2010 INTEGRATED REPORT

CLEAN WATER ACT
Sections 303(d), 305(b) and 314

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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
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

Preface: An Overview of Guam

The Island of Guam is an unincorporated territory of the United States. It is the westernmost point of the U.S., lying at latitude 13º28" N and longitude 144º45" E, or about 1,500 miles south of Tokyo, 1,730 miles east of Manila and 3,840 miles west and slightly south of Honolulu, Hawaii. Guam has an area of approximately 212 square miles (549 sq km) and measures about 30 miles (69 km) long with widths from 11 miles (25.3 km) in the south to 4 miles (9.2 km) in the center and 8 miles (18.4 km) in the north. **See Appendix A, Figure 1**.

The population projection for 2009 is approximately 178,287[1] people throughout the island except for certain military properties and the steep interior mountains of the South. The average population density is 730 per square mile; however, the density in the north is approximately 1,200 per square mile while the density in the south is 300 per square mile. Practically all residences are served by public/military community water supply systems, with a large number of single-family dwellings using 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.

Guam is the largest and southernmost of the Marianas Archipelago of islands 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 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

[1] Source: 2000 Census Population and Housing: Guam; International Programs Center, U.S. Census Bureau

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 larger 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 consisting of 20 watersheds. 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 Surface Water and Ground Water Quality

1.1 Marine Waters

Guam's marine waters are generally "good". 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).

Marine Bays

Guam included 66 Marine Bays in its assessment of these waterbodies for the reporting period. This list is provided in Table 22, pages 36a-c, Part III. Surface Water Monitoring and Assessment.

- 24 assessed marine bays met some designated uses but more data is needed to make a use determination for these waters;
- 31 marine bays were not assessed;
- 11 marine bays were placed on the 2010 303(d) list of impaired waters

IMPAIRED MARINE BAYS 2008-2009

Waterbody Name/Assessment ID	Size of Assessed Waterbody	Reason for Impaired 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: <u>11 Marine Bays</u> **<u>14.76 square miles impaired waters</u>**

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 list of Guam waterbodies considered for assessment during the reporting period is provided in Section III. Surface Water Monitoring and Assessment, Table 21, pages 35a-h.

- In 2008, Guam EPA monitored 15.46 of the total 43.65 shoreline miles of Guam coastal waters. Of the shoreline miles monitored, 0.24 miles fully supported and attained GWQS for the designated uses; 1.41 miles partially supported and attained GWQS; and 13.81 miles did not support or attain GWQS.

- In 2009, the Agency monitored 15.46 of the total 43.65 shoreline miles of coastal waters. Of the shoreline miles monitored, zero miles fully supported and attained GWQS for the designated uses; 1.99 partially supported and attained GWQS; and 13.47 miles did not support or attain GWQS.[2]

Swimming advisories are issued based upon either an instantaneous concentration of 104 MPN/100mL or a geometric mean concentration of 35 MPN/100mL, over a five week period. During 2008, 762 swimming advisories were issued. During 2009, 752 swimming advisories were issued and West Hagatna Bay was closed for 365 days due to a sewage leak in the effluent pipe from the Hagatna Sewage Treatment Plant. **(Refer to Tables B7a-d and B8a-d, Appendix B).**

Table 23, located on pages 37a-f of Part III. Surface Water Monitoring and Assessment, identifies the twenty six recreational waterbodies listed as impaired for the reporting period. 25 of these waterbodies are Recreational Beach Monitoring Program (RBMP) sites impaired because they exceed allowable water quality standards for bacteria. Gabgab Beach is not a RBMP site and located within a military installation. It is impaired because the waterbody is subject to a Fish Consumption Advisory.

1.2 Fresh Water

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 did not satisfy all monitoring and reporting requirements in 2008. In 2009, the Navy water system met all primary drinking water

[2] See Appendix H, Table B5: Guam Beach Use Support

standards except for the treatment techniques standard for turbidity. A discussion is provided in Part III. Surface Water Monitoring and Assessment, pages 45-46.

Rivers and Streams

Table 20 located in Section III. Surface Water Monitoring and Assessment, pages 33a-f, provides information about the one hundred thirty-two (132) fresh water assessment units which represent two-hundred one (201) Guam rivers and streams. The following river waterbodies are impaired and on Guam's 2010 303(d) list.

Impaired River/Stream/Wetland	***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	GUPGRL-1-51B	0.04 mi
5. Landfill Leachate Stream	GUPGRL-0	0.05 mi
6. Pago River 1	GUPGRP-1-51A	0.06 mi
7. Pago River 2	GUPGRP-2	4.73 mi
8. Storm Drain	GUAGRD	0.21 mi

Table 23 identifies the basis for impairment and the pollutants for these impaired waters. Six (6) Ugum River assessment units totaling 21.58 miles are impaired, however, because a Sediment TMDL has been developed, these river units are reported under Category 4a.[3]

Northern Guam Lens (NGL) – Guam Sole Source Aquifer

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.

In March 2007 Guam EPA hosted a groundwater workshop to initiate a water quality study on the Northern Guam Lens. The study expects to determine if wells, the aquifer and or sub-basins qualify as "Groundwater under the direct influence of surface water" or GWUDI. GWUDI refers to groundwater where water at the surface, like rainwater, can wash pollutants down to a well without any natural purification. GWUDI wells need additional treatment to make the water safe. The study is on-going.

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

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 was **enterococcus,** a pathogen indicator. In 2008, 13.81 shoreline miles of recreational beaches were impaired by these bacteria. In 2009, these same stressors caused 13.47 shoreline miles of recreational beaches to be impaired. 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 is still being investigated.

2.2 Fresh Waters

Impaired surface waters on the 2010 303(d) list identify the following pollutants.

Rivers and Streams

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

Landfill Leachate Stream: GUPGRL-0 0.05 miles

Pollutants: E. coli, Nitrate, Dissolved Oxygen

Source: Ordot Dump

Pago River segments: GUPGRP-1-51-A 0.06 miles
GUPGRP-2 4.73 miles

Pollutants: E. coli, Dissolved Oxygen

Source: Urban runoff, storm sewers, contaminated sediments

Agana River GUAGRA-3 0.52 miles
GUAGRA-2-1A .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, Nitrates, Total Suspended Solids, Turbidity, Salinity

Source: Urban runoff, storm sewers, contaminated sediments, sewer system/manhole overflows

Wetlands

Agana Swamp: GUG1-B 6.40 acres

Pollutants: PCBs in fish tissue

Source: Agana Power Plant

Groundwater

As listed in **Table B9. Appendix B., t**he ten priority sources of groundwater contamination and the respective contaminants associated with each source are:

- **Agricultural Activities**:
  - Animal feed lots --- nitrates, 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 CWA 319 and CZARA 6217 programs.

To meet all federal and local reporting requirements the CMS for the island of Guam includes ten distinct individual monitoring plans. The programs developed or proposed 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 Plan
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

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
Section 6217 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 B10., Appendix B.

Guam EPA also recognizes the Guam Waterworks Authority (GWA) Stipulated Order for Preliminary Relief which outlines a list of mandated actions for GWA. The list includes the development and implementation of a comprehensive Water Master Plan and the financing of water and wastewater capital improvement projects. Continued compliance with this Order should improve water quality as a result of infrastructure improvements to sewage treatment plants, pump stations, and ground water facilities. The completion of the Water Master Plan will also provide a strategic roadmap for the utility to meet quality water demand and the wastewater treatment needs of the island.

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.

The economy depends largely on US military spending and tourism. Total US grants, wage payments, and procurement outlays amounted to $1.3 billion in 2004. Over the past 30 years, the tourist industry has grown to become the largest income source following national defense. The Guam economy continues to experience expansion in both its tourism and military sectors.[4]

According to the ***Economic Forecast***[5] Guam stands out as one of the few places in today's world that has a brighter economic future. The coming military buildup occupied center stage on Guam in 2008 and 2009. The publication writes, "…It is assured that the buildup will come, and parts of it are already underway, even though some uncertainty still exists as to the exact timing of the transfer of the III Marine Expeditionary Force from Okinawa, Japan. The biggest changes since 2008 have come in the economic environment elsewhere. The island has felt the impact in its external investment and real estate sectors, and this is likely to continue to be the case. Also, Guam tourism has been impacted negatively over the past year. Declines in visitors from Japan and Korea, its two main markets, are signs of the hard times that now plague the world economy. Over the longer haul, the military buildup will make Guam's economy more resilient, similar to other economies that have a significant federal spending component. Various industries in the private sector such as tourism and construction are always subject to some kind of cyclical variation. Tourism may be affected by exchange rates and economic cycles in visitors' own economies, for example. But the military provides an underpinning that is always there…"

Although the agency faces significant issues of concern (i.e. the Ordot dump closure and the construction of a new landfill, "groundwater under the influence" concerns, impacts

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[4] CIA, The World Factbook

[5] Economic Forecast – 2009 Guam-CNMI Edition. First Hawaiian Bank
http://www.guamchamber.com.gu/pdf/2009/FHB_Economi_Forecast2009.pdf

of the upcoming military buildup, 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 Comprehensive Monitoring Strategy programs 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;
- The continuing effort to facilitate provisions of Executive Order 2004-04 and implement a comprehensive Watershed Planning Process for the Northern, Ugum and Talofofo Watersheds;
- Overseeing and enforcing (with EPA support) GWA compliance with provisions of the Stipulated Order for Preliminary Relief;
- 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 improve Guam's Certification Program for Water and Wastewater Systems operators;
- Providing oversight for current and future Title II EPA funded Sewer Construction Grants projects;
- 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, rules/regulations primarily to support compliance and enforcement, i.e. the updated Guam Pesticides Act; the development of an initial draft *Erosion Control and Stormwater Management Regulations;*
- 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.

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.

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

II. BACKGROUND INFORMATION

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

Table 1.
Atlas of Guam Coastal and Aquatic Resources

Topic	Value
State population	**178,287** [1]
Land Surface Area	**212 square miles**
Coast	**116.5 miles**
Sandy Beaches	**35.9 miles**
Coral Reef	**9,080 acres**
Seagrass Beds	**353 acres**
Watersheds (#)	**20**
Perennial Streams (#)	**97**
Streams	**228.65 miles**
Lakes (Reservoir) (#)	**1**
Lakes (Reservoir)	**195 acres**
Freshwater Wetlands	**3,785 acres**
Lacustrine Wetlands	**198 acres**
Estuarine Systems	**915 acres**
Mangroves	**176 acres**

A. Overview of Guam's Water Resources

The categories of water established under the Guam Water Quality Standards (§5102, 2001 Revision) are Groundwater, Marine waters, and Surface waters. **Table 1** summarizes Guam's coastal and aquatic resources.

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 Water lens, 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).

[1] Source: 2000 Census of Population and Housing: Guam; International Programs Center, U.S. Census Bureau

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 75% 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 sub-basins (Agana, Mangilao, Andersen, Agafa Gumas, Finegayan, Yigo) containing 47 management zones.[2] **See Figure 2.** 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 Reservoir water is treated (to reduce turbidity) and chlorinated.

2.1 Wetlands

Wetlands on Guam **(Wetlands Map, FIGURE 4a.)** have been officially estimated to comprise less than four percent of the total land area, although more recent field based estimates suggest a substantially greater percentage. 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.

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[2] Northern Guam Lens Study , Guam EPA 1982
[3] 1987 Wetland Delineation Manual

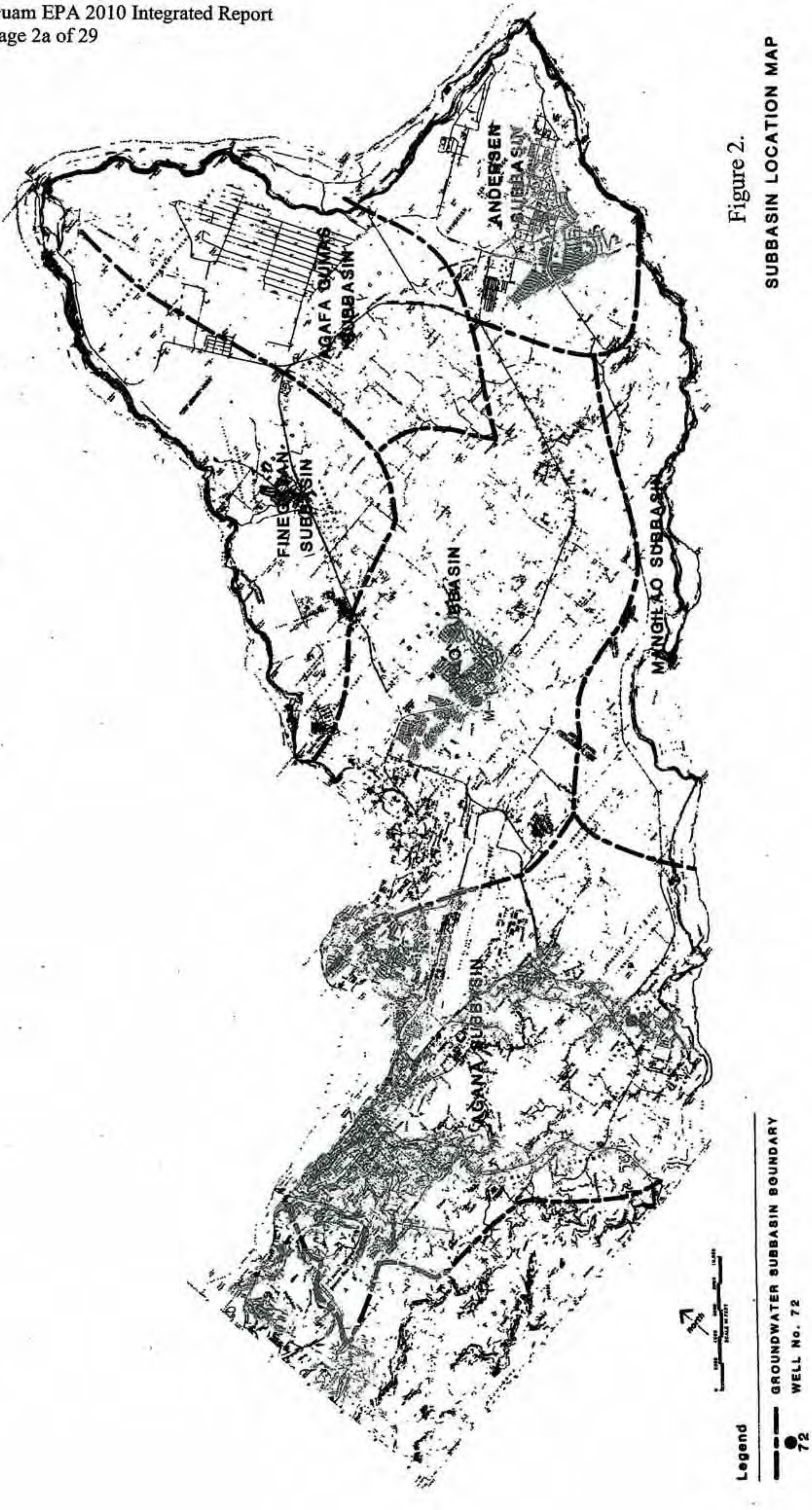

Figure 2.
SUBBASIN LOCATION MAP

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. **Table 2** presents a breakdown of the National Wetlands Inventory of Guam by U.S. Fish and Wildlife Service (FWS) category.

Table 2. Wetlands Inventory of Guam

FWS Category	Acreage	System
Coral Reef	**9,080**	Marine
Forested Scrub-shrub	**2,170**	Palustrine
Emergent Wetlands	**1,386**	Palustrine
Open Water	**713**	Estuarine
Seagrass Beds	**353**	Marine
	198	Lacustrine
Mangrove Forest	**176**	Estuarine
Unvegetated Shoreline	**83**	Marine
Open Water/Aq Bed	**27**	Palustrine
Other	**26**	Estuarine
	4	Riverine
TOTAL	14,216	

Source: 1983 National Wetlands Inventory

Over 15 years of actual field delineation work has lead both local and federal wetland experts to conclude that the NWI estimates for emergent and forested scrub-shrub wetlands are significantly understated. A significant number of wetland systems have been accurately delineated for Section 404 jurisdictional purposes over the 15+-year period. Maps were digitized and added to the Inventory by the Guam Coastal Management Program (GCMP).

Guam EPA maintains copies of jurisdictional wetland delineation maps. Wetland delineation verifications and determinations continue to be made, mostly involving small wetlands systems (less than 1 acre). The majority of these determinations and field verifications are required to facilitate development activities and do not require delineation mapping because plans are made or modified to avoid impacts.

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 212 square miles of land surrounded by 116.5 miles of

WETLANDS BOUNDARY

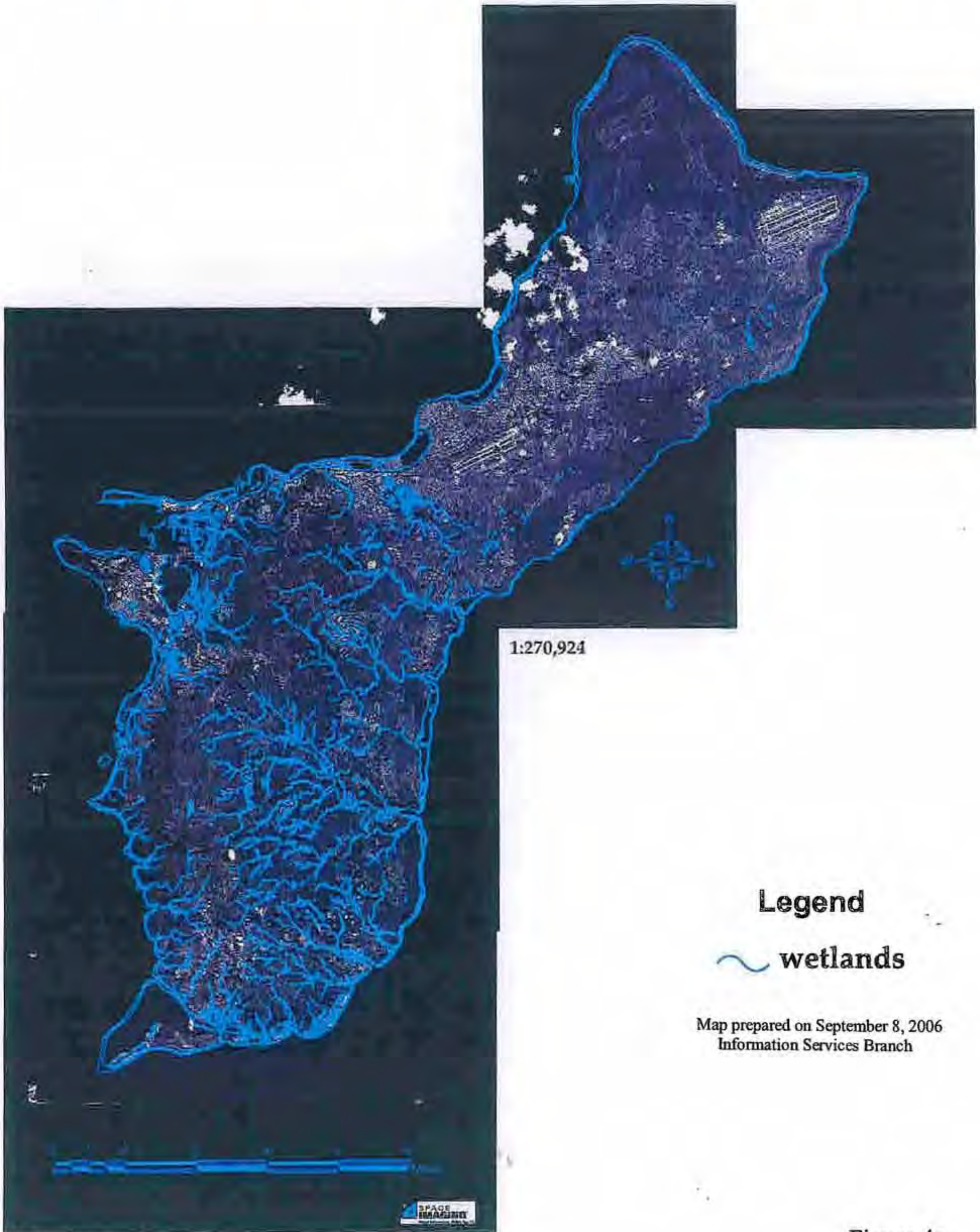

Figure 4a.

Data set is not for use in litigation. While efforts have been made to ensure that these data are accurate and reliable within Guam, Guam Environmental Protection Agency (GEPA), cannot assume liability for any damages, or misrepresentations, caused by any inaccuracies in the data, or as a result of the data to be used on a particular system. GEPA makes no warranty, expressed or implied, nor does the fact of distribution constitute such a warranty.

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[4], September 1999, addresses Guam EPA's overall approach for managing water resources. Guam uses a balanced 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 non federal agencies, other

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

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)**[5]. The 1998 WPC used an NRCS map, which delineated watersheds on Guam, to organize the watersheds by category based on national criteria, the data available for each watershed, and the severity of environmental impact suffered by each watershed. That 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.[6]

1.1 Northern Watershed Restoration Strategy (NWRS)[7]

The NWRS established projects to document, investigate, and reduce potential contaminant sources located within the Tumon/Yigo Sub-basin; complete an innovative septic tank design pilot project; and conduct public education and outreach activities designed to help restore the Northern Watershed. *Unfortunately, the WPC has been inactive since mid 2008 as the Agency prioritized its limited manpower and funding on 1) other core program and regulatory activities 2) intensified participation in the NEPA process related to Guam's impending military build-up and 3) building the support system to meet the complex demands and impacts of the military buildup.*

Follow-up work to the NWRS has been difficult, however, the following Agency coordinated projects were undertaken to support the restoration of Northern watershed during the reporting period:

a. *Wastewater Revolving Fund Loan Program*: This is a program developed via a Memorandum of Understanding between Guam EPA and GWA. $75,000 was granted to GWA in 2008 to design and implement a mechanism for eligible applicants to acquire funding (via a low-interest loan). Approved applicants will use funds to connect their home to the existing sewer system. GWA is required to submit quarterly progress reports.
b. *Guam Northern Watershed Bacteria TMDLs*: U.S. EPA approved seventeen Guam TMDLs prepared by Tetra Tech, Inc. (March 2010). The document consolidates summarized information for seventeen Tier 1 beaches located in the Northern Watershed which are impaired due to exceedances of Guam Water Quality Standards for enterococci bacteria. The TMDLs will be used

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[5] 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. A copy is provided in Appendix D.

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

[7] See Appendix G.

by the Agency to support development of information-based, water quality management strategies. A copy of the document is provided in **Appendix F**.

1.2 Ugum Watershed Restoration Strategy[8]

The objective of the Ugum restoration strategy is to improve the drinking water quality and the ecosystem functioning of the Ugum Watershed. Erosion is the most significant factor interfering with the achievement of this objective. The most effective means of preventing and minimizing soil erosion is to encourage actions which maximize vegetative cover, particularly forest. The following priorities were identified for an effective Ugum restoration strategy:

a. Conserve and protect the ravine forest.
b. Re-vegetate badlands within the savanna grasslands.
c. Minimize fires.
d. Inform and involve the public.

Although a coordinated implementation effort via the WPC was absent during the reporting period, efforts which support continuing restoration of the Ugum Watershed include:

- The award of an ARRA[9] grant to Guam EPA. A portion of $70,000.00 will be used to update the 1996 Ugum Watershed Management Plan (December 2010);
- The availability of a Rapid Watershed Assessment compiled by the U.S. Department of Agriculture Natural Resources Conservation Service (NRCS) to assist local land managers, planners, and others in evaluating opportunities to implement conservation and resource prevention measures within the Ugum watershed. View at http://www.pia.nrcs.usda.gov/technical/rwa.html;
- Continuing watershed research program efforts by the Water and Environmental Research Institute (WERI), i.e., the *Natural Resources Atlas of Southern Guam*: a reference and educational tool that provides a comprehensive picture of the natural resources found within the fourteen watersheds of southern Guam, including the Ugum Watershed. View at http://www.hydroguam.net);
- The implementation of a Guam Campaign for Effective Watershed Management (A RARE Pride Campaign).
  Approach: The local project manager writes "the *Campaign for Effective Watershed Management/Guam*[10] will increase the percentage of branching coral species by reducing the number of fires on the island, thereby decreasing sedimentation and improving water quality. This threat will be reduced because hunters will stop using fire to disturb animals, and the community will more diligently report fires, which is enabled by the fact that the alternative use of bait to attract deer, the introduction of a hotline for community members to report fire violations, and a fire violation citations

[8] See Appendix G.
[9] American Reinvestment and Recovery Act
[10] Elaina Todd: local project Manager

programs will be adopted by the hunters and Southern community at large. We will know that the campaign is having an impact when we observe increased discussion about hunters and wildfire prevention among the target audience. The target audience will be willing to engage in this new behavior because a Pride campaign will change their opinion on the importance of preventing wildfires and knowledge of how wildfires pollute the community's water.

Strategy for success: Success of the Guam Pride campaign will be measured highly if human induced conservation threats (such as arson induced wildfires, de-vegetation of watersheds, destructive recreational and fishing practices) are dramatically reduced within the Piti Bomb Holes Marine Preserve and Sella/Cetti Bay in Guam. In particular, the campaign will seek to: Reduce illegal fires (arson) by 50% by 2011; Reduce sedimentation by 10% in watersheds; 80% implementation of BMPs for new developments by 2011; Plant at least 210,000 seedlings over 18 acres in the Piti/Asan watershed. Additionally, the campaign will aim to create "community watershed monitoring" groups as well as increase public support for watershed."

A *Sediment TMDL for the Ugum Watershed* was approved by USEPA in 2006 **(Appendix E)** and is pending implementation.

1.3 Talofofo Watershed

The award of an ARRA grant to Guam EPA in support of watershed planning will be used to develop a Talofofo Sub-watershed Management Plan. (December 2011). The Agency intends to develop and include a protection and restoration strategy in accordance with the approved Guam Coastal Nonpoint Pollution Control Program and other on-going nonpoint source efforts. Information about the Talofofo watershed is available at *www.hydroguam.net*.

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. The Water Pollution Control Program oversees the implementation and compliance of conditions imposed by Guam EPA Water Quality Certification (Section 401) and the National Pollutant Discharge Elimination System (NPDES) permits issued to industrial and non-industrial facilities. Information about Guam EPA permits is available at *http://node.guamepa.net/permits/guidebook.html*.

Although the NPDES permit is administered by EPA, Region 9, the Guam EPA Water Pollution Control Program in coordination with the Environmental Planning and Review Division is responsible for certifying all permit applications and recommending the conditions and abatement schedules for each permit. All permittees are monitored by both the Water Pollution Control Program and EPA staff to verify compliance with applicable permit requirements and compliance schedules.

There were nineteen (19) active NPDES permits on Guam in 2008-2009. **See Table 3.** The discharge from these permitted facilities included effluent from wastewater treatment plants, thermal effluent from the power plants and a number of discharges which contained minor amounts of oil and other toxic materials. The guidelines for effluent limitations are based on the Revised 2001 Guam Water Quality Standards.

(b) **Enforcement** - The Water Pollution Control Act and Guam Water Quality Standards authorize Guam EPA to take legal action against those who pollute the waters of Guam. Enforcement is carried out through site and sampling inspections. NPDES permittees submit quarterly Discharge Monitoring Reports (DMRs) to EPA Region 9 for review

Table 3. Federal National Pollutant Discharge Elimination System Permits Guam: 2008 – 2009

Permit No.	Facility	Receiving Water(s)
GU0020087	GWA, Agana STP	Philippine Sea
GU0020141	GWA, Northern District STP	Philippine Sea
GU0020222	GWA, Agat/Santa Rita STP	Philippine Sea
GU0020273	GWA, Umatac-Merizo STP	Philippine Sea
GU0020095	GWA, Baza Gardens STP	Pacific Ocean
GU0020001	GPA, Cabras Power Plant	Apra Harbor
GU0000027	GPA, Tanguisson Power Plant	Philippine Sea
GU0020141	GPA, Piti Power Plant	Philippine Sea
GU0000035	Guam Shipyard	Apra Harbor
GU0110019	USN, Apra Harbor STP	Philippine Sea
GU0020150	Shell Agat Terminal	Apra Harbor
GU0020338	Shell Guam, F-1 Pier	Apra Harbor
GU0020036	Mobil Oil Guam, Inc.	Apra Harbor
GU0020079	South Pacific Petroleum Corp.	Apra Harbor
GU0020281	Continental Micronesia	Harmon Sink
GU0020290	Guam Airport Authority	Harmon Sink
GU0020303	Manenggon Hills Resort	Ylig River
GU0020168	UOG, Marine Laboratory	Pacific Ocean
GU0020346	Unitek Environmental-Guam	Apra Harbor

Source: Guam EPA Water Pollution Control Program

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 surface and groundwater. And as the overall designated Agency responsible for protecting the quality of waters in Guam, Guam EPA oversees the following activities under its Water Pollution Control Program, the Watershed Planning Committee and NPS 319 program, and Guam's coastal NPS program, to prevent and control nonpoint source contamination.

Table 4. Wastewater Permits 2000 – 2009

Permits Issued	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	TOTALS BY PERMIT TYPES
Sewer Connections	**152**	**89**	**88**	**154**	**110**	**143**	**198**	**226**	**181**	**151**	**1492**
Septic Tank/ Leaching Field	**398**	**281**	**171**	**311**	**163**	**171**	**203**	**228**	**260**	**219**	**2405**
Misc. Permits	**115**	**105**	**62**	**99**	**289**	**522**	**556**	**465**	**352**	**337**	**2902**
ANNUAL TOTALS	**665**	**475**	**321**	**564**	**562**	**836**	**957**	**919**	**793**	**707**	**6799**

Source: Guam EPA Water Pollution Control Program

3.1 <u>Individual Wastewater Permits</u>

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 economic difficulties, such development is occurring without adequate sewage infrastructure. As a result, occupants depend on septic tank and leaching field systems for waste disposal.

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 the reporting period a total of one thousand five hundred (1,500) permits were issued by the Agency. Of this, three hundred thirty-two (332) were sewer connection permits, four hundred seventy-nine (479) were permits for septic tank/leaching field systems, and six hundred eighty-nine (689) were miscellaneous permits. **See Table 4.**

3.2 Soil Erosion and Sediment Control Program

Soil erosion is one of the island's most serious nonpoint source pollution problems especially in the southern area. With increased local development, in particular the movement of land development to the Southern half of the island, disturbance of Guam's soil caused by site grading operations and by burning of natural vegetation has 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 animals die or leave the area.

Guam EPA enforces the *Guam Soil Erosion and Sediment Control Regulations* (P.L. 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 2008-2009, a total of three hundred fifty six (356) permits were issued and subject to compliance with the Guam Soil Erosion and Sedimentation Control Regulations. Of this total, one-hundred sixty (160) were permits for clearing; one hundred (100) were permits for grading; and ninety-six (96) were permits for clearing and grading. **See Table 5.**

3.3 Feedlot Waste Management Program

In 1986, the Guam EPA developed Feedlot Waste Management Regulations (http://www.guamepa.net/regs/feedlot_regs.pdf) 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 20 swine or 500 fowl. On-site visits to smaller livestock operations are undertaken when identified; and where improper handling of wastes exists, corrective action is recommended to the operator. The problem associated with these smaller facilities is frequently handled through modifications in "housekeeping" procedures. The need to develop specific control over the smaller operations has yet to

Table 5. Clearing and Grading Permits 2000- 2009											
Activity:	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Activity Totals
Clearing	55	51	41	37	57	76	90	79	105	55	646
Grading	45	57	40	32	22	33	53	54	62	38	436
Clearing and Grading	13	27	19	14	23	40	33	41	55	41	306
Annual Totals	113	135	100	83	102	149	176	174	222	134	1388
Erosion Control Plan	42	29	59	19	28	41	69	51	89	51	478

Source: Guam EPA Water Pollution Control Program

be evaluated.

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 local 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. Program staff annually monitors feedlot operations to verify compliance with respective regulations and operation and maintenance standards for the permitted facility.

The Agency also 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.

No feedlot operators were registered with Guam EPA in 2009.

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.

During the reporting period, the Agency completed its initial draft of the *Guam Erosion Control and Stormwater Management Regulations* which incorporates provisions for stormwater management based on criteria in the Manual.[11] Upon approval and adoption (via the local administrative adjudication process), it is anticipated that effective regulations will be applicable to and enforceable upon both public and private sector communities.

3.5 Federal Sewer Construction Grants

The Water Quality Act of 1987, which amended the Federal Clean Water Act, provides for the establishment of the State Revolving Fund Program which may be used for the construction of publicly owned sewage treatment works and related facilities in rural communities.

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 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 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. During the reporting period, the Agat Collector System, Phase IV construction was completed. Pending are the lateral system connections to homes in the project area.

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

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[11] 2006 CNMI and Guam Stormwater Management Manual

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 help clarify what water quality levels are necessary 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 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.

[Guam's Water Quality Standards (122 page document) can be reviewed electronically at http://www.epa.gov/waterscience/standards/wqslibrary/territories/guam_9_wqs.pdf]

Guam EPA intends to initiate its next Triennial Review in 2011. Priority WQS issues under evaluation include:

- 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 or clarification of mixing zone standards

Guam EPA plans to seek and obtain [from EPA or other available resource Agency] technical assistance to support its review of the GWQS.

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 eighteen TMDLs for Guam: a *Sediment TMDL for the Ugum Watershed* prepared by Tetra Tech, Inc. and EPA for Guam EPA in October 2006; and the *Northern Watershed Bacteria TMDLs* (also prepared by Tetra Tech, Inc., March 2010) for seventeen recreational beaches **(See Appendix F.)**

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 EPA's Methodology for Developing the 303(d) List

Guam EPA compiles the 303(d) list using existing scientific data and best professional judgment 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 that 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 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.

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 uses computer models to 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. Water quality management plans to restore waterbodies to water quality standards, 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 have responsibility to develop water quality management plans of federal lands, with oversight by Guam EPA. 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

Those watersheds that have management plans approved by EPA will have their waterbodies or waterbody segments removed 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 waterbodies taken off the list to ensure that management plans are being implemented, and water quality standards achieved.

Guam's 303(d) list is presented in **Table 23.**

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*"[12]. 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.

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[12] Protecting and Restoring Guam's Waters, (Guam EPA September 1999)

6.1 Interacting With Other Agencies and Organizations

6.1.1 *Taking the lead on maintaining the Watershed Planning Committee (WPC)*[13]

The committee meetings and all documents prepared by the WPC are open to the public.

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
Port Authority of Guam
Department of Education
Department of Public Works
Guam Waterworks Authority
Department of Parks and Recreation
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, 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). Interactions are increasing and improving; and through collaborative work there occurs frequent

[13] Executive Order 2004-04, Appendix D.; the WPC has been inactive since mid 2008.

opportunities for sharing expertise, ideas and perspectives, and resources. Specific examples of collaborative work include:

- Weekly meetings between Guam EPA and GWA to discuss drinking water and wastewater management efforts;
- Participation in program development meetings for WERI's environment advisory board (annual planning meetings), the Marianas RC & D Council, the Guam Soil Conservation Districts, and the local Coastal Reef Initiative Task Force;
- Relative to the anticipated military build-up, participation in the Civilian Military Task Force meetings and meetings of its environmental and natural resources sub-committees;
- 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 (Military Build-up & the DEIS), 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 which are still in effect include E.O. 2004-04 which restructured the Watershed Planning Committee and its goals and E.O. 2005-35 which adopted stormwater criteria for government of Guam projects.

Public laws passed during the reporting period (29^{th} & 30^{th} Legislature) most relative to Guam EPA involved water rights, the new landfill and the Ordot dump, recycling, radioactive material leakage in Apra Harbor, renewable energy, implementation of the 2009 Building Code, and cigarette littering penalties. These laws can be viewed at http://www.guamlegislature.com.

Of particular importance was Bill 30-164, an act to provide for an autonomous Guam Environmental Protection Authority. A core group representing Guam EPA employees discussed issues of concern with the members of the legislative oversight Committee. Although amendments to the original provisions of the autonomy bill have been proposed, one critical issue involves the identification of reliable "sustainable funding"; this would be money from federal/other sources without long-term subsidy from the government of Guam general fund. Future discussion is expected on Bill 30-164.

6.3 Working Closely With the Military

6.3.1 Environmental Restoration Program

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. Additionally, the Navy, through the Base Realignment and Closure Program (BRAC), has been actively investigating and mitigating the impact of past contamination looking toward the return of U.S. Government lands to the people of Guam. The BRAC process involves Guam EPA and numerous other agencies and members of the public. Meetings are publicly announced and held twice a year, during which technical updates, work progress and relevant issues and concerns can be addressed. Environmental concerns and requirements for military work to proceed in accordance with local laws and regulations are frequent topics.

Air Force facilities on Guam (i.e. Andersen Air Force Base) are on the Superfund list of sites requiring cleanup under federal CERCLA regulations. Guam EPA was an equal player in the negotiation and implementation of the Federal Facilities Compliance Agreement (FFCA). The FFCA set out enforceable schedules and actions that the Air Force must undertake on Guam with oversight by both EPA and Guam EPA.

Guam and EPA environmental regulations and statutes govern Navy clean up operations on island. The funding that the Navy expends for cleanup activities is often driven by required compliance with these environmental regulations and statutes. Guam EPA provides the necessary oversight to ensure compliance. Additionally, any lands that the Navy plans to return to the people of Guam must go through a rigorous environmental baseline survey to ensure that the property being transferred is not contaminated. If contamination is found, appropriate cleanup work is scheduled and implemented under Guam EPA oversight. For example, Guam EPA has overseen the design, and installation and operation of two groundwater remediation systems at military facilities to date. The Navy has installed an Activated Carbon filtration system to help remediate a TCE plume identified beneath the former Naval Air Station in Agana. Similarly, the Air Force installed an air stripper used to remediate groundwater contaminated with TCE, PCE and TCA. Both remediation systems are used to restore contaminated groundwater to within Safe Drinking Water standards, which is subsequently used as a drinking water supply.

6.3.2 E-Permitting System

During the reporting period, Guam EPA and representatives of the DoD Joint Region Marianas continued to collaborate in establishing an e-permitting system. This system is defined as:

- An online permit tracking system to streamline the environmental permitting process of critical DoD projects and keep efficient records of every environmental project requirement;
- A central, highly accessible system incorporating an estimated 30 interactive permit application forms from Guam EPA.

6.3.3 Environmental Forum

Guam EPA, Joint Region Marianas (Department of Defense, DoD) and EPA also continue to host an Environmental Forum every six months. The goals of these meetings are to continue important dialogue among the entities on environmental and sustainability issues, to share various agency priorities and perspectives, to enhance mutual understanding, to continue development of mutually beneficial approaches, and to facilitate partnering opportunities. A forum was held on May 19, 2008 and March 24, 2009.

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 non point 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 Pacific Basin Association of 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. During 2008-2009, with the assistance of EPA Region 9, Guam EPA sponsored the Groundwater Under the Direct Influence (GWUDI) of Surface water workshops and an

Environmental Impact Assessment Review Workshop. The Agency also continues to proctor the Water and Wastewater Operator Certification Exams generally twice a year.

Guam EPA staff attended workshops and/or training opportunities to include:

- Guam Environmental Screening Levels Workshop
- Wetland Delineation Training
- Natural Resource Damage Assessment Training
- Human Health Risk Assessment Workshop
- LEED Workshop
- US Coast Guard Oil Spills and Incident Response Training
- GIS Workshops
- Industry Forum (related to the military buildup)
- PEACE TALK – Mediating Environmental Conflicts
- Watershed Management, Planning, & Assessment
- Nonpoint Source Monitoring

6.5 <u>Public Involvement and Environmental Education</u>

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 coordinates Earth Week every year in April. Typical events include public tours of its facility for Guam's school children; public static displays; featured themed Contests; the distribution of educational information via newspaper, magazine, television and radio; an island pride festival/fair involving community partners from both the public and private sectors;
- 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 environmental 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 Environmental Education Committee meetings and events.

7.0 Water Pollution Control Programs and Improved Water Quality

Guam EPA's water pollution control programs are progressively maintaining and improving water quality on island. During the reporting period, program efforts included:

- Guam EPA oversight of Guam's Construction Grants/Sewer Revolving Fund project: the Replacement of Old Agat Sewer Collector Lines. The implementation of this project confines the disposal of pollutants so they do not migrate and cause water or other environmental pollution;
- Annual permit compliance inspections of major and minor NPDES permitted facilities; these inspections were conducted at the Agana and Northern WWTPs (outfall installation projects), Agat, Baza, and Umatac-Merizo WWTPs and associated pump stations, and the Ugum Water Treatment Plant (refurbishment project).
- The continuing enforcement and implementation of Guam's Soil Erosion and Sedimentation Control rules and regulations. Guam EPA recorded an estimated 409 permits for clearing, grading, and stockpiling projects since the last reporting period in 2006.
- Guam EPA submittal of the draft *Erosion Control and Stormwater Management Regulations* to the Office of the Attorney General for review and comment. These draft regulations update and revise the current Soil Erosion and Sedimentation regulations and incorporate stormwater management criteria adopted via Executive Order 2005-35.
- Progress on watershed restoration activities via 1) the EPA approved list of impaired waterbodies (not meeting GWQS) 2) EPA technical assistance for developing TMDLs for seventeen northern watershed impaired beaches 3) the GWA Wastewater Revolving Loan Program using $75K (Guam EPA grant funding) to help eligible program residents connect their homes to the available village public sewer system 4) Cooperative government agency training/workshops/projects such as the Center for Watershed Protection Watershed Management Workshop, NOAA funded technical assistance project in support of revising Guam's Soil Erosion and Sediment Control regulations and incorporating stormwater management criteria 5) continuing work by partnering agencies and organizations to initiate and implement environmental awareness on Guam.
- Renewed program focus on feedlot operations tasks, i.e. review of disposal system plans and issue of required permits; investigate complaints and cite illegal operations; and collaborate with UOG and the Department of Agriculture for innovative animal waste disposal systems. The program responded to twenty feedlot complaints and recorded seven notices of violation (NOV).
- 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. The Agency recorded seven hundred ninety three (793) accepted, reviewed and approved construction plans; 371 septic tank/leaching field inspections; about 400 site inspections; and more than 200 grease trap inspections.

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 Division should complete a draft strategy for the 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
- any 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 the draft 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 the CNMI and 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 *Environmental Education Committee*

The Agency should continue to support and participate in this active 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

Section 305 requires the States to report on the economic and social costs and benefits of actions necessary to achieve the objective of the Clean Water Act. Limited information is provided for this reporting period. Guam EPA makes note of the suggested guideline information that should be included in future IR narratives.

1.0 COSTS

A. Capital investments in municipal and industrial facilities
B. Investments in nonpoint source measures
C. Annual operation and maintenance costs of municipal and industrial facilities
D. Total annual costs of municipal and industrial facilities
E. Annual costs to Guam to administer water pollution control activities

Guam Waterworks Authority

Cost Category>	A*	B	C*	D*	E
Year ↓	Capital Investments	Investments in NPS	Annual O & M Costs	Total Annual Costs	Annual Cost WPC Projects
2009	$279,320,424	INA	$57,628,642	$128,209,278	INA
2008	$267,744,474	INA	$54,685,837	$130,451,933	INA
2007	$254,399,284	INA	$48,850,549	$136,632,884	INA
2006	$239,602,789	INA	$48,039,113	$143,206,488	INA
2005	$220,166,031	INA	$42,680,281	$53,844,351	INA
2004	$221,668,469	INA	$42,248,398	$37,287,470	INA
2003	$227,778,375	INA	$47,056,949	$38,288,811	INA

INA = information not obtained; * Obtained from GWA Annual Financial Audits/Reports.

2.0 BENEFITS

- *Improvements in recreational and commercial fishing*
- *Extent of stream miles, lakes acres, etc. improved from impaired to meeting WQSs*
- *Reduced costs of drinking water treatment due to cleaner intake water*
- *Increase in use of beaches and recreational boating due to improved water quality*

D. Special State Concerns and Recommendations

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

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

*These key issue*s 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 (i.e. the Department of Defense) 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 Stipulated Order for Preliminary Relief[14]

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 are ordered to implement provisions under fourteen headings, including the following I) Submittals; II) Management and Organizational Structure of GWA; III) Operations at GWA; IV) Financial Administration at GWA; V) Construction and Rehabilitation Projects at GWA; VI) Training at GWA; and VII) Reporting Requirements and Notice Provisions, etc. Among the required tasks: hire a qualified management team to include a General Manager, Chief Engineer, Chief Financial Officer, and a Compliance Officer (to monitor progress towards implementation of the Stipulated Order). The Order required GWA to create an interim financial plan and to petition the Guam PUC for rate relief to fund the financial plan. The cost of the Stipulated Order as it related to the interim financial plan is approximately $225 million. GWA intends to borrow approximately $160 million to fund the capital projects listed in the plan. Another requirement of the Order is to complete a Master Plan for the water system which will culminate in the development of a final financial plan which, when

[14] http://www.guamwaterworks.org/documents/2ndAmendedSO_001.pdf

implemented, will assure that the residents of Guam will continue to receive safe, reliable water and wastewater services for the foreseeable future.

In October 2006, the parties, through their respective undersigned counsel, jointly requested the Court for stipulated changes in the Order. The most recent GWA quarterly compliance report can be accessed via the Agency website at http://www.guamwaterworks.org/documents/QuarterlyComplianceProgressReport19.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).

The complete Ordot Closure and ceasing of all discharges was initially targeted to occur on October 23, 2007. The beginning of operations and opening of the new Landfill was targeted for September 23, 2007. "Though the present governor is committed to complying with the Consent Decree, the governor's efforts and those of the DPW employees are not enough to rectify the island's solid waste crisis. 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."[15] 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: **Guam Solid Waste Receivership | Gershman, Brickner & Bratton, Inc., Receiver** *or www.guamsolidwastereceiver.org/courtorder.html.*

3.0 Military Buildup on Guam[16]

Since the last IR, the Draft Environmental Impact Statement (DEIS) was released in November 2009 for the GUAM AND CNMI MILITARY RELOCATION: Relocating Marines from Okinawa, Visiting Aircraft Carrier Berthing, and Army Air and Missile Defense Task Force. A copy of the document's organization is shown on the following page. The DEIS Executive Summary provides the following introduction narrative:

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[15] Excerpt from GBB web site overview. *http://guamsolidwastereceiver.org/courtorder.html*

[16] http://www.guambuildupeis.us/

"As a result of reviews of the United States (U.S.) defense posture in the Pacific region and the U.S. alliance with Japan, a portion of U.S. Marine Corps (Marine Corps) forces currently located in Okinawa, Japan would be relocated to Guam. This relocation is proposed to occur during the same timeframe as a proposed wharf construction in Guam's Apra Harbor to support U.S. Navy (Navy) transiting nuclear aircraft carriers. A U.S. Army (Army) Air and Missile Defense Task Force (AMDTF) is also proposed for Guam to protect against the threat of harm from ballistic missile attacks. For the purposes of this Draft Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS), these three proposed actions are referred to as the Guam and the Commonwealth of the Northern Mariana Islands (CNMI) military relocation.

This Draft EIS/OEIS was prepared in compliance with the National Environmental Policy Act (NEPA) (42 United States Code § 4321, as amended); the Council on Environmental Quality Regulations for Implementing the Procedural Provisions of NEPA (Title 40 Code of Federal Regulations [CFR] § 1500-1508, July 1, 1986); and the Navy Procedures for Implementing NEPA (32 CFR § 775). It was prepared to inform decisions based on an understanding of the environmental consequences of the proposed Guam and CNMI military relocation and take measures to protect, restore, and enhance the environment. The decisions to be made are whether and how to implement the proposed actions.

Actions with the potential to significantly harm the environment beyond U.S. territorial waters (i.e., beyond 12 nautical miles (nm) (22.2 kilometers [km]) must be analyzed using the procedures set forth in Executive Order (EO) 12114 and associated implementing regulations. An impact statement prepared under EO12114 is identified as an Overseas Environmental Impact Statement (OEIS). Although this document was also initiated as an OEIS, EO 12114 is not applicable to the actions as now proposed. The document, through this draft, remains labeled as a Draft EIS/OEIS. It will, however, be re-titled as an EIS and developed solely under NEPA, subject to information received during the public comment process.

The three main components of the proposed actions are briefly stated as follows:
1. Marine Corps. (a) Develop and construct facilities and infrastructure to support approximately 8,600 Marines and their 9,000 dependents relocated from Okinawa to Guam. (b) Develop and construct facilities and infrastructure to support training and operations on Guam and Tinian (CNMI) for the relocated Marines.

2. Navy. Construct a new deep-draft wharf with shoreside infrastructure improvements creating the capability in Apra Harbor, Guam to support a transient nuclear powered aircraft carrier.

3. *Army.* (a) Develop facilities and infrastructure on Guam to support relocating approximately 600 military personnel and their 900 dependents to establish and operate an Army AMDTF.

The proposed action for the Marine Corps includes personnel from the units being relocated and the associated base support personnel that must also be present at an installation to support the military mission.

The project locations addressed in this Draft EIS/OEIS are Guam and Tinian. Guam and Tinian are part of the Mariana Islands archipelago. They are located within the Mariana Islands Range Complex (MIRC), an area used by the Department of Defense (DOD) for readiness training."

Guam EPA submitted about 198 written comments to the DEIS to the Joint Program Office and participated in numerous task force, environmental sub-committee, and public meetings to help the government and the community at large determine environmental concerns and potential environmental impacts of the planned military expansion, including impacts projected to occur off DoD properties. Guam's comments can be reviewed at http://www.guambuildupeis.us/.

III. SURFACE WATER MONITORING AND ASSESSMENT

This section includes a description of Guam's monitoring program, a description of the assessment methodology for determining a 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 surface water monitoring. Other related surface 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 National Oceanic and Atmospheric Administration (NOAA), the National Park Service (NPS), and Guam Waterworks Authority (GWA).

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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.

2.0 Monitoring Goals and Objectives

The goals of the CMS 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 the waters of Guam are suitable for their designated uses;
- Evaluate if the GWQS are appropriate and relevant to present conditions for the waters of Guam; and
- Coordinate new approaches to improving and protecting the island's water resources through the implementation and enforcement of CWA 319 and CZARA 6217 programs.

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, northern and southern. 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)[2]

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 **(See Appendix A: Figures 2a-2c and Appendix B: Table B1).**

The design of the STMP is based on a judgmental sampling design within a "Rotating Basin" concept. Four to six resource units (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 resource unit. Resource units 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 current ranking of resource units is based on the Guam EPA's 2004 Section 303(d) list of impaired waters. Those priority watersheds are scheduled during the first four years of monitoring. The watershed monitoring schedule, **Table 6**, correlates with the watershed locations illustrated in **Figure 3, Appendix A.**

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[2] STMP monitoring has been suspended due to funding constraints. The described framework can be applied when monitoring resumes. STMP Monitoring for 2010 forward is not expected to be implemented (see Table 6) unless resources are identified to support this program.

Table 6. 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 this monitoring schedule is subject to funding availability.

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 9**.)

Some confirmed and possible sources of pollution in these resource units 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.[3] **Refer to Table 7.**

Table 7. 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

[3] The implementation of the Monitoring Schedule proposed in Table 7. (Particularly for *Sample Years* 2011 and forward) is dependent on EMAP funding availability and the "national EMAP focus". It is anticipated that "Wetlands" may be the national focus resource type during the next reporting period. Consequently, Guam EPA would probably interrupt the GEMAP schedule and participate in this "national monitoring strategy" (by applying for available grant funding and completing the scope of work as approved by the grantor). The 2006 Surface Water Monitoring project is still in progress.

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 **Figures 4. and 5. Appendix A,** and **Tables B2. and B3. Appendix B).**

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 5, Appendix A).**

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. **(Refer to Figure 4, Appendix A; 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. To monitor and test for the designated use "Whole Body/Primary Contact", weekly water grab samples are collected and tested for the approved EPA bacterial indicator. The presence of elevated levels of these microbial organisms has been proven to indicate diseases such as gastroenteritis, hepatitis, and cholera. The most common of these swimming-associated diseases is gastroenteritis (NRDC, July 1996). Symptoms of this disease include vomiting, diarrhea, headache, and fever (basic flu-like symptoms); and those at greatest risk are the young and elderly swimmers and swimmers with compromised immune systems.

Guam EPA uses the national standards of 35 enterococci/100mL (geometric mean indicator density based on five (5) samples collected over a 30 day period) and 104 enterococci/100mL (instantaneous indicator density based on a single sample) (EPA440/5-84-002). These standards translate to the probability that within the United States, nineteen (19) swimmers for every one thousand (1,000) will show signs of illness (NRDC, July 1996).

The designated use "Whole-body contact/primary contact" means the use of 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 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 2010 IR, several monitoring stations were found to represent the same beach. The revised list of beaches for Guam consists of 103 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 103 beaches, sixty-six (66) are classified as Tier 1 with the remaining thirty-seven (37) 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 43. On May 19, 2005, station S1-Rizal Beach was officially dropped from the monitoring list because access was restricted. The current number of monitoring stations under the RBMP is forty-two (42). The number of beaches assessed by these 42 stations is thirty-one (31).

Swimming advisories are issued based upon either an instantaneous concentration of 104 MPN/100mL or a geometric mean concentration of 35 MPN/100mL, over a five week period. 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://node.guamepa.net/programs/emas/beach.html]

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).

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

Wednesdays 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)

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 integrity. While water quality physical and chemical parameters for wetlands exist, the Agency has yet to adopt wetland criteria or any method for biological assessment. Guam EPA expects to develop and adopt wetland specific criteria within the next five years and identify a funding source to support a sustainable Wetlands Monitoring Program.

In the meantime, Guam relies on partnering organizations 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.

UOG graduate students are instrumental in gathering data for WERI's wetlands program. One such project was funded by the Government of Guam (Bureau of Planning) and aimed to develop a geochemical-sedimentation model that describes the flux of metals and nutrients being stored and moving through a perennial palustrine wetland downslope from a large tract of badlands. The study involved establishing hydrologic parameters, measuring slope retreat and sediment throughput out of the badlands, and chemically analyzing surface runoff and wetland pore waters, the latter through a gridded lysimeter array in the wetlands. Preliminary analysis of pore waters indicate that the wetlands are mobilizing and storing iron and manganese that enter from the badlands via groundwater seepage and in suspension. Concentrations of those metals may exceed three orders of magnitude beyond normal Guam river waters. Future related research will involve a) analyzing geochemical cycling in tidal riverine and estuarine wetlands, b) quantifying badlands denudation rates, c) studying geochemical reactions involving manganese and iron in the wetlands and downstream at the coast where they are co-precipitate on reef debris. For more information about WERI wetland projects visit www.weriguam.org.

3.5 Fish and Shellfish Contaminant Monitoring Program (FSCMP)

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:

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 are being developed and will follow the EPA national guidance for fish and shellfish consumption advisories. If projected funding and staffing are allocated, the FSCMP is expected to be fully developed and implemented within the next reporting period. 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 7, Appendix A.)**

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. Detailed information about Guam's Marine Preserves and respective studies conducted by the Division of Aquatic Wildlife Resources are available at **www.guamdawr.org/aquatics/mpa.**

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, Guam EPA intends to assist DAWR with the collection of water quality data at all fish survey transect sites within the marine preserves as well as all non-preserve sites.[4] 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 8).** All monitoring stations will have GPS coordinates recorded.

Table 8. Co-located Fish Transect and Water Quality Locations for MPWQA

Marine Preserve Sites				Non-Preserve (Control) Sites			
Site	Sampling Location		# of Samples	Site	Sampling Location		# of Samples
Piti Bomb Holes Preserve	FRS	20-30 ft	2	Asan Bay	FRS	20-30 ft	2
		40-50 ft	2			40-50 ft	2
	Flat	Seagrass	1		Shore	Rivers	1
		Coral/Rubble	1	Cocos Lagoon	Flat	Seagrass	1
		Channel	1			Coral/Rubble	1
		Observatory	1			Channel	1
	Shore	Rivers	3		Shore	Rivers	1
Achang Reef Flat Preserve	FRS	20-30 ft	2	Cocos Fore Reef	FRS	20-30 ft	2
		40-50 ft	2			40-50 ft	2
	Flat	Seagrass	1	Pago Bay	Flat	Seagrass	1
		Coral/Rubble	1			Coral/Rubble	1
	Shore	Rivers	8		Shore	Rivers	1
Tumon Bay Preserve	FRS	20-30 ft	3	Tumon Bay Control	FRS	20-30 ft	3
		40-50 ft	3			40-50 ft	3
	Flat	Sand	3		Flat	Sand	3
		Coral/Rubble	3			Coral/Rubble	3
		Coral	3			Coral	3
	Shore	Rivers	0		Shore	Rivers	TBD*
Total Samples:			**40**	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**

* TBD – To Be Determined

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

[4] Table 8 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.

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 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.

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

3.7 Special Studies Monitoring 2008-2009

Outside the scope of specific annual programs are special studies performed under ongoing environmental programs within Guam EPA or in partnerships with other Agencies. 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 Guam EPA – Primary Screening for Chemicals of Environmental Concern in Guam's Coastal Waters, 2007 [5]

Project Objective: Deploy SPMDs three times over a year at eight hotspot areas around Guam to verify the presence/absence of chemicals of environmental concern.

Historically, water quality monitoring on Guam has been carried out by the Guam Environmental Protection Agency (GEPA) and limited to microbiological and

[5] Data was used for evaluation purposes in the 2010 IR.

physical/chemical analyses. A toxic monitoring program was incorporated into the island's monitoring strategy but was only conducted on a project-by-project basis. This resulted in large data gaps for Chemicals of Environmental Concern (CEC). This project attempted to address this CEC data shortage by conducting a primary-level screening monitoring using Semi-Permeable Membrane Devices (SPMD) in lieu of tissue samples. The SPMDs will passively collect and estimate dissolved concentrations of CECs (e.g. hydrophobic organic contaminants such as organochlorine and organophosphate pesticides, and PCBs) at eight specific sites around the Island of Guam.

SPMDs have been designed to passively imitate the biological processes that take place in aquatic organisms which bioconcentrate hydrophobic organic compounds. They are constructed from a lay flat low-density polyethylene (LDPE) tubular membrane with pore sizes less than 10 Å in diameter. The membranes are then filled with one gram of triolein, a neutral lipid commonly found in aquatic organisms, which then sequester the chemicals. Several of these tubes are then placed in stainless steel carriers for deployment or for long term storage in canisters filled with argon gas.

Three 30-day exposure deployments occurred once during the wet and dry seasons and once during a transition period between seasons. After the deployment period, all SPMDs were repackaged and sent to an off-island laboratory for dialysis and analyzed using either GC/MS or GC/ECD techniques.

3.7.2 *Water and Environmental Research Institute – 2009*

Report Number 124: *Watershed Land Cover Change in Guam* (Authors: Yuming Wen, Shahram Khosrowpanah, and Leroy F. Heitz)

Land cover change (LCC) has been a subject of concern for the past century, particularly the past few decades around the world. Although many of the changes have been recorded qualitatively through the use of comparative photography and historical reports, little quantitative information has been available at watershed scale. It is currently possible to detect land cover change and determine trends in ecological and hydrological condition at watershed scale using advanced geo-spatial technologies. Satellite remote sensing, spatial statistics, geographic information systems (GIS), and global positioning system (GPS) can be used to identify LCC of watersheds. These technologies provide the basis for developing landscape composition and pattern indicators as sensitive measures of environmental change and thus, may provide an effective and economical method for evaluating watershed condition related to disturbance from human and natural stresses.

Recent surveys indicate that land cover/use changes have a direct and enormous effect on water quality and environmental change. Watershed water quality and ecosystem are threatened constantly by both human impacts such as forest fires and development and also natural phenomena such as storms and droughts. Therefore, it is critical to conduct research on land cover change in watersheds.

This study focused on land cover change from 1973 to 2001. Landsat MSS image of November 14, 1973, and Landsat TM image of March 15, 2001 were available for this study. However, the Landsat MSS image is covered by a lot of clouds and shadows. In order to improve the land cover classification results, historical GIS data such as DLG, DRG and air photos were used to assist land cover classification. There is no doubt that land cover classification result is affected by the quality and resolution of source data. That's why the land cover classification accuracy for 1973 is not as good as that of 2001. Referencing Table 1 from this report, the following conclusions can be made.

- The watersheds in southern Guam were mainly covered by forest and grassland in both years of 1973 and 2001.
- The area of forest increased by about 3% from 1973 to 2001, but the area of grassland decreased by over 17% between 1973 and 2001.
- The built-up/urban area increased by over 3 times from 1973 to 2001, and most of the increased urban areas occurred in forest and grassland.
- There were some burned areas identified from the Landsat TM image of March 15, 2001. The early time in 2001 was very dry, which might make some grassland and forest areas very vulnerable to wildfires. The burned areas were probably caused by wildfires set by local people for hunting deer and wild pigs. Local people have such a tradition for hunting.
- The urban area will continue to increase in the following few years. Report Figure 15 shows a subset QuickBird image of 2006, which focuses on the UOG campus. The WERI and Marine Lab buildings are located at the lower bottom of this image. Report Figure 16 indicates that the highlighted forest area has been cleared for new residential buildings. The U.S. Department of Defense is planning a major expansion of its facilities and personnel on Guam. About 40,400 active military personnel and dependents will be relocated in Guam by 2014 (ICF International, 2009). The military build-up activities will be a potential driving force for stimulating the local economy and a major cause for more non-urban areas lost to military build-up activities on Guam in the following years.

Land cover change in each of the Southern watersheds is discussed in the report. This report can be viewed on-line at http://www.weriguam.org/docs/reports/124.pdf.

3.7.3 *Other Studies and Data Sources*

Environmental Baseline Survey, Ylig Bridge Replacement Project

August 2009. Duenas, Camacho, and Associates, Inc.

The following excerpt is from a summary provided by DCA, Inc. "... The purpose of this Environmental Baseline Survey (EBS) is to document the existing environmental conditions within the project area for use in the development planning of engineering design alternatives and support documentation for NEPA requirements. ... The Ylig River serves as the outlet point of the Ylig Watershed, which encompasses a drainage area of approximately 16.08 square miles (10,294 acres). The Ylig Bridge traverses the Ylig River with a span of approximately 180 feet. The southeastern side of the Ylig Bridge has a paved parking area and a boat ramp which is regularly used by the public. The monthly discharge of the Ylig River is typically the highest for the months of

August, September, and October, with average discharge rates of 33.96mgd, 37.99 mgd, and 35.81 mgd, respectively, for the period from 1952 to 2002)."

Ylig River water samples delivered to the WERI laboratory on May 8, 2009 resulted in the following analysis of four parameters:

	Upstream	Downstream	Units
pH	8.11	8.33	standard units
turbidity	4.6	3.5	NTU
salinity	23.0	27.0	parts per thousands
total suspended solids	11.4	6.6	milligrams per liter

Discharge Monitoring Reports (DMRs) [6]

DMRs are 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

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[6] 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.

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 is currently upgrading its data storage and data sharing capabilities. With the recent purchase of several computers and networking software, the agency will soon have 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) where users will be able to import, process and export data in a variety of formats with relative ease. The networked database along with an assortment of file transfer processes will provide extremely powerful data sharing capabilities at the local, regional and national levels.

Prior to input into the 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 STORET (STOrage and RETrieval), U.S. EPA's computerized data storage and retrieval system. 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 USEPA R9 STORET representative, who will then upload it into STORET 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 STORET 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.***

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:** Possible relocation of the laboratory must be considered. Such action will severely impact the operations of the laboratory. 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 9, 10, and 11 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.

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 2002, lists *Enterococci* and *Eschericia 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 42 marine recreational sites yearly **(See Figure 6, Appendix A and Table B4, Appendix B).** Advisories are released weekly based on instantaneous and geometric mean standards (from 1986 Ambient Water Quality Criteria for Bacteria).

Monitoring of bacteria (*E. coli*) levels in all other freshwater bathing areas (monitored based on a rotating-basin approach) is not of sufficient frequency (<5 samples during a 30-day period) to apply geometric mean criteria as required by the RBMP. Therefore, freshwater microbiological data is not used for public health advisory releases; but this data is used to determine use-support for recreation if five sequential samples are collected. From these five (or more) data points, a geometric mean can be calculated.

Because of Guam's tropical environment, the recreational bathing season is considered year-round. In addition, recreational use even in sites designated for limited contact recreation may be high. Therefore, waters designated for limited contact recreation (S3 and M3 sites) utilize the "Moderate Full Body Contact Recreation" allowable densities from the 1986 criteria. Whole body contact recreation waters (S1, S2, M1, and M2) incorporate the "Designated Beach Area" assignments.

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 12**. Criteria are consistent with recommendations from 1997 EPA guidance.

3.2 Limited Contact Recreation

Bacterial criteria used to determine use support for waters designated for limited (secondary) contact recreation use (S3 and M3) are depicted in **Table 13**. These criteria are consistent with recommendations from 1997 EPA guidance.

Table 9. 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

Table 10. 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 11. 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 10)**

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 Evaluation 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 14.**

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 15 and Table 16** 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**.

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 17.**

7.0 Bioassessment

Limited bioassessment data has been submitted by the Government of Guam Department of Agriculture, Division of Aquatic and Wildlife Resources (DAWR). 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 18.**

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 10, 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 only supply of surface 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 monitoring undertaken to meet requirements of the SDWA 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 of raw water from the river is extremely high during rainy seasons that even the existing conventional treatment system cannot process finish water meeting the SDWA Standards without pre-sedimentation basins.
- Public water suppliers requiring increased monitoring due to the inability of the Ugum Water Treatment Plant to treat water from the river meeting the turbidity standards.
- 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 19** was cited from the federal guidelines and illustrates the classification, monitoring data, and use support restrictions evaluated to make use support decisions.

Table 12. Whole Body Contact Recreation Use Support

Level of Use Support	Criteria	
	Marine Water M1 and M2	Fresh Water S1 and S2
Fully Supporting	***Enterococci*: A geometric mean of 35 enterococci per 100mL (based on 5 sequential samples) is not exceeded AND the single sample density does not exceed 104 enterococci per 100mL.** ***Fecal coliform*: The single sample density does not exceed 200 cfu/100mL AND an arithmetic mean of effluent samples taken during 30-consecutive days does not exceed 200 cfu/100mL AND an arithmetic mean of effluent samples taken during 7-consecutive days does not exceed 400 cfu/100mL.**	***Escherichia coli*: A geometric mean of 126 e. coli per 100mL (based on 5 samples taken sequentially) is not exceeded AND the single sample density does not exceed 235 e. coli per 100mL.** ***Enterococci*: A geometric mean of 33 enterococci/100mL (based on 5 sequential samples) is not exceeded AND the single sample density does not exceed 61 enterococci per 100mL.** ***Fecal coliform*: The single sample density does not exceed 200 cfu/100mL AND An arithmetic mean of effluent samples taken during 30-consecutive days does not exceed 200 cfu/100mL AND an arithmetic mean of effluent samples taken during 7-consecutive days does not exceed 400 cfu/100mL**
Partially Supporting	***Enterococci*: Geometric mean of 35 enterococci per 100mL (based on 5 sequential samples) is met AND the single-sample criterion of 104 enterococci per 100mL is exceeded during the year.** ***Fecal coliform*: The single sample density of 200 cfu/100mL is exceeded during the year AND the arithmetic mean of effluent samples taken during 30-days consecutive does not exceed 200 cfu/100mL during the year AND an arithmetic mean of effluent samples taken during 7-days consecutive does not exceed 400 cfu/100mL during the year.**	***Escherichia coli*: Geometric mean of 126 e. coli per 100mL (based on 5 sequential samples) is met AND single-sample criterion of 235 enterococci per100mL is exceeded during the year.** ***Enterococci*: A geometric mean of 33 enterococci/100mL (based on 5 sequential samples) is met during the year AND the single-sample density of 61 enterococci per 100mL is exceeded during the year.** ***Fecal coliform*: The single sample density of 200 cfu/100mL is exceeded during the year AND the arithmetic mean of effluent samples taken during 30-days consecutive does not exceed 200 cfu/100mL during the year AND the arithmetic mean of effluent samples taken during 7-days consecutive does not exceed 400 cfu/100mL during the year.**
Not Supporting	***Enterococci*: Geometric mean standard of 35 enterococci per 100mL is not met.** ***Fecal coliform*: Arithmetic mean standard of 200 cfu per 100mL from 30-consecutive days is not met during the year AND the arithmetic mean standard of 400 cfu per 100mL from 7 consecutive days is not met during the year**	***Escherichia coli*: Geometric mean standard of 126 e.coli per 100mL is not met.** ***Enterococci*: Geometric mean standard of 35 enterococci per 100mL is not met.** ***Fecal coliform*: Arithmetic mean standard of 200 cfu per 100mL from 30-consecutive days is not met during the year AND arithmetic mean standard of 400 cfu per 100mL from 7 consecutive days is not met during the year.**

Table 13. Criteria for Limited Contact Recreation Use at Bathing Areas

Degree of Recreation Use Support	Criteria	
	Marine Water M3	Fresh Water S3
Fully Supporting	***Enterococci*: A geometric mean of 35 enterococci per 100mL (based on 5 sequential samples) is not exceeded AND the single sample density does not exceed 124 enterococci per 100mL.** ***Fecal coliform*: The single sample density does not exceed 200 cfu/100mL AND An arithmetic mean of effluent samples taken during 30-consecutive days does not exceed 200 cfu/100mL AND an arithmetic mean of effluent samples taken during 7-consecutive days does not exceed 400 cfu/100mL.**	***Escherichia coli*: A geometric mean of 126 e. coli per 100mL (based on 5 samples taken sequentially) is not exceeded AND the single sample density does not exceed 298 e. coli per 100mL.** ***Enterococci*: A geometric mean of 33 enterococci/100mL (based on 5 sequential samples) is not exceeded AND the single sample density does not exceed 89 enterococci per 100mL.** ***Fecal coliform*: The single sample density does not exceed 200 cfu/100mL AND** **An arithmetic mean of effluent samples taken during 30-consecutive days does not exceed 200 cfu/100mL AND an arithmetic mean of effluent samples taken during 7-consecutive days does not exceed 400 cfu/100mL.**
Partially Supporting	***Enterococci*: Geometric mean of 35 enterococci per 100mL (based on 5 sequential samples) is met AND the single-sample criterion of 124 enterococci per 100mL is exceeded during the year.** ***Fecal coliform*: The single sample density of 200 cfu/100mL is exceeded during the year AND the arithmetic mean of effluent samples taken during 30-days consecutive does not exceed 200 cfu/100mL during the year AND an arithmetic mean of effluent samples taken during 7-days consecutive does not exceed 400 cfu/100mL during the year.**	***Escherichia coli*: Geometric mean of 126 e. coli per 100mL (based on 5 sequential samples) is met AND single-sample criterion of 298 enterococci per 100mL is exceeded during the year.** ***Enterococci*: A geometric mean of 33 enterococci/100mL (based on 5 sequential samples) is met during the year AND the single-sample density of 89 enterococci per 100mL is exceeded during the year.** ***Fecal coliform*: The single sample density of 200 cfu/100mL is exceeded during the year AND the arithmetic mean of effluent samples taken during 30-days consecutive does not exceed 200 cfu/100mL during the year AND the arithmetic mean of effluent samples taken during 7-days consecutive does not exceed 400 cfu/100mL during the year.**
Not Supporting	***Enterococci*: Geometric mean standard of 35 enterococci per 100mL is not met.** ***Fecal coliform*: Arithmetic mean standard of 200 cfu per 100mL from 30-consecutive days is not met during the year AND the arithmetic mean standard of 400 cfu per 100mL from 7 consecutive days is not met during the year.**	***Escherichia coli*: Geometric mean standard of 126 e.coli per 100mL is not met.** ***Enterococci*: Geometric mean standard of 35 enterococci per 100mL is not met.** ***Fecal coliform*: Arithmetic mean standard of 200 cfu per 100mL from 30-consecutive days is not met during the year AND arithmetic mean standard of 400 cfu per 100mL from 7 consecutive days is not met during the year.**

Table 14. 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.**	

Table 15. Decision Guidelines for Conventionals[7] 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 16. Decision Guidelines for Toxicants[8] 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] 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.

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

Table 17. 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 18. 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.**

Table 19. 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 surface water assessments, including the categorization of surface water segments based on designated use support data, (2) probability-based survey results, and (3) Guam's list of impaired and threatened waters in accordance with Section 303(d) of the CWA. A copy of the 2010 Assessment Methodology narrative and monitoring data are available in Appendix H.

1.0 Five –Part Categorization of Surface Waters

The five (5) Reporting Category types for surface water 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 2010 IR Data

Guam reporting relies on data sets from local academia and local and federal government agencies. For this reporting period, data was solicited from the Navy, WERI, and the Government of Guam. Projects with useable data for the 2010 IR are identified in the following chart. Information for Current Advisory Areas (Fish and Seafood Consumption and Closures to Wading) was also considered in the assessment.

Projects with Usable Data for the Guam 2010 IR

Organization	Project	Waterbody Type	Use Support	Year of data	Data Quality
Guam EPA	Status and Trends Monitoring Project (STMP)	Marine Waterbodies and Rivers/Streams (reaches)	Body Contact, Aquatic Life (WQ)*	2009	For use support determination
Guam EPA	Status and Trends Monitoring Project (STMP BIO)	Marine Waterbodies	Aquatic Life (benthic bioassessments)	2009	For use support determination
Guam EPA	Guam Coastal Assessment (GCA)	Marine Waterbodies	Body Contact, Aquatic Life (WQ), Aquatic Life (Concentration. of Oil/Petroleum), Aquatic Life (benthic bioassessments), Aquatic Life (Toxicants - Sediment), Human Health (organism consumption)	2005	For use support determination
Guam EPA	Recreational Beach Monitoring Project (RBMP)	Marine Beaches	Body Contact	2008 and 2009	For use support determination
Guam EPA	Semi-Permeable Membrane Device (SPMD) Project	Marine Waterbodies and Rivers/Streams (reaches)	Aquatic Life (Toxicants - Water column)	2007	Evaluation only
US Navy	Navy Nuclear Propulsion Program (at Apra Harbor)	Marine Waterbodies	Aquatic Life (Radiological Materials)	Quarterly monitoring	For use support determination
NOAA/Guam EPA	NOAA& Guam EPA Fish Tissue Project	Marine Waterbodies	Human Health (organism consumption)	2006	Evaluation only

Source: Guam EPA EMAS Division * (WQ = water quality)

The quality of each data set and project was evaluated by reviewing project objectives, quality assurance requirements, laboratory method compatibility, analysis quality, and Minimum Detection Limits (MDLs).

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 lists (Tables 20, 21, 22) are classified under one of the five surface water reporting categories described in Section 1.0.

1.2 Monitoring Stations

One hundred fifty four (154) monitoring stations from six (6) projects were considered for this assessment. **(See Appendix H., Table 4. Project Stations)** These stations are located within one of 66 marine waterbodies, 201 freshwater stream/river reaches, or 103 coastal/recreational beaches.

Station locations are depicted in **Appendix H**., **Figures A.1a-A.1e, (Sub-Appendix A)**: North and Central Marine Stations, Central and South Marine Stations, Beach Stations and River/Stream Stations, and Benthic Visual Bioassessment Stations. These figures also show current Advisories (Fish and Seafood Consumption and Closures to Wading).

Waterbodies were analyzed for indicators based on individual project objectives as shown in **Appendix H. Table 5. Project Indicators**. These indicator tables also show how many samples were used in this assessment.

2.0 Guam Rivers/Streams

Table 20 provides the following assessment data for one hundred thirty-two (132) fresh water assessment units which represent two-hundred one (201) Guam rivers/streams.[9]

* Waterbody name
* Location (watershed location)
* Water status (i.e. impaired, not assessed)
* Surface water reporting category (see Section 1.0 above)
* Assessment Unit ID
* Assessed Water Size
* Water classification

In summary, Table 20 provides the following information:

Total Channel Length of Guam Rivers/Streams: **232.65 miles**

[9] Table 20 does not include Agana Swamp. See Table 24.

Table 20. 2010 Assessment Data for Rivers -Streams

Waterbody Name	Assessment Unit ID	Location	State	Water Type & Classification	Channel length in Miles	Miles Assessed	Waterbody Status	Reporting Category
Achang River 1	GUMZRAC-2	WATERSHED: Manell	GU	RIVER-S2	0.50	0.00	NOT ASSESSED	3
Achang River 2	GUMZRAC	WATERSHED: Manell	GU	RIVER-S2	0.30	0.00	NOT ASSESSED	3
Agaga River	GUULRAG	WATERSHED: Cetti	GU	RIVER-S2	0.78	0.00	NOT ASSESSED	3
Agana River 1	GUAGRA-3	WATERSHED: Hagatna	GU	RIVER-S2	0.52	0.52	IMPAIRED	5
Agana River 2	GUAGRA-2-1A	WATERSHED: Hagatna	GU	RIVER-S2	0.67	0.67	IMPAIRED	5
Agana Springs	GUAGRA-1	WATERSHED: Hagatna	GU	RIVER-S2	0.04	0.00	NOT ASSESSED	3
Aguada River	GUAPRAG	WATERSHED: Apra	GU	RIVER-S3	2.15	1.95	ASSESSED	2
Ajayan River	GUMZRAJ	WATERSHED: Manell	GU	RIVER-S2	3.95	0.00	NOT ASSESSED	3
Almagosa Spring	GUFLRA-1	WATERSHED: Talofofo	GU	RIVER-S1	0.09	0.00	NOT ASSESSED	3
Asalonso River / unnamed tributary	GUINRAS	WATERSHED: Asalonso	GU	RIVER-S3	2.84	0.00	NOT ASSESSED	3
Asan River 1	GUASRI-3	WATERSHED: Piti/Asan	GU	RIVER-S3	1.32	0.00	NOT ASSESSED	3
Asan River 2	GUASRI-4	WATERSHED: Piti/Asan	GU	RIVER-S3	0.79	0.00	NOT ASSESSED	3
Aslinget River 1	GUINRAL-1	WATERSHED: Dandan	GU	RIVER-S3	1.23	0.00	NOT ASSESSED	3
Aslinget River 2	GUINRAL-2	WATERSHED: Dandan	GU	RIVER-S3	1.33	0.00	NOT ASSESSED	3
Asmafines River	GUULRAS	WATERSHED: Cetti	GU	RIVER-S2	0.83	0.00	NOT ASSESSED	3
Atantano River 1	GUAPRA-2	WATERSHED: Apra	GU	RIVER-S3	3.30	3.30	ASSESSED	2
Atantano River 2	GUAPEA	WATERSHED: Apra	GU	RIVER-S3	6.38	6.23	ASSESSED	2
Big Guatali River	GUAPRA-1	WATERSHED: Apra	GU	RIVER-S3	2.15	2.15	ASSESSED	2
Bonya River	GUMLRB	WATERSHED: Talofofo	GU	RIVER-S1	4.03	0.00	NOT ASSESSED	3
Cetti River	GUULRCL	WATERSHED: Cetti	GU	RIVER-S2	1.92	0.00	NOT ASSESSED	3
Chagame River/ La Sa Fua River	GUULRL-1	WATERSHED: Umatac	GU	RIVER-S2	2.50	0.00	NOT ASSESSED	3
Chaligan Creek 1	GUATRC-2	WATERSHED: Taelayag	GU	RIVER-S3	0.92	0.00	NOT ASSESSED	3
Chaligan Creek 2	GUATRC	WATERSHED: Taelayag	GU	RIVER-S3	0.06	0.00	NOT ASSESSED	3
Chaot River	GUAGRA-2	WATERSHED: Hagatna	GU	RIVER-S2	2.22	2.22	ASSESSED	2

Table 20. 2010 Assessment Data for Rivers -Streams

Waterbody Name	Assessment Unit ID	Location	State	Water Type & Classification	Channel length in Miles	Miles Assessed	Waterbody Status	Reporting Category
Finile Creek	GUATRF	WATERSHED: Agat	GU	RIVER-S3	1.04	0.00	NOT ASSESSED	3
Fonte River 1	GUAGRF-2	WATERSHED: Fonte	GU	RIVER-S2	1.16	1.16	ASSESSED	2
Fonte River 2	GUAGRF-1	WATERSHED: Fonte	GU	RIVER-S2	2.02	0.00	NOT ASSESSED	3
Gaan River 1	GUATRG-2	WATERSHED: Agat	GU	RIVER-S3	0.56	0.00	NOT ASSESSED	3
Gaan River 2	GUATRG	WATERSHED: Agat	GU	RIVER-S3	0.63	0.00	NOT ASSESSED	3
Geus River 1	GUMZRG-1	WATERSHED: Geus	GU	RIVER-S1	0.99	0.00	NOT ASSESSED	3
Geus River 2	GUMZRG	WATERSHED: Geus	GU	RIVER-S2	0.52	0.00	NOT ASSESSED	3
Geus River 3	GUMZRG-2	WATERSHED: Geus	GU	RIVER-S3	0.78	0.00	NOT ASSESSED	3
Imong River 1	GUFLRI-2	WATERSHED: Talofofo	GU	RIVER-S1	2.54	0.00	NOT ASSESSED	3
Imong River 2	GUFLRI-1	WATERSHED: Talofofo	GU	RIVER-S1	1.93	0.00	NOT ASSESSED	3
Inarajan River 1	GUINRI-1	WATERSHED: Inarajan	GU	RIVER-S3	8.83	8.64	ASSESSED	2
Inarajan River 2	GUINRI-2	WATERSHED: Inarajan	GU	RIVER-S3	0.86	0.00	NOT ASSESSED	3
La Sa Fua River	GUULRL-2	WATERSHED: Umatac	GU	RIVER-S2	2.02	0.00	NOT ASSESSED	3
Laelae River	GUULRU-1	WATERSHED: Umatac	GU	RIVER-S1	1.94	0.00	NOT ASSESSED	3
Laguas River	GUAPRL	WATERSHED: Apra	GU	RIVER-S3	0.85	0.00	NOT ASSESSED	3
Landfill Leachate Stream	GUPGRL-0	WATERSHED: Pago	GU	RIVER-S1	0.05	0.05	IMPAIRED	5
Laolao River	GUINRL	WATERSHED: Inarajan	GU	RIVER-S2	4.25	0.00	NOT ASSESSED	3
Liyog River	GUMZRL	WATERSHED: Manell	GU	RIVER-S2	1.83	0.00	NOT ASSESSED	3
Lonfit River 1	GUPGRL-1	WATERSHED: Pago	GU	RIVER-S1	6.86	0.00	NOT ASSESSED	3
Lonfit River 2	GUPGRL-2	WATERSHED: Pago	GU	RIVER-S2	1.07	1.07	IMPAIRED	5
Lonfit River 3	GUPGRP-1-51B	WATERSHED: Pago	GU	RIVER-S1	0.04	0.04	IMPAIRED	5
Maagas River 1	GUTURM-1	WATERSHED: Talofofo	GU	RIVER-S2	0.39	0.00	NOT ASSESSED	3
Maagas River 2	GUTURT-2-48F	WATERSHED: Talofofo	GU	RIVER-S2	1.68	0.00	NOT ASSESSED	3
Madofan River	GUULRMF	WATERSHED: Cetti	GU	RIVER-S2	0.77	0.00	NOT ASSESSED	3

Table 20. 2010 Assessment Data for Rivers -Streams

Waterbody Name	Assessment Unit ID	Location	State	Water Type & Classification	Channel length in Miles	Miles Assessed	Waterbody Status	Reporting Category
Madog River	GUULRM	WATERSHED: Umatac	GU	RIVER-S3	2.11	0.00	NOT ASSESSED	3
Mahlac River	GUTURMA-1	WATERSHED: Talofofo	GU	RIVER-S1	4.86	0.00	NOT ASSESSED	3
Manell River	GUMZRML	WATERSHED: Manell	GU	RIVER-S2	2.77	0.00	NOT ASSESSED	3
Masso River 1	GUAPRM-1B	WATERSHED: Piti/Asan	GU	RIVER-S3	0.31	0.00	NOT ASSESSED	3
Masso River 2	GUAPRM-1A	WATERSHED: Piti/Asan	GU	RIVER-S3	2.99	0.00	NOT ASSESSED	3
Matague River	GUASRM	WATERSHED: Piti/Asan	GU	RIVER-S3	1.25	1.20	ASSESSED	2
Maulap River 1	GUFLRM-1	WATERSHED: Talofofo	GU	RIVER-S1	0.44	0.00	NOT ASSESSED	3
Maulap River 2	GUFLRM-2	WATERSHED: Talofofo	GU	RIVER-S1	2.43	0.00	NOT ASSESSED	3
Namo River 1	GUATRN-1A	WATERSHED: Agat	GU	RIVER-S3	2.93	0.00	NOT ASSESSED	3
Namo River 2	GUATRN-2	WATERSHED: Agat	GU	RIVER-S3	0.36	0.36	ASSESSED	2
Namo River/ unnamed tributary	GUATRN-1	WATERSHED: Agat	GU	RIVER-S3	0.11	0.00	NOT ASSESSED	3
Ascola Sito Creek	GUATRT-1	WATERSHED: Taelayag	GU	RIVER-S3	0.97	0.00	NOT ASSESSED	3
Pago River 1	GUPGRP-1-51A	WATERSHED: Pago	GU	RIVER-S2	0.06	0.06	IMPAIRED	5
Pago River 2	GUPGRP-2	WATERSHED: Pago	GU	RIVER-S3	4.74	4.73	IMPAIRED	5
Pago River 3	GUPGEP	WATERSHED: Pago	GU	RIVER-S3	0.54	0.00	NOT ASSESSED	3
Pago River 4	GUPGMPW	WATERSHED: Pago	GU	RIVER-S3	0.52	0.00	NOT ASSESSED	3
Paulliuc River	GUINRAP	WATERSHED: Dandan	GU	RIVER-S3	4.93	0.00	NOT ASSESSED	3
Pigua River 1	GUMZRP	WATERSHED: Toguan	GU	RIVER-S3	0.18	0.00	NOT ASSESSED	3
Pigua River 2	GUMZRP-2	WATERSHED: Toguan	GU	RIVER-S3	1.50	1.50	ASSESSED	2
Sadog Gago River	GUFLRSG-1	WATERSHED: Talofofo	GU	RIVER-S1	0.52	0.00	NOT ASSESSED	3
Sagua River	GUATRSG	WATERSHED: Taelayag	GU	RIVER-S3	0.58	0.00	NOT ASSESSED	3
Salinas River	GUATRS	WATERSHED: Agat	GU	RIVER-S3	0.78	0.00	NOT ASSESSED	3
Sarasa River 1	GUTURS-1	WATERSHED: Talofofo	GU	RIVER-S2	0.05	0.00	NOT ASSESSED	3
Sarasa River 2	GUTURT-2-48B	WATERSHED: Talofofo	GU	RIVER-S2	2.25	0.00	NOT ASSESSED	3

Table 20. 2010 Assessment Data for Rivers -Streams

Waterbody Name	Assessment Unit ID	Location	State	Water Type & Classification	Channel length in Miles	Miles Assessed	Waterbody Status	Reporting Category
Malaja/Sagge Tinechong River	GUTURT-2	WATERSHED: Talofofo	GU	RIVER-S2	7.59	0.00	NOT ASSESSED	3
Sasa River 1	GUAPRS-1	WATERSHED: Apra	GU	RIVER-S3	0.85	0.85	ASSESSED	2
Sasa River 2	GUAPRS-2	WATERSHED: Apra	GU	RIVER-S3	1.36	1.15	ASSESSED	2
Sella River	GUULRS	WATERSHED: Cetti	GU	RIVER-S2	2.55	0.00	NOT ASSESSED	3
Sigua River	GUPGRS	WATERSHED: Pago	GU	RIVER-S1	6.15	0.00	NOT ASSESSED	3
Sumay River	GUMZRSY	WATERSHED: Manell	GU	RIVER-S2	1.06	0.00	NOT ASSESSED	3
Storm Drain	GUAGRD	WATERSHED: Northern	GU	RIVER-S2	0.21	0.21	IMPAIRED	5
Taelayag Creek	GUATRTA	WATERSHED: Taelayag	GU	RIVER-S3	1.37	0.00	NOT ASSESSED	3
Taleyfac River	GUATRT-2	WATERSHED: Taelayag	GU	RIVER-S3	3.85	3.79	ASSESSED	2
Talofofo River 2	GUTUETO	WATERSHED: Talofofo	GU	RIVER-S3	0.46	0.00	NOT ASSESSED	3
Talofofo River 3	GUTUETU-48A	WATERSHED: Talofofo	GU	RIVER-S2	0.96	0.00	NOT ASSESSED	3
Talofofo River 1	GUTURT-2-48A	WATERSHED: Talofofo	GU	RIVER-S2	2.09	0.00	NOT ASSESSED	3
Togcha River 1	GUTURTG-C	WATERSHED: Togcha	GU	RIVER-S3	0.99	0.00	NOT ASSESSED	3
Togcha River 2	GUTURTG-1A	WATERSHED: Togcha	GU	RIVER-S3	0.95	0.93	ASSESSED	2
Togcha River 3	GUTURTG-2	WATERSHED: Togcha	GU	RIVER-S3	0.06	0.00	NOT ASSESSED	3
Togcha River 4	GUTURTG-X	WATERSHED: Togcha	GU	RIVER-S3	0.04	0.00	NOT ASSESSED	3
Togcha River 5	GUTURTG-1C	WATERSHED: Togcha	GU	RIVER-S3	0.50	0.00	NOT ASSESSED	3
Togcha River 6	GUTURTG-1B	WATERSHED: Togcha	GU	RIVER-S3	0.08	0.00	NOT ASSESSED	3
Togcha River (Agat)	GUATRTO	WATERSHED: Agat	GU	RIVER-S3	1.10	0.00	NOT ASSESSED	3
Toguan River 1	GUMZRT-2	WATERSHED: Toguan	GU	RIVER-S3	0.20	0.00	NOT ASSESSED	3
Toguan River 2	GUMZRT-1	WATERSHED: Toguan	GU	RIVER-S3	1.21	0.00	NOT ASSESSED	3
Unnamed Creek 1	GUASRI-2	WATERSHED: Piti/Asan	GU	RIVER-S3	0.19	0.00	NOT ASSESSED	3
Unnamed Creek 2	GUASRI-1	WATERSHED: Piti/Asan	GU	RIVER-S3	0.17	0.00	NOT ASSESSED	3
Ugum River 1	GUTURU2	WATERSHED: Ugum	GU	RIVER-S2	1.05	1.05	IMPAIRED	4a

Table 20. 2010 Assessment Data for Rivers -Streams

Waterbody Name	Assessment Unit ID	Location	State	Water Type & Classification	Channel length in Miles	Miles Assessed	Waterbody Status	Reporting Category
Ugum River 2	GUTURU-1A	WATERSHED: Ugum	GU	RIVER-S2	12.57	12.57	IMPAIRED	4a
Ugum River 3	GUTURU-1B	WATERSHED: Ugum	GU	RIVER-S2	0.18	0.18	IMPAIRED	4a
Ugum River 4	GUTUETU-48H	WATERSHED: Talofofo	GU	RIVER-S3	0.39	0.39	IMPAIRED	4a
Ugum River 5	GUTURU-1C	WATERSHED: Ugum	GU	RIVER-S2	2.96	2.96	IMPAIRED	4a
Ugum River 6	GUTURU-1A-48H	WATERSHED: Ugum	GU	RIVER-S2	4.43	4.43	IMPAIRED	4a
Umatac River	GUULRU-2	WATERSHED: Umatac	GU	RIVER-S3	0.92	0.00	NOT ASSESSED	3
Ylig River 1	GUYNRY-1	WATERSHED: Ylig	GU	RIVER-S3	23.57	0.00	NOT ASSESSED	3
Ylig River 2	GUYNRY-2	WATERSHED: Ylig	GU	RIVER-S3	3.33	0.00	NOT ASSESSED	3
Ylig River 3	GUYNRY-3	WATERSHED: Ylig	GU	RIVER-S3	0.41	0.41	ASSESSED	2
Unnamed River 1	GUULRCR	WATERSHED: Cetti	GU	RIVER-S2	0.36	0.00	NOT ASSESSED	3
Unnamed River 2	GUINRAGB	WATERSHED: Inarajan	GU	RIVER-S3	0.95	0.00	NOT ASSESSED	3
Almagosa River	GUFLRA-2	WATERSHED: Talofofo	GU	RIVER-S1	2.23	0.00	NOT ASSESSED	3
Unnamed River 3	GUG-35	WATERSHED: Manell	GU	RIVER-S2	1.06	0.00	NOT ASSESSED	3
Unnamed Tributary 2	GUG-43A	WATERSHED: Inarajan	GU	RIVER	0.58	0.00	NOT ASSESSED	3
Unnamed Tributary 3	GUG-43B	WATERSHED: Inarajan	GU	RIVER	0.58	0.00	NOT ASSESSED	3
Unnamed Stream 1	GUG-55	WATERSHED: Talofofo	GU	RIVER	0.38	0.00	NOT ASSESSED	3
Intermittent Tributary 1	GUG-43C	WATERSHED: Inarajan	GU	RIVER	1.17	0.00	NOT ASSESSED	3
Intermittent Tributary 2	GUG-43D	WATERSHED: Inarajan	GU	RIVER	0.37	0.00	NOT ASSESSED	3
Intermittent Tributary 3	GUG-43E	WATERSHED: Inarajan	GU	RIVER	0.24	0.00	NOT ASSESSED	3
Intermittent Tributary 4	GUG-43F	WATERSHED: Inarajan	GU	RIVER	0.58	0.00	NOT ASSESSED	3
Taguag River	GUG-5	WATERSHED: Piti/Asan	GU	RIVER	0.62	0.00	NOT ASSESSED	3
Auau Creek	GUG-16	WATERSHED: Agat	GU	RIVER	0.86	0.00	NOT ASSESSED	3
Bile River	GUG-30	WATERSHED: Toguan	GU	RIVER	0.64	0.00	NOT ASSESSED	3
Suyafe River	GUG-36	WATERSHED: Manell	GU	RIVER	0.88	0.00	NOT ASSESSED	3

Table 20. 2010 Assessment Data for Rivers -Streams

Waterbody Name	Assessment Unit ID	Location	State	Water Type & Classification	Channel length in Miles	Miles Assessed	Waterbody Status	Reporting Category
Asgado Creek	GUG-39	WATERSHED: Manell	GU	RIVER	0.59	0.00	NOT ASSESSED	3
Asmaile River	GUG-40	WATERSHED: Manell	GU	RIVER	0.77	0.00	NOT ASSESSED	3
Tongan Creek	GUG-42	WATERSHED: Inarajan	GU	RIVER	0.86	0.00	NOT ASSESSED	3
Agfayan River	GUG-43	WATERSHED: Inarajan	GU	RIVER	3.15	0.00	NOT ASSESSED	3
Unnamed Tributary 4	GUG-57B	WATERSHED: Talofofo	GU	RIVER	0.82	0.00	NOT ASSESSED	3
Tolaeyuus River	GUG-60	WATERSHED: Talofofo	GU	RIVER-S1	0.39	0.00	NOT ASSESSED	3
Talisay River	GUG-61	WATERSHED: Talofofo	GU	RIVER-S1	3.72	0.00	NOT ASSESSED	3
Unnamed Tributary 5	GUG-62	WATERSHED: Talofofo	GU	RIVER-S1	0.28	0.00	NOT ASSESSED	3
Unnamed Tributary 6	GUG-63	WATERSHED: Talofofo	GU	RIVER-S1	0.22	0.00	NOT ASSESSED	3
Maemong River	GUG-64	WATERSHED: Talofofo	GU	RIVER-S1	2.71	0.00	NOT ASSESSED	3
Unnamed Tributary 7	GUG-65	WATERSHED: Talofofo	GU	RIVER-S1	0.57	0.00	NOT ASSESSED	3
Unnamed Tributary 8	GUG-66	WATERSHED: Talofofo	GU	RIVER-S1	0.66	0.00	NOT ASSESSED	3

Reporting Category	Category Miles	% of Total Miles
C2 – At least one designated use met; more information needed	35.84	15.40%
C3 – No information available to make designated use determination	167.88	72.16%
C4a – TMDL approved	21.58	9.28%
C5 – Waterbody impaired; TMDL needed	7.35	3.16%

Six (6) Ugum River assessment units totaling 21.58 miles are impaired, however, because a TMDL has been developed, these river units are reported under Category 4a.[10]

Impaired River/Stream/Wetland	*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	GUPGRL-1-51B	0.04 mi
5. Landfill Leachate Stream	GUPGRL-0	0.05 mi
6. Pago River 1	GUPGRP-1-51A	0.06 mi
7. Pago River 2	GUPGRP-2	4.73 mi
8. Storm Drain	GUAGRD	0.21 mi

See Table 23 : 2010 303(d) List --- Impaired Guam Waterbodies

Table B.4. Rivers Use Support, Appendix H. provides the base information used to develop Table 20. Note that the population of rivers/tributaries is identified according to assigned Guam River Identification Numbers (UOG Marine Lab Technical Report 75)[11] . The following information is also provided for each river/tributary:[12] *Channel length (in miles); Receiving Water (location into which river/tributary waters flow); Segment ID (monitoring station I.D.); Guam Water Quality (Standards) Classification (GWQC) which determines the designated uses for that body of water; sampling status entries for each designated use; recommended reporting category; assessed miles;*

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

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

[12] Rivers/Tributaries which have "(NA)" entries under **Segment ID** and **Segment Length (miles)** do not have an existing monitoring station at that location.

Refer to Table 9 (page 23) for clarification about Guam Surface Water Classifications S1, S2, S3 and respective designated uses assigned to those waters.

Table B.2, Appendix H provides rivers assessment information for the reporting period. The pollutants for those rivers on Guam's 303(d) List of impaired waters are identified in Table 23.

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 Contact". All other Goal and Use categories were considered "Not Applicable".

As discussed in Appendix H., **Recreational beach sizes (miles)** are delineated using best professional judgment based on accessibility and existing sandy shorelines. For this reporting period, **Assessed beach size (miles)** is not based on the 400 yard radius assessment criteria. Rather, it is delineated based on the location of existing monitoring stations within a designated beach stretch and its delineation will equal Recreational Beach Sizes. Both *Beach size* and *Assessment size* are shown in **Table B5. Guam Beach Use Support**, also in Appendix H.

Enterococcus (in Marine Waters) and E. coli (in Fresh Waters) are assessed for this reporting period. Exceedances are based on single-sample and geometric mean criteria. Use Support is dependent on the total number of exceedances of single sample and geometric mean criteria. The guideline to determine degree of use support is presented in Table 13 (page 28). 2008 and 2009 Body Contact Use Support assessment for Guam's Tier 1&2 Beaches show:

	2008 TOTAL	2008 MILES		2009 TOTAL	2009 MILES
Fully Supporting	2	0.24	Fully Supporting	0	0
Partially Supporting	4	1.41	Partially Supporting	7	1.99
Not Supporting	36	13.81	Not Supporting	35	13.47
	42	**15.46**		**42**	**15.46**
Use support	Monitoring Stations	43.65 = Total Beach Miles	Use support	Monitoring Stations	43.65 = Total Beach Miles

In 2009, more beach miles are Partially Supporting (1.99 miles) and fewer miles are Fully Supporting (0 miles) or Not Supporting (13.47 miles) than the previous year.

Table 21. 2010 Assessment Data for Coastal/Recreational Waters

Waterbody Name	Assessment Unit ID	Location	State	Water Type	Water Size	Unit	Miles Assessed	Water Status	Reporting Category
Tarague and Scout Beach	GU-GB1	Tarague and Scout Beach	GU	COASTAL WATERS M1	3.42	MILES	0.00	NOT ASSESSED	3
Jinapsan Beach	GU-GB3	Jinapsan Beach	GU	COASTAL WATERS M1	1.28	MILES	0.00	NOT ASSESSED	3
Ritidian Beach	GU-GB4	Ritidian Beach	GU	COASTAL WATERS M1	2.21	MILES	0.00	NOT ASSESSED	3
Uruno Beach	GU-GB5	Uruno Beach	GU	COASTAL WATERS M1	1.74	MILES	0.00	NOT ASSESSED	3
Falcona Beach (Urunao)	GU-GB6	Falcona Beach (Urunao)	GU	COASTAL WATERS M1	0.37	MILES	0.00	NOT ASSESSED	3
South of Falcona Beach (Urunao)	GU-GB7	South of Falcona Beach (Urunao)	GU	COASTAL WATERS M1	0.24	MILES	0.00	NOT ASSESSED	3
Haputo Beach	GU-GB8	Haputo Beach	GU	COASTAL WATERS M1	0.19	MILES	0.00	NOT ASSESSED	3
Intermittent Beach - Shark's Hole	GU-GB9	Intermittent Beach - Shark's Hole	GU	COASTAL WATERS M1	0.19	MILES	0.00	NOT ASSESSED	3
Intermittent Beach - Tanguisson Pt.	GU-GB10	Intermittent Beach - Tanguisson Pt. (Northern Watershed)	GU	COASTAL WATERS M2	0.26	MILES	0.00	NOT ASSESSED	3
Intermittent Beach - North of NCS/Tanguisson	GU-GB11	Intermittent Beach - North of NCS/Tanguisson	GU	COASTAL WATERS M2	0.26	MILES	0.00	NOT ASSESSED	3
Fafai Beach	GU-GB13	Fafai Beach	GU	COASTAL WATERS M2	0.37	MILES	0.00	NOT ASSESSED	3
Alupang Island Beach, East Hagatna Bay	GU-GB21	Alupang Island Beach, East Hagatna Bay	GU	COASTAL WATERS M2	0.02	MILES	0.00	NOT ASSESSED	3
West of volcanic headland, Asan Bay	GU-GB29	West of volcanic headland, Asan Bay	GU	COASTAL WATERS M2	0.37	MILES	0.00	NOT ASSESSED	3
Ski Beach	GU-GB38	Ski Beach	GU	COASTAL WATERS M3	0.40	MILES	0.00	NOT ASSESSED	3
SRF Beach	GU-GB40	SRF Beach	GU	COASTAL WATERS M3	0.40	MILES	0.00	NOT ASSESSED	3

Table 21. 2010 Assessment Data for Coastal/Recreational Waters

Waterbody Name	Assessment Unit ID	Location	State	Water Type	Water Size	Unit	Miles Assessed	Water Status	Reporting Category
Marianas Yacht Club Beach, Sasa Bay	GU-GB41	Marianas Yacht Club Beach, Sasa Bay	GU	COASTAL WATERS M2	0.18	MILES	0.00	NOT ASSESSED	3
Polaris Beach	GU-GB42	Polaris Beach	GU	COASTAL WATERS M2	0.19	MILES	0.00	NOT ASSESSED	3
Gabgab Beach	GU-GB43	Gabgab Beach	GU	COASTAL WATERS M2	0.65	MILES	0.65	IMPAIRED	5
Orote Point Beaches	GU-GB44	Orote Point Beaches	GU	COASTAL WATERS M1	0.46	MILES	0.00	NOT ASSESSED	3
Tipalao Beach	GU-GB45	Tipalao Beach	GU	COASTAL WATERS M2	0.15	MILES	0.00	NOT ASSESSED	3
Dadi Beach	GU-GB46	Dadi Beach	GU	COASTAL WATERS M2	0.57	MILES	0.00	NOT ASSESSED	3
Rizal Beach	GUS-01	Rizal Beach	GU	COASTAL WATERS M2	0.26	MILES	0.00	NOT ASSESSED	3
Apaca Park Beach	GU-GB48	Apaca Park Beach	GU	COASTAL WATERS M2	0.14	MILES	0.00	NOT ASSESSED	3
Salinas Beach	GU-GB51	Salinas Beach	GU	COASTAL WATERS M2	0.49	MILES	0.00	NOT ASSESSED	3
Beach North of Finile River	GU-GB52	Beach North of Finile River	GU	COASTAL WATERS M2	0.30	MILES	0.00	NOT ASSESSED	3
Taelayag Beach	GU-GB56	Taelayag Beach	GU	COASTAL WATERS M1	0.87	MILES	0.00	NOT ASSESSED	3
Sagua Beach	GU-GB57	Sagua Beach	GU	COASTAL WATERS M1	0.62	MILES	0.00	NOT ASSESSED	3
Facpi Point Beaches	GU-GB58	Facpi Point Beaches	GU	COASTAL WATERS M1	0.66	MILES	0.00	NOT ASSESSED	3
Beach south of Achugao	GU-GB59	Beach south of Achugao	GU	COASTAL WATERS M1	0.29	MILES	0.00	NOT ASSESSED	3
Beach south of Agaga River	GU-GB60	Beach south of Agaga River	GU	COASTAL WATERS M1	0.25	MILES	0.00	NOT ASSESSED	3

Table 21. 2010 Assessment Data for Coastal/Recreational Waters

Waterbody Name	Assessment Unit ID	Location	State	Water Type	Water Size	Unit	Miles Assessed	Water Status	Reporting Category
Beach north of Asmafines River	GU-GB62	Beach north of Asmafines River	GU	COASTAL WATERS M1	0.12	MILES	0.00	NOT ASSESSED	3
Beach south of Sella River	GU-GB63	Beach south of Sella River	GU	COASTAL WATERS M1	0.12	MILES	0.00	NOT ASSESSED	3
Abong Beach	GU-GB64	Abong Beach	GU	COASTAL WATERS M1	0.62	MILES	0.00	NOT ASSESSED	3
Mouth of Cetti Bay	GU-GB65	Mouth of Cetti Bay	GU	COASTAL WATERS M1	0.50	MILES	0.00	NOT ASSESSED	3
Head of Fouha Bay	GU-GB66	Head of Fouha Bay	GU	COASTAL WATERS M1	0.06	MILES	0.00	NOT ASSESSED	3
South of Machadgan Point	GU-GB68	South of Machadgan Point	GU	COASTAL WATERS M2	0.25	MILES	0.00	NOT ASSESSED	3
Ajmo Beach	GU-GB70	Ajmo Beach	GU	COASTAL WATERS M2	0.16	MILES	0.00	NOT ASSESSED	3
Bile Bay Beach	GU-GB71	Bile Bay Beach	GU	COASTAL WATERS M2	0.03	MILES	0.00	NOT ASSESSED	3
Pigua River Beach	GU-GB72	Pigua River Beach	GU	COASTAL WATERS M2	0.08	MILES	0.00	NOT ASSESSED	3
Cocos Island	GU-GB73	Cocos Island	GU	COASTAL WATERS M1	1.16	MILES	0.00	NOT ASSESSED	3
Islet	GU-GB74	Islet	GU	COASTAL WATERS M1	0.07	MILES	0.00	NOT ASSESSED	3
Piga Beach/Talona Beach	GU-GB76	Piga Beach/Talona Beach	GU	COASTAL WATERS M2	0.42	MILES	0.00	NOT ASSESSED	3
Aba Beach	GU-GB78	Aba Beach	GU	COASTAL WATERS M1	0.19	MILES	0.00	NOT ASSESSED	3
Aang Beach	GU-GB79	Aang Beach	GU	COASTAL WATERS M1	0.12	MILES	0.00	NOT ASSESSED	3
ACHANG BAY	GU-GB80	ACHANG BAY	GU	COASTAL WATERS M1	0.55	MILES	0.00	NOT ASSESSED	3

Table 21. 2010 Assessment Data for Coastal/Recreational Waters

Waterbody Name	Assessment Unit ID	Location	State	Water Type	Water Size	Unit	Miles Assessed	Water Status	Reporting Category
Beach to Liyog River Mouth	GU-GB81	Beach to Liyog River Mouth	GU	COASTAL WATERS M1	0.77	MILES	0.00	NOT ASSESSED	3
Liyog river Mouth	GU-GB82	Liyog river Mouth	GU	COASTAL WATERS M1	0.18	MILES	0.00	NOT ASSESSED	3
Beach to Asgadao Bay	GU-GB83	Beach to Asgadao Bay	GU	COASTAL WATERS M1	0.04	MILES	0.00	NOT ASSESSED	3
Intermittent Beach, Asgadao Bay	GU-GB84	Intermittent Beach 1, Asgadao Bay	GU	COASTAL WATERS M1	0.12	MILES	0.00	NOT ASSESSED	3
Intermittent Beach 1, Ajayan Bay	GU-GB85	Intermittent Beach 2, Asgadao Bay	GU	COASTAL WATERS M1	0.12	MILES	0.00	NOT ASSESSED	3
Intermittent Beach 2, Ajayan Bay	GU-GB86	Intermittent Beach 3, Asgadao Bay	GU	COASTAL WATERS M1	0.09	MILES	0.00	NOT ASSESSED	3
Ajayan River Mouth 1	GU-GB87	Ajayan River Mouth	GU	COASTAL WATERS M1	0.03	MILES	0.00	NOT ASSESSED	3
Intermittent Beach 3, Ajayan Bay	GU-GB88	Intermittent Beach 4, Asgadao Bay	GU	COASTAL WATERS M1	0.19	MILES	0.00	NOT ASSESSED	3
Ajayan River Mouth 2	GU-GB89	Ajayan River Mouth	GU	COASTAL WATERS M1	0.06	MILES	0.00	NOT ASSESSED	3
Intermittent beach 4, AJAYAN BAY	GU-GB90	Intermittent beach at AJAYAN BAY	GU	COASTAL WATERS M1	0.09	MILES	0.00	NOT ASSESSED	3
Aga Beach	GU-GB91	Aga Beach	GU	COASTAL WATERS M1	0.08	MILES	0.00	NOT ASSESSED	3
Guijen Rock area	GU-GB92	Guijen Rock area	GU	COASTAL WATERS M1	0.44	MILES	0.00	NOT ASSESSED	3
Atao Beach	GU-GB93	Atao Beach	GU	COASTAL WATERS M1	0.38	MILES	0.00	NOT ASSESSED	3
Beach north of Acho Point	GU-GB94	Beach north of Acho Point	GU	COASTAL WATERS M1	0.27	MILES	0.00	NOT ASSESSED	3
Agfayan River Beach	GU-GB95	Agfayan River Beach	GU	COASTAL WATERS M2	0.07	MILES	0.00	NOT ASSESSED	3

Table 21. 2010 Assessment Data for Coastal/Recreational Waters

Waterbody Name	Assessment Unit ID	Location	State	Water Type	Water Size	Unit	Miles Assessed	Water Status	Reporting Category
Beach at Pauliluc Bay	GU-GB98	Beach at Pauliluc Bay	GU	COASTAL WATERS M2	0.28	MILES	0.00	NOT ASSESSED	3
ULOMAI BEACH	GU-GB99	ULOMAI BEACH	GU	COASTAL WATERS M2	0.11	MILES	0.00	NOT ASSESSED	3
Perez Beach	GU-GB101	Perez Beach	GU	COASTAL WATERS M2	0.26	MILES	0.00	NOT ASSESSED	3
Asiga Beach Area (Inarajan)	GU-GB102	Asiga Beach Area (Inarajan)	GU	COASTAL WATERS M1	0.23	MILES	0.00	NOT ASSESSED	3
Head of Paicpouc Cove	GU-GB103	Head of Paicpouc Cove	GU	COASTAL WATERS M2	0.09	MILES	0.00	NOT ASSESSED	3
Calvos Beach	GU-GB108	Calvos Beach	GU	COASTAL WATERS M2	0.51	MILES	0.00	NOT ASSESSED	3
Jones Beach	GU-GB110	Jones Beach	GU	COASTAL WATERS M2	0.09	MILES	0.00	NOT ASSESSED	3
North of Togcha Point	GU-GB114	North of Togcha Point	GU	COASTAL WATERS M2	1.03	MILES	0.00	NOT ASSESSED	3
Head of Ylig Bay	GU-GB115	Head of Ylig Bay	GU	COASTAL WATERS M2	0.18	MILES	0.00	NOT ASSESSED	3
Beach North of Ylig Bay	GU-GB116	Beach North of Ylig Bay	GU	COASTAL WATERS M2	0.07	MILES	0.00	NOT ASSESSED	3
North Pago Bay Beach	GU-GB119	North Pago Bay Beach	GU	COASTAL WATERS M2	0.24	MILES	0.00	NOT ASSESSED	3
Asan Bay Beach	GUN-14	Asan Memorial Beach, Head of Asan Bay	GU	COASTAL WATERS M2	0.53	MILES	0.53	IMPAIRED	5
Bangi Beach	GUS-04	Beach South of Finile River	GU	COASTAL WATERS M2	1.17	MILES	1.17	IMPAIRED	5
Adelup Beach Park	GUN-21	Beach at Fonte River, West Hagatna Bay	GU	COASTAL WATERS M2	0.13	MILES	0.13	IMPAIRED	5
Inarajan Bay	GUS-10	Beach at Inarajan Bay	GU	COASTAL WATERS M2	0..46	MILES	0.46	IMPAIRED	5

Table 21. 2010 Assessment Data for Coastal/Recreational Waters

Waterbody Name	Assessment Unit ID	Location	State	Water Type	Water Size	Unit	Miles Assessed	Water Status	Reporting Category
Beach at Pago Bay	GUS-15	Pago Bay	GU	COASTAL WATERS M2	0.96	MILES	0.96	IMPAIRED	5
Santos Memorial Park	GUN-16	Beach at Piti Bay	GU	COASTAL WATERS M2	0.46	MILES	0.46	IMPAIRED	5
Piti Bay	GUN-15	Beach at Piti Bay	GU	COASTAL WATERS M2	0.62	MILES	0..62	IMPAIRED	5
Togcha Bay	GUS-13	Beach North of Togcha River	GU	COASTAL WATERS M2	0.27	MILES	0.27	IMPAIRED	5
Dungca's Beach - Sleepy Lagoon	GUN-06	Dungca's Beach East Hagatna Bay	GU	COASTAL WATERS M2	0.34	MILES	0.34	IMPAIRED	4a
Dungca's Beach	GUN-07	Dungca's Beach East Hagatna Bay	GU	COASTAL WATERS M2	0.65	MILES	0.65	IMPAIRED	4a
Family Beach	GUN-19	Family Beach	GU	COASTAL WATERS M2	0.15	MILES	0.15	IMPAIRED	5
Ipan Point Beach	GUS-18	First Beach	GU	COASTAL WATERS M2	0.06	MILES	0.06	IMPAIRED	5
Gongna Beach -North San Vitores	GUN-25	Gongna Beach, Tumon Bay	GU	COASTAL WATERS M2	0.14	MILES	0.14	IMPAIRED	4a
Gun Beach	GUN-24	Gun Beach, Tumon Bay	GU	COASTAL WATERS M2	0.23	MILES	0.23	IMPAIRED	4a
Hagatna Channel -Outrigger Ramp	GUN-11	Hagatna Marina	GU	COASTAL WATERS M2	0.15	MILES	0.15	IMPAIRED	4a
Hagatna Boat Basin	GUN-12	Hagatna Marina	GU	COASTAL WATERS M2	0.12	MILES	0.12	IMPAIRED	4a
Hagatna Channel	GUN-10	Hagatna Marina	GU	COASTAL WATERS M2	0.15	MILES	0.15	IMPAIRED	4a
Talofofo Bay	GUS-11	Head of Talofofo Bay	GU	COASTAL WATERS M2	0.21	MILES	0.21	IMPAIRED	5
Umatac Bay	GUS-06	Head of Umatac Bay	GU	COASTAL WATERS M2	0.14	MILES	0.14	IMPAIRED	5

Table 21. 2010 Assessment Data for Coastal/Recreational Waters

Waterbody Name	Assessment Unit ID	Location	State	Water Type	Water Size	Unit	Miles Assessed	Water Status	Reporting Category
Inarajan Pool	GUS-09	Inarajan Pools	GU	COASTAL WATERS M2	0.07	MILES	0.07	IMPAIRED	5
Merizo Pier -Mamaon Channel	GUS-08	Merizo Public Pier Park	GU	COASTAL WATERS M2	0.46	MILES	0.46	IMPAIRED	5
Tanguisson Beach	GUN-01	NCS Beach /Tanguisson Beach	GU	COASTAL WATERS M2	0.25	MILES	0.25	IMPAIRED	4a
Naton Beach -Guma Trankilidat	GUN-04	Naton Beach, Tumon Bay	GU	COASTAL WATERS M2	0.18	MILES	0.18	IMPAIRED	4a
Naton Beach -San Vitores	GUN-02	Naton Beach, Tumon Bay	GU	COASTAL WATERS M2	0.23	MILES	0.23	IMPAIRED	4a
Naton Beach -Fujita	GUN-23	Naton Beach, Tumon Bay	GU	COASTAL WATERS M2	0.36	MILES	0.36	IMPAIRED	4a
Naton Beach -Matapang Beach Park	GUN-03	Naton Beach Matapang Beach Park	GU	COASTAL WATERS M2	0.33	MILES	0.33	IMPAIRED	4a
Nimitz Beach	GUS-05	Nimitz Beach	GU	COASTAL WATERS M2	0.49	MILES	0.49	IMPAIRED	5
Outhouse Beach	GUN-18	Outhouse Beach	GU	COASTAL WATERS M3	0.46	MILES	0.46	IMPAIRED	5
Port Authority Beach	GUN-20	Port Authority Beach	GU	COASTAL WATERS M3	0.46	MILES	0.46	IMPAIRED	5
Tagachang Beach Park	GUS-14	Tagachang Beach	GU	COASTAL WATERS M2	0.07	MILES	0.07	IMPAIRED	5
Toguan Bay	GUS-07	Toguan Bay	GU	COASTAL WATERS M2	0.46	MILES	0.46	IMPAIRED	5
Togcha Beach Southern Christian Academy	GUS-17	Togcha Beach -aka Agat Beach	GU	COASTAL WATERS M2	0.31	MILES	0.31	IMPAIRED	5
Togcha Beach Namo Bay	GUS-02	Togcha Beach -aka Agat Beach	GU	COASTAL WATERS M2	0.33	MILES	0.33	IMPAIRED	5
Togcha Bay Agat Beach	GUS-03	Togcha Beach -aka Agat Beach	GU	COASTAL WATERS M2	0.15	MILES	0.15	IMPAIRED	5

Table 21. 2010 Assessment Data for Coastal/Recreational Waters

Waterbody Name	Assessment Unit ID	Location	State	Water Type	Water Size	Unit	Miles Assessed	Water Status	Reporting Category
Trinchera Beach, East Hagatna Bay	GUN-08	Trinchera Beach East Hagatna Bay	GU	COASTAL WATERS M2	0.48	MILES	0.48	IMPAIRED	4a
Trinchera Beach, Alupang Beach Towers	GUN-26	Trinchera Beach East Hagatna Bay	GU	COASTAL WATERS M2	0.25	MILES	0.25	IMPAIRED	4a
Padre Palomo	GUN-09	Trinchera Beach East Hagatna Bay	GU	COASTAL WATERS M2	0.42	MILES	0.42	IMPAIRED	4a
United Seamen's Service Beach (USO Beach)	GUN-17	United Seamen's Service	GU	COASTAL WATERS M2	0.52	MILES	0.52	IMPAIRED	5
West Hagatna Beach	GUN-13	Hagatna Bayside	GU	COASTAL WATERS M2	1.11	MILES	1.11	IMPAIRED	4a
West of Adelup Point, Asan Bay	GUN-22	Beach West of Adelup	GU	COASTAL WATERS M2	0.41	MILES	0.41	IMPAIRED	5
Ypan Beach Park Beach (Ipan Public Beach)	GUS-12	Ipan Beach	GU	COASTAL WATERS M2	0.30	MILES	0.30	IMPAIRED	5
Ypao Beach, Tumon Bay	GUN-05	Ypao Beach	GU	COASTAL WATERS M2	0.42	MILES	0.42	IMPAIRED	4a

Twenty five Tier 1 Guam Beaches remain on Guam's 2010 CWA 303(d) List of impaired waters (carried forward from the 2008 303(d) List). Guam was able to develop EPA approved TMDLs for seventeen impaired beaches located in the Northern Watershed. (See Appendix F.) These beaches were removed (de-listed) from the impaired waters list and are categorized as 4a in Table 21. Guam also 303(d) listed Gabgab Beach as an impaired waterbody because a Fish Consumption Advisory remains in effect for that waterbody.

Table 21 provides assessment data for one hundred thirteen (113) Guam Coastal/Recreational Waterbodies. Forty-two (42) Tier 1 Beach Stations representing thirty one beaches were monitored by Guam EPA. The following is a summary of Table 21 data.

Number of Beaches	103
Accessible (Tier 1 & 2 beaches)	66
Inaccessible (Tier 3 beaches)	37
Number of assessed Beaches	31
Number of monitoring stations	42
Impaired (Category 5)*	25
TMDL available (Category 4a)	17
Beach miles monitored	15.46

* does not include Gabgab Beach

3.2. Marine Bays

Table 22 provides 2008-2009 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: <u>11 Marine Bays</u> <u>14.76 square miles of impaired waters</u>

TABLE 22. 2010 MARINE BAY ASSESSMENT DATA

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

TABLE 22. 2010 MARINE BAY ASSESSMENT DATA

Waterbody Name	Assessment Unit ID	WATERSHED Location	STATE	Water Classification	Water Size	Unit	Square Miles Assessed	Water Status	Reporting Category
UMATAC BAY 1	GUG-016B-1	UMATAC	GU	M1	0.06	SQUARE MILES	0.00	NOT ASSESSED	3
UMATAC BAY 2	GUG-016B-2	UMATAC		M2	0.34	SQUARE MILES	0.00	NOT ASSESSED	3
YLIG BAY	GUG-005A	YLIG	GU	M2	0.45	SQUARE MILES	0.45	ASSESSED	2
RITIDIAN POINT BEACH AREA	GUG-047	NORTHERN	GU	M1	1.42	SQUARE MILES	1.42	ASSESSED	2
URUNO BEACH AREA	GUG-058	NORTHERN	GU	M1	0.58	SQUARE MILES	0.00	NOT ASSESSED	3
FALCONA BEACH AREA	GUG-031	NORTHERN	GU	M1	0.19	SQUARE MILES	0.00	NOT ASSESSED	3
HAPUTO BEACH AREA	GUG-033	NORTHERN	GU	M1	0.07	SQUARE MILES	0.00	NOT ASSESSED	3
SOUTH HAPUTO BEACH AREA	GUG-051	NORTHERN	GU	M1	0.20	SQUARE MILES	0.00	NOT ASSESSED	3
OKA POINT	GUG-041	NORTHERN	GU	M2	0.20	SQUARE MILES	0.00	NOT ASSESSED	3
ASAN BAY	GUG-006A	PITI/ASAN	GU	M2	0.58	SQUARE MILES	0.58	ASSESSED	2
PITI BAY	GUG-006B	PITI/ASAN	GU	M2	1.35	SQUARE MILES	1.35	ASSESSED	2
LUMINAO REEF/CALALA BANK	GUG-037	PITI/ASAN	GU	M2	1.17	SQUARE MILES	1.17	ASSESSED	2
PITI CHANNEL/ CABRAS ISLAND	GUG-045	PITI/ASAN	GU	M3	0.24	SQUARE MILES	0.00	NOT ASSESSED	3
SASA BAY	GUG-052	APRA	GU	M2	0.74	SQUARE MILES	0.74	ASSESSED	2
NORTH OROTE PENINSULA SEA CLIFFS	GUG-042	APRA	GU	M1	0.23	SQUARE MILES	0.23	IMPAIRED	5
SOUTH OROTE PENINSULA SEA CLIFFS	GUG-043	APRA	GU	M2	0.02	SQUARE MILES	0.02	IMPAIRED	5
SOUTH FACPI POINT BEACHES/ROCKY SHORELINES	GUG-054	TAELAYAG	GU	M1	0.66	SQUARE MILES	0.00	NOT ASSESSED	3
SELLA BAY	GUG-053	CETTI	GU	M1	0.27	SQUARE MILES	0.27	ASSESSED	2
TOGUAN BAY	GUG-018A	TOGUAN	GU	M2	0.26	SQUARE MILES	0.26	ASSESSED	2
BILE BAY	GUG-030	TOGUAN	GU	M2	0.17	SQUARE MILES	0.17	ASSESSED	2

TABLE 22. 2010 MARINE BAY ASSESSMENT DATA

Waterbody Name	Assessment Unit ID	WATERSHED Location	STATE	Water Classification	Water Size	Unit	Square Miles Assessed	Water Status	Reporting Category
SUMAY BAY	GUG-055	MANELL	GU	M1	0.79	SQUARE MILES	0.00	NOT ASSESSED	3
ASGADAO BAY	GUG-027	MANELL	GU	M1	0.56	SQUARE MILES	0.00	NOT ASSESSED	3
AJAYAN BAY	GUG-026	MANELL	GU	M1	0.24	SQUARE MILES	0.00	NOT ASSESSED	3
AGA BAY	GUG-025	MANELL	GU	M1	0.10	SQUARE MILES	0.10	ASSESSED	2
INARAJAN REEF FLAT	GUG-034	INARAJAN	GU	M1	0.82	SQUARE MILES	0.00	NOT ASSESSED	3
INARAJAN BAY	GUG-017B	INARAJAN	GU	M2	0.17	SQUARE MILES	0.00	NOT ASSESSED	3
GUAIFAN POINT REEF FLAT	GUG-032	DANDAN	GU	M2	0.08	SQUARE MILES	0.00	NOT ASSESSED	3
PAULILUC BAY	GUG-044	DANDAN	GU	M2	0.08	SQUARE MILES	0.00	NOT ASSESSED	3
ULOMAI BEACH AREA	GUG-057	DANDAN	GU	M2	0.09	SQUARE MILES	0.09	ASSESSED	2
NOMNA BAY	GUG-039	DANDAN	GU	M2	0.17	SQUARE MILES	0.00	NOT ASSESSED	3
NOMNA POINT REEF FLAT	GUG-040	DANDAN	GU	M1	0.32	SQUARE MILES	0.00	NOT ASSESSED	3
ASIGA POINT BEACH AREA	GUG-028	DANDAN	GU	M1	0.16	SQUARE MILES	0.00	NOT ASSESSED	3
MATALA POINT REEF FLAT	GUG-038	DANDAN	GU	M1	0.25	SQUARE MILES	0.00	NOT ASSESSED	3
TALOFOFO BEACHES	GUG-007B	TALOFOFO	GU	M2	0.61	SQUARE MILES	0.00	NOT ASSESSED	3
BEACH NORTH OF TOGCHA POINT	GUG-029	YLIG	GU	M2	0.53	SQUARE MILES	0.00	NOT ASSESSED	3
TAGACHANG BEACH PARK	GUG-005B	YLIG	GU	M2	0.24	SQUARE MILES	0.00	NOT ASSESSED	3
S. FADIAN POINT	GUG-049	NORTHERN	GU	M2	0.58	SQUARE MILES	0.00	NOT ASSESSED	3
N. FADIAN POINT	GUG-046	NORTHERN	GU	M1	0.56	SQUARE MILES	0.56	ASSESSED	2
S. JANUM POINT	GUG-050	NORTHERN	GU	M1	2.29	SQUARE MILES	2.29	ASSESSED	2
JANUM POINT REEF FLAT	GUG-035	NORTHERN	GU	M1	0.09	SQUARE MILES	0.00	NOT ASSESSED	3
PATI POINT	GUG-048	NORTHERN	GU	M1	5.35	SQUARE MILES	0.00	NOT ASSESSED	3
TARAGUE BEACH	GUG-056	NORTHERN	GU	M1	3.09	SQUARE MILES	0.00	NOT ASSESSED	3
JINAPSAN BEACH	GUG-036	NORTHERN	GU	M1	0.75	SQUARE MILES	0.00	NOT ASSESSED	3

Those waterbodies impaired by Fish Advisories are under continuing investigation/restoration by the Department of Defense. See **Table 23.**

- 24 marine bays were assessed and placed under Reporting Category 2;
- 31 marine bays were not assessed. These waterbodies reported under Category 3:

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 24 provides a list of nineteen Guam wetlands totaling about 1,964.48 acres. The Agana Swamp[13], 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 provided for the remaining eighteen wetlands.

5.0 Results of Probability-based Surveys

Data from Guam EPA monitoring project GCA-05 which utilized probability-based surveying was used this reporting period. The result of this coastal assessment project is discussed in Appendix H. *Guam EPA monitoring project GWSA-06 is still on-going. The results of this survey will be discussed in a future integrated report.*

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 2010 is provided in **Table 23**.

Guam EPA followed the EPA's 1997 and 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;

13 See under this Part III. F. Consumption Concerns, Section 3.2.2. Agana Swamp.

Table 23. 2010 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
Asan Bay Beach	GUN-14	Asan Memorial Beach, Head of Asan Bay (ASAN)	GU	COASTAL WATERS M-2	0.53	MILES	0.53	Enterococcus	Exceeds WQS >10%of Samples	HIGH
Bangi Beach	GUS-04	Beach South of Finile River (AGAT)	GU	COASTAL WATERS M-2	1.17	MILES	1.17	Enterococcus	Exceeds WQS >10%of Samples	HIGH
Adelup Beach Park	GUN-21	Beach at Fonte River, West Hagatna Bay (ADELUP)	GU	COASTAL WATERS M-2	0.13	MILES	0.13	Enterococcus	Exceeds WQS >10%of Samples	HIGH
Inarajan Bay	GUS-10	Beach at Inarajan Bay (INARAJAN)	GU	COASTAL WATERS M-2	0.46	MILES	0.46	Enterococcus	Exceeds WQS >10%of Samples	HIGH
Beach at Pago Bay	GUS-15	Pago Bay (CHALAN PAGO)	GU	COASTAL WATERS M-2	0.96	MILES	0.96	Enterococcus	Exceeds WQS >10%of Samples	HIGH
Santos Memorial Park	GUN-16	Beach at Piti Bay (PITI)	GU	COASTAL WATERS M-2	0.46	MILES	0.46	Enterococcus	Exceeds WQS >10%of Samples	HIGH
Piti Bay	GUN-15	Beach at Piti Bay (PITI)	GU	COASTAL WATERS M-2	0.62	MILES	0.62	Enterococcus	Exceeds WQS >10%of Samples	HIGH
Togcha Bay	GUS-13	Beach North of Togcha River (IPAN)	GU	COASTAL WATERS M-2	0.27	MILES	0.27	Enterococcus	Exceeds WQS >10%of Samples	HIGH
Ipan Point Beach	GUS-18	First Beach (IPAN)	GU	COASTAL WATERS M-2	0.06	MILES	0.06	Enterococcus	Exceeds WQS >10%of Samples	HIGH

Table 23. 2010 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
Talofofo Bay	GUS-11	Head of Talofofo Bay (TALOFOFO)	GU	COASTAL WATERS M-2	0.21	MILES	0.21	Enterococcus	Exceeds WQS >10%of Samples	HIGH
Umatac Bay	GUS-06	Head of Umatac Bay (UMATAC)	GU	COASTAL WATERS M-2	0.14	MILES	0.14	Enterococcus	Exceeds WQS >10%of Samples	HIGH
Inarajan Pool	GUS-09	Inarajan Pools (INARAJAN)	GU	COASTAL WATERS M-2	0.07	MILES	0.07	Enterococcus	Exceeds WQS >10%of Samples	HIGH
Merizo Pier -Mamaon Channel	GUS-08	Merizo Public Pier Park (MERIZO)	GU	COASTAL WATERS M-2	0.46	MILES	0.46	Enterococcus	Exceeds WQS >10%of Samples	HIGH
Nimitz Beach	GUS-05	Nimitz Beach (AGAT)	GU	COASTAL WATERS M-2	0.49	MILES	0.49	Enterococcus	Exceeds WQS >10%of Samples	HIGH
Outhouse Beach	GUN-18	Outhouse Beach (CABRAS)	GU	COASTAL WATERS M-2	0.46	MILES	0.46	Enterococcus	Exceeds WQS >10%of Samples	HIGH
Port Authority Beach	GUN-20	Port Authority Beach (PITI)	GU	COASTAL WATERS M-2	0.46	MILES	0.46	Enterococcus	Exceeds WQS >10%of Samples	HIGH
Tagachang Beach	GUS-14	Tagachang Beach Park (YONA)	GU	COASTAL WATERS M-2	0.07	MILES	0.07	Enterococcus	Exceeds WQS >10%of Samples	HIGH
Toguan Bay	GUS-07	Toguan Bay (UMATAC)	GU	COASTAL WATERS M-2	0.46	MILES	0.46	Enterococcus	Exceeds WQS >10%of Samples	HIGH

Table 23. 2010 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
Togcha Beach -Southern Christian Academy	GUS-17	Togcha Beach aka Agat Beach (AGAT)	GU	COASTAL WATERS M-2	0.31	MILES	0.31	Enterococcus	Exceeds WQS >10%of Samples	HIGH
Togcha Beach -Namo Bay	GUS-02	Togcha Beach aka Agat Beach (AGAT)	GU	COASTAL WATERS M-2	0.33	MILES	0.33	Enterococcus	Exceeds WQS >10%of Samples	HIGH
Togcha Beach -Agat Bay	GUS-03	Togcha Beach aka Agat Beach (AGAT)	GU	COASTAL WATERS M-2	0.15	MILES	0.15	Enterococcus	Exceeds WQS >10%of Samples	HIGH
United Seamen's Service	GUN-17	United Seamen's Service Beach (USO Beach, PITI)	GU	COASTAL WATERS M-2	0.52	MILES	0.52	Enterococcus	Exceeds WQS >10%of Samples	HIGH
Beach West of Adelup	GUN-22	West of Adelup Point, Asan Bay (ASAN)	GU	COASTAL WATERS M-2	0.41	MILES	0.41	Enterococcus	Exceeds WQS >10%of Samples	HIGH
Ipan Beach	GUS-12	Ypan Beach Park Beach (Ipan Public Beach)	GU	COASTAL WATERS M-2	0.30	MILES	0.30	Enterococcus	Exceeds WQS >10%of Samples	HIGH
Family Beach	GUN-19	Family Beach (CABRAS)	GU	COASTAL WATERS M-2	0.15	MILES	0.15	Enterococcus	Exceeds WQS >10%of Samples	HIGH
Gabgab Beach	GU-GB43	Gabgab Beach (NAVAL STATION)	GU	COASTAL WATERS M-2	0.65	MILES	0.65	PCBS in fish tissue	Fish Advisory (1999)	LOW
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

Table 23. 2010 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 2	GUAGRA-2-1A	WATERSHED: Hagatna	GU	RIVER S2	0.67	MILES	0.67	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
Tipalao Bay	GUG-010A	WATERSHED: Agat	GU	MARINE BAY M2	0.10	SQUARE MILES	0.10	PCBs in fish tissue	Fish Advisory (1999)	LOW
Apra Harbor 2	GUG-008A-2	WATERSHED: Apra	GU	MARINE BAY M2	4.61	SQUARE MILES	4.61	PCBs in fish tissue	Fish Advisory (1999)	LOW
Apra Harbor 1	GUG-008A-1	WATERSHED: Apra	GU	MARINE BAY M1	0.05	SQUARE MILES	0.05	PCBs in fish tissue	Fish Advisory (1999)	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
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
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

Table 23. 2010 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
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
Agana Swamp	GUG-1B	WATERSHED: Hagatna	GU	WETLAND	6.40	ACRES	6.40	PCBs in fish tissue	Fish Advisory (2001)	LOW
Landfill Leachate Stream	GUPGRL-0	WATERSHED: Pago	GU	RIVER -S1	0.05	MILES	0.05	E. coli, Nitrate, Dissolved Oxygen	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 23. 2010 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

- 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 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 eighteen 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 A Comparison of Guam's 2010 and 2008 305(b) and 303(d) Lists

The formats of Guam's 2010 IR assessment tables, Tables 20, 21, 22, 24 and 303(d) list of impaired waters, Table 23, were modified slightly to examine the waterbody size as compared to how much of it was assessed during the reporting period. More waterbodies were included in the assessment base overall.

The underlying factor in developing the IR is to align Guam's data with information required in EPA's Assessment Data Base. Guam EPA continues to work toward establishing a compatible electronic reporting system to assist in meeting IR deadlines.

Data from five monitoring projects were used during this reporting period compared to data from primarily the Recreational Beach Monitoring Program for the 2008 period.

6.1.1 Rivers/Streams

2010 Total Assessment Units	From 2008 vs. New Units		2010 303(d) Listed = 8
132	97	35	6 carried over from 2008
			2 * newly listed units in 2010
[These units represent 201			
Guam rivers and tributaries.]			Agana River 1 & Agana River 2*
			Landfill Leachate Stream
			Lonfit River 2 & Lonfit River 3
			Pago River 1 & Pago River 2
			Storm Drain*

There are two additional river assessment units listed for 2010:

1. GUAGRD (Storm Drain). The pollutants are E. coli, dissolved oxygen, nitrates, total suspended solids, turbidity, and salinity;
2. GUAGRA-2-1A (Agana River 2). The pollutants are PCBs in fish tissue

The impaired waterbodies carried forward from the 2008 reporting period include:

- *Lonfit River*
  There are two Lonfit River assessment units **(GUPGRL-2 and GUPGRP-1-51B)** associated with the specific leachate pollutants listed in Table 23, page 37f (6). The sizes of these waters are 1.07 and 3.79 miles, respectively.
- *Pago River*
  Pago River assessment units **GUPGRP-2** and **GUPGRP-1-51A** are impaired for bacteria, specifically E. coli. A second pollutant, dissolved oxygen, was recorded at levels exceeding GWQS at river assessment unit ID: GUPGRP-2.
- *Landfill Leachate Stream*
  The 1996-1997 narrative discussing the impairments in what was known as the PAGO RIVER COMPLEX cites that the nitrate, dissolved oxygen and E. coli violations occurred at an upstream monitoring site, assessment unit ID: **GUPGRL-0**, on the Lonfit River. This assessment unit is 0.05 river miles in size.

6.1.2 Wetlands

- *Agana Swamp*
  Assessment unit ID: **GUG-1B** is forwarded from the Guam 2008 303(d) List of impaired waters to the 2010 303(d) List. The pollutant is PCBs in fish tissue.

6.1.3 Marine Bays (and Harbors)

The impaired bay(s)/harbor waterbodies on the 2008 303(d) List (and carried forward to the 2010 List) are Agat Bay, and Apra Harbor, Cocos Lagoon, Pago Bay, and Tumon Bay. Four additional bays have been added to the 2010 List: Tipalao Bay, North and South Orote Peninsula Sea Cliffs bays, and the bay at Tanguisson Beach. There are Human Health Risk Advisories associated with these waterbodies as listed in Table 23. The increase in the population of assessed marine bays from eighteen to sixty-six corresponds to the increase in 2010 assessment stations for Guam's marine waterbodies.

TABLE 24. 2010 WETLANDS ASSESSMENT DATA

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

- *Agat Bay 1*
  A portion of Agat Bay waters remain impaired (Agat Bay 1) as previously listed in 2008. The size of the entire bay is 2.54 square miles but only 0.63 square miles are impaired and subject to the pollutants (PCBs in fish tissue, chlordane in fish tissue and dioxins in fish tissue) based on Guam EPA's 2010 assessment.
- *Apra Harbor 1 & 2*
  The 2010 assessment of Apra Harbor waters identified three separate areas of the bay based on water classification. Apra Harbor 2 (4.61 square miles) and Apra Harbor 1 (0.05 square miles) remain impaired (pollutant: PCBs in fish tissue) as previously listed in 2008. The size of the entire bay is 5.08 square miles.
- *Tumon Bay*
  The size of this bay is corrected from 0.96 to 1.98 square miles. The 2008 list of pollutants remains the same for the 2010 reporting period.

- *Pago Bay*
  The size of Pago Bay is corrected from 0.73 to 0.70 square miles. The 2010 list of pollutants remains the same for the 2010 reporting period.
- *Cocos Lagoon 1 & 2*
  This marine waterbody was added to the Guam 2008 303(d) List. Two monitoring stations represent the two marine water classifications delineated in the Lagoon and are carried forward to the 2010 List. The size of the bay is corrected from 5.24 square miles to 6.04 square miles. The pollutant is PCBs in fish tissue.

Total Marine Waterbodies	**From 2008 vs. New Waterbody**	**303(d) Listed = 11**
66	25 (18+7) 41	7 carried over from 2008
2008 List = 18 waterbodies	*Agat Bay +1	4 newly listed in 2010
	Apra Harbor +2	Tipaleo Bay
	Cocos Lagoon +1	Tanguisson Beach 2
	Taleyfac Bay +1	N. Orote Peninsula Sea Cliffs
	Umatac Bay +1; Tanguisson Beach +1	S. Orote Peninsula Sea Cliffs

* Multiples represent this 2008 waterbody in 2010 Table, i.e. Agat Bay 1 & 2; Apra Harbor 1, 2 & 3.

6.1.4 Coastal/Recreational Waterbodies

- 42 coastal/recreational assessment units were categorized as *impaired* for 2008; 26 coastal/recreational assessment units were categorized as impaired for 2010. The decrease in the number of impaired Category 5 waterbodies was due to an approved bacteria TMDL for 17 northern watershed beaches.
- The pollutant for these waterbodies is specifically identified in **Table 23** as *Enterococcus,* except for Gabgab Beach where the pollutant is PCBs in fish tissue;
- The sizes of all coastal assessment units can be found in **Table 21** for the current reporting period.

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.

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.
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.

FENA RESERVOIR, GUAM

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 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 Planning and Review 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

As previously mentioned in this report, no monitoring efforts were undertaken during this reporting period. The Agency's 2006 Comprehensive Monitoring Strategy includes a ***Wetlands Monitoring Program***, which is discussed under the Monitoring Program narrative, section **III.A.3.4.** The Agency's stream/river monitoring program is likely to include an initial wetland monitoring strategy which may serve as a basis for establishing wetland water quality standards. 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 at this time.

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. Beneficial uses and narrative/numeric criteria for wetlands are issues Guam EPA would like to research and develop in the next triennial review of GWQS.

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. One of two assessments, the Ugum Watershed Resource Assessment (DeMeo, et al. 1995), examined water quality as affected by erosion. According to the assessment, the major sources of erosion are: (1) sheet and rill (2) road-surface, and (3) stream channel. Slope road erosion exhibits the highest rates within the watershed at 27 times the rate of soil loss from ravine forest areas. From 1975 to 1993 aerial photos document that the length of unimproved roads doubled in this watershed alone from 33.6 to 68.8 kilometers respectively. The Ugum Watershed is a high priority watershed with ongoing restoration efforts as guided by GWA non-point source and watershed management initiatives of the Guam Watershed Planning Committee. The Ugum Watershed is a critical source which can produce nearly 2 mgd of drinking water for several southern villages. There are no ongoing data collection efforts to compile and track the types and extent of stressors or sources of impairment other than those mentioned above.

5.0 Extent of Wetland Resources

As introduced in the opening chapter of this report, 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. The Bureau of Statistics and Plans developed a compilation map of the NWI and all of the official wetland delineation maps produced in the late 1980s to the mid 1990s. The Agency does maintain a comprehensive set (copies) of delineation maps produced since 1990.

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 non-point 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 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 the 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.

E. Trend Analysis For Surface Water

Trend analysis for surface water is not available for this report period.

F. Public Health and Aquatic Life Concerns

1.0 <u>Drinking Water Supplies</u>

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 2008[14]

In 2008, the Navy water system did not satisfy all monitoring and reporting requirements as set by the National Primary Drinking Water Regulations. The U.S. Navy is required to monitor system drinking water for specific contaminants on a regular basis. Results of regular monitoring are an indicator of whether or not system drinking water meets health standards. Turbidity is a measure of the cloudiness of water and is used to indicate water quality and filtration effectiveness. It is a requirement to monitor the turbidity levels of the water at the NWTP water filters every 15 minutes. During November 2007 to January

[14] 2008 U.S. Navy Water System Water Quality Report

2008, the Navy did not complete all continuous monitoring for turbidity, and therefore cannot be sure of the quality of system drinking water during that time. On January 16, 2008, the Navy discovered that the turbidity meter that monitors water at NWTP filter # 5 did not function properly and was defective since November 2007. The Navy repaired the meter on January 16, 2008. Guam EPA requires the timely submittal of laboratory results to their agency for their review. This is to ensure that the water the Navy produces meets regulatory standards and is safe for consumption. The Navy ships some of the water samples it takes to an off-island laboratory, and unfortunately, some results are delayed because of this process. In 2008, the Navy did not submit some monitoring results on or before their respective regulatory deadlines due to delays with the off-island laboratory providing results. However, none of the delayed laboratory results yielded any exceedances of MCLs.

Water Quality Report – January to December 2009[15]
In 2009 the Navy Water System met all primary drinking water standards except for the treatment technique standard for turbidity. The Guam Primary Safe Drinking Water Regulations set the maximum turbidity of the treatment plant's combined filtered water at one (1) Nephelometric Turbidity Units (NTU). On April 6, 2009, one filter failed to operate properly and allowed partially filtered water to pass through and raised the combined filtered water turbidity to 1.5 NTU. The treatment plant operators immediately shut down the defective filter, and within 30 minutes, filtered water turbidity fell below 1 NTU.

Turbidity is a measure of the cloudiness of water and is used to indicate water quality and filtration effectiveness. Turbidity has no health effects. However, turbidity can interfere with disinfection process and provide a medium for microbial growth. Turbidity may indicate the presence of disease causing organisms. These organisms include bacteria, viruses, and parasites that can cause symptoms such as nausea, cramps, diarrhea, and associated headaches.

In the first quarter of 2009, the Navy was late in submitting some of its results and did not complete all the monitoring requirements at one well before it went off line. Therefore it cannot be sure of the quality of its drinking water at that time.

Monitoring of Navy system source water as required by Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR) indicated the presence of Cryptosporidium in 1 out of 24 sampling events. Based on the initial monitoring, no additional treatment will be required at the Navy Water Treatment Plant.

Cryptosporidium is a microbial pathogen found in surface water throughout the U.S. Although filtration removes Cryptosporidium, the most commonly-used filtration system methods cannot guarantee 100% removal. Current test methods do not allow the Navy to determine if the organisms are dead or if they are capable of causing disease. Symptoms of infection include nausea, diarrhea, and abdominal cramps. Most healthy individuals

[15] 2009 U.S. Navy Water System Water Quality Report

can overcome the disease within a few weeks. However, immuno-compromised people, infants and small children, and the elderly are at greater risk of developing life-threatening illness. The Navy encourages immuno-compromised individuals to consult their doctor regarding appropriate precautions to take to avoid infection. Cryptosporidium must be ingested to cause disease, and it may spread through means other than drinking water.

1.2 Air Force Water System[16]

Andersen AFB provides drinking water to all base housing and facilities from the Northern Guam Lens aquifer which is a groundwater source underlying the northern portion of Guam. This northern lens was designated a principle sole-source aquifer by the USEPA in 1978, under the provisions of the SDWA.

In the event of contamination of the groundwater aquifer or water system, base demand may be partially met by water sharing agreements with US Navy and Guam Water Authority, on-base treatment of local surface waters, bottled water supply, water trucks, and rationing.

Drinking water drawn from groundwater sources such as ours is inherently better quality than that drawn from surface water sources. This is because the ground acts as a natural filter to remove particulates and contaminants. All of AAFB drinking water is treated with chlorine and fluoride to ensure the health of every consumer. Chlorine acts as a disinfectant to reduce bacterial contamination. Fluoride is added at sufficient levels as recommended by the American Dental Association to prevent dental caries (cavities). It is maintained at levels low enough to prevent dental and skeletal fluorosis, especially in children.

Andersen AFB's drinking water is managed by two base agencies. Civil Engineering (36 CES/CEOIU) manages the maintenance and operations of the drinking water supply and distribution system. Bioenvironmental Engineering (36 MDOS/SGOAB) monitors the quality of the drinking water provided to consumers and addresses any related health concerns. At Andersen AFB, Bioenvironmental Engineering monitors the contaminant groups using EPA-certified laboratories and approved methods.

Andersen AFB is in compliance with all federal, Department of Defense and Guam drinking water regulations. To ensure AAFB drinking water is of the highest quality, Bioenvironmental Engineering collected many samples and had them analyzed for various contaminants. The contaminants presented in the AAFB Consumer Confidence Report were monitored from January to December during 2009. If a substance was not required to be sampled during 2009, the results of earlier testing are provided. A copy of the CCR is available from the Andersen Air Force Base web page.

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[16] Consumer Confidence Report January 1, 2009 - December 31, 2009, Andersen Air Force Base, Guam

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 supplied from the Fena Reservoir (purchased from the Navy). Fena water supplies goes to the villages of Asan, Piti, Anigua, Agat, Santa Rita and some areas of Barrigada and Mongmong-Toto-Maite.

1.3.1 GWA Water System Quality Reports[17]

Water quality data for January 1 to December 31, 2008 and 2009 are provided in the following pages.

1.3.2 Ugum River and Ugum Water Treatment Plant

"Water quality in the Ugum River has declined in recent years as a result of human activities that have increased erosion and the resultant sedimentation in the streams and near shore waters. Off-road recreational vehicles, intentionally-set fires, and agricultural activities are the primary causes of the increased erosion and sedimentation. The increased sedimentation is considered especially significant in the Ugum watershed because the Ugum Water Treatment Plant is a primary source of drinking water in southern Guam. During the past several years the Treatment Plant has had to periodically shut down when suspended sediment at the intake reaches excessive levels. The treatment plant has been secured fifty two (52) times during the period of January 1 to December 31, 2004, lasting from two hours to twenty four hours duration at any given time. *The highest turbidity level at the intake (river) during the same period is 270 NTU and the average is 72 NTU. Also, during the following year, January 1 to December 2005, the treatment plant was secured thirty five (35) times due to high turbidity at the intake. The highest turbidity level during the same period is 3,018 NTU and the average is 516 NTU.* The increased sedimentation also contributes to poor quality in-stream aquatic habitats, a smothering of the coral reefs, and a decline in fish populations."[18]

Improvement in water quality to the Ugum River and to the Ugum Water Treatment Plant should occur with the implementation of the following activities:

- *Implementation of the Ugum River TMDL*
  Ugum River was delisted from Guam's 2006 303(d) list of waters that do not meet GWQS because a required Sediment TMDL was approved by EPA in 2006. The

[17] 2008 and 2009 GWA Water Quality Reports
[18] TMDL document for Ugum Watershed, Tetra Tech,Inc. and USEPA for Guam EPA (Aug. 2006)

2008 WATER QUALITY DATA

PRIMARY STANDARDS: Mandatory Health-Related Standards

CONTAMINANT (units)	MCLG	MCL	GROUND WATER		UGUM WATER		FENA WATER		Major Sources of Contaminant
			Range	RV	Range	RV	Range	RV	
Regulated VOCs									
Carbon Tetrachloride (ppb)	0	5	nd	nd	nd	nd	nd	nd	Discharge from industrial activities
Tetrachloroethylene (PCE) (ppb)	0	5	nd - 1.5	1.5	nd	nd	nd	nd	Leaching from PVC pipes, discharge from dry cleaners
Trichloroethylene (TCE) (ppb)	0	5	nd - 1.4	1.4	nd	nd	nd	nd	Discharge from metal degreasing sites
Regulated SOCs									
Chlordane (ppb)	0	2	nd - 3.3	1.06	nd	nd	nd	nd	Banned termiticide residue
Endrin (ppb)	0	2	nd - 0.04	0.04	nd	nd	nd	nd	Banned insecticide residue
Picloram (ppt)	0	500	nd - 0.14	nd	nd	nd	nd	nd	Herbicide runoff
Regulated IOCs									
Antimony (ppb)[1]	6	6	nd - 1.8	2	nd	nd	nd	nd	Occurs naturally
Barium (ppb)[1]	2000	2000	nd - 13	13	nd - 2.2	2.2	nd - 6.2	6.2	Occurs naturally
Chromium (ppb)[1]	100	100	nd - 17	17	nd	nd	nd	nd	Erosion of natural deposits
Fluoride (ppm)[1]	4	4	nd - 0.82	0.82	nd - 0.05	0.1	nd - 0.74	0.74	Water additive; naturally occuring which promotes strong teeth
Nitrate-N (ppm)	10	10	nd - 4.5	4.50	nd	nd	nd	nd	Runoff from fertilizer use; leaching from sewage
Radionuclides[1]									
Radium 228 (pCi/l)	0	5	<0.5 - 5.6	2.10	nd	nd	nd - 5	n/a	Erosion of natural deposits
Gross Alpha Activity (pCi/l)	0	15	nd - 7.3	n/a	nd	nd	nd - 5	n/a	Erosion of natural deposits
Gross Beta Activity (pCi/l)	0	50*	nd - 10	n/a	nd	nd	nd - 4.5	n/a	Decay of natural and man-made deposits

* The MCL for beta particles is 4 mrem/year. However, EPA considers 50 pCi/l to be the level of concern for beta particles.

