Guam Environmental Protection Agency

2020 INTEGRATED REPORT

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PHYSICAL & MAILING ADDRESS
3304 Mariner Avenue, Bldg. 17
Tiyan, Guam 96913

Tel: (671) 300-4751
Fax: (671) 300-4530

Visit us online at epa.guam.gov

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Abbreviations and Acronyms

AAFB	Anderson Air Force Base
AOC	Area of Concern
BRAC	Base Realignment and Closure
CB	Construction Battalion
CCU	Consolidated Commission on Utilities
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
CMS	Comprehensive Monitoring Strategy
CWA	Clean Water Act
CWAP	Clean Water Action Plan
CZMP	Coastal Zone Management Program
DAWR	Division of Aquatic Wildlife Resources
DMR	Discharge Monitoring Report
DoD, IRP	Department of Defense, Installation Restoration Program
ECP	Erosion Control Plan
EDB	Ethylene Dibromide
EPA	U.S. Environmental Protection Agency
FFCA	Federal Facilities Compliance Agreement
FSCMP	Fish and Shellfish Contaminant Monitoring Program
FIFRA	Federal Insecticide, Fungicides, and Rodenticide Act
GCA	Guam Code Annotated or Guam Coastal Assessment
GCMP	Guam Coastal Management Program
GEMAP	Guam Environment Monitoring and Assessment Program
GHS	Guam Hydrologic Survey
GIAA	Guam International Airport Authority
GIS	Geographic Information System
GWA	Guam Waterworks Authority
GWSA	Guam Wadeable Stream Assessment
GWMS	Guam Water Monitoring Strategy
GWQS	Guam Water Quality Standards
IR	Integrated Report
LUST	Leaking Underground Storage Tank
MCL	Maximum Contaminant Levels
MPWQAP	Marine Preserve Water Quality Assessment Program
MSWLF	Municipal Solid Waste Landfill Facility
NGL	Northern Guam Lens
NOAA	National Oceanic and Atmospheric Administration
NOV	Notice of Violation
NPDES	National Pollution Discharge Elimination System

NPL	National Priority List
NPS	National Park Service
NRCS	National Resources Conservation Service
NWI	National Wetlands Inventory
PCB	Polychlorinated Biphenyl
PCE	Tetrachloroethene
PWSS	Public Water Supply System
QA/QC	Quality Assurance/Quality Control
RBMP	Recreational Beach Monitoring Program
RCRA	Resource Conservation and Recovery Act
ROD	Record of Decision
SDWA	Safe Drinking Water Act
STMP	Status and Trends Monitoring Program
SWMS	Surface Water Monitoring Strategy
SVE	Soil Vapor Extraction
TCE	Trichloroethylene
TMDL	Total Maximum Daily Load
UIC	Underground Injection Control
UOG	University of Guam
USACE	United States Army Corps of Engineers
USGS	U.S. Geological Service
WERI	Water and Environmental Research Institute
WMP	Wetlands Monitoring Program
WPC	Watershed Planning Committee

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PART I. INTRODUCTION

Preface: An Overview of Guam

The Island of Guam is a self-governing unincorporated territory of the United States. It is the westernmost point of the U.S., lying at latitude 13º N and longitude 144º E, a strategic location in the North Pacific Ocean. Air travel distances from Guam to nearby destinations are:

- 1,571 miles south of Tokyo, Japan;
- 1,599 miles east of Manila, Philippines; and
- 3,805 miles west and slightly south of Honolulu, Hawaii, USA.

Figure 1. Guam Location Map

Guam has an area of approximately 210 square miles (544 sq. km) and measures about 30 miles (51 km) long with widths from 11 miles (25.3 km) in the south to 4 miles (7 km) in the center and 8 miles (18.4 km) in the north. The population, estimated as of January 14, 2020, is 168,094[1] people. Guam's population density is an average of 809 people per square mile.[2] Nearly all residences are served by public/military water supply systems, while a large number of single-family homes use individual septic tank - leaching field systems. Approximately one million tourists visit Guam annually, largely drawn by Guam's tropical climate and clean recreational marine and fresh waters. According to a January 7, 2019 Guam Visitors Bureau press release, Guam achieved the best Calendar Year arrivals in the island's history with 1.55 million visitors. It was the third consecutive year of an increase in the annual total. The total number of arrivals in calendar year 2019 was a record high, with 1,666,665 visitors.[3]

Guam is the largest and southernmost island in the Mariana Islands archipelago and possesses the largest fresh water resources of these islands. Guam has a tropical oceanic climate, with warm temperatures and high humidity. Daily temperatures year around consist of highs in the middle eighties (degrees Fahrenheit) and daily lows in the low seventies. Relative humidity ranges between 65% and 75% in the afternoon to between 85% and 90% at night. Seasonal changes relate to amounts of rainfall. Wet season normally extends from July to November and dry season from January to May, with transitional periods between. Annual average rainfall varies from about 110 inches in the higher areas

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[1] Source: *worldometers.info/world-population/guam-population*

[2] Ibid.

[3] Economic Outlook 2021.Gary Hiles, Chief Economist, Guam Department of Labor.

to about 80 inches along the shores. Periodic El Nino/ Southern Oscillation large-scale weather events trigger decreased rainfall and higher risks of typhoons on Guam in certain years. The largest measured El Nino event occurred in 1997-98. Guam is located in an area of the Western Pacific that experiences 38% of all the destructive tropical storms in the world. Torrential rains accompany frequently passing storms and typhoons.

Guam is divided into two distinct geological formations by a central fault line. The northern half is mainly a broad sloping limestone plateau, which is bordered by steep seaward cliffs and fringed by narrow coral reefs.

The southern half of the island is generally composed of eroded volcanic mountainous formations with numerous rivers and streams. These tropical streams and those of most Pacific islands are typically short in length and have very low mineral concentrations. These concentrations are similar island to island because the underlying geological formation is usually basalt. Another important characteristic of short tropical island streams is that photosynthesis by primary aquatic producers is not the dominant source of food. The major source of food for island stream ecosystems is usually the vegetation that falls into the streams from the plants along the banks as well as those that overhang the stream.

The fauna, fish, shrimp, eels, worms, and snails, found in island streams were originally marine organisms that adapted to freshwater conditions. Larvae from many of these organisms still develop in the ocean and return to fresh water streams as adults. But the insects and algae found in tropical island streams are truly freshwater organisms, unique to the islands. Also many of the freshwater fauna are morphologically adapted for climbing and can migrate through all the reaches of the stream, even up waterfalls.

The entire island of Guam is classified as a coastal zone. It is surrounded by 116.5 miles of shoreline divided into three distinct classifications: rocky coastline, sandy beaches, and mangrove mud flats. The rocky coastline classification surrounds the northern end of the island with a few isolated stretches in the south. It is approximately 72.5 miles in length or 62% of the total shoreline. Sandy beaches are scattered intermittently around the island and comprises 35.9 miles of shoreline or 31% of the total. The remaining 8.1 miles or 7% of the total shoreline are classified as mangrove mud flats and are centered mainly within Apra Harbor and Merizo. There are also approximately 14.2 square miles of coral reefs, 0.55 square miles of seagrass beds, 1.43 square miles of estuarine systems, and 21.73 square miles of marine bays.

Shallow fringing coral reefs with outer slopes and margins supporting live coral colonies surround most of Guam. The bordering fringing reefs in the south are broader than in the north. The width of these reefs ranges from very narrow benches (as narrow as 10 to 20 feet) on the northeastern coast, to broad reef flats forming the popular recreational and fishing areas in Tumon, Hagåtña, Agat, and Asan Bays and on the shore side of Cocos Lagoon. These reefs are extremely valuable in terms of marine life, aesthetics, food supply, recreation and protection of Guam's highly erodible shorelines from storm waves, currents, and tsunamis. Two large barrier reef systems occur at Cocos Lagoon and at Apra Harbor. Cocos Island Lagoon and its reefs form an atoll-like environment about four square miles in area, with a greatest lagoon depth of approximately 40 feet. The uplifted limestone plateau of Orote,

Cabras Island and a large artificial breakwater, which was built on a shallow reef platform and adjacent submerged bank, bound the much deeper lagoon of Apra Harbor, with depths over 120 feet. Seaward, the reef front slopes gently downward to a terrace at a depth of approximately 20-30 feet. Here, submarine channels cut the surface of the reef. These channels are lined with living corals and contain the richest fauna (animal life) to be found in any reef zone. The submarine terrace slopes gently downward to a depth of 30-50 feet. This zone supports many scattered colonies of coral.

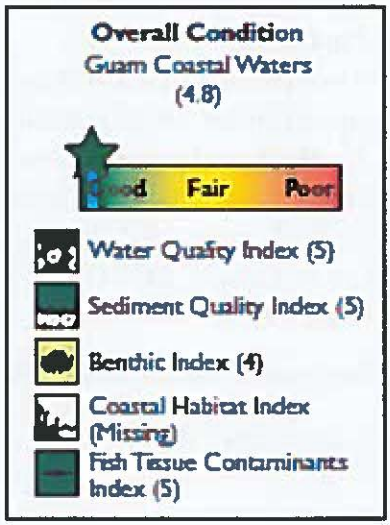
The North Equatorial Current, driven by northeast trade winds, generally sets in a western direction around Guam with a velocity of 0.5 to 1.0 knot. Guam tides are semi-diurnal with a mean range of 1.6 feet and diurnal range of 2.3 feet. Extreme predicted tide range is about 3.5 feet.

EXECUTIVE SUMMARY

1.0 Overall Water Quality

1.1 Marine Waters

Guam's marine waters are generally "good". The figure to the right summarizes the overall condition of Guam Coastal Waters as concluded in the *2012 EPA Report: Fourth National Coastal Conditions Assessment – NCCR IV* (See special footnote below).



Water in this category must be of sufficient quality to allow for the propagation and survival of marine organisms, particularly shellfish and other similarly harvested aquatic organisms, corals and other reef-related resources, and whole body contact recreation. Other important intended uses include mariculture activities, aesthetic enjoyment and related activities (Guam Water Quality Standards, GWQS).

Guam Reef Flats

The National Coastal Condition Assessment (NCCA) is an ongoing environmental survey developed by the United States Environmental Protection Agency (USEPA) in order to assess the condition of the coastal waters of the United States. The survey design utilizes multi-tiered, integrated monitoring of selected environmental indicators. Guam has participated in three NCCA surveys, the first in 2005, the second in 2010, and the most recent in 2015. The NCCA provides a 'snapshot' of conditions of US coastal waters. For Guam and the Pacific Islands, the condition of our coastal and reef flat resources is important to determine support of designated uses as defined by the Clean Water Act. The results of Guam's 2015 survey were not available for inclusion in this report.

Special Footnote: NCCR IV assesses the condition of the nation's estuaries and coastal embayments, including coastal waters of the conterminous United States, Southeastern Alaska, Hawaii, American Samoa, Guam, Puerto Rico, and the US Virgin Islands. The assessment primarily used EPA's National Coastal Assessment (NCA) Program data collected between 2003 and 2006. Go to this link: *https://www.epa.gov/sites/production/files/2016-01/documents/ncca_2010_report.pdf*

Marine Bays

The Marine Bays inventory, consists of **66** waterbodies classified under the following assessment categories for 2020. The number of impaired marine bays remains unchanged from the 2018 reporting period.

- 8 marine bays meet some designated uses but more data is needed to make a use determination for these waters (C2);
- 47 marine bays were not assessed (C3);
- 11 marine bays are impaired (C5).

For the inventory of Guam Marine Bays, see **Table 26**, Part III. Marine and Surface Water Monitoring and Assessment.

IMPAIRED MARINE BAYS 2018-2019

Waterbody Name/Assessment ID	Size of Assessed Waterbody	Status
1. Agat Bay 1/GUG-010B-1	0.63 square miles	Fish Advisory
2. Tipalao Bay/GUG-010A	0.10 square miles	Fish Advisory
3. Apra Harbor 2/GUG-008A-2	4.61 square miles	Fish Advisory
4. Apra Harbor 1/GUG-008A-1	0.05 square miles	Fish Advisory
5. North Orote Peninsula Sea Cliffs/GUG-042	0.23 square miles	Fish Advisory
6. South Orote Peninsula Sea Cliffs/GUG-043	0.02 square miles	Fish Advisory
7. Cocos Lagoon 1/GUG-20A-1	5.70 square miles	Fish Advisory
8. Cocos Lagoon 2/GUG-20A-2	0.34 square miles	Fish Advisory
9. Pago Bay/GUG-003A	0.70 square miles	>10% samples exceed WQS
10. Tanguisson Beach 2/GUG-001B-2	0.40 square miles	Seafood Consumption Advisory
11. Tumon Bay/GUG-001C	1.98 square miles	Waters not Attaining Designated uses
TOTALS: **11 Marine Bays**	**14.76 square miles impaired**	

Coastal/Recreational Waters

Guam coastal/recreational waters were assessed only for the Goal "Protect and Enhance Public Health" and the Use "Primary Contact/Swimming and Secondary Contact". The inventory of recreational/coastal waters, consists of 116 waterbodies classified under the following assessment categories for 2020. The number of impaired waterbodies remains unchanged from the 2018 reporting period.

- 70 Coastal/recreational waterbodies were not assessed (C3);
- 1 Coastal/recreational waterbody , GabGab Beach, is impaired (C5);
- 45 Coastal/recreational assessment units are impaired and a TMDL has been developed for them (4a)[4].

For the inventory of Guam Coastal/ Recreational Waters, see **Table 25**, Part III. Marine and Surface Water Monitoring and Assessment.

[4] 42 EPA approved Bacteria TMDLS developed by TetraTech, Inc. dated 2010 & 2015, respectively.

1.2 Fresh Waters

Fena Reservoir

The only inland body of water on Guam is Fena Reservoir, constructed by the Navy as a drinking water supply. "The Fena Reservoir is the primary source of water for the U.S. Navy Water System and is supplemented by the Almagosa and Bona Springs." No assessment data was available for these surface water sources.

Water from the reservoir and springs is processed at the Navy Water Treatment Plant before distribution. The Navy water system met all primary drinking water standards during the 2018 reporting period.[5]

Rivers and Streams

Table 24 provides information about the one hundred thirty-three (133) fresh water assessment units which represent two-hundred one (201) Guam rivers and streams. [The assessment unit (AU) identification is derived from the AU location in relation to the Guam River ID#/the River Name/the GEPA STMP Segment ID.] Seven river waterbodies remain impaired and are carried forward on Guam's 2020 303(d) list from the 2018 reporting cycle. Three additional rivers in the Manell Watershed were assessed as impaired in 2020 and have been added to the proposed 2020 303(d) list. The Ugum River, represented by six (6) 4a category waterbodies, remains impaired but has an approved Sediment TMDL. No additional waterbodies have been delisted since the last reporting cycle.

2020 303(d) Listed IMPAIRED RIVERS AND STREAMS

Waterbody Name/Assessment ID	Size of Assessed Waterbody	Status
1. Agana River 1/GUAGRA-3	0.52 mi	Fish Advisory
2. Agana River 2/GUAGRA-2-1A	0.67 mi	Fish Advisory
3. Pago River 1/GUPGRP-1-51-A	0.06 mi	WQS Exceedances
4. Pago River 2/GUPGRP-2	4.74 mi	WQS Exceedances
5. Storm Drain/GUAGRD	0.21 mi	WQS Exceedances
6. Lonfit River 2/GUPGRL-2	1.07 mi	Consent Decree
7. Lonfit River 3/GUPGRP-1-51B	0.04 mi	Consent Decree
8. Ajayan River	3.86 mi	WQS Exceedances
9. Liyog River	1.81 mi	WQS Exceedances
10. Sumay River	1.02 mi	WQS Exceedances
TOTALS: 10 Rivers/Streams	**14.00 miles impaired**	

Delisted IMPAIRED RIVERS AND STREAMS

11. Ugum River	21.58 mi	WQS Exceedance

Northern Guam Lens Aquifer (NGLA) – Guam Sole Source Aquifer

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[5] *2018 U.S. Navy Water System Water Quality Report. No report was available for 2019 as of March 2020.*

The overall water quality of the NGL is good. However, it is significantly vulnerable to contaminants, including chloride contamination induced from over pumping of water supply wells, and groundwater well influence by surface water or raw sewage from leaking sewer pumps or sewer pipes. Because of its designation as Guam's Sole Source Aquifer and because of the magnitude of incidences observed in which the levels of pollutants (Bacteria, Nutrients, Chlorides, and Toxic Contaminants) exceeded GWQS, action to restore, protect, and sustain the NGL remains a high priority.

2.0 Causes and Sources of Water Quality Impairments

The causes and sources of water quality impairments are discussed in the following sections.

2.1 Marine Waters

Applicable categories of causes or stressors for impaired marine bays or recreational beaches are respectively listed in **Tables B5b. and B5c., Appendix B.**

For Marine Bays these categories include pesticides, PCBs, dioxins, nutrients, pathogen indicators, and dissolved oxygen.

The pollutant causing recreational beach impairments is **enterococcus,** a pathogen indicator. Gabgab Beach, 0.65 miles, is impaired by PCBs in fish tissue.

Of the various source categories listed in **Tables B6b. or B6c.** for recreational beaches, suspected source categories include municipal point sources, combined sewer overflows, agriculture, urban runoff/storm sewers, contaminated sediments, and groundwater seeps/springs. The source of PCBs continues to be investigated.

2.2 Fresh Waters

Impaired surface waters on the 2020 303(d) list identify the following pollutants.

Rivers and Streams

Pago River segments: GUPGRP-1-51-A 0.06 miles
GUPGRP-2 4.74 miles

Pollutants: E. coli, Dissolved Oxygen

Source: Urban runoff, storm sewers, contaminated sediments

Lonfit River segments: GUPGRP-1-51B .04 miles
GUPGRL-2 1.07 miles

Pollutants: Aluminum, Salinity, Temperature, Nitrate, Ammonia, Total Coliform, E. coli, Enterococcus, Iron, Manganese, Copper, Zinc, Chromium, Nickel, Total Suspended Solids, Total Dissolved Solids

Source: Ordot Dump

Agana River GUAGRA-3 0.52 miles
GUAGRA-2-1A 0.67 miles

Pollutants: Enterococcus, Dissolved Oxygen; PCBs in fish tissue
Source: Agana Swamp for PCBs; urban runoff, storm sewers, contaminated sediments

Storm Drain GUAGRD 0.21 miles
Pollutants: E. coli, Dissolved Oxygen, Nitrate, Total Suspended Solids, Turbidity, Salinity
Source: Urban runoff, storm sewers, contaminated sediments, sewer system/manhole overflows

Sumay River **GUMZRSY** **1.02 miles**
Pollutants: Dissolved Oxygen, Orthophosphates, Nitrates, Suspended Solids
Source: Runoff, agricultural activities, septic systems

As Liyog River **GUMZRL** **1. 81 miles**
Pollutants: Dissolved Oxygen, Orthophosphates, Suspended Solids
Source: Runoff, agricultural activities, septic systems

Ajayan River **GUMZRAJ** **3.86 miles**
Pollutants: Dissolved Oxygen, Orthophosphates, Suspended Solids
Source: Runoff, agricultural activities, septic systems

Ugum River *	**GUTURU**	**1.05 miles**
(six segments)	**GUTURU-1A**	**12.57 miles**
	GUTURU-1B	**0.18 miles**
	GUTUETU-48H	**0.39 miles**
	GUTURU-1C	**2.96 miles**
	GUTURU-1A-48H	**4.43 miles**

Pollutants: Sediment
Source: Soil Erosion

Table B.5a, Appendix B, lists the total sizes of waters impaired by various cause or stressor categories for rivers/streams. * Impaired, removed from the 303(d) List in 2007.

Wetlands

Agana Swamp: GUG1-B 6.40 acres
Pollutants: PCBs in fish tissue
Source: Agana Power Plant

Other Cause/Stressor Categories for wetlands are listed in Table B.5d, Appendix B.

Groundwater

As listed in **Table 29, Part IV page 3,** the ten priority sources of groundwater contamination and the respective contaminants associated with each source are:

- **Agricultural Activities:**
  Animal feed lots --- nitrate, bacteria
  Fertilizer applications --- nitrate
  Pesticide applications --- organic & inorganic pesticides
- **Storage and Treatment Activities:**
  Underground storage tanks --- petroleum compounds
- **Disposal Activities:**
  Landfills --- inorganic & organic pesticides, halogenated solvents, petroleum compounds, nitrate, metals, other
  Septic systems --- nitrate, protozoa, bacteria, viruses
- **Other:**
  Hazardous waste generators --- halogenated solvents
  Pipelines and sewer lines --- nitrate, protozoa, bacteria, viruses
  Salt water intrusion --- salinity/brine
  Urban runoff --- inorganic & organic pesticides, halogenated solvents, petroleum compounds, Nitrate

3.0 Comprehensive Monitoring Strategy for All Waters

Guam EPA Monitoring Goals and Objectives are to:

- Conduct a comprehensive assessment of water quality throughout the island using a rotating basin approach;
- Complete a thorough evaluation of monitoring data;
- Evaluate if the quality of island waters are suitable for their designated uses;
- Evaluate if the Guam Water Quality Standards are appropriate and relevant to present conditions in the waters of the island; and
- Coordinate new approaches to improving and protecting the island's water resources through the implementation and enforcement of nonpoint source programs.

To meet all federal and local reporting requirements the CMS for the island of Guam includes ten distinct individual monitoring plans. Although programs are developed for each of these plans, some programs remain inactive because of funding/staffing constraints.

1. Status and Trends Monitoring Program (suspended)
2. Guam Environmental Monitoring and Assessment Program (active)
3. Recreational Beach Monitoring Program (active)
4. Wetlands Monitoring Program (suspended)
5. Fish and Shellfish Consumption Monitoring Program (suspended)
6. Groundwater Assessment Monitoring Plan (active)
7. Marine Preserve Water Quality Assessment Program (active)
8. Nonpoint Source Pollution Monitoring Program (active)

9. Underground Injection Control Monitoring Program (active)

10. Man-Made Impoundments Monitoring Program (active)

4.0 Programs to Correct Impairments

Guam EPA has programs in place to correct, prevent or minimize the impairment of waterbodies, fresh or marine. These programs are mandated by local and federal statutes, and are implemented to the maximum extent possible. Programs applied by Guam EPA include but are not limited to:

Guam Water Quality Standards
Guam Comprehensive Monitoring Strategy
Section 401 Water Quality Certification
NPDES Permitting
Individual Wastewater System Permitting
Sewer Connection Permitting
Soil Erosion and Sediment Control Regulations
Clearing, Grading, and Stockpiling Permitting
Environmental Protection Plan Requirement
Water Quality Monitoring Requirement
Erosion Control Plan Requirement
Section 319 NPS Programs
Coastal NPS Pollution Program
Feedlot Waste Management Program
Land Use and Wetland Use Permitting under the Guam Land Use Commission
Seashore Protection Permitting under the Guam Seashore Protection Commission
Wellhead Protection Program
Well Licensing Program
Pesticides Enforcement Program
Air Pollution Permitting Program
Groundwater Programs or Activities listed in Table 30

Guam EPA also recognizes the Guam Waterworks Authority (GWA) November 2011 Court Order (CO) which specifies 93 deliverable tasks that must be completed by December 2020. It also sets priorities for GWA's capital improvement focus.

In GWA's 2017 Annual Report[6], the Compliance and Safety Division reported: There are a number of milestones within the CO of which 80 have been completed on time, nine have been completed later than the specified compliance date, one is incomplete and behind schedule, and three remain in progress on time. The net performance of GWA's work on the CO is 98.9%. The CO does not cover all the needs of GWA in its effort to improve service to the Island of Guam that are planned by the Consolidated Commission.

[6] Guam Waterworks Authority Annual Report 2017, page 81.

Furthermore in 2017, the Division:

- Opened the new Agat Waste Water Treatment Plant. [CO 11 (c)].
- Completed Ground Water Rule (GWR) compliance for the northern and central well water systems [CO 22(c)]
- Increased the CO performance rating to 98.9 percent
- Continued to make the GWA Sewer Hook-Up Revolving Loan Fund program available. [CO 20]
- Began construction on the new GWA Compliance Laboratory, designed by Laguaña LLC, that will be put in service early in 2018
- Exceeded all required water quality standards involving the Ugum Surface Water Treatment Plant's continuous membrane filtration process.
- Coordinated the Wellhead Protection Plan alongside the Guam Environmental Protection Agency (GEPA), using the Wellhead Assessment by EA Engineering Science and Technology, Inc.
- Completed GWA's backflow / cross-connections control programs.
- Achieved full compliance with the Safe Drinking Water Act (SDWA).
- Continued to develop source control programs, including educational outreach and compliance inspections, with the assistance of Brown and Caldwell, the GWA Program Management Office.
- Continued GWA advanced safety training with Water Maintenance and Operations and Utilities Services
- Surpassed the national average safety incident rating (based on lost time accidents) by 14 points with a total safety incident rating of 28.

5.0 Trends

The quality of Guam's waters will vary considerably, depending on a variety of factors including geology, human population density, level of coastal and urban development, level and types of uses of marine, surface and groundwater resources, to include frequency of natural disturbances, such as typhoons and earthquakes.

Guam Economy

US national defense spending is the main driver of Guam's economy, followed closely by tourism and other services. Guam serves as a forward US base for the Western Pacific and is home to thousands of American military personnel. Total federal spending (defense and non-defense) amounted to $1.988 billion in 2016, or 34.2 of Guam's GDP. Of that total, federal grants and cover-over payments amounted to $344.4 million in 2016, or 35.8% of Guam's total revenues for the fiscal year. In 2016, Guam's economy grew 0.3%. Despite slow growth, Guam's economy has been stable over the last decade. National defense spending cushions the island's economy against fluctuations in tourism. Service exports, mainly spending by foreign tourists in Guam, amounted to over $1 billion for the first time in 2016, or 17.8% of GDP.[7]

Chief Economist Gary Hiles, Guam Department of Labor, summarized the Economic Outlook for Guam in FY 2019 as follows: "The Outlook for Guam's economy in Fiscal Year 2019 is a continuation of a general trend of modest growth and stability in an economic environment characterized by growth both in the U.S. and internationally. The outlook is tempered by possible downside risks.

[7] Guam Economy 2020. Updated January 27, 2020. https://theodora.com/wfbcurrent/guam/guam_economy.html

The forecast is for continued economic expansion as measured by growth in Gross Domestic Product, which has occurred every year since 2006 but has been slowing in recent years. Expansion is expected to be driven by near-record tourist arrivals, increased visitor expenditures and a rebound in construction. The likelihood of increased construction activity is supported by high dollar amounts of building permits and DOD construction contracts associated with preparation for the Marine Corps relocation from Okinawa; a backlog of funded projects in all sectors; and eased restrictions on foreign worker importation which should reduce labor capacity constraints.

Downside risks to the favorable outlook are present. Long-standing international tensions with North Korea and others in the region may flare, impacting tourism and the overall economy. Recent airline capacity reductions constrain short-term growth prospects. Further delays to a myriad of construction projects could materially alter the forecast. Recent U.S. Federal income tax changes will have both positive and negative effects on Guam's economy."

Guam EPA Water Quality Protection Activities and Programs

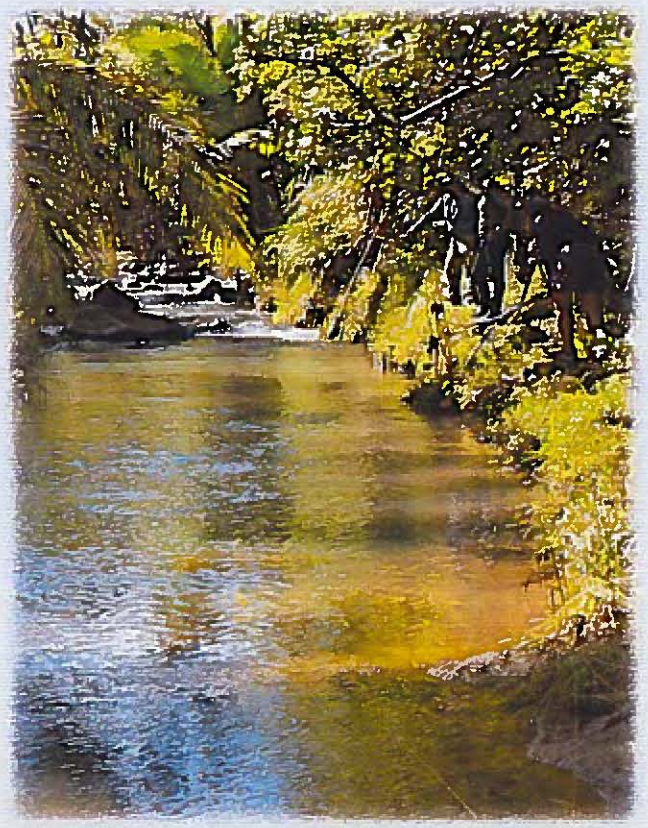
Although the agency faces issues of concern (i.e. undertaking multi-program environmental permitting and related regulatory inspections, potential *impacts* of the upcoming military buildup, GEPA staff shortages and funding needs, to name a few), conditions of its EPA Consolidated Grant must be met and objectives of respective program work plans must be carried out in a timely and effective manner. Guam EPA anticipates significant improvements to both the water and wastewater systems, and other infrastructure, despite the challenging economic situation on Guam.

Agency activities and programs which support the protection and improvement of water quality on Guam include but are not limited to:

- The continuing development of programs under the Comprehensive Monitoring Strategy and the implementation of Coastal Monitoring, Wadeable Streams Assessment, and Recreational Beach Monitoring, to include cooperative efforts with DAWR to complete the Marine Preserve Monitoring Plan;
- Ensuring a sustained Safe Drinking Water Program so that potable water produced by GWA and other purveyors continues to meet Safe Drinking Water Act requirements;
- Providing training opportunities for Agency employees and other partner agency personnel, i.e., facilitating technical assistance to support and develop programs that implement the minimum control measures contained in DPW's 2018 MS4 Permit;
- Meeting reporting conditions/requirements, i.e. Guam's CWA 303(d) list of impaired waterbodies; developing and implementing TMDLs for impaired water bodies;
- Funding needed water studies/research projects. Resulting data/information is important in validating the development or modification of strategic source water protection programs and programs targeted to ensure the sustainability of the NGL;
- Developing and/or updating environmental policy, plans, statutes, rules/regulations to strengthen compliance and enforcement capacity and minimize negative impacts to the environment;

- Maintaining regulatory oversight of local environmental restoration efforts undertaken by the Department of Defense (Navy and Air Force) under the DSMOA program;
- Conducting the triennial review of the GWQS; and implementing information and outreach programs that cause community action to protect and sustain clean air, water and land for Guam.

A Guam EPA biologist engages elementary students in Q & A during a Department of Agriculture sponsored 2019 ARBOR DAY outreach event in Dededo village.



GEPA provides in-kind support to its community partners when possible. Agency and UOG's watershed restoration "GROW" project staff conduct an Ugum River site visit to identify possible water quality sampling locations.

I. INTRODUCTION

The purpose of the Integrated Water Quality Monitoring and Assessment Report

The Clean Water Act (CWA) requires states to provide every two years an assessment of the quality of all their waters (section 305(b)) and a list of those that are impaired or threatened (section 303(d)). The U.S. Environmental Protection Agency (EPA) subsequently condenses all information from state reports into one summary document which it sends to Congress.

Guam submitted its first Integrated Report (IR) in 2006, which was developed in accordance with *2006 Integrated Water Quality Monitoring and Assessment Report Guidelines (USEPA, July 2005).* All future reports shall be developed in accordance with updated EPA guidelines or directives. Beginning in 2018, all IR submissions (both attribute and geospatial data) will be submitted electronically via ATTAINS (Assessment TMDL Tracking And ImplementatioN System) data exchange.

A summary of CWA reporting requirements for sections 303(d), 305(b), and 314, is provided below:

Section 303(d) – a list of impaired and threatened waters still requiring Total Maximum Daily Loads (TMDLs); identification of the impairing pollutant(s); and priority ranking of these waters, including waters targeted for TMDL development within the next two years.
Section 305(b) – a description of the water quality of all waters of the state (including, rivers/streams, lakes, estuaries/oceans and wetlands). States may also include in their section 305(b) submittal a description of the nature and extent of ground water pollution and recommendations of state plans or programs needed to maintain or improve groundwater quality.
Section 314 – in each section 305(b) submittal, an assessment of status and trends of significant publicly owned lakes including the extent of point source and nonpoint source impacts due to toxics, conventional pollutants, and acidification.

In satisfying the above reporting requirements, Guam EPA also satisfies the 305(b) reporting requirement for section 106 grant funds. Guam has the means to monitor water quality and annually update water quality data which is included in this submittal.

This IR will report on the water quality standards attainment status of all waters, document the availability of data and information for each water, identify certain trends in water quality conditions, and provide information to managers and others in setting priorities for future actions to protect and restore the health of our island's water resources

PART II. BACKGROUND

II. BACKGROUND INFORMATION

This section discusses Guam's total waters, the Agency's Water Pollution Control Program, actions needed to achieve objectives of the CWA, and special concerns and recommendations.

A. Overview of Guam's Water Resources

The categories of water established in the Guam Water Quality Standards (§5102, 2017 Revision) are Groundwater, Marine waters, and Surface waters.

1.0. Groundwater

This water category encompasses all subsurface water and includes basal and parabasal water, perched water, all water below the groundwater table, water percolating through the unsaturated zone (vadose water), all saline waters below and along the perimeter of the basal fresh water body (freshwater lens), and water on the surface that has been collected with the specific intent of recharging or disposing of that water to the subsurface by means of injection, infiltration, percolation, etc. The Northern Guam Lens Aquifer, (NGLA) which is the Principal Source Aquifer, and any other groundwater resources, as they are identified, shall continue to receive protection under the Guam Wellhead Protection Program and other applicable groundwater regulations (GWQS).

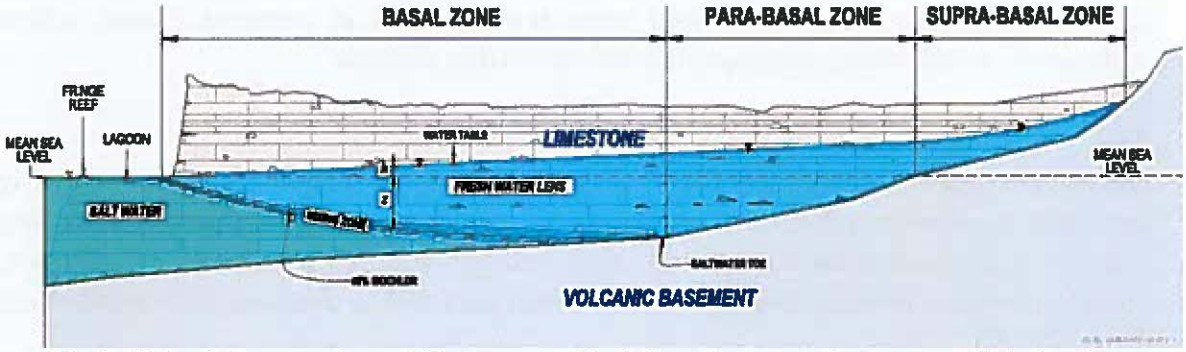


Fig. 2. Volcanic basement beneath limestone aquifer defines three groundwater zones: 1) the basal zone, where the fresh water lens is underlain by sea water, 2) the para-basal zone, where the fresh water is underlain by the volcanic rock, and 3) the supra-basal zone, where the fresh water moving down-slope toward the para-basal zone is lies above sea level. (WERI, CWMP FY 2012 Status Report. November 2012)

The northern half of Guam, considered the Northern Watershed, has no perennial streams because of the porosity and permeability of its calcareous rock formations. Rainfall percolates rapidly through the limestone to the freshwater lens or aquifer which is in contact with seawater below it. This fresh groundwater provides approximately 80% of the public drinking water supply. The aquifer is estimated to have a total average daily recharge of 111.9 million gallons and a sustainable yield of up to 60 million gallons per day (MGD). It is divided into six basins shown below (**Hagatna, Mangilao, Upi**

(Andersen), Machanao (Agafa Gumas), Finegayan, and Yigo-Tumon) containing 47 management zones.[1]

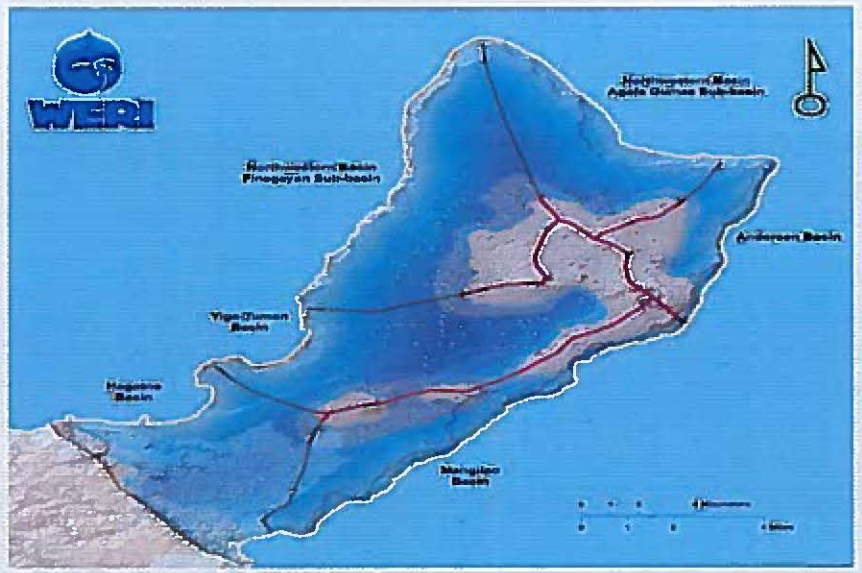


Fig.3.
Revised contour map of the volcanic basement underlying the limestone plateau in northern Guam. Northern Watershed Sub-basins.

(WERI, CWMP 2012 Status Report. November 2012)

An updated NGLA map can be found at:
https://guamhydrologicsurvey.uog.edu/wp-content/Maps/WERI2018-NGLAMap1.pdf

Over 100 ponding basins associated with developments in northern Guam, collect stormwater runoff which subsequently percolates into the lens.

2.0. Surface Waters

This category consists of all surface freshwater including (1) waters that flow continuously over land surfaces in a defined channel or bed, such as streams and rivers; (2) standing water in basins, such as lakes, impoundments, and reservoirs, either natural or man-made; and (3) all waters flowing over the land as runoff confined to channels with intermittent flow (GWQS).

The southern half of Guam contains the island's surface freshwater resources. Its volcanic slopes are deeply channeled by 97 streams (16 are major streams) with a total stream length of 228.65 miles. Western slope streams are short with steep gradients and drainage areas of less than three square miles each. The eastern slopes are steep in their upper reaches with long gently sloping streambeds that terminate in wide flat valleys.

The largest inland body of water on Guam is the Fena Reservoir constructed by the Navy as a drinking water supply. Its watershed is 5.88 square miles in area with 195 acres of water surface when full and 7,182 acre-feet of water storage (1949 original design: 8,300 acre-feet). It is the main drinking water source for the Navy. Fena

[1] Northern Guam Lens Study , Guam EPA 1982

Reservoir water is treated (to reduce turbidity) and chlorinated.

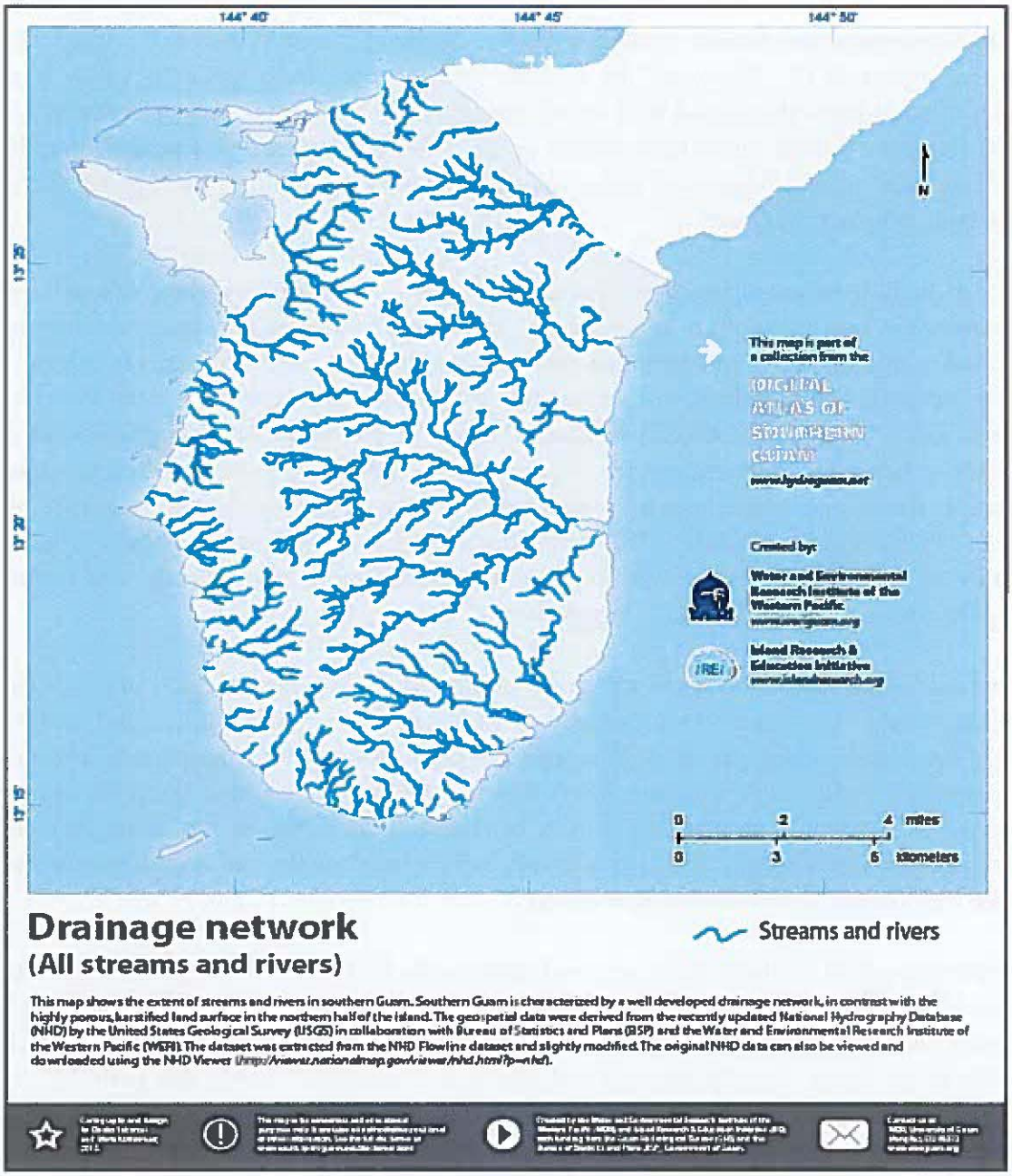


Fig. 4. Streams and rivers in southern Guam from *Digital Atlas of Southern Guam WERI Map Collection*, HydroGuam.net

2.1. Wetlands

"Guam's wetland resources provide values to our community which are often over-looked or misunderstood. Many island residents who own wetlands believe it is an impediment to their use of private property. To some degree this is true since wetlands are both federally and locally protected by the "Federal Clean Water Act", and local Executive order 90-13. However, the benefits which accrue from wetlands result in a combination of highest and best uses for all residents and for larger ecosystem diversity. Guam has inventoried more than 14,000 acres of wetlands (1983 National Wetlands Inventory), half of which are coral reefs. Inland fresh water wetlands make up only 3.8% of the total land area of Guam."[2]

Wetlands include swamps, marshes, mangroves, springs, and forested river valleys and are seasonally, but more often, permanently inundated with water or have soil that is saturated at the surface. Some wetlands dry up completely for several months each year. Guam wetlands are identified, for jurisdictional purposes, in accordance with the U.S. Army Corps of Engineers (USACE) Wetland Delineation Manual[3]. This manual employs the multi-parameter approach, which requires the combined presence of hydric soils, wetland hydrology and hydrophytic vegetation. The Guam Land Use Commission/Guam Seashore Protection Commission (Title XVIII and XIV of the Government Code of Guam) expands the federal definition to include ponds, estuaries and surface springs, and refers to aquatic life in addition to aquatic vegetation.

Guam has considerably more wetlands and a wider variety of types than any of the other Mariana Islands. All of its rivers and nearly all wetlands occur in the southern and central parts of the island, where clay or argillaceous limestone soils retard water percolation and permit surface waters to accumulate. Many interior wetlands are located along the upper drainages of rivers and smaller tributaries. In contrast, the northern limestone plateau allows rapid water seepage, and consequently only a few marshy areas and ephemeral streams exist in the vicinity of Mt Santa Rosa. [4]

Significant losses of wetland have occurred historically on Guam, although it is difficult to quantify the extent of the losses. Reclamation of wetlands by the U.S. military was extensive in and around Apra Harbor from 1945 to 1950 during the expansion of port facilities by the Navy. An estimated 500 ha of land area was filled during this period (U.S. Navy, 1978), and involved the destruction of mangrove communities fringing the eastern harbor and freshwater wetlands along the Sasa, Atantano and Namo Rivers and at the present-day Naval Station. Smaller fills have also occurred more recently at several of these sites, one of which was the expansion of a garbage dump into the Naval Station Marsh. At the Agana Swamp, filling along the edges was a chronic problem until about

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[2] "Wetlands" A Valuable Island Resource, R.L. Sablan, former GEPA Planner.
[3] 1987 Wetland Delineation Manual.
[4] Wetlands of Guam, Gary J. Wiles and Michael W. Ritter. January 1993.

1980. The original building of a coastal highway around the southern half of Guam by the Spanish, and subsequent improvements, resulted in the laying of a roadbed across wetlands next to river mouths and likely altered natural drainage patterns. From the 1970s to mid-1980s, several sets of aquaculture ponds were constructed in wetlands along the Talofofo, Agfayan and Ajayan Rivers, and resulted in vegetation loss.[5]

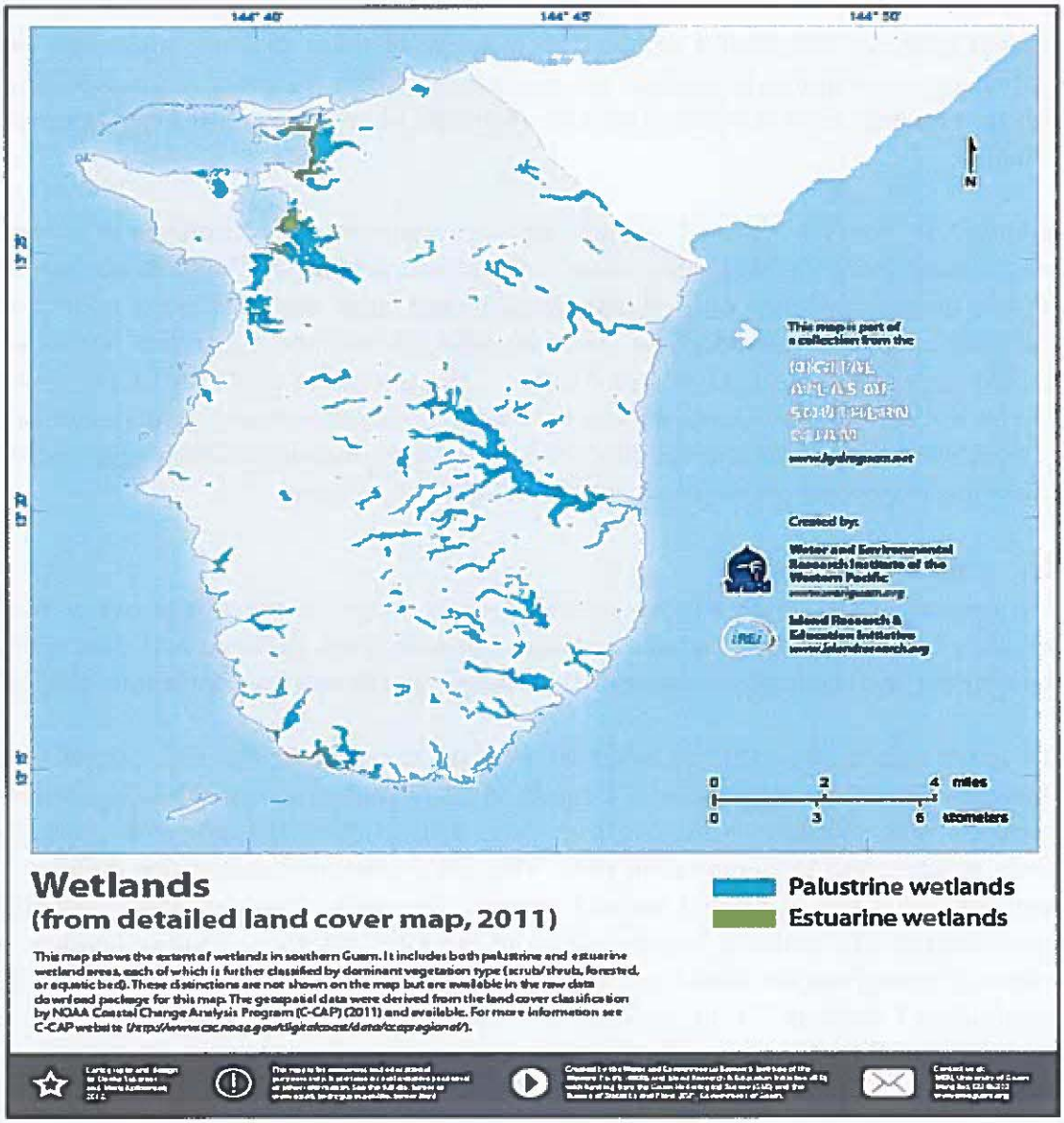

Fig. 5. Wetlands in southern Guam from *Digital Atlas of Southern Guam*, HydroGuam.net

[5] Ibid.

A substantial number of wetland systems have been accurately delineated for Section 404 jurisdictional purposes since the 1983 National Wetland Inventory was conducted. Such maps have been digitized and added to Guam's Inventory by the Guam Coastal Management Program.

Guam EPA maintains copies of jurisdictional wetland delineation maps. Wetland delineation verifications and determinations continue to be made, mostly involving small wetland systems (less than 1 acre). The majority of these determinations and field verifications are required to facilitate development activities. As much as possible, Guam EPA recommends modifications to land development plans which circumvent impacts to wetlands.

In May 2014, the U.S. Fish and Wildlife Service announced the completion of the most comprehensive and detailed U.S. wetland data set ever produced. The *Wetlands Inventory Mapper* (http://www.fws.gov/wetlands/Data/Mapper.html) digitally maps and makes publically available wetland in the lower 48 states, Hawaii and dependent territories – **GUAM** included, as well as 35% of Alaska. Per Executive Order 90-13, the official, interim wetland map for Guam shall be the National Wetlands Inventory map published by the United States Fish and Wildlife Service. All Government of Guam agencies shall utilize this map in the review of physical development projects.

3.0. Marine Waters

This category includes all coastal waters off-shore from the mean high water mark, including estuarine waters, lagoons and bays, brackish areas, wetlands and other special aquatic sites, and other inland waters that are subject to ebb and flow of the tides (GWQS).

The entire island of Guam, classified as a coastal zone under the U.S. Coastal Zone Management Act, is comprised of 210 square miles of land surrounded by 116.5 miles of shoreline. This shoreline is divided into three distinct classifications: rocky coastline, sandy beaches, and mangrove mud flats. The rocky coastline classification outlines the northern end of the island and isolated areas in the south. Rocky coastline represents approximately 72.5 miles in length or 62% of the total shoreline. Sandy beaches are scattered throughout the island and comprise 35.9 miles or 31% of total shoreline. The remaining 8.1 miles or 7% of shoreline are classified as mangrove mud flats and are located primarily within Apra Harbor and in Merizo.

Shallow fringing coral reefs with outer slopes and margins supporting live coral colonies encircle most of Guam. The width of these reefs ranges from very narrow benches (as narrow as 10 to 20 feet) on the northeastern coast, to broad reef flats forming the popular recreational and fishing areas in Tumon, Hagatna, Agat, and Asan Bays and on the shore side of Cocos Lagoon. These reefs are extremely valuable in terms of marine life, aesthetics, food supply, and recreation. Reefs also protect Guam's highly erodible

shorelines from storm waves, currents, and tsunamis. Barrier reefs occur at Apra Harbor and Cocos Lagoon. Cocos Island Lagoon and its reefs form an atoll-like environment approximately four square miles in area. Bound by the uplifted limestone plateau of Orote, Cabras Island and a large artificial breakwater (built on a shallow reef platform and adjacent submerged bank) is the much deeper lagoon of Apra Harbor.

