UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105

June 10, 2011

In Reply Refer To: WTR-7

Andra Samoa, CEO
American Samoa Power Authority
P.O. Box PPB
Pago Pago, AS 96799

Re: September 28-29, 2010 Clean Water Act Inspections

Dear Ms. Samoa:

Enclosed is the June 10, 2011 report for our September 28-29 diagnostic inspection of the American Samoa Power Authority ("ASPA"), Tutuila Island sewage treatment works.

We found that in 2010 the ASPA wastewater utility functioned largely as designed and up to capability just as it did in the year before, however with two significant improvements. First, a first-time assessment of sewer rates now links funding for utility operations to sewer service. Second, ASPA has an increased engineering capability to better execute capital improvement projects. Overall, the sewage treatment plants and their sewer collections systems continue to be well run and maintained; the staff is trained, largely experienced, and fully capable to successfully operate and maintain plant and equipment. The only detrimental difference from the year before was the tsunami-related damage sustained at three lift stations.

Future compliance largely depends on (1) whether the NPDES permits are reissued with their 301(h) waivers intact, (2) how the water quality standards will be measured, and (3) future installation of disinfection. Tentative waiver denials were issued last year but the final decisions have not yet been reached. Without the waivers, compliance with future NPDES permits would depend on extensive capital outlays to upgrade treatment to full secondary.

The main requirements and recommendations of this inspection are summarized below:

- ASPA must complete the rehabilitation of the Malaloloa, Satala, and Korea House lift station, and of the Utulei Clarigester #1.

- ASPA should consider reinstating formal staff training through courses in the operation and maintenance of plant and equipment.

- Sewage sludges must be self-monitored and the results reported at least once per year.

- Sewage spills must be reported as bypasses of treatment necessary to comply.

- The water quality standards for nutrients would better apply to the sewage treatment plant outfall discharges as NPDES permit effluent limits.

- ASPA should install disinfection at both sewage treatment plants and consider non-chlorine methods such as on-site bleach generation from salt brine reduction.

- Self-monitoring for both sewage treatment plants should also include total nitrogen, total phosphorus, ammonia, enterococci, and eventually chlorine residual.

- The critical initial dilution factors for both ocean outfalls and the expected peak flows through the outfalls should be verified.

I appreciate the helpfulness extended to me by the ASPA staff during this inspection. Please do not hesitate to call me at (415) 972-3504, or e-mail arthur.greg@epa.gov.

Sincerely,

Greg V. Arthur

cc: Fai Mareko, Wastewater Operations Manager, ASPA
LT Matt Vojic, USPHS, American Samoa EPA

U.S. ENVIRONMENTAL PROTECTION AGENCY

REGION 9

CLEAN WATER ACT COMPLIANCE OFFICE

NPDES DIAGNOSTIC EVALUATION INSPECTION

NPDES Permittee:	American Samoa Power Authority
	• Fogagogo-Tafuna Sewage Treatment Plant and Ocean Outfall Serving the Southwestern Tutuila Island Sewer Collection System (NPDES Permit No. AS0020010)
	• Utulei Sewage Treatment Plant and Harbor Outfall Serving the Pago Pago Harbor Sewer Collection System (NPDES Permit No. AS0020001)

Dates of Inspection:	09/28/2010	Utulei Sewage Treatment Plant Inspection
	09/28/2010	Sewer Collection System Inspection
	09/29/2010	Fogagogo-Tafuna Sewage Treatment Plant Inspection

Inspection Participants:

US EPA:	Greg V. Arthur, CWA Compliance Office, (415) 972-3504
American Samoa EPA:	LT Lyle Setwyn, Technical Services Representative (684) 731-1326
ASPA:	Fai Mareko, Wastewater Mgr, (684) 733-6132 Lino Ameperosa, Mechanic and Electrician Foreman, (684) 770-1613 Naseri Fiso, WW Services Dept, Lab Technician, (684) 633-5753

Report Prepared By: Greg V. Arthur, Environmental Engineer, USEPA Region 9
June 10, 2011

Table of Contents

1.0 Scope and Purpose

On September 28-29, 2010, EPA conducted an NPDES diagnostic evaluation inspection of the American Samoa Power Authority ("ASPA"), Tutuila Island sewage treatment works. The purpose of this evaluation inspection was to ensure compliance with the two controlling NPDES permits and to reassess the operational capability of the public utility to provide sewage collection and treatment now and in the future.

This report covers the two principal publicly-owned treatment works on Tutuila Island owned and operated by ASPA, one serving the Pago Pago harbor area, and the other serving the airport, the business park, community college, and domestic structures in the Tafuna plains. This report covers the findings and assessments pertaining to the Utulei and Tafuna sewage treatment plants, their outfalls to the harbor and ocean, and their separate sewer collection systems. This inspection does not cover the other sewage related utility work performed by ASPA in the villages outside of the sewer service areas and on other islands.

This NPDES diagnostic evaluation inspection of the ASPA Tutuila Island sewage treatment works consisted of the following:

- On-site inspection of the Tafuna sewage treatment plant;
- On-site inspection of the Utulei sewage treatment plant,
- On-site inspections of 14 of 24 on-island sewage lift stations (Atu'u, Satala, Fatumafuti, Korea House, Malaloloa Main, Coconut 1, Coconut 2, Coconut 3, Andy, Sagamea, Papa Stream, Vaitele, Skill Center, and Airport);
- Review of equipment maintenance, data management, and operator training procedures;
- Review of the ASPA FY2011 budget and the five-year capital improvement plan;
- Review of 2010 daily operations data for the Tafuna and Utulei sewage treatment plants;
- Review of 2010 effluent data for the Tafuna and Utulei sewage treatment plants;
- Review of 2010 receiving water data for both outfalls and reference stations;
- Review of 2010 spill reports for the sewage collection systems.

The inspection participants are listed on the title page. Arthur conducted the inspections on September 28 and 29.

1.1 Wastewater Facilities Plan

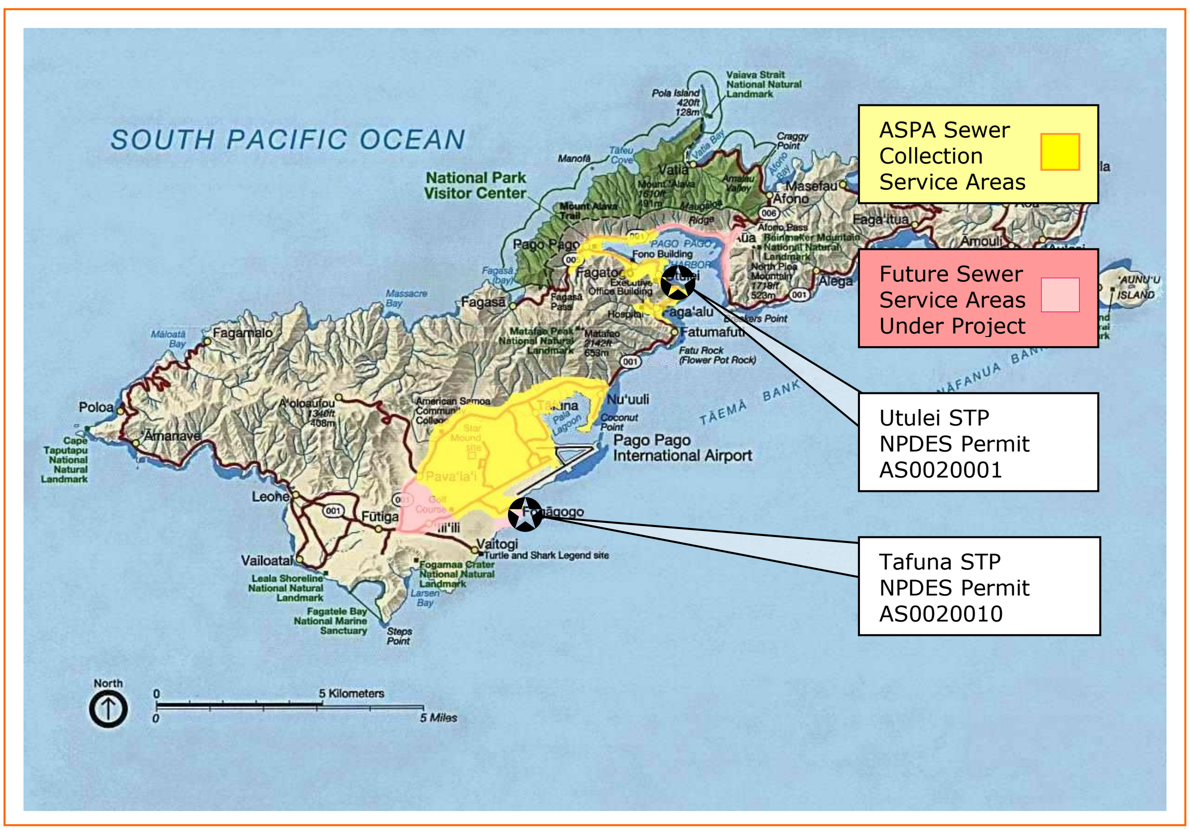
The 1985 wastewater facilities plan prepared by CH2MHill for the American Samoa Environmental Protection Agency ("ASEPA") established the course of action now followed of expanding the two existing primary sewage treatment plants to accommodate expanded sewer service areas throughout the built-up areas. ASEPA revised the wastewater facilities plan in 2003 to specifically direct funding toward the public health issues posed by raw sewage discharges. Capital improvement projects are funded through outside grants from the US Department of the Interior and the US Environmental Protection Agency. Funding for capital improvement projects is projected to be $2.755 million per year over the next five years, with water and solid waste projects averaging $1.3 million per year, and wastewater projects averaging $1.5 million per year.

The current capital improvement projects identified for future 2011-2015 funding include sewer service into Aua with upgrades of the Malaloloa pump station and one of the Utulei clarigesters ($5.4 million), furthering sewer service in Taulauta ($655k), and sewer system rehabilitation ($600k). The capital improvement projects identified for funding also included the island-wide and off-island installation of satellite septic systems ($805k).

Five-Year Wastewater CIP Plan	FY2011	FY2012	FY2013	FY2014	FY2015
Aua Sewers / Utulei Clarigester #1 Rehab	$1,755,000	$850,000	$1,500,000	$700,000	$600,000
Tualauta Sewers	-	$400,000	-	-	$255,000
Lift Station Upgrades and Sewers Rehab	-	-	-	$200,000	$400,000
Tutuila On-Island Satellite Installations	-	-	-	$500,000	-
Outer Island Satellite Installations	-	$305,000	-	-	-

1.2 Description of the Sewer Service Area

The facilities comprise two sewer service areas, independent from each other, and each handling the sewage through primary sewage treatment plants for discharge through outfalls to the ocean. <u>See</u> sections 2.1, 2.2, 2.3, 3.1, 3.2 and 3.3 of this report for configuration, operational, and capacity details.



1.3 NPDES Permits

EPA reissued the NPDES permits on September 30, 1999 for the Tafuna sewage treatment plant and on October 5, 2001 for the Utulei sewage treatment plant. Both permits advance less-than-secondary technology-based limits based on 1999 EPA 301(h) ocean waiver variance final decisions. The less-than-secondary limits for BOD and TSS removal rates are based on a Federal minimum of 30% for primary treatment. The BOD and TSS concentration and loading limits reflect past performance data. Both permits also establish limits to apply at and beyond the Zone of Initial Dilution based on the American Samoa water quality standards, which differ for Utulei into Pago Pago Harbor and Tafuna into Vai Cove. The receiving water permit limits are water column averages of discrete samples taken at three depths (top, mid, bottom) from defined water column sampling stations. Both reissued permits also establish additional monitoring requirements of the sediment, benthic communities, and sludge. See Tables 1 and 2 on pages 25 and 26 of this report for summaries of the permit requirements.

