III. MARINE AND SURFACE WATER MONITORING AND ASSESSMENT

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

A. Monitoring Program "2006 Comprehensive Monitoring Strategy"

1.0 Monitoring Program Strategy

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

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

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

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

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

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

2.0 Monitoring Goals and Objectives

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

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

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

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

3.0 Monitoring Design

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

3.1 Status and Trends Monitoring Program (STMP)

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

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

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

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

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

Table 13. Status and Trends Monitoring Program: 8-Year Monitoring Schedule*

Sample Year	Watershed	# of Stations
YEAR 1	Ugum/Apra	58 Core + 14 (72)
YEAR 2	Hagatna/Fonte/Piti-Asan/ Taelayag	+ 20 (78)
YEAR 3	Pago/Cetti	+ 18 (76)
YEAR 4	Tumon/Yigo /Toguan	+ 7 (65)
YEAR 5	Agat/Inarajan/Dandan/Asalonso	+ 18 (76)
YEAR 6	Northern/Umatac	+ 15 (73)
YEAR 7	Togcha/Talofofo	+ 28 (86)
YEAR 8	Geus/Manell/Ylig	+ 17 (75)

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

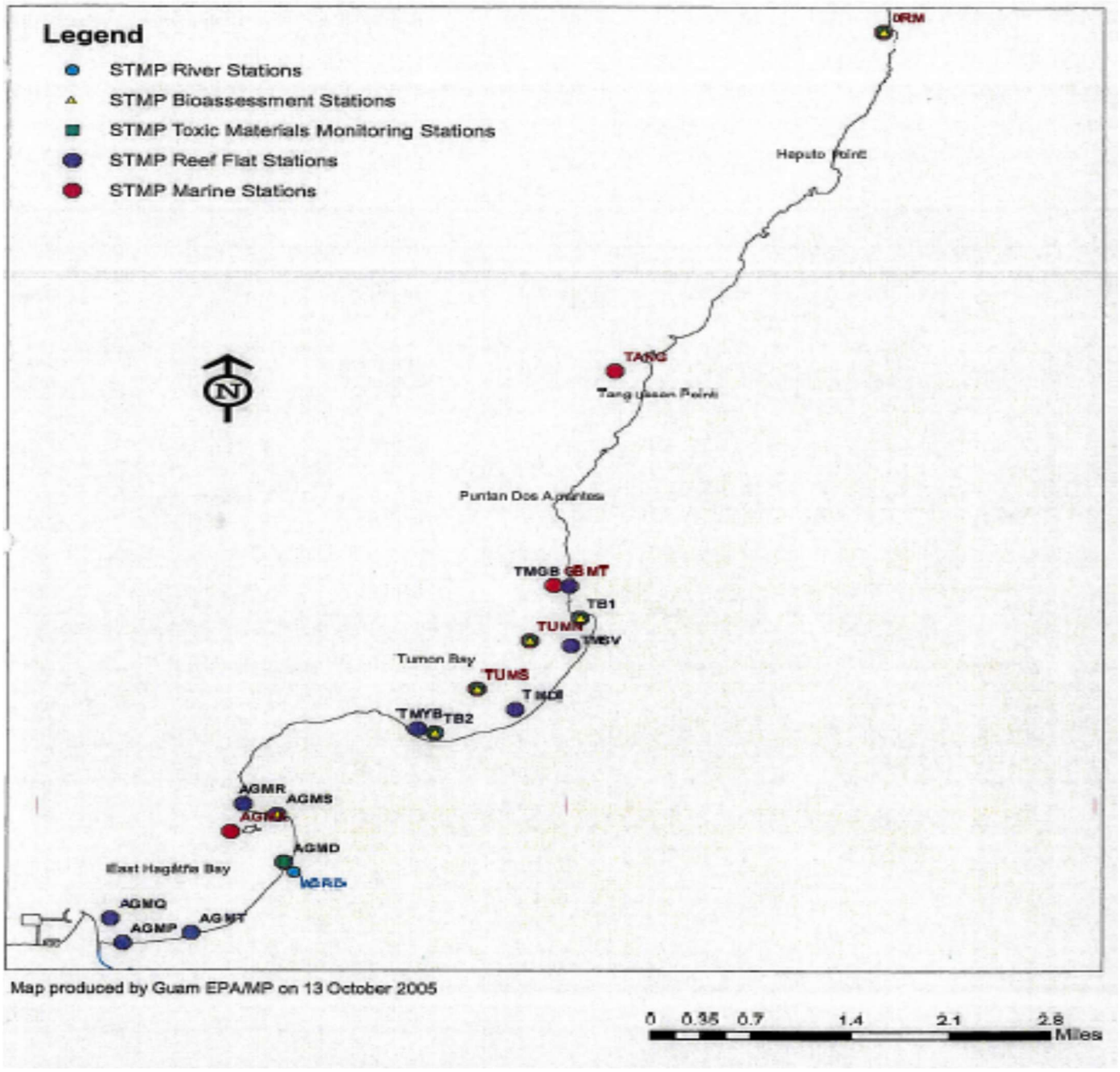


FIGURE 22a. Northern Guam: Status and Trends Monitoring Program (STMP) Stations Map

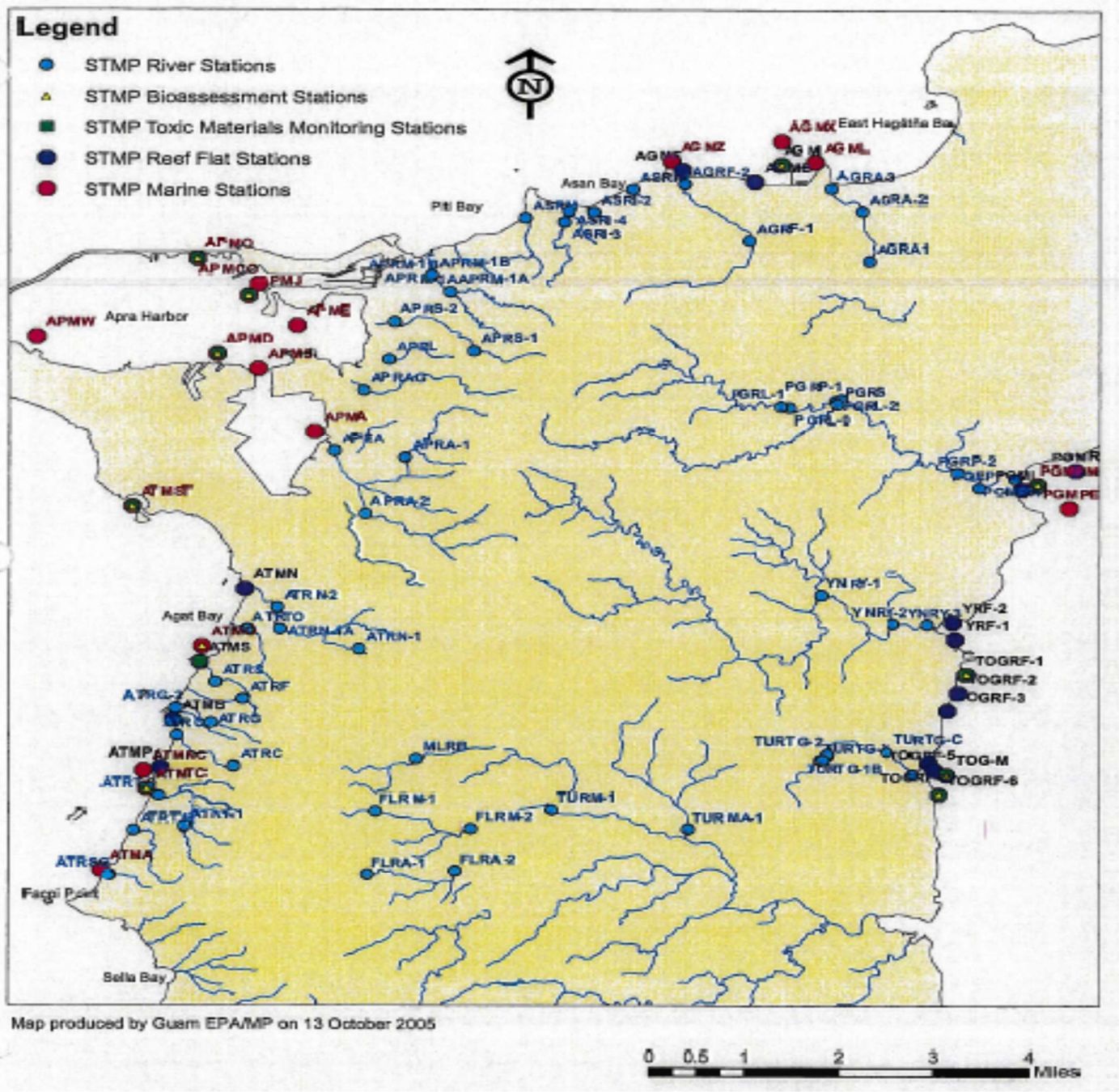


FIGURE 22b. Central Guam: Status and Trends Monitoring Program (STMP) Stations Map

