "pavement habitat" and Area 4, where construction is not currently proposed, as an area that would likely have minimal impact to marine resources, it appears based on our assessments and data that all of the proposed target areas do have live coral and seagrass stands. DCRM encourages further consideration of Area 4 as an alternative construction area where impacts to marine resources may be minimized, and recommends that Phase II scoping consider UXO removal costs in this area compared to potential compensatory mitigation costs in Areas 1-3. Regarding the breakwater extension proposed in Area 1, we suggest consideration of other, potentially less impactful wave attenuation interventions, such as possible installation of jacks instead of a fully hardened breakwater to encourage coral re-growth.

Given the sensitivity of coral assemblages, DCRM agrees with the statements in both reports that minimal footprints of breakwater and harbor facility structures should be encouraged and that a turbidity control plan at later stages of the project proposal would be recommended. It is worth noting that coral spawning should be considered and construction avoided during this period when further developing proposals and construction timelines. Sediment and hydrodynamic modeling should be considered during Phase II to inform potential stress to sensitive habitats as well as identify potential changes in shoreline sediment transport and resulting beach shape. Additional recommendations for best management practices to control turbidity and protect seagrass and coral habitat should be coordinated with DCRM's Marine Monitoring Team and Water Quality Branch, as well as the Permitting Section to ensure compliance with enforceable policies and regulations implementing the Coastal Zone Management Act.

Overall, DCRM supports these much needed harbor improvement projects, and further, agrees that compensatory mitigation will be needed for any section of the proposed projects where impacts to seagrass and coral habitat are unavoidable. As the scale of that mitigation is yet to be determined, we welcome the opportunity to comment further pending submission of the second phase of these projects. As discussed in these phase I reports, downscaling of the target areas would reduce the amount of live corals and seagrass directly impacted by construction of the breakwaters, although the adverse effects of sedimentation may cause additional damage to adjacent coral stands.

Continued collaboration between federal and local partners during the second phase of this project will greatly assist federal partners in ensuring effective minimization and mitigation of damaged coral and seagrass habitats that may be affected by this project. For example, although turtle sightings were noted in the draft reports provided for review, it does not appear that potential impacts to turtle habitat or populations were rigorously assessed. DLNR may have input regarding potential impacts to turtle nesting or grazing habitats, a topic which is not addressed in this DCRM comment, highlighting the importance of interagency coordination early in this planning process. We suggest that planning and development of subsequent phases of this project should include biologists and project leads from relevant resource management agencies to ensure that proper measures are taken towards minimization and mitigation of impacts to these habitats. To this end, we would be happy to participate in planning dialogs and share additional resources as these conversations continue.

Comment #2. Continued: CNMI's Bureau of Environmental and Coastal Quality comments received February 22, 2017.

Once planning progresses, DCRM is prepared to facilitate local project permitting, including Major Siting Permit applications for proposed harbor expansion activities and 401 Water Quality Certifications. While a pre-application meeting is required for major siting permit applications, we would further encourage early coordination in permitting dialogs in order to expedite this process moving forward.

Thank you for this opportunity to comment on these important proposals.

Sincerely,

For: FRANCES A. CASTRO
Director
Division of Coastal Resources Management

Page **3** of **3**

Appendix 3

Engineering Appendix

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Tinian Harbor, CNMI
Harbor Modification Study
Feasibility Report
Appendix 3
Engineering Appendix

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1 Introduction

1.1 Appendix Purpose

This appendix summarizes the engineering design elements of the Tinian Harbor Modifications Study. It describes the process and analysis used for feasibility-level design of General Navigation Features, including natural forces, existing conditions, harbor operational conditions, and breakwater construction alternatives.

1.2 Study Purpose

The purpose of this study is to assess the current and future conditions of Tinian Harbor, and to identify improvements that will enable increased access and operations at Tinian Harbor. Potential improvements were evaluated and screened based on the SMART Planning process, and in accordance with the usage and needs of harbor users. The report details the plan formulation efforts used to determine Federal interest.

1.3 Project Area Description

The Northern Mariana Islands are located in the Western Pacific, approximately 3,800 miles west of Hawaii. Tinian is located 14 miles south-southwest of Saipan and 120 miles north-northeast of Guam. The island is approximately 10.5 miles long and 5 miles wide. Tinian Harbor is located within a natural embayment on the southwest coast of Tinian, at San Jose, the urban center (Figure A1) and is the primary point of entry for vessel passengers and commodities. There is currently no Federal navigation project at the harbor. The existing harbor shown in Figure A2 was constructed in 1944-1945 during World War II. The entrance channel is about 2600 feet long, approximately 525 feet wide and has been dredged to a depth of about 30 feet Mean Lower Low Water (MLLW). The channel dimensions and limits shown are based on historical maps and plans. There is no currently authorized Federal channel at Tinian Harbor. The wharves and harbor turning basin were dredged to depths of 28 to 30 feet MLLW, respectively.

The total length of the breakwater is 4,600 feet and its original crest elevation was about 15 feet above MLLW. The 1,100 feet of inner breakwater length from the shore to the outer breakwater (referred to here as the "northwest breakwater") was constructed of a single row of sheet piling. Much of the sheet pile on the northwest breakwater has deteriorated and collapsed. The 3,500 foot long outer breakwater (referred to here as the "main breakwater") was constructed of interlocking, half-inch thick steel sheet piling in circular cell configuration. The interior of the cells was filled with quarried limestone. A 10-inch thick, unreinforced concrete slab was constructed flush with the top of the sheet piles. Other than a 900-foot reach in the middle of the breakwater which was repaired in 1979 following a tsunami, the structure is severely deteriorated and little remains of the steel sheet pile cells. The loss of the sheet pile has resulted in the fill material being washed out and deposited along the harbor side of the breakwater. The last 300 feet of the breakwater head is significantly degraded and/or submerged. The deteriorated structure does provide some energy dissipation for typically prevailing small waves, however it provides little or no protection against storm waves.

Interior infrastructure at the harbor consists of an approximately 2000 ft-long "north wharf" with four berthing areas, an adjacent "east wharf", a set of two finger piers, and a small boat basin to the west of the finger piers (see Figure A2). The finger piers have had little maintenance, and the small boat basin is exposed to incoming waves from west and southwest due to the degraded and primarily submerged inner breakwater. Various structural repairs have been made to the existing inner harbor pier and wharf structures, including reconstruction of the concrete cap beams on various sections of the bulkhead walls, and most recently the installation of new fenders and mooring bollards at the Mobil fueling berth (M-N Assessment, 2015). Kammer Beach is a long sandy beach just east of the harbor that is frequented by tourists visiting Tinian.

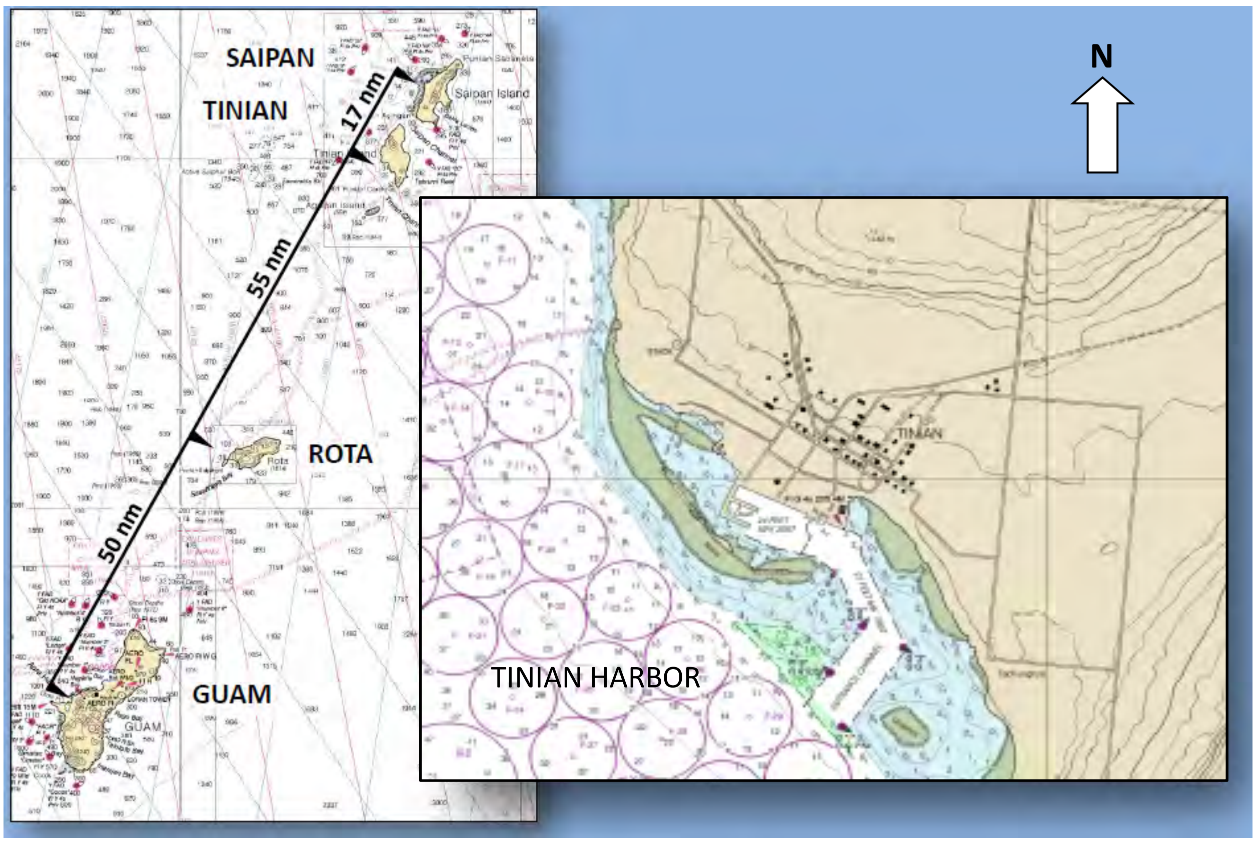


Figure A1. Vicinity and Location Maps of Tinian Island and Tinian Harbor

1.4 Existing Conditions

Because of its remoteness and isolation, Tinian imports virtually all of its commodities and relies primarily on waterborne commerce for this purpose. Air transportation of goods is limited and expensive. Tinian Harbor is exposed to persistent tradewind seas, seasonal open ocean swell, and frequent tropical storm activity. It is partially protected by a shallow, fringing reef. The typical wind and wave activity, in combination with the deteriorated condition of the breakwater, can cause rough conditions in the harbor for extended periods, which are challenging for both small vessel transit around the finger piers and large vessel operations at the wharf. In addition, damage to the north wharf at the southeast end (Berth #4) has rendered this area unusable in recent years. The majority of Berth 4 and the east wharf (collectively called East Quay by CPA) have been leased to others for the development of the Titanic Casino and Hotel complex (presently under construction).

Figure A2. Project Map of Tinian Harbor

2 Natural Forces

2.1 Winds

The predominant winds in the CNMI are the tradewinds, which occur approximately 70 percent of the time and arrive from north-northeast (22.5 degrees) True North (TN) through east-southeast (112.5 deg TN). The tradewinds are most consistent between January and June, averaging between 15 to 25 miles per hour (13 to 21 knots). Wind data offshore of the project area is available from the the U.S. Army Corps of Engineers (USACE) Wave Information Study (WIS) Program (http://wis.usace.army.mil). WIS hindcast data are generated using a numerical hindcast model driven by wind fields overlaying a bathymetric grid. Model output includes significant wave height, peak and mean wave period, peak and mean wave direction, wind speed, and wind direction. In the Pacific, the WIS hindcast database covers a 32-year period of record extending from 1980 to 2011. A wind rose from WIS Station 81104 near Tinian (Figure A3) shows frequency, wind speed, and direction of average annual winds in Figure A4.

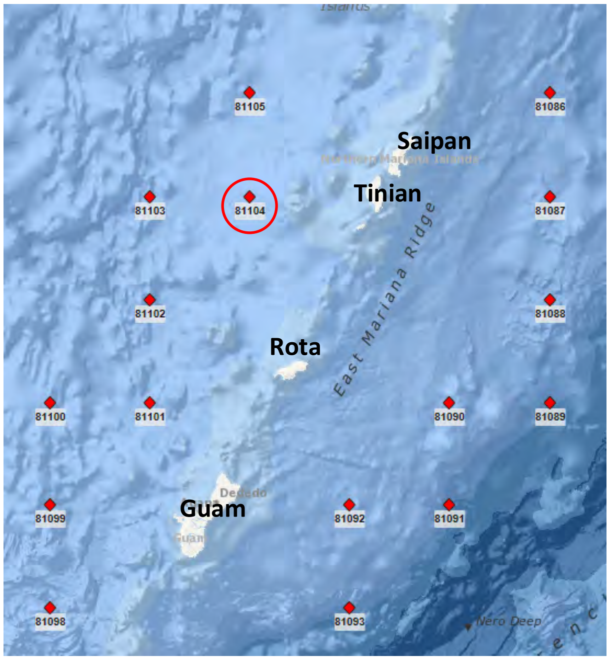


Figure A3. WIS Hindcast stations in the CNMI. Station 81104 near Tinian circled in red.

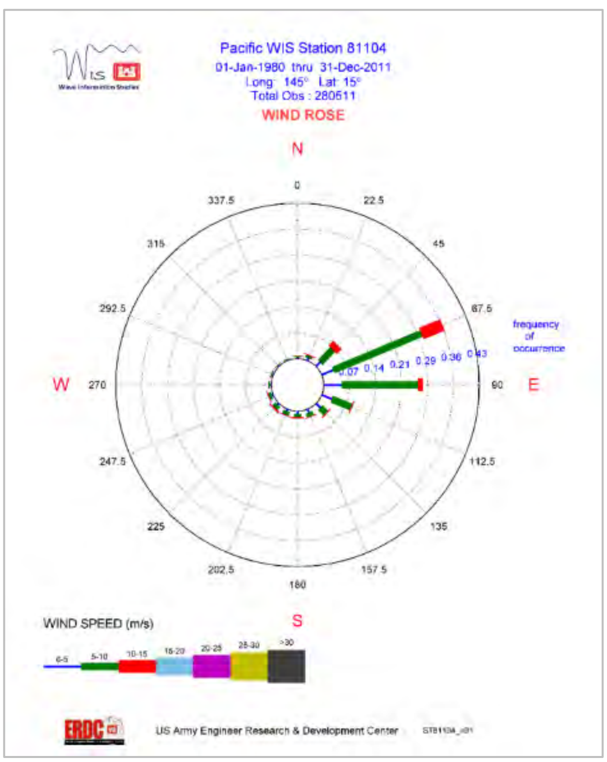


Figure A4. Wind Rose from WIS hindcast station 81104 near Tinian.

During the July – December period, the winds often become lighter and more variable. This is generally considered the wetter season, with about 70 percent of annual rainfall occurring during this period. This second half of the year is also the active tropical cyclone season. Typhoons and tropical storms can develop quickly and bring high, damaging winds (up to 120 mph or more) and intense rainfall. An average of three tropical storms and one typhoon pass within 180 miles of the CNMI each year (http://weather.unisys.com/hurricane/w_pacific/). Winds are also affected by the climate pattern known as the El Niño Southern Oscillation (ENSO). During an El Niño year, tradewinds are usually weaker, there is less rainfall within the CNMI, and the ocean surface is warmer with above-average sea surface temperatures.

2.2 Tides and Currents

Tides in Tinian are semi-diurnal and the tide range is 1.6 ft (0.5 m), with two high and two low tides each day. The closest tide station maintained by the National Oceanographic and Atmospheric Administration (NOAA) is about 50 miles southeast of Tinian at Apra Harbor, Guam (Station 1630000). The mean tide range at this station is 1.62 feet, and the spring tide range is 2.35 feet. The station has been recording water levels since 1948 (approximately 70 years), and shows the maximum water level occurring on August 28, 1992 at an elevation of 2.92 feet Mean Sea Level (MSL), during Typhoon Omar which made landfall on Guam. Tidal datums at Apra Harbor for the tidal epoch spanning 1983-2001 are shown in Table A1. The standard navigation project datum of MLLW will be used for this report.

Table A1. Tidal Datums at NOAA Station 1630000: Apra Harbor, Guam

Tidal Datum	Feet (above MSL)
Mean Higher High Water (MHHW)	0.97
Mean High Water (MHW)	0.85
Mean Tide Level (MTL)	0.04
Mean Sea Level (MSL)	0.00
Guam Vertical Datum of 2004 (GUVD04)	0.00
Mean Low Water (MLW)	-0.77
Mean Lower Low Water (MLLW)	-1.37

Tidal and wave induced currents in the Tinian Harbor area typically flow from west to east through the harbor, due to the submerged inner portion of the existing breakwater. Strong currents can develop in the harbor as a result of wave setup and water flow into the northwest basin through the porous breakwater. Current speeds up to about 5 knots (8.4 ft/s) flow through the harbor and out the entrance during high wave events, with the strongest current at the gap between the finger piers and the breakwater. In addition, a wave generated current of 3-4 knots (5.0-6.75 ft/s) flows from west to east along the ocean side of the breakwater and into the entrance channel. A surf zone rip current exists off Kammer Beach which also feeds into the entrance channel. These three currents converge and flow outward in the entrance channel with a speed of about 2 knots (3.4 ft/s) (SEI, 2015).

2.3 Waves

The island of Tinian is exposed to three distinct wave types: waves generated by the prevailing local winds, swell waves generated by distant storms, and waves from tropical cyclones passing near the CNMI. Tradewind waves are typically from northeast through east-southeast, with wave heights in the range of 1 to 6 feet (0.3 to 2 m) and wave periods between 5 to 10 seconds. Swell waves from distant storms (usually in the north Pacific) can range from 6 to 18 feet (2 to 6 m) in height and have wave periods from 10 to 16 seconds. Tropical storm and typhoon waves can approach from almost any direction (though the storms typically track east to west), resulting in waves to 40+ feet (13 m) in deep water and wave periods in the 11 to 14 second range.

The location of Tinian Harbor on the southwest side of the island protects it from waves approaching from east and north. Deep water waves are affected by refraction and bottom friction that cause waves to change height and direction by the time they reach the nearshore. This results in a “wave window” of 140 degrees TN (southeast) through 320 degrees TN (northwest) with waves approaching normal to the shoreline from southwest (Figure A5).

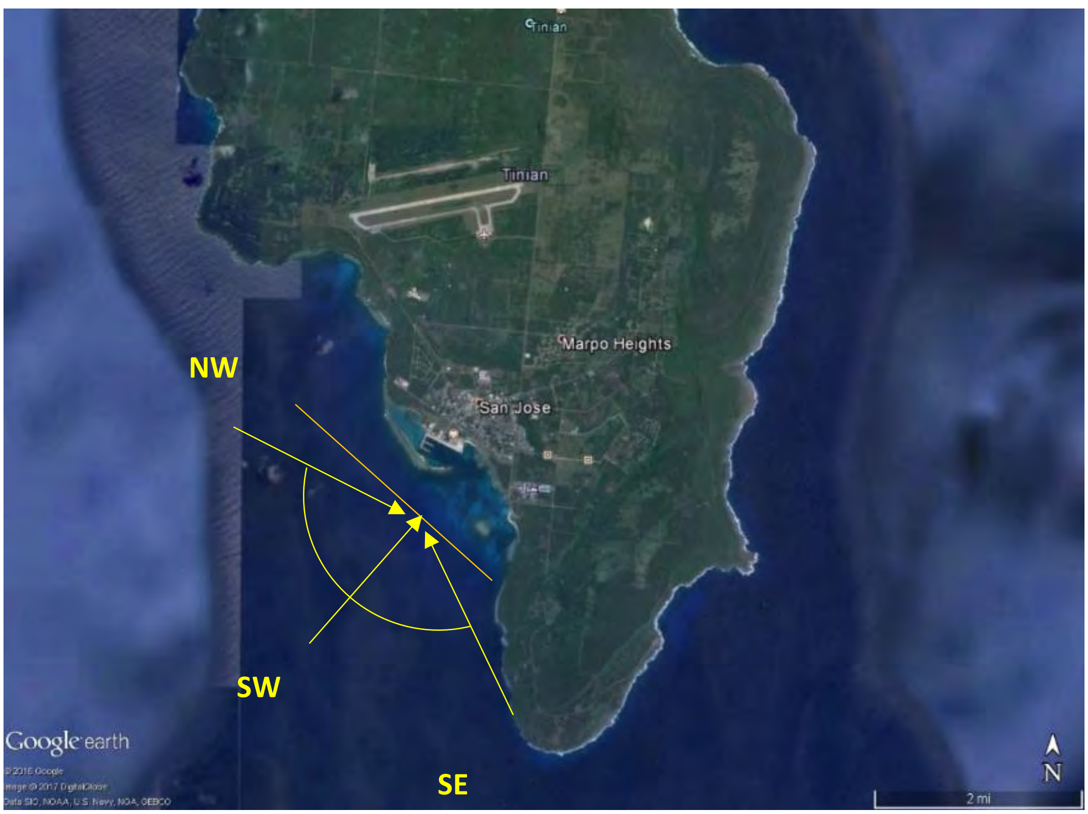


Figure A5. Wave approach window for Tinian Harbor

Analysis of WIS Station 81104 hindcast data with waves approaching from directions outside of this identified window filtered out indicated that the most frequent waves affecting Tinian Harbor arrive from the west, southwest and west-southwest and are up to 15 feet (5 m) in significant wave height. A wave rose, filtered by wave direction, is shown in Figure A6, and tables showing frequency of occurrence (by direction bin) based on wave height and wave period are shown in Tables A2 and A3, respectively.

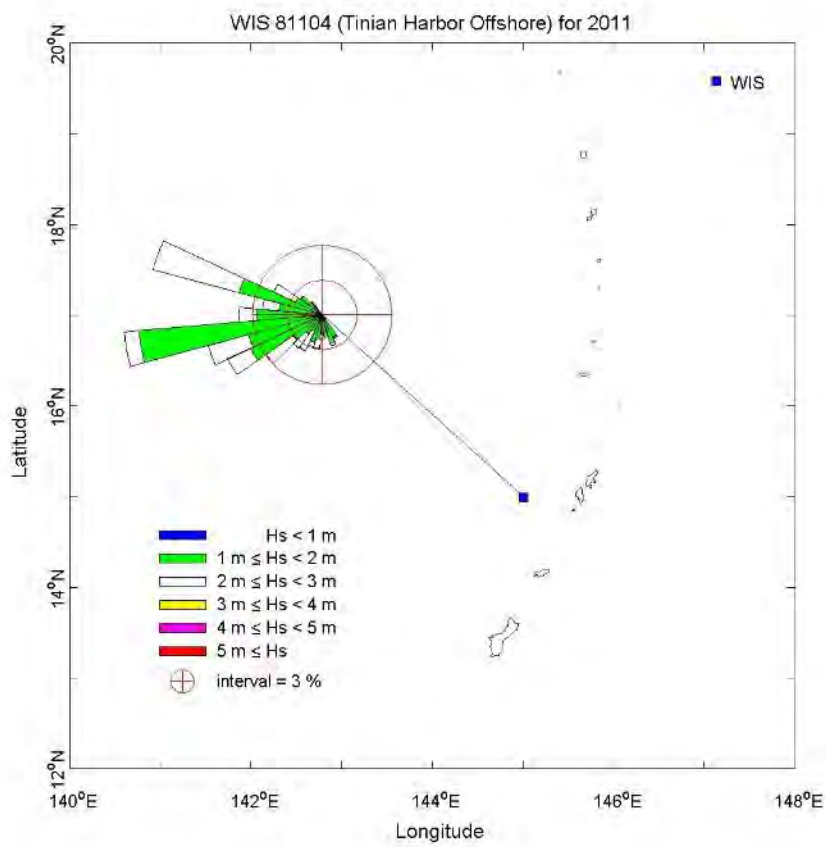


Figure A6. Wave Rose for WIS Station 81104, filtered by directions affecting Tinian Harbor

The extreme wave climate is driven by typhoon and tropical storms in this region. The WIS hindcast is the most appropriate database to analyze extreme waves, due to its long period of record (32 years). The largest wave in the hindcast record (1980-2011) occurred in November 1997 during Typhoon Keith, with a deep water wave height of 43.9 feet (14 m) and wave period of 14.0 seconds, approaching from 83 deg (east). This corresponds to a return period of approximately 75 years based on the extremal wave analysis at this location (Station 81104). A plot of significant wave height return periods (based on waves from all directions) and wave parameters for the top ten storm events during the hindcast period are shown in Figure A7. The majority of events show waves approaching from northeast through east, with two from the west-southwest, one from the southeast, and one from the north. The predicted 50-year return period wave is 41.1 feet (12.5m) at this deep water location. Not included in this hindcast database is Typhoon Soudelor, which caused significant damage to the CNMI (making landfall in Saipan as a Category 4 storm) in August 2015. Sustained winds were 130 miles per hour and the Tanapag, Saipan CDIP buoy recorded a significant wave height of 21.4 ft (6.51m), a wave period of 9.9 sec, and direction of 29.2 deg during the peak of the storm (http://cdip.ucsd.edu/?nav=historic&sub=data&units=metric&tz=UTC&pub=public&map_stati=1,2,3&stn=197&stream=p1&xitem=info).

Table A2. Frequency of occurrence table for wave height vs. direction at Tinian Harbor

	Direction (TN)																			
Hs (ft)	**140.00**	**150.00**	**160.00**	**170.00**	**180.00**	**190.00**	**200.00**	**210.00**	**220.00**	**230.00**	**240.00**	**250.00**	**260.00**	**270.00**	**280.00**	**290.00**	**300.00**	**310.00**	**320.00**	**Total**
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.02	0.21	0.34	0.20	0.12	0.16	0.14	0.11	0.13	0.08	0.17	0.16	0.07	0.08	0.14	0.17	0.06	0.08	0.19	2.63
4	0.05	0.66	0.61	0.43	0.51	0.71	0.66	0.69	0.59	0.76	0.76	1.06	1.37	0.96	0.88	1.18	0.97	1.10	0.93	14.89
5	0.09	0.66	0.76	0.64	0.58	0.69	0.74	0.93	0.90	1.34	1.57	2.05	2.32	2.70	2.71	2.11	1.75	1.37	1.30	25.22
6	0.02	0.20	0.27	0.24	0.31	0.39	0.55	0.63	1.00	1.16	1.32	2.00	1.91	2.00	1.92	1.78	1.29	1.19	0.71	18.88
7	0.01	0.18	0.15	0.19	0.16	0.25	0.21	0.28	0.52	0.83	1.05	1.52	1.59	1.33	0.96	0.78	0.48	0.45	0.27	11.20
8	0.00	0.07	0.15	0.22	0.17	0.25	0.20	0.27	0.55	0.66	0.82	0.93	0.96	1.25	0.59	0.68	0.39	0.18	0.13	8.48
9	0.01	0.11	0.14	0.16	0.15	0.20	0.18	0.20	0.40	0.48	0.63	0.62	0.73	0.53	0.30	0.36	0.13	0.09	0.11	5.53
10	0.01	0.03	0.04	0.11	0.08	0.07	0.11	0.22	0.25	0.50	0.40	0.40	0.62	0.31	0.18	0.08	0.05	0.08	0.04	3.59
11	0.01	0.08	0.04	0.06	0.09	0.12	0.11	0.10	0.20	0.33	0.25	0.50	0.48	0.26	0.07	0.02	0.07	0.06	0.07	2.90
12	0.00	0.04	0.07	0.06	0.04	0.11	0.09	0.08	0.09	0.13	0.18	0.17	0.17	0.14	0.06	0.04	0.03	0.01	0.01	1.52
13	0.00	0.02	0.06	0.05	0.04	0.04	0.12	0.05	0.08	0.11	0.13	0.18	0.20	0.14	0.14	0.02	0.01	0.03	0.02	1.43
14	0.01	0.03	0.08	0.02	0.02	0.04	0.04	0.06	0.06	0.17	0.21	0.24	0.14	0.07	0.01	0.01	0.01	0.01	0.03	1.25
15	0.00	0.02	0.02	0.02	0.03	0.03	0.02	0.05	0.04	0.20	0.16	0.05	0.07	0.07	0.01	0.01	0.00	0.01	0.02	0.83
16	0.00	0.01	0.01	0.02	0.03	0.01	0.04	0.02	0.02	0.08	0.06	0.01	0.16	0.13	0.00	0.01	0.01	0.00	0.01	0.63
17	0.00	0.01	0.02	0.00	0.02	0.02	0.03	0.06	0.00	0.06	0.02	0.01	0.06	0.08	0.00	0.01	0.00	0.01	0.01	0.40
18	0.00	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.02	0.01	0.06	0.01	0.06	0.01	0.00	0.00	0.01	0.00	0.01	0.24
19	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.00	0.03	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.13
20	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07
21	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.05
22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.03
23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.02
24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30+	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.22	2.35	2.78	2.43	2.39	3.13	3.26	3.74	4.87	6.92	7.83	9.97	10.98	10.08	7.99	7.27	5.25	4.69	3.86	100.00
Statistics	**140.00**	**150.00**	**160.00**	**170.00**	**180.00**	**190.00**	**200.00**	**210.00**	**220.00**	**230.00**	**240.00**	**250.00**	**260.00**	**270.00**	**280.00**	**290.00**	**300.00**	**310.00**	**320.00**	**Overall**
Mean	5.33	5.43	5.63	5.97	6.23	6.12	6.28	6.26	6.51	7.02	6.98	6.58	6.73	6.34	5.59	5.40	5.27	5.20	5.15	6.00
StDev	2.62	3.01	3.16	2.98	3.34	3.16	3.18	3.07	2.72	3.17	3.27	2.85	3.08	2.65	1.91	1.75	1.71	1.90	2.28	2.73
Min	2.36	2.03	2.07	2.10	2.13	2.10	2.23	2.23	2.26	2.26	2.36	2.46	2.59	2.26	2.62	2.53	2.43	2.36	2.36	2.03
Max	13.78	27.76	26.02	24.48	20.14	23.10	21.69	19.13	19.52	21.95	26.35	26.31	23.52	20.21	18.44	18.01	18.70	20.77	21.75	27.76

Table A3. Frequency of occurrence table for wave period vs. direction at Tinian Harbor

	Direction																			
Tp (sec)	**140**	**150**	**160**	**170**	**180**	**190**	**200**	**210**	**220**	**230**	**240**	**250**	**260**	**270**	**280**	**290**	**300**	**310**	**320**	**Total**
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0.1	0.22	0.19	0.13	0.1	0.09	0.18	0.2	0.12	0.18	0.27	0.32	0.1	0.13	0.11	0.09	0.03	0.01	2.6
8	0.08	0.85	1.11	0.84	0.88	1.25	1.27	1.21	1.37	1.8	1.78	2.48	1.94	1.38	1.22	1.1	0.72	0.46	0.28	22.02
10	0.11	1.02	0.97	0.95	0.87	1.13	1.12	1.41	2.03	2.83	3.21	3.98	4.33	3.56	3.05	2.27	1.72	1.3	1.25	37.11
12	0.03	0.32	0.37	0.37	0.41	0.57	0.68	0.8	0.95	1.93	2.24	2.64	3.64	4.06	2.79	2.63	1.71	1.92	1.61	29.66
14	0	0.06	0.09	0.05	0.09	0.08	0.11	0.15	0.31	0.23	0.39	0.57	0.74	0.95	0.6	0.96	0.94	0.96	0.7	7.97
16	0	0	0.02	0.03	0.01	0	0	0	0	0.01	0.01	0.03	0.01	0.02	0.18	0.14	0.07	0.03	0.01	0.58
18	0	0	0	0	0	0	0	0	0	0	0.01	0	0	0	0	0.05	0	0	0	0.06
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20+	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0.22	2.35	2.78	2.43	2.39	3.13	3.26	3.74	4.87	6.92	7.83	9.97	10.98	10.08	7.99	7.27	5.25	4.69	3.86	100
Statistics	**140**	**150**	**160**	**170**	**180**	**190**	**200**	**210**	**220**	**230**	**240**	**250**	**260**	**270**	**280**	**290**	**300**	**310**	**320**	**Overall**
Mean	8.29	8.29	8.15	8.28	8.37	8.34	8.46	8.5	8.68	8.8	8.93	8.89	9.13	9.54	9.46	9.72	9.77	10.08	10	8.93
StDev	1.21	1.44	1.74	1.63	1.65	1.57	1.57	1.65	1.65	1.52	1.65	1.69	1.65	1.57	1.72	1.94	1.9	1.78	1.61	1.64
Min	4.7	4.3	4.3	4.7	4.7	4.3	4.7	4.7	4.3	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.3	4.3
Max	11	13.3	14.7	14.7	14.7	14.7	14.7	13.3	14.7	14.7	16.1	14.7	14.7	14.7	16.1	16.1	14.7	14.7	14.7	16.1

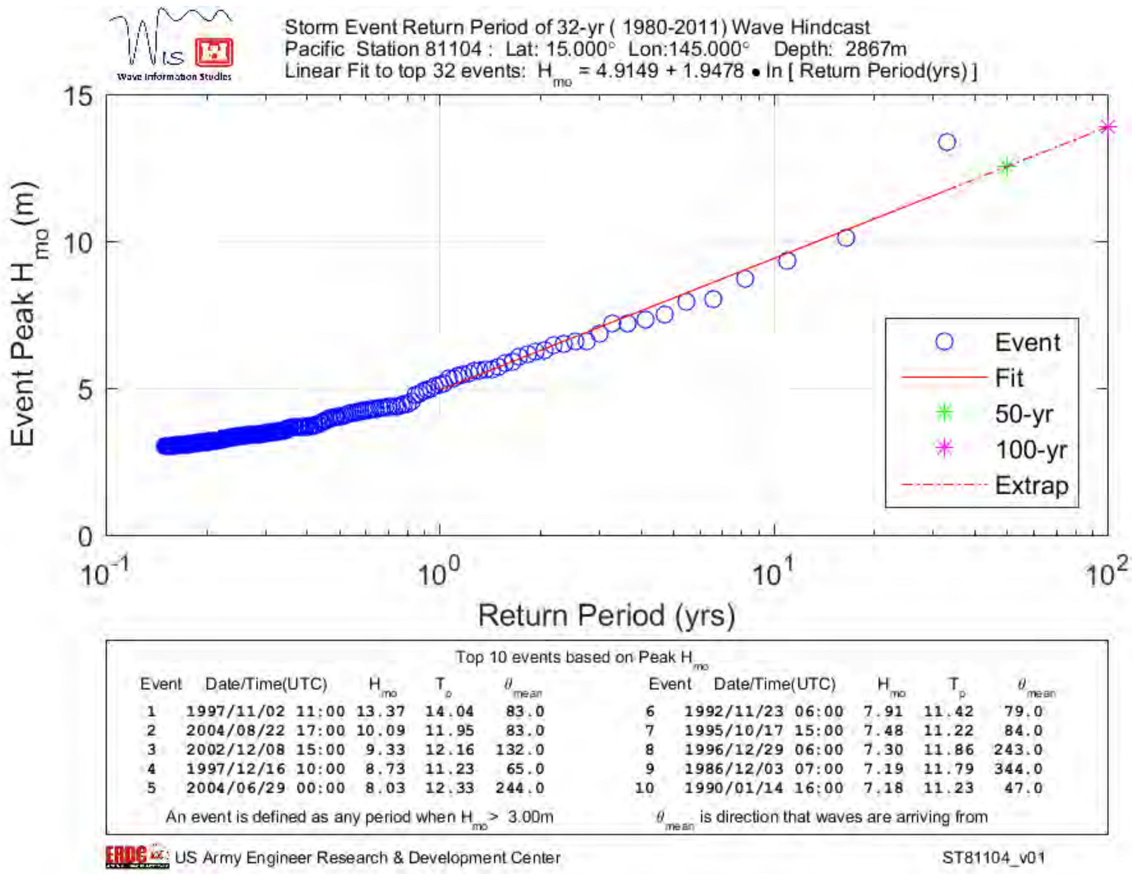


Figure A7. WIS Station 81104 deep water wave height return period analysis (based on waves from all directions)

2.4 Water Level

Water level plays a critical role in design of coastal navigation projects, particularly in those locations where waves are depth limited. The super-elevation of water level near the coast can be a controlling factor in determining the amount of wave energy affecting the harbor and shorelines. It can significantly affect coastal processes such as harbor seiching, wave breaking, wave generated currents, wave runup and inundation, and sediment transport.

Water level is a combination of many factors that can occur over different temporal and spatial scales. Longer-term water level increases may be due to sea level changes, and/or annual or decadal anomalies such as El Nino/La Nina or the Pacific Decadal Oscillation. These phenomena will be discussed in the next section. Shorter-term effects on nearshore still water level are astronomic tide, storm surge (which includes wind setup and localized increase due to low pressure), and wave setup. Wave runup can be added to the still water level in areas where inundation along the shoreline or overtopping of a structure is a concern.

2.4.1 Astronomic Tide

The tidal range in Tinian is relatively small, with a maximum range of about 2.35 feet (0.7 m). Design calculations typically evaluate a tide level of both Mean Sea Level (MSL, the mean of all observed water levels in the tide gage record) as well as Mean Higher High Water (MHHW, the mean of the higher high tides in the tide record). MHHW is a frequently occurring tide level that may coincide with high wave events that persist over several hours or days, and therefore, its potential effects on still water level must be evaluated. As shown in Table A1, MHHW is 0.97 feet (0.3 m) above the MSL datum, and 2.34 feet (0.7 m) above MLLW.

2.4.2 Storm Surge

Elevated water levels occur during storms due to two primary forcings. Wind setup creates an increase in the water surface elevation caused by the surface frictional stress generated by wind blowing over the water surface in shallow water. When strong winds blow onshore, this process effectively piles up water near the shoreline, creating a higher water level. Wind setup is typically a smaller contributor to storm surge in island environments where deep water extends close to shore, reducing bottom friction effects. In addition, low barometric pressures which accompany storms (both tropical and extra-tropical) create an inverted barometer effect, pulling the water surface up in areas of lower pressure, which also causes a local elevation of water level. Tinian is subject to severe storm surge during the passing of tropical storms and typhoons, with these storm surge effects contributing to elevation of the still water level on the order of 2 to 4 feet (0.61 to 1.22 m) above the tidal elevation.

2.4.3 Wave Setup

Wave setup is an elevation in water level that occurs in the surf zone, due to transfer of momentum to the water column during wave breaking. Wave setup is affected by the bottom slope, roughness, breaking wave height, and wave period. This component of dynamic still water level is particularly important in island environments subject to large waves and with steep-faced, fringing reefs. Wave setup can contribute to elevation of the water level by an amount anywhere from 10 to 35 percent of the breaking wave height. Typical wave setup values in the Pacific Islands range from 3 to 6 feet (1 to 2 m) in the most extreme cases. This phenomenon can also generate nearshore wave-induced currents due to gradients in water elevation between areas of breaking and non-breaking waves.

2.4.4 Sea Level Change and Variability due to Pacific Climate Patterns

Relative sea level change (SLC) is the local change in sea level relative to the elevation of the land at a specific point on the coast, including the lowering or rising of land through geologic processes such as subsidence and glacial rebound. Relative SLC is a combination of both global and local SLC caused by changes in estuarine and shelf hydrodynamics, regional oceanographic circulation patterns (often caused by changes in regional atmospheric patterns), hydrologic cycles (river flow), and local and/or regional vertical land motion (subsidence or uplift). Thus, relative SLC is variable along the coast.

To incorporate the direct and indirect physical effects of projected future sea level change on design, construction, operation, and maintenance of coastal projects, USACE has provided guidance in the form of Engineering Regulation, ER 1110-2-8162 (USACE, 2013). ER 1110-2-8162 provides both a methodology and a procedure for determining a range of sea level change estimates based on global sea level change rates, the local historic sea level change rate, the construction (base) year of the project, and the design life of the project. Three estimates are required by the guidance, a Baseline (or "Low") estimate, which is based on historic sea level change and represents the minimum expected sea level change, an Intermediate estimate (NRC Curve I), and a High estimate (NRC Curve III) representing the maximum expected sea level change. All three scenarios are based on the following eustatic sea level rise (sea level change due to glacial melting and thermal expansion of sea water) equation:

$$E(t) = 0.0017t + bt^2$$

where E(t) is the eustatic sea level rise (in meters); t represents years, starting in 1992 (the midpoint of the current National Tidal Datum Epoch of 1983-2001); and b is a constant equal to 2.71E-5 (NRC Curve I), 7.00E-5 (NRC Curve II), and 1.13E-4 (NRC Curve III). This equation assumes a global mean sea level change rate of +1.7mm/year.

In order to estimate the eustatic sea level change over the life of the project, the above equation is modified as follows:

$$E(t_2) - E(t_1) = 0.0017(t_2 - t_1) + (t_2^2 - t_1^2)$$

where t_1 is the time between the project's construction date and 1992, and t_2 is the time between the end of the project life and 1992.

In order to estimate the required Baseline, Intermediate, and High Relative Sea Level (RSL) changes over the life of the project, the eustatic sea level rise equation is further modified to include site specific sea level change as follows:

$$RSL(t_2) - RSL(t_1) = (e+M)\ (t_2 - t_1) + b(t_2^2 - t_1^2)$$

where $RSL(t_1)$ and $RSL(t_2)$ are the total RSL at times t_1 and t_2, and the quantity (e + M) is the local sea level rise in mm/year. Local sea level rise accounts for the eustatic change (e) (1.7mm/year or 0.0056 ft/year) as well as uplift, subsidence, and other effects (M) and is generally available from the nearest tide gage (NOAA Station 1630000 at Apra Harbor, Guam approximately 50 miles from Tinian Harbor) with a tidal record of approximately 40 years.

Over the past two decades, sea level trends have increased in the western tropical Pacific Ocean with rates that are approximately three times the global average. Several papers including Merrifield and Maltrud (2011) have shown that the high rates of SLC recorded are caused by a gradual intensification of Pacific trade winds since the early 1990s. Multi-decadal tradewind shifts in the Pacific (1950-1990 had weak tradewinds, while 1990-present have shown strong tradewinds) are likely related to the Pacific Decadal Oscillation (Merrifield et al., 2012), a recurring pattern of ocean-atmosphere climate variability centered over the mid-latitude Pacific basin. These low frequency tradewind changes can contribute on the order of 1 cm variations in sea level in western tropical Pacific. Multi-decadal variations such as these can lead to linear trend changes over 20 year time scales that are as large as the global SLC rate, and even higher at individual tide gauges, such as Apra Harbor, Guam (Merrifield, 2011 and Merrifield et al., 2012).

In addition, higher frequency interannual variations in Pacific water levels can be caused by the effect of the ENSO; the climate phenomenon in the Pacific evidenced by alternating periods of ocean warming and high air pressure in the western Pacific (El Nino) and cooler sea temperatures accompanied by lower air pressure in the western Pacific (La Nina). In fact, it is known that the largest interannual variability of sea level around the globe occurs in the tropical Pacific, due to these climate patterns (Widlansky et al., 2015). During El Nino years, sea level in the western tropical Pacific is known to drop by 20 to 30 cm, while La Nina phases cause an average sea level rise of about 10 cm. Additionally, and throughout the tropical Pacific, prolonged interannual sea level inundations are also found to become more likely with greenhouse warming and increased frequency of extreme La Niña events, thus exacerbating the coastal impacts of the projected global mean sea level rise (Widlansky et al., 2015).

Anecdotal reports have suggested a possible recent reversal in the 20+ year trend of dramatically rising sea levels in the western tropical Pacific, possibly due in part to the strong El Nino cycle documented in 2015/2016; however, analysis and published research supporting this change in trend is not yet available. These phenomena are documented here to emphasize the large variability in sea level that is experienced in the western tropical Pacific, and to indicate that sea level trends reported by the nearest NOAA tide gage to Tinian Harbor (Apra Harbor, Guam) are likely affected by this variability.

The mean sea level trend reported by NOAA at Apra Harbor Station 1630000 is 4.55 mm/year (+/- 4.68 mm/year 95% confidence interval), as shown in Figure A8. The two trend lines in the figure are indicative of rates prior to and following the 1993 earthquake in Guam. The land elevation experienced an approximately 10 cm drop during the earthquake and is now slowly subsiding, which affects the local relative SLC rate. In addition, the division of the MSL trend into pre- and post-earthquake results in a shorter period of record of approximately 24 years (1993 – present), which is less than the suggested 40 year period of record in ER 1110-2-8162.

NOAA also provides information on the historical Mean Sea Level trend, shown in Figure A9. This figure gives additional information on the variability of the average rate of change, as it is basically a look at the historical “trend of the trend”. The figure shows that as recently as 2008, the MSL trend was as high as 10.85 mm/year, over 6 mm/year higher than its present rate, a significant difference that would be amplified when calculating the “intermediate” and “high” curves of potential accelerated SLC.

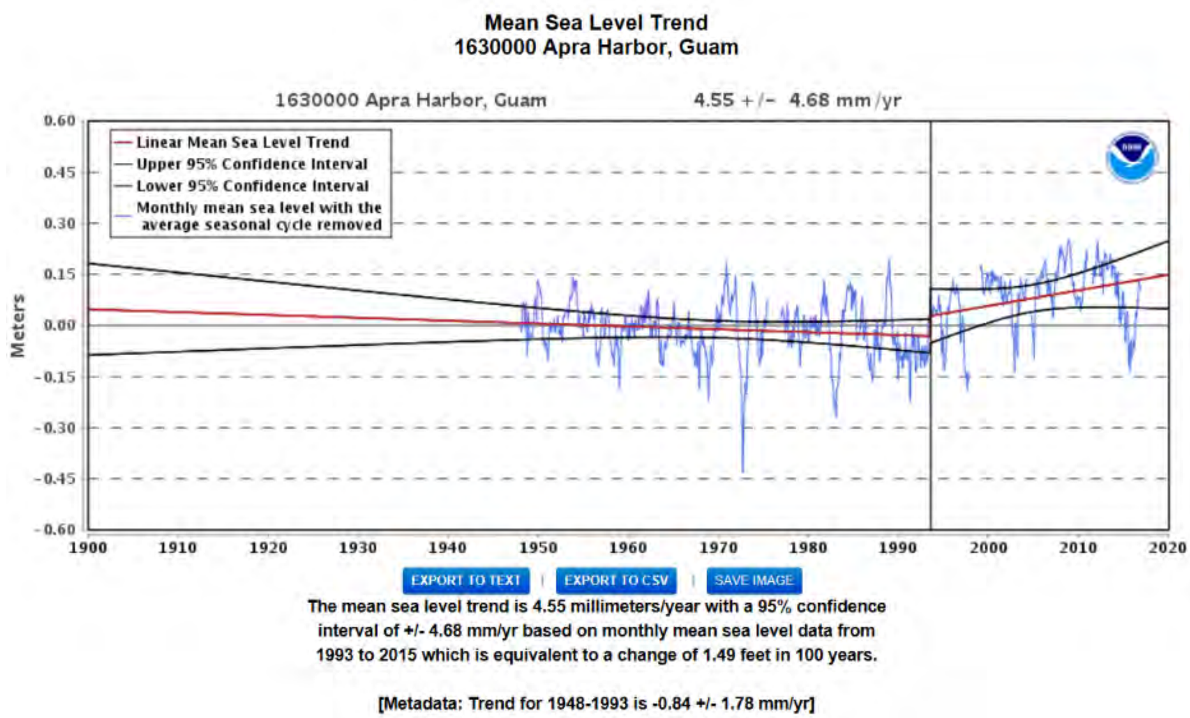


Figure A8. Mean Sea Level Trend from NOAA Tide Gage 1630000 – Apra Harbor, Guam

Due to the variability in MSL trends in the western Pacific over recent years outlined above, in addition to the short post-earthquake trend at Apra Harbor, Guam, a different approach was taken for determination of the rate of relative SLC at Tinian Harbor. The rate for Tinian Harbor is estimated by using the global eustatic rate of SLC, +1.7 mm/year added to a measured rate of Vertical Land Movement (VLM) rate of -1.0 mm/year (as reported by the NASA Jet Propulsion Laboratory website https://sideshow.jpl.nasa.gov/post/series.html – an average of two monitoring stations on Guam and one on Saipan). Since eustatic sea level is rising, and the land is subsiding, this results in a relative SLC rate of 2.7 mm/year (= +1.7 mm/year – (-1.0 mm/year)) or 0.0089 feet/year for Tinian Harbor. The USACE SLC calculator was used to plot the three potential curves based on this rate, shown in Figure A10. The curves show that by project construction (estimated to be 2020) relative SLC at the project will be between 0.2 ft or 0.06 m (low curve) and 0.5 ft or 0.16 m (high curve). By the end of the 50-year project life in 2070, sea level will have risen between 0.7 and 2.9 feet (0.23 to 0.9 m); and by 2120 at the end of the 100-year adaptation planning horizon, sea level will have risen between 1.1 ft and 7.2 ft (0.33 and 2.2 m) relative to the existing MSL datum. Discussion of these values, including their effect on alternative selection, project design, and future adaptation strategies over the project life, will be presented in later chapters.