The 301(h) waiver of secondary standards for sewage treatment works requires the nine conditions in addition to those in the NPDES permit to be met through the life of the permit:

- Applicable water quality standards specific to the pollutants modified by the waiver;
- No interference with the attainment or maintenance of receiving water quality (public water supply, balanced aquatic life, recreational activities)
- Establish a system for monitoring the impacts in the receiving waters;
- No resulting additional requirements on any other point or non-point source;
- Enforcement of applicable pretreatment requirements for non-domestic sources;
- A pretreatment program for treatment works serving a population over 50,000;
- Controls for toxic pollutants from domestic sources into the treatment works;
- No substantial increases in the permitted discharge volume;
- The discharge of primary or equivalent treated wastewater that also meets the water quality standards in the receiving waters after initial mixing.

ASPA submitted NPDES permit renewal applications on May 4, 2004 for Tafuna, and on May 1, 2006 for Utulei. Both renewal applications included requests to extend the section 301(h) variance waivers. On January 14, 2009, EPA issued Tentative Decision Documents denying the 301(h) variances from secondary treatment requirements in the NPDES permits to be reissued for both treatment plants. No Final Decisions have not been issued as of yet.

2.0 Description of Wastewater Treatment Plant and Equipment

Summary

Both the Tafuna and Utulei sewage treatment plants provide primary sedimentation, anaerobic sludge digestion, and ocean outfall discharge. Both plants currently operate below their design capacities. The Tafuna sewage treatment plant accepts all septage and some collected grease generated island-wide and provides covered sludge drying beds for all digested sludge. The Tafuna plant discharges a quarter mile off-shore into the Pacific Ocean. The Utulei sewage treatment plant discharges 400 feet into the Pago Pago outer harbor with its digested sludge trucked to the Tafuna plant for sludge drying. Eight lift stations pump to Utulei. Eleven pump to Tafuna. Two plant lift stations serve as treatment plant intakes. Three out-of-service-area lift stations discharge through unpermitted outfalls to the ocean.

Requirements

- None.

Recommendations

- ASPA should complete the repair or replacement of Utulei Clarigester No.1, the tsunami-damaged Satala and Korea House lift stations, and the Malaloloa main lift station.

- ASPA should complete the lift station installations of SCADA remote sensing telemetry.

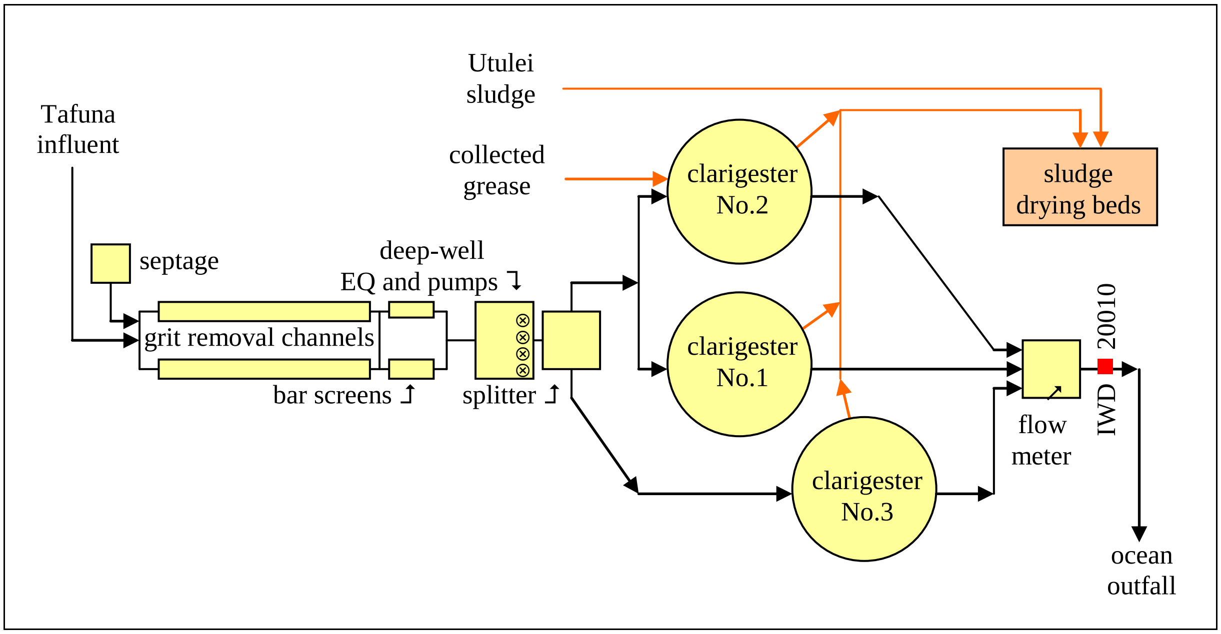
2.1 Tafuna Sewage Treatment Plant

The condition of the Tafuna sewage treatment plant was found in this inspection to be essentially the same as it was in the July 2007 and April 2009 inspections, before the tsunami. The destruction of the back fence and gate appeared to be the only unrepaired damage from the tsunami. The tsunami also scoured away shoreline riprap leaving the ocean outfall terminal box exposed. See Photos #1 through #7 in Section 2.5 on pages 11 and 12 of this report.

The Tafuna sewage treatment plant provides primary treatment and undisinfected discharge through an ocean outfall. The unit processes consist of long-channel grit removal, manual bar screens, a deep-well influent pump station, three clarigesters, and an ocean outfall. Outfall studies have listed the critical initial dilution from the Tafuna outfall to be 187:1. Clarigesters are primary sedimentation basins with a clear well section above an anaerobic digester section. Like primary sedimentation basins, clarigesters are outfitted with a rotating arm to scrape off scum. Unlike primary sedimentation basins, clarigester sludge drains directly to the underlying digester section through a portal in the conical-shaped partition.

ASPA operates the Tafuna sewage treatment plant under the assumption that each clarigester has a rated capacity of 1.0 mgd, for a total rated plant capacity of 3.0 mgd. However, the as-built drawings list a smaller design criterion of 2.16 mgd. The average daily flows of 1.94

mgd in 2010 are nearing the as-built design criteria but not the assumed rated capacity. Maximum daily flows in 2010 reached 5.3 mgd. These peak flows indicate that short-term conditions can result in flows that nearly reach the standard 3.0 design daily peaking factor. Moreover, the influent wastewater arrives near normal strength in organics but slightly weak in solids with influent concentrations averaging around 152 mg/l BOD and 105 mg/l TSS. As a result, Tafuna sewage treatment plant is not nearing capacity.



Plant Design Criteria	
Daily Peak Flow	6.00 mgd
Average Daily Flow	2.16 mgd
Minimum Daily Flow	0.60 mgd
Service Population	14424
Sewer Inlet Diameter	24 inch
Outfall Diameter	24 inch
Outfall Length	1562 ft
Outfall Diffuser Depth	95 ft
Diffuser Design	7 ports
Critical Initial Dilution	187:1-190:1

Primary Sed Section	No.1	Nos.2,3
Diameter	45 ft	45 ft
Surface Area	1590 ft^2	1590 ft^2
Sidewall Depth	8.0 ft	9.0 ft
Volume	95153 gal	107048 gal
Hydraulic Detention	3.50 hrs	3.50 hrs
Min Detention Time	1.25 hrs	1.25 hrs

Anaerobic Digesters	No.1	Nos.2,3
Diameter	45 ft	45 ft
Height	12 ft	12 ft
Volume	142743 gal	142743 gal
Sludge @ 3% solids	180 lbs/d	180 lbs/d
Residence Time	> 20 days	> 20 days

Wet-well Design	
Wet-well Capacity	4300 gal
Number of Pumps	4 - 17 ft of head
Pump Capacity	2 @ 400 / 2 @ 900 gpm

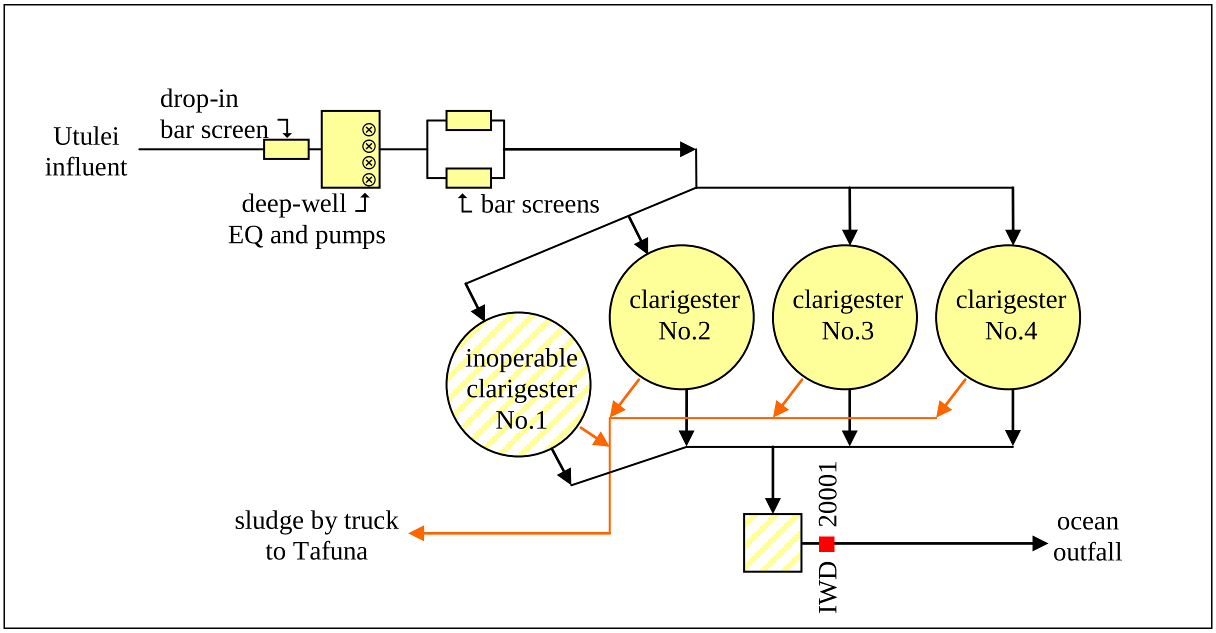
Operations at Tafuna have remained essentially unchanged since the previous NPDES permit issued in 1999. With one exception, all plant and equipment, including flow metering, were observed to be in working order. The one exception, Clarigester No.2, had bulking sludge. According to ASPA representatives, the bulking sludge is caused by the introduction of restaurant grease, collected island-wide from the school lunch program, and delivered by pumper truck for disposal into only the Clarigester No.2. See Table 3 on page 27 of this report for the statistical summaries of the influent and effluent sampling at Tafuna.

2.2 Utulei Sewage Treatment Plant

The condition of the Utulei sewage treatment plant was found during this inspection to be essentially the same as it was in the July 2007 and April 2009 inspections, with no evident tsunami damage. See Photos #8 through #10 in Section 2.5 on page 12 of this report.

The Utulei sewage treatment plant provides primary treatment and undisinfected discharge through an outfall to the outer Pago Pago harbor. The unit processes consist of a manual bar screen dropped into a deep-well influent pump station, a flow splitter box, four clarigesters, a decommissioned chlorine contact outlet structure, and an ocean outfall. The unit processes do not include grit removal or sludge drying. Outfall studies have listed the critical initial dilution from the Utulei outfall to be between 90:1 to 202:1. The Utulei plant occupies a fully-developed site without room for expansion, between cliffs, a highway along the waterfront, and a tank farm.

The Utulei as-built drawings list a design dry-weather capacity of 2.21 mgd. The average daily flows of 1.21 mgd in 2010 not only are not nearing the as-built design criterion but also and have dropped in two years by 40%. Maximum daily flows of 4.4 mgd did not exceed the standard 3.0 design daily peaking factor. The influent wastewater also arrives less than half strength in organics and solids with influent concentrations averaging around 115 mg/l BOD and 73 mg/l TSS.