Microbial Contaminants[2]

CONTAMINANT (units)	MCLG	MCL	NORTHERN		CENTRAL		SOUTHERN		Major Sources of Contaminant
			Violation	RV	Violation	RV	Violation	RV	
Total Coliform (TC) (% positive/month)	0	5%	No	0.1%	No	0%	No	0.3%	Naturally present in environment
Fecal coliform (FC) or *E. coli*	0	See Note 1	No	0	No	0	No	0	Human and animal fecal waste

Note 1: MCL = a routine sample and a repeat sample are TC positive, and one is also FC or *E. coli* positive

Disinfection Byproducts and Disinfection Residuals[2]

CONTAMINANT (units)	MCLG	MCL	NORTHERN		CENTRAL		SOUTHERN		Major Sources of Contaminant
			Violation	RV	Violation	RV	Violation	RV	
HAA5 (Five Haloacetic Acids) (ppb)[2]	n/a	60	nd - 60	22.1	nd - 84	62.5	14 - 95	53.3	By-product of drinking water chlorination
Total Trihalomethanes (ppb)[2]	n/a	80	nd - 112	74.4	5.5 - 110	87.3	24 - 86	61	By-product of drinking water chlorination
Chlorine (ppm)[2]	MRDLG 4	MRDL 4	nd - 3.5	1.4	0.3 - 3.0	1.6	0.5 - 3.0	1.2	Water additive to control microbes

Turbidity as Indicator of Filtration Performance

CONTAMINANT (units)	MCLG	MCL	UGUM WATER		FENA WATER		Major Sources of Contaminant
			RV	Violation	RV	Violation	
Turbidity (ntu)	n/a	TT See Note 2	99.60%	No	100.00%	No	Soil runoff

Note 2: TT = 95 % of samples measured every 4 hours < 0.3 ntu

Unregulated Contaminants (Monitoring Required)**

CONTAMINANT (units)	MCLG	MCL	GROUND WATER		UGUM WATER		FENA WATER	
			Range	RV	Range	RV	Range	RV
Unregulated VOCs								
Bromodichloromethane (ppb)	ns	ns	nd - 2.6	2.6	7.1 - 11	11	7.4 - 17	17
Bromoform (ppb)	ns	ns	nd - 15	15	nd - 0.5	0.5	nd	nd
Chlorodibromomethane (ppb)	ns	ns	nd - 11	11.0	0.9 - 4.3	4.3	2.3 - 2.6	2.6
Chloroform (ppb)	ns	ns	nd - 2.0	2	13 - 37	37	12 - 56	56
Unregulated SOCs								
Dieldrin (ppb)	ns	ns	nd - 0.04	0.04	nd	nd	nd	nd
Unregulated IOCs								
Sulfate (ppm)[1]	ns	250	5.5 - 81	81	nd - 29	29	nd - 26	26

** Unregulated contaminant monitoring helps EPA to determine where certain contaminants occur and whether there is a need to regulate those contaminants.

Secondary Maximum Contaminant Levels - Consumer Acceptance Limits***

CONTAMINANT (units)	MCLG	MCL	GROUND WATER	UGUM WATER	FENA WATER
			Range	Range	Range
Chloride (ppm)	n/a	250	14 - 762	9 - 29	20 - 31
Conductivity (mmho/cm)	n/a	1600	346 - 2664	120 - 155	195 - 257
pH (units)	n/a	6.5 - 8.5	7.18 - 7.59	7.09 - 7.49	6.97 - 7.49

*** Secondary MCL monitoring helps GWA to determine areas in need of adjustment, additional maintenance or rehabilitation in order to provide a high quality water that appeals to the consumer

Additional Constituents Analyzed

CONTAMINANT (units)	MCLG	MCL	GROUND WATER	UGUM WATER	FENA WATER
			Range	Range	Range
Alkalinity as $CaCO_3$ (ppm)	n/a	n/a	117 - 335	20 - 66	42 - 115
Sodium (ppm)	n/a	n/a	8.1 - 270	nd - 8.1	nd - 27
Hardness as $CaCO_3$ (ppm)	n/a	n/a	164 - 534	52 - 62	100 - 120

About the Data:

1. Data presented in these tables list the results of tests done between Jan 1 – Dec 31, 2008. Tables list only the contaminants detected. Detection does not necessarily mean a violation or exceedence of an MCL or Treatment Technique. GWA monitors for some constituents less than once per year because they are not expected to vary significantly from year to year. Therefore, some of the water quality data reported, although representative, may be more than one year old. If you have questions about this water quality report, please contact Carmen M. Sian-Denton, GWA's Monitoring Laboratory Services Administrator at 632-9697 or 637-2895.

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2009 WATER QUALITY DATA

PRIMARY STANDARDS: Mandatory Health-Related Standards

CONTAMINANT (units)	MCLG	MCL	GROUND WATER		UGUM WATER		FENA WATER		Major Sources of Contaminant
			Range	RV	Range	RV	Range	RV	
Regulated VOCs									
Tetrachloroethylene (PCE) (ppb)	0	5	nd - 1.3	1.3	nd	nd	nd	nd	Leaching from PVC pipes, discharge from dry cleaners
Trichloroethylene (TCE) (ppb)	0	5	nd - 3.0	3	nd	nd	nd	nd	Discharge from metal degreasing sites
Regulated SOCs									
Chlordane (ppb)	0	2	nd - 1.2	1.2	nd	nd	nd	nd	Banned termiticide residue
Hexachlorocyclopentadiene (ppb)	50	50	nd	nd	nd	nd	nd - 0.055	0.055	Discharge from chemical factories
Regulated IOCs									
Arsenic (ppb)[1]	0	10	nd - 1.4	1.4	nd	nd	nd - 1.2	1.2	Erosion of natural deposits
Barium (ppb)[1]	2000	2000	nd - 7.3	7.3	nd - 3.5	3.5	nd - 12	12.0	Erosion of natural deposits
Chromium (ppb)[1]	100	100	nd - 27	27	nd	nd	nd - 2.32	2.3	Erosion of natural deposits
Fluoride (ppm)[1]	4	4	nd - 0.16	0.16	nd	nd	0.65 - 0.74	0.74	Water additive; naturally occuring which promotes strong teeth
Nitrate-N (ppm)	10	10	nd - 4.8	4.80	nd	nd	0.08 - 2.20	2.20	Runoff from fertilizer use; leaching from sewage
Selenium (ppb)[1]	50	50	nd - 5.7	5.70	nd	nd	nd	nd	Erosion of natural deposits
Radionuclides[1]									
Radium 228 (pCi/l)	0	5	nd	nd	nd	n/a	0.24 - 2.01	2.01	Erosion of natural deposits
Gross Alpha Activity (pCi/l)	0	15	3.2 - 11	11.0	nd	n/a	nd - 8.3	8.30	Erosion of natural deposits
Gross Beta Activity (pCi/l)	0	50*	3.2 - 6.5	6.5	nd	n/a	nd	n/a	Decay of natural and man-made deposits

* The MCL for beta particles is 4 mrem/year. However, EPA considers 50 pCi/l to be the level of concern for beta particles.

Microbial Contaminants[2]

CONTAMINANT (units)	MCLG	MCL	NORTHERN		CENTRAL		SOUTHERN		Major Sources of Contaminant
			Violation	RV	Violation	RV	Violation	RV	
Total Coliform (TC) (% positive/month)	0	5 %	No	0.9%	No	0%	No	0.3%	Naturally present in environment
Fecal coliform (FC) or *E. coli*	0	See Note 1	Yes Note 2	1	No	0	No	0	Human and animal fecal waste

Note 1: MCL = a routine sample and a repeat sample are TC positive, and one is also FC or *E. coli* positive

Note 2: Fecal coliform violation was localized to Agana Heights. It was not system wide.

Disinfection Byproducts and Disinfection Residuals[2]

CONTAMINANT (units)	MCLG	MCL	NORTHERN		CENTRAL		SOUTHERN		Major Sources of Contaminant
			Violation	RV	Violation	RV	Violation	RV	
HAA5 (Five Haloacetic Acids) (ppb)[2]	n/a	60	No	14.1	Yes	73	No	55.3	By-product of drinking water chlorination
Total Trihalomethanes (ppb)[2]	n/a	80	No	46.4	Yes	120	No	55.3	By-product of drinking water chlorination
	MRDLG	MRDL							
Chlorine (ppm)[2]	4	4	0.8 - 1.7	1.7	0.7 - 2.0	2.0	1.5 - 2.0	2.0	Water additive to control microbes

Turbidity as Indicator of Filtration Performance

CONTAMINANT (units)	MCLG	MCL	UGUM WATER		FENA WATER		Major Sources of Contaminant
			RV	Violation	RV	Violation	
Turbidity (ntu)	n/a	TT See Note 2	99.8%	No	99.0%	No	Soil runoff

Note 2: TT = 95 % of samples measured every 4 hours < 0.3 ntu

Unregulated Contaminants (Monitoring Required)**

CONTAMINANT (units)	MCLG	MCL	GROUND WATER		UGUM WATER		FENA WATER	
			Range	RV	Range	RV	Range	RV
Unregulated VOCs								
Bromodichloromethane (ppb)	ns	ns	nd - 1.8	1.8	7.1 - 11	11	7.4 - 17	17
Bromoform (ppb)	ns	ns	nd - 3.0	3	nd - 0.5	0.5	nd	nd
Chlorodibromomethane (ppb)	ns	ns	nd - 2.9	2.9	0.9 - 4.3	4.3	2.3 - 2.6	2.6
Chloroform (ppb)	ns	ns	nd - 1.5	1.5	13 - 37	37	12 - 56	56
Unregulated SOCs								
Dieldrin (ppb)	ns	ns	nd - 0.32	0.32	nd	nd	nd	nd
Unregulated IOCs								
Sulfate (ppm)[1]	ns	250	3.3 - 89	89	nd - 13	13	nd - 26	26

** Unregulated contaminant monitoring helps EPA to determine where certain contaminants occur and whether there is a need to regulate those contaminants.

Secondary Maximum Contaminant Levels - Consumer Acceptance Limits***

CONTAMINANT (units)	MCLG	MCL	GROUND WATER	UGUM WATER	FENA WATER
			Range	Range	Range
Chloride (ppm)	n/a	250	17 - 826	14 - 31	16 - 37
Copper (ppb)	n/a	1000	2.0 - 150	32	nd - 12
Conductivity (umho/cm)	n/a	1600	281 - 3240	106 - 138	215 - 234
pH (units)	n/a	6.5 - 8.5	7.07 - 8.12	6.4 - 7.14	7.3 - 7.55

*** Secondary MCL monitoring helps GWA to determine areas in need of adjustment, additional maintenance or rehabilitation in order to provide a high quality water that appeals to the consumer.

Additional Constituents Analyzed

CONTAMINANT (units)	MCLG	MCL	GROUND WATER	UGUM WATER	FENA WATER
			Range	Range	Range
Alkalinity as $CaCO_3$ (ppm)	n/a	n/a	142 - 340	30 - 47	87 - 95
Sodium (ppm)	n/a	n/a	2.5 - 380	nd - 9.9	nd - 7.9
Hardness as $CaCO_3$ (ppm)	n/a	n/a	172 - 640	60 - 70	102 - 150

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implementation of this plan should bring the Ugum River into compliance with or prevent a violation of GWQS.

- *Ugum Water Treatment Plant (UWTP) Rehabilitation*

In compliance with the GWA Stipulated Order for Preliminary Relief, GWA is required to undertake this project. This $8.5M project is designed to renovate the Ugum Treatment plant to add capacity and improve the reliability of the treatment process during the rainy season. The refurbishment will include the conversion of existing conventional surface water plant to a micro-filtration system; replacement of electrical control systems; replacement of finished water pumps; installation of SCADA equipment; and the refurbishment of the backwash waste handling system. A design build project was awarded, the design work progressed, and construction was completed in February 2009.

- *Watershed Restoration Project*

Tree planting projects in the Ugum watershed have been implemented under the leadership of local and federal agencies and supported by community groups. These projects have resulted in reducing erosion and run off, the conversion of badlands and grasslands into a forest, and the restoration of watershed segments affected by fire. These projects have also promoted environmental awareness about the destructive effects of fires and the positive impact of reforestation on water quality, wildlife habitat, and coral reefs. More restorative work is expected under the coordination of the Watershed Planning Committee and other environmental education groups.

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. West Hagatna Bay was closed during the reporting period due to a sewage leak in the effluent pipe from the Hagatna Sewage Treatment Plant.

For fiscal year 2008, 42 Tier 1 beaches were monitored for the U.S. EPA approved *enterococci* indicator, (weekly, year round). This resulted in approximately 2,184 samples analyzed and 762 swimming advisories issued.

In fiscal year 2009, the same 42 Tier 1 beaches were monitored for the U.S. EPA approved *enterococci* indicator (weekly, year round). This resulted in approximately 2,182 samples analyzed and 752 swimming advisories issued. **(Refer to Tables B7a-d and B8a-d, Appendix B).**

Swimming advisories are issued based upon either an instantaneous concentration of 104 MPN/100mL or a geometric mean concentration of 35 MPN/100mL, over a five week period. All 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.* **(http://node.guamepa.net/programs/emas/beach.html)**

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.

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. Newly created 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. (See page 11.)

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[19]

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.

Preliminary 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

[19] Fact Sheet No. 8, November 2009. Fish Tissue Sampling Results Update, Orote Landfill COMNAVMARIANAS, GUAM

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. Evaluation of the remaining chemical test results were in progress at the time the reference fact sheet was issued.

The Navy continues to work closely with regulators in evaluating 2009 fish sample results and the risks to the reef fish and the risks to fish-eating seabirds and humans from consumption of the fish. The updated risk assessment results will be compared to those of 2001 fish sampling study to decide whether any recommendation to changing the Seafood Consumption Advisory is appropriate.

Apra Harbor Fish Sampling[20]
Fish species from approximately 14 discrete sampling locations were collected from specific sites in both the inner and outer Apra Harbors on Guam. The whole body fish tissue was then subjected to chemical analysis to measure the concentration of a broad range of chemical contaminants of concern to Guam EPA. The general classification of contaminants sampled and analyzed for included pesticides, heavy metals, and a group of persistent organic pollutants - most notably the polychlorinated biphenyls or PCBs. Based upon the analytical results, human health risk estimates were then calculated based upon hypothetical consumption of those contaminated fish. The fish consumption rates (or amount of fish consumed per day) were based upon previous work that Guam EPA conducted to better understand the amounts and types of fish which are customarily consumed by village residents and subgroups living on Guam. The trends and risk estimates of the analysis thus far are extremely preliminary and subject to quality control confirmation. A map showing the advisory area is provided on the next page.

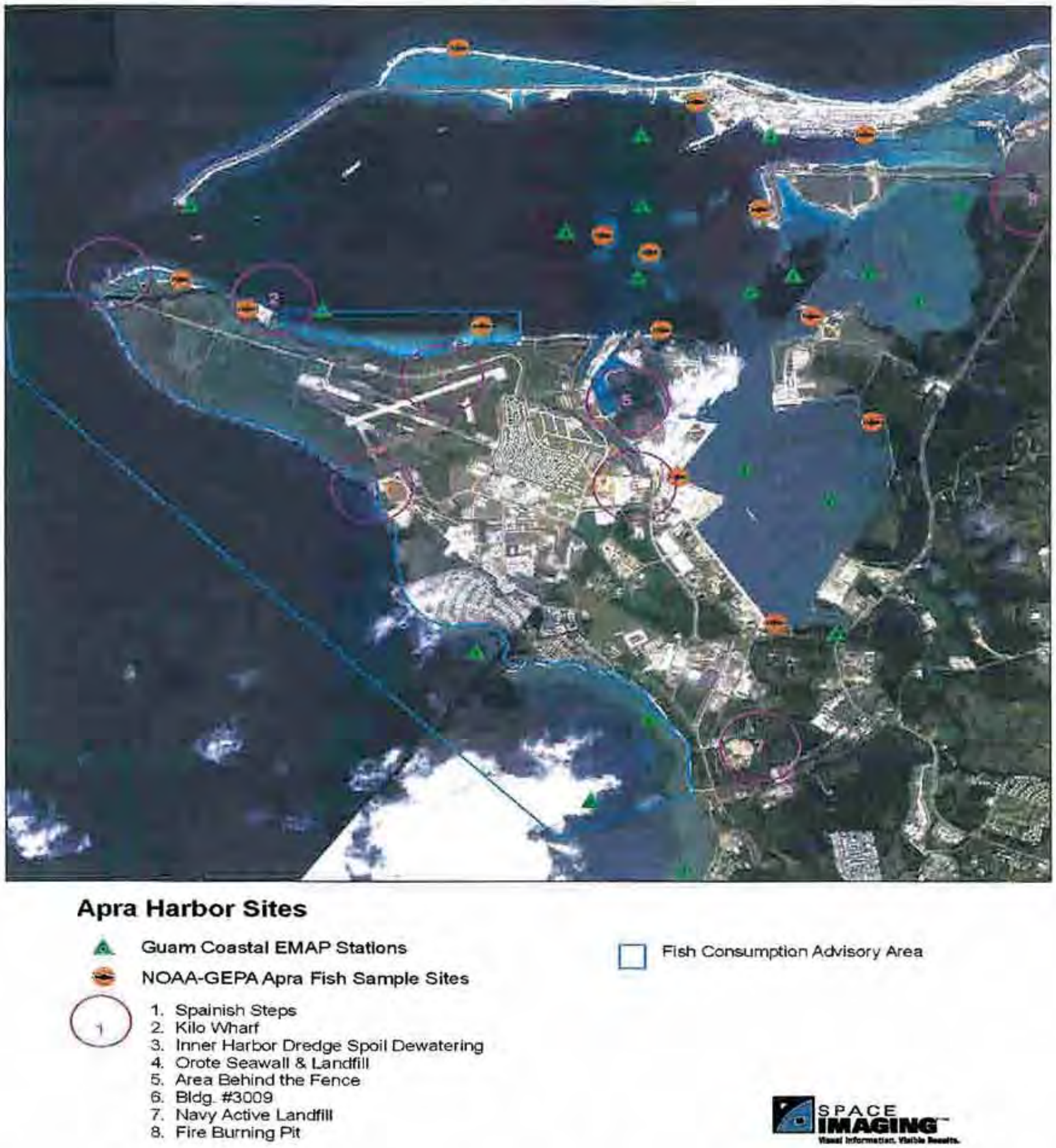
3.2.2 *Agana Swamp*
The Fish Advisory in effect for the Agana Swamp is related to polychlorinated biphenyl (PCB) contamination from the Agana Power Plant (former U.S. Navy facility). The US Navy conducted an investigation and cleanup of the Agana Power Plant located in Mongmong, Guam. This included the 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 shows that some of the fish in the swamp and river are now testing higher for PCBs

20 Information provided by Patrick Wilson, Ph.D., M.P.H., Senior Regional Toxicologist, USEPA R-9

than back in 2000. The Navy and local officials have different opinions about why that occurred. The Navy has requested the U.S. Army Corps of Engineers to consider the Agana Springs site as a formerly used defense site to address further investigation and cleanup of PCBs in soil and sediment.

Meanwhile, the Navy has suggestions in place regarding the consumption of catfish and eel from the Agana Swamp area. The recommendation is that people can eat one fish per



adult per month. No such recommendations exist for eating shrimp or snails or fruits and vegetables. Guam EPA DSMOA representatives note that there is a cancer risk because of the PCBs.

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.

An environmental site investigation was conducted at the former U.S. Coast Guard (USCG) Long Range Navigation (LORAN) station at Cocos Island, Guam.[21] 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 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

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[21] *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.

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.

IV. GROUND WATER MONITORING AND ASSESSMENT

A summary of Guam's ground water monitoring and protection programs, ground water quality, ground water contamination sources, and groundwater/surface water interactions is provided in this section.

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 sub-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

Table B9, Appendix B identifies the following ten contaminant sources as the greatest threat to Guam's ground water quality. "Professional judgment" was used to complete the respective table. Each source of groundwater contamination is associated with factors considered in its selection and a contaminant(s).

- **animal feedlots**
- **fertilizer applications`**
- **pesticide applications**
- **underground storage tanks**
- **landfills**
- **septic systems/cesspools**
- **hazardous waste generators**
- **fuel pipelines and sewer lines**
- **salt water intrusion**
- **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 <u>"Protecting and Restoring Guam's Waters" – *water resources protection and restoration, and pollution prevention approach*</u>

In September 1999 Guam EPA documented its overall approach for managing water 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 under ground 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".

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. **Table B10, Appendix B** summarizes the status of ground water protection programs in Guam. Related information is available at **<u>www.guamepa.net.</u>** 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.

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 required legislative and legal measures that should be developed to properly implement the program.

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 at **http://node.guamepa.net/regs/chapter46.html**.

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 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. This public law also provides matching funds for WERI to administer the joint WERI-USGS Comprehensive Water Monitoring Program (CWMP) on Guam (as mandated by PL 24-161 regarding data collection on salt water intrusion, water lens thickness in the northern part of Guam, stream flow data in the southern part of Guam and related matters).

Funding levels reported were:

	GHS	CWMP
Appropriations	$204,200	$173,948
2009	$192,307	$163,817

A copy of the status reports for both years can be found at www.weriguam.org.

http://www.weriguam.org/pdf/status-reports/ghs-guam-monitoring-fy2009-project-synopsis.pdf
http://www.weriguam.org/pdf/status-reports/ghs-guam-monitoring-fy2008-project-synopsis.pdf

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 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.

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 four hundred eighty-two (482) permitted wells. There are sixty-one (61) permittees with a general breakdown of ownership as follows:

1.	Andersen Air Force Base (USAF)	104
2.	Guam International Airport Authority (GovGuam)	28
3.	Department of Public Works (GovGuam)	48
4.	Agana Shopping Center	28
5.	Guam Memorial Hospital Authority (GovGuam)	13
6.	Guam Okura Hotel	20
7.	Atkins Kroll (Toyota)	10
8.	Hyatt Regency Hotel	52
9.	Westin Resort	18
10.	Other permittees (with <10 UIC systems)	161

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, in the last 10 years, 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.

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, there were sixty-one UIC well owners operating a total of 396 individual wells/systems located over the northern Guam lens.

Table 25. 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
MCLs are based on the most current Guam Water Quality Standards.

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 25**.

5.0 Ground Water Assessment Monitoring

An ambient ground water monitoring system has been established for Guam ground water under Guam EPA. Pump rates and chloride concentrations of all production wells are currently being monitored. Guam EPA proposes to establish a monitoring well network that would allow the Agency to monitor lateral and vertical salinity trends within the aquifer.

This assessment monitoring program is an annual evaluation of groundwater chemical, physical and yield characteristics to track trends within the Northern Aquifer – the principal potable water supply resource for the island. The program is a judgmental sampling design which incorporates a sampling frequency based on Guam's two index periods. The sampling frequency is one sample event per production well (Total of 110) per index period, resulting in a total of 220 samples per calendar year for each resource unit. Resource units are then rotated through a four year cycle.
The first index period on Guam is a dry season, which occurs from January through June. The island's wet season, July through December, makes up the second index period.

The goal of this program is specifically to provide the Guam EPA with baseline water quality data, to characterize and define trends in the, chemical, physical and yield conditions of the island's primary groundwater supply. It is also 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 this program are to:
1) Identify, document and predict the conditions of Guam's water resources; assist in determining the status of the aquifer's "environmental health".
2) Document potential problem areas;
3) Identify water quality changes over time in aquifer subbasin water bodies;
4) Provide information to managers, legislators, agencies and the public;
5) Determine the proportion of the state's water bodies that meet water quality criteria.

To meet its environmental goals and objectives, this program integrates a combination of chemical, physical, and yield indicators to monitor and assess site specific water quality conditions and aquifer long term water quality trends.

The general list of Indicators is listed below, with a complete list in **Table C5, Appendix C.**

- General water chemistry (chlorides, nitrates)
- Organic and Inorganic Constituents
- Physical Parameters (Water Level, Yields)

Another component of this plan is the Production Well chemical monitoring required as part of the Safe Drinking Water permits for a Public Water Supply System (PWSS). The schedule presented in **Table 26** is an example of Organic and Inorganic Monitoring.

Table 26. Groundwater Source & Water Distribution System: Organic & Inorganic Sampling Schedule

2011	GWA/Earth Tech Production Wells	GWA Water Distribution System
1st Quarter	A-1, A-2, A-3, A-4, A-5, A-6	Agana Heights Mayor's Office
2nd Quarter	D-2, D-3, D-4, D-5, D-6, D-7	GWA Laboratory, Dededo
3rd Quarter	F-2, F-3, F-4, F-5 F-6, F-7	Northern District Sewage Treatment Plant
4th Quarter	M-12, M-14, M-15, M-17a, M-17b, M-18	Mangilao Mayor's Office
2012	**GWA/Earth Tech Production Wells**	**GWA Water Distribution System**
1st Quarter	A-7, A-8 A-9, A-10, A-11, A-12	Sinajana Mayor's Office
2nd Quarter	D-8, D-9, D-10, D-11, D-12, D-13	Merizo Mayor's Office
3rd Quarter	F-8, F-9, F-10, F-11, F-12, F-13	Finegayan Elementary School
4th Quarter	M-20a, M-21, M-22, M-23, MJ-1, MJ-5	Inarajan Middle School
2013	**GWA/Earth Tech Production Wells**	**GWA Water Distribution System**
1st Quarter	A-13, A-14, A-15, A-17, A-18, A-19	Piti Mayor's Office
2nd Quarter	D-14, D-15, D-16, D-17, D-18, D-19	Umatac Mayor's Office
3rd Quarter	F-15, F-16, F-17, F-18, F-19, F-20	Tamuning Mayor's Office
4th Quarter	NAS-1, Y-1, Y-2, Y-3, Y-4, Y-5	Santa Rita Spring
2014	**GWA/Earth Tech Production Wells**	**GWA Water Distribution System**
1st Quarter	A-21, A-23, A-25, A-26, A-28, A-29	Barrigada Mayor's Office
2nd Quarter	D-20, D-21, D-22a, D-23a, D-24, D-25	Agueda Johnston Middle School
3rd Quarter	GH-501, H-1, HGC-2, M-1, M-2, M-3	Toto Mayor's Office
4th Quarter	Y-6, Y-7, Y-9, Y-10, Y-12, Y-14	Yigo Mayor's Office
2015	**GWA/Earth Tech Production Wells**	**GWA Water Distribution System**
1st Quarter	A-30, A-31, A-32, AG-1, AG-2a, D-1	Asan Mayor's Office
2nd Quarter	D-26, D-27, D-28, EX-5a, EX-11, F-1	Yona Mayor's Office
3rd Quarter	M-4, M-5, M-6, M-7, M-8, M-9	Talofofo Elementary School
4th Quarter	Y-15, Y-17, Y-18, Y-19, Y-20, Y-21a, Y-22	Upi Elementary School, Yigo

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Table 27. 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	2011	2012
	Potts Junction	12	Rte 9; 500 Feet West of Well HGC-3	2011	2013
	Marianas Terrace	36A	Gayinero Street, Yigo	2011	2014
	Airport road Extension	72A	Route 10A (South Side)	2011	2015
II	GHURA 502	20	Route 3 (Astumbo Gardens)	2012	2011
	Ypaopao Estates	42B	Behind PUAG Pump Station	2012	2013
	Hatsuho Golf Course	12E	Route 3 (Near Club House)	2012	2014
	Harmon Sinkhole	71	Route 10A (Near Hotel Mai'Ana)	2012	2015
III	Agana Hts. Injection Wells	79	F. Xavier Dr./Salamon Dr., Agana Hts	2013	2011
	Guam Community College	76A	Sesame Street, Mangilao	2013	2012
	GHURA 503	15	Route 3 (Fern Terrace)	2013	2014
	Guam Intl. Airport Terminal	72	Route 10A (Across Airport Parking Lot)	2013	2015
IV	Barrigada 76 Gas Station	74	Route 10 & Route 8 Intersection	2014	2011
	GHURA 35	48B	Near Northern Public Health Center	2014	2012
	Macheche Subdivision	55A	Macheche Avenue, Dededo	2014	2013
	GHURA 505	41	Atsadas Street, Yigo	2014	2015
V	Sinajana Baseball Field	79B	Chalan Guma' Yuus, Sinajana	2015	2011
	Latte Heights	56A	Gardenia Ave. & Carnation Ave.	2015	2012
	GHURA 506	38	Near Simon Sanchez High School	2015	2013
	Dededo Public Park	47A	Rte. 1 & Ysengsong Rd. Intersection	2015	2014

performed by the PWSSs. This data is also used to track trends and provide data for more detailed investigations.

6.0 Man-Made Impoundment Monitoring

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 27** presents the locations and a proposed schedule for surface impoundment (i.e. ponding basins) sampling. It is 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

C. Summary of Ground Water Contamination Sources

The top ten contaminant sources presenting the greatest threat to Guam's ground water quality were identified earlier in this section and reference can be made to related contaminant information in **Table B9, Appendix B**. Guam EPA includes the following narrative on major contaminant sources and groundwater locations most at risk on Guam.

1.0 Septic Systems[1]

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 affects 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.[2] In this area, rainwater and water from other sources percolates 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.

2.0 CERCLA[3] 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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[1] Volume 3, Chapter 6: Septic Systems & Unsewered Areas. October 2006 Final Water Resources Master Plan

[2] PUAG's Rural Island-wide Wastewater Facilities Plan delineates Guam regions as Northern, Central and Southern.

[3] 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.

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. Active information about AAFB as a superfund site is available at http://yosemite.epa.gov/r9/sfund/r9sfdocw.nsf/ViewByEPAID/gu6571999519?OpenDocument

2.1 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. Regulatory issues delayed the signing of the ROD for Building 18006. In fiscal year 2010 under the IRP, AAFB will begin the RI/FS for Building 18006, finalize the ROD, and transfer environmental restoration responsibilities to Navy Base Guam.

2.2 Air Force Marbo Groundwater Impacted by TCE and PCE

The groundwater table beneath the Andersen Air Force Base MARBO Annex ranges from approximately 281 to 400 feet below ground surface. There are water production wells within the MARBO Annex area. This water is blended with water from other production wells and is distributed to various villages. As a consequence of past Air Force activities at MARBO Annex, the groundwater beneath the Annex area has been impacted by trichloroethylene (TCE) in the northern portion and tetrachloroethene (PCE) in the vicinity of the former MARBO Laundry facility. This contamination was first detected in MARBO groundwater when appropriate groundwater sampling and analysis was initiated some 30 years ago. As a result, Andersen Air Force Base has been identified as the responsible party for the groundwater contamination and has since implemented some actions to address the situation.

In November of 2009, the United States Air Force (USAF) updated the original selected remedy, *Natural Attenuation with Wellhead Treatment*, for MARBO Annex Groundwater at AAFB, by amending certain aspects of the June 1998 MARBO Annex OU Record of Decision. The amended selected remedy is *Long-Term Groundwater Monitoring with Contingency for Wellhead Treatment.*

Since the implementation of 1998 selected remedy, semi-annual groundwater sampling and analysis has shown that natural attenuation has not been effective in reducing TCE and PCE concentrations in the deep portions of the freshwater aquifer. Therefore, the USAF concluded that specific fundamental changes are needed to modify the MARBO Annex Groundwater remedy of *Natural Attenuation with Wellhead Treatment* selected in the 1998 ROD.[4]

Navy Environmental Restoration Program

2.3. Tiyan – former NAS Agana

Groundwater beneath Tiyan has been investigated since 1986 under the DOD, IRP. 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 BRAC has shown the presence of an extensive area of contamination of PCE and TCE.

In July 1993, the (Base Realignment and Closure) 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,

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[4] November 2009 AMENDMENT: Proposed Plan MARBO Annex Groundwater, MARBO Annex Operable Unit, AAFB, Guam

except for the Agana Power Plant.

Contamination in NAS-1 is currently being remediated through wellhead treatment through activated carbon filtration.

2.4 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. A five year review is planned for 2012. Annual reviews and landfill cover maintenance are ongoing.[5]

3.0 Ground Water Conditions in the Vicinity of the Orote "Landfill"

The Orote "Landfill" was an uncontrolled Navy dump throughout its operational history. Contaminants initially detected in soil and buried waste at the facility include PCBs, dioxins (including 2,3,7,8 TCDD) and furans, polychlorinated aliphatic hydrocarbons, volatile organic compounds (including TCE, PCE, TCA, DCA, and BTEX), metals, and pesticides. These same contaminants have also been detected in groundwater in monitoring wells in and around the dump, coastal fresh water springs and marine waters, and marine sediments and organisms (including fish).

In 2001 the beach area immediately adjacent to the dump was cleaned up of metallic debris, a sea wall was constructed to minimize further erosion of contaminated soil and buried waste, and an impermeable cap was constructed over the dump in an attempt to isolate contaminated waste from the groundwater and marine water beneath and adjacent to the dump.

Subsequent sampling of groundwater, spring and marine waters, and off-shore biota indicate that the contaminants persist in the local environment. A study of the effects of storm-induced waves, tides, and heavy rains on the water table in the vicinity of the capped dump has demonstrated that groundwater rises into buried waste and probably remobilizes contaminants thought to have been isolated from the groundwater and marine environment by the cap and seawall. It was also determined that storms cause temporary reversals of the water table and groundwater flow direction, thus continuing to disperse contaminants away from the dump through the groundwater pathway.

The site is now in long-term management. Fish sampling data evaluation is ongoing. Cap and seawall maintenance is ongoing. Groundwater monitoring is planned.

4.0 Other CERCLA Sites

There are several CERCLA sites located in the Southern Guam hydrogeologic province not over the NGL: the Ordot Landfill and numerous sites belonging to the Navy.

4.1 Ordot Dump

The Ordot Dump is listed on the NPL, but no groundwater contamination resulting from

[5] Fact Sheet 1: Navy's Guam Environmental Restoration Program – Site Status Update , November 2009

activities at the site has been documented. However, leachate impacts to the Lonfit River have been documented resulting in the impairment and 303(d) listing of this waterbody. It is suspected that the Lonfit River is hydraulically connected with the southern-most extension of the NGL; therefore, impacts to the NGL from Ordot leachate are possible.

4.2 Navy's Guam Environmental Restoration Program

The Environmental Restoration Program is organized into three programs based on the site type and location. Appendix I. provides Fact Sheet 1 dated November 2009. This document describes the status categories of the environmental cleanup sites on Guam by program.

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.

During the last quarter of 2005 Guam EPA under the lead of its Safe Drinking Water Program, investigated requirements of "Ground Water Under the Direct Influence of Surface Water" because of the contamination of several GWA ground water wells and possibly U.S. Navy wells. Staff suspected that these wells were potentially influenced by surface water or raw sewage from leaking sewer pumps or sewer pipes. The Agency has formulated draft guidance to determine the source, if the groundwater is under the influence of surface water.

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.

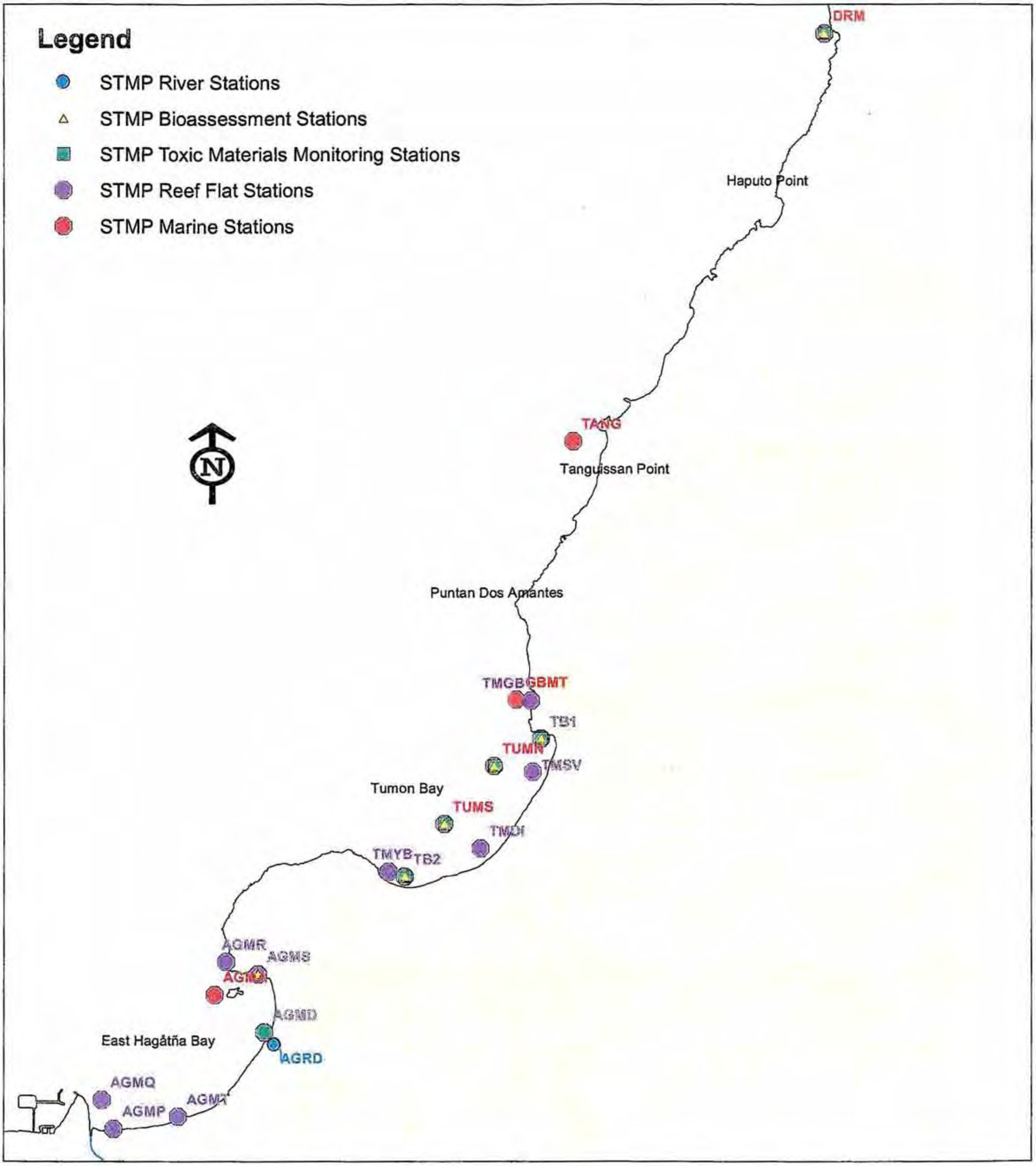
Guam EPA intends to use the results of the spring discharge study and information from the recent Northern Watershed Bacteria TMDL to prioritize and mitigate documented impacts on Tumon Bay and other northern beaches.

2010 GUAM INTEGRATED REPORT

APPENDIX A

C.I.A. 1991 Shaded Relief Map from www.lib.utexas.edu/Libs/PCL/Map_collection/guam.html

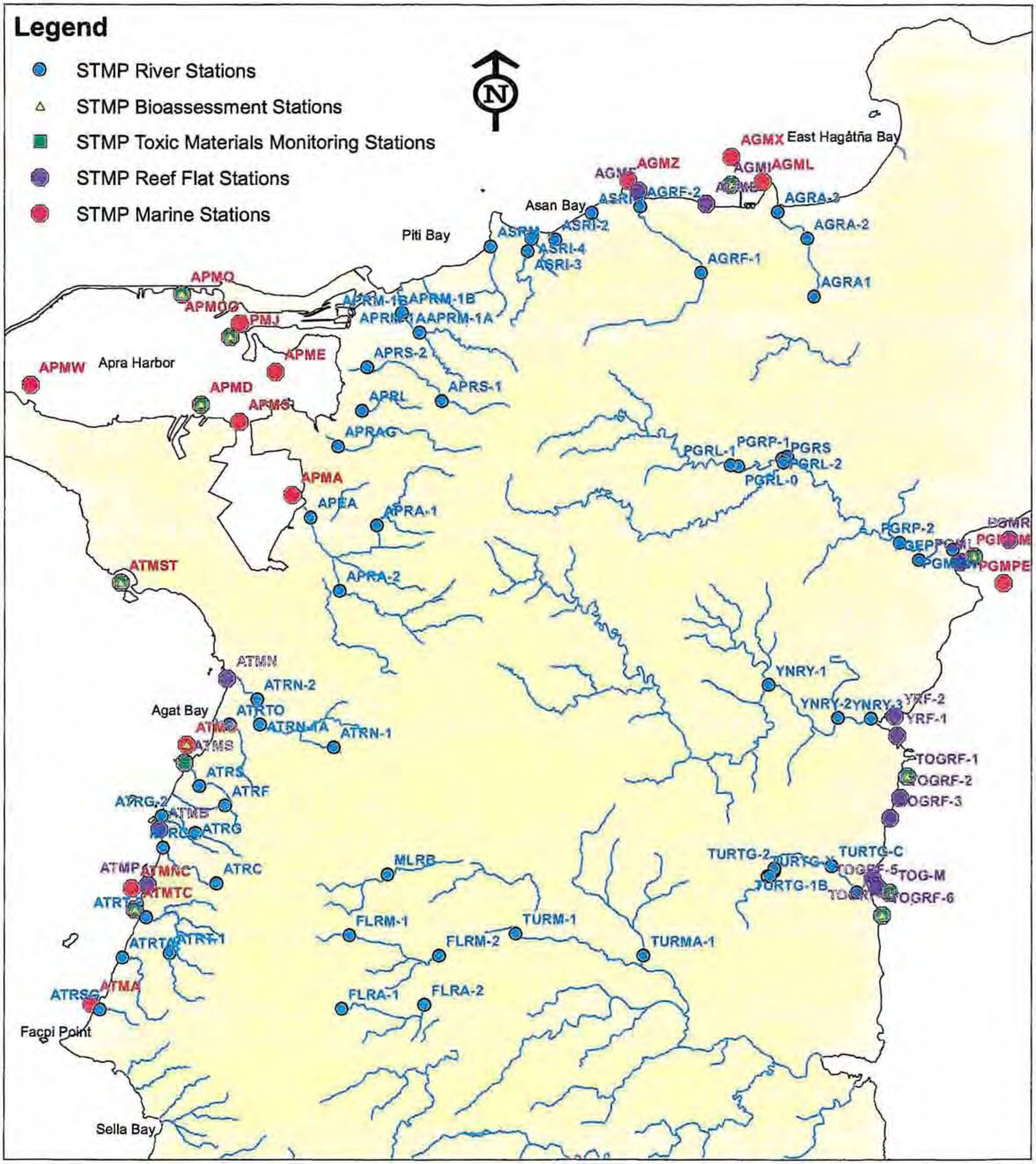
Figure 1. Guam Location Map



Map produced by Guam EPA/MP on 13 October 2005

0 0.35 0.7 1.4 2.1 2.8 Miles

Figure 2a. Northern Guam: Status and Trends Monitoring Program (STMP) Stations Map



Map produced by Guam EPA/MP on 13 October 2005

0 0.5 1 2 3 4 Miles

Figure 2b. Central Guam: Status and Trends Monitoring Program (STMP) Stations Map

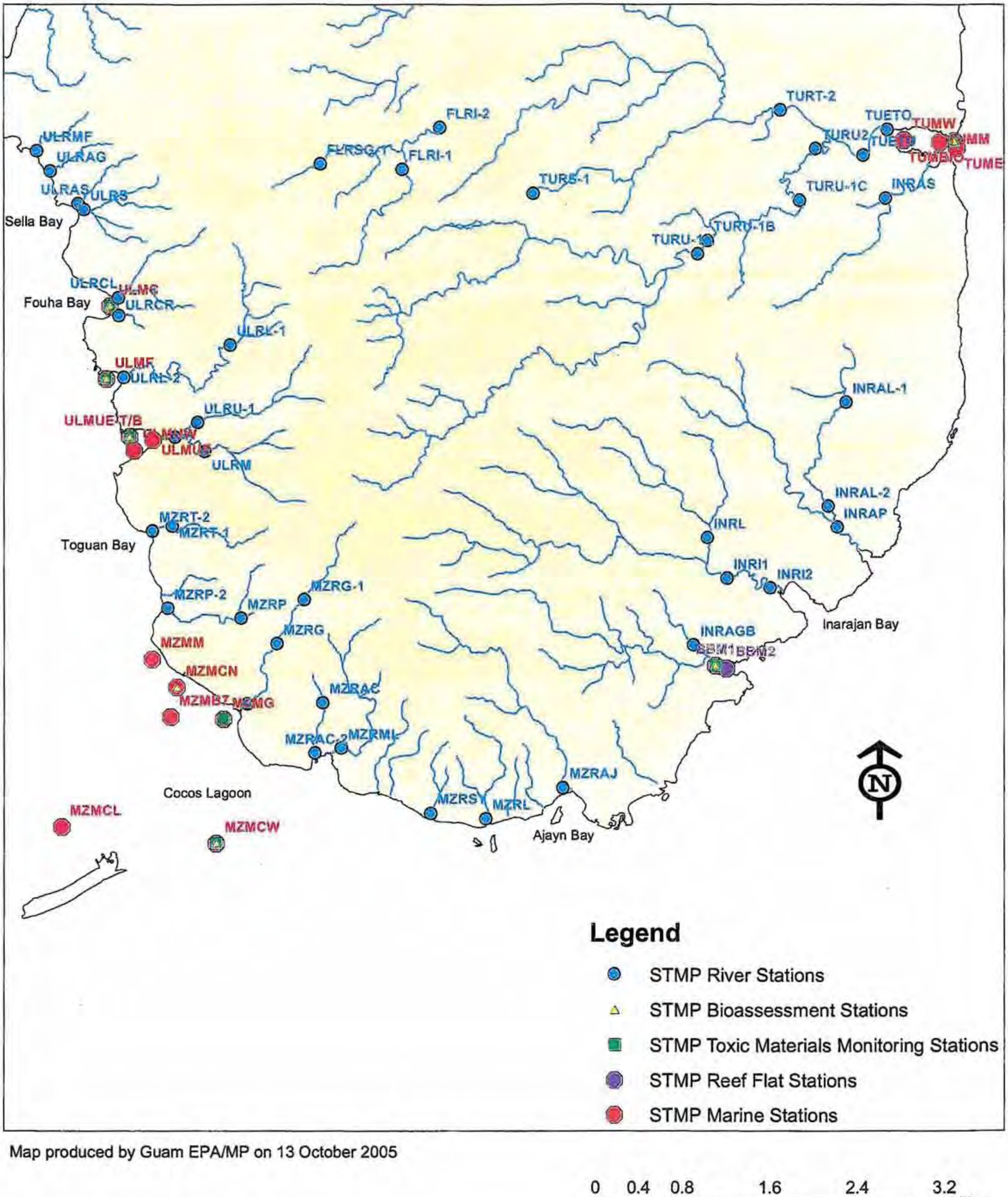
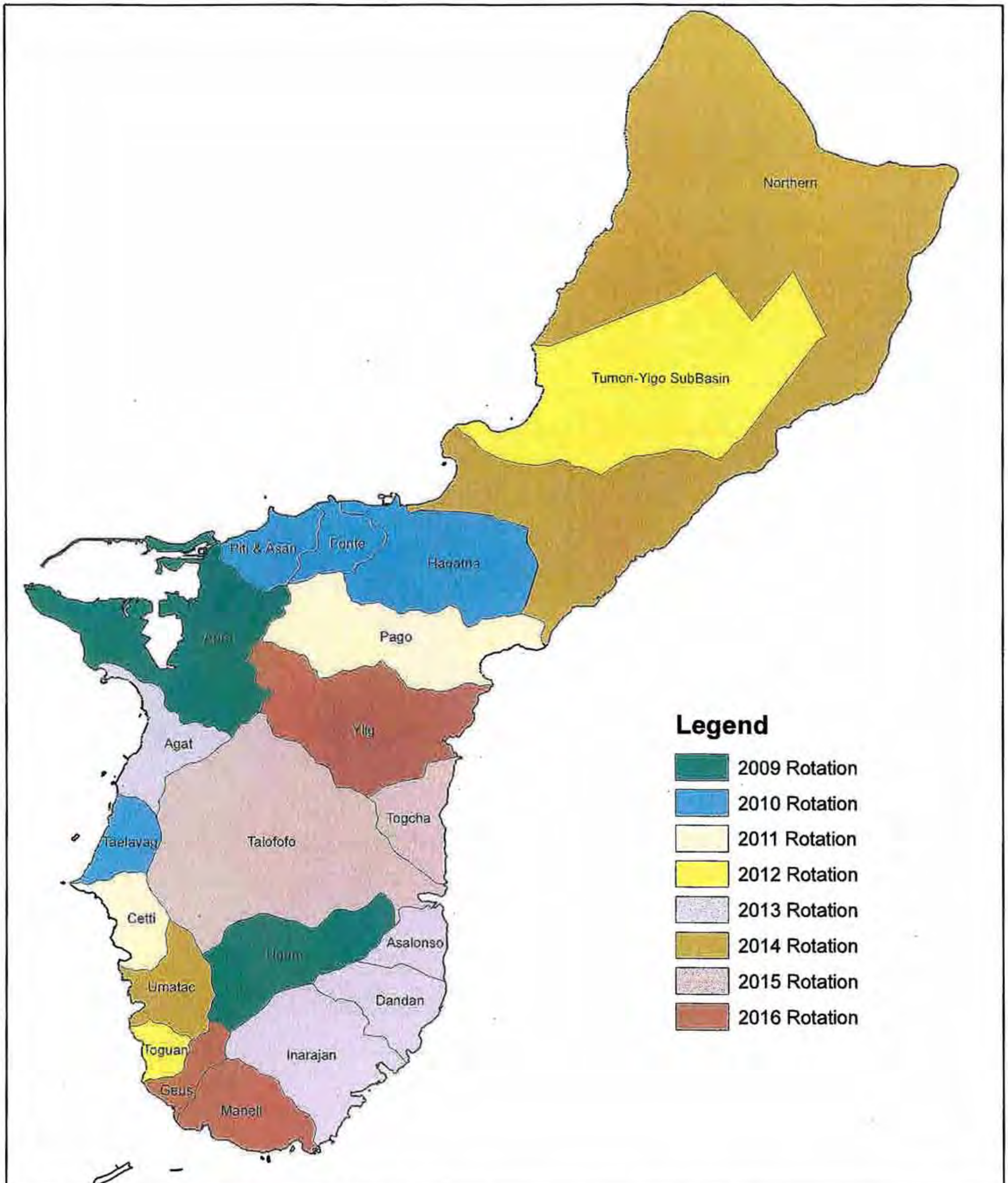


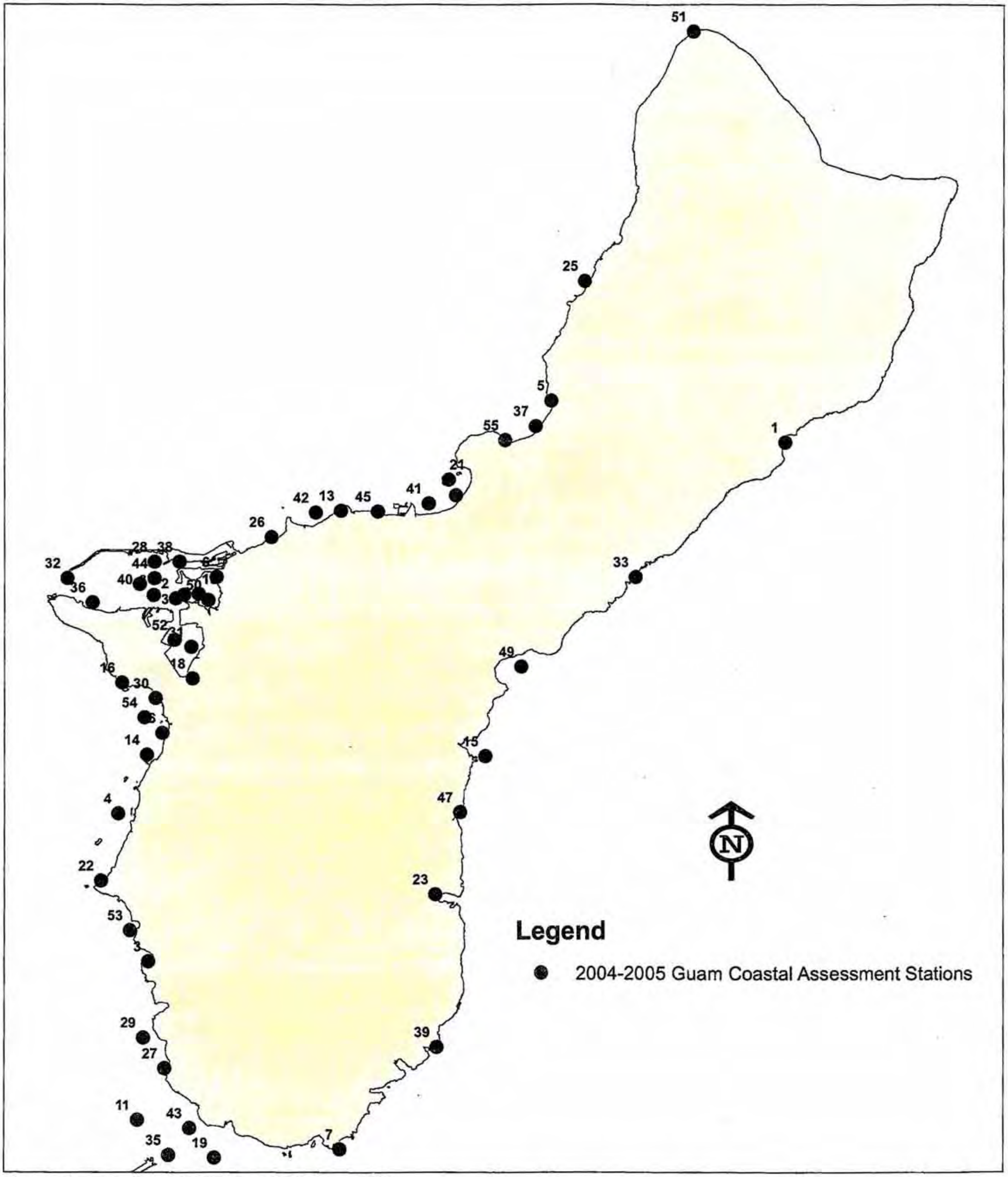
Figure 2c. Southern Guam: Status and Trends Monitoring Program (STMP) Stations Map



Map produced by Guam EPA/MP on March 26, 2009.

0 1 2 4 6 8 Miles

Figure 3. Guam EPA Status and Trends Program Rotating Watershed Schedule



Map produced by Guam EPA/MP on 17 October 2005

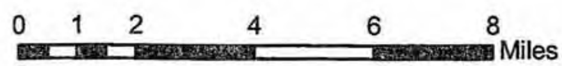
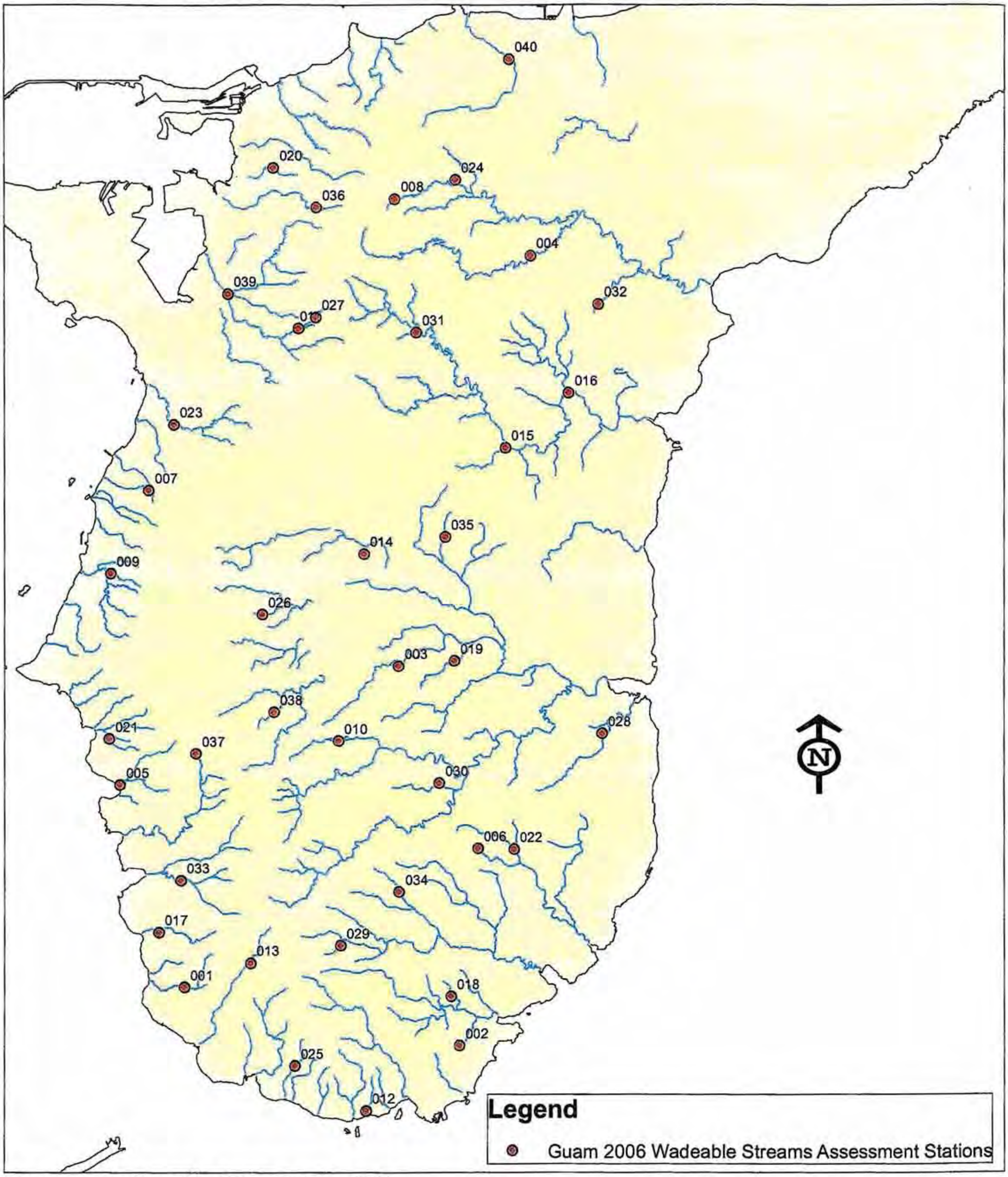


Figure 4. 1st Year Guam Coastal Assessment Stations



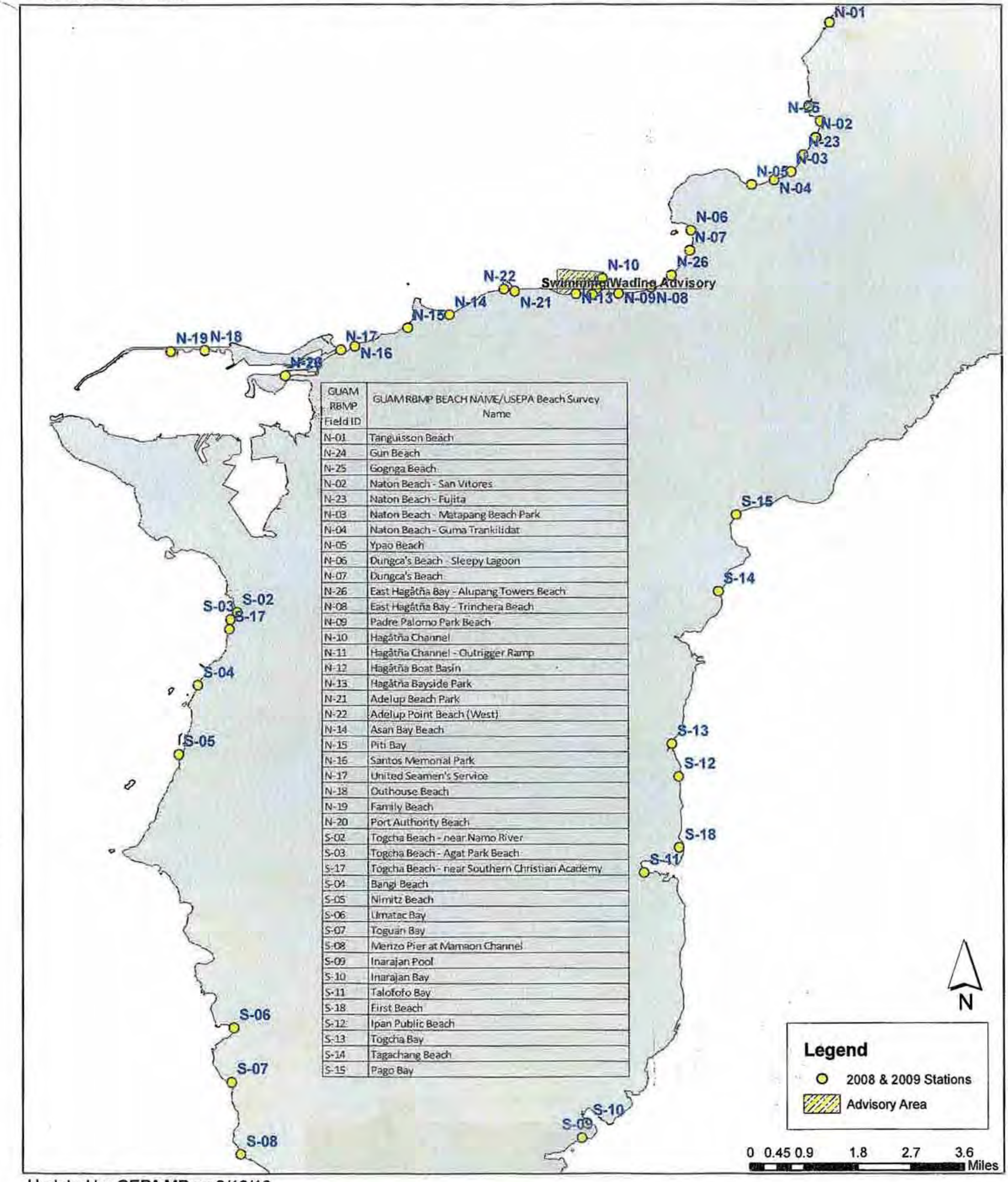
Map produced by Guam EPA/MP on 17 October 2005

0 0.35 0.7 1.4 2.1 2.8 Miles

Figure 5. 1st Year Guam WSA Stations

GUAM BEACH WATCH Ablson Tåsen Guahan

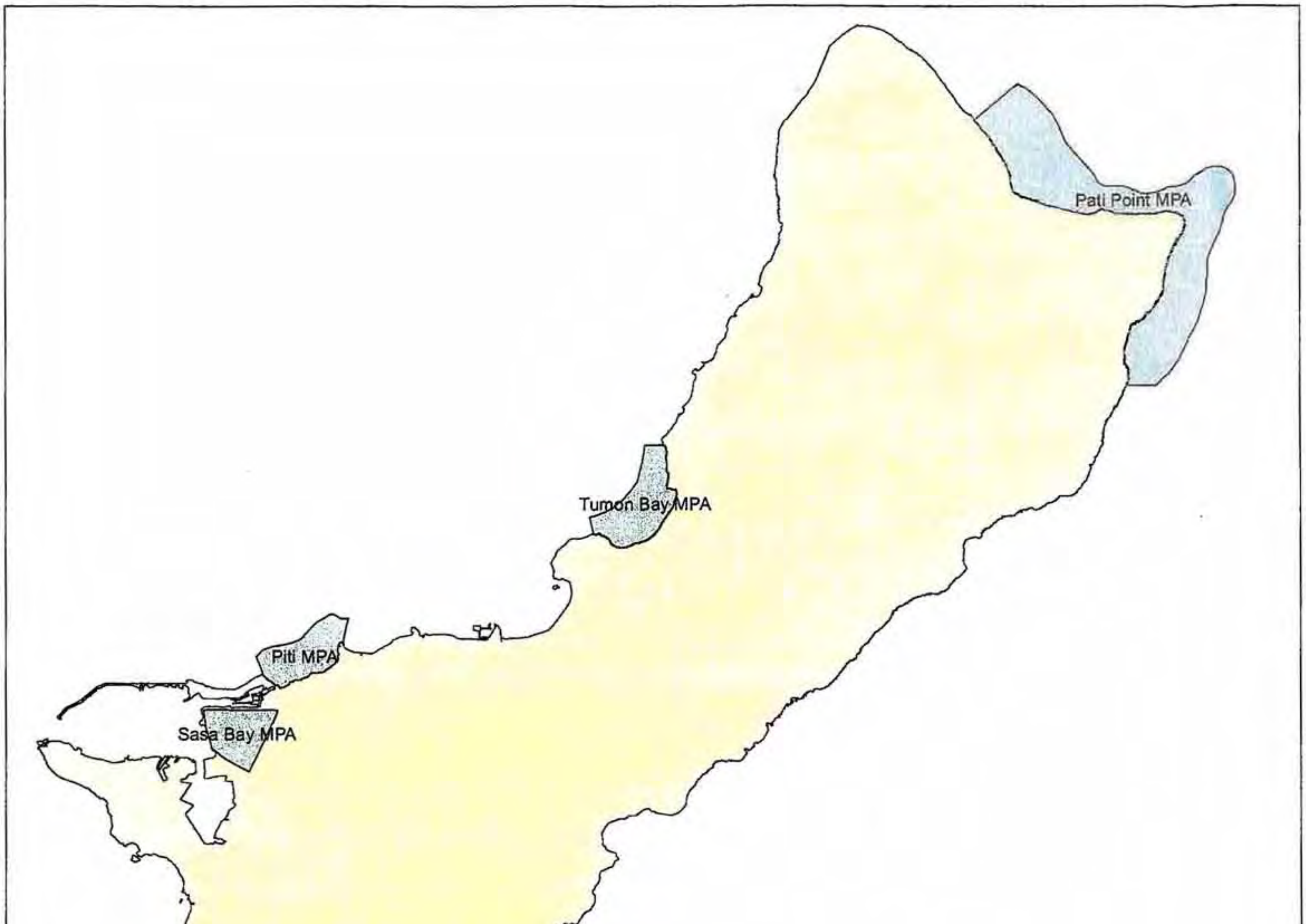
Guam EPA
2008 & 2009 RBMP Beach Stations



GUAM RBMP Field ID	GUAM RBMP BEACH NAME/USEPA Beach Survey Name
N-01	Tanguisson Beach
N-24	Gun Beach
N-25	Gognga Beach
N-02	Naton Beach - San Vitores
N-23	Naton Beach - Fujita
N-03	Naton Beach - Matapang Beach Park
N-04	Naton Beach - Guma Trankilidat
N-05	Ypao Beach
N-06	Dungca's Beach - Sleepy Lagoon
N-07	Dungca's Beach
N-26	East Hagåtña Bay - Alupang Towers Beach
N-08	East Hagåtña Bay - Trinchera Beach
N-09	Padre Palomo Park Beach
N-10	Hagåtña Channel
N-11	Hagåtña Channel - Outrigger Ramp
N-12	Hagåtña Boat Basin
N-13	Hagåtña Bayside Park
N-21	Adelup Beach Park
N-22	Adelup Point Beach (West)
N-14	Asan Bay Beach
N-15	Piti Bay
N-16	Santos Memorial Park
N-17	United Seamen's Service
N-18	Outhouse Beach
N-19	Family Beach
N-20	Port Authority Beach
S-02	Togcha Beach - near Namo River
S-03	Togcha Beach - Agat Park Beach
S-17	Togcha Beach - near Southern Christian Academy
S-04	Bangi Beach
S-05	Nimitz Beach
S-06	Umatac Bay
S-07	Toguan Bay
S-08	Merizo Pier at Mamaon Channel
S-09	Inarajan Pool
S-10	Inarajan Bay
S-11	Talofofo Bay
S-18	First Beach
S-12	Ipan Public Beach
S-13	Togcha Bay
S-14	Tagachang Beach
S-15	Pago Bay

Updated by GEPA MP on 2/16/10.

Figure 6. RBMP Beach Stations



Map produced by Guam EPA/MP on 17 October 2005

Figure 7. Water Quality Monitoring Stations at Marine Protected Areas (MPA)

2010 GUAM INTEGRATED REPORT

APPENDIX B

Table B1. STMP Stations

Watershed	Water Body Name	GEPA GIS ID	GWQS Classification	Depth (m)	Latitude D.d	Longitude D.d	Station Type
Agat	Agat Bay	ATMO	M2	0,5	13.389833	144.656500	Marine
Agat	Tipaleo Bay	ATMST	M2	0,10,20	13.416328	144.645467	Marine
Agat	Agat Bay	ATMN	M2	0	13.400667	144.663167	Reef Flat
Agat	Agat Bay	ATMS	M2	0	13.386833	144.656167	Reef Flat
Agat	Finile Creek	ATRF	S3	0	13.379736	144.662900	River/Stream
Agat	Gaan River	ATRG	S3	0	13.375283	144.657964	River/Stream
Agat	Gaan River	ATRG-2	S3	0	13.378028	144.652408	River/Stream
Agat	Namo River/unnamed tributary	ATRN-1	S3	0	13.389275	144.680997	River/Stream
Agat	Namo River	ATRN-1A	S3	0	13.393000	144.668667	River/Stream
Agat	Namo River	ATRN-2	S3	0	13.397131	144.668225	River/Stream
Agat	Salinas River	ATRS	S3	0	13.382903	144.658681	River/Stream
Agat	Togcha River (Agat)	ATRTO	S3	0	13.393000	144.663667	River/Stream
Apra	Apra Harbor	APMA	M2	0	13.430717	144.673953	Marine
Apra	Apra Harbor	APMCO	M3	0,5,10	13.458667	144.665167	Marine
Apra	Apra Harbor	APMD	M2	0	13.445500	144.658833	Marine
Apra	Apra Harbor	APME	M2	0	13.450833	144.671167	Marine
Apra	Apra Harbor	APMJ	M2	0	13.456500	144.663667	Marine
Apra	Apra Harbor	APMO	M3	0	13.463500	144.655667	Marine
Apra	Apra Harbor	APMS	M2	0,10,20	13.442667	144.665167	Marine
Apra	Apra Harbor	APMW	M2	0,10,20	13.448667	144.630500	Marine
Apra	Atantano River	APEA	S3	0	13.426922	144.677123	River/Stream
Apra	Big Gautali River	APRA-1	S3	0	13.425667	144.688167	River/Stream
Apra	Atantano River	APRA-2	S3	0	13.414928	144.681997	River/Stream
Apra	Aguada River	APRAG	S3	0	13.438539	144.681686	River/Stream
Apra	Laguas River	APRL	S3	0	13.444433	144.685700	River/Stream
Apra	Sasa River	APRS-1	S3	0	13.446000	144.698833	River/Stream
Apra	Sasa River	APRS-2	S3	0	13.451500	144.686500	River/Stream
Asalonso	Asalonso River/unnamed tributary	INRAS	S3	0	13.329919	144.761775	River/Stream
Cetti	Cetti Bay	ULMC	M1	0,5,10	13.315667	144.656667	Marine
Cetti	Agaga River	ULRAG	S2	0	13.333475	144.648675	River/Stream
Cetti	Asmafines River	ULRAS	S2	0	13.329142	144.652433	River/Stream
Cetti	Cetti River	ULRCL	S2	0	13.316733	144.657819	River/Stream
Cetti	unnamed river	ULRCR	S2	0	13.314394	144.657917	River/Stream
Cetti	Madofan River	ULRMF	S2	0	13.336156	144.646858	River/Stream
Cetti	Sella River	ULRS	S2	0	13.328394	144.653200	River/Stream

Table B1. STMP Stations

Watershed	Water Body Name	GEPA GIS ID	GWQS Classification	Depth (m)	Latitude D.d	Longitude D.d	Station Type
Dandan	Aslinget River	INRAL-1	S3	0	13.302900	144.756367	River/Stream
Dandan	Aslinget River	INRAL-2	S3	0	13.289000	144.754000	River/Stream
Dandan	Pauliluc River	INRAP	S3	0	13.286217	144.755192	River/Stream
Fonte	West Hagatna Bay	AGMZ	M2	0,10,20	13.481992	144.729631	Marine
Fonte	West Hagatna Bay	AGMF	M2	0	13.480333	144.731333	Reef Flat
Fonte	Fonte River	AGRF-1	S2	0	13.466922	144.741858	River/Stream
Fonte	Fonte River	AGRF-2	S2	0	13.477658	144.731725	River/Stream
Geus	Cocos Lagoon	MZMB7	M1	0,5,10	13.261000	144.664833	Marine
Geus	Cocos Lagoon	MZMCL	M1	0,5	13.246333	144.650167	Marine
Geus	Cocos Lagoon	MZMCN	M2	0,5	13.264933	144.665708	Marine
Geus	Cocos Lagoon	MZMCW	M1	0	13.244167	144.671000	Marine
Geus	Cocos Lagoon	MZMG	M2	0,10,20	13.260667	144.672000	Marine
Geus	Cocos Lagoon	MZMM	M2	0,10,20	13.268667	144.662333	Marine
Geus	Geus River	MZRG	S2	0	13.270667	144.679333	River/Stream
Geus	Geus River	MZRG-1	S1	0	13.276517	144.683028	River/Stream
Geus	Geus River	MZRG-2	S3	0	13.262631	144.675308	River/Stream
Hagatna	West Hagatna Bay	AGML	M2	0,10	13.481833	144.752000	Marine
Hagatna	West Hagatna Bay	AGMX	M2	0,10,20	13.485833	144.746833	Marine
Hagatna	West Hagatna Bay	AGMX1	M2	0,10,20	(variable)	(variable)	Marine
Hagatna	West Hagatna Bay	AGMX2	M2	0,10,20	(variable)	(variable)	Marine
Hagatna	West Hagatna Bay	AGMB	M2	0	13.478167	144.742667	Reef Flat
Hagatna	West Hagatna Bay	AGMI	M2	0	13.481333	144.746833	Reef Flat
Hagatna	Hagatna Springs	AGRA1	S2	0	13.463086	144.760686	River/Stream
Hagatna	Hagatna River	AGRA-2	S2	0	13.472517	144.759542	River/Stream
Hagatna	Hagatna River	AGRA-3	S2	0	13.476831	144.754639	River/Stream
Inarajan	Agfayan Bay	BBM1	M2	0	13.267833	144.738667	Reef Flat
Inarajan	Agfayan Bay	BBM2	M2	0	13.267500	144.740167	Reef Flat
Inarajan	unnamed river	INRAGB	S3		13.270531	144.735692	River/Stream
Inarajan	Inarajan River	INRI1	S3		13.279414	144.740256	River/Stream
Inarajan	Inarajan River	INRI2	S3		13.278117	144.746139	River/Stream
Inarajan	Laolao River	INRL	S2	0	13.284831	144.737561	River/Stream
Manell	Achang River	MZRAC	S2	0	13.262831	144.685558	River/Stream
Manell	Achang River	MZRAC-2	S2		13.256131	144.684489	River/Stream
Manell	Ajayan River	MZRAJ	S2	0	13.251506	144.717944	River/Stream
Manell	Liyog River	MZRL	S2	0	13.247383	144.707417	River/Stream
Manell	Manell River	MZRML	S2		13.256792	144.688094	River/Stream

Table B1. STMP Stations

Watershed	Water Body Name	GEPA GIS ID	GWQS Classification	Depth (m)	Latitude D.d	Longitude D.d	Station Type
Manell	Sumay River	MZRSY	S2		13.248114	144.700022	River/Stream
Northern	East Hagatna Bay	AGMA	M2	0,2	13.492572	144.768400	Marine
Northern	Double Reef	DRM	M1	0	13.597333	144.836000	Marine
Northern	Double Reef	DRM			13.596667	144.832500	Marine
Northern	Tanguisson Beach	TANG	M2	0,10,20	13.553000	144.808167	Marine
Northern	East Hagatna Bay	AGMD	M2	0	13.488500	144.773833	Reef Flat
Northern	East Hagatna Bay	AGMP	M2	0	13.478000	144.757167	Reef Flat
Northern	East Hagatna Bay	AGMQ	M2	0	13.481167	144.755833	Reef Flat
Northern	East Hagatna Bay	AGMR	M2	0	13.496144	144.769639	Reef Flat
Northern	East Hagatna Bay	AGMS	M2	0	13.494833	144.773167	Reef Flat
Northern	East Hagatna Bay	AGMT	M2	0	13.479333	144.764333	Reef Flat
Northern	(open storm drain)	AGRD	S2	0	13.487119	144.774983	River/Stream
Pago	Pago Bay	PGMPE	M2	0,10,20	13.416333	144.792333	Marine
Pago	Pago Bay	PGMPM	M2	0,5,10	13.420683	144.787431	Marine
Pago	Pago Bay				13.420000	144.782500	Marine
Pago	Pago Bay				13.420833	144.775556	Marine
Pago	Pago Bay	PGML	M2	0	13.419833	144.785000	Reef Flat
Pago	Pago Bay	PGMR	M2	0	13.423431	144.793336	Reef Flat
Pago	Pago River	PGEP	S3	0,1,2	13.420011	144.778353	River/Stream
Pago	Pago River	PGMPW	S3	0,1,2	13.421739	144.783947	River/Stream
Pago	Landfill Leachate Steam	PGRL-0	S1	0	13.435353	144.748114	River/Stream
Pago	Lonfit River	PGRL-1	S1	0	13.435528	144.746858	River/Stream
Pago	Lonfit River	PGRL-2	S2	0	13.436603	144.755450	River/Stream
Pago	Pago River	PGRP-1	S2	0	13.436972	144.756322	River/Stream
Pago	Pago River	PGRP-2	S3	0	13.422856	144.775075	River/Stream
Pago	Sigua River	PGRS	S1	0	13.436028	144.755669	River/Stream
Piti/Asan	Masso River	APRM-1A	S3	0	13.457167	144.695167	River/Stream
Piti/Asan	Masso River	APRM-1B	S3	0	13.460378	144.692281	River/Stream
Piti/Asan	unnamed creek	ASRI-1	S3	0	13.476564	144.723569	River/Stream
Piti/Asan	Unnamed creek	ASRI-2	S3	0	13.472231	144.717478	River/Stream
Piti/Asan	Asan River	ASRI-3	S3	0	13.470386	144.712961	River/Stream
Piti/Asan	Asan River	ASRI-4	S3	0	13.472392	144.713594	River/Stream
Piti/Asan	Matague River	ASRM	S3		13.471139	144.706839	River/Stream
Taelayag	Taleyfac Bay	ATMA	M1	0	13.347500	144.640667	Marine
Taelayag	Taleyfac Bay	ATMNC	M2	0,5	13.366333	144.647333	Marine
Taelayag	Taleyfac Bay	ATMTC	M2	0,5	13.362833	144.647833	Marine

Table B1. STMP Stations

Watershed	Water Body Name	GEPA GIS ID	GWQS Classification	Depth (m)	Latitude D.d	Longitude D.d	Station Type
Taelayag	Agat Bay	ATMB	M2	0	13.375886	144.651900	Reef Flat
Taelayag	Taleyfac Bay	ATMP	M2	0	13.366833	144.650000	Reef Flat
Taelayag	Chaligan Creek	ATRC	S3	0	13.367014	144.661497	River/Stream
Taelayag	Chaligan Creek	ATRC-2			13.372867	144.652644	River/Stream
Taelayag	Sagua River	ATRSG	S3	0	13.346467	144.642117	River/Stream
Taelayag	Pagachao Creek	ATRT-1	S3	0	13.355672	144.653742	River/Stream
Taelayag	Taleyfac River	ATRT-2	S3	0	13.361500	144.649833	River/Stream
Taelayag	Taelayag Creek	ATRTA	S3	0	13.354925	144.645864	River/Stream
Talofofo	Talofofo Bay	TUMBIO	M2	--	13.337500	144.771000	Marine
Talofofo	Talofofo Bay	TUME	M2	0,10,20	13.336667	144.771333	Marine
Talofofo	Talofofo Bay	TUMM	M2	0,10,20	13.337333	144.769000	Marine
Talofofo	Talofofo Bay	TUMW	M2	0	13.337667	144.764167	Marine
Talofofo	Almagosa Spring	FLRA-1	S1	0	13.346594	144.682308	River/Stream
Talofofo	unnamed tributary	FLRA-2	S1	0	13.347281	144.696083	River/Stream
Talofofo	Imong River	FLRI-1	S1	0	13.333706	144.696211	River/Stream
Talofofo	Imong River	FLRI-2	S1	0	13.339225	144.701222	River/Stream
Talofofo	Maulap River	FLRM-1	S1	0	13.358581	144.683586	River/Stream
Talofofo	Maulap River	FLRM-2	S1	0	13.355297	144.698469	River/Stream
Talofofo	Sadog Gago River	FLRSG-1	S1	0	13.334397	144.685258	River/Stream
Talofofo	Bonya River	MLRB	S1	0	13.368528	144.689897	River/Stream
Talofofo	Talofofo River	TUETO	S1-S3	0,10,20	13.339000	144.761956	River/Stream
Talofofo	Talofofo River	TUETU	S2	0,1,2	13.335586	144.758664	River/Stream
Talofofo	Maagas River	TURM-1	S2		13.358850	144.711064	River/Stream
Talofofo	Mahlac River	TURMA-1	S1		13.355294	144.732450	River/Stream
Talofofo	Sarasa River	TURS-1	S2		13.330533	144.713850	River/Stream
Talofofo	Talofofo River	TURT-2	S2		13.341592	144.747386	River/Stream
Togcha	Togcha River	TURTG-1A	S3	0	13.368244	144.753125	River/Stream
Togcha	Togcha River	TURTG-1B	S3	0	13.369103	144.754189	River/Stream
Togcha	Togcha River	TURTG-1C	S3	0	13.365667	144.768000	River/Stream
Togcha	Togcha River	TURTG-2	S3	0	13.369544	144.754253	River/Stream
Togcha	Togcha River	TURTG-C	S3	0	13.369917	144.763797	River/Stream
Togcha	Togcha River	TURTG-X	S3	0	13.368344	144.753536	River/Stream
Togcha	Togcha Bay	TOG-M	M2	0,5	13.365700	144.773358	Reef Flat
Togcha	Togcha Bay	TOGRF-1	M2	0	13.384667	144.776333	Reef Flat
Togcha	Togcha Bay	TOGRF-2	M2	0	13.381167	144.775167	Reef Flat
Togcha	Togcha Bay	TOGRF-3	M2	0	13.377833	144.773500	Reef Flat

Table B1. STMP Stations

Watershed	Water Body Name	GEPA GIS ID	GWQS Classification	Depth (m)	Latitude D.d	Longitude D.d	Station Type
Togcha	Togcha Bay	TOGRF-4	M2	0	13.368000	144.770500	Reef Flat
Togcha	Togcha Bay	TOGRF-5	M2	0	13.366667	144.771333	Reef Flat
Togcha	Togcha Bay	TOGRF-6	M2	0	13.362000	144.772167	Reef Flat
Toguan	Pigua River	MZRP	S3	0	13.274053	144.674453	River/Stream
Toguan	Pigua River	MZRP-2	S3		13.275381	144.664492	River/Stream
Toguan	Toguan River	MZRT-1	S3	0	13.286300	144.665114	River/Stream
Toguan	Toguan River	MZRT-2	S3	0	13.285694	144.662436	River/Stream
Tumon/Yigo Subbasin	Tumon Bay reef slope	GBMT			13.524767	144.801856	Marine
Tumon/Yigo Sub-basin	Tumon Bay	TUMN	M2	0,5	13.517500	144.799333	Marine
Tumon/Yigo Sub-basin	Tumon Bay	TUMS	M2	0,5	13.511167	144.793833	Marine
Tumon/Yigo Sub-basin	Tumon Bay	TB1	M2	--	13.520472	144.804611	Reef Flat
Tumon/Yigo Sub-basin	Tumon Bay	TB2	M2	--	13.505456	144.789450	Reef Flat
Tumon/Yigo Sub-basin	Tumon Bay	TMDI	M2	0	13.508500	144.797833	Reef Flat
Tumon/Yigo Sub-basin	Tumon Bay	TMGB	M2	0	13.524667	144.803500	Reef Flat
Tumon/Yigo Sub-basin	Tumon Bay	TMSV	M2	0	13.516833	144.803667	Reef Flat
Tumon/Yigo Sub-basin	Tumon Bay	TMYB	M2	0	13.506000	144.787667	Reef Flat
Ugum	Ugum River	TURU-1A	S2	0	13.322558	144.736153	River/Stream
Ugum	Ugum River	TURU-1B	S2	0	13.324306	144.737511	River/Stream
Ugum	Ugum River	TURU-1C	S2	0	13.329667	144.750000	River/Stream
Ugum	Ugum River	TURU2		0	13.336472	144.752211	River/Stream
Umatac	Fouha Bay	ULMF	M1	0,5,10	13.306000	144.656167	Marine
Umatac	Umatac Bay	ULMUE	M2	0	13.297936	144.662464	Marine
Umatac	Umatac Bay	ULMUE-T/B	M2	0	13.298294	144.659306	Marine
Umatac	Umatac Bay	ULMUW	M2	0,5,10	13.296483	144.659917	Marine
Umatac	Chagame River/La Sa Fua River	ULRL-1	S2	0	13.310442	144.672978	River/Stream
Umatac	La Sa Fua River	ULRL-2	S2	0	13.306164	144.658589	River/Stream
Umatac	Madog River	ULRM	S3	0	13.296278	144.669539	River/Stream
Umatac	Laelae River	ULRU-1	S1	0	13.300150	144.668556	River/Stream
Umatac	Umatac River	ULRU-2	S3	0	13.298167	144.665500	River/Stream
Ylig	Ylig Bay	YRF-1	M2	0	13.391333	144.774667	Reef Flat
Ylig	Ylig Bay	YRF-2	M2	0	13.394547	144.774275	Reef Flat
Ylig	Ylig River	YNRY-1	S3	0	13.399514	144.753283	River/Stream
Ylig	Ylig River	YNRY-2	S3	0	13.394167	144.764833	River/Stream
Ylig	Ylig River	YNRY-3	S3	0	13.394000	144.770333	River/Stream

Table B2. 2005 Guam Coastal Assessment Stations

EMAP Station ID	Watershed	Station Location	Latitude D.d.	Longitude D.d.
GU04_0001	NORTHERN	Pagat Point	13.504430	144.892312
GU04_0002	APRA	Mouth of Inner Harbor	13.447234	144.665594
GU04_0003	CETTI	Cetti Bay	13.314444	144.655556
GU04_0004	TAELAYAG	Agat Marina Channel	13.368331	144.644471
GU04_0005	TUMON/YIGO	Tumon Bay - Okura reef flat	13.519375	144.805056
GU04_0006	APRA	Sasa Bay Mangrove	13.454981	144.680773
GU04_0007	MANELL	Aga Bay - Inarajan	13.246053	144.726841
GU04_0008	APRA	Apra Harbor - near Dry Dock	13.448391	144.657518
GU04_0009	NORTHERN	East Hagatna Bay - ABT	13.484975	144.769508
GU04_0010	APRA	Sasa Bay	13.448812	144.674139
GU04_0011	GEUS	Cocos Lagoon - Outside	13.256783	144.651585
GU04_0013	FONTE	West Adelup Park	13.479183	144.727217
GU04_0014	AGAT	Gaan Point Agat	13.389859	144.654985
GU04_0015	YLIG	Ylig Bay	13.389359	144.780495
GU04_0016	AGAT	Tipalao Bay	13.416300	144.645833
GU04_0018	APRA	North Inner Harbor	13.417889	144.671814
GU04_0019	MANELL	Southeast Cocos Lagoon	13.243023	144.680069
GU04_0021	NORTHERN	South of Alupang Island	13.490731	144.766854
GU04_0022	TAELAYAG	Facpi Point	13.343755	144.638013
GU04_0023	TALOFOFO	Talofofo Bay Bridge	13.338886	144.761994
GU04_0025	NORTHERN	Tanguisson Point	13.562906	144.817621
GU04_0026	PITI/ASAN	Piti Bomb Holes	13.469646	144.701335
GU04_0027	TOGUAN	Bile Bay	13.275522	144.661618
GU04_0028	APRA	Apra Harbor-off Seaplane Ramp	13.460556	144.657778
GU04_0029	TOGUAN	Mamatguan Point	13.286739	144.653697
GU04_0030	AGAT	Agat Bay - Dadi Beach	13.410556	144.658333
GU04_0031	APRA	South Inner Harbor	13.429375	144.671331
GU04_0032	APRA	Apra Harbor Mouth	13.454483	144.625467
GU04_0033	NORTHERN	Mangilao Golf Course Terrace	13.454993	144.836858
GU04_0034	APRA	Mouth of Sasa Bay	13.448590	144.668726
GU04_0035	GEUS	South Cocos Lagoon	13.243877	144.663089
GU04_0036	APRA	Apra Harbor - Kilo Wharf	13.445583	144.634889
GU04_0037	TUMON/YIGO	Tumon Bay - Matapang	13.510086	144.799111
GU04_0038	APRA	Port Authority Dock	13.460508	144.667089
GU04_0039	DANDAN	Ulomai Beach - Inarajan	13.283376	144.762569
GU04_0040	APRA	Apra Harbor - Deep	13.452371	144.652364
GU04_0041	NORTHERN	East Hagatna Bay - Reef margin (Linda's Café)	13.482017	144.759517
GU04_0042	PITI/ASAN	Asan Cut	13.478518	144.717726
GU04_0043	GEUS	Cocos Lagoon - mid	13.253750	144.670733
GU04_0044	APRA	Apra Harbor - West Jade Shoals	13.454506	144.657834
GU04_0045	HAGATNA	West Hagatna Bay	13.478894	144.740850
GU04_0046	AGAT	Agat Bay Channel	13.397725	144.660802
GU04_0047	TOGCHA	Togcha Bay	13.368867	144.771100
GU04_0049	PAGO	Pago Bay Reef Margin	13.422239	144.793942
GU04_0050	APRA	South Sasa Bay	13.446559	144.677716
GU04_0051	NORTHERN	Ritidian Point	13.653732	144.858006
GU04_0052	APRA	Inner Apra Harbor (West)	13.431937	144.665148
GU04_0053	CETTI	Sella Bay	13.325719	144.648765
GU04_0054	AGAT	Rizal Beach	13.403577	144.654103
GU04_0055	TUMON/YIGO	Ypao Beach	13.504954	144.787812

Table B3. 2006 Guam WSA Stations

	GEPA Station Label	Station Location (RIVER NAME)	WATERSHED	DISCHARGE BODY	Latitude (D.d.)	Longitude (D.d.)
1	GWSA05-001	Pigua River	Toguan	Bile Bay	13.274239	144.671391
2	GWSA05-002	intermittent tributary	Inarajan	Agfayan River	13.262059	144.730170
3	GWSA05-003	Sagge River	Talofofo	Talofofo River	13.341807	144.717151
4	GWSA05-004	Sigua River	Pago	Pago River	13.427974	144.745426
5	GWSA05-005	Cetti River	Cetti	Cetti Bay	13.316709	144.657729
6	GWSA05-006	unnamed tributary	Dandan	Tinago River	13.303382	144.734084
7	GWSA05-007	Finile Creek	Agat	Agat Bay	13.378802	144.663886
8	GWSA05-008	Lonfit River	Pago	Pago River	13.439857	144.716363
9	GWSA05-009	unnamed creek	Taelayag	Ascola Sito Creek	13.361307	144.655729
10	GWSA05-010	unnamed tributary	Ugum	Bubulao River	13.325978	144.704480
11	GWSA05-011	Paulana River	Apra	Atantano River	13.412762	144.695991
12	GWSA05-012	Asgado Creek	Manell	Asgadao Bay	13.248421	144.710328
13	GWSA05-013	Geus River	Geus	Cocos Lagoon	13.279308	144.685665
14	GWSA05-014	Bonya River	Talofofo	Morrow Lake	13.365453	144.709864
15	GWSA05-015	Ylig River	Ylig	Ylig Bay	13.387752	144.740040
16	GWSA05-016	Ylig River	Ylig	Ylig Bay	13.399268	144.753694
17	GWSA05-017	Toguan River	Toguan	Toguan Bay	13.285711	144.666017
18	GWSA05-018	unnamed tributary	Inarajan	Agfayan River	13.272378	144.728375
19	GWSA05-019	unnamed tributary	Talofofo	Sagge River	13.342864	144.729031
20	GWSA05-020	Laguas River	Apra	Apra Harbor	13.446390	144.690587
21	GWSA05-021	unnamed tributary	Cetti	Sella River	13.326391	144.655409
22	GWSA05-022	Tinago River	Dandan	Pauliluc River	13.303217	144.741882
23	GWSA05-023	Namo River	Agat	Agat Bay	13.392632	144.669234
24	GWSA05-024	Lonfit River	Pago	Pago River	13.443894	144.729237
25	GWSA05-025	unnamed river	Manell	Sumay Bay	13.257801	144.695086
26	GWSA05-026	unnamed tributary	Talofofo	Maulap River	13.352654	144.688161
27	GWSA05-027	Paulana River	Apra	Atantano River	13.415075	144.699665
28	GWSA05-028	Asalonso River	Asalonso	Talofofo Bay	13.327557	144.760892
29	GWSA05-029	unnamed tributary	Inarajan	Dante River	13.283020	144.704946
30	GWSA05-030	Ugum River	Ugum	Talofofo River	13.317153	144.725830
31	GWSA05-031	unnamed tributary	Ylig	Ylig River	13.411920	144.720888
32	GWSA05-032	intermittent tributary	Pago	Pago River	13.417858	144.760026
33	GWSA05-033	Madog River	Umatac	Umatac River	13.296645	144.670703
34	GWSA05-034	Nelansa River	Inarajan	Yledigao River	13.294260	144.717260
35	GWSA05-035	unnamed tributary	Talofofo	Mahlac River	13.369047	144.727115
36	GWSA05-036	Aguada River	Apra	Apra Harbor	13.438062	144.699746
37	GWSA05-037	Chagame River	Umatac	La Sa Fua River	13.323283	144.673909
38	GWSA05-038	intermittent tributary	Talofofo	Sadog Gago River	13.332034	144.690674
39	GWSA05-039	Atantano River	Apra	Apra Harbor	13.420016	144.680797
40	GWSA05-040	Fonte River	Fonte	West Agana Bay	13.469120	144.740707

Table B4. Guam Recreational Beach Monitoring Program (RBMP) Stations

	RBMP Station ID	Watershed	RBMP Beach Name	Primary Type	Latitude (WGS 84) at Sampling Point	Longitude (WGS 84) at Sampling Point
1	N-01	Northern	Tanguisson Beach	Ocean	13.5438333	144.8085000
2	N-02	Tumon/Yigo Sub-basin	Naton Beach - San Vitores	Ocean	13.5158333	144.8055000
3	N-03	Tumon/Yigo Sub-basin	Naton Beach - Matapang Beach Park	Ocean	13.5596667	144.8110000
4	N-04	Tumon/Yigo Sub-basin	Naton Beach - Guma Trankilidat	Ocean	13.5053333	144.7948333
5	N-05	Tumon/Yigo Sub-basin	Ypao Beach	Ocean	13.5041667	144.7890000
6	N-06	Northern	Dungca's Beach - Sleepy Lagoon	Ocean	13.4933333	144.7748333
7	N-07	Northern	Dungca's Beach	Ocean	13.4880000	144.7740000
8	N-08	Northern	East Hagatna Bay - Trinchera Beach	Ocean	13.4793333	144.7650000
9	N-09	Hagatna	Padre Palomo	Ocean	13.4778333	144.7570000
10	N-10	Hagatna	Hagatna Channel	Ocean	13.4816667	144.7531667
11	N-11	Hagatna	Hagatna Channel - Outrigger Ramp	Ocean	13.4791667	144.7510000
12	N-12	Hagatna	Hagatna Boat Basin	Ocean	13.4776667	144.7496667
13	N-13	Hagatna	Hagatna Bayside Park	Ocean	13.4770000	144.7468333
14	N-14	Piti / Asan	Asan Bay Beach	Ocean	13.4726667	144.7156667
15	N-15	Piti / Asan	Piti Bay	Ocean	13.4695000	144.7055000
16	N-16	Piti / Asan	Santos Memorial	Ocean	13.4650000	144.6926667
17	N-17	Piti / Asan	United Seamen's Service	Ocean	13.4641667	144.6891667
18	N-18	Apra	Outhouse Beach	Ocean	13.4641667	144.6560000
19	N-19	Apra	Family Beach	Ocean	13.4638333	144.6476667
20	N-20	Apra	Port Authority Beach	Ocean	13.4578333	144.6755000
[redacted]						
22	S-02	Agat	Togcha Beach - Namo	Ocean	13.3998333	144.6636667
23	S-03	Agat	Togcha Beach - Agat	Ocean	13.3981667	144.6620000
24	S-04	Agat	Bangi Beach	Estuary	13.3820000	144.6540000
25	S-05	Taelayag	Nimitz Beach	Ocean	13.3651667	144.6493333
26	S-06	Umatac	Umatac Bay	Ocean	13.2985000	144.6626667
27	S-07	Toguan	Toguan Bay	Estuary	13.2853333	144.6621667
28	S-08	Geus	Merizo Pier - Mamaon Channel	Ocean	13.2678333	144.6643333
29	S-09	Inarajan	Inarajan Pool	Ocean	13.2718333	144.7475000
30	S-10	Inarajan	Inarajan Bay	Estuary	13.2753333	144.7488333
31	S-11	Talofofo	Talofofo Bay	Estuary	13.3361667	144.7630000
32	S-12	Togcha	Ipan Public Beach	Ocean	13.3596667	144.7715000
33	S-13	Togcha	Togcha Bay	Estuary	13.3676667	144.7698333
34	S-14	Ylig	Tagachang Beach	Ocean	13.4050000	144.7811667
35	S-15	Pago	Pago Bay	Estuary	13.4238333	144.7856667
36	N-21	Fonte	Adelup Beach Park	Estuary	13.4785100	144.7316000
37	N-22	Fonte	Adelup Point Beach (West)	Ocean	13.4789700	144.7289000
38	S-17	Agat	Togcha Beach - SCA	Ocean	13.395669	144.661702
39	N-23	Tumon/Yigo Sub-basin	Naton Beach - Fujita	Ocean	13.5115642	144.8021156
40	N-24	Tumon/Yigo Sub-basin	Gun Beach - Nikko Hotel	Ocean	13.5234420	144.8033110
41	N-25	Tumon/Yigo Sub-basin	Gognga Beach - Okura Hotel	Ocean	13.5199250	144.8061720
42	N-26	Northern	Trinchera Beach - Alupang Beach	Ocean	13.4823360	144.7700190
43	S-18	Talofofo	First Beach	Ocean	13.3423170	144.7715750

Table B5a. Total Sizes of Waters Impaired by Various Cause/Stressor Categories Type of Waterbody: Rivers and Streams (reported in miles).

Cause/Stressor Category	Size of Waters Impaired
Cause/Stressor Unknown	-
Unknown Toxicity	-
Pesticides	-
Priority Organics	-
Non-priority Organics	-
PCBs	6.4 Acres
Dioxins	-
Metals	1.11
Ammonia	1.11
Cyanide	-
Sulfates	-
Chloride	-
Other Inorganics	-
Nutrients	1.37
pH	-
Siltation	-
Organic Enrichment/low DO	5.00
Salinity/TDS/Chlorides	1.32
Thermal Modifications	*
Flow Alterations	-
Other Habitat Alterations	-
Pathogen Indicators	6.17
Radiation	*
Oil and Grease	-
Taste and Odor	*
Suspended Solids	1.32
Noxious Aquatic Plants (Macrophytes)	-
Excessive Algal Growth	-
Total Toxics	-
Turbidity	0.21
Exotic Species	-
Other (specify) Temperature	1.11

Notes: zero (**0**) = Category applicable, but size of water in category is zero
dash (**-**) = Category applicable no data available
asterisk (*****) = category not applicable

Table B5b. Total Sizes of Waters Impaired by Various Cause/Stressor Categories Type of Waterbody: Marine Bays (reported in square miles).

Cause/Stressor Category	Size of Waters Impaired
Cause/Stressor Unknown	-
Unknown Toxicity	0.40
Pesticides	1.98
Priority Organics	2.61
Non-priority Organics	1.98
PCBs	11.68
Dioxins	0.63
Metals	1.98
Ammonia	-
Cyanide	-
Sulfates	-
Chloride	-
Other Inorganics	-
Nutrients	0.70
pH	-
Siltation	-
Organic Enrichment/low DO	0.70
Salinity/TDS/Chlorides	-
Thermal Modifications	*
Flow Alterations	-
Other Habitat Alterations	-
Pathogen Indicators	0.70
Radiation	*
Oil and Grease	-
Taste and Odor	*
Suspended Solids	-
Noxious Aquatic Plants (Macrophytes)	-
Excessive Algal Growth	-
Total Toxics	-
Turbidity	-
Exotic Species	-
Other (specify)	
Secchi Visibility	-

Notes: zero (**0**) = Category applicable, but size of water in category is zero
dash (**-**) = Category applicable no data available
asterisk (*****) = category not applicable

Table B5c. Total Sizes of Waters Impaired by Various Cause/Stressor Categories Type of Waterbody: Recreational Beaches (reported in shoreline miles).

Cause/Stressor Category	Size of Waters Impaired	
	2008	2009
Cause/Stressor Unknown	-	-
Unknown Toxicity	-	-
Pesticides	-	-
Priority Organics	-	-
Non-priority Organics	-	-
PCBs	0.65	0.65
Dioxins	-	-
Metals	-	-
Ammonia	-	-
Cyanide	-	-
Sulfates	-	-
Chloride	-	-
Other Inorganics	-	-
Nutrients	-	-
pH	-	-
Siltation	-	-
Organic Enrichment/low DO	-	-
Salinity/TDS/Chlorides	-	-
Thermal Modifications	*	*
Flow Alterations	-	-
Other Habitat Alterations	-	-
Pathogen Indicators	13.81	13.47
Radiation	*	*
Oil and Grease	-	-
Taste and Odor	*	*
Suspended Solids	-	-
Noxious Aquatic Plants (Macrophytes)	-	-
Excessive Algal Growth	-	-
Total Toxics	-	-
Turbidity	-	-
Exotic Species	-	-
Other (specify)	-	-

Notes: zero (0) = Category applicable, but size of water in category is zero
dash (-) = Category applicable no data available
asterisk (*) = category not applicable

Table B6a. Total Sizes of Waters Impaired by Various Source Categories
Type of Waterbody: Rivers and Streams (reported in miles)

Source Category	Sized Impaired
Industrial Point Sources	-
Municipal Point Sources	6.92
Combined Sewer Overflows	-
Collection System Failure	0.21
Domestic Wastewater Lagoon	*
Agriculture	-
Crop-related sources	*
Grazing-related sources	*
Intensive Animal Feeding Operations	*
Silviculture	*
Construction	0.21
Urban Runoff/Storm Sewers	5.53
Resource Extraction	*
Land Disposal	1.16
Hydromodification	*
Habitat modification (non-hydromod)	-
Marinas and recreational Boating	*
Erosion from Derelict Land	-
Atmospheric Deposition	-
Waste Storage/Storage Tank Leaks	-
Leaking Underground Storage Tanks	-
Highway maintenance and Runoff	-
Spills (Accidental)	-
Contaminated Sediments	-
Debris and Bottom Deposits	-
Internal Nutrient Cycling (Primary lakes)	*
Sediment Resuspension	-
Natural Sources	0.21
Recreational And Tourism Activities	-
Salt Storage Sites	*
Groundwater Loadings	*
Groundwater Withdrawal	*
Other Specify	-
Unknown Source	-
Sources Outside State Jurisdiction	*

Note:

asterisk (*) = category not applicable
dash (-) = Category applicable no data available
zero (0) = Category applicable, but size of water in category is zero

Table B6b. Total Sizes of Waters Impaired by Various Source Categories
Type of Waterbody: Marine Bays (reported in square miles)

Source Category	Sized Impaired
Industrial Point Sources	-
Municipal Point Sources	-
Combined Sewer Overflows	-
Collection System Failure	-
Domestic Wastewater Lagoon	*
Agriculture	-
Crop-related sources	*
Grazing-related sources	*
Intensive Animal Feeding Operations	*
Silviculture	*
Construction	-
Urban Runoff/Storm Sewers	0.70
Resource Extraction	*
Land Disposal	*
Hydromodification	*
Habitat modification (non-hydromod)	-
Marinas and recreational Boating	*
Erosion from Derelict Land	-
Atmospheric Deposition	-
Waste Storage/Storage Tank Leaks	6.04
Leaking Underground Storage Tanks	-
Highway maintenance and Runoff	-
Spills (Accidental)	-
Contaminated Sediments	-
Debris and Bottom Deposits	-
Internal Nutrient Cycling (Primary lakes)	*
Sediment Resuspension	-
Natural Sources	-
Recreational And Tourism Activities	1.98
Salt Storage Sites	*
Groundwater Loadings	-
Other Specify: Leachate from dump	0.70
Other Specify: Groundwater seeps/springs	1.98
Unknown Source	6.04
Sources Outside State Jurisdiction	*

Note:

asterisk (*) = category not applicable

dash (-) = Category applicable no data available

zero (0) = Category applicable, but size of water in category is zero

Table B6c. Total Sizes of Waters Impaired by Various Source Categories
Type of Waterbody: Recreational Beaches (reported in shoreline miles)

Source Category	Sized Impaired
Industrial Point Sources	-
Municipal Point Sources	-
Combined Sewer Overflows	-
Collection System Failure	-
Domestic Wastewater Lagoon	*
Agriculture	-
Crop-related sources	*
Grazing-related sources	*
Intensive Animal Feeding Operations	*
Silviculture	*
Construction	-
Urban Runoff/Storm Sewers	9.65
Resource Extraction	*
Land Disposal	*
Hydromodification	*
Habitat modification (non-hydromod)	-
Marinas and recreational Boating	*
Erosion from Derelict Land	-
Atmospheric Deposition	-
Waste Storage/Storage Tank Leaks	-
Leaking Underground Storage Tanks	-
Highway maintenance and Runoff	-
Spills (Accidental)	-
Contaminated Sediments	-
Debris and Bottom Deposits	-
Internal Nutrient Cycling (Primary lakes)	*
Sediment Resuspension	-
Natural Sources	-
Recreational And Tourism Activities	-
Salt Storage Sites	*
Groundwater Loadings	*
Groundwater Withdrawal	*
Other Specify	-
Unknown Source	0.65
Sources Outside State Jurisdiction	*

Note:

asterisk (*) = category not applicable
dash (-) = Category applicable no data available
zero (0) = Category applicable, but size of water in category is zero

able B7a. FY08 Guam RBMP (Northern) Advisory Summary.

Field ID	Site Location	Number of Advisories Oct-Dec 2007	Number of Days on Advisory Oct-Dec 2007*	Number of Advisories Jan-Mar 2008	Number of Days on Advisory Jan-Mar 2008 *	Number of Advisories Apr-Jun 2008	Number of Days on Advisory Apr-Jun 2008*	Number of Advisories Jul-Sept 2008	Number of Days on Advisory Jul-Sept 2008*	Total Number of Advisories 2008	Total Number of Days on Advisory 2008*
N01	Tanguisson Beach	2	11	10	67	7	48	3	22	22	148
N02	Naton Beach - San Vitores	1	6	7	46	12	83	10	71	30	206
N03	Naton Beach - Matapang Beach Park	1	6	4	28	0	0	0	0	5	34
N04	Naton Beach - Guma Trankilidat	0	0	0	0	0	0	0	0	0	0
N05	Ypao Beach	0	0	1	7	1	7	2	15	4	29
N06	Dungca's Beach - Sleepy Lagoon	3	22	3	14	0	0	0	0	6	36
N07	Dungca's Beach	8	56	10++	67++	3	23	1	7	12	86
N08	East Hagåtña Bay - Trinchera Beach	9	58	12	84	6	40	5	36	32	218
N09	Padre Palomo Park Beach	10	70	12	81	6	44	9	61	37	256
N10	Hagåtña Channel	Closure+ (see Table 1d.)								Closure+ (see Table 1d.)	
N11	Hagåtña Channel - Outrigger Ramp										
N12	Hagåtña Boat Basin										
N13	Hagåtña Bayside Park										
N14	Asan Bay Beach	12	81	11	77	8	58	9	61	40	277
N15	Piti Bay	5	37	9	63	5	32	0	0	19	132
N16	Santos Memorial Park	13	88	11	77	7	49	11	77	42	291
N17	United Seamen's Service	0	0	0	0	0	0	0	0	0	0
N18	Outhouse Beach	0	0	0	0	0	0	3	22	3	22
N19	Family Beach	0	0	0	0	1	4	4	29	5	33
N20	Port Authority Beach	0	0	0	0	0	0	0	0	0	0
N21	Adelup Beach Park	10	70	5	35	1	7	4	26	20	138
N22	Adelup Point Beach (West)	0	0	8	56	0	0	1	7	9	63
N23	Naton Beach - Fujita	0	0	1	7	1	7	0	0	2	14
N24	Gun Beach	3	20	1	7	0	0	0	0	4	27
N25	Gognga Beach	2	14	1	7	1	7	6	43	10	71
N26	East Hagåtña Bay - Alupang Towers Beach	11	76	12++	84++	3	21	8	56	22	153
	Subtotal	90		96		62		76		324	

able B7b. FY08 Guam RBMP (Southern) Advisory Summary.

Field ID	Site Location	Number of Advisories Oct-Dec 2007	Number of Days on Advisory Oct-Dec 2007*	Number of Advisories Jan-Mar 2008	Number of Days on Advisory Jan-Mar 2008 *	Number of Advisories Apr-Jun 2008	Number of Days on Advisory Apr-Jun 2008*	Number of Advisories Jul-Sept 2008	Number of Days on Advisory Jul-Sept 2008*	Total Number of Advisories 2008	Total Number of Days on Advisory 2008*
S01	Rizal Beach	Site Retired								Site Retired	
S02	Togcha Beach - near Namo River	9	63	5	35	0	0	3	21	17	119
S03	Togcha Beach - Agat Park Beach	7	48	7	49	8	53	10	71	32	221
S04	Bangi Beach	12	84	13	88	11	76	12	82	48	330
S05	Nimitz Beach	11	78	6	42	6	42	11	75	34	237
S06	Umatac Bay	9	61	5	35	5	35	9	61	28	192
S07	Toguan Bay	13	88	13	88	11	76	13	90	50	342
S08	Merizo Pier at Mamaon Channel	11	77	8	53	13	90	13	90	45	310
S09	Inarajan Pool	10	70	3	21	0	0	8	54	21	145
S10	Inarajan Bay	12	84	10	67	2	13	13	90	37	254
S11	Talofofo Bay	13	88	12	81	5	33	13	90	43	292
S12	Ipan Public Beach	1	9	1	7	0	0	1	7	3	23
S13	Togcha Bay	8	51	0	0	3	21	3	19	14	91
S14	Tagachang Beach	0	0	0	0	5	35	2	14	7	49
S15	Pago Bay	10	70	0	0	0	0	10	68	20	138
S16	Lonfit River Swimming Hole (summer station)	Site Retired								Site Retired	
S17	Togcha Beach - near Southern Christian Academy	10	70	6	42	10	70	9	61	35	243
S18	First Beach	4	30	0	0	0	0	0	0	4	30
	Subtotal	140		89		79		130		438	

able B7c. FY08 Guam RBMP (Combined) Advisory Summary.

RBMP Area	Number of Advisories Oct-Dec 2007*	Number of Advisories Jan-Mar 2008 *	Number of Advisories Apr-Jun 2008*	Number of Advisories Jul-Sept 2008*	Total Number of Advisories 2008
Northern Subtotal	90	96	62	76	324
Southern Subtotal	140	89	79	130	438
Total	**230**	**185**	**141**	**206**	**762**

able B7d. FY08 Guam EPA/Guam Dept. of Public Health Closure Summary.

Beach Area	Number of Closures Oct-Dec 2007*	Number of Closures Jan-Mar 2008*	Number of Closures Apr-Jun 2008*	Number of Closures Jul-Sept 2008*	Total Number of Closures 2008	Total Number of Days on Closure 2008*
West Hagatna Bay	1	1	1	1	4	366
Dungca's Beach	0	1	0	0	1	3
East Hagåtña Bay - Alupang Towers Beach	0	1	0	0	1	3

*Note: 1st Q FY08 = October - December 2007 (92 days); 2nd Q FY08 = January - March 2008 (91 days); 3rd Q FY08 = April - June 2008 (91 days); 4th Q FY08 = July - September 2008 (92 days)

**Note: 2nd Q FY08 'Number of Days on Advisory' values were adjusted to reflect actual calendar days in the quarter.

+Closure: West Hagåtña Bay is currently closed due to a sewage leak in the effluent pipe from the Hagåtña Sewage Treatment Plant.

++Closure: Dungca's Beach and East Hagatna Bay at Alupang Beach Towers were closed 3/25-27/2008 due to sewage overflows (Spill report attached).

Table B8a. FY09 Guam RBMP (Northern) Advisory Summary.

Field ID	Site Location	Number of Advisories 1st Q FY09	Number of Days on Advisory 1st Q FY09*	Number of Advisories 2nd Q FY09	Number of Days on Advisory 2nd Q FY09*	Number of Advisories 3rd Q FY09	Number of Days on Advisory 3rd Q FY09*	Number of Advisories 4th Q FY09	Number of Days on Advisory 4th Q FY09*	Total Number of Advisories FY09	Total Number of Days on Advisory FY09*
N01	Tanguisson Beach	3	22	5	42	9	62	5	36	22	162
N02	Naton Beach - San Vitores	1	5	0	0	7	48	10	70	18	123
N03	Naton Beach - Matapang Beach Park	0	0	0	0	5	35	1	7	6	42
N04	Naton Beach - Guma Trankilidat	0	0	0	0	2	14	0	0	2	14
N05	Ypao Beach	0	0	0	0	1	7	2	14	3	21
N06	Dungca's Beach - Sleepy Lagoon	0	0	2	14	3	21	8	56	13	91
N07	Dungca's Beach	8	50	5	42	7	50	11	77	31	219
N08	East Hagåtña Bay - Trinchera Beach	10	68	0	0	10	70	10	69	30	207
N09	Padre Palomo Park Beach	8	51	6	47	8	55	9	63	31	216
N10	Hagåtña Channel	Closure' (see Table 1d.)								Closure' (see Table 1d.)	
N11	Hagåtña Channel - Outrigger Ramp										
N12	Hagåtña Boat Basin										
N13	Hagåtña Bayside Park										
N14	Asan Bay Beach	9	65	4	35	6	43	11	76	30	219
N15	Piti Bay	12	82	0	7	2	12	6	41	20	142
N16	Santos Memorial Park	11	75	4	35	2	14	11	76	28	200
N17	United Seamen's Service	1	7	1	7	0	0	1	7	3	21
N18	Outhouse Beach	0	0	0	0	0	0	1	7	1	7
N19	Family Beach	3	18	0	0	0	0	1	7	4	25
N20	Port Authority Beach	1	7	0	0	1	7	7	48	9	62
N21	Adelup Beach Park	7	50	0	0	0	0	7	48	14	98
N22	Adelup Point Beach (West)	6	45	0	0	0	0	1	7	7	52
N23	Naton Beach - Fujita	0	0	0	0	2	14	1	7	3	21
N24	Gun Beach	0	0	1	7	5	35	2	14	8	56
N25	Gognga Beach	1	7	1	7	6	42	9	63	17	119
N26	East Hagåtña Bay - Alupang Towers Beach	10	64	3	28	2	14	10	69	25	175
	Subtotal	91		32		78		124		325	

Table B8b. FY09 Guam RBMP (Southern) Advisory Summary.

Field ID	Site Location	Number of Advisories 1st Q FY09	Number of Days on Advisory 1st Q FY09*	Number of Advisories 2nd Q FY09	Number of Days on Advisory 2nd Q FY09*	Number of Advisories 3rd Q FY09	Number of Days on Advisory 3rd Q FY09*	Number of Advisories 4th Q FY09	Number of Days on Advisory 4th Q FY09*	Total Number of Advisories FY09	Total Number of Days on Advisory FY09*
S01	Rizal Beach	Site Retired								Site Retired	
S02	Togcha Beach - near Namo River	11	68	9	70	6	42	10	69	36	249
S03	Togcha Beach - Agat Park Beach	2	14	6	40	8	54	11	77	27	185
S04	Bangi Beach	13	86	9	70	6	41	12	83	40	280
S05	Nimitz Beach	7	53	9	70	6	42	13	91	35	256
S06	Umatac Bay	14	91	4	35	5	35	9	62	32	223
S07	Toguan Bay	14	91	6	49	12	83	13	91	45	314
S08	Merizo Pier at Mamaon Channel	13	84	10	77	9	62	13	91	45	314
S09	Inarajan Pool	1	8	0	0	3	21	10	69	14	98
S10	Inarajan Bay	13	86	10	75	7	50	13	91	43	302
S11	Talofofo Bay	14	91	10	77	2	13	12	83	38	264
S12	Ipan Public Beach	0	0	1	7	0	0	0	0	1	7
S13	Togcha Bay	3	22	0	0	2	14	11	76	16	112
S14	Tagachang Beach	0	0	1	7	0	0	0	0	1	7
S15	Pago Bay	8	58	0	0	4	28	9	62	21	148
S16	Lonfit River Swimming Hole (summer station)	Site Retired								Site Retired	
S17	Togcha Beach - near Southern Christian Academy	4	30	3	21	11	75	13	91	31	217
S18	First Beach	0	0	0	0	0	0	2	14	2	14
	Subtotal	117		78		81		151		427	

Table B8c. FY09 Guam RBMP (Combined) Advisory Summary.

RBMP Area	Number of Advisories 1st Q FY09*	Number of Advisories 2nd Q FY09*	Number of Advisories 3rd Q FY09*	Number of Advisories 4th Q FY09*	Total Number of Advisories FY09
Northern Subtotal	91	32	78	124	325
Southern Subtotal	117	78	81	151	427
Total	208	110	159	275	752

Table B8d. FY09 Guam EPA/Guam Dept. of Public Health Closure Summary.

Beach Area	Number of Closures 1st Q FY09*	Number of Closures 2nd Q FY09*	Number of Closures 3rd Q FY09*	Number of Closures 4th Q FY09*	Total Number of Closures FY09	Total Number of Days on Closure FY09*
West Hagatna Bay	1	1	1	1	4	365

*Note: 1st Q FY09 = October - December 2008 (92 days)
2nd Q FY09 = January - March 2009 (90 days)
3rd Q FY09 = April - June 2009 (91 days)
4th Q FY09 = July - September 2009 (92 days)

'Closure: West Hagåtña Bay is currently closed due to a sewage leak in the effluent pipe from the Hagåtña Sewage Treatment Plant.

Table B.9 Major Sources of Groundwater Contamination 2008-2009

Contaminant Source	Ten Highest-Priority Sources (✓) [1]	Factors Considered in Selecting a Contaminant Source [2]	Contaminants [3]
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 (above ground)			
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)			

Table B.10 Summary of Guam Groundwater Protection Programs 2008-2009

Programs or Activities	Check (✓) (1)	Implementation Status (2)	Responsible State Agency (3)
Active SARA Title III Program			
Ambient ground water monitoring system			
Aquifer vulnerability assessment			
Aquifer mapping	✓		GEPA, WERI
Aquifer characterization	✓		GEPA, WERI
Comprehensive data management system	✓		WERI
EPA-endorsed Core Comprehensive State Ground Water Protection Program (CSGWPP)			
Ground water discharge permits	✓		GEPA
Ground water Best Management Practices	✓		GEPA, WPC
Ground water legislation	✓		GEPA
Ground water classification	✓		GEPA
Ground water quality standards	✓		GEPA
Interagency coordination for ground water protection initiatives	✓		AAFB,GEPA*
Nonpoint source controls	✓		GEPA
Pesticide State Management Plan	✓		GEPA
Pollution Prevention Program	✓		GEPA
Resource Conservation and Recovery Act (RCRA) Primacy	✓		GEPA
Source Water Assessment Program(4)			
State Superfund	✓		GEPA
State RCRA Program incorporating more stringent requirements than RCRA Primacy	✓		GEPA
State septic system regulations	✓		GEPA*
Underground storage tank installation requirements			
Underground Storage Tank Remediation Fund			
Underground Storage Tank Permit Program	✓		GEPA
Underground Injection Control Program	✓		GEPA
Vulnerability assessment for drinking water/wellhead protection	✓		GEPA
Well abandonment regulations	✓		GEPA
Wellhead Protection Program (EPA-approved)	✓		GEPA
Well installation regulations	✓		GEPA
Other programs or activities (please specify)			
Watershed Planning Committee activities	✓		GEPA*

2010 GUAM INTEGRATED REPORT

APPENDIX C

Table C1. CMS Physical/Community Parameters

Physical/Community	STMP (Marine)	STMP (Rivers)	RBMP	GCA	GWSA	FSCMP	MPWQA
PHYSICAL HABITAT *in situ*							
THALWEG PROFILE							
Thalweg depth					X		
Wetted width					X		
Habitat class					X		
WOODY DEBRIS TALLY							
Large woody debris					X		
CHANNEL & RIPARIAN CROSS-SECTIONS							
Slope and bearing					X		
Substrate size					X		
Bank angle					X		
Bank incision					X		
Bank undercut					X		
Bankful width					X		
Bankful height					X		
Canopy cover					X		
Riparian vegetation structure					X		
Fish cover, algae, macrophytes					X		
Human influence					X		
STREAM DISCHARGE							
Discharge m/s or L/min					X		
BENTHOS & FISH							
Benthic community							
Infaunal composition				X			X
Infaunal abundance				X			X
Fish Community							
Composition				X	X		X
Abundance				X	X		X
Biomass estimate (Length)				X	X		X
Frequency of external anomalies					X		
Periphyton							
Periphyton: Species	X				X		
Periphyton: Biomass: Ash-Free Dry Mass	X				X		

Table C1. CMS Physical/Community Parameters

Physical/Community	STMP (Marine)	STMP (Rivers)	RBMP	GCA	GWSA	FSCMP	MPWQA
Periphyton (continued)							
Periphyton: Chlorophyll-a and Pheophytin	X				X		
Periphyton: Alkaline/Acid Phosphatase					X		
Plankton							
Plankton: Species	X						
Plankton: Chlorophyll-a and Pheophytin	X						
Plankton: Biomass: Ash-Free Dry Mass	X						
Benthic Invertebrates							
Stream Benthic Integrity Index (BII)					X		
Biological Condition					X		
BENTHOS & FISH (continued)							
Benthic habitat description							
Aerial coverage (veg & substrate)	X			X			
Invertebrate composition & abundance	X			X			
Degree of wave impact				X			
Anthropogenic debris				X			
Threatened/endangered species				X			

Table C2. CMS Water Parameters

WATER	STMP (Marine)	STMP (Rivers)	RBMP	GCA	GWSA	FSCMP	MPWQA
Water Column Characteristics in situ							
Conductivity, *field* (HACH METER)	X	X			X		
Conductivity, *field* (YSI or HYDROLAB)				X			X
Current speed and direction, *field*	X						
Depth assigned, *field* (YSI/HYDROLAB)	X			X			X
Dissolved Oxygen, *in situ* (HACH METER)		X		X	X		X
Dissolved Oxygen, *in situ*	X			X			X
pH, *field* (HACH METER)	X	X		X			X
pH, *field* (YSI/HYDROLAB)	X			X			X
Temperature, *in situ* (HACH METER)		X		X	X		X
Temperature, *in situ* (YSI/HYDROLAB)				X			X
Temperature, *in situ* (FIELD	X			X			X
Salinity (field), *in situ*	X						
Transparency/clarity (Secchi Visibility), *field*	X			X			X
Transparency/clarity (PAR), *field*				X			X
Turbidity (NTU), *field* (HACH METER)	X	X		X	X		X
Turbidity (NTU), *field* (YSI/HYDROLAB)	X			X			X
Water Column Parameters							
Acid Neutralizing Capacity-Alkalinity (ANC)					X		
Aluminum, monomeric and organic					X		
Aluminum, total dissolved					X		
Bacteria (E. coli)		X	X				
Bacteria (enterococci)	X		X	X			X
Carbon, dissolved inorganic (DIC), closed					X		
Carbon, dissolved organic (DOC)					X		
Chemical Oxygen Demand		X					
Chlorophyll a and Pheophytin a				X			X
Conductivity, laboratory	X	X		X	X		X
Dissolved Oxygen, laboratory	X	X		X	X		X
Major Anion - Chloride, dissolved					X		
Major Anion - Nitrate, dissolved					X		
Major Anion -Sulfate, dissolved					X		
Major Cation - Calcium dissolved					X		

Table C2. CMS Water Parameters

WATER	STMP (Marine)	STMP (Rivers)	RBMP	GCA	GWSA	FSCMP	MPWQA
Water Column Parameters (continued)							
Major Cation - Magnesium, dissolved					X		
Major Cation - Potassium, dissolved					X		
Major Cation - Sodium, dissolved					X		
N tot, Total dissolved nitrogen	X	X			X		
NH3, Ammonium				X			X
NH3, Ammonium (Wet Deposition)					X		
NO2, Nitrite	X	X		X			X
NO3, Nitrate nitrogen	X	X		X			X
P -PO4, Orthophosphorus	X	X		X			X
P tot, Total dissolved phosphorus	X	X			X		
pH, closed system					X		
pH, Electometric Method	X	X		X			X
Silica, dissolved in Fresh water					X		
Total Filterable Solids/Dissolved Solids	X	X					
Total Nonfilterable/Total Suspended Solids	X	X		X	X		X
True Color					X		
Trace Metals:							
Arsenic	X	X					
Cadmium	X	X					
Chromium III		X					
Chromium IV	X	X					
Copper	X	X					
Lead	X	X					
Mercury	X	X					

Table C3. CMS Tissue
Parameters

TISSUE	STMP (Marine)	STMP (Rivers)	RBMP	GCA	GWSA	FSCMP
Polynuclear Aromatic hydrocarbons (PAHs):						
Acenaphthylene				X		X
Acenaphthene				X		X
Anthracene				X		X
Benz(a)anthracene				X		X
Benzo(a)pyrene + (e) for FSCMP only				X		X
Benzo(b)fluoranthene				X		X
Biphenyl				X		
Benzo(k)fluoranthene + (e) for FSCMP only				X		X
Benzo(g,h,i)perylene				X		X
Chrysene				X		X
Dibenz(a,h)anthracene				X		X
Dibenzothiophene				X		
Fluoranthene				X		X
Fluorene				X		X
2,6-dimethylnaphthalene				X		
Indeno(1,2,3-c,d)pyrene				X		X
Naphthalene				X		
Pyrene				X		X
1-methylnaphthalene				X		
1-methylphenanthrene				X		
2-methylnaphthalene				X		
2,3,5-trimethylnaphthalene				X		
2,6-dimethylnaphthalene				X		
PCB Congeners:						
8 - 2-4'-dichlorobiphenyl	X			X	X	X
18 - 2,2',5-trichlorobiphenyl	X			X	X	X
28 - 2,4,4'-trichlorobiphenyl	X			X	X	X
44 - 2,2',3,5'-tetrachlorobiphenyl	X			X	X	X
52 - 2,2',5,5'-tetrachlorobiphenyl	X			X	X	X
66 - 2,3',4,4'-tetrachlorobiphenyl	X			X	X	X
101 - 2,2',4,5,5'-pentachlorobiphenyl	X			X	X	X
105 - 2,3,3',4,4'-pentachlorobiphenyl	X			X	X	X
110/77 - 2,3,3',4',6-pentachlorobiphenyl	X			X		
#77 3,3',4,4'-tetrachlorobiphenyl	X			X	X	X
118 - 2,3',4,4',5-pentachlorobiphenyl	X			X	X	X
126 - 3,3',4,4',5-pentachlorobiphenyl	X			X	X	X
128 - 2,2',3,3',4,4'-hexachlorobiphenyl	X			X	X	X
138 -2,2',3,4,4',5'-hexachlorobiphenyl	X			X	X	X
153 - 2,2',4,4',5,5'-hexachlorobiphenyl	X			X	X	X
#169 - 3,3',4,4',5,5' Hexachlorobiphenyl					X	X
170 - 2,2',3,3',4,4',5-heptachlorobiphenyl	X			X	X	X
180 - 2,2',3,4,4',5,5'-heptachlorobiphenyl	X			X	X	X
187 - 2,2',3,4',5,5',6-heptachlorobiphenyl	X			X	X	X
195 - 2,2',3,3',4,4',5,6-octachlorobiphenyl	X			X	X	
206 - 2,2',3,3',4,4',5,5',6-nonachlorobiphenyl	X			X	X	
209 - 2,2',3,3',4,4',5,5',6,6'-decachlorobiphenyl	X			X	X	

Table C3. CMS Tissue Parameters

TISSUE	STMP (Marine)	STMP (Rivers)	RBMP	GCA	GWSA	FSCMP
Dioxins/furans						X
Chlorinated Pesticides other than DDT:						
Aldrin (309-00-2)				X	X	
Carbaryl (Sevin) (63-25-2)	X					
chlorodane, Alpha-				X		
Chlordane-cis (5103-71-9)					X	X
Chlordane-*trans* (5103-74-2)					X	X
Chlorpyrifos (Dursban Pro/insecticide)					X	X
Diazinon	X				X	X
Dicofol						X
Dieldrin (60-57-1)				X	X	X
Disulfoton					X	X
Endosulfan total						X
Endosulfan I (959-98-8)				X	X	X
Endosulfan II (33213-65-9)				X	X	X
Endosulfan sulfate (1031-07-8)				X		
Endrin (72-20-8)	X			X	X	X
2,4-D (Esteron 99)	X					
Ethion					X	X
Heptachlor (76-44-8)				X	X	
Heptachlor epoxide (1024-57-3)				X	X	X
Hexachlorobenzene (118-74-1)				X	X	X
Hexachlorocyclohexane (58-89-9)	X			X	X	X
Malathion	X					
Methoxychlor	X					
Mirex (2385-85-5)				X	X	X
Naled (Dibrom)	X					
Trans-Nonachlor (3765-80-5)				X	X	X
cis-Nonachlor (5103-73-1)					X	X
Oxychlordane (27304-13-8)					X	X
Oxyfluorfen						X
2,4,5-TP Silvex	X					
Terbufos					X	X
Toxaphene	X			X		X
DDT° and Metabolites:						
2,4' -DDD (53-19-0)				X	X	X
4,4' -DDD (72-54-8)				X	X	X
2,4' -DDE (3424-82-6)				X	X	X
4,4' -DDE (72-55-9)				X	X	X
2,4' -DDT (789-02-6)				X	X	X
4,4' -DDT (50-29-3)				X	X	X
Inorganics						
Aluminum CAS No. (7429-90-5)				X	X	
Arsenic (7440-38-2) inorganic	X			X	X	X
Cadmium (7440-43-9)	X			X	X	X
Chromium (7440-47-3)	X			X	X	
Copper (7440-50-8)	X			X	X	

Table C3. CMS Tissue Parameters

TISSUE	STMP (Marine)	STMP (Rivers)	RBMP	GCA	GWSA	FSCMP
Inorganics (continued)						
Iron (7439-89-6)				X	X	
Lead (7439-92-1)	X			X	X	
Mercury-methy (7439-97-6)	X			X	X	X
Nickel (7440-02-0)	X			X	X	
Selenium (7782-49-2)	X			X	X	X
Silver (7440-22-4)	X			X	X	
Tin (7440-31-5)				X	X	
Tributyltin					X	X
Zinc (7440-66-6)				X	X	
Tissue Chemistry						
Percent Lipid Determination	X			X	X	X

Table C4. CMS Sediment
Parameters

SEDIMENT	STMP (Marine)	STMP (Rivers)	RBMP	GCA	GWSA	FSCMP
Sediment: Physical Characteristics						
Total organic carbon				X		
Granulometry				X		
Sediment toxicity						
Amphipod Bioassay				X		
Sediment: contaminant analyses						
Polynuclear Aromatic hydrocarbons (PAHs):						
Acenaphthylene				X		
Acenaphthene				X		
Anthracene				X		
Benz(a)anthracene				X		
Benzo(a)pyrene				X		
Benzo(b)fluoranthene				X		
Biphenyl				X		
Benzo(k)fluoranthene				X		
Benzo(g,h,i)perylene				X		
Chrysene				X		
Dibenz(a,h)anthracene				X		
Dibenzothiophene				X		
Fluoranthene				X		
Fluorene				X		
2,6-dimethylnaphthalene				X		
Indeno(1,2,3-c,d)pyrene				X		
Naphthalene				X		
Pyrene				X		
1-methylnaphthalene				X		
1-methylphenanthrene				X		
2-methylnaphthalene				X		
2,3,5-trimethylnaphthalene				X		
2,6-dimethylnaphthalene				X		
PCB Congeners						
8 - 2-4'-dichlorobiphenyl				X		
18 - 2,2',5-trichlorobiphenyl				X		
28 - 2,4,4'-trichlorobiphenyl				X		
44 - 2,2',3,5'-tetrachlorobiphenyl				X		
52 - 2,2',5,5'-tetrachlorobiphenyl				X		
66 - 2,3',4,4'-tetrachlorobiphenyl				X		
101 - 2,2',4,5,5'-pentachlorobiphenyl				X		
105 - 2,3,3',4,4'-pentachlorobiphenyl				X		
110/77 - 2,3,3',4',6-pentachlorobiphenyl				X		
3,3',4,4'-tetrachlorobiphenyl				X		
118 - 2,3',4,4',5-pentachlorobiphenyl				X		
126 - 3,3',4,4',5-pentachlorobiphenyl				X		
128 - 2,2',3,3',4,4'-hexachlorobiphenyl				X		
138 -2,2',3,4,4',5'-hexachlorobiphenyl				X		
153 - 2,2',4,4',5,5'-hexachlorobiphenyl				X		
170 - 2,2',3,3',4,4',5-heptachlorobiphenyl				X		
180 - 2,2',3,4,4',5,5'-heptachlorobiphenyl				X		
187 - 2,2',3,4',5,5',6-heptachlorobiphenyl				X		
195 - 2,2',3,3',4,4',5,6-octachlorobiphenyl				X		
206 - 2,2',3,3',4,4',5,5',6-nonachlorobiphenyl				X		
209 - 2,2',3,3',4,4',5,5',6,6'-				X		

Table C4. CMS Sediment
Parameters

SEDIMENT		STMP (Marine)	STMP (Rivers)	RBMP	GCA	GWSA	FSCMP
Chlorinated pesticides other than DDT							
	Aldrin				X		
	Alpha-chlorodane				X		
	Dieldrin				X		
	Endosulfan I				X		
	Endosulfan II				X		
	Endosulfan sulfate				X		
	Endrin				X		
	Heptachlor				X		
	Heptachlor epoxide (breakdown of				X		
	Hexachlorobenzene				X		
	Lindane (gamma-BHC)				X		
	Mirex				X		
	Toxaphene				X		
	Trans-Nonachlor				X		
DDT and Metabolites							
	2,4' -DDD				X		
	4,4' -DDD				X		
	2,4' -DDE				X		
	4,4' -DDE				X		
	2,4' -DDT				X		
	4,4' -DDT				X		
Inorganics							
	Aluminum				X		
	Antimony				X		
	Arsenic				X		
	Cadmium				X		
	Chromium				X		
	Copper				X		
	Iron				X		
	Lead				X		
	Manganese				X		
	Mercury				X		
	Nickel				X		
	Selenium				X		
	Silver				X		
	Tin				X		
	Zinc				X		

Table C5. Analytical Parameters

Parameters	Method number
pH	EPA 150.1
Total Non-filterable Solids	EPA 160.1
Total Filterable Solids	EPA 160.2
Temerature	EPA 170.1
Turbidity	EPA 180.1
*Seleinum	EPA 200.9
*Arsenic	EPA 206.3
*Barium	EPA 208.1
*Cadmium	EPA 213.2
Calcium	EPA 215.1
*Chromium	EPA 218.2
Cobalt	EPA 219.2
*Copper	EPA 220.2
*Lead	EPA 239.2
Mercury	EPA 245.1
Nickel	EPA 249.2
Silver	EPA 272.2
Sodium	EPA 273.1
Chloride	EPA 325.3
Nitrate-nitrogen	EPA 352.1
Dissolved Oxygen	EPA 360.2
Biochemical Oxygen Demand	EPA 405.1
Chemical Oxygen Demand	EPA 410.1
*Endrin	EPA 505
*Lindane	EPA 505
*Methoxychlor	EPA 505
*Toxaphene	EPA 505
PCB's	EPA 505
***2,4-D (Esteron 99)	EPA 515.1
***2,4,5-TP Silvex	EPA 515.1
VOC's	EPA 524.2
Carbaryl (Sevin)	EPA 531.1
Glysphosate	EPA 547
**Diazinon	EPA 8140
**Malathion	EPA 8140
**Naled (Dibrom)	EPA 8140
Chlorophyll A	SM 10200-H
Salinity (ppt)	SM 2520A
Nitrite-nitrogen	SM 4500-NO2
Total Phosphorus	SM 4500-P
Conductivity	SM 9050
Fecal coliform	SM 9131
Enterococci coliform	SM 9230

Note: * (asterisks) - Denotes Drinking Water Parameter
** Methods are not set up for Extraction

Table C6. Parameters for Physical and Chemical Monitoring of Rivers and Marine Waters

PARAMETERS		GWQS		
Marine Water	Surface Water	M1/S1	M2/S2	M3/S3
Enterococci (24 or 48hr.)		MARINE five sequential single sample geometric mean of 35 CFU/100mL and instantaneous/single sample of 104 CFU/100mL; FRESHWATER five sequential single sample geometric mean of 33 CFU/100mL and instantaneous/single sample of 61 CFU/100mL		MARINE five sequential single sample geometric mean of 35 CFU/100mL and instantaneous/single sample of 276 CFU/100mL; FRESHWATER five sequential single sample geometric mean of 33 CFU/100mL and instantaneous/single sample of 108 CFU/100mL
--	E. coli	FRESHWATER ONLY Five sequential single sample geometric mean of 126 CFU/100mL and instantaneous/single sample maximum of 235 CFU/100mL.		FRESHWATER ONLY Five sequential single sample geometric mean of 126 CFU/100mL and instantaneous/single sample maximum of 406 CFU/100mL.
Fecal coliform (shellfish harvesting & growing areas)		Median of 14 fecal coliform/100mL and 10% of water samples taken from growing area should not exceed 43 fecal coliform/100mL.		
pH		Marine, Estuarine: 6.5 - 8.5 range (also, in deeper than euphotic zones, not >0.2pH from ambient) Freshwater: 6.5 - 9.0		
Ortho-phosphate (PO4-P)		not > 0.025 mg/L	not > 0.05 mg/L	not > 0.10 mg/L
Nitrate-nitrogen (NO3-N)		not > 0.10 mg/L	not > 0.20 mg/L	not > 0.50 mg/L
Ammonia-nitrogen		MARINE (M-1, M-2, M-3): 0.02 mg/L (table IV GWQS) FRESHWATER (S-1,S-2,S-3): 1hour average conc. not > CMC more than once every 3 years AND 30day average conc. not > CCC more than once every 3 years AND the average conc. over 30days not > CCC AND ambient conc. averaged over 4days not > 2xCCC.		
Dissolved Oxygen		Not decreased to < 75% saturation at any time [OR at 30degC Fresh water not < 5.6 mg/L; Marine and Wetlands Water not < 4.6 mg/L at 26degC Fresh water not < 6.2 mg/L; Marine and Wetlands Water not < 5.0 mg/L]		
Salinity	Salinity/Chlorides/Sulfates Total Dissolved Solids	Marine, estuarine, wetlands: not > +10% of ambient Freshwater only: max Cl and SO4 = 250 mg/L; TDS not > 500 mg/L or 133% of ambient; Salinity not > +20% of ambient.		
Residue (TSS)		TSS: not increased from ambient and not > 5 mg/L	TSS: not > +10% ambient and not > 20 mg/L	TSS: not > +25% ambient and not > 40 mg/L
Turbidity		not > 0.5 NTU over ambient (except when due to natural conditions)	not > 1.0 NTU over ambient (except when due to natural conditions)	
Secchi Visibility (Vertical or Horizontal)		not < 5m from ambient (except when due to natural conditions)		
Water Temperature		not changed more than 1.0^{0}C or 1.8^{0}F from ambient (Thermal effluent not meeting this standard shall be considered as having an adverse effect on aquatic life).		
Radioactive Materials		Discharges at any level into any waters are strictly prohibited.		
Oil or Petroleum Products		1) Shall not detect a visible film, sheen or result in visible discoloration of the surface with a corresponding oil or petroleum product odor, 2) Shall not cause damage to fish, inverts or objectionable degradation of drinking water quality, 3) shall not form an oil deposit on the shores or bottom of the receiving body of water.		
Toxic Substances (water column, sediment, drinking water consumption, organisms consumption)		General: 1) All waters shall be maintained free of toxic substances in concentrations that produce detrimental physiological, acute or chronic responses in human, plant, animal or aquatic life. 2) All waters shall be maintained free of toxic subs in conc. that produce contamination in harvestable aquatic life to the extent that it causes detrimental physiological, acute or chronic responses in humans or protected wildlife, when consumed. 3) The survival of aquatic life in marine and surface waters subjected to a waste discharge, or other controllable water quality factors, shall not be less than that for the same water body in areas unaffected by the waste discharge. Numeric criteria: see Appendix A in 2001 GWQS.		

2010 GUAM INTEGRATED REPORT

APPENDIX D

GOVERNMENT OF GUAM
OFFICE OF THE GOVERNOR

EXECUTIVE ORDER NO. 2004-04

ESTABLISHING THE WATERSHED PLANNING COMMITTEE AND REQUIRING THE IMPLEMENTATION OF A COMPREHENSIVE WATERSHED PLANNING PROCESS

WHEREAS, Guam's surface and groundwater resources provide drinking water, world-class recreational opportunities, diverse coral reef ecosystems and marine resources, all of which are dependent on clean water; and,

WHEREAS, watersheds are the land areas over which water drains, including wetlands, streams, rivers, estuaries, and karst limestone formations which contribute to a body of water such as a reservoir, an aquifer or the ocean. Because watersheds are complete hydrological units they represent the most appropriate environmental context in which to manage water resources; and,

WHEREAS, nonpoint source pollution is caused by rainfall moving over and through the ground. As the water moves it picks up and carries away natural and human-made pollutants, finally depositing them into lakes, rivers, wetlands, coastal waters and even underground sources of drinking water or aquifers. These pollutants include fertilizers, pesticides, oil, grease, toxic chemicals, sediment, bacteria and nutrients; and,

WHEREAS, nonpoint source pollution management, as mandated by Section 319 of the Federal Water Pollution Control Act (WPCA) and Section 6217 of the Coastal Zone Act Reauthorization Amendments (CZARA), requires enforceable programs to protect and restore water resources through a Comprehensive Watershed Planning Process and the systematic implementation of Restoration Strategies and projects to achieve protection and restoration objectives; and,

WHEREAS, Executive Order 99-09 amplified the Water Planning Committees' (WPC) work as well as described and endorsed the "watershed approach" for managing water resources by prioritizing watersheds of impaired water bodies, engaging stakeholders, determining the need for and the developing legislation to further the mandates and initiatives related to WPC work, and identify other support functions to the WPC.

NOW, THEREFORE, I, FELIX P. CAMACHO, Governor of Guam, Pursuant to the authority vested in me by the Organic Act of Guam, do hereby declare that:

(1) Executive Order 99-09 is repealed in its entirety.

(2) The Water Planning Committee shall henceforth be known as the Watershed Planning Committee (WPC).

(3) Participation by the following WPC Government of Guam member agencies is mandatory:

Guam Environmental Protection Agency (GEPA), Chair
Bureau of Statistics and Plans (BSP)
Department of Agriculture (DoAg)
Department of Land Management (DLM)
Department of Public Works (DPW)
Guam Waterworks Authority (GWA)
Port Authority of Guam (PAG)
Department of Education (DoE)
Department of Parks and Recreation (DPR)
University of Guam Marine Laboratory (Marine Lab)
University of Guam Water and Environmental Research Institute (WERI)
University of Guam College of Natural and Applied Sciences (CNAS)

The WPC will maintain a standing policy that membership by invitation for Federal Government agencies and community-based organizations, is encouraged:

U.S. Navy (USN)
U.S. Air Force (USAF)
U. S. Coast Guard (USCG)
U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS)
U.S. Environmental Protection Agency (USEPA)
U.S. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA)
National Park Service (NPS)
U.S. Fish & Wildlife Service (FWS)
Northern and Southern Guam Soil and Water Conservation Districts (SWCD)

(4) The Committee will develop and incorporate a Guam Comprehensive Watershed Planning Process (CWPP), under the direction of the GEPA in cooperation with the Bureau of Statistics and Plans, Guam Coastal Management Program (GCMP), to serve as the programmatic basis for developing Watershed Management Plans. In addition, the Committee will develop a plan for the implementation of the CWPP throughout the entire coastal zone over a period of 15 years.

Watershed Management Plans will address nonpoint source pollution control through the assessment and prioritization of pollutant sources and by identifying opportunities for and the implementation of appropriate Management Measures to reduce nonpoint pollution. Furthermore, where appropriate, the government of Guam member agencies of the WPC will apply all relevant enforceable polices to control identified sources. This planning approach expands upon existing WPC planning work which has produced Watershed Restoration Action Strategies.

Strategies.

(5) A major focus of the CWPP is to include the systematic assessment and identification of opportunities to reduce nonpoint source pollution in accordance with Coastal Zone Act Reauthorization Amendments (CZARA), Section 6217 (g) *Guidance* as well as to refine the Guam Nonpoint Source Pollution Control Program as authorized by Section 319 of the WPCA. Pursuant to these requirements, the CWPP will be responsible for identifying and assessing, on a watershed basis, all relevant existing sources of nonpoint pollution and opportunities for reducing said sources, including those from Urban, Agricultural, and Hydromodification activities.

(6) The Committee will formulate and identify Critical Coastal Areas in Guam that need additional measures to protect against current and anticipated nonpoint pollution problems. The Committee will develop a process to identify, implement, evaluate , and as necessary, revise additional management measures to mitigate problems that may occur in these identified areas of concern.

(7) All departments, agencies and instrumentalities of the government of Guam will comply with the intent, regulatory requirements, and guidance for incorporating Management Measures in the conduct of their business, including but not limited to, current operations and existing development, redevelopment, restoration activities, and future development, in accordance with the Guam Soil Erosion and Sedimentation Control Regulations (GSESCR), 6217 (g) Guidance for the Guam Coastal Nonpoint Pollution Control Program (GCNPCP), and all other applicable rules which directly or indirectly support efforts to control nonpoint source pollution. All departments will consult with the Guam Environmental Protection Agency early in the process of development planning to determine the scope and extent of requirements necessary to comply with the GCNPCP, GSESCR, and other applicable rules.

(8) The WPC will develop a final strategy and time-line for implementing the CWPP throughout Guam within 180 days of the effective date of this Executive Order. A pilot Watershed Management Plan project will be undertaken to implement the CWPP in one watershed prior to full implementation of the process.

(9) The WPC Environmental Education Subcommittee, with GEPA serving as the lead agency, is directed to prepare an Environmental Education and Awareness Strategy to address a comprehensive range of environmental and natural resource issues, including watershed protection and the framework for a single entity to coordinate education and awareness activities for the island, which shall be completed and submitted to the Governor's Office for review not more than 270 days from the effective date of this Order. The Department of Education shall fully participate on the WPC as a member of this subcommittee.

(10) Guam's "Northern Watershed," which consists of six (6) sub-basins, and the Talofofo Watershed, which includes the Ugum Watershed, remain the island's Priority Watersheds for the planning and implementation of Watershed Restoration Strategies and Management Measures. These watersheds are the source of approximately eighty percent (80%) of Guam's drinking water supply. The economic significance of these resources cannot be overstated and therefore they must be diligently managed for sustainability.

(11) Whenever appropriate, the WPC will coordinate its activities with other committees and groups that focus on similar natural resource issues, such as the Coral Reef Initiative Coordinating Committee (CRICC).

(12) Through the implementation of the CWPP and the collection of relevant water quality monitoring data, the WPC will assess the need for additional or amended legislation or additional management measures to enhance the watershed management approach, the CWPP, and/or existing regulatory framework that controls nonpoint source pollution. Any such need or amendments to existing rules and regulations shall be identified, legislation developed and forwarded to the Office of the Governor for appropriate action.

SIGNED AND PROMULGATED at Hagåtña, Guam this 3rd **day of** March **2004.**

FELIX P. CAMACHO
I Maga'Lahen Guåhan
Governor of Guam

COUNTERSIGNED:

KALEO S. MOYLAN
I Segundo Maga'Lahen Guåhan
Lt. Governor

2010 GUAM INTEGRATED REPORT

APPENDIX E

Sediment TMDL
Ugum Watershed, Guam USA

Prepared By

Tetra Tech, Inc. and U.S. Environmental Protection Agency for

Guam Environmental Protection Agency

October 16, 2006

EXECUTIVE SUMMARY

Section 303(d) of the Clean Water Act requires States and authorized Tribes to identify polluted waters for which technology-based effluent limitations are not stringent enough to achieve applicable water quality standards, and to assign priority rankings based on the severity of pollution and intended uses of these waters. The Clean Water Act also requires preparation of pollutant control plans called Total Maximum Daily Loads (TMDLs) all waters and pollutants on the Section 303(d) list. TMDLs identify the pollutant reductions needed to restore good water quality in a water body and allocate pollutant control responsibility among different contributing sources.

The Ugum Watershed is located in southern Guam directly south of the Talofofo and Fena Watersheds and covers an area of approximately 18.9 square kilometers (7.33 square miles; 4,691 acres) of rolling hills with areas of very steep slopes. Water quality in the Ugum River has declined in recent years as a result of human activities that have increased sedimentation in the streams and near shore waters. As required by Section 303(d) of the Clean Water Act, a TMDL has been developed to address the sediment-related impairments observed in the Ugum River.

Available water quality data and information on potential pollutant sources in the watershed were reviewed to develop the TMDL. The applicable water quality standard for turbidity was applied as the TMDL endpoint, an existing sediment study was used for the source assessment, and a relatively simple linkage analysis was used to relate the two and determined necessary sediment reductions. The analysis indicates sediment yield in the watershed needs to be reduced by approximately 25% to meet the applicable water quality standards. Load allocations that will be sufficient to attain the necessary reductions in sediment presented, as is an implementation strategy for reducing erosion in the watershed.

TMDLs are usually expressed in terms of mass load per day. For sediment TMDLs, longer term average sediment loading rates may also be an appropriate measure as there is substantial short term variability in sediment loading that is less important in terms of sediment effects in the River than longer term sediment loading rates. Therefore, the TMDLs are expressed both in terms of average daily and annual mass loads. Attainment of the average daily and annual load reductions identified through the TMDL should be sufficient to result in attainment of the related turbidity standards.

The TMDL is set equal to the estimated loading capacity of Ugum River for sediment load. This loading capacity is the amount of sediment the River can assimilate and meet the applicable water quality standards. The sum of sediment loads from all significant sediment sources may not exceed the TMDL or loading capacity. Therefore, the TMDL is also expressed as the sum of wasteload allocations (WLA) to point sources (e.g. wastewater treatment plants) plus the sum of load allocations (LA) to nonpoint sources (e.g., erosion from streambanks or fields) and natural background, plus a required margin of safety to account for uncertainty in the TMDL analysis. As there are no point sources that discharge sediment to Ugum River, the wasteload allocation is zero. A 10% margin of safety is subtracted from the overall TMDL. All of the remaining allowable load is allocated to nonpoint sources through the LA. The resulting TMDL for Ugum River is as follows:

$$TMDL = \sum WLA + \sum LA + MOS$$

46118 tpy = 0 tpy + 41000 tpy + 5118 tpy, or
126 average tons/day = 0 tpd + 112 tpd + 14 tpd

Under the Clean Water Act, TMDLs are to be implemented through other existing pollution control programs that address point and nonpoint sources. For nonpoint sources, which are the only sources needing attention in the Ugum River watershed, Guam EPA intends to work with local landowners and managers to identify appropriate land management practices that will reduce sediment erosion from land surfaces, gullies, road surfaces, and potentially stream banks. These practices will be implemented on a voluntary basis, but Guam EPA is interested in working with landowners to identify the best locations to implement such practices and assisting in funding implementation work by cooperating landowners. We expect to build upon the watershed planning process that is currently underway in the watershed and believe substantial progress can be made in addressing sediment impairment through the voluntary watershed management process.

1.0 INTRODUCTION

Section 303(d) of the Clean Water Act requires States, Territories, and authorized Tribes to identify polluted waters for which technology-based effluent limitations are not stringent enough to achieve applicable water quality standards, and to assign priority rankings based on the severity of pollution and intended uses of these waters. The Clean Water Act and EPA regulations also require development of pollutant control plans called the Total Maximum Daily Loads (TMDLs) for all waters on the Section 303(d) list. The requirements of a TMDL are described in 40 CFR 130.2 and 130.7 and Section 303(d) of the CWA, as well as in various guidance documents (e.g., USEPA, 1991).

TMDLs are usually expressed in terms of mass load per day. For sediment TMDLs, longer term average sediment loading rates may also be an appropriate measure as there is substantial short term variability in sediment loading that is less important in terms of sediment effects in the River than longer term sediment loading rates. Therefore, the TMDLs are expressed both in terms of average daily and annual mass loads. Attainment of the average daily and annual load reductions identified through the TMDL should be sufficient to result in attainment of the related turbidity standards.

The TMDL is set equal to the estimated loading capacity of Ugum River for sediment load. This loading capacity is the amount of sediment the River can assimilate and meet the applicable water quality standards. The sum of sediment loads from all significant sediment sources may not exceed the TMDL. Therefore, the TMDL is also expressed as the sum of wasteload allocations (WLA) to point sources (e.g. wastewater treatment plants) plus the sum of load allocations (LA) to nonpoint sources (e.g., erosion from streambanks or fields), plus a required margin of safety to account for uncertainty in the TMDL analysis. A TMDL is often expressed using the following equation:

$$TMDL = \sum WLA + \sum LA + \text{Margin of Safety}$$

where WLA = waste load allocation and LA = load allocation. A TMDL is also required to be developed with seasonal variations and must include a margin of safety that addresses the uncertainty in the analysis. TMDLs are implemented through a combination of regulatory and voluntary approaches, depending upon the type of source at issue. For Ugum River, nonpoint sources are of concern, and Guam EPA intends that they be implemented through cooperative, voluntary actions by land owners and managers to address key sediment loading sources in the watershed. The ongoing watershed planning process should provide the best vehicle for targeting such actions.

1.1 Background

The Ugum watershed is located in southern Guam directly south of the Talofofo and Fena Watersheds (Figure 1). The Ugum watershed stretches from Mount Bolanos which rises to 378.5 meters (1,241 feet) and forms the western limits of the watershed to the Talofofo River near the Pacific Ocean in the east. Mount Bolanos includes the headwaters of the Atate and Bubulao river systems which flow into the Ugum River.