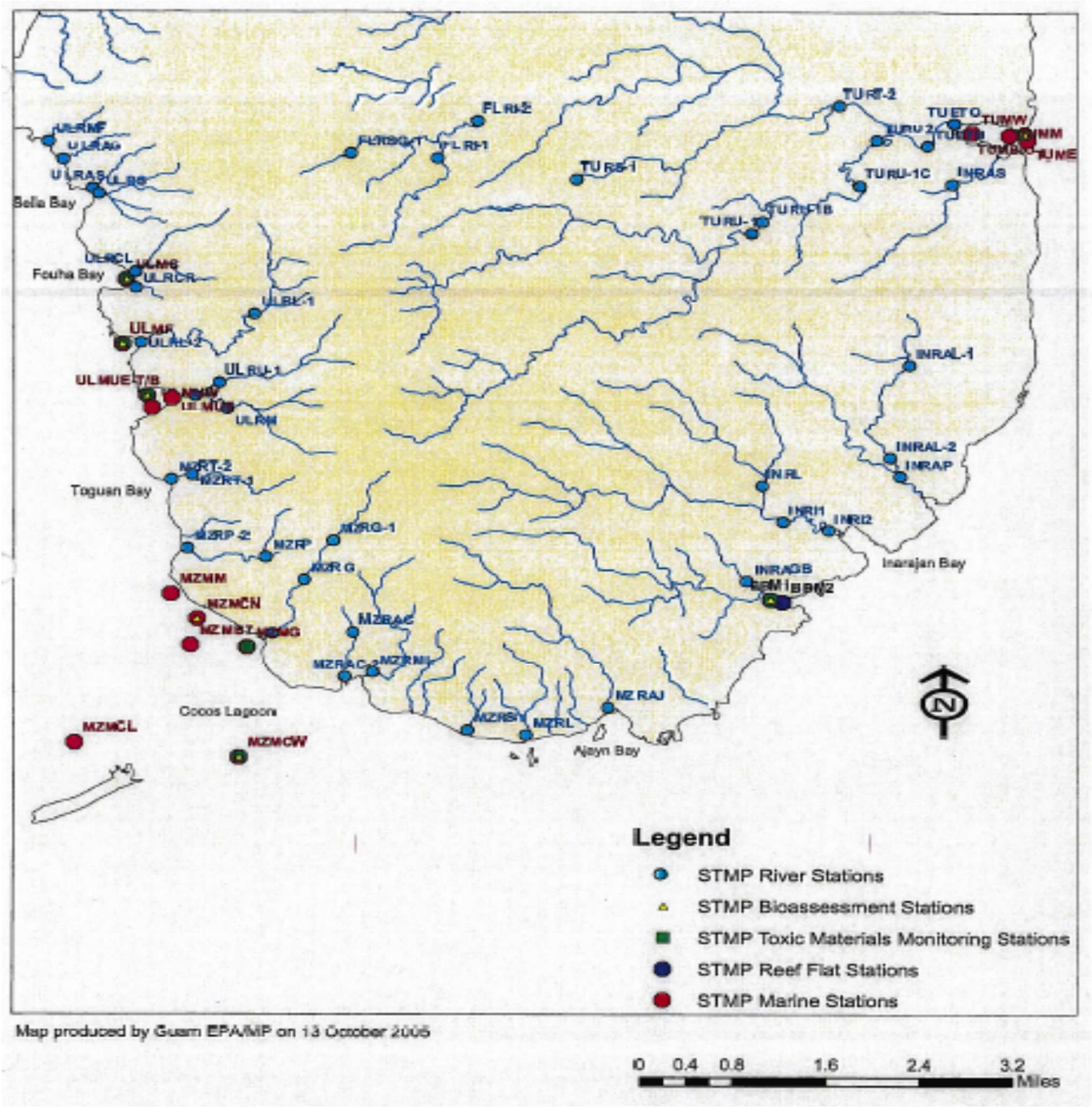


FIGURE 22c. Southern Guam: Status and Trends Monitoring Program (STMP) Stations Map

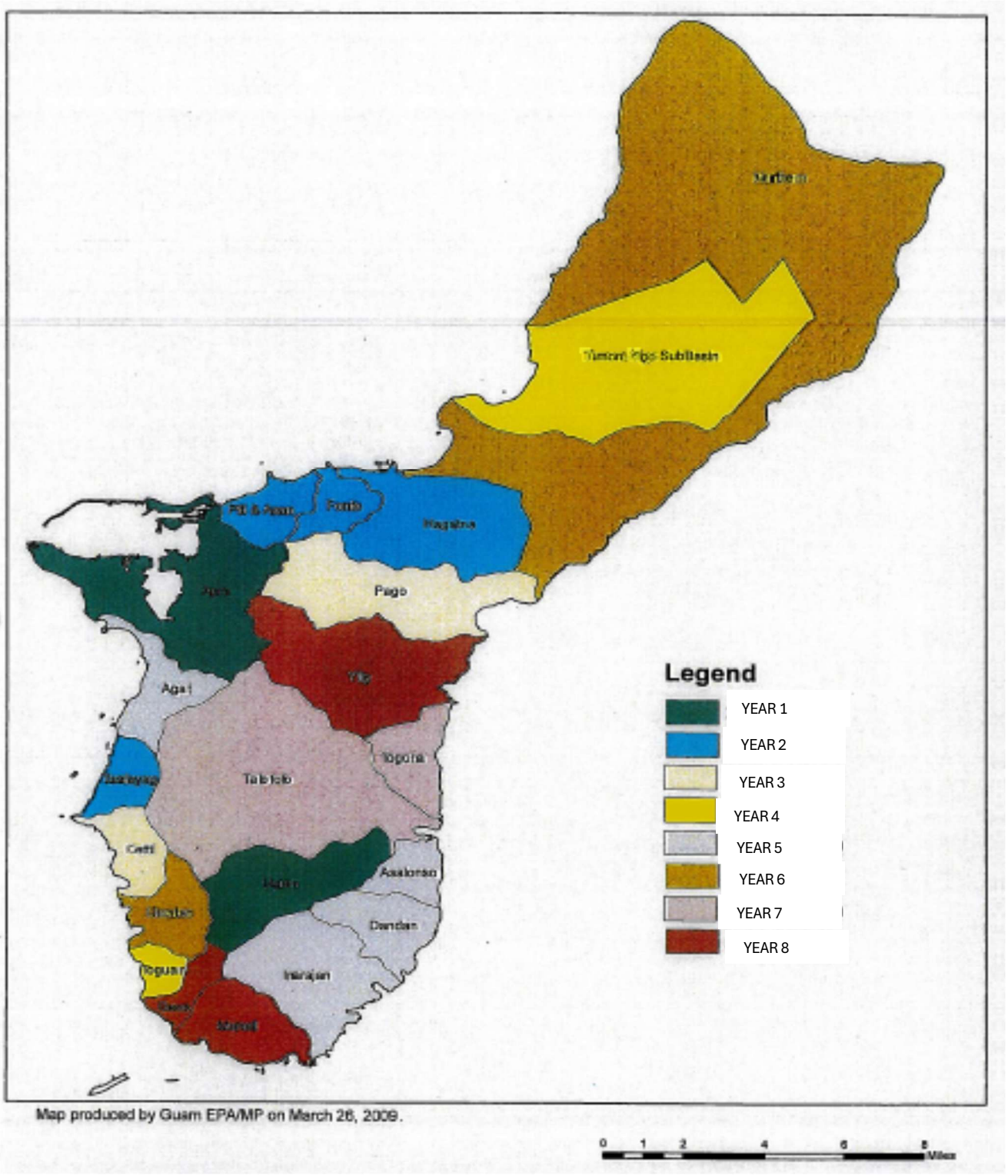


FIGURE 23. Guam EPA Status and Trends Program Rotating Watershed Schedule

3.1.1 *STMP Goals/Objectives*

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

The specific objectives of the STMP are to:

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

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

Designated uses assigned to STMP watershed monitoring stations are determined by each station's water classification, i.e. M-1, S-3, M-3, etc. (Refer to **Table 16**.)

