Total Maximum Daily Loads for Coastal Waters Impaired by Bacteria on Saipan

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ACRONYMS AND ABBREVIATIONS

ACOR	Alternate Contract Officer Representative
BECQ	Bureau of Environmental and Coastal Quality
BMP	Best Management Practice
CAFO	Confined Animal Feeding Operations
CALM	Consolidated Assessment and Listing Methodology
CCAP	Coastal Change Analyses Program
CNMI	Commonwealth of the Northern Mariana Islands
CWA	Clean Water Act
DEM	Digital Elevation Model
EMC	Event-Mean Concentration
GIS	Geographic Information System
IP	Implementation Plan
IWDS	Individual Wastewater Disposal Systems
LA	Load Allocation
LDC	Load Duration Curve
LiDAR	Light Detecting and Ranging
LSPC	Loading Simulation Program - C++
MPA	Marine Protected Area
MS4	Municipal Separate Storm Sewer System
NCDC	National Climatic Data Center
NHDPlus	National Hydrography Dataset Plus
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint Source
PCS	EPAs Permit and Compliance System
STORET	EPAs Storage and Retrieval System
STV	Statistical Threshold Value
TMDL	Total Maximum Daily Load
USDA	United States Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USFS	United States Forest Service
USGS	U.S. Geological Survey
WLA	Waste Load Allocation
WQS	Water Quality Standards
WWTP	Wastewater Treatment Plant

1 DESCRIPTION OF WATERBODY, POLLUTANT OF CONCERN, POLLUTANT SOURCES, AND PRIORITY RANKING

Saipan is the capital of the Commonwealth of the Northern Mariana Islands (CNMI), a group of fifteen islands in the northwestern Pacific Ocean. These islands reside on the still volcanically active Mariana Ridge and the present composition and terraced structure of the southern islands in CNMI is the result of limestone reef deposition, geologic uplifting, and sea level shifts. The total population of CNMI is 53,883 and contains a total of 182.9 square miles of surface area (US Census 2010). CNMI contains 73.4 miles of streams and 235.3 miles of coastline (BECQ 2016).

Saipan, the capital of CNMI, is the largest and most populated of the islands, with 48,220 inhabitants (US Census 2010). Saipan has five Marine Protected Areas (MPAs) including Bird Island Marine Sanctuary (Segment 12), Lau Lau Bay Sea Cucumber Sanctuary (Segments 14, 15, and 16) and the Lighthouse Reef Trochus Sanctuary (Segment 18A).

A Total Maximum Daily Load (TMDL) is a calculation of the maximum amount of a pollutant allowed to enter a waterbody such that the waterbody continues to meet water quality standards for that pollutant. A TMDL also determines pollutant reduction targets and allocates those reductions necessary to meet that target. Pollutant sources can be classified as either point sources that receive a wasteload allocation (WLA) or nonpoint sources that receive a load allocation (LA). Point sources are subject to regulation under the National Pollutant Discharge Elimination System (NPDES) and may include wastewater treatment facilities, concentrated animal feeding operations (CAFOs), landfills, etc. Waterbodies that require TMDLs are listed on the US Environmental Protection Agency's (USEPA) 303(d) list for impaired waters in accordance with the Clean Water Act. US states and territories determine whether a waterbody meets water quality standards by evaluating water quality data and "all existing and readily available information" about that waterbody (40 C.F.R. §130.7(b) (5)).

This TMDL document details probable sources of pollution and the degree to which pollutant sources need to be reduced to meet water quality standards. Further, it identifies source control practices that could reduce pollutant loadings, and describes the range of pollutant reductions that can be achieved from the practices. Saipan's impaired coastlines and lake include contamination caused by both *Enterococcus* bacteria and fecal coliform bacteria. No previous TMDLs have been developed for Saipan, although integrated monitoring reports date back to 1998, with the most recent reports published in 2014 and 2016. TMDLs have been completed for the nearby islands of Guam and American Samoa.

1.1 Classification of Marine Water and Surface Water Uses

Water Quality Standards (WQS) require designated uses that specify the goals and expectations for how each waterbody is used. WQS also require the development of criteria protective of each designated use. Examples of designated uses include swimming, recreation, public water supply, and/or aquatic life. In simple terms, if the WQS are being met, the designated uses for that waterbody are also being met.

There are two classes of marine water uses designated for the CNMI in the WQS: Class AA and Class A (BECQ 2014). Class AA waters should remain in their natural pristine state as much as possible with minimal pollution or alteration of water quality from human-related activity. Designated uses protected in these waters include: support and propagation of marine life, conservation of coral reefs and wilderness areas, oceanographic research, and aesthetic enjoyment and compatible recreation inclusive of whole body contact (i.e. swimming, snorkeling). All coastal and oceanic waters surrounding Saipan are designated Class AA except for those Class A "industrial" areas containing the seaport, marinas, Lower Base wastewater treatment plant outfall, and Agingan Point municipal wastewater treatment plant outfall (BECQ 2014a). Class A waters are also found surrounding Tinian, Aguigan, and Rota: San Jose Harbor for Tinian and Aguigan, and East Harbor and West Harbor for Rota Island. Waters up to 3,000 feet from the mean high-water mark on the shoreline from the entrance to Smiling Cove Marina to Saddok As Agatan, as well as waters surrounding the Agingan Wastewater Treatment Plant within a 1,000-foot radius of the outfall are designated Class A. Designated uses for Class A waters are recreational use in/on the water with limited body contact and aesthetic enjoyment, as well as protection and propagation of marine life and wildlife.

All freshwater surface waters on Saipan are designated as Class 1, meaning all fresh surface waters in the CNMI should remain in a pristine state with an absolute minimum exposure to pollution or alteration of water quality from any human related source. The Consolidated Assessment and Listing Methodology (CALM) was also used in CNMI Integrated Reports as described in the 2005 USEPA Guidance for 2006 Assessment, Listing and Reporting Requirements Pursuant to Sections 303(d), 305(b) and 314 of the CWA, and in the recent 2016 USEPA Memorandum from USEPA containing information concerning 2016 Clean Water Act Sections 303(d), 305(b) and 314 Integrated Reporting and Listing Decisions. Each water body type was assigned a CALM category based on designated classes and descriptions for each category. These categories help determine the extent that waterbodies are attaining WQS, to characterize waters that are impaired through a ranking system, and to give prioritization to those that are least supporting designated uses. The CALM categorization process is iterative and has involved many different work groups of federal and state staff with the goal of assessing each designated use for attainment. The designated CALM category, after this analysis, is derived as a culmination of the attainment or impairment of each use designation. All impaired segments (including Lake Susupe) received a CALM assessment category of 5, except Segment 14, Kagman, which received a category of 3. A CALM assessment category of 5 means there is at least one designated use that is not being supported or is threatened and a TMDL is needed, while a category of 3 means there is insufficient data and/or information to make a use support determination. **Table 1-1** summarizes the impairments by Saipan segment from the 2014 303(d) list of impaired waterbodies.

1.2 Description of Waterbodies and Background Information

Saipan, the capital of CNMI, is the largest and most populated of the islands, with 48,220 inhabitants (US Census 2010). Saipan has five Marine Protected Areas (MPAs) including Bird Island Marine Sanctuary (Segment 12), Lau Lau Bay Sea Cucumber Sanctuary (Segments 14, 15, and 16) and the Lighthouse Reef Trochus Sanctuary (Segment 18A). MPAs are an important consideration in TMDL development, as they are also federally regulated and must be prioritized based on water quality impacts, designated uses, and intent to preserve marine resources and ecosystems. A total of 30.6 miles of impaired coastal land exists in Saipan (BECQ 2016) with 10 coastal segments and 1 lake listed as impaired on the USEPA 303(d) list of impaired waterbodies (**Figure 1-1**). Each coastal segment contains an offshore Marine Assessment Unit as well (marine assessment units were not included for non-listed segments). Saipan has one lake, Lake Susupe, several dispersed wetland regions, and intermittent and ephemeral streams which flow during rainfall events. Most of the stream beds are used for hiking and training by recreational and professional athletes who visit the island, and in some instances as secondary roads. Currently, most of the coastal waters surrounding the island of Saipan do not fully support all designated uses.

When developing TMDLs and accounting for various land-based sources, the land use composition of the watersheds contributing to the assessment units is reviewed and summarized. Saipan is the most populated island of CNMI, and yet has only 20% impervious or developed lands. Forested lands cover the greatest area (61% of the island). Shrubland and grassland cover 8% and 6% of the island, respectively. **Figure 1-2** highlights the listed watershed segments and land use distribution in each watershed. Land cover in Saipan varies by watershed, although forested land is the dominant land cover across all watersheds. Land cover was derived from the National Oceanic and Atmospheric Association (NOAA) Office for Coastal Management's 2005 Coastal Change Analyses Program (CCAP) and is depicted in **Figure 1-3** for watersheds that contain 303(d) listed shorelines.

Table 1-1. Summary of 303(d) segments with bacteria impairments.

Segment	Watershed	Class	Reason for Designation
12	Kalabera	AA	Support for propagation of fish, recreation
13	Talofofo	AA	Support for propagation of fish, recreation
14	Kagman	AA	Support for propagation of fish, recreation
15	Lao Lao	AA	Support for propagation of fish, recreation
17A	Isley West	A	Municipal wastewater outfall
17B	Isley East	AA	Support for propagation of fish, recreation
18A	Susupe North	AA	Support for propagation of fish, recreation
18B	Susupe South	A	Municipal wastewater outfall
19A	W. Takpochau North	A	Commercial port, Municipal wastewater outfall
19B	W. Takpochau Central	AA	Support for propagation of fish, recreation
19C	W. Takpochau South	AA	Support for propagation of fish, recreation
20A	Achugao North	AA	Support for propagation of fish, recreation
20B	Achugao South	AA	Support for propagation of fish, recreation
22	Banaderu	AA	Support for propagation of fish, recreation
18LAK	Lake Susupe	Class 1	Support for propagation of fish, recreation

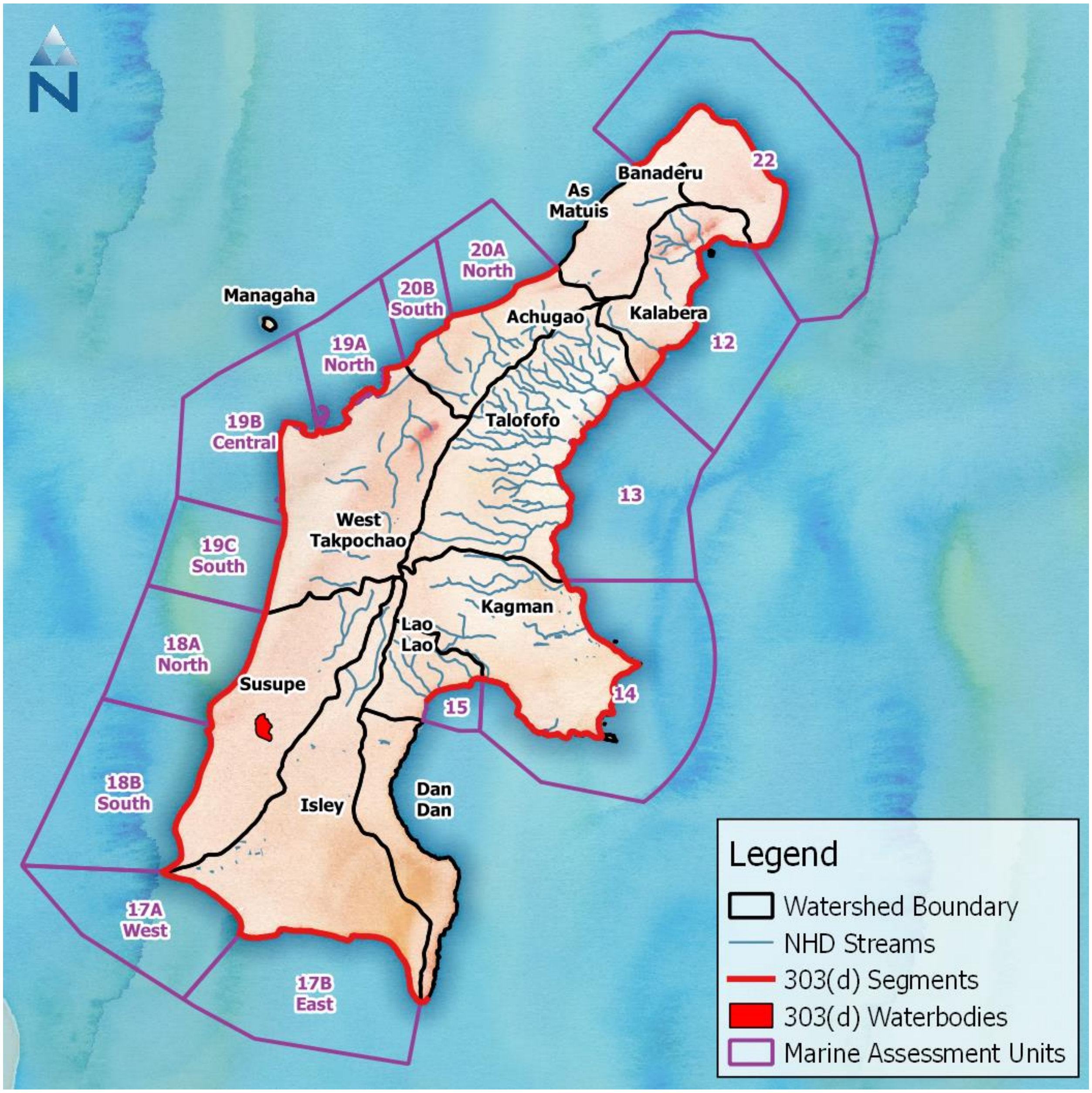

Figure 1-1. Map of Saipan showing 303(d) listed waterbodies and contributing drainage areas.

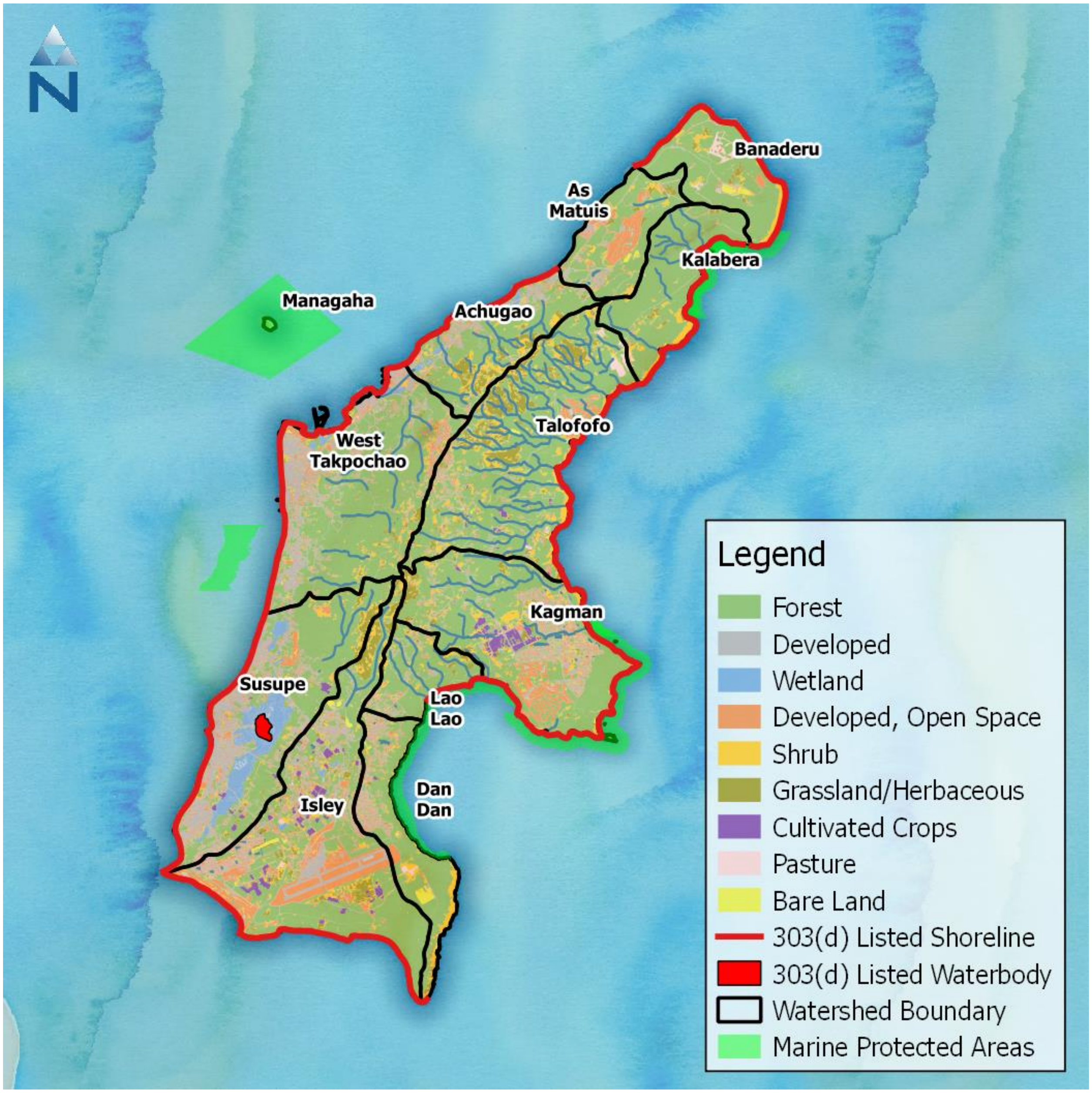

Figure 1-2. Map of Saipan Land Uses.

