gdc

COASTAL AND INSHORE ANALYSTS

9 May 2000

Mr. Carl Goldstein
American Samoa Program Manager
Office of Pacific Islands
and Native American Programs
U.S. Environmental Protection Agency
75 Hawthorne Street
San Francisco, CA 94105

Ms Sheila Wiegman
American Samoa
Environmental Protection Agency
American Samoa Government
Pago Pago, American Samoa 96799

Re: Effluent Chemistry – Selenium Re-analysis (February Sampling Episode)
StarKist Samoa (NPDES Permit AS0000019)
COS Samoa Packing (NPDES Permit AS0000027)

Dear Carl and Sheila:

Enclosed are two copies each of a technical memorandum describing re-analysis of cannery effluent for selenium from the February 2000 sampling episode for each of the canneries.

Sincerely,

Steven L. Costa, Ph.D.
Karen A. Glatzel, Ph.D.

Enclosure 1: Chemical Re-Analysis of StarKist Samoa Effluent–Selenium-February 2000 Sampling
Enclosure 2: Chemical Re-Analysis of COS Samoa Packing Effluent–Selenium-February 2000 Sampling

cc: Phil Thirkel/StarKist Samoa (w/enclosure 1)
Jim Cox/COS International (w/enclosure 2)
Joe Carney/StarKist Samoa (w/enclosure 1)
Brett Ransby/COS Samoa Packing (w/enclosures 2)
David Wilson/CH2M Hill/SEA (w/ all enclosures)
John Lee/CH2M Hill/SEA (w/o enclosures)

P.O. BOX 1238 • TRINIDAD, CA • 95570
PHONE: 707-677-0123 • FAX: 707-677-9210
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TECHNICAL MEMORANDUM

CH2MHILL

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CHEMICAL RE-ANALYSIS OF STARKIST SAMOA EFFLUENT – SELENIUM: FEBRUARY 2000 SAMPLING

Prepared For: StarKist Samoa, Inc.
(NPDES Permit AS0000019)

Prepared By: Steve Costa/ gdc
Karen Glatzel/ gdc

Date: 9 May 2000

Distribution: Carl Goldstein
United States Environmental Protection Agency, Region 9
Sheila Wiegman
American Samoa Environmental Protection Agency

Reviewing the February 2000 effluent chemistry data we noted that the selenium analysis had a detection limit that was unacceptably high that may have been caused by seawater matrix interference. The unpreserved metals sample was re-analyzed for selenium by another laboratory using an alternative method with significantly lower reporting limits. The results are shown in the table below and the laboratory report with QA/QC is provided in Attachment A.

Table 1.
StarKist Samoa
Selenium Results- February 2000 Effluent Analysis

Sample No.	Method	Detection Limits (µg/l)		Value Reported (µg/l)
		Requested	Achieved	
Sample 1 - ARI	EPA 270.1	5	20	ND
Sample 2 - TEL	EPA 200.8-M	5	2	3.87

ATTACHMENT A

LABORATORY DATA REPORT
TEL

StarKist Samoa, Inc. Effluent Sample

Selenium Analysis

February 2000

GDC **P.O. Box 1238** **Trinidad, CA 95570**	**ELAP No.:** 2400 **Date Sampled:** 02/11/00 **Date Received:** 02/16/00 **Date Prepared:** 04/18/00 **Date Analyzed:** 04/18/00
TEL Project No.: 0002-002 **Client Project ID:** **Sample Matrix:** Water	**Analyst:** NM **Report Date:** 04/18/00

Individual Metals (TTLC)
Analysis Method: EPA Method 200.8-M

Sierra Sample No.	Client Sample No.	Test Parameters:					Units
		Selenium					
126	Effluent SKS	3.87					µg/L
Practical Quantitation Limit		2.00					

ND means Not Detected

GDC
P.O. Box 1238
Trinidad, CA 95570

TEL Project No.: 0002-002
Client Project ID:
Sample Matrix: Water

ELAP No.: 2400
Date Sampled: 2/10/00
Date Received: 2/16/00
Date Prepared 4/18/00
Date Analyzed 4/18/00
Analyst: NM

Report Date: 4/18/00

CCR Title 22 Metals (TTLC)
Analysis Method: EPA Method 200.8-M

Element	Method Blank ppb	LFB	125	125 Dup	125 MS (0.25ppb)	125 MSD (0.25ppb)	Relative Percent Difference between Duplicates	Percent Recovery	LCS CASS	LCS True Value	Detection Limit
Se	ND	0.255	ND	ND	0.196	0.196	0.00	78	---	---	0.10

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 14:46:08
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\Blank.002
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: Blank
Sample Type: Sample

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77		1003	2.5 %			ug/L	%
Se	78		20430	0.6 %			ug/L	%
Se	82		531	97.9 %			ug/L	%
Hg	202		17497	3.1 %			ug/L	%
Cl	37		13951078	1.6 %			ug/L	%
Br	79		23229	3.9 %			mg/L	%
Kr	83		11462	1.5 %			mg/L	%

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 14:47:58
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\Standard 1.003
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: Standard 1
Sample Type: Sample

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77	1003	14401	1.6 %			ug/L	%
Se	78	20430	62950	2.3 %			ug/L	%
Se	82	531	16707	3.9 %			ug/L	%
Hg	202	17497	14464	11.0 %			ug/L	%
Cl	37	13951078	14031401	2.0 %			ug/L	%
Br	79	23229	23466	3.0 %			mg/L	%
Kr	83	11462	11738	3.9 %			mg/L	%

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 14:50:21
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\Standard 2.004
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: Standard 2
Sample Type: Sample

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77	1003	33181	2.1 %	**0.2402**	0.00514	ug/L	2.1 %
Se	78	20430	119801	2.3 %	**0.2337**	0.00655	ug/L	2.8 %
Se	82	531	42434	2.4 %	**0.2590**	0.00624	ug/L	2.4 %
Hg	202	17497	11397	4.3 %			ug/L	%
Cl	37	13951078	14459482	1.5 %			ug/L	%
Br	79	23229	21130	5.2 %			mg/L	%
Kr	83	11462	11757	4.0 %			mg/L	%

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 14:52:14
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\Standard 3.005
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: Standard 3
Sample Type: Sample

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77	1003	64295	0.6 %	**0.4890**	0.00290	ug/L	0.6 %
Se	78	20430	214764	1.6 %	**0.4843**	0.00851	ug/L	1.8 %
Se	82	531	81983	2.4 %	**0.4883**	0.01161	ug/L	2.4 %
Hg	202	17497	11282	4.3 %			ug/L	%
Cl	37	13951078	14098848	1.1 %			ug/L	%
Br	79	23229	21645	0.6 %			mg/L	%
Kr	83	11462	11677	2.6 %			mg/L	%

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 14:54:27
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\Standard 4.006
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: Standard 4
Sample Type: Sample

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77	1003	125874	0.7 %	**0.9815**	0.00687	ug/L	0.7 %
Se	78	20430	368406	2.0 %	**0.8888**	0.01916	ug/L	2.2 %
Se	82	531	168845	3.0 %	**1.0277**	0.03094	ug/L	3.0 %
Hg	202	17497	10423	7.9 %			ug/L	%
Cl	37	13951078	13859582	1.4 %			ug/L	%
Br	79	23229	21879	6.8 %			mg/L	%
Kr	83	11462	11631	1.2 %			mg/L	%

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 14:56:21
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\CCB.007
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: CCB
Sample Type: Sample

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77	1003	874	9.0 %	**-0.0010**	0.00063	ug/L	61.1 %
Se	78	20430	19977	1.3 %	**-0.0013**	0.00073	ug/L	57.9 %
Se	82	531	21	2526.3 %	**-0.0031**	0.00316	ug/L	103.5 %
Hg	202	17497	15510	4.4 %			ug/L	%
Cl	37	13951078	13731929	0.7 %			ug/L	%
Br	79	23229	21988	4.3 %			mg/L	%
Kr	83	11462	11234	1.3 %			mg/L	%

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 14:58:12
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\CCV 0.25PPB.008
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: CCV 0.25PPB
Sample Type: Sample

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77	1003	34177	2.5 %	**0.2645**	0.00673	ug/L	2.5 %
Se	78	20430	123389	3.1 %	**0.2871**	0.01053	ug/L	3.7 %
Se	82	531	43059	2.1 %	**0.2543**	0.00529	ug/L	2.1 %
Hg	202	17497	14064	36.9 %			ug/L	%
Cl	37	13951078	14367139	1.0 %			ug/L	%
Br	79	23229	21075	5.0 %			mg/L	%
Kr	83	11462	11490	1.4 %			mg/L	%

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 15:02:16
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\ICV 0.25PPB.009
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: ICV 0.25PPB
Sample Type: Sample

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77	1003	33013	3.9 %	**0.2552**	0.01038	ug/L	4.1 %
Se	78	20430	122384	0.6 %	**0.2843**	0.00215	ug/L	0.8 %
Se	82	531	42252	2.2 %	**0.2495**	0.00557	ug/L	2.2 %
Hg	202	17497	20521	84.2 %			ug/L	%
Cl	37	13951078	14036547	0.8 %			ug/L	%
Br	79	23229	20854	2.9 %			mg/L	%
Kr	83	11462	11386	2.1 %			mg/L	%

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 15:05:04
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\125 20X.010
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: 125 20X
Sample Type: Sample

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77	1003	11264	3.3 %	1.6359	0.05986	ug/L	3.7 %
Se	78	20430	55458	3.6 %	1.9536	0.11009	ug/L	5.6 %
Se	82	531	13797	6.9 %	1.5867	0.11372	ug/L	7.2 %
Hg	202	17497	22093	3.9 %			ug/L	%
Cl	37	13951078	14412682	3.7 %			ug/L	%
Br	79	23229	25603	3.6 %			mg/L	%
Kr	83	11462	11645	2.6 %			mg/L	%

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 15:07:24
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\125 20X DUP.011
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: 125 20X DUP
Sample Type: Sample

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77	1003	11085	1.7 %	1.6075	0.02949	ug/L	1.8 %
Se	78	20430	52171	3.5 %	1.7703	0.10267	ug/L	5.8 %
Se	82	531	13753	5.1 %	1.5815	0.08347	ug/L	5.3 %
Hg	202	17497	23063	4.8 %			ug/L	%
Cl	37	13951078	14303283	1.3 %			ug/L	%
Br	79	23229	25205	2.4 %			mg/L	%
Kr	83	11462	11127	3.0 %			mg/L	%

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 15:13:25
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\125 20X + 0.25ppb.012
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: 125 20X + 0.25ppb
Sample Type: Sample

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77	1003	22983	5.0 %	**0.1752**	0.00919	ug/L	5.2 %
Se	78	20430	90808	3.4 %	**0.1963**	0.00870	ug/L	4.4 %
Se	82	531	30384	2.3 %	**0.1785**	0.00421	ug/L	2.4 %
Hg	202	17497	30486	17.2 %			ug/L	%
Cl	37	13951078	14305557	3.0 %			ug/L	%
Br	79	23229	25522	6.0 %			mg/L	%
Kr	83	11462	11149	3.0 %			mg/L	%

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 15:16:20
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\125 20X + 0.25ppb MSD.013
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: 125 20X + 0.25ppb MSD
Sample Type: Sample

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77	1003	23866	1.1 %	**0.1823**	0.00217	ug/L	1.2 %
Se	78	20430	90772	2.0 %	**0.1962**	0.00508	ug/L	2.6 %
Se	82	531	30951	5.6 %	**0.1819**	0.01035	ug/L	5.7 %
Hg	202	17497	26600	5.8 %			ug/L	%
Cl	37	13951078	13555083	1.3 %			ug/L	%
Br	79	23229	26490	4.5 %			mg/L	%
Kr	83	11462	11208	3.3 %			mg/L	%

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 15:23:01
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\126 20X .014
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: 126 20X
Sample Type: Sample

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77	1003	25116	2.1 %	**0.1922**	0.00418	ug/L	2.2 %
Se	78	20430	98430	3.3 %	**0.2175**	0.00902	ug/L	4.1 %
Se	82	531	32853	1.3 %	**0.1933**	0.00257	ug/L	1.3 %
Hg	202	17497	36622	21.8 %			ug/L	%
Cl	37	13951078	13946359	4.0 %			ug/L	%
Br	79	23229	25382	1.4 %			mg/L	%
Kr	83	11462	11249	2.8 %			mg/L	%

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 15:23:01
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\126 20X .014
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: 126 20X
Sample Type:

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77	1003	25116	2.1 %	**3.8445**	0.08354	ug/L	2.2 %
Se	78	20430	98430	3.3 %	**4.3504**	0.18043	ug/L	4.1 %
Se	82	531	32853	1.3 %	**3.8660**	0.05133	ug/L	1.3 %
Hg	202	17497	36622	21.8 %			ug/L	%
Cl	37	13951078	13946359	4.0 %			ug/L	%
Br	79	23229	25382	1.4 %			mg/L	%
Kr	83	11462	11249	2.8 %			mg/L	%

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 15:25:07
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\CCB.015
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: CCB
Sample Type: Sample

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77	1003	541	11.0 %	**-0.0037**	0.00047	ug/L	12.9 %
Se	78	20430	17659	1.2 %	**-0.0077**	0.00061	ug/L	7.9 %
Se	82	531	183	197.4 %	**-0.0021**	0.00216	ug/L	103.8 %
Hg	202	17497	9667	6.0 %			ug/L	%
Cl	37	13951078	13718943	3.2 %			ug/L	%
Br	79	23229	20677	2.2 %			mg/L	%
Kr	83	11462	11468	2.1 %			mg/L	%

TECHNICAL MEMORANDUM

CH2MHILL

gdc

CHEMICAL RE-ANALYSIS OF STARKIST SAMOA EFFLUENT – SELENIUM: FEBRUARY 2000 SAMPLING

Prepared For: StarKist Samoa, Inc.
(NPDES Permit AS0000019)

Prepared By: Steve Costa/ gdc
Karen Glatzel/ gdc

Date: 9 May 2000

Distribution: Carl Goldstein
United States Environmental Protection Agency, Region 9
Sheila Wiegman
American Samoa Environmental Protection Agency

Reviewing the February 2000 effluent chemistry data we noted that the selenium analysis had a detection limit that was unacceptably high that may have been caused by seawater matrix interference. The unpreserved metals sample was re-analyzed for selenium by another laboratory using an alternative method with significantly lower reporting limits. The results are shown in the table below and the laboratory report with QA/QC is provided in Attachment A.

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StarKist Samoa
Selenium Results– February 2000 Effluent Analysis

Sample No.	Method	Detection Limits (µg/l)		Value Reported (µg/l)
		Requested	Achieved	
Sample 1 - ARI	EPA 270.1	5	20	ND
Sample 2 - TEL	EPA 200.8-M	5	2	3.87

ATTACHMENT A

LABORATORY DATA REPORT
TEL

StarKist Samoa, Inc. Effluent Sample

Selenium Analysis

February 2000

GDC **P.O. Box 1238** **Trinidad, CA 95570**	**ELAP No.:** 2400 **Date Sampled:** 02/11/00 **Date Received:** 02/16/00 **Date Prepared:** 04/18/00 **Date Analyzed:** 04/18/00 **Analyst:** NM
TEL Project No.: 0002-002 **Client Project ID:** **Sample Matrix:** Water	**Report Date:** 04/18/00

Individual Metals (TTLC)
Analysis Method: EPA Method 200.8-M

Sierra Sample No.	Client Sample No.	Test Parameters:					Units
		Selenium					
126	Effluent SKS	3.87					µg/L
Practical Quantitation Limit		2.00					

ND means Not Detected

GDC
P.O. Box 1238
Trinidad, CA 95570

TEL Project No.: 0002-002
Client Project ID:
Sample Matrix: Water

ELAP No.: 2400
Date Sampled: 2/10/00
Date Received: 2/16/00
Date Prepared 4/18/00
Date Analyzed 4/18/00
Analyst: NM

Report Date: 4/18/00

CCR Title 22 Metals (TTLC)
Analysis Method: EPA Method 200.8-M

Element	Method Blank ppb	LFB	125	125 Dup	125 MS (0.25ppb)	125 MSD (0.25ppb)	Relative Percent Difference between Duplicates	Percent Recovery	LCS CASS	LCS True Value	Detection Limit
Se	ND	0.255	ND	ND	0.196	0.196	0.00	78	---	---	0.10

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 14:46:08
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\Blank.002
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: Blank
Sample Type: Sample

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77		1003	2.5 %			ug/L	%
Se	78		20430	0.6 %			ug/L	%
Se	82		531	97.9 %			ug/L	%
Hg	202		17497	3.1 %			ug/L	%
Cl	37		13951078	1.6 %			ug/L	%
Br	79		23229	3.9 %			mg/L	%
Kr	83		11462	1.5 %			mg/L	%

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 14:47:58
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\Standard 1.003
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: Standard 1
Sample Type: Sample

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77	1003	14401	1.6 %			ug/L	%
Se	78	20430	62950	2.3 %			ug/L	%
Se	82	531	16707	3.9 %			ug/L	%
Hg	202	17497	14464	11.0 %			ug/L	%
Cl	37	13951078	14031401	2.0 %			ug/L	%
Br	79	23229	23466	3.0 %			mg/L	%
Kr	83	11462	11738	3.9 %			mg/L	%

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 14:50:21
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\Standard 2.004
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: Standard 2
Sample Type: Sample

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77	1003	33181	2.1 %	**0.2402**	0.00514	ug/L	2.1 %
Se	78	20430	119801	2.3 %	**0.2337**	0.00655	ug/L	2.8 %
Se	82	531	42434	2.4 %	**0.2590**	0.00624	ug/L	2.4 %
Hg	202	17497	11397	4.3 %			ug/L	%
Cl	37	13951078	14459482	1.5 %			ug/L	%
Br	79	23229	21130	5.2 %			mg/L	%
Kr	83	11462	11757	4.0 %			mg/L	%

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 14:52:14
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\Standard 3.005
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: Standard 3
Sample Type: Sample

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77	1003	64295	0.6 %	**0.4890**	0.00290	ug/L	0.6 %
Se	78	20430	214764	1.6 %	**0.4843**	0.00851	ug/L	1.8 %
Se	82	531	81983	2.4 %	**0.4883**	0.01161	ug/L	2.4 %
Hg	202	17497	11282	4.3 %			ug/L	%
Cl	37	13951078	14098848	1.1 %			ug/L	%
Br	79	23229	21645	0.6 %			mg/L	%
Kr	83	11462	11677	2.6 %			mg/L	%

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 14:54:27
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\Standard 4.006
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: Standard 4
Sample Type: Sample

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77	1003	125874	0.7 %	0.9815	0.00687	ug/L	0.7 %
Se	78	20430	368406	2.0 %	0.8888	0.01916	ug/L	2.2 %
Se	82	531	168845	3.0 %	1.0277	0.03094	ug/L	3.0 %
Hg	202	17497	10423	7.9 %			ug/L	%
Cl	37	13951078	13859582	1.4 %			ug/L	%
Br	79	23229	21879	6.8 %			mg/L	%
Kr	83	11462	11631	1.2 %			mg/L	%

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 14:56:21
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\CCB.007
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: CCB
Sample Type: Sample

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77	1003	874	9.0 %	-0.0010	0.00063	ug/L	61.1 %
Se	78	20430	19977	1.3 %	-0.0013	0.00073	ug/L	57.9 %
Se	82	531	21	2526.3 %	-0.0031	0.00316	ug/L	103.5 %
Hg	202	17497	15510	4.4 %			ug/L	%
Cl	37	13951078	13731929	0.7 %			ug/L	%
Br	79	23229	21988	4.3 %			mg/L	%
Kr	83	11462	11234	1.3 %			mg/L	%

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 14:58:12
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\CCV 0.25PPB.008
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: CCV 0.25PPB
Sample Type: Sample

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77	1003	34177	2.5 %	**0.2645**	0.00673	ug/L	2.5 %
Se	78	20430	123389	3.1 %	**0.2871**	0.01053	ug/L	3.7 %
Se	82	531	43059	2.1 %	**0.2543**	0.00529	ug/L	2.1 %
Hg	202	17497	14064	36.9 %			ug/L	%
Cl	37	13951078	14367139	1.0 %			ug/L	%
Br	79	23229	21075	5.0 %			mg/L	%
Kr	83	11462	11490	1.4 %			mg/L	%

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 15:02:16
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\ICV 0.25PPB.009
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: ICV 0.25PPB
Sample Type: Sample

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77	1003	33013	3.9 %	**0.2552**	0.01038	ug/L	4.1 %
Se	78	20430	122384	0.6 %	**0.2843**	0.00215	ug/L	0.8 %
Se	82	531	42252	2.2 %	**0.2495**	0.00557	ug/L	2.2 %
Hg	202	17497	20521	84.2 %			ug/L	%
Cl	37	13951078	14036547	0.8 %			ug/L	%
Br	79	23229	20854	2.9 %			mg/L	%
Kr	83	11462	11386	2.1 %			mg/L	%

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 15:05:04
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\125 20X.010
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: 125 20X
Sample Type: Sample

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77	1003	11264	3.3 %	1.6359	0.05986	ug/L	3.7 %
Se	78	20430	55458	3.6 %	1.9536	0.11009	ug/L	5.6 %
Se	82	531	13797	6.9 %	1.5867	0.11372	ug/L	7.2 %
Hg	202	17497	22093	3.9 %			ug/L	%
Cl	37	13951078	14412682	3.7 %			ug/L	%
Br	79	23229	25603	3.6 %			mg/L	%
Kr	83	11462	11645	2.6 %			mg/L	%

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 15:07:24
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\125 20X DUP.011
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: 125 20X DUP
Sample Type: Sample

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77	1003	11085	1.7 %	1.6075	0.02949	ug/L	1.8 %
Se	78	20430	52171	3.5 %	1.7703	0.10267	ug/L	5.8 %
Se	82	531	13753	5.1 %	1.5815	0.08347	ug/L	5.3 %
Hg	202	17497	23063	4.8 %			ug/L	%
Cl	37	13951078	14303283	1.3 %			ug/L	%
Br	79	23229	25205	2.4 %			mg/L	%
Kr	83	11462	11127	3.0 %			mg/L	%

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 15:13:25
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\125 20X + 0.25ppb.012
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: 125 20X + 0.25ppb
Sample Type: Sample

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77	1003	22983	5.0 %	0.1752	0.00919	ug/L	5.2 %
Se	78	20430	90808	3.4 %	0.1963	0.00870	ug/L	4.4 %
Se	82	531	30384	2.3 %	0.1785	0.00421	ug/L	2.4 %
Hg	202	17497	30486	17.2 %			ug/L	%
Cl	37	13951078	14305557	3.0 %			ug/L	%
Br	79	23229	25522	6.0 %			mg/L	%
Kr	83	11462	11149	3.0 %			mg/L	%

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 15:16:20
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\125 20X + 0.25ppb MSD.013
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: 125 20X + 0.25ppb MSD
Sample Type: Sample

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77	1003	23866	1.1 %	0.1823	0.00217	ug/L	1.2 %
Se	78	20430	90772	2.0 %	0.1962	0.00508	ug/L	2.6 %
Se	82	531	30951	5.6 %	0.1819	0.01035	ug/L	5.7 %
Hg	202	17497	26600	5.8 %			ug/L	%
Cl	37	13951078	13555083	1.3 %			ug/L	%
Br	79	23229	26490	4.5 %			mg/L	%
Kr	83	11462	11208	3.3 %			mg/L	%

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 15:23:01
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\126 20X .014
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: 126 20X
Sample Type: Sample

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77	1003	25116	2.1 %	**0.1922**	0.00418	ug/L	2.2 %
Se	78	20430	98430	3.3 %	**0.2175**	0.00902	ug/L	4.1 %
Se	82	531	32853	1.3 %	**0.1933**	0.00257	ug/L	1.3 %
Hg	202	17497	36622	21.8 %			ug/L	%
Cl	37	13951078	13946359	4.0 %			ug/L	%
Br	79	23229	25382	1.4 %			mg/L	%
Kr	83	11462	11249	2.8 %			mg/L	%

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 15:23:01
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\126 20X .014
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: 126 20X
Sample Type:

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77	1003	25116	2.1 %	**3.8445**	0.08354	ug/L	2.2 %
Se	78	20430	98430	3.3 %	**4.3504**	0.18043	ug/L	4.1 %
Se	82	531	32853	1.3 %	**3.8660**	0.05133	ug/L	1.3 %
Hg	202	17497	36622	21.8 %			ug/L	%
Cl	37	13951078	13946359	4.0 %			ug/L	%
Br	79	23229	25382	1.4 %			mg/L	%
Kr	83	11462	11249	2.8 %			mg/L	%

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 15:25:07
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\CCB.015
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: CCB
Sample Type: Sample

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77	1003	541	11.0 %	**-0.0037**	0.00047	ug/L	12.9 %
Se	78	20430	17659	1.2 %	**-0.0077**	0.00061	ug/L	7.9 %
Se	82	531	183	197.4 %	**-0.0021**	0.00216	ug/L	103.8 %
Hg	202	17497	9667	6.0 %			ug/L	%
Cl	37	13951078	13718943	3.2 %			ug/L	%
Br	79	23229	20677	2.2 %			mg/L	%
Kr	83	11462	11468	2.1 %			mg/L	%

TECHNICAL MEMORANDUM

CH2MHILL

gdc

CHEMICAL RE-ANALYSIS OF COS SAMOA PACKING EFFLUENT – SELENIUM: FEBRUARY 2000 SAMPLING

Prepared For: COS Samoa Packing, Inc.
(NPDES Permit AS0000027)

Prepared By: Steve Costa/ gdc
Karen Glatzel/ gdc

Date: 9 May 2000

Distribution: Carl Goldstein
United States Environmental Protection Agency, Region 9
Sheila Wiegman
American Samoa Environmental Protection Agency

Reviewing the February 2000 effluent chemistry data we noted that the selenium analysis had a detection limit that was unacceptably high that may have been caused by seawater matrix interference. The unpreserved metals sample was re-analyzed for selenium by another laboratory using an alternative method with significantly lower reporting limits. The results are shown in the table below and the laboratory report with QA/QC is provided in Attachment A.

Table 1.
COS Samoa Packing
Selenium Results- February 2000 Effluent Analysis

Sample No.	Method	Detection Limits (μg/l)		Value Reported (μg/l)
		Requested	Achieved	
Sample 1 - ARI	EPA 270.1	5	10	50
Sample 2 - TEL	EPA 200.8-M	5	2	2

ATTACHMENT A

LABORATORY DATA REPORT
TEL

COS Samoa Packing Effluent Sample

Selenium Analysis

February 2000

GDC **P.O. Box 1238** **Trinidad, CA 95570**	**ELAP No.:** 2400 **Date Sampled:** 02/10/00 **Date Received:** 02/16/00 **Date Prepared:** 04/18/00 **Date Analyzed:** 04/18/00 **Analyst:** NM
TEL Project No.: 0002-002 **Client Project ID:** **Sample Matrix:** Water	**Report Date:** 04/18/00

Individual Metals (TTLC)
Analysis Method: EPA Method 200.8-M

Sierra Sample No.	Client Sample No.	Test Parameters:					Units
		Selenium					
125	Effluent COS Sampac	ND					µg/L
Practical Quantitation Limit		2.00					

ND means Not Detected

GDC
P.O. Box 1238
Trinidad, CA 95570

TEL Project No.: 0002-002
Client Project ID:
Sample Matrix: Water

ELAP No.: 2400
Date Sampled: 2/10/00
Date Received: 2/16/00
Date Prepared 4/18/00
Date Analyzed 4/18/00
Analyst: NM

Report Date: 4/18/00

CCR Title 22 Metals (TTLC)
Analysis Method: EPA Method 200.8-M

Element	Method Blank ppb	LFB	125	125 Dup	125 MS (0.25ppb)	125 MSD (0.25ppb)	Relative Percent Difference between Duplicates	Percent Recovery	LCS CASS	LCS True Value	Detection Limit
Se	ND	0.255	ND	ND	0.196	0.196	0.00	78	---	---	0.10

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 14:46:08
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\Blank.002
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: Blank
Sample Type: Sample

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77		1003	2.5 %			ug/L	%
Se	78		20430	0.6 %			ug/L	%
Se	82		531	97.9 %			ug/L	%
Hg	202		17497	3.1 %			ug/L	%
Cl	37		13951078	1.6 %			ug/L	%
Br	79		23229	3.9 %			mg/L	%
Kr	83		11462	1.5 %			mg/L	%

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 14:47:58
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\Standard 1.003
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: Standard 1
Sample Type: Sample

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77	1003	14401	1.6 %			ug/L	%
Se	78	20430	62950	2.3 %			ug/L	%
Se	82	531	16707	3.9 %			ug/L	%
Hg	202	17497	14464	11.0 %			ug/L	%
Cl	37	13951078	14031401	2.0 %			ug/L	%
Br	79	23229	23466	3.0 %			mg/L	%
Kr	83	11462	11738	3.9 %			mg/L	%

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 14:50:21
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\Standard 2.004
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: Standard 2
Sample Type: Sample

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77	1003	33181	2.1 %	**0.2402**	0.00514	ug/L	2.1 %
Se	78	20430	119801	2.3 %	**0.2337**	0.00655	ug/L	2.8 %
Se	82	531	42434	2.4 %	**0.2590**	0.00624	ug/L	2.4 %
Hg	202	17497	11397	4.3 %			ug/L	%
Cl	37	13951078	14459482	1.5 %			ug/L	%
Br	79	23229	21130	5.2 %			mg/L	%
Kr	83	11462	11757	4.0 %			mg/L	%

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 14:52:14
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\Standard 3.005
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: Standard 3
Sample Type: Sample

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77	1003	64295	0.6 %	**0.4890**	0.00290	ug/L	0.6 %
Se	78	20430	214764	1.6 %	**0.4843**	0.00851	ug/L	1.8 %
Se	82	531	81983	2.4 %	**0.4883**	0.01161	ug/L	2.4 %
Hg	202	17497	11282	4.3 %			ug/L	%
Cl	37	13951078	14098848	1.1 %			ug/L	%
Br	79	23229	21645	0.6 %			mg/L	%
Kr	83	11462	11677	2.6 %			mg/L	%

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 14:54:27
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\Standard 4.006
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: Standard 4
Sample Type: Sample

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77	1003	125874	0.7 %	0.9815	0.00687	ug/L	0.7 %
Se	78	20430	368406	2.0 %	0.8888	0.01916	ug/L	2.2 %
Se	82	531	168845	3.0 %	1.0277	0.03094	ug/L	3.0 %
Hg	202	17497	10423	7.9 %			ug/L	%
Cl	37	13951078	13859582	1.4 %			ug/L	%
Br	79	23229	21879	6.8 %			mg/L	%
Kr	83	11462	11631	1.2 %			mg/L	%

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 14:56:21
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\CCB.007
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: CCB
Sample Type: Sample

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77	1003	874	9.0 %	-0.0010	0.00063	ug/L	61.1 %
Se	78	20430	19977	1.3 %	-0.0013	0.00073	ug/L	57.9 %
Se	82	531	21	2526.3 %	-0.0031	0.00316	ug/L	103.5 %
Hg	202	17497	15510	4.4 %			ug/L	%
Cl	37	13951078	13731929	0.7 %			ug/L	%
Br	79	23229	21988	4.3 %			mg/L	%
Kr	83	11462	11234	1.3 %			mg/L	%

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 14:58:12
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\CCV 0.25PPB.008
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: CCV 0.25PPB
Sample Type: Sample

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77	1003	34177	2.5 %	**0.2645**	0.00673	ug/L	2.5 %
Se	78	20430	123389	3.1 %	**0.2871**	0.01053	ug/L	3.7 %
Se	82	531	43059	2.1 %	**0.2543**	0.00529	ug/L	2.1 %
Hg	202	17497	14064	36.9 %			ug/L	%
Cl	37	13951078	14367139	1.0 %			ug/L	%
Br	79	23229	21075	5.0 %			mg/L	%
Kr	83	11462	11490	1.4 %			mg/L	%

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 15:02:16
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\ICV 0.25PPB.009
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: ICV 0.25PPB
Sample Type: Sample

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77	1003	33013	3.9 %	**0.2552**	0.01038	ug/L	4.1 %
Se	78	20430	122384	0.6 %	**0.2843**	0.00215	ug/L	0.8 %
Se	82	531	42252	2.2 %	**0.2495**	0.00557	ug/L	2.2 %
Hg	202	17497	20521	84.2 %			ug/L	%
Cl	37	13951078	14036547	0.8 %			ug/L	%
Br	79	23229	20854	2.9 %			mg/L	%
Kr	83	11462	11386	2.1 %			mg/L	%

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 15:05:04
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\125 20X.010
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: 125 20X
Sample Type: Sample

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77	1003	11264	3.3 %	**1.6359**	0.05986	ug/L	3.7 %
Se	78	20430	55458	3.6 %	**1.9536**	0.11009	ug/L	5.6 %
Se	82	531	13797	6.9 %	**1.5867**	0.11372	ug/L	7.2 %
Hg	202	17497	22093	3.9 %			ug/L	%
Cl	37	13951078	14412682	3.7 %			ug/L	%
Br	79	23229	25603	3.6 %			mg/L	%
Kr	83	11462	11645	2.6 %			mg/L	%

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 15:07:24
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\125 20X DUP.011
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: 125 20X DUP
Sample Type: Sample

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77	1003	11085	1.7 %	**1.6075**	0.02949	ug/L	1.8 %
Se	78	20430	52171	3.5 %	**1.7703**	0.10267	ug/L	5.8 %
Se	82	531	13753	5.1 %	**1.5815**	0.08347	ug/L	5.3 %
Hg	202	17497	23063	4.8 %			ug/L	%
Cl	37	13951078	14303283	1.3 %			ug/L	%
Br	79	23229	25205	2.4 %			mg/L	%
Kr	83	11462	11127	3.0 %			mg/L	%

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 15:13:25
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\125 20X + 0.25ppb.012
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: 125 20X + 0.25ppb
Sample Type: Sample

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77	1003	22983	5.0 %	**0.1752**	0.00919	ug/L	5.2 %
Se	78	20430	90808	3.4 %	**0.1963**	0.00870	ug/L	4.4 %
Se	82	531	30384	2.3 %	**0.1785**	0.00421	ug/L	2.4 %
Hg	202	17497	30486	17.2 %			ug/L	%
Cl	37	13951078	14305557	3.0 %			ug/L	%
Br	79	23229	25522	6.0 %			mg/L	%
Kr	83	11462	11149	3.0 %			mg/L	%

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 15:16:20
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\125 20X + 0.25ppb MSD.013
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: 125 20X + 0.25ppb MSD
Sample Type: Sample

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77	1003	23866	1.1 %	**0.1823**	0.00217	ug/L	1.2 %
Se	78	20430	90772	2.0 %	**0.1962**	0.00508	ug/L	2.6 %
Se	82	531	30951	5.6 %	**0.1819**	0.01035	ug/L	5.7 %
Hg	202	17497	26600	5.8 %			ug/L	%
Cl	37	13951078	13555083	1.3 %			ug/L	%
Br	79	23229	26490	4.5 %			mg/L	%
Kr	83	11462	11208	3.3 %			mg/L	%

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 15:23:01
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\126 20X .014
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: 126 20X
Sample Type: Sample

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77	1003	25116	2.1 %	**0.1922**	0.00418	ug/L	2.2 %
Se	78	20430	98430	3.3 %	**0.2175**	0.00902	ug/L	4.1 %
Se	82	531	32853	1.3 %	**0.1933**	0.00257	ug/L	1.3 %
Hg	202	17497	36622	21.8 %			ug/L	%
Cl	37	13951078	13946359	4.0 %			ug/L	%
Br	79	23229	25382	1.4 %			mg/L	%
Kr	83	11462	11249	2.8 %			mg/L	%

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 15:23:01
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\126 20X .014
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: 126 20X
Sample Type:

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77	1003	25116	2.1 %	**3.8445**	0.08354	ug/L	2.2 %
Se	78	20430	98430	3.3 %	**4.3504**	0.18043	ug/L	4.1 %
Se	82	531	32853	1.3 %	**3.8660**	0.05133	ug/L	1.3 %
Hg	202	17497	36622	21.8 %			ug/L	%
Cl	37	13951078	13946359	4.0 %			ug/L	%
Br	79	23229	25382	1.4 %			mg/L	%
Kr	83	11462	11249	2.8 %			mg/L	%

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 15:25:07
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\CCB.015
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: CCB
Sample Type: Sample

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77	1003	541	11.0 %	**-0.0037**	0.00047	ug/L	12.9 %
Se	78	20430	17659	1.2 %	**-0.0077**	0.00061	ug/L	7.9 %
Se	82	531	183	197.4 %	**-0.0021**	0.00216	ug/L	103.8 %
Hg	202	17497	9667	6.0 %			ug/L	%
Cl	37	13951078	13718943	3.2 %			ug/L	%
Br	79	23229	20677	2.2 %			mg/L	%
Kr	83	11462	11468	2.1 %			mg/L	%

TECHNICAL MEMORANDUM

CH2MHILL

gdc

CHEMICAL RE-ANALYSIS OF COS SAMOA PACKING EFFLUENT – SELENIUM: FEBRUARY 2000 SAMPLING

Prepared For: COS Samoa Packing, Inc.
(NPDES Permit AS0000027)

Prepared By: Steve Costa/ gdc
Karen Glatzel/ gdc

Date: 9 May 2000

Distribution: Carl Goldstein
United States Environmental Protection Agency, Region 9
Sheila Wiegman
American Samoa Environmental Protection Agency

Reviewing the February 2000 effluent chemistry data we noted that the selenium analysis had a detection limit that was unacceptably high that may have been caused by seawater matrix interference. The unpreserved metals sample was re-analyzed for selenium by another laboratory using an alternative method with significantly lower reporting limits. The results are shown in the table below and the laboratory report with QA/QC is provided in Attachment A.

Table 1.
COS Samoa Packing
Selenium Results– February 2000 Effluent Analysis

Sample No.	Method	Detection Limits (µg/l)		Value Reported (µg/l)
		Requested	Achieved	
Sample 1 - ARI	EPA 270.1	5	10	50
Sample 2 - TEL	EPA 200.8-M	5	2	2

ATTACHMENT A

LABORATORY DATA REPORT
TEL

COS Samoa Packing Effluent Sample

Selenium Analysis

February 2000

GDC P.O. Box 1238 Trinidad, CA 95570		ELAP No.: Date Sampled: Date Received: Date Prepared: Date Analyzed: Analyst:	2400 02/10/00 02/16/00 04/18/00 04/18/00 NM
TEL Project No.: Client Project ID: Sample Matrix:	0002-002 Water	Report Date:	04/18/00

Individual Metals (TTLC)
Analysis Method: EPA Method 200.8-M

Sierra Sample No.	Client Sample No.	Test Parameters:					Units
		Selenium					
125	Effluent COS Sampac	ND					µg/L
Practical Quantitation Limit		2.00					

ND means Not Detected

GDC
P.O. Box 1238
Trinidad, CA 95570

TEL Project No.: 0002-002
Client Project ID:
Sample Matrix: Water

ELAP No.: 2400
Date Sampled: 2/10/00
Date Received: 2/16/00
Date Prepared 4/18/00
Date Analyzed 4/18/00
Analyst: NM

Report Date: 4/18/00

CCR Title 22 Metals (TTLC)
Analysis Method: EPA Method 200.8-M

Element	Method Blank ppb	LFB	125	125 Dup	125 MS (0.25ppb)	125 MSD (0.25ppb)	Relative Percent Difference between Duplicates	Percent Recovery	LCS CASS	LCS True Value	Detection Limit
Se	ND	0.255	ND	ND	0.196	0.196	0.00	78	---	---	0.10

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 14:46:08
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\Blank.002
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: Blank
Sample Type: Sample

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77		1003	2.5 %			ug/L	%
Se	78		20430	0.6 %			ug/L	%
Se	82		531	97.9 %			ug/L	%
Hg	202		17497	3.1 %			ug/L	%
Cl	37		13951078	1.6 %			ug/L	%
Br	79		23229	3.9 %			mg/L	%
Kr	83		11462	1.5 %			mg/L	%

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 14:47:58
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\Standard 1.003
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: Standard 1
Sample Type: Sample

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77	1003	14401	1.6 %			ug/L	%
Se	78	20430	62950	2.3 %			ug/L	%
Se	82	531	16707	3.9 %			ug/L	%
Hg	202	17497	14464	11.0 %			ug/L	%
Cl	37	13951078	14031401	2.0 %			ug/L	%
Br	79	23229	23466	3.0 %			mg/L	%
Kr	83	11462	11738	3.9 %			mg/L	%

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 14:50:21
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\Standard 2.004
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: Standard 2
Sample Type: Sample

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77	1003	33181	2.1 %	**0.2402**	0.00514	ug/L	2.1 %
Se	78	20430	119801	2.3 %	**0.2337**	0.00655	ug/L	2.8 %
Se	82	531	42434	2.4 %	**0.2590**	0.00624	ug/L	2.4 %
Hg	202	17497	11397	4.3 %			ug/L	%
Cl	37	13951078	14459482	1.5 %			ug/L	%
Br	79	23229	21130	5.2 %			mg/L	%
Kr	83	11462	11757	4.0 %			mg/L	%

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 14:52:14
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\Standard 3.005
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: Standard 3
Sample Type: Sample

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77	1003	64295	0.6 %	**0.4890**	0.00290	ug/L	0.6 %
Se	78	20430	214764	1.6 %	**0.4843**	0.00851	ug/L	1.8 %
Se	82	531	81983	2.4 %	**0.4883**	0.01161	ug/L	2.4 %
Hg	202	17497	11282	4.3 %			ug/L	%
Cl	37	13951078	14098848	1.1 %			ug/L	%
Br	79	23229	21645	0.6 %			mg/L	%
Kr	83	11462	11677	2.6 %			mg/L	%

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 14:54:27
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\Standard 4.006
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: Standard 4
Sample Type: Sample

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77	1003	125874	0.7 %	0.9815	0.00687	ug/L	0.7 %
Se	78	20430	368406	2.0 %	0.8888	0.01916	ug/L	2.2 %
Se	82	531	168845	3.0 %	1.0277	0.03094	ug/L	3.0 %
Hg	202	17497	10423	7.9 %			ug/L	%
Cl	37	13951078	13859582	1.4 %			ug/L	%
Br	79	23229	21879	6.8 %			mg/L	%
Kr	83	11462	11631	1.2 %			mg/L	%

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 14:56:21
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\CCB.007
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: CCB
Sample Type: Sample

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77	1003	874	9.0 %	-0.0010	0.00063	ug/L	61.1 %
Se	78	20430	19977	1.3 %	-0.0013	0.00073	ug/L	57.9 %
Se	82	531	21	2526.3 %	-0.0031	0.00316	ug/L	103.5 %
Hg	202	17497	15510	4.4 %			ug/L	%
Cl	37	13951078	13731929	0.7 %			ug/L	%
Br	79	23229	21988	4.3 %			mg/L	%
Kr	83	11462	11234	1.3 %			mg/L	%

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 14:58:12
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\CCV 0.25PPB.008
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: CCV 0.25PPB
Sample Type: Sample

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77	1003	34177	2.5 %	0.2645	0.00673	ug/L	2.5 %
Se	78	20430	123389	3.1 %	0.2871	0.01053	ug/L	3.7 %
Se	82	531	43059	2.1 %	0.2543	0.00529	ug/L	2.1 %
Hg	202	17497	14064	36.9 %			ug/L	%
Cl	37	13951078	14367139	1.0 %			ug/L	%
Br	79	23229	21075	5.0 %			mg/L	%
Kr	83	11462	11490	1.4 %			mg/L	%

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 15:02:16
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\ICV 0.25PPB.009
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: ICV 0.25PPB
Sample Type: Sample

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77	1003	33013	3.9 %	0.2552	0.01038	ug/L	4.1 %
Se	78	20430	122384	0.6 %	0.2843	0.00215	ug/L	0.8 %
Se	82	531	42252	2.2 %	0.2495	0.00557	ug/L	2.2 %
Hg	202	17497	20521	84.2 %			ug/L	%
Cl	37	13951078	14036547	0.8 %			ug/L	%
Br	79	23229	20854	2.9 %			mg/L	%
Kr	83	11462	11386	2.1 %			mg/L	%

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 15:05:04
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\125 20X.010
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: 125 20X
Sample Type: Sample

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77	1003	11264	3.3 %	**1.6359**	0.05986	ug/L	3.7 %
Se	78	20430	55458	3.6 %	**1.9536**	0.11009	ug/L	5.6 %
Se	82	531	13797	6.9 %	**1.5867**	0.11372	ug/L	7.2 %
Hg	202	17497	22093	3.9 %			ug/L	%
Cl	37	13951078	14412682	3.7 %			ug/L	%
Br	79	23229	25603	3.6 %			mg/L	%
Kr	83	11462	11645	2.6 %			mg/L	%

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 15:07:24
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\125 20X DUP.011
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: 125 20X DUP
Sample Type: Sample

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77	1003	11085	1.7 %	**1.6075**	0.02949	ug/L	1.8 %
Se	78	20430	52171	3.5 %	**1.7703**	0.10267	ug/L	5.8 %
Se	82	531	13753	5.1 %	**1.5815**	0.08347	ug/L	5.3 %
Hg	202	17497	23063	4.8 %			ug/L	%
Cl	37	13951078	14303283	1.3 %			ug/L	%
Br	79	23229	25205	2.4 %			mg/L	%
Kr	83	11462	11127	3.0 %			mg/L	%

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 15:13:25
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\125 20X + 0.25ppb.012
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: 125 20X + 0.25ppb
Sample Type: Sample

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77	1003	22983	5.0 %	**0.1752**	0.00919	ug/L	5.2 %
Se	78	20430	90808	3.4 %	**0.1963**	0.00870	ug/L	4.4 %
Se	82	531	30384	2.3 %	**0.1785**	0.00421	ug/L	2.4 %
Hg	202	17497	30486	17.2 %			ug/L	%
Cl	37	13951078	14305557	3.0 %			ug/L	%
Br	79	23229	25522	6.0 %			mg/L	%
Kr	83	11462	11149	3.0 %			mg/L	%

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 15:16:20
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\125 20X + 0.25ppb MSD.013
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: 125 20X + 0.25ppb MSD
Sample Type: Sample

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77	1003	23866	1.1 %	**0.1823**	0.00217	ug/L	1.2 %
Se	78	20430	90772	2.0 %	**0.1962**	0.00508	ug/L	2.6 %
Se	82	531	30951	5.6 %	**0.1819**	0.01035	ug/L	5.7 %
Hg	202	17497	26600	5.8 %			ug/L	%
Cl	37	13951078	13555083	1.3 %			ug/L	%
Br	79	23229	26490	4.5 %			mg/L	%
Kr	83	11462	11208	3.3 %			mg/L	%

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 15:23:01
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\126 20X .014
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: 126 20X
Sample Type: Sample

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77	1003	25116	2.1 %	**0.1922**	0.00418	ug/L	2.2 %
Se	78	20430	98430	3.3 %	**0.2175**	0.00902	ug/L	4.1 %
Se	82	531	32853	1.3 %	**0.1933**	0.00257	ug/L	1.3 %
Hg	202	17497	36622	21.8 %			ug/L	%
Cl	37	13951078	13946359	4.0 %			ug/L	%
Br	79	23229	25382	1.4 %			mg/L	%
Kr	83	11462	11249	2.8 %			mg/L	%

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 15:23:01
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\126 20X .014
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: 126 20X
Sample Type:

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77	1003	25116	2.1 %	**3.8445**	0.08354	ug/L	2.2 %
Se	78	20430	98430	3.3 %	**4.3504**	0.18043	ug/L	4.1 %
Se	82	531	32853	1.3 %	**3.8660**	0.05133	ug/L	1.3 %
Hg	202	17497	36622	21.8 %			ug/L	%
Cl	37	13951078	13946359	4.0 %			ug/L	%
Br	79	23229	25382	1.4 %			mg/L	%
Kr	83	11462	11249	2.8 %			mg/L	%

Quantitative Analysis Summary

Sample Date/Time: Tuesday, April 18, 2000 15:25:07
Method File: D:\dataset\Method\Fias-SE noHg.mth
Dataset File: D:\dataset\Dataset\Results\0400\041800\CCB.015
Number of Replicates: 3
Dual Detector Mode: Dual
Auto Lens Mode: Off
Sample ID: CCB
Sample Type: Sample

Summary

Analyte	Mass	Blank Intensity	Meas. Intensity	Intens. RSD	Conc. Mean	Conc. SD		Conc. RSD
Se	77	1003	541	11.0 %	**-0.0037**	0.00047	ug/L	12.9 %
Se	78	20430	17659	1.2 %	**-0.0077**	0.00061	ug/L	7.9 %
Se	82	531	183	197.4 %	**-0.0021**	0.00216	ug/L	103.8 %
Hg	202	17497	9667	6.0 %			ug/L	%
Cl	37	13951078	13718943	3.2 %			ug/L	%
Br	79	23229	20677	2.2 %			mg/L	%
Kr	83	11462	11468	2.1 %			mg/L	%

CH2MHILL

Steve Costa
Karen Glatzel

216 Driftwood Lane
P.O. Box 1238
Trinidad, CA 95570-1238

707-677-0123 (Tel)
707-677-9210 (Fax)
510-508-5020 (Cell)

16 May 2005

Mr. Carl Goldstein
Pacific Insular Area Programs
CMD-1
Environmental Protection Agency
75 Hawthorne Street
San Francisco, CA 94105

Mr. Peter Peshut
American Samoa Environmental Protection Agency
American Samoa Government
P.O. Box 368A
Pago Pago, American Samoa 96799

Enclosed is the required report for the bioassay test results for the March 2005 effluent sampling for the Joint Cannery Outfall in American Samoa. The sampling and analysis were carried out without problems, although there was a longer than usual delay in shipping time as described below. The results are similar to the past bioassay test results.