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

3.2 Guam Environmental Monitoring and Assessment Program (GEMAP)

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

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

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

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

The sampling frequency for each resource type will be rotated every other year to achieve complete coverage of the island during the CWA Section 305(b) reporting cycle.[2] **Refer to Table 14.**

Table 14. GEMAP: 10-year Monitoring Schedule

Sample Year	Resource Type	# of Stations
Year 1	Marine Waters*	50
Year 2	Surface Waters*	38 (+ 10 repeats)
Year 3	Marine Waters	50 (10% 2005 repeats)
Year 4	Surface Waters	50 (10% repeats)
Year 5	Marine Waters	50 (10% repeats)
Year 6	Surface Waters	50 (10% repeats)
Year 7	Marine Waters	50 (10% repeats)
Year 8	Surface Waters	50 (10% repeats)
Year 9	Marine Waters	50 (10% repeats)
Year 10	Surface Waters	50 (10% repeats)

* EMAP Pilot Projects

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

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

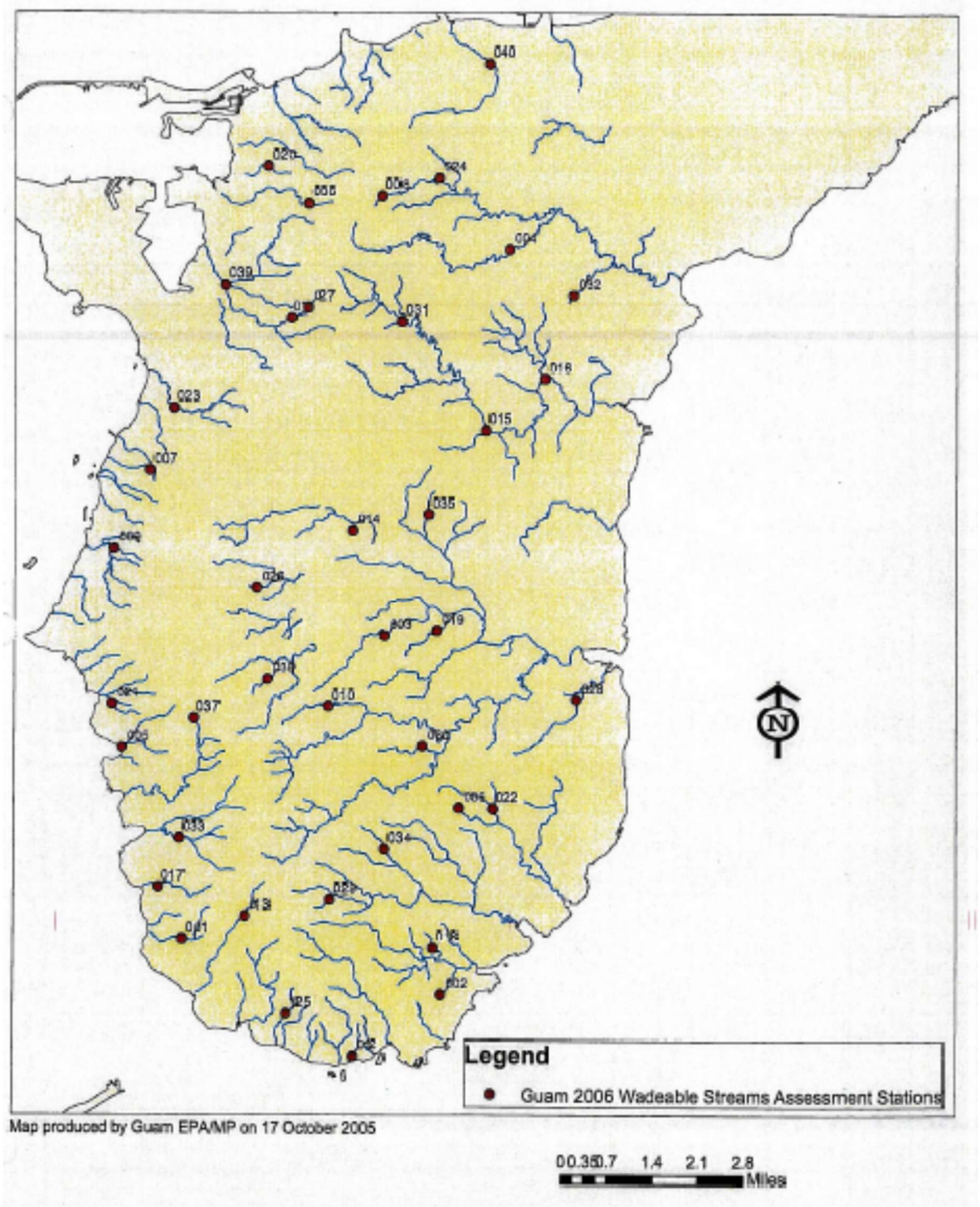


FIGURE 24. First Year Guam WSA Stations

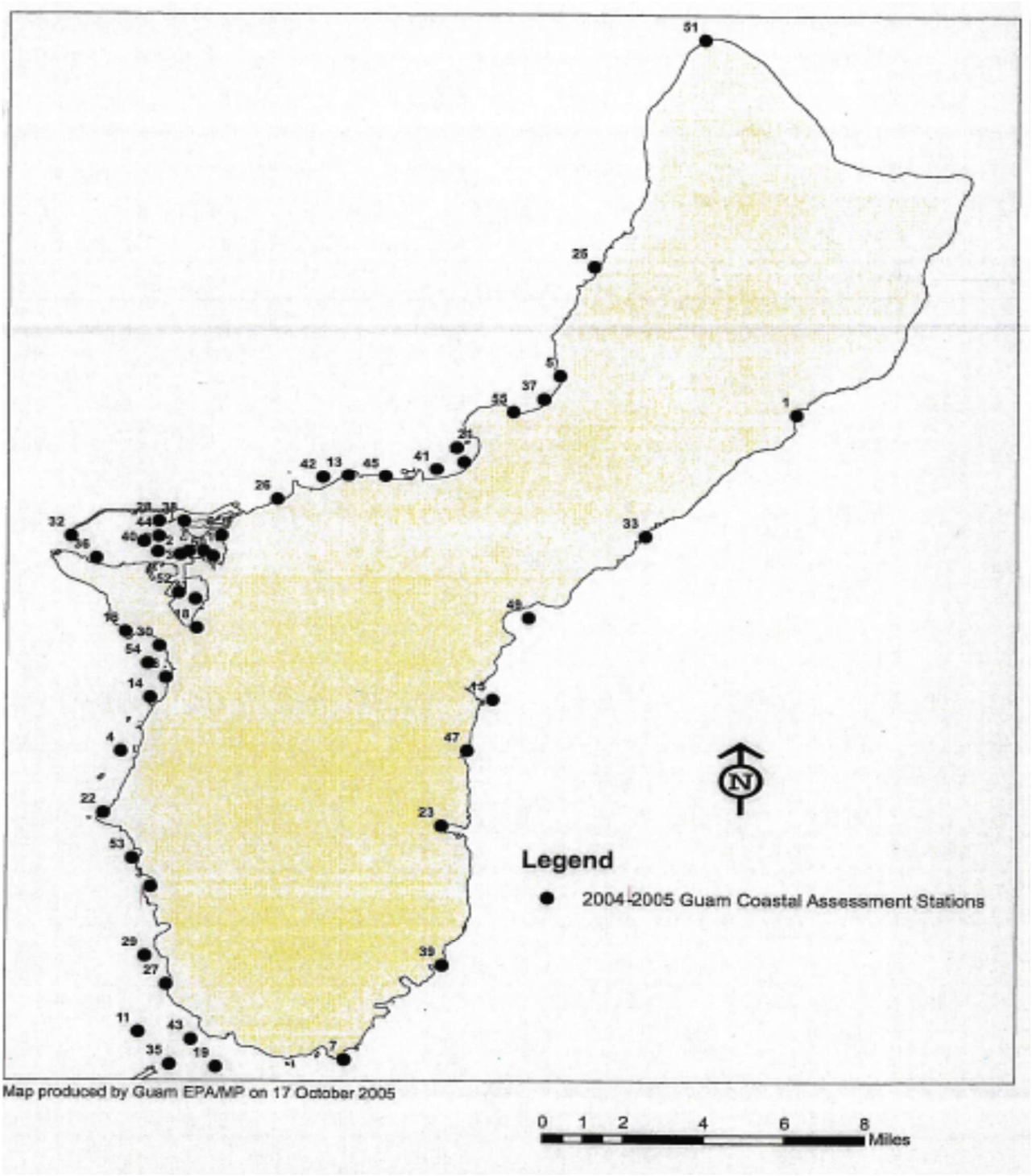


FIGURE 25. First Year Guam Coastal Assessment Stations

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

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

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

3.2.1 *GEMAP Goals*

The goals of GEMAP are:

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

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

3.2.2 *Guam Wadeable Stream Assessment (GWSA)*

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

Guam's 97 rivers and streams, totaling 228.65 miles, are located throughout the island's 19 central and southern watersheds. **(Figure 24.)**

The following is a general list of GEMAP Indicators. See **Appendix C.** for specific GCA and GWSA parameters.

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

3.2.3 *Guam Coastal Assessment (GCA)*

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

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

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

3.3 Recreational Beach Monitoring Program (RBMP)

Guam's subtropical climate allows for year-round recreation at all beaches, and fishing from both along the shoreline and offshore. The majority of this type of recreational activity occurs along stretches of sandy beaches or limestone plateaus easily accessible from shore. These waters are classified as "M-2 waters" or "Good" under the GWQS.

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

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

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

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

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

The designated use "Limited-body contact/secondary contact" means the recreational use of marine and surface water causes the human body to come into direct contact with the

water, but normally not to the point of complete submergence, i.e. wading or boating. It is not likely that ingestion of water will occur under this designated use, and sensitive body organs such as the eyes, ears, or nose will not normally be exposed to direct contact with the water.