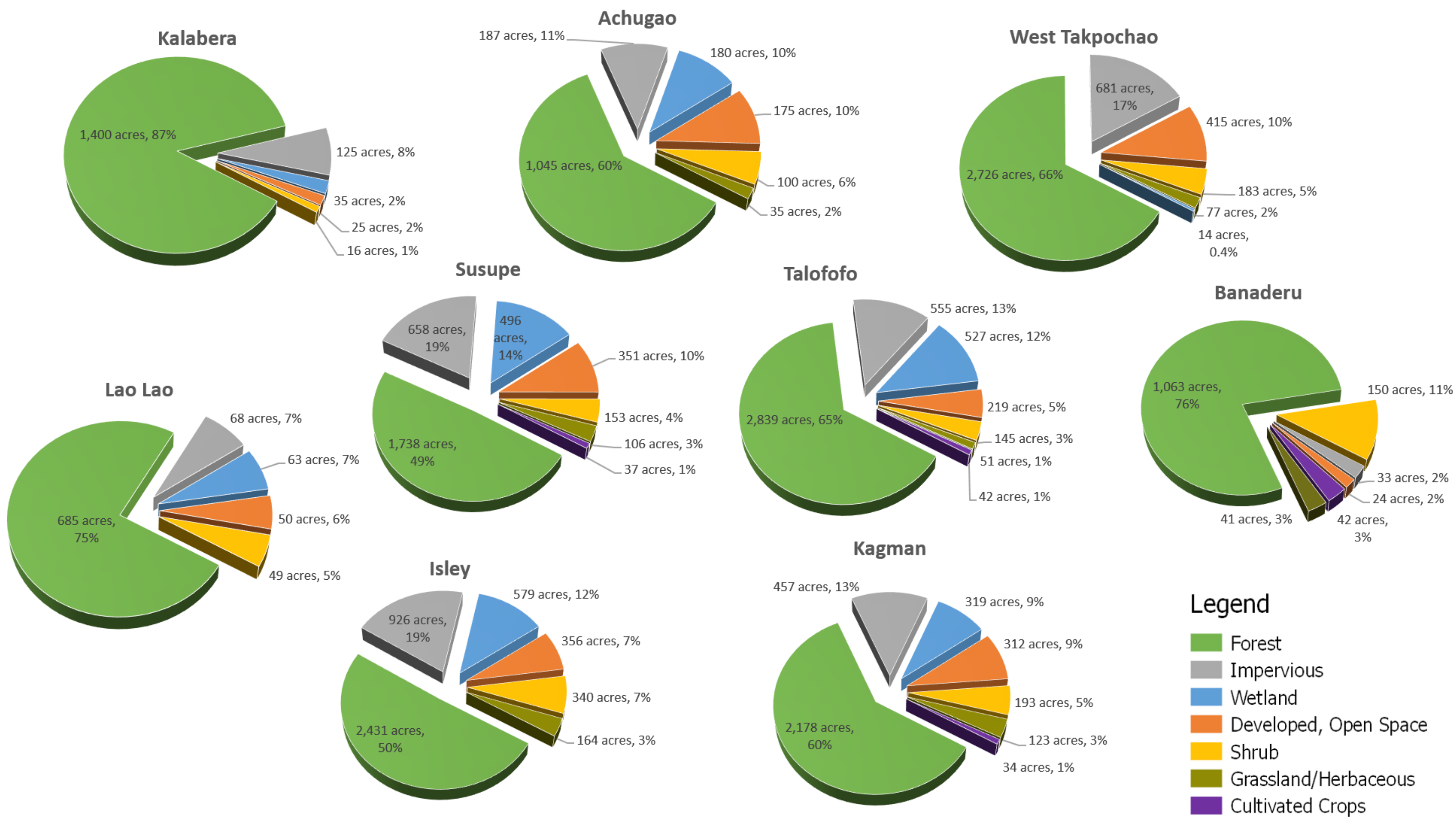

Figure 1-3 Land use in watersheds that contain 303(d) listed segments in Saipan.

1.3 Pollutants of Concern

Pollutants of concern for these TMDLs are indicator bacteria *Enterococci* and *E. coli*. The following summarizes the (1) priority rank of each of the listed waterbodies, (2) applicable WQS for both marine and inland fresh waters, and (3) available water quality data used to assess existing conditions. **Section 2** presents more detailed analysis of bacteria concentrations and trends.

1.4 Priority Ranking

Table 1-2 presents the priority rankings for the establishment of TMDLs for the pollutants listed on the 2014 and 2016 Section 303(d) list. Seven of the fifteen waterbodies are considered *High* priority, seven waterbodies are considered *Medium* priority, and one waterbody is considered *Low* priority for establishment of a bacteria TMDL. The pollutants of concern for marine waters are *Enterococci*, and for fresh waters are *E. coli* based on the WQS presented in **Section 1.5**. TMDLs have been developed for all waterbodies included in **Table 1-2**.

Table 1-2. Summary of 2014 and 2016 303(d) Priority Ranking Saipan waterbody bacteria impairments.

Segment	Segment Name	Pollutant	Priority
12	Kalabera	*Enterococci*	Low
13	Talofofo	*Enterococci*	High
14	Kagman	*Enterococci*	High
15	Lao Lao	*Enterococci*	High
17A	Isley West	*Enterococci*	Medium
17B	Isley East	*Enterococci*	Medium
18A	Susupe North	*Enterococci*	Medium
18B	Susupe South	*Enterococci*	Medium
19A	W. Takpochau North	*Enterococci*	High
19B	W. Takpochau Central	*Enterococci*	High
19C	W. Takpochau South	*Enterococci*	Medium
20A	Achugao North	*Enterococci*	Medium
20B	Achugao South	*Enterococci*	High
22	Banaderu	*Enterococci*	High
18LAK	Lake Susupe	*E. coli*	Medium

1.5 Water Quality Standards

The waterbodies listed in **Table 1-2** are designated as one of three waterbody classifications: Class AA, A and 1. Most marine waterbodies in Saipan are designated as Class AA. Three waterbodies that are located near municipal wastewater outfalls, Isley West (17A), Susupe South (18B), and West Takpochau North (19A) are listed as Class A. A description of the marine water objectives for Class AA & A are as follows (BECQ 2014b):

> **Class AA**: *It is the objective of this class that these waters remain in their natural pristine state as nearly as possible with an absolute minimum of pollution or alteration of water quality from any human-related source or actions. To the extent practicable, the wilderness character of such areas shall be protected.*
>
> **Class A**: *It is the objective of this class of waters that their use for recreational purposes and aesthetic enjoyment be protected.*

Lake Susupe is the only surface waterbody included in this TMDL and the only lake on the island of Saipan. It lies near four communities that contain over half of the Island's population. Lake Susupe is a brackish-water lake (USGS 2000), though is categorized as a fresh surface water Class 1 waterbody and is designated to support propagation of fish and recreation. Studies have evaluated the feasibility of using Lake Susupe as a potable water supply. With proper treatment, the Lake could support the domestic drinking water designated use, though at present no surface water in Saipan is used as potable water supply (Environet 2006). A description of the fresh surface water objectives for Class 1 waterbodies is as follows (BECQ 2014b):

> **Class 1**: *It is the objective of this class that these waters remain in their natural state as nearly as possible with an absolute minimum of pollution from any human-caused source. To the extent possible, the wilderness character of such areas shall be protected. Wastewater discharges and zone of mixing into these waters are prohibited.*

Numeric water quality standards for *Enterococcus* and *E. coli* were developed to support these Class AA, Class A, and Class 1 waterbody objectives. The applicable WQS that were used to develop the TMDLs (see **Section 4.2**) are presented in **Table 1-3**.

Table 1-3. Water quality standards for 303(d) listed constituents in project watersheds.

Constituent	Criteria	Units	Condition(s)
Enterococci	35	MPN/100mL	30 day Geomean
	130	MPN/100mL	Statistical Threshold Value*
E. coli	126	MPN/100mL	30 day Geomean
	410	MPN/100 mL	Statistical Threshold Value

*STV approximates the 90th percentile of the WQ distribution and should not be exceeded by more than 10 percent of the samples.

1.6 Summary of Monitoring Data

Monitoring data for Saipan was obtained directly from BECQ data sheets from their beach monitoring program and Lake Susupe. **Table 1-4** presents a summary of the number of monitoring locations by listed segment and notes whether each segment contains a bacteria listing. **Appendix B** includes a tabular summary of all water quality sampling data used for evaluating current conditions and developing the bacteria concentration and exceedance trend analyses presented in **Section 2**.

Table 1-4. Summary of available *Enterococci* (MPN/100mL) data by station.

Segment Number	Segment Name	Ocean Shoreline (miles)	Sampling Station ID	Sampling Station Name	Bacteria Listing?
12	Kalabera	3.7	NEB 02	Bird Island	●
13	Talofofo	4.6	NEB 03	Jeffrey's	●
			NEB 07	Hidden Beach	
			NEB 04	Old Man By the Sea	
14	Kagman	5.2	NEB 05	Marine Beach	●
			NEB 06	Tank Beach	
15	Lao Lao	2.1	SEB 02	North Laolao	●
			SEB 03	South Laolao	
17A	Isley West	1.6	SEB 06	Unai Dangkulo	●
17B	Isley East	3.6	SEB 04	Obyan	●
			SEB 05	Ladder	
18A	Susupe North	1.5	WB 25	San Jose	●
			WB 26	Civic Center	
			WB 27	Diamond Hotel	
			WB 28	Grand Hotel	
			WB 29	Community School	
18B	Susupe South	2.7	WB 30	Sugar Dock	●
			WB 31	CK Dist #2 Drain	
			WB 32	CK Dist #4 Lally	
			WB 33	Chalan Piao	
			WB 34	Hopwood School	
			WB 35	San Antonio	
			WB 36	PIC	
			WB 37	San Antonio Lift Stn.	
19A	West Takpochau (North)	4.1	WB 09	Sea Plane Ramp	●
			WB 10	DPW Channel Bridge	
			WB 11.2	South Puerto Rico Dump	
			WB 12	Smiling Cove Marina	

Segment Number	Segment Name	Ocean Shoreline (miles)	Sampling Station ID	Sampling Station Name	Bacteria Listing?
			WB 12.1	American Memorial Park Drain	
			WB 13	Outer Cove Marina	
19B	West Takpochau (Central)	3	WB 14	Micro Beach	●
			WB 15	Hyatt Hotel	
			WB 16	Dai-Ichi Hotel	
			WB 17	Drainage #1 (Dai-ichi)	
			WB 18	Samoa Housing	
			WB 19	Hafa-Adai Hotel	
			WB 20	Drainage #2 (Hafa-Adai Hotel)	
			WB 21	Garapan Fishing Dock	
			WB 22	Garapan Beach	
			WB 23	Drainage #3 (Garapan)	
19C	West Takpochau (South)	1.2	WB 24	Chalan Laulau	●
20A	Achugao (North)	1.7	WB 03	Nikko Hotel	●
			WB 04	San Roque School Beach	
			WB 05	Plumeria Hotel	
			WB 06	Aqua Resort Hotel	
20B	Achugao (South)	1.2	WB 07	Tanapag Meeting Hall	●
			WB 08	Central Repair Shop	
21	As Matuis	2.1	WB 01	Wing Beach	--
			WB 02	Pau-Pau Beach	
22	Banaderu	4.6	NEB 01	Grotto Cave	●

● Segment is listed for bacteria
-- Segment is not listed for bacteria

2 BACTERIA TRENDS ANALYSIS

A bacteria trends analysis captures bacteria water quality data (*Enterococcus/E. coli*) paired with precipitation or streamflow over a period of time. This analysis involves grouping data by categories based on time (e.g., seasonally, monthly) or flow characteristics (e.g., 90th percentile storm) to detect a general pattern or relationship between variables and to predict future water quality outcomes.

The analyses presented in this report are heavily reliant on an understanding of rainfall-runoff and flow patterns and how sources of bacteria are aligned with the patterns. Therefore, before analyzing trends in the water quality data, an analysis of precipitation patterns and a review of other available studies were conducted. Saipan is classified as tropical marine with an average temperature of 80°F and receives about 80 inches of rain per year, with the months of July through November typically receiving most of the rainfall (~67%) (Carruth 2003).

Applying the flow duration approach to TMDLs required the development of defined flow duration intervals and "seasons" to serve as loading capacity and allocation analytical units. These flow and seasonal groups were defined to reasonably identify discrete conditions where specific bacteria sources and their transport to waterbodies could be characterized. A review of previous bacteria TMDLs developed in American Samoa and Guam (USEPA 2013; USEPA 2014) provided reasonable rationale for developing the following flow duration intervals, grouped into five main zones: low flows (0 to 10 %), low-mid range flows (10 to 40 %), mid-range flows (40 to 60 %), mid-high range flows (60 to 90 %), and high flows (90 to 100%). The high zone is centered at the 95th percentile storm, and the low zone is centered at the 5th percentile storm. In general, if a sample exceeds the WQS during high flow periods, exceedance values are likely associated with rainfall. If a sample exceeds the WQS during low zones, exceedance values are associated with dry weather pollution events. Statistical Threshold Values (STV) and geometric means, or geomean for short, (see **Table 1-3**) were calculated for each flow regime and beach monitoring site, and summarized by impaired segment.

The flow duration curve analysis also accounts for seasonal variation to differentiate between dry season (November to June) and wet season (July to October). Rainfall data was assessed for distinct monthly or seasonal patterns—average conditions were used given the long period of record available. These seasons were identified based on analysis of precipitation patterns in Saipan. **Table 2-1** summarizes the seasonal and flow duration categories utilized in the analyses. In addition, **Figure 2-1** presents an analysis of rainfall data from 1999 to 2016 (from the Saipan International Airport), further portraying the designated wet season on Saipan.

Table 2-1. Seasonal and Flow Duration Category Summary.

Month	Dry	Low - Mid	Mid	Mid - High	High
	(0 - 10%)	(10 - 40 %)	(40 - 60 %)	(60 - 90 %)	(90 - 100%)
January	D	D	D	D	D
February	D	D	D	D	D
March	D	D	D	D	D
April	D	D	D	D	D
May	D	D	D	D	D
June	D	D	D	D	D
July	W	W	W	W	W

Month	Dry	Low - Mid	Mid	Mid - High	High
	(0 - 10%)	(10 - 40 %)	(40 - 60 %)	(60 - 90 %)	(90 - 100%)
August	W	W	W	W	W
September	W	W	W	W	W
October	W	W	W	W	W
November	D	D	D	D	D
December	D	D	D	D	D

D: Dry season; W: wet season

Another important consideration is the quantity and quality of available bacteria data. Our review of the data and our collaboration with BECQ identified the last 5 years of bacteria data as the most complete data and also most representative of current watershed trends. However, prior to developing a 5-year trend analysis, an assessment of precipitation trends was conducted to ensure that the selected 5-year window was representative of a longer data record (i.e., does our selected 5-year window include typical high and low seasonal and annual precipitation amounts). **Figure 2-1** shows the average monthly distribution of rainfall collected at Saipan International Airport, and the percent of total rainfall that falls during each month. **Figure 2-2** shows the distribution of daily rainfall (top graph) and yearly rainfall (bottom graph) collected at Saipan International Airport across water years 1988 to 2016 (past 30 years), 2006 to 2016 (past 10 years), and 2012 to 2016 (past 5 years). The analysis confirms that the 5-year trend (using WY 2012 to 2016) is representative of the 10-year and 30-year daily and yearly rainfall trends.