This sample was collected on the 3rd and 4th of March 2005 and shipped via DHL on the 4th of March 2005. However, as we previously notified you by email, the sample was delayed in shipping and did not reach the laboratory until 15 March 2005. The tests were run immediately by the laboratory. The results of the tests were consistent with the previous tests (see the enclosed report). In the early 1990's when we started doing these tests it was concluded that potential toxicity in the effluent was most likely the result of high ammonia. The sample received by the laboratory was tested for ammonia and the levels were within the range found for previous samples sent to the laboratory and within the range generally reported by the canneries in the discharge monitoring reports. The results of the toxicity tests and the concentrations of the most likely source of toxicity are consistent with previous data and it does not appear that the shipping delay biased the results.

It is recognized that normally five days is about the absolute minimum that we could achieve in point-to-point delivery to the laboratory under the best possible conditions. The reasons are as follows:

- The effluent should be a "representative sample". In general (based on past discussions with EPA and based on typical cannery operations) we need to collect our composite sample sometime between noon Monday (Monday AM is often start up and not typical) and noon Friday (Friday PM is typically wash

down and not typical). If extended full production shifts are run through the weekend this timeframe might be extended - but we can not plan on that since such schedule changes are rare (if ever), and would be unpredictable and sporadic.

- We need a 24-hour composite sample.

- DHL (the only express door-to-door shipper on the island) ships out on Friday and Monday afternoons.

- For the Friday flight we start sampling Thursday morning through Friday morning, composite and pack and deliver to DHL by 2 PM (Friday cut off). This shipment recently started going through Guam and LAX and then gets to the lab by Wednesday or Thursday as a best case. In the past the Friday shipment went through Honolulu, and often got the laboratory Tuesday or Wednesday

- For the Monday flight we would start sampling the previous Thursday afternoon to finish by Friday noon, and composite some time before Monday. This shipment goes through Honolulu to the mainland (probably LAX) and the best case delivery is still Wednesday or Thursday. (We typically use the Friday flight and seldom follow this schedule.)

Keep in mind that the cannery permits recognize this problem and explicitly state:

> "*Every reasonable effort shall be made to ship the samples to the testing laboratory in a manner to meet holding times and maintain sample temperature at 4 [degrees] C. ASEPA and USEPA may, at their discretion, allow deviations from the published holding time and sample temperature requirements to accommodate unavoidable delays in shipping from American Samoa to the laboratory.*"

I believe American Samoa Power (ASPA) collects samples on Sunday and Monday and ships via Hawaiian airfreight on Monday for the samples EPA uses for ASPA's bioassay tests. Since ASAP is collecting from a domestic wastewater source the constraints are not as serious to get a representative sample. I am not sure how customs and delivery is handled on the SFO end but this allows somewhat quicker delivery. Unfortunately the cannery samples cannot be collected on the weekend for a representative sample and we are sending the sample to a commercial lab so we need to have deliver to their door.

In the past we used to collect samples and hand carry (as checked baggage) them to Honolulu or Seattle and then FedEx to the lab. That does not save a substantial amount

of time (usually only a day). This has become difficult and problematic with the new diligence of customs and TSA. As far as we know, there are no labs in Hawaii available to do the required tests.

Therefore, we typically exceed the generally accepted holding times, and sample shipments usually take more than five days. We believe these delays are unavoidable. Based on the receiving water monitoring and the high initial dilution of the diffuser (confirmed by dye studies) we do not see any real area of concern for the environment. The primary concern is regulatory compliance, which is generally covered in the permit language.

There is now a new shipping schedule because Hawaiian has changed to Sunday and Thursday flights after 1 May 2005. However, this is not going to make much difference, possibly saving one day in transit if everything goes well. It should also be noted that service from the only express delivery available in Samoa, DHL, has degraded significantly over the past year and longer delays in the future are anticipated. To avoid this we are exploring another shipping option where we would ship Hawaiian Air, have the shipment intercepted in Honolulu have the sample re-iced, and transferred to FedEx for delivery to the laboratory. With a Thursday shipment, if this approach proves viable, we could have delivery to the laboratory on Monday (typically laboratories do not accept Saturday delivery and would not start the test until Monday anyway).

Because of the apparently valid test results, and because of the inherent difficulties in shipping, it is our recommendation that this test be accepted and not rerun. The next test is scheduled for the August-October tradewind season. In the meantime we will continue to explore alternate shipping strategies.

Please call us if you have any questions or comments on the enclosed report.

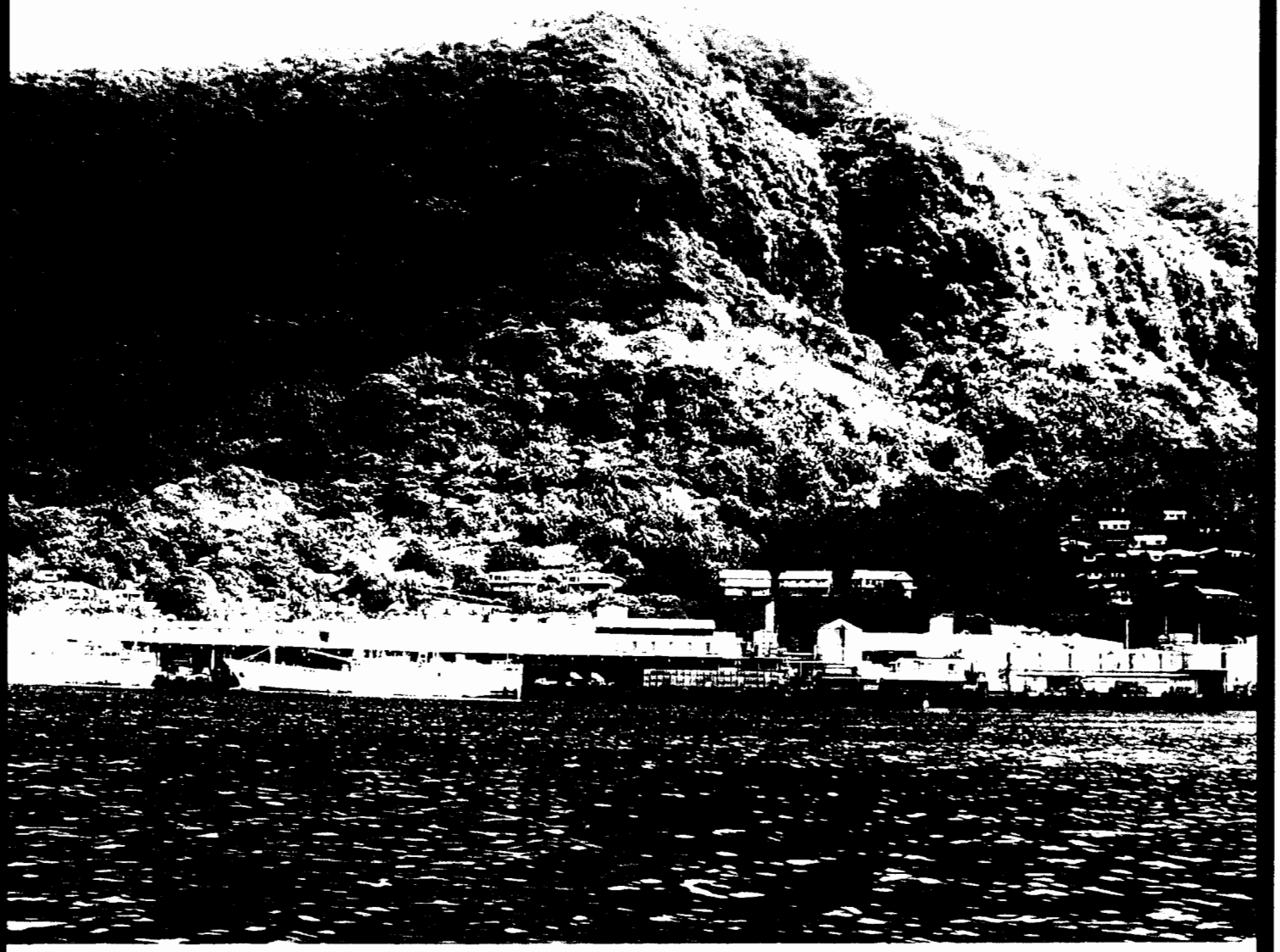
Sincerely,

Karen A. Glatzel
Steven L. Costa

cc: Jim Cox, COS International; Herman Gebauer, COS; Brett Ransby, COS; Phil Thirkel, StarKist Samoa; Joe Carney, StarKist Samoa; Tim Ruby, Del Monte; David Wilson, CH2M HILL.

Encl: Bioassay Testing – Joint Cannery Outfall Effluent September 2004 Sampling

Samoa Joint Cannery Outfall
2004 Tradewind Season
Effluent Bioassay Test Results
September 2004 Sampling



16 November 2004

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TECHNICAL MEMORANDUM

BIOASSAY TESTING – JOINT CANNERY OUTFALL EFFLUENT SEPTEMBER 2004 SAMPLING

Prepared For: StarKist Samoa (NPDES Permit AS0000019)
COS Samoa Packing (NPDES Permit AS0000027)

Prepared By: Steve Costa
Karen Glatzel

Date: 16 November 2004

Distribution: Carl Goldstein
United States Environmental Protection Agency, Region 9
Peter Peshut
American Samoa Environmental Protection Agency

Purpose

This memorandum presents the results of the bioassay testing of the Joint Cannery Outfall effluent sample that was collected in September 2004. The testing is required by the NPDES Permits that became effective in January 2001. This is the eighth required semi-annual test required by the current permits and the twenty-fourth test, over twenty-two semi-annual periods, conducted since testing of the Joint Cannery Outfall effluent began in 1993[1].

Study Objectives

Section D.1 of the StarKist Samoa and COS Samoa Packing NPDES Permits requires that semiannual definitive acute bioassays (96-hour static bioassays) be conducted on the cannery effluent. The purpose of these tests is to determine whether, and at what effluent concentration, acute toxicity may be detected for the combined joint cannery effluent discharge into Pago Pago Harbor.

---

[1] Testing was not conducted during 1999. Extra tests using two organisms were conducted in March 1995 and February 1996.

Study Approach

U.S. EPA has conducted a number of reviews of the effluent sampling, analysis, and bioassay tests conducted in the past. All comments from U.S. EPA have been incorporated into the sampling and sample handling standard operating procedures (SOP) or have been incorporated into the procedures used by the laboratory doing the test. The comments, responses, and SOP have been documented in previous reports.

The permit conditions require that the bioassay tests be conducted with the white shrimp, *Penaeus vannami* (postlarvae). In the event *Penaeus vannami* is not available at the time of the tests, the permit specifies the substitute species, *Mysidopsis bahia,* which now has been renamed *Americamysis bahia.* For the September 2004 sampling, *Penaeus vannami* was not available and *Americamysis bahia* was used.

Effluent samples were collected from the StarKist Samoa and COS Samoa Packing facilities as 24-hour composite samples. The acute effluent bioassay test was conducted using a combined, flow-weighted, composite effluent sample made up from the effluent samples from both canneries, as allowed by the permit condition. This combined effluent bioassay is representative of the wastewater discharged from the joint cannery outfall to Pago Pago Harbor.

Effluent Sampling Methods

Between 1000 on 23 September 2004 and 0700 on 24 September 2004, 24-hour flow-weighted composite samples of final effluent were collected from both the StarKist Samoa and COS Samoa Packing effluent discharges. Samples were collected from the established effluent sampling sites. Detailed sampling procedures are described in the established SOP for cannery effluent sampling.

A total of eight grab samples were collected into 1-gallon plastic cubitainers at each plant. Samples were collected at approximately three-hour intervals over a 24-hour period. The samples were stored on ice or in a refrigerator until the completion of the 24-hour sampling period. After all samples were collected a flow-proportioned composite sample was prepared. The grab sample collection times, effluent flow rates, and the relative effluent flow volumes calculated from plant flow records are summarized in Table 1. The relative effluent flow volumes were used to prepare the final composite sample, which was used to fill the sample container shipped to the laboratory for testing.

A 5-gallon cubitainer containing the composite sample was packed on ice in an ice chest for shipment to the laboratory. A chain-of-custody form for the sample was completed and sealed into a zip-lock bag and taped inside the lid of the ice chest. The sample was shipped via DHL to the testing laboratory. The chain-of-custody form and the DHL waybill are provided in Attachment I.

Table 1
StarKist Samoa and COS Samoa Packing
24-hour Composite Effluent Sample for Bioassay Testing
September 2004

Grab Sample Number	COS Samoa Packing		StarKist Samoa		COS Samoa Packing Percent of Total Flow	StarKist Samoa Percent Of Total Flow
	Sampling Date and Time	Effluent Flow Rate (mgd)	Sampling Date and Time	Effluent Flow Rate (mgd)		
1	23 Sept 2004 1000	0.60	23 Sept 2004 1000	1.44	0.0254	0.0610
2	1300	0.38	1300	2.13	0.0161	0.0901
3	1600	0.68	1600	2.92	0.0288	0.1235
4	1900	0.68	1900	2.50	0.0288	0.1055
5	2200	0.56	2200	2.73	0.0237	0.1154
6	24 Sept 2004 0100	0.56	24 Sept 2004 0100	2.53	0.0237	0.1070
7	0400	0.56	0400	2.76	0.0237	0.1166
8	0700	0.66	0700	1.96	0.0279	0.0829
Total		4.68		18.97	0.1979	0.8021
Mean		0.59		2.37	Total = 1.00	

Bioassay Testing Procedures

EnviroSystems, Inc. located in Hampton, New Hampshire conducted the bioassay tests. The testing procedures and results of the bioassay tests are provided in the Laboratory report included as Attachment II. This report summarizes the 96-hour acute bioassay test conducted with reference to the U.S. EPA document Methods for Measuring the Acute Toxicity of Effluents to Freshwater and Marine Organisms (EPA-821-R-02-012), 2002 as the sources of methods for conducting the test. The bioassay test was conducted considering and including U.S. EPA's comments on previous bioassay tests, as documented in previous reports.

The test organisms were ≤ 5 days old and the test temperature was to be held at 20 ±1°C, with actual temperatures ranging between 20°C and 22°C. Salinity was adjusted to 25 ppt at the start of the test and ranged during the test between 24 and

28 ppt. Demonstrated potential for a lethal immediate dissolved oxygen demand (IDOD) had been discussed and documented in previous bioassay technical memoranda, which describe the first two tests conducted in 1993. Therefore, all of the bioassay test chambers were continuously aerated during the bioassay tests to maintain adequate levels of dissolved oxygen (DO)[2]. The test was renewed with oxygenated sample at 48 hours.

Bioassay tests were carried out for effluent concentrations of 50, 25, 12.5, 6.25, and 3.1 percent as vol:vol dilutions in seawater. Water quality was monitored daily and parameters measured included DO, pH, salinity, and temperature. Total residual chlorine and ammonia were measured. Water quality data are provided in the Laboratory Report (Attachment II). Reference toxicant tests using sodium dodecyl sulfonate (SDS) are conducted regularly by ESI with the last one completed on 29 September 2004 and results were within one standard deviation of the historic laboratory mean.

Summary Results: Americamysis bahia Effluent Bioassay

All results from the bioassay tests are included in Attachment II. The results of the mysid bioassay tests indicate the 96-hour LC_{50} for the effluent tested was >50 percent. The no observable effects concentration (NOEC) for the 96-hour bioassay was 50 percent and the least observable effects concentration (LOEC) was >50 percent. Results on a daily basis are summarized in Table 2.

Table 2
StarKist Samoa and COS Samoa Packing
Combined Effluent Bioassay Results
September 2004 Sampling

Exposure Time	Parameter		
	LC_{50}	NOEC[1]	LOEC
24 hours	>50%	50%	>50%
48 hours	>50%	50%	>50%
72 hours	>50%	50%	>50%
96 hours	>50%	50%	>50%

[1] Highest concentration tested was 50% so NOEC can be considered ≥50%

[2] The high initial dilution of the actual effluent discharge (>100:1) into the Harbor, in a very short time, removes any concern about IDOD effects in the receiving water.

Discussion

Table 3 summarizes the results of the effluent bioassay tests for the samples collected in the September 2004 sampling compared to the previous bioassay tests. The LC_{50}, NOEC, and LOEC are within the range or higher than that obtained from previous tests where *Americamysis bahia* (*Mysidopsis bahia*) was used in place of *Penaeus vannami*. Figure 1 summarizes the LC_{50} for the mysid and penaeid tests done since February 1993. Figure 2 presents the range of LC_{50} results for mysids tests conducted since 1994. There is some variability observed in test results. The September 2004 test results along with the previous test results, for February 2004, were the highest LC_{50} values recorded for this organism. Higher LC_{50} values indicate lower whole effluent toxicity. There is a possible trend toward lower toxicity (higher LC_{50}) with time (see Figure 2). The trend is statistically significant at the <5% level. However, the actual significance and reason for the trend is unknown.

Conclusions

The bioassay tests for the Joint Cannery Outfall effluent for September 2004 do not indicate effluent toxicity levels to be of concern. As discussed in the previous bioassay test reports on the effluent, the time scale of the mixing of the effluent with the receiving water is on the order of seconds to achieve dilutions that will eliminate possible toxic effects as reflected by the bioassay results. For example, an LC_{50} of 50%, which was observed in September 2004, corresponds to a dilution of 2:1, which is achieved within one second and within one meter of the discharge point. The discharge is located in about 180 feet of water and the effluent toxicity tests indicate that the discharge is diluted to non-toxic levels immediately after discharge and well within the initial dilution plume.

Table 3
StarKist Samoa and COS Samoa Packing
Combined Effluent Bioassay Results

Date	*Species*	Parameters		
		LC_{50}	NOEC	LOEC
2/93	*Penaeus vannami*	4.8%[1]	3.1%	6.25%
10/93	*Penaeus vannami*	15.67%	3.1%	6.25%
2/94	*Penaeus vannami*	15.76%	<1.6%	1.6%
10/94	*Mysidopsis bahia*[2]	31.2%	25%	50%
3/95	*Penaeus vannami*	14.8%	6.25%	12.5%
3/95	*Mysidopsis bahia*[3]	10.8%	6.25%	12.5%
2/96	*Penaeus vannami*	>50%	>50%	>50%
2/96	*Mysidopsis bahia*[3]	28.36%	12.5%	25%
3/96	*Penaeus vannami*	44.4%	25%	50%
11/96	*Penaeus vannami*	7.11%	3.1%	6.25%
03/97	*Penaeus vannami*	39.36%	12.5%	25%
09/97	*Penaeus vannami*[4]	12.3%	6.25%	12.5%
06/98	*Mysidopsis bahia*[2]	17.2%	6.25%	12.5%
11/98	*Mysidopsis bahia*[2]	15%	6.25%	12.5%
02/00	*Mysidopsis bahia*[2]	20%	6.25%	12.5%
08/00	*Mysidopsis bahia*[2]	17.1%	3.1%	6.25%
03/01	*Americamysis bahia*[2,5]	13.8%	12.5%	25%
10/01	*Americamysis bahia*[2,6]	37.5%	25.0%	50.0%
3/02	*Americamysis bahia*[2,6]	16.1%	12.5%	25%
8/02	*Americamysis bahia*[2,6]	10.23%	6.25%	12.5%
03/03	*Americamysis bahia*[2,6]	28.4%	25%	50%
08/03	*Americamysis bahia*[2,6]	43.2%	25.0%	50.0%
02/04	*Americamysis bahia*[2,6]	>50%	50%	>50%
09/04	***Americamysis bahia*[2,6]**	**>50%**	**50%**	**>50%**

[1]The February 1993 samples were not aerated until after the first day of the test. For subsequent tests the samples were aerated for the entire duration of the tests.
[2]*Mysidopsis bahia* used as substitutes because *Penaeus vannami* not available: as directed and approved by U. S. EPA.
[3]*Mysidopsis bahia* used in addition to *Penaeus vannami* as described in text of technical memorandums reporting test results. Only one species is required by the permit conditions.
[4]Stage 1 (3 mm) *Penaeus vannami* were used for testing because older Stage 7 and 8 (8-10 mm) *Penaeus vannami* were not available.
[5]*Mysidopsis bahia* renamed *Americamysis bahia*. Results indicate increased toxicity because of low DO in renewal concentrations as renewal water was not aerated prior to use
[6] *Mysidopsis bahia* renamed *Americamysis bahia*

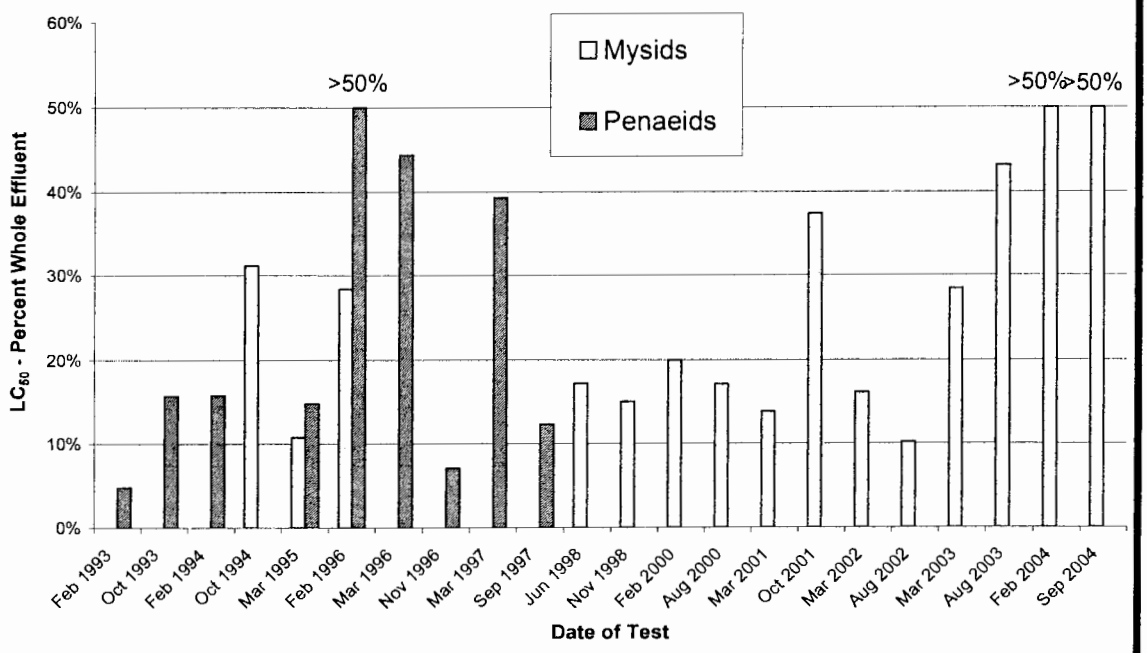


Figure 1. LC_{50} for Mysid and Penaeid Tests

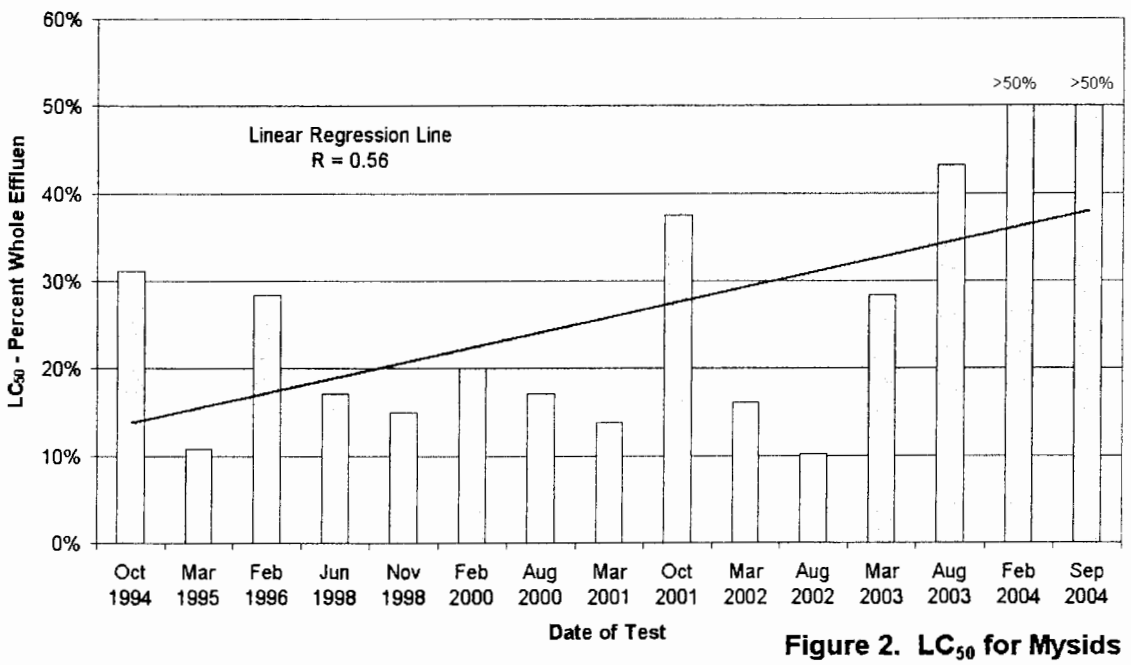


Figure 2. LC_{50} for Mysids

ATTACHMENT I

Chain-of-Custody

Samoa

CH2M HILL
APPLIED SCIENCES LABORATORY

CHAIN OF CUSTODY RECORD AND AGREEMENT TO PERFORM SERVICES

CH2M Hill Project #: 147323.JC.04.TW

Purchase Order #:

Project Name: SAMOA JOINT CANNERY OUTFALL

Company Name/CH2M HILL Office: CH2M HILL

Project Manager & Phone #: Mr. [ ] Ms. [ ] Dr. [ ] STEVE COSTA 707-677-0123

Report Copy to: SAME 707-677-0123

Requested Completion Date:

Sampling Requirements: SDWA [ ] NPDES [ ] RCRA [ ] OTHER ____

Sample Disposal: Dispose [ ] Return [ ]

LAB TEST CODES

ANALYSES REQUESTED

SHADED AREA– FOR LAB USE ONLY: Lab 1 # / Lab 2 # / Quote # / Kit Request # / Project # / No. of Samples / Page of / Login / LIMS Ver

Sampling Date	Sampling Time	Type COMP	Type GRAB	Matrix WATER	Matrix SOIL	Matrix AIR	CLIENT SAMPLE ID (9 CHARACTERS)	# OF CONTAINERS	ANALYSES REQUESTED	REMARKS	LAB 1 ID	LAB 2 ID
9/23	-24	X		X			JC0-04TW	1	BIOASSAY TEST W/ MYSID 96-HR STATIC RENEWAL 12584	-001		

Sampled By & Title (Please sign and print name) S. Costa	Date/Time 9/24/04	Relinquished By (Please sign and print name) S. Costa	Date/Time 9/24/04
Received By (Please sign and print name)	Date/Time 10/1/04 1510	Relinquished By (Please sign and print name)	Date/Time
Received By (Please sign and print name)	Date/Time	Relinquished By (Please sign and print name)	Date/Time
Received By (Please sign and print name)	Date/Time	Shipped Via UPS BUS Fed-Ex Hand Other DHL	Shipping # 8446187702
Work Authorized By (Please sign and print name)	Remarks MAINTAIN DO LEVELS - AERATE CONTINUOUSLY & BEFORE RENEWAL		

QC Level: 1 2 3 Other:
COC Rec / ICE
Ana Req / TEMP
Cust Seal / Ph

Instructions and Agreement Provisions on Reverse Side

DISTRIBUTION: Original - LAB, Yellow - LAB, Pink - Client

REORDER 920701629-1 QTY 25

4/05/01 6

Shipment Airwaybill

DHL WORLDWIDE EXPRESS

1-800-CALL-DHL (Non negotiable) in USA only

WEB ADDRESS: http://www.dhl.com

PPF PPF

8446187702

Quote this shipment number in an inquiry

ORIGIN	DESTINATION
SLV	PRT

1 From (Shipper)

Account no.: 920701629

Shipper's reference: 147323.JC.04.TW

Company name: CH2M HILL

Shipper's name: STEVE COSTA / JIM CRAWFORD

Address: ~~777 108TH AVE NE~~ ~~BELLEVUE WA~~ Lefalepole Faga'alu American Samoa ~~684-633-5264~~

Zip code (required): ~~98004~~ 96799

Phone/Fax/E-mail circle one (required): (425)453-5000

2 To (Recipient)

Company name: ENVIROSYSTEMS, INC

Attention: PETRA KARBE

Delivery address: ONE LAFAYETTE ROAD HAMPTON, NEW HAMPSHIRE USA

Zip/Postcode (required): 03842

Phone/Fax/E-mail circle one (required): 603-962-3345

3 Shipment details

Domestic Services
- [ ] USA OVERNIGHT

International Services
- [ ] INT'L DOCUMENT EXPRESS
- [ ] WORLDWIDE PRIORITY EXPRESS (Non document shipments / unlimited weight)
- [x] WORLDFREIGHT (Prior arrangements required / 220 lbs. Minimum)

WorldMail Services [ ] 1st [ ] APM [ ] 2nd [ ] IPA [ ] ISAL

Special Services extra charges may apply
- [ ] SATURDAY DELIVERY (not available to all locations)
- [ ] POD ..... Shipper's fax/e-mail for POD (optional)
- [ ] OTHER ..... / .....

Payment Options not all options available to all countries
- [x] Shipper's account
- [ ] Recipient
- [ ] Third party

Acct. No. .....

- [ ] Cash / Check / Credit Card circle one

No. .....

Expires. ..... Type .....

Shipment insurance if desired, enter amount below

US $ ..... Insured value

Full description of contents

WATER QUALITY SAMPLE FOR LABORATORY ANALYSIS

NO COMMERCIAL VALUE

International non document shipments only

Attach original and four copies of a Commercial Invoice

Declared value for customs (In US $): $50.00

Export License No./Symbol (if applicable):

Harmonized Sched. B No. (if applicable):

Type of export (If left blank, Permanent is assumed)
- [ ] Permanent
- [ ] Temporary
- [ ] Repair/Return

Shipper's EIN/SSN:

These commodities, technology or software were exported from the United States in accordance with the export administration regulations. Diversion contrary to U.S. law prohibited.

Destination duties/taxes *If left blank recipient pays duties/taxes*
- [ ] Recipient
- [x] Shipper
- [ ] Other ..... Specify destination approved account number

4 Pcs/Weight/Size

No. of pieces: 1

Weight if DHL Express Document packaging is used, enter XD: 60 lb

Dimensions in inches

Pieces	length	width	height
___ @	x	x	
___ @	x	x	
___ @	x	x	

DIMENSIONAL/CHARGED WEIGHT lb

CODES	CHARGES Services
	Special services
	Insurance
Drop Box/ Exp. Center #	
TOTAL	

TRANSPORT COLLECT STICKER No.

PICKED UP BY

Time 1:01

Date 4/1/01

5 Shipper's authorization and signature

I/we agree that DHL's standard terms apply to this shipment and limit DHL's liability for loss or damage to U.S. $ 100. The Warsaw Convention may also apply (see reverse). I/we authorize DHL to complete other documents necessary to export this shipment. I/we understand that insurance is available on request, for an extra charge. I/we agree to pay all charges if the recipient or third party does not pay. I/we understand that DHL DOES NOT TRANSPORT CASH.

Signature (required): Steve L Costa

Date: / /

557209 7/00

DHL AIRWAYS, INC. • 333 TWIN DOLPHIN DRIVE, REDWOOD CITY, CA 94065

Shipper's Copy

ATTACHMENT II

EnviroSystems, Inc. Laboratory Report

TOXICOLOGICAL EVALUATION OF A TREATED EFFLUENT: BIOMONITORING SUPPORT FOR A NPDES PERMIT OCTOBER 2004

American Samoa Joint Cannery Outfall

Prepared For

CH2M Hill, Incorporated
P.O. Box 1238
Trinidad, California 95570-1238

By

EnviroSystems, Incorporated
One Lafayette Road
Hampton, New Hampshire 03842

October 2004
Reference Number CH2M-Samoa12584-04-10

STUDY NUMBER 12584

EXECUTIVE SUMMARY

The following summarizes the results of acute exposure bioassays performed from October 1-5, 2004 in support of the NPDES biomonitoring requirements of the American Samoa Joint Cannery Outfall. The 96 hour acute definitive assay was conducted using the marine species, *Americamysis bahia.*

Acute Toxicity Evaluation

Species	Exposure	LC-50	NOEC	LOEC
Americamysis bahia	24-Hours	>50%	50%	>50%
	48-Hours	>50%	50%	>50%
	72-Hours	>50%	50%	>50%
	96-Hours	>50%	50%	>50%

TOXICOLOGICAL EVALUATION OF A TREATED EFFLUENT: BIOMONITORING SUPPORT FOR A NPDES PERMIT OCTOBER 2004

American Samoa Joint Cannery Outfall

1.0 INTRODUCTION

Acute toxicity tests involve preparing a series of concentrations by diluting effluent with control water. Groups of test organisms are exposed to each effluent concentration and a control for a specified period. In acute tests, mortality data for each concentration are used to calculate (by regression) the median lethal concentration, or LC-50, defined as the effluent concentration which kills half of the test organisms. Samples with high LC-50 values are less likely to cause significant environmental impact. The acute no observed effect concentration (NOEC) and lowest observed effect concentration (LOEC) document the highest and lowest effluent concentrations that have no impact and a significant impact on the test species, respectively.

This report presents the results of an acute toxicity test conducted on an effluent sample collected from the American Samoa Joint Cannery Outfall. Testing was based on programs and protocols developed by the US EPA (2002) and involved conducting 96 hour acute static renewal toxicity tests with the marine species, *Americamysis bahia*. Testing was performed at EnviroSystems, Incorporated (ESI), Hampton, New Hampshire in accordance with the provisions of the NELAC Standards (2000).

2.0 MATERIALS AND METHODS

2.1 General Methods

Toxicological and analytical protocols used in this program follow procedures primarily designed by the EPA to provide standard approaches for the evaluation of toxicological effects of discharges on aquatic organisms, and for the analysis of water samples. See Section 4.0 for a list of references.

2.2 Test Species

Every attempt was made to acquire the species, *Penaeus vannami,* as this is the preferred organism under the Cannery's permit. ESI was unable to obtain reasonably priced *P. vannami*. Due to the exorbitant expense, the decision was made to use an alternate species, *Americamysis bahia*.

A. bahia, ≤5 days old, were from maintained at ESI. Test organisms were transferred to test chambers by large bore pipet, minimizing the amount of water added to test solutions.

2.3 Effluent and Dilution Water

The effluent sample used in the assay was identified as "JCO-04TW." Sample collection information is provided in Table 4. Upon receipt, the sample was stored at 4°C. All sample material used in the assay was warmed to 20±1°C prior to preparing test solutions. Total residual chlorine (TRC) was measured using amperometric titration (MDL 0.05 mg/L). As the effluent sample contained <0.05 mg/L, TRC dechlorination with sodium thiosulfate was not required (EPA 2002). Aliquots of the undiluted effluent sample were collected for ammonia analysis when the sample arrived and again prior to renewal. Upon arrival, the effluent sample had a salinity of 12‰. Salinity of the effluent was increased to 25‰ by the addition of artificial sea salts. Test concentrations for the assays were 50%, 25%, 12.5%, 6.25% and 3.1% effluent with a laboratory water diluent control.

The dilution water used in this assay was collected from the sea water system at ESI. The water is pumped in daily from the Hampton Estuary on the flood tide, filtered through a high volume sand filter, and stored in 3000 gallon polyethylene tanks. The water is classified as Class SA-1 by the State of New Hampshire, and has been used to culture test organisms for over 20 years. Sea water used in the assay had a salinity of 25±2‰ and a TRC of <0.05 mg/L.

2.4 Acute Toxicity Tests

The 96 hour acute static renewal toxicity test was conducted at 20±2°C with a photoperiod of 16:8 hours light:dark. Test chambers for the acute assays were 250 mL glass beakers containing 200 mL test solution in each of 5 replicates, with 10 organisms/replicate. Survival, dissolved oxygen, pH, salinity and temperature were measured daily in all replicates. Test solutions were renewed after 48 hours using effluent from the start sample. Mysid shrimp were fed daily with <24 hour old brine shrimp.

2.5 Data Analysis

At 24 hour intervals, survival data was analyzed to assess toxicity using a program developed by Stephan (1982). LC-50 values were computed using the Spearman-Karber, Binomial, and Probit methods. If survival in the highest test concentration was >50%, LC-50 values were obtained by direct observation of the raw data. The NOEC was determined as the highest test concentration which caused no significant mortality while the LOEC was determined as the lowest concentration that did cause significant mortality.

2.6 Quality Control

As part of the laboratory quality control program, standard reference toxicant assays are conducted on a regular basis for each test species. These results provide relative health and response data while allowing for comparison with historic data sets. See Table 2 for details.

Note: No Page 5 of 9 in original ESI Report, and no information missing

TABLE 1. Summary of Acute Evaluation Results. American Samoa Joint Cannery Outfall Effluent Evaluation. October 2004.

Concentration % Effluent	Exposure	Replicates A	B	C	D	E	Mean	Standard Deviation	Coefficient of Variation
Lab Control	Start	10	10	10	10	10	100%	0.000	0.00%
	24-Hours	10	10	10	10	10	100%	0.000	0.00%
	48-Hours	10	10	10	10	10	100%	0.000	0.00%
	72 Hours	10	9	10	10	10	98%	0.400	4.08%
	96-Hours	10	9	10	10	10	98%	0.400	4.08%
3.1%	24-Hours	10	10	10	10	10	100%	0.000	0.00%
	48-Hours	10	10	10	10	9	98%	0.400	4.08%
	72 Hours	10	10	10	10	9	98%	0.400	4.08%
	96-Hours	10	9	10	10	9	96%	0.490	5.10%
6.25%	24-Hours	10	10	10	10	9	98%	0.400	4.08%
	48-Hours	10	10	10	10	9	98%	0.400	4.08%
	72 Hours	9	9	10	10	7	90%	1.095	12.17%
	96-Hours	9	9	10	10	7	90%	1.095	12.17%
12.5%	24-Hours	10	10	10	10	10	100%	0.000	0.00%
	48-Hours	10	10	10	10	10	100%	0.000	0.00%
	72 Hours	10	10	10	10	10	100%	0.000	0.00%
	96-Hours	10	10	10	10	10	100%	0.000	0.00%
25%	24-Hours	10	10	10	9	10	98%	0.400	4.08%
	48-Hours	10	10	10	9	10	98%	0.400	4.08%
	72 Hours	10	9	10	9	10	96%	0.490	5.10%
	96-Hours	10	9	10	9	10	96%	0.490	5.10%
50%	24-Hours	10	9	10	10	10	98%	0.400	4.08%
	48-Hours	10	9	10	6	3	76%	2.728	35.89%
	72 Hours	9	8	10	6	3	72%	2.482	34.47%
	96-Hours	9	8	10	6	3	72%	2.482	34.47%

SUMMARY OF ENDPOINTS

Exposure Period	LC-50 (95% Limits)	METHOD	NOEC	LOEC
24 Hours	>50%	Direct	50%	>50%
48 Hours	>50%	Direct	50%	>50%
72 Hours	>50%	Direct	50%	>50%
96 Hours	>50%	Direct	50%	>50%

TABLE 2. Summary of Reference Toxicant Data. American Samoa Joint Cannery Outfall Effluent Evaluation. February 2004.

Concentrations Expressed as mg/L Sodium Dodecyl Sulfate

Species	Date	LC-50	Historic Mean	Number of Tests	±1 STD Deviation	±2 STD Deviations
A. bahia	09/29/04	19.4	21.2	20	3.59	7.19

TABLE 3. Summary of Effluent and Diluent Characteristics. American Samoa Joint Cannery Outfall Effluent Evaluation. October 2004.

PARAMETER	UNITS	100% EFFLUENT	50% EFFLUENT	DILUENT
Salinity - As Received	‰	12	-	24
Salinity - After Salinity Adjustment	‰	25	25	-
pH - As Received	SU	6.48	-	8.05
pH - After Salinity Adjustment	SU	6.72	6.97	-
TRC - As Received	mg/L	‡	-	<0.05
Dissolved Oxygen - As Received	mg/L	0.9	-	-
Dissolved Oxygen - After Aeration	mg/L	-	4.8	7.6
Ammonia - As Received	mg/L as N	59	-	<0.1
Unionized Ammonia - As Received	mg/L as N	0.076	-	<0.005
Ammonia - Salinity Adjusted	mg/L as N	-	29	-
Unionized Ammonia - Salinity Adjusted	mg/L as N	-	0.115	-
Ammonia - at 48 Hours	mg/L as N	59	29	<0.1
Unionized Ammonia - at 48 Hours	mg/L as N	0.085	0.559	<0.005

TABLE 4. Summary of Sample Collection Information. American Samoa Joint Cannery Outfall Effluent Evaluation. October 2004.

Sample Description	Type	Collection Date	Collection Time	Receipt Date	Receipt Time	Arrival Temp °C
EFFLUENT	Comp	09/23-24/04	ND	10/01/04	1510	21

COMMENTS:
‡ - Analysis could not be performed due to interference.
ND - No data was recorded on chain of custody.

