TECHNICAL MEMORANDUM gdc

RECOMMENDED MODIFICATIONS TO TAFUNA WWTP AND UTULEI WWTP DIFFUSER CONFIGURATIONS

Prepared For: American Samoa Power Authority Tafuna WWTP
(NPDES Permit Nos. AS0020010 and AS0020001)

Prepared By: gdc, PO. Box 1238, Trinidad, CA 95570
707-677-0123 – gdcocn@earthlink.net

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Distribution: Pascal Mues
United States Environmental Protection Agency, Region 9
Michael Wolfram
United States Environmental Protection Agency, Region 9
Christianera Tuitele
American Samoa Environmental Protection Agency

SUMMARY

Recommended diffuser configurations to increase the initial dilution from the Tafuna and Utulei wastewater treatment plant outfall discharges were developed in a scoping study prepared for the American Samoa Power Authority in 2012. The scoping study conclusions recommended configurations including the addition of an end port and changes to the existing side port sizes on the existing outfall diffusers. This Technical Memorandum presents a re-evaluation of the specific port sizes previously recommended in the scoping study. Minor changes in the sizes of the ports for each of the facilities diffusers are developed and recommended to further increase dilution performance. The changes are relatively minor compared to the recommended configurations in the scoping study. The proposed end port for the Tafuna diffuser is reduced from a 12-inch diameter port to an 11- inch diameter port and the six side ports remain as 6-inch ports (reduced from 8-inch ports on the existing diffuser). This has little effect on overall dilution but better balances the dilution from each of the ports. The proposed end port for the Utulei diffuser is increased from a 10.5-inch port to an 11-inch port and the six side ports remain at 5.5-inch ports (reduced from 6-inch ports on the existing diffuser). This results in an increase in dilution as well as a better balance in dilution from each of the ports.

1. INTRODUCTION

The American Samoa Power Authority (ASPA) owns and operates the Tafuna and Utulei wastewater treatment plants (WWTPs)[1]. The WWTPs discharge primary treated domestic wastewater into coastal waters on the southwest shore of Tutuila Island (Tafuna WWTP) and into Pago Pago Outer Harbor (Utulei WWTP). The U.S. Environmental Protection Agency (USEPA) has issued Administrative Orders (AOs)[2] that require scoping studies to investigate the feasibility of increasing the critical initial dilution (CID)[3] and/or the size of the zone of initial dilution (ZID) for the discharges from the Tafuna and Utulei WWTPs. The required scoping studies included possible projects that would reduce peak flows through the WWTPs, thus increasing the CID and/or ZID, and diffuser configuration changes that would increase the CID and/or ZID.

As a part of the required scoping studies, a Technical Memorandum (TM) was prepared that addressed potential diffuser configuration changes to increase initial dilution (diffuser scoping study).[4] Recommended diffuser configurations were developed and presented in that TM. The recommended configurations included the addition of an end port and modification of the sizes of the side ports. However, the TM indicated that additional modeling would be conducted to confirm and finalize the recommended configurations, with the potential of slight adjustments to the final configuration. This TM provides the final recommended diffuser modifications for both diffusers.

2. TAFUNA WWTP DIFFUSER CONFIGURATION

This section describes the existing diffuser configuration, the proposed diffuser configuration presented in the diffuser scoping study, and the final recommended diffuser configuration. The existing diffuser configuration is based on a recent diver inspection of the diffuser. The dilution performance of the three configurations is presented. Additional details of the diffuser configuration and the modeling used to develop the dilution performance is described in the diffuser scoping study TM. It is noted that all dilution calculations presented in this TM are based on the assumption that the plumes from the side ports discharging in alternating directions do not merge. Merging is accounted for in the case of ports discharging in the same direction.

2.1 Existing Tafuna Diffuser Configuration

The Fogagogo (Tafuna) WWTP outfall is a 24-inch diameter HDPE pipeline that extends approximately 1,600 feet from the treatment plant and is anchored to the ocean floor with a steel anchorage system attached to concrete weights placed on coral reef, sand and rock. The outfall is located on the south side of Tutuila Island adjacent the Pago Pago International Airport (Figure 2-1). The outfall terminates at a depth of approximately 95 feet with effluent released through six 8-inch diameter ports spaced over a length of 50 feet (based on drawings submitted

[1] NPDES Permits AS0020010 and AS0020001 for the Tafuna and Utulei WWTPs, respectively.

[2] CWA-309(a)-11-016 and CWA-309(a)-11-017. Issued by USEPA-Region 9 on July 27, 2011, for the Tafuna and Utulei WWTPs, respectively.

[3] The CID is the initial dilution under discharge and ambient conditions resulting in the lowest expected dilution of the effluent plume.

[4] Diffuser Configuration and Performance: Scoping Studies for the Tafuna and Utulei WWTPs. **gdc**, June 30, 2012.

with the recent inspection report). The outfall replaced a 12-inch diameter iron pipeline that remains within close proximity to the replacement outfall.

The diffuser consists of a blind flange on the end of the diffuser barrel and 6 gooseneck risers. The diffuser is connected to the outfall pipeline by a flange. The total length of the diffuser section is 61 feet; the diffuser risers span a distance of 50 feet. At the time of the recent inspection, the blind flange was partially buried in the sandy bottom. Each gooseneck riser extends directly up from the top of the diffuser barrel 28 inch high with a spacing of 10 feet between risers. The risers have 8-inch diameter ports discharging horizontally and orientated in alternating east-west directions perpendicular to the diffuser barrel. The depth of each port was measured during the inspection. The six ports were observed to have strong and equal discharge. The offshore end of the outfall is in 96 feet of water. The port depths range from 87 feet to 94 feet. Based on the recent inspections the existing diffuser configuration is described in Table 2-1.