Month	Average Monthly Rainfall	% of total
Jan	3.79	4.9%
Feb	2.95	3.8%
Mar	2.32	3.0%
April	2.83	3.7%
May	4.05	5.2%
June	5.01	6.5%
July	8.14	10.5%
Aug	15.46	20.0%
Sept	12.14	15.7%
Oct	10.57	13.7%
Nov	5.58	7.2%
Dec	4.51	5.8%

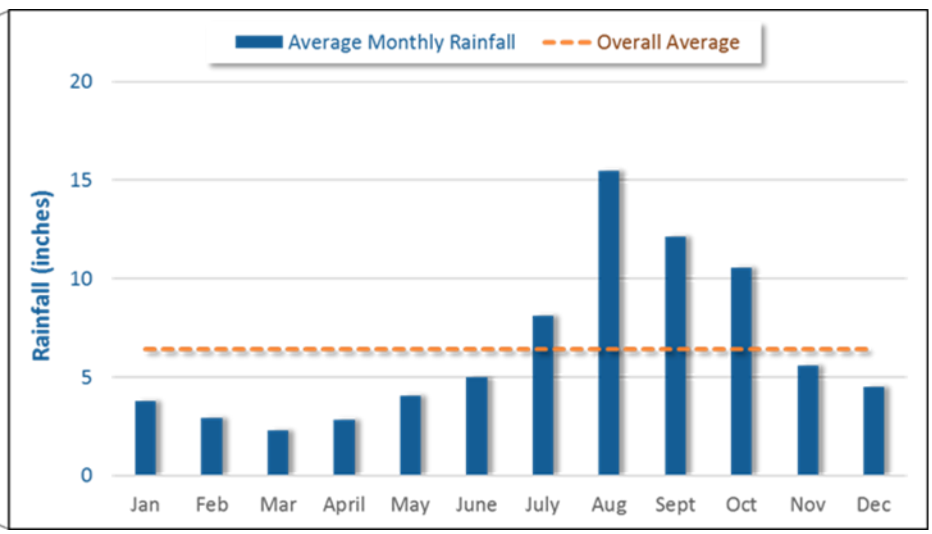

Figure 2-1. Average Monthly Rainfall Distribution at Saipan International Airport (1999 - 2016).

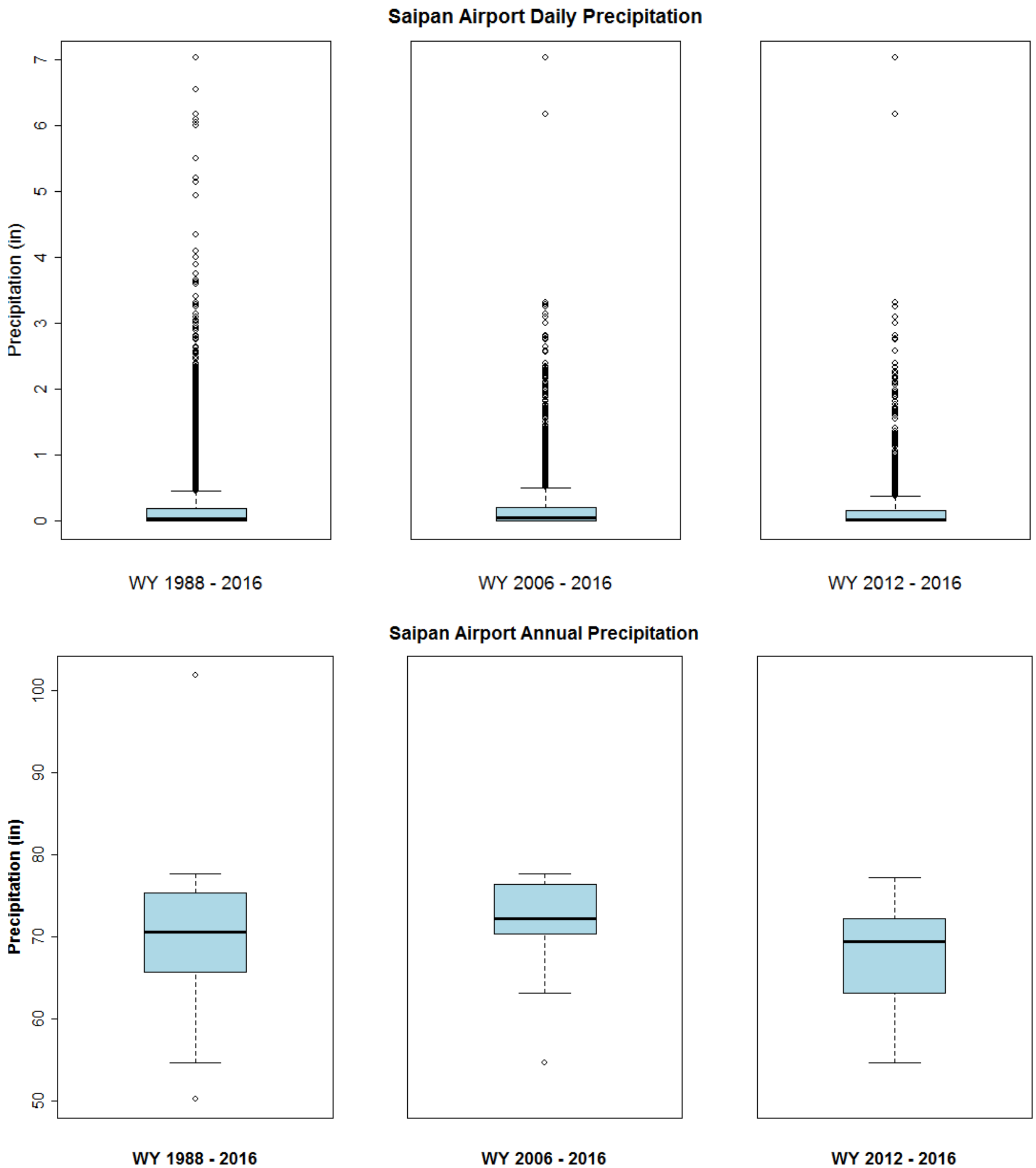

Figure 2-2. Saipan International Airport Daily and Annual Precipitation by Water Year.

A five-year analysis of water quality trends was conducted for each BECQ beach monitoring station (presented in **Appendix C**). For each station, a two-panel graphic was created that depicts bacteria concentration and exceedance trends across the following temporal conditions:

- **Annual** (left panel): *Presents a summary of bacteria concentrations and exceedances over time by Water Year (WY), expressed as October 1st of the previous year through September 30th of the current year. Annual rainfall totals are presented across the top x-axis.*
- **Seasonal** (right panel): *Presents an aggregate summary of bacteria concentrations and exceedances by season and month. Monthly rainfall totals are presented across the top x-axis.*

An example bacteria trends analysis for Garapan Beach (WB22—located in West Takpochau South (Segment 19C) for the most recent 5 years is presented in **Figure 2-3**. In each of the panels, the available observed monitoring data and corresponding rainfall (when applicable) were aggregated. The graphs represent the temporal distribution of samples each year **(left)** and each month **(right)**. The height of the orange bars represents the average concentration (MPN/100 mL) of all samples. The percent of samples that exceeded the WQS are noted on the top of each bar. In general, if samples tend to exceed standards with greater rainfall, there is pollution associated with storms. A full set of bacteria concentration and exceedance trends are presented in **Appendix C** by beach site. These analyses can be extended with a longer period of record using additional historic data.

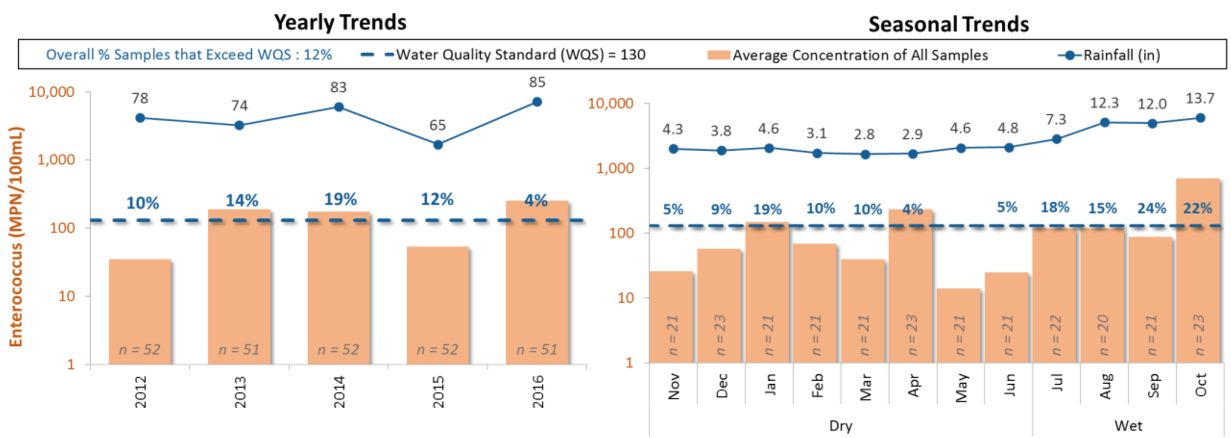

Figure 2-3. Example bacteria trends and exceedance analysis for Garapan Beach (WB22).

The rainfall duration percentile analysis was performed using a rainfall time series developed from the National Climatic Data Center (NCDC) Global Historic Climate Network Daily (GHCN-D) data set for the Saipan International Airport station (CQC00914855). The rainfall time series used for this analysis covers a period of record from October 1, 1988 through September 30, 2016.

A sample was flagged as an exceedance if any of the WQS presented in **Table 1-3** were violated. Exceedances for the trends analysis used flagging provided by BECQ for consistency which applies the 130 MPN/100mL WQS for Class AA and Class A marine waters as a STV. The water quality data sheets provided in **Appendix B** detail individual exceedance flagging of both WQS thresholds (geomean and STV) for *Enterococcus* and *E. coli* by individual sample.

3 POLLUTANT SOURCES

The following sections summarize the potential sources of bacteria for each of the waters included in the 303(d) lists. This information will inform the calculation of existing loading of the pollutants and the reductions needed from the sources to attain or maintain WQS. This TMDL effort included conducting a detailed reconnaissance visit to Saipan to: 1) tour each of the impaired watersheds; 2) meet with local agencies and other local contacts to develop a better understanding of the issues, obstacles or impediments to implementation and to ensure local practitioner viewpoints were understood and considered; and 3) develop an understanding of implementation activities that are already occurring and their success (adoption and efficacy).

3.1 Background

The island of Saipan has a rich history of large-scale disturbances from natural events (storms, typhoons, storm surges), changing cultural practices, and perhaps most significantly by conflicts arising from foreign occupations, colonization, and war. As such, there have been large-scale and permanent shifts in the land cover, species assemblages, ecology and soil characteristics on the island that have fundamentally changed the frame of reference for future land cover and natural resources, and the island's resilience to environmental changes.

Recent landfall of Super Typhoon Soudelor (ST Soudelor) in 2015 was a critical force of physical and residential community changes in Saipan, having destroyed many buildings, downed trees and powerlines, caused virtual isolation from communication networks off-island, and created wide-scale flooding that included damage to the island's power facility. Repair and maintenance of the power, water and wastewater facilities took months to achieve functional status. The latter is most relevant to water quality, as much of the piping infrastructure remains from developments made by Japan during the World War II occupation period in the 1940s. The losses of clean water, power, transportation and communication had profound effects on the communities and management organizations of Saipan, where management for "resilience" to disturbances has become a priority along with environmental stewardship among long-time residents.

Saipan is a popular destination for tourists, who mostly come from Asian countries. Since 2014, there has been a rapid increase in construction to accommodate new tourism facilities as well as repair of typhoon damage. These efforts have resulted in the import of investment and migratory laborers. Housing for this labor force (in the thousands of people) has often led to the reopening of former textile factories or encampments of temporary container housing. Because these facilities, particularly decommissioned warehouses, were not intended for dense housing, the wastewater capacity is often exceeded with sewer mains backing up or overflowing. Permits for these housing facilities are issued and water quality compliance is strictly and effectively enforced by BECQ, and has led to frequent and heavy fines for construction companies. However, the core issue of an ageing wastewater infrastructure against a backdrop of increased population growth remains.

A current socio-environmental challenge for Saipan is the integration of permanent, newcomer and transient residents, and the awareness of environmental stewardship and managing for resilience to change, especially among people from differing cultures and backgrounds. Many of the lessons learned and outcomes from ST Soudelor have emphasized the needs to upgrade current infrastructure, participate in sound planning for residential, farm and business areas, incorporate necessary buffers to prepare for resource rationing (energy, water, food), and to maintain and enhance primary ecosystem services so that any damage is less disruptive, less permanent, and requires shorter recovery times.

Incorporating the importance of ecosystem services by way of pollution control and water availability is a key interest among resource managers within BECQ and other organizations on Saipan, and remains a key challenge with community outreach, particularly among transient migratory workers and tourists that span a wide cultural spectrum. Cross-disciplinary programs have been initiated to provide sanitation options at popular tourist sites, inspection and enforcement of wastewater treatment facilities in worker residence centers and construction sites, stream channel improvement and paving of roads to limit sediment flow, and a host of other activities that will increase resilience to climate change events (storms and storm surges, sea level rise, droughts, rainfall torrents, flooding). Outreach and activities that underscore how individual behavior may adversely affect the environment, and to provide viable alternatives to behavior remain a constant challenge.

As a Commonwealth of the United States, Saipan differs from most other islands in the Pacific Region in that there is considerable technical capacity for resource management, including a cadre of professionals representing a range of foci, including coastal management enforcement, earth movement, water quality monitoring, public works, permitting, CNMI Forestry, DEQ drinking water branch, floodplain management, wastewater engineers, community outreach, and academia. Federal capacity for watershed management is also productive and represented well by NOAA Fisheries and NRCS. There is a comparatively rich source of available spatial and time-series data pertaining to watershed and infrastructural features, including those required for assessment of water quality.

Due to the size and relative isolation of Saipan in relation to areas in the continental United States, there is a high level of collaboration among agencies and professional personnel, with high knowledge capacity of the natural resource issues affecting the island. This collaboration is manifested in a variety of programs and working groups, including those focusing on watershed enhancement and implementation projects, with technical capacity provided by NOAA Fisheries and NRCS, as well as very high capacity in engagement with local communities. While programs exist, there is a need to meet the current high level of professional capacity Saipan offers with solid sources of implementation funds to execute plans that increase island resilience to climate change, including infrastructural improvements and increased community outreach, particularly with the tourism and construction sectors.

Probable sources of bacterial pollution, as indicated in the 2016 Water Quality Assessment Integrated Report, include roaming domestic and feral animals, fecal contamination from tourists and birds, and from municipal sanitary sewer systems (due to issues with infiltration and inflow). Identified probable sources from the Integrated Report are summarized by waterbody and presented in **Table 3-1** (BECQ 2016). In addition, a detailed table of probable sources identified from research and site visits is presented in **Table 3-2.**

Table 3-1. Summary of bacteria listed segments and probable sources by impaired segment

Segment	Waterbody	Probable Bacteria Sources
12	Kalabera	Fecal contamination from bird guano
13	Talofofo	Roaming domestic and feral animals, increase in tourists to remote beaches & lack of restroom facilities
14	Kagman	Free roaming domestic and feral animals, stormwater runoff
15	Lao Lao	Free roaming domestic and feral animals
17A	Isley West	Sewer overflows from upland sewer line
17B	Isley East	Increase in tourists to remote beach, lack of restroom facilities
18A	Susupe North	Overflows and leaks from the CUC sewage collection system, urban runoff
18B	Susupe South	Overflows and leaks from the CUC sewage collection system, urban runoff
19A	W. Takpochau North	Industry from marinas & closed municipal dump
19B	W. Takpochau Central	Piggeries in the upper watershed, illicit discharges
19C	W. Takpochau South	Sanitary sewer overflows, urban runoff, sedimentation
20A	Achugao North	On-site treatment systems, sanitary sewer overflows, urban runoff, livestock
20B	Achugao South	On-site wastewater treatment systems, urban runoff, roaming livestock upland, feral pigs and failing septic systems
22	Banaderu	Increase in tourists, illegal dumps or other inappropriate waste disposal
18LAK	Lake Susupe	Recreation, bird guano

Table 3-2. Probable sources of bacteria loading by impaired segment.

Segment		Wastewater sources			Stormwater Sources		Recreational and Other Sources					
Number	Name	Septic Systems	Sanitary Sewer Overflow	WWTP	Maintenance/ construction runoff	Road runoff / sedimentation from unpaved roads	Coastal zone erosion	Erosion from Private Lands / Burning	Marine and recreational boating	Recreational and Tourism Activities	Feral Animals / Wildlife	Livestock Facilities & Agriculture
12	Kalabera					●	●			●	●	
13	Talofofo					●	●	●		●	●	●
14	Kagman	●			●	●	●	●			●	●
15	Lao Lao	●				●	●			●	●	
17A	Isley West		●	●	●	●	●			●		
17B	Isley East				●	●	●			●		
18A	Susupe North		●	●	●	●	●			●	●	
18B	Susupe South		●	●	●	●	●			●	●	
19A	W. Takpochau North		●	●		●	●		●			
19B	W. Takpochau Central	●	●		●	●	●					●
19C	W. Takpochau South	●	●		●	●	●					
20A	Achugao North	●			●	●	●				●	●
20B	Achugao South	●			●	●	●				●	●
22	Banaderu					●	●			●		
18LAK	Lake Susupe	●	●			●	●			●	●	

3.2 Permitted Discharges

Municipal point sources, including wastewater treatment plants (WWTP) and municipal separate storm sewers (MS4), are permitted to discharge effluent to receiving waters under the NPDES program. Four active NPDES permits, three wastewater treatment plants and one MS4 stormwater permit were identified as possible sources of effluent to receiving waters which could contain bacteria. Permit locations and discharge monitoring records (DMR) containing any available records of the discharged effluent were obtained for these facilities, where available, using the USEPA PCS-ICIS reporting system. **Table 3-3** presents a summary of active permits and indicates the segment where each NPDES facility is located. A waste-load allocation (WLA) will be assigned to any permitted discharge that contributes a pollutant of concern.