The North Equatorial Current, driven by northeast trade winds, generally sets in a western direction around Guam with velocities ranging from 0.5 to 1.0 knots. Guam tides are semi-diurnal with a mean range of 1.6 feet and diurnal range of 2.3 feet. Extreme predicted tide range is approximately 3.5 feet.

Surface sea temperatures average close to 80 degrees Fahrenheit year-round.

B. Water Pollution Control Programs

Protecting and Restoring Guam's Waters[6], September 1999, addresses Guam EPA's overall approach for managing water resources. Guam uses an approach that emphasizes both island-wide nonpoint source programs and on the ground management of individual watersheds where waters are impaired and/or threatened.

The watershed approach is focused over a relatively small land area which is necessary to address problems at a watershed scale. Guam EPA also maintains core programs which are island-wide, covering both point and nonpoint sources of water pollution. These programs are discussed in the following.

1.0. Watershed Approach - Executive Order 2004-04 and the 1998 Clean Water Action Plan for Guam: *Unified Watershed Assessment*

In 1998, President Clinton announced a new clean water initiative to speed the restoration of our nation's waters. This initiative, called the Clean Water Action Plan (CWAP), aimed to achieve clean waters by encouraging federal and nonfederal agencies, other organizations and interested citizens to work in a collaborative manner to restore our highest priority watersheds.

Guam responded to this federal initiative through Executive Order 99-09, which re-established an interagency work group called the **Water Planning Committee (WPC)**[7]. The 1998 WPC used an NRCS map delineating Guam watersheds to organize the watersheds by category based on (1) national criteria (2) the data available for each watershed, and (3) the severity of environmental impact suffered by each watershed. That

[6] Document submitted to achieve compliance with updated requirements for Section 319 of the federal CWA and related NPS Program and Grants guidance dated May 1996.

[7] The Water Planning Committee is now known as Watershed Planning Committee (WPC). It was originally formed in August 1987 under §57034, Title 10, Guam Code Annotated, Public Law 17-87. The WPC became inactive in 1989, was re-established in June 1998 then promulgated through E.O. 99-09. E.O. 2004-04 rescinded the former executive order and restructured the WPC and its goals.

work group decided that addressing the drinking water impairment criterion (by protecting the Island's drinking waters) was a high priority. Drawing on experience and best professional judgment, three watersheds containing key drinking water resources were selected as the WPC's highest priority watersheds; and these three watersheds, Northern, Ugum, and Talofofo, were targeted for initial CWAP restoration during 1999-2000.[8] They remain high priority watersheds.

A second set of priority watersheds identified in the CWAP share the common characteristic of experiencing impacts to the marine environment.

The following narratives present projects and activities (federally, locally, privately funded) which are planned for implementation, already implemented, or in progress. These undertakings aim to protect, maintain, restore, and/or sustain Guam's natural resources in priority and targeted watersheds.

1.1. Northern Watershed

Projects and activities undertaken to bring attention to the value of and impacts to natural resources in the Northern Watershed include:

a. *Wastewater Revolving Loan Fund Program*: This program was developed via a Memorandum of Understanding between Guam EPA and GWA. $75,000 was granted to GWA in 2010 to design and implement a mechanism for eligible applicants to abandon their septic tank leaching field system and connect their houses to the public sewer system. GWA is required to submit quarterly progress reports. Guam EPA and GWA have targeted the assessment of about 144 houses in the Agafa Gumas area in implementing this "sewer hookup" program. These homes are located over the Northern Guam Lens Aquifer, the island's primary source of drinking water.

b. *Guam Northern Watershed Bacteria TMDLs*: In 2010, U.S. EPA approved seventeen (17) Bacteria TMDLs prepared by Tetra Tech, Inc. These TMDLs contained individual beach assessments for 17 Tier 1 beaches located in the Northern Watershed, impaired due to exceedances of Guam Water Quality Standards for enterococci bacteria. Guam EPA's goal is to reduce the bacteria exceedances at these beaches by linking the TMDL to key Agency or partnering agency programs. An alternative option would be to implement TMDL projects using a request for proposal (RFP) process.

   Guam EPA issued an RFP and awarded the selected contractor $109K to implement a nonpoint source project beginning in FY 2018. The focus of the project was to reduce Enterococci loads to Guam beaches through stormwater best management practices (BMPs), including structural methods, pollution prevention and source control. While implementation throughout the island

[8] Clean Water Action Plan for Guam: *Unified Watershed Assessment*, September 15, 1998.

of Guam was evaluated, this Project focused on Agana Bay and the Dungca stream.

The initial efforts identified and ranked potential structural BMPs for use on Guam to reduce bacterial loads in stormwater. The results of the ranking system indicated that the most effective BMPs, with respect to bacteria removal, are infiltration basins, wetland structures and bioretention structures. Local conditions are an important factor for the implementation of any structural stormwater BMP and as a result the Project ranking system would be used to select the most appropriate structural BMP.

With respect to the Dungca stream location, a constructed extended detention wetland is recommended to maximize bacterial removal. The BMP design and maintenance must maximize exposure to sunlight to provide optimal bacterial removal.

Of the evaluated non-structural stormwater BMPs, sanitary sewer source control measures can have the greatest impact in the Project study area. Guam EPA is actively collaborating with the Guam Waterworks Authority to develop a cooperative, effective source control program. Long term planning will require the cooperation of Guam EPA, Department of Public Works and the Guam Waterworks Authority.

Guam EPA intends to implement the next phase of the Agana Bay/Dungca stream nonpoint source project by fiscal year 2023 (the end of the current grant cycle) which is: the design and construction/implementation of recommended BMPs for stormwater treatment and bacteria removal and/or reduction at the selected beach.

c. *Tumon Bay TMDL Project*: Between August 2000 and August 2001, four (4) rounds of ground water sampling from eight springs in Tumon Bay were completed (*Summary Report of Tumon Bay Springs Sampling for Chemical Analysis, December 2002*). The project intended to characterize background concentrations and seasonal variations in contaminant concentrations resulting from varying rainfall conditions over an annual cycle. Since that study, Tumon Bay has been listed as impaired.

   USEPA has funded a supplemental Tumon Bay study and TMDL project which begins implementation in fiscal year 2020. The project scope of work includes the following tasks through March of 2021:

   - Collecting water, tissue, and Polyethylene Device (PED) samples for analysis;
   - Analytes of samples;

- Completing specific sections of the TMDL
- Compiling data, identifying data gaps, and producing the report/sections; and
- Providing recommendations for completing the TMDL

The resulting TMDL will address impairments in Tumon Bay for antimony, arsenic, total chlordane, dieldrin, TCE, and PCE.

d. *Guam Nature Alliance (GNA) events:* This group consists of government, non-profit and educational organizations interested in promoting environmental education on Guam. As a whole, the GNA supports numerous environmental education efforts on island by providing information, speakers or outreach materials. Executive Order 2014-07 established the former Environmental Education Sub-Committee as GNA in March 2014. The GNA is organized into three separate groups focused on different resource areas. The groups include: TANO (Land) - focus is on land resources including forested areas, limestone forest, badlands, and hiking trails; TASI (Ocean) - focus is on ocean resources including near shore areas, coral reefs, estuaries and lagoons; HANOM (Water) - focus on freshwater resources including rivers, streams, the Northern Guam Lens, estuaries and reservoir areas.

1.2. Ugum Watershed

The objective of the initial Ugum restoration strategy was to improve the drinking water quality and the ecosystem functioning of the Ugum Watershed. Erosion was the most significant challenge in achieving these objectives.

Watershed partners find that the most effective means of preventing and minimizing soil erosion is to encourage actions which maximize vegetative cover, particularly forest.

A coordinated implementation effort via the Ugum Watershed Action Team continues in the watershed to include:

- Planting acacia and native tree seedlings in the Layon and Ugum-Atate regions of the watershed. To date, over 1500 such seedlings have been planted;
- Conducting information and outreach efforts; engaging with private landowners to implement conservation practices using partner agency programs such as EQIP, Forest Stewardship Program, wetland protection program, etc.

The most recent project supported by Guam EPA in the Ugum Watershed is sponsored by the University of Guam (UOG) SeaGrant Program, known as the Guam Restoration of Watersheds (**GROW**) Initiative. To enhance local stakeholders' understanding of environmental stressors, the GROW Initiative conducts outreach and research. Guam EPA has committed to assisting with water quality sampling at established Ugum River

monitoring sites for the GROW project in the Ugum Watershed. The focus of the project is to plant stands of acacia trees/ native plants and install other amendments, in a selected Ugum watershed location, maximize vegetative cover (and improve soil health) then, evaluate the impact of the applied restoration practice on river water quality. A *Sediment TMDL for the Ugum Watershed* was approved by USEPA in 2006.

1.3. Talofofo Watershed Restoration

The Talofofo River Watershed is the largest watershed on the island. The watershed is comprised of two sub-basins, an upper and a lower drainage area. The 23 square mile watershed is partially regulated at the upper end of the drainage by the Fena Reservoir, which also acts as a sediment trap and diversion for the island's drinking water supply (WERI UOG, 1998, verbal communication). The flow from the Fena drainage is controlled at the spillway by the amount of pumpage from the reservoir and storage within Fena Lake. All flow thereafter is otherwise affected by the combined flow of the Maagas and the Tolaeyuus or Lost Rivers. The lower Talofofo "sub-watershed" is comprised of deeply weathered volcanic derived sediments with thicker sections of alluvial deposits near the lower sections (USGS Hydrology of Guam, Ward, Hoffard, and Davis, 1985)[9]

1.3.1. Upper Sub-basin: Fena River Sub-watershed

The Fena River sub-watershed is a river reach in the western sector of the Talofofo drainage area. It is comprised of the Imong, Almagosa, and Maulap Rivers. Total drainage area of the dam spillway is 5.9 square miles. It is a relatively hilly to very steep, undeveloped watershed, except for the Navy's munitions storage area. The western part is a limestone karst terrain with a very thin granular clayey cover.[10]

a. *Technical Experts (Working Group) for the Guam Water Resources Development Group:*

To ensure Guam's water resources are well managed and protected, the GWA continues the effort to foster continued cooperation and sharing of information with its partners and critical stakeholders.[11] Guam EPA has participated in the technical experts working group meetings since 2014. Memoranda of Understanding (GWA and the Navy; GWA and UOG-WERI)[12] have resulted in key studies, among other efforts, several which provide updated information for the Fena surface water resource. These studies can be found at www.usgs.gov and include:

(1) Storage capacity of the Fena Valley Reservoir, Guam, Mariana Islands, 2014. Published in 2015. To determine the current storage capacity, the United States Geological Survey in cooperation with the United States Navy resurveyed the bathymetry of the reservoir in February 2014. Preliminary analyses of the

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[9] Clean Water Action Plan for Guam: *Unified Watershed Assessment*, September 15, 1998.
[10] Ibid. A model to compute reservoir sedimentation rates at daily timescales is presented.
[11] Evangeline Lujan, GWA Senior Regulatory Analyst. Working Group Meeting Email 10-13-2014.
[12] Navy-GWA MOU signed 7-14-2010; GWA-UOG/WERI MOU signed 10-23-2014.

bathymetric data indicate that the reservoir currently has 6,916 acre-ft of storage capacity. The original 1951 reservoir storage capacity was estimated at 8,365 acre-ft. Thus, between 1951 and 2014, the total storage capacity decreased by 1,449 acre-ft (a loss of 17 percent of the original storage capacity), and an average decrease of 23.0 acre-ft/yr.[13]

(2) Daily reservoir sedimentation model: Case study from the Fena Valley Reservoir, Guam, Published in 2017. A model to compute reservoir sedimentation rates at daily timescales is presented. The model results show that the highest rate of deposition occurred during two typhoons (Typhoon Alice in 1953 and Typhoon Tingting in 2004); each storm decreased reservoir capacity by approximately 2–3% in only a few days. The presented model can be used to evaluate the impact of an extreme event, or it can be coupled with a watershed runoff model to evaluate potential impacts to storage capacity as a result of climate change or other hydrologic modifications.[14]

(3) Fena Valley Reservoir watershed and water-balance model updates and expansion of watershed modeling to southern Guam, First Published in 2017; revised 2019. In 2014, the U.S. Geological Survey, in cooperation with the U.S. Department of Defense's Strategic Environmental Research and Development Program, initiated a project to evaluate the potential impacts of projected climate-change on Department of Defense installations that rely on Guam's water resources. A major task of that project was to develop a watershed model of southern Guam and a water-balance model for the Fena Valley Reservoir.

Two important surface-water resources for the U.S. Navy and the citizens of Guam were modeled in this (updated) study; the extended model now includes the Ugum River watershed and improves upon the previous model of the Fena Valley watersheds. Surface water from the Ugum River watershed is diverted and treated for drinking water, and the Fena Valley watersheds feed the largest surface-water reservoir on Guam.

The new Fena Valley Reservoir water-balance model is useful as an updated tool to forecast short-term changes in the surface-water resources of Guam. Furthermore, the now spatially complete southern Guam watershed model can be used to evaluate changes in streamflow and recharge owing to climate or land-cover changes.[15]

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[13] Marineau, M.D., and Wright, S.A, 2015, Storage capacity of the Fena Valley Reservoir, Guam, Mariana Islands, 2014: U.S. Geological Survey Scientific Investigations Report 2015–5128, 31 p., http://dx.doi.org/10.3133/sir20155128.

[14] Marineau, M.D., Wright, S.A., Daily Reservoir Sedimentation Model: Case Study from the Fena Valley Reservoir, Guam, ASCE Journal of Hydraulic Research, vol 143(9), doi: 10.1061/(ASCE)HY.1943-7900.0001344.

[15] Rosa, S.N., and Hay, L.E., 2019, Fena Valley Reservoir watershed and water-balance model updates and expansion of watershed modeling to southern Guam (ver. 1.1, February 2019): U.S. Geological Survey

(4) Water resources on Guam—Potential impacts of and adaptive response to climate change, Published 2019. The goals of this joint U.S. Geological Survey, University of Hawai'i, University of Guam, University of Texas, and East-West Center study were to (a) provide basic understanding about water resources for U.S. Department of Defense installations on Guam and (b) assess the resulting effect of sea-level rise and a changing climate on freshwater availability, on the basis of historic information, sea-level rise projections, and global-climate model temperature and rainfall projections.[16]

1.3.2. Lower Sub-basin:

Where the river discharges to Talofofo Bay, and in the adjacent estuary, recreational activities in the form of fishing, swimming, and river cruises occur. Impacts from the Talofofo Watershed to Talofofo Bay occur regularly in the form of concentrations of bacteria which exceed USEPA standards for primary recreational marine beaches. (2018 Guam 305b Inventory of Coastal/Recreational Waters). Guam EPA uses the enterococci standard as the indicator species for bacteriological quality of primary recreational marine beaches.[17]

a. *Bacteria TMDLs for 25 Guam Beaches, Tetra Tech, Inc., December 2013.* (Approved by USEPA in 2015.)

Table 1. Bacteria TMDLs: Talofofo Beaches

Site ID	Station Name	Village	Water	Beach	Shore Access (miles)	Features
S-11	Talofofo Bay	Inarajan/Talofofo	Talofofo Bay	Head of Talofofo Bay	0.21	Talofofo Beach Park
S-18	First Beach-Talofofo	Talofofo	Beach at Asanite Point (Talofofo)	First Beach	0.06	
S-12	Ipan Beach	Talofofo	Mana Bay		0.30	Ipan Beach Park
S-13	Togcha Bay-Talofofo	Yona	Togcha Bay	Beach north of Togcha River	.27	

Data collected through Guam's Recreational Beach Monitoring Program (RBMP) served as the basis to place all RBMP sites on Guam's §303(d) list of Impaired Waters in 2006 — due to exceedances of Guam's Water Quality Standards (GWQS) for enterococci bacteria. Guam's Integrated Report indicates that a priority action is to work towards developing Total Maximum Daily Loads (TMDLs) for impaired Tier 1 beaches. This TMDL report summarizes information for 16 beaches located in the Southern

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Scientific Investigations Report 2017–5093, 64 p., https://doi.org/10.3133/sir20175093.

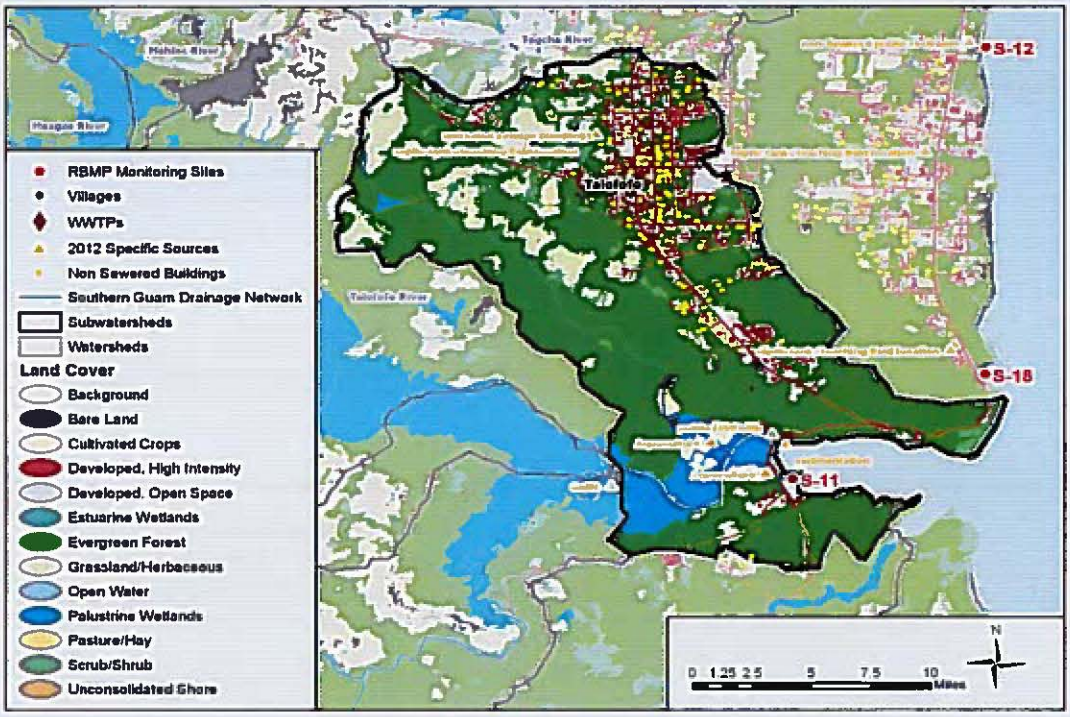
[16] Gingerich, S.B., Johnson, A.G., Rosa, S.N., Marineau, M.D., Wright, S.A., Hay, L.E., Widlansky, M.J., Jenson, J.W., Wong, C.I., Banner, J.L., Keener, V.W., and Finucane, M.L., 2019, Water resources on Guam—Potential impacts of and adaptive response to climate change: U.S. Geological Survey Scientific Investigations Report 2019–5095, 55 p., https://doi.org/10.3133/sir20195095.

[17] Clean Water Action Plan for Guam: *Unified Watershed Assessment*, September 15, 1998.

Guam Watershed and nine beaches located along the southeast coastline of the Northern Watershed, and describes the approach used to develop TMDLs for these impaired waters. Four of these 25 beaches (listed in Table 1) are located along the Talofofo coastline. The (25) beaches have been removed from Guam's 303(d) Impaired Waters List because respective Beach Bacteria TMDLs have been approved by EPA. However, these beaches remain impaired and are assigned an impairment "category 4a"[18] until such time that they meet GWQS for enterococci bacteria.

b. *GEPA Microbial Source Tracking Project for Talofofo Bay*
(RBMP station S-11)

Fig. 6. (2013 TMDL). Land cover and location of Talofofo Bay relative to potential source areas.



The Agency developed a proposal in 2017 to collect and test water samples from four (4) beaches with bacteria TMDLs to determine whether the dominant source of Fecal Indicator Bacteria (FIB) is human[19] or non-human.[20] This sampling approach is considered a screening to help Guam EPA get a better understanding of the human fecal pollution contribution. *This project is targeted for implementation*

[18] Impaired waters without a TMDL are assigned an impairment "category 5".
[19] From sewage or septage.
[20] From cow, water buffalo, chicken/bird, deer, dog, and/or pig.

in the 2019-2023 GEPA grant cycle.

Talofofo Bay (RBMP station S-11) had the most advisories in both 2015 and 2016. In 2016, S-11 had 82% frequency of advisory where 21 advisories were released during the dry season and 25 were released during the wet season. [In 2016, n= 51, Min conc: ND, Max conc: 15,531 MPN].

The information below is from the document *Development of Bacteria TMDLs for Twenty-five Guam Beaches, 2013.*

Table 2. Potential Pollutant Sources Talofofo Bay Beach

Station	Wastewater: Septic systems	Wastewater: SSO	Wastewater: WWTP	Wastewater: Sewer line block/break	Wildlife	River discharge	Storm water runoff	Storm drains
Talofofo Bay (S-11)	X	X			X	X	X	

1.4. Other Priority Watersheds

Guam watersheds, shown to the right as delineated in the 1998 Guam Unified Watershed Assessment. More recent WERI watershed maps have grouped southern Guam's many small drainage basins into fourteen large watersheds.[21]

The same *Unified Watershed Assessment* identified a second set of priority watersheds which shared the common characteristic of experiencing **impacts to the marine environment.** Marine impacts from this group of watersheds were in the form of exceedances of Guam Water Quality standards for biological parameters (Guam Water Quality Report to Congress, 1998, Federal Water Pollution Control Act Section 305 (b)). Coastal impacts also resulted from high sedimentation loads during periods of high runoff. These impacts were determined most pronounced in areas used most heavily for recreational activities (Agana, Pago, Ylig, Togcha, Agat, and Inarajan Watersheds). Pago Watershed was of additional concern because it serves as a recharge area to the

[21] https://south.hydroguam.net/watersheds-overview.php

northern aquifer. The following narrative provides brief summaries of restoration or related activities in Guam watersheds over the last five years.

1.4.1. ***Hagatna Watershed*** **(Sub-Basin in the Northern Watershed)**

Watershed size: 10.3 square miles. The Hagåtña Watershed includes parts of the municipalities of Hagåtña, Agana Heights, Mongmong/Toto/Maite, Chalan Pago/Ordot, Mangilao, Barrigada, Tamuning and all of Sinajana. Guam EPA has established water quality (WQ) monitoring and biological assessment sites in the Hagåtña Watershed. These are shown in the figure below and include: Six (6) river WQ sites, seven (7) marine WQ sites, and two (2) marine water biological assessment sites.

Fig. 7. Hagåtña Watershed. Base map imagery from Guam Bureau of Statistics and Plans (GIS_Data_BSP\Imagery\guam_wv2_rgb_ps_02052011_v1_lut.sid). Elevation and Relief model from HydroGuam.net and derived from Digital Elevation Model (DEM) of Guam created by the U.S. Geological Survey. [GEPA 2013 STMP Surface Water Quality Assessment, Part 1 of 3]

a. *Impaired Waterbodies in the Hagatna Watershed*

1.4.1.1 ***Agana Swamp*** – Wetland, 6.40 acres assessed.
Pollutant - PCBs in fish tissue. Pollutant Source: former Agana Power

Plant. (Category 5)[22]

Background. When the Navy started remedial investigation in 1998, it found out that the soil in the power plant, as well as fish from the swamp and river, had high concentrations of polychlorinated biphenyls, or PCBs, according to the Navy. What's now known as the Agana Power Plant is located adjacent to the northern border of the Utan arm of Agana Swamp. Runoff from the power plant site drains into Agana Swamp via an outfall located along the site's southern border. The Agana Swamp and River empties into Agana Bay near Paseo de Susana Park in Hagåtña.

In 1999 and 2000, the Navy excavated and disposed of PCB-contaminated soil. The Navy also found out that fish from the Agana Swamp and River had "elevated levels of PCBs." As a result, the Guam Department of Public Health and Social Services issued in 2000 a fish advisory, "warning people not to consume fish, eels, or shell fish caught in Agana Swamp or River."

In 2006, the Navy conducted a new round of fish sampling. It found out that "fish tissue PCB concentrations collected from 2006 increased compared to the fish collected in 2000 in the Agana River downstream and outlying areas, were about the same in the Agana River Channel, and decreased in the Utan Arm."

The U.S. Environmental Protection Agency, under its Brownfields Program, also cleaned up about 264 tons of PCB-contaminated soil in the Agana Springs area from 2011 to 2012.[23]

Update. December 2019. The Navy conducted a new round of fish sampling in the Agana Swamp and River to determine whether or not fish caught from it is safe to eat, "based on concentrations of PCBs."

The Naval Facilities Engineering Command Pacific led the project, with AECOM as its contractor. According to a December 2019 fish sampling work plan that NAVFAC provided, "if PCB concentrations are above 98 micrograms per kilogram, the data will be provided to Guam EPA for application to the Agana Swamp and River fish consumption advisory and the Navy will evaluate the need for further action." However, if PCB concentrations do not exceed 98 micrograms per kilogram, then the

[22] Impaired waterbody on Guam 303(d) List.
[23] "Agana Swamp fish sampling to check if they're still PCB-contaminated", Haidee Eugenio Gilbert. Pacific Daily News, December 10, 2019.

Navy and Guam EPA need to re-evaluate if any additional action is warranted at the site.[24] The Fish Advisory for the Agana Swamp and Hagatna River remain in effect.

1.4.1.2. *Agana River* – 2 river segments (Category 5)

Agana River 1 - 0.52 miles. Pollutants: Enterococcus, Dissolved Oxygen, PCBs in fish tissue.

Agana River 2 – 0.67 miles. Pollutant: PCBs in fish tissue. Fish Advisory in effect for these Agana River waterbodies since 2001.

Sources of pollution: Agana Power Plant, discharges from the Agana Swamp, urban stormwater runoff, discharges from the Chaot River. Agana River has been included in the series of Agana Swamp PCB assessments conducted by the Navy and USEPA.

1.4.1.3 *"Storm Drain"* – 0.21 miles. (Category 5)

Pollutants: E. Coli, Turbidity, Salinity, Dissolved Oxygen, Nitrates, Total Suspended Solids.

Sources of pollution: Urban runoff, storm sewers, contaminated sediments, sewer system/manhole overflows.

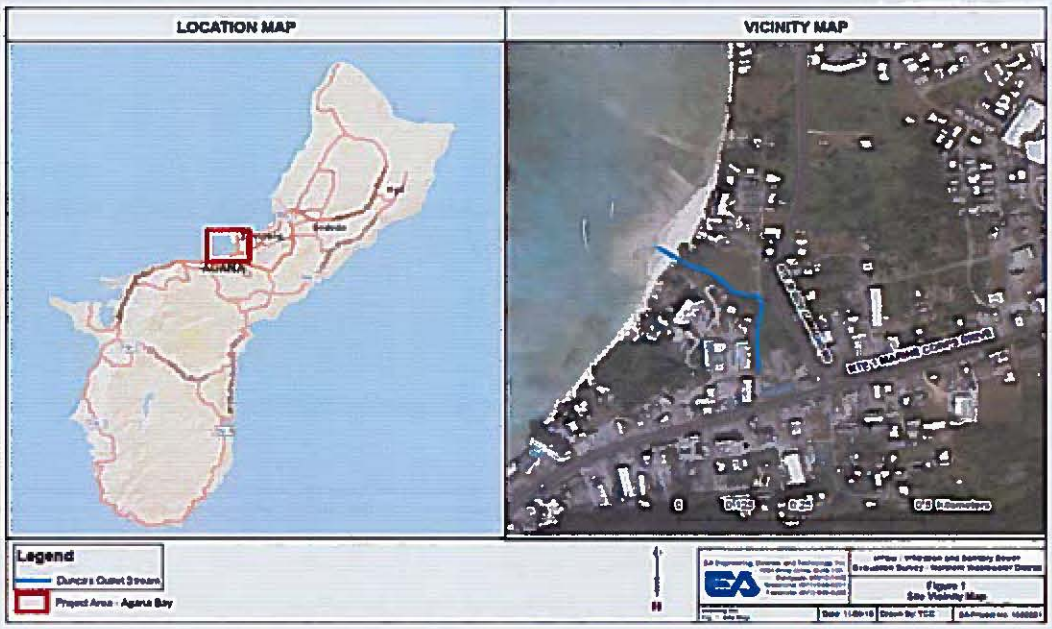


Fig. 8. Site Vicinity Map: "Storm Drain"

The impaired waterbody is shown in the vicinity map, Figure 8 on the previous page. It is one of several sampling sites under investigation in

[24] Ibid.

GEPA's 2018 East Hagatna Bay Bacteria TMDL project. The goal is to design and install recommended Best Management Practice(s) (BMPs) that will reduce the high concentration of bacteria discharged into the nearby marine waters, especially during rain events. See Section 1.1. b., page 8.

1.4.1.4. *Recreational/Coastal Waters (Beaches)* (Category 4b)[25]
Bacteria Impairment.
Hagatna Marina – 0.43 miles
Trinchera Beach (East Hagatna Bay) – 1.16 miles
West Hagatna Beach – 1.11 miles
Dungca's Beach (East Hagatna Bay) – 0.99 miles

Approved EPA Bacteria TMDLs for these beaches identify potential sources of pollutants (to these coastal waters) which include: stormdrain runoff, wastewater, sewage overflow, and stormwater runoff. Other more site specific sources are the Hagatna Marina, lack of on-site drainage, failing or no oil water separators, and stormwater UICs.

- ***Bacteria TMDL project East Hagatna Bay and Dungca's stream***
  A brief is discussion is located on page 8, Section 1.1. b.

- ***GEPA Microbial Source Tracking (MST) Project for Hagatna Boat Basin (RBMP station N-12)***

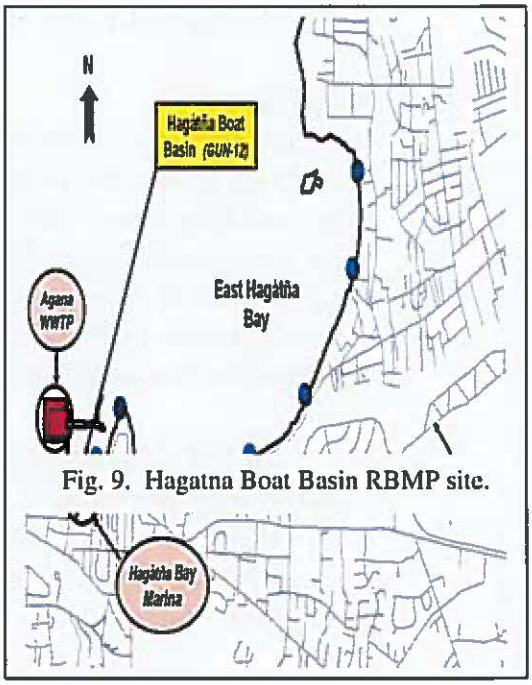


Fig. 9. Hagatna Boat Basin RBMP site.

The Agency developed a proposal in 2017 to collect and test water samples from four (4) beaches with bacteria TMDLs to determine if the dominant source of Fecal Indicator Bacteria (FIB) is human[26] or non-human.[27] This sampling approach is considered a screening to help Guam EPA get a better understanding of the human fecal pollution contribution. *This project is targeted for implementation in the*

[25] Impaired waters delisted from Guam 303(d) List because a TMDL has been developed.
[26] From sewage or septage.
[27] From cow, water buffalo, chicken/bird, deer, dog, and/or pig.

2019-2023 GEPA grant cycle.

Hagatna Boat Basin (RBMP station N-12) is included in this MST project. In 2016, N-12 had 71% frequency of advisory where 11 advisories were released during the dry season and 25 were released during the wet season. [In 2016, n= 51, Min conc: ND, Max conc: 10,462 MPN].

Table 3. Potential Pollutant Sources for Hagatna Boat Basin Site *(Bacteria TMDL for 25 Guam Beaches, 2013)*

Station	Wastewater: Septic systems	Wastewater: SSO	Wastewater: WWTP	Wastewater: Sewer line block/break	Wildlife	River discharge	Storm water runoff	Storm drains
Hagatna Boat Basin (N-12)		X	X				X	X

b. ***U.S. Army Corps of Engineers (ACOE) Agana River Civil Works Study***[28]

The study will focus on significant flood inundation damages and road closures within the Agana River floodplain during and after recent tropical cyclones, including significant flooding issues in the downtown Hagatna area. The three-year, $3 million study is 100 percent federally funded and will be managed by ACOE Honolulu District's Civil and Public Works branch. The ACOE civil works team started initial analysis and survey of the Agana River area in early March 2020.

1.4.2. *Pago Watershed*

The Pago watershed is located in the east of central Guam. It has a drainage area of 10.35 sq. miles. The main rivers in the watershed include Sigua River, Lonfit River, and Pago River with approximate lengths of 4.79 miles, 3.81 miles and 2.81 miles respectively. Sigua River and Lonfit River discharge from west to east to Pago River, and then to Pago Bay in the Pacific Ocean.[29] The Map of Guam on the next page, highlights these rivers that drain the Pago watershed. (GIS data: University of Guam, Water and Environment Research Institute.)

a. ***Impaired Waters in the Pago Watershed***

1.4.2.1. ***Pago Bay*** – ***(marine waters)*** .70 square miles (Category 5).
Pollutants: Enterococcus, Dissolved Oxygen, Nitrate.
Sources of pollutants: Urban runoff, storm sewers, contaminated sediments.

[28] USACOE News Release No. 20-014. Published March 17, 2020.
[29] https://south.hydroguam.net/watersheds-pago.php

1.4.2.2. *Pago River*

2 freshwater segments (Category 5).
Pago River 1 0.06 mi
Pollutant: E. coli
Pago River 2 4.74 mi
Pollutant: E coli, Dissolved Oxygen.
Sources of pollutants: Urban runoff, storm sewers, contaminated sediments.

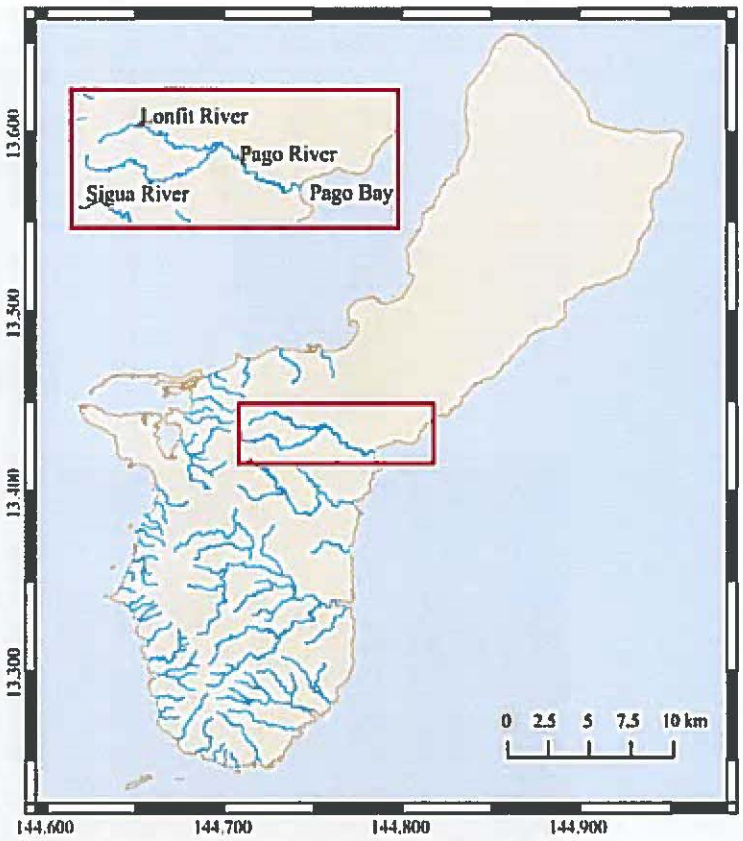


Fig. 10. Map of Guam: Pago Watershed Rivers

1.4.2.3. *Lonfit River*

2 freshwater segments. (Category 5).
Lonfit River 2 1.07 mi
Lonfit River 3 0.04 mi
Waters impaired by the following pollutants: Aluminum, Salinity, Zinc, Temperature, Nitrate, Total Coliform, Enterococcus, E. coli, Iron, Manganese, Copper, Ammonia, Nickel, Chromium, Total Suspended Solids, Total Dissolved Solids.
Source of pollutants: Ordot Dump

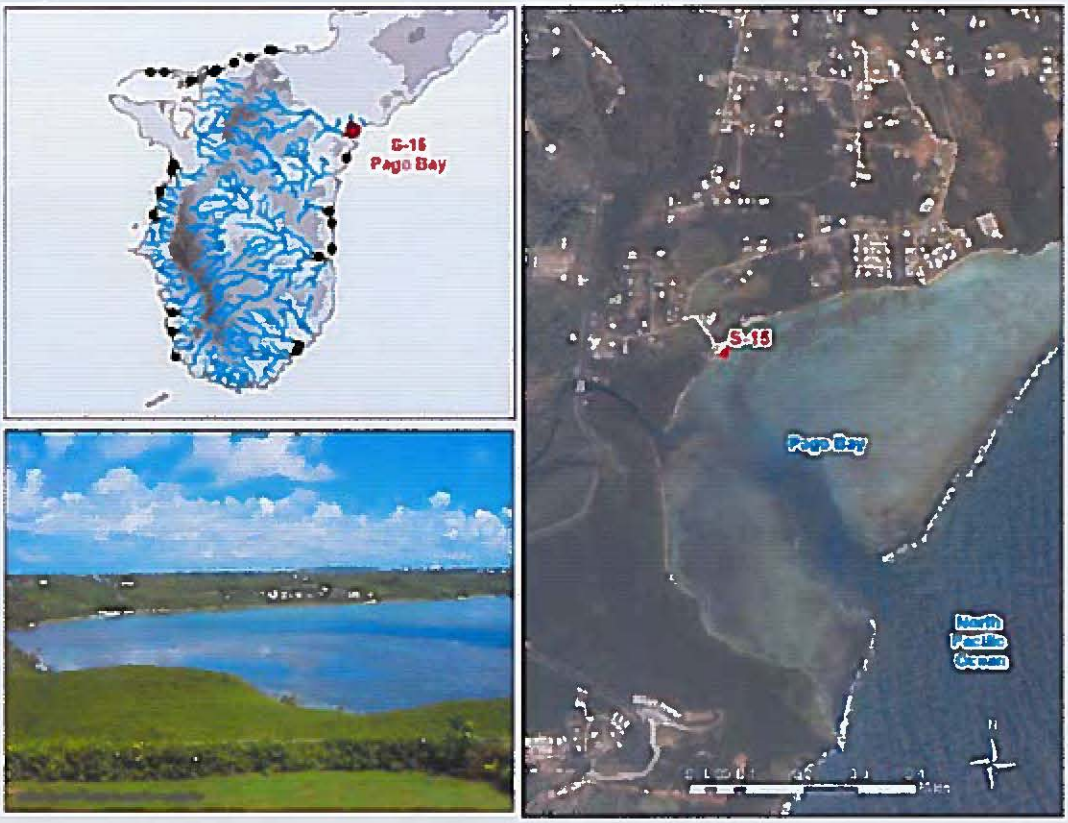
1.4.2.4 *Recreational Waters (Beaches) Category 4b.*

Beach at Pago Bay – 0.96 miles.
Pollutant source: Wastewater, squatters, and river discharge. This recreational beach site, S-15, is the most northern site on the east coast of Guam.

b. ***Pago Watershed Restoration Activities***

Projects and activities have occurred in the watershed over the last five years to investigate terrestrial natural resources, marine and freshwater quality, and the habitat and aquatic life in these environments. The data and outcomes of such projects continue to support the protection and restoration of watershed resources.

Fig. 11. Location of the Beach at Pago Bay relative to other RBMP sites.



- ***Ordot Dump Post-closure activities.*** Situated on 63-acres of land, the Ordot Dump had been the sole disposal facility for Guam's waste since the 1940s. Undocumented materials including unexploded ordnance and leachate discharge had hampered closure efforts for years. Brown and Caldwell led the investigation and design team that developed the closure plan and ended an era of long-running environmental issues, including releases of contaminated leachate into local water bodies, methane gas emissions, and odor problems. The plan includes a path to achieving Subtitle D and Clean Water Act compliance, converting a portion of the site to a public park, and using landfill gas to generate up to 500 KW of power. Brown and Caldwell is continuing post-closure activities by performing inspections, O&M, and implementation of the site post closure monitoring plan.[30] Of priority importance to Guam EPA are the results obtained from continued water quality monitoring of the Lonfit River. With the closure of the Ordot Dump, it is expected that the health of the river will gradually improve.

[30] https://brownandcaldwell.com/project/ordot-landfill-closure/

- *SeaGrant – Builders of a Better Bay Project (focus on watershed education for K-12 students, 2013-2015).* This project was initiated to help students understand the extent to which upland activities affect the ocean, and to create more research opportunities for students to collect turbidity and water level data at rivers within the Pago Watershed.[31]

- *Guam Pago Watershed Conservation Study, (2016).* The purpose of this research is to explore water science methodologies in determining the source of sedimentation in the Guam Pago Watershed. Watersheds provide drinking water, an agricultural water source, and forms of recreation. However, from years of soil erosion and several factors occurring inland, the mouth of Pago River has widened allowing a larger amount of sediment and nutrient rich water onto a greater area of coral. With the use of water science equipment such as the Manta turbidity logger and rain gauges, initial monitoring focused on narrowing down the causes of sedimentation. In order to distinguish inland factors from coastal factors, loggers were launched at an upstream point where the Sigua and Lonfit rivers converge, and at a point near the opening of Pago Bay. As a relatively small island, research and education are key in achieving and maintaining a sustainable environment. In order to encourage an action for improvement or mitigation to target behaviors within the target audience, this study intended to increase scientific and community understanding of the effects of land usage on Pago Bay.[32]

- ***Research Project:*** *Banded Application of GeoJute® Barriers to a Representative Area in Guam's Pago Watershed, (Published 2016).* Coral reefs around Guam are faced with multiple threats including soil erosion and sedimentation. In several of Guam's southern watersheds, infertile soil upland has significantly deterred the growth of erosion-mitigating vegetation. Additionally, sediments that wash down to sea reduce the ability of coral reefs to thrive. The need to ameliorate the ecosystem decline related to erosion and sedimentation is particularly patent and pertinent in Pago Watershed. To inform restoration efforts, this research will identify the efficiency of GeoJute® barriers as a method of erosion control. Factoring cost, labor, and effectiveness in containing sediment, GeoJute® barriers are hypothesized as a practical and sustainable method...[33]

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[31] https://seagrant.noaa.gov/Program-Locations/GUAM/edgpid/1757/edgmid/2561

[32] Maria Lynn Cruz, Student, University of Guam Sea Grant, Mangilao, GU 96923.
Laura F. Biggs, Assistant Professor, Outreach and Education Services, University of Guam, Mangilao, GU 96923

[33] Casila, Joseph L.; Biggs, PhD, Laura; Flisco, Victoria; and Lawrence, Bart (2016) "Banded Application of GeoJute® Barriers to a Representative Area in Guam's Pago Watershed," *Journal of Health*

- ***Physical dynamics of the reef flat, channel, and fore reef areas of a fringing reef embayment: An oceanographic study of Pago Bay, Guam,*** *(Published 2019).* Long-term observations of oceanographic patterns and processes provide necessary context for integrative ecological studies and for assessing and mitigating anthropogenic impacts to coastal ecosystems. The oceanographic patterns and processes of Pago Bay, Guam, a tropical coral reef system with a small estuary, were observed for one year. An array of 50 sensors including current profilers, temperature and dissolved oxygen loggers, and water quality sensors were deployed throughout Pago Bay from 0–26 m depth...[34] Highlights:
  - Circulation in the Pago Bay reef flat and channel is strongly driven by wave height.
  - Circulation on the fore reef is affected by wave height and wind.
  - The reef flat experienced diel temperature shifts with a range as large as 12.8 °C.
  - Pulses of relatively cooler water were observed at 16-26 m depth.
  - Heavy rain events can cause dramatic changes in channel water quality.

1.4.3. *Agat Watershed*

The Agat watershed is located in the southern coast of the southern Guam, south of Apra Harbor. It has a drainage area of 4.36 sq. miles. The main rivers in the watershed include Namo River, Gaan River, Togcha River, Finile Creek and Salinas River with approximate lengths of 2.62 miles, 1.30 miles, 1.17 miles, 0.94 mile, and 0.56 mile respectively. These rivers discharge to Agat Bay from east to west.

a. ***Agat Watershed Impaired Waters***

1.4.3.1 ***Agat Bay 1*** 0.63 square miles. (Category 5).

The pollutants are PCBs, Chlordane, and Dioxin in fish tissue.

Orote Seafood Advisory: A seafood advisory issued in 2001 for the west side of Orote Peninsula (Rizal Beach to Spanish Steps- this includes a section of Agat Bay) and Gabgab Beach in Apra Harbor remains in effect. Seafood caught in these areas may contain polychlorinated biphenyls

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[34] Christina M. Comfort [a,*], Gordon O. Walker [a], Margaret A. McManus [a], Atsushi G. Fujimura [b], Chris E. Ostrander [c], Terry J. Donaldson [b]

a Department of Oceanography, University of Hawaii at Manoa, Honolulu, HI 96822, USA

b Marine Laboratory, University of Guam, Mangilao, GU 96923, USA

c University of Utah, Salt Lake City, UT 84112, USA

* Correspondence to: Department of Oceanography, University of Hawaii at Manoa, 1000 Pope Road, Honolulu, HI 96822, USA. E-mail address: ccomfort@hawaii.edu (C.M. Comfort).

https://doi.org/10.1016/j.rsma.2019.100740

(PCBs), chlorinated pesticides or dioxins at levels that are not safe to eat. This includes fish, shellfish and algae or sea grapes.[35]

1.4.3.2 ***Recreational Waterbodies (Beaches)*** (Category 4b).
Togcha Beach 0.79 miles (aka Agat Beach)
Nimitz Beach 0.49 mile
Bangi Beach 1.47 miles

Pollutant: Enterococcus
Sources: Wastewater, storm water, and river discharges. Specific sources for Nimitz Beach: Marina and recreational boating, and boat discharge.

Fig. 13. Nimitz Beach (S-05)

Fig. 12. Togcha Beach Monitoring Sites

Nimitz Beach is located on the southern edge of Agat on the shore of Taleyfac Bay. It is a popular site and recreational area. (Bacteria TMDL for 25 Guam Beaches, 2013).

b. ***Agat Watershed Project: GEPA Microbial Source Tracking (MST) for BangiBeach-S04*** The Agency developed a proposal in 2017 to collect and test water samples from four (4) beaches with bacteria TMDLs to determine whether the dominant source of Fecal Indicator Bacteria (FIB) is human[36] or non-human.[37] This sampling approach is considered a screening to help Guam EPA get a better understanding of the human fecal pollution contribution. *This project is targeted for implementation in the 2019-2023 GEPA grant cycle.*

[35] Guam EPA Fish Advisory language for Orote.
[36] From sewage or septage.
[37] From cow, water buffalo, chicken/bird, deer, dog, and/or pig.

Fig. 14. Location of Bangi Beach (S-04) and an aerial view of the area.

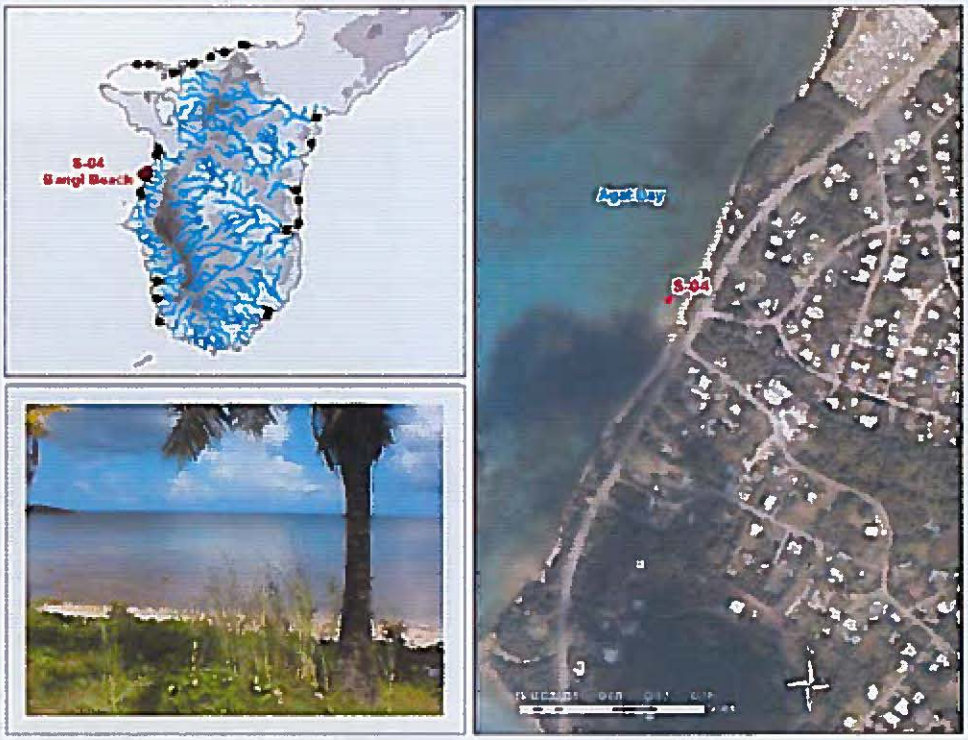

Table 4. Potential Pollution Sources for Bangi Beach

Station	Wastewater: Septic systems	Wastewater: SSO	Wastewater: WWTP	Wastewater: Sewer line block/break	Wildlife	River discharge	Storm water runoff	Storm drains
Bangi Beach (S-04)		X		X	*	X	X	

* This suspected potential source not listed in the 2013 TMDL.

In 2016, S-04 had 57% frequency of advisory where 8 advisories were released during the dry season and 21 were released during the wet season. [In 2016, n= 51, Min conc: ND, Max conc: 11,199 MPN]. (Beach information from *Bacteria TMDL for 25 Guam Beaches, 2013*.) Potential sources of pollution identified in Table 4.

1.4.4. Apra Watershed

Apra watershed is located in the southern coast in the middle of Guam, including Apra Harbor. It has a drainage area of 13.65 sq. miles. The main rivers in the watershed include Atantano River, Sasa River, Aguada River, Big Guatali River, Aplacho River, Maggo River, Guatali River, Laghas River, Tenjo River and

Paulana River with approximate lengths of 2.65 miles, 2.48 miles, 2.42 miles, 2.42 miles, 2.32 miles, 2.17 miles, 1.36 miles, 1.18 miles, 1.15 miles and 0.93 mile respectively. These rivers discharge to Apra Harbor from east to west.[38]

a. *Impaired waters*

1.4.4.1. ***Marine Bays***-Category 5
These Bays are subject to a Fish Advisory.
Apra Harbor: 2 waterbodies
Apra Harbor 2 4.61 mi²
Apra Harbor 1 0.05 mi²
North Orote Peninsula
Sea Cliffs 0.23 mi²
South Orote Peninsula
Sea Cliffs 0.02 mi²
Tipalao Bay 0.10 mi²
Pollutant: PCBs in fish tissue.

Fig. 15. Impaired Marine Bays: Apra Watershed. Orote Seafood Advisory Study: Orote Landfill Site COMNAVMAR, Guam. Fact Sheet No. 2, August 2002

A seafood advisory issued in 2001 for the west side of Orote Peninsula (Rizal Beach to Spanish Steps) and Gabgab Beach in Apra Harbor remains in effect. Seafood caught in these areas may contain polychlorinated biphenyls (PCBs), chlorinated pesticides or dioxins at levels that are not safe to eat. This includes fish, shellfish and algae or sea grapes.[39] Source of pollutants: Orote Landfill and surrounding area. The Landfill was used for disposal of residential, commercial, and industrial waste from approximately 1944 to 1969.

1.4.4.2. ***Recreational Waters (Beaches)*** (Category 4b, except for Gabgab Beach Category 5)
Gabgab Beach 0.65 miles **Subject to Fish Advisory for PCBs**
Outhouse Beach 0.46 miles
Family Beach 0.15 miles

[38] http://south.hydroguam.net/watersheds-apra.php
[39] Guam EPA Fish Advisory language for Orote.

Port Authority Beach 0.46 miles

Sources of Pollutants: Gabgab Beach- Orote Landfill and surrounding area;

The sources of pollutants for the three remaining beaches include: wastewater from septic systems and permitted discharges from industrial point sources; stormwater runoff; and for Family beach, recreational and tourism activities. (*Bacteria TMDL for 25 Guam Beaches, 2013*).