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

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

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

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

In 2005, four new monitoring stations were added to bring the official total to 43. On May 19, 2005, station S1-Rizal Beach was officially dropped from the monitoring list because access was restricted. Two new monitoring stations in West Hagatna Beach, N-27 and N-28, were added in 2013. Monitoring station N-12 was suspended during the 2020 reporting period as its location in the nearby boat marina is a "no swimming" zone. The current number of active monitoring stations under the RBMP is forty-three (43). The number of beaches assessed by these 43 stations is thirty-one (31).

Data collected weekly from fixed sampling sites along selected stretches of coastline is used to advise the public against swimming in waters exceeding bacterial standards. Weekly press releases identify those beaches (where indicators in weekly water samples exceed water quality standards). All advisories are released and/or reported weekly, prior to the weekend, via print, radio, and television media to local government agencies, private individuals, and finally posted on the Guam EPA web site.

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

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

The annual prioritizing criteria are:

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

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

3.4 Wetlands Monitoring Program (WMP)[3]

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, a method for wetland biological assessment, and identify a funding source to support a sustainable Wetlands Monitoring Program.

[3] Suspended pending implementation of future wetlands EMAP.

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

3.5 Fish and Shellfish Contaminant Monitoring Program (FSCMP)[4]

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.

[4] Suspended pending inclusion to future EMAP efforts.

The partial parameter list for the FSCMP is:

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

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

3.5.2 *FSCMP Network Design and Rationale*

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

3.6 Marine Preserve Water Quality Assessment Program (MPWQAP)

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

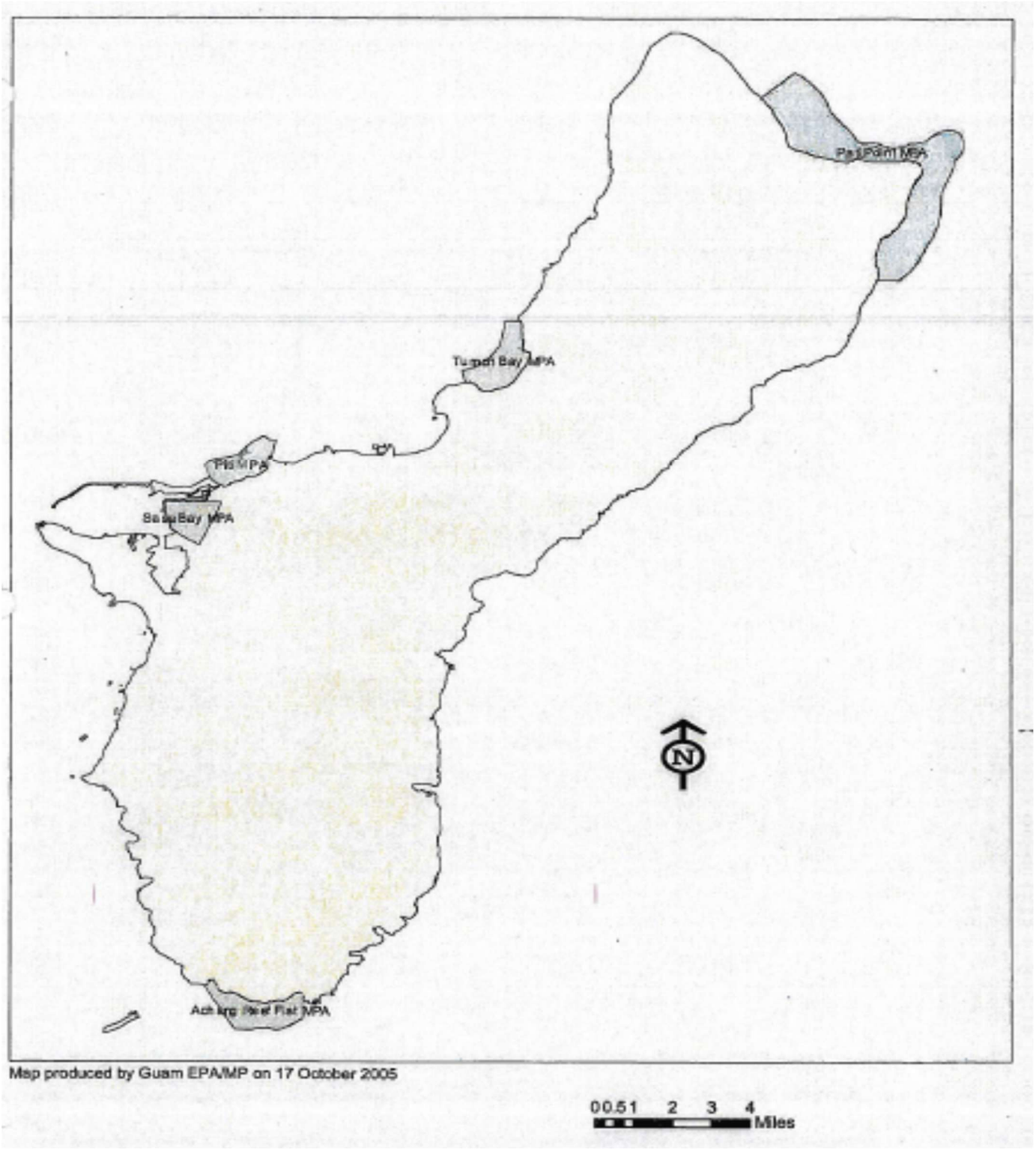


FIGURE 26. Water Quality Monitoring Stations at Marine Protected Areas (MPA)

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

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

Biologists at DAWR who monitor the preserves found that food fish density and diversity within the five established marine preserves has dramatically increased over those in the non-preserve areas. It was also identified that there was a lack of water quality data for all marine preserves. To address this data gap, DAWR coordinates with Guam EPA to assist with the collection of water quality data at all fish survey transect sites within the marine preserves as well as all non-preserve sites.[5] 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 15).** All monitoring stations will have GPS coordinates recorded.

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

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

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

nitrogen, Chlorophyll a and Pheophytin a, Ammonium, Total Nitrogen, Ortho-Phosphate, Total Dissolved Phosphorus, pH, Total Dissolved Solids, Total Suspended Solids and Dissolved Oxygen. All water quality samples will be analyzed by the Guam EPA Laboratory and adhere to all EPA and Guam EPA QA/QC requirements.

Table 15. Co-located Fish Transect and Water Quality Locations for MPWQA

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

Non-Preserve (Control) Sites			
Site	**Sampling Location**		**# of Samples**
Asan Bay	FRS	20-30 ft.	2
		40-50 ft.	2
	Shore	Rivers	1
Cocos Lagoon	Flat	Seagrass	1
		Coral/Rubble	1
		Channel	1
	Shore	Rivers	1
Cocos Fore Reef	FRS	20-30 ft.	2
		40-50 ft.	2
Pago Bay	Flat	Seagrass	1
		Coral/Rubble	1
	Shore	Rivers	1
Tumon Bay Control	FRS	20-30 ft.	3
		40-50 ft.	3
	Flat	Sand	3
		Coral/Rubble	3
		Coral	3
	Shore	Rivers	TBD[6]
Fouha Bay	FRS	20-30 ft.	1
		40-50 ft.	1
	Flat	Coral/Rubble	2
	Shore	Rivers	1
Double Reef	FRS	20-30 ft.	1
		40-50 ft.	1
Western Shoals	Harbor	20-30 ft.	1
		40-50 ft.	1
Facpi Point	FRS	20-30 ft.	1
		40-50 ft.	1
Total Samples:			**42**

For *in situ* water quality measurements using a Hach Data Sonde or similar product, stations with less than 2 meters depth readings will be recorded every 0.5 meters. Stations with greater than 2 meters, but less than 10 meters, depth readings will be recorded at 0.5 meters from the surface and 1 meter intervals until 0.5 meters from the bottom. Stations that have a depth greater than 10 meters but less than 20 meters will have a sampling profile of 0.5 meters from the surface and 1 meter intervals until 10 meters, then 5 meter interval until 0.5 meters from the bottom. Parameters that will be analyzed are Conductivity/Salinity, Depth, Dissolved Oxygen, pH, Temperature, Turbidity (NTU) and Transparency/clarity (Secchi Visibility).

[6] To Be Determined

3.7 Special Studies 2018-2019

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

3.7.1 2019 **NCCOS Assessment:** *Measurement of Turbidity and Nutrients in Three Rivers that Drain to the Achang Reef Flat from Manell Watershed, Guam, from 2016-12-01 to 2018-12-31* (NCEI Accession 0204837)[7] This dataset contains results from the monitoring of nutrients and turbidity in three rivers in the Manell watershed in southern Guam, which drain to the Achang Reef Flat Marine Preserve. The dataset contains a series of data tables and a data dictionary for the monitoring that occurred between December 2016 and December 2018. The dataset includes tables on nutrient monitoring, suspended sediment concentration (SSC), results from automated monitoring of stream levels, rainfall and turbidity, and a table of water quality measurements.