Plant Design Criteria	
Daily Peak Flow	6.13 mgd
Average Daily Flow	2.21 mgd
Minimum Daily Flow	0.80 mgd
Service Population	14734
Sewer Inlet Diameter	24 inch
Outfall Diameter	24 inch
Outfall Length	954 ft
Outfall Diffuser Depth	150 ft
Diffuser Design	6 ports
Critical Initial Dilution	90:1-202:1

Primary Sed Section	Nos.1,2	Nos.3,4
Diameter	35 ft	40 ft
Surface Area	962 ft^2	1257 ft^2
Sidewall Depth	6.5 ft	9.0 ft
Volume	47000 gal	85000 gal
Hydraulic Detention	2.90 hrs	2.90 hrs
Min Detention Time	1.00 hrs	1.00 hrs

Anaerobic Digesters	Nos.1,2	Nos.3,4
Diameter	35 ft	40 ft
Height	12 ft	12 ft
Volume	86342 gal	112776 gal
Sludge @ 3% solids	180 lbs/d	180 lbs/d
Residence Time	> 20 days	> 20 days

Wet-well Design	
Wet-well Capacity	21000 gal
Number of Pumps	4 - 55 ft of head
Pump Capacity	2 @ 900 / 2 @ 1600 gpd

Operations at Utulei have remained essentially unchanged since the previous NPDES permit issued in 2001. Clarigester No.1 and the chlorine contact chamber were observed to be inoperative. Everything else, including flow metering, was observed to be fully operational. See Table 4 on page 28 of this report for the statistical summaries of the influent and effluent sampling at Utulei.

2.3 Sewage Collection Systems

ASPA owns and operates two independent sewer systems. The Utulei sewer system has one main and seven satellite lift stations. The Tafuna sewer system has one main and ten satellite lift stations. The plant inlet lift stations each have four pumps. The main sewer system lift stations each have three pumps. Fifteen satellite lift stations are dual pump stations. Five are single pump stations. ASPA has installed but not begun the operation of SCADA telemetry at the lift stations. The lift stations are listed on the next page.

Most portions of both sewer systems were found to be in good condition although there was unrepaired damaged from the tsunami on the sewer line west of Atu'u. Listed below are the inspection findings of collection system integrity (+) and collection system disrepair (-).

+ All lift stations were functioning.
- Three lift stations had tsunami damage to their electrical controls and perimeter fencing.
- One low lying lift station showed evidence from silt of high inflow from a nearby road.
- The Malaloloa lift station control panel bypass was observed in 2007, 2009, and 2010.
+ All pumps except one were found operational and in working condition.
+ There was little evidence of concrete spalling around and within any of the lift stations.
+ Metal frames, covers, and hardware were painted and functioning.

+ There was some corrosion but little evident metal disintegration.
+ There were no signs of groundwater seepage into any of the lift stations.
+ All 49 pumps of differing capacities and sizes are manufactured by Flygt as a sole source.
+ ASPA maintains spare stand-by pumps of different sizes.

ASPA Lift Stations	Discharge	Capacity (gpd)	Condition on September 28-29, 2010	
Atu'u	Utulei STP	2 @ 200	good	fully operational as designed
Satala	Utulei STP	2 @ 200	poor	tsunami damaged electrical controls
Korea House	Utulei STP	2 @ 300	poor	tsunami damaged electrical controls
Fatumafuti	Utulei STP	2 @ 200	good	fully operational as designed
Matafao School	Utulei STP	not assessed	n/a	not assessed during this inspection
Fagaalu	Utulei STP	not assessed	n/a	not assessed during this inspection
Special Ed	Utulei STP	2 @ 200	good	fully operational as designed
Malaloloa Main	Utulei STP	3 @ 900	poor	prior damaged electrical controls
Utulei STP Inlet	Utulei Ocean Outfall	2@900 / 2@1600	good	fully operational as designed
Coconut No.1	Tafuna STP	2 @ 200	good	fully operational - high inflow
Coconut No.2	Tafuna STP	2 @ 200	good	fully operational as designed
Coconut No.3	Tafuna STP	2 @ 200	fair	one pump inoperable
Andy	Tafuna STP	2 @ 200	fair	pump outlet not seated
Sagamea	Tafuna STP	2 @ 200	fair	flange connections not tightened
Papa Stream	Tafuna STP	2 @ 450	good	fully operational as designed
Skill Center	Tafuna STP	2 @ 300	good	fully operational as designed
Airport	Tafuna STP	2 @ 300	good	fully operational as designed
Lavatai	Tafuna STP	not assessed	n/a	not assessed during this inspection
Fogagogo	Tafuna STP	not assessed	n/a	not assessed during this inspection
Vaitele Main	Tafuna STP	3 @ 900	good	fully operational as designed
Tafuna STP Inlet	Tafuna Ocean Outfall	2@400 / 2@900	good	fully operational as designed

Three remote lift stations to unpermitted outfalls at Aunu'u Island, Leone High School, Fagaitua High School.

See Photos #11 through #28 in Section 2.5 on pages 12 through 15 of this report. Also see Section 3.0 on page 16 for a discussion of the operation and maintenance system-wide.

2.4 Point(s) of Compliance

Sewage Treatment Standards - Federal secondary sewage treatment standards as modified by the 301(h) waivers and the American Samoa water quality standards for pH apply end-of-process-after-treatment to the discharge into the ocean outfall effluent discharge points, designated in this report by NPDES permit numbers (NPDES-0020001 and 0020010).

Receiving Water Standards - The NPDES permit also sets zone-of-initial-dilution limits for turbiditiy, nutrients (total phosphorus, total nitrogen), dissolved oxygen, pH, change in pH, and indicator parameters (enterococci, chlorophyll-a, light penetration). These zone-of-initial-dilution limits are water column averages of discrete samples taken at three depths (top, mid, bottom) from defined water column sampling stations.

2.5 Photo Documentation

Twenty-eight of the 42 photographs taken by Arthur during this inspection are depicted here in this report. All 42 photographs are stored as digital files and available.

Photo #1: Tafuna STP – Headworks
Taken By: Greg V. Arthur
Date: 09/29/10

Photo #2: Tafuna STP – Clarigester No.1
Taken By: Greg V. Arthur
Date: 09/29/10

Photo #3: Tafuna STP – Clarigester No.2
Taken By: Greg V. Arthur
Date: 09/29/10

Photo #4: Tafuna STP – Clarigester No.3
Taken By: Greg V. Arthur
Date: 09/29/09

Photo #5: Tafuna STP – Sludge Drying Beds No.1
Taken By: Greg V. Arthur
Date: 09/29/10

Photo #6: Tafuna STP – Sludge Drying Beds No.2
Taken By: Greg V. Arthur
Date: 09/29/10

Photos #1 through #7 are of the Tafuna sewage treatment plant. Photos #8 through #10 are of the Utulei sewage treatment plant. Photos #11 through #28 are of the collection systems.

Photo #7: Tafuna STP – Septage Inlet
Taken By: Greg V. Arthur
Date: 09/29/10

Photo #8: Utulei STP – Wet-Well and Cage Barscreen
Taken By: Greg V. Arthur
Date: 09/28/10

Photo #9: Utulei STP – Clarigester Sludge Draw-off
Taken By: Greg V. Arthur
Date: 09/28/10

Photo #10: Utulei STP – Clarigester Effluent
Taken By: Greg V. Arthur
Date: 09/28/09

Photo #11: Atu'u Lift Station (Utulei service area)
Taken By: Greg V. Arthur
Date: 09/28/10

Photo #12: Satala Lift Station (Utulei service area)
Taken By: Greg V. Arthur
Date: 09/28/10

Photos #1 through #7 are of the Tafuna sewage treatment plant. Photos #8 through #10 are of the Utulei sewage treatment plant. Photos #11 through #28 are of the collection systems.

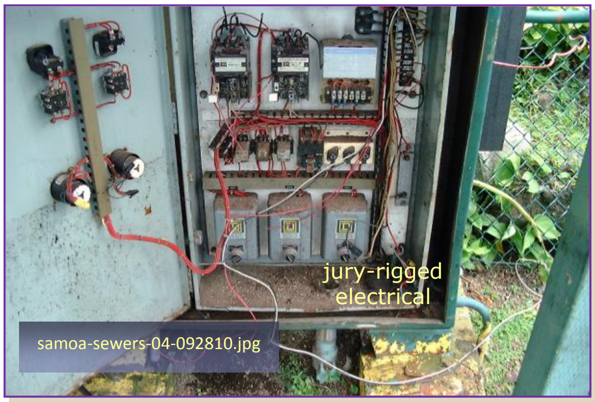


Photo #13: Satala Lift Station (Utulei service area)
Taken By: Greg V. Arthur
Date: 09/28/10

Photo #14: Satala Lift Station (Utulei service area)
Taken By: Greg V. Arthur
Date: 09/28/10

Photo #15: Malaloloa Main Lift Station (To Utulei)
Taken By: Greg V. Arthur
Date: 09/28/10

Photo #16: Malaloloa Main Lift Station (To Utulei)
Taken By: Greg V. Arthur
Date: 09/28/09

Photo #17: Korea House Lift Station (To Utulei)
Taken By: Greg V. Arthur
Date: 09/28/10

Photo #18: Fatumafuti Lift Station (To Utulei)
Taken By: Greg V. Arthur
Date: 09/28/10

Photos #1 through #7 are of the Tafuna sewage treatment plant. Photos #8 through #10 are of the Utulei sewage treatment plant. Photos #11 through #28 are of the collection systems.

Photo #19: Fatumafuti Lift Station (To Utulei)
Taken By: Greg V. Arthur
Date: 09/28/10

Photo #20: Coconut No.3 Lift Station (To Tafuna)
Taken By: Greg V. Arthur
Date: 09/28/10

Photo #21: Coconut No.2 Lift Station (To Tafuna)
Taken By: Greg V. Arthur
Date: 09/28/10

Photo #22: Coconut No.1 Lift Station (To Tafuna)
Taken By: Greg V. Arthur
Date: 09/28/10

Photo #23: Andy Lift Station (Tafuna service area)
Taken By: Greg V. Arthur
Date: 09/28/10

Photo #24: Sagamea Lift Station (To Tafuna)
Taken By: Greg V. Arthur
Date: 09/28/10

Photos #1 through #7 are of the Tafuna sewage treatment plant. Photos #8 through #10 are of the Utulei sewage treatment plant. Photos #11 through #28 are of the collection systems.

Photo #25: Papa Stream Lift Station (To Tafuna)
Taken By: Greg V. Arthur
Date: 09/28/10

Photo #26: Vaitele Main Lift Station (To Tafuna)
Taken By: Greg V. Arthur
Date: 09/28/10

Photo #27 Skill Center Lift Station (To Tafuna)
Taken By: Greg V. Arthur
Date: 09/28/10

Photo #28: Airport Lift Station (Tafuna service area)
Taken By: Greg V. Arthur
Date: 09/28/10

All 42 photographs taken during this inspection are stored as digital files named Samoa-Tafuna-01-092910.jpg to Samoa-Tafuna-11-092910.jpg for the Tafuna sewage treatment plant, Samoa-Utulei-01-092810.jpg to Samoa-Utulei-07-092810.jpg for the Utulei sewage treatment plant, and Samoa-Sewers-01-092810.jpg to Samoa-Sewers-24-092810.jpg for the two independent sewer systems feeding into the Utulei and Tafuna sewage treatment plants.