1.4.5 Piti/Asan Watershed

The Piti-Asan Watershed consists of two Sub-Watersheds: the Piti Watershed outlets flow into Piti Bay and the Asan Watershed flows directly into Asan Bay. Furthermore, the watershed is divided into several sub-basins identified in Figure 15. These sub-basins collect runoff which is deposited into their respective rivers. The major contributors of runoff to the Piti-Asan Watershed are the Asan River in the Asan sub-basin of the Asan Sub-Watershed and the Masso River in the Masso sub-basin of the Piti Sub-Watershed.[40]

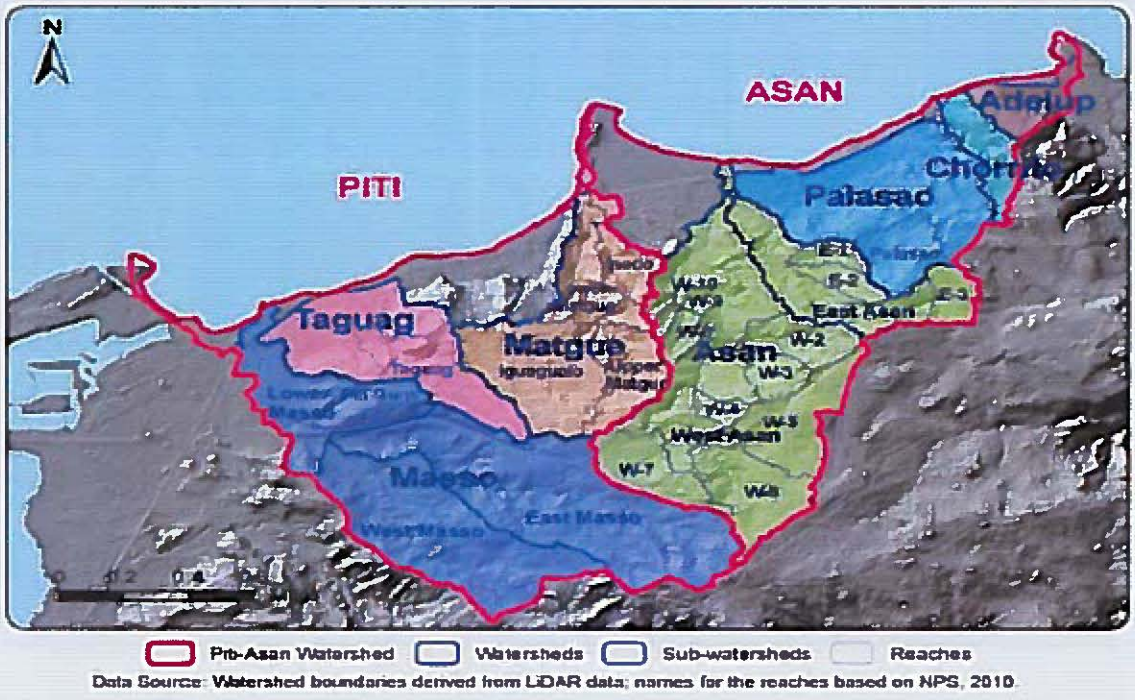

Fig. 16. Piti-Asan Watershed Sub-basins (WERI Technical Report No. 138, 2012)

The watershed has an area of about three square miles. Large areas are under conservation status in the watershed including three War in the Pacific National

[40] Khosrowpanah, S., Lander, M., Golabi, M., Manibusan, S. 2012. A GIS-BASED WATERSHED MANAGEMENT PLAN FOR THE PITI-ASAN WATERSHEDS. Technical Report No. 139, Water and Environment Research Institute, University of Guam.

Historic Park Units and the Masso Conservation Area. The main pollutants impacting water quality in this watershed are sediments and bacteria (fecal coliform). The major threats posed to the overall health of the watershed and specifically to water quality are erosion and associated sedimentation, development, wildland fires, invasive species, and pollutants.[41]

a. ***Impaired Waters in the Piti-Asan Watershed***

1.4.5.1 ***Recreational Waterbodies (Beaches)*** (Category 4b)

Asan Bay Beach	0.46 miles
Tepungan Beach	1.08 miles
Santos Memorial Park	0.26 miles
USO Beach 2	0.26 miles

Pollution sources by beach, Table 5. (*Bacteria TMDLs for 25 Guam Beaches, 2013*).

Table 5. Specific Piti-Asan Beach Potential Source Summary.

Site	Type of Source	Notes
Asan Bay Beach N-14	Wastewater	Septic system
	Stormwater	Highway maintenance & runoff
	Recreation and Other	Recreation & Tourism activities
		River discharge
Tepungan Beach (Piti Bay) (N-15)	Wastewater	Septic system
	Stormwater	Highway maintenance & runoff
	Recreation and Other	Recreation & Tourism activities
		River discharge
USO Beach 1 (Santos Memorial Park Beach) (N-16)	Wastewater	Septic system
	Stormwater	Stormwater runoff
	Other	Historical combined animal feedlot (chicken)
		River discharge
USO Beach 2 (United Seamen's Service) N-17	Recreation and Other	Recreational & tourism activities

b. ***Inventory and Monitoring at War in the Pacific National Historical Park (Asan)***[42]

"While primarily a World War II historical park, the seven units of War in the Pacific National Historical Park (Guam) encompass coral reefs, seagrass beds, tropical savanna grasslands, a mahogany forest, limestone forests, bogs, streams, coastal and forest wetlands, and offshore islets.

[41] Kottermair, M., 2012. Piti-Asan Watershed Management Plan. Technical Report 138, Water and Environmental Research Institute, University of Guam.

[42] https://www.nps.gov/im/pacn/wapa.htm

These outstanding environments provide homes for rare animals and provide a laboratory for scientific inquiry and research.

What's Monitored Here? Benthic Marine Communities, Climate, Marine Fish, Plant Communities, Streams, and Water Quality. Guam EPA is most interested in the water quality information obtained for Guam's marine and fresh waters connected with the local National Park Service sites."

The NPS provides the following description and rational for water quality monitoring.
"The quality of surface waters, marine waters, and groundwater is fundamental to the ecosystems across the Pacific islands. Parks must determine the quality of their water resources, strive to avoid human-caused pollution occurring within and outside of park boundaries, and maintain surface waters and groundwaters as essential components of park aquatic and terrestrial systems.

All pacific island national parks are also concerned about effects of adjacent land uses and increasing development in watersheds connected to the parks' marine, freshwater, and groundwater resources.

The four core parameters chosen for monitoring by the NPS Water Resources Division (temperature, conductivity/salinity, pH, and dissolved oxygen) provide baseline data for water quality assessment. In addition, turbidity, total nitrate, total nitrogen, total phosphorous, and chlorophyll are monitored by the Pacific Island Network for their ecological significance."

Guam EPA has used NPS water quality reports and data to support Guam water quality monitoring and assessment integrated reporting (biannually) to USEPA. The most recent Guam NPS surface and marine water quality reports include:

- Raikow DF and Others. 2017. Marine water quality in in War in the Pacific National Historical Park Summary Report 2009-2014. Natural Resource Data Series. NPS/PACN/NRDS—2017/1122.National Park Service. Fort Collins, Colorado

- Raikow DF and Farahi A. 2014. Water quality in the Asan River, War in the Pacific National Historical Park: Summary report 2007–2012. Natural Resource Data Series NPS/PACN/NRDS—2014/662. National Park Service, Fort Collins, Colorado.. Natural Resource Data Series. NPS/PACN/NRDS—2014/662. Fort Collins, Colorado

1.4.6 Cetti Watershed

Cetti watershed is located south of Talofofo Village, occupying a small southern part of Agat village and a small northern part of Umatac Village. It has a drainage area of 3.07 sq. miles. The main rivers in the watershed include Cetti River, Agaga River, Sella River, Asmafines River and Madofan River with approximate lengths of 1.32 miles, 1.21 miles, 1.03 miles, 1.02 miles and 0.76 mile respectively. Cetti River discharges to Cetti Bay, Sella River and Asmafines River discharge to Sella Bay, and Agaga River and Madofan River discharge to the Philippine Sea in the north of Sella Bay.[43]

a. ***Cetti Watershed Restoration: Cetti Bay Reforestation Project***

On June 5, 2008, the Cetti Bay Watershed Agreement was signed by the U.S. Navy and Government of Guam officials. The agreement provided funding from the Navy for a $4.7 million reforestation project of eroded areas in Cetti Bay. The Navy negotiated the effort in consideration of coral reef affected by planned extensions of Kilo Wharf at U.S. Naval Base Guam.

The U.S. Fish and Wildlife Service, the U.S. National Marine Fisheries Service, U.S. Environmental Protection Agency, U.S. Forest Service and the U.S. Army Corps of Engineers partnered with the Navy and GOVGUAM for the planning and implementation of this project.[44]

Background:[45]

"The Cetti Bay watershed reforestation project is the Navy's preferred mitigation action... a mutual consensus was reached between Navy and GOVGUAM that the Cetti Bay watershed reforestation project will consist of reforestation of up to 500 ac (202 ha) of savanna grasslands and/or badlands within the Cetti Bay watershed, located on the southwestern coast of Guam, approximately 9 miles (14.4 kilometers) south of Apra Harbor.

As stated in the Guam Department of Agriculture (GDOAG) reforestation plan, the bay's coral reef resources have been heavily degraded over the past few decades. One of the factors is believed to be upland erosion caused primarily by road construction, wildland fires, and feral ungulates (unrelated to Navy activities). Reforestation of the savanna grasslands and/or badlands within the Cetti Bay Watershed will reduce terrigenous sediment loads entering Cetti Bay, thereby improving water quality. This

[43] http://south.hydroguam.net/watersheds-cetti.php
[44] Jesse Leon Guerrero, U.S. Naval Forces Marianas Public Affairs. Story Number NNS080623-04 6/23/08.
[45] Record of Decision for Kilo Wharf Extension (MILCON P-502) at Apra Harbor Naval Complex, Guam, Mariana Islands. 1/9/08. https://www.federalregister.gov/d/E8-103

may have an indirect beneficial effect on the coral reef habitat in the receiving waters. Reducing sediment flow is intended to support and enhance the terrestrial and marine ecosystems, including fish and wildlife habitat within Cetti Bay and the Cetti Bay watershed.

The following provides examples of the actions included in the reforestation project: (1) Conversion of savanna grasslands and/or badlands to forest lands around Cetti Bay; (2) reforestation of the area's badlands; (3) fencing of identified reforested areas to provide ungulate control; and (4) implementation of erosion BMPs....

GDOAG will be responsible for the implementation and long term management of the reforestation projects....The Navy will fund a third party contractor to conduct the terrestrial and marine monitoring at Cetti Bay as prescribed in the Mitigation Plan."

1.4.7 Umatac Watershed

The Umatac watershed is located in the southwest coast of Guam, north of Merizo and south of Agat. It has a drainage area of 3.84 square miles. The main rivers in the watershed include La Sa Fua River, Laelae River, Madog River, Chagame River and Astaban River with approximate lengths of 2.11 miles, 1.9 miles, 1.59 miles, 1.02 miles and 0.2 miles respectively. Chagame River flows from north to south, and merges to La Sa Fua River which discharges to Fouha Bay in the Philippine Sea. Astaban River discharges to Madog River, which merges to Umatac River. Laelae River drains from east to west to Umatac River. Umatac River discharges to Umatac Bay.

a. *Impaired Waters in the Umatac Watershed*

1.4.7.1 *Umatac Bay Beach* 0.14 miles.
Sources of pollution are stormwater runoff and river discharge.
The rocky shore of this recreational beach, S-06, offers a scenic walk, tables, benches, and a basketball court for visitors and recreational users. Umatac Bay Beach is located on the eastern shore of Umatac Bay, a popular spot for many Umatac Bay visitors.

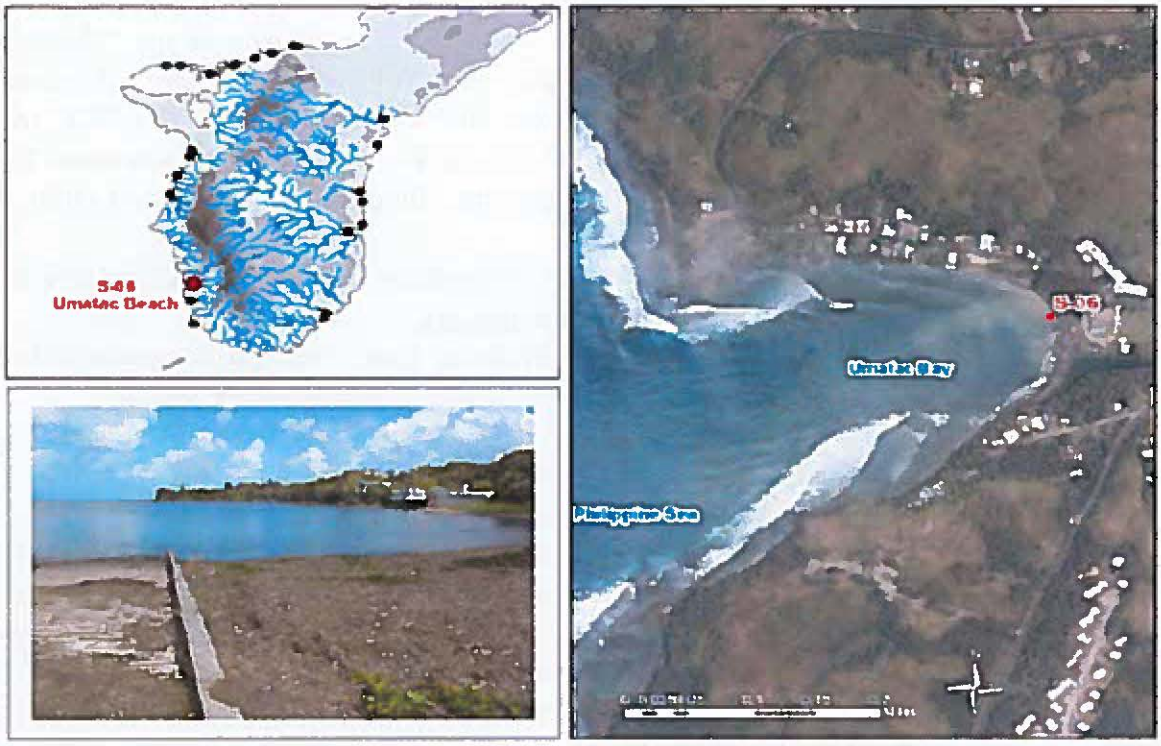

Fig. 17. Location of Umatac Bay Beach relative to other TMDL beaches

b. ***Umatac Watershed Restoration Activities***

(1) Humatak Community Foundation (HCF):

The HCF was created in September 3, 2011 as a public, non-profit corporation, for the people of the village of Humatak (Umatac) as well as family and friends living on and off the island of Guam to work together towards sustainable natural and cultural resources for our people and our future. It is a volunteer based-organization comprised of diverse community leaders of business, government policy, non-profit management, preservation & conservation, education, and technology.[46] Foundation results include:

- *Umatac Coral Reef Ambassadors:* A conservation program comprised of adult and youth mentors and youth ambassadors, created to provide the community with a life-long learning experience in the conservation of our natural resources through awareness, personal growth, teamwork, leadership skills, and a traditional and environmental mindset for the future.
  - Training to monitor coast reef off Humatak Bay, Fouha Bay, and Cetti Bay;
  - Conservation learning exchanges with other islands.

[46] www.humatak.org

- *Umatac Village Heritage Museum:* A component of the "Heritage Mission" of the HCF, proposed to be located in the F.Q. school facility (registered historic site) and managed by the HCF and community volunteers. One of the four goals is to showcase the people and history of Umatac village in its natural and cultural environment.
  - Portable Exhibition- "Umatac by the Sea". Also available for viewing at www.humatak.org.
  - Humatak Heritage Walking Tour – trained docents (guides) walk visitors through the historic streets of the village;
- *Initiative for developing a village charter school: Francisco Quinata Sanchez Community Charter School.*

(2) **The Humatak Project: "Reviving Guam, one bay at a time"**[47]

"...The Humatak Project became a community-led with numerous partner organizations in the government, the university and high schools, and non-governmental organizations. Project Coordinator Austin Shelton was a marine biology Ph.D. student and a research assistant to Dr. Robert Richmond at the University of Hawaii Marine Laboratory. Scientific guidance and coordination for the Project's community restoration effort was provided under a NOAA grant.[48] Components of the Humatak Project (https:www.humatakproject.org)

- *Educational Outreach*
  Educational projects designed to increase environmental awareness in the community.
- *Watershed Management*
  Implemented erosion control projects (planted tree seedling and installed sediment filter socks on the slopes of the Fouha watershed) that promoted community volunteerism and discouraged arson by deer hunters.
- *Scientific Research*
  Implemented projects fulfilling need for long-term comprehensive data (engaged partners to monitor the health of the reefs—including coral habitat and associated biological communities);
  Completed study of sedimentation in Fouha Bay (collected turbidity, temperature and salinity data for comparative study).

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[47] Stories from Oceania. "Guam – the Humatak Project", Author Regina Gregory, September 2013. https://www.ecotippingpoints.org/our-stories/region-oceania.html

[48] NOAA grant entitled: "Science to Conservation: Linking Coral reefs, coastal watersheds, and their human communities in the Pacific Islands."

1.4.8. Manell-Geus Watershed

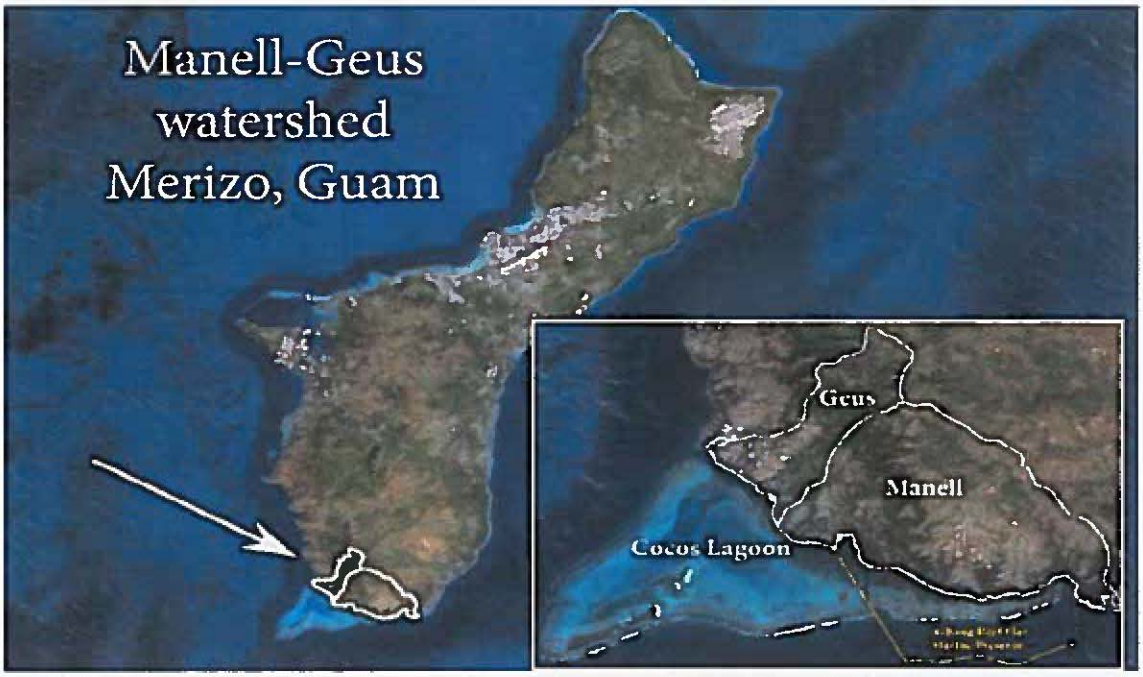

Fig. 18. Manell-Geus Watershed (www.noaa.gov/habitatblueprint)

Manell watershed is located in the south of Guam. Most of the watershed is located in Merizo Village. It has a drainage area of 4.55 sq. miles. The main rivers in the watershed include Ajayan River, Nelansa River, Laolao River, Fintasa River, Liyog River and Asgadao Creek with approximate lengths of 2.91 miles, 2.01 miles, 0.98 mile, 0.77 mile, 0.72 mile and 0.5 mile respectively. Ajayan River discharges to Ajayan Bay in the Pacific Ocean, and the other rivers discharge directly to the Pacific Ocean.[49]

Geus watershed is located in the southwest of Guam. Most of the watershed is located in Merizo Village. It has a drainage area of 1.73 sq. miles. The main river is the Geus River with approximate length of 2.71 miles. Geus River discharges to the Philippine Sea.[50]

a. ***Impaired Waters in Manell-Geus Watershed***

1.4.8.1 ***Marine Bays***

Cocos Lagoon *2 waterbodies* Category 5
Cocos Lagoon 1 5.70 square miles
Cocos Lagoon 2 0.34 square miles
Pollutant: PCBs in fish tissue. The lagoon is under a Fish Advisory.

[49] http://south.hydroguam.net/watersheds-manell.php
[50] http://south.hydroguam.net/watersheds-geus.php

Cocos Lagoon is an atoll-like coral reef lagoon located on the southwestern coast of the island of Guam. The lagoon is separated from the open ocean by a series of fringing reefs and barrier islands, of which Cocos Island is the largest. Cocos Lagoon is a popular area for recreational activities including fishing, boating and diving, along with subsistence fishing.

Between 1944 and 1963, the U.S. Coast Guard (USCG) operated a Long Range Navigation (LORAN) station on Cocos Island. Components from the LORAN station, including several transformers and capacitors containing PCBs, likely used in the operation of the station were found on land and in nearby waters. The USCG has since removed the PCB containing transformers and capacitors, along with a substantial amount of contaminated soil, but there is evidence that these chemicals have migrated into several marine matrices including fish and nearshore sediments. This is of concern to local managers and to the public. Exposure to PCBs has been found to elicit a range of toxic responses in animal studies including reduced growth, reproductive impairment, and vertebral abnormalities. PCBs may also cause cancer in animals. A fish consumption advisory was put in place in Cocos Lagoon in 2006, following detection of PCBs in fish through USCG-funded research. In 2015, local resource managers asked NCCOS for help in assessing chemical contaminants in sediments and fish to understand the extent of the contamination throughout Cocos Lagoon.

("Assessment of Chemical Contaminants in Sediments and Biota from Cocos Lagoon, Guam") This National Oceanic and Atmospheric Administration (NOAA) National Centers for Coastal Ocean Science (NCCOS) research project, funded by the NOAA's Coral Reef Conservation Program (CRCP), began in May 2015 and is ongoing. The goal of this project is to quantify the extent of chemical contamination in sediments and fish in Cocos Lagoon, Guam. Significant chemical contaminant issues have been identified in the area of Cocos Island, as a result of past land use activities. The project is providing an assessment of the spatial distribution of a suite of both organic and inorganic chemical contaminants in sediments, as well as contaminant body burdens in fish.[51]

1.4.8.2. ***Recreational Waters (Beaches)***

Merizo Pier – Mamaon Channel 0.46 miles (Category 4b).
Potential sources of pollutants are wastewater sources such as sewer line blockages or breaks and sewer system overflows.

[51] EPA Fish and Shellfish Program Newsletter, May 2018. EPA 823-N-18-005

b. ***Manell-Geus Watershed Restoration Projects***

(1) Manell-Geus Watershed as NOAA Habitat Focus Area

In 2014, the National Oceanic and Atmospheric Administration (NOAA) announced its designation of Guam's Manell-Geus Watershed as a Habitat Focus Area under its Habitat Blueprint framework.[52]

While this site has amazing marine resources, the coastal ecosystem is impacted by poor water quality linked to erosion on the steep hillsides and along streambanks. Wildland fires, feral animals, and off-roading vehicles have accelerated the erosion. These conditions can lead to flooding in downstream areas, affecting the village and its adjacent reef.

Sedimentation can have serious impacts to coral health by increasing susceptibility to disease, decreasing growth rates, and affecting coral settlement. These problems are made worse by outbreaks of crown-of-thorns starfish (a carnivorous predator that preys on reef coral polyps) and overharvesting of key species such as large parrotfish.[53]

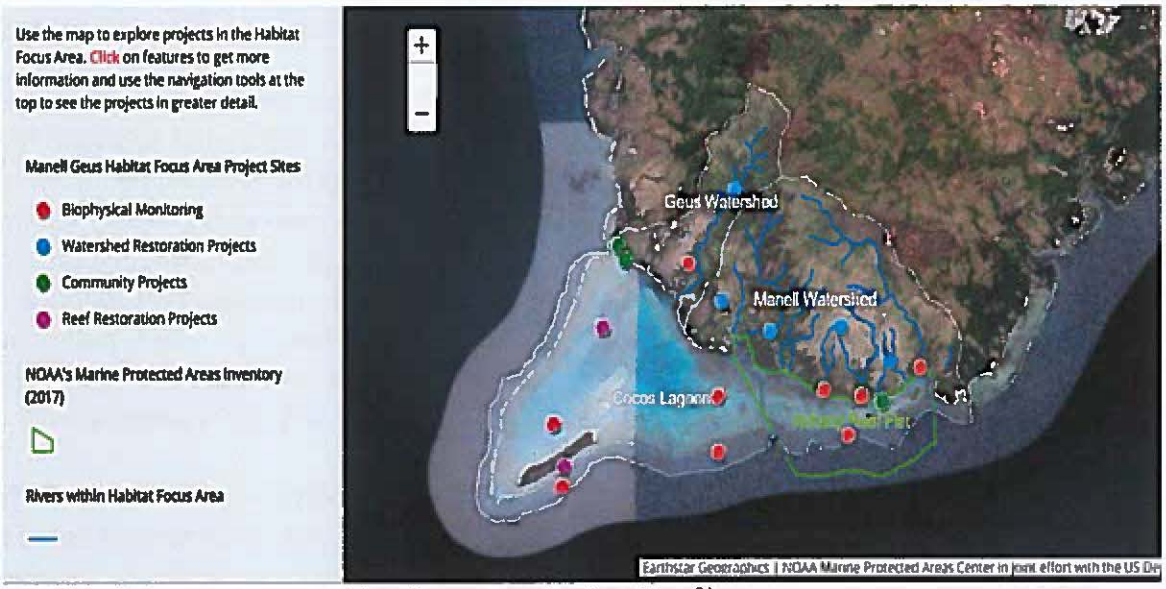

Fig. 19. Manell Geus Habitat Focus Area Project Sites[54]

The story map site provides detailed information about the HFA:

- priority issues (upland erosion/wildland fires, stream erosion and flooding, water quality, algal growth, and coral bleaching);
- focus area objectives (to promote healthier reefs, to encourage

[52] https://www.habitatblueprint.noaa.gov/wp-content/uploads/2016/04/Habitat-Blueprint-1p-Fact-Sheet_19Nov2015.pdf

[53] https://www.habitatblueprint.noaa.gov/habitat-focus-areas/manell-geus-guam/

[54] Ibid. Story Map.

healthier and safer coastal communities, to enhance community engagement);
- the projects (see Fig. 18); and
- partners for the work undertaken in the watershed.

1.4.9. Toguan Watershed

The Toguan watershed is located between the villages of Umatac and Merizo. It has a drainage area of 1.41 sq. miles. The main rivers in the watershed include Toguan Creek, Pigua River and Bile River with approximate lengths of 1.38 miles, 1.09 miles and 0.73 mile respectively. Toguan Creek drains to Toguan Bay in the Philippine Sea, and Bile River and Pigua River discharge to Bile Bay in the Philippine Sea. All these rivers flow from east to west.[55]

a. ***Impaired Waters in the Toguan Watershed***

1.4.9.1 ***Recreational Waters (Beaches) Category 4a***

Toguan Bay Beach 0.46 miles

Sources of pollutants are identified in Table 5 on the next page.

b. ***Watershed Project: GEPA Microbial Source Tracking (MST) for Toguan Bay Beach (S-07)***

The Agency developed a proposal in 2017 to collect and test water samples from four (4) beaches with bacteria TMDLs to determine whether the dominant source of Fecal Indicator Bacteria (FIB) is human[56] or non-human.[57] This sampling approach is considered a screening to help Guam EPA get a better understanding of the human fecal pollution contribution. *This project is targeted for implementation in the 2019-2023 GEPA grant cycle.*

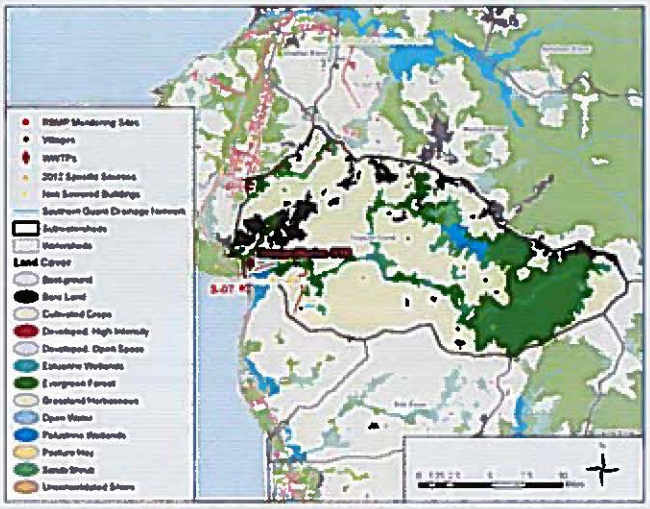

Fig. 20. Location of Toguan Bay Beach to potential sources. (Guam Bacteria TMDL, 2013).

In 2016, S-07 had 78% frequency of advisory where 19 advisories were released during the dry season and 21 were released during the wet season. [In 2016, n= 51, Min conc: ND, Max conc: >24,196 MPN].

[55] http://south.hydroguam.net/watersheds-toguan.php
[56] From sewage or septage.
[57] From cow, water buffalo, chicken/bird, deer, dog, and/or pig.

Table 6. Potential Pollutant Sources: Toguan Bay Beach (S-07).

Station	Wastewater : Septic systems	Wastewater : SSO	Wastewater : WWTP	Wastewater : Sewer line block/break	Wildlife	River discharge	Storm water runoff	Storm drains
Toguan Bay (S-07)			X		*	X	X	

* Suspected potential source not listed in the TMDL document.

2.0 Point Source Pollution Control Program

The Agency implements the following specific programs designed to address known sources of pollution (point sources) including pipes, ditches, and sanitary or storm sewers. (a) **Permit Compliance** – This program activity is implemented through site inspections and surveillance of conditions imposed via an approved Guam EPA Water Quality Certification (Section 401) and a National Pollutant Discharge Elimination System (NPDES) permit issued to industrial and non-industrial facilities. Information about these program permits is available at http://epa.guam.gov/documents/waterpermits/

Table 7. Federal National Pollutant Discharge Elimination System (NPDES) Permits 2018-2019

Permit No.	Facility – Permit Expiration Date		Receiving Water(s)
GU0020087	GWA, Agana STP	12-31-2024	Philippine Sea
GU0020141	GWA, Northern District STP	12-31-2024	Philippine Sea
GU0020222	GWA, Agat/Santa Rita STP	12-31-2024	Philippine Sea
GU0020273	GWA, Umatac-Merizo STP	12-31-2024	Philippine Sea
GU0020371	GWA, Ugum Surface Water Treatment Plant	08-03-2021	Ugum River
GU0020001	GPA, Cabras Power Plant	01-31-2025	Apra Harbor
GU0110019	USN, Apra Harbor STP	04-30-2022	Philippine Sea
GU0020389	USN, Fena Water Treatment Plant	03-21-2022	Namo River
GUG000001[Δ] (BULK FUEL STORAGE)	Tristar Agat Terminal	03-31-2025	Big Guatali River
	Tristar, F-1 Pier		Apra Harbor
	Mobil Oil Guam, Inc.		Apra Harbor
	South Pacific Petroleum Corp.		Apra Harbor
	GPA, Piti Terminal		Piti Channel, Apra Harbor
GU00200397	Cabras Marine	07-30-2023	Apra Harbor
GU0020168	UOG, Marine Laboratory	AE*	Pacific Ocean
GU0020346	Unitek Environmental-Guam	08-31-2022	Apra Harbor
GUS040000	Department of the Navy, MS4•	01-31-2024	DON MS4 Permit Area[58]
GUS040001	Guam DPW, MS4•	01-31-2024	DPW MS4 Permit Area[59]
GU0020095	GWA, Baza Gardens STP	08-31-2018	Permit terminated 1-31-2019
GU0020362	Guam Shipyard Dry Dock Facility		Permit terminated 12-06-2018

[Δ] Five existing permitted facilities consolidated by EPA under General Bulk Fuel Storage Facility Permit
AE* terms of existing permit administratively extended pending issuance of a new permit
• Municipal Separate Storm Sewer System NPDES Permit

[58] See Fig. 20
[59] The entire Island of Guam, except for areas under jurisdiction of military. DPW permit Appendix C.

Guam NPDES permits are administered by U.S. EPA, Region 9. The Guam EPA Environmental Monitoring and Analytical Services (EMAS) Division is responsible for reviewing Section 401 Water Quality Certification (WQC)[60] applications and processing them for action by the Agency Administrator. NPDES permits require 401 WQCs. The EMAS and Water Divisions review draft NPDES permits and develop the respective 401 WQC conditions and abatement schedules per the provisions of the NPDES permit and/or the 401 WQC application.

Table 6 identifies NPDES permits for the reporting period. The discharges from these permitted facilities included effluent from wastewater treatment plants, thermal effluent from the power plants, a number of discharges contained minor amounts of oil and other toxic materials, and storm water discharges. The guidelines for effluent limitations are based on the Revised 2017 Guam Water Quality Standards. Two permits were terminated by U.S. EPA during the reporting period: the permit for GWA's Baza Gardens STP and the permit for the Guam Shipyard facility.

GWA WWTP NPDES Permits

In late 2019, EPA reissued all four GWA WWTP permits jointly in a single document to promote consistent regulatory requirements across all facilities, including a joint set of general conditions applicable to all four facilities. The permits became effective in January 2020 and expire December 2024.

BULK FUEL STORAGE General NPDES Permit for Guam

The EPA Regional Administrator determined that bulk fuel storage facilities operating in the areas described in the proposed general NPDES permit are more appropriately and effectively controlled by a general permit than by individual permits. The subject general NPDES permit was issued January 31, 2019, effective April 1, 2019. It establishes effluent limitations, prohibitions, and other conditions on discharges from facilities in the general permit area. These conditions are based on the administrative record. EPA regulations and the permit contain a procedure which allows the owner or operator of a point source discharge to apply for an individual permit instead. The expiration date for this bulk fuel storage general permit is March 31, 2024.

Guam MS4 Permits

Two Municipal Separate Storm Sewer Permits were issued on Guam in December 2018, effective February 2019. The permittees were the Department of the Navy (DON) and the Guam Department of Public Works (DPW). The DON permit was modified in April 2020, effective May 2020. Both MS4 permits expire at the end of January 2024. These permits can be reviewed at https://www.epa.gov/npdes-permits/guam-npdes-permits.

[60] GWQS. 22 GAR Chapter 5, Section 5106. Section 401 Certifications.

The Navy MS4 permit area includes the following facilities (Naval Base Guam, Apra Heights, Nimitz Hill, Naval Magazine and Naval Hospital and adjacent high school), located in any of the following watersheds: Agat, Apra, Cetti, Dandan, Fonte, Geus, Hagåtña, Inarajan, Manell, Pago, Piti-Asan, Taelayag, Talofofo, Toguan, Ugum, Umatac, and Ylig. In addition, the village limits of the village of Tamuning are included to the extent these limits extend northward beyond the boundaries of the Hagåtña watershed. The western tip of Navy Barrigada in the Hagåtña watershed is not covered.[61]

The Guam DPW permit The DPW permit covers the entire Island of Guam, except for the areas under the jurisdiction of the military.[62]

Fig. 21. MS4 Permit Coverage Area (Source: EPA)

(b) **Enforcement** – Guam's Water Pollution Control Act and local Water Quality Standards authorize Guam EPA to take legal action against those who pollute the waters of Guam. Enforcement is carried out through site inspections coupled with an assessment of respective water quality monitoring data. NPDES permittees submit quarterly DMRs or Discharge Monitoring Reports to EPA Region 9 for review and evaluation. Appropriate enforcement action is applied for non-compliance to approved permit conditions.

3.0 Nonpoint Source Pollution Control Program

In February 1987 U.S. Congress passed the Water Quality Act which required states and territories to assess nonpoint source problems and develop management programs to control them. Nonpoint source pollution presents a serious threat to the quality of Guam's marine, surface and groundwater. And as the overall designated Agency responsible for protecting the quality of waters in Guam, Guam EPA oversees the following activities

[61] DON MS4 NPDES Permit Appendix E, https://www.epa.gov/npdes-permits/guam-npdes-permits
[62] Guam DPW MS4 NPDES Permit Appendix C, https://www.epa.gov/npdes-permits/guam-npdes-permits

under its Water Pollution Control Program, NPS 319 program, and Guam's coastal NPS program, to prevent and control nonpoint source contamination.

3.1 Individual Wastewater Permits

Domestic wastewater associated with population increase is the largest potential source of pollution to all waters of Guam. The island's most extensive population development is occurring in the northern watershed above its federally designated sole source aquifer. Due to government funding constraints, such development is occurring without adequate sewage infrastructure. As a result, occupants depend on septic tank and leaching field systems for waste disposal.

Table 8. Wastewater Permitting Activities

Wastewater (Permit) Activity	2017	2018	2019
ST/LF* Permit Applications Reviewed & Processed	172	154	N
SC** Applications Reviewed & Processed	88	143	N
ST/LF Inspections	132	149	115
ST/LF Inspections (approved)	95	138	115
Occupancy Permits : ST/LF	64	130	115
Occupancy Permits : SC	39	9	N
Grease Trap Follow Up Inspections	142	173	160
Grease Trap inspected & Approved	17	7	26

Source: Guam EPA Water Pollution Control Program
* Septic Tank/Leaching Field ** Sewer Connection
N – new reporting format only quantifies ***total numbers***, i.e. applications reviewed & processed; total inspections.

To control this nonpoint source of pollution, Section 48102, Chapter 48 of 10 Guam Code Annotated (GCA) requires that no building shall be occupied or used as a dwelling, school, public building, commercial building, industrial building or place of assembly without toilet or sewage facilities of a type inspected and approved for the disposition of human excreta and other domestic wastes.

Furthermore, in the northern area of Guam, permitted housing density has been decreased to one residential dwelling unit per half acre of property in unsewered areas to protect the groundwater from contamination.

Permits are required for new and remodeled buildings. To ensure the installation of proper sewage disposal systems, the permitting process includes mandatory on-site inspection and building plan review, permit issuance and final inspection of the completed disposal system. Building occupancy permits are only issued upon approval of the structure's sewage disposal system.

During 2018, a total of two hundred ninety seven (297) permit applications were reviewed and processed for septic tank/leaching fields (ST/LF) and connections to public sewer. Two hundred fifty three (253) of two hundred sixty-four (264) ST/LFs met inspection criteria during the reporting period (2018-2019). Two hundred forty five ST/LFs met occupancy permit requirements. The Agency conducted four hundred seventy-five grease trap follow-up compliance inspections. Thirty three grease traps met approved inspection requirements. **(Table 8).**

3.2 Soil Erosion and Sediment Control Program

Soil erosion is one of the island's most serious nonpoint source pollution problems especially in southern Guam. Increased local development has disturbed Guam's soils and greatly accelerated erosion that follows every rainfall. Erosion not only removes the productive top soil and substrata, it leaves scars which regenerate growth with much difficulty. Eroded top soils are transported to streams and rivers, reefs and beaches, where recreational sites and wildlife habitats are destroyed. The fragile, filter feeding organisms of the reef are smothered, light penetration into the water is drastically reduced and silt covers the bottom with a soft layer unsuitable for bottom-dwelling plants and animals. As pollution increases, the productivity decreases and the fish and other animal die or leave the area.

Table 9. Soil Erosion & Sediment Control Permitting Activities

SE&SC (Permit) Activity	2017	2018	2019
Clearing	67	41	*New reporting format used. Some permit activity data merged and hard to quantify.*
Grading	54	26	
Clearing & Grading	21	33	
Stockpiling	20	4	
Clearing/Grading/ Stockpiling	22	7	
Enforcement Routine/Follow-up Inspection	119	76	
Site Ocular Inspections	90	75	
Reviewed & Approved EPP/ECP*	89	75	

Source: Guam EPA Water Pollution Control Program
* Environmental Protection Plan/Erosion Control Plan

Guam EPA enforces the *Guam Soil Erosion and Sediment Control Regulations* (Public Law 25-152) to prevent, reduce, and control soil erosion or other environmental impacts to the community. Enforcement action is supported by an inspection program and an application review and approval process for all clearing, grading, or stockpiling permits.

For most clearing and/or grading permits involving disturbed areas of one acre or more, there must be an accompanying Erosion Control Plan (ECP) which sets specific conditions to protect the quality and designated uses of the waters of Guam.
During 2018, a total of one hundred eleven (111) permits were issued and subject to compliance with the Guam Soil Erosion and Sedimentation Control Regulations. Of this total, forty one (41) were permits for clearing; twenty-six (26) were permits for grading; and thirty-three (33) were permits for clearing and grading. A total of seventy five (75) EPPs/ECPs were reviewed and approved. The Water Pollution Control Program transitioned to a new reporting format in FY 2019. Some permitting activities and respective data reported in FYs 2016-2018 could not be similarly quantified for FY 2019. See Table 9.

3.3 Feedlot Waste Management Program

In 1986, the Guam EPA developed Feedlot Waste Management Regulations to control livestock operations which generate in excess of one hundred (100) pounds of waste per day. This volume constitutes a significant concentration of waste that would typically be generated by facilities housing approximately twenty (20) swine or five hundred (500) fowl. On-site visits to smaller livestock operations are undertaken when identified. Where improper handling of wastes exists, corrective action is recommended to the operator which is often handled through modifications in "housekeeping" procedures.

No feedlot operators were registered with Guam EPA during the reporting period. However, the Agency responds to reported complaints possibly connected to illegal livestock operations. A notice of violation may be issued to any person found in violation of the Feedlot Waste Management Regulations.

Improper handling, treatment and storage of wastes from livestock operations are a concern because of the potential contamination of the island's water resources. In southern Guam, improper control of livestock wastes results in pollutants being transported to surface waters. Similarly in the north, such wastes may be readily transported through the porous limestone to groundwater.

- *All proposed feedlot operations are required to obtain a permit from the Department of Public Works.*
- *The permitting process involves zoning assessment and site approval by the Department of Land Management and assessment for proper vector control measures by the Department of Public Health and Social Services.*
- *Guam EPA reviews the feedlot operations permit application and the facility plans and specifications to assess the adequacy of waste storage, disposal and treatment facilities. Once construction is completed and Guam EPA has inspected and approved the facility, an operating permit is issued to the proposed feedlot operator. Annually monitoring of permitted feedlot operations is required.*

3.4 Urban Runoff

Urban runoff is one of Guam's most voluminous nonpoint source problems which impacts both groundwater and coastal waters. Urbanization generally increases the sheer volume of stormwater runoff because of the large amount of impermeable surfaces associated with construction or land development. As a result, rainwater is not naturally allowed to percolate into the ground.

Guam EPA continues to improve stormwater management via its permitting process regulating any construction, land development or earth-moving operations. Project applications are evaluated for stormwater run-off disposal and mandated to incorporate "Best Management Practices" (BMPs). Permitted projects must implement these BMPs to maximize on-site containment and/or treatment of stormwater prior to discharge, especially discharges into any near shore waters of Guam. In Tumon Bay, discharges to coastal waters have been decreased with the elimination of most existing storm drains near shore.

The Water Division continues its efforts to modernize review procedures or applicable regulations by incorporating provisions for stormwater management based on criteria in the Manual.[63] The Agency utilizes the expertise of its assigned legal counsel to support the modernization and adjudication of outdated statutes and regulations.

3.5 Clean Water and Drinking Water Grants to Guam

EPA allots a portion of the Drinking Water State Revolving Fund (DWSRF) and Clean Water State Revolving Fund (CWSRF) as grants to Washington, D.C., and the U.S. territories of U.S. Virgin Islands (USVI), Guam, American Samoa, and the Commonwealth of the Northern Mariana Islands (CNMI) for drinking water and wastewater infrastructure.

Congress exempted the District and the U.S. territories from establishing state revolving loan fund programs. The District and the U.S. territories listed above instead chose to continue receiving funds under the Construction Grants Program. EPA supports public health and environmental protection in the U.S. territories and the District by helping communities develop and maintain their water infrastructure through funding, tools, training, and technical assistance.

Under Section 201 and 601 of the Federal Clean Water Act as amended, Guam EPA administers the use of federal funds to control point and nonpoint source pollution, resulting from small communities that generate raw sewage discharges and/or have on-site disposal systems, which do not function properly due to poor soil characteristics and/or improper operation and maintenance. Guam receives its allotment of federal

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[63] 2006 CNMI and Guam Stormwater Management Manual

funds based on its construction needs, in accordance with a construction grants priority list and system established by the Guam EPA Board of Directors. The priority list is usually revised annually to reflect impacts of each individual project on public health and the Northern Aquifer, the island's designated sole source of drinking water.

Since 1968, over $59 million has been provided to Guam by the EPA for the planning, design, and construction of wastewater collector systems and treatment facilities, as mandated by Title II and VI of the Federal Clean Water Act as amended. In 2017, EPA awarded just over $9 million in Clean Water and Safe Drinking Water State Revolving Funds to Guam Waterworks Authority (GWA).

As an example of the work performed using DWSRF and CWSRF funding, From October 1, 2016 through September 30, 2017, through an in-kind technical services contract, EPA provided grant funding to increase the technical, financial, and managerial capacities at GWA. The project included the development and implementation of enterprise-wide standard operating procedures, an upgraded geographic information system, and the creation of an asset management program. Working closely with EPA's contractor on asset management, GWA completed an asset inventory, installed a new computerized maintenance and management system for the control and tracking of work orders, and implemented a condition and criticality assessment tool. GWA is beginning to see a significant increase in the ratio of preventative to corrective maintenance. The five-year project helped GWA improve operations and management of their water and wastewater systems and implement standardized procedures and tracking for a more effective and efficient capital improvement program.[64]

4.0 Guam Water Quality Standards (GWQS)

Guam's Water Quality Standards are provisions of law which establish both the water quality goals for specific waters, and the regulatory basis for treatment controls and strategies.

- GWQS were initially adopted in 1975, and revised in 1987 and 1992.
- These standards were revised in 2001 and received EPA Region 9 approval in 2002. The most notable revisions address 1) *Anti-degradation*. The existing policy was revised to meet federal requirements 2) *Groundwater*. Numeric water quality criteria for groundwater were included. The criteria helped clarify necessary water quality levels to retain our sole source aquifer as an acceptable drinking water resource. 3) *Numeric Criteria for surface waters*. Numeric criteria (e.g. microbiology, pH, nutrients, and toxic substances) were updated and newly adopted to reflect updated federal requirements. 4) *Effluent limitations*. Protections were included for threatened and endangered species, and for those organisms harvested for food. Sections were added which allow schedules of compliance for point source

[64] EPA Document 830R18002. July 2018

discharges that need time to comply with the new requirements, establish federally required low-flow requirements for permit limit calculations, and identify petroleum spill prevention requirements for those facilities having a capacity of 660 gallons or greater. 5) *Wetlands and water quality certifications.* Requirements related to these sections were clarified. Unnecessary or redundant language was removed. Application forms were eliminated from the body of these standards so that revisions to the forms can be made by Agency staff as necessary, without going through a regulatory revision process.

- Amendments to the GWQS were filed with the Guam Legislature in October 2017, (effective 90 days thereafter), and approved by USEPA in March 2018. These amendments appropriately adopted the EPA's 2012 Recreational Water Quality Criteria for protecting human health in recreational waters. The amendments include updated recreational water criteria; revised categories of waterbodies to which the recreational water criteria apply; and Statistical Threshold Values (STVs).
- A Triennial Review of GWQS was conducted in 2018 with a public hearing held January 15, 2019, in accordance with CWA Section 303(c)(1) and EPA's implementing regulations at 40CFR 131.20. The next Triennial Review is planned in 2021.

Guam EPA intends to revise the 2017 WQS in a variety of ways including additions of and revisions to water quality criteria, adopted implementation procedures, or other general policies. Guam's Water Quality Standards can be reviewed electronically at http://www.guamcourts.org/compileroflaws/GAR/22GAR/22gar05.pdf.

Other priority WQS issues under evaluation include but are not limited to:

- development of biological indices for water quality in all waters
- development of local wetland water quality standards
- re-assessment of marine water classifications: M-1, M-2, M-3
- new parameters for sediment quality criteria for selected contaminants
- changes to WQS for Cu, Ni, Al and/or clarification of mixing zone standards

5.0 Total Maximum Daily Loads (TMDLs)

A TMDL specifies the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards, and allocates pollutant loading among point and nonpoint pollutant sources. A TMDL also includes a margin of safety to ensure protection of the water.

EPA has approved forty-three TMDLs for Guam: a *Sediment TMDL for the Ugum Watershed* prepared by Tetra Tech, Inc. and EPA for Guam EPA in October 2006[65]; the *Northern Watershed Bacteria TMDLs*[66] (Tetra Tech, Inc., March 2010) for seventeen recreational beaches; and twenty-five (25) additional Bacteria TMDLs[67] were developed (Tetra Tech, Inc., December 2013) for recreational beach sites in central and southern Guam.

Another TMDL for Tumon Bay is being developed with the draft document scheduled for preliminary review in early 2021.

5.1 The Clean Water Act and the 303(d) List

Under section 303(d) of the 1972 Clean Water Act, Guam is required to develop its list of impaired waters. These impaired waters do not meet water quality standards that Guam has set, even after point sources of pollution have installed the minimum required levels of pollution control technology. The law requires that Guam establish priority ranking for waters on the list and develop TMDLs for these waters.

Section 303(d) of the CWA requires each state to submit an updated 303(d) list of impaired waters to EPA every two years. The 303(d) list provides a way for Guam EPA to identify and prioritize water quality problems. The list also serves as a guide for developing and implementing watershed recovery plans to protect beneficial uses while achieving federal and state water quality standards. The list is meant only as a means of identifying water quality problems-not the cause of water quality problems.

Causes of water quality problems are determined when water quality management plans are developed for the watersheds in which the listed segments are located. These plans contain controls referred to as the TDML.

5.2 Guam's Methodology for Developing the 303(d) List

Existing scientific data and best professional judgment are used to assess water quality and to determine which waterbodies should be listed. Guam EPA develops a draft list and presents the list for public comment. All public comments are reviewed and evaluated in the development of the final 303(d) list which is forwarded to the EPA for approval.

Guam EPA seeks all available information to determine if Guam's surface water is violating water quality standards. The assessment of impaired waters for 303(d) listing

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[65] Go to:
https://ofmpub.epa.gov/waters10/attains_impaired_waters.show_tmdl_document?p_tmdl_doc_blobs_id=72383

[66] Go to:
https://ofmpub.epa.gov/waters10/attains_impaired_waters.show_tmdl_document?p_tmdl_doc_blobs_id=71725

[67] Go to:
https://ofmpub.epa.gov/waters10/attains_impaired_waters.show_tmdl_document?p_tmdl_doc_blobs_id=67942

considers data submitted/generated by individuals, organizations and government agencies, as well as Guam EPA monitoring data.

Guam EPA follows federal criteria, GWQS, and scientific protocols in developing the list. It reviews all available data to ensure conformance with specified minimum quality assurance requirements:

- Sampling and analysis must be conducted under a written Quality Assurance/Quality Control Plan or by established and approved protocols
- Data must demonstrate that field instruments were operated according to accepted methods
- Data must demonstrate that biological monitoring followed standardize protocols
- Data must demonstrate that certain other testing methods complied with accepted practices

EPA listing guidelines require that Guam demonstrate good cause for not placing a waterbody on the list. If available data indicates a waterbody is not meeting water quality standards, and the data meets listing guidelines, then Guam EPA must assume that the waterbody is water quality limited.

Guam EPA does not have information on all Guam waterbodies. Those without information, or information not compatible with the EPA guidelines, are not included on the 303(d) list. Streams and rivers with suspected problems are identified as "Waterbodies of Potential Concern." Streams and rivers will not be placed on the 303(d) list until sufficient data is available that indicates a violation of water quality standards. Guam EPA is mandated to protect water quality by establishing standards (GWQS) to protect beneficial uses. While there may be competing beneficial uses in a waterbody, federal law requires Guam EPA to protect the most sensitive of these beneficial uses. Guam EPA standards include parameters such as bacteria, pH (acidity level), turbidity, and dissolved gas, certain toxic and carcinogenic compounds, habitat and flow modification, and aquatic weeds or algae that affect aquatic life.