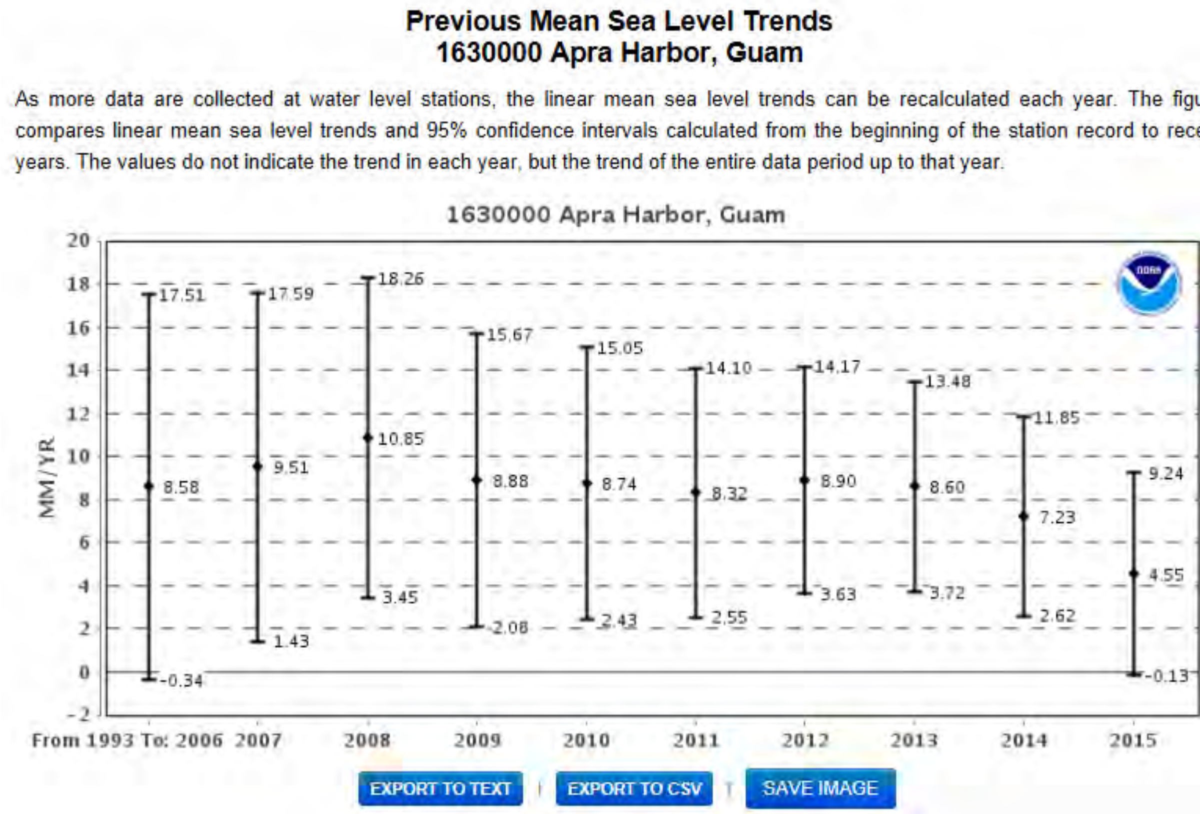


Figure A9. Previous Mean Sea Level Trends from NOAA Tide Gage 1630000 – Apra Harbor, Guam

The inter-annual and inter-decadal variability in sea levels of the western tropical Pacific should be accounted for by an additional term when calculating future total water level for design purposes. By using this method, the result will be a robust design that will be resilient to potentially variable and elevated water levels from the project start, rather than some time later in the project life-cycle. In addition, using a lower rate of SLC than is indicated by the post-earthquake MSL trend will ensure that water level variability is not included twice - in both the original design water level as well as any adaptations in anticipation of future sea level rise. Due to the variability and uncertainty in sea level trends outlined above, it will be important to fully evaluate the "high" SLC curve as design parameters are further refined, both to ensure that the project is resilient to this potential outcome and to realistically predict what adaptations could be necessary and what they would cost.

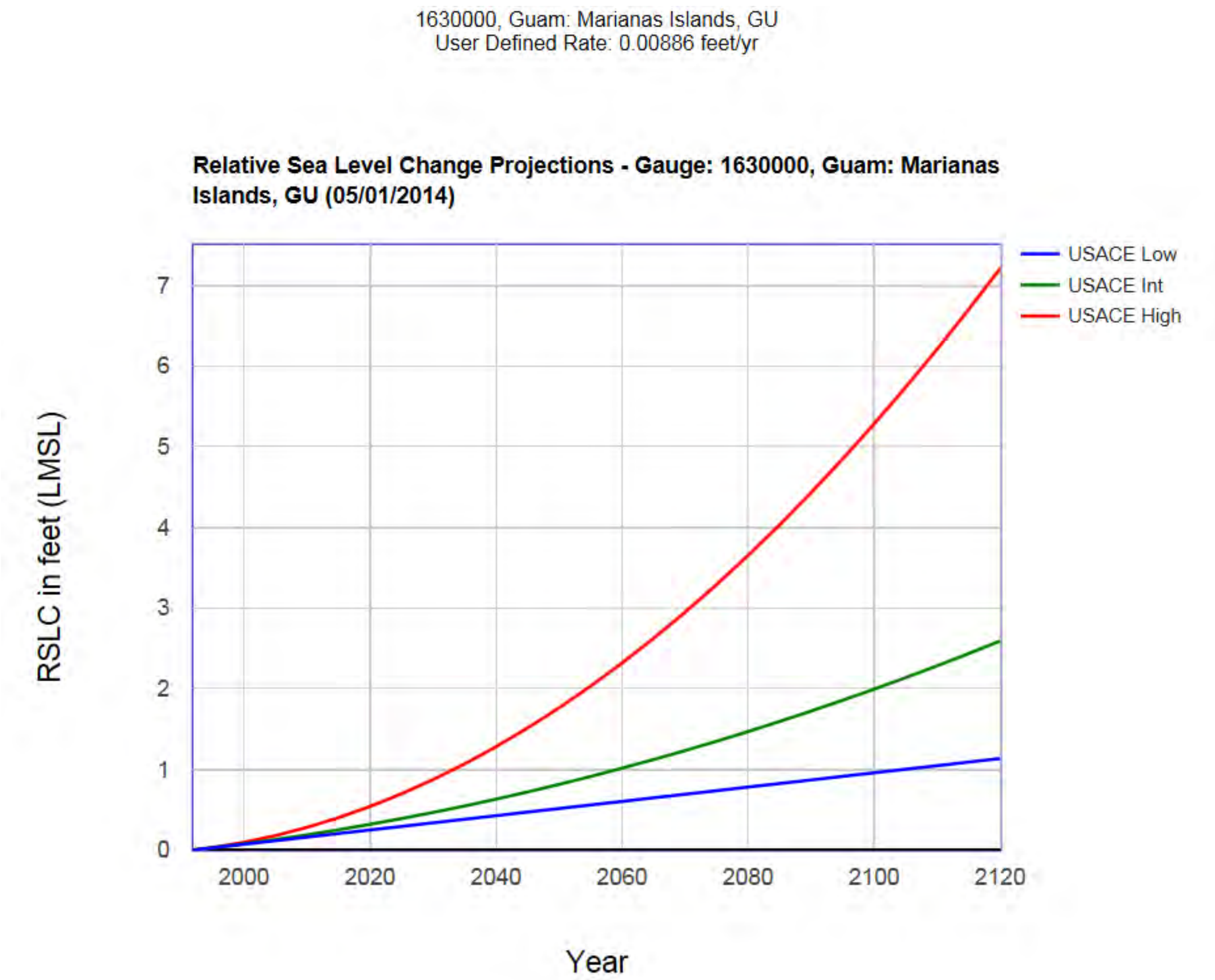


Figure A10. Relative Sea Level Change curves at Tinian Harbor, based on SLC rate of 2.7 mm/year

3 Geology and Geotechnical Conditions

Tinian is a volcanic island overlain with coralline limestone. The present topography is fairly flat, the highest elevation being 560 feet. Most of Tinian's shoreline is comprised of sea cliffs with pocket beaches and is encircled by a narrow fringing reef. Core borings taken at Tinian Harbor's pier and wharf structures in previous studies show a foundation of hard coralline limestone below a depth of about 25-30 feet (8-10 m). The limestone is covered by a surface layer of sandy limestone gravel. The fill materials behind the bulkheads generally consist of approximately 10 feet (3.05 m) of firm and non-cohesive sand/gravel, with no silt or clay. Native fill materials extend approximately 15 to 20 feet (5 to 6.8 m) below this layer, and they are also gravelly and sandy, generally dense, except for a few thin pockets of loose sand. The fill materials are not expected to liquefy during a seismic event. (Moffat-Nichol, 2015)

Tinian Harbor was constructed on the southwest coast of Tinian where a shallow fringing reef offers the harbor natural protection. It was dredged from the reef during World War II by U.S. Navy Seabees. The shallow reef that wraps around from the north has water depths of 1-3 feet (0.31 to 0.91 m) on the reef flat, which is 300-500 feet (91-152 m) wide. The fore reef has a steep slope of about 1/14, dropping of quickly to deep water depths. Consequently, incident waves are not affected by the open ocean bathymetry until they propagate over the fringing reef and to the harbor. Waves setup over the fore reef and break at the reef crest, just before the breakwater. Breaking waves over the reef generate wave-induced currents, which can affect navigation into/out of the harbor.

4 Alternative Plans Considered

4.1 No Action

The “no action” plan was considered and compared against alternatives as part of the planning process. In this case, the breakwater would continue to deteriorate, allowing increasing amounts of wave energy into the harbor, and potentially increasing currents inside the harbor. If the harbor were affected by a tsunami or typhoon that approaches near to (or makes landfall) at Tinian, the existing sheetpile could be damaged such that the only remaining portion of the structure is below water. This was the assumption made for modeling of the Future Without Project (FWOP) condition. This alternative would result in continued (and increasing) adverse wave and current conditions in the small boat navigation route, turning basin, and along the wharf during moderate wave events. In the future, these conditions may be exacerbated by sea level rise contributing to larger waves breaking across the reef and stronger current velocities in the harbor under higher water levels, as well as unprotected land side infrastructure being overtopped more frequently. The result could be harbor closures, operational difficulty, unsafe conditions for small boats, damage to existing and new infrastructure, and continued economic and social hardship for the residents of Tinian.

4.2 Non-Structural Alternatives

A number of non-structural options were also considered when formulating alternatives, particularly during the study charrette held at the beginning of the planning process. The majority of these alternatives were eliminated during the screening process, based on the following criteria: affordability, completeness, constructability, adaptability, environmental concerns, effectiveness, social effects, and safety. The screening process was to first remove any measure that did not meet the ‘Effective’ criteria. Next, any measures not meeting two or more other criteria (other than affordability, considered later in the planning process) were removed. Table A4 lists the non-structural alternatives considered, the screening criteria used, and which measures were removed from consideration (the far right column of each table indicates whether the measure was kept or removed from further consideration).

Table A4: Non-structural measures considered and screening criteria

Non-Structural Measures	Criteria Used to Screen Management Measures								
	Affordability	Completeness	Constructability	Adaptability	Environmental	Effectiveness	Social Effects	Safety	Keep ✓ Remove ✗
Moor vessels offshore and lighter cargo						X	X		✗
Use smaller vessels, more frequent trips	X					X			✗
Facilitate better surge forecasting						X			✗
Add bollards						X			✗
Reinforce bollards						X			✗
Optimize operations						X			✗
Require harbor pilots	X					X			✗
Relocate/modify aids to navigation						X			✗
Close port at times of high surge							X		✓
Allow 24-hour operations	X						X	X	✗
Use more tug assistance	X					X			✗
Add more accurate GPS technology in the harbor and lobby NOAA to install PORTS	X		X				X		✗
Add vessels similar to MV Luta	X								✓
Moor vessels either offshore or deeper areas of the harbor during high wave conditions							X		✓
Use counterweights on vessels to dampen surge while moored						X			✗

The three remaining non-structural measures left after the screening process were: 1) close ports at time of high surge, 2) add vessels similar to MV Luta, and 3) moor vessels offshore or deeper areas of the harbor during high wave conditions. These measures are described and further evaluated in the following paragraphs.

4.2.1 Non-Structural Measure 1: Close the port at times of high waves/surge

The non-structural measure of modifying operations to close the port at times of high waves and surge was suggested as a potential solution to reduce vessel and infrastructure damages, and to reduce perceived risks to vessel and passenger safety when transiting the channel under moderate wave conditions. It was noted by the CPA that this measure is already implemented under current operations; the harbor is closed when conditions offshore exceed approximately 6 feet (1.83 m) in wave height. Therefore, the risk of vessel damages is eliminated, and infrastructure damage would be unchanged except for reduction in damage to bollards/cleats since no vessels would be moored. It is the discretion of harbor pilots to determine if vessels can safely navigate the channel when the harbor is open; therefore, there should be no vessels entering the harbor if safety of the vessels or passengers is at risk. For these reasons, this non-structural measure was eliminated from further consideration.

4.2.2 Non-Structural Measure 2: Add vessels similar to the MV Luta

The MV Luta is a general cargo vessel approximately 155 feet (47 m) in length and drafting 8.2 feet (2.5 m). The vessel was used during a portion of 2016 to deliver cargo throughout the CNMI, including calls at Tinian Harbor. According to anecdotal reports by the CPA, the MV Luta was able to operate in “advisory” wave conditions of 4 to 6 feet (1.2 to 1.8 m) at the entrance channel. This allowed cargo to be delivered during conditions when a tug and barge would not be able to enter the harbor due to the high waves and more limited maneuverability of this vessel. The MV Luta has a smaller cargo capacity than a barge, more trips are required to deliver an equivalent amount of cargo, increasing transportation costs. The MV Luta is no longer in service in the CNMI, and it would be the responsibility of the CPA to acquire or lease a vessel with similar capability, or to return the MV Luta back into service.

The consideration of this measure included discussions with the CPA (non-Federal sponsor) as well as the U.S. Coast Guard. It is not considered feasible to replace all tug and barge operations with a vessel such as MV Luta or one that is similar, so barge deliveries would still be limited by conditions at the harbor. However, this measure could augment the delivery of cargo during times of the year when the wave conditions are rough. This measure has been suggested as a potential improvement of operations to the CPA, but since this is a non-Federal responsibility, it was removed from subsequent inclusion in the Federal plan formulation process.

4.2.3 Non-Structural Measure 3: Moor vessels offshore or in deeper areas of the harbor during high wave conditions

The non-structural measure of mooring large vessels either offshore, or in deeper areas of the harbor (away from the wharf and finger piers) during high wave conditions was included as a potential change to operations that could reduce vessel and infrastructure damage, and to reduce perceived risks to vessel and passenger safety when transiting the channel under moderate wave conditions. It was noted by the CPA that the harbor is closed when conditions offshore exceed approximately 6 feet (1.82 m) in wave height. Large vessels would not transit to Tinian Harbor in these conditions, and would choose to omit delivery. Consequently, the risk of large vessel damages is eliminated, and infrastructure damage would be unchanged except for reduction in damage to bollards/cleats since no vessels would be moored. In addition, it is the discretion of harbor pilots to determine if vessels can safely navigate the channel when the harbor is open; therefore, there should be no vessels entering the harbor if safety of the vessels or passengers is at risk. Small vessels would not be operating in these conditions. For these reasons, this non-structural measure was eliminated from further consideration.

4.3 Structural Alternatives

4.3.1 Replace Existing Breakwater in Place

This measure involves removal of the approximately 4,600 ft (1,400 m) existing cellular sheet pile breakwater, including debris, sand/silt/coral rubble, vegetation, and steel sheet piles down to the approximate 3 foot (0.91 m) elevation contour relative to Mean Lower Low Water. Some of this in place material (e.g., coral rubble) may either remain or be reused for the core of the new breakwater structure; however, the majority will be disposed of at a landfill (either on Tinian or shipped to Saipan).

The new breakwater will be rebuilt along the existing structure alignment, but with varying cross-sectional area composed of either stone, or stone and concrete armor units. Figure A11 shows the alignment of the existing structure, as well as the conceptual footprint (not to scale) of the replaced structure, including both the northwest breakwater and main breakwater sections. The northwest breakwater will require a smaller cross-section (due to less wave exposure) and can be built with a stone armor layer and underlayer. A typical cross-section for this reach is shown in Figure A12. The oceanside and harborside toes of the structure will be placed into a trench excavated into hard foundation material. Existing depths in this area range from approximately 3.0 to 10.5 ft (0.9 to 3.2 m) below MLLW. The breakwater cross-section will be approximately 60 feet (18.2 m) wide and 14 feet (4.3 m) in total height on average, with an elevation 8 feet (2.4 m) above MLLW datum.

Figure A11. Conceptual Layout of Replace Existing Breakwater

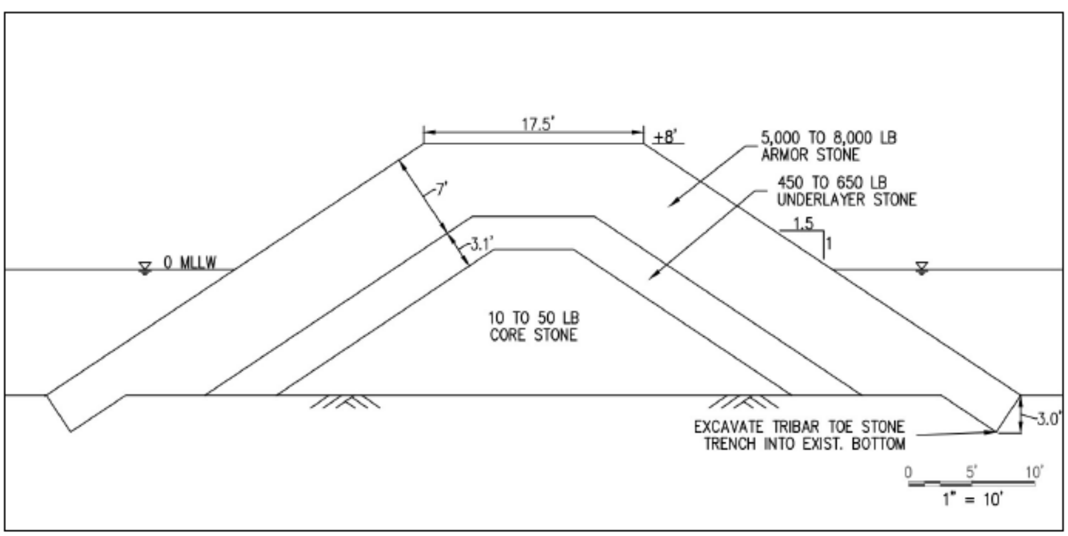


Figure A12. Typical Cross-section of Replace Existing Northwest Breakwater (Sta 0+00 to 11+00) (Sea Engineering, 2015)

The remaining 3,500 feet (1,067 m) of breakwater will consist of a more robust cross-section, due to head on exposure to larger waves (including those from typhoon events). This portion of the breakwater ("Main Breakwater") would follow the alignment of the existing breakwater, and would utilize the remnants of the existing breakwater as a portion of the core. Remnants extending above 3 feet (0.91 m) MLLW elevation would be removed so as to not protrude into the new breakwater stone layers. A new core would be constructed around the remnants, using quarry run stone, or other suitable material. Successive layers would be placed over the core material, consisting of a geotextile filter fabric, a 1.5-foot (0.46 m) thick bedding layer of 10 to 50 pound (4.53 to 22.7 kg) stone, a two-stone thick underlayer of 250 to 500 pound (113.4 to 226.8 kg) stone, and a 2.5-ton tribar (or 1.8 ton Core-Loc) armor layer. A cast-in-place concrete cap would be used to stabilize the crest. A rubble mound structure constructed of armor stone was considered; however, preliminary calculations indicated that this would require stone sizes of approximately 14 to 20 tons (12,700 to 18,144 kg) to remain stable under extreme wave conditions. This size stone is not available within the CNMI or Guam. The oceanside and harborside toes of the structure will be placed into a trench excavated into hard foundation material and further stabilized with tremie concrete. The breakwater cross-section will be approximately 65 feet (19.8 m) wide and 15 feet (4.6 m) in total height, with an elevation 12 feet (3.7 m) above MLLW datum. A typical cross-section is shown in Figure A13.

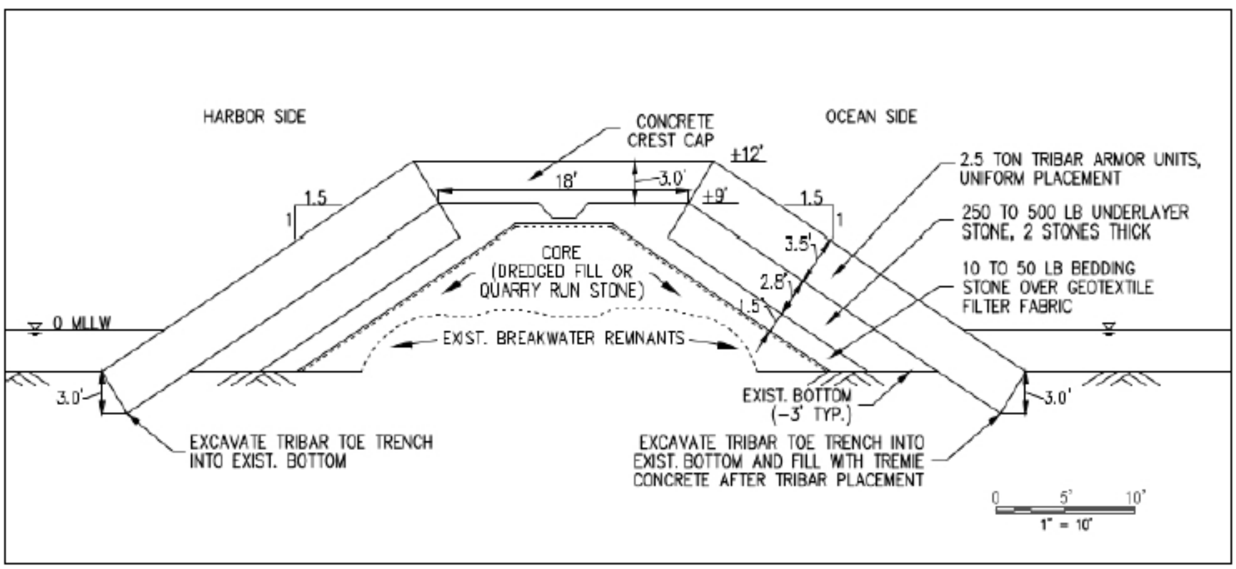


Figure A13. Typical Cross-section of Replace Existing Main Breakwater (Sta 11+00 to 46+00) (Sea Engineering, 2015)

4.3.2 Replace and Extend Existing Breakwater

This alternative involves all of the same demolition and breakwater replacement methods described in the Replace Breakwater alternative, with the addition of an approximately 300 ft (91.44 m) extension to the breakwater, increasing the total length to approximately 4,900 ft

(1,494 m). Figure A14 shows the alignment of the existing structure, as well as the conceptual footprint of the replaced structure, including the breakwater extension. The length of the extension will be optimized based on costs and reduction to wave energy within the harbor. The 300 ft (91.44 m) length would be the maximum due to both the location of the entrance channel and the depth contours near the end of the existing breakwater alignment. The full extension would result in the new breakwater foundation depth ranging from 10 to 25 ft (3.04 to 7.62 m) below MLLW. The cross-section would likely be composed of a stone core and underlayer, with concrete armor units on the armor layer, similar to the design of the replaced main breakwater, but with a significantly wider footprint and larger concrete armor units due to deeper foundation depths in this area.

A new core would be constructed, using salvaged breakwater material, quarry run stone, or other suitable material. Successive layers would be placed over the core material, consisting of a geotextile filter fabric, a 1.5-foot (0.46 m) thick bedding layer of 20 to 100 pound (9.1 to 45.4 kg) stone, a two-stone thick underlayer of 400 to 800 pound (181.4 to 362.9 kg) stone, and a 4.3-ton tribar armor layer (or 3.2-ton Core-Loc). A cast-in-place concrete cap would be used to stabilize the crest. The oceanside and harborside toes of the structure will be placed into a trench excavated into hard foundation material and further stabilized with tremie concrete. The breakwater cross-section will be approximately 130 ft (39.6 m) wide and 22 to 40 feet in total height, with an elevation 12 ft (3.7 m) above MLLW datum. A typical cross-section of the extension to the breakwater is shown in Figure A15.

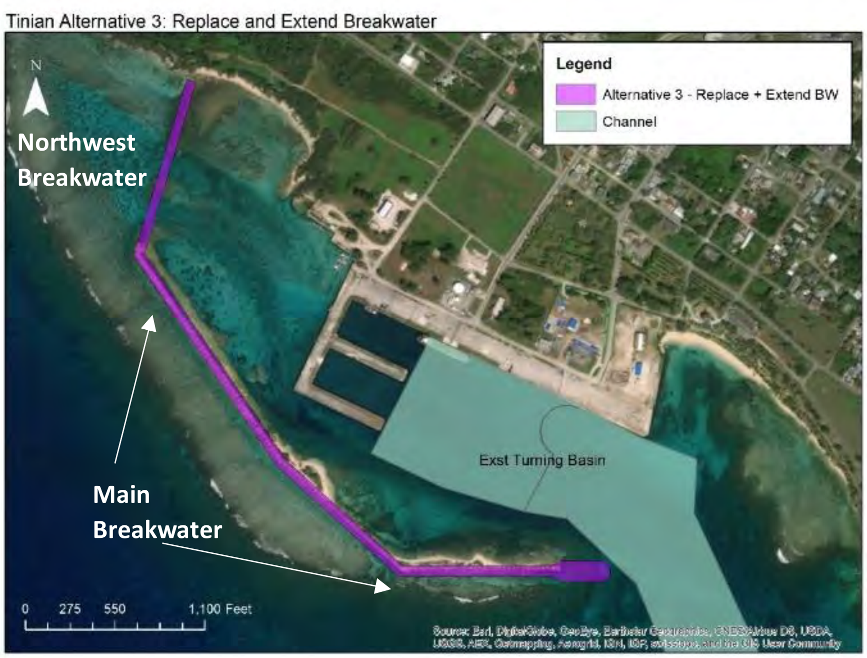


Figure A14. Conceptual Layout of Replace and Extend Existing Breakwater

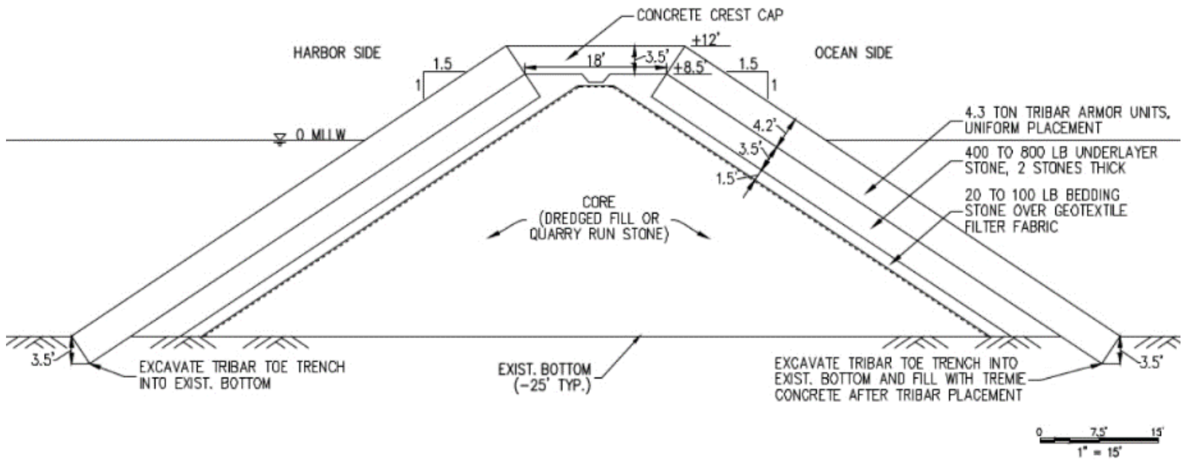


Figure A15. Typical Cross-section of Alternative 2: Breakwater Extension (Sea Engineering, 2015)

4.3.3 Replace Existing Breakwater and Add New "East" Breakwater

This alternative involves all of the same demolition and breakwater replacement methods described in the previous alternatives, with the addition of another breakwater on the east side of the existing entrance channel. Figure A16 shows the alignment of the existing structure, as well as the conceptual footprint of the new East Breakwater. This alternative would be built on the shallow reef flat that currently exists along the shoreline east of the harbor, with a cross-section similar to that shown in Figure A13. The intent of this alternative is to reduce the width of the opening to the harbor, thereby reducing the wave energy entering the harbor area. Preliminary wave modeling indicated that this additional structure would not provide wave sheltering or a reduction in wave energy affecting the channel, turning basin, berthing areas, or wharf. It also would not affect currents within the harbor. In addition, preliminary benthic surveys indicated significant environmental resources in this previously untouched area. This alternative was therefore eliminated from further consideration.

Figure A16. Conceptual Layout of Rebuild Existing Breakwater and Add New Breakwater.

4.3.4 Dredge Entrance Channel and Turning Basin to Original Depths

During the planning charrette, interest in deepening areas within the harbor limits was expressed by the non-Federal sponsor. The estimated original dredge depths are approximately 30 feet below MLLW in the entrance channel, and 28 to 30 ft (8.5 to 9.14 m) below MLLW in the turning basin and wharf area; however, since this is not currently a Federally-maintained harbor, limited documentation during original construction is available.

During the course of the study, the CPA acquired a bathymetric survey of the harbor using multibeam hydrosurvey methods. The October 2016 survey, a portion of which is shown in Figure A17, shows that the majority of the channel and turning basin is at or below 30 feet (9.1 m) MLLW. There is an area within the established channel limits along the eastern end of the wharf and the East Quay area that has shallower depths, with a minimum depth of approximately 15 ft (4.6 m) below MLLW. Due to the orientation of the channel and location of the active berthing areas (further west), this area is not widely used by large vessels approaching the wharf at the present time, and is not posing a safety hazard to navigation. Further discussion with the sponsor and stakeholders regarding current operational procedures as well as the existing and future vessel fleet indicated that existing depths within the channel and turning basin, in addition to the present channel width and turning basin radius, are sufficient for the harbor users, now and in the future. Dredging of the channel and/or turning basin was eliminated from further consideration. Further detail on the existing/future vessel fleet can be found later in this appendix and in the Economics Appendix.

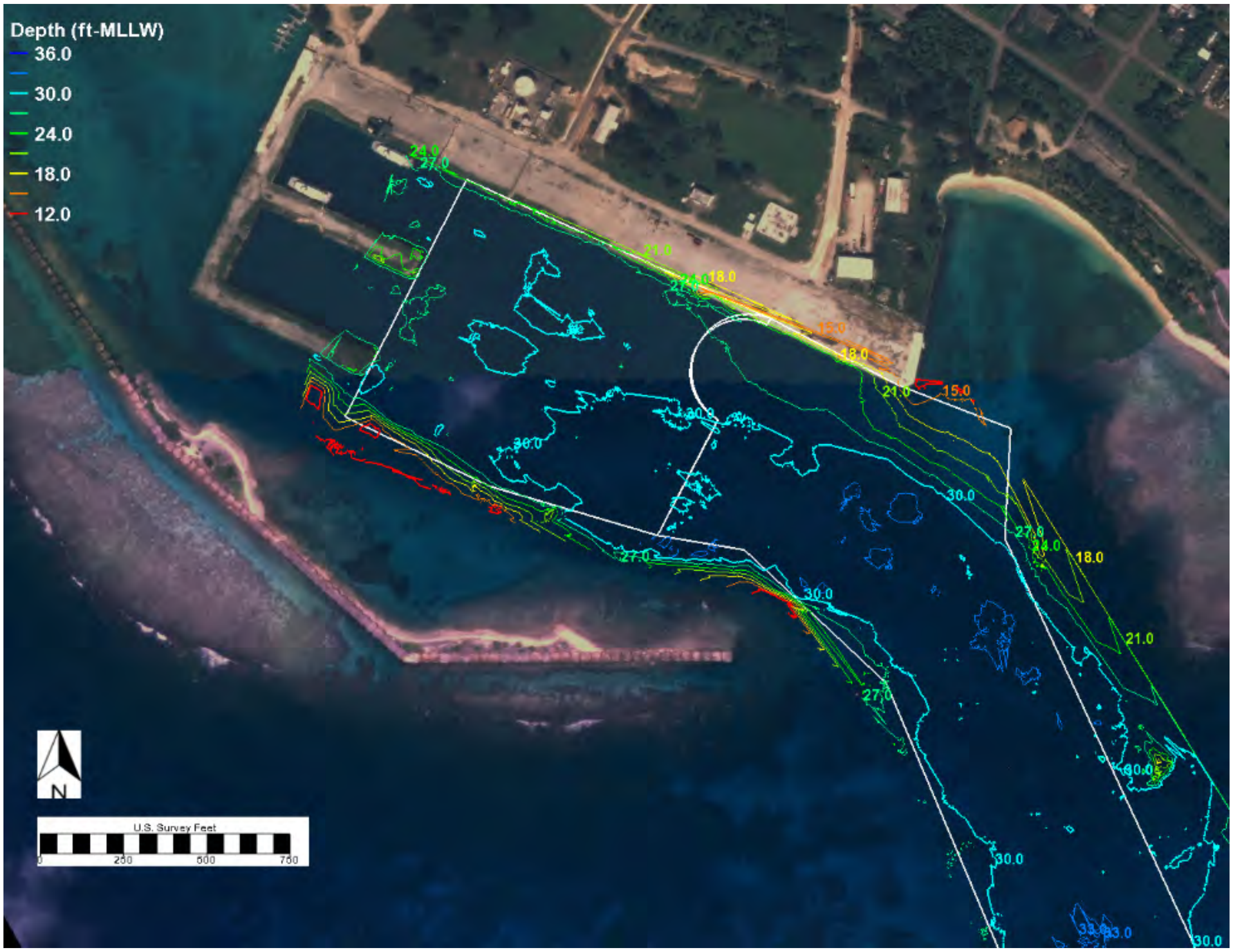


Figure A17. October 2016 Multibeam Hydrosurvey of Tinian Harbor Channel and Turning Basin

4.4 Final Array of Alternatives

Alternatives carried forward to the final array for detailed modeling are the following: Alternative 1 (No-Action), Alternative 2 (Replace Breakwater), and Alternative 3 (Replace and Extend Breakwater). It is assumed that future Sea Level Change will affect the structural alternatives (Alternatives 2 and 3) similarly, since these are both breakwaters that will be constructed out of comparable materials and have similar cross sectional design. The materials required for the structure armor layers (concrete armor units and a cast-in-place concrete cap) are not easily adapted for sea level change. Raising the crest height of the structure would require a parapet wall or similar cast-in-place concrete feature above the original concrete cap. This could be accompanied by an additional layer of armor units to increase the elevation of the side slopes if necessary, however, the interlocking of armor units required for stability would be difficult to achieve in construction.

This challenge to adaptability should be further considered when selecting the final elevation of the structure in the detailed design phase. However, at the present stage, adaptability of all alternatives is analogous, and does not significantly distinguish them for comparison based on sea level change.

4.5 Wave Transformation Modeling

Two numerical wave models, CMS-Wave and BOUSS-2D (B2D), are often used in the harbor studies. When addressing a broad range of oceanic and coastal wave modeling needs of navigation projects, the computational constraints require the use of a combination of spectral and Boussinesq-type wave models such as these (Lin and Demirbilek, 2005 and 2012).

CMS-Wave, a two dimensional (2D) spectral wave model, was applied to large domains, covering deep-water offshore areas up to the shoreline. The computational efficiency of CMS-Wave permitted the simulation of a very large number of deep-water wave conditions for determining the accessibility and utilization of the harbor and proposed modifications.

B2D, a Boussinesq-type model, could be used during the detailed design with small local domains in the nearshore which include details of harbors, channels and harbor infrastructure. This tandem use of two classes of wave models is necessary to investigate waves affecting safe and efficient usage of Tinian Harbor. Because no wave data was collected in Tinian Harbor, the numerical model was calibrated and validated with available data during the preliminary design stage.

4.5.1 CMS-Wave Model Application

The details of the navigation channel, turning basin, harbor structures, and adjacent coasts were included in the CMS-WAVE modeling grids. Bathymetry data was obtained from the UH-SOEST Pacific Islands Benthic Habitat Mapping Center (PIBHMC) (http://www.soest.hawaii.edu/pibhmc/cms/) and includes deep water multibeam survey data collected by NOAA Ship Hiialaka'i and R/V Ahi between 2003 and 2007, in addition to shallow water (less than 65 ft or 20 m depth) data derived from World View-2 satellite imagery (Figure A18). In 2013, a LiDAR survey was completed of the entire coastal zone of Tinian in support of Navy sponsored marine resources surveys being conducted around the island. The LiDAR survey was conducted by Fugro Earth Data, Inc. and provided 1.6 to 9.8 ft (0.5 to 3 m) resolution elevation data from the land to water depths of approximately 65 feet (20 m). Multibeam data was collected in late 2016 by Moffatt-Nichol, Inc. on behalf of the CPA, and was used to update and augment model grid bathymetry.

A nested grid setup was utilized for CMS-WAVE to transform deep or intermediate-water incident waves to the nearshore. The regional wave grid (with its boundary located at WIS Station 81104) was used in half-plane mode and oriented in alignment with the approaching wave window shown in Figure A5. The 32-year (1980-2011) wave record of WIS hindcast data was transformed in the regional grid from deep water (9,400 ft or 2,865 m depth at station 81104) to nearshore. Comparisons of WIS hindcast data to WaveWatch 3 (WW3) nowcast data and nearby wave buoys were also completed as a supplementary check of wave climate. This transformation modeling indicated that the majority of waves are less than 6 ft (1.82 m) by the time they reach the nearshore, and approach the entrance channel from directions between 220 and 250 deg. This regional grid provided wave output data at the approximately 65.6 ft (20 m) depth contour, which was used as an input boundary condition for the higher resolution local CMS-Wave grid. Figure A19 shows the boundaries of the regional (red) and local (yellow) wave grids.

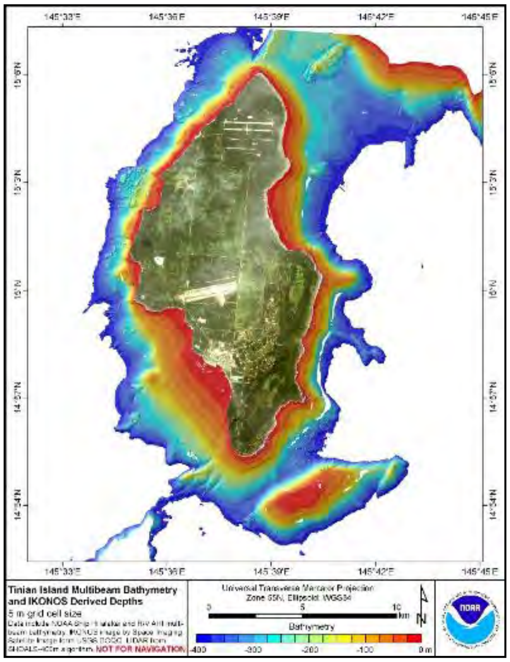


Figure A18. Multibeam bathymetry data around Tinian collected by UH-SOEST PIBHMC

Figure A19. Wave model grid boundaries at Tinian Harbor.

Model simulations of the future without project harbor and two proposed structural alternatives using high resolution "local" CMS-Wave grids were conducted for typical sea states (to evaluate operational conditions and harbor usability) and storm conditions (for structure stability analysis and design) and associated water levels for each were included. Operational wave model runs were based on the most frequently occurring conditions in the wave climate determined at the 20 meter contour, including: five wave heights of 2 ft (0.6 m), 3 ft (0.91 m), 4 ft (1.21 m), 5 ft (1.52 m), 6 ft (1.82 m), two wave periods associated with these wave heights (11 sec and 13 sec), three wave directions (230 deg , 240 deg, and 250 deg TN), and two water levels (0 ft MSL, 0.3 ft (0.09 m) MSL corresponding to MHHW condition). Elevated water levels representing future sea level rise should be modeled in the detailed design of the selected alternative. This resulted in a total of 30 unique wave/water level conditions for each harbor configuration, or a total of 90 model runs overall. A summary table of operational wave model conditions simulated for Tinian Harbor is shown in Table A5.

An example of the nearshore wave field modeled for the no-action/future without project harbor condition with significant wave height of 4 ft (1.22 m), wave period of 13 sec, and wave direction of 240 deg is shown in Figure A20. It is evident from the figure that waves in this scenario break on the edge of the reef fronting the breakwater, but propagate directly through the harbor entrance. This offshore wave condition results in an approximately 5.0 ft (1.5m) wave in the entrance channel and a 2.5 ft (0.75m) wave height at the east end of the wharf. Detailed results of these simulations and the potential effects of waves on harbor usability are discussed in Chapter 6.

Table A5. Operational Wave Conditions used for Tinian Harbor CMS-Wave Model

Wave Ht Range (m)	Max Wave Ht, H_s (m)	Peak Wave Period, T_p (sec)	Mean Dir, Θ_m* (deg, azimuth)	Water Level+ (m, MSL)
0.31 – 0.61 (1 to 2 ft)	0.61 (2 ft)	11	230, 240, 250	0, 0.3
0.61 – 0.91 (2 to 3 ft)	0.91 (3 ft)	13	230, 240, 250	0, 0.3
0.91 – 1.22 (3 to 4 ft)	1.22 (4 ft)	13	230, 240, 250	0, 0.3
1.22 – 1.53 (4 to 5 ft)	1.53 (5 ft)	13	230, 240, 250	0, 0.3
1.53 – 1.82 (5 to 6 ft)	1.82 (6 ft)	13	230, 240, 250	0, 0.3

* shore-normal is ~ 240 deg

\+ 0.3 m is the MHHW

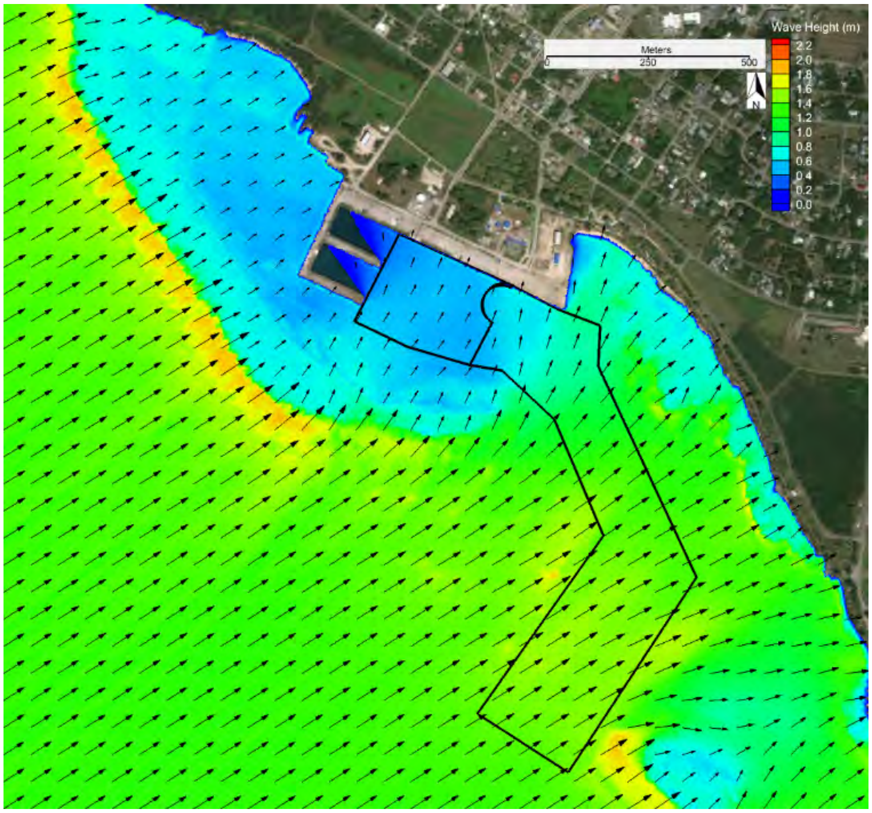


Figure A20. Example CMS-Wave simulation for existing/no-action conditions at Tinian Harbor (Hs=4 ft, Tp=13 sec, Dir=240 deg)

4.6 Hydrodynamic Modeling and Steering Runs with CMS-Wave

As discussed, wave conditions at Tinian Harbor affect currents through wave setup, and currents may also affect the waves themselves, affecting wave steepness and wave breaking, particularly in shallow water. The CMS models (CMS-Wave and CMS-Flow) are well suited to evaluate this interaction because of their capability for inline steering (coupling) of results from one model to the other. This interaction means that for every time step (or iteration) in the simulation, the wave model will pass steady-state calculated wave height and other parameters to the flow model for its calculations, which in turn will pass back wave-induced current data to the wave model, enabling a direct solution for a seemingly difficult iterative process.

4.6.1 Circulation Model Description

CMS-Flow is a 2D shallow-water wave model that can be used for hydrodynamic modeling (calculation of water level and current). Both the explicit and implicit versions of the flow (circulation) model are available to provide estimates of water level and current given tides, winds, and river flows (where applicable) as boundary conditions. CMS-Flow solves the conservative form of the shallow-water equations that includes terms for the Coriolis force, wind stress, wave stress, bottom stress, vegetation flow drag, bottom friction, wave roller, and turbulent diffusion. Governing equations are solved using the finite volume method on a non-uniform Cartesian grid.

4.6.2 CMS-Flow Application

CMS-Flow was applied using a domain identical in size, resolution and bathymetry to the local CMS-Wave grid, both for efficiency and compatibility between the two models during steering simulations. The model was forced using wave conditions (wave height, wave period, wave direction, wave dissipation, radiation stress gradient) from CMS-Wave in order to calculate water levels and current velocities within and adjacent to the harbor. An example of the nearshore current field modeled for the existing harbor condition with significant wave height of 4 ft (1.2 m), wave period of 13 sec, and wave direction of 240 deg (same offshore conditions as example wave field shown in Figure A20) is shown in Figure A21. The current simulation shows relatively high currents on the outside of the remaining breakwater, (on the order of 3.0 to 4.0 ft/sec (1.0 to 1.2 m/sec)), directed toward the entrance channel. Currents also flow through the damaged sections of the northwest breakwater, through the harbor toward the east, and are highest in the narrow area between the breakwater and finger piers, at approximately 4.9 ft/sec (1.5 m/sec) for this wave condition. This is the route that small boats navigate to enter and exit the harbor. Results of these simulations and the potential effects of currents on harbor usability are discussed in Chapter 5.