TABLE 5. **Summary of StarKist Samoa and COS Samoa Packing Combined Effluent Bioassay Results. American Samoa Joint Cannery Outfall Effluent Evaluation. October 2004.**

Date	Species	96-Hour Endpoints		
		LC-50	NOEC	LOEC
02/93[1]	*Penaeus vannami*	4.8%	3.1%	6.25%
10/93[1]	*Penaeus vannami*	15.67%	3.1%	6.25%
02/94[1]	*Penaeus vannami*	15.76%	<1.6%	1.6%
10/94[1]	*Americamysis bahia*	31.2%	25.0%	50.0%
03/95[1]	*Penaeus vannami*	14.8%	6.25%	12.5%
03/95[1]	*Americamysis bahia*	10.8%	6.25%	12.5%
02/96[1]	*Penaeus vannami*	>50.0%	>50.0%	>50.0%
03/96[1]	*Penaeus vannami*	44.4%	25.0%	50.0%
11/96[1]	*Penaeus vannami*	7.11%	3.1%	6.25%
03/97[1]	*Penaeus vannami*	39.36%	12.5%	25.0%
09/97[1]	*Penaeus vannami*	12.3%	6.25%	12.5%
06/98[1]	*Americamysis bahia*	17.2%	6.25%	12.5%
11/98[1]	*Americamysis bahia*	15.0%	6.25%	12.5%
02/00[1]	*Americamysis bahia*	20.0%	6.25%	12.5%
08/00[1]	*Americamysis bahia*	17.1%	3.1%	6.25%
03/01[2]	*Americamysis bahia*	13.81%	12.5%	25.0%
03/02[2]	*Americamysis bahia*	16.13%	12.5%	25.0%
08/02[2]	*Americamysis bahia*	10.23%	6.25%	12.5%
03/03[2]	*Americamysis bahia*	28.4%	25.0%	50.0%
08/03[2]	*Americamysis bahia*	43.2%	25.0%	50.0%
03/04[2]	*Americamysis bahia*	>50.0%	50.0%	>50.0%
10/04[2]	*Americamysis bahia*	>50.0%	50.0%	>50.0%

Notes:

1. Assays conducted by Advanced Biological Testing, Inc., Rohnert Park, California
2. Assays conducted by EnviroSystems, Inc., Hampton, New Hampshire

APPENDIX A

DATA SHEETS

STATISTICAL SUPPORT

Contents	Number of Pages
Methods Used in NPDES Permit Biomonitoring Testing	1
A. bahia Acute Bioassay Data Summary	2
A. bahia Survival Statistics: LC-50, NOEC	4
A. bahia Organism Culture Sheet	1
Preparation of Dilutions	1
Record of Meters Used for Water Quality Measurements	1
Unionized Ammonia Calculation	1
Sample Receipt Record	1
Chain of Custody	1

METHODS USED IN NPDES PERMIT BIOMONITORING TESTING

Parameter	Method
Acute Exposure Bioassays	
Ceriodaphnia dubia, Daphnia pulex	EPA-821-R-02-012
Pimephales promelas	EPA-821-R-02-012
Americamysis bahia	EPA-821-R-02-012
Menidia beryllina, Cyprinodon variegatus	EPA-821-R-02-012
Chronic Exposure Bioassays	
Ceriodaphnia dubia	EPA-821-R-02-013, 1002.0
Pimephales promelas	EPA-821-R-02-013, 1000.0
Cyprinodon variegatus	EPA-821-R-02-014, 1004.0
Menidia beryllina	EPA-821-R-02-014, 1006.0
Arbacia punctulata	EPA-821-R-02-014, 1008.0
Champia parvula	EPA-821-R-02-014, 1009.0
Trace Metals:	
ICP Metals	EPA 200.7/SW 6010
Hardness	Standard Methods 20th Edition - Method 2340 B
Wet Chemistries:	
Alkalinity	EPA 310.2
Chlorine, Residual	Standard Methods 20th Edition - Method 4500CLD
Total Organic Carbon	Standard Methods 20th Edition - Method 5310C
Specific Conductance	Standard Methods 20th Edition - Method 2510B
Nitrogen - Ammonia	Standard Methods 20th Edition - Method 4500NH3G
pH	Standard Methods 20th Edition - Method 4500H+B
Solids, Total (TS)	Standard Methods 20th Edition - Method 2540.B
Solids, Total Suspended (TSS)	Standard Methods 20th Edition - Method 2540D
Dissolved Oxygen	Standard Methods 20th Edition - Method 4500-O G

ACUTE BIOASSAY DATA SUMMARY

20°C

STUDY: 12584		"AS RECEIVED" EFFLUENT AND DILUENT CHEMISTRIES						
CLIENT: CH2M Hill	TEST ORGANISM: *A. bahia*		TRC	AMM 0 HR✖	AMM 48 HR✖	pH	DO	Salinity
SAMPLE: American Samoa	ORGANISM SUPPLIER/BATCH/AGE: *See Organism Culture Sheet*	EFFLUENT	See "EFFLUENT & DILUENT CHEMISTRY and WATER QUALITY DATA" sheet					
DILUENT: LAB SALT		DILUENT						

SALINITY ADJUSTMENT RECORD (IF APPLICABLE): 4000 ML EFFLUENT + 60 G SEA SALTS = 100% ACTUAL PERCENTAGE

CONC	REP	SURVIVAL 0	24	48	72	96	✦DISSOLVED OXYGEN (MG/L)✦ 0	24	48◊	48☆	72	96	PH (SU) 0	24	48◊	48☆	72	96	TEMPERATURE (°C) 0	24	48◊	48	72	96	SALINITY (ppt) 0	24	48◊	48	72	96
LAB	A	10	10	10	10	10	7.6	7.2	7.0	7.0	7.1	7.3	8.05	8.05	8.06	8.05	8.07	8.04	21	22	22	22	22	21	24	27	25	25	26	27
	B	10	10	10	9	9	7.6	7.1	7.0	7.2	7.1	7.2	8.05	8.09	8.12	8.09	8.10	8.04	21	22	22	22	22	21	24	27	27	25	27	27
	C	10	10	10	10	10	7.6	7.1	7.1	7.2	7.2	7.1	8.05	8.10	8.10	8.09	8.10	8.04	21	22	22	22	22	22	24	27	27	26	28	29
	D	10	10	10	10	10	7.6	7.2	7.2	7.2	7.1	7.1	8.05	8.09	8.11	8.09	8.09	8.07	21	22	22	22	22	22	24	27	27	25	28	29
	E	10	10	10	10	10	7.6	7.1	7.0	7.3	7.2	7.1	8.05	8.10	8.05	8.08	8.06	8.04	21	22	22	22	21	22	24	27	27	25	27	28
3.1%	A	10	10	10	10	10	7.3	6.9	6.8	7.1	7.2	7.0	7.89	8.11	8.13	8.04	8.10	8.06	21	22	22	22	22	21	25	25	27	25	27	28
	B	10	10	10	9	9	7.3	7.0	7.0	7.1	7.0	7.2	7.89	8.10	8.15	8.04	8.05	8.06	21	22	22	22	22	22	25	25	26	25	27	28
	C	10	10	10	10	10	7.3	7.0	7.0	7.1	6.8	7.1	7.89	8.11	8.15	8.04	8.10	8.07	21	22	22	22	22	23	25	25	27	25	27	29
	D	10	10	10	10	10	7.3	7.0	6.9	7.1	6.9	7.1	7.89	8.12	8.14	8.04	8.09	8.09	21	22	22	22	22	23	25	25	27	25	27	29
	E	10	9	9	9	9	7.3	6.9	5.4	6.7	5.0	6.9	7.79	8.11	7.78	8.04	7.67	8.09	21	22	21	22	21	23	25	25	27	25	27	29
6.25%	A	10	10	10	9	9	7.2	6.9	6.8	7.0	7.2	6.9	7.85	8.15	8.12	7.98	8.07	8.04	21	22	21	22	21	20	25	25	27	26	27	28
	B	10	10	10	9	9	7.2	6.9	7.0	7.0	3.8	7.0	7.85	8.15	8.15	7.96	7.62	8.07	21	22	21	22	21	20	25	25	27	26	26	28
	C	10	10	10	10	10	7.2	6.7	6.9	7.0	7.1	7.1	7.85	8.15	8.17	7.97	8.03	8.09	21	22	21	22	21	21	25	25	27	26	27	28
	D	10	10	10	10	10	7.2	6.8	7.0	6.8	7.0	7.2	7.85	8.15	8.10	7.95	8.06	8.06	21	22	21	22	21	21	25	25	27	26	27	28
	E	10	9	9	9	9	7.2	6.8	5.2	6.7	4.0	7.0	7.85	8.14	7.76	7.89	7.61	8.08	21	22	21	22	21	21	25	25	27	26	27	28
DATE		10/1/04	10/2	10/3	10/4/04	10/5	10/1/04	10/2	10/3	10/3	10/4/04	10/5																		
TIME		1635	1440	1445	1415	1620	1600	1430	1420	1515	1345	1605																		
INITIALS		[illegible]	KK	TP	[illegible]	TP	BB	KK	TP	TP	[illegible]	TP																		
FED?		/																												

Pull NH3 on 100% + 50% Effluent + Lab Salt at 48 hrs. Record pH prior to preservation.

✖ - See:" EFFLUENT & DILUENT CHEMISTRY and WATER QUALITY DATA" sheet.
✦ - AERATE FROM START! ◊ - "Old" water qualities (prior to renewal) ☆ - "New"water qualities (post renewal)

ACUTE BIOASSAY DATA SUMMARY

STUDY: 12584	SAMPLE RECEIVED:	"AS RECEIVED" EFFLUENT AND DILUENT CHEMISTRIES						
CLIENT: CH2M Hill	TEST ORGANISM: *A. bahia*		TRC	AMM 0 HR✖	AMM 48 HR✖	pH	DO	Salinity
SAMPLE: American Samoa	ORGANISM SUPPLIER:	EFFLUENT	See "EFFLUENT & DILUENT CHEMISTRY and WATER QUALITY DATA" sheet					
DILUENT: LAB SALT	ORGANISM BATCH/AGE:	DILUENT						

CONC	REP	SURVIVAL 0	24	48	72	96	✦DISSOLVED OXYGEN (MG/L)✦ 0	24	48◊	48☆	72	96	PH (SU) 0	24	48◊	48☆	72	96	TEMPERATURE (°C) 0	24	48◊	48	72	96	SALINITY (ppt) 0	24	48◊	48	72	96
12.5%	A	10	10	10	10	10	6.9	6.7	6.4	6.6	6.9	6.8	7.60	8.19	8.07	7.83	8.04	8.12	21	22	21	22	22	21	25	25	26	25	26	27
	B	10	10	10	10	10	6.9	6.8	6.4	6.5	7.0	6.9	7.60	8.18	8.04	7.80	8.09	8.13	21	22	21	22	21	21	25	25	26	25	27	28
	C	10	10	10	10	10	6.9	6.7	6.3	6.5	7.0	7.0	7.60	8.15	8.08	7.78	8.08	8.11	21	22	21	22	22	21	25	25	26	25	26	28
	D	10	10	10	10	10	6.9	6.7	5.7	6.6	7.0	6.9	7.60	8.16	7.98	7.74	8.09	8.10	21	22	21	22	22	21	25	25	26	25	26	28
	E	10	10	10	10	10	6.9	6.6	5.9	6.4	6.9	7.0	7.60	8.12	8.03	7.77	8.10	8.09	21	22	22	22	22	21	25	25	27	25	27	28
25%	A	10	10	10	10	10	6.4	6.1	6.0	6.0	6.9	6.5	7.25	8.19	8.14	7.56	8.13	8.18	21	22	22	22	22	21	25	25	26	25	26	28
	B	10	10	10	9	9	6.4	6.2	6.1	6.0	6.9	6.9	7.25	8.23	8.15	7.59	8.12	8.19	21	22	22	22	23	21	25	25	27	25	27	28
	C	10	10	10	10	10	6.4	6.3	6.1	6.0	6.5	6.9	7.25	8.20	7.99	7.58	8.17	8.17	21	22	22	22	23	21	25	25	26	25	27	28
	D	10	9	9	9	9	6.4	6.2	5.5	5.8	6.4	6.7	7.25	8.19	8.07	7.56	8.10	8.16	21	22	22	22	23	21	25	25	26	25	26	28
	E	10	10	10	10	10	6.4	6.0	5.9	5.8	6.5	6.6	7.25	8.14	8.17	7.55	8.12	7.82	21	22	22	22	23	20	25	25	27	25	26	28
50%	A	10	10	10	9	9	4.8	6.2	5.7	4.2	6.4	6.5	6.97	8.30	8.19	7.32	8.13	8.22	21	22	21	22	22	20	25	25	26	25	27	28
	B	10	9	9	8	8	4.8	6.2	5.8	4.2	6.5	6.7	6.97	8.27	8.24	7.36	8.15	8.25	21	22	21	22	22	20	25	25	26	25	27	28
	C	10	10	6/10	10	10	4.8	6.0	6.0	3.8	6.5	6.8	6.97	8.25	8.19	7.45	8.16	8.27	21	22	21	22	22	20	25	25	26	25	27	28
	D	10	10	6	6	6	4.8	6.1	5.4	4.0	6.4	7.0	6.97	8.24	8.20	7.42	8.11	8.25	21	22	21	22	22	20	25	25	26	25	26	28
	E	10	10	3	3	3	4.8	6.0	5.4	4.0	6.4	6.8	6.97	8.15	8.22	7.42	8.15	8.24	21	22	21	22	22	20	25	25	26	25	27	28
DATE		10/1/04	10/2	10/3	10/4/04	10/5	10/1/04	10/2	10/3	10/3	10/4/04	10/5																		
TIME		1635	1450	1445	1415	1620	1600	1750	1420	1515	1345	1605																		
INITIALS		[illegible]	KC	TP	✓	TP	BB	KC	TP	TP	✓	TP																		
FED?		✓																												

✖ - See:" EFFLUENT & DILUENT CHEMISTRY and WATER QUALITY DATA" sheet.
✦ - AERATE FROM START! ◊ - "Old" water qualities (prior to renewal) ☆ - "New"water qualities (post renewal)

Title: 12584 American Samoa: A. bahie 48hr Survival
File: 584ab48sv Transform: ARC SINE(SQUARE ROOT(Y))

Shapiro - Wilk's Test for Normality

D = 0.5969
W = 0.7483

Critical W = 0.9000 (alpha = 0.01 , N = 30)
W = 0.9270 (alpha = 0.05 , N = 30)

Data FAIL normality test (alpha = 0.01). Try another transformation.

Warning - The first three homogeneity tests are sensitive to non-normality and should not be performed with this data as is.

Title: 12584 American Samoa: A. bahie 48hr Survival
File: 584ab48sv Transform: ARC SINE(SQUARE ROOT(Y))

Hartley's Test for Homogeneity of Variance
Bartlett's Test for Homogeneity of Variance

These two tests can not be performed because at least one group has zero variance.

Data FAIL to meet homogeneity of variance assumption.
Additional transformations are useless.

Title: 12584 American Samoa: A. bahie 48hr Survival
File: 584ab48sv Transform: ARC SINE(SQUARE ROOT(Y))

Summary Statistics on Transformed Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Lab	5	1.4120	1.4120	1.4120
2	3.1	5	1.2490	1.4120	1.3794
3	6.25	5	1.2490	1.4120	1.3794
4	12.5	5	1.4120	1.4120	1.4120
5	25	5	1.2490	1.4120	1.3794
6	50	5	0.5796	1.4120	1.1078

Title: 12584 American Samoa: A. bahie 48hr Survival
File: 584ab48sv Transform: ARC SINE(SQUARE ROOT(Y))

Summary Statistics on Transformed Data TABLE 2 of 2

58448

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	Lab	0.0000	0.0000	0.0000	0.0000
2	3.1	0.0053	0.0729	0.0326	5.2837
3	6.25	0.0053	0.0729	0.0326	5.2837
4	12.5	0.0000	0.0000	0.0000	0.0000
5	25	0.0053	0.0729	0.0326	5.2837
6	50	0.1333	0.3651	0.1633	32.9575

Title: 12584 American Samoa: A. bahie 48hr Survival
File: 584ab48sv Transform: ARC SINE(SQUARE ROOT(Y))

Steel's Many-One Rank Test - Ho: Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	RANK SUM	CRIT. VALUE	DF	SIG 0.05
1	Lab	1.4120				
2	3.1	1.3794	25.00	16.00	5.00	
3	6.25	1.3794	25.00	16.00	5.00	
4	12.5	1.4120	27.50	16.00	5.00	
5	25	1.3794	25.00	16.00	5.00	
6	50	1.1078	20.00	16.00	5.00	

Critical values are 1 tailed (k = 5)

Title: 12584 American Samoa: A. bahia 72 & 96 Hr Survival
File: 584ab7296ab Transform: ARC SINE(SQUARE ROOT(Y))

Shapiro - Wilk's Test for Normality

D = 0.6257
W = 0.9083

Critical W = 0.9000 (alpha = 0.01 , N = 30)
W = 0.9270 (alpha = 0.05 , N = 30)

Data PASS normality test (alpha = 0.01). Continue analysis.

Title: 12584 American Samoa: A. bahia 72 & 96 Hr Survival
File: 584ab7296ab Transform: ARC SINE(SQUARE ROOT(Y))

Hartley's Test for Homogeneity of Variance
Bartlett's Test for Homogeneity of Variance

These two tests can not be performed because at least one group has zero variance.

Data FAIL to meet homogeneity of variance assumption.
Additional transformations are useless.

Title: 12584 American Samoa: A. bahia 72 & 96 Hr Survival
File: 584ab7296ab Transform: ARC SINE(SQUARE ROOT(Y))

Summary Statistics on Transformed Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Lab	5	1.2490	1.4120	1.3794
2	3.1	5	1.2490	1.4120	1.3468
3	6.25	5	0.9912	1.4120	1.2627
4	12.5	5	1.4120	1.4120	1.4120
5	25	5	1.2490	1.4120	1.3468
6	50	5	0.5796	1.4120	1.0468

Title: 12584 American Samoa: A. bahia 72 & 96 Hr Survival
File: 584ab7296ab Transform: ARC SINE(SQUARE ROOT(Y))

Summary Statistics on Transformed Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	Lab	0.0053	0.0729	0.0326	5.2837

5847296

2	3.1	0.0080	0.0893	0.0399	6.6278
3	6.25	0.0297	0.1723	0.0770	13.6431
4	12.5	0.0000	0.0000	0.0000	0.0000
5	25	0.0080	0.0893	0.0399	6.6278
6	50	0.1055	0.3248	0.1453	31.0291

Title: 12584 American Samoa: A. bahia 72 & 96 Hr Survival
File: 584ab7296ab Transform: ARC SINE(SQUARE ROOT(Y))

Steel's Many-One Rank Test - Ho: Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	RANK SUM	CRIT. VALUE	DF	SIG 0.05
1	Lab	1.3794				
2	3.1	1.3468	25.00	16.00	5.00	
3	6.25	1.2627	22.00	16.00	5.00	
4	12.5	1.4120	30.00	16.00	5.00	
5	25	1.3468	25.00	16.00	5.00	
6	50	1.0468	18.50	16.00	5.00	

Critical values are 1 tailed (k = 5)

EnviroSystems, Incorporated
Organism Culture Record

Client and ESI Study Number: American Samoa #12584
Assay: _____

I. Organism History

Species: Americamysis bahia

Source: Lab Reared ✓ Hatchery Reared _____ Field Collected _____

Hatch Date: 9/28-10/1/04 Receipt Date _____ Age: 1-5 days

Lot Number: 100104AB Strain _____

Brood Origin: Aquatic Research Organisms

II. Culture Conditions

System: Recirc. Sw

Diet: Flake Food _____ Phytoplankton _____ Trout Chow _____

Brine Shrimp ✓ Rotifers _____ Other _____

Prophylactic Treatments _____

Comments _____

III. Water Quality

Temperature 24.5 °C Salinity 30.1 ppt DO_2 6.9 mg/L

pH 7.76 SU Hardness _____ mg/L Alkalinity _____ mg/L

Other _____

IV. Comments

_____

Biologist [signature] Date 11/3/04

EFFLUENT & DILUENT CHEMISTRY and WATER QUALITY DATA

PARAMETER	100% Effluent	50% Effluent	Diluent - Lab Salt
TRC	Not Recorded - Interfe		<0.05
As Received - pH (SU) @ 20°C	6.48		8.05
As Received - Salinity (ppt)	12		24
As Received - Dissolved Oxygen (mg/L)‡	0.9		7.6
As Received - Ammonia (pull)	-002		12597-001
Salinity Adjusted - pH (SU) @ 20°C	6.72	6.97	
Salinity Adjusted - Salinity (ppt)	25	25	
~~After Aeration~~ - Dissolved Oxygen (mg/L)	1.3	4.8	
Salinity Adjusted - Ammonia (pull)		-003	
48 hour Ammonia (pull) off sal. adj.	-004	-005	12597 -002
48 hour pH (SU) @ 20°C cubes	6.81	7.32	8.05

‡ - Aerate prior to mixing concentrations.

PREPARATION OF DILUTIONS

STUDY: 12584

SPECIES: *A. bahia*

CLIENT: CH2M HILL - American Samoa

Diluent: Lab Salt	Day: 0 Sample: -001		Day: 2 Sample: 504	
Concentration	Vol. Eff.	Final Vol	Vol. Eff.	Final Vol
LAB	0	1000	0	750
3.1%	31		23.25	
6.25%	625		46.84	
12.5%	125		93.75	
25%	250		187.5	
50%	500		375	

HRS	Date	Time	Initials
0	10/1/04	1550	BB
48	10/3/04	1505	TPM

Comments:

RECORD OF METERS USED FOR WATER QUALITY MEASUREMENTS

STUDY: 12584	CLIENT: CH2M HILL - American Samoa					
WATER QUALITIES - A. bahia						
HOURS:	0	24	48 - old	48 - new	72	96
Water Quality Station #	2	2	1	1	2	1
Initials	BB	KY	TP	TP	✓	TP
Date	10/1/04	10/2	10/3	10/3	10/4/04	10/5/04

Water Quality Station #1		Water Quality Station #2		COMMENTS
DO meter #	18	DO meter #	3	
DO probe #	10	DO probe #	11	
pH meter #	1097	pH meter #	1138	
pH probe #	40	pH probe #	39	
S/C meter #	YSI30B	S/C meter #	YSI30B	
S/C probe #	✓	S/C probe #	✓	
Salinity meter #	✓	Salinity meter #	✓	

STUDY: 12584
CLIENT: CH2MHill - American Samoa
PROJECT: Wastewater Treatment Plant
TASK: Unionized Ammonia Calculations

Day / Date	Treatment	Temperature Deg C	Sample pH SU	NH_3 mg/L	Unionized NH_3 mg/L
Day 0	Lab	21	8.05	0.1	0.005
10/01/04	As Received 100% Effluent	21	6.48	59.0	0.076
	50% Salinity Adjusted Effluent	21	6.97	29.0	0.115
					0.000
Day 2	Lab	22	8.05	0.10	0.005
10/03/04	50% Salinity Adjusted Effluent	22	7.32	59.00	0.559
	100% Salinity Adjusted Effluent	22	6.81	29.00	0.085

ESI

SAMPLE RECEIPT RECORD

EnviroSystems, Inc.
One Lafayette Road
P.O. Box 778
Hampton, N.H. 03843-0778
(603) 926-3345 • (603) 926-3521 Fax
www.envirosystems.com

ESI STUDY NUMBER: 12584 CLIENT: CH2M - Am. Samoa

SAMPLE RECEIPT:
DATE: 10/1/04 TIME: 1510 BY: BB

DELIVERED VIA: ☐ FEDEX ☐ CLIENT ☐ ESI ☐ UPS ☑ OTHER DHL

LOGGED INTO LAB:
DATE: 10/1/04 TIME: 1510 BY: BB

SAMPLE CONDITION:

CHAIN OF CUSTODY:	☑ YES	☐ NO
CHAIN OF CUSTODY SIGNED:	☑ YES	☐ NO
CHAIN OF CUSTODY COMPLETE:	☐ YES	☑ NO
SAMPLE DATE:	☑ YES	☐ NO
SAMPLE TIME RECORDED:	☐ YES	☑ NO
SAMPLE TYPE IDENTIFIED:	☑ YES	☐ NO
CUSTODY SEAL IN PLACE:	☑ YES	☐ NO
SHIPPING CONTAINER INTACT:	☑ YES	☐ NO

SAMPLE TEMPERATURE (AT ARRIVAL): 21 °C

DOES CLIENT NEED NOTIFICATION OF TEMPERATURE?	☐ YES	☑ NO
SAMPLE ARRIVED ON ICE:	☐ YES	☑ NO

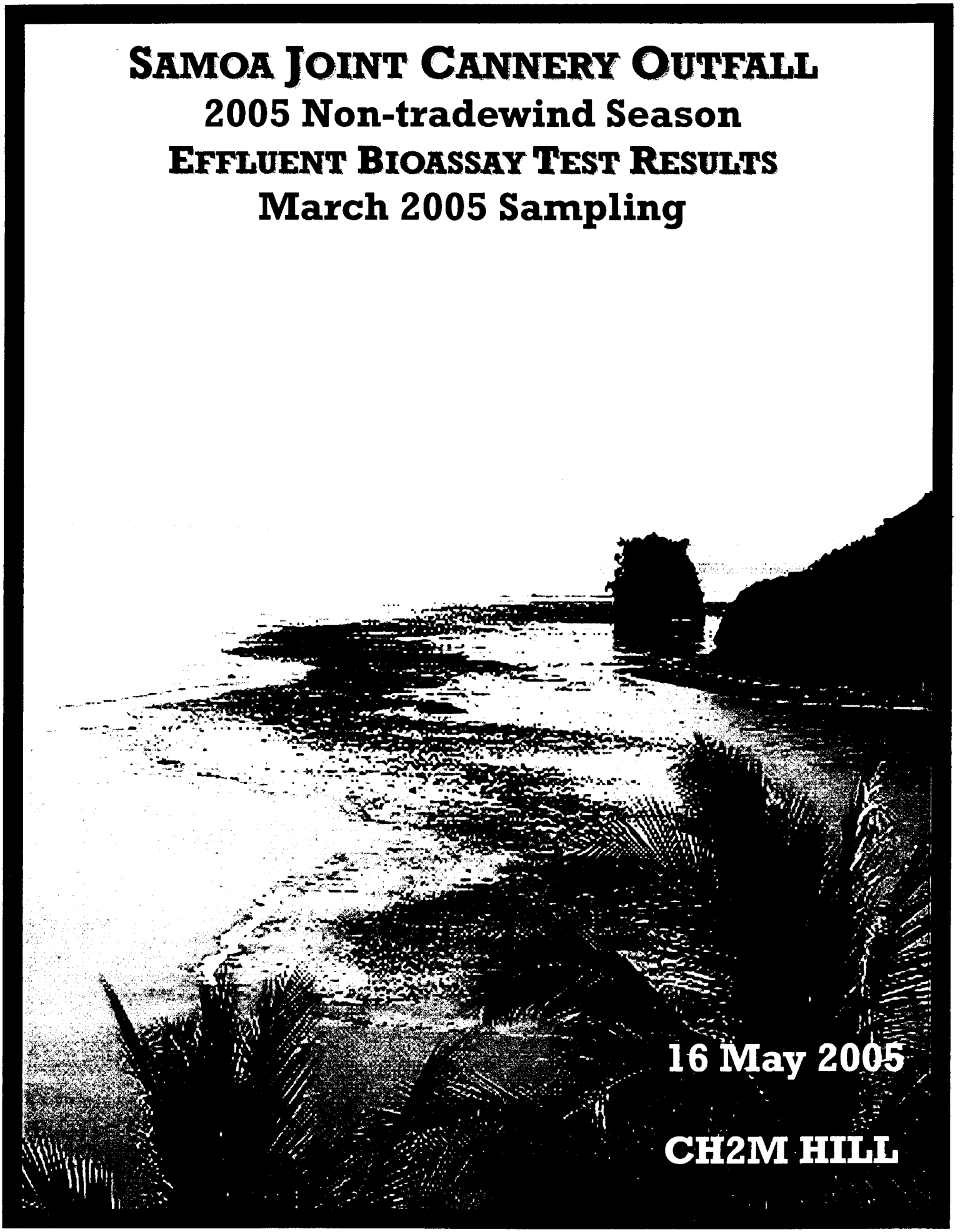
COMMENTS: 1x 5gal

SAMOA JOINT CANNERY OUTFALL

2005 Non-tradewind Season

EFFLUENT BIOASSAY TEST RESULTS

March 2005 Sampling



16 May 2005

CH2M HILL

CH2MHILL

TECHNICAL MEMORANDUM

BIOASSAY TESTING – JOINT CANNERY OUTFALL EFFLUENT MARCH 2005 SAMPLING

Prepared For: StarKist Samoa (NPDES Permit AS0000019)
COS Samoa Packing (NPDES Permit AS0000027)

Prepared By: Steve Costa
Karen Glatzel

Date: 16 May 2005

Distribution: Carl Goldstein
United States Environmental Protection Agency, Region 9
Peter Peshut
American Samoa Environmental Protection Agency

Purpose

This memorandum presents the results of the bioassay testing of the Joint Cannery Outfall effluent sample that was collected in March 2005. The testing is required by the NPDES Permits that became effective in January 2001. This is the ninth required semi-annual test required by the current permits and the twenty-fifth test, over twenty-three semi-annual periods, conducted since testing of the Joint Cannery Outfall effluent began in 1993[1].

Study Objectives

Section D.1 of the StarKist Samoa and COS Samoa Packing NPDES Permits requires that semiannual definitive acute bioassays (96-hour static bioassays) be conducted on the cannery effluent. The purpose of these tests is to determine whether, and at what effluent concentration, acute toxicity may be detected for the combined joint cannery effluent discharge into Pago Pago Harbor.

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[1] Testing was not conducted during 1999. Extra tests using two organisms were conducted in March 1995 and February 1996.

Study Approach

U.S. EPA has conducted a number of reviews of the effluent sampling, analysis, and bioassay tests conducted in the past. All comments from U.S. EPA have been incorporated into the sampling and sample handling standard operating procedures (SOP) or have been incorporated into the procedures used by the laboratory doing the test. The comments, responses, and SOP have been documented in previous reports.

The permit conditions require that the bioassay tests be conducted with the white shrimp, *Penaeus vannami* (postlarvae). In the event *Penaeus vannami* is not available at the time of the tests, the permit specifies the substitute species, *Mysidopsis bahia,* which now has been renamed *Americamysis bahia.* For the March 2005 sampling, *Penaeus vannami* was not available and *Americamysis bahia* was used.

Effluent samples were collected from the StarKist Samoa and COS Samoa Packing facilities as 24-hour composite samples. The acute effluent bioassay test was conducted using a combined, flow-weighted, composite effluent sample made up from the effluent samples from both canneries, as allowed by the permit condition. This combined effluent bioassay is representative of the wastewater discharged from the joint cannery outfall to Pago Pago Harbor.

Effluent Sampling Methods

Between 0900 on 3 March 2005 and 0600 on 4 March 2005, a 24-hour flow-weighted composite sample of final effluent was collected from both the StarKist Samoa and COS Samoa Packing effluent discharges. Samples were collected from the established effluent sampling sites. Detailed sampling procedures are described in the established SOP for cannery effluent sampling.

A total of eight grab samples were collected into 1-gallon plastic cubitainers at each plant. Samples were collected at approximately three-hour intervals over the 24-hour period. The samples were stored on ice or in a refrigerator until the completion of the 24-hour sampling period. After all samples were collected a flow-proportioned composite sample was prepared. The grab sample collection times, effluent flow rates, and the relative effluent flow volumes calculated from plant flow records are summarized in Table 1. The relative effluent flow volumes were used to prepare the final composite sample, which was used to fill the sample container shipped to the laboratory for testing.

A 5-gallon cubitainer containing the composite sample was packed on ice in an ice chest for shipment to the laboratory. A chain-of-custody form for the sample was completed and sealed into a zip-lock bag and taped inside the lid of the ice chest. The sample was shipped via DHL to the testing laboratory. The chain-of-custody form and the DHL waybill are provided in Attachment I.

Table 1
StarKist Samoa and COS Samoa Packing
24-hour Composite Effluent Sample for Bioassay Testing
March 2005

Grab Sample Number	COS Samoa Packing		StarKist Samoa		COS Samoa Packing Percent of Total Flow	StarKist Samoa Percent Of Total Flow
	Sampling Date and Time	Effluent Flow Rate (mgd)	Sampling Date and Time	Effluent Flow Rate (mgd)		
1	3 March 2005 09:00	0.72	3 March 2005 09:00	1.86	3.2%	8.3%
2	12:00	0.76	12:00	1.78	3.4%	8.0%
3	15:00	0.72	15:00	2.02	3.2%	9.0%
4	18:00	0.72	18:00	2.23	3.2%	9.9%
5	21:00	0.68	21:00	1.83	3.0%	8.2%
6	4 March 2005 00:00	0.68	4 March 2005 00:00	1.97	3.0%	8.8%
7	03:00	0.68	03:00	2.66	3.0%	11.9%
8	06:00	0.80	06:00	2.30	3.6%	10.3%
Total		5.76 [A]		16.65 [A]	25.7%	74.3%
Mean		0.72		2.08	Total = %100	

[A] Numerical total of column for calculation purposes. Total flow over period will be approximately the calculated mean.

Bioassay Testing Procedures

EnviroSystems, Inc. located in Hampton, New Hampshire conducted the bioassay tests. The testing procedures and results of the bioassay tests are provided in the Laboratory report included as Attachment II. This report summarizes the 96-hour acute bioassay test conducted with reference to the U.S. EPA document Methods for Measuring the Acute Toxicity of Effluents to Freshwater and Marine Organisms (EPA-821-R-02-012), 2002 as the sources of methods for conducting the test. The bioassay test was conducted considering and including U.S. EPA's comments on previous bioassay tests, as documented in previous reports.

The test organisms were ≤ 5 days old and the test temperature was to be held at a nominal 20 °C, with actual temperatures ranging between 18°C and 22°C. Salinity was adjusted to 25 ppt at the start of the test and ranged during the test between 24 and 29 ppt. Demonstrated potential for a lethal immediate dissolved oxygen demand (IDOD) had been discussed and documented in previous bioassay technical memoranda, which describe the first two tests conducted in 1993. Therefore, all of the bioassay test chambers were continuously aerated during the bioassay tests to maintain adequate levels of dissolved oxygen (DO)[2]. The test was renewed with oxygenated sample at 48 hours.

Bioassay tests were carried out for effluent concentrations of 50, 25, 12.5, 6.25, and 3.1 percent as vol:vol dilutions in seawater. Water quality was monitored daily and parameters measured included DO, pH, salinity, and temperature. Total residual chlorine and ammonia were measured. Water quality data are provided in the Laboratory Report (Attachment II). Reference toxicant tests using sodium dodecyl sulfonate (SDS) are conducted regularly by ESI with the last one completed on 23 March 2004 and results were within one standard deviation of the historic laboratory mean.

Summary Results: Americamysis bahia Effluent Bioassay

All results from the bioassay tests are included in Attachment II. The results of the mysid bioassay tests indicate the 96-hour LC_{50} for the effluent tested was >50 percent. The no observable effects concentration (NOEC) for the 96-hour bioassay was 50 percent and the least observable effects concentration (LOEC) was >50 percent. Results on a daily basis are summarized in Table 2.

Table 2
StarKist Samoa and COS Samoa Packing
Combined Effluent Bioassay Results
March 2005 Sampling

Exposure Time	Parameter		
	LC_{50}	NOEC[1]	LOEC
24 hours	>50%	50%	>50%
48 hours	>50%	50%	>50%
72 hours	50%	25%	50%
96 hours	48.5%	25%	50%

[1] Highest concentration tested was 50% so NOEC at 50% can be considered ≥50%

[2] The high initial dilution of the actual effluent discharge (>100:1) into the Harbor, in a very short time, removes any concern about IDOD effects in the receiving water.

Discussion

Table 3 summarizes the results of the effluent bioassay tests for the samples collected in the March 2005 sampling compared to the previous bioassay tests. The LC_{50}, NOEC, and LOEC are within the range obtained from previous tests where *Americamysis bahia* (*Mysidopsis bahia*) was used in place of *Penaeus vannami*. Figure 1 summarizes the LC_{50} for the mysid and penaeid tests done since February 1993. Figure 2 presents the range of LC_{50} results for mysids tests conducted since 1994. There is some variability observed in test results. The March 2005 test results are among the highest LC_{50} values recorded for this organism. Higher LC_{50} values indicate lower whole effluent toxicity. There is a possible trend toward lower toxicity (higher LC_{50}) with time (see Figure 2). The trend is statistically significant at the <1% level. However, the actual significance and reason for the trend is unknown.

Conclusions

The bioassay tests for the Joint Cannery Outfall effluent for March 2005 do not indicate effluent toxicity levels to be of concern. As discussed in the previous bioassay test reports on the effluent, the time scale of the mixing of the effluent with the receiving water is on the order of seconds to achieve dilutions that will eliminate possible toxic effects as reflected by the bioassay results. For example, an LC_{50} of 48.5% after 96 hours of exposure, which was observed in March 2005, corresponds to a dilution of 2:1, which is achieved within one second and within one meter of the discharge point. The discharge is located in about 180 feet of water and the effluent toxicity tests indicate that the discharge is diluted to non-toxic levels immediately after discharge and well within the initial dilution plume.

Table 3
StarKist Samoa and COS Samoa Packing
Combined Effluent Bioassay Results

Date	Species	Parameters		
		LC_{50}	NOEC	LOEC
2/93	*Penaeus vannami*	4.8%[1]	3.1%	6.25%
10/93	*Penaeus vannami*	15.67%	3.1%	6.25%
2/94	*Penaeus vannami*	15.76%	<1.6%	1.6%
10/94	*Mysidopsis bahia*[2]	31.2%	25%	50%
3/95	*Penaeus vannami*	14.8%	6.25%	12.5%
3/95	*Mysidopsis bahia*[3]	10.8%	6.25%	12.5%
2/96	*Penaeus vannami*	>50%	>50%	>50%
2/96	*Mysidopsis bahia*[3]	28.36%	12.5%	25%
3/96	*Penaeus vannami*	44.4%	25%	50%
11/96	*Penaeus vannami*	7.11%	3.1%	6.25%
03/97	*Penaeus vannami*	39.36%	12.5%	25%
09/97	*Penaeus vannami*[4]	12.3%	6.25%	12.5%
06/98	*Mysidopsis bahia*[2]	17.2%	6.25%	12.5%
11/98	*Mysidopsis bahia*[2]	15%	6.25%	12.5%
02/00	*Mysidopsis bahia*[2]	20%	6.25%	12.5%
08/00	*Mysidopsis bahia*[2]	17.1%	3.1%	6.25%
03/01	*Americamysis bahia*[2,5]	13.8%	12.5%	25%
10/01	*Americamysis bahia*[2,6]	37.5%	25%	50%
3/02	*Americamysis bahia*[2,6]	16.1%	12.5%	25%
8/02	*Americamysis bahia*[2,6]	10.23%	6.25%	12.5%
03/03	*Americamysis bahia*[2,6]	28.4%	25%	50%
08/03	*Americamysis bahia*[2,6]	43.2%	25%	50%
02/04	*Americamysis bahia*[2,6]	>50%	50%	>50%
09/04	*Americamysis bahia*[2,6]	>50%	50%	>50%
03/05	*Americamysis bahia*[2,6]	**48.5%**	**25%**	**50%**

[1]The February 1993 samples were not aerated until after the first day of the test. For subsequent tests the samples were aerated for the entire duration of the tests.
[2]*Mysidopsis bahia* used as substitutes because *Penaeus vannami* not available: as directed and approved by U. S. EPA.
[3]*Mysidopsis bahia* used in addition to *Penaeus vannami* as described in text of technical memorandums reporting test results. Only one species is required by the permit conditions.
[4]Stage 1 (3 mm) *Penaeus vannami* were used for testing because older Stage 7 and 8 (8-10 mm) *Penaeus vannami* were not available.
[5]*Mysidopsis bahia* renamed *Americamysis bahia*. Results indicate increased toxicity because of low DO in renewal concentrations as renewal water was not aerated prior to use
[6] *Mysidopsis bahia* renamed *Americamysis bahia*

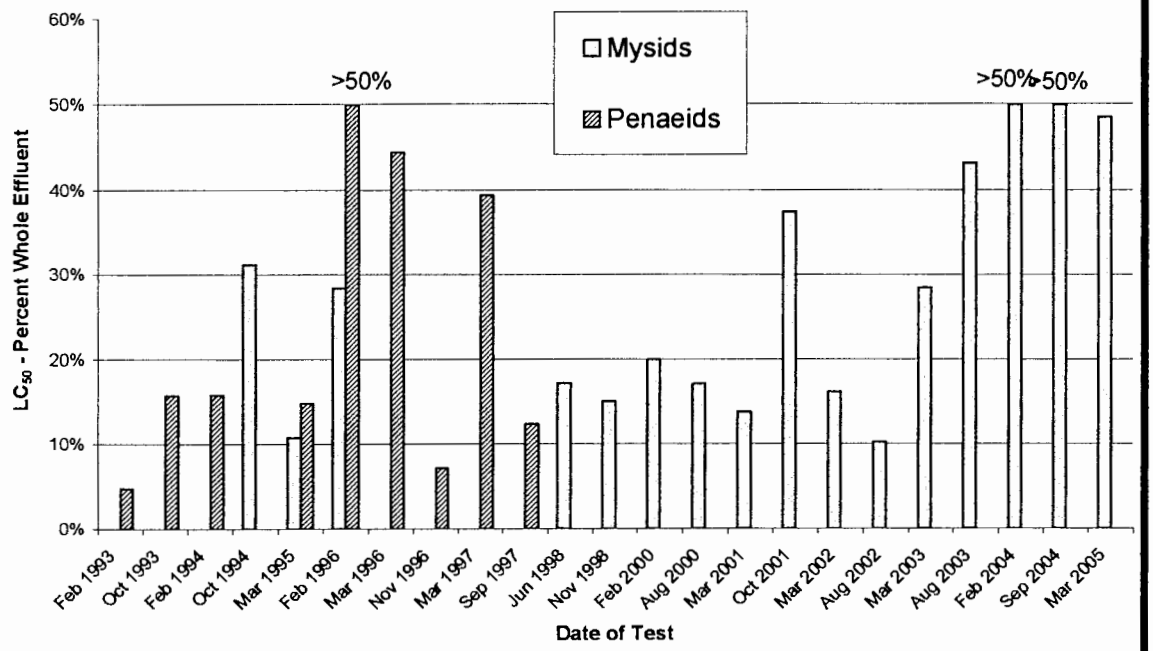

Figure 1. LC_{50} for Mysid and Penaeid Tests

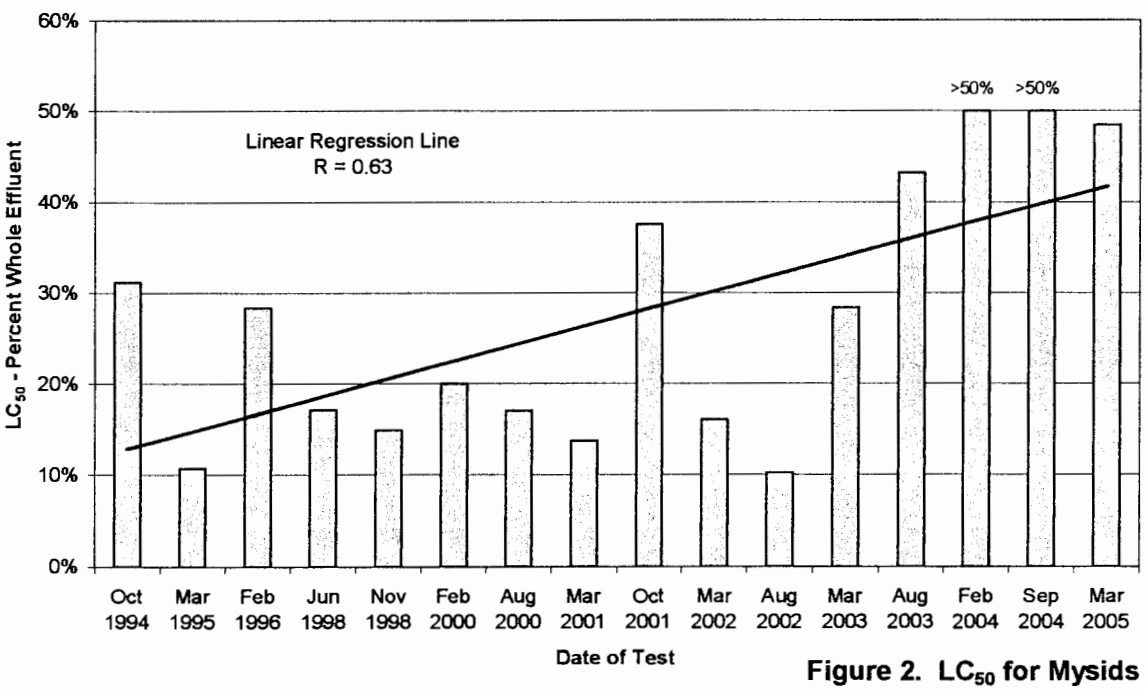

Figure 2. LC_{50} for Mysids

ATTACHMENT I

Chain-of-Custody

13114

CH2M HILL
APPLIED SCIENCES LABORATORY

CHAIN OF CUSTODY RECORD AND AGREEMENT TO PERFORM SERVICES

CH2M Hill Project #: 147323.JC.05.NT
Purchase Order #:
Project Name: JOINT CANNERY OUTFALL
Company Name/CH2M HILL Office: CH2M HILL
Project Manager & Phone #: Mr. [ ] Ms. [ ] Dr. [ ] STEVE COSTA 707-677-0123
Report Copy to: SAME
Requested Completion Date:
Sampling Requirements: SDWA [ ] NPDES [X] RCRA [ ] OTHER ____
Sample Disposal: Dispose [X] Return [ ]

SHADED AREA - FOR LAB USE ONLY: Lab 1 #, Lab 2 #, Quote #, Kit Request #, Project #, No. of Samples, Page of, Login, LIMS Ver, REMARKS, LAB 1 ID, LAB 2 ID

ANALYSES REQUESTED: ACUTE BIOASSAY W/ MYSIDOPSIS

Sampling Date	Sampling Time	Type COMP	Type GRAB	Matrix WATER	Matrix SOIL	Matrix AIR	CLIENT SAMPLE ID (9 CHARACTERS)	# OF CONTAINERS	ACUTE BIOASSAY W/ MYSIDOPSIS	REMARKS
3-4 MAR 2005		X		X			05NT	1	X	CONTINUOUS AERATION - INCLUDING RENEWAL DILUTIONS at 50/25/12½/6¼/3

Sampled By & Title (Please sign and print name)	Date/Time 4MAR05	Relinquished By (Please sign and print name)	Date/Time 4MAR05	QC Level (1, 2, 3, Other)	
Received By (Please sign and print name)	Date/Time 3/15/05 1300	Relinquished By (Please sign and print name)	Date/Time	COC Rec	ICE
Received By (Please sign and print name)	Date/Time	Relinquished By (Please sign and print name)	Date/Time	Ana Req	TEMP
				Cust Seal	Ph
Received By (Please sign and print name)	Date/Time	Shipped Via: UPS BUS Fed-Ex Hand Other DHL	Shipping # 844 6187 665		
Work Authorized By (Please sign and print name)	Remarks				

Instructions and Agreement Provisions on Reverse Side

DISTRIBUTION: Original - LAB, Yellow - LAB, Pink - Client
REV 3/94 FORM 340

MS ORDER 920701629-1 QTY 25

Shipment Airwaybill

PPF
PPF

DHL WORLDWIDE EXPRESS

1-800-CALL-DHL (Non negotiable) in USA only
WEB ADDRESS: http://www.dhl.com

8446187665

Quote this shipment number in an inquiry

4/05/01

ORIGIN	DESTINATION
PPF	PRT

1 From (Shipper)

Account no.: 920701629

Shipper's reference: 147323.JC.05.NT

Company name: CHEM HILL

Shipper's name: STEVE COSTA 684-633-5264 707-677-0123

Address: 777 106TH AVE NE BELLEVUE WA 98004

LEFALE PULE FAGA'ALU PAGO PAGO, AMERICAN SAMOA 96799

Zip code (required): 96799

Phone/Fax/E-mail circle one (required): (425)453-5000

2 To (Recipient)

Company name: ENVIROSYSTEMS INC

Attention: PETRA KARBE

Delivery address: ONE LAFAYETTE ROAD HAMPTON, NEW HAMPSHIRE USA

Zip/Postcode (required): 03842

Phone/Fax/E-mail circle one (required): 603-926-3345

3 Shipment details

Domestic Services
- [ ] USA OVERNIGHT

International Services
- [ ] INT'L DOCUMENT EXPRESS
- [x] WORLDWIDE PRIORITY EXPRESS — Non document shipments / unlimited weight
- [ ] WORLDFREIGHT — Prior arrangements required / 220 lbs. Minimum

WorldMail Services [ ] 1st
- [ ] APM [ ] 2nd [ ] IPA [ ] ISAL

Special Services extra charges may apply
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US $ 50 — Insured value

Full description of contents
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ATTACHMENT II

EnviroSystems, Inc. Laboratory Report

TOXICOLOGICAL EVALUATION OF A TREATED EFFLUENT: BIOMONITORING SUPPORT FOR A NPDES PERMIT MARCH 2005

American Samoa Joint Cannery Outfall

Prepared For

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By

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One Lafayette Road
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March 2005
Reference Number CH2M-Samoa13114-05-03

STUDY NUMBER 13114

EXECUTIVE SUMMARY

The following summarizes the results of acute exposure bioassays performed from March 15-19, 2005 in support of the NPDES biomonitoring requirements of the American Samoa Joint Cannery Outfall. The 96 hour acute definitive assay was conducted using the marine species, *Americamysis bahia.*

Acute Toxicity Evaluation

Species	Exposure	LC-50	NOEC	LOEC
Americamysis bahia	24-Hours	>50%	50%	>50%
	48-Hours	>50%	50%	>50%
	72-Hours	50%	25%	50%
	96-Hours	48.5%	25%	50%

TOXICOLOGICAL EVALUATION OF A TREATED EFFLUENT: BIOMONITORING SUPPORT FOR A NPDES PERMIT MARCH 2005

American Samoa Joint Cannery Outfall

1.0 INTRODUCTION

Acute toxicity tests involve preparing a series of concentrations by diluting effluent with control water. Groups of test organisms are exposed to each effluent concentration and a control for a specified period. In acute tests, mortality data for each concentration are used to calculate (by regression) the median lethal concentration, or LC-50, defined as the effluent concentration which kills half of the test organisms. Samples with high LC-50 values are less likely to cause significant environmental impact. The acute no observed effect concentration (NOEC) and lowest observed effect concentration (LOEC) document the highest and lowest effluent concentrations that have no impact and a significant impact on the test species, respectively.