Appendix A contains the methodology narrative for developing Guam's 2020 303(d) List.

5.3 Listed Waterbodies

Once a waterbody is placed on the 303(d) list Guam EPA must develop a TMDL for that waterbody. Guam EPA has committed to develop TMDLs on high priority listed waterbodies within 10 years. This time frame takes into account the urgency to protect public health, safeguard Guam drinking water sources, and the desire of landowners to begin working on restoration efforts.

Guam EPA's comprehensive watershed approach for protecting water quality includes developing TMDLs for both point and non-point sources. When establishing limits for pipes (point sources), Guam EPA monitors to determine what pollutant is causing water quality problems and in what amounts it is entering the water. The monitoring also attempts to determine how much of the pollution comes from non-point pollution, such as surface runoff, and how much is naturally occurring.

Guam EPA has received technical assistance from USEPA for all its TMDLs. Computer models determine what effect point source pollution is having on the waterbody, and how much of the pollutant can be discharged without exceeding water quality standards in the watershed. Computer modeling is also used to establish permit limits on the amount of pollutant each pipe can discharge.

When controlling pollution from non-point sources, several factors must combine to form a comprehensive approach to TMDL development.

5.4 Water Quality Management Plan Development

The Clean Water Act requires the state to develop a water quality management plan to reduce pollution on each waterbody on the 303(d) list. As much as possible, water quality management plans will be developed by government agencies in cooperation with landowners. If the land is agricultural, then the Guam Department of Agriculture and the Natural Resources Conservation Service (NRCS) of the U.S. Department of Agriculture may be involved to work with the landowners in the watershed to devise and implement a management plan. Federal agencies (such as the U.S. Navy and the Air Force) would be responsible for developing water quality management plans for federal lands, with Guam EPA oversight. The above plans should be sent to Guam EPA for inclusion in an overall watershed plan, which Guam EPA would then submit to EPA for approval.

5.5 Removing Waterbodies from the 303(d) list

A waterbody is removed from the list when there is evidence that:

- A TMDL has been approved;
- Water quality standards are met;
- Water quality standards are violated due only to natural conditions (meaning that there is no human-caused influence);
- The original listing was in error.

Guam EPA will continue to evaluate delisted waterbodies to ensure that management plans are being implemented, and water quality standards achieved. Guam's 303(d) list is presented in **Table 28**.

6.0 Program Coordination with Other Agencies

One of the elements of Guam's strategy for effective water quality protection and

restoration and pollution prevention is *"utilizing and developing our local expertise"*[68]. The information and collaborative partnerships established by working with others will help the island identify its resource problems and priorities, and collectively develop and implement effective resource protection and restoration activities.

Key components of Guam's approach include:

- Interacting with other agencies and organizations and capitalizing on the best resources possible;
- Establishing executive and legislative support to sustain the long term commitment necessary for environmental work;
- Working closely with the military, a major island landowner, particularly regarding land use activities and impacts resulting from significant increases in military presence;
- Capacity building facilitated through technical assistance, workshops, and training activities; and,
- Promoting public involvement and environmental education.

6.1 Interacting With Other Agencies and Organizations

6.1.1 *Taking the lead on maintaining the Watershed Planning Committee (WPC)*[69]

The committee meetings and all documents prepared by the WPC are open to the public. However, staffing and funding constraints have affected the Agency's capacity to staff and coordinate regular effective WPC meetings. Guam EPA continues to collaborate with WPC agency representatives on watershed issues and provides support to subject projects and activities as Guam EPA resources are available.

The WPC is made up of representatives from the following organizations and agencies:

(Mandatory)

Bureau of Statistics and Plans
Department of Agriculture
Department of Land Management
University of Guam Marine Lab
Department of Parks and Recreation
Port Authority of Guam
Department of Education
Department of Public Works
Guam Waterworks Authority
University of Guam Water and Environmental Research Institute
University of Guam College of Natural and Applied Sciences
Guam Environmental Protection Agency (Chair)

(Membership by Invitation)

U.S. Navy, U.S. Air Force, U.S. Coast Guard, U.S. Department of Agriculture, Natural Resources Conservation Service, U.S. Environmental Protection Agency, U.S. Department of Commerce, National Oceanic and Atmospheric Administration,

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[68] Protecting and Restoring Guam's Waters, (Guam EPA September 1999)
[69] Executive Order 2004-04.

National Park Service, U.S. Fish & Wildlife Service, Northern and Southern Guam Soil and Water Conservation Districts

Past projects accomplished with a high level of WPC involvement include:

- Publication of *Guam's Unified Watershed Assessment (1998)*, which included the delineation, categorization and prioritization of watersheds on Guam;
- Development of restoration strategies for the two highest priority watersheds identified in the Unified Watershed Assessment (2000);
- Initiation of implementation of restoration strategies in Guam's priority watersheds (2001);
- Completion of a watershed executive order to promote the watershed approach; and
- Review and comment on documents and work products relative to strategies for managing water resources on Guam.

6.1.2 *Participating in External Forums to Improve Water Resources Coordination*

One of Guam EPA's priorities is to improve coordination between the highly overlapping areas of freshwater and coral reef protection activities, coastal zone and watershed programs, and water quality regulatory actions. This requires working with partner agencies (e.g.; GWA, Division of Aquatic Wildlife Resources, Division of Forestry, University of Guam Marine Lab, WERI, and Bureau of Planning's CZMP). Through collaborative work there occurs frequent opportunities for sharing expertise, ideas and perspectives, and resources. Specific examples of collaborative work include:

- Scheduled meetings between Guam EPA and GWA to discuss drinking water and wastewater management efforts;
- Participation in program development meetings for WERI, the Guam Soil & Water Conservation Districts, and the local Coral Reef Initiative Task Force;
- Relative to the anticipated military build-up, participation in Civilian-Military Task Force meetings;
- Meeting with government of Guam and non-governmental organizations to discuss, promote and develop program implementation mechanisms, i.e. Hotel and Restaurant Association (Pesticide Regulations), Rotary Club (Environmental issues), legislative oversight committee, Bureau of Planning (watershed planning), etc.

6.2 Establishing Executive and/or Legislative Support

All inter-organizational projects need external acknowledgment and support to be effective on a long-term basis. Executive and legislative support is particularly valuable.

Executive Orders (E.O.) developed by Guam EPA include E.O. 2004-04 which restructured the Watershed Planning Committee and its goals and E.O. 2014-07 which renamed the Environmental Education Sub-Committee as the "Guam Nature Alliance".

Public laws can be viewed at http://www.guamlegislature.com.

6.3 Working Closely With the Military

6.3.1 Environmental Restoration Program

The Department of Defense (DoD) and State/Territorial Memorandum of Agreement (DSMOA) Program works closely with DoD on environmental restoration and clean-up work in Guam. The program was created by the Superfund Amendment and Reauthorization Act of 1986.

Under the DSMOA Program, Guam EPA has regulatory oversight of the Navy and Air Force environmental restoration efforts to ensure compliance with local and federal laws and regulations. DSMOA oversees the following DoD programs:

- **Base Realignment and Closure** (BRAC): A clean-up program to ensure the environmental suitability of properties for transfer to GovGuam.
- **Installation Restoration Program**: The main DoD environmental restoration program which covers on-base actions, such as the Orote landfill at COMNAVMAR and CB landfill clean-up at Finegayan.
- **Formerly Used Defense Sites (FUDS):** U.S. Army Corps of Engineers program to clean up military sites that are no longer owned by the U.S. Government.
- **Superfund:** A clean-up program under the federal government to clean up the nation's uncontrolled hazardous waste sites listed under the National Priorities List (NPL). Anderson Air Force Base is under the NPL and listed as a Superfund site.

Restoration Advisory Board

Under the Defense Environmental Restoration Program, the Department of Defense has been conducting environmental restoration activities at its Navy and Air Force facilities on Guam. These activities focus on reducing the impact of present and past contamination from military operations.

In 1995, the United States Air Force (USAF) established a Restoration Advisory Board (RAB) to inform the local community of cleanup activities. The RAB is comprised of community members, USAF officials and representatives from regulatory agencies. The USAF RAB continues to meet on a quarterly basis to discuss program progress and to advise the community on the status and plans for the various Installation Restoration Program (IRP) sites. Most Air Force restoration projects are on long-term remedial alternative status and more recent meetings address DoD prioritized sites under the Military Munitions Response Program (MMRP).

The Navy Area-Wide RAB members are from the community and other entities such as the Navy, USEPA, and Guam EPA. Membership is unlimited and members remain active

until they elect to resign. Meetings occur at least biannually, but meeting schedules are dictated by what projects are active, the status of these projects, decisions on cleanups, and/or the development of a sampling plan. RAB meetings are a platform in which the Navy can inform the community of the status of ongoing cleanup efforts. Such meetings provide an opportunity for participants to become familiar with the technical aspects of the cleanups, ask questions, and in turn the public may provide knowledge and expertise to the Navy.

Navy Environmental Restoration Program (ERP)

The purpose of the ERP is to determine if any past spills or releases of hazardous substances from Navy activities pose unsafe risks to human health and environment and to ascertain what type of cleanup is necessary for these sites. The ERP is divided into three sections:

- Installation Restoration (IR) – this program focuses on investigation and cleanup of hazardous substances at active Navy Bases;
- Munitions Response – this program concentrates on investigation cleanup of munitions, i.e., unexploded ordnances (UXO) and related compounds;
- BRAC – this program is similar to the IR and Munitions Response programs, but highlights sites that are BRACs transferred from the Navy to another entity.

6.4 Capacity building through technical assistance, workshops and training

Given Guam's small local population, limited expertise, and geographical isolation, capacity building (building our expertise) is critical. Various forums for capacity building are utilized including on-the-ground assistance, training, and workshops.

On-the-ground technical assistance is an important component of capacity building. It is one of the areas that occupy the majority of Agency time. Guam EPA assistance is intended to promote water management objectives consistent with both coastal zone and nonpoint source management measures. Examples include inspections of drinking water systems, septic tank/leaching field systems, and erosion and sediment control projects. All involve extensive interaction with and training and education of "customers" as to the environmental or public health aspects of the particular situation, and the regulatory/programmatic considerations.

The Agency also provides technical assistance to architects, engineers, the public and Government of Guam agencies during the design stage and plan review process of projects. During these phases, Guam EPA recommends and/or requires the best management practices and management measures suitable for the sites under evaluation. Non-regulatory groups, such as Bureau of Planning, NRCS, Conservation Districts, Extension Services, Division of Aquatic Wildlife Resources (DAWR), Division of Forestry, and WERI, are also engaged in capacity building, by promoting activities consistent with coastal zone management and nonpoint source pollution objectives in their work. Examples of a few of their relevant activities include:

- Environmental Quality Incentive Program (NRCS)
- Hosting Conservation Districts workshops
- Forest Stewardship programs (Division of Forestry)
- Publications of "Man, Land and Sea" (Bureau of Planning environmental newsletter)
- Education on appropriate use of fertilizers and pesticides through meetings with landscapers, 4-H programs, newspaper articles, and other forums (UOG - CALS)
- Educational presentations focusing on watersheds and marine conservation (DAWR, Guam EPA, WERI, Coast Zone Management Program, and NPS)

Workshops are also vitally important to local staff. They provide an option for training and for sharing expertise and ideas. With the shrinking economy, Guam EPA has increasingly looked to on-island workshops and on-line webcasts to fulfill this need.

6.5 Public Involvement and Environmental Education

The government of Guam is collectively responsible for the current and future state of water resources on Guam. Perhaps the most significant long term impact the government can make in protecting and restoring these resources is to involve the public in this objective, and to support environmental education. Guam EPA is actively involved in this area in the following ways:

- The Agency solicits public review and comment on various plans and regulations it develops. Such action is undertaken in accordance with the local administrative adjudication law and guidance from its Guam EPA Board of Directors;
- Guam EPA leads, supports and participates in annual Earth Week/Month events. Typical events include tours of its lab for Guam's school children; public static displays; the distribution of educational information via newspaper, magazine, television and radio; Guam Nature Alliance community events featuring land, ocean, and river site-specific events like tree planting, river tours and monitoring activities, snorkeling/related ocean safety talks, and beach clean-ups;
- Guam EPA actively participates in numerous Island clean-up activities, i.e. Annual Guam International Coastal Clean-up;
- When possible, the Agency subject matter experts provide presentations at schools, to real estate groups, legislators and mayors, to members of the local Chamber of Commerce and other business groups, etc.;
- Agency representatives participate in public forums or public hearings especially as they relate to environmental issues;
- Agency representatives participate in Guam nature Alliance (GNA) meetings.

7.0 Water Pollution Control Programs and Improved Water Quality

Guam EPA's water pollution control programs continue the mission to maintain and/or

improve surface water quality on island. During the reporting period, program efforts included:

- Permit compliance inspections as required.
- Continued enforcement and implementation of Guam's Soil Erosion and Sedimentation Control rules and regulations.
- Progress on watershed restoration activities via 1) Guam EPA collaboration with village mayors/partner government agencies to investigate water quality issues in nearby coastal waters and rivers/streams. 2) Efforts by partnering agencies and organizations to initiate and implement environmental awareness on Guam.
- Meeting the growing demand and challenges of permitting and enforcement under the Individual Wastewater Regulations, i.e. reviewing construction plans; inspecting completed and existing wastewater disposal systems; issuing occupancy permit clearances; initiating enforcement actions against illegally occupied buildings, etc.

7.1 Recommendations

7.1.1 *Watershed Planning Committee Support*

Guam EPA should maintain and support regular meetings of the WPC. CWA Section 319 funds should be budgeted to 1) sustain the WPC and to implement watershed planning and management processes 2) implement TMDL and watershed restoration projects which help waterbodies meet GWQS.

7.1.2. *Nonpoint Source (NPS) Pollution Monitoring*

The Water and EMAS Divisions should collaborate to complete the drafted strategy for a NPS Pollution Monitoring Plan. The Comprehensive Monitoring Strategy includes "Nonpoint Source Pollution Monitoring" as one of its ten monitoring programs. The goal of such assessment activity is to identify nonpoint source pollutants affecting water quality. In general, NPS Pollution Monitoring will involve:

a). Assessing water quality based on a variety of monitoring data contained in

- 305(b) and related plans
- permitting data
- enforcement records and existing GIS data
- Guam EPA quarterly reports
- available water quality reports
- compliance monitoring reports submitted to Guam EPA

b). Performing discrete sampling events for site specific activities, as well as sub-watershed areas encompassing several square miles, to evaluate stormwater runoff contaminants from a variety of land uses;

c). Evaluating nonpoint source Best Management Practices (BMPs) implementation to understand the most effective combination for reducing nonpoint source pollutants.

7.1.3 Develop enforceable regulations that implement the criteria contained in the *CNMI/Guam Stormwater Management Manual*

Guam EPA should complete the comprehensive review, approval, and adjudication process for modernized Erosion Control and Stormwater Management Regulations. When this is accomplished, the Manual and its accompanying regulations shall be the standard:

a) to protect the waters of Guam from the adverse impacts of urban stormwater runoff

b) to provide design guidance on the most effective best management practices (BMPs) for new development sites and redevelopment sites both during and post construction; and

c) to improve the quality of BMPs that are constructed in the CNMI and Guam, specifically in regard to their performance, longevity, safety, ease of maintenance, community acceptance and environmental benefit.

7.1.4 *Guam Nature Alliance*

The Agency should continue to support this active education committee which has implemented a diversity of creative and unique environmental awareness, outreach and information projects.

7.1.5 *Update Rules and Regulations to Support Compliance and Enforcement Action and Increase or Create Fees to Support Increasing Cost(s) of Service*

In order to strengthen enforcement and compliance action, Guam EPA should invest time and effort in revising and updating all its rules and regulations, incorporating reasonable fee schedules proportionate to the costs of services which the Agency provides and crafting respective legislation. Public education campaigns should be developed and implemented to build support from policy makers and other stakeholders and to educate the public in general.

C. Cost/Benefit Assessment

No report available.

D. Special State Concerns and Recommendations

Significant issues that affect Guam's Water Quality Programs include:

- *GWA Order for Preliminary Relief*
- *Consent Decree*
- *Military Buildup*

These key issues present increasing pressure on the Agency to oversee and/or undertake critical environmental regulatory and enforcement tasks. The Agency's dilemma becomes even more challenging because it is experiencing personnel losses due to (staff) retirement, and competition with other organizations offering improved employment. Lastly, the Agency is facing financial challenges in managing its resources in the wake of

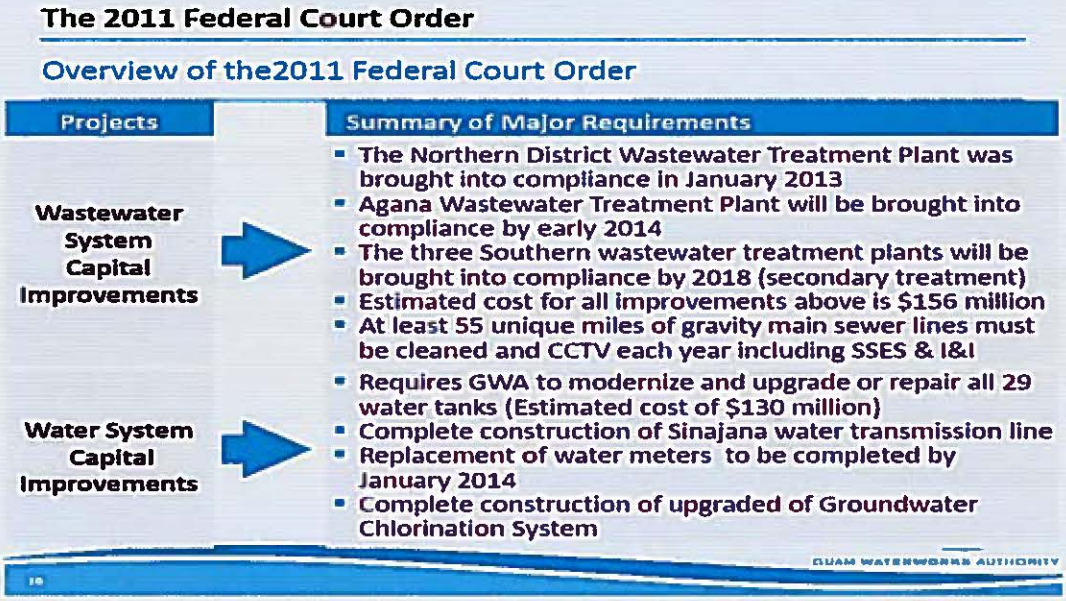
increasing employee costs, nation-wide competition for federal dollars, outdated fees for the cost of services Guam EPA provides, and the overall state of Guam's economy.

1.0 GWA Order for Preliminary Relief[70]

In fiscal year 2003 the of Government of Guam and the Guam Waterworks Authority (jointly "Defendants") and the United States of America ("Plaintiff) agreed and entered into a Stipulated Order for Preliminary Relief (Order) as the most appropriate way to require the immediate implementation of short-term projects and initial planning measures by the "Defendants" to begin to address issues of compliance at GWA's Publicly Owned Treatment Works and three public water systems. GWA and the Government of Guam were ordered to implement provisions under fourteen headings.

In October 2006, the parties, through their respective undersigned counsel, jointly requested the Court for stipulated changes in the Order.

An overview of the 2011 amended Federal Court Order is shown below.[71] GWA must complete significant CIP projects exceeding $375M between 2013 and 2021.



Guam Waterworks Authority Annual Report 2017 provides an update on the progress the Authority has made regarding the milestones contained in the 2011 Court Order.

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[70] http://guamwaterworks.org/compliance-and-safety/2011-court-order/
[71] http://guamwaterworks.org/documents/GWAInformationBriefing09172013v3Final.pdf

2.0 ORDOT CONSENT DECREE

On February 11, 2004, the Government of Guam (Guam Department of Public Works and Guam Environmental Protection Agency) entered into a Consent Decree (Civil Case No. 02-00022) with the United States of America (U.S. Environmental Protection Agency with the U.S. Department of Justice) in U.S. District Court, Territory of Guam. The Consent Decree is a settlement agreement to resolve issues related to the unauthorized discharge of pollutants from the Ordot Dump to the Lonfit River. The historical and continuing discharge of pollutants to the Lonfit River is a violation of the Clean Water Act (CWA).

The Consent Decree outlined a timeline that the Government of Guam agreed to follow in completing specific tasks to correct the violation. These tasks included financing the closure of Ordot Dump, and the siting, design and construction of a new Municipal Solid Waste Landfill Facility (MSWLF) that is fully compliant with Subtitle D of the federal Resource Conservation and Recovery Act (RCRA).

"...On March 17, 2008, Gershman, Brickner & Bratton, Inc. (GBB), solid waste management consultants, was appointed as Receiver by the District Court of Guam to achieve the government's compliance with the Clean Water Act as set forth in the Consent Decree."[72] An update to the status of the Consent Decree, the closing of the Ordot Dump and the opening of a new Guam municipal landfill can be found at the following link: **http://guamsolidwastereceiver.org/updates-done.shtml**

As of April 2019, the Court issued an order partially ending the receivership. It also authorized the Receiver to continue its work to complete the post-closure plan for the Ordot Dump.

3.0 Military Buildup on Guam[73]

The Department of the Navy released the Record of Decision (ROD) for relocating U.S. Marine Corps forces to Guam on August 29, 2015.

The Department of the Navy selected the preferred alternatives as described in the Final Supplemental Environmental Impact Statement (SEIS). This includes:

- Cantonment and family housing Alternative E with the USMC cantonment to be located at Navy Computer and Telecommunications Station – Guam (Finegayan), and family housing to be located at Andersen Air Force Base.
- Live Fire Training Range Complex (LFTRC) option selected was Alternative 5 to be located at Andersen Air Force Base – Northwest Field. The LFTRC also includes a stand-alone hand grenade range at Andersen South. This action will ensure consistency with the new force posture adopted by the Department of

[72] Excerpt from GBB web site overview. *http://guamsolidwastereceiver.org/courtorder.html*
[73] http://www.guambuildupeis.us/

Defense in accordance with the April 2012 Roadmap Adjustments' international agreement.

This ROD provides for a smaller force on Guam than originally was proposed in the 2010 Final EIS, while fulfilling U.S. national security interests in the Western Pacific. A copy of the ROD can be downloaded at http://guambuildupeis.us.

PART III. MARINE AND SURFACE WATER MONITORING AND ASSESSMENT

III. MARINE AND SURFACE WATER MONITORING AND ASSESSMENT

This section includes a description of Guam's monitoring program, a description of the assessment methodology for determining a marine or fresh surface water's appropriate "Reporting Category", assessment results for the reporting period, a description of the island's wetlands program, and information on public health issues.

A. Monitoring Program "2006 Comprehensive Monitoring Strategy"

1.0 Monitoring Program Strategy

The United States federal and Guam environmental legislation and regulations all apply in Guam. The Guam Water Pollution Control Act (10 GCA, Chapter 47) mirrors many of the same concerns and requirements of the Federal Water Pollution Control Act. In addition, the Guam Environmental Protection Agency Act (10 GCA, Chapter 45) created the Guam EPA and its Board of Directors in 1973.

There are Guam legal requirements for the classification of waters, establishing standards of water quality, permitting discharging facilities, and public information functions. An additional Guam law, the Water Resources Conservation Act (10 GCA, Chapter 46), requires identification of Guam's significant water resources and the necessary planning, regulation and management of these resources for their protection, conservation and rational development.

The Guam Water Monitoring Strategy (GWMS) was originally implemented in 1978, with the first major adopted revision occurring in 1983.[1] This monitoring strategy is currently directed at the systematic collection of physical and chemical data from fixed locations. The sampling frequencies are maintained at sufficient intervals to assess the various land-use impacts on water quality.

Guam EPA and the Department of Agriculture, DAWR are the main agencies engaged in local marine and fresh surface water monitoring. Other related water monitoring, research, and assessment activities are conducted in Guam by (but not limited to) the University of Guam (UOG) Water and Environmental Research Institute (WERI), the

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[1] Provisions for biological monitoring were incorporated into the GWMS, but resource limitations hindered the implementation of this program. Reinstatement of the biological program occurred during fiscal year 1998, however river/stream monitoring was suspended (since 1998), and no biological data was gathered for physical and chemical parameters for seven years (1999-2005). The only portion of the GWMS that has been continuously performed is the Recreational Beach Monitoring. The GWMS underwent a major strategy and implementation revision during fiscal years 2002-2004. The new **Comprehensive Monitoring Strategy** (CMS) was submitted to EPA late in 2005 and initiated that fiscal year. It was presented for the first time in this section of the 2006 Integrated Report.

National Oceanic and Atmospheric Administration (NOAA), the National Park Service (NPS), and Guam Waterworks Authority (GWA).

2.0 Monitoring Goals and Objectives

The CMS was designed to compare the GWQS to the prevailing conditions within Guam waters. This is done to insure that the quality of the waters of Guam remains high or improves. Community planners use this data to assess if current water quality is suitable for their intended uses. The data is also analyzed for trends in water quality to identify possible sources of pollution and to assess the effectiveness of present treatment practices.

As previously discussed, Guam is divided into two distinct regions, north and south. Differing geological and hydrologic features create that distinction. The Surface Water Monitoring Strategy (SWMS) outlined in the overall CMS, focuses on the southern region of Guam where the majority of all surface water features exist.

To meet all federal and local reporting requirements the CMS includes ten distinct individual monitoring plans. The programs developed for each of these plans are:

1. Status and Trends Monitoring Program
2. Guam Environmental Monitoring and Assessment Program
3. Recreational Beach Monitoring Program
4. Wetlands Monitoring Program
5. Fish and Shellfish Consumption Monitoring Program
6. Groundwater Assessment Monitoring Program
7. Marine Preserve Water Quality Assessment Program
8. Nonpoint Source Pollution Monitoring Program
9. Underground Injection Control Monitoring Program
10. Man-Made Impoundments Monitoring Program

3.0 Monitoring Design

The CMS relies on a variety of approaches in conducting its monitoring and assessments. The most common approach is to measure the chemical and physical constituents in the water itself. The concentrations of these constituents are then compared to appropriate standards to determine if the designated uses of the waterbody are supported. Sampling will also be extended under the CWS to include sediment and biological tissue (macro-invertebrate and fish). While water sampling provides a

snapshot of conditions at the time of sample collection, sediment and tissue results provide a view of conditions over a somewhat longer time period.

3.1 Status and Trends Monitoring Program (STMP)

The *Status and Trends Monitoring Program* (STMP) is the current version of the original "Guam Water Monitoring Strategy". The GWMS was the Agency's primary water quality monitoring program for the island (which was) approved by EPA in 1983. It has been internally revised several times over the years.

The STMP incorporates the original GWMS monitoring stations (58 core stations) plus additional judgmental stations (this number varies based on the targeted watersheds) to increase spatial coverage. The sampling frequency has been standardized via a rotating basin design which is the only major change to the original program.

Two Guam water classification types are assessed: *Surface Waters*, which are rivers and streams, with salinity less than 0.5 ppt, and *Marine Waters*, which are defined as coastal waters with salinity greater than 0.5 ppt. These water classifications are further subdivided into specific geographic complexes or reporting units, based on major river drainage basins/watersheds, including associated coastal receiving waters. Northern, Central, and Southern STMP stations are mapped in the following pages (**Figures 22a-22c**). STMP stations are listed by watershed location in **Appendix B: Table B1**.

The design of the STMP is based on a judgmental sampling design within a "Rotating Basin" concept. Four to six watersheds are sampled semi-annually, once every eight years. The sampling frequency is six samples per station per index period, resulting in a total of twelve monitoring samples per calendar year for each watershed. Watersheds are then rotated through an eight year cycle.

The first index period on Guam is a dry season which occurs from January through June. The second index period is the island's wet season which occurs from July through December. The watershed monitoring schedule below correlates with the watershed locations illustrated in **Figure 23.**

Table 10. Status and Trends Monitoring Program: 8-Year Monitoring Schedule*

Sample Year	Watershed	# of Stations
2009	Ugum/Apra	58 Core + 14 (72)
2010	Hagatna/Fonte/Piti-Asan/ Taelayag	+ 20 (78)
2011	Pago/Cetti	+ 18 (76)
2012	Tumon/Yigo /Toguan	+ 7 (65)
2013	Agat/Inarajan/Dandan/Asalonso	+ 18 (76)
2014	Northern/Umatac	+ 15 (73)
2015	Togcha/Talofofo	+ 28 (86)
2016	Geus/Manell/Ylig	+ 17 (75)

* Implementation of any scheduled or future monitoring is subject to funding availability.

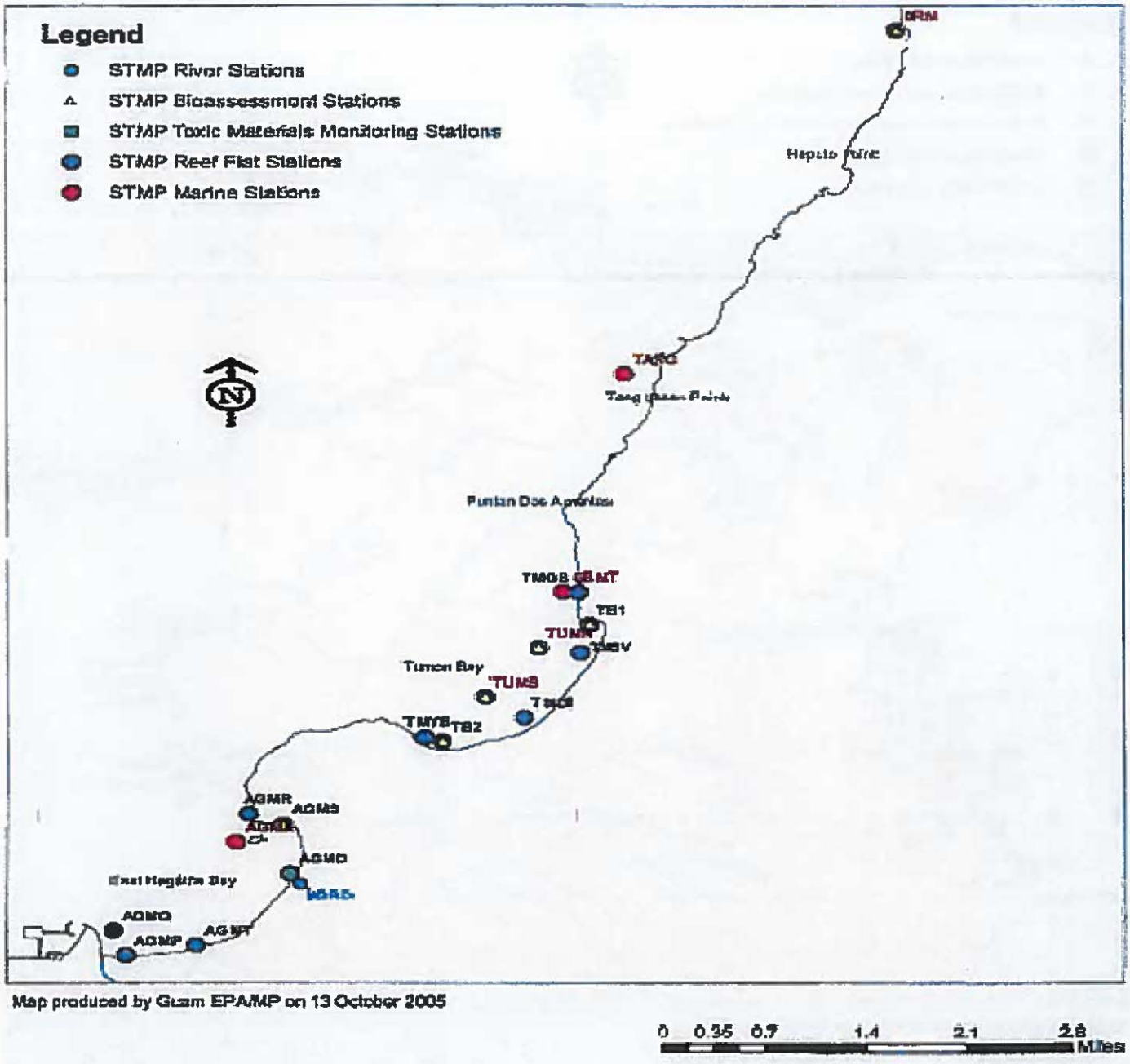

FIGURE 22a. Northern Guam: Status and Trends Monitoring Program (STMP) Stations Map

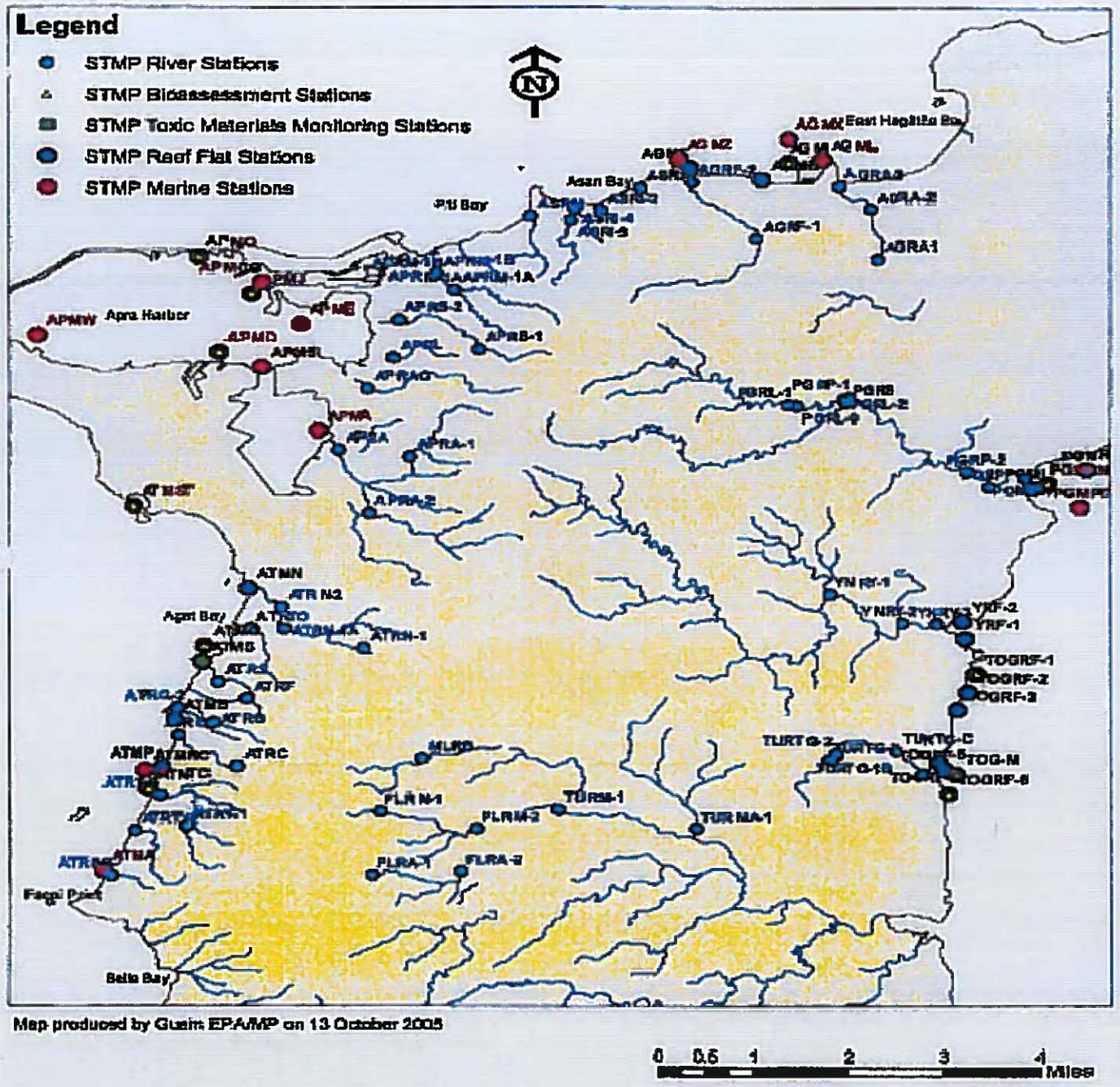

FIGURE 22b. Central Guam: Status and Trends Monitoring Program (STMP) Stations Map

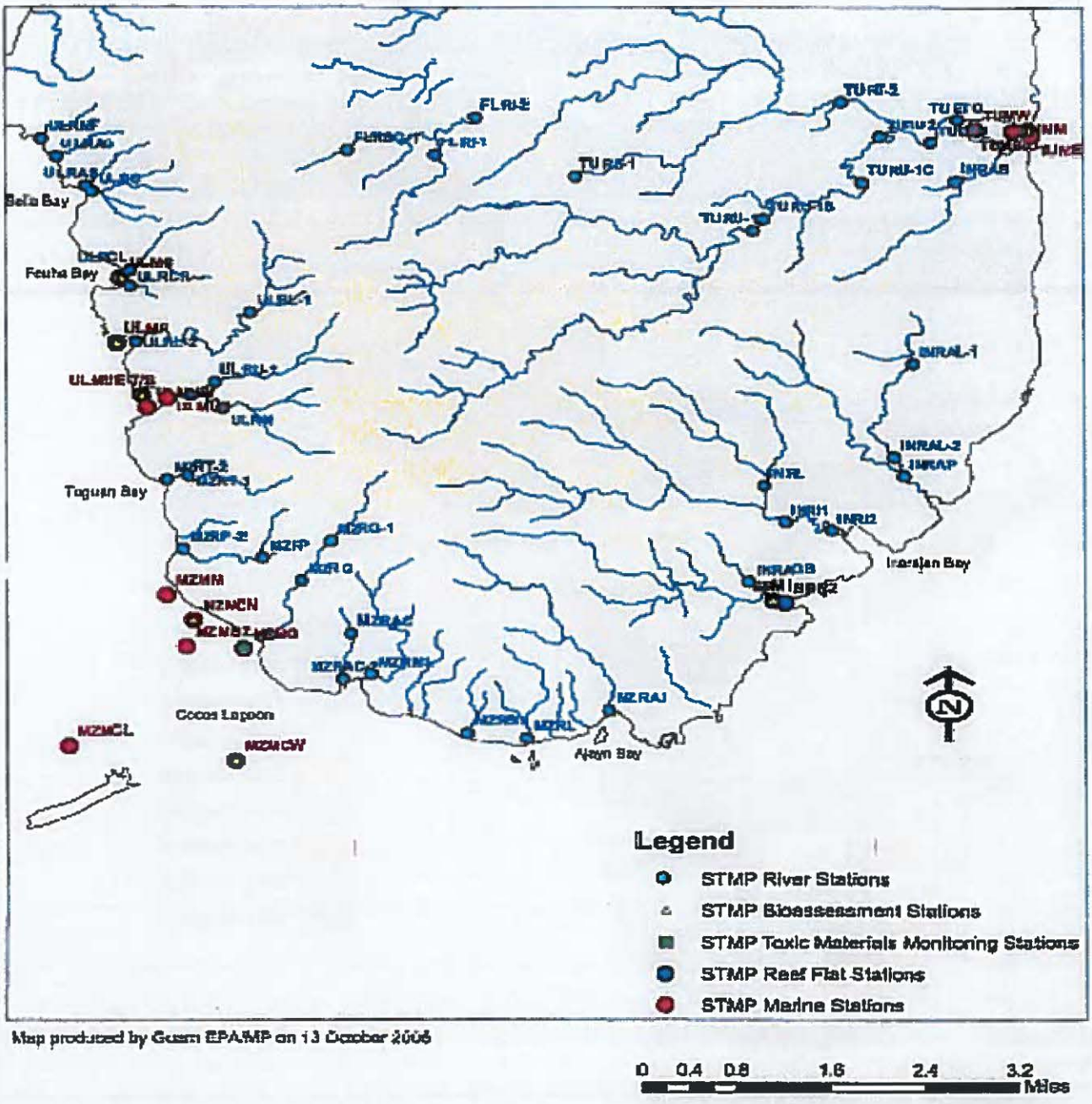

FIGURE 22c. Southern Guam: Status and Trends Monitoring Program (STMP) Stations Map

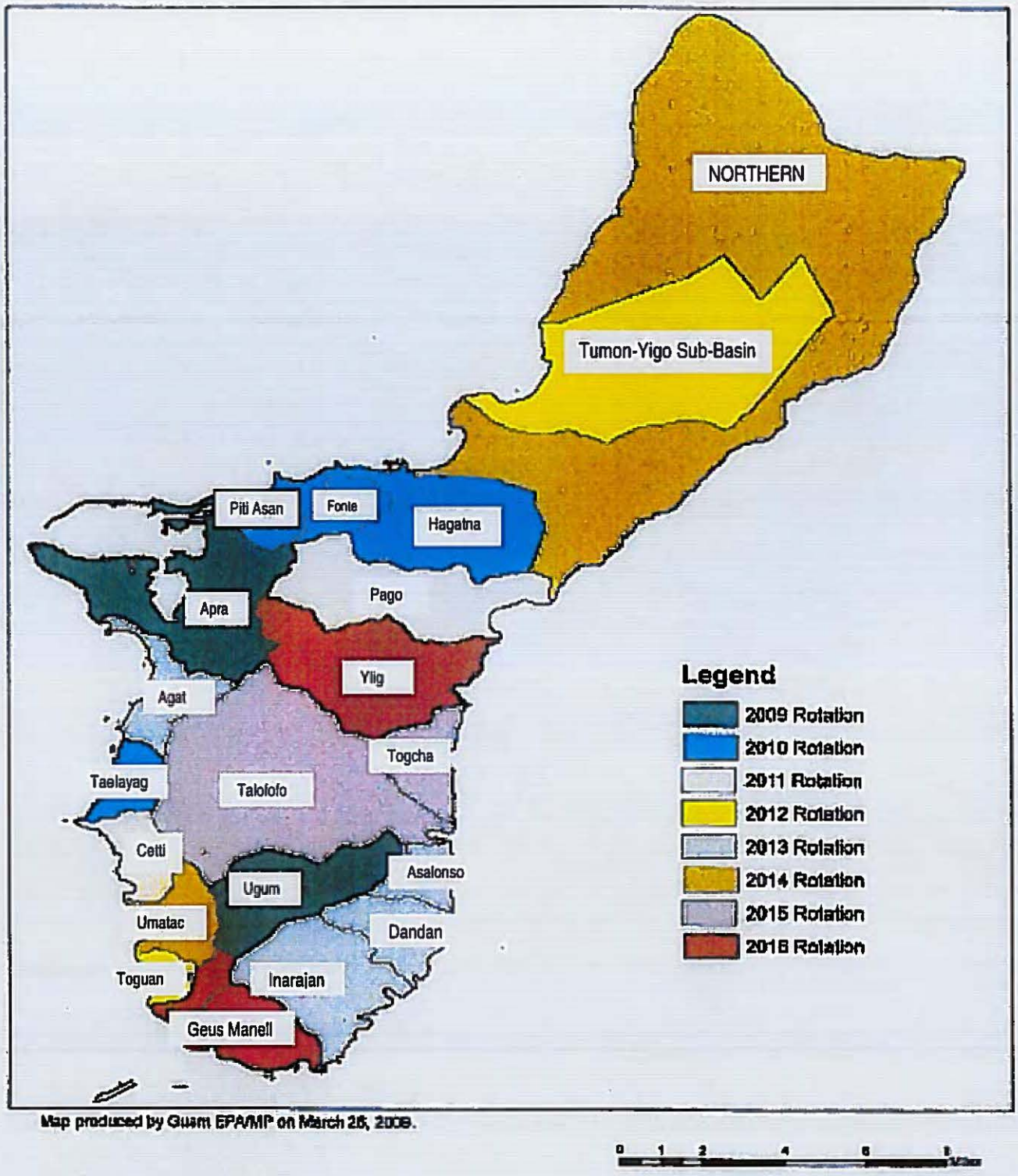

FIGURE 23. Guam EPA Status and Trends Program Rotating Watershed Schedule

3.1.1 *STMP Goals/Objectives*

The overall goal of the STMP is to provide the Guam EPA with baseline water quality data to characterize and define trends in the biological, chemical, and physical conditions of the waters of Guam. It is designed to identify new or existing water quality problems and to act as a triggering mechanism for focused studies, investigations, inspections and enforcement, or other appropriate actions by the Agency.

The specific objectives of the STMP are to:

1) Identify, document and predict the conditions of Guam's water resources.
2) Assist in determining the status of an ecosystem's "environmental health".
3) Establish the water quality of aquatic reference sites for comparison with affected surface water, groundwater, and ecosystems.
4) Document potential problem areas.
5) Identify water quality changes over time in pertinent waterbodies.
6) Provide information to managers, legislators, agencies and the public.

To meet its environmental goals and objectives, the STMP integrates a combination of biological, chemical, physical, and toxic parameter indicators to monitor and assess site specific water quality conditions, along with island-wide long term water quality trends. Applicable parameters for the STMP are provided in **Appendix C**, Tables C1- C3.

Designated uses assigned to STMP watershed monitoring stations are determined by each station's water classification, i.e. M-1, S-3, M-3, etc. (Refer to **Table 13.**)

Some confirmed and possible sources of pollution in watersheds are development (increases in impervious cover), construction (anthropogenic disturbances), erosion, non-point (run-off) and point source (sewage) pollution, increases in feral animal and wildlife populations, agriculture-use, aquaculture-use, and physical disturbances to riparian vegetation and sandy and rocky coasts.

3.2 Guam Environmental Monitoring and Assessment Program (GEMAP)

The *Guam Environmental Monitoring and Assessment Program* (GEMAP), or the island-wide probability-based assessment, will be the primary monitoring tool for assessing and describing the general water quality for Guam. The program is designed to assess and determine to what extent the waters of Guam meet CWA goals and assigned designated use classifications and water quality standards. The assessment data is then compiled and reported as a portion of Guam's biennial CWA Section 305(b) Report to Congress.

By randomly sampling surface and marine water resources, Guam EPA can assume that all segments of the resource have equal probability of being sampled and therefore, "the sample set is an adequate measure of the resource in that reporting unit". The

advantage of random sampling is that unbiased answers to questions can be presented with known statistical confidence.

Guam EPA will be conducting probabilistic monitoring in Surface Water and Marine Water, but with specific limitations. The surface waters will be further characterized as all "wadeable" rivers and streams having salinity less than 0.5 ppt and monitored under the Guam **Wadeable Stream Assessment** program. The marine waters will be described as all coastal waters from the mean low water mark to a depth of 60 feet, with a depth exemption for Apra Harbor, and having salinity greater than 0.5 ppt. These marine waters will be monitored under the **Guam Coastal Assessment** program.

The sampling frequency for each resource type will be rotated every other year to achieve complete coverage of the island during the CWA Section 305(b) reporting cycle.[2] **Refer to Table 11.**

Table 11. GEMAP: 10-year Monitoring Schedule

Sample Year	Resource Type	# of Stations
2005	Marine Waters*	50
2006	Surface Waters*	38 (+ 10 repeats)
2010	Marine Waters	50 (10% 2005 repeats)
2011	Surface Waters	50 (10% repeats)
2012	Marine Waters	50 (10% repeats)
2013	Surface Waters	50 (10% repeats)
2014	Marine Waters	50 (10% repeats)
2015	Surface Waters	50 (10% repeats)
2016	Marine Waters	50 (10% repeats)
2017	Surface Waters	50 (10% repeats)

* EMAP Pilot Projects

The GEMAP is based on U.S. EPA's EMAP program that advocates a survey sampling design using "Geographic Information System (GIS) technology to probabilistically generate sampling locations". GEMAP utilizes this same probabilistic, stratified-random sampling design; therefore each resource type has a specific sampling design. Initially Guam EPA will receive 50 randomly chosen monitoring sites from EPA-ORD for both resource types. In each succeeding assessment year, GEPA will receive 45 new stations and repeat 5 previous stations (10%) for program Quality Assurance/Quality Control. See the following pages for **Figures 24. (Wadeable streams assessment stations)** and **25. (Coastal assessment stations)** EMAP Stations are listed in **Tables B2. and B3., Appendix B.**

[2] The implementation of the Monitoring Schedule proposed in Table 11. (Particularly for *Sample Years* 2011 and forward) is dependent on EMAP funding availability and the "national EMAP focus".

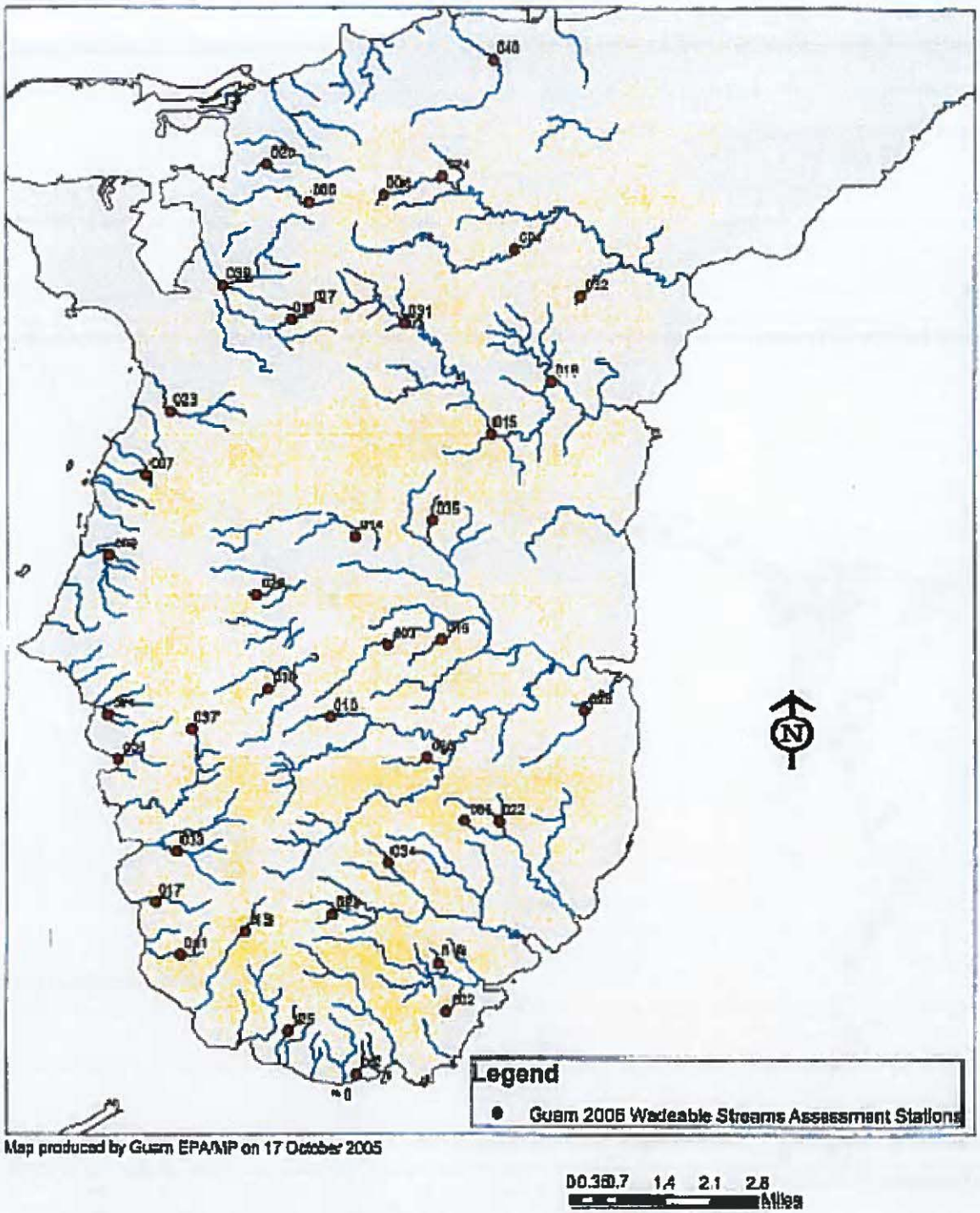

FIGURE 24. First Year Guam WSA Stations

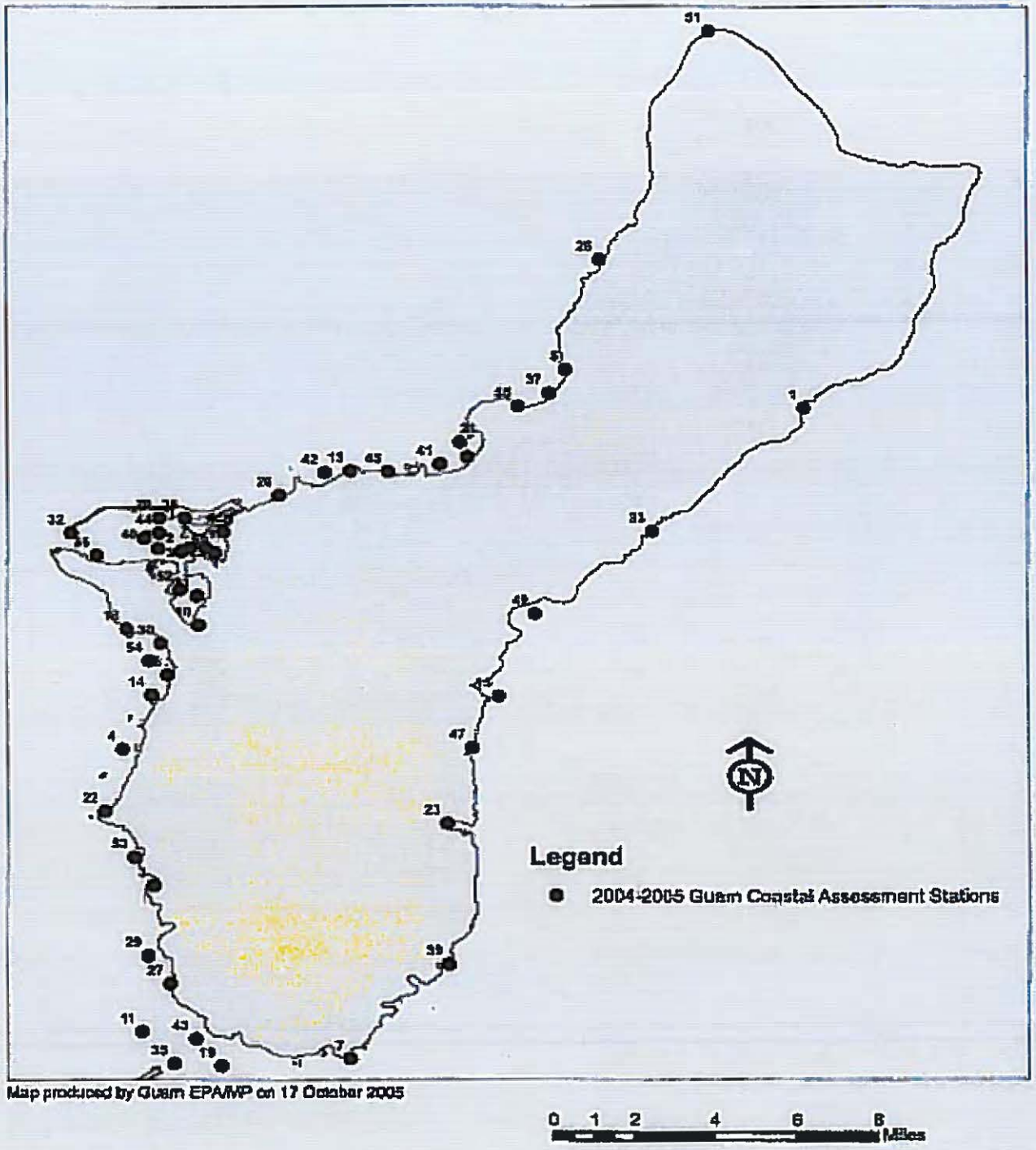

FIGURE 25. First Year Guam Coastal Assessment Stations

The sampling design criterion for Marine Waters is all waters from the mean low water mark to the 60 foot depth contour. The exemption to this criterion is Apra Harbor, a special study area for Guam. Within Apra Harbor, a modified sampling procedure will be utilized to allow sampling only for water column and sediment chemistry at depths greater than 60 feet. The marine waters assessment will be conducted during the Island's wet season, July through December, in even numbered years.