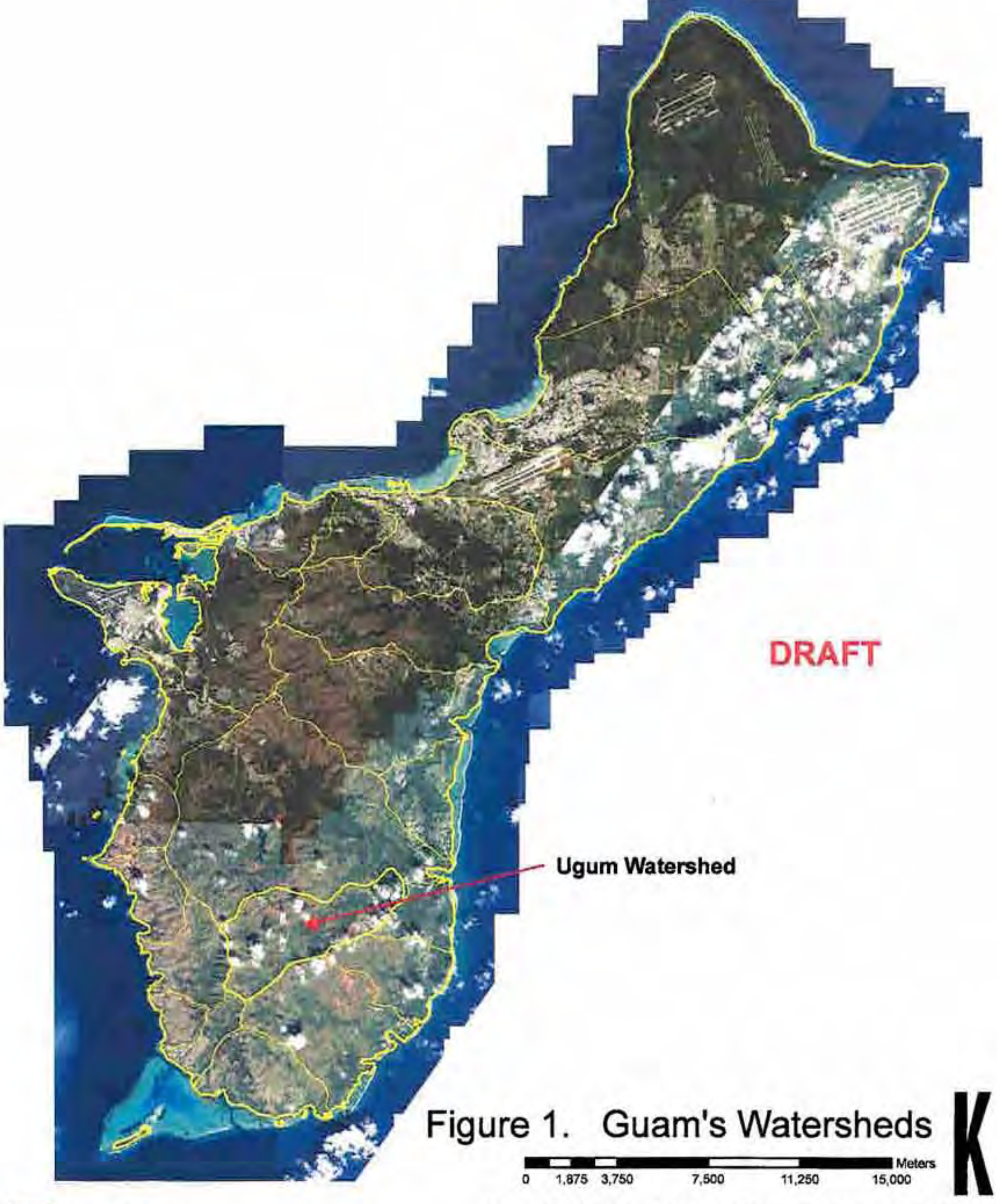


Figure 1. Guam's Watersheds

SPACE IMAGING
Visual Information. Visible Results.

Note: This map and data are for planning purposes only. Not for use in litigation cases. Guam EPA dose not assume responsibility for any inaccuracies in the data presented.

The Ugum watershed covers an area of approximately 18.9 square kilometers (7.33 square miles; 4,691 acres) of rolling hills with areas of very steep slopes. The 37 kilometers of rivers and streams in the Ugum watershed spread from the mountains to sea level where the Ugum River drains into the Talofofo River only 1,300 meters (4,275 feet) inland from Talofofo Bay.

Water quality in the Ugum River has declined in recent years as a result of human activities that have increased erosion and the resultant sedimentation in the streams and near shore waters. Off-road recreational vehicles, intentionally-set fires, and agricultural activities are the primary cause of the increased erosion and sedimentation. The increased sedimentation is considered especially significant in the Ugum watershed because the Ugum Water Treatment Plant is a primary source of drinking water in southern Guam. During the past several years the Treatment Plant has had to periodically shut down when suspended sediment at the intake reaches excessive levels. The treatment plant has been secured fifty two (52) times during the period of January 1 to December 31, 2004, lasted from two hours to twenty four hours duration at any given time. The highest turbidity level at the intake (river) during the same period is 270 NTU and the average is 72 NTU. Also, during the following year, January 1 to December 2005, the treatment plant was secured thirty five (35) times due to high turbidity at the intake. The highest turbidity level during the same period is 3,018 NTU and the average is 516 NTU. The increased sedimentation also contributes to poor quality in-stream aquatic habitats, a smothering of the coral reefs, and a decline in fish populations.

The following text from the *Resource Assessment* (NRCS, 1995) summarizes some of the effects of soil erosion in the Ugum watershed:

> "Soil erosion affects the productivity of the land, aggravates drinking water treatment systems, and negatively impacts aquatic life in the watershed's streams and downstream coastal areas. When erosion leaves behind unproductive soils in the Ugum Watershed, vegetation changes, from forest to savanna grassland, or from savanna grassland to badlands. The ecology of the land changes in this process, and water quality and wildlife habitat suffers. This change in vegetation type directly affects the uses of the watershed. The (relatively undisturbed) ravine forest in the Ugum contributes to the stability of the watershed. Its forest structure protects the soil surface from the direct impacts of intensive tropical rainstorms, and minimizes sediment runoff. Because these forests are typically located next to watershed streams, they serve as catchments to filter eroding sediments from savanna grasslands and badlands, which occupy ridge tops and road ridges of the area. When these forests are replaced by savanna grasslands, they no longer can provide these benefits. And, while the cover of grasses appears to fully occupy the site from a distance, the dominant grass species in the watershed actually has a clumped distribution with significant areas of exposed soil surfaces between the individual plant clumps. During periods of intense tropical rainfall, the exposed soil surface is susceptible to sheet and rill erosion. The continual erosion and intense leaching result in an overall lowering of soil and water quality in these areas."

1.2 Applicable Water Quality Standards

The Ugum River is currently classified as a Surface Water 2 (S-2). S-2 waters are medium quality freshwaters that support recreation, drinking water (if treated), aquatic life, and aesthetics. The applicable turbidity standard for S-2 water is as follows:

"Turbidity values at any point shall not exceed 1.0 NTU over ambient conditions except when due to natural conditions." Reference: Section 5103(b)(7) of the Guam Water Quality Standards.

2.0 TMDL TARGET AND WATER QUALITY ASSESSMENT

This section discusses available water quality data for the watershed and explains the numeric target or goal set to protect Ugum River from the adverse effects of elevated sediment levels.

2.1 Discussion of Instream Water Quality

2.1.1 Inventory of Available Water Quality Monitoring Data

There are three sources of water quality data for the Ugum River watershed (Table 1). As mentioned previously, historical data are available for the TURU2 station, an old USGS Gauging station located on Ugum River. There are also data available for the TURU1 station, which is located above the Talofofo Falls on Ugum River. Water quality data are also available from the Guam Waterworks Ugum Treatment Plant. Sample collection and preservation for all of these data were conducted according to EPA Method 180.1.

Table 1. Summary of Available Water Quality Data Sources for the Ugum River

Name	Period of Record	Responsible Agency	Parameters Monitored	Number of Observations
TURU1	01/22/80 to 10/25/90	GEPA	Turbidity	122
TURU2	2/19/80 to 10/25/90	GEPA	Turbidity	52
Ugum Treatment Plant	1995 to 1996	Guam Waterworks	Turbidity	256 (1995) 150 (1996)
Ugum Treatment Plant	1/2002-3/2004	Guam Waterworks	Turbidity	792

2.1.2 Analysis of Instream Water Quality Monitoring Data

The average turbidity value for the TURU2 monitoring site was 9.1 NTU (nephelometric turbidity units). The average turbidity value for the TURU1 monitoring site was 7.6 NTU. An analysis of precipitation records shows that very few of the historical observations at either TURU1 or TURU2 were taken during or shortly after significant rainfall events.

More complete water quality observations are available for a River site at the Guam Waterworks Ugum Treatment Plant. For the most part, the plant conducts sampling at its intake pipe every two hours[1]. These values were averaged by day for this analysis to correspond to the previous turbidity data and available precipitation data. The results indicated that the average turbidity value for 1995 was 15 NTU. The average turbidity value for 2002-2004 was 12 NTU (see Table 2). During the wet season period (July-November), the average turbidity value for 2002-2004 was 21 NTU with a maximum value of 240 NTU.

Table 2. Summary of the Turbidity Test Results from the Ugum Water Treatment Plant*

Statistical Data	All Data	Wet Season** (July 1 to November 30)
#Samples	792	306
Samples with NTU>12.5	26%	48%
Arithmetic Mean (NTU)	12	21
Upper 5% Confidence Level (NTU)	48	57
Lower 5% Confidence (NTU)	2.1	3.4

* Raw intake water samples collected from January 1, 2002 through March 8, 2004; No data for Dec. 9 through Dec. 14, 2002.
** Wet season data for 2002 and 2003 only.

To assess the degree to which precipitation influenced turbidity values, the daily precipitation and turbidity values were compared. (Recent flow data for the Ugum River were not available so it was not possible to conduct a similar analysis of the relationship between turbidity and flow.) The 1996 precipitation data consisted of the average daily values from several nearby rain stations (Windward Hills, Talofofo, and the Inarajan Agricultural station). All available 1996 turbidity data were used to assess the impact of rainfalls on the turbidity. As expected, a statistical test indicated that there was a significant relationship between these two variables at a 95% confidence interval. This suggests that increases in turbidity are related to rainfall-induced sediment erosion.

2.2 Selection of a TMDL Target and Critical Condition

To develop a TMDL it is necessary to have a quantitative expression of the desired water quality conditions. For Ugum River, Guam water quality standards include numeric criteria for turbidity

[1]There were apparently days when the water was not sampled at the plant or the values were not recorded. There were also no data available at the plant for the first several months of 1996.

(the degree of water clarity), which is closely related to suspended sediment levels in the water body. As discussed in greater detail below, a numeric target was developed based on the applicable turbidity criteria (no turbidity increase greater than 1 NTU above ambient natural conditions). This necessitated the estimation of ambient natural turbidity conditions in the watershed.

The 1980 to 1990 time period was used to define ambient conditions as referenced in the water quality standard because there was significantly less activity in the watershed compared to the present. Since 1990 a number of factors have changed which have resulted in increased human impact to the watershed. These include the following: the use of off-road recreational vehicles has increased; there have been an increased number of fires; the Guam Waterworks Ugum Treatment plant was built; and a safari tour and tourist facility at Talofofo Falls have begun operations (thus increasing overall traffic in the watershed).

The mean of the turbidity observations for the 1980 to 1990 time period is 9.1 NTU. However, there is a concern that this value might be artificially low because it includes very few observations taken during wet weather events (when turbidity values are expected to be higher). For example, there was only one observation taken on a day when the rainfall was greater than 0.5" (considered a significant rainfall event for this portion of Guam (Lander, 1999)). The maximum turbidity value that was observed was 42 NTU. (Turbidity values as high as 150 NTU during wet weather events have been observed in recent years). Because of this concern, a statistical analysis of the available data was performed to identify the likely range of ambient turbidity values.

The sample mean of the TURU2 data is merely an estimate of the "true" population mean of turbidity values. Variability exists between each data point and the sample mean and this variability can be measured by a statistic called the standard error of the mean (SE_{mean} = Standard deviation/square root of the number of samples). Using the standard error, it is possible to express a confidence interval (or range of values) that, at a certain confidence level, may include the true population mean for turbidity. This confidence interval is the product of the standard error value and the appropriate "t" value from a statistical distribution called the *Student's t*. The confidence interval is then added or subtracted from the sample mean to determine the lower and upper confidence limits.

Table 3 below shows the calculations for upper and lower confidence limits for the turbidity observations at the 5%, 2% and 1% significance levels. For example, at the 5% confidence limit (95% confidence interval) the limits are 11.7 and 6.5 (upper and lower respectively) and we would assert that there is only a 5% chance that the true population mean is outside this interval.

Table 3. TURU2 Turbidity Analysis (for ambient conditions)*

Sample Mean	9.1		
Standard Deviation	9.5		
Number of Samples	52		
Standard Error	1.32		
Degrees of Freedom	51	(C.I. = standard error * t value)	
t value (TABLE):		UPPER C.L.	LOWER C.L.
5%	2.01	11.74	6.45
2%	2.4	12.26	5.93
1%	2.68	12.63	5.57
Min	0		
MAX	42		

* Samples were collected from 1980 to 1991; Statistical analysis from Field and Laboratory Methods for General Ecology 3rd ed., Brower,et al, (1990).
C.L. = Confidence level

Because of the concern over the relatively few wet weather sampling observations, a decision was made to choose a value from the upper end of the 5% confidence interval as a conservative indication of the true average turbidity observed at TURU2. The ambient average turbidity value for the 1980 - 1990 periods for the Ugum River was therefore estimated to be approximately 11.5 NTU. The applicable numeric criteria for turbidity, used as the numeric target for the TMDL, are therefore:

Ambient natural turbidity + 1 NTU = Criteria Value = TMDL Numeric Target
11.5 NTU + 1 NTU = 12.5 NTU

Another potentially useful, supplemental indicator of the impairment of the Ugum River would be the average turbidity values that occur during wet weather events. For example, another way to express the TMDL endpoint would be to say that the average turbidity values observed during wet weather events need to decrease by X%. These events represent the critical condition in the watershed because it is during periods of high rainfall that turbidity values reach excessive levels and the treatment plant is forced to shut down. As has been indicated previously, however, there are only limited historical data available for wet weather turbidity values in the Ugum watershed. This unfortunately made the adoption of an appropriate wet weather turbidity endpoint difficult.

3.0 SOURCE ASSESSMENT

The purpose of the source assessment is to demonstrate that all pollutant sources have been considered, and significant sources estimated, in order to help determine the degree of pollutant reductions needed to meet numeric targets and allocation of pollutant allowances among sources. In order to develop individual allocations, existing and potential sources must first be characterized. The description of sources for this TMDL is taken primarily from *Resource Assessment, Ugum Watershed, Guam*, which was prepared by the Natural Resources Conservation Service, Pacific Basin, Agana, Guam (NRCS, 1995).

3.1 Assessment of Point Sources

There are no point sources in the watershed, therefore, point source loads are estimated to be zero.

3.2 Assessment of Nonpoint Sources

As discussed in section 1.1, soil erosion in the watershed has caused changes in vegetation type that increase the tendency of eroded soils to reach waterways. Because the Ugum watershed soils have a very high clay content (40%) much of the soil that is eroded ends up in the Ugum River and is carried to Talofofo Bay and the surrounding coral reefs (NRCS, 1995). This contributes to poor quality in-stream aquatic habitats, a smothering of the coral reefs and a decline in fish populations.

Major types of soil erosion active in the watershed include sheet and rill, road surface, road cut, and stream bank erosion (NRCS, 1995). A modified version of the Universal Soil Loss Equation (USLE) method was used to estimate mean annual soil loss from sheet and rill erosion. The Alutin Rill erosion method (NRCS, 1967) was used to estimate erosion from the road surfaces, and the Direct Volume method was used to determine average annual soil loss from road cuts and the stream banks. Detailed information regarding the application of these methods to the Ugum watershed is available in *Resource Assessment, Ugum Watershed, Guam* (NRCS, 1995).

Table 4 shows the estimated erosion rate from various sources in the watershed. Major sources of erosion in the Ugum Watershed are sheet and rill erosion from forest, savanna grasslands, agriculture, and badlands, and erosion from road surfaces. Stream channel erosion is also a significant source in the watershed. Per acre, the sloped road surface erosion (roads which go across the contour lines) comprises the highest erosion rate within the watershed; badland erosion is the second highest. However, the greatest total amount of erosion is from the savanna grassland. Close to half (49%) of the total erosion in the watershed is derived from the savanna grassland due to its moderate erosion rate and large relative area (42%) in the watershed.

The sediment load (the amount of eroded sediment that actually reaches water body channels) was determined by multiplying the erosion rate for each source by the corresponding sediment delivery ratio. The sediment delivery ratio was calculated using the Slope Continuity Procedure developed by Flaxman (1974). A sediment delivery ratio of 55 percent for sheet and rill erosion was calculated for the upper watershed (due to steeper slopes) and a ratio of 35 percent was calculated for the lower watershed. The sediment delivery ratio for the stream bank erosion was 90 percent; the stream bank is steep and most of the bank erosion will land in the river. Overall, the sediment load was estimated to equal 44% of the amount of sediment eroded in the watershed.

Table 4. Estimates of Sediment Eroded from Various Sources

Source	Erosion Rate (Tons/acre/Year)	Acreage	Total (Tons/Year)
Road Surface-Sloping	324	26 (0.55%)	8,424 (6.5%)
Badlands	243	100 (2.1%)	24,300 (19%)
Road Surface-Level	75	23 (0.49%)	1,725 (1.3%)
Grasslands	32	1,972 (42%)	63,104 (49%)
Agricultural Lands	20	17 (0.36%)	340 (0.26%)
Forest	12	2,569 (55%)	30,828 (24%)
Total		4,707	128,721

Source: NRCS, 1995.

The NRCS sediment analysis also presented sediment yield estimates by sub watershed. The Ugum watershed was divided into five sub watersheds for this purpose (Figure 2).

The total estimated sediment load per sub watershed is shown in Table 5. The sediment load to each sub watershed was routed through the larger Ugum watershed to the confluence with the Talofofo River. The transport of sediment depends on the velocity of the water and the particle size of the sediment. Particles may be transported suspended in the water or bounced and rolled along the stream bottom. As velocity decreases the heavier particles fall from suspension or stop moving along the bottom. Sediment accumulates in the stream along the stream banks or in the channel during low flows. During high flows the systems tends to be flushed out, but some sediment is deposited on the flood plain when the stream floods over the banks. To complete the sediment routing, the sediment load to the uppermost sub watershed must be routed through the next sub watershed downstream. The results of this routing are added to the sediment yield from the second sub watershed. This total is then routed through the next lower sub watershed and the process continues for each tributary until the end of the watershed is reached. The transport through the streams and rivers was assumed to deposit 100% of the gravels, 100% of the sands, and 50% of the fines. These percentages were based on observation of the stream and river bottoms and professional judgment (NRCS, 1995). Overall, NRCS estimated that 47% of sediments discharged to waterways in the watersheds are yielded from the mouth of the watershed.

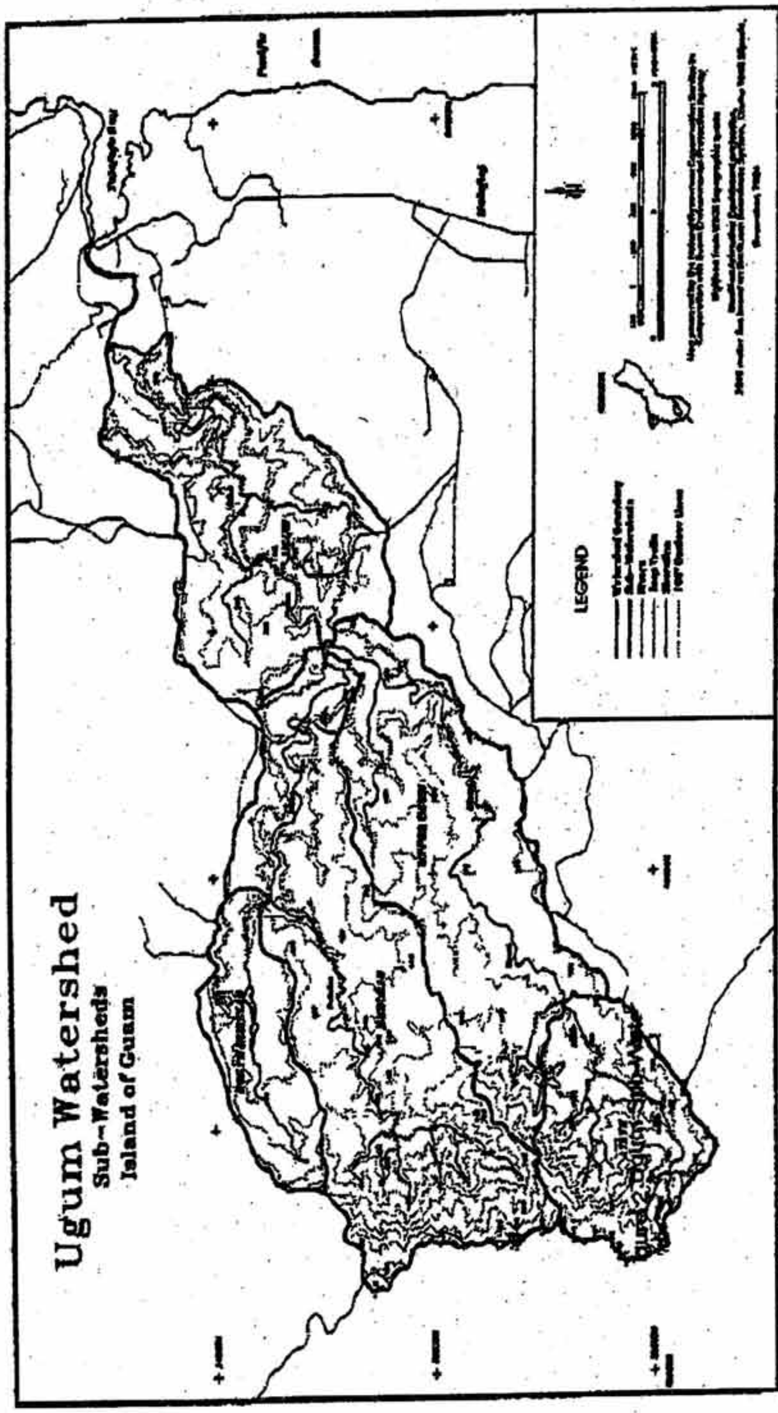


Figure 2 Ugum Sub-Watersheds

Table 5. Total Sediment Yield per Sub watershed in the Ugum Watershed (Tons per Year)

Sub watershed	Cut and Rill[1]	Roads	Stream bank erosion	Total
Bubulao	17396	1301	290	18987
Ugum	8909	1511	297	10717
Upper Ugum	9069	1175	241	10485
Atate	7505	245	140	7890
N. Bubulao	6868	327	68	7263
Total	**49747**	**4559**	**1036**	**55342**

[1]Cut and Rill - Includes total of erosion from forest, savanna grasslands, agriculture, badlands.
Source: NRCS, 1995.

Table 6 indicates that the total estimated sediment yield from the Ugum Watershed is approximately 25,770 tons/yr.

Table 6. Sediment Routing for the Ugum Watershed (Tons/Year)

Sub watershed	Gravel	Sand	Fines	Total Sediment
From N. Bubulao	182	1090	5993	7265
Deposited in Bubulao Watershed	182	1090	2997	4268
Subtotal Routed Sediment	0	0	2997	2997
From Bubulao Watershed	760	2849	15383	18992
To Ugum Watershed	760	2849	18380	21988
From Atate	395	1184	6315	7893
Deposited in Upper Ugum	395	1184	3157	4736
Substal Routed Sediment	0	0	3157	3157
From Upper Ugum Watershed	535	1605	8559	10699
To Ugum Watershed	535	1605	11716	13856
From Bubulao	760	2849	18380	21988
From Upper Ugum	535	1605	11716	13856
Subtotal Routed Sediment	1295	4454	30096	35844
Deposited in Ugum Watershed	1295	4454	15048	20796
Subtotal Routed Sediment	0	0	15048	15048
From Ugum Watershed	429	1929	8361	10719
Total Sediment Yield	429	1929	23409	25767

4.0 LINKING THE SOURCES TO THE NUMERIC TARGET

4.1 Linkage Framework

One of the essential steps in developing a TMDL is to establish a link or relationship between the numeric instream targets that have been chosen and the predicted loadings to determine how much reduction in sediment loading is needed to attain the applicable targets and associated water quality standards. Once this link has been established, it is possible to determine the capacity of the waterbody to assimilate sediment loadings and still support designated uses.

For this TMDL it was decided to assume a direct relationship between the estimated sediment loadings and the existing instream turbidity values. For example, it was assumed that a 10% reduction in sediment loadings would result in a corresponding 10% reduction in instream turbidity levels. This relatively simple approach is discussed in EPA's Protocol for Developing Sediment TMDLs (EPA, 1999) and was determined to be an acceptable technique given the relatively limited available monitoring data and the commitment to implementation and future monitoring (i.e., monitoring will be used to determine whether the load reductions result in the desired effect on instream water quality (and thus validate the direct relationship). The approach is summarized below:

$$\frac{\text{Existing instream turbidity values}}{\text{Desired instream turbidity values}} \approx \frac{\text{Existing sediment loadings}}{\text{Target sediment loadings}}$$

The existing instream turbidity values were calculated as the average of the turbidity values recorded by the Ugum Treatment Plant during 1995. These data were used because they match the time period of the resource assessment study. We note the 2002-2004 data are fairly close in that average measured turbidity values for the entire period were slightly lower than the 1995 average, and somewhat higher for the wet season period. Current conditions in the watershed are considered to be essentially similar to those that existed in 1995. The average turbidity value for the 1995 sampling observations was 15 NTU.

As presented in section 2.2, the numeric target representing desired instream turbidity values is 12.5 NTU.

As described above, the existing sediment loadings were based on the detailed resource assessment study. This study estimated that 55,342 tons/year are being deposited into tributaries in the Ugum watershed. This value was therefore used to estimate the target sediment loadings that would be needed to reduce turbidity to the desired target.

$$\frac{\text{Existing instream turbidity values (15 NTU)}}{\text{Desired instream turbidity values (12.5 NTU)}} \approx \frac{\text{Existing sediment loadings (55,342 tons/yr)}}{\text{Target sediment loadings (46,118 tons/yr)}}$$

The total loading capacity of the Ugum River is therefore estimated to be 46,118 tons of sediment per year. This equates to an average of 126 tons per day.

5.0 TMDL AND ALLOCATIONS

As described in Section 1, the TMDL is required to include a margin of safety to account for uncertainty in the analysis. Its purpose is to account for any uncertainty or lack of knowledge concerning the relationship between pollutant loading and water quality. The MOS can either be implicit (e.g., incorporated into the TMDL analysis through conservative assumptions) or explicit (e.g., expressed in the TMDL as a portion of the loadings).

An explicit MOS of 11% was selected for this TMDL. Therefore, 11% of the estimated loading capacity is being held in reserve as a margin of safety, yielding an estimated allowable sediment load of 41,045 tons/year (46,118 tons/year * 0.89). This equates to an average daily load of 112 tpd (126 tpd * 0.89). As discussed below, allowable sediment loads from the land to the tributary streams in the watershed are higher than the allowable sediment yield at the bottom of the watershed because a substantial proportion of discharged sediments remain in stream channel, stream bank, or floodplain areas. Section 5.2 explains how the allowable sediment loads were calculated to derive the load allocations.

5.1 Wasteload Allocations

There are no point sources of sediment in the Ugum watershed and therefore the wasteload allocation for this TMDL is set at zero.

5.2 Load Allocations

Load allocations are defined as the portion of a receiving water's loading capacity that is attributed either to existing or future nonpoint sources of pollution or to natural background sources. The load allocations for the Ugum River sediment TMDL are grouped by the type of erosion and by subwatershed.

As discussed in Section 3.2, the amount of eroded sediment actually yielded from the watershed is approximately 47% of the total sediment load because substantial amounts of coarser sediments are deposited in stream channels and on streambanks and floodplains. Adjusting for this difference in sediment loads to stream channels in the watershed and the resulting sediment yield at the bottom of the watershed, the resulting allowable sediment load is estimated at 41,045 tons/year (rounded to 41,000 tons/year for allocation purposes). This equates to approximately 112 tons per day. The allocations were calculated by reducing by approximately 25% of the current estimated loads by subwatershed and source category as presented in Table 5. These estimates indicate a needed reduction of approximately 25% in sediment loads to Ugum watershed tributary streams. Tables 7 and 8 present the resulting annual load allocations and daily load allocations, respectively.

Table 7. Annual Load Allocations to Meet the TMDL (Tons/Year)

Subwatershed	Cut and Rill[1]	Roads	Stream bank erosion	Total
Bubulao	13000	700	300	14000
Ugum	6000	700	300	7000
Upper Ugum	7000	800	200	8000
Atate	5950	150	100	6200
N. Bubulao	5650	300	50	5800
Total				**41,000**

Table 8. Daily Load Allocations to Meet the TMDL (Tons/Day)

Subwatershed	Cut and Rill[1]	Roads	Stream bank erosion	Total
Bubulao	36	1.9	0.82	38
Ugum	16	1.9	0.82	19
Upper Ugum	19	2.2	0.55	22
Atate	16	0.41	0.27	17
N. Bubulao	15	0.82	0.14	16
Total				**112**

5.3 Seasonality and Critical Conditions

As mentioned previously, the critical conditions for the sediment impairment are the wet weather, storm events. The analysis of the data showed a statistically significant, positive correlation between precipitation and observed turbidity values at the Guam Waterworks Ugum Treatment Plant. The best management practices that are expected to be used to implement this TMDL will reduce loads during the wet weather events (e.g., the conversion of badlands to forest will mean that much less surface erosion will occur during heavy rainfalls). In addition, once additional wet weather data are collected they could be used to set a supplemental, wet weather TMDL endpoint. The current lack of data precluded the use of such an endpoint for the first phase of the TMDL.

6.0 IMPLEMENTATION RECOMMENDATIONS

The TMDL analysis indicates that loads to waterways in Ugum River watershed would need to be reduced by approximately 25% to attain the TMDL and remedy the impacts of excessive sedimentation on the river. A range of options is necessary for achieving the desired reduction in current sediment loadings. The various options need to be based on the practicality of implementation and the degree to which they would have a significant impact on the overall sediment yield (e.g., reducing the runoff from land in closer proximity to the stream and reducing runoff from upland areas). A watershed approach will be used to identify a feasible, practical action plan to have the results necessary for reduction of current sediment loadings in the Ugum.

Guam's Watershed Planning Committee has already initiated restoration action activities that include implementation of reforestation and soil erosion activities in the Ugum Watershed. To date, a total of 300 acres of grasslands and badland areas have been planted with seedlings of acacia trees and 30 acres of ground cover and erosion control fabrics in various areas of the Ugum Watershed to address soil erosion and sediment loading to the Ugum River. The Ugum Watershed subcommittee is continuing with its reforestation and soil erosion activities with additional tree plantings and placement of soil erosion fabrics.

In addition, under the Section 6217 of the National Oceanic and Atmospheric Administration's (NOAA) Coastal Zone Management Act, Guam is required to develop a Coastal Nonpoint Pollution Control Program (CNPCP) to include management measures to control nonpoint sources of pollution. Guam's approved CNPCP will include the preparation and implementation of comprehensive watershed plans which will include the Ugum Watershed as a priority watershed. The comprehensive watershed plan for the Ugum Watershed will include the development of control strategies to prevent and minimize nonpoint pollution and achieve enhancement of water quality such as the control of erosion and sediment loading to the Ugum River. The Watershed plan will evaluate sediments and other pollutants relating to agricultural practices, urban areas (storm water, roads, highways and bridges, etc.), hydromodification issues, loss of aquatic ecosystems, and any other source or potential source that may occur in the watershed. The Ugum Watershed Plan will include the development of a strategy for implementing a watershed action plan to address soil erosion and sediment loading to the Ugum River.

Implementation of this option will result in the reduction sediment loading and reduced erosion runoff. Additional options for obtaining the necessary load reductions will be identified as the action plan strategy progresses. An adaptive management approach will be used whereby continued monitoring of the Ugum River will provide insight regarding the effectiveness of the proposed implementation and ideas for future restoration.

6.1 Follow-up Monitoring

The comprehensive watershed plan will include the development of a long term monitoring plan for evaluating the overall effectiveness of the action plan in preventing and correcting surface water quality impacts from nonpoint pollution (sediment). The long term monitoring program shall provide information on trends related to sediment runoff and determine whether the nonpoint pollution control strategies in the action plan are effective. The long term monitoring program will be developed and implemented as part of the Ugum Watershed Action Plan.

In addition, Guam's CNPCP includes a Nonpoint Source Monitoring Strategy that will be used as a basis to evaluate the performance of nonpoint source management measures quantitatively and qualitatively to determine the success of NPS management measures in reducing pollution loads and improving water quality. The monitoring strategy approach includes baseline monitoring, trend monitoring (designated use support determinations and watershed trend assessments), investigative monitoring (for problem areas initially identified in baseline monitoring or incompatible uses exist), effectiveness monitoring (for selected management measures) and implementation monitoring (management practice tracking techniques).

Ugum River turbidity monitoring data from the Guam Waterworks Authority Ugum Water Treatment Plant will be used to track the effectiveness of upstream best management practices, such as tree planting and installation of erosion control measures. The Guam Waterworks Authority monitors for turbidity on an hourly, day-to-day basis to track trends in river turbidity.

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2010 GUAM INTEGRATED REPORT

APPENDIX F

Guam Northern Watershed Bacteria TMDLs

December 16, 2009

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USEPA Region 9
Guam Environmental Protection Agency

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Contents

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1. Overview

Data collected through Guam's Recreational Beach Monitoring Program (RBMP) has served as the basis to place a number of locations on their §303(d) list. Guam's Integrated Report indicates that a priority action is to work towards developing TMDLs for impaired Tier 1 beaches. This TMDL report summarizes information for seventeen beaches located in the Northern Watershed and describes the approach used to develop TMDLs for these impaired waters. These seventeen beaches, identified in Table 1-1, are listed as impaired due to exceedances of Guam's Water Quality Standards for enterococci bacteria.

Table 1-1. Waterbodies covered under the Guam Northern Watershed Bacteria TMDLs.

Waterbody ID	Name	Impairment
GUN-01	Tanguisson Beach	*Enterococci*
GUN-24	Gun Beach	*Enterococci*
GUN-25	North San Vitores / Okura	*Enterococci*
GUN-02	San Vitores	*Enterococci*
GUN-23	Fujita	*Enterococci*
GUN-03	Matapang Beach Park	*Enterococci*
GUN-04	Guma Trankilidat	*Enterococci*
GUN-05	Ypao Beach	*Enterococci*
GUN-06	Sleepy Lagoon	*Enterococci*
GUN-07	Dungca's Beach	*Enterococci*
GUN-26	Alupang Towers Beach	*Enterococci*
GUN-08	Trinchera Beach	*Enterococci*
GUN-09	Padre Palomo Park	*Enterococci*
GUN-10	Hagåtña Channel	*Enterococci*
GUN-11	Paseo Outrigger Ramp	*Enterococci*
GUN-12	Hagåtña Boat Basin	*Enterococci*
GUN-13	Hagåtña Bayside Park	*Enterococci*

These TMDLs will address the enterococci impairments. The report begins with a short summary of the setting and general water quality concerns including applicable standards. An important part of TMDL development is to build on existing knowledge. This involves a review and analysis of data collected from project area beaches. Included are groupings for beach TMDLs based on location, physical characteristics, and potential sources. Potential sources that affect water quality at RBMP sites are summarized and TMDL allocations are provided.

These TMDLs use a hydrology-based framework, combining RBMP data with flow and precipitation information. This provides an expanded analysis of the monitoring data, which allows patterns to be examined, based on estimates of flows conditions (e.g., wet versus dry). Knowledge of conditions most likely to cause water quality problems supports a meaningful transition to implementation efforts.

2. Setting

Guam has a tropical oceanic climate with warm temperatures and high humidity. The subtropical weather allows for year-round recreation at all beaches. The majority of recreational activity occurs along stretches of sandy beaches or limestone plateaus easily accessible from the shore that are classified as “M-2 waters” or “Good” under Guam’s Water Quality Standards.

Data has been provided from 17 RBMP stations for the purpose of developing bacteria TMDLs. These sites are situated along Guam’s northwestern shoreline *(Figure 2-1)*. Basic station information is summarized in Table 2-1. With the exception of Tanguisson Beach (GUN-01), the stations are grouped by the major water where they are located (e.g., Tumon Bay, East Hagåtña Bay, West Hagåtña Bay).

Information from the Recreational Beach Monitoring Program has been the basis for issuing health advisories at project area beaches, as well as including these waters on Guam’s §303(d) list. Potential causes include wastewater related sources (septic systems, sewer line breaks, sanitary sewer overflows, treatment plant discharges), storm water (surface runoff from developed land, roads, construction areas), and recreation related sources (marinas, boat discharges).

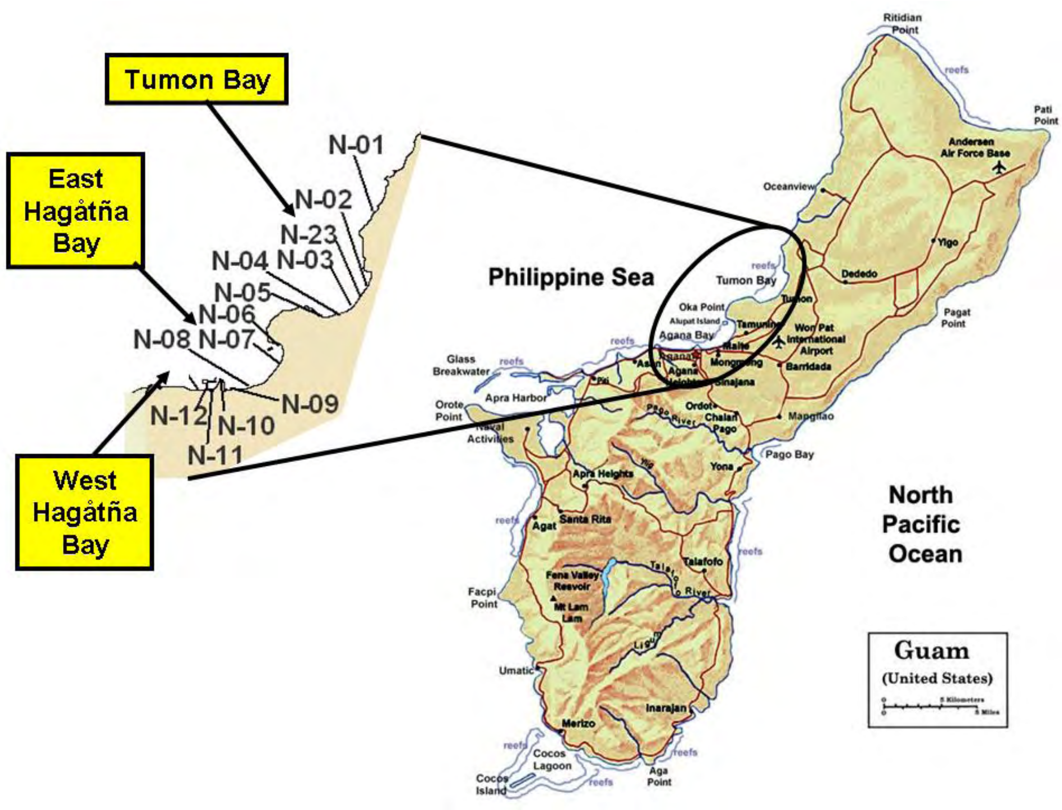

Figure 2-1. Location of Northern Guam TMDL project area beaches.

Table 2-1. Northern Guam TMDL project area beaches.

Village	Water	Beach	Site ID	Shore Access *(mi)*	Station Name	Features
Harmon	Northern	Tanguisson	GUN-01	0.25	Tanguisson Beach	Tanguisson Beach Park
Tamuning - Tumon	Tumon Bay	Gun	GUN-24	0.23	Gun Beach	
		Gognga	GUN-25	0.14	North San Vitores / Okura	
		Naton	GUN-02	0.39	San Vitores	Matapang Beach Park, Cushing Zoo
			GUN-23	0.29	Fujita	
			GUN-03	0.30	Matapang Beach Park	
			GUN-04	0.40	Guma Trankilidat	
		Ypao	GUN-05	0.46	Ypao Beach	Ypao Beach Park
Tamuning	East Hagåtña Bay	Dungca's	GUN-06	0.46	Sleepy Lagoon	
			GUN-07	0.46	Dungca's Beach	
		Alupang Towers	GUN-26	0.02	Alupang Towers Beach	
		Trinchera	GUN-08	0.46	Trinchera Beach	Padre Palomo Memorial Park
		Padre Palomo	GUN-09	0.46	Padre Palomo Park Beach	
Hagåtña	West Hagåtña Bay	Hagåtña Channel	GUN-10	0.15	Hagåtña Channel	Agana Marina
			GUN-11	0.15	Paseo Outrigger Ramp	
			GUN-12	0.12	Hagåtña Boat Basin	
		Bayside	GUN-13	0.31	Hagåtña Bayside Park	

3. Applicable Water Quality Standards

Criteria have been developed that form the basis of Guam's beach advisory program. These criteria are based on the applicable water quality standards. Guam's waterbodies are classified into categories based on designated uses. These categories for marine waters are M-1 / Excellent (whole body contact recreation), M-2 / Good (whole body contact recreation) and M-3 / Fair (limited body contact recreation). All beaches in the Northern Watershed TMDL project area are classified as M-2.

The applicable standards for whole body contact recreation and the rationale supporting the criteria are described in *"Recreational Beach Monitoring Plan: Guam Coastal Waters"* (Guam EPA, 2003). Guam uses the enterococci bacterial indicator to establish criteria that protect for contact recreational uses. For M-1 and M-2 waters, Guam's water quality standards state that:

> *"Concentrations of enterococci bacteria shall not exceed 35 enterococci/100 mL based upon the geometric mean of five (5) sequential samples taken over a period of thirty (30) days. No instantaneous reading shall exceed 104 enterococci/100 mL"*.

Recreational swimming and wading occurs year round on Guam's beaches. Guam EPA issues swimming advisories based upon either an instantaneous concentration of 104 MPN/100mL or a geometric mean concentration of 35 MPN/100mL, over a five week period. Advisory procedures are described in the RBMP Plan. Guam's *"2006 Integrated Report"* indicated that for calendar year 2004, 864 swimming advisories were issued, while in calendar year 2005, 535 swimming advisories were issued. (Guam EPA, 2006, Tables B7a-c and B8a-c, Appendix B).

4. Water Quality Data

An important step in the TMDL development process is the review of water quality conditions, particularly data and information used to list segments. Examination of water quality monitoring data is a key part of defining the problem that these TMDLs are intended to address. This section provides a brief review of available water quality information including a summary of the spatial distribution for the bacteria monitoring data. The discussion also considers seasonal patterns and trends in order to help identify potential analytical methods that can strengthen the TMDL development process for Guam's Northern Watershed beaches.

4.1 Available Information

The importance of Guam's beaches for water contact recreation has provided long standing support for the RBMP. Data has been collected by Guam EPA under this program for over 20 years. As a result of the Beach Act, an inventory of 113 beaches was conducted. Of these, 73 were prioritized into three tiers. Tier 1 includes beaches that are easily accessible, highly visited, characterized by a high number pollution sources, and require frequent monitoring.

Guam's Northern RBMP monitoring stations identified in Table 2-1 are all classified as Tier 1. Data collected weekly from these sites is used to make beach advisory decisions, as well as to assess status and trends. Table 4-1 provides an inventory that summarizes locations sampled each year since 1997.

Table 4-1. Inventory of Northern Watershed recreational beach TMDL project monitoring data.

Station ID	Station Name	Data Coverage										
		97	98	99	00	01	02	03	04	05	06	07
GUN-01	Tanguisson Beach	X	X	X	X	X	X	X	X	X	X	X
GUN-24	Gun Beach									X	X	X
GUN-25	North San Vitores / Okura									X	X	X
GUN-02	San Vitores	X	X	X	X	X	X	X	X	X	X	X
GUN-23	Fujita					X	X	X	X	X	X	X
GUN-03	Matapang Beach Park		X	X	X	X	X	X	X	X	X	X
GUN-04	Guma Trankilidat	X	X	X	X	X	X	X	X	X	X	X
GUN-05	Ypao Beach	X	X	X	X	X	X	X	X	X	X	X
GUN-06	Sleepy Lagoon	X	X	X	X	X	X	X	X	X	X	X
GUN-07	Dungca's Beach	X	X	X	X	X	X	X	X	X	X	X
GUN-26	Alupang Towers Beach									X	X	X
GUN-08	Trinchera Beach	X	X	X	X	X	X	X	X	X	X	X
GUN-09	Padre Palomo Park	X	X	X	X	X	X	X	X	X	X	X
GUN-10	Hagåtña Channel	X	X	X	X	X	X	X	X	X	X	X
GUN-11	Paseo Outrigger Ramp			X	X	X	X	X	X	X	X	X
GUN-12	Hagåtña Boat Basin	X	X	X	X	X	X	X	X	X	X	X
GUN-13	Hagåtña Bayside Park	X	X	X	X	X	X	X	X	X	X	X

4.2 Spatial Distribution

Sites included in the Northern Watershed TMDL project area represent an array of settings. Each has a unique set of features that includes effects from a range of different sources. A logical starting point for developing these beach TMDLs is to examine the spatial distribution of enterococcus concentrations using the RBMP information. Figure 4-1 shows the spatial distribution for sites (from north to south) grouped by major water. In particular, Figure 4-1 displays the frequency of advisories for each beach, based on monitoring data collected between 1997 and 2007. Figure 4-2 provides a summary of the data distribution for each beach over the same period using the *"box and whisker"* format.

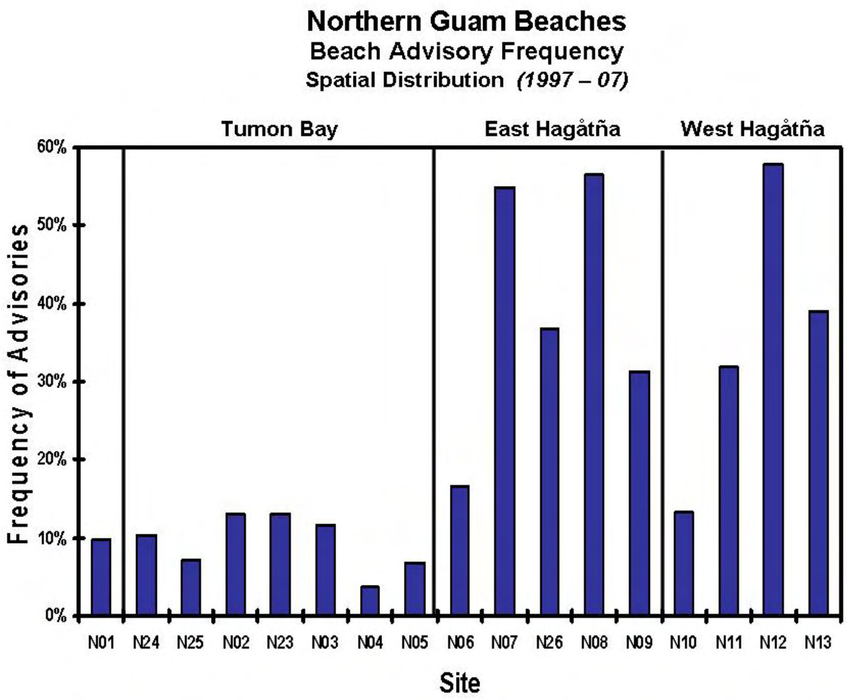

Figure 4-1. Spatial distribution of Northern Guam Watershed TMDL project area beach advisories.

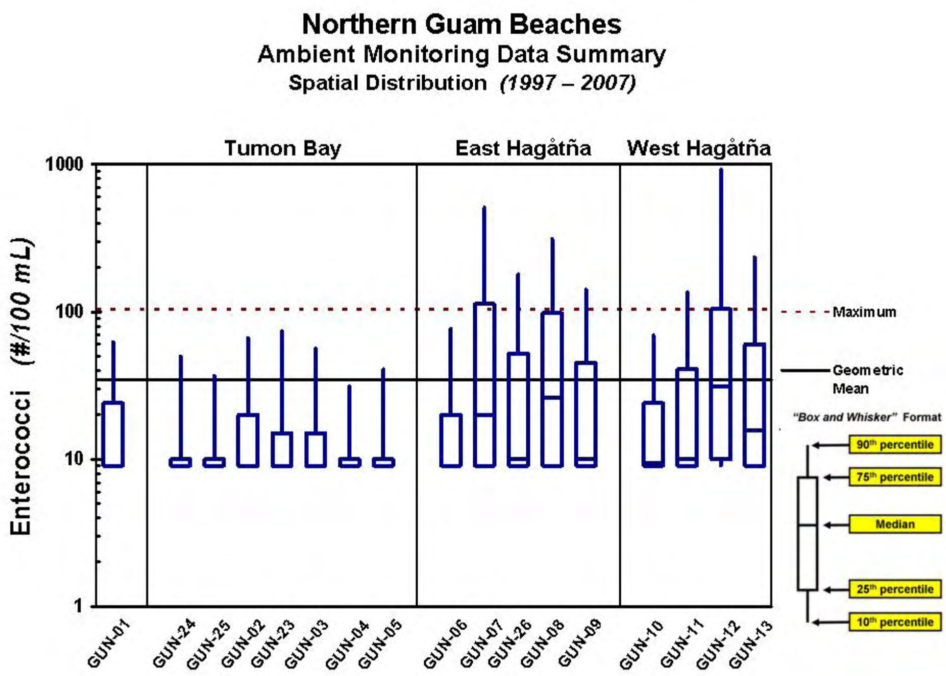

Figure 4-2. Spatial distribution of Northern Watershed TMDL project beach monitoring data.

The *"box and whisker"* format allows analysis of general patterns by displaying the data distribution. The top of the *"whisker"* is the 90th percentile, i.e. ninety percent of all data are at or below that level. The *"box"* depicts the 75th percentile (top) and the 25th percentile (bottom). Half of all observed values fall within this range. The line through the *"box"* is the median (or 50th percentile), while the bottom of the *"whisker"* represents the 10th percentile.

Several patterns emerge from this visual display that warrant further analysis. For instance, Hagåtña Bay clearly has the highest concentrations. Tanguisson Beach, located at the northern end of the project area, also experiences elevated levels. Within Tumon Bay, three sites on Naton Beach (San Vitores, Fujita, and Matapang) deserve a closer look. In addition to potential sources, factors to be considered in a more detailed analysis include seasonal variation and trends.

4.3 Seasonal Variation

TMDL development must consider temporal (e.g., seasonal or inter-annual) variations in discharge rates, receiving water flows, and effects on designated uses. These considerations are particularly important because point and nonpoint sources can discharge at different rates during different time periods (see USEPA Pathogen Protocol for more detail).

Seasonal changes often relate to typical amounts of rainfall. In Guam, the 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 to about 80 inches along the shores.

4.3.1 Seasonal Patterns in Beach Monitoring Data

Figure 4-3 depicts an example display of seasonal patterns at one of the project area monitoring sites. While general patterns may be apparent, there is also a noticeable amount of variability. Some of this variability is likely attributed to different source areas that affect each site. In addition, samples taken during the dry season could coincide with rain events. This would result in measured bacteria concentrations that reflect wet-weather sources. Similarly, wet season samples could have been collected following a dry period.

Methods exist to improve the analysis of wet- versus dry-weather patterns. One option is to display concentration measurements against precipitation data. However, adjustments would need to be made to account for runoff processes and lag time. These adjustments can be made through use of a rainfall-runoff model. This approach allows screening tools to be utilized that enable a look at the role of hydrologic conditions. In particular, patterns in observed bacteria levels can be examined in terms of surface runoff or stream flow.

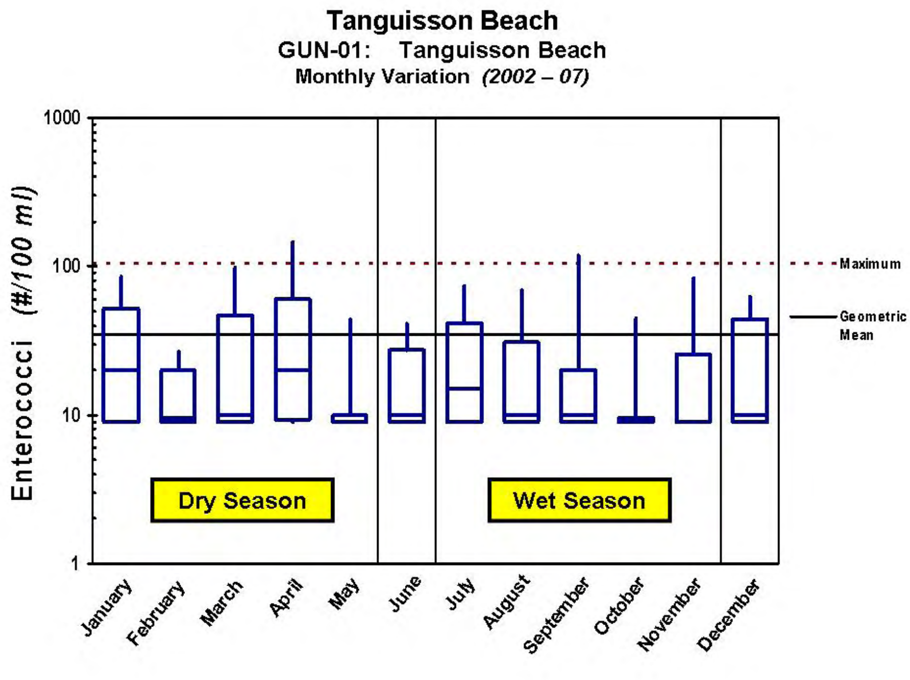

Figure 4-3. Seasonal variation at Tanguisson Beach.

4.3.2 Stream Flow and Seasonal Variation

Water quality at some beaches is severely influenced during heavy rainfall events either by excessive runoff from land or by storm drains. Guam EPA has identified beaches that receive additional monitoring after a rainfall event greater than two inches in a 24-hour period, including a number in the TMDL project area. In fact several beaches in the project area have signs posted advising the public of the risk associated with elevated bacteria levels associated with excessive rainfall and the proximity of storm drains at those sites.

Water quality parameters can often be related to stream flow rates, particularly for samples associated with storm events. The connection between beach advisories and rainfall is an example, where sites are affected by surface runoff or located near storm drains. Seasonal variation in flow can be a key part of TMDL development. Routine flow monitoring of storm runoff has not been conducted in the project area. This is largely due to the lack of perennial streams that discharge to Northern Watershed beaches.

The U.S. Geological Survey (USGS) operates a flow gage on the Pago River, which is located in the general proximity *(Figure 4-4)*. In some situations, flow information from nearby sites can be used as an indicator of general hydrologic conditions. Although the data is collected outside the immediate project area, the information may be of utility in examining water quality patterns in the Northern Watershed beaches.

Figure 4-5 illustrates the seasonal variation in flow for the Pago River. There is definitely a seasonal pattern that shows the difference between wet- and dry-seasons. Information from this gage could be used to explore potential relationships between observed bacteria levels and hydrologic conditions.

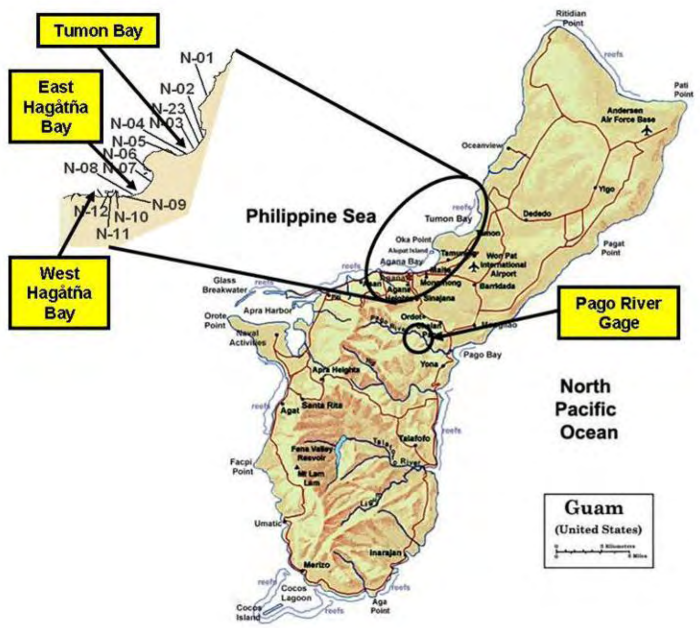

Figure 4-4. Location of Pago River stream gage.

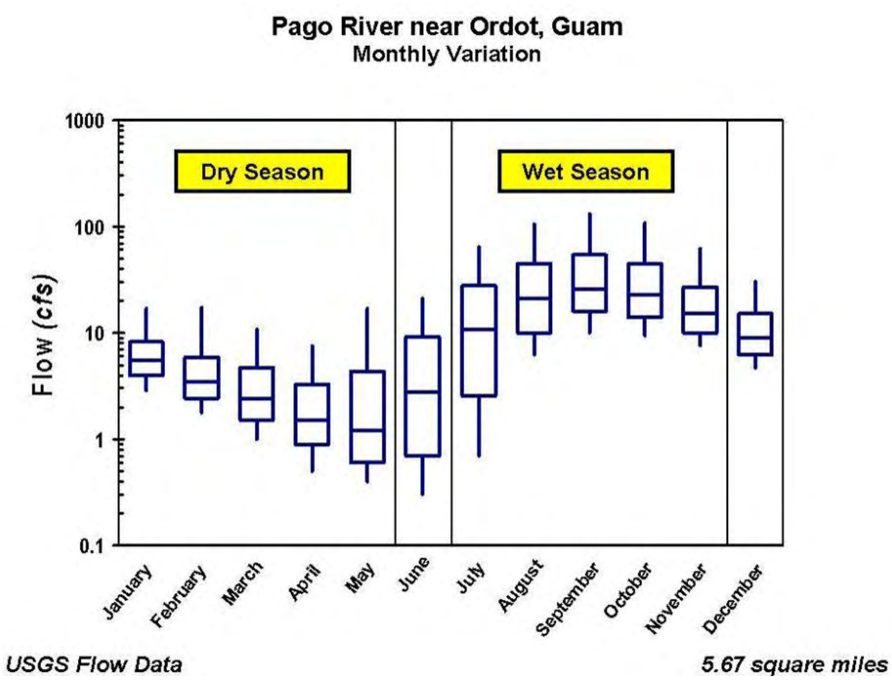

Figure 4-5. Seasonal variation of flows for the Pago River.

4.3.3 Flow Duration Curves

Flow duration curves provide a way to address the inherent variability associated with hydrologic information (e.g., seasonal variation, year-to-year variation). Duration curves describe the percentage of time during which specified flows are equaled or exceeded *(Leopold, 1994)*. Flow duration analysis looks at the cumulative frequency of historic flow data over a specified period. Duration analysis results in a curve, which relates flow values to the percent of time those values have been met or exceeded. Low flows are exceeded a majority of the time, whereas floods are exceeded infrequently.

Duration curves provide the benefit of considering the full range of flow conditions. Development of a flow duration curve is based on daily average stream discharge data. A typical curve runs from high flows to low flows along the x-axis, as illustrated in Figure 4-6 for the Pago River. Note the flow duration interval of sixty associated with a stream discharge of 5.6 cfs (i.e., sixty percent of all observed stream discharge values equal or exceed 5.6 cfs).

Flow duration curve intervals can be grouped into several broad categories or zones. These zones provide additional insight about conditions and patterns associated with the impairment. A common way to look at the duration curve is by dividing it into five zones, as illustrated in Figure 4-6: one representing *high flows (0-10%)*, another for *moist conditions (10-40%)*, one covering *mid-range flows (40-60%)*, another for *dry conditions (60-90%)*, and one representing *low flows (90-100%)*. This particular approach places the midpoints of the moist, mid-range, and dry zones at the 25th, 50th, and 75th percentiles respectively (i.e., the quartiles). The high zone is centered at the 5th percentile, while the low zone is centered at the 95th percentile.

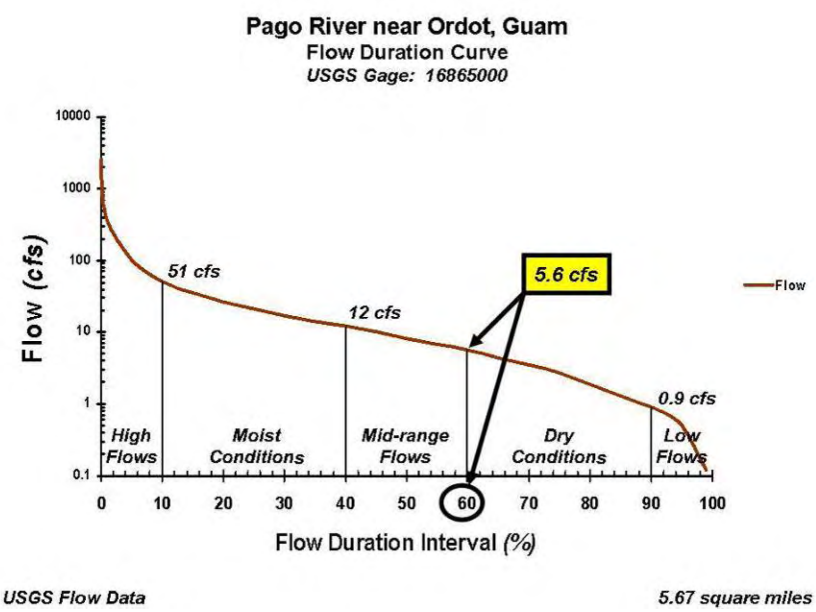

Figure 4-6. Flow duration curve for Pago River.

4.3.4 Water Quality Duration Curves

Ambient monitoring data, taken with some measure or estimate of flow at the time of sampling, can be used to develop water quality duration curves. Using the relative percent exceedance from the flow duration curve that corresponds to the stream discharge at the time the sample was taken, the water quality value can be plotted in a duration curve format.

By displaying ambient water quality data and the daily average flow on the date of the sample (expressed as a flow duration curve interval), a pattern develops. This pattern describes the characteristics of the water quality impairment. Values that plot above the criterion or numeric target indicate an exceedance of the water quality criterion, while those below the load duration curve show compliance.

The pattern of impairment can be examined to see if it occurs across all flow conditions, corresponds strictly to high flow events, or conversely, only to low flows. Impairments observed in the low flow zone typically indicate the influence of point sources, while those further left generally reflect potential nonpoint source contributions. This concept is illustrated in Figure 4-7. Data may also be separated by season (e.g., wet versus dry). For example, Figure 4-7 uses a “+” to identify those samples collected during the wet season (July – November).

The utility of duration curve zones for pattern analysis can be further enhanced to characterize wet-weather concerns. Some measure or estimate of flow is available to develop the duration curves. As a result, stream discharge measurements on days preceding collection of the ambient water quality sample may also be examined.

Rapid increases in the daily average flow can serve as an indicator of storm events. This concept is illustrated in Figure 4-7 by comparing the flow on the day the sample was collected with the flow on the preceding day. Any one-day increase in flow is assumed to be the result of surface runoff due to a storm event. In Figure 4-7, these samples are identified with a shaded diamond.

Figure 4-7 illustrates the utility of water quality duration curves in assessing Guam’s Recreational Beach Monitoring Program data. A definite pattern exists between enterococci measurements at this site and flow conditions associated with the Pago River gage. For example, the highest bacteria levels are generally associated with storm events (indicated by the shaded diamonds) and high flow conditions. Several of the high flow exceedances did occur during the dry season.

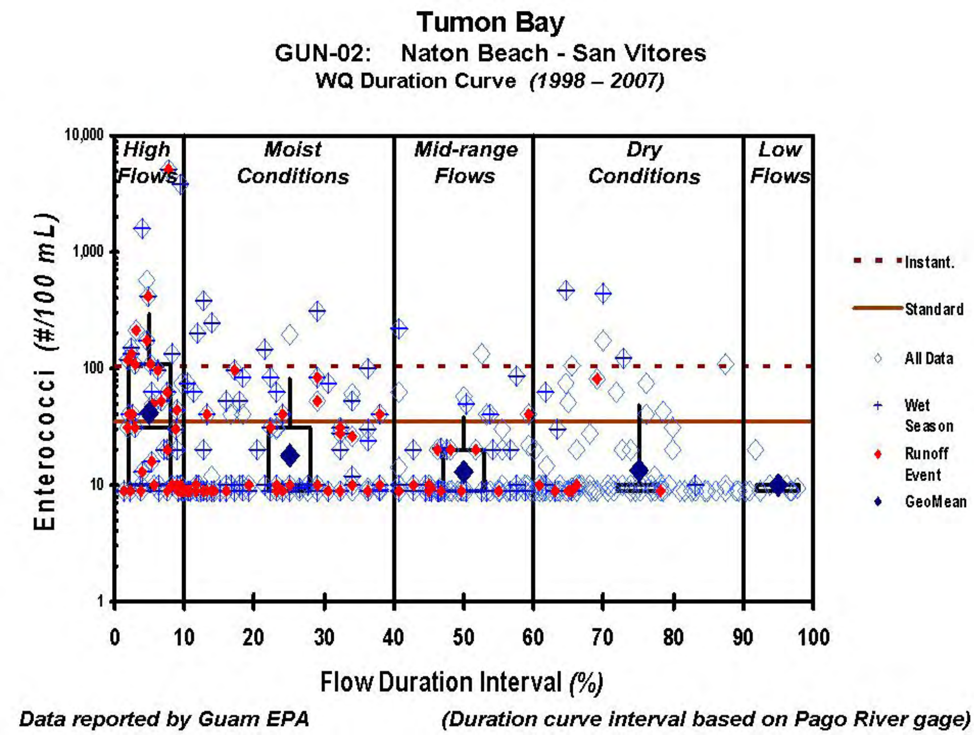

Figure 4-7. Water quality duration curve for San Vitores Beach site.

The duration curve framework provides a way to address variability issues described earlier relative to dry- versus wet season type analysis. Another observation is the high levels in the dry condition and low flow zones. These are likely associated with dry weather source areas and delivery mechanisms, which warrant further investigation.

4.3.5 Trends

The 2006 Integrated Report describes actions that have been taken to improve water quality at several sites. Figure 4-8 presents a year-by-year summary of the RBMP data for one site. This provides a useful way to examine trends at each site relative to both central tendency and annual variation. One important factor to consider in looking at the graph is that a change in analytical methods occurred starting with samples collected in September 2000. Data notes indicate that after September 2000, the IDEXX test was used to determine enterococcus concentrations.

This type of analysis is useful in looking at specific sites where efforts to address beach advisories have been implemented. For example, a focus on patterns such as trends in geometric means or 90th percentiles provides a visual analysis that can be used to evaluate program effectiveness.

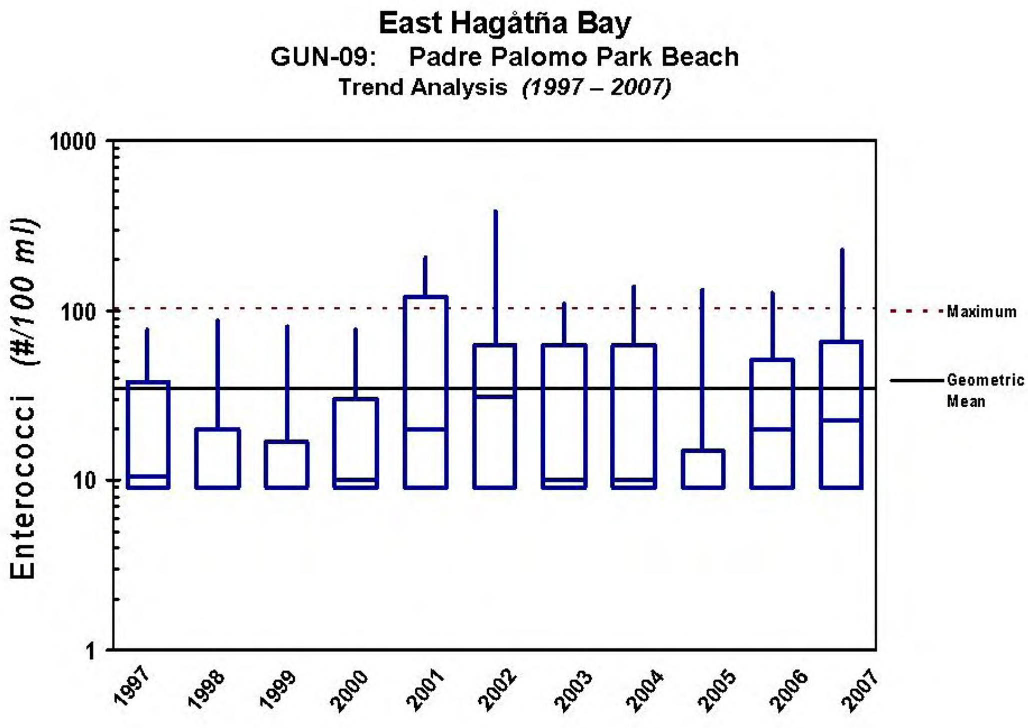

Figure 4-8. Trend analysis for Padre Palomo Beach site.

5. Source Assessment

Source assessments are an important component of water quality management plan and TMDL development. These analyses are generally used to evaluate the type, magnitude, timing, and location of pollutant loading to a waterbody (USEPA, 1999). Source assessment methods vary widely with respect to their applicability, the ease of use, and acceptability. This document contains a detailed discussion of potential bacteria sources to Northern Guam Beaches.

Assessment reports prepared by Guam EPA have identified a number of pollution threats to these beaches. Included are concerns such as storm water runoff, sewer line blockages and breaks, point source effluents, sanitary system overflows, septic systems, marina and recreational boating, debris and bottom deposits, and seeps connected to storm water ponding basins. For purposes of this assessment, potential sources have been grouped into three general categories that include:

- Waste Water
- Storm Water
- Recreation and Other

The intent of these groupings is two-fold. The first is to examine potential source area and delivery mechanisms. This supports informed decisions regarding the most appropriate technical approach for connecting water quality data to TMDL targets. For example, storm water sources are driven by rainfall and the resultant runoff. Elevated bacteria levels under high flow conditions reflect this pattern where storm water is a significant source.

The second reason for grouping categories is to align sources in a way that looks ahead to those water quality management programs and implementation efforts best suited to address the problems.

5.1 Waste Water Sources

This group includes those sources associated with the generation, conveyance, treatment, and discharge of domestic and industrial waste water. Potential threats identified in Guam EPA assessments are:

- Septic systems
- Sewer line blockages and / or breaks
- Sanitary system overflows (SSOs)
- Publicly owned treatment works (POTWs)
- Industrial point sources (e.g., GPA effluent)

Domestic waste water associated with population increase is the largest potential source of pollution to all waters of Guam (GEPA, 2006). There are a number of potential opportunities for waste water sources to contribute bacteria to Northern Guam recreational beach waters. Transport and delivery mechanisms include:

- Groundwater transport of leachate from failed septic systems either directly or indirectly to coastal waters
- Leaking from blockage or breakage of sewerage mains that result in either direct or indirect discharge to coastal waters
- Inadequate treatment or lack of disinfection from POTWs

These processes tend to be more common in areas with higher population densities, such as residential or commercial zones. Due to economic difficulties, development in many areas has occurred without adequate sewage infrastructure. As a result, a number of residential and commercial buildings depend on septic tanks and leaching field systems for waste disposal. Guam EPA has identified buildings in the TMDL project area that are not sewered through Geographic Information System (GIS) data layers *(Figure 5-1)*.

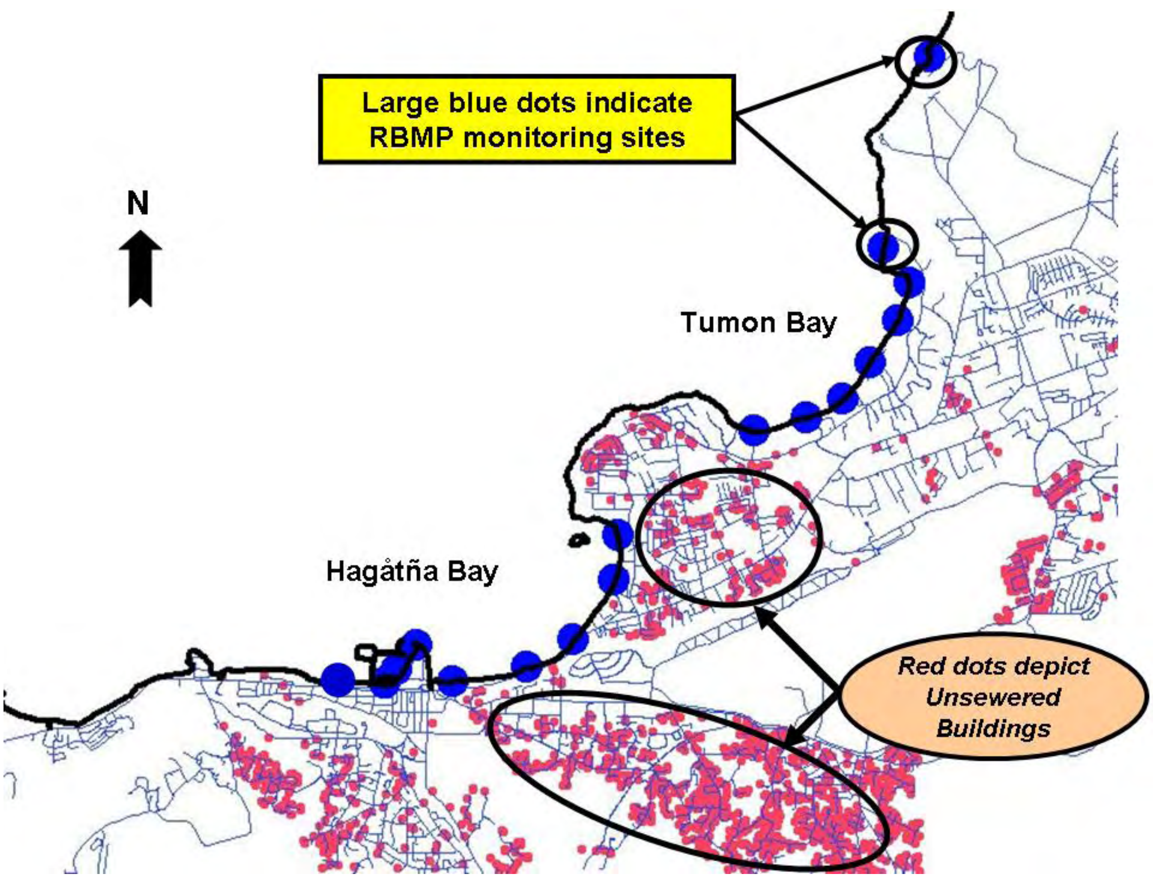

Figure 5-1. Location of unsewered buildings in Northern Guam Beach TMDL project area.

Residential septic systems treat human wastes using a collection system that discharges liquid wastes into the soil through a series of distribution lines that comprise the drain field. Bacteria naturally die-off as the effluent percolates through the soil to groundwater. Septic systems are designed to effectively remove bacteria when properly installed and maintained.

A septic system failure occurs when there is a discharge of waste to the soil surface where it becomes available for washoff into surface waters (both directly or indirectly through the network of storm drains and ditches). Failing septic systems can deliver high bacteria loads to surface waters, depending on the proximity of the discharge to drainage systems and the timing of opportunities for pollutant delivery (e.g., rainfall events). Septic system failures typically occur in older systems that are not adequately maintained with periodic pump outs.

In more densely populated areas, residential and commercial buildings have been connected to wastewater collection systems. Efforts to phase out septic systems has resulted in reduced bacteria loads from these sources. However, portions of the collection system suffer from sewer line blockages or breaks. This results in sanitary system overflows (SSOs) or direct discharge to coastal waters. SSOs and sewer line breaks can also result in indirect discharge to coastal waters by conveyance through the storm drainage or ditch network.

Several point sources with NPDES permits discharge in areas that may affect water quality at Northern Guam recreational beaches *(Table 5-1)*. The Guam Waterworks Authority (GWA) owns and operates two wastewater treatment facilities that affect these TMDL waters, shown in Figure 5-2. GWA is currently under a Stipulated Order to address several problems that contribute to beach advisories. Included in the Order are renovations and upgrades to the WWTPs, as well as actions to correct problems associated with portions of the conveyance system. Permitted facilities identified in Table 5-1 will receive waste load allocations (WLAs). The Government of Guam will receive load allocations (LAs) to address nonpoint sources.

Table 5-1. Point sources with NPDES permits that may affect Northern Guam Beaches.

NPDES ID	Facility Name	Receiving Water
GU0020087	Agana WWTP	Philippine Sea
GU0020141	Northern District WWTP	Philippine Sea
GU0000027	GPA Tanguisson Power Plant	Philippine Sea
GU0020281	Continental Micronesia	Harmon Sink
GU0020290	Guam Airport Authority	Harmon Sink

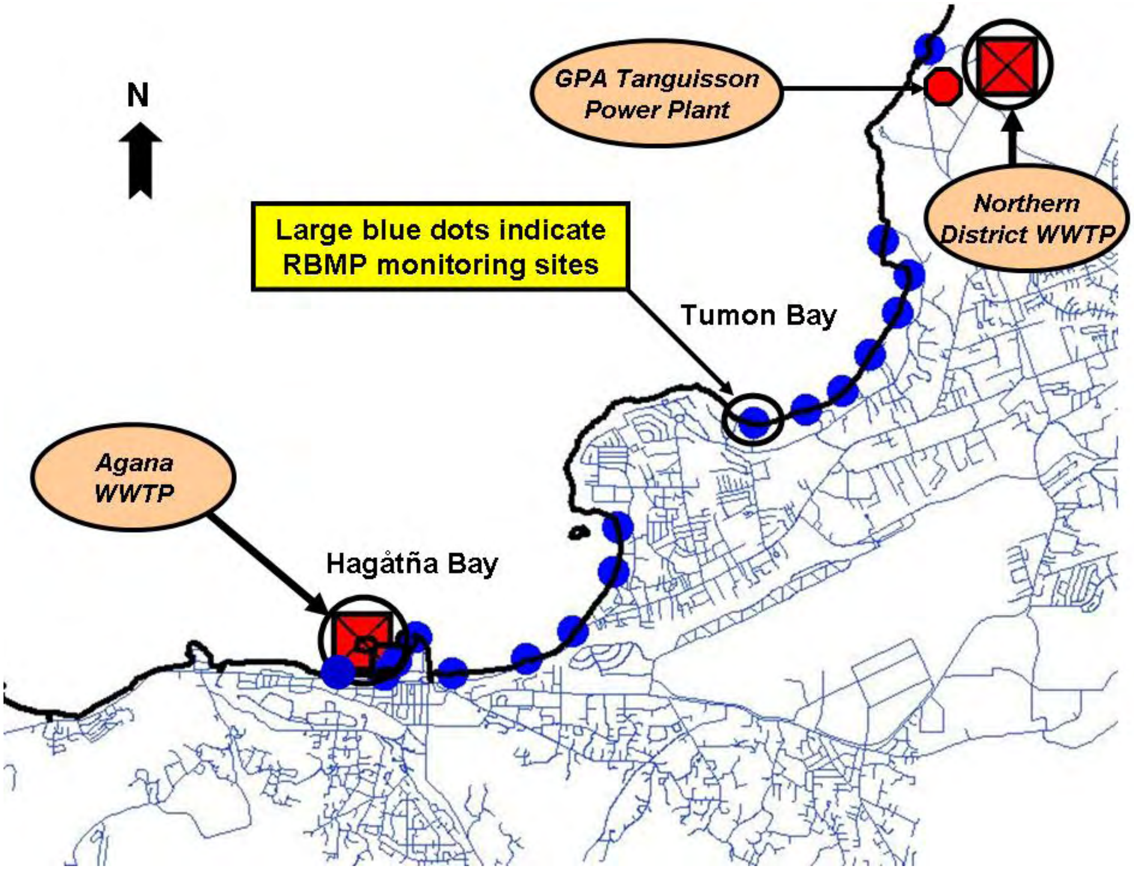

Figure 5-2. Location of WWTPs in Northern Guam Beach TMDL project area.

5.2 Storm Water Sources

This group includes those sources associated with bacteria delivered to Northern Guam Recreational Beach waters as a result of storm water runoff. Potential threats identified in Guam EPA assessments are:

- Storm water runoff (nonpoint source)
- Storm water runoff (associated with permitted areas)
- Highway / road / bridge runoff
- Highway maintenance and runoff
- Construction

Urban areas are generally characterized by higher percentages of impervious land due to conversion of natural surfaces to pavement, concrete, and buildings. Higher percentages of impervious area, if not properly managed, result in greater surface runoff due to the reduced ability of water to infiltrate into the ground during rain events.

As water flows across the land and paved surfaces, debris and pollutants such as bacteria are entrained. Bacteria subsequently flow with the water into storm drains and ditches that lead to local coastal waters. Harmful bacteria and viruses carried by runoff from developed land to local waters can threaten human health and contribute to recreational beach closures. Studies have shown that bacteria levels are typically high in urban runoff (USEPA, 2001). Bacteria delivered to coastal waters from developed land may be a significant source of pollution to Northern Guam's Recreational Beaches.

5.3 Recreation and Other Sources

This group includes sources related to recreational activities and other concerns that could deliver bacteria to Guam's Northern recreational beaches. Potential threats identified in Guam EPA assessments are:

- Marina and recreational boating
- Boat discharges
- Recreation and tourism activities
- Debris and bottom deposits
- Contaminated sediments
- Spills
- Seepage from storm water ponding basins and infiltration chambers

Unsolicited discharge of untreated wastewater to coastal beaches can occur from recreational sources, notably boats and marinas. Moored boats may be transient and may not pose a constant threat to water quality. Frequency of use in the area and number of boats that may discharge their holding tanks directly to coastal waters are major factors that affect the pollution threat from these sources.

Bacteria discharges from boats in marinas may have a more significant effect on coastal waters based on their sheltered locations and reduced freshwater and tidal inflows. Figure 5-3 shows the location of a major marina identified in Guam EPA GIS data files.

Another concern is seepage from storm water ponding basins and infiltration chambers *(Figure 5-4)*. The largest and most studied is the Harmon Sink. The Sink, located 1 to 3 km south of Tumon Bay and 2 to 4 km east of Agana Bay, is surrounded by Guam's densest industrial and urban areas. The Harmon Sink collects storm water from a surrounding industrial park and the adjacent airport. In recent years, the Sink has also received large discharges of sewage from failing lift stations. There has been concern that contaminants entering the Sink may be carried to recreational beaches by groundwater discharging in the coastal zone.

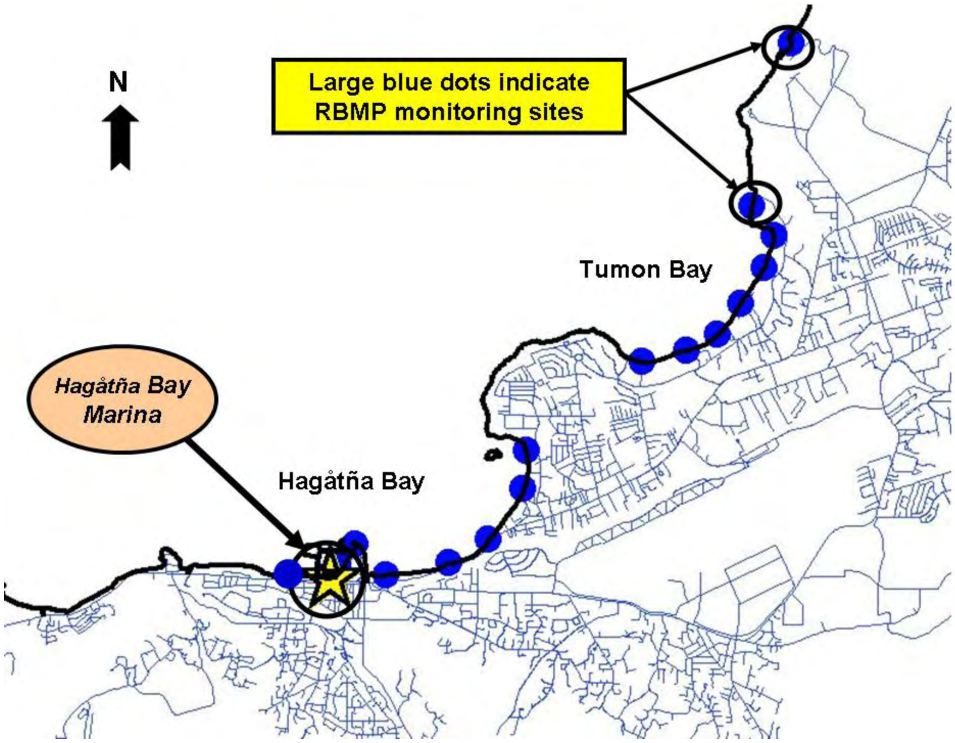

Figure 5-3. Location of marinas in Northern Guam Beach TMDL project area.

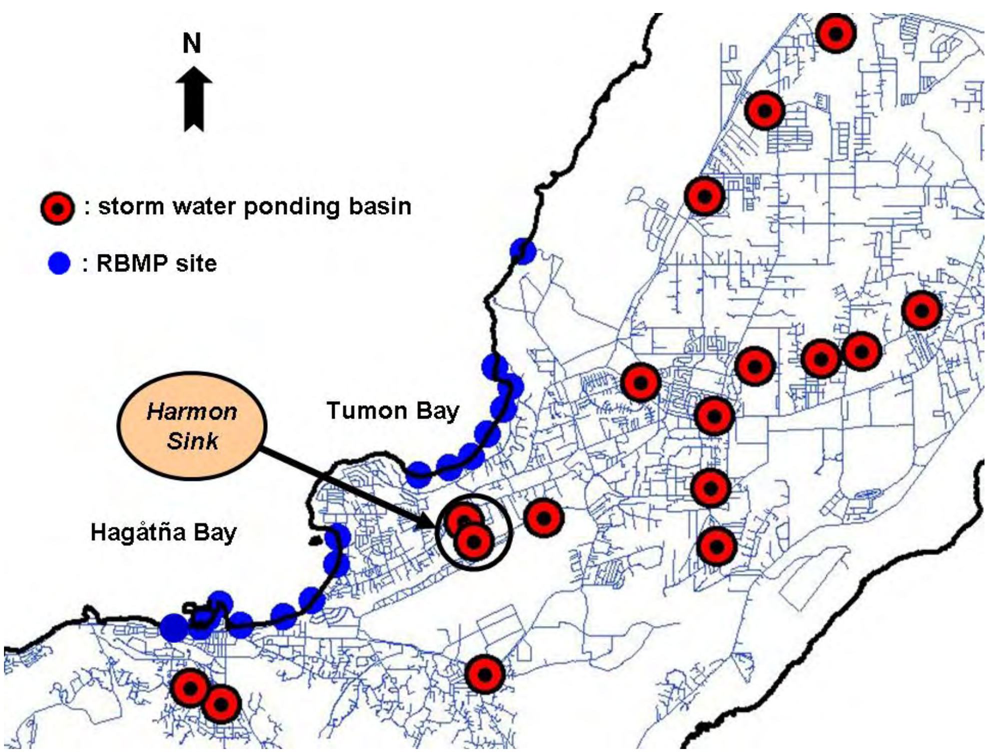

Figure 5-4. Location of storm water ponding basins in Northern Guam Beach TMDL project area.

The University of Guam Water and Environmental Research Institute (WERI) conducted a dye trace study to help characterize groundwater transport from the Sink to the adjacent coastal zone (Moran and Jenson, 2004). Dye receptors were placed at seeps and springs in both East Hagåtña and Tumon Bays.

Dye from the Harmon Sink surface injection was detected earliest at two locations on East Hagåtña Bay (within 4 to 6 days). The study hypothesized that the relatively fast transport to East Hagåtña Bay is controlled by relatively open, regional-scale fracture pathways. Dye was detected much later (day 17) and at much lower levels at the Tumon Bay site (Ypao Beach). The approximate flow path from the Harmon Sink to each site is shown in Figure 5-5. The wider arrow from the Harmon Sink illustrates the direction that the faster transport seemed to occur, based on reported study results.

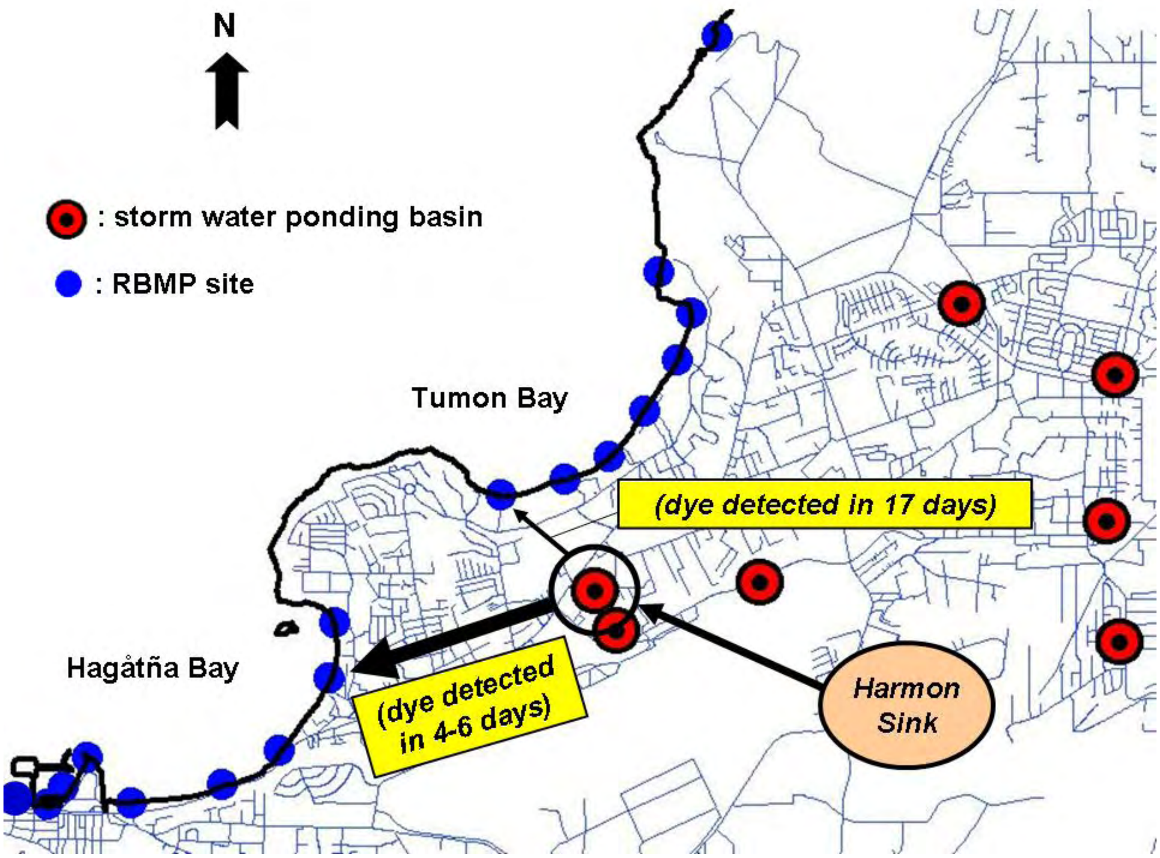

Figure 5-5. Harmon Sink dye study flow paths.

5.4 Summary

In addition to describing pollution threats, reports prepared by Guam EPA provide an indication of those beaches that may be affected by various source categories. Table 5-2 summarizes pollution threats identified in the §305(b) report for the TMDL project area beaches. Table 5-2 provides a transition into the linkage analysis, where the water quality data is evaluated in a way that considers potential sources.

Table 5-2. Pollution threats for northern Guam TMDL project area beaches.

Water	Beach	Site	Name	Pollution Threats		
				Wastewater	**Storm Water**	**Recreation & Other**
Northern	Tanguisson	N-01	Tanguisson Beach	W1, W3, W4, W5	S1	O2, O3, O4, O5, O6
Tumon Bay	Gun	N-24	Gun Beach	W1	S1, S5	R3
	Gognga	N-25	San Vitores / Okura	W1, W2	S1, S5	R3
	Naton	N-02	San Vitores Beach	W1, W2, W3	S1, S4, S5	R3
		N-23	Fujita			
		N-03	Matapang Beach Park			
		N-04	Guma Trankilidat Beach			
	Ypao	N-05	Ypao Beach	W1, W2, W3	S1, S4, S5	R3
East Hagåtña Bay	Dungca's	N-06	Sleepy Lagoon	W1, W2, W3	S1, S2	R4, O1
		N-07	Dungca's Beach			
	Alupang	N-26	Alupang Towers Beach	W1, W2, W3	S1, S2, S3	R4
	Trinchera	N-08	Trinchera Beach	W1, W2, W3	S1, S2, S3	R4, O1
	Palomo	N-09	Padre Palomo Park			
West Hagåtña Bay	Hagåtña Channel	N-10	Hagåtña Channel	W1, W2, W3, W4	S1, S2	R1, R2
		N-11	Paseo Outrigger Ramp			
		N-12	Hagåtña Boat Basin			
	Bayside	N-13	Hagåtña Bayside Park			

Pollution Threat Codes	**Wastewater**	W1	Septic Systems
		W2	Sewer line Blockage / Break
		W3	SSO
		W4	POTW
		W5	Industrial point source (GPA effluent)
	Storm Water	S1	Storm Water Runoff
		S2	Storm Water Runoff (permitted)
		S3	Highway / Road / Bridge Runoff
		S4	Highway Maintenance and Runoff
		S5	Construction
	Recreation & Other	R1	Marina and Recreational Boating
		R2	Boat Discharge
		R3	Recreational & Tourism Activities
		R4	Recreational & Tourism Activities (RUMP)
		O1	Debris & Bottom Deposits
		O2	Contaminated Sediments
		O3	Spill (Oil Underground)
		O4	Atmospheric Deposition
		O5	Squatters
		O6	Wildlife

6. Technical Approach and Linkage Analysis

Developing TMDLs requires a combination of technical analysis, practical understanding of important watershed processes, and interpretation of watershed loadings and receiving water responses to those loadings. In identifying the technical approach for development of the bacteria TMDLs for Guam's Northern Beaches, the following core set of principles was identified and applied:

- ***The TMDLs must be based on scientific analysis and reasonable and acceptable assumptions.*** All major assumptions have been made based on available data and in consultation with appropriate agency staff.

- ***The TMDLs must use the best available data.*** All available data in the watershed were reviewed and were used in the analysis where possible or appropriate.

- ***Methods should be clear and as simple as possible to facilitate explanation to stakeholders.*** All methods and major assumptions used in the analysis are described. The TMDL document has been presented in a format accessible by a wide range of audiences, including the public and interested stakeholders.

An essential component of TMDL development is establishing a relationship between numeric indicators intended to measure attainment of beneficial uses and source loads. The linkage analysis examines connections between water quality targets, available data, and potential sources.

6.1 Pattern Analysis

The seventeen beaches that are the focus of this TMDL report represent an array of situations, as evidenced by information presented in the data summary and source assessment. One way to capitalize on the wealth of ambient beach monitoring information is to examine patterns associated with potential source area and delivery mechanisms. The duration curve method provides one option for building a framework that supports pattern analysis.

For instance, use of the Pago River gage to identify duration curve intervals demonstrated the connection between high flow conditions following storm events and elevated bacteria levels at beach monitoring sites. Although duration curve intervals based on flow conditions highlight advantages of the method, data gaps at the Pago River gage prevent full use of the RBMP monitoring information. One way to address this issue is to utilize precipitation data to determine duration curve intervals.

A simple rainfall – runoff model, such as the P8 – Urban Catchment Model (P8-UCM), can be combined with northern Guam precipitation data to develop duration curve interval estimates. This approach accounts for the lag between the onset of a storm event and actual delivery to beach waters from potential source areas, as opposed to simply using rainfall data alone.

Figure 6-1 displays data from a site presented earlier *(Figure 4-7)*. Duration curve intervals are based on estimates using P8-UCM and precipitation information rather than flow data from the Pago River gage. In this case, the patterns are very similar to the previous example *(Figure 4-7)* as indicated by the *"box and whisker"* plot in each duration curve zone. However, the use of P8-UCM supports a more robust analysis of the monitoring information by including data for samples taken when Pago River flows were not measured.

In this situation, the largest geometric means occur under high flow conditions. The same pattern exists for the upper range of the *"box and whisker"* plot (e.g., the 90th percentile). In considering the potential threats identified for this site *(*Table 5-2*)*, the most likely dominant source under high flow conditions is storm water runoff. Thus, targets identified in the TMDL for this site should support a focus on source control efforts to address bacteria delivered to recreational beach waters that result from storm water runoff.

The duration curve framework provides the opportunity to connect water quality data with TMDLs and subsequent implementation efforts. In order to take advantage of this approach, all duration curves used for the Northern Guam Beach TMDLs were created using the P8-UCM model.

6.1.1 Spatial Patterns

The geometric mean and 90th percentile are used to compare patterns between the different flow zones, as demonstrated by Figure 6-1. These values enable a comparison of patterns between each of the beach monitoring sites. In addition to being a criteria value for enterococci in Guam's water quality standards, the geometric mean provides a measure of central tendency; an important factor to guide long-term program implementation efforts. The 90th percentile, on the other hand, complements the geometric mean by providing a measure that reflects recurring shorter-term problems (e.g. sewer line breaks or spills).

Using these measures, the next step in the linkage analysis is to examine patterns at all 17 TMDL beach sites. Table 6-1 summarizes the geometric means associated with each duration curve zone for the RBMP monitoring sites in the project area. Table 6-2 provides a summary of the 90th percentiles for the same sites. This information was developed using all data regardless of season. Similar to the situation observed in Figure 6-1, the greatest values for each site occur under high flow conditions.

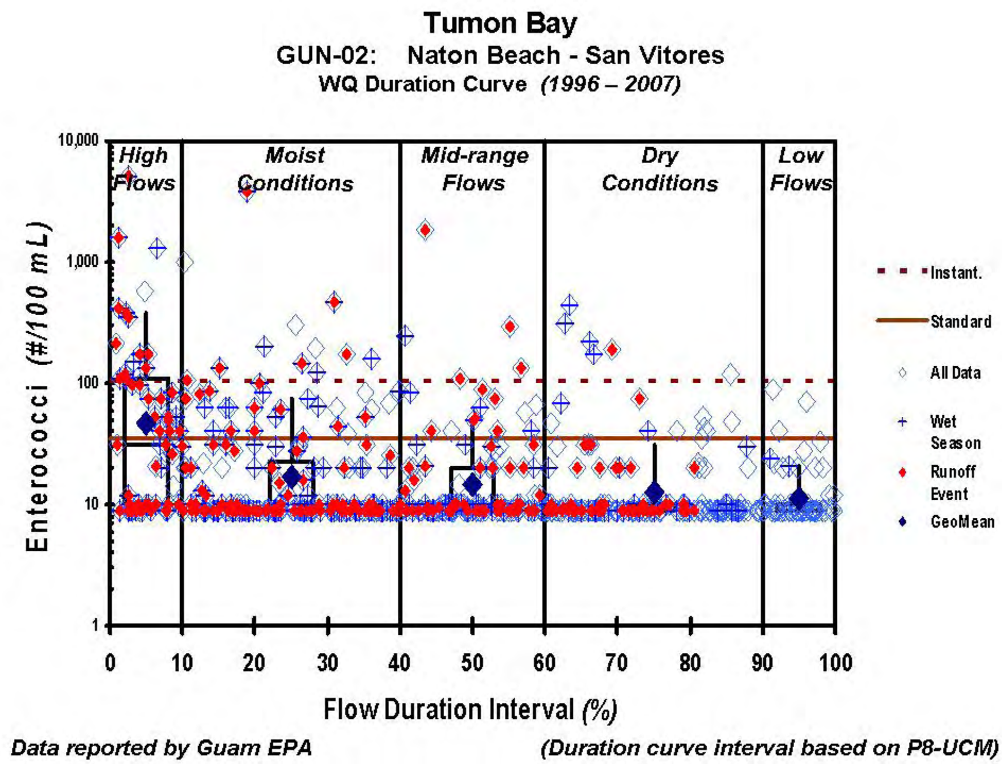

Figure 6-1. Water quality duration curve for San Vitores Beach site.

Table 6-1 enables a comparison of patterns between duration curve zones by site. It also highlights sites and duration curve zones that exceed Guam's geometric mean criteria (those cells are shaded). Similarly, Table 6-2 highlights sites and duration curve zones where the 90th percentile exceeds Guam's instantaneous maximum criteria.

Examining the geometric mean on a year round basis, for example, the majority of the exceedances occur in Hagåtña Bay during high flow conditions. This analysis identifies the area and conditions where bacteria sources have the most long-term, chronic effect. Efforts to achieve Northern Guam Beach TMDL targets based on the geometric mean should focus on storm water discharges to Hagåtña Bay.

In addition, the data indicates that storm water sources are also a concern in Tumon Bay. For instance, the geometric mean at Naton Beach (site GUN-02) under high flow conditions exceeds the 35 #/100 mL criteria. The Naton Beach concern becomes more evident when comparing the 90th percentile values against the instantaneous criteria *(*Table 6-2*)*.

Table 6-1. Northern Guam TMDL beach data summary *(Geometric Mean – year round)*.

Water	Beach	Site ID	Duration Curve Zone				
			High	***Moist***	***Mid***	***Dry***	***Low***
Northern	Tanguisson	GUN-01	32	13	15	17	17
Tumon Bay	Gun	GUN-24	18	17	13	11	10
	Gognga	GUN-25	23	13	12	13	11
	Naton	GUN-02	46	17	15	13	11
		GUN-23	27	14	15	13	14
		GUN-03	27	15	15	12	12
		GUN-04	17	12	13	12	12
	Ypao	GUN-05	19	13	14	12	12
East Hagåtña Bay	Dungca's	GUN-06	57	17	15	14	13
		GUN-07	226	44	31	25	27
	Alupang Towers	GUN-26	129	28	21	24	12
	Trinchera	GUN-08	107	34	40	32	27
	Padre Palomo	GUN-09	102	28	21	16	14
West Hagåtña Bay	Hagåtña Channel	GUN-10	50	16	15	14	13
		GUN-11	96	23	19	22	18
		GUN-12	223	74	37	31	20
	Bayside Park	GUN-13	126	35	22	21	15

Note: Shaded cells indicate those zones where the geometric mean criterion was exceeded. This is indicative of potential long term, chronic problems under those conditions.

Table 6-2. Northern Guam TMDL beach data summary *(90th percentile – year round)*.

Water	Beach	Site ID	Duration Curve Zone				
			High	***Moist***	***Mid***	***Dry***	***Low***
Northern	Tanguisson	GUN-01	133	31	51	64	69
Tumon Bay	Gun	GUN-24	86	79	50	10	10
	Gognga	GUN-25	91	37	20	31	19
	Naton	GUN-02	386	74	49	31	21
		GUN-23	212	56	74	47	21
		GUN-03	190	78	38	20	25
		GUN-04	52	30	30	24	20
	Ypao	GUN-05	109	38	41	24	31
East Hagåtña Bay	Dungca's	GUN-06	635	63	62	52	39
		GUN-07	4,611	522	352	205	205
	Alupang Towers	GUN-26	7,717	196	158	141	20
	Trinchera	GUN-08	933	249	325	299	154
	Padre Palomo	GUN-09	717	130	84	84	58
West Hagåtña Bay	Hagåtña Channel	GUN-10	560	69	73	48	40
		GUN-11	2,268	129	83	96	74
		GUN-12	1,802	1,687	370	171	87
	Bayside Park	GUN-13	1,681	266	84	150	46

Note: Shaded cells indicate those zones where the 90th percentile exceeded the instantaneous maximum criterion. This is indicative of recurring short term problems under those conditions.

6.1.2 Seasonal Patterns

Developing duration curve intervals based on P8-UCM also enables a closer look at factors, such as seasonality. This provides the opportunity to examine patterns that may be associated with other potential bacteria sources. For example, bacteria delivered through seeps connected to storm water ponds are more likely to affect beach monitoring data during the wet season. Similar to the analysis of spatial patterns, the geometric mean and 90th percentile serve as the primary measures for examining seasonality. This is illustrated in Figure 6-2.

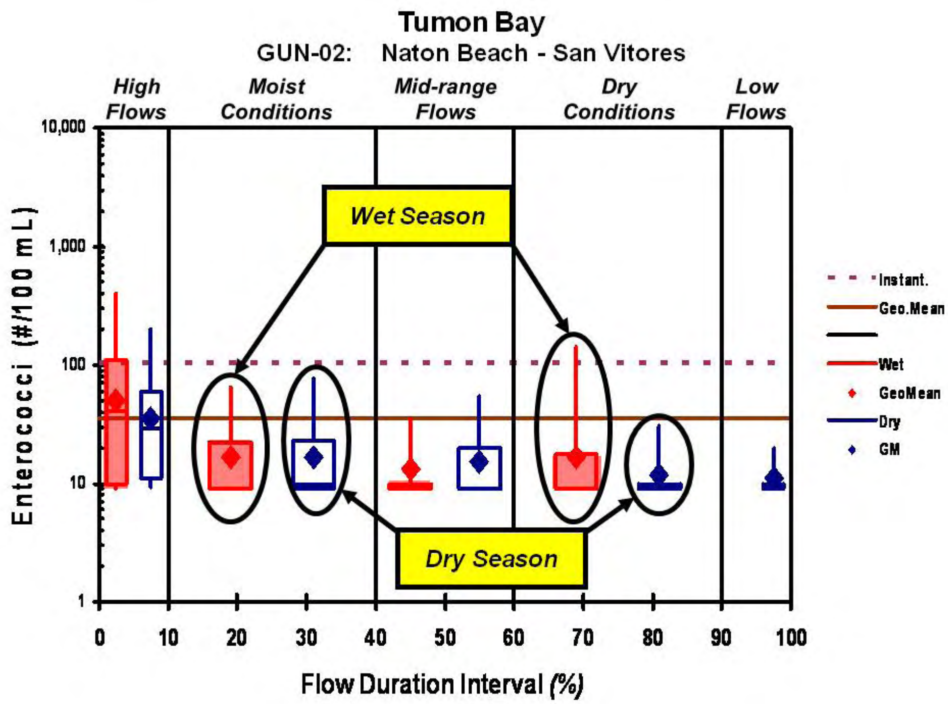

Figure 6-2. Wet versus dry season comparison for Naton Beach – San Vitores site.

The effect of storm water runoff is evident for both the wet and dry seasons under high flow and moist conditions. However, the wet season patterns under dry conditions indicate a concern relative to achieving the 90th percentile. Bacteria delivered under dry conditions are not typically associated with surface runoff from storm events. However, this could be the result of seepage from storm water ponds described in the source assessment.

The following tables summarize seasonality information for all RBMP sites.

Table 6-3. Northern Guam TMDL beach data summary *(Geometric Mean – dry season)*.

Water	Beach	Site ID	Duration Curve Zone				
			High	*Moist*	*Mid*	*Dry*	*Low*
Northern	Tanguisson	GUN-01	45	14	15	17	16
Tumon Bay	Gun	GUN-24		16	11	10	10
	Gognga	GUN-25		11	11	12	11
	Naton	GUN-02	36	17	15	12	11
		GUN-23	23	15	13	12	14
		GUN-03	21	18	15	12	12
		GUN-04	15	13	13	11	12
	Ypao	GUN-05	28	13	15	11	12
East Hagåtña Bay	Dungca's	GUN-06	63	18	16	13	13
		GUN-07	348	44	32	25	25
	Alupang Towers	GUN-26		27	21	22	12
	Trinchera	GUN-08	141	42	41	33	27
	Padre Palomo	GUN-09	48	24	19	14	13
West Hagåtña Bay	Hagåtña Channel	GUN-10	34	15	14	14	13
		GUN-11	92	19	19	21	17
		GUN-12	268	72	33	30	19
	Bayside Park	GUN-13	191	37	23	21	15

Note: Shaded cells indicate those zones where the geometric mean criterion was exceeded. This is indicative of potential long term, chronic problems under those conditions.

Table 6-4. Northern Guam TMDL beach data summary *(Geometric Mean – wet season)*.

Water	Beach	Site ID	Duration Curve Zone				
			High	*Moist*	*Mid*	*Dry*	*Low*
Northern	Tanguisson	GUN-01	28	13	15	15	
Tumon Bay	Gun	GUN-24	19	18	17	18	
	Gognga	GUN-25	24	15	14	25	
	Naton	GUN-02	50	17	13	16	
		GUN-23	29	14	18	21	
		GUN-03	29	14	15	15	
		GUN-04	18	12	13	16	
	Ypao	GUN-05	17	13	13	21	
East Hagåtña Bay	Dungca's	GUN-06	55	16	13	17	
		GUN-07	198	44	30	24	
	Alupang Towers	GUN-26	96	28	21	35	
	Trinchera	GUN-08	99	30	37	31	
	Padre Palomo	GUN-09	129	30	26	22	
West Hagåtña Bay	Hagåtña Channel	GUN-10	56	16	16	16	
		GUN-11	98	25	19	29	
		GUN-12	210	76	44	33	
	Bayside Park	GUN-13	110	34	20	20	

Note: Shaded cells indicate those zones where the geometric mean criterion was exceeded. This is indicative of potential long term, chronic problems under those conditions.

Table 6-5. Northern Guam TMDL beach data summary *(90th percentile – dry season)*.

Water	Beach	Site ID	Duration Curve Zone				
			High	***Moist***	***Mid***	***Dry***	***Low***
Northern	Tanguisson	GUN-01	205	37	48	64	68
Tumon Bay	Gun	GUN-24		19	19	10	10
	Gognga	GUN-25		19	10	26	19
	Naton	GUN-02	201	76	55	31	20
		GUN-23	227	59	33	20	21
		GUN-03	138	96	34	20	22
		GUN-04	29	33	31	20	20
	Ypao	GUN-05	511	41	54	20	31
East Hagåtña Bay	Dungca's	GUN-06	2,025	84	79	30	40
		GUN-07	5,676	354	313	164	182
	Alupang Towers	GUN-26		400	158	135	20
	Trinchera	GUN-08	985	264	334	325	157
	Padre Palomo	GUN-09	332	121	62	50	37
West Hagåtña Bay	Hagåtña Channel	GUN-10	199	48	40	32	37
		GUN-11	626	94	75	84	59
		GUN-12	1,490	1,447	368	178	71
	Bayside Park	GUN-13	1,613	243	85	145	48

Note: Shaded cells indicate those zones where the 90th percentile exceeded the instantaneous maximum criterion. This is indicative of recurring short term problems under those conditions.

Table 6-6. Northern Guam TMDL beach data summary *(90th percentile – wet season)*.

Water	Beach	Site ID	Duration Curve Zone				
			High	***Moist***	***Mid***	***Dry***	***Low***
Northern	Tanguisson	GUN-01	122	31	55	51	
Tumon Bay	Gun	GUN-24	88	86	118	91	
	Gognga	GUN-25	92	76	28	430	
	Naton	GUN-02	400	65	35	141	
		GUN-23	161	41	103	277	
		GUN-03	202	41	51	78	
		GUN-04	52	27	30	97	
	Ypao	GUN-05	72	31	35	175	
East Hagåtña Bay	Dungca's	GUN-06	543	55	37	115	
		GUN-07	1,487	576	353	212	
	Alupang Towers	GUN-26	4,896	135	132	218	
	Trinchera	GUN-08	879	235	273	159	
	Padre Palomo	GUN-09	1,273	133	130	195	
West Hagåtña Bay	Hagåtña Channel	GUN-10	717	99	77	93	
		GUN-11	2,325	158	83	187	
		GUN-12	3,582	1,695	361	145	
	Bayside Park	GUN-13	1,621	267	58	204	

Note: Shaded cells indicate those zones where the 90th percentile exceeded the instantaneous maximum criterion. This is indicative of recurring short term problems under those conditions.

6.2 Relationship to Other Indicators

Guam EPA's beach monitoring data can be combined with field observations of wind, tide, and water clarity conditions to examine patterns by duration curve zones. As part of the RBMP, Guam EPA staff noted field observations for several indicators that can be incorporated into the data analysis. These include observations such as tidal stage and presence or absence of turbidity.

The combination of patterns with some of these observations could be related to potential source areas and delivery mechanism that might affect bacteria concentrations at any particular beach of interest. For example, the presence or absence of turbidity may also be an indicator of either storm water runoff or suspended material associated with wind action. This approach to the analysis provides information that might prove useful in guiding implementation efforts intended to address documented problems. The intent is to make the greatest use of the ambient monitoring data in a way that can help identify potential solutions to beach closures.

Figure 6-3 provides a spatial summary of the presence or absence of turbidity information reported by Guam EPA staff. This shows the percent of time at a given location where turbidity was present at the time the bacteria sample was collected. As can be seen, there are certain areas where turbidity seemed more prevalent (e.g., N01: Tanguisson Beach, N02: San Vitores Beach, N12: Hagåtña Boat Basin)

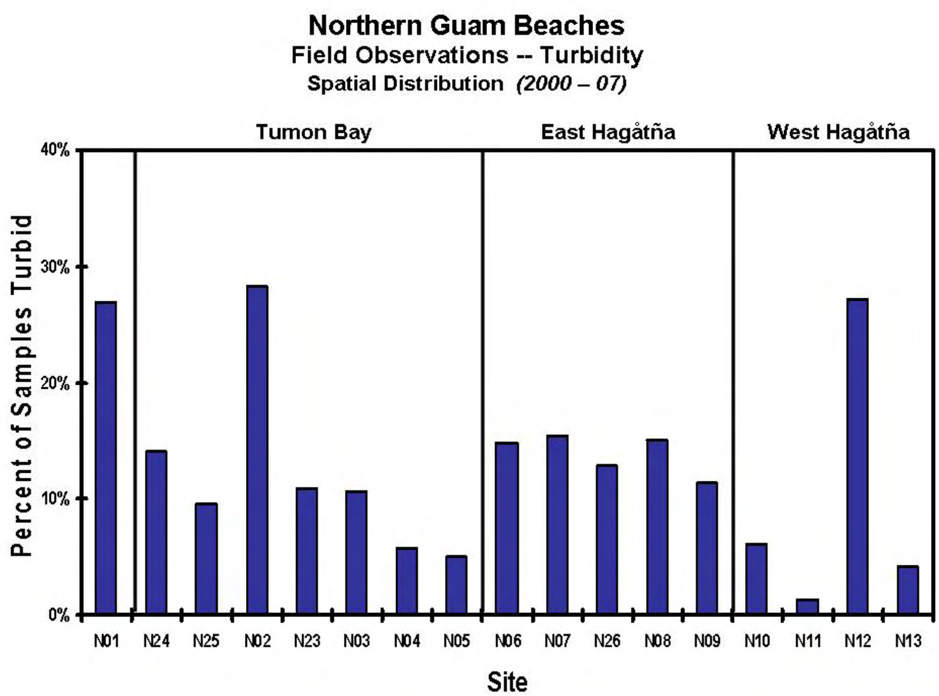

Figure 6-3. Spatial analysis of turbidity field observations during bacteria sampling events.

As an example, Figure 6-4 shows the difference between bacteria levels when turbidity was present or absent during sample collection under the various flow conditions. The increased levels when turbidity was present under high, moist, and mid-range flow conditions likely reflects the effect of bacteria transported with fine particles during storm events. However, the effect of bacteria associated with resuspension of bottom sediments should also be considered as a possible source when wind and wave action could affect beach water quality. This potential effect could be examined by evaluating bacteria levels at other sites during similar conditions.

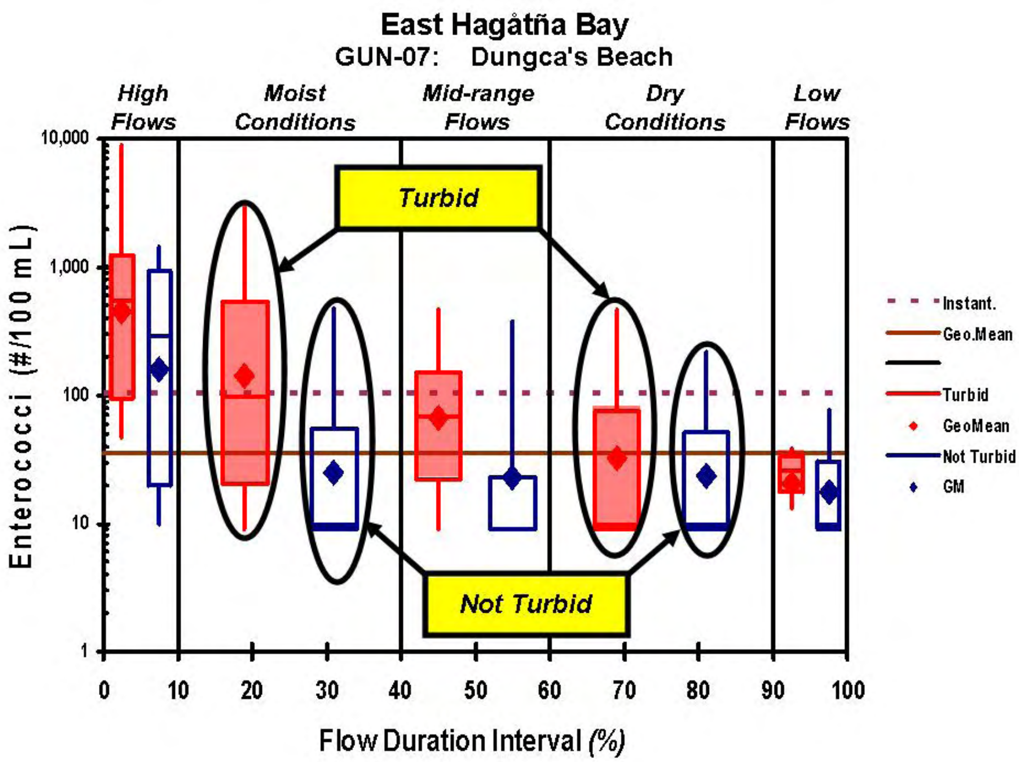

Figure 6-4. Turbid versus non-turbid sample comparison for Dungca's Beach site.

7. TMDL Development

These TMDLs are designed to address bacteria impairments on seventeen water quality-limited segments located in the Guam's Northern Watershed. Section 303(d)(1)(C) of the Federal Clean Water Act requires that TMDLs must be *"… established at a level necessary to implement the applicable water quality standards with seasonal variations and a margin of safety which takes into account any lack of knowledge concerning the relationship between effluent limitations and water quality"*.

Federal regulations provide further definition regarding the structure and content of Total Maximum Daily Loads. TMDLs are defined as the sum of the individual waste load allocations (WLAs), load allocations (LAs), and the margin of safety. TMDLs can be expressed in terms of *"… mass per time, toxicity, or other appropriate measure"* [40 CFR §130.2(i)]. WLAs are the portion of the receiving water's loading capacity allocated to existing or future point sources [40 CFR §130.2(h)]. LAs are the portion of the receiving water's loading capacity allocated to existing or future nonpoint sources or to natural background sources [40 CFR §130.2(g)]. Conceptually, this definition is denoted by the equation

$$\text{TMDL} = \Sigma\ \text{WLAs} + \Sigma\ \text{LAs} + \text{MOS}$$

Under the current regulatory framework for development of TMDLs, calculation of the loading capacity for impaired segments identified on the §303(d) list is an important step. EPA's regulation defines loading capacity as *"the greatest amount of loading that a water can receive without violating water quality standards"*. The loading capacity provides a reference, which helps guide pollutant reduction efforts needed to bring a water into compliance with standards.

7.1 Options Considered

The loading capacity of the Northern Guam Beaches for enterococcus is the amount that can be assimilated in the listed segments without exceeding the water quality criteria. Based on USEPA protocols for TMDL development, as well as bacteria TMDLs established in other states and territories, several options were identified. These include:

- ✓ Load-based approach (mass per unit time)
- ✓ Concentration-based method
- ✓ Reference method with exceedance day frequencies
- ✓ Tidal prism method
- ✓ Concentration-based duration curve approach

The following factors were considered in reviewing each option and selecting a method for determining the loading capacity and allocation method:

- ✓ Ability of the method to adequately assess the loading capacity
- ✓ Availability of adequate data to apply to the method
- ✓ Ability of the method to account for seasonal variation
- ✓ Degree of uncertainty associated with the method
- ✓ Ease of determining compliance
- ✓ Equity of the methodology

7.1.1 Load-Based Approach (mass per unit time)

A load-based approach is defined in terms of a mass per unit time. For bacteria TMDLs, the most common expression of loading capacity using this approach is counts per day. Determination of a load-based approach requires an estimate of the volume of water or the amount of flow available to assimilate the pollutant load. For a pollutant in a typical river or stream, where flow is only in one direction, the loading capacity, or allowable loading over a given time interval, is determined by calculating the product of flow rate, the water quality criterion concentration (e.g. 35 counts per 100 mL), and a unit conversion factor.

For hydrologically complex waters, such as coastal beaches, several challenges exist relative to the load-based approach. First, there is a high degree of uncertainty in estimating loads associated with determining the appropriate receiving water volumes at each beach location. In addition, flow is in more than one direction due to effects of tides, which also adds to the uncertainty in identifying a loading capacity for each listed segment. Finally, determining compliance with these TMDLs would not be a simple task because of the amount of information needed to determine loads associated with each sample event.

7.1.2 Concentration-Based Method

Another common approach used for development of bacteria TMDLs is the concentration-based method. Basically, the loading capacity is defined in terms of maximum allowable concentrations. For the Northern Beaches, TMDLs using this method would be based on simply attaining the enterococcus concentrations defined in Guam’s water quality standards. In other words, enterococcus concentrations must not exceed Guam’s water quality criteria in order to meet the TMDLs.

This approach addresses most of the factors being considered. Because the loading capacity is equivalent to the numeric criteria, evaluating compliance with the TMDLs is straightforward. There is also adequate data to apply the method. The only uncertainties are those associated with the monitoring program itself.

Although seasonal variation is accounted for implicitly, a concentration-based approach adds only limited value to relating TMDL targets to those conditions of greatest concern (e.g., wet-weather versus dry-weather). For this reason, it is often difficult to connect concentration-based TMDLs with implementation programs needed to solve water quality problems.

7.1.3 Reference Method with Exceedance Day Frequencies

The State of California has utilized an *"exceedance day frequency"* to identify loading capacity targets for several beach TMDLs. The focus of this approach recognizes that under certain conditions, natural background loads exert a major effect on water quality criteria violations. Numeric targets are expressed as allowable exceedance days of the single sample criteria. Allowable exceedance days are based on an analysis of conditions at a reference site.

Advantages of the method include ease of determining compliance. The approach used in California also accounts for seasonal variation by identifying different summer and winter targets. The approach basically allows for exceptions under which the single sample criteria may be exceeded. Data from reference beaches are needed that describe situations where natural conditions are the only sources. In the case of the Northern Guam Beaches, each site included in these TMDLs is affected by some potential anthropogenic source. Furthermore, the method does not account for the 30-day geometric mean component of the water quality standards. A separate analysis is needed to demonstrate that the geometric mean criteria will also be achieved using and *"exceedance day frequency"* approach.

7.1.4 Tidal Prism Method

The tidal prism approach used to develop TMDLs for recreational beaches in the U.S. Virgin Islands. This concept behind the tidal prism method centers on that amount of water moved in and out of an impaired segment between ebb and flood tides. This provides an estimate of volume per unit time, which enables a loading calculation. The method then uses load estimates from land-based sources to develop components of the TMDLs (e.g., loading capacities and allocations). In short, the tidal prism method estimates the volume of the segment, and then adjusts for tidal flushing, freshwater inflow, and bacteria loads to the waterbody.

The major advantage of this method is that targets are expressed as loads; consistent with the strict statutory definition of a TMDL. However, disadvantages are quite similar to those associated with a load-based approach. Most notably, the need for additional data, uncertainties associated with developing load estimates, and difficulties related to determining compliance.

7.1.5 Concentration-Based Duration Curve Method

This approach is a variation of the concentration-based method. Again, the loading capacity is defined in terms of attaining the maximum allowable enterococcus concentrations simply defined in Guam's water quality standards. In addition, TMDL targets are expressed in terms of flow conditions using either stream gage data or model estimates (as described earlier in the data analysis section). These flow estimates can be used to identify whether elevated bacteria levels occur during rainfall events (and are likely watershed-driven) or during dry conditions.

The advantage of this approach is that both seasonal and flow variations are explicitly considered. This addresses one of the disadvantages of the plain concentration-based approach (i.e., conditions of concern are explicitly identified). There is no uncertainty in the calculation of loading capacities (again, simply the water quality criteria concentrations).

7.1.6 Selected Approach

The approach used to develop these Northern Guam Beaches bacteria TMDLs is the concentration-based duration curve method. The framework provides a way to assess the loading capacity because it is derived directly from Guam's water quality criteria. In addition, the method takes full advantage of Guam's RBMP information, using the data to examine patterns associated with flow conditions. The approach also accounts for seasonal variation and determining compliance with the TMDLs is relatively straightforward. There is equity in the method in that all sources are expected to meet the concentration-based targets.

Finally, the concentration-based duration curve method supports a meaningful transition into implementation programs. Because water quality data is used to examine flow-related patterns, monitoring information can be used to determine source areas and delivery mechanisms associated with these different conditions. This, in turn, can be used to identify those actions most likely needed to address water quality problems.

7.2 TMDL Components

Table 7-1 presents an example TMDL for one of the beach locations, identifying the loading capacity and allocations. These concentration-based values apply across all flow zones.

Table 7-1. Northern Guam Watershed TMDL summary *(Site GUN-01: Tanguisson Beach)*.

TMDL Component	Enterococcus Concentration *(# / 100 mL)*
Geometric Mean	
TMDL	**35**
Future Growth	35
Waste Load Allocation	35
Load Allocation	35
Instantaneous Maximum	
TMDL	**104**
Future Growth	104
Waste Load Allocation	104
Load Allocation	104

7.3 Margin of Safety

The Clean Water Act requires that each TMDL be established with a margin of safety. The statutory requirement that TMDLs incorporate a margin of safety is intended to account for any uncertainty or lack of knowledge concerning the relationship between pollutant loading and water quality. The MOS also accounts for uncertainty in available data or in the actual effect controls will have on loading reductions and receiving water quality.

A margin of safety is expressed as unallocated assimilative capacity or conservative analytical assumptions used in establishing the TMDLs (e.g., derivation of numeric targets, modeling assumptions or effectiveness of proposed management actions). The margin of safety may be implicit, as in conservative assumptions used in calculating the loading capacity, WLAs, and LAs. The margin of safety may also be explicitly stated as an added, separate quantity in the TMDL calculation. The MOS may also be a combination of both.

These TMDLs use an implicit MOS, through inclusion of two conservative assumptions. First, the TMDLs do not account for mixing in the receiving waters and assumes that zero dilution is available. Realistically, influent water will mix with the receiving water and become diluted below the water quality standard, provided that the receiving water concentration does not exceed the TMDL concentration. Second, the goal of attaining standards at the point of discharge does not account for losses due to die-off and settling of indicator bacteria that are known to occur. In addition, the concentration criteria accounts for seasonal variations and critical conditions.

8. Individual Beach Assessments and TMDLs

An important part of the transition from TMDL targets to program implementation is information derived from site-specific analyses. In particular, an in-depth evaluation of monitoring data relative to potential sources that may affect water quality at each station adds value to the overall process. Individual beach assessments can be used to guide development of strategies that address documented problems.

The purpose of this section is to present a beach-by-beach analysis and the TMDL for each location. Connections between observed water quality patterns, factors that affect each site, and potential solutions are highlighted. Figure 8-1 displays the Northern Guam Beach TMDL project area. Each of the seventeen monitoring sites is identified in relation to key bays, notably Tumon and Hagåtña.

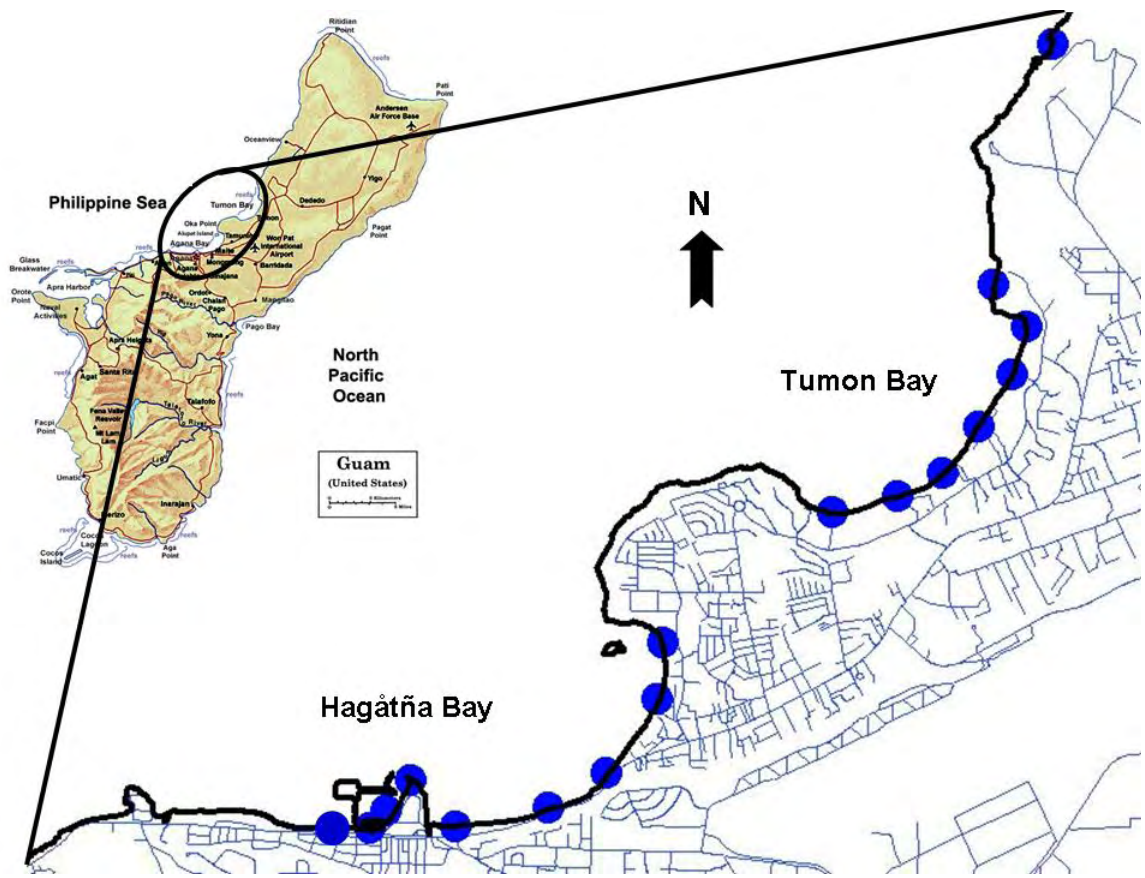

Figure 8-1. Location of monitoring sites in the Northern Guam Beach TMDL project area.

Individual assessments provides brief background material on each beach including a longitudinal graph, which highlights bacteria levels at that site compared to other project area monitoring stations. Summary graphs are presented using monitoring data to examine patterns. Information is related to potential sources through the use of additional maps. Table 8-1 summarizes the list of GIS coverages provided by Guam EPA that were considered in developing individual beach assessments.

Table 8-1. Geographic Information System data layers considered in individual beach assessments.

Data Category	Description
Coast	*Guam coast line*
Contours	*Elevation contours (10 meter intervals) used to characterize topography*
Beach TMDL Sites	*Location of Recreational Beach Monitoring Program stations*
WWTP	*GWA Waste Water Treatment Plant locations*
Marinas	*Location of Guam marinas under jurisdiction of Port Authority of Guam*
Streets	*Streets mapped in GEPA data base as of October 2008*
Buildings	*Buildings identified in GEPA data base as of June 2006*
Sewered Buildings	*Buildings in data base identified as connected to sewer*
Non-sewered Buildings	*Buildings in data base identified as not connected to sewer*
Main Sewer	*Main sewer lines under jurisdiction of Guam Waterworks Authority (GWA)*
Lateral Sewer	*Lateral sewer lines identified by GWA*
Pump Station	*Location of GWA sewer pump / lift stations*
Fittings	*Loaction of GWA sewer fittings*
Manhole	*Sewer manholes*
SIA Ponding Basins	*Surface Impoundment Areas identified by Guam Dept. of Public Works*

8.1 Tanguisson Beach (GUN-01)

Tanguisson Beach is the northernmost beach in the TMDL project area *(Figure 8-2)*. Relative to the other sites, it is fairly isolated. Access is through Tanguisson Park, and the beach itself is situated behind the Tanguisson Power Plant. Although less frequently visited by bathers compared to the other beaches, the location is used for fishing.

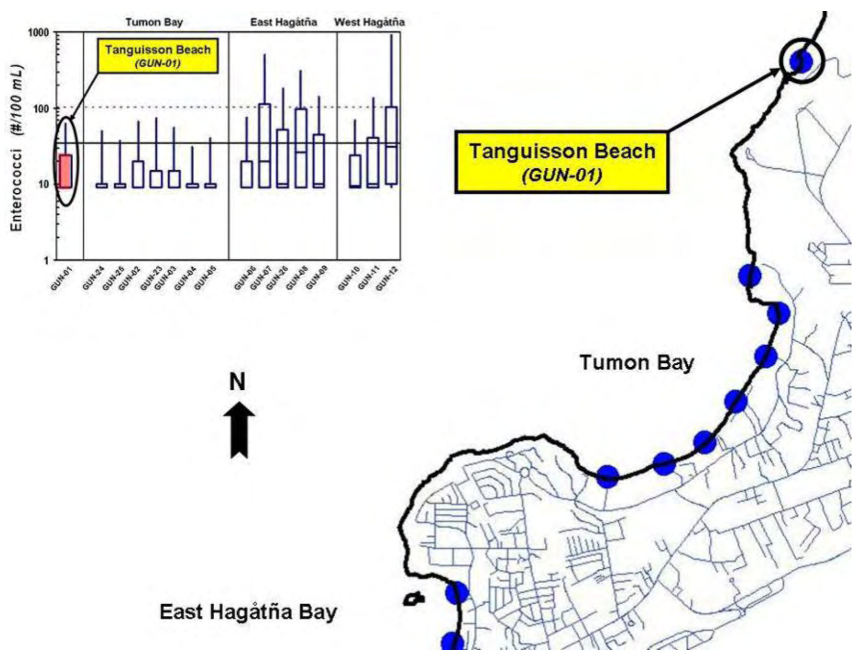

Figure 8-2. Location of Tanguisson Beach relative to other Northern Guam TMDL sites.

The frequency of beach advisories at Tanguisson Beach between 1997 and 2007 was low (10%) compared to other RBMP sites in the Northern Beach TMDL project area *(Figure 4-1)*. Enterococci concentrations at Tanguisson Beach were basically in the same range as other project area monitoring stations *(Figure 4-2 and Figure 8-2)*. The geometric mean of all individual samples was 16 counts /100mL, while the 75^{th} and 90^{th} percentiles were 24 and 63 counts /100 mL respectively. Although bacteria concentrations are lower than other RBMP sites, this beach is still impaired. Water quality improvements are clearly needed, though they will not be as significant as those required at other project area locations.

A key part of the data analysis for individual beaches is to examine water quality patterns by season and relative to flow conditions (e.g., runoff dominated versus base flows). Figure 8-3 shows the seasonal variability of bacteria concentrations at Tanguisson Beach. The highest concentrations were observed between January and April, indicating the importance of dry season sources at Tanguisson Beach.

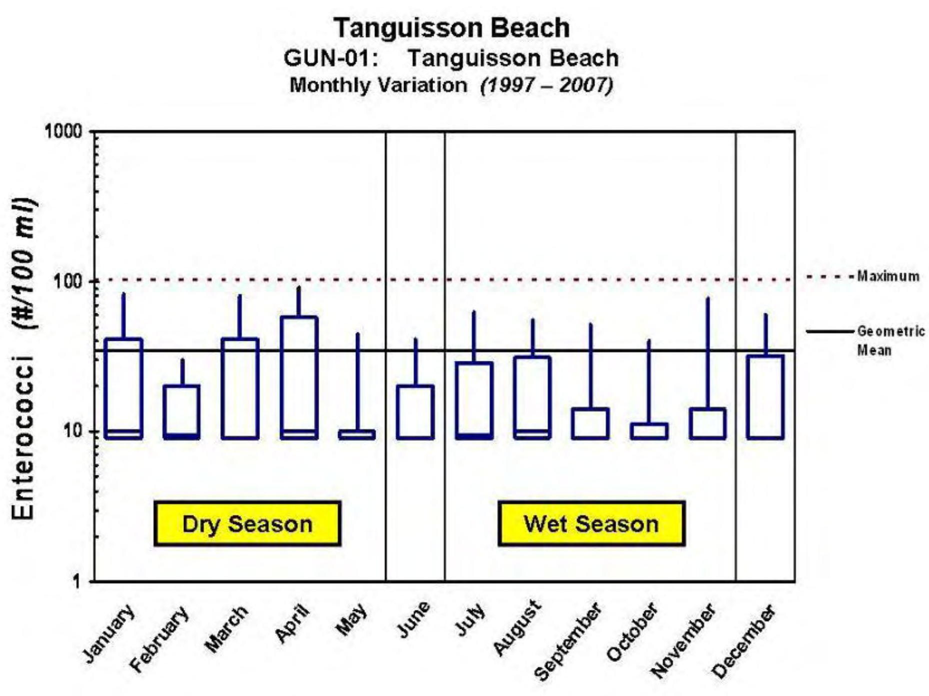

Figure 8-3. Seasonal variation at Tanguisson Beach.

Effect of Flow Conditions. A useful approach for relating water quality information to potential source areas is to examine bacteria levels in terms of hydrologic conditions. Figure 8-4 shows enterococci monitoring data collected at Tanguisson Beach using a duration curve framework. Although there is significant variability in the data, which is characteristic of bacteria monitoring information, a definite pattern exists.

As indicated by the *"box and whisker"* plots in Figure 8-4, the highest bacteria concentrations occur under high flow conditions. This is not unexpected because water quality at most beaches is strongly influenced by storm water runoff during heavy rainfall events. The magnitude of the increase is slightly higher than that observed at other Northern Guam RBMP sites. However, the 90th percentile exceeds the instantaneous maximum criterion in the high flow zone. This indicates that sources associated with periodic short term problems (e.g., sewer overflows during heavy rains) may be a concern under these conditions.

One interesting observation at Tanguisson Beach is the increase in bacteria concentrations moving across from the moist condition zone to the low flow zone. This pattern is often indicative of the influence of point source loads. This is again consistent with seasonal patterns noted earlier relative to the potential effect of the Northern District WWTP at Tanguisson Beach.

Incorporating seasonality into the analysis allows a closer look at patterns that may be associated with certain source categories. For example, bacteria delivered through seeps connected to storm water ponds are more likely to affect beach monitoring data during the wet season. In contrast, bacteria contributed from more continuous sources (e.g., leaky sewer lines or failing septics) will exert a greater effect during the dry season. Comparisons between the geometric means, the 75th and 90th percentiles for each duration curve zone serve as primary measures for examining seasonality. This is illustrated in Figure 8-5.

The effect of storm water runoff is evident for both the wet and dry seasons under high flow and moist conditions. One interesting observation is the higher bacteria concentrations during the dry season across the moist, mid-range, and dry zones. As mentioned above, this is likely due to the effect of the Northern District WWTP which would tend to be more pronounced when wet weather sources are less of a concern.

Relationship to Other Indicators. In addition to seasonal patterns, the relationship of bacteria concentrations to other parameters can be incorporated into the data analysis. Guam EPA staff noted field data for several indicators at the time of bacteria sample collection as part of the RBMP. These include observations such as tidal stage and presence or absence of turbidity.

The combination of patterns with some of these observations could be related to potential source areas and delivery mechanism that might affect bacteria concentrations at any particular beach of interest. For example, the presence or absence of turbidity may also be an indicator of either storm water runoff or suspended material associated with wind action. This approach to the analysis provides information that might prove useful in guiding implementation efforts intended to address documented problems.

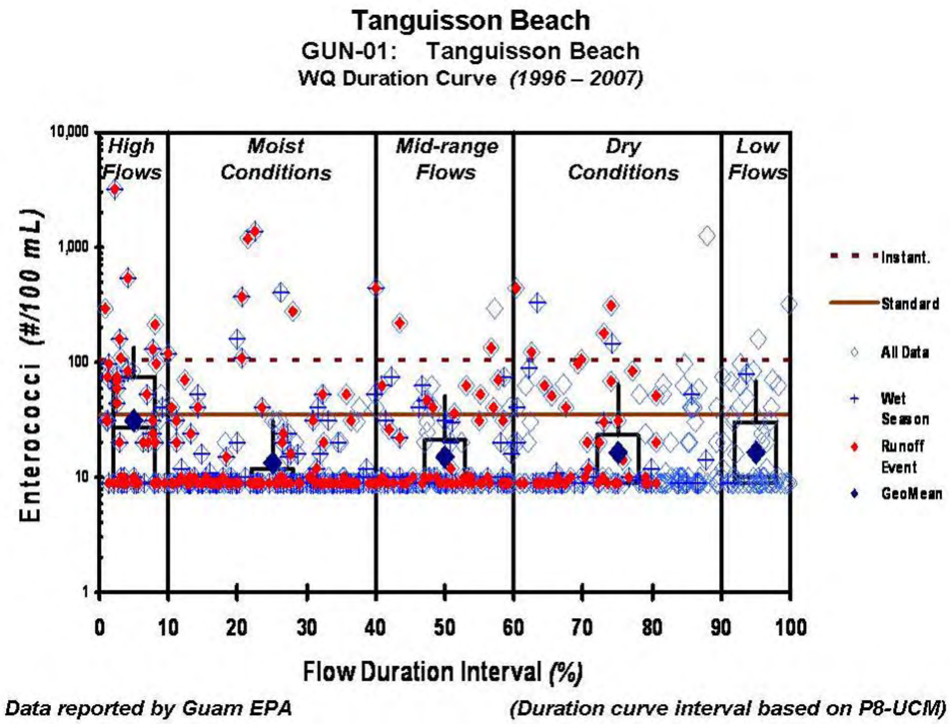

Figure 8-4. Water quality duration curve for Tanguisson Beach site.

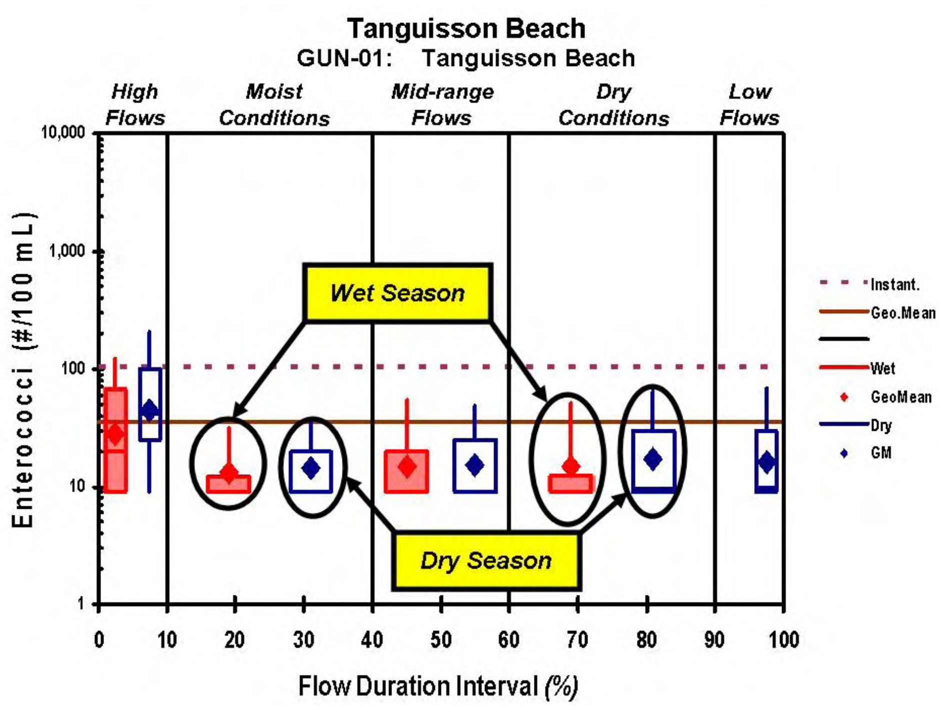

Figure 8-5. Wet versus dry season comparison for Tanguisson Beach.

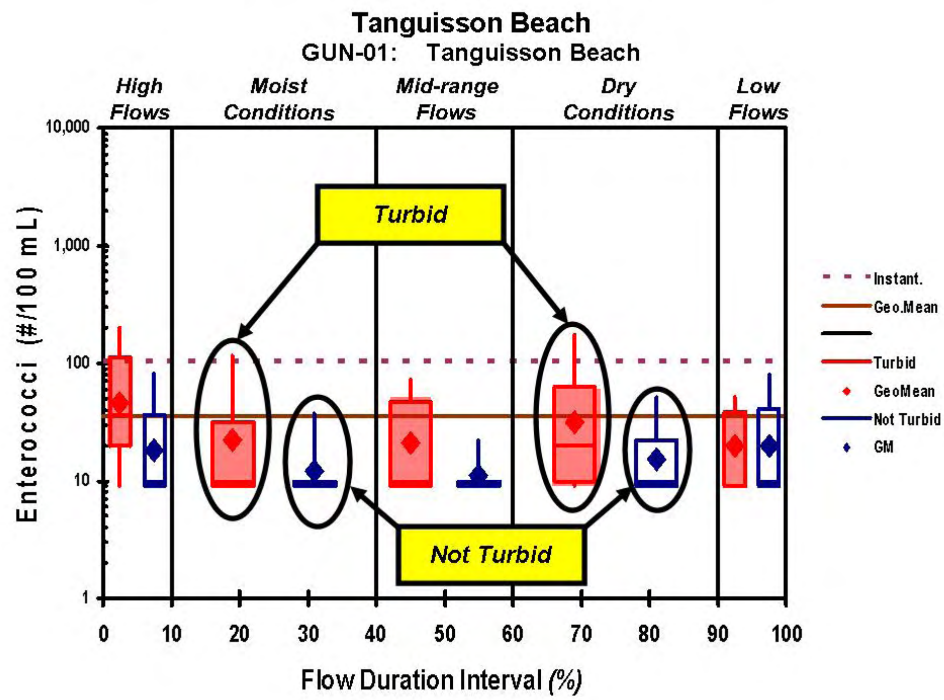

Figure 8-6. Turbid versus non-turbid sample comparison for Tanguisson Beach site.

Figure 8-6 shows the difference between bacteria levels when turbidity was present or absent during sample collection under the various flow conditions. The increased levels when turbidity was present under high, moist, and mid-range flow conditions likely reflects the effect of bacteria transported with fine particles during storm events. The effect of bacteria associated with resuspension of bottom sediments might also be the result of wind and wave action, which could affect beach water quality.

Potential Sources. The Source Assessment (Section 5, Table 5-2) summarized potential sources that may affect bacteria concentrations at Tanguisson Beach. Included are wastewater sources (septic systems, SSO, WWTP, GPA Power Plant), storm water runoff, and other sources (squatters, wildlife, debris and bottom deposits, atmospheric deposition). In addition, GEPA staff identified specific potential sources that could affect water quality at Tanguisson Beach *(Table 8-2)*.

Figure 8-7 provides a closer look at the Tanguisson Beach monitoring site relative to upland areas that potentially contribute bacteria during storm events. For example, roads can provide a general indication of the urban drainage network and accompanying storm drains.

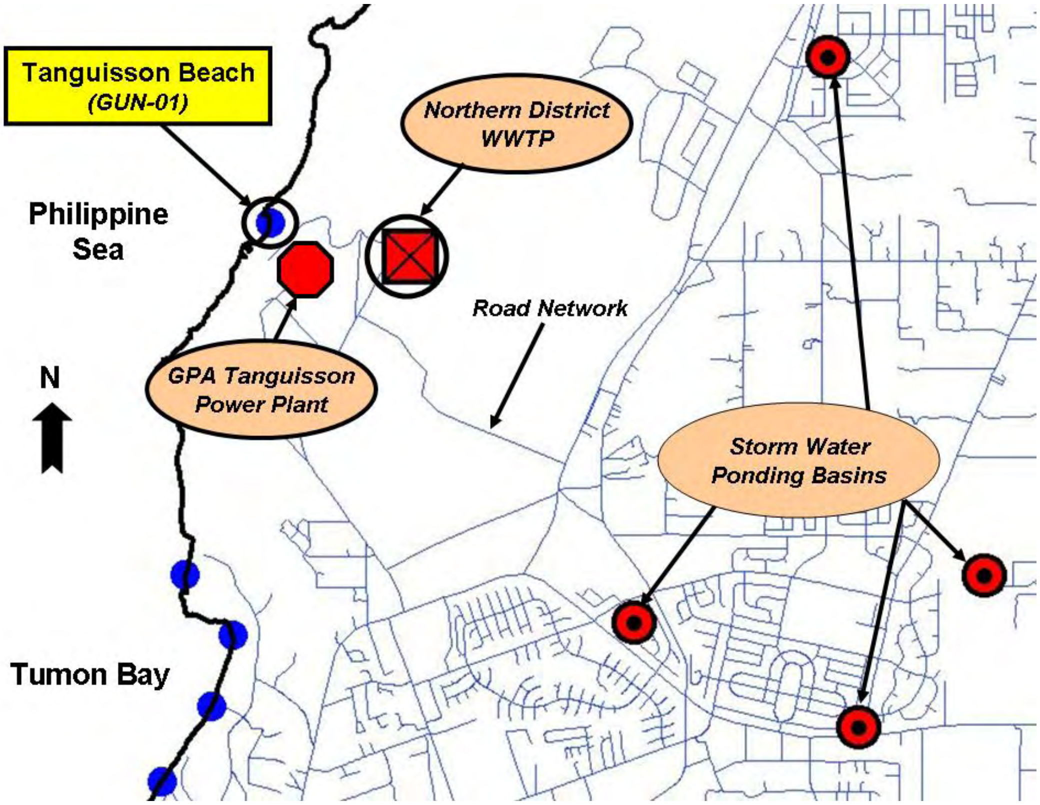

Figure 8-7. Location of Tanguisson Beach relative to potential source areas.

Table 8-2. Beach specific potential source summary *(Site GUN-01: Tanguisson Beach)*.

Site ID	Type	Source Name *(notes)*
GUN-01	Wastewater	GWA Northern District WWTP Sewage outfall
		GWA Northern District (new) WWTP outfall
	Cooling water	GPA Tanguisson outfall
	Squatters	Squatters

Figure 8-8 shows unsewered buildings in the upland area adjacent to Tanguisson Beach. Sewer line blockages and breaks, as well as SSOs, could also contribute to elevated bacteria levels. Figure 8-8 shows the location of both sewer mains and pump stations, as indicators of potential water quality problems associated with wastewater conveyance systems.

Figure 8-9 shows an air photo of the area adjacent to Tanguisson Beach. This provides a different perspective, which highlights the remoteness of Tanguisson Beach in comparison to other project area monitoring locations.

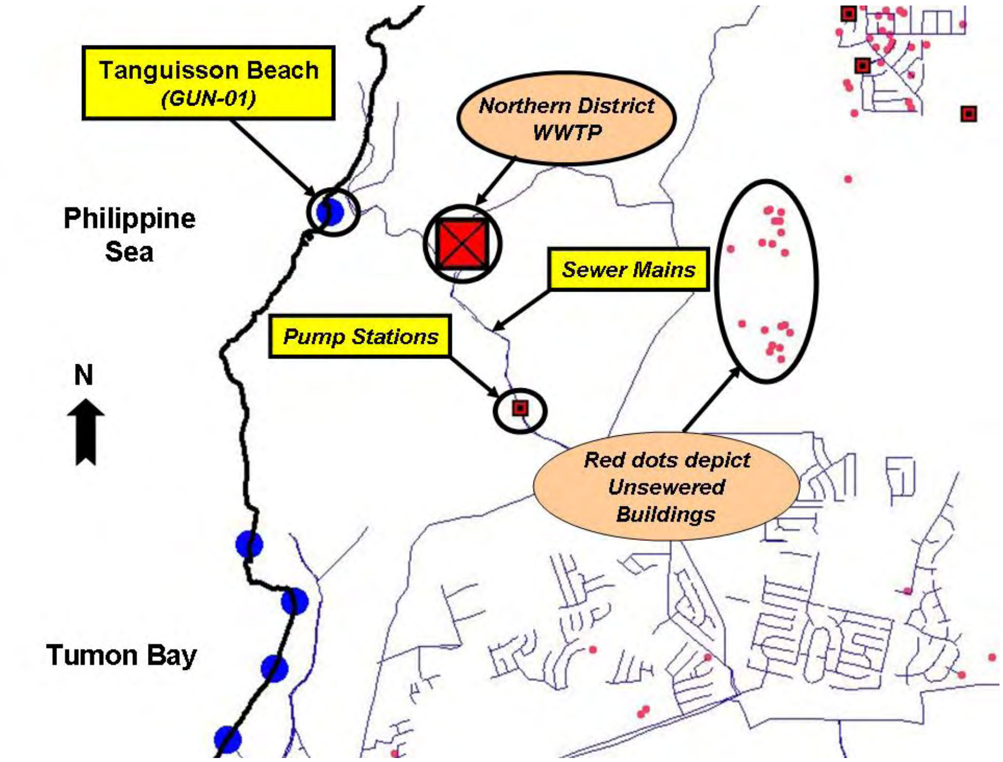

Figure 8-8. Location of Tanguisson Beach relative to potential unsewered buildings.