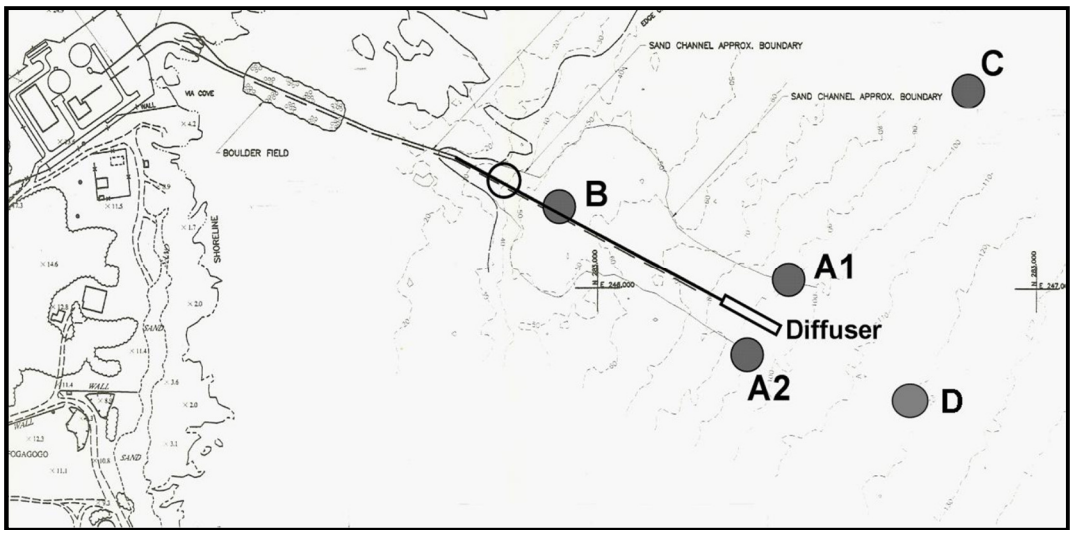

Figure 2-1. Tafuna Outfall and Diffuser Location
(The shaded circles are the current sampling points used for receiving water monitoring.)

Table 2.1 Existing Tafuna Diffuser Configuration	
Parameter	**Tafuna WWTP Diffuser**
Diffuser Barrel Diameter - inches (meters)	24 (0.609)
Riser Diameter - inches (meters)	8 (0.2032)
Riser Length - inches (meters)	28 (0.711)
Number of Ports	6
Port Discharge Angle (Vertical Angle)	0º (Horizontal)
Port Discharge Angle (Horizontal Relative to Diffuser Barrel)	±90º (Perpendicular in alternating directions)
Port Spacing - feet (meters)	10 (3.05)
Port Diameter - inches (meters)	8 (0.203)
Average Port Depth - feet (meters)	89.2 (27.19)

The model predicted dilution[5] performance of the existing Tafuna diffuser is shown in Table 2-2 and Figure 2-2 for a range of effluent flows. These results are used to assess potential improvements for alternative diffuser configurations in Sections 2.2 and 2.3.

Table 2-2. Tafuna Existing Diffuser Performance

Flow (mgd)	Densimetric Froude Number	Trapping Level[1] (m)	Maximum Rise Level[2] (m)	Dilution at:	
				Trapping Level	Maximum Rise
1	0.97	RD[3]			
2	1.94	RD[3]			
3	2.91	3.18	27.16	361.21	404.71
4	3.88	2.95	26.98	292.57	322.56
6	5.81	2.59	26.90	221.48	239.60
8	7.75	2.37	27.39	183.61	199.42
10	9.69	2.13	27.15	160.07	170.88

[1] Trapping level is the predicted distance below the surface of the plume centerline
[2] Maximum rise is the predicted distance above the discharge point of the plume centerline
[3] RD indicates the model run was discontinued because the Froude number was below a critical value and calculations may not be reliable.

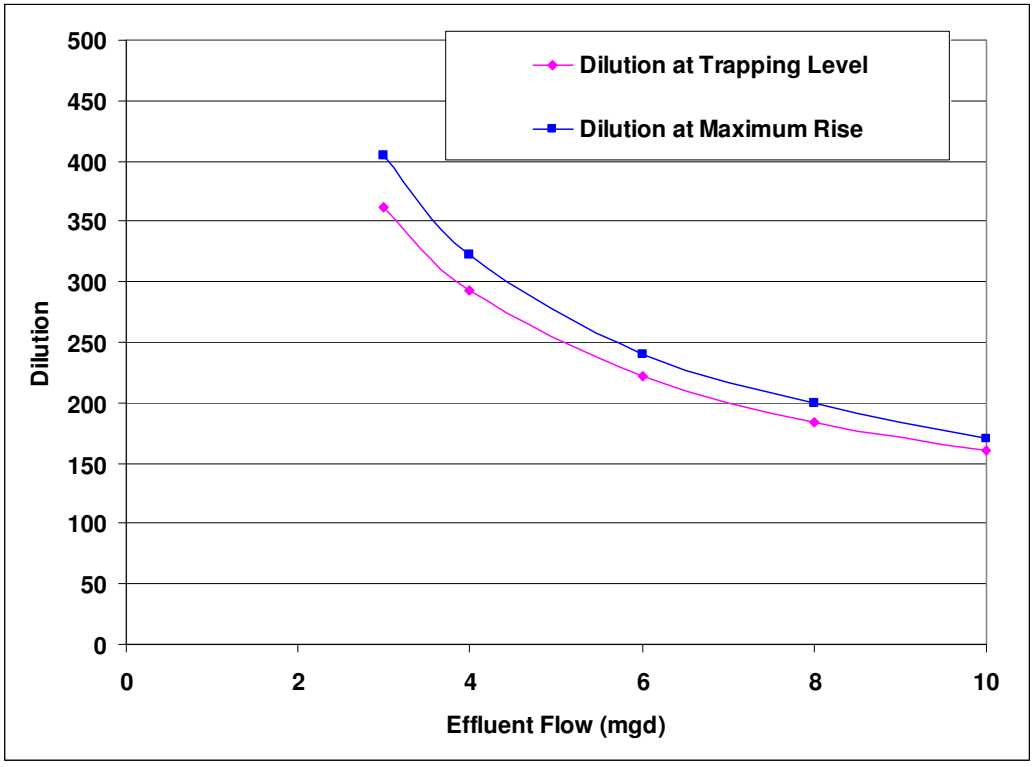

Figure 2-2. Tafuna Dilution for Existing Diffuser Configuration

[5] The model used for all predictions in this TM was UDKHDEN. Model inputs and procedures are the same as those used in the 2012 diffuser scoping study. Dilution as presented here and predicted by the model is defined as the total volume (flow) in the discharge plume (effluent plus entrained receiving water) divided by the effluent volume (flow).

2.2 Previously Proposed Tafuna Diffuser Changes

The existing total port area of the Tafuna diffuser is quite likely as large as is prudent to be assured that persistent seawater intrusion is not an issue (this is discussed in detail in the diffuser scoping study). Therefore, the approach was to reduce the sizes of the existing ports by installing orifice plates and adding a port on the end gate. The total port area is kept approximately the same as the existing diffuser. As a representative example, reducing the existing ports from 8 inches to 6 inches in diameter with an end port of 12.5 inches in diameter was considered in the diffuser scoping study. The flow through the six-inch ports is nearly uniform for all ports, so these ports were modeled as a port group. The head loss is well below the available head loss for the outfall.