3.0 Description of Wastewater Operations and Maintenance

Summary

The ASPA wastewater utility functions as designed and up to capability. Both sewage treatment plants and their sewer collections systems are well run and maintained. Nearly all aspects of the sewerage works were found to be in working order, although three tsunami-damaged lift stations in need of capital improvement did not operate as designed, and one clarigester remains inoperable. Both sewage treatment plants have standby power generators. The staff was trained, largely experienced, and capable to successfully operate and maintain plant and equipment. Operating revenue is now generated by sewer use rates. The budgeting for capital improvement continues to rely on grants and not involve bonding or capitalizing new construction. The engineering capability to manage capital improvement projects has increased although there is no engineer dedicated to wastewater.

Requirements

- None.

Recommendations

- ASPA should reinstating formal staff training through courses in the operation and maintenance of plant and equipment.

3.1 Operation and Maintenance Procedures

The sewage treatment plants and contributing sewer collection systems continue to be well run and maintained as they were found to be in the July 2007 and April 2009 inspections.

All aspects of the sewerage works were observed to be functioning. One clarigester remains inoperable, and the tsunami-damaged lift stations need repair or replacement. ASPA has the in-house abilities and procedures to properly operate and maintain the sewerage works but capital improvements for wastewater lag. ASPA uses computer calendar scheduling. All operational steps, routine maintenance tasks, and the manufacturers' maintenance tasks for every piece of equipment are entered into a database which generates a daily punch list. All work orders and trouble calls are entered into the scheduling database upon completion to ensure staff accountability. ASPA staff has radio and cell phone communication throughout the service area, and has begun the installation of SCADA remote sensing telemetry in all 24 pump stations. There is lab capability for BOD, TSS, pH, temperature, and meter calibration at both sewage treatment plants.

<u>Tafuna Sewage Treatment Plant</u> - ASPA mans the Tafuna sewage treatment plant around the clock. The staff isolates the grit channels in order to pump and manually shovel them out one channel at a time. The headworks also include manually-cleaned bar screens. All four influent pumps in the wet-well were observed to be in working order. The influent pumps

feed up to a small surge tank and flow splitter to provide gravity feed to the three clarigesters. The Tafuna plant includes a standby generator.

Utulei Sewage Treatment Plant - ASPA mans the Utulei sewage treatment plant around the clock. The Wastewater Services Department is headquartered at the Utulei sewage treatment plant, which includes the main office, a small lab, and maintenance shop and stores. A course screen cage is dropped into the influent wet-well by a hoist. There is no grit removal. The wet-well pumps, which turn on and off in response to float-level switches, pulse feed incoming sewage to a surge tank above the clarigesters. All four influent pumps in the wet-well were observed to be in working order. The flows split by gravity through hand gates to the clarigesters. The Utulei plant has a standby generator. Digested sewage from Utulei is trucked to the sludge drying beds at the Tafuna sewage treatment plant.

Sewer Collection Systems - ASPA has instituted effective procedures to ensure the continuous operation of the sewers. A collection crew visits all lift stations daily for inspection, recordings of electrical and pump readings, painting, clean-up, routine maintenance, and work order requests. There is no vandalism so the fences around the lift stations are gated but left unlocked. ASPA keeps an inventory of spare pumps of each model, and repair kits for in-house repacking. ASPA contracts out rewinding. The ASPA Power Generation machine shop has the capability to repair worn shafts. The Wastewater Division of ASPA has instituted a computerized inventory of the all plant and equipment parts for automatic reordering. The use of ITT Flygt as the sole source pump supplier has allowed ASPA to standardize procedures.

3.2 Training and Staffing

Staffing - ASPA has 28 positions dedicated to wastewater operations. Four wastewater branches function within the Wastewater Services Department of ASPA (*Treatment Plants*, *Collections*, *Maintenance*, *Line Maintenance*). A fifth wastewater branch functions in the Engineering Services Department (*Construction*).

Wastewater Services Department Staffing (September 2010)		
Supervisor’s Office	4 staff	wastewater operations and maintenance supervision, office administration, self-monitoring, laboratory analyses
Utulei Treatment Plant	5 staff	routine sewage treatment plant operations, self-monitoring, sampling, work order requests
Tafuna Treatment Plant	4 staff	
Utulei Collections	3 staff	routine collection system and lift station operations, FOG inspections of grease traps, work order requests
Tafuna Collections	2 staff	
Mechanical and Electrical	4 staff	pump inventory and maintenance with surplus assistance from ASPA Power Generation Division
Line Maintenance	6 staff	sewer line pressure flushing, connections smoke testing, facility inventory, sewer connections, heavy equipment operations

Engineering Services Department Staffing (September 2010)		
Construction	0+ staff	capital improvement projects for ASPA wastewater

Experience - The Wastewater Services Division has experienced personnel, with 30 years of service in one position and between 10-15 years in four positions. More than half of the positions are staffed by workers with more than four years of experience. The engineering and construction positions are in the Engineering Services Division. Engineering capabilities have remained under serviced because the old engineering position transferred as vacant to the Engineering Services Division, and the staff engineer handles all utility functions. ASPA indicated that it intends to hire two engineers for wastewater.

Training - ASPA started the plant and equipment maintenance program in 1994. The initial program involved skills packages by position which ASPA implemented as the basis of its wastewater training program. ASPA has funded cross training in wastewater and electrical power distribution with other utilities, in particular with the Rotorua District Council in New Zealand. The Wastewater Services Division also has cross trained staff members from other branches to do the critical function of pump repair. ASPA maintains good records of the training offered and who completed the training. The training has included courses in Flygt pump, confined space entry, electrical fundamentals, collection system operations, treatment plant operations, installation of electrical metering, utility and office software, as well as a Wastewater Level 1 Certification. ASPA has de-invested from technical training courses, and instead now relies upon in-house training. The Wastewater Services Department last held technical training courses for plant and equipment in April 2006.

3.3 Budgeting

ASPA has a wastewater operating budget for FY2011 of nearly $6.7 million, an increase of 60% over FY2010 and 95% over FY2009. For FY2011, ASPA funds wastewater operations through wastewater rates ($3,568,500), new connection fees ($50,000), and Federal capital improvement project grants from EPA ($2,550,000), from FWMA ($207,500), and from the Department of Interior ($861,500). This FY2011 budget for the first time incorporates revenue from wastewater rates based on a usage fee of $12.50 per month per water meter, and a volume charge of $1.00 per 1000 gallons. The FY2011 budget also for the first time returns a subsidy to the electrical department from wastewater billing receipts (-$771,500). In years past the wastewater department received a 13% subsidy from electrical billing.

All of this now means that operational funding is linked to sewer services. Capital improvement projects are still funded strictly through Federal grants. Bonding for future capital improvements very unlikely and may still prove difficult but not impossible now that there is a rate structure linked to sewer services.

4.0 Wastewater Treatment Plant Performance

The sewage treatment plants must meet discharge effluent limits for conventional pollutants, removal rates, pH, and nuisance conditions. [NPDES Permit AS0020010 for Tafuna §A(1,2) and NPDES Permit AS0020001 for Utulei §A(1,2)]

The receiving waters near the sewage treatment plants must meet zone-of-initial-dilution limits for nutrients, pH, enterococci, and other indicators of ambient conditions. [Tafuna Permit §A(3) and Utulei Permit §A(3)]

Sewage entering the collection systems may only discharge from the ocean outfalls of the sewage treatment plants. [Tafuna Permit §A(1) and Utulei Permit §A(1)]

Sewage sludges must meet the Federal sludge standards in 40 CFR 503. [Tafuna Permit §D(1-8) and Utulei Permit §D(1-8)]

Summary

The sewage treatment plants consistently comply with their NPDES permit effluent limits. ASPA identified no sewer system spills due to equipment failure. Both plants provisionally can be considered to have the capacity and capability to handle the domestic contributions into their collection systems. However, neither plant provides disinfection and the impacts upon their receiving waters through water column sampling are not clear. In particular, although the receiving waters have not consistently met the water quality standards at the zones-of-initial-dilution around both outfalls, the water quality at the reference stations does not significantly differ for most parameters, except enterococci and perhaps turbidity. Moreover, both plants might meet the water quality standards for nutrients, if they were applied as effluent discharge limits. See Tables 3, 4, 7, and 8 on pages 27, 28, 31, and 32 of this report.

Requirements

- Sewage sludges must be self-monitored and the results reported at least once per year.
- Sewage spills must be reported as bypasses of treatment necessary to comply.

Recommendations

- The water quality standards for total nitrogen and phosphorus would better apply to the sewage treatment plant discharges as NPDES permit effluent limits.
- ASPA should install disinfection at both sewage treatment plants and consider the use of non-chlorine methods such as on-site hypochlorite generation from salt brine reduction.
- Both sewage treatment plant discharges should be self-monitored for ammonia, total nitrogen, total phosphorus, enterococci, and eventually for residual chlorine.
- The critical initial dilution factors for both ocean outfalls and the expected peak flows through the outfalls should be verified.

4.1 NPDES Permit Limits for Tafuna

4.1.1 - Conventional Pollutants

Tafuna produces primary-treated wastewater that consistently complies with the NPDES permit effluent discharge limits for conventional pollutants. The effluent average and calculated 99th% peaks are 84 and 126 mg/l BOD and 37 and 66 mg/l TSS. The Tafuna influent is essentially equivalent in strength to typical domestic sewage, with influent average and calculated 99th% peaks of 153 and 212 mg/l BOD and 105 and 190 mg/l TSS. Consistent operation of the primary treatment results in BOD and TSS removals rates that average 44% and 58%, respectively, above the 30% NPDES permit requirements but nowhere near the 85% secondary treatment standards. All daily pH measurements and settleable solids samples complied with NPDES permit effluent limits.

4.1.2 - Nutrients

The NPDES permit sets zone-of-initial-dilution ("ZID") receiving water limits for total nitrogen and phosphorus. The water column sampling for the Tafuna outfall indicates that the receiving waters usually exceed the water quality standards for nutrients. However, the water column sampling for total phosphorus at the ZID stations did not statistically differ from the samples at the reference station sited away from the outfall's influence. For total nitrogen, the water column samples at the ZID stations statistically were slightly less contaminated than those at the reference station.

- Total Nitrogen - The average and calculated 99th% peaks were 242 and 674 μg/l at the ZID stations, and 308 and 1148 μg/l at the reference station.

- Total Phosphorus - The average and calculated 99th% peaks were 20 and 48 μg/l at the ZID stations, and 19 and 51 μg/l at the reference station.

The water quality standards, if applied upstream as effluent discharge limits, would translate upward by a factor proportional to the critical initial dilution, which is 187:1. The resulting water quality standards for the discharge would calculate out to 24.3 mg/l total nitrogen and 2.8 mg/l phosphorus. Typical weak-strength sewage has ~15 mg/l total nitrogen and ~4 mg/l total phosphorus. Typical primary treatment removes 20% and 30% of the nitrogen and phosphorus. As a result, although there is no sampling of the Tafuna discharges for nutrients, the effluent is expected to be ~12 mg/l nitrogen and ~3 mg/l phosphorus and thus should meet the calculated limits consistently for nitrogen and most of the time for phosphorus. See Section 4.5 on page 24 of this report for a discussion of the critical initial dilution factors.

4.1.3 - Indicator Parameters

Turbidity and dissolved oxygen are indicators of suspended solids and biological growth. Chlorophyll-a is an indicator parameter of nutrient-induced algal growth. Water column sampling for these indicator parameters at the ZID stations did not statistically differ to any significant degree from the samples at the reference station sited away from the outfall's influence.

- Turbidity - The average and calculated 99th% peaks were 0.17 and 0.44 NTUs at the ZID stations, and 0.15 and 0.38 NTUs at the reference station.

- Dissolved Oxygen - The average and calculated 1% minimum were 6.16 and 5.19 mg/l at the ZID stations, and 6.12 and 5.34 mg/l at the reference station.

- Chlorophyll-a - The average and calculated 99th% peaks were 191 and 751 µg/l at the ZID stations, and 215 and 717 µg/l at the reference station.