This report presents the results of an acute toxicity test conducted on an effluent sample collected from the American Samoa Joint Cannery Outfall. Testing was based on programs and protocols developed by the US EPA (2002) and involved conducting 96 hour acute static renewal toxicity tests with the marine species, *Americamysis bahia*. Testing was performed at EnviroSystems, Incorporated (ESI), Hampton, New Hampshire in accordance with the provisions of the NELAC Standards (2000).

2.0 MATERIALS AND METHODS

2.1 General Methods

Toxicological and analytical protocols used in this program follow procedures primarily designed by the EPA to provide standard approaches for the evaluation of toxicological effects of discharges on aquatic organisms, and for the analysis of water samples. See Section 4.0 for a list of references.

2.2 Test Species

Every attempt was made to acquire the species, *Penaeus vannami,* as this is the preferred organism under the Cannery's permit. ESI was unable to obtain reasonably priced *P. vannami*. Due to the exorbitant expense, the decision was made to use an alternate species, *Americamysis bahia*.

A. bahia, ≤5 days old, were from maintained at ESI. Test organisms were transferred to test chambers by large bore pipet, minimizing the amount of water added to test solutions.

2.3 Effluent and Dilution Water

The effluent sample used in the assay was identified as "05NT" Sample collection information is provided in Table 4. Upon receipt, the sample was stored at 4°C. All sample material used in the assay was warmed to 20±1°C prior to preparing test solutions. Total residual chlorine (TRC) was measured using amperometric titration (MDL 0.05 mg/L). When the sample matrix is too turbid amperometric titration is not possible. In these cases an indicator strip is used to access chlorine level. As the effluent sample contained <0.05 mg/L, TRC dechlorination with sodium thiosulfate was not required (EPA 2002). Aliquots of the undiluted effluent sample were collected for ammonia analysis when the sample arrived and again prior to renewal. Upon arrival, the effluent sample had a salinity of 10‰. Salinity of the effluent was increased to 25‰ by the addition of artificial sea salts. Test concentrations for the assays were 50%, 25%, 12.5%, 6.25% and 3.1% effluent with a laboratory water diluent control.

The dilution water used in this assay was collected from the sea water system at ESI. The water is pumped in daily from the Hampton Estuary on the flood tide, filtered through a high volume sand filter, and stored in 3000 gallon polyethylene tanks. The water is classified as Class SA-1 by the State of New Hampshire, and has been used to culture test organisms for over 20 years. Sea water used in the assay had a salinity of 25±2‰ and a TRC of <0.05 mg/L.

2.4 Acute Toxicity Tests

The 96 hour acute static renewal toxicity test was conducted at 20±2°C with a photoperiod of 16:8 hours light:dark. Test chambers for the acute assays were 250 mL glass beakers containing 200 mL test solution in each of 5 replicates, with 10 organisms/replicate. Survival, dissolved oxygen, pH, salinity and temperature were measured daily in all replicates. Test solutions were renewed after 48 hours using effluent from the start sample. Mysid shrimp were fed daily with <24 hour old brine shrimp.

2.5 Data Analysis

At 24 hour intervals, survival data was analyzed to assess toxicity using a program developed by Stephan (1982). LC-50 values were computed using the Spearman-Karber, Binomial, and Probit methods. If survival in the highest test concentration was >50%, LC-50 values were obtained by direct observation of the raw data. The NOEC was determined as the highest test concentration which caused no significant mortality while the LOEC was determined as the lowest concentration that did cause significant mortality.

2.6 Quality Control

As part of the laboratory quality control program, standard reference toxicant assays are conducted on a regular basis for each test species. These results provide relative health and response data while allowing for comparison with historic data sets. See Table 2 for details.

3.0 RESULTS

Results of the acute exposure bioassay conducted using the mysid shrimp, *A. bahia*, are summarized in Table 1. A summary of reference toxicant data for the test species is presented in Table 2. Effluent and dilution water characteristics are presented in Table 3. Sample collection information is provided in Table 4. Table 5 provides a summary of historic data associated with the discharge. Support data are included in Appendix A.

3.1 Acute Toxicity Test - *Americamysis bahia*

Control survival after 24, 48 and72 hours exposure was 98%. Control survival after 96 hours exposure was 96%. These results are an indication of healthy test organisms and that the dilution water had no adverse impact on the outcome of the assay.

Table 1 provides a summary of the acute exposure data and results.

3.2 Summary

The salinity adjusted effluent sample collected from the American Samoa Joint Cannery Outfall did exhibit signs of acute toxicity, at a dilution of 50% effluent, to the mysid shrimp, *Americamysis bahia,* during the 96 hour exposure period,.

4.0 LITERATURE CITED

APHA. 1998. *Standard Methods for the Examination of Water and Wastewater*, 20th Edition. Washington D.C.

National Environmental Laboratory Accreditation Conference: Quality Systems. Chapter 5. June 2000.

Stephan, C. 1982. Documentation for Computing LC-50 Values with a Mini Computer. Unpublished.

US EPA. 2002. *Attachment G: NPDES Whole Effluent Toxicity Testing, Monitoring and Reporting Tips and Common Pitfalls.* Dated December 2002. US EPA Region I Offices, Boston, Massachusetts.

U.S. EPA. 2002. *Methods for Measuring the Acute Toxicity of Effluents to Freshwater and Marine Organisms.* Fifth Edition. EPA-821-R-02-012.

TABLE 1. Summary of Acute Evaluation Results. American Samoa Joint Cannery Outfall Effluent Evaluation. March 2005.

Concentration % Effluent	Exposure	Replicates A	B	C	D	E	Mean	Standard Deviation	Coefficient of Variation
Lab Control	Start	10	10	10	10	10	100.0%	0.000	0.00%
	24-Hours	10	10	10	9	10	98.0%	0.400	4.08%
	48-Hours	10	10	10	9	10	98.0%	0.400	4.08%
	72-Hours	10	10	10	9	10	98.0%	0.400	4.08%
	96-Hours	10	9	10	9	10	96.0%	0.490	5.10%
3.1%	24-Hours	10	10	10	10	10	100.0%	0.000	0.00%
	48-Hours	9	10	10	10	9	96.0%	0.490	5.10%
	72-Hours	6	10	10	10	9	90.0%	1.549	17.21%
	96-Hours	6	10	10	9	9	88.0%	1.470	16.70%
6.25%	24-Hours	10	10	10	10	10	100.0%	0.000	0.00%
	48-Hours	10	10	10	10	10	100.0%	0.000	0.00%
	72-Hours	10	10	10	10	10	100.0%	0.000	0.00%
	96-Hours	9	10	9	10	9	94.0%	0.490	5.21%
12.5%	24-Hours	9	10	10	10	10	98.0%	0.400	4.08%
	48-Hours	9	10	10	10	10	98.0%	0.400	4.08%
	72-Hours	9	10	10	10	10	98.0%	0.400	4.08%
	96-Hours	9	10	10	8	10	94.0%	0.800	8.51%
25%	24-Hours	10	10	9	10	10	98.0%	0.400	4.08%
	48-Hours	10	9	9	10	10	96.0%	0.490	5.10%
	72-Hours	10	9	9	10	9	94.0%	0.490	5.21%
	96-Hours	10	9	9	10	9	94.0%	0.490	5.21%
50%	24-Hours	0**	9	10	8	10	92.5%	0.829	8.96%
	48-Hours	0**	9	8	8	10	87.5%	0.829	9.48%
	72-Hours	0**	3	3	6	8	50.0%	2.121	42.43%
	96-Hours	0**	2	3	6	8	47.5%	2.385	50.21%

Comments: ** Air line came out of the 50% A replicate resulting in a dissolved oxygen value of 0.6mg/L. Therefore, the 50% A replicate was discarded for the statistical analysis.

SUMMARY OF ENDPOINTS

Exposure Period	LC-50 (95% Limits)	METHOD	NOEC	LOEC
24 Hours	>50%	Direct Observation	50%	>50%
48 Hours	>50%	Direct Observation	50%	>50%
72 Hours	50%	Binomial Method	25%	50%
96 Hours	48.5%	Binomial Method	25%	50%

TABLE 2. **Summary of Reference Toxicant Data. American Samoa Joint Cannery Outfall Effluent Evaluation. March 2005.**

Concentrations Expressed as mg/L Sodium Dodecyl Sulfate

Species	Date	LC-50	Historic Mean	Number of Tests	±1 STD Deviation	±2 STD Deviations
A. bahia	03/23/04	21.1	20.3	20	3.15	6.31

TABLE 3. **Summary of Effluent and Diluent Characteristics. American Samoa Joint Cannery Outfall Effluent Evaluation. March 2005.**

PARAMETER	UNITS	100% EFFLUENT	50% EFFLUENT	DILUENT
Salinity - As Received	‰	10	-	24
Salinity - After Salinity Adjustment	‰	25	25	-
pH - As Received	SU	6.46	-	7.81
pH - After Salinity Adjustment	SU	6.69	7.00	-
TRC - As Received	mg/L	<0.05	-	<0.05
Dissolved Oxygen - As Received	mg/L	0.7	-	-
Dissolved Oxygen - After Aeration	mg/L	7.2	5.3	7.5
Ammonia - As Received	mg/L as N	60.0	-	<0.1
Unionized Ammonia - As Received	mg/L as N	0.068	-	<0.002
Ammonia - Salinity Adjusted	mg/L as N	-	29.0	-
Unionized Ammonia - Salinity Adjusted	mg/L as N	-	0.114	-
Ammonia - at 48 Hours	mg/L as N	63.0	29.0	<0.1
Unionized Ammonia - at 48 Hours	mg/L as N	0.116	0.177	<0.002

TABLE 4. **Summary of Sample Collection Information. American Samoa Joint Cannery Outfall Effluent Evaluation. March 2005.**

Sample Description	Type	Collection Date	Collection Time	Receipt Date	Receipt Time	Arrival Temp °C
EFFLUENT	Comp	03/03-04/04	ND	03/15/04	1330	18

COMMENTS:
ND - No data was recorded on chain of custody.

TABLE 5. **Summary of StarKist Samoa and COS Samoa Packing Combined Effluent Bioassay Results. American Samoa Joint Cannery Outfall Effluent Evaluation. March 2005.**

Date	Species	96-Hour Endpoints		
		LC-50	NOEC	LOEC
02/93[1]	*Penaeus vannami*	4.8%	3.1%	6.25%
10/93[1]	*Penaeus vannami*	15.67%	3.1%	6.25%
02/94[1]	*Penaeus vannami*	15.76%	<1.6%	1.6%
10/94[1]	*Americamysis bahia*	31.2%	25.0%	50.0%
03/95[1]	*Penaeus vannami*	14.8%	6.25%	12.5%
03/95[1]	*Americamysis bahia*	10.8%	6.25%	12.5%
02/96[1]	*Penaeus vannami*	>50.0%	>50.0%	>50.0%
03/96[1]	*Penaeus vannami*	44.4%	25.0%	50.0%
11/96[1]	*Penaeus vannami*	7.11%	3.1%	6.25%
03/97[1]	*Penaeus vannami*	39.36%	12.5%	25.0%
09/97[1]	*Penaeus vannami*	12.3%	6.25%	12.5%
06/98[1]	*Americamysis bahia*	17.2%	6.25%	12.5%
11/98[1]	*Americamysis bahia*	15.0%	6.25%	12.5%
02/00[1]	*Americamysis bahia*	20.0%	6.25%	12.5%
08/00[1]	*Americamysis bahia*	17.1%	3.1%	6.25%
03/01[2]	*Americamysis bahia*	13.81%	12.5%	25.0%
03/02[2]	*Americamysis bahia*	16.13%	12.5%	25.0%
08/02[2]	*Americamysis bahia*	10.23%	6.25%	12.5%
03/03[2]	*Americamysis bahia*	28.4%	25.0%	50.0%
08/03[2]	*Americamysis bahia*	43.2%	25.0%	50.0%
03/04[2]	*Americamysis bahia*	>50.0%	50.0%	>50.0%
10/04[2]	*Americamysis bahia*	>50.0%	50.0%	>50.0%
03/05[2]	*Americamysis bahia*	48.5%	25.0%	50.0%

Notes:

1. Assays conducted by Advanced Biological Testing, Inc., Rohnert Park, California
2. Assays conducted by EnviroSystems, Inc., Hampton, New Hampshire

APPENDIX A

DATA SHEETS

STATISTICAL SUPPORT

Contents	Number of Pages
Methods Used in NPDES Permit Biomonitoring Testing	1
A. bahia Acute Bioassay Data Summary	2
A. bahia Survival Statistics: LC-50, NOEC	15
A. bahia Organism Culture Sheet	1
Effluent & Diluent Chemistry and Water Quality Data / Preparation of Dilutions	1
Record of Meters Used for Water Quality Measurements	1
Unionized Ammonia Calculation	1
Sample Receipt Record	1
Chain of Custody	1

METHODS USED IN NPDES PERMIT BIOMONITORING TESTING

Parameter	Method
Acute Exposure Bioassays	
Ceriodaphnia dubia, Daphnia pulex	EPA-821-R-02-012
Pimephales promelas	EPA-821-R-02-012
Americamysis bahia	EPA-821-R-02-012
Menidia beryllina, Cyprinodon variegatus	EPA-821-R-02-012
Chronic Exposure Bioassays	
Ceriodaphnia dubia	EPA-821-R-02-013, 1002.0
Pimephales promelas	EPA-821-R-02-013, 1000.0
Cyprinodon variegatus	EPA-821-R-02-014, 1004.0
Menidia beryllina	EPA-821-R-02-014, 1006.0
Arbacia punctulata	EPA-821-R-02-014, 1008.0
Champia parvula	EPA-821-R-02-014, 1009.0
Trace Metals:	
ICP Metals	EPA 200.7/SW 6010
Hardness	Standard Methods 20th Edition - Method 2340 B
Wet Chemistries:	
Alkalinity	EPA 310.2
Chlorine, Residual	Standard Methods 20th Edition - Method 4500CLD
Total Organic Carbon	Standard Methods 20th Edition - Method 5310C
Specific Conductance	Standard Methods 20th Edition - Method 2510B
Nitrogen - Ammonia	Standard Methods 20th Edition - Method 4500NH3G
pH	Standard Methods 20th Edition - Method 4500H+B
Solids, Total (TS)	Standard Methods 20th Edition - Method 2540.B
Solids, Total Suspended (TSS)	Standard Methods 20th Edition - Method 2540D
Dissolved Oxygen	Standard Methods 20th Edition - Method 4500-O G

ACUTE BIOASSAY DATA SUMMARY

STUDY: 1314		"AS RECEIVED" EFFLUENT AND DILUENT CHEMISTRIES						
CLIENT: CH2M Hill	TEST ORGANISM: *A. bahia*		TRC	AMM 0 HR✖	AMM 48 HR✖	pH	DO	Salinity
SAMPLE: American Samoa	ORGANISM SUPPLIER/BATCH/AGE: *See Organism Culture Sheet*	EFFLUENT	See "EFFLUENT & DILUENT CHEMISTRY and WATER QUALITY DATA" sheet					
DILUENT: LAB SALT		DILUENT						

SALINITY ADJUSTMENT RECORD (IF APPLICABLE): 800 ML EFFLUENT + 141 G SEA SALTS = 100% ACTUAL PERCENTAGE

CONC	REP	SURVIVAL 0	24	48	72	96	✦DISSOLVED OXYGEN (MG/L)✦ 0	24	48◊	48☆	72	96	PH (SU) 0	24	48◊	48☆	72	96	TEMPERATURE (°C) 0	24	48◊	48	72	96	SALINITY (ppt) 0	24	48◊	48	72	96
LAB	A	10	10	10	10	10	7.5	7.1	7.1	7.5	7.6	7.2	7.81	7.90	7.89	7.77	7.97	7.87	21	19	20	22	18	20	24	25	26	25	25	27
	B	10	10	10	10	9	7.5	7.2	6.9	7.4	7.6	7.0	7.81	7.95	7.94	7.80	7.98	8.01	21	20	20	22	18	20	24	26	27	26	27	28
	C	10	10	10	10	10	7.5	7.3	7.1	7.4	7.6	7.1	7.81	7.96	7.97	7.82	7.96	8.03	21	20	20	22	18	20	24	26	26	26	27	28
	D	10	9	9	9	9	7.5	7.3	7.2	7.4	7.6	7.2	7.82	7.96	7.99	7.82	7.97	8.05	21	20	21	22	18	20	24	26	27	26	28	29
	E	10	10	10	10	10	7.5	7.2	7.2	7.4	7.7	6.8	7.82	7.92	7.99	7.82	7.99	8.04	21	19	21	22	18	20	24	26	27	26	28	29
3.1%	A	10	10	9	6	6	7.5	7.2	7.2	7.4	7.7	6.7	7.74	7.96	7.99	7.76	8.00	8.04	21	19	21	22	18	20	24	25	26	25	26	28
	B	10	10	10	10	10	7.4	7.3	7.2	7.3	7.7	6.7	7.74	7.97	7.97	7.74	7.99	8.04	21	20	21	22	18	20	24	25	26	26	26	28
	C	10	10	10	10	10	7.3	7.4	7.1	7.2	7.7	6.9	7.74	7.98	7.98	7.75	7.99	8.06	21	21	22	22	18	20	24	25	27	26	27	28
	D	10	10	10	10	9	7.2	7.3	6.9	7.2	7.7	6.8	7.75	7.99	7.99	7.76	7.99	8.08	21	20	22	22	19	20	24	26	27	26	27	28
	E	10	10	9	9	9	7.2	7.2	6.9	7.2	7.7	6.7	7.75	7.98	8.00	7.76	8.00	8.08	21	19	21	22	19	20	24	26	27	26	27	28
6.25%	A	10	10	10	10	9	7.1	7.2	6.8	7.2	7.7	6.9	7.65	7.95	8.01	7.73	8.02	8.09	21	19	20	22	19	20	25	26	27	26	26	28
	B	10	10	10	10	10	7.0	7.2	6.9	7.2	7.7	6.8	7.63	7.95	8.02	7.70	8.01	8.09	21	20	20	22	19	20	25	26	27	26	26	28
	C	10	10	10	10	9	7.0	7.3	7.0	7.1	7.7	6.7	7.63	7.97	8.00	7.70	8.00	8.10	21	21	20	22	19	20	25	26	27	26	26	28
	D	10	10	10	10	10	7.0	7.2	7.0	7.1	7.7	6.8	7.63	7.97	8.00	7.69	8.02	8.10	21	21	20	22	19	20	25	26	28	26	27	28
	E	10	10	10	10	9	7.0	7.0	7.1	7.1	7.7	6.7	7.62	7.95	8.01	7.70	8.03	8.10	21	20	20	22	19	20	25	26	27	26	27	28
DATE		3/15/05	3/16/05	3/17/05	3/18/05	3/19	3/15	3/16/05	3/17/05	3/17/05	3/18/05	3/19																		
TIME		1525	1600	1700	1545	1500	1440	1540	1635	1715	1525	1440																		
INITIALS						ICK						ICK																		
FED?		✓	✓	✓	✓				✓																					

✖ - See:" EFFLUENT & DILUENT CHEMISTRY and WATER QUALITY DATA" sheet.
✦ - AERATE FROM START! ◊ - "Old" water qualities (prior to renewal) ☆ - "New"water qualities (post renewal)

ACUTE BIOASSAY DATA SUMMARY

		"AS RECEIVED" EFFLUENT AND DILUENT CHEMISTRIES					
STUDY: 13114	SAMPLE RECEIVED:		TRC	AMM 0 HR✖	AMM 48 HR✖	pH	DO	Salinity
CLIENT: CH2M Hill	TEST ORGANISM: *A. bahia*						
SAMPLE: American Samoa	ORGANISM SUPPLIER:	EFFLUENT	See "EFFLUENT & DILUENT CHEMISTRY and WATER QUALITY DATA" sheet				
DILUENT: LAB SALT	ORGANISM BATCH/AGE:	DILUENT					

CONC	REP	SURVIVAL 0	24	48	72	96	✦DISSOLVED OXYGEN (MG/L)✦ 0	24	48◊	48☆	72	96	PH (SU) 0	24	48◊	48☆	72	96	TEMPERATURE (°C) 0	24	48◊	48	72	96	SALINITY (ppt) 0	24	48◊	48	72	96
12.5%	A	10	9	9	9	9	7.0	6.8	6.9	6.4	7.6	6.2	7.47	7.90 ~~7.90~~	8.04 8.05	7.61	8.02	8.12	20	19	20	22	19	20	25	26	27	25	26	27
	B	10	10	10	10	10	6.8	6.8	6.8	6.4	7.6	6.4	7.47	7.90	8.04	7.57	8.02	8.11	20	19	20	22	19	20	25	26	27	26	26	28
	C	10	10	10	10	10	6.8	6.8	6.8	6.2	7.6	6.6	7.46	7.89	8.04	7.58	8.01	8.11	20	20	20	22	20	20	25	26	27	26	26	27
	D	10	10	10	10	8	6.8	6.8	6.9	6.4	7.5	6.6	7.47	7.93	8.04	7.58	8.04	8.13	20	20	20	22	20	20	25	26	27	26	26	28
	E	10	10	10	10	10	6.8	6.8	6.9	6.5	7.4	6.8	7.47	7.92	8.04	7.57	8.05	8.13	20	20	20	22	19	20	25	26	27	26	26	28
25%	A	10	10	10	10	10	6.5	6.7	7.1	6.5	7.4	6.7	7.24	7.88	8.09	7.41	8.07	8.14	20	19	22	22	19	20	25	26	28	26	27	28
	B	10	10	9	9	9	6.4	6.7	6.9	5.9	7.4	6.2	7.24	7.93	8.09	7.37	8.08	8.18	20	19	22	22	20	20	25	26	27	26	26	28
	C	10	9	9 (E3) 0.13	9	9	6.4	6.7	6.8	5.8	7.6	6.6	7.22	7.99	8.09	7.38	8.08	8.21	20	20	21	22	21	20	25	26	27	26	26	28
	D	10	10	10	10	10	6.4	6.6	6.7	5.7	7.4	6.5	7.23	7.94	8.09	7.39	8.11	8.22	20	21	20	22	21		25	26	27	26	26	28
	E	10	10	10	9	9	6.4	6.2	6.6	5.7	7.2	6.4	7.22	7.92	8.10	7.40	8.11	8.18	20	20	20	22	20	20	25	26	27	26	26	28
50%	A	10	0	0	0	0	5.3	0.6 (E8)	–	–	–	–	7.00	7.58	–	–	–	–	20	19	–	–	–	–	25	26	–	–	–	–
	B	10	9	9	3	2	5.1	4.9	6.9	5.8	7.2	6.4	7.00	7.88	8.16	7.19	8.15	8.21	20	20	20	23	20	20	25	26	28	26	26	28
	C	10	10	8	3	3	5.1	5.1	6.8	4.4	7.4	6.7	6.99	7.93	8.19	7.17	8.16	8.25	20	21	20	23	21	20	25	26	27	26	26	28
	D	10	8	8	6	6	5.1	5.1	6.8	4.3	7.1	6.6	6.99	7.85	8.19	7.20	8.16	8.25	20	21	20	23	21	20	25	26	28	26	26	28
	E	10	10	10	8	8	5.1	5.1	6.7	4.3	6.9	6.5	6.99	7.92	8.19	7.20	8.17	8.22	20	20	20	23	20	20	25	26	28	26	26	27
DATE		3/15/05	3/16/05	3/17/05	3/18/05	3/19	3/15	3/16/05	3/17/05	3/17/05	3/18/05	3/19/05																		
TIME		1525	1600	1650	1545	1510	1440	1540	1635	1715	1525	1450																		
INITIALS		✓	✓	PS	✓	KK	✓	✓	✓	✓	✓	KK																		
FED?		✓	✓	✓	✓																									

(E10) Aeration line fell out over the 24hr. period causing the low D.O. reading.

✖ - See:" EFFLUENT & DILUENT CHEMISTRY and WATER QUALITY DATA" sheet.
✦ - AERATE FROM START! ◊ - "Old" water qualities (prior to renewal) ☆ - "New"water qualities (post renewal)

1311424B

Title: American Samoa 13114: A. bahia 24 hr survival
File: 1311424 Transform: ARC SINE(SQUARE ROOT(Y))

Shapiro - Wilk's Test for Normality

D = 0.1285
W = 0.7944

Critical W = 0.8980 (alpha = 0.01 , N = 29)
W = 0.9260 (alpha = 0.05 , N = 29)

Data FAIL normality test (alpha = 0.01). Try another transformation.

Warning - The first three homogeneity tests are sensitive to non-normality and should not be performed with this data as is.

Title: American Samoa 13114: A. bahia 24 hr survival
File: 1311424 Transform: ARC SINE(SQUARE ROOT(Y))

Hartley's Test for Homogeneity of Variance
Bartlett's Test for Homogeneity of Variance

These two tests can not be performed because at least one group has zero variance.

Data FAIL to meet homogeneity of variance assumption.
Additional transformations are useless.

Title: American Samoa 13114: A. bahia 24 hr survival
File: 1311424 Transform: ARC SINE(SQUARE ROOT(Y))

Summary Statistics on Transformed Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Lab	5	1.2490	1.4120	1.3794
2	3.1	5	1.4120	1.4120	1.4120
3	6.25	5	1.4120	1.4120	1.4120
4	12.5	5	1.2490	1.4120	1.3794
5	25	5	1.2490	1.4120	1.3794
6	50	4	1.1071	1.4120	1.2951

Title: American Samoa 13114: A. bahia 24 hr survival
File: 1311424 Transform: ARC SINE(SQUARE ROOT(Y))

Summary Statistics on Transformed Data TABLE 2 of 2

1311424B

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	Lab	0.0053	0.0729	0.0326	5.2837
2	3.1	0.0000	0.0000	0.0000	0.0000
3	6.25	0.0000	0.0000	0.0000	0.0000
4	12.5	0.0053	0.0729	0.0326	5.2837
5	25	0.0053	0.0729	0.0326	5.2837
6	50	0.0216	0.1470	0.0735	11.3473

Title: American Samoa 13114: A. bahia 24 hr survival
File: 1311424 Transform: ARC SINE(SQUARE ROOT(Y))

Wilcoxon's Rank Sum Test w/ Bonferroni Adjustment Ho: Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	RANK SUM	CRIT. VALUE	REPS	SIG 0.05
1	Lab	1.3794				
2	3.1	1.4120	30.00	16	5	
3	6.25	1.4120	30.00	16	5	
4	12.5	1.3794	27.50	16	5	
5	25	1.3794	27.50	16	5	
6	50	1.2951	16.50	10	4	

Critical values are 1 tailed (k = 5)

1311448B

Title: American Samoa 13114 A. bahia 48 hr survival
File: 1311448 Transform: ARC SINE(SQUARE ROOT(Y))

Shapiro - Wilk's Test for Normality

D = 0.1694
W = 0.8741

Critical W = 0.8980 (alpha = 0.01 , N = 29)
W = 0.9260 (alpha = 0.05 , N = 29)

Data FAIL normality test (alpha = 0.01). Try another transformation.

Warning - The first three homogeneity tests are sensitive to non-normality and should not be performed with this data as is.

Title: American Samoa 13114 A. bahia 48 hr survival
File: 1311448 Transform: ARC SINE(SQUARE ROOT(Y))

Hartley's Test for Homogeneity of Variance
Bartlett's Test for Homogeneity of Variance

These two tests can not be performed because at least one group has zero variance.

Data FAIL to meet homogeneity of variance assumption.
Additional transformations are useless.

Title: American Samoa 13114 A. bahia 48 hr survival
File: 1311448 Transform: ARC SINE(SQUARE ROOT(Y))

Summary Statistics on Transformed Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Lab	5	1.2490	1.4120	1.3794
2	3.1	5	1.2490	1.4120	1.3468
3	6.25	5	1.4120	1.4120	1.4120
4	12.5	5	1.2490	1.4120	1.3794
5	25	5	1.2490	1.4120	1.3468
6	50	4	1.1071	1.4120	1.2188

Title: American Samoa 13114 A. bahia 48 hr survival
File: 1311448 Transform: ARC SINE(SQUARE ROOT(Y))

Summary Statistics on Transformed Data TABLE 2 of 2

1311448B

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	Lab	0.0053	0.0729	0.0326	5.2837
2	3.1	0.0080	0.0893	0.0399	6.6278
3	6.25	0.0000	0.0000	0.0000	0.0000
4	12.5	0.0053	0.0729	0.0326	5.2837
5	25	0.0080	0.0893	0.0399	6.6278
6	50	0.0211	0.1451	0.0726	11.9065

Title: American Samoa 13114 A. bahia 48 hr survival
File: 1311448 Transform: ARC SINE(SQUARE ROOT(Y))

Wilcoxon's Rank Sum Test w/ Bonferroni Adjustment Ho: Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	RANK SUM	CRIT. VALUE	REPS	SIG 0.05
1	Lab	1.3794				
2	3.1	1.3468	25.00	16	5	
3	6.25	1.4120	30.00	16	5	
4	12.5	1.3794	27.50	16	5	
5	25	1.3468	25.00	16	5	
6	50	1.2188	13.50	10	4	

Critical values are 1 tailed (k = 5)

****

STUDY NO.: 13114 ASSAY START: 03/15/05

SPECIES: A.bahia EXPOSURE: 72 hours

SAMPLE: American Samoa

****

At a confidence level of 95 percent, the binomial test
shows that the LC50 is above 25

The usefulness of any LC50 calculated from this set of data
is questionable because a concentration-effect relationship
has not been demonstrated over a reasonable range (e.g.,
<37 to >63) of percent affected.
50 can be used as an approximate LC50 for this set of data.

----------RESULTS CALCULATED USING THE MOVING AVERAGE METHOD----------

Span	G	LC50	95 Percent Confidence Limits	
1	.157435	49.99998	42.49589	67.92381

An LC50 calculated using the Moving Average method may not be a very good
estimate if the span is much less than the number of concentrations.

If any higher concentration produces a lower percent affected
than a lower concentration, the confidence limits obtained
by the Moving Average method will probably be too close.

----------RESULTS CALCULATED USING THE PROBIT METHOD----------

Iterations	G	H	Chi-Square	Probability
5	6.663816	16.28386	48.85157	LESS THAN 0.001

As the probability associated with this value is <0.05, results should
be used with caution.

Slope = 2.516864
95 Percent Confidence Limits =-3.980261 and 9.013988

LC50 = 64.82584
95 Percent Confidence Limits = 0 and +INFINITY

---------RESULTS CALCULATED USING THE TRIMMED SPEARMAN-KARBER METHOD-------

Conc.	Dose =Ln (Conc)	Percent Dead	Monotonic Rel. Freq.	Trimmed Rel. Freq.
50	3.912023	50	.5	.5
25	3.218876	6	.06	-5.000001E-02 *
12.5	2.525729	2	.02	-9.999999E-02 *
6.25	1.832581	0	.01	-.1125 *
3.1	1.131402	2	.01	-.1125 *

Alpha = 10 %
Groups trimmed and therefore not used in estimating LC50
are marked with an asterisk above.
LC50 = 6.040446
Estimated 95 Percent Confidence Limits
Lower: 4.217017 Upper: 8.652321
Variance estimate = 3.228306E-02

Variance may be underestimated because all data were outside trimmed range.

****

STUDY NO.: 13114 ASSAY START: 03/15/05

SPECIES: A.bahia EXPOSURE: 72 hours

SAMPLE: American Samoa

****

SUMMARY TABLE

04-28-2005 13:03:33

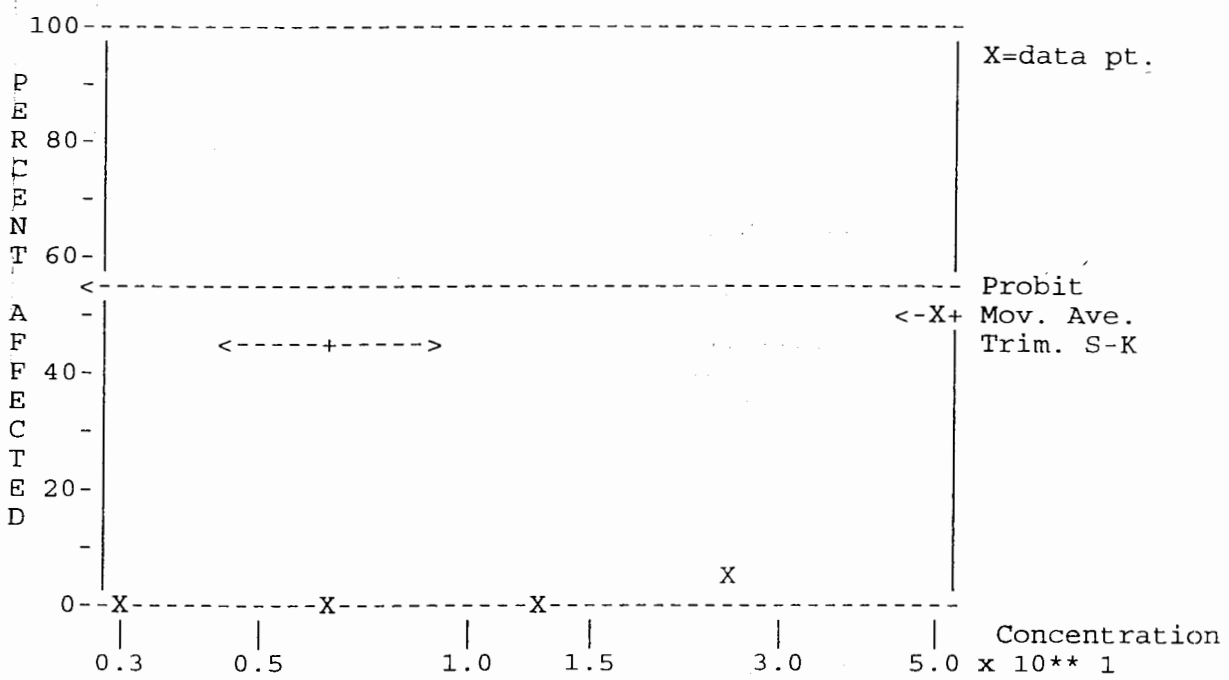
Data:

Conc.	Exposed	Dead	Percent
50	40	20	50
25	50	3	6
12.5	50	1	2
6.25	50	0	0
3.1	50	1	2

	LC50	Lower 95% Limit	Upper 95% Limit	
Probit Analysis	64.82584	0	0	
Moving Average	49.99998	42.49589	67.92381	Span= 1
Spearman-Karber	6.040446	4.217017	8.652321	Alpha= 10 %

Compare results with original data to see if they are reasonable.

****



Title: American Samoa 13114 A. bahia 72 hr survival
File: 1311472 Transform: ARC SINE(SQUARE ROOT(Y))

Shapiro - Wilk's Test for Normality

D = 0.4809
W = 0.9262

Critical W = 0.8980 (alpha = 0.01 , N = 29)
W = 0.9260 (alpha = 0.05 , N = 29)

Data PASS normality test (alpha = 0.01). Continue analysis.

Title: American Samoa 13114 A. bahia 72 hr survival
File: 1311472 Transform: ARC SINE(SQUARE ROOT(Y))

Hartley's Test for Homogeneity of Variance
Bartlett's Test for Homogeneity of Variance

These two tests can not be performed because at least one group has zero variance.

Data FAIL to meet homogeneity of variance assumption.
Additional transformations are useless.

Title: American Samoa 13114 A. bahia 72 hr survival
File: 1311472 Transform: ARC SINE(SQUARE ROOT(Y))

Summary Statistics on Transformed Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Lab	5	1.2490	1.4120	1.3794
2	3.1	5	0.8861	1.4120	1.2742
3	6.25	5	1.4120	1.4120	1.4120
4	12.5	5	1.2490	1.4120	1.3794
5	25	5	1.2490	1.4120	1.3142
6	50	4	0.5796	1.1071	0.7881

Title: American Samoa 13114 A. bahia 72 hr survival
File: 1311472 Transform: ARC SINE(SQUARE ROOT(Y))

Summary Statistics on Transformed Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	Lab	0.0053	0.0729	0.0326	5.2837

1311472B

2	3.1	0.0521	0.2282	0.1020	17.9068
3	6.25	0.0000	0.0000	0.0000	0.0000
4	12.5	0.0053	0.0729	0.0326	5.2837
5	25	0.0080	0.0893	0.0399	6.7921
6	50	0.0661	0.2571	0.1286	32.6218

Title: American Samoa 13114 A. bahia 72 hr survival
File: 1311472 Transform: ARC SINE(SQUARE ROOT(Y))

Wilcoxon's Rank Sum Test w/ Bonferroni Adjustment Ho: Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	RANK SUM	CRIT. VALUE	REPS	SIG 0.05
1	Lab	1.3794				
2	3.1	1.2742	24.50	16	5	
3	6.25	1.4120	30.00	16	5	
4	12.5	1.3794	27.50	16	5	
5	25	1.3142	22.50	16	5	
6	50	0.7881	10.00	10	4	*

Critical values are 1 tailed (k = 5)

****

STUDY NO.: 13114 ASSAY START: 03/15/05

SPECIES: A.bahia EXPOSURE: 96 hours

SAMPLE: American Samoa

****

At a confidence level of 95 percent, the binomial test
shows that the LC50 is above 25

The usefulness of any LC50 calculated from this set of data
is questionable because a concentration-effect relationship
has not been demonstrated over a reasonable range (e.g.,
<37 to >63) of percent affected.
An approximate LC50 of 48.47288 is obtained by
nonlinear interpolation between 25 and 50

----------RESULTS CALCULATED USING THE MOVING AVERAGE METHOD----------

Span	G	LC50	95 Percent Confidence Limits	
1	.1436596	48.47283	41.66249	63.50122

An LC50 calculated using the Moving Average method may not be a very good
estimate if the span is much less than the number of concentrations.

If any higher concentration produces a lower percent affected
than a lower concentration, the confidence limits obtained
by the Moving Average method will probably be too close.

----------RESULTS CALCULATED USING THE PROBIT METHOD----------

Iterations	G	H	Chi-Square	Probability
5	5.74183	8.382775	25.14832	LESS THAN 0.001

As the probability associated with this value is <0.05, results should
be used with caution.

Slope = 1.006258
95 Percent Confidence Limits =-1.404949 and 3.417465

LC50 = 153.8657
95 Percent Confidence Limits = 17.39524 and +INFINITY

---------RESULTS CALCULATED USING THE TRIMMED SPEARMAN-KARBER METHOD-------

Conc.	Dose =Ln (Conc)	Percent Dead	Monotonic Rel. Freq.	Trimmed Rel. Freq.
50	3.912023	52.5	.525	.53125
25	3.218876	6	7.499998E-02	-3.125003E-02 *
12.5	2.525729	6	7.499998E-02	-3.125003E-02 *
6.25	1.832581	6	7.499998E-02	-3.125003E-02 *
3.1	1.131402	12	7.499998E-02	-3.125003E-02 *

Alpha = 10 %
Groups trimmed and therefore not used in estimating LC50

re marked with an asterisk above.

LC50 = 6.7152

Estimated 95 Percent Confidence Limits

Lower: 4.820528 Upper: 9.354557

Variance estimate = 2.747144E-02

Variance may be underestimated because all data were outside trimmed range.

****

STUDY NO.: 13114 ASSAY START: 03/15/05

SPECIES: A.bahia EXPOSURE: 96 hours

SAMPLE: American Samoa

****

SUMMARY TABLE

04-28-2005 13:05:42

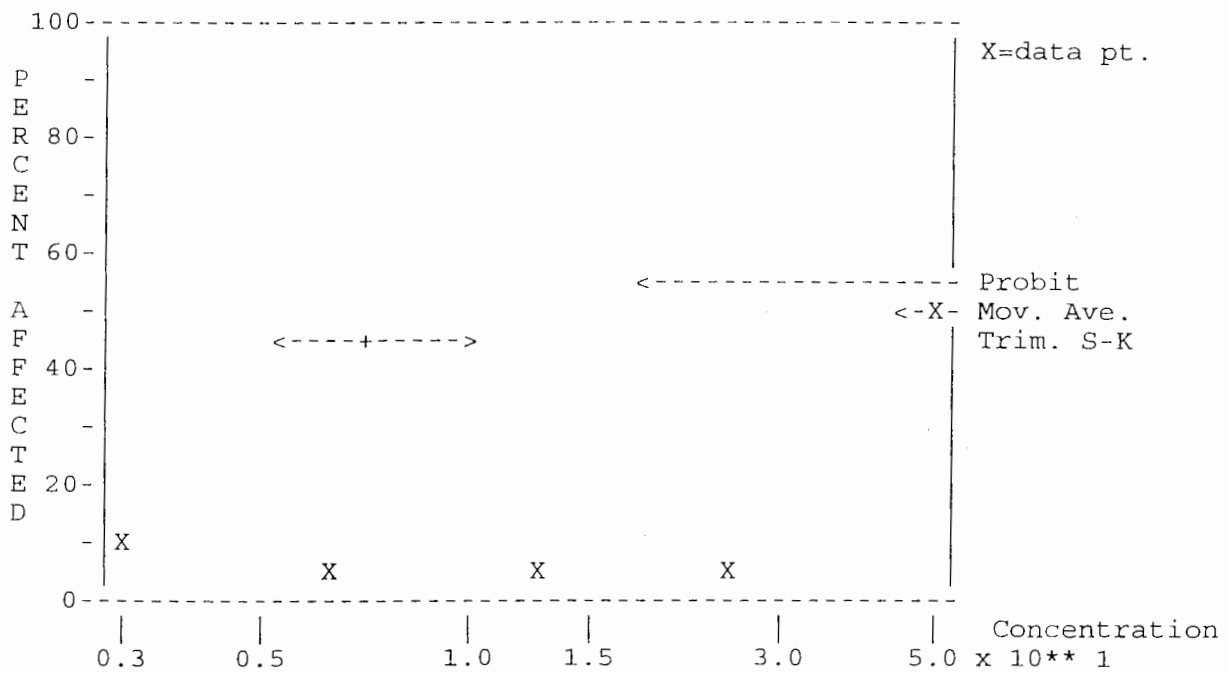
Data:	Conc.	Exposed	Dead	Percent
	50	40	21	52.5
	25	50	3	6
	12.5	50	3	6
	6.25	50	3	6
	3.1	50	6	12

	LC50	Lower 95% Limit	Upper 95% Limit	
Probit Analysis	153.8657	17.39524	0	
Moving Average	48.47283	41.66249	63.50122	Span= 1
Spearman-Karber	6.7152	4.820528	9.354557	Alpha= 10 %

Binomial 48.47288

Compare results with original data to see if they are reasonable.

****



Title: American Samoa 13114 A. bahia 96 hr survival
File: 1311496 Transform: ARC SINE(SQUARE ROOT(Y))

Shapiro - Wilk's Test for Normality

D = 0.6127
W = 0.9500

Critical W = 0.8980 (alpha = 0.01 , N = 29)
W = 0.9260 (alpha = 0.05 , N = 29)

Data PASS normality test (alpha = 0.01). Continue analysis.

Title: American Samoa 13114 A. bahia 96 hr survival
File: 1311496 Transform: ARC SINE(SQUARE ROOT(Y))

Bartlett's Test for Homogeneity of Variance

Calculated B1 statistic = 9.2048 (p-value = 0.1012)

Data PASS B1 homogeneity test at 0.01 level. Continue analysis.

Critical B = 15.0863 (alpha = 0.01, df = 5)
= 11.0705 (alpha = 0.05, df = 5)

Using Average Degrees of Freedom
(Based on average replicate size of 4.83)

Calculated B2 statistic = 7.3692 (p-value = 0.1946)

Data PASS B2 homogeneity test at 0.01 level. Continue analysis.

Title: American Samoa 13114 A. bahia 96 hr survival
File: 1311496 Transform: ARC SINE(SQUARE ROOT(Y))

Summary Statistics on Transformed Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Lab	5	1.2490	1.4120	1.3468
2	3.1	5	0.8861	1.4120	1.2416
3	6.25	5	1.2490	1.4120	1.3142
4	12.5	5	1.1071	1.4120	1.3185
5	25	5	1.2490	1.4120	1.3142
6	50	4	0.4636	1.1071	0.7591

1311496B

GROUP	IDENTIFICATION	NUM OF REPS	MIN SIG DIFF (IN ORIG. UNITS)	% OF CONTROL	DIFFERENCE FROM CONTROL
1	Lab	5			
2	3.1	5	0.1656	17.4	0.0800
3	6.25	5	0.1656	17.4	0.0200
4	12.5	5	0.1656	17.4	0.0200
5	25	5	0.1656	17.4	0.0200
6	50	4	0.1786	18.8	0.4850

EnviroSystems, Incorporated
Organism Culture Record

Client and ESI Study Number: American Samoa #13114
Assay:

I. Organism History

Species: Americamysis bahia

Source: Lab Reared ✓ Hatchery Reared ____ Field Collected ____

Hatch Date: 3/13-15/05 Receipt Date: ____ Age: 1-5 days

Lot Number: 031505AB Strain: ____

Brood Origin: Aquatic Research Organisms

II. Culture Conditions

System: Aquatic Systems

Diet: Flake Food ____ Phytoplankton ____ Trout Chow ____

Brine Shrimp ✓ Rotifers ____ Other ____

Prophylactic Treatments: ____

Comments: ____

III. Water Quality

Temperature 22.6 °C Salinity 29.0 ppt DO_2 7.7 mg/L

pH 7.73 SU Hardness ____ mg/L Alkalinity ____ mg/L

Other: ____

IV. Comments

Biologist: [signature] Date: 4/26/05

EFFLUENT & DILUENT CHEMISTRY and WATER QUALITY DATA

PARAMETER	100% Effluent	50% Effluent	Diluent - Lab Salt
TRC	0.0 Hr.PS A-1638B		<0.05
As Received - pH (SU) @ 20°C	6.46		7.81
As Received - Salinity (ppt)	9.7		24
As Received - Dissolved Oxygen (mg/L)‡	0.7		7.5
As Received - Ammonia (pull)	63 ~~-001~~ -002		13053-020
Salinity Adjusted - pH (SU) @ 20°C	6.69	7.60	
Salinity Adjusted - Salinity (ppt)	25	25	
After Aeration - Dissolved Oxygen (mg/L)	63 ~~-003~~ 7.2	5.3	
Salinity Adjusted - Ammonia (pull)		-003	
48 hour Ammonia (pull)	-004	-005	13053-023
48 hour pH (SU) @ 20°C	6.67	7.19	7.77

‡ - Aerate prior to mixing concentrations.