The dilution model was run using the appropriate flows for the modified port configuration[6]. The 6-inch ports and 12.5-inch end port are run separately and the dilution was calculated as the flux averaged dilution[7]. The results are shown in Table 2-3 for the evaluation where the oppositely directed side ports do not merge[8]. The results are shown graphically in Figure 2.3. A meaningful increase in dilution is noted for this configuration compared to the existing diffuser.

Table 2-3. Diffuser Performance for Tafuna Modified Diffuser with 12.5-inch End Gate Port

Flow (mgd)	Densimetric Froude Number		Trapping Level[1] (m)		Maximum Rise Level[2] (m)		Flux Average Dilution at:	
							Trapping Level (m)	Maximum Rise (m)
	12.5" port	6" ports	12.5" port	6" ports	12.5" port	6" ports		
1	0.65	1.31	RD[3]					
2	1.30	2.63	RD[4]	3.82	RD[4]	25.72	612.41[4]	684.22[4]
4	2.61	5.23	2.96	3.32	26.82	27.14	382.66	438.69
6	3.92	7.84	2.75	3.06	26.96	27.28	286.86	325.14
8	5.22	10.46	2.44	2.83	26.96	27.16	238.91	265.92
10	6.53	13.07	2.36	2.58	23.22	27.12	217.32	236.20

[1] Trapping level is the distance below the surface of the plume centerline
[2] Maximum rise is the distance above the discharge point of the plume centerline
[3] RD indicates the model run was discontinued because the Froude number was below a critical value and calculations may not be reliable.
[4] The dilution through the end port (12.5-inch port) was estimated by trend line analysis.

[6] The flow distribution and head loss through the ports was modeled using the same standard diffuser hydraulics model used in the diffuser scoping study.

[7] Flux averaged dilution is the flow weighted dilution based on the dilution and flow from each port or port group and is typically the dilution used for compliance purposes. Dilution from individual ports or port groups is provided in the model runs in the Attachments to this TM.

[8] This is a physically realistic approach and is an approach indicated as appropriate in the U.S. Environmental Protection Agency's Amended 301(h) Technical Support Document..

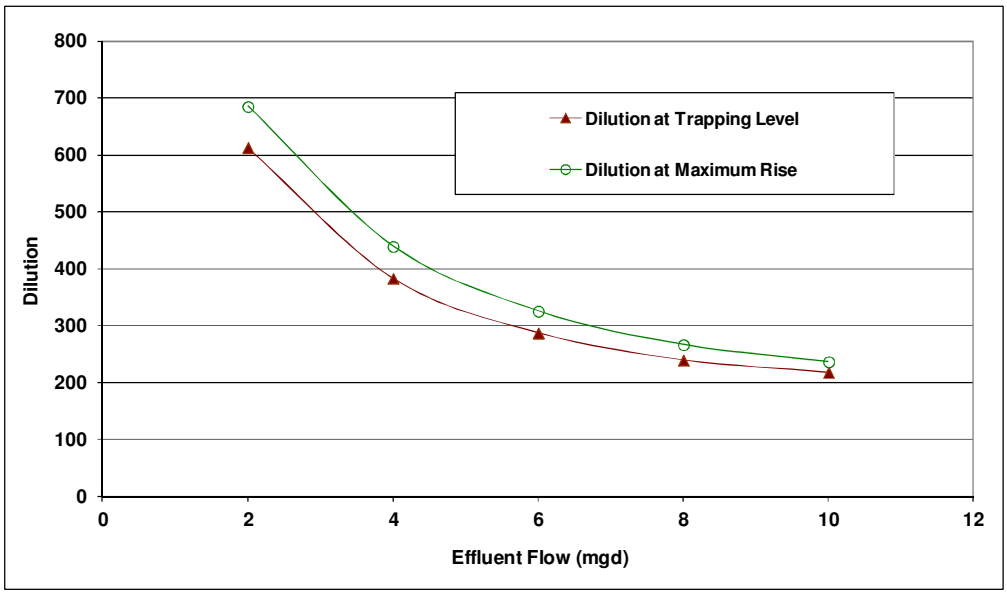

Figure 2-3. Dilution for Modified Tafuna Diffuser Configuration with End Gate Port

2.3 Recommended Tafuna Diffuser Configuration

The diffuser scoping study indicated the most effective way to increase initial dilution for the Tafuna diffuser was to add and end port discharging seaward and to change the sizes of the existing ports by adding orifice plates to the risers. Additional analysis was conducted to further evaluate the appropriate port sizes. A wide variety of side port and end port size combinations was modeled. The final recommended configuration was selected to be 6-inch side ports (as in the diffuser scoping study) and an 11-inch end port (somewhat smaller than that selected in the diffuser scoping study). This port configuration results in a dilution similar to that presented in the diffuser scoping study and better balances dilutions from the side ports and end port. The results for this configuration are shown in Table 2-4 and Figure 2-4. The model runs are provided in Attachment 1. The dilution model UDKHDEN was used for consistency with the diffuser scoping study.

Table 2-4. Diffuser Performance for Tafuna Modified Diffuser with 11-inch End Gate Port and 6-inch Side Ports

Flow (mgd)	Densimetric Froude Number		Trapping Level[1] (m)		Maximum Rise Level[2] (m)		Flux Average Dilution at:	
							Trapping Level (m)	Maximum Rise (m)
	11" port	6" ports	11" port	6" ports	11" port	6" ports		
1	0.76	1.43	RD[3]					
2	1.52	2.82	RD[4]	3.7	RD[4]	25.99	607.74[4]	695.58[4]
4	3.02	5.67	3.3	3.3	26.85	27.26	383.02	443.06
6	4.54	8.47	2.9	3.0	26.85	27.00	290.14	326.75
8	6.03	11.32	2.8	2.8	26.98	27.15	240.97	269.22
10	7.55	14.18	2.6	2.6	27.26	26.95	210.61	232.86

[1] Trapping level is the distance below the surface of the plume centerline
[2] Maximum rise is the distance above the discharge point of the plume centerline
[3] RD indicates the model run was discontinued because the Froude number was below a critical value and calculations may not be reliable.
[4] The dilution through the end port (11-inch port) was estimated by trend line analysis.