3.7.2 2019 ***Organic chemical contaminants measured by PED (polyethylene device) passive water samplers deployed at Cocos Island, Guam from 2017-09-18 to 2017-10-30*** (NCEI Accession 0184259)[8] The Cocos Island, Guam PEDs (polyethylene device) passive water sampler data set contains results of the analysis from Project 31181 funded by NOAA's Coral Reef Conservation Program. The project involved NOAA National Center for Coastal Ocean Science, Guam Environmental Protection Agency and the United States Environmental Protection Agency. The data resulted from the deployment of an array of PEDs passive water samplers in the waters around Cocos Island in Cocos Lagoon, Guam. Duplicate PEDs were deployed at 26 sites by NOAA and Guam EPA personnel in September 2017, and then retrieved one month later by Guam EPA personnel. At 22 sites, the PEDs were deployed in the water column along six transects on the northwest shore of Cocos Island; an additional PED was deployed in the water column along the southeast shore. At two sites (9-1 and 9-2), PEDs were embedded in the sand along the shore, with the remaining PED (4-3 #035) embedded in the sand underwater at site 4-3. The duplicate PEDs from each site were combined and analyzed as one sample, in an effort to increase the sensitivity of the analysis (lower detection limit). The PEDs were analyzed for a series of organic chemical contaminants including polychlorinated biphenyls (PCBs), organochlorine pesticides and petroleum hydrocarbons (PAHs), all of which are

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

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

contaminants of concern in the area. The polyethylene sheets comprising the PEDs at each site was analyzed, and the results are reported as nanograms of contaminant per each analysis, or ng/ea.

3.7.3 2019 Manell Watershed Report[9] The goal of this project, funded by NOAA's Coral Reef Conservation Program and requested by local partners, was to monitor water quality in three rivers that drain to the Achang Reef Flat Marine Preserve at the southern tip of Guam, in order to provide a baseline of conditions for environmental managers. The spatial and temporal variation of turbidity, suspended sediment concentration (SSC), and nutrients were determined at sites on the Ajayan, As Liyog, and Sumay rivers. Using Guam EPA water quality standards, SSC and turbidity in the rivers were generally classified as excellent to good, although occasionally the waters were ranked as fair, particularly on the As Liyog River during higher rainfall. Overall, nitrate was found to be in the excellent range, and orthophosphate generally in the good to fair range. There was some evidence that a number of the parameters showed decreasing trends in concentration during the project. Further monitoring would help determine if these decreases are real, which could be an indication of the benefits of the ongoing restoration activities in the watershed, evidence of natural revegetation subsequent to wildfires, or a combination of both. In any case, additional restoration efforts along with public education and outreach would be helpful to further reduce runoff to the rivers that drain to the Achang Reef Flat Marine Preserve.

3.7.4 Assessment of a Dynamic Watershed via Field Studies and GIS-Based Erosion Model[10] This paper presents a one-year-long study of the baseline hydrologic conditions of the Geus Watershed in the tropical island of Guam, through field observations. Data analyses show a strong correlation between stream level, turbidity, and rainfall within the watershed, suggesting a highly dynamic nature of Geus watershed. Field data were then used to create a stage discharge curve, which increases the efficiency of future watershed management by providing an estimate of stream flow from a simple measure of water level. The supplemental analyses based on the test results of soil samples and a GIS-based erosion model identified areas within the watershed with higher contributions to erosion potential. In addition, synthesis of the information in this watershed study will allow for future recommendations for effective and sustainable watershed management strategies, thereby opening a way for evaluating progress within the Geus watershed with continued monitoring.

3.7.5 Quarterly Reports to the Court, Guam Solid Waste Receiver Information Center (http://www.guamsolidwastereceiver.org/updates-done.shtml) Information in these

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

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

quarterly reports may include results and/or the status of activities related to water quality issues of concern at the (now closed) Ordot Dump and the new Layon Landfill.

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

4.0 Core and Supplemental Indicators

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

5.0 Quality Assurance Program and Quality Management Plans

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

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

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

The Guam EPA QA/QC officer ensures that proper containers are selected for sampling as well as the proper preservation and an adequate volume collected. Sample chain of custody procedures are strictly adhered to in order to ensure that sample integrity is maintained. An accurate record is needed to trace the possession of each sample from the

time of collection to analysis. Guam's quality management plans and quality assurance program/project plans are described in the following.

5.1 Quality Assurance (QA) Program

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

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

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

5.2 Quality Control (QC) Program

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

The Guam EPA laboratory uses the following QC assessment tools:

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

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

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

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

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

6.0 Data Management

Guam EPA continues efforts to upgrade its data storage and data sharing capabilities using funding from annual information exchange grants. Anticipated procurement of several computers and networking software, will enable the Agency to employ a system that will greatly enhance water quality assessment efforts at a local level. By using a standard database platform (i.e. Microsoft Access in conjunction with a Laboratory

Information Management system) users have the potential to import, process and export data in a variety of formats with relative ease. The planned networked database along with an assortment of file transfer processes should provide extremely powerful data sharing capabilities at the local, regional and national levels.

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

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

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

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

7.0 Data Analysis/Assessment

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

8.0 Reporting

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

9.0 Programmatic Evaluation

Guam EPA, in consultation with U.S. EPA Region 9, conducts periodic reviews of each aspect of its monitoring program to determine how well the program serves its water quality decision needs for all Guam waters, including all waterbody types. This involves evaluating the monitoring program to determine how well each of the elements is addressed and determining how needed changes and additions are incorporated into

future monitoring cycles. U.S. EPA Region 9 representatives conduct program reviews twice annually; and teleconferencing is scheduled between Guam program managers/staff and federal representatives as necessary.

10.0 General Support and Infrastructure Planning

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

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

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

B. Assessment Methodology

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

1.0 Guam's Water Classification System

Tables 16, 17, and 18 summarize respective information about Guam's water classification system and associated "Designated Uses" and "Use Support" criteria. This information

forms the basis of assessments, methodologies or determinations relative to the extent Guam waters or specific waterbodies achieve designated uses.

Table 16. Categories and Designated Uses Assigned to Guam Waters

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

2.0 Types of Assessment Information

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

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

3.0 Guidelines for Use Support Determination for Guam Waters

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

Guam EPA conducts weekly analysis of 43 marine recreational sites yearly. Advisories are released weekly based on Guam's bacteriological standards (adopted from the 2012 Recreational Water Quality Criteria, EPA – 820-F-12-061).

Table 17. 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 18. 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 17)**

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 19**.

3.2 Limited Contact Recreation

Microbiological criteria used to determine use support for waters designated for limited (secondary) contact recreation use (S3 and M3) are depicted in **Table 19**.

3.3 Shellfish Consumption from Shellfish Growing Area Use Support

Microbiological criteria used to determine use support for waters designated for shellfish growing area use (M1,M2,M3) and (S1,S2,S3) are depicted in **Table 20.**

4.0 Aquatic Life Use Support (ALUS)

Four data types are used for ALUS determination: habitat, toxicological, physical/chemical, and biological. Guam EPA generally conducts the physical/chemical methods (conventional) and toxicological methods during the effective reporting period. Habitat data and bioassessment data are generated by the DAWR, Department of Agriculture. Guam EPA collaborates with DAWR so that available habitat and bioassessment data is incorporated in the Agency's assessment and monitoring reports. Guam Waterworks Authority (GWA) also conducts limited toxicant methods (priority pollutants and metals) and limited conventional methods. Available data may similarly be incorporated in the Agency's assessment and monitoring reports. These data are of varying data quality levels; the Hierarchy of physical/chemical Data Levels for valuation of Aquatic Life Use Attainment (1997 305(b) EPA guidance) will be used to determine ALUS. The guideline for determining ALUS using more than one type of data is shown in **Table 21.**

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 22 and Table 23** describe the decision guidelines used for determining ALUS using Physical/Chemical Methods (conventionals data and toxicant data). The Guam WQS provide standards for these conventionals which are presented in **Table C6 in Appendix C**.

Table 19. Guidelines for Determining Whole Body Contact and Limited-Body Contact Recreation Use Support

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

Table 20. Guidelines for Determining Shellfish Growing Areas Use Support for Shellfish Consumption

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

Table 21. Determination of ALUS Using More Than One Data Type

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

6.0 Habitat Assessment

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

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

Federal guidelines for ALUS determination using habitat assessment data are provided in **Table 24.**

Table 22. Decision Guidelines for Conventionals[11] 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 23. Decision Guidelines for Toxicants[12] Used to Assess ALUS in Freshwater Rivers and in Marine Waters

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

7.0 Bioassessment

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

[11] 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.