The Surface Water assessment criteria will be based on the wadeable perennial stream channel of each river or stream. A center location will be plotted and a total reach length of 150 meters will be delineated. The assessment will be conducted during the Island's dry season, January through June, in odd numbered years.

All methods for sample collection, handling and processing will follow documented EPA standard operating procedures. The Agency will coordinate the data collection and management while adhering to all QA/QC procedures throughout each step of the project.

3.2.1 *GEMAP Goals*

The goals of GEMAP are:

1) To assess the physical, biological, and chemical condition of Guam's Surface and Marine waters using standardized methods and a suite of environmental indicators;
2) To rank the relative importance of various stressors on the affected resource types;
3) To develop the Surface and Marine EMAP locally; and in the future, to assess island surface and marine water quality throughout the Marianas;
4) To build partnerships among implementing agencies for more effective future monitoring and assessment.

Data analysis and interpretation will be a joint effort between personnel from Guam EPA and EPA EMAP to facilitate capacity building within the Agency.

3.2.2 *Guam Wadeable Stream Assessment (GWSA)*

The Surface Water EPA EMAP protocols were originally designed for temperate eco-regions and biota, and not a tropical island environment like Guam's. There is no current designated eco-region for Guam or for the Western Pacific. During the first year of the GWSA, Guam EPA will conduct a demonstration project to adapt the temperate assessment protocols and indicators to those more appropriate to Guam. Once these adapted protocols are established (for Guam), they can be exported for use in the state of Hawaii, the remaining U.S. Pacific Flag Islands (American Samoa and the Commonwealth of the Northern Marianas), the Federated States of Micronesia, and the island nation of Palau. This project would also be an opportunity for EPA to establish protocols and collect valuable data to help establish an eco-region for tropical islands in

the Western Pacific.

Guam's 97 rivers and streams, totaling 228.65 miles, are located throughout the island's 19 central and southern watersheds. **(Figure 24.)**
The following is a general list of GEMAP Indicators. See **Appendix C.** for specific GCA and GWSA parameters.

- general water chemistry
- EMAP physical habitat parameters/ stream discharge measurements
- periphyton community structure and abundance, biomass, chlorophyll
- fish community structure and abundance
- macroinvertebrate community structure and abundance
- fish tissue chemistry/contaminants
- rapid habitat and visual stream assessments

3.2.3 *Guam Coastal Assessment (GCA)*

The GCA is based on procedures and methods adapted from the 2001 State of Hawaii EMAP (HEMAP) documents and the 2001 EPA National Coastal Assessment (NCA). Following the HEMAP and the NCA plans ensure that the GEMAP will be consistent with national EMAP activities while taking into account reviewed and approved modifications for island environments. The environmental parameters to be assessed are a subset of those recommended by the NCA program. They are outlined below and explained in the Guam Coastal EMAP QAPP 2003.

Major modifications to the parameter list are: the substitution of the traditional fish trawls (which are very destructive to coral reef communities) with visual census protocols in conjunction with reef and pelagic fish standing stock coefficients; the substitution of a species of sea cucumber or crab for the collection of fishes, for tissue analysis and as gross pathology analyses and tissue contaminant analyses. Another unique assessment included in the GCA, is the benthic habitat and community assessment for macroinvertebrates, marine algae and benthic infauna, which was adapted from the HEMAP.

The GCA parameters that are similar to the NCA are the water column nutrient, sediment and tissue chemistry, and the identification of soft bottom community organisms. Parameters that were added include fish biomass estimates, storm wave impact estimates, percent cover of macroalgae, and water column analyses of bacteria. An additional parameter under consideration for future monitoring is coral disease identification. See **Figure 25**; also **Table B2, Appendix B; and Appendix C.)**

3.3 Recreational Beach Monitoring Program (RBMP)

Guam's subtropical climate allows for year-round recreation at all beaches, and fishing from both along the shoreline and offshore. The majority of this type of recreational activity occurs along stretches of sandy beaches or limestone plateaus easily accessible

from shore. These waters are classified as "M-2 waters" or "Good" under the GWQS.

10 Guam Code Annotated (GCA) Chapter 47 – Water Pollution Control mandates the monitoring of Guam's recreational beaches in order to protect public health from the adverse effects of swimming in polluted waters. Prior to 1993, RBMP primarily used the *fecal coliform* indicator and associated standard to determine the microbiological water quality of Guam's recreational beaches. Based upon the recommendation of US EPA in 1986 to adopt the *enterococci* standard, the Water Resources Research Center at the University of Hawaii in conjunction with Guam EPA (in an agreement with US EPA) produced a study to assess the applicability of the new *enterococci* standard for Guam. Researchers at the University of Hawaii determined that it was "feasible for Guam to accept the new US EPA marine recreational water quality standard of 35 *enterococci*/100mL using 5 sample per month geometric mean" (R. Fujioka. Applicability of New Marine Recreational Water Quality Standards in Guam", prepared for US EPA. August 1996). In addition, staff of the RBMP conducted separate analyses of compiled bacteriological data and also determined that Guam's *enterococci* concentrations and subsequent number of violations are consistent with the concentrations and number of violations reported using the *fecal coliform* indicator ($p>0.10$).

In 2018, Guam EPA adopted the 2012 RWQC recommendations for using Enterococci and Escherichia coli criteria to protect human health in all coastal and non-coastal waters designated for primary contact recreation use.

To monitor and test for the designated use "Whole Body/Primary Contact", weekly water grab samples are collected and tested for the approved human health enterococci or *Escherichia coli* (E. coli) bacterial indicator.

Guam EPA uses the national standards of (enterococci) 35 CFU/100mL and STV of 130 CFU/100mL or (E. coli) 126 CFU/100mL and STV of 410 CFU/100mL. For both indicators, the standards represent the geometric mean of samples taken in any thirty day interval and STV should not be exceeded by more than 10 percent of the samples taken in the same thirty day interval.

The designated use "Whole-body contact/primary contact" means the use of marine and surface water for swimming or other recreational activity that causes the human body to come into direct contact with the water to the point of complete submergence. It is likely that ingestion of the water will occur under this designated use, and sensitive body organs, such as the eyes, ears, or nose may be exposed to direct contact with water. "Whole-body contact/primary contact" designated uses include, but are not limited to swimming, wading, water-skiing, skin and scuba diving, surfing, motorized water sport activities, and fishing.

The designated use "Limited-body contact/secondary contact" means the recreational use of marine and surface water causes the human body to come into direct contact with the water, but normally not to the point of complete submergence, i.e. wading or boating. It is not likely that ingestion of water will occur under this designated use, and sensitive body organs such as the eyes, ears, or nose will not normally be exposed to direct contact with the water.

Bacteriological data has been collected by Guam EPA under the Recreational Beach Monitoring Program (RBMP) for over 20 years. The number and the location of stations have varied over these years. As a result of the newly enacted *Beach Act* grant requirements, a new inventory of Guam's beaches was conducted. The original beach inventory yielded a total of 115 beaches. In reviewing this inventory for inclusion in the IR, several monitoring stations were found to represent the same beach. The revised list of beaches for Guam consists of 102 beaches which are prioritized into three tiers, using the following criteria.

Tier 1 Beaches: Beaches that are easily accessible, highly visited, characterized by a high number of possible pollution sources, and require frequent monitoring.
Tier 2 Beaches: Beaches with restricted accessibility, beaches that are less frequented, beaches characterized by a few pollution sources that do not require constant monitoring.
Tier 3 Beaches: Beaches classified as remote and/or very inaccessible, beaches that are rarely visited and not usually monitored.

Of the 102 beaches, sixty-six (66) are classified as Tier 1 with the remaining thirty-six (36) classified as Tier 3. During the ranking procedure several beaches were technically classified as Tier 2. However, these particular beaches were reclassified as Tier 1 because of their accessibility (by samplers) and their inclusion would not be detrimental to the program.

All Tier 1 beaches are located in waters classified in the GWQS as Good/M-2 (Whole Body Contact), with the exception of two beaches (Outhouse Beach/N18 and Port Authority Beach/N-20) located in Fair/M-3 (Limited Body Contact) waters. Excellent/M-1 (Whole Body Contact) waters are located along the northern coasts of the island which are mostly inaccessible to the public. These coasts are either under military or private control, access is physically barred by the environment, or no public beaches are located within these waters.

In 2005, four new monitoring stations were added to bring the official total to 43. On May 19, 2005, station S1-Rizal Beach was officially dropped from the monitoring list because access was restricted. Two new monitoring stations in West Hagatna Beach, N-27 and N-28, were added in 2013. Monitoring station N-12 was suspended during the

reporting period as its location in the nearby boat marina is a "no swimming" zone. The current number of active monitoring stations under the RBMP is forty-three (43)[3]. The number of beaches assessed by these 43 stations is thirty one (31). See Appendix A, Table 10.

Data collected weekly from fixed sampling sites along selected stretches of coastline is used to advise the public against swimming in waters exceeding bacterial standards. Weekly press releases identify those beaches (where indicators in weekly water samples exceed water quality standards). All advisories are released and/or reported weekly, prior to the weekend, via print, radio, and television media to local government agencies, private individuals, and finally posted on the Guam EPA web site. *[Advisory information can be located on-line at: http://epa.guam.gov/beach-report/]*

Trend analysis (using the weekly data) is used to characterize risks of exposure to contaminated waters. Resulting trends allow for the ranking of beaches which enable biologists to determine the need for further monitoring or the need to include additional unmonitored beaches to the list.

RBMP personnel conduct annual reviews of all prioritized and monitored beaches to ascertain their continued inclusion in the original RBMP tier. All reprioritization information is forwarded to EPA's Beach Watch Program during the annual Beach Survey period.

The annual prioritizing criteria are:

- proximity to potential pollution sources
- intensity of use by the public
- ease of accessibility by the public
- public input
- best professional judgment of Guam EPA staff

Thursdays are targeted days for sampling to allow for laboratory analysis and re-sampling if required. Samples are collected in the morning hours to obtain microbial concentrations prior to prolonged exposure to sunlight. This allows a more conservative approach to public health protection.

3.4 Wetlands Monitoring Program (WMP)[4]

Guam EPA recognizes the importance of monitoring the overall health of wetlands and has proposed a Wetlands Monitoring Program in its comprehensive monitoring strategy. Wetland characteristics which should be assessed and documented include wetland delineation and mapping, hydrologic regimes, water quality, and biological

[3] See Appendix A, Figure A.1. 2018-2019 IR Stations, page 33.
[4] Suspended pending implementation of future wetlands EMAP.

integrity. While water quality physical and chemical parameters for wetlands exist, the Agency has yet to adopt wetland criteria, a method for wetland biological assessment, and identify a funding source to support a sustainable Wetlands Monitoring Program.

In the meantime, Guam relies on partnering organizations, such as WERI, and/or private companies for wetlands monitoring information. WERI provides water and environmental resources information by conducting basic and applied research in an interdisciplinary environment, training students, and disseminating research results.

For more information about WERI wetland projects visit www.weri.uog.edu.

3.5 Fish and Shellfish Contaminant Monitoring Program (FSCMP)[5]

The Guam EPA proposes the conduct of fish and shellfish tissue monitoring to assess tissue quality for consumption and to determine the need for consumption advisories. The tissue monitoring effort will involve the collection of fish and shellfish tissue samples from recreational, commercial (including imported fish and shellfish), and subsistence fish and shellfish harvesting sites (inland and along Guam's coast) for analyses of priority pollutants.

The contaminant levels in fish will be monitored via a cooperative program among government of Guam agencies including Guam EPA, the Department of Agriculture/DAWR and the Guam Department of Public Health & Social Services (DPHSS). Guam EPA will collect and analyze the samples, DAWR will determine appropriate species for sampling and sampling locations, and DPHSS will issue advisories needed as determined by the sampling effort.

3.5.1 *FSCMP Objectives*

The objectives of the *Guam Fish and Shellfish Contaminant Monitoring Program* (FSCMP), based on the EPA National 3-tier Guidance, are:

- To investigate and detect the presence and build-up of toxic and potentially hazardous substances in fish and shellfish, encompassing both fish toxicity and public health implications.
- To determine the impact of fish contaminants upon the suitability of aquatic environments for supporting abundant, useful, and diverse communities of fish life in coastal areas of Guam.
- To aid in the location of sources of toxic material discharges and evaluate long-term effects of source controls and land use changes.

Either of two standards will be used in the analysis of whole fish data:

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[5] Suspended pending inclusion to future EMAP efforts.

1) Risk-based criteria adopted by the FSCMP; or
2) Recommended screening values (SVs) for certain target analytes for recreational and subsistence fishers (EPA 823-B-00-007, November 2000).

Guam will also use these standards in the issuing of sport fish consumption advisories.

The partial parameter list for the FSCMP is:

- Dieldrin
- SDDT and Analogs
- Aldrin
- Endrin
- Methoxychlor
- Heptachlor
- Heptachlor Epoxide
- Lindane
- Benzene Hexachloride (BHC)
- Toxaphane
- Mirex
- Hexachlorobenzene (HCB)
- Polychlorinated Biphenyls,
- Chlordane
- Mercury

Whole fish data will be used primarily for detecting trends and new contaminants not routinely analyzed. As new contaminants are identified and trends in the concentration of routine contaminants are defined, the program shall adjust its sampling to meet these changes.

3.5.2 *FSCMP Network Design and Rationale*

The design and rationale for this program have yet to be developed; but should follow the EPA national guidance for fish and shellfish consumption advisories. Projected monitoring sites and species will be based upon the fishing areas designated by the DAWR Inshore Creel Survey. These monthly surveys collect data on the fish species, quantity, and method-of-capture by local fishermen island-wide.

3.6 Marine Preserve Water Quality Assessment Program (MPWQAP)

On May 16, 1997, Public Law 24-21 was implemented creating five (5) marine preserves and making changes to Guam's fishing regulations. The names of the preserves are the Pati Point Preserve, the Tumon Bay Preserve, the Piti Bomb Holes Preserve, the Sasa Bay Preserve, and the Achang Reef Flat Preserve. **(Figure 26)**

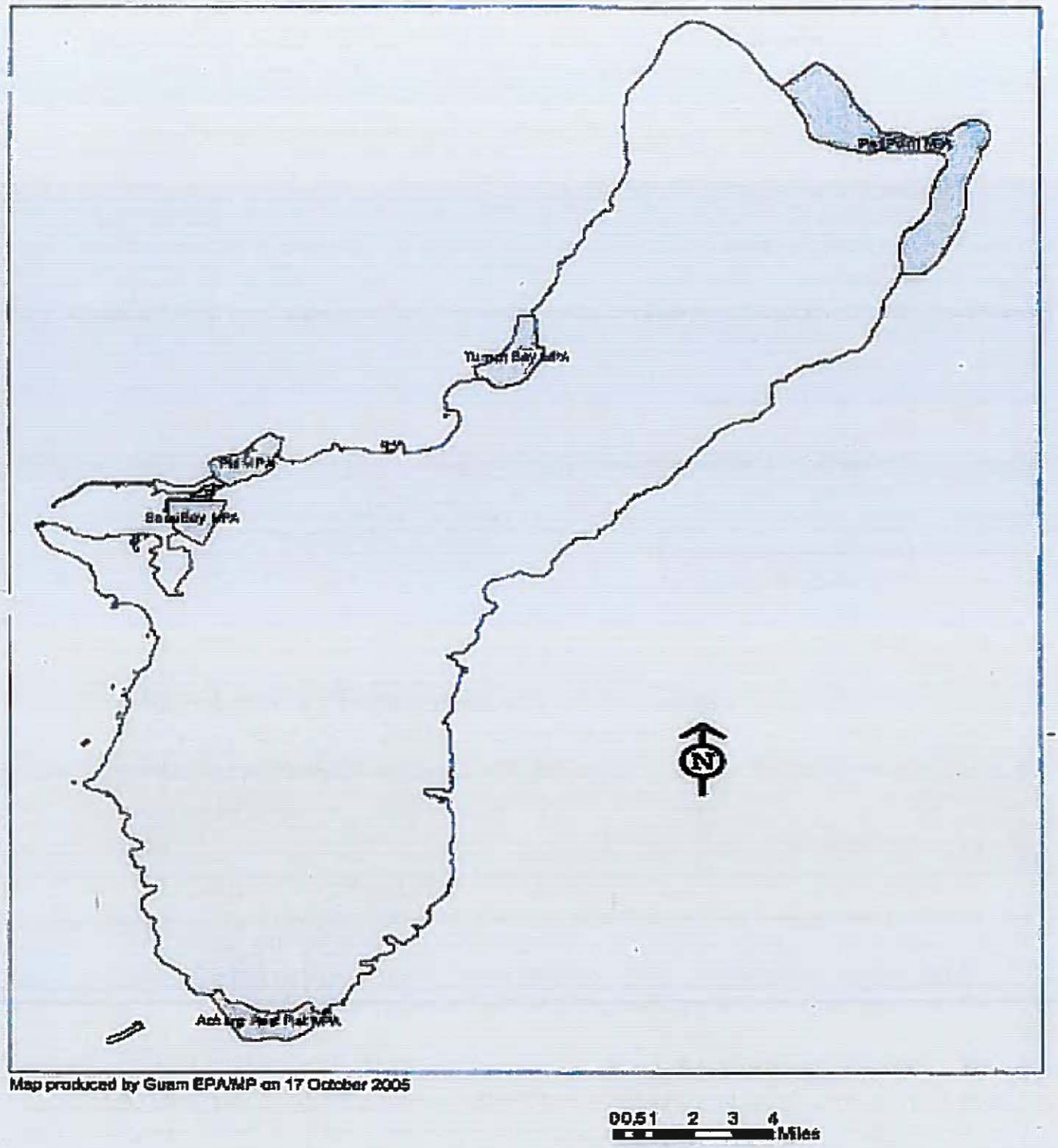

FIGURE 26. Water Quality Monitoring Stations at Marine Protected Areas (MPA)

With the enactment of P.L. 24-21, DAWR was required to monitor if observable increases in food fish density and diversity within the established marine preserves could be seen versus non-preserve (control sites) areas. The three "control sites" are Asan Fore Reef slope, Cocos Fore Reef and Lagoon and Pago Bay. A special sub-study area within the Piti Bomb Holes, the Piti Underwater Observatory, began in January 2001.

The fish survey methods include "Strip Transect", Visual Timed-Swim Surveys" and "Video Transect Techniques." Transects are situated on reef flats by habitats (sandy bottom, seagrass beds, and coral/rubble fields) and on the fore reef slopes by depth (-20, -30, -40, and -50 foot contours). All data collection and analyses are conducted and completed by the DAWR.

Biologists at DAWR who monitor the preserves found that food fish density and diversity within the five established marine preserves has dramatically increased over those in the non-preserve areas. It was also identified that there was a lack of water quality data for all marine preserves. To address this data gap, DAWR coordinates with Guam EPA to assist with the collection of water quality data at all fish survey transect sites within the marine preserves as well as all non-preserve sites.[6] Water quality monitoring stations will be co-located with current fish survey transects. A total of 84 water quality monitoring stations will be located at the mid-point (25 meter mark) of each fish survey transect. **(Refer to Table 12).** All monitoring stations will have GPS coordinates recorded.

Two monitoring stations will be established for each fore reef slope site, one between the -20 and -30 foot transects, and one between the -40 and -50 foot transects. One monitoring station will be established for each cluster of transects on the reef flat (e.g. 1 station for a cluster of three coral/rubble transects). Stations will also be located at the mouth of the rivers in the preserve and non-preserve areas. DAWR will provide GPS coordinates for each station. Stations will be monitored monthly (if possible, otherwise quarterly) for the standard water chemistry parameters outlined below and listed in **Tables C1. and C2. in Appendix C.** Reef flat stations will be sampled at high tide.

Water quality sampling procedures follow those outlined in the Guam Coastal Assessment Program for data comparison and analyses. The sampling procedure is as follows: Discrete grab samples will be collected using a horizontal Van Dorn sampler or a similar product at 0.5 meters from the surface and 0.5 meters from the bottom for stations less than 2 meters in depth. For stations greater than 2 meters in depth, samples will be collected at 0.5 meters from the surface, mid-depth and 0.5 meters from the

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[6] Table 12 presents sampling locations for only three of the marine preserves. Physical constraints for **Pati Point** prohibit access and regular monitoring (i.e. limited accessibility due to Department of Defense restrictions; boat launching and tide situation hardship). Based on professional experience, the monitoring staff finds the **Sasa Bay** water quality as too silted for legitimate water quality work.

bottom. Parameters that will be analyzed are Bacteria (enterococci), Conductivity, Nitrate-nitrogen, Chlorophyll a and Pheophytin a, Ammonium, Total Nitrogen, Ortho-Phosphate, Total Dissolved Phosphorus, pH, Total Dissolved Solids, Total Suspended Solids and Dissolved Oxygen. All water quality samples will be analyzed by the Guam EPA Laboratory and adhere to all EPA and Guam EPA QA/QC requirements.

Table 12. Co-located Fish Transect and Water Quality Locations for MPWQA

Marine Preserve Sites			
Site	**Sampling Location**		**# of Samples**
Piti Bomb Holes Preserve	FRS	20-30 ft.	2
		40-50 ft.	2
	Flat	Seagrass	1
		Coral/Rubble	1
		Channel	1
		Observatory	1
	Shore	Rivers	3
Achang Reef Flat Preserve	FRS	20-30 ft.	2
		40-50 ft.	2
	Flat	Seagrass	1
		Coral/Rubble	1
	Shore	Rivers	8
Tumon Bay Preserve	FRS	20-30 ft.	3
		40-50 ft.	3
	Flat	Sand	3
		Coral/Rubble	3
		Coral	3
	Shore	Rivers	0
Total Samples:			**40**

Non-Preserve (Control) Sites			
Site	**Sampling Location**		**# of Samples**
Asan Bay	FRS	20-30 ft.	2
		40-50 ft.	2
	Shore	Rivers	1
Cocos Lagoon	Flat	Seagrass	1
		Coral/Rubble	1
		Channel	1
	Shore	Rivers	1
Cocos Fore Reef	FRS	20-30 ft.	2
		40-50 ft.	2
Pago Bay	Flat	Seagrass	1
		Coral/Rubble	1
	Shore	Rivers	1
Tumon Bay Control	FRS	20-30 ft.	3
		40-50 ft.	3
	Flat	Sand	3
		Coral/Rubble	3
		Coral	3
	Shore	Rivers	TBD[7]
Fouha Bay	FRS	20-30 ft.	1
		40-50 ft.	1
	Flat	Coral/Rubble	2
	Shore	Rivers	1
Double Reef	FRS	20-30 ft.	1
		40-50 ft.	1
Western Shoals	Harbor	20-30 ft.	1
		40-50 ft.	1
Facpi Point	FRS	20-30 ft.	1
		40-50 ft.	1
Total Samples:			**42**

For *in situ* water quality measurements using a Hach Data Sonde or similar product, stations with less than 2 meters depth readings will be recorded every 0.5 meters. Stations with greater than 2 meters, but less than 10 meters, depth readings will be recorded at 0.5 meters from the surface and 1 meter intervals until 0.5 meters from the bottom. Stations that have a depth greater than 10 meters but less than 20 meters will have a sampling profile of 0.5 meters from the surface and 1 meter intervals until 10 meters, then 5 meter interval until 0.5 meters from the bottom. Parameters that will be

[7] To Be Determined

analyzed are Conductivity/Salinity, Depth, Dissolved Oxygen, pH, Temperature, Turbidity (NTU) and Transparency/clarity (Secchi Visibility).

3.7 Special Studies 2018-2019

Outside the scope of specific annual programs are special studies performed under ongoing environmental programs within Guam EPA or by other Agencies and/or organizations. These studies range from specific contaminant investigations to the monitoring of non-point source watershed projects. During the reporting period such studies included but are not limited to:

3.7.1 2019 NCCOS Assessment: *Measurement of Turbidity and Nutrients in Three Rivers that Drain to the Achang Reef Flat from Manell Watershed, Guam, from 2016-12-01 to 2018-12-31* (NCEI Accession 0204837)[8] This dataset contains results from the monitoring of nutrients and turbidity in three rivers in the Manell watershed in southern Guam, which drain to the Achang Reef Flat Marine Preserve. The dataset contains a series of data tables and a data dictionary for the monitoring that occurred between December 2016 and December 2018. The dataset includes tables on nutrient monitoring, suspended sediment concentration (SSC), results from automated monitoring of stream levels, rainfall and turbidity, and a table of water quality measurements.

3.7.2 2019 *Organic chemical contaminants measured by PED (polyethylene device) passive water samplers deployed at Cocos Island, Guam from 2017-09-18 to 2017-10-30* (NCEI Accession 0184259)[9] The Cocos Island, Guam PEDs (polyethylene device) passive water sampler data set contains results of the analysis from Project 31181 funded by NOAA's Coral Reef Conservation Program. The project involved NOAA National Center for Coastal Ocean Science, Guam Environmental Protection Agency and the United States Environmental Protection Agency. The data resulted from the deployment of an array of PEDs passive water samplers in the waters around Cocos Island in Cocos Lagoon, Guam. Duplicate PEDs were deployed at 26 sites by NOAA and Guam EPA personnel in September 2017, and then retrieved one month later by Guam EPA personnel. At 22 sites, the PEDs were deployed in the water column along six transects on the northwest shore of Cocos Island; an additional PED was deployed in the water column along the southeast shore. At two sites (9-1 and 9-2), PEDs were embedded in the sand along the shore, with the remaining PED (4-3 #035) embedded in the sand underwater at site 4-3. The duplicate PEDs from each site were combined and analyzed as one sample, in an effort to increase the sensitivity of the analysis (lower detection

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[8] Pait, Tony; Hartwell, Ian; Apeti, Dennis; Mason, Andrew (2019). NCCOS Assessment: Measurement of Turbidity and Nutrients in Three Rivers that Drain to the Achang Reef Flat from Manell Watershed, Guam, from 2016-12-01 to 2018-12-31 (NCEI Accession 0204837). NOAA National Centers for Environmental Information. Dataset. https://doi.org/10.25921/mxzk-je14. Accessed September 2020

[9] Pait, Tony; Hartwell, Ian; Mason, Andrew; Apeti, Dennis; Cruz, Jesse; Mills, Marc (2019). Organic chemical contaminants measured by PED (polyethylene device) passive water samplers deployed at Cocos Island, Guam from 2017-09-18 to 2017-10-30 (NCEI Accession 0184259). NOAA National Centers for Environmental Information. Dataset. https://doi.org/10.25921/a4ev-8453. Accessed September 2020.

limit). The PEDs were analyzed for a series of organic chemical contaminants including polychlorinated biphenyls (PCBs), organochlorine pesticides and petroleum hydrocarbons (PAHs), all of which are contaminants of concern in the area. The polyethylene sheets comprising the PEDs at each site was analyzed, and the results are reported as nanograms of contaminant per each analysis, or ng/ea.

3.7.3 **2019 Manell Watershed Report**[10] The goal of this project, funded by NOAA's Coral Reef Conservation Program and requested by local partners, was to monitor water quality in three rivers that drain to the Achang Reef Flat Marine Preserve at the southern tip of Guam, in order to provide a baseline of conditions for environmental managers. The spatial and temporal variation of turbidity, suspended sediment concentration (SSC), and nutrients were determined at sites on the Ajayan, As Liyog, and Sumay rivers. Using Guam EPA water quality standards, SSC and turbidity in the rivers were generally classified as excellent to good, although occasionally the waters were ranked as fair, particularly on the As Liyog River during higher rainfall. Overall, nitrate was found to be in the excellent range, and orthophosphate generally in the good to fair range. There was some evidence that a number of the parameters showed decreasing trends in concentration during the project. Further monitoring would help determine if these decreases are real, which could be an indication of the benefits of the ongoing restoration activities in the watershed, evidence of natural revegetation subsequent to wildfires, or a combination of both. In any case, additional restoration efforts along with public education and outreach would be helpful to further reduce runoff to the rivers that drain to the Achang Reef Flat Marine Preserve.

3.7.4 **Assessment of a Dynamic Watershed via Field Studies and GIS-Based Erosion Model**[11] This paper presents a one-year-long study of the baseline hydrologic conditions of the Geus Watershed in the tropical island of Guam, through field observations. Data analyses show a strong correlation between stream level, turbidity, and rainfall within the watershed, suggesting a highly dynamic nature of Geus watershed. Field data were then used to create a stage discharge curve, which increases the efficiency of future watershed management by providing an estimate of stream flow from a simple measure of water level. The supplemental analyses based on the test results of soil samples and a GIS-based erosion model identified areas within the watershed with higher contributions to erosion potential. In addition, synthesis of the information in this watershed study will allow for future recommendations for effective and sustainable watershed management strategies, thereby opening a way for evaluating progress within the Geus watershed with continued monitoring.

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[10] Pait, Anthony S. ; Whitman, William M.C. ; Hartwell, S. Ian ; Whitall, David R. ; Apeti, Dennis A. ; NOAA Technical Memorandum NOS NCCOS; 268

[11] William M. C. Whitman, Shahram Khosrowpanah, Mark A. Lander, Ujwalkumar D. Patil, Joseph D. Rouse. Assessment of a Dynamic Watershed via Field Studies and GIS-Based Erosion Model. *Hydrology*. Vol. 6, No. 3, 2018, pp. 88-99. doi: 10.11648/j.hyd.20180603.12

3.7.5 Quarterly Reports to the Court, Guam Solid Waste Receiver Information Center (http://www.guamsolidwastereceiver.org/updates-done.shtml) Information in these quarterly reports may include results and/or the status of activities related to water quality issues of concern at the (now closed) Ordot Dump and the new Layon Landfill.

3.7.6 Discharge Monitoring Reports (DMRs) Defined by EPA as the form used (including any subsequent additions, revisions, or modifications) to report self-monitoring results by NPDES permittees. DMRs must be used by approved states as well as by EPA and required quarterly from all NPDES permittees. Reports are submitted to EPA and Guam EPA. DMR data was not assessed this reporting period.

4.0 Core and Supplemental Indicators

Core indicators selected to represent each applicable designated use are listed in *CMS Parameters*, Appendix C.

5.0 Quality Assurance Program and Quality Management Plans

The EMAS Division Administrator serves as the Quality Assurance Officer for the agency and coordinates the internal quality assurance program. The laboratory quality assurance program encompasses every aspect of the laboratory analysis from container preparation through the actual data release from the Analytical Services Laboratory to the programs. Analytical Services has developed quality control manuals which detail the operation of the quality assurance program. The elements of quality control addressed in the manuals include organization and sample chain of custody; personnel training; quality control of laboratory services, scope and application, equipment and supplies, reagents, standards, methodology, preservation and storage, calibration, performance criteria and quality assurance, and waste management.

The overall laboratory quality assurance program is in compliance with all USEPA guidelines and is noted in the manuals. The Guam EPA laboratory performs replicate analyses, positive test controls; media control tests, equipment control tests, etc., as required by EPA Laboratory Certification and Evaluation guidelines for Microbiological samples. In addition, the laboratory also participates in annual Water Supply and Water Pollution Proficiency Testing Programs. All Guam EPA personnel who collect samples that require field testing participate in a Proficiency Testing Program administered by Guam EPA.

The laboratory analyses are conducted according to the List of Approved Test Procedures in the Federal Register, Volume 49, No. 209, October 26, 1984; Federal Register, Volume 59, No. 20, January 31, 1994; and Federal Register, Volume 67, No. 205, October 23, 2002.

The Guam EPA QA/QC officer ensures that proper containers are selected for sampling as well as the proper preservation and an adequate volume collected. Sample chain of custody procedures are strictly adhered to in order to ensure that sample integrity is maintained. An accurate record is needed to trace the possession of each sample from the time of collection to analysis. Guam's quality management plans and quality assurance program/project plans are described in the following.

5.1 Quality Assurance (QA) Program

The goal of the QA Program at the Guam EPA laboratory is to provide data which meets or exceeds the data quality objectives associated with each project that passes through the laboratory. This is achieved through the implementation of quality assurance and quality control measures designed to improve the level of quality of all operations within the laboratory, from sample acceptance to sample handling, and from analysis to reporting. Guam EPA laboratory staff recognizes that the data they generate must be legally defensible. To ensure data is legally defensible, the QA Program emphasizes the implementation of quality control processes, which identify, control, correct, and prevent quality problems, rather than simply to detect and make subsequent corrections. The QA Program is used to demonstrate attainment of a state of statistical control, and to demonstrate that the data generation system produces data that are scientifically valid, traceable and retrievable.

Guam EPA laboratory implements the following practices as part of its QA program:

- Strict adherence to principles of good laboratory practice such as the use of legible handwriting; the use of indelible black ink; and single line, initialed and dated corrections.
- The consistent use of Standard Operating Procedures. The laboratory uses program specific approved methodologies (e.g., approved drinking water methods for the drinking water program). Standard Operating Procedures specific to the laboratory instrumentation and equipment are written for each method and are updated every two years or sooner if needed.
- The use of qualified personnel.
- Reliable and well maintained equipment.
- Appropriate calibrations and standards; including the use of traceable or certified reference materials.
- The implementation of a comprehensive, organized and straightforward documentation system.
- A program of "in house" training and proficiency of the analysts on analytical procedures, methods, and instrumentation. The documentation of training is maintained in individual training files.
- Appropriate reagents and supplies.
- The close supervision of all operations by the Agency Laboratory QA Officer, management and senior personnel.

5.2 Quality Control (QC) Program

QC consists of the techniques used to assess and ensure the quality of the analytical measurement process. Laboratory personnel routinely check the quality of analytical work through analysis of reference samples, duplicate samples, and spiked samples. Accuracy and precision are evaluated on each analytical batch and completeness may be evaluated for specific projects by the QA Officer. Statistically based control limits are established for each analytical method and matrix and are used to assess the quality of analytical results.

The Guam EPA laboratory uses the following QC assessment tools:

- Accuracy is evaluated through the use of spiked samples (matrix spikes and matrix spike duplicates, blank spikes and blank spike duplicates, and surrogate spikes) for each analytical batch or for each sample matrix, whichever is more frequent. The spiked results are calculated and a percent recovery determination is calculated by the analyst. The percent recovery is compared to the appropriate statistically based control limits to assess method performance and the effect the sample matrix has on the analysis.

- The use of duplicate samples (sample duplicates, matrix spike duplicates and blank spike duplicates) enables the laboratory staff to assess the precision of the analytical batch. The relative percent difference (RPD) between the original sample and its duplicate is calculated by the analyst. The RPD is compared to the appropriate statistically based control limit to assess method reproducibility and the sample homogeneity.

In addition, the laboratory ensures all data meets the overall QA objectives with the following QC tools:

- The use of peer and/or supervisory review of all data inputs, calculations, and reports. A knowledgeable and well-trained analyst, supervisor or QA Officer reviews all data prior to release.

- The use of second source checks standards to ensure reliability of the primary source.

6.0 Data Management

Guam EPA continues efforts to upgrade its data storage and data sharing capabilities using funding from annual information exchange grants. Anticipated procurement of

several computers and networking software, will enable the Agency to employ a system that will greatly enhance water quality assessment efforts at a local level. By using a standard database platform (i.e. Microsoft Access in conjunction with a Laboratory Information Management system) users have the potential to import, process and export data in a variety of formats with relative ease. The planned networked database along with an assortment of file transfer processes should provide extremely powerful data sharing capabilities at the local, regional and national levels.

Prior to input into the anticipated Laboratory Information Management System, the Laboratory QA/QC certifying officer evaluates all data with project data quality criteria and performance specifications. Data entry and access to information is restricted to authorized users (i.e. password protected) and two system administrators, who reside within the laboratory.

Data management and analysis procedures emphasize the use of the **Water Quality Exchange (WQX)**, the mechanism for data partners to submit water monitoring data to EPA. The **Water Quality Portal (WQP)** is the mechanism for anyone, including the public, to *retrieve* water monitoring data from EPA.

Each data processing step is accompanied by a QA/QC check to assure the availability of an accurate database. All data are verified from original field sheets and data printouts. Corrections are made, checked and the procedure repeated until an error-free copy is obtained. All verified data is then forwarded to the WQX representative, who will then upload it into WQX as soon as possible.

The Guam EPA database will also be used to regularly update information into the U.S. EPA Assessment Database and the WQX database to facilitate report generation for all federal reporting requirements. All databases are being incorporated into a Geographic Information System to visually display and analyze the data.

7.0 Data Analysis/Assessment

The data analysis and assessment methodology for determining attainment of water quality standards is described under section III.B. ***Assessment Methodology*** and in ***Appendix A*** (for the reporting period).

8.0 Reporting

Guam produces water quality reports and lists called for under Sections 305(b), 303(d), 314, and 319 of the Clean Water Act and Section 406 of the Beaches Act.

9.0 Programmatic Evaluation

Guam EPA, in consultation with U.S. EPA Region 9, conducts periodic reviews of each aspect of its monitoring program to determine how well the program serves its water

quality decision needs for all Guam waters, including all waterbody types. This involves evaluating the monitoring program to determine how well each of the elements is addressed and determining how needed changes and additions are incorporated into future monitoring cycles. U.S. EPA Region 9 representatives conduct program reviews twice annually; and teleconferencing is scheduled between Guam program managers/staff and federal representatives as necessary.

10.0 General Support and Infrastructure Planning

Budgetary, personnel, and logistical constraints limit the number and frequency of water-quality samples collected as part of a water-quality monitoring program. Laboratory chemical analyses are relatively expensive, and field personnel are not always able to collect data during critical conditions or events (for example, during extreme high- or low-flow conditions, spills, or during weekends and/or late-night hours). These constraints can limit the ability of environmental monitoring programs to document important water-quality conditions.

EMAS's current and future resource needs required to fully implement its monitoring program strategy include:

- **Funding:** The initial funding for EMAP was limited to one year. An alternate funding source must be identified to incorporate EMAP as a regular monitoring tool under the Comprehensive Monitoring Strategy (CMS). Needed funds will be used for off-island analytical services.
- **Personnel:** Additional personnel are required to effectively conduct the added monitoring tasks under the CMS. EMAS may reorganize its current staff in an effort to meet the mandates of the division; and in the meantime, efforts will be undertaken to recruit additional staff. The base pay of a level one biologist is about $31,000/year without benefits. EMAS is proposing that each monitoring program be implemented by one staff.
- **Training:** Training and professional development have always been a priority. As training plans become more formalized and strategic in nature, new emphasis will be placed on *minimum proficiencies* at recruitment, developing *program specific skills and knowledge, cross-training,* and specialized or *career enhancement training.*
- **Lab resources:** EMAS will follow its five year workplan and prioritize core objectives to maximize use of resources.

B. Assessment Methodology

Guam surface and marine waters have multiple **"Designated Uses"** ranging from *aquatic life protection* (preservation, propagation, survival and maintenance), *primary* (whole body) *and secondary* (limited) *contact recreation,* and *drinking water use* (freshwater sources only). Assessment methodologies and specific designated-use criteria employed in determining a waterbody's "use-support status" are discussed in this section.

1.0 Guam's Water Classification System

Tables 13, 14, and 15 summarize respective information about Guam's water classification system and associated "Designated Uses" and "Use Support" criteria. This information forms the basis of assessments, methodologies or determinations relative to the extent Guam waters or specific waterbodies achieve designated uses.

Table 13. Categories and Designated Uses Assigned to Guam Waters

Category	Quality	Description	Primary Designated Uses
M-1	Excellent	Marine Waters	whole body contact recreation, aquatic life, consumption
M-2	Good	Marine Waters	whole body contact recreation, aquatic life, consumption
M-3	Fair	Marine Waters	limited body contact recreation, aquatic life, consumption
S-1	High	Surface Water	whole body contact recreation, drinking water, aquatic life, consumption
S-2	Medium	Surface Water	whole body contact recreation, drinking water (with treatment), aquatic life, consumption
S-3	Low	Surface Water	limited body contact, aquatic life, consumption
G-1	Resource	Groundwater	drinking water
G-2	Recharge	Groundwater	recharge to G-1

2.0 Types of Assessment Information

"Evaluated Waters" are those for which the use support decision is based on information other than site-specific ambient data. These include data on land use, location of sources, and best professional judgment of qualified biologists. Any data over five years old are considered "evaluated data".

"Monitored Waters" are those for which the use support decision is principally based on current, site-specific, ambient monitoring data believed to accurately portray water quality conditions. Minimum data collection is quarterly.

3.0 Guidelines for Use Support Determination for Guam Waters

The Guam WQS, revised and adopted in 2018, lists *Enterococci* and *Escherichia coli* as its primary indicators for microbiological quality in marine and freshwater, respectively. Guam EPA has been using these indicators since 1995.

Guam EPA conducts weekly analysis of 43 marine recreational sites yearly (See **Appendix A., Table 6** on page 12 **and Figure A.1. 2018-2019 IR Stations.** Advisories are

released weekly based on Guam's bacteriological standards (adopted from the 2012 Recreational Water Quality Criteria, EPA – 820-F-12-061).

Table 14. Selected Numeric Criteria for Priority Toxic Pollutants

Compound	AQUATIC LIFE				HUMAN HEALTH	
	Freshwater (µg/l)		Saltwater (µg/l)		Consumption (µg/l)	
	Acute	Chronic	Acute	Chronic		
	(B1)	(B2)	(C1)	(C2)	(D1*)	(D2*)
Copper	18	12	4.8	3.1	1300	X
Mercury	2.4	0.012	2.1	0.025	0.050	0.051
Cyanide	22	5.2	X	X	700	200,000
Benzene	X	X	X	X	1.2	71
Thallium	X	X	X	X	1.7	6.3

*D1 = Assumes exposure due to consumption of (fresh) water plus organisms living in the water
*D2 = Assumes exposure due to consumption of organisms only (e.g. marine water organisms)
X = No assigned Value

Table 15. Numeric Criteria Applied to Categories of Water

Water Categories	Numeric Criteria*
M–1	C1, C2, D2
M-2	C1, C2, D2
M-3	C1, C2, D2
S-1	B1, B2, D1
S-2	B1, B2, D1
S-3	B1, B2, D2
G-1	Refer to the Guam Water Quality Standards
G-2	Refer to the Guam Water Quality Standards

*(Refers to columns provided in Table 14)

3.1 Whole Body Contact Recreation

Microbiological criteria, used to determine use support for waters designated for whole body contact recreation (S1, M1, S2 and M2), are depicted in Table 16.

3.2 Limited Contact Recreation

Microbiological criteria used to determine use support for waters designated for limited (secondary) contact recreation use (S3 and M3) are depicted in **Table 16**.

3.3 Shellfish Consumption from Shellfish Growing Area Use Support

Microbiological criteria used to determine use support for waters designated for shellfish growing area use (M1,M2,M3) and (S1,S2,S3) are depicted in **Table 17.**

4.0 Aquatic Life Use Support (ALUS)

Four data types are used for ALUS determination: habitat, toxicological, physical/chemical, and biological. Guam EPA generally conducts the physical/chemical methods (conventional) and toxicological methods during the effective reporting period. Habitat data and bioassessment data are generated by the DAWR, Department of Agriculture. Guam EPA collaborates with DAWR so that available habitat and bioassessment data is incorporated in the Agency's assessment and monitoring reports. Guam Waterworks Authority (GWA) also conducts limited toxicant methods (priority pollutants and metals) and limited conventional methods. Available data may similarly be incorporated in the Agency's assessment and monitoring reports. These data are of varying data quality levels; the Hierarchy of physical/chemical Data Levels for valuation of Aquatic Life Use Attainment (1997 305(b) EPA guidance) will be used to determine ALUS. The guideline for determining ALUS using more than one type of data is shown in **Table 18.**

5.0 Physical/Chemical Methods

As previously stated, the assessment for Aquatic Life Use Support is based on physical/chemical data collected for fresh and marine water samples. Both conventional and toxicant data are analyzed by Guam EPA. Guam EPA has collected extensive physical and chemical data at sites established during the early 1980s and utilizes this collected data as ambient characteristics.

Analytical parameters evaluated by Guam EPA are listed in **Table C5 in Appendix C.** All of Guam EPA Physical/Chemical data is considered "moderate/high quality", based on technical components and spatial/temporal coverage, as defined by USEPA guidance documents.

EPA guidance (Sept. 1997) states the importance of incorporating the established criteria for conventionals and toxicants in ALUS determinations and to use the "worst case" approach where multiple parameters are available (EPA, 1997). **Table 19 and Table 20** describe the decision guidelines used for determining ALUS using Physical/Chemical Methods (conventionals data and toxicant data). The Guam WQS provide standards for these conventionals which are presented in **Table C6 in Appendix C.**

Table 16. Guidelines for Determining Whole Body Contact and Limited-Body Contact Recreation Use Support

Level of Use Support	Criteria	
	Marine Water M1, M2, M3	Fresh Water S1, S2, S3
Fully Supporting	***Enterococci***: Concentrations of enterococci bacteria do not exceed 35 CFU/100 ml based upon the geometric mean of samples taken in any thirty (30) day interval and the Statistical Threshold Value (STV) OF 130 CFU/100 ml is not exceeded by more than 10 percent of the samples taken during the same thirty (30) day interval.	***Enterococci***: Concentrations of enterococci bacteria do not exceed 35 CFU/100 ml based upon the geometric mean of samples taken in any thirty (30) day interval and the Statistical Threshold Value (STV) OF 130 CFU/100 ml is not exceeded by more than 10 percent of the samples taken during the same thirty (30) day interval. ***Escherichia coli***: Concentrations of E. coli are not greater than 126 CFU/100 ml based upon the geometric mean of samples taken over a thirty (30) day period and the Statistical Threshold Value (STV) of 410 CFU/100 ml is not be exceeded by more than 10 percent of the samples taken during the same thirty (30) day interval.
Partially Supporting	***Enterococci***: Concentrations of enterococci bacteria do not exceed 35 CFU/100 ml based upon the geometric mean of samples taken in any thirty (30) day interval and the Statistical Threshold Value (STV) OF 130 CFU/100 ml is exceeded by more than 10 percent of the samples taken during the same thirty (30) day interval.	***Enterococci***: Concentrations of enterococci bacteria do not exceed 35 CFU/100 ml based upon the geometric mean of samples taken in any thirty (30) day interval and the Statistical Threshold Value (STV) OF 130 CFU/100 ml is exceeded by more than 10 percent of the samples taken during the same thirty (30) day interval. ***Escherichia coli***: Concentrations of E. coli are not greater than 126 CFU/100 ml based upon the geometric mean of samples taken over a thirty (30) day period and the Statistical Threshold Value (STV) of 410 CFU/100 ml is exceeded by more than 10 percent of the samples taken during the same thirty (30) day interval.
Not Supporting	***Enterococci***: Concentrations of enterococci bacteria exceeds 35 CFU/100 ml based upon the geometric mean of samples taken in any thirty (30) day interval and the Statistical Threshold Value (STV) OF 130 CFU/100 ml is exceeded by more than 10 percent of the samples taken during the same thirty (30) day interval.	***Enterococci***: Concentrations of enterococci bacteria exceeds 35 CFU/100 ml based upon the geometric mean of samples taken in any thirty (30) day interval and the Statistical Threshold Value (STV) OF 130 CFU/100 ml is exceeded by more than 10 percent of the samples taken during the same thirty (30) day interval. ***Escherichia coli***: Concentrations of E. coli are greater than 126 CFU/100 ml based upon the geometric mean of samples taken over a thirty (30) day period and the Statistical Threshold Value (STV) of 410 CFU/100 ml is exceeded by more than 10 percent of the samples taken during the same thirty (30) day interval.

Table 17. Guidelines for Determining Shellfish Growing Areas Use Support for Shellfish Consumption

Level of Use Support	Criteria
	Marine Water M1, M2, M3 Fresh Water S1, S2, S3
Fully Supporting	***Fecal coliform:*** **Where shellfish are commonly collected for human consumption, water samples collected at growing areas are not greater than a median of fourteen (14) fecal coliform/100 ml; and 10 percent of water samples taken from a growing area do not exceed forty-three (43) fecal coliform/100 ml.**
Partially Supporting	***Fecal coliform:*** **Where shellfish are commonly collected for human consumption, water samples collected at growing areas are not greater than a median of fourteen (14) fecal coliform/100 ml; and more than 10 percent of water samples taken from a growing area exceeds forty-three (43) fecal coliform/100 ml.**
Not Supporting	***Fecal coliform:*** **Where shellfish are commonly collected for human consumption, water samples collected at growing areas are greater than a median of fourteen (14) fecal coliform/100 ml; and more than 10 percent of water samples taken from a growing area exceeds forty-three (43) fecal coliform/100 ml.**

Table 18. Determination of ALUS Using More Than One Data Type

ALUS Attainment	
Fully Supporting:	**No impairment indicated by all data types.**
Fully Supporting but Threatened:	**No impairment indicated by all data types; one or more categories indicate an apparent decline in ecological quality over time or potential water quality problems requiring additional data or verification or other information suggest a threatened determination.**
ALUS Non-Attainment	
***Partially Supporting:**	**Impairment indicated by one or more data types and no impairment indicated by others.**
***Not Supporting:**	**Impairment indicated by all data types.**
***A determination of *Partially Supporting* or *Not Supporting* could be made based on the nature and rigor of the data and site-specific conditions in the results of the data types. If bioassessment (usually Level 3 or 4) indicates impairment, then a determination of *Not Supporting* should be made.**	

6.0 Habitat Assessment

Limited habitat assessment data has been submitted by the Government of Guam Department of Agriculture, Division of Aquatic and Wildlife Resources. Data are

categorized as either level 1 data quality (unknown or low precision and sensitivity) or level 2 (low precision and sensitivity).