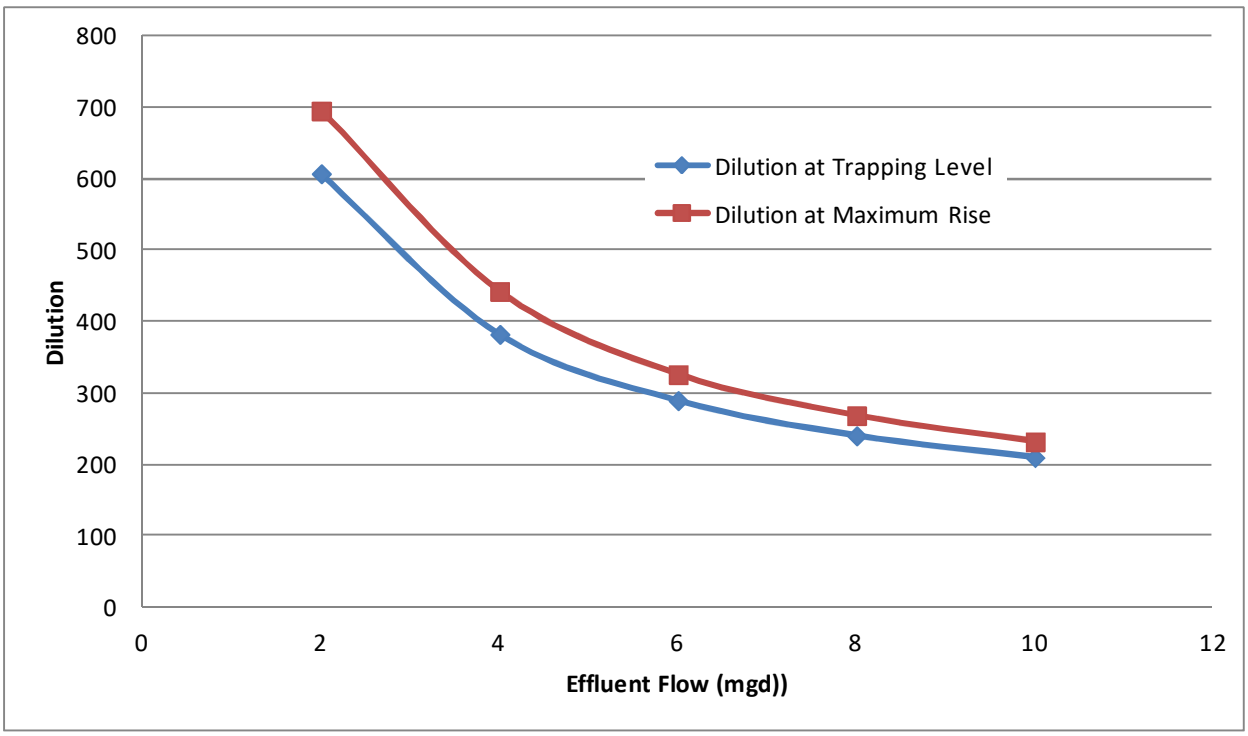

Figure 2-4. Dilution for Recommended Tafuna Diffuser Configuration with New End Gate Port

3. UTULEI WWTP DIFFUSER CONFIGURATION

This section describes the existing diffuser configuration, the proposed diffuser configuration presented in the diffuser scoping study, and the final recommended diffuser configuration. The existing diffuser configuration is based on a recent diver inspection of the diffuser. The dilution performance of the three configurations is presented. Additional details of the diffuser configuration and the modeling used to develop the dilution performance is described in the diffuser scoping study TM. As mentioned above, all dilution calculations presented in this TM are based on the assumption that the plumes from the side ports discharging in alternating directions do not merge. Merging is accounted for in the case of ports discharging in the same direction.

3.1 Existing Utulei Diffuser Configuration

The Utulei WWTP outfall discharges to Outer Pago Pago Harbor (Figure 3.1). The outfall is a 24-inch diameter ductile iron and high density polyethylene (HDPE) pipeline extending approximately 1,050 feet from the treatment plant with approximately 700 feet buried in the coral reef flat and the exposed offshore portion descending the reef slope. The inshore section of the outfall is ductile iron and the offshore section is HDPE. The outfall is secured to the reef by a unique gimbaled frame that holds the outfall in place on the top of the reef slope. The outfall drops off the reef flat at a steep angle and touches the Harbor bottom 65 feet below the gimbaled frame. Effluent is released through five, 6-inch diameter ports and one 4-inch port spaced over a length of 35 feet (based on drawings submitted with the recent diver inspection report). Evaluation of the existing configuration was conducted with the 4-inch orifice plate removed and all ports as 6-inch diameter.

There are six gooseneck risers on the diffuser section of the outfall that rise directly from the top of the diffuser barrel. The ports on the gooseneck risers discharge horizontally in alternate directions perpendicular to the diffuser barrel. Three of the gooseneck risers were replaced in 2007 with ROMAC repair gooseneck risers. These repaired risers have 6-inch diameter openings and are 16″ tall. The remaining 3 gooseneck risers are original and are 27″ tall. Two of the original risers have 6-inch diameter ports and port number 2 has a restrictor plate over the opening which reduces the 6-inch port opening to 4 inches in diameter. The depth for each diffuser port was measured from the top of the diffuser. The depths for each port vary from 146 feet to 154 feet. The ROMAC repaired gooseneck risers are showing signs of moderate corrosion with one having a small leak at its base.

In general, the flows were strong and equal from all ports, although debris was observed hindering flow from at least one of the ports. The diffuser terminates with a blind flange that is partially buried at a depth of approximately 160 feet in a sandy/muddy bottom. Based on the recent diver inspections the existing diffuser configuration, as modeled, is described in Table 3-1.