4.1.4 - Pathogens

The NPDES permit sets zone-of-initial-dilution receiving water limits for enterococci as an indicator of pathogenic hazard. Water column sampling for enterococci at the ZID stations statistically exceeds the samples at the reference station sited away from the influence of the outfall. Since the Tafuna sewage treatment plant does not disinfect, the plant is a likely contributing source of enterococci detected in the receiving waters. See section 4.2.4 on page 22 of this report.

- Enterococci - The geometric mean and calculated 95th% peaks were 41 and 5017 MPN/100ml at the ZID stations, and 11 and 477 MPN/100 ml at the reference station.

4.2 NPDES Permit Limits for Utulei

4.2.1 - Conventional Pollutants

The Utulei sewage treatment plant produces primary-treated wastewater that consistently complies with the NPDES permit effluent discharge limits for conventional pollutants. The effluent average and calculated 99th% peaks are 65 and 109 mg/l BOD and 28 and 45 mg/l TSS. The Utulei influent arrives weaker than typical domestic sewage, with influent average and calculated 99th% peaks of 115 and 177 mg/l BOD and 73 and 133 mg/l TSS. Nevertheless, consistent operation of the primary treatment results in BOD and TSS removals rates that average 44% and 58%, respectively, above the 30% NPDES permit requirements but nowhere near the 85% secondary treatment standards. All daily pH measurement and settleable solids samples complied with NPDES permit effluent limits.

4.2.2 - Nutrients

The NPDES permit sets zone-of-initial-dilution ("ZID") receiving water limits for total nitrogen and phosphorus. The water column sampling for the Utulei outfall indicates that the receiving waters sometimes exceed the water quality standards for nutrients. However, the water column sampling at the ZID stations also did not significantly differ from the samples at the reference station sited away from the outfall's influence.

- Total Nitrogen - The average and calculated 99th% peaks were 309 and 1351 µg/l at the ZID stations, and 316 and 1676 µg/l at the reference station.

- Total Phosphorus - The average and calculated 99th% peaks were 16 and 49 μg/l at the ZID stations, and 16 and 52 μg/l at the reference station.

The water quality standards, if applied upstream as effluent discharge limits, would translate upward by a factor proportional to the critical initial dilution, which was calculated for Utulei to be 202:1 in 1999 and 90:1 in 2006. The resulting water quality standards for the Utulei discharge would calculate out to 40.4 mg/l total nitrogen and 6.1 mg/l phosphorus at a critical initial dilution factor of 202:1, and 18.0 mg/l total nitrogen and 2.7 mg/l phosphorus at a factor of 90:1. The weak sewage strength and primary treatment removals would result in effluent discharges expected to be ~12 mg/l nitrogen and ~3 mg/l phosphorus. As a result, the Utulei discharges should meet the calculated 202:1 limits for nitrogen consistently and for phosphorus most of the time, but the calculated 90:1 limits for nitrogen and phosphorus most of the time. See Section 4.5 on page 24 of this report for a discussion of the critical initial dilution factors.

4.2.3 - Indicator Parameters

Turbidity and dissolved oxygen are indicators of suspended solids and biological growth. Chlorophyll-a is an indicator parameter of nutrient-induced algal growth. Water column sampling for these indicator parameters at the ZID stations did not significantly differ from the samples at the reference station sited away from the outfall's influence.

- Turbidity - The average and calculated 99th% peaks were 0.25 and 0.76 NTUs at the ZID stations, and 0.13 and 0.41 NTUs at the reference station.

- Dissolved Oxygen - The average and calculated 1% minimum were 6.1 and 4.9 mg/l at the ZID stations, and 6.1 and 4.3 mg/l at the reference station.

- Chlorophyll-a - The average and calculated 99th% peaks were 401 and 1041 μg/l at the ZID stations, and 328 and 838 μg/l at the reference station.

4.2.4 - Pathogens

The NPDES permit sets zone-of-initial-dilution receiving water limits for enterococci as an indicator of pathogenic hazard. Since the Utulei sewage treatment plant does not disinfect, it may be a source of enterococci detected in the receiving waters. Utulei had the capability to chlorinate. Chlorination was decommissioned because of the hazards involved in the trans-portaion of chlorine to the island, its delivery to the treatment plants, and its use at the plants. Therefore, chlorination may not be an available option on American Samoa. However, there are disinfection methods that do not use gas cylinder chlorine, such as on-site systems that generate hypochlorite bleach through salt brine reduction.

4.3 Collection Systems Spills

The NPDES permits requires all domestic sewage contributions into the sewage collection systems to be discharged only through the ocean outfalls [§*A(1a) of the permits*]. The

NPDES permits also prohibit the bypassing of treatment necessary to comply with standards [*Attachment 4 (14d) of the permits*]. Sewage spills would violate both provisions. The NPDES permits do not require explicitly the reporting of sewage spills, although they do require notice of bypassing [*Attachment 4 (14c) of the permits*].

ASPA records the occurrence of spills on a daily work history by account. A 2010 work history summary recorded 15 spills from sewer line back-ups and line breaks, at times from unrelated construction and excavation work by contractors or ASPA Water. The work history summary does not include the volume or duration of the spills or whether the spills reached the harbor or streams.

Spill Date	Spill Cause	Volume	Duration	Sewage Spills in 2010
01/07/2010	Sewer Back-up	unk	unk	Tafuna WWTP influent lift station wet well overflow
01/27/2010	Sewer Back-up	unk	unk	ASTCA manhole overflow
02/13/2010	Sewer Back-up	unk	unk	ASTCA manhole overflow
02/25/2010	Sewer Back-up	unk	unk	ASTCA manhole overflow
03/27/2010	Sewerline Break	unk	unk	Malaloloa lift station force main broken by construction crew
05/10/2010	Sewer Back-up	unk	unk	Matafao lift station wet well overflow
06/28/2010	Sewerline Break	unk	unk	AS Community College 8" main line
07/07/2010	Sewer Back-up	unk	unk	Petesa 4" line broken by construction company
07/29/2010	Sewer Back-up	unk	unk	Fagaalu manhole overflow
08/06/2010	Sewerline Break	unk	unk	Nuuuli 4" line broken by ASPA Water crew
09/17/2010	Sewer Back-up	unk	unk	Temporary Market manhole overflow
09/23/2010	Sewerline Break	unk	unk	KS Mart 4" line broken by construction company
10/04/2010	Sewer Back-up	unk	unk	Fagatogo manhole overflow
12/05/2010	Sewerline Break	unk	unk	Utulei 4" line broken by ASPA Water crew
12/07/2010	Sewer Back-up	unk	unk	Tafuna WWTP influent lift station wet well overflow

These spills were identified through ASPA's daily inspection of each lift station and through extensive customer use of an ASPA tip line. There were no reports submitted by ASPA to EPA or ASEPA listing these sewage spills in 2010.

4.4 Federal Sewage Sludge Disposal Limits

The sewage sludges from both Tafuna and Utulei are mixed together for combined handling and drying at the Tafuna sewage treatment plant prior to disposal. A single sample from 2004 of combined Tafuna and Utulei sludges complied with the Federal ceiling sludge metals limits for disposal as landfill cover in Table 1 of 40 CFR 503.13, and the more stringent Federal clean sludge metals limits suitable for any reuse in Table 3 of 40 CFR 503.13. No PCBs were detected. No other pesticides and toxic organics except a DDT derivative were detected at levels above quantification.

The Federal standards set requirements for only metals content, PCBs content, vector attraction, and pathogenic destruction. Compliance with the vector attraction and pathogenic destruction requirements would be expected because the treatment plants provide more than enough anaerobic digestion time in the clarigesters. Compliance with the metals and PCBs content requirements also would be expected since there are no identified sources of industrial wastewaters into the sewer systems. The industrial wastewaters from the tuna canneries discharge through an independent outfall owned by the canneries.

4.5 Critical Initial Dilution Factors

The 1999 final decision extending the 301(h) waivers and the 2009 tentative decision denying the waivers cited differing critical initial dilution factors for the zones-of-initial-dilutions established for both treatment plant outfalls. The critical initial dilution factors were calculated to be 190:1 in 1999 and 187:1 in 2009 for Tafuna and 202:1 in 1999 and 90:1 in 2009 for Utulei. The calculations depend on a number of fixed constants, in particular, the outfall diffuser depth, diffuser length, the number of diffuser ports, density differences, and the receiving water currents. The calculations are also dependent on the independent variable of the expected peak outfall discharge flow rates.

Critical Initial Dilution Factors	Analysis Year		Diffuser Design		WWTP Design Capacity		2010 Flow Statistics (mgd)			
	2009	1999	depth	ports	dry-mean	wet-peak	mean	99th%	d-max	hr-max
Tafuna Outfall	187:1	190:1	95 ft	7	2.1 mgd	6.0 mgd	1.94	3.77	5.3	5.6
Utulei Outfall	90:1	202:1	150 ft	6	2.1 mgd	6.1 mgd	1.20	2.71	4.4	5.9

Two capital improvement projects could increase the receiving water dilution for these outfalls. First, extensions of the diffusers and the subsequent increases in the number of diffuser ports would reduce peak exit flow rates and increase the calculated critical initial dilution factors. Second, the installation of surge capacity within the sewer systems or at the treatment plants would reduce the peak flow rates, which also would reduce peak exit flow rates and also increase the calculated critical initial dilution factor.

Table 1
NPDES Permit and Sludge Limits and Monitoring Requirements for Tafuna WWTP

Tafuna Effluent Limits	mo-avg	7d-avg	d-max	discreet	geo-µ	sample freq	sample type
flow (mgd)	-	-	-	-	-	continuous	continuous
BOD (mg/l)	100	150	200	-	-	once/week inf and eff	8-hr comp
BOD (lbs/day)	1669	2504	3338	-	-		
BOD (%removal)	>30%	-	-	-	-		
TSS (mg/l)	75	113	150	-	-	once/week inf and eff	8-hr comp
TSS (lbs/day)	1252	1878	2504	-	-		
TSS (%removal)	>30%	-	-	-	-		
settleable solids (ml/l)	1.0	-	2.0	-	-	once/day	grab
pH (s.u.)	-	-	-	6.5-8.6	-	once/week	grab
oil and grease (mg/l)	-	-	-	-	-	quarterly	grab
toxicity (TUc)	-	-	-	-	-	quarterly	24-hr comp

Tafuna Water Column Limits	mo-avg	7d-avg	d-max	discreet	geo-µ	sample freq	sample type
turbidity (NTU)	-	-	-	0.25	-	quarterly	metering
total phosphorus (µg/l)	-	-	-	15	-	quarterly	grab
total nitrogen (µg/l)	-	-	-	130	-	quarterly	grab
chlorophyll-a (µg/l)	-	-	-	0.25	-	quarterly	grab
light penetrate (ft-50%)	-	-	-	<130	-	quarterly	secchi disk
dissolved oxygen (mg/l)	-	-	-	5.5	-	quarterly	grab
pH (s.u.)	-	-	-	6.5-8.6	-	quarterly	grab
ΔpH (s.u.)	-	-	-	≤ 0.2	-		
enterococci (cfu/100ml)	-	-	-	124	35	quarterly	grab

Fed Sewage Sludge Limits	Table 1	Table 3				sample freq	sample type
arsenic (mg/kg-dry)	75	41	-	-	-	annually	grab
cadmium (mg/kg-dry)	85	39	-	-	-	annually	grab
copper (mg/kg-dry)	4300	1500	-	-	-	annually	grab
lead (mg/kg-dry)	840	300	-	-	-	annually	grab
mercury (mg/kg-dry)	57	17	-	-	-	annually	grab
molybdenum (mg/kg-dry)	75	-	-	-	-	annually	grab
nickel (mg/kg-dry)	420	420	-	-	-	annually	grab
selenium (mg/kg-dry)	100	100	-	-	-	annually	grab
zinc (mg/kg-dry)	7500	2800	-	-	-	annually	grab