PREPARATION OF DILUTIONS

STUDY: 13114

SPECIES: *A. bahia*

CLIENT: CH2M HILL - American Samoa

Diluent: Lab Salt	Day: 0 Sample:		Day: 2 Sample:	
Concentration	Vol. Eff.	Final Vol	Vol. Eff.	Final Vol
LAB	0	1000	0	750
3.1%	31	↓	23.4	↓
6.25%	62.5	↓	46.9	↓
12.5%	125	↓	93.75	↓
25%	250	↓	187.5	↓
50%	500	↓	63 ~~750~~ 375	↓

HRS	Date	Time	Initials
0	3/15	1430	m
48	3/17/05	1700	PS

Comments:

RECORD OF METERS USED FOR WATER QUALITY MEASUREMENTS

STUDY: 13114	CLIENT: CH2M HILL - American Samoa

WATER QUALITIES - A. bahia

HOURS:	0	24	48 - old	48 - new	72	96
Water Quality Station #	2	2	1	2	2	1
Initials	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
Date	3/15/05	3/16/05	3/17/05	3/17/05	3/18/05	3/19/05

Water Quality Station #1		Water Quality Station #2		COMMENTS
DO meter #	18	DO meter #	19	
DO probe #	10	DO probe #	11	
pH meter #	1097	pH meter #	1138	
pH probe #	40	pH probe #	39	
S/C meter #	YSI 30B	S/C meter #	YSI 30B	
S/C probe #	1	S/C probe #	↓	
Salinity meter #	YSI 30B	Salinity meter #	↓	

STUDY: 13114
CLIENT: CH2MHill - American Samoa
PROJECT: Wastewater Treatment Plant
TASK: Unionized Ammonia Calculations

Day / Date	Treatment	Temperature Deg C	Sample pH SU	NH_3 mg/L	Unionized NH_3 mg/L
Day 0	Lab	20	7.81	< 0.1	0.002
03/15/05	As Received 100% Effluent	20	6.46	60.0	0.068
	50% Salinity Adjusted Effluent	20	7.00	29.0	0.114
					0.000
Day 2	Lab	20	7.77	< 0.1	0.002
03/17/05	50% Salinity Adjusted Effluent	20	7.19	29.0	0.177
	100% Salinity Adjusted Effluent	20	6.67	63.0	0.116

ESI

EnviroSystems, Inc.
One Lafayette Road
P.O. Box 778
Hampton, NH 03843-0778
Telephone: 603-926-3345

SAMPLE RECEIPT RECORD

ESI STUDY NUMBER: 13114 CLIENT: American Samoa

SAMPLE RECEIPT:
DATE: 3/15 TIME: 1330 BY: m

DELIVERED VIA: ☐ FEDEX ☐ CLIENT ☐ ESI ☐ UPS ☒ OTHER

LOGGED INTO LAB:
DATE: 3/15 TIME: 1330 BY: m

SAMPLE CONDITION:

CHAIN OF CUSTODY:	☒ YES	☐ NO
CHAIN OF CUSTODY SIGNED:	☒ YES	☐ NO
CHAIN OF CUSTODY COMPLETE:	☐ YES	☒ NO
SAMPLE DATE:	☒ YES	☐ NO
SAMPLE TIME RECORDED:	☐ YES	☒ NO
SAMPLE TYPE IDENTIFIED:	☒ YES	☐ NO
CUSTODY SEAL IN PLACE:	☒ YES	☐ NO
SHIPPING CONTAINER INTACT:	☒ YES	☐ NO
SAMPLE TEMPERATURE (AT ARRIVAL): 18 °C		
DOES CLIENT NEED NOTIFICATION OF TEMPERATURE?	☐ YES	☒ NO
SAMPLE ARRIVED ON ICE:	☒ YES	☐ NO

COMMENTS: 1x5 gal Eff

SAMOA JOINT CANNERY OUTFALL

2005 Non-tradewind Season

EFFLUENT BIOASSAY TEST RESULTS

March 2005 Sampling

16 May 2005

CH2M HILL

CH2MHILL

TECHNICAL MEMORANDUM

BIOASSAY TESTING – JOINT CANNERY OUTFALL EFFLUENT MARCH 2005 SAMPLING

Prepared For: StarKist Samoa (NPDES Permit AS0000019)
COS Samoa Packing (NPDES Permit AS0000027)

Prepared By: Steve Costa
Karen Glatzel

Date: 16 May 2005

Distribution: Carl Goldstein
United States Environmental Protection Agency, Region 9
Peter Peshut
American Samoa Environmental Protection Agency

Purpose

This memorandum presents the results of the bioassay testing of the Joint Cannery Outfall effluent sample that was collected in March 2005. The testing is required by the NPDES Permits that became effective in January 2001. This is the ninth required semi-annual test required by the current permits and the twenty-fifth test, over twenty-three semi-annual periods, conducted since testing of the Joint Cannery Outfall effluent began in 1993[1].

Study Objectives

Section D.1 of the StarKist Samoa and COS Samoa Packing NPDES Permits requires that semiannual definitive acute bioassays (96-hour static bioassays) be conducted on the cannery effluent. The purpose of these tests is to determine whether, and at what effluent concentration, acute toxicity may be detected for the combined joint cannery effluent discharge into Pago Pago Harbor.

---

[1] Testing was not conducted during 1999. Extra tests using two organisms were conducted in March 1995 and February 1996.

Study Approach

U.S. EPA has conducted a number of reviews of the effluent sampling, analysis, and bioassay tests conducted in the past. All comments from U.S. EPA have been incorporated into the sampling and sample handling standard operating procedures (SOP) or have been incorporated into the procedures used by the laboratory doing the test. The comments, responses, and SOP have been documented in previous reports.

The permit conditions require that the bioassay tests be conducted with the white shrimp, *Penaeus vannami* (postlarvae). In the event *Penaeus vannami* is not available at the time of the tests, the permit specifies the substitute species, *Mysidopsis bahia*, which now has been renamed *Americamysis bahia*. For the March 2005 sampling, *Penaeus vannami* was not available and *Americamysis bahia* was used.

Effluent samples were collected from the StarKist Samoa and COS Samoa Packing facilities as 24-hour composite samples. The acute effluent bioassay test was conducted using a combined, flow-weighted, composite effluent sample made up from the effluent samples from both canneries, as allowed by the permit condition. This combined effluent bioassay is representative of the wastewater discharged from the joint cannery outfall to Pago Pago Harbor.

Effluent Sampling Methods

Between 0900 on 3 March 2005 and 0600 on 4 March 2005, a 24-hour flow-weighted composite sample of final effluent was collected from both the StarKist Samoa and COS Samoa Packing effluent discharges. Samples were collected from the established effluent sampling sites. Detailed sampling procedures are described in the established SOP for cannery effluent sampling.

A total of eight grab samples were collected into 1-gallon plastic cubitainers at each plant. Samples were collected at approximately three-hour intervals over the 24-hour period. The samples were stored on ice or in a refrigerator until the completion of the 24-hour sampling period. After all samples were collected a flow-proportioned composite sample was prepared. The grab sample collection times, effluent flow rates, and the relative effluent flow volumes calculated from plant flow records are summarized in Table 1. The relative effluent flow volumes were used to prepare the final composite sample, which was used to fill the sample container shipped to the laboratory for testing.

A 5-gallon cubitainer containing the composite sample was packed on ice in an ice chest for shipment to the laboratory. A chain-of-custody form for the sample was completed and sealed into a zip-lock bag and taped inside the lid of the ice chest. The sample was shipped via DHL to the testing laboratory. The chain-of-custody form and the DHL waybill are provided in Attachment I.

Table 1
StarKist Samoa and COS Samoa Packing
24-hour Composite Effluent Sample for Bioassay Testing
March 2005

Grab Sample Number	COS Samoa Packing		StarKist Samoa		COS Samoa Packing Percent of Total Flow	StarKist Samoa Percent Of Total Flow
	Sampling Date and Time	Effluent Flow Rate (mgd)	Sampling Date and Time	Effluent Flow Rate (mgd)		
1	3 March 2005 09:00	0.72	3 March 2005 09:00	1.86	3.2%	8.3%
2	12:00	0.76	12:00	1.78	3.4%	8.0%
3	15:00	0.72	15:00	2.02	3.2%	9.0%
4	18:00	0.72	18:00	2.23	3.2%	9.9%
5	21:00	0.68	21:00	1.83	3.0%	8.2%
6	4 March 2005 00:00	0.68	4 March 2005 00:00	1.97	3.0%	8.8%
7	03:00	0.68	03:00	2.66	3.0%	11.9%
8	06:00	0.80	06:00	2.30	3.6%	10.3%
Total		5.76 [A]		16.65 [A]	25.7%	74.3%
Mean		0.72		2.08	Total = %100	

[A] Numerical total of column for calculation purposes. Total flow over period will be approximately the calculated mean.

Bioassay Testing Procedures

EnviroSystems, Inc. located in Hampton, New Hampshire conducted the bioassay tests. The testing procedures and results of the bioassay tests are provided in the Laboratory report included as Attachment II. This report summarizes the 96-hour acute bioassay test conducted with reference to the U.S. EPA document Methods for Measuring the Acute Toxicity of Effluents to Freshwater and Marine Organisms (EPA-821-R-02-012), 2002 as the sources of methods for conducting the test. The bioassay test was conducted considering and including U.S. EPA's comments on previous bioassay tests, as documented in previous reports.

The test organisms were ≤ 5 days old and the test temperature was to be held at a nominal 20 °C, with actual temperatures ranging between 18°C and 22°C. Salinity was adjusted to 25 ppt at the start of the test and ranged during the test between 24 and 29 ppt. Demonstrated potential for a lethal immediate dissolved oxygen demand (IDOD) had been discussed and documented in previous bioassay technical memoranda, which describe the first two tests conducted in 1993. Therefore, all of the bioassay test chambers were continuously aerated during the bioassay tests to maintain adequate levels of dissolved oxygen (DO)[2]. The test was renewed with oxygenated sample at 48 hours.

Bioassay tests were carried out for effluent concentrations of 50, 25, 12.5, 6.25, and 3.1 percent as vol:vol dilutions in seawater. Water quality was monitored daily and parameters measured included DO, pH, salinity, and temperature. Total residual chlorine and ammonia were measured. Water quality data are provided in the Laboratory Report (Attachment II). Reference toxicant tests using sodium dodecyl sulfonate (SDS) are conducted regularly by ESI with the last one completed on 23 March 2004 and results were within one standard deviation of the historic laboratory mean.

Summary Results: Americamysis bahia Effluent Bioassay

All results from the bioassay tests are included in Attachment II. The results of the mysid bioassay tests indicate the 96-hour LC_{50} for the effluent tested was >50 percent. The no observable effects concentration (NOEC) for the 96-hour bioassay was 50 percent and the least observable effects concentration (LOEC) was >50 percent. Results on a daily basis are summarized in Table 2.

Table 2
StarKist Samoa and COS Samoa Packing
Combined Effluent Bioassay Results
March 2005 Sampling

Exposure Time	Parameter		
	LC_{50}	NOEC[1]	LOEC
24 hours	>50%	50%	>50%
48 hours	>50%	50%	>50%
72 hours	50%	25%	50%
96 hours	48.5%	25%	50%

[1] Highest concentration tested was 50% so NOEC at 50% can be considered ≥50%

[2] The high initial dilution of the actual effluent discharge (>100:1) into the Harbor, in a very short time, removes any concern about IDOD effects in the receiving water.

Discussion

Table 3 summarizes the results of the effluent bioassay tests for the samples collected in the March 2005 sampling compared to the previous bioassay tests. The LC_{50}, NOEC, and LOEC are within the range obtained from previous tests where *Americamysis bahia* (*Mysidopsis bahia*) was used in place of *Penaeus vannami*. Figure 1 summarizes the LC_{50} for the mysid and penaeid tests done since February 1993. Figure 2 presents the range of LC_{50} results for mysids tests conducted since 1994. There is some variability observed in test results. The March 2005 test results are among the highest LC_{50} values recorded for this organism. Higher LC_{50} values indicate lower whole effluent toxicity. There is a possible trend toward lower toxicity (higher LC_{50}) with time (see Figure 2). The trend is statistically significant at the <1% level. However, the actual significance and reason for the trend is unknown.

Conclusions

The bioassay tests for the Joint Cannery Outfall effluent for March 2005 do not indicate effluent toxicity levels to be of concern. As discussed in the previous bioassay test reports on the effluent, the time scale of the mixing of the effluent with the receiving water is on the order of seconds to achieve dilutions that will eliminate possible toxic effects as reflected by the bioassay results. For example, an LC_{50} of 48.5% after 96 hours of exposure, which was observed in March 2005, corresponds to a dilution of 2:1, which is achieved within one second and within one meter of the discharge point. The discharge is located in about 180 feet of water and the effluent toxicity tests indicate that the discharge is diluted to non-toxic levels immediately after discharge and well within the initial dilution plume.

Table 3
StarKist Samoa and COS Samoa Packing
Combined Effluent Bioassay Results

Date	*Species*	Parameters		
		LC_{50}	NOEC	LOEC
2/93	*Penaeus vannami*	4.8%[1]	3.1%	6.25%
10/93	*Penaeus vannami*	15.67%	3.1%	6.25%
2/94	*Penaeus vannami*	15.76%	<1.6%	1.6%
10/94	*Mysidopsis bahia*[2]	31.2%	25%	50%
3/95	*Penaeus vannami*	14.8%	6.25%	12.5%
3/95	*Mysidopsis bahia*[3]	10.8%	6.25%	12.5%
2/96	*Penaeus vannami*	>50%	>50%	>50%
2/96	*Mysidopsis bahia*[3]	28.36%	12.5%	25%
3/96	*Penaeus vannami*	44.4%	25%	50%
11/96	*Penaeus vannami*	7.11%	3.1%	6.25%
03/97	*Penaeus vannami*	39.36%	12.5%	25%
09/97	*Penaeus vannami*[4]	12.3%	6.25%	12.5%
06/98	*Mysidopsis bahia*[2]	17.2%	6.25%	12.5%
11/98	*Mysidopsis bahia*[2]	15%	6.25%	12.5%
02/00	*Mysidopsis bahia*[2]	20%	6.25%	12.5%
08/00	*Mysidopsis bahia*[2]	17.1%	3.1%	6.25%
03/01	*Americamysis bahia*[2,5]	13.8%	12.5%	25%
10/01	*Americamysis bahia*[2,6]	37.5%	25%	50%
3/02	*Americamysis bahia*[2,6]	16.1%	12.5%	25%
8/02	*Americamysis bahia*[2,6]	10.23%	6.25%	12.5%
03/03	*Americamysis bahia*[2,6]	28.4%	25%	50%
08/03	*Americamysis bahia*[2,6]	43.2%	25%	50%
02/04	*Americamysis bahia*[2,6]	>50%	50%	>50%
09/04	*Americamysis bahia*[2,6]	>50%	50%	>50%
03/05	*Americamysis bahia*[2,6]	**48.5%**	**25%**	**50%**

[1]The February 1993 samples were not aerated until after the first day of the test. For subsequent tests the samples were aerated for the entire duration of the tests.
[2]*Mysidopsis bahia* used as substitutes because *Penaeus vannami* not available: as directed and approved by U. S. EPA.
[3]*Mysidopsis bahia* used in addition to *Penaeus vannami* as described in text of technical memorandums reporting test results. Only one species is required by the permit conditions.
[4]Stage 1 (3 mm) *Penaeus vannami* were used for testing because older Stage 7 and 8 (8-10 mm) *Penaeus vannami* were not available.
[5]*Mysidopsis bahia* renamed *Americamysis bahia.* Results indicate increased toxicity because of low DO in renewal concentrations as renewal water was not aerated prior to use
[6] *Mysidopsis bahia* renamed *Americamysis bahia*

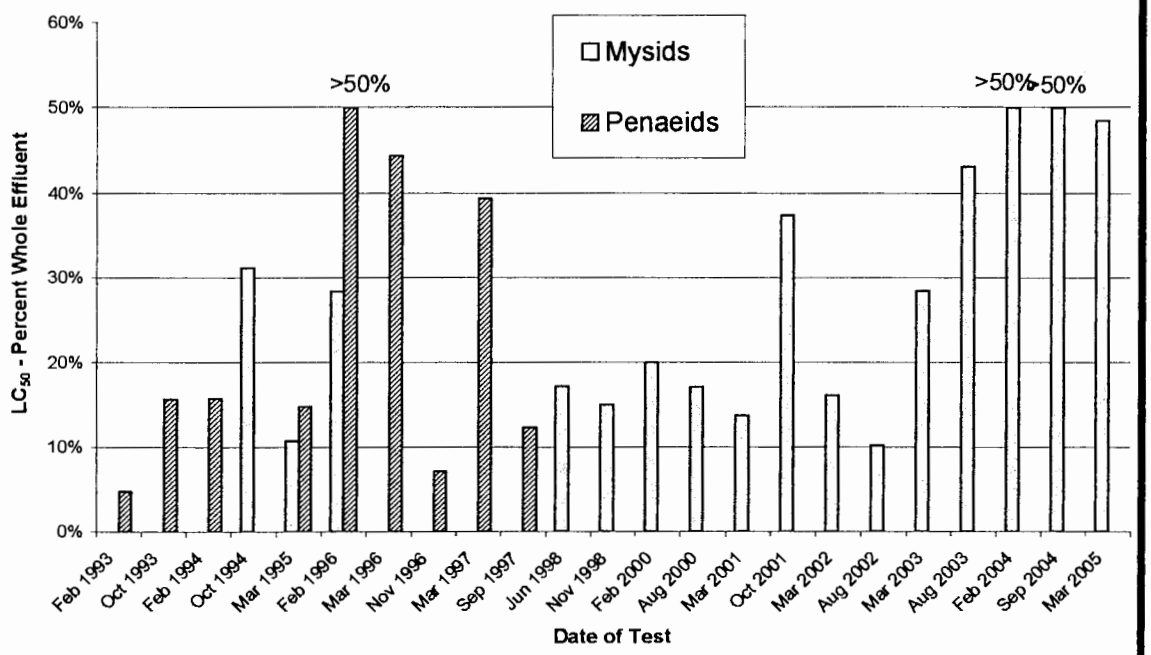


Figure 1. LC_{50} for Mysid and Penaeid Tests

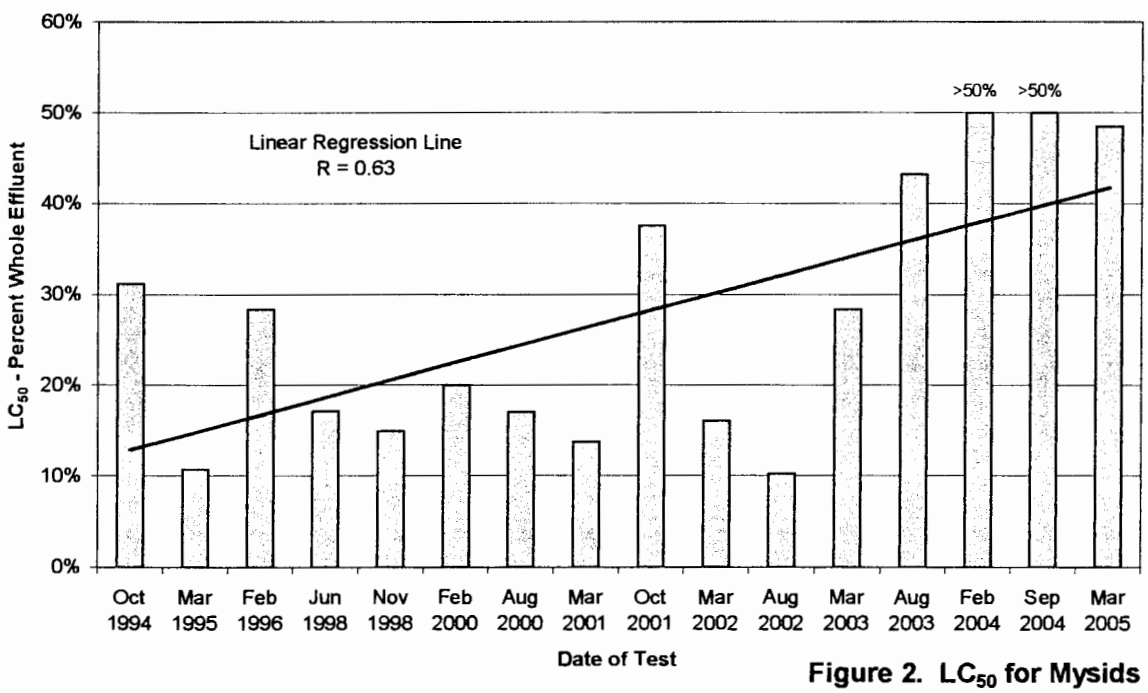


Figure 2. LC_{50} for Mysids

ATTACHMENT I

Chain-of-Custody

13114

CH2M HILL
APPLIED SCIENCES LABORATORY

CHAIN OF CUSTODY RECORD AND AGREEMENT TO PERFORM SERVICES

CH2M Hill Project #: 147323.JC.05.NT
Purchase Order #:
Project Name: JOINT CANNERY OUTFALL
Company Name/CH2M HILL Office: CH2M HILL
Project Manager & Phone #: Mr. [ ] Ms. [ ] Dr. [ ] STEVE COSTA 707-677-0123
Report Copy to: SAME
Requested Completion Date:
Sampling Requirements: SDWA [ ] NPDES [X] RCRA [ ] OTHER ____
Sample Disposal: Dispose [X] Return [ ]

SHADED AREA - FOR LAB USE ONLY: Lab 1 #, Lab 2 #, Quote #, Kit Request #, Project #, No. of Samples, Page ___ of ___, Login, LIMS Ver #, REMARKS, LAB 1 ID, LAB 2 ID

ANALYSES REQUESTED: ACUTE BIOASSAY W/ MYSIDOPSIS

Sampling Date	Sampling Time	Type COMP	Type GRAB	Matrix WATER	Matrix SOIL	Matrix AIR	CLIENT SAMPLE ID (9 CHARACTERS)	# OF CONTAINERS	ACUTE BIOASSAY W/ MYSIDOPSIS	REMARKS
3-4 MAR 2005		X		X			05NT	1	X	CONTINUOUS AERATION - INCLUDING RENEWAL DILUTIONS at 50/25/12½/6¼/3

Sampled By & Title (Please sign and print name)	Date/Time 4MAR05	Relinquished By (Please sign and print name)	Date/Time 4MAR05	QC Level: 1 2 3 Other	
Received By (Please sign and print name)	Date/Time 3/15/05 1300	Relinquished By (Please sign and print name)	Date/Time	COC Rec	ICE
Received By (Please sign and print name)	Date/Time	Relinquished By (Please sign and print name)	Date/Time	Ana Req	TEMP
Received By (Please sign and print name)	Date/Time	Shipped Via: UPS BUS Fed-Ex Hand Other DHL	Shipping # 844 6187 665	Cust Seal	Ph
Work Authorized By (Please sign and print name)	Remarks				

Instructions and Agreement Provisions on Reverse Side

DISTRIBUTION: Original - LAB, Yellow - LAB, Pink - Client
REV 3/94 FORM 340

RESIDER 920701629-1 QTY 25

4/05/01

Shipment Airwaybill

DHL WORLDWIDE EXPRESS

1-800-CALL-DHL (Non negotiable) in USA only
WEB ADDRESS: http://www.dhl.com

PPF
PPF

8446187665

Quote this shipment number in an inquiry

8446187665

ORIGIN	DESTINATION
PPF	PRT

1 From (Shipper)

Account no.: 920701629

Shipper's reference: 147323.JC.05.NT

Company name: CHEM HILL

Shipper's name: STEVE COSTA 684-633-5264 707-677-0123

Address: 777 106TH AVE NE BELLEVUE WA 98004

LEFALE PULE FAGA'ALU PAGO PAGO, AMERICAN SAMOA 96799

Zip code (required): 96799

Phone/Fax/E-mail circle one (required): (425) 453-5000

2 To (Recipient)

Company name: ENVIROSYSTEMS INC

Attention: PETRA KARBE

Delivery address: ONE LAFAYETTE ROAD HAMPTON, NEW HAMPSHIRE USA

Zip/Postcode (required): 03842

Phone/Fax/E-mail circle one (required): 603-926-3345

3 Shipment details

Domestic Services
- [ ] USA OVERNIGHT

International Services
- [ ] INT'L DOCUMENT EXPRESS
- [x] WORLDWIDE PRIORITY EXPRESS — Non document shipments / unlimited weight
- [ ] WORLDFREIGHT — Prior arrangements required / 220 lbs. Minimum

WorldMail Services [ ] 1st
- [ ] APM [ ] 2nd [ ] IPA [ ] ISAL

Special Services extra charges may apply
- [ ] SATURDAY DELIVERY (not available to all locations)
- [ ] POD ..... Shipper's fax/e-mail for POD (optional)
- [ ] OTHER ..... specify / .....

Payment Options not all options available to all countries
- [x] Shipper's account
- [ ] Recipient [ ] Third party

Acct. No. .....
- [ ] Cash / Check / Credit Card circle one

No. .....
Expires. ..... Type .....

Shipment insurance if desired, enter amount below
US $ 50 — Insured value

Full description of contents
WATER QUALITY SAMPLES FOR LABORATORY ANALYSIS NO COMMERCIAL VALUE

International non document shipments only
Attach original and four copies of a Commercial Invoice

Declared value for customs (In US $): 50

Export License No./Symbol (if applicable)

Harmonized Sched. B No. (if applicable)

Type of export — If left blank, Permanent is assumed
- [ ] Permanent
- [ ] Temporary [ ] Repair/Return

Shipper's EIN/SSN

These commodities, technology or software were exported from the United States in accordance with the export administration regulations. Diversion contrary to U.S. law prohibited.

Destination duties/taxes If left blank recipient pays duties/taxes
- [ ] Recipient [x] Shipper [ ] Other ..... Specify destination approved account number

4 Pcs/Weight/Size

No. of pieces: 1

Weight if DHL Express Document packaging is used, enter XD: 61 lb

Dimensions in inches: 21 x 14 x 16 — Pieces length width height

DIMENSIONAL/CHARGED WEIGHT lb

CODES	CHARGES Services
	Special services
	Insurance
Drop Box/ Exp. Center #	
TOTAL	

TRANSPORT COLLECT STICKER No.

PICKED UP BY

Time 1466 123

Date

5 Shipper's authorization and signature

I/we agree that DHL's standard terms apply to this shipment and limit DHL's liability for loss or damage to U.S. $ 100. The Warsaw Convention may also apply (see reverse). I/we authorize DHL to complete other documents necessary to export this shipment. I/we understand that insurance is available on request, for an extra charge. I/we agree to pay all charges if the recipient or third party does not pay. I/we understand that DHL DOES NOT TRANSPORT CASH.

Signature (required): [signature]

Date: 4MAR05

557209 7/00

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ATTACHMENT II

EnviroSystems, Inc. Laboratory Report

TOXICOLOGICAL EVALUATION OF A TREATED EFFLUENT: BIOMONITORING SUPPORT FOR A NPDES PERMIT MARCH 2005

American Samoa Joint Cannery Outfall

Prepared For

CH2M Hill, Incorporated
P.O. Box 1238
Trinidad, California 95570-1238

By

EnviroSystems, Incorporated
One Lafayette Road
Hampton, New Hampshire 03842

March 2005
Reference Number CH2M-Samoa13114-05-03

STUDY NUMBER 13114

EXECUTIVE SUMMARY

The following summarizes the results of acute exposure bioassays performed from March 15-19, 2005 in support of the NPDES biomonitoring requirements of the American Samoa Joint Cannery Outfall. The 96 hour acute definitive assay was conducted using the marine species, *Americamysis bahia.*

Acute Toxicity Evaluation

Species	Exposure	LC-50	NOEC	LOEC
Americamysis bahia	24-Hours	>50%	50%	>50%
	48-Hours	>50%	50%	>50%
	72-Hours	50%	25%	50%
	96-Hours	48.5%	25%	50%

TOXICOLOGICAL EVALUATION OF A TREATED EFFLUENT: BIOMONITORING SUPPORT FOR A NPDES PERMIT MARCH 2005

American Samoa Joint Cannery Outfall

1.0 INTRODUCTION

Acute toxicity tests involve preparing a series of concentrations by diluting effluent with control water. Groups of test organisms are exposed to each effluent concentration and a control for a specified period. In acute tests, mortality data for each concentration are used to calculate (by regression) the median lethal concentration, or LC-50, defined as the effluent concentration which kills half of the test organisms. Samples with high LC-50 values are less likely to cause significant environmental impact. The acute no observed effect concentration (NOEC) and lowest observed effect concentration (LOEC) document the highest and lowest effluent concentrations that have no impact and a significant impact on the test species, respectively.

This report presents the results of an acute toxicity test conducted on an effluent sample collected from the American Samoa Joint Cannery Outfall. Testing was based on programs and protocols developed by the US EPA (2002) and involved conducting 96 hour acute static renewal toxicity tests with the marine species, *Americamysis bahia*. Testing was performed at EnviroSystems, Incorporated (ESI), Hampton, New Hampshire in accordance with the provisions of the NELAC Standards (2000).

2.0 MATERIALS AND METHODS

2.1 General Methods

Toxicological and analytical protocols used in this program follow procedures primarily designed by the EPA to provide standard approaches for the evaluation of toxicological effects of discharges on aquatic organisms, and for the analysis of water samples. See Section 4.0 for a list of references.

2.2 Test Species

Every attempt was made to acquire the species, *Penaeus vannami,* as this is the preferred organism under the Cannery's permit. ESI was unable to obtain reasonably priced *P. vannami*. Due to the exorbitant expense, the decision was made to use an alternate species, *Americamysis bahia*.

A. bahia, ≤5 days old, were from maintained at ESI. Test organisms were transferred to test chambers by large bore pipet, minimizing the amount of water added to test solutions.

2.3 Effluent and Dilution Water

The effluent sample used in the assay was identified as "05NT" Sample collection information is provided in Table 4. Upon receipt, the sample was stored at 4°C. All sample material used in the assay was warmed to 20±1°C prior to preparing test solutions. Total residual chlorine (TRC) was measured using amperometric titration (MDL 0.05 mg/L). When the sample matrix is too turbid amperometric titration is not possible. In these cases an indicator strip is used to access chlorine level. As the effluent sample contained <0.05 mg/L, TRC dechlorination with sodium thiosulfate was not required (EPA 2002). Aliquots of the undiluted effluent sample were collected for ammonia analysis when the sample arrived and again prior to renewal. Upon arrival, the effluent sample had a salinity of 10‰. Salinity of the effluent was increased to 25‰ by the addition of artificial sea salts. Test concentrations for the assays were 50%, 25%, 12.5%, 6.25% and 3.1% effluent with a laboratory water diluent control.

The dilution water used in this assay was collected from the sea water system at ESI. The water is pumped in daily from the Hampton Estuary on the flood tide, filtered through a high volume sand filter, and stored in 3000 gallon polyethylene tanks. The water is classified as Class SA-1 by the State of New Hampshire, and has been used to culture test organisms for over 20 years. Sea water used in the assay had a salinity of 25±2‰ and a TRC of <0.05 mg/L.

2.4 Acute Toxicity Tests

The 96 hour acute static renewal toxicity test was conducted at 20±2°C with a photoperiod of 16:8 hours light:dark. Test chambers for the acute assays were 250 mL glass beakers containing 200 mL test solution in each of 5 replicates, with 10 organisms/replicate. Survival, dissolved oxygen, pH, salinity and temperature were measured daily in all replicates. Test solutions were renewed after 48 hours using effluent from the start sample. Mysid shrimp were fed daily with <24 hour old brine shrimp.

2.5 Data Analysis

At 24 hour intervals, survival data was analyzed to assess toxicity using a program developed by Stephan (1982). LC-50 values were computed using the Spearman-Karber, Binomial, and Probit methods. If survival in the highest test concentration was >50%, LC-50 values were obtained by direct observation of the raw data. The NOEC was determined as the highest test concentration which caused no significant mortality while the LOEC was determined as the lowest concentration that did cause significant mortality.

2.6 Quality Control

As part of the laboratory quality control program, standard reference toxicant assays are conducted on a regular basis for each test species. These results provide relative health and response data while allowing for comparison with historic data sets. See Table 2 for details.

3.0 RESULTS

Results of the acute exposure bioassay conducted using the mysid shrimp, *A. bahia*, are summarized in Table 1. A summary of reference toxicant data for the test species is presented in Table 2. Effluent and dilution water characteristics are presented in Table 3. Sample collection information is provided in Table 4. Table 5 provides a summary of historic data associated with the discharge. Support data are included in Appendix A.

3.1 Acute Toxicity Test - *Americamysis bahia*

Control survival after 24, 48 and72 hours exposure was 98%. Control survival after 96 hours exposure was 96%. These results are an indication of healthy test organisms and that the dilution water had no adverse impact on the outcome of the assay.

Table 1 provides a summary of the acute exposure data and results.

3.2 Summary

The salinity adjusted effluent sample collected from the American Samoa Joint Cannery Outfall did exhibit signs of acute toxicity, at a dilution of 50% effluent, to the mysid shrimp, *Americamysis bahia,* during the 96 hour exposure period,.

4.0 LITERATURE CITED

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Stephan, C. 1982. Documentation for Computing LC-50 Values with a Mini Computer. Unpublished.

US EPA. 2002. *Attachment G: NPDES Whole Effluent Toxicity Testing, Monitoring and Reporting Tips and Common Pitfalls.* Dated December 2002. US EPA Region I Offices, Boston, Massachusetts.

U.S. EPA. 2002. *Methods for Measuring the Acute Toxicity of Effluents to Freshwater and Marine Organisms.* Fifth Edition. EPA-821-R-02-012.

TABLE 1. Summary of Acute Evaluation Results. American Samoa Joint Cannery Outfall Effluent Evaluation. March 2005.

Concentration % Effluent	Exposure	Replicates A	B	C	D	E	Mean	Standard Deviation	Coefficient of Variation
Lab Control	Start	10	10	10	10	10	100.0%	0.000	0.00%
	24-Hours	10	10	10	9	10	98.0%	0.400	4.08%
	48-Hours	10	10	10	9	10	98.0%	0.400	4.08%
	72-Hours	10	10	10	9	10	98.0%	0.400	4.08%
	96-Hours	10	9	10	9	10	96.0%	0.490	5.10%
3.1%	24-Hours	10	10	10	10	10	100.0%	0.000	0.00%
	48-Hours	9	10	10	10	9	96.0%	0.490	5.10%
	72-Hours	6	10	10	10	9	90.0%	1.549	17.21%
	96-Hours	6	10	10	9	9	88.0%	1.470	16.70%
6.25%	24-Hours	10	10	10	10	10	100.0%	0.000	0.00%
	48-Hours	10	10	10	10	10	100.0%	0.000	0.00%
	72-Hours	10	10	10	10	10	100.0%	0.000	0.00%
	96-Hours	9	10	9	10	9	94.0%	0.490	5.21%
12.5%	24-Hours	9	10	10	10	10	98.0%	0.400	4.08%
	48-Hours	9	10	10	10	10	98.0%	0.400	4.08%
	72-Hours	9	10	10	10	10	98.0%	0.400	4.08%
	96-Hours	9	10	10	8	10	94.0%	0.800	8.51%
25%	24-Hours	10	10	9	10	10	98.0%	0.400	4.08%
	48-Hours	10	9	9	10	10	96.0%	0.490	5.10%
	72-Hours	10	9	9	10	9	94.0%	0.490	5.21%
	96-Hours	10	9	9	10	9	94.0%	0.490	5.21%
50%	24-Hours	0**	9	10	8	10	92.5%	0.829	8.96%
	48-Hours	0**	9	8	8	10	87.5%	0.829	9.48%
	72-Hours	0**	3	3	6	8	50.0%	2.121	42.43%
	96-Hours	0**	2	3	6	8	47.5%	2.385	50.21%

Comments: ** Air line came out of the 50% A replicate resulting in a dissolved oxygen value of 0.6mg/L. Therefore, the 50% A replicate was discarded for the statistical analysis.

SUMMARY OF ENDPOINTS

Exposure Period	LC-50 (95% Limits)	METHOD	NOEC	LOEC
24 Hours	>50%	Direct Observation	50%	>50%
48 Hours	>50%	Direct Observation	50%	>50%
72 Hours	50%	Binomial Method	25%	50%
96 Hours	48.5%	Binomial Method	25%	50%

TABLE 2. Summary of Reference Toxicant Data. American Samoa Joint Cannery Outfall Effluent Evaluation. March 2005.

Concentrations Expressed as mg/L Sodium Dodecyl Sulfate

Species	Date	LC-50	Historic Mean	Number of Tests	±1 STD Deviation	±2 STD Deviations
A. bahia	03/23/04	21.1	20.3	20	3.15	6.31

TABLE 3. Summary of Effluent and Diluent Characteristics. American Samoa Joint Cannery Outfall Effluent Evaluation. March 2005.

PARAMETER	UNITS	100% EFFLUENT	50% EFFLUENT	DILUENT
Salinity - As Received	‰	10	-	24
Salinity - After Salinity Adjustment	‰	25	25	-
pH - As Received	SU	6.46	-	7.81
pH - After Salinity Adjustment	SU	6.69	7.00	-
TRC - As Received	mg/L	<0.05	-	<0.05
Dissolved Oxygen - As Received	mg/L	0.7	-	-
Dissolved Oxygen - After Aeration	mg/L	7.2	5.3	7.5
Ammonia - As Received	mg/L as N	60.0	-	<0.1
Unionized Ammonia - As Received	mg/L as N	0.068	-	<0.002
Ammonia - Salinity Adjusted	mg/L as N	-	29.0	-
Unionized Ammonia - Salinity Adjusted	mg/L as N	-	0.114	-
Ammonia - at 48 Hours	mg/L as N	63.0	29.0	<0.1
Unionized Ammonia - at 48 Hours	mg/L as N	0.116	0.177	<0.002

TABLE 4. Summary of Sample Collection Information. American Samoa Joint Cannery Outfall Effluent Evaluation. March 2005.

Sample Description	Type	Collection Date	Collection Time	Receipt Date	Receipt Time	Arrival Temp °C
EFFLUENT	Comp	03/03-04/04	ND	03/15/04	1330	18

COMMENTS:
ND - No data was recorded on chain of custody.

TABLE 5. Summary of StarKist Samoa and COS Samoa Packing Combined Effluent Bioassay Results. American Samoa Joint Cannery Outfall Effluent Evaluation. March 2005.

Date	Species	96-Hour Endpoints		
		LC-50	NOEC	LOEC
02/93[1]	*Penaeus vannami*	4.8%	3.1%	6.25%
10/93[1]	*Penaeus vannami*	15.67%	3.1%	6.25%
02/94[1]	*Penaeus vannami*	15.76%	<1.6%	1.6%
10/94[1]	*Americamysis bahia*	31.2%	25.0%	50.0%
03/95[1]	*Penaeus vannami*	14.8%	6.25%	12.5%
03/95[1]	*Americamysis bahia*	10.8%	6.25%	12.5%
02/96[1]	*Penaeus vannami*	>50.0%	>50.0%	>50.0%
03/96[1]	*Penaeus vannami*	44.4%	25.0%	50.0%
11/96[1]	*Penaeus vannami*	7.11%	3.1%	6.25%
03/97[1]	*Penaeus vannami*	39.36%	12.5%	25.0%
09/97[1]	*Penaeus vannami*	12.3%	6.25%	12.5%
06/98[1]	*Americamysis bahia*	17.2%	6.25%	12.5%
11/98[1]	*Americamysis bahia*	15.0%	6.25%	12.5%
02/00[1]	*Americamysis bahia*	20.0%	6.25%	12.5%
08/00[1]	*Americamysis bahia*	17.1%	3.1%	6.25%
03/01[2]	*Americamysis bahia*	13.81%	12.5%	25.0%
03/02[2]	*Americamysis bahia*	16.13%	12.5%	25.0%
08/02[2]	*Americamysis bahia*	10.23%	6.25%	12.5%
03/03[2]	*Americamysis bahia*	28.4%	25.0%	50.0%
08/03[2]	*Americamysis bahia*	43.2%	25.0%	50.0%
03/04[2]	*Americamysis bahia*	>50.0%	50.0%	>50.0%
10/04[2]	*Americamysis bahia*	>50.0%	50.0%	>50.0%
03/05[2]	*Americamysis bahia*	48.5%	25.0%	50.0%

Notes:

1. Assays conducted by Advanced Biological Testing, Inc., Rohnert Park, California
2. Assays conducted by EnviroSystems, Inc., Hampton, New Hampshire

APPENDIX A

DATA SHEETS

STATISTICAL SUPPORT

Contents	Number of Pages
Methods Used in NPDES Permit Biomonitoring Testing	1
A. bahia Acute Bioassay Data Summary	2
A. bahia Survival Statistics: LC-50, NOEC	15
A. bahia Organism Culture Sheet	1
Effluent & Diluent Chemistry and Water Quality Data / Preparation of Dilutions	1
Record of Meters Used for Water Quality Measurements	1
Unionized Ammonia Calculation	1
Sample Receipt Record	1
Chain of Custody	1

METHODS USED IN NPDES PERMIT BIOMONITORING TESTING

Parameter	Method
Acute Exposure Bioassays	
Ceriodaphnia dubia, Daphnia pulex	EPA-821-R-02-012
Pimephales promelas	EPA-821-R-02-012
Americamysis bahia	EPA-821-R-02-012
Menidia beryllina, Cyprinodon variegatus	EPA-821-R-02-012
Chronic Exposure Bioassays	
Ceriodaphnia dubia	EPA-821-R-02-013, 1002.0
Pimephales promelas	EPA-821-R-02-013, 1000.0
Cyprinodon variegatus	EPA-821-R-02-014, 1004.0
Menidia beryllina	EPA-821-R-02-014, 1006.0
Arbacia punctulata	EPA-821-R-02-014, 1008.0
Champia parvula	EPA-821-R-02-014, 1009.0
Trace Metals:	
ICP Metals	EPA 200.7/SW 6010
Hardness	Standard Methods 20th Edition - Method 2340 B
Wet Chemistries:	
Alkalinity	EPA 310.2
Chlorine, Residual	Standard Methods 20th Edition - Method 4500CLD
Total Organic Carbon	Standard Methods 20th Edition - Method 5310C
Specific Conductance	Standard Methods 20th Edition - Method 2510B
Nitrogen - Ammonia	Standard Methods 20th Edition - Method 4500NH3G
pH	Standard Methods 20th Edition - Method 4500H+B
Solids, Total (TS)	Standard Methods 20th Edition - Method 2540.B
Solids, Total Suspended (TSS)	Standard Methods 20th Edition - Method 2540D
Dissolved Oxygen	Standard Methods 20th Edition - Method 4500-O G

ACUTE BIOASSAY DATA SUMMARY

STUDY: 1314		"AS RECEIVED" EFFLUENT AND DILUENT CHEMISTRIES						
CLIENT: CH2M Hill	TEST ORGANISM: *A. bahia*		TRC	AMM 0 HR✖	AMM 48 HR✖	pH	DO	Salinity
SAMPLE: American Samoa	ORGANISM SUPPLIER/BATCH/AGE: *See Organism Culture Sheet*	EFFLUENT	See "EFFLUENT & DILUENT CHEMISTRY and WATER QUALITY DATA" sheet					
DILUENT: LAB SALT		DILUENT						

SALINITY ADJUSTMENT RECORD (IF APPLICABLE): 800 0 ML EFFLUENT + 141 G SEA SALTS = 100% ACTUAL PERCENTAGE

CONC	REP	SURVIVAL 0	24	48	72	96	✦DISSOLVED OXYGEN (MG/L)✦ 0	24	48◊	48☆	72	96	PH (SU) 0	24	48◊	48☆	72	96	TEMPERATURE (°C) 0	24	48◊	48	72	96	SALINITY (ppt) 0	24	48◊	48	72	96
LAB	A	10	10	10	10	10	7.5	7.1	7.1	7.5	7.6	7.2	7.81	7.90	7.89	7.77	7.97	7.87	21	19	20	22	18	20	24	25	26	25	25	27
	B	10	10	10	10	9	7.5	7.2	6.9	7.4	7.6	7.0	7.81	7.95	7.94	7.80	7.98	8.01	21	20	20	22	18	20	24	26	27	26	27	28
	C	10	10	10	10	10	7.5	7.3	7.1	7.4	7.6	7.1	7.81	7.96	7.97	7.82	7.96	8.03	21	20	20	22	18	20	24	26	26	26	27	28
	D	10	9	9	9	9	7.5	7.3	7.2	7.4	7.6	7.2	7.82	7.96	7.99	7.82	7.97	8.05	21	20	21	22	18	20	24	26	27	26	28	29
	E	10	10	10	10	10	7.5	7.2	7.2	7.4	7.7	6.8	7.82	7.92	7.99	7.82	7.99	8.04	21	19	21	22	18	20	24	26	27	26	28	29
3.1%	A	10	10	9	6	6	7.5	7.2	7.2	7.4	7.7	6.7	7.74	7.96	7.99	7.76	8.00	8.04	21	19	21	22	18	20	24	25	26	25	26	28
	B	10	10	10	10	10	7.4	7.3	7.2	7.3	7.7	6.7	7.74	7.97	7.97	7.74	7.99	8.04	21	20	21	22	18	20	24	25	26	26	26	28
	C	10	10	10	10	10	7.3	7.4	7.1	7.2	7.7	6.9	7.74	7.98	7.98	7.75	7.99	8.06	21	21	22	22	18	20	24	25	27	26	27	28
	D	10	10	10	10	9	7.2	7.3	6.9	7.2	7.7	6.8	7.75	7.99	7.99	7.76	7.99	8.08	21	20	22	22	19	20	24	26	27	26	27	28
	E	10	10	9	9	9	7.2	7.2	6.9	7.2	7.7	6.7	7.75	7.98	8.00	7.76	8.00	8.08	21	19	21	22	19	20	24	26	27	26	27	28
6.25%	A	10	10	10	10	9	7.1	7.2	6.8	7.2	7.7	6.9	7.65	7.95	8.01	7.73	8.02	8.09	21	19	20	22	19	20	25	26	27	26	26	28
	B	10	10	10	10	10	7.0	7.2	6.9	7.2	7.7	6.8	7.63	7.95	8.02	7.70	8.01	8.09	21	20	20	22	19	20	25	26	27	26	26	28
	C	10	10	10	10	9	7.0	7.3	7.0	7.1	7.7	6.7	7.63	7.97	8.00	7.70	8.00	8.10	21	21	20	22	19	20	25	26	27	26	26	28
	D	10	10	10	10	10	7.0	7.2	7.0	7.1	7.7	6.8	7.63	7.97	8.00	7.69	8.02	8.10	21	21	20	22	19	20	25	26	28	26	27	28
	E	10	10	10	10	9	7.0	7.0	7.1	7.1	7.7	6.7	7.62	7.95	8.01	7.70	8.03	8.10	21	20	20	22	19	20	25	26	27	26	27	28

	0	24	48	72	96	0	24	48◊	48☆	72	96
DATE	3/15/05	3/16/05	3/17/05	3/18/05	3/14	3/15	3/16/05	3/17/05	3/17/05	3/18/05	3/14
TIME	1525	1600	700	1545	1500	1449	1540	1635	1715	1525	1440
INITIALS	[illegible]	[illegible]	[illegible]	[illegible]	ICK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	ICK
FED?	✓	✓	✓	✓				✓			

✖ - See:" EFFLUENT & DILUENT CHEMISTRY and WATER QUALITY DATA" sheet.
✦ - AERATE FROM START! ◊ - "Old" water qualities (prior to renewal) ☆ - "New"water qualities (post renewal)

ACUTE BIOASSAY DATA SUMMARY

STUDY: 1311 4	SAMPLE RECEIVED:	"AS RECEIVED" EFFLUENT AND DILUENT CHEMISTRIES						
CLIENT: CH2M Hill	TEST ORGANISM: *A. bahia*		TRC	AMM 0 HR✖	AMM 48 HR✖	pH	DO	Salinity
SAMPLE: American Samoa	ORGANISM SUPPLIER:	EFFLUENT	See "EFFLUENT & DILUENT CHEMISTRY and WATER QUALITY DATA" sheet					
DILUENT: LAB SALT	ORGANISM BATCH/AGE:	DILUENT						

CONC	REP	SURVIVAL 0	24	48	72	96	✦DISSOLVED OXYGEN (MG/L)✦ 0	24	48◊	48☆	72	96	PH (SU) 0	24	48◊	48☆	72	96	TEMPERATURE (°C) 0	24	48◊	48	72	96	SALINITY (ppt) 0	24	48◊	48	72	96
12.5%	A	10	9	9	9	9	7.0	6.8	6.9	6.4	7.6	6.2	7.47	7.90 ~~7.90~~	8.04 8.05	7.61	8.02	8.12	20	19	20	22	19	20	25	26	27	25	26	27
	B	10	10	10	10	10	6.8	6.8	6.8	6.4	7.6	6.4	7.47	7.90	8.04	7.57	8.02	8.11	20	19	20	22	19	20	25	26	27	26	26	28
	C	10	10	10	10	10	6.8	6.8	6.8	6.2	7.6	6.6	7.46	7.89	8.04	7.58	8.01	8.11	20	20	20	22	20	20	25	26	27	26	26	27
	D	10	10	10	10	8	6.8	6.8	6.9	6.4	7.5	6.6	7.47	7.93	8.04	7.58	8.04	8.13	20	20	20	22	20	20	25	26	27	26	26	28
	E	10	10	10	10	10	6.8	6.8	6.9	6.5	7.4	6.8	7.47	7.92	8.04	7.57	8.05	8.13	20	20	20	22	19	20	25	26	27	26	26	28
25%	A	10	10	10	10	10	6.5	6.7	7.1	6.5	7.4	6.7	7.24	7.88	8.09	7.41	8.07	8.14	20	19	22	22	19	20	25	26	28	26	27	28
	B	10	10	9	9	9	6.4	6.7	6.9	5.9	7.4	6.2	7.24	7.93	8.09	7.37	8.08	8.18	20	19	22	22	20	20	25	26	27	26	26	28
	C	10	9	9 8.5	9	9	6.4	6.7	6.8	5.8	7.6	6.6	7.22	7.99	8.09	7.38	8.08	8.21	20	20	21	22	21	20	25	26	27	26	26	28
	D	10	10	10	10	10	6.4	6.6	6.7	5.7	7.4	6.5	7.23	7.94	8.09	7.39	8.11	8.22	20	21	20	22	21		25	26	27	26	26	28
	E	10	10	10	9	9	6.4	6.2	6.6	5.7	7.2	6.4	7.22	7.92	8.10	7.40	8.11	8.18	20	20	20	22	20	20	25	26	27	26	26	28
50%	A	10	0	0	0	0	5.3	0.6 (E10)	–	–	–	–	7.00	7.58	–	–	–	–	20	19	–	–	–	–	25	26	–	–	–	–
	B	10	9	9	3	2	5.1	4.9	6.9	5.8	7.2	6.4	7.00	7.88	8.16	7.19	8.15	8.21	20	20	20	23	20	20	25	26	28	26	26	28
	C	10	10	8	3	3	5.1	5.1	6.8	4.4	7.4	6.7	6.99	7.93	8.19	7.17	8.16	8.25	20	21	20	23	21	20	25	26	27	26	26	28
	D	10	8	8	6	6	5.1	5.1	6.8	4.3	7.1	6.6	6.99	7.85	8.19	7.20	8.16	8.25	20	21	20	23	21	20	25	26	28	26	26	28
	E	10	10	10	8	8	5.1	5.1	6.7	4.3	6.9	6.5	6.99	7.92	8.19	7.20	8.17	8.22	20	20	20	23	20	20	25	26	28	26	26	27

DATE	3/15/05	3/16/05	3/17/05	3/12/05	3/14	3/15	3/16/05	3/17/05	3/17/05	3/18/05	3/17/0
TIME	1525	1600	1650	1545	1510	1440	1540	1635	1715	1525	1450
INITIALS	✓	✓	PS	✓	KK	✓	✓	✓	✓	✓	KK
FED?	/	✓	/	/							

(E10) Aeration line fell out over the 24hr. period causing the low D.O. reading.