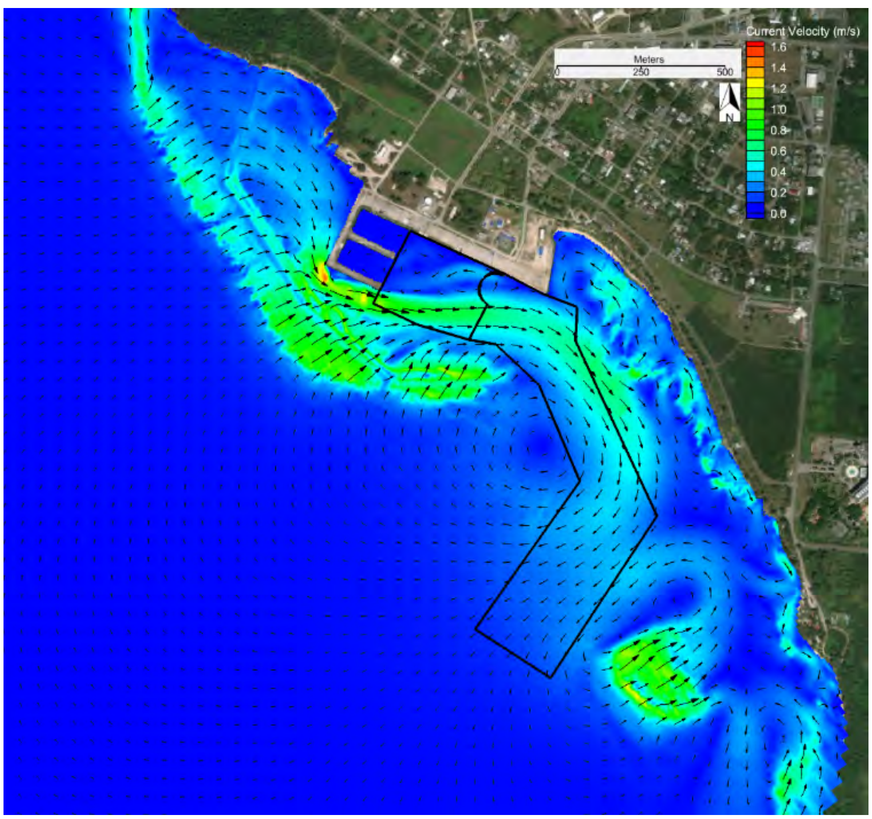


Figure A21. Example CMS-Flow simulation for future without project conditions at Tinian Harbor (Hs=4 ft, Tp=13 sec, Dir=240 deg)

5 Operational Wave Conditions and Harbor Usability Analysis

One of the primary objectives for this study is to identify improvements that will enable improved operations and small boat navigation at Tinian Harbor for a wider range of offshore conditions, thereby improving navigation and operational efficiency. Formulation of these improvements requires an analysis of wave conditions under which vessels can transit to Tinian from other locations ("operational wave conditions") and would attempt to navigate the entrance channel and moor at the wharf within the harbor. According to discussions with the non-Federal sponsor (Tinian HarborMaster) and harbor users (harbor pilots), deep water waves up to 5 or 6 feet (1.52 m or 1.83 m) are the limit for most vessels to deliver cargo to Tinian Harbor. The approach for this study was to define a baseline condition as the percentage of time that the harbor will be considered "accessible" and "useable" (based on a pre-defined set of thresholds) in the future without project (or no action) harbor configuration during these operational conditions, and to evaluate potential modifications to the harbor under the same conditions for comparison.

5.1 Design Vessel

The primary large vessel traffic at Tinian Harbor is cargo vessels and a fuel tanker. Cargo is delivered by a tug and barge predominantly (with the inconsistent exception of self-powered vessels such as the M/V Luta discussed in Section 4.2.2). The fuel tanker is the MV Akri, with dimensions 344 ft (104.9 m) length, 54 ft (16.5 m) beam, and 18 ft (5.5 m) draft. The tug and barge is used as the design vessel to determine harbor usability, because these vessels are typically less maneuverable than self-powered vessels, and therefore must operate in wave and current conditions that are more favorable.

Tinian Harbor also has a marina and launch ramp for smaller vessels that use the harbor. Several small vessels utilize the harbor for small cargo loading and docking. Because these vessels are not commercial vessels, they are not recorded by the harbor master. Since these crafts travel in and out of the harbor, they are impacted by wave and current conditions in the entrance channel and along the route to the small boat harbor.

Finally, the Department of Defense (DoD) usage of Tinian Harbor was also considered during plan formulation. These vessels are typically Logistics Support Vessels (LSV), Landing Craft Utility (LCU), High Speed Vessels (HSV; a hybrid catamaran), and Joint High Speed Vessels (JHSV; catamaran). These vessels draft up to 12 ft (3.7 m), and have lengths and beam widths of up to 340 ft (103.6 m) and 94 ft (28.7 m), respectively. These vessels are highly maneuverable and are relatively shallow-draft, such that existing channel dimensions and depths at Tinian Harbor are sufficient for their use.

5.2 Navigation and Operational Thresholds

Due to the usage of less maneuverable tug and barge delivery of cargo, as well as the presence of small recreational vessels in Tinian Harbor, design thresholds for small craft as noted the

Coastal Engineering Manual (CEM), V-5-2, “Defining Vessel Requirements” are adopted for this usability analysis. The CEM states that typical criteria are: 1) significant wave height will not exceed 1 ft (0.3m) more than 10 percent of the time at mooring areas, and 2) significant wave height will not exceed 2 ft (0.6 m) more than 10 percent of the time at access channels.

Design thresholds for current velocity are not specifically listed in USACE design guidance, as they are highly dependent on channel dimensions, ship maneuverability, and other factors. The Unified Facilities Criteria (UFC) 4-152-07, “Design: Small Craft Berthing Facilities” notes that currents in excess of 3 ft/sec (1 m/sec) in berthing areas may be a significant factor in design, UFC 4-150-06, “Military Harbors and Coastal Facilities” suggests that current velocity should not exceed 4 knots (6.5 ft/sec or 2 m/sec) except in localized areas and/or special considerations. It is noted that cross-currents (currents directed perpendicular to the channel or direction of travel) are most difficult, particularly for vessels with limited maneuverability, as they can cause yawing of the vessel. Because of the high spatial variability and inconsistent nature of harbor currents, as well as the fact that large waves and currents are closely correlated at Tinian Harbor, current velocity is evaluated qualitatively in this analysis, with the above mentioned general guidelines in mind.

Harbor “access” refers to ability of vessels for safe transit into a harbor. Harbor “usability” is an indicator of vessels’ ability to safely stay within a harbor to perform routine operations. Harbor access/usability will be defined for Tinian Harbor as both a wave threshold (less than 2 ft (0.61 m) in the entrance channel and less than 1 ft (0.3 m) at mooring areas as defined previously), and the duration of exceedance of these acceptable conditions. Based on discussions with the CPA, when wave heights at Tinian Harbor cause the port to be closed for operations, these conditions persist for several hours or several days. In addition, since most vessels are transiting from Guam or Saipan, they must decide several hours advance of leaving those ports whether conditions at Tinian Harbor will be acceptable for transit through the entrance and operations at the wharf. The operating procedure at Tinian Harbor is to evaluate conditions at the port in the morning of or night prior to a vessel call. If the conditions are not favorable for navigation/operations, the port is considered “closed” for that entire day. For these reasons, any exceedance of the stated wave threshold for one or more consecutive hours will cause the harbor to be considered unusable for that entire day (defined as 6 am to 6 pm since this is a daylight only port).

5.3 Accessibility/Usability Analysis

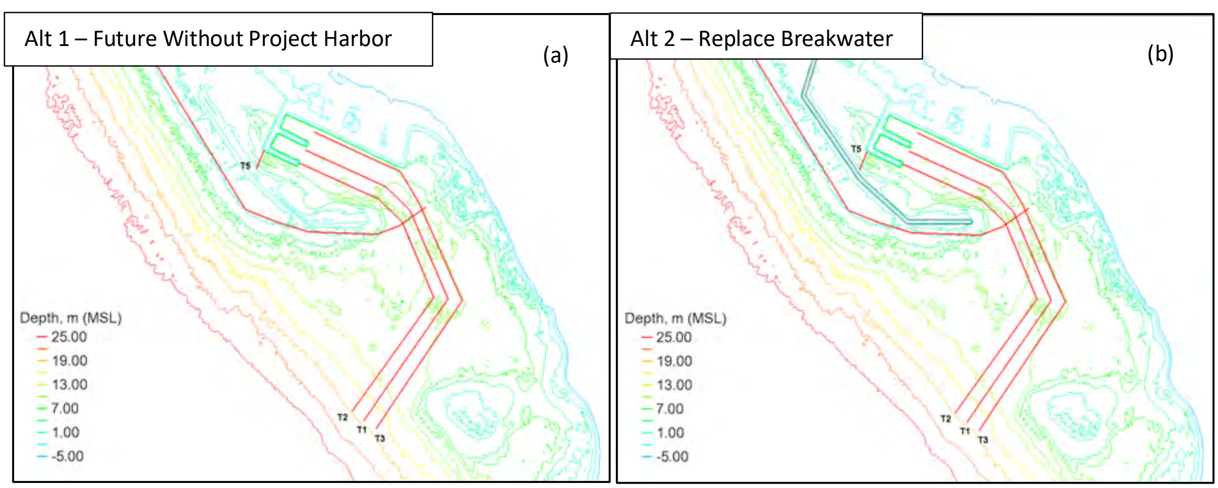
As noted in Chapter 4, 32 years of hindcast waves from deep water were transformed to the nearshore (66 ft or 20 m depth), and the most frequently occurring conditions (30 unique combinations of wave height/period, wave direction, and water level) were modeled in the nearshore grid for the future without project (no action) harbor configuration and two modification alternatives. A sensitivity analysis was also conducted for wave heights between 4 to 6 ft (1.21 to 1.83 m) at the nearshore grid boundary, as well as for wave directions outside the 230 – 250 deg window, to determine whether any of these conditions would affect the results of the analysis. The difference in the number of accessible/usable days in the final analysis was negligible.

The results of these simulations were used along with occurrence probabilities of individual waves (Hs, Tp, and Dir combinations) at the nearshore model boundary to evaluate the probability of exceedance of the selected wave/duration thresholds on an annual basis. The modeled wave fields were evaluated for threshold exceedance along identical transects placed in the areas of interest for the future without project (FWOP) configuration (Alt 1), replacement breakwater (Alt 2), and the breakwater replacement and extension (Alt 3). The transects and alternative grids are shown in Figure A22(a) through Figure A22(c).

5.3.1 Wave Reduction in Entrance Channel

The results of the wave transformation along transect T1, which follows the approximate centerline of the channel from well outside of the existing channel all the way through the turning basin and up to the middle finger pier, are shown in Figure A23 for the wave condition Hs = 4.0 ft, Tp = 13 sec, Dir = 230 degs and water levels at MSL and MHHW. The orientation of the figure is offshore at the origin, and progressing toward land and into the turning basin along the x-axis. This transect is considered representative of the entrance channel and turning basin, the limits of which are annotated in the figure for reference. The wave thresholds of 2 ft (0.61 m) and 1 ft (0.30 m) are also annotated for visualization of threshold exceedance. Similar figures for the same wave height and period at directions 240 deg and 250 deg are shown in Figures A24 and A25, respectively.

These figures are shown as an example representation for the 2 ft, 3 ft, 4 ft, 5 ft, and 6 ft (0.61. 0.91 m, 1.22m, 1.52, 1.83 m)) incident wave cases that were completed, the results of which are summarized later in this section.



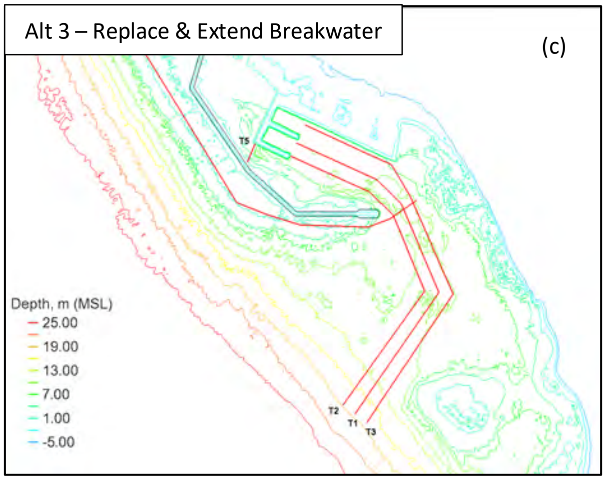


Figure A22. CMS-Wave/Flow Model Bathymetry and Transects for (a) Alt 1 – No-action/FWOP Harbor, (b) Alt 2 – Replace Breakwater, (c) Alt 3 - Replace and Extend Breakwater

Comparison of these three figures yields several observations. First, it is evident that under 4 ft (1.22 m)incident wave conditions the wave height in the FWOP entrance channel (Alt 1, shown in blue solid and dashed lines) exceeds the 2-foot "accessibility" threshold along the entire ~1000 ft (300 m) of the channel centerline. Neither Alt 2 (Replace Breakwater, red lines) nor Alt 3 (Replace and Extend breakwater, black lines) reduce the wave height in the entrance channel below the threshold (except for Alt 3 along a short section of the interior channel). All three alternatives are nearly identical in wave height along the T1 transect within the channel. This is not unexpected, given that the majority of the entrance channel is seaward of the breakwater, and does not benefit from its sheltering effect, now or under any repair scenarios. The resulting wave heights are similar for wave directions of 240 deg and 250 deg (Figures A24 and A25, respectively), with only a small difference in the wave height along the T1 transect for all three alternatives under the 250 deg wave angle, which is the most oblique (and westerly) of the wave directions simulated. This indicates that, in general, wave heights in the entrance channel are not highly sensitive to changes in incident wave direction.

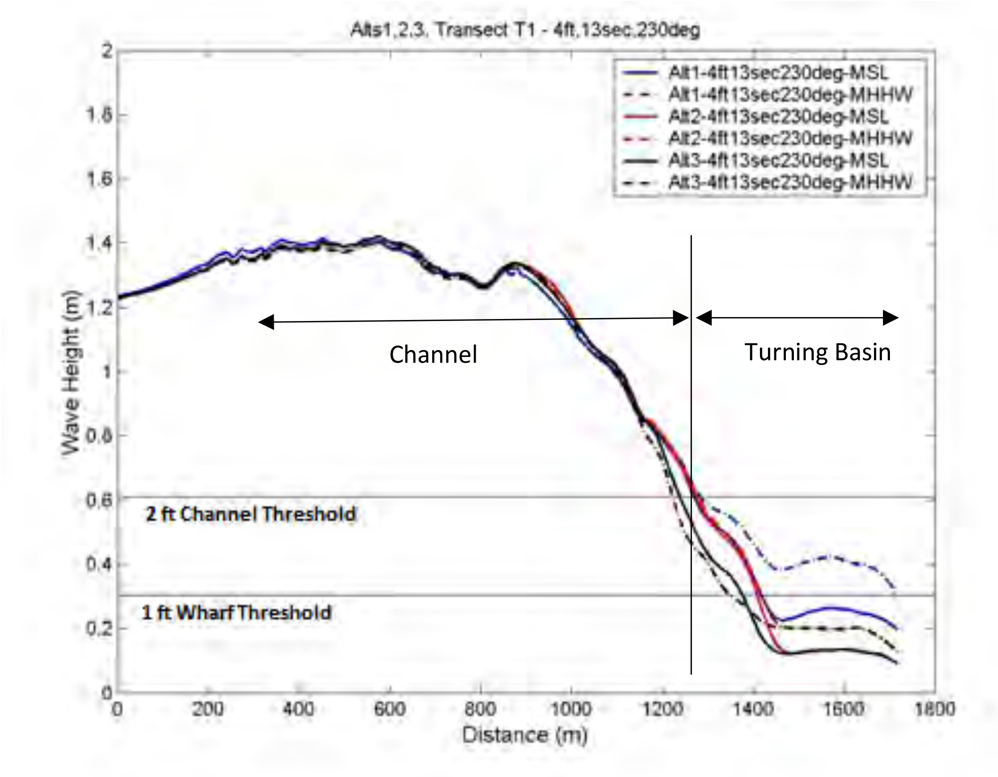


Figure A23. Wave height along transect T1 (Entrance Channel) for 230 deg wave approach

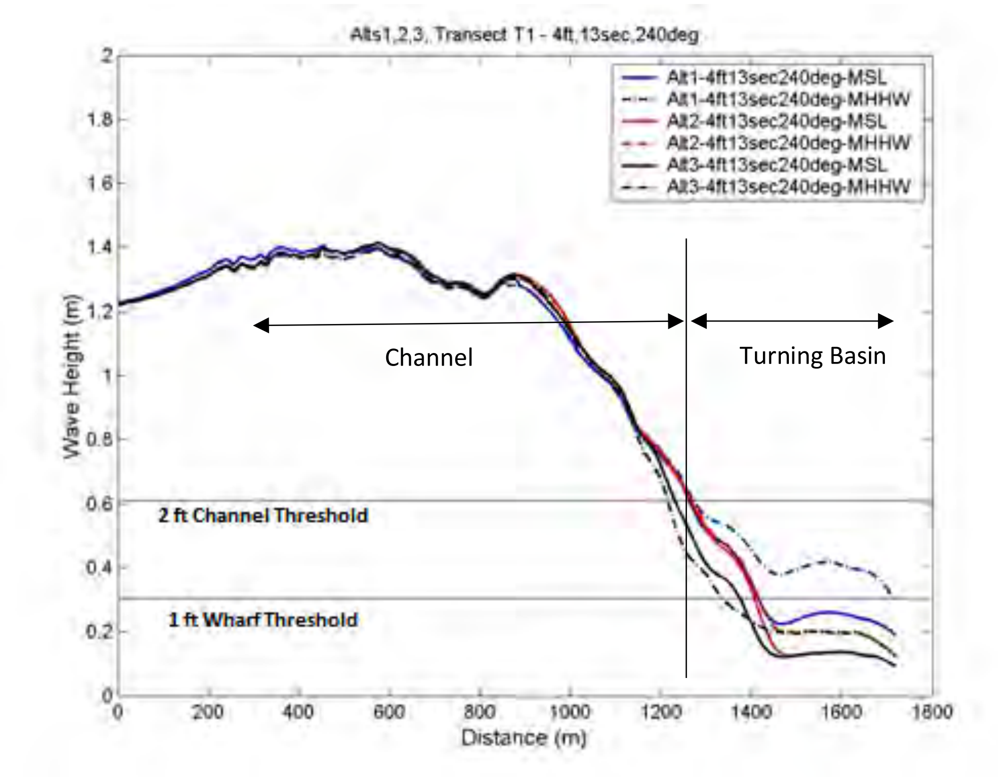


Figure A24. Wave height along transect T1 (Entrance Channel) for 240 deg wave approach

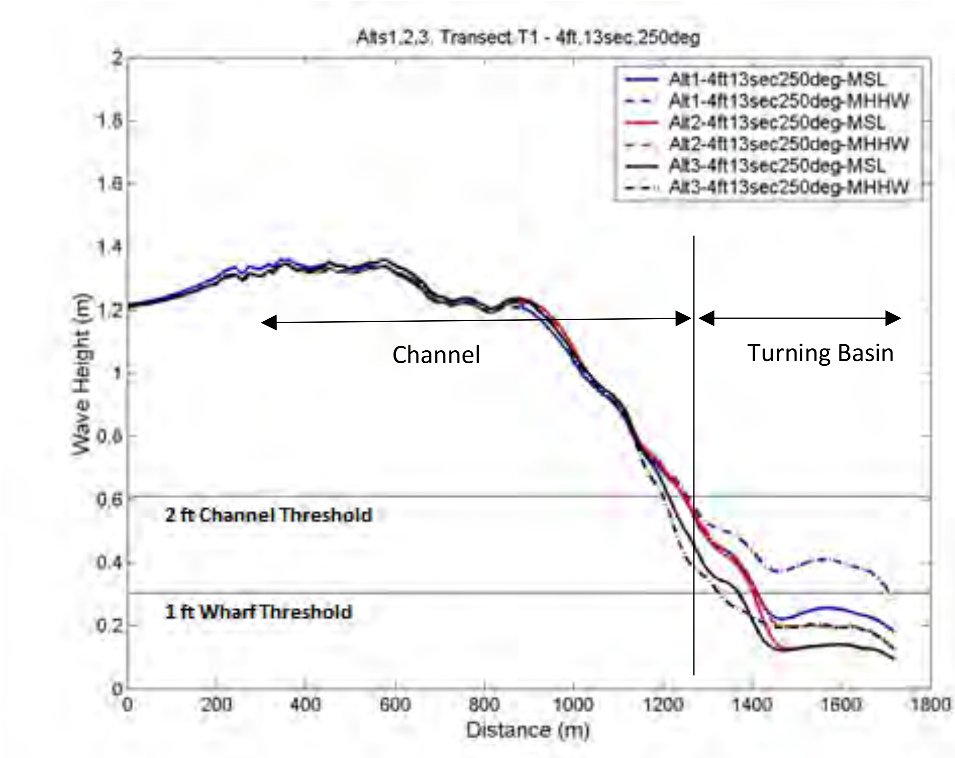


Figure A25. Wave height along transect T1 (Entrance Channel) for 250 deg wave approach

Secondly, comparison of the solid (MSL water level) and dashed (MHHW water level) lines for each alternative indicate that there is minimal difference in wave height at most locations within the entrance channel between the two water levels modeled. Because the entrance channel is relatively deep (30 ft below MLLW) in comparison to the incident wave height (4 feet), the waves are not depth-limited along this transect, and are not significantly affected by minor changes to water level. There are noticeable differences in wave height for varying water levels inside the turning basin. The FWOP/no-action configuration (Alt 1) results in larger waves for the MHHW water level as compared to the MSL water level within the turning basin. Alts 2 and 3 (replace breakwater and replace/extend breakwater, respectively) also show a slightly greater wave height magnitude for the MHHW case in the turning basin. This is true for all wave directions.

Finally, one last observation of note in these figures is made along the interior of transect T1 (within the turning basin). Alternatives 2 and 3 cause a reduction in wave height in the turning basin at both water levels (MSL and MHHW) as compared to the FWOP/no-action condition. Though the wave heights for Alts 2 and 3 do not fall below the 1-foot (0.3 m) wharf usability criteria along the entire transect, it is clear that a repaired or repaired and extended breakwater provides additional wave protection, with the extended footprint providing the most protection at the outer portion of the basin. This is true for all three wave directions. This would allow for easier maneuvering and turning within the basin. Further discussion of wave modeling results along the berthing areas is presented in the following section.

5.3.2 Wave Reduction at Tinian Wharf

The results of the wave transformation modeling for all three alternatives along transect T3, which runs longitudinally through the eastward half of the entrance channel and eventually along the entire length of the Tinian wharf, are shown in Figure A26, for the wave condition Hs = 4.0 ft (1.22 m), Tp = 13 sec, Dir = 230 deg and water levels at both MSL and MHHW. The orientation of the figure is offshore at the origin, and progressing toward land before changing orientation and becoming parallel to the wharf along the final 4000 ft (1,220 m) of the x-axis. This transect is considered representative of the conditions at the wharf and berthing areas, the limits of which are annotated in the figure for reference. The wave thresholds of 2 ft (0.60 m) for the entrance channel and 1 foot (0.30 m) for the berthing/wharf areas are also annotated for visualization of threshold exceedance. Similar figures for the same wave height and period, at directions 240 deg and 250 deg are shown in Figures A27 and A28, respectively. These figures are shown as an example representation for the 2 ft, 3 ft, 4 ft , 5 ft and 6 ft (0.61, 0.9 m, 1.22 m, 1.52, 1.83 m) incident wave cases that were completed, the results of which are summarized later in this section.

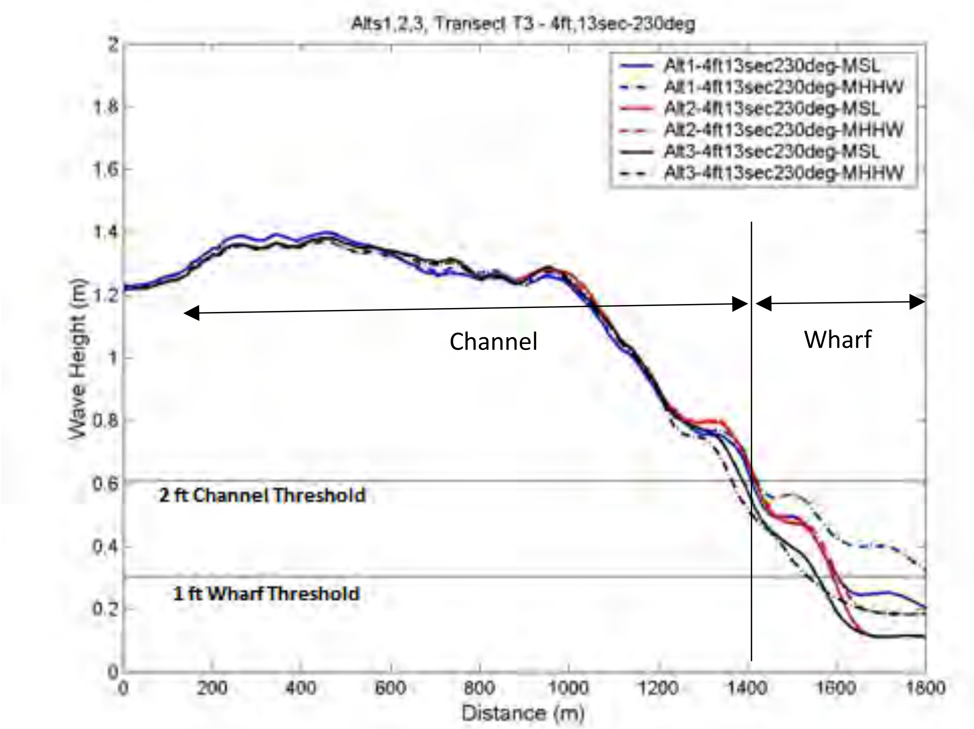


Figure A26. 4-foot Incident Wave height along transect T3 for 230 deg wave direction

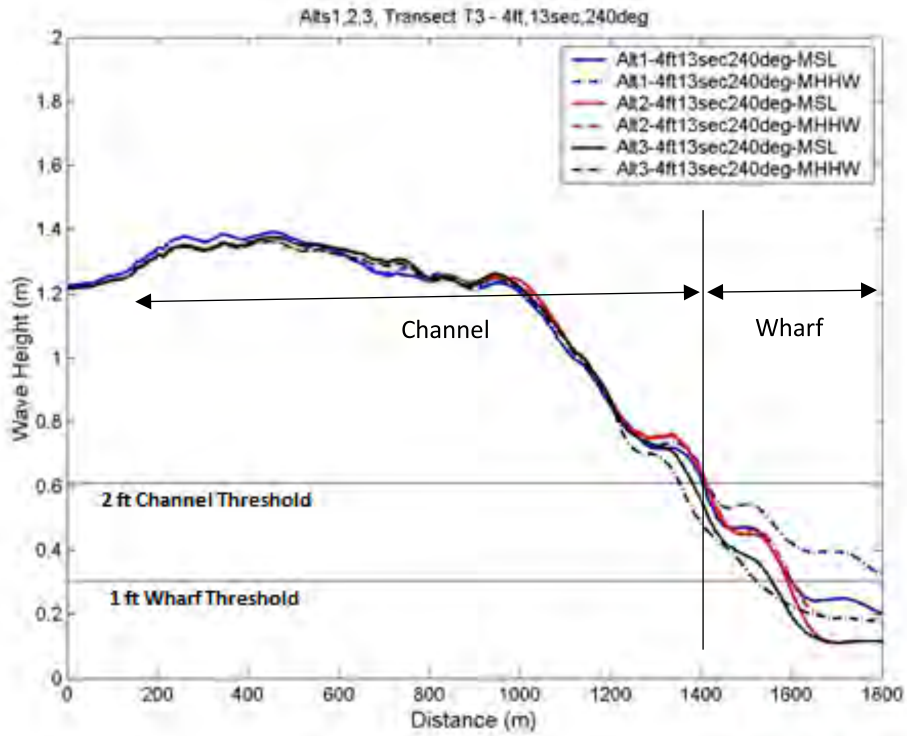


Figure A27. 4-foot Incident Wave height along transect T3 for 240 deg wave direction

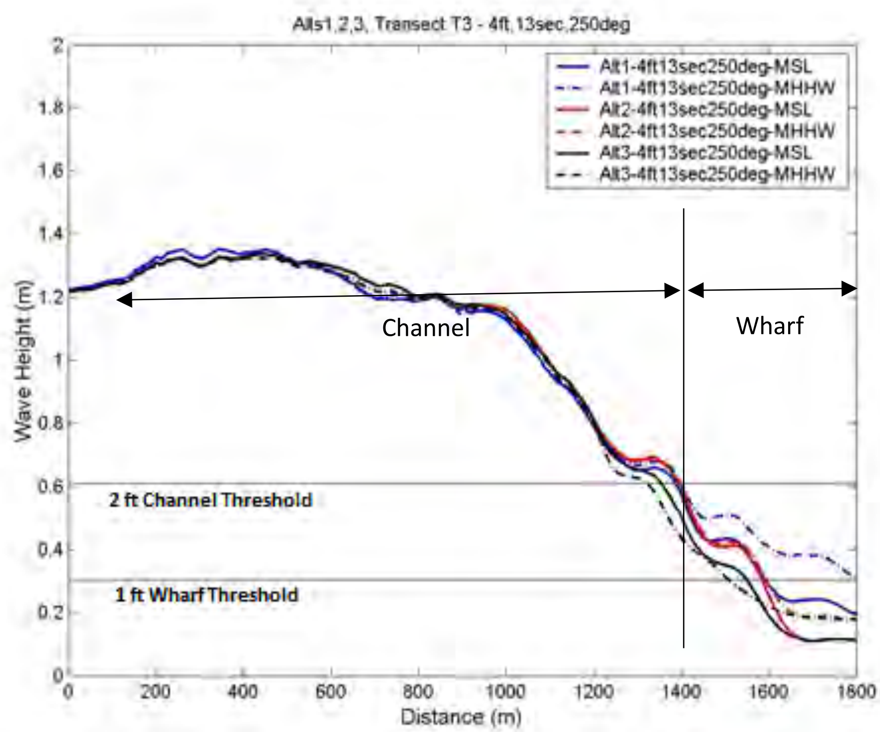


Figure A28.4-foot Incident Wave height along transect T3 for 250 deg wave direction

Evaluation of the results shown in these figures indicates several items of note. First, there is minimal difference in wave height along the T3 transect (at both the entrance and wharf areas) for the varying wave directions. This is true for both water levels (MSL and MHHW), and all three alternatives modeled (Alts 1/2/3). Indicating again that in general, wave heights in the entrance channel and along the wharf are not highly sensitive to changes in incident wave direction.

The comparison figures also show that, though the replacement breakwater, (Alt 2), and to a greater degree the breakwater extension (Alt 3), reduce wave height along some or all of the wharf, neither alternative achieves the complete "usability" condition of wave height below 1 ft (0.3m) along the entire wharf for this incident wave condition. The eastern end of the wharf (approximately 1400 m to 1550 m along the x-axis in the figures) is exposed to wave energy propagating through the entrance channel and diffracting around the head of the breakwater alternative in each scenario. The breakwater extension (Alt 3, black lines) reduces this energy by the greatest amount, but does not bring it below the 1 foot threshold for this case. For the 2-foot (0.61 m) incident wave case that was modeled (not shown), Alt 3 does improve the wave heights such that the entire wharf is below the 1-foot (0.3 m) threshold. These results are reflected in the overall accessibility/usability analysis.

Finally, and perhaps most noticeably, these figures show that the replacement (Alt 2) or replacement and extension (Alt 3) of the breakwater do not dramatically reduce wave height magnitude at the wharf in comparison to the future without project condition (Alt 1). Wave height reduction for similar input parameters varies between 0 to 50% along the wharf, with a maximum reduction of approximately 0.66 ft (0.2 m) between Alt 1 and Alt 3.

5.3.3 Current Velocity at Entrance Channel and Small Boat Navigation Route

Circulation modeling of the existing harbor using CMS-Flow (coupled with CMS-Wave) was conducted under the same incident wave conditions and water levels that were used for CMS-Wave, and were presented in Table A5. As previously noted, CMS-Flow used wave parameters (wave height, wave period, wave direction, wave dissipation, radiation stress gradient) from CMS-Wave (and a static tide level in this case because tide range is small) in order to calculate water levels and wave-induced current velocities within and adjacent to the harbor. Current velocity magnitudes were extracted from the model at the same transects shown previously in Figure A22, including a transect between the breakwater and finger piers (Transect T5), in order to evaluate the effect of currents on the areas of interest (entrance channel and small boat navigation route). Currents near the wharf were not identified as a problem in the existing or probable future without condition, and were not specifically evaluated.

Figures A29 and A30 show current magnitudes for incident waves of 4 ft (1.22 m), along transect T1 and T5 respectively, for all three alternatives. As with previous plots of wave height, the orientation Figure A29 (transect T1) is offshore at the origin, and progressing toward land and into the turning basin along the x-axis. This plot indicates that water level has a somewhat greater influence on current velocity than it does on wave height in this location. The dashed line in this figure indicates the velocity magnitudes during the higher MHHW level, while the solid line relate to MSL. For the 2- and 3-ft wave conditions (not shown), currents are lower in the entrance channel at MHHW; however, in higher incident wave conditions (4 to 6 ft) such as that shown here, velocities during MHHW begin to overtake and exceed velocities under MSL. This suggests that additional wave setup generated by larger waves breaking on the adjacent reef (enabled by the higher tide level) is causing greater volumes of water to flow off the reefs and through the channel entrance, thereby increasing current velocity.

The figure also shows that, with incident waves of 4 feet, current velocities in the entrance channel and turning basin under the no-action harbor configuration do not exceed the UFC suggested threshold of concern for berthing areas (3.2 ft/sec or 1 m/sec) or the maximum velocity recommended (6.5 ft/sec or 2 m/sec). This threshold was not exceeded for the 6-foot (1.83 m) incident wave height either. The highest currents along this transect are located within the turning basin, with maximum velocities between 0.5 to 0.6 m/sec (1.6 to 2.0 ft/sec) in this case. Currents increase and decrease proportionally with incident wave height. The current is highest in this location due to the flow of water through the harbor from northwest to southeast, which affects the turning basin before moving offshore through the entrance channel. This is clear upon examination of Alt 2 (replace breakwater, red lines) and Alt 3 (replace/extend breakwater, black lines) in Figure A29, where velocities in the turning basin are reduced to a negligible amount with the repaired northwest breakwater in place. Both Alt 2 and Alt 3 significantly reduce currents in the entrance channel as well, with maximum velocities under various water level scenarios ranging from 0.1 to 0.3 m/sec (0.5 to 1.0 ft/sec) for this incident wave case, well within the UFC suggested threshold.

Current velocities in the small boat navigation route were evaluated using transect T5 (Figure A30). These results show that the maximum current along this transect for the no-action/FWOP condition (under 4-foot incident wave conditions) is approximately 4.6 ft/sec (1.4 m/sec). Again, this is a representative case - currents at this location increase and decrease proportionally with incident wave height. This is an opposing or following current for small boats traveling to or from the small boat basin, and approaches (but does not exceed) the UFC maximum recommended velocity of 6.5 ft/sec or 2 m/sec. As expected, the replacement of the breakwater in both Alt 2 and Alt 3 which eliminates flows through the harbor, reduces the currents in this area to virtually zero. The replacement of the breakwater, whether along the current alignment, or extended, would improve safety conditions for small boats navigating to and from the harbor entrance. The selected plan should be further evaluated using B2D for its effects on current velocities during the detailed design phase.

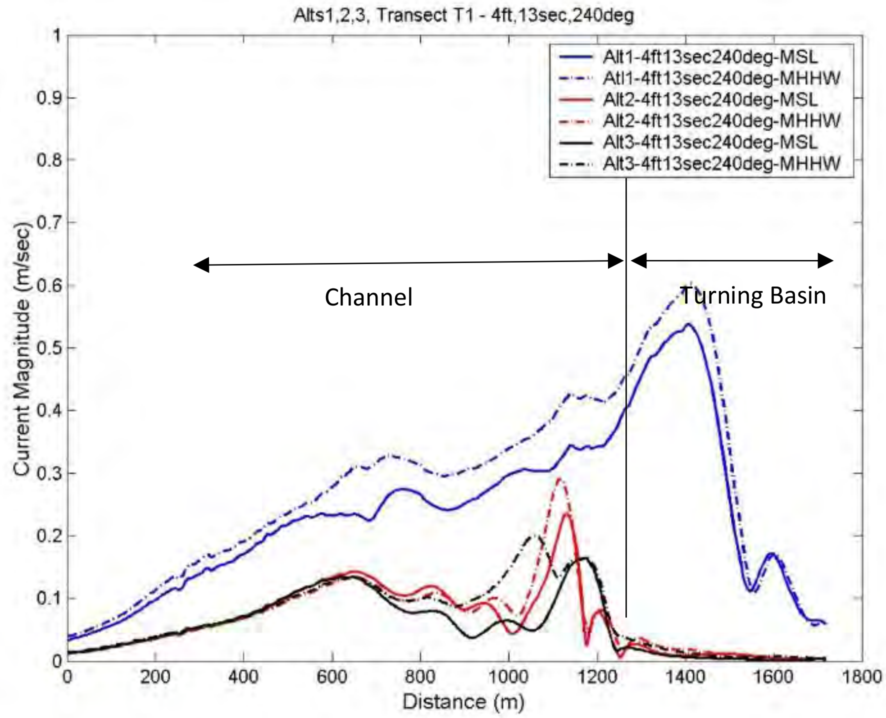


Figure A29. Current Velocity for Alternatives (4-foot Incident wave) along transect T1

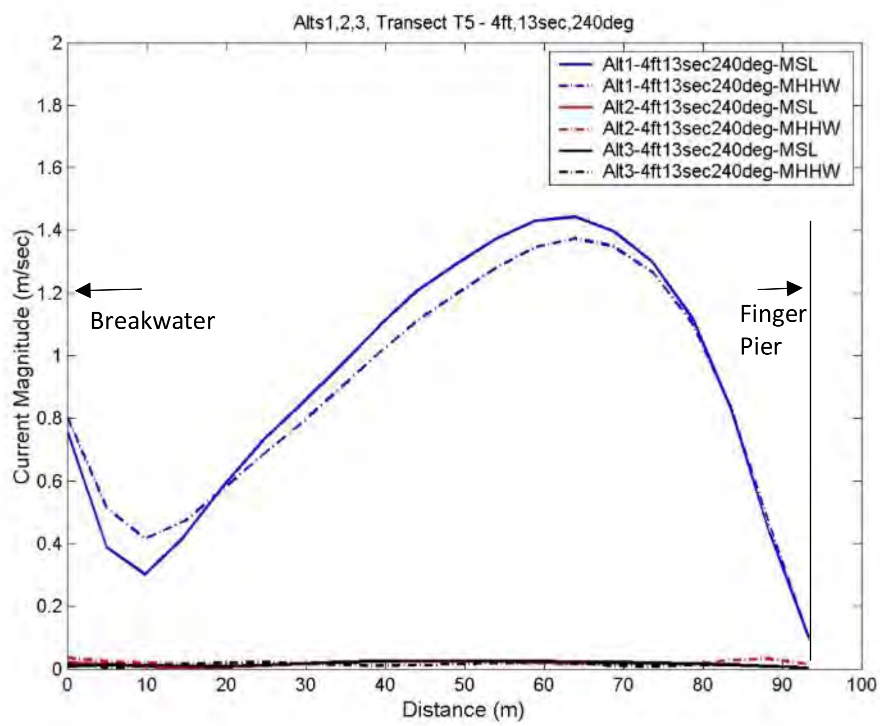


Figure A30. Current Velocity for Alternatives (4-foot Incident wave) along transect T5

5.3.4 Summary of Harbor Accessibility/Usability Analysis Based on Wave Height

As noted previously, harbor usability was evaluated for various alternatives and compared to future without project conditions based only on wave height and duration thresholds under operational conditions. The calculation, based on the requirement that this usability wave threshold may not be exceeded for a duration of greater than one hour, was completed based on all 32 years (1980-2011) of WIS hindcast wave data, and averaged to determine an annual number of “unusable” days for each alternative. Analysis with the duration threshold raised to two consecutive hours yielded little difference in annual days/year. This is due to the typical persistence of wave events over days or weeks. In all cases, only the wave height threshold of 1 feet (0.3 m) or less at the wharf was used as the requirement, since the repair of the breakwater has little effect on conditions in the entrance channel. Since there is not a reasonable way to protect the entrance with a coastal structure due to the depth and length of the existing channel, the requirement for the criteria only at the wharf to be satisfied is appropriate.

Table A6 presents the average annual percentage of time and average annual number of days that the harbor is considered unusable under operational conditions for the no-action/FWOP condition, Alternative 2 (replace breakwater), and Alternative 3 (replace/extend breakwater). The table shows that in the predicted future condition, there are an average 49 days per year (7 weeks or 1.75 months) that the wharf may be unusable. Alternative 2 reduces this to 45 days/year, an improvement of 4 days. Alternative 3 reduces the unusable days to 37 days/year, an improvement of 12 more useable days in comparison with the future without project condition. Alternative 3 also achieves the CEM design guidance stating that the mooring and access channel wave thresholds should not be exceeded more than 10 percent of the time.

Table A6. Summary of Harbor Usability Percentage and Days/Year (Operational Conditions)

Averages	Alt 1	Alt 2	Alt 3
Based on 1980-2011 WIS Data	(No-Action/FWOP)	(Replace BW)	(Replace/Extend BW)
Percent Unusable	13.4%	12.2%	10.0%
(Percent Usable)	86.6%	87.8%	90.0%
Unusable Days Per Year	49 days/yr	45 days/yr	37 days/yr

The reason for the relatively small differences in number of useable days between the future without project condition and each alternative is that the existing reef and sediment surrounding the deteriorating sheetpile structure (which would be expected to remain even with continued breakwater deterioration in the future) provide a significant amount of wave sheltering to the harbor under operational wave conditions. This analysis does not account for days exceeding these conditions, when vessels would not be transiting to Tinian. Waves conditions exceeding 6 feet that would be expected during a large swell event or tropical storm would be accompanied by increased water levels due to storm surge and wave setup. This increase in water level reduces the protection provided by the shallow reef dramatically. If no breakwater (or a severely compromised breakwater) were in place during an extreme wave event, waves and currents in the harbor would be significantly larger and more damaging to harbor infrastructure and any vessels within the harbor at that time.

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Appendix 4

Coral Mitigation Plan & HEA Analysis

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Tinian Harbor, CNMI
Harbor Modification Study
Feasibility Report
Appendix 4
Mitigation Plan for Coral Resources Associated with Tinian Harbor Navigation Improvements

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LIST OF ACRONYMS AND ABBREVIATIONS

%	percent
BMPs	best management practices
BP	British Petroleum
CM	centimeter
CWA	Clean Water Act
CMNI	Commonwealth of the Northern Marianas Islands
DEQ	Department of Environmental Quality
EIS	Environmental Impact Statement
EO	Executive Order
EPA	Environmental Protection Agency
FAD	fish attracting device
FDEP	Florida Department Environmental Protection
HEA	Habitat Equivalency Analysis
MLLW	Mean Lower Low Water
MOA	Memorandum of Agreement
N/A	not applicable
NCRI	National Coral Reef Institute
NOAA	National Oceanic and Atmospheric Administration
NRDA	Natural Resource Damage Assessment
O&M	Operations and Maintenance
OMB	Office of Management and Budget
RGL	Regulatory Guidance Letter
SCUBA	Self-contained underwater breathing apparatus
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Services
WWII	World War II

1 INTRODUCTION

The Honolulu District, U.S. Corps of Engineers (Corps) is presently completing an integrated Feasibility/EIS report to evaluate the construction of navigational improvements for Tinian Harbor, CNMI (Figure 1-1). The proposed project would impact offshore marine biological resources, including reef communities both adjacent to and within the port. The Corps conducted mitigation requirement analysis utilizing the “Visual HEA (Habitat Equivalency Analysis)” software package developed by the National Coral Reef Institute (NCRI) (Kohler and Dodge 2006).

In March 2015, the Corps recently prepared a mitigation plan for the Port Everglades Harbor Navigation Study (USACE 2015). That document contained a stand-alone mitigation plan appendix which included a detailed mitigation requirements analysis. This document for the Tinian Harbor Improvements contained herein is mirrored off the Port Everglades document due to the extensive planning and justification performed prior to and during the HEA analysis.

Figure 1- 1 Map of Tinian, CNMI. Arrow points to location of navigation improvement project area in Tinian (San Jose) Harbor.

1.1 Coral Reef Protection and Mitigation

Coral reef ecosystems are unique and among the most complex and biodiverse ecosystems on earth. Coral reefs support more species per unit area than any other marine environment, including about 4,000 species of fish, 800 species of hard corals and hundreds of other species. The United States contains an estimated 17,000 square kilometers (km^2) of coral reef habitat in Hawaii, Guam, American Samoa, Commonwealth of the Northern Mariana Islands (CNMI), Florida, Texas, U.S. Virgin Islands (USVI), and Puerto Rico. The U.S. Compact States of the Republic of Palau (ROP), Federated States of Micronesia (FSM), and Republic of the Marshall Islands (RMI) contain as many as 81,500 km^2 of coral reef habitat (Holthus et al. 1993). Coral reef resources are important to humans because they provide a number of directly beneficial ecosystem functions and services, including but not limited to the following:

- Coastal shore protection: Coral reefs can dissipate wave energy reducing damage to adjacent land. More than 150,000 km of shoreline in 100 countries and territories receive some protection from reefs.
- Diverse opportunities for jobs and recreation: The annual value of the ecosystem services provided by coral reefs is estimated to be over $375 billion.
- Sources of food and raw materials: Corals provide three dimensional structure and substrate to house and feed marine organisms i.e. fish that humans eat. Estimates say over 1 billion people depend on food from coral reefs. Due to the sheer biodiversity of coral reefs, coral reef plants and animals are important sources of medicinal compounds being developed to treat cancer, arthritis, bacterial infections, heart disease, and viruses.
- Societal importance and cultural significance: Sites of important cultural heritage and traditions.

Coral reef impacts are anticipated under currently proposed actions for the Tinian Harbors Modification project. The US Fish and Wildlife Service (USFWS) specifically identified biological resources in the project areas during a Phase 1 Marine Habitat Characterization study performed in 2016 (USFWS 2017a). Coral resources of concern include, but are not limited to, the ESA listed coral (*Acropora globiceps*), other stony corals, soft corals, and coralline algae.

In response to the concern of these potential coral reef impacts, individuals from Corps (USACE), USFWS, and National Oceanic and Atmospheric Administration (NOAA), as well as the U.S. Coral Reef Task Force website were consulted in this process. There are currently no USACE, or other agency approved models for quantifying coral compensatory mitigation values. The USACE has evaluated potential mitigation models and has selected the HEA model mentioned above to quantify the resource service lost within the natural resources damage assessment (NRDA) legal and economic framework as applicable to coral reefs.

The Corps conducted a Habitat Equivalency Analysis (HEA) using a 0% discount rate, in compliance with OMB Circulars and Corps regulations and guidance (discussed in detail below). Inputs into the Corps' HEA are based on actual site conditions and peer reviewed literature.

1.2 Mitigation Goals and Objectives

As stated in The United States Army Corps of Engineers (USACE) Regulatory Guidance Letter (RGL)-02-2: "applicants will be encouraged to provide compensatory mitigation projects that include a mix of habitats such as open water, wetlands, and adjacent uplands. When viewed from a watershed perspective, such projects often provide a greater variety of functions." The most important aspect of the compensatory mitigation process for losses to coral reef habitats is to achieve on-the-ground replacement of lost coral reef functions (Shutler et al. 2006).

In accordance with Section 404(b)1 of the Clean Water Act (CWA), the United States Fish and Wildlife Service (USFWS) 2(b) report, and Executive Order (EO) 13089, the proposed action will avoid and minimize impacts to coral reefs and waters of the United States (U.S.) to the maximum extent practicable. Where impacts are unavoidable, compensatory mitigation will be provided to compensate for the functions and values lost.

The policies and procedures to be followed for this project are in accordance with the "Memorandum of Agreement (MOA) between the U.S. Environmental Protection Agency (EPA) and the Department of the Army Concerning the Determination of Mitigation under the CWA Section 404(b)(1) Guidelines" dated February 7, 1990. Compensatory mitigation designed for the site follows the guidelines of the MOA, which sets forth a minimum requirement for one-to-one (1:1) functional replacement with an adequate margin of safety to reflect any uncertainty or risk of the selected mitigation measures. Mitigation measures are to be tailored to each unique site, as developed using assessments and methodologies by qualified professionals.