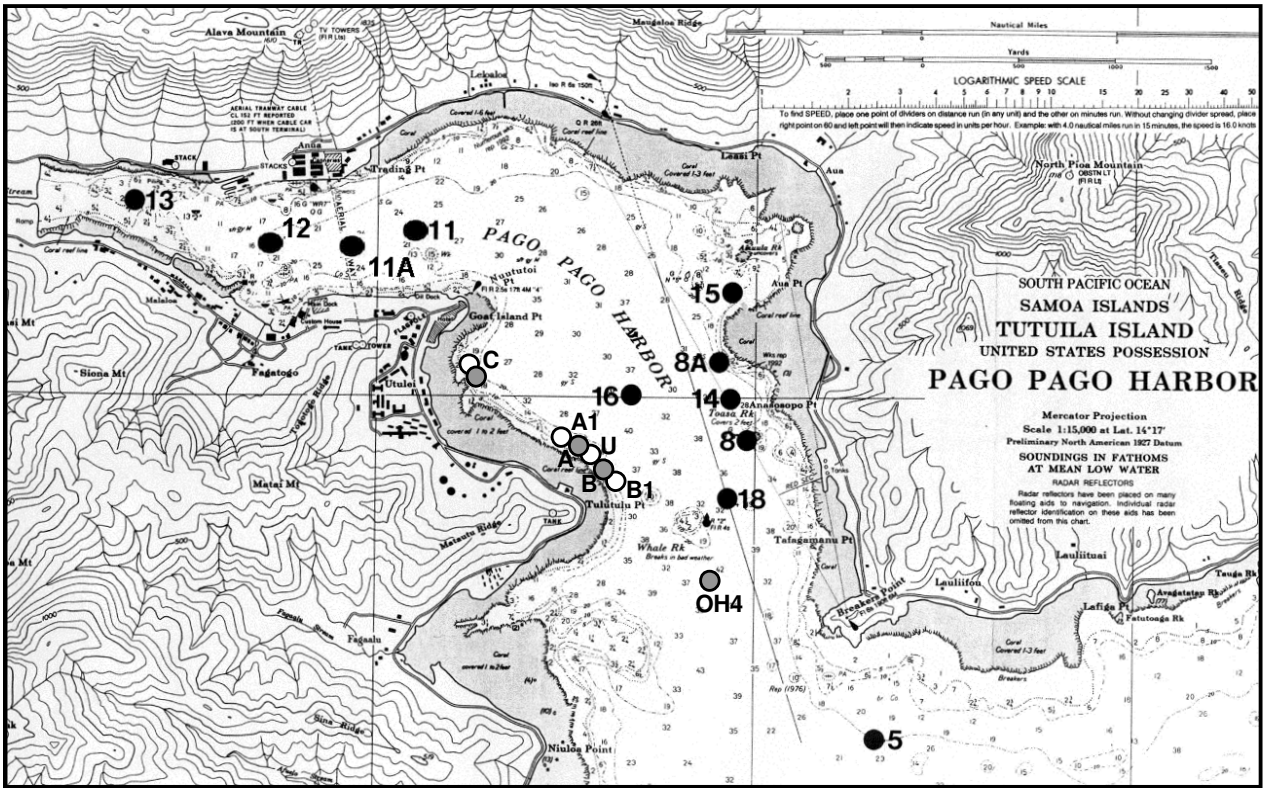

Figure 3-1. Utulei WWTP Diffuser Location (Station U)

(The circles are sampling points used for receiving water monitoring either currently or in the past, throughout Pago Pago Harbor)

Table 3-1 Existing Utulei Diffuser Configuration	
Parameter	**Utulei WWTP Diffuser**
Diffuser Barrel Diameter - inches (meters)	24 (0.609)
Riser Diameter - inches (meters)	6 (0.1524)
Riser Length - inches (meters)	16 (0.406) [1]
Number of Ports	6
Port Discharge Angle (Vertical Angle)	0º (Horizontal)
Port Discharge Angle (Horizontal Relative to Diffuser Barrel)	±90º (Perpendicular in alternating directions)
Port Spacing - feet (meters)	7.1 (2.16)
Port Diameter - inches (meters)	6 (0.152) [1]
Average Port Depth - feet (meters)	150.4 (45.84)
[1] Used for purposes of modeling, see text for detailed description	

The predicted dilution performance of the existing Utulei diffuser is shown in Table 3-2 and Figure 3-2 for a range of effluent flows. These results are used to assess potential improvements for alternative diffuser configurations discussed in Sections 3.2 and 3.3.

Table 3-2. Utulei Existing Diffuser Performance					
Flow (mgd)	Densimetric Froude Number	Trapping Level[1] (m)	Maximum Rise Level[2] (m)	Dilution at:	
				Trapping Level	Maximum Rise
1	1.99	RD[3]			
2	3.97	25.69	29.92	311.46	443.63
4	7.94	15.97	40.94	265.87	344.14
6	11.91	12.77	44.16	218.45	275.89
8	15.88	10.33	45.70	191.25	232.53
10	19.86	6.09	45.31	181.49	200.35
[1] Trapping level is the distance below the surface of the plume centerline [2] Maximum rise is the distance above the discharge point of the plume centerline [3] RD indicates the model run was discontinued because the Froude number was below a critical value and calculations may not be reliable.					

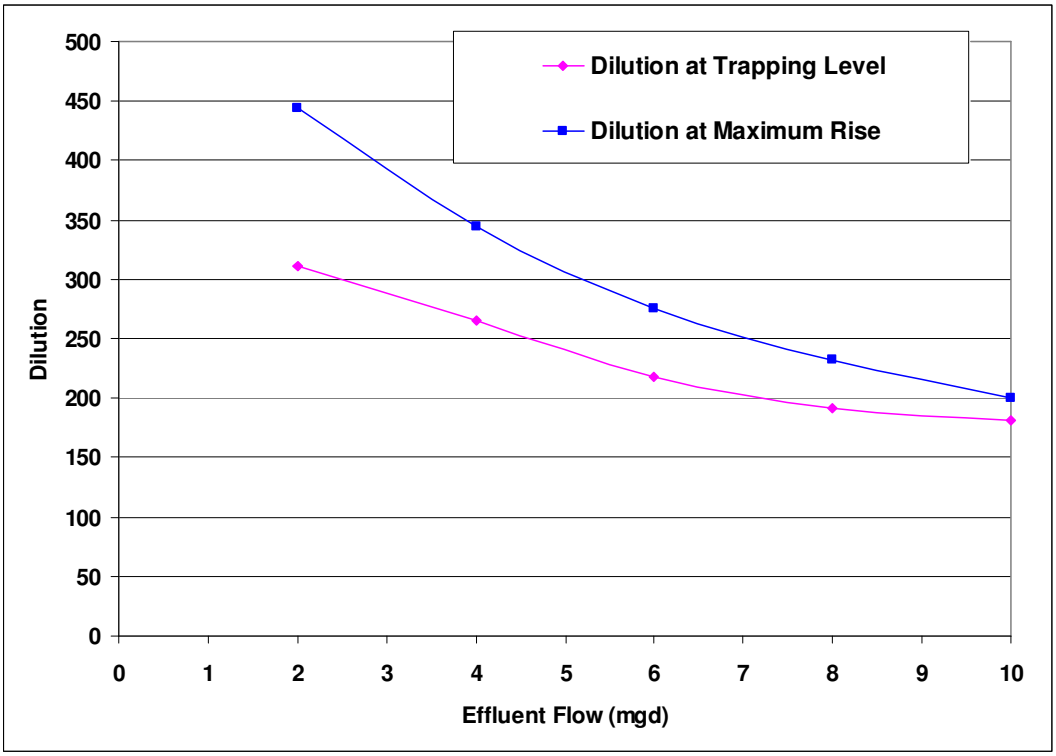

Figure 3-2 - Utulei Dilution for Existing Diffuser Configuration

3.2 Previously Proposed Utulei Diffuser Changes

The existing total port area of the Utulei diffuser appears to be sufficient to be assured that persistent seawater intrusion is not an issue. However, it appears that the total port area can be increased somewhat to improve dilution performance and still avoid persistent seawater intrusion. Therefore, the approach is to reduce the sizes of the existing ports by installing orifice plates and adding a larger port on the end gate. The total port area is increased but kept to about 50 percent of the barrel cross sectional area. As a representative example reducing the existing ports from 6 inches to 5.5 inches in diameter with an end port of 10.5 inches in diameter was considered. The flow through the 5.5-inch ports is nearly uniform for all ports, so these ports can be modeled as a port group. The head loss is well below the available head loss for the outfall.