✖ - See:" EFFLUENT & DILUENT CHEMISTRY and WATER QUALITY DATA" sheet.
✦ - AERATE FROM START! ◊ - "Old" water qualities (prior to renewal) ☆ - "New"water qualities (post renewal)

1311424B

Title: American Samoa 13114: A. bahia 24 hr survival
File: 1311424 Transform: ARC SINE(SQUARE ROOT(Y))

Shapiro - Wilk's Test for Normality

D = 0.1285
W = 0.7944

Critical W = 0.8980 (alpha = 0.01 , N = 29)
W = 0.9260 (alpha = 0.05 , N = 29)

Data FAIL normality test (alpha = 0.01). Try another transformation.

Warning - The first three homogeneity tests are sensitive to non-normality and should not be performed with this data as is.

Title: American Samoa 13114: A. bahia 24 hr survival
File: 1311424 Transform: ARC SINE(SQUARE ROOT(Y))

Hartley's Test for Homogeneity of Variance
Bartlett's Test for Homogeneity of Variance

These two tests can not be performed because at least one group has zero variance.

Data FAIL to meet homogeneity of variance assumption.
Additional transformations are useless.

Title: American Samoa 13114: A. bahia 24 hr survival
File: 1311424 Transform: ARC SINE(SQUARE ROOT(Y))

Summary Statistics on Transformed Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Lab	5	1.2490	1.4120	1.3794
2	3.1	5	1.4120	1.4120	1.4120
3	6.25	5	1.4120	1.4120	1.4120
4	12.5	5	1.2490	1.4120	1.3794
5	25	5	1.2490	1.4120	1.3794
6	50	4	1.1071	1.4120	1.2951

Title: American Samoa 13114: A. bahia 24 hr survival
File: 1311424 Transform: ARC SINE(SQUARE ROOT(Y))

Summary Statistics on Transformed Data TABLE 2 of 2

1311424B

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	Lab	0.0053	0.0729	0.0326	5.2837
2	3.1	0.0000	0.0000	0.0000	0.0000
3	6.25	0.0000	0.0000	0.0000	0.0000
4	12.5	0.0053	0.0729	0.0326	5.2837
5	25	0.0053	0.0729	0.0326	5.2837
6	50	0.0216	0.1470	0.0735	11.3473

Title: American Samoa 13114: A. bahia 24 hr survival
File: 1311424 Transform: ARC SINE(SQUARE ROOT(Y))

Wilcoxon's Rank Sum Test w/ Bonferroni Adjustment Ho: Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	RANK SUM	CRIT. VALUE	REPS	SIG 0.05
1	Lab	1.3794				
2	3.1	1.4120	30.00	16	5	
3	6.25	1.4120	30.00	16	5	
4	12.5	1.3794	27.50	16	5	
5	25	1.3794	27.50	16	5	
6	50	1.2951	16.50	10	4	

Critical values are 1 tailed (k = 5)

1311448B

Title: American Samoa 13114 A. bahia 48 hr survival
File: 1311448 Transform: ARC SINE(SQUARE ROOT(Y))

Shapiro - Wilk's Test for Normality

D = 0.1694
W = 0.8741

Critical W = 0.8980 (alpha = 0.01 , N = 29)
W = 0.9260 (alpha = 0.05 , N = 29)

Data FAIL normality test (alpha = 0.01). Try another transformation.

Warning - The first three homogeneity tests are sensitive to non-normality and should not be performed with this data as is.

Title: American Samoa 13114 A. bahia 48 hr survival
File: 1311448 Transform: ARC SINE(SQUARE ROOT(Y))

Hartley's Test for Homogeneity of Variance
Bartlett's Test for Homogeneity of Variance

These two tests can not be performed because at least one group has zero variance.

Data FAIL to meet homogeneity of variance assumption.
Additional transformations are useless.

Title: American Samoa 13114 A. bahia 48 hr survival
File: 1311448 Transform: ARC SINE(SQUARE ROOT(Y))

Summary Statistics on Transformed Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Lab	5	1.2490	1.4120	1.3794
2	3.1	5	1.2490	1.4120	1.3468
3	6.25	5	1.4120	1.4120	1.4120
4	12.5	5	1.2490	1.4120	1.3794
5	25	5	1.2490	1.4120	1.3468
6	50	4	1.1071	1.4120	1.2188

Title: American Samoa 13114 A. bahia 48 hr survival
File: 1311448 Transform: ARC SINE(SQUARE ROOT(Y))

Summary Statistics on Transformed Data TABLE 2 of 2

1311448B

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	Lab	0.0053	0.0729	0.0326	5.2837
2	3.1	0.0080	0.0893	0.0399	6.6278
3	6.25	0.0000	0.0000	0.0000	0.0000
4	12.5	0.0053	0.0729	0.0326	5.2837
5	25	0.0080	0.0893	0.0399	6.6278
6	50	0.0211	0.1451	0.0726	11.9065

Title: American Samoa 13114 A. bahia 48 hr survival
File: 1311448 Transform: ARC SINE(SQUARE ROOT(Y))

Wilcoxon's Rank Sum Test w/ Bonferroni Adjustment Ho: Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	RANK SUM	CRIT. VALUE	REPS	SIG 0.05
1	Lab	1.3794				
2	3.1	1.3468	25.00	16	5	
3	6.25	1.4120	30.00	16	5	
4	12.5	1.3794	27.50	16	5	
5	25	1.3468	25.00	16	5	
6	50	1.2188	13.50	10	4	

Critical values are 1 tailed (k = 5)

****

STUDY NO.: 13114 ASSAY START: 03/15/05

SPECIES: A.bahia EXPOSURE: 72 hours

SAMPLE: American Samoa

****

At a confidence level of 95 percent, the binomial test
shows that the LC50 is above 25

The usefulness of any LC50 calculated from this set of data
is questionable because a concentration-effect relationship
has not been demonstrated over a reasonable range (e.g.,
<37 to >63) of percent affected.
50 can be used as an approximate LC50 for this set of data.

----------RESULTS CALCULATED USING THE MOVING AVERAGE METHOD----------

Span	G	LC50	95 Percent Confidence Limits	
1	.157435	49.99998	42.49589	67.92381

An LC50 calculated using the Moving Average method may not be a very good
estimate if the span is much less than the number of concentrations.

If any higher concentration produces a lower percent affected
than a lower concentration, the confidence limits obtained
by the Moving Average method will probably be too close.

----------RESULTS CALCULATED USING THE PROBIT METHOD----------

Iterations	G	H	Chi-Square	Probability
5	6.663816	16.28386	48.85157	LESS THAN 0.001

As the probability associated with this value is <0.05, results should
be used with caution.

Slope = 2.516864
95 Percent Confidence Limits =-3.980261 and 9.013988

LC50 = 64.82584
95 Percent Confidence Limits = 0 and +INFINITY

---------RESULTS CALCULATED USING THE TRIMMED SPEARMAN-KARBER METHOD-------

Conc.	Dose =Ln (Conc)	Percent Dead	Monotonic Rel. Freq.	Trimmed Rel. Freq.
50	3.912023	50	.5	.5
25	3.218876	6	.06	-5.000001E-02 *
12.5	2.525729	2	.02	-9.999999E-02 *
6.25	1.832581	0	.01	-.1125 *
3.1	1.131402	2	.01	-.1125 *

Alpha = 10 %
Groups trimmed and therefore not used in estimating LC50
are marked with an asterisk above.
LC50 = 6.040446
Estimated 95 Percent Confidence Limits
Lower: 4.217017 Upper: 8.652321
Variance estimate = 3.228306E-02

Variance may be underestimated because all data were outside trimmed range.

****

STUDY NO.: 13114 ASSAY START: 03/15/05

SPECIES: A.bahia EXPOSURE: 72 hours

SAMPLE: American Samoa

****

SUMMARY TABLE

04-28-2005 13:03:33

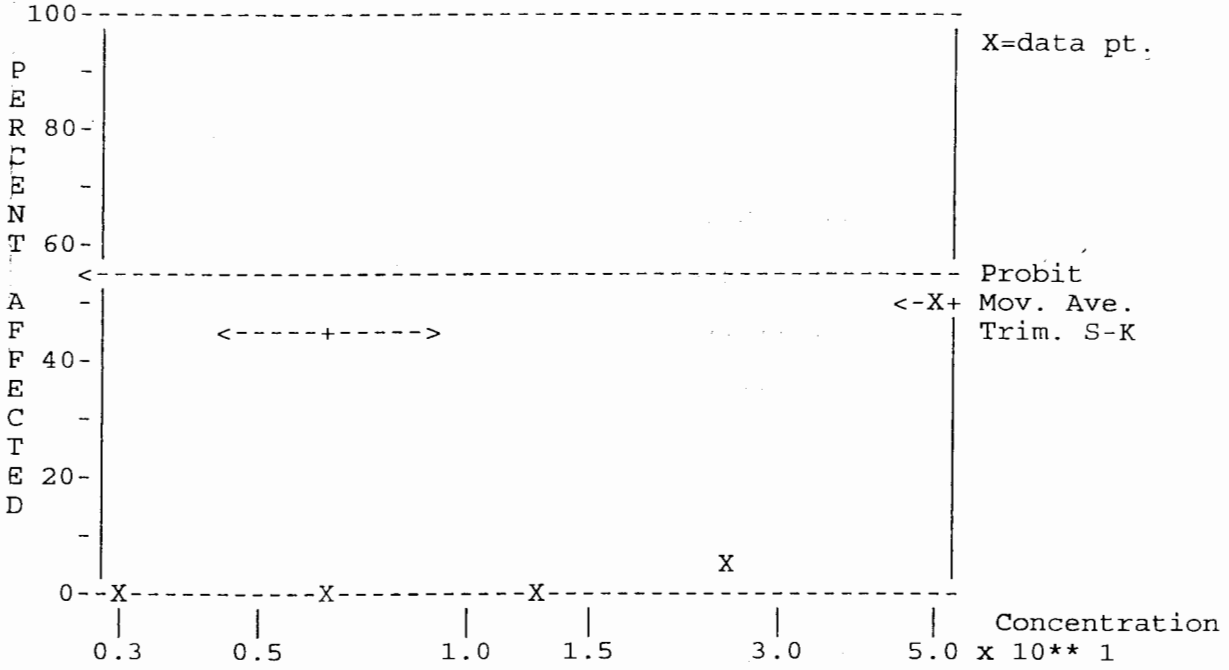
Data:

Conc.	Exposed	Dead	Percent
50	40	20	50
25	50	3	6
12.5	50	1	2
6.25	50	0	0
3.1	50	1	2

	LC50	Lower 95% Limit	Upper 95% Limit	
Probit Analysis	64.82584	0	0	
Moving Average	49.99998	42.49589	67.92381	Span= 1
Spearman-Karber	6.040446	4.217017	8.652321	Alpha= 10 %

Compare results with original data to see if they are reasonable.

****



1311472B

Title: American Samoa 13114 A. bahia 72 hr survival
File: 1311472 Transform: ARC SINE(SQUARE ROOT(Y))

Shapiro - Wilk's Test for Normality

D = 0.4809
W = 0.9262

Critical W = 0.8980 (alpha = 0.01 , N = 29)
W = 0.9260 (alpha = 0.05 , N = 29)

Data PASS normality test (alpha = 0.01). Continue analysis.

Title: American Samoa 13114 A. bahia 72 hr survival
File: 1311472 Transform: ARC SINE(SQUARE ROOT(Y))

Hartley's Test for Homogeneity of Variance
Bartlett's Test for Homogeneity of Variance

These two tests can not be performed because at least one group has zero variance.

Data FAIL to meet homogeneity of variance assumption.
Additional transformations are useless.

Title: American Samoa 13114 A. bahia 72 hr survival
File: 1311472 Transform: ARC SINE(SQUARE ROOT(Y))

Summary Statistics on Transformed Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Lab	5	1.2490	1.4120	1.3794
2	3.1	5	0.8861	1.4120	1.2742
3	6.25	5	1.4120	1.4120	1.4120
4	12.5	5	1.2490	1.4120	1.3794
5	25	5	1.2490	1.4120	1.3142
6	50	4	0.5796	1.1071	0.7881

Title: American Samoa 13114 A. bahia 72 hr survival
File: 1311472 Transform: ARC SINE(SQUARE ROOT(Y))

Summary Statistics on Transformed Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	Lab	0.0053	0.0729	0.0326	5.2837

2	3.1	0.0521	0.2282	0.1020	17.9068
3	6.25	0.0000	0.0000	0.0000	0.0000
4	12.5	0.0053	0.0729	0.0326	5.2837
5	25	0.0080	0.0893	0.0399	6.7921
6	50	0.0661	0.2571	0.1286	32.6218

Title: American Samoa 13114 A. bahia 72 hr survival
File: 1311472 Transform: ARC SINE(SQUARE ROOT(Y))

Wilcoxon's Rank Sum Test w/ Bonferroni Adjustment Ho: Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	RANK SUM	CRIT. VALUE	REPS	SIG 0.05
1	Lab	1.3794				
2	3.1	1.2742	24.50	16	5	
3	6.25	1.4120	30.00	16	5	
4	12.5	1.3794	27.50	16	5	
5	25	1.3142	22.50	16	5	
6	50	0.7881	10.00	10	4	*

Critical values are 1 tailed (k = 5)

****

STUDY NO.: 13114 ASSAY START: 03/15/05

SPECIES: A.bahia EXPOSURE: 96 hours

SAMPLE: American Samoa

****

At a confidence level of 95 percent, the binomial test
shows that the LC50 is above 25

The usefulness of any LC50 calculated from this set of data
is questionable because a concentration-effect relationship
has not been demonstrated over a reasonable range (e.g.,
<37 to >63) of percent affected.
An approximate LC50 of 48.47288 is obtained by
nonlinear interpolation between 25 and 50

----------RESULTS CALCULATED USING THE MOVING AVERAGE METHOD----------

Span	G	LC50	95 Percent Confidence Limits	
1	.1436596	48.47283	41.66249	63.50122

An LC50 calculated using the Moving Average method may not be a very good
estimate if the span is much less than the number of concentrations.

If any higher concentration produces a lower percent affected
than a lower concentration, the confidence limits obtained
by the Moving Average method will probably be too close.

----------RESULTS CALCULATED USING THE PROBIT METHOD----------

Iterations	G	H	Chi-Square	Probability
5	5.74183	8.382775	25.14832	LESS THAN 0.001

As the probability associated with this value is <0.05, results should
be used with caution.

Slope = 1.006258
95 Percent Confidence Limits =-1.404949 and 3.417465

LC50 = 153.8657
95 Percent Confidence Limits = 17.39524 and +INFINITY

---------RESULTS CALCULATED USING THE TRIMMED SPEARMAN-KARBER METHOD-------

Conc.	Dose =Ln (Conc)	Percent Dead	Monotonic Rel. Freq.	Trimmed Rel. Freq.
50	3.912023	52.5	.525	.53125
25	3.218876	6	7.499998E-02	-3.125003E-02 *
12.5	2.525729	6	7.499998E-02	-3.125003E-02 *
6.25	1.832581	6	7.499998E-02	-3.125003E-02 *
3.1	1.131402	12	7.499998E-02	-3.125003E-02 *

Alpha = 10 %
Groups trimmed and therefore not used in estimating LC50

re marked with an asterisk above.

LC50 = 6.7152

Estimated 95 Percent Confidence Limits

Lower: 4.820528 Upper: 9.354557

Variance estimate = 2.747144E-02

Variance may be underestimated because all data were outside trimmed range.

****

STUDY NO.: 13114 ASSAY START: 03/15/05

SPECIES: A.bahia EXPOSURE: 96 hours

SAMPLE: American Samoa

****

SUMMARY TABLE

04-28-2005 13:05:42

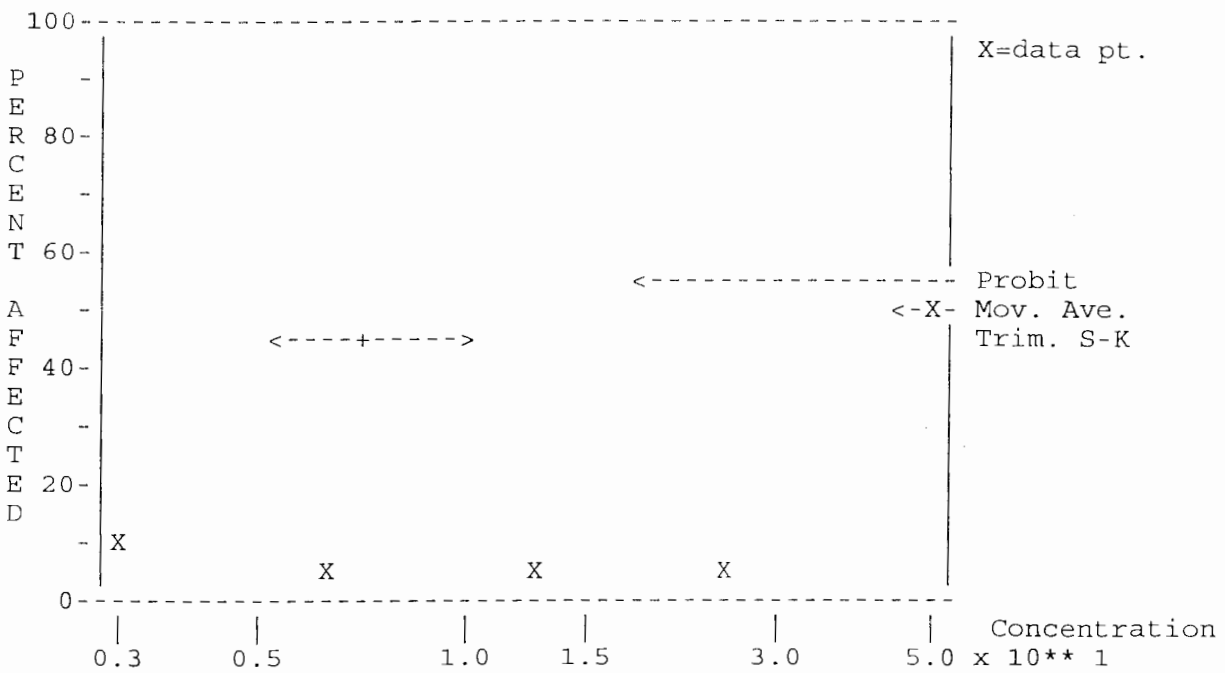
Data: Conc.	Exposed	Dead	Percent
50	40	21	52.5
25	50	3	6
12.5	50	3	6
6.25	50	3	6
3.1	50	6	12

	LC50	Lower 95% Limit	Upper 95% Limit	
Probit Analysis	153.8657	17.39524	0	
Moving Average	48.47283	41.66249	63.50122	Span= 1
Spearman-Karber	6.7152	4.820528	9.354557	Alpha= 10 %

Binomial 48.47288

Compare results with original data to see if they are reasonable.

****



Title: American Samoa 13114 A. bahia 96 hr survival
File: 1311496 Transform: ARC SINE(SQUARE ROOT(Y))

Shapiro - Wilk's Test for Normality

D = 0.6127
W = 0.9500

Critical W = 0.8980 (alpha = 0.01 , N = 29)
W = 0.9260 (alpha = 0.05 , N = 29)

Data PASS normality test (alpha = 0.01). Continue analysis.

Title: American Samoa 13114 A. bahia 96 hr survival
File: 1311496 Transform: ARC SINE(SQUARE ROOT(Y))

Bartlett's Test for Homogeneity of Variance

Calculated B1 statistic = 9.2048 (p-value = 0.1012)

Data PASS B1 homogeneity test at 0.01 level. Continue analysis.

Critical B = 15.0863 (alpha = 0.01, df = 5)
= 11.0705 (alpha = 0.05, df = 5)

Using Average Degrees of Freedom
(Based on average replicate size of 4.83)

Calculated B2 statistic = 7.3692 (p-value = 0.1946)

Data PASS B2 homogeneity test at 0.01 level. Continue analysis.

Title: American Samoa 13114 A. bahia 96 hr survival
File: 1311496 Transform: ARC SINE(SQUARE ROOT(Y))

Summary Statistics on Transformed Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Lab	5	1.2490	1.4120	1.3468
2	3.1	5	0.8861	1.4120	1.2416
3	6.25	5	1.2490	1.4120	1.3142
4	12.5	5	1.1071	1.4120	1.3185
5	25	5	1.2490	1.4120	1.3142
6	50	4	0.4636	1.1071	0.7591

Title: American Samoa 13114 A. bahia 96 hr survival

1311496B

GROUP	IDENTIFICATION	NUM OF REPS	MIN SIG DIFF (IN ORIG. UNITS)	% OF CONTROL	DIFFERENCE FROM CONTROL
1	Lab	5			
2	3.1	5	0.1656	17.4	0.0800
3	6.25	5	0.1656	17.4	0.0200
4	12.5	5	0.1656	17.4	0.0200
5	25	5	0.1656	17.4	0.0200
6	50	4	0.1786	18.8	0.4850

EnviroSystems, Incorporated
Organism Culture Record

Client and ESI Study Number: American Samoa # 13114
Assay:

I. Organism History

Species: Americamysis bahia

Source: Lab Reared ✓ Hatchery Reared ____ Field Collected ____

Hatch Date: 3/13-15/05 Receipt Date: ____ Age: 1-5 days

Lot Number: 031505AB Strain: ____

Brood Origin: Aquatic Research Organisms

II. Culture Conditions

System: Static Sieve

Diet: Flake Food ____ Phytoplankton ____ Trout Chow ____

Brine Shrimp ✓ Rotifers ____ Other ____

Prophylactic Treatments: ____

Comments: ____

III. Water Quality

Temperature 22.6 °C Salinity 29.0 ppt DO_2 7.7 mg/L

pH 7.73 SU Hardness ____ mg/L Alkalinity ____ mg/L

Other: ____

IV. Comments

Biologist: [illegible] Date: 4/26/05

EFFLUENT & DILUENT CHEMISTRY and WATER QUALITY DATA

PARAMETER	100% Effluent	50% Effluent	Diluent - Lab Salt
TRC	0.0 Hrips A-1638B		<0.05
As Received - pH (SU) @ 20°C	6.46		7.81
As Received - Salinity (ppt)	9.7		24
As Received - Dissolved Oxygen (mg/L)‡	0.7		7.5
As Received - Ammonia (pull)	(63) ~~-004~~ -002		13053-020
Salinity Adjusted - pH (SU) @ 20°C	6.69	7.60	
Salinity Adjusted - Salinity (ppt)	25	25	
After Aeration - Dissolved Oxygen (mg/L)	(63) ~~-003~~ 7.2	5.3	
Salinity Adjusted - Ammonia (pull)		-003	
48 hour Ammonia (pull)	-004	-005	13053-023
48 hour pH (SU) @ 20°C	6.67	7.19	7.77

‡ - Aerate prior to mixing concentrations.

PREPARATION OF DILUTIONS

STUDY: 13114

SPECIES: *A. bahia*

CLIENT: CH2M HILL - American Samoa

Diluent: Lab Salt	Day: 0 Sample:		Day: 2 Sample:	
Concentration	Vol. Eff.	Final Vol	Vol. Eff.	Final Vol
LAB	0	1000	0	750
3.1%	31	↓	23.4	↓
6.25%	62.5	↓	46.9	↓
12.5%	125	↓	93.75	↓
25%	250	↓	187.5	↓
50%	500	↓	(63) ~~750~~ 375	↓

HRS	Date	Time	Initials
0	3.15	1430	m
48	3/17/05	1700	PS

Comments:

RECORD OF METERS USED FOR WATER QUALITY MEASUREMENTS

STUDY: 13114	CLIENT: CH2M HILL - American Samoa

WATER QUALITIES - A. bahia

HOURS:	0	24	48 - old	48 - new	72	96
Water Quality Station #	2	2	1	2	2	1
Initials	[illegible]	[illegible]	[illegible]		[illegible]	KH
Date	3/15/05	3/16/05	3/17/05	3/17/05	3/18/05	3/19/05

Water Quality Station #1		Water Quality Station #2		COMMENTS
DO meter #	18	DO meter #	19	
DO probe #	10	DO probe #	11	
pH meter #	1097	pH meter #	1138	
pH probe #	40	pH probe #	39	
S/C meter #	YSI 30B	S/C meter #	YSI 30B	
S/C probe #	1	S/C probe #	↓	
Salinity meter #	YSI 30B	Salinity meter #	↓	

STUDY: 13114
CLIENT: CH2MHill - American Samoa
PROJECT: Wastewater Treatment Plant
TASK: Unionized Ammonia Calculations

Day / Date	Treatment	Temperature Deg C	Sample pH SU	NH_3 mg/L	Unionized NH_3 mg/L
Day 0	Lab	20	7.81	< 0.1	0.002
03/15/05	As Received 100% Effluent	20	6.46	60.0	0.068
	50% Salinity Adjusted Effluent	20	7.00	29.0	0.114
					0.000
Day 2	Lab	20	7.77	< 0.1	0.002
03/17/05	50% Salinity Adjusted Effluent	20	7.19	29.0	0.177
	100% Salinity Adjusted Effluent	20	6.67	63.0	0.116

ESI

EnviroSystems, Inc.
One Lafayette Road
P.O. Box 778
Hampton, NH 03843-0778
Telephone: 603-926-3345

SAMPLE RECEIPT RECORD

ESI STUDY NUMBER: 13114 CLIENT: American Samoa

SAMPLE RECEIPT:
DATE: 3/15 TIME: 1330 BY: lm

DELIVERED VIA: ☐ FEDEX ☐ CLIENT ☐ ESI ☐ UPS ☒ OTHER

LOGGED INTO LAB:
DATE: 3/15 TIME: 1330 BY: lm

SAMPLE CONDITION:

CHAIN OF CUSTODY:	☒ YES	☐ NO
CHAIN OF CUSTODY SIGNED:	☒ YES	☐ NO
CHAIN OF CUSTODY COMPLETE:	☐ YES	☒ NO
SAMPLE DATE:	☒ YES	☐ NO
SAMPLE TIME RECORDED:	☐ YES	☒ NO
SAMPLE TYPE IDENTIFIED:	☒ YES	☐ NO
CUSTODY SEAL IN PLACE:	☒ YES	☐ NO
SHIPPING CONTAINER INTACT:	☒ YES	☐ NO
SAMPLE TEMPERATURE (AT ARRIVAL): 18 °C		
DOES CLIENT NEED NOTIFICATION OF TEMPERATURE?	☐ YES	☒ NO
SAMPLE ARRIVED ON ICE:	☒ YES	☐ NO

COMMENTS: 1x5 gal Eff

Joint Cannery Outfall Coral Reef Survey

Pago Pago Harbor

American Samoa

March 2002

Submitted by:

StarKist Samoa

NPDES Permit AS0000019

COS Samoa Packing

NPDES Permit AS0000027

Submitted to:

U.S. Environmental Protection Agency

American Samoa Environmental Protection Agency

CH2M HILL

February 2003

JOINT CANNERY OUTFALL
CORAL REEF SURVEY REPORT
MARCH 2002 SURVEY

Submitted to:

U.S. Environmental Protection Agency – Region 9

and

American Samoa Environmental Protection Agency

Submitted by:

StarKist Samoa, Inc.

NPDES Permits AS0000019

and

COS Samoa Packing Company

NPDES Permit AS0000027

Prepared by:

CH2M HILL

28 February 2002

Executive Summary

The year 2002 coral reef survey was been conducted in Pago Pago Harbor as required by the StarKist Samoa and COS Samoa Packing NPDES permit conditions. The survey was conducted during March 2002. This survey represents the fifth coral reef survey conducted at the same sites since 1991. Four locations throughout the Harbor were surveyed.

The required series of coral reef surveys is designed to provide data needed to evaluate potential impacts of treated wastewater discharged from the Joint Cannery Outfall (JCO) on the nearby coral reef. The coral reef surveys provide information needed to evaluate and detect significant differences, if any, from an earlier study done in January of 1991. The survey sites and data collected in March 2002 were consistent with the 1991 study, and the previous results of the 1993, 1995, and 1997 surveys.

The survey was done by making video recordings of transects along constant depth contours at three depths at each site. The video recordings were then analyzed and summarized by a qualified marine ecologist with expertise in coral reef taxonomy and previous experience in American Samoa. The survey data are presented in terms of estimated hard coral coverage and the number of hard coral species identified for each transect. The surveys and the analysis of the video records were done by the same staff that conducted all of the previous surveys.

Prior to February 1992 the wastewater discharge from the canneries were through two short outfalls located in the inner Harbor. The discharge point for the canneries was relocated to the outer Harbor using the JCO. In addition, the canneries instituted high strength waste segregation in August of 1990, using an EPA approved ocean disposal site for the high strength wastes. When compared with previous surveys, the survey data for the sites studied in 2002 indicates a general improvement at three of the four sites. The fourth site shows no signs of degradation but appears to be influenced by sediment loads from a nearby stream. The site closest to the JCO discharge shows no evidence of wastewater impacts or settleable solids. A potential improvement in coral growth has been observed at this station. Since the discharge plume in the outer Harbor is trapped deeper than 60 feet most, if not all, of the time, no impact from the relocated discharge is expected in the middle or outer Harbor.

Any impacts to coral reef communities due to high strength waste segregation and outfall relocation are expected to be long term and difficult to distinguish from variability caused by other factors. The results from the previous coral reef surveys support this expectation and no definitive observable trends in reef coral communities were previously obvious based on the survey data. This was not unanticipated. However, it has been five years since the last survey in 1997 and in that time there appears to have been a quantifiable improvement in the coral reef communities at the sites surveyed in 2002.

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1. INTRODUCTION

This report presents the field survey results of coral reef surveys in the middle, and outer regions of Pago Pago Harbor, American Samoa. The survey was conducted March 13-14, 2002 and is the fourth in a series of required surveys and the fifth survey to be conducted at the designated stations using the same methods and scientific staff.

1.1 Purpose

The purpose of this report is to present the results of the most recent (March 2002) coral reef survey and compare the results to previous surveys. The survey is intended to provide information for comparison with past and future surveys. This work was conducted to comply with conditions of the United States Environmental Protection Agency (EPA) NPDES Permit No. AS0000019 for Star-Kist Samoa Inc. and NPDES Permit No. AS0000027 for COS Samoa Packing Company, Inc.

1.2 Background

The coral reef surveys are required under Section G of the current NPDES permits, which states the following:

> *"The canneries (StarKist Samoa and COS Samoa Packing) shall cooperatively continue the coral reef survey based on the previously approved study plan for the monitoring conducted during 1993-1997 with the modifications described below. The purpose of the study is to assess the potential impacts of the discharge on the nearby coral reef. The intent of the survey is to detect significant differences, if any, from the previous surveys. VCR formatted video copies and a report of results shall be submitted to the ASEPA and USEPA with reports within 120 days of the survey.*
>
> *The survey will be done twice during the permit period, once in year two of the permit and once in year 5 of the permit. These surveys will include a subset of the previous transect locations. Transect locations to be surveyed are MH-1, MH-4, OH-5, and OH-I (see Figure 3*[Figure 2 in this report]*). After reviewing the results of the first survey, ASEPA and USEPA may require different or additional transacts during the second survey and/or additional surveys."*

As indicated in the permit condition above, this survey continues the work required under the previous permit (Section I), which required:

> *"Within six months of the effective date of this NPDES permit, the permittee, in cooperation with {Samoa Packing Co.; Star-Kist Samoa}, shall submit a field study design for approval by ASEPA and EPA Region 9 to assess the potential impacts of the discharge on the nearby coral reef. The study shall include coral reef transects which shall conform to locations found on Figure 4 in the* <u>*USE ATTAINABILITY AND SITE-SPECIFIC CRITERIA ANALYSES; PAGO PAGO HARBOR, AMERICAN SAMOA, FINAL REPORT*</u> *(CH2M HILL, March 15, 1991). The intent of this annual survey is to detect significant differences, if any, from the database information found in*

the above-cited document. Videos shall be submitted to both the USEPA and ASEPA. Guidance for designing such surveys is provided in the Design of 301(h) Monitoring Programs for Municipal Wastewater Discharges to Marine Waters *November 1982, EPA #430/0-82-010 (pages 70-71). In addition, the discharger should consult* Ecological Impacts of Sewage Discharges on Coral Reef Communities, *September 1983, EPA #430/9-83-010, for further information. The study shall be conducted within one year of the effective date of this permit and every two years thereafter."*

A Coral Reef Survey Study Plan was submitted for review and approval to the EPA and ASEPA on January 8, 1993. The study plan was designed, to the extent possible, to be consistent with a previous study done by CH2M HILL in January 1991 as referenced above in the permit condition. During the development and review of the Coral Reef Survey Study Plan, comments received from USEPA and ASEPA were reviewed and incorporated into the study plan, as necessary. The study plan, the comments on the study plan, and the response comments on the study plan were included in the study report for the February 1993 coral reef survey (CH2M HILL, 1993).

The first required study under the NPDES permit was conducted in February 1993 and reviewed by USEPA and ASEPA. One comment was received on the 1993 study, which is discussed in the description of study approach below. During the 1995 study no substantial recommended changes to the study plan were identified for future surveys, although CH2M HILL did recommend that positioning be done using an appropriate global positioning system (GPS) rather than a MiniRanger system. The last survey conducted prior to the one described in this report was in March 1997.

The current NPDES permit condition states that coral reef surveys shall be conducted at four of the same sites surveyed during the 1991 *Use Attainability Analysis* (CH2M HILL, 1991) to detect significant differences, if any, from the 1991 baseline reef survey data. These four stations are the closest stations to the present discharge of the Canneries through the Joint Cannery Outfall (JCO). The wastewater discharge locations and methods for the canneries have changed between the 1991 survey and the initiation of surveys required under the previous NPDES permit condition. This change in discharge locations has had an effect on improving receiving water conditions throughout the Harbor.

In January 1991, when the baseline reef survey study was conducted, the two canneries operated separate wastewater outfalls in the inner Harbor area of Pago Pago Harbor. Currently, Star-Kist Samoa and COS Samoa Packing operate the JCO that extends over 7,000 feet west from the canneries to a deep-water site offshore of Anasosopo Point in the outer Harbor. The outfall consists of a 16-inch HDPE pipe that terminates with a multiport diffuser at a depth of 176 feet below mean lower low water (MLLW). The outfall pipeline route and diffuser location are shown in Figure 1-1. In addition to relocating the discharge in February of 1992, the canneries began high strength waste segregation in August of 1990. Since that time cooker juice, press liquor, and DAF sludge have been disposed of at an EPA-approved ocean disposal site.

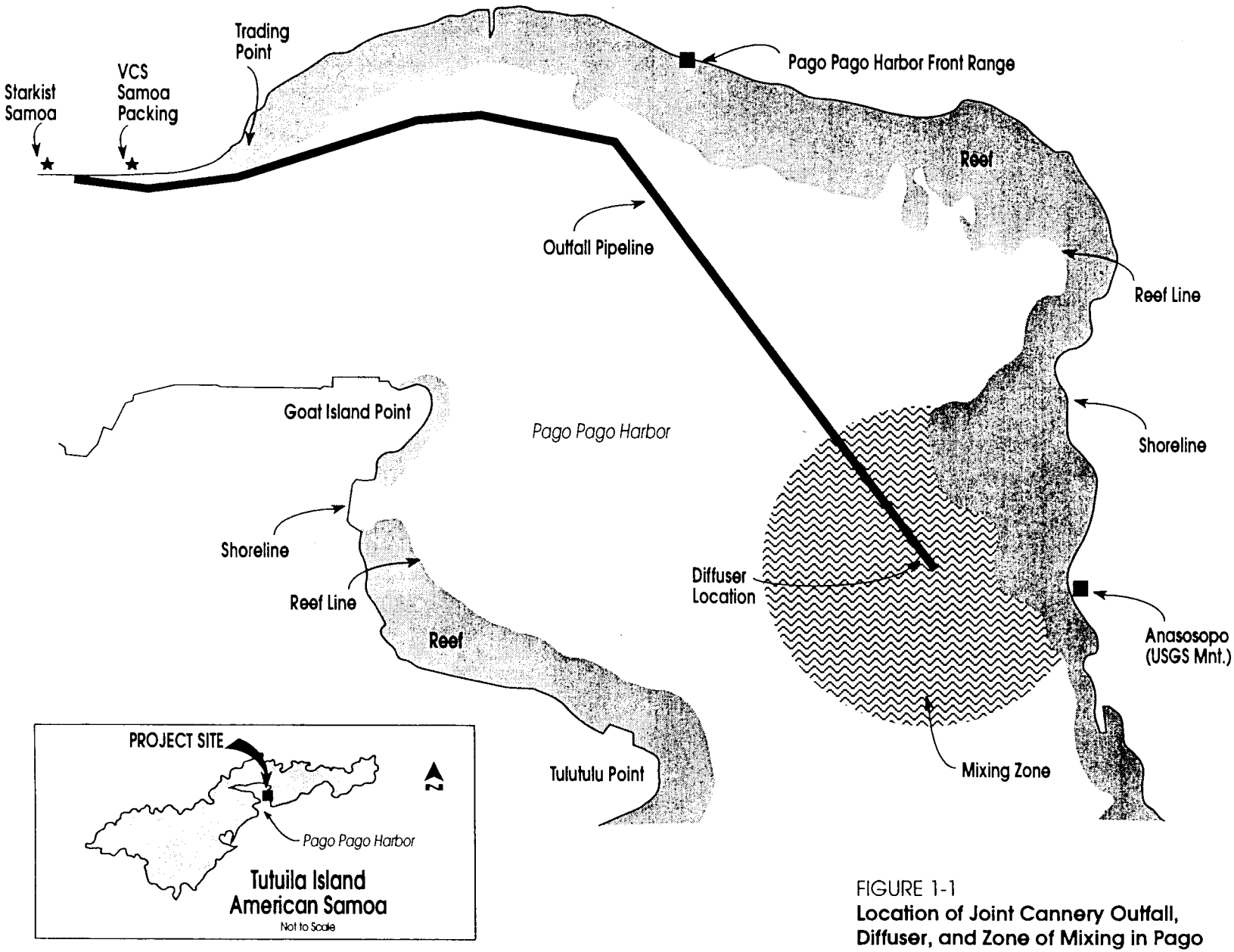

FIGURE 1-1
Location of Joint Cannery Outfall, Diffuser, and Zone of Mixing in Pago Pago Harbor

The January 1991, February 1993, March 1995, March 1997, and March 2002 surveys involved recording reef transects at multiple-depths along the reef fronts at sites located around the entire perimeter of Pago Pago Harbor. The coral reef field surveys were designed to provide comparable records of the reef conditions throughout the Harbor for use in an evaluation of reef-face habitat conditions in areas of the inner, middle, and outer Pago Pago Harbor. These surveys were designed to provide a semi-quantitative summary of reef corals and other benthic species. Reef fish identifications were incidental.

1.3 Approach

The approach and methodology for the coral reef survey has been designed, to the extent feasible, to maintain consistency between the periodic studies, and to be consistent with available guidance provided in the *Design of 301(h) Monitoring Programs for Municipal Wastewater Discharges to Marine Waters* (USEPA, November, 1982). To meet the NPDES permit conditions, video transects were recorded at multiple depths at each of the four established reef transect sites around Pago Pago Harbor (Figure 1-2). Detailed methodology is presented in Sections 2 and 3 below.

The coral reef field survey described in this report was conducted to provide video transect records of the reef conditions in the areas adjacent to the canneries discharge that can be compared with the 1991, 1993, 1995, and 1997 surveys and with future surveys at the same locations. These surveys can be used to evaluate the condition of, and changes to, the reef-face habitat in areas of interest. The surveys are limited to providing semi-quantitative data on the type and percent cover of live reef corals and other benthic species. Reef fish identifications are incidental to the reef habitat evaluation.

The intent of the study is to monitor long term overall changes in the various portions of the Harbor. Since video records at the start and end of the transect locations are at fixed points, and additionally the video transect record includes scale by including the tape measure placed on the bottom, both fixed and random locations of known area can be derived from the video record if desired. However, the analysis presented in this report is intended to be a monitoring or screening level exercise to detect the onset of significant changes in the Harbor. If such changes are detected, and are considered potential adverse impacts, additional work may be required to assess the significance and causes of such changes.

The video transect records were analyzed and summarized by Mr. Troy Buckley of the University of Washington School of Fisheries. Mr. Buckley is a qualified marine ecologist with knowledge of tropical reef taxonomy and several years of site-specific experience in American Samoa. He also analyzed the 1991, 1993, 1995, and 1997 survey videos. Estimates were developed of live coral coverage and specific benthic genera identifications were provided, as feasible, from the video record. Field survey data are presented in tabular formats in the results section of this report. Supporting data are included in Appendix A. Copies of the video records are provided to ASEPA and USEPA as separate attachments to this report.

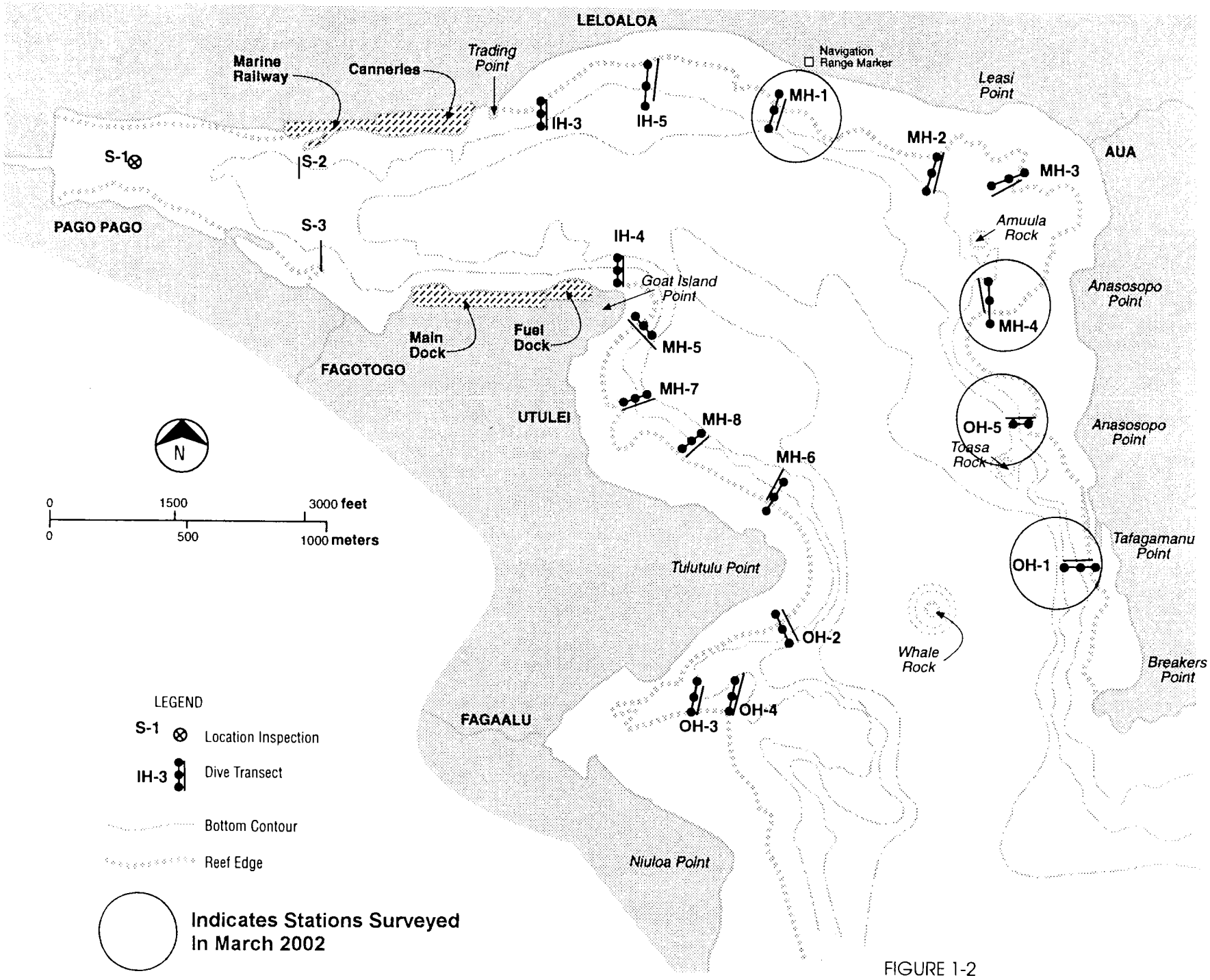

FIGURE 1-2
Location of Coral Reef Transects in Pago Pago Harbor

1.4 Study Site Description

The *American Samoa Coral Reef Inventory* (published by the U.S. Army Corps of Engineers in 1981), reports that the fringing coral reefs in Pago Pago Harbor have been extensively modified, primarily by the U.S. Navy and American Samoan Government. Dredging, filling, construction of rock seawalls and other structures for roadway slope stabilization, and other construction activities have resulted in physical alterations to the coral reefs. These activities began around 1900. The most dramatic changes occurred during World War II and since 1960. The Coral Reef Inventory reports that approximately 23-percent of the original reef flat area in Pago Pago Harbor has been filled.