Table 3-3. Summary of active NPDES permits potentially discharging indicator bacteria.

NPDES Permit Number	Facility Name	Adjacent Segment
MP0020028	Agingan WWTP	17A, 18B
MP0020010	Sadog Tasi WWTP	19A
MP0020397	Mobil Oil Mariana Islands, Inc.	19A
MP0020371	Managaha Island WWTP	--
MPS040000[1]	Island of Saipan MS4	--

1. This Island of Saipan MS4 permit was set to expire on September 21, 2011. A new or renewed permit was not found during preliminary searches.

The Managaha Island WWTP is not located on the Island of Saipan. However, it was retained in **Table 3-3** for completeness as effluent discharged could be subject to mixing or ocean currents that may influence water quality along adjacent segments. All references located during preliminary research regarding the Island of Saipan MS4 permit (MPS040000) indicate that the permit was set to expire on September 21, 2011. No renewed permit was initially identified; however, it is likely that the MS4 continues to operate so the 2011 permit was retained in **Table 3-3**.

3.3 Nonpoint Sources

The following subsections summarize specific information known about probable nonpoint pollutant sources for each waterbody segment.

3.3.1 Kalabera (Segment 12)

The Kalabera watershed is in northeastern Saipan and is characterized by steep topographic relief from the central mountains to a wide shelf. The road network is paved in the northern ends and serves as a transport corridor for popular tourist destinations outside of the watershed (The Grotto and Suicide Cliff/Marpi National Historic Landmark) as well as within the watershed (Bird Island caters to an estimated 29,000 people visits per month). Road access via Kalabera Cave is unpaved, though it is developed on the coastal shelf and well buffered from the coastal waterbody through both vegetation and distance. The Bird Island water quality monitoring station has indicated elevated levels of *Enterococcus*, likely from resident bird population guano and potentially from human sources from visitors. The latter was observed at the Grotto tourist site with human waste around bathrooms and is a chronic issue facing Saipan with a fast-growing tourism industry (see outreach challenges above).

The watershed has little development other than the road network and a few dispersed houses with small livestock facilities or free-range animals, although the topography and vegetation profiles do not suggest that these would be potential primary sources of *Enterococcus*. The unpaved road network is mostly set apart from the outcrop coastal interface on clay and clay loam substrates; high rainfall events may contribute sediment pulses to the area. Though heavily used, the road does not appear to have large rill erosion or high connectivity to the seaward edge.

Overall this watershed may be contributing a natural background of *Enterococcus* that is derived from bird guano sources at Bird Island and from soil sources, delivered as sediment during rainfall events.

3.3.2 Talofofo Watershed (Segment 13)

The Talofofo watershed contains a mix of land uses in a topographically complex environment. There are several very popular tourist beaches that are accessible by a short hike and do not contain restroom facilities. The road network accessing these beaches generally is directly in-line with the slope (e.g. no cross-slope roads to access) and are deeply eroded, despite frequent repairs. Access to these beaches are often facilitated by on-island tour companies as well as independent tourists renting vehicles. The influence of tourists is quite high for these beaches. The locations are more rugged and isolated than beaches elsewhere on the island; there are no restroom or garbage bin facilities. The road network is undersized and is heavily eroded.

The upland areas of the Talofofo watershed contain many dispersed houses and small farms. The landscape is a patchwork mosaic of grasses and mixed scrub forest types, with frequent maintenance by fire to promote grasses (or clear land for agriculture) in the upland areas. Many of the cleared and post-burned lands are on exposed hilltops and contribute directly to steep ravines that flow directly to the coastal edge—most appear to be concentrated in intermittent gullies that have evidence of high flow events, based upon streambed substrate sizes.

Downstream, at the beach interfaces, the stream substrates are composed of large rocks and boulders (>~50 cm in diameter) and fine sediments—fine sediments are abundant and deep at the terminal ends of the gullies. Roads and road cuts are generally connected to the gully networks, contributing stormwater flows to the gullies during rainfall events.

3.3.3 Kagman Watershed (Segment 14)

The Kagman watershed is a large watershed and represents one of the island's growth areas for housing developments, with approximately 6,000 inhabitants – mostly moderate to low income housing. The headwaters are steep and form a complex network of streams and gullies, with a large (paved) road network, and large and flat lowland areas suitable for agriculture and development. There have been significant infrastructural investments in the Kagman watershed, mostly geared toward stormwater management and sediment mitigation, and the use/conveyance of stormwater for agricultural irrigation. This large project (NRCS-funded) has an elaborate system of stormwater catchment from the steep slopes of Mount Takpochao, through the road network, through a series of canals and settling ponds, and settlement to a quarry, with the purpose of providing agricultural irrigation water. Settling ponds are manually cleaned for sediment and appear to be in good repair.

Upland areas in the Kagman watershed have steep slopes and are generally deforested, with the highest incident rainfall on the island. Burning to clear lands is prevalent as with other watersheds. The road networks off the central highway system are steep and unpaved and off-road vehicle tourism is a popular use, contributing to very high levels of erosion on the upper elevation (unpaved) roads. Stormwater flows appear to be relegated to the stormwater system and to the large gully systems that feed popular beach areas (Tank Beach and Marine Beach). The BECQ provides extensive testing in these areas and is diligent with other agencies operating to identify methods of improvement for the watershed area and affected waterbodies.

Due to population growth and the nature of the limestone soils, the Kagman watershed is currently listed as a priority area for a third wastewater treatment plant. Current treatment plants near Agingan (at Susupe/Isley boundary—waterbodies 17A and 18B) and Puerto Rico (near north end of West Takpochao watershed, waterbody 19A) are operating at 50% capacity, although there is concern for meeting increased demand with high population growth. The Kagman watershed is currently not operating on centralized wastewater treatment; feasibility studies are being conducted to determine best course of action (new plant or connect with nearby plants).

Increased housing and agricultural densities in the lowland and highly permeable soils may be contributing to waterbody impairment. Sediment discharge from powerful rainfall events appears to be mitigated in some ways by the current stormwater infrastructure, although larger drainages where unpaved roads are adjacent are likely contributing to potential contamination via uncollected sediment. Furthermore, the riparian structures and erosion control of existing streambeds may be further enhanced to minimize sediment discharge. Old or undersized septic systems and subsurface contamination may be more of a contributor than surface discharge to waterbody contamination.

Golf courses, agriculture, and septic systems may also increase nitrogen and phosphorus loading, and current efforts are underway to determine the extent of the issue, if any.

3.3.4 Lao Lao Watershed (Segment 15)

The Lao Lao watershed has been a focal area for restoration and enhancement for several years and has been the recipient of project-level funding to improve water quality. Of note, focused projects have included:

- Installation and maintenance with stormwater structures entering the watershed
- Improvement in parking facilities and beach facilities to accommodate tourists (mostly diving enthusiasts)
- Engineering projects that have hardened and fortified road surfaces to mitigate erosion and road connectivity issues for sediment
- Outreach with tourism companies to educate and enforce best practices for watersports.

Overall there is an apparent consensus that Lao Lao is a "model watershed" for types of activities that can be done on island to enhance water quality, and there appear to be high levels of success in inter-agency coordination in identifying watershed priorities, designing appropriate solutions, conducting project maintenance, and monitoring implementation success. Capacity in both expertise for design and implementation is strong on Saipan.

While there are purposeful efforts underway to limit sediment delivery to the reef environment and to limit pollutant loads, there remain areas of hydrologically-connected unpaved roads that may be low-cost solutions to take full advantage of work done to date.

3.3.5 East Isley Watershed (Segment 17B)

This watershed segment is mostly undeveloped, except for the airport and small communities nearby to Ladder Beach. Both Obyan and Ladder Beach monitoring stations indicated elevated *Enterococci* bacteria, which may have originated from beach users. Obyan Beach road is paved and well maintained; the developed beach area is also well maintained with improved access. Signage reflects the importance of green sea turtle nesting sites and the need for improved water and beach quality. Ladder Beach is a popular tourist area, with a steep descent to access the beach and the caves. Off road vehicle use is high on the roads leading to the beach area, and trash is found around the parking areas as well as inside the cave structures. Actions have been made by the Marianas Visitor Authority's Beautify My Marianas campaign to support trash collection and beach cleanup, although local impressions suggest tourists (in particular) are not packing trash out when they leave. Plastic bags left behind for later pickup are often ripped open by feral dogs and cats, allowing rubbish to spread.

The vegetation structure in this watershed is short scrub and grasses, with a fair amount of areas that are prone to erosion. The terrain is generally flat, and sediment-based *Enterococcus* is assumed to be lower from terrestrial sources, with possible exception of the evident active beach and coastal zone erosion at the waterbody interface.

3.3.6 North Susupe (Segment 18A)

North Susupe watershed is located along the western shore of Saipan, and contains several resorts, hotels, and public beaches. Beaches are frequently visited by tourists and residents, and contain scenic views, marine sports, swimming, and fishing. The North Susupe watershed sanitary surveys have not been completed, though there may be some surface runoff from the southwestern area of Mount Takpochau. It is likely that *Enterococcus* exceedances are due to on-site wastewater treatment systems, sanitary sewer overflows, urban runoff, and livestock further upstream in the watershed.

3.3.7 West Isley & South Susupe Watersheds (Segments 17A & 18B)

These watersheds are grouped to reflect the listed issue between 18B South and 17B West waterbodies due to *Enterococci* loading from the same municipal outfall of the wastewater treatment plant located on Point Agingan. The contributing areas are also directly adjacent to the Coral Ocean Point Resort and Golf Course (17A West) and urban development with popular beach access in the Susupe watershed (18B South). Monitors within BECQ have indicated that improvements have been made to the municipal outfall, and that current plans and operations are underway. As such, implementation options for the outfall should be to support ongoing plans, especially regarding maintenance. The current capacity of the treatment facility is approximately 50%, and there are active planning efforts to determine feasibility for this and potential future treatment facilities to meet the rapid demand from population growth of the area.

3.3.8 West Takpochao North (Segment 19A)

The defining features of this waterbody include the wastewater treatment plant (at Puerto Rico), closure of the open dump, and the port facility. The closure and decommissioning of the open dump marked a milestone in environmental management for the CNMI and the Pacific region. Work conducted on Saipan to decommission the open dump and open the first USEPA -approved landfill (Marpi Landfill, in the north of Saipan) served as a model for the Layon Landfill on Guam and can serve as a roadmap for American Samoa for a future transition of their open dump facility to an approved landfill facility. In addition to the above, the upland areas are dispersed neighborhoods and homesteads, with similar issues as above with dispersed livestock farms. A small mangrove area exists within the waterbody segment, mostly relegated to a small patch next to the port facility.

Water quality "red flags" at the DPW Channel Bridge indicate frequent exceedance detections of *Enterococcus*. BECQ monitors conducted forensic assessments to identify potential sources and discovered the frequent incidence of contamination originated from a broken sewer line located in the middle of a mangrove stand that was from old wastewater infrastructure that was unknown and therefore not documented in the utility's GIS layers – much of the sewer in this area was built during the Japanese Occupation in the 1930-40s. Asbestos pipes were installed during this time, which have become vulnerable though time and have been identified by CNMI government as a threat to water quality. Wastewater infrastructure improvements to not only modernize, but support future capacity is a key need for Saipan and critical in water quality improvement.

3.3.9 West Takpochau "Garapan" (Segment 19B)

The drainage area to this waterbody is a complex network of land uses, and contains the urban center of the island (Garapan), which is the center of the tourism industry on the island. The most dominant activity is the construction of a new casino/ hotel in the center of town, involving several city blocks and thousands of construction workers.

The drainage area originates from steep slopes connecting to the island ridgeline, with three major gully systems that drain to the coastal flats, in the center of town. A large-scale stormwater catchment system was installed and forms a central canal (Dai-Ichi Drainage site WB17) through town, in front of an ongoing large casino construction site financed by Best Sunshine International (Macau group) to a beach outlet.

As part of the $7 billion integrated resort and shopping mall under construction by Best Sunshine International, the design criteria included expansion and improvements made on the stormwater canal system, including increasing its size and installing sediment catchment devices to minimize seaward inputs. BECQ has maintained a highly vigilant stance on water quality monitoring and compliance for the construction projects. Several individuals from each branch, including CDRM permitting, enforcement, WQS/NPS, DEQ, Wastewater, and Drinking Water branches are involved in these projects.

The upland areas of the watershed, including homesteads and dispersed housing, are not connected by the wastewater treatment system and are operating on older septic systems. There are lower income homesteads that operate small livestock farms (piggeries and poultry), mostly in low grade facilities with little to no wastewater treatment. There are current grant programs in place (NRCS) to help these farmers improve water quality by installing farm septic systems, wastewater holding tanks with regular pump out, or dry litter piggeries for composting waste. BECQ is assisting in the identification and compliance of these projects, working with farmers to help to understand water quality issues and signing up for the program (rather than fining for compliance violations). Outreach for such projects is critical and requires clear and culturally sensitive approaches, which BECQ was observed to have excellent capacity to assist these landowners in a meaningful and respectful way.

Many of the lowland wetland areas that exist in this area (as well as to the north in 19A and 20B) have been converted to urban uses. The American Memorial Park (US National Park Service) administers a large landholding at the West Takpochao point on the north end of Garapan that contains a slough, flowing north into a small harbor. This slough was the target of a mangrove restoration project to also help to mitigate flooding in town (a frequent occurrence). The slough was also previously used to manage discharge brine from a reverse osmosis desalination plant from a local hotel, which contributed to a wide swing in salinity and lowering success of wetland species restorations. The brine is now discharged into a deep injection well, and as such, the slough offers an excellent opportunity for community-based ecosystem restoration and outreach, urban and community forestry activities, and a potential model for town beautification and ecosystem service restoration

3.3.10 West Takpochau South (Segment 19C)

West Takpochau South watershed contains two beaches: Chalan LauLau and Garapan Beach. The Saipan Beach Pathway runs from the base of the segment north through Garapan and into American

Memorial Park (Segment 19B). The beach path is enjoyed by residents and tourists who bike, walk, and enjoy the ocean breeze along the walkway. Seagrass lines the coast line, and no homes or hotels are located on the coast. West Takpochau South contains high percentages of impervious cover, with a large paved populated area, that is known to be degraded by runoff. During storm events, this runoff drains into the lagoon off the coast of Southwest Takpochau, potentially transporting *Enterococcus* loads. Failing wastewater collection systems may be a source of bacteria along the segment, as well as sanitary sewer overflows and urban runoff.

3.3.11 North Achugao Watershed (Segment 20A)

North Achugao watershed contains three hotel complexes, of which two have been out of operation in recent years due to new renovations. The watershed is also enjoyed by residents who frequent the beaches to swim, fish, and picnic. Biological conditions in the watershed have improved, likely due to mass vacancy in the resorts due to renovations, which in turn, leads to less beach goers within the watershed. North Achugao Watershed was added to the USEPA 303(d) List of Impaired Waters in 2016 again due to *Enterococci* exceedances of the WQS. These exceedances are thought to be connected to the resort renovations, causing an increase in workers visiting the area, and higher wastewater flow during peak hours. BECQ was alerted to the segment, due to complaints by the surrounding community, of foul smelling stormwater. Upon investigation, BECQ identified an overflowing manhole cover in a drainage that flows to the lagoon off the coast of North Achugao. The pump was replaced, and the pump station will be upgraded. The sewer lines in the North Achugao Watershed are also currently being upgraded, and funding should continue to ensure utility infrastructure is updated to meet existing demands.

3.3.12 South Achugao Watershed (Segment 20B)

Extending north from Garapan, this watershed is most affected by new housing developments and homestead areas. The lower watershed contains a mosaic of industrial areas and coastal strand/ wetland areas. Upland areas are mostly homesteads and large grasslands that appear to be maintained by fire. These upland areas are likely sources of sediment delivery to the waterbody.