Federal guidelines for ALUS determination using habitat assessment data are provided in **Table 21.**

Table 19. Decision Guidelines for Conventionals[12] Used to Assess ALUS in Freshwater Rivers and in Marine Waters

Degree of Aquatic Life Use Support	Criteria
Fully Supporting	For any one pollutant, GUAM WQS exceeded in ≤ 10 percent of measurements.
Partially Supporting	For any one pollutant, GUAM WQS exceeded in 11 to 25 percent of measurements.
Not Supporting	For any one pollutant, GUAM WQS exceeded in > 25 percent of measurements.

Table 20. Decision Guidelines for Toxicants[13] Used to Assess ALUS in Freshwater Rivers and in Marine Waters

Degree of Aquatic Life Use Support	Criteria
Fully Supporting	For any one pollutant, no more than 1 exceedance of acute criteria within a 3-year period based on grab or composite samples and no more than 1 exceedance of chronic criteria within a 3-year period based on grab or composite samples
Partially Supporting	For any one pollutant, acute or chronic criteria exceeded more than once within a 3-year period, but in ≤ □10 percent of samples.
Not Supporting	For any one pollutant, acute or chronic criteria exceeded in >10 percent of samples.

7.0 Bioassessment

Limited bioassessment data has been submitted by the Government of Guam Department of Agriculture, Division of Aquatic and Wildlife Resources (DAWR).

[12] Conventionals are usual or established analytes monitored by GEPA. These include bacteria, dissolved oxygen, water temperature, pH, Total dissolved solids, Total suspended solids, Total phosphorus, Total nitrates, and Turbidity.

[13] A toxicant is a poisonous substance, such as metals, ammonia, or pesticides.

Bioassessment data are categorized as being level 1 through level 4 data quality, depending on the waterbody assessed.
Federal guidelines for ALUS determination using bioassessment data are provided in **Table 22.**

Table 21. ALUS Determination Based on Habitat Assessment Data

Degree of Aquatic Life Use Support	Criteria
Fully Supporting	Reliable data indicate natural channel morphology, substrate composition, bank/riparian structure, and flow regime of region. Riparian vegetation of natural types and of relatively full standing crop biomass (i.e., minimal grazing or destructive pressure).
Partially Supporting	Modification of habitat slight to moderate usually due to road crossings, limited riparian zones because of encroaching land-use patterns, and some watershed erosion. Channel modification slight to moderate.
Not Supporting	Moderate to severe habitat alteration by channelization and dredging activities, removal of riparian vegetation, bank failure, heavy watershed erosion or alteration of flow regime.

Table 22. ALUS Determination Based on Bioassessment Data

Degree of Aquatic Life Use Support	Criteria
Fully Supporting	Reliable data indicate functioning, sustainable biological assemblages (e.g. fish, macro invertebrates, or algae) none of which has been modified significantly beyond the natural range of the reference condition.
Partially Supporting	At least one assemblage (e.g. fish, macro invertebrates, or algae) indicates moderate modification of the biological community compared to the reference condition.
Not Supporting	At least one assemblage indicates nonsupport. Data clearly indicate severe modification of the biological community compared to the reference condition.

8.0 DAWR River Classification Procedures

When available, DAWR assessment data may be used to determine if rivers/streams are meeting their designated uses.

Local freshwater literature would be researched for information on native and introduced species, level of development, and status of habitat. Rivers may also be

inspected from the road on a drive-by survey. Data from river surveys performed by DAWR staff would be reviewed.

A river is considered *fully supporting* ***biologically*** if no introduced species were reported from that river; *partially supporting biologically* if there were more native species than introduced or if only estuarine species were seen; and *not supporting biologically* if there were more introduced species than native.
Regarding **habitat assessment** data, a river is considered *fully supporting* if minimal human impacts were evident; *partially supporting* if some development had occurred; and *not supporting* if the river was heavily impacted (i.e. channelized and/or adjacent to heavily developed areas).

Regarding the classification of ***level of information for bioassessment,*** *levels 3 and 4* are reserved for rivers where extensive surveys have been conducted; *level 2* is given to ***rivers if information was available from the local literature;*** and *level 1* is used for ***rivers assessed during the drive-by survey or by anecdotal information.*** For habitat assessment, only levels 1 and 2 are used because no SOPs are currently in place. Level 2 is used in cases where rivers were extensively surveyed and level 1 was used for rivers assessed in the drive-by survey. In cases where no data is available, no assessment is made and no level of information specified.

9.0 Human Health Consumption

Waters designated for aquatic life on Guam and elsewhere in the United States, are also designated as protected for human consumption based on the premise that where there is aquatic life there is likely to be human consumption as well. For fresh waters that are designated for drinking water (S1), human consumption criteria **(Table 14, Column D1)** are calculated based on the possibility of people being exposed to contaminants by drinking the water and from eating aquatic organisms that have been living in the same water. For fresh waters not designated for drinking water (S2 and S3), and for marine waters, human consumption is based on the possibility of people eating aquatic organisms, only.

10.0 Drinking Water

The Ugum River and Fena Reservoir are the island's surface water sources for drinking water. Guam EPA utilized the guidance provided in the federal 305(b) guidelines to make its use determinations, which recommend tapping a variety of information types to reach conclusions. Guam EPA's best data are provided by SDWA compliance monitoring and information related to use restrictions including:

- Closures of source waters that are used for drinking water supply;
- Contamination-based drinking water supply advisories lasting more than 30 days per year;

- Turbidity data of raw water from the river especially during rainy season;
- Public water suppliers requiring increased monitoring due to the inability of the Water Treatment Plant to treat river water compliant with GWQS for turbidity;
- Failure to achieve the removal and/or inactivation of Giardia and viruses via treatment techniques consisting of sedimentation, filtration and disinfection that require a massive protection of source water from human or animal activity that contribute disease causing organisms in the source water.

The Assessment Framework on **Table 18** was cited from the federal guidelines and illustrates the classification, monitoring data, and use support restrictions evaluated to make use support decisions.

Table 23. Assessment Framework for Determining Degree of Drinking Water Use Support

Classification	Monitoring Data		Use Support Restrictions
Full Support	**Contaminants do not exceed water quality criteria**	**and/or**	**Drinking water use restrictions are not in effect.**
Full Support but Threatened	**Contaminants are detected but do not exceed water quality criteria**	**and/or**	**Some drinking water use restrictions have occurred and/or the potential for adverse impacts to source water quality exists.**
Partial Support	**Contaminants exceed water quality criteria intermittently**	**and/or**	**Drinking water use restrictions resulted in the need for alternative treatment techniques with associated increases in cost.**
Nonsupport	**Contaminants exceed water quality criteria constantly**	**and/or**	**Drinking water use restrictions resulted in closures.**
Unassessed	**Source water quality has not been assessed for contaminants used or potentially present**		

C. Assessment Results

This section provides: (1) the results of Guam's marine and surface water assessments, including the categorization of water segments based on designated use support data, and (2) Guam's list of impaired and threatened waters in accordance with Section 303(d) of the CWA. The 2020 Assessment Methodology narrative and monitoring data are available in **Appendix A.**

1.0 Five –Part Categorization of Marine and Surface Waters

The five (5) Reporting Category types for marine and surface waters are:

Category 1: All designated uses are supported;

Category 2: Available data and/or information indicate that some, but not all of the designated uses are supported;

Category 3: There is insufficient available data and/or information to make a use support determination;

Category 4: Available data and/or information indicate that at least one designated use is not being supported, but a TMDL is not needed;

Category 4a: A TMDL to address a specific segment/pollutant combination has been approved or established by EPA;

Category 4b: A use impairment caused by a pollutant is being addressed by the state through other pollution control requirements;

Category 4c: A use is impaired, but the impairment is not caused by a pollutant; and

Category 5: Available data and/or information indicate that at least one designated use is not being supported and a TMDL is needed.

1.1 2020 IR Data

Projects with useable data for the 2020 IR are identified in **Appendix A:** ***Marine and Surface Water Monitoring and Assessment Methodology.***

Designated use determinations are intended to identify waterbodies that meet or do not meet established criteria and decision guidelines for the degree of use support. All waterbodies on Guam's 305b Waterbody Inventory lists (Tables 24, 25, 26, & 27) are classified under one of the five surface water reporting categories described in Section 1.0 above.

2.0 Guam Rivers/Streams

Table 24 provides assessment data for one hundred thirty-three (133) fresh water assessment units which represent two-hundred one (201) Guam rivers/streams.[14] The population of rivers/tributaries is based on River Identification Numbers contained in UOG Marine Lab Technical Report 75[15] .

Assessment results for the NOAA Manell Study are included in **Appendix A** beginning on page 21. Three Manell Watershed rivers have been assigned a Category 5 (C5)

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[14] Table 24 does not include Agana Swamp. See Table 26.

[15] Best, B.R. & C.E. Davidson. 1981. Inventory and Atlas of the Inland Aquatic Ecosystems of the Marianas Archipelago. 226 pages.

Table 24. 2020 GUAM ASSESSMENT DATA FOR RIVERS-STREAMS

Waterbody Name	Assessment Unit ID	Guam Location	Water Type & Classification	Channel length in Miles	Assessable Miles	ASSESSED MILES	Reporting Category
Achang River 1	GUMZRAC-2	WATERSHED: Manell	RIVER-S2	0.50	0.50	0.00	3
Achang River 2	GUMZRAC	WATERSHED: Manell	RIVER-S2	0.30	0.30	0.00	3
Agaga River	GUULRAG	WATERSHED: Cetti	RIVER-S2	0.78	0.72	0.00	3
Agana River 1	GUAGRA-3	WATERSHED: Hagatna	RIVER-S2	0.52	0.52	0.52	5
Agana River 2	GUAGRA-2-1A	WATERSHED: Hagatna	RIVER-S2	0.67	0.67	0.67	5
Agana Springs	GUAGRA-1	WATERSHED: Hagatna	RIVER-S2	0.04	0.04	0.00	3
Aguada River	GUAPRAG	WATERSHED: Apra	RIVER-S3	2.15	1.95	0.00	2
Ajayan River	GUMZRAJ	WATERSHED: Manell	RIVER-S2	3.95	3.86	0.00	5
Almagosa Spring	GUFLRA-1	WATERSHED: Talofofo	RIVER-S1	0.09	0.09	0.00	3
Asalonso River / unnamed tributary	GUINRAS	WATERSHED: Asalonso	RIVER-S3	2.84	2.10	0.00	3
Asan River 1	GUASRI-3	WATERSHED: Piti/Asan	RIVER-S3	1.32	1.32	1.32	3
Asan River 2	GUASRI-4	WATERSHED: Piti/Asan	RIVER-S3	0.79	0.71	0.71	3
Aslinget River 1	GUINRAL-1	WATERSHED: Dandan	RIVER-S3	1.23	1.23	0.00	3
Aslinget River 2	GUINRAL-2	WATERSHED: Dandan	RIVER-S3	1.33	1.33	0.00	3
Asmafines River	GUULRAS	WATERSHED: Cetti	RIVER-S2	0.83	0.78	0.00	3
Atantano River 1	GUAPRA-2	WATERSHED: Apra	RIVER-S3	3.30	3.30	0.00	3
Atantano River 2	GUAPEA	WATERSHED: Apra	RIVER-S3	6.38	6.23	0.00	3
Big Guatali River	GUAPRA-1	WATERSHED: Apra	RIVER-S3	2.15	2.15	0.00	2
Bonya River	GUMLRB	WATERSHED: Talofofo	RIVER-S1	4.03	1.79	0.00	3

Table 24. 2020 GUAM ASSESSMENT DATA FOR RIVERS-STREAMS

Cetti River	GUULRCL	WATERSHED: Cetti	RIVER-S2	1.92	1.89	0.00	3
Chagame River/ La Sa Fua River	GUULRL-1	WATERSHED: Umatac	RIVER-S2	2.50	2.46	0.00	3
Chaligan Creek 1	GUATRC-2	WATERSHED: Taelayag	RIVER-S3	0.92	0.92	0.00	3
Chaligan Creek 2	GUATRC	WATERSHED: Taelayag	RIVER-S3	0.06	0.06	0.00	3
Chaot River	GUAGRA-2	WATERSHED: Hagatna	RIVER S2	2.22	2.22	0.00	3
Finile Creek	GUATRF	WATERSHED: Agat	RIVER-S3	1.04	0.36	0.36	2
Fonte River 1	GUAGRF-2	WATERSHED: Fonte	RIVER-S2	1.16	1.16	1.16	2
Fonte River 2	GUAGRF-1	WATERSHED: Fonte	RIVER-S2	2.02	1.93	0.00	3
Gaan River 1	GUATRG-2	WATERSHED: Agat	RIVER-S3	0.56	0.56	0.00	3
Gaan River 2	GUATRG	WATERSHED: Agat	RIVER-S3	0.63	0.63	0.00	3
Geus River 1	GUMZRG-1	WATERSHED: Geus	RIVER-S1	0.99	0.99	0.99	3
Geus River 2	GUMZRG	WATERSHED: Geus	RIVER-S2	0.52	0.52	0.52	3
Geus River 3	GUMZRG-2	WATERSHED: Geus	RIVER-S3	0.78	0.78	0.78	3
Imong River 1	GUFLRI-2	WATERSHED: Talofofo	RIVER-S1	2.54	2.54	0.00	3
Imong River 2	GUFLRI-1	WATERSHED: Talofofo	RIVER-S1	1.93	1.93	0.00	3
Inarajan River 1	GUINRI-1	WATERSHED: Inarajan	RIVER-S3	8.83	8.64	0.00	3
Inarajan River 2	GUINRI-2	WATERSHED: Inarajan	RIVER-S3	0.86	0.86	0.86	3
La Sa Fua River	GUULRL-2	WATERSHED: Umatac	RIVER-S2	2.02	2.02	0.00	3
Laelae River	GUULRU-1	WATERSHED: Umatac	RIVER-S1	1.94	1.94	0.00	3
Laguas River	GUAPRL	WATERSHED: Apra	RIVER-S3	0.85	0.81	0.00	3

Table 24. 2020 GUAM ASSESSMENT DATA FOR RIVERS-STREAMS

Landfill Leachate Stream	GUPGRL-0	WATERSHED: Pago	RIVER-S1	0.05	0.05	0.05	3
Laolao River	GUINRL	WATERSHED: Inarajan	RIVER-S2	4.25	4.25	0.00	3
Liyog River	GUMZRL	WATERSHED: Manell	RIVER-S2	1.83	1.81	1.81	5
Lonfit River 1	GUPGRL-1-51 -B	WATERSHED: Pago	RIVER-S1	3.79	3.79	3.79	3
Lonfit River 2	GUPGRL-2	WATERSHED: Pago	RIVER-S2	1.07	1.07	1.07	5
Lonfit River 3	GUPGRP-1-51B	WATERSHED: Pago	RIVER-S1	0.04	0.04	0.04	5
Maagas River 1	GUTURM-1	WATERSHED: Talofofo	RIVER-S2	0.39	0.39	0.00	3
Maagas River 2	GUTURT-2-48F	WATERSHED: Talofofo	RIVER-S2	1.68	1.68	0.00	3
Madofan River	GUULRMF	WATERSHED: Cetti	RIVER-S2	0.77	0.73	0.00	3
Madog River	GUULRM	WATERSHED: Umatac	RIVER-S3	2.11	2.11	0.00	3
Mahlac River	GUTURMA-1	WATERSHED: Talofofo	RIVER-S1	4.86	4.86	0.00	3
Manell River	GUMZRML	WATERSHED: Manell	RIVER-S2	2.77	2.65	0.00	3
Masso River 1	GUAPRM-1B	WATERSHED: Piti/Asan	RIVER-S3	0.31	0.31	0.31	2
Masso River 2	GUAPRM-1A	WATERSHED: Piti/Asan	RIVER-S3	2.99	2.99	0.00	3
Matgue River	GUASRM	WATERSHED: Piti/Asan	RIVER-S3	1.25	1.20	1.20	2
Maulap River 1	GUFLRM-1	WATERSHED: Talofofo	RIVER-S1	0.44	0.44	0.00	3
Maulap River 2	GUFLRM-2	WATERSHED: Talofofo	RIVER-S1	2.43	2.43	0.00	3
Namo River 1	GUATRN-1A	WATERSHED: Agat	RIVER-S3	2.93	2.93	2.93	2
Namo River 2	GUATRN-2	WATERSHED: Agat	RIVER-S3	0.36	0.36	0.36	2
Namo River/ unnamed tributary	GUATRN-1	WATERSHED: Agat	RIVER-S3	0.11	0.11	0.00	3

Table 24. 2020 GUAM ASSESSMENT DATA FOR RIVERS-STREAMS

Ascola Sito Creek	GUATRT-1	WATERSHED: Taelayag	RIVER-S3	0.97	0.97	0.00	3
Pago River 1	GUPGRP-1-51A	WATERSHED: Pago	RIVER-S2	0.06	0.06	0.06	5
Pago River 2	GUPGRP-2	WATERSHED: Pago	RIVER-S3	4.74	4.74	4.74	5
Pago River 3	GUPGEP	WATERSHED: Pago	RIVER-S3	0.54	0.54	0.00	3
Pago River 4	GUPGMPW	WATERSHED: Pago	RIVER-S3	0.52	0.52	0.52	3
Paulituc River	GUINRAP	WATERSHED: Dandan	RIVER-S3	4.93	4.55	0.00	3
Pigua River 1	GUMZRP	WATERSHED: Toguan	RIVER-S3	0.18	0.18	0.00	3
Pigua River 2	GUMZRP-2	WATERSHED: Toguan	RIVER-S3	1.50	1.50	0.00	3
Sadog Gago River	GUFLRSG-1	WATERSHED: Talofofo	RIVER-S1	0.52	0.52	0.00	3
Sagua River	GUATRSG	WATERSHED: Taelayag	RIVER-S3	0.58	0.53	0.00	3
Salinas River	GUATRS	WATERSHED: Agat	RIVER-S3	0.78	0.47	0.00	3
Sarasa River 1	GUTURS-1	WATERSHED: Talofofo	RIVER-S2	0.05	0.05	0.00	3
Sarasa River 2	GUTURT-2-48B	WATERSHED: Talofofo	RIVER-S2	2.25	2.25	0.00	3
Malaja/Sagge Tinechong River	GUTURT-2	WATERSHED: Talofofo	RIVER-S2	7.59	7.59	0.00	3
Sasa River 1	GUAPRS-1	WATERSHED: Apra	RIVER-S3	0.85	0.85	0.00	3
Sasa River 2	GUAPRS-2	WATERSHED: Apra	RIVER-S3	1.36	1.15	0.00	3
Sella River	GUULRS	WATERSHED: Cetti	RIVER-S2	2.55	2.49	0.00	3
Sigua River	GUPGRS	WATERSHED: Pago	RIVER-S1	6.15	6.13	0.00	3
Sumay River	GUMZRSY	WATERSHED: Manell	RIVER-S2	1.06	1.02	1.02	5
Storm Drain	GUAGRD	WATERSHED: Northern	RIVER-S2	0.21	0.21	0.21	5

Table 24. 2020 GUAM ASSESSMENT DATA FOR RIVERS-STREAMS

Taelayag Creek	GUATRTA	WATERSHED: Taelayag	RIVER-S3	1.37	1.34	0.00	3
Taleyfac River	GUATRT-2	WATERSHED: Taelayag	RIVER-S3	3.85	3.79	3.79	2
Talofofo River 2	GUTUETO	WATERSHED: Talofofo	RIVER-S3	0.46	0.46	0.46	2
Talofofo River 3	GUTUETU-48A	WATERSHED: Talofofo	RIVER-S2	0.96	0.96	0.00	3
Talofofo River 1	GUTURT-2-48A	WATERSHED: Talofofo	RIVER-S2	2.09	2.09	0.00	3
Togcha River 1	GUTURTG-C	WATERSHED: Togcha	RIVER-S3	0.99	0.99	0.00	3
Togcha River 2	GUTURTG-1A	WATERSHED: Togcha	RIVER-S3	0.95	0.93	0.00	3
Togcha River 3	GUTURTG-2	WATERSHED: Togcha	RIVER-S3	0.06	0.06	0.00	3
Togcha River 4	GUTURTG-X	WATERSHED: Togcha	RIVER-S3	0.04	0.04	0.00	3
Togcha River 5	GUTURTG-1C	WATERSHED: Togcha	RIVER-S3	0.50	0.50	0.50	3
Togcha River 6	GUTURTG-1B	WATERSHED: Togcha	RIVER-S3	0.08	0.08	0.00	3
Togcha River (Agat)	GUATRTO	WATERSHED: Agat	RIVER-S3	1.10	0.87	0.00	3
Toguan River 1	GUMZRT-2	WATERSHED: Toguan	RIVER-S3	0.20	0.20	0.20	2
Toguan River 2	GUMZRT-1	WATERSHED: Toguan	RIVER-S3	1.21	1.21	0.00	3
Unnamed Creek 1	GUASRI-2	WATERSHED: Piti/Asan	RIVER-S3	0.19	0.06	0.06	3
Unnamed Creek 2	GUASRI-1	WATERSHED: Piti/Asan	RIVER-S3	0.17	0.17	0.00	3
Ugum River 1	GUTURU2	WATERSHED: Ugum	RIVER-S2	1.05	1.05	1.05	4a
Ugum River 2	GUTURU-1A	WATERSHED: Ugum	RIVER-S2	12.57	12.57	12.57	4a
Ugum River 3	GUTURU-1B	WATERSHED: Ugum	RIVER-S2	0.18	0.18	0.18	4a
Ugum River 4	GUTUETU-48H	WATERSHED: Talofofo	RIVER-S3	0.39	0.39	0.39	4a

Table 24. 2020 GUAM ASSESSMENT DATA FOR RIVERS-STREAMS

Ugum River 5	GUTURU-1C	WATERSHED: Ugum	RIVER-S2	2.96	2.96	2.96	4a
Ugum River 6	GUTURU-1A-48H	WATERSHED: Ugum	RIVER-S2	4.43	4.43	4.43	4a
Umatac River	GUULRU-2	WATERSHED: Umatac	RIVER-S3	0.92	0.74	0.74	2
Ylig River 1	GUYNRY-1	WATERSHED: Ylig	RIVER-S3	23.57	23.47	0.00	3
Ylig River 2	GUYNRY-2	WATERSHED: Ylig	RIVER-S3	3.33	3.33	0.00	3
Ylig River 3	GUYNRY-3	WATERSHED: Ylig	RIVER-S3	0.41	0.41	0.00	3
Unnamed River 1	GUULRCR	WATERSHED: Cetti	RIVER-S2	0.36	0.30	0.00	3
Unnamed River 2	GUINRAGB	WATERSHED: Inarajan	RIVER-S3	0.95	0.06	0.06	3
Almagosa River	GUFLRA-2	WATERSHED: Talofofo	RIVER-S1	2.23	2.18	0.00	3
Unnamed River 3	GUG-35	WATERSHED: Manell	RIVER-S2	1.06	0.00	0.00	3
Unnamed Tributary 2	GUG-43A	WATERSHED: Inarajan	RIVER-S3	0.58	0.00	0.00	3
Unnamed Tributary 3	GUG-43B	WATERSHED: Inarajan	RIVER-S3	0.58	0.00	0.00	3
Unnamed Stream 1	GUG-55	WATERSHED: Talofofo	RIVER-S1	0.38	0.00	0.00	3
Intermittent Tributary 1	GUG-43C	WATERSHED: Inarajan	RIVER-S3	1.17	0.00	0.00	3
Intermittent Tributary 2	GUG-43D	WATERSHED: Inarajan	RIVER-S3	0.37	0.00	0.00	3
Intermittent Tributary 3	GUG-43E	WATERSHED: Inarajan	RIVER-S3	0.24	0.00	0.00	3
Intermittent Tributary 4	GUG-43F	WATERSHED: Inarajan	RIVER-S3	0.58	0.00	0.00	3
Taguag River	GUG-5	WATERSHED: Piti/Asan	RIVER-S3	0.62	0.00	0.00	3
Auau Creek	GUG-16	WATERSHED: Agat	RIVER-S3	0.86	0.00	0.00	3
Bile River	GUG-30	WATERSHED: Toguan	RIVER-S3	0.64	0.00	0.00	3

Table 24. 2020 GUAM ASSESSMENT DATA FOR RIVERS-STREAMS

Suyafe River	GUG-36	WATERSHED: Manell	RIVER-S2	0.88	0.00	0.00	3
Asgado Creek	GUG-39	WATERSHED: Manell	RIVER-S2	0.59	0.00	0.00	3
Asmalle River	GUG-40	WATERSHED: Manell	RIVER-S2	0.77	0.00	0.00	3
Tongan Creek	GUG-42	WATERSHED: Inarajan	RIVER-S3	0.86	0.00	0.00	3
Agfayan River	GUG-43	WATERSHED: Inarajan	RIVER-S3	3.15	0.00	0.00	3
Unnamed Tributary 4	GUG-57B	WATERSHED: Talofofo	RIVER-S3	0.82	0.00	0.00	3
Tolaeyuus River	GUG-60	WATERSHED: Talofofo	RIVER-S1	0.39	0.00	0.00	3
Talisay River	GUG-61	WATERSHED: Talofofo	RIVER-S1	3.72	0.00	0.00	3
Unnamed Tributary 5	GUG-62	WATERSHED: Talofofo	RIVER-S1	0.28	0.00	0.00	3
Unnamed Tributary 6	GUG-63	WATERSHED: Talofofo	RIVER-S1	0.22	0.00	0.00	3
Maemong River	GUG-64	WATERSHED: Talofofo	RIVER-S1	2.71	0.00	0.00	3
Unnamed Tributary 7	GUG-65	WATERSHED: Talofofo	RIVER-S1	0.57	0.00	0.00	3
Unnamed Tributary 8	GUG-66	WATERSHED: Talofofo	RIVER-S1	0.66	0.00	0.00	3
Intermittent Tributary 5	PGRL-1	WATERSHED: PAGO	RIVER-S3	3.07	3.07	0.00	3

indicating that one designated use is not supported and that a TMDL is needed. The Sumay, Liyog, and Ajayan Rivers have been 303(d) listed for the reporting period.

SUMMARY:

Reporting Category and # of rivers	Miles	% of Assessable Miles
C2 – At least one designated use met; more information needed (12)	15.61	7.72%
C3 – No information available to make designated use determination (105)	151.24	74.79%
C4a – TMDL approved[16] (6)	21.58	10.67%
C5 – Waterbody impaired; TMDL needed (10)	13.79	6.82%

Total assessable miles: 202.22

List of 303(d) (Impaired) Rivers/Streams: Category 5

Impaired River/Stream	*Assessment ID:*	*Size:*
1. Agana River 1	GUAGRA-3	0.52 mi
2. Agana River 2	GUAGRA-2-1A	0.67 mi
3. Lonfit River 2	GUPGRL-2	1.07 mi
4. Lonfit River 3	GUPGRP-1-51B	0.04 mi
5. Pago River 1	GUPGRP-1-51A	0.06 mi
6. Pago River 2	GUPGRP-2	4.74 mi
7. Storm Drain	GUAGRD	0.21 mi
8. Sumay River	GUMZRSY	1.02 mi
9.Liyog River	GUMZRL	1.81mi
10.Ajayan River	GUMZRAJ	3.86 mi

Refer to **Table 13** for clarification about Guam Surface Water Classifications S1, S2, S3 and respective designated uses assigned to those waters.

3.0 Near Coastal and Marine Waters

3.1 Coastal and Recreational Waters

Guam Coastal/Recreational waters were assessed only for the Goal: "Protect and Enhance Public Health" and the Use: "Primary Contact/Swimming and Secondary

[16] The Ugum River was de-listed in the 2006 reporting period. It has an EPA approved TMDL.

Contact". All other Goal and Use categories were considered "Not Applicable". **Recreational beach sizes (miles)** are delineated using best professional judgment based on accessibility and existing sandy shorelines. **Table 10** in **APPENDIX A**, (pp. 22-23) provides Individual Recreational Beach Use-Support Assessment information for the reporting period.

EPA approved Bacteria TMDLs have been developed for Guam's 43 RBMP sites. These beaches are categorized as 4a waterbodies in **Table 25**.

Guam listed Gabgab Beach as an impaired waterbody because a Fish Consumption Advisory remains in effect for that waterbody.

Table 25 provides assessment data for one hundred sixteen (116) assessment units representing one hundred two (102) Guam Beaches.

3.2. Marine Bays

Table 26 provides 2018-2019 assessment data for Guam's population of 66 Marine Bays. Eleven (11) Marine Bays reported under Category 5 include:

Waterbody Name/Assessment ID	Assessed Water Size	Reason for Impaired Status
1. Agat Bay 1/GUG-10B-1	0.63 square miles	Fish Advisory
2. Tipalao Bay/GUG-010A	0.10 square miles	Fish Advisory
3. Apra Harbor 2/GUG-008A-2	4.61 square miles	Fish Advisory
4. Apra Harbor 1/GUG-008A-1	0.05 square miles	Fish Advisory
5. North Orote Peninsula Sea Cliffs/GUG-042	0.23 square miles	Fish Advisory
6. South Orote Peninsula Sea Cliffs/GUG-043	0.02 square miles	Fish Advisory
7. Cocos Lagoon 1/GUG-20A-1	5.70 square miles	Fish Advisory
8. Cocos Lagoon 2/GUG-20A-2	.34 square miles	Fish Advisory
9. Pago Bay/GUG003A	0.70 square miles	>10% samples Exceed WQS
10. Tanguisson Beach 2/GUG-001B-2	0.40 square miles	Seafood Consumption Advisory
11. Tumon Bay/GUG-001C	1.98 square miles	Waters not attaining designated uses
TOTALS:	**11 Marine Bays**	**14.76 square miles of impaired waters**

Waterbodies impaired by Fish Advisories are under continuing investigation/restoration by the Department of Defense. See **Table 28.**

- 15 marine bays were assessed and placed under Reporting Category 2;
- 40 marine bays were not assessed. These waterbodies reported under Category 3.

Table 25. 2020 GUAM ASSESSMENT DATA FOR COASTAL/RECREATIONAL WATERS

Waterbody Name	Assessment Unit ID	Location	Coastal Water Classification (Designated Use)	Water Size in Miles	Waterbody Status	Reporting Category
Tarague and Scout Beach	GU-GB1	Tarague and Scout Beach	M1	3.42	NOT ASSESSED	3
Jinapsan Beach	GU-GB3	Jinapsan Beach	M1	1.28	NOT ASSESSED	3
Ritidian Beach	GU-GB4	Ritidian Beach	M1	2.21	NOT ASSESSED	3
Uruno Beach	GU-GB5	Uruno Beach	M1	1.74	NOT ASSESSED	3
Falcona Beach (Urunao)	GU-GB6	Falcona Beach (Urunao)	M1	0.37	NOT ASSESSED	3
South of Falcona Beach (Urunao)	GU-GB7	South of Falcona Beach (Urunao)	M1	0.24	NOT ASSESSED	3
Haputo Beach	GU-GB8	Haputo Beach	M1	0.19	NOT ASSESSED	3
Intermittent Beach - Shark's Hole	GU-GB9	Intermittent Beach - Shark's Hole	M1	0.19	NOT ASSESSED	3
Intermittent Beach - Tanguisson Pt.	GU-GB10	Intermittent Beach - Tanguisson Pt.	M2	0.26	NOT ASSESSED	3
Intermittent Beach - NorthTanguisson	GU-GB11	Intermittent Beach - North of NCS/Tanguisson	M2	0.26	NOT ASSESSED	3
Fafai Beach	GU-GB13	Fafai Beach	M2	0.37	NOT ASSESSED	3
Alupang Island Beach, East Hagatna Bay	GU-GB21	Alupang Island Beach, East Hagatna Bay	M2	0.02	NOT ASSESSED	3
West of volcanic headland, Asan Bay	GU-GB29	West of volcanic headland, Asan Bay	M2	0.37	NOT ASSESSED	3
Ski Beach	GU-GB38	Ski Beach	M3	0.40	NOT ASSESSED	3
SRF Beach	GU-GB40	SRF Beach	M3	0.40	NOT ASSESSED	3
Marianas Yacht Club Beach, Sasa Bay	GU-GB41	Marianas Yacht Club Beach, Sasa Bay	M2	0.18	NOT ASSESSED	3
Polaris Beach	GU-GB42	Polaris Beach	M2	0.19	NOT ASSESSED	3
Gabgab Beach	GU-GB43	Gabgab Beach	M2	0.65	IMPAIRED	5
Orote Point Beaches	GU-GB44	Orote Point Beaches	M1	0.21	NOT ASSESSED	3
Tipalao Beach	GU-GB45	Tipalao Beach	M2	0.15	NOT ASSESSED	3
Dadi Beach	GU-GB46	Dadi Beach	M2	0.57	NOT ASSESSED	3

Table 25. 2020 GUAM ASSESSMENT DATA FOR COASTAL/RECREATIONAL WATERS

Rizal Beach	GU-GB47	Rizal Beach	M2	0.26	NOT ASSESSED	3
Apaca Park Beach	GU-GB48	Apaca Park Beach	M2	0.14	NOT ASSESSED	3
Salinas Beach	GU-GB51	Salinas Beach	M2	0.49	NOT ASSESSED	3
Taelayag Beach	GU-GB56	Taelayag Beach	M1	0.87	NOT ASSESSED	3
Sagua Beach	GU-GB57	Sagua Beach	M1	0.62	NOT ASSESSED	3
Facpi Point Beaches	GU-GB58	Facpi Point Beaches	M1	0.66	NOT ASSESSED	3
Beach south of Achugao	GU-GB59	Beach south of Achugao	M1	0.29	NOT ASSESSED	3
Beach south of Agaga River	GU-GB60	Beach south of Agaga River	M1	0.25	NOT ASSESSED	3
Beach north of Asmafines River	GU-GB62	Beach north of Asmafines River	M1	0.12	NOT ASSESSED	3
Beach south of Sella River	GU-GB63	Beach south of Sella River	M1	0.12	NOT ASSESSED	3
Abong Beach	GU-GB64	Abong Beach	M1	0.62	NOT ASSESSED	3
Mouth of Cetti Bay	GU-GB65	Mouth of Cetti Bay	M1	0.50	NOT ASSESSED	3
Head of Fouha Bay	GU-GB66	Head of Fouha Bay	M1	0.06	NOT ASSESSED	3
South of Machadgan Point	GU-GB68	South of Machadgan Point	M2	0.25	NOT ASSESSED	3
Ajmo Beach	GU-GB70	Ajmo Beach	M2	0.16	NOT ASSESSED	3
Bile Bay Beach	GU-GB71	Bile Bay Beach	M2	0.03	NOT ASSESSED	3
Pigua River Beach	GU-GB72	Pigua River Beach	M2	0.08	NOT ASSESSED	3
Cocos Island	GU-GB73	Cocos Island	M1	1.16	NOT ASSESSED	3
Islet	GU-GB74	Islet	M1	0.07	NOT ASSESSED	3
Piga Beach/Talona Beach	GU-GB76	Piga Beach/Talona Beach	M2	0.42	NOT ASSESSED	3
Aba Beach	GU-GB78	Aba Beach	M1	0.19	NOT ASSESSED	3
Aang Beach	GU-GB79	Aang Beach	M1	0.12	NOT ASSESSED	3
ACHANG BAY	GU-GB80	ACHANG BAY	M1	0.55	NOT ASSESSED	3

Table 25. 2020 GUAM ASSESSMENT DATA FOR COASTAL/RECREATIONAL WATERS

Beach to Liyog River Mouth	GU-GB81	Beach to Liyog River Mouth	M1	0.77	NOT ASSESSED	3
Liyog river Mouth	GU-GB82	Liyog river Mouth	M1	0.18	NOT ASSESSED	3
Beach to Asgadao Bay	GU-GB83	Beach to Asgadao Bay	M1	0.04	NOT ASSESSED	3
Intermittent Beach, Asgadao Bay	GU-GB84	Intermittent Beach 1, Asgadao Bay	M1	0.12	NOT ASSESSED	3
Intermittent Beach 1, Ajayan Bay	GU-GB85	Intermittent Beach 2, Asgadao Bay	M1	0.12	NOT ASSESSED	3
Intermittent Beach 2, Ajayan Bay	GU-GB86	Intermittent Beach 3, Asgadao Bay	M1	0.09	NOT ASSESSED	3
Ajayan River Mouth 1	GU-GB87	Ajayan River Mouth	M1	0.03	NOT ASSESSED	3
Intermittent Beach 3, Ajayan Bay	GU-GB88	Intermittent Beach 4, Asgadao Bay	M1	0.09	NOT ASSESSED	3
Ajayan River Mouth 2	GU-GB89	Ajayan River Mouth	M1	0.06	NOT ASSESSED	3
Intermittent Beach 4, AJAYAN BAY	GU-GB90	Intermittent beach at AJAYAN BAY	M1	0.09	NOT ASSESSED	3
Aga Beach	GU-GB91	Aga Beach	M1	0.08	NOT ASSESSED	3
Guijen Rock area	GU-GB92	Guijen Rock area	M1	0.44	NOT ASSESSED	3
Atao Beach	GU-GB93	Atao Beach	M1	0.38	NOT ASSESSED	3
Beach north of Acho Point	GU-GB94	Beach north of Acho Point	M1	0.27	NOT ASSESSED	3
Agfayan River Beach	GU-GB95	Agfayan River Beach	M2	0.07	NOT ASSESSED	3
Beach at Pauliluc Bay	GU-GB98	Beach at Pauliluc Bay	M2	0.28	NOT ASSESSED	3
ULOMAI BEACH	GU-GB99	ULOMAI BEACH	M2	0.11	NOT ASSESSED	3
Perez Beach	GU-GB101	Perez Beach	M2	0.26	NOT ASSESSED	3
Asiga Beach Area (Inarajan)	GU-GB102	Asiga Beach Area (Inarajan)	M1	0.22	NOT ASSESSED	3
Head of Paicpouc Cove	GU-GB103	Head of Paicpouc Cove	M2	0.09	NOT ASSESSED	3
Calvos Beach	GU-GB108	Calvos Beach	M2	0.51	NOT ASSESSED	3
Jones Beach	GU-GB110	Jones Beach	M2	0.09	NOT ASSESSED	3
North of Togcha Point	GU-GB114	North of Togcha Point	M2	1.03	NOT ASSESSED	3

Table 25. 2020 GUAM ASSESSMENT DATA FOR COASTAL/RECREATIONAL WATERS

Head of Ylig Bay	GU-GB115	Head of Ylig Bay	M2	0.18	NOT ASSESSED	3
Beach North of Ylig Bay	GU-GB116	Beach North of Ylig Bay	M2	0.07	NOT ASSESSED	3
North Pago Bay Beach	GU-GB119	North Pago Bay Beach	M2	0.24	NOT ASSESSED	3
Asan Bay Beach	GUN-14	Asan Memorial Beach, Head of Asan Bay	M2	0.46	IMPAIRED	4a
Adelup Beach Park	GUN-21	Beach at Fonte River, West Hagatna Bay	M2	0.13	IMPAIRED	4a
Inarajan Bay	GUS-10	Beach at Inarajan Bay	M2	0.56	IMPAIRED	4a
Beach at Pago Bay	GUS-15	Pago Bay	M2	0.96	IMPAIRED	4a
USO Beach 1	GUN-16	Santos Memorial Park Beach	M2	0.52	IMPAIRED	4a
USO Beach 2	GUN-17	United Seamen's Service	M2		IMPAIRED	4a
Piti Bay/Tepungan Beach	GUN-15	Piti Bay	M2	1.16	IMPAIRED	4a
Togcha Bay	GUS-13	Beach North of Togcha River	M2	0.27	IMPAIRED	4a
Dungca's Beach - Sleepy Lagoon	GUN-06	Dungca's Beach East Hagatna Bay	M2	0.99	IMPAIRED	4a
Dungca's Beach	GUN-07	Dungca's Beach East Hagatna Bay	M2		IMPAIRED	4a
Family Beach	GUN-19	Family Beach	M2	0.15	IMPAIRED	4a
Ipan Point Beach	GUS-18	First Beach	M2	0.06	IMPAIRED	4a
Gognga Beach North San Vitores	GUN-25	Gognga Beach, Tumon Bay	M2	0.15	IMPAIRED	4a
Gun Beach	GUN-24	Gun Beach, Tumon Bay	M2	0.23	IMPAIRED	4a
Hagatna Channel - Outrigger Ramp	GUN-11	Hagatna Marina	M2	0.15	IMPAIRED	4a
Hagatna Boat Basin	(GUN-12)	Hagatna Marina	M2	0.43	IMPAIRED	4a
Hagatna Channel	GUN-10	Hagatna Marina	M2		IMPAIRED	4a
Talofofo Bay	GUS-11	Head of Talofofo Bay	M2		IMPAIRED	4a
Umatac Bay	GUS-06	Head of Umatac Bay	M2	0.14	IMPAIRED	4a
Inarajan Pool	GUS-09	Inarajan Pools	M2	0.08	IMPAIRED	4a

Table 25. 2020 GUAM ASSESSMENT DATA FOR COASTAL/RECREATIONAL WATERS

Merizo Pier - Mamaon Channel	GUS-08	Merizo Public Pier Park	M2	0.46	IMPAIRED	4a
Tanguisson Beach	GUN-01	NCS Beach /Tanguisson Beach	M2	0.25	IMPAIRED	4a
Naton Beach- Guma Trankilidat	GUN-04	Naton Beach, Tumon Bay	M2	1.11	IMPAIRED	4a
Naton Beach - San Vitores	GUN-02	Naton Beach, Tumon Bay	M2		IMPAIRED	4a
Naton Beach - Fujita	GUN-23	Naton Beach, Tumon Bay	M2		IMPAIRED	4a
Naton Beach - Matapang Beach Park	GUN-03	Naton Beach Matapang Beach Park	M2		IMPAIRED	4a
Beach North of Finile River	GU-GB52	Bangi Beach	M2	D	IMPAIRED	4a**
Beach South of Finile River	GUS-04	Bangi Beach	M2	0.88	IMPAIRED	4a
Nimitz Beach	GUS-05	Nimitz Beach	M2	0.56	IMPAIRED	4a
Outhouse Beach	GUN-18	Outhouse Beach	M3	0.46	IMPAIRED	4a
Port Authority Beach	GUN-20	Port Authority Beach	M3	0.46	IMPAIRED	4a
Tagachang Beach Park	GUS-14	Tagachang Beach	M2	0.18	IMPAIRED	4a
Toguan Bay	GUS-07	Toguan Bay	M2	0.46	IMPAIRED	4a
Togcha Beach Southern Christian Academy	GUS-17	Togcha Beach -aka Agat Beach	M2	0.79	IMPAIRED	4a
Togcha Beach (small cemetery)	GUS-25		M2		IMPAIRED	4a**
Togcha Beach Namo Bay	GUS-02		M2		IMPAIRED	4a
Togcha Bay Agat Beach	GUS-03		M2		IMPAIRED	4a
Trinchera Beach, East Hagatna Bay	GUN-08	Trinchera Beach East Hagatna Bay	M2	1.16	IMPAIRED	4a
Trinchera Beach, Alupang Beach Towers	GUN-26		M2		IMPAIRED	4a
Padre Palomo	GUN-09		M2		IMPAIRED	4a
West Hagatna Beach	GUN-13	Hagatna Bayside Park	M2	1.11	IMPAIRED	4a
West Hagatna Beach 2	GUN-27	West Hagatna Bay- Park	M2		IMPAIRED	4a**
West Hagatna Beach 3	GUN-28	West Hagatna Bay- West Stormdrain	M2		IMPAIRED	4a**

Table 25. 2020 GUAM ASSESSMENT DATA FOR COASTAL/RECREATIONAL WATERS

West of Adelup Point, Asan Bay	GUN-22	Beach West of Adelup	M2	0.41	IMPAIRED	4a
Ypan Beach Park Beach (Ipan Public Beach)	GUS-12	Ipan Beach	M2	0.30	IMPAIRED	4a
Ypao Beach, Tumon Bay	GUN-05	Ypao Beach	M2	0.42	IMPAIRED	4a

4a** - Supplemental assessment sites for an approved Bacteria TMDL Beach

Table B5b in **Appendix B** shows applicable **Categories of Causes/Stressors** (i.e. Unknown toxicity, Pesticides, PCBs, etc.) which contribute to the impairment of Guam's Marine Bays.

Table B6b in Appendix B shows the applicable **Source Categories** (i.e. Industrial Point Sources, Combined Sewer Overflows, Agriculture, etc.) which contribute to the impairment of Guam's Marine Bays.

4.0 Wetlands

Table 27 provides a list of nineteen Guam wetlands totaling about 1,964.48 acres. The Agana Swamp[17], Guam's largest freshwater marsh, is impaired with 6.4 acres subject to an on-going Fish Consumption Advisory because of PCBs in fish tissue. No assessment data is available for the remaining eighteen wetlands.

5.0 Results of Probability-based Surveys

No surveys this reporting period.

6.0 Section 303(d) List

The Clean Water Act and EPA regulations require Guam to submit a list of water quality-limited (impaired and threatened) waters still requiring Total Maximum Daily Loads (TMDLs), the pollutants causing the impairment, and priority ranking for TMDL development. Guam's 303(d) list for 2020 is provided in **Table 28.**

Guam EPA followed the EPA's 2006 Integrated Report Guidance in evaluating available data/information and identifying impaired waters. Guam EPA considered how data was collected and analyzed and placed greater weight on data collected using approved quality assurance/quality control plans and procedures.

The following criteria were used to identify waters as impaired:

- 10% of annual samples of conventional pollutant (e.g., bacteria, sediment, and nutrients) exceeded currently applicable Guam numeric water quality standards;
- Numeric water quality standards for toxic pollutants were exceeded in two or more samples collected in any three year period;
- Aquatic sediment and/or fish tissue data results indicated that pollutants were present in sediment and/or fish tissue at levels of concern or at levels that exceed commonly applied screening guidelines;
- Coral reef assessment results found that the health of individual reef and lagoon areas were impaired due to pollutant discharges, such as sediment runoff from

[17] See page 51, Part III. F. Consumption Concerns, Section 3.2.2. Agana Swamp.

Table 26. 2020 GUAM ASSESSMENT DATA FOR MARINE BAYS

Waterbody Name	Assessment Unit ID	WATERSHED Location	Water Classification	Water Size (Sq. Mi.)	Square Miles Assessed	Water Status	Reporting Category
AGAT BAY 1	GUG-010B-1	AGAT	M2	0.63	0.63	IMPAIRED	5
AGAT BAY 2	GUG-010B-2	AGAT	M2	1.91	1.91	ASSESSED	2
TIPALAO BAY	GUG-010A	AGAT	M2	0.10	0.10	IMPAIRED	5
APRA HARBOR 2	GUG-008A-2	APRA	M2	4.61	4.61	IMPAIRED	5
APRA HARBOR 3	GUG-008A-3	APRA	M3	0.42	0.42	ASSESSED	2
APRA HARBOR 1	GUG-008A-1	APRA	M1	0.05	0.05	IMPAIRED	5
COCOS LAGOON 1	GUG-020A-1	GEUS	M1	5.70	5.70	IMPAIRED	5
COCOS LAGOON 2	GUG-020A-2		M2	0.34	0.34	IMPAIRED	5
CETTI BAY	GUG-014A	CETTI	M1	0.65	0.00	NOT ASSESSED	3
PAGO BAY	GUG-003A	PAGO	M2	0.70	0.70	IMPAIRED	5
WEST HAGATNA BAY	GUG-002A	HAGATNA & FONTE	M2	1.56	1.56	ASSESSED	2
EAST HAGATNA BAY	GUG-001D	NORTHERN	M2	0.93	0.93	ASSESSED	2
AGFAYAN BAY: INARAJAN POOLS	GUG-017A	INARAJAN	M2	0.08	0.08	ASSESSED	3
AGFAYAN BAY	GUG-017C	INARAJAN	M2	0.08	0.00	NOT ASSESSED	3
DOUBLE REEF	GUG-001A	NORTHERN	M1	0.64	0.00	NOT ASSESSED	3
TANGUISSON BEACH 2	GUG-001B-2	NORTHERN	M2	0.40	0.40	IMPAIRED	5
TANGUISSON BEACH 1	GUG-001B-1	NORTHERN	M1	0.29	0.00	NOT ASSESSED	3
TALEYFAC BAY 1	GUG-012A-1	TAELAYAG	M1	0.71	0.00	NOT ASSESSED	3
TALEYFAC BAY 2	GUG-012A-2	TAELAYAG	M2	0.37	0.37	ASSESSED	3
TALOFOFO BAY	GUG-011A	TALOFOFO	M2	0.15	0.15	ASSESSED	2
TOGCHA BAY	GUG-007A	TOGCHA	M2	0.41	0.41	ASSESSED	2
TUMON BAY	GUG-001C	NORTHERN	M2	1.98	1.98	IMPAIRED	5
FOUHA BAY	GUG-016A	UMATAC	M1	0.26	0.00	NOT ASSESSED	3
UMATAC BAY 1	GUG-016B-1	UMATAC	M1	0.06	0.00	NOT ASSESSED	3

Table 26. 2020 GUAM ASSESSMENT DATA FOR MARINE BAYS

UMATAC BAY 2	GUG-016B-2	UMATAC	M2	0.34	0.34	ASSESSED	3
YLIG BAY	GUG-005A	YLIG	M2	0.45	0.00	NOT ASSESSED	3
RITIDIAN POINT BEACH AREA	GUG-047	NORTHERN	M1	1.42	0.00	NOT ASSESSED	3
URUNO BEACH AREA	GUG-058	NORTHERN	M1	0.58	0.00	NOT ASSESSED	3
FALCONA BEACH AREA	GUG-031	NORTHERN	M1	0.19	0.00	NOT ASSESSED	3
HAPUTO BEACH AREA	GUG-033	NORTHERN	M1	0.07	0.00	NOT ASSESSED	3
SOUTH HAPUTO BEACH AREA	GUG-051	NORTHERN	M1	0.20	0.00	NOT ASSESSED	3
OKA POINT	GUG-041	NORTHERN	M2	0.20	0.00	NOT ASSESSED	3
ASAN BAY	GUG-006A	PITI/ASAN	M2	0.58	0.58	ASSESSED	2
PITI BAY	GUG-006B	PITI/ASAN	M2	1.35	1.35	ASSESSED	2
LUMINAO REEF/CALALA BANK	GUG-037	PITI/ASAN	M2	1.17	0.00	NOT ASSESSED	3
PITI CHANNEL/ CABRAS ISLAND	GUG-045	PITI/ASAN	M3	0.24	0.24	ASSESSED	3
SASA BAY	GUG-052	APRA	M2	0.74	0.00	NOT ASSESSED	3
NORTH OROTE PENINSULA SEA CLIFFS	GUG-042	APRA	M1	0.23	0.23	IMPAIRED	5
SOUTH OROTE PENINSULA SEA CLIFFS	GUG-043	APRA	M2	0.02	0.02	IMPAIRED	5
SOUTH FACPI POINT BEACHES/ROCKY SHORELINES	GUG-054	TAELAYAG	M1	0.66	0.00	NOT ASSESSED	3
SELLA BAY	GUG-053	CETTI	M1	0.27	0.00	NOT ASSESSED	3
TOGUAN BAY	GUG-018A	TOGUAN	M2	0.26	0	NOT ASSESSED	3
BILE BAY	GUG-030	TOGUAN	M2	0.17	0	NOT ASSESSED	3
SUMAY BAY	GUG-055	MANELL	M1	0.79	0.00	NOT ASSESSED	3
ASGADAO BAY	GUG-027	MANELL	M1	0.56	0.00	NOT ASSESSED	3
AJAYAN BAY	GUG-026	MANELL	M1	0.24	0.00	NOT ASSESSED	3
AGA BAY	GUG-025	MANELL	M1	0.10	0.00	NOT ASSESSED	3
INARAJAN REEF FLAT	GUG-034	INARAJAN	M1	0.82	0.00	NOT ASSESSED	3
INARAJAN BAY	GUG-017B	INARAJAN	M2	0.17	0.17	ASSESSED	3
GUAIFAN POINT REEF FLAT	GUG-032	DANDAN	M2	0.08	0.00	NOT ASSESSED	3

Table 26. 2020 GUAM ASSESSMENT DATA FOR MARINE BAYS

PAULILUC BAY	GUG-044	DANDAN	M2	0.08	0.00	NOT ASSESSED	3
ULOMAI BEACH AREA	GUG-057	DANDAN	M2	0.09	0.00	NOT ASSESSED	3
NOMNA BAY	GUG-039	DANDAN	M2	0.17	0.00	NOT ASSESSED	3
NOMNA POINT REEF FLAT	GUG-040	DANDAN	M1	0.32	0.00	NOT ASSESSED	3
ASIGA POINT BEACH AREA	GUG-028	DANDAN	M1	0.16	0.00	NOT ASSESSED	3
MATALA POINT REEF FLAT	GUG-038	DANDAN	M1	0.25	0.00	NOT ASSESSED	3
TALOFOFO BEACHES	GUG-007B	TALOFOFO	M2	0.61	0.61	ASSESSED	3
BEACH NORTH OF TOGCHA POINT	GUG-029	YLIG	M2	0.53	0.00	NOT ASSESSED	3
TAGACHANG BEACH PARK	GUG-005B	YLIG	M2	0.24	0.24	ASSESSED	3
S. FADIAN POINT	GUG-049	NORTHERN	M2	0.58	0.00	NOT ASSESSED	3
N. FADIAN POINT	GUG-046	NORTHERN	M1	0.56	0.00	NOT ASSESSED	3
S. JANUM POINT	GUG-050	NORTHERN	M1	2.29	0.00	NOT ASSESSED	3
JANUM POINT REEF FLAT	GUG-035	NORTHERN	M1	0.09	0.00	NOT ASSESSED	3
PATI POINT	GUG-048	NORTHERN	M1	5.35	0.00	NOT ASSESSED	3
TARAGUE BEACH	GUG-056	NORTHERN	M1	3.09	0.00	NOT ASSESSED	3
JINAPSAN BEACH	GUG-036	NORTHERN	M1	0.75	0.00	NOT ASSESSED	3

the land and groundwater discharge high in nutrients;
- Other data and information indicated that a specific water quality standard was exceeded based on the professional judgment of Guam EPA staff.