The inner Harbor area has been the most affected by development activities. According to the Coral Reef Inventory, 95 percent of the original reef in the Inner Harbor has been converted to dry land. Some remnant reef is found in the inner Harbor area but living corals have been absent from the inner Harbor for many years. This conclusion, presented in the Coral Reef Inventory, was drawn from a 1977 study.

Substantial physical alterations to the reef in the Middle and Outer Harbor include the following as presented in the Coral Reef Inventory:

- The reef flat off the Rainmaker Hotel and Utulei Beach has been dredged to provide sandy areas for swimming and access across the reef.
- Near Aua Point, a borrow pit 18 feet deep was dredged to obtain roadbed fill material, creating a large lagoon inside the inner reef.
- The shoreline north of Tafagamanu Point was extended 300 feet onto the reef flat by filling for a sanitary landfill.
- An extensive fill area along the south Fagaalu Bay was developed for a public park from material dredged from the reef flat.
- The discharge of sediments from the streams draining into the Harbor has led to extensive siltation over large portions of the reef near the mouths of these streams (described in detail below).

The coral reefs of American Samoa have been subjected to periodic infestations or population explosions of the coral-feeding crown-of-thorns starfish (*Acanthaster planci*). The 1981 Coral Reef Inventory reported serious crown-of-thorns infestations on the reefs of Tutuila Island in the 1920s and most recently in the late 1970s and early 1980s. These periodic infestations have greatly reduced the live coral assemblages on the fringing reefs. Destruction of the live coral assemblages has been shown to vary widely, but, as described in the Coral Reef Inventory, roughly 50 to 95 percent of live coral were estimated to have been destroyed by the 1970-80 starfish infestation.

Recent dive surveys of the coral reefs in the Fagatele Bay Marine Sanctuary have shown live coral coverages of approximately 50 percent after nearly complete destruction by the

crown-of-thorns starfish. The fringing reefs of middle and outer Pago Pago Harbor were also substantially damaged by the crown-of-thorns infestation. The starfish were observed on the reefs off Aua (in middle Harbor) and of Fagaalu (outer Harbor) during 1980 when the Coral Reef Inventory was conducted. Reef recovery from these infestations is slow, and the existing live coral coverages on the fringing reefs of Tutuila Island still show large areas of dead coral.

Periodic hurricanes pass near or directly over Tutuila Island, and these storms generate large waves. Waves approaching from the south enter the outer and middle Harbor and break on fringing reef, damaging the reef habitat either directly or by disturbing sediments that are deposited on the reefs. Recent intense hurricanes, particularly Hurricane Fay, have had significant impacts on the fringing reefs in Pago Pago Harbor through wave impacts, siltation, and longline vessels grounded on the reefs. In addition, until recently, much of the roadbed abutting the reef flat was unprotected from erosion through riprap cover or other stabilization techniques, leading to extensive siltation of some areas of the reef flats. In recent years erosion protection along portions of the roadway has been substantially improved.

Potential impacts from cannery, and other point source, discharges include direct sedimentation on the reef, reduced water clarity because of sediments, and high algal productivity resulting from nutrient inputs. Affects on coral reef communities appear to have been substantially eliminated with the implementation of high strength waste stream segregation and the relocation of the outfall diffuser to water depths of more than 170 feet in the outer Harbor.

Dye studies conducted by CH2M HILL (1992, 1993) as a condition of the NPDES permit indicate that the plume typically remains trapped in the lower part of the water column. Under certain meteorological and oceanographic conditions the plume rises further but is typically diluted to more than 2000:1 it the edge of the permitted mixing zone and does not impact the nearby coral reefs.

Harbor water quality monitoring conducted in March 1995, March 1996, November 1996, March 1997, and more recently in 2001 and 2002, as a condition of the NPDES permit, indicates that nutrient levels have fallen below the American Samoa water quality standards (ASWQS) and phytoplankton levels have similarly fallen (CH2M HILL, 1995, 1997a, 1997b, 1997c, 2002a, 2002b, 2003a, 2003b). The same studies have indicated that light penetration also meets the ASWQS.

2. FIELD SURVEY METHODS

This section describes the methods and equipment used for the coral reef surveys, including horizontal positioning at each reef site, sampling methods, and QA/QC procedures. The same divers that conducted the previous surveys did the 2002 survey.

2.1 Field Equipment

Field equipment requirements for the reef surveys are listed in Table 2-1. A small work vessel was used for the surveys. A three-person staff was aboard to conduct the reef survey transects. Two divers conducted the surveys, with a third person assigned as a boat handler and support.

Table 2-1
Field Equipment for Coral Reef Surveys

Equipment Item	Purpose	Number of Units
Work Vessel	Field Sampling Platform	1
SCUBA diving equipment and tanks	Underwater surveys	5
Dive Computer	Continuous dive logging for each diver's repetitive dives and surface intervals (safety equipment)	2
Sony 8mm Video camera w/ underwater housing and lights	Underwater videotaping of reef transects	2
Sony 8mm Videotape player	Viewing and verification of videotape records	1
100 feet fiberglass tape measure	Provide reference line for video transects	1
Transect Stakes	Re-establish start and end point for any missing stakes	10
Depth Gage	Verify transect depths	2
GPS System	Global Positioning System	1

2.2 Survey Sites and Field Positioning

Four reef sites were surveyed in March 2002 (Figure 1-2). Multiple transects were conducted at three depths at each of these sites. The four reef survey sites were located based on the descriptions in the 1991 Use Attainability Analysis reef survey logbook and photographs of the reef and shoreline at each site. The horizontal position of each site was established in February 1993 using a Motorola Mini-Ranger III electronic positioning system. The Mini-Ranger III provides positioning range accuracy of approximately ±2 meters. The previously established Mini-Ranger locations of each site and the site descriptions are given in Table 2-2.

Table 2-2 **Middle Harbor Transect Locations for Coral Reef Survey Pago Pago Harbor** Established During February 1993 Survey ***{Indicated Transects Re-established During March 1995 Survey}***			
Station	**Sampling Location and Depth (feet)**	**Navigation Coordinates for MiniRanger System (a,b)**	
		Code 1	**Code 4**
MH-1	Middle Harbor, located off Harbor front range marker (Code 1), Transects at 25, 40, and 60 feet	216 (S)	1198 (S)
MH-4	Middle Harbor, located on north face of reef and west of Aua Point, Transects at 25, 40, and 60 feet	1082 (S)	1649 (S)
OH-1	Outer Harbor, located on west face of reef off Tafagamanu Point, Transects at 25, 40, and 60 feet	2033 (S) ***{1954 (S)}***	2166 (S) ***{2154 (S)}***
OH-5	Outer Harbor, located on west face of reef off Anasosopo Point, Transects at 25, 40, and 60 feet	1466 (S) ***{1646 (S)}***	1799 (S) ***{1992(S)}***

(a) The shore-based Mini-Ranger transponders were located at survey control points as follows:
Code 1 - located at Pago Pago Harbor Front Range Tower (261,551.58E and 309,857.04N, State Coordinates (feet));
Code 4 - located at Fagatogo Tram Park Building (258,117.06E and 305,879.24N, State Coordinates (feet)).

(b) The navigation readings are designated as either north (N) or south (S) of the alignment between the Code 1 and Code 4 shore transponder stations.

Each of the four sites was relocated in 2002 by means of the transect marker stakes placed in 1993 (or as replaced in 1995 or 1997) at the start of each transect. Transect marker stakes were relocated by visual positioning and GPS positioning. Markers at some of the transects were degraded or missing and were replaced. However, sufficient markers were recovered at all locations to provide a high degree of confidence that the same transects were filmed as in the previous surveys. A buoy was deployed to assist divers to search for the stakes when not immediately recovered.

2.3 Reef Transect Methods

Marine biologist-divers recorded underwater video transects on the reef front at the four sites in Pago Pago Harbor (Figure 1-2). Video transects were recorded along the reef face at three depths. Each video transect was conducted parallel with the reef face (along a constant depth contour) along a 30-meter fixed transect line on the reef. The depths at which video transects were recorded included: the reef edge (15- to 20-foot depth), on the reef face (at 30- to 40-foot depth), and near the base of the reef face (at 55- to 65-foot depth).

One diver maintained position along the transect stake location and handled a 100-foot tape measure (also marked in meters). The other diver swam slowly along the established 30-meter transect line with the video camera. At the completion of the transect filming, the transect line was picked up and moved to the next transect depth and the procedure was repeated.

A field logbook was maintained and included: the sampling dates and times, descriptions of the site, transect depths, reef face structure and features, reef biota observations, and weather and sea conditions. The videotape was reviewed at the completion of each day in the field to ensure that the record is complete and to verify the location of each transect record on the video tape.

2.4 Quality Assurance and Quality Control

The quality assurance and quality control objectives for the coral reef surveys are to record representative reef-front transects at each site and provide scientific interpretations and summaries of these reef transect videos that are of known and acceptable quality. The following requirements were instituted for the field data collection to meet the objectives.

- Establish long-term transect markers and document survey site positions (within 2 meters) for repeat surveys.

- Provide field equipment redundancy (backup equipment).

- Develop a field operations and safety plan for conducting the reef surveys to summarize the schedule, survey procedures, field data recording, and safety procedures. This operations and safety plan is a key element of quality assurance and control activities.

- Test all dive and photographic equipment onsite prior to the beginning of the surveys and conduct daily equipment checks.

In addition, the data analysis, described below in Section 3, was accomplished in a manner to provide verifiable photographic interpretations of the reef transect videos. Portions of video transects were reanalyzed to verify transcription accuracy.

3. DATA ANALYSIS AND PRESENTATION OF RESULTS

The field surveys of the fringing coral reef in Pago Pago Harbor were conducted March 13-14, 2002. The coral reef surveys are used to evaluate the condition of, and changes to, the reef-face habitat in Pago Pago Harbor in the vicinity of the JCO. The surveys are limited to providing semi-quantitative data on the type and percent cover of live reef corals and other benthic species. The intent of the surveys is to provide information necessary to generally characterize and document changes to the reef habitat. It is not intended that the data be used to quantitatively describe details of the reef habitat or communities. The surveys are targeted at examination of the benthic substrate and species. Reef fish identifications are not an objective of the study.

3.1 Analysis of Video Tapes

The videotape transect records were analyzed and summarized by a qualified marine ecologist with tropical reef knowledge and several years of experience specifically in American Samoa. The videotape analysis involves repeated slow-frame viewing of the transect video to record estimates of live coral coverage and specific benthic genera. The percent of live coral was estimated at 5 meter intervals along the transect line, for 2.5 meter segments. Benthic genera identifications were made, as feasible, from the video record. Field survey data was then summarized from notes made during the video transect viewing.

Using mobile species like fish to assess ecological impacts or habitat quality on a relatively small scale is not feasible without conducting the survey over a long period of time. Many environmental and behavioral factors (season, lunar phase, time of day, tide, weather patterns, etc.) may influence the abundance of fish species in a given area at a given time. Using the sessile benthic community (primarily scleractinian corals) and habitat complexity and structure to assess the prevailing or average ecological condition introduces the least amount of bias due to immediate conditions and diver avoidance.

Data collection with video tapes of prescribed areas, or transects, reduces the limitation of SCUBA diver bottom time. However, some detail will be lost and some bias will be introduced by the camera and the camera operator. Use of video transects in this case reduced the ability to detect and distinguish between encrusting corals, coralline algae, sponges and other organisms. Camera operator bias can be introduced in several ways; traveling speed and distance from bottom, camera angle, straying from transect, recognition of organisms requiring closer focus to be identified by the video tape reviewer, and in some cases, not providing scale with the transect line as a reference.

Translation of the video tape records into semi-quantitative data required identifications, and estimations of sizes and percentage of area covered, to the extent possible by viewing the tapes. Coral identification is only provided to the generic level. Levels of uncertainty vary and depend on colony size and shape and the uniqueness of the colony form to certain

genera (for example *Echinopora* and *Montipora* are easily confused by video inspection). Distance, angle and form of the colony can cause errors in estimating size and areal coverage. This is compounded by the inability to distinguish between encrusting organisms.

Although there are biases unavoidably introduced in a survey such as the one reported here, gross identification of the larger benthic organisms, including corals, and a general characterization of the habitat structure and complexity were achieved. Biological interpretations and projections of the results are difficult, and are especially vulnerable to an individual's predicated bias. However, for the purpose of detecting general habitat changes over long time periods the techniques used in this survey are acceptable and adequate to achieve the objectives of the NPDES permit condition.

3.2 Reef Survey Results

The transect analyses notes are presented in Appendix A. Table 3-1 summarizes the semi-quantitative survey results. The summary table provides the station characteristics, benthic or sessile organisms coverage, and hard coral coverage for each transect. Copies of the video records are provided to ASEPA and USEPA as a separate attachment to this report.

Stations MH-1 is located along the northern shore that receives direct wave impacts from the south. The transects conducted at this station had 78 percent live coral coverage at the 25-foot transect depth, compared to 36 percent in the 1997 survey. The 40-foot depth had coverage of hard coral of 50 percent compared to 22 percent in 1997. The lowest coverage at this station was 32 percent at the 60-foot depth compared to 8 percent in 1997. Coverage in previous surveys (1995, 1993, and 1991) was even lower than the 1997 survey percent cover values. The severe impacts of Tropical Cyclone Val in December 1991, Tropical Cyclone Ofa, in February of 1990, and Tropical Cyclone Lin in February of 1993 were evident in previous surveys. For example, in the 1993 survey the 25- and 40-foot transects at this station showed much higher sand/silts and rubble coverage, which represented a substantial increase over the 1991 values. Evidence of the hurricane wave forces is exhibited by the six longline vessels that were grounded on the reef flats between Leloaloa and the harbor navigation range marker (site of MH-1).

The results of the reef survey at MH-4, located inside the semi-enclosed embayment between Leasi Point and Aua Point, show moderately diverse coral representation. The 25-foot transect at these stations had 35 percent live coral compared to 28 percent live coral in the 1997 survey and 20 percent in the 1993 survey. In this survey (March 2002) the coverage of the bottom with sand/silt and rubble at MH-4 remained essentially the same as in the 1997 survey.

The percentages of live corals on the steep reef face structure at Station OH-1 increased noticeably at the 25- and 40- foot depths compared to 1997. The 1997 survey showed similar conditions to the 1993 and 1995 surveys. Silt coverage, and benthic diversity observed at Station OH-1 was comparable to the reef face conditions during 1997. Wave conditions are more intense at this station than the others surveyed.

Table 3-1
Results of March 2002 Coral Reef Survey

Station	MH-1			MH-4			OH-1			OH-5		
Station Characteristics												
Depth (ft)	25	40	60	25	40	60	25	40	60	25	40	60
Percent Sand, Sediment & Rubble		5	15	20	60	85	3	7	80	1	5	40
Refuse				<1	<1	<1						
Slope Description	FS	T/S	T/G	T/S	T/S	G	W	W	FS	W	FS	G
Sessile Organisms (percent coverage)												
Algae		<1	3	1	1			<1		<1	4	1
Coralline algae	10	35	45	20		2	45	55	10	50	50	40
Encrusting ascidians							5P	2P	2P	2P	2P	1P
Encrusting sponges	5P	5P	2P	2P	1P		3P	3P	2P	2P	5P	5P
Sponges	5	5	2	8	3	2	7	7	1	3	5	3
Unidentified epiphytes					<1	<1		1	3			5
Styllaster (hydrocorallina)								<1				
Millepora (hydrocorallina)					<1					3		
Zoanthids	3			4	<1							
Soft coral			2	10	4							
Other Organisms							3P					
Hard Coral (percent coverage)												
Pocillopora	10	3								5		
Montipora	50	35	22	8	1		25	20		20	25	4
Acropora	2	5								3		
Fungia		1	<1		<1	<1				1	1	
Porites	5	5	3	15			2P	3	2	6	3	1P
Faviidae	<1						5	1		3	<1	
Diploastrea heliopora	5		3	12	25	10			<1			
Galaxea		<1						<1		<1	<1	
Lobophyllia			1									
Styllophora										<1		
Astreopora							2					
Turbinaria (or Mycedium)			2									
Unidentified Encrusting Forms	5				3							
Total Percent Live Hard Coral	**78**	**50**	**32**	**35**	**30**	**11**	**34**	**25**	**3**	**40**	**31**	**5**
Total Number of Hard Coral Genera	**6**	**6**	**6**	**3**	**3**	**2**	**4**	**4**	**2**	**5**	**5**	**2**
Total Hard Coral Genera per Station	**10**			**4**			**6**			**8**		

P = believed to be present (coverage estimated)
<1% = 1% when calculating coverage
Unidentified not included in genera count
Coverage does not include Styllaster and Millepora
Slopes as follows: G = Gradual, FS = Fairly Steep, S = Steep, W = Wall, T = Terraced

The transect conducted at 25- and 40-feet at Station OH-5 consists primarily of a steep slope of staghorn coral (*Acropora)* rubble with coralline algae and encrusting sponges and ascidians on the rubble. OH-5 had a similar species composition in previous surveys. The total percent live hard coral at OH-5 was greater in 2002 than in 1997 at all depths. Visual observations in 1991 and 1993 showed that this reef face displayed indications of typical wave damage down to 50 feet depth. The sand/silt and rubble coverage at these two transect depths was much improved in 1997 from previous surveys, and improved even further at the 60 foot depth in 2002. Station OH-5 is located approximately 600 feet from the JCO diffuser. No evidence of the wastewater impacts or settleable solids was observed at this station.

3.3 Discussion of Results

This report presents the results of the coral reef survey conducted to monitor possible changes in reef conditions following relocation of the canneries discharge points and the implementation of high strength waste segregation. These coral reef field surveys were also designed and conducted to allow comparisons of the reef conditions over time. Previous coral reef survey reports also provided comparisons between regions in the harbor.

A general qualitative comparison can be made between this survey and the previous surveys done by CH2M HILL in 1991, 1993, 1995 and 1997. The results of this comparison are summarized in Table 3-2. Table 3-2 attempts to provide an overall synthesis by examination of the total percent covered by hard coral at all depths combined, and the total number of genera identified. The summary of results includes the following points:

- Three of the four stations show apparent improvement over time in terms of percent hard coral coverage.

- Station MH-1 also appears to show a trend towards higher diversity in terms of total number of genera.

- Station MH-4 does not indicate as clear a trend of improvement, but there is no indication of degradation. This station appears to be affected by sediment loads from the nearby stream, and this is reflected in the observation that the percent sand and silt is substantially higher than for the other stations.

- Station OH-5, closest to the JCO discharge appears to be improving, and no effect of the discharge is discernable.

Table 3-3 provides a more detailed compassion than discussed above for total percent live hard coral and the total number of hard coral genera for all the studies by transect and depth. Differences in details such as variability with depth of actual numbers and genera, and other station characteristics, can be examined by comparing Table 3-1 with previous results in the reports for the 1997, 1995, 1993, and 1991 surveys.

Table 3-2
Summary Results of the 2002, 1997, 1995, 1993 and 1991 Coral Reef Surveys For 2002 Transects

Station	MH1	MH4	OH1	OH5[A]
March 2002 Survey				
Total Percent Live Hard Coral Coverage (depth average)	52	25	21	36
Total Number of Live Hard Coral Genera Identified per Station (all depths)	11	5	6	8
March 1997 Survey				
Total Percent Live Hard Coral Coverage (depth average)	22	22	15	18
Total Number of Live Hard Coral Genera Identified per Station (all depths)	9	6	6	5
March 1995 Survey				
Total Percent Live Hard Coral Coverage (depth average)	9	33	20	21
Total Number of Live Hard Coral Genera Identified per Station (all depths)	5	8	5	6
February 1993 Survey				
Total Percent Live Hard Coral Coverage (depth average)	11	15	13	6
Total Number of Live Hard Coral Genera Identified per Station (all depths)	5	4	6	4
January 1991 Survey				
Total Percent Live Hard Coral Coverage (depth average)	13	20	8	8
Total Number of Live Hard Coral Genera Identified per Station (all depths)	4	7	4	7

[A] The 60 foot depth data removed from OH-5 to make results comparable with the 1991 survey.

Table 3-3
Summary Results of the Coral Reef Survey Transects by Depth for Stations Occupied in 2002

Station	MH1			MH4			OH1			OH5		
Depth (ft) for all Surveys Except 1991	25	40	60	25	40	60	25	40	60	25	40	60
March 2002 Survey												
Total Percent Live Hard Coral	78	50	32	35	30	11	34	25	3	40	31	5
Total Number of Hard Coral Genera	6	6	6	3	3	2	4	4	2	5	5	2
March 1997 Survey												
Total Percent Live Hard Coral	35	22	8	28	31	7	24	16	4	21	15	1
Total Number of Hard Coral Genera	6	5	5	5	2	2	4	3	2	5	3	0
March 1995 Survey												
Total Percent Live Hard Coral	7	15	5	25	26	3	34	25	0	29	12	1
Total Number of Hard Coral Genera	3	3	4	3	2	2	4	3	0	6	2	0
February 1993 Survey												
Total Percent Live Hard Coral	20	<9	<5	20	30	0	27	7	<5	5	7	4
Total Number of Hard Coral Genera	2	4	0	1	1	0	5	2	0	2	4	2
January 1991 Survey												
Total Percent Live Hard Coral	<1	>30	>8	10	50	0	10	<5	<10	10	5	--
Total Number of Hard Coral Genera	1	3	3	1	1	0	3	2	3	4	4	--
Depth (ft) for January 1991 Study	20	35	55	15	40	60	20	35	60	30	50	--

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CH2M HILL. Receiving Water Quality Monitoring Report, Pago Pago Harbor, American Samoa, August 2002. March 2003b (in preparation).

APPENDIX A

CORAL REEF TRANSECT ANALYSIS

FIELD SURVEYS CONDUCTED 13-14 MARCH 2002

TRANSECT SUMMARIES

FIELD SURVEYS CONDUCTED BY CH2M HILL 13-14 MARCH 2002

VIDEO INTERPRETATION BY TROY BUCKLEY

Descriptions of each transect include estimates of the percent areal coverage, summarized over the entire transect, by substrate type and by distinguishable types of biota.

Station MH-1 Transects

At this station the reef front is fairly steep with a "spur-and-groove"-like topography providing complex and varied habitat. Large coral colonies of *Diploastrea heliopora* and *Porites* were seen near the transects. A large number and variety of fishes were identified at the station that were not encountered on the transects including parrotfishes (scaridae - *Scarus* sp.), wrasses (labridae - *Bodianus axillaris, Labroides* sp.), surgeonfishes (acanthuridae - *Acanthurus* sp., *Ctenochaetus striatus, Naso lituratus, Zebrasoma scopas*), triggerfishes (balistidae), damselfishes (pomacentridae - black and white *Chromis* sp.), bannerfishes (chaetodontidae - *Heniochus monoceros, H. varius, H. acuminatus*), and butterflyfishes (also chaetodontidae - *Chaetodon unimaculatus, C. vagabundus, C. ornatissimus, C. lunula, C. ephippium*)

25-foot Depth

At a depth of 25 feet, the habitat was composed of a variety of complex coral formations affording a wide size-range of caves, crevices and holes. The substrate was encrusted with coralline algae (10%) and probably sponges (5%). Standing sponges were very common (5%). Living corals were represented primarily by encrusting and plate colonies of *Montipora* (50%), *Porites* (5%), and unidentified types (5%). Small colonies of *Pocillopora* (10%) were numerous, colonies of digitate *Acropora* (2%) were present, and a colony of *Diploastrea heliopora* (5%) and an unidentified Faviid (<1%) occurred. Some zoanthids (3%) were also present and two ropes run through this transect. Wrasses (labridae including *Cheilinus* sp.), damselfish (pomacentridae) including blue damselfish (perhaps *Chrysiptera taupou [cyanea]* or *Pomacentrus pavo*) and farmerfish (*Stegastes* sp.), and a pufferfish (tetraodontidae) were seen on the transect.

40-foot Depth

At a depth of 40 feet, the habitat was moderately complex, alternating between large limestone boulders, vertical areas with terraced plates and low pockets of rubble. Larger rubble was partially consolidated by encrusting organisms and some horizontal surfaces had some sand and silt (5%). Most hard surfaces were encrusted by coralline algae (35%) and probably some encrusting sponges (5%). Standing sponges (5%) were also common at this depth. Living corals included encrusting and plate-like corals -

Montipora (35%) and *Porites* (5%) - digitate *Acropora* (5%), *Pocillopora* (3%), *Galaxea* (<1%), and *Fungia* (1%). A branching, possibly calcified algae (or bryozoan?) (<1%) was also present, and two ropes, partially encrusted by coral colonies, run through this transect. Fishes observed on the transect include butterflyfishes (chaetodontidae - *Forcipiger flavissimus* and *Chaetodon reticulatus*) and farmerfish (pomacentridae - *Stegastes* sp.).

60-foot Depth

At a depth of about 60 feet, the habitat alternated between dead coral plates that formed a fairly complex terraced slope, semi-consolidated coral rubble (40 to 60 cm plate and massive forms) and gentler sloping areas with smaller coral rubble. Silt cover (15%) was light on solid surfaces but more concentrated in depressions, often with smaller rubble. Coralline algae (45%) consolidated some of the coral rubble and was common on solid surfaces. Sponges (2%) were seen, but not as numerous as in shallower depths, and encrusting sponges (2%) were probably present. Soft coral (alcyonacea) (2%) was seen. Scleractinian corals were mostly encrusting and laminar plate forms of *Montipora* (22%) and *Porites* (3%). Although a young colony of *Diploastrea heliopora* (3%), a *Fungia* (<1%), a plate-like colony (possibly *Turbinaria* or *Mycedium*) (2%), and a small colony of (probably) *Lobophyllia* (1%) occurred. A fleshy or calcified-looking algae (2%) and a stringy-looking red algae (maybe *Plocamium* sp.) (<1%) occurred. A surgeonfish (acanthuridae) was seen on the transect.

STATION MH-4 TRANSECTS

At this station, just a few meters from the transect stakes, huge *Diploastrea heliopora* shields extend from the reeftop downwards on the steep reef face. Some digitate *Acropora* and soft corals were seen in the area. Fishes were abundant in this area and include butterflyfishes (*Chaetodon* spp. - chaetodontidae), lemon peel angelfish (pomacanthidae - *Centropyge flavissimus*), and damselfishes (pomacentridae - light blue *Chromis* sp.).

25-foot Depth

At a depth of 25 feet, consolidated coral rubble and coral formations were interspersed with depressions where silt and sand (10%) accumulated. Silt (10%) covered some of the consolidated coral formations, especially in pockets of rubble, and a beverage can (<1%) occurred. Sponges (the common, standing, orange type (6%) and a spherical, brown type (2%)) were plentiful. Two types of soft corals (alcyonacea) (10%) were common and zoanthids (4%) were seen. Coralline algae (20%) and probably sponges (2%) encrusted most the coral-free, hard surfaces. Some algae (1%) also occurred. Live coral cover included encrusting and plate forms of *Porites (rus?)* (15%) and *Montipora* (8%), and a few small and large colonies of *Diplostrea heliopora* (12%). The reticulated butterflyfish (chaetodontidae - *Chaetodon reticulatus*), Moorish idol, (zanclidae - *Zanclus cornutus*), surgeonfishes (acanthuridae), and several types of damselfishes (pomacentridae) were seen, including farmerfish (*Stegastes* sp.) and blue damselfish (perhaps *Chrysiptera taupou [cyanea]* or *Pomacentrus pavo*). A starfish was observed near the beginning of the transect.

40-foot Depth

At a depth of 40 feet, the silt, sand and rubble slope was periodically interrupted by patches of shields and ledges, consolidated rubble, and consolidated larger coral forms. Overall, silt and sand (60%) covered rubble and solid surfaces, and some of the silt appeared consolidated by epiphytes (<1%) (perhaps hydroids and algae). A palm frond (<1%) and two types of sponges (3%) were seen, and encrusting sponges (1%) were probably present. Soft corals (alcyonacea) (4%), zoanthids (<1%), a fleshy algae (1%) and non-scleractinian *Millepora* (hydrocorallina) (<1%) were present. Scleractinian corals were dominated by remnants of large *Diploastrea heliopora* (25%) shields, but *Fungia* (<1%) and encrusting and thin plate-like corals (*Montipora* - 1% and unidentified - 3%) also occurred. Damselfishes (pomacentridae - including *Stegastes* sp.), pufferfish (tetraodontidae), bicolor angelfish (pomacanthidae - *Centropyge bicolor*), and vagabond butterflyfish (chaetodontidae - *Chaetodon vagabundus*) were seen on the transect.

60-foot Depth

At a depth of 60 feet, the water appeared turbid and the visibility was poor. Patches of accumulated silt (40%) interrupted the low-plate and shield formations at the base of the reef slope. One beverage bottle (<1%) was observed. The silt on the low, semi-foliaceous plates and dead coral shields (45%) appeared to be somewhat consolidated by various epiphytes (<1%). Sponges (2%) and coralline algae (2%) were present. Living coral included several young or recovered *Diploastrea heliopora* (10%) colonies and a *Fungia* (<1%). Damselfishes (pomacentridae) and wrasses (labridae) were seen on the transect.

Station OH-1 Transects

At this station, the reef face is nearly a vertical wall with overhangs and caves providing some complexity. The wall extends down to a depth of about 60 feet where the transition to a silt, sand and rubble slope takes place. A large *Diploastrea heliopora* colony was seen below the 25-ft depth transect stake. Near the 40-ft depth transect stake, colonies of *D. heliopora, Porites rus* and *Montipora* plates were seen. The non-scleractinian "pink lace coral" *Stylaster* (hydrocorallina) occurred under ledges. The wide variety of fishes in the area were also mostly seen on the transects, except for a large group of poison-fang blennies (blenniidae - *Meiacanthus atrodorsalis*).

25-foot Depth

At a depth of 25 feet, the nearly vertical reef face had a wide size-range of holes, caves and overhangs that gave the habitat some complexity. A little sand and silt (3%) occurred on horizontal surfaces. The hard substrate was encrusted with coralline algae (45%), probably encrusting sponges (3%), ascidians (5%) and other organisms (3%). Sponges were very common (7%). Living corals were represented primarily by encrusting and plate colonies of *Montipora* (25%), encrusting to massive Faviids (and/or Mussids) (5%), *Astreopora* (2%) and probably *Porites* (2%). Many fishes were seen on and near the transect at this depth including damselfishes (pomacentridae) of the genera *Abudefduf, Chromis, Stegastes,* and either *Chrysiptera taupou [cyanea]* or *Pomacentrus pavo;* Moorish idols (zanclidae - *Zanclus cornutus*); goatfish (mullidae); wrasses (labridae);

pufferfish (tetraodontidae); and surgeonfishes (acanthuridae - *Acanthurus* sp., *Ctenochaetus striatus, Zebrasoma scopas*).

40-foot Depth

At a depth of 40 feet, the reef face was steeply sloping or nearly vertical with many overhanging ledges and caves that created some complexity at a variety of scales. Silt (7%) accumulated with some rubble in one low pocket and covered some of the horizontal surfaces where it seemed somewhat consolidated by epiphytes (possibly algae and hydroids) (1%). Filamentous algae was seen (<1%) and most surfaces were encrusted by coralline algae (55%), sponges (maybe 3%) and possibly ascidians (maybe 2%). Sponges (7%) were also numerous at this depth. The non-scleractinian "pink lace coral" *Stylaster* (hydrocorallina) (<1%) was seen under a ledge. Encrusting and plate-like corals - *Montipora* (20%) and *Porites* (3%) - were the most common types, but small massive colonies of an unidentified Faviid (1%) (possibly *Montastrea*) and *Galaxea* (<1%) also occurred. Damselfishes (pomacentridae), surgeonfishes (acanthuridae) and a small white fish, probably a gobie (gobiidae), were seen on the transect.

60-foot Depth

The transect at a depth of 60 feet was mostly on a rubble and silt slope at the base of the reef wall. It crossed a variety of low complexity habitat types, from a sand and silt bottom with dead *Diploastrea heliopora* shields overhanging above, to a near vertical reef wall to low consolidated coral formations. Overall, silt and sand (70%) bottom, sometimes mixed with rubble, and silt on solid horizontal surfaces of coral formations (10%) were most common. Epiphytes (3%) may have been consolidating some of the silt. Few sponges were seen (1%), and most silt-free surfaces were encrusted with coralline algae (10%) and probably encrusting sponges (2%) and ascidians (2%). Few living coral colonies were encountered - encrusting *Porites* (2%) and *Diploastrea heliopora* (<1%). Many fishes were observed on the transect including farmerfish (pomacentridae - *Stegastes* sp.), jewel damsels (pomacentridae - *Plectroglyphidodon lacrymatus*), regal angelfish (pomacanthidae - *Pygoplites diacanthus*), Moorish idols (zanclidae - *Zanclus cornutus*), parrotfish (scaridae), filefish (monacanthidae), goatfish (mullidae), and a honeycomb grouper (serranidae - *Epinephelus* sp.).

Station OH-5 Transects

At this station the "spur-and-groove"-like reef face slopes away from the reef break, decreasing in steepness with increasing depth. Habitat complexity, coral diversity and fish abundance appear to be fairly high. Fishes observed at this station, but not on the transects include wrasses (labridae - *Labroides dimidiatus, Cheilinus* spp.), parrotfishes (scaridae), damselfishes (pomacentridae - *Pomacentrus vaiuli*), butterflyfishes (chaetodontidae - *Chaetodon ephippium, C. trifasciatus, C. unimaculatus*), surgeonfishes (acanthuridae - *Naso lituratus, Acanthurus nigricans, A. thompsoni*), and jacks (carangidae - probably *Caranx sexfasciatus*).

25-Foot Depth

At a depth of 25 feet, the transect crossed a spur and groove reef front below the reef break. The habitat was a complex array of large and small formations and crevices creating a fairly rugose habitat. Silt (1%) rarely occurred and only in small pockets with rubble. Some of the *Fungia* appeared to be partially white indicating recent stress due to high water temperatures or siltation, or perhaps natural death. Most of the larger coral rubble and formations were solidly consolidated by coralline algae (50%), encrusting sponges (maybe 2%) and ascidians (maybe 2%). Sponges (3%) and stringy-looking red algae (maybe *Plocamium* sp.) (<1%) were observed on the transect. Most living corals were large and small encrusting colonies of *Montipora* (20%), *Porites* (5%), *Acropora* (3%), and non-scleractinian *Millepora* (hydrocorallina) (3%). Other small colonies were common and include *Pocillopora* (5%), unidentified faviids (3%), *Porites rus* (1%), *Fungia* (1%), *Styllophora* (<1%) and *Galaxea* (<1%). were also identified. Surgeonfishes (acanthuridae - *Acanthurus* sp., *Zebrasoma scopas, Ctenochaetus striatus*); Moorish idol (zanclidae - *Zanclus cornutus*); regal angelfish (pomacanthidae - *Pygoplites diacanthus*); reticulated butterflyfish (chaetodontidae - *Chaetodon reticulatus*); damselfishes (pomacentridae); including many blue damsels (*Chrysiptera taupou [cyanea]* or *Pomacentrus pavo*), white-tail damsels (*Chromis* sp.), jewel damsels (*Plectroglyphidodon lacrymatus*), Johnston Island damsel (*P. johnstonianus*), and scissor-tail sergeants (*Abudefduf sexfasciatus*); and trumpetfish (aulostomidae - *Aulostomus chinensis*) were seen on this transect.

40-Foot Depth

The transect at the 40 foot depth is still in spur and groove topography, and is fairly complex habitat with a variety of holes and crevices. Very little silt (5%) was present except for some accumulations in the lowest areas, sometimes with small rubble. One rope crossed the transect at this depth. Solid surfaces were encrusted and loose rubble was semi-consolidated by coralline algae (50%), encrusting sponges (maybe 5%) and ascidians (maybe 2%). Standing sponges (5%) were common, and patches of fleshy, stringy-looking red algae (maybe *Plocamium* sp.) (1%) and a whitish fleshy algae (3%) were also noted. The live coral cover was mostly dominated by encrusting or small, plate-like forms of *Montipora* (25%) and *Porites* (3%), but a small colony of *Galaxea* (<1%), an unidentified Faviid (<1%), and several small *Fungia* (1%) were also seen. A high diversity and number of fishes were also seen on the transect at this depth, including angelfishes (pomacanthidae - *Pygoplites diacanthus, Centropyge flavissimus*); butterflyfishes and bannerfishes (chaetodontidae - *Chaetodon reticulatus, Heniochus* sp.); juvenile and adult parrotfishes (scaridae); Moorish idol (zanclidae - *Zanclus cornutus*); surgeonfishes (acanthuridae); filefish (monacanthidae); pufferfish (tetraodontidae); poison-fang blennie (blenniidae - *Meiacanthus atrodorsalis*); flame-tailed snapper (lutjanidae - *Lutjanus fulvus*); bigeye emperor (lethrinidae - *Monotaxis grandoculus*); and damselfishes (pomacentridae - including blue damsels (*Chrysiptera taupou [cyanea]* or *Pomacentrus pavo*, and farmerfish (*Stegastes* sp.)).

60-Foot Depth

At a depth of 60 feet, the gentle slope habitat was composed of semi-consolidated rubble of various sizes and low coral formations. Loose sand and silt (40%) was accumulated in

depressions but was on some hard surfaces and occasionally appeared consolidated by epiphytes (5%). Coralline algae (maybe 40%) encrusted most of the silt free hard surfaces, but encrusting sponges (5%) and ascidians (1%) may have also been present. Sponges (3%) were fairly common and a few patches of fleshy, stringy-looking red algae (maybe *Plocamium* sp.) (1%) also occurred. There appeared to be very little live coral cover at this depth, and it consisted of some small, thin, plate-like or encrusting colonies of *Montipora* (4%) and perhaps *Porites* (1%). A dead *Fungia* was seen. A similar community of fishes were observed here as in shallower depths at this station and included farmerfish (pomacentridae - *Stegastes* sp.), reticulated butterflyfish (chaetodontidae - *Chaetodon reticulatus*), surgeonfishes (acanthuridae), several bicolor angelfish (pomacanthidae - *Centropyge bicolor*), regal angelfish (pomacanthidae - *Pygoplites diacanthus*), and goatfishes (mullidae) were seen mostly near the sand bottom.

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19 December 2003

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Enclosed is the required report for the bioassay test results for the August 2003 effluent sampling for the Joint Cannery Outfall in American Samoa. The sampling and analysis were carried out without problems. The result are similar to the past bioassay test results. We have added Figure 1 to the normal reporting format to illustrate the cumulative results for all tests conducted with mysid shrimp.

Please call us if you have any questions or comments on the enclosed report,

Sincerely,

Karen A. Glatzel

Cc: Jim Cox, COS International; Herman Gebauer, COS; Brett Ransby, COS; Phil Thirkel, StarKist Samoa; Joe Carney, StarKist Samoa; Steve Erickson, Del Monte; David Wilson, CH2M HILL.

Encl: Bioassay Testing – Joint Cannery Outfall Effluent March 2003 Sampling

Sanger Joint Cannery Outfall

2003 Tradewind Season

Effluent Bioassay Test Results

August 2003 Sampling

15 December 2003

CH2MHILL

CH2MHILL

TECHNICAL MEMORANDUM

BIOASSAY TESTING – JOINT CANNERY OUTFALL EFFLUENT AUGUST 2003 SAMPLING

Prepared For: StarKist Samoa (NPDES Permit AS0000019)
COS Samoa Packing (NPDES Permit AS0000027)

Prepared By: Steve Costa
Karen Glatzel

Date: 15 December 2003

Distribution: Carl Goldstein
United States Environmental Protection Agency, Region 9
Peter Peshut
American Samoa Environmental Protection Agency

Purpose

This memorandum presents the results of the bioassay testing of the Joint Cannery Outfall effluent sample that was collected in August 2003. The testing is required by the NPDES Permits that became effective in January 2001. This is the sixth required semiannual test required by the current permits and the twenty-second semiannual test conducted since testing for the Joint Cannery Outfall began in 1993.

Study Objectives

Section D.1 of the StarKist Samoa and COS Samoa Packing NPDES Permits requires that semiannual definitive acute bioassays (96-hour static bioassays) be conducted on the cannery effluent. The purpose of these tests is to determine whether, and at what effluent concentration, acute toxicity may be detected for the combined joint cannery effluent discharge into Pago Pago Harbor.

Study Approach

U.S. EPA has conducted a number of reviews of the effluent sampling, analysis, and bioassay tests conducted in the past. All comments from U.S. EPA have been incorporated into the sampling and sample handling standard operating procedures (SOP) or have been incorporated into the procedures used by the laboratory doing the test. The comments, responses, and SOP have been documented in previous reports.

The permit conditions require that the bioassay tests be conducted with the white shrimp, *Penaeus vannami* (postlarvae). In the event *Penaeus vannami* is not available at the time of the tests, the permit specifies the substitute species, *Mysidopsis bahia*, which now has been renamed *Americamysis bahia*. For the August 2003 sampling, *Penaeus vannami* was not available and *Americamysis bahia* was used.

Effluent samples were collected from the StarKist Samoa and COS Samoa Packing facilities as 24-hour composite samples. The acute effluent bioassay test was conducted using a combined, flow-weighted, composite effluent sample made up from the effluent samples from both canneries, as allowed by the permit condition. This combined effluent bioassay is representative of the wastewater discharged from the joint cannery outfall to Pago Pago Harbor.

Effluent Sampling Methods

Between 1200 noon on 6 August 2003 and 0900 on 7 August 2003, 24-hour flow-weighted composite samples of final effluent were collected from both the StarKist Samoa and COS Samoa Packing effluent discharges. Samples were collected from the established effluent sampling sites. Detailed sampling procedures are described in the established SOP for cannery effluent sampling.

A total of eight grab samples were collected into 1-gallon plastic cubitainers at each plant. Samples were collected at approximately three-hour intervals over a 24-hour period. The samples were stored on ice or in a refrigerator until the completion of the 24-hour sampling period. After all samples were collected a flow-proportioned composite sample was prepared. The grab sample collection times, effluent flow rates, and the relative effluent flow volumes calculated from plant flow records are summarized in Table 1. The relative effluent flow volumes were used to prepare the final composite sample, which was used to fill the sample container shipped to the laboratory for testing.

A 5-gallon cubitainer containing the composite sample was packed on ice in an ice chest for shipment to the laboratory. A chain-of-custody form for the sample was completed and sealed into a zip-lock bag and taped inside the lid of the ice chest. The sample was shipped via DHL to the testing laboratory. The chain-of-custody form and the DHL waybill are provided in Attachment I.

Table 1
StarKist Samoa and COS Samoa Packing
24-hour Composite Effluent Sample for Bioassay Testing
August 2003

Grab Sample Number	COS Samoa Packing		StarKist Samoa		COS Samoa Packing Percent of Total Flow	StarKist Samoa Percent Of Total Flow
	Sampling Date and Time	Effluent Flow Rate (mgd)	Sampling Date and Time	Effluent Flow Rate (mgd)		
1	06 Aug 0900 1200	0.860	06 Aug 0900 1200	1.75	3.9	8.0
2	1500	0.800	1500	2.61	3.6	11.9
3	1800	0.640	1800	1.85	2.9	8.4
4	2100	0.600	2100	2.70	2.7	12.3
5	07 Aug 2003 0000	0.460	07 Aug 2003 0000	2.10	2.1	9.5
6	0300	0.460	0300	2.10	2.1	9.5
7	0600	0.600	0600	2.16	2.7	9.8
8	0900	0.560	0900	1.77	2.5	8.0
Total		4.98		17.04	22.6	77.4
Mean		0.62		2.13	100.0	

Bioassay Testing Procedures

EnviroSystems, Inc. located in Hampton, New Hampshire conducted the bioassay tests. The testing procedures and results of the bioassay tests are provided in the Laboratory report included as Attachment II. This report summarizes the 96-hour acute bioassay test conducted with reference to U.S. EPA documents Methods for Measuring the Acute Toxicity of Effluents to Freshwater and Marine Organisms (EPA-821-R-02-012), 2002 as the sources of methods for conducting the test. The bioassay test was conducted considering and including U.S. EPA's comments on previous bioassay tests, as documented in previous reports.

The test organisms were ≤ 5 days old and the test temperature was to be held at 20 ±1°C, with actual temperatures ranging between 19°C and 23°C. Salinity was

adjusted to 25 ppt at the start of the test and ranged during the test between 24 and 26 ppt. Demonstrated potential for a lethal immediate dissolved oxygen demand (IDOD) had been discussed and documented in previous bioassay technical memoranda, which describe the first two tests conducted in 1993. Therefore, all of the bioassay test chambers were continuously aerated during the bioassay tests to maintain adequate levels of dissolved oxygen (DO). The test was renewed with oxygenated sample at 48 hours.

Bioassay tests were carried out for effluent concentrations of 50, 25, 12.5, 6.25, and 3.1 percent as vol:vol dilutions in seawater. Water quality was monitored daily and parameters measured included DO, pH, salinity, and temperature. Total residual chlorine and ammonia were measured. Reference toxicant tests using sodium dodecyl sulfonate (SDS) are conducted regularly by ESI with the last one completed on 26 August 2003 and results were within one standard deviation of the historic laboratory mean.

Summary Results: Americamysis bahia Effluent Bioassay

All results from the bioassay tests are included in Attachment II. The results of the mysid bioassay tests indicate the 96-hour LC_{50} for the effluent tested was 43.2 percent. The no observable effects concentration (NOEC) for the 96-hour bioassay was 25 percent and the least observable effects concentration (LOEC) was 50 percent. Results on a daily basis are summarized in Table 2.

Table 2
StarKist Samoa and COS Samoa Packing
Combined Effluent Bioassay Results August 2003 Sampling

Exposure Time	Parameter		
	LC_{50}	NOEC	LOEC
24 hours	50.0	50%	>50%
48 hours	50.0	50%	>50%
72 hours	50.0	50%	>50%
96 hours	43.2	25%	50%

Discussion

Table 3 summarizes the results of the effluent bioassay tests for the samples collected in the August 2003 sampling compared to the previous bioassay tests. The

LC_{50}, NOEC and LOEC are within the range obtained from previous reports where *Mysidopsis bahia* was used in place of *Penaeus vannami*. Figure 1 presents the range of results for LC_{50} for the mysid tests for all tests done since 1994. There is some variability observed in test results, and the August 2003 test results were the highest LC_{50} values recorded for this organism. Higher LC_{50} values indicate lower whole effluent toxicity. There is a possible trend toward lower toxicity (higher LC_{50}) with time, however the trend is not statistically significant.