Population growth from transient foreign labor has required establishing temporary housing facilities to accommodate the staff. Saipan had a robust textile industry and many of the legacy factories are in the Achugao watershed. Recently a building was commissioned for approximately 350 workers. Current counts indicate over 700 are residing there, taxing the wastewater infrastructure. BECQ conducts routine inspections of these facilities and issues citations to the permittee (construction company) for violations. In February 2017, there were several violations with raw sewage overflowing and entering a neighboring wetland area. Fines were issued and the following week another inspection was conducted (during the reconnaissance visit by the Paradigm team). While a fix was applied to the initial violation, two additional overflows were found with ~2-6 inches of standing sewage flowing over the concrete lot and into a wetland area. BECQ professional staff issued citations and worked with the site managers to identify the violation and needs to improve infrastructure to avoid future citations.

Homesteads in the area have been recipients of an NRCS grant program to improve water quality. Generally, these homesteads are local farmers with low incomes. One farm visited was selected for funds (NRCS grant) to construct a wastewater system to handle waste from 15 pigs. Current infrastructure was poor, with minimal improvements and remnants of typhoon damage. The wastewater ran overland into a wetland. The grant was established to create "off the shelf" septic systems for these small operations to minimize cost and be effective in reducing contamination. These types of grant programs work well in the Pacific region as they both provide awareness and are effective in treating dispersed water contamination issues at a relatively low cost of installation and maintenance. There is clear coordination with BECQ, NRCS and other organizations to help promote these low-cost and effective programs; additional fiscal support for community outreach is needed to promote success to more rural farmers.

3.3.13 Banaderu (Segment 22)

Banaderu, the northernmost watershed on Saipan, is known for its excellent snorkeling, cliff diving, and scuba diving opportunities. Grotto Cave, a naturally formed clear-water grotto, contains deep clear waters and is a popular destination for recreating, often featured in international dive publications. In fiscal year 2015, public advisories for Grotto Cave increased significantly due to *Enterococci* exceedances. Banaderu was therefore added to the USEPA 303(d) list of impaired waters in 2016, with the suspected source being the lack of regularly operational public restrooms during visitor hours. Restrooms are designed with a septic holding tank that is maintained by regular pump out, though restrooms are closed when the rainwater catchment system has an insufficient volume of water to supply their usage, resulting in alternate bathroom usage by visitors. BECQ staff met with Department of Lands and Natural Resources and Marianas Visitor Authority (MVA) to request additional water supplies be brought to ensure restrooms are open during all hours of operation.

3.3.14 Lake Susupe (Segment 18 LAK)

Lake Susupe is a unique landform, uplift from former lagoon habitat. The wetland is complex and is surrounded by development housing; it is unclear how many residents are on wastewater treatment versus septic systems. In both cases via ageing and undersized infrastructure, there is likely leakage contributing to the *E. coli* detections in the waterbody. There have been many studies for Lake Susupe as a potential water reservoir. Overall the lake is shallow and mostly a wetland vegetative area, with dense and dispersed housing all around the perimeter, with unknown or unclear wastewater infrastructure integrity. Ironwood species (Causarina sp.) are prevalent—their extensive litterfall also likely contributes to tannins and higher acidity, and is an indicator of higher salinity environments.

4 LOADING CAPACITY –LINKING WATER QUALITY AND POLLUTANT SOURCES

A TMDL establishes the allowable load of a pollutant or other quantifiable parameter based on the relationship between pollutant sources and instream water quality. This document provides the scientific basis for to the establishment of water quality-based controls to reduce pollution from both point and nonpoint sources and to restore and maintain the quality of the territory's water resources (USEPA 1991). An important first step in the development of a TMDL is the calculation of the loading capacity for impaired waters identified on the 303(d) lists. The loading capacity is defined as the greatest amount of loading that a water can receive without violating WQS. The loading capacity ultimately provides a reference point that informs the pollutant reduction efforts needed to comply with WQS. The loading capacity must consider the WQS for Saipan receiving waters for bacteria presented in **Section 1.3**. The remainder of this section summarizes existing conditions and outlines the approach utilized to calculate the capacities for each pollutant included on the 303(d) lists.

4.1 Current Conditions

Segments included in this TMDL are defined by a myriad of characteristics, and each has a unique set of features, sources of bacteria, and conditions that affect contaminant transport. A logical method of characterizing current conditions across each segment is to examine the distribution of *Enterococci* and *E. coli* concentrations across different flow regimes. This data display provides a template for visual and statistical analysis of exceedances under differing conditions (i.e. dry season vs. wet season, high flows vs. low flows, geomean vs. STV, site by site, or any combination).

Load and flow duration curves provide a means to consider and incorporate the variability associated with hydrologic data and conditions. The process allows for a more detailed understanding of how water quality impairments are affected by flow regimes and provides insights into probable source categories. Water quality flow duration analysis examines the cumulative frequency of historic flow data, and sorts water quality by flow duration zone (based on percentiles). Water quality impairments and exceedances can then be investigated to determine whether they occur during all flow conditions or whether they correspond to specific flow events. For example, WQS exceedances occurring during low flow would indicate the influence of dry-weather sources like point source discharges, spills, illicit discharges, etc. Exceedances observed during wet-weather, high flow conditions, might indicate that nonpoint source contributions (land runoff) are the major sources. When the exceedances can be characterized and sorted by flow condition or season, it allows for analyses that can account for seasonal variation. Load and flow duration analysis ultimately supports efforts to identify the hydrologic conditions behind the bacterial pollution sources and the WQS exceedances observed in Saipan.

In the remainder of this section, water quality monitoring data is tabulated into a load duration curve analysis, using water quality data collected over the past 5 years and flow data from the past 10 years. Geomean and STV analyses were used to examine hydrologic patterns for all TMDL segments and assess current conditions/achievement of WQS. Flow duration intervals are grouped into five main zones consistent with the TMDL approaches employed in American Samoa and Guam (USEPA 2013; USEPA 2014): low flows (0 – 10 %), low-mid range flows (10 – 40 %), mid- range flows (40 – 60 %), mid-high range flows (60 – 90 %), and high flows (90 – 100%). The high zone is centered at the 95th percentile storm, and the low zone is centered at the 5th percentile storm. In general, if a sample exceeds the WQS during high flow periods, exceedance values are likely associated with wet-weather events. If a sample exceeds the water quality standards during low flow zones, exceedance values are likely associated with direct discharges or other non-rainfall associated sources. Geomean values and STV exceedances for all samples were calculated for each flow regime and beach monitoring site, and summarized by impaired segment.

The flow duration analysis was performed using a time series of streamflow derived for each major watershed (**Figure 1-3**) using the Load Simulation Program - C++ (LSPC) watershed model. This watershed model was developed using the above-mentioned rainfall time series from the Saipan International Airport. Land cover was represented using the 2005 CCAP high resolution land cover data set developed by the NOAA Office for Coastal Management. The watershed model was not calibrated against observed streamflow data as no known data sets were available for performing calibration; however, representative parameters by land cover and regional rainfall patterns were selected based on available technical guidance (USEPA 2000, USGS 1995). The resulting timeseries create a relative scale of flow magnitude based on a consistent rainfall gage (Saipan International Airport) for further organizing water quality samples.

Samples were also grouped by dry season (November to June) or wet season (July to October). These seasons were identified based on analysis of precipitation patterns in Saipan (**Section 1.6**). STV Exceedances and geomean across all seasons by flow duration group are shown in **Table 4-1** and **Table 4-2**, respectively. Dry season STV and geomean summaries are shown in **Table 4-3** and **Table 4-4,** respectively. Wet season summaries are shown in **Table 4-5** and **Table 4-6**, respectively. STV and geomean concentrations are also shown by site and presented in **Appendix F**.

Figures for the load duration curves were also developed to visually display existing conditions across all segments. These paneled plots show single sample and geomean average concentrations by segment and average flow grouped by all seasons, wet season, and dry season. The figures also aid in identifying patterns of exceedance for current conditions. An example flow duration curve panel for Segment 19A (West Takpochau North) is displayed in **Figure 4-1**. Figures for all other listed segments are included in **Appendix D**.

The summary of STV Exceedances for all seasons is shown in **Table 4-1** below. The grey shading indicates flow duration curve zones where over 10% of samples exceeded the STV WQS of 130 MPN/100 mL for *Enterococcus* and 410 MPN/100 mL for E.*coli.* Across most segments, samples exceeded the WQS during high flow duration curve zones (Mid-High and High) with five segments also showing exceedances above the WQS during dry periods. Further explanation of these exceedances and linkage to sources is discussed in **Section 4.2** and **Section 4.3**.

Table 4-1. All Seasons: Summary of STV Exceedances Across Flow Duration Curve Zones by 303(d) Listed Segment.

Segment		# of Beach Sample Sites	Count	Exceedances	STV (# Exceeding)					
					WQS	Duration Curve Zone				
Number	Name					Dry (0 - 10%)	Low - Mid (10 - 40 %)	Mid (40 - 60 %)	Mid - High (60 - 90 %)	High (90 - 100%)
12	Kalabera	1	127	15	130	3	3	5	2	2
13	Talofofo	3	388	49	130	9	6	7	11	16
14	Kagman	2	266	10	130	2	3	2	4	6
15	Lao Lao	2	268	20	130	0	3	1	8	8
17A	Isley West	1	133	18	130	2	1	4	9	2
17B	Isley East	2	266	17	130	3	4	1	4	5
18A	Susupe North	5	1,284	36	130	5	8	4	15	4
18B	Susupe South	8	2,014	116	130	15	22	17	49	13
19A	West Takpochau (North)	6	1,410	165	130	21	29	22	67	26
19B	West Takpochau (Central)	9	2,523	264	130	36	52	14	97	65
19C	West Takpochau (South)	1	259	11	130	0	3	1	7	0
20A	Achugao (North)	4	1,015	60	130	6	8	6	23	17
20B	Achugao (South)	2	491	80	130	7	14	8	24	27
22	Banaderu	1	258	11	130	1	3	1	4	2
18LAK	Lake Susupe	1	97	8	410	0	2	1	1	4

over 10% of samples exceeded the STV WQS within the flow duration curve zone

The summary of geomean concentrations for all seasons is shown in **Table 4-2** below. The grey shading indicates flow duration curve zones where the geomean exceeded the WQS of 35 MPN/100 mL for *Enterococcus* and 126 for E.*coli.* There are less exceedances of the geomean

WQS than the STV, though a similar pattern emerges across all seasons, where the WQS is exceeded more during Mid-High and High flow duration curve zones. Achugao South is the exception, where the geomean was exceeded in each flow duration curve zone. Further explanation of these exceedances and linkage to sources is discussed in **Section 4.2** and **Section 4.3**.

Table 4-2. All Seasons: Summary of Geomean Exceedances Across Flow Duration Curve Zones by 303(d) Listed Segment.

Segment		# of Beach Sample Sites	Count	Exceedances	Geomean (MPN/ 100mL)					
					WQS	Duration Curve Zone				
Number	Name					Dry (0 - 10%)	Low - Mid (10 - 40 %)	Mid (40 - 60 %)	Mid - High (60 - 90 %)	High (90 - 100%)
12	Kalabera	1	127	30	35	22	22	32	25	29
13	Talofofo	3	388	146	35	30	32	24	43	56
14	Kagman	2	266	24	35	15	17	14	26	23
15	Lao Lao	2	268	52	35	16	20	19	44	70
17A	Isley West	1	133	34	35	66	20	29	35	21
17B	Isley East	2	266	34	35	20	19	19	32	22
18A	Susupe North	5	1,284	45	35	13	13	14	15	16
18B	Susupe South	8	2,014	238	35	17	20	18	25	23
19A	West Takpochau (North)	6	1,410	417	35	29	33	39	53	74
19B	West Takpochau (Central)	9	2,265	613	35	26	33	25	44	77
19C	West Takpochau (South)	1	259	17	35	12	20	18	23	17
20A	Achugao (North)	4	1,015	106	35	18	16	19	27	35
20B	Achugao (South)	2	491	214	35	36	39	39	180	119
22	Banaderu	1	258	14	35	13	14	13	17	22
18LAK	Lake Susupe	1	97	19	126	74	94	37	115	228

(grey shading) samples exceeded the Geomean WQS within the flow duration curve zone

The summary of STV exceedances for the dry season is shown in **Table 4-3** below. The grey shading indicates flow duration curve zones where over 10% of samples exceeded the STV WQS of 130 MPN/100 mL for *Enterococcus* and 410 MPN/100 mL for E.*coli*. Further explanation of these exceedances and linkage to sources is discussed in **Section 4.2** and **Section 4.3**.

Table 4-3. Dry Season: Summary of STV Exceedances Across Flow Duration Curve Zones by 303(d) Listed Segment.

Segment		# of Beach Sample Sites	Count	Exceedances	STV (# Exceeding)					
					WQS	Duration Curve Zone				
Number	Name					Dry (0 - 10%)	Low - Mid (10 - 40 %)	Mid (40 - 60 %)	Mid - High (60 - 90 %)	High (90 - 100%)
12	Kalabera	1	91	9	130	3	3	3	0	0
13	Talofofo	3	365	35	130	8	4	5	5	4
14	Kagman	2	184	3	130	3	0	0	0	0
15	Lao Lao	2	184	6	130	0	0	1	3	2
17A	Isley West	1	92	12	130	2	0	4	6	0
17B	Isley East	2	184	9	130	3	4	0	2	0
18A	Susupe North	5	858	18	130	5	8	2	3	0
18B	Susupe South	8	1,348	56	130	13	15	8	18	2
19A	West Takpochau (North)	6	952	91	130	19	21	15	34	2
19B	West Takpochau (Central)	9	1,681	112	130	29	35	12	32	4
19C	West Takpochau (South)	1	173	4	130	0	3	0	1	0
20A	Achugao (North)	4	678	30	130	6	6	5	4	9
20B	Achugao (South)	2	335	39	130	7	11	4	9	8
22	Banaderu	1	335	39	130	2	2	2	1	2
18LAK	Lake Susupe	1	61	2	410	0	2	0	0	0

over 10% of samples exceeded the STV WQS within the flow duration curve zone during this season

The summary of geomean concentrations for the dry season is shown in **Table 4-4** below. The grey shading indicates flow duration curve zones where the geomean exceeded the WQS of 35 MPN/100 mL for *Enterococcus* and 126 for E.*coli.* Further explanation of these exceedances and linkage to sources is discussed in **Section 4.2** and **Section 4.3**.

Table 4-4. Dry Season: Summary of Geomean Exceedances Across Flow Duration Curve Zones by 303(d) Listed Segment.

Segment		# of Beach Sample Sites	Count	Exceedances	Geomean (MPN/ 100mL)					
						Duration Curve Zone				
Number	Name				WQS	Dry (0 - 10%)	Low - Mid (10 - 40 %)	Mid (40 - 60 %)	Mid - High (60 - 90 %)	High (90 - 100%)
12	Kalabera	1	91	19	35	22	22	32	25	29
13	Talofofo	3	365	58	35	28	28	22	27	31
14	Kagman	2	184	6	35	15	17	13	21	19
15	Lao Lao	2	184	19	35	16	18	19	30	23
17A	Isley West	1	92	20	35	66	20	29	35	21
17B	Isley East	2	184	21	35	20	17	18	29	10
18A	Susupe North	5	858	16	35	12	13	13	14	14
18B	Susupe South	8	1,348	122	35	17	18	18	21	17
19A	West Takpochau (North)	6	952	227	35	24	32	38	52	53
19B	West Takpochau (Central)	9	1,681	291	35	19	23	25	26	30
19C	West Takpochau (South)	1	173	5	35	12	20	13	16	18
20A	Achugao (North)	4	678	53	35	18	16	18	17	33
20B	Achugao (South)	2	335	133	35	36	34	37	38	72
22	Banaderu	1	335	133	35	50	26	25	23	96
18LAK	Lake Susupe	1	61	5	126	74	94	37	115	228

(shaded) samples exceeded the Geomean WQS within the flow duration curve zone during this season

The summary of STV exceedances for the wet season is shown in **Table 4-5** below. The grey shading indicates flow duration curve zones where over 10% of samples exceeded the STV WQS of 130 MPN/100 mL for *Enterococcus* and 410 MPN/100 mL for E.*coli.* Further explanation of these exceedances and linkage to sources is discussed in **Section 4.2** and **Section 4.3**.