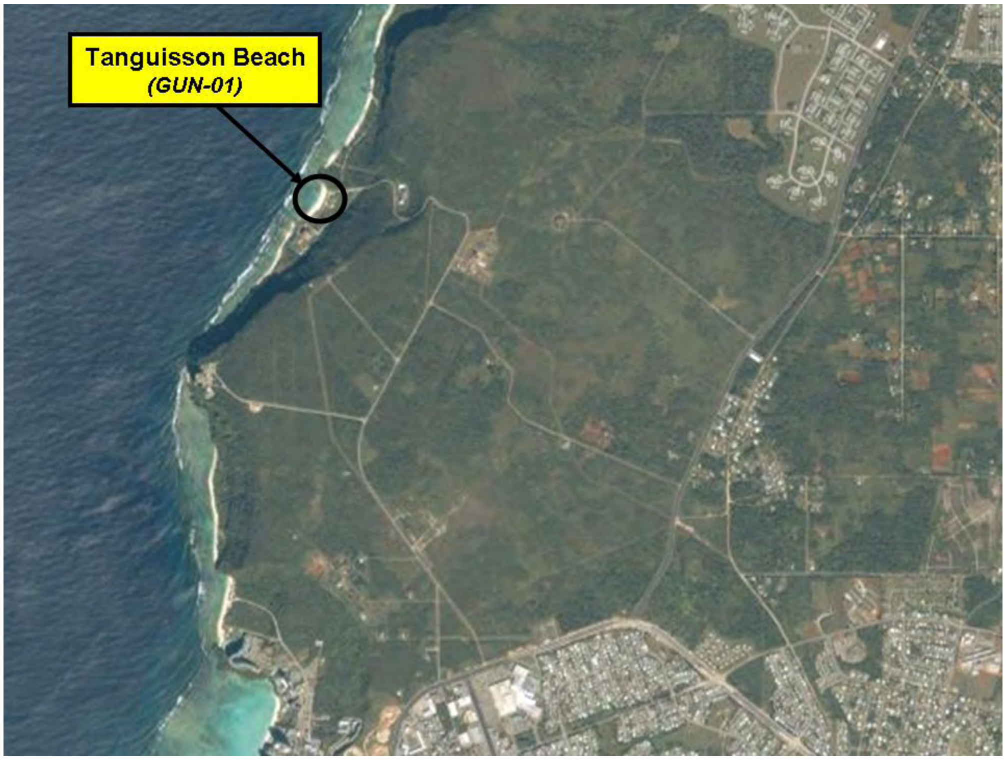

Figure 8-9. Air photo of Tanguisson Beach vicinity.

This beach is at a relatively remote location, is situated within a park, and has a low population density. For this reason, the influence of storm water runoff and septic tanks is not expected to be as dominant as at other sites. The major source of concern at Tanguisson Beach is the Northern District WWTP. This point source would tend to exert a greater influence during the dry season, consistent with the observations noted on Figure 8-4 and Figure 8-5.

Trends. Figure 8-10 presents a year-by-year summary of the enterococcus data for the Tanguisson Beach site. This provides a useful way to examine trends relative to both central tendency and annual variation. This type of analysis is useful in looking at specific sites where efforts to address beach advisories have been implemented. For example, a focus on patterns such as trends in geometric means or 90th percentiles provides a visual analysis that can be used to evaluate program effectiveness. With respect to trends, it should be noted that a laboratory analytical method change occurred in September 2000. The IDEXX test was used to determine enterococcus concentrations on all samples collected after September 2000.

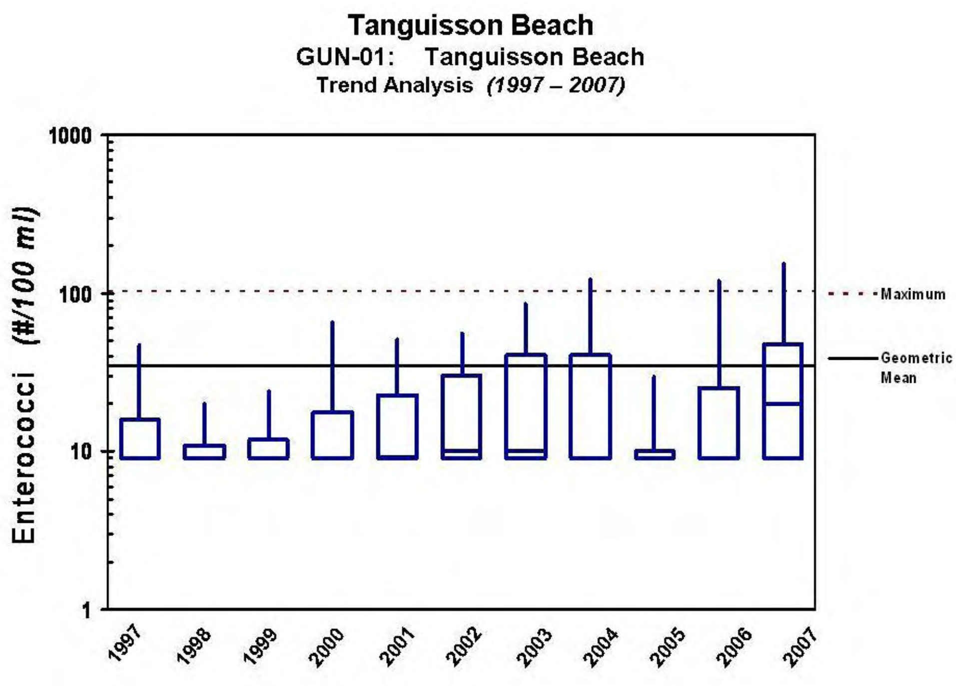

Figure 8-10. Trend analysis for Tanguisson Beach site.

Linkage Analysis. The numeric target for this TMDL is Guam's concentration-based criteria for enterococci bacteria (i.e., a geometric mean of 35 counts / 100 mL and an instantaneous maximum of 104 counts / 100 mL). The relationship between this target and potential sources at Tanguisson Beach is demonstrated through an analysis of water quality monitoring data at this site. Seasonal patterns, for example, show that the highest concentrations are observed between January and April, indicating the importance of dry season sources at Tanguisson Beach. This is consistent with the presence of point source loads identified at this location.

The connection between storm water sources and exceedances of numeric targets is also confirmed by examining the effect of flow conditions. At Tanguisson Beach, the highest bacteria concentrations occur under high flows. In short, the technical analyses presented in this assessment of Tanguisson Beach describe the relationship between water quality patterns and potential sources at this location. The loading capacity and allocations are all concentrations set at the criteria values for enterococci bacteria. This TMDL will clearly meet water quality standards and protect recreational uses at this beach.

TMDL Components. Table 8-3 presents the TMDL for Tanguisson Beach, identifying the loading capacity and allocations expressed as concentration-based values for enterococcus. This TMDL uses an implicit MOS, through inclusion of two conservative assumptions. First, the TMDL does not account for mixing in the receiving waters and assumes that zero dilution is available. Second, the goal of attaining standards at the point of discharge does not account for losses due to die-off and settling of indicator bacteria that are known to occur.

Table 8-3. Northern Guam Watershed TMDL summary *(Site GUN-01: Tanguisson Beach)*.

TMDL Component	Enterococcus Concentration *(# / 100 mL)*
Geometric Mean	
TMDL	**35**
Future Growth	35
Waste Load Allocation	35
Load Allocation	35
Instantaneous Maximum	
TMDL	**104**
Future Growth	104
Waste Load Allocation	104
Load Allocation	104

A hydrology-based framework using duration curve zones allows the TMDL to evaluate monitoring data in a way that reflects major watershed processes indicative of different flows. This approach enables numeric targets in the TMDL to consider watershed processes, such as hydrology and source assessment information including land use.

Table 8-4 identifies reductions for each duration curve zone by season using the TMDL targets. These estimates can serve to guide problem solving discussions on appropriate management strategies (based on knowledge associated with likely source areas, delivery mechanisms, and appropriate control measures that correspond to particular hydrologic conditions).

Table 8-4. Needed reductions to meet TMDL targets *(Site GUN-01: Tanguisson Beach)*.

Needed Reductions	**Flow Conditions** *(expressed as percentage)*				
	High	**Moist**	**Mid**	**Dry**	**Low**
Dry Season					
Based on geometric mean	22%	---	---	---	---
Based on instantaneous maximum	49%	---	---	---	---
Wet Season					
Based on geometric mean	---	---	---	---	---
Based on instantaneous maximum	15%	---	---	---	---

8.2 Gun Beach (GUN-24)

Gun Beach is located on the northern most point of Tumon Bay past the last hotel *(Figure 8-11)*. Relative to the other sites on Tumon Bay, it is fairly isolated being located at the end of the road. It is named for the anti-aircraft gun found next to the cliff wall at the northern end of the beach. Relative to most other beaches in the project area, Gun Beach is fairly secluded.

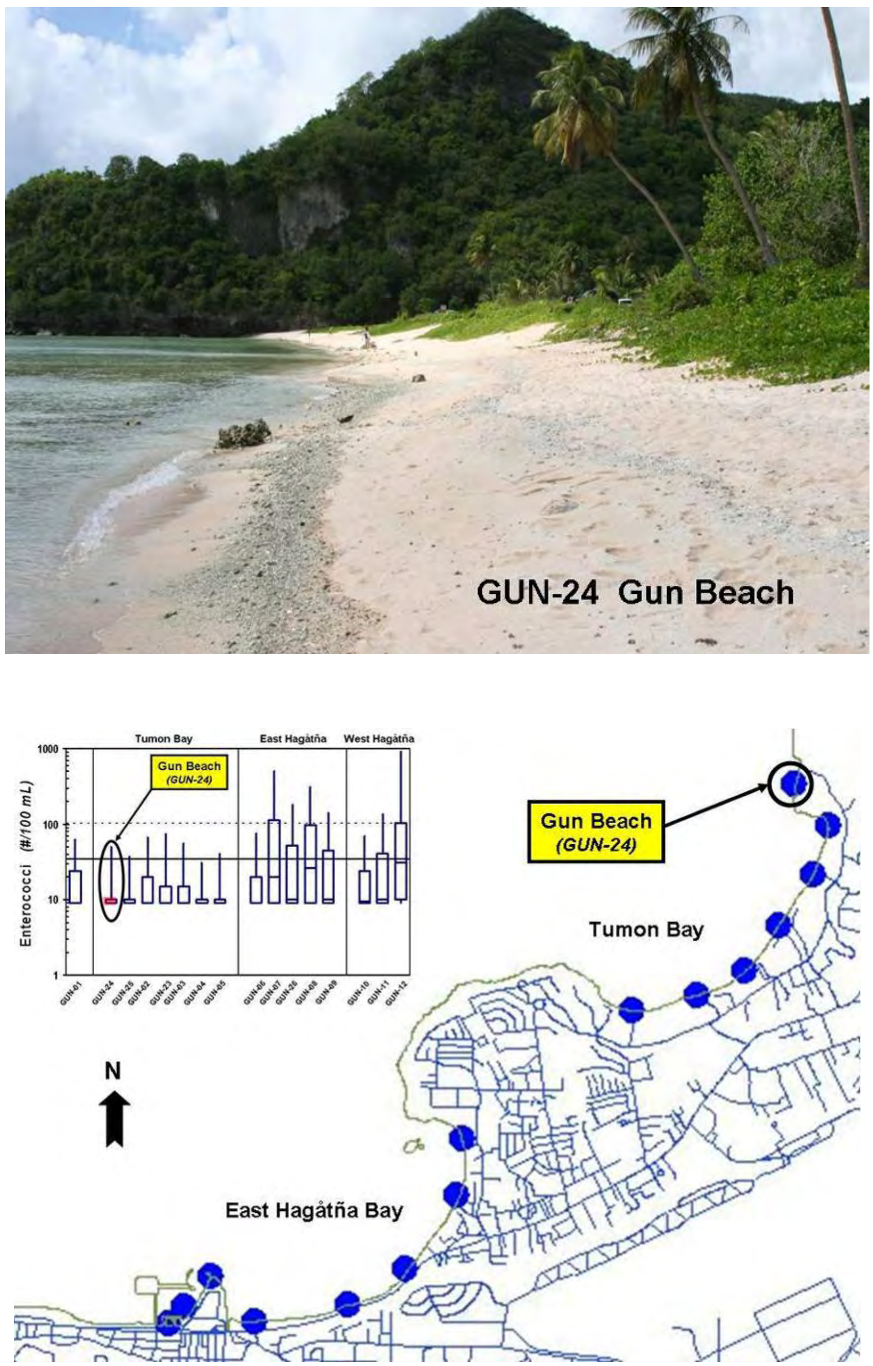

Figure 8-11. Location of Gun Beach relative to other Northern Guam TMDL sites.

The frequency of beach advisories at Gun Beach between 2005 and 2007 was low (10%) compared to other RBMP sites in the Northern Beach TMDL project area *(Figure 4-1)*. Enterococci concentrations at Gun Beach were among the lowest of all project area monitoring stations *(Figure 4-2 and Figure 8-11)*. The geometric mean of all individual samples was 13 counts /100mL, while the 75th and 90th percentiles were 10 and 50 counts /100 mL respectively. Although bacteria concentrations are lower than other RBMP sites, this beach is still impaired. Water quality improvements are clearly needed, though they will not be as significant as those required at other project area locations.

A key part of the data analysis for individual beaches is to examine water quality patterns by season and relative to flow conditions (e.g., runoff dominated versus base flows). Figure 8-12 shows the seasonal variability of bacteria concentrations at Gun Beach. The highest concentrations were observed between July and October, indicating the importance of wet season sources at Gun Beach.

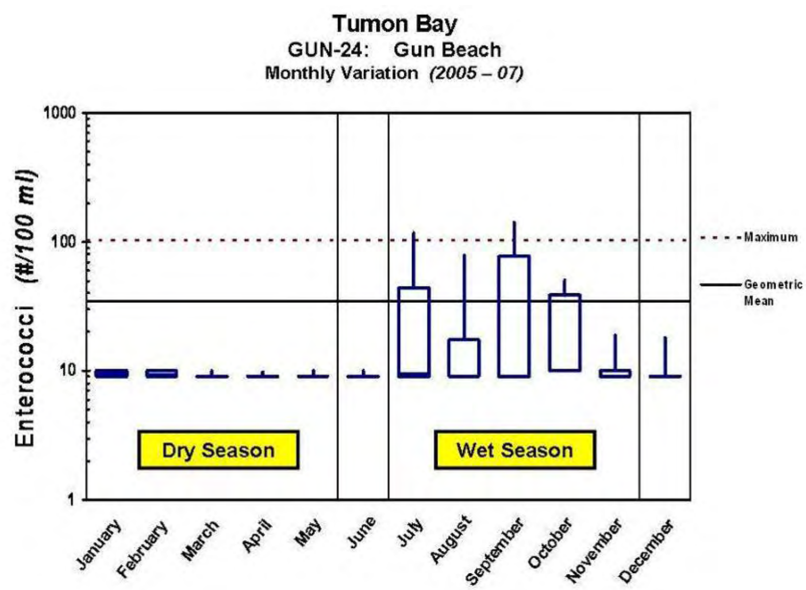

Figure 8-12. Seasonal variation at Gun Beach.

Effect of Flow Conditions. A useful approach for relating water quality information to potential source areas is to examine bacteria levels in terms of hydrologic conditions. Figure 8-13 shows enterococci monitoring data collected at Gun Beach using a duration curve framework. Although there is significant variability in the data, which is characteristic of bacteria monitoring information, a definite pattern exists.

As indicated by the *"box and whisker"* plots in Figure 8-13, the highest bacteria concentrations occur under high flow conditions. This is not unexpected because water quality at most beaches is strongly influenced by storm water runoff during

heavy rainfall events. The magnitude of the increase appears to be lower than that observed at other Northern Guam RBMP sites.

Incorporating seasonality into the analysis allows a closer look at patterns that may be associated with certain source categories. For example, bacteria delivered through seeps connected to storm water ponds are more likely to affect beach monitoring data during the wet season. In contrast, bacteria contributed from more continuous sources (e.g., leaky sewer lines or failing septics) will exert a greater effect during the dry season. Comparisons between the geometric means, the 75th and 90th percentiles for each duration curve zone serve as primary measures for examining seasonality. This is illustrated in Figure 8-14.

As noted earlier *(Figure 8-3)*, dry season bacteria concentrations observed at Gun Beach are extremely low. This pattern is consistent across all flow zones. However, Figure 8-14 shows that during the wet season, measured values are at comparable levels in the high, moist, mid-range, and dry zones. This seems to indicate that seeps connected to storm water sources may be affecting water quality at this site.

Relationship to Other Indicators. In addition to seasonal patterns, the relationship of bacteria concentrations to other parameters can be incorporated into the data analysis. Guam EPA staff noted field data for several indicators at the time of bacteria sample collection as part of the RBMP. These include observations such as tidal stage and presence or absence of turbidity.

The combination of patterns with some of these observations could be related to potential source areas and delivery mechanism that might affect bacteria concentrations at any particular beach of interest. For example, the presence or absence of turbidity may also be an indicator of either storm water runoff or suspended material associated with wind action. This approach to the analysis provides information that might prove useful in guiding implementation efforts intended to address documented problems.

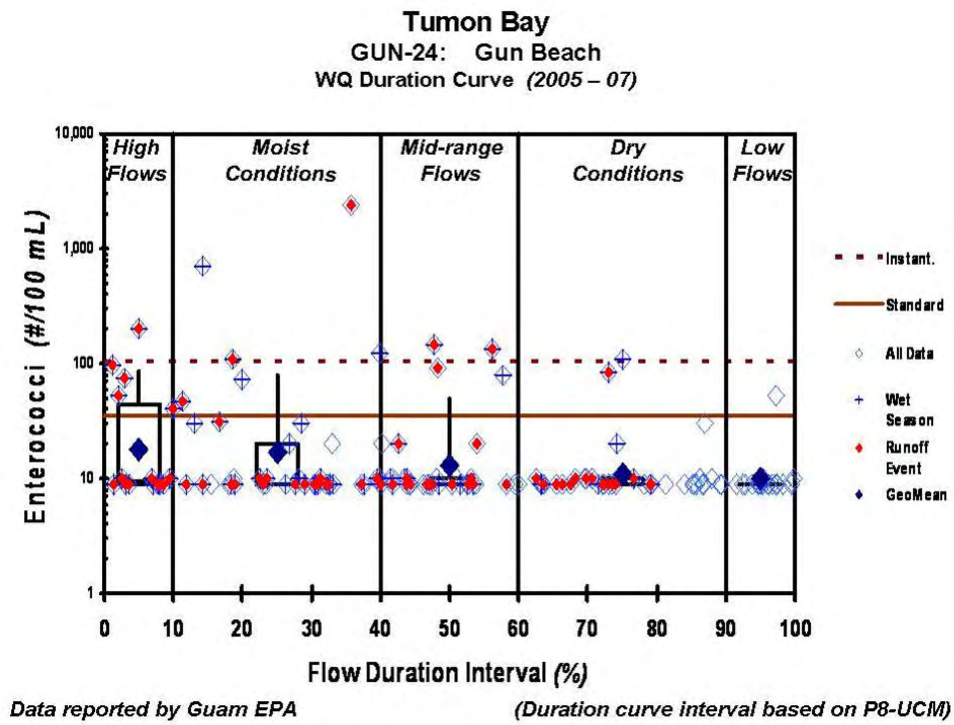

Figure 8-13. Water quality duration curve for Gun Beach site.

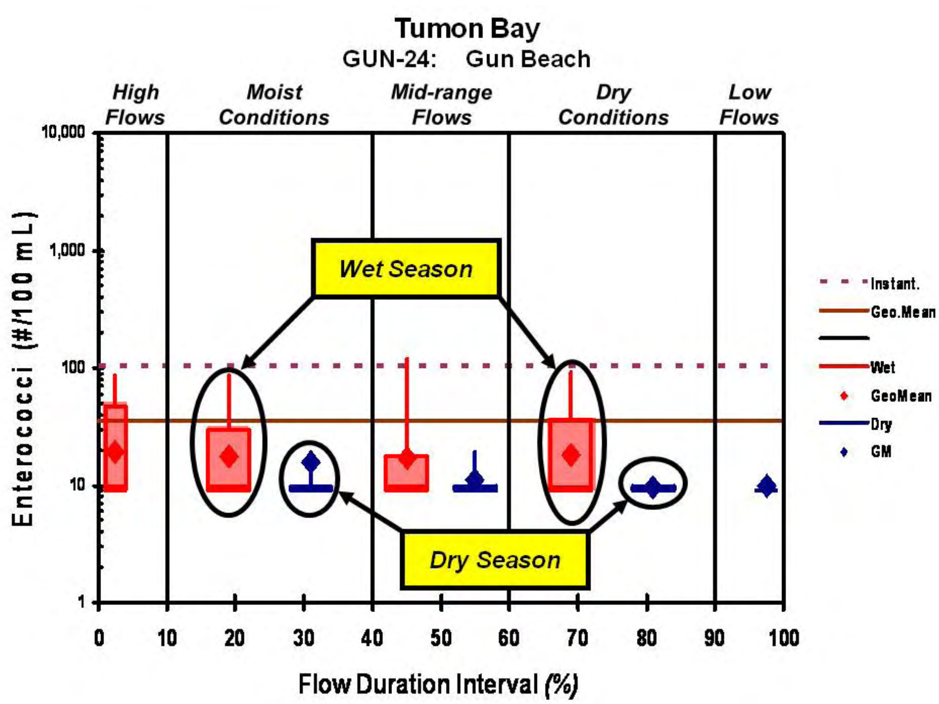

Figure 8-14. Wet versus dry season comparison for Gun Beach.

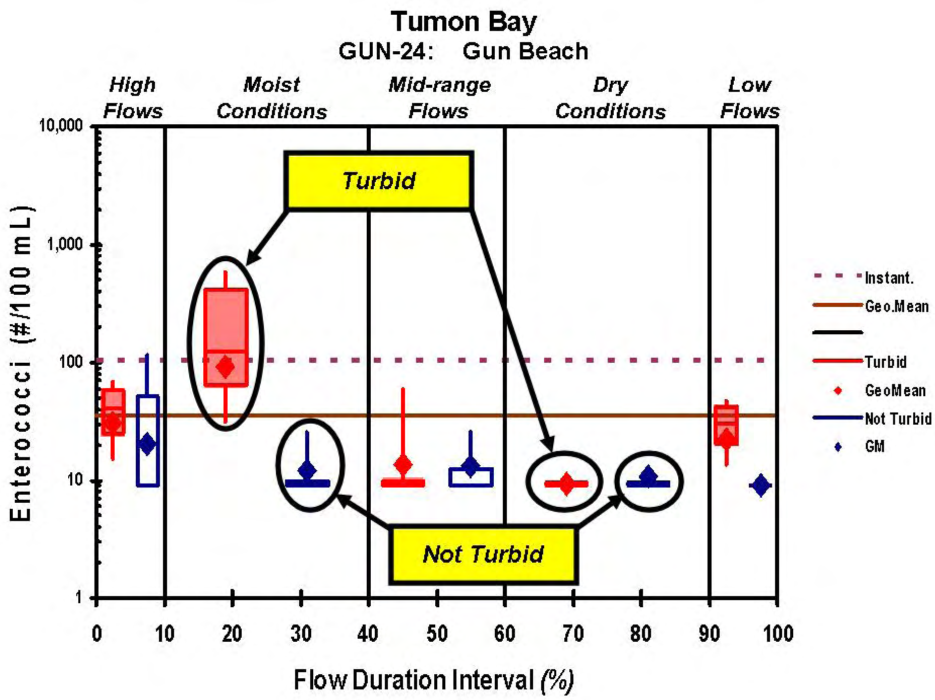

Figure 8-15. Turbid versus non-turbid sample comparison for Gun Beach site.

Figure 8-15 shows the difference between bacteria levels when turbidity was present or absent during sample collection under the various flow conditions. The increased levels when turbidity was present under high and moist conditions likely reflect the effect of bacteria transported with fine particles during storm events. The effect of bacteria associated with resuspension of bottom sediments might also be the result of wind and wave action, which could affect beach water quality.

Potential Sources. The Source Assessment (Section 5, Table 5-2) summarized potential sources that may affect bacteria concentrations at Gun Beach. Included are wastewater sources (septic systems), storm water (overland runoff, construction), and other sources (recreation & tourism activities). In addition, GEPA staff identified specific potential sources that could affect water quality at Gun Beach *(Table 8-5)*.

Figure 8-16 provides a closer look at the Gun Beach monitoring site relative to upland areas that potentially contribute bacteria during storm events. Figure 8-16 includes roads, which can provide a general indication of the urban drainage network and accompanying storm drains. Figure 8-16 also identifies major storm water ponding basins, including the Harmon Sink.

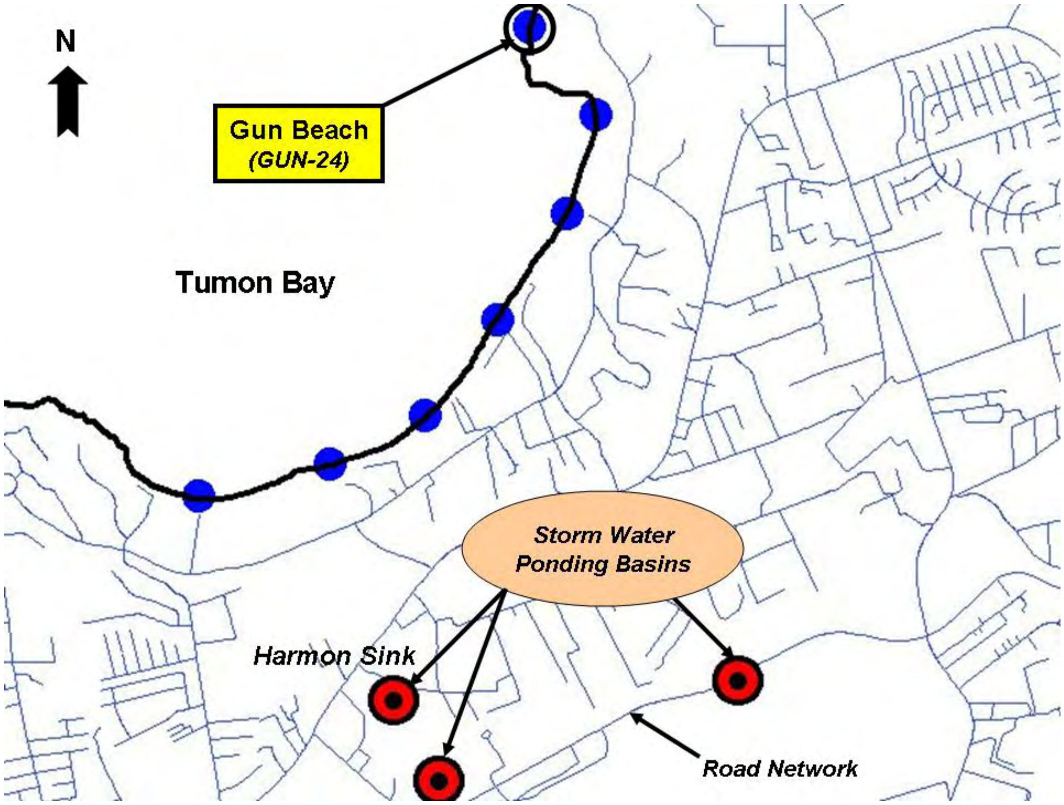

Figure 8-16. Location of Gun Beach relative to potential source areas.

Table 8-5. Beach specific potential source summary *(Site GUN-24: Gun Beach)*.

Site ID	Type	Source Name *(notes)*
GUN-24	Storm drain runoff	Ponding Basin (possibly natural) *Low depression in natural topology results in runoff ponding area.*
		Harmon Sinkhole *Guam International Airport Authority storm water flows to Harmon Sinkhole via concrete channel (includes failing oil / water separator).*
	Sewage overflow	Harmon Sinkhole *Receives sewage overflow from Mamajanao Pump Station.*

A review of GIS information shows a number of unsewered buildings in the upland area adjacent to Gun Beach. This information is shown in Figure 8-17. Sewer line blockages and breaks, as well as SSOs, could also contribute to elevated bacteria levels. Figure 8-17 shows the location of both sewer mains and pump stations, as indicators of potential water quality problems associated with wastewater conveyance systems.

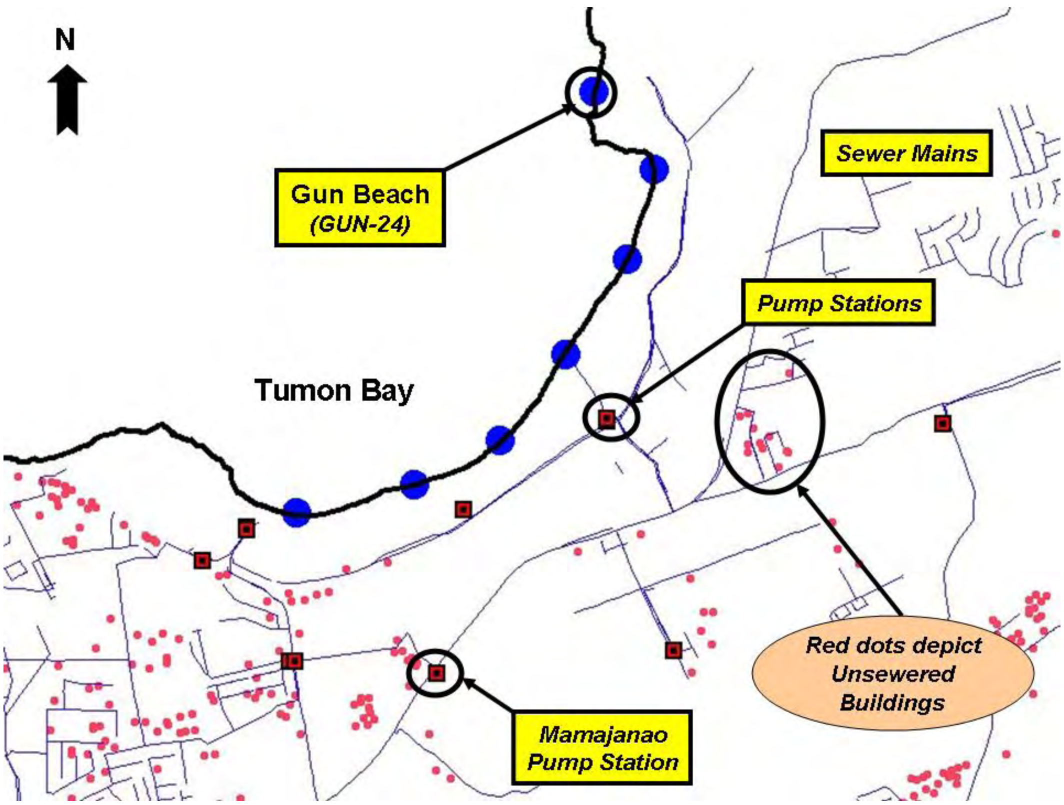

Figure 8-17. Location of Gun Beach relative to potential unsewered buildings.

Figure 8-18 shows an air photo of the area adjacent to Gun Beach. This provides a different perspective, which highlights the secluded nature of Gun Beach in comparison to other project area monitoring locations.

In addition to previous assessments and GIS information, Guam EPA staff identified other potential sources that could affect water quality at Gun Beach. Specifically, there is a low depression in natural topology in the immediate vicinity. This feature could result in a runoff ponding area that may collect storm drain runoff.

Figure 8-18. Air photo of Gun Beach vicinity.

Trends. Figure 8-19 presents a year-by-year summary of the enterococcus data for the Gun Beach site. This provides a useful way to examine trends relative to both central tendency and annual variation. This type of analysis is useful in looking at specific sites where efforts to address beach advisories have been implemented. For example, a focus on patterns such as trends in geometric means or 90th percentiles provides a visual analysis that can be used to evaluate program effectiveness. With respect to trends, it should be noted that a laboratory analytical method change occurred in September 2000. The IDEXX test was used to determine enterococcus concentrations on all samples collected after September 2000.

Linkage Analysis. The numeric target for this TMDL is Guam's concentration-based criteria for enterococci bacteria (i.e., a geometric mean of 35 counts / 100 mL and an instantaneous maximum of 104 counts / 100 mL). The relationship between this target and potential sources at Gun Beach is demonstrated through an analysis of water quality monitoring data at this site. Seasonal patterns, for example, show that the highest concentrations are observed between July and October, indicating the importance of wet season sources at Gun Beach. This is consistent with the presence of potential storm water sources identified at this location.

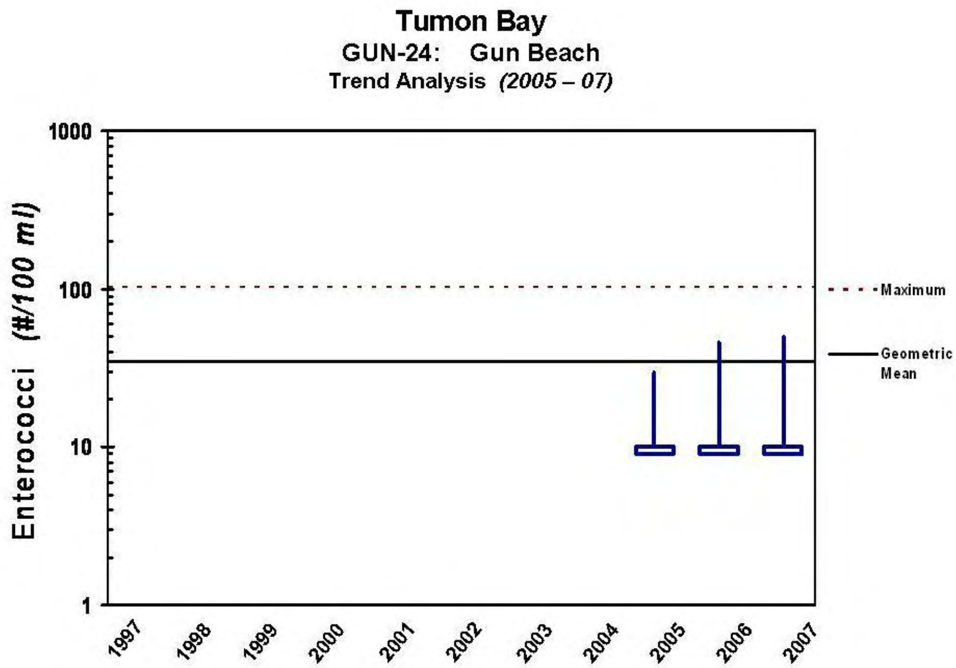

Figure 8-19. Trend analysis for Gun Beach site.

The connection between storm water sources and exceedances of numeric targets is further confirmed by examining the effect of flow conditions. At Gun Beach, the highest bacteria concentrations occur under high flows. Water quality conditions that reflect this pattern are strongly influenced by storm water runoff during heavy rainfall events. In short, the technical analyses presented in this assessment of Gun Beach describe the relationship between water quality patterns and potential sources at this location. The loading capacity and allocations are all concentrations set at the criteria values for enterococci bacteria. This TMDL will clearly meet water quality standards and protect recreational uses at this beach.

TMDL Components. Table 8-6 presents the TMDL for Gun Beach, identifying the loading capacity and allocations expressed as concentration-based values for enterococcus. These concentration-based values apply across all flow zones. This TMDL uses an implicit MOS, through inclusion of two conservative assumptions. First, the TMDL does not account for mixing in the receiving waters and assumes that zero dilution is available. Second, the goal of attaining standards at the point of discharge does not account for losses due to die-off and settling of indicator bacteria that are known to occur.

Table 8-6. Northern Guam Watershed TMDL summary *(Site GUN-24: Gun Beach)*.

TMDL Component	**Enterococcus Concentration** *(# / 100 mL)*
Geometric Mean	
TMDL	**35**
Future Growth	35
Waste Load Allocation	35
Load Allocation	35
Instantaneous Maximum	
TMDL	**104**
Future Growth	104
Waste Load Allocation	104
Load Allocation	104

A hydrology-based framework using duration curve zones allows the TMDL to evaluate monitoring data in a way that reflects major watershed processes indicative of different flows. This approach enables numeric targets in the TMDL to consider watershed processes, such as hydrology and source assessment information including land use.

Table 8-7 identifies reductions for each duration curve zone by season using the TMDL targets. These estimates can serve to guide problem solving discussions on appropriate management strategies (based on knowledge associated with likely source areas, delivery mechanisms, and appropriate control measures that correspond to particular hydrologic conditions).

Table 8-7. Needed reductions to meet TMDL targets *(Site GUN-24: Gun Beach)*.

Needed Reductions	**Flow Conditions** *(expressed as percentage)*				
	High	**Moist**	**Mid**	**Dry**	**Low**
Dry Season					
Based on geometric mean	---	---	---	---	---
Based on instantaneous maximum	---	---	---	---	---
Wet Season					
Based on geometric mean	---	---	---	---	---
Based on instantaneous maximum	---	---	12%	---	---

8.3 North San Vitores / Okura Beach (GUN-25)

North San Vitores / Okura Beach (also known as Gognga Beach) is one of several beaches located on Tumon Bay *(Figure 8-20)*. It is situated at the northern end of the bay, adjacent to the Aurora Resort. All of Tumon Bay is protected by a natural reef that stretches out about one mile from the beach shore. This portion of the project area is highly used for swimming, wind-surfing, snorkeling, kayaking and other popular water activities.

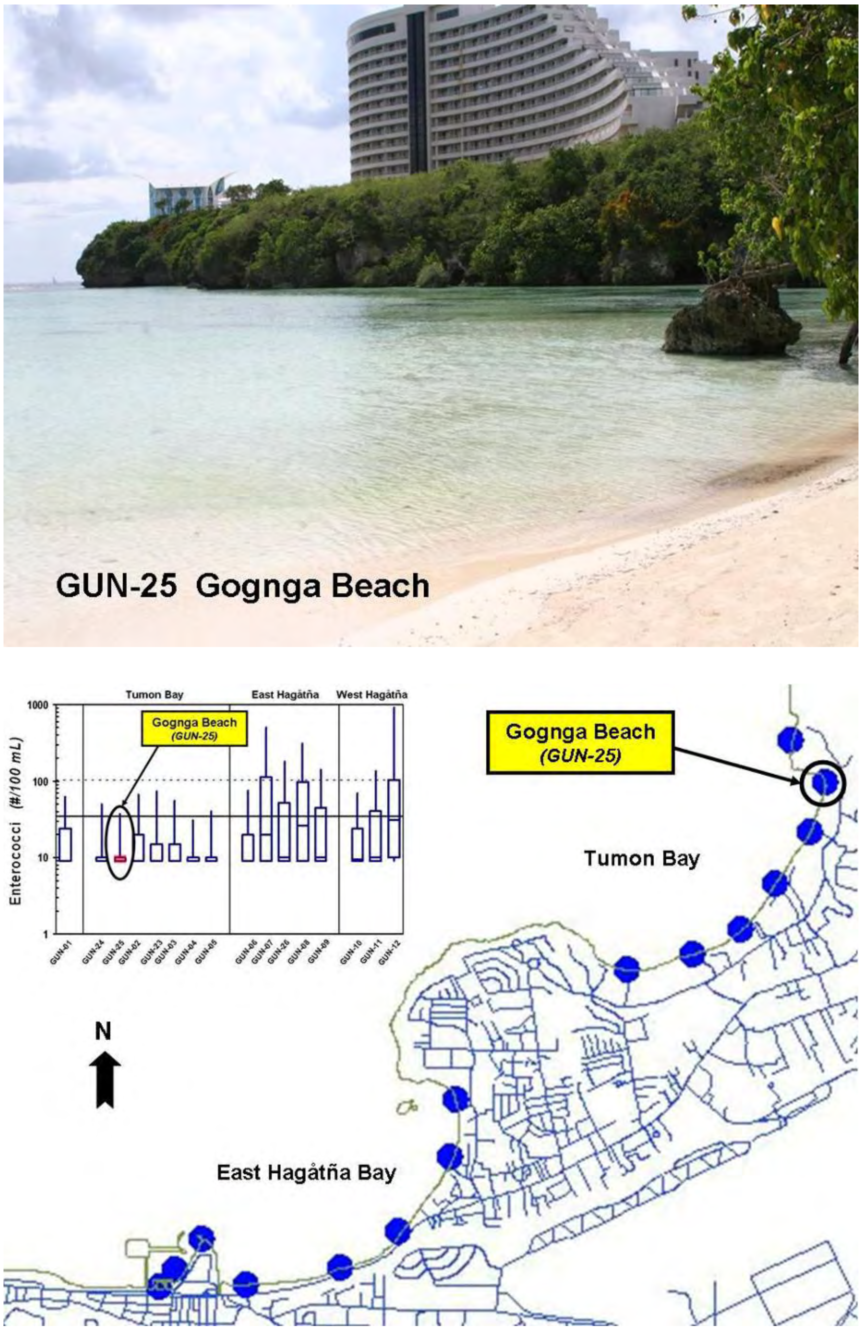

Figure 8-20. Location of North San Vitores / Okura Beach relative to other Northern Guam sites.

The frequency of beach advisories at North San Vitores / Okura Beach between 2005 and 2007 was low (7%) compared to other RBMP sites in the Northern Beach TMDL project area *(Figure 4-1)*. Enterococci concentrations at North San Vitores / Okura Beach were among the lowest of all project area monitoring stations *(Figure 4-2 and Figure 8-20)*. The geometric mean of all individual samples was 13 counts /100mL, while the 75th and 90th percentiles were 10 and 37 counts /100 mL respectively.

Although bacteria concentrations are lower than other RBMP sites, this beach is still impaired. Water quality improvements are clearly needed, though they will not be as significant as those required at other project area locations.

A key part of the data analysis for individual beaches is to examine water quality patterns by season and relative to flow conditions (e.g., runoff dominated versus base flows). Figure 8-21 shows the seasonal variability of bacteria concentrations at North San Vitores / Okura Beach. The highest concentrations were observed between July and October, indicating the importance of wet season sources at North San Vitores / Okura Beach.

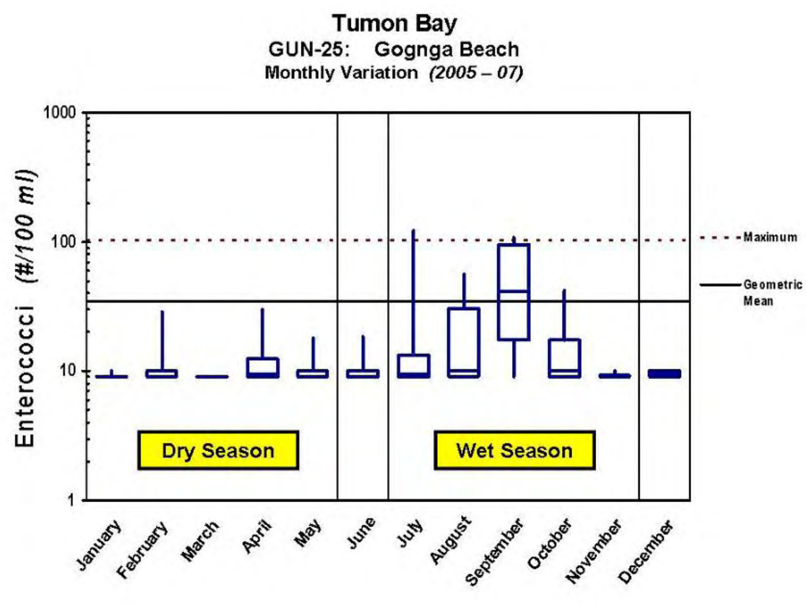

Figure 8-21. Seasonal variation at North San Vitores / Okura Beach.

Effect of Flow Conditions. A useful approach for relating water quality information to potential source areas is to examine bacteria levels in terms of hydrologic conditions. Figure 8-22 shows enterococci monitoring data collected at North San Vitores / Okura Beach using a duration curve framework. Although there is significant variability in the data, which is characteristic of bacteria monitoring information, a definite pattern exists.

As indicated by the *"box and whisker"* plots in Figure 8-22, the highest bacteria concentrations occur under high flow conditions. This is not unexpected because water quality at most beaches is strongly influenced by storm water runoff during heavy rainfall events. The magnitude of the increase appears to be fairly consistent with that observed at other Northern Guam RBMP sites.

Incorporating seasonality into the analysis allows a closer look at patterns that may be associated with certain source categories. For example, bacteria delivered through seeps connected to storm water ponds are more likely to affect beach monitoring data during the wet season. In contrast, bacteria contributed from more continuous sources (e.g., leaky sewer lines or failing septics) will exert a greater effect during the dry season. Comparisons between the geometric means, the 75th and 90th percentiles for each duration curve zone serve as primary measures for examining seasonality. This is illustrated in Figure 8-23.

As noted earlier *(Figure 8-21)*, dry season bacteria concentrations observed at North San Vitores / Okura Beach are extremely low. This pattern is consistent across all flow zones. However, Figure 8-23 shows that during the wet season, measured values are at elevated levels in the high, moist, mid-range, and dry zones. The higher wet season values in the dry zone are particularly interesting. This seems to indicate that seeps connected to storm water sources may be affecting water quality at this site.

Relationship to Other Indicators. In addition to seasonal patterns, the relationship of bacteria concentrations to other parameters can be incorporated into the data analysis. Guam EPA staff noted field data for several indicators at the time of bacteria sample collection as part of the RBMP. These include observations such as tidal stage and presence or absence of turbidity.

The combination of patterns with some of these observations could be related to potential source areas and delivery mechanism that might affect bacteria concentrations at any particular beach of interest. For example, the presence or absence of turbidity may also be an indicator of either storm water runoff or suspended material associated with wind action. This approach to the analysis provides information that might prove useful in guiding implementation efforts intended to address documented problems.

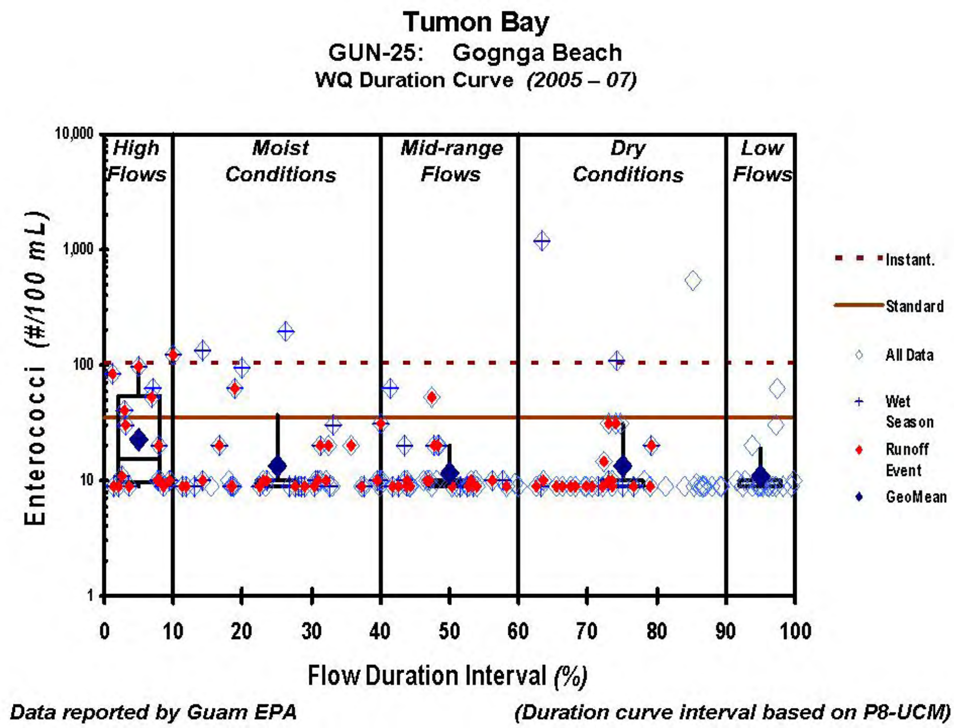

Figure 8-22. Water quality duration curve for North San Vitores / Okura Beach site.

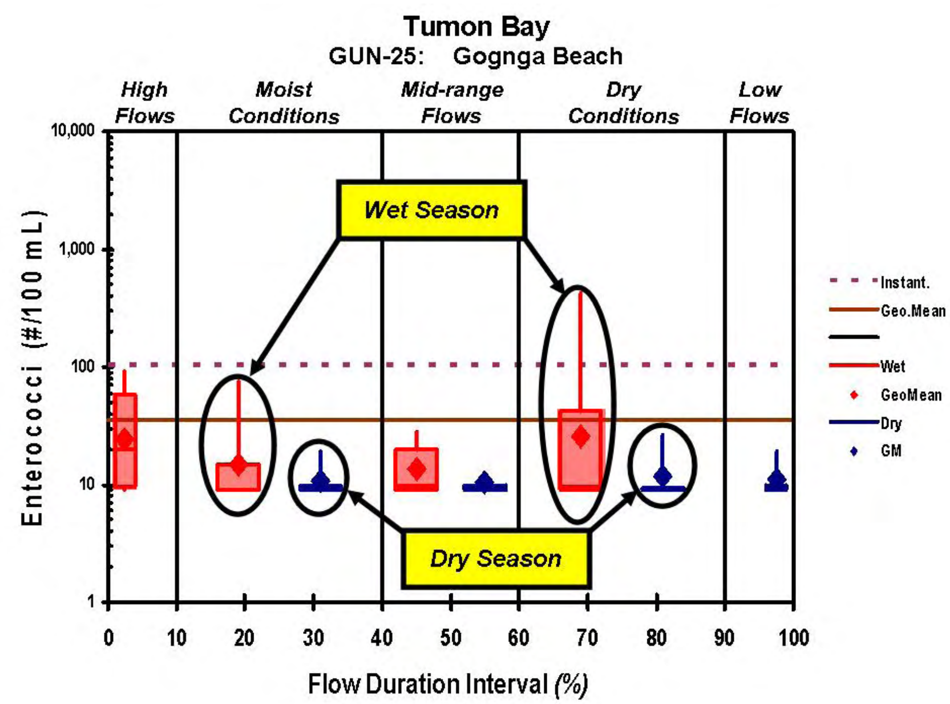

Figure 8-23. Wet versus dry season comparison for North San Vitores / Okura Beach.

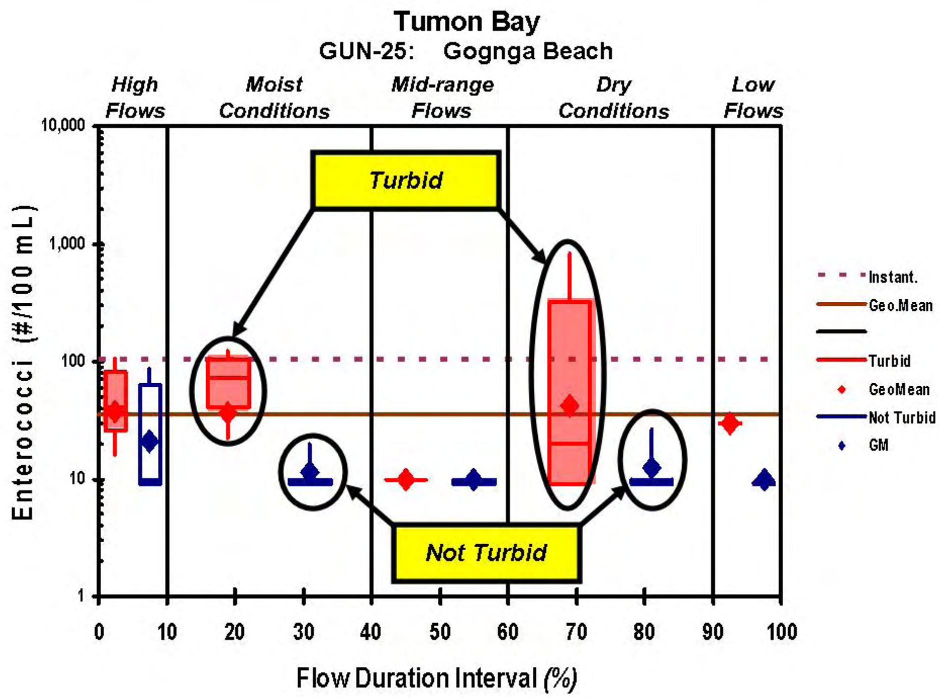

Figure 8-24. Turbid versus non-turbid sample comparison for N. San Vitores / Okura Beach site.

Figure 8-24 shows the difference between bacteria levels when turbidity was present or absent during sample collection under the various flow conditions. The increased levels when turbidity was present under high and moist conditions likely reflect the effect of bacteria transported with fine particles during storm events. The effect of bacteria associated with resuspension of bottom sediments might also be the result of wind and wave action, which could affect beach water quality.

Potential Sources. The Source Assessment (Section 5, Table 5-2) summarized potential sources that may affect bacteria concentrations at North San Vitores / Okura Beach. Included are wastewater sources (septic systems, sewer line blockages & breaks), storm water (overland runoff, construction), and other sources (recreation & tourism activities). In addition, GEPA staff identified specific potential sources that could affect water quality at North San Vitores / Okura Beach *(Table 8-8)*.

Figure 8-25 provides a closer look at the North San Vitores / Okura Beach monitoring site relative to upland areas that potentially contribute bacteria during storm events. Figure 8-25 includes roads, which can provide a general indication of the urban drainage network and accompanying storm drains. Figure 8-25 also identifies major storm water ponding basins, including the Harmon Sink.

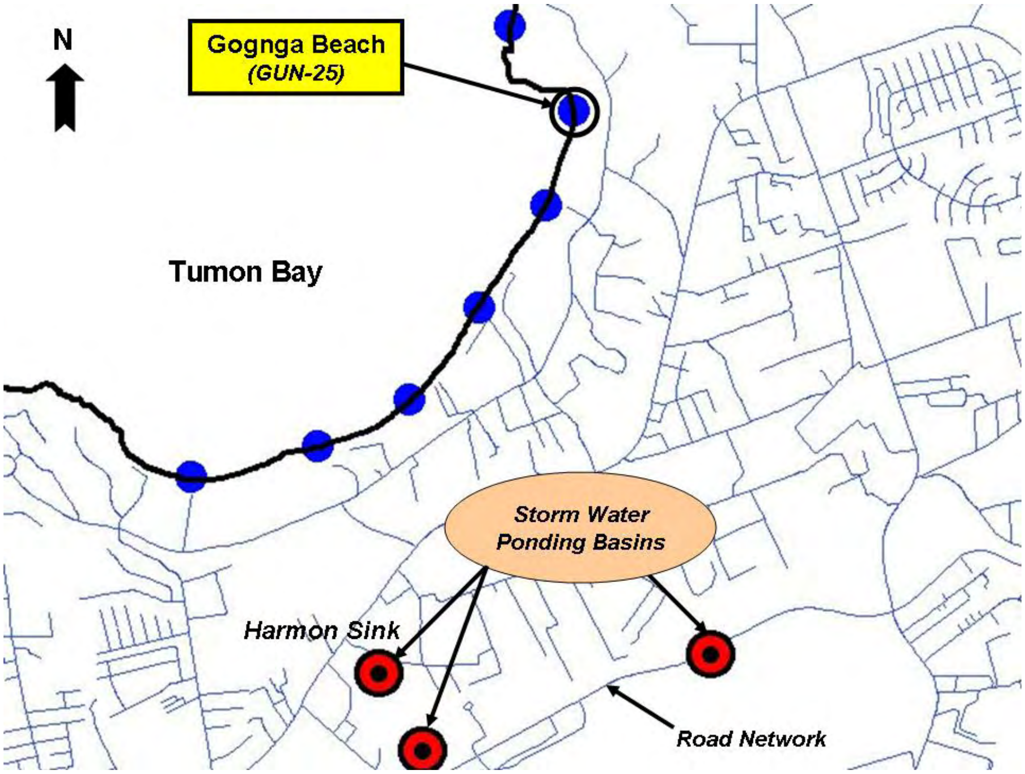

Figure 8-25. Location of North San Vitores / Okura Beach relative to potential source areas.

Table 8-8. Beach specific potential source summary *(Site GUN-25: Gognga Beach)*.

Site ID	Type	Source Name ***(notes)***
GUN-25	Runoff	Okura Sinkhole
	Storm drain runoff	Guam Aurora Resort (formerly Guam Hotel Okura)
		Harmon Sinkhole *Guam International Airport Authority storm water flows to Harmon Sinkhole via concrete channel (includes failing oil / water separator).*
	Sewage overflow	Harmon Sinkhole *Receives sewage overflow from Mamajanao Pump Station.*

A review of GIS information shows a number of unsewered buildings in the upland area adjacent to North San Vitores / Okura Beach. This information is shown in Figure 8-26. Sewer line blockages and breaks, as well as SSOs, could also contribute to elevated bacteria levels. Figure 8-26 shows the location of both sewer mains and pump stations, as indicators of potential water quality problems associated with wastewater conveyance systems.

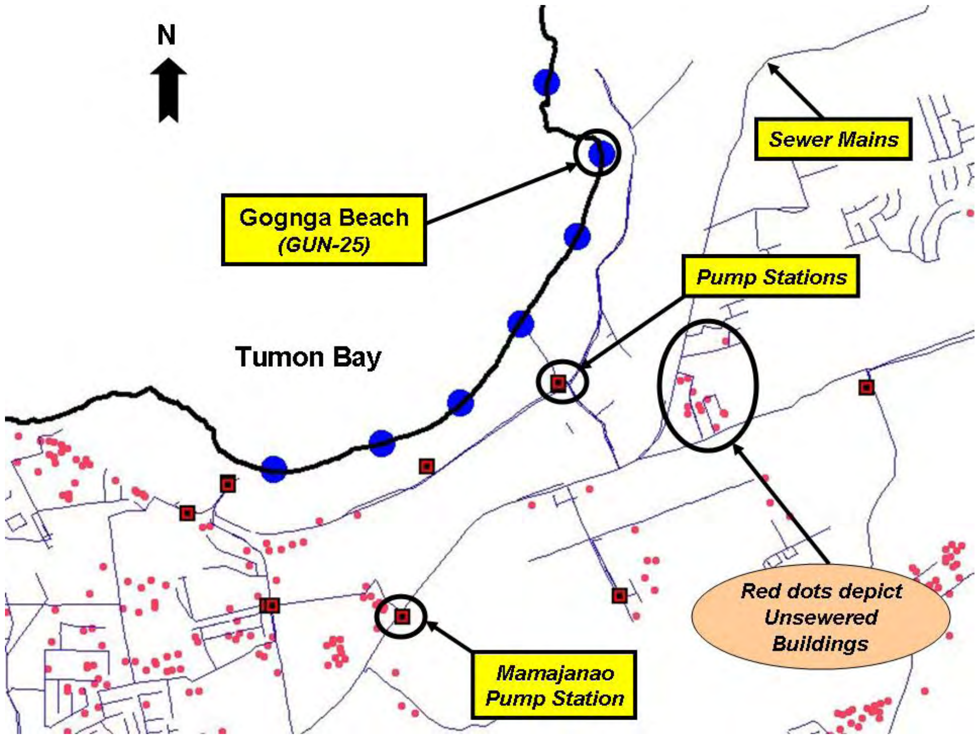

Figure 8-26. Location of N. San Vitores / Okura Beach relative to potential unsewered buildings.

Figure 8-27. Air photo of North San Vitores / Okura Beach vicinity.

Figure 8-27 shows an air photo of the area adjacent to North San Vitores / Okura Beach. This provides a different perspective, which highlights the high density of roads and buildings in the area adjacent to North San Vitores / Okura Beach.

In addition to previous assessments and GIS information, Guam EPA staff identified other potential sources that could affect water quality at North San Vitores / Okura Beach. Specifically, the Okura Sinkhole and storm drain runoff from the Guam Aurora Resort (formerly the Guam Hotel Okura) could exert an influence on bacteria concentrations at this monitoring site.

Trends. Figure 8-28 presents a year-by-year summary of the enterococcus data for the North San Vitores / Okura Beach site. This provides a useful way to examine trends relative to both central tendency and annual variation. This type of analysis is useful in looking at specific sites where efforts to address beach advisories have been implemented. For example, a focus on patterns such as trends in geometric means or 90th percentiles provides a visual analysis that can be used to evaluate program effectiveness. With respect to trends, it should be noted that a laboratory analytical method change occurred in September 2000. The IDEXX test was used to determine enterococcus concentrations on all samples collected after September 2000.

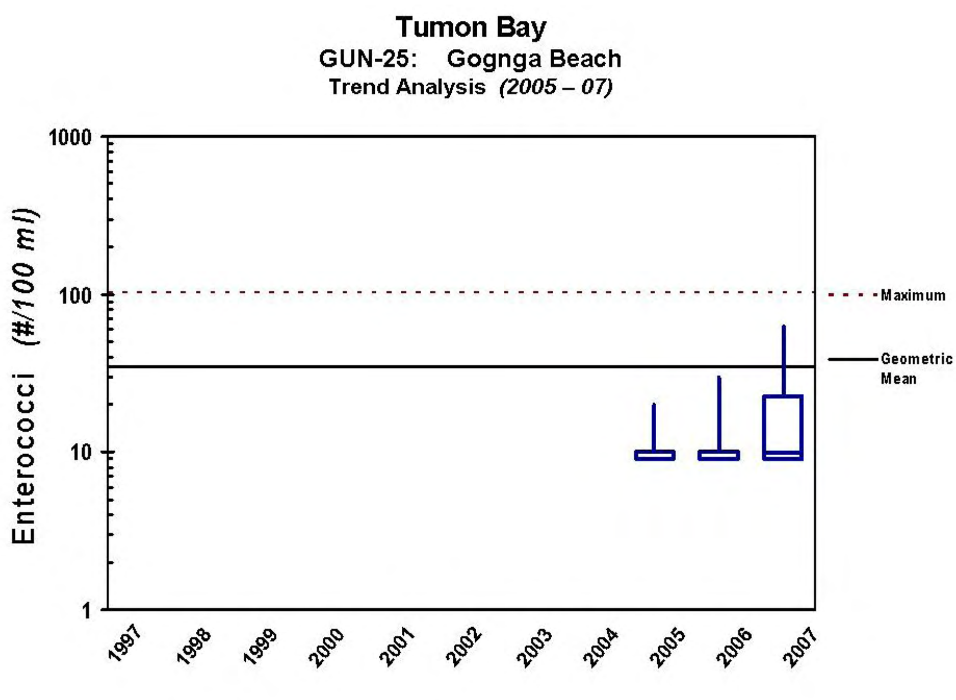

Figure 8-28. Trend analysis for North San Vitores / Okura Beach site.

Linkage Analysis. The numeric target for this TMDL is Guam's concentration-based criteria for enterococci bacteria (i.e., a geometric mean of 35 counts / 100 mL and an instantaneous maximum of 104 counts / 100 mL). The relationship between this target and potential sources at North San Vitores / Okura Beach is demonstrated through an analysis of water quality monitoring data at this site. Seasonal patterns, for example, show that the highest concentrations are observed between July and October, indicating the importance of wet season sources at North San Vitores / Okura Beach. This is consistent with the presence of potential storm water sources identified at this location.

The connection between storm water sources and exceedances of numeric targets is further confirmed by examining the effect of flow conditions. At North San Vitores / Okura Beach, the highest bacteria concentrations occur under high flows. Water quality conditions that reflect this pattern are strongly influenced by storm water runoff during heavy rainfall events. In short, the technical analyses presented in this assessment of North San Vitores / Okura Beach describe the relationship between water quality patterns and potential sources at this location. The loading capacity and allocations are all concentrations set at the criteria values for enterococci bacteria. This TMDL will clearly meet water quality standards and protect recreational uses at this beach.

TMDL Components. Table 8-9 presents the TMDL for North San Vitores / Okura Beach, identifying the loading capacity and allocations expressed as concentration-based values for enterococcus. These concentration-based values apply across all flow zones. This TMDL uses an implicit MOS, through inclusion of two conservative assumptions. First, the TMDL does not account for mixing in the receiving waters and assumes that zero dilution is available. Second, the goal of attaining standards at the point of discharge does not account for losses due to die-off and settling of indicator bacteria that are known to occur.

Table 8-9. Northern Guam TMDL summary *(Site GUN-25: North San Vitores / Okura Beach)*.

TMDL Component	**Enterococcus Concentration** *(# / 100 mL)*
Geometric Mean	
TMDL	**35**
Future Growth	35
Waste Load Allocation	35
Load Allocation	35
Instantaneous Maximum	
TMDL	**104**
Future Growth	104
Waste Load Allocation	104
Load Allocation	104

A hydrology-based framework using duration curve zones allows the TMDL to evaluate monitoring data in a way that reflects major watershed processes indicative of different flows. This approach enables numeric targets in the TMDL to consider watershed processes, such as hydrology and source assessment information including land use.

Table 8-10 identifies reductions for each duration curve zone by season using the TMDL targets. These estimates can serve to guide problem solving discussions on appropriate management strategies (based on knowledge associated with likely source areas, delivery mechanisms, and appropriate control measures that correspond to particular hydrologic conditions).

Table 8-10. Needed reductions to meet TMDL *(Site GUN-25: N. San Vitores / Okura Beach)*.

Needed Reductions	**Flow Conditions** *(expressed as percentage)*				
	High	**Moist**	**Mid**	**Dry**	**Low**
Dry Season					
Based on geometric mean	---	---	---	---	---
Based on instantaneous maximum	---	---	---	---	---
Wet Season					
Based on geometric mean	---	---	---	---	---
Based on instantaneous maximum	---	---	---	76%	---

8.4 San Vitores Beach (GUN-02)

San Vitores is part of the stretch known as Naton Beach; a strip of beach along the northern most chain of hotels on Tumon Bay *(Figure 8-29)*. This area is also known as tourism central for the Tumon area; an extremely popular location for tourists looking to participate in water activities such as kayaking, beachcombing, and snorkeling.

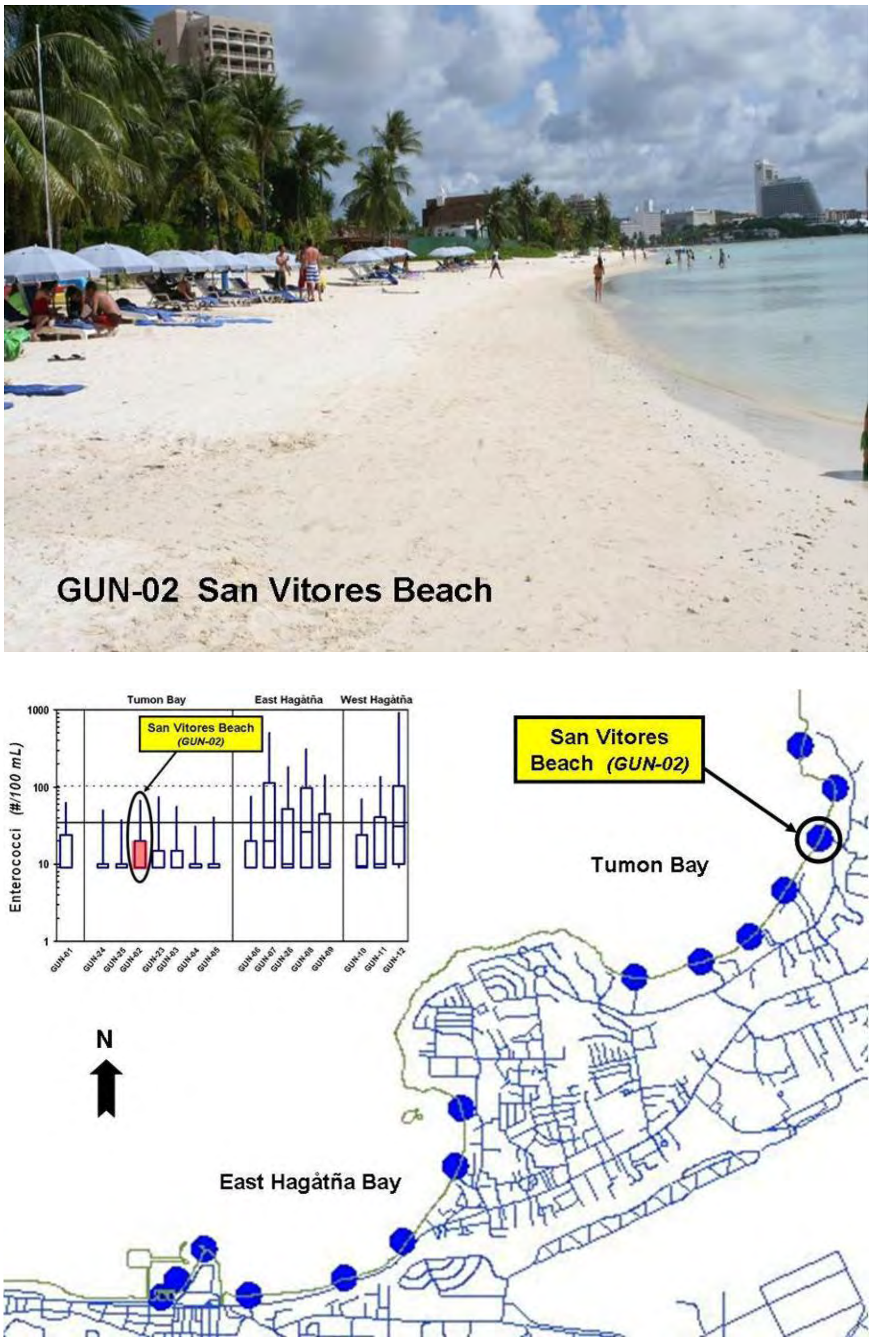

Figure 8-29. Location of San Vitores Beach relative to other Northern Guam TMDL sites.

The frequency of beach advisories at San Vitores Beach between 1997 and 2007 was typical (13%) of many RBMP sites in the Northern Beach TMDL project area *(Figure 4-1)*. Enterococci concentrations at San Vitores Beach were basically in the same range as a number of other project area monitoring stations *(Figure 4-2 and Figure 8-29)*. The geometric mean of all individual samples was 16 counts /100mL, while the 75th and 90th percentiles were 20 and 66 counts /100 mL respectively.

A key part of the data analysis for individual beaches is to examine water quality patterns by season and relative to flow conditions (e.g., runoff dominated versus base flows). Figure 8-30 shows the seasonal variability of bacteria concentrations at San Vitores Beach. The highest concentrations were observed between June and December, indicating the importance of wet season sources at San Vitores Beach.

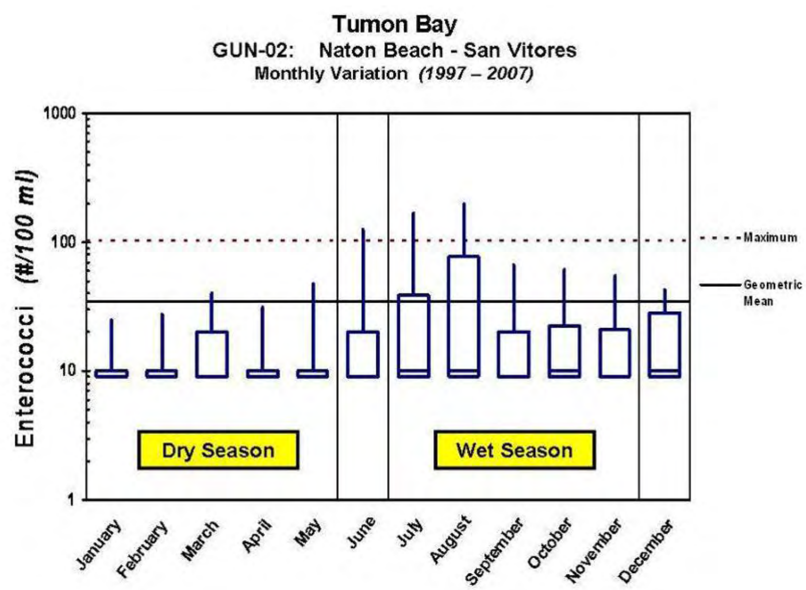

Figure 8-30. Seasonal variation at San Vitores Beach.

Effect of Flow Conditions. A useful approach for relating water quality information to potential source areas is to examine bacteria levels in terms of hydrologic conditions. Figure 8-31 shows enterococci monitoring data collected at San Vitores Beach using a duration curve framework. Although there is significant variability in the data, which is characteristic of bacteria monitoring information, a definite pattern exists.

As indicated by the *"box and whisker"* plots in Figure 8-31, the highest bacteria concentrations occur under high flow conditions. This is not unexpected because water quality at most beaches is strongly influenced by storm water runoff during heavy rainfall events. The magnitude of the increase appears to be higher than that observed at other Tumon Bay monitoring sites. In fact, the geometric mean exceeded the criterion under high flow conditions, which indicates potential need to address storm water sources. This concern is reinforced by the fact that the 75th percentile in the high flow zone is close to the instantaneous maximum criterion value. This indicates that sources associated with periodic short term problems (e.g., spills into the storm drain system or sewer overflows during heavy rains) may also be a concern under these conditions.

Incorporating seasonality into the analysis allows a closer look at patterns that may be associated with certain source categories. For example, bacteria delivered through seeps connected to storm water ponds are more likely to affect beach monitoring data during the wet season. In contrast, bacteria contributed from more continuous sources (e.g., leaky sewer lines or failing septics) will exert a greater effect during the dry season. Comparisons between the geometric means, the 75th and 90th percentiles for each duration curve zone serve as primary measures for examining seasonality. This is illustrated in Figure 8-32.

The effect of storm water runoff is evident for both the wet and dry seasons under high flow and moist conditions. This reinforces the need to focus on storm water sources at San Vitores Beach. However, an interesting observation is the difference between the wet and dry season patterns under mid-range and dry conditions. The higher wet season values in the dry zone indicate the potential for seeps connected to storm water sources to be affecting water quality at this site.

Relationship to Other Indicators. In addition to seasonal patterns, the relationship of bacteria concentrations to other parameters can be incorporated into the data analysis. Guam EPA staff noted field data for several indicators at the time of bacteria sample collection as part of the RBMP. These include observations such as tidal stage and presence or absence of turbidity.

The combination of patterns with some of these observations could be related to potential source areas and delivery mechanism that might affect bacteria concentrations at any particular beach of interest. For example, the presence or absence of turbidity may also be an indicator of either storm water runoff or suspended material associated with wind action. This approach to the analysis provides information that might prove useful in guiding implementation efforts intended to address documented problems.

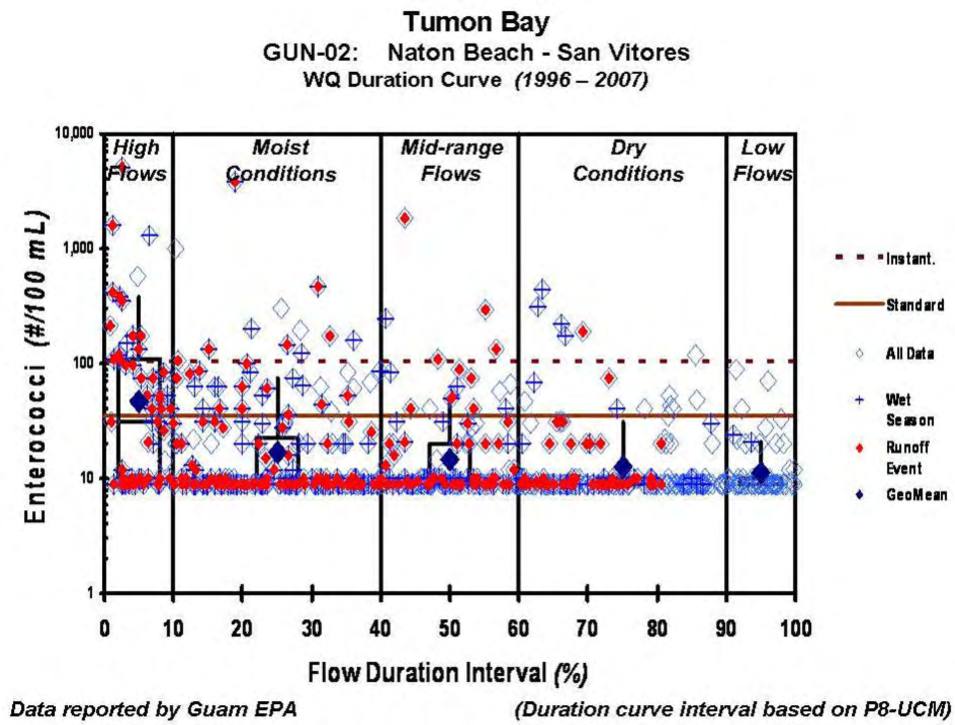

Figure 8-31. Water quality duration curve for San Vitores Beach site.

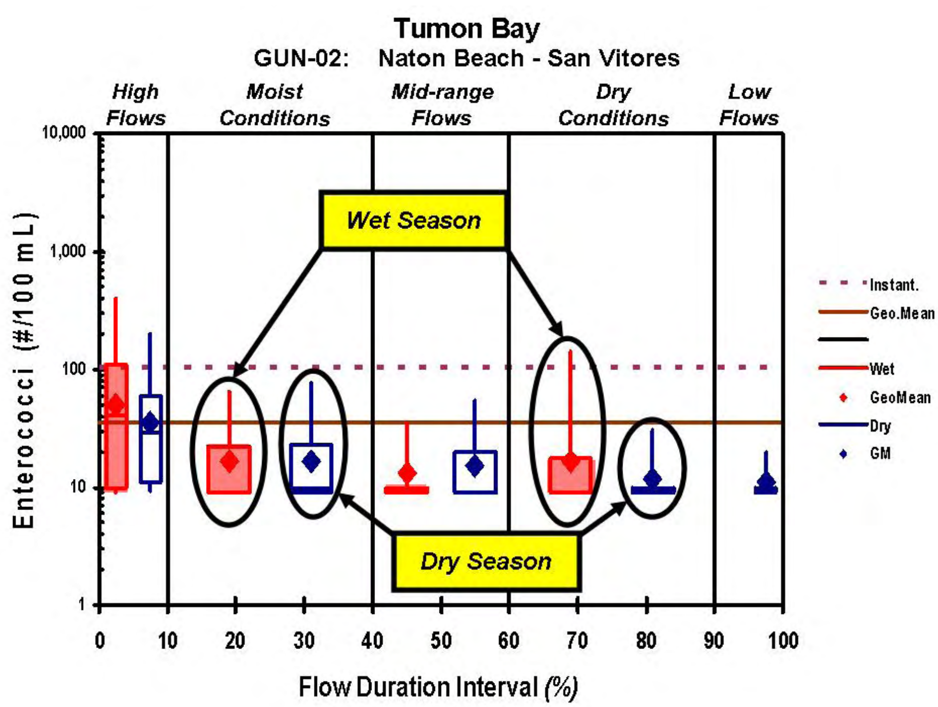

Figure 8-32. Wet versus dry season comparison for San Vitores Beach.

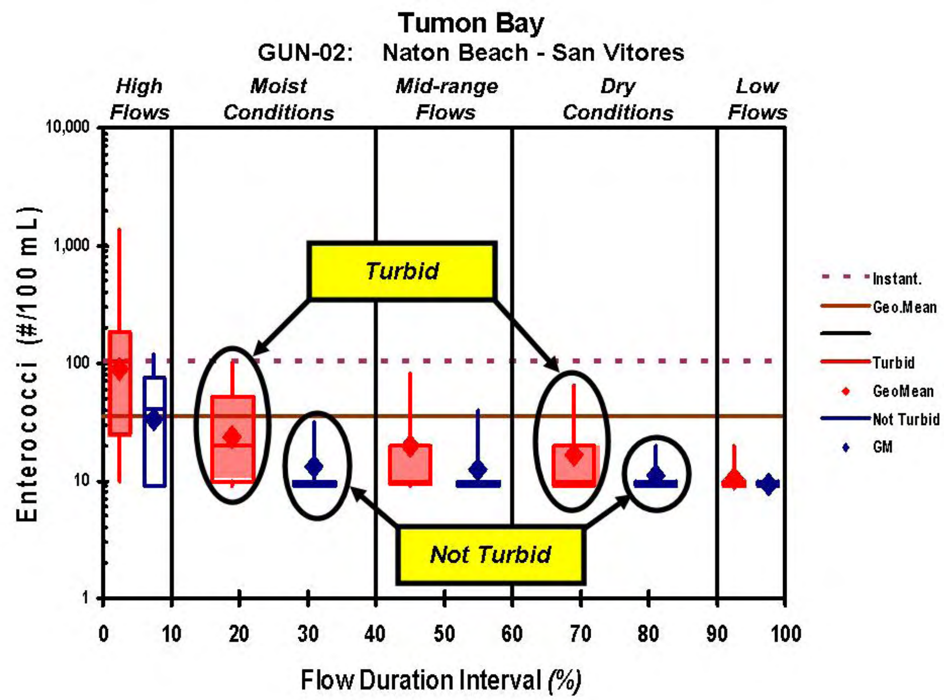

Figure 8-33. Turbid versus non-turbid sample comparison for San Vitores Beach site.

Figure 8-33 shows the difference between bacteria levels when turbidity was present or absent during sample collection under the various flow conditions. The increased levels when turbidity was present under high, moist, and mid-range flow conditions likely reflects the effect of bacteria transported with fine particles during storm events. The effect of bacteria associated with resuspension of bottom sediments might also be the result of wind and wave action, which could affect beach water quality.

Potential Sources. The Source Assessment (Section 5, Table 5-2) summarized potential sources that may affect bacteria concentrations at San Vitores Beach. Included are wastewater sources (septic systems, sewer line blockages & breaks, SSO), storm water (overland runoff, highway maintenance & runoff, construction), and other sources (recreation & tourism activities). In addition, GEPA staff identified specific potential sources that could affect water quality at San Vitores Beach *(Table 8-11)*.

Figure 8-34 provides a closer look at the San Vitores Beach monitoring site relative to upland areas that potentially contribute bacteria during storm events. Figure 8-34 includes roads, which can provide a general indication of the urban drainage network and accompanying storm drains. Figure 8-34 also identifies major storm water ponding basins, including the Harmon Sink.

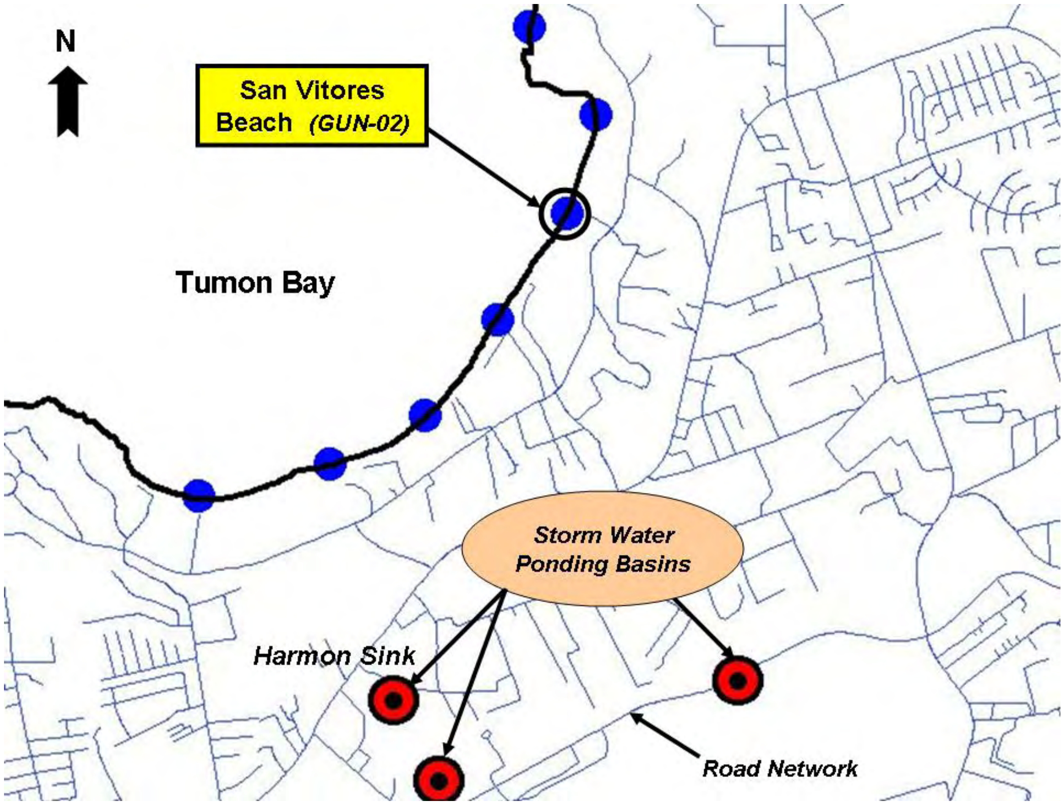

Figure 8-34. Location of San Vitores Beach relative to potential source areas.

Table 8-11. Beach specific potential source summary *(Site GUN-02: San Vitores Beach)*.

Site ID	Type	Source Name *(notes)*
GUN-02	Storm drain runoff	Outrigger Hotel Storm Drain
		Harmon Sinkhole *Guam International Airport Authority storm water flows to Harmon Sinkhole via concrete channel (includes failing oil / water separator).*
	Cleanout overflow to storm drain	Rivera St. Holding Tank (near Capital Hotel and Tarza WaterPark) *Holding tank not connected to public sewer, clean out is overflowing to road and storm drain.*
	Sewage overflow	Harmon Sinkhole *Receives sewage overflow from Mamajanao Pump Station.*

In addition to previous assessments and GIS information, Guam EPA staff identified other potential sources that could affect water quality at San Vitores Beach. Specifically, there are two areas of concern. First, storm drain runoff from the Outrigger Hotel may be affecting water quality at this site. Second, the Rivera Street holding tank (near the Capital Hotel and Tarza Water Park) is not connected to the public sewer. There have been problems with the clean out overflowing to the road and nearby storm drain. This could explain periodic elevated bacteria concentrations at this location.

A review of GIS information shows a number of unsewered buildings in the upland area adjacent to San Vitores Beach. This information is shown in Figure 8-35. Sewer line blockages and breaks, as well as SSOs, could also contribute to elevated bacteria levels. Figure 8-35 shows the location of both sewer mains and pump stations, as indicators of potential water quality problems associated with wastewater conveyance systems.

Figure 8-36 shows an air photo of the area adjacent to San Vitores Beach. This provides a different perspective, which highlights the high density of roads and buildings in the area adjacent to San Vitores Beach.

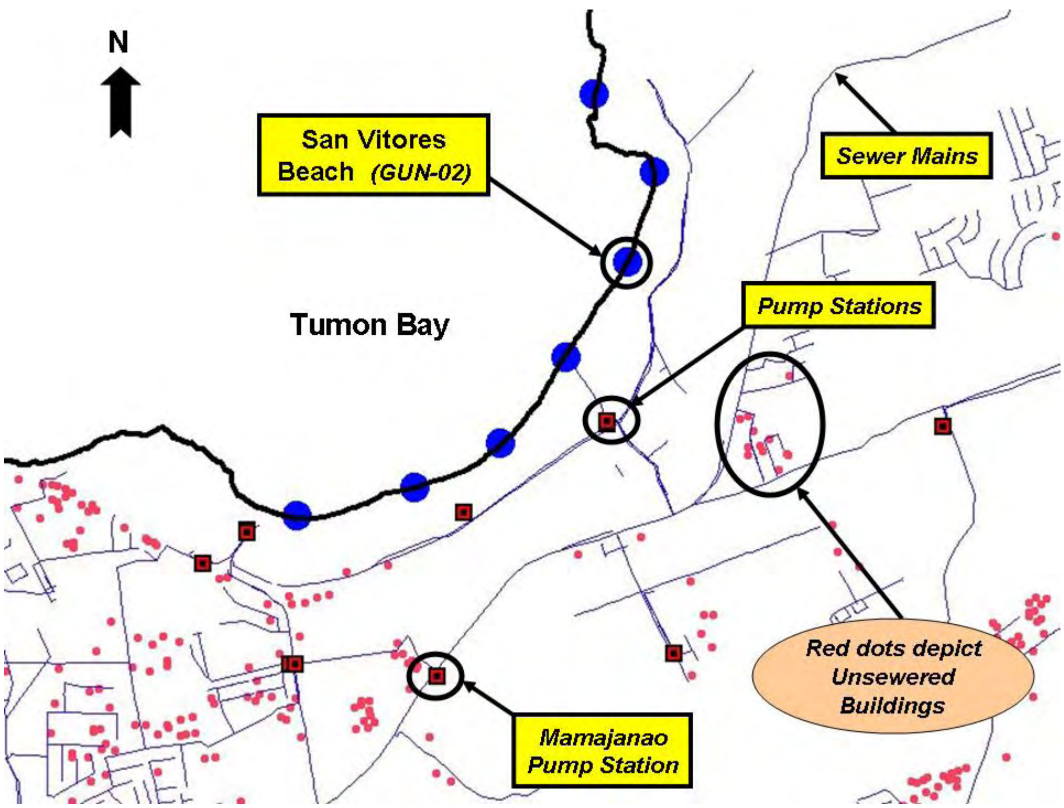

Figure 8-35. Location of San Vitores Beach relative to potential unsewered buildings.

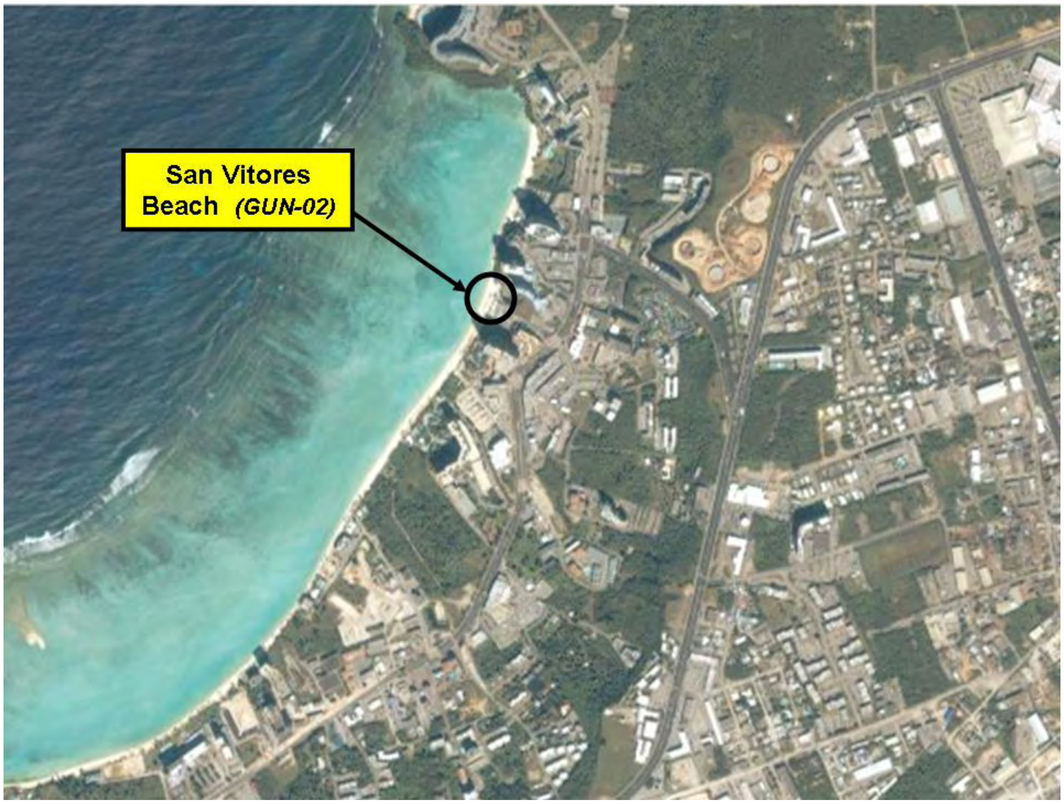

Figure 8-36. Air photo of San Vitores Beach vicinity.

Trends. Figure 8-37 presents a year-by-year summary of the enterococcus data for the San Vitores Beach site. This provides a useful way to examine trends relative to both central tendency and annual variation. This type of analysis is useful in looking at specific sites where efforts to address beach advisories have been implemented. For example, a focus on patterns such as trends in geometric means or 90th percentiles provides a visual analysis that can be used to evaluate program effectiveness. With respect to trends, it should be noted that a laboratory analytical method change occurred in September 2000. The IDEXX test was used to determine enterococcus concentrations on all samples collected after September 2000.

Linkage Analysis. The numeric target for this TMDL is Guam's concentration-based criteria for enterococci bacteria (i.e., a geometric mean of 35 counts / 100 mL and an instantaneous maximum of 104 counts / 100 mL). The relationship between this target and potential sources at San Vitores Beach is demonstrated through an analysis of water quality monitoring data at this site. Seasonal patterns, for example, show that the highest concentrations are observed between June and December, indicating the importance of wet season sources at San Vitores Beach. This is consistent with the presence of potential storm water sources identified at this location.

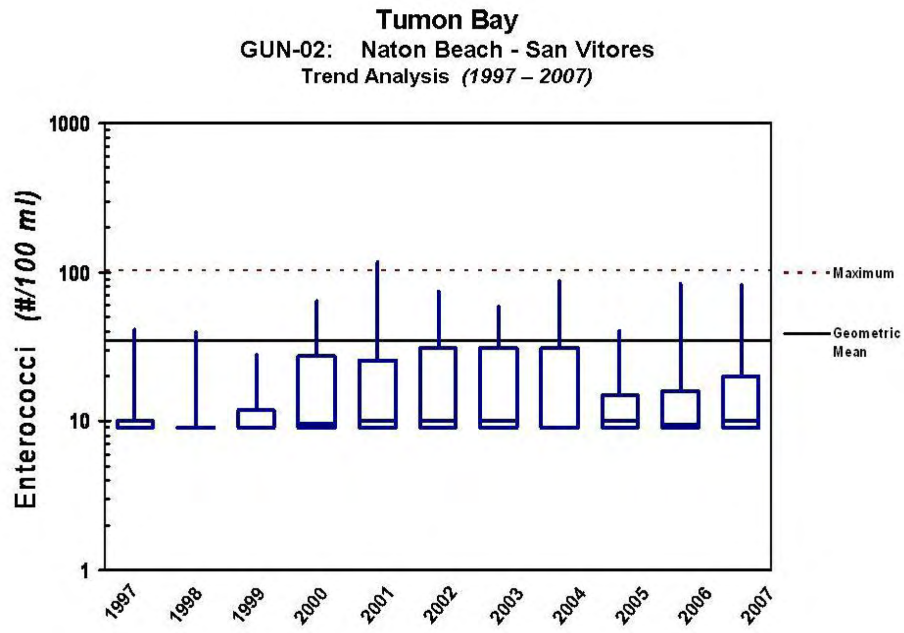

Figure 8-37. Trend analysis for San Vitores Beach site.

The connection between storm water sources and exceedances of numeric targets is further confirmed by examining the effect of flow conditions. At San Vitores Beach, the highest bacteria concentrations occur under high flows. Water quality conditions that reflect this pattern are strongly influenced by storm water runoff during heavy rainfall events. In short, the technical analyses presented in this assessment of San Vitores Beach describe the relationship between water quality patterns and potential sources at this location. The loading capacity and allocations are all concentrations set at the criteria values for enterococci bacteria. This TMDL will clearly meet water quality standards and protect recreational uses at this beach.

TMDL Components. Table 8-12 presents the TMDL for San Vitores Beach, identifying the loading capacity and allocations expressed as concentration-based values for enterococcus. These concentration-based values apply across all flow zones. This TMDL uses an implicit MOS, through inclusion of two conservative assumptions. First, the TMDL does not account for mixing in the receiving waters and assumes that zero dilution is available. Second, the goal of attaining standards at the point of discharge does not account for losses due to die-off and settling of indicator bacteria that are known to occur.

Table 8-12. Northern Guam Watershed TMDL summary *(Site GUN-02: San Vitores Beach)*.

TMDL Component	Enterococcus Concentration *(# / 100 mL)*
Geometric Mean	
TMDL	**35**
Future Growth	35
Waste Load Allocation	35
Load Allocation	35
Instantaneous Maximum	
TMDL	**104**
Future Growth	104
Waste Load Allocation	104
Load Allocation	104

A hydrology-based framework using duration curve zones allows the TMDL to evaluate monitoring data in a way that reflects major watershed processes indicative of different flows. This approach enables numeric targets in the TMDL to consider watershed processes, such as hydrology and source assessment information including land use.

Table 8-13 identifies reductions for each duration curve zone by season using the TMDL targets. These estimates can serve to guide problem solving discussions on appropriate management strategies (based on knowledge associated with likely source areas, delivery mechanisms, and appropriate control measures that correspond to particular hydrologic conditions).

Table 8-13. Needed reductions to meet TMDL targets *(Site GUN-02: San Vitores Beach)*.

Needed Reductions	Flow Conditions *(expressed as percentage)*				
	High	**Moist**	**Mid**	**Dry**	**Low**
Dry Season					
Based on geometric mean	3%	---	---	---	---
Based on instantaneous maximum	48%	---	---	---	---
Wet Season					
Based on geometric mean	30%	---	---	---	---
Based on instantaneous maximum	74%	---	---	26%	---

8.5 Fujita Beach (GUN-23)

Fujita Beach is also part of the stretch known as Naton Beach; a strip of beach along the northern most chain of hotels on Tumon Bay *(Figure 8-38)*. Centrally situated in the Tumon area, Fujita Beach is an extremely popular location for tourists looking to participate in water activities such as kayaking, beachcombing, and snorkeling.

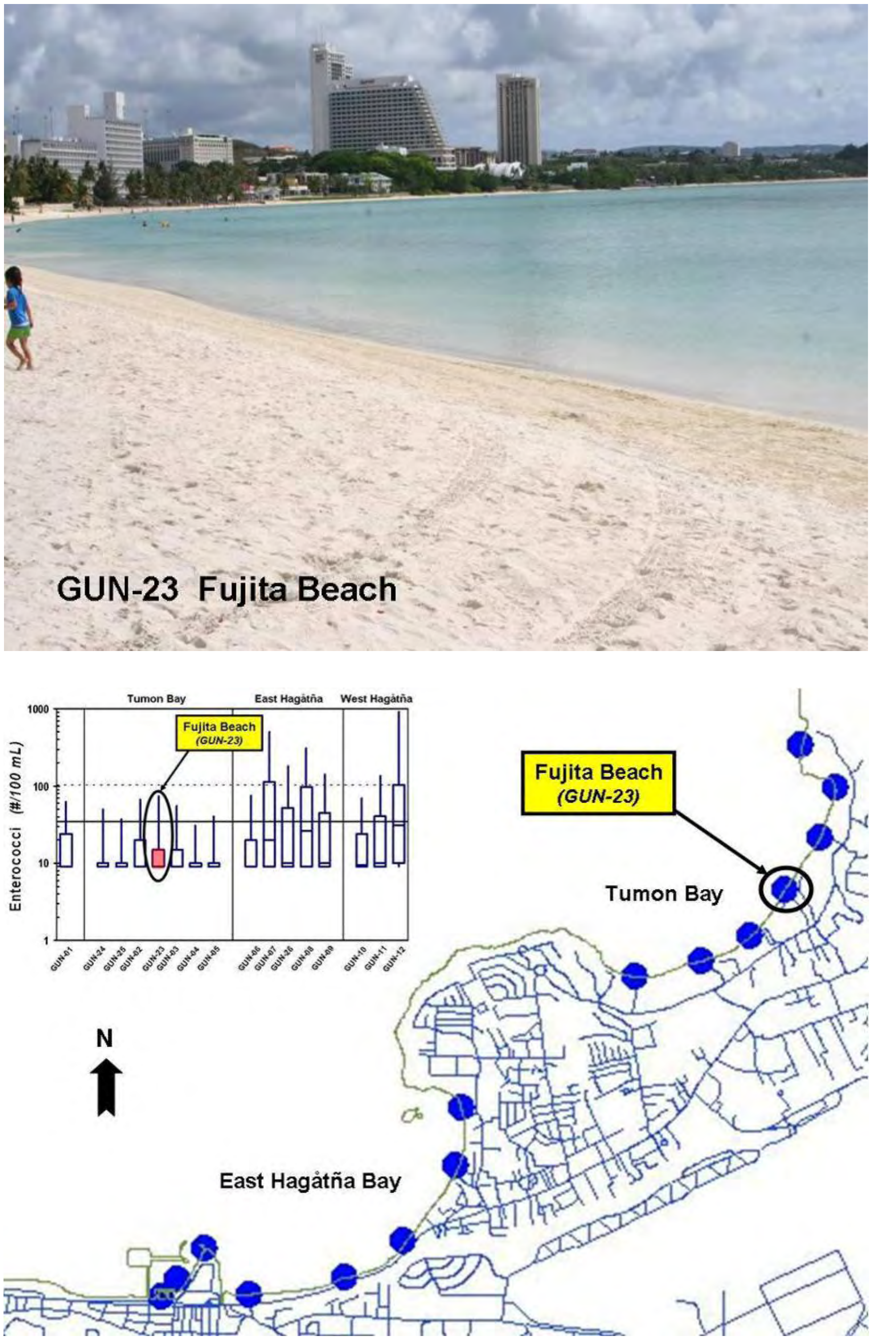

Figure 8-38. Location of Fujita Beach relative to other Northern Guam TMDL sites.

The frequency of beach advisories at Fujita Beach between 2001 and 2007 was typical (13%) of many RBMP sites in the Northern Beach TMDL project area *(Figure 4-1)*. Enterococci concentrations at Fujita Beach were basically in the same range as a number of other project area monitoring stations *(Figure 4-2 and Figure 8-38)*. The geometric mean of all individual samples was 15 counts /100mL, while the 75th and 90th percentiles were 15 and 74 counts /100 mL respectively.

A key part of the data analysis for individual beaches is to examine water quality patterns by season and relative to flow conditions (e.g., runoff dominated versus base flows). Figure 8-39 shows the seasonal variability of bacteria concentrations at Fujita Beach. With the exception of March, the highest concentrations were observed between July and October, indicating the importance of wet season sources at Fujita Beach.

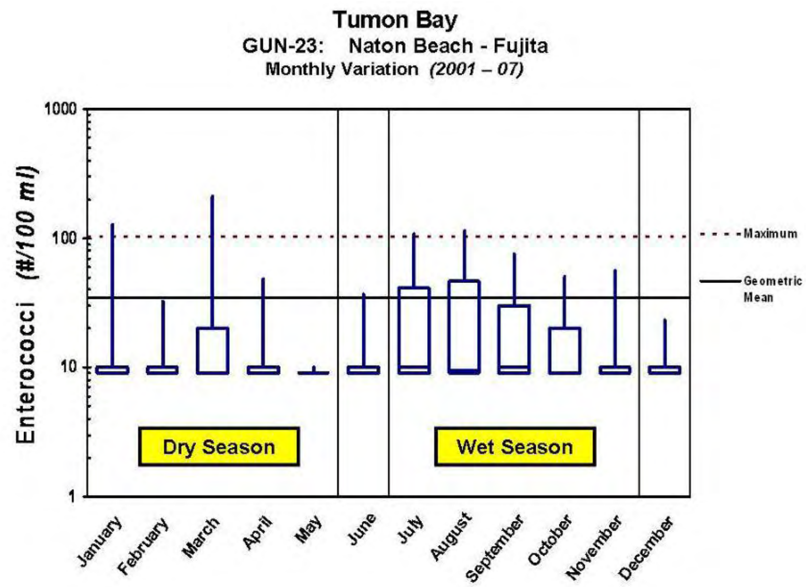

Figure 8-39. Seasonal variation at Fujita Beach.

Effect of Flow Conditions. A useful approach for relating water quality information to potential source areas is to examine bacteria levels in terms of hydrologic conditions. Figure 8-40 shows enterococci monitoring data collected at Fujita Beach using a duration curve framework. Although there is significant variability in the data, which is characteristic of bacteria monitoring information, a definite pattern exists.

As indicated by the *"box and whisker"* plots in Figure 8-40, the highest bacteria concentrations occur under high flow conditions. This is not unexpected because water quality at most beaches is strongly influenced by storm water runoff during heavy rainfall events. The magnitude of the increase appears to be fairly consistent with that observed at other Tumon Bay monitoring sites. However, the

90th percentile exceeds the instantaneous maximum criterion in the high flow zone. This indicates that sources associated with periodic short term problems (e.g., spills into the storm drain system or sewer overflows during heavy rains) may be a concern under these conditions.

Incorporating seasonality into the analysis allows a closer look at patterns that may be associated with certain source categories. For example, bacteria delivered through seeps connected to storm water ponds are more likely to affect beach monitoring data during the wet season. In contrast, bacteria contributed from more continuous sources (e.g., leaky sewer lines or failing septics) will exert a greater effect during the dry season. Comparisons between the geometric means, the 75th and 90th percentiles for each duration curve zone serve as primary measures for examining seasonality. This is illustrated in Figure 8-41.

The effect of storm water runoff is evident for both the wet and dry seasons under high flow conditions. This reinforces the need to focus on storm water sources at Fujita Beach. However, an interesting observation is the difference between the wet and dry season patterns under mid-range and dry conditions. The higher wet season values in both these zones indicate the potential for seeps connected to storm water sources to be affecting water quality at this site.

Relationship to Other Indicators. In addition to seasonal patterns, the relationship of bacteria concentrations to other parameters can be incorporated into the data analysis. Guam EPA staff noted field data for several indicators at the time of bacteria sample collection as part of the RBMP. These include observations such as tidal stage and presence or absence of turbidity.

The combination of patterns with some of these observations could be related to potential source areas and delivery mechanism that might affect bacteria concentrations at any particular beach of interest. For example, the presence or absence of turbidity may also be an indicator of either storm water runoff or suspended material associated with wind action. This approach to the analysis provides information that might prove useful in guiding implementation efforts intended to address documented problems.

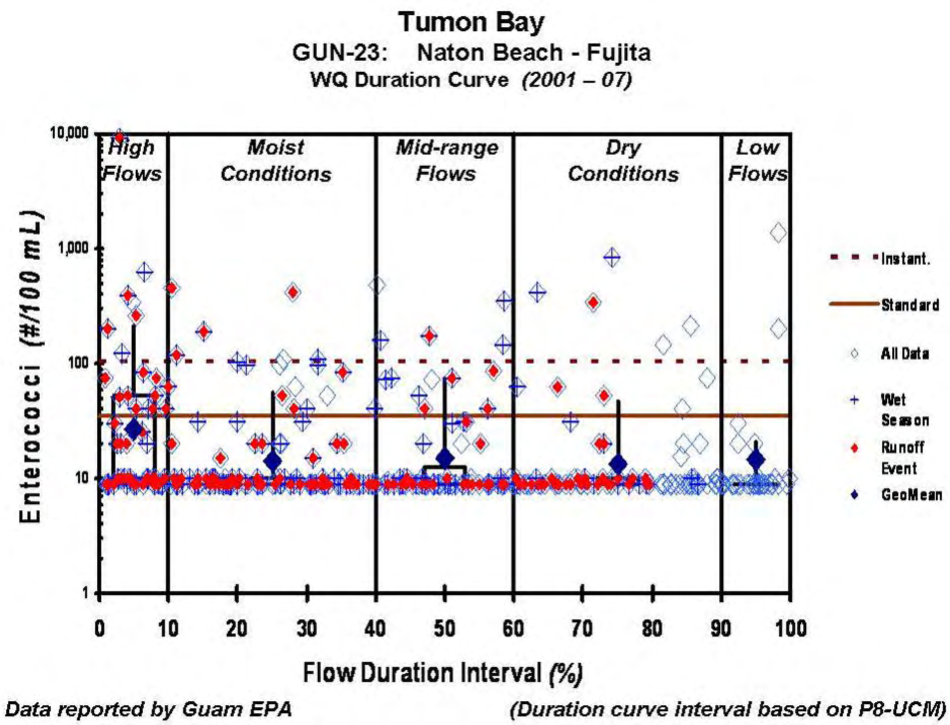

Figure 8-40. Water quality duration curve for Fujita Beach site.

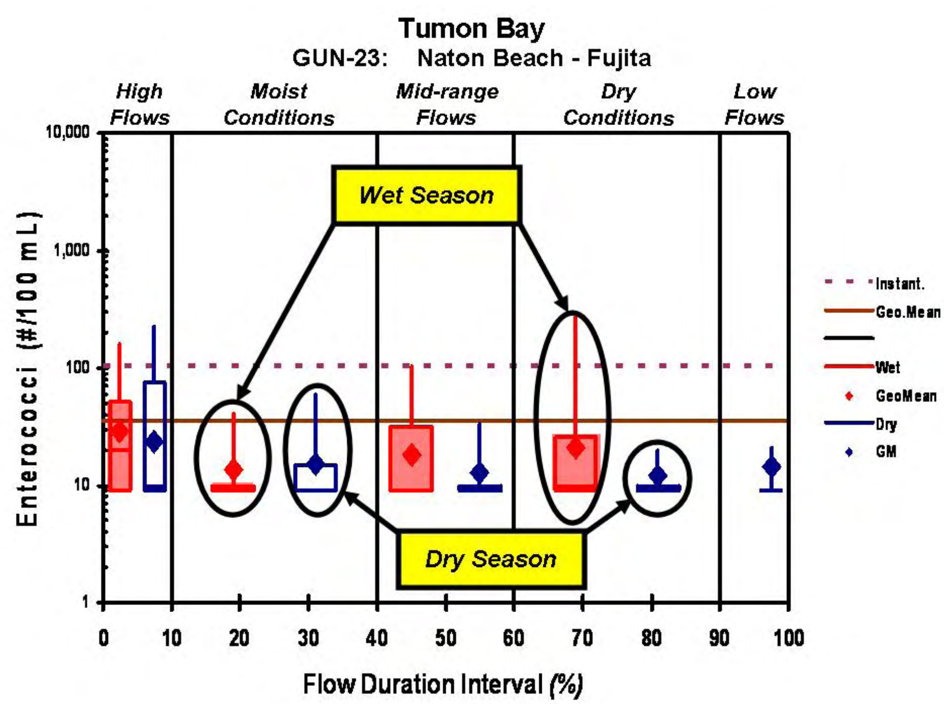

Figure 8-41. Wet versus dry season comparison for Fujita Beach.

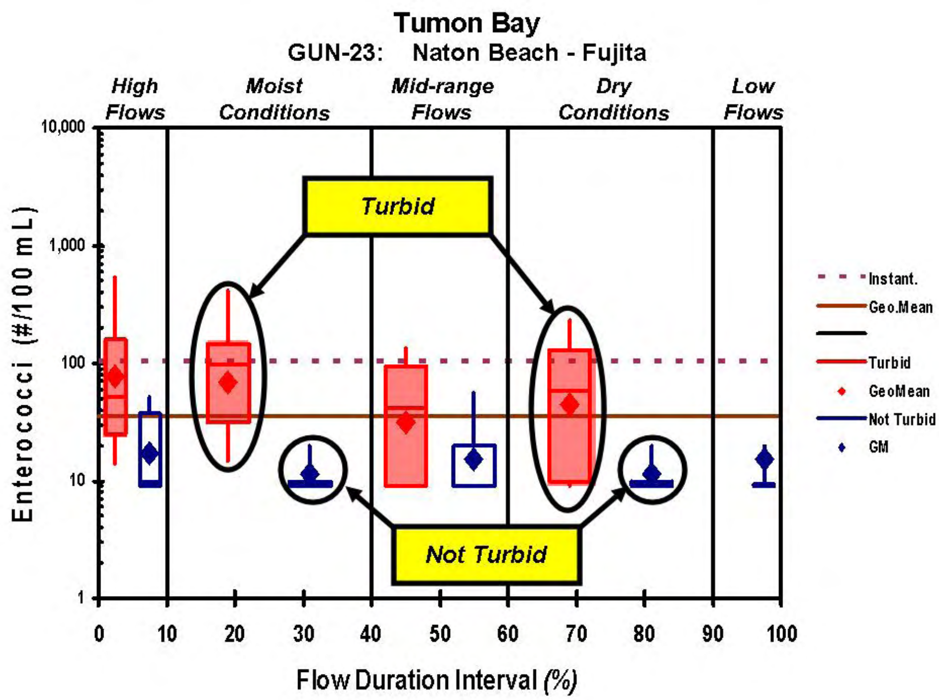

Figure 8-42. Turbid versus non-turbid sample comparison for Fujita Beach site.

Figure 8-42 shows the difference between bacteria levels when turbidity was present or absent during sample collection under the various flow conditions. The increased levels when turbidity was present under high, moist, and mid-range flow conditions likely reflects the effect of bacteria transported with fine particles during storm events. The effect of bacteria associated with resuspension of bottom sediments might also be the result of wind and wave action, which could affect beach water quality.

Potential Sources. The Source Assessment (Section 5, Table 5-2) summarized potential sources that may affect bacteria concentrations at Fujita Beach. Included are wastewater sources (septic systems, sewer line blockages & breaks, SSO), storm water (overland runoff, highway maintenance & runoff, construction), and other sources (recreation & tourism activities). In addition, GEPA staff identified specific potential sources that could affect water quality at Fujita Beach *(Table 8-14)*.

Figure 8-43 provides a closer look at the Fujita Beach monitoring site relative to upland areas that potentially contribute bacteria during storm events. Figure 8-43 includes roads, which can provide a general indication of the urban drainage network and accompanying storm drains. Figure 8-43 also identifies major storm water ponding basins, including the Harmon Sink.

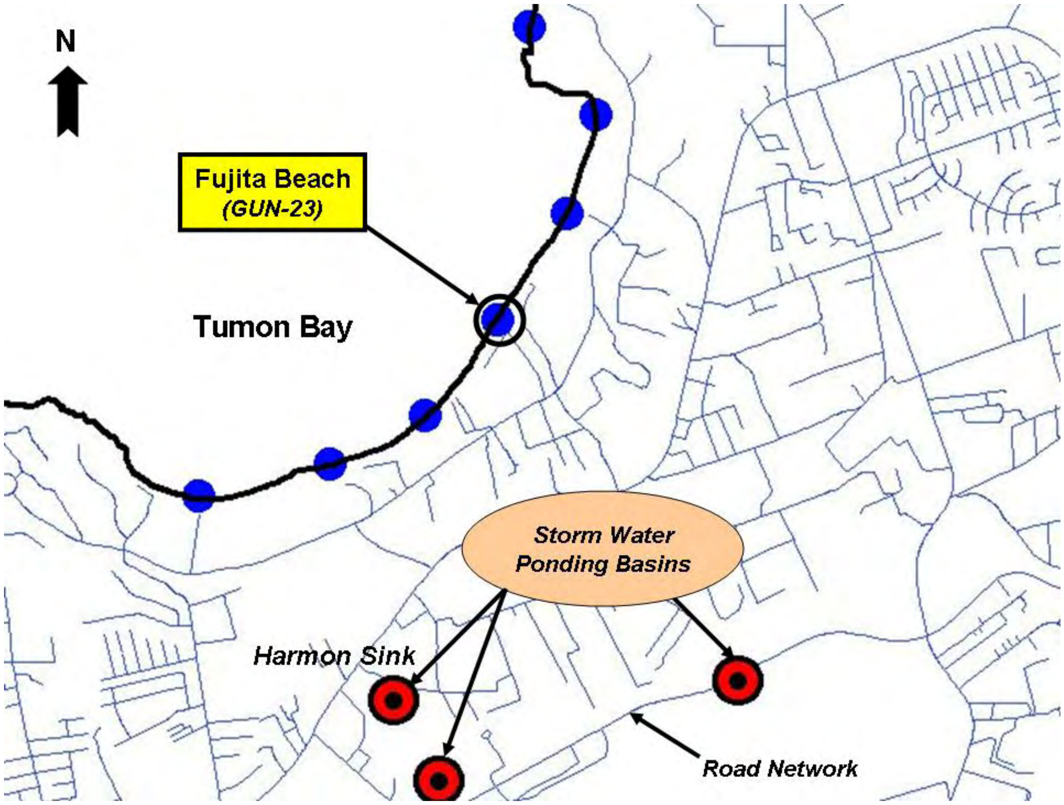

Figure 8-43. Location of Fujita Beach relative to potential source areas.

Table 8-14. Beach specific potential source summary *(Site GUN-23: Fujita Beach)*.

Site ID	Type	Source Name *(notes)*
GUN-23	SIA – SW *	SIA DPW 4 corner of Fujita Rd. and San Vitores Rd. *Fujita Road*
	Sewage overflow	Fujita Sewage Pump Station
		Harmon Sinkhole *Receives sewage overflow from Mamajanao Pump Station.*
	Storm drain runoff	Harmon Sinkhole *Guam International Airport Authority storm water flows to Harmon Sinkhole via concrete channel (includes failing oil / water separator).*
Notes: * SIA - SW: Surface Impoundment Area – Storm Water		

A review of GIS information shows a number of unsewered buildings in the upland area adjacent to Fujita Beach. This information is shown in Figure 8-44. Sewer line blockages and breaks, as well as SSOs, could also contribute to elevated bacteria levels. Figure 8-44 shows the location of both sewer mains and pump stations, as indicators of potential water quality problems associated with wastewater conveyance systems.

Figure 8-45 shows an air photo of the area adjacent to Fujita Beach. This provides a different perspective, which highlights the high density of roads and buildings in the area adjacent to Fujita Beach.

In addition to previous assessments and GIS information, Guam EPA staff identified other potential sources that could affect water quality at Fujita Beach. Specifically, there are two areas of concern. First, there is a storm water surface impoundment area (SIA DPW 4) at the corner of Fujita and San Vitores Roads that may be affecting water quality at this site. Second, the Fujita Pump Station *(Figure 8-44)* is located nearby. There has been occasional sewage overflows associated with this facility, which could explain periodic elevated bacteria concentrations at this location.

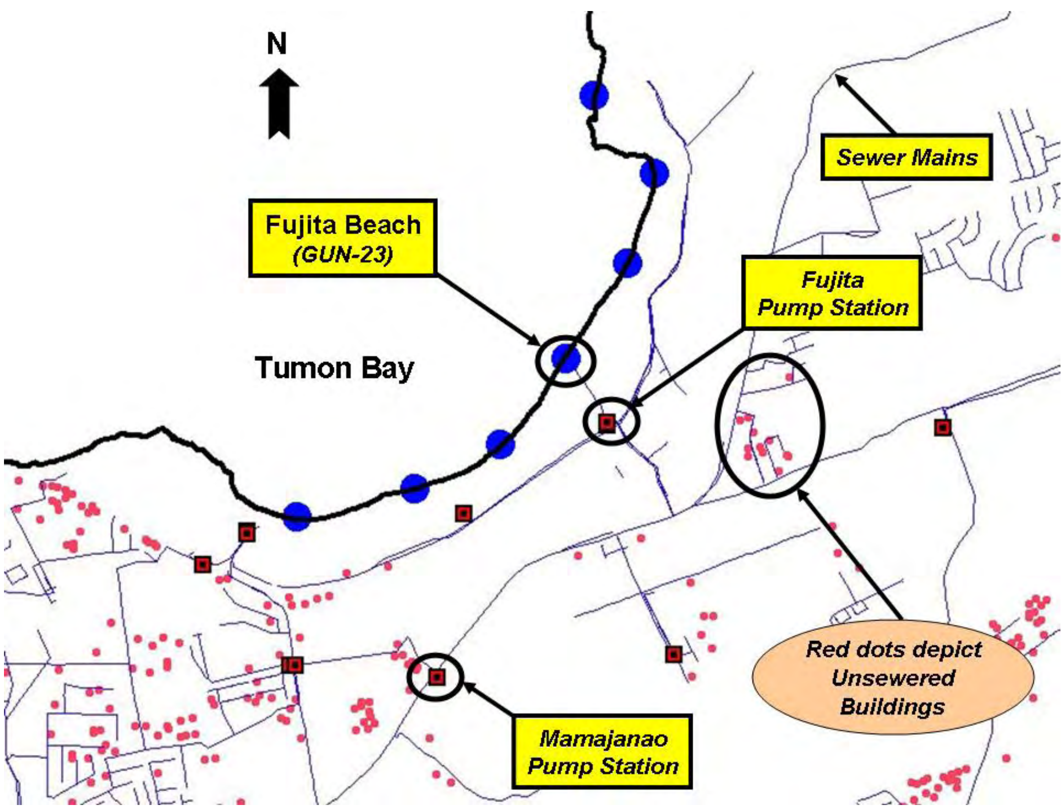

Figure 8-44. Location of Fujita Beach relative to potential unsewered buildings.

Figure 8-45. Air photo of Fujita Beach vicinity.

Trends. Figure 8-46 presents a year-by-year summary of the enterococcus data for the Fujita Beach site. This provides a useful way to examine trends relative to both central tendency and annual variation. This type of analysis is useful in looking at specific sites where efforts to address beach advisories have been implemented. For example, a focus on patterns such as trends in geometric means or 90th percentiles provides a visual analysis that can be used to evaluate program effectiveness. With respect to trends, it should be noted that a laboratory analytical method change occurred in September 2000. The IDEXX test was used to determine enterococcus concentrations on all samples collected after September 2000.

Linkage Analysis. The numeric target for this TMDL is Guam's concentration-based criteria for enterococci bacteria (i.e., a geometric mean of 35 counts / 100 mL and an instantaneous maximum of 104 counts / 100 mL). The relationship between this target and potential sources at Fujita Beach is demonstrated through an analysis of water quality monitoring data at this site. Seasonal patterns, for example, show that the highest concentrations are observed between July and October, indicating the importance of wet season sources at Fujita Beach. This is consistent with the presence of potential storm water sources identified at this location.

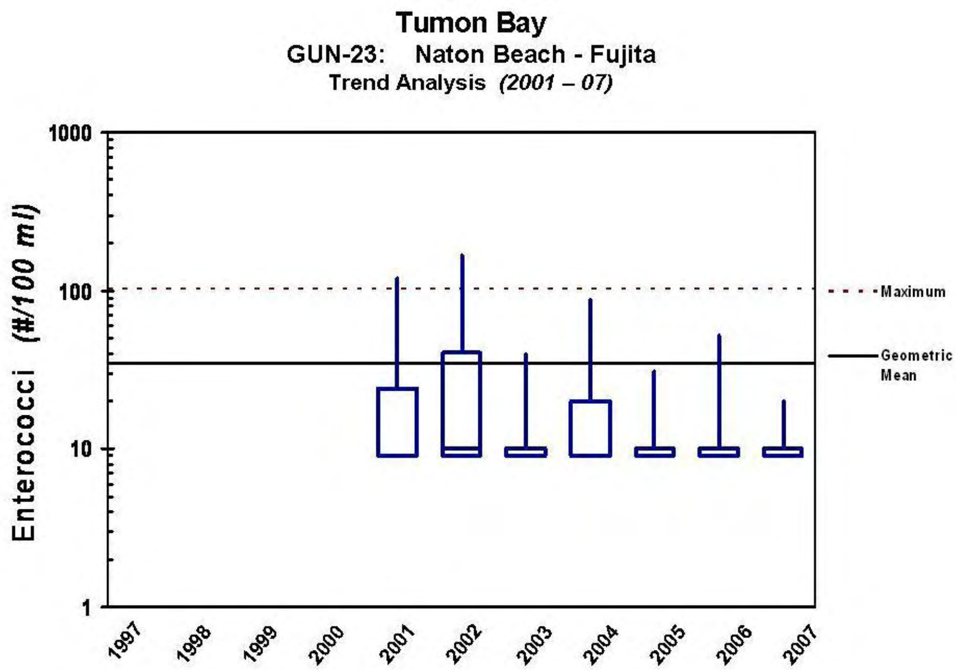

Figure 8-46. Trend analysis for Fujita Beach site.

The connection between storm water sources and exceedances of numeric targets is further confirmed by examining the effect of flow conditions. At Fujita Beach, the highest bacteria concentrations occur under high flows. Water quality conditions that reflect this pattern are strongly influenced by storm water runoff during heavy rainfall events. In short, the technical analyses presented in this assessment of Fujita Beach describe the relationship between water quality patterns and potential sources at this location. The loading capacity and allocations are all concentrations set at the criteria values for enterococci bacteria. This TMDL will clearly meet water quality standards and protect recreational uses at this beach.

TMDL Components. Table 8-15 presents the TMDL for Fujita Beach, identifying the loading capacity and allocations expressed as concentration-based values for enterococcus. These concentration-based values apply across all flow zones. This TMDL uses an implicit MOS, through inclusion of two conservative assumptions. First, the TMDL does not account for mixing in the receiving waters and assumes that zero dilution is available. Second, the goal of attaining standards at the point of discharge does not account for losses due to die-off and settling of indicator bacteria that are known to occur.

Table 8-15. Northern Guam Watershed TMDL summary *(Site GUN-23: Fujita Beach)*.

TMDL Component	Enterococcus Concentration *(# / 100 mL)*
Geometric Mean	
TMDL	**35**
Future Growth	35
Waste Load Allocation	35
Load Allocation	35
Instantaneous Maximum	
TMDL	**104**
Future Growth	104
Waste Load Allocation	104
Load Allocation	104

A hydrology-based framework using duration curve zones allows the TMDL to evaluate monitoring data in a way that reflects major watershed processes indicative of different flows. This approach enables numeric targets in the TMDL to consider watershed processes, such as hydrology and source assessment information including land use.

Table 8-16 identifies reductions for each duration curve zone by season using the TMDL targets. These estimates can serve to guide problem solving discussions on appropriate management strategies (based on knowledge associated with likely source areas, delivery mechanisms, and appropriate control measures that correspond to particular hydrologic conditions).

Table 8-16. Needed reductions to meet TMDL targets *(Site GUN-23: Fujita Beach)*.

Needed Reductions	Flow Conditions *(expressed as percentage)*				
	High	Moist	Mid	Dry	Low
Dry Season					
Based on geometric mean	---	---	---	---	---
Based on instantaneous maximum	54%	---	---	---	---
Wet Season					
Based on geometric mean	---	---	---	---	---
Based on instantaneous maximum	35%	---	---	62%	---

8.6 Matapang Beach Park (GUN-03)

Matapang Beach is located in the central portion of the Tumon Bay area *(Figure 8-47)*. It is one of the only two beach parks in Tumon. The water off the coast of Matapang Beach consists of a soft, sandy sea-floor with fairly calm waters making it an excellent place to go swimming for tourists.

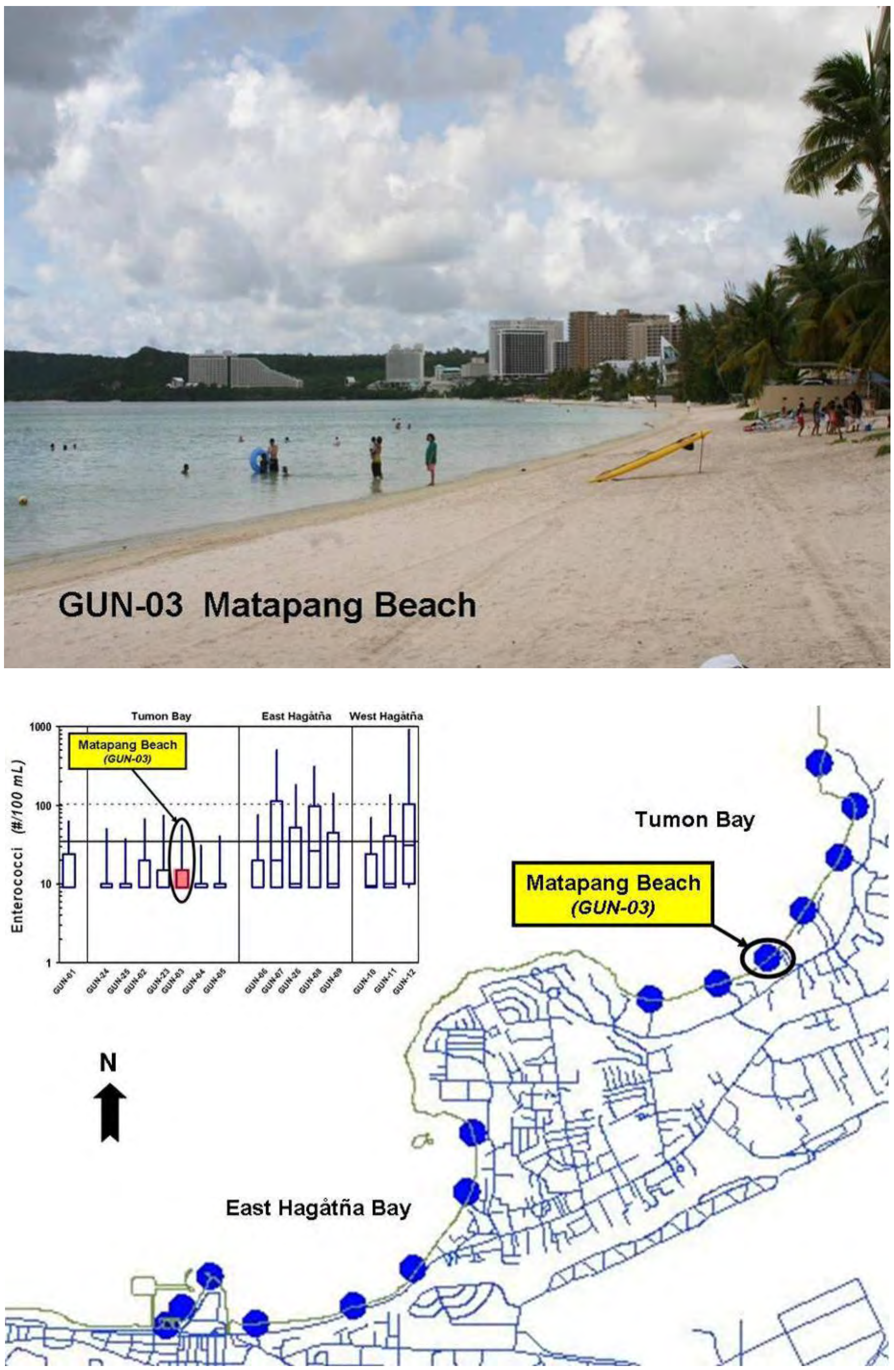

Figure 8-47. Location of Matapang Beach relative to other Northern Guam TMDL sites.

The frequency of beach advisories at Matapang Beach between 1998 and 2007 was typical (12%) of many RBMP sites in the Northern Beach TMDL project area *(Figure 4-1)*. Enterococci concentrations at Matapang Beach were basically in the same range as a number of other project area monitoring stations *(Figure 4-2 and Figure 8-47)*. The geometric mean of all individual samples was 15 counts /100mL, while the 75th and 90th percentiles were 15 and 56 counts /100 mL respectively.

A key part of the data analysis for individual beaches is to examine water quality patterns by season and relative to flow conditions (e.g., runoff dominated versus base flows). Figure 8-48 shows the seasonal variability of bacteria concentrations at Matapang Beach. The highest concentrations were observed between July and September, indicating the importance of wet season sources at Matapang Beach.

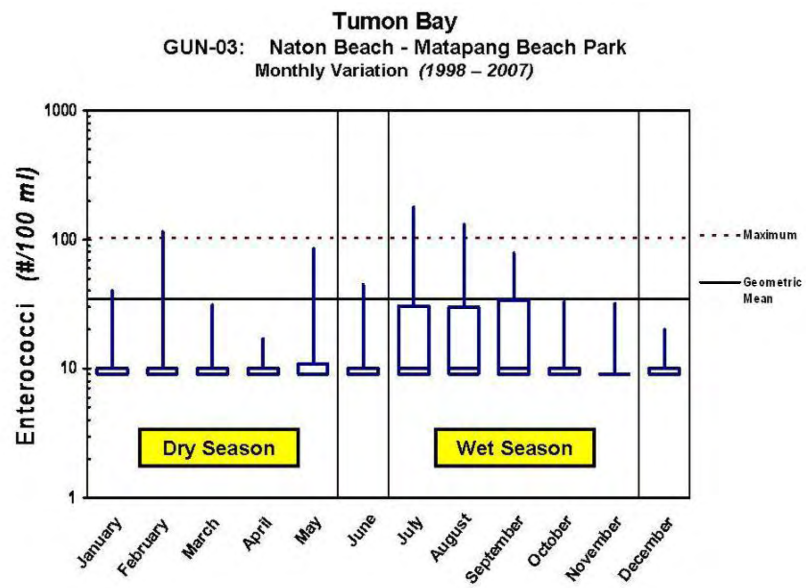

Figure 8-48. Seasonal variation at Matapang Beach.

Effect of Flow Conditions. A useful approach for relating water quality information to potential source areas is to examine bacteria levels in terms of hydrologic conditions. Figure 8-49 shows enterococci monitoring data collected at Matapang Beach using a duration curve framework. Although there is significant variability in the data, which is characteristic of bacteria monitoring information, a definite pattern exists.

As indicated by the *"box and whisker"* plots in Figure 8-49, the highest bacteria concentrations occur under high flow conditions. This is not unexpected because water quality at most beaches is strongly influenced by storm water runoff during heavy rainfall events. The magnitude of the increase appears to be fairly consistent with that observed at other Tumon Bay monitoring sites. However, the 90th percentile exceeds the instantaneous maximum criterion in the high flow zone. This indicates that sources associated with periodic short term problems (e.g., spills into the storm drain system or sewer overflows during heavy rains) may be a concern under these conditions.

Incorporating seasonality into the analysis allows a closer look at patterns that may be associated with certain source categories. For example, bacteria delivered through seeps connected to storm water ponds are more likely to affect beach monitoring data during the wet season. In contrast, bacteria contributed from more continuous sources (e.g., leaky sewer lines or failing septics) will exert a greater effect during the dry season. Comparisons between the geometric means, the 75th and 90th percentiles for each duration curve zone serve as primary measures for examining seasonality. This is illustrated in Figure 8-50.

The effect of storm water runoff is evident for both the wet and dry seasons under high flow and moist conditions. This reinforces the need to focus on storm water sources at Matapang Beach. Furthermore, the low values observed for both the wet and dry seasons in the mid-range and dry zones confirm the fact that storm water sources are the major concern at this site.

Relationship to Other Indicators. In addition to seasonal patterns, the relationship of bacteria concentrations to other parameters can be incorporated into the data analysis. Guam EPA staff noted field data for several indicators at the time of bacteria sample collection as part of the RBMP. These include observations such as tidal stage and presence or absence of turbidity.

The combination of patterns with some of these observations could be related to potential source areas and delivery mechanism that might affect bacteria concentrations at any particular beach of interest. For example, the presence or absence of turbidity may also be an indicator of either storm water runoff or suspended material associated with wind action. This approach to the analysis provides information that might prove useful in guiding implementation efforts intended to address documented problems.

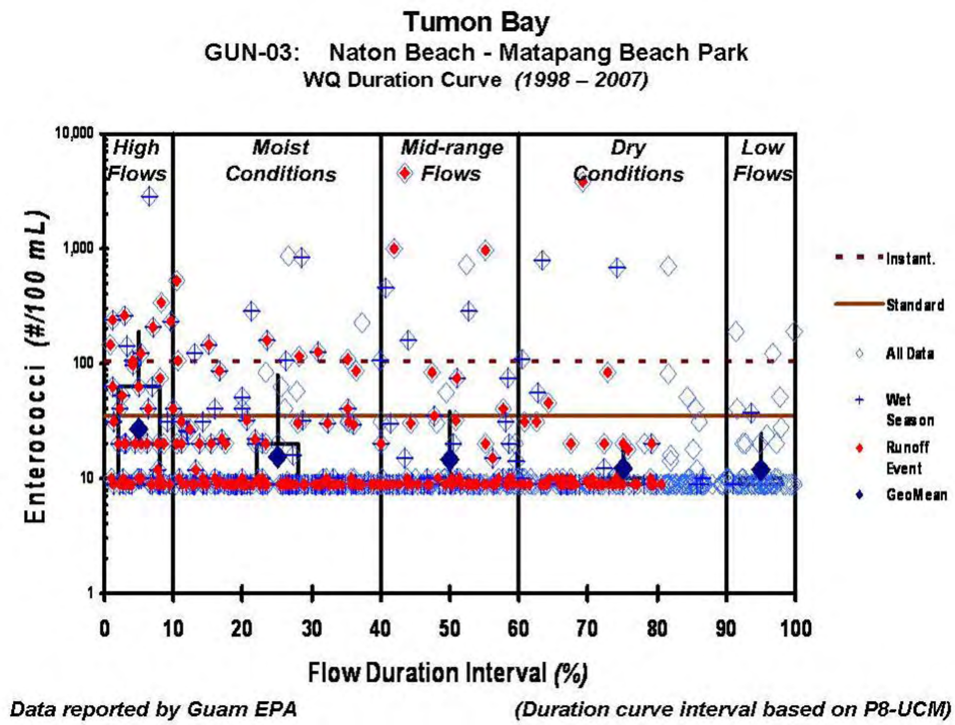

Figure 8-49. Water quality duration curve for Matapang Beach site.

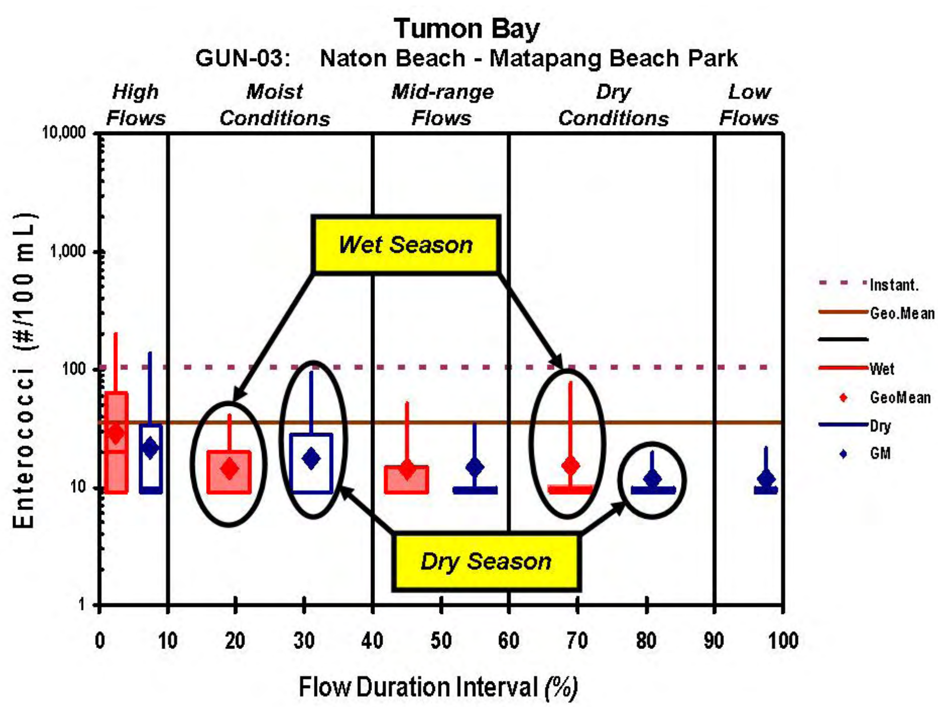

Figure 8-50. Wet versus dry season comparison for Matapang Beach.

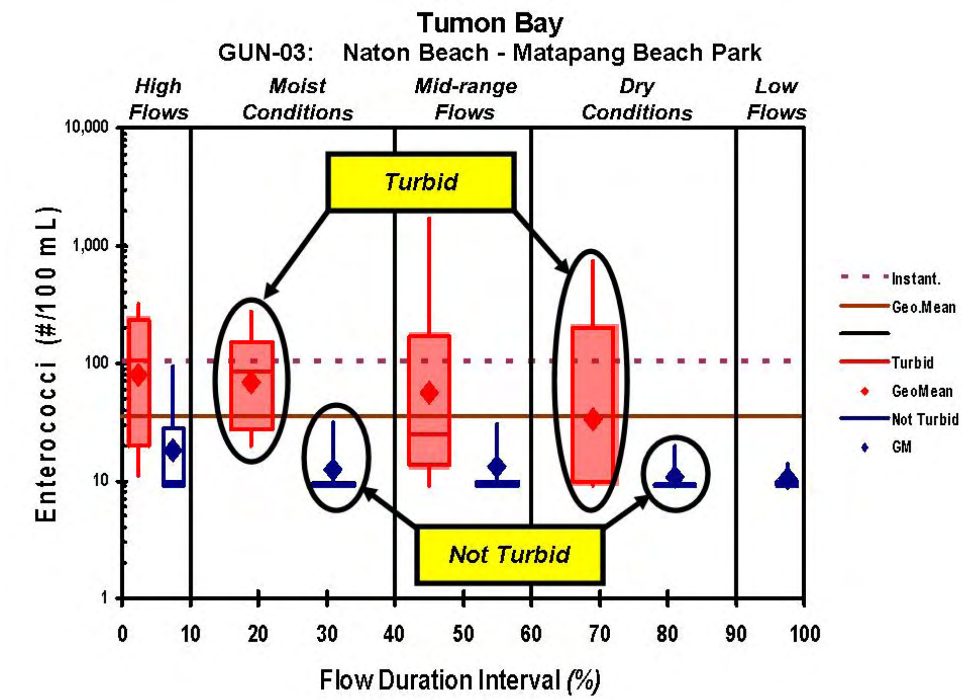

Figure 8-51. Turbid versus non-turbid sample comparison for Matapang Beach site.

Figure 8-51 shows the difference between bacteria levels when turbidity was present or absent during sample collection under the various flow conditions. The increased levels when turbidity was present under high, moist, and mid-range flow conditions likely reflects the effect of bacteria transported with fine particles during storm events. The effect of bacteria associated with resuspension of bottom sediments might also be the result of wind and wave action, which could affect beach water quality.

Potential Sources. The Source Assessment (Section 5, Table 5-2) summarized potential sources that may affect bacteria concentrations at Matapang Beach. Included are wastewater sources (septic systems, sewer line blockages & breaks, SSO), storm water (overland runoff, highway maintenance & runoff, construction), and other sources (recreation & tourism activities). In addition, GEPA staff identified specific potential sources that could affect water quality at Matapang Beach *(Table 8-17)*.

Figure 8-52 provides a closer look at the Matapang Beach monitoring site relative to upland areas that potentially contribute bacteria during storm events. Figure 8-52 includes roads, which can provide a general indication of the urban drainage network and accompanying storm drains. Figure 8-52 also identifies major storm water ponding basins, including the Harmon Sink.

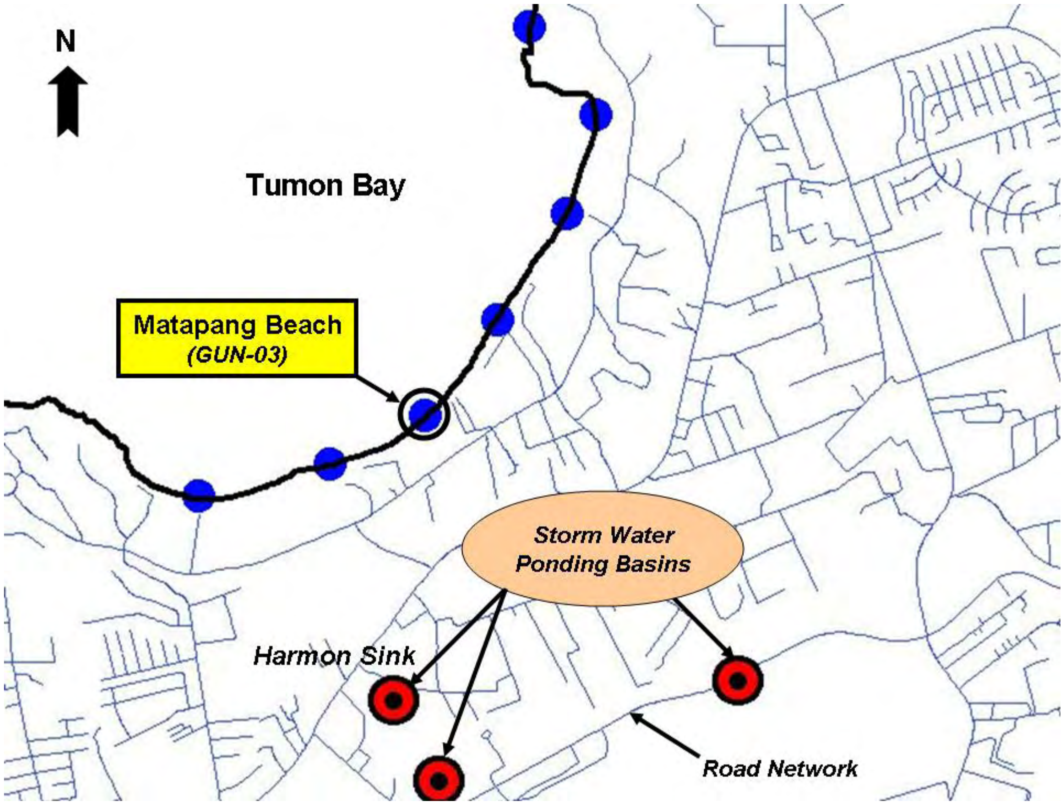

Figure 8-52. Location of Matapang Beach relative to potential source areas.

Table 8-17. Beach specific potential source summary *(Site GUN-03: Matapang Beach)*.

Site ID	Type	Source Name *(notes)*
GUN-03	Stormwater runoff	Cushing Zoo *Animal waste from zoo. Research management options.*
	Storm drain runoff	Harmon Sinkhole *Guam International Airport Authority storm water flows to Harmon Sinkhole via concrete channel (includes failing oil / water separator).*
	UIC - SW *	UIC DPW Matapang Beach UIC encompasses entire parking area of park.
	Sewage overflow	Harmon Sinkhole *Receives sewage overflow from Mamajanao Pump Station.*
Notes: * UIC - SW: Underground Injection Control – Storm Water		

A review of GIS information shows a number of unsewered buildings in the upland area adjacent to Matapang Beach. This information is shown in Figure 8-53. In addition, sewer line blockages and breaks, as well as SSOs could contribute to elevated bacteria levels. Figure 8-53 shows the location of both sewer mains and pump stations, as indicators of potential water quality problems associated with wastewater conveyance systems.

Figure 8-54 shows an air photo of the area adjacent to Matapang Beach. This provides a different perspective, which highlights the high density of roads and buildings in the area adjacent to Matapang Beach.

In addition to previous assessments and GIS information, Guam EPA staff identified other potential sources that could affect water quality at Matapang Beach. Specifically, there are two areas of concern. First, storm water runoff from the Cushing Zoo may be affecting water quality at this site. Second, a storm water underground injection control (UIC) facility encompasses the entire parking area of Matapang Park. This facility may have an influence on bacteria concentrations at this location.

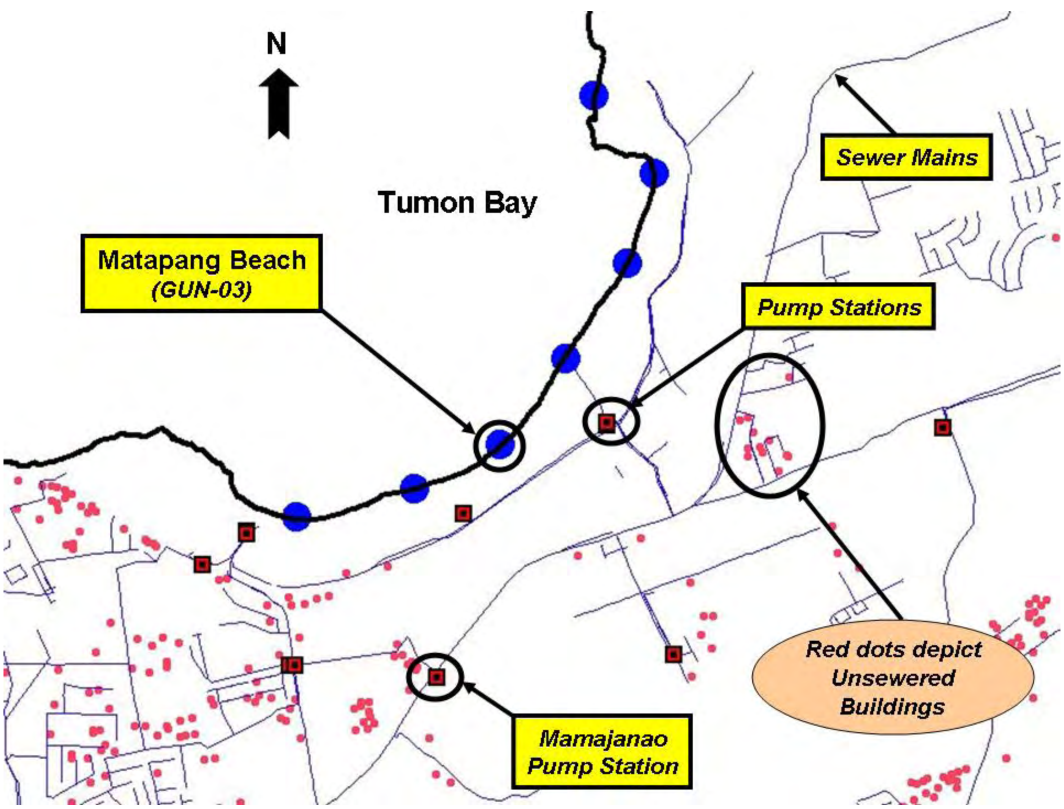

Figure 8-53. Location of Matapang Beach relative to potential unsewered buildings.

Figure 8-54. Air photo of Matapang Beach vicinity.

Trends. Figure 8-55 presents a year-by-year summary of the enterococcus data for the Matapang Beach site. This provides a useful way to examine trends relative to both central tendency and annual variation. This type of analysis is useful in looking at specific sites where efforts to address beach advisories have been implemented. For example, a focus on patterns such as trends in geometric means or 90th percentiles provides a visual analysis that can be used to evaluate program effectiveness. With respect to trends, it should be noted that a laboratory analytical method change occurred in September 2000. The IDEXX test was used to determine enterococcus concentrations on all samples collected after September 2000.

Linkage Analysis. The numeric target for this TMDL is Guam's concentration-based criteria for enterococci bacteria (i.e., a geometric mean of 35 counts / 100 mL and an instantaneous maximum of 104 counts / 100 mL). The relationship between this target and potential sources at Matapang Beach is demonstrated through an analysis of water quality monitoring data at this site. Seasonal patterns, for example, show that the highest concentrations are observed between July and September, indicating the importance of wet season sources at Matapang Beach. This is consistent with the presence of potential storm water sources identified at this location.

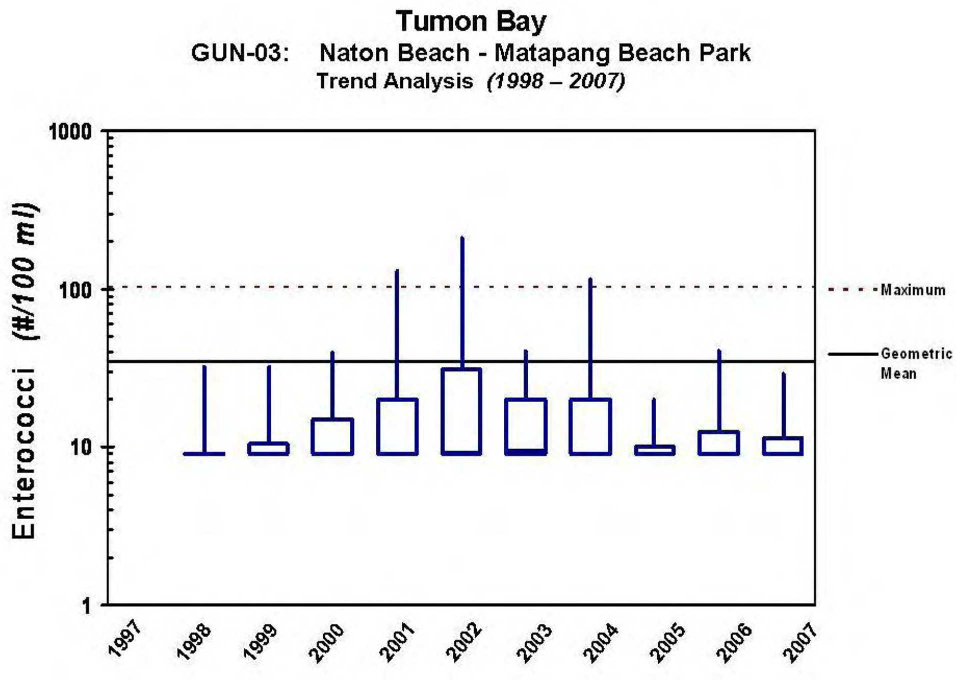

Figure 8-55. Trend analysis for Matapang Beach site.

The connection between storm water sources and exceedances of numeric targets is further confirmed by examining the effect of flow conditions. At Matapang Beach, the highest bacteria concentrations occur under high flows. Water quality conditions that reflect this pattern are strongly influenced by storm water runoff during heavy rainfall events. In short, the technical analyses presented in this assessment of Matapang Beach describe the relationship between water quality patterns and potential sources at this location. The loading capacity and allocations are all concentrations set at the criteria values for enterococci bacteria. This TMDL will clearly meet water quality standards and protect recreational uses at this beach.

TMDL Components. Table 8-18 presents the TMDL for Matapang Beach, identifying the loading capacity and allocations expressed as concentration-based values for enterococcus. These concentration-based values apply across all flow zones. This TMDL uses an implicit MOS, through inclusion of two conservative assumptions. First, the TMDL does not account for mixing in the receiving waters and assumes that zero dilution is available. Second, the goal of attaining standards at the point of discharge does not account for losses due to die-off and settling of indicator bacteria that are known to occur.

Table 8-18. Northern Guam Watershed TMDL summary *(Site GUN-03: Matapang Beach)*.