The dilution model was run using the appropriate flows for the modified port configuration. The 5.5-inch ports and 10.5-inch port are run separately and the dilution is calculated as the flux averaged dilution. The results are shown in Table 3-3 and Figure 3-3.

Table 3-3. Diffuser Performance for Utulei Modified Diffuser with 10.5-inch End Gate Port

Flow (mgd)	Densimetric Froude Number		Trapping Level[1] (m)		Maximum Rise Level[2] (m)		Flux Average Dilution at:	
	10.5" port	5.5" ports	10.5" port	5.5" ports	10.5" port	5.5" ports	Trapping Level (m)	Maximum Rise (m)
1	RD[4]							
2	RD[4]	3.33	RD[3]	29.83	RD[3]	23.35	376.35[4]	581.91[4]
4	3.82	6.66	19.61	21.75	34.85	34.60	333.96	499.31
6	5.73	10.00	14.90	17.15	39.20	40.69	306.64	434.75
8	7.65	13.33	13.67	14.07	41.05	43.11	272.20	376.72
10	9.56	16.66	12.86	12.05	42.03	43.98	246.94	267.59

[1] Trapping level is the distance below the surface of the plume centerline
[2] Maximum rise is the distance above the discharge point of the plume centerline
[3] RD indicates the model run was discontinued because the Froude number was below a critical value and calculations may not be reliable.
[4] The dilution through the end port (10.5-inch port) was estimated by trend line analysis.

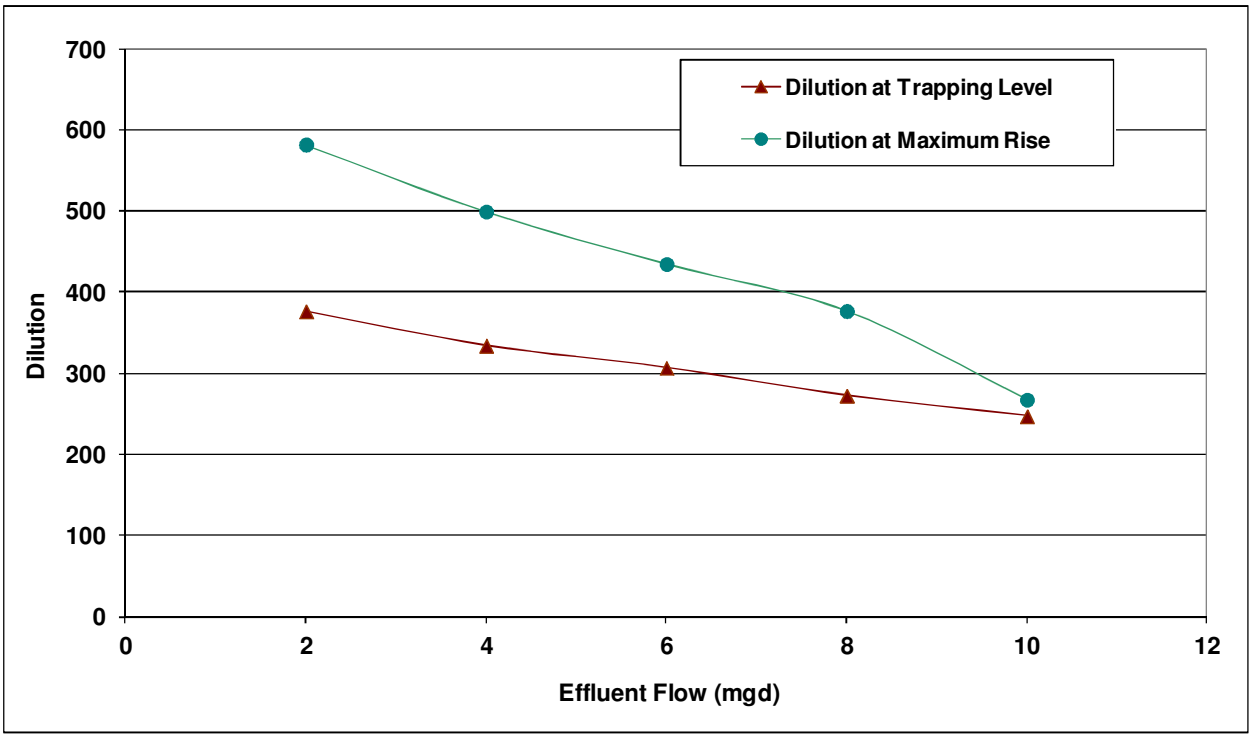

Figure 3-3. Dilution for Modified Utulei Diffuser Configuration with 10.5-inch End Gate Port

3.3 Recommended Utulei Diffuser Configuration

The diffuser scoping study indicated the most effective way to increase initial dilution for the Utulei diffuser was to add an end port discharging seaward and possibly change the sizes of the existing ports by adding orifice plates to the risers. Additional analysis was conducted to further evaluate the appropriate port sizes. A wide variety of side port and end port size

combinations was modeled. The final recommended configuration was selected to be 5.5-inch side ports (as in the diffuser scoping study) and an 11-inch end port (slightly larger than that used in the diffuser scoping study). This port configuration results in a dilution similar to but notably higher than, that of the diffuser scoping study and better balances dilutions from the side ports and end port. The results for this configuration are shown in Table 3-4 and Figure 3-4. The model runs are provided in Attachment 2. The dilution model UDKHDEN was used for consistency with the diffuser scoping study.

Table 3-4. Diffuser Performance for Utulei Modified Diffuser with 11-inch End Gate Port and 5.5-inch Side Ports

Flow (mgd)	Densimetric Froude Number		Trapping Level[1] (m)		Maximum Rise Level[2] (m)		Flux Average Dilution at:	
							Trapping Level (m)	Maximum Rise (m)
	11" port	5.5" ports	11" port	5.5" ports	11" port	5.5" ports		
1	0.92	1.63	RD[3]					
2	1.81	3.23	RD[4]	30.3	RD[4]	22.78	427.54[4]	738.02[4]
4	3.64	6.47	19.0	22.0	35.4	34.08	403.94	664.08
6	5.45	9.68	14.6	16.7	40.08	40.78	391.94	604.28
8	7.25	12.91	13.3	14.0	41.72	43.29	346.98	525.44
10	9.06	16.15	12.4	12.6	42.84	44.46	315.45	471.80

[1] Trapping level is the distance below the surface of the plume centerline
[2] Maximum rise is the distance above the discharge point of the plume centerline
[3] RD indicates the model run was discontinued because the Froude number was below a critical value and calculations may not be reliable.
[4] The dilution through the end port (11-inch port) was estimated by trendline analysis.