Table 4-5. Wet Season: Summary of STV Exceedances Across Flow Duration Curve Zones by 303(d) Listed Segment

Segment		# of Beach Sample Sites	Count	Exceedances	STV (# Exceeding)					
					WQS	Duration Curve Zone				
Number	Name					Dry (0 - 10%)	Low - Mid (10 - 40 %)	Mid (40 - 60 %)	Mid - High (60 - 90 %)	High (90 - 100%)
12	Kalabera	1	36	6	130	0	0	2	2	2
13	Talofofo	3	150	29	130	1	2	2	6	12
14	Kagman	2	82	7	130	0	1	0	2	4
15	Lao Lao	2	84	14	130	0	3	0	5	6
17A	Isley West	1	41	6	130	0	1	0	3	2
17B	Isley East	2	82	8	130	0	0	1	2	5
18A	Susupe North	5	426	18	130	0	0	2	12	4
18B	Susupe South	8	666	60	130	2	7	9	31	11
19A	West Takpochau (North)	6	458	74	130	2	8	7	33	24
19B	West Takpochau (Central)	9	842	152	130	7	17	2	65	61
19C	West Takpochau (South)	1	86	7	130	0	0	1	6	0
20A	Achugao (North)	4	337	30	130	0	2	1	19	8
20B	Achugao (South)	2	156	41	130	0	3	4	15	19
22	Banaderu	1	156	41	130	0	1	1	2	0
18LAK	Lake Susupe	1	36	6	410	0	0	1	1	4

over 10% of samples exceeded the STV WQS within the flow duration curve zone during this season

The summary of geomean concentrations for the wet season is shown in **Table 4-6** below. The grey shading indicates flow duration curve zones where the geomean exceeded the WQS of 35 MPN/100 mL for *Enterococcus* and 126 for E.*coli.* Further explanation of these exceedances and linkage to sources is discussed in **Section 4.2** and **Section 4.3**.

Table 4-6. Wet Season: Summary of Geomean Exceedances Across Flow Duration Curve Zones by 303(d) Segment.

Segment		# of Beach Sample Sites	Count	Exceedances	Geomean (MPN/ 100mL)					
						Duration Curve Zone				
Number	Name				WQS	Dry (0 - 10%)	Low - Mid (10 - 40 %)	Mid (40 - 60 %)	Mid - High (60 - 90 %)	High (90 - 100%)
12	Kalabera	1	36	11	35	22	22	32	25	29
13	Talofofo	3	150	58	35	43	43	41	68	60
14	Kagman	2	82	18	35	13	16	20	34	23
15	Lao Lao	2	84	33	35	16	29	19	60	77
17A	Isley West	1	41	14	35	66	20	29	35	21
17B	Isley East	2	82	13	35	17	22	33	36	23
18A	Susupe North	5	426	29	35	18	14	16	17	16
18B	Susupe South	8	666	116	35	22	25	21	30	23
19A	West Takpochau (North)	6	458	190	35	78	39	44	54	75
19B	West Takpochau (Central)	9	842	322	35	106	58	29	64	79
19C	West Takpochau (South)	1	86	12	35	14	22	44	30	17
20A	Achugao (North)	4	337	53	35		19	20	35	36
20B	Achugao (South)	2	156	81	35		56	44	282	125
22	Banaderu	1	156	81	35	14	18	22	34	34
18LAK	Lake Susupe	1	36	14	126	74	94	37	115	228

(grey shading) samples exceeded the Geomean WQS within the flow duration curve zone during this season

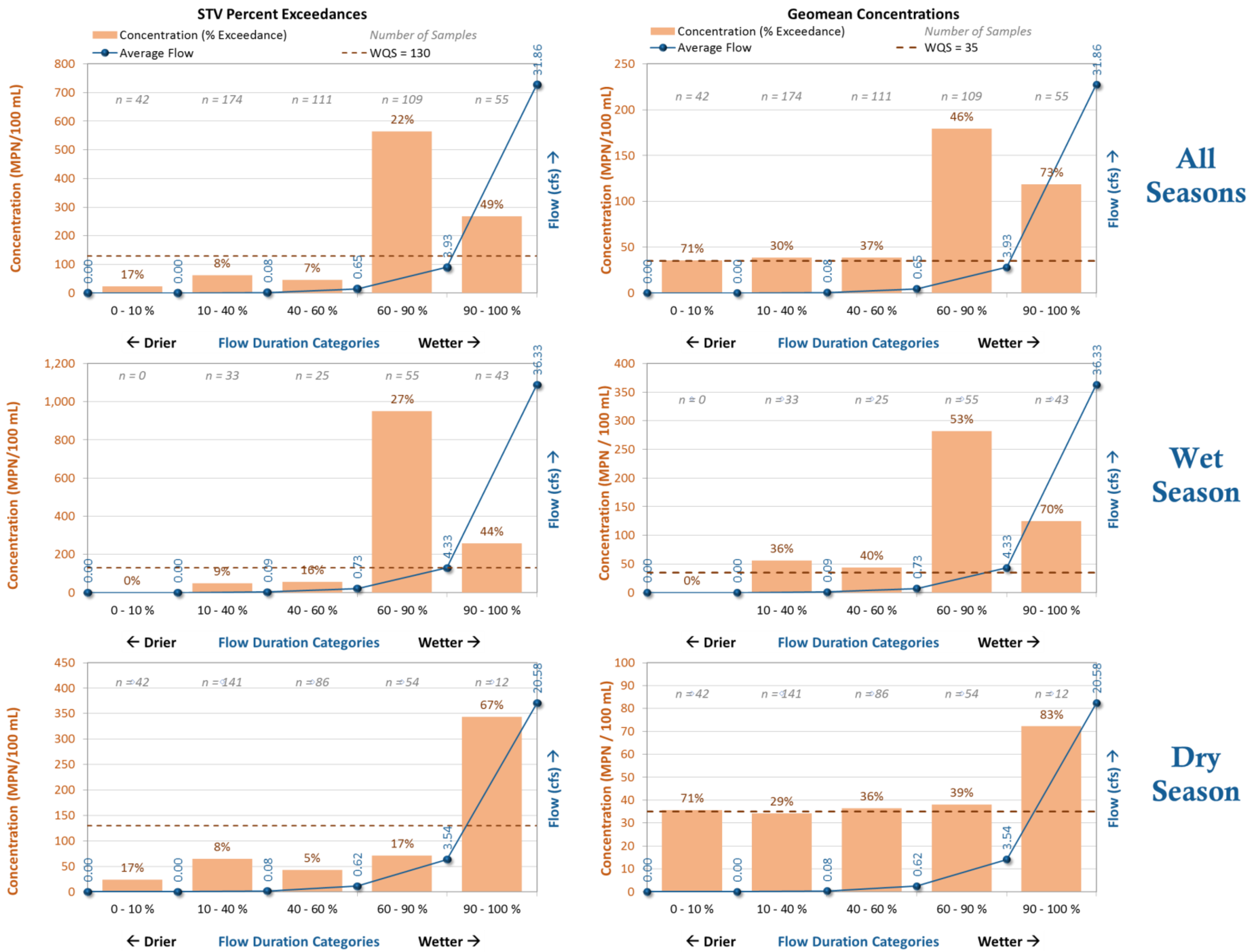

Figure 4-1. Example Single Sample and Geomean average concentration distribution for Segment 19A.

4.2 Nonpoint Sources

Nonpoint source bacterial pollution, unlike pollution from sewage treatment plants and other point sources, is usually associated with rainfall. For this reason, if higher *Enterococcus* and *E. coli* concentrations are observed during the wet season or high flows (i.e. flow duration percentages above 60% in Mid-High and High zones), it is likely that nonpoint sources are the primary pollutant source.

Overall, concentrations (single sample and geomean) for all seasons tend to be higher during higher flows. Seasonal patterns show that the highest concentrations across most segments are observed between the wet-weather months of July through October. This overall trend is highlighted in **Figure 4-2**, with higher exceedance percentages during months with high rainfall (right panel). Nearly half of the total number of WQS exceedances occur at the highest flows, indicating that wet-weather sources are a major contributor to exceedances of WQS. The geomean WQS of 35 (*Enterococcus*) and 126 (*E. coli*) is exceeded less frequently across all segments and seasons, though it also tends to exceed more frequently at higher flows.

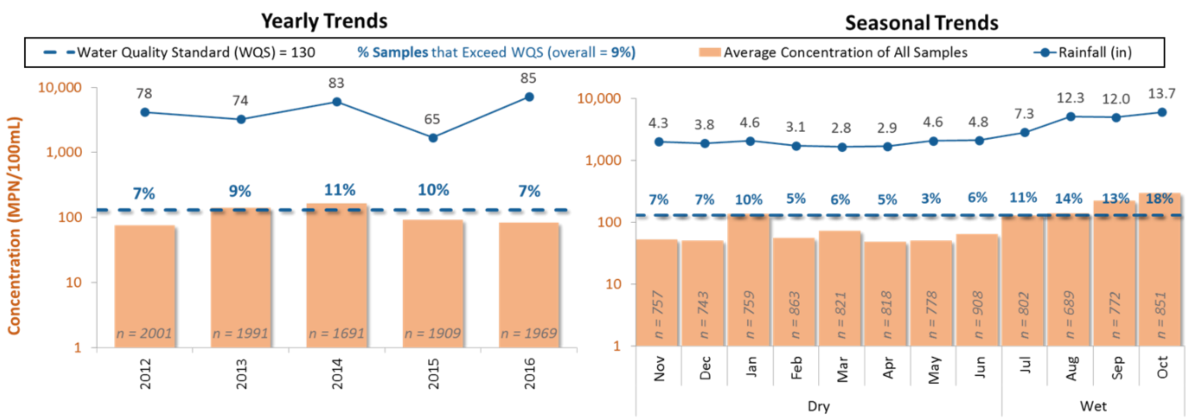

Figure 4-2. Summary of All Enterococcus Data for All Listed Segments.

All segments except Talofofo (Segment 13) and West Takpochau Central (Segment 19B) are experiencing higher *Enterococcus* and *E. coli* loading during the wet season at high flow duration curve zones (Mid - High) compared with low flow duration zones. Six segments exceed the WQS from the Low flow duration curve zone to the Low-Mid zone, though concentrations are generally much higher above the 60th percentile (Mid Zone). Stormwater runoff associated with maintenance and construction may be contributing to wet-weather pollution in Kagman (14), Isley West (17A), Isley East (17B), Susupe South (18B), W. Takpochau Central (19B), and Achugao North and South (20A & 20B). Kagman and Achugao South are impacted by new housing developments, while Isley West and Susupe South contain new resorts and golf courses. Achugao South (20B) has very high geomeans for Mid-High and High duration curve zones, though the geomean is exceeded across all duration curve zones. These wet weather exceedances are likely due to housing developments that are booming with new construction that place stress on current wastewater infrastructure in the area. W. Takpochau Central is the site of the new casino and hotel, which is likely to have an impact on bacteria loading to local waterways and beaches through increased construction and maintenance crews. W. Takpochau Central also encompasses the urbanized town of Garapan, which is impacted by high stormwater runoff. Talofofo (13) has high STV percent exceedances for the Low flow duration curve zone during the wet season, and is likely impacted by tourists who visit the area's remote beaches, without access to restroom facilities. All segments are likely experiencing sedimentation from unpaved roads associated with stormwater runoff, and coastal zone erosion that increases during the wet season when precipitation is greater. Kagman (14) is also affected by nonpoint source erosion from private lands that were previously burned.

In addition to stormwater runoff, feral animals and other wildlife guano may be contributing to nonpoint source pollution. In segments Kalabera (12), Talofofo (13), Kagman (14), Lao Lao (15), Achugao South (20B) and near Lake Susupe (18LAK), domestic and feral animals are most prevalent, though they are also present island-wide.

4.2.1 Onsite Wastewater Systems

While many residents and land owners in Saipan are served by the island's wastewater treatment plants, some are served by onsite wastewater, or septic systems. These systems may be a small, but are an important factor in bacteria loading to receiving waters, and if not designed, operated, or maintained properly, may cause the release of pathogens and excess nutrients in addition to bacteria loading to waterways. Aging, undersized, or overburdened septic systems in some watersheds may be a greater contributor to bacteria pollution than other point sources or surface water discharges.

Segments that are likely most affected by onsite wastewater systems, based on field reconnaissance, are Kagman (14), Lao Lao (15), West Takpochau Central (19B), North Achugao (20A), South Achugao (20B), and possibly near Lake Susupe. During the wet season, these segments are more likely to be impacted by bacterial loading from flooded septic systems. Heavy rainfall can saturate the ground around onsite wastewater systems, causing flooding and bacterial contamination to local waterbodies. In Lao Lao (15) for example STV exceedances are about the same for Low-Mid and Mid-High duration curve zones in Wet Season, though the geomean is significantly higher in the High duration curve zone. It is difficult to point directly to septic systems for these exceedances, but is likely that they are caused by nonpoint source pollution. In general, regulations require permits for new septic systems and other individual wastewater disposal systems (IWDS), and these systems are inspected and inventoried across Saipan. However, to characterize the extent and impact of this source, there is a need for a survey and inventory of septic and sewer systems island-wide.

4.3 Permitted Discharges & Other Point Sources

Pollution from permitted discharges and point sources occurs year-round, and usually regardless of seasons or precipitation patterns. For these reasons, if higher *Enterococcus* or *E. coli* concentrations are observed during the dry season, low flows, or equally across flow duration curve zones during wet or dry season, point sources are likely a major cause of pollution.

During the dry season, five segments had exceeded the STV WQS at low flows (Dry and Low-Mid duration curve zones): Kalabera (12), Talofofo (13), Isley West (17A), Achugao South (20B), and Banaderu (11%). Isley West, Achugao South and Banaderu also exceeded the geomean WQS at low flow duration curve zones.

Susupe South (18B) and W. Takpochau North (19A) contain wastewater treatment plants that have permits to discharge (see **Table 3-3**). These are likely sources of dry-weather loading, especially at W. Takpochau North which contains exceedances across all zones during the wet season (Low to High zones) and exceedances during dry season across Mid to High duration curve zones. W. Takpochau North, in addition, may receive bacteria loading from recreational boating and the marina near its shore.

Recreational and tourism activities may also be contributing to dry and wet-weather bacteria loading, especially in Kalabera (12), Talofofo (13), Lao Lao (15), Isley West (17A), Isley East (17B), Susupe North (18B), and near Lake Susupe. Some of these segments contain remote beaches where restroom facilities are uncommon or nonexistent, contributing to dry weather bacteria loading, or high exceedances in High duration curve zones during the dry season. Four segments are also impacted by livestock facilities and agricultural practices, which may contribute to higher *Enterococcus* concentrations: Talofofo (13), Kagman (14), W. Takpochau Central (19B) and Achugao South (20B). Achugao North, Achugao South, and Banaderu have the highest STV exceedances and contain high geomeans (Achugao South has a geomean of 72 and Banaderu has a geomean of 96) during the highest flow duration curve zones during the dry season. These segments are more affected by dry weather rain events than other segments, possibly due to agricultural practices and tourism in the watersheds.

5 TMDL ALLOCATIONS

These TMDLs are designed to address impairments to each of the 15 impaired segments on the island of Saipan. Section 303(d)(1)(C) of the Clean Water Act requires that TMDLs must be "…*established at a level necessary to implement the applicable water quality standards with seasonal variations and a margin of safety which takes into account any lack of knowledge concerning the relationship between effluent limitations and water quality*". The following sections describe how the TMDLs, margin of safety, and specific allocations were established for each impaired segment on Saipan.

5.1 Establishment of the TMDL

A TMDL for a given waterbody and pollutant includes three fundamental components: (1) a wasteload allocation (WLA) for each point source contributing to the waterbody, (2) a load allocation (LA) for the sum of all nonpoint sources (including ambient sources) contributing to the waterbody, and (3) a margin of safety (MOS) that accounts for uncertainty in the waterbody's response to the application of the point source and nonpoint source loads. The basic TMDL equation, whether developed directly through a pollutant or through surrogate indicators, is commonly expressed using these three fundamental components as:

$$TMDL = WLA + LA + MOS$$

TMDLs are also often described as the total mass of a pollutant that a waterbody can assimilate and still maintain its designated uses as expressed via a TMDL target, and frequently related directly to a numeric WQS. In determining the three components of a TMDL, the total allowable pollutant loadings from each source category (or individual source where applicable) contributing to the waterbody must be less than or equal to the TMDL target. In accordance with 40 CFR 130.2(1), TMDLs may be expressed in terms of allowable mass loadings or in terms water quality concentrations that may not be exceeded. The following sections describe the calculated TMDLs for Saipan.

Numeric targets identify the specific water column, sediment, and/or tissue goals or endpoints for the TMDL that equate to attainment of the narrative and/or numeric WQS. Impairments included on the 303(d) lists for the Saipan segments include *Enterococcus* and *E. coli*, therefore; WQS for both the geomean and single sample maximum for these two bacteria types will be used throughout for all TMDLs. All TMDL efforts will focus on load reductions that lead to attainment of these WQS and the TMDL Implementation Plan (IP) efforts will identify and prioritize efforts that lead to restoration of water quality to WQS.