1.3 Impact Site

Tinian Harbor (a.k.a. San Jose Harbor) is located on the southeast coast of Tinian, in the village of San Jose. There is currently no Federal navigation project at the harbor. The existing harbor was constructed in 1944-1945 during World War II (WWII). The entrance channel is about one-half mile long, approximately 525 feet wide and has been dredged to a depth of about 30 feet. The wharves and harbor turning basin were dredged to depths of 28 to 30 feet.

The existing breakwater is 4,805 feet long with a crest elevation of approximately 14 feet above mean sea level. The 1,210 foot long inner breakwater extends from the shore to the outer breakwater and is constructed of single row sheet piling. Much of the sheet pile on the inner breakwater has deteriorated and collapsed. The 3,595 foot long outer breakwater is constructed of interlocking, half-inch thick steel sheet piling in circular cell configuration. The interior of the cells are filled with quarried limestone. A 10-inch thick, unreinforced concrete slab is constructed flush with the top of the sheet-piles. The steel sheet pile breakwater is almost completely deteriorated. Figure 1-2 shows a historical breakwater location and the footprint of the navigation study.

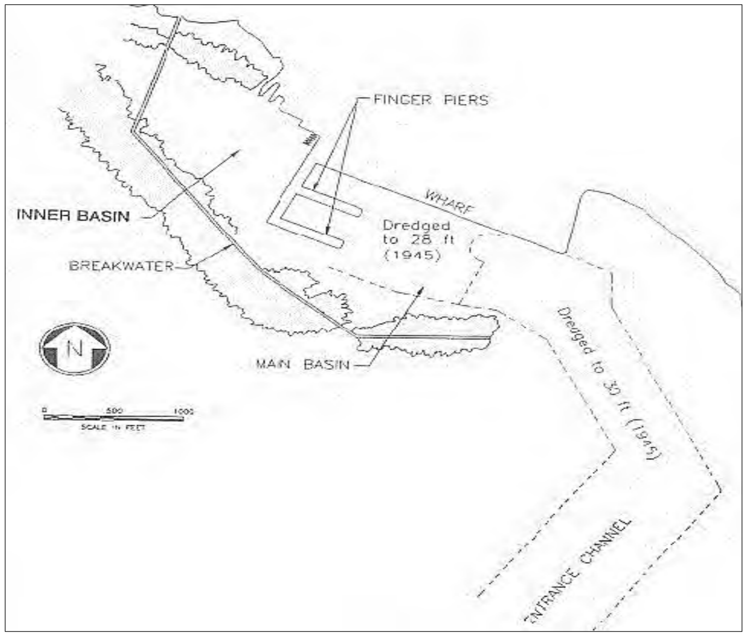

Figure 1- 2 Navigation Project - Tinian Harbor

Tinian Harbor is the only commercial navigation harbor on the island of Tinian, CNMI. The existing breakwater, designed to lessen wave impacts to the harbor and shore-side facilities, is in a state of disrepair as described above. If the deterioration of the breakwater is allowed to continue, safe navigation, cargo transportation and port operations will be put at significant risk. Additionally, the current harbor depth and dimensions may not be sufficient to safely accommodate current and future vessel fleets.

Importantly, the harbor is vital for the economy and quality of life for this geographically isolated community. The economy is dependent on imported goods. Tinian Harbor is the sole commercial harbor servicing the island of Tinian. The proposed improvements will negate adverse wave conditions within the harbor, preventing damages to pier infrastructure and vessels. Failure would result in the eventual complete closure of the harbor, requiring costly air transport as the only remaining option to deliver essential commodities to the island.

The primary concerns associated with the proposed project at Tinian Harbor include potential direct and secondary impacts to the marine habitat within and adjacent to the proposed sites. The specific planning objective is to provide technical assistance to the USACE for the development of alternative project plans and/or best management practices to minimize the impact to coral wildlife resources. Threatened and endangered species are known to occur within or adjacent to USACE's proposed project footprint. These include Endangered Species Act (ESA) listed coral (*Acropora globiceps*) and Sea Turtles (*Chelonia mydas* and *Eretmochelys imbricata*).

1.4 Baseline Resource Information Used for Impact and Proposed Mitigation Sites

A detailed site investigation and resource survey was performed by USFWS. These data, collected in the project area, are used as a guide to assist in determining project impacts (USFWS 2017a).

1.4.1 Habitat Zones and Structures

Six habitat zones were observed within the proposed project site target area. They include:

- Channel – Natural channels or reef passes that often cut across several other zones (does not include artificial channels for harbors).
- Harbor – Area that is used for vessel mooring and is generally considered to be inside the outer points of the rock jetty at the mouth of the harbor entrance.
- Back Reef – Area between the seaward edge of a lagoon floor and the landward edge of a reef crest. This zone is present when a reef crest and lagoon exist.
- Reef Flat – Shallow, semi-exposed area between the shoreline intertidal zone and the reef crest of a fringing reef. This zone is protected from the high-energy waves commonly experienced on the shelf and reef crest.
- Lagoon – Shallow area (relative to the deeper water of the bank/shelf) between the shoreline intertidal zone and the back reef of a barrier island. This zone is relatively protected from the high-energy waves commonly experienced on the bank/shelf and reef crest. If no reef crest is present there is no lagoon zone.
- Back Reef – Area between the seaward edge of a lagoon floor and the landward edge of a reef crest. This zone is present when a reef crest and lagoon exist.

Five habitat structures were observed within the proposed project site target area. They include:

- Scattered Coral/Rock in Unconsolidated Sediment – Primarily unconsolidated sediment bottom with scattered rocks/boulders or small, isolated coral heads that are too small to be delineated individually (i.e. smaller than individual patch reef). (Major Structure: Mixed)
- Pavement – Flat, low-relief, and solid (carbonate or basalt substratum) bottom with coverage of macroalgae, coral, and other benthic invertebrates that are dense enough to begin to obscure the underlying surface. (Major Structure: Hard Bottom)
- Pavement with Sand Channels – Habitats of pavement with alternating sand/rubble channel formations. The sand/rubble channels of this feature have low vertical relief relative to spur and groove formations (less than 1 m). (Major Structure: Mixed)

- Spur and Groove – High vertical relief relative to pavement, and having alternating sand/rubble (groves) and reef (spurs) formations (greater than 1 m of vertical relief). (Major Structure: Mixed)
- Unconsolidated Sediment – Area comprising sand, mud, rubble, or cobble without isolated scattered coral/ rocks or large corals. See definitions of sediment terms below for sand, mud, rubble, and cobble. (Major Structure: Unconsolidated Sediment)

Based on the USFWS mitigation policy and the habitat characteristics within Target Area, Aggregate Reef, Pavement, and Spur and Groove were considered to be the highest value habitat structures, followed by Scattered Coral/Rock in Unconsolidated Sediment. Unconsolidated Sediment habitat is the lowest value, but still provides certain important biological functions and services to consider for resource impacts. Coral cover was generally low throughout the project area (USFWS 2017a).

1.4.2 Characterization of Coral Resources in Proposed Impact Area

In addition to the intrinsic depressed nature of the benthic resources both within and outside of the proposed project area due to long-term alteration of the harbor (construction of breakwater and dredging of channel), these coral communities are also subject to on-going natural and human disturbances. These disturbances include the negative effects of acute heavy wave action during hurricanes and storms; sediment resuspension; and low abundance, coral predation by Crown-of-Thorn (COTS) starfish, and diversity of herbivores (echinoids). These disturbances, both separately and in combination, are responsible for the way these communities appear and function today. Over the past 15 years in CNMI, a period of high COTS densities led to significant coral declines. Yet, the failure of some reefs to recovery is attributed to localized stressors, which transformed the substrates opened up by coral loss into persistent stands of turf and macroalgae, less conducive for coral replenishment and recovery (Houk et al. 2014). As a whole, CNMI's marine waters meet the high water quality standards designated by the CNMI Division of Environmental Quality (DEQ). The majority of CNMI's marine waters are designated "Class AA" which reflects the highest water quality. However, five areas in the CNMI have been designated "Class A" to allow for industrial activities and this includes San Jose Harbor, Tinian (Houk 2004).

The above discussion of the diminished present condition of the benthic community, compared to its pre-World War II condition, however, is not meant to diminish its present or future value in terms of socio-economic services and resource use. It is intended to be used as a guide for developing an accurate functional baseline for determining the scale and scope of ecosystem service losses expected as a result of implementation of the proposed Tinian Harbor Navigation Improvements, and determining sufficient compensation to the public for any resulting damage to the affected natural marine resources.

2 THE ROLE OF HABITAT EQUIVALENCY ANALYSES

Compensatory mitigation is intended to replace the ecological services that are lost as a result of unavoidable impacts to resources affected by a given project. "Ecological services" refer to the services performed by a resource for the benefit of other resources or the public. The baseline for quantifying lost ecological services is the full complement of services that would have been provided absent project implementation. Lost ecological services are quantified as the reduction in the provision of services below this baseline. Compensatory mitigation must restore services commensurate with the character of lost services. The *amount* of compensatory mitigation needed to replace lost services depends, in part, on the ability of the affected resources to return to their baseline conditions. Factors relevant in that regard include the quantity of the affected resources and how fast and how completely they return to their baseline conditions. The amount of compensatory mitigation also depends on the ability of the selected compensatory mitigation measures to replace lost services. Relevant factors for replacement include how fast the compensatory mitigation measures become fully functional and the relative degree to which they provide additional ecological services. An HEA takes into account the above factors, and can be used to determine the appropriate quantity of compensatory mitigation (King et al. 1991, King 1997).

Habitat equivalency analysis is specifically designed to determine the compensation the public is due to reconcile injuries to the ecosystem and the lost services the ecosystem provides to the biotic component. King (1997) noted "when injured resources and/or services are primarily of indirect human use the appropriate basis for evaluating and scaling the restoration is HEA." The HEA method is specifically used in cases of habitat injury when the service of the injured area is ecologically equivalent to the service that will be provided by the replacement habitat. This approach is termed "service-to-service" (Strange 2002) and assumes the public is willing to accept a one-to-one trade-off between the service lost and the service gained by the restoration (NOAA 1997). Of course, HEAs are, by necessity, simplified representations of very complex ecosystems.

Multiple types of injuries can be quantified in an equivalent manner through the use of HEA (Dunford *et al*. 2004). For marine environments, the HEA method has been successfully applied to vessel groundings on coral reefs (Milon and Dodge 2001, Precht and Robbart 2006, Piniak et al. 2006, Shutler et al. 2006) and seagrass damage cases (Fonseca *et al*. 1998; Fonseca *et al*. 2000). When this approach is used for scaling losses of fish, birds, and other wildlife, the method is sometimes termed resource equivalency analysis (REA). REA is a resource-to-resource method that references the number of organisms lost and gained. NOAA has recently used the REA method to scale injuries to coral resources related to vessel groundings within the Florida Keys National Marine Sanctuary (FKNMS) by evaluating the losses to stony corals and not the entire habitat affected (see also Viehman et al. 2009). Additionally, REA lacks the extensive background and legal review that HEA has undergone. A similar approach was employed by the National Coral Reef Institute (NCRI 2003) for a cable injury to hardbottom resources in the vicinity of Hillsboro Inlet in Broward County, Florida.

HEA has also been used in other policy contexts involving the loss of ecological services. For example, it is widely used in natural resource damage assessments conducted under the Oil Pollution Act of 1990 (33 U.S.C. 2701 *et seq.*) and the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (42 U.S.C. 9601 *et seq.*) and was used extensively by the U.S. Government in their NRDA claim against British Petroleum (BP) in the Deepwater Horizon Oil Spill in the Gulf of Mexico.

3 HEA THEORY AND METHODOLOGY

King and Adler (1991) first described HEA as a methodology for scaling compensatory mitigation under Section 404 of the Clean Water Act. A more recent description of the methodology can be found in Allen et al. (2005). Briefly, HEA calculates compensatory mitigation so that the total quantity of ecological services it provides is sufficient to offset the total quantity of lost ecological services resulting from the project impacts. When quantifying ecological services, it is important to note that they have a temporal dimension as well as a geographic (spatial) dimension (e.g., a given area of coral habitat provides beneficial services over a period of time). Therefore, ecological services are quantified in HEA as units of measure, such as acre-years. An acre-year refers to all the ecological services provided by one acre of habitat for one year. For example, 100 acre-years of services might be provided by a 5-acre habitat over a period of 20 years, or by a 10-acre habitat over a 10-year period. This characterization captures not only the important aspect of the physical size of a resource, but also the time interval during which functions are provided.

This measure (“acre-years”) of ecological services is obviously habitat-specific, as different habitats provide different services. Therefore, it is important to select compensatory mitigation measures that provide replacement services that are comparable to the lost services (i.e., in-kind replacement). If that is not possible, some meaningful adjustment must be made to equate the replacement services to lost services.

Another important consideration in the quantification of services is time preference. In general, many people prefer present resource uses over future uses for a variety of reasons (such as uncertainty and impatience). This time preference is important when considering how to balance lost and replacement services that occur at different times, since their tradeoffs vary through time. Therefore, the quantities of ecological services occurring at different times are not valued on an equivalent basis and must be adjusted before they can be compared in a meaningful way. This adjustment process, known as discounting, permits one to examine quantities occurring at different times on a comparable basis. The adjustment involves decreasing future quantities and increasing past quantities each year by a proportional amount, known as the discount rate. Discounting, in this context, is analogous to a bank’s calculation of compound interest for a deposit or loan. The common time period to which all lost and replacement ecological services are discounted for sake of comparison is known as the present time period.

Through this process of quantifying and discounting ecological services, HEA takes into account losses and gains that occur over different timeframes to determine a scale of compensatory mitigation that is commensurate with the type, level, and duration of lost services. Because HEA accounts for all these important aspects, different compensatory mitigation projects will generally have different scales. For example, a compensatory mitigation project that becomes fully functional in five years will have a smaller indicated scale than one that requires ten years to become fully functional. Therefore, it is important that the compensatory mitigation projects selected for analysis be chosen carefully. HEA is not used to select compensatory mitigation projects, only to determine their scale.

The public is considered fully compensated for ecological losses when the scale of restoration needed to offset losses of resources and services is achieved. HEA establishes the discounted service acre-year as the "common currency" for comparison of the public's value of past injury and future restoration in a common time frame (Julius 1999). One service acre-year is defined as the ecological service provided by one acre in one year. Economic discounting is used to express past injury and future restoration units in a common time (Julius 1999). So, one discounted service acre-year (DSAY) is the service provided by one acre in one year "discounted" to net present value. Area of injured habitat, percent loss of ecological services, duration of injury, are considered in HEA to determine DSAYs.

Cumulative DSAYs earned for a particular restoration project are dependent upon the type of habitat that is restored, the increases in habitat services offered as a result of restoration construction, and the amount of time over which services are provided by the restored habitat. The DSAYs earned over the duration of the restoration project are then translated to present time using a 0% discount rate (see discussion of selection of discount rate below) per the CORPS and Office of Management and Budget regulations and guidance for Federal water resource development projects. Because the Corps is required to apply a 0% discount rate to HEA, the outputs from Visual HEA for this analysis are referred to as SAYs instead of DSAYs since they are not discounted.

Two different methods of calculating HEA exist, Landscape and Population HEA (Milon and Dodge, 2001). Landscape HEA is most appropriate when the impacted habitat is relatively uniform landscapes (habitats) with little difference in biological functions across the injured area, this is the method historically employed by NOAA. Examples include injuries to coral reef (Juliuis, et al, 1995), and seagrass (Zieman, 1997). Population HEA may be considered where the total injury area is characterized by a variety of organism groups with different life histories (i.e lifespan). The Population HEA is calculated using the proportional cover of the different groups that make up the community. This results in a recovery time for the population of the group(s) chosen for HEA analysis.

4 TECHNICAL APPROACH FOR TINIAN HARBOR HEA

4.1 HEA Model Certification

Coral reef impacts were anticipated under currently proposed actions for both the Rota and Tinian Harbor Improvement Projects. The US Fish and Wildlife Service (USFWS) identified biological resources in the project areas during a Phase 1 Marine Habitat Characterization study performed in 2016 at both Rota Harbor and Tinian Harbor (USFWS 2017a, 2017b).

There are currently no USACE, or other agency approved models for quantifying coral compensatory mitigation values. The USACE has evaluated potential mitigation models and selected the Habitat Equivalency Analysis (HEA) model to quantify the resource service lost within the natural resources damage assessment (NRDA) legal and economic framework as applicable to coral reefs.

A document justifying the selection of the HEA model to quantify coral compensatory mitigation values for the Rota and Tinian Harbors Repair Projects was submitted to the USACE, National Ecosystem Restoration planning Center of Expertise (ECO-PCX) in February 2017. This information was reviewed and a recommendation memo for the Visual Habitat Equivalency Analysis (HEA) Model was produced. The ECO-PCX found the HEA model has sufficient technical and system quality, meets usability criteria, and complies with USACE policy. The memo recommends approval of the HEA model for single use in the harbor improvement studies at Rota and Tinian Islands in the Commonwealth of the Northern Mariana Islands, and a non-related project in San Juan, Puerto Rico. On 13 June 2017, the HQ Model Certification Panel approved the HEA for use in the Rota, and Tinian Harbors Improvements Studies. The official Head Quarters approval memo is forthcoming.

4.2 Type of HEA Used for Analyses

For the purpose of the Tinian Harbor HEA, the method employed for use by the Corps uses a Landscape HEA with stony corals as the representative proxy for the entire habitat affected. While stony coral coverage is relatively low in the project footprint and vicinity (TINIAN REFS), we did not use a proportional analysis to calculate the coral impacts. Instead, the losses are calculated as the amount of time it would take for the slowest-growing members of the ecosystem, in this case the stony corals, to recover back to the pre-project functional baseline, for the entire project footprint. Therefore, it is assumed that all other functional attributes of the system (soft corals, sponges, calcareous algae, mobile fauna, etc.) will recover to baseline in less time. This landscape HEA is an extremely conservative estimate of the recovery for the entire ecosystem and therefore, is the most appropriate method for scaling the required compensatory mitigation for impacts such as the proposed Tinian Harbor Improvements.

4.3 Impact Assessment

4.3.1 Direct and Incidental Impacts

The proposed project areas will be directly impacted by the construction of the breakwater alternatives. There are three potential direct/incidental impact alternatives. Mitigation for all of the alternatives have been determined and will be included in the project cost analysis.

4.3.2 Project Alternatives

The following three alternatives for consideration in addressing navigational concerns at Tinian Harbor:

Alternative 1: No Action Alternative

Under the No Action alternative, the proposed modification project at Tinian Harbor would not be implemented and the continued deterioration of the breakwater would lead to the existing sheet pile being damaged such that the only remaining portion of the structure is below water. This alternative would result in continued (and increasing) adverse wave and current conditions in the small boat navigation route, turning basin, and along the wharf during moderate wave events, and potentially eventual closure of the port. This would be costly to the island economy and community, as most of the commodities come through the seaport, and would instead need to be transported by aircraft. It would also limit future developments (i.e. casinos, hotels, construction) and travel by sea.

Alternative 2: Replace Existing Breakwater along Current Alignment

This measure involves removal of the approximately 4600 ft existing cellular sheet pile breakwater, including debris, sand/silt/coral rubble, vegetation, and steel sheet piles down to the approximate 3 foot elevation contour relative to Mean Lower Low Water (MLLW) elevation. Some of this in place material (eg – coral rubble) may either remain or be reused for the core of the new breakwater structure; however, the majority will need to be disposed of at a landfill (either on Tinian or shipped to Saipan). The new breakwater will be rebuilt along the existing structure alignment, but with varying cross-sectional area composed of either stone, or stone and concrete armor units. The "Northwest Breakwater", the section of the structure tying into land and extending approximately 1100 feet will require a smaller cross-section (due to less wave exposure) and can be built with a stone armor layer and underlayer. The oceanside and harborside toe of the structure will be placed into a trench excavated into hard foundation material. The section will be approximately 60 feet wide and 14 feet in total height, with an elevation 8 feet above MLLW datum. The remaining 3500 feet of breakwater will consist of a more robust cross-section, due to head on exposure to larger waves (including those from typhoon events). This portion of the breakwater ("Main

Breakwater") would follow the alignment of the existing breakwater, and would utilize the remnants of the existing breakwater as a portion of the core. Remnants extending above 3 feet MLLW elevation would be removed so as to not protrude into the new breakwater stone layers. A new core would be constructed around the remnants, using dredged material, quarry run stone, or other suitable material. Successive layers would be placed over the core material, consisting of a geotextile filter fabric, a 1.5-foot thick bedding layer of 10 to 50 pound stone, a two-stone thick underlayer of 250 to 500 pound stone, and a 2.5-ton tribar (or 1.8 ton Core-Loc) armor layer. A cast-in-place concrete crest cap would be used to stabilize the crest. A rubble mound structure constructed of armor stone was considered; however, preliminary calculations indicated that this would require stone sizes of approximately 14 to 20 tons to remain stable under extreme wave conditions. This size stone is not available within the CNMI or Guam. The oceanside and harborside toe of the structure will be placed into a trench excavated into hard foundation material and further stabilized with tremie concrete. The section will be approximately 65 feet wide and 15 feet in total height, with an elevation 12 feet above MLLW datum. Figure 4-1 shows the alignment of the existing structure, as well as the conceptual footprint (not to scale) of the replaced structure, including the Northwest Breakwater and Main Breakwater section.

Figure 4-1 Conceptual Layout of Alternative 2- Replace Existing Breakwater along Current Alignment

Alternative 3: Replace and Extend Existing Breakwater along Current Alignment

This measure involves all of the same demolition and breakwater replacement methods described in Alternative 2, with the addition of an approximately 300 ft extension to the breakwater, increasing the total length to approximately 4900 feet. The length of the extension will be optimized based on costs and reduction to wave energy within the harbor. The 300 ft length would be the maximum due to both the location of the entrance channel and the depth contours near the end of the existing breakwater alignment. The full extension would result in the new breakwater foundation depth ranging from 10 to 25 feet below MLLW. The cross-section would likely be composed of a stone core and underlayer, with concrete armor units on the armor layer, similar to the design of the replaced Main Breakwater, but with a significantly wider footprint due to deeper foundation depths in this area.

A new core would be constructed, using dredged material, quarry run stone, or other suitable material. Successive layers would be placed over the core material, consisting of a geotextile filter fabric, a 1.5-foot thick bedding layer of 10 to 50 pound stone, a two-stone thick underlayer of 400 to 800 pound stone, and a 4.3-ton tribar armor layer. A cast-in-place concrete crest cap would be used to stabilize the crest. The oceanside and harborside toe of the structure will be placed into a trench excavated into hard foundation material and further stabilized with tremie concrete. The section will be approximately 130 feet wide and 22-40 feet in total height, with an elevation 12 feet above MLLW datum (see Figure 4-2).

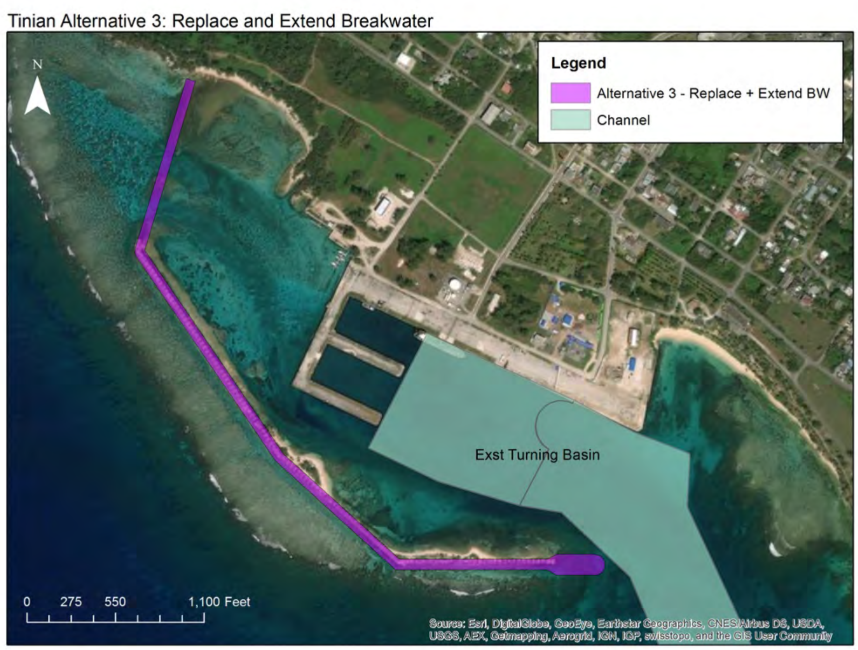

Figure 4-2 Conceptual Layout of Alternative 3 – Replace and Extend Existing Breakwater along Current Alignment

Table 4.1 Lists the amount of direct impacts that would occur depending on which impact alternatives are enacted.

Table 4- 1 Direct Effects of Project

Components	**Direct Impacts (acres)**	**Functional Loss Calculated in HEA for Required Mitigation**
Alternative 2 Replace Existing	6.76	100%
Alternative 3 Replace and Extend	7.67	100%

4.3.3 Indirect Impacts

The Corps proposed the establishment of an "indirect impact zone" extending 150 meters around the proposed project footprint. This zone includes many habitat types, including reef flat, fore reef, and bank/shelf habitat. The 150 meter buffer is based on previous interagency discussions on previous Corps projects where the agencies agreed that 150 meters was a sufficient distance to monitor for events.

In an effort to be extremely conservative and protective of any resources adjacent to the Tinian Harbor project , the Corps decided to implement a 150-meter indirect impact buffer for sedimentation impacts, and calculate necessary mitigation for impacts associated with construction activities.

The "future with the project" analysis of the Economic Analysis estimates 81 vessel calls in 2070, an increase over the 2016 baseline of 9 vessel calls. Because there is an increase in ships arriving at the port in the future with the expansion project, there is a minor incremental increase in turbidity and sedimentation associated with the project after construction is complete.

For the purposes of this analysis, only those impacts that permanently remove habitat via construction activities are considered direct (Alternatives 2 and 3). Incidental impacts are those which are construction equipment related and may or may not occur depending on construction methodologies used by the contractor. All other impacts are considered indirect, since they are solely temporal in nature. The amount of indirect impacts differs depending on which Alternative is selected. Table 4.2 lists the amount of indirect impacts that would occur depending on which impact Components are enacted.

Table 4- 2 Indirect Effects of Project

Components	Indirect Impacts (acres) within 150-m of the project area	Functional Loss Calculated in HEA for Required Mitigation
Alternative 2 Replace Existing	17.28	10%
Alternative 3 Replace and Extend	19.26	10%

5 MITIGATION SITE SELECTION AND JUSTIFICATION

5.1 Avoidance and Minimization

USACE recommends a strategy of impact minimization and control wherever possible. This could involve minimizing the footprint of the breakwater and modifying the alignment and/or placement. The main component of this strategy includes engineering controls and best management practices (BMPs; see FDEP 2008 and Culberg et al. 2010). In addition, any work would not occur during the period of peak coral spawning, usually around the full moons of June, July, and August.

5.2 USACE Recommended Mitigation Projects

- ***USACE Project #1: Artificial Substrate (Reef Ball) With Coral Transplantation***

The USACE proposes the installation of Reef Ball artificial structures for use at the mitigation site. Reef Balls are small enough (as small as one meter across) that they can be discretely placed in sandy patch areas, avoiding any existing corals or hardbottom areas. They can provide high relief environments that immediately attract fish and invertebrates (http://www.reefball.org/index.html, 2008). Reef Balls can be placed into 4-module reef units in a square configuration. This degree of separation is sufficient to avoid interaction between adjacent Reef Balls in terms of coral settlement, but is close enough to allow the four modules to function as a single reef unit for fish recruitment, habitat, and coral sexual reproduction. Gentle handling to transplant sites that are favorable, wave-protected areas are crucial in transplantation success.

The Reef Balls, seeded with transplanted corals, would serve several purposes. First, the adult corals attached to the substrate would immediately function as replacement for lost habitat. Second, the adult corals would provide a source for sexual recruitment of new corals, a more genetically diverse and thus more valuable solution than transplants. Third, the modular structures would provide immediate habitat for fish and invertebrates.

The mitigation plan represents a replacement service that is intended to be fully equivalent to the loss from project impacts (i.e., it would be qualified at a 100% level of relative productivity, in terms of proportional equivalence). Compensation achieved under this project would be a 1:1 in-kind replacement of coral reef habitat in close proximity to the area of coral loss.

This scaling is appropriate due to the proven success of Reef Ball projects in other areas of the world. The environmental conditions at the selected mitigation site are supportive of coral growth, and thus this project is anticipated to be a success.

The goal of the proposed project is to compensate for the temporary and permanent loss of coral reef habitat in the vicinity of the construction area. The proposed mitigation site will be designed to enable transplantation of corals, recruitment of corals, and provide artificial habitat for fish and invertebrates.

The targeted transplantation zone appears to have several large sandy patches that would be ideal for location of Reef Ball structures. The intent is not to completely fill the sandy patches, as this could end up being disruptive to the natural ecology of the area. The Reef Balls with coral transplants provide an opportunity to preserve the genetic diversity of corals currently growing in the area, and allow them to seed the area such that natural coral growth in the project area will be jump-started. The number and distribution of Reef Ball modules has been designed to enhance the coral cover, habitat complexity, and recruitment potential of an area adjacent to the impact site.

Other mitigation projects were evaluated and subsequently eliminated early-on in the planning process. These included:

- ***USACE Project #2: Quarried Limestone Boulders with Coral Transplantation***
  Alternative eliminated because of extensive costs to acquire and deploy quarried limestone boulders. Similar 1:1 scaling as with Reef Ball alternative. This is one of the preferred alternatives approved for use in USACE Port Everglades Deepening Project and used in the recently completed at the Port Miami Deep Dredge Project.

  Need -- 3000-4000 tons of boulders per acre of mitigation. Density of placement should allow 10% open space +/-5%. Boulder sizes with >1m diameter = 1.5-2.5 tons per boulder.

  Cost to acquire and deploy quarried limestone boulders = $1,640.00.00 per acre.
- ***USACE Project #3: Remove Sunken Vessel***
  Alternative eliminated because did not provide in-kind service loss, was difficult to scale, and did not provide enough service gain to offset project impacts.

- ***USACE Project #4: Development and Maintenance of Local In-Water Coral Nursery***
  Alternate eliminated because of long-term commitment to maintenance and operation of facility. Would need to have additional projects requiring compensatory mitigation waiting in the wing. Not appropriate for use in a one-off project that does not require a steady stream of coral out-plants for successful restoration.

- ***USACE Project #5: Debris Removal***
  Debris has been observed throughout the harbor. Most importantly, there are several old sunken landing craft, potentially from WWII. The removal of such metal and objects may also provide an opportunity to obtain mitigation credits. Debris from WWII invasions and later dumping activities remains embedded in the reef along the entire west coast of Tinian. While debris removal may be used in conjunction with other alternatives, the amount of mitigation credits (SAYs gained) would not offset project impacts (SAYs lost). This alternative might function best as a contingency for additional mitigation (if required) due to some unforeseen project impact.

5.3 Assumptions for HEAs

5.3.1 Context for Coral Reef Community Impacts and Recovery

The proposed construction would have direct and indirect effects on the benthic communities and seafloor substrate within and outside of the proposed project footprint. The direct (i.e., construction) disturbance in the project area caused construction will be relatively short in duration, but will have an acute effect on the mobile reef organisms (biological environment), and the seafloor substrate (physical environment).

Any pre- and post-construction restoration actions (i.e., those that “jump-start” recovery) will be beneficial to habitat recovery because coral growth rates are slow even under optimal conditions, and barren areas have low natural recruitment rates (Jaap 2000). Following the recommendations in Jaap (2000) and Precht and Dodge (2003), the highest priority for restoration action should be the salvage of corals from the direct impact areas and subsequent transplantation, which will accelerate recovery and improve the aesthetic value of the artificial reef system. Structural three-dimensional reconstruction can be attained outside the project limits by installing reef balls that will provide surface area for coral, sponge, and algae recruits, and provide habitat to fish and lobsters (Jaap 2000; DERM 2004; DERM 2007).

Suspected indirect effects of adjacent construction activities include sub-lethal effects (injury, decreased fecundity, etc.) on corals due to sedimentation and turbidity. Several biological monitoring studies have documented coral “health” related to adjacent construction activities.

The following assumptions for the Tinian Harbor Modifications are noted as follows (see Tables 5-1 and 5-2). Please note Corps policy constrained the time period for service gains and losses and discount rates.

5.3.1.1 Start Year: 2022

If the project schedule changes, start and end years would change accordingly, however the time period for service gains and losses would remain the same.

5.3.1.2 End Year: 2072

Corps policy limits the time period for service gains and losses to no more than 50 years based on the 50-year project life set forth in the Corps' Planning Guidance Notebook (ER-1105-2-100; Chpt 2 (4) j; Append D, D-6 a.(3)(a)(2)) which sets the maximum period of analysis at 50 years.

5.3.1.3 Discount Rates

When weighing the benefits and costs of coastal restoration projects and other environmental management programs, the selection of a "discount rate" is a key consideration. The discount rate is the rate at which society, as a whole, is willing to trade-off "present" for "future" benefits. In essence, to make past and future losses and gains comparable, a discount rate must be applied. Federal regulations and NOAA (1999 and 2005) recommend using a 3% discount rate when scaling compensatory restoration for discounting interim service losses and restoration gains. NOAA recommends using the social, or consumer, rate of time preference for discounting interim service losses and restoration gains, when scaling compensatory restoration (NOAA 1995, 1997, 1999, 2000, 2005).

When weighing the decision to undertake a project with long-term benefits versus one with short-term benefits and long-term costs, the discount rate plays an extremely important role in determining the outcome of the analysis. High discount rates tend to discourage projects that generate long-term benefits, and favor those that create short-term benefits. Specifically, the discount factor decreases the value of future services and increases the value of past services in order to reflect how much the public values future (or past) service benefits today. This incorporates the assumption that services provided sooner are more highly valued than those provided later (Kohler and Dodge 2006). However, this assumption does not well represent our present society's strong preference to ensure the long-term sustainability of our natural and environmental resources. In other words, they fail to recognize that the concerns/values of future generations are relevant when resource management and policy-making decisions are evaluated (Prager and Shertzer 2006). Hence, many authors have recently recommended capping a discount rate for environmental projects at 1%.

The OMB guidance regarding discount rates for Federal water resource development projects is calculated by using the federal cost of capital. The generally accepted practice is to apply the effective yield on comparable-term treasury securities. During the 1990s, the average 10-year Treasury bond rate was 6.01%, whereas inflation averaged 2.88%. Thus, the real rate of interest on treasury bonds was roughly 3.13% (Bellas and Zerbe 2003). Alternatively, from 1990 to 2003, real gross domestic product grew by 2.96% (NOAA 2005). Thus, using productivity over that period as the basis of the discount rate also generates an approximate 3.0% rate.

The outcome of the analysis in an HEA is highly sensitive to the discount rate. A high discount rate reduces the benefit-cost ratio, because the costs associated with the restoration project are experienced disproportionately during the first half of the recovery analysis timeframe. Arbitrarily selecting discount rates to meet short-term political goals could have long-term consequences. For example, high discount rates tend to discourage projects with high up-front costs, such as the proposed Port Everglades construction project. However, they also discourage hardbottom and reef restoration programs that may be associated with such projects.

Below are the published discount rates from the White House Office of Budget and Management (OMB Circular No. A-94 Revised November 2016); note that the federal discount rate is presently significantly lower than the 3% discount rate generally used by the Federal Government (NOAA) in performing HEA calculations:

Real Discount Rates. A forecast of real interest rates from which the inflation premium has been removed and based on the economic assumptions from the 2018 Budget is presented below. These real rates are to be used for discounting constant-dollar flows, as is often required in cost-effectiveness analysis.

Real Interest Rates on Treasury Notes and Bonds of Specified Maturities (in percent)

3-Year	5-Year	7-Year	10-Year	20-Year	30-Year
-0.5	-0.3	0.0	0.1	0.5	0.7

Analyses of programs with terms different from those presented above may use a linear interpolation. For example, a four-year project can be evaluated with a rate equal to the average of the three-year and five-year rates. Programs with durations longer than 30 years may use the 30-year interest rate.

As previously stated, Under Office of Management and Budget Circulars A-4 and A-94 (Regulatory Analysis and Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs, respectively), when federal agencies are determining costs and benefits of a federal water resources development project, *no discounting should occur* (emphasis added). Specifically Circular A-94 states "Specifically exempted from the scope of this

Circular are decisions concerning water resource projects guidance for which is the approved Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies."

The Tinian Harbor Modifications, and all of the components of that study, falls under the aforementioned water resource principles and guidelines. Additionally, Under Corps Regulations (ER 1105-2-100, Appendix E, Pg E-154), any mitigation plan developed for the Tinian Harbor Project will be evaluated using a Cost Effectiveness/Incremental Cost Analysis (CE/ICA). The regulations for CE/ICA require that the models utilized to determine benefits (or habitat recovery when assessing mitigation) not utilize a discount rate to be in compliance with the OMB guidance documents previously presented. The regulations for CE/ICA require that the models utilized to determine benefits (or habitat recovery when assessing mitigation) not value the same quality habitat less in the future than in the present. The HEA prepared for the Corps in this analysis does not utilize a discount rate and for the calculations; 0% will be used. Accordingly, the mitigation needs analysis performed by the Corps utilized the Visual HEA software package (Kohler and Dodge 2006) method utilizing a 0% discount rate.

5.3.1.4 Recovery Rates

An assessment of how long it would take resources subject to each injury type to fully recover was conducted by determining the trajectory of the recovery over time. These recovery trajectories depend on the species of coral affected, the type and degree of injury, any primary restoration to be implemented, and the type of environment in which the injury occurred (Precht et al. 2001, Precht and Aronson 2006, Darling et al. 2012, 2013). Data from literature and field observations and best professional judgment were used to inform values for these parameters (Colgan 1987, Burdick et al. 2008, Turgeon et al. 2008, Richmond et al. 2008, Houk and van Woesik 2010, Houk et al. 2014, USFWS 2017a). While the ecological succession of most coral reef ecosystems follow the law of sigmoidal growth, a linear recovery trajectory was used for all HEAs performed in this report. This is common industry practice and includes most HEAs performed to date for marine resource valuations that deal with corals (Kohler and Dodge 2006).

In practice, recovery rates can be attenuated by limiting sedimentation, siltation, and turbidity during construction; and salvaging and transplanting scleractinian corals from the impact site to the mitigation site. Actual recovery rates of both the impacted area and the mitigation site should be accessed through a dedicated, long-term monitoring program that evaluates the effectiveness of the mitigative measures by assessing the functional attributes of sessile and mobile reef organisms (Precht and Aronson 2006, Darling et al. 2012).

5.3.1.5 Initial Services

In order to determine the action (or funds) required for compensation (mitigation), the scale of restoration was determined by calculating the benefit from a reef mitigation project constructed using Reef Balls. The calculations regarding benefits of this action were divided into two components: (1) Reef Ball emplacement (10% initial service gain), and (2) transplantation of mature coral colonies from the area of direct project impacts onto the constructed Reef Ball artificial reef (an additional 15% initial service gain). This yields a 25% initial service gain.

5.3.1.6 Maximum Increase in Services

After 25 years, (year 25, 2045) the mitigation site is assumed to achieve an additional 25% increase in services above the immediately post mitigation service level of 0.25 yielding a maximum recovery level of 50%. This is equivalent to the pre-project service baseline.

Table 5- 1 Direct and Indirect Reef Impacts – Alternative 2

INJURY			
Claim year = Date of Injury	2022	Value-injured/value restored	1/1
Site name	Tinian Harbor	Equilibrium level to which recovery can reach	7.5%
Type of injury (direct, indirect+)	Direct, Indirect	Injury recovery time to equilibrium	25 years, 25 years
# of injured area units	Direct = 6.76 acres, Indirect = 17.28 acres	Shape of recovery trajectory	Linear
Pre-injury service level	50%	Time units	Years
Post-recovery service level Direct, Indirect	40%, 50%	Service level at end of project life Direct, Indirect	40%, 50%
Degree of services lost immediately following injury (%)	Direct =100%, Indirect = 10%	Discount rate per time unit (%)	0%

Table 5- 2 Direct and Indirect Reef Impacts – Alternative 3

INJURY			
Claim year = Date of Injury	2022	Value-injured/value restored	1/1
Site name	Tinian Harbor	Equilibrium level to which recovery can reach	7.5%
Type of injury (direct, indirect+)	Direct, Indirect	Injury recovery time to equilibrium	25 years, 25 years
# of injured area units	Direct = 7.67 acres, Indirect = 19.26 acres	Shape of recovery trajectory	Linear
Pre-injury service level	50%	Time units	Years
Post-recovery service level Direct, Indirect	40%, 50%	Service level at end of project life Direct, Indirect	40%, 50%
Degree of services lost immediately following injury (%)	Direct =100%, Indirect = 10%	Discount rate per time unit (%)	0%

6 HEA RESULTS

Tables 6-1 and 6-2 below, reveal the impacts of the proposed alternates and the service gains provided using the preferred Reef Ball with coral transplants mitigation option. The HEA model calculates the amount of compensatory required for each of the alternatives both with and without the 150 m project buffer (see Figure 6-1 for example).

Table 6- 1 Direct Effects of Project

Components	Direct Impacts during construction (acres)	Required Replacement Habitat (Acres)	SAYs Lost	SAYs Gained
Alternative 1 No Action	-----	----	----	----
Alternative 2 Replace Existing	6.76	3.07	67.94	149.57
Alternative 3 Replace and Extend	7.67	3.48	77.08	169.70

Table 6- 2 Indirect Effects of Project

Components	Indirect Impacts (acres) within 150-m of the project area	Required Replacement Habitat (Acres)	SAYs Lost	SAYs Gained
Alternative 1 No Action	----	----	----	----
Alternative 2 Replace Existing	17.28	0.98	21.60	382.32
Alternative 3 Replace and Extend	19.26	1.09	24.08	426.13

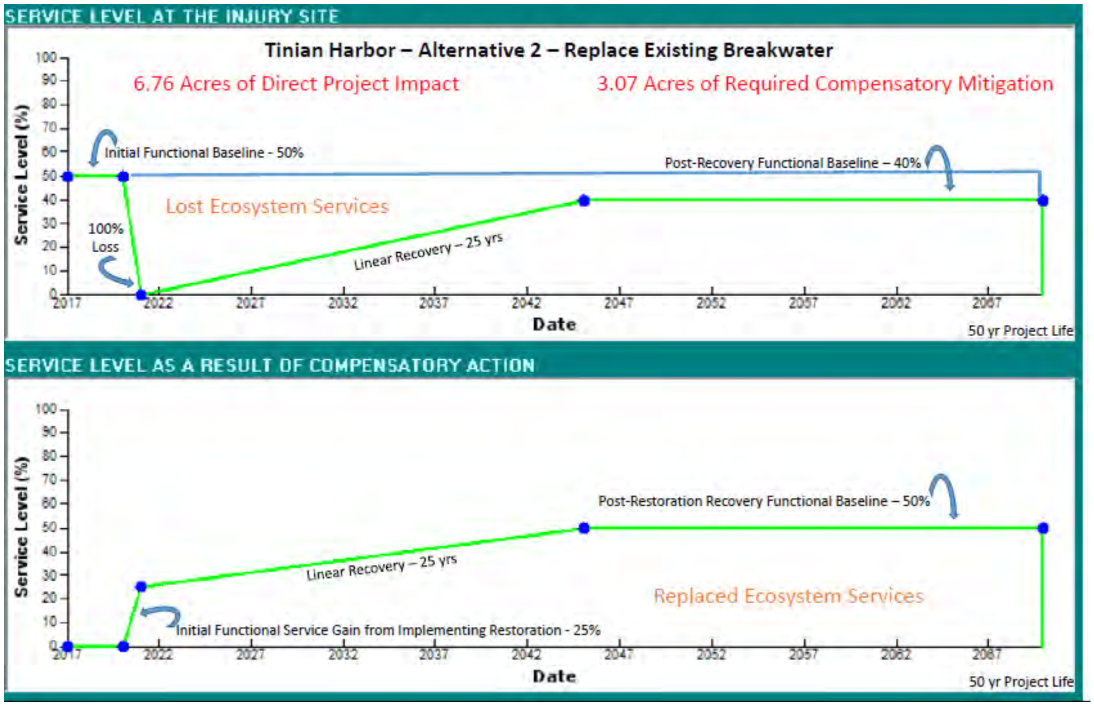

Figure 6- 1 Example of Visual HEA model run showing Direct Impact for Alternative 2. Descriptive notations added later.

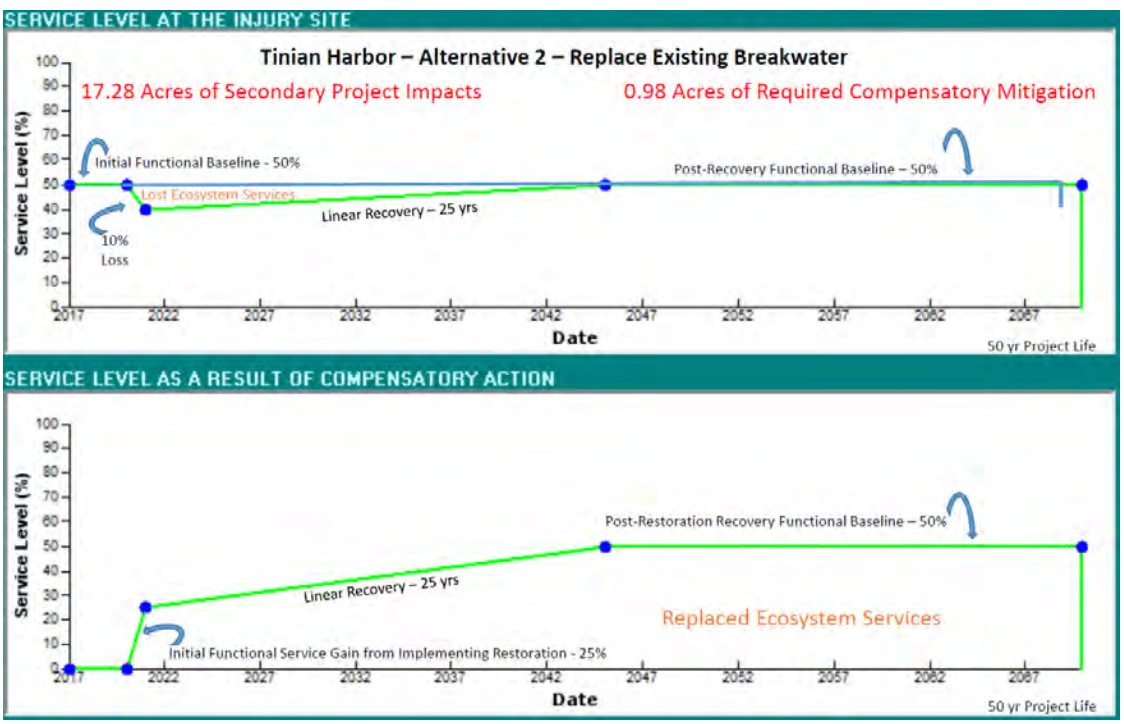

Figure 6- 2 Example of Visual HEA model run showing Indirect Impacts for Alternative 2. Descriptive notations added later.

Table 6-3 is the total compensatory mitigation for both Alternatives 2 and 3. This is calculated by adding the required compensatory mitigation for both direct and indirect (150 m buffer) project impacts.

Table 6- 3 Combined Direct and Indirect Effects of Project

Components	Direct and Indirect Impacts (acres)	Required Replacement Habitat (Acres)	SAYs Lost	SAYs Gained
Alternative 1 No Action	----	----	----	----
Alternative 2 Replace Existing	24.04	4.05	89.54	531.89
Alternative 3 Replace and Extend	26.93	4.57	101.16	595.83

Table 6-4 below shows the service gains and recovery projections for the preferred restoration option.