TMDL Component	Enterococcus Concentration *(# / 100 mL)*
Geometric Mean	
TMDL	**35**
Future Growth	35
Waste Load Allocation	35
Load Allocation	35
Instantaneous Maximum	
TMDL	**104**
Future Growth	104
Waste Load Allocation	104
Load Allocation	104

A hydrology-based framework using duration curve zones allows the TMDL to evaluate monitoring data in a way that reflects major watershed processes indicative of different flows. This approach enables numeric targets in the TMDL to consider watershed processes, such as hydrology and source assessment information including land use.

Table 8-19 identifies reductions for each duration curve zone by season using the TMDL targets. These estimates can serve to guide problem solving discussions on appropriate management strategies (based on knowledge associated with likely source areas, delivery mechanisms, and appropriate control measures that correspond to particular hydrologic conditions).

Table 8-19. Needed reductions to meet TMDL targets *(Site GUN-03: Matapang Beach)*.

Needed Reductions	Flow Conditions *(expressed as percentage)*				
	High	**Moist**	**Mid**	**Dry**	**Low**
Dry Season					
Based on geometric mean	---	---	---	---	---
Based on instantaneous maximum	25%	---	---	---	---
Wet Season					
Based on geometric mean	---	---	---	---	---
Based on instantaneous maximum	49%	---	---	---	---

8.7 Guma Trankilidat Beach (GUN-04)

Guma Trankilidat Beach is located on Tumon Bay between Ypao Park and the Pacific Islands Club *(Figure 8-56)*. It is situated at the southern end of the bay. Because all of Tumon Bay is protected by a natural reef that stretches out about one mile from the beach shore, this beach can be used for swimming, wind-surfing, snorkeling, kayaking and other water activities.

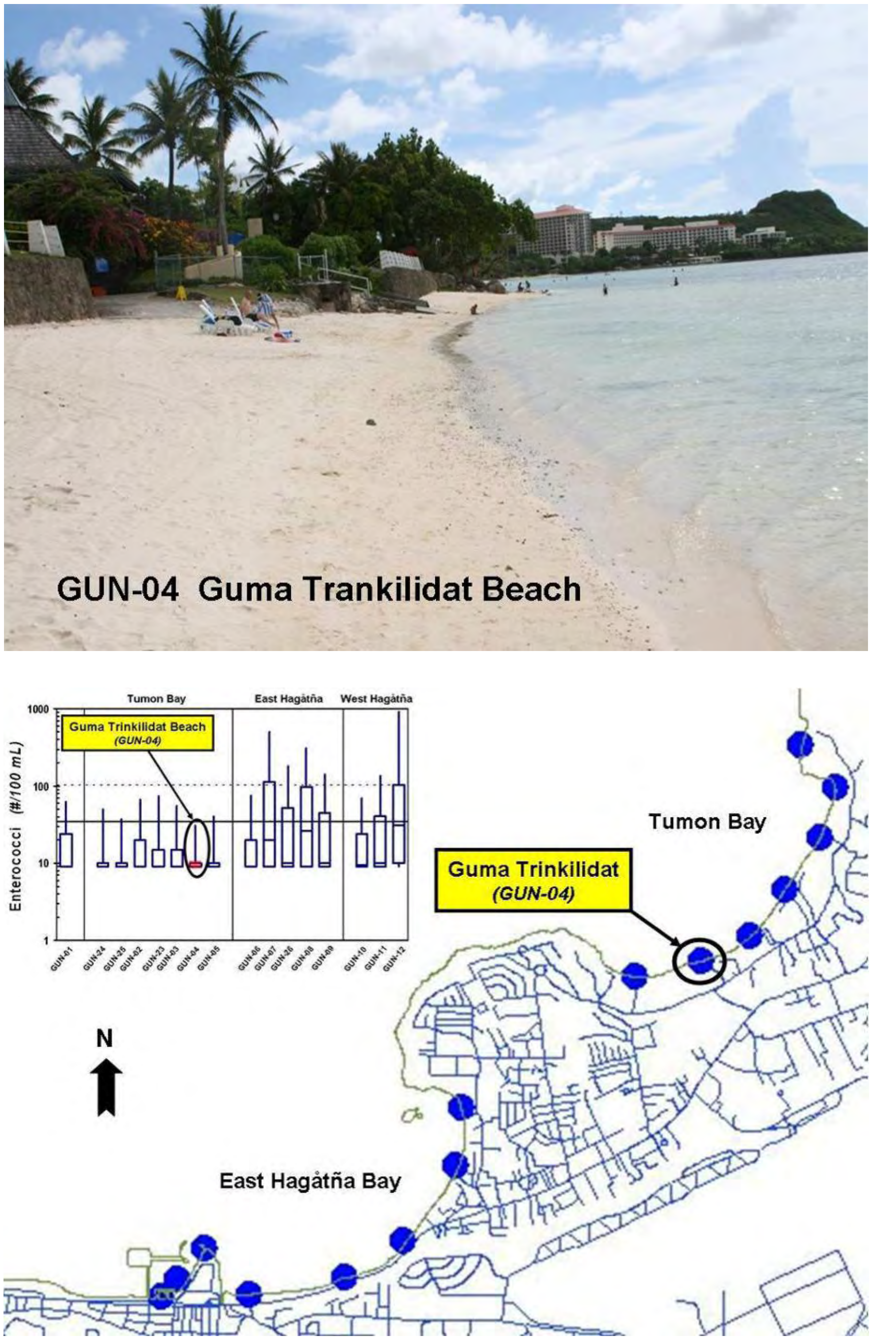

Figure 8-56. Location of Guma Trankilidat Beach relative to other Northern Guam TMDL sites.

The frequency of beach advisories at Guma Trankilidat Beach between 2005 and 2007 was low (4%) compared to other RBMP sites in the Northern Beach TMDL project area *(Figure 4-1)*. Enterococci concentrations at Guma Trankilidat Beach were among the lowest of all project area monitoring stations *(Figure 4-2 and Figure 8-56)*. The geometric mean of all individual samples was 13 counts /100mL, while the 75th and 90th percentiles were 10 and 31 counts /100 mL respectively. Although bacteria concentrations are lower than other RBMP sites, this beach is still impaired. Water quality improvements are clearly needed, though they will not be as significant as those required at other project area locations.

A key part of the data analysis for individual beaches is to examine water quality patterns by season and relative to flow conditions (e.g., runoff dominated versus base flows). Figure 8-57 shows the seasonal variability of bacteria concentrations at Guma Trankilidat Beach. The highest concentrations were observed between July and September, indicating the importance of wet season sources at Guma Trankilidat Beach.

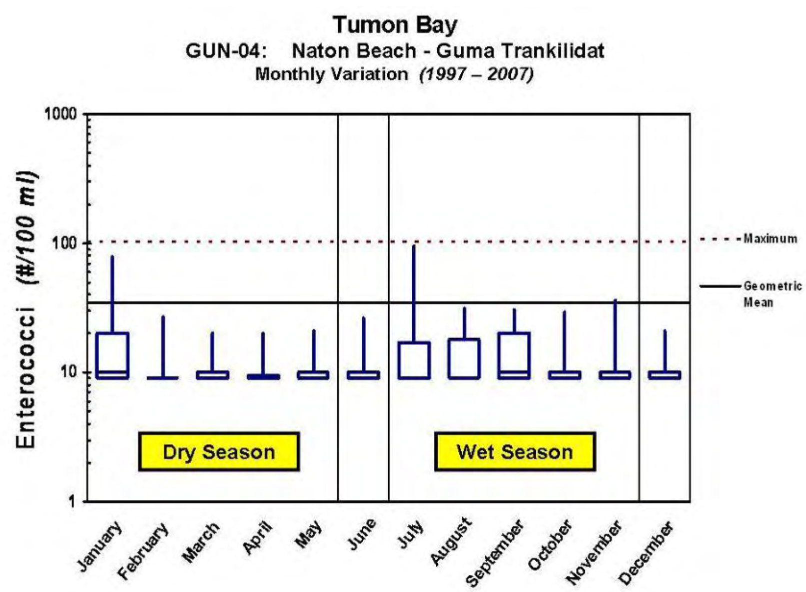

Figure 8-57. Seasonal variation at Guma Trankilidat Beach.

Effect of Flow Conditions. A useful approach for relating water quality information to potential source areas is to examine bacteria levels in terms of hydrologic conditions. Figure 8-58 shows enterococci monitoring data collected at Guma Trankilidat Beach using a duration curve framework. Although there is significant variability in the data, which is characteristic of bacteria monitoring information, a definite pattern exists.

As indicated by the *"box and whisker"* plots in Figure 8-58, the highest bacteria concentrations occur under high flow conditions. This is not unexpected because water quality at most beaches is strongly influenced by storm water runoff during

heavy rainfall events. The magnitude of the increase appears to be fairly consistent with that observed at other Tumon Bay monitoring sites.

Incorporating seasonality into the analysis allows a closer look at patterns that may be associated with certain source categories. For example, bacteria delivered through seeps connected to storm water ponds are more likely to affect beach monitoring data during the wet season. In contrast, bacteria contributed from more continuous sources (e.g., leaky sewer lines or failing septics) will exert a greater effect during the dry season. Comparisons between the geometric means, the 75^{th} and 90^{th} percentiles for each duration curve zone serve as primary measures for examining seasonality. This is illustrated in Figure 8-59.

As noted earlier *(Figure 8-57)*, dry season bacteria concentrations observed at Guma Trankilidat Beach are extremely low. This pattern is consistent across all flow zones. The moderate effect of storm water runoff is evident for both the wet and dry seasons under high flow conditions. This reinforces the need to focus on storm water sources at Guma Trankilidat Beach. Furthermore, the low values observed for both the wet and dry seasons in the moist, mid-range, and dry zones confirm the fact that storm water sources are the major concern at this site.

Relationship to Other Indicators. In addition to seasonal patterns, the relationship of bacteria concentrations to other parameters can be incorporated into the data analysis. Guam EPA staff noted field data for several indicators at the time of bacteria sample collection as part of the RBMP. These include observations such as tidal stage and presence or absence of turbidity.

The combination of patterns with some of these observations could be related to potential source areas and delivery mechanism that might affect bacteria concentrations at any particular beach of interest. For example, the presence or absence of turbidity may also be an indicator of either storm water runoff or suspended material associated with wind action. This approach to the analysis provides information that might prove useful in guiding implementation efforts intended to address documented problems.

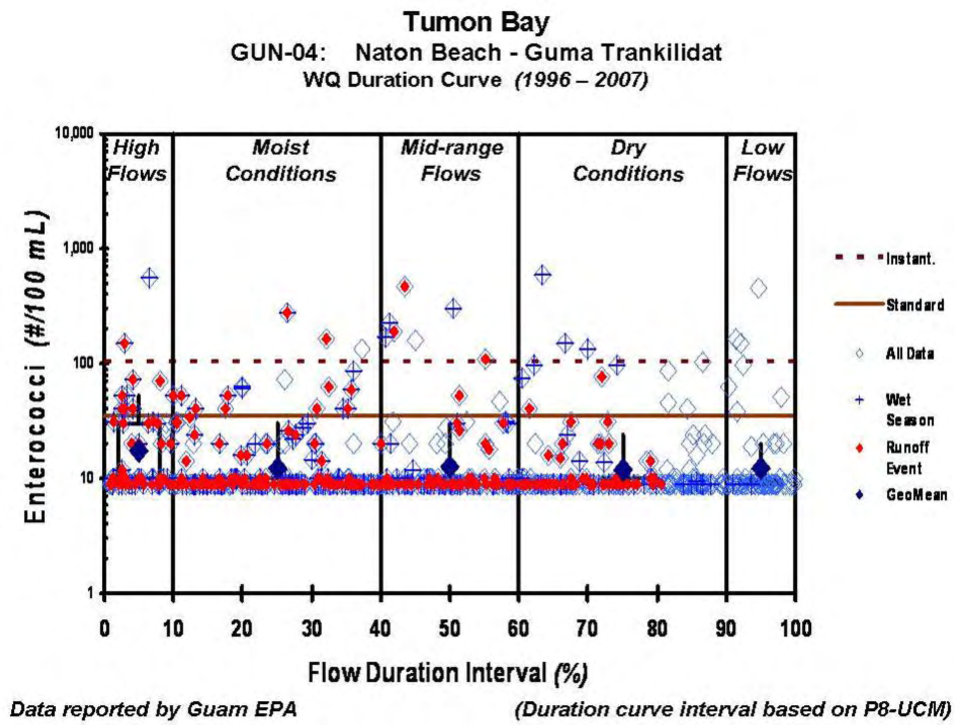

Figure 8-58. Water quality duration curve for Guma Trankilidat Beach site.

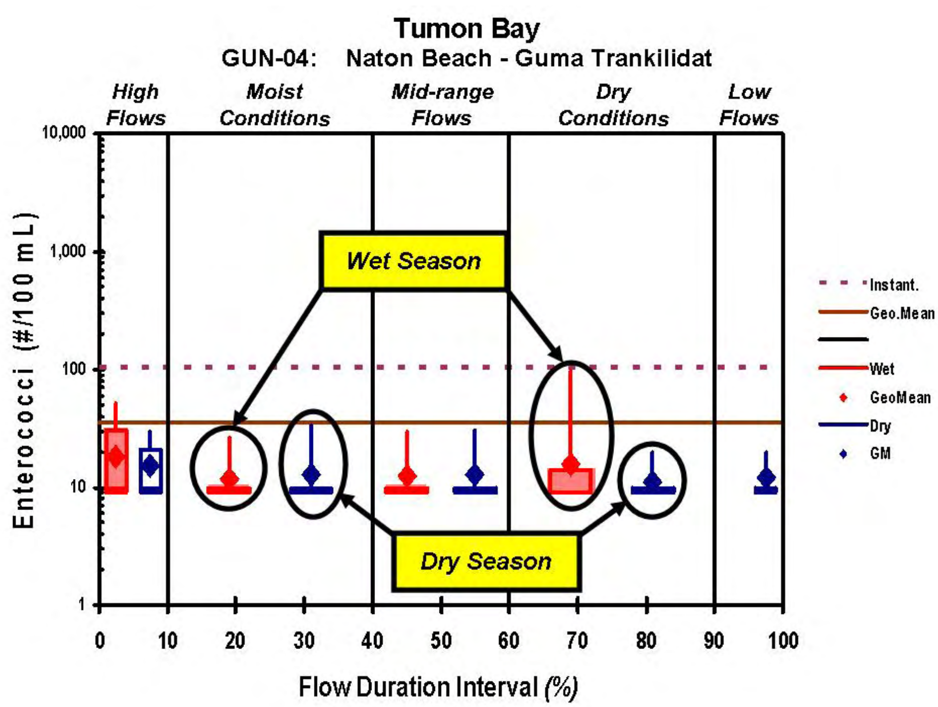

Figure 8-59. Wet versus dry season comparison for Guma Trankilidat Beach.

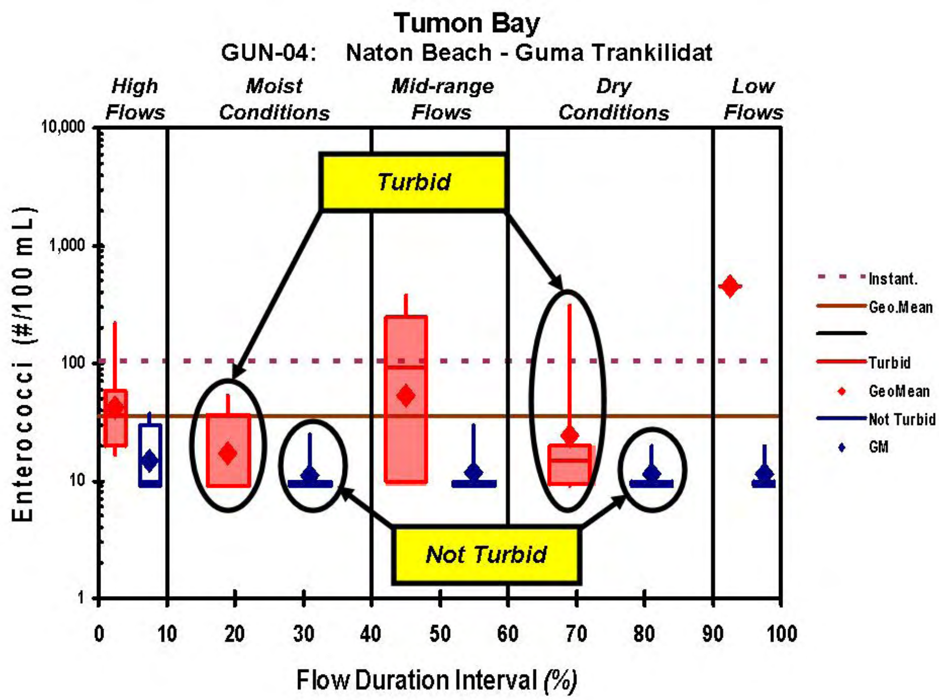

Figure 8-60. Turbid versus non-turbid sample comparison for Guma Trankilidat Beach site.

Figure 8-60 shows the difference between bacteria levels when turbidity was present or absent during sample collection under the various flow conditions. The increased levels when turbidity was present under high, moist, and mid-range flow conditions likely reflects the effect of bacteria transported with fine particles during storm events. The effect of bacteria associated with resuspension of bottom sediments might also be the result of wind and wave action, which could affect beach water quality.

Potential Sources. The Source Assessment (Section 5, Table 5-2) summarized potential sources that may affect bacteria concentrations at Guma Trankilidat Beach. Included are wastewater sources (septic systems, sewer line blockages & breaks, SSO), storm water (overland runoff, highway maintenance & runoff, construction), and other sources (recreation & tourism activities). In addition, GEPA staff identified specific potential sources that could affect water quality at Guma Trankilidat Beach *(Table 8-20)*.

Figure 8-61 provides a closer look at the Guma Trankilidat Beach monitoring site relative to upland areas that potentially contribute bacteria during storm events. Figure 8-61 includes roads, which can provide a general indication of the urban drainage network and accompanying storm drains. Figure 8-61 also identifies major storm water ponding basins, including the Harmon Sink.

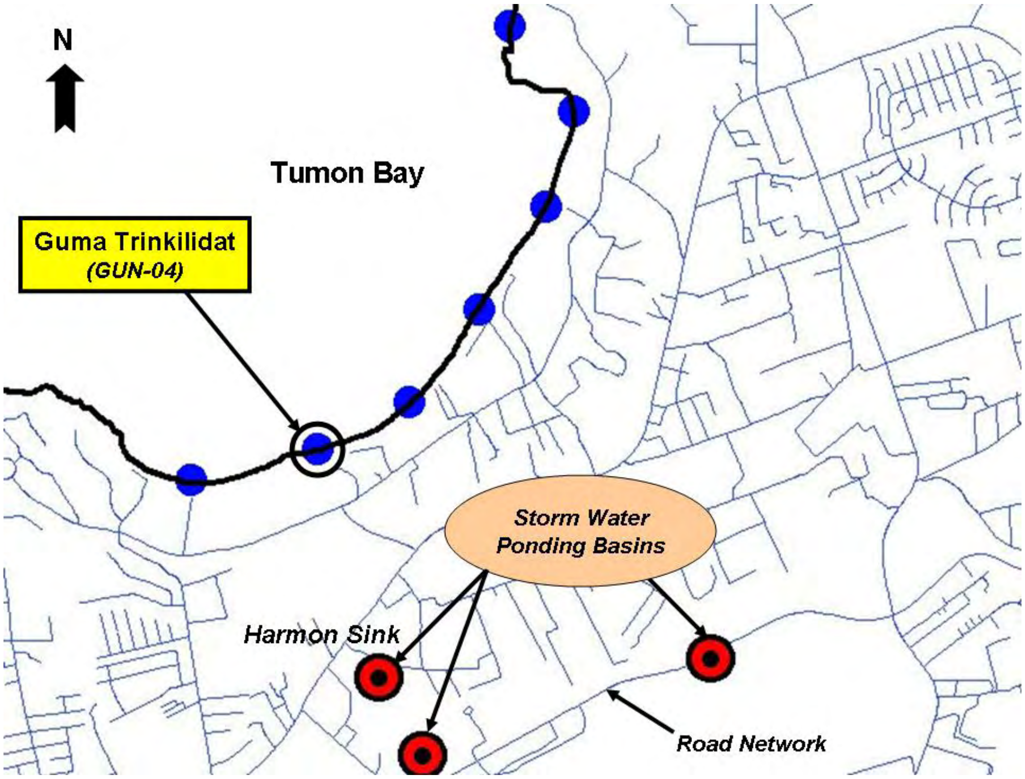

Figure 8-61. Location of Guma Trankilidat Beach relative to potential source areas.

Table 8-20. Beach specific potential source summary *(Site GUN-04: Guma Trankilidat Beach)*.

Site ID	Type	Source Name *(notes)*
GUN-04	Storm drain runoff	Harmon Sinkhole *Guam International Airport Authority storm water flows to Harmon Sinkhole via concrete channel (includes failing oil / water separator).*
	Sewage overflow	Harmon Sinkhole *Receives sewage overflow from Mamajanao Pump Station.*

A review of GIS information shows a number of unsewered buildings in the upland area adjacent to Guma Trankilidat Beach. This information is shown in Figure 8-62. In addition, sewer line blockages and breaks, as well as SSOs could contribute to elevated bacteria levels. Figure 8-62 shows the location of both sewer mains and pump stations, as indicators of potential water quality problems associated with wastewater conveyance systems.

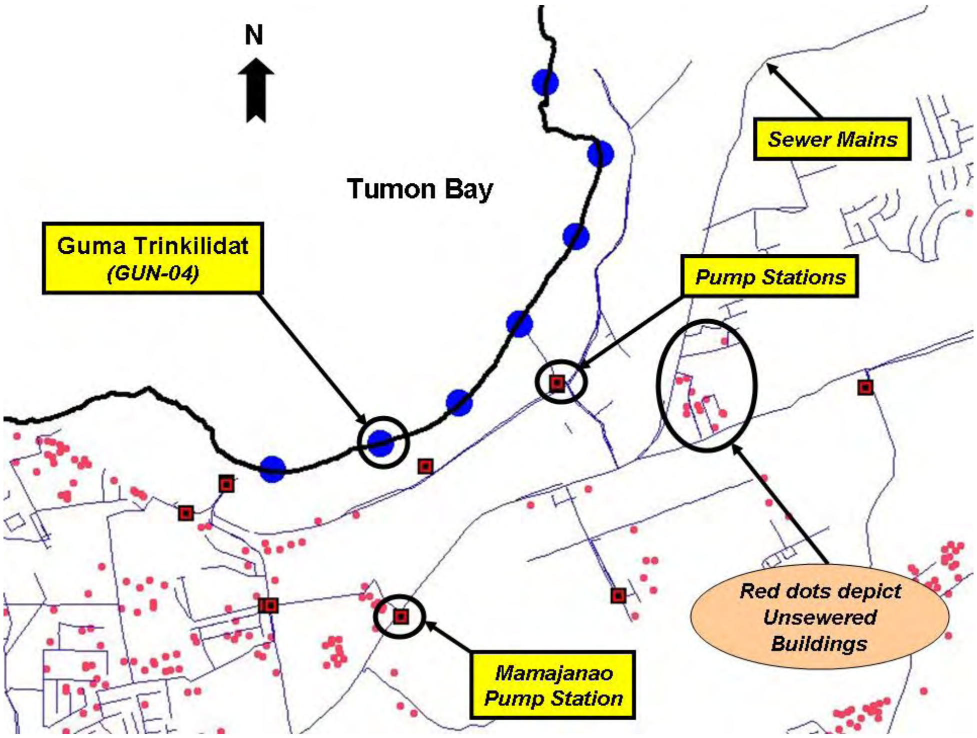

Figure 8-62. Location of Guma Trankilidat Beach relative to potential unsewered buildings.

Figure 8-63. Air photo of Guma Trankilidat Beach vicinity.

Figure 8-63 shows an air photo of the area adjacent to Guma Trankilidat Beach. This provides a different perspective, which highlights the high density of roads and buildings in the area adjacent to Guma Trankilidat Beach.

Trends. Figure 8-64 presents a year-by-year summary of the enterococcus data for the Guma Trankilidat Beach site. This provides a useful way to examine trends relative to both central tendency and annual variation. This type of analysis is useful in looking at specific sites where efforts to address beach advisories have been implemented. For example, a focus on patterns such as trends in geometric means or 90th percentiles provides a visual analysis that can be used to evaluate program effectiveness. With respect to trends, it should be noted that a laboratory analytical method change occurred in September 2000. The IDEXX test was used to determine enterococcus concentrations on all samples collected after September 2000.

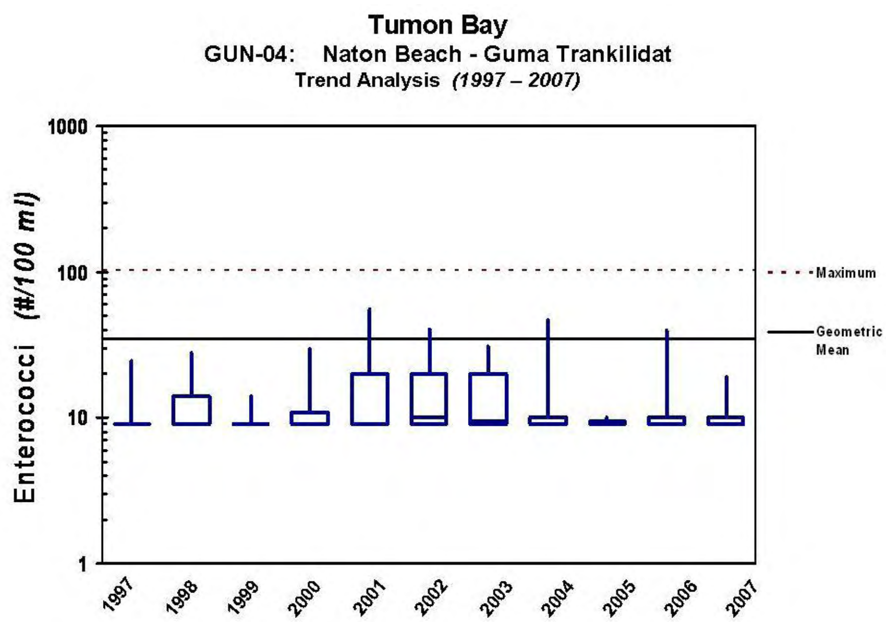

Figure 8-64. Trend analysis for Guma Trankilidat Beach site.

Linkage Analysis. The numeric target for this TMDL is Guam's concentration-based criteria for enterococci bacteria (i.e., a geometric mean of 35 counts / 100 mL and an instantaneous maximum of 104 counts / 100 mL). The relationship between this target and potential sources at Guma Trankilidat Beach is demonstrated through an analysis of water quality monitoring data at this site. Seasonal patterns, for example, show that the highest concentrations are observed between July and September, indicating the importance of wet season sources at Guma Trankilidat Beach. This is consistent with the presence of potential storm water sources identified at this location.

The connection between storm water sources and exceedances of numeric targets is further confirmed by examining the effect of flow conditions. At Guma Trankilidat Beach, the highest bacteria concentrations occur under high flows. Water quality conditions that reflect this pattern are strongly influenced by storm water runoff during heavy rainfall events. In short, the technical analyses presented in this assessment of Guma Trankilidat Beach describe the relationship between water quality patterns and potential sources at this location. The loading capacity and allocations are all concentrations set at the criteria values for enterococci bacteria. This TMDL will clearly meet water quality standards and protect recreational uses at this beach.

TMDL Components. Table 8-21 presents the TMDL for Guma Trankilidat Beach, identifying the loading capacity and allocations expressed as concentration-based values for enterococcus. These concentration-based values apply across all flow zones. This TMDL uses an implicit MOS, through inclusion of two conservative assumptions. First, the TMDL does not account for mixing in the receiving waters and assumes that zero dilution is available. Second, the goal of attaining standards at the point of discharge does not account for losses due to die-off and settling of indicator bacteria that are known to occur.

Table 8-21. Northern Guam Watershed TMDL summary *(Site GUN-04: Guma Trankilidat Beach)*.

TMDL Component	Enterococcus Concentration *(# / 100 mL)*
Geometric Mean	
TMDL	**35**
Future Growth	35
Waste Load Allocation	35
Load Allocation	35
Instantaneous Maximum	
TMDL	**104**
Future Growth	104
Waste Load Allocation	104
Load Allocation	104

A hydrology-based framework using duration curve zones allows the TMDL to evaluate monitoring data in a way that reflects major watershed processes indicative of different flows. This approach enables numeric targets in the TMDL to consider watershed processes, such as hydrology and source assessment information including land use.

Table 8-22 identifies those conditions under which Guam's water quality criteria for enterococci was exceeded. This information can serve to guide problem solving discussions on appropriate management strategies (based on knowledge associated with likely source areas, delivery mechanisms, and appropriate control measures that correspond to particular hydrologic conditions). As noted, reductions could not be determined based on the 90th percentile of the monitoring data. However, advisories have still been issued at this location indicating the need for water quality improvements.

Table 8-22. Needed reductions to meet TMDL targets *(Site GUN-04: Guma Trankilidat Beach)*.

Needed Reductions	**Flow Conditions** *(expressed as percentage)*				
	High	**Moist**	**Mid**	**Dry**	**Low**
Dry Season					
Based on geometric mean	---	---	---	---	---
Based on instantaneous maximum	---	*Note ***	*Note ***	*Note ***	*Note ***
Wet Season					
Based on geometric mean	---	---	---	---	---
Based on instantaneous maximum	*Note ***	*Note ***	*Note ***	*Note ***	---

Note: Although reductions could not be determined based on the 90th percentile of monitoring data, exceedances of the instantaneous maximum criteria were observed in zones noted. These exceedances indicate that this beach is threatened until exceedances are eliminated.

8.8 Ypao Beach (GUN-05)

Ypao Beach is situated at the southern end of the Tumon Bay, and is one of the only two beach parks in Tumon. *(Figure 8-65)*. Ypao Beach is one of the island's most popular recreational parks for picnics, sporting activities, and concerts. This beach is highly used for swimming, wind-surfing, kayaking and other popular water activities. Because Tumon Bay is protected by a natural reef, the waters off Ypao Beach offer access to excellent snorkeling spots with a multitude of sea life gathered around live coral on the sea floor.

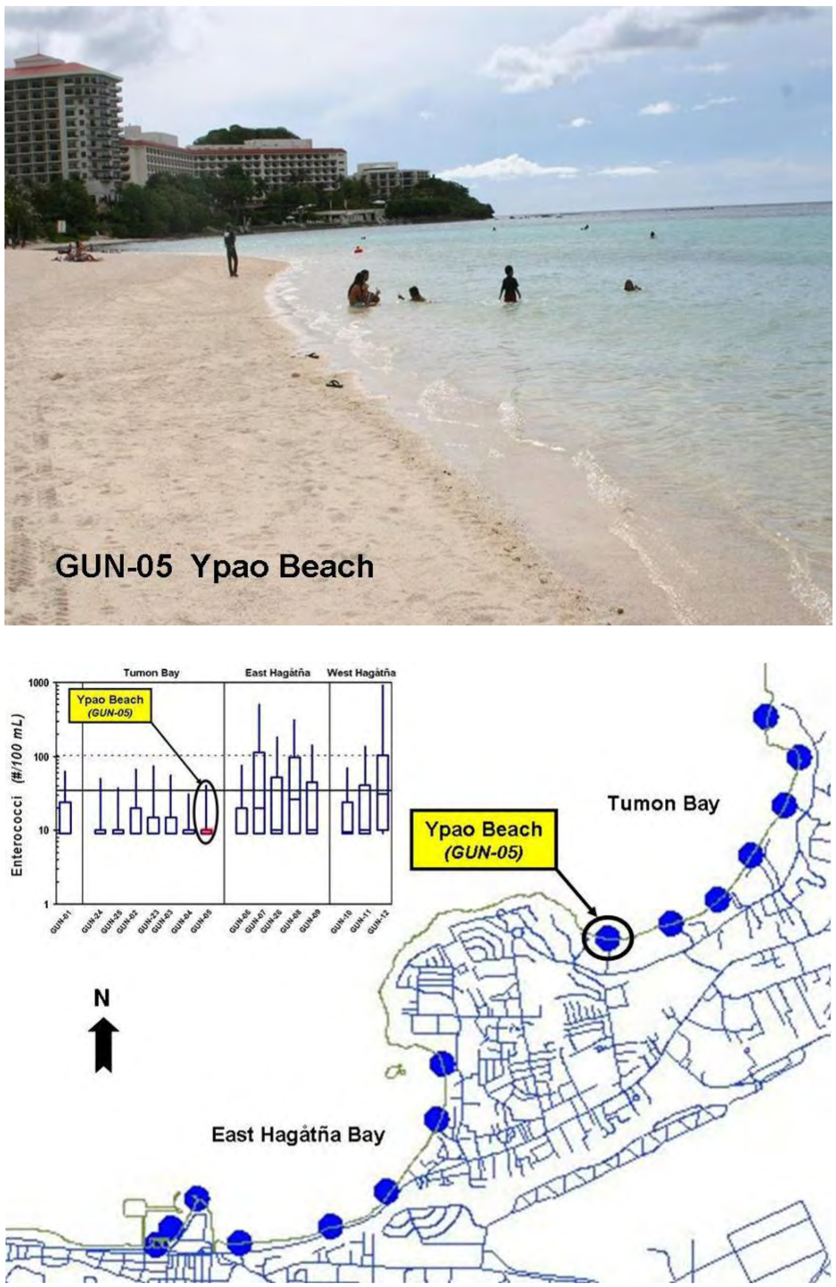

Figure 8-65. Location of Ypao Beach relative to other Northern Guam TMDL sites.

The frequency of beach advisories at Ypao Beach between 1997 and 2007 was low (7%) compared to other RBMP sites in the Northern Beach TMDL project area *(Figure 4-1)*. Enterococci concentrations at Ypao Beach were among the lowest of all project area monitoring stations *(Figure 4-2 and Figure 8-65)*. The geometric mean of all individual samples was 13 counts /100mL, while the 75th and 90th percentiles were 10 and 41 counts /100 mL respectively.

Although bacteria concentrations are lower than other RBMP sites, this beach is still impaired. Water quality improvements are clearly needed, though they will not be as significant as those required at other project area locations.

A key part of the data analysis for individual beaches is to examine water quality patterns by season and relative to flow conditions (e.g., runoff dominated versus base flows). Figure 8-66 shows the seasonal variability of bacteria concentrations at Ypao Beach. The highest concentrations were observed in July and August, indicating the importance of wet season sources at Ypao Beach.

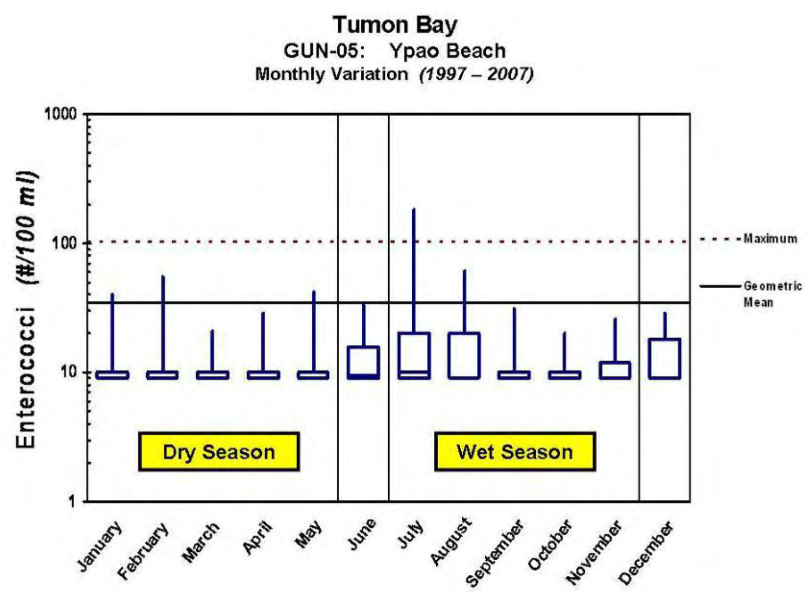

Figure 8-66. Seasonal variation at Ypao Beach.

<u>Effect of Flow Conditions</u>. A useful approach for relating water quality information to potential source areas is to examine bacteria levels in terms of hydrologic conditions. Figure 8-67 shows enterococci monitoring data collected at Ypao Beach using a duration curve framework. Although there is significant variability in the data, which is characteristic of bacteria monitoring information, a definite pattern exists.

As indicated by the *"box and whisker"* plots in Figure 8-67, the highest bacteria concentrations occur under high flow conditions. This is not unexpected because water quality at most beaches is strongly influenced by storm water runoff during heavy rainfall events. The magnitude of the increase appears to be fairly consistent with that observed at other Tumon Bay monitoring sites.

Incorporating seasonality into the analysis allows a closer look at patterns that may be associated with certain source categories. For example, bacteria delivered through seeps connected to storm water ponds are more likely to affect beach monitoring data during the wet season. In contrast, bacteria contributed from more continuous sources (e.g., leaky sewer lines or failing septics) will exert a greater effect during the dry season. Comparisons between the geometric means, the 75th and 90th percentiles for each duration curve zone serve as primary measures for examining seasonality. This is illustrated in Figure 8-68.

As noted earlier *(Figure 8-66)*, dry season bacteria concentrations observed at Ypao Beach are extremely low. This pattern is consistent across all flow zones. The moderate effect of storm water runoff is evident for both the wet and dry seasons under high flow conditions. This reinforces the need to focus on storm water sources at Ypao Beach. However, an interesting observation is the difference between the wet and dry season patterns under dry conditions. The higher wet season values in this zone indicate the potential for seeps connected to storm water sources to be affecting water quality at this site.

Relationship to Other Indicators. In addition to seasonal patterns, the relationship of bacteria concentrations to other parameters can be incorporated into the data analysis. Guam EPA staff noted field data for several indicators at the time of bacteria sample collection as part of the RBMP. These include observations such as tidal stage and presence or absence of turbidity.

The combination of patterns with some of these observations could be related to potential source areas and delivery mechanism that might affect bacteria concentrations at any particular beach of interest. For example, the presence or absence of turbidity may also be an indicator of either storm water runoff or suspended material associated with wind action. This approach to the analysis provides information that might prove useful in guiding implementation efforts intended to address documented problems.

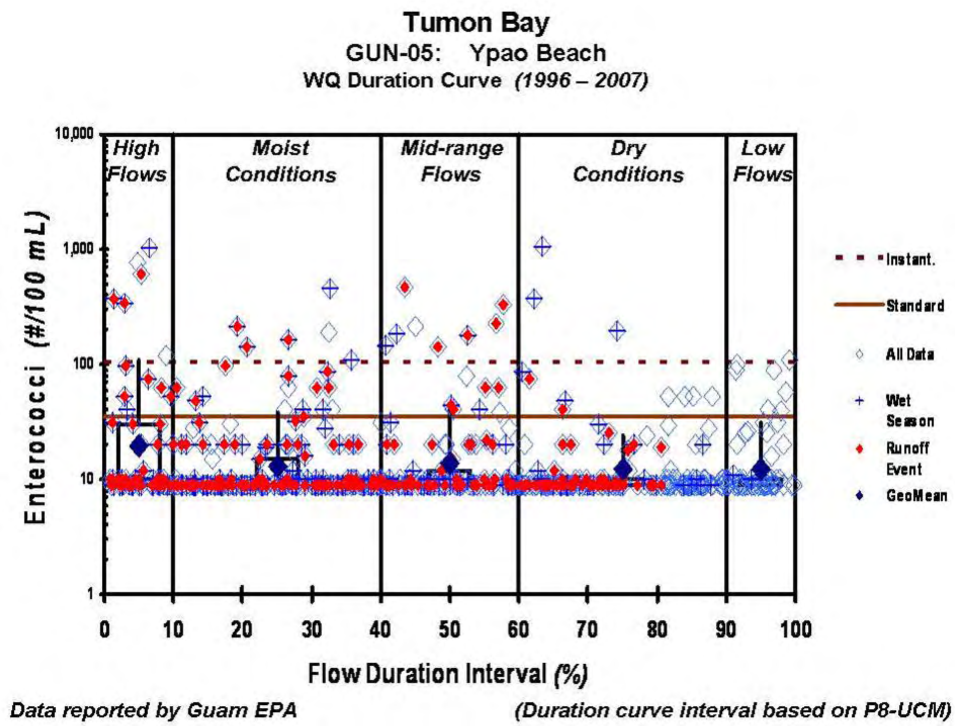

Figure 8-67. Water quality duration curve for Ypao Beach site.

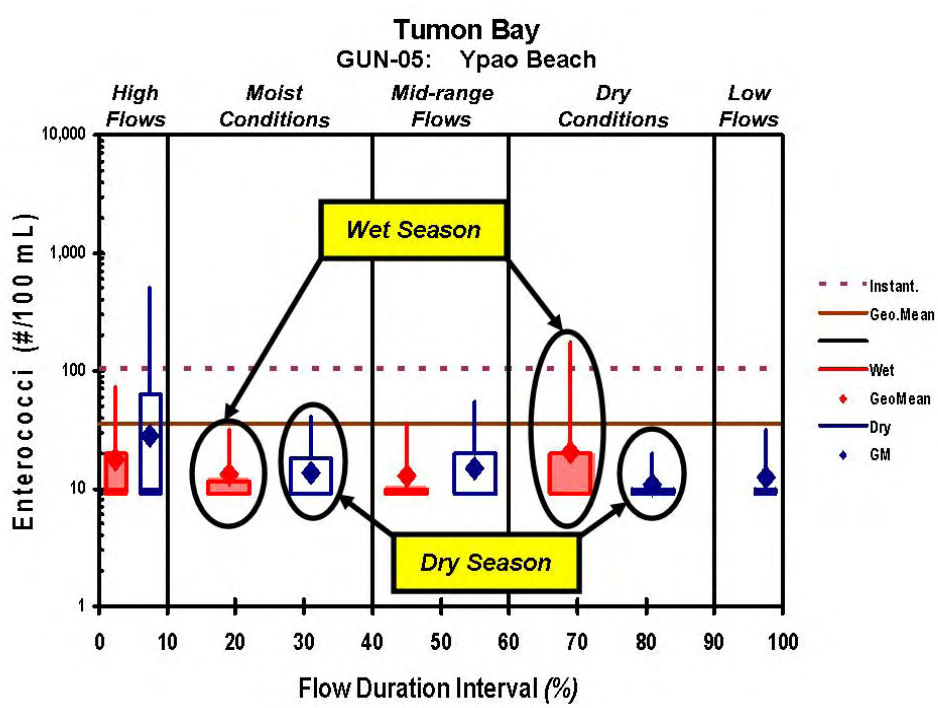

Figure 8-68. Wet versus dry season comparison for Ypao Beach.

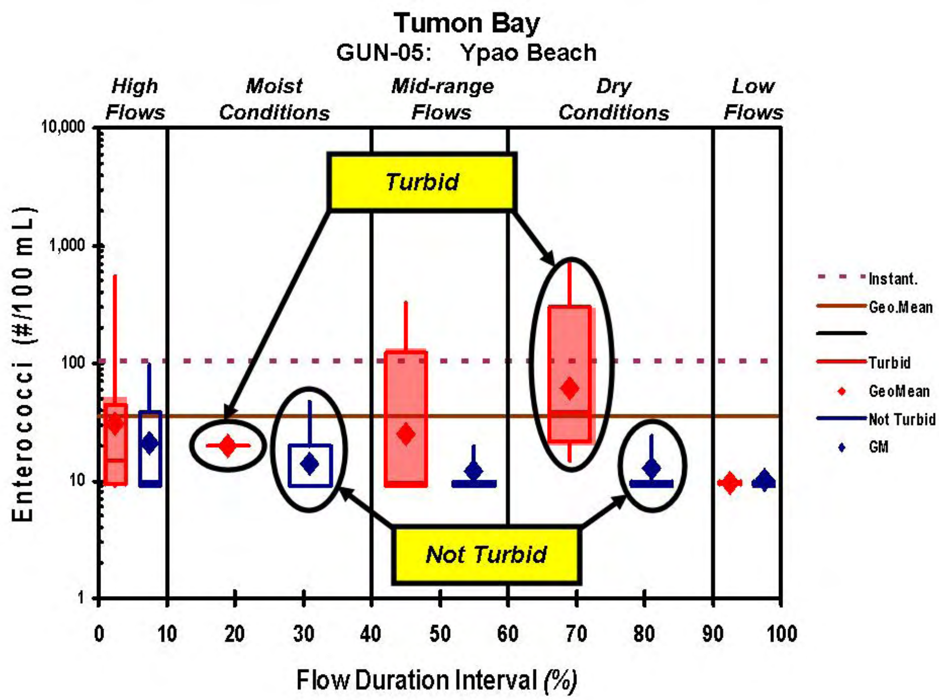

Figure 8-69. Turbid versus non-turbid sample comparison for Ypao Beach site.

Figure 8-69 shows the difference between bacteria levels when turbidity was present or absent during sample collection under the various flow conditions. The increased levels when turbidity was present under high, moist, and mid-range flow conditions likely reflects the effect of bacteria transported with fine particles during storm events. The effect of bacteria associated with resuspension of bottom sediments might also be the result of wind and wave action, which could affect beach water quality.

Potential Sources. The Source Assessment (Section 5, Table 5-2) summarized potential sources that may affect bacteria concentrations at Ypao Beach. Included are wastewater sources (septic systems, sewer line blockages & breaks, SSO), storm water (overland runoff, highway maintenance & runoff, construction), and other sources (recreation & tourism activities). In addition, GEPA staff identified specific potential sources that could affect water quality at Ypao Beach *(Table 8-23)*.

Figure 8-70 provides a closer look at the Ypao Beach monitoring site relative to upland areas that potentially contribute bacteria during storm events. Figure 8-70 includes roads, which can provide a general indication of the urban drainage network and accompanying storm drains. Figure 8-70 also identifies major storm water ponding basins, including the Harmon Sink.

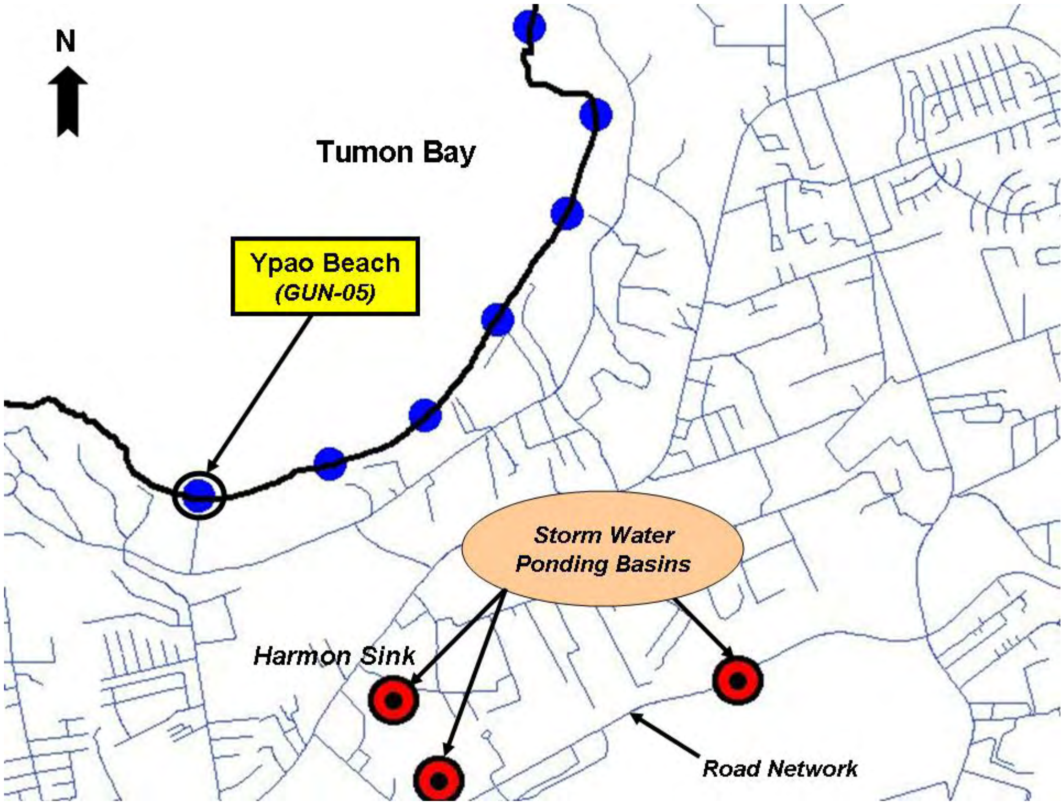

Figure 8-70. Location of Ypao Beach relative to potential source areas.

Table 8-23. Beach specific potential source summary *(Site GUN-05: Ypao Beach)*.

Site ID	Type	Source Name *(notes)*
GUN-05	Sewage overflow	Ypao Sewage Pump Station
		Manhole- sewer overflow *FID #952*
		Harmon Sinkhole *Receives sewage overflow from Mamajanao Pump Station.*
	Storm drain runoff	Harmon Sinkhole *Guam International Airport Authority storm water flows to Harmon Sinkhole via concrete channel (includes failing oil / water separator).*

A review of GIS information shows a number of unsewered buildings in the upland area adjacent to Ypao Beach. This information is shown in Figure 8-71. In addition, sewer line blockages and breaks, as well as SSOs could contribute to elevated bacteria levels. Figure 8-71 shows the location of both sewer mains and pump stations, as indicators of potential water quality problems associated with wastewater conveyance systems.

Figure 8-72 shows an air photo of the area adjacent to Ypao Beach. This provides a different perspective, which highlights the high density of roads and buildings in the area adjacent to Ypao Beach.

In addition to previous assessments and GIS information, Guam EPA staff identified other potential sources that could affect water quality at Ypao Beach. Specifically, there are two areas of concern. First, there is a manhole (FID #952) that has had sewage overflow problems, which may be affecting water quality at this site. Second, the Ypao Pump Station *(Figure 8-71)* is located nearby. There has been occasional sewage overflows associated with this facility, which could explain periodic elevated bacteria concentrations at this location.

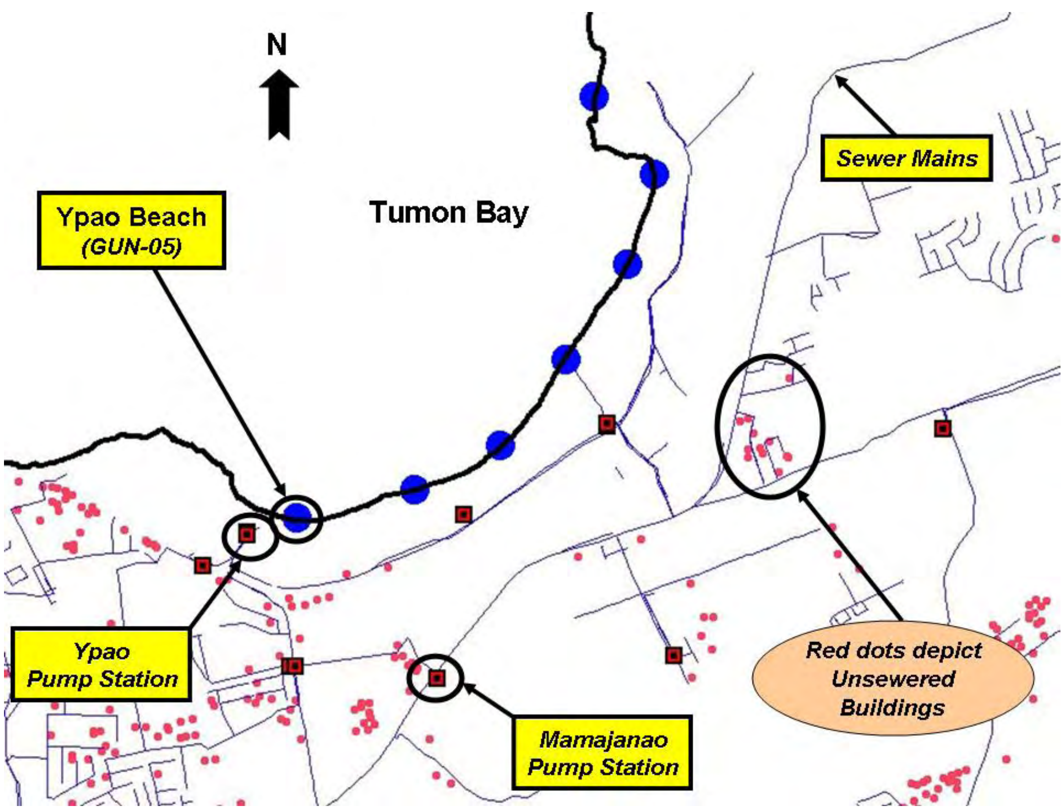

Figure 8-71. Location of Ypao Beach relative to potential unsewered buildings.

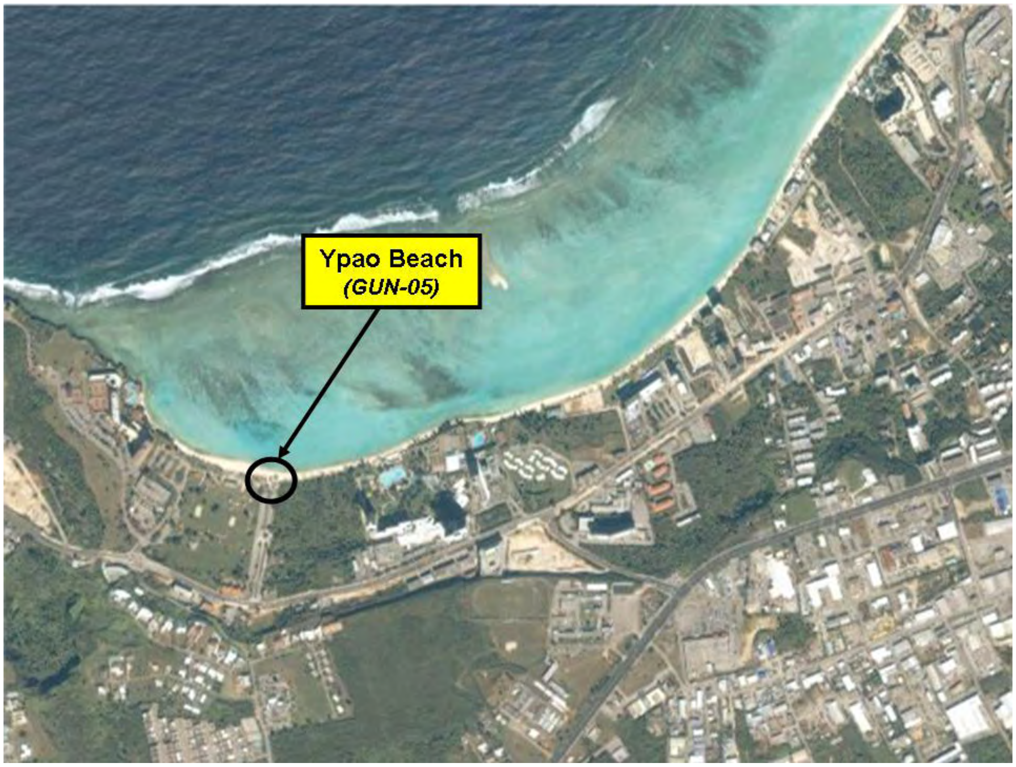

Figure 8-72. Air photo of Ypao Beach vicinity.

Trends. Figure 8-73 presents a year-by-year summary of the enterococcus data for the Ypao Beach site. This provides a useful way to examine trends relative to both central tendency and annual variation. This type of analysis is useful in looking at specific sites where efforts to address beach advisories have been implemented. For example, a focus on patterns such as trends in geometric means or 90th percentiles provides a visual analysis that can be used to evaluate program effectiveness. With respect to trends, it should be noted that a laboratory analytical method change occurred in September 2000. The IDEXX test was used to determine enterococcus concentrations on all samples collected after September 2000.

Linkage Analysis. The numeric target for this TMDL is Guam's concentration-based criteria for enterococci bacteria (i.e., a geometric mean of 35 counts / 100 mL and an instantaneous maximum of 104 counts / 100 mL). The relationship between this target and potential sources at Ypao Beach is demonstrated through an analysis of water quality monitoring data at this site. Seasonal patterns, for example, show that the highest concentrations are observed between July and August, indicating the importance of wet season sources at Ypao Beach. This is consistent with the presence of potential storm water sources identified at this location.

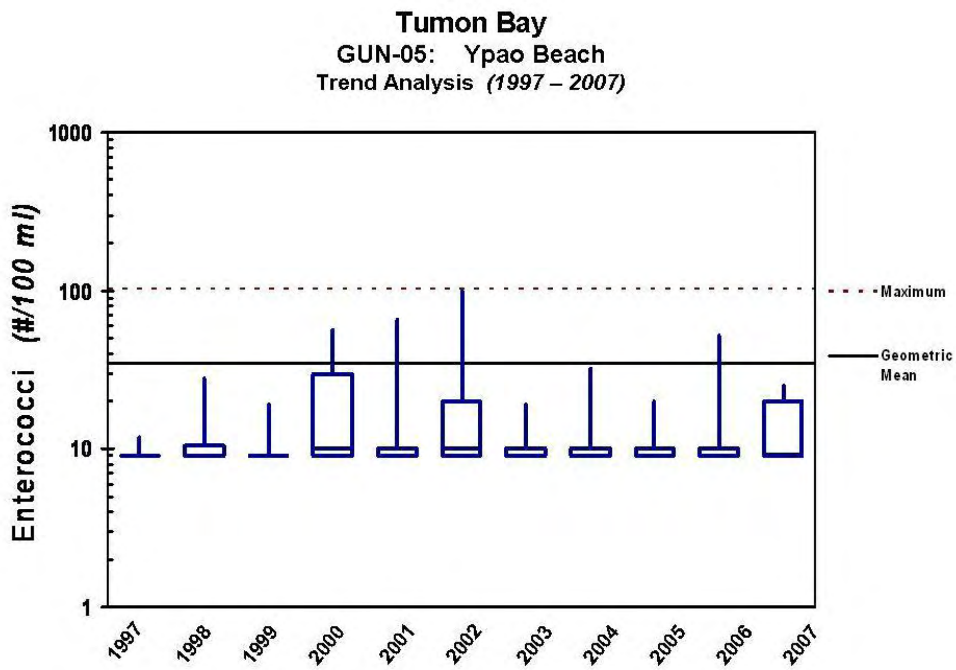

Figure 8-73. Trend analysis for Ypao Beach site.

The connection between storm water sources and exceedances of numeric targets is further confirmed by examining the effect of flow conditions. At Ypao Beach, the highest bacteria concentrations occur under high flows. Water quality conditions that reflect this pattern are strongly influenced by storm water runoff during heavy rainfall events. In short, the technical analyses presented in this assessment of Ypao Beach describe the relationship between water quality patterns and potential sources at this location. The loading capacity and allocations are all concentrations set at the criteria values for enterococci bacteria. This TMDL will clearly meet water quality standards and protect recreational uses at this beach.

TMDL Components. Table 8-24 presents the TMDL for Ypao Beach, identifying the loading capacity and allocations expressed as concentration-based values for enterococcus. These concentration-based values apply across all flow zones. This TMDL uses an implicit MOS, through inclusion of two conservative assumptions. First, the TMDL does not account for mixing in the receiving waters and assumes that zero dilution is available. Second, the goal of attaining standards at the point of discharge does not account for losses due to die-off and settling of indicator bacteria that are known to occur.

Table 8-24. Northern Guam Watershed TMDL summary *(Site GUN-05: Ypao Beach)*.

TMDL Component	Enterococcus Concentration *(# / 100 mL)*
Geometric Mean	
TMDL	**35**
Future Growth	35
Waste Load Allocation	35
Load Allocation	35
Instantaneous Maximum	
TMDL	**104**
Future Growth	104
Waste Load Allocation	104
Load Allocation	104

A hydrology-based framework using duration curve zones allows the TMDL to evaluate monitoring data in a way that reflects major watershed processes indicative of different flows. This approach enables numeric targets in the TMDL to consider watershed processes, such as hydrology and source assessment information including land use.

Table 8-25 identifies reductions for each duration curve zone by season using the TMDL targets. These estimates can serve to guide problem solving discussions on appropriate management strategies (based on knowledge associated with likely source areas, delivery mechanisms, and appropriate control measures that correspond to particular hydrologic conditions).

Table 8-25. Needed reductions to meet TMDL targets *(Site GUN-05: Ypao Beach)*.

Needed Reductions	Flow Conditions *(expressed as percentage)*				
	High	Moist	Mid	Dry	Low
Dry Season					
Based on geometric mean	---	---	---	---	---
Based on instantaneous maximum	80%	---	---	---	---
Wet Season					
Based on geometric mean	---	---	---	---	---
Based on instantaneous maximum	---	---	---	41%	---

8.9 Sleepy Lagoon (GUN-06)

Sleepy Lagoon Beach is the northernmost monitoring site on East Hagåtña Bay *(Figure 8-74)*. It is a very popular destination for water sports including parasailing, kayaking, and jet skiing. Several hotels are located along the shoreline to the north and south of Sleepy Lagoon Beach. The upland area to the east of Sleepy Lagoon Beach is predominantly residential with some commercial business along main roads.

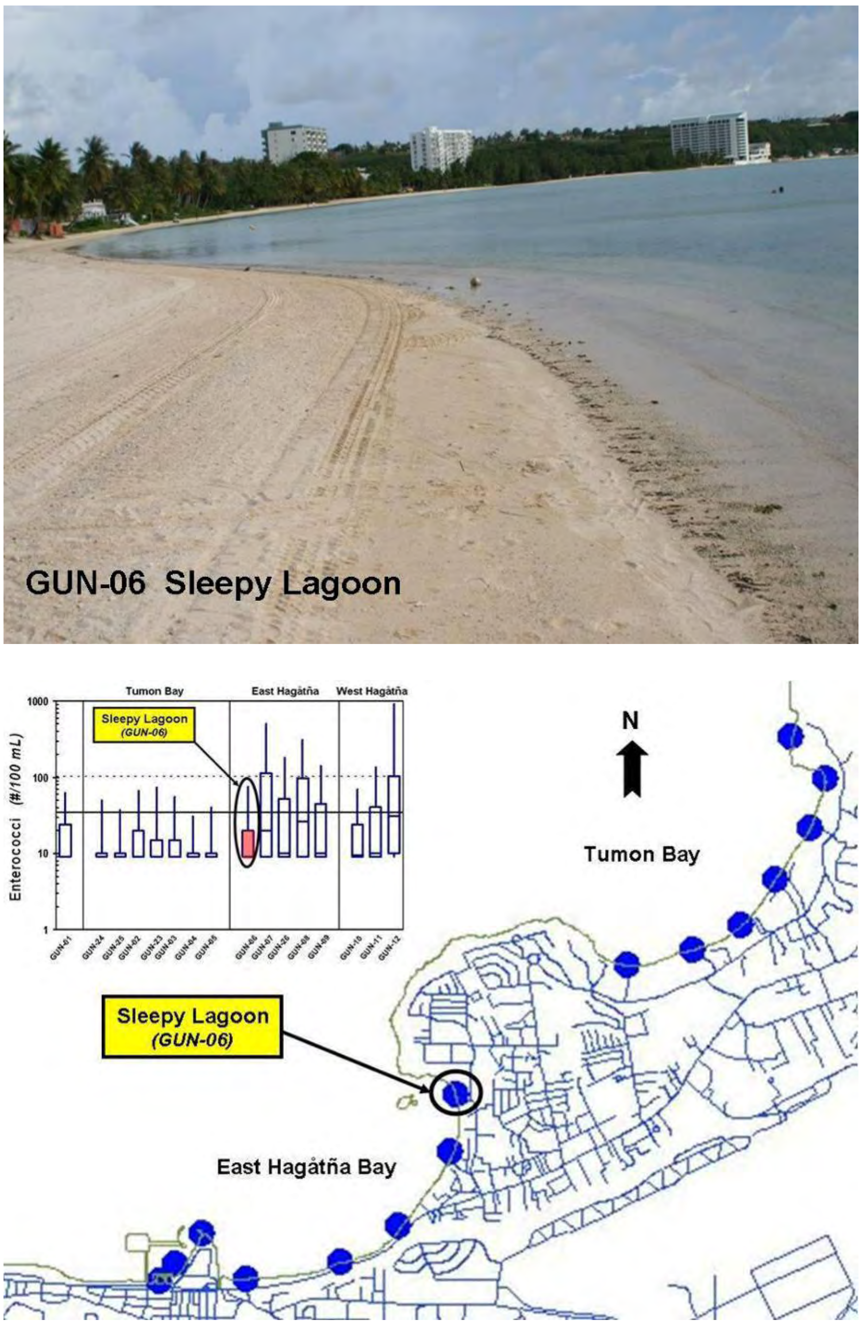

Figure 8-74. Location of Sleepy Lagoon Beach relative to other Northern Guam TMDL sites.

The frequency of beach advisories at Sleepy Lagoon Beach between 1997 and 2007 was slightly higher (16%) than other RBMP sites in the Northern Beach TMDL project area *(Figure 4-1)*. Enterococci concentrations at Sleepy Lagoon Beach were basically in the same range as a number of other project area monitoring stations *(Figure 4-2 and Figure 8-74)*. The geometric mean of all individual samples was 17 counts /100mL, while the 75th and 90th percentiles were 20 and 76 counts /100 mL respectively.

A key part of the data analysis for individual beaches is to examine water quality patterns by season and relative to flow conditions (e.g., runoff dominated versus base flows). Figure 8-75 shows the seasonal variability of bacteria concentrations at Sleepy Lagoon Beach. The highest concentrations were observed between July and March, indicating the importance of both wet and dry season sources at Sleepy Lagoon Beach.

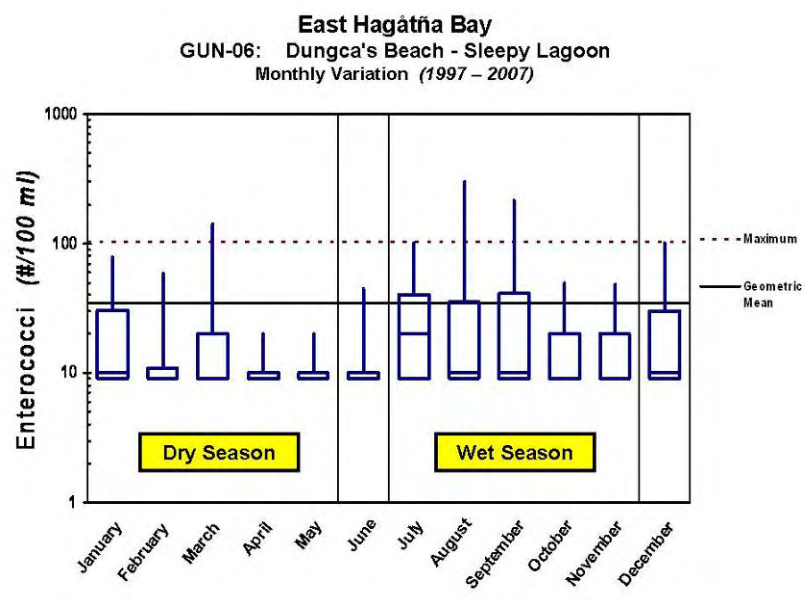

Figure 8-75. Seasonal variation at Sleepy Lagoon Beach.

Effect of Flow Conditions. A useful approach for relating water quality information to potential source areas is to examine bacteria levels in terms of hydrologic conditions. Figure 8-76 shows enterococci monitoring data collected at Sleepy Lagoon Beach using a duration curve framework. Although there is significant variability in the data, which is characteristic of bacteria monitoring information, a definite pattern exists.

As indicated by the *"box and whisker"* plots in Figure 8-76, the highest bacteria concentrations occur under high flow conditions. This is not unexpected because water quality at most beaches is strongly influenced by storm water runoff during heavy rainfall events. The magnitude of the increase is higher than that observed at other Northern Guam RBMP sites. In fact, the geometric mean

exceeded the criterion under high flow conditions, which indicates the need to address storm water sources. This concern is reinforced by the fact that over 30 percent of all values in the high flow zone exceed the instantaneous maximum criterion value. This indicates that sources associated with periodic short term problems (e.g., spills into the storm drain system or sewer overflows during heavy rains) may also be a concern under these conditions.

Incorporating seasonality into the analysis allows a closer look at patterns that may be associated with certain source categories. For example, bacteria delivered through seeps connected to storm water ponds are more likely to affect beach monitoring data during the wet season. In contrast, bacteria contributed from more continuous sources (e.g., leaky sewer lines or failing septics) will exert a greater effect during the dry season. Comparisons between the geometric means, the 75th and 90th percentiles for each duration curve zone serve as primary measures for examining seasonality. This is illustrated in Figure 8-77.

The effect of storm water runoff is evident for both the wet and dry seasons under high flow and moist conditions. This reinforces the need to focus on storm water sources at Sleepy Lagoon Beach. However, an interesting observation is the difference between the wet and dry season patterns under dry conditions. The higher wet season values in the dry zone indicate the potential for seeps connected to storm water sources to be affecting water quality at this site.

<u>Relationship to Other Indicators</u>. In addition to seasonal patterns, the relationship of bacteria concentrations to other parameters can be incorporated into the data analysis. Guam EPA staff noted field data for several indicators at the time of bacteria sample collection as part of the RBMP. These include observations such as tidal stage and presence or absence of turbidity.

The combination of patterns with some of these observations could be related to potential source areas and delivery mechanism that might affect bacteria concentrations at any particular beach of interest. For example, the presence or absence of turbidity may also be an indicator of either storm water runoff or suspended material associated with wind action. This approach to the analysis provides information that might prove useful in guiding implementation efforts intended to address documented problems.

Figure 8-78 shows the difference between bacteria levels when turbidity was present or absent during sample collection under the various flow conditions. The increased levels when turbidity was present under high, moist, and mid-range flow conditions likely reflects the effect of bacteria transported with fine particles during storm events. The effect of bacteria associated with resuspension of bottom sediments might also be the result of wind and wave action, which could affect beach water quality.

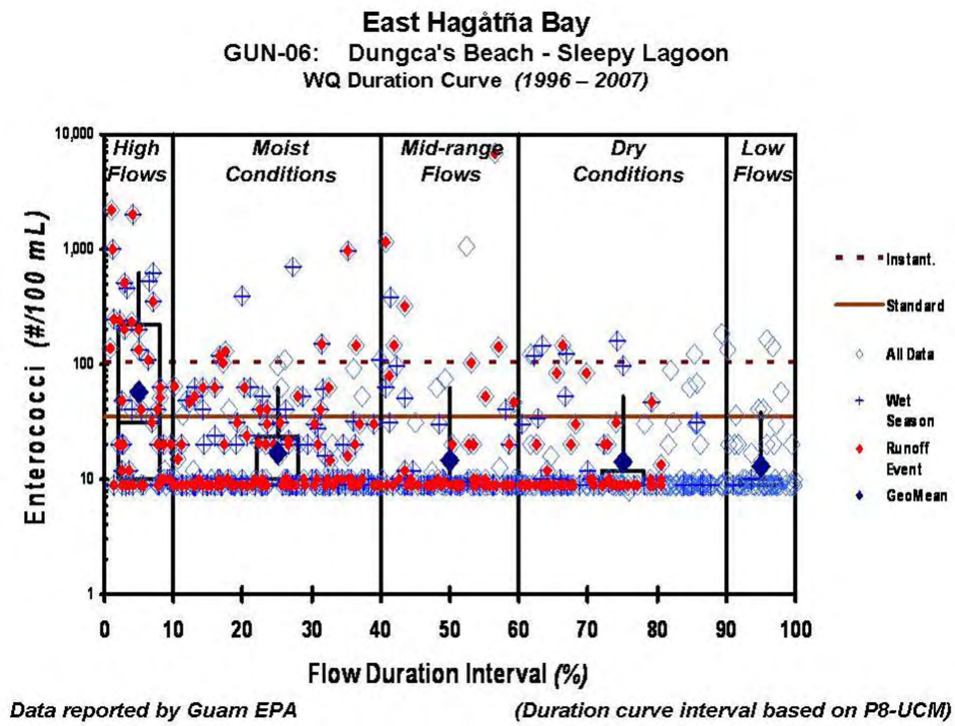

Figure 8-76. Water quality duration curve for Sleepy Lagoon Beach site.

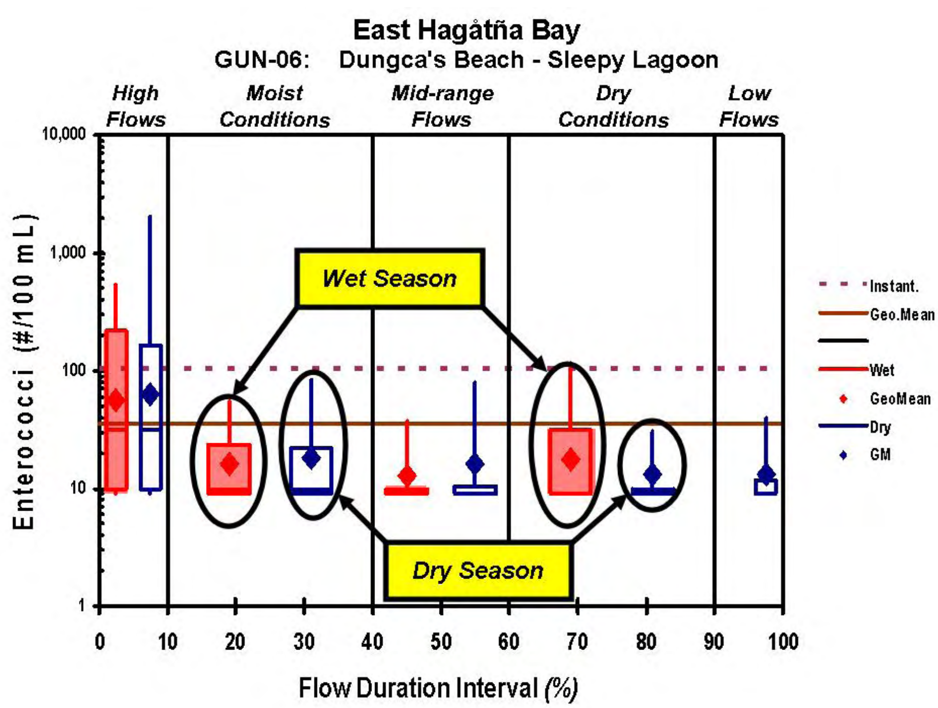

Figure 8-77. Wet versus dry season comparison for Sleepy Lagoon Beach.

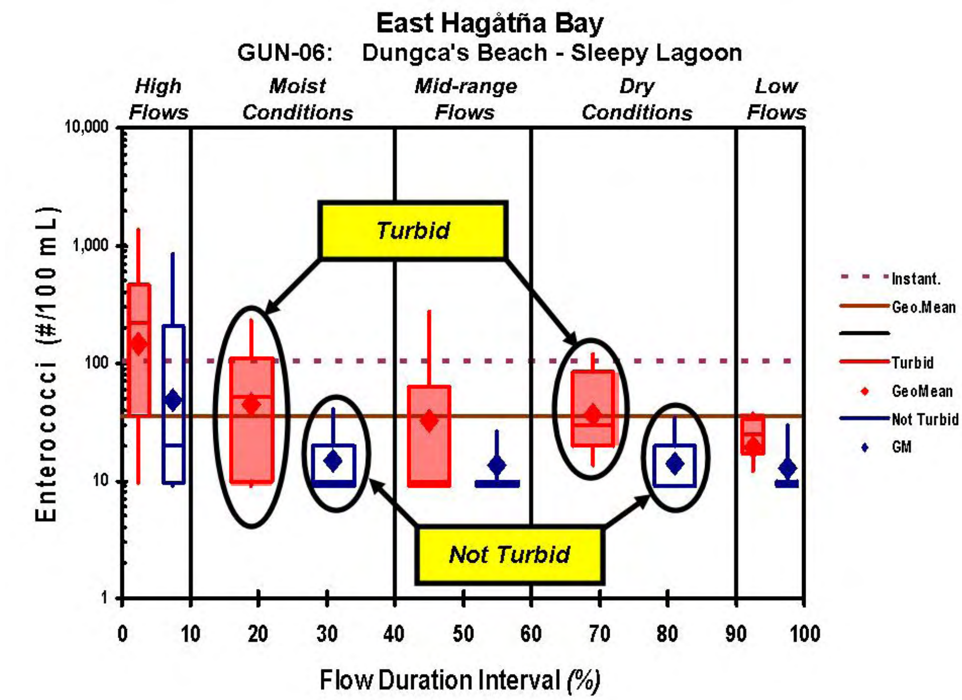

Figure 8-78. Turbid versus non-turbid sample comparison for Sleepy Lagoon Beach site.

Potential Sources. The Source Assessment (Section 5, Table 5-2) summarized potential sources that may affect bacteria concentrations at Sleepy Lagoon Beach. Included are wastewater sources (septic systems, sewer line blockages & breaks, SSO), storm water runoff, and other sources (recreation & tourism activities, debris & bottom deposits). In addition, GEPA staff identified specific potential sources that could affect water quality at Sleepy Lagoon Beach *(Table 8-26)*.

Figure 8-79 provides a closer look at the Sleepy Lagoon Beach monitoring site relative to upland areas that potentially contribute bacteria during storm events. Figure 8-79 includes roads, which can provide a general indication of the urban drainage network and accompanying storm drains. Figure 8-79 also identifies major storm water ponding basins, including the Harmon Sink.

A review of GIS information shows a number of unsewered buildings in the upland area adjacent to Sleepy Lagoon Beach. This information is shown in Figure 8-80. In addition, sewer line blockages and breaks, as well as SSOs, could contribute to elevated bacteria levels. Figure 8-80 shows the location of both sewer mains and pump stations, as indicators of potential water quality problems associated with wastewater conveyance systems.

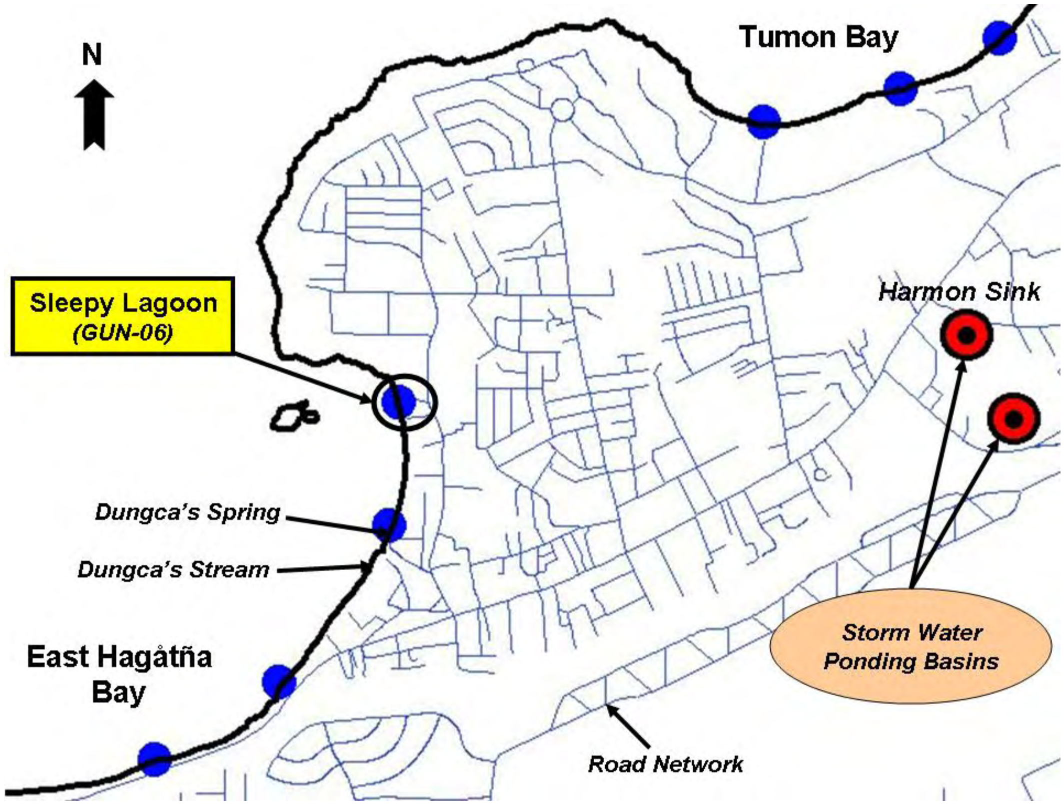

Figure 8-79. Location of Sleepy Lagoon Beach relative to potential source areas.

Table 8-26. Beach specific potential source summary *(Site GUN-06: Sleepy Lagoon Beach)*.

Site ID	Type	Source Name *(notes)*
GUN-06	Sewage overflow	Manhole- sewer overflow *Frequent overflows to storm drain leading to East Hagåtña Bay.*
		Harmon Sinkhole *Receives sewage overflow from Mamajanao Pump Station.*
	Wastewater	Septic systems *Concentrated number of unsewered buildings in upland area adjacent to beach*
	Storm drain runoff	Harmon Sinkhole *Guam International Airport Authority storm water flows to Harmon Sinkhole via concrete channel (includes failing oil / water separator).*

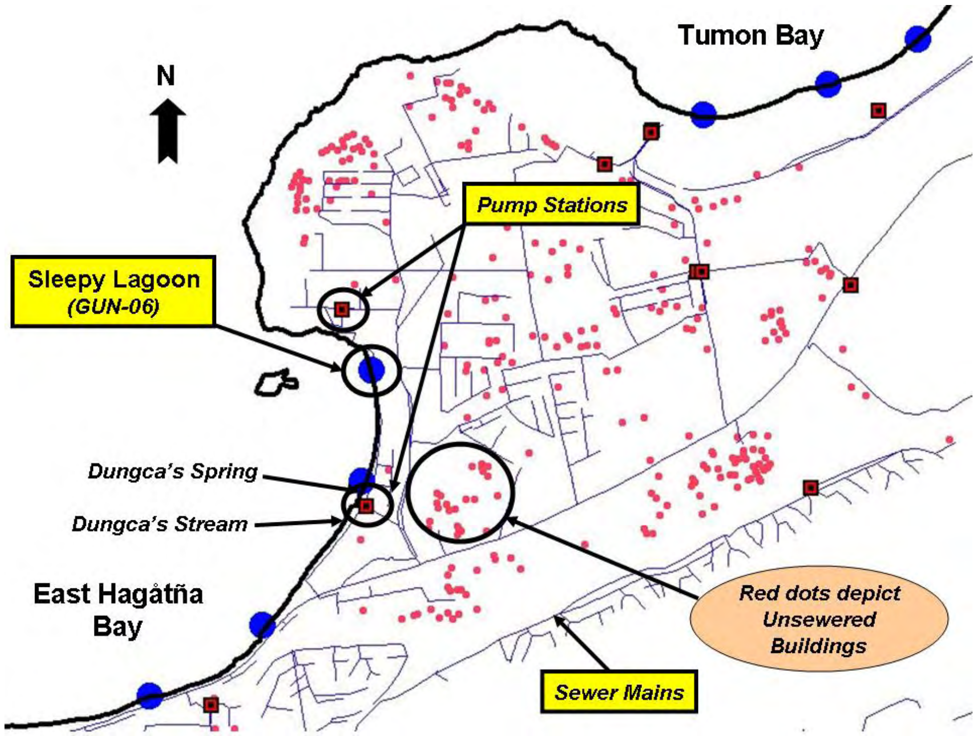

Figure 8-80. Location of Sleepy Lagoon Beach relative to potential unsewered buildings.

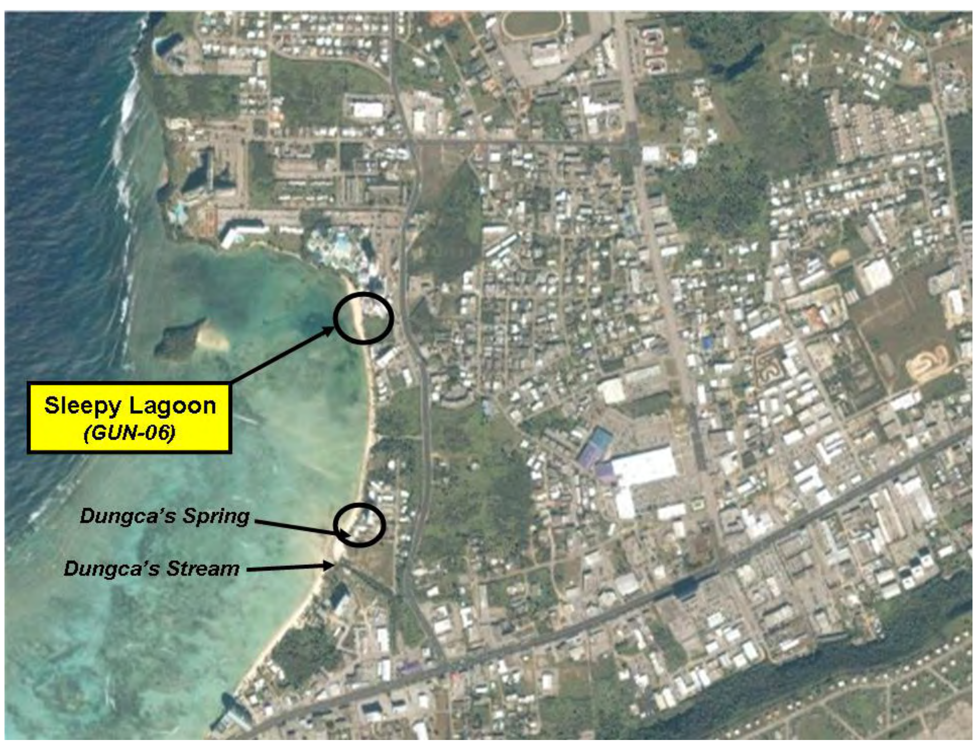

Figure 8-81. Air photo of Sleepy Lagoon Beach vicinity.

Figure 8-81 shows an air photo of the area adjacent to Sleepy Lagoon Beach. This provides a different perspective, which highlights the high density of roads and buildings in the area adjacent to Sleepy Lagoon Beach.

In addition to previous assessments and GIS information, Guam EPA staff identified other potential sources that could affect water quality at Sleepy Lagoon Beach. Specifically, there are a number of concerns in the vicinity of Dungca's Beach described in Section 8.10. These potential source areas, under the right wind and tide conditions, could also have an adverse effect on water quality at Sleepy Lagoon Beach.

Trends. Figure 8-82 presents a year-by-year summary of the enterococcus data for the Sleepy Lagoon Beach site. This provides a useful way to examine trends relative to both central tendency and annual variation. This type of analysis is useful in looking at specific sites where efforts to address beach advisories have been implemented. For example, a focus on patterns such as trends in geometric means or 90th percentiles provides a visual analysis that can be used to evaluate program effectiveness. With respect to trends, it should be noted that a laboratory analytical method change occurred in September 2000. The IDEXX test was used to determine enterococcus concentrations on all samples collected after September 2000.

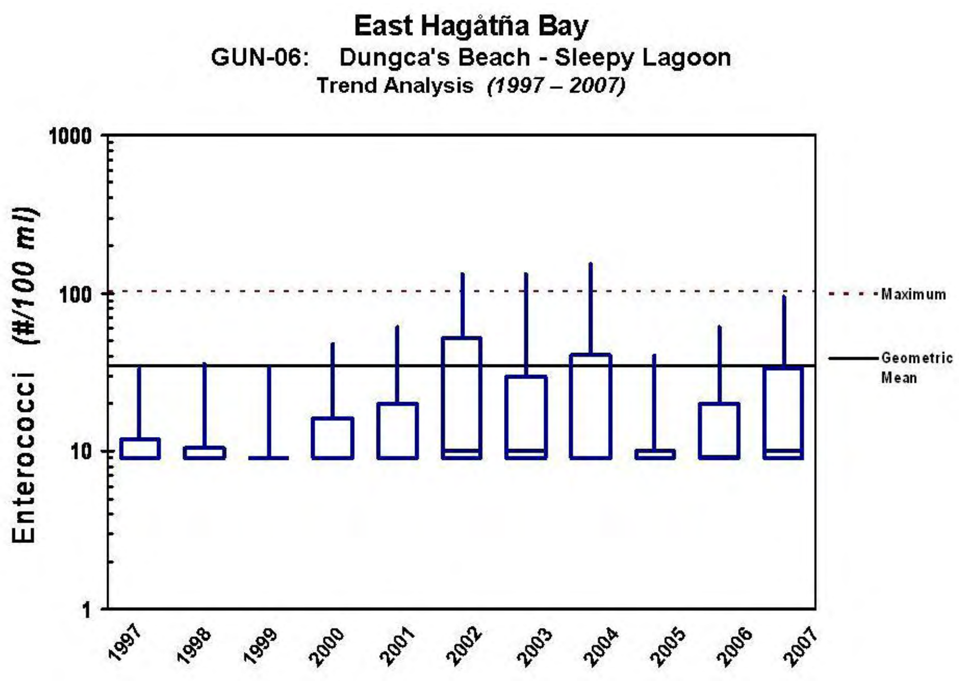

Figure 8-82. Trend analysis for Sleepy Lagoon Beach site.

Linkage Analysis. The numeric target for this TMDL is Guam's concentration-based criteria for enterococci bacteria (i.e., a geometric mean of 35 counts / 100 mL and an instantaneous maximum of 104 counts / 100 mL). The relationship between this target and potential sources at Sleepy Lagoon Beach is demonstrated through an analysis of water quality monitoring data at this site. Seasonal patterns, for example, show that the highest concentrations are observed between July and March, indicating the importance of both wet and dry season sources at Sleepy Lagoon Beach. This is consistent with the presence of potential storm water sources identified at this location.

The connection between storm water sources and exceedances of numeric targets is further confirmed by examining the effect of flow conditions. At Sleepy Lagoon Beach, the highest bacteria concentrations occur under high flows. Water quality conditions that reflect this pattern are strongly influenced by storm water runoff during heavy rainfall events. In short, the technical analyses presented in this assessment of Sleepy Lagoon Beach describe the relationship between water quality patterns and potential sources at this location. The loading capacity and allocations are all concentrations set at the criteria values for enterococci bacteria. This TMDL will clearly meet water quality standards and protect recreational uses at this beach.

TMDL Components. Table 8-27 presents the TMDL for Sleepy Lagoon Beach, identifying the loading capacity and allocations expressed as concentration-based values for enterococcus. These concentration-based values apply across all flow zones. This TMDL uses an implicit MOS, through inclusion of two conservative assumptions. First, the TMDL does not account for mixing in the receiving waters and assumes that zero dilution is available. Second, the goal of attaining standards at the point of discharge does not account for losses due to die-off and settling of indicator bacteria that are known to occur.

Table 8-27. Northern Guam Watershed TMDL summary *(Site GUN-06: Sleepy Lagoon Beach)*.

TMDL Component	Enterococcus Concentration *(# / 100 mL)*
Geometric Mean	
TMDL	**35**
Future Growth	35
Waste Load Allocation	35
Load Allocation	35
Instantaneous Maximum	
TMDL	**104**
Future Growth	104
Waste Load Allocation	104
Load Allocation	104

A hydrology-based framework using duration curve zones allows the TMDL to evaluate monitoring data in a way that reflects major watershed processes indicative of different flows. This approach enables numeric targets in the TMDL to consider watershed processes, such as hydrology and source assessment information including land use.

Table 8-28 identifies reductions for each duration curve zone by season using the TMDL targets. These estimates can serve to guide problem solving discussions on appropriate management strategies (based on knowledge associated with likely source areas, delivery mechanisms, and appropriate control measures that correspond to particular hydrologic conditions).

Table 8-28. Needed reductions to meet TMDL targets *(Site GUN-06: Sleepy Lagoon Beach)*.

Needed Reductions	**Flow Conditions** *(expressed as percentage)*				
	High	**Moist**	**Mid**	**Dry**	**Low**
Dry Season					
Based on geometric mean	44%	---	---	---	---
Based on instantaneous maximum	95%	---	---	---	---
Wet Season					
Based on geometric mean	36%	---	---	---	---
Based on instantaneous maximum	81%	---	---	10%	---

8.10 Dungca's Beach (GUN-07)

Dungca's Beach is situated along the northern coast of the East Hagåtña Bay beach front *(Figure 8-83)*. It is a very popular destination for water sports including banana boat rides, parasailing, kayaking, and jet skiing. Several hotels are located along the shoreline to the north and south of Dungca's Beach. The upland area to the east of Dungca's Beach is predominantly residential with some commercial business along main roads.

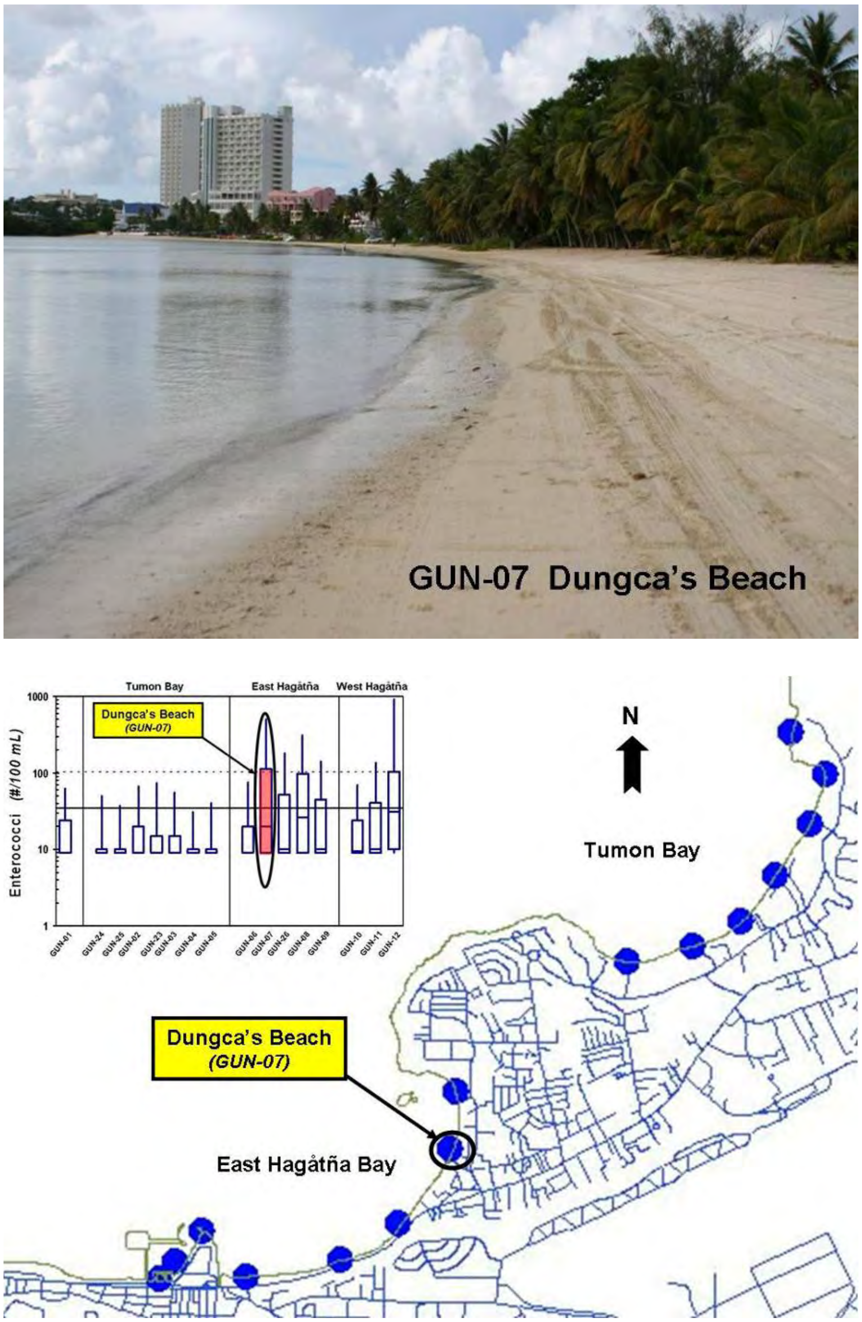

Figure 8-83. Location of Dungca's Beach relative to other Northern Guam TMDL sites.

The frequency of beach advisories at Dungca's Beach between 1997 and 2007 was very high (55%) compared to other RBMP sites in the Northern Beach TMDL project area *(Figure 4-1)*. Enterococci concentrations at Dungca's Beach were also quite high compared to other project area monitoring stations *(Figure 4-2 and Figure 8-83)*. The geometric mean of all individual samples was 38 counts /100mL, while the 75th and 90th percentiles were 112 and 506 counts /100 mL respectively.

A key part of the data analysis for individual beaches is to examine water quality patterns by season and relative to flow conditions (e.g., runoff dominated versus base flows). Figure 8-84 shows the seasonal variability of bacteria concentrations at Dungca's Beach. High concentrations were observed all year, indicating the importance of both wet and dry season sources at Dungca's Beach.

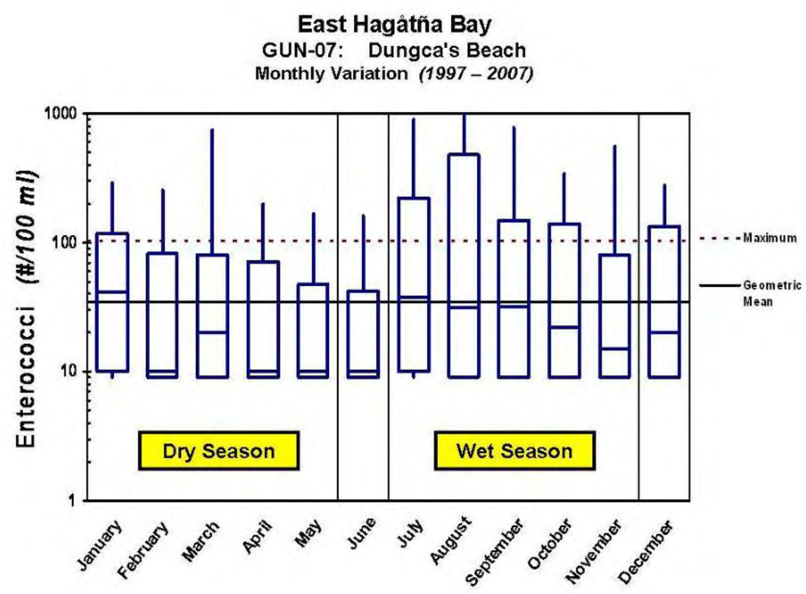

Figure 8-84. Seasonal variation at Dungca's Beach.

Effect of Flow Conditions. A useful approach for relating water quality information to potential source areas is to examine bacteria levels in terms of hydrologic conditions. Figure 8-85 shows enterococci monitoring data collected at Dungca's Beach using a duration curve framework. Although there is significant variability in the data, which is characteristic of bacteria monitoring information, a definite pattern exists.

As indicated by the *"box and whisker"* plots in Figure 8-85, the highest bacteria concentrations occur under high flow conditions. This is not unexpected because water quality at most beaches is strongly influenced by storm water runoff during heavy rainfall events. The magnitude of the increase is significantly higher than that observed at other Northern Guam RBMP sites. In fact, the geometric mean exceeded the criterion under both high flow and moist conditions, which indicates the need to address storm water sources. This concern is reinforced by the fact that over 60 percent of all values in the high flow zone and 30 percent of all values in the moist zone exceed the instantaneous maximum criterion value. Furthermore, the 90th percentile exceeds the instantaneous maximum criterion value across all zones, indicating that sources other than storm water are adversely affecting bacteria concentrations at Dungca's Beach.

Incorporating seasonality into the analysis allows a closer look at patterns that may be associated with certain source categories. For example, bacteria delivered through seeps connected to storm water ponds are more likely to affect beach monitoring data during the wet season. In contrast, bacteria contributed from more continuous sources (e.g., leaky sewer lines or failing septics) will exert a greater effect during the dry season. Comparisons between the geometric means, the 75th and 90th percentiles for each duration curve zone serve as primary measures for examining seasonality. This is illustrated in Figure 8-86.

The effect of storm water runoff is evident for both the wet and dry seasons under high flow and moist conditions. One noteworthy observation is the elevated dry season geometric mean and 90th percentile under high flow conditions. This could be due to bacteria sources associated with overland flow and storm water ponding basins. High flows in the dry season tend to be primarily influenced by storm events. In contrast, high flows during the wet season result from a combination of storm events and more saturated groundwater conditions.

Relationship to Other Indicators. In addition to seasonal patterns, the relationship of bacteria concentrations to other parameters can be incorporated into the data analysis. Guam EPA staff noted field data for several indicators at the time of bacteria sample collection as part of the RBMP. These include observations such as tidal stage and presence or absence of turbidity.

The combination of patterns with some of these observations could be related to potential source areas and delivery mechanism that might affect bacteria concentrations at any particular beach of interest. For example, the presence or absence of turbidity may also be an indicator of either storm water runoff or suspended material associated with wind action. This approach to the analysis provides information that might prove useful in guiding implementation efforts intended to address documented problems.

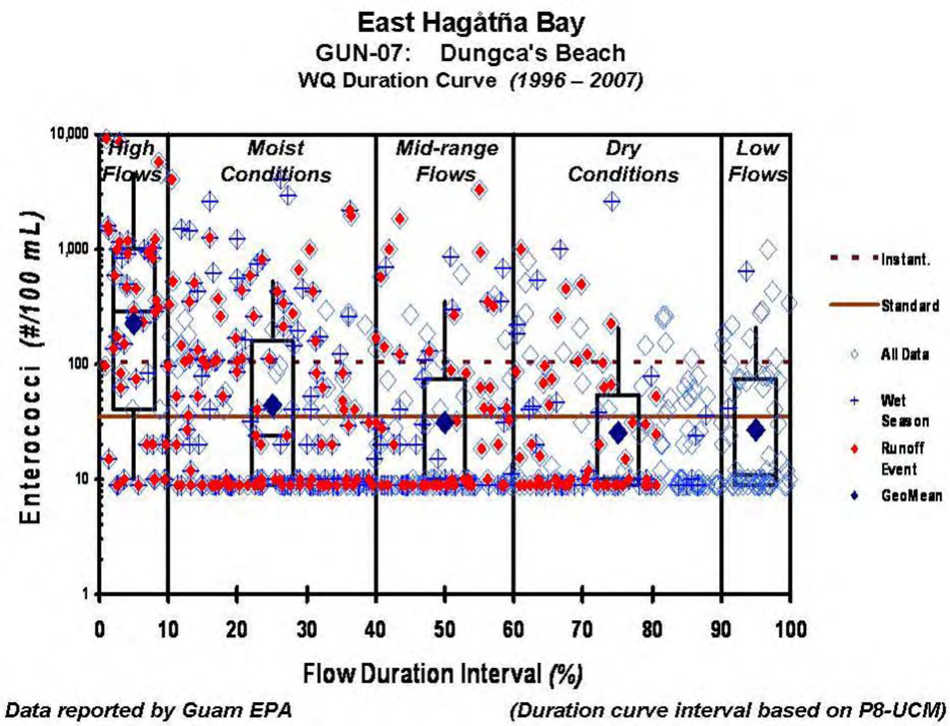

Figure 8-85. Water quality duration curve for Dungca's Beach site.

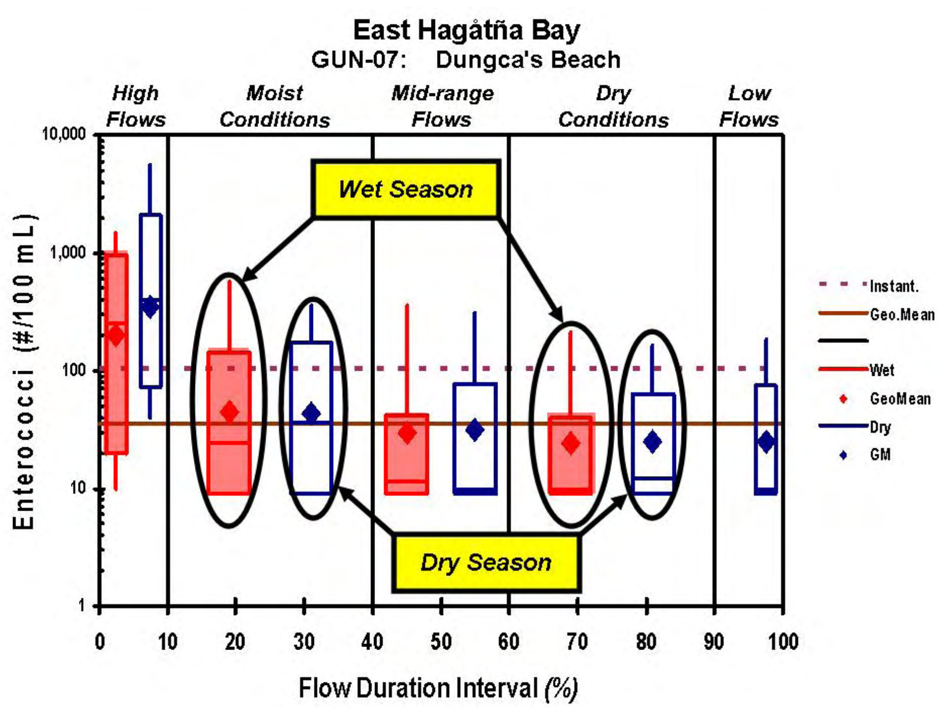

Figure 8-86. Wet versus dry season comparison for Dungca's Beach.

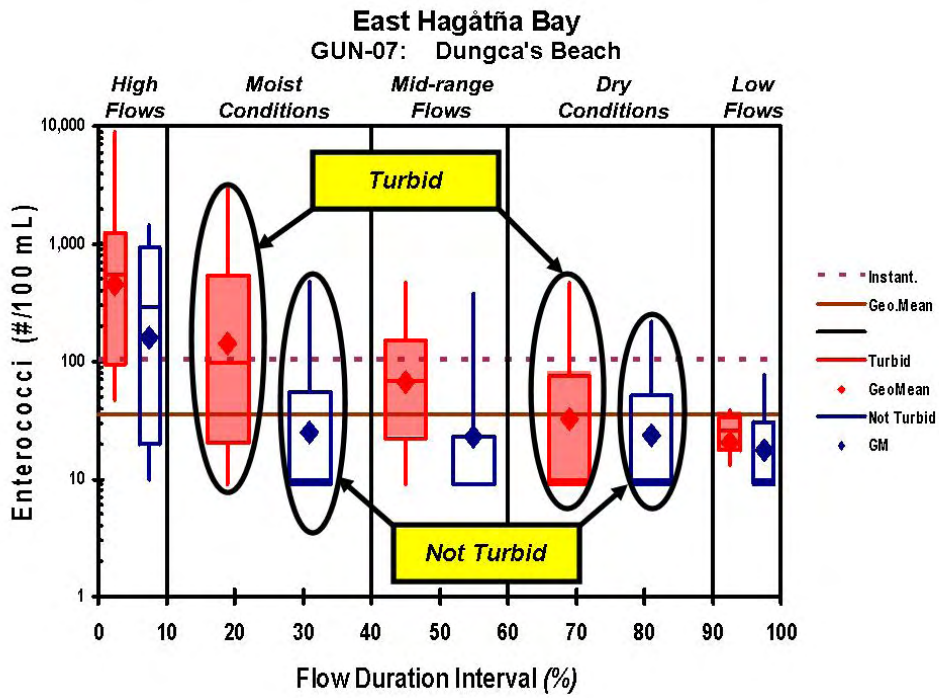

Figure 8-87. Turbid versus non-turbid sample comparison for Dungca's Beach site.

Figure 8-87 shows the difference between bacteria levels when turbidity was present or absent during sample collection under the various flow conditions. The increased levels when turbidity was present under high, moist, and mid-range flow conditions likely reflects the effect of bacteria transported with fine particles during storm events. The effect of bacteria associated with resuspension of bottom sediments might also be the result of wind and wave action, which could affect beach water quality.

Potential Sources. The Source Assessment (Section 5, Table 5-2) summarized potential sources that may affect bacteria concentrations at Dungca's Beach. Included are wastewater sources (septic systems, sewer line blockages & breaks, SSO), storm water (overland runoff; highway, road, & bridge runoff), and other sources (recreation & tourism activities). In addition, GEPA staff identified specific potential sources that could affect water quality at Dungca's Beach *(Table 8-29)*.

Table 8-29. Beach specific potential source summary *(Site GUN-07: Dungca's Beach)*.

Site ID	Type	Source Name *(notes)*
GUN-07	Storm drain runoff	Dungca's River - an open Storm Drain *This system drains runoff from Marine Drive from Airport Road.*
		Guam Premier Outlet (GPO) storm water *Runoff from GPO drains to Marine Drive and out Dungca's River/open storm drain.*
		Ben Franklin *Pipe drains to Dungca's River / open storm drain.*
		Harmon Sinkhole *Guam International Airport Authority storm water flows to Harmon Sinkhole via concrete channel (includes failing oil / water separator).*
	Sewage overflow	Manhole- sewer overflow • *via Dungca's River / open storm drain.* • *Frequent overflows to storm drain leading to East Hagåtña Bay.*
		Manhole- sewer overflow *(5 locations)* *via Marine Drive Storm drainage to Dungca's River / open storm drain.*
		Manhole- sewer overflow *(2 locations)* *Near airport in Tiyan housing Lower E. Sunset Road.*
		GWA sewer main lines inadequate slope (east to Rt 30 intersection) *Inadequate slope of road results in grit accumulation and sewer overflows.*
		Bayside sewage Pump Station
		Tiyan 2 sewage Pump Station *Near airport in Tiyan housing Lower E. Sunset Road.*
		Harmon Sinkhole *Receives sewage overflow from Mamajanao Pump Station.*
	Wastewater	Septic systems *Concentrated number of unsewered buildings in upland area adjacent to beach*
	No on-site drainage	Ocean Jet Club *No on-site drainage at repair shop, no fuel storage containment.*
	Failing oil / water separator	Mark's Motor Repair Shop

Figure 8-88 provides a closer look at the Dungca's Beach monitoring site relative to upland areas that potentially contribute bacteria during storm events. Figure 8-88 includes roads, which can provide a general indication of the urban drainage network and accompanying storm drains. Figure 8-88 also identifies major storm water ponding basins, including the Harmon Sink.

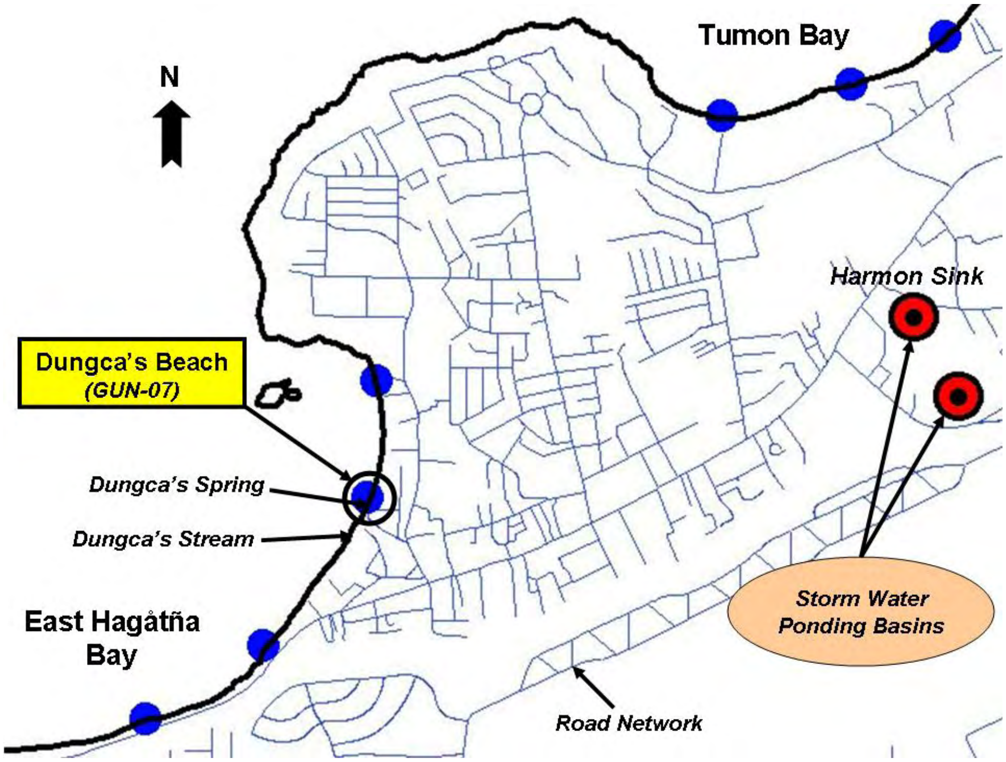

Figure 8-88. Location of Dungca's Beach relative to potential upland storm water source areas.

A review of GIS information shows a number of unsewered buildings in the upland area adjacent to Dungca's Beach. This information is shown in Figure 8-89. In addition, sewer line blockages and breaks, as well as SSOs could contribute to elevated bacteria levels under these conditions. Figure 8-89 shows the location of both sewer mains and pump stations. Figure 8-90 shows an air photo of the area adjacent to Dungca's Beach. This provides a different perspective, which highlights the high density of roads and buildings in the area adjacent to Dungca's Beach.

The source assessment (Section 5.3) discussed the potential effect of seepage from storm water ponding basins and infiltration chambers on beach water quality. The Harmon Sink, which collects storm water from a surrounding industrial park and adjacent airport, is of particular concern. There has been concern that contaminants entering the Sink may be carried to recreational beaches by groundwater discharging in the coastal zone.

Dye receptors in the WERI study were placed at seeps and springs in both East Hagåtña and Tumon Bays. Dye from the Harmon Sink surface injection was detected earliest at two locations on East Hagåtña Bay near Dungca's Beach: Dungca's Stream and Dungca's Spring (just north of Dungca's Stream). The study hypothesized that the relatively fast transport to East Hagåtña Bay is controlled by relatively open, regional-scale fracture pathways.

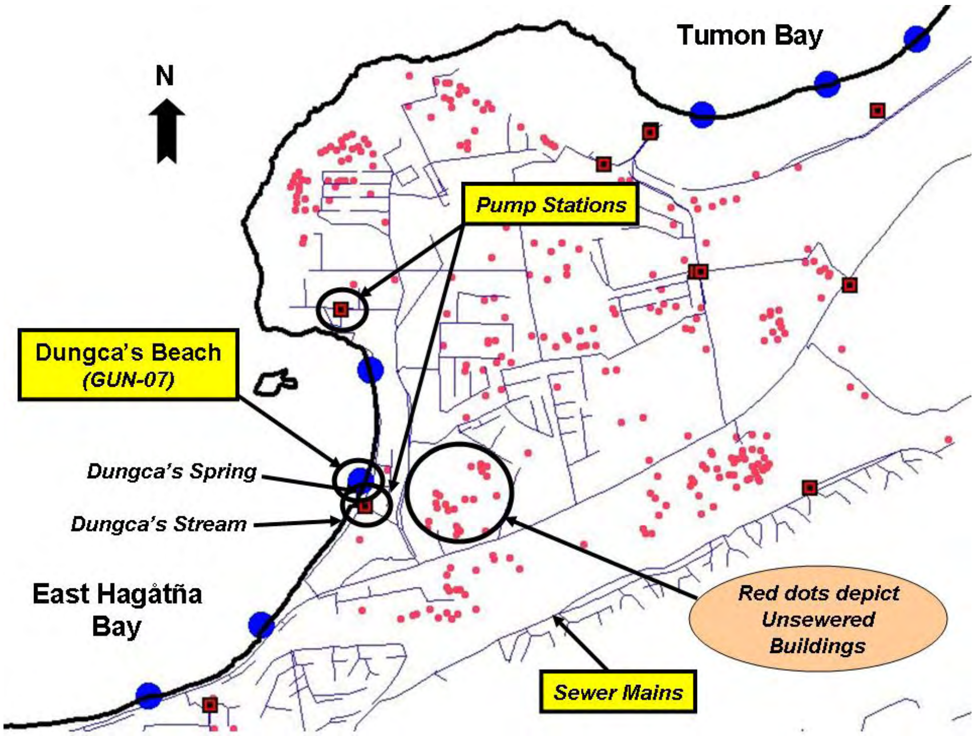

Figure 8-89. Location of Dungca's Beach relative to potential unsewered buildings.

Figure 8-90. Air photo of Dungca's Beach vicinity.

In addition to previous assessments and GIS information, Guam EPA staff identified other potential sources that could affect water quality at Dungca's Beach. Specifically, there are a number of manholes that have had sewage overflow problems, which may be affecting water quality at this site. Many of these overflows discharge to Dungca's Stream, ultimately causing an adverse effect on water quality at Dungca's Beach.

The Bayside Pump Station *(Figure 8-89)* is located nearby. There has been occasional sewage overflows associated with this facility, which would also explain elevated bacteria concentrations at this location. Furthermore, two GPA sewer mains are situated such that, inadequate slope results in grit accumulation and sanitary sewer overflows (SSOs) that may affect water quality at this location. Finally, storm drains from several commercial locations channel storm water to Dungca's Stream and East Hagåtña Bay; another potential source of problems at Dungca's Beach.

Trends. Figure 8-91 presents a year-by-year summary of the enterococcus data for the Dungca's Beach site. This provides a useful way to examine trends relative to both central tendency and annual variation. This type of analysis is useful in looking at specific sites where efforts to address beach advisories have been implemented. For example, a focus on patterns such as trends in geometric means or 90th percentiles provides a visual analysis that can be used to evaluate program effectiveness. With respect to trends, it should be noted that a laboratory analytical method change occurred in September 2000. The IDEXX test was used to determine enterococcus concentrations on all samples collected after September 2000.

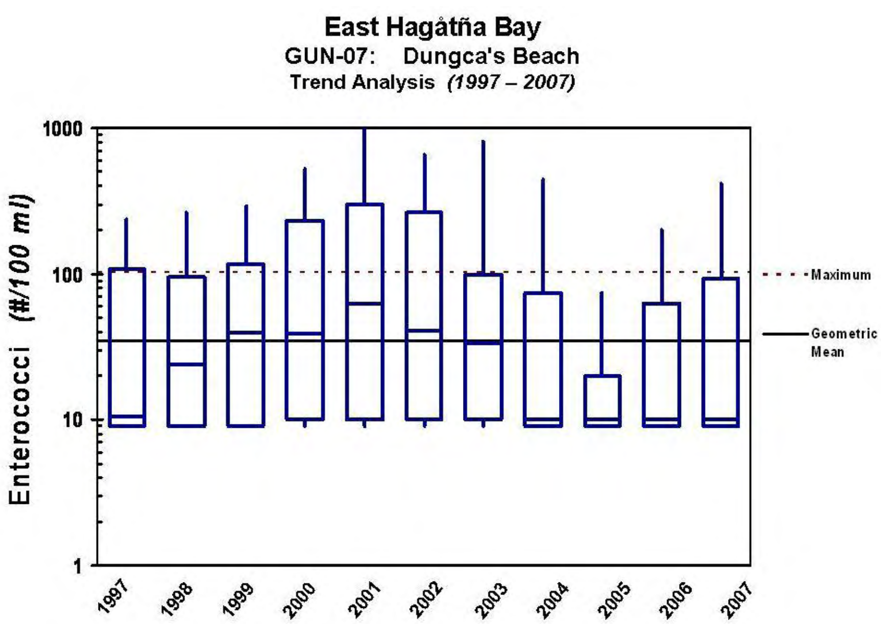

Figure 8-91. Trend analysis for Dungca's Beach site.

Linkage Analysis. The numeric target for this TMDL is Guam's concentration-based criteria for enterococci bacteria (i.e., a geometric mean of 35 counts / 100 mL and an instantaneous maximum of 104 counts / 100 mL). The relationship between this target and potential sources at Dungca's Beach is demonstrated through an analysis of water quality monitoring data at this site. Seasonal patterns, for example, show that the high concentrations are observed all year, indicating the importance of both wet and dry season sources at Dungca's Beach. This is consistent with the presence of potential storm water sources identified at this location.

The connection between storm water sources and exceedances of numeric targets is further confirmed by examining the effect of flow conditions. At Dungca's Beach, the highest bacteria concentrations occur under high flows. Water quality conditions that reflect this pattern are strongly influenced by storm water runoff during heavy rainfall events. In short, the technical analyses presented in this assessment of Dungca's Beach describe the relationship between water quality patterns and potential sources at this location. The loading capacity and allocations are all concentrations set at the criteria values for enterococci bacteria. This TMDL will clearly meet water quality standards and protect recreational uses at this beach.

TMDL Components. Table 8-30 presents the TMDL for Dungca's Beach, identifying the loading capacity and allocations expressed as concentration-based values for enterococcus. These concentration-based values apply across all flow zones. This TMDL uses an implicit MOS, through inclusion of two conservative assumptions. First, the TMDL does not account for mixing in the receiving waters and assumes that zero dilution is available. Second, the goal of attaining standards at the point of discharge does not account for losses due to die-off and settling of indicator bacteria that are known to occur.

Table 8-30. Northern Guam Watershed TMDL summary *(Site GUN-07: Dungca's Beach)*.

TMDL Component	Enterococcus Concentration *(# / 100 mL)*
Geometric Mean	
TMDL	**35**
Future Growth	35
Waste Load Allocation	35
Load Allocation	35
Instantaneous Maximum	
TMDL	**104**
Future Growth	104
Waste Load Allocation	104
Load Allocation	104

A hydrology-based framework using duration curve zones allows the TMDL to evaluate monitoring data in a way that reflects major watershed processes indicative of different flows. This approach enables numeric targets in the TMDL to consider watershed processes, such as hydrology and source assessment information including land use.

Table 8-31 identifies reductions for each duration curve zone by season using the TMDL targets. These estimates can serve to guide problem solving discussions on appropriate management strategies (based on knowledge associated with likely source areas, delivery mechanisms, and appropriate control measures that correspond to particular hydrologic conditions).

Table 8-31. Needed reductions to meet TMDL targets *(Site GUN-07: Dungca's Beach)*.

Needed Reductions	**Flow Conditions** *(expressed as percentage)*				
	High	**Moist**	**Mid**	**Dry**	**Low**
Dry Season					
Based on geometric mean	90%	20%	---	---	---
Based on instantaneous maximum	98%	71%	67%	37%	43%
Wet Season					
Based on geometric mean	82%	20%	---	---	---
Based on instantaneous maximum	93%	82%	71%	51%	---

8.11 Alupang Towers Beach (GUN-26)

Alupang Towers Beach is along the southern edge of East Hagåtña Bay *(Figure 8-92)*. It is at the eastern end of the long strip of beach along Marine Drive that continues to Paseo Beach Park. The beach is situated adjacent to the Alupang Towers Hotel. It is a popular destination for water activities including parasailing, kayaking, and jet skiing. The upland area to the east of the beach is predominantly residential with some commercial business along main roads.

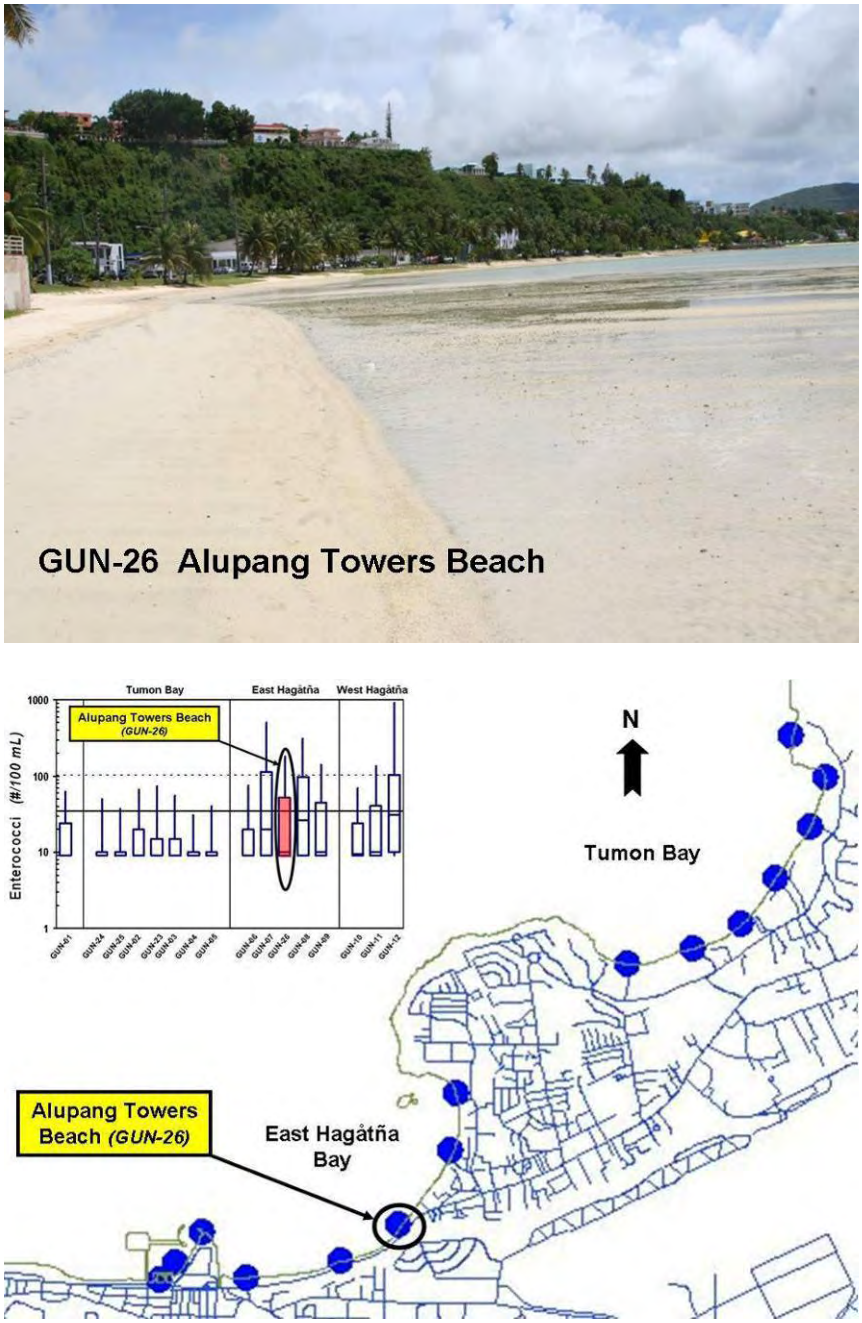

Figure 8-92. Location of Alupang Towers Beach relative to other Northern Guam TMDL sites.

The frequency of beach advisories at Alupang Towers Beach between 2005 and 2007 was relatively high (37%) compared to other RBMP sites in the Northern Beach TMDL project area *(Figure 4-1)*. Enterococci concentrations at Alupang Towers Beach were also higher than other project area monitoring stations *(Figure 4-2 and Figure 8-92)*. The geometric mean of all individual samples was 26 counts /100mL, while the 75th and 90th percentiles were 52 and 180 counts /100 mL respectively.

A key part of the data analysis for individual beaches is to examine water quality patterns by season and relative to flow conditions (e.g., runoff dominated versus base flows). Figure 8-93 shows the seasonal variability of bacteria concentrations at Alupang Towers Beach. The highest concentrations were observed between July and March, indicating the importance of both wet and dry season sources at Alupang Towers Beach.

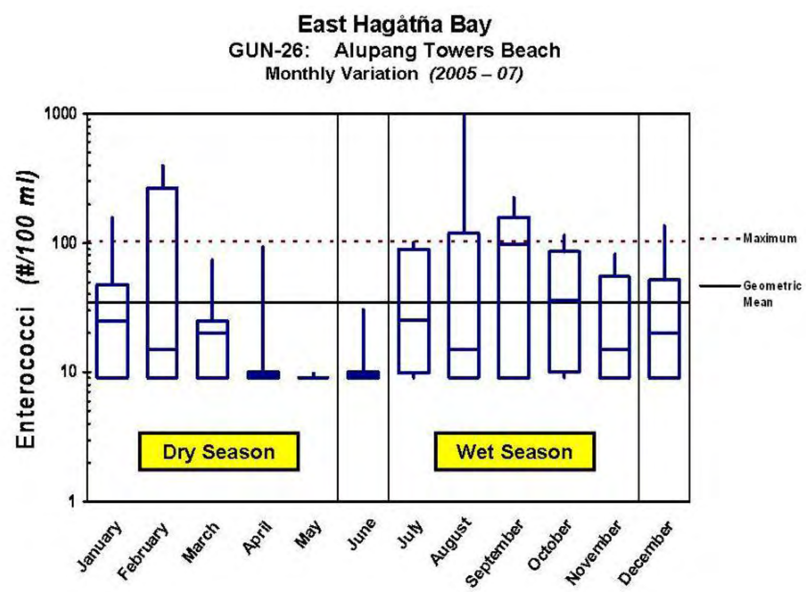

Figure 8-93. Seasonal variation at Alupang Towers Beach.

Effect of Flow Conditions. A useful approach for relating water quality information to potential source areas is to examine bacteria levels in terms of hydrologic conditions. Figure 8-94 shows enterococci monitoring data collected at Alupang Towers Beach using a duration curve framework. Although there is significant variability in the data, which is characteristic of bacteria monitoring information, a definite pattern exists.

As indicated by the *"box and whisker"* plots in Figure 8-94, the highest bacteria concentrations occur under high flow conditions. This is not unexpected because water quality at most beaches is strongly influenced by storm water runoff during heavy rainfall events. The magnitude of the increase is higher than that observed at other Northern Guam RBMP sites. In fact, the geometric mean

exceeded the criterion under high flow conditions, which indicates the need to address storm water sources. This concern is reinforced by the fact that over 30 percent of all values in the high flow zone exceed the instantaneous maximum criterion value. Furthermore, the 90th percentile exceeds the instantaneous maximum criterion value across all zones except low flows, indicating that sources other than storm water are adversely affecting bacteria concentrations at Alupang Towers Beach.

Incorporating seasonality into the analysis allows a closer look at patterns that may be associated with certain source categories. For example, bacteria delivered through seeps connected to storm water ponds are more likely to affect beach monitoring data during the wet season. In contrast, bacteria contributed from more continuous sources (e.g., leaky sewer lines or failing septics) will exert a greater effect during the dry season. Comparisons between the geometric means, the 75th and 90th percentiles for each duration curve zone serve as primary measures for examining seasonality. This is illustrated in Figure 8-95.

The patterns observed for both wet and dry seasons in the moist and mid-range zones are quite similar. Storm water and other sources appear to have approximately the same effect under those conditions at Alupang Towers Beach. However, the difference between the wet and dry season patterns under dry conditions is noteworthy. The higher wet season values in the dry zone indicate the potential for seeps connected to storm water sources to be affecting water quality at this site.

<u>Relationship to Other Indicators.</u> In addition to seasonal patterns, the relationship of bacteria concentrations to other parameters can be incorporated into the data analysis. Guam EPA staff noted field data for several indicators at the time of bacteria sample collection, such as tidal stage and presence or absence of turbidity. The combination of patterns with some of these observations could be related to potential source areas and delivery mechanism that might affect bacteria concentrations at any particular beach of interest. For example, the presence or absence of turbidity may also be an indicator of either storm water runoff or suspended material associated with wind action.

This approach to the analysis provides information that might prove useful in guiding implementation efforts intended to address documented problems. Figure 8-96 shows the difference between bacteria levels when turbidity was present or absent during sample collection under the various flow conditions. The increased levels when turbidity was present under high, moist, and mid-range flow conditions likely reflects the effect of bacteria transported with fine particles during storm events. The effect of bacteria associated with resuspension of bottom sediments might also be the result of wind and wave action, which could affect beach water quality.

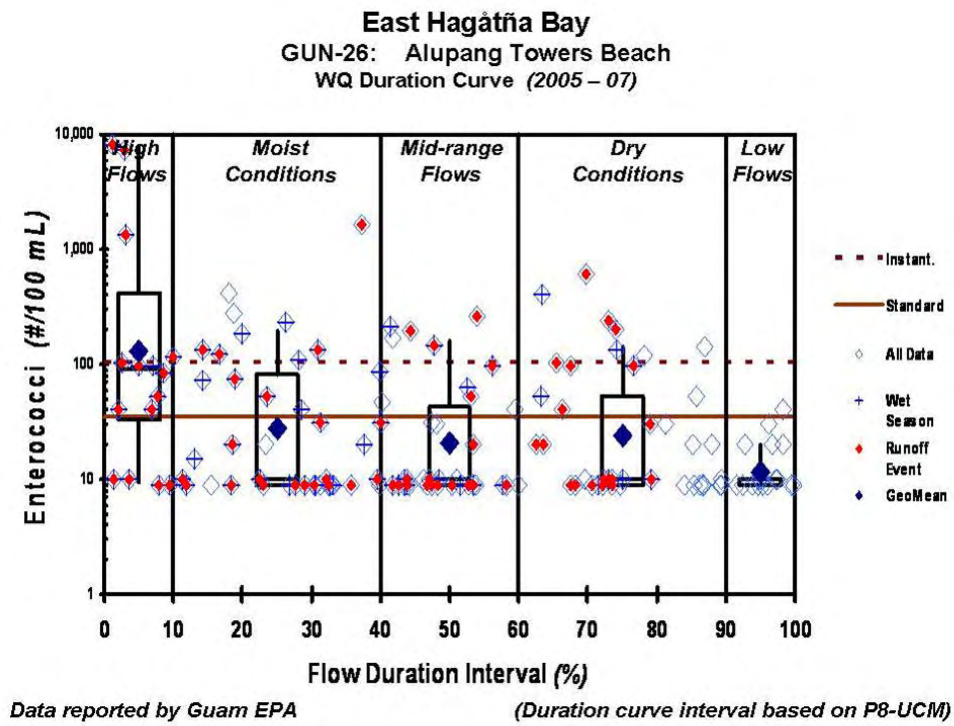

Figure 8-94. Water quality duration curve for Alupang Towers Beach site.

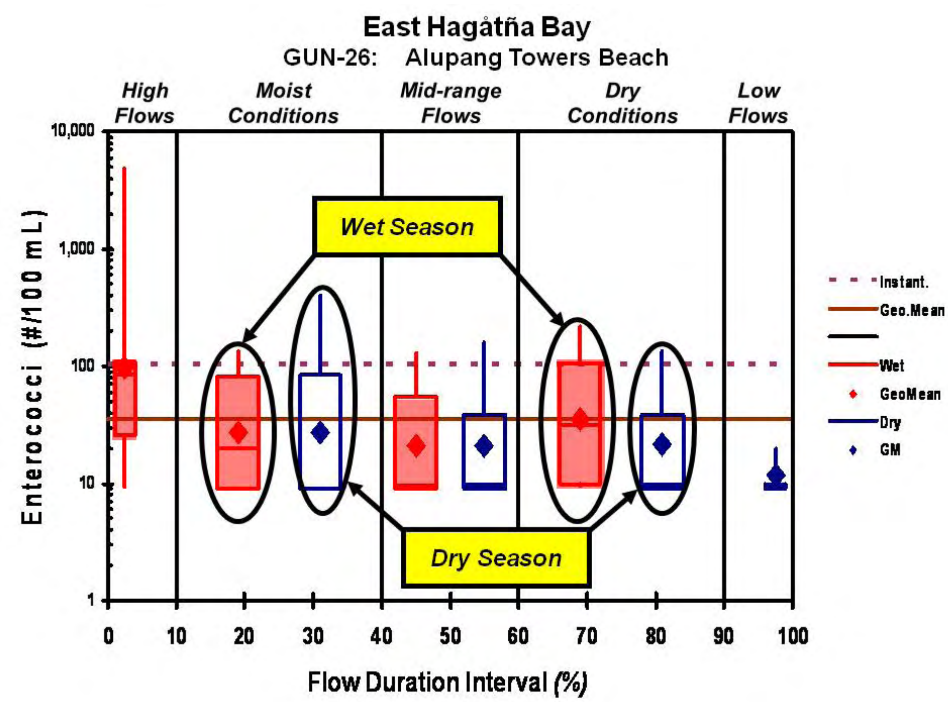

Figure 8-95. Wet versus dry season comparison for Alupang Towers Beach.

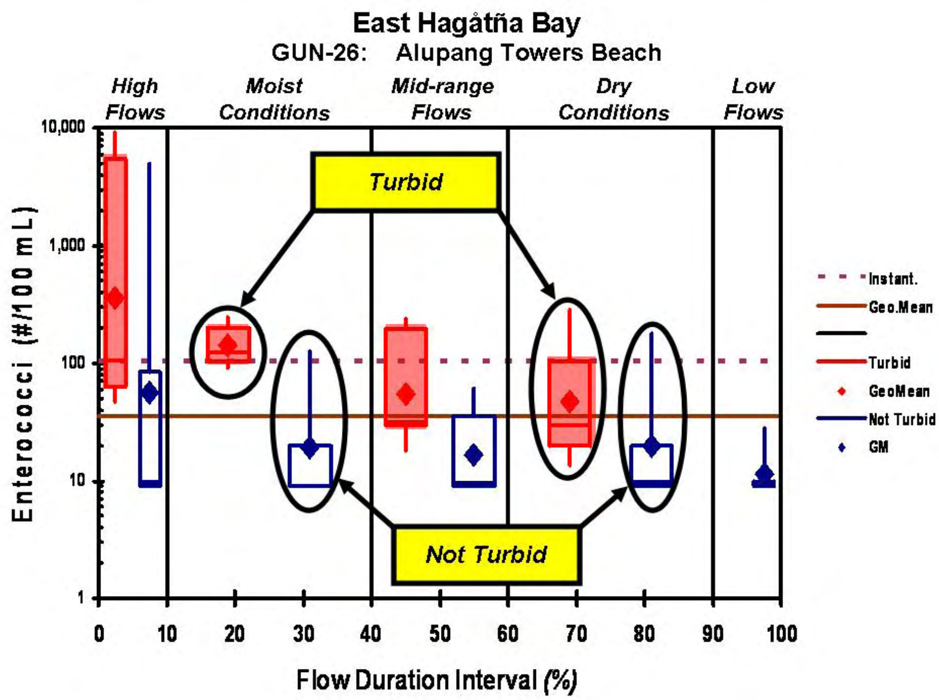

Figure 8-96. Turbid versus non-turbid sample comparison for Alupang Towers Beach site.

Potential Sources. The Source Assessment (Section 5, Table 5-2) summarized potential sources that may affect bacteria concentrations at Alupang Towers Beach. Included are wastewater sources (septic systems, sewer line blockages & breaks, SSO), storm water (overland runoff; highway, road, & bridge runoff), and other sources (recreation & tourism activities). In addition, GEPA staff identified specific potential sources that could affect water quality at Alupang Towers Beach *(Table 8-32)*.

Table 8-32. Beach specific potential source summary *(Site GUN-26: Alupang Towers Beach)*.

Site ID	Type	Source Name ***(notes)***
GUN-26	Storm drain runoff	DPW storm drain *Storm drain for Tiyan and airport area.*
		Harmon Sinkhole *Guam International Airport Authority storm water flows to Harmon Sinkhole via concrete channel (includes failing oil / water separator).*
	No on-site drainage	Ocean Jet Club *No on-site drainage at repair shop, no fuel storage containment.*
	Wastewater	Septic systems *Concentrated number of unsewered buildings in upland area adjacent to beach*
	Sewage overflow	GWA sewer main lines inadequate slope *Inadequate slope of road results in grit accumulation and sewer overflows.*
		Manhole- sewer overflow • *Overflows to ground. Located in housing behind Tiyan Guam Police Dept.* • *Frequent overflows to storm drain leading to East Hagåtña Bay.*
		Harmon Sinkhole *Receives sewage overflow from Mamajanao Pump Station.*

Figure 8-97 provides a closer look at the Alupang Towers Beach monitoring site relative to upland areas that potentially contribute bacteria during storm events. Figure 8-97 includes roads, which can provide a general indication of the urban drainage network and accompanying storm drains. Figure 8-97 also identifies major storm water ponding basins, including the Harmon Sink.

A review of GIS information shows a number of unsewered buildings in the upland area adjacent to Alupang Towers Beach. This information is shown in Figure 8-98. In addition, sewer line blockages and breaks, as well as SSOs could contribute to elevated bacteria levels. Figure 8-98 shows the location of both sewer mains and pump stations, as indicators of potential water quality problems associated with wastewater conveyance systems.

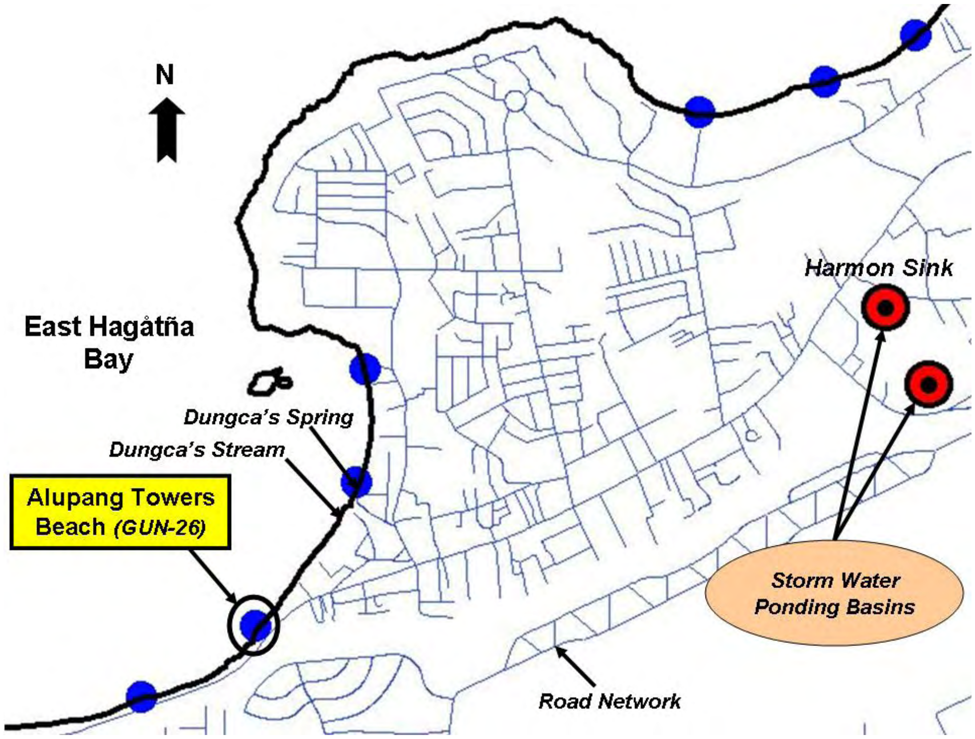

Figure 8-97. Location of Alupang Towers Beach relative to potential source areas.

Figure 8-99 shows an air photo of the area adjacent to Alupang Towers Beach. This provides a different perspective, which highlights the high density of roads and buildings in the area adjacent to Alupang Towers Beach.

In addition to previous assessments and GIS information, Guam EPA staff identified other potential sources that could affect water quality at Alupang Towers Beach. Specifically, there are a number of concerns in the vicinity of Dungca's Beach described in Section 8.10 including seepage from Harmon Sink. These potential source areas, under the right wind and tide conditions, could have an adverse effect on water quality at Alupang Towers Beach.

Furthermore, two GPA sewer mains are situated such that, inadequate slope results in grit accumulation and sanitary sewer overflows (SSOs) that may affect this location. There is also a major DPW storm drain that channels runoff from Tiyan and the airport area to a discharge point close to Trinchera Beach. Storm water from this drain may influence bacteria concentrations at this site. Lastly, there is a manhole that has had sewage overflow problems, which may be affecting water quality at this site.

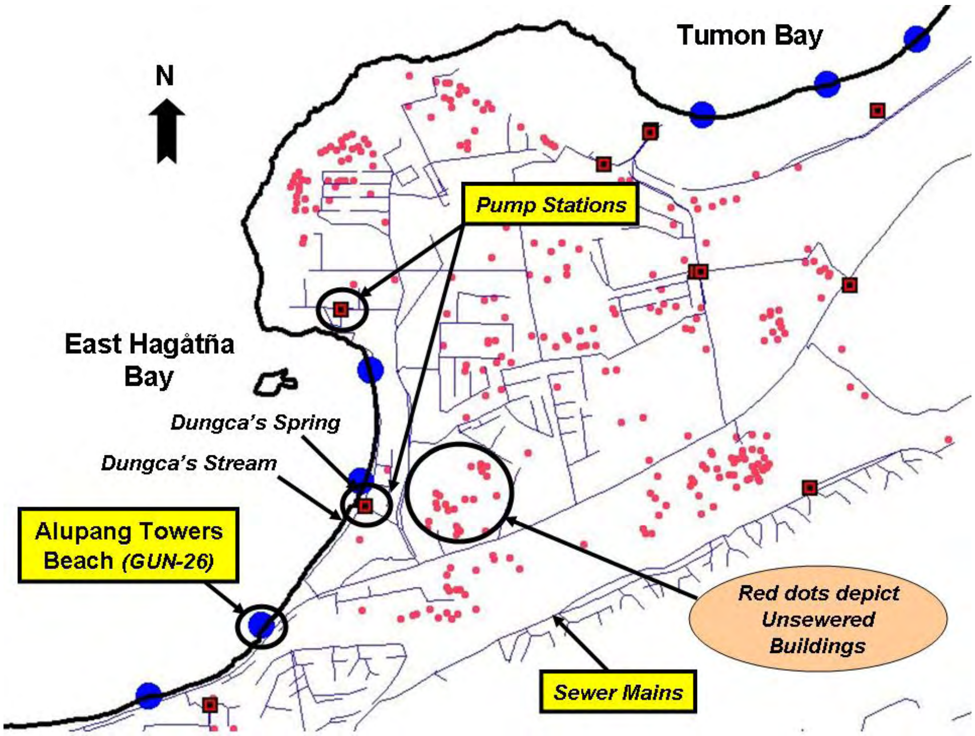

Figure 8-98. Location of Alupang Towers Beach relative to potential unsewered buildings.

Figure 8-99. Air photo of Alupang Towers Beach vicinity.

Trends. Figure 8-100 presents a year-by-year summary of the enterococcus data for the Alupang Towers Beach site. This provides a useful way to examine trends relative to both central tendency and annual variation. This type of analysis is useful in looking at specific sites where efforts to address beach advisories have been implemented. For example, a focus on patterns such as trends in geometric means or 90th percentiles provides a visual analysis that can be used to evaluate program effectiveness. With respect to trends, it should be noted that a laboratory analytical method change occurred in September 2000. The IDEXX test was used to determine enterococcus concentrations on all samples collected after September 2000.

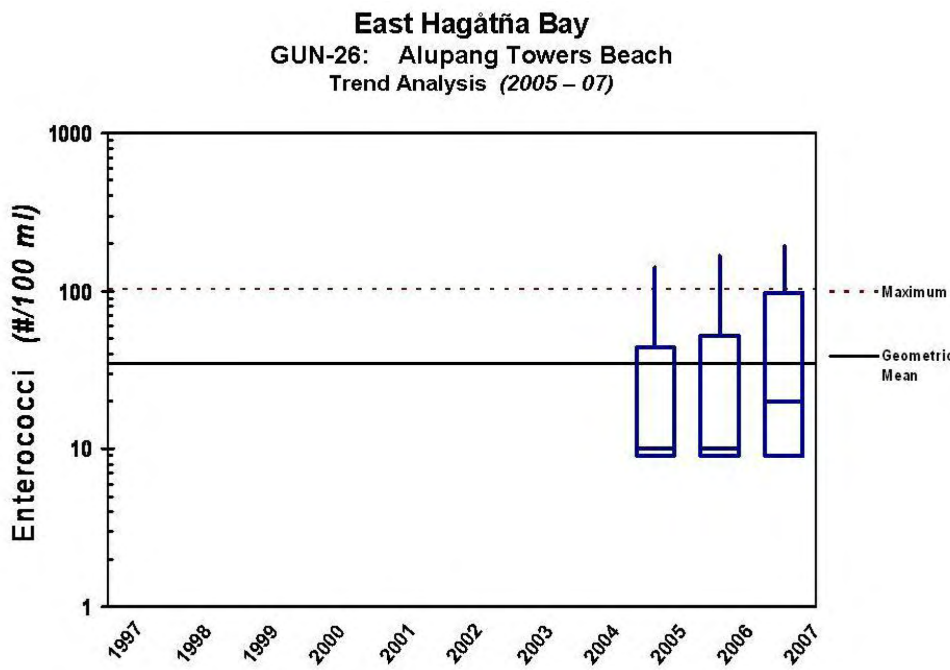

Figure 8-100. Trend analysis for Alupang Towers Beach site.

Linkage Analysis. The numeric target for this TMDL is Guam's concentration-based criteria for enterococci bacteria (i.e., a geometric mean of 35 counts / 100 mL and an instantaneous maximum of 104 counts / 100 mL). The relationship between this target and potential sources at Alupang Towers Beach is demonstrated through an analysis of water quality monitoring data at this site. Seasonal patterns, for example, show that the highest concentrations are observed between July and March, indicating the importance of both wet and dry season sources at Alupang Towers Beach. This is consistent with the presence of potential storm water sources identified at this location.

The connection between storm water sources and exceedances of numeric targets is further confirmed by examining the effect of flow conditions. At Alupang Towers Beach, the highest bacteria concentrations occur under high flows. Water quality conditions that reflect this pattern are strongly influenced by storm water runoff during heavy rainfall events. In short, the technical analyses presented in this assessment of Alupang Towers Beach describe the relationship between water quality patterns and potential sources at this location. The loading capacity and allocations are all concentrations set at the criteria values for enterococci bacteria. This TMDL will clearly meet water quality standards and protect recreational uses at this beach.

TMDL Components. Table 8-33 presents the TMDL for Alupang Towers Beach, identifying the loading capacity and allocations expressed as concentration-based values for enterococcus. These concentration-based values apply across all flow zones. This TMDL uses an implicit MOS, through inclusion of two conservative assumptions. First, the TMDL does not account for mixing in the receiving waters and assumes that zero dilution is available. Second, the goal of attaining standards at the point of discharge does not account for losses due to die-off and settling of indicator bacteria that are known to occur.

Table 8-33. Northern Guam Watershed TMDL summary *(Site GUN-26: Alupang Towers Beach)*.

TMDL Component	Enterococcus Concentration *(# / 100 mL)*
Geometric Mean	
TMDL	**35**
Future Growth	35
Waste Load Allocation	35
Load Allocation	35
Instantaneous Maximum	
TMDL	**104**
Future Growth	104
Waste Load Allocation	104
Load Allocation	104

A hydrology-based framework using duration curve zones allows the TMDL to evaluate monitoring data in a way that reflects major watershed processes indicative of different flows. This approach enables numeric targets in the TMDL to consider watershed processes, such as hydrology and source assessment information including land use.

Table 8-34 identifies reductions for each duration curve zone by season using the TMDL targets. These estimates can serve to guide problem solving discussions on appropriate management strategies (based on knowledge associated with likely source areas, delivery mechanisms, and appropriate control measures that correspond to particular hydrologic conditions).

Table 8-34. Needed reductions to meet TMDL targets *(Site GUN-26: Alupang Towers Beach)*.

Needed Reductions	**Flow Conditions** *(expressed as percentage)*				
	High	**Moist**	**Mid**	**Dry**	**Low**
Dry Season					
Based on geometric mean	---	---	---	---	---
Based on instantaneous maximum	---	74%	34%	23%	---
Wet Season					
Based on geometric mean	64%	---	---	---	---
Based on instantaneous maximum	98%	23%	21%	52%	---

8.12 Trinchera Beach (GUN-08)

Trinchera Beach makes up the southern half of East Hagåtña Bay *(Figure 8-101)*. It is the long strip of beach along Marine Drive between the Alupang Beach Hotel and Paseo Beach Park. The beach is a popular destination for jet skiing, parasailing, and other water vehicle type activities. It is accessed by a number of small parking lots along Marine Drive with pavilions and benches along Marine Drive.

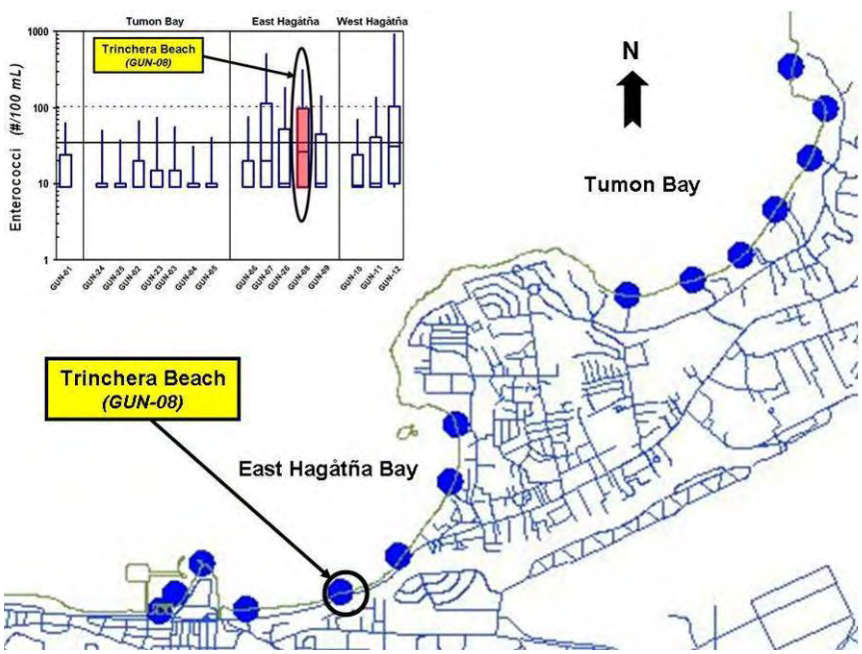

Figure 8-101. Location of Trinchera Beach relative to other Northern Guam TMDL sites.