5.2 Margin of Safety

The Clean Water Act requires each TMDL to be established with a MOS. A MOS is expressed as unallocated assimilative capacity or conservative assumptions used in TMDL establishment. It may be implicit (i.e. conservative assumptions used in calculating the loading capacity), or explicit, as an added separate quantity used in the TMDL calculation. The MOS accounts for uncertainty in available data, or known controls that will influence loading reductions and water quality.

An implicit MOS was incorporated into each of the TMDL calculations due to conservative assumption, primarily, the application of WQS without accounting for mixing in the receiving water which would lead to dilution of concentrations.

5.3 TMDL Allocations

Percent reductions were applied to each flow duration category based on STV and the geomean WQS for *Enterococcus* and *E. coli* (**Table 5-1**). Percent reduction targets are presented for both the geomean and STV for both wet and dry seasons. For each season, the geomean of the *Enterococci* data (or *E. coli* for Lake Susupe) for listed segments is compared to the geomean WQS and the STV WQS. These reduction targets demonstrate the extent of impairment for each flow duration category and are measures of actions necessary to improve water quality.

Percent reductions by segment based on the STV and geomean (dry season) are presented in **Table 5-2** and **Table 5-3** respectively. Percent reductions for the wet season are presented in **Table 5-4** (based on STV) and **Table 5-5** (based on geomean). In addition to tabular data, flow duration percent reduction figures were created for each listed segment. These paneled figures show baseline (existing conditions) and conditions with the applied necessary reductions for wet and dry seasons. An example percent reduction figure for Segment 19A (West Takpochau North) is shown in **Figure 5-1**. Figures for all other impaired segments are included in **Appendix E**. Reductions are presented across each flow duration curve zone; the flow duration curve zone approach and rationale is outlined at the beginning of **Section 4.1.**

Table 5-1. TMDLs and Allocations for All Segments

TMDL Component	*Enterococcus* (All Coastal Segments)	*E. coli* (Lake Susupe)
Statistical Threshold Value	130	410
Geometric Mean	35	126

5.3.1 TMDL Allocations: Dry Season

The summary of percent reductions required during the dry season using the STV WQS across each flow duration curve zone is presented in **Table 5-2** below. Reductions are consistently highest across all segments when flow is higher (i.e. a 68% reduction in the Mid-High zone for Isley West compared to a 43% reduction in the Mid zone and a 20% reduction in the Dry zone). Kalabera is the only segment with higher percent reductions in the Dry zone for the dry season.

The summary of percent reductions required during the dry season using the Geomean WQS across each flow duration curve zone is presented in **Table 5-3** below. Less segments require reductions when applying this method, though three have the greatest reductions in the High duration curve zone, except for Isley West, which has a 49% reduction requirement during dry weather events.

Table 5-2. Dry Season: Summary of Percent Reduction (based on Single Sample Values) Across Flow Duration Curve Zones by 303(d) Listed Segment

Segment		# of Beach Sample Sites	Count	Exceedances	Percent Reduction (STV) (%)					
					WQS	Duration Curve Zone				
Number	Name					Dry (0 - 10%)	Low - Mid (10 - 40 %)	Mid (40 - 60 %)	Mid - High (60 - 90 %)	High (90 - 100%)
12	Kalabera	1	91	9	130	37%	7%	13%	0%	0%
13	Talofofo	3	365	35	130	29%	0%	0%	18%	70%
14	Kagman	2	184	3	130	0%	0%	0%	0%	0%
15	Lao Lao	2	184	6	130	0%	0%	0%	0%	70%
17A	Isley West	1	92	12	130	20%	0%	43%	68%	0%
17B	Isley East	2	184	9	130	0%	0%	0%	0%	0%
18A	Susupe North	5	858	18	130	0%	0%	0%	0%	0%
18B	Susupe South	8	1,348	56	130	0%	0%	0%	0%	20%
19A	West Takpochau (North)	6	952	91	130	0%	0%	0%	44%	40%
19B	West Takpochau (Central)	9	1,681	112	130	0%	0%	0%	0%	45%
19C	West Takpochau (South)	1	173	4	130	0%	0%	0%	0%	0%
20A	Achugao (North)	4	678	30	130	0%	0%	0%	0%	71%
20B	Achugao (South)	2	335	39	130	40%	0%	0%	40%	85%
22	Banaderu	1	335	39	130	10%	0%	0%	0%	80%
18LAK	Lake Susupe	1	61	2	410	0%	0%	0%	0%	0%

Indicates required reduction (shaded cells)

Table 5-3. Dry Season: Summary of Percent Reduction (based on Geomean) Across Flow Duration Curve Zones by 303(d) Listed Segment

Segment		# of Beach Sample Sites	Count	Exceedances	Percent Reduction (Geomean) (%)					
					WQS	Duration Curve Zone				
Number	Name					Dry (0 - 10%)	Low - Mid (10 - 40 %)	Mid (40 - 60 %)	Mid - High (60 - 90 %)	High (90 - 100%)
12	Kalabera	1	91	19	35	0%	0%	0%	0%	0%
13	Talofofo	3	365	58	35	0%	0%	0%	0%	0%
14	Kagman	2	184	6	35	0%	0%	0%	0%	0%
15	Lao Lao	2	184	19	35	0%	0%	0%	0%	0%
17A	Isley West	1	92	20	35	49%	0%	0%	2%	0%
17B	Isley East	2	184	21	35	0%	0%	0%	0%	0%
18A	Susupe North	5	858	16	35	0%	0%	0%	0%	0%
18B	Susupe South	8	1,348	122	35	0%	0%	0%	0%	0%
19A	West Takpochau (North)	6	952	227	35	0%	0%	8%	33%	34%
19B	West Takpochau (Central)	9	1,681	291	35	0%	0%	0%	0%	0%
19C	West Takpochau (South)	1	173	5	35	0%	0%	0%	0%	0%
20A	Achugao (North)	4	678	53	35	0%	0%	0%	0%	0%
20B	Achugao (South)	2	335	133	35	2%	0%	4%	8%	52%
22	Banaderu	1	172	5	35	30%	0%	0%	0%	63%
18LAK	Lake Susupe	1	61	5	126	0%	0%	0%	0%	0%

Indicates required reduction

5.3.2 TMDL Allocation: Wet Season

The summary of percent reductions required during the wet season using the STV WQS across each flow duration curve zone is presented in **Table 5-4** below. More reductions are required across all zones during the wet season than the dry season (see **Table 5-2** for comparison), with some of the drier zones experiencing high reduction percentages (i.e. Talofofo with a reduction of 70% during the driest zone but 68% in the wettest zone) during the wet season.

The summary of percent reductions required during the wet season using the Geomean WQS across each flow duration curve zone is presented in **Table 5-5** below. More reductions are required across all zones during the wet season that the dry season (see **Table 5-3** for comparison), with some of the drier zones experiencing high reduction percentages (i.e. West Takpochau North with a reduction of 55% during the driest zone and 53% in the wettest zone) during the wet season.

Table 5-4. Wet Season: Summary of Percent Reduction (based on Single Sample) Across Flow Duration Curve Zones by 303(d) Listed Segment

Segment		# of Beach Sample Sites	Count	Exceedances	Percent Reduction (STV) (%)					
					WQS	Duration Curve Zone				
Number	Name					Dry (0 - 10%)	Low - Mid (10 - 40 %)	Mid (40 - 60 %)	Mid - High (60 - 90 %)	High (90 - 100%)
12	Kalabera	1	36	6	130	0%	0%	75%	60%	40%
13	Talofofo	3	150	29	130	70%	0%	40%	53%	68%
14	Kagman	2	82	7	130	0%	0%	0%	0%	30%
15	Lao Lao	2	84	14	130	0%	27%	0%	44%	57%
17A	Isley West	1	41	6	130	0%	10%	0%	57%	30%
17B	Isley East	2	82	8	130	0%	0%	40%	0%	44%
18A	Susupe North	5	426	18	130	0%	0%	0%	0%	0%
18B	Susupe South	8	666	60	130	15%	0%	47%	15%	0%
19A	West Takpochau (North)	6	458	74	130	10%	0%	59%	46%	39%
19B	West Takpochau (Central)	9	842	152	130	56%	4%	0%	47%	59%
19C	West Takpochau (South)	1	86	7	130	0%	0%	50%	38%	0%
20A	Achugao (North)	4	337	30	130	0%	0%	0%	38%	0%
20B	Achugao (South)	2	156	41	130	0%	0%	38%	63%	77%
22	Banaderu	1	156	41	130	0%	0%	60%	45%	0%
18LAK	Lake Susupe	1	36	6	410	0%	0%	20%	0%	75%

Indicates required reduction

Table 5-5. Wet Season: Summary of Percent Reduction (based on Geomean) Across Flow Duration Curve Zones by 303(d) Listed Segment

Segment		# of Beach Sample Sites	Count	Exceedances	Percent Reduction (Geomean) (%)					
					WQS	Duration Curve Zone				
Number	Name					Dry (0 - 10%)	Low - Mid (10 - 40 %)	Mid (40 - 60 %)	Mid - High (60 - 90 %)	High (90 - 100%)
12	Kalabera	1	36	11	35	0%	0%	36%	6%	0%
13	Talofofo	3	150	58	35	19%	18%	15%	49%	42%
14	Kagman	2	82	18	35	0%	0%	0%	0%	0%
15	Lao Lao	2	84	33	35	0%	0%	0%	41%	55%
17A	Isley West	1	41	14	35	0%	0%	40%	0%	0%
17B	Isley East	2	82	13	35	0%	0%	0%	2%	0%
18A	Susupe North	5	426	29	35	0%	0%	0%	0%	0%
18B	Susupe South	8	666	116	35	0%	0%	0%	0%	0%
19A	West Takpochau (North)	6	458	190	35	55%	9%	20%	35%	53%
19B	West Takpochau (Central)	9	842	322	35	67%	40%	0%	45%	56%
19C	West Takpochau (South)	1	86	12	35	0%	0%	21%	0%	0%
20A	Achugao (North)	4	337	53	35	0%	0%	0%	0%	2%
20B	Achugao (South)	2	156	81	35	0%	38%	20%	88%	72%
22	Banaderu	1	86	9	35	0%	0%	0%	0%	0%
18LAK	Lake Susupe	1	36	14	126	57%	54%	0%	21%	46%

Indicates required reduction (grey shading)

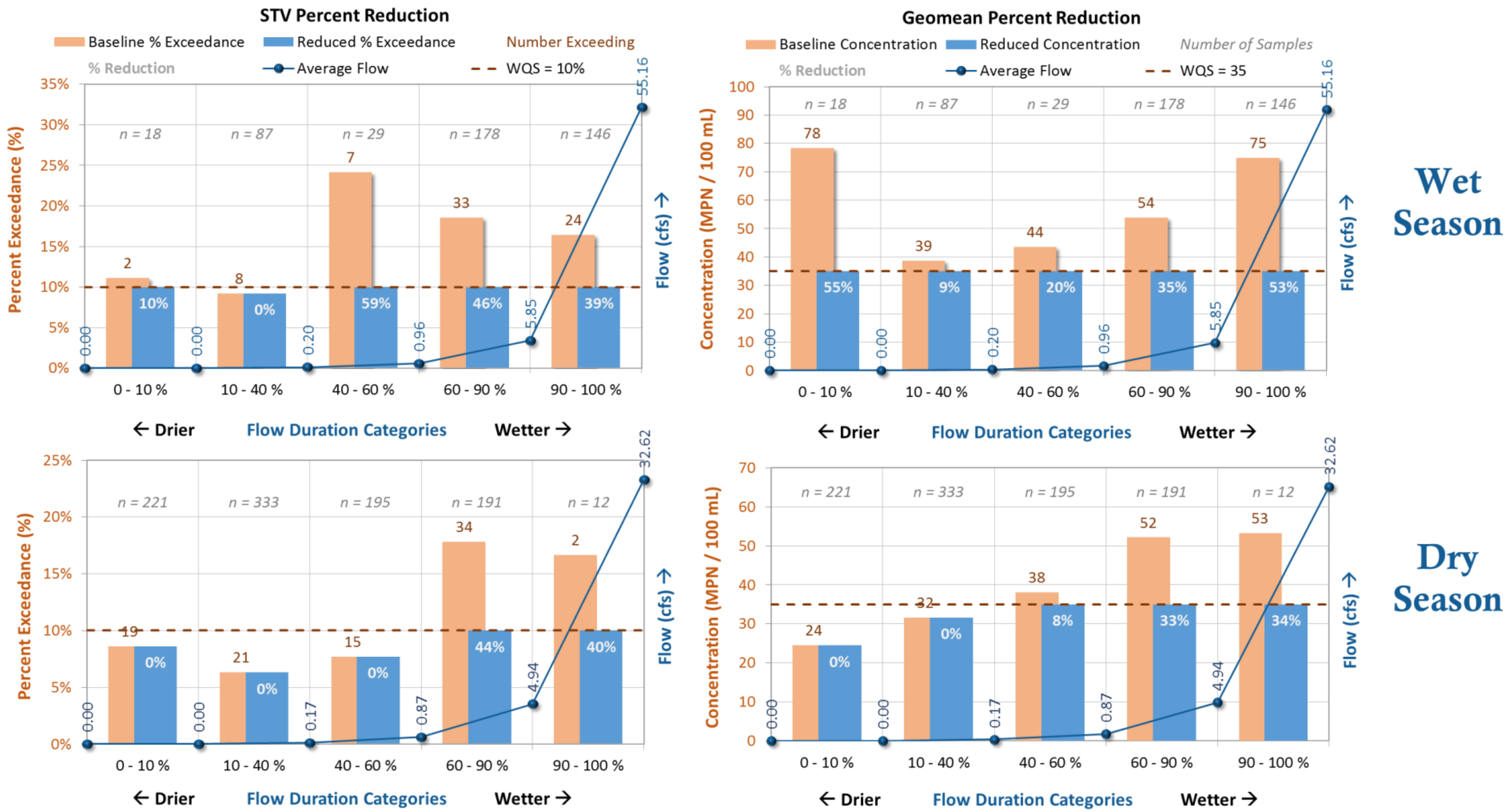

Figure 5-1. Percent Reduction of STV and Geomean Exceedances across Flow Duration Categories for Segment 19A (West Takpochau North).

6 SEASONAL VARIATION

Temporal variations are important considerations in the establishment of a TMDL and in bacterial trend analysis. Water quality analysis must consider variations in discharge rates, receiving water flows, and effects on designated uses that come from changes in seasonal precipitation patterns. Seasonal changes in Saipan are mostly affected by changes in rainfall amounts. Saipan has a wet season which normally extends from July to October, and a dry season from November to June. An analysis of rainfall patters is presented in **Section 1.5** (see **Figure 2-1**). The seasonal variation is evident when evaluated by month, with the highest rainfall amounts occurring from July to October.

Bacterial trend analysis, loading, and reductions were provided for both dry and wet seasons, allowing seasonal variation to be accounted for in TMDL calculations and implementation planning. Trends are often observed when comparing data for wet and dry seasons, and variability within these seasons can be attributed to both the frequency and magnitude of rainfall events or localized sources. For example, even during the dry season, there are likely to be precipitation events that would result in bacteria concentrations similar to wet weather events. Linkages can then be made to potential sources during each season and over the course of different flow duration curve zones.

When a TMDL is developed for waters that are impaired by point sources alone, the issuance of NPDES permits provides the reasonable assurance that WLA identified in the TMDL will be achieved. The limits provided in the NPDES permits are set at a level protective of water quality. Detailed monitoring requirements assure compliance with the limits and enforcement actions can be taken when out of compliance. When a TMDL is developed that allocates pollutant loads to both point and nonpoint sources, the TMDL should demonstrate reasonable assurance that the LAs will be achieved and the WQS will be attained. The rationale for the reasonable assurance is to ensure that the WLAs and LAs established in the TMDL are not based on unreasonable or unrealistic assumptions regarding the amount of nonpoint source pollutant reductions that will occur. This is necessary because the WLAs for point sources are determined, in part, based on the expected contributions made by nonpoint sources to the total pollutant reductions necessary to achieve WQS. If the reductions embodied in LAs are not fully achieved because of a failure to fully implement needed nonpoint source pollution controls or if the reduction potential of the proposed best management practices (BMPs) was overestimated, the collective reductions from all sources will not result in attainment of WQS. In waters impaired by nonpoint sources alone and where no WLA's are assigned, there is no requirement to demonstrate reasonable assurance as a condition of USEPA approval of the TMDL.

For this TMDL, the nonpoint source LAs make up most the pollutant contributions and, therefore, proposed nonpoint source control measures will be critical to meeting WQS.

There is reasonable assurance that the goals of these TMDLs can be met with continued watershed planning efforts of the kind referenced in this TMDL document.