Table 6- 4 HEA Calculations for Proposed Compensatory Mitigation

Category of Restoration/Replacement	Initial Service Gained (%)	Recovery Service Level @ Maturity (%)	Time to Full Recovery (yrs)
1) Created Reef-Ball reef with relocated coral for Component 1 impacts	25	50	25

7 COST FEASIBILITY ANALYSIS

Although required compensatory mitigation has been receiving a good deal of attention among Federal agencies, nowhere is it specified what methods should be used for developing mitigation plans nor what criteria should be used for decisions regarding "how much mitigation is enough." This has fostered confusion among resource managers and has resulted in friction between the USACE and the USFWS over mitigation planning. To help resolve these conflicts we have used the Visual HEA Model to determine the required mitigation for each of the project alternatives. However, cost is one of nine criteria established by USEPA to guide remedy selection decision making and is a critical factor in the process of identifying a preferred remedy or alternative. In addition, to be implemented, the remedy selected must be cost-effective. Accordingly, cost estimates have been developed for each of the project alternatives for comparison purposes (see Table 7-1 below).

Table 7- 1 Mitigation Costs for Combined Direct and Indirect Impacts

Components	Direct and Indirect Impacts (acres)	Required Replacement Habitat (Acres)	Cost Per Acre	Total Cost
Alternative 2 Replace Existing	24.04	4.05	$597,199.00*	$2,418,655.95
Alternative 3 Replace and Extend	26.93	4.57	$597,199.00	$2,729,199.43

Cost estimates in Table 7-1 allows the user to make direct comparative estimates so that decisions between alternatives can be appropriately considered for implementation. Cost estimates for the analysis of the alternatives are intended to provide a measure of total resource costs over time (i.e., "life cycle costs") associated with any given alternative.

*Cost breakdown per acre of required mitigation:

Reef Balls -- Cost to build and deploy per acre = $392,750

Coral relocation to move all corals from project footprint onto artificial Reefs total cost = $392,200; Cost per acre = $98,050

Coral monitoring = $58,800 per event x eight (8) events increase by 3% each year = $484,598; Cost to monitor per acre = $106,449.

Total Project cost per acre = $597,199.00

Contingency is factored into a cost estimate to cover unknowns, unforeseen circumstances, or unanticipated conditions that are not possible to evaluate from the data on hand at the time the estimate is prepared. It is used to reduce the risk of possible cost overruns.

7.1 Project Contingency Review

Contingency is an integral part of the total estimated costs of a project and is defined as — "An amount added to an estimate to allow for items, conditions, or events for which the state, occurrence, or effect is uncertain and that experience shows will likely result, in aggregate, in additional costs (Cost Engineering Terminology, 2007). Typically, this is estimated using statistical analysis or judgment based on past asset or project experience. [Contingency is] particularly important where previous experience relating estimates and actual costs has shown that unforeseeable events which will increase costs are likely to occur (Cost Engineering Terminology, 2007). This definition has been adopted by the American Association of Cost Engineers (AACE). For instance, in government contracting the USDOE has elected to narrow the scope of this definition and defines contingency as follows: "covers costs that may result from incomplete design, unforeseen and unpredictable conditions, or uncertainties within the defined project scope. The amount of the contingency will depend on the status of design, procurement, and construction; and the complexity and uncertainties of the component parts of the project. Contingency is not to be used to avoid making an accurate assessment of expected cost. Estimators should be aware that contingency is an integral part of the estimate (Uppal 2007).

The estimated costs of the known-unknowns are referred to by cost estimators as cost contingency. No restoration project has ever been accomplished exactly as it was planned. Restoration is a multivariate undertaking, and it is impossible to account for all eventualities. Examples of contingencies during construction are state-of-the-art design, scheduling and permitting, required reliability, equipment complexity, severe weather events and increases in direct costs (e.g. fuel). Examples of post-construction contingences include colonization by invasive species, vandalism, other items unique to the project and unanticipated events elsewhere in the landscape that impact the project site. The need to conduct at least some remediation post construction is a near certainty (Wickham, 1998). Generally, the cost of remediation increases in relation to the time it takes to respond after its need is discovered. For these reasons, contingency funds should be available on short notice. Contingency is included in most estimates, and is expected to be expended. Traditionally cost estimates are deterministic i.e. point estimates for each cost element based on their most likely value. Contingencies are often calculated as an across-the-board percentage addition on the base estimate, typically derived from intuition, past experience and historical data. Research indicates that this is the most common approach for estimating project cost contingency (Baccarini, 2005) and is a cost effective approach to contingency planning for projects where the overall construction costs are small. Surveys of federal agencies using this method generally between 10-25% across the board cost contingency factor for ecosystem restoration projects (Megdal, 2005). In addition, discussions with independent contractors performing ecological coastal and marine restoration projects in south Florida also yields an average addition of about 15-20% to the base project cost to cover unforeseen costs and cost overruns. For large-scale projects, full risk analysis using computer statistical simulations are recommended. While these simulations are usually very accurate, they are also costly to run and must therefore must be included in the overall project costs. For large-scale Port projects the USACE usually uses about a 20% contingency, however, they refine and fine-tune their cost contingency for final construction based on a detailed risk analysis of the project by the project delivery team (PDT) (Terri Jordan-Sellers, personal communication).

The risk analysis process for this study follows the USACE Headquarters requirements as well as the guidance provided by the Cost Engineering Dx (USACE, 2016). Risk analysis results are also intended to provide project leadership with contingency information for scheduling, budgeting, and project control purposes, as well as to provide tools to support decision making and risk management as the project progresses through planning and implementation. To fully recognize its benefits, cost and schedule risk analysis should be considered as an ongoing process conducted concurrent to, and iteratively with, other important project processes such as scope and execution plan development, resource planning, procurement planning, cost estimating, budgeting and scheduling.

The risk analysis process uses Monte Carlo techniques to determine probabilities and contingency (Hollmann, 2007). The Monte Carlo techniques are facilitated computationally by a commercially available risk analysis software package (Crystal Ball) that is an add-in to Microsoft Excel. Cost estimates are packaged into an Excel format and used directly for cost risk analysis purposes. The level of detail recreated in the Excel-format schedule is sufficient for risk analysis purposes that reflect the established risk register, but generally less than that of the native format.

Identifying the risk factors via the PDT is considered a qualitative process that results in establishing a risk register that serves as the document for the quantitative study using the Crystal Ball risk software. Risk factors are events and conditions that may influence or drive uncertainty in project performance. They may be inherent characteristics or conditions of the project or external influences, events, or conditions such as weather or economic conditions. Risk factors may have either favorable or unfavorable impacts on project cost and schedule.

Contingency is analyzed using the Crystal Ball software, an add-in to the Microsoft Excel format of the cost estimate and schedule. Monte Carlo simulations are performed by applying the risk factors (quantified as probability density functions) to the appropriate estimated cost and schedule elements identified by the PDT. Contingencies are calculated by applying only the moderate and high level risks identified for each option (i.e., low-level risks are typically not considered, but remain within the risk register to serve historical purposes as well as support follow-on risk studies as the project and risks evolve).

For the cost estimate, the contingency is calculated as the difference between the cost forecast and the baseline cost estimate. Each option-specific contingency is then allocated on a civil works feature level based on the dollar-weighted relative risk of each feature as quantified by Monte Carlo simulation (Hollmann, 2007). Standard deviation is used as the feature-specific measure of risk for contingency allocation purposes. This approach results in a relatively larger portion of all the project feature cost contingency being allocated to features with relatively higher estimated cost uncertainty.

For the purposes of this mitigation plan analysis, contingency is typically applied as a percentage of the total cost of construction and O&M activities costs. Accordingly, we have added a 15% contingency factor to the cost estimate based upon best professional judgement of similar past projects (see Table 7-2 below).

Table 7-2. Contingency Costs for Combined Direct and Indirect Impacts

Components	Total Cost	15% Contingency	Total Cost Including Contingency
Alternative 2 Replace Existing	$2,418,655.95	$362,798.39	$2,781,454.34
Alternative 3 Replace and Extend	$2,729,199.43	$409,379,91	$3,138,579.34

8 MITIGATION WORK PLAN

8.1 Timing

Artificial reefs can be built year round, but are best deployed during calmer seas. The best time to plant a coral fragment is when you are entering a cooler season. This is because the fragments don't have to deal with as much algae growth, bleaching events or lower oxygen levels that are associated with higher water temperatures. It is also important to plant when it is entering a dry season rather than a wet season because rain and run-off can impact coral health and reduce the efficiency of divers and propagation efforts. Ideal planting times are typically within a few months following coral spawning events to maximize natural coral recruitment. Therefore, mitigation work will take all this into account and schedule the transplanting of the coral colonies in the best conditions prior to construction work. This will allow the corals to be removed and replanted onto the Reef Balls. Any work would not occur during the period of peak coral spawning, usually around the full moons of June, July, and August.

8.2 Equipment

Corals will be removed using common hand tools such as crowbars, hammers and chisels. Removed corals will be immediately placed in nets to be transported to the propagation staging area, where holding structures and propagation tables will be used to hold the transplants and prepare the propagules for transplantation.

Reef Ball modules will be made using cement and additives on-site, with the same equipment that will be used to construct jetty materials. The modules will be made from a single mold that will be shipped from Florida and transported to the construction staging area.

Coral fragments will be set into small concrete molds at the propagation table, and then transported to the Reef Ball structures to be cemented in-place.

8.3 Schedule

Reef Balls will be fabricated in the construction staging yard prior to construction, and will be stockpiled until the time of deployment. Deployment of Reef Balls will occur several days prior to construction. Select corals will be removed from the project area in the 3-week period prior to construction, and transported to the propagation staging area where they will be prepared for transplantation. Transplantation will begin immediately after removal, and thus coral removal and transplantation will be occurring simultaneously.

8.4 Transplanted and Recruited Biota

The goal of the mitigation project is to restore the ecosystem function of the removed corals. The highest likelihood of successful transplantation will be for coral colonies of a similar depth as the transplant site, as they will be acclimated to the amount and intensity of light irradiation (Maragos 1974).

In addition to coral colonies transplanted to the Reef Balls, some amount of natural recruitment is anticipated to occur. Reef Balls will be placed in sandy patch areas that are not currently able to support coral growth due to lack of suitable substrate. The introduction of hard-surfaced Reef Balls will remedy that lack, and recruitment could be anticipated within a year or two of deployment of the Reef Balls. The coral fragments transplanted to the Reef Balls will also be a source of gametes during coral spawning events, which will assist in providing coral larvae to recolonize the following the completion of construction activities.

Projected costs for coral relocation efforts to move corals from project footprint (>20 cm in diameter) onto Reef Ball structures as part of the mitigation program = $392,200.00.

9 PERFORMANCE STANDARDS

9.1 Evaluation Parameters

Success of the project will be evaluated by quantifiably monitoring the species abundance and diversity of fish, invertebrates, and corals, survivorship of transplanted corals, recruitment, and percent coral cover. To account for any environmental impacts that might be affecting the success of the mitigation site, the Reef Ball transplant area will be compared with a nearby reference site. Some of the goals are to achieve a similar percentage as the nearby reference sites.

Targeted goals of the mitigation site are presented in Table 9-1.

Table 9- 1 Mitigation Goals

Parameter	Goal
Fish biomass	No more than 15% below the reference site
Mean coral cover (on Reef Balls)	Initial of 25% post transplantation
Survivorship of transplants	80% within first 90 days, 50% within first year
Invertebrate abundance	No more than 15% below the reference site
Invertebrate diversity	No more than 15% below the reference site
Coral recruitment	20% in five years
Coral Cover	Full recovery to baseline in 25 years

10 SITE PROTECTION AND MAINTENANCE

10.1 Long-Term Legal Protection Instrument

This project is a federally funded, compensatory mitigation project, and as such implementation will be required in order for the harbor improvements project to proceed.

The biological assessment conducted by the USFWS did not indicate a strong presence of any invasive species in the area proposed for compensatory mitigation. The proposed deployment sequence of the Reef Balls has been designed to establish coral cover immediately, thereby reducing the possibility of invasive species colonizing the artificial structures. Invasive species are not anticipated to present a barrier to project success. The first three monitoring events will thus allow for the possibility of removing invasive species that present a threat to the survivorship of transplanted corals.

10.2 Monitoring Plan

Prior to project inception, the impact site, mitigation site, and reference site will be assessed to describe the coral reef community in the areas, and to establish a baseline against which future monitoring events will be compared. The assessment will look at distribution and relative abundance of algae, corals and other macro-invertebrates, and reef fishes. Following transplant activities, monitoring will expand to include an assessment of coral survivorship and recruitment and an assessment of the stability of Reef Ball structures. As discussed previously in this document, parameters in the mitigation site will be compared against a nearby reference site to account for any environmental changes that may be impacting the success of the mitigation site (see Precht 2008).

The project team proposes a five-year schedule (eight events) for monitoring is as follows:

- Baseline survey upon completion
- Six-month and one-year review of transplantation (survivorship and invasive species / coral predator monitoring, and Reef Ball placement/stability only);
- Semi-annually for the subsequent two years; and
- Annually for the subsequent two years.

Projected monitoring costs for eight events = $484,598.00

Proposed monitoring activities are described in the sections below.

10.2.1 Transect Locations

Four fixed 20 meter biological monitoring transects will be established to monitor benthic colonization on the segment of artificial reef structure that will serve as mitigation for this project, and four similar transects will be established in the nearby reference site.

Transects will be randomly placed following the deployment of Reef Balls in the project area. To ensure permanence, stainless steel markers and/or sand anchors will be installed along the transect lines so repeated measures monitoring can be made of the same sites through time.

10.2.2 Video Transects

A survey tape will be stretched the length of each of the 20 meter transect lines to delineate distance and the transect center line during the video taping of the Reef Balls. The video surveys will be conducted by a biologist using SCUBA and a digital video camera (Aronson et al. 1994). The biologist will swim at approximately 4-5 meters per minute while filming each video transect from west to east. Video footage will be subsequently reviewed using CPCe software to quantify abundance and diversity of benthic macro-invertebrates present within each of the transect lines, and to make general observations on health, survivorship and growth of corals present within each transect (Kohler and Gill 2008).

10.2.3 Fish counts

Counts of fish species will be conducted along the established transect lines using both timed and stationary counts. The timed swims will be conducted to ensure that representative samples of visually conspicuous species and life stages are collected. During a timed swim, all fish within 15 feet on either side of the diver will be identified by life stage. The diver will be free to look under ledges, crevices, and overhead in the water column during the swim.

The stationary sampling method will include one stationary count at each transect. These counts are made from randomly chosen points censuses by a solitary diver adjacent to the permanent monitoring transects. Each sampling point consists of an imaginary cylinder 10 feet in diameter extending from the surface to the bottom (Bohnsack and Bannerot 1986). The location of each stationary count is determined using randomly generated compass headings and distances (measured by swimming kicks) from the center of the monitoring transects. Each point is sampled by a single diver, who for 5 minutes lists all fish observed within the cylinder by rotating slowly in one direction and scanning the successive sectors. Species abundances are recorded by life stage categories (adult, juvenile, and newly settled).

10.2.4 Belt Transect For Corals and Benthic Invertebrates

A 0.5 meter wide belt transect will be surveyed for coral and benthic invertebrate species richness. The belt transect will overlap the four 20 meter transects. The biologist will compile a species list of sessile and motile invertebrate fauna, attempting to record the maximum practicable species richness. The location of the first sighting of each species will be noted so that this data may also contribute to species-area analyses. This survey is necessarily constrained to visually conspicuous organisms with well-defined discrimination characteristics for visual on-consumptive identification. Visual identification to species-level is not possible for many fauna. When species-level identification is not possible, the biologist will record the most specific taxonomic level possible. All visible hard and soft coral colonies with centers located within 0.5 meters of each side of the transect line will be identified to the species level, counted and visually assigned to a size category.

10.2.5 Coral Cover and Transplant Survivorship

A representative number of Reef Balls will be randomly chosen as long-term monitoring stations to quantify the survivorship of transplanted corals and the change in percent coral cover over time. These Reef Balls will be tagged for identification, and will be photographed with a scale bar visible in the background at each monitoring event. Data collected from these long term observations will be used to determine whether the mitigation project is meeting the performance standard goals of percent coral cover and survivorship

10.2.6 Invasive Species and Coral Predators

The first 90 days following deployment of coral propagules has been noted as the most critical time period for establishment of a healthy, stable system. The first three monitoring events will thus include a swim-through of the entire project area to look for invasive species or coral predators that might pose a threat to the survivorship of coral transplants. Any such species identified will be removed from the project area by the monitoring team, to the extent practicable.

10.2.7 Reef Ball Stability

During all monitoring events, the monitoring team will conduct a swim-through of the area to look for any loose or dislodged Reef Ball structures. Corrective action may include re-anchoring loose structures, or removing damaged structures that cannot be re-anchored.

11 ADAPTIVE MANAGEMENT PLAN

11.1 Responsible Parties

The parties responsible for adaptive management of this proposed mitigation plan are CNMI and the USACE.

11.2 Potential Challenges

Success of the project will face several challenges. The most serious threats will be water quality during construction, strong wave activity or storms, and decreased resilience of transplanted corals during the first six months to one year following the move. The proposed mitigation site has been designed to minimize these threats to the maximum extent practicable. Best Management Practices (BMPs) such as silt fences will be required during construction to reduce the amount of suspended sediment in the water (FDEP 20XX). Coral transplant activities will be timed for the summer months, when the chances of storm surge and strong waves will be lower. Reef Ball restoration experts will be subcontracted to oversee and direct the transplantation activities to minimize the impacts to the coral colonies being transplanted.

11.3 Potential Remedial Measures

Although the proposed mitigation project is anticipated to achieve an acceptable level of success, it is possible that the project may fall short of the performance standards proposed in Section 5.1. If this happens, the first step in assessing the project will be to compare the mitigation site to the reference site. If the two are similar, it will be taken as an indication that environmental conditions at the site have degraded to such a degree that the mitigation project has been compromised, and that it was not the design or implementation of the mitigation project that caused the shortfall. This would be considered a situation not requiring the implementation of remedial measures. If, however, the reference site is healthy while the mitigation site falls short of the performance standards, the project team will consider the need to implement remedial measures.

The type and degree of remedial measures will depend upon the degree to which performance standards have not been met. Not all performance standards are considered equally important. Coral cover and survivorship of transplanted fragments are the two most important standards, with the other standards are of lesser consequence. If either percent coral cover or survivorship is deemed to be failures within five years of the project implementation, the project team will reassess the project to identify whether additional coral transplantation should be attempted. If this is deemed impractical, the project team may recommend adding a supplemental mitigation activity.

11.4 Modification of Performance Standards

Coral reefs are complex ecological systems, and transplant projects can be problematic due to all of the uncertainty involved. It is possible that the proposed mitigation project will meet some of the mitigation goals in unanticipated ways. This mitigation plan should be flexible enough to allow for this possibility.

Some examples of unanticipated success could be low survivorship of coral transplants, but a high degree of natural recruitment, or low survivorship and low recruitment but an increase in fish and invertebrate biomass and/or diversity. If one or two of the performance standards proposed are not met, but others are exceeded by a wide margin, the mitigation project may be considered a success.

11.5 Financial Assurances

CNMI and the USACE are jointly responsible for all stages of the project, from construction and implementation to monitoring.

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APPENDIX A

HEA Input/Output Summaries and Data

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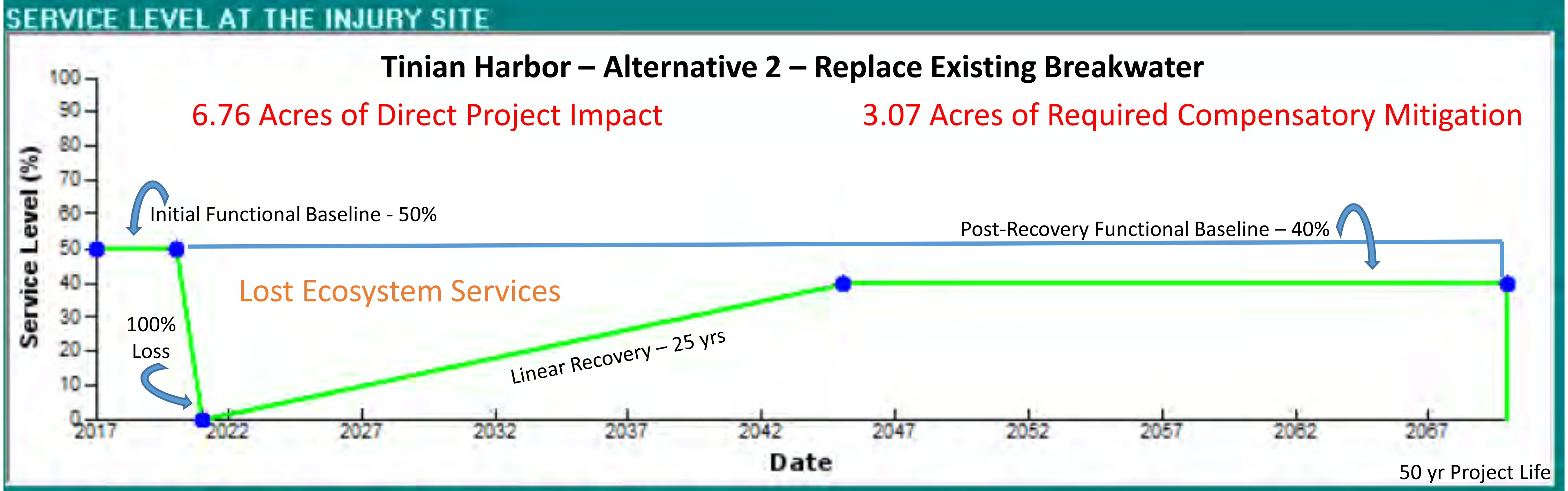
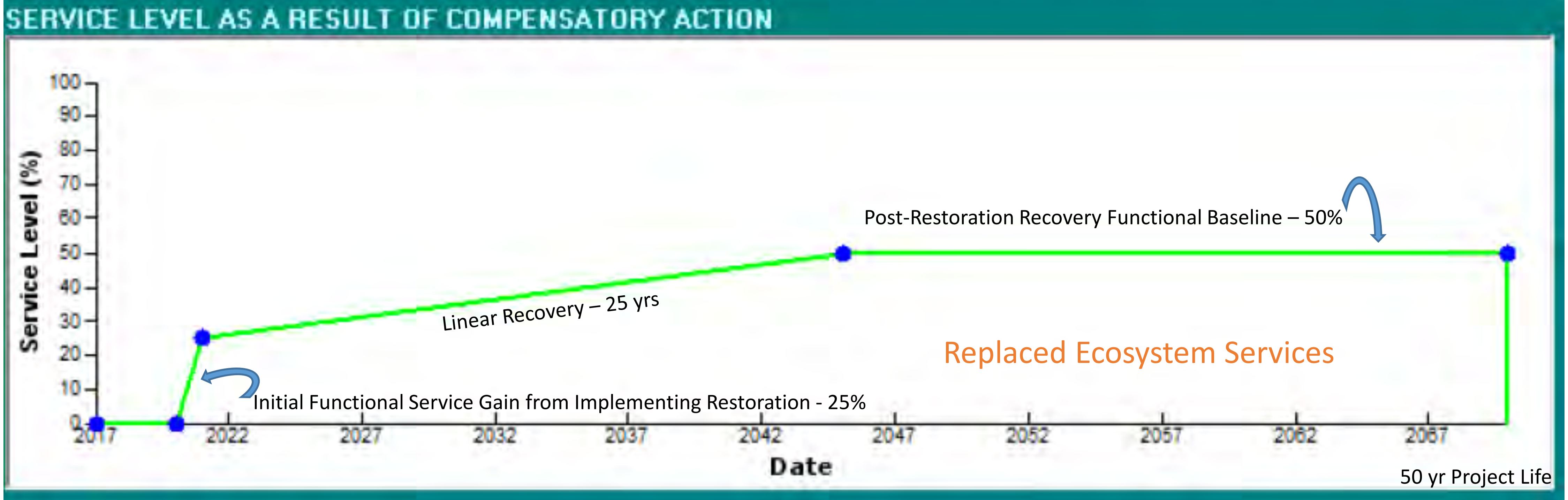
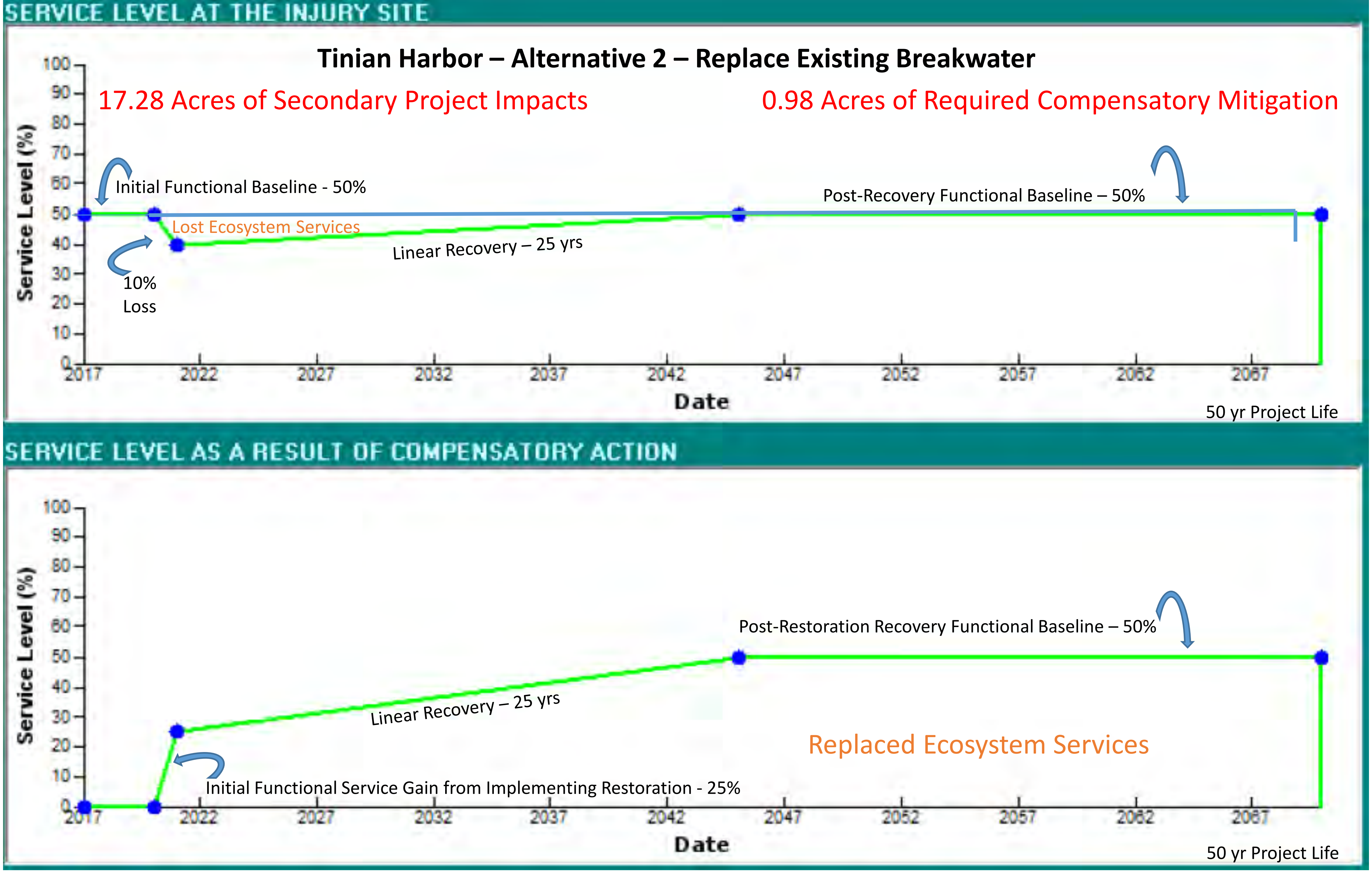

SERVICE LEVEL AT THE INJURY SITE
Tinian Harbor – Alternative 2 – Replace Existing Breakwater
6.76 Acres of Direct Project Impact
3.07 Acres of Required Compensatory Mitigation
Initial Functional Baseline - 50%
Post-Recovery Functional Baseline – 40%
Lost Ecosystem Services
100% Loss
Linear Recovery – 25 yrs
Service Level (%)
Date
50 yr Project Life


SERVICE LEVEL AS A RESULT OF COMPENSATORY ACTION
Post-Restoration Recovery Functional Baseline – 50%
Linear Recovery – 25 yrs
Replaced Ecosystem Services
Initial Functional Service Gain from Implementing Restoration - 25%
Service Level (%)
Date
50 yr Project Life

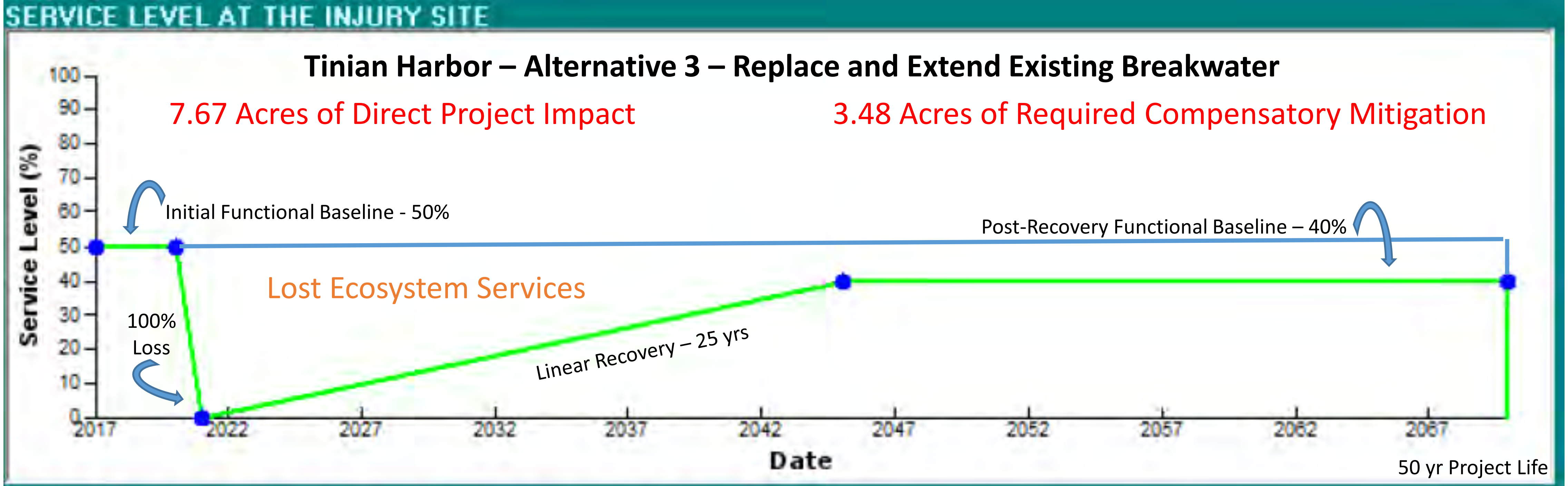


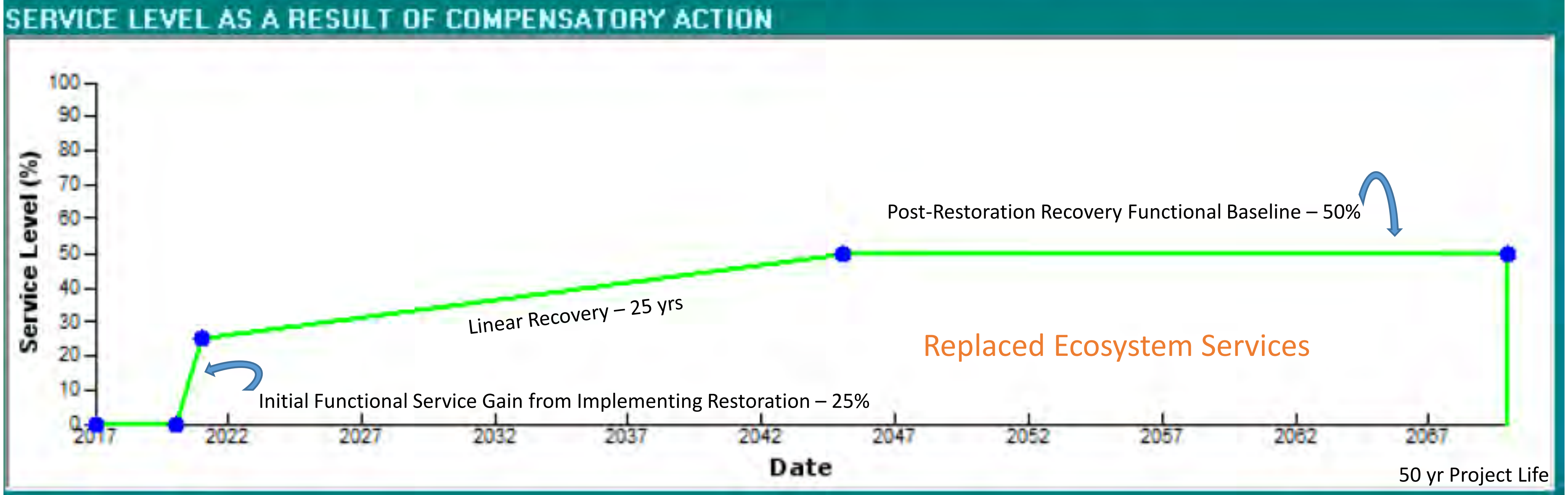
SERVICE LEVEL AT THE INJURY SITE
Tinian Harbor – Alternative 2 – Replace Existing Breakwater
17.28 Acres of Secondary Project Impacts
0.98 Acres of Required Compensatory Mitigation
Initial Functional Baseline - 50%
Post-Recovery Functional Baseline – 50%
Lost Ecosystem Services
Linear Recovery – 25 yrs
10% Loss
Service Level (%)
Date
50 yr Project Life
SERVICE LEVEL AS A RESULT OF COMPENSATORY ACTION
Post-Restoration Recovery Functional Baseline – 50%
Linear Recovery – 25 yrs
Replaced Ecosystem Services
Initial Functional Service Gain from Implementing Restoration - 25%
Service Level (%)
Date
50 yr Project Life

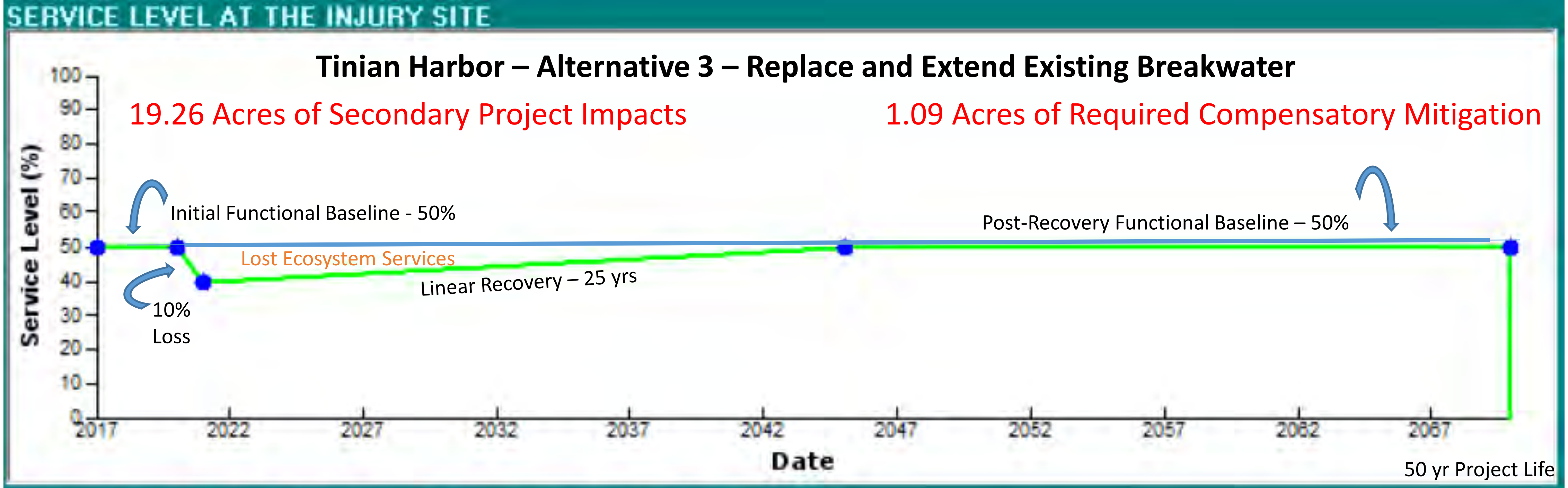
Tinian Harbor – Alternative 3 – Replace and Extend Existing Breakwater

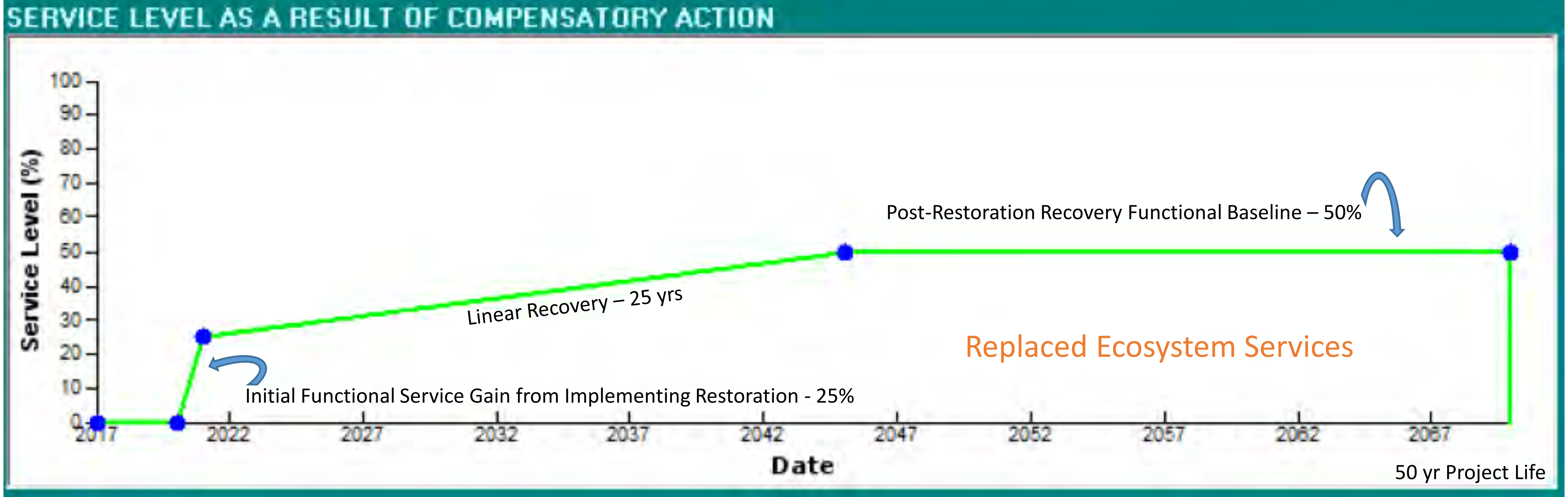
7.67 Acres of Direct Project Impact

3.48 Acres of Required Compensatory Mitigation






SERVICE LEVEL AT THE INJURY SITE
Tinian Harbor – Alternative 3 – Replace and Extend Existing Breakwater
19.26 Acres of Secondary Project Impacts
1.09 Acres of Required Compensatory Mitigation
Initial Functional Baseline - 50%
Post-Recovery Functional Baseline – 50%
Lost Ecosystem Services
Linear Recovery – 25 yrs
10%
Loss
Service Level (%)
100
90
80
70
60
50
40
30
20
10
0
2017
2022
2027
2032
2037
2042
2047
2052
2057
2062
2067
Date
50 yr Project Life


SERVICE LEVEL AS A RESULT OF COMPENSATORY ACTION
Post-Restoration Recovery Functional Baseline – 50%
Linear Recovery – 25 yrs
Replaced Ecosystem Services
Initial Functional Service Gain from Implementing Restoration - 25%
Service Level (%)
100
90
80
70
60
50
40
30
20
10
0
2017
2022
2027
2032
2037
2042
2047
2052
2057
2062
2067
Date
50 yr Project Life

VISUAL_HEA HABITAT EQUIVALENCY ANALYSIS

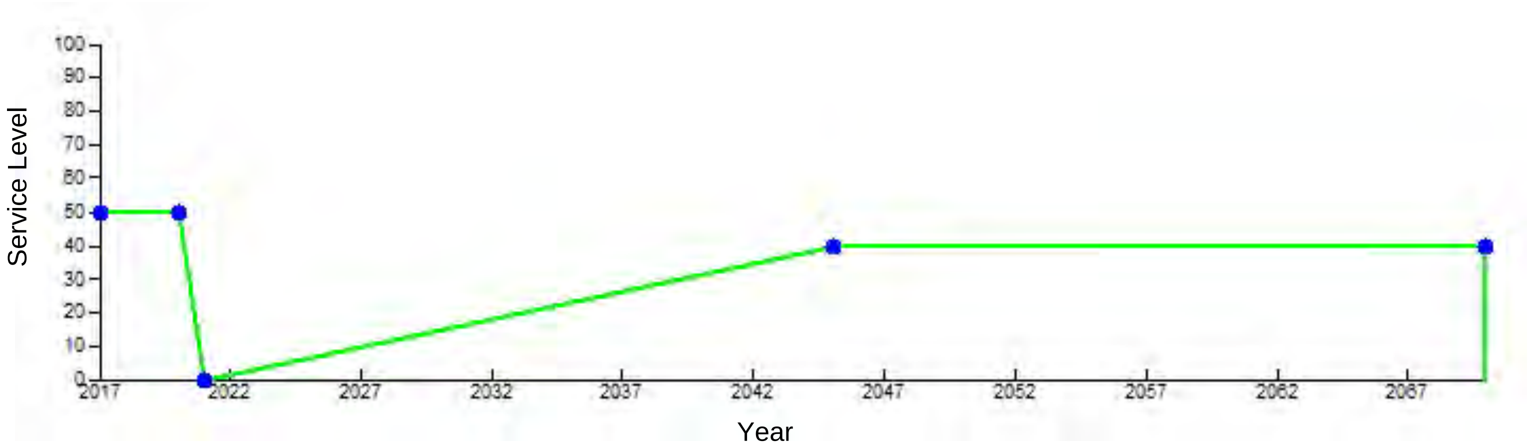
Sitename: Tinian 25 years 6.76 acres

Date: 9/1/2017 12:14:55 PM
Datafile: C:\\Users\\Martha\\Desktop\\HEA Tinian\\Final\\Tinian 50% 25 years 6.76 acres.hea

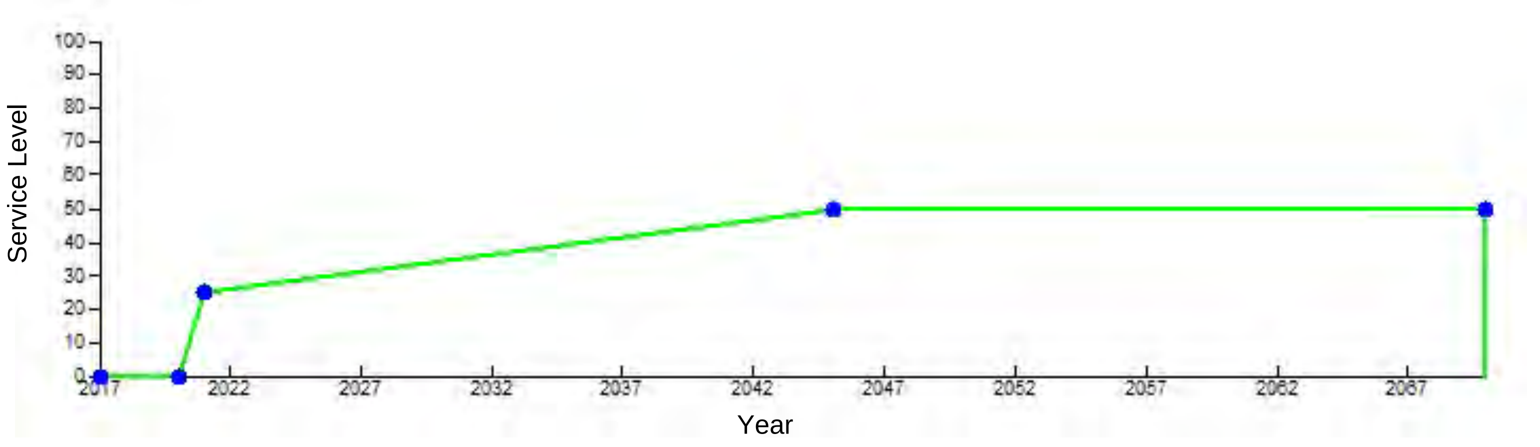
Units: acre
Time units: year

Claim year: 2020
Amount of affected units: 6.76
Pre-injury service level (%): 50.00%
Pre-restoration service level (%): 0.00%
Value ratio injured/restored: 1.00
Discount rate per unit of time(%): 0.000

Service losses at the Injury Area



Service Gains at the Compensatory Area



Service losses at the Injury Area

Year	% Services lost Beginning	End	Mean	Raw SUYs lost	Discount Factor	Discounted SUYs lost
2017	.00%	.00%	0.00%	0.000	1.000	0.000
2018	.00%	.00%	0.00%	0.000	1.000	0.000
2019	.00%	.00%	0.00%	0.000	1.000	0.000
2020	.00%	50.00%	25.00%	1.690	1.000	1.690
2021	50.00%	48.33%	49.17%	3.324	1.000	3.324
2022	48.33%	46.67%	47.50%	3.211	1.000	3.211
2023	46.67%	45.00%	45.83%	3.098	1.000	3.098
2024	45.00%	43.33%	44.17%	2.986	1.000	2.986
2025	43.33%	41.67%	42.50%	2.873	1.000	2.873
2026	41.67%	40.00%	40.83%	2.760	1.000	2.760
2027	40.00%	38.33%	39.17%	2.648	1.000	2.648
2028	38.33%	36.67%	37.50%	2.535	1.000	2.535
2029	36.67%	35.00%	35.83%	2.422	1.000	2.422
2030	35.00%	33.33%	34.17%	2.310	1.000	2.310
2031	33.33%	31.67%	32.50%	2.197	1.000	2.197
2032	31.67%	30.00%	30.83%	2.084	1.000	2.084
2033	30.00%	28.33%	29.17%	1.972	1.000	1.972
2034	28.33%	26.67%	27.50%	1.859	1.000	1.859
2035	26.67%	25.00%	25.83%	1.746	1.000	1.746
2036	25.00%	23.33%	24.17%	1.634	1.000	1.634
2037	23.33%	21.67%	22.50%	1.521	1.000	1.521
2038	21.67%	20.00%	20.83%	1.408	1.000	1.408
2039	20.00%	18.33%	19.17%	1.296	1.000	1.296
2040	18.33%	16.67%	17.50%	1.183	1.000	1.183
2041	16.67%	15.00%	15.83%	1.070	1.000	1.070
2042	15.00%	13.33%	14.17%	0.958	1.000	0.958
2043	13.33%	11.67%	12.50%	0.845	1.000	0.845
2044	11.67%	10.00%	10.83%	0.732	1.000	0.732
2045	10.00%	10.00%	10.00%	0.676	1.000	0.676
2046	10.00%	10.00%	10.00%	0.676	1.000	0.676
2047	10.00%	10.00%	10.00%	0.676	1.000	0.676
2048	10.00%	10.00%	10.00%	0.676	1.000	0.676
2049	10.00%	10.00%	10.00%	0.676	1.000	0.676
2050	10.00%	10.00%	10.00%	0.676	1.000	0.676
2051	10.00%	10.00%	10.00%	0.676	1.000	0.676
2052	10.00%	10.00%	10.00%	0.676	1.000	0.676
2053	10.00%	10.00%	10.00%	0.676	1.000	0.676
2054	10.00%	10.00%	10.00%	0.676	1.000	0.676
2055	10.00%	10.00%	10.00%	0.676	1.000	0.676
2056	10.00%	10.00%	10.00%	0.676	1.000	0.676
2057	10.00%	10.00%	10.00%	0.676	1.000	0.676
2058	10.00%	10.00%	10.00%	0.676	1.000	0.676
2059	10.00%	10.00%	10.00%	0.676	1.000	0.676
2060	10.00%	10.00%	10.00%	0.676	1.000	0.676
2061	10.00%	10.00%	10.00%	0.676	1.000	0.676
2062	10.00%	10.00%	10.00%	0.676	1.000	0.676
2063	10.00%	10.00%	10.00%	0.676	1.000	0.676
2064	10.00%	10.00%	10.00%	0.676	1.000	0.676
2065	10.00%	10.00%	10.00%	0.676	1.000	0.676
2066	10.00%	10.00%	10.00%	0.676	1.000	0.676
2067	10.00%	10.00%	10.00%	0.676	1.000	0.676