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

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 25.**

Table 24. 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 25. ALUS Determination Based on Bioassessment Data

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

8.0 DAWR River Classification Procedures

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

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

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

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

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

9.0 Human Health Consumption

Waters designated for aquatic life on Guam and elsewhere in the United States, are also designated as protected for human consumption based on the premise that where there is aquatic life there is likely to be human consumption as well. For fresh waters that are designated for drinking water (S1), human consumption criteria **(Table 17, Column D1)** are calculated based on the possibility of people being exposed to contaminants by drinking the water and from eating aquatic organisms that have been living in the same water. For fresh waters not designated for drinking water (S2 and S3), and for marine waters, human consumption is based on the possibility of people eating aquatic organisms, only.

10.0 Drinking Water

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

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

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

The Assessment Framework on **Table 21** was cited from the federal guidelines and illustrates the classification, monitoring data, and use support restrictions evaluated to make use support decisions.

Table 26. Assessment Framework for Determining Degree of Drinking Water Use Support

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

C. Assessment Results

This section provides: (1) the results of Guam's marine and surface water assessments, including the categorization of water segments based on designated use support data, and (2) Guam's list of impaired and threatened waters in accordance with Section 303(d) of the CWA. The 2022-2024 Assessment Methodology narrative and monitoring data are available in **Appendix A**.

1.0 Five –Part Categorization of Marine and Surface Waters

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

Category 1: All designated uses are supported;

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

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

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

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

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

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

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

1.1 2022-2024 IR Data

Projects with useable data for the 2022-2024 IR are identified in **Appendix A**: ***Marine and Surface Water Monitoring and Assessment Methodology***.

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

2.0 Guam Rivers/Streams

Guam has an inventory of one hundred fifty-one (151) freshwater assessment units which represent two-hundred one (201) Guam rivers/streams and tributaries.

RIVERS/STREAMS: IR REPORTING CATEGORY	WATER SIZE (Miles)	ASSESSMENT UNIT COUNT
2: meets some designated uses but more Data is needed to make a use determination	25.20	18
3: not assessed	162.86	110
4a: impaired – TMDL Developed **Ugum River**	7.48	5
5: 303(d) listed - impaired waters	22.77	18
Total	**218.31**	**151**

2022-2024 303(d) LIST - IMPAIRED RIVERS AND STREAMS			
Assessment Unit ID	Waterbody Name	Size (miles)	Status
1. GUAGRA-3	Agana River 1	0.52	Fish Advisory
2. GUAGRA-2-1A	Agana River 2	0.67	Fish Advisory
3. GUPGRP-1-51-A	Pago River 1	0.06	>10% of samples exceed WQS
4. GUPGRP-2	Pago River 2	4.74	>10% of samples exceed WQS
5. GUAGRD	Storm Drain	0.21	>10% of samples exceed WQS
6. GUPGRL-2	Lonfit River 2	1.07	Consent Decree
7. GUPGRP-1-51B	Lonfit River 3	0.04	Consent Decree
8. GUMZRAJ	Ajayan River	3.95	>10% of samples exceed WQS
9. GUMZRL	Liyog River	1.83	>10% of samples exceed WQS
10. GUMZRSY	Sumay River	1.06	>10% of samples exceed WQS
11. GUINRAP-46B	Aslinget River 3	0.18	>10% of samples exceed WQS
12. GUMZRML	Manell River	2.77	>10% of samples exceed WQS
13. GUMZRT-2	Toguan River 1	0.20	>10% of samples exceed WQS
14. GUPGMPW	Pago River 4	0.52	>10% of samples exceed WQS
15. GUAGRF-2	Fonte River 1	1.16	>10% of samples exceed WQS
16. GUSURW	West Surface Drainage	0.36	>10% of samples exceed WQS
17. GU6TINAGO	Tinago River	2.93	>10% of samples exceed WQS
18. GUTURTG-1C	Togcha River 5	0.50	>10% of samples exceed WQS
Total		**22.77 miles**	

Of the eighteen (18) river waterbodies 303(d) listed as impaired (Category 5), ten were carried forward from the 2020 reporting cycle. Eight (8) new units were assessed as impaired during the 2022-2024 reporting cycle. The population of rivers/tributaries is based on River Identification Numbers in UOG Marine Lab Technical Report 75[13] .

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". **Recreational beach sizes (miles)** are delineated using best professional judgment based on accessibility and existing sandy shorelines. A**PPENDIX A** provides Individual Recreational Beach Use-Support Assessment information for the reporting period.

COASTAL WATERS: IR REPORTING CATEGORY	WATER SIZE (Miles)	ASSESSMENT UNIT COUNT
3: not assessed	26.80	68
4a: impaired and TMDL has been developed	16.65	45
5: impaired – **GabGab Beach**	0.65	1
Total	**44.1**	**114**

EPA approved Bacteria TMDLs have been developed for Guam's 45 RBMP sites (4a waterbodies) Gabgab Beach remains impaired because a Fish Consumption Advisory remains in effect for that waterbody.

3.2. Marine Bays

2022-2024 assessment data for Guam's 66 Marine Bays can be found in Appendix A.

MARINE BAYS: IR REPORTING CATEGORY	WATER SIZE (Square Miles)	ASSESSMENT UNIT COUNT
2 : meets some designated uses but more data is needed to make a use determination	7.31	8
3: not assessed	28.02	47
5: impaired	14.76	11
Total	**50.09**	**66**

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

2022-2024 303(d) LIST - IMPAIRED MARINE BAYS			
Assessment Unit ID	Waterbody Name	Size (square miles)	Status
1. GUG-010B-1	Agat Bay 1	0.63	Fish Advisory
2. GUG-010A	Tipalao Bay	0.10	Fish Advisory
3. GUG-008A-2	Apra Harbor 2	4.61	Fish Advisory
4. GUG-008A-1	Apra Harbor 1	0.05	Fish Advisory
5. GUG-042	North Orote Peninsula Sea Cliffs	0.23	Fish Advisory
6. GUG-043	South Orote Peninsula Sea Cliffs	0.02	Fish Advisory
7. GUG-20A-1	Cocos Lagoon 1	5.70	Fish Advisory
8. GUG-20A-2	Cocos Lagoon 2	0.34	Fish Advisory
9. GUG-003A	Pago Bay	0.70	>10% of samples exceed WQS
10. GUG-001B-2	Tanguisson Beach 2	0.40	Seafood Consumption Advisory
11. GUG-001C	Tumon Bay	1.98	Waters not Attaining Designated Uses
TOTAL:	**11 Impaired Waterbodies**	**14.76 square miles**	

4.0 Wetlands

The Agana Swamp, Guam's largest freshwater marsh, is impaired. 6.4 acres is subject to an on-going Fish Consumption Advisory because of PCBs in fish tissue. No assessment data is available for the remaining eighteen wetlands.

WETLANDS: IR REPORTING CATEGORY	WATER SIZE (Acres)	ASSESSMENT UNIT COUNT
3: not assessed	1789.04	18
5: impaired – **Agana Swamp**	6.40	1
Total	**1795.44**	**19**

5.0 Results of Probability-based Surveys

No results this reporting period.

6.0 Section 303(d) List

The Clean Water Act and EPA regulations require Guam to submit a list of water quality-limited (impaired and threatened) waters still requiring Total Maximum Daily Loads (TMDLs), the pollutants causing the impairment, and priority ranking for TMDL development. Guam's 303(d) list for 2022-2024 is in Appendix A.

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

The following criteria were used to identify waters as impaired:

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

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

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

TMDL Priority rankings were set based on the Guam EPA staff judgments concerning:

- The importance of uses to be made of the water;
- The magnitude of incidences observed;
- The fit of TMDL development work with other assessment, planning, or pollution control activities planned by the Agency; and
- The degree of public interest in or concern about the water body.

6.1 2022-2024 303(d) List (Appendix A)

Total Waterbodies: 31

Carried Forward from the 2020 303(d) List: 23
10 Rivers/Streams; 1 Recreational Water; 11 Marine Bays; 1 Wetland

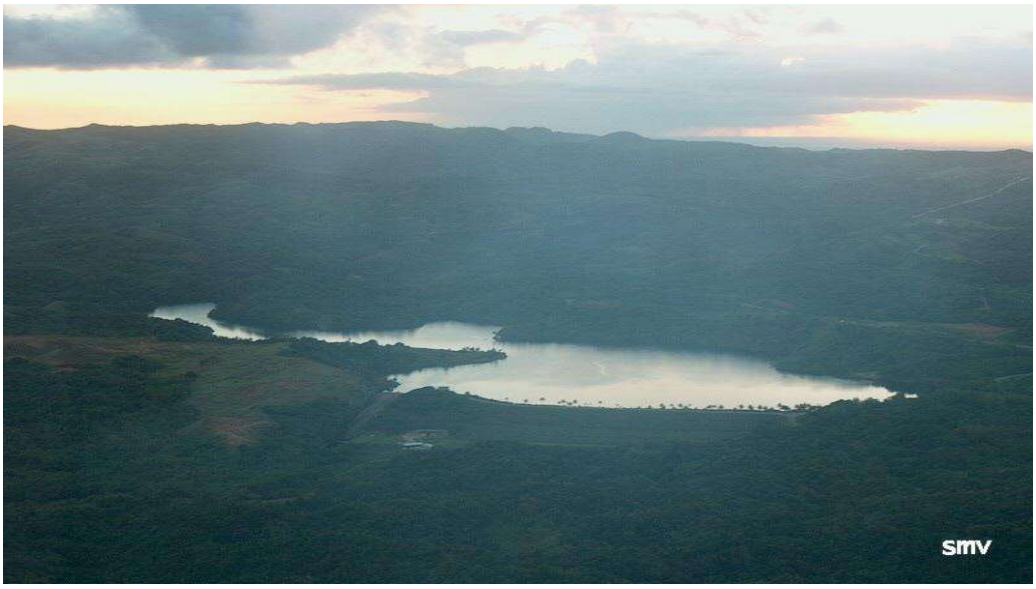
New 303(d) Listed Waterbodies: 8
8 Rivers/Streams