7 MONITORING PLAN TO TRACK TMDL EFFECTIVENESS

After recommended management actions have been implemented, TMDL effectiveness monitoring and assessment are conducted to track the effectiveness of TMDL implementation, and to evaluate whether alternative management approaches are needed. This monitoring plan is an essential component of TMDL implementation that serves as a source of feedback for refining and optimizing these management approaches. The inter-agency operators on Saipan appear to have a strong network and high capacity for technical support across a dedicated staff. Most states rely on their current ambient monitoring network to evaluate TMDL effectiveness, but this is not always ideal because ambient water quality networks are not typically designed to provide targeted data. Instead, they are often focused on condition assessment and characterizing conditions at a watershed scale. A TMDL effectiveness monitoring plan should build on current water quality monitoring efforts, and include selecting a study design, choosing water quality parameters to monitor, and estimating sample size requirements.

There are various considerations for study designs for TMDL effectiveness monitoring. Trend monitoring involves long-term sampling data, analyzed for trends over time, from samples that are collected from the same location at regular intervals. Before/After samples are collected before and after TMDL implementation from the same location to test whether changes in water quality have occurred. Another study design involves using Upstream/Downstream samples that are collected on the same day from upstream and downstream of an implementation action to test whether water quality changes have occurred. Finally, a paired watershed study design involves samples collected on the same day from the target watershed in addition to a nearby watershed where no management actions have been taken to test whether water quality changes have occurred.

Many variables, including precipitation, seasonal pollution, and tourism fluxes impact water quality within Saipan regarding *Enterococcus* concentrations. For these reasons, it can be useful to assess TMDL effectiveness if those parameters are statistically associated with bacteria concentrations. A common covariate for pollutants in surface waters, especially rivers, is streamflow. From a review of the data available for the assessment units listed as impaired, it is recommended that the post-TMDL monitoring program reassess the available data, including sample locations and timing. In addition, a well-defined monitoring plan should be developed that focuses specific pollution sources and their impacts (land uses, discharge points, areas of concentrated construction and erosion activity). In addition, adding sample locations should be considered that help capture ambient water quality and flow/current conditions outside of the direct influence of land-based sources as a means of better understanding natural sources. Once determined, the sample locations should be used for all sampling events and should not be moved or modified without a compelling reason. Emphasis should also be placed on capturing consistent streamflow data on the island, and perhaps tidal fluctuation information. Local agencies can partner with USEPA to install flow gauges that can be monitored and maintained year-round.

Consideration should also be given to water quality monitoring during "first flush" events in key watersheds. Monitoring would include strategic timing to sample priority waterbodies during the first storm event(s) following a prolonged dry period. Sampling during these times will provide the magnitude of stored pollutants (e.g. septic effluent, created eroded materials, etc.) during the dry period. This sampling will also illuminate the magnitude of stored land-based pollutant loads and prioritize watersheds for water quality mitigation activities. In addition, it is important to have sample size requirements to demonstrate statistically significant changes in each watershed.

Given the typical impairments observed, the following is recommended as a minimum sampling parameter suite. Sampling data should include metadata that documents conditions during sampling, including weather conditions (e.g., flagging as wet vs. dry weather samples) and presence of possible pollution sources (for example, outfalls), etc. This information provides supporting information that can help interpret data, particularly when the data are out of the ordinary for a specific location.

- Total Suspended Solids
- Total Suspended Sediment
- Turbidity
- Water Temperature
- pH
- BOD
- Dissolved oxygen
- Total Phosphorous
- Orthophosphate
- Nitrate/Nitrite
- Ammonia
- Total Kjeldahl Nitrogen
- *Enterococcus* bacteria
- *E. coli bacteria*

Sediment and turbidity, can be helpful in identifying sources of *Enterococcus* contributions from the landscape and determining which form (particulate or dissolved) they originate from. As with other fecal indicator bacteria, *Enterococcus* bacteria are usually found in areas with high nutrient concentrations from wastewater contamination or fecal coliforms. Therefore, nutrient sampling may help further identify sources of *Enterococcus* bacteria across the landscape. Finally, factors such as pH and water temperature help govern the fluctuations of bacteria in waterbodies.

8 IMPLEMENTATION PLAN

This TMDL has a goal of promoting a new collaborative framework for implementing the Clean Water Act (CWA) Section 303(d) program with Saipan. A review of existing research and literature, site visits across the island, interviews and meetings with academics, industrial personnel, residents, and federal and territorial agency personnel were conducted to identify major implementation opportunities across priority watersheds. The full trip report, including photos and detailed watershed-specific information can be found in **Appendix A**.

The following subsections provide a general summary of findings and recommendations to be implemented island-wide as well as specific recommendations for each impaired segment. Implementation actions were identified based on stakeolder interviews, site visits, existing reports (i.e. integrated reports, research studies, and nearby TMDLs), and discussions with residents and experts. The implementation plan included in this TMDL should be viewed as the starting point and as a highly dynamic, living document. Numerous other opportunities not identified in this TMDL should be added continuously for consideration.

8.1 Island-wide recommendations

Saipan's inter-agency operators appear to have a strong network to identify water quality concerns, needs for training, and water quality enforcement and execution. Water quality improvements on Saipan should be implemented through support of the highly dedicated local staff. The following summarizes potential measures that can be explored by USEPA to support island-scale water quality implementation activities:

1. Support water quality projects as tourism and transient/migrant populations continue to grow. The island has current capacity to meet demand, although the pace of growth is beginning to exceed capacity to adapt. Support for water quality improvements to new and existing infrastructure, vegetation restoration and other infrastructure projects is needed.
2. Support educational programs and new infrastructure as needed, to minimize water quality impairments associated with garbage collection and properly sized and serviced restrooms. Install new or upgrade facilities in popular tourist locations.
3. Continue to implement road monitoring programs that reduce the ability for sediment to erode (i.e. road paving, increased riparian buffer using local trees, and installing green infrastructure features like bio-swales).
4. Integrate USEPA with other federal agencies to identify a pathway (or use an existing pathway) to provide funding for water quality projects that meet common goals. Currently the USEPA is known to support BECQ programs but is not active in cross-agency planning efforts involving both CNMI and Federal agencies. NRCS and NOAA Fisheries on Saipan (and Hawaii), as well as USDA Forest Service (Hawaii and California) and the Federal Highway Administration (Hawaii) are straight-forward linkages that can help to deploy funds in meaningful ways. The existing Watershed Working Group should be used to coordinate across stakeholder agencies regarding implementation planning and actions.
5. Understand planning required on tropical islands and Saipan's unique needs. Current USEPA driven regulations and assumptions for CONUS-based areas differ from those in the tropics. One such example is *Enterococcus* is native to tropical soils. However, the need to maintain and monitor water quality is essential and review of current guidelines for tropical systems may be warranted to increase relevance for the Pacific insular areas.

8.2 Kalabera Watershed (Segment 12)

Overall this watershed may be seeing significant contributions of *Enterococcus* from background sources such as bird guano at Bird Island and from soil sources, delivered as sediment during rainfall events. Potential implementation actions to improve water quality include:

- Monitoring road conditions for erosion and reducing connectivity of sediment derived from roads to waterbodies
    - Paving and grading roads, where applicable, especially highly trafficked traverses
    - Planting vegetation or green infrastructure (e.g., bio-swales) to capture sediment and water during heavy rain events.
- Provide serviced restroom facilities for tourists to match current visitation numbers
- Manage tourist traffic and limit traffic to designated areas that contain proper amenities
- Revegetate the landscape from grass-dominated to forest-dominated species, which would provide more groundwater recharge and accumulate less surface runoff.

8.3 Talofofo Watershed (Segment 13)

Implementation options to improve water quality in Talofofo Watershed, a watershed known for its popular tourist beaches and hiking, include the following; many of which have been designed or identified by on-island agencies:

- Decommissioning of unpaved roads and development of parking areas (with permeable surfaces) to limit vehicle traffic on underdeveloped roads leading to beach access
- Establishment of garbage collection and adequate restroom facilities, with maintenance
- Educational awareness at popular sites for "leave only footprints" type of campaign, with restroom and garbage collection facilities nearby.
- Greater enforcement of littering and use of designated toilet areas
- Work with ongoing efforts by the Watershed Working Group to increase vegetative cover on private lands to minimize erosion
    - Riparian planting along roads and waterways
    - Outreach & awareness about positive impacts of vegetated cover
    - Implementation of programs that promote planting native trees
    - Outreach on consequences of burning for vegetation management
    - Continued exposure with erosion campaigns and funding sources (e.g. NRCS).
- Work with NRCS, and other local groups, to improve wastewater management for livestock facilities in the watershed
- Stormwater improvements to slow sediment flow from highly erosive and connective areas (i.e. green infrastructure and bio-swales).

8.4 Kagman Watershed (Segment 14)

Kagman watershed, one of the largest watersheds with one of the island's growth areas for housing development, contains a large road network, and steep headwaters, with large lowland areas used for agriculture and urban development. Implementation activities in the Kagman watershed include:

- Active engagement with operating agencies to address Kagman water quality issues, including completion of stormwater structures, mitigating upland sediment sources (e.g., burned areas and roads)

- Support efforts and necessary feasibility studies to address wastewater treatment needs, especially in development of a potential third wastewater treatment plant
- Support water quality testing facility and staff to stay ahead of potential water quality issues associated with high development rates
- Support inspectors with BECQ (coastal zone management, etc.) to curb development violations pertaining to wastewater
- Improve overall watershed functioning to reduce burning, improve riparian function, and reforest upland areas to slow stormwater flow
- Work with NRCS and NOAA Fisheries staff directly on stormwater enhancement activities that could be supported across agency programs – expand to include USDA Forest Service and Federal Highways, where applicable, to best identify synergies in support mechanisms.

8.5 Lao Lao Watershed (Segment 15)

For several years, various restoration and watershed enhancements have been prioritized in Lao Lao Watershed and it has been the recipient of project-level funding to improve water quality. These projects include improvement of parking facilities, outreach with tourism companies, and fortification of road surfaces. There is an existing group of natural resource managers working in the Lao Lao watershed and the following represent additional potential avenues to help to improve and execute the TMDL:

- Assist in planning associated with unpaved roads in the area, particularly short sections that contribute sediment and pollutants directly to stream channels
- Support monitoring of septic systems and potential discharge from golf courses to identify any point source contaminants

8.6 East Isley Watershed (Segment 17B)

East Isley Watershed is predominantly undeveloped, and is known for containing the Saipan airport and small communities. The watershed is likely impaired by sediment-based *Enterococcus* from terrestrial sources and potentially coastal zone erosion along the seaward boundary. Potential implementation actions in East Isley Watershed include:

- Service and maintain restroom facilities for tourists
- Signage and awareness to "pack your trash" for visitors

8.7 North Susupe (Segment 18A)

The North Susupe segment is a popular destination for tourists and residents, offering beach and picnic access and large hotel accommodations as well as community events. The major road network supports major shopping centers, businesses, and inland access. Residential areas are generally smaller and on unpaved road networks. *Enterococcus* loading in these areas may be sourced from human-caused beach access, sediment derived from construction areas, and potentially from wastewater infrastructure (e.g. septic systems, large hotels). Potential implementation actions include:

- Support BECQ and other local agencies to determine types of wastewater infrastructure and methods of maintenance and citizen engagement (especially for septic usage).
- Continue funding utility infrastructure upgrades to existing sewer line to meet demands
- Work with CNMI government to evaluate options for water quality improvement particularly along beach areas and rural residential areas.

8.8 West Isley and South Susupe Watersheds (Segments 17A and 18B)

The West Isley and South Susupe watersheds receive loading from the wastewater treatment plant located on Point Agingan, and are therefore grouped to provide implementation actions for both. Urban development and popular beach access, as well as resorts and golf courses, are some of the sources that contribute to *Enterococcus* loading in these segments. Implementation actions include:

- Support ongoing plans and operations for improvements to the municipal wastewater treatment plant outfall (especially regarding maintenance).
    - Support active planning efforts to determine feasibility of increasing capacity for the treatment plant
- Increase access to restroom facilities and garbage bins

8.9 West Takpochao North (Segment 19A)

The West Takpochao North segment is defined by the wastewater treatment plant at Puerto Rico, a decommissioned open dump, and a port facility, in addition to a small mangrove area. Focused improvement in this segment includes:

- Upgrade failing infrastructure at the wastewater treatment plant (the current infrastructure contains asbestos pipes and have been identified by CNMI government as a threat to water quality)
- Expansion and enhancement of wetland vegetation, including mangroves and upland wetland areas

8.10 West Takpochao Central (Segment 19B)

The West Takpochau Central watershed is highly complex and is the center of the tourism industry on the island (with the most dominant industry being construction of a new casino/hotel). The watershed has active engagement by many local and Federal agencies, and utilizing USEPA funds to support ongoing efforts and plans would help to contribute to improvements in water quality. Suggested implementation pathways for USEPA include:

- Engage other Federal agencies with ongoing efforts to apply implementation funds to meet current needs, including NRCS, NOAA Fisheries, Federal Highway Administration, National Park Service, and USDA Forest Service State & Private Forestry (Urban & Community Forestry)
- Support increased staffing or cross-training in development inspection and enforcement to improve institutional capacity within BECQ
- Support training and implementation for wetland restoration projects in and around Garapan through existing watershed groups
- Review construction water quality BMPs for tropical island environments and consult local BECQ staff as to needs for improvement
- Support review of the new casino/hotel/shopping mall wastewater volumes and treatment pathways to identify infrastructural needs
- Consider town beautification campaigns that also increase ecosystem services, such as urban tree planting, bio-swales, and other vegetation-based flood mitigation designs.

8.11 West Takpochao South (Segment 19C)

This segment has a steady increase in population into the southern reaches of Garapan, with two road systems. Beach Road (Route 30) is narrowly adjacent to the beachfront area, and Middle Road, which services several businesses, has more topography and is connected by unpaved roads downslope. *Enterococcus* sources are likely attributed to the erosion potentials and distributed access, along with rural activities in the uplands, which is conveyed via stormwater during high events. Options include:

- Assessment of wastewater systems, including septic
- Support BECQ and NRCS watershed planning processes, including outreach to communities in rural areas to take advantage of small wastewater solutions for livestock
- Support urban planning along Middle Road, particularly for wastewater treatment
- Identify road-derived sediment sources to create mitigation designs to trap sediment during high flow events, or reduce sediment altogether.
- Work with NOAA Fisheries and other agencies to improve land-derived pollution sources that may affect Lighthouse Reef Trochus Sanctuary.

8.12 North Achugao (Segment 20A) & South Achugao (Segment 20B)

South Achugao watershed contains mostly industrial areas to the south (and a coastal wetland area) and transitions northward to a generally more rural North Achugao. Both have upland areas containing predominantly homesteads and grasslands that are frequently burned, causing additional erosion issues. These new housing developments are likely the greatest sources of sediment delivery and *Enterococcus* to the waterbodies. Options for USEPA to consider for implementation in this watershed include:

- Engage NRCS and consider USEPA NPS implementation funds for supporting small-scale water quality projects
- Engage CNMI government in planning for population growth from both migratory and immigration pathways
- Support regular site reviews of local piggeries and other local farm sites
- Support continued outreach and capacity building work with farmers and local managers to comply with WQS (to receive NRCS funding)
- Support ongoing watershed efforts in reducing fires and engagement in replanting or restoration projects.

8.13 Banaderu (Segment 22)

This watershed is largely limestone uplift, is rural, and has several popular tourist destinations that see over 30,000 people a month. The coastline is generally well-mixed and clifflike, offering very limited access other than The Grotto cave site on the eastern end of the watershed. *Enterococcus* sources from human waste at the restroom sites, or directly in the water at the Grotto are the likely sources. Implementation options include:

- Restroom improvement at the Grotto including expansion and alternative water supplies or infrastructure, closing the park when bathroom is not available (i.e. outside of regular business hours), installing an entrance gate.
- Department of Land and Natural Resources (DLNR) parks will establish user fees which will be used to increase Ranger presence and provide maintenance and enforcement in the Grotto

- Marianas Visitor Authority (MVA) will begin a mandatory Tour Operator Certification Course in October where all tour operators will be held responsible for their participants' actions. They will also install visitor friendly images for the Certification course manual about proper use of facilities.
- Support island-wide assessment of public restroom facilities, capacities and conditions
- Improve capacity for Saipan government to service restroom facilities to match tourist demands
- Support management of visitor facilities to limit guests or adapt to large influxes of tourists through moderating usage (e.g. maximum capacity limits)

8.14 Susupe Lake (Segment 18LAK)

Lake Susupe is a shallow lake and wetland habitat complex. Surrounding the lake are housing developments though it is unclear whether septic or wastewater treatment are serving the houses. Implementation measures to improve water quality include:

- Support BECQ and other local agencies to determine types of wastewater infrastructure and methods of maintenance and citizen engagement (especially for septic usage)
- Work with CNMI government to evaluate options for water quality improvement

9 ADMINISTRATIVE RECORD

An electronic copy of the administrative record was compiled to support these TMDLs.

10 REFERENCES

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