Service losses at the Injury Area

Year	Beginning	% Services lost End	Mean	Raw SUYs lost	Discount Factor	Discounted SUYs lost
2068	10.00%	10.00%	10.00%	0.676	1.000	0.676
2069	10.00%	10.00%	10.00%	0.676	1.000	0.676
2070	10.00%	10.00%	10.00%	0.676	1.000	0.676

Total Discounted Service Unit Years (DSUYs) lost: 67.938

Service Gains at the Compensatory Area

Year	% Services gained Beginning	End	Mean	Raw SUYs lost	Discount Factor	Discounted SUYs gained
2017	.00%	.00%	0.00%	0.000	1.000	0.000
2018	.00%	.00%	0.00%	0.000	1.000	0.000
2019	.00%	.00%	0.00%	0.000	1.000	0.000
2020	.00%	25.00%	12.50%	0.845	1.000	0.845
2021	25.00%	26.04%	25.52%	1.725	1.000	1.725
2022	26.04%	27.08%	26.56%	1.796	1.000	1.796
2023	27.08%	28.13%	27.60%	1.866	1.000	1.866
2024	28.13%	29.17%	28.65%	1.936	1.000	1.936
2025	29.17%	30.21%	29.69%	2.007	1.000	2.007
2026	30.21%	31.25%	30.73%	2.077	1.000	2.077
2027	31.25%	32.29%	31.77%	2.148	1.000	2.148
2028	32.29%	33.33%	32.81%	2.218	1.000	2.218
2029	33.33%	34.38%	33.85%	2.289	1.000	2.289
2030	34.38%	35.42%	34.90%	2.359	1.000	2.359
2031	35.42%	36.46%	35.94%	2.429	1.000	2.429
2032	36.46%	37.50%	36.98%	2.500	1.000	2.500
2033	37.50%	38.54%	38.02%	2.570	1.000	2.570
2034	38.54%	39.58%	39.06%	2.641	1.000	2.641
2035	39.58%	40.63%	40.10%	2.711	1.000	2.711
2036	40.63%	41.67%	41.15%	2.781	1.000	2.781
2037	41.67%	42.71%	42.19%	2.852	1.000	2.852
2038	42.71%	43.75%	43.23%	2.922	1.000	2.922
2039	43.75%	44.79%	44.27%	2.993	1.000	2.993
2040	44.79%	45.83%	45.31%	3.063	1.000	3.063
2041	45.83%	46.88%	46.35%	3.134	1.000	3.134
2042	46.88%	47.92%	47.40%	3.204	1.000	3.204
2043	47.92%	48.96%	48.44%	3.274	1.000	3.274
2044	48.96%	50.00%	49.48%	3.345	1.000	3.345
2045	50.00%	50.00%	50.00%	3.380	1.000	3.380
2046	50.00%	50.00%	50.00%	3.380	1.000	3.380
2047	50.00%	50.00%	50.00%	3.380	1.000	3.380
2048	50.00%	50.00%	50.00%	3.380	1.000	3.380
2049	50.00%	50.00%	50.00%	3.380	1.000	3.380
2050	50.00%	50.00%	50.00%	3.380	1.000	3.380
2051	50.00%	50.00%	50.00%	3.380	1.000	3.380
2052	50.00%	50.00%	50.00%	3.380	1.000	3.380
2053	50.00%	50.00%	50.00%	3.380	1.000	3.380
2054	50.00%	50.00%	50.00%	3.380	1.000	3.380
2055	50.00%	50.00%	50.00%	3.380	1.000	3.380
2056	50.00%	50.00%	50.00%	3.380	1.000	3.380
2057	50.00%	50.00%	50.00%	3.380	1.000	3.380
2058	50.00%	50.00%	50.00%	3.380	1.000	3.380
2059	50.00%	50.00%	50.00%	3.380	1.000	3.380
2060	50.00%	50.00%	50.00%	3.380	1.000	3.380
2061	50.00%	50.00%	50.00%	3.380	1.000	3.380
2062	50.00%	50.00%	50.00%	3.380	1.000	3.380
2063	50.00%	50.00%	50.00%	3.380	1.000	3.380
2064	50.00%	50.00%	50.00%	3.380	1.000	3.380
2065	50.00%	50.00%	50.00%	3.380	1.000	3.380
2066	50.00%	50.00%	50.00%	3.380	1.000	3.380
2067	50.00%	50.00%	50.00%	3.380	1.000	3.380

Service Gains at the Compensatory Area

Year	% Services gained Beginning	End	Mean	Raw SUYs lost	Discount Factor	Discounted SUYs gained
2068	50.00%	50.00%	50.00%	3.380	1.000	3.380
2069	50.00%	50.00%	50.00%	3.380	1.000	3.380
2070	50.00%	50.00%	50.00%	3.380	1.000	3.380

Total Discounted Service Unit Years (DSUYs) Gained: 149.565
Discounted SUYs gained per unit: 22.125

Replacement habitat size (acre): 1.00 * 67.938/22.125 3.071

VISUAL_HEA HABITAT EQUIVALENCY ANALYSIS

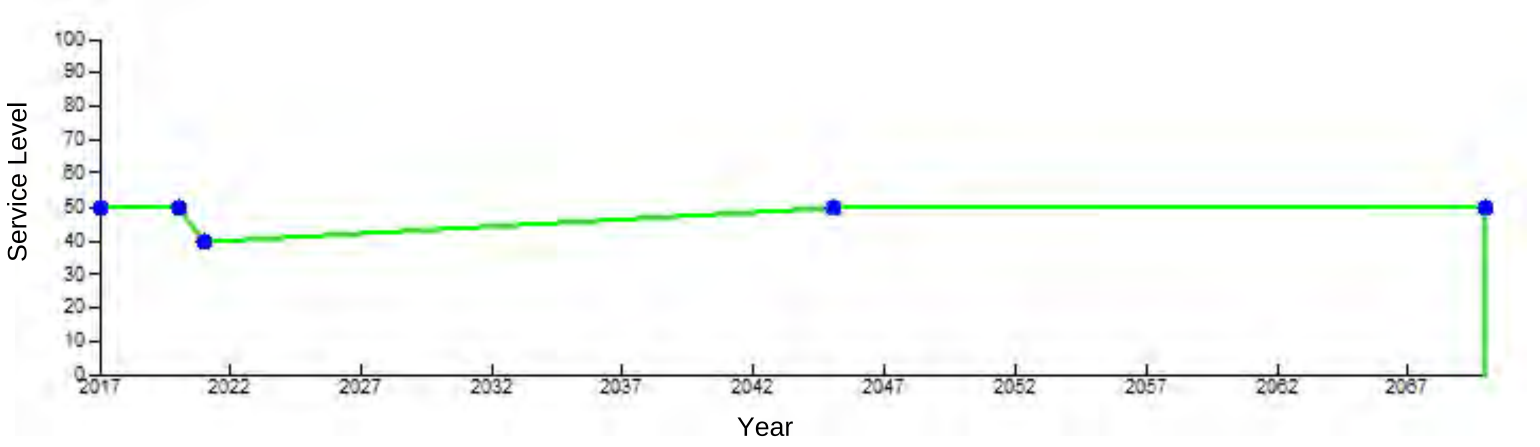
Sitename: Tinian Alt 2 150m buffer

Date: 9/1/2017 12:16:01 PM
Datafile: C:\\Users\\Martha\\Desktop\\HEA Tinian\\Final\\Alternative 2 150m Buffer (17.28 acres).hea

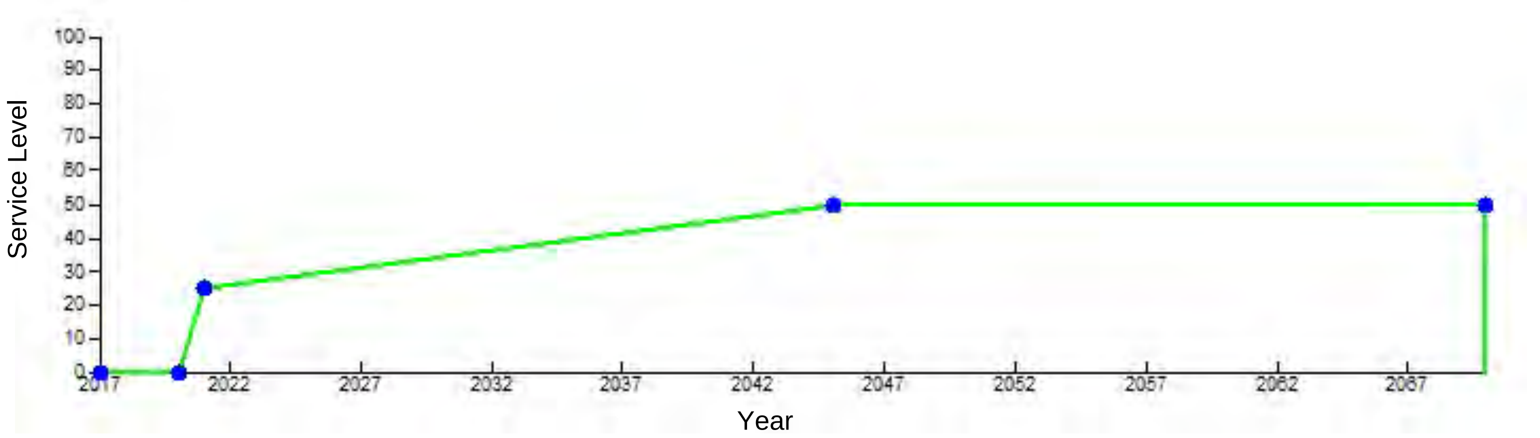
Units: acre
Time units: year

Claim year: 2020
Amount of affected units: 17.28
Pre-injury service level (%): 50.00%
Pre-restoration service level (%): 0.00%
Value ratio injured/restored: 1.00
Discount rate per unit of time(%): 0.000

Service losses at the Injury Area



Service Gains at the Compensatory Area



Service losses at the Injury Area

Year	% Services lost Beginning	End	Mean	Raw SUYs lost	Discount Factor	Discounted SUYs lost
2017	.00%	.00%	0.00%	0.000	1.000	0.000
2018	.00%	.00%	0.00%	0.000	1.000	0.000
2019	.00%	.00%	0.00%	0.000	1.000	0.000
2020	.00%	10.00%	5.00%	0.864	1.000	0.864
2021	10.00%	9.58%	9.79%	1.692	1.000	1.692
2022	9.58%	9.17%	9.37%	1.620	1.000	1.620
2023	9.17%	8.75%	8.96%	1.548	1.000	1.548
2024	8.75%	8.33%	8.54%	1.476	1.000	1.476
2025	8.33%	7.92%	8.12%	1.404	1.000	1.404
2026	7.92%	7.50%	7.71%	1.332	1.000	1.332
2027	7.50%	7.08%	7.29%	1.260	1.000	1.260
2028	7.08%	6.67%	6.87%	1.188	1.000	1.188
2029	6.67%	6.25%	6.46%	1.116	1.000	1.116
2030	6.25%	5.83%	6.04%	1.044	1.000	1.044
2031	5.83%	5.42%	5.62%	0.972	1.000	0.972
2032	5.42%	5.00%	5.21%	0.900	1.000	0.900
2033	5.00%	4.58%	4.79%	0.828	1.000	0.828
2034	4.58%	4.17%	4.37%	0.756	1.000	0.756
2035	4.17%	3.75%	3.96%	0.684	1.000	0.684
2036	3.75%	3.33%	3.54%	0.612	1.000	0.612
2037	3.33%	2.92%	3.12%	0.540	1.000	0.540
2038	2.92%	2.50%	2.71%	0.468	1.000	0.468
2039	2.50%	2.08%	2.29%	0.396	1.000	0.396
2040	2.08%	1.67%	1.87%	0.324	1.000	0.324
2041	1.67%	1.25%	1.46%	0.252	1.000	0.252
2042	1.25%	.83%	1.04%	0.180	1.000	0.180
2043	.83%	.42%	0.62%	0.108	1.000	0.108
2044	.42%	.00%	0.21%	0.036	1.000	0.036
2045	.00%	.00%	0.00%	0.000	1.000	0.000
2046	.00%	.00%	0.00%	0.000	1.000	0.000
2047	.00%	.00%	0.00%	0.000	1.000	0.000
2048	.00%	.00%	0.00%	0.000	1.000	0.000
2049	.00%	.00%	0.00%	0.000	1.000	0.000
2050	.00%	.00%	0.00%	0.000	1.000	0.000
2051	.00%	.00%	0.00%	0.000	1.000	0.000
2052	.00%	.00%	0.00%	0.000	1.000	0.000
2053	.00%	.00%	0.00%	0.000	1.000	0.000
2054	.00%	.00%	0.00%	0.000	1.000	0.000
2055	.00%	.00%	0.00%	0.000	1.000	0.000
2056	.00%	.00%	0.00%	0.000	1.000	0.000
2057	.00%	.00%	0.00%	0.000	1.000	0.000
2058	.00%	.00%	0.00%	0.000	1.000	0.000
2059	.00%	.00%	0.00%	0.000	1.000	0.000
2060	.00%	.00%	0.00%	0.000	1.000	0.000
2061	.00%	.00%	0.00%	0.000	1.000	0.000
2062	.00%	.00%	0.00%	0.000	1.000	0.000
2063	.00%	.00%	0.00%	0.000	1.000	0.000
2064	.00%	.00%	0.00%	0.000	1.000	0.000
2065	.00%	.00%	0.00%	0.000	1.000	0.000
2066	.00%	.00%	0.00%	0.000	1.000	0.000
2067	.00%	.00%	0.00%	0.000	1.000	0.000

Service losses at the Injury Area

Year	% Services lost Beginning	End	Mean	Raw SUYs lost	Discount Factor	Discounted SUYs lost
2068	.00%	.00%	0.00%	0.000	1.000	0.000
2069	.00%	.00%	0.00%	0.000	1.000	0.000
2070	.00%	.00%	0.00%	0.000	1.000	0.000

Total Discounted Service Unit Years (DSUYs) lost: 21.600

Service Gains at the Compensatory Area

Year	% Services gained					
	Beginning	End	Mean	Raw SUYs lost	Discount Factor	Discounted SUYs gained
2017	.00%	.00%	0.00%	0.000	1.000	0.000
2018	.00%	.00%	0.00%	0.000	1.000	0.000
2019	.00%	.00%	0.00%	0.000	1.000	0.000
2020	.00%	25.00%	12.50%	2.160	1.000	2.160
2021	25.00%	26.04%	25.52%	4.410	1.000	4.410
2022	26.04%	27.08%	26.56%	4.590	1.000	4.590
2023	27.08%	28.13%	27.60%	4.770	1.000	4.770
2024	28.13%	29.17%	28.65%	4.950	1.000	4.950
2025	29.17%	30.21%	29.69%	5.130	1.000	5.130
2026	30.21%	31.25%	30.73%	5.310	1.000	5.310
2027	31.25%	32.29%	31.77%	5.490	1.000	5.490
2028	32.29%	33.33%	32.81%	5.670	1.000	5.670
2029	33.33%	34.38%	33.85%	5.850	1.000	5.850
2030	34.38%	35.42%	34.90%	6.030	1.000	6.030
2031	35.42%	36.46%	35.94%	6.210	1.000	6.210
2032	36.46%	37.50%	36.98%	6.390	1.000	6.390
2033	37.50%	38.54%	38.02%	6.570	1.000	6.570
2034	38.54%	39.58%	39.06%	6.750	1.000	6.750
2035	39.58%	40.63%	40.10%	6.930	1.000	6.930
2036	40.63%	41.67%	41.15%	7.110	1.000	7.110
2037	41.67%	42.71%	42.19%	7.290	1.000	7.290
2038	42.71%	43.75%	43.23%	7.470	1.000	7.470
2039	43.75%	44.79%	44.27%	7.650	1.000	7.650
2040	44.79%	45.83%	45.31%	7.830	1.000	7.830
2041	45.83%	46.88%	46.35%	8.010	1.000	8.010
2042	46.88%	47.92%	47.40%	8.190	1.000	8.190
2043	47.92%	48.96%	48.44%	8.370	1.000	8.370
2044	48.96%	50.00%	49.48%	8.550	1.000	8.550
2045	50.00%	50.00%	50.00%	8.640	1.000	8.640
2046	50.00%	50.00%	50.00%	8.640	1.000	8.640
2047	50.00%	50.00%	50.00%	8.640	1.000	8.640
2048	50.00%	50.00%	50.00%	8.640	1.000	8.640
2049	50.00%	50.00%	50.00%	8.640	1.000	8.640
2050	50.00%	50.00%	50.00%	8.640	1.000	8.640
2051	50.00%	50.00%	50.00%	8.640	1.000	8.640
2052	50.00%	50.00%	50.00%	8.640	1.000	8.640
2053	50.00%	50.00%	50.00%	8.640	1.000	8.640
2054	50.00%	50.00%	50.00%	8.640	1.000	8.640
2055	50.00%	50.00%	50.00%	8.640	1.000	8.640
2056	50.00%	50.00%	50.00%	8.640	1.000	8.640
2057	50.00%	50.00%	50.00%	8.640	1.000	8.640
2058	50.00%	50.00%	50.00%	8.640	1.000	8.640
2059	50.00%	50.00%	50.00%	8.640	1.000	8.640
2060	50.00%	50.00%	50.00%	8.640	1.000	8.640
2061	50.00%	50.00%	50.00%	8.640	1.000	8.640
2062	50.00%	50.00%	50.00%	8.640	1.000	8.640
2063	50.00%	50.00%	50.00%	8.640	1.000	8.640
2064	50.00%	50.00%	50.00%	8.640	1.000	8.640
2065	50.00%	50.00%	50.00%	8.640	1.000	8.640
2066	50.00%	50.00%	50.00%	8.640	1.000	8.640
2067	50.00%	50.00%	50.00%	8.640	1.000	8.640

Service Gains at the Compensatory Area

Year	% Services gained Beginning	End	Mean	Raw SUYs lost	Discount Factor	Discounted SUYs gained
2068	50.00%	50.00%	50.00%	8.640	1.000	8.640
2069	50.00%	50.00%	50.00%	8.640	1.000	8.640
2070	50.00%	50.00%	50.00%	8.640	1.000	8.640

Total Discounted Service Unit Years (DSUYs) Gained: 382.320

Discounted SUYs gained per unit: 22.125

Replacement habitat size (acre): 1.00 * 21.6/22.125 0.976

VISUAL_HEA HABITAT EQUIVALENCY ANALYSIS

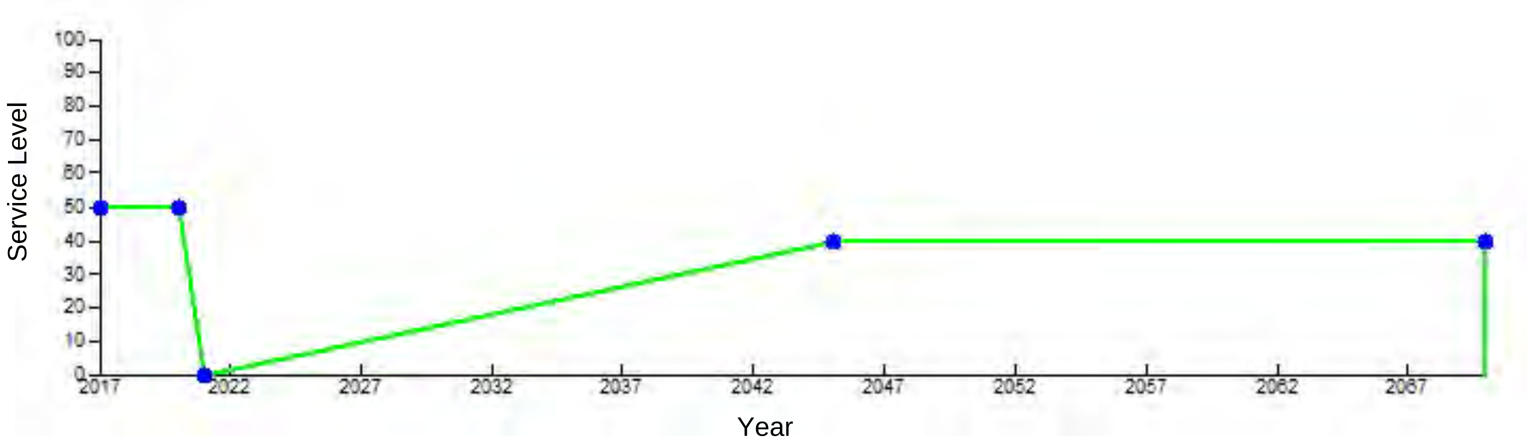
Sitename: Tinian 25 years 7.67 acres

Date: 9/1/2017 12:15:31 PM
Datafile: C:\\Users\\Martha\\Desktop\\HEA Tinian\\Final\\Tinian 50% 25 years 7.67 acres.hea

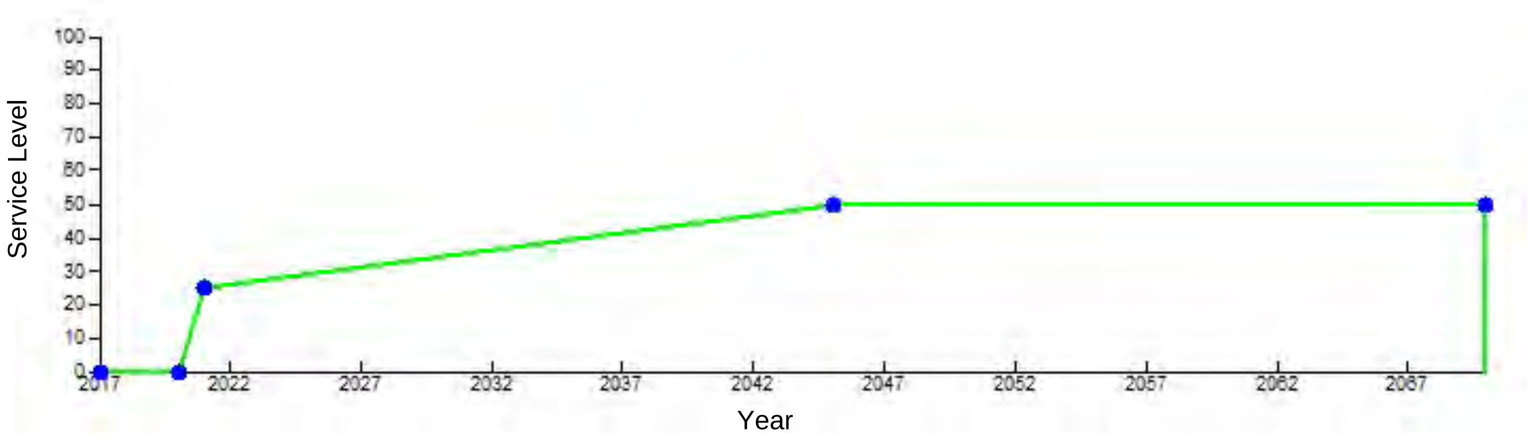
Units: acre
Time units: year

Claim year: 2020
Amount of affected units: 7.67
Pre-injury service level (%): 50.00%
Pre-restoration service level (%): 0.00%
Value ratio injured/restored: 1.00
Discount rate per unit of time(%): 0.000

Service losses at the Injury Area



Service Gains at the Compensatory Area



Service losses at the Injury Area

Year	% Services lost Beginning	End	Mean	Raw SUYs lost	Discount Factor	Discounted SUYs lost
2017	.00%	.00%	0.00%	0.000	1.000	0.000
2018	.00%	.00%	0.00%	0.000	1.000	0.000
2019	.00%	.00%	0.00%	0.000	1.000	0.000
2020	.00%	50.00%	25.00%	1.918	1.000	1.918
2021	50.00%	48.33%	49.17%	3.771	1.000	3.771
2022	48.33%	46.67%	47.50%	3.643	1.000	3.643
2023	46.67%	45.00%	45.83%	3.515	1.000	3.515
2024	45.00%	43.33%	44.17%	3.388	1.000	3.388
2025	43.33%	41.67%	42.50%	3.260	1.000	3.260
2026	41.67%	40.00%	40.83%	3.132	1.000	3.132
2027	40.00%	38.33%	39.17%	3.004	1.000	3.004
2028	38.33%	36.67%	37.50%	2.876	1.000	2.876
2029	36.67%	35.00%	35.83%	2.748	1.000	2.748
2030	35.00%	33.33%	34.17%	2.621	1.000	2.621
2031	33.33%	31.67%	32.50%	2.493	1.000	2.493
2032	31.67%	30.00%	30.83%	2.365	1.000	2.365
2033	30.00%	28.33%	29.17%	2.237	1.000	2.237
2034	28.33%	26.67%	27.50%	2.109	1.000	2.109
2035	26.67%	25.00%	25.83%	1.981	1.000	1.981
2036	25.00%	23.33%	24.17%	1.854	1.000	1.854
2037	23.33%	21.67%	22.50%	1.726	1.000	1.726
2038	21.67%	20.00%	20.83%	1.598	1.000	1.598
2039	20.00%	18.33%	19.17%	1.470	1.000	1.470
2040	18.33%	16.67%	17.50%	1.342	1.000	1.342
2041	16.67%	15.00%	15.83%	1.214	1.000	1.214
2042	15.00%	13.33%	14.17%	1.087	1.000	1.087
2043	13.33%	11.67%	12.50%	0.959	1.000	0.959
2044	11.67%	10.00%	10.83%	0.831	1.000	0.831
2045	10.00%	10.00%	10.00%	0.767	1.000	0.767
2046	10.00%	10.00%	10.00%	0.767	1.000	0.767
2047	10.00%	10.00%	10.00%	0.767	1.000	0.767
2048	10.00%	10.00%	10.00%	0.767	1.000	0.767
2049	10.00%	10.00%	10.00%	0.767	1.000	0.767
2050	10.00%	10.00%	10.00%	0.767	1.000	0.767
2051	10.00%	10.00%	10.00%	0.767	1.000	0.767
2052	10.00%	10.00%	10.00%	0.767	1.000	0.767
2053	10.00%	10.00%	10.00%	0.767	1.000	0.767
2054	10.00%	10.00%	10.00%	0.767	1.000	0.767
2055	10.00%	10.00%	10.00%	0.767	1.000	0.767
2056	10.00%	10.00%	10.00%	0.767	1.000	0.767
2057	10.00%	10.00%	10.00%	0.767	1.000	0.767
2058	10.00%	10.00%	10.00%	0.767	1.000	0.767
2059	10.00%	10.00%	10.00%	0.767	1.000	0.767
2060	10.00%	10.00%	10.00%	0.767	1.000	0.767
2061	10.00%	10.00%	10.00%	0.767	1.000	0.767
2062	10.00%	10.00%	10.00%	0.767	1.000	0.767
2063	10.00%	10.00%	10.00%	0.767	1.000	0.767
2064	10.00%	10.00%	10.00%	0.767	1.000	0.767
2065	10.00%	10.00%	10.00%	0.767	1.000	0.767
2066	10.00%	10.00%	10.00%	0.767	1.000	0.767
2067	10.00%	10.00%	10.00%	0.767	1.000	0.767

Service losses at the Injury Area

Year	% Services lost Beginning	End	Mean	Raw SUYs lost	Discount Factor	Discounted SUYs lost
2068	10.00%	10.00%	10.00%	0.767	1.000	0.767
2069	10.00%	10.00%	10.00%	0.767	1.000	0.767
2070	10.00%	10.00%	10.00%	0.767	1.000	0.767

Total Discounted Service Unit Years (DSUYs) lost: 77.083

Service Gains at the Compensatory Area

Year	% Services gained					
	Beginning	End	Mean	Raw SUYs lost	Discount Factor	Discounted SUYs gained
2017	.00%	.00%	0.00%	0.000	1.000	0.000
2018	.00%	.00%	0.00%	0.000	1.000	0.000
2019	.00%	.00%	0.00%	0.000	1.000	0.000
2020	.00%	25.00%	12.50%	0.959	1.000	0.959
2021	25.00%	26.04%	25.52%	1.957	1.000	1.957
2022	26.04%	27.08%	26.56%	2.037	1.000	2.037
2023	27.08%	28.13%	27.60%	2.117	1.000	2.117
2024	28.13%	29.17%	28.65%	2.197	1.000	2.197
2025	29.17%	30.21%	29.69%	2.277	1.000	2.277
2026	30.21%	31.25%	30.73%	2.357	1.000	2.357
2027	31.25%	32.29%	31.77%	2.437	1.000	2.437
2028	32.29%	33.33%	32.81%	2.517	1.000	2.517
2029	33.33%	34.38%	33.85%	2.597	1.000	2.597
2030	34.38%	35.42%	34.90%	2.677	1.000	2.677
2031	35.42%	36.46%	35.94%	2.756	1.000	2.756
2032	36.46%	37.50%	36.98%	2.836	1.000	2.836
2033	37.50%	38.54%	38.02%	2.916	1.000	2.916
2034	38.54%	39.58%	39.06%	2.996	1.000	2.996
2035	39.58%	40.63%	40.10%	3.076	1.000	3.076
2036	40.63%	41.67%	41.15%	3.156	1.000	3.156
2037	41.67%	42.71%	42.19%	3.236	1.000	3.236
2038	42.71%	43.75%	43.23%	3.316	1.000	3.316
2039	43.75%	44.79%	44.27%	3.396	1.000	3.396
2040	44.79%	45.83%	45.31%	3.475	1.000	3.475
2041	45.83%	46.88%	46.35%	3.555	1.000	3.555
2042	46.88%	47.92%	47.40%	3.635	1.000	3.635
2043	47.92%	48.96%	48.44%	3.715	1.000	3.715
2044	48.96%	50.00%	49.48%	3.795	1.000	3.795
2045	50.00%	50.00%	50.00%	3.835	1.000	3.835
2046	50.00%	50.00%	50.00%	3.835	1.000	3.835
2047	50.00%	50.00%	50.00%	3.835	1.000	3.835
2048	50.00%	50.00%	50.00%	3.835	1.000	3.835
2049	50.00%	50.00%	50.00%	3.835	1.000	3.835
2050	50.00%	50.00%	50.00%	3.835	1.000	3.835
2051	50.00%	50.00%	50.00%	3.835	1.000	3.835
2052	50.00%	50.00%	50.00%	3.835	1.000	3.835
2053	50.00%	50.00%	50.00%	3.835	1.000	3.835
2054	50.00%	50.00%	50.00%	3.835	1.000	3.835
2055	50.00%	50.00%	50.00%	3.835	1.000	3.835
2056	50.00%	50.00%	50.00%	3.835	1.000	3.835
2057	50.00%	50.00%	50.00%	3.835	1.000	3.835
2058	50.00%	50.00%	50.00%	3.835	1.000	3.835
2059	50.00%	50.00%	50.00%	3.835	1.000	3.835
2060	50.00%	50.00%	50.00%	3.835	1.000	3.835
2061	50.00%	50.00%	50.00%	3.835	1.000	3.835
2062	50.00%	50.00%	50.00%	3.835	1.000	3.835
2063	50.00%	50.00%	50.00%	3.835	1.000	3.835
2064	50.00%	50.00%	50.00%	3.835	1.000	3.835
2065	50.00%	50.00%	50.00%	3.835	1.000	3.835
2066	50.00%	50.00%	50.00%	3.835	1.000	3.835
2067	50.00%	50.00%	50.00%	3.835	1.000	3.835

Service Gains at the Compensatory Area

Year	% Services gained					
	Beginning	End	Mean	Raw SUYs lost	Discount Factor	Discounted SUYs gained
2068	50.00%	50.00%	50.00%	3.835	1.000	3.835
2069	50.00%	50.00%	50.00%	3.835	1.000	3.835
2070	50.00%	50.00%	50.00%	3.835	1.000	3.835

Total Discounted Service Unit Years (DSUYs) Gained: 169.699
Discounted SUYs gained per unit: 22.125

Replacement habitat size (acre): 1.00 * 77.083/22.125 3.484

VISUAL_HEA HABITAT EQUIVALENCY ANALYSIS

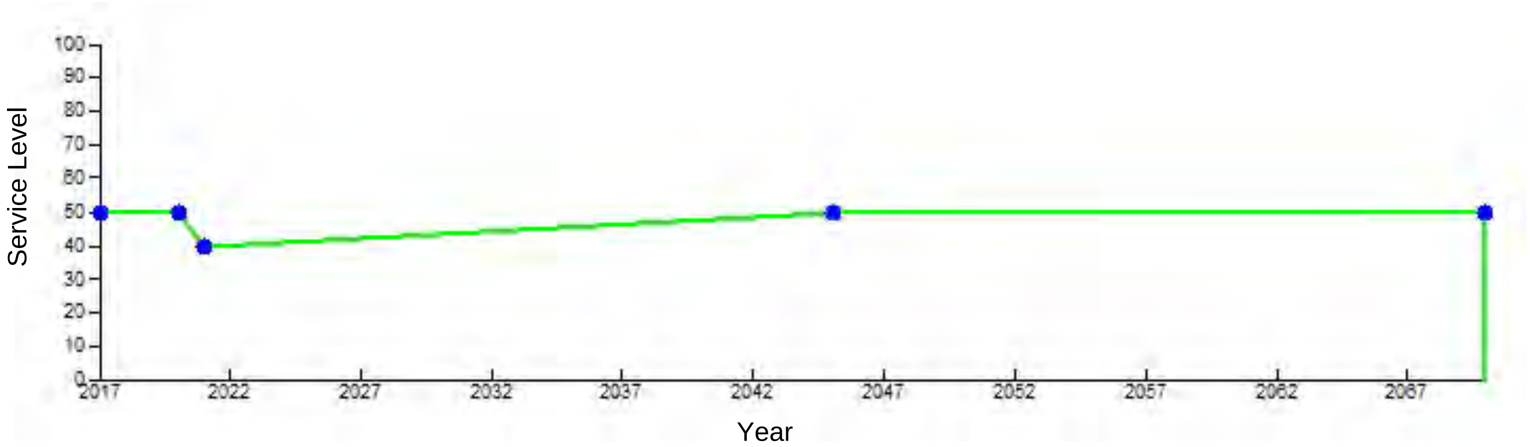
Sitename: Tinian Alt 2 150m buffer

Date: 9/1/2017 12:16:28 PM
Datafile: C:\\Users\\Martha\\Desktop\\HEA Tinian\\Final\\Alternative 3 150m Buffer (19.26 acres).hea

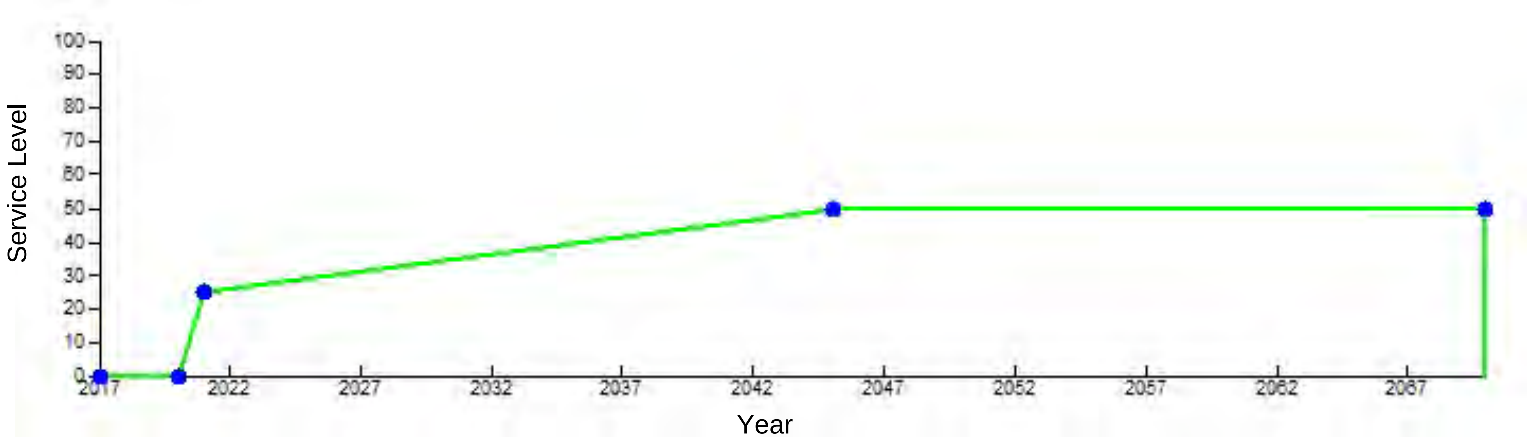
Units: acre
Time units: year

Claim year: 2020
Amount of affected units: 19.26
Pre-injury service level (%): 50.00%
Pre-restoration service level (%): 0.00%
Value ratio injured/restored: 1.00
Discount rate per unit of time(%): 0.000

Service losses at the Injury Area



Service Gains at the Compensatory Area



Service losses at the Injury Area

Year	% Services lost Beginning	End	Mean	Raw SUYs lost	Discount Factor	Discounted SUYs lost
2017	.00%	.00%	0.00%	0.000	1.000	0.000
2018	.00%	.00%	0.00%	0.000	1.000	0.000
2019	.00%	.00%	0.00%	0.000	1.000	0.000
2020	.00%	10.00%	5.00%	0.963	1.000	0.963
2021	10.00%	9.58%	9.79%	1.886	1.000	1.886
2022	9.58%	9.17%	9.37%	1.806	1.000	1.806
2023	9.17%	8.75%	8.96%	1.725	1.000	1.725
2024	8.75%	8.33%	8.54%	1.645	1.000	1.645
2025	8.33%	7.92%	8.12%	1.565	1.000	1.565
2026	7.92%	7.50%	7.71%	1.485	1.000	1.485
2027	7.50%	7.08%	7.29%	1.404	1.000	1.404
2028	7.08%	6.67%	6.87%	1.324	1.000	1.324
2029	6.67%	6.25%	6.46%	1.244	1.000	1.244
2030	6.25%	5.83%	6.04%	1.164	1.000	1.164
2031	5.83%	5.42%	5.62%	1.083	1.000	1.083
2032	5.42%	5.00%	5.21%	1.003	1.000	1.003
2033	5.00%	4.58%	4.79%	0.923	1.000	0.923
2034	4.58%	4.17%	4.37%	0.843	1.000	0.843
2035	4.17%	3.75%	3.96%	0.762	1.000	0.762
2036	3.75%	3.33%	3.54%	0.682	1.000	0.682
2037	3.33%	2.92%	3.12%	0.602	1.000	0.602
2038	2.92%	2.50%	2.71%	0.522	1.000	0.522
2039	2.50%	2.08%	2.29%	0.441	1.000	0.441
2040	2.08%	1.67%	1.87%	0.361	1.000	0.361
2041	1.67%	1.25%	1.46%	0.281	1.000	0.281
2042	1.25%	.83%	1.04%	0.201	1.000	0.201
2043	.83%	.42%	0.62%	0.120	1.000	0.120
2044	.42%	.00%	0.21%	0.040	1.000	0.040
2045	.00%	.00%	0.00%	0.000	1.000	0.000
2046	.00%	.00%	0.00%	0.000	1.000	0.000
2047	.00%	.00%	0.00%	0.000	1.000	0.000
2048	.00%	.00%	0.00%	0.000	1.000	0.000
2049	.00%	.00%	0.00%	0.000	1.000	0.000
2050	.00%	.00%	0.00%	0.000	1.000	0.000
2051	.00%	.00%	0.00%	0.000	1.000	0.000
2052	.00%	.00%	0.00%	0.000	1.000	0.000
2053	.00%	.00%	0.00%	0.000	1.000	0.000
2054	.00%	.00%	0.00%	0.000	1.000	0.000
2055	.00%	.00%	0.00%	0.000	1.000	0.000
2056	.00%	.00%	0.00%	0.000	1.000	0.000
2057	.00%	.00%	0.00%	0.000	1.000	0.000
2058	.00%	.00%	0.00%	0.000	1.000	0.000
2059	.00%	.00%	0.00%	0.000	1.000	0.000
2060	.00%	.00%	0.00%	0.000	1.000	0.000
2061	.00%	.00%	0.00%	0.000	1.000	0.000
2062	.00%	.00%	0.00%	0.000	1.000	0.000
2063	.00%	.00%	0.00%	0.000	1.000	0.000
2064	.00%	.00%	0.00%	0.000	1.000	0.000
2065	.00%	.00%	0.00%	0.000	1.000	0.000
2066	.00%	.00%	0.00%	0.000	1.000	0.000
2067	.00%	.00%	0.00%	0.000	1.000	0.000

Service losses at the Injury Area

Year	% Services lost					
	Beginning	End	Mean	Raw SUYs lost	Discount Factor	Discounted SUYs lost
2068	.00%	.00%	0.00%	0.000	1.000	0.000
2069	.00%	.00%	0.00%	0.000	1.000	0.000
2070	.00%	.00%	0.00%	0.000	1.000	0.000

Total Discounted Service Unit Years (DSUYs) lost: 24.075

Service Gains at the Compensatory Area

Year	% Services gained					
	Beginning	End	Mean	Raw SUYs lost	Discount Factor	Discounted SUYs gained
2017	.00%	.00%	0.00%	0.000	1.000	0.000
2018	.00%	.00%	0.00%	0.000	1.000	0.000
2019	.00%	.00%	0.00%	0.000	1.000	0.000
2020	.00%	25.00%	12.50%	2.408	1.000	2.408
2021	25.00%	26.04%	25.52%	4.915	1.000	4.915
2022	26.04%	27.08%	26.56%	5.116	1.000	5.116
2023	27.08%	28.13%	27.60%	5.317	1.000	5.317
2024	28.13%	29.17%	28.65%	5.517	1.000	5.517
2025	29.17%	30.21%	29.69%	5.718	1.000	5.718
2026	30.21%	31.25%	30.73%	5.918	1.000	5.918
2027	31.25%	32.29%	31.77%	6.119	1.000	6.119
2028	32.29%	33.33%	32.81%	6.320	1.000	6.320
2029	33.33%	34.38%	33.85%	6.520	1.000	6.520
2030	34.38%	35.42%	34.90%	6.721	1.000	6.721
2031	35.42%	36.46%	35.94%	6.922	1.000	6.922
2032	36.46%	37.50%	36.98%	7.122	1.000	7.122
2033	37.50%	38.54%	38.02%	7.323	1.000	7.323
2034	38.54%	39.58%	39.06%	7.523	1.000	7.523
2035	39.58%	40.63%	40.10%	7.724	1.000	7.724
2036	40.63%	41.67%	41.15%	7.925	1.000	7.925
2037	41.67%	42.71%	42.19%	8.125	1.000	8.125
2038	42.71%	43.75%	43.23%	8.326	1.000	8.326
2039	43.75%	44.79%	44.27%	8.527	1.000	8.527
2040	44.79%	45.83%	45.31%	8.727	1.000	8.727
2041	45.83%	46.88%	46.35%	8.928	1.000	8.928
2042	46.88%	47.92%	47.40%	9.128	1.000	9.128
2043	47.92%	48.96%	48.44%	9.329	1.000	9.329
2044	48.96%	50.00%	49.48%	9.530	1.000	9.530
2045	50.00%	50.00%	50.00%	9.630	1.000	9.630
2046	50.00%	50.00%	50.00%	9.630	1.000	9.630
2047	50.00%	50.00%	50.00%	9.630	1.000	9.630
2048	50.00%	50.00%	50.00%	9.630	1.000	9.630
2049	50.00%	50.00%	50.00%	9.630	1.000	9.630
2050	50.00%	50.00%	50.00%	9.630	1.000	9.630
2051	50.00%	50.00%	50.00%	9.630	1.000	9.630
2052	50.00%	50.00%	50.00%	9.630	1.000	9.630
2053	50.00%	50.00%	50.00%	9.630	1.000	9.630
2054	50.00%	50.00%	50.00%	9.630	1.000	9.630
2055	50.00%	50.00%	50.00%	9.630	1.000	9.630
2056	50.00%	50.00%	50.00%	9.630	1.000	9.630
2057	50.00%	50.00%	50.00%	9.630	1.000	9.630
2058	50.00%	50.00%	50.00%	9.630	1.000	9.630
2059	50.00%	50.00%	50.00%	9.630	1.000	9.630
2060	50.00%	50.00%	50.00%	9.630	1.000	9.630
2061	50.00%	50.00%	50.00%	9.630	1.000	9.630
2062	50.00%	50.00%	50.00%	9.630	1.000	9.630
2063	50.00%	50.00%	50.00%	9.630	1.000	9.630
2064	50.00%	50.00%	50.00%	9.630	1.000	9.630
2065	50.00%	50.00%	50.00%	9.630	1.000	9.630
2066	50.00%	50.00%	50.00%	9.630	1.000	9.630
2067	50.00%	50.00%	50.00%	9.630	1.000	9.630

Service Gains at the Compensatory Area

Year	% Services gained Beginning	End	Mean	Raw SUYs lost	Discount Factor	Discounted SUYs gained
2068	50.00%	50.00%	50.00%	9.630	1.000	9.630
2069	50.00%	50.00%	50.00%	9.630	1.000	9.630
2070	50.00%	50.00%	50.00%	9.630	1.000	9.630

Total Discounted Service Unit Years (DSUYs) Gained: 426.128

Discounted SUYs gained per unit: 22.125

Replacement habitat size (acre): 1.00 * 24.075/22.125 1.088

Appendix 5

Remote and Subsistence Harbors Authority

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Water Resources Reform and Development Act

Water Resources Reform and Development Act (WRRDA) is the primary legislation by which Congress authorizes the Corps of Engineers' key civil works missions, including navigation, flood risk management and environmental restoration. The authorities provided in WRRDA help USACE continue to provide value to the nation in developing and maintaining the nation's waterways and harbors, reducing damages from storm events, and restoring the environment.

Tinian Harbor Modification Project was evaluated under WRRDA, specifically Section 2006, Remote and Subsistence Harbors, as economically, the project could not be justified for federal civil works interest. Section 2006 is outlined below. Additional documentation regarding the proposed use of WRRDA, Section 2006 is provided as attachments.

SEC. 2006. REMOTE AND SUBSISTENCE HARBORS.

(a) IN GENERAL.—In conducting a study of harbor and navigation improvements, the Secretary may recommend a project without the need to demonstrate that the project is justified solely by national economic development benefits if the Secretary determines that—

> (1)(A) the community to be served by the project is at least 70 miles from the nearest surface accessible commercial port and has no direct rail or highway link to another community served by a surface accessible port or harbor; or
>
> (B) the project would be located in the State of Hawaii, the Commonwealth of Puerto Rico, Guam, the Commonwealth of the Northern Mariana Islands, the United States Virgin Islands, or American Samoa;
>
> (2) the harbor is economically critical such that over 80 percent of the goods transported through the harbor would be consumed within the community served by the harbor and navigation improvement; and
>
> (3) the long-term viability of the community would be threatened without the harbor and navigation improvement.

(b) JUSTIFICATION.—In considering whether to recommend a project under subsection (a), the Secretary shall consider the bene- fits of the project to—

> (1) public health and safety of the local community, including access to facilities designed to protect public health and safety;
>
> (2) access to natural resources for subsistence purposes;
>
> (3) local and regional economic opportunities;
>
> (4) welfare of the local population; and
>
> (5) social and cultural value to the community.

Attachments:

- Tinian Harbor Modification Study, Viability Discussion

Tinian Harbor Modification Study
Viability Discussion

The island of Tinian is located within the Commonwealth of the Northern Mariana Islands, approximately 15 miles from the island of Saipan, the closest transshipment point for waterborne commerce. Tinian Harbor serves as a lifeline to the islands' 3,100 residents, approximately 90 percent of all goods and materials on the island are imported, of which 90 percent enter through the harbor.