7.0 Clean Lakes Program

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

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 RESERVOIR, GUAM

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

D. Wetlands Program

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

1.0 Program Description

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

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

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

2.0 Wetlands Monitoring

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

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

3.0. Development of Wetland Water Quality Standards

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

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

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

4.0. Integrity of Wetland Resources

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

The attainment of uses generally, is another area lacking substantive investigation to date. The only observations and assumptions that might be offered are directly associated with known anthropogenic disturbances and impacts reported elsewhere. Assessments point to the fact that potential for accelerating erosion exists from activities such as poor construction practices, illegal and unimproved road development, including off-road activities, wild-land fires, unsustainable farming practices, and similar land disturbances.

5.0 Extent of Wetland Resources

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

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

6.0. Additional Wetland Activities

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

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

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

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

Guam's 2022-2024 305b inventory of waterbodies lists nineteen (19) wetlands described in a study funded by the U.S. FWS (Project FW-2R-28). These wetlands do not represent all of the wetlands on the island, rather they represent unique wetlands where moorhens regularly nested at the time of the study. Four of the nineteen sites contain mangroves and twelve are used by moorhens.

E. Trend Analysis for Surface Water

A three part document entitled *"Status and Trend Monitoring Program Surface Water Quality Assessment"*, November 2013, is a work in progress being compiled to provide an

inventory of surface water resources water quality data collected by Guam EPA. The assessment is organized to quickly access water quality and habitat condition information collected from freshwater and marine water sites. Each part provides information for a set of Guam watersheds, associated river reaches, marine waterbodies, and Guam EPA water quality monitoring sites or Guam EPA biological monitoring sites.

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

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

F. Public Health and Aquatic Life Concerns

1.0 Drinking Water Supplies

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

The major objectives are to ensure the public of a continuous supply of safe water for the prevention and control of drinking water pollution, and to obtain full compliance with the Safe Drinking Water Act and the Memorandum of Agreement between Guam EPA and U.S EPA.

1.1 U.S. Navy Water System -*Water Quality Report – January 1 to December 31, 2023*

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

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

Groundwater wells at Marine Corps Base Camp Blaz, Naval Computer Telecommunication Station (NCTS) Barrigada, and Naval Hospital further augment the Navy water system supplying these areas and supplementing the surface-water-fed areas. U.S. Navy Water System Wells NCS 2, NCS 5, NCS B1, NCS 6, NCS 7, NCS 9A, NCS 10, NCS 11, and NCS 12 are now under Marine Corps Base Camp Blaz real property jurisdiction.

The 2023 annual report contains information about the quality of the water supplied by the U.S. Navy Water System during the period of January 1 to December 31, 2023. Included as part of this report is the "2023 U.S. Navy Water Quality Data" table which present the 2023 water quality monitoring results of each detected contaminant in comparison with the established drinking water standards. The table also summarizes the monitoring times, the range of detections, whether or not the drinking water standards were met, the major sources of the contaminant, and the locations detected.

The report listed four violations and included specific notes addressing how mitigation measures and compliance with Safe Drinking Water regulations were undertaken in a timely manner.

2023 SPECIAL MONITORING FOR PER–AND POLYFLUOROALKYL SUBSTANCES (PFAS)
In June and September 2023, samples were collected from entry points in the distribution of the US Navy Water System. 5 of the 29 PFAS compounds covered by the sampling method were detected above the method reporting limit (MRL). The results were provided in the 2023 water quality report. There is no immediate cause for concern, but the Navy will continue to monitor the drinking water closely. For regulated PFAS above the new MCL (Maximum Contaminant Level) and in accordance with DoD policy, Navy is coordinating with DoD to plan and program operational controls or additional treatment to ensure the drinking water meets the MCLs as soon as practicable at all impacted installations.

1.2 Air Force Water System[14]

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

In 2023, the Andersen Air Force Base Water System met all primary drinking water quality standards. No violation of any Maximum Contaminant Level, Secondary Maximum Contaminant Level, or any other water quality standards was reported. All safe drinking water reports, along with supporting laboratory reports were submitted on time as required by Guam EPA.

PFAS MONITORING. In September 2023, Anderson Air Force Base collected samples from entry points in its distribution system. 2 of the 29 PFAS compounds covered by the sampling method were detected above the MRL. The results were provided in the 2023 water quality report. Like the Navy, Anderson Air Force Base will continue to monitor its drinking water closely and act in accordance with MCLs for regulated PFAS exceeding criteria and DoD policy.

[14] 2023 Annual Drinking Water Quality Report. Department of the Air Force

1.3 GWA Water System

Sources of Drinking Water. 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 120 wells. Surface sources used by GWA include an intake from the Ugum River and water purchased from the Navy's Fena system. Spring water from Santa Rita is used to supplement the water supply from Fena for the villages of Asan, Piti, Anigua, Agat, Santa Rita and some areas of Barrigada and Mongmong-Toto-Maite.

1.3.1 GWA Water System Quality Reports[15]

Water quality data for January 1 to December 31, 2023 (and prior years) is available on GWA's web site. ***During the reporting period 2022-2024,*** GWA monitored Guam's drinking water for all regulated contaminants and unregulated constituents as it leaves our drinking water sources and enters the distribution system. Contaminants measured include: Microbial contaminants, inorganic contaminants, pesticides and herbicide contaminants, organic chemical contaminants, and radioactive contaminants. Results show that the water provided by GWA meets the MCLs established for the regulated contaminants, as required by the Guam Primary and Secondary Safe Drinking Water Regulations and the Federal Safe Drinking Water Act.

2.0 Beach Use

Recreational Swimming Notifications

Guam EPA and the Department of Public Health and Social Services have joint authority regarding the closure of public beaches. 62 beach closures were recorded both in year 2020 and year 2021; 31 beach closures were recorded in year 2022 and 217 beach closures during year 2023. All closures were attributed to rainfall advisories/storm conditions except in year 2020 where beach closure was precautionary to COVID-19 conditions.

For reporting years 2020-2021, 44 Tier 1 beaches were monitored for the U.S. EPA approved *enterococci* indicator, (weekly, year-round). This resulted in approximately 1,621 and 2,107 water samples analyzed in 2020 and 2021, respectively. Recorded swimming advisories issued: 338 – year 2020; 472 – year 2021.

In reporting years 2022-2023, the same 44 Tier 1 beaches were monitored for the U.S. EPA approved *enterococci* indicator (weekly, year-round). This resulted in approximately 2,106 and 2,166 water samples analyzed in 2022 and 2023, respectively. Recorded swimming advisories issued: 431 – year 2022; 701 – year 2023.

[15] 2020 - 2023 GWA Water Quality Reports

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

3.0 Consumption Concerns

3.1 Seaweed Consumption Advisories

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

3.2 Fish/Shellfish Consumption

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

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

3.2.1 *Orote Peninsula*

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

2009 Reef Fish Sampling[16] *and Updates*

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

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

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

*Update: "*Another round of fish sampling proposes to sample the same types or near-shore territorial fish sampled in 2001 and 2009 at the same nine (9) general locations between Orote Point and Rizal Beach. The fish will be collected by UOG Marine Lab scientific divers using spears. UOG will also perform a fish age study by viewing the fish otolith (ear bone) specimens. The fish will then be shipped to chemistry laboratory to measure the concentrations of chemicals present in the fish tissue. Risks to people and wildlife will be estimated using the 2014 chemical data measure in fish tissue following current Navy and EPA risk assessment procedures. The results of the 2014 fish sampling activities and risk assessments are expected in the winter of 2014/2015."
The objectives are to:

- Determine whether the risk of consuming reef fish caught from the Seafood Consumption Advisory area changed since 2009;
- Determine whether recommending changes to the Seafood Consumption Advisory area is appropriate.

(Minutes, 6/4/2014 RAB Meeting)

Apra Harbor Remedial Investigation[17]
Site Location: Apra Harbor is the only deep-water harbor on the island of Guam and is the primary berthing facility on the island. Apra Harbor is generally divided into two parts: Outer Apra Harbor supports Navy, commercial, and recreational activities, and Inner Apra Harbor, where Naval Base Guam is located.