The frequency of beach advisories at Trinchera Beach between 1997 and 2007 was very high (56%) compared to other RBMP sites in the Northern Beach TMDL project area *(Figure 4-1)*. Enterococci concentrations at Trinchera Beach were also quite high compared to other project area monitoring stations *(Figure 4-2 and Figure 8-101)*. The geometric mean of all individual samples was 37 counts /100mL, while the 75^{th} and 90^{th} percentiles were 97 and 314 counts /100 mL respectively.

A key part of the data analysis for individual beaches is to examine water quality patterns by season and relative to flow conditions (e.g., runoff dominated versus base flows). Figure 8-102 shows the seasonal variability of bacteria concentrations at Trinchera Beach. High concentrations were observed all year, indicating the importance of both wet and dry season sources at Trinchera Beach.

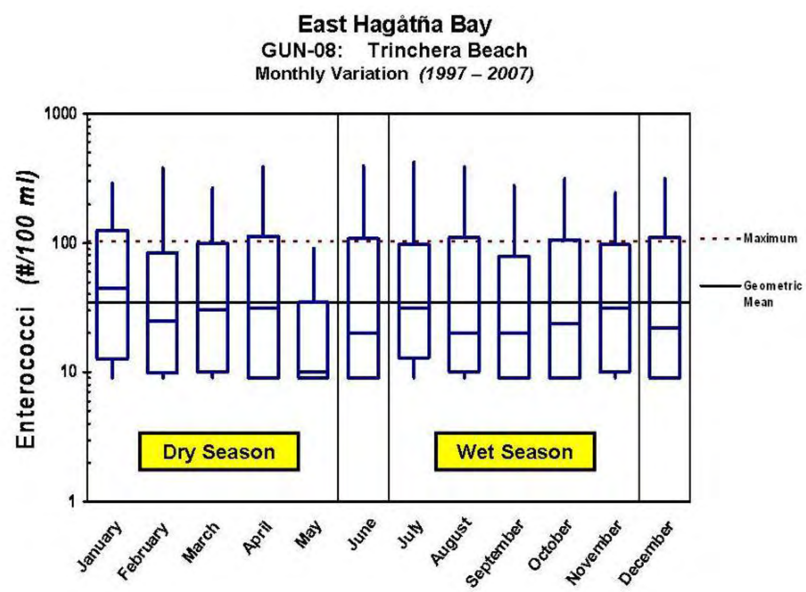

Figure 8-102. Seasonal variation at Trinchera Beach.

Effect of Flow Conditions. A useful approach for relating water quality information to potential source areas is to examine bacteria levels in terms of hydrologic conditions. Figure 8-103 shows enterococci monitoring data collected at Trinchera Beach using a duration curve framework. Although there is significant variability in the data, which is characteristic of bacteria monitoring information, a definite pattern exists.

As indicated by the *"box and whisker"* plots in Figure 8-103, the highest bacteria concentrations occur under high flow conditions. This is not unexpected because water quality at most beaches is strongly influenced by storm water runoff during heavy rainfall events. The magnitude of the increase is higher than that observed at other Northern Guam RBMP sites. In fact, the geometric mean

exceeded the criterion under high flow conditions, which indicates the need to address storm water sources. This concern is reinforced by the fact that nearly 50 percent of all values in the high flow zone exceed the instantaneous maximum criterion value. Furthermore, the geometric mean exceeds the criterion value in the mid-range zone, and is close to it in the moist and dry zones. In addition, the 90th percentile exceeds the instantaneous maximum criterion value across all zones. This indicates that sources other than storm water are adversely affecting bacteria concentrations at Trinchera Beach.

Incorporating seasonality into the analysis allows a closer look at patterns that may be associated with certain source categories. For example, bacteria delivered through seeps connected to storm water ponds are more likely to affect beach monitoring data during the wet season. In contrast, bacteria contributed from more continuous sources (e.g., leaky sewer lines or failing septics) will exert a greater effect during the dry season. Comparisons between the geometric means, the 75th and 90th percentiles for each duration curve zone serve as primary measures for examining seasonality. This is illustrated in Figure 8-104.

The patterns observed for both wet and dry seasons in the high, moist, mid-range and dry zones are all quite similar. Storm water and other sources appear to have approximately the same effect under those conditions at Trinchera Beach. This confirms observations made regarding Figure 8-102 and Figure 8-103. Numerous sources appear to affect bacteria concentrations at this site and seasonal differences do not appear to be a factor.

Relationship to Other Indicators. In addition to seasonal patterns, the relationship of bacteria concentrations to other parameters can be incorporated into the data analysis. Guam EPA staff noted field data for several indicators at the time of bacteria sample collection as part of the RBMP. These include observations such as tidal stage and presence or absence of turbidity.

The combination of patterns with some of these observations could be related to potential source areas and delivery mechanism that might affect bacteria concentrations at any particular beach of interest. For example, the presence or absence of turbidity may also be an indicator of either storm water runoff or suspended material associated with wind action. This approach to the analysis provides information that might prove useful in guiding implementation efforts intended to address documented problems.

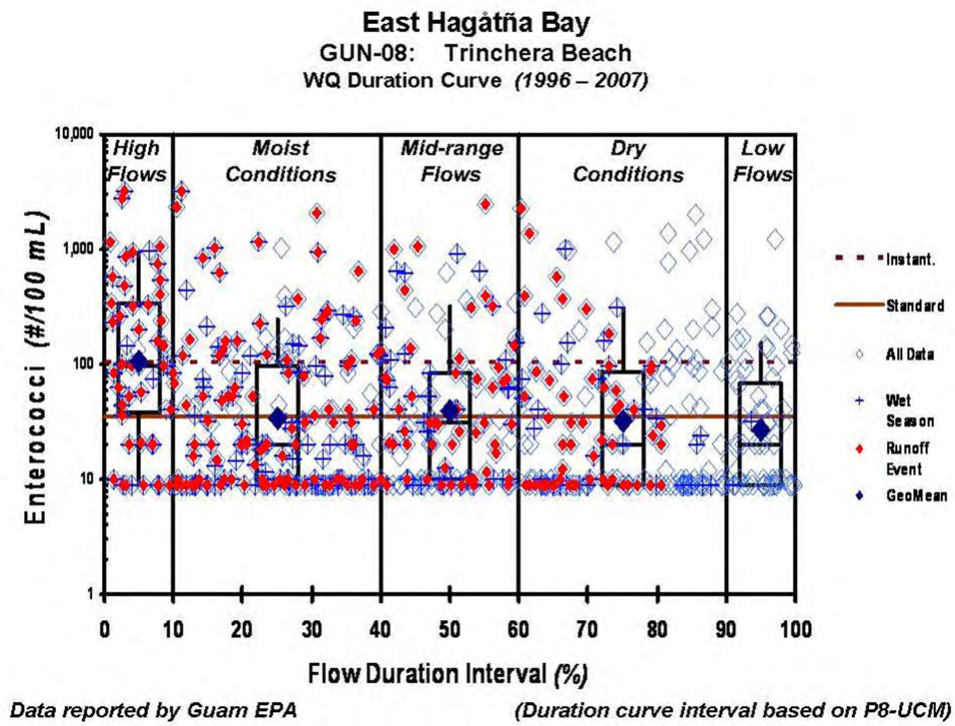

Figure 8-103. Water quality duration curve for Trinchera Beach site.

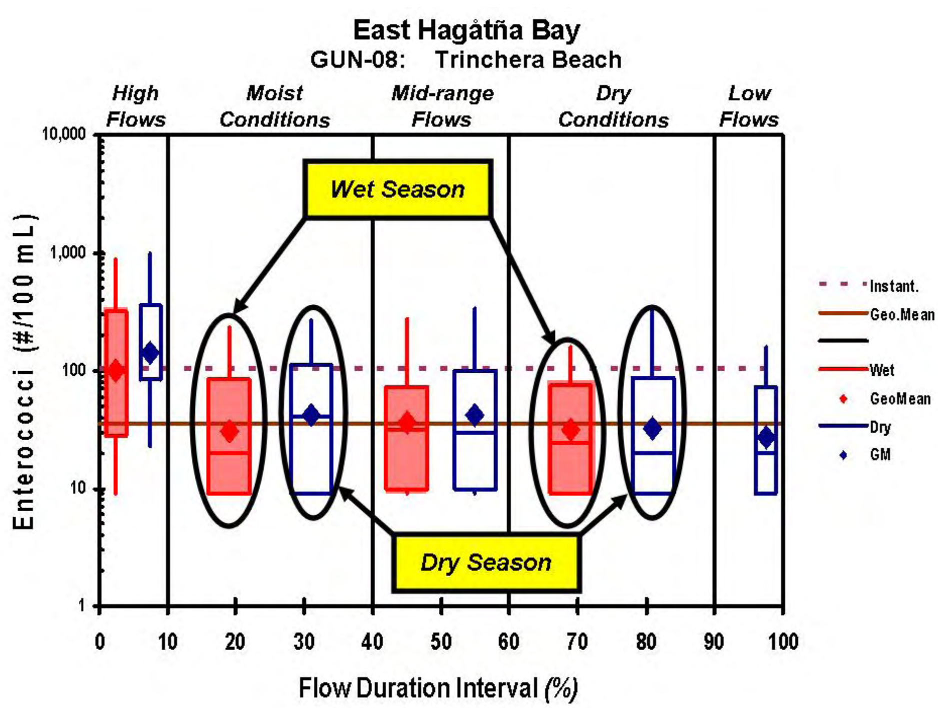

Figure 8-104. Wet versus dry season comparison for Trinchera Beach.

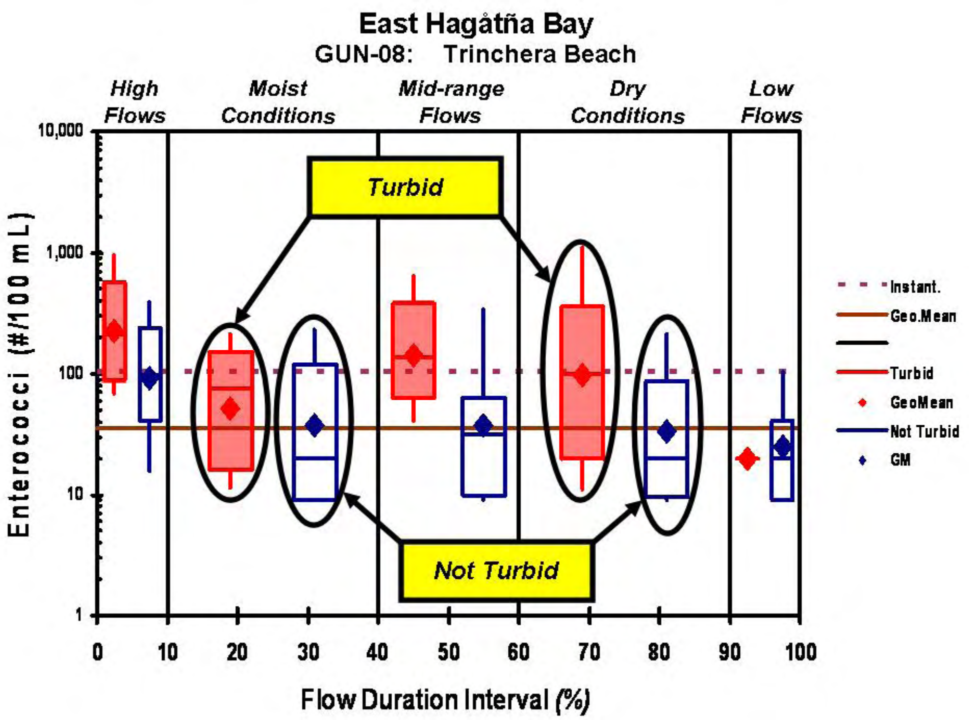

Figure 8-105. Turbid versus non-turbid sample comparison for Trinchera Beach site.

Figure 8-105 shows the difference between bacteria levels when turbidity was present or absent during sample collection under the various flow conditions. The increased levels when turbidity was present under high, moist, and mid-range flow conditions likely reflects the effect of bacteria transported with fine particles during storm events. The effect of bacteria associated with resuspension of bottom sediments might also be the result of wind and wave action, which could affect beach water quality.

Potential Sources. The Source Assessment (Section 5, Table 5-2) summarized potential sources that may affect bacteria concentrations at Trinchera Beach. Included are wastewater sources (septic systems, sewer line blockages & breaks, SSO), storm water (overland runoff; highway, road, & bridge runoff), and other sources (recreation & tourism activities, debris & bottom deposits). In addition, GEPA staff identified specific potential sources that could affect water quality at Trinchera Beach *(Table 8-35)*.

Figure 8-106 provides a closer look at the Trinchera Beach monitoring site relative to upland areas that potentially contribute bacteria during storm events. Figure 8-106 includes roads, which can provide a general indication of the urban drainage network and accompanying storm drains. The map also highlights the location of the Agana WWTP and the Hagåtña Bay Marina.

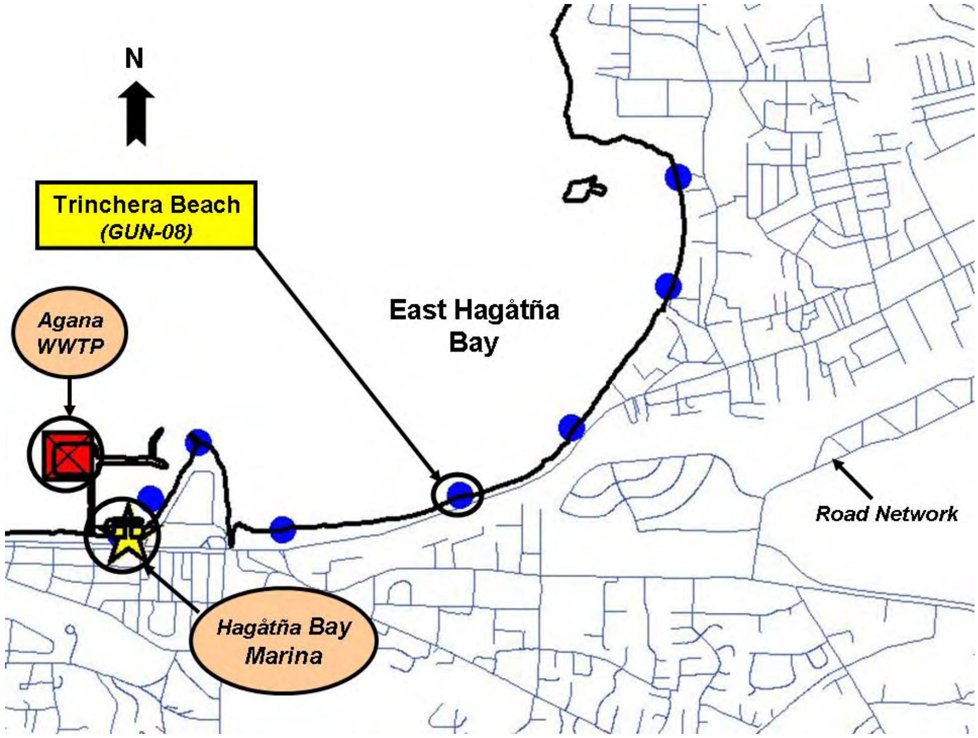

Figure 8-106. Location of Trinchera Beach relative to potential source areas.

Table 8-35. Beach specific potential source summary *(Site GUN-08: Trinchera Beach)*.

Site ID	Type	Source Name *(notes)*
GUN-08	Storm drain runoff	DPW storm drain *Storm drain for Tiyan and airport area.*
		Harmon Sinkhole *Guam International Airport Authority storm water flows to Harmon Sinkhole via concrete channel (includes failing oil / water separator).*
	Wastewater	Septic systems *Concentrated number of unsewered buildings in upland area adjacent to beach*
	Sewage overflow	GWA sewer main lines inadequate slope *Inadequate slope of road results in grit accumulation and sewer overflows.*
		Manhole- sewer overflow *Frequent overflows to storm drain leading to East Hagåtña Bay.*
		Harmon Sinkhole *Receives sewage overflow from Mamajanao Pump Station.*

A review of GIS information shows a number of unsewered buildings in the upland area adjacent to Trinchera Beach. This information is shown in Figure 8-107. In addition, sewer line blockages and breaks, as well as SSOs could contribute to elevated bacteria levels. Figure 8-107 shows the location of both sewer mains and pump stations, as indicators of potential water quality problems associated with wastewater conveyance systems.

Figure 8-108 shows an air photo of the area adjacent to Trinchera Beach. This provides a different perspective, which highlights the high density of roads and buildings in the area adjacent to Trinchera Beach.

In addition to previous assessments and GIS information, Guam EPA staff identified other potential sources that could affect water quality at Trinchera Beach. Specifically, there are a number of concerns in the vicinity of Dungca's Beach described in Section 8.10 including seepage from Harmon Sink. These potential source areas, under the right wind and tide conditions, could have an adverse effect on water quality at Trinchera Beach. Furthermore, two GPA sewer mains are situated such that, inadequate slope results in grit accumulation and sanitary sewer overflows (SSOs) that may affect this location. Finally, there is a major DPW storm drain that channels runoff from Tiyan and the airport area to a discharge point close to Trinchera Beach. Storm water from this drain may influence bacteria concentrations at this site.

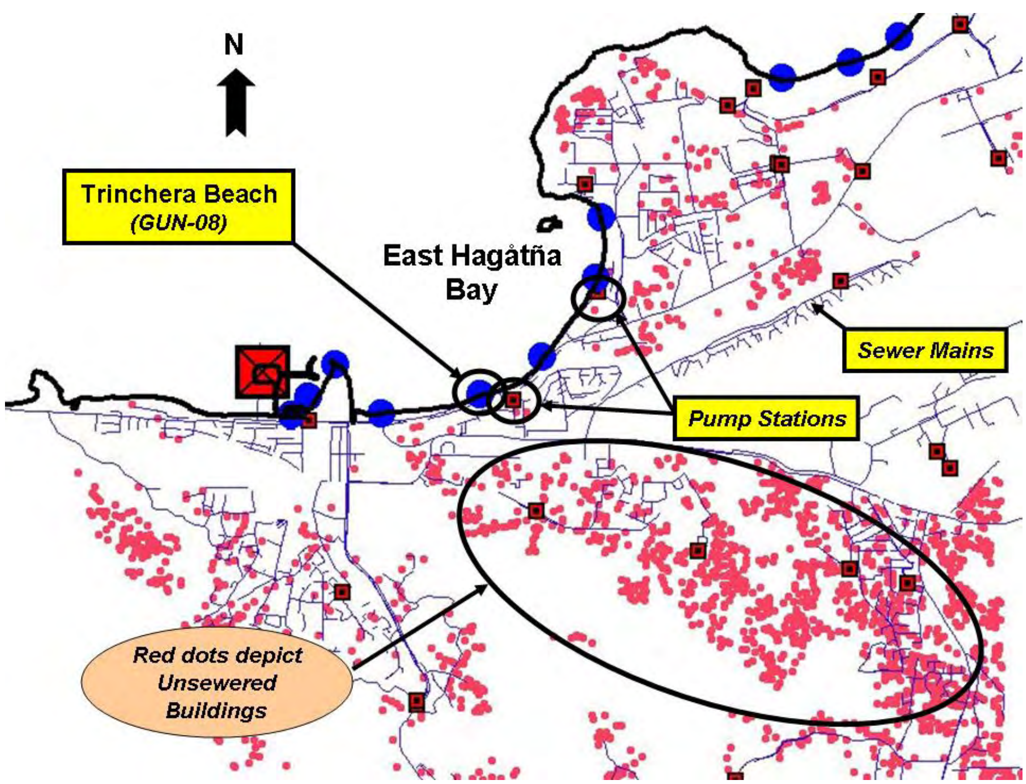

Figure 8-107. Location of Trinchera Beach relative to potential unsewered buildings.

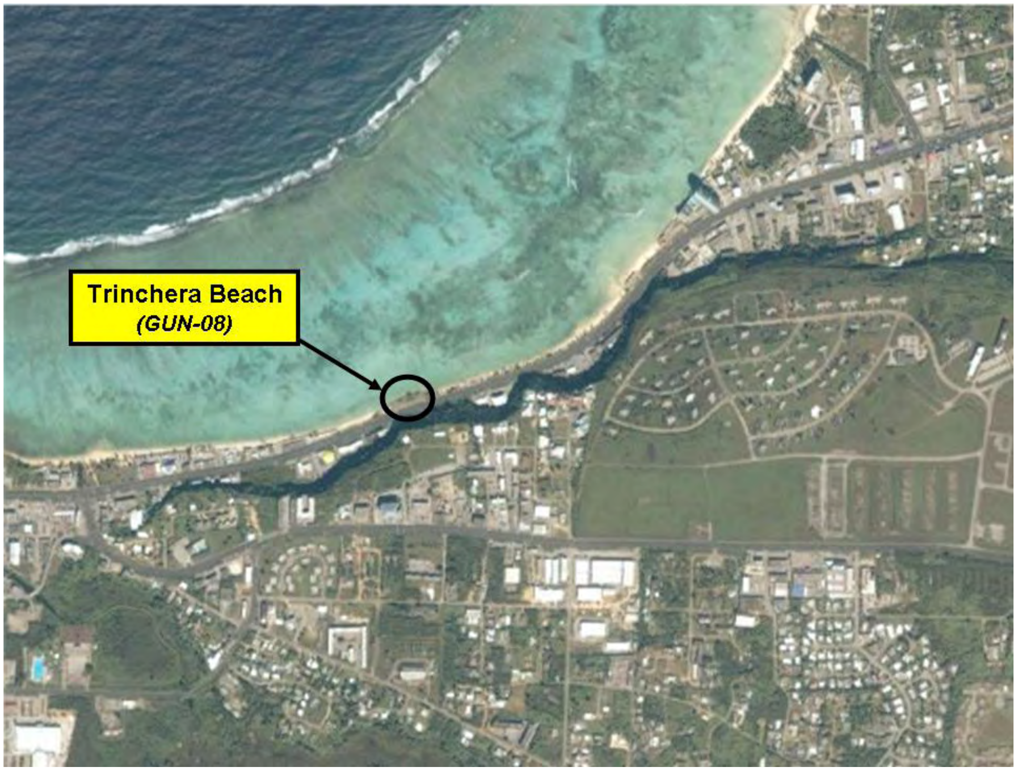

Figure 8-108. Air photo of Trinchera Beach vicinity.

Trends. Figure 8-109 presents a year-by-year summary of the enterococcus data for the Trinchera Beach site. This provides a useful way to examine trends relative to both central tendency and annual variation. This type of analysis is useful in looking at specific sites where efforts to address beach advisories have been implemented. For example, a focus on patterns such as trends in geometric means or 90th percentiles provides a visual analysis that can be used to evaluate program effectiveness. With respect to trends, it should be noted that a laboratory analytical method change occurred in September 2000. The IDEXX test was used to determine enterococcus concentrations on all samples collected after September 2000.

Linkage Analysis. The numeric target for this TMDL is Guam's concentration-based criteria for enterococci bacteria (i.e., a geometric mean of 35 counts / 100 mL and an instantaneous maximum of 104 counts / 100 mL). The relationship between this target and potential sources at Trinchera Beach is demonstrated through an analysis of water quality monitoring data at this site. Seasonal patterns, for example, show that the highest concentrations are observed all year, indicating the importance of both wet and dry season sources at Trinchera Beach. This is consistent with the presence of potential storm water sources identified at this location.

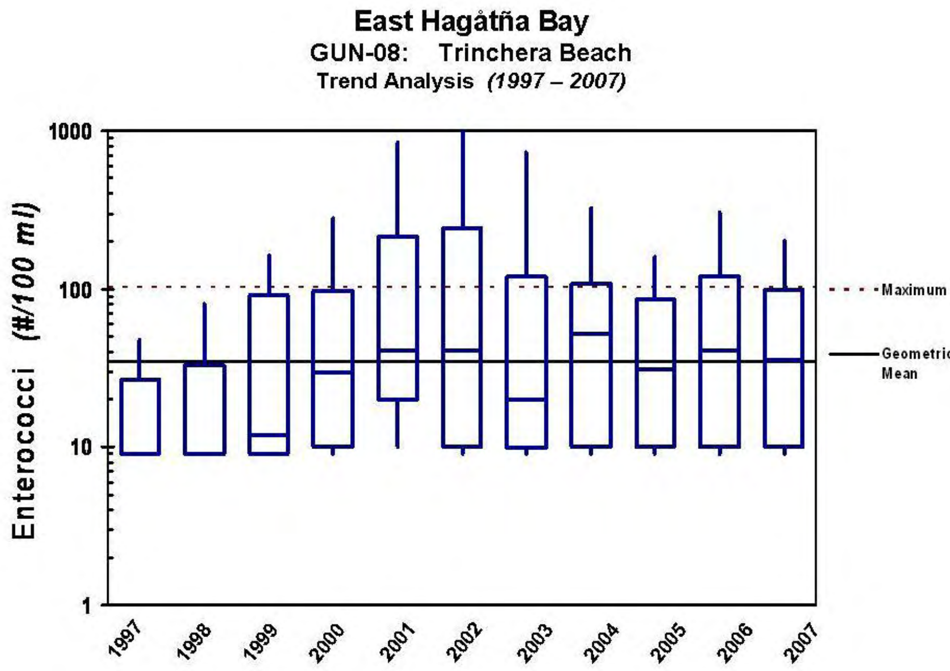

Figure 8-109. Trend analysis for Trinchera Beach site.

The connection between storm water sources and exceedances of numeric targets is further confirmed by examining the effect of flow conditions. At Trinchera Beach, the highest bacteria concentrations occur under high flows. Water quality conditions that reflect this pattern are strongly influenced by storm water runoff during heavy rainfall events. In short, the technical analyses presented in this assessment of Trinchera Beach describe the relationship between water quality patterns and potential sources at this location. The loading capacity and allocations are all concentrations set at the criteria values for enterococci bacteria. This TMDL will clearly meet water quality standards and protect recreational uses at this beach.

TMDL Components. Table 8-36 presents the TMDL for Trinchera Beach, identifying the loading capacity and allocations expressed as concentration-based values for enterococcus. These concentration-based values apply across all flow zones. This TMDL uses an implicit MOS, through inclusion of two conservative assumptions. First, the TMDL does not account for mixing in the receiving waters and assumes that zero dilution is available. Second, the goal of attaining standards at the point of discharge does not account for losses due to die-off and settling of indicator bacteria that are known to occur.

Table 8-36. Northern Guam Watershed TMDL summary *(Site GUN-08: Trinchera Beach)*.

TMDL Component	Enterococcus Concentration *(# / 100 mL)*
Geometric Mean	
TMDL	**35**
Future Growth	35
Waste Load Allocation	35
Load Allocation	35
Instantaneous Maximum	
TMDL	**104**
Future Growth	104
Waste Load Allocation	104
Load Allocation	104

A hydrology-based framework using duration curve zones allows the TMDL to evaluate monitoring data in a way that reflects major watershed processes indicative of different flows. This approach enables numeric targets in the TMDL to consider watershed processes, such as hydrology and source assessment information including land use.

Table 8-37 identifies reductions for each duration curve zone by season using the TMDL targets. These estimates can serve to guide problem solving discussions on appropriate management strategies (based on knowledge associated with likely source areas, delivery mechanisms, and appropriate control measures that correspond to particular hydrologic conditions).

Table 8-37. Needed reductions to meet TMDL targets *(Site GUN-08: Trinchera Beach)*.

Needed Reductions	Flow Conditions *(expressed as percentage)*				
	High	**Moist**	**Mid**	**Dry**	**Low**
Dry Season					
Based on geometric mean	75%	17%	15%	---	---
Based on instantaneous maximum	89%	61%	69%	68%	34%
Wet Season					
Based on geometric mean	65%	---	5%	---	---
Based on instantaneous maximum	88%	56%	62%	35%	---

8.13 Padre Palomo Park Beach (GUN-09)

Padre Palomo Park Beach is situated on the southern half of East Hagåtña Bay *(Figure 8-110)*. It is at the western end of the long strip of beach starting at the Alupang Towers Hotel that continues along Marine Drive. The site is located slightly east of Paseo Beach Park. The beach is a popular destination for jet skiing, parasailing, and other water vehicle type activities.

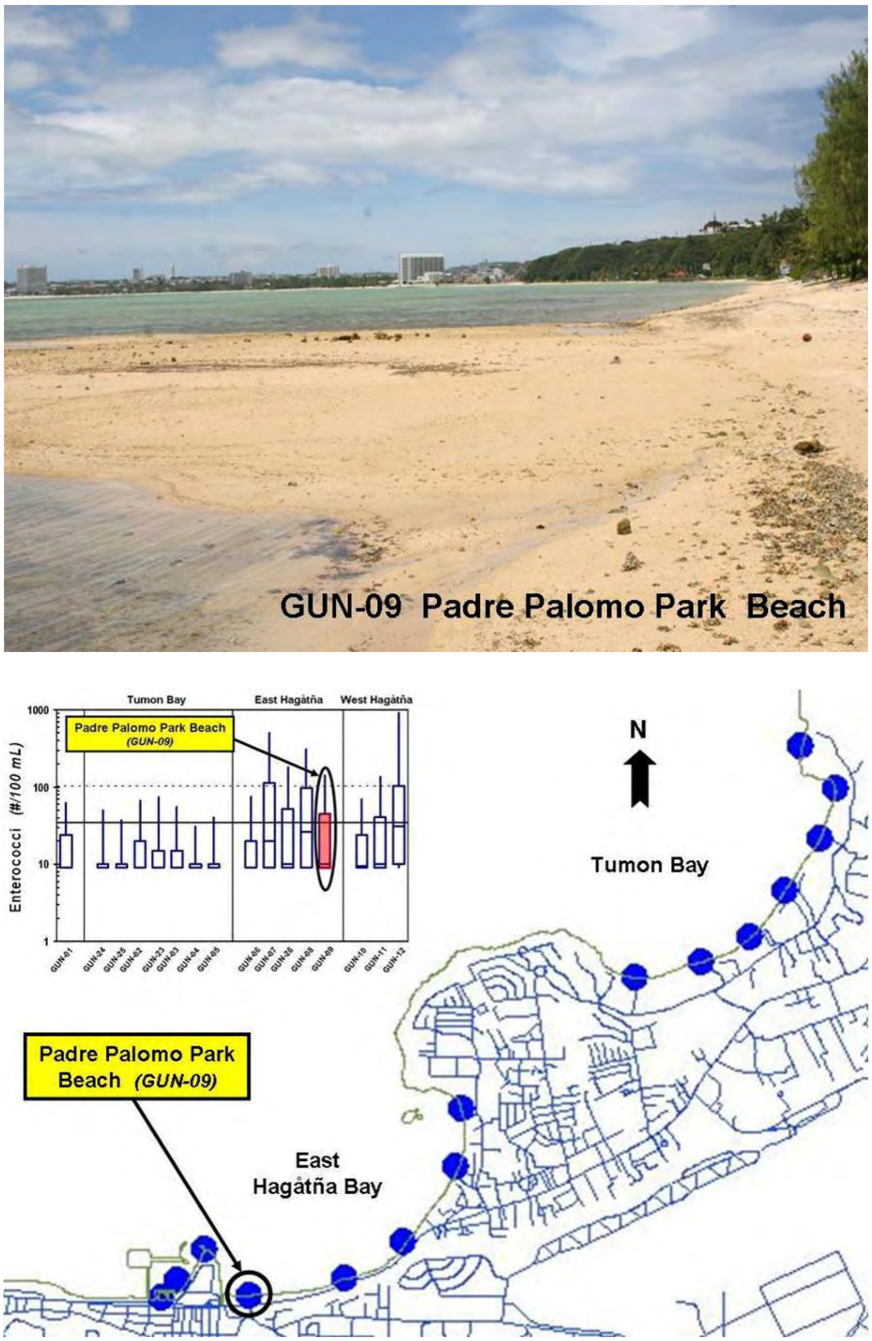

Figure 8-110. Location of Padre Palomo Park Beach relative to other Northern Guam TMDL sites.

The frequency of beach advisories at Padre Palomo Park Beach between 1997 and 2007 was relatively high (31%) compared to other RBMP sites in the Northern Beach TMDL project area *(Figure 4-1)*. Enterococci concentrations at Padre Palomo Park Beach were also high compared to other project area monitoring stations *(Figure 4-2 and Figure 8-110)*. The geometric mean of all individual samples was 23 counts /100mL, while the 75th and 90th percentiles were 45 and 141 counts /100 mL respectively.

A key part of the data analysis for individual beaches is to examine water quality patterns by season and relative to flow conditions (e.g., runoff dominated versus base flows). Figure 8-111 shows the seasonal variability of bacteria concentrations at Padre Palomo Park Beach. High concentrations were observed all year, indicating the importance of both wet and dry season sources at Padre Palomo Park Beach (although wet season concentrations were noticeably greater).

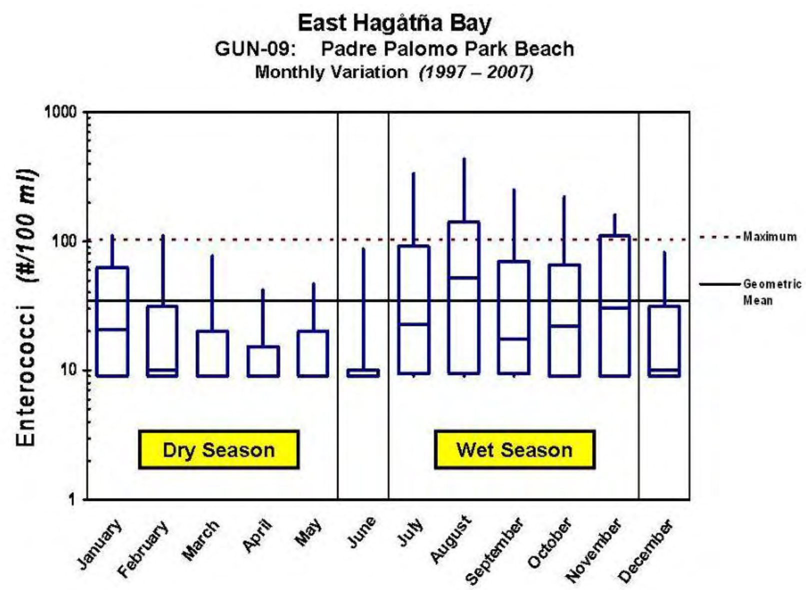

Figure 8-111. Seasonal variation at Padre Palomo Park Beach.

Effect of Flow Conditions. A useful approach for relating water quality information to potential source areas is to examine bacteria levels in terms of hydrologic conditions. Figure 8-112 shows enterococci monitoring data collected at Padre Palomo Park Beach using a duration curve framework. Although there is significant variability in the data, which is characteristic of bacteria monitoring information, a definite pattern exists.

As indicated by the *"box and whisker"* plots in Figure 8-112, the highest bacteria concentrations occur under high flow conditions. This is not unexpected because water quality at most beaches is strongly influenced by storm water runoff during heavy rainfall events. The magnitude of the increase is higher than that observed at other Northern Guam RBMP sites. In fact, the geometric mean exceeded the criterion under high flow conditions, which indicates the need to address storm water sources. This concern is reinforced by the fact that over 50 percent of all values in the high flow zone exceed the instantaneous maximum criterion value. Furthermore, the 90th percentile exceeds the instantaneous maximum criterion in the moist zone. This indicates that sources associated with periodic short term problems (e.g., spills into the storm drain system or sewer overflows during rain events) may be a concern under these conditions at Padre Palomo Park Beach.

Incorporating seasonality into the analysis allows a closer look at patterns that may be associated with certain source categories. For example, bacteria delivered through seeps connected to storm water ponds are more likely to affect beach monitoring data during the wet season. In contrast, bacteria contributed from more continuous sources (e.g., leaky sewer lines or failing septics) will exert a greater effect during the dry season. Comparisons between the geometric means, the 75th and 90th percentiles for each duration curve zone serve as primary measures for examining seasonality. This is illustrated in Figure 8-113.

The patterns observed for both wet and dry seasons in the high, moist, mid-range and dry zones are all generally similar. Wet season values are moderately higher than those observed during the dry season. The higher wet season values, particularly in the high flow and dry zones, indicate the potential for seeps connected to storm water sources to be affecting water quality at this site.

Relationship to Other Indicators. In addition to seasonal patterns, the relationship of bacteria concentrations to other parameters can be incorporated into the data analysis. Guam EPA staff noted field data for several indicators at the time of bacteria sample collection as part of the RBMP. These include observations such as tidal stage and presence or absence of turbidity.

The combination of patterns with some of these observations could be related to potential source areas and delivery mechanism that might affect bacteria concentrations at any particular beach of interest. For example, the presence or absence of turbidity may also be an indicator of either storm water runoff or suspended material associated with wind action. This approach to the analysis provides information that might prove useful in guiding implementation efforts intended to address documented problems.

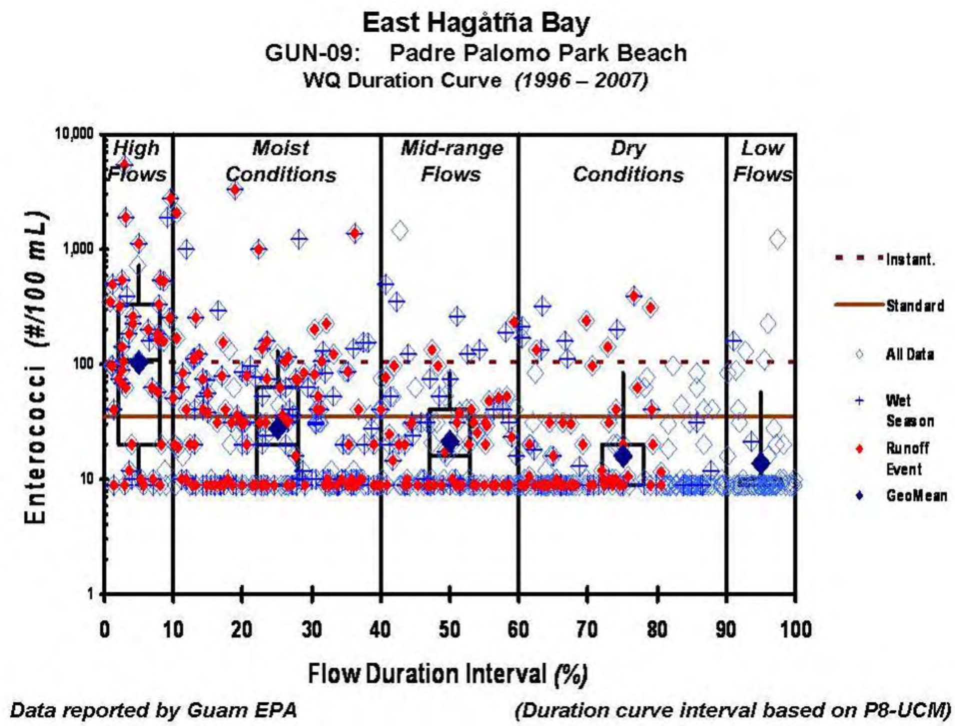

Figure 8-112. Water quality duration curve for Padre Palomo Park Beach site.

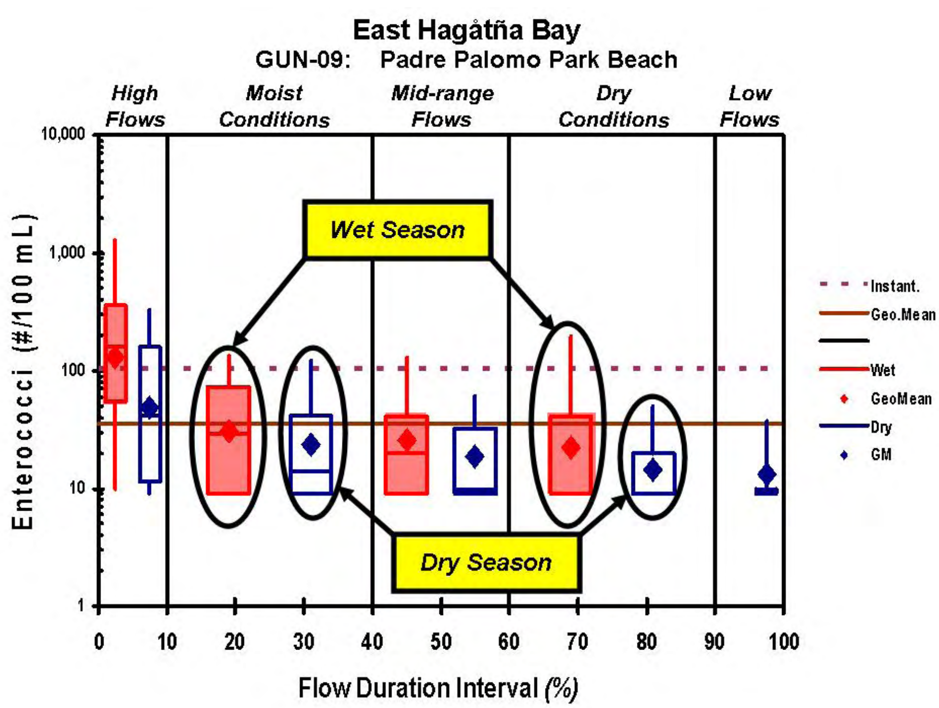

Figure 8-113. Wet versus dry season comparison for Padre Palomo Park Beach.

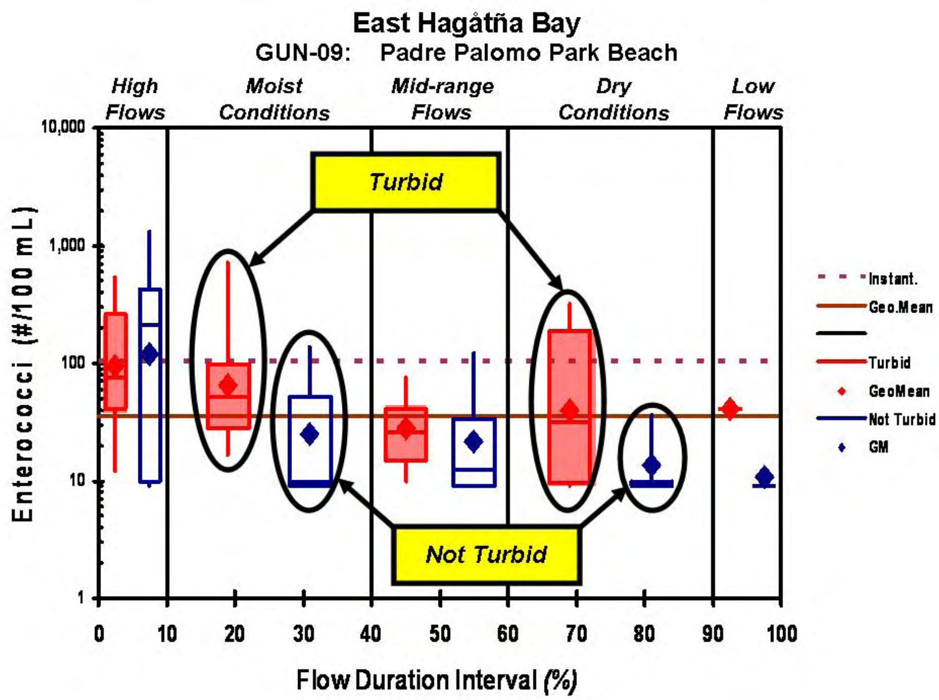

Figure 8-114. Turbid versus non-turbid sample comparison for Padre Palomo Park Beach site.

Figure 8-114 shows the difference between bacteria levels when turbidity was present or absent during sample collection under the various flow conditions. The increased levels when turbidity was present under high, moist, and mid-range flow conditions likely reflects the effect of bacteria transported with fine particles during storm events. The effect of bacteria associated with resuspension of bottom sediments might also be the result of wind and wave action, which could affect beach water quality.

Potential Sources. The Source Assessment (Section 5, Table 5-2) summarized potential sources that may affect bacteria concentrations at Padre Palomo Park Beach. Included are wastewater sources (septic systems, sewer line blockages & breaks, SSO), storm water (overland runoff; highway, road, & bridge runoff), and other sources (recreation & tourism activities, debris & bottom deposits). In addition, GEPA staff identified specific potential sources that could affect water quality at Padre Palomo Park Beach *(Table 8-38)*.

Figure 8-115 provides a closer look at the Padre Palomo Park Beach monitoring site relative to upland areas that potentially contribute bacteria during storm events. Figure 8-115 includes roads, which can provide a general indication of the urban drainage network and accompanying storm drains. The map also highlights the location of the Agana WWTP and the Hagåtña Bay Marina.

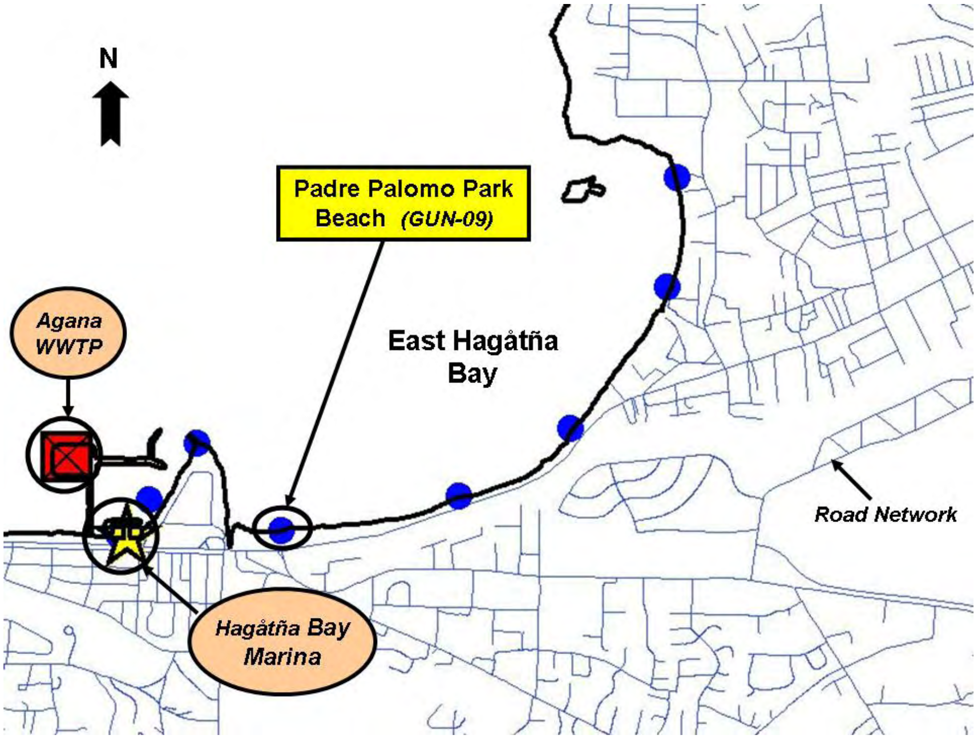

Figure 8-115. Location of Padre Palomo Park Beach relative to potential source areas.

Table 8-38. Beach specific potential source summary *(Site GUN-09: Padre Palomo Beach)*.

Site ID	Type	Source Name *(notes)*
GUN-09	Storm drain runoff	DPW storm drains • *Storm drain for Marine Drive and Route 8.* • *Runoff from Hagatna village.*
		Harmon Sinkhole *Guam International Airport Authority storm water flows to Harmon Sinkhole via concrete channel (includes failing oil / water separator).*
	Wastewater	Septic systems *Concentrated number of unsewered buildings in upland area adjacent to beach*
	Sewage overflow	GWA sewer main lines inadequate slope *Inadequate slope of road results in grit accumulation and sewer overflows.*
		Manhole- sewer overflows • *Near Hagåtña Mayor's office overflows into stream.* • *Frequent overflows to storm drain leading to East Hagåtña Bay.*
		Harmon Sinkhole *Receives sewage overflow from Mamajanao Pump Station.*

A review of GIS information shows a number of unsewered buildings in the upland area adjacent to Padre Palomo Park Beach. This information is shown in Figure 8-116. In addition, sewer line blockages and breaks, as well as SSOs could contribute to elevated bacteria levels. Figure 8-116 shows the location of both sewer mains and pump stations, as indicators of potential water quality problems associated with wastewater conveyance systems.

Figure 8-117 shows an air photo of the area adjacent to Padre Palomo Park Beach. This provides a different perspective, which highlights the high density of roads and buildings in the area adjacent to Padre Palomo Park Beach.

In addition to previous assessments and GIS information, Guam EPA staff identified other potential sources that could affect water quality at Padre Palomo Park Beach. Specifically, there are two major DPW storm drains that channel runoff to discharge points, which may influence bacteria concentrations at this site. Surface runoff from Hagåtña village could be exerting an effect on water quality at this location as well. There is also a manhole near Hagåtña village mayor's office that has had occasional sewage overflows, which could influence monitoring measurements at this site. Finally, two GPA sewer mains are situated such that, inadequate slope results in grit accumulation and sanitary sewer overflows (SSOs).

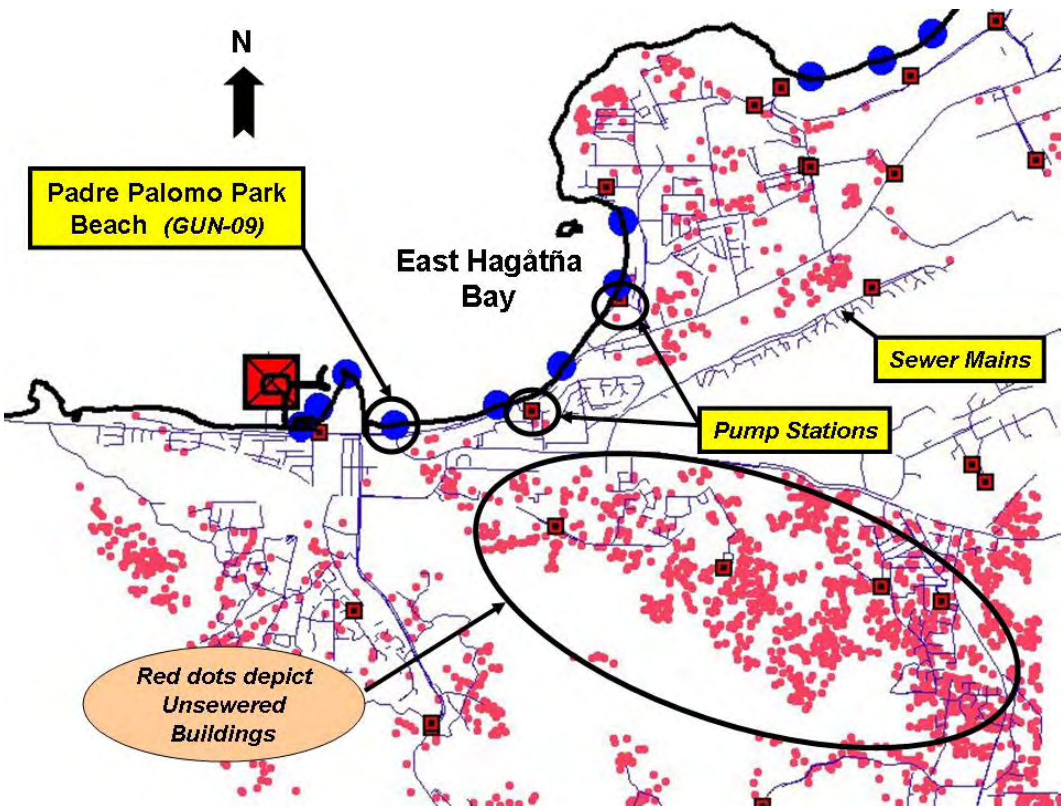

Figure 8-116. Location of Padre Palomo Park Beach relative to potential unsewered buildings.

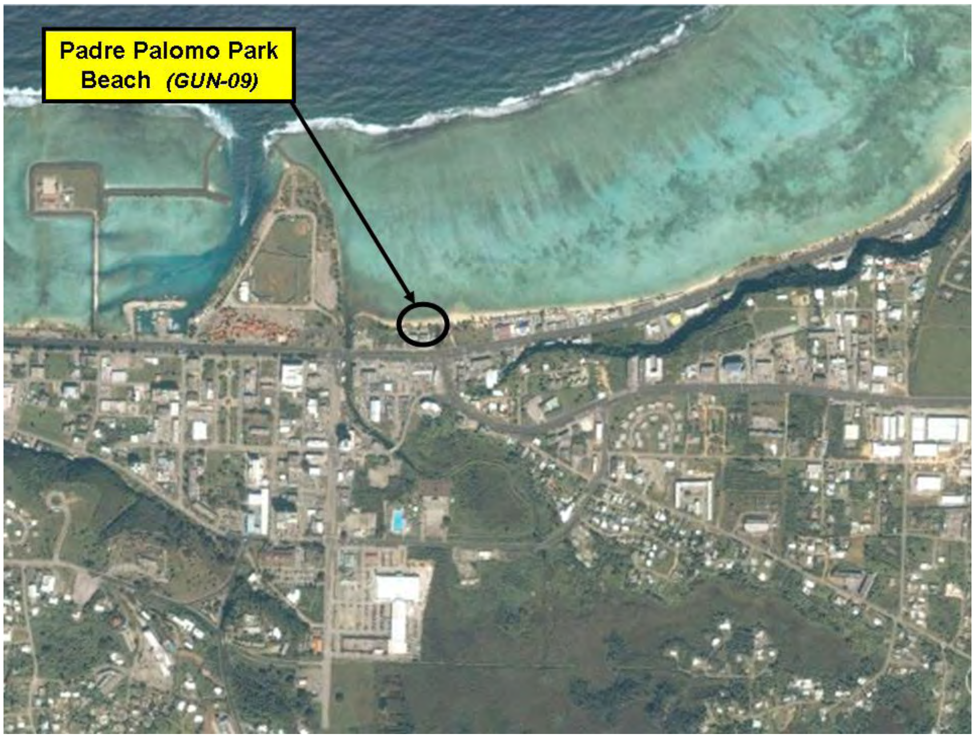

Figure 8-117. Air photo of Padre Palomo Park Beach vicinity.

Trends. Figure 8-118 presents a year-by-year summary of the enterococcus data for the Padre Palomo Park Beach site. This provides a useful way to examine trends relative to both central tendency and annual variation. This type of analysis is useful in looking at specific sites where efforts to address beach advisories have been implemented. For example, a focus on patterns such as trends in geometric means or 90th percentiles provides a visual analysis that can be used to evaluate program effectiveness. With respect to trends, it should be noted that a laboratory analytical method change occurred in September 2000. The IDEXX test was used to determine enterococcus concentrations on all samples collected after September 2000.

Linkage Analysis. The numeric target for this TMDL is Guam's concentration-based criteria for enterococci bacteria (i.e., a geometric mean of 35 counts / 100 mL and an instantaneous maximum of 104 counts / 100 mL). The relationship between this target and potential sources at Padre Palomo Park Beach is demonstrated through an analysis of water quality monitoring data at this site. Seasonal patterns, for example, show that the highest concentrations are observed all year, indicating the importance of both wet and dry season sources at Padre Palomo Park Beach. This is consistent with the presence of potential storm water sources identified at this location.

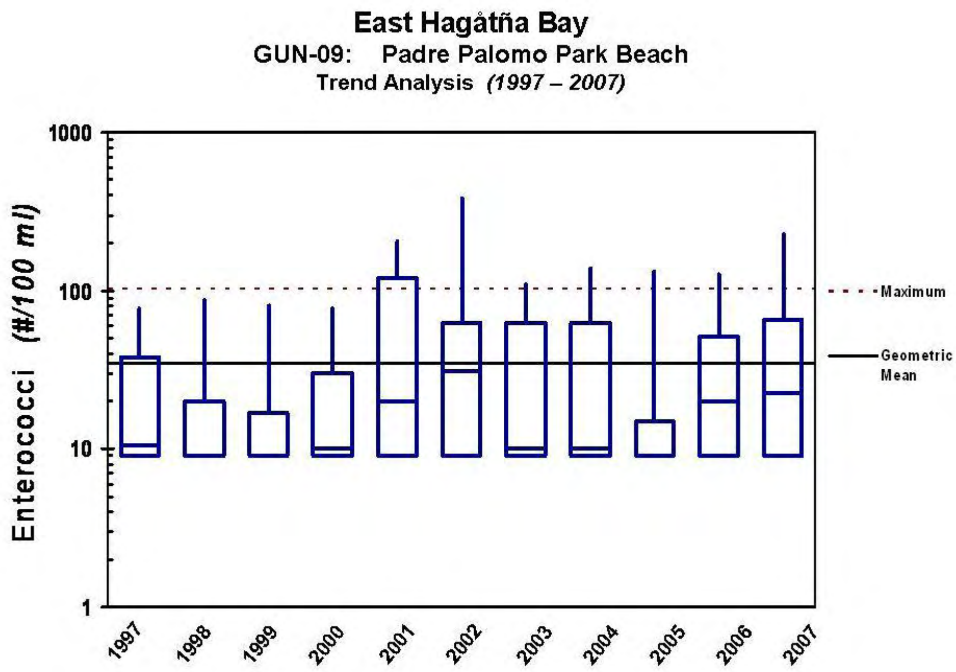

Figure 8-118. Trend analysis for Padre Palomo Park Beach site.

The connection between storm water sources and exceedances of numeric targets is further confirmed by examining the effect of flow conditions. At Padre Palomo Park Beach, the highest bacteria concentrations occur under high flows. Water quality conditions that reflect this pattern are strongly influenced by storm water runoff during heavy rainfall events. In short, the technical analyses presented in this assessment of Padre Palomo Park Beach describe the relationship between water quality patterns and potential sources at this location. The loading capacity and allocations are all concentrations set at the criteria values for enterococci bacteria. This TMDL will clearly meet water quality standards and protect recreational uses at this beach.

TMDL Components. Table 8-39 presents the TMDL for Padre Palomo Park Beach, identifying the loading capacity and allocations expressed as concentration-based values for enterococcus. These concentration-based values apply across all flow zones. This TMDL uses an implicit MOS, through inclusion of two conservative assumptions. First, the TMDL does not account for mixing in the receiving waters and assumes that zero dilution is available. Second, the goal of attaining standards at the point of discharge does not account for losses due to die-off and settling of indicator bacteria that are known to occur.

Table 8-39. Northern Guam TMDL summary *(Site GUN-09: Padre Palomo Park Beach)*.

TMDL Component	Enterococcus Concentration *(# / 100 mL)*
Geometric Mean	
TMDL	**35**
Future Growth	35
Waste Load Allocation	35
Load Allocation	35
Instantaneous Maximum	
TMDL	**104**
Future Growth	104
Waste Load Allocation	104
Load Allocation	104

A hydrology-based framework using duration curve zones allows the TMDL to evaluate monitoring data in a way that reflects major watershed processes indicative of different flows. This approach enables numeric targets in the TMDL to consider watershed processes, such as hydrology and source assessment information including land use.

Table 8-40 identifies reductions for each duration curve zone by season using the TMDL targets. These estimates can serve to guide problem solving discussions on appropriate management strategies (based on knowledge associated with likely source areas, delivery mechanisms, and appropriate control measures that correspond to particular hydrologic conditions).

Table 8-40. Needed reductions to meet TMDL targets *(Site GUN-09: Padre Palomo Park Beach)*.

Needed Reductions	Flow Conditions *(expressed as percentage)*				
	High	Moist	Mid	Dry	Low
Dry Season					
Based on geometric mean	27%	---	---	---	---
Based on instantaneous maximum	69%	14%	---	---	---
Wet Season					
Based on geometric mean	73%	---	---	---	---
Based on instantaneous maximum	92%	22%	20%	47%	---

8.14 Hagåtña Channel (GUN-10)

Hagåtña Channel is the waterway that connects the Hagåtña Boat Basin to East Hagåtña Bay *(Figure 8-119)*. For this reason, the channel experiences heavy boating activity by recreational users. Just beyond the rocks that mark the entrance to the channel is a popular surfing and body boarding surf break among the local residents.

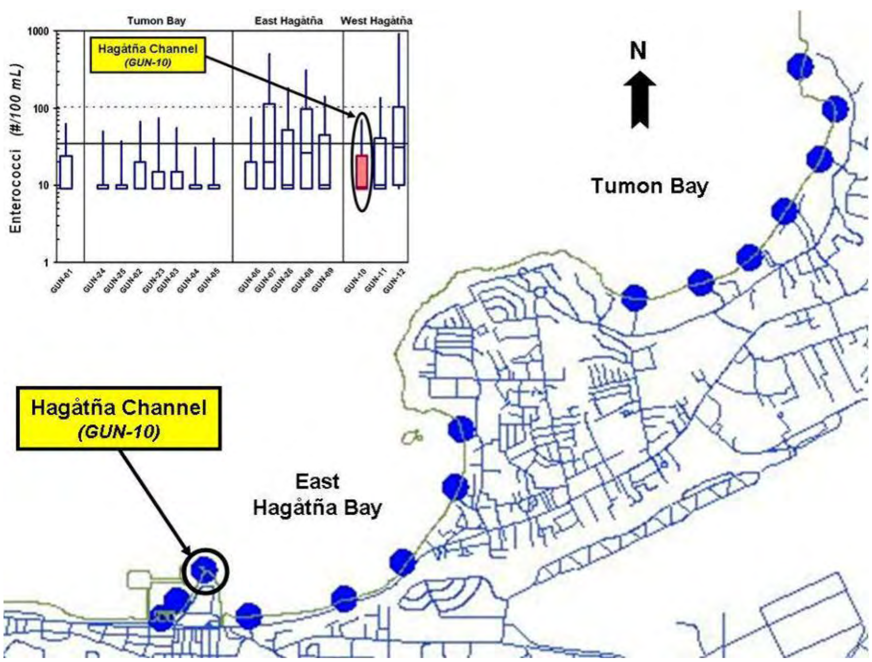

Figure 8-119. Location of Hagåtña Channel relative to other Northern Guam TMDL sites.

The frequency of beach advisories at Hagåtña Channel between 1997 and 2007 was typical (13%) of many RBMP sites in the Northern Beach TMDL project area *(Figure 4-1)*. Enterococci concentrations at Hagåtña Channel were basically in the same range as a number of other project area monitoring stations *(Figure 4-2 and Figure 8-119)*. The geometric mean of all individual samples was 16 counts /100mL, while the 75th and 90th percentiles were 24 and 69 counts /100 mL respectively.

A key part of the data analysis for individual beaches is to examine water quality patterns by season and relative to flow conditions (e.g., runoff dominated versus base flows). Figure 8-120 shows the seasonal variability of bacteria concentrations at Hagåtña Channel. The highest concentrations were observed between July and March, indicating the importance of both wet and dry season sources at the Hagåtña Channel.

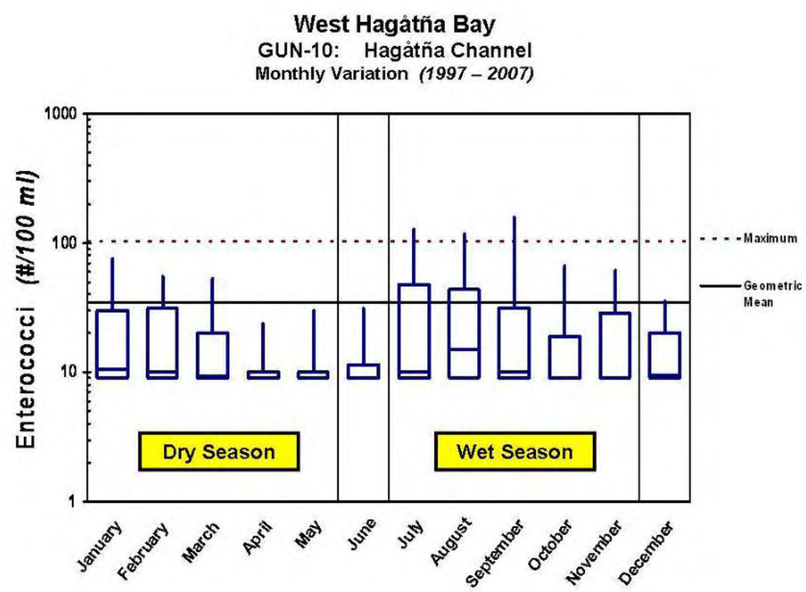

Figure 8-120. Seasonal variation at Hagåtña Channel.

Effect of Flow Conditions. A useful approach for relating water quality information to potential source areas is to examine bacteria levels in terms of hydrologic conditions. Figure 8-121 shows enterococci monitoring data collected at Hagåtña Channel using a duration curve framework. Although there is significant variability in the data, which is characteristic of bacteria monitoring information, a definite pattern exists.

As indicated by the *"box and whisker"* plots in Figure 8-121, the highest bacteria concentrations occur under high flow conditions. This is not unexpected because water quality at most beaches is strongly influenced by storm water runoff during heavy rainfall events. The magnitude of the increase is higher than that observed at other Northern Guam RBMP sites. In fact, the geometric mean

exceeded the criterion under high flow conditions, which indicates the need to address storm water sources. This concern is reinforced by the fact that nearly 30 percent of all values in the high flow zone exceed the instantaneous maximum criterion value.

Incorporating seasonality into the analysis allows a closer look at patterns that may be associated with certain source categories. For example, bacteria delivered through seeps connected to storm water ponds are more likely to affect beach monitoring data during the wet season. In contrast, bacteria contributed from more continuous sources (e.g., leaky sewer lines or failing septics) will exert a greater effect during the dry season. Comparisons between the geometric means, the 75th and 90th percentiles for each duration curve zone serve as primary measures for examining seasonality. This is illustrated in Figure 8-122.

The patterns observed for both wet and dry seasons in the high, moist, mid-range and dry zones are all generally similar. Wet season values are moderately higher than those observed during the dry season in the high flow zone. This confirms the importance of storm water sources that affect Hagåtña Channel. Other sources that influence water quality in the moist, mid-range, and dry zones appear to have approximately the same effect under those conditions. Seasonal differences at this site do not appear to be a major factor.

Relationship to Other Indicators. In addition to seasonal patterns, the relationship of bacteria concentrations to other parameters can be incorporated into the data analysis. Guam EPA staff noted field data for several indicators at the time of bacteria sample collection as part of the RBMP. These include observations such as tidal stage and presence or absence of turbidity.

The combination of patterns with some of these observations could be related to potential source areas and delivery mechanism that might affect bacteria concentrations at any particular beach of interest. For example, the presence or absence of turbidity may also be an indicator of either storm water runoff or suspended material associated with wind action. This approach to the analysis provides information that might prove useful in guiding implementation efforts intended to address documented problems.

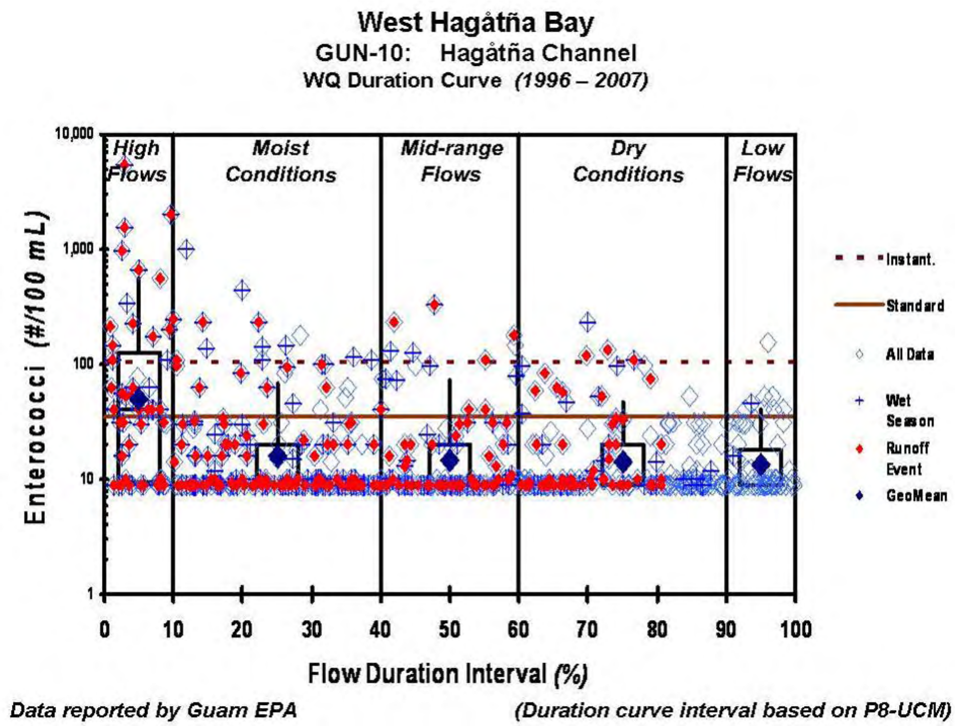

Figure 8-121. Water quality duration curve for Hagåtña Channel site.

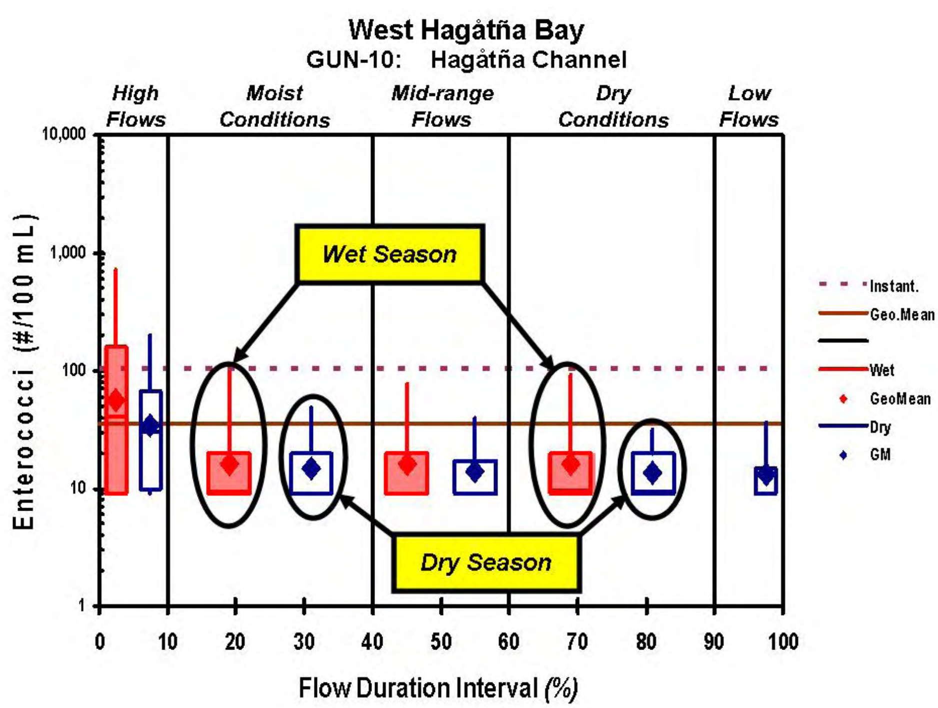

Figure 8-122. Wet versus dry season comparison for Hagåtña Channel.

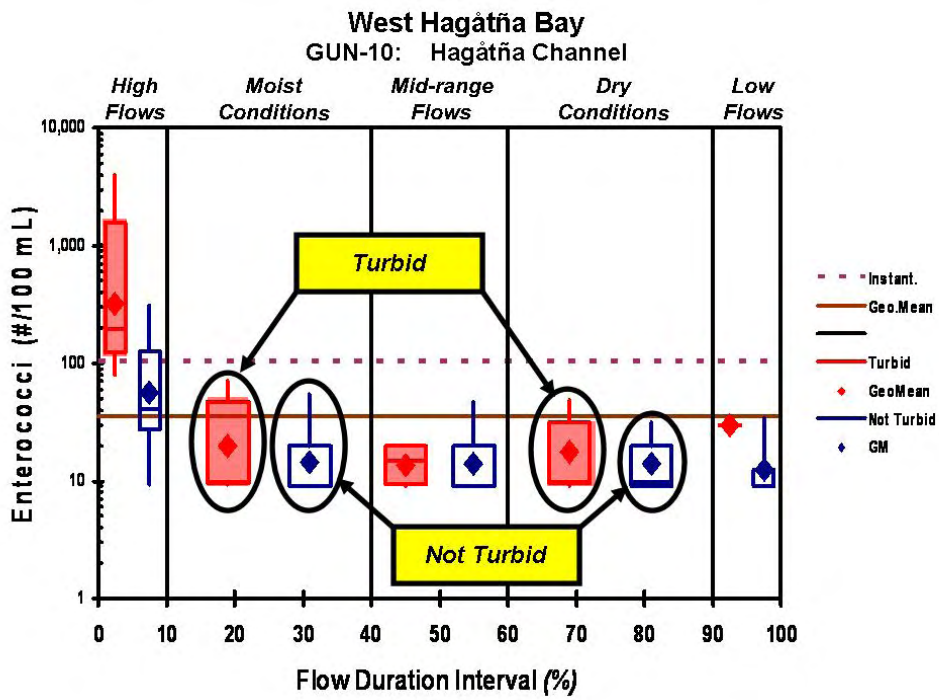

Figure 8-123. Turbid versus non-turbid sample comparison for Hagåtña Channel site.

Figure 8-123 shows the difference between bacteria levels when turbidity was present or absent during sample collection under the various flow conditions. The increased levels when turbidity was present under high and moist conditions likely reflect the effect of bacteria transported with fine particles during storm events. The effect of bacteria associated with resuspension of bottom sediments might also be the result of wind and wave action, which could affect beach water quality.

Potential Sources. The Source Assessment (Section 5, Table 5-2) summarized potential sources that may affect bacteria concentrations at Hagåtña Channel. Included are wastewater sources (septic systems, sewer line blockages & breaks, SSO, Agana WWTP), storm water runoff, and other sources (marina, recreational boating, boat discharges). In addition, GEPA staff identified specific potential sources that could affect water quality at Hagåtña Channel *(Table 8-41)*.

Figure 8-124 provides a closer look at the Hagåtña Channel monitoring site relative to upland areas that potentially contribute bacteria during storm events. Figure 8-124 includes roads, which can provide a general indication of the urban drainage network and accompanying storm drains. The map also highlights the location of the Agana WWTP and the Hagåtña Bay Marina.

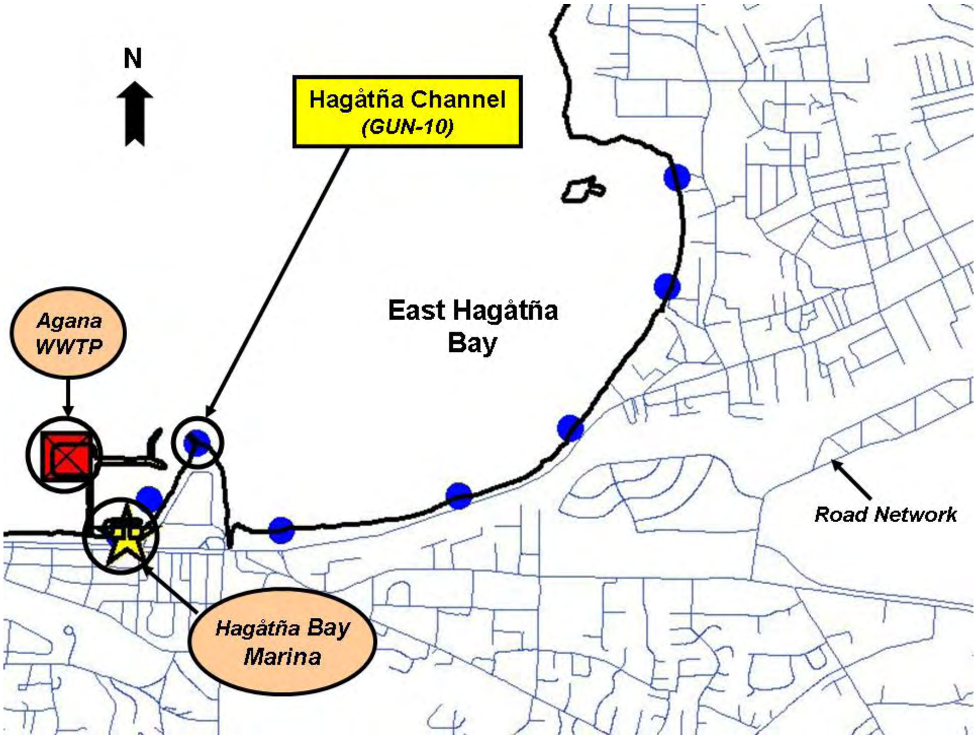

Figure 8-124. Location of Hagåtña Channel relative to potential source areas.

Table 8-41. Beach specific potential source summary *(Site GUN-10: Hagåtña Channel)*.

Site ID	Type	Source Name *(notes)*
GUN-10	Wastewater	GWA Hagåtña WWTP Sewage Outfall (old) *Old line is currently cracked on reef margin and connected to system for sporadic use.*
		GWA Hagåtña WWTP Sewage Outfall (new) *New line completed 2009.*
	Marina	Hagåtña Bay Marina (Port Authority of Guam)
	Storm water runoff	DPW Routes 7 and 7A *Runoff to Hagåtña village and storm drains to West Hagåtña Bay.*
	Storm drain runoff	DPW storm drains *Runoff from Hagåtña village and Route 1.*
	Sewage overflow	Manhole- sewer overflow *Frequent overflows to storm drain leading to West Hagåtña Bay.*

A review of GIS information shows a number of unsewered buildings in the upland area adjacent to Hagåtña Channel. This information is shown in Figure 8-125. In addition, sewer line blockages and breaks, as well as SSOs could contribute to elevated bacteria levels. Figure 8-125 shows the location of both sewer mains and pump stations, as indicators of potential water quality problems associated with wastewater conveyance systems.

Figure 8-126 shows an air photo of the area adjacent to Hagåtña Channel. This provides a different perspective, which highlights the high density of roads and buildings in the area adjacent to Hagåtña Channel.

In addition to previous assessments and GIS information, Guam EPA staff identified other potential sources that could affect water quality at Hagåtña Channel. Specifically, there is a major DPW storm drain that channels runoff to a discharge point, which may influence bacteria concentrations at this site. Also, surface runoff from Hagåtña village could be exerting an effect on water quality at this location. Finally, the old line associated with the Agana WWTP was cracked on the reef margin, which may have resulted in sporadic increases in enterococci measurements at this monitoring station.

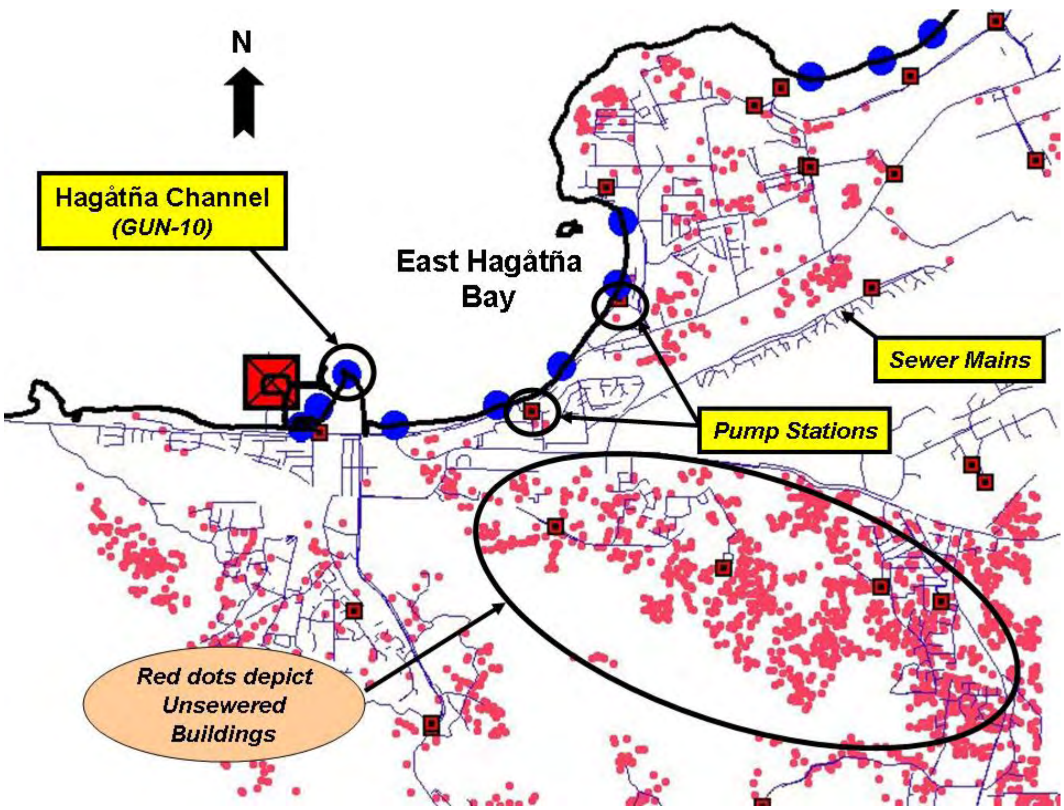

Figure 8-125. Location of Hagåtña Channel relative to potential unsewered buildings.

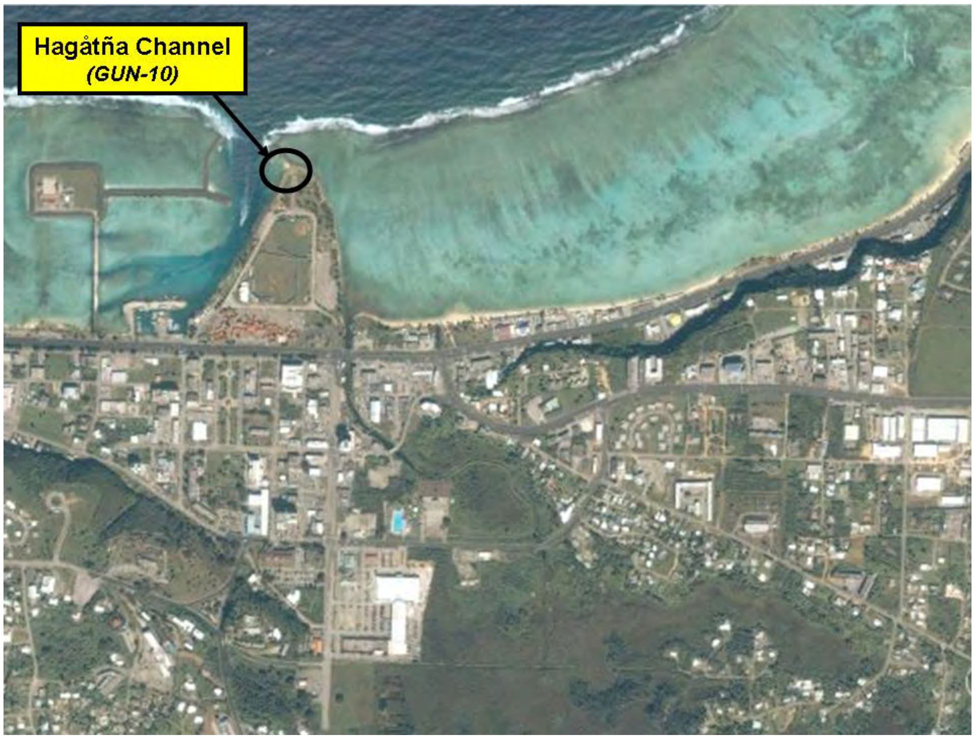

Figure 8-126. Air photo of Hagåtña Channel vicinity.

Trends. Figure 8-127 presents a year-by-year summary of the enterococcus data for the Hagåtña Channel site. This provides a useful way to examine trends relative to both central tendency and annual variation. This type of analysis is useful in looking at specific sites where efforts to address beach advisories have been implemented. For example, a focus on patterns such as trends in geometric means or 90th percentiles provides a visual analysis that can be used to evaluate program effectiveness. With respect to trends, it should be noted that a laboratory analytical method change occurred in September 2000. The IDEXX test was used to determine enterococcus concentrations on all samples collected after September 2000.

Linkage Analysis. The numeric target for this TMDL is Guam's concentration-based criteria for enterococci bacteria (i.e., a geometric mean of 35 counts / 100 mL and an instantaneous maximum of 104 counts / 100 mL). The relationship between this target and potential sources at Hagåtña Channel is demonstrated through an analysis of water quality monitoring data at this site. Seasonal patterns, for example, show that the highest concentrations are observed between July and March, indicating the importance of both wet and dry season sources at Hagåtña Channel. This is consistent with the presence of potential storm water sources identified at this location.

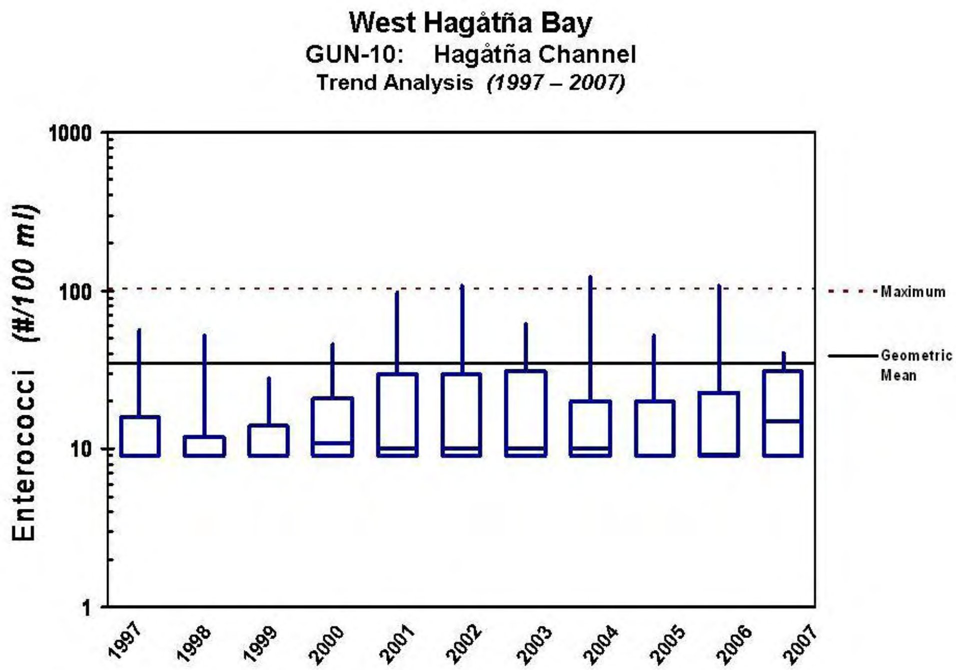

Figure 8-127. Trend analysis for Hagåtña Channel site.

The connection between storm water sources and exceedances of numeric targets is further confirmed by examining the effect of flow conditions. At Hagåtña Channel, the highest bacteria concentrations occur under high flows. Water quality conditions that reflect this pattern are strongly influenced by storm water runoff during heavy rainfall events. In short, the technical analyses presented in this assessment of Hagåtña Channel describe the relationship between water quality patterns and potential sources at this location. The loading capacity and allocations are all concentrations set at the criteria values for enterococci bacteria. This TMDL will clearly meet water quality standards and protect recreational uses at this beach.

TMDL Components. Table 8-42 presents the TMDL for Hagåtña Channel, identifying the loading capacity and allocations expressed as concentration-based values for enterococcus. These concentration-based values apply across all flow zones. This TMDL uses an implicit MOS, through inclusion of two conservative assumptions. First, the TMDL does not account for mixing in the receiving waters and assumes that zero dilution is available. Second, the goal of attaining standards at the point of discharge does not account for losses due to die-off and settling of indicator bacteria that are known to occur.

Table 8-42. Northern Guam Watershed TMDL summary *(Site GUN-10: Hagåtña Channel)*.

TMDL Component	**Enterococcus Concentration** *(# / 100 mL)*
Geometric Mean	
TMDL	**35**
Future Growth	35
Waste Load Allocation	35
Load Allocation	35
Instantaneous Maximum	
TMDL	**104**
Future Growth	104
Waste Load Allocation	104
Load Allocation	104

A hydrology-based framework using duration curve zones allows the TMDL to evaluate monitoring data in a way that reflects major watershed processes indicative of different flows. This approach enables numeric targets in the TMDL to consider watershed processes, such as hydrology and source assessment information including land use.

Table 8-43 identifies reductions for each duration curve zone by season using the TMDL targets. These estimates can serve to guide problem solving discussions on appropriate management strategies (based on knowledge associated with likely source areas, delivery mechanisms, and appropriate control measures that correspond to particular hydrologic conditions).

Table 8-43. Needed reductions to meet TMDL targets *(Site GUN-10: Hagåtña Channel)*.

Needed Reductions	**Flow Conditions** *(expressed as percentage)*				
	High	**Moist**	**Mid**	**Dry**	**Low**
Dry Season					
Based on geometric mean	---	---	---	---	---
Based on instantaneous maximum	48%	---	---	---	---
Wet Season					
Based on geometric mean	38%	---	---	---	---
Based on instantaneous maximum	85%	---	---	---	---

8.15 Paseo Outrigger Ramp (GUN-11)

Paseo Outrigger Ramp is situated on the Hagåtña Channel side of Paseo Beach Park *(Figure 8-128)*. It is along the waterway that connects the Hagåtña Boat Basin to East Hagåtña Bay, serving as an access point from the park. For this reason, this location experiences heavy boating activity by recreational users.

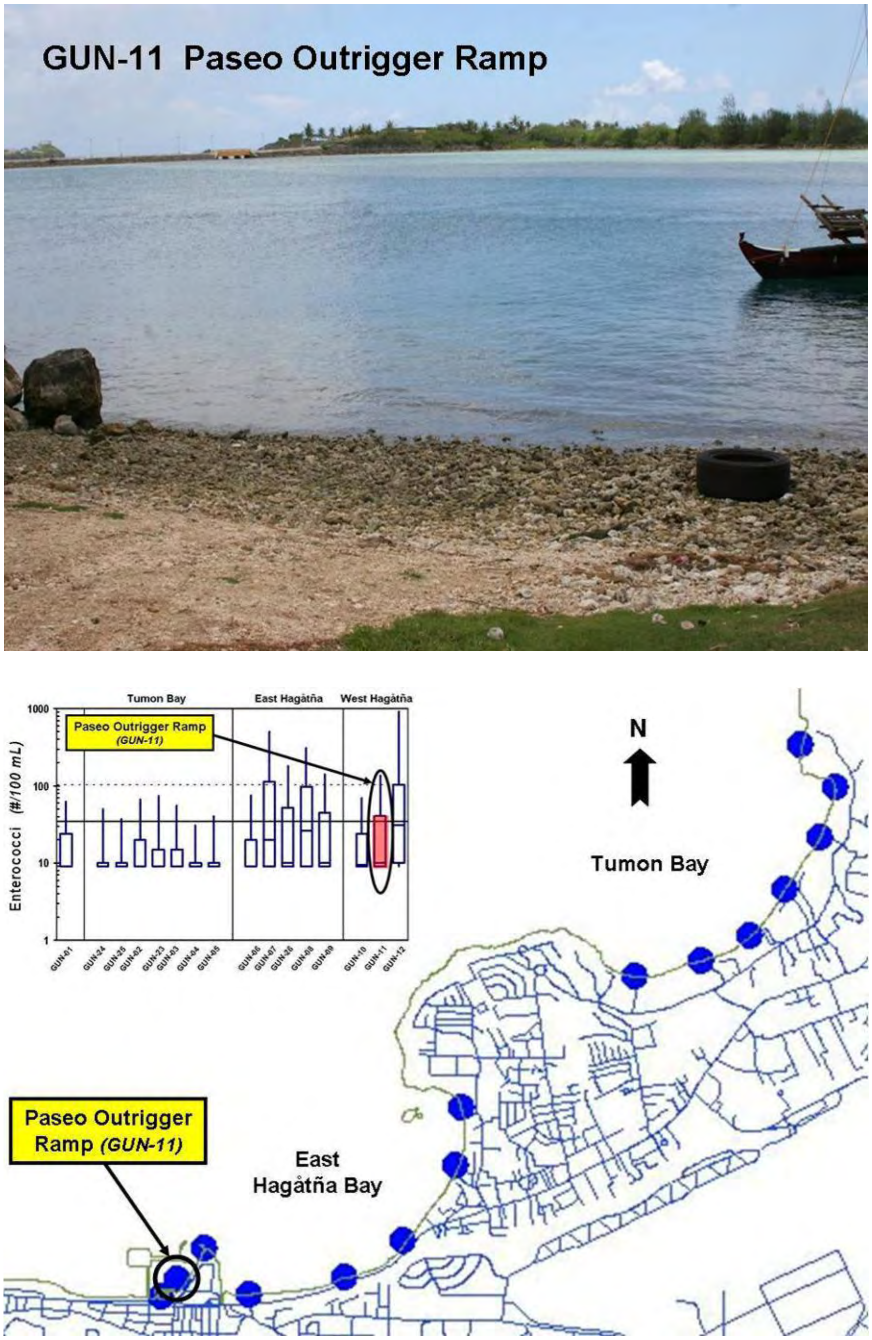

Figure 8-128. Location of Paseo Outrigger Ramp relative to other Northern Guam TMDL sites.

The frequency of beach advisories at Paseo Outrigger Ramp between 1999 and 2007 was relatively high (32%) compared to other RBMP sites in the Northern Beach TMDL project area *(Figure 4-1)*. Enterococci concentrations at Paseo Outrigger Ramp were also high compared to other project area monitoring stations *(Figure 4-2 and Figure 8-128)*. The geometric mean of all individual samples was 24 counts /100mL, while the 75th and 90th percentiles were 41 and 136 counts /100 mL respectively.

A key part of the data analysis for individual beaches is to examine water quality patterns by season and relative to flow conditions (e.g., runoff dominated versus base flows). Figure 8-129 shows the seasonal variability of bacteria concentrations at Paseo Outrigger Ramp. The highest concentrations were observed between June and December, indicating the importance of wet season sources at Paseo Outrigger Ramp.

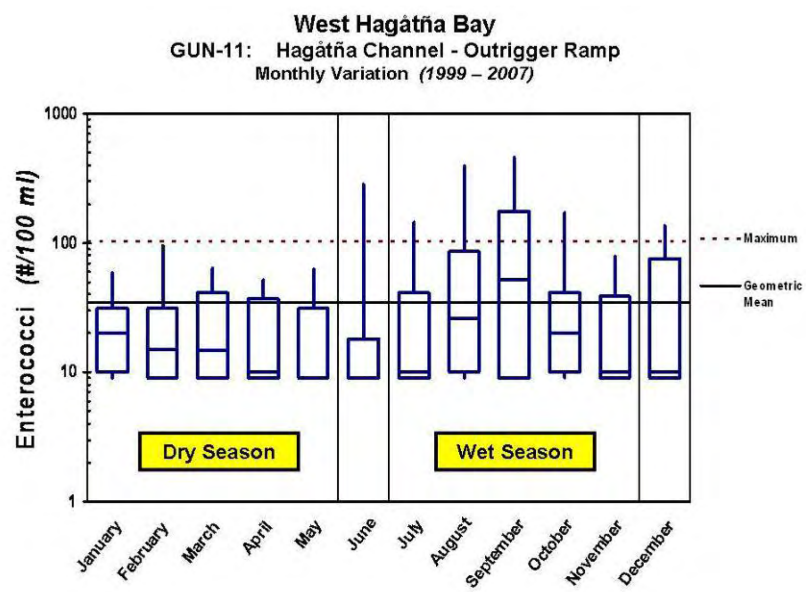

Figure 8-129. Seasonal variation at Paseo Outrigger Ramp.

Effect of Flow Conditions. A useful approach for relating water quality information to potential source areas is to examine bacteria levels in terms of hydrologic conditions. Figure 8-130 shows enterococci monitoring data collected at Paseo Outrigger Ramp using a duration curve framework. Although there is significant variability in the data, which is characteristic of bacteria monitoring information, a definite pattern exists.

As indicated by the *"box and whisker"* plots in Figure 8-130, the highest bacteria concentrations occur under high flow conditions. This is not unexpected because water quality at most beaches is strongly influenced by storm water runoff during heavy rainfall events. The magnitude of the increase is higher than that observed at other Northern Guam RBMP sites. In fact, the geometric mean

exceeded the criterion under high flow conditions, which indicates the need to address storm water sources. This concern is reinforced by the fact that nearly 40 percent of all values in the high flow zone exceed the instantaneous maximum criterion value. Furthermore, the 90th percentile exceeds the instantaneous maximum criterion in the moist zone. This indicates that sources associated with periodic short term problems (e.g., spills into the storm drain system or sewer overflows during rain events) may be a concern under these conditions at Paseo Outrigger Ramp.

Incorporating seasonality into the analysis allows a closer look at patterns that may be associated with certain source categories. For example, bacteria delivered through seeps connected to storm water ponds are more likely to affect beach monitoring data during the wet season. In contrast, bacteria contributed from more continuous sources (e.g., leaky sewer lines or failing septics) will exert a greater effect during the dry season. Comparisons between the geometric means, the 75th and 90th percentiles for each duration curve zone serve as primary measures for examining seasonality. This is illustrated in Figure 8-131.

The patterns observed for both wet and dry seasons in the high, moist, mid-range and dry zones are all generally similar. Wet season values are moderately higher than those observed during the dry season, particularly in the moist, mid-range, and dry zones. These moderately higher wet season values indicate the slight possibility that seeps connected to storm water sources may be affecting water quality at this site.

Relationship to Other Indicators. In addition to seasonal patterns, the relationship of bacteria concentrations to other parameters can be incorporated into the data analysis. Guam EPA staff noted field data for several indicators at the time of bacteria sample collection as part of the RBMP. These include observations such as tidal stage and presence or absence of turbidity.

The combination of patterns with some of these observations could be related to potential source areas and delivery mechanism that might affect bacteria concentrations at any particular beach of interest. For example, the presence or absence of turbidity may also be an indicator of either storm water runoff or suspended material associated with wind action. This approach to the analysis provides information that might prove useful in guiding implementation efforts intended to address documented problems.

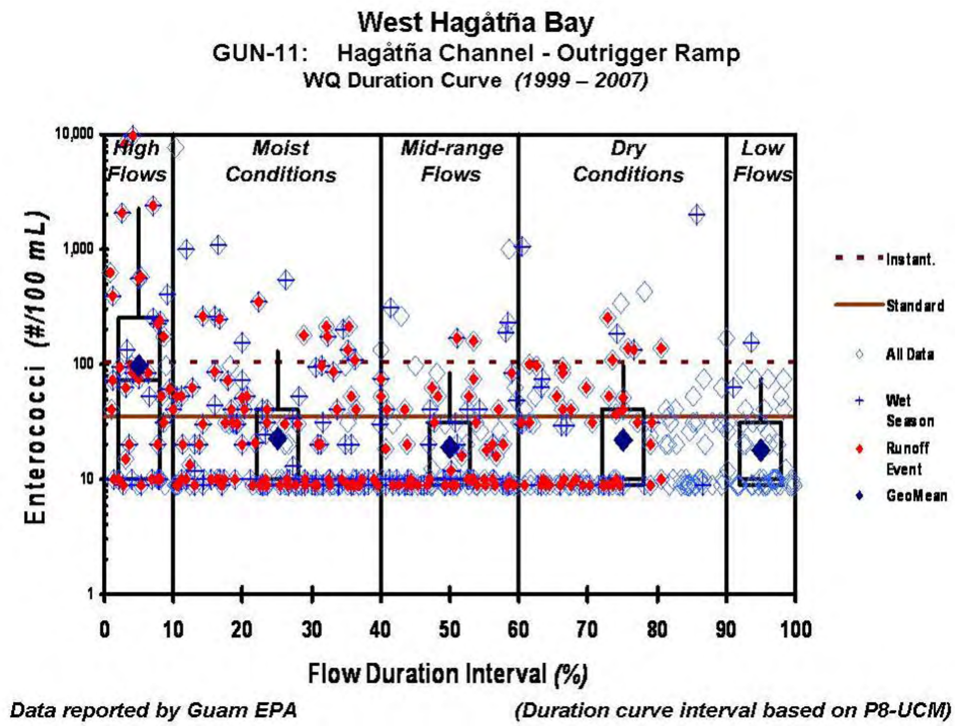

Figure 8-130. Water quality duration curve for Paseo Outrigger Ramp site.

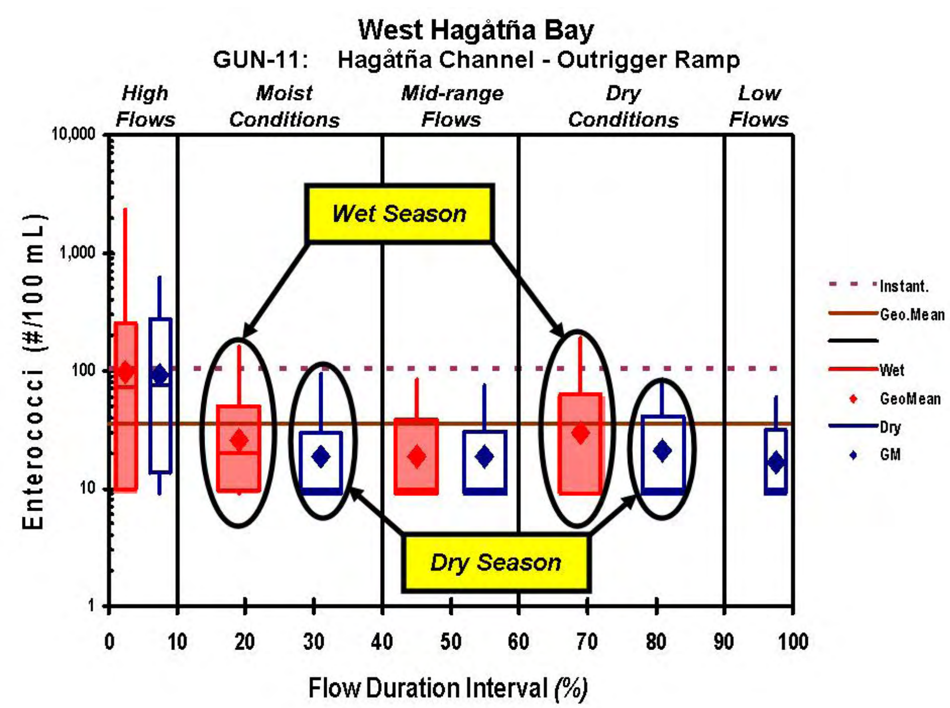

Figure 8-131. Wet versus dry season comparison for Paseo Outrigger Ramp.

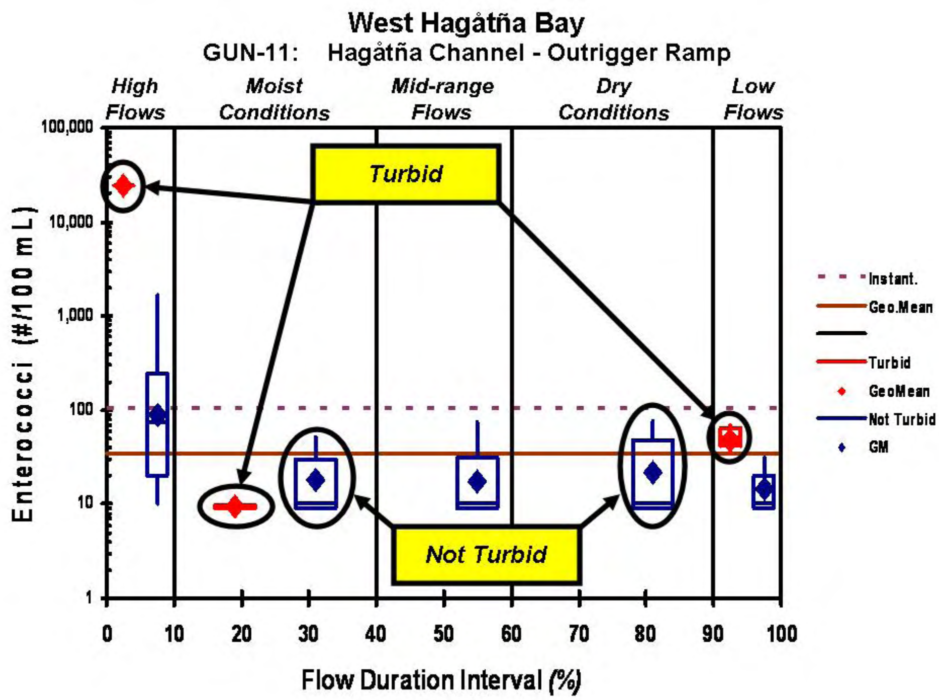

Figure 8-132. Turbid versus non-turbid sample comparison for Paseo Outrigger Ramp site.

Figure 8-132 shows the difference between bacteria levels when turbidity was present or absent during sample collection under the various flow conditions. The increased levels when turbidity was present under high flow conditions likely reflect the effect of bacteria transported with fine particles during storm events. The effect of bacteria associated with resuspension of bottom sediments might also be the result of wind and wave action, which could affect beach water quality.

Potential Sources. The Source Assessment (Section 5, Table 5-2) summarized potential sources that may affect bacteria concentrations at the Paseo Outrigger Ramp. Included are wastewater sources (septic systems, sewer line blockages & breaks, SSO, Agana WWTP), storm water runoff, and other sources (marina, recreational boating, boat discharges). In addition, GEPA staff identified specific potential sources that could affect water quality at the Paseo Outrigger Ramp *(Table 8-44)*.

Figure 8-133 provides a closer look at the Paseo Outrigger Ramp monitoring site relative to upland areas that potentially contribute bacteria during storm events. Figure 8-133 includes roads, which can provide a general indication of the urban drainage network and accompanying storm drains. The map also highlights the location of the Agana WWTP and the Hagåtña Bay Marina.

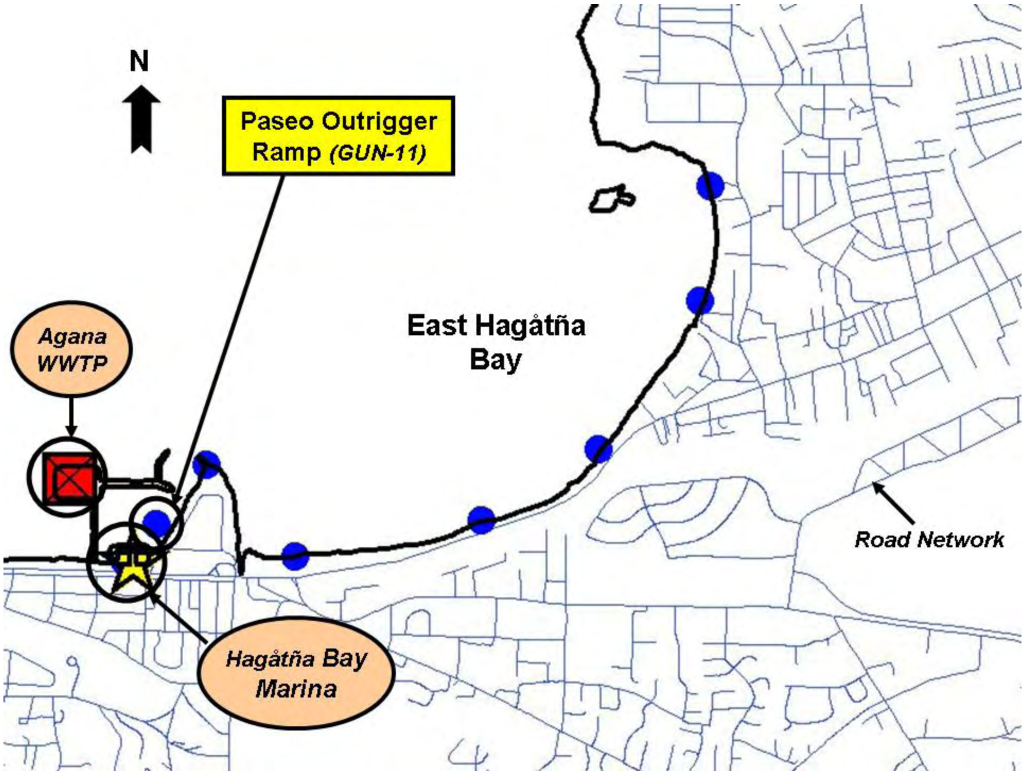

Figure 8-133. Location of Paseo Outrigger Ramp relative to potential source areas.

Table 8-44. Beach specific potential source summary *(Site GUN-11: Paseo Outrigger Ramp)*.

Site ID	Type	Source Name *(notes)*
GUN-11	Wastewater	GWA Hagåtña WWTP Sewage Outfall (old) *Old line is currently cracked on reef margin and connected to system for sporadic use.*
		GWA Hagåtña WWTP Sewage Outfall (new) *New line completed 2009.*
	Storm water runoff	DPW Routes 7 and 7A *Runoff to Hagåtña village and storm drains to West Hagåtña Bay.*
	Storm drain runoff	DPW storm drains *Runoff from Hagåtña village and Route 1.*
	Sewage overflow	Manhole- sewer overflow *Frequent overflows to storm drain leading to West Hagåtña Bay.*

A review of GIS information shows a number of unsewered buildings in the upland area adjacent to Paseo Outrigger Ramp. This information is shown in Figure 8-134. In addition, sewer line blockages and breaks, as well as SSOs could contribute to elevated bacteria levels. Figure 8-134 shows the location of both sewer mains and pump stations, as indicators of potential water quality problems associated with wastewater conveyance systems.

Figure 8-135 shows an air photo of the area adjacent to Paseo Outrigger Ramp. This provides a different perspective, which highlights the high density of roads and buildings in the area adjacent to Paseo Outrigger Ramp.

In addition to previous assessments and GIS information, Guam EPA staff identified other potential sources that could affect water quality at Paseo Outrigger Ramp. Specifically, there is a major DPW storm drain that channels runoff to a discharge point, which may influence bacteria concentrations at this site. Also, surface runoff from Hagåtña village could be exerting an effect on water quality at this location. Finally, the old line associated with the Agana WWTP was cracked on the reef margin, which may have resulted in sporadic increases in enterococci measurements at this monitoring station.

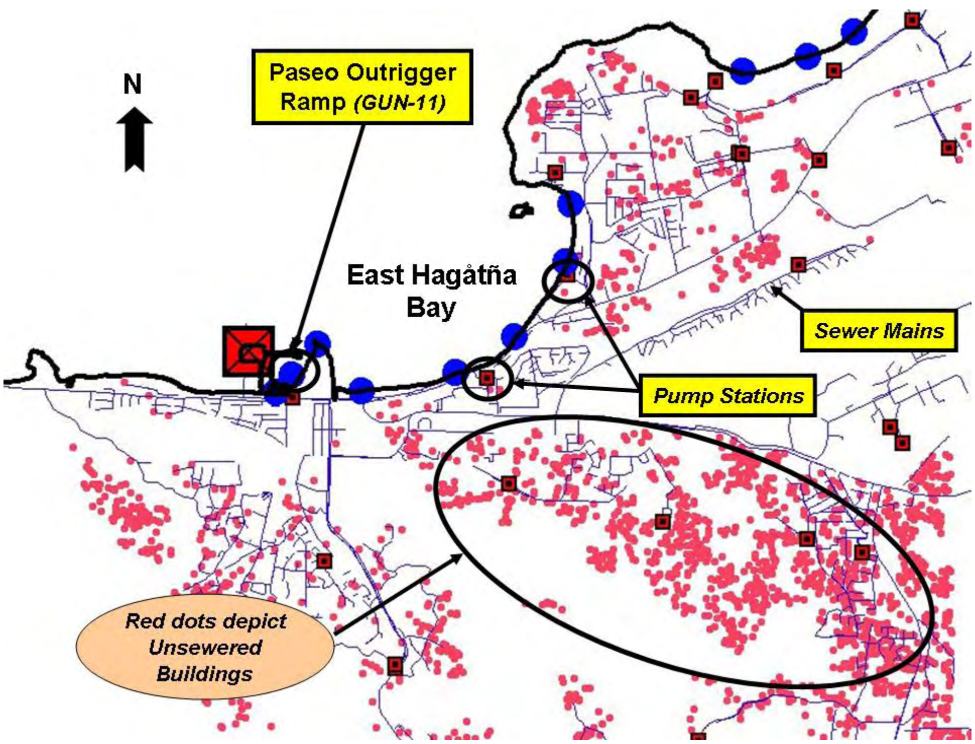

Figure 8-134. Location of Paseo Outrigger Ramp relative to potential unsewered buildings.

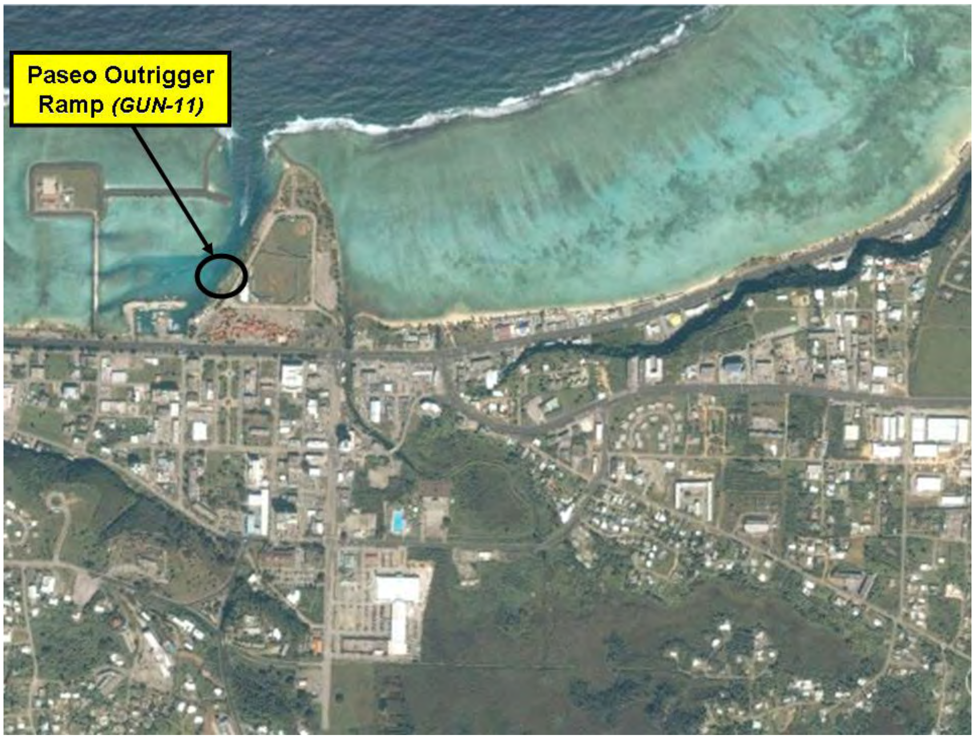

Figure 8-135. Air photo of Paseo Outrigger Ramp vicinity.

Trends. Figure 8-136 presents a year-by-year summary of the enterococcus data for the Paseo Outrigger Ramp site. This provides a useful way to examine trends relative to both central tendency and annual variation. This type of analysis is useful in looking at specific sites where efforts to address beach advisories have been implemented. For example, a focus on patterns such as trends in geometric means or 90th percentiles provides a visual analysis that can be used to evaluate program effectiveness. With respect to trends, it should be noted that a laboratory analytical method change occurred in September 2000. The IDEXX test was used to determine enterococcus concentrations on all samples collected after September 2000.

Linkage Analysis. The numeric target for this TMDL is Guam's concentration-based criteria for enterococci bacteria (i.e., a geometric mean of 35 counts / 100 mL and an instantaneous maximum of 104 counts / 100 mL). The relationship between this target and potential sources at Paseo Outrigger Ramp is demonstrated through an analysis of water quality monitoring data at this site. Seasonal patterns, for example, show that the highest concentrations are observed between June and December, indicating the importance of wet season sources at Paseo Outrigger Ramp. This is consistent with the presence of potential storm water sources identified at this location.

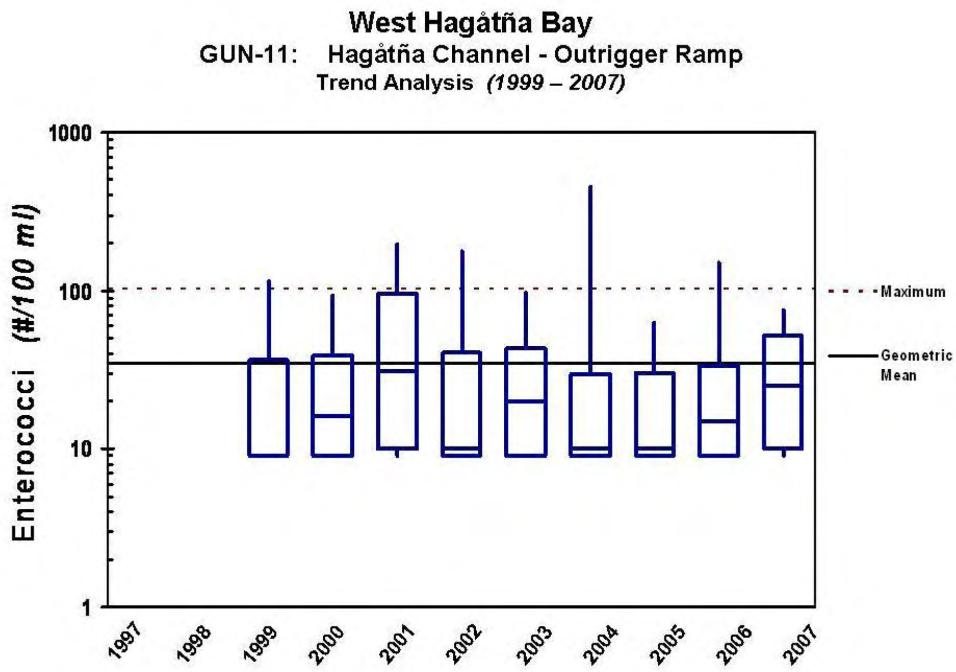

Figure 8-136. Trend analysis for Paseo Outrigger Ramp site.

The connection between storm water sources and exceedances of numeric targets is further confirmed by examining the effect of flow conditions. At Paseo Outrigger Ramp, the highest bacteria concentrations occur under high flows. Water quality conditions that reflect this pattern are strongly influenced by storm water runoff during heavy rainfall events. In short, the technical analyses presented in this assessment of Paseo Outrigger Ramp describe the relationship between water quality patterns and potential sources at this location. The loading capacity and allocations are all concentrations set at the criteria values for enterococci bacteria. This TMDL will clearly meet water quality standards and protect recreational uses at this beach.

TMDL Components. Table 8-45 presents the TMDL for Paseo Outrigger Ramp, identifying the loading capacity and allocations expressed as concentration-based values for enterococcus. These concentration-based values apply across all flow zones. This TMDL uses an implicit MOS, through inclusion of two conservative assumptions. First, the TMDL does not account for mixing in the receiving waters and assumes that zero dilution is available. Second, the goal of attaining standards at the point of discharge does not account for losses due to die-off and settling of indicator bacteria that are known to occur.

Table 8-45. Northern Guam Watershed TMDL summary *(Site GUN-11: Paseo Outrigger Ramp)*.

TMDL Component	Enterococcus Concentration *(# / 100 mL)*
Geometric Mean	
TMDL	**35**
Future Growth	35
Waste Load Allocation	35
Load Allocation	35
Instantaneous Maximum	
TMDL	**104**
Future Growth	104
Waste Load Allocation	104
Load Allocation	104

A hydrology-based framework using duration curve zones allows the TMDL to evaluate monitoring data in a way that reflects major watershed processes indicative of different flows. This approach enables numeric targets in the TMDL to consider watershed processes, such as hydrology and source assessment information including land use.

Table 8-46 identifies reductions for each duration curve zone by season using the TMDL targets. These estimates can serve to guide problem solving discussions on appropriate management strategies (based on knowledge associated with likely source areas, delivery mechanisms, and appropriate control measures that correspond to particular hydrologic conditions).

Table 8-46. Needed reductions to meet TMDL targets *(Site GUN-11: Paseo Outrigger Ramp)*.

Needed Reductions	Flow Conditions *(expressed as percentage)*				
	High	Moist	Mid	Dry	Low
Dry Season					
Based on geometric mean	62%	---	---	---	---
Based on instantaneous maximum	83%	---	---	---	---
Wet Season					
Based on geometric mean	64%	---	---	---	---
Based on instantaneous maximum	96%	34%	---	44%	---

8.16 Hagåtña Boat Basin (GUN-12)

Hagåtña Boat Basin is situated along the waterfront in the city of Hagåtña *(Figure 8-137)*. It is the principal location in the project area for boating activity that accesses Hagåtña Bay.

Figure 8-137. Location of Hagåtña Boat Basin relative to other Northern Guam TMDL sites.

The frequency of beach advisories at the Hagåtña Boat Basin between 1997 and 2007 was very high (58%) compared to other RBMP sites in the Northern Beach TMDL project area *(Figure 4-1)*. Enterococci concentrations at the Hagåtña Boat Basin were also quite high compared to other project area monitoring stations *(Figure 4-2 and Figure 8-137)*. The geometric mean of all individual samples was 48 counts /100mL, while the 75th and 90th percentiles were 104 and 921 counts /100 mL respectively.

A key part of the data analysis for individual beaches is to examine water quality patterns by season and relative to flow conditions (e.g., runoff dominated versus base flows). Figure 8-138 shows the seasonal variability of bacteria concentrations at the Hagåtña Boat Basin. High concentrations were observed all year, indicating the importance of both wet and dry season sources at Hagåtña Boat Basin.

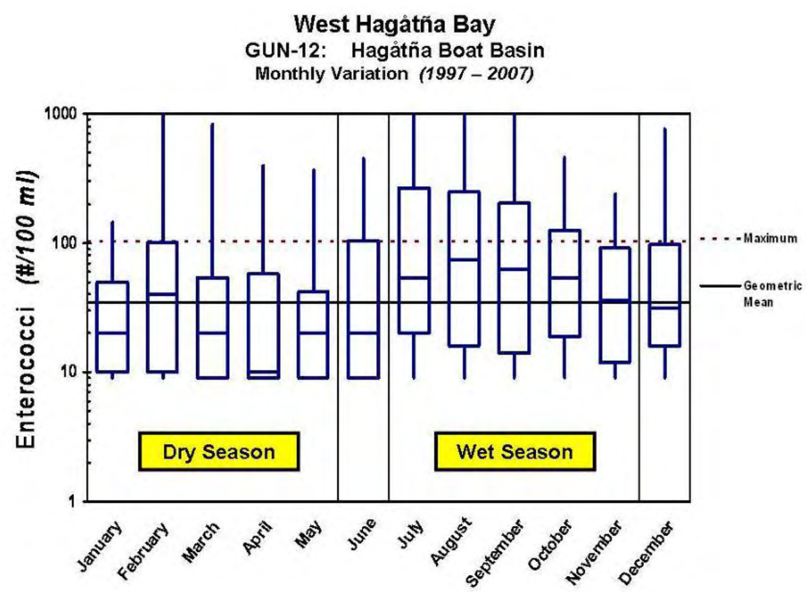

Figure 8-138. Seasonal variation at Hagåtña Boat Basin.

Effect of Flow Conditions. A useful approach for relating water quality information to potential source areas is to examine bacteria levels in terms of hydrologic conditions. Figure 8-139 shows enterococci monitoring data collected at the Hagåtña Boat Basin using a duration curve framework. Although there is significant variability in the data, which is characteristic of bacteria monitoring information, a definite pattern exists.

As indicated by the *"box and whisker"* plots in Figure 8-139, the highest bacteria concentrations occur under high flow conditions. This is not unexpected because water quality at most beaches is strongly influenced by storm water runoff during heavy rainfall events. The magnitude of the increase is significantly higher than that observed at other Northern Guam RBMP sites. In fact, the geometric mean exceeded the criterion under the high, moist, and mid-range conditions. This highlights concerns at this site for storm water sources, as well as other potential sources of bacteria contamination. This concern is also confirmed by the fact that nearly 70 percent of all values in the high flow zone and over 30 percent of all values in the moist zone exceed the instantaneous maximum criterion value. Furthermore, the 90th percentile exceeds the instantaneous maximum criterion value across all zones except low flows. This indicates that sources other than storm water are adversely affecting bacteria concentrations at the Hagåtña Boat Basin.

Incorporating seasonality into the analysis allows a closer look at patterns that may be associated with certain source categories. For example, bacteria delivered through seeps connected to storm water ponds are more likely to affect beach monitoring data during the wet season. In contrast, bacteria contributed from more continuous sources (e.g., leaky sewer lines or failing septics) will exert a greater effect during the dry season. Comparisons between the geometric means, the 75th and 90th percentiles for each duration curve zone serve as primary measures for examining seasonality. This is illustrated in Figure 8-140.

The patterns observed for both wet and dry seasons in the high, moist, mid-range and dry zones are all quite similar. Storm water and other sources appear to have approximately the same effect under those conditions at the Hagåtña Boat Basin. This confirms observations made regarding Figure 8-138 and Figure 8-139. Numerous sources appear to affect bacteria concentrations at this site and seasonal differences do not appear to be a factor.

Relationship to Other Indicators. In addition to seasonal patterns, the relationship of bacteria concentrations to other parameters can be incorporated into the data analysis. Guam EPA staff noted field data for several indicators at the time of bacteria sample collection as part of the RBMP. These include observations such as tidal stage and presence or absence of turbidity.

The combination of patterns with some of these observations could be related to potential source areas and delivery mechanism that might affect bacteria concentrations at any particular beach of interest. For example, the presence or absence of turbidity may also be an indicator of either storm water runoff or suspended material associated with wind action. This approach to the analysis provides information that might prove useful in guiding implementation efforts intended to address documented problems.

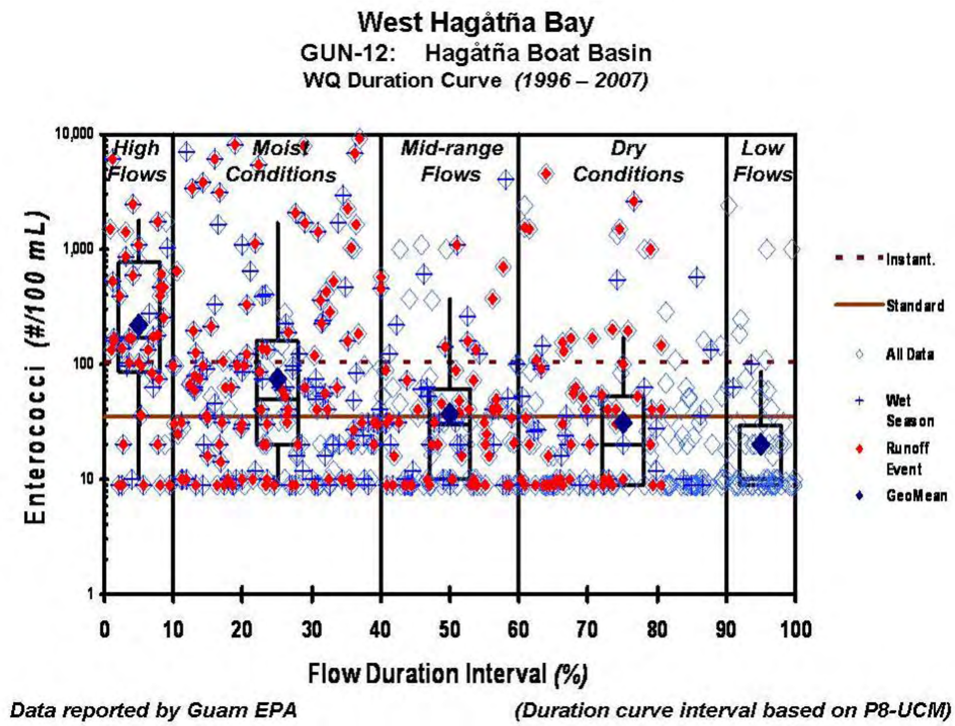

Figure 8-139. Water quality duration curve for Hagåtña Boat Basin site.

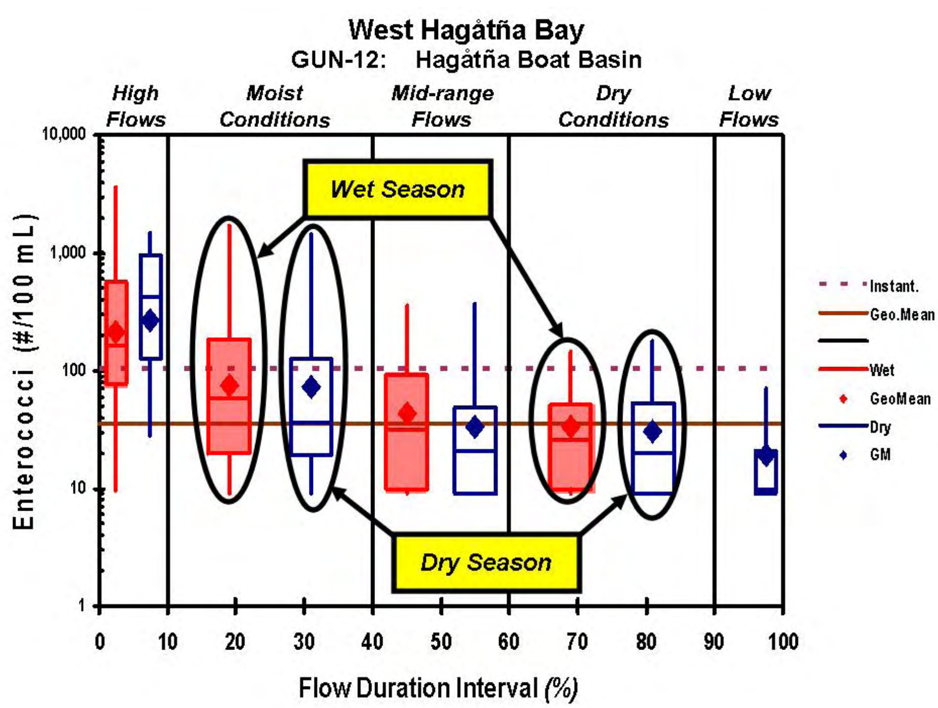

Figure 8-140. Wet versus dry season comparison for Hagåtña Boat Basin.

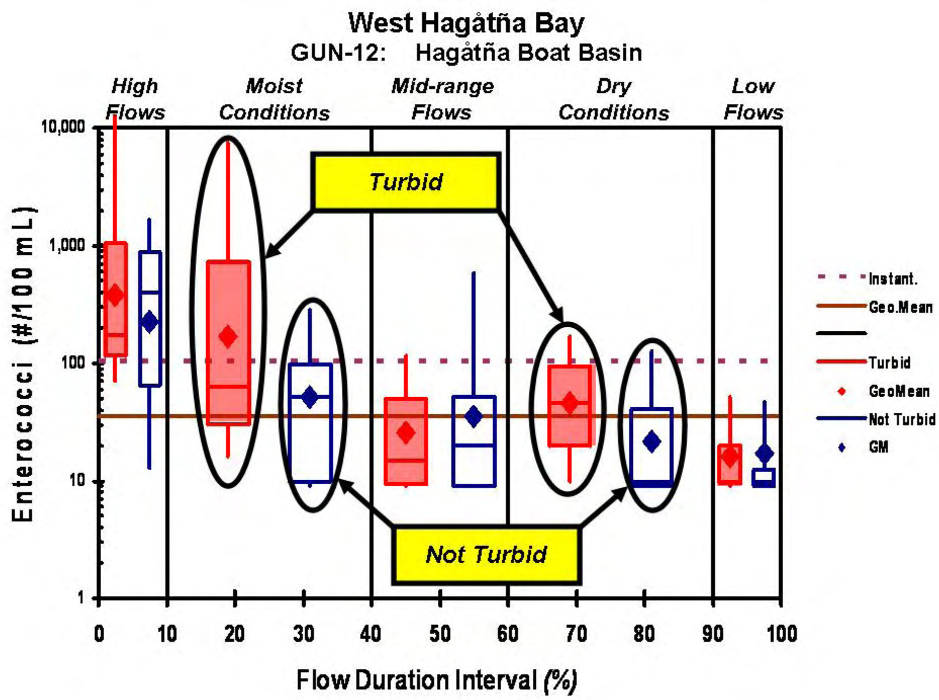

Figure 8-141. Turbid versus non-turbid sample comparison for Hagåtña Boat Basin site.

Figure 8-141 shows the difference between bacteria levels when turbidity was present or absent during sample collection under the various flow conditions. The increased levels when turbidity was present under high, moist, and mid-range flow conditions likely reflects the effect of bacteria transported with fine particles during storm events. The effect of bacteria associated with resuspension of bottom sediments might also be the result of wind and wave action, which could affect beach water quality.

Potential Sources. The Source Assessment (Section 5, Table 5-2) summarized potential sources that may affect bacteria concentrations at the Hagåtña Boat Basin. Included are wastewater sources (septic systems, sewer line blockages & breaks, SSO, Agana WWTP), storm water runoff, and other sources (marina, recreational boating, boat discharges). In addition, GEPA staff identified specific potential sources that could affect water quality at the Hagåtña Boat Basin *(Table 8-47)*.

Figure 8-142 provides a closer look at the Hagåtña Boat Basin monitoring site relative to upland areas that potentially contribute bacteria during storm events. Figure 8-142 includes roads, which can provide a general indication of the urban drainage network and accompanying storm drains. The map also highlights the location of the Agana WWTP and the Hagåtña Bay Marina.

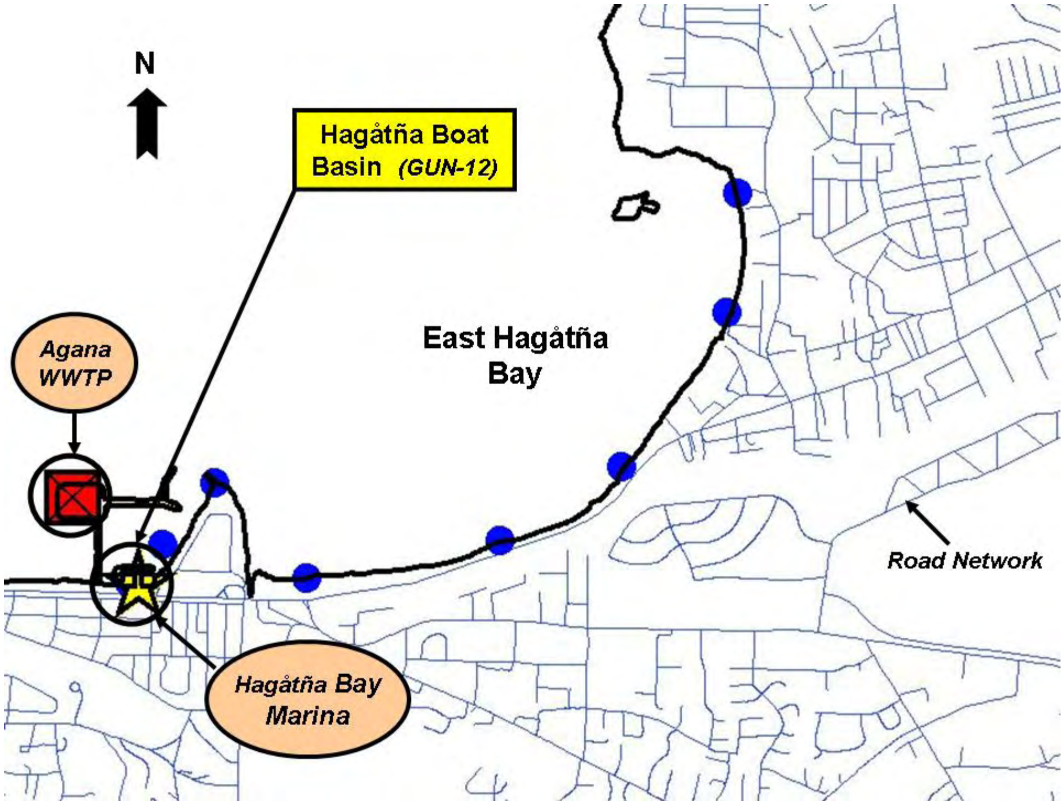

Figure 8-142. Location of Hagåtña Boat Basin relative to potential source areas.

Table 8-47. Beach specific potential source summary *(Site GUN-12: Hagåtña Boat Basin)*.

Site ID	Type	Source Name *(notes)*
GUN-12	Wastewater	GWA Hagåtña WWTP Sewage Outfall (old) *Old line is currently cracked on reef margin and connected to system for sporadic use.*
		GWA Hagåtña WWTP Sewage Outfall (new) *New line completed 2009.*
	Storm water runoff	DPW Routes 7 and 7A *Runoff to Hagåtña village and storm drains to West Hagåtña Bay.*
	Storm drain runoff	DPW storm drains *Runoff from Hagåtña village and Route 1.*
	Sewage overflow	Manhole- sewer overflow *Frequent overflows to storm drain leading to West Hagåtña Bay.*

A review of GIS information shows a number of unsewered buildings in the upland area adjacent to the Hagåtña Boat Basin. This information is shown in Figure 8-143. In addition, sewer line blockages and breaks, as well as SSOs, could contribute to elevated bacteria levels. Figure 8-143 shows the location of both sewer mains and pump stations, as indicators of potential water quality problems associated with wastewater conveyance systems.

Figure 8-144 shows an air photo of the area adjacent to the Hagåtña Boat Basin. This provides a different perspective, which highlights the high density of roads and buildings in the area adjacent to Hagåtña Boat Basin.

In addition to previous assessments and GIS information, Guam EPA staff identified other potential sources that could affect water quality at the Hagåtña Boat Basin. Specifically, there is a major DPW storm drain that channels runoff to a discharge point that may influence bacteria concentrations at this site. Also, surface runoff from Hagåtña village could be exerting an effect on water quality at this location. Finally, the old line associated with the Agana WWTP was cracked on the reef margin, which may have resulted in sporadic increases in enterococci measurements at this monitoring station.

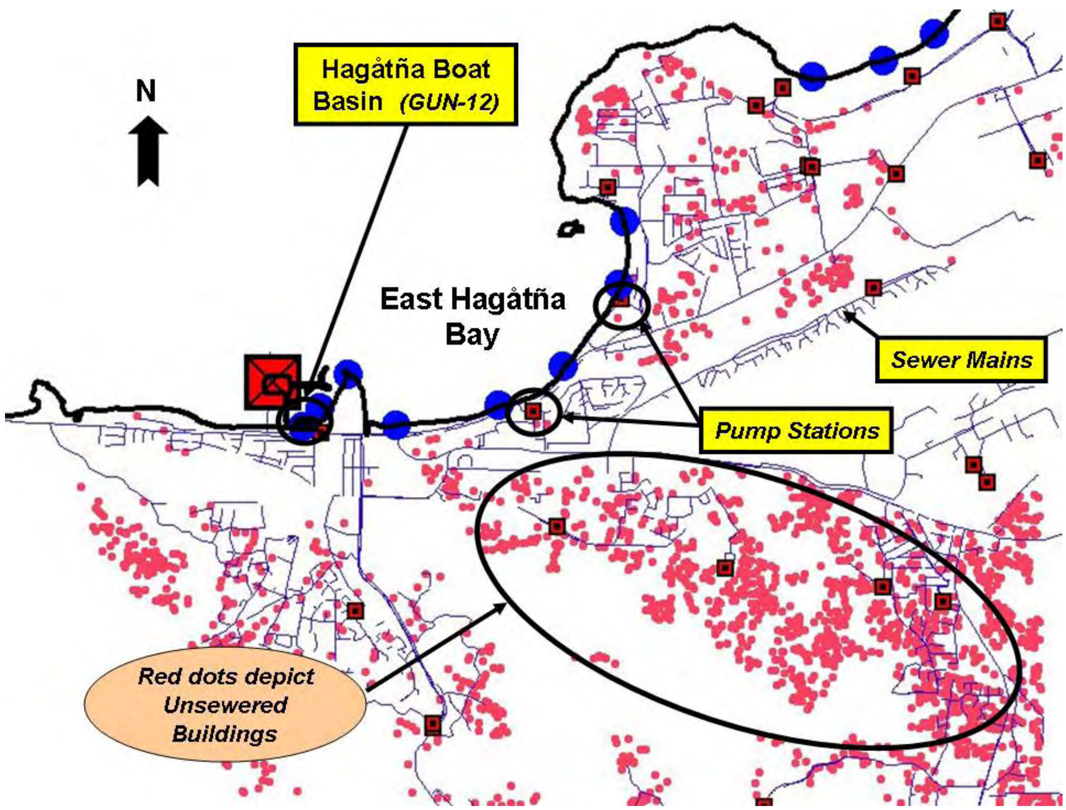

Figure 8-143. Location of Hagåtña Boat Basin relative to potential unsewered buildings.

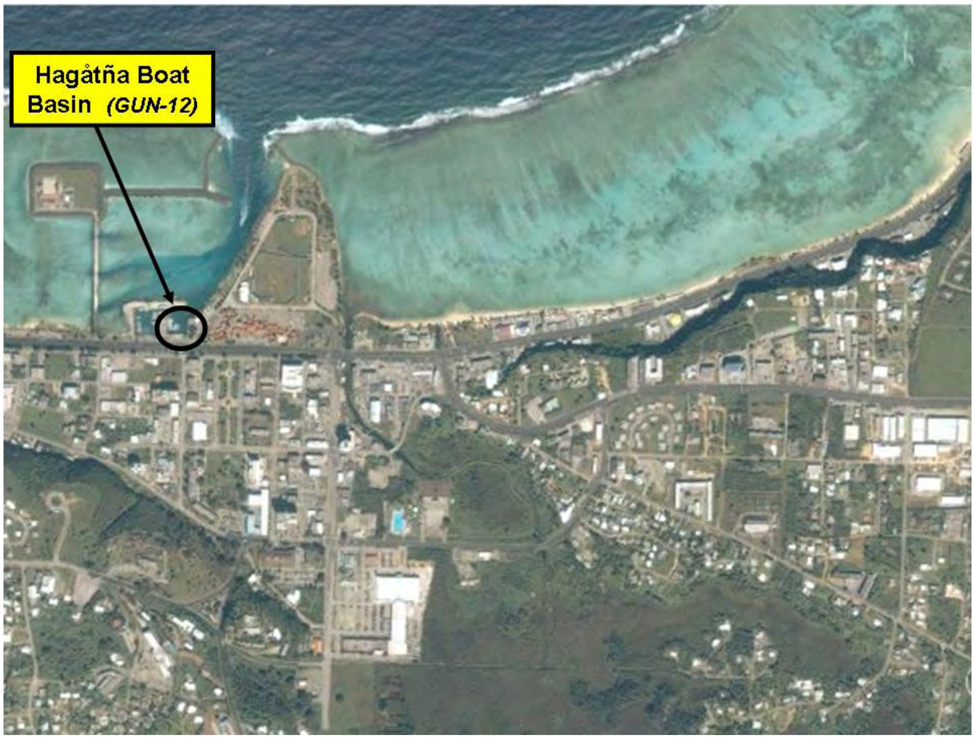

Figure 8-144. Air photo of Hagåtña Boat Basin vicinity.

Trends. Figure 8-145 presents a year-by-year summary of the enterococcus data for the Hagåtña Boat Basin site. This provides a useful way to examine trends relative to both central tendency and annual variation. This type of analysis is useful in looking at specific sites where efforts to address beach advisories have been implemented. For example, a focus on patterns such as trends in geometric means or 90th percentiles provides a visual analysis that can be used to evaluate program effectiveness. With respect to trends, it should be noted that a laboratory analytical method change occurred in September 2000. The IDEXX test was used to determine enterococcus concentrations on all samples collected after September 2000.

Linkage Analysis. The numeric target for this TMDL is Guam's concentration-based criteria for enterococci bacteria (i.e., a geometric mean of 35 counts / 100 mL and an instantaneous maximum of 104 counts / 100 mL). The relationship between this target and potential sources at the Hagåtña Boat Basin is demonstrated through an analysis of water quality monitoring data at this site. Seasonal patterns, for example, show that the highest concentrations are observed all year, indicating the importance of wet season sources at the Hagåtña Boat Basin. This is consistent with the presence of potential storm water sources identified at this location.

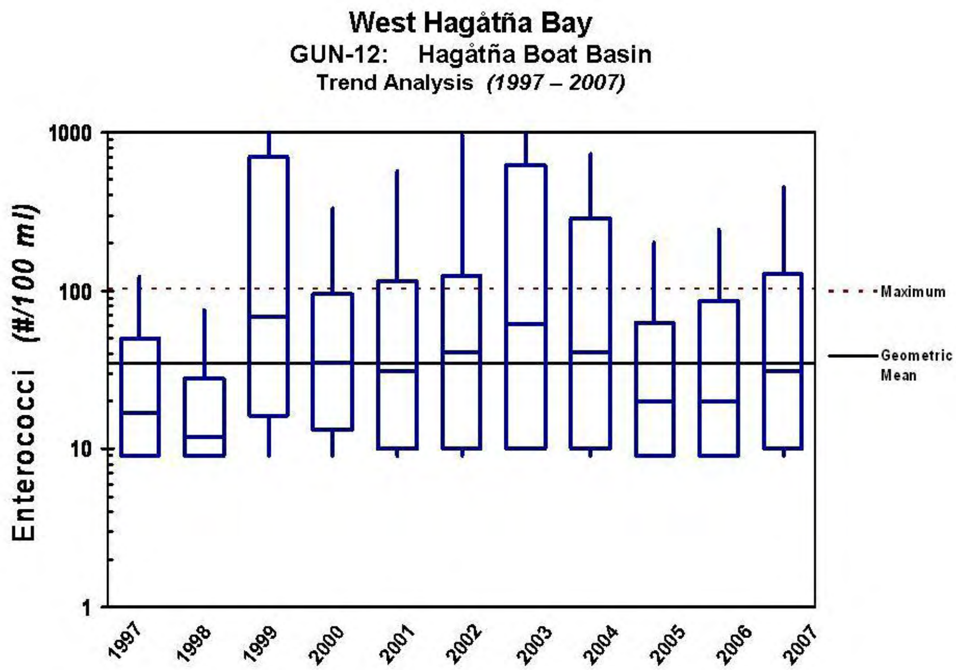

Figure 8-145. Trend analysis for Hagåtña Boat Basin site.

The connection between storm water sources and exceedances of numeric targets is further confirmed by examining the effect of flow conditions. At the Hagåtña Boat Basin, the highest bacteria concentrations occur under high flows. Water quality conditions that reflect this pattern are strongly influenced by storm water runoff during heavy rainfall events. In short, the technical analyses presented in this assessment of the Hagåtña Boat Basin describe the relationship between water quality patterns and potential sources at this location. The loading capacity and allocations are all concentrations set at the criteria values for enterococci bacteria. This TMDL will clearly meet water quality standards and protect recreational uses at this beach.

TMDL Components. Table 8-48 presents the TMDL for the Hagåtña Boat Basin, identifying the loading capacity and allocations expressed as concentration-based values for enterococcus. These concentration-based values apply across all flow zones. This TMDL uses an implicit MOS, through inclusion of two conservative assumptions. First, the TMDL does not account for mixing in the receiving waters and assumes that zero dilution is available. Second, the goal of attaining standards at the point of discharge does not account for losses due to die-off and settling of indicator bacteria that are known to occur.

Table 8-48. Northern Guam Watershed TMDL summary *(Site GUN-12: Hagåtña Boat Basin)*.

TMDL Component	Enterococcus Concentration *(# / 100 mL)*
Geometric Mean	
TMDL	**35**
Future Growth	35
Waste Load Allocation	35
Load Allocation	35
Instantaneous Maximum	
TMDL	**104**
Future Growth	104
Waste Load Allocation	104
Load Allocation	104

A hydrology-based framework using duration curve zones allows the TMDL to evaluate monitoring data in a way that reflects major watershed processes indicative of different flows. This approach enables numeric targets in the TMDL to consider watershed processes, such as hydrology and source assessment information including land use.

Table 8-49 identifies reductions for each duration curve zone by season using the TMDL targets. These estimates can serve to guide problem solving discussions on appropriate management strategies (based on knowledge associated with likely source areas, delivery mechanisms, and appropriate control measures that correspond to particular hydrologic conditions).

Table 8-49. Needed reductions to meet TMDL targets *(Site GUN-12: Hagåtña Boat Basin)*.

Needed Reductions	Flow Conditions *(expressed as percentage)*				
	High	**Moist**	**Mid**	**Dry**	**Low**
Dry Season					
Based on geometric mean	87%	51%	---	---	---
Based on instantaneous maximum	93%	93%	72%	42%	---
Wet Season					
Based on geometric mean	83%	54%	20%	---	---
Based on instantaneous maximum	97%	94%	71%	28%	---

8.17 Hagåtña Bayside Park (GUN-13)

Hagåtña Bayside Park is situated along the waterfront in the city of Hagåtña *(Figure 8-146)*. It is located just west of the Hagåtña Boat Basin. The beach is used destination for jet skiing, parasailing, and other water vehicle type activities. The close proximity of this beach to the Hagåtña Boat Basin warrants its inclusion in the project area for these TMDLs.

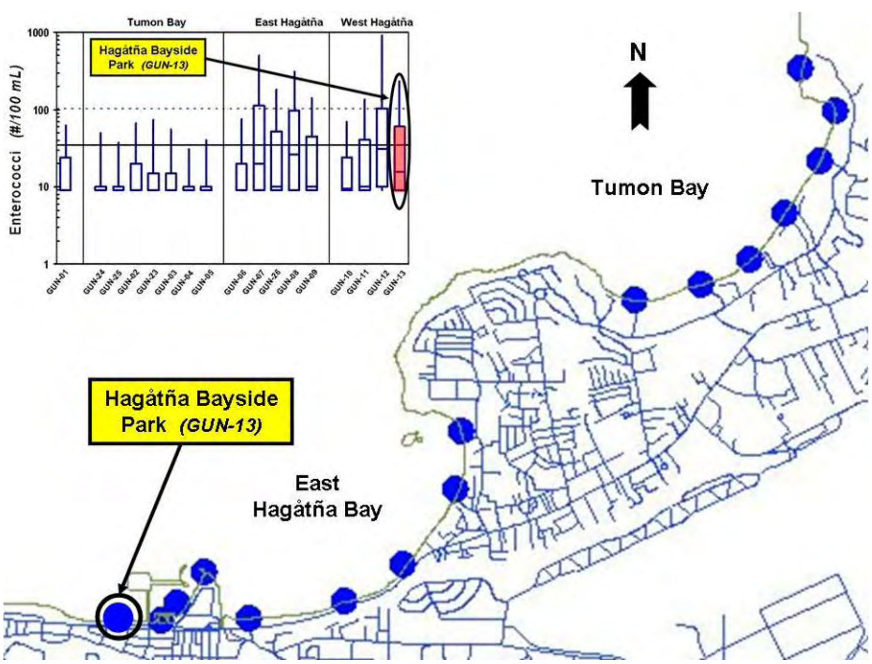

Figure 8-146. Location of Hagåtña Bayside Park relative to other Northern Guam TMDL sites.

The frequency of beach advisories at the Hagåtña Bayside Park between 1997 and 2007 was relatively high (39%) compared to other RBMP sites in the Northern Beach TMDL project area *(Figure 4-1)*. Enterococci concentrations at the Hagåtña Bayside Park were also higher compared to other project area monitoring stations *(Figure 4-2 and Figure 8-146)*. The geometric mean of all individual samples was 28 counts /100mL, while the 75th and 90th percentiles were 60 and 234 counts /100 mL respectively.

A key part of the data analysis for individual beaches is to examine water quality patterns by season and relative to flow conditions (e.g., runoff dominated versus base flows). Figure 8-147 shows the seasonal variability of bacteria concentrations at the Hagåtña Bayside Park. The highest concentrations were observed between June and October, indicating the importance of wet season sources at Hagåtña Bayside Park. The 75th and 90th percentiles were also elevated during the other months. This shows that dry season sources can occasional influence water quality at this site.

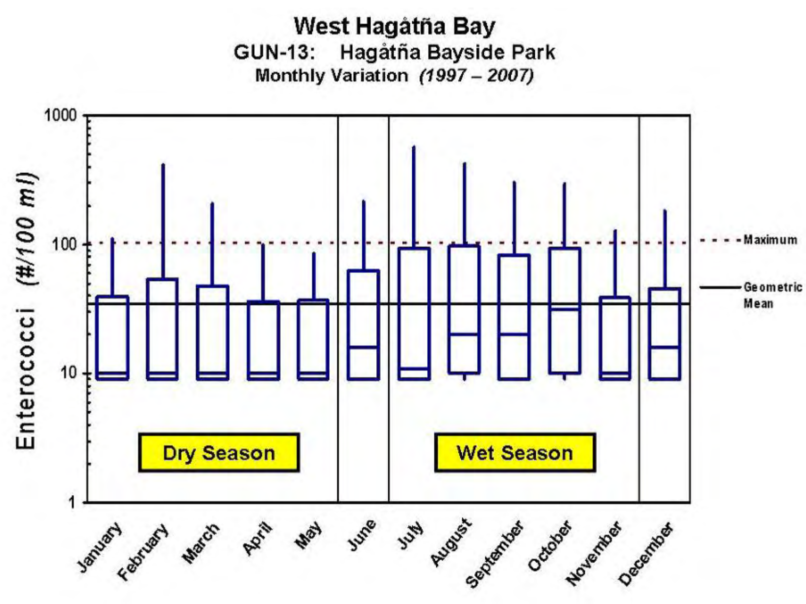

Figure 8-147. Seasonal variation at Hagåtña Bayside Park.

Effect of Flow Conditions. A useful approach for relating water quality information to potential source areas is to examine bacteria levels in terms of hydrologic conditions. Figure 8-148 shows enterococci monitoring data collected at the Hagåtña Bayside Park using a duration curve framework. Although there is significant variability in the data, which is characteristic of bacteria monitoring information, a definite pattern exists.

As indicated by the *"box and whisker"* plots in Figure 8-148, the highest bacteria concentrations occur under high flow conditions. This is not unexpected because water quality at most beaches is strongly influenced by storm water runoff during

heavy rainfall events. The magnitude of the increase is significantly higher than that observed at other Northern Guam RBMP sites. In fact, the geometric mean exceeded the criterion under high and moist conditions, which indicates the need to address storm water sources. This concern is reinforced by the fact that over 50 percent of all values in the high flow zone exceed the instantaneous maximum criterion value. Furthermore, the 90^{th} percentile exceeds the instantaneous maximum criterion in the moist and dry zones. This indicates that sources associated with periodic short term problems (e.g., spills into the storm drain system or sewer overflows during rain events) may be a concern under these conditions at Hagåtña Bayside Park Beach.