Cancelled Calls and Impact to Community Welfare:
While usability days does help to screen alternatives, the impacts to the welfare and local population is a justification mechanism used for the Remote and Subsistence Harbor authorization. The true impacts on an increase in usable days is best described by the increased probability of vessels to effectively navigate within the harbor without cancelled vessel calls. Fortunately for Tinian, the protection of the breakwater reduces the amount of cancelled calls, however, as realized in the CNMI, cancelled calls can mean an increase cost of ocean transported food items. The correlation between cancelled vessel calls and increased food costs in the CNMI is one-to-one meaning that an increase in cancelled vessel calls increases food costs and, likewise, a decrease in cancelled vessel calls, decreases food costs.
Access to essential commodities relies heavily on the ability for vessels to enter into the harbor.

Petroleum and energy supply accounts for 47% of all commodities while food and beverages follow at over 16% of all commodities that enter the harbor. When calls are cancelled due to wave and current conditions, the local community experiences a hardship. This hardship comes from a delay of goods and an increase in the cost of goods, which affects the welfare of the community. Transporting commodities in air is not possible for petroleum and is much more expensive than ocean cargo. When air cargo occurs, the added expense is for transporting goods is transferred to the consumer. Reducing the need for air cargo will help to manage the cost of food and goods on the island. This will have both short and long term effects on the price of goods in the community.

Subsistence and Recreational Fishing:
Fishing in Tinian is very common to the local population with linkages to the ancient Chamorran traditions. Over 50 percent of the residents in Tinian are of Chamorro background and practice Chamorro culture regularly. Fishing is a heavily practiced cultural tradition to many of its residents. The ancient Chamorros relied heavily on resources of the sea for their substances and the traditions are practiced by some still today1. While the number of subsistence fishing is low, many of its residents practice recreational fishing regularly2. If wave conditions become a challenge for residents, there is a great possibility that there will be a decline in subsistence fishing is partially attributed to the intensity of waves.

Wave conditions in the harbor limit the availability of days to practice subsistence and recreational fishing. Conditions as these discourage residents by limiting their access to traditional and cultural practices. If conditions in the harbor decline, subsistence and recreational fishing could decline, ultimately eliminating the social and cultural traditions in the community.

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[1] Cunningham, Lawrence J. Ancient Chamorro Society. pp. 30-31, 41
[2] CNMI Department of Commerce. http://i2io42u7ucg3bwn5b3l0fquc.wpengine.netdna-cdn.com/wp-content/uploads/2012/12/2010-Census-Demographics-Profile-Summary-Rota-Village-Tables.pdf

Potential Typhoon Damage and Recovery Efforts:
The viability of the community is currently at considerable risk due to the deteriorated and vulnerable condition of the breakwater. It is not uncommon for “super typhoons”, defined as a typhoon exceeding the maximum wind speed of a Category 5 cyclone (175 mph), to affect this area. Between 1945 and 2015, approximately 50 storms in the western Pacific met this criteria. Based on the wave heights and storm surge experienced in historical typhoon events in this region, if Tinian were to experience a direct hit (or near miss) by a typhoon greater than Category 3, the combination of storm surge and high waves affecting the breakwater remnants would likely destroy much or all of the above-water remaining structure.

During this or subsequent high wave events, waves would propagate unimpeded into the harbor creating dangerous conditions in the turning basin, and potentially inundating the wharf area and causing significant damage to harbor infrastructure and landside facilities. This would render the harbor incapacitated for an extended period of time, causing an effective standstill to port operations and delivery of goods such as fuel, food and emergency supplies.
As the only commercial harbor serving the island of Tinian, there would be a heavy dependence on the harbor to import materials and supplies needed for post-storm recovery efforts. Disruption to port operations (inability to import materials through the port) would add substantially to the time and cost required to reconstruct the breakwater, repair damages to port facilities to restore operations, and significantly delay recovery efforts island wide.

In addition, damage to the without project breakwater during a typhoon event could result in debris and broken sheetpile being transported to the channel or up onto land, requiring costly debris removal efforts to enable port usage and/or breakwater repair. A repaired breakwater would be much less likely to sustain heavy damage in a storm, and would not scatter debris around the harbor. Damages to marine resources (e.g. – corals) in a typhoon may also be reduced if a controlled repair of the breakwater has already been completed.

Wave modeling of the 50-year (2% probability) wave conditions (Wave Ht = 33 ft, Wave Period = 12s) and water level (10 ft of storm surge) that would be expected during a powerful typhoon indicates that under both the Future Without Project Condition and Alternative 2 (replace existing breakwater), the significant amount of storm surge will inundate the Tinian Harbor wharf. The protection that Alternative 1 provides by sheltering the wharf from breaking waves (and therefore wave setup of water level) will reduce the surge elevations at the wharf by up to 6.5 feet in some areas (See Figure 1), and protect it from turbulence due to breaking waves. In other words, the wharf will be flooded in both cases (with and without project) but wave breaking and turbulence at specific water elevations during such a storm would be reduced under Alternative 1. This is likely to result in less damage to the wharf and landside facilities.

Strategic Importance to US National Defense:
The Commonwealth of the Northern Mariana Islands is recognized as strategically important to U.S. national defense and stability in the Asia-Pacific region. Two-thirds of the island of Tinian, major portions of land on Saipan, and the entire island of Farallon de Medinilla have been leased to the U.S. government for military purposes.

The planned relocation of approximately 5,000 Okinawa-based Marines to Guam (Guam Buildup) is part of a broader agreement between the U.S. and Japan governments to reduce the presence of Marines on the island of Okinawa, Japan.   Additionally, in 2016 the U.S. Air Force selected the Tinian International Airport as the location for planned Divert Activities and Exercises Initiative.

Tinian Harbor is an essential component of the military's plans for training and divert activities on the island. It serves as an entry point for equipment, supplies and materials needed to support the military's activities.   Any disruption to military's activities on the island would negatively impact its readiness to meet U.S. national security obligations in the Western Pacific, and risk long term regional and national viability.

Figure 1. Water Elevation Difference Between Future Without Project Condition and Replace Breakwater Alternative (shown in meters), modeled for 50-year (2% probability) wave and storm surge due to typhoon (using CMS-Wave)

Appendix 6

Best Management Practices

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Tinian Harbor, CNMI
Harbor Modification Study
Feasibility Report
Appendix 6
Best Management Practices

Table of Contents

1 INTRODUCTION

This section provides mitigative measures that would eliminate and/or reduce potential harm to less than significant. General and specific Best Management Practices (BMPs) for planning construction and operation activities are discussed below for each of the affected environments evaluated in this F/EIS.

1.1 AIR QUALITY

Air impacts may be minimized by implementing proper planning BMPs. Specific planning phase BMPs include: selection of minimal dust-generating equipment and materials to be used during construction and consideration of local meteorological condition and receptor locations when designing projects. These specific mitigation measures if implemented prior to final design would minimize potential adverse impacts to air quality.

Construction impacts to air quality are anticipated to be less than significant, direct, short-term and adverse. These impacts would arise from vehicle emissions during construction and from potentially stockpiled materials. Impacts from dust and airborne particles from construction is expected to be significant but can be minimized through planned and preemptive general dust control practices, such as, suppression with water of exposed areas or covering with a nonpermeable wrapper. Construction activities to include any air emissions should be completed in accordance with common industry BMPs.

The following general BMPs should also be implemented to reduce impacts to air quality. Implementation of appropriate mitigation measures would result in a less than significant impact to air quality.

Planning BMPs

- Ensure equipment proposed for the TSP and Alternatives are compliant with applicable regulations.
- Consider chemicals used that generate emissions and substitute for less harmful constituents if possible.
- Planning and design elements for the Proposed Action should include consideration of affected environments.

Construction BMPs

- Sufficiently watering all excavated materials to prevent excessive dust generation.
- Use of environmentally safe additives to amend the stockpiled soil to minimize offensive odors.
- Maintain equipment for continued compliance with applicable regulations.
- Use of products, such as filters, to reduce emissions from equipment.
- Do not leave vehicles idling.

1.2 WATER QUALITY

Impacts to water quality may be minimized by implementing specific planning BMPs. Consideration of surface water bodies, production and implementation of site-specific plans (i.e., natural resources management plan) and selection of non-hazardous chemicals during construction and operation are specific mitigation measures that should be regarded prior to final design.

The TSP and Alternatives are anticipated to result in significant, direct and indirect, short-term adverse impacts to surface waters. Implementation of BMPs during construction activities would reduce impacts. Mitigation would include a "contamination prevention frame", or an underwater curtain that is attached to the construction barge and surrounds the construction area, helping to prevent sediment material from scattering outside the immediate work area, to protect the surrounding marine environment.

Proper chemical handling procedures, adherence to spill prevention plans and implementation of BMPs designed to prevent and/or mitigate releases to the stormwater system and subsequent surface water bodies would further minimize impact.

The following BMPs could further mitigate impacts:

Planning BMPs

- Design project site or relocated to avoid delays necessitated by additional investigation, consultation or mitigation.
- Reduce footprint of an impact when avoidance is not possible.
- Investigate and employ methods and practices to reduce impacts or to replace impacts to acceptable levels when impacts are more than minimal or impacts are unavoidable.
- Plan for construction to avoid the rainy season.

Construction BMPs

- Remove debris stockpiles in a timely manner.
- Cover stockpiles to prevent erosion and implement sediment control practices.
- Construction vehicles exiting the construction site should not track or spill dust, soil, or debris. Vehicles tires should be cleaned of accumulated mud or dirt before leaving the construction site.
- Inspect BMPs to ensure they are maintained and effective.
- Ensure adequate spill prevention kits.
- Provide primary and secondary containment that is specific to the type and volume of chemicals stored on site.
- Compliance with Stormwater Pollution Prevention Plan.
- Ensure any direct/indirect discharges are within CWA criteria.

1.3 SOILS, GEOLOGY AND TOPOGRAPHY

Ground disturbance from the TSP and Alternatives have little potential to affect soil stability and to increase soil runoff into local streams, drainages and water bodies. Impacts, both temporary and permanent, are mostly to previously disturbed areas and consists of stockpiling or staging activities. The site area will experience some change in surficial characteristics even with proposed post-construction stabilization and re-vegetation. These changes will not differ from those that would result from any other industrial development and are not significant. If BMPs are followed, regarding soil stabilization and subsequent planting of vegetation, potential contribution to cumulative impacts of soil erosion are not anticipated. Since the geologic environment has already been impacted, the irreversible or irretrievable impacts anticipated will be minimal.

General mitigative measures include:

Planning BMPs

- Investigate and employ methods and practices to reduce impacts or to replace impacts to acceptable levels when impacts are more than minimal or impacts are unavoidable.
- Review of project plans.

Construction BMPs

- Use of plastic underlayment.
- Ensure adequate coverage.
- Limit water flow.
- Ensure proper slope.
- Use of socks and dikes as appropriate.

1.4 TRANSPORTATION

Impacts to the transportation environment may be minimized by implementing proper planning BMPs. Proper infrastructure planning and the addition and evaluation of alternate routes of access are specific mitigation measures that should be regarded prior to final design. These mitigating measures would decrease the impact to transportation.

1. During construction activities, less than significant adverse impacts are anticipated. Staging and mobilizing/demobilizing may have temporary increases in traffic. Also, additional personnel to perform the construction work will be accessing the area. Temporary traffic control personnel could be placed at affected areas associated with the Proposed Action to facilitate traffic movement. Staggered delivery schedules for equipment and supply materials could further reduce impacts to less than significant at areas associated with the TSP and Alternatives. Further benefits could result from work-force car-pooling.

General transportation mitigative measures include:

Planning BMPs

- Consider additional infrastructure during project planning to accommodate additional anticipated traffic.

Construction BMPs

- Encourage staggered work shifts.
- Encourage the use of work shifts during off-peak hours.
- Encourage construction work-force car-pooling.
- Implement alternative routes or delivery schedules.
- Offer bus or shuttle service from remote parking.
- Provide a temporary traffic control officer during the peak hours of the peak construction month(s).

1.5 HAZARDOUS MATERIAL/WASTE AND SOLID WASTE

Impacts to the hazardous material/waste and solid waste environments may be minimized by implementing proper planning BMPs. Consideration of processes and selection of materials that are non- or less hazardous are specific mitigation measures that should be regarded prior to final design.

The TSP and Alternatives are anticipated to result in significant, direct and indirect, short-term adverse impacts to the environment from hazardous material/waste and solid waste. Construction activities associated with the TSP and Alternatives would result in a temporary increase in the generation of hazardous material/waste and solid waste. Mitigation will include disposal of excavated sediment in accordance with regulatory requirements. Disposal options under consideration are:

- Land disposal as appropriate based on the chemical/physical characteristics of the soil:
    - Soils meeting regulatory standards may be used for 'beneficial reuse' as fill or for other purposes; or
    - Soils meeting regulatory standards may be placed in unconfined landfills.
- Temporarily stockpiling pending future disposal. Appropriate measures for control/prevention of runoff and migration of soil are required under this option.
- Stockpile locations must be planned and coordinated as local residents, port operations, or other military departments may utilize those areas.

These increases could result in significant, direct, short-term adverse impacts to human and ecological health if these materials are not handled properly. Adherence to management requirements and guidelines would reduce adverse impacts to less than significant. Furthermore, they must ensure occupant and worker safety during all maintenance, repair and renovation activities that disturb areas known or assumed to have lead-based paint. Significant, indirect, short-term adverse impacts may occur if the local landfill is incapable of processing the additional waste. These impacts would be reduced to less than significant by implementation of aggressive recycling initiatives.

The following preventative measures may be considered to minimize impacts to the hazardous material/waste and solid waste streams:

Planning BMPs

- Investigate and employ methods and practices to reduce impacts or to replace impacts to acceptable levels when impacts are more than minimal or impacts are unavoidable.

Construction BMPs

- A "contamination prevention frame", which is essentially a 14 m by 14 m underwater curtain that is attached to the construction barge and surrounds the construction area, helps to prevent sediment material from scattering outside the immediate work area, to protect the surrounding marine environment.

- Inform the USACE about all hazardous wastes removed during construction activities and all hazardous materials used in construction projects.

- Contact USACE if unusual soil coloration and/or odors are detected and if small arms debris is found.

- Hazardous Waste Accumulation Points would ideally be located near areas where hazardous wastes are generated. Hazardous wastes must be stored in containers with logs documenting the contents of the containers maintained.

1.6 CULTURAL RESOURCES: HISTORICAL/ARCHEOLOGICAL

Impacts to the cultural resource environments may be minimized by implementing proper planning BMPs. Identifying areas with cultural resources and designing projects to avoid these areas, as practicable, should be regarded prior to final design.

Areas with known cultural resources should be labeled in the field so they are easily recognizable and avoidable. Adherence to mitigation measures and to management practices set forth in Section 4 of this F/EIS would further reduce adverse impacts to less than significant.

The following general preventative measures may be considered to minimize impacts to the cultural environment:

Planning BMPs

- Coordinate closely with USACE Archeological/Cultural and CNMI Historic Preservation Office prior to construction. The Proposed Action proposes maintenance construction only. There should not be any impacts to areas not previously disturbed by prior construction activities.

Construction BMPs

- Known cultural resources are to be protected from impact from the implementation of the TSP and Alternatives. Areas that are affected by major construction activity must undergo analysis, survey, implementation of preventative measures, or other appropriate treatment. Compliance with recommended preventative measures concerning the TSP and Alternatives may avoid potential harm to identified significant resources.

- Effects on shrines, tombs, or other such familial oriented sites may be mitigated/evaluated in close consultation with project subject matter expert, cultural resource managers and any consanguine relations that can be located/contacted in the area.

- Should an unintended discovery of cultural resources occur, construction activities shall cease, the cultural resource manager shall be informed immediately of the discovery and the general area will be secured from further disturbance.

- Implement a cultural resource management plan to address areas that contain cultural/archeological resources.

- Earthwork construction crews should be trained or educated in proper response should a cultural resource be discovered.

1.7 NOISE

Noise impacts to the environment may be minimized by implementing proper planning BMPs. Identifying equipment that may generate adverse noise levels and either substituting equipment or retro-fitting equipment with noise dampening devices would reduce noise impacts.

Equipment necessary for construction activities may result in less than significant, direct, short-term adverse impacts to the noise environment. Noise from construction activities would add to current noise levels, but its overall duration would be brief and would not be expected to significantly alter the acoustic environment of the region. The actual noise levels produced during construction would be a function of the methods employed during each stage of the construction process. Construction should take place during daytime hours (0700-1900). Minimizing the use of loud equipment to the extent possible and use of noise dampening devices may be considered to further reduce the impact of noise levels generated by the equipment.

Additional BMPs that may further reduce impacts to the noise environment include the following:

Planning BMPs

- Select equipment that do not generate adverse levels of noise.

- Plan temporary enclosures or barrier walls into design layouts.

Construction BMPs

- Replace excessive noise generating equipment with those that generate less noise.

- Ensure all equipment uses manufacturer specified muffling devices and ensure that all construction equipment is maintained in good working order.
- If noise barriers or wall are currently in use or is planned to be used, make sure they are maintained and adequately reducing noise levels.

1.8 SAFETY

Safety impacts may be minimized by implementing proper planning BMPs. Preparation of site-specific health and safety documents in compliance with EM 385-1-1 would identify procedures and equipment associated with the TSP and Alternatives that could possibly cause harm to individuals and the environment.

Construction activities would have a less than significant, direct and indirect, short-term and long-term adverse impact to safety at the TSP and Alternative locations. All Department of Defense activities must comply with EM 385-1-1. All individuals should be adequately trained in their area of expertise. Heavy machinery used during construction could pose hazards including struck-by, noise and crushing.

Other preventative measures which may be considered to minimize impacts to safety include:

Planning BMPs

- Prepare site-specific health and safety construction and operation documents.

Construction BMPs

- Compliance with site-specific health and safety documents.
- Ensure all equipment utilized are properly maintained and have adequate protective measures.
- Ensure all personnel are properly trained to perform their work function.
- Coordinate with local government and USACE to inform of construction schedule.
- Consider obstruction warning light system for new construction structures and construction equipment.
- Should construction activities encounter munitions, the area should be marked off and avoided. All work shall cease and the USACE and local government point of contact shall be notified immediately.

1.9 LAND MANAGEMENT

As noted earlier, short-term, less than significant, direct impacts to land use are anticipated during construction activities, and long-term, less than significant, direct impacts are anticipated during operations. No incompatibilities between management plans guiding land uses within Tinian Harbor and mission requirements are anticipated from the TSP or Alternatives.

1.10 BIOLOGICAL RESOURCES

This section recommends measures to avoid, minimize or compensate for potential temporary and permanent impacts to the biological environment from the implementation of the TSP and Alternatives. Protected or endangered species were encountered during the surveys conducted at Tinian Harbor and adjacent areas. Implementation of BMPs can reduce impacts to species' habitats. BMPs such as working during non-breeding seasons, and avoidance or accommodation of areas where species may rely on for normal ecological activities, such as breeding and foraging behavior, would further reduce impacts to biological resources.

Direct, short- and long-term adverse impact to biological resources from construction could result in increased mortality or altered ecological activities of plant or animal species during implementation of the TSP and Alternatives. Additional direct, short-term adverse impacts are anticipated from noise and traffic due to construction equipment and vehicles. Potential impacts from construction activities on biological resources can be reduced with the implementation of BMPs.

Temporary impacts to the quality of surface waters may affect threatened or endangered plant or animal species in the short-term. In addition, noise and traffic may also have adverse effects to protected species. Implementation of previously identified mitigation measures to soils, noise and traffic would further reduce adverse impacts to biological resources.

Planning BMPs

- Design port operations to avoid or accommodate areas which may be important for normal ecological activities.
- A US Fish and Wildlife Service Phase 2 Survey will be performed prior to the start of construction activities.
- Prepare areas for stockpiling to protect threatened or endangered species. This would include putting up barriers to prevent noted species from entering areas to be used during the project and cleaning the areas once the project is completed.

Construction BMPs

- Inform workers of potential protected species.
- Preservation of important ecological habitats if encountered.
- Implementation of mitigation measures for soils, surface water, noise and traffic.
- Should an unintended discovery of coral reefs (e.g., Acropora globiceps) occur construction activities shall cease and the natural resources program manager shall be informed immediately.

Appendix 7

Real Estate Planning Report

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Real Estate Planning Report

Tinian Navigation Improvements Project

Section 216 of Flood Control Act of 1970
(Public Law 91-611)

Prepared for
Honolulu District, USACE

Prepared by:

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EXECUTIVE SUMMARY

The Tinian Harbor Navigation Improvements Project is in the feasibility phase focusing on a study approach that addresses navigational and operational limitations due to the existing configuration exposing the harbor and dock facilities to extremely difficult wind, wave, and current conditions. The Feasibility Cost Share Agreement (FCSA) for the study was initiated in December 2015. This harbor was constructed during World War II and was not a federally authorized project. From the array of alternatives, alternatives “S-1 and S-2” was selected to take forward into the feasibility phase.

At the request of the sponsor, the Commonwealth Ports Authority, Commonwealth of Northern Mariana Islands (CNMI), a 905(b) Analysis for Navigation Improvements, CNMI was completed in October 2001. The recommendation was to proceed to cost-shared feasibility studies for both Tinian and Rota Harbors.

Tinian Harbor is located on the southwest coast of Tinian and is on the west coast line adjacent to the village of San Jose. The harbor was originally developed and constructed by the Japanese during World War II.

The existing configuration of navigational features exposes the harbor and dock facilities to extremely difficult wind, wave and current conditions, which result in significant disruption to navigation and port operations. Tourism and related service industries are growing economic factors on Tinian. Economic growth requires a harbor facility which can safely and efficiently accommodate both present and future cargo demands. The Commonwealth Port Authority requested in July 1997 that the Corps of Engineers investigate possible modifications to the existing harbors within the CNMI to ensure safe and efficient passage of all waterborne commerce to and from all of the major islands of Saipan, Tinian and Rota.

The current proposed alternatives “S-1 & S-2” consists of repairing the offshore breakwater and extension of 300 feet onto the existing breakwater. The breakwater will function to reduce damage and improve navigation conditions.

The breakwater repairs will be conducted within navigable water and no real estate interest will be acquired due to navigation servitude. Additional feature needs consist of upland disposal and a small temporary work area. All of these features are located on then non-federal sponsor’s fee owned lands.

No acquisitions are involved and the estimated real estate administrative costs associated with the purposed alternatives “S-1 & S-2” is approximately $20,000, including all LERRD and administrative costs.

1. AUTHORITY/PURPOSE

The Tinian Harbor was originally constructed in 1944-1945 during World War II. The Harbor was never authorized as a federal project, there for the Government has never held federal interest in Tinian Harbor.

Under authority of Section 444 of the Water Resources and Development Act of 1996 (PL 104-303) and the Water Resource Development Act of 2007, section 2006, US Army Corps Engineers proposes to construct breakwater repairs to improve navigation conditions at Tinian Harbor.

Currently the project is in the feasibility phase of study with the draft report to be completed by August 2017.

The Commonwealth of Northern Mariana Islands, Commonwealth Port Authority will be the local sponsor for the project.

2. DESCRIPTION

Tinian Harbor is located on the southeast coast of Tinian, at San Jose, the primary urban center. There is currently no Federal navigation project at the harbor. The existing harbor was constructed in 1944-1945 during World War II. The entrance channel is about one-half mile long, approximately 525 feet wide and has been dredged to a depth of about 30 feet. The wharves and harbor turning basin were dredged to depths of 28 to 30 feet.

The total length of the breakwater is 4,805 feet long and the crest elevation is about 14 feet above mean sea level. The inner breakwater, with a length of 1,210 feet from the shore to the outer breakwater was constructed of a single row sheet piling. Much of the sheet pile on the inner breakwater has deteriorated and collapsed. The outer breakwater, with a length of 3,595 feet, was constructed of interlocking, half-inch thick steel sheet piling in circular cell configuration. The interior of the cells was filled with quarried limestone. A 10-inch thick, unreinforced concrete slab was constructed flush with the top of the sheet piles. The steel sheet pile breakwater is almost completely deteriorated.

The existing configuration of navigational features exposes the harbor and dock facilities to extremely difficult wind, wave and current conditions, which result in significant disruption to navigation and port operations.

The proposed alternatives “S-1 & S-2” consists of replacing the existing offshore breakwater along the current alignment and a 300 foot extension of the breakwater.

S-1: Replace Existing Breakwater Along Current Alignment:

This measure involves removal of the approximately 4600 ft existing cellular sheet pile breakwater, including debris, sand/silt/coral rubble, vegetation, and steel sheet piles down to the approximate 3 foot depth contour relative to Mean Lower Low Water (MLLW) elevation. Some of this in place material (eg – coral rubble) may either remain or be reused for the core of the new breakwater structure; however, the majority will need to be disposed of at a landfill.

The new breakwater will be rebuilt along the existing structure alignment, but with varying cross-sectional area composed of either stone, or stone and concrete armor units. The “Northwest Breakwater”, the section of the structure tying into land and extending approximately 1100 feet will require a smaller cross-section (due to less wave exposure) and can be built with a stone armor layer and underlayer. The oceanside and harborside toe of the structure will be placed into a trench excavated into hard foundation material. The section will be approximately 60 feet wide and 14 feet in total height, with an elevation 8 feet above MLLW datum. A typical cross-section for this reach is shown in Figure 1 of the project features maps.

The remaining 3500 feet of breakwater will consist of a more robust cross-section, due to head on exposure to larger waves (including those from typhoon events). This portion of the breakwater (“Main Breakwater”) would follow the alignment of the existing breakwater, and would utilize the remnants of the existing breakwater as a portion of the core. Remnants extending above +3 feet would be removed so as to not protrude into the new breakwater stone layers. A new core would be constructed around the remnants, using dredged material, quarry run stone, or other suitable material. Successive layers would be placed over the core material, consisting of a geotextile filter fabric, a 1.5-foot thick bedding layer of 10 to 50 pound stone, a two-stone thick underlayer of 250 to 500 pound stone, and a 2.5-ton tribar armor layer. A cast-in-place concrete crest cap would be used to stabilize the crest. The oceanside and harborside toe of the structure will be placed into a trench excavated into hard foundation material and further stabilized with tremie concrete. The section will be approximately 65 feet wide and 15 feet in total height, with an elevation 12 feet above MLLW datum. A typical cross-section for this reach is shown in Figure 2 of the project features maps.

Figure 3 of the project features maps shows the alignment of the existing structure, as well as the conceptual footprint (not to scale) of the replaced structure, including the Northwest Breakwater and Main Breakwater sections.

S-2: Replace and Extend Existing Breakwater Along Current Alignment:
This measure involves all of the same demolition and breakwater replacement methods described in measure S-1, with the addition of an approximately 300 ft extension to the breakwater, increasing the total length to approximately 4600 feet. The length of the extension will be optimized based on costs and reduction to wave energy within the harbor. The 300 ft length would be the maximum due to both the location of the entrance

channel and the depth contours near the end of the existing breakwater alignment. The full extension would result in the new breakwater foundation depth ranging from 10 to 25 feet below MLLW. The cross-section would likely be composed of a stone core and underlayer, with concrete armor units on the armor layer, similar to the design of the replaced Main Breakwater, but with a significantly wider footprint due to deeper foundation depths in this area.

A new core would be constructed, using dredged material, quarry run stone, or other suitable material. Successive layers would be placed over the core material, consisting of a geotextile filter fabric, a 1.5-foot thick bedding layer of 10 to 50 pound stone, a two-stone thick underlayer of 400 to 800 pound stone, and a 4.3-ton tribar armor layer. A cast-in-place concrete crest cap would be used to stabilize the crest. The Oceanside and harbor side toe of the structure will be placed into a trench excavated into hard foundation material and further stabilized with tremie concrete. The section will be approximately 130 feet wide and 22-40 feet in total height, with an elevation 12 feet above MLLW datum. A typical cross-section is shown in Figure 4 of project features maps.

Figure 6 shows the alignment of the existing structure, as well as the conceptual footprint of the replaced structure, including the breakwater extension.

The repairs to the breakwater will require to dispose of approximately 50,000 cubic yards of sheet pile, limestone rock, and sand material. The material will be dewatered within the temporary work area located in the northwest corner of the Tinian Harbor footprint shown on Figure 6 of project features maps. The temporary work area is approximately 8.3 acres of open storage space consisting of grass and gravel. The temporary work area will be used as a staging area for equipment and construction materials. This property is owned in fee by the non-federal sponsor and is located within the project site.

The final disposal location for all disposal material will be placed in a low depression areas next to the Tinian airport runway. The non-federal sponsor identified disposal locations shown on Figure 7of project feature maps, which is approximately 48.9 acres of land. The property is an open grass area that is maintained on a regular basis. The excess sheet pile material may be placed in the Saipan landfill if the airport facility is not sufficient. All disposal locations are owned in fee by the non-federal sponsor and all land has been reported available for this project.

All access routes to the temporary work area and the final disposal site is owned by the non-federal sponsor and is available for the project.

The following project features and parcel owners are identified in the proposed project.

Parcel	Owner	Ownership Area in Acres
Disposal Site (Tinian Airport)	Commonwealth Port Authority, CNMI	1,416
Temporary Work Area Parcel Nos. 080 T 17	Commonwealth Port Authority, CNMI	8.3

3. SPONSOR'S REAL ESTATE INTERESTS

The non-federal sponsor, the Commonwealth Port Authority, is the current fee owner of all identified land for this project. All land has been under control of Commonwealth Port Authority since the original project was constructed.

Neither parcel was purchased in anticipation of the proposed project nor were federal funds provided for the acquisition.

4. ESTATES TO BE ACQUIRED

Project features consist of a breakwater, disposal sites, and a small temporary work area. All lands identified for this project are currently located within the Non-federal fee owned property. However, if at a later date additional lands are required for disposal sites the required estate to acquire is Fee. If additional temporary work space is required the required estate is a temporary work area easement. The following estates, if found necessary at a later date, would be required for the project.

Fee

The fee simple title to (the land described in Schedule A) (Tracts Nos. A-01, A-02 and A-03), subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

TEMPORARY WORK AREA EASEMENT:

A temporary easement and right-of-way in, on, over and across (the land described in Schedule A) Tracts No., E-001, for a period not to exceed 12 months, beginning with date possession of the land is granted to the United States, for use by the United States, its representatives, agents, and contractors as a work area, including the right to deposit fill, spoil and waste material thereon. Move, store and remove equipment and supplies, and erect and remove temporary structures on the land and to perform any other work necessary and incident to the construction of the Project, together with the right to trim, cut, fell and remove, therefore all trees, underbrush, obstructions, and any other vegetation, structures, or obstacles within the limits of the right-of-way; reserving, however, to the landowners, their heirs and assigns, all such rights and privileges as may be used without interfering with or abridging the rights and easement hereby acquired; subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

5. FEDERAL PROJECTS/OWNERSHIP

The Tinian Harbor was originally constructed in 1944-1945 during World War II. The Harbor was never authorized as a federal project, there for the Government has never held federal interest in Tinian Harbor. There are no federal owned lands in the immediately vicinity.

6. NAVIGATION SERVITUDE

Lands required for the channel improvement are within navigable water of the Non-federal Sponsor and are available by navigation servitude. The proposed repairs of the breakwater structure are also within navigable water of the Non-federal sponsor and are available by navigation servitude.

7. MAPS

Real Estate mapping is not typically provided by the district at this stage of the project. Detailed mapping will be provided prior to the notification to the sponsor to provide the required LERRD. Maps depicting the project features are attached in the addendum.

8. INDUCED FLOODING

No induced flooding will result from the project features.

9. BASELINE COST ESTIMATE FOR REAL ESTATE

Fee Title …………………………………………………………………..$ 0

Temporary Work Area Easement……………….....……………………………$ 0

Improvements…………………………………………………………….$ 0

Hazard Removals………………………………………………………….$ 0

Mineral Rights…………………………………………………………….$ 0

Damages……………………………………………………………………..$ 0

Incremental real estate costs (formally known as contingencies)……………...$ 0

Relocations…………………………………………………………………..$ 0

Uniform Relocation Assistance (PL 91-646)…………………………………...$ 0

Acquisition Administrative Costs……………………………………………$ 20,000

TOTAL COST………………………………………………………………..$20,000

10. PL 91-646 RELOCATION BENEFITS

Public Law 91-646, The Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended, commonly called the Uniform Act, is the primary law for acquisition and relocation activities on Federal or federally assisted projects and programs. The non-federal sponsor is required to follow the guidance in this public law. The sponsor is aware of this and has experience in the Uniform Act policies.

There will be no displaced persons due to the proposed acquisitions and no PL 91-646 benefits are anticipated.

11. MINERALS

The Commonwealth of Northern Mariana Islands owns all mineral rights within the territory and there are no surface or subsurface minerals known that would impact the project.

12. ASSESSMENT OF SPONSOR'S ACQUISITION CAPABILITY

An assessment of the sponsor's acquisition capabilities to acquire the land necessary for this project has not been done for this project as of the writing of this REP. However, the local sponsors have partnered in other projects on the island. The Commonwealth Port Authority, Commonwealth of Northern Marina Islands is considered fully capable and have Eminent Domain authority. Real Estate will require the sponsor to provide an assessment of their acquisition capability and when completed, this assessment will be added to the REP.

13. ZONING

All lands involved in the project features are currently zoned as industrial. No impacts of this project will result in a taking of a real property interest due to enactment or enforcement of the zoning ordinance.

14. MILESTONES

The following real estate milestones have been coordinated with Real Estate, the Project Manager, and the non-federal sponsor. No acquisition will be involved but the sponsor will need to demonstrate possession of the fee title. Real Estate availability is certified prior to the solicitation notice for construction.

Provide Survey Maps/ LERRD Documents 30 Days

15. PUBLIC UTILITIES RELOCATIONS

There are no known public utilities that are impacted by the project.

16. ENVIRONMENTAL IMPACTS

Environmental impacts, if any, are discussed in other sections of the Engineering Documentation Report. A supplemental Environmental Assessment is being prepared to address any environmental concerns but none are anticipated. A cultural assessment is also ongoing for this project. There are no known environmentally adverse operations on the property of which I am aware.

17. ATTITUDES OF LANDOWNWERS

There is no know opposition to the project.

18. NOTIFICATION TO SPONSOR

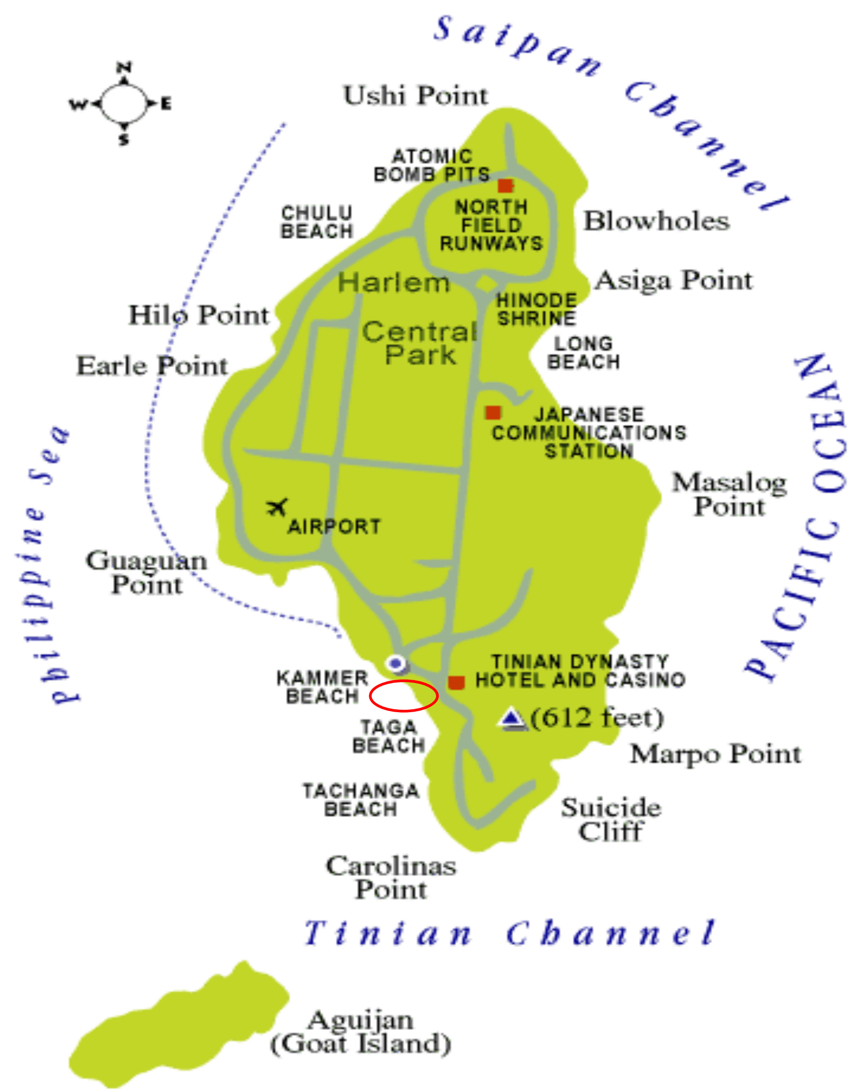
The non-Federal sponsor, Commonwealth Port Authority, are fully involved in the planning process. They are also experienced in working with US Army Corps of Engineers on similar projects. There are no acquisitions involved in the project and no risk of premature actions by the sponsor.

ADDENDUM

Location of Tinian Island / Project Location
Project Feature Map
Photos

Location of Tinian Island / Project Location

Fast Facts
Activities
Cultural Attractions
Current Weather
Accommodations
Events Calendar
PATA Members
Articles



Project Feature Maps

Figures Corresponding to Tinian Measure Descriptions:

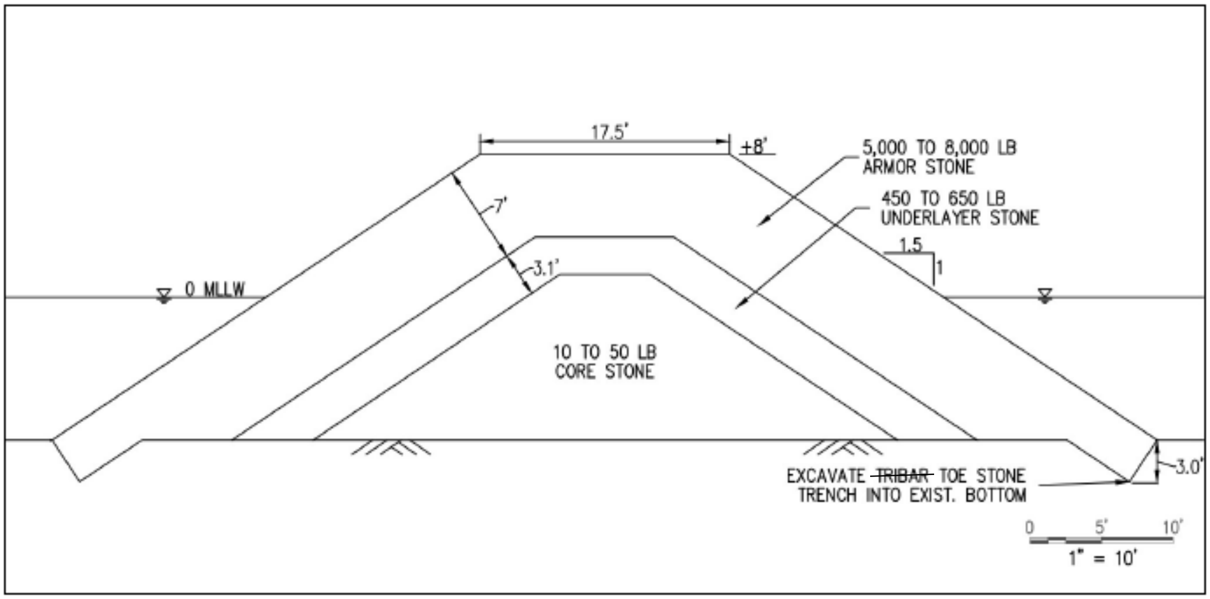


Figure 1. Typical cross-section for Northwest Breakwater Replacement

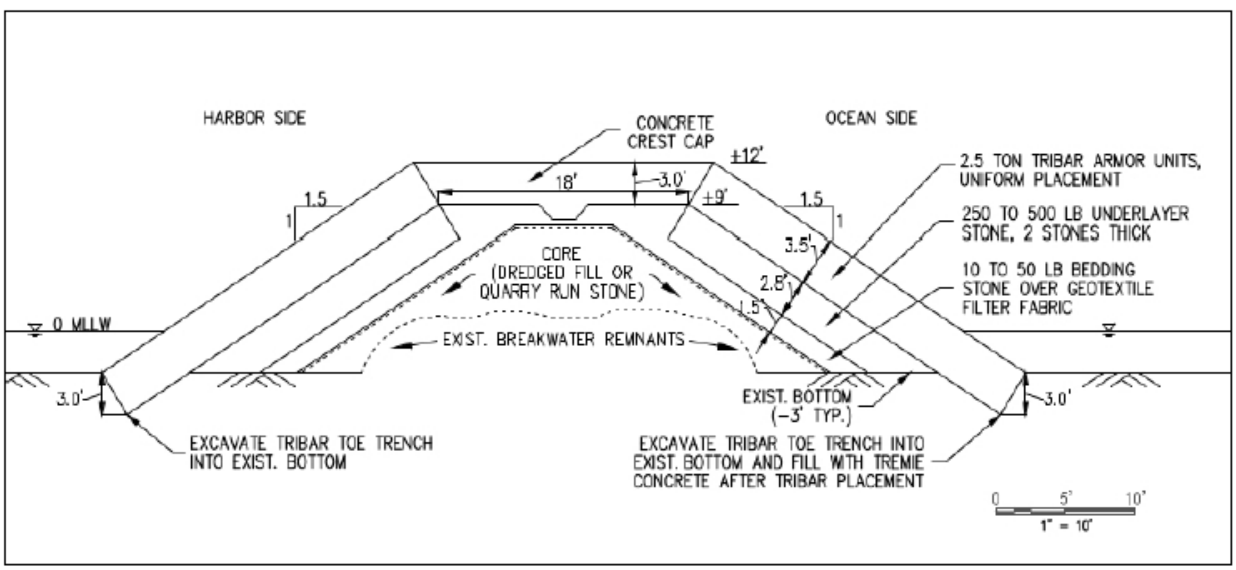


Figure 2. Typical cross-section for Main Breakwater Replacement

Tinian Alternative 1: Replace Breakwater

Figure 3. Plan view layout of Measure S-1, Replace Existing Breakwater Along Current Alignment

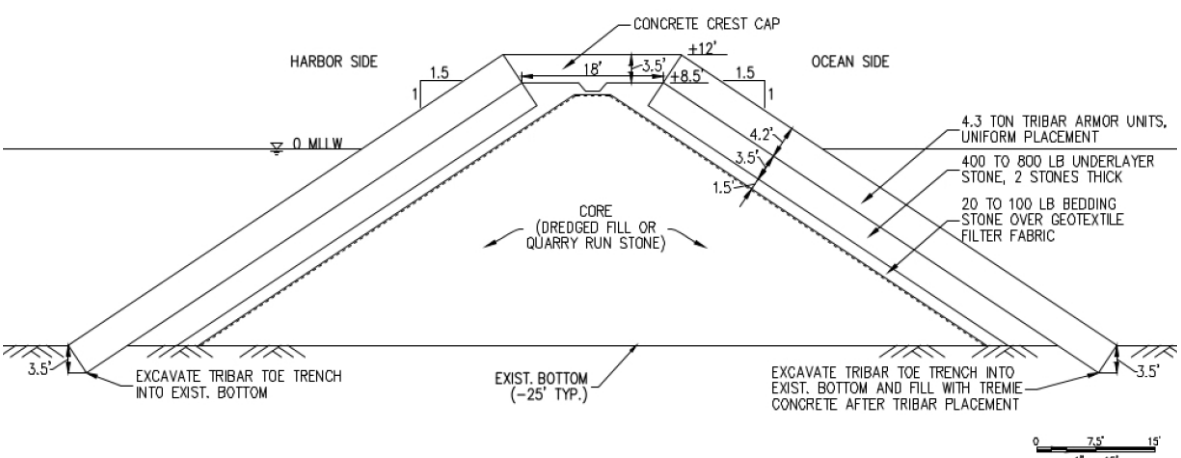


Figure 4. Typical Cross-Section for Breakwater Extension

Figure 5. Plan view layout of Measure S-2, Replace Existing Breakwater Along Current Alignment and Add 300 ft extension

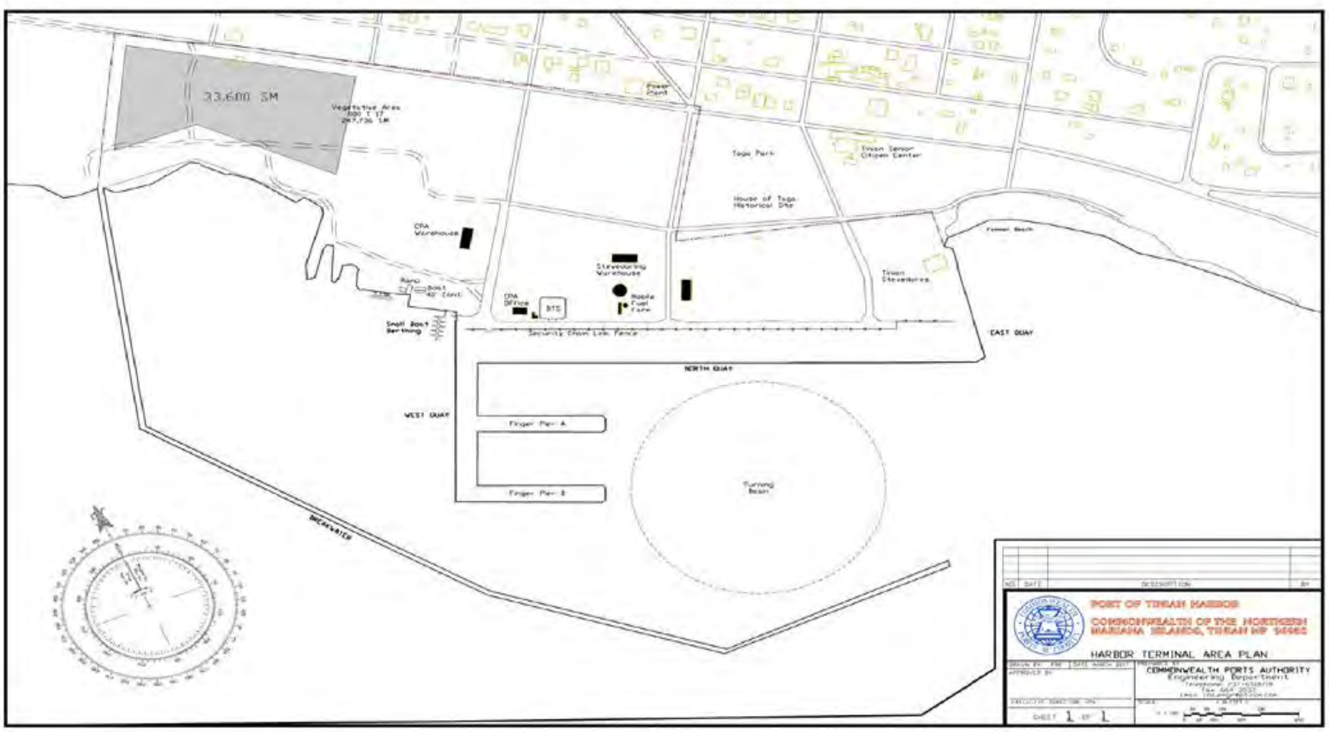


Figure 6. Plan view layout for Temporary Work Area (Approx. 8.3 acres)

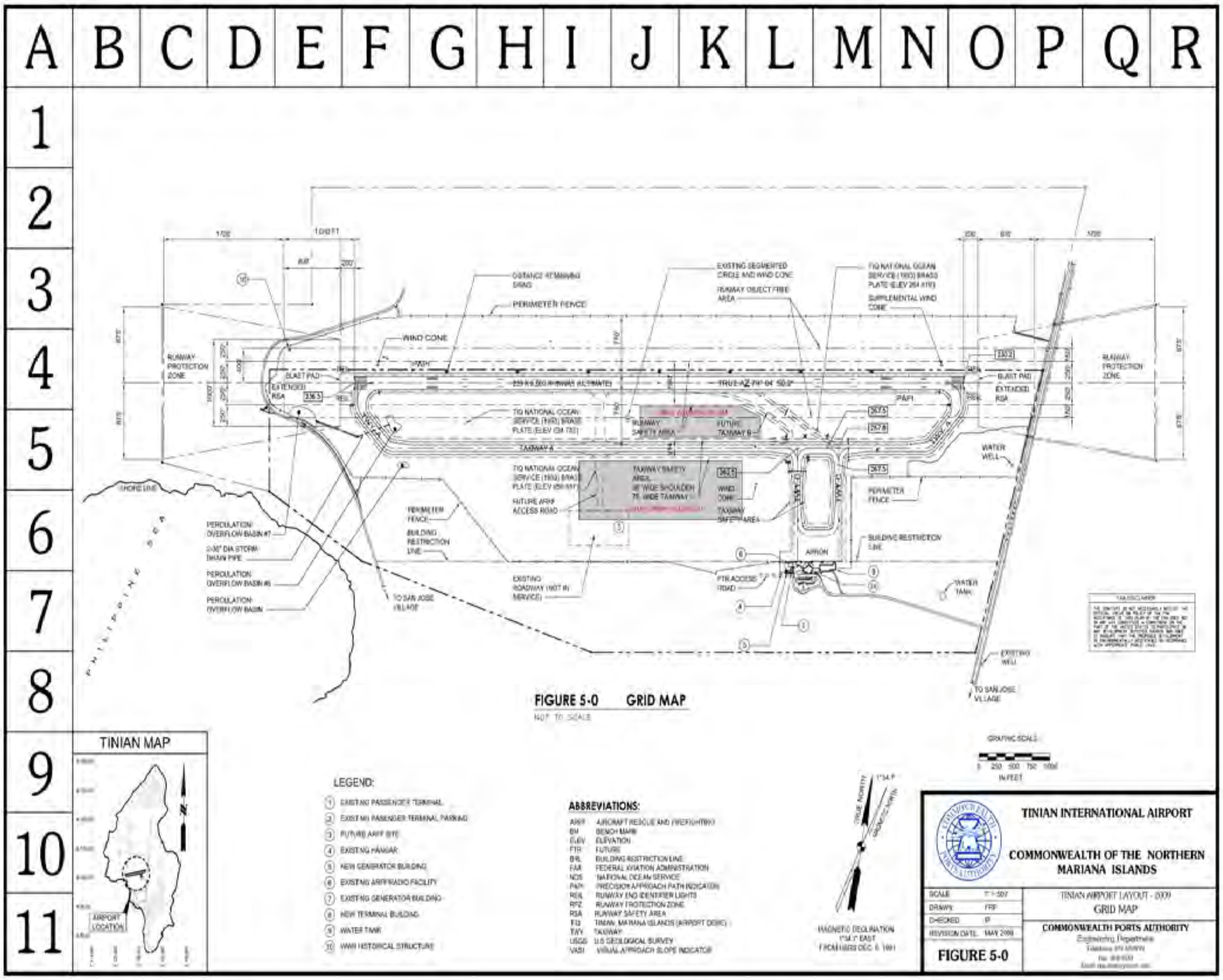


Figure 7. Plain view layout for disposal location on Tinian Island

Fast Facts
Activities
Cultural Attractions
Current Weather
Accommodations
Events Calendar
PATA Members
Articles

Tinian Harbor Entrance Channel

Tinian Harbor Main Breakwater

Location of Temporary Work Area

Additional Main Breakwater structure

Appendix 8

Public Involvement Documentation

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42,000 views on Liberation Day Facebook Page

(Press Release) — Many firsts occurred that are bound to change the way the CNMI celebrate the festivities.