All waterbody and pollutant listings received a priority ranking of high, medium, or low. Waters with high priority rankings will be targeted for TMDL development within the next two years as required by 40 CFR 130.7. Guam EPA intends to work with interested parties and EPA to determine the schedule for future TMDL development. Guam has forty-three EPA approved TMDLs.

For all waters identified for inclusion on the Section 303(d) impaired waters list, the Agency set priority rankings to guide Total Maximum Daily Load (TMDL) development. [TMDLs identify allowable pollutant loads to a waterbody, from both point and non-point sources, that will prevent a violation of water quality standards. When TMDLs are developed, the causes of water quality problems are identified]

TMDL Priority rankings were set based on the Guam EPA staff judgments concerning:
- The importance of uses to be made of the water;
- The magnitude of incidences observed;
- The fit of TMDL development work with other assessment, planning, or pollution control activities planned by the Agency; and
- The degree of public interest in or concern about the water body.

6.1 2020 303(d) List (Table 28)

Total Waterbodies: 23

Carried Forward from the 2018 303(d) List: 20
7 Rivers/Streams; 1 Recreational Water; 11 Marine Bays; 1 Wetland

New 303(d) Listed Waterbodies: 3
3 Rivers/Streams

7.0 Clean Lakes Program

Guam does not have any publicly owned lakes. The largest open body of fresh water on the island is the Navy Reservoir known as ***Fena Lake,*** constructed by the Navy in 1951 as a source of drinking water supply; and located in the watershed area on the eastern slope in southern Guam, having an impoundment capacity of approximately 7,182 acre-feet and a surface area of 195 acres. Besides rainwater in the watershed, it receives a water supply supplement from Almagosa and Bona Springs.

TABLE 27. 2020 GUAM ASSESSMENT DATA FOR WETLANDS

Waterbody Name	Assessment Unit ID	WATERSHED Location	STATE	Water Type & Classification	Water Size (Acres)	Acres Assessed	Water Status	Reporting Category
Agana Swamp	GUG-1B	HAGATNA	GU	Wetlands - S2	175.44	6.40	IMPAIRED	5
Barrigada Ponding Basin	GUW-001	NORTHERN	GU	Wetlands - S2	0.74	0.00	Not Assessed	3
Masso Reservoir	GUW-002	PITI/ASAN	GU	Wetlands - S3	4.94	0.00	Not Assessed	3
Sasa Bay Wetlands	GUW-003	APRA	GU	Wetlands - S3	252.05	0.00	Not Assessed	3
Atantano Wetlands	GUW-004	APRA	GU	Wetlands - S3	321.24	0.00	Not Assessed	3
Shell Oil Wetlands	GUW-005	APRA	GU	Wetlands - S3	5.68	0.00	Not Assessed	3
Naval Station Marsh	GUW-006	APRA	GU	Wetlands - S3	98.84	0.00	Not Assessed	3
San Luis Ponds	GUW-007	APRA	GU	Wetlands - S3	18.53	0.00	Not Assessed	3
Namo River Marsh	GUW-008	AGAT	GU	Wetlands - S3	81.54	0.00	Not Assessed	3
Pulantat Marshes	GUW-009	YLIG	GU	Wetlands - S3	4.94	0.00	Not Assessed	3
Naval Magazine Pond	GUW-010	YLIG	GU	Wetlands - S3	1.24	0.00	Not Assessed	3
Fena Valley Reservoir	GUW-011	TALOFOFO	GU	Wetlands - S1	200.16	0.00	Not Assessed	3
Naval Magazine Marshes	GUW-012	TALOFOFO	GU	Wetlands -S1	5.93	0.00	Not Assessed	3
Talofofo River Valley	GUW-013	TALOFOFO	GU	Wetlands - S1	689.42	0.00	Not Assessed	3
Sarasa Marsh	GUW-014	TALOFOFO	GU	Wetlands - S1	6.18	0.00	Not Assessed	3
Assupian Marsh	GUW-015	INARAJAN	GU	Wetlands - S3	1.24	0.00	Not Assessed	3
Yabai Wetland	GUW-016	INARAJAN	GU	Wetlands - S3	2.47	0.00	Not Assessed	3
Agfayan River Valley	GUW-017	INARAJAN	GU	Wetlands - S3	69.19	0.00	Not Assessed	3
Achang Bay Mangroves	GUW-018	GEUS	GU	Wetlands - M1	24.71	0.00	Not Assessed	3

The Navy Water Treatment Plant (NWTP) processes the water from the reservoir and the springs before distribution. Water from these sources is pre-chlorinated before dosing with aluminum sulfate and lime for coagulation. The water then flows into a clarifier where the settled solids are discharged and the clarified water flows to filters for removal of the remaining turbidity. After filtration, the water is chlorinated for disinfection.

FENA RESERVOIR, GUAM

The NWTP was built in the 1950's, but 2007 upgrades have been made to meet the latest EPA water treatment standards. Plant upgrades include an ultra-violet disinfection system that reduces the amount of chlorinated organic compounds in treated water. Additional improvements include the construction of ballasted floc clarifiers that improve plant performance and reduce turbidity (cloudiness) following significant weather disturbances such as typhoons. Other modern plant features include the addition of redundant process treatment units that allow individual units to be taken off-line for maintenance without interruption of service, and the addition of emergency power generation systems that allow the entire plant to remain in operation during power outages.

Fena Lake supplies water, via the NWTP, to the U.S. Navy operations and personnel as well as military dependents; GWA purchases water from the Navy for the civilian population. Fena Reservoir's fresh water is classified as "S-1" water, designated for drinking water (without treatment), aquatic life and human consumption.

D. Wetlands Program

Guam Executive Order (EO) 90-13 and its predecessor EO 78-21 established the basis for an initial integrated wetland protection and management program among a handful of government agencies. These agencies included the Guam Coastal Management Program (GCMP) at the Bureau of Statistics and Plans, the Division of Aquatic and

TABLE 28. 2020 GUAM LIST OF IMPAIRED WATERBODIES

[Clean Water Act, Section 303(d)]

Waterbody Name	Assessment ID	Location	State	Water Type & Classification	Waterbody Size	Unit	Assessed Units	Pollutants	Basis for Listing	Priority Ranking
Agana River 1	GUAGRA-3	WATERSHED: Hagatna	GU	RIVER S2	0.52	MILES	0.52	Enterococcus, Dissolved Oxygen; PCBs in fish tissue	Exceeds WQS >10%of Samples; Fish Advisory (2001)	LOW
Agana River 2	GUAGRA-2-1A	WATERSHED: Hagatna	GU	RIVER S2	0.67	MILES	0.67	PCBs in fish tissue	Fish Advisory (2001)	LOW
Agana Swamp	GUG-1B	WATERSHED: Agana	GU	WETLAND	6.40	ACRES	6.40	PCBs in fish tissue	Fish Advisory (2001)	LOW
Agat Bay 1	GUG-010B-1	WATERSHED: Agat	GU	MARINE BAY M2	0.63	SQUARE MILES	0.63	PCBs in fish tissue, Chlordane in fish tissue, Dioxin in fish tissue	Fish Advisory (2001 & 2002)	LOW
Apra Harbor 1	GUG-008A-2	WATERSHED: Apra	GU	MARINE BAY M1	0.05	SQUARE MILES	0.05	PCBs in fish tissue	Fish Advisory (1999)	LOW
Apra Harbor 2	GUG-008A-1	WATERSHED: Apra	GU	MARINE BAY M2	4.61	SQUARE MILES	4.61	PCBs in fish tissue	Fish Advisory (1999)	LOW
Cocos Lagoon 1	GUG-020A-1	WATERSHED: Geus	GU	MARINE BAY M1	5.70	SQUARE MILES	5.70	PCBs in fish tissue	Fish Advisory (2006)	LOW
Cocos Lagoon 2	GUG-020A-2	WATERSHED: Geus	GU	MARINE BAY M2	0.34	SQUARE MILES	0.34	PCBs in fish tissue	Fish Advisory (2006)	LOW
North Orote Peninsula Sea Cliffs	GUG-042	WATERSHED: Apra	GU	MARINE BAY M1	0.23	SQUARE MILES	0.23	PCBs in fish tissue	Fish Advisory (1999)	LOW
South Orote Peninsula Sea Cliffs	GUG-043	WATERSHED: Apra	GU	MARINE BAY M2	0.02	SQUARE MILES	0.02	PCBs in fish tissue	Fish Advisory (1999)	LOW
Gabgab Beach	GU-GB43	Gabgab Beach	GU	COASTAL WATERS M2	0.65	MILES	0.65	PCBS in fish tissue	Fish Advisory (1999)	LOW

TABLE 28. 2020 GUAM LIST OF IMPAIRED WATERBODIES

[Clean Water Act, Section 303(d)]

Waterbody Name	Assessment ID	Location	State	Water Type & Classification	Waterbody Size	Unit	Assessed Units	Pollutants	Basis for Listing	Priority Ranking
Lonfit River 2	GUPGRL-2	WATERSHED: Pago	GU	RIVER-S2	1.07	MILES	1.07	Aluminum, Salinity, Temperature, Nitrate, Ammonia, Total Coliform, E. coli, Enterococcus, Iron, Manganese, Copper, Zinc, Chromium, Nickel, Total Suspended Solids, Total Dissolved Solids	Consent Decree	LOW
Lonfit River 3	GUPGRP-1-51B	WATERSHED: Pago	GU	RIVER-S1	0.04	MILES	0.04	Aluminum, Salinity, Temperature, Nitrate, Ammonia, Total Coliform, E. coli, Enterococcus, Iron, Manganese, Copper, Zinc, Chromium, Nickel, Total Suspended Solids, Total Dissolved Solids	Consent Decree	LOW
Pago Bay	GUG-003A	WATERSHED: Pago	GU	MARINE BAY M2	0.70	SQUARE MILES	0.70	Enterococcus, Dissolved Oxygen, Nitrate	Exceeds WQS >10%of Samples	MEDIUM
Pago River 1	GUPGRP-1-51A	WATERSHED: Pago	GU	RIVER- S2	0.06	MILES	0.06	E. coli	Exceeds WQS >10%of Samples	MEDIUM
Pago River 2	GUPGRP-2	WATERSHED: Pago	GU	RIVER - S3	4.74	MILES	4.74	E. coli, Dissolved Oxygen	Exceeds WQS >10%of Samples	MEDIUM
Storm Drain	GUAGRD	WATERSHED: Northern	GU	RIVER -S2	0.21	MILES	0.21	E. Coli, Dissolved Oxygen, Nitrates, Total Suspended Solids, Turbidity, Salinity	Exceeds WQS >10%of Samples	MEDIUM

TABLE 28. 2020 GUAM LIST OF IMPAIRED WATERBODIES

[Clean Water Act, Section 303(d)]

Waterbody Name	Assessment ID	Location	State	Water Type & Classification	Waterbody Size	Unit	Assessed Units	Pollutants	Basis for Listing	Priority Ranking
Tanguisson Beach 2	GUG-001B-2	WATERSHED: Northern	GU	MARINE BAY M2	0.40	SQUARE MILES	0.40	Toxic substance in seaweed	Seafood Consumption Advisory	LOW
Tipalao Bay	GUG-010A	WATERSHED: Agat	GU	MARINE BAY M2	0.10	SQUARE MILES	0.10	PCBs in fish tissue	Fish Advisory (1999)	LOW
Tumon Bay	GUG-001C	WATERSHED: Northern	GU	MARINE BAY M2	1.98	SQUARE MILES	1.98	Tetrachloroethene, Trichloroethylene, Antimony, Arsenic, Dieldrin, Total Chlordane	Waters Not Attaining Designated Uses	HIGH
Ajayan River	GUMZRAJ	WATERSHED: Manell	GU	RIVER -S2	3.95	MILES	3.86	Dissolved Oxygen, Orthophosphates, Suspended Solids	Exceeds WQS >10% of Samples	MEDIUM
Liyog River	GUMZRL	WATERSHED: Manell	GU	RIVER -S2	1.83	MILES	1,81	Dissolved Oxygen, Orthophosphates, Suspended Solids	Exceeds WQS >10% of Samples	MEDIUM
Sumay River	GUMZRSY	WATERSHED: Manell	GU	RIVER -S2	1.06	MILES	1.02	Dissolved Oxygen, Orthophosphates, Nitrates, Suspended Solids	Exceeds WQS >10% of Samples	MEDIUM

Wildlife Resources (DAWR) at the Department of Agriculture, the Department of Land Management and the Guam Environmental Protection Agency.

1.0 Program Description

The Guam Land Use Commission (GLUC), through its Wetland Area Rules and Regulations, is the permitting authority and the Department of Agriculture, DAWR provides lead technical support to the Commission under the permit system. The Guam EPA and other agencies provide technical review and recommendations to the Commission on wetland development permit applications through their membership on the Application Review Committee (ARC). The Agency also typically has the responsibility to oversee the environmental impact assessment procedures which must be part of many permit applications.

Guam EPA has maintained an array of program support functions in the area of wetland protection since approximately 1978. Aside from the 401 Water Quality Certification (permit), the Agency does not have a lead resource management or permitting role. Most of the functions listed are undertaken in support of both the GLUC and Army Corps of Engineers Section 404 permit systems. A substantial range of wetland development activities may require both federal and local permits. The following list of functions is mainly provided through the Agency's Water Division and EMAS Division.

- Building permit and plan review
- Field inspections and delineation verification
- Field determinations
- Enforcement
- Planning
- Policy development
- Public awareness and education
- Consultation
- Section 401 WQC (federal permits only)

2.0 Wetlands Monitoring

Wetland monitoring efforts were undertaken during this reporting period only to facilitate federal permit application processes. The Agency's 2006 Comprehensive Monitoring Strategy proposes a ***Wetlands Monitoring Program,*** which is briefly discussed under the Monitoring Program narrative, section **III.A.3.4.** Historically, wetlands water quality monitoring has been conducted only in relation to construction permit performance primarily for sediment. Much of this type of monitoring was accomplished by visual observation since most projects were small. The largest construction monitoring project which examined wetland water quality occurred over 10 years ago on a 1300-acre golf resort project in central Guam.

On the issue of a "no net loss" policy, Guam has not established a formal permit and compliance tracking system of either the GLUC or U.S. Army Corps Section 404 systems to accurately determine policy compliance. Based on extensive knowledge of most wetland related permits and enforcement activities, the Agency believes that a significant number local actions have not included appropriate mitigation provisions. Furthermore, based on just gross application numbers for wetland type development, the Section 404 permit program has far out-paced the GLUC system for the same projects. The Agency has limited involvement in U.S. Army Corps of Engineer mitigation projects.

3.0. Development of Wetland Water Quality Standards

Interim wetland water quality standards, including coverage related to anti-degradation, were established in the 1992 amendments to the Guam Water Quality Standards by including wetlands in the definition of Guam Waters. No beneficial uses and narrative/numeric criteria for wetlands are established.

Under the Guam Water Quality Standards, the Agency's Section 401 WQC program is involved in a number of important ways to protect and monitor wetland resources. The following list highlights some of these provisions.

Requires wetland delineations (1987 U.S. ACE Manual)
Ecological evaluations
Environmental baseline surveys
Prohibited discharge statements
Mitigation policy statements
Public review and input

4.0. Integrity of Wetland Resources

Guam has not undertaken more than preliminary assessments of its wetland resources. There is no ongoing or formal program to examine wetland physical, biological, or chemical properties. The study conducted by WERI investigators in the Ugum Watershed did describe and examine preliminary functional attributes of a Palustrine-Riverine wetland system (Siegrist et al, 1996). Generally, the study confirms that wetlands are functionally important to overall water quality in the watershed by regulating and recycling trace metals, and nutrients and regulating sediment transport through the watershed. The study concludes and the Agency concurs that more study effort should be directed at Guam's tropical wetland systems to better understand the water quality implications of both disturbed and relatively undisturbed systems.

The attainment of uses generally, is another area lacking substantive investigation to date. The only observations and assumptions that might be offered are directly associated with known anthropogenic disturbances and impacts reported elsewhere.

Assessments point to the fact that potential for accelerating erosion exists from activities such as poor construction practices, illegal and unimproved road development, including off-road activities, wild-land fires, unsustainable farming practices, and similar land disturbances.

5.0 Extent of Wetland Resources

The 1983 National Wetland Inventory (NWI) identified just over 5,000 acres of fresh water wetlands including mangroves and excluding marine dominated systems (i.e., coral reefs and seagrass beds). This represents approximately 4% of the total island landmass and nearly all of the wetlands in Guam are located in the island's central and southern regions.

More recently (May 2014), the U.S. Fish and Wildlife Service made available the *Wetlands Inventory Mapper,* which digitally maps and makes publically available Guam's wetland data set.

6.0. Additional Wetland Activities

Wetlands and watershed protection must eventually be integrated. The Agency leads an inter-agency work group called the Watershed Planning Committee which evaluates and administers Section 319 funds for nonpoint source restoration projects in accordance with five year restoration strategies. The bulk of surface water non-point source abatement and restoration efforts have centered on reforestation projects and public awareness of the Ugum Watershed. The Ugum Watershed Management Plan and its supporting Watershed Resource Assessment provide an excellent basis for further integration, at least in this watershed.

The major impediments to substantive integration and of wetlands into any major water quality program are programmatic in nature. Guam EPA is the lead entity for ensuring that wetland water quality is maintained and improved throughout the island. Much of this work has been shared with a number of resource agencies both federal and local. The Agency does not have direct permit system decision making authority except when water quality certification is required for certain federal permits. Most 404 permit projects are small and discrete construction events which can be managed accordingly. Some of the challenges (or needs) to broaden programmatic effectiveness are listed here.

Comprehensive inventory and data management
Local permit system reform, including legislation
Baseline biological and water quality studies
Public awareness
Comprehensive watershed planning

Having identified the issues, challenges, and opportunities to advancing wetland resource protection, specifically those aimed at the water quality components, the single most significant impediment to improvement is actually long term project management capacity. It is anticipated that several modest projects such as implementing a basic monitoring strategy, developing narrative criteria and designating uses could be accomplished at current resource levels. Long term projects and more focused leadership to oversee water quality studies will require additional personnel.

Guam's 2020 305b inventory of waterbodies **(Table 27)** lists nineteen (19) wetlands described in a study funded by the U.S. FWS (Project FW-2R-28). These wetlands do not represent all of the wetlands on the island, rather they represent unique wetlands where moorhens regularly nested at the time of the study. Four of the nineteen sites contain mangroves and twelve are used by moorhens.

E. Trend Analysis for Surface Water

A three part document entitled *"Status and Trend Monitoring Program Surface Water Quality Assessment"*, November 2013, is a work in progress being compiled to provide an inventory of surface water resources water quality data collected by Guam EPA. The assessment is organized to quickly access water quality and habitat condition information collected from freshwater and marine water sites. Each part provides information for a set of Guam watersheds, associated river reaches, marine waterbodies, and Guam EPA water quality monitoring sites or Guam EPA biological monitoring sites.

- Part 1 Watersheds: Agat, Apra, Asalonso, Cetti, Dandan, Fonte, Geus, Hagatna
- Part 2 Watersheds: Inarajan, Manell, Northern, Pago, Piti/Asan, and Taelayag

Guam EPA water quality data is verified and forwarded to a R9 representative for integration to WQX (Water Quality Exchange), the mechanism for data partners to submit water monitoring data to EPA. Such comprehensive data is incorporated in the November 2013 STMP Assessment. In the document, links to a watershed, a river reach, a marine water body, and a water quality monitoring site or a biological monitoring site enables access to respective resource data, site data, site assessment data and trends.

F. Public Health and Aquatic Life Concerns

1.0 Drinking Water Supplies

Guam EPA Safe Drinking Water Program was established for the implementation and enforcement of the Guam Primary and Secondary Safe Drinking Water Regulations in accordance with the Safe Drinking Water Act.

The major objectives are to ensure the public of a continuous supply of safe water for the prevention and control of drinking water pollution, and to obtain full compliance with

the Safe Drinking Water Act and the Memorandum of Agreement between Guam EPA and U.S EPA.

1.1 U.S. Navy Water System -*Water Quality Report – January to December 2018 and 2019* [18]

The Naval Facilities Engineering Command Marianas operates the U.S. Navy Water System with support provided by its Base Operations Support contractor, DZSP21, LLC.

The primary source of water for the Navy Water System is the Navy (Fena) Reservoir. It is supplemented by the Almagosa and Bona Springs and is processed at the Navy Water Treatment Plant prior to distribution. This water serves Naval Base Guam and surrounding areas.

In 2018, the U.S. Navy Water System water quality met all federal and local drinking water health standards.

1.2 Air Force Water System[19]

Andersen AFB provides drinking water to all base housing and facilities derived from the Northern Guam Lens aquifer, which is a groundwater source underlying the northern portion of Guam. Groundwater is pumped from the underground aquifer into the water distribution system by 13 wells.

In 2018, the Andersen Air Force Base Water System met all primary drinking water quality standards. No violation of any Maximum Contaminant Level, Secondary Maximum Contaminant Level, or any other water quality standards was reported. All safe drinking water reports, along with supporting laboratory reports were submitted on time as required by Guam EPA.

1.3 GWA Water System

GWA water is derived from several sources including ground, surface, and spring water. Guam's principal source of potable water comes from groundwater contained in the aquifer beneath the northern half of the island. Groundwater is pumped from this underground aquifer into the water distribution system through the use of more than 121 wells. Surface sources used by GWA include an intake from the Ugum River and water purchased from the Navy. Spring water from Santa Rita is used to supplement the water supply from Fena for the villages of Asan, Piti, Anigua, Agat, Santa Rita and some areas of Barrigada and Mongmong-Toto-Maite.

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[18] 2018 U.S. Navy Water System Water Quality Report; 2015 Report not available

[19] 2018 Annual Drinking Water Quality Report. Department of the Air Force

1.3.1 GWA Water System Quality Reports[20]

Water quality data for January 1 to December 31, 2018 is provided in the following pages. The report for 2019 was not available.

For 2018: GWA conducted more than 2000 tests for over 100 contaminants that may be in our drinking water. The results show that the water provided by GWA meets the MCLs established for the regulated contaminants, as required by the Guam Primary and Secondary Safe Drinking Water Regulations and the Federal Safe Drinking Water Act.

2.0 Beach Use

Recreational Swimming Notifications

Guam EPA and the Department of Public Health and Social Services have joint authority regarding the closure of public beaches. No beach closures were recorded during the reporting period.

For fiscal year 2018, 44 Tier 1 beaches were monitored for the U.S. EPA approved *enterococci* indicator, (weekly, year round). This resulted in approximately 2,001 samples analyzed and 526 swimming advisories issued.

In fiscal year 2019, the same 44 Tier 1 beaches were monitored for the U.S. EPA approved *enterococci* indicator (weekly, year round). This resulted in approximately 2,176 samples analyzed and 484 swimming advisories issued. **(Refer to Tables B7a. and B7b., Appendix B).**

Swimming advisories are released and/or reported weekly, prior to the weekend, in local print, radio, and television media, to other local government agencies, private individuals, and posted on the Guam Environmental Protection Agency official web page. The latest advisory can be reviewed using the following link: **http://epa.guam.gov/beach-report/current-beach-report/**

3.0 Consumption Concerns

3.1 Seaweed Consumption Advisories

There has been a fish/seaweed consumption advisory for the Tanguisson Beach area since 1991. In that year, three people died and two more became ill after consuming seaweed, *Gracilaria tsudae*, collected from this beach. Samples of the seaweed were sent to Japan for toxicological analyses. It was determined that polycavernosides were the toxic agents responsible for the deaths and illnesses. The exact source of this toxic substance has yet to be identified. Therefore, this beach has been permanently included in Guam EPA's weekly advisories which warn the public to avoid the harvesting and consumption of seaweed, fish or marine organisms from this location.

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[20] 2018 GWA Water Quality Reports

3.2 Fish/Shellfish Consumption

There have been no reported cases of shellfish contamination from local harvests. Officially, there are no designated shellfish collection areas for the island of Guam. All historic shellfish areas have been decimated by either over harvesting or habitat loss. Fish preserves are expected to allow local recovery of previously over harvested shellfish. The Guam EPA proposes the conduct of fish and shellfish tissue monitoring to assess tissue quality for consumption and to determine the need for consumption advisories. (Review narrative on pages 17-18.)

Three longstanding fish/shellfish advisories, issued by the Guam Department of Public Health and Social Services, remain in effect for Orote Point, Agana Swamp, and Cocos Lagoon.

3.2.1 *Orote Peninsula*

A seafood consumption advisory was issued in October 2001 by the Guam Department of Public Health for Agat Bay, based upon contaminated fishes located on the Orote peninsula. The consumption advisory remains in effect for the Orote peninsula and GabGab Beach (located on the naval base). The consumption advisory was issued for all reef fish in this area due to elevated levels of polychlorinated biphenyls (PCBs), chlorinated pesticides, and/or dioxins.

2009 Reef Fish Sampling[21] *and Updates*

Fish sampling was conducted in December 2008 and January 2009 to collect samples of the same fish species from the same nine locations sampled previously in 2001 in accordance with the Fish Sampling Work Plan dated November 2008.

Data evaluation shows that fish collected at the seawall area in 2001 and 2009 have similar PCB concentrations, which are about 10 times or more, greater than samples collected from the areas north and south of the seawall. To the north and south of the seawall area, fish collected in 2009 have lower PCB concentrations than those collected there in 2001. PCBs are the largest contributors to unacceptable risks in the advisory area. Concentrations of dioxins/furans and the pesticide dieldrin are generally about the same or slightly higher in 2009 than those in the 2001 fish samples. Based on these results the Seafood Consumption Advisory was retained unchanged and remains in effect today.

Update: "Another round of fish sampling proposes to sample the same types or near-shore territorial fish sampled in 2001 and 2009 at the same nine (9) general locations between Orote Point and Rizal Beach. The fish will be collected by UOG Marine Lab scientific divers using spears. UOG will also perform a fish age study by viewing the

[21] Fact Sheet No. 11, June 2014. 2014 Fish Tissue Sampling Work Plan, Orote Landfill Naval Base Guam

fish otolith (ear bone) specimens. The fish will then be shipped to chemistry laboratory to measure the concentrations of chemicals present in the fish tissue. Risks to people and wildlife will be estimated using the 2014 chemical data measure in fish tissue following current Navy and EPA risk assessment procedures. The results of the 2014 fish sampling activities and risk assessments are expected in the winter of 2014/2015."
The objectives are to:

- Determine whether the risk of consuming reef fish caught from the Seafood Consumption Advisory area changed since 2009;
- Determine whether recommending changes to the Seafood Consumption Advisory area is appropriate.

(Minutes, 6/4/2014 RAB Meeting)

Apra Harbor Remedial Investigation[22]
Site Location: Apra Harbor is the only deep-water harbor on the island of Guam and is the primary berthing facility on the island. Apra Harbor is generally divided into two parts: Outer Apra Harbor supports Navy, commercial, and recreational activities, and Inner Apra Harbor, where Naval Base Guam is located.

Site Background: Previous studies have indicated elevated levels of heavy metals and polychlorinated biphenyls (PCBs) in Apra Harbor sediment and marine life. Multiple Navy studies of dredged material sampling have also indicated the presence of chemicals in Inner Apra Harbor sediment.

Most Guam-based operations for the Department of the Navy (DON) occur on the land surrounding Apra Harbor. Current and historical facilities on the land surrounding Apra Harbor include the following potential sources:

- Ship Repair Facility
- Navy Public Works Center
- Guam Naval Complex
- Multiple fuel tank farms

Potential non-point sources of chemicals in harbor sediments include runoff of pesticide, residues and emissions from automotive vehicles, and general urbanization. Transport pathways that could potentially carry chemicals from land-based sites to Apra Harbor sediments include storm drains, runoff, and rivers and streams.

In-water operations that could potentially impact harbor sediments include dry dock activities, vessel cleaning and painting, accidental releases of fuel or solvent, and harbor dredging.

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[22] Fact Sheet No. 01, February 2014. Draft Remedial Investigation Work Plan: Apra Harbor Sediment Operable Units Naval Base Guam

3.2.2 *Agana Swamp*

The Fish Advisory in effect for the Agana Swamp is related to polychlorinated biphenyl (PCB) contamination from the Agana Power Plant (former U.S. Navy facility). The US Navy conducted an investigation and cleanup of the Agana Power Plant located in Mongmong, Guam. This included the removal of PCB contaminated soil from the upland facility as well as the off site contaminated areas. Off-site contamination was found in storm water drainage areas, storm water outfall areas and associated slope leading into the Agana Swamp, and in the sediments of the Agana Swamp. A fish tissue investigation was conducted. Also during that time the U.S. military conducted tests to try and identify PCB sources to the Agana Swamp and river not related to the Agana Power Plant. That study identified Agana Springs as a possible PCB source.

The U.S. Navy, with environmental oversight from Guam EPA and USEPA via the BRAC process, removed all PCB contaminated soil and sediment associated with the Agana Power Plant activities. Based on the analysis of the fish tissue investigation, it was determined that a fish advisory should be implemented for the Agana Swamp in 2001 and that advisory remains in effect. A testing conducted by the Navy in October 2006 revealed that some of the fish in the swamp and river are now testing higher for PCBs than back in 2000. Between 2008 and 2011 the following related activities are recorded: Guam EPA requested funding and technical assistance (from EPA) to help characterize the extent of PCB contamination of Agana Swamp; site assessment and sampling reports submitted by contractor to EPA (Agana Springs pond sediment and soil sampling). As of January 2012, EPA filed action memo requesting for continuing removal action at the site.

3.2.3. *Cocos Lagoon*

In 2005 a fish advisory was issued after numerous fish samples tested positive for harmful PCBs. The fish consumption advisory remains in effect for fish caught in the Cocos Lagoon. Public Health epidemiologist Dr. Robert Haddock noted that theoretically there is some statistical risk of developing cancer, but probably very small. It would only occur in people that ate a lot of fish every week from this area. Officials did not feel there was enough information to close Cocos Lagoon to fishing as additional studies would be conducted to narrow down the geographic range that may be contaminated.

2006 Investigation: An environmental site investigation was conducted at the former U.S. Coast Guard (USCG) Long Range Navigation (LORAN) station at Cocos Island, Guam.[23] Potentially hazardous materials are believed to have been disposed in the vicinity of the former LORAN station during its operation in the years between 1944 and

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[23] *Final Report, Environmental Site Investigation, Former LORAN Station Cocos Island, Cocos Island, Guam.* Prepared by Element Environmental, LLC for the USCG under Contract No. HSCG86-06-R-6XA125.

1963. This investigation included assessment of soil, sediment, sea water, groundwater and biota in the vicinity of the site. This investigation was conducted as a follow-on investigation to the preliminary investigation conducted by Environet, Inc. (EI) in 2005.

Field work for this project was conducted between July 25 and August 15, 2006. The primary objective of this project was to further delineate polychlorinated biphenyl (PCB), metals and petroleum contamination at the former LORAN Cocos Island site in order to provide a more comprehensive evaluation of potential PCB, petroleum, and metals contamination in relevant matrices (soil, sediment, sea water, ground water and biota). The results of this investigation will be used to determine if additional characterization and remediation with regard to the former LORAN Cocos Island facilities is necessary to protect human health and the environment.

The following recommendations were provided in the report.
PCBs in Site Soils: It is recommended that the PCB-impacted soil (i.e. soil containing concentrations greater than the TSCA cleanup level of 1.0 mg/kg) be removed and/or treated in order to eliminate the potential PCB source from the site. Biota sampling indicated that PCBs were present in biota collected adjacent to the site and thus the impacted soils at the site could be a potential source of PCBs detected in the biota. [Action has been undertaken to remediate the PCB-impacted soil.]
PCBs in Biota Specimens: It is recommended that the USCG work with the GEPA to possibly modify the current fishing advisory placed on Cocos Lagoon based on the results of this report. It is also recommended that additional biota specimens be collected from the near-shore area of the lagoon along the entire shoreline of Cocos Island from areas not previously sampled during this investigation or the preliminary investigation in order to expand on the biota data generated during this investigation and to further delineate the PCB-impacted biota.
TPH-diesel in Site Soils and Groundwater: Results of the investigation indicate that diesel is present in site soils and groundwater beneath the site. Additional soil and groundwater sampling and analysis are recommended in order to further delineate the extent of the diesel contamination, particularly in the area to the west southwest of Piezometer # 10 and #14 installed during this investigation.

2014 Follow-on Investigation:[24] This investigation included assessment of soil, ground water and biota in the vicinity of the site. This investigation was conducted by Element Environmental LLC (E2) as a continuation of ongoing post-remediation monitoring subsequent to remediation conducted by Unitek Environmental Guam in 2007.

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[24] *Final Report, Follow-on Environmental Site Investigation, Former LORAN Station Cocos Island, Cocos Island, Guam.* Prepared by Element Environmental, LLC for the USCG under Contract No. HSCG86-14-N-PXA003.

Field work for this project was conducted between January 20 and January 23, 2014. Major tasks performed during this project included collection and analysis of subsurface soil and groundwater samples from the vicinity of the former LORAN Power Transmitter Building and collection and analysis of biota samples from the Cocos Lagoon fronting the 2007 remediation area.

The primary objective of this project was to further characterize and monitor petroleum contamination in soil and groundwater in the vicinity of the former LORAN Transmitter Building and to capture and test biota samples to continue the periodic, post-remediation monitoring. The results of soil and groundwater testing will be used to determine the extent of petroleum contamination and if additional characterization and remediation with regard to the former LORAN Cocos Island facilities is necessary to protect human health and the environment. The results of the additional biota testing will be used, in conjunction with former biota testing results, to possibly update the current fishing restriction area within the Cocos Lagoon.

The following recommendations were provided in the report.
TPH in Site Soils and Groundwater: Results of this investigation indicate that TPH concentrations in subsurface soil and groundwater are lower than those detected during the 2008, 2010 and 2012 investigations. The volume of petroleum-impacted soil containing concentrations of TPH of 100 ppm or greater was estimated to be approximately 3,500 cubic yards, during the 2012 investigation. This estimate remains the same based on the results of the 2014 investigation. It is recommended that periodic monitoring (every five years) of trace TPH levels in the groundwater and soil continue in order to monitor natural attenuation and migration of TPH.
PCBs in The Remnant Sewer Pipeline: Analytical results did not indicate significant PCB concentrations present in the coating on the remnant steel former sewer pipeline. No further action is recommended with regard to the former pipeline.
PCBs in Biota Specimens: Results of this investigation indicate that PCB concentrations in Biota continue to trend downward. It is recommended that biota specimens be collected periodically (every five years) from the near-shore area of the lagoon, adjacent to the former LORAN site (Area 1) and off shore of the former LORAN station (Area 2) in order to monitor post-cleanup PCB concentrations in biota.

2015 Study.[25] As part of the NOAA Coral Reef Conservation Program (CRCP) jurisdictional priority gathering, local agencies in Guam identified Cocos Lagoon as an area potentially impacted by land-based sources of pollution. The US Coast Guard operated a Long Range Navigation (LORAN) station on Cocos Island at the southern end of Cocos Lagoon from 1944 to 1963. Disposal of materials from the operation of the

[25] Hartwell, S. Ian ; Apeti, Dennis A. ; Pait, Anthony S. ; Mason, Andrew L. ; Robinson, Char'mane ; An analysis of chemical contaminants in sediments and fish from Cocos Lagoon, Guam. Published 2017. NOAA Technical Memorandum NOS NCCOS; 235.

station are suspected of resulting in chemical contamination of the island and surrounding waters.

To help address this, this NCCOS (National Centers for Coastal Ocean Science) research project collected sediment samples (25 total) and samples of eight species of fish (27 total) representative of those that are locally eaten. Fish were collected using a cast net or hook and line. Sediment and fish tissue (whole fish) samples were analyzed for approximately 190 chemical contaminants, including 83 PCBs, petroleum hydrocarbons, heavy metals, and several pesticides such as DDT (dichlorodiphenyltrichloethane).

What NCCOS Found. ***Sediments***. Concentrations of chemical contaminants in sediments were low. One sediment sample near Cocos Island slightly exceeded a sediment quality guideline established by NOAA for the banned pesticide DDT. The sediments that occur throughout most of Cocos Lagoon consist of sand and coral gravel, which do not readily accumulate organic chemical contaminants.
Fish. Concentrations of total PCBs (sum of the 83 PCBs measured) were above EPA SV for some of the fish caught in Cocos Lagoon. Total PCB concentrations were above the EPA recreational SV in five species (banded sergeant, blackspot sergeant, convict tang, honeycomb grouper, and orange-striped emperor) from around Cocos Island. No fish from other locations in the lagoon were above the recreational PCB screening values. Four honeycomb groupers caught in other parts of Cocos Lagoon were above the subsistence SV. DDT was found at concentrations above the recreational fisher SV for two fish species, and above the subsistence SV for four other species around Cocos Island. No fish from any other areas of Cocos Lagoon were above either SV for DDT. No other chemical contaminants analyzed for this project were above available EPA SV.

Next Steps. NOAA will continue data analysis, working with Guam EPA, the EPA, and the USCG. EPA has indicated that it will conduct further human health risk assessments using the NOAA data. A technical memorandum on the results from the collection and analysis of sediments and fish became available in late 2017 and can be found here: https://repository.library.noaa.gov/view/noaa/17261.

3.3 Consumption Recommendations

Seafood including fish, shellfish, algae, or sea grapes caught in the above referenced areas, may contain PCBs, chlorinated pesticides, or dioxins at levels that are not safe to eat. The Agency for Toxic Substances & Disease Registry (ATSDR) advises choosing younger, smaller fish and other seafood to reduce exposure to contaminants whenever possible. Residents are also encouraged to remove skin, internal organs, and fatty tissue in the belly and along the side of seafood to reduce potential exposure to chemicals.

PART IV. GROUND WATER MONITORING AND ASSESSMENT

IV. GROUND WATER MONITORING AND ASSESSMENT

This section describes Guam's ground water monitoring and protection programs, ground water quality, ground water contamination sources, and ground water - surface water interactions.

A. Overview of Ground Water Contamination Sources

1.0 Hydrogeology

Guam is comprised of two sub-equally sized hydrogeologic provinces. In the southern half of the island, fresh groundwater occurs in weathered volcanic rock of low permeability, unconsolidated sediments within river drainages, and along the eastern coast's fringing limestone formations. The water table in the southern province reaches elevations of hundreds of feet above sea level in the volcanic rock and unconsolidated sediments. Other than a few springs, groundwater production in southern Guam is restricted to the narrow fringing limestone along the eastern coast, where the water table rarely reaches elevations greater than a few feet above sea level. Brackish to saline groundwater occurs along the southern and western coasts of the southern province within fractured limestone, artificial fill, and unconsolidated marine and estuarine sediments.

The northern half of the island is comprised of a limestone plateau bounded on the west, north and east by near-vertical cliffs and fringing reefs and on the south by the Adelup Fault that stretches from Adelup to Pago Bay. Groundwater in northern Guam is contained within the aquifer termed the "Northern Guam Lens" (NGL). This aquifer was designated a "principle source aquifer" in 1978 by the U.S. Environmental Protection Agency, and is essentially the groundwater source for the island. The aquifer is contained within a fractured carbonate complex ranging in age from Tertiary to Pleistocene (Tracey, 1962). The carbonate rock sequence has been significantly altered by tectonic and geochemical processes that have resulted in the formation of multiple stages of porosity and permeability. The resulting aquifer is therefore comprised of primary porosity and dissolution features of varying scale, both of which have been modified and/or enhanced by fracturing.

Guam's northern limestone plateau was deposited subaqueously as a result of down faulting along the Adelup fault and is underlain by nearly impermeable volcanic rock that is exposed at the surface in southern Guam. The limestone plateau reaches thicknesses of approximately 1000 feet and extends below sea level over most of its extent. As a result sea water has intruded into the island producing a layer of saltwater that overlies the volcanic rocks and extends into the limestone plateau. Guam's fresh groundwater is contained in a modified Ghyben-Herzberg lens system underlying most of northern Guam, having been formed by infiltrating rainfall that collected on top of the more dense

saltwater. The NGL has been estimated to be capable of supplying 60 million gallons per day (60 MGD) of fresh water (Camp, Dresser, and McKee, 1982). The aquifer is divided into six basins, containing 47 management zones (Camp, Dresser and McKee, 1982).

The NGL has been formed from surface recharge in northern Guam percolating through soils to the underlying limestone where it accumulates in a lens, which "floats" on and displaces the denser seawater. Analysis of the Dynamic Responses of the Northern Guam Lens Aquifer to Sea Level Change and Recharge (Wuerch, Cruz and Olson, 2007) has documented the dynamics of fresh water lens response to short- and long-term recharge events. The study was designed to more clearly define the percentage of recharge that remains in storage within the NGL and is available for production as drinking water. The moderate to high permeability of the limestone permits the ready flow of fresh water toward areas of discharge along the coast. Mixing of fresh and saltwater at the base of the lens produces a transition zone in which groundwater becomes progressively more saline downward and seaward.

Groundwater that occurs in the manner described above is called *"basal"* groundwater, and results in a water table that rarely exceeds approximately ten feet elevation. Most groundwater in the NGL is present under these conditions. Where infiltrating precipitation encounters the volcanic basement at elevations greater than approximately ten feet, the resulting groundwater rests upon the impermeable volcanic rock and *"parabasal"* conditions exist. Groundwater under these conditions can be produced without significant threat of salt water intrusion. The NGL is the selected aquifer for this assessment due to the abundance of excellent drinking water it contains, the large demand placed on the water from this unit, and its obvious vulnerability.

2.0 Sources of Ground Water Contamination

The following table identifies ten contaminant sources representing the greatest threats to Guam's ground water quality. They include: **animal feedlots, fertilizer applications, pesticide applications, underground storage tanks, landfills, septic systems/cesspools, hazardous waste generators, fuel pipelines and sewer lines, salt water intrusion, and urban runoff.**

The two most common factors considered in the selection of these contaminant sources were human health and/or environmental risk (toxicity) and location of the sources relative to drinking water sources. The common contaminant in six of the ten sources was "nitrate".

2.1 "Protecting and Restoring Guam's Waters" – *water resources protection and restoration, and pollution prevention approach*

In September 1999 Guam EPA documented its overall approach for managing water

Table 29. MAJOR SOURCES OF GROUND WATER CONTAMINATION

Contaminant Source	Ten Highest-Priority Sources (√)	Factors Considered in Selecting a Contaminant Source	Contaminants
Agricultural Activities			
Agricultural chemical facilities			
Animal feedlots	√	A,C,D	E,J
Drainage wells			
Fertilizer applications	√	A,C,D	E
Irrigation practices			
Pesticide applications	√	A,C,D	A,B
On-farm agricultural mixing and loading procedures			
Land application of manure (unregulated)			
Storage and Treatment Activities			
Land application (regulated or permitted			
Material stockpiles			
Storage tanks (underground)	√	A,C,D,E	D
Surface impoundments			
Waste piles			
Waste tailings			
Disposal Activities			
Deep injection wells			
Landfills	√	A,C,D,E	A,B,C,D,E,H,M
Septic systems	√	A,C,D	E,J,K,L
Shallow injection wells			
Other			
hazardous waste generators	√	A,C,E	C
Hazardous waste sites			
Large industrial facilities			
Material transfer operations			
Mining and mine drainage			
Pipelines and sewer lines	√	A,C,D	E,J,K,L
Salt storage and road salting			
Salt water intrusion	√	E,F	G
Spills			
Transportation of materials			
Urban runoff	√	A,C,D,E	A,B,C,D,E
Small-scale manufacturing and repair shops			
Other sources (please specify)			

FACTORS

Factors used to select each of the contaminant sources. Denote factor by using corresponding letter (A-I). List in order of importance.
A. Human health and/or environmental risk (toxicity)
B. Size of the population at risk
C. Location of the sources relative to drinking water sources
D. Number and/or size of contaminant sources
E. Hydrologic sensitivity
F. State findings, other finding
G. Documented from mandtory reporting
H. Geographic distribution/occurrence
I. Other criteria (please add or describe in the narrative)

CONTAMINANTS

Contaminants/classes of contaminants considered to be associated with each source checked. Denote contaminants/classes of contaminants by corresponding letter (A-M).
A. Inorganic pesticides
B. Organic pesticides
C. Halogenated solvents
D. Petroleum compounds
E. Nitrate
F. Fluoride
G. Salinity/brine
H. Metals
I. Radionuclides
J. Bacteria
K. Protozoa
L. Viruses
M. Other (please add or describe in the narrative)

The Agency used professional judgment to identify the highest priority contaminant sources for Guam.

resources on Guam. This document, entitled *"Protecting and Restoring Guam's Waters"*, identified the most significant threat to Guam's water quality as **development without adequate infrastructure support.** It further stated that such development "leads to a high density of septic systems over a high permeability substrate, an insufficient and poorly maintained sewage treatment system, erosion problems from poorly managed construction projects, over-pumping groundwater production wells, and groundwater impacts from inadequate environmental practices of poorly managed light industries."

This document identified its list of on-island sources of water pollutants which included:

- inadequate domestic waste water treatment (sewage treatment plants and septic tanks/leaching fields) contributing to elevated levels of bacteria and nitrates in our groundwater;
- urban storm water runoff, particularly in the north, contributing to nutrients in our near shore waters;
- unconfirmed sources contributing to elevated levels of TCE and TCA (solvents and degreasers), PCE (dry cleaners and degreasers); thallium (insecticides); and EDB (pesticides) in groundwater;
- aquaculture facilities and golf courses contributing to elevated nutrients and pesticide levels;
- accidental spills of pollutants and hazardous materials from sites with inadequate spill prevention control countermeasure plans;
- leaking above and underground storage tanks and associated pipelines;
- construction without adequate erosion and sediment control measures;
- wildfires, and off-road vehicle use, particularly evident in the south, causing excess siltation, turbidity and sedimentation;
- leachate from landfills and agricultural runoff;
- past activities on military sites;
- recreational water craft, including jet-skis, which are damaging marine life; and
- inadequate enforcement.

The only difference between these two lists (of sources of water pollutants) was "salt water intrusion".

2.2 Guam Hydrologic Survey and Comprehensive Water Monitoring Program 2019 Annual Report (September 2019)[1]

a. Contamination issues of concern to Guam's groundwater resources.

- *Contamination, one of three main reasons production wells had been shut down*
  Four production wells have been taken offline due to exceeding maximum

[1] Prepared by Dr. Nathan C. Habana,GHS Program Manager; Dr. Yong Sang "Barry" Kim,GHS Research Affiliate; Kaylyn K. Bautista, WERI Research Associate; Dr. John W. Jenson, WERI Director. Water & Environmental Research Institute of the Western Pacific, University of Guam. (https://www.guamhydrologicsurvey@uog.edu)

contaminant levels (MCL) and health advisory levels. - Chlordane: Well M-14, Yigo-Tumon, basal zone (since 1983) - PCE: Well A-28, Hagatna, basal zone (since 2006) - PFOS: Well A-23, A-25, Hagatna, pare-basal zone (since 2017).

- *Potential PFAs contamination sites*

  Recent UCMR3[2] results reveal three Guam Waterworks Authority (GWA) production wells to be contaminated with perfluorooctanesulfonic acid (PFOS). One of these wells (NAS-1) is located inside of the former Naval Air Station at Tiyan, in the village of Barrigada. PFOS concentrations found in this well to date range from 67-110 ng/L. The two other wells (A-23 and A-25) are located in Hagåtña, one of the oldest villages on Guam. PFOS concentrations determined in both of these wells to date are consistently above 70 ng/L with maximum levels occasionally exceeding 400 ng/L in well A-25. Both wells are currently off-line. Ongoing PFOS source studies have so far identified four potential contamination sites based on historical records and favorable hydrogeological properties of the surrounding area. These sites include: 1) a defective wastewater pump station that leaked millions of gallons of wastewater into the Chaot River over a 25-year period, 2) Agana swamp which drains the Chaot River and where chronic illegal dumping has occurred since WWII, 3) neighboring ponding basins that direct stormwater into the underlying aquifer, and 4) a nearby air flight crash site. Soil/sediment samples were retrieved for analyses of PFOS and other five unregulated perfluoralkyl substances (PFAS) from 22 sampling sites overall. 4.8 ug/Kg of PFOS was detected with the highest level among all sampling sites at one of ponding basins near the Well A-25. 28.29 ug/Kg of six PFASs (sum) was the highest near the GWA wastewater pump station.

- *NGLA Maps: Wastewater Sources and Production Well Nitrates*

  By far the most important tool for successfully locating site for new wells that will deliver abundant high-quality water from the Northern Guam Lens Aquifer is an accurate and precise map of the aquifer's subsurface structure and hydrologic components. Other ideas have emerged to further improve the mapping of the NGLA --- such as the layover of the wastewater system.

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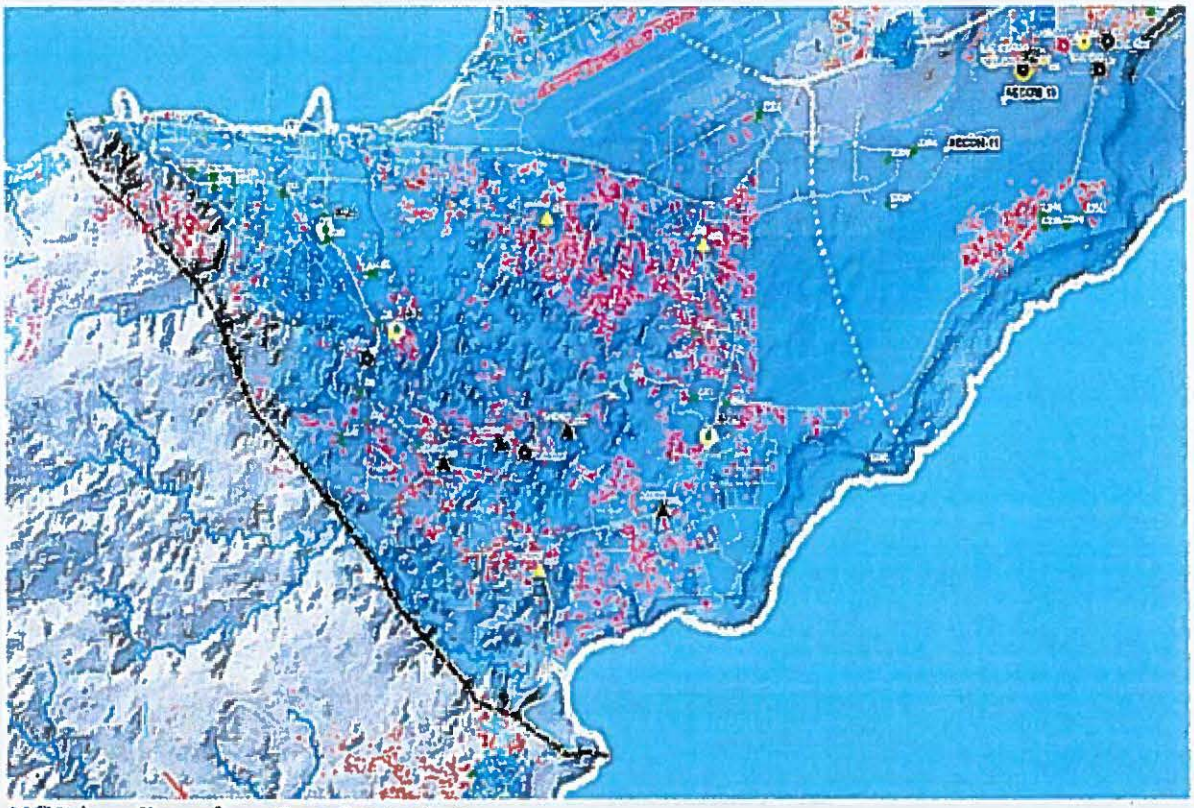
[2] The 1996 amendments to the Safe Drinking Water Act (SDWA) require that once every five years, the U.S. Environmental Protection Agency (EPA) issue a new list of no more than 30 unregulated contaminants to be monitored by public water systems (PWSs). The Unregulated Contaminant Monitoring Rule (UCMR) provides EPA and other interested parties with scientifically valid data on the occurrence of contaminants in drinking water. These data serve as a primary source of occurrence and exposure information that the agency uses to develop regulatory decisions. The final rule "Revisions to the Unregulated Contaminant Monitoring Rule (UCMR 3) for Public Water Systems" was published in the Federal Register on May 2, 2012 (77 FR 26072). UCMR 3 monitoring took place from 2013-2015, and included monitoring for 28 chemicals and two viruses.