Table 2
NPDES Permit Limits and Monitoring Requirements for Utulei WWTP

Utulei Effluent Limits	mo-avg	7d-avg	d-max	discreet	geo-µ	sample freq	sample type
flow (mgd)	-	-	-	-	-	continuous	continuous
BOD (mg/l)	78.3	117	157	-	-	once/week inf and eff	8-hr comp
BOD (lbs/day)	1085	1628	2170	-	-		
BOD (%removal)	>30%	-	-	-	-		
TSS (mg/l)	75	113	150	-	-	once/week inf and eff	8-hr comp
TSS (lbs/day)	1377	2065	2754	-	-		
TSS (%removal)	>30%			-	-		
settleable solids (ml/l)	1.0	-	2.0	-	-	once/day	grab
pH (s.u.)	-	-	-	6.5-8.6	-	once/week	grab
oil and grease (mg/l)	-	-	-	-	-	quarterly	grab
toxicity (TUc)	-	-	-	-	-	quarterly	24-hr comp

Utulei Water Column Limits	mo-avg	7d-avg	d-max	discreet	geo-µ	sample freq	sample type
turbidity (NTU)	-	-	-	0.75	-	quarterly	metering
total phosphorus (µg/l)	-	-	-	30	-	quarterly	grab
total nitrogen (µg/l)	-	-	-	200	-	quarterly	grab
chlorophyll a (µg/l)	-	-	-	1.0	-	quarterly	grab
light penetrate (ft-50%)	-	-	-	<65	-	quarterly	secchi disk
dissolved oxygen (mg/l)	-	-	-	5.0	-	quarterly	grab
pH (s.u.)	-	-	-	6.5-8.6	-	quarterly	grab
ΔpH (s.u.)	-	-	-	≤ 0.2	-		
enterococci (cfu/100ml)	-	-	-	104	35	quarterly	grab

Table 3
Compliance with NPDES Permit and Sludge Limits at the Tafuna WWTP

Tafuna WWTP Influent (Jan 2010 – Dec 2010)	2010 sampling statistics						viols	sample events
	mean	min	5th%	95th%	99th%	d-max		
flow (mgd)	1.94	0.00	-	3.24	3.77	5.3	-	365
BOD daily-max (mg/l)	152.5	103	-	194.4	211.7	236	-	51
TSS daily-max (mg/l)	105.3	48	-	165.5	190.3	200	-	51
settleable solids (ml/l)	5.09	4.5	-	6.23	6.69	10.0	-	246

Tafuna WWTP Effluent (Jan 2010 – Dec 2010)	2010 sampling statistics						viols	sample events
	mean	min	5th%	95th%	99th%	d-max		
BOD daily-max (mg/l)	84.4	44	-	113.8	125.8	122	0/51	51
TSS daily-max (mg/l)	36.9	18	-	57.5	66.0	71	0/51	51
settleable solids (ml/l)	0.16	0.10	-	0.26	0.30	0.50	0/245	245
BOD removal rates (%)	44.4	27.2	28.7	60.1	66.6	61.7	0/12	51
TSS removal rates (%)	63.5	44.5	48.5	78.5	84.8	85.0	0/12	51
pH min/max (s.u.)	7.0 med	6.8	-	-	-	7.8	0/245	245

Tafuna Outfall Receiving Water Columns (Jan 2005 - Dec 2010)	2005-2010 sampling statistics [2]						viols [2]	sample events[2]
	ZID[1] stations A1 /A2			reference[1] station C				
	mean	95th%	99th%	mean	95th%	99th%		
total nitrogen (µg/l)	242	548	674	308	903	1148	50/84	84
total phosphorus (µg/l)	20	40	48	19	41	51	57/84	84
turbidity (NTU)	0.167	0.358	0.437	0.151	0.312	0.379	21/84	84
chlorophyll-a (µg/l)	191	587	751	215	571	717	19/84	84
dissolved oxygen (mg/l)	6.156	5.469	5.186	6.115	5.569	5.344	6/84	84
pH min/max (s.u.) [3]	8.17	7.53 min - 8.38 max		8.17	7.62 min - 8.33 max		0/83	83
enterococci (CFR/100ml) [3]	41	5017	12031	11	477	2909	30/84	84

[1] zone-of-initial-dilution and reference stations defined in §E(1a) of the NPDES permit for Tafuna
[2] stations sampled at the surface, mid-depth, and bottom. See Table 7 on page 31 of this report for all sample results.
[3] pH statistics are reported as median and min/max - enterococci as geometric-mean, geo-95th%, and max.

Tafuna/Utulei Sewage Sludge (jan 2001 - Dec 2010)	2001-2010 sludge sampling statistics [1]						viols	sample events
	mean	min	5th%	95th%	99th%	d-max		
arsenic (mg/kg-dry)	-	-	-	-	-	4.8	0/1	1
cadmium (mg/kg-dry)	-	-	-	-	-	2.8	0/1	1
copper (mg/kg-dry)	-	-	-	-	-	168.9	0/1	1
lead (mg/kg-dry)	-	-	-	-	-	32.3	0/1	1
mercury (mg/kg-dry)	-	-	-	-	-	0.18	0/1	1
molybdenum (mg/kg-dry)	-	-	-	-	-	-	-	1
nickel (mg/kg-dry)	-	-	-	-	-	210.0	0/1	1
selenium (mg/kg-dry)	-	-	-	-	-	4.3	0/1	1
zinc (mg/kg-dry)	-	-	-	-	-	894.3	0/1	1

[1] Tafuna and Utulei sludge sampling results adjusted to dry weight basis - solids content of 68.1%

Table 4
Compliance with NPDES Permit Limits at the Utulei WWTP

Utulei WWTP Influent (Jan 2010 - Dec 2010)	2010 sampling statistics						viols	sample events
	mean	min	5th%	95th%	99th%	d-max		
flow (mgd)	1.21	0.00	-	2.27	2.71	4.4	-	365
BOD daily-max (mg/l)	115.4	59	-	159.1	177.2	192	-	51
TSS daily-max (mg/l)	72.5	40	-	115.4	133.0	140	-	51
settleable solids (ml/l)	3.86	2.1	-	4.98	5.45	5.3	-	245

Utulei WWTP Effluent (Jan 2010 - Dec 2010)	2010 sampling statistics						viols	sample events
	mean	min	5th%	95th%	99th%	d-max		
BOD daily-max (mg/l)	64.6	19	-	95.8	108.7	110	0/51	51
TSS daily-max (mg/l)	28.3	18	-	40.2	45.0	49	0/51	51
settleable solids (ml/l)	0.11	0.10	-	0.18	0.20	0.50	0/244	244
BOD removal rates (%)	44.3	17.5	28.6	60.0	66.4	67.8	0/12	51
TSS removal rates (%)	58.2	27.9	38.7	77.7	85.6	79.8	0/12	51
pH min/max (s.u.)	7.0 med	6.5	-	-	-	7.2	0/245	245

Utulei Outfall Receiving Water Columns (Jan 2005 – Dec 2010)	2005-2010 sampling statistics [2]						viols [2]	sample events[2]
	ZID[1] stations A1/B1			reference[1] station 5				
	mean	95th%	99th%	mean	95th%	99th%		
total nitrogen (µg/l)	309	1047	1351	316	1279	1676	20/71	71
total phosphorus (µg/l)	16	33	49	16	42	52	4/71	71
turbidity (NTU)	0.253	0.612	0.760	0.128	0.327	0.410	3/72	72
chlorophyll-a (µg/l)	401	854	1041	328	689	838	4/72	72
dissolved oxygen (mg/l)	6.098	5.258	4.911	6.059	4.778	4.251	2/72	72
pH min/max (s.u.) [3]	8.15	7.80 min - 8.50 max		8.16	7.84 min - 8.29 max		0/72	72
enterococci (CFR/100ml) [3]	17	907	4691	9	652	3847	0/72	72

[1] zone-of-initial-dilution and reference stations defined in §E(1a) of the NPDES permit for Utulei
[2] stations sampled at the surface, mid-depth, and bottom - See Table 8 on page 32 of this report for all sample results.
[3] pH statistics are reported as median and min/max - enterococci as geometric-mean, geo-95th%, and max.

Sewage Sludge (Jan 2001 – Dec 2010)	2001-2010 sampling statistics						viols	sample events
	mean	min	5th%	95th%	99th%	d-max		
Tafuna and Utulei sludges are handled together at Tafuna. See Table 3.								

Table 5
Priority Pollutants and General Constituents for Tafuna

Tafuna WWTP Effluent	Mar05	Sep04						
ammonia-N (mg/l)	26.6	32.0						
total kjeldahl nitrogen (mg/l)	39.3	41.4						
total phosphorus (mg/l)	3.6	4.2						
oil and grease (mg/l)	26	13						
total sulfides (mg/l)	0.33	0.10						
sulfite (mg/l)	16	5						
sulfate (mg/l)	10.9	17.7						
MBAS (mg/l)	1.7	0.7						
total phenolics (mg/l)	0.14	0.08						
cyanide (mg/l)	<0.003	<0.003						
aluminum (µg/l)	484	711						
arsenic (µg/l)	<1.0	<5.0						
barium (µg/l)	6.9	9.8						
boron (µg/l)	106	127						
cadmium (µg/l)	<2.0	<5.0						
chromium (µg/l)	3.1	<3.0						
copper (µg/l)	7.4	7.2						
iron (µg/l)	252	293						
lead (µg/l)	<1.0	2.5						
manganese (µg/l)	24.0	28.9						
mercury (µg/l)	0.0464	0.07						
molybdenum (µg/l)	<5.0	<9.0						
nickel (µg/l)	<3.0	<20.0						
selenium (µg/l)	<1.0	<1.0						
silver (µg/l)	<9.0	<5.0						
zinc (µg/l)	38.6	50.6						
4,4'-DDT (µg/l)	<0.029	0.018						
other pesticides (µg/l)	<0.010	<0.010						
1,4-dichlorobenzene (µg/l)	4.8	6.0						
toluene (µg/l)	<0.25	4.7						
phenol (µg/l)	82	84						
diethyl phthalate (µg/l)	6.2	7.5						
bis(2-ethylhexyl)phthalate (µg/l)	22	16						
4-nitrophenol (µg/l)	<2.7	6.6						
chloroform (µg/l)	<0.21	0.45						
methylene chloride (µg/l)	<0.21	0.64						
4-chloro-3-methylphenol (µg/l)	<0.69	1.1						
butyl benzyl phthalate (µg/l)	<0.26	1.2						
other volatiles/semi-voas (µg/l)	<0.40	<0.40						
dioxins (µg/l)	116(10^{-6})	88 (10^{-6})						

Table 6
Priority Pollutants and General Constituents for Utulei

Utulei WWTP Effluent	Mar05	Sep04					
ammonia-N (mg/l)	23.2	51.3					
total kjeldahl nitrogen (mg/l)	34.5	86.6					
total phosphorus (mg/l)	2.81	22.3					
oil and grease (mg/l)	5.5	21					
total sulfides (mg/l)	0.10	0.97					
sulfite (mg/l)	31	19					
sulfate (mg/l)	118	11.7					
MBAS (mg/l)	1.6	0.04					
total phenolics (mg/l)	0.13	0.09					
cyanide (mg/l)	<0.01	<0.003					
aluminum (µg/l)	320	356					
arsenic (µg/l)	<1.0	<5.0					
barium (µg/l)	15.3	24.2					
boron (µg/l)	276	554					
cadmium (µg/l)	<2.0	<5.0					
chromium (µg/l)	<3.0	<3.0					
copper (µg/l)	<7.0	8.1					
iron (µg/l)	275	191					
lead (µg/l)	<1.0	<2.0					
manganese (µg/l)	36.8	36.8					
mercury (µg/l)	0.0647	0.24					
molybdenum (µg/l)	<5.0	<9.0					
nickel (µg/l)	<3.0	<20					
selenium (µg/l)	<1.0	<5.0					
silver (µg/l)	<9.0	<5.0					
zinc (µg/l)	28.5	27.7					
4,4'-DDT (µg/l)	0.019	0.018					
other pesticides (µg/l)	<0.010	<0.010					
1,4-dichlorobenzene (µg/l)	4.3	4.1					
toluene (µg/l)	2.3	0.51					
phenol (µg/l)	32	12					
diethyl phthalate (µg/l)	4.4	3.5					
bis(2-ethylhexyl)phthalate (µg/l)	12.0	8.6					
4-nitrophenol (µg/l)	<0.40	13					
chloroform (µg/l)	<0.40	1.5					
methylene chloride (µg/l)	<0.40	0.42					
fluorine (µg/l)	0.38	<0.40					
phenanthrene (µg/l)	0.56	<0.40					
other volatiles/semi-voas (µg/l)	<0.40	<0.40					
dioxins (µg/l)	75 (10^{-6})	88 (10^{-6})					