Incorporating seasonality into the analysis allows a closer look at patterns that may be associated with certain source categories. For example, bacteria delivered through seeps connected to storm water ponds are more likely to affect beach monitoring data during the wet season. In contrast, bacteria contributed from more continuous sources (e.g., leaky sewer lines or failing septics) will exert a greater effect during the dry season. Comparisons between the geometric means, the 75^{th} and 90^{th} percentiles for each duration curve zone serve as primary measures for examining seasonality. This is illustrated in Figure 8-149.

The patterns observed for both wet and dry seasons in the high and moist zones are all quite similar. Storm water and other sources appear to have approximately the same effect under those conditions at the Hagåtña Bayside Park. This confirms observations made regarding Figure 8-147 and Figure 8-148. One interesting observation is the higher bacteria concentrations during the dry season across the mid-range and dry zones. This is likely due to the effect of problems at the Agana WWTP, which would tend to be more pronounced when wet weather sources are less of a concern.

Relationship to Other Indicators. In addition to seasonal patterns, the relationship of bacteria concentrations to other parameters can be incorporated into the data analysis. Guam EPA staff noted field data for several indicators at the time of bacteria sample collection as part of the RBMP. These include observations such as tidal stage and presence or absence of turbidity.

The combination of patterns with some of these observations could be related to potential source areas and delivery mechanism that might affect bacteria concentrations at any particular beach of interest. For example, the presence or absence of turbidity may also be an indicator of either storm water runoff or suspended material associated with wind action. This approach to the analysis provides information that might prove useful in guiding implementation efforts intended to address documented problems.

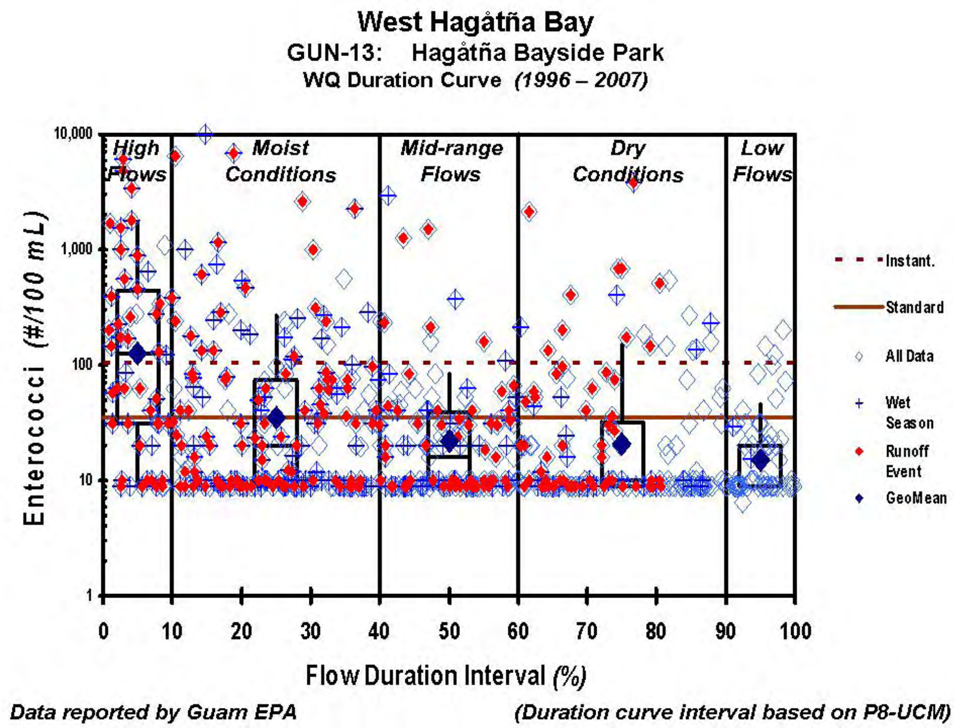

Figure 8-148. Water quality duration curve for Hagåtña Bayside Park site.

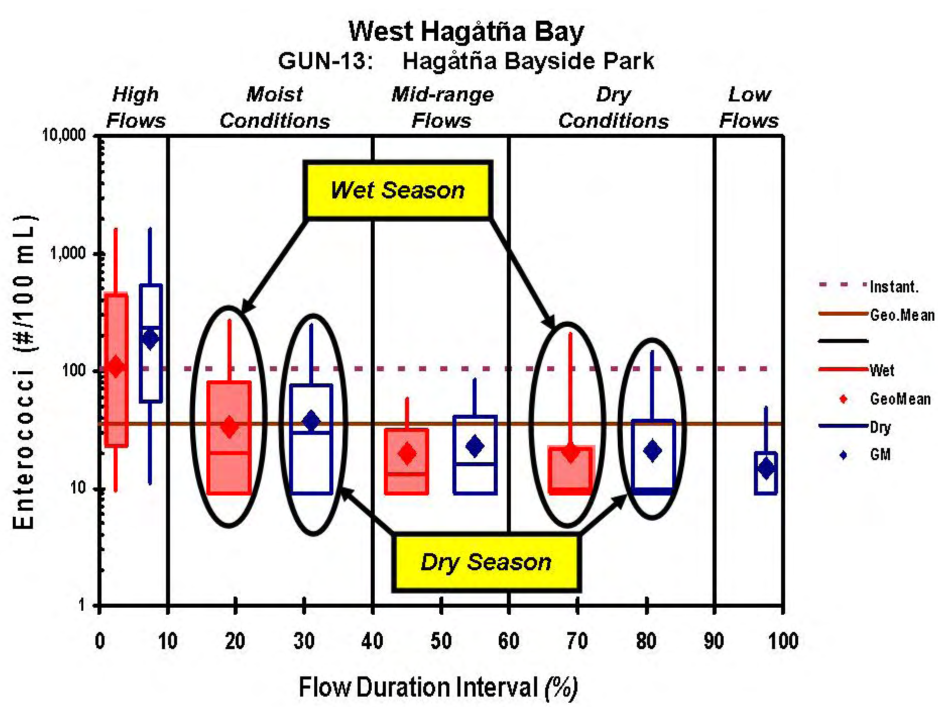

Figure 8-149. Wet versus dry season comparison for Hagåtña Bayside Park.

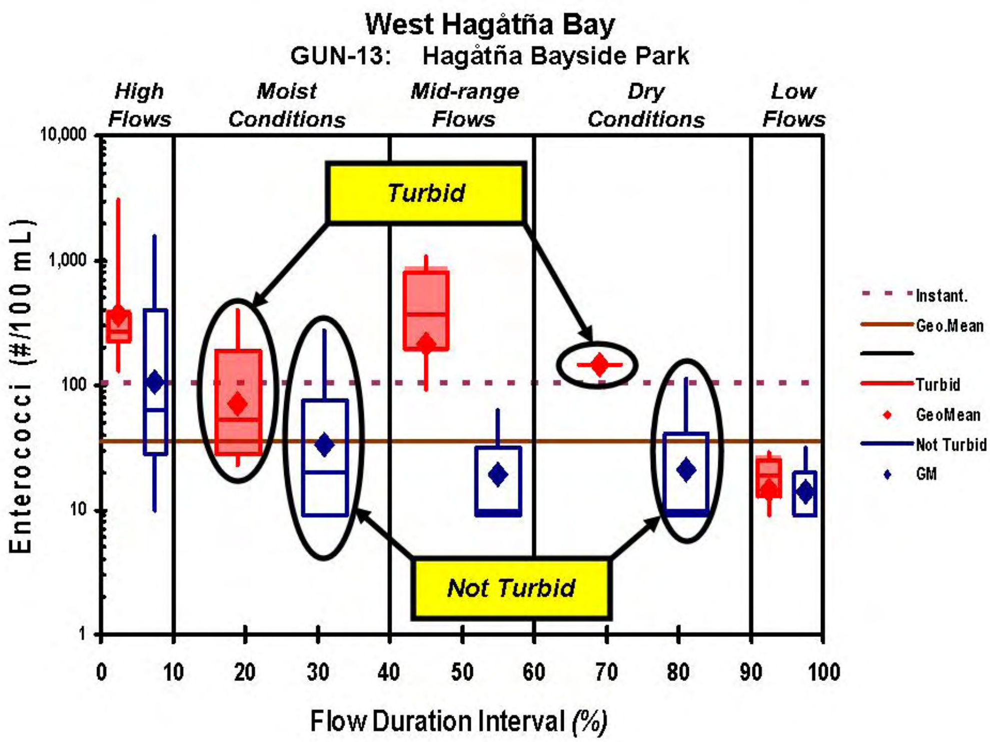

Figure 8-150. Turbid versus non-turbid sample comparison for Hagåtña Bayside Park site.

Figure 8-150 shows the difference between bacteria levels when turbidity was present or absent during sample collection under the various flow conditions. The increased levels when turbidity was present under high, moist, mid-range, and dry flow conditions likely reflects the effect of bacteria transported with fine particles during storm events. The effect of bacteria associated with resuspension of bottom sediments might also be the result of wind and wave action, which could affect beach water quality.

Potential Sources. The Source Assessment (Section 5, Table 5-2) summarized potential sources that may affect bacteria concentrations at the Hagåtña Bayside Park. Included are wastewater sources (septic systems, sewer line blockages & breaks, SSO, Agana WWTP), storm water runoff, and other sources (marina, recreational boating, boat discharges). In addition, GEPA staff identified specific potential sources that could affect water quality at Hagåtña Bayside Park *(Table 8-50)*.

Table 8-50. Beach specific potential source summary *(Site GUN-13: Hagåtña Bayside Park)*.

Site ID	Type	Source Name *(notes)*
GUN-13	Wastewater	GWA Hagåtña WWTP Sewage Outfall (new) *New line completed 2009.*
		Septic systems *Concentrated number of unsewered buildings in upland area adjacent to beach*
		Wastewater pumping activities (portable toilets).
	Storm water runoff	DPW Routes 7 and 7A *Runoff to Hagåtña village and storm drains to West Hagåtña Bay.*
	Storm drain runoff	DPW storm drains *Runoff from Hagåtña village and Route 1.*
	Sewage overflow	Manhole- sewer overflow *Frequent overflows to storm drain leading to West Hagåtña Bay.*
	UIC - SW *	US District Court *(3 locations)*
		Oil collection activities *(facility)*

Notes: * UIC - SW: Underground Injection Control – Storm Water

Figure 8-151 provides a closer look at the Hagåtña Bayside Park monitoring site relative to upland areas that potentially contribute bacteria during storm events. Figure 8-151 includes roads, which can provide a general indication of the urban drainage network and accompanying storm drains. The map also highlights the location of the Agana WWTP and the Hagåtña Bay Marina.

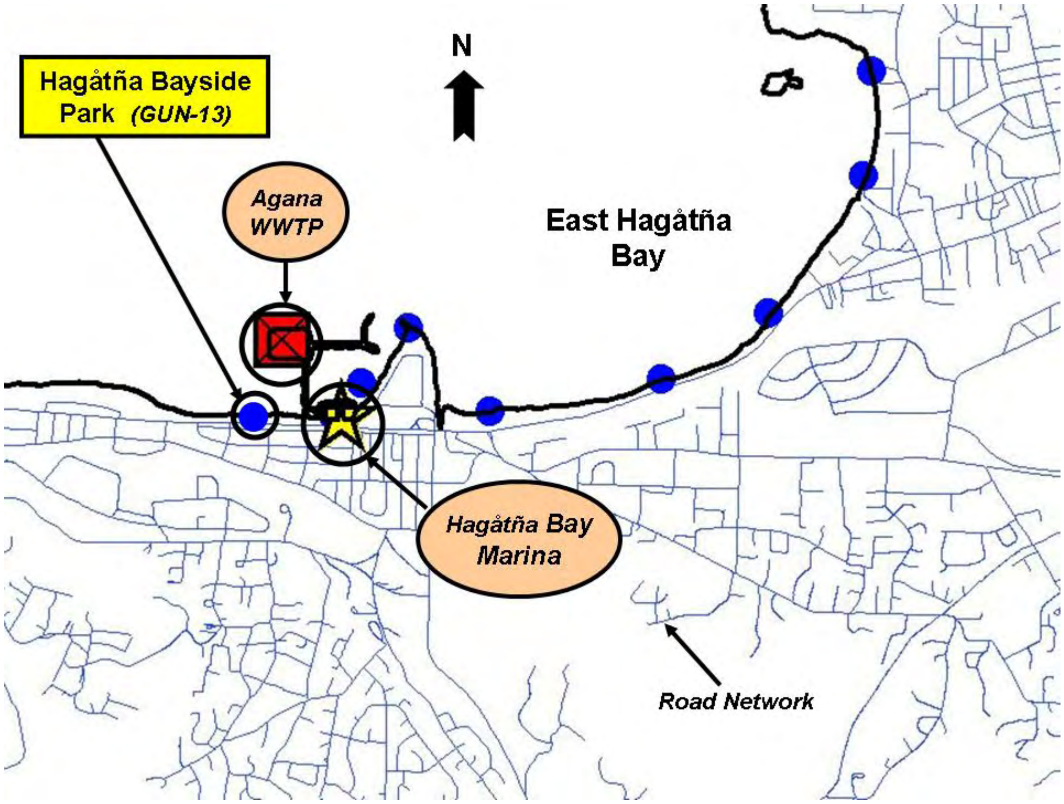

Figure 8-151. Location of Hagåtña Bayside Park relative to potential source areas.

A review of GIS information shows a number of unsewered buildings in the upland area adjacent to the Hagåtña Bayside Park. This information is shown in Figure 8-152. In addition, sewer line blockages and breaks, as well as SSOs, could contribute to elevated bacteria levels. Figure 8-152 shows the location of both sewer mains and pump stations, as indicators of potential water quality problems associated with wastewater conveyance systems.

Figure 8-153 shows an air photo of the area adjacent to the Hagåtña Bayside Park. This provides a different perspective, which highlights the high density of roads and buildings in the area adjacent to Hagåtña Bayside Park.

In addition to previous assessments and GIS information, Guam EPA staff identified other potential sources that could affect water quality at the Hagåtña Bayside Park. Specifically, there is a major DPW storm drain that channels runoff to a discharge point that may influence bacteria concentrations at this site. Also, surface runoff from Hagåtña village could be exerting an effect on water quality at this location. Finally, the old line associated with the Agana WWTP was cracked on the reef margin, which may have resulted in sporadic increases in enterococci measurements at this monitoring station.

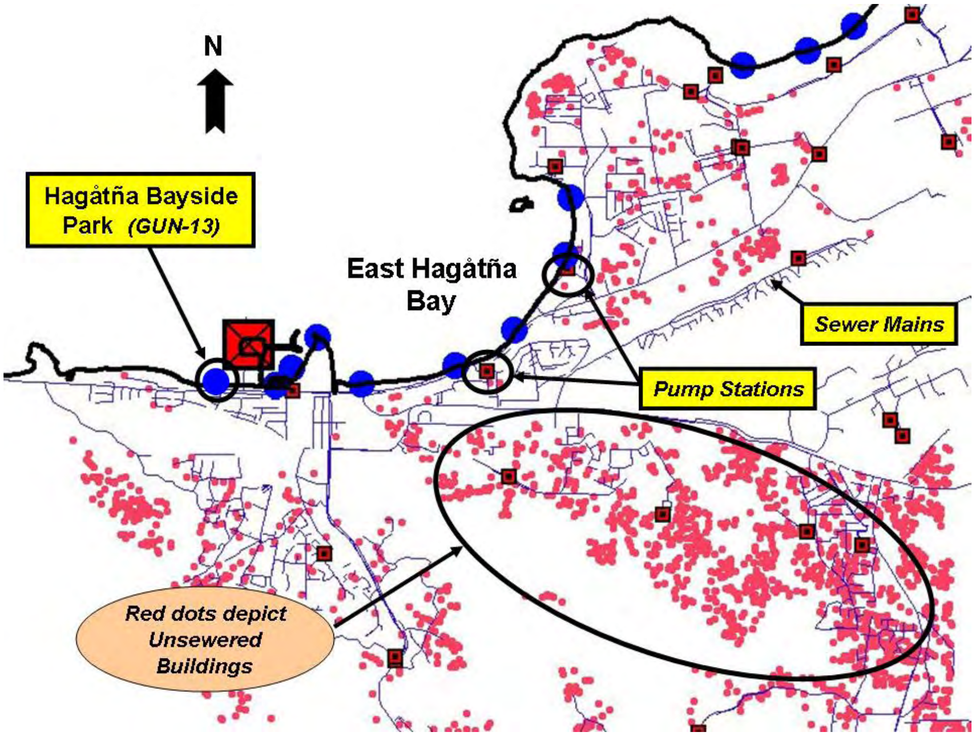

Figure 8-152. Location of Hagåtña Bayside Park relative to potential unsewered buildings.

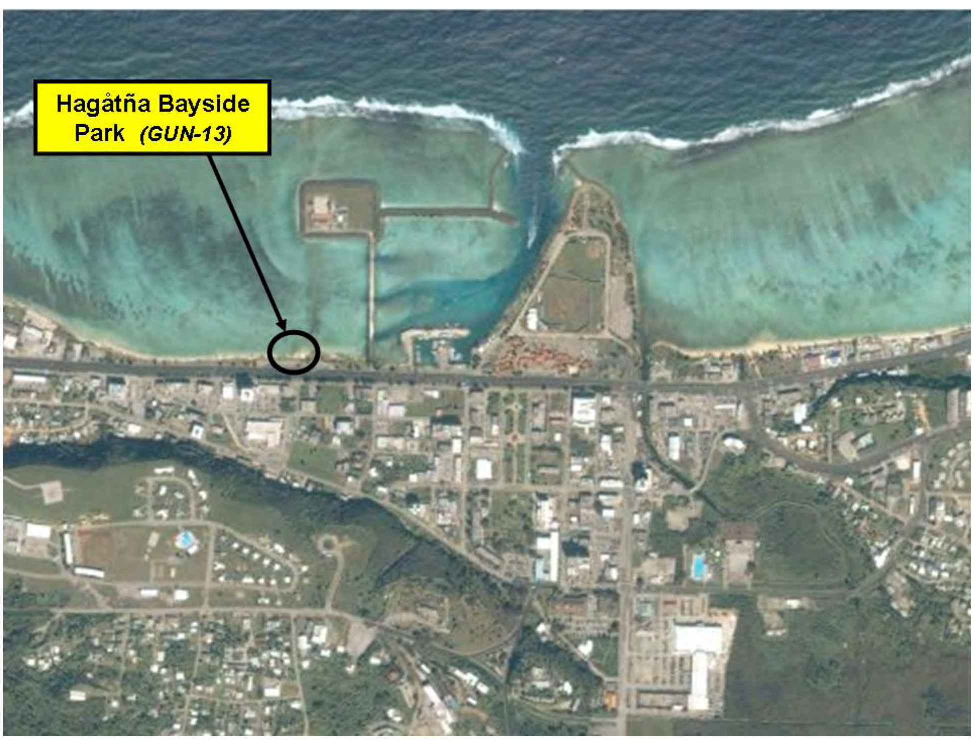

Figure 8-153. Air photo of Hagåtña Bayside Park vicinity.

Trends. Figure 8-154 presents a year-by-year summary of the enterococcus data for the Hagåtña Bayside Park site. This provides a useful way to examine trends relative to both central tendency and annual variation. This type of analysis is useful in looking at specific sites where efforts to address beach advisories have been implemented. For example, a focus on patterns such as trends in geometric means or 90th percentiles provides a visual analysis that can be used to evaluate program effectiveness. With respect to trends, it should be noted that a laboratory analytical method change occurred in September 2000. The IDEXX test was used to determine enterococcus concentrations on all samples collected after September 2000.

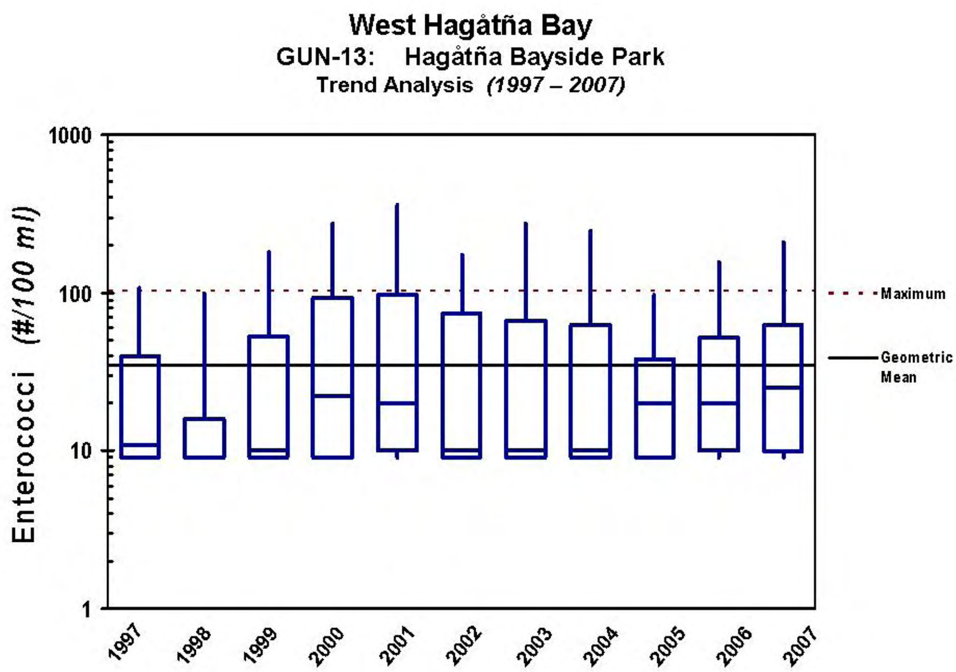

Figure 8-154. Trend analysis for Hagåtña Bayside Park site.

Linkage Analysis. The numeric target for this TMDL is Guam's concentration-based criteria for enterococci bacteria (i.e., a geometric mean of 35 counts / 100 mL and an instantaneous maximum of 104 counts / 100 mL). The relationship between this target and potential sources at Hagåtña Bayside Park Beach is demonstrated through an analysis of water quality monitoring data at this site. Seasonal patterns, for example, show that the highest concentrations are observed all year, indicating the importance of both wet and dry season sources at Hagåtña Bayside Park Beach. This is consistent with the presence of potential storm water sources identified at this location.

The connection between storm water sources and exceedances of numeric targets is further confirmed by examining the effect of flow conditions. At Hagåtña Bayside Park Beach, the highest bacteria concentrations occur under high flows. Water quality conditions that reflect this pattern are strongly influenced by storm water runoff during heavy rainfall events. In short, the technical analyses presented in this assessment of Hagåtña Bayside Park Beach describe the relationship between water quality patterns and potential sources at this location. The loading capacity and allocations are all concentrations set at the criteria values for enterococci bacteria. This TMDL will clearly meet water quality standards and protect recreational uses at this beach.

TMDL Components. Table 8-51 presents the TMDL for Hagåtña Bayside Park Beach, identifying the loading capacity and allocations expressed as concentration-based values for enterococcus. These concentration-based values apply across all flow zones. This TMDL uses an implicit MOS, through inclusion of two conservative assumptions. First, the TMDL does not account for mixing in the receiving waters and assumes that zero dilution is available. Second, the goal of attaining standards at the point of discharge does not account for losses due to die-off and settling of indicator bacteria that are known to occur.

Table 8-51. Northern Guam Watershed TMDL summary *(Site GUN-13: Hagåtña Bayside Park)*.

TMDL Component	Enterococcus Concentration *(# / 100 mL)*
Geometric Mean	
TMDL	**35**
Future Growth	35
Waste Load Allocation	35
Load Allocation	35
Instantaneous Maximum	
TMDL	**104**
Future Growth	104
Waste Load Allocation	104
Load Allocation	104

A hydrology-based framework using duration curve zones allows the TMDL to evaluate monitoring data in a way that reflects major watershed processes indicative of different flows. This approach enables numeric targets in the TMDL to consider watershed processes, such as hydrology and source assessment information including land use.

Table 8-52 identifies reductions for each duration curve zone by season using the TMDL targets. These estimates can serve to guide problem solving discussions on appropriate management strategies (based on knowledge associated with likely source areas, delivery mechanisms, and appropriate control measures that correspond to particular hydrologic conditions).

Table 8-52. Needed reductions to meet TMDL targets *(Site GUN-13: Hagåtña Bayside Park)*.

Needed Reductions	**Flow Conditions** *(expressed as percentage)*				
	High	**Moist**	**Mid**	**Dry**	**Low**
Dry Season					
Based on geometric mean	82%	5%	---	---	---
Based on instantaneous maximum	94%	57%	---	28%	---
Wet Season					
Based on geometric mean	68%	---	---	---	---
Based on instantaneous maximum	94%	61%	---	49%	---

9. Potential TMDL Follow-up Activities

A strength of the TMDL program is its ability to support development of information-based, water quality management strategies. An important key to success is engaging the public and utilizing linkages to other programs. Basic components of the TMDL, namely the loading capacity and allocations, provide numeric targets that consider watershed processes, such as hydrology, as well as source assessment information including land use. These targets play a major role in building a problem solving framework that guides development of an effective implementation program.

Implementation planning typically identifies feasible and cost effective management measures capable of reducing pollutant loads to required levels. It is a key part of the water quality management process. TMDLs and implementation planning work together in that TMDLs provide the ability to support development of information-based, water quality management strategies.

The intent of implementation planning is to provide information to local stakeholders regarding the selection of cost-effective best management practices (BMPs). Monitoring is an important element of implementation planning because it produces data needed to refine management strategies. Monitoring data often enables the overall water quality management process to incorporate adaptive management concepts.

9.1 Activities

A number of programs and activities exist that address documented water quality problems on Guam's Northern Beaches. Several programs are implemented by GEPA, which are specifically designed to address known sources of pollution including pipes, ditches, and sanitary or storm sewers. Others rely on efforts of partner agencies. If fully implemented, measurable reductions in bacteria levels should lead to achievement of the TMDLs. Key programs include:

- NPDES Permits and Section 401 Water Quality Certification
- Individual Wastewater System Permits
- Storm Water Management
- Underground Injection Control (UIC)

A brief description of each program is provided in the following sections. Key aspects of these efforts that will lead to reductions in bacteria concentrations are discussed.

9.1.1 NPDES Permits and Section 401 Water Quality Certification

National Pollutant Discharge Elimination System (NPDES) permits in Guam are issued by USEPA Region 9. Permitted facilities that potentially affect Northern Guam beaches in the TMDL project area were listed Table 5-1. GEPA's Water Pollution Control (WPC) Program in coordination with the Environmental Planning and Review Division are responsible for certifying all permit applications. During certification, conditions and abatement schedules for each permit are recommended. The guidelines for effluent limitations in each permit are based on the revised 2001 Guam Water Quality Standards.

The WPC Program oversees implementation and compliance of conditions imposed by GEPA §401 Water Quality Certification for NPDES permits issued to industrial and non-industrial facilities. All permittees are monitored by both WPC Program and USEPA staff to ensure compliance with applicable permit requirements and schedules. The Water Pollution Control Act and Guam Water Quality Standards authorize Guam EPA to take legal action against those who pollute island waters. Enforcement is carried out through scheduled site and sampling inspections. NPDES permittees submit quarterly Discharge Monitoring Reports (DMRs) to USEPA Region 9 for review and evaluation. Appropriate enforcement action is applied for non-compliance to approved permit conditions.

One major action resulting from NPDES compliance efforts is the Guam Waterworks Authority (GWA) Stipulated Order for Preliminary Relief. This Order is one key part towards solving water quality problems in the TMDL project area. The Order outlines a list of mandated actions for GWA, including the development and implementation of a comprehensive Water Master Plan. The Order also addresses the financing of wastewater capital improvement projects.

Continued compliance with the GWA Stipulated Order will improve water quality as a result of infrastructure improvements to sewage treatment plants, pump stations, and ground water facilities. Completion of the Water Master Plan provides a strategic roadmap for the utility to meet the wastewater treatment needs in the TMDL project area. This includes bacteria contamination of the TMDL beaches that are associated with compliance issues at the two wastewater treatment facilities. The Order will also address water quality problems adversely affecting beaches on the §303(d) list that are associated with pump station failures and Sanitary System Overflows (SSOs).

9.1.2 Individual Wastewater System Permits

A number of problems discussed in the individual beach assessments are the result of inadequate on-site wastewater treatment. The concerns arise both in unsewered areas, as well as in areas where residences have not yet connected to available sewer systems. GEPA's Integrated Report indicates that domestic wastewater associated with population increase is the largest potential source of pollution to all waters of Guam. Due to economic difficulties, development associated with the population increase can occur without adequate sewage infrastructure. As a result, occupants depend on septic tank and leaching field systems for waste disposal.

The island's most extensive population development is occurring in the northern watershed above Guam's federally designated sole source aquifer. The problem is further exacerbated where development has resulted in a high density of septic systems over the high permeability substrate typical of northern Guam coupled with insufficient and poorly maintained sewage treatment systems. The combination of these factors can also affect beaches in the TMDL project area.

A key implementation tool to control this source of pollution is set forth in Section 48102, Chapter 48 of 10 Guam Code Annotated (GCA). This rule 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. Permits are required for new and remodeled buildings.

In order 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. 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.

Another part of this program is sanitary surveys conducted by GEPA staff. For example, approximately 125 buildings were connected to the public sewer system in 2006 as a result of sanitary surveys and enforcement action. In 2007 GEPA staff concentrated on identifying strategic northern locations with available sewer systems. Subsequently, sanitary surveys were conducted of those residences with or without connections to the nearby systems. Enforcement action is forthcoming. A focus on continued sanitary surveys in areas that contribute to bacterial pollution of beaches in the TMDL project area is another key part of addressing documented water quality problems.

9.1.3 Storm Water Management

Storm water management is another key part of efforts to reduce bacterial contamination in the northern Guam beach TMDL project area. Although the projected 2007 population of the island was over 170,000, Guam is not covered under the USEPA Municipal Separate Storm Sewer System (MS4) program. Consequently, storm water management in the TMDL project area must rely on coordination between an array of Guam agencies and other local efforts. Guam EPA has made great improvements towards implementing storm water management through requirements under its Nonpoint Source Management Program. Large and commercial developments are required to submit "Best Management Practices" for the total elimination of storm water discharges to near shore waters of Guam. In Tumon Bay, discharges have been decreased with the elimination of most existing storm drains near shore.

GEPA and the Commonwealth of the Northern Mariana Islands (CNMI) have collaborated to produce a technical guidance document that governs storm water planning and design in both Guam and the CNMI. This effort took advantage of the geographic proximity of the islands and their similar climatic regimes, as well as local studies. The purpose of *the "CNMI / Guam Storm Water Management Manual"* and accompanying regulations is to:

- to protect the waters of the CNMI and Guam from the adverse impacts of urban stormwater runoff;
- to provide design guidance on the most effective best management practices (BMPs) for new development sites and redevelopment sites both during post construction; and
- 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.

GEPA requires that all storm water disposal for new facilities be contained on-site, up to the 20-year, 24-hour storm event. Permits for and upgrades to storm water management systems are required to accommodate large expected increases to flows and decreases to quality of the storm water, whether discharged to the ground or to surface waters.

Prior to finalizing the "*Guam / CNMI Stormwater Manual*", Executive Order 2005-35 was promulgated on October 21, 2005. This provided interim adoption of storm water management criteria for the Department of Public Works (DPW) and other government of Guam projects. GEPA is in the process of developing local storm water regulations based on criteria in the "*Guam / CNMI Stormwater Manual*". GEPA intends to incorporate them into a revision / update of current soil erosion and sediment control regulations. Upon approval and adoption, such regulations will be applicable to and enforceable upon both public and private sector communities.

9.1.4 Underground Injection Control

Recent concern has developed over the proliferation and extensive use, in the last several years, by commercial establishments to contain storm water runoff within its boundaries. A common method of storm water disposal in Guam is through the use of ponding basins. Over 100 ponding basins associated with developments in northern Guam, collect stormwater runoff, which subsequently percolates into the Northern Guam Lens (NGL).

Because of their configuration and purpose, these storm water drainage systems are regulated as Class V injection wells and require a UIC permit. The UIC permit, issued by GEPA's Water Resources Management Program, provides a means of tracking all injection wells and ensuring, through inspection, that such wells are properly maintained. All injection wells in Guam that have been issued permits are inspected annually. At present, there are two hundred ninety-four (294) permitted wells in Guam. The majority of these storm water ponding wells that potentially affect TMDL project area beaches are owned by the Guam International Airport Authority, the Department of Public Works (DPW), and the Guam Power Authority (GPA).

9.1.5 Other Programs

The Coastal Zone Act Reauthorization Amendments (CZARA) was passed by Congress to address nonpoint source pollution in coastal waters. Section 6217 of CZARA requires states and territories (including Guam) to develop Coastal Nonpoint Pollution Control Programs. The Coastal Nonpoint Program builds upon existing state coastal zone management and water quality programs by applying a consistent set of economically achievable management measures to prevent and mitigate polluted runoff. These measures are designed to control runoff from six main sources:

- Urban areas
- Marinas
- Forestry
- Agriculture
- Hydromodification (shoreline and stream channel modification)
- Loss of wetlands and riparian areas

State coastal nonpoint programs implement the measures and provide accountability through a variety of tools, including rules, ordinances, voluntary approaches, educational campaigns and financial incentives, all backed by enforceable policies and mechanisms.

In its program, a state or territory describes how it will implement nonpoint source pollution control management measures. If the original management measures fail to produce the necessary coastal water quality improvements, a state or territory then must implement additional management measures to address remaining water quality problems.

Guam's Coastal Nonpoint Control Program (CNPCP) was approved in 2007. The approval document describes mechanisms in place that Guam can use to control runoff from nonpoint sources. Urban programs were described earlier in this section under storm water management. Designation of the urban portions of Guam to be subject to NPDES MS4 permit requirements is an option that would strengthen the storm water management program relative to TMDL implementation. In fact, the water quality benefits to be achieved under an NPDES MS4 permit were noted in the final decision document approving Guam's CNPCP.

The final decision document approving Guam's CNPCP also describes mechanisms in place to address water quality problems associated with marinas. The primary mechanisms in place to address pollution problems associated with marinas rely on Guam's Water Quality Standards and Marina Rules and Regulations of the Port Authority of Guam (Marina Rules and Regulations).

Guam's Marina Rules and Regulations address vessel, property or facility cleanliness and sanitation (Section 4.02); management, control and disposal of shipboard solid waste (Section 4.03); and disposal of any litter, sewage, or other gaseous, liquid or solid materials into the water (Section 4.06 and 4.07). Guam's Recreational Water Use Management Plan (RWUMP) establishes rules to regulate uses of recreational and commercial watercraft within the waters of Guam.

In addition to these regulatory components, Guam has laid out a process and timeline for developing a comprehensive clean marina program. The Clean Marina Advisory Group has identified and is beginning to implement priority actions to reduce nonpoint source pollution from Guam's marinas, including installing hazardous waste storage containers and wash down facilities at the two most heavily used marinas. The Advisory Group is also improving public outreach and education by installing educational signage about clean marina BMPs at the marinas and working closely with the Port Authority of Guam as it updates its marina rules and regulations to incorporate additional clean marina BMPs.

If these programs fail to address problems associated with marinas, another option is be to explore the use of a Multi-Sector General Permit under the NPDES program. Marinas are a designated SIC category under EPA's storm water management rules. A permit could be issued with appropriate conditions that would lead to achieving water quality standards and TMDL targets.

9.1.6 Military Expansion

The Guam Civilian / Military Task Force (GCMTF) was created by Executive Order 2006-10 to create an integrated comprehensive master plan that will address issues related to the military buildup. The purpose of this master plan is to maximize opportunities resulting from this expansion for the benefit of all the civilian and military community. An Environment Sub-Committee to this Task Force has been created under the lead of GEPA. This Sub-Committee must determine environmental concerns including adverse effects projected to occur off Department of Defense (DOD) properties.

Activities associated with the military buildup will have a direct effect on efforts to implement the Guam Northern Watershed Bacteria TMDLs. One of the more significant impacts is the increased pressure on the wastewater infrastructure system. GWA is already conducting activities under a Stipulated Order to address documented problems that lead to beach advisories. This includes sewage overflows, pump station failures, and wastewater treatment plant performance. Potential effects of the military expansion on efforts by local agencies to implement the TMDL need to be recognized and addressed in the planning and funding process.

Similarly, the increased population associated with the military expansion includes not only direct personnel, but also dependents, construction and support staff. The increased numbers of people will undoubtedly use the existing road system and commercial facilities in the TMDL project area. Individual beach assessments identified several locations where improved storm water management is a key to successful implementation. As local agencies work to improve storm water management, DOD can clearly help provide leadership in implementing solutions.

An example is DOD's efforts to implement the Energy Independence and Security Act. Section 438 of this legislation establishes strict storm water runoff requirements for Federal development and redevelopment. The Navy, for instance, has a policy that requires the implementation of Low Impact Development (LID). The Navy's experience and expertise in the application of LID could serve as a technical resource for local agencies in their efforts to improve stormwater management in the TMDL project area.

9.2 Connections to TMDLs

A major advantage of the duration curve framework is the ability to provide meaningful connections between TMDL allocations and implementation efforts. Because the flow duration interval serves as a general indicator of hydrologic condition (i.e., wet versus dry and to what degree), allocations and reduction targets can be linked to source areas, delivery mechanisms, and the appropriate set of management practices. The implementation programs discussed in Section 9.1 are all aimed at reducing delivery of bacteria, which cause beach advisories in the TMDL project area.

The connection between the duration curve framework and development of management strategies is illustrated in Table 9-1. Potential implementation opportunities are identified, which could be most effective under each of the different flow zones. For example, GWA's efforts to address sewerage infrastructure problems (notably pump station failures and sewer overflows) are targeted to preventing delivery of bacteria that could occur under any flow conditions. The TMDL analysis demonstrated specific beaches where these problems are a likely source of bacteria.

The same rationale applies to implementation activities designed to address problems with individual waste water systems. Storm water management programs will reduce delivery of bacteria to beaches under high flow and moist conditions. Thus, the use of duration curves enables a framework that can help guide implementation efforts to address water quality concerns, particularly when ambient monitoring data is available for pattern analysis of existing conditions.

Table 9-1. Opportunities highlighted using a duration curve framework.

<table>
<tr><th rowspan="7">Opportunities</th><th colspan="5">Duration Curve Zone</th></tr>
<tr><th>High</th><th>Moist</th><th>Mid-Range</th><th>Dry</th><th>Low</th></tr>
<tr><td colspan="3">Storm Water Management</td><td colspan="2"></td></tr>
<tr><td colspan="5">GWA Sewerage System Improvements to Address Pump System Failures and Reduce Sewer System Overflows</td></tr>
<tr><td colspan="5">Individual On-site Waste Water Permits, Sanitary Survey & Enforcement, and Sewer Connections</td></tr>
<tr><td colspan="2" rowspan="2"></td><td colspan="3">Implement Waste Water Treatment Plant Improvements through NPDES Permits</td></tr>
<tr><td colspan="3">Marina Management</td></tr>
</table>

Tables 9-2 through Table 9-5 summarize reduction targets from the individual beach assessments. These tables show conditions that correspond with water quality patterns exhibiting the greatest concern at each beach. These summaries can be combined with information in Table 9-1 to highlight key implementation activities pertinent to the location (or in several cases, a set of locations) in a way that brings everything together.

Table 9-2. Summary of needed reductions to meet TMDL *(Geometric Mean – dry season)*.

Water	Beach	Site ID	Duration Curve Zone				
			High	***Moist***	***Mid***	***Dry***	***Low***
Northern	Tanguisson	GUN-01	22%	---	---	---	---
Tumon Bay	Gun	GUN-24	---	---	---	---	---
	Gognga	GUN-25	---	---	---	---	---
	Naton	GUN-02	3%	---	---	---	---
		GUN-23	---	---	---	---	---
		GUN-03	---	---	---	---	---
		GUN-04	---	---	---	---	---
	Ypao	GUN-05	---	---	---	---	---
East Hagåtña Bay	Dungca's	GUN-06	44%	---	---	---	---
		GUN-07	90%	20%	---	---	---
	Alupang Towers	GUN-26	---	---	---	---	---
	Trinchera	GUN-08	75%	17%	15%	---	---
	Padre Palomo	GUN-09	27%	---	---	---	---
West Hagåtña Bay	Hagåtña Channel	GUN-10	---	---	---	---	---
		GUN-11	62%	---	---	---	---
		GUN-12	87%	51%	---	---	---
	Bayside Park	GUN-13	82%	5%	---	---	---

Note: Shaded cells indicate those zones where the geometric mean criterion was exceeded. This is indicative of potential long term, chronic problems under those conditions.

Table 9-3. Summary of needed reductions to meet TMDL *(Geometric Mean – wet season)*.

Water	Beach	Site ID	Duration Curve Zone				
			High	***Moist***	***Mid***	***Dry***	***Low***
Northern	Tanguisson	GUN-01	---	---	---	---	---
Tumon Bay	Gun	GUN-24	---	---	---	---	---
	Gognga	GUN-25	---	---	---	---	---
	Naton	GUN-02	30%	---	---	---	---
		GUN-23	---	---	---	---	---
		GUN-03	---	---	---	---	---
		GUN-04	---	---	---	---	---
	Ypao	GUN-05	---	---	---	---	---
East Hagåtña Bay	Dungca's	GUN-06	36%	---	---	---	---
		GUN-07	82%	20%	---	---	---
	Alupang Towers	GUN-26	64%	---	---	---	---
	Trinchera	GUN-08	65%	---	5%	---	---
	Padre Palomo	GUN-09	73%	---	---	---	---
West Hagåtña Bay	Hagåtña Channel	GUN-10	38%	---	---	---	---
		GUN-11	64%	---	---	---	---
		GUN-12	83%	54%	20%	---	---
	Bayside Park	GUN-13	68%	---	---	---	---

Note: Shaded cells indicate those zones where the geometric mean criterion was exceeded. This is indicative of potential long term, chronic problems under those conditions.

Table 9-4. Summary of needed reductions to meet TMDL *(90th percentile – dry season)*.

Water	Beach	Site ID	Duration Curve Zone				
			High	Moist	Mid	Dry	Low
Northern	Tanguisson	GUN-01	49%	---	---	---	---
Tumon Bay	Gun	GUN-24	---	---	---	---	---
	Gognga	GUN-25	---	---	---	---	---
	Naton	GUN-02	48%	---	---	---	---
		GUN-23	54%	---	---	---	---
		GUN-03	25%	---	---	---	---
		GUN-04	---	---	---	---	---
	Ypao	GUN-05	80%	---	---	---	---
East Hagåtña Bay	Dungca's	GUN-06	95%	---	---	---	---
		GUN-07	98%	71%	67%	37%	43%
	Alupang Towers	GUN-26	---	74%	34%	23%	---
	Trinchera	GUN-08	89%	61%	69%	68%	34%
	Padre Palomo	GUN-09	69%	14%	---	---	---
West Hagåtña Bay	Hagåtña Channel	GUN-10	48%	---	---	---	---
		GUN-11	83%	---	---	---	---
		GUN-12	93%	93%	72%	42%	---
	Bayside Park	GUN-13	94%	57%	---	28%	---

Note: Shaded cells indicate those zones where the 90th percentile exceeded the instantaneous maximum criterion. This is indicative of recurring short term problems under those conditions.

Table 9-5. Summary of needed reductions to meet TMDL *(90th percentile – wet season)*.

Water	Beach	Site ID	Duration Curve Zone				
			High	Moist	Mid	Dry	Low
Northern	Tanguisson	GUN-01	15%	---	---	---	---
Tumon Bay	Gun	GUN-24	---	---	12%	---	---
	Gognga	GUN-25	---	---	---	76%	---
	Naton	GUN-02	74%	---	---	26%	---
		GUN-23	35%	---	---	62%	---
		GUN-03	49%	---	---	---	---
		GUN-04	---	---	---	---	---
	Ypao	GUN-05	---	---	---	41%	---
East Hagåtña Bay	Dungca's	GUN-06	81%	---	---	10%	---
		GUN-07	93%	82%	71%	51%	---
	Alupang Towers	GUN-26	98%	23%	21%	52%	---
	Trinchera	GUN-08	88%	56%	62%	35%	---
	Padre Palomo	GUN-09	92%	22%	20%	47%	---
West Hagåtña Bay	Hagåtña Channel	GUN-10	85%	---	---	---	---
		GUN-11	96%	34%	---	44%	---
		GUN-12	97%	94%	71%	28%	---
	Bayside Park	GUN-13	94%	61%	---	49%	---

Note: Shaded cells indicate those zones where the 90th percentile exceeded the instantaneous maximum criterion. This is indicative of recurring short term problems under those conditions.

9.3 Monitoring and TMDL Re-Assessment

The application of the duration curve framework allows water quality monitoring information to be used in a way, which characterizes concerns and describes patterns associated with impairments. Continued data collection at these seventeen beaches under the RBMP will provide information that enables these TMDLs to be evaluated in terms of progress towards achieving Guam's Water Quality Standards.

NPDES permits are re-issued every 5 years and the §303(d) impaired waters list is re-assessed every 2 years. Because a number of critical implementation actions are connected to compliance with the permits, these TMDLs will be re-evaluated in seven years. If sufficient progress has not been made during the seven year timeframe, the TMDLs will be re-opened. Sufficient progress is defined as removal of at least 50% (or nine of the seventeen beaches) from the impaired waters list. Any adjustments to wasteload and load allocations needed to meet water quality standards will be incorporated into revised TMDLs.

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2010 GUAM INTEGRATED REPORT

APPENDIX G

NORTHERN WATERSHED RESTORATION STRATEGY

SUBMITTED BY:

NORTHERN WATERSHED WORKING GROUP

RESTORATION STRATEGY FOR THE NORTHERN WATERSHED

1.0 Introduction

1.1 Background

In his 1998 State of the Union Address, President Clinton announced a major new Clean Water Initiative to speed the restoration of our nation's waters. This initiative is designed to achieve clean waters by encouraging federal and non-federal agencies, other organizations and interested citizens to work in a collaborative manner to restore our highest priority watersheds. In October, 1997, Vice President Gore directed the Department of Agriculture (USDA) and the Environmental Protection Agency (EPA) to work with other federal agencies and the public to prepare the action plan that would form the foundation for this collaborative effort. The plan was completed in May, 1998; it is called the Clean Water Action Plan (CWAP). The federal government is committed to contributing its technical and financial resources to the implementation of the Plan, but only to those states, territories, and tribes that meet the Plan's requirements and time lines.

Guam responded to this federal offer and to the opportunity to work together to restore and protect our waters, by creating an interagency work group to design a CWAP for Guam. The group was formed in June, 1998. The group worked quickly and after less that two months released the first required CWAP product, the Unified Watershed Assessment. This document describes the CWAP and the process used by the group to respond to the CWAP challenge, and presents the group's Unified Watershed Assessment that describes and prioritizes Guam's watersheds. This document provides the basis for the development of the next CWAP requirement, the Restoration Strategy for Guam's priority watersheds. The Restoration Strategy presents the group's proposed restoration activities for the Northern Watershed.

1.2 Restoration Strategy Development Team Organization

The Water Planning Committee (WPC) was formed on August 1987 under Section 57034 of Title 10, Guam Code Annotated (GCA), Public Law 17-87 authorizes and directs the Governor of Guam and the GEPA Administrator to enter into agreements with the agencies of the United States of America. The WPC first convened in August 1987 and became inactive in 1989. The committee was re-established in June of 1998, in time to work with the new national water initiatives announced by President Clinton in his 1998 State of the Union Address. The WPC was formed to delineate watersheds on Guam, and to prioritize the watersheds in terms of those with the greatest need for the development and implementation of restoration strategies. In July of 1998, the Natural Resources Conservation Service (NRCS) presented a map to the WPC that delineated watersheds on Guam. The WPC then organized those watersheds by category based on national criteria, the data available for each watershed, and the severity of environmental impacts suffered by each watershed.

The Northern Watershed was designated by the Water Planning Committee as the priority for the development and implementation of a restoration strategy. This was done because the Northern Watershed comprises the Northern Guam Lens (NGL), which was designated as a sole source aquifer by the USEPA in 1978, under the provisions of Section 1424 (e) of the federal Safe Drinking Water Act and is the source for the vast majority of Guam's drinking water. The Northern Watershed Working Group was appointed by the WPC in July 1998. It consists of the Department of Agriculture, Department of the Air Force, Natural Resources Conservation Service, Guam Waterworks and Guam EPA, with the Water and Environmental Research Institute (WERI) being designated as the Group Leader.

1.3 Northern Watershed Restoration Strategy Rationale

The Tumon Bay area of the Northern Watershed was designated as the highest priority watershed in the 1998 303(d) list for Guam for which Total Maximum Daily Loads (TMDLs) need to be developed. The restoration strategy described herein is aimed at the eventual development through a phased approach of establishing TMDLs for specific chemicals in the Tumon/Yigo Sub-basin. The specific chemicals in groundwater and surface water in the Tumon/Yigo Sub-basin for which TMDLs need to be developed are shown in Figure 1 and in Table 1. The Tumon/Yigo Sub-basin was delineated as the Yigo Sub-basin in the NGL Study (1982) (Figure 2). Delineation of the sub-basin was based on the configuration of the volcanic basement which in part controls the occurrence and flow of groundwater within the aquifer. The topography of the upper surface of the basement acts to provide sub-surface groundwater divides which partially separate groundwater connection in different parts of the aquifer. The assumption is that precipitation which infiltrates within a particular sub-basin will recharge groundwater in that sub-basin and will not impact or flow into other sub-basins.

This document refers to the subject sub-basin as the Tumon/Yigo Sub-basin, shown in Figure 3 as part of the Northern Watershed. This was done because groundwater not intercepted by pumping wells within this sub-basin flows beneath Tumon Village and discharges to Tumon Bay. Any contamination present in this portion of the aquifer will, therefore, ultimately affect groundwater production in Tumon Village and recreational beaches along the bay, which receives groundwater discharges in the form of springs and seeps.

Tumon Bay is an area that is currently under intensive recreational use and can be characterized as "threatened water which currently fully supports beneficial uses... but is expected to degrade as a result of (impact) from planned development..." (EXPECTATIONS FOR IMPLEMENTATION FOR CLEAN WATER ACT SEC. 303 (D)). In light of the expected increase in development in Tumon, a decrease in impacts to the Bay is not evident in the near future. Because of its economic and recreational importance to Guam, Tumon Bay needs to be monitored closely for impacted water quality due to storm water drainage, the occurrence of high fecal bacteria counts found in the sediment at the shore of Tumon Bay (a study by E. Matson of UOG titled "TERRESTRIAL GROUNDWATER SOURCES OF FECAL INDICATOR BACTERIA IN GUAM"), the alteration of groundwater flow under Tumon Bay due to active hotel construction (MATSON, 1996) and high nutrient concentration in Tumon Bay spring discharges resulting from possible use of fertilizers on hotel grounds near the bay (Denton, 1998). Our proposal is to earmark this bay as high priority site for TMDL development and to conduct a two (2) year study at this bay that will include physical and chemical analysis, toxic pollutant analysis and further water quality characterization by biological assessments.

2.0 Geology

Guam is the largest and southernmost island of the Mariana archipelago in the west central Pacific (Figure 4). It is located about 3,800 miles west-southwest of Hawaii and 1,600 miles east of the Philippines. The island is about 30 miles long and 4 to 12 miles wide.

Northern Guam is underlain by at least a 250-meter section of Neogene limestones, deposited as reef systems on an early Tertiary seamount (Tracey et al, 1964) (Figure 5). The two aquifers in northern Guam are the Miocene Barrigada Limestone, considered by earlier studies to represent deeper water, off-reef platform conditions and the Pleistocene Mariana Limestone which contains a wide spectrum of shallow-water carbonate facies, but is believed on many lines of evidence to represent a Pleistocene reef-margin complex (Tracey et al, 1964, Schlanger, 1964). Geomorphically, northern Guam is a terraced plateau comprised of karstic areas the locations of which and degree of development are controlled by normal faults and shear zones extending into the volcanic basement (Barrett et al 1982).

Southern Guam consists of highly eroded terrain generally comprised of volcanic rocks. Carbonates are restricted to intermittently distributed coastal escarpments and narrow terraces where Neogene reef-margin facies persist. Volcanics range from pillowed flows along the southwest coast through thick and often slumped sequences of highly weathered agglomerates, tuffaceous mudstones, and graywackes further inland.

In central Guam and along the southeastern coast, the Mariana Limestone lies in either faulted or unconformable sedimentary contact with weathered volcaniclastics and the older limestones (Figure 5). In these areas, except Orote Point and the reef facies the Mariana is argillaceous (up to 16% by weight (Schlanger 1964), a condition that affects both groundwater and surface water hydrology. It should be noted that the Alifan limestone located in central Guam is not argillaceous and is highly permeable.

3.0 Hydrogeology

Guam is comprised of two equally sized hydrogeologic provinces. In the southern half of the island, groundwater is present in volcanic rock of low permeability, and the water table rises to hundreds of feet above sea level. In northern Guam, most groundwater is contained within the aquifer termed the Northern Guam Lens (NGL) that occurs within karstic and highly permeable Barrigada and Mariana Limestones. Groundwater flow occurs within the NGL both as diffused flow porous sections and conduit flow through solution channels. The water table rises from sea level at the coast to tens of feet in southern portions of the NGL where the limestone is in close proximity to volcanic rock which has contributed significant amounts of clay during deposition of the limestone thus reducing the permeability of the aquifer. The NGL was designated as a principal source aquifer in 1978 (Guam EPA).

Most of the freshwater supply is contained in a characteristic "lens" beneath the limestone plateau in the northern part of the island. This groundwater lens occurs in two conditions. Whenever the total depth of the porous limestone extends significantly below sea level, it is termed a "basal" condition. Under basal conditions the fresh groundwater lens is underlain by salt water. Where impermeable volcanic material protrudes into the aquifer at or near sea level, a "parabasal" condition exists (i.e.,. the fresh water lens is underlain by volcanics).

In the basal zone, freshwater exists in equilibrium contact with saltwater. Freshwater extends some 40 feet below sea level for each foot of head above sea level, as developed by pressure differences due to density differences of the fluids present in the aquifer. The transition zone between freshwater and saltwater is thickest near the coast, where it is affected by tidal forces, and thinnest at the furthermost point inland.

Generally the high permeability of the limestone aquifer limits the static head of groundwater to content, heads can reach up to 30 feet above sea level.

A quasi-equilibrium of such a groundwater lens is achieved by leakage from the lens to the sea through springs and seeps along the coastline, and recharge which takes place as rainfall percolates into the ground and flows through channels and interconnected pores in the limestone into the freshwater lens.

The porosity of the limestone occurs as well defined open spaces created by the presence of freshwater in the interstices of the rock. Secondary porosity within the vadose zone results from the dissolution of limestone by infiltrating rainfall which is initially under saturated with respect to calcite and becomes saturated as it approaches the water table. In the saturated zone, porosity development occurs at the base of the lens where mixtures of fresh and saline waters are again under saturated with respect to calcite. During quiescent geologic periods of time when Guam's elevation has remained relatively constant, horizons of increase porosity has developed.

Continual uplifting of the limestone plateau has resulted in large solution cavities being lifted above the water table. As these caverns lose their hydraulic support, collapse has taken place resulting in surface karst features being formed such as sinkholes, troughs and escarpments. Along and parallel to fault lines in the volcanic basement, this process has been magnified to the extent that major surface expressions have been created, such as the Yigo Trough, the Harmon Sink and Agana Swamp.

4.0 Restoration Strategy

The restoration strategy proposed herein has been scoped to focus on watershed restoration goals for the Tumon/Yigo Sub-basin which can be initiated and partially realized within the implemented as a phased approach which will lead to the development of chemical-specific TMDLs for this watershed. The proposed strategy for the first phase of restoration of the Tumon/Yigo Sub-basin consists of three task; 1) contaminant source identification and reduction, 2) innovative septic tank design pilot project, and 3) public education. The three tasks are outlined below. Specific actions within the three tasks proposed to be performed during the first year of funding are identified in the following sections. Cost estimates for each proposed action are presented in Section 5.0.

4.1 Source Reduction.

The major focus of the restoration strategy for the northern watershed will be the documentation, investigation, and eventual reduction of potential contaminant sources located within the Tumon/Yigo Sub-basin (Figure 3). Contaminants have not only impacted production wells in the sub-basin, they have also migrated to the coast where they are present in spring discharges to Tumon Bay, a popular recreational beach. This sub-basin is the area of major production of potable groundwater within the Northern Watershed, and has also been subjected to extensive urbanization. This urbanization includes numerous medium- and small-size industrial operations which use and store hazardous materials, and hotels located along Tumon Bay. These operations include dry cleaners, automobile repair shops, gas stations, and other small-scale industrial operations. Hotel operations include dry cleaning and the potential use of fertilizers and pesticides, as discussed below.

Reasons for delineating this area as a priority are basically two fold. Firstly, because of the facts stated above, it is critical that groundwater quality in this sub-basin is protected. As presented in the Northern Watershed Assessment Report (Guam EPA, 1998), chemical contaminants have already been detected in production wells within the sub-basin, and further groundwater quality degradation needs to be guarded against. Once chemical contaminants find their way into the aquifer, the most efficient method of removing them from drinking water is through wellhead treatment. This process is very costly.

Secondly, closer to Tumon Bay, the discharge zone for the Tumon/Yigo Sub-basin, high-density urbanization in the form of high rise hotels and condominiums has resulted in high capacity infrastructure systems, increased urban runoff, inadequate stormwater retention/detection systems, and potentially unquantified pesticide and fertilizer use on hotel grounds. Water samples collected from beaches and spring discharges to Tumon Bay have indicated elevated concentrations of fecal bacteria (Matson), nutrients (Denton), and thallium, and detections of TCA and PCE (Naval Facilities Engineering Command, 1996). High nutrient levels in spring water appear to spawn localized algal blooms that degrade the aesthetic quality of recreational beaches. Thallium concentrations in spring waters have been measured at levels well above the 2 ppb MCL of the safe drinking water standards. Two known uses of thallium are as an insecticide and rodenticide.

The restoration strategy proposed herein will focus on Tumon Bay and aquifer restoration in terms of the identification and reduction of contaminant sources responsible for occurrences of TCA, TCE and PCE in production wells in the sub-basin, and fecal bacteria, thallium, TCA, PCE, and nutrients in Tumon Bay springs and beaches. A likely source for the detections of PCE, TCA and TCE in groundwater is poor operational and disposal methods for solvents at dry cleaners. Two possible sources of thallium in spring discharges are pesticide and rodenticide use at Tumon hotels. Fertilizer use at hotels and various infrastructure leaks and associated operational and maintenance problems are likely sources of nutrients and bacteria, respectively, in spring discharges and beaches. The first step in the restoration strategy will be to establish background levels and seasonal fluctuations of contaminants in spring discharge along Tumon Bay.

4.1.1 Tumon Bay Restoration

The Proposed method to identify and reduce potential sources of spring discharge contamination will follow a strategy similar to the one proposed to be used for groundwater contamination in the sub-basin. Note that only the first bullet listed below in Section 4.1.1 is proposed to be accomplished during the first year of funding. A cost estimate for this action is presented in Section 5.0. The over all strategy consists of:

- Establish background and comprehensive seasonal variation in contaminant concentration resulting from varying rainfall conditions through sampling and analysis of each of the springs to be considered as part of this restoration strategy, even though chemical impacts to spring discharges have been measured by past investigations.
- An inventory and record search of suspected hotels and infrastructure systems.
- Investigate possible bacteria sources issuing from springs present along Tumon Bay, especially sources of the integrity of local sewage and drainage systems.
- Link possible sources to specific spring discharges through a series of dye trace studies.

- Assess spring discharges for nutrient and bacteria loading, and the proliferation of algal blooms to determine the relationship between nutrient and bacteria load and algae growth to the nutrient and bacteria sources.

- Reduce and eliminate contaminant sources determined to adversely affect the quality of spring discharges. By successfully reducing sources and measuring the reduction of chemical impacts to spring discharges would allow TMDL's to be developed for the various contaminants.

4.1.2 Aquifer Restoration

For TCA, TCE and PCE present in production wells in the sub-basin, the proposed restoration strategy to be performed in the years subsequent to the first year of funding will consists of:

- A search of inventory records of materials used and stored at various facilities, focusing on dry cleaning operations.

- From this records search, facilities which use significant quantities of materials which Contain TCA, TCE or PCE would be investigated by inspectors to insure that none of the hazardous materials have been or are being disposed of improperly or escaping into the environment due to inappropriate operations.

- Suspect facilities would subsequently be investigated by field crews collecting samples for chemical analysis of the above listed contaminants. Samples would be in the form of soil gas and soil matrix in order to determine the presence or absence of contaminants within the soil at the facility. If contaminants are found to be present, additional samples may be required to determine the extent and magnitude of contamination in order to assess the magnitude of the threat contaminants pose to human health and the environment.

- If a significant threat is determined to exist, appropriate remedial and removal actions would be designed and implemented to restore and protect the watersheds including enforcement of existing laws.

The Northern Watershed Working Group is proposing that the above investigative and remedial actions be undertaken over a period of years by consultants selected by the WPC under the supervision and management of GEPA which will supply any enforcement authority necessary for the performance of the work. Consultants will be selected by the WPC based on their responses to requests for proposals. Work will be contracted on an iterative basis whereby the scope of work for each phase of investigation will be determined by the results obtained from the previous phrase or phases of investigations. For example, the number and scope of investigations into facilities, hotels and infrastructure systems will be determined from the results of the record searches, and the number and scope of remedial and removal actions will be determined from the results of site visits and sampling. It should be noted that the strategy is a multi-year effort. Only those actions that have been scoped in terms of estimated costs are proposed for funding for the first year of implementation.

4.2 Innovative septic tank design pilot project.

Another impact to watershed groundwater was identified in the Northern Watershed Assessment Report (Guam EPA, 1998) as an increase in nitrate concentrations in production wells within the Tumon/Yigo Sub-basin, as well as elsewhere in the watershed. There are many possible sources of nitrate input to groundwater in the watershed; one of which is the use of septic systems for sewage disposal. Implementation of the I Tanota Land Use Plan is expected in the near future. Implementation of this plan will potentially increased the density of residential lots to four per acre in the Tumon/Yigo Sub-basin. If sewer systems will not be available in these areas, nitrate introduction to the aquifer would increased. To determine the extent to which current septic systems are a source of nitrate to the aquifer, a pilot project is proposed to compare effluent discharges from a current system to discharges from a septic system designed to reduce nitrate emissions. An example of a proposed design and specifications of the system to reduce nitrates from septic effluent are presented in Appendix 1.

The pilot project will consist of the installation of an innovative system at a residential site over the aquifer. Over a period of time designed to represent various weather conditions typical for the island, system effluent will be monitored within the leach field in terms of the parameters specified in Appendix 1. Over the same period of time, leachate will be sampled for the same parameters in the leach field of a conventional septic system at a near by residence. The selection of the conventional system will be based on the similarity of physical conditions and system usage between the two test case sites. Physical conditions such as the proximity of the two test sites, soil thickness and type, vegetation, weather conditions, and surface topography will be considered. System usage similarity will be based on the number and age of permanent and temporary residents, and lifestyle. A cost estimate for this action is presented in Section 5.0.

4.3 Public education

Appropriate educational programs would be designed to help restore the northern Guam watershed. They could focus on a number of issues and stakeholders, and employ a variety of teaching and training resources. The common denominator is an increased and educated awareness of the basic hydrologic components of the northern Guam watershed, and a working knowledge of the key environmental/economic parameters tied into its restoration. The educational program of the restoration strategy could include any or all of the following tasks:

- Introduce 2 semester course consisting of a number of sequenced water resource training modules designed for local school teachers at all levels. Modules could be offered and coordinated through UOG/College of Continuing Education.

- Develop curricular materials for direct introduction into DOE and private school classrooms. Materials could include posters, coloring books, videos, slide sets, maps, field trip guides, water testing kits, etc. Materials will address a number of broad as well as specific issues including hydrologic cycle, hydrogeology, water production, field measurement techniques, well and stream management practices, pollution, water quality, toxicology, water and sewer transmission and treatment, economics, wetlands issues, flooding, sedimentation, and much more.

- Develop short courses and/or workshops targeted to specific stakeholders in the community: politicians, planners, business community, government agency personnel, village mayors, teachers, professors, etc.

- Arrange for full tuition, partial stipend scholarships at UOG for one or more graduate students in the Environmental Sciences Masters Program who would undertake thesis research projects on the northern Guam watershed.

5.0 Cost Estimates

- Tumon Bay spring sampling. Assumptions:

  Sample 10 springs, 5 times each during one year. A total of 50 samples.
  Sample for full chemical analysis.
  QA/QC samples at 10 percent (field blanks and duplicates) = 10 samples.
  60 samples at $1,520/sample = **$91,200**
  Contractor labor : two people for 120 hours at $100/hr. (With reports) = **$24,000.**

  Total cost = **$115,200**

- Installation and monitoring of innovative septic system. Assumptions:

  Install one septic system similar to that in Appendix 1 = **$10,000.**
  Install four lysimeters to monitor leachate quality at the site of the innovative design, and at a selected control site with a standard septic design (8 total).
  8 lysimeters @ $ 4,000/ lysimeter = **$32,000**
  Sample leachate from 8 lysimeters 5 times during one year = 40 samples.
  QA/QC samples at 10 percent = 8 samples; 48 total samples.
  Analyze leachate for nitrate, phosphate, and bacteria.
  48 samples X $120/sample = **$ 5,760**
  Contractor labor two people for 80 hours at $100/hr. (With report) = **$16,000.**

  Total cost = **$ 53,760**

- Public education. Assumptions:

Two semester UOG course for school teachers.	**$3,000**
Curricular materials.	**$6,000**
Short course development and initial presentation	**$4,000**
Tuition scholarship and partial stipend	**$5,000**
Total Cost	**$18,000**

Total first year project cost **$186,960**

6.0 Summary

6.1 Implement an Innovative Septic Tank Pilot

Population over this sub basin is growing, along with an increased density of residential lots. The sewage infrastructure is expected to continue to be far from adequate. Concerns related to septic contamination of aquifer are growing, with increasing levels of nitrate concentrations in production wells within the Tumon/Yigo Sub-basin.

6.1.1 Proposed Action

1. Determine the extent to which current septic systems are a source of nitrate to the aquifer. Assess and compare the current system with an innovative septic tank system, one which is designed to reduce nitrate emissions.
   Lead - GEPA
   Cost - $52,000

6.2 Assess contaminant contributions from the Harmon Industrial Area

The Harmon Industrial area was once home to the Navy's Brewer Field, and now supports most of the Guam's light industries. It is immediately upstream of the Tumon-Maui well and upstream of Tumon Bay springs, both of which are experiencing some levels of contamination from industrial chemicals. It is highly probable that the source of the contamination of the Tumon-Maui well and Tumon Bay is this industrial area. This conclusion, though based on best professional judgement, is speculative, because we do not have site information for this area.

6.2.1 Proposed actions

1. Inventory the area for industrial concerns and type of chemical is utilizes in their operations. Complete a map and a GIS compatible database of information.
   Lead - Galt Siegrist, utilizing St. John's students
   Cost - $2,000 for supplies
2. Explore possibility of federally funded pontentially responsible parties (PRP) search.
   Lead - GEPA, coordinating with USEPA
3. Investigation and enforcement
   Lead - GEPA
4. Note - $35,000 additional is available from CZM for documentation, investigation, and reducation of potential contaminant sources in the sub- basin, and for public education. More tasks could be added, based on results of inventory and other analyses.

6.3 Clean - up Contaminated Drinking Water Production Wells.

The Tumon-Maui well is one of our major potential production wells (900+ gallons per minute), and is an important water source for GWA. It also provides "a window" into the aquifer. The well is contaminated (TCA and PCE,), and the Air Force has shut the well down.

The Air Force is not pursuing remediation or monitoring at the well. Past remediation on Guam has utilized air filters or charcoal filter systems, both of which face numerous technical challenges here, with our high mineral levels. Alternative, more innovative techniques for well remediation are being utilized and researched elsewhere and may be practical here on Guam.

6.3.1 Proposed Action

The WPC recognizes the contamination of this well as a major concern in the watershed. The WPC will table immediate action on this item, however, pending the outcome of several other issues (for example, decisions about well ownership).

6.4 Assess level of fertilizers/pesticides/herbicides utilized in Tumon Area

There is at least a perception that the aesthetics of Tumon Bay are declining due to perceived increasing levels of algae in Tumon Bay. And, elevated levels of thallium in several Tumon springs, are of concern. (Thallium is linked to the use of pesticides and herbicides.) It is possible that near shore impacts from landscaping practices may elevate levels of nutrients, pesticides and herbicides in the bay.

6.4.1 Proposed Actions

1) Conduct a survey of fertilizers and pesticides/herbicides utilized in Tumon Area
   Cost - $7,500
2) Conduct verification sampling, as deemed necessary.
   Example - 10 sites, 5 samples per site for metals and nutrients; $140/sample = $14,500

6.5 Conduct Baseline Monitoring (of downstream) Tumon Bay Springs.

All restoration projects should include in their design, the ability to evaluate the (lack of) success of the work. The springs along Tumon Bay are the outlet for ground water flow from the Tumon-Yigo sub-basin, and should be representative of ground water contamination levels. Sampling these springs will provide baseline data, data which is currently inadequate.

6.5.1 Proposed Action

1) Sample Tumon Bay springs
   Sample 10 springs, 4 times per year = 40 samples; Complete full chemical analysis;
   QA/QC; labor - 2 people for 100 hours (field sampling and report preparation)
   Lead - GEPA
   Total cost - $96,000

6.6 Public Education

Public education is key to preventing further groundwater contamination problems.

6.6.1 Proposed Actions

1) Three day hydrology course for Island teachers $4,000
2) Curricular materials
3) Short course development and initial presentation
4) Publication of annual "State of the Watersheds" $5,000
for both watersheds, which summarizes the results of the watershed restoration successes and progress. This might be used to produce a newspaper supplement.
5) Radio spots and/or publication of brochures targeted for those sectors that are contributing to ground water contamination problems.
6) Public recognition for "clean establishments."

7.0 References

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UGUM WATERSHED RESTORATION STRATEGY

June 14, 1999

I. BACKGROUND

In his 1998 State of the Union Address, President Clinton announced a major new national Clean Water Initiative, the Clean Water Action Plan (CWAP). This initiative aims 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. The federal government has committed to contributing its technical and financial resources to the implementation of the plan.

Guam responded to this federal initiative by convening a work group, the Water Planning Committee (WPC), which is made up of representatives from fourteen agencies and interested organizations. The WPC completed an assessment of the island's watersheds and selected three, the Northern, Ugum and Talofofo, as its highest priority watersheds due to their value as drinking water resources. Two have been targeted for CWAP restoration in the 1999-2000 time period, the Northern and Ugum Watersheds.

This document presents the strategy for protecting the Ugum Watershed. It includes elements consistent with federal guidelines, such as measurable project goals, identification of the sources and contributions of water pollution, planned restoration actions (time line& cost), monitoring and evaluation plans, funding sources, and a process for public involvement.

This strategy was developed by a subgroup of the WPC, represented by numerous organizations: Department of Agriculture - Divisions of Forestry and Aquatic and Wildlife Resources, Department of Commerce, Guam Environmental Protection Agency, Natural Resources Conservation Service (chair) and University of Guam College of Agriculture and Life Sciences.

II. AVAILABLE INFORMATION

This project has been very fortunate, in that it has been able to benefit from earlier extensive, thorough and excellent work completed on the watershed in 1996, by the Natural Resources Conservation Service (Ugum Watershed Management Plan, Territory of Guam US Department of Agriculture, Natural Resources Conservation Service, Pacific Basin Area; March 1996). The entire watershed has been mapped, and resources inventoried and assessed. The major watershed problems and opportunities were prioritized in public meetings and reported in the Management Plan's companion document, The Ugum Watershed Resource Assessment . Enough baseline information exists to set priorities, make management decisions, and implement restoration measures.

Four management scenarios or options were proposed in the Ugum Watershed Management Plan: 1) No Action, 2) Maintenance, 3) Improvement, and 4) Reserve. The Ugum Watershed work group of the WPC has concluded that the Improvement Scenario offers the best set of objectives to meet CWAP goals. The Ugum Watershed Restoration Strategy, proposed here, relies extensively on these earlier products; it presents a refined list of actions drawn from the Ugum Watershed Plan that are practical to implement at this time.

III. OBJECTIVES FOR THE UGUM WATERSHED

The Ugum Watershed, about 19 square kilometers of lush vegetation, productive wetlands, savanna grasslands, badlands, and numerous springs and feeder streams, is one of Guam's last relatively pristine natural areas. It is home to wild pigs, deer and carabao, as well as many birds, some of which are endangered. The Ugum Water Treatment Plant on the Ugum River supplies drinking water to southeastern island villages. A short distance downstream of the watershed boundary, the Talofofo and Ugum Rivers merge and flow into Talofofo Bay.

The goal of the restoration strategy for the Ugum Watershed is to maintain and preserve water quality and quantity in the Ugum Watershed far into the future; more specifically, to:

1. Reduce instream turbidity in the Ugum watershed; this will improve the quality of drinking watersupplied to residents of southern Guam by increasing the effectiveness of microbial treatment at the Ugum treatment plant.

A federally mandated quantitative pollutant loading plan, a Total Maximum Daily Load (TMDL), is being developed for the Ugum Watershed (anticipated completion date is April 2000). The draft TMDL identifies the reduction in turbidity levels in the river that are necessary to achieve the drinking water objective, the sources of turbidity in the watershed and their estimated contributions, and the anticipated reductions in turbidity when the restoration plan is implemented. This strategy is consistent with the draft TMDL targets.

2. Improve ecosystem function (both in-stream and downstream marine, including coral reefs) by lessening the level of non point source problems in the watershed, and associated deterioration of fish and wildlife habitat.

Measuring the improvement to ecosystem function in the downstream waters due to this restoration project is less direct. The strategy's working assumption is that turbidity and sediment reductions from actions designed to reduce upstream erosion will benefit downstream stream waters and coral reef ecosystems. A biological monitoring program associated with this restoration project will track changes in aquatic ecosystem functioning.

IV. WATERSHED ASSESSMENT

A. Watershed erosion

The parameters of concern for the Ugum River are turbidity and sediments in the water. Microorganisms harmful to humans may also be present in the watershed. These parameters are related to one another. After storms, the high turbidity of the surface water and sediment loading from soil erosion in the watershed affects the productivity of the land, aggravates the Ugum drinking water treatment plant's system's ability to treat possible microorganisms potentially harmful to humans, and negatively impacts aquatic life (e.g.; fish, aquatic invertebrates, reefs) in the watershed's streams and downstream coastal areas.

Much of the Ugum watershed was originally forested. The relatively undisturbed and existing ravine forest contributes to the stability of the watershed. Its forest structure protects the soil surface from the direct impacts of intensive tropical rainstorms, and minimizes sediment runoff. Because these forests are typically located next to watershed streams, they serve as catchments to filter eroding sediments from savanna grasslands and badlands, which occupy ridge tops and road ridges of the area. They provide shade which helps maintain cooler stream temperatures, and they contribute leaf-litter and other debris used by fauna as cover and food. These forests are also relatively resistant to fire. In forested lands, loss of water through heavy rain or storms is drastically reduced. The dead branches, twigs and leaves on the forest floor accumulate and eventually turn into humus and act as a sponge, providing water retention. Moreover, roots penetrate into the subsoil and enhance the infiltration and storage of rainwater.

Fires in the Ugum Watershed have contributed to changes in vegetative types, soil organic matter content, and wildlife habitat. Decades of periodic burning of the savanna plant communities have resulted in severe erosion and leaching of essential nutrients. Wild land fires usually occur in the savanna grassland ecosystem, because savanna grassland burns easily. It is dominated by bunch grasses, which are fire prone during the dry season. Fire causes the savanna grassland to rejuvenate and spread by burning the edge of the ravine forest. This grassland is a fast-growing community. Because of the high rate of soil erosion and reduced soil productivity under this highly exposed clumped vegetative cover, the ravine forest cannot easily compete with the invading grassland, and is not easily reestablished. Fires have contributed to a decrease in acres of forest; without the exclusion of fire, the ravine forest cannot expand and the revegetated acreage cannot be sustained.

Uncontrolled access by off road vehicles for recreational purposes also accelerates erosion rates and prevents revegetation of sensitive areas. (The roads' patterns are often in clusters and circular). Many of the recreational vehicle drivers are unaware of the consequences of their actions, and prefer starting new trails to following existing ones. This activity contributes to the establishment of badlands.

The movements of large mammals, such as carabou, in and around rivers contribute to bank destabilization. Rooting and wallowing of pigs can also cause severe damage to the forest, resulting in increased erosion. Additionally, deer, pigs and other mammals can be vectors for pathogens, such as *Crypto sporidium, Giardia* and *Leptospirosis*. Humans can be infected with these pathogens indirectly by contact with contaminated water or soil.

The soils throughout the Ugum have at least 40% clay content, and once suspended in moving water, are too light to settle out. Therefore, sediment from the highly eroding roads, badlands and burned-over grasslands is virtually directly transported to the Ugum River, and downstream to Talofofo Bay and the surrounding coral reefs. This causes numerous shut downs of the treatment plant and harms downstream reefs.

In summary, when soil erosion occurs in the Ugum Watershed, vegetation changes, from forest to savanna grassland, or from savanna grassland to badlands. This erosion and the loss of ravine forest contributes to poor quality in-stream aquatic habitats, frequent shut-downs at the Ugum Treatment Plant, and the smothering of the coral reefs and a decline in fish populations. The effects of erosion and sedimentation are cumulative; over time the impacts from these processes magnify and continue to worsen.

B. The major contributors to watershed erosion

The processes of erosion and sedimentation are natural and occur all the time. However, the rate of soil erosion and sedimentation of our rivers and reefs is accelerated by human activities.

Fire

Fires are a serious problem in the Ugum Watershed. Virtually all are human caused, whether for hunting and food-gathering access or from carelessness or recreation, and most are intentionally started.

Ugum Watershed Guam Fire Statistics (1985-1997)		
Year	**Number of Fires**	**Acres Burned**
1987	921	8,800
1988	436	10,263
1990	110	800
1991	318	1,338
1992	558	5,686
1993	693	2,341
1994	152	221
1995	427	4,862
1996	174	500
1997	344	844
1998	1,200	13,000

Roads

Sloped road surface erosion contributes the highest rate of erosion per area in the Ugum (but ranks number four in terms of total contribution to sediment per year). These roads have increased in recent years. From 1975 to 1993, the total road miles more than doubled. If this current trend of doubling the steep road surface area within the watershed continues, sediment yield from roads will considerably increase.

Development
At this time, the Ugum watershed is relatively undeveloped. However, the Ugum Watershed Management Plan projected that 200 to 500 agricultural homestead lots will be developed within the next 20 years, and that all of the land on these half-hectare lots will be cleared for cropping, with small areas set aside for home development. It is not clear at this time what affect the passage of I'Tano-'ta will have on the quality and extent of development in the watershed. (See Appendix II, for a brief summary of how I'Tano-'ta will apply to this watershed.)

Poorly developed golf courses, tourist facilities, residential subdivisions and other large scale construction, and habitation degrades water quality. Uncontrolled erosion will carry sediment to wetlands and waters during each rain event. Recreational activities may introduce pathogens into the water which may or may not be readily treated by drinking water treatment plants. And, nitrates (from septic discharges), fertilizers, pesticides, diesel oil, gasoline and other substances may be applied or spilled onto nearby lands and may reach the water. These pollutants are not treated by the conventional water treatment plant and so must be carefully managed, minimized or eliminated, as appropriate, to protect water quality.

Agriculture
Agricultural impacts are considered minor. Agricultural clearing occurs on approximately 7- 40 hectares per year within the Ugum Watershed. Residue is typically left on the surface, and weed control is accomplished by light use of chemicals such as the product Roundup®. Soil loss from agricultural fields is currently 315 to 1,800 tonnes.

C. Relative contributions of erosion to the watershed
Erosion sources must be evaluated both in terms of volume eroded *per acre* per year, and in total volume *per watershed* per year. As the tables below illustrate, for example, the grassland erodes at a lower rate per acre than the other major sources, but it covers 41% of the watershed and therefore contributes the majority of erosion in the watershed.

Total tons sediment eroded per acre per year		
1	Road Surface - sloping	324
2	Badlands	243
3	Road Cuts	74 - 705 T/Y
4	Stream bank erosion	75 - 330 T/Y
5	Road Surface - Level	75
6	Grasslands	32
7	Agriculture	20
8	Forest	12

Total tons sediment yield per year		
1	Grasslands	27,134
2	Forest	10,348
3	Badlands	10,125
4	Road Surface - Sloping	3,195
5	Stream bank erosion	1,036
6	Road Cut	720
7	Road Surface - level	644
8	Agriculture	136

Total Sediment Yield per Subwatershed in the Ugum Watershed (tons)

Subwatershed	*Cut and Rill	Roads	Stream bank erosion	Total
Bubulao	17,396	1301	290	18,987
Ugum	8,909	1511	297	10,707
Upper Ugum	9,069	1175	241	10,485
Atate	7,505	245	140	7,890
N. Bubulao	6,868	327	68	7,263

*Cut and Rill - Includes erosion from forest, savanna grasslands, agriculture, badlands.
"Sediment Yield" is the amount of eroded soil in the river delivered to the downstream boundary of the Ugum watershed, located at the confluence of the Ugum and Talofofo Rivers.

V. Conclusion

The objective of the Ugum Restoration strategy is to improve the drinking water quality and the ecosystem functioning of the Ugum Watershed. Erosion is the most significant factor interfering with the achievement of this objective. The most effective means of preventing and minimizing soil erosion is to encourage actions which maximize vegetative cover, particularly forest.

An effective restoration strategy for the Ugam watershed should include the following priorities:

1) **Conserve and protect the ravine forest** . The ravine forest provides the best natural protection of water quality. It contributes less erosion than any other cover. Also, it is large and continuous, and provides habitat to a very diverse flora and fauna, some of which are rare and endangered species.
2) **Revegetate badlands within the savanna grasslands** . These sites contribute a significant

amount of sediments reaching surface waters.

3) **Minimize fires.** Fire must be contained to protect existing forest and any investment in tree planting associated with this restoration strategy, and to minimize badland formation.

4) **Inform and involve the public.** This watershed presents excellent opportunities to educate and involve the public in watershed protection. For example:
   - 1) The relative simplicity of this watershed allows the public to understand that there is a strong and direct connection between activities such as fire burning, land clearing and off-roading, and increased watershed erosion, which, in turn, causes harmful downstream impacts to drinking water and coral resources;
   - 2) Experience gained in protecting and restoring this watershed will help achieve public education that is necessary for constructive public dialogue related to potential future development of southern watersheds as drinking water supplies.
   - 3) Tree planting, a key component of this restoration strategy, will involve the volunteers from the public. This provides tremendous opportunities for both education and personal commitment to long term watershed health. It creates media opportunities, which is "free" public education. Finally, it provides an immediate and tangible sense of success, which will promote more watershed protection interest and support.

VI. 1999-2000 UGUM WATERSHED ACTION PLAN

Total CWAP Funds Requested	**$74,730**

1. Obtain special recognition and standing which supports the Ugum Watershed as is a Priority Watershed. This will heighten general public awareness for the values of watersheds and would allow GovGuam agencies to implement protection measures described in this strategy.

- *Obtain recognition and standing for Priority Watersheds through an Executive Order.* April 1999 - WPC and Attorney Generals' office; June - GEPA board; July - Governor GEPA; CWAP funds = 0

2. Minimize fires

- 1) Reinforce the Division of Agriculture MOA with Fire Department to prioritize wildland fire suppression in the Ugum watershed;
  2) Work with Navy to request their help in fire suppression, particularly in higher elevations which are inaccessible to ground forces; and
  3) Consider a total prohibition on permitted fires in the watershed.
  Department of Agriculture Divisions of Forestry and Aquatic and Wildlife Resources. By August, 1999; CWAP funds = 0

3. Apply vegetation treatments

- *Reforest 35 acres* June - September 1999, taking into consideration effectiveness, accessibility, and visibility. As much as possible, use volunteers for tree planting (e.g. work release prison population; Conservation Corps; summer youth programs; Scouts; Americore; DYA, non-governmental organizations). This keeps costs down and contributes to public education and involvement.

Plant Acacia mangium and Acacia auriculiformis. These species can grow vigorously in badland areas and grasslands, can help reduce erosion and can neutralize soil acidity, are nitrogen fixers, and can be planted in such a way as to eliminate grasses and weeds, thus reducing fuel load (fires). Establish vegetative row barriers on ravine ridges to decrease impact of grassland fires on ravine species and decrease movement of soil into riparian and wetland areas. (This may potentially allow ravine species to creep into the savanna environment.)

Reclaim off road and other trails through planting of live fascines, tree planting and critical area sowing of ground cover, and/or reduce uncontrolled access to area.

Stabilize erosion by planting on and through strips of erosion control matting, on five acres, as a pilot project.

Division of Forestry - Scope of Work for Planting Trees in the Ugum Watershed	
Average number of trees planted per acre (badlands)	700 trees
Average number of trees planted per acre (buffer zones by ravine forests)	100 trees
Total area	35 acres
Planting Costs for 35 acres of Trees ($1,900 per acre)	$66,500
Erosion Control Fabric & Seeds for 5 acres of tree plantings in 5 acres of badlands @ $1,646.00 per acre	$8,230
Total Cost - CWAP Funds	**$74,730**

4. Inform and involve the public about both this strategy and resource management and conservation.

- *Conduct meetings with property owners* to obtain their input on the Ugum restoration strategy, inform them of potential voluntary incentives for watershed protection (e.g.; Forest stewardship, Wetland Conservation and Agricultural Programs), and discuss possible tree planting sites.
  May, 1999; Frank Cruz, Randy Sablan, Dave Limtiaco, Colleen Simpson, Mr. Siguenza; CWAP funds = 0
- *Seek endorsement of GEPA Board* for this strategy
  July 1999
  GEPA; CWAP funds = 0
- *Conduct educational presentations* at island schools and during EarthWeek
  On-going

WPC members; CWAP funds = 0

5. Encourage environmentally sound development

- *Apply I Tano'-ta measures* , and encourage environmentally sound practices, such as proper installation of silt fences, restricting work to the dry season, and preserving native vegetation and established vegetative cover.
  On-going
  GEPA, DAWR, Division of Forestry; CWAP funds = 0

6. Utilize compliance and enforcement

Note: The planning team supports voluntary compliance for all management measures where possible, but at the same time it is realized that the Government of Guam has a large role in providing the incentives necessary to make the voluntary compliance desirable.

- *Increase surveillance* of poachers and fire starters in the watershed.
  On-going
  DAWR, and Division of Forestry; CWAP funds = 0
- *Enforce existing applicable regulations* (e.g., Sediment and Erosion Control, Pesticide, Septic Tank, Road Construction).
  On-going
  GEPA; CWAP funds = 0
- *Keep Attorney General's office informed* about Watershed Activities and Priorities.
  On-going
  GEPA, Forestry, DAWR; CWAP funds = 0

7. Monitor and evaluate

Watershed monitoring will be systematically targeted and evaluated to determine the effectiveness of watershed restoration activities.

- *Convene an interagency team* to plan for and implement watershed monitoring. Members will include GEPA (water quality), NRCS (agricultural plans), Forestry (tree planting success, incidence of watershed fires), Aquatic Wildlife (fish fauna & density studies), GWA (Treatment Plant monitoring such as river flow, turbidity, precipitation), WERI (climatological data).
  May 1999; completed by July 1999
  DAWR; CWAP funds = 0

VII. References

Resource Assessment Ugum Watershed, Guam. US Department of Agriculture, Natural Resources Conservation Service, Pacific Basin Area; January 1995.

Ugum Watershed Management Plan, Territory of Guam US Department of Agriculture, Natural Resources Conservation Service, Pacific Basin Area; March 1996.

APPENDICES

I. ACTIONS TO BE TAKEN IN THE UGUM AS RESOURCES ALLOW

Address roads *(The proposed activities are dependent upon landowner interest & support.)*

- Minimize and contain off-road use areas. Help identify appropriate areas for off road recreation including for ORV and mountain bikes. Construct jeep trails that are designed so that they would not erode as badly as the existing ad hoc network.
- Provide technical assistance regarding new road designs or maintenance of existing roads (e.g.. better to build along contours; include vegetative buffer strips; provide sediment traps along major roads and off-road recreational sites).
- Work with tour operators, encourage the importance of roads used to transport tourists to sites in the watershed.
- Encourage surface rehabilitation (and maintenance) of main roads and old abandoned roads/trails.
- Develop driver education materials detailing the "good and bad" of off-roads and trails in watersheds.

Plant native primary ravine forest

- After the Acacia has been planted, and has had a chance to establish itself and stabilize and "fertilize" the soil, begin to plant native primary forest plants in the Acacia stands. Although a certain number of native species will seed themselves in the stands, active native plantings will significantly speed up recreation of a native forest ecosystem.

Encourage sustainable agricultural practices

- NRCS, Guam Field Office and Guam Cooperative Extension, with support of the Guam Southern Soil & Water Conservation District (SSWCD) will determine the level of farming in the Ugum Watershed. The development and application of conservation plans for all farming activity will be promoted. Plans will address all resource concerns (soil, water, air, plant, animal and human). NRCS, Guam Cooperative Extension and the SSWCD are non-regulatory agencies and the adoption of recommended practices is on a voluntary basis by farmers.)
- Develop and deliver educational materials on: 1) contour cultivation and organic matter management practices such as cover crops, strip cropping, and minimum or no-till practices; 2) water management, fertilizer selection, application, timing and base application rates on soil tests and crop needs; and 3) crop specific protection and management guidelines.
- Pursue agroforestry possibilities with Department of Forestry, including the use and integration of multipurpose trees with fruit and vegetable crop production and poultry, livestock and aquaculture production systems. Encourage the use of hedge row plantings for animal feed, organic matter and green manure production, and cover crops, including nitrogen-fixing legumes in agroforestry systems and especially sloping lands.

II. I TANO'-TA REQUIREMENTS

I Tano'-ta (effective May 1, 1999) designates the majority of the Ugum Watershed as Zoning District 2; a small section in the upper watershed is designated District 1. Land and/or waters within District 1 are to be conserved and preserved for future generations. District 2 accommodates low-density residential neighborhoods and neighborhood-oriented commercial activities, and agriculture and aquaculture activities. Performance Standards are to ensure that the natural functions of environmentally sensitive areas such as very steep slopes, wetlands, flood plains, ravine and limestone forests are maintained and will be enforced.

The following actions would support the achievement of performance standards:

- Limit construction and development to areas with suitable soils and slope and should avoid critical/sensitive habitats. Encourage developers to provide riparian buffer zones in the very steep and sensitive areas in the upper watershed along the streams and waterways.
- Encourage developers to eliminate or minimize the introduction of pollutants into the watershed (e.g. nitrates, treatment-resistant pathogens, if any, associated with in stream recreational activities, pesticides, herbicides, diesel fuels, etc.)
- Development should complement and support the objectives of this restoration strategy.
- Identify high value and/or critical/sensitive habitat (e.g. wetlands) and protect these areas.

III. A REFORESTATION SUCCESS STORY

In Guam, the rate of deforestation is substantially greater than that of reforestation. Some of the deforested government lands are used for agriculture and a few are converted to housing projects. Since the early part of 1970, the Forestry and Soil Resources Division of the Department of Agriculture has tried to convert the deforested and fire prone savanna areas into less flammable forest stands.

Reforestation methods in Guam rely heavily on leguminous (nitrogen fixing) exotic species such as Acacia, because of their ability to grow in infertile soils. Furthermore, they are fast growing. In three to five years, they form dense stands 20-30 feet high, which slowly suppress the grasses, below. Once these leguminous species are established and the soil condition has improved, enrichment planting of broad leaf species can follow.

In the past ten years, reforestation activities on Guam have been accelerated. Reforestation of badly denuded and highly acidic areas in the southern portion of the island has shown signs of success. In 1980, Acacia mangium and Acacia auriculiformis were introduced in the Cotal Conservation Reserve off Cross Island Road and found to grow vigorously. Today, almost the entire Reserve is planted with Acacia species. This successful establishment of forest tree stands is a clear indication that the harsh and badly denuded areas in Guam can be successfully reforested.

2010 GUAM INTEGRATED REPORT

APPENDIX H

Guam 2010 IR Assessment Methodology

Assessment methodology is guided by the 2001 Guam Water Quality Standards (GWQS) that describes criteria and standards to be met by each water body of Guam. Narrative and numeric standards from the 2001 GWQS are applicable to specific "Categories of Waters" (S-1, S-2, S-3, M-1, M-2 and M-3 classification). Generally, all Guam waterbodies follow the designated uses that are listed in the following table (Table 1):

Table 1. Guam Designated Uses and Indicators for Use Support determination (from GWQS 2001)

Designated USE:	**Body Contact (primary/whole body, secondary /limited)**	**Aquatic Life (Preserve, Protect, Propagate, Survival, Protect, Maintenance)**	**Human Health Consumption (Toxics)**
GWQS Indicators:	E. coli Enterococci Fecal coliform - shellfish waters	Water Quality: pH Orthophosphates OPO4 Nitrate NO3 Ammonia NH4 Dissolved Oxygen Salinity Chlorides Sulfates SO4 Total Dissolved Solids Total Suspended Solids Turbidity Secchi Disc Visibility Water Temperature Radioactive Materials Conc. of Oil/Petroleum Product Biological/Benthic Assessment Toxicants (Water column and Sediment)	Drinking Water (S-1, S-2) Organisms (and S1 water)

Each indicator listed above is subject to established criteria presented in the next table (Table 2) taken from the 2001 GWQS. Further assessment of Use Support involves determining to what degree these indicators support designated uses. Guidelines for determining the 'Degree of Use Support' is described further in Part III of the Guam EPA 2008 IR (IR Tables 12 – 19).

Table 2. Criteria (from GWQS 2001) to be used in the Guidelines for the Degree of Use Support:

PARAMETERS		GWQS		
Marine Water	Surface Water	M1/S1	M2/S2	M3/S3
Enterococci (24 or 48hr.)		MARINE five sequential single sample geometric mean of 35 CFU/100mL and instantaneous/single sample of 104 CFU/100mL; FRESHWATER five sequential single sample geometric mean of 33 CFU/100mL and instantaneous/single sample of 61 CFU/100mL		MARINE five sequential single sample geometric mean of 35 CFU/100mL and instantaneous/single sample of 276 CFU/100mL; FRESHWATER five sequential single sample geometric mean of 33 CFU/100mL and instantaneous/single sample of 108 CFU/100mL
--	E. coli	FRESHWATER ONLY Five sequential single sample geometric mean of 126 CFU/100mL and instantaneous/single sample maximum of 235 CFU/100mL.		FRESHWATER ONLY Five sequential single sample geometric mean of 126 CFU/100mL and instantaneous/single sample maximum of 406 CFU/100mL.
Fecal coliform (shellfish harvesting & growing areas)		Median of 14 fecal coliform/100mL and 10% of water samples taken from growing area should not exceed 43 fecal coliform/100mL.		
pH		Marine, Estuarine: 6.5 - 8.5 range (also, in deeper than euphotic zones, not >0.2pH from ambient) Freshwater: 6.5 - 9.0		
Ortho-phosphate (PO4-P)		not > 0.025 mg/L	not > 0.05 mg/L	not > 0.10 mg/L
Nitrate-nitrogen (NO3-N)		not > 0.10 mg/L	not > 0.20 mg/L	not > 0.50 mg/L
Ammonia-nitrogen		MARINE (M-1, M-2, M-3): 0.02 mg/L (table IV GWQS) FRESHWATER (S-1,S-2,S-3): 1hour average conc. not > CMC more than once every 3 years AND 30day average conc. not > CCC more than once every 3 years AND the average conc. over 30days not > CCC AND ambient conc. averaged over 4days not > 2xCCC.		
Dissolved Oxygen		Not decreased to < 75% saturation at any time [OR at 30degC Fresh water not < 5.6 mg/L; Marine and Wetlands Water not < 4.6 mg/L at 26degC Fresh water not < 6.2 mg/L; Marine and Wetlands Water not < 5.0 mg/L]		
Salinity	Salinity/Chlorides/Sulfates Total Dissolved Solids	Marine, estuarine, wetlands: not > +10% of ambient Freshwater only: max Cl and SO4 = 250 mg/L; TDS not > 500 mg/L or 133% of ambient; Salinity not > +20% of ambient.		
Residue (TSS)		TSS: not increased from ambient and not > 5 mg/L	TSS: not > +10% ambient and not > 20 mg/L	TSS: not > +25% ambient and not > 40 mg/L
Turbidity		not > 0.5 NTU over ambient (except when due to natural conditions)	not > 1.0 NTU over ambient (except when due to natural conditions)	
Secchi Visibility (Vertical or Horizontal)		not < 5m from ambient (except when due to natural conditions)		
Water Temperature		not changed more than 1.0^{0}C or 1.8^{0}F from ambient (Thermal effluent not meeting this standard shall be considered as having an adverse effect on aquatic life).		
Radioactive Materials		Discharges at any level into any waters are strictly prohibited.		
Oil or Petroleum Products		1) Shall not detect a visible film, sheen or result in visible discoloration of the surface with a corresponding oil or petroleum product odor, 2) Shall not cause damage to fish, inverts or objectionable degradation of drinking water quality, 3) shall not form an oil deposit on the shores or bottom of the receiving body of water.		
Toxic Substances (water column, sediment, drinking water consumption, organisms consumption)		General: 1) All waters shall be maintained free of toxic substances in concentrations that produce detrimental physiological, acute or chronic responses in human, plant, animal or aquatic life. 2) All waters shall be maintained free of toxic subs in conc. that produce contamination in harvestable aquatic life to the extent that it causes detrimental physiological, acute or chronic responses in humans or protected wildlife, when consumed. 3) The survival of aquatic life in marine and surface waters subjected to a waste discharge, or other controllable water quality factors, shall not be less than that for the same water body in areas unaffected by the waste discharge. Numeric criteria: see Appendix A in 2001 GWQS.		

Guam reporting relies on data sets from local academia as well as local and federal government agencies. For this reporting period, data was solicited from Navy environmental, Water and Energy Resource Institute of Guam, Government of Guam Fisheries and Wildlife Programs, and Guam Environmental Protection Agency. The projects listed in Table 3 below were identified for assessment in the Guam 2010 IR assessment:

Table 3. Identified projects with usable data for the Guam 2010 IR assessment:

Organization	Project	Waterbody Type	Use Support	Year of data	Data Quality
Guam EPA	Status and Trends Monitoring Project (STMP)	Marine Waterbodies and Rivers/Streams (reaches)	Body Contact, Aquatic Life (WQ)	Jan – Dec 2009	For use support determination
Guam EPA	Status and Trends Monitoring Project (STMP BIO)	Marine Waterbodies	Aquatic Life (benthic bioassessments)	Jan – Dec 2009	For use support determination
Guam EPA	Guam Coastal Assessment (GCA)	Marine Waterbodies	Body Contact, Aquatic Life (WQ), Aquatic Life (Conc. of Oil/Petrol), Aquatic Life (benthic bioassessments), Aquatic Life (Toxicants - Sediment), Human Health (organism consumption)	Nov 2003 – August 2005	For use support determination
Guam EPA	Recreational Beach Monitoring Project (RBMP)	Marine Beaches	Body Contact	Jan – Dec 2008 and 2009	For use support determination
Guam EPA	Semi-Permeable Membrane Device (SPMD) Project	Marine Waterbodies and Rivers/Streams (reaches)	Aquatic Life (Toxicants - Water column)	Jan – Dec 2007	Evaluation only
US Navy	Navy Nuclear Propulsion Program (at Apra Harbor)	Marine Waterbodies	Aquatic Life (Radiological Materials)	Quarterly monitoring 2008-2009	For use support determination
NOAA/Guam EPA	NOAA& Guam EPA Fish Tissue Project	Marine Waterbodies	Human Health (organism consumption)	Jan – Dec 2006	Evaluation only

Current Advisory Areas (Fish and Seafood Consumption and Closures to Wading) are also included in the current assessment and are reflected in Water body Use Support tables and the 2010 IR station location figures.

The quality of each data set and project was evaluated by reviewing project objectives, quality assurance requirements, laboratory method compatibility, analysis quality and MDLs. Data was either identified as 'good quality' for direct use in Use Support Determinations or as for use as 'evaluation only' (see 'Data Quality' column in table above). 'Evaluation only' data are data sets that do not have specific associated criteria and thus are used as supportive data.

Available data sets for this reporting period are listed in the following Project Stations table (Table 4). According to this table, one hundred fifty four (154) stations from six (6) projects are considered for the Guam 2010 IR assessment. These stations are located within one of either 66 marine waterbodies (WB), one of 202 freshwater stream/river reaches or one of 103 beach stretches. Marine WB, Freshwater reaches and Guam Beaches are listed in the Appendix A Waterbody Tables A1 - A3. Station locations of these waterbodies and stations are shown in Appendix A. (Figure A1a.North and Central Marine Stations, Figure A1b. Central and South Marine Stations, Figure A1c. River and Stream Stations and

Figure A1d. Beach Stations). These figures also show current Advisories (Fish and Seafood Consumption and Closures to Wading). Waterbodies were analyzed based on individual project objectives and assessed indicators as shown in *Table 5. Project Indicators* below. This table also shows how many samples were used in this assessment.

Data for 2010 IR assessment:

Table 4. Project Stations:

Guam Coastal Assessment (GCA) Stations 1 visit/station during Nov 2004 - August 2005			
Marine Water Station ID	GWQS class	Marine Water Station ID	GWQS class
GU04-0001	M-1	**GU04-0030**	M-2
GU04-0002	M-2	GU04-0031	M-2
GU04-0003	M-1	GU04-0032	M-2
GU04-0004	M-2	**GU04-0033**	M-1
GU04-0005	M-2	GU04-0034	M-2
GU04-0006	M-2	GU04-0035	M-1
GU04-0007	M-1	GU04-0036	M-2
GU04-0008	M-2	GU04-0037	M-2
GU04-0009	M-2	GU04-0038	M-3
GU04-0010	M-2	GU04-0039	M-2
GU04-0011	M-1	GU04-0040	M-2
GU04-0013	M-2	GU04-0041	M-2
GU04-0014	M-2	GU04-0042	M-2
GU04-0015	M-2	GU04-0043	M-1
GU04-0016	M-2	GU04-0044	M-2
GU04-0018	M-2	GU04-0045	M-2
GU04-0019	M-1	GU04-0046	M-2
GU04-0021	M-2	GU04-0047	M-2
GU04-0022	M-1	GU04-0049	M-2
GU04-0023	M-2	GU04-0050	M-2
GU04-0025	M-1	GU04-0051	M-1
GU04-0026	M-2	GU04-0052	M-2
GU04-0027	M-2	**GU04-0053**	M-1
GU04-0028	M-3	GU04-0054	M-2
GU04-0029	M-2	GU04-0055	M-2

TOTAL Stations: 50

10 Bold Stations are Tissue Analysis stations.

Status and Trends Monitoring Program(STMP) (WQ and BIO) Feb - Oct 2009					
Fresh Water Station ID	GWQS class	No. visits	Marine Water Station ID	GWQS class	No. visits
AGRA-2	S-2	5	**AGMI**	M-2	4
AGRD	S-2	5	AGMS	M-2	4
AGRF-2	S-2	5	AGMZ-0	M-2	2
APEA	S-3	5	APMCO	M-3	1
APRA-1	S-3	5	APMD	M-2	1
APRA-2	S-3	5	APME	M-2	1
APRAG	S-3	5	APMFR	M-3	1
APRS-1	S-3	5	APMJ	M-2	1
APRS-2	S-3	5	APMO	M-3	1
ASRM	S-3	5	**ATMS**	M-2	4
ATRN-2	S-3	6	BBM1	M-2	4
ATRT-2	S-3	6	DRM	M-1	2
INRI-1	S-3	1	GBMS	M-2	3
MZRP-2	S-3	5	GBMT	M-2	3
PGRP-1	S-2	6	**TB2**	M-2	3
TURTG-1A	S-3	5	TOGRF-4	M-2	2
TURU-1A	S-2	6	TUMN-0	M-2	2
TURU-1B	S-2	6	TUMS-0	M-2	2
TURU-1C	S-2	5	YRF-2	M-2	1
TURU-2	S-2	5			
YNRY-3	S-3	6			

TOTAL Stations: 40

3 Bold Stations are Biological Assessment stations.

Naval Nuclear Propulsion Program Quarterly
Station ID
Within Apra Harbor (M-2) Waterbody (South)

(Continued) Data for 2010 IR assessment:

Table 4 (cont). Project Stations:

Recreational Beach Monitoring Program (RBMP) Jan 2008 - Dec 2009					
Marine Water Station ID	GWQS class	No. visits	Marine Water Station ID	GWQS class	No. visits
N-01	M-2	100	N-22	M-2	100
N-02	M-2	100	N-23	M-2	100
N-03	M-2	100	N-24	M-2	100
N-04	M-2	100	N-25	M-2	100
N-05	M-2	100	N-26	M-2	101
N-06	M-2	100	S-02	M-2	100
N-07	M-2	101	S-03	M-2	100
N-08	M-2	100	S-04	M-2	100
N-09	M-2	100	S-05	M-2	100
N-10	M-2	100	S-06	M-2	100
N-11	M-2	100	S-07	M-2	100
N-12	M-2	100	S-08	M-2	100
N-13	M-2	100	S-09	M-2	100
N-14	M-2	100	S-10	M-2	100
N-15	M-2	100	S-11	M-2	100
N-16	M-2	99	S-12	M-2	100
N-17	M-2	98	S-13	M-2	98
N-18	M-2	100	S-14	M-2	100
N-19	M-2	100	S-15	M-2	100
N-20	M-2	100	S-17	M-2	100
N-21	M-2	100	S-18	M-2	100

TOTAL Stations: 42

Semi-Permeable Membrane Devices (SPMD) (WC Tox) 3 visit/station 2007	
Station ID	Station Location
GUSPMD001	Dungca's River
GUSPMD002	Hagatna River Mouth
GUSPMD003	Pago River
GUSPMD004	GHURA Dededo Well
GUSPMD005	Talofofo River
GUSPMD006	Togcha River
GUSPMD007	Faifai Beach (cave)
GUSPMD008	Apra Harbor-Western Shoal

Total Stations: 8

GEPA/NOAA Fish Contaminant Study 1 visit/station 2006
Station ID
FT1A
FT1B
FT2
FT3
FT4
FT5
FT7
FT8
FT9
FT10
FT11
FT12
FT13
FT14

Total Stations: 14

Table 5. Project Indicators

Guam Coastal Assessment Stations	
1 visit/station during Nov 2004 - August 2005; 50 stations	
Field Parameter	**No. samples used for 2010IR**
Water Temperature	50
Conductivity	not used in 2010IR; No criteria
Depth (m)	not used in 2010IR; No criteria
Dissolved Oxygen (mg/L)	50
Dissolved Oxygen (%Sat)	50
pH	50
Salinity	50
Turbidity	50
Photosynthetically Active Radiation	not used in 2010IR; No criteria
Laboratory Parameter (WQ)	**No. samples used for 2010IR**
Ammonia, NH4-N	50
Nitrite, NO2-N	not used in 2010IR; No criteria
Nitrate, NO3-N	50
Orthophosphate, PO4-P	50
Total Suspended Solids	50
Enterococci	50
Chlorophyll-a	not used in 2010IR; questionable data
Field Observations	**No. samples used for 2010IR**
Water color and Odor and Turbid observation	not used in 2010IR; No criteria
Tidal and surf height; Sea state	not used in 2010IR; No criteria
Current direction	not used in 2010IR; No criteria
Weather at time of station occupation	not used in 2010IR; No criteria
Air temperature	not used in 2010IR; No criteria
Wind speed and direction	not used in 2010IR; No criteria
Municipal Sewer Outfall presence	not used in 2010IR; No criteria
Number of dogs, birds, people	not used in 2010IR; No criteria
Floating grease (sheen)	50
Transect debris underwater	not used in 2010IR; No criteria
Bioassessment data	**No. samples used for 2010IR**
Mobile Invertebrate abundance	not used in 2010IR; No reference/baseline
Fish abundance and biomass	not used in 2010IR; No reference/baseline
Point-Quadrat Abundance	not used in 2010IR; No reference/baseline
Sediment Analyses	**No. samples used for 2010IR**
Sediment Chemistry **(see table in Sediment Chem section)**	50
Sediment Infaunal	not used in 2010IR; No reference/baseline
Sediment granulometry, Color, Composition, Odor	not used in 2010IR; No reference/baseline
Sediment toxicity	not used in 2010IR; No reference/baseline
Tissue Analysis	**No. samples used for 2010IR**
Tissue chemistry **(see table in Human Health Tox section)**	10

STMP (WQ)	
Feb-Oct 2009	
Field Parameter	**No. samples used for 2010IR**
Water Temperature	104
Depth (m)	not used in 2010IR; No criteria
Dissolved Oxygen (mg/L)	99
Dissolved Oxygen (%Sat)	98
Salinity	101
Laboratory Parameter (WQ)	**No. samples used for 2010IR**
Conductivity	not used in 2010IR; No criteria
pH	167
Turbidity	167
Ammonia, NH4-N	167
Nitrite, NO2-N	not used in 2010IR; No criteria
Nitrate, NO3-N	172
NO3+NO2-N	not used in 2010IR; No criteria
Orthophosphate, PO4-P	178
Total Suspended Solids	167
Enterococci (marine water only)	65
E. coli	241
Total Dissolved Solids (fresh water only)	103
Color (Apparent)	not used in 2010IR; No criteria
Field Observations	**No. samples used for 2010IR**
Air temperature	not used in 2010IR; No criteria
Tidal height	not used in 2010IR; No criteria
Tidal phase	not used in 2010IR; No criteria
Weather at time of station occupation	not used in 2010IR; No criteria
Landuse in watershed	not used in 2010IR; No criteria
Wind speed and direction	not used in 2010IR; No criteria
Turbid observation	not used in 2010IR; No criteria
Current flow observ and direction	not used in 2010IR; No criteria
Biota observation	not used in 2010IR; No criteria
STMP (BIO)	
1 visit/station in 2009	
Bioassessment data	**No. samples used for 2010IR**
Mobile Invertebrate abundance	not used in 2010IR; No reference/baseline
Fish abundance and biomass	not used in 2010IR; No reference/baseline
Point-Quadrat Abundance	not used in 2010IR; No reference/baseline
Field Observations	**No. samples used for 2010IR**
Transect debris underwater	not used in 2010IR; No reference/baseline
Rugosity	not used in 2010IR; No reference/baseline

Table 5 (cont). Project Indicators

RBMP	
Jan2008 - Dec 2009	
Laboratory Parameter	No. samples used for 2010IR
Enterococci (MPN)	4,197
Field Observations	No. samples used for 2010IR
Weather (past 24 hours)	not used in 2010IR; No reference/baseline
Weather at time of station occupation	not used in 2010IR; No reference/baseline
Rainfall weekly accumulation	not used in 2010IR; No reference/baseline
Average Air Temperature	not used in 2010IR; No reference/baseline
Wind type and direction	not used in 2010IR; No reference/baseline
Tidal Stage	not used in 2010IR; No reference/baseline
Water surface condition	not used in 2010IR; No reference/baseline
Water color	not used in 2010IR; No reference/baseline
Turbid observation	not used in 2010IR; No reference/baseline
Water odor	not used in 2010IR; No reference/baseline

SPMD (Org Tox)	
3 visit/ 8 stations 2007	
Surrogate Tissue Analysis	No. samples used for 2010IR
Aldrin	absence/presence; as supplement to tissue assessment; evaluation data set only.
α-BHC	
β-BHC	
δ-BHC	
γ-BHC (Lindane)	
Chlordane	
p,p'-DDD	
p,p'-DDE	
p,p'-DDT	
Dieldrin	
Endosulfan I (Thiodan)	
Endosulfan II	
Endosulfan sulfate	
Endrin	
Endrin aldehyde	
Endrin ketone	
Heptachlor	
Heptachlor epoxide	
Methoxychlor	
Toxaphene	
PCB Arochlor mixes:	
Arochlor 1242	
Arochlor 1248	
Arochlor 1254	
Arochlor 1260	
Arochlor 1268	

GEPA/NOAA 2006Fish Contaminant Study	
1 visit/station 2006	
Tissue Analysis	No. samples used for 2010IR
Tissue chemistry	1 sample; Evaluation data set only

Naval Nuclear Propulsion Program	
Quarterly or annual	
Media	No. samples used for 2010IR
Water column	4
Sediment	4
Algae	1
Mussels	1

Stations are compiled by water body location and GWQS Classification as Marine waterbodies or Beach stretches (M-1, M-2 and M-3) or Freshwater Rivers waterbodies (S-1, S-2, S-3). Each indicator concentration is then compared to applicable GWQS criteria in order to determine **Exceedances**. An Exceedance is defined as **one violation of GWQS criteria**. Trend Assessments, although done for individual projects, are not included in this assessment because criteria based on trend analyses are not established.

Use Support Determinations are intended to identify waterbodies that meet or do not meet established criteria and decision guidelines for Degree of Use Support. Waterbodies that meet established criteria and guidelines, are identified as 'Fully Supporting' while waterbodies that do not meet established criteria and guidelines are identified as 'Partially' or 'Not Supporting'.

Degree of Use Support for each data type is then determined by applying the appropriate guidelines shown in Table 12 through 19 of IR to the compiled data at each water body. Individual water body assessments are presented in Appendix B Tables B1. *Marine Waterbody (MW) Assessment* and B2. *Rivers Assessment*. These tables show the degree of use support for the parameters of three designated uses at each waterbody. Project stations, number of samples/visits, and the specific indicator for each designated use are included in this table.

Based on *Degree of Use Support* determinations, all waterbodies are then categorized as one of the following category assignments:

Category 1: All designated uses are supported, no use is threatened,

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 or threatened, 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 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 or is threatened, and a TMDL is needed.

This categorization aids in focusing future monitoring efforts and management plans for watersheds and waterbodies in the form of additional monitoring and mitigation. Categorization of Guam's waterbodies for this reporting period is shown in Appendix B Tables B3 *Marine Waters Use Support*, B4 *Rivers Use Support* and B5 *Guam Beach Use Support*. In summary,

- Of 66 Marine waterbodies, 24 (17.21 square miles) are assigned Category 2 for this reporting period, 31 (18.10 sq mi) are assigned Category 3 and 11 (14.75 sq mi) are assigned Category 5. Figure C1a. and Figure C1b. in Appendix C shows categorization of Guam marine waterbodies for this reporting period.
- Of 232.65 miles of Rivers, 35.84 miles is assigned Category 2, 167.88 miles is assigned Category 3, 21.58 miles is assigned Category 4a, and 7.35 miles is assigned Category 5. Figure C2 in Appendix C shows categorization of Guam River waterbodies for this reporting period.

- Of 42 monitored Beaches with 15.46 assessed miles, 17 (5.81 miles) are assigned Category 4a and 25 (9.65 miles) are assigned Category 5 for this reporting period. Figure C3 in Appendix C shows categorization of Guam Beaches for this reporting period.

The following rational describes how individual available data sets assess the assigned Designated Uses of *Body Contact Use Support, Aquatic Life Use Support (ALUS), and Human Health Consumption* during this reporting period in to produce Use Support Determinations presented in Tables B3, B4 and B5.

Body Contact Use Support is conducted on recreational beach miles, river/stream reach miles and marine waterbody square miles. **Recreational beach sizes (miles)** are delineated using best professional judgment based on accessibility and existing sandy shorelines. For this reporting period, **Assessed beach size (miles)** is not based on the 400 yard radius assessment criteria but rather is delineated based on the location of existing monitoring stations within a designated beach stretch and its delineation will equal Recreational Beach Sizes. Both Beach size and Assessment size are shown in Table B5. *Guam Beach Use Support.* Enterococcus (in Marine Waters) and E. coli (in Fresh Waters) are assessed for this reporting period. Exceedances are based on single-sample and geometric mean criteria. Use Support is dependent on the total number of exceedances of single sample and geometric mean criteria. The guideline to determine degree of use support is presented in Table 13 Guam 2008 IR. 2008 and 2009 *Body Contact Use Support* assessment at Guam's Tier 1&2 Beaches (*B5 Guam Beach Use Support)* show that 15.46 miles of beach miles were assessed. In 2008, 0.24 miles is Fully Supporting for Whole Body Contact or Limited Contact Recreation while 1.41 miles are Partially Supporting and 13.81 miles are Not Supporting. In 2009, more beach miles are Partially Supporting (1.99 miles) and fewer miles are Fully Supporting (0 miles) or Not Supporting (13.47 miles) than the previous year.

Currently, all 42 Tier 1 Guam Beaches are listed in Guam's 303d and for 2006 and 2007 are Category 5 Surface Waters. There is currently a TMDL process underway for 17 northern Tier 1 & 2 beaches.

Aquatic Life Use Support (ALUS) is assessed using data from

- water quality (physical and chemical parameters),
- Radioactive Materials,
- concentrations of oil,
- benthic bioassessments,
- sediment chemistry,
- organism toxicants.

1. Water Quality (physical and chemical parameters) in this assessment is applicable to Marine waterbodies and fresh waterbodies (rivers and streams). The *Project Indicator* table (Table 5) above shows the number of samples collected at each project and station used in this assessment. Applicable indicators are under the headings "Field Parameter" and "Laboratory Parameter (WQ)". The following tables identify method number, units, MDLs, qualifier, non-detect values and applicability values of these indicators in both the STMP project and then the GCA project. Also provided are some common QA and Qualifier Codes associated with indicators in the GCA project.

STMP WQ Parameters and QA - NDs for assessment:

Parameter	2008-2009 Method No.	Units	MDL	Qualifier	ND Value used for IR10 assessment	Applicable to Fresh or Marine Waters
E. coli	SM 9222D	MPN	10	ND	9	FW
Enterococci	SM 9223	MPN	10	ND	9	MW
pH (meter)	SM 4500H	std units			NA	FW & MW
OPO4-P orthophosphate	EPA 365.1	mg/L	0.005	ND	0.004	FW & MW
Nitrite NO3	EPA 353.2	mg/L	0.020	ND	0.019	FW & MW
Ammonia (NH4 - N)	EPA 350.1	mg/L	0.010	ND	0.009	FW & MW
Dissolved Oxygen mg/L and %sat (meter)	EPA 360.1	mg/L			NA	FW & MW
Salinity (meter)	120.1	ppt			NA	FW & MW
Total Suspended Solids	SM 2540D	mg/L	10	ND	5	FW & MW
Turbidity	EPA 180.1	NTU	0.05	ND	0.04	FW & MW
Secchi Disc						MW
Total Dissolved Solids	SM 2540C	mg/L	10	ND	5	FW
Water Temperature (meter)						FW & MW

GCA WQ Parameters and QA - NDs for assessment:

Parameter	2004-2005 Method No.	Units	MDL	Qualifier	ND Value used for IR10 assessment	Applicable to Fresh or Marine Waters
Enterococci	SM 9223	MPN	10	ND	9	MW
pH (meter)	EPA 150.1	std units			NA	MW
OPO4-P orthophosphate	SM4500P	mg/L	0.020	ND	0.019	MW
Nitrite NO3	EPA 353.2	mg/L	0.050	ND	0.04	MW
Ammonia (NH4 - N)	EPA 350.1	mg/L	0.010	ND	0.009	MW
Dissolved Oxygen mg/L and %sat (meter)	EPA 360.1	mg/L			NA	MW
Salinity (meter)	120.1	ppt			NA	MW
Total Suspended Solids	SM 2540D	mg/L	10	ND	5	MW
Turbidity (meter)	EPA 180.1	NTU	0.05	ND	0.04	MW
Water Temperature (meter)	EPA 170.1	Degree C				MW

GCA QA and Qualifier Codes	
BRL	Below Reporting Limit
Q	Questionable Data
JGEPA	Below the Practical Quantitation Limit
NR	Not Recorded
NS	Not Sampled
P	Present, not counted

Aquatic Life Use Support for Water Quality (Physical/Chemical indicators) is listed by water body in Appendix B Tables B1. *Marine Waterbody (MW) Assessment* and B2. *Rivers Assessment*. Degree of Use Support Designations used in these tables is defined by the following assessment criteria:

Fully Supporting (FS)	For each pollutant, GWQS exceeded in 10% or less of measurements,
Partially Supporting (PS)	For each pollutant: GWQS exceeded in 11% to 25% of measurements,
Not Supporting (NS)	For each pollutant: GWQS exceeded in greater than 25% of measurements,
NA	Not assessed due to ambient data not available,
Fail	Not assessed due to method fail,
UD	Not sampled

Marine Waterbodies WQ Assessment

Water Quality parameters were assessed this reporting period by the STMP and GCA projects. Stations in both projects conducted water column profiling (measurements at surface, middle and bottom or at every 1m depth). This assessment uses only the surface water concentrations (<2m) or averages of the shallow measurements. In the GCA, if a station had a depth of less than 2m, and there were two or three water column samples- surface, middle and/or bottom, these concentrations were averaged to characterize the surface concentration at that station. Also in the projects, a datasonde was used to measure physical indicators. These measurements were typically taken at 0.5m depth and then every meter thereafter to 0.5m off the bottom. For this assessment, the 0.5m measurement and the 1m measurement were averaged to characterize the surface concentration at that station.

The GWQS criteria table above shows that the Bacteria indicators (Enterococci and E. coli) are acceptable indicators for body contact use assessment. The preferred indicator for marine water in both the STMP and GCA is Enterococci. All samples in both the STMP and the GCA were below standards. The highest concentrations in the STMP were 10 MPN at AGMI and AGMZ, while in the GCA the highest concentration of 59 MPN was found at site -0033.

The GWQS criteria table above also shows that Salinity, Total Dissolved Solids, Total Suspended Solids, Turbidity, Secchi Disc Visibility, and Water Temperature indicators are assessed using ambient data:. For this reporting period, 'ambient data' for each of these parameters is defined as data collected from Guam EPA's STMP project that is collected prior to the year 2000. The following table lists STMP stations that have ambient data for use in this current assessment.

Ambient Station SURFACE ONLY (STMP)	Waterbody	Applicable to 2010 Assessment Station	Applicable to 2010 Parameters
DRM	Rocky Shorelines Northwest Coast (Double Reef)	DRM	Salinity, TSS, Turbidity, Water Temperature
GBMT, GBMS, TUMN, TUMS	Tumon Bay Coastal	GBMT, GBMS, TUMN, TUMS	Salinity, TSS, Turbidity, Water Temperature
TMDI, TMGB, TMSV, TMYB	Tumon Bay Reef flat	GU04-005, GU04-0037, GU04-0055, TB2	Salinity, TSS, Turbidity, Water Temperature, Secchi Visibility
AGMS, AGMP, AGMD, AGMR, AGMT, AGMQ	Hagatna Bay East Reef Flat	AGMS, GU04-0009, GU04-0041,	Salinity, TSS, Turbidity, Water Temperature, Secchi Visibility

AGMI, AGML, AGMB, AGMF	Hagatna Bay West Reef Flat	AGMI, GU04-0045	Salinity, TSS, Turbidity, Water Temperature, Secchi Visibility
AGMZ, AGMA	Hagatna Bay Coastal	GU04-0021, AGMZ	Salinity, TSS, Turbidity, Water Temperature
APMW	Apra Harbor (M-2) West	APMFR-0, APMO, GU04-0032, GU04-0036	Salinity, TSS, Turbidity, Water Temperature
APMJ	Apra Harbor (M-2) North central	APMJ, GU04-0040, GU04-0044	Salinity, TSS, Turbidity, Water Temperature
APMD	Apra Harbor (M-2) South central	APMD, GU04-0008,	Salinity, TSS, Turbidity, Water Temperature
APMS	Apra Harbor (M-2) Inner Harbor Mouth	GU04-0002	Salinity, TSS, Turbidity, Water Temperature
APMA	Apra Harbor (M-2) Inner Harbor	GU04-0018, GU04-0031, GU04-0052	Salinity, TSS, Turbidity, Water Temperature
APMCO-0	Apra Harbor (M-3)	APMCO-0, GU04-0028, GU04-0038	Salinity, TSS, Turbidity, Water Temperature
APME	Sasa Bay Coastal	GU04-0006, APME, GU04-0034, GU04-0010, GU04-0050	Salinity, TSS, Turbidity, Water Temperature
ATMN	Agat Bay Reef flat	GU04-0030, GU04-0046	Salinity, TSS, Turbidity, Water Temperature
ATMS		ATMS	Salinity, TSS, Turbidity, Water Temperature, Secchi Visibility
ATMO	Agat Bay Coastal	GU04-0014, GU04-0054	Salinity, TSS, Turbidity, Water Temperature
ATMNC		GU04-0004	Salinity, TSS, Turbidity, Water Temperature
ATMA	Taleyfac Bay (M-1)	GU04-0022	Salinity, TSS, Turbidity, Water Temperature
MZMCW	Cocos Lagoon (M-1)	GU04-0035, GU04-0019	Salinity, TSS, Turbidity, Water Temperature
TUMW	Talofofo Bay	GU04-0023	Salinity, TSS, Turbidity, Water Temperature
TOGRF-4	Togcha Bay	GU04-0047, TOGRF-4	Salinity, TSS, Turbidity, Water Temperature, Secchi Visibility
PGMPE	Pago Bay	GU04-0049	Salinity, TSS, Turbidity, Water Temperature

If ambient data is not available for a waterbody or station, an assessment on that parameter was not conducted and is identified as “NA” in B1. *Marine Waterbody (MW) Assessment*.

For all ambient Water Temperature records, the 95% confidence interval for average water temperature in the dry season (Jan to June) and in the wet season (July to Dec) was calculated and then 1 degree was subtracted from the lower limit and 1 degree was added to the upper limit. Water Temperature records used for the 2010 IR were then compared to these calculated values. Similarly for Salinity, TSS and Turbidity, the upper level 95% CI for dry and wet season was used for criteria involving ambient mean if a significant difference (<0.05) is exhibited between seasons using the Two-Sample T Tests and Test for Equality of Variances (Statistix 8). TSS criterion is two-fold. There is an ambient related criterion as well as a numeric limit criterion. At stations were there are no ambient data available, only the numeric limit criterion is applied and the ambient related criterion is disregarded. In cases where the Turbidity measured concentration of NTU is ‘ND’ (non-detect) <0.05NTU, the use support is Fully Supporting. For secchi visibility, the lower level 95% CI for dry and wet season was used for criteria involving ambient mean if a significant difference (<0.05) is exhibited between seasons using the Two-Sample T Tests and Test for Equality of Variances (Statistix 8).

For this reporting period, Secchi discs visibility measurements are taken only at STMP stations. On shallow reef flats the disc is oriented horizontally while at deeper coastal sites the disc is oriented vertically from a boat. Upon validation of the STMP dataset, it was determined that secchi visibility data recorded as 'visibility to bottom' does not meet requirements of the criteria and that although 'visibility to the bottom' may an indication of acceptable water clarity, stations with this description is reported in the B1. *Marine Waterbody (MW) Assessment* as 'Fail'. This means that the secchi visibility records were unable to be analyzed using bottom depth values and the method failed to analyze according to the criteria.

Upon validation of the GCA dataset, five TSS records were flagged as questionable data (Q) and thus were not incorporated in this assessment.

During this reporting period, water quality (WQ) for ALUS in marine waterbodies was assessed by one or more stations from the STMP and GCA projects as illustrated in Figure A1a and A1b. If a violation of a WQ parameter occurred at a station within a waterbody containing multiple stations from either projects, the number of violations were divided by the total number of samples from all stations within the waterbody and then multiplied by 100 to determine the ALUS level for water quality phys/chem (Fully supporting 1-10% exceedance, Partially supporting 11-25% exceedance, not supporting >25% exceedance).

Finally, determination of Use Support for *Aquatic Life Phys/Chem Water Quality (WQ)* considers the worst support determination of all physical/chemical indicators assessed. These results are shown in Table B3 *Marine Waters Use Support.*

River/Stream Waterbodies

Water Quality parameters were assessed by the STMP only for this reporting period. Samples from the FW STMP stations are collected at the surface only (no profiling). The criteria table above shows that E. coli and Enterococci are acceptable indicators for assessing body contact support in S1, S2 and S3 classified rivers. In the FW STMP, the preferred indicator is E. coli. Also, the criteria table shows that the same WQ indicators as in the marine water assessment, with the inclusion of Total Dissolved Solids, involve ambient data in determining exceedances of criteria. Ambient data for each parameter is compiled from years prior to 2000 at the same station (station ID). If ambient data is not available for a station, an assessment on that parameter was not conducted and is identified as "NA" in Table B2. *Rivers Assessment*.

Total Dissolved Solids is analyzed on freshwater samples. Freshwater samples are defined as being 0 ppt of salinity. Estuarine rivers (mouths of rivers emptying to marine bays) have saline water. Thus, TDS was not analyzed and is identified by a "UD" in the Table B2. *Rivers Assessment*.

For all ambient Water Temperature records, the 95% confidence interval for average water temperature in the dry season (Jan to June) and in the wet season (July to Dec) was calculated. Then 1 degree was subtracted from the lower limit and 1 degree was added to the upper limit. Water Temperature records used for the 2010 IR were then compared to these calculated values. Similarly for Salinity, TDS, TSS and Turbidity, the upper level 95% CI for dry and wet season was used for criteria involving ambient mean if a significant difference (<0.05) is exhibited between seasons using the Two-Sample T Tests and Test for Equality of Variances (Statistix® 8).

TSS and TDS criteria are two-fold. There is an ambient related criterion as well as a numeric limit criterion. At stations where there are no applicable ambient data, only the numeric limit criterion is applied and the ambient related criterion is disregarded.

In cases where the Turbidity concentration (NTU) is 'ND' (non-detect <0.5NTU), concentration is considered not to be over ambient conditions and thus the use support is Fully Supporting.

During this reporting period, water quality (WQ) for ALUS in rivers is assessed by one station from the STMP with multiple visits while Human Health (organism consumption) is evaluated by two SPMD stations with multiple visits (conc. of pollutants averaged). Also, SPMD evaluation was conducted at one groundwater monitoring well and its location is shown along with the rivers stations. Station locations are shown in Figure A1c. River and Stream Stations. If a violation of a WQ parameter occurred at a station within a reach, the number of violations were divided by the total number of samples and then multiplied by 100 to determine the ALUS level for water quality phys/chem (Fully supporting 1-10% exceedance, Partially supporting 11-25% exceedance, not supporting >25% exceedance).

Finally, determination of Use Support for *Aquatic Life Phys/Chem Water Quality (WQ)* in the rivers component considers the worst support determination for all physical/chemical indicators assessed. If the worst support determination for all the WQ indicator assessed is "Not Supporting", then the waterbody is assigned a Not Supporting Use Determination for *Aquatic Life Phys/Chem Water Quality (WQ)* regardless of indicators resulting in better quality. This process is reflected in Table B2. *Rivers Assessment*.

2. Radioactive Materials are monitored quarterly within the Naval Nuclear Propulsion Program. This monitoring has been going on since the 1960s. This monitoring is conducted in Apra Harbor M-2 water body and assesses radioactive components in sediment, shellfish, algae and water. Data is not included in this report but all samples collected since the inception of the program is reported as negative for radioactive material. Therefore, radioactive materials are marked as "Fully Supporting" in Table B1. *Marine Waterbody (MW) Assessment* for Apra Harbor M-2 Water body. All other waterbodies are Not Assessed (UD).

3. Observations of "Concentrations of Oil" are conducted within the GCA project in marine waterbodies. A visual observation of floating grease and an observation of petroleum odor in collected sediment were conducted at 50 GCA stations. All stations observed came back negative for floating petroleum and petroleum sediment odor. Figure A1a.North and Central Marine Stations and Figure A1b. Central and South Marine Stations in Appendix A show the location of the GCA stations where observations occurred. Future assessment of the category should include data from USCG National Response Center and from Guam EPA oil spill records (water and land spills) for a more comprehensive assessment of this data type.

4. Benthic Bioassessments are conducted only in marine waterbodies for this reporting period. Benthic Assessments in marine stations were collected at 35 GCA stations (exception for those in Apra Harbor deep sites) and at two STMP stations. A former Guam EPA biologist collected

benthic data in the early 1980s and reports were released in 1981, 1983 and 1984. Up to 14 stations were revisited each year where the frequency and percent cover of four components - algae, coral, substrate and invertebrate - were counted from 10 quadrats along a 25m transect. The significant difference in the four cover types over the three years was tested using statistics (single class ANOVA). Significant changes were identified at three stations where invertebrate, coral or algae increased as substrate (pavement, sand or rubble) decreased. Review of the percent cover records in the 3rd Report brought up questions and flags regarding calculations. Out of 14 reported stations, 12 stations have Percent Cover of invertebrate, coral, algae and substrate equaling more than 100%. Furthermore, raw data for these reports could not be located in order to rectify this error. Therefore, for this reporting period, assessment of collected bioassessment data will not be conducted as Bioassessment criteria for degree of ALUS is based on a reference condition. There is no other reference or baseline data available at this time. For future reporting, these 35 GCA and 2 STMP bioassessments conducted recently may be used as baseline/reference conditions for benthic data sets anticipated from future GCA and STMP projects. Figure A1e. *Benthic Visual Bioassessment Stations* in Appendix A show the location of benthic bioassessment during this reporting period.

5. Sediment Chemistry analyses was conducted at 50 marine stations within the GCA project. These stations are located within 25 of the 66 marine waterbodies. Aquatic Life Use Support Decision for Sediments for this reporting period is based on NOAA's Screening Quick Reference Tables (SQRTs) criteria (Buchman, M.F., 1999). Criteria values of the compounds analyzed are shown in the next table (Table 6) and are the lowest toxicity gradient listed (Threshold Effects Level) or the Apparent Effects Threshold (AET) when there is no other criteria available. COCs listed in *Table B1. Marine Waterbody (MW) Assessment* did not meet the TEL or the AET screening value and are listed for evaluation purposes only. .Project sample size is not large enough (1 sample only) to completely assess applicable waterbodies. However, for evaluation purposes, actual concentrations in exceedance of criteria are shown in the raw data table (Table 7 below). Assessment of this data is used in this reporting period as an EVALUATION tool only and will be used toward making a support use decision when more sediment chemistry samples and data are collected. Further investigation is needed based on additional funding.

EVALUATION ONLY

Table 6. 2004-2005 GCA Project: Toxics in Sediment - Criteria, Method

	Sediment compounds	'99 NOAA screen SQRTs TELs (ppb) Marine Seds [italics = AET]	MDL	RL	UNITS
Metal	Aluminum	*1.80%*	8.9	99.6	ug/g dry wt
Metal	Antimony	*9300*	0.22	1	ug/g dry wt
Metal	Arsenic	7240	0.41	5	ug/g dry wt
Metal	Cadmium	676	0.14	0.5	ug/g dry wt
Metal	Chromium	52300	0.49	2	ug/g dry wt
Metal	Copper	18700	0.25	2	ug/g dry wt
Metal	Iron	*22%*	10.6	49.8	ug/g dry wt
Metal	Lead	30240	0.34	1	ug/g dry wt
Metal	Manganese	*260000*	0.16	1	ug/g dry wt
Metal	Mercury	130	0.01	0.033	ug/g dry wt
Metal	Nickel	15900	0.25	1	ug/g dry wt
Metal	Selenium	*1000*	0.84	5	ug/g dry wt
Metal	Silver	730	0.046	0.3	ug/g dry wt
Metal	Tin	48	0.38	2.5	ug/g dry wt
Metal	Zinc	124000	0.42	2	ug/g dry wt
PAH	PAH_total	1684.06			
PAH	1-Methylnaphthalene		10	10	ng/g dry wt
PAH	1-Methylphenanthrene		10	10	ng/g dry wt
PAH	2,3,5-Trimethylnaphthalene		10	10	ng/g dry wt
PAH	2,6-Dimethylnaphthalene		10	10	ng/g dry wt
PAH	2-Methylnaphthalene	20.21	10	10	ng/g dry wt
PAH	Acenaphthene	6.71	10	10	ng/g dry wt
PAH	Acenaphthylene	5.87	10	10	ng/g dry wt
PAH	Anthracene	46.85	10	10	ng/g dry wt
PAH	Benz(a)anthracene	74.83	10	10	ng/g dry wt
PAH	Benzo(a)pyrene	88.81	10	10	ng/g dry wt
PAH	Benzo(b)fluoranthene	*1800*	10	10	ng/g dry wt
PAH	Benzo(g,h,i)perylene	*670*	10	10	ng/g dry wt
PAH	Benzo(k)fluoranthene	*1800*	10	10	ng/g dry wt
PAH	Biphenyl		10	10	ng/g dry wt
PAH	Chrysene	107.11	10	10	ng/g dry wt
PAH	Dibenzo(a,h)anthracene	6.22	10	10	ng/g dry wt
PAH	Dibenzothiophene		10	10	ng/g dry wt
PAH	Fluoranthene	112.82	10	10	ng/g dry wt
PAH	Fluorene	21.17	10	10	ng/g dry wt
PAH	Indeno(1,2,3-c,d)pyrene	*600*	10	10	ng/g dry wt
PAH	Naphthalene	34.57	10	10	ng/g dry wt
PAH	Phenanthrene	86.68	10	10	ng/g dry wt
PAH	Pyrene	152.66	10	10	ng/g dry wt
PCB	PCB_total	21.55			
PCB	PCB101		0.05	1	ng/g dry wt
PCB	PCB105		0.05	1	ng/g dry wt
PCB	PCB110		0.05	1	ng/g dry wt
PCB	PCB118		0.05	1	ng/g dry wt
PCB	PCB126		0.05	1	ng/g dry wt
PCB	PCB128		0.05	1	ng/g dry wt
PCB	PCB138		0.05	1	ng/g dry wt
PCB	PCB153		0.05	1	ng/g dry wt
PCB	PCB170		0.05	1	ng/g dry wt
PCB	PCB18		0.05	1	ng/g dry wt
PCB	PCB180		0.05	1	ng/g dry wt

EVALUATION ONLY

Table 6. 2004-2005 GCA Project: Toxics in Sediment - Criteria, Method

	Sediment compounds	'99 NOAA screen SQRTs TELs (ppb) Marine Seds [italics = AET]	MDL	RL	UNITS
PCB	PCB187		0.05	1	ng/g dry wt
PCB	PCB195		0.05	1	ng/g dry wt
PCB	PCB206		0.05	1	ng/g dry wt
PCB	PCB209		0.05	1	ng/g dry wt
PCB	PCB28		0.05	1	ng/g dry wt
PCB	PCB44		0.05	1	ng/g dry wt
PCB	PCB52		0.05	1	ng/g dry wt
PCB	PCB66		0.05	1	ng/g dry wt
PCB	PCB77		0.05	1	ng/g dry wt
PCB	PCB8		0.05	1	ng/g dry wt
PEST	DDT_total	3.89			
PEST	2,4'-DDD		0.5	0.5	ng/g dry wt
PEST	2,4'-DDE		0.5	0.5	ng/g dry wt
PEST	2,4'-DDT		0.5	0.5	ng/g dry wt
PEST	4,4'-DDD	1.22	0.23	0.5	ng/g dry wt
PEST	4,4'-DDE	2.07	0.21	0.5	ng/g dry wt
PEST	4,4'-DDT	1.19	0.92	0.5	ng/g dry wt
PEST	Aldrin	*9.5*	0.16	0.5	ng/g dry wt
PEST	BHC-gamma (Lindane)	0.32	0.16	0.5	ng/g dry wt
PEST	Total Chlordane	2.26			
PEST	Alpha-Chlordane		0.4	0.5	ng/g dry wt
PEST	Trans-Nonachlor		0.03	0.5	ng/g dry wt
PEST	Dieldrin	0.715	0.35	0.5	ng/g dry wt
PEST	Endosulfan Sulfate		0.28	0.5	ng/g dry wt
PEST	Endosulfan I	none	0.18	0.5	ng/g dry wt
PEST	Endosulfan II	none	0.95	0.5	ng/g dry wt
PEST	Endrin	none	0.23	0.5	ng/g dry wt
PEST	Heptachlor	*0.3*	0.51	0.5	ng/g dry wt
PEST	Heptachlor epoxide	none	0.16	0.5	ng/g dry wt
PEST	Hexachlorobenzene	*6*	0.5	0.5	ng/g dry wt
PEST	Mirex	none	0.5	0.5	ng/g dry wt
PEST	Toxaphene	none	12	50	ng/g dry wt

EVALUATION ONLY:

Table 7. 2004-2005 GCA: Sediment Chemistry/Contaminants Exceeding Criteria

Group	Compound	'99 NOAA screen SQRTs TELs (ppb) Marine Seds [italics = AET]	SED CONC (ppb) [italics = below MCL]	WaterBodyName	Station Location
Metal	Tin	48	2500	Pagat Point Bank/Shelf	Pagat Point
Metal	Chromium	52300	105000	Cetti Bay	Cetti Bay
Metal	Manganese	*260000*	354000	Cetti Bay	Cetti Bay
Metal	Nickel	15900	59500	Cetti Bay	Cetti Bay
Metal	Tin	48	2700	Cetti Bay	Cetti Bay
Metal	Manganese	*260000*	285500	Taleyfac Bay	Agat Marina Channel
Metal	Tin	48	2600	Tumon Bay	Tumon Bay - Okura reef flat
Metal	Arsenic	7240	20800	Sasa Bay	Sasa Bay Mangrove
Metal	Chromium	52300	69600	Sasa Bay	Sasa Bay Mangrove
Metal	Copper	18700	34800	Sasa Bay	Sasa Bay Mangrove
Metal	Manganese	*260000*	502000	Sasa Bay	Sasa Bay Mangrove
Metal	Nickel	15900	32200	Sasa Bay	Sasa Bay Mangrove
Metal	Tin	48	2700	Sasa Bay	Sasa Bay Mangrove
Metal	Arsenic	7240	8700	Apra Harbor	Apra Harbor - near Dry Dock
Metal	Copper	18700	35200	Apra Harbor	Apra Harbor - near Dry Dock
Metal	Manganese	*260000*	312000	Apra Harbor	Apra Harbor - near Dry Dock
Metal	Mercury	130	180	Apra Harbor	Apra Harbor - near Dry Dock
Metal	Nickel	15900	23600	Apra Harbor	Apra Harbor - near Dry Dock
Metal	Tin	48	4800	Apra Harbor	Apra Harbor - near Dry Dock
Metal	Tin	48	2700	East Hagatna Bay	East Hagatna Bay - ABT
Metal	Arsenic	7240	10300	Sasa Bay	Sasa Bay
Metal	Chromium	52300	70700	Sasa Bay	Sasa Bay
Metal	Copper	18700	[illegible]	Sasa Bay	Sasa Bay
Metal	Manganese	*260000*	364000	Sasa Bay	Sasa Bay
Metal	Nickel	15900	31800	Sasa Bay	Sasa Bay
Metal	Tin	48	3900	Sasa Bay	Sasa Bay
Metal	Tin	48	2600	Cocos Lagoon	Cocos Lagoon - Outside
Metal	Tin	48	2600	Asan Bay	West Adelup Park
Metal	Tin	48	3100	Agat Bay	Gaan Point Agat
Metal	Arsenic	7240	8600	Tipalao Bay	Tipalao Bay
Metal	Copper	18700	[illegible]	Tipalao Bay	Tipalao Bay
Metal	Lead	30240	88400	Tipalao Bay	Tipalao Bay
Metal	Nickel	15900	19200	Tipalao Bay	Tipalao Bay
Metal	Tin	48	17300	Tipalao Bay	Tipalao Bay
Metal	Zinc	124000	131000	Tipalao Bay	Tipalao Bay
PCB	PCB_total	21.55	42.61	Tipalao Bay	Tipalao Bay
Metal	Arsenic	7240	12100	Apra Harbor (Abo Cove)	South Inner Harbor
Metal	Cadmium	676	720	Apra Harbor (Abo Cove)	South Inner Harbor
Metal	Chromium	52300	143000	Apra Harbor (Abo Cove)	South Inner Harbor
Metal	Copper	18700	[illegible]	Apra Harbor (Abo Cove)	South Inner Harbor

EVALUATION ONLY:

Table 7. 2004-2005 GCA: Sediment Chemistry/Contaminants Exceeding Criteria

Group	Compound	'99 NOAA screen SQRTs TELs (ppb) Marine Seds [italics = AET]	SED CONC (ppb) [italics = below MCL]	WaterBodyName	Station Location
Metal	Lead	30240	32400	Apra Harbor (Abo Cove)	South Inner Harbor
Metal	Manganese	260000	671000	Apra Harbor (Abo Cove)	South Inner Harbor
Metal	Nickel	15900	78500	Apra Harbor (Abo Cove)	South Inner Harbor
Metal	Tin	48	4900	Apra Harbor (Abo Cove)	South Inner Harbor
Metal	Zinc	124000	136000	Apra Harbor (Abo Cove)	South Inner Harbor
Metal	Tin	48	2600	Cocos Lagoon	Southeast Cocos Lagoon
Metal	Tin	48	2700	East Hagatna Bay	South of Alupang Island
Metal	Tin	48	2500	Taleyfac Bay	Facpi Point
Metal	Cadmium	676	1300	Talofofo Bay	Talofofo Bay Bridge
Metal	Chromium	52300	59100	Talofofo Bay	Talofofo Bay Bridge
Metal	Copper	18700	157000	Talofofo Bay	Talofofo Bay Bridge
Metal	Manganese	260000	1690000	Talofofo Bay	Talofofo Bay Bridge
Metal	Nickel	15900	33500	Talofofo Bay	Talofofo Bay Bridge
Metal	Tin	48	3600	Talofofo Bay	Talofofo Bay Bridge
Metal	Tin	48	2600	Piti Bay	Piti Bomb Holes
Metal	Chromium	52300	254000	Bile Bay	Bile Bay
Metal	Copper	18700	[illegible]	Bile Bay	Bile Bay
Metal	Manganese	260000	725000	Bile Bay	Bile Bay
Metal	Nickel	15900	97900	Bile Bay	Bile Bay
Metal	Tin	48	2900	Bile Bay	Bile Bay
Metal	Copper	18700	[illegible]	Apra Harbor	Apra Harbor-off Seaplane Ramp
Metal	Lead	30240	36100	Apra Harbor	Apra Harbor-off Seaplane Ramp
Metal	Mercury	130	240	Apra Harbor	Apra Harbor-off Seaplane Ramp
Metal	Tin	48	4900	Apra Harbor	Apra Harbor-off Seaplane Ramp
Metal	Arsenic	7240	14500	Apra Harbor	East Inner Harbor
Metal	Cadmium	676	680	Apra Harbor	East Inner Harbor
Metal	Chromium	52300	135000	Apra Harbor	East Inner Harbor
Metal	Copper	18700	[illegible]	Apra Harbor	East Inner Harbor
Metal	Lead	30240	35900	Apra Harbor	East Inner Harbor
Metal	Manganese	260000	673000	Apra Harbor	East Inner Harbor
Metal	Mercury	130	270	Apra Harbor	East Inner Harbor
Metal	Nickel	15900	68800	Apra Harbor	East Inner Harbor
Metal	Tin	48	5000	Apra Harbor	East Inner Harbor
Metal	Zinc	124000	146000	Apra Harbor	East Inner Harbor
Metal	Tin	48	2600	East Reef Flat (Mangilao)	Mangilao Golf Course Terrace
Metal	Arsenic	7240	9100	Sasa Bay	Mouth of Sasa Bay
Metal	Chromium	52300	82000	Sasa Bay	Mouth of Sasa Bay
Metal	Copper	18700	[illegible]	Sasa Bay	Mouth of Sasa Bay
Metal	Lead	30240	34500	Sasa Bay	Mouth of Sasa Bay
Metal	Manganese	260000	414000	Sasa Bay	Mouth of Sasa Bay

EVALUATION ONLY:

Table 7. 2004-2005 GCA: Sediment Chemistry/Contaminants Exceeding Criteria

Group	Compound	'99 NOAA screen SQRTs TELs (ppb) Marine Seds [italics = AET]	SED CONC (ppb) [italics = below MCL]	WaterBodyName	Station Location
Metal	Mercury	130	170	Sasa Bay	Mouth of Sasa Bay
Metal	Nickel	15900	37400	Sasa Bay	Mouth of Sasa Bay
Metal	Tin	48	4300	Sasa Bay	Mouth of Sasa Bay
Metal	Tin	48	2600	Tumon Bay	Tumon Bay - Matapang
Metal	Copper	18700	20800	Apra Harbor	Apra Harbor - Deep
Metal	Mercury	130	190	Apra Harbor	Apra Harbor - Deep
Metal	Nickel	15900	16800	Apra Harbor	Apra Harbor - Deep
Metal	Tin	48	4700	Apra Harbor	Apra Harbor - Deep
Metal	Tin	48	2800	East Hagatna Bay	East Hagatna Bay - Reef margin
Metal	Tin	48	2500	Cocos Lagoon	Cocos Lagoon - mid
Metal	Copper	18700	33900	Apra Harbor	Apra Harbor - West Jade Shoals
Metal	Mercury	130	250	Apra Harbor	Apra Harbor - West Jade Shoals
Metal	Nickel	15900	17000	Apra Harbor	Apra Harbor - West Jade Shoals
Metal	Tin	48	4600	Apra Harbor	Apra Harbor - West Jade Shoals
Metal	Tin	48	2700	West Hagatna Bay	West Hagatna Bay
Metal	Tin	48	2500	Pago Bay	Pago Bay Reef Margin
Metal	Arsenic	7240	21300	Sasa Bay	South Sasa Bay
Metal	Cadmium	676	810	Sasa Bay	South Sasa Bay
Metal	Chromium	52300	117000	Sasa Bay	South Sasa Bay
Metal	Copper	18700	62500	Sasa Bay	South Sasa Bay
Metal	Manganese	*260000*	583000	Sasa Bay	South Sasa Bay
Metal	Nickel	15900	53100	Sasa Bay	South Sasa Bay
Metal	Tin	48	3700	Sasa Bay	South Sasa Bay
Metal	Arsenic	7240	15300	Inner Apra Harbor	West Inner Harbor
Metal	Chromium	52300	96300	Inner Apra Harbor	West Inner Harbor
Metal	Copper	18700	78700	Inner Apra Harbor	West Inner Harbor
Metal	Lead	30240	31700	Inner Apra Harbor	West Inner Harbor
Metal	Manganese	*260000*	567000	Inner Apra Harbor	West Inner Harbor
Metal	Mercury	130	260	Inner Apra Harbor	West Inner Harbor
Metal	Nickel	15900	47900	Inner Apra Harbor	West Inner Harbor
Metal	Tin	48	4600	Inner Apra Harbor	West Inner Harbor
PCB	PCB_total	21.55	38.33	Inner Apra Harbor	West Inner Harbor
PEST	DDT_total	3.89	5.9	Inner Apra Harbor	West Inner Harbor
Metal	Arsenic	7240	17900	Sella Bay	Sella Bay
Metal	Chromium	52300	157000	Sella Bay	Sella Bay
Metal	Copper	18700	26500	Sella Bay	Sella Bay
Metal	Manganese	*260000*	838000	Sella Bay	Sella Bay
Metal	Nickel	15900	89900	Sella Bay	Sella Bay
Metal	Tin	48	2500	Tumon Bay	Ypao Beach

Human Health Consumption of toxicants is assessed this reporting period using current consumption advisories. Current Seafood and Fish Consumption Advisories required a human health risk assessment based on multiple samples or in the case of Tanguisson Beach is the result of deaths associated with consumption. Waterbodies under consumption advisory are identified in Table B1. *Marine Waterbody (MW) Assessment* as not supporting (NS) for the human health/consumption designated use.

Where consumption is concerned, studies that assess organism tissue generally are designed to first screen pollutants and then intensify monitoring efforts to determine the human health risk associated with organism size, amount and frequency of consumption. Full blown fish and shellfish consumption programs are therefore generally expensive and require a great amount of financial and logistical support. Three additional projects outside the scope and short of the required sample size requirement of these Human Health Risk Assessments (HHRA) were conducted within various projects on Guam from 2005-2007. These projects are the sea cucumber tissue concentrations from the 2004-2005 GCA Project, the 2006 NOAA and Guam EPA Fish Tissue Contaminant Study in Apra Harbor, and the 2007 Semi-Permeable Membrane Device project. Data from these projects are used in this report as 'evaluation only' data sets and can be used towards identifying waterbodies that require more intensified studies in the future. Results are reported here based on the fact that tissue analyses were conducted and in some cases, chemicals of concern (COC) were detected above existing criteria. Investigation into these elevated concentrations is required. A determination should be conducted on whether these data sets can be used in making use support decisions and/or be used towards a HHRA.

The 2004-2005 GCA Project used sea cucumber tissue as the target species for tissue analysis testing. Sea cucumber is commonly harvested and eaten in the Pacific. Ten (10) stations were selected for this analysis based on COC concentrations found in the sediment. Metals, PCB and/or PAHs were present above MDLs in samples from all ten stations. Concentrations of compounds measured in the tissue were compared to either '01 Guam WQS,'09 NRWQC or '00 EPA SV criteria. These criteria are shown in the next table (Table 8). Bold concentrations in the table are selected for comparison to measured concentrations. More data is needed but any exceedances identified here are listed as 'SeaCucumber EVAL' in Table B1. *Marine Waterbody (MW) Assessment* for manager's consideration in future planning. Actual concentrations in exceedance of criteria are shown in the raw data table below (Table 9).