Development over the NGLA is a concern of possible wastewater contamination. The aquifer's water resource in a durable karst plateau provides an economic access for development, but the residential and business wastewater discharged above it may be a threat to the freshwater resource. Increased and dense development must be assessed as it may intensify wastewater discharge. The NGLA map and the layover of the wastewater system provides a useful assessment tool for contaminant transport. The map may also be used to determine prioritization of sewer systems. The wastewater system map over the NGLA map helps planners strategize future development and reduce wastewater contamination.



NGLA wells and wastewater system

b. Comprehensive Water Monitoring Programs (CWMP)

In 1998, the CWMP was made a permanent part of WERI4)'s program when Governor Gutierrez signed PL 24-161 and PL 24-247. This resulted in the refurbishment of the deep monitoring wells and a renewed program of water resource monitoring on Guam. The intent of PL 24-161 was to restore, and then to expand, as needed, the discontinued monitoring program in order to help Guam

manage and safeguard all of its freshwater resources, now and in the future. Under PL 24-161, WERI/UOG and the USGS entered into a memorandum of understanding to administer and fund this program on a 50/50 cost-sharing basis.

The CWMP program collects pertinent hydrologic data and applies analysis and interpretation. The analysis and interpretation is conducted in research projects that will contribute to the status our water resources and new findings. The CWMP program is organized into two components, the monitoring program and data analysis research.

1) *Monitoring (observation) Program* - USGS-WERI continues to work as a team in collecting well hydrologic information. WERI and GWA established cooperation in a Memorandum of Understanding, where GWA shares the monthly water production report and quarterly well water chloride concentration data. Wastewater-N data is now being logged in two production wells in the Yigo area. Additional monitoring program activities are described in the annual report.
2) *Data Analysis Research* – Relevant projects described in the annual report include:
   - *Salinity patterns and trends in the NGLA* - This project focused on processing, visualization and analysis of the patterns and trends of salinity from drinking wells in the Northern Guam Lens Aquifer (NGLA). Water quality data is available from GWA. GIS is utilized to process and analyze the salinity data, and to locate wells with water quality problems with salinity. Since high levels of salinity in drinking water pose risks to man's health, it is crucial to locate wells with problems with salinity, and archive those wells in a format that permits rapid visualization of spatial and temporal trends of salinity in the wells in the study area using the state-of-art GIS technology. Figures on page 32 of the 2019 annual report indicate wells with salinity problems and the salinity distribution the in the first quarter of 2001.
   - *N-data collection: Phase II* - The Northern Guam Lens Aquifer (NGLA) is Guam's primary source of freshwater for potable use. This porous limestone formation currently provides approximately 80% of the island's municipal water supply. Aggressive production of groundwater has grown to 40 million gallons per day (mgd). With water demand rising and concerns over water quality increasing, proper management of this freshwater source has become critical to the welfare of the island's increasing population of residents and tourists. Preliminary inquiries have suggested that contaminants from anthropogenic sources are showing up in the NGLA. Much more baseline data of contaminant concentrations is needed to determine if the problem is greater in zones

with sewer collection lines, or in zones that rely on household septic tanks; furthermore, it is not known if contaminant levels are increasing, or not. It is essential that these issues be studied before actions are taken to extend sewer collection lines or even build new wastewater treatment plants in Northern Guam. In addition, the effectiveness of septic tanks is also an issue of concern. As an alternative to traditional septic tanks, consideration is increasingly given to use of single-family prefabricated, packaged treatment units. It is considered that these units could serve to reduce the potential of contamination reaching the water table.

Objectives: The objectives of this project are: (a) Data acquisition and literature review of wastewater-N and groundwater-N cycle transformation triggers, and study of groundwater contaminant transport. (b) Analysis of spatial time-series wastewater-N data at sites with rainfall and other possible influences such as pH, ORP, sewage discharge events, etc. (c) Translation/interpretation of analysis such as increasing/decreasing trends, averages, and spatial distribution. (d) Suggest/recommend development strategies to improve wastewater management.

B. Overview of Guam's Ground Water Protection Program

Guam EPA manages different environmental programs which serve to protect ground water resources. Most programs are fully established but undergo continuous revision based on changes in statutes or regulations or to maintain effective control measures. The table below summarizes the status of ground water protection programs in Guam. Related information is available at www.epa.guam.gov and https://weri.uog.edu/

Information about Guam's key ground water protection programs are presented in the following.

1.0 Northern Guam Lens Study

It has been long recognized that the NGL supply needed protection and on April 26, 1978 the groundwater lens in northern Guam was defined as a "sole source aquifer," by the EPA Administrator under Section 1424(e) of the Safe Drinking Water Act (SDWA), Federal Register citation 43FR17867.

In order to properly protect this "sole source aquifer", it was necessary to define the range or extent of the aquifer, the types of protection and/or controls needed, and the type of management system needed to monitor, control, develop, and protect this resource.

Table 30. SUMMARY OF STATE GROUND WATER PROTECTION PROGRAMS

Programs or Activities	Check (√)	Implementation Status	Responsible Agency
Active SARA title III Program			
Ambient ground water monitoring system			
Aquifer vulnerability assessment			
Aquifer mapping	√	Continuing efforts	GEPA, WERI
Aquifer characterization	√	Continuing efforts	GEPA, WERI
Comprehensive data management system	√	Continuing efforts	WERI
EPA-endorsed Core Comprehensive State Ground Water Protection Program (CSGWPP)			
Ground water discharge permits			
Ground water Best Management Practices	√	Continuing efforts	GEPA
Ground water legislation	√	Continuing efforts	GEPA, GWA
Ground water classification	√	fully established	GEPA
Ground water quality standards	√	fully established	GEPA
Interagency coordination for ground water protection initiatives	√	Continuing efforts	GEPA*, GWA, JOINT REGION
Nonpoint source controls	√	Continuing efforts	GEPA
Pesticide State Management Plan	√		GEPA
Pollution Prevention Program	√	Continuing efforts	GEPA
Resource Conservation and Recovery Act (RCRA) Primacy	√	fully established	GEPA
Source Water Assessment Program			
State Superfund	√	Continuing efforts	GEPA
State RCRA Program incorporating more stringent requirements than RCRA Primacy	√	fully established	GEPA
State septic system regulations	√	fully established	GEPA*
Underground storage tank installation requirements			
Underground Storage Tank Remediation Fund			
Underground Storage Tank Permit Program	√	fully established	GEPA
Underground Injection Control Program	√	fully established	GEPA
Vulnerability assessment for drinking water wellhead protection	√	Continuing efforts	GEPA, GWA
Well abandonment regulations	√	fully established	GEPA
Wellhead Protection Program (EPA-approved)	√	fully established	GEPA
Well installation regulations	√	fully established	GEPA
Other programs or activities (please specify)			
Watershed Planning Committee activities	√	Continuing efforts	GEPA*

* Multiple agencies involved

In 1979 Guam EPA initiated the Northern Guam Lens Study (NGLS), which was completed in December 1982. This study sufficiently defined the range or extent of the aquifer and the types of protection and/or controls needed. It also outlined the framework necessary for Guam EPA to implement the type of management system needed to monitor, control, develop, and protect this resource. This 21-year old study is still in use.

The Northern Lens Study concluded the following:

a. The aquifer and its recharge areas cover almost the entire northern half of the island and are divided into six major sub-basins based on the volcanic subsurface topography. These sub-basins are further divided into 47 management zones, which could provide an estimated sustainable yield of 59 million gallons a day.

b. The lens contains very high quality water but needs to be protected against both contamination from percolation of surface pollution through the very permeable soils and salt-water intrusion due to over-pumping of the lens.

c. The management system defines the necessary data to be collected, construction practices, the operation and maintenance practices needing modification, and the 2)required legislative and legal measures that should be developed to properly implement the program.

1.1 Other Aquifer Related Studies[3]

Other studies of the NGL aquifer include:

- Mink (BCG, 1992) Update to the 1982 study;
- Department of Defense Installation Restoration Program project studies relevant to the aquifer 1) Dye Traces (Barner, 1997) 2) WERI Aquifer Modeling in the 1990's and early 2000s (Contractor and Srivastva-1990; Contractor and Jenson -2000; and Jocson et al.- 2002);
- USGS "Groundwater Availability Study for Guam" (Gingerich and Jenson, 2010) where five component projects were undertaken in collaboration with WERI. 1) NGLA Database Report 2) Aquifer Recharge Report (Johnson, 2012) 3) Field study of regional hydraulic conductivity (Rotzoll et al., 2013) 4) Update of the Aquifer Basement Map (Vann et al., 2014) 5) Three Dimensional Numerical Model of the NGL aquifer (Gingerich and Jenson, 2010).

2.0 Ground Water Legislation, Statutes, Rules, and/or Regulations

The statutory authority for water resources management programs fall under the provisions of 10 GCA, Chapter 46 (Water Resources Conservation Act). This and other pertinent regulations can be found on the Guam EPA website www.epa.guam.gov under the REGULATIONS or LAWS tab.

Public Law 24-247 (August 1998) established the Guam Hydrologic Survey (GHS) as a permanent program to be created and administered by WERI. Among the five points detailed as the mission of the GHS, the program is to locate, inventory, and evaluate all

[3] The Northern Guam Lens Aquifer Database. Viviana M. Bendixson, John W. Jenson, Nathan C. Habana. Technical Report No. 141, 2nd Edition, October 2014, p. 5.

hydrologic data pertaining to Guam and consolidate the data into a single computer-based data library form which information can be easily accessed and retrieved.

The Northern Guam Lens Aquifer Database, is a comprehensive centralized database containing information on custodianship, function, operational status, and the geographical hydrological, engineering, and geological attributes of each well installed in northern Guam for which records could be found. The database is integrated with current ArcGIS® geospatial information visualization tools. Developed in support of the 2010-2013 "Guam Groundwater Availability Study" led by the USGS's Pacific Islands Water Science Center, with funding by the US Marine Corps, and in conjunction with the 2010 NavFacPac Exploratory Drilling Program on northern Guam, its integration into WERI's GHS Program will keep it up to date and make it permanently and readily accessible to professional and scientific users.[4] (Visit: **www.guamhydrologicsurvey.uog.edu**)

3.0. Wellhead Protection Program

Provisions for wellhead protection were adopted as part of the reauthorization of the Safe Drinking Water Act (SDWA), signed into law in June 1986. The legislation established a nationwide program to encourage states to develop systematic and comprehensive programs within their jurisdiction. Such programs were intended to protect water supply wells and well fields from all sources of anthropogenic contamination.

Water Resource Development and Operating Regulations were adopted on January 25, 1985 and amended August 2, 1990.
(www.guamcourts.org/CompilerofLaws/GAR/22GAR/22GAR002-7a.pdf)
Section 7130. Wellhead Protection for Public Water Supply Well contains regulations intended to safeguard the public health, safety, and welfare by providing established standards.

A draft report on Guam's drinking water assessment entitled "Guam Drinking Water Source Assessment and Protection Program and Wellhead Protection Plan" listed the overall vulnerability ranking of GWA's drinking water supply wells to contamination, from high risk to moderate to low risk. Of the 122 wells, 77 are considered high risk, 39 moderate risk, and 6 low risk. GWA intends to address these high risk wells through its Capital Improvement Plan. A Wellhead Protection Plan was completed which provides management strategies for GWA to continue and improve protection of wells.[5]

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[4] Ibid. p. iii.
[5] June 29, 2015. Guam Office of Public Accountability, GWA FY 2014 Financial Highlights, p.1.

4.0 Underground Injection Control (UIC) Well and UIC Permitting Program

The only type of injection well in Guam is the Class V well used primarily for drainage of storm water runoff. All injection wells in Guam have been issued permits and are inspected annually.

At present, there are five hundred sixteen (516) permitted wells. A general breakdown of well ownership is as follows:

PERMITTE	# of WELLS
Andersen Air Force Base (USAF)	106
Guam International Airport Authority (GovGuam)	28
Department of Public Works (GovGuam)	48
Agana Shopping Center	28
Guam Memorial Hospital Authority (GovGuam)	13
Lotte Hotel	20
Atkins Kroll (Toyota)	10
Hyatt Regency Hotel	46
Westin Resort	18
Crown International Plaza	10
Mobil Guam	15
Summer Towers Apartments	11
Other permittees (with <10 UIC systems)	60
TOTAL	**516**[6]

The Guam EPA Water Resources Management Program conducts annual compliance inspections to

- verify if the site or location of injection wells conform with its operating permit requirements and conditions;
- assure adequate maintenance of the wells to prevent groundwater contamination; and
- identify discrepancies or deficiencies between the inspected well and its permitted requirements and conditions.

A UIC permit is required for anyone who has constructed a well, used primarily for drainage of storm water runoff. The permit provides a means of tracking all injection wells and insuring, through inspection, that such wells are properly maintained. Recent concern has developed over the proliferation and extensive use by commercial establishments to contain stormwater runoff within its boundaries. These drainage systems, because of their configuration and purpose, are now considered injection wells requiring a UIC permit.

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[6] Source: Guam EPA Water Resources Management Program

4.1 Underground Injection Control Monitoring

Guam EPA's UIC program has a Permit-driven water quality monitoring requirement for UIC well/system owners. As of this reporting period, permitted UIC well owners are operating a total of 516 individual wells/systems located over the northern Guam lens.

The UIC well/system owners are required to perform water quality monitoring sampling semiannually on 19 chemicals. The owners are required to grab the first set of samples during the first significant rainfall between the months of April and July which represent the end of the dry season and the onset of the rainy season. This sampling event is scheduled during this period as a way of capturing the illusive *first flush*. The second set of samples is grabbed between the months of October and December which are the last three months of the rainy season. The 19 chemicals of concern and their respective MCLs are listed in **Table 31 below.**

Table 31. UIC Sampling Parameters

	Chemical	MCL (mg/l)		Chemical	MCL (mg/l)
1.	MBAS	0.5	11.	Lead	0.015
2.	Oil and Grease*	N/D	12.	Benzene	0.005
3.	NO_3-N	10.0	13.	Ethylbenzene	0.7
4.	Endrin	0.002	14.	Xylene	10.0
5.	Lindane	0.0002	15.	Toluene	1.0
6.	Toxaphene	0.003	16.	Boron	5.0
7.	2, 4-D**	0.07	17.	COD	50.0
8.	2, 4, 5 -TP Silvex***	0.05	18.	pH	6.5-8.5
9.	Heptachlor	0.0004	19.	MTBE	0.02
10.	Methoxychlor	0.04			

* Not Detected using 0.05 ppm MDL ** 2,4 - Dichlorophenoxyacetic Acid
*** 2,4,5 - Trichlorophenoxy Propioacid Silvex
MCLs are based on the most current Guam Water Quality Standards.

5.0 Ground Water Assessment Monitoring

An ambient groundwater monitoring system has been established for Guam groundwater under Guam EPA. Pump rates and chloride and nitrate sampling are among a set of key annual inspection and testing parameters of all production wells currently being monitored. The Agency reports a total of 194 production wells owned as follows: GWA-121; Private – 40; Navy-14; and AAFB-19.

WERI and the water resource monitoring program for the NGLA[7]

The water resource monitoring program for the Northern Guam Lens Aquifer (NGLA), designated a Sole Source Aquifer in 1978 by the U.S. EPA, had been established in the 1950s by the USGS. However, in the 1990s, this program was forced to downsize when funding from the local government could not be met, which resulted in data disruption to deep well monitoring for saltwater intrusion in the north and stream gage data in the south. In 1998 the Comprehensive Water Monitoring Program (Guam Public Law 24-161) became a permanent program of the Water and Environmental Research Institute (WERI) of the Western Pacific and resulted in the refurbishment of the deep monitoring wells and a renewed program of water resource monitoring on Guam. In the same year, the Guam Hydrologic Survey (Guam Public Law 24-247) was made a permanent program, administered by WERI, to develop an inter-agency cooperation for gathering and publicly providing water and environmental information. Current withdrawals from production wells estimate to 40 Mgal/d. Over the next decade, population growth, inclusive of the proposed military forces relocation, projects a production increase as much as 25 percent. Increased withdrawals, in the long-term, were modeled to result in a decline in water levels and a rise in the freshwater-saltwater transition zone. To assist with water-resource management, an inter-agency framework for information sharing and decision making has been established with a Memorandum of Understanding, signed in 2010, under the Monitoring System Expansion and Rehabilitation Program. 7 new deep monitoring wells will be drilled, and 12 existing monitoring wells will be rehabilitated to expand groundwater monitoring from only two NGLA sub-basins to include the remaining four sub-basins. As partners in the island's technical/scientific experts group, WERI and the USGS will assume data collection, analyses, and reporting, to provide best practices for sustainable management.

The general list of Indicators for groundwater monitoring is listed below. (See list in **Table C5, Appendix C.**)

- General water chemistry (chlorides, nitrates)
- Organic and Inorganic Constituents
- Physical Parameters (Water Level, Yields)

6.0 Man-Made Impoundment Monitoring[8]

The Man-Made Impoundment Monitoring Plan primarily evaluates chemical data sampled from man-made impoundments very much like the UIC plan and focuses on surface impoundment impacts to groundwater. **Table 32** presents the locations and a proposed schedule for surface impoundment (i.e. ponding basins) sampling. It is

[7] Guam Water Resources Monitoring Program, Groundwater Week, Exhibits Workshop Summit, National Groundwater Association, Las Vegas, Nevada. Bautista, K., Jenson, J.W., Habana, N.C., Kim, Y.S. 2018
[8] Suspended program. No laboratory capacity to sustain program.

proposed that this monitoring program be extended to include the surface impoundments of Southern Guam that affect surface water quality of receiving streams and other water bodies.

Table 32. Man-Made Impoundment Area WQM Schedule.

Cycle	SIA Name	Site No.	Location	Cycle Sampling Year	Plus One Site Each from Other Four Cycles
I	GHURA 501	43	Behind Dededo Transfer Station	Year 1	Year 2
	Potts Junction	12	Rte 9; 500 Feet West of Well HGC-3	Year 1	Year 3
	Marianas Terrace	36A	Gayinero Street, Yigo	Year 1	Year 4
	Airport road Extension	72A	Route 10A (South Side)	Year 1	Year 5
II	GHURA 502	20	Route 3 (Astumbo Gardens)	Year 2	Year 1
	Ypaopao Estates	42B	Behind PUAG Pump Station	Year 2	Year 3
	Hatsuho Golf Course	12E	Route 3 (Near Club House)	Year 2	Year 4
	Harmon Sinkhole	71	Route 10A (Near Hotel Mai'Ana)	Year 2	Year 5
III	Agana Hts. Injection Wells	79	F. Xavier Dr./Salamon Dr., Agana Hts.	Year 3	Year 1
	Guam Community College	76A	Sesame Street, Mangilao	Year 3	Year 2
	GHURA 503	15	Route 3 (Fern Terrace)	Year 3	Year 4
	Guam Intl. Airport Terminal	72	Route 10A (Across Airport Parking Lot)	Year 3	Year 5
IV	Barrigada 76 Gas Station	74	Route 10 & Route 8 Intersection	Year 4	Year 1
	GHURA 35	48B	Near Northern Public Health Center	Year 4	Year 2
	Macheche Subdivision	55A	Macheche Avenue, Dededo	Year 4	Year 3
	GHURA 505	41	Atsadas Street, Yigo	Year 4	Year 5
V	Sinajana Baseball Field	79B	Chalan Guma' Yuus, Sinajana	Year 5	Year 1
	Latte Heights	56A	Gardenia Ave. & Carnation Ave.	Year 5	Year 2
	GHURA 506	38	Near Simon Sanchez High School	Year 5	Year 3
	Dededo Public Park	47A	Rte. 1 & Ysengsong Rd. Intersection	Year 5	Year 4

C. Summary of Ground Water Contamination Sources

The top ten contaminant sources presenting the greatest threat to Guam's ground water quality were identified on page 3. Guam EPA includes the following narrative on major contaminant sources and groundwater locations most at risk on Guam.

1.0 Septic Systems[9]

Septic systems are currently in use throughout Guam for wastewater collection and disposal in the areas not sewered. It is estimated that 41% of the island residents use individual wastewater disposal systems (IWDS) as reflected in GWA's customer count list.

There are parts of Guam that are more sensitive to the effects of septic systems than other parts of the island. The Northern Region and the northern portion of the Central Region are located over an aquifer in an area of limestone formations that provides an environment for the septic-treated wastewater to filter down to the island's groundwater source.[10] In this area, rainwater and water from other sources percolate through the limestone aquifer rapidly. Any pollutants, such as nitrates resulting from septic system wastewater treatment, eventually make their way to the aquifer.

GWA's customer count shows that approximately 42% of all the septic systems on island are located in the Northern Region (Dededo, Yigo and Mangilao) and approximately 44% are located in the Central Region (Agana, Sinajana, Mongmong-Toto-Maite, Agana Heights, Tamuning, Barrigada, Chalan Pago – Ordot, Yona, Asan, Piti, and Santa Rita). Approximately 13% of the island's septic systems are located in the southern region of Guam.

See page 7 for the narrative about WERI's *N-Data Collection: Phase II Project* which proposes to conduct research on spatial and temporal trends in levels of contaminants in Guam's groundwater, as well as the need for continuous baseline studies on levels of nitrogenous compounds, etc. with respect to time and location. It also proposes to address the need for evaluation of innovative wastewater treatment units as alternatives to conventional septic tanks for individual homes, commercial buildings, or hotels.

2.0 CERCLA[11] Sites Overlying the NGL

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), commonly known as Superfund, was enacted by Congress on December 11, 1980. This law created a tax on the chemical and petroleum industries and provided broad Federal authority to respond directly to releases or threatened releases of hazardous substances that may endanger public health or the environment. Over five years, $1.6 billion was collected and the tax went to a trust fund for cleaning up abandoned or uncontrolled hazardous waste sites. CERCLA:

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[9] Volume 3, Chapter 6: Septic Systems & Unsewered Areas. October 2006 Final Water Resources Master Plan
[10] PUAG's Rural Island-wide Wastewater Facilities Plan delineates Guam regions as Northern, Central and Southern.
[11] EPA website

- established prohibitions and requirements concerning closed and abandoned hazardous waste sites;
- provided for liability of persons responsible for releases of hazardous waste at these sites; and
- established a trust fund to provide for cleanup when no responsible party could be identified.

The law authorizes two kinds of response actions:

- Short-term removals, where actions may be taken to address releases or threatened releases requiring prompt response.
- Long-term remedial response actions, that permanently and significantly reduce the dangers associated with releases or threats of releases of hazardous substances that are serious, but not immediately life threatening. These actions can be conducted only at sites listed on EPA's National Priorities List (NPL).

CERCLA also enabled the revision of the National Contingency Plan (NCP). The NCP provided the guidelines and procedures needed to respond to releases and threatened releases of hazardous substances, pollutants, or contaminants. The NCP also established the NPL.

There are CERCLA sites, which overlie the NGL: Andersen Air Force Base (AAFB), Tiyan (the former Naval Air Station, Agana), and the Navy Construction Battalion (CB) Landfill.

2.1 AAFB

Andersen Air Force Base was listed on the National Priority List (NPL) in October 1992. Groundwater beneath the site has been investigated in accordance with the Federal Facility Agreement (FFA) since that time. Prior to NPL listing, groundwater was investigated under the Department of Defense, Installation Restoration Program (DOD, IRP) beginning in 1986.

Initial Actions: Closure of the main base landfill in accordance with the requirements of the Resource Conservation and Recovery Act (RCRA) finished in 1994. Landfill closure included the construction of a cover over the landfill.

Long-Term Cleanup: The Main Base Operable Unit, Northwest Field Operable Unit and the Site-Wide Operable Unit encompasses the entire Andersen Air Force Base property. The Main Base contains active runways, bulk fuel storage facilities, housing areas, and the majority of the operations and administrative structures and functions. Northwest Field is home to Rapid Engineer Deployable Heavy Operations Repair Squadron Engineer facilities and operations. The three operable units include seventy-one (71) out of

the eighty-one (81) IRP sites and 18 MRP sites. Only seven (7) IRP sites and eleven (11) MRP sites remain under investigation and remedial cleanup.

For active information about AAFB as a superfund site go to https://cumulis.epa.gov/supercpad/SiteProfiles/index.cfm?fuseaction=second.Cleanup&id=0902825#Status

2.1.1 AAFB Main Base TCE Groundwater Contamination - Building 18006

Building 18006 has been operational since the 1960's. AAFB started looking at this site after its status was converted from an Area of Concern (AOC) to an Installation Restoration (IR) site in the beginning of CY 2005. This was done to access funding to start an investigation into whether Building 18006 may be contributing to the groundwater TCE contamination. In fiscal year 2008, AAFB began the Remedial Investigation (RI) and feasibility study (FS) proposed plans for Building 18006.

Selected Remedy[12]

The USN is managing remediation of contamination at the Site-Wide OU in accordance with CERCLA as required by the Defense Environmental Restoration Program (DERP). The USN and the United States Environmental Protection Agency (USEPA) have jointly selected the remedy for the site, and Guam Environmental Protection Agency (Guam EPA) has concurred with the selected remedy, under the guidelines established in the Federal Facilities Agreement (FFA) signed in February 1993 by representatives of USEPA Region IX, Guam EPA, and the United States Air Force (USAF) (USEPA et al., 1993).

The USN selected *Long-Term Groundwater Monitoring with Contingency for Wellhead Treatment* as the preferred alternative for Site 54. The major components of this selected remedy are as follows:

- Long-term groundwater monitoring and assessment to monitor plume stability and evaluate contaminant trends within the groundwater contaminant plume
- Land Use Controls (LUCs): LUCs shall be implemented through the Base Master Plan and the Guam EPA's Wellhead Protection Program. As part of its Wellhead Protection Program, Guam EPA limits the location of newly installed wells (must be at least 1,000 feet from existing wells) and requires that any new well be sampled prior to being connected to the water supply system. If sampling at a newly installed well indicates that TCE/PCE is present, the USN will evaluate the need to install and operate wellhead treatment whenever levels exceed one half

[12] Record of Decision for Site 54 Site-Wide Operable Unit Andersen Air Force Base, Guam. August 2015. Indefinite Delivery/Indefinite Quantity Contract Number N40192-11-D-5001, CTO 0026

of the respective maximum contaminant level (MCL). LUCs will be maintained until the concentrations of hazardous substances in the groundwater are at such levels to allow for unrestricted use and exposure.

- Contingency for Wellhead Treatment: at potential future water production wells within the extent of the PCE and TCE plume. Upon TCE or PCE concentrations exceeding half of the MCL, the USN will perform additional sampling and analysis to determine if the concentration is likely to approach the MCL (5 µg/L). If statistical significance is found, the well will continue to be monitored for potential exceedance of the MCL. If PCE or TCE concentrations exceed the MCL, wellhead treatment will be applied to the affected well.
- A technical impracticability (TI) waiver to waive the requirement to achieve Federal and Territory of Guam drinking water maximum contaminant levels (MCLs) for tetrachloroethene (PCE) and trichloroethene (TCE) in the aquifer where concentrations exceed the MCLs. The TI waiver is necessary because it is not practicable or feasible from an engineering and technological perspective to remediate the dissolved-phase PCE and TCE in the aquifer within a reasonable time frame.
- Regular reporting and five-year regulatory reviews to assess the effectiveness of the remedy.

The selected remedy for Site 54 addresses the principal threats posed by the site through implementation of wellhead treatment, if needed, to treat contaminated groundwater at potential future production wellhead(s), thereby preventing potential future exposure to contaminated groundwater. Successful implementation of the selected remedy at Site 54 would effectively mitigate all unacceptable risks to human receptors at the site and render the site suitable for unrestricted use. Monitoring at the site would be performed regularly to determine whether contaminant concentrations in the groundwater have attenuated to levels that would allow the removal of the wellhead treatment contingency.

2.1.2 Air Force Marbo Groundwater Impacted by TCE and PCE

The MARBO Operable Unit is located several miles south-southeast of the Main Base and covers 2,342 acres. The final remedy for soils included removing some hazardous soils off-island and removing other, less hazardous soils to the Main Base landfill. Ground water is contaminated with trichloroethylene, a degreasing solvent. The remedy, selected in 1998, is monitored natural attenuation. Long-term monitoring has shown that the contaminants at the bottom of the aquifer, directly over the saltwater zone, are not decreasing, so the Air Force and EPA re-evaluated the remedy in 2014 and proposed a waiver for technical impracticability. Because cleaning the aquifer directly over the saltwater interface would cause upwelling of salt water into the drinking water portion of the aquifer, there is no practical way to implement a remedy. Thus, the remedy update

included institutional controls prohibiting the pumping of ground water in the deep plume area, long-term groundwater monitoring and contingencies for well-head treatment.

2.2. Tiyan – former NAS Agana

Groundwater beneath Tiyan has been investigated since 1986 under the Department of Defense Installation Restoration Program. Groundwater contamination beneath Tiyan has been detected in the form of TCE and PCE. One production well (NAS-1) exists on the former base and a water sample collected in January 1991 exceeded the MCL for TCE. Subsequent groundwater sampling of monitoring wells under the Base Realignment and Closure (BRAC) program has shown the presence of an extensive area of contamination of PCE and TCE.

In July 1993, the BRAC Commission recommended closure of Naval Air Station (NAS) Agana. The installation was closed on March 31, 1995.

All cleanup work on BRAC sites is complete and the sites are in long-term management (Action conducted after cleanup to monitor effectiveness of the remedy and ensure site restrictions remain in place). All former NAS Agana property has been transferred, except for the Agana Power Plant.

Contamination in NAS-1 is currently being remediated through wellhead treatment through activated carbon filtration.

2.3 Construction Battalion Landfill – IRP Long-term Management Site

In 1998, a soil and synthetic liner system was completed. The site is now in long-term management. Annual inspections and cover maintenance are ongoing, and five-year review results will be published in 2014.[13]

3.0 Other CERCLA Sites

There are several CERCLA sites located in the Southern Guam hydrogeologic province not over the NGL: the Ordot Dump and numerous sites belonging to the Navy.

3.1. Ordot Dump[14]

The 23-acre Ordot Landfill site was Guam's primary landfill for industrial and municipal waste near Ordot and Chalan Pago. Site investigations revealed leachate flowing from the site to the Lonfit River. EPA deferred cleanup to EPA's Water Program in 1998.

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[13] Fact Sheet 5: Navy's Guam Environmental Restoration Program – Site Status Update , February 2014

[14] https://www.guamsolidwastereceiver.org/updates-done.shtml

The Ordot Dump was in operation, beginning in the 1940s until August 31, 2011, polluting the Lonfit River in violation of the Clean Water Act. Working in conjunction with the United States Environmental Protection Agency (USEPA), the Guam Environmental Protection Agency (EPA), the Ordot Mayor's Office, and the people who live in the immediate vicinity of the Ordot Dump, the Receiver, (Gershman, Brickner & Bratton, Inc. (GBB), solid waste management consultants, appointed on March 17, 2008 as Receiver by the District Court of Guam to achieve the government's compliance with the Clean Water Act as set forth in the Consent Decree) oversaw the design of an approved plan that met all of the legal and environmental requirements of the Federal and Territorial Governments.

A plan developed by the Receiver, USEPA and Guam EPA, provided the legally-required 30 year post-closure care of this facility. Such care included monitoring groundwater, leachate collection and control, methane gas collection and control, and financial assurance that the money would be available to carry out these activities. Leachate, which had been leaking out of the Ordot Dump and polluting the Lonfit River, is now being captured and diverted to a waste water treatment facility for proper treatment. From January 30, 2015 to March 10, 2016, 8 million gallons of leachate has been directed away from the Lonfit River to the waste water treatment plant. The environmental closure of the Ordot Dump also captures harmful methane gas, a greenhouse gas that contributes to climate change. From September 14, 2015 through March 9, 2016, 12,539 metric tons of methane has been captured and properly disposed, rather than escaping into the atmosphere. This is the equivalent of the carbon produced by 2,640 passenger vehicles per year.

On March 28, 2016 the District Court of Guam held a special Hearing that officially concluded the Environmental Closure of the Ordot Dump.

On April 29, 2019, the Court issued an Order partially ending the Receivership. Under the receivership, the Ordot Dump has been closed and the Receiver installed the necessary systems to protect Guam's waters from this environmental hazard that had plagued the island for decades. The Receiver built a modern solid waste system for the island which includes a compliant solid waste landfill, a recycling program and a household hazardous waste disposal center. (The Court authorized the Receiver to continue its work to complete the post-closure plan for the Ordot Dump.)

3.2 Navy's Guam Environmental Restoration Program Sites

The Environmental Restoration Program is organized into three programs based on the site type and location.

- Installation Restoration Program (IRP): The IRP addresses chemical at sites located on active Navy installations and property;
- Munitions Response Program (MRP): The MRP addresses cleanup at sites with munitions on active Navy installations and property;
- Base Realignment and Closure (BRAC) Program: The BRAC Program addresses chemicals on sites located on closed or transferring Navy installations and property.

Fact Sheet 5 dated February 2014 follows in the next few pages. It describes the status of each of the Navy's ERP sites on Guam. Updates will be included in the next reporting period Integrated Report.

D. Summary of Ground Water Quality

The overall ground water quality of the NGL is good, however, it is significantly vulnerable to contaminants, including chloride contamination induced from over pumping of water supply wells. These threats increase the NGL's contamination potential.

The preservation of the Northern Guam Lens Aquifer is a priority because of its designation as Guam's Sole Source Aquifer and because of the magnitude of incidences observed in which the levels of pollutants (Bacteria, Nutrients, Chlorides, and Toxic Contaminants) exceeded Guam Water Quality Standards. The Agency will facilitate assessment, planning, or pollution control activities necessary to improve water quality such that it complies with local standards. The degree of public interest in or concern about the water body is extremely high.

E. Summary of Groundwater-Surface Water Interactions

Guam EPA has a growing awareness of ground water-surface water interactions and their contribution to water quality problems.

Another aspect of groundwater is spring discharge along the coast in the inter- and sub-tidal zones. These springs comprise the discharge of the NGL aquifer. A completed study has characterized the chemistry of discharge from selected springs into Tumon Bay. The study consisted of sampling eight Tumon Bay springs during four discrete sampling events. Total discharge estimated for the seven springs is 17 million gallons per day.

The two-year study consisted of four sample rounds (of eight springs along the Bay) during both the wet and dry seasons. Chemicals detected above Guam EPA water quality standards included Tetrachloroethene, Trichloroethylene, Aluminum, Antimony, Arsenic, Magnesium, Chloride, Sulfate, Oil & Grease, Total Coliform and Fecal Coliform. Pesticides Dieldrin, Alpha-Chlordane, and Gama Chlordane were also detected in spring discharge; however no Guam EPA water quality standards currently exist for these compounds. The study was funded with Clean Water Action Plan money through the Watershed Planning Committee.

In 2020, Guam EPA received EPA technical assistance to support development of a TMDL for Tumon Bay. This work shall include water, tissue and PED sampling, review and analysis of data, development of maps using available GIS data, TMDL calculations, development of draft and final TMDL reports, and implementation recommendations. Following the first study, the six chemicals of concern for the TMDL are: Trichloroethene (a.k.a. trichloroethylene or TCE), Tetrachloroethene PCE, Dieldrin, Total Chlordane, Antimony, and Arsenic. A draft TMDL is targeted for completion in the summer of 2021.

Navy's Guam Environmental Restoration Program

Site Status Update

Fact Sheet 5 — February 2014

INTRODUCTION

The purpose of the Navy's Environmental Restoration Program is to reduce risk to humans and the environment from historical activities at Navy properties. The Environmental Restoration Program is organized into three programs based on the site type and location as seen in the box to the right. This fact sheet provides a status for each of the Navy's Environmental Restoration Program sites in Guam. Additional information on the investigation and cleanup process followed at each site is included as

Navy Environmental Restoration Programs

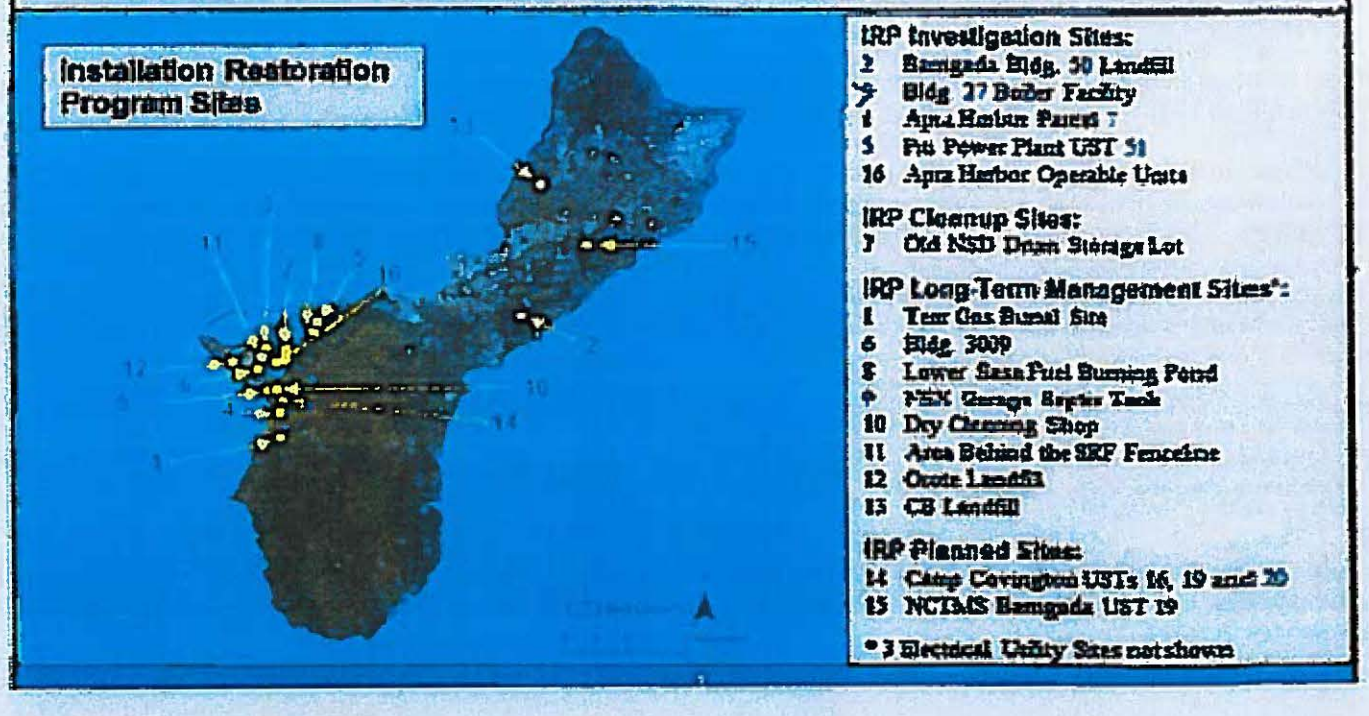
Installation Restoration Program (IRP): The IRP addresses chemicals at sites located on active Navy installations and property.

Munitions Response Program (MRP): The MRP addresses cleanup at sites with munitions and explosives of concern and chemical contamination hazards from the past use of military munitions on active Navy installations and property.

Base Realignment and Closure (BRAC) Program: The BRAC Program addresses chemicals on sites located on closed or transferring Navy installations and property.

IRP SITES ON GUAM

The Navy began work on the Guam IRP in the 1980s. Currently, there are 19 active IRP sites on Guam; 5 are being investigated, 1 is in the cleanup phase, 11 are in long-term management, and 2 are planned for future actions.



Fact Sheet 3

IRP Investigation Sites

2. Barrigada Bldg. 50 Landfill: Final Work Plan completed in August 2013. Field work scheduled for March 2014 to occur during dry season. Subsurface anomalies being investigated.

3. Building 27 Boiler Facility: The Remedial Investigation published in 2013 concluded no further action is required for this site. A Decision Document specifying this recommendation will be prepared in 2014.

4. Apra Harbor Parcel 7: The Phase II Remedial Investigation Report will be published in 2014. No further action is recommended for this site.

5. Piti Power Plant UST 51: Draft Work Plan scheduled for February 2014 for fuel contamination investigation.

16. Apra Harbor Operable Units: Sediment/biota study in inner and outer Apra Harbor. Draft Work Plan currently in review by regulatory agencies. Field work scheduled for Summer 2014, report to follow.

IRP Cleanup Sites

7. Old NSD Drum Storage Lot: Work Plan for waste removal and site investigation will be finalized in early 2014. Field work to follow.

IRP Long-Term Management Sites

1. Tear Gas Burial Site: No traces of tear gas were found but low levels of hydrocarbons were found in the soil. A Decision Document detailing Land Use Controls (LUCs) to limit future exposure to the soil was signed in 2012. Annual inspections are ongoing, five-year review results due in 2014.

6. Building 3009: Groundwater studies completed in 2012 found no impact to groundwater quality. The site entered Long-Term Management in 2013. Annual inspections are ongoing.

8. Lower Sasa Fuel Burning Pond: Fuel contaminated soil cleanup complete in 2007. Annual inspections are ongoing, and five-year review results will be published in 2014.

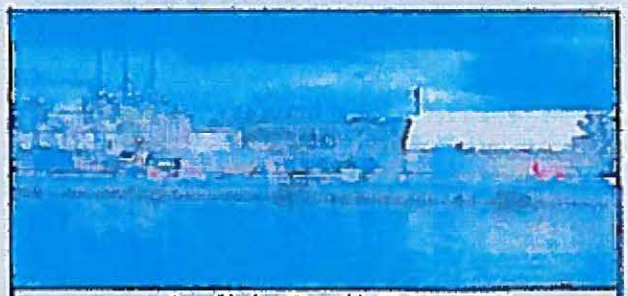
9. NEX Garage Septic Tank: The septic tank was cleaned and removed/sealed. Annual inspections are ongoing, and five-year review results will be published in 2014.

10. Dry Cleaning Shop: Six underground storage tanks (USTs) and 2 concrete sumps were removed in April 1994. Annual inspections are ongoing, and five-year review results will be published in 2014.

11. Area Behind the SRF Fenceline: A vegetated soil cover was built on exposed sandblast grit/soil in 2007. Also, wetland shoreline restored. Annual inspections and cover maintenance are ongoing, and five-year review results will be published in 2014.

12. Orote Landfill: A seawall and vegetated soil cap were built in 2000, and fish sampling was completed in 2010. Annual inspections and cap and seawall maintenance are ongoing. The upgradient groundwater study was completed in 2013. Five-year review results are due in 2014.

13. CB Landfill: A soil/synthetic cover system was built in 1998. Annual inspections and cover maintenance are ongoing, and five-year review results will be published in 2014.



Apra Harbor Operable Units

Electrical Utility Sites (*3 Sites not shown on map): Barrigada Substation, Harmon Substation, and Piti Substation—Completed thermal treatment of PCB contaminated soil and excavation and off-island disposal of metal contaminated soil in June 2010. Annual inspections are ongoing, and five-year review results will be published in 2014.

IRP Planned Sites:

14. Camp Covington USTs 16, 19, and 20: Draft work plan scheduled for 2016 for fuel contamination investigation.

15. NCTMS Barrigada UST 19: Draft work plan scheduled for 2016 for fuel contamination investigation.

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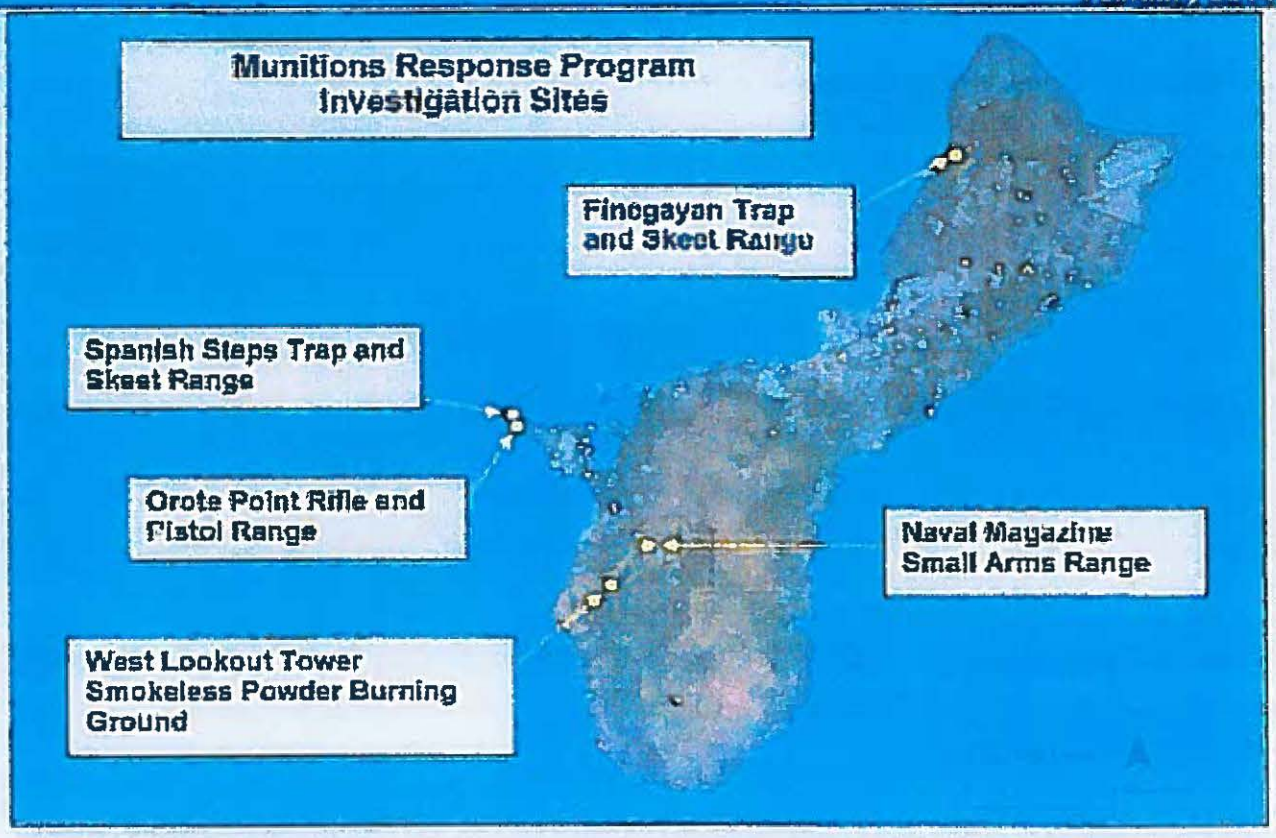

MRP SITES ON GUAM

The Navy's MRP began in 2000. A Site Inspection was completed at each of the five MRP sites in 2010, and further study or investigation was recommended for all five sites.

Orote Point Rifle and Pistol Range: Remedial investigation field work will be followed by a draft report in 2014 to address potential risk from levels of antimony, copper and lead in the soil.

Former Small Arms Firing Mound at Orote Point

Spanish Steps Trap and Skeet Range: Preparation of a Remedial Investigation Work Plan is scheduled for 2014 to address potential risk from levels of lead and polyaromatic hydrocarbons (PAHs) in the soil.

West Lookout Tower Smokeless Powder Burning Ground: Preparation of a Remedial Investigation Work Plan is scheduled for 2015 to address potential risk from levels of various metals in the soil.

Naval Magazine Small Arms Range: A Supplemental Risk Assessment is scheduled for 2014 to address the potential risk to human health from levels of copper and lead in the soil.

Finegayan Trap and Skeet Range (NCTMS): Remedial investigation field work will be followed by a draft report in 2014 to address potential risk from levels of lead and polyaromatic hydrocarbons (PAHs) in the soil.

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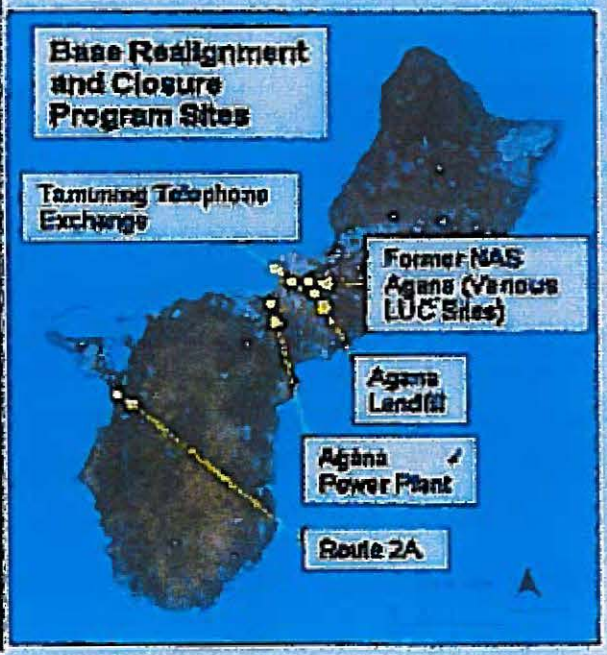
BRAC SITES ON GUAM: All BRAC sites on Guam are in long-term management.

Site Name	Status Summary
Various former NAS Agana Land Use Control (LUC) Sites	LUCs have been implemented at 11 sites to ensure they remain restricted to industrial/ commercial reuse. Five-year review completed in June 2013.
Agana (Tiyan) Landfill (located at former NAS Agana)	A landfill cap was built over consolidated landfill waste in 2004. Annual inspections and cap maintenance ongoing; five-year review completed in June 2013.
Agana Power Plant	PCB cleanup at the site and drainage outfall areas completed 2005. Annual inspections ongoing; five-year review completed in 2013. Leased to Guam Power Authority.
Tamuning Telephone Exchange	Lead contaminated soil cleaned up in July 2001. Five-year review completed in June 2013.
Route 2A (Old WESTPAC Site)	PCB contaminated soil cleaned up in 2004. Five-year review completed in June 2013.



PUBLIC PARTICIPATION

The Navy encourages local community members to become involved in the environmental cleanup program on Guam. The easiest way is through participation on the Navy Guam Restoration Advisory Board (RAB). This is a group made up primarily of local community members who meet regularly to discuss environmental cleanup program plans and progress with representatives with the Navy, Guam EPA, and the U.S. EPA Region 9. Community members can participate in the RAB either by becoming an official RAB member or simply attend meetings as a member of the public.

FOR MORE INFORMATION

Copies of all official environmental program documents are available for review at the information repositories located at the Nieves M. Flores Library in Hagatna and the University of Guam Robert F. Kennedy Memorial Library.

If you are interested in RAB participation or want more information on the Navy Guam Environmental Restoration Program, please contact:

Naval Facilities Engineering Command Marianas
Public Affairs Officer
PSC 455 Box 195
FPO AP 96540-2937
Phone: (671) 349-4063
Fax (671) 349-7148
Email: william.austin@fe.navy.mil

Mr. Michael Mann
U.S. Environmental Protection Agency
Region 9
Pacific Islands Office
Phone: (415) 972-3505

Mr. Michael Cruz
Guam Environmental Protection Agency
Phone: (671) 300-4751