Table 7
Six-Year Receiving Water Monitoring for Tafuna Outfall (2005-2010)

Tafuna	Total-N			Total-P			DO			pH			chlor-a			entero						turb		
Limits	**0.13**	**mg/l**		**0.015**	**mg/l**		**5.5**	**mg/l**		**6.5-8.6**	**s.u.**		**0.25**	**mg/l**		**124/35**	**mpn/100ml**					**0.25**	**ml/l**	
Stations	**A1**	**A2**	**C**	**A1**	**A2**	**C**	**A1**	**A2**	**C**	**A1**	**A2**	**C**	**A1**	**A2**	**C**	**A1**	**A1-lnx**	**A2**	**A2-lnx**	**C**	**C-lnx**	**A1**	**A2**	**C**
Mar-05	0.11	0.12	<0.11	0.02	0.02	0.01	6.17	6.14	6.25	8.21	8.2	8.22	0.15	1.05	0.3	10	2.303	10	2.303	10	2.303	0.2	0.2	0.19
	0.18	<0.11	<0.11	0.03	0.02	0.01	6.19	6.18	6.07	8.14	8.21	8.2	0.55	0.32	0.27	10	2.303	20	2.996	52	3.951	0.4	0.16	0.17
	<0.11	0.13	<0.11	0.02	0.02	0.01	6.15	6.3	6.14	8.13	8.22	8.21	0.14	0.18	0.95	10	2.303	10	2.303	10	2.303	0.15	0.3	0.18
Jun-05	0.4	0.26	0.35	0.02	0.02	0.02	5.97	6.06	6.07	8.31		8.08	0.13	0.13	0.13	3255	8.088	305	5.720	2909	7.976	0.3	0.3	0.19
	0.13	0.24	0.24	0.02	0.01	0.01	5.9	6.22	6.13	8.34	8.33	8.09	0.13	0.13	0.13	10	2.303	10	2.303	0	0.000	0.2	0.17	0.3
	0.6	0.24	0.23	0.01	0.01	0.01	5.69	6.21	6.16	8.1	8.38	8.1	0.27	<0.05	0.27	0	0.000	0	0.000	10	2.303	0.18	0.11	0.14
Aug-05	0.602	0.321	0.138	0.04	0.02	0.03	6.41	6.47	6.06	8.27	8.3	8.29	0.8	<0.05	<0.05	52	3.951	0	0.000	63	4.143	0.15	0.15	0.17
	0.244	0.171	0.131	0.02	0.02	0.04	6.42	6.35	6.15	8.19	8.26	8.29	0.4	<0.05	<0.05	31	3.434	10	2.303	256	5.545	0.17	0.15	0.17
	0.292	0.169	0.197	0.03	0.03	0.02	6.25	6.26	6.24	8.1	8.31	8.33	<0.05	0.27	<0.05	256	5.545	10	2.303	52	3.951	0.14	0.15	0.11
Oct-05	0.24	0.389	0.201	0.02	0.02	0.01	6.2	6.08	5.86	8.21	8.23	8.2	<0.05	0.8	0.7	1565	7.356	4352	8.379	41	3.714	0.3	0.2	0.2
	0.22	0.737	0.127	0.02	0.01	0.009	5.94	6.12	5.73	8.13	8.23	8.24	<0.05	0.8	0.8	85	4.440	52	3.951	0	0.000	0.3	0.17	0.18
	0.107	0.112	0.362	0.01	0.02	0.01	5.89	6.02	5.66	8.08	8.22	8.24	<0.05	<0.05	<0.05	10	2.303	20	2.996	0	0.000	0.2	0.3	0.19
Feb-06	0.53	0.13	0.24	0.03	0.03	0.02	8.02	6.31	6.3	8.18	8.13	8.12	<0.05	<0.05	0.28	0	0.000	0	0.000	10	2.303	<0.01	<0.01	<0.01
	0.13	0.31	0.2	0.01	0.02	0.01	5.58	6.27	6.08	8.21	8.2	8.18	0.13	<0.05	0.13	0	0.000	0	0.000	20	2.996	<0.01	<0.01	<0.01
	0.14	0.21	0.12	0.008	0.02	0.02	4.83	5.89	5.78	8.19	8.18	8.18	1.3	0.27	0.48	0	0.000	0	0.000	472	6.157	0.5	<0.01	<0.01
Nov-06	0.275	0.367	0.353	0.03	0.02	0.02	6.1	6.13	5.89	8.13	8.25	8.2	0.27	0.27	<0.8	12031	9.395	20	2.996	0	0.000	<0.01	<0.01	<0.01
	0.284	0.293	0.266	0.02	0.03	0.02	6.09	6.02	6.11	8.22	8.2	8.28	0.27	<0.8	<0.8	86	4.454	31	3.434	85	4.443	<0.01	<0.01	0.1
	0.191	0.231	0.214	0.02	0.05	0.02	6.01	6.12	6.21	8.23	8.19	8.23	<0.8	0.27	0.27	187	5.231	98	4.585	20	2.996	0.4	0.1	0.1
Feb-07	0.13	0.12	0.29	0.01	0.02	0.02	6.56	6.46	6.2	7.84	7.84	7.8	<0.09	<0.09	<0.09	7701	8.949	0	0.000	0	0.000	0.1	<0.01	<0.01
	0.14	0.11	0.11	0.02	0.01	0.02	6.56	6.65	6.45	7.86	7.88	7.81	<0.09	<0.09	<0.09	20	2.996	223	5.407	31	3.434	<0.01	<0.01	<0.01
	0.106	0.11	0.12	0.02	0.01	0.02	6.75	6.7	6.8	7.87	7.87	7.78	<0.09	<0.09	<0.09	161	5.081	63	4.143	74	4.304	<0.01	<0.01	<0.01
Sep-07	0.274	0.164	0.169	0.03	0.02	0.04	6.21	6.23	6.25	8.15	8.29	8.23	<0.3	<0.3	0.3	2723	7.909	31	3.434	988	6.896	0.08	<0.01	0.45
	0.104	0.104	0.614	0.02	0.02	0.02	6.26	6.29	6.31	8.33	7.99	8.26	0.8	<0.3	<0.3	2359	7.766	0	0.000	31	3.434	0.02	0.03	<0.01
	0.172	0.554	0.104	0.02	0.06	0.01	6.25	6.3	6.27	8.27	8.32	8.22	<0.3	<0.3	0.3	10	2.303	52	3.950	0	0.000	<0.01	0.01	<0.01
Feb-08	0.279	0.109	1.415	0.04	0.03	0.03	6.09	6.3	5.92	8.13	8.15	8.11	<0.2	<0.2	<0.2	2481	7.816	1565	7.356	216	5.375	0.28	0.22	0.25
	0.109	0.109	0.109	0.02	0.02	0.02	6.42	6.2	6.2	8.17	8.16	8.17	<0.2	<0.2	<0.2	0	0.000	0	0.000	0	0.000	0.28	0.21	0.19
	0.109	0.109	0.109	0.02	0.02	0.02	6.19	6.19	6.07	8.16	8.17	8.16	0.5	<0.2	0.5	0	0.000	0	0.000	0	0.000	0.28	0.21	0.23
May-08	0.234	1.104	0.794	0.04	0.08	0.01	5.94	5.71	5.86	8.14	7.94	7.62	<0.3	<0.3	<0.3	1989	7.595	2755	7.921	31	3.434	0.14	0.18	0.13
	0.134	0.164	0.104	0.02	0.01	0.01	5.92	5.34	5.51	7.8	7.52	8.08	<0.3	<0.3	<0.3	1100	7.003	269	5.595	10	2.303	0.16	0.04	0.11
	0.404	0.434	0.374	0.01	0.01	0.09	5.83	5.26	5.06	8.07	7.87	8.13	<0.3	<0.3	<0.3	20	2.996	41	3.714	20	2.996	0.12	0.13	0.12
Feb-09	0.279	0.109	1.415	0.04	0.03	0.03	6.09	6.3	5.92	8.13	8.15	8.11	<0.2	<0.2	<0.2	2481	7.816	1565	7.356	216	5.375	0.28	0.22	0.25
	0.109	0.109	0.109	0.02	0.02	0.02	6.42	6.2	6.2	8.17	8.16	8.17	<0.2	<0.2	<0.2	0	0.000	0	0.000	0	0.000	0.28	0.21	0.19
	0.109	0.109	0.109	0.02	0.02	0.02	6.19	6.19	6.07	8.16	8.17	8.16	0.5	<0.2	0.5	0	0.000	0	0.000	0	0.000	0.28	0.21	0.23
Sep-09	0.519	0.629	1.419	0.012	0.024	0.011	6.44	6.42	6.96	8.13	8.13	8.2	0.27	0.27	<0.15	504	6.223	3654	8.204	0	0.000	0.19	0.34	0.18
	0.509	0.609	0.859	0.01	0.01	0.011	6.25	6.32	6.77	8.14	8.12	8.15	<0.15	<0.15	<0.15	0	0.000	0	0.000	0	0.000	0.16	0.17	0.16
	0.629	0.068	0.519	0.01	<0.01	<0.01	6.08	6.11	6.63	8.16	8.15	8.17	<0.15	<0.15	<0.15	10	2.303	185	5.220	10	2.303	0.17	0.16	0.17
Feb-10	0.133	0.221	0.141	0.016	0.016	0.015	6.39	6.43	6.31	8.18	8.24	8.14	<0.3	<0.3	<0.3	1782	7.485	987	6.895	0	0.000	0.26	0.2	0.16
	0.184	0.254	0.131	0.007	0.007	0.007	6.61	6.51	6.06	8.28	8.3	8.27	<0.3	<0.3	<0.3	63	4.143	10	2.303	0	0.000	0.12	0.16	0.21
	0.201	0.23	0.142	0.008	0.009	0.009	6.6	6.53	5.89	8.28	8.31	8.27	<0.3	<0.3	<0.3	10	2.303	10	2.303	0	0.000	0.14	0.14	0.12
Oct-10	0.18	0.13	<0.05	0.007	0.022	0.013	5.25	6.52	6.11	7.99	7.95	8.02	<0.6	<0.6	<0.6	959	6.866	907	6.810	20	2.996	0.37	0.28	0.23
	<0.05	0.11	<0.05	0.013	0.015	0.013	5.1	5.81	6.1	8.1	8.07	8.06	<0.6	<0.6	<0.6	691	6.538	393	5.973	63	4.143	0.42	0.18	0.32
	0.07	<0.05	<0.05	0.013	0.014	0.012	5.18	5.62	6.02	8.1	8.09	8.14	<0.6	<0.6	<0.6	6867	8.834	10	2.303	0	0.000	0.28	0.2	0.18
Statistics		**A1/A2**	**C**		**A1/A2**	**C**		**A1/A2**	**C**		**A1/A2**	**C**		**A1/A2**	**C**			**A1/A2**	ln*x*	**C**	ln*x*		**A1/A2**	**C**
mean μ		0.242	0.308		0.020	0.019		6.156	6.115		8.17	8.17		0.191	0.215			41	3.712	11	2.430		0.167	0.151
σ(n-1)		0.186	0.361		0.012	0.014		0.416	0.331		median	median		0.240	0.216			n/a	2.921	n/a	2.264		0.116	0.098
z-95th%		0.548	0.903		0.040	0.041		5.469	5.569					0.587	0.571			5017	8.531	477	6.167		0.358	0.312
z-99th%		0.674	1.148		0.048	0.051		5.186	5.344					0.751	0.717			36930	10.52	2223	7.707		0.437	0.379
min		<0.05	<0.05		0.007	0.007		4.83	5.06		7.53	7.62		<0.05	<0.05			0	0.000	0	0.000		<0.01	<0.01
max		1.104	1.419		0.080	0.090		8.02	6.96		8.38	8.33		1.30	0.95			12031	9.395	2909	7.976		0.50	0.45
n		84	42		84	42		84	42		83	42		84	42			84	84	42	42		84	42
viols		50	26		57	21		6	1		0	0		19	13			30		6			21	3
viols%		60%	62%		68%	50%		7%	2%		0%	0%		23%	31%			36%		14%			25%	7%
correlation		ZID ≤ Reference			ZID ≈ Reference			ZID ≈ Reference			ZID ≈ Reference			ZID ≈ Reference				ZID > Reference					ZID ≥ Reference	