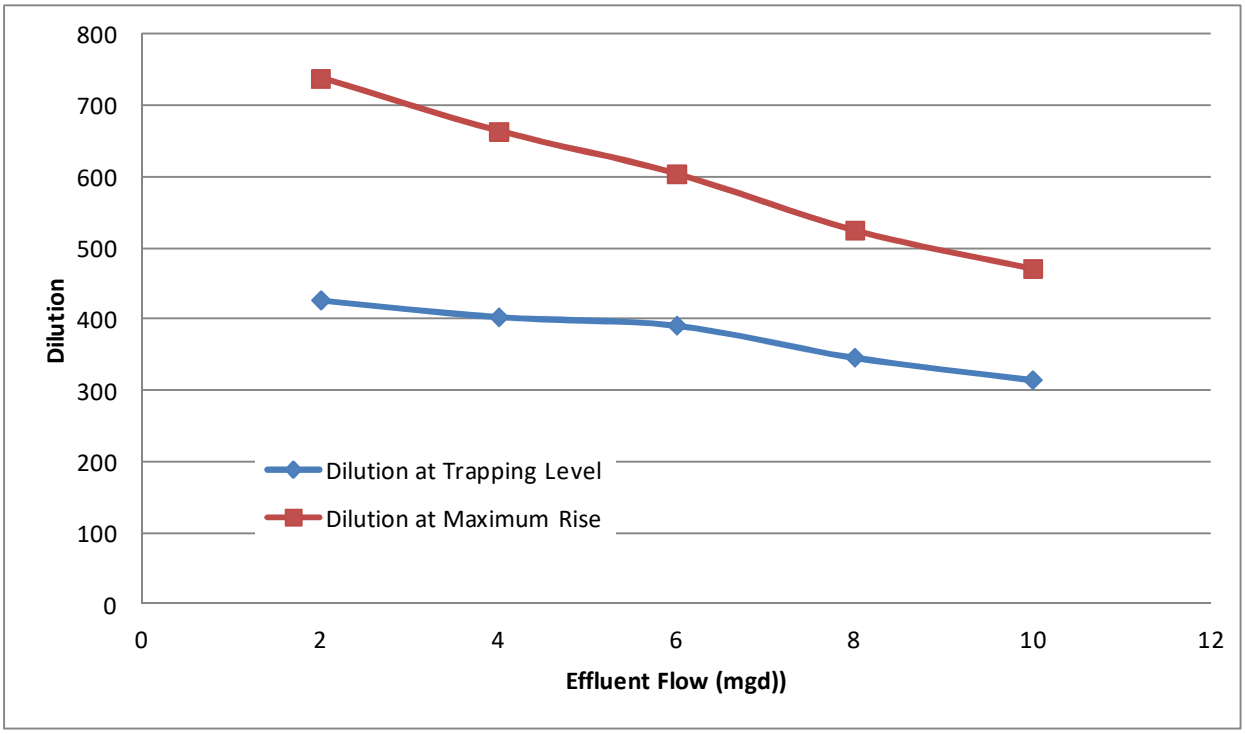

Figure 3-4. Dilution for Recommended Utulei Diffuser Configuration with End Gate Port

4. CONCLUSIONS AND RECOMMENDATIONS

The final recommended diffuser configurations are very similar to the configurations presented in the diffuser scoping study with some minor changes in recommended port sizes. The final configurations are described in Sections 4.1 for the Tafuna WWTP diffuser and in Section 4.4 for the Utulei WWTP diffuser configuration. These configurations are recommended to provide the highest dilutions without anticipated occurrence of persistent seawater intrusion.

4.1 Recommended Tafuna Configuration

Table 4-1 summarizes the diffuser configurations for the Tafuna WWTP outfall discussed in this TM. Figures 4-1 and 4-2 illustrate the dilution performance of the recommended configuration compared to the existing configuration and the configuration presented in the diffuser scoping study. Figure 4-1 illustrates the dilution as the plume first passes through the trapping level (level of equal density between the plume and the ambient water), which is generally used for compliance calculations by regulatory agencies. Typically the momentum of the plume carries the plume past the trapping level and it subsequently collapses back to a water column location somewhat higher than the initially calculated trapping level. The dilution models used, as well as most other dilutions models, do not account for the subsequent collapse. Figure 4-2 shows the dilution at the height of maximum rise and can be considered a more accurate characterization of the dilution achieved, although additional dilution will occur during the subsequent plume collapse.

The modifications required to implement the final recommendation for the Tafuna WWTP diffuser are:

- Replace the existing blind flange on the end of the diffuser barrel with a new end flange with an eleven-inch port angled 15 degrees upward. The 15 degree angle is used to avoid bottom contact of the discharge plume.

- Install six-inch orifice plates on the existing eight-inch port openings using the existing structure

The difference in dilution between the diffuser scoping study is minimal as shown in Figures 4-1 and 4-2. However, the dilution from the 11-inch and 6-inch ports is better balanced.

Table 4-1. Tafuna Diffuser Configurations

Configuration	End-Gate Port Size	Side Port Sizes
Existing	None	Six 8-inch ports
Diffuser Scoping Study	One 12.5-inch port	Six 6-inch ports
Final Recommendation	One 11-inch port	Six 6-inch ports