EVALUATION ONLY

Table 8. 2004-2005 GCA Project: Toxics in Organisms - Compound, Criteria

	Tissue compounds Analyzed	'01 Guam WQS (ppb) 1	'09 NRWQC (ppb) [italics = nonpriority] 2	'00 EPA SV (ppb) [italics = noncarcinogens] 3	MDL	RL	Units	AnalysisMethod
Metal	Aluminum	none	none	none	1	5	µg/wet g	SW6020
Metal	Antimony	4300	**640**	none	0.025	0.05	µg/wet g	SW6020
Metal	Arsenic (inorganic)	5 (for S1 water+org)	0.14	**3.27**	0.025	0.05	µg/wet g	SW6020
Metal	Barium	none	***1000 water+org***	none	0.025	0.05	µg/wet g	SW6020
Metal	Beryllium	narrative	none	none	0.025	0.05	µg/wet g	SW6020
Metal	Cadmium	narrative	none	***491***	0.025	0.05	µg/wet g	SW6020
Metal	Chromium	narrative	none	none	0.025	0.05	µg/wet g	SW6020
Metal	Cobalt	none	none	none	0.025	0.05	µg/wet g	SW6020
Metal	Copper	1300 (for S1 water+org)	**1000 organoleptic**	none	0.025	0.05	µg/wet g	SW6020
Metal	Iron	none	***300 water+org***	none	1	5	µg/wet g	SW6020
Metal	Lead	narrative	none	none	0.025	0.05	µg/wet g	SW6020
Metal	Manganese	none	***100***	none	0.025	0.05	µg/wet g	SW6020
Metal	Mercury	**0.051**	0.3 (methyl-)	*49 (methyl-)*	0.025	0.02	µg/wet g	EPA245.7
Metal	Molybdenum	none	none	none	0.025	0.05	µg/wet g	SW6020
Metal	Nickel	**4600**	4600	none	0.025	0.05	µg/wet g	SW6020
Metal	Selenium	narrative	4200	***2457***	0.025	0.05	µg/wet g	SW6020
Metal	Silver	none	none	none	0.025	0.05	µg/wet g	SW6020
Metal	Strontium	none	none	none	0.025	0.05	µg/wet g	SW6020
Metal	Thallium	6.3	**0.47**	none	0.025	0.05	µg/wet g	SW6020
Metal	Tin	none	none	***147 (tributyl-)***	0.025	0.05	µg/wet g	SW6020
Metal	Titanium	none	none	none	0.025	0.05	µg/wet g	SW6020
Metal	Vanadium	none	none	none	0.025	0.05	µg/wet g	SW6020
Metal	Zinc	69000	**26000 (5000 organoleptic)**	none	0.025	0.05	µg/wet g	SW6020
PAH	PAH_total			**0.673**	1		ng/wet g	SW8270C
PAH	1-Methylnaphthalene				1	5	ng/wet g	SW8270C
PAH	1-Methylphenanthrene				1	5	ng/wet g	SW8270C
PAH	2,3,5-Trimethylnaphthalene				1	5	ng/wet g	SW8270C
PAH	2,6-Dimethylnaphthalene				1	5	ng/wet g	SW8270C
PAH	2-Methylnaphthalene				1	5	ng/wet g	SW8270C
PAH	Acenaphthene	2700	**990 (20 organoleptic)**		1	5	ng/wet g	SW8270C
PAH	Acenaphthylene	none	none		1	5	ng/wet g	SW8270C
PAH	Anthracene	110000	**40000**		1	5	ng/wet g	SW8270C
PAH	Benz[a]anthracene	0.049	0.018		1	5	ng/wet g	SW8270C
PAH	Benzo[a]pyrene	0.049	**0.018**		1	5	ng/wet g	SW8270C
PAH	Benzo[b]fluoranthene	0.049	**0.018**		1	5	ng/wet g	SW8270C
PAH	Benzo[e]pyrene				1	5	ng/wet g	SW8270C
PAH	Benzo[g,h,i]perylene	none			1	5	ng/wet g	SW8270C

EVALUATION ONLY

Table 8. 2004-2005 GCA Project: Toxics in Organisms - Compound, Criteria

	Tissue compounds Analyzed	'01 Guam WQS (ppb) 1	'09 NRWQC (ppb) [italics = nonpriority] 2	'00 EPA SV (ppb) [italics = noncarcinogens] 3	MDL	RL	Units	AnalysisMethod
PAH	Benzo[k]fluoranthene	0.049	**0.018**		1	5	ng/wet g	SW8270C
PAH	Biphenyl				1	5	ng/wet g	SW8270C
PAH	Chrysene	0.049	**0.018**		1	5	ng/wet g	SW8270C
PAH	Dibenzo[a,h]anthracene	0.049	0.018		1	5	ng/wet g	SW8270C
PAH	Dibenzothiophene				1	5	ng/wet g	SW8270C
PAH	Fluoranthene	370	**140**		1	5	ng/wet g	SW8270C
PAH	Fluorene	14000	**5300**		1	5	ng/wet g	SW8270C
PAH	Indeno[1,2,3-c,d]pyrene	0.049	0.018		1	5	ng/wet g	SW8270C
PAH	Naphthalene	none	none		1	5	ng/wet g	SW8270C
PAH	Perylene				1	5	ng/wet g	SW8270C
PAH	Phenanthrene	none	none		1	5	ng/wet g	SW8270C
PAH	Pyrene	11000	**4000**		1	5	ng/wet g	SW8270C
PCB	PCB_total	0.00017	0.000064	2.45				
PCB	PCB101				1	5	ng/wet g	SW8270C
PCB	PCB105				1	5	ng/wet g	SW8270C
PCB	PCB110				1	5	ng/wet g	SW8270C
PCB	PCB114				1	5	ng/wet g	SW8270C
PCB	PCB118				1	5	ng/wet g	SW8270C
PCB	PCB119				1	5	ng/wet g	SW8270C
PCB	PCB123				1	5	ng/wet g	SW8270C
PCB	PCB126				1	5	ng/wet g	SW8270C
PCB	PCB128				1	5	ng/wet g	SW8270C
PCB	PCB138				1	5	ng/wet g	SW8270C
PCB	PCB141				1	5	ng/wet g	SW8270C
PCB	PCB149				1	5	ng/wet g	SW8270C
PCB	PCB151				1	5	ng/wet g	SW8270C
PCB	PCB153				1	5	ng/wet g	SW8270C
PCB	PCB156				1	5	ng/wet g	SW8270C
PCB	PCB157				1	5	ng/wet g	SW8270C
PCB	PCB158				1	5	ng/wet g	SW8270C
PCB	PCB167				1	5	ng/wet g	SW8270C
PCB	PCB168+132				1	5	ng/wet g	SW8270C
PCB	PCB169				1	5	ng/wet g	SW8270C
PCB	PCB170				1	5	ng/wet g	SW8270C
PCB	PCB174				1	5	ng/wet g	SW8270C
PCB	PCB177				1	5	ng/wet g	SW8270C
PCB	PCB18				1	5	ng/wet g	SW8270C
PCB	PCB180				1	5	ng/wet g	SW8270C
PCB	PCB183				1	5	ng/wet g	SW8270C
PCB	PCB187				1	5	ng/wet g	SW8270C
PCB	PCB189				1	5	ng/wet g	SW8270C
PCB	PCB194				1	5	ng/wet g	SW8270C

EVALUATION ONLY

Table 8. 2004-2005 GCA Project: Toxics in Organisms - Compound, Criteria

	Tissue compounds Analyzed	'01 Guam WQS (ppb) 1	'09 NRWQC (ppb) [italics = nonpriority] 2	'00 EPA SV (ppb) [italics = noncarcinogens] 3	MDL	RL	Units	AnalysisMethod
PCB	PCB195				1	5	ng/wet g	SW8270C
PCB	PCB200				1	5	ng/wet g	SW8270C
PCB	PCB201				1	5	ng/wet g	SW8270C
PCB	PCB206				1	5	ng/wet g	SW8270C
PCB	PCB209				1	5	ng/wet g	SW8270C
PCB	PCB28				1	5	ng/wet g	SW8270C
PCB	PCB31				1	5	ng/wet g	SW8270C
PCB	PCB33				1	5	ng/wet g	SW8270C
PCB	PCB37				1	5	ng/wet g	SW8270C
PCB	PCB44				1	5	ng/wet g	SW8270C
PCB	PCB49				1	5	ng/wet g	SW8270C
PCB	PCB52				1	5	ng/wet g	SW8270C
PCB	PCB56/60				1	5	ng/wet g	SW8270C
PCB	PCB66				1	5	ng/wet g	SW8270C
PCB	PCB70				1	5	ng/wet g	SW8270C
PCB	PCB74				1	5	ng/wet g	SW8270C
PCB	PCB77				1	5	ng/wet g	SW8270C
PCB	PCB8				1	5	ng/wet g	SW8270C
PCB	PCB81				1	5	ng/wet g	SW8270C
PCB	PCB87				1	5	ng/wet g	SW8270C
PCB	PCB95				1	5	ng/wet g	SW8270C
PCB	PCB97				1	5	ng/wet g	SW8270C
PCB	PCB99				1	5	ng/wet g	SW8270C
PEST	DDT_total			14.4	1		ng/wet g	SW8270C
PEST	2,4'-DDD				1	5	ng/wet g	SW8270C
PEST	2,4'-DDE				1	5	ng/wet g	SW8270C
PEST	2,4'-DDT				1	5	ng/wet g	SW8270C
PEST	4,4'-DDD	0.00084	0.00031		1	5	ng/wet g	SW8270C
PEST	4,4'-DDE	0.00059	0.00022		1	5	ng/wet g	SW8270C
PEST	4,4'-DDT	0.00059	0.00022		1	5	ng/wet g	SW8270C
PEST	Aldrin	0.00014	0.00005		1	5	ng/wet g	SW8270C
PEST	BHC-alpha	0.013	0.0049		1	5	ng/wet g	SW8270C
PEST	BHC-beta	0.046	0.017		1	5	ng/wet g	SW8270C
PEST	BHC-delta	none	none		1	5	ng/wet g	SW8270C
PEST	BHC-gamma (Lindane)	0.063	1.8	3.78	1	5	ng/wet g	SW8270C
PEST	Total Chlordane	0.0022	0.00081	14	1		ng/wet g	SW8270C
PEST	Chlordane-alpha (cis)				1	5	ng/wet g	SW8270C
PEST	Chlordane-gamma (beta)				1	5	ng/wet g	SW8270C
PEST	Cis-Nonachlor				1	5	ng/wet g	SW8270C
PEST	Trans-Nonachlor				1	5	ng/wet g	SW8270C
PEST	Oxychlordane				1	5	ng/wet g	SW8270C
PEST	DCPA (dacthal)				1	10	ng/wet g	SW8270C

EVALUATION ONLY

Table 8. 2004-2005 GCA Project: Toxics in Organisms - Compound, Criteria

	Tissue compounds Analyzed	'01 Guam WQS (ppb) 1	'09 NRWQC (ppb) [italics = nonpriority] 2	'00 EPA SV (ppb) [italics = noncarcinogens] 3	MDL	RL	Units	AnalysisMethod
PEST	Dicofol			*196*	1	5	ng/wet g	SW8270C
PEST	Dieldrin	0.00014	0.000054	0.307	1	5	ng/wet g	SW8270C
PEST	Endosulfan Sulfate	240	89		1	5	ng/wet g	SW8270C
PEST	Endosulfan-I (alpha)	240	89	*2949*	1	5	ng/wet g	SW8270C
PEST	Endosulfan-II (beta)	240	89		1	5	ng/wet g	SW8270C
PEST	Endrin	0.81	0.06	*147*	1	5	ng/wet g	SW8270C
PEST	Endrin Aldehyde	0.81	0.3		1	5	ng/wet g	SW8270C
PEST	Endrin Ketone				1	5	ng/wet g	SW8270C
PEST	Heptachlor	0.00021	0.000079		1	5	ng/wet g	SW8270C
PEST	Heptachlor Epoxide	0.00011	0.000039	0.54	1	5	ng/wet g	SW8270C
PEST	Hexachlorobenzene	0.00077	0.00029	3.07	1	5	ng/wet g	SW8270C
PEST	Methoxychlor		*100 (water+org)*		1	5	ng/wet g	SW8270C
PEST	Mirex		none	*98*	1	5	ng/wet g	SW8270C
PEST	Perthane				1	10	ng/wet g	SW8270C
PEST	Toxaphene	0.00075	0.00028	4.46	1	50	ng/wet g	SW8270C

1 Guam Water Quality Standards. Guam Environmental Protection Agency. 2001 Revision.

2 National Recommended Water Quality Criteria. Office of Water and Office of Science and Technology, United States Environmental Protection Agency. 2009. View online at http://www.epa.gov/ost/criteria/wqctable/.

3 Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories. EPA 823-B-00-007. Office of Water, United States Environmental Protection Agency. November 2000.

EVALUATION ONLY:

Table 9. 2004-2005 GCA: Sea Cucumber Tissue Contaminants Exceeding Criteria

Group	Compound	Criteria (ppb)	TISSUE CONC (ppb) [italics = below MCL]	WaterBodyName	Station Location
METALS	Arsenic	**3.27**	1900	East Hagatna Bay	East Hagatna Bay - ABT
METALS	Copper	**1000**	1400	East Hagatna Bay	East Hagatna Bay - ABT
METALS	Iron	**300**	38000	East Hagatna Bay	East Hagatna Bay - ABT
METALS	Manganese	**100**	1000	East Hagatna Bay	East Hagatna Bay - ABT
METALS	Mercury	**0.051**	*2*	East Hagatna Bay	East Hagatna Bay - ABT
PAH	Chrysene	**0.018**	*0.6*	East Hagatna Bay	East Hagatna Bay - ABT
PAH	PAH_total	**0.673**	4.2	East Hagatna Bay	East Hagatna Bay - ABT
METALS	Arsenic	**3.27**	1800	East Hagatna Bay	South of Alupang Island
METALS	Iron	**300**	33000	East Hagatna Bay	South of Alupang Island
METALS	Manganese	**100**	1300	East Hagatna Bay	South of Alupang Island
METALS	Mercury	**0.051**	*1*	East Hagatna Bay	South of Alupang Island
PAH	Benzo[a]pyrene	**0.018**	*0.8*	East Hagatna Bay	South of Alupang Island
PAH	PAH_total	**0.673**	10.6	East Hagatna Bay	South of Alupang Island
METALS	Arsenic	**3.27**	900	Asan Bay	West Adelup Park
METALS	Copper	**1000**	1500	Asan Bay	West Adelup Park
METALS	Iron	**300**	74000	Asan Bay	West Adelup Park
METALS	Manganese	**100**	1100	Asan Bay	West Adelup Park
METALS	Mercury	**0.051**	*1*	Asan Bay	West Adelup Park
PAH	Benzo[b]fluoranthene	**0.018**	1.7	Asan Bay	West Adelup Park
PAH	Benzo[k]fluoranthene	**0.018**	1	Asan Bay	West Adelup Park
PAH	PAH_total	**0.673**	7.4	Asan Bay	West Adelup Park
METALS	Arsenic	**3.27**	2500	Piti Bay	Piti Bomb Holes
METALS	Iron	**300**	253000	Piti Bay	Piti Bomb Holes
METALS	Manganese	**100**	6700	Piti Bay	Piti Bomb Holes
METALS	Mercury	**0.051**	*3*	Piti Bay	Piti Bomb Holes
PAH	Benzo[b]fluoranthene	**0.018**	*0.5*	Piti Bay	Piti Bomb Holes
PAH	PAH_total	**0.673**	4.7	Piti Bay	Piti Bomb Holes
METALS	Arsenic	**3.27**	1200	Tipalao Bay	Tipalao Bay
METALS	Copper	**1000**	2900	Tipalao Bay	Tipalao Bay
METALS	Iron	**300**	354000	Tipalao Bay	Tipalao Bay
METALS	Manganese	**100**	2000	Tipalao Bay	Tipalao Bay
METALS	Mercury	**0.051**	*1*	Tipalao Bay	Tipalao Bay
METALS	Tin	**147**	400	Tipalao Bay	Tipalao Bay
PAH	Benzo[a]pyrene	**0.018**	1.5	Tipalao Bay	Tipalao Bay
PAH	PAH_total	**0.673**	7.7	Tipalao Bay	Tipalao Bay

EVALUATION ONLY:

Table 9. 2004-2005 GCA: Sea Cucumber Tissue Contaminants Exceeding Criteria

Group	Compound	Criteria (ppb)	TISSUE CONC (ppb) [italics = below MCL]	WaterBodyName	Station Location
PCB	PCBs_total	**2.45**	15.9	Tipalao Bay	Tipalao Bay
METALS	Arsenic	**3.27**	7400	Agat Bay	Agat Bay - Dadi Beach
METALS	Copper	**1000**	1200	Agat Bay	Agat Bay - Dadi Beach
METALS	Iron	**300**	246000	Agat Bay	Agat Bay - Dadi Beach
METALS	Manganese	**100**	13900	Agat Bay	Agat Bay - Dadi Beach
METALS	Mercury	**0.051**	*5*	Agat Bay	Agat Bay - Dadi Beach
PAH	PAH_total	**0.673**	5.1	Agat Bay	Agat Bay - Dadi Beach
METALS	Arsenic	**3.27**	1300	Sella Bay	Sella Bay
METALS	Iron	**300**	274000	Sella Bay	Sella Bay
METALS	Manganese	**100**	6000	Sella Bay	Sella Bay
METALS	Mercury	**0.051**	*1*	Sella Bay	Sella Bay
PAH	PAH_total	**0.673**	6.1	Sella Bay	Sella Bay
METALS	Arsenic	**3.27**	2300	Mamatguan Point Bank/Shelf	Mamatguan Point
METALS	Barium	**1000**	1700	Mamatguan Point Bank/Shelf	Mamatguan Point
METALS	Copper	**1000**	2700	Mamatguan Point Bank/Shelf	Mamatguan Point
METALS	Iron	**300**	160000	Mamatguan Point Bank/Shelf	Mamatguan Point
METALS	Manganese	**100**	2400	Mamatguan Point Bank/Shelf	Mamatguan Point
METALS	Mercury	**0.051**	*1*	Mamatguan Point Bank/Shelf	Mamatguan Point
METALS	Tin	**147**	[illegible]	Mamatguan Point Bank/Shelf	Mamatguan Point
PAH	**Benzo[a]pyrene**	**0.018**	1.8	Mamatguan Point Bank/Shelf	Mamatguan Point
PAH	Benzo[k]fluoranthene	**0.018**	*0.6*	Mamatguan Point Bank/Shelf	Mamatguan Point
PAH	PAH_total	**0.673**	9.1	Mamatguan Point Bank/Shelf	Mamatguan Point
METALS	Arsenic	**3.27**	1300	Cocos Lagoon	Cocos Lagoon - Outside
METALS	Copper	**1000**	1100	Cocos Lagoon	Cocos Lagoon - Outside
METALS	Iron	**300**	39000	Cocos Lagoon	Cocos Lagoon - Outside
METALS	Manganese	**100**	900	Cocos Lagoon	Cocos Lagoon - Outside
PAH	PAH_total	**0.673**	6.1	Cocos Lagoon	Cocos Lagoon - Outside
METALS	Arsenic	**3.27**	3200	East Reef Flat (Mangilao)	Mangilao Golf Course Terrace
METALS	Iron	**300**	17000	East Reef Flat (Mangilao)	Mangilao Golf Course Terrace
METALS	Manganese	**100**	600	East Reef Flat (Mangilao)	Mangilao Golf Course Terrace
METALS	Mercury	**0.051**	*2*	East Reef Flat (Mangilao)	Mangilao Golf Course Terrace
PAH	Benzo[a]pyrene	**0.018**	1.5	East Reef Flat (Mangilao)	Mangilao Golf Course Terrace
PAH	PAH_total	**0.673**	7.1	East Reef Flat (Mangilao)	Mangilao Golf Course Terrace

In 2006, NOAA and Guam EPA conducted a Fish Tissue Contaminant Study in M-2 and M-3 waters of Apra Harbor, Piti Channel/Cabras Island and Luminao Reef. Fish species from fourteen (14) sites were collected and analyzed for COCs. Based on preliminary draft data on these samples, the COCs for Human Health Risk Assessment main risk drivers are:

PCB specifically Congener 126, 169,
Arsenic (not form that is associated with cancer)
Aldrin
Dieldrin
Chlordane

This project was conducted once in 2006. The amount of samples collected does not statistically support the human health risk assessment process for designating a fish advisory area. This study supports that the need for further sampling and assessment. Further investigation is needed and requires additional funding. As with the sea cucumber tissue project, more data is needed to meet the ALUS decision guideline but any exceedances identified here are listed as 'Fish EVAL' in *Table B1. Marine Waterbody (MW) Assessment*.

Overall COC detection includes:

PCB
DDT and its metabolites DDD and DDE
alpha-gamma chlordane
cis- and trans-nonachlor
heptachlor and its metabolites heptachlor epoxide and oxychloradane
BHC isomers, alpha, beta, gamma, and delta
Endosulfan I and II and the metabolite endosulfan sulfate
Endrin and its metabolites endrin aldehyde and endrin ketone
aldrin
chlorpyrifus
dieldrin
isodrin
arsenic
copper
iron
zinc
manganese
mercury
antimony
chromium
lead
nickel
tin

The 2007 SPMD project assesses 8 sites in marine (5 sites), fresh water (2 sites), ground water (1 site) using semi-permeable membrane devices that act as a surrogate for organism tissue. Concentrations were reported as nanograms/SPMD and were unable to be converted to water column concentrations. This data is used as evaluation data only and will be used toward making a support use decision if more data is collected. However, the presence of any Chemical of Concern (COC) below is indicated as a 'SPMD EVAL' in *Table B1. Marine Waterbody (MW) Assessment* and *Table B2. Rivers Assessment*.

Location of the groundwater sample is shown in Appendix A *Figure A1c. River and Stream Stations* where the SPMD was placed in a monitoring well on a golf course. Table 10 below shows the presence of Total Chlordane and Dieldrin in the groundwater SPMD. The presence of these COCs supports the need for further investigation of whether these pollutants are getting into the groundwater. COCs analyzed and subsequent average concentrations are shown in the table below.

FOR EVALUATION ONLY.

Table 10. SPMD COC Summary at Locations (nanograms/SPMD)

	GUSPMD001	GUSPMD002	GUSPMD003	GUSPMD004	GUSPMD005	GUSPMD006	GUSPMD007	GUSPMD008
	Dungca's River	Hagatna River Mouth	Pago River	GHURA Dededo Well	Talofofo River	Togcha River	Faifai Beach Cave	Apra Harbor-Western Shoals
	Marine Water	Marine Water	Fresh Water	Ground Water	Fresh Water	Marine Water	Marine Water	Marine Water
	N=3	N=3	N=2	N=3	N=3	N=3	N=3	N=3
Aldrin	<20	<20	<20	<20	<20	<20	<20	<20
Arochlor 1242	<100	<100	<100	<100	<100	<100	<100	<100
Arochlor 1248	<100	<100	<100	<100	<100	<100	<100	<100
Arochlor 1254	<100	<100	<100	<100	<100	<100	<100	<100
Arochlor 1260	<100	<100	<100	<100	<100	<100	<100	<100
Arochlor 1268	<100	<100	<100	<100	<100	<100	<100	<100
Total Chlordane	**33667**	**1000**	<100	**217**	<100	**817**	**2283**	**<100***
Dieldrin	**4767**	**285**	**43**	**108**	**27**	**43**	**435**	<20
Endosulfan I (Thiodan)	<20	<20	<20	<20	<20	<20	<20	<20
Endosulfan II	<20	<20	<20	<20	<20	<20	<20	<20
Endosulfan sulfate	**<20***	<20	<20	<20	<20	<20	<20	<20
Endrin	**53**	<20	<20	<20	<20	<20	**<20***	<20
Endrin aldehyde	<20	<20	<20	<20	<20	<20	<20	<20
Endrin ketone	<20	<20	<20	<20	<20	<20	<20	<20
Heptachlor	<20	<20	<20	<20	<20	<20	<20	<20
Heptachlor epoxide	**127**	<20	<20	<20	<20	<20	**29**	<20
Methoxychlor	<40	<40	<40	<40	<40	**<40***	<40	<40
p,p'-DDD	**<20***	**<20***	<20	<20	<20	<20	<20	<20
p,p'-DDE	**33**	<20	<20	<20	<20	<20	**<20***	<20
p,p'-DDT	<20	<20	<20	<20	<20	<20	<20	<20
Toxaphene	<20	<20	<20	<20	<20	<20	<20	<20
α-BHC	<20	<20	<20	<20	<20	<20	<20	<20
β-BHC	<20	<20	<20	<20	<20	<20	<20	<20
γ-BHC (Lindane)	<20	<20	<20	<20	<20	<20	<20	<20
δ-BHC	<20	<20	<20	<20	<20	<20	<20	<20

MDLs indicted with "<" Values and are a value of 0 in averages.

(MDL)* indicates a concentration below the MDL is reported or calculated (averaged).

Appendix A. Waterbodies Table and Figures

Table A1. Guam Marine Waterbodies

	Watershed	VillageLoc	MPA	WaterBodyName/BayName	Guam Marine Waterbody ID	GWQS Class	AREA SqMi
1		Inarajan	none	Aga Bay	G-025	M-1	0.10
2	Agat	Santa Rita & Agat	none	Agat Bay 1	GUG-010B-1	M-2	0.63
3	Agat	Santa Rita & Agat	none	Agat Bay 2	GUG-010B-2	M-2	1.91
4	Inarajan	Inarajan	none	Agfayan Bay	G-017C	M-2	0.08
5	Inarajan	Inarajan	none	Agfayan Bay: Inarajan Pools	G-017A	M-2	0.08
6		Merizo & Inarajan	Achang	Ajayan Bay	G-026	M-1	0.24
7		Santa Rita	none	Apra Harbor (M-1)	G-008A	M-1	0.05
8	Apra	Santa Rita & Piti	none	Apra Harbor (M-2)	G-008A	M-2	4.61
9	Apra	Piti	none	Apra Harbor (M-3)	G-008A	M-3	0.42
10	Piti/Asan	Asan	none	Asan Bay	G-006A	M-2	0.58
11		Merizo	Achang	Asgadao Bay	G-027	M-1	0.56
12		Inarajan	none	Asiga Point Beach Area	G-028	M-1	0.16
13		Yona	none	Beach North of Togcha Point	G-029	M-2	0.53
14		Merizo	none	Bile Bay	G-030	M-2	0.17
15	Cetti	Umatac	none	Cetti Bay	G-014A	M-1	0.65
16	Geus	Merizo	Achang	Cocos Lagoon (M-1)	G-020A	M-1	5.70
17	Geus	Merizo	none	Cocos Lagoon (M-2)	G-020A	M-2	0.34
18		Dededo	none	Falcona Beach Area	G-031	M-1	0.19
19	Umatac	Umatac	none	Fouha Bay	G-016A	M-1	0.26
20		Inarajan	none	Guaifan Point Reef Flat	G-032	M-2	0.08
21	Northern	Tamuning	none	Hagatna Bay: East Hagatna Bay	G-001D	M-2	0.93
22	Hagatna & Fonte	Hagatna	none	Hagatna Bay: West Hagatna Bay	G-002A	M-2	1.56
23		Dededo	none	Haputo Beach Area	G-033	M-1	0.07
24	Inarajan	Inarajan	none	Inarajan Bay	G-017B	M-2	0.17
25		Inarajan	none	Inarajan Reef Flat	G-034	M-1	0.82
26		Yigo	none	Janum Point Reef Flat	G-035	M-1	0.09
27		Yigo	none	Jinapsan Beach Area	G-036	M-1	0.75
28		Piti	none	Luminao Reef and Calalan Bank	G-037	M-2	1.17
29		Inarajan	none	Matala Point Reef Flat	G-038	M-1	0.25
30		Inarajan	none	Nomna Bay	G-039	M-2	0.17
31		Inarajan	none	Nomna Point Reef Flat	G-040	M-1	0.32
32		Tamuning	none	Oka Point	G-041	M-2	0.20
33		Santa Rita	none	Orote Peninsula Sea Cliffs (North)	G-042	M-1	0.23
34		Santa Rita	none	Orote Peninsula Sea Cliffs (South)	G-043	M-2	0.02
35	Pago	Yona/Chalan Pago/Ordot/ Mangilao	none	Pago Bay	G-003A	M-2	0.70

Table A1. Guam Marine Waterbodies

	Watershed	VillageLoc	MPA	WaterBodyName/BayName	Guam Marine Waterbody ID	GWQS Class	AREA SqMi
36		Inarajan	none	Pauliluc Bay	G-044	M-2	0.08
37	Piti/Asan	Piti	Piti	Piti Bay	G-006B	M-2	1.35
38		Piti	none	Piti Channel and Cabras Island	G-045	M-3	0.24
39		Mangilao	none	Reef Flat Northeast Coast (N Fadian Point)	G-046	M-1	0.56
40		Yigo & Dededo	none	Ritidian Point Beach Area	G-047	M-1	1.42
41		Yigo	Pati	Rocky Shorelines Northeast Coast (Pati Point)	G-048	M-1	5.35
42		Mangilao	none	Rocky Shorelines Northeast Coast (S Fadian Point)	G-049	M-2	0.58
43		Mangilao & Yigo	none	Rocky Shorelines Northeast Coast (S Janum Point)	G-050	M-1	2.29
44	Northern	Dededo	none	Rocky Shorelines Northwest Coast (Double Reef)	G-001A	M-1	0.64
45		Dededo	none	Rocky Shorelines Northwest Coast (South Haputo)	G-051	M-1	0.20
46		Piti	Sasa	Sasa Bay	G-052	M-2	0.74
47		Umatac	none	Sella Bay	G-053	M-1	0.27
48		Umatac	none	South Facpi Point beaches and rocky shorelines	G-054	M-1	0.66
49		Merizo	Achang	Sumay Bay	G-055	M-1	0.79
50	Ylig	Yona	none	Tagachan Beach Park Area	G-005B	M-2	0.24
51	Taelayag	Agat	none	Taleyfac Bay (M-1)	G-012A	M-1	0.71
52	Agat	Agat	none	Taleyfac Bay (M-2)	G-012A	M-2	0.37
53	Talofofo	Talofofo & Inarajan	none	Talofofo Bay	G-011A	M-2	0.15
54	Togcha	Talofofo	none	Talofofo Beaches	G-007B	M-2	0.61
55		Dededo	none	Tanguisson Beach Area (M-1)	G-001B	M-1	0.29
56	Northern	Dededo & Tamuning	none	Tanguisson Beach Area (M-2)	G-001B	M-2	0.40
57		Yigo	Pati	Tarague Beach (Scout Beach Area)	G-056	M-1	3.09
58	Agat	Santa Rita	none	Tipalao Bay	G-010A	M-2	0.10
59	Togcha	Yona and Talofofo	none	Togcha Bay	G-007A	M-2	0.41
60	Toguan	Umatac & Merizo	none	Toguan Bay	G-018A	M-2	0.26
61	Tumon/Yigo Sub-basin	Tamuning	Tumon	Tumon Bay	G-001C	M-2	1.98
62		Inarajan	none	Ulomai Beach Area	G-057	M-2	0.09
63		Umatac	none	Umatac Bay (M-1)	G-016B	M-1	0.06
64	Umatac	Umatac	none	Umatac Bay (M-2)	G-016B	M-2	0.34
65		Dededo	none	Uruno Beach Area	G-058	M-1	0.58
66	Ylig	Yona	none	Ylig Bay	G-005A	M-2	0.45

Table A2. Guam Rivers & Streams

Guam River ID #	RIVER/ TRIBUTARY NAME	Channel length	Receiving Water
G-1A	Agana River	1.19	Agana Bay - Padre Palomo Park
G-1D	Chaot River	1.43	Agana Swamp
G-1F	intermittent tributary	0.79	Chaot River
G-1B	Agana Swamp	(NA)	Agana River
G-1C	Agana Spring	0.04	Agana Swamp
G-58	Storm Drain	0.21	East Agana Bay (Dungca's Beach)
G-2	Fonte River	3.18	West Agana Bay (Pigo Cemetery)
G-59	unnamed creek	0.17	East Asan Bay
G-3A	Asan River	1.55	Asan Bay - Asan Park
G-3B	unnamed tributary	0.56	Asan River
G3C	unnamed creek	0.19	Asan River to Asan Bay - Adelup
G-4	Matague River	0.96	Piti Bay
G-4A	unnamed tributary	0.29	Matague River
G-5	Taguag River	0.62	Piti Bay - past "bomb" holes
G-6	Masso River	2.34	Piti Bay - Santos Memorial Park
G-6A	intermittent tributary	0.96	Masso River
G-7	Sasa River	2.21	Apra Harbor mangroves
G-8	Laguas River	0.85	Apra Harbor mangroves
G-9	Aguada River	2.15	Apra Harbor - before Polaris Point
G-10G	unnamed tributary	0.67	Big Gautali River
G-10B	Big Gautali River	2.29	Atantano Wetland
G-10H	intermittent tributary	0.56	Big Gautali River
G-10D	Aplacho River	1.96	Atantano Wetland
G-10E	Gautali River	0.70	Atantano Wetland
G-10F	Tenjo River	1.23	Atantano Wetland
G-10A	Atantano River	2.51	Inner Apra Harbor
G-10J	intermittent tributary	0.91	Atantano River
G-10C	Paulana River	0.84	Atantano River
G-10I	unnamed tributary	0.16	Paulana River
G-11	Namo River	2.40	Agat Bay - Apaca Pnt.
G-11B	unnamed tributary	0.36	Namo River
G-11A	unnamed tributary	0.64	Namo River
G-12	Togcha River	1.10	Agat Bay - Salinas Beach
G-13	Salinas River	0.78	Agat Bay - Salinas Beach before Gaan Pt.
G-45G	Nelansa River	0.93	Yledigao River
G-45H	Pasmano River	2.25	Inarajan River
G-45I	Dante River	1.52	Pasamano River
G-45J	unnamed tributary	0.43	Dante River
G-45K	unnamed tributary	0.43	Dante River
G-45B	Laolao River	0.40	Inarajan River
G-45C	Fensol River	1.20	Laolao River
G-45D	Fintasa River	2.12	Laolao River
G-45L	unnamed tributary	0.80	Fintasa River
G-46A	Pauliluc River	0.42	Pauliluc Bay
G-46C	Tinago River	2.93	Pauliluc River
G-46D	unnamed tributary	0.85	Tinago River
G-46E	unnamed tributary	0.55	Tinago River
G-46B	Aslinget River	2.22	Pauliluc River
G-46F	Assupian	0.52	Aslinget River
G-47	Asalonso River	2.54	Talofofo Bay-Matala Pt.
G-47A	unnamed tributary	0.30	Asalonso River
G-48I	Bubulao River	4.81	Ugum River
G-48P	unnamed tributary	0.42	Bubulao River
G-48R	unnamed tributary	0.43	Bubulao River
G-48Q	unnamed tributary	0.33	G-48R
G-48S	unnamed tributary	0.33	Bubulao River
G-48V	unnamed tributary	2.01	Bubulao River
G-48J	Atate River	1.16	Ugum River
G-48K	Ieygo River	1.15	Atate River
G-48L	unnamed tributary	0.25	Atate River
G-48M	unnamed tributary	0.22	Ugum River
G-48N	unnamed tributary	0.36	Ugum River
G-48O	intermittent tributary	1.10	Ugum River
G-48T	intermittent tributary	0.64	Ugum River
G-48U	unnamed tributary	0.89	Ugum River
G-48H	Ugum River	7.48	Talofofo River
G-48A	Talofofo River	3.51	Talofofo Bay
G-48Y	unnamed tributary	0.81	Mahlac River

Table A2. Guam Rivers & Streams

Guam River ID #	RIVER/ TRIBUTARY NAME	Channel length	Receiving Water
G-14	Finile Creek	0.81	Agat Bay - directly south of Agat Village
G-14A	unnamed tributary	0.17	Finile Creek
G-14B	unnamed tributary	0.06	Finile Creek
G-15	Gaan River	1.19	Agat Bay - Before Bangi Island (south)
G-16	Auau Creek	0.86	Taleyfac Bay
G-17	Chaligan Creek	0.98	Taleyfac Bay
G-18B	Ascola Sito Creek	1.85	Taleyfac River
G-18D	unnamed tributary	0.59	Ascola Sito Creek
G-18E	unnamed tributary	0.55	Ascola Sito Creek
G-18C	Pagachao Creek	0.65	Ascola Sito Creek
G-18A	Taleyfac River	1.18	Taleyfac Bay - Agat
G-19	Taelayag Creek	1.37	Taleyfac Bay (Taelayag Beach-Anae Is)
G-20	Sagua River	0.58	Taleyfac Bay (Sagua Beach-Facpi Pnt.)
G-21	Madofan River	0.77	South Achugao Point
G-22	Agaga River	0.78	South Achugao Point
G-23	Asmafines River	0.83	North Sella Bay
G-24	Sella River	0.88	South Sella Bay
G-24A	unnamed tributary	0.58	Sella River
G-24B	unnamed tributary	0.71	Sella River
G-24C	unnamed tributary	0.38	G-24B
G-25	Cetti River	1.15	North Cetti Bay
G-25A	unnamed tributary	0.77	Cetti River
G-26	unnamed river	0.36	Cetti Bay
G-27A	La Sa Fua River	2.02	Fouha Bay
G-27C	Chagame River	1.21	La Sa Fua River
G-27B	Alatgue River	0.40	Chagame River
G-27D	Laguan River	0.43	Chagame River
G-27E	San Nicolas River	0.46	Chagame River
G-28D	Astaban River	0.59	Madog River
G-28G	unnamed tributary	0.32	Astaban River
G-28C	Madog River	1.65	Umatac River
G-28A	Umatac River	0.24	Umatac Bay
G-28B	Laelae River	1.00	Umatac River
G-28E	Bolanos River	0.49	Laelae River
G-48AA	unnamed tributary	0.94	Mahlac River
G-48Z	unnamed tributary	0.70	G-48AA
G-48G	Mahlac River	2.56	Talofofo River
G-48C	Malaja River	0.64	Sarasa River
G-48X	unnamed tributary	0.45	Talofofo River
G-48D	Sagge River	3.85	Talofofo River
G-48E	Tinechong River	1.27	Sagge River
G-48W	unnamed tributary	1.23	Sagge River
G-48F	Maagas River	2.07	Talofofo River
G-48B	Sarasa River	2.30	Talofofo River
G-49	Togcha River	1.91	Togcha Bay
G-49A	intermittent tributary	0.65	Togcha River
G-49B	unnamed tributary	0.06	Togcha River
G-50V	unnamed tributary	1.23	Ylig River
G-50G	intermittent tributary	0.81	Ylig River
G-50A	Ylig River	8.93	Ylig Bay
G-50B	Manengon River	1.81	Ylig River
G-50Q	unnamed tributary	0.51	Manengon River
G-50R	unnamed tributary	0.71	Manengon River
G-50S	unnamed tributary	0.85	Manengon River
G-50T	unnamed tributary	1.17	Manengon River
G-50U	unnamed tributary	0.30	G-50T
G-50C	Tarzan River	2.67	Ylig River
G-50D	unnamed tributary	0.98	Ylig River
G-50E	unnamed tributary	0.99	Ylig River
G-50F	unnamed tributary	0.53	Ylig River
G-50H	unnamed tributary	0.49	Ylig River
G-50I	unnamed tributary	0.94	Tarzan River
G-50J	unnamed tributary	0.32	Ylig River
G-50K	unnamed tributary	0.76	Ylig River
G-50L	unnamed tributary	0.75	Ylig River
G-50M	unnamed tributary	0.72	G-50L
G-50N	unnamed tributary	0.74	Ylig River
G-50P	unnamed tributary	0.72	Ylig River

Table A2. Guam Rivers & Streams

Guam River ID #	RIVER/ TRIBUTARY NAME	Channel length	Receiving Water
G-28F	Pajon River	0.68	Laelae River
G-29	Toguan River	1.41	Toguan Bay
G-30	Bile River	0.64	North Bile Bay
G-31	Pigua River	1.06	South Bile Bay
G-31A	intermittent tributary	0.62	Pigua River
G-32	Geus River	2.29	Piga Beach - Cocos Lagoon
G-33	Achang River	0.80	Cocos Lagoon
G-34	Manell River	2.11	Cocos Lagoon - East Achang Bay
G-34A	unnamed tributary	0.32	Manell River
G-34B	unnamed tributary	0.34	Manell River
G-35	unnamed river	1.06	Sumay Bay
G-36	Suyafe River	0.88	Achang Reef - Sumay Maleso
G-37	Sumay River	0.81	Achang Reef - Sumay Bay
G-37A	unnamed tributary	0.25	Sumay River
G-38	Liyong River	0.75	Achang Reef/Asgadao Bay at Liguan Pt.
G-38A	unnamed tributary	1.08	Liyog River
G-39	Asgado Creek	0.59	Achang Reef/Asgadao Bay
G-40	Asmaile River	0.77	Asgadao Bay
G-41	Ajayan River	2.89	Ajayan Bay
G-41A	intermittent tributary	0.44	Ajayan River
G-41B	unnamed tributary	0.62	Ajayan River
G-42	Tubgah Creek	0.86	Suren Palm beach area
G-43	Agfayan River	3.15	South Agfayan Bay
G-43A	unnamed tributary	0.58	Agfayan River
G-43B	unnamed tributary	0.58	Agfayan River
G-43C	intermittent tributary	1.17	Agfayan River
G-43D	intermittent tributary	0.37	G-43C
G-43E	intermittent tributary	0.24	G-43C
G-43F	intermittent tributary	0.58	Agfayan River
G-44	unnamed river	0.95	North Agfayan Bay
G-45A	Inarajan River	2.23	Inarajan Bay
G-45E	Yledigao River	0.59	Inarajan River
G-45F	Topony River	1.04	Yledigao River

Guam River ID #	RIVER/ TRIBUTARY NAME	Channel length	Receiving Water
G-50O	unnamed tributary	0.38	Ylig River
G-51H	intermittent tributary	1.08	Pago River
G-51I	intermittent tributary	0.99	Pago River
G-51A	Pago River	3.79	Pago Bay
G-51B	Lonfit River	4.90	Pago River
G-51E	intermittent tributary	1.29	Lonfit River
G-51F	intermittent tributary	1.09	Lonfit River
G-51G	intermittent tributary	0.69	Lonfit River
G-51D	Landfill Leachate stream	0.05	Lonfit River
G-51C	Sigua River	6.03	Pago River
G-51J	unnamed tributary	0.12	Pago River
G-53	Sadog Gago River	1.49	Imong River
G-53A	intermittent tributary	0.79	Sadog Gago River
G-52	Imong River	1.99	**Fena Lake**
G-52A	intermittent tributary	0.72	Imong River
G-55	unnamed stream	0.38	Fena Lake
G-54	Almagosa River	1.23	Fena Lake
G-54A	unnamed tributary	0.70	Almagosa River
G-54B	unnamed tributary	0.30	Almagosa River
G-54C	Almagosa Spring	0.09	Almagosa River
G-56	Maulap River	1.71	**Fena Lake**
G-56A	unnamed tributary	0.57	Maulap River
G-56B	unnamed tributary	0.59	Maulap River
G-57	Bonya River	3.21	**Morrow Lake**
G-57A	unnamed tributary	0.82	Bonya River
G-57B	unnamed tributary	0.82	Bonya River
G-60	Tolaeyuus River	0.39	Morrow Lake
G-61	Talisay River	3.72	Maemong River
G-62	unnamed tributary	0.28	Talisay River
G-63	unnamed tributary	0.22	Maemong River
G-64	Maemong River	2.71	Tolaeyuus River
G-65	unnamed tributary	0.57	Maemong River
G-66	unnamed tributary	0.66	Maemong River
Totals:	202	232.65	

Table A3. Guam Beaches

GEPA Beach Number	BEACH NAME	USEPA BEACH ID	Beach size (sandy shoreline miles)	Shoreline miles Represented by Station	accessible beach?	2008-2009 GEPA Station ID	GEPA Station ID Location Description
GB1	Tarague Beach/Scout Beach		3.42		no		
GB2	Tarague Beach/Scout Beach						
GB3	Jinapsan Beach		1.28		no		
GB4	Ritidian Beach		2.21		no		
GB5	Uruno Beach		1.74		no		
GB6	Falcona Beach (Urunao)		0.37		no		
GB7	South of Falcona Beach (Urunao)		0.24		no		
GB8	Haputo Beach		0.19		no		
GB9	Intermittent beach - Shark's Hole		0.19		no		
GB10	Intermittent beach - Tanguisson Pt.		0.26		no		
GB11	Intermittent beach - North of NCS/Tanguisson	GU231281	0.26		yes		
GB12	NCS Beach/Tanguisson Beach	GU900850	0.25	0.25	yes	N-01	Tanguisson Beach
GB13	Fafai Beach		0.37		no		
GB15	Gun Beach, Tumon Bay	GU446721	0.23	0.23	yes	N-24	Gun Beach
GB16	Gonga Beach, Tumon Bay	GU610162	0.14	0.14	yes	N-25	Gonga Beach
GB17	Naton Beach, Tumon Bay	GU763206	1.1	0.23	yes	N-02	Naton Beach - San Vitores
GB17	Naton Beach, Tumon Bay	GU763206		0.36		N-23	Naton Beach - Fujita
GB18	Naton Beach, Tumon Bay	GU763206		0.33		N-03	Naton Beach - Matapang Beach Park
GB17	Naton Beach, Tumon Bay	GU763206		0.18		N-04	Naton Beach - Guma Trankilidat
GB19	Ypao Beach, Tumon Bay	GU425480	0.42	0.42	yes	N-05	Ypao Beach
GB21	Alupang Island Beach, East Hagåtña Bay		0.02		no		
GB22	Dungca's Beach, East Hagåtña Bay	GU203410	0.99	0.34	yes	N-06	Dungca's Beach - Sleepy Lagoon
GB22	Dungca's Beach, East Hagåtña Bay	GU203410		0.65		N-07	Dungca's Beach
GB23	Trinchera Beach, East Hagåtña Bay	GU458635	1.15	0.25	yes	N-26	East Hagåtña Bay - Alupang Towers Beach
GB23	Trinchera Beach, East Hagåtña Bay	GU458635		0.48		N-08	East Hagåtña Bay - Trinchera Beach
GB24	Trinchera Beach, East Hagåtña Bay	GU458635		0.42		N-09	Padre Palomo Park Beach
GB25	Hagåtña Marina	GU176012	0.42	0.15	yes	N-10	Hagåtña Channel
GB25	Hagåtña Marina	GU176012		0.15		N-11	Hagåtña Channel - Paseo Outrigger Canoe Ramp
GB25	Hagåtña Marina	GU176012		0.12		N-12	Hagåtña Boat Basin

Table A3. Guam Beaches

GEPA Beach Number	BEACH NAME	USEPA BEACH ID	Beach size (sandy shoreline miles)	Shoreline miles Represented by Station	accessible beach?	2008-2009 GEPA Station ID	GEPA Station ID Location Description
GB26	West Hagåtña Beach	GU468763	1.11	1.11	yes	N-13	Hagåtña Bayside Park
GB27	Beach at Fonte River, West Hagatna Bay	GU208533	0.13	0.13	yes	N-21	Adelup Beach Park
GB28	West of Adelup Point, Asan Bay	GU241731	0.41	0.41	yes	N-22	Adelup Point Beach (West of Adelup Park)
GB29	West of volcanic headland, Asan Bay	GU845649	0.37		yes		
GB31	Asan Memorial Beach, Head of Asan Bay	GU732200	0.53	0.53	yes	N-14	Asan Bay Beach
GB32	Beach at Piti Bay	GU196164	1.08	0.62	yes	N-15	Piti Bay
GB33	Beach at Piti Bay	GU196164		0.46		N-16	Santos Memorial Park Beach
GB34	United Seamen's Service Beach (USO Beach)	GU790189	0.52	0.52	yes	N-17	United Seamen's Service
GB35	Outhouse Beach	GU745740	0.46	0.46	yes	N-18	Outhouse Beach
GB36	Family Beach	GU179655	0.15	0.15	yes	N-19	Family Beach
GB37	Port Authority Beach	GU233053	0.46	0.46	yes	N-20	Port Authority Beach
GB38	Ski Beach	GU427179	0.4		yes		
GB40	SRF Beach		0.4		no		
GB41	Marianas Yacht Club Beach, Sasa Bay	GU826563	0.18		yes		
GB42	Polaris Beach		0.19		no		
GB43	Gabgab Beach		0.65		no		
GB44	Orote Point Beaches		0.46		no		
GB45	Tipalao Beach		0.15		no		
GB46	Dadi Beach		0.57		no		
GB47	Rizal Beach (not accessible)	GU031839	0.26		no		
GB48	Apaca Park Beach		0.14		no		
GB50	Togcha Beach aka Agat Beach	GU374433	0.79	0.33	yes	S-02	Togcha Beach - Namo
GB50	Togcha Beach aka Agat Beach	GU374433		0.15		S-03	Togcha Beach - Agat Bay
GB50	Togcha Beach aka Agat Beach	GU374433		0.31		S-17	Togcha Beach - Beach at SCA
GB51	Salinas Beach	GU959524	0.49		yes		
GB52	Beach North of Finile River	GU324640	0.3		yes		
GB53	Beach South of Finile River	GU922647	1.17	1.17	yes	S-04	Bangi Beach
GB55	Nimitz Beach	GU016244	0.49	0.49	yes	S-05	Nimitz Beach
GB56	Taelayag Beach	GU524587	0.87		yes		

Table A3. Guam Beaches

GEPA Beach Number	BEACH NAME	USEPA BEACH ID	Beach size (sandy shoreline miles)	Shoreline miles Represented by Station	accessible beach?	2008-2009 GEPA Station ID	GEPA Station ID Location Description
GB57	Sagua Beach		0.62		no		
GB58	Facpi Point Beaches		0.66		no		
GB59	Beach south of Achugao		0.29		no		
GB60	Beach south of Agaga Riv		0.25		no		
GB62	Beach north of Asmafines Riv		0.12		no		
GB63	Beach south of Sella Riv		0.12		no		
GB64	Abong Beach		0.62		no		
GB65	Mouth of Cetti Bay		0.5		no		
GB66	Head of Fouha Bay		0.06		no		
GB67	Head of Umatac Bay	GU654723	0.14	0.14	yes	S-06	Umatac Bay
GB68	South of Machadgan Point		0.25		no		
GB69	Toguan Bay	GU311098	0.46	0.46	yes	S-07	Toguan Bay
GB70	Ajmo Beach	GU894296	0.16		yes		
GB71	Bile Bay Beach	GU757210	0.03		yes		
GB72	Pigua River Beach	GU418215	0.08		yes		
GB73	Cocos Island		1.16		no		
GB74	Islet		0.07		no		
GB75	Merizo Public Pier Park	GU038434	0.46	0.46	yes	S-08	Merizo Pier - Mamaon Channel
GB76	Piga Beach/Talona Beach	GU249673	0.42		yes		
GB77	Cocos Lagoon (btw Piga&Aba Beach)	GU249673			no		
GB78	Aba Beach	GU164107	0.19		yes		
GB79	Aang Beach	GU561116	0.12		yes		
GB80	Achang Bay		0.55		yes		
GB81	Beach to Liyog Riv Mouth	GU519084	0.77		yes		
GB82	Liyog river Mouth	GU463873	0.18		yes		
GB83	Beach to Asgadao Bay	GU280102	0.04		yes		
GB84	Intermittent beach, Asgadao Bay	GU621836	0.12		yes		
GB85	Intermittent beach 1, Ajayan Bay	GU515461	0.12		yes		
GB86	Intermittent beach 2, Ajayan Bay	GU196675	0.09		yes		
GB87	Ajayan River Mouth 1	GU344686	0.03		yes		

Table A3. Guam Beaches

GEPA Beach Number	BEACH NAME	USEPA BEACH ID	Beach size (sandy shoreline miles)	Shoreline miles Represented by Station	accessible beach?	2008-2009 GEPA Station ID	GEPA Station ID Location Description
GB88	Intermittent beach 3, Ajayan Bay	GU461933	0.19		yes		
GB89	Ajayan River Mouth 2	GU954089	0.06		yes		
GB90	Intermittent beach 4, Ajayan Bay	GU370300	0.09		yes		
GB91	Aga Beach	GU581113	0.08		yes		
GB92	Guijen Rock area	GU535422	0.44		yes		
GB93	Atao Beach	GU303218	0.38		yes		
GB94	Beach north of Acho Pnt.	GU755429	0.27		yes		
GB95	Agfayan River Beach	GU867073	0.07		yes		
GB96	Inarajan Pools	GU057929	0.07	0.07	yes	S-09	Inarajan Pool
GB97	Beach at Inarajan Bay	GU605963	0.46	0.46	yes	S-10	Inarajan Bay
GB98	Beach at Pauliluc Bay	GU208080	0.28		yes		
GB99	Ulomai Beach		0.11		no		
GB101	Perez Beach		0.26		no		
GB102	Asiga Beach Area (Inarajan)		0.23		no		
GB103	Head of Paicpouc Cove		0.09		no		
GB105	Head of Talofofo Bay	GU367361	0.21	0.21	yes	S-11	Talofofo Bay
GB106	First Beach	GU812957	0.06	0.06	yes	S-18	First Beach - Talofofo
GB108	Calvos Beach	GU304652	0.51		yes		
GB110	Jones Beach	GU473279	0.09		yes		
GB111	Ypan Beach Park Beach (Ipan Public Beach)	GU139377	0.3	0.3	yes	S-12	Ipan Beach
GB113	Beach north of Togcha River	GU721999	0.27	0.27	yes	S-13	Togcha Bay - Talofofo
GB114	North of Togcha Point	GU631282	1.03		yes		
GB115	Head of Ylig Bay	GU425901	0.18		yes		
GB116	Beach North of Ylig Bay	GU834889	0.07		yes		
GB117	Tagachan Beach Park	GU996375	0.07	0.07	yes	S-14	Tagachang Beach
GB118	Beach at Pago Bay	GU875627	0.96	0.96	yes	S-15	Pago Bay
GB119	North Pago Bay Beach		0.24		no		

Number of Beaches	**103**
Number of assessed Beaches	**31**
Number of monitoring stations	**42**
Beach miles monitored	**15.46**

37 inaccessible beaches

66 accessible

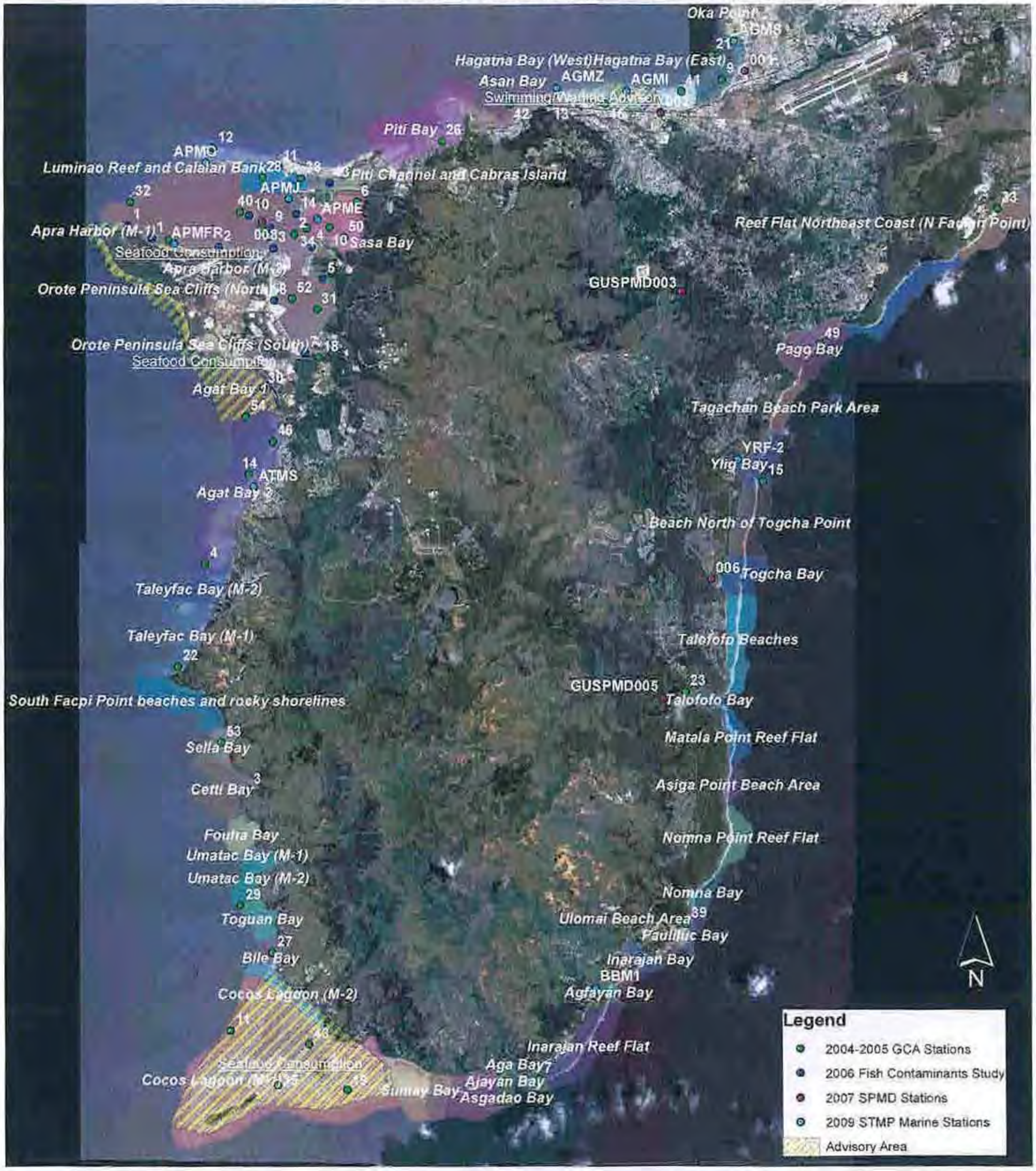
Guam 2010 Integrated Report
Station Location
North and Central Marine Waterbodies and 2010 IR Stations

Generated by GEPAMP Feb 2010.

0 0.375 0.75 1.5 2.25 3 Miles

Figure A1a. North and Central Marine Stations

Guam 2010 Integrated Report
Station Locations
Central and South Marine Waterbodies and 2010 IR Stations



Generated by GEPAMP Feb 2010.

0 0.5 1 2 3 4 Miles

Figure A1b. Central and South Marine Stations

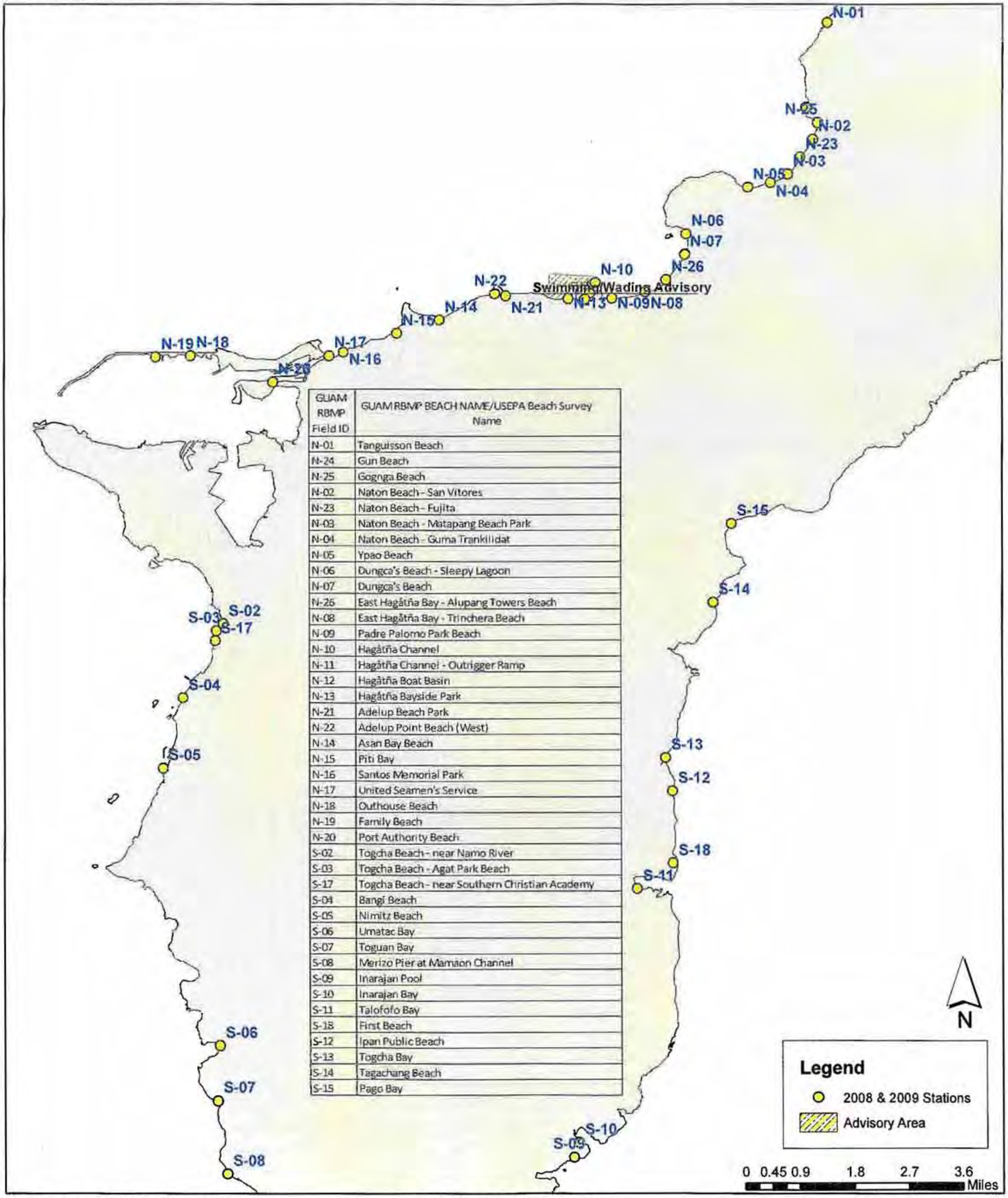
Guam 2010 Integrated Report
Station Locations
Guam Rivers/Streams and 2010 IR Stations

Generated by GEPAMP Feb 2010.

Figure A1c. River and Stream Stations

Guam EPA
2008 & 2009 RBMP Beach Stations

GUAM BEACH WATCH
Abison Tåsen Guahan



GUAM RBMP Field ID	GUAM RBMP BEACH NAME/USEPA Beach Survey Name
N-01	Tanguisson Beach
N-24	Gun Beach
N-25	Gognga Beach
N-02	Naton Beach - San Vitores
N-23	Naton Beach - Fujita
N-03	Naton Beach - Matapang Beach Park
N-04	Naton Beach - Guma Trankilidat
N-05	Ypao Beach
N-06	Dungca's Beach - Sleepy Lagoon
N-07	Dungca's Beach
N-26	East Hagåtña Bay - Alupang Towers Beach
N-08	East Hagåtña Bay - Trinchera Beach
N-09	Padre Palomo Park Beach
N-10	Hagåtña Channel
N-11	Hagåtña Channel - Outrigger Ramp
N-12	Hagåtña Boat Basin
N-13	Hagåtña Bayside Park
N-21	Adelup Beach Park
N-22	Adelup Point Beach (West)
N-14	Asan Bay Beach
N-15	Piti Bay
N-16	Santos Memorial Park
N-17	United Seamen's Service
N-18	Outhouse Beach
N-19	Family Beach
N-20	Port Authority Beach
S-02	Togcha Beach - near Namo River
S-03	Togcha Beach - Agat Park Beach
S-17	Togcha Beach - near Southern Christian Academy
S-04	Bangi Beach
S-05	Nimitz Beach
S-06	Umatac Bay
S-07	Toguan Bay
S-08	Merizo Pier at Mamaon Channel
S-09	Inarajan Pool
S-10	Inarajan Bay
S-11	Talofofo Bay
S-18	First Beach
S-12	Ipan Public Beach
S-13	Togcha Bay
S-14	Tagachang Beach
S-15	Pago Bay

Updated by GEPA MP on 2/16/10.

Figure A1d. Beach Stations

Guam 2010 Integrated Report

Benthic Visual Bioassessment Stations

Generated by GEPAMP Feb 2010.

Figure A1e. Benthic Visual Bioassessment Stations

Appendix B. Assessment Tables and Use Support Determination Tables

Table B1. Marine Waterbody (WB) Assessment

				DU1	DU2															DU3
				Body Contact	Aquatic Life Phys/Chem Water Quality (%VIOL)												Aquatic Life Bioassessment		Aquatic Life Toxicological (water column and sediment)	Human Health Consumption (Toxics)
Guideline/degree of ALUS (Table from IR):				IR Table 12 & 13	IR Table 15												IR Table 18		IR Table 16	IR Table 10 & GWQS Appendix A Table 3 (D2) & Table 4
Marine WB name	Station	Type	No. occupy Station	Enterococci	pH	OPO4	NO3	NH3	DO	Salinity	TSS	Turbidity	Secchi Vis	Water Temp	Radio-active Materials[1]	Conc. of Oil/ Petrol Product	Total Fish Biomass (g)	Percent Cover (Algae, Coral, Invertebrates, Substrate)	Sediment Chemistry EVALUATION ONLY * presence in conc above NOAA SQRTs criteria Evaluation data set only	Current advisories (and SPMD, Seacucumber, Fish Tissue as EVALUATION only)
Ritidian Point Beach Area	GU04-0051	Reef flat	1	FS	FS	FS	FS	FS	FS	NA	Fail	NA	UD	NA	UD	FS	NA	NA	non detect	UD
Rocky Shorelines Northwest Coast (Double Reef)	DRM	Coastal	2	FS	FS	FS	FS	NS (n=2 avg 0.02mg/l)	FS	FS	FS	FS	Fail (Vis to bottom)	FS	UD	UD	UD	UD	UD	UD
Tanguisson Beach Area (M-1)	GU04-0025	Coastal	1	FS	FS	FS	FS	FS	FS	NA	FS	NA	UD	NA	UD	FS	NA	NA	non detect	UD
Tanguisson Beach Area (M-2)	*Seafood Consumption Advisory*	Coastal		UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	NS (*Seafood Advisory*; Driver: Deaths suspected by Palytoxin uptake by G. tsudae)
Tumon Bay	GU04-0005	Reef flat	1	FS	FS	PS	PS	NS	FS	FS	PS	PS	FS (on TB2 only)	FS	UD	FS	NA	NA	* (Tin)	SPMD EVAL - Total Chlordane, Dieldrin, Heptachlor epoxide.
	GUSPMD-007		3																	
	GU04-0037		1																	
	GU04-0055		1																	
	TB2		3																	
	GBMT	Coastal	3	FS	FS	FS	FS	FS	FS	FS	PS	FS	Fail (Vis to bottom)	NS	UD	UD	UD	UD	UD	UD
	GBMS		3																	
	TUMN		2																	
	TUMS		2																	
Hagatna Bay	AGMS	Reef flat East	4	FS	FS	FS	PS	NS	FS	NS	FS	FS	FS	PS	UD	FS	NA	NA	* (Tin)	UD
	GUSPMD-001																			SPMD EVAL - Total Chlordane, Dieldrin, Endrin, Heptachlor epoxide, p,p'-DDE.
	GU04-0009		1																	SeaCucumber EVAL (Arsenic, Copper, Iron, Manganese, Mercury, Chrysene, Total PAH)
	GU04-0041																			UD
	GUSPMD-002		1																	SPMD EVAL - Total Chlordane, Dieldrin.
	Beach Closure	Reef flat West		NS (*Bay Swimming Closure*)	FS	FS	FS	PS	FS	FS	FS	FS	FS	PS	UD	FS	NA	NA	* (Tin)	UD
	AGMI		4																	
	GU04-0045		1	FS																
	GU04-0021	Coastal	1	FS	FS	FS	FS	NS	FS	FS	FS	FS	Fail (Vis to bottom)	PS	UD	FS	NA	NA	* (Tin)	SeaCucumber EVAL (Arsenic, Iron, Manganese, Mercury, Benzo[a]pyrene, Total PAH)
	AGMZ		2																	UD
Asan Bay	GU04-0013	Reef flat	1	FS	FS	FS	FS	NS	FS	NA	FS	NA	UD	NA	UD	FS	NA	NA	* (Tin)	SeaCucumber EVAL (Arsenic, Copper, Iron, Manganese, Mercury, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Total PAH)
	GU04-0042	Coastal	1	FS	FS	FS	FS	FS	FS	NA	Fail	NA	UD	NA	UD	UD	NA	NA	non detect	UD
Piti Bay	GU04-0026	Reef flat	1	FS	FS	FS	FS	NS	FS	NA	FS	NA	UD	NA	UD	FS	NA	NA	* (Tin)	SeaCucumber EVAL (Arsenic, Iron, Manganese, Mercury, Benzo(b)fluoranthene, Total PAH)
Luminao Reef and Calalan Bank	Fish06-012	Reef flat	1	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	Fish EVAL - PCB, Arsenic, Aldrin, Dieldrin, Chlordane.
	APMFR-0		1																UD	
	APMI		1																	
	APMO		1																	
	APMD		2																	
	GU04-0002		1																non detect	

Table B1. Marine Waterbody (WB) Assessment

				DU1	DU2															DU3
				Body Contact	Aquatic Life Phys/Chem Water Quality (%VIOL)												Aquatic Life Bioassessment		Aquatic Life Toxicological (water column and sediment)	Human Health Consumption (Toxics)
Guideline/degree of ALUS (Table from IR):				IR Table 12 & 13	IR Table 15												IR Table 18		IR Table 16	IR Table 10 & GWQS Appendix A Table 3 (D2) & Table 4
Marine WB name	Station	Type	No. occupy Station	Enterococci	pH	OPO4	NO3	NH3	DO	Salinity	TSS	Turbidity	Secchi Vis	Water Temp	Radio-active Materials[1]	Conc. of Oil/ Petrol Product	Total Fish Biomass (g)	Percent Cover (Algae, Coral, Invertebrates, Substrate)	Sediment Chemistry EVALUATION ONLY * present in conc above NOAA SQRTs criteria. Evaluation data set only.	Current advisories (and SPMD, Seacucumber, Fish Tissue as EVALUATION only)
Apra Harbor (M-2)	GU04-0008	Coastal (Lagoon)	1	FS	FS	FS	FS	FS	FS	FS	FS	FS	Fail (Vis to bottom)	FS	FS	FS	UD	UD	* (Arsenic, Copper, Manganese, Mercury, Nickel, Tin)	NS (Fish Consumption Advisory; Driver: PCBs, ChlorPest, Dioxins)
	GU04-0031		1																* (Arsenic, Cadmium, Chromium, Copper, Lead, Manganese, Mercury, Nickel, Tin, Zinc)	
	GU04-0032		1														NA	NA	non detect	
	GU04-0036		1														UD	UD	non detect	
	Seafood Consumption Advisory																		UD	
	GU04-0040		1																* (Copper, Mercury, Nickel, Tin)	
	GU04-0044		1																	
	GU04-0052		1																* (Arsenic, Chromium, Copper, Lead, Manganese, Mercury, Nickel, Tin, Total PCB, Total DDT)	
	GU04-0018		1																* (Arsenic, Cadmium, Chromium, Copper, Lead, Manganese, Nickel, Tin, Zinc)	
	Fish06-01a		1																UD	FISH EVAL - PCB, Arsenic, Aldrin, Dieldrin, Chlordane.
	Fish06-01b		1																	
	Fish06-02		1																	
	Fish06-03		1																	
	Fish06-04		1																	
	Fish06-05		1																	
	Fish06-07		1																	
	Fish06-08		1																	
	Fish06-09		1																	
	Fish06-10		1																	
	Fish06-14		1																	
	GUSPMD-008		3																	SPMD EVAL - No hits.
Apra Harbor (M-3)	APMCO-0	Coastal	1	FS	FS	NS	FS	FS	FS	FS	FS	FS	Fail (Vis to bottom)	FS	UD	FS	UD	UD	UD	Fish EVAL - PCB, Arsenic, Aldrin, Dieldrin, Chlordane.
	GU04-0028		1																* (Copper, Lead, Mercury, Tin)	
	Fish06-011		1																UD	
	GU04-0038		1																non detect	
Piti Channel and Cabras Island	Fish06-013	Coastal	1	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	Fish EVAL - PCB
Sasa Bay	GU04-0006	Coastal	1	FS	FS	FS	FS	FS	FS	FS	NS	NS	Fail (Vis to bottom)	FS	UD	FS	UD	UD	* (Arsenic, Chromium, Copper, Manganese, Nickel, Tin)	UD
	APME		1																UD	
	GU04-0034		1																* (Arsenic, Chromium, Copper, Lead, Manganese, Mercury, Nickel, Tin)	

Table B1. Marine Waterbody (WB) Assessment

Marine WB name	Station	Type	No. occupy Station	Enterococci	pH	OPO4	NO3	NH3	DO	Salinity	TSS	Turbidity	Secchi Vis	Water Temp	Radio-active Materials[2]	Conc. of Oil/ Petrol Product	Total Fish Biomass (g)	Percent Cover (Algae, Coral, Invertebrates, Substrate)	Sediment Chemistry EVALUATION ONLY * presence in conc above NOAA SQuiRTs criteria Evaluation data set only.	Current advisories (and SPMD; Seacucumber, Fish Tissue as EVALUATION only)
				DU1	DU2															DU3
				Body Contact	Aquatic Life Phys/Chem Water Quality (%VIOL)												Aquatic Life Bioassessment		Aquatic Life Toxicological (water column and sediment)	Human Health Consumption (Toxics)
Guideline/degree of ALUS (Table from IR):				IR Table 12 & 13	IR Table 15												IR Table 18		IR Table 16	IR Table 10 & GWQS Appendix A Table 3 (D2) & Table 4
	GU04-0010		1																* (Arsenic, Chromium, Copper, Manganese, Nickel, Tin)	
	GU04-0050		1																* (Arsenic, Cadmium, Chromium, Copper, Manganese, Nickel, Tin)	
Apra Harbor (M-1)	*Seafood Consumption Advisory*	Coastal		UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	NS (*Fish Consumption Advisory*; Driver: PCBs, ChlorPest, Dioxins)
Orote Peninsula Sea Cliffs (North)		Coastal		UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	
Orote Peninsula Sea Cliffs (South)		Coastal		UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	
Tipalao Bay	GU04-0016	Coastal	1	FS	FS	FS	FS	NS	FS	NA	FS	NA	UD	NA	UD	FS	NA	NA	* (Arsenic, Copper, Lead, Nickel, Tin, Zinc, Total PCB)	NS (*Fish Consumption Advisory*; Driver: PCBs, ChlorPest, Dioxins); SeaCucumber EVAL (Arsenic, Copper, Iron, Manganese, Mercury, Tin, Benzo[a]pyrene, Total PAH, Total PCB)
Agat Bay	GU04-0030	Reef flat	1	FS	FS	PS	FS	NS	PS	FS	FS	FS	FS	PS	UD	PS [illegible]	NA	NA	non detect	NS (*Fish Consumption Advisory*; Driver: PCBs, ChlorPest, Dioxins); SeaCucumber EVAL (Arsenic, Copper, Iron, Manganese, Mercury, Total PAH)
	GU04-0046		1																non detect	UD
	ATMS		4																UD	
	GU04-0054	Coastal	1	FS	FS	FS	FS	FS	NS	FS	FS	FS	UD	FS	UD	FS	NA	NA	non detect	NS (*Fish Consumption Advisory*; Driver: PCBs, ChlorPest, Dioxins)
	GU04-0014		1																* (Tin)	UD
	GU04-0004		1																* (Manganese)	
Taleyfac Bay (M-1)	GU04-0022	Coastal	1	FS	FS	FS	FS	NS	FS	FS	FS	FS	UD	FS	UD	FS	NA	NA	* (Tin)	UD
Sella Bay	GU04-0053	Coastal	1	FS	FS	FS	FS	FS	FS	NA	Fail	FS (measured value is <MDL)	UD	NA	UD	FS	NA	NA	* (Arsenic, Chromium, Copper, Manganese, Nickel)	SeaCucumber EVAL (Arsenic, Iron, Manganese, Mercury, Total PAH)
Cetti Bay	GU04-0003	Reef flat	1	FS	FS	NS	FS	FS	FS	NA	FS	FS (measured value is <MDL)	UD	NA	UD	FS	NA	NA	* (Chromium, Manganese, Nickel, Tin)	UD
Toguan Bay	GU04-0029	Coastal	1	FS	FS	FS	FS	FS	FS	NA	FS	NA	UD	NA	UD	FS	NA	NA	non detect	SeaCucumber EVAL (Arsenic, Barium, Copper, Iron, Manganese, Mercury, Tin, Benzo[a]pyrene, Benzo[k]fluoranthene, Total PAH)
Bile Bay	GU04-0027	Coastal	1	FS	FS	NS	FS	FS	FS	NA	FS	NA	UD	NA		FS	NA	NA	* (Chromium, Copper, Manganese, Nickel, Tin)	UD
Cocos Lagoon (M-2)	*Seafood Consumption Advisory*	Coastal		UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	NS (Fish Consumption Advisory; Driver: PCBs); *Fish Consumption Advisory*; Driver: PCBs)
Cocos Lagoon (M-1)	GU04-0011	Coastal	1	FS	FS	NS	FS	NS	FS	NA	FS	FS	UD	NA	UD	FS	NA	NA	* (Tin)	NS (*Fish Consumption Advisory*; Driver: PCBs); SeaCucumber EVAL (Arsenic, Copper, Iron, Manganese, Total PAH)
	Seafood Consumption Advisory	Coastal & Lagoon																		NS (*Fish Consumption Advisory*; Driver: PCBs)
	GU04-0043		1																* (Tin)	

Table B1. Marine Waterbody (WB) Assessment

				DU1	DU2															DU3
				Body Contact	Aquatic Life Phys/Chem Water Quality (%VIOL)												Aquatic Life Bioassessment		Aquatic Life Toxicological (water column and sediment)	Human Health Consumption (Toxics)
Guideline/degree of ALUS (Table from IR):				IR Table 12 & 13	IR Table 15												IR Table 18		IR Table 16	IR Table 10 & GWQS Appendix A Table 3 (D2) & Table 4
Marine WB name	Station	Type	No. occupy Station	Enterococci	pH	OPO4	NO3	NH3	DO	Salinity	TSS	Turbidity	Secchi Vis	Water Temp	Radio-active Materials[1]	Conc of Oil/ Petrol Product	Total Fish Biomass (g)	Percent Cover (Algae, Coral, Invertebrates, Substrate)	Sediment Chemistry EVALUATION ONLY * presence in conc above NOAA SQRTs criteria. Evaluation data set only	Current advisories (and SPMD, Seacucumber, Fish Tissue as EVALUATION only)
	GU04-0035	Lagoon	1	FS	FS	FS	FS	NS	FS	FS	FS	FS	UD	FS	UD	FS	NA	NA	non detect	
	GU04-0019		1																* (Tin)	
Aga Bay	GU04-0007	Reef flat	1	FS	FS	NS	FS	NS	FS	NA	Fail	FS	UD	NA	UD	FS	NA	NA	non detect	UD
Agfayan Bay	BBM1	Reef flat	4	FS	FS	FS	FS	FS	FS	NA	FS	NA	UD	NA	UD	UD	UD	UD	UD	UD
Urunao Beach Area	GU04-0039	Reef flat	1	FS	FS	FS	FS	NS	FS	NA	Fail	NA	UD	NA	UD	FS	NA	NA	non detect	UD
Talofofo Bay	GU04-0023	Coastal	1	FS	FS	NS	FS	NS	FS	UD	NS (numeric crit)	NS	UD	FS	UD	FS	UD	UD	* (Cadmium, Chromium, Copper, Manganese, Nickel, Tin)	UD
Togcha Bay	GU04-0047	Reef flat	1	FS	FS	FS	FS	NS	FS	FS	FS	NS	FS	FS	UD	FS	NA	NA	non detect	UD
	TOGRF-4		2																UD	
	GUSPMD-006		1																	SPMD EVAL - Total Chlordane, Dieldrin.
Ylig Bay	YRF-2	Reef flat	1	FS	FS	FS	FS	FS	FS	NA	NS	NA	NA	NA	UD	UD	NA	NA	UD	UD
	GU04-0015	Coastal	1	FS	FS	NS	FS	FS	FS	NA	UD	NA	NA	NA	UD	FS			non detect	
Fago Bay	GU04-0049	Coastal	1	FS	FS	FS	FS	FS	FS	FS	FS	FS	UD	FS	UD	FS	NA	NA	* (Tin)	UD
Reef Flat Northeast Coast (N Fadian Point)	GU04-0033	Reef flat	1	FS	FS	FS	FS	FS	FS	NA	FS	NA	NA	NA	UD	FS	NA	NA	* (Tin)	SeaCucumber EVAL (Arsenic, Iron, Manganese, Mercury, Benzo[a]pyrene, Total PAH)
Rocky Shorelines Northeast Coast (S Janum Point)	GU04-0001	Coastal	1	FS	FS	FS	FS	FS	FS	NA	FS	NA	NA	NA	UD	FS	NA	NA	* (Tin)	UD

1 Naval Nuclear Propulsion Program (Quarterly Monitoring)

FS	Fully Supporting (FS)
PS	Partially Supporting (PS)
NS	Not Supporting (NS)
NA	Not assessed due to ambient data not available,
Fail	Not assessed due to method fail,
UD	Not sampled

Table B2. Rivers Assessment

				DU1		DU2													DU3	
				Body Contact		Aquatic Life Phys/Chem Water Quality (%VIOL)											Aquatic Life Bioassessment		Human Health Consumption	
Guideline/degree of ALUS (Table from IR):				IR Table 12 & 13		IR Table 15											IR Table 18		IR Table 10 & GWQS Appendix A Table 3 (D2) & Table 4	
RIVER NAME	Guam River ID #	Station	No. occupy Station	E. coli single sample	E. coli Geo Mean	pH	OPO4	NO3	DO	TDS	TSS	Turbidity	Salinity	Water Temp	Radio-active Materials	Conc. of Oil/Petrol Product	Total Fish Biomass (g)	% Cover (Algae, Coral, Inverts, Substrate)	SPMD (P/A)	Human Health (Toxics)
Agana River	G-1A	AGRA-2, *Fish Consumption Advisory*	5	NS	NS	FS	FS	FS	NS	NS	FS	NS	PS	PS	UD	UD	UD	UD	UD	NS (*Fish Consumption Advisory*: Driver: PCBs)
Chaot River	G-1D	AGRA-2																		UD
intermittent tributary	G-1F																			
Storm Drain	G-58	AGRD	5	NS	NS	FS	FS	NS	NS	UD	NS	NS	NS	FS	UD	UD	UD	UD	UD	UD
Fonte River	G-2	AGRF-2	5	NS	NS	FS	FS	NS	NS	FS	FS	PS	PS	FS	UD	UD	UD	UD	UD	UD
Matague River	G-4	ASRM	5	NS	NS	FS	NS	NS	NS	FS	FS	NA	NA	NA	UD	UD	UD	UD	UD	UD
unnamed tributary	G-4A																			
Sasa River	G-7	APRS-1	5	PS	FS	FS	FS	FS	FS	FS	FS	FS	FS	PS	UD	UD	UD	UD	UD	UD
		APRS-2	5	PS	NS	FS	FS	FS	NS	FS	FS	FS	FS	PS	UD	UD	UD	UD	UD	UD
Aguada River	G-9	APRAG	5	PS	NS	FS	FS	FS	NS	FS	FS	NS	FS	FS	UD	UD	UD	UD	UD	UD
unnamed tributary	G-10G	APRA-1	5	FS	FS	FS	FS	FS	FS	FS	FS	PS	FS	PS	UD	UD	UD	UD	UD	UD
Big Gautali River	G-10B																			
intermittent tributary	G-10H	APEA	5	NS	NS	FS	FS	FS	NS	UD	FS	FS	FS	NS	UD	UD	UD	UD	UD	UD
Aplacho River	G-10D																			
Gautali River	G-10E																			
Tenjo River	G-10F																			
Atantano River	G-10A																			
intermittent tributary	G-10J	APRA-2	5	FS	FS	FS	FS	FS	PS	FS	FS	FS	FS	PS	UD	UD	UD	UD	UD	UD
Paulana River	G-10C																			
unnamed tributary	G-10I																			
Namo River	G-11	ATRN-2	6	NS	NS	FS	FS	FS	NS	FS	FS	FS	FS	PS	UD	UD	UD	UD	UD	UD
Ascola Sito Creek	G-18B	ATRT-2	6	NS	NS	FS	FS	FS	NS	UD	FS	PS	PS	PS	UD	UD	UD	UD	UD	UD
unnamed tributary	G-18D																			
unnamed tributary	G-18E																			
Pagachao Creek	G-18C																			
Taleyfac River	G-18A																			
Pigua River	G-31	M2RP-2	5	NS	NS	FS	FS	FS	NS	FS	FS	NA	NA	NA	UD	UD	UD	UD	UD	UD
intermittent tributary	G-31A																			
Inarajan River	G-45A																			

Table B2. Rivers Assessment

RIVER NAME	Guam River ID #	Station	No. occupy Station	E. coli single sample	E. coli Geo Mean	pH	OPO4	NO3	DO	TDS	TSS	Turbidity	Salinity	Water Temp	Radio-active Materials	Conc. of Oil/ Petrol Product	Total Fish Biomass (g)	% Cover (Algae, Coral, Inverts, Substrate)	SPMD (P/A)	Human Health (Toxics)
				DU1		DU2													DU3	
				Body Contact		Aquatic Life Phys/Chem Water Quality (%VIOL)											Aquatic Life Bioassessment		Human Health Consumption	
		Guideline/degree of ALUS (Table from IR):		IR Table 12 & 13		IR Table 15											IR Table 18		IR Table 10 & GWQS Appendix A Table 3 (D2) & Table 4	
Yledigao River	G-45E	INRI1	1	UD	UD	FS	FS	FS	FS	FS	FS	NA	NA	FS	UD	UD	UD	UD	UD	UD
Topony River	G-45F																			
Nelansa River	G-45G																			
Pasmano River	G-45H																			
Dante River	G-45I																			
unnamed tributary	G-45J																			
unnamed tributary	G-45K																			
Laolao River	G-45B																			
Bubulao River	G-48I	TURU-1A	6, 3	PS	UD	FS	FS	FS	PS	FS	NS	PS	FS	PS	UD	UD	UD	UD	SPMD hits** Dieldrin	UD
unnamed tributary	G-48P																			
unnamed tributary	G-48R																			
unnamed tributary	G-48Q																			
unnamed tributary	G-48S																			
unnamed tributary	G-48V																			
Atate River	G-48J																			
Ieygo River	G-48K																			
unnamed tributary	G-48L																			
unnamed tributary	G-48M																			
unnamed tributary	G-48N																			
intermittent tributary	G-48O																			
intermittent tributary	G-48T	TURU-1C, GUSPMD-005	5, 3	PS	UD	FS	FS	FS	FS	FS	NS	NS	FS	NS	UD	UD	UD	UD		
unnamed tributary	G-48U																			
Ugum River	G-48H	TURU-1B, GUSPMD-005	6, 3	NS	UD	PS	FS	FS	FS	FS	NS	PS	FS	NS	UD	UD	UD	UD		
		TURU2, GUSPMD-005	5, 3	FS	UD	FS	FS	FS	PS	PS	NS	PS	FS	PS	UD	UD	UD	UD		
		TURU-1A, GUSPMD-005		*PS*	***UD***	*FS*	*FS*	*FS*	*PS*	*FS*	*NS*	*PS*	*FS*	*PS*	UD	UD	UD	UD		
		GUSPMD-005	6, 3	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD		
Talofofo River	G-48A	GUSPMD-005	3	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD		
		GUSPMD-005	3	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD		

Table B2. Rivers Assessment

				DU1		DU2													DU3	
				Body Contact		Aquatic Life Phys/Chem Water Quality (%VIOL)											Aquatic Life Bioassessment		Human Health Consumption	
Guideline/degree of ALUS (Table from IR):				IR Table 12 & 13		IR Table 15											IR Table 18		IR Table 10 & GWQS Appendix A Table 3 (D2) & Table 4	
RIVER NAME	Guam River ID #	Station	No. occupy Station	E. coli single sample	E. coli Geo Mean	pH	OPO4	NO3	DO	TDS	TSS	Turbidity	Salinity	Water Temp	Radio-active Materials	Conc. of Oil/ Petrol Product	Total Fish Biomass (g)	% Cover (Algae, Coral, Inverts, Substrate)	SPMD (P/A)	Human Health (Toxics)
unnamed tributary	G-48Y			UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	
unnamed tributary	G-48AA			UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	
unnamed tributary	G-48Z			UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	
Mahlac River	G-48G			UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	
Malaja River	G-48C			UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	
unnamed tributary	G-48X			UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	
Sagge River	G-48D			UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	
Tinechong River	G-48E			UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	
unnamed tributary	G-48W			UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	
Maagas River	G-48F			UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	
Sarasa River	G-48B			UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	
Togcha River	G-49	TURTG-1A	5	FS	UD	FS	PS	FS	NS	PS	NS	NS	FS	PS	UD	UD	UD	UD	UD	UD
intermittent tributary	G-49A																			
Ylig River	G-50A	YNRY-3	6	NS	NS	FS	FS	FS	PS	UD	FS	NA	FS	PS	UD	UD	UD	UD	UD	UD
Pago River	G-51A	GUSPMD-003	3	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	SPMD hits** Dieldrin	
		G51_PGRP-1, GUSPMD-003	6, 3	FS	FS	FS	FS	NS	NS	FS	FS	PS	FS	PS	UD	UD	UD	UD		
Lonfit River	G-51B	GUSPMD-003	3	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD
Intermittent tributary	G-51E																			
intermittent tributary	G-51F																			
intermittent tributary	G-51G																			
Landfill Leachate stream	G-51D																			
Sigua River	G-51C																			
unnamed tributary	G-51J																			

Table B3. Marine Waters Use Support

					DU1	DU2	DU3					
Marine Waterbody Name	Guam Marine Water Body ID	GWQS Class	Water Body size (sq.mi)	Project	Body Contact (primary/ whole body, secondary /limited) Enterococci	Aquatic Life (Preserve, Protect, Propagate, Survival, Protect, Maintenance) WQ, Bio, SedTox	Human Health (Toxics) SPMD & organisms	303d listed?	Single Category Assignment (5part)	Water Body size (sq.mi)	Reasoning	Notes
Ritidian Point Beach Area		M-1	1.42	GCA	Fully supporting	Fully Supporting	Not Assessed	NO	C2	1.42	No assessment for DU3.	
Uruno Beach Area		M-1	0.58		Not Assessed			NO	C3	0.58		
Falcona Beach Area		M-1	0.19		Not Assessed			NO	C3	0.19		
Rocky Shorelines Northwest Coast (Double Reef)	G-001A	M-1	0.64	STMP	Fully supporting	Not Supporting (NH3)	Not Assessed	NO	C2	0.64	need more info for NH3 criteria and DU3.	
Haputo Beach Area		M-1	0.07		Not Assessed			NO	C3	0.07		
Rocky Shorelines Northwest Coast (South Haputo)		M-1	0.20		Not Assessed			NO	C3	0.20		
Tanguisson Beach Area (M-1)	G-001B	M-1	0.29	GCA	Fully supporting	Fully Supporting	Not Assessed	NO	C2	0.29	No assessment for DU3.	
Tanguisson Beach Area (M-2)	G-001B	M-2	0.40		Not Assessed	Not Assessed	Advisory (Seafood Consumption)	NO	C5	0.40	Consumption not supported.	Making our IR report better.
Tumon Bay	G-001C	M-2	1.98	Reef flat STMP/GCA/SPMD	Fully supporting	Not Supporting (NH3 and EVAL for Sed screen)	EVAL (SPMD) Tot Chlordane & Dieldrin	YES	C5	1.98	need more info on nutrient loading and pollutant uptake in sed and org tissue.	Look for study: which area is 303 based on TCEs, metals (An, Ar), dieldrin and tot chlordane. Where found - in seds or tissue?
				Coastal STMP	Fully supporting	Not Supporting (on water temp ambient wet season criteria)	Not Assessed				need more info on ALUS for w. temp and other DU2 and DU3.	
Oka Point		M-2	0.20		Not Assessed			NO	C3	0.20		
Hagatna Bay (East)	G-001D	M-2	0.93	East Reef flat + coastal STMP/GCA	Fully supporting	Not Supporting (NH3, Sed EVAL Tin)	EVAL (SPMD and sea cucumber)	NO	C2	0.93	need more info on NH3 criteria, Tissue contaminants and pollutant uptake in seds and orgs.	Salinity based on random sites also that may have raised conc. Need clarification on NH3 criteria.
Hagatna Bay (West)	G-002A	M-2	1.56	West Reef flat + coastal STMP/GCA	Bay Swimming Closure	Partially Supporting (NH3, w.temp andSed EVAL Tin)	Not Assessed	NO	C2	1.56	intended use of cracked sewage pipe. Need more info on pollutant uptake in seds and orgs.	Need clarification on NH3 criteria.
Asan Bay	G-006A	M-2	0.24	Reef flat GCA	Fully supporting	Not Supporting (NH3 , Sed EVAL Tin)	EVAL (sea cucumber)	NO	C2	0.58	Need more info on NH3 criteria and pollutant uptake in seds and orgs.	
			0.34	Coastal GCA	Fully supporting	Fully Supporting	Not Assessed					
Piti Bay	G-006B	M-2	1.35	Reef flat GCA	Fully supporting	Not Supporting (NH3 , Sed EVAL Tin)	EVAL (sea cucumber)	NO	C2	1.35	Need more info on NH3 criteria and pollutant uptake in seds and orgs.	
Luminao Reef and Calalan Bank		M-2	1.17		Not Assessed	Not Assessed	EVAL (Fish NOAA/GEPA)	NO	C2	1.17	Need info on fish tissue study- were samples from this area contaminated?	

Table B3. Marine Waters Use Support

Marine Waterbody Name	Guam Marine Water Body ID	GWQS Class	Water Body size (sq.mi)	Project	DU1 Body Contact (primary/ whole body, secondary /limited) Enterococci	DU2 Aquatic Life (Preserve, Protect, Propagate, Survival, Protect, Maintenance) WQ, Bio, SedTox	DU3 Human Health (Toxics) SPMD & organisms	303d listed?	Single Category Assignment (5part)	Water Body size (sq.mi)	Reasoning	Notes
Apra Harbor (M-2)	G-008A	M-2	4.61	STMP/GCA/SPMD	Fully supporting	Partially Supporting (OPO4) and Sed EVAL for numerous COCs.	Advisory (Fish Consumption)	YES	C5	4.61	Consumption not supported. Current fish consumption advisory.	
Apra Harbor (M-3)	G-008A	M-3	0.42	STMP/GCA	Fully supporting	Not Supporting (OPO4) and Sed EVAL for numerous COCs.	EVAL (Fish NOAA/GEPA)		C2	0.42	Need to address and validate NOAA/GEPA fish tissue study.	
Piti Channel and Cabras Island		M-3	0.24		Not Assessed	Not Assessed	EVAL (Fish NOAA/GEPA)		C3	0.24		
Sasa Bay		M-2	0.74	STMP/GCA	Fully supporting	Not Supporting (TSS, Turb) and Sed EVAL for numerous metals.	Not Assessed		C2	0.74	TSS and Turb in mangroves is natural? Need more info. Also, metals in sediment.	
Apra Harbor (M-1)	G-008A	M-1	0.05		Not Assessed	Not Assessed	Advisory (Fish Consumption)	YES	C5	0.05	Consumption not supported. Current fish consumption advisory.	
Orote Peninsula Sea Cliffs (North)		M-1	0.23		Not Assessed		Advisory (Fish Consumption)	YES	C5	0.23		
Orote Peninsula Sea Cliffs (South)		M-2	0.02		Not Assessed		Advisory (Fish Consumption)	YES	C5	0.02		
Tipalao Bay	G-010A	M-2	0.10	GCA	Fully supporting	Not Supporting (NH3) and Sed EVAL (metals, tot PCB)	Advisory (Fish Consumption)	YES	C5	0.10		
Agat Bay 2	G-010B	M-2	1.91	Reef flat STMP/GCA	Fully supporting	Not Supporting (NH3)	Advisory (Fish Consumption)	YES	C2	1.91	C2: Need more info on NH3 criteria C5: Consumption not supported. Current fish consumption advisory.	Reef flat is 1.91 sq. miles
Agat Bay 1		M-2	0.63	Coastal GCA	Fully supporting	Not Supporting (DO) and Sed EVAL for Tin, Manganese	Not Assessed	NO	C5	0.63		Coastal is 0.63 square miles
Taleyfac Bay (M-2)	G-012A	M-2	0.37			Not Assessed		NO	C3	0.37		
Taleyfac Bay (M-1)	G-012A	M-1	0.71	GCA	Fully supporting	Not Supporting (NH3) and Sed EVAL Tin	Not Assessed	NO	C2	0.71	Need more info on NH3 criteria and pollutant uptake in seds and orgs.	
South Facpi Point beaches and rocky shorelines		M-1	0.66			Not Assessed		NO	C3	0.66		
Sella Bay		M-1	0.27	GCA	Fully supporting	Sed EVAL - metals	EVAL (sea cucumber for metals and totPAH)	NO	C2	0.27	Need more info on pollutant uptake in seds and orgs.	
Cetti Bay	G-014A	M-1	0.65	GCA	Fully supporting	Not Supporting (OPO4) and Sed EVAL for numerous COCs.	Not Assessed	NO	C2	0.65	Need more info on nutrient loading and pollutant uptake in seds and orgs.	
Fouha Bay	G-016A	M-1	0.26			Not Assessed		NO	C3	0.26		
Umatac Bay (M-1)	G-016B	M-1	0.06			Not Assessed		NO	C3	0.06		
Umatac Bay (M-2)	G-016B	M-2	0.34			Not Assessed		NO	C3	0.34		

Table B3. Marine Waters Use Support

					DU1	DU2	DU3					
Marine Waterbody Name	Guam Marine Water Body ID	GWQS Class	Water Body size (sq.mi)	Project	Body Contact (primary/ whole body, secondary /limited) Enterococci	Aquatic Life (Preserve, Protect, Propagate, Survival, Protect, Maintenance) WQ, Bio, SedTox	Human Health (Toxics) SPMD & organisms	303d listed?	Single Category Assignment (5part)	Water Body size (sq.mi)	Reasoning	Notes
Toguan Bay	G-018A	M-2	0.26	GCA	Fully supporting	Fully Supporting	EVAL (sea cucumber for metals and organics)	NO	C2	0.26	Need more info on pollutant uptake in orgs.	
Bile Bay		M-2	0.17	GCA	Fully supporting	Not Supporting (OPO4) and Sed EVAL for metals.	Not Assessed	NO	C2	0.17	Need more info on nutrient loading pollutant uptake in seds and orgs.	
Cocos Lagoon (M-2)	G-020A	M-2	0.34		Not Assessed	Not Assessed	Advisory (Fish Consumption)	YES	C5	0.34	Consumption not supported. Current fish consumption advisory. Need more info on nutrient loading and pollutant uptake in seds.	
Cocos Lagoon (M-1)	G-020A	M-1	5.70	Coastal & Lagoon GCA	Fully supporting	Not Supporting (OPO4, NH3) and Sed EVAL for Tin	Advisory (Fish Consumption)		C5	5.70		
Sumay Bay		M-1	0.79		Not Assessed			NO	C3	0.79		
Asgadao Bay		M-1	0.56		Not Assessed			NO	C3	0.56		
Ajayan Bay		M-1	0.24		Not Assessed			NO	C3	0.24		
Aga Bay		M-1	0.10	GCA	Fully supporting	Not Supporting (OPO4 and NH3)	Not Assessed	NO	C2	0.10	Need more info on nutrient loading and pollutant uptake in orgs.	
Inarajan Reef Flat		M-1	0.82		Not Assessed			NO	C3	0.82		
Agfayan Bay	G-017C	M-2	0.08	STMP	Fully supporting	Partially Supporting (TSS)	Not Assessed	NO	C2	0.08	Need more info on sed loading and pollutant uptake in seds and tissue.	
Agfayan Bay: Inarajan Pools	G-017A	M-2	0.08		Not Assessed			NO	C3	0.08		
Inarajan Bay	G-017B	M-2	0.17		Not Assessed			NO	C3	0.17		
Guaifan Point Reef Flat		M-2	0.08		Not Assessed			NO	C3	0.08		
Pauliluc Bay		M-2	0.08		Not Assessed			NO	C3	0.08		
Ulomai Beach Area		M-2	0.09	GCA	Fully supporting	Not Supporting (NH3)	Not Assessed	NO	C2	0.09	Need more info on NH3 criteria and pollutant uptake in seds and orgs.	
Nomna Bay		M-2	0.17		Not Assessed			NO	C3	0.17		
Nomna Point Reef Flat		M-1	0.32		Not Assessed			NO	C3	0.32		
Asiga Point Beach Area		M-1	0.16		Not Assessed			NO	C3	0.16		
Matala Point Reef Flat		M-1	0.25		Not Assessed			NO	C3	0.25		

Table B3. Marine Waters Use Support

					DU1	DU2	DU3					
Marine Waterbody Name	Guam Marine Water Body ID	GWQS Class	Water Body size (sq.mi)	Project	Body Contact (primary/ whole body, secondary /limited) Enterococci	Aquatic Life (Preserve, Protect, Propagate, Survival, Protect, Maintenance) WQ, Bio, SedTox	Human Health (Toxics) SPMD & organisms	303d listed?	Single Category Assignment (5part)	Water Body size (sq.mi)	Reasoning	Notes
Talofofo Bay	G-011A	M-2	0.15	GCA	Fully supporting	Not Supporting (OPO4, NH3, TSS, Turb) and Sed EVAL for numerous metals.	Not Assessed	NO	C2	0.15	Need more info on nutrient and sediment loading, NH3 criteria and pollutant uptake in seds and orgs.	
Talofofo Beaches		M-2	0.61		Not Assessed			NO	C3	0.61		
Togcha Bay	G-007A	M-2	0.41	Reef flat STMP/GCA/SPMD	Fully supporting	Not Supporting (NH3, Turb)	EVAL SPMD TotChlordane, Dieldrin	NO	C2	0.41	Need more info on NH3 criteria, sediment loading and pollutant uptake in orgs.	
Beach North of Togcha Point		M-2	0.53		Not Assessed			NO	C3	0.53		
Ylig Bay	G-005A	M-2	0.45	Reef flat STMP	Fully supporting	Not Supporting (TSS)	Not Assessed	NO	C2	0.45	Need more info on sediment and nutrient loading and pollutant uptake in orgs.	
				Coastal GCA	Fully supporting	Not Supporting (OPO4)	Not Assessed					
Tagachan Beach Park Area	G-005B	M-2	0.24		Not Assessed			NO	C3	0.24		
Pago Bay	G-003A	M-2	0.70	GCA	Fully supporting	Sed EVAL - Tin	Not Assessed	YES	C5	0.70	For this reporting period, 303d listed pollutants are fully supporting based on 1 sample in 2005- need more monitoring for 303d listed drivers. Need info on sed conc. of tin.	303d listed pollutant drivers: bacti, DO, Nitrate.
Rocky Shorelines Northeast Coast (S Fadian Point)		M-2	0.58		Not Assessed			NO	C3	0.58		
Reef Flat Northeast Coast (N Fadian Point)		M-1	0.56	GCA	Fully supporting	Sed EVAL - Tin	EVAL (sea cucumber for metals and PAHs)	NO	C2	0.56	Need info on sed conc. of tin.	
Rocky Shorelines Northeast Coast (S Janum Point)		M-1	2.29	GCA	Fully supporting	Sed EVAL - Tin	Not Assessed	NO	C2	2.29	Need info on sed conc. of tin and info on pollutant uptake in orgs.	
Janum Point Reef Flat		M-1	0.09		Not Assessed			NO	C3	0.09		
Rocky Shorelines Northeast Coast (Pati Point)		M-1	5.35		Not Assessed			NO	C3	5.35		
Tarague Beach (Scout Beach Area)		M-1	3.09		Not Assessed			NO	C3	3.09		

Table B3. Marine Waters Use Support

Marine Waterbody Name	Guam Marine Water Body ID	GWQS Class	Water Body size (sq.mi)	Project	DU1 Body Contact (primary/ whole body, secondary /limited) Enterococci	DU2 Aquatic Life (Preserve, Protect, Propagate, Survival, Protect, Maintenance) WQ, Bio, SedTox	DU3 Human Health (Toxics) SPMD & organisms	303d listed?	Single Category Assignment (Spart)	Water Body size (sq.mi)	Reasoning	Notes
Jinapsan Beach Area		M-1	0.75		Not Assessed			NO	C3	0.75		
66			**50.06**							**50.06**		

17.21	C2	24	= some DUs assessed but not all so need more information
18.10	C3	31	= no DUs assessed this reporting period so need more information
14.75	C5	11	=Available data and/or information indicate that at least one des. Use is not supported or is threatened. TMDL is needed.
50.06		**66**	

Table B4. Rivers Use Support

Guam River ID #	RIVER NAME	Receiving Water	Channel length (miles)	STMP Segment ID	STMP Segment Length (miles)	GWQC	DU1 Body Contact (primary/ whole body, secondary /limited) Enterococci	DU2 Aquatic Life (Preserve, Protect, Propagate, Survival, Protect, Maintenance) WQ Phys/Chem ONLY (ALUS Bio and Tox NOT DONE)	DU3 Human Health (Toxics) SPMD & organisms	303d listed?	Single Category Assignment (5part)	Miles Assessed	Reasoning	Notes	Receiving Marine Waterbody
G-1A	Agana River	Agana Bay - Padre Palomo Park	1.19	G1_AGRA-3	0.55	S2	UD	UD	NS (on-going Fish Consumption Advisory)	Yes	C5	1.19	C5 - 0.4mi AGRA3 + 0.6mi AGRA2 PCBs in Fish Tissue. Need more WQ samples and info on other DU2 and DU3.	303d listed for DO and entero.	East Hagatna Bay
				G1_AGRA-2	0.64	S2	NS	NS (DO, TSS, Turb)							
G-1D	Chaot River	Agana Swamp	1.43		1.43				UD	NO	C2	1.43	Chaot River has been lumped into Agana River waterquality assessments via AGRA2. Recommend that the Chaot reach is assessed separately.	segment assesed by AGRA2 during this reporting period.	
G-1F	Intermittent tributary	Chaot River	0.79		0.79				UD		C2	0.79			
G-1B	Agana Swamp	Agana River	(NA)	(NA)	(NA)		UD	UD	NS (on-going Fish Consumption Advisory)	YES			C5 : PCBs in Fish Tissue.		
G-1C	Agana Spring	Agana Swamp	0.04	G1_AGRA-1	0.04	S2	UD	UD	UD	NO	C3				
G-58	Storm Drain	East Agana Bay (Dungca's Beach)	0.21	G58_AGRD	0.21	S2	NS	NS (NO3, DO, TSS wet, Turbidity wet, Salinity wet)	UD	NO	C5	0.21	Storm Drain effluent is untreated. Need more info on other DU2 and DU3.	MW assessment (E. Hag Bay) shows possible organics and metals enrichment.	
G-2	Fonte River	West Agana Bay (Pigo Cemetery)	3.18	G2_AGRF-1	1.93	S2	UD	UD	UD	NO	C3				West Hagatna Bay
				G2_AGRF-2	1.25	S2	NS	NS (NO3, DO)	UD	NO	C2	1.16	Need more ALUS WQ samples and other DU2 and DU3.		
G-59	unnamed creek	East Asan Bay	0.17	G59_ASRI-1	0.17	S3	UD	UD	UD	NO	C3				Asan Bay
G-3A	Asan River	Asan Bay - Asan Park	1.55	G3_ASRI-3	1.32	S3	UD	UD	UD	NO	C3				
				G3_ASRI-4	0.15	S3	UD	UD	UD	NO	C3			0.08 mi below ASRI4 drains to bay.	
G-3B	unnamed tributary	Asan River	0.56		0.56		UD	UD	UD	NO	C3				
G3C	unnamed creek	Asan River to Asan Bay - Adelup	0.19	G3_ASRI-2	0.06	S3	UD	UD	UD	NO	C3				
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	NS	NS (OPO4, NO3, DO)	UD	NO	C2	1.2	Nutrient and e. coli exceedences indicate possible sewage contamination. Sanitary inspection ongoing.	Reported to WPC in 2009.	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]		[illegible]				UD						
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		UD	UD	UD	NO	C3				
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	UD	UD	UD	NO	C3				
				[illegible]	[illegible]	[illegible]	UD	UD	UD	NO					
[illegible]	[illegible]	[illegible]	[illegible]		[illegible]		UD	UD	UD	NO	C3				
				G7_APRS-1	0.85	S3	PS	PS (w. temp)	UD	NO	C2	0.85			Apra Harbor

Table B4. Rivers Use Support

Guam River ID #	RIVER NAME	Receiving Water	Channel length (miles)	STMP Segment ID	STMP Segment Length (miles)	GWQC	DU1 Body Contact (primary/ whole body, secondary /limited) Enterococci	DU2 Aquatic Life (Preserve, Protect, Propagate, Survival, Protect, Maintenance) WQ Phys/Chem ONLY (ALUS Bio and Tox NOT DONE)	DU3 Human Health (Toxics) SPMD & organisms	303d listed?	Single Category Assignment (5part)	Miles Assessed	Reasoning	Notes	Receiving Marine Waterbody
G-7	Sasa River	Apra Harbor mangroves	2.21	G7_APRS-2	1.15	S3	NS	NS (DO)	UD	NO	C2	1.15	Need more ALUS WQ samples and DO samples.		
G-8	Laguas River	Apra Harbor mangroves	0.85	G8_APRL	0.81	S3	UD	UD	UD	NO	C3				
G-9	Aguada River	Apra Harbor - before Poians Point	2.15	G9_APRAG	1.95	S3	NS	NS (DO, Turb) need more samples	UD	NO	C2	1.95	Need more ALUS WQ samples and other DU2 and DU3.	Ambient turbidity is based on a limited sample size. Need more information.	
G-10G	unnamed tributary	Big Gautali River	0.67	G10_APRA-1	0.67	S3	FS	PS (turb. w. temp)	UD	NO	C2	2.15			
G-10B	Big Gautali River	Atantano Wetland	2.29		1.48				UD						
				G10_APEA	0.81	S3	NS	NS (DO, w. temp)	UD	NO	C2	6.23	Need assessment of additional ALUS WQ samples and DO samples.		
G-10H	intermittent tributary	Big Gautali River	0.56		0.56				UD						
G-10D	Apiacho River	Atantano Wetland	1.96		1.96				UD						
G-10E	Gautali River	Atantano Wetland	0.70		0.70				UD						
G-10F	Tenjo River	Atantano Wetland	1.23		1.23				UD						
G-10A	Atantano River	Inner Apra Harbor	2.51		0.97				UD						
				G10_APRA-2	1.39	S3	FS	PS (DO, w. temp)	UD	NO	C2	3.30	Need assessment of additional ALUS WQ samples and DO samples.		
G-10J	intermittent tributary	Atantano River	0.91		0.91				UD						
G-10C	Paulana River	Atantano River	0.84		0.84				UD						
G-10I	unnamed tributary	Paulana River	0.16		0.16				UD						
G-11	Namo River	Agat Bay - Apaca Pnt.	2.40	G11_ATRN-2	0.36	S3	NS	NS (DO)	UD	NO	C2	0.36	Need assessment of more ALUS WQ samples and DO samples.		Agat Bay
				G11_ATRN-1A	1.55	S3	UD	UD	UD	NO	C3				
G-11B	unnamed tributary	Namo River	0.36		0.36		UD	UD	UD	NO	C3				
G-11A	unnamed tributary	Namo River	0.64		0.53		UD	UD	UD	NO	C3				
				G11_ATRN-1	0.11	S3	UD	UD	UD	NO	C3				
G-12	Togcha River	Agat Bay - Salinas Beach	1.10	G12_ATRTO	0.87	S3	UD	UD	UD	NO	C3				
G-13	Salinas River	Agat Bay - Salinas Beach before Gaan Pt.	0.78	G13_ATRS	0.47	S3	UD	UD	UD	NO	C3				
G-14	Finile Creek	Agat Bay - directly after Agat Village (southbound)	0.81	G14_ATRF	0.13	S3	UD	UD	UD	NO	C3				
G-14A	unnamed tributary	Finile Creek	0.17		0.17		UD	UD	UD	NO	C3				
G-14B	unnamed tributary	Finile Creek	0.06		0.06		UD	UD	UD	NO	C3				
G-15	Gaan River	Agat Bay - Before Bangi Island	1.19	G15_ATRG	0.62	S3	UD	UD	UD	NO	C3				

Table B4. Rivers Use Support

Guam River ID #	RIVER NAME	Receiving Water	Channel length (miles)	STMP Segment ID	STMP Segment Length (miles)	GWQC	DU1 Body Contact (primary/ whole body, secondary /limited) Enterococci	DU2 Aquatic Life (Preserve, Protect, Propagate, Survival, Protect, Maintenance) WQ Phys/Chem ONLY (ALUS Bio and Tox NOT DONE)	DU3 Human Health (Toxics) SPMD & organisms	303d listed?	Single Category Assignment (5part)	Miles Assessed	Reasoning	Notes	Receiving Marine Waterbody
		(southbound)		G15_ATRG-2	0.55	S3	UD	UD	UD	NO	C3				
G-16	Auau Creek	Taleyfac Bay	0.86	(NA)	(NA)		UD	UD	UD	NO	C3				Taleyfac Bay
G-17	Chaligan Creek	Taleyfac Bay	0.98	G17_ATRC	0.06	S3	UD	UD	UD	NO	C3				
				G17_ATRC-2	0.91	S3	UD	UD	UD	NO	C3				
G-18B	Ascola Sito Creek	Taleyfac River	1.85	G18_ATRT-1	0.97	S3	UD	UD	UD	NO	C3				
				G18_ATRT-2	0.88	S3	NS	NS (DO)	UD	NO	C2	0.88			
G-18D	unnamed tributary	Ascola Sito Creek	0.59		0.59				UD	NO	C2	2.91	Need assessment of additional ALUS WQ samples and DO samples.		
G-18E	unnamed tributary	Ascola Sito Creek	0.55		0.55				UD						
G-18C	Pagachao Creek	Ascola Sito Creek	0.65		0.65				UD						
G-18A	Taleyfac River	Taleyfac Bay - Agat	1.18		1.12				UD						
G-19	Taelayag Creek	Taleyfac Bay (Taelayag Beach-Anae Island)	1.37	G19_ATRTA	1.34	S3	UD	UD	UD	NO	C3				
G-20	Sagua River	Taleyfac Bay (Sagua Beach-Facpi Pnt.)	0.58	G20_ATRSG	0.53	S3	UD	UD	UD	NO	C3				
G-21	Madofan River	South Achugao Point	0.77	G21_ULRMF	0.73	S2	UD	UD	UD	NO	C3				Cetti Bay
G-22	Agaga River	South Achugao Point	0.78	G22_ULRAG	0.72	S2	UD	UD	UD	NO	C3				
G-23	Asmafines River	North Sella Bay	0.83	G23_ULRAS	0.78	S2	UD	UD	UD	NO	C3				
G-24	Sella River	South Sella Bay	0.88	G24_ULRS	0.82	S2	UD	UD	UD	NO	C3				
G-24A	unnamed tributary	Sella River	0.58		0.58		UD	UD	UD	NO	C3				
G-24B	unnamed tributary	Sella River	0.71		0.71		UD	UD	UD	NO	C3				
G-24C	unnamed tributary	G-24B	0.38		0.38		UD	UD	UD	NO	C3				
G-25	Cetti River	North Cetti Bay	1.15	G25_ULRCL	1.12	S2	UD	UD	UD	NO	C3				
G-25A	unnamed tributary	Cetti River	0.77		0.77		UD	UD	UD	NO	C3				
G-26	unnamed river	Cetti Bay	0.36	G26_ULRCR	0.30	S2	UD	UD	UD	NO	C3				
G-27A	La Sa Fua River	Fouha Bay	2.02	G27_ULRL-2	2.02	S2	UD	UD	UD	NO	C3				Fouha Bay
G-27C	Chagame River	La Sa Fua River	1.21	G27_ULRL-1	1.17	S2	UD	UD	UD	NO	C3				
G-27B	Alaigue River	Chagame River	0.40		0.40		UD	UD	UD	NO	C3				
G-27D	Laguan River	Chagame River	0.43		0.43		UD	UD	UD	NO	C3				
G-27E	San Nicolas River	Chagame River	0.46		0.46		UD	UD	UD	NO	C3				
G-28D	Astaban River	Madog River	0.59	G28_ULRM	0.59	S3	UD	UD	UD	NO	C3				Umatac Bay
G-28G	unnamed tributary	Astaban River	0.32		0.32		UD	UD	UD	NO	C3				
G-28C	Madog River	Umatac River	1.65		1.20		UD	UD	UD	NO	C3				
				G28_ULRU-2	0.45	S3	UD	UD	UD	NO	C3				
G-28A	Umatac River	Umatac Bay	0.24		0.06		UD	UD	UD	NO	C3				

Table B4. Rivers Use Support

Guam River ID #	RIVER NAME	Receiving Water	Channel length (miles)	STMP Segment ID	STMP Segment Length (miles)	GWQC	DU1 Body Contact (primary/ whole body, secondary /limited) Enterococci	DU2 Aquatic Life (Preserve, Protect, Propagate, Survival, Protect, Maintenance) WQ Phys/Chem ONLY (ALUS Bio and Tox NOT DONE)	DU3 Human Health (Toxics) SPMD & organisms	303d listed?	Single Category Assignment (5part)	Miles Assessed	Reasoning	Notes	Receiving Marine Waterbody
G-28B	Laelae River	Umatac River	1.00		0.23		UD	UD	UD	NO	C3				
				G28_ULRU-1	0.77	S1	UD	UD	UD	NO	C3				
G-28E	Bolanos River	Laelae River	0.49		0.49		UD	UD	UD	NO	C3				
G-28F	Pajon River	Laelae River	0.68		0.68		UD	UD	UD	NO	C3				
G-29	Toguan River	Toguan Bay	1.41	G29_MZRT-1	1.19	S3	UD	UD	UD	NO	C3				Toguan Bay
				G29_MZRT-2	0.19	S3	UD	UD	UD	NO	C3				
G-30	Bile River	North Bile Bay	0.64	(NA)	(NA)		UD	UD	UD	NO	C3				Bile Bay
G-31	Pigua River	South Bile Bay	1.05	G31_MZRP	0.13	S3	UD	UD	UD	NO	C3				
				G31_MZRP-2	0.88	S3	NS	NS (DO)	UD	NO	C2	0.88	Need assessment of more ALUS WQ samples and DO samples. Check reasons for low river flow.	0.05 mi drains to bay below MZRP2.	
G-31A	intermittent tributary	Pigua River	0.62		0.62				UD			0.62			
G-32	Geus River	Piga Beach - Cocos Lagoon	2.29	G32_MZRG-1	0.96	S1	UD	UD	UD	NO	C3				Cocos Lagoon (Mamaon & Manell Channel)
				G32_MZRG-2	0.76	S3	UD	UD	UD	NO	C3				
				G32_MZRG	0.50	S2	UD	UD	UD	NO	C3				
G-33	Achang River	Cocos Lagoon	0.80	G33_MZRAC	0.30	S2	UD	UD	UD	NO	C3				
				G33_MZRAC-2	0.50	S2	UD	UD	UD	NO	C3				
G-34	Manell River	Cocos Lagoon - East Achang Bay	2.11	G34_MZRML	1.99	S2	UD	UD	UD	NO	C3				
G-34A	unnamed tributary	Manell River	0.32		0.32		UD	UD	UD	NO	C3				
G-34B	unnamed tributary	Manell River	0.34		0.34		UD	UD	UD	NO	C3				
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		UD	UD	UD	NO	C3				[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	(NA)	(NA)		UD	UD	UD	NO	C3				
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	UD	UD	UD	NO	C3				
[illegible]	[illegible]	[illegible]	[illegible]		[illegible]		UD	UD	UD	NO	C3				
G-38	[illegible] River	Achang Reef/Asgadao Bay at Liguan Pt	0.75	G38_MZRL	0.73	S2	UD	UD	UD	NO	C3				Asgadao Bay
G-38A	unnamed tributary	[illegible] River	1.08		1.08		UD	UD	UD	NO	C3				
G-39	Asgadao Creek	Achang Reef/Asgadao Bay	0.59	(NA)	(NA)		UD	UD	UD	NO	C3				
G-40	Asmafie River	Asgadao Bay	0.77	(NA)	(NA)		UD	UD	UD	NO	C3				
G-41	Ajayan River	Ajayan Bay	2.89	G41_MZRAJ	2.80	S2	UD	UD	UD	NO	C3				Ajayan Bay
G-41A	intermittent tributary	Ajayan River	0.44		0.44		UD	UD	UD	NO	C3				
G-41B	unnamed tributary	Ajayan River	0.62		0.62		UD	UD	UD	NO	C3				
[illegible]	[illegible] Creek	[illegible]	[illegible]	[illegible]	[illegible]		UD	UD	UD	NO	C3				[illegible]

Table B4. Rivers Use Support

Guam River ID #	RIVER NAME	Receiving Water	Channel length (miles)	STMP Segment ID	STMP Segment Length (miles)	GWQC	DU1 Body Contact (primary/ whole body, secondary /limited) Enterococci	DU2 Aquatic Life (Preserve, Protect, Propagate, Survival, Protect, Maintenance) WQ Phys/Chem ONLY (ALUS Bio and Tox NOT DONE)	DU3 Human Health (Toxics) SPMD & organisms	303d listed?	Single Category Assignment (5part)	Miles Assessed	Reasoning	Notes	Receiving Marine Waterbody
G-43	Agfayan River	South Agfayan Bay	3.15	(NA)	(NA)		UD	UD	UD	NO	C3				Agfayan Bay
G-43A	unnamed tributary	Agfayan River	0.58	(NA)	(NA)		UD	UD	UD	NO	C3				
G-43B	unnamed tributary	Agfayan River	0.58	(NA)	(NA)		UD	UD	UD	NO	C3				
G-43C	intermittent tributary	Agfayan River	1.17	(NA)	(NA)		UD	UD	UD	NO	C3				
G-43D	intermittent tributary	G-43C	0.37	(NA)	(NA)		UD	UD	UD	NO	C3				
G-43E	intermittent tributary	G-43C	0.24	(NA)	(NA)		UD	UD	UD	NO	C3				
G-43F	intermittent tributary	Agfayan River	0.58	(NA)	(NA)		UD	UD	UD	NO	C3				
G-44	unnamed river	North Agfayan Bay	0.95	G44_INRAGB	0.72	S3	UD	UD	UD	NO	C3				
G-45A	Inarajan River	Inarajan Bay	2.23	G45_INRI2	0.86	S3	UD	UD	UD	NO	C3				Inarajan Bay
				G45_INRI1	1.18	S3									
G-45E	Yledigao River	Inarajan River	0.59		0.59										
G-45F	Topony River	Yledigao River	1.04		1.04										
G-45G	Nelansa River	Yledigao River	0.93		0.93										
G-45H	Pasmano River	Inarajan River	2.25		2.25										
G-45I	Dante River	Pasamano River	1.52		1.52		UD	FS	UD	NO	C2	8.64	Use Support based on 1 sample. Need assessment of additional ALUS WQ samples and other DUs. Site access restricted during wet weather. Consider alternate access routes.		
G-45J	unnamed tributary	Dante River	0.43		0.43										
G-45K	unnamed tributary	Dante River	0.43		0.43										
G-45B	Laolao River	Inarajan River	0.40		0.27										
				G45_INRL	0.13	S2	UD	UD	UD	NO	C3				
G-45C	Fensol River	Laolao River	1.20		1.20		UD	UD	UD	NO	C3				
G-45D	Fintasa River	Laolao River	2.12		2.12		UD	UD	UD	NO	C3				
G-45L	unnamed tributary	Fintasa River	0.80		0.80		UD	UD	UD	NO	C3				
G-46A	Pauliluc River	Pauliluc Bay	0.42	G46_INRAP	0.04	S3	UD	UD	UD	NO	C3				Pauliluc Bay
G-46C	Tinago River	Pauliluc River	2.93		2.93		UD	UD	UD	NO	C3				
G-46D	unnamed tributary	Tinago River	0.85		0.85		UD	UD	UD	NO	C3				
G-46E	unnamed tributary	Tinago River	0.55		0.55		UD	UD	UD	NO	C3				
G-46B	Aslinget River	Pauliluc River	2.22		0.18		UD	UD	UD	NO	C3				
				G46_INRAL-2	1.33	S3	UD	UD	UD	NO	C3				
				G46_INRAL-1	0.71	S3	UD	UD	UD	NO	C3				
G-46F	Assupian	Aslinget River	0.52		0.52		UD	UD	UD	NO	C3				
G-47	Asalonso River	Talofofo Bay - Matala Pt.	2.54	G47_INRAS	1.80	S3	UD	UD	UD	NO	C3				Talofofo Bay
G-47A	unnamed tributary	Asalonso River	0.30		0.30		UD	UD	UD	NO	C3				
G-48I	Bubulao River	Ugum River	4.81		4.81										
G-48P	unnamed tributary	Bubulao River	0.42		0.42										
G-48R	unnamed tributary	Bubulao River	0.43		0.43										

Table B4. Rivers Use Support

Guam River ID #	RIVER NAME	Receiving Water	Channel length (miles)	STMP Segment ID	STMP Segment Length (miles)	GWQC	DU1 Body Contact (primary/ whole body, secondary /limited) Enterococci	DU2 Aquatic Life (Preserve, Protect, Propagate, Survival, Protect, Maintenance) WQ Phys/Chem ONLY (ALUS Bio and Tox NOT DONE)	DU3 Human Health (Toxics) SPMD & organisms	303d listed?	Single Category Assignment (Spart)	Miles Assessed	Reasoning	Notes	Receiving Marine Waterbody
G-48Q	unnamed tributary	G-48R	0.33	G48_TURU-1A	0.33	S2	PS	NS (TSS)	EVAL (Dieldrin SPMD)	NO	C4A	12.57	Current sampling effort, although limited in sample quantity, shows TSS and sedimentation an issue in this watershed. Also, Turbidity is *PS* for this reporting period. SPMD assessment showed presence of Dieldrin.		
G-48S	unnamed tributary	Bubulao River	0.33		0.33										
G-48V	unnamed tributary	Bubulao River	2.01		2.01										
G-48J	Atate River	Ugum River	1.16		1.16										
G-48K	Ieygo River	Atate River	1.15		1.15										
G-48L	unnamed tributary	Atate River	0.25		0.25										
G-48M	unnamed tributary	Ugum River	0.22		0.22										
G-48N	unnamed tributary	Ugum River	0.36		0.36										
G-48O	intermittent tributary	Ugum River	1.10		1.10										
G-48T	intermittent tributary	Ugum River	0.64	G48_TURU-1C	0.64	S2	PS	NS (TSS, Turbidity)	EVAL (Dieldrin SPMD)	NO	C4A	2.96			
G-48U	unnamed tributary	Ugum River	0.89		0.89										
G-48H	Ugum River	Talofofo River	7.48		1.43										
				G48_TURU-1B	0.18	S2	NS	NS (TSS)	EVAL (Dieldrin SPMD)	NO	C4A	0.18			
				G48_TURU2	1.05	S2	FS	NS	EVAL (Dieldrin SPMD)	NO	C4A	1.05			
				G48_TURU-1A	4.43	S2	PS	NS	EVAL (Dieldrin SPMD)	NO	C4A	4.43			
				G48_TUETU	0.39	S3	UD	UD	EVAL (Dieldrin SPMD)	NO	C4A	0.39	SPMD assessment showed presence of Dieldrin. Assessment limited.		
G-48A	Talofofo River	Talofofo Bay	3.51		0.96					NO	C3				
				G48_TUETO	0.46	S3	UD	UD	UD	NO	C3				
				G48_TURT-2	2.09	S2	UD	UD	EVAL (Dieldrin SPMD)	NO	C3		SPMD placed at lower reach of Talofofo River which is receiving water of these river bodies. SPMD assessment showed presence of Dieldrin. Assessment limited.		
G-48Y	unnamed tributary	Mahlac River	0.81	G48_TURMA-1	0.81	S1	UD	UD		NO	C3				
G-48AA	unnamed tributary	Mahlac River	0.94		0.94		UD	UD		NO	C3				
G-48Z	unnamed tributary	G-48AA	0.70		0.70		UD	UD		NO	C3				
G-48G	Mahlac River	Talofofo River	2.56		2.41		UD	UD		NO	C3				
				G48_TURT-2	0.15	S2	UD	UD		NO	C3				
G-48C	Malaja River	Sarasa River	0.64		0.64		UD	UD		NO	C3				
G-48X	unnamed tributary	Talofofo River	0.45		0.45		UD	UD		NO	C3				
G-48D	Sagge River	Talofofo River	3.85		3.85		UD	UD		NO	C3				
G-48E	Tinechong River	Sagge River	1.27		1.27		UD	UD		NO	C3				

Table B4. Rivers Use Support

Guam River ID #	RIVER NAME	Receiving Water	Channel length (miles)	STMP Segment ID	STMP Segment Length (miles)	GWQC	DU1 Body Contact (primary/ whole body, secondary /limited) Enterococci	DU2 Aquatic Life (Preserve, Protect, Propagate, Survival, Protect, Maintenance) WQ Phys/Chem ONLY (ALUS Bio and Tox NOT DONE)	DU3 Human Health (Toxics) SPMD & organisms	303d listed?	Single Category Assignment (5part)	Miles Assessed	Reasoning	Notes	Receiving Marine Waterbody
G-48W	unnamed tributary	Sagge River	1.23		1.23		UD	UD		NO	C3				
G-48F	Maagas River	Talofofo River	2.07	G48_TURM-1	0.39	S2	UD	UD		NO	C3				
				G48_TURT-2	1.68	S2	UD	UD		NO	C3				
G-48B	Sarasa River	Talofofo River	2.30		2.25		UD	UD		NO	C3				
				G48_TURS-1	0.05	S2	UD	UD		NO	C3				
G-49	Togcha River	Togcha Bay	1.91	G49_TURTG-X	0.03	S3	UD	UD	UD	NO	C3				Togcha Bay
				G49_TURTG-1B	0.07	S3	UD	UD	UD	NO	C3				
				G49_TURTG-C	0.91	S3	UD	UD	UD	NO	C3				
				G49_TURTG-1C	0.46	S3	UD	UD	UD	NO	C3				
				G49_TURTG-1A	0.28	S3	FS	NS (DO, TSS, Turb)	UD	NO	C2	0.93	Need more ALUS WQ samples and DO samples.		
G-49A	intermittent tributary	Togcha River	0.65		0.65				UD						
G-49B	unnamed tributary	Togcha River	0.06	G49_TURTG-2	0.05	S3	UD	UD	UD	NO	C3				
G-50V	unnamed tributary	Ylig River	1.23	G50_YNRY-2	1.23	S3	UD	UD	UD	NO	C3				Ylig Bay
G-50G	intermittent tributary	Ylig River	0.81		0.81		UD	UD	UD	NO	C3				
G-50A	Ylig River	Ylig Bay	8.93		1.29		UD	UD	UD	NO	C3				
				G50_YNRY-3	0.41	S3	NS	PS	UD	NO	C2	0.41	Need more ALUS WQ samples and DO samples.		
					7.13		UD	UD	UD	NO	C3				
G-50B	Manengon River	Ylig River	1.81	G50_YNRY-1	1.81	S3	UD	UD	UD	NO	C3				
G-50Q	unnamed tributary	Manengon River	0.51		0.51		UD	UD	UD	NO	C3				
G-50R	unnamed tributary	Manengon River	0.71		0.71		UD	UD	UD	NO	C3				
G-50S	unnamed tributary	Manengon River	0.85		0.85		UD	UD	UD	NO	C3				
G-50T	unnamed tributary	Manengon River	1.17		1.17		UD	UD	UD	NO	C3				
G-50U	unnamed tributary	G-50T	0.30		0.30		UD	UD	UD	NO	C3				
G-50C	Tarzan River	Ylig River	2.67		2.67		UD	UD	UD	NO	C3				
G-50D	unnamed tributary	Ylig River	0.98		0.98		UD	UD	UD	NO	C3				
G-50E	unnamed tributary	Ylig River	0.99		0.99		UD	UD	UD	NO	C3				
G-50F	unnamed tributary	Ylig River	0.53		0.53		UD	UD	UD	NO	C3				
G-50H	unnamed tributary	Ylig River	0.49		0.49		UD	UD	UD	NO	C3				
G-50I	unnamed tributary	Tarzan River	0.94		0.94		UD	UD	UD	NO	C3				

Table B4. Rivers Use Support

Guam River ID #	RIVER NAME	Receiving Water	Channel length (miles)	STMP Segment ID	STMP Segment Length (miles)	GWQC	DU1 Body Contact (primary/ whole body, secondary /limited) Enterococci	DU2 Aquatic Life (Preserve, Protect, Propagate, Survival, Protect, Maintenance) WQ Phys/Chem ONLY (ALUS Bio and Tox NOT DONE)	DU3 Human Health (Toxics) SPMD & organisms	303d listed?	Single Category Assignment (5part)	Miles Assessed	Reasoning	Notes	Receiving Marine Waterbody
G-50J	unnamed tributary	Ylig River	0.32		0.32		UD	UD	UD	NO	C3				
G-50K	unnamed tributary	Ylig River	0.76		0.76		UD	UD	UD	NO	C3				
G-50L	unnamed tributary	Ylig River	0.75		0.75		UD	UD	UD	NO	C3				
G-50M	unnamed tributary	G-50L	0.72		0.72		UD	UD	UD	NO	C3				
G-50N	unnamed tributary	Ylig River	0.74		0.74		UD	UD	UD	NO	C3				
G-50P	unnamed tributary	Ylig River	0.72		0.72		UD	UD	UD	NO	C3				
G-50O	unnamed tributary	Ylig River	0.38		0.38		UD	UD	UD	NO	C3				
G-51H	intermittent tributary	Pago River	1.08	G51_PGRP-2	1.08	S3	UD	UD	UD	NO	C5	1.08			Pago Bay
G-51I	intermittent tributary	Pago River	0.99		0.99		UD	UD	UD	NO	C5	0.99			
G-51A	Pago River	Pago Bay	3.79		2.66		UD	UD	EVAL	YES	C5	2.66	Not assessed for WQ or other DUs. SPMD assessment showed presence of Dieldrin. Assessment limited and need more investigation.	303D listed for e.coli and DO.	
				G51_PGEP	0.54	S3	UD	UD	UD	NO	C3				
				G51_PGMPW	0.52	S3	UD	UD	UD	NO	C3				
				G51_PGRP-1	0.06	S2	FS	NS (NO3, DO)	EVAL	YES	C5	0.1	Current assessment 5 e.coli samples fully supporting. 3 of 6 NO3 samples exceed WQS. DO needs more sampling. SPMD assessment showed presence of Dieldrin in the watershed.	303D listed for e.coli.	
G-51B	Lonfit River	Pago River	4.90		0.04										
				G51_PGRL-2	1.07	S2	UD	UD	UD	YES	C5	1.07			
					3.79		UD	UD	UD	NO	C3				
G-51E	intermittent tributary	Lonfit River	1.29	G51_PGRL-1	1.29	S1	UD	UD	UD	NO	C3				
G-51F	intermittent tributary	Lonfit River	1.09		1.09		UD	UD	UD	NO	C3				
G-51G	intermittent tributary	Lonfit River	0.69		0.69		UD	UD	UD	NO	C3				
G-51D	Landfill Leachate stream	Lonfit River	0.05	G51_PGRL-0	0.05	S1	UD	UD	UD	YES	C5	0.05			
G-51C	Sigua River	Pago River	6.03	G51_PGRS	6.01	S1	UD	UD	UD	NO	C3				
G-51J	unnamed tributary	Pago River	0.12		0.12		UD	UD	UD	NO	C3				
G-53	Sadog Gago River	Imong River	1.49	G53_FLRSG-1	0.52	S1	UD	UD	UD	NO	C3				NA
					0.97	S1	UD	UD	UD	NO	C3				

Table B4. Rivers Use Support

Guam River ID #	RIVER NAME	Receiving Water	Channel length (miles)	STMP Segment ID	STMP Segment Length (miles)	GWQC	DU1 Body Contact (primary/ whole body, secondary /limited) Enterococci	DU2 Aquatic Life (Preserve, Protect, Propagate, Survival, Protect, Maintenance) WQ Phys/Chem ONLY (ALUS Bio and Tox NOT DONE)	DU3 Human Health (Toxics) SPMD & organisms	303d listed?	Single Category Assignment (5part)	Miles Assessed	Reasoning	Notes	Receiving Marine Waterbody
G-53A	intermittent tributary	Sadog Gago River	0.79	G53_FLRI-2	0.79	S1	UD	UD	UD	NO	C3				
G-52	Imong River	Fena Lake	1.99		0.78	S1	UD	UD	UD	NO	C3				
				G52_FLRI-1	1.11	S1	UD	UD	UD	NO	C3				
G-52A	intermittent tributary	Imong River	0.72		0.72	S1	UD	UD	UD	NO	C3				
G-55	unnamed stream	Fena Lake	0.38	(NA)	(NA)	S1	UD	UD	UD	NO	C3				
G-54	Almagosa River	Fena Lake	1.23	G54_FLRA-2	1.18	S1	UD	UD	UD	NO	C3				
G-54A	unnamed tributary	Almagosa River	0.70		0.70	S1	UD	UD	UD	NO	C3				
G-54B	unnamed tributary	Almagosa River	0.30		0.30	S1	UD	UD	UD	NO	C3				
G-54C	Almagosa Spring	Almagosa River	0.09	G54_FLRA-1	0.09	S1	UD	UD	UD	NO	C3				
G-56	Maulap River	Fena Lake	1.71	G56_FLRM-1	0.44	S1	UD	UD	UD	NO	C3				
				G56_FLRM-2	1.25	S1	UD	UD	UD	NO	C3				
G-56A	unnamed tributary	Maulap River	0.57		0.57		UD	UD	UD	NO	C3				
G-56B	unnamed tributary	Maulap River	0.59		0.59		UD	UD	UD	NO	C3				
G-57	Bonya River	Morrow Lake	3.21	G57_MLRB	0.97	S1	UD	UD	UD	NO	C3				NA
G-57A	unnamed tributary	Bonya River	0.82		0.82		UD	UD	UD	NO	C3				
G-57B	unnamed tributary	Bonya River	0.82	(NA)	(NA)	S1	UD	UD	UD	NO	C3				
G-60	Tolaeyuus River	Morrow Lake	0.39	(NA)	(NA)	S1	UD	UD	UD	NO	C3				
G-61	Talisay River	Maemong River	3.72	(NA)	(NA)	S1	UD	UD	UD	NO	C3				
G-62	unnamed tributary	Talisay River	0.28	(NA)	(NA)	S1	UD	UD	UD	NO	C3				
G-63	unnamed tributary	Maemong River	0.22	(NA)	(NA)	S1	UD	UD	UD	NO	C3				
G-64	Maemong River	Tolaeyuus River	2.71	(NA)	(NA)	S1	UD	UD	UD	NO	C3				
G-65	unnamed tributary	Maemong River	0.57	(NA)	(NA)	S1	UD	UD	UD	NO	C3				
G-66	unnamed tributary	Maemong River	0.66	(NA)	(NA)	S1	UD	UD	UD	NO	C3				

202 Total Miles of River/Streams 232.65

UD Not sampled

C2	35.84	= some DUs assessed but not all so need more information
C3	167.88	= no DUs assessed this reporting period so need more information
C4a	21.58	= A TMDL to address A specific segment/pollutant combination has been approved or established by EPA
C5	7.35	=Available data and/or information indicate that at least one des. Use is not supported or is threatened. TMDL is needed.
	232.65	

Table B5. Guam Beach Use Support

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	303d listed?	Single Category Assignment (5part)
GB1, GB2	3.42	Tarague Beach/Scout Beach					UD			UD			C3
GB3	1.28	Jinapsan Beach					UD			UD			C3
GB4	2.21	Ritidian Beach					UD			UD			C3
GB5	1.74	Uruno Beach					UD			UD			C3
GB6	0.37	Falcona Beach (Urunao)					UD			UD			C3
GB7	0.24	South of Falcona Beach (Urunao)					UD			UD			C3
GB8	0.19	Haputo Beach					UD			UD			C3
GB9	0.19	Intermittent beach - Shark's Hole					UD			UD			C3
GB10	0.26	Intermittent beach - Tanguisson Pt.					UD			UD			C3
GB11	0.26	Intermittent beach - North of NCS/Tanguisson					UD			UD			C3
GB12	0.25	NCS Beach/Tanguisson Beach	N-01	Tanguisson Beach[1]	0.25	53	NS	NABS	47	NS	NABS	Yes	C4a
GB13	0.37	Fafai Beach					UD			UD			C3
GB15	0.23	Gun Beach, Tumon Bay	N-24	Gun Beach	0.23	53	PS	NABS	47	NS	NABS	Yes	C4a
GB16	0.14	Gonga Beach, Tumon Bay	N-25	Gonga Beach	0.14	53	NS	NABS	47	NS	NABS	Yes	C4a
GB17	1.1	Naton Beach, Tumon Bay	N-02	Naton Beach - San Vitores	0.23	53	NS	NABS	47	NS	NABS	Yes	C4a
GB17			N-23	Naton Beach - Fujita	0.36	53	PS	NABS	47	PS	NABS	Yes	C4a
GB18			N-03	Naton Beach - Matapang Beach Park	0.33	53	NS	NABS	47	NS	NABS	Yes	C4a
GB17			N-04	Naton Beach - Guma Trankilidat	0.18	53	FS	NABS	47	PS	NABS	Yes	C4a
GB19	0.42	Ypao Beach, Tumon Bay	N-05	Ypao Beach	0.42	53	NS	NABS	47	PS	NABS	Yes	C4a
GB21	0.02	Alupang Island Beach, East Hagåtña Bay					UD			UD			C3
GB22	0.99	Dungca's Beach, East Hagåtña Bay	N-06	Dungca's Beach - Sleepy Lagoon	0.34	53	NS	NABS	47	NS	NABS	Yes	C4a
GB22			N-07	Dungca's Beach	0.65	53	NS	NABS	48	NS	NABS	Yes	C4a

Table B5. Guam Beach Use Support

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	303d listed?	Single Category Assignment (5part)
GB23	1.15	Trinchera Beach, East Hagåtña Bay	N-26	East Hagåtña Bay - Alupang Towers Beach	0.25	53	NS	NABS	48	NS	NABS	Yes	C4a
GB23			N-08	East Hagåtña Bay - Trinchera Beach	0.48	53	NS	NABS	47	NS	NABS	Yes	C4a
GB24			N-09	Padre Palomo Park Beach	0.42	53	NS	NABS	47	NS	NABS	Yes	C4a
GB25	0.42	Hagåtña Marina	N-10	Hagåtña Channel[2]	0.15	53	NS	NABS	47	NS	NABS	Yes	C4a
GB25			N-11	Hagåtña Channel - Paseo Outrigger Canoe Ramp[2]	0.15	53	NS	NABS	47	NS	NABS	Yes	C4a
GB25			N-12	Hagåtña Boat Basin[2]	0.12	53	NS	NABS	47	NS	NABS	Yes	C4a
GB26	1.11	West Hagåtña Beach	N-13	Hagåtña Bayside Park[2]	1.11	53	NS	NABS	47	NS	NABS	Yes	C4a
GB27	0.13	Beach at Fonte River, West Hagatna Bay	N-21	Adelup Beach Park	0.13	53	NS	NABS	47	NS	NABS	Yes	C5
GB28	0.41	West of Adelup Point, Asan Bay	N-22	Adelup Point Beach (West of Adelup Park)	0.41	53	NS	NABS	47	NS	NABS	Yes	C5
GB29	0.37	West of volcanic headland, Asan Bay					UD			UD			C3
GB31	0.53	Asan Memorial Beach, Head of Asan Bay	N-14	Asan Bay Beach	0.53	53	NS	NABS	47	NS	NABS	Yes	C5
GB32	1.08	Beach at Piti Bay (Tepungan Beach)	N-15	Piti Bay	0.62	53	NS	NABS	47	NS	NABS	Yes	C5
GB33			N-16	Santos Memorial Park Beach	0.46	53	NS	NABS	46	NS	NABS	Yes	C5
GB34	0.52	United Seamen's Service Beach (USO Beach)	N-17	United Seamen's Service	0.52	52	PS	NABS	46	PS	NABS	Yes	C5
GB35	0.46	Outhouse Beach	N-18	Outhouse Beach	0.46	53	NABS	NS	47	NABS	NS	Yes	C5
GB36	0.15	Family Beach	N-19	Family Beach	0.15	53	NS	NABS	47	PS	NABS	Yes	C5
GB37	0.46	Port Authority Beach	N-20	Port Authority Beach	0.46	53	NABS	NS	47	NABS	NS	Yes	C5
GB38	0.4	Ski Beach					UD			UD			C3
GB40	0.4	SRF Beach					UD			UD			C3
GB41	0.18	Marianas Yacht Club Beach, Sasa Bay					UD			UD			C3
GB42	0.19	Polaris Beach					UD			UD			C3
GB43	0.65	Gabgab Beach					UD			UD			C3
GB44	0.46	Orote Point Beaches					UD			UD			C3
GB45	0.15	Tipalao Beach					UD			UD			C3
GB46	0.57	Dadi Beach					UD			UD			C3
GB47	0.26	Rizal Beach					UD			UD			C3
GB48	0.14	Apaca Park Beach					UD			UD			C3
GB50	0.79	Togcha Beach aka Agat Beach	S-02	Togcha Beach - Namo	0.33	53	NS	NABS	47	NS	NABS	Yes	C5
GB50			S-03	Togcha Beach - Agat Bay	0.15	53	NS	NABS	47	NS	NABS	Yes	C5

Table B5. Guam Beach Use Support

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	303d listed?	Single Category Assignment (5part)
GB50			S-17	Togcha Beach - Beach at SCA	0.31	53	NS	NABS	47	NS	NABS	Yes	C5
GB51	0.49	Salinas Beach				UD			UD				C3
GB52	0.3	Beach North of Finile River				UD			UD				C3
GB53	1.17	Beach South of Finile River	S-04	Bangi Beach	1.17	53	NS	NABS	47	NS	NABS	Yes	C5
GB55	0.49	Nimitz Beach	S-05	Nimitz Beach	0.49	53	NS	NABS	47	NS	NABS	Yes	C5
GB56	0.87	Taelayag Beach				UD			UD				C3
GB57	0.62	Sagua Beach				UD			UD				C3
GB58	0.66	Facpi Point Beaches				UD			UD				C3
GB59	0.29	Beach south of Achugao				UD			UD				C3
GB60	0.25	Beach south of Agaga Riv				UD			UD				C3
GB62	0.12	Beach north of Asmafines Riv				UD			UD				C3
GB63	0.12	Beach south of Sella Riv				UD			UD				C3
GB64	0.62	Abong Beach				UD			UD				C3
GB65	0.5	Mouth of Cetti Bay				UD			UD				C3
GB66	0.06	Head of Fouha Bay				UD			UD				C3
GB67	0.14	Head of Umatac Bay	S-06	Umatac Bay	0.14	53	NS	NABS	47	NS	NABS	Yes	C5
GB68	0.25	South of Machadgan Point				UD				UD			C3
GB69	0.46	Toguan Bay	S-07	Toguan Bay	0.46	53	NS	NABS	47	NS	NABS	Yes	C5
GB70	0.16	Ajmo Beach				UD			UD				C3
GB71	0.03	Bile Bay Beach				UD			UD				C3
GB72	0.08	Pigua River Beach				UD			UD				C3
GB73	1.16	Cocos Island				UD			UD				C3
GB74	0.07	Islet				UD			UD				C3
GB75	0.46	Merizo Public Pier Park	S-08	Merizo Pier - Mamaon Channel	0.46	53	NS	NABS	47	NS	NABS	Yes	C5
GB76	0.42	Piga Beach/Talona Beach				UD			UD				C3
GB77		Cocos Lagoon (btw Piga&Aba Beach)				UD			UD				C3
GB78	0.19	Aba Beach				UD			UD				C3
GB79	0.12	Aang Beach				UD			UD				C3
GB80	0.55	Achang Bay				UD			UD				C3
GB81	0.77	Beach to Liyog Riv Mouth				UD			UD				C3
GB82	0.18	Liyog river Mouth				UD			UD				C3

Table B5. Guam Beach Use Support

[illegible]	[illegible]	BEACH NAME	[illegible]	EPA Station ID Location/Description	[illegible]	[illegible]	Whole Body Contact [illegible]	Limited Body Contact [illegible]	[illegible]	Whole Body Contact [illegible]	Limited Body Contact [illegible]	303d listed?	Single Category Assignment (5part)
GB83	0.04	Beach to Asgadao Bay					UD			UD			C3
GB84	0.12	Intermittent beach, Asgadao Bay					UD			UD			C3
GB85	0.12	Intermittent beach 1, Ajayan Bay					UD			UD			C3
GB86	0.09	Intermittent beach 2, Ajayan Bay					UD			UD			C3
GB87	0.03	Ajayan River Mouth 1					UD			UD			C3
GB88	0.19	Intermittent beach 3, Ajayan Bay					UD			UD			C3
GB89	0.06	Ajayan River Mouth 2					UD			UD			C3
GB90	0.09	Intermittent beach 4, Ajayan Bay					UD			UD			C3
GB91	0.08	Aga Beach					UD			UD			C3
GB92	0.44	Guijen Rock area					UD			UD			C3
GB93	0.38	Atao Beach					UD			UD			C3
GB94	0.27	Beach north of Acho Pnt.					UD			UD			C3
GB95	0.07	Agfayan River Beach					UD			UD			C3
GB96	0.07	Inarajan Pools	S-09	Inarajan Pool	0.07	53	NS	NABS	47	NS	NABS	Yes	C5
GB97	0.46	Beach at Inarajan Bay	S-10	Inarajan Bay	0.46	53	NS	NABS	47	NS	NABS	Yes	C5
GB98	0.28	Beach at Pauliluc Bay					UD			UD			C3
GB99	0.11	Ulomai Beach					UD			UD			C3
GB101	0.26	Perez Beach					UD			UD			C3
GB102	0.23	Asiga Beach Area (Inarajan)					UD			UD			C3
GB103	0.09	Head of Paicpouc Cove					UD			UD			C3
GB105	0.21	Head of Talofofo Bay	S-11	Talofofo Bay	0.21	53	NS	NABS	47	NS	NABS	Yes	C5
GB106	0.06	First Beach	S-18	First Beach - Talofofo	0.06	53	FS	NABS	47	PS	NABS	Yes	C5
GB108	0.51	Calvos Beach					UD			UD			C3
GB110	0.09	Jones Beach					UD			UD			C3
GB111	0.3	Ypan Beach Park Beach (Ipan Public Beach)	S-12	Ipan Beach	0.3	53	PS	NABS	47	PS	NABS	Yes	C5
GB113	0.27	Beach north of Togcha River	S-13	Togcha Bay - Talofofo	0.27	53	NS	NABS	45	NS	NABS	Yes	C5
GB114	1.03	North of Togcha Point					UD			UD			C3
GB115	0.18	Head of Ylig Bay					UD			UD			C3
GB116	0.07	Beach North of Ylig Bay					UD			UD			C3
GB117	0.07	Tagachan Beach Park	S-14	Tagachang Beach	0.07	53	NS	NABS	47	NS	NABS	Yes	C5

Table B5. Guam Beach Use Support

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	303d listed?	Single Category Assignment (5part)
GB118	0.96	Beach at Pago Bay	S-15	Pago Bay	0.96	53	NS	NABS	47	NS	NABS	Yes	C5
GB119	0.24	North Pago Bay Beach				UD			UD				C3
	43.65	**103**	**42**		**15.46**								

	2008 TOTAL	2008 MILES		2009 TOTAL	2009 MILES
FS	2	0.24	FS	0	0
PS	4	1.41	PS	7	1.99
NS	36	13.81	NS	35	13.47
	42	**15.46**		**42**	**15.46**

[1] **Seafood Consumption Advisory in effect**

[2] **Beach Closure to Swimming and Wading in effect**

*From IR Table 12 & 13

FS	Fully Supporting -Entero geomean max not exceeded and single sample max not exeeded
PS	Partially Supporting- Entero geomean max not exceeded and single sample max is exeeded
NS	Not Supporting -Entero geomean max exceeded
NABS	Not Applicable to Beach Stretch
UD	Not sampled

17	C4a	5.81	= A TMDL to address A specific segment/pollutant combination has been approved or established by EPA
25	C5	9.65	=Available data and/or information indicate that at least one des. Use is not supported or is threatened. TMDL is needed.
42	totals	15.46	

Appendix C. 2010 IR Categorization Figures

Guam 2010 Integrated Report
2010 IR Catagorization of Marine Water Bodies
Northern Water Bodies

Generated by GEPAMP Feb 2010.

Figure C1a. North and Central Guam Marine Waterbodies 2010 Categorization

Guam 2010 Integrated Report

2010 IR Catagorization of Marine Water Bodies
Southern Water Bodies

Generated by GEPAMP Feb 2010.

0 0.5 1 2 3 4 Miles

Figure C1b. Southern Central Guam Marine Waterbodies 2010 Categorization

Guam 2010 Integrated Report

2010 IR Catagorization of Rivers and Streams

Generated by GEPAMP Feb 2010.

Figure C2. Guam River Waterbodies 2010 Categorization