Table 8
Six-Year Receiving Water Monitoring for Utulei Outfall (2005-2010)

Utulei	Total-N			Total-P			DO			pH			chlor-a			entero						turb		
Limits	0.200			0.030			5.0			6.5-8.6			1.0			104/35						0.75		
Stations	A1	B1	5	A1	B1	5	A1	B1	5	A1	B1	5	A1	B1	5	A1	A1-ln*x*	B1	B1-ln*x*	C	C-ln*x*	A1	B1	5
Feb-05	0.11	0.12	1.11	0.02	0.02	0.02	5.94	5.87	5.97	8.18	8.10	8.19	0.27	0.025	0.32	0	0.000	0	0.000			0.15	0.15	0.16
	0.12	0.11	0.65	0.01	0.01	0.02	5.78	5.91	6.06	8.18	8.13	8.22	0.025	0.139	0.4	85	4.443	0	0.000			0.18	0.11	0.17
	0.11	0.11	0.11	0.009	0.009	0.02	5.85	5.93	5.95	8.18	8.21	8.10	0.27	0.179	0.3	109	4.691	0	0.000			0.20	0.16	0.15
Aug-05	0.132	0.152	0.109	0.04	0.002	0.10	6.52	6.47	6.31	8.28	8.23	8.29	0.05	0.13	0.13	250	5.521	238	5.472			0.12	0.16	0.11
	0.08	0.144	0.01	0.05	0.02	0.02	6.51	6.28	6.25	8.26	8.20	8.28	0.27	0.13	0.24	41	3.714	145	4.977			0.14	0.13	0.11
		0.154	0.11		0.03	0.01	6.69	6.37	6.30	8.26	8.16	8.28	0.5	0.13	0.13	120	4.787	134	4.898			0.15	0.18	0.13
Feb-06	0.111	0.122	0.112	0.01	0.01	0.007	6.34	6.31	8.35	8.13	8.15	8.19	0.27	0.4	0.27	0	0.000	10	2.303			<0.02	<0.02	<0.02
	0.114	0.11	0.111	0.01	0.01	0.01	6.03	6.20	6.62	8.16	8.14	8.20	0.14	1.00	0.15	0	0.000	197	5.283			<0.02	<0.02	<0.02
	0.11	0.111	0.241	0.01	0.01	0.01	5.75	5.98	6.51	8.15	8.14	8.21	0.67	0.29	0.35	86	4.454	73	4.290			0.30	<0.02	<0.02
Nov-06	0.178	0.214	0.453	0.01	0.009	0.005	6.02	6.12	6.47	8.22	8.24	8.28	0.8	1.1	0.09	171	5.142	10	2.303			<0.02	<0.02	<0.02
	0.147	0.278	0.676	0.008	0.005	0.004	6.09	5.94	6.25	8.24	8.22	8.25	0.8	0.53	0.09	10	2.303	223	5.407			<0.02	<0.02	<0.02
	0.247	0.114	0.321	0.006	0.003	0.003	6.05	6.13	6.17	8.25	8.19	8.26	0.8	0.53	0.09	0	0.000	0	0.000			<0.02	<0.02	<0.02
Feb-07	0.234	0.169	0.107	0.02	0.03	0.019	6.04	6.05	5.95	7.93	7.91	7.92	0.09	0.09	0.09	10	2.303	0	0.000			0.30	0.30	<0.02
	0.132	0.124	0.104	0.02	0.03	0.017	5.67	5.88	5.93	7.89	7.88	7.90	0.8	0.8	0.09	591	6.382	74	4.304			0.00	0.00	<0.02
	0.215	0.19	0.108	0.03	0.03	0.016	5.62	6.09	6.00	7.86	7.87	7.89	0.09	0.09	0.09	0	0.000	20	2.996			0.30	<0.03	<0.02
Sep-07	1.013	0.115	0.11	0.02	0.02	0.02	6.53	6.68	6.83	8.50	8.11	8.29	1.1	0.5	0.27	121	4.796	74	4.304	1354	7.211	0.56	0.51	0.10
	0.334	0.111	0.176	0.02	0.02	0.02	6.46	6.57	6.75	8.32	8.14	8.23	0.5	0.5	0.27	10	2.303	341	5.832	132	4.883	1.14	0.28	0.10
	0.796	0.109	0.106	0.02	0.01	0.03	6.28	6.37	6.67	8.27	8.14	8.21	0.3	0.3	0.09	31	3.401	10	2.303	10	2.303	0.10	0.23	<0.02
May-08	0.124	0.242	0.311	0.03	<0.004	0.009	5.22	4.54	5.09	8.02	8.17	8.13	1.1	0.5	<0.3	0	0.000	0	0.000	31	3.434	0.30	0.38	0.07
	0.127	0.571	0.254	0.01	<0.004	0.01	5.14	4.70	5.24	8.11	8.17	8.10	0.5	0.5	0.5	1043	6.950	246	5.505	0	0.000	0.36	0.21	0.08
	0.194	0.624	0.564	0.008	0.004	0.007	5.42	5.13	5.25	8.07	8.16	8.16	0.5	<0.3	0.5	10	2.303	0	0.000	10	2.303	0.24	0.18	0.01
Sep-08	0.524	0.125	0.113	0.04	0.03	0.02	5.88	5.95	6.27	8.14	8.14	8.17	<0.2	0.8	0.8	0	0.000	529	6.271	809	6.696	0.34	0.30	0.25
	0.152	0.118	0.117	0.03	0.02	0.02	5.85	6.00	6.19	8.17	8.17	8.14	<0.2	<0.2	0.8	66	4.190	66	4.190	0	0.000	0.40	0.40	0.19
	0.12	0.134	0.16	0.04	0.02	0.01	5.92	6.02	6.08	8.15	8.14	8.16	<0.2	<0.2	0.8	20	2.996	31	3.434	0	0.000	0.32	0.52	0.16
Feb-09	0.109	0.109	0.109	0.02	0.02	0.01	6.99	6.92	6.31	8.21	8.21	8.15	1.1	0.3	0.5	0	0.000	0	0.000	0	0.000	0.85	0.45	0.34
	0.109	0.889	0.109	0.02	0.02	0.02	6.58	6.63	6.25	8.17	8.17	8.14	0.5	0.5	0.3	213	5.361	0	0.000	0	0.000	0.43	0.50	0.31
	0.109	0.999	0.109	<0.004	0.007	0.02	6.19	6.04	5.47	8.15	8.15	8.12	0.3	<0.2	0.5	0	0.000	0	0.000	20	2.996	0.45	0.40	0.29
Sep-09	2.275	1.646	3.439	0.018	0.018	0.011	5.34	5.83	5.11	8.14	8.16	8.15	0.8	0.53	0.53	10	2.303	31	3.434	10	2.303	0.44	0.44	0.38
	1.640	0.689	0.629	0.017	0.016	0.011	5.65	5.59	5.69	8.15	8.16	8.16	<0.3	<0.3	<0.3	0	0.000	0	0.000	0	0.000	0.66	0.8	0.32
	1.919	0.629	0.189	0.013	0.012	0.011	5.75	5.73	5.52	8.17	8.17	8.16	0.53	<0.3	<0.3	0	0.000	0	0.000	0	0.000	0.58	0.25	0.48
Feb-10	0.109	0.109	0.11	0.008	0.009	0.013	7.11	7.04	6.31	8.14	8.17	8.13	0.53	<0.3	<0.3	2098	7.649	1607	7.382	2481	7.816	0.18	0.21	0.08
	0.109	0.109	0.159	0.013	0.008	0.012	6.47	6.52	3.08	8.12	8.15	8.18	0.8	0.53	<0.3	10	2.303	1106	7.009	0	0.000	0.16	0.15	0.09
	0.109	0.127	0.109	0.008	0.009	0.013	6.30	6.25	5.87	8.14	8.17	8.18	<0.3	<0.3	<0.3	74	4.304	10	2.303	10	2.303	0.18	0.13	0.04
Oct-10	0.0532	0.0677	0.0532	0.005	0.013	0.013	7.15	6.54	6.59	7.80	7.98	7.84	0.8	<0.6	0.8	0	0.000	10	2.303	31	3.434	0.22	0.15	0.26
	0.0532	0.0532	0.0532	0.014	0.013	0.012	6.62	6.22	6.33	7.87	8.00	7.90	<0.6	<0.6	<0.6	52	3.951	573	6.351	0	0.000	0.11	0.15	0.21
	0.0532	0.0532	0.0532	0.014	0.013	0.012	6.77	5.77	6.12	7.89	8.01	7.93	<0.6	0.8	<0.6	41	3.714	0	0.000	0	0.000	0.14	0.17	0.20
Statistics		**A1/B1**	**5**		**A1/B1**	**5**		**A1/B1**	**5**		**A1/B1**	**5**		**A1/B1**	**5**			**A1/B1**	ln*x*	**C**	ln*x*		**A1/B1**	**5**
mean μ		0.309	0.316		0.016	0.016		6.098	6.059		8.15	8.16		0.401	0.328			17	2.821	9	2.175		0.253	0.128
σ(n-1)		0.447	0.584		0.010	0.016		0.510	0.776		median	median		0.275	0.219			n/a	2.417	n/a	2.609		0.218	0.121
z-95th%		1.047	1.279		0.033	0.042		5.258	4.778					0.854	0.689			907	6.810	652	6.481		0.612	0.327
z-99th%		1.351	1.676		0.049	0.052		4.911	4.251					1.041	0.838			4691	8.45	3847	8.255		0.76	0.41
min		0.0532	0.010		<0.004	<0.004		4.54	3.08		7.80	7.84		0.025	0.09			0	0.000	0	0.000		<0.02	<0.02
max		2.275	3.439		0.050	0.100		7.15	8.35		8.50	8.29		1.10	0.8			2098	7.649	2481	7.816		1.14	0.48
n		71	36		71	36		72	36		72	36		72	36			72	72	21	21		72	36
viols		20	11		4	1		2	1		0	0		4	0			20		4			3	0
viols%		28%	31%		6%	3%		2%	2%		0%	0%		6%	0%			28%		19%			4%	0%
correlation		ZID ≈ Reference			ZID ≈ Reference			ZID ≈ Reference			ZID ≈ Reference			ZID ≥ Reference				ZID ≈ Reference					ZID ≥ Reference	