Site Background: Previous studies have indicated elevated levels of heavy metals and polychlorinated biphenyls (PCBs) in Apra Harbor sediment and marine life. Multiple Navy studies of dredged material sampling have also indicated the presence of chemicals in Inner Apra Harbor sediment.

Most Guam-based operations for the Department of the Navy (DON) occur on the land surrounding Apra Harbor. Current and historical facilities on the land surrounding Apra Harbor include the following potential sources:

- Ship Repair Facility

[17] Fact Sheet No. 01, February 2014. Draft Remedial Investigation Work Plan: Apra Harbor Sediment Operable Units Naval Base Guam

- Navy Public Works Center
- Guam Naval Complex
- Multiple fuel tank farms

Potential non-point sources of chemicals in harbor sediments include runoff of pesticide, residues and emissions from automotive vehicles, and general urbanization. Transport pathways that could potentially carry chemicals from land-based sites to Apra Harbor sediments include storm drains, runoff, and rivers and streams.

In-water operations that could potentially impact harbor sediments include dry dock activities, vessel cleaning and painting, accidental releases of fuel or solvent, and harbor dredging.

3.2.2 *Agana Swamp*

The Fish Advisory in effect for the Agana Swamp is related to polychlorinated biphenyl (PCB) contamination from the Agana Power Plant (former U.S. Navy facility). The US Navy conducted an investigation and cleanup of the Agana Power Plant located in Mongmong, Guam. This included the removal of PCB contaminated soil from the upland facility as well as the off-site contaminated areas. Off-site contamination was found in storm water drainage areas, storm water outfall areas and associated slope leading into the Agana Swamp, and in the sediments of the Agana Swamp. A fish tissue investigation was conducted. Also during that time the U.S. military conducted tests to try and identify PCB sources to the Agana Swamp and river not related to the Agana Power Plant. That study identified Agana Springs as a possible PCB source.

The U.S. Navy, with environmental oversight from Guam EPA and USEPA via the BRAC process, removed all PCB contaminated soil and sediment associated with the Agana Power Plant activities. Based on the analysis of the fish tissue investigation, it was determined that a fish advisory should be implemented for the Agana Swamp in 2001 and that advisory remains in effect. A testing conducted by the Navy in October 2006 revealed that some of the fish in the swamp and river are now testing higher for PCBs than back in 2000. Between 2008 and 2011 the following related activities are recorded: Guam EPA requested funding and technical assistance (from EPA) to help characterize the extent of PCB contamination of Agana Swamp; site assessment and sampling reports submitted by contractor to EPA (Agana Springs pond sediment and soil sampling). As of January 2012, EPA filed action memo requesting for continuing removal action at the site.

3.2.3. *Cocos Lagoon*

In 2005 a fish advisory was issued after numerous fish samples tested positive for harmful PCBs. The fish consumption advisory remains in effect for fish caught in the Cocos Lagoon. Public Health epidemiologist Dr. Robert Haddock noted that theoretically there is some statistical risk of developing cancer, but probably very small. It would only occur

in people that ate a lot of fish every week from this area. Officials did not feel there was enough information to close Cocos Lagoon to fishing as additional studies would be conducted to narrow down the geographic range that may be contaminated.

2006 Investigation: An environmental site investigation was conducted at the former U.S. Coast Guard (USCG) Long Range Navigation (LORAN) station at Cocos Island, Guam.[18] 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 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

[18] *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.

diesel contamination, particularly in the area to the west southwest of Piezometer # 10 and #14 installed during this investigation.

2014 Follow-on Investigation:[19] This investigation included assessment of soil, ground water and biota in the vicinity of the site. This investigation was conducted by Element Environmental LLC (E2) as a continuation of ongoing post-remediation monitoring subsequent to remediation conducted by Unitek Environmental Guam in 2007.

Field work for this project was conducted between January 20 and January 23, 2014. Major tasks performed during this project included collection and analysis of subsurface soil and groundwater samples from the vicinity of the former LORAN Power Transmitter Building and collection and analysis of biota samples from the Cocos Lagoon fronting the 2007 remediation area.

The primary objective of this project was to further characterize and monitor petroleum contamination in soil and groundwater in the vicinity of the former LORAN Transmitter Building and to capture and test biota samples to continue the periodic, post-remediation monitoring. The results of soil and groundwater testing will be used to determine the extent of petroleum contamination and if additional characterization and remediation with regard to the former LORAN Cocos Island facilities is necessary to protect human health and the environment. The results of the additional biota testing will be used, in conjunction with former biota testing results, to possibly update the current fishing restriction area within the Cocos Lagoon.

The following recommendations were provided in the report.
TPH in Site Soils and Groundwater: Results of this investigation indicate that TPH concentrations in subsurface soil and groundwater are lower than those detected during the 2008, 2010 and 2012 investigations. The volume of petroleum-impacted soil containing concentrations of TPH of 100 ppm or greater was estimated to be approximately 3,500 cubic yards, during the 2012 investigation. This estimate remains the same based on the results of the 2014 investigation. It is recommended that periodic monitoring (every five years) of trace TPH levels in the groundwater and soil continue in order to monitor natural attenuation and migration of TPH.
PCBs in The Remnant Sewer Pipeline: Analytical results did not indicate significant PCB concentrations present in the coating on the remnant steel former sewer pipeline. No further action is recommended with regard to the former pipeline.
PCBs in Biota Specimens: Results of this investigation indicate that PCB concentrations in Biota continue to trend downward. It is recommended that biota specimens be collected periodically (every five years) from the near-shore area of the lagoon, adjacent to the

[19] *Final Report, Follow-on Environmental Site Investigation, Former LORAN Station Cocos Island, Cocos Island, Guam.* Prepared by Element Environmental, LLC for the USCG under Contract No. HSCG86-14-N-PXA003.

former LORAN site (Area 1) and off shore of the former LORAN station (Area 2) in order to monitor post-cleanup PCB concentrations in biota.

2015 Study.[20] As part of the NOAA Coral Reef Conservation Program (CRCP) jurisdictional priority gathering, local agencies in Guam identified Cocos Lagoon as an area potentially impacted by land-based sources of pollution. The US Coast Guard operated a Long Range Navigation (LORAN) station on Cocos Island at the southern end of Cocos Lagoon from 1944 to 1963. Disposal of materials from the operation of the station are suspected of resulting in chemical contamination of the island and surrounding waters.

To help address this, this NCCOS (National Centers for Coastal Ocean Science) research project collected sediment samples (25 total) and samples of eight species of fish (27 total) representative of those that are locally eaten. Fish were collected using a cast net or hook and line. Sediment and fish tissue (whole fish) samples were analyzed for approximately 190 chemical contaminants, including 83 PCBs, petroleum hydrocarbons, heavy metals, and several pesticides such as DDT (dichlorodiphenyltrichloethane).

What NCCOS Found. ***Sediments***. Concentrations of chemical contaminants in sediments were low. One sediment sample near Cocos Island slightly exceeded a sediment quality guideline established by NOAA for the banned pesticide DDT. The sediments that occur throughout most of Cocos Lagoon consist of sand and coral gravel, which do not readily accumulate organic chemical contaminants.
Fish. Concentrations of total PCBs (sum of the 83 PCBs measured) were above EPA SV for some of the fish caught in Cocos Lagoon. Total PCB concentrations were above the EPA recreational SV in five species (banded sergeant, blackspot sergeant, convict tang, honeycomb grouper, and orange-striped emperor) from around Cocos Island. No fish from other locations in the lagoon were above the recreational PCB screening values. Four honeycomb groupers caught in other parts of Cocos Lagoon were above the subsistence SV. DDT was found at concentrations above the recreational fisher SV for two fish species, and above the subsistence SV for four other species around Cocos Island. No fish from any other areas of Cocos Lagoon were above either SV for DDT. No other chemical contaminants analyzed for this project were above available EPA SV.

Next Steps. NOAA will continue data analysis, working with Guam EPA, the EPA, and the USCG. EPA has indicated that it will conduct further human health risk assessments using the NOAA data. A technical memorandum on the results from the collection and analysis of sediments and fish became available in late 2017 and can be found here: https://repository.library.noaa.gov/view/noaa/17261.

[20] Hartwell, S. Ian ; Apeti, Dennis A. ; Pait, Anthony S. ; Mason, Andrew L. ; Robinson, Char'mane ; An analysis of chemical contaminants in sediments and fish from Cocos Lagoon, Guam. Published 2017. NOAA Technical Memorandum NOS NCCOS; 235.

3.3 Consumption Recommendations

Seafood including fish, shellfish, algae, or sea grapes caught in the above referenced areas, may contain PCBs, chlorinated pesticides, or dioxins at levels that are not safe to eat. The Agency for Toxic Substances & Disease Registry (ATSDR) advises choosing younger, smaller fish and other seafood to reduce exposure to contaminants whenever possible. Residents are also encouraged to remove skin, internal organs, and fatty tissue in the belly and along the side of seafood to reduce potential exposure to chemicals.