This year, Dr. Hu Bo and his team at Skywalker Communications Group introduced online live broadcasting on two of the world's largest and most used platforms, YouTube and Facebook.

Allowing the residents of the CNMI as well as those abroad to participate with families and friends at the festival grounds via the World Wide Web.

The CNMI has one of the highest military recruit rates per capita in the United States, along with Guam and American Samoa. For this reason, Skywalker Communications Group's Managing Director made it their goal to ensure the broadcasts of the CNMI Liberation Day Festivities goes live on the Internet.

"Many sons and daughters, mothers and fathers, friends and family members of the CNMI live abroad doing service for the country and fight for Freedom. Having had the opportunity to spend some time with our Liberation Day Volunteer Program leader, Randy Johnson, an injured veteran, it became apparent to the Skywalker Communications Team that many of those in the military, whether active, reserve, or veteran, tend to remain in the contiguous United States or other parts of the world. A large percentage of them have not had the privilege of celebrating one of the most important days that honor their services and their commitment to their peoples and country. In our attempt to honor them as well as this year's theme, 'Our Islands Our Heritage' we wanted to make sure they are part of the celebration, thus leaving no one behind." Leonard Leon, Skywalker Communications Group art director.

On the 4th of July, the turnout for the live broadcast was more than a success as evident by the number of live broadcast viewers, page likes, video likes, comments, shares, tags, and more.

Within the past 7 days alone, the CNMI Liberation Festivities Facebook page has had an explosive impact with:

- 36,068 views on live broadcasts.
- 42,775 new interactions by visitors to the page.
- 39,229 additional Facebook users reached
- Over 250 new likes for the page

A large number of CNMI and diaspora residents' tagged friends and family members living locally and abroad, ensuring they witness the parade unfold. This ability is an innovative collaboration by Skywalker Communications Group and IT&E Saipan that has revolutionized the Liberation Day Festivities and marketing strategies in the CNMI.

One of the great advantages of the social media live broadcast by Skywalker Communications Group is the interaction between the viewers. A viewer with the Facebook name Nizelynn Teregeyo Masayos commented with excitement; "Ah! I see my ssterrr!."

Jacqueline Tudela Apatang Rogers says; "Miss home wish i could bring my family to see our culture thanks for posting this."

Others like Joaquin Tenorio Sablan, one of the hundreds of viewers who tuned in from the U.S., commented "Happy Liberation Day CNMI!!! from Vancouver WA." And joining in on the announcements of their current locations resulting in an extensive and diverse list of locales from Hawaii, North Carolina, and Washington D.C., Utah, California, and many other states with viewers thanking organizers for "a chance to see home again."

For those who missed the chance to watch the live broadcasts, Skywalker Communications uploaded the videos onto the Facebook page, CNMI Liberation Day Festival and the Skywalker Communications Group official channel on YouTube.

"The CNMI can expect a lot more innovative ideas, pioneering marketing strategies, and fresh perspectives from Skywalker," Etti Ahmed, social media campaign manager at Skywalker Communications Group.

Sophia Alvarez, account director for Skywalker Communications Group states, "Skywalker Communications Group has years of experience in media hybridization in China with television, newspaper, magazines, and social media platforms such as QQ (China's advance version of Facebook), WeChat (China's advance version of WhatsApp), Youku (China's advance version of YouTube) and many others."

NOTICE OF PUBLIC SCOPING MEETINGS

**Commonwealth of the Northern Mariana Islands, Commonwealth Ports Authority and
U.S. Department of the Army, Corps of Engineers
Public Scoping Meetings for an Integrated Feasibility/Environmental Impact Statement for the Proposed Rota Harbor Modifications Project, Island of Rota,
Commonwealth of the Northern Mariana Islands**

The Commonwealth Ports Authority (CPA) and the U.S. Army Corps of Engineers (USACE) are hosting public scoping meetings for the Proposed Rota Harbor Modifications Project, Island of Rota, Commonwealth of the Northern Mariana Islands (CNMI). The purpose of these meetings are to solicit participation and input from all interested federal, state, and local agencies, Native American groups, and other concerned private organizations or individuals on the scope of analysis for the Integrated Feasibility/Environmental Impact Statement (F/EIS). A Federal Notice of Intent to prepare an F/EIS for the proposed project was published in the Federal Register on July 8, 2016.

The F/EIS Public Scoping meetings will be held as follows:

Rota: July 18, 2016
Rota Roundhouse, Songsong Village
4:30 pm – Poster Session
5:00 pm – 7:00 pm – Formal Scoping Meeting

Saipan: July 20, 2016
CPA Saipan Seaport Conference Room, Charlie Dock, Puerto Rico Village
4:30 pm – Poster Session
5:00 pm – 7:00 pm – Formal Scoping Meeting

Project Site and Background Information: Since its construction in 1985, users of the Rota West Harbor have experienced problems with navigation within the entrance channel and with vessels docked at the piers attributable to adverse wave conditions and the current harbor configuration. As recently as late 2013, there have been periods when the harbor has shut down and cargo flown to the island at a considerable cost to the island residents. The project will evaluate wave action within the harbor and identify modifications to general navigations features to improve operating inefficiency and safe navigation and address the need to expand the harbor basin to accommodate larger vessels.

Proposed Action(s): The study reports will assess the technical, environmental and economic feasibility in the implementation of navigation improvement. These include: 1) navigation improvement measures that expand the federal turning basin; 2) surge reduction measures by constructing protective structures; and 3) dredging harbor sediments to allow larger vessels access to the harbor.

Issues: Potentially significant issues associated with the project may include: aesthetics/visual impacts, air quality emissions, biological resource impacts, environmental justice, hazards and hazardous materials, hydrology and water quality, noise, traffic and transportation, and cumulative impacts from past, present and reasonably foreseeable future projects.

Mail written comments concerning this notice to: Mr. Milton Yoshimoto, Project Manager, Civil and Public Works Branch, Honolulu District, U.S. Army Corps of Engineers, Civil and Public Works Branch, Bldg 230, Fort Shafter, Hawaii 96858. Comment letters should include the commenter's physical mailing address and the project title in the subject line. In order to be considered in the Draft F/EIS, comments and suggestions should be received within 30 days after the last public scoping meeting.

For more information, please contact Mr. Milton Yoshimoto, U.S. Army Corps of Engineers, Honolulu District, Bldg 230, Ft Shafter, HI 96858, milton.t.yoshimoto@usace.army.mil.

For media enquiries, please contact POH Public Affairs Office at (808) 835-4004 or CEPOH-PA@usace.army.mil.

NOTICE OF PUBLIC SCOPING MEETINGS

**Commonwealth of the Northern Mariana Islands, Commonwealth Ports Authority and
U.S. Department of the Army, Corps of Engineers
Public Scoping Meetings for an Integrated Feasibility/Environmental Impact Statement for the Proposed Tinian Harbor Modifications Project, Island of Tinian,
Commonwealth of the Northern Mariana Islands**

The Commonwealth Ports Authority (CPA) and the U.S. Army Corps of Engineers (USACE) are hosting public scoping meetings for the Proposed Tinian Harbor Modifications Project, Island of Tinian, Commonwealth of the Northern Mariana Islands (CNMI). The purpose of these meetings are to solicit participation and input from all interested federal, state, and local agencies, Native American groups, and other concerned private organizations or individuals on the scope of analysis for the Integrated Feasibility/Environmental Impact Statement (F/EIS). A Federal Notice of Intent to prepare an F/EIS for the proposed project was published in the Federal Register on July 8, 2016.

The F/EIS Public Scoping meetings will be held as follows:

Tinian: July 19, 2016
Tinian Courthouse, San Jose Village
4:30 pm – Poster Session
5:00 pm – 7:00 pm – Formal Scoping Meeting

Saipan: July 20, 2016
CPA Saipan Seaport Conference Room, Charlie Dock, Puerto Rico Village
4:30 pm – Poster Session
5:00 pm – 7:00 pm – Formal Scoping Meeting

Project Site and Background Information: Tinian Harbor is the sole commercial harbor servicing the island of Tinian, CNMI and is owned and maintained by the CPA. Due to its isolation, the harbor is extremely important for the continual flow and transit of goods and materials for the small island community. The CNMI is threatened annually by typhoons and tropical storms which has resulted in the deterioration of the protective breakwater and harbor facilities. Failure of the breakwater would result in complete closure of the harbor, requiring costly air transport as the only remaining option to deliver essential commodities to the island. The project will focus on the repair/reconfiguration of the breakwater and an incremental analysis of the harbor depth to assure safe and efficient operation of commercial vessels.

Proposed Action(s): The study reports will assess the technical, environmental and economic feasibility in the implementation of navigation improvement. These include: 1) navigation improvement measures that expand the federal turning basin; 2) surge reduction measures by constructing protective structures; and 3) expand and deepen the harbor basin and entrance channel to accommodate larger vessels by dredging.

Issues: Potentially significant issues associated with the project may include: aesthetics/visual impacts, air quality emissions, biological resource impacts, environmental justice, hazards and hazardous materials, hydrology and water quality, noise, traffic and transportation, and cumulative impacts from past, present, and reasonably foreseeable future projects.

Mail written comments concerning this notice to: Mr. Milton Yoshimoto, Project Manager, Civil and Public Works Branch, Honolulu District, U.S. Army Corps of Engineers, Civil and Public Works Branch, Bldg 230, Fort Shafter, Hawaii 96858. Comment letters should include the commenter's physical mailing address and the project title in the subject line. In order to be considered in the Draft F/EIS, comments and suggestions should be received within 30 days after the last public scoping meeting.

For more information, please contact Mr. Milton Yoshimoto, U.S. Army Corps of Engineers, Honolulu District, Bldg 230, Ft Shafter, HI 96858, milton.t.yoshimoto@usace.army.mil.

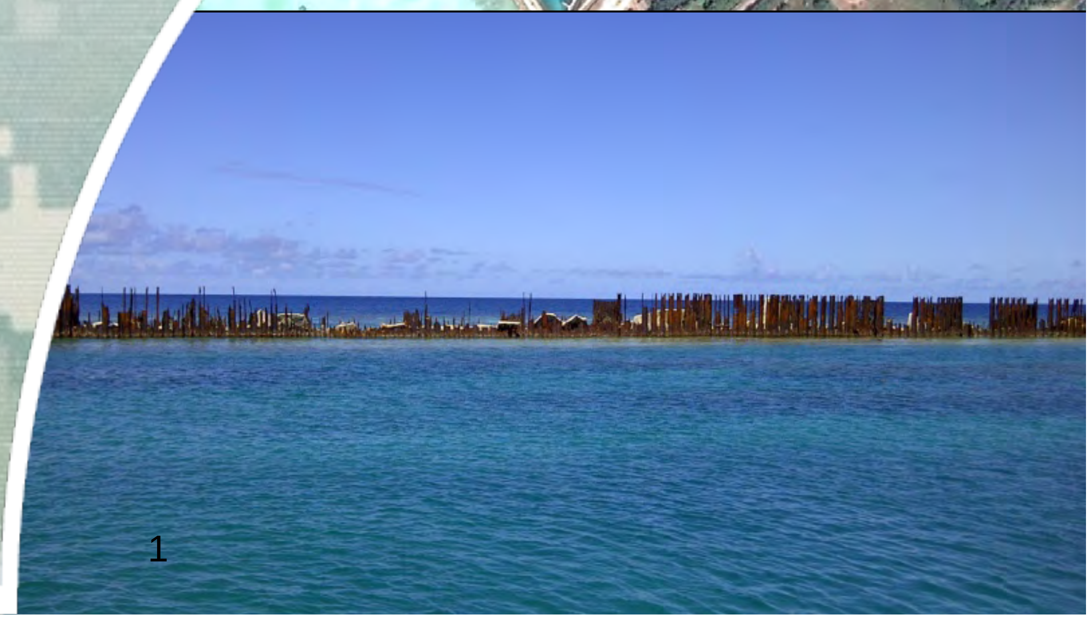
For media enquiries, please contact POH Public Affairs Office at (808) 835-4004 or CEPOH-PA@usace.army.mil.

Public Scoping Meeting

Navigation Improvements
Tinian Harbor

Integrated Feasibility Study and Environmental Impact Statement

19 July 2016



US Army Corps of Engineers
BUILDING STRONG®

Public Scoping Meeting

National Environmental Policy Act

Tuesday, 19 June 2016

4:30 PM – Poster Session

5:00 pm-7:00 pm – Formal Scoping Meeting

Tini'an Courthouse

Navigation Improvements Project

Agenda

- Welcome and Introductions
- Purpose of the Meeting
- Project Background
- Project Alternatives
- NEPA Process and Next Steps
- Public Scoping Process and Public Comments

Navigation Improvements Project

Meeting Ground Rules

- Comments will be taken during the open mic portion of the meeting.
- Commenters will be limited to 3 minutes, so as to allow everyone a chance to speak.
- Written comments are preferred.

Navigation Improvements Project

Purpose of the Meeting

- National Environmental Policy Act (NEPA)
  - ►Initiate project's environmental review to comply with Federal Law
- Obtain public comments on potential actions
  - ►Solicit public interest to serve as consulting parties

Project Background

Early Planning Activities

- Stakeholder Meetings & Site Visit
  - ▶ Held in January 2016
- Planning Charette
  - ▶ Held in February 2016 with sponsor and stakeholders to gather input on problems/needs and available data
- NEPA Milestones
  - ▶ Notice of Intent to prepare an Integrated Feasibility/ Environmental Impact Statement (F/EIS), published July 2016

Project Background

Purpose

The purpose of this planning effort is to conduct two feasibility studies with integrated NEPA documents to assess the technical, environmental and economic feasibility of the implementation of navigation improvements at the Tinian Harbors.

The study shall evaluate the feasibility of navigation improvement measures to : 1) allow for larger vessels; 2) improve efficiency of operations; and 3) reduce vessel damages, harbor closures, and life safety risks due to wave action within the entrance channel and turning basin.

Project Background
Needs

- Critical component of Tinian navigation route
- Currently impacting cargo supply to the islands and residents
- Safety concerns for port users
- Operational inefficiencies
- Increase accommodation to larger vessels

Project Background

Tinian Harbor

Problem: The CNMI is threatened annually by typhoons and tropical storms which has resulted in the deterioration of the protective breakwater and harbor facilities. Failure of the breakwater would result in complete closure of the harbor, requiring costly air transport as the only remaining option to deliver essential commodities to the island.

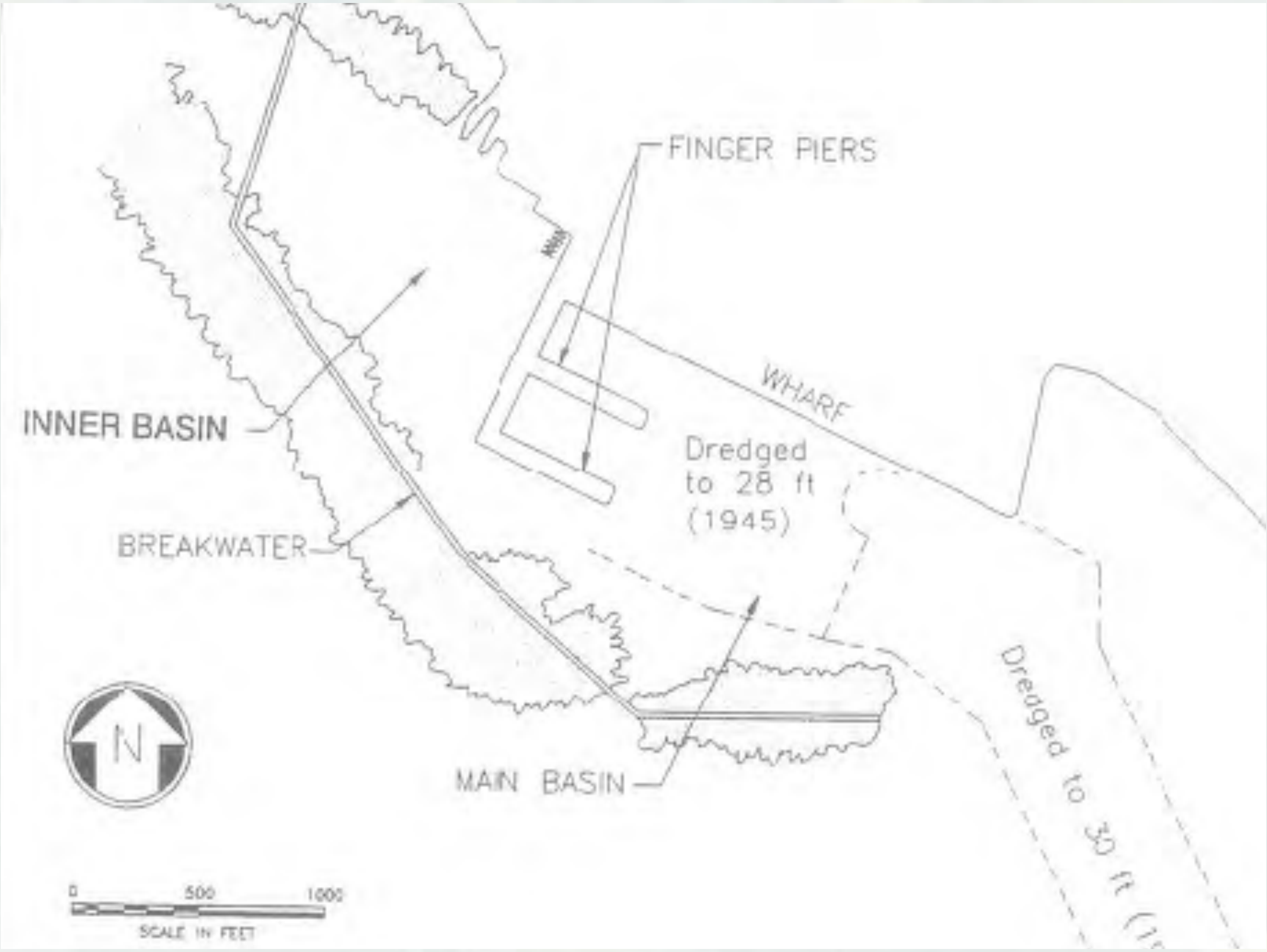
Study Purpose: The project will focus on the repair/reconfiguration of the breakwater and an evaluation of existing/future requirements for harbor depth to assure safe and efficient operation of commercial vessels.

Project Background

Tinian Harbor Map and Existing Condition

Project Background

Tinian Harbor Map



Project Alternatives

Alternatives Considered : Tinian Harbor

- Deepening of existing entrance channel and/or turning basin
- Reconstruction of existing breakwater
- Reconstruction and extension of breakwater
- Reconstruction of existing breakwater and new breakwater on east side of channel
- Non-structural alternatives

Project Alternatives

Alternatives Considered : Tinian Harbor

Alternative 1: Rebuild Existing Breakwater

Project Alternatives

Alternatives Considered : Tinian Harbor

Alternative 2: Rebuild and Extend Existing Breakwater

Project Alternatives

Alternatives Considered : Tinian Harbor

Alternative 3: Rebuild Existing Breakwater and Add New Breakwater

Environmental Review

NEPA Process and Schedule

Notice of Intent	Formally announces project and initiates environmental reviews.	8 July 2016
Scoping Process	*Establishes framework for environmental review.*	*18/19/20 July 2016*
	Scoping Comment Period Ends	19 August 2016
Draft Feasibility/ Environmental Impact Statement	Documents potential environmental, social, and economic effects.	Spring/Summer 2017
Public Review	Minimum 45-day review period of Draft document, including a public hearing.	Summer/Fall 2017
Final Environmental Impact Statement	Addresses public and agency comments.	
Record of Decision	Decision Document that officially identifies the preferred alternative and mitigative measures. End of NEPA process and allows project to enter design and construction.	

Next Steps
NEPA Draft F/EIS

Prepare a NEPA Draft Feasibility/Environmental Impact Statement that will…

- Address public comments received during the NEPA scoping period
- Identify and address significant issues associated with the project may include:
  - aesthetics/visual impacts,
  - biological resource impacts,
  - hazards and hazardous materials,
  - noise,
  - air quality emissions,
  - environmental justice,
  - hydrology and water quality,
  - traffic and transportation,
  - cumulative impacts from past, present and reasonably foreseeable future projects.
- Identify mitigation measures.

Public Scoping Process

Submission of Written Comments

By E-mail

TinianHarborPublicComments@usace.army.mil

By Mail

Mr. Milton Yoshimoto

U.S. Army Corps of Engineers

Honolulu District, Building 230

Ft. Shafter, HI 96858

All comments are due by August 19, 2016

TINIAN HARBOR PUBLIC SCOPING MEETING
19 July 2016, 5:00 PM

Name	Affiliation	Email/Contact Info
GARY KUWABARA	OFFICE OF ECONOMIC ADJUSTMENT	GARY.D.KUWABARA.CIV@MAIL.MIL
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Mihai Letu	USCG	mihai.letu@uscg.mil
BRYCE VAN CLEEF	USCG	BRYCE.L.VANCLEEF@uscg.mil
Jose P. Kiyoshi	TCGLC	jpkcommissioner@gmail.com
EDWINA MENZIES	LOCAL RESIDENT	dinataitano@yahoo.com
David M Evangelista	MOT Mayors office	tootinas69@gmail.com
ROSALINA LAZARO	CPA	rslazaro82@gmail.com
LARRY KRAMER	USCG	LARRY.G.KRAMER@uscg.mil
GERALD CRISOSTOMO	CPA - Tinian	gkcrisostomo@cpa.gov.mp
Trenton B. Conner	Bridge Investment Group.	tbc_conner@hotmail.com
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Ed Hofschneider	DCRM - Tinian	edhofschneider@hotmail.com
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ROTA HARBOR AND TINIAN HARBOR PUBLIC SCOPING MEETING
20 July 2016, 5:00 PM

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Appendix: Public Comments and Concerns

1.1 Public Scoping Comments and Resources of Concern*

Scoping the feasibility study used several outreach strategies including notifying local CNMI residents and local government natural resource agencies via email, letters, and word of mouth. The USACE and CNMI conducted a planning Charrette in Honolulu between February 16, 2016 and February 18, 2016 that included the U.S. Fish and Wildlife Service (USFWS), NOAA, CNMI regulatory agencies, and other interested parties. The USACE published a Notice of Intent of an Environmental Impact Statement on July 8, 2016 to inform the public about the upcoming study and solicit public comments on scoping. The CNMI posted information on their social media outlets and in their local newspapers. Additionally, the USACE and CNMI jointly hosted public meetings on Tinian and Saipan on July 19, 2016 and July 20, 2016 to gather comments on issues of concern and to scope the feasibility study to the appropriate area and resources. The USACE and CNMI based the scope of the study on issues raised by the local communities and natural resources agencies at those meetings. The study team also included issues that commonly arise during other dredging, port facility and navigation construction projects. Tables 3-1 and 3-2 in Section 3 provides the results of scoping of resources studied.

1.2 Project Sponsors' Objectives and Public Concerns - Problems

According to the CNMI, the Northern Mariana Islands are experiencing their most challenging economic status since the birth of the Commonwealth in 1976. By definition, the CNMI is in an economic depression unmatched even by the Great Depression of the United States in 1929-1931 (CEDS 2009). The following provides some of the economic challenges facing the CNMI:

- The total loss of the garment industry and the downturn in tourism since 2005 due to the loss of air service from Japan has resulted in the local government losing over 35% of its budget.
- Rising cost of power and jobs on the islands have contributed to a substantial population decline, estimated at over 20,000 people leaving the Commonwealth in the past several years. Once nearing 78,000, the current population was estimated by economists to be approximately 50,000 to 55,000 in 2009. The decrease in population has proved to be a challenge for the local government as well as businesses that are facing declining markets.
- Challenges associated with the rising minimum wage, now mandated by federal law to increase by $0.50 each year until the Northern Marianas reaches the U.S. federal minimum wage of $7.25 per hour. As of 2016, the current minimum wage in the CNMI sits at $6.55 per hour. Therefore, the CNMI is expected to see increases annually for the next two years, regardless of the health of the local economy.
- The growth of the military base in Guam will result in a regional labor shortage. There have already been a significant number of local CNMI families that have relocated to Guam to pursue higher paying job opportunities. Employers are forced to compete regionally for qualified workers. The likely effect of this will be high turnover costs and an upward pressure on wages and benefits to compete with Guam employers. In order to keep its residents for employment purposes, as well as to attract new industries and investors, the CNMI must seek new ways to

become efficient and reduce the costs of living and doing business. This will require major investments in upgrades to the Commonwealth's primary infrastructure.

- The cost of doing business on Saipan is much higher than Guam, while Rota and Tinian are even costlier than Saipan due to inadequate basic infrastructure and the added cost of shipping goods into the islands. In the case of Rota and Tinian, the higher cost of shipping goods into the islands makes doing business very expensive.

1.3 Project Sponsors' Objectives and Public Concerns – Opportunities

Given the significant challenges described above, the CNMI has made it a priority to continue to improve its infrastructure with local, federal, public and private funds. Improvements to Tinian Harbor could facilitate more regular sea freight service, thereby reducing the cost of all goods. The following provides potential opportunities if harbor infrastructure is improved:

- Infrastructure improvements could encourage the military's use of Tinian as a training zone.
- Harbor improvements could facilitate the agricultural industry. On Tinian, the Mayor's office has spearheaded efforts to: build a community center that can be the location of a farmer's market in the future, seek funding for a USDA-approved slaughterhouse facility that can be used to help boost the sales of local meat, and seek additional technical assistance and shared fumigation facilities to bring local produce up to USDA standards for export.
- Harbor improvements could facilitate growth in aquaculture. The aquaculture industry is currently in the infancy stage in the CNMI. There is a successful shrimp production facility in Saipan, however, the operational challenges inherent to doing business in the CNMI continues to inhibit the maturation of the industry. This is due to CNMI utility infrastructure and costs coupled with shipping issues. Diversification of CNMI's aquaculture industry by way of various product offerings may promote export activity as compared to that of a single product offering. Research is currently underway through Northern Marianas College, Cooperative Research Extension & Educational Services (NMC-CREES) sponsored Abalone project (2013 CNMI Economic Development Forum Report and Recommendations).
- Both a challenge and major opportunity for the future of the region is the upcoming military build-up and move of U.S. Marine forces from Okinawa, Japan to Guam. The impact of relocating approximately 8,000 Marines and 9,000 family members, plus the movement of other forces and capabilities to Guam will be significant for the entire region. The U.S. Department of Defense population on Guam is expected to grow from its current state of approximately 14,000 to nearly 40,000 over a five-year period.
- Both a challenge and major opportunity for the future of the region is the upcoming military build-up and move of U.S. Marine forces from Okinawa, Japan to Guam. The impact of relocating approximately 8,000 Marines and 9,000 family members, plus the movement of other forces and capabilities to Guam will be significant for the entire region. The U.S. Department of Defense population on Guam is expected to grow from its current state of approximately 14,000 to nearly 40,000 over a five-year period.

- The addition of Marine Corps personnel and their families is shedding light on the pre-existing infrastructure and social service challenges on Guam and the CNMI. Utilities and public works, health care, education and other areas have lacked significant attention over the years and may now directly affect or be affected by the relocation effort. Significant issues can be broadly categorized into the categories of environmental, socio-economic, infrastructure, health and human services, and labor/workforce. The proximity of the military build-up to the CNMI stands to bring additional investment and capabilities to the islands.

Appendix 9

DQC Review

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CERTIFICATION OF DISTRICT QUALITY CONTROL REVIEW

Tinian Harbor Navigation Improvement
Feasibility Study

District Quality Control (DQC) review was completed for the Civil Works Review Plan and no major technical concerns were identified. All concerns resulting from the DQC review of the project have been fully resolved to the satisfaction of the reviewers. The study has been determined to be technically correct and policy compliant.

The DQC review, verified that the report used justified and valid assumptions and is in compliance with established policy principles and procedures.

All comments resulting from the DQC Review have been resolved and closed.

SMITH.THOMAS.D.1230034610 Digitally signed by SMITH.THOMAS.D.1230034610 DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USA, cn=SMITH.THOMAS.D.1230034610 Date: 2018.04.13 18:24:22 -10'00'

4/13/2018

Thomas D. Smith, P.E
CEPOH-EC-T
DQC Review Team Lead

Date

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Comment Report: All Comments
Project: Tinian Harbor F/EIS
Review: DQC Review
Displaying 22 comments for the criteria specified in this report.

Id	Discipline	Section/Figure	Page Number	Line Number
7033343	Economics	n/a	n/a	n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

Detailed Project Report:
-Concern: Multiple numbers don't match tables in the Economic Appendix.

Justification: On pages 2-5, 3-39, and on Table 3-7, multiple numbers don't match corresponding tables in the Economic Appendix.

Significance: Low

Recommendation: Edit the DPR to match tables in the Economic Appendix.

Submitted By: Andrew Bazzle (2516944101). Submitted On: Jun 22 2017

1-0 Evaluation **Concurred**
Will update DPR to match Economic Appendix.

Submitted By: Sherida Bonton (808-835-4027) Submitted On: Jun 22 2017

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Andrew Bazzle (2516944101) Submitted On: Jun 26 2017

Current Comment Status: **Comment Closed**

Id	Discipline	Section/Figure	Page Number	Line Number
7033345	Economics	n/a	n/a	n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

Economic Appendix:

-Concern: No O&M costs listed

Justification: Section 6-5 has no O&M costs listed. ROM costs for environmental mitigation and not O&M are all that's been included at this stage. While it may not change the economic justification of the alternatives, all costs need to be accounted for prior to the TSP milestone and subsequent release of the draft report.

Significance: Medium

Recommendation: Ensure full O&M costs are estimated and included in the analysis by TSP.

Submitted By: Andrew Bazzle (2516944101). Submitted On: Jun 22 2017

1-0 Evaluation **Concurred**

Draft report release will include full O&M Costs. Engineering has not dictated the extent of O&M required and plan to once plan selection process is reviewed.

Submitted By: Sherida Bonton (808-835-4027) Submitted On: Jun 22 2017

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Andrew Bazzle (2516944101) Submitted On: Jun 26 2017

Current Comment Status: **Comment Closed**

7151356	Environmental	n/a	Global	n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

Please refer to the project as "proposed" project or "proposed" action to avoid appearing as predecisional in nature. It is imperative that this document convey the process of our due diligence.

Submitted By: Uyen Tran (808-835-4096). Submitted On: Sep 14 2017

1-0 Evaluation **Concurred**

References to the project have been revised to reflect "proposed project/action".

Submitted By: Rachel Okoji (8087836840) Submitted On: Oct 23 2017 (Attachment: Tinian_Integrated_Feasibility_Study_and_EIS_DQC_r.pdf)

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Uyen Tran (808-835-4096) Submitted On: Oct 24 2017

Current Comment Status: **Comment Closed**

7151361	Environmental	1.5	1-5	25

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

Move last two paragraphs in section (pg 1-6, ln 17-26) to follow purpose paragraph on page 1-5. Please revise for better flow.

Delete Purpose and Need subheaders.

The rest of the section can remain as is.
This section should be cut and paste into the Executive summary in it's entirety.

Submitted By: Uyen Tran (808-835-4096). Submitted On: Sep 14 2017

1-0 Evaluation **Concurred**

Two paragraphs have been moved and text modified as specified. The subheaders have been deleted and the section has been copied into Section ES-4 of the Executive Summary.

Submitted By: Rachel Okoji (8087836840) Submitted On: Oct 03 2017

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Uyen Tran (808-835-4096) Submitted On: Oct 24 2017

Current Comment Status: **Comment Closed**

7151372	Environmental	Section 4	n/a	n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

The region of influence (ROI) for each resource needs to be identified at the beginning of every resource section. This will help focus the discussion on project specific resources and the impacts on them from the project. ROIs for each resource section can be different. For example, the ROI for ground water is different from the ROI for Air Quality. Identification of the ROI should not only consider the actual project footprint but should also include disposal sites, staging sites, etc. Project impacts for the environmental consequences section need to include discussion of impacts on the entire ROI.

Submitted By: Uyen Tran (808-835-4096). Submitted On: Sep 14 2017

1-0 Evaluation **Concurred**

A description of the ROI has been added to the beginning of Environmental Consequences to each resource section.

Submitted By: Rachel Okoji (8087836840) Submitted On: Oct 03 2017

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Uyen Tran (808-835-4096) Submitted On: Oct 24 2017

Current Comment Status: **Comment Closed**

7151373	Environmental	Section 4	n/a	n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

Each Affected Environment section should describe the specific resource within the ROI and the existing condition for each resource section. This is inconsistently done for the various resources throughout Section 4.

Submitted By: Uyen Tran (808-835-4096). Submitted On: Sep 14 2017

1-0 Evaluation **Concurred**
A description of the ROI has been added to the beginning of Environmental Consequences to each resource section.

Submitted By: Rachel Okoji (8087836840) Submitted On: Oct 03 2017

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Uyen Tran (808-835-4096) Submitted On: Oct 24 2017

Current Comment Status: **Comment Closed**

7151377	Environmental	Section 4	n/a	n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

When writing your Affected Environment, it should tie into the Environmental Consequences factors considered to be significant. We should be able to look at the AE and clearly see whether or not there are impacts based on factors considered to be significant. And then the impact analysis should discuss. And everything should also tie back in to the purpose and need of the proposed action. This is not consistently done through out the various resource sections.

Submitted By: Uyen Tran (808-835-4096). Submitted On: Sep 14 2017

1-0 Evaluation **Non-concurred**
Impacts to each of the affected environments is described in a general sense, then significant environmental consequences is described as it pertains to the region of influence. Lastly, each alternative is discussed separately indicating if there are impacts and what type of impact (long-term/short-term, adverse/beneficial, significant/less than significant, direct/indirect).

Submitted By: Rachel Okoji (8087836840) Submitted On: Oct 17 2017

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Uyen Tran (808-835-4096) Submitted On: Oct 24 2017

Current Comment Status: **Comment Closed**

7151388	Environmental	Figure 4-2	4-25	n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

Why is the Military Lease Area called out in this figure while our project site is not? This seems to occur throughout the document on several different figures.

Submitted By: Uyen Tran (808-835-4096). Submitted On: Sep 14 2017

1-0 Evaluation **Concurred**
Figures have been modified to show the Project Site when appropriate.

Submitted By: Rachel Okoji (8087836840) Submitted On: Oct 03 2017
1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Uyen Tran (808-835-4096) Submitted On: Oct 24 2017
Current Comment Status: **Comment Closed**

7151395 Environmental Section 4.8 n/a n/a
Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

Please review this section and make sure that this is written for our proposed action.

Submitted By: Uyen Tran (808-835-4096). Submitted On: Sep 14 2017
1-0 Evaluation **Concurred**
The section was written for this report. No change.

Submitted By: Rachel Okoji (8087836840) Submitted On: Oct 03 2017
1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Uyen Tran (808-835-4096) Submitted On: Oct 24 2017
Current Comment Status: **Comment Closed**

7151406 Environmental n/a 4-38 20-21
Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

FAA is not a cooperating agency for this F/EIS.

Submitted By: Uyen Tran (808-835-4096). Submitted On: Sep 14 2017
1-0 Evaluation **Concurred**
Language stating that the FAA is a cooperating agency for this F/EIS has been removed.

Submitted By: Rachel Okoji (8087836840) Submitted On: Oct 03 2017
1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Uyen Tran (808-835-4096) Submitted On: Oct 24 2017
Current Comment Status: **Comment Closed**

7151413 Environmental n/a 4-84 – 4-85 AND GLOBAL 41-1

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

What surveys are you referring to? There was one survey done for this project.
This entire section keeps referring to surveys conducted in support of the F/EIS and citing DoN 2013. The DoN did not do surveys in support of our F/EIS.
Please make sure this document does not refer to the CJMT project as our own!
PLEASE DO A GLOBAL SEARCH AND VERIFY THAT WE DO NOT DO THIS.

Submitted By: Uyen Tran (808-835-4096). Submitted On: Sep 14 2017

1-0 Evaluation **Concurred**
The references to the surveys being conducted for the F/EIS study have been removed. A global search did not identify and additional references.

Submitted By: Rachel Okoji (8087836840) Submitted On: Oct 03 2017

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Uyen Tran (808-835-4096) Submitted On: Oct 24 2017
Current Comment Status: **Comment Closed**

7151417 Environmental n/a 4-92 7

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

I still do not agree that this significant impact is a direct result (or indirect result) of our project. This immigration/emigration situation is currently happening and would still occur independent of our porposed project being implemented. What is the evidence that leads to this impact analysis? What says that it is our no action alternative or our action alternatives that would lead directly or indirectly to this significant impact? Is there a study or survey which leads to this conclusion?

Submitted By: Uyen Tran (808-835-4096). Submitted On: Sep 14 2017

1-0 Evaluation **Non-concurred**
We agree that immigration/emigration is currently occurring. We believe it to be partially attributed to the high cost of living and lack of opportunity some of which is due to lack of reliable transport. This was relayed during face to face meetings with the stakeholders.

Submitted By: Rachel Okoji (8087836840) Submitted On: Oct 17 2017

1-1 Backcheck Recommendation **Close Comment**
We shall agree to disagree.

Submitted By: Uyen Tran (808-835-4096) Submitted On: Oct 24 2017
Current Comment Status: **Comment Closed**

7151450 Environmental Section 4.12.5.2 4-92 n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

Alternative 2 would result in destroying the breakwater. Only a portion would be protected in place. This impact needs to be identified. Please include this discussion. The existing breakwater will not be repaired.

Submitted By: Uyen Tran (808-835-4096). Submitted On: Sep 14 2017

1-0 Evaluation **Concurred**

The introductory sentence of the second paragraph changed to read: "Implementing Alternative 2 would remove and replace most of the existing breakwater." The first paragraph changed to say: "...the structural changes will adversely impact some of the historical features of the breakwater as an archaeological site."

Submitted By: Rachel Okoji (8087836840) Submitted On: Oct 03 2017

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Uyen Tran (808-835-4096) Submitted On: Oct 24 2017

Current Comment Status: **Comment Closed**

7151452	Environmental	Section 4.12.5.3	4-93	n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

Alternative 3 would result in destroying the breakwater. Only a portion would be protected in place. This impact needs to be identified. Please include this discussion. The existing breakwater will not be repaired.

Submitted By: Uyen Tran (808-835-4096). Submitted On: Sep 14 2017

1-0 Evaluation **Concurred**

This section does specify that most of the existing breakwater will be demolished. The first sentence of the second paragraph is changed to read: "The structural changes will adversely impact some of the historical features of the breakwater as an archaeological site."

Submitted By: Rachel Okoji (8087836840) Submitted On: Oct 03 2017

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Uyen Tran (808-835-4096) Submitted On: Oct 24 2017

Current Comment Status: **Comment Closed**

7151537	Environmental	ection 4.19.1	4-139	n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

The list of projects presented for the cumulative impacts section is lacking. What about CJMT? Why wouldn't we include in cumulative impacts? Cumulative impact levels might change under a number of resources sections with the additional demand CJMT will put on natural resources.What about projects that the DOI is doing? The project PM might be a good source of information for this.

Submitted By: Uyen Tran (808-835-4096). Submitted On: Sep 14 2017

1-0 Evaluation **Concurred**

Projects proposed in the CJMT have been included as a single action since the actions consist of changes in training activities which may include individual infrastructure adjustments. The impacts of these activities are included in the analysis.

Submitted By: Rachel Okoji (8087836840) Submitted On: Oct 03 2017

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Uyen Tran (808-835-4096) Submitted On: Oct 24 2017

Current Comment Status: **Comment Closed**

7151551 Environmental Section 4.19.1 4-139 n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

The level of detail for the Master Plan seems odd compared to some of the level of detail for our own project. There's more figures and tables in this small section than in the entire Section 4. Please scale appropriately.

Submitted By: Uyen Tran (808-835-4096). Submitted On: Sep 14 2017

1-0 Evaluation **Concurred**

The level of detail about ship types and other aspects of the Master Plan has been removed.

Submitted By: Rachel Okoji (8087836840) Submitted On: Oct 03 2017

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Uyen Tran (808-835-4096) Submitted On: Oct 24 2017

Current Comment Status: **Comment Closed**

7151559 Environmental Section 4.19.2 n/a n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

Are cumulative impacts identified consistent with impacts discussions and levels identified in Section 4? Please verify that impact levels for cumulative impacts identified are consistent with Section 4.

Submitted By: Uyen Tran (808-835-4096). Submitted On: Sep 14 2017

1-0 Evaluation **Concurred**

The cumulative impacts has been reviewed and revised for consistency with previous discussions in Section 4.

Submitted By: Rachel Okoji (8087836840) Submitted On: Oct 03 2017

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Uyen Tran (808-835-4096) Submitted On: Oct 24 2017

Current Comment Status: **Comment Closed**

7151567 Environmental Section 4.19.2.2.7 GLOBAL and 4-152 n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

I would caution the over sensationalization of economic growth here in this section and throughout this entire document. What leads us to believe that there will be significant economic growth? Our discussion does not necessarily support this claim.

Submitted By: Uyen Tran (808-835-4096). Submitted On: Sep 14 2017

1-0 Evaluation **Non-concurred**

This is based on face to face discussions with stakeholders. We can discuss further.

Submitted By: Rachel Okoji (8087836840) Submitted On: Oct 17 2017

1-1 Backcheck Recommendation **Close Comment**

We shall agree to disagree.

Submitted By: Uyen Tran (808-835-4096) Submitted On: Oct 24 2017

Current Comment Status: **Comment Closed**

7151570 Environmental n/a 4-153 ln 5

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

We should not narrow the cumulative impact analysis to just the Master Plan.

Submitted By: Uyen Tran (808-835-4096). Submitted On: Sep 14 2017

1-0 Evaluation **Concurred**
Projects other than those included in the Master Plan are in the analysis and other projects have been added. Attempts to locate additional projects have been unsuccessful.

Submitted By: Rachel Okoji (8087836840) Submitted On: Oct 03 2017

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Uyen Tran (808-835-4096) Submitted On: Oct 24 2017

Current Comment Status: **Comment Closed**

7158388 Environmental n/a 1, para 1 & Global n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**
(Document Reference: Mitigation Plan for Coral Resources Associated with Tinian Harbor Navigation Improvements)

This comment is for the Mitigation Plan for Coral Resources Associated with Tinian Harbor Navigation Improvements.

It is an Integrated Feasibility/EIS report. Please refer to report as such.

Submitted By: Uyen Tran (808-835-4096). Submitted On: Sep 20 2017

1-0 Evaluation **Concurred**
Report is referenced as an "Integrated Feasibility/EIS report" in the Coral Mitigation Plan document.

Submitted By: Rachel Okoji (8087836840) Submitted On: Oct 20 2017 (Attachment: Mitigation_Plan_for_Tinian_Harbor_Improvements.pdf)

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Uyen Tran (808-835-4096) Submitted On: Oct 26 2017

Current Comment Status: **Comment Closed**

7158392 Environmental n/a 2, Section 1.1 n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**
(Document Reference: Mitigation Plan for Coral Resources Associated with Tinian Harbor Navigation Improvements)

This comment is for the Mitigation Plan for Coral Resources Associated with Tinian Harbor Navigation Improvements.

The title of this section is Rationale. Of what? Can you add more description to this title?

Submitted By: Uyen Tran (808-835-4096). Submitted On: Sep 20 2017

1-0 Evaluation **Concurred**

Section 1.1 has been renamed "Coral Reef Protection and Mitigation"

Submitted By: Rachel Okoji (8087836840) Submitted On: Oct 17 2017

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Uyen Tran (808-835-4096) Submitted On: Oct 26 2017

Current Comment Status: **Comment Closed**

7158442	Environmental	Section 7	n/a	n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

(Document Reference: Mitigation Plan for Coral Resources Associated with Tinian Harbor Navigation Improvements)

This comment is for the Mitigation Plan for Coral Resources Associated with Tinian Harbor Navigation Improvements.

The cost feasibility analysis does not provide information on how cost per acre was developed. Please include this information in this discussion.

Submitted By: Uyen Tran (808-835-4096). Submitted On: Sep 20 2017

1-0 Evaluation **Concurred**

Section 7 has been revised to incorporate cost breakdown and contingency discussion.

Submitted By: Rachel Okoji (8087836840) Submitted On: Oct 17 2017

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Uyen Tran (808-835-4096) Submitted On: Oct 26 2017

Current Comment Status: **Comment Closed**

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