Figure 4-1. Dilution for Tafuna Diffuser Configurations at the Trapping Level

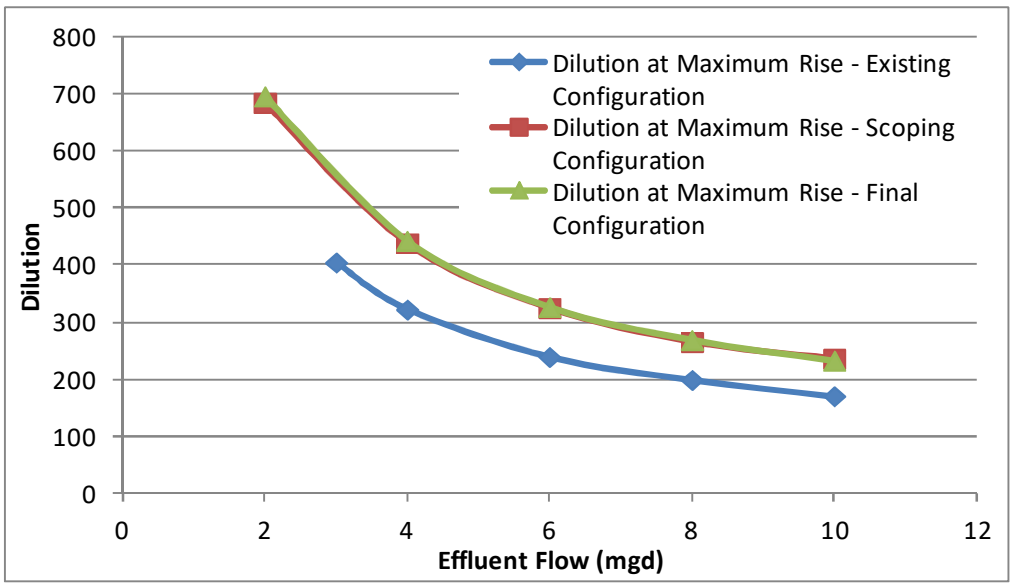

Figure 4-2. Dilution for Tafuna Diffuser Configurations at Maximum Rise Height

4.2 Recommended Utulei Configuration

Table 4-2 summarizes the diffuser configurations for the Utulei WWTP outfall discussed in this TM. Figures 4-3 and 4-4 illustrate the dilution performance of the recommended configuration compared to the existing configuration and the configuration presented in the diffuser scoping study. Figure 4-3 illustrates the dilution as the plume first passes through the trapping level. Figure 4-4 shows the dilution at the height of maximum rise. The significance of the trapping level and height of maximum rise is discussed in Section 4.1

The modifications required to implement the final recommendation for the Utulei WWTP diffuser are:

- Replace the existing blind flange on the end of the diffuser barrel with a new end flange with an eleven-inch port angled 15 degrees upward. The 15 degree angle is used to avoid bottom contact of the discharge plume.

- Install 5.5-inch orifice plates on the existing port openings using the existing structure. To accomplish this, three of the risers currently on the diffuser will need to be replaced or modified. These risers were previously installed to repair broken risers. One of these risers is leaking at the base and needs repair regardless of the diffuser modifications.

The difference in dilution between the diffuser scoping study configuration and the recommend configuration results in a notable increase in dilution and better balanced dilution between the end port and the side ports.

Table 4-2. Utulei Diffuser Configurations

Configuration	End-Gate Port Size	Side Port Sizes
Existing	None	Six 6-inch ports
Diffuser Scoping Study	One 10.5-inch port	Six 5.5-inch ports

Final Recommendation	One 11-inch port	Six 5.5-inch ports

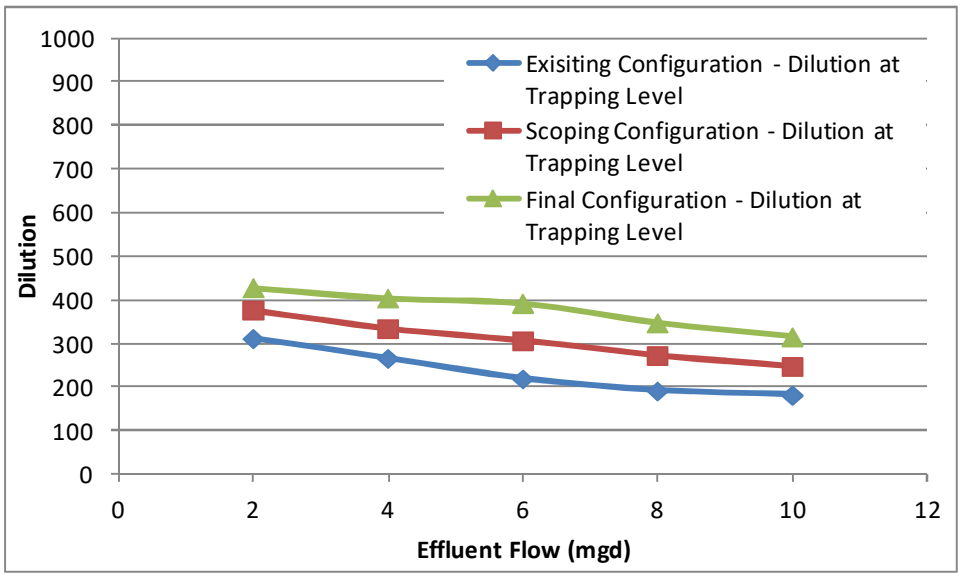

Figure 4-3. Dilution for Utulei Diffuser Configurations at the Trapping Level

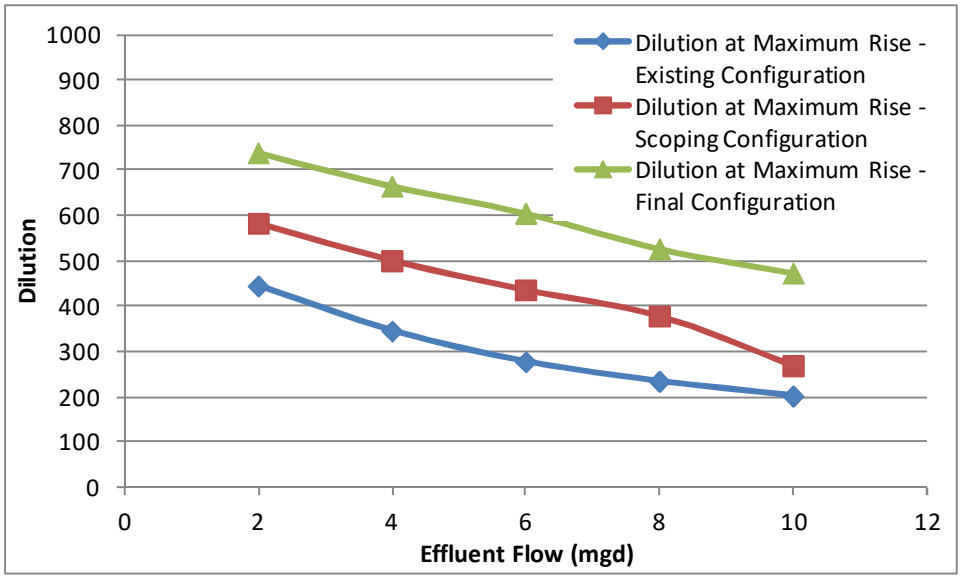

Figure 4-4. Dilution for Utulei Diffuser Configurations at the Maximum Rise

ATTACHMENTS – PROVIDED ON CD-ROM

Attachment 1: Modeling Results for the Tafuna WWTP

Attachment 2: Modeling Results for the Utulei WWTP