Conclusions

The bioassay tests for the Joint Cannery Outfall effluent for August 2003 do not indicate effluent toxicity levels to be of concern. As discussed in the previous bioassay test reports on the effluent, the time scale of the mixing of the effluent with the receiving water is on the order of seconds to achieve dilutions that will eliminate possible toxic effects as reflected by the bioassay results. For example, an LC_{50} of 43.2%, which was observed in August 2003, corresponds to a dilution of 2.3:1, which is achieved within one second and within one meter of the discharge point. The discharge is located in about 180 feet of water and the effluent toxicity tests indicate that the discharge is diluted to non-toxic levels immediately after discharge and well within the initial dilution plume.

Table 3
StarKist Samoa and COS Samoa Packing
Combined Effluent Bioassay Results

Date	*Species*	Parameters		
		LC 50	NOEC	LOEC
2/93	*Penaeus vannami*	4.8%[1]	3.1%	6.25%
10/93	*Penaeus vannami*	15.67%	3.1%	6.25%
2/94	*Penaeus vannami*	15.76%	<1.6%	1.6%
10/94	*Mysidopsis bahia*[2]	31.2%	25%	50%
3/95	*Penaeus vannami*	14.8%	6.25%	12.5%
3/95	*Mysidopsis bahia*[3]	10.8%	6.25%	12.5%
2/96	*Penaeus vannami*	>50%	>50%	>50%
2/96	*Mysidopsis bahia*[3]	28.36%	12.5%	25%
3/96	*Penaeus vannami*	44.4%	25%	50%
11/96	*Penaeus vannami*	7.11%	3.1%	6.25%
03/97	*Penaeus vannami*	39.36%	12.5%	25%
09/97	*Penaeus vannami*[4]	12.3%	6.25%	12.5%
06/98	*Mysidopsis bahia*[2]	17.2%	6.25%	12.5%
11/98	*Mysidopsis bahia*[2]	15%	6.25%	12.5%
02/00	*Mysidopsis bahia*[2]	20%	6.25%	12.5%
08/00	*Mysidopsis bahia*[2]	17.1%	3.1%	6.25%
03/01	*Americamysis bahia*[5]	13.8%	12.5%	25%
10/01	*Americamysis bahia*[6]	37.5%	25.0%	50.0%
3/02	*Americamysis bahia*[6]	16.1%	12.5%	25%
8/02	*Americamysis bahia*[6]	10.23%	6.25%	12.5%
03/03	*Americamysis bahia*[6]	28.4%	25%	50%
08/03	***Americamysis bahia*[6]**	**43.2%**	**25.0%**	**50.0%**

[1]The February 1993 samples were not aerated until after the first day of the test. For subsequent tests the samples were aerated for the entire duration of the tests.
[2]*Mysidopsis bahia* used as substitutes because *Penaeus vannami* not available: as directed and approved by U. S. EPA.
[3]*Mysidopsis bahia* used in addition to *Penaeus vannami* as described in text of technical memorandums reporting test results. Only one species is required by the permit conditions.
[4]Stage 1 (3 mm) *Penaeus vannami* were used for testing because older Stage 7 and 8 (8-10 mm) *Penaeus vannami* were not available.
[5]*Mysidopsis bahia* renamed *Americamysis bahia*. Results indicate increased toxicity because of low DO in renewal concentrations as renewal water was not aerated prior to use
[6] *Mysidopsis bahia* renamed *Americamysis bahia*

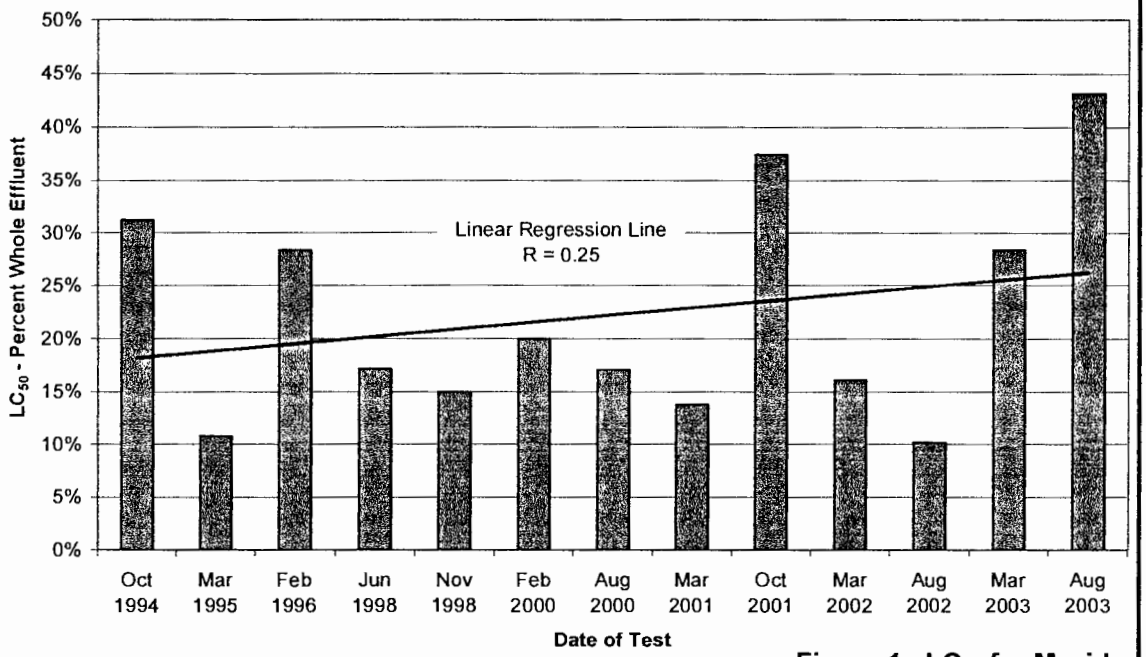

Figure 1. LC_{50} for Mysids

ATTACHMENT I

Chain-of-Custody

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Shipper's name: STEVE COSTA

Address: ~~772 108TH AVE NE BELLEVUE WA~~ LA FALEPOLE FAGA'ALU AMERICAN SAMOA 684-633-5264

Zip code (required): ~~[illegible]~~ 96799

Phone/Fax/E-mail circle one (required): (425)453-5000

2 To (Recipient)

Company name: ENVIROSYSTEMS, INC

Attention: PETRA KARBE

Delivery address: ONE LAFAYETTE ROAD HAMPTON, NEW HAMPSHIRE

Zip/Postcode (required): 03842

Phone/Fax/E-mail circle one (required): 603-926-3345

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☐ **LKW** Canviro Analytical Laboratories, Inc., 50 Bathurst, Unit 12, Waterloo, Ontario, Canada N2V 2C5, (519) 747-2575 FAX (519) 747-3806
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Project #	147323.JC.03.TW
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Project Manager or Contact & Phone #	STEVE COSTA 707-677-0123
Report Copy to:	SAME
Requested Completion Date:	
Site ID	
Sample Disposal:	Dispose ☑ Return ☐

Sampling Date	Sampling Time	Type COMP	Type GRAB	Matrix WATER	Matrix SOIL	Matrix AIR	CLIENT SAMPLE ID (9 CHARACTERS)	LAB QC	TOTAL # OF CONTAINERS	Requested Analytical Method # (BIOASSAY TEST W/MYSIDOPSIS 96 HR STATIC RENEWAL)	Preservative	THIS AREA FOR LAB USE ONLY: Alternate Description	Lab ID
01 7 AUG 2003		X		X			JCO-03-TW		1	X		50-25-12½-6-3% AERATE CONTINUOUSLY AND BEFORE RENEWAL	

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THIS AREA FOR LAB USE ONLY

Lab #	Page	of
Lab PM	Custody Review	
Log In	LIMS Verification	
pH	Custody Seals Y N	
	Ice Y N	
QC Level 1 2 3 Other		
Cooler Temperature		

Relinquished By	Empty Bottles	Date/Time	Received By / Empty Bottles / Date/Time
Sampled By and Title (Please sign and print name)		Date/Time 7 AUG 03	Relinquished By (Please sign and print name) / Date/Time 7 AUG 2003
Received By (Please sign and print name) Ryan Carrin		Date/Time 8/13/03 1045	Relinquished By (Please sign and print name) / Date/Time
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ATTACHMENT II

EnviroSystems, Inc. Laboratory Report

TOXICOLOGICAL EVALUATION OF A TREATED EFFLUENT: BIOMONITORING SUPPORT FOR A NPDES PERMIT AUGUST 2003

American Samoa Joint Cannery Outfall

Prepared For

CH2M Hill, Incorporated
P.O. Box 1238
Trinidad, California 95570-1238

By

EnviroSystems, Incorporated
One Lafayette Road
Hampton, New Hampshire 03842

August 2003
Reference Number CH2M-Samoa11419-03-08

STUDY NUMBER 11419

EXECUTIVE SUMMARY

The following summarizes the results of acute exposure bioassays performed from August 13-17, 2003 in support of the NPDES biomonitoring requirements of the American Samoa Joint Cannery Outfall. The 96 hour acute definitive assay was conducted using the marine species, *Americamysis bahia.*

Acute Toxicity Evaluation

Species	Exposure	LC-50	NOEC	LOEC
Americamysis bahia	24-Hours	>50.0%	50.0%	>50.0%
	48-Hours	>50.0%	50.0%	>50.0%
	72-Hours	50.0%	50.0%	>50.0%
	96-Hours	43.2%	25.0%	50.0%

TOXICOLOGICAL EVALUATION OF A TREATED EFFLUENT: BIOMONITORING SUPPORT FOR A NPDES PERMIT AUGUST 2003

American Samoa Joint Cannery Outfall

1.0 INTRODUCTION

Acute toxicity tests involve preparing a series of concentrations by diluting effluent with control water. Groups of test organisms are exposed to each effluent concentration and a control for a specified period. In acute tests, mortality data for each concentration are used to calculate (by regression) the median lethal concentration, or LC-50, defined as the effluent concentration which kills half of the test organisms. Samples with high LC-50 values are less likely to cause significant environmental impact. The acute no observed effect concentration (NOEC) and lowest observed effect concentration (LOEC) document the highest and lowest effluent concentrations that have no impact and a significant impact on the test species, respectively.

This report presents the results of an acute toxicity test conducted on an effluent sample collected from the American Samoa Joint Cannery Outfall. Testing was based on programs and protocols developed by the US EPA (2002) and involved conducting 96 hour acute static renewal toxicity tests with the marine species, *Americamysis bahia*. Testing was performed at EnviroSystems, Incorporated (ESI), Hampton, New Hampshire in accordance with the provisions of the NELAC Standards (2000).

2.0 MATERIALS AND METHODS

2.1 General Methods

Toxicological and analytical protocols used in this program follow procedures primarily designed by the EPA to provide standard approaches for the evaluation of toxicological effects of discharges on aquatic organisms, and for the analysis of water samples. See Section 4.0 for a list of references.

2.2 Test Species

Every attempt was made to acquire the species, *Penaeus vannami,* as this is the preferred organism under the Cannery's permit. ESI was unable to obtain reasonably priced *P. vannami.* Due to the exorbitant expense, the decision was made to use an alternate species, *Americamysis bahia*.

A. bahia, ≤5 days old, were from cultures maintained by ESI. Test organisms were transferred to test chambers by large bore pipet, minimizing the amount of water added to test solutions.

2.3 Effluent and Dilution Water

The effluent sample used in the assay was identified as "JCO-03-TW." Sample collection information is provided in Table 4. Upon receipt, the sample was stored at 4°C. All sample material used in the assay was warmed to 20±1°C prior to preparing test solutions. Total residual chlorine (TRC) was measured using amperometric titration (MDL 0.05 mg/L). As the effluent sample contained <0.05 mg/L, TRC dechlorination with sodium thiosulfate was not required (EPA 2002). Aliquots of the undiluted effluent sample were collected for ammonia analysis when the sample arrived and again prior to renewal. At arrival, the effluent sample had a salinity of 12‰. Salinity of the effluent was increased to 25‰ by the addition of artificial sea salts. Test concentrations for the assays were 50%, 25%, 12.5%, 6.25% and 3.1% effluent with a laboratory water diluent control.

The dilution water used in this assay was collected from the sea water system at ESI. The water is pumped in daily from the Hampton Estuary on the flood tide, filtered through a high volume sand filter, and stored in 3000 gallon polyethylene tanks. The water is classified as Class SA-1 by the State of New Hampshire, and has been used to culture test organisms for over 20 years. Sea water used in the assay had a salinity of 25±2‰ and a TRC of <0.05 mg/L.

2.4 Acute Toxicity Tests

The 96 hour acute static renewal toxicity test was conducted at 20±2°C with a photoperiod of 16:8 hours light:dark. Test chambers for the acute assays were 250 mL glass beakers containing 200 mL test solution in each of 5 replicates, with 10 organisms/replicate. Survival, dissolved oxygen, pH, salinity and temperature were measured daily in all replicates. Test solutions were renewed after 48 hours using effluent from the start sample. Mysid shrimp were fed daily with <24 hour old brine shrimp.

2.5 Data Analysis

At 24 hour intervals, survival data was analyzed to assess toxicity using a program developed by Stephan (1982). LC-50 values were computed using the Spearman-Karber, Binomial, and Probit methods. If survival in the highest test concentration was >50%, LC-50 values were obtained by direct observation of the raw data. The NOEC was determined as the highest test concentration which caused no significant mortality while the LOEC was determined as the lowest concentration that did cause significant mortality.

2.6 Quality Control

As part of the laboratory quality control program, standard reference toxicant assays are conducted on a regular basis for each test species. These results provide relative health and response data while allowing for comparison with historic data sets. See Table 2 for details.

3.0 RESULTS

Results of the acute exposure bioassay conducted using the mysid shrimp, *A. bahia*, are summarized in Table 1. A summary of reference toxicant data for the test species is presented in Table 2. Effluent and dilution water characteristics are presented in Table 3. Sample collection information is provided in Table 4. Table 5 provides a summary of historic data associated with the discharge. Support data are included in Appendix A.

3.1 Acute Toxicity Test - *Americamysis bahia*

Control survival was 100% after 24 hours exposure, and 96% after 48, 72 and 96 hours exposure. These results are an indication of healthy test organisms and that the dilution water had no adverse impact on the outcome of the assay.

Table 1 provides a summary of the acute exposure data and results.

3.2 Summary

The salinity adjusted effluent sample collected from the American Samoa Joint Cannery Outfall did exhibit signs of acute toxicity to the mysid shrimp, *Americamysis bahia,* during the 96 hour exposure period.

4.0 LITERATURE CITED

APHA. 1998. *Standard Methods for the Examination of Water and Wastewater*, 20th Edition. Washington D.C.

National Environmental Laboratory Accreditation Conference: Quality Systems. Chapter 5. June 2000.

Stephan, C. 1982. Documentation for Computing LC-50 Values with a Mini Computer. Unpublished.

US EPA. 2002. *Attachment G: NPDES Whole Effluent Toxicity Testing, Monitoring and Reporting Tips and Common Pitfalls.* Dated December 2002. US EPA Region I Offices, Boston, Massachusetts.

U.S. EPA. 2002. *Methods for Measuring the Acute Toxicity of Effluents to Freshwater and Marine Organisms.* Fifth Edition. EPA-821-R-02-012.

TABLE 1. Summary of Acute Evaluation Results. American Samoa Joint Cannery Outfall Effluent Evaluation. August 2003.

Concentration % Effluent	Exposure	Replicates A	B	C	D	E	Mean	Standard Deviation	Coefficient of Variation
Lab Control	Start	10	10	10	10	10	100%	0.000	0.00%
	24-Hours	10	10	10	10	10	100%	0.000	0.00%
	48-Hours	10	10	9	9	10	96%	0.548	5.71%
	72 Hours	10	10	9	9	10	96%	0.548	5.71%
	96-Hours	10	10	9	9	10	96%	0.548	5.71%
3.1%	24-Hours	10	10	10	10	10	100%	0.000	0.00%
	48-Hours	10	10	10	10	10	100%	0.000	0.00%
	72 Hours	10	10	10	10	10	100%	0.000	0.00%
	96-Hours	10	10	10	10	10	100%	0.000	0.00%
6.25%	24-Hours	10	10	10	10	10	100%	0.000	0.00%
	48-Hours	10	10	10	10	10	100%	0.000	0.00%
	72 Hours	10	10	10	10	10	100%	0.000	0.00%
	96-Hours	10	10	9	10	10	98%	0.447	4.56%
12.5%	24-Hours	10	10	10	10	10	100%	0.000	0.00%
	48-Hours	10	10	10	10	10	100%	0.000	0.00%
	72 Hours	10	10	10	10	10	100%	0.000	0.00%
	96-Hours	10	10	10	9	9	96%	0.548	5.71%
25%	24-Hours	10	10	10	10	10	100%	0.000	0.00%
	48-Hours	10	10	10	10	10	100%	0.000	0.00%
	72 Hours	10	10	10	10	10	100%	0.000	0.00%
	96-Hours	10	10	10	9	8	94%	0.894	9.52%
50%	24-Hours	10	10	10	10	10	100%	0.000	0.00%
	48-Hours	10	7	3	5	1	52%	3.493	67.17%
	72 Hours	10	7	3	5	0	50%	3.808	76.16%
	96-Hours	1	4	1	2	0	16%	1.517	94.79%

SUMMARY OF ENDPOINTS

Exposure Period	LC-50 (95% Limits)	METHOD	NOEC	LOEC
24 Hours	>50.0%	Direct Observation	50.0%	>50.0%
48 Hours	>50.0%	Direct Observation	50.0%	>50.0%
72 Hours	50.0%	Direct Observation	50.0%	>50.0%
96 Hours	43.2%	Binomial	25.0%	50.0%

TABLE 2. Summary of Reference Toxicant Data. American Samoa Joint Cannery Outfall Effluent Evaluation. August 2003.

Concentrations Expressed as mg/L Sodium Dodecyl Sulfate

Species	Date	LC-50	Historic Mean	Number of Tests	±1 STD Deviation	±2 STD Deviations
A. bahia	08/26/03	19.8	19.9	151	4.28	8.56

TABLE 3. Summary of Effluent and Diluent Characteristics. American Samoa Joint Cannery Outfall Effluent Evaluation. August 2003.

PARAMETER	UNITS	EFFLUENT	DILUENT
Salinity - Upon Arrival	‰	11	25
After Salinity Adjustment ‡	‰	25	-
pH - Upon Arrival	SU	6.50	7.95
After Salinity Adjustment ‡	SU	7.23	-
TRC	mg/L	<0.05	<0.05
Dissolved Oxygen - Upon Arrival	mg/L	0.9	6.9
After Aeration ‡	mg/L	4.4	6.9
Ammonia - at Start	mg/L as N	49.0	0.21
Unionized Ammonia	mg/L as N	0.06	0.01
Ammonia - at Start- Salinity Adjusted ‡	mg/L as N	25.0	-
Unionized Ammonia ‡	mg/L as N	0.17	-
Ammonia - at 48 Hours	mg/L as N	No Data	No Data

TABLE 4. Summary of Sample Collection Information. American Samoa Joint Cannery Outfall Effluent Evaluation. March 2003.

Sample Description	Type	Collection Date	Collection Time	Receipt Date	Receipt Time	Arrival Temp °C
EFFLUENT	Comp	08/07/03	ND	08/13/03	1045	19

COMMENTS:
‡ - Analysis conducted on 50% effluent, the highest concentration tested.
ND - No data was recorded on chain of custody.

TABLE 5. Summary of StarKist Samoa and COS Samoa Packing Combined Effluent Bioassay Results. American Samoa Joint Cannery Outfall Effluent Evaluation. March 2003.

Date	Species	96-Hour Endpoints		
		LC-50	NOEC	LOEC
02/93[1]	*Penaeus vannami*	4.8%	3.1%	6.25%
10/93[1]	*Penaeus vannami*	15.67%	3.1%	6.25%
02/94[1]	*Penaeus vannami*	15.76%	<1.6%	1.6%
10/94[1]	*Americamysis bahia*	31.2%	25.0%	50.0%
03/95[1]	*Penaeus vannami*	14.8%	6.25%	12.5%
03/95[1]	*Americamysis bahia*	10.8%	6.25%	12.5%
02/96[1]	*Penaeus vannami*	>50.0%	>50.0%	>50.0%
03/96[1]	*Penaeus vannami*	44.4%	25.0%	50.0%
11/96[1]	*Penaeus vannami*	7.11%	3.1%	6.25%
03/97[1]	*Penaeus vannami*	39.36%	12.5%	25.0%
09/97[1]	*Penaeus vannami*	12.3%	6.25%	12.5%
06/98[1]	*Americamysis bahia*	17.2%	6.25%	12.5%
11/98[1]	*Americamysis bahia*	15.0%	6.25%	12.5%
02/00[1]	*Americamysis bahia*	20.0%	6.25%	12.5%
08/00[1]	*Americamysis bahia*	17.1%	3.1%	6.25%
03/01[2]	*Americamysis bahia*	13.81%	12.5%	25.0%
03/02[2]	*Americamysis bahia*	16.13%	12.5%	25.0%
08/02[2]	*Americamysis bahia*	10.23%	6.25%	12.5%
03/03[2]	*Americamysis bahia*	28.4%	25.0%	50.0%
08/03[2]	*Americamysis bahia*	43.2%	25.0%	50.0%

Notes:

1. Assays conducted by Advanced Biological Testing, Inc., Rohnert Park, California
2. Assay conducted by EnviroSystems, Inc., Hampton, New Hampshire

APPENDIX A

DATA SHEETS

STATISTICAL SUPPORT

Contents	Number of Pages
Methods Used in NPDES Permit Biomonitoring Testing	1
A. bahia Acute Bioassay Data Summary	2
A. bahia Survival Statistics: LC-50, NOEC	10
A. bahia Organism Culture Sheet	1
Preparation of Dilutions	1
Record of Meters Used for Water Quality Measurements	1
Sample Receipt Record	1
Chain of Custody	1

METHODS USED IN NPDES PERMIT BIOMONITORING TESTING

Parameter	Method
Acute Exposure Bioassays	
Ceriodaphnia dubia, Daphnia pulex	EPA-821-R-02-012
Pimephales promelas	EPA-821-R-02-012
Americamysis bahia	EPA-821-R-02-012
Menidia beryllina, Cyprinodon variegatus	EPA-821-R-02-012
Chronic Exposure Bioassays	
Ceriodaphnia dubia	EPA-821-R-02-013, 1002.0
Pimephales promelas	EPA-821-R-02-013, 1000.0
Cyprinodon variegatus	EPA-821-R-02-014, 1004.0
Menidia beryllina	EPA-821-R-02-014, 1006.0
Arbacia punctulata	EPA-821-R-02-014, 1008.0
Champia parvula	EPA-821-R-02-014, 1009.0
Trace Metals:	
ICP Metals	EPA 200.7/SW 6010
Hardness	Standard Methods 20th Edition - Method 2340 B
Wet Chemistries:	
Alkalinity	EPA 310.2
Chlorine, Residual	Standard Methods 20th Edition - Method 4500CLD
Total Organic Carbon	Standard Methods 20th Edition - Method 5310C
Specific Conductance	Standard Methods 20th Edition - Method 2510B
Nitrogen - Ammonia	Standard Methods 20th Edition - Method 4500NH3G
pH	Standard Methods 20th Edition - Method 4500H+B
Solids, Total (TS)	Standard Methods 20th Edition - Method 2540.B
Solids, Total Suspended (TSS)	Standard Methods 20th Edition - Method 2540D
Dissolved Oxygen	Standard Methods 20th Edition - Method 4500-O G

ACUTE BIOASSAY DATA SUMMARY

STUDY: 11419

CLIENT: CH2M Hill | TEST ORGANISM: *A. bahia*

SAMPLE: American Samoa | ORGANISM SUPPLIER/BATCH/AGE: *See Organism Culture Sheet*

DILUENT: LAB SALT

"AS RECEIVED" EFFLUENT AND DILUENT CHEMISTRIES

	TRC	AMM 0 HR✖	AMM 48 HR✖	pH	DO	Salinity
EFFLUENT	<0.05	-002 (100%) / -003 (50%)		6.50	0.9	10.6
DILUENT	<0.05	11389-022		7.95	6.9	25

SALINITY ADJUSTMENT RECORD (IF APPLICABLE): 8,400 ML EFFLUENT + 135 G SEA SALTS = 100% ACTUAL PERCENTAGE

CONC	REP	SURVIVAL 0	SURVIVAL 24	SURVIVAL 48	SURVIVAL 72	SURVIVAL 96	✦DISSOLVED OXYGEN (MG/L)✦ 0	DO 24	DO 48◊	DO 48☆	DO 72	DO 96	PH (SU) 0	PH 24	PH 48◊	PH 48☆	PH 72	PH 96	TEMPERATURE (°C) 0	TEMP 24	TEMP 48◊	TEMP 48	TEMP 72	TEMP 96	SALINITY (ppt) 0	SAL 24	SAL 48◊	SAL 48	SAL 72	SAL 96
LAB	A	10	10	10	10	10	6.9	7.7	7.2	6.8	7.0	7.6	7.95	7.85	7.94	7.91	7.83	7.81	21	20	19	22	20	19	25	26	26	24	25	26
	B	10	10	10	10	10	7.0	7.7	7.2	6.8	7.0	7.6	7.98	7.87	7.95	7.91	7.83	7.87	21	20	19	22	19	19	25	26	26	25	26	26
	C	10	10	9 ~~10~~	~~10~~ 9	9	7.0	7.7	7.2	6.8	7.0	7.6	7.98	7.87	7.98	7.92	7.84	7.86	21	20	19	22	19	19	25	26	26	24	25	26
	D	10	10	~~10~~ 9	~~10~~ 9	9	7.1	7.7	7.2	6.8	7.0	7.6	7.99	7.90	7.98	7.93	7.83	7.85	21	20	19	22	19	19	25	26	26	24	25	26
	E	10	10	10	10	10	7.1	7.8	7.2	6.8	7.0	7.5	7.98	7.80	7.96	7.93	7.83	7.84	21	20	19	22	19	19	25	26	26	24	25	26
3.1%	A	10	10	10	10	10	6.9	7.8	7.1	6.8	6.8	7.0	7.91	7.88	7.93	7.90	7.82	7.72	21	20	19	22	19	19	25	26	27	24	25	26
	B	10	10	10	10	10	6.9	7.7	7.1	6.7	6.8	7.6	7.92	7.86	7.91	7.87	7.80	7.87	21	20	19	22	19	19	25	26	26	24	25	26
	C	10	10	10	10	10	6.9	7.6	7.0	6.6	6.7	7.6	7.92	7.81	7.90	7.85	7.83	7.89	21	20	19	22	19	19	25	26	26	24	25	26
	D	10	10	10	10	10	6.9	7.6	7.0	6.6	6.8	7.6	7.93	7.85	7.85	7.84	7.83	7.88	21	20	19	22	19	19	25	26	26	24	25	26
	E	10	10	10	10	10	6.9	7.6	6.9	6.6	6.8	7.6	7.93	7.89	7.86	7.82	7.83	7.90	21	20	19	22	19	19	25	26	26	24	25	26
6.25%	A	10	10	10	10	10	6.6	7.7	7.0	6.6	6.9	7.6	7.85	7.84	7.89	7.82	7.87	7.94	21	19	19	23	19	19	25	26	26	24	25	26
	B	10	10	10	10	10	6.7	7.5	7.0	6.5	6.9	5.5	7.84	7.86	7.92	7.80	7.86	7.62	21	19	19	23	19	19	25	26	26	24	25	26
	C	10	10	10	10	9	6.7	7.5	6.9	6.5	6.9	7.4	7.84	7.87	7.90	7.79	7.86	7.89	21	19	19	23	19	19	25	26	26	24	25	26
	D	10	10	10	10	10	6.8	7.5	6.9	6.5	6.9	7.5	7.83	7.87	7.88	7.79	7.86	7.90	21	19	19	23	19	19	25	26	26	24	25	26
	E	10	10	~~10~~ 10	10	10	6.8	7.5	6.9	6.5	6.8	7.5	7.83	7.89	7.89	7.78	7.86	7.91	21	20	19	23	19	19	25	26	26	24	25	26
DATE		8/15/03	8/16	8/15/03	8/16	8/17	8/13	8/14	8/15/03	8/15/03	8/16	8/17																		
TIME		1335	1440	1620	1330	1510	1230	1430	1600	1640	1320	1445																		
INITIALS		✓	BM	✓	BM	RC	RC	BM	✓	✓	BM	RC																		
FED?		✓	✓	✓	✓																									

(E3) BM

: - Pull on 50% effluent also.
- "Old" water qualities (prior to renewal)

✦ - AERATE FROM START!
☆ - "New" water qualities (post renewal)

ACUTE BIOASSAY DATA SUMMARY

STUDY: 11419	SAMPLE RECEIVED:	"AS RECEIVED" EFFLUENT AND DILUENT CHEMISTRIES						
CLIENT: CH2M Hill	TEST ORGANISM: *A. bahia*		TRC	AMM 0 HR✖	AMM 48 HR✖	pH	DO	Salinity
SAMPLE: American Samoa	ORGANISM SUPPLIER:	EFFLUENT	See page 1 for details and salinity adjustment record.					
DILUENT: LAB SALT	ORGANISM BATCH/AGE:	DILUENT						

CONC	REP	SURVIVAL 0	SURVIVAL 24	SURVIVAL 48	SURVIVAL 72	SURVIVAL 96	✦DISSOLVED OXYGEN (MG/L)✦ 0	DO 24	DO 48◊	DO 48☆	DO 72	DO 96	PH (SU) 0	PH 24	PH 48◊	PH 48☆	PH 72	PH 96	TEMPERATURE (°C) 0	TEMP 24	TEMP 48◊	TEMP 48	TEMP 72	TEMP 96	SALINITY (ppt) 0	SAL 24	SAL 48◊	SAL 48	SAL 72	SAL 96
12.5%	A	10	10	10	10	10	6.5	7.4	6.8	6.0	6.6	7.5	7.71	7.87	7.91	7.68	7.84	7.99	21	19	19	23	20	19	25	26	26	24	25	26
	B	10	10	10	10	10	6.5	7.3	6.8	6.0	6.7	7.6	7.71	7.88	7.87	7.67	7.84	7.99	21	19	19	23	20	19	25	26	26	24	25	26
	C	10	10	10	10	10	6.5	7.3	6.7	6.0	6.7	7.6	7.70	7.87	7.87	7.66	7.85	7.99	21	19	19	23	20	19	25	26	26	24	25	26
	D	10	10	10	10	9	6.5	7.3	6.7	5.9	6.7	7.6	7.70	7.87	7.89	7.66	7.85	7.98	21	19	19	22	19	19	25	26	26	24	25	26
	E	10	10	10	10	9	6.4	7.3	6.8	6.1	6.7	7.4	7.69	7.85	7.91	7.66	7.85	7.92	21	19	19	23	20	19	25	26	26	24	25	26
25%	A	10	10	10	10	10	5.8	6.9	6.8	6.1	6.3	7.3	7.47	7.86	7.92	7.64	7.81	7.98	21	19	19	23	20	20	25	26	26	24	25	26
	B	10	10	10	10	10	5.8	6.9	6.8	5.9	6.3	7.2	7.46	7.86	7.93	7.53	7.82	8.00	21	19	19	23	20	20	25	26	26	24	25	26
	C	10	10	10	10	10	5.7	6.3	6.7	5.6	6.4	7.1	7.45	7.85	7.94	7.50	7.83	7.96	21	19	19	23	20	19	25	26	27	24	25	26
	D	10	10	10	10	9	5.8	6.7	6.7	5.4	6.1	7.2	7.45	7.85	7.85	7.48	7.83	8.01	21	19	19	23	20	19	25	26	26	24	25	26
	E	10	10	10	10	8	5.8	6.9	6.7	5.3	6.1	7.2	7.45	7.85	7.90	7.46	7.83	8.00	21	19	19	23	20	20	25	26	27	24	25	26
50%	A	10	10	10	10	1	4.5	6.5	6.4	4.6	5.3	6.6	7.23	7.90	7.98	7.31	7.83	7.95	22	19	19	23	20	20	25	26	26	24	25	26
	B	10	10	7 ~~10~~	7	4	4.6	6.5	6.4	4.6	5.2	6.8	7.23	7.90	8.02	7.31	7.85	7.94	22	19	19	23	20	19	25	26	26	24	25	26
	C	10	10	3	3	1	4.4	6.0	6.4	4.6	5.2	6.8	7.22	7.88	8.05	7.31	7.81	7.99	22	19	19	23	20	20	25	26	26	24	25	26
	D	10	10	5	5	2	4.4	6.0	6.3	4.6	5.3	6.9	7.22	7.89	8.04	7.33	7.81	8.03	22	19	19	23	20	20	25	26	26	24	25	26
	E	10	10	1	0	—	4.4	6.6	6.3	3.6	5.1	—	7.23	7.88	8.04	7.35	7.82	—	22	19	19	23	20	~~20~~	25	26	26	24	25	~~26~~
DATE		8/13/03	8/14	8/15/03	8/16	8/17	8/13	8/14	8/15/03	8/15/03		8/17																		
TIME		1335	1440	1620	1340	1510	1230	1430	1600	1640		1445																		
INITIALS		r	BM	r	BM	RC	RC	BM	r	r		RC																		
FED?		✓	✓	✓	✓																									

✖ - Pull on 50% effluent also.
◊ - "Old" water qualities (prior to renewal)
✦ - AERATE FROM START!
☆ - "New"water qualities (post renewal)

Title: CH2MHill American Samoa 11419 48 hour A-NOEC
File: 11419Ab48 Transform: ARC SINE(SQUARE ROOT(Y))

Shapiro - Wilk's Test for Normality

D = 0.7189
W = 0.6409

Critical W = 0.9000 (alpha = 0.01 , N = 30)
W = 0.9270 (alpha = 0.05 , N = 30)

Data FAIL normality test (alpha = 0.01). Try another transformation.

Warning - The first three homogeneity tests are sensitive to non-normality and should not be performed with this data as is.

Title: CH2MHill American Samoa 11419 48 hour A-NOEC
File: 11419Ab48 Transform: ARC SINE(SQUARE ROOT(Y))

Hartley's Test for Homogeneity of Variance
Bartlett's Test for Homogeneity of Variance

These two tests can not be performed because at least one group has zero variance.

Data FAIL to meet homogeneity of variance assumption.
Additional transformations are useless.

Title: CH2MHill American Samoa 11419 48 hour A-NOEC
File: 11419Ab48 Transform: ARC SINE(SQUARE ROOT(Y))

Summary Statistics on Transformed Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Lab	5	1.2490	1.4120	1.3468
2	3.1%	5	1.4120	1.4120	1.4120
3	6.25%	5	1.4120	1.4120	1.4120
4	12.5%	5	1.4120	1.4120	1.4120
5	25%	5	1.4120	1.4120	1.4120
6	50%	5	0.3218	1.4120	0.8180

Title: CH2MHill American Samoa 11419 48 hour A-NOEC

File: 11419Ab48 Transform: ARC SINE(SQUARE ROOT(Y))

Summary Statistics on Transformed Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	Lab	0.0080	0.0893	0.0399	6.6278
2	3.1%	0.0000	0.0000	0.0000	0.0000
3	6.25%	0.0000	0.0000	0.0000	0.0000
4	12.5%	0.0000	0.0000	0.0000	0.0000
5	25%	0.0000	0.0000	0.0000	0.0000
6	50%	0.1717	0.4144	0.1853	50.6634

Title: CH2MHill American Samoa 11419 48 hour A-NOEC
File: 11419Ab48 Transform: ARC SINE(SQUARE ROOT(Y))

Steel's Many-One Rank Test - Ho: Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	RANK SUM	CRIT. VALUE	DF	SIG 0.05
1	Lab	1.3468				
2	3.1%	1.4120	32.50	16.00	5.00	
3	6.25%	1.4120	32.50	16.00	5.00	
4	12.5%	1.4120	32.50	16.00	5.00	
5	25%	1.4120	32.50	16.00	5.00	
6	50%	0.8180	18.50	16.00	5.00	

Critical values are 1 tailed (k = 5)

****

STUDY NO.: 11419 ASSAY START: 08/13/03

SPECIES: A. bahia EXPOSURE: 72 hours

SAMPLE: American Samoa

****

At a confidence level of 95 percent, the binomial test
shows that the LC50 is above 25

The usefulness of any LC50 calculated from this set of data
is questionable because a concentration-effect relationship
has not been demonstrated over a reasonable range (e.g.,
<37 to >63) of percent affected.
50 can be used as an approximate LC50 for this set of data.

When there are less than two concentrations at which the percent
affected is between 0 and 100, neither the Moving Average method
nor the probit method can give any statistically sound results.

---------RESULTS CALCULATED USING THE TRIMMED SPEARMAN-KARBER METHOD-------

Conc.	Dose =Ln (Conc)	Percent Dead	Monotonic Rel. Freq.	Trimmed Rel. Freq.
50	3.912023	50	.5	.5
25	3.218876	0	0	-.125 *
12.5	2.525729	0	0	-.125 *
6.25	1.832581	0	0	-.125 *
3.1	1.131402	0	0	-.125 *

Alpha = 10 %
Groups trimmed and therefore not used in estimating LC50
are marked with an asterisk above.
LC50 = 6.155722
Estimated 95 Percent Confidence Limits
Lower: 4.639187 Upper: 8.168005
Variance estimate = .02
Variance may be underestimated because all data were outside trimmed range.

****

STUDY NO.: 11419 ASSAY START: 08/13/03

SPECIES: A. bahia EXPOSURE: 72 hours

SAMPLE: American Samoa

****

SUMMARY TABLE

09-03-2003 12:30:15

Data: Conc.	Exposed	Dead	Percent
50	50	25	50
25	50	0	0
12.5	50	0	0
6.25	50	0	0
3.1	50	0	0

	LC50	Lower 95% Limit	Upper 95% Limit	
Probit Analysis	0	0	0	
Moving Average	0	0	0	Span= 0
Spearman-Karber	6.155722	4.639187	8.168005	Alpha= 10 %

Compare results with original data to see if they are reasonable.

****

```
 100-----------------------------------------------------
     |                                                  | X=data pt.
P   -|                                                  |
E    |                                                  |
R 80-|                                                  |
C    |                                                  |
E   -|                                                  |
N    |                                                  |
T 60-|                                                  |
     |                                                  |
A   -|                                                X |
F    |        <----+---->                               | Trim. S-K
F 40-|                                                  |
E    |                                                  |
C   -|                                                  |
T    |                                                  |
E 20-|                                                  |
D    |                                                  |
    -|                                                  |
     |                                                  |
   0--X-----------X-----------X----------X-------------
      |       |          |      |          |        |   Concentration
     0.3     0.5        1.0    1.5        3.0      5.0 x 10** 1
```

Title: CH2MHill American Samoa 11419 72 Hour A-NOEC
File: 11419Ab72 Transform: ARC SINE(SQUARE ROOT(Y))

Shapiro - Wilk's Test for Normality

D = 0.9019
W = 0.6105

Critical W = 0.9000 (alpha = 0.01 , N = 30)
W = 0.9270 (alpha = 0.05 , N = 30)

Data FAIL normality test (alpha = 0.01). Try another transformation.

Warning - The first three homogeneity tests are sensitive to non-normality and should not be performed with this data as is.

Title: CH2MHill American Samoa 11419 72 Hour A-NOEC
File: 11419Ab72 Transform: ARC SINE(SQUARE ROOT(Y))

Hartley's Test for Homogeneity of Variance
Bartlett's Test for Homogeneity of Variance

These two tests can not be performed because at least one group has zero variance.

Data FAIL to meet homogeneity of variance assumption.
Additional transformations are useless.

Title: CH2MHill American Samoa 11419 72 Hour A-NOEC
File: 11419Ab72 Transform: ARC SINE(SQUARE ROOT(Y))

Summary Statistics on Transformed Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Lab	5	1.2490	1.4120	1.3468
2	3.1%	5	1.4120	1.4120	1.4120
3	6.25%	5	1.4120	1.4120	1.4120
4	12.5%	5	1.4120	1.4120	1.4120
5	25%	5	1.4120	1.4120	1.4120
6	50%	5	0.1588	1.4120	0.7854

Title: CH2MHill American Samoa 11419 72 Hour A-NOEC

File: 11419Ab72 Transform: ARC SINE(SQUARE ROOT(Y))

Summary Statistics on Transformed Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	Lab	0.0080	0.0893	0.0399	6.6278
2	3.1%	0.0000	0.0000	0.0000	0.0000
3	6.25%	0.0000	0.0000	0.0000	0.0000
4	12.5%	0.0000	0.0000	0.0000	0.0000
5	25%	0.0000	0.0000	0.0000	0.0000
6	50%	0.2175	0.4664	0.2086	59.3791

Title: CH2MHill American Samoa 11419 72 Hour A-NOEC
File: 11419Ab72 Transform: ARC SINE(SQUARE ROOT(Y))

Steel's Many-One Rank Test - Ho: Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	RANK SUM	CRIT. VALUE	DF	SIG 0.05
1	Lab	1.3468				
2	3.1%	1.4120	32.50	16.00	5.00	
3	6.25%	1.4120	32.50	16.00	5.00	
4	12.5%	1.4120	32.50	16.00	5.00	
5	25%	1.4120	32.50	16.00	5.00	
6	50%	0.7854	18.50	16.00	5.00	

Critical values are 1 tailed (k = 5)

****

STUDY NO.: 11419 ASSAY START: 08/13/03

SPECIES: A. bahia EXPOSURE: 96 Hours

SAMPLE: American Samoa

****

At a confidence level of 95 percent, the binomial test
shows that the LC50 is below 50
shows that the LC50 is above 25

An approximate LC50 of 43.20606 is obtained by
nonlinear interpolation between 25 and 50

----------RESULTS CALCULATED USING THE MOVING AVERAGE METHOD----------

Span	G	LC50	95 Percent Confidence Limits	
1	8.730414E-02	43.20603	38.85539	49.92278

An LC50 calculated using the Moving Average method may not be a very good estimate if the span is much less than the number of concentrations.

----------RESULTS CALCULATED USING THE PROBIT METHOD----------

Iterations	G	H	Chi-Square	Probability
7	1.502618	5.458608	16.37582	LESS THAN 0.001

As the probability associated with this value is <0.05, results should be used with caution.

Slope = 3.364528
95 Percent Confidence Limits =-.7597542 and 7.488811

LC50 = 45.79345
95 Percent Confidence Limits = 16.10194 and +INFINITY

---------RESULTS CALCULATED USING THE TRIMMED SPEARMAN-KARBER METHOD-------

Conc.	Dose =Ln (Conc)	Percent Dead	Monotonic Rel. Freq.	Trimmed Rel. Freq.
50	3.912023	64	.64	.675
25	3.218876	6	.06	-5.000001E-02 *
12.5	2.525729	4	.04	-.075 *
6.25	1.832581	2	.02	-9.999999E-02 *
3.1	1.131402	0	0	-.125 *

Alpha = 10 %
Groups trimmed and therefore not used in estimating LC50
are marked with an asterisk above.
LC50 = 11.27752
Estimated 95 Percent Confidence Limits
Lower: 9.432698 Upper: 13.48315
Variance estimate = 7.977126E-03
Variance may be underestimated because all data were outside trimmed range.

****

STUDY NO.: 11419 ASSAY START: 08/13/03

SPECIES: A. bahia EXPOSURE: 96 Hours

SAMPLE: American Samoa

****

SUMMARY TABLE

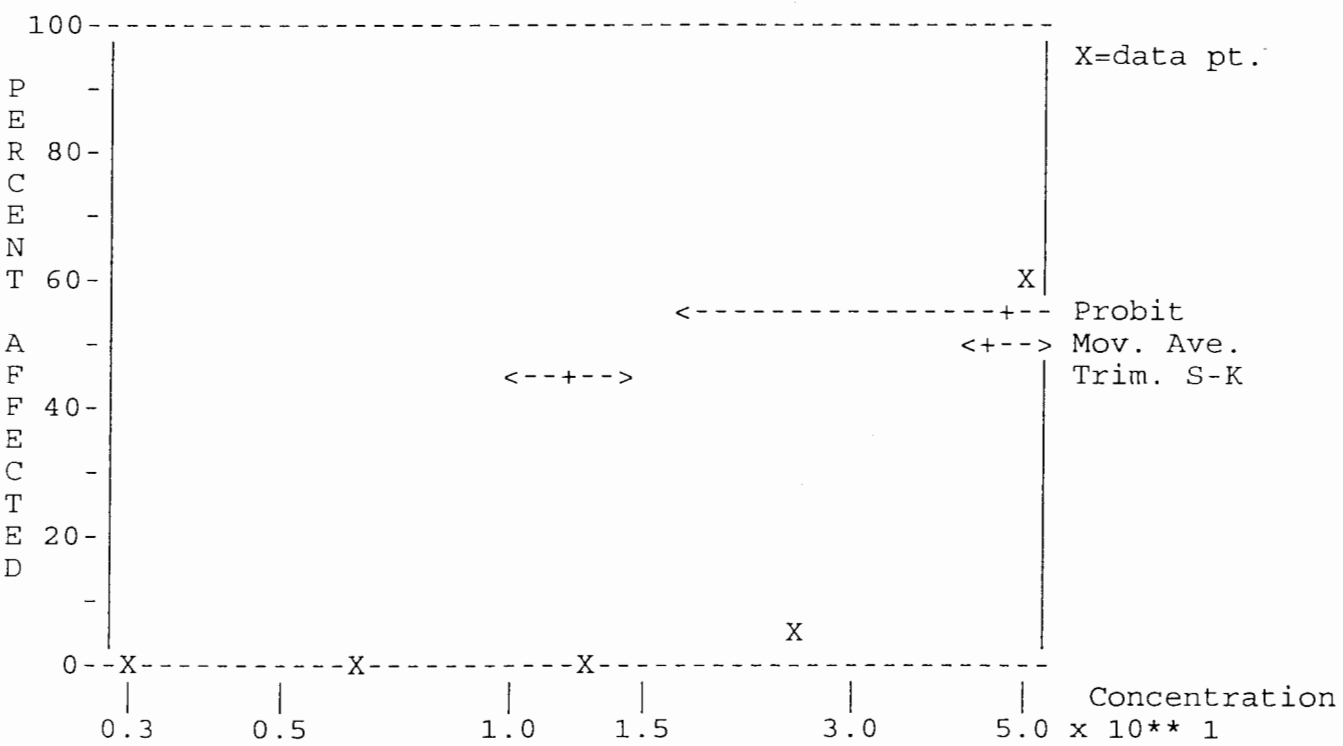
09-03-2003 12:31:43

Data: Conc.	Exposed	Dead	Percent
50	50	32	64
25	50	3	6
12.5	50	2	4
6.25	50	1	2
3.1	50	0	0

	LC50	Lower 95% Limit	Upper 95% Limit	
Probit Analysis	45.79345	16.10194	0	
Moving Average	43.20603	38.85539	49.92278	Span= 1
Spearman-Karber	11.27752	9.432698	13.48315	Alpha= 10 %
Binomial	43.20606			

Compare results with original data to see if they are reasonable.

****



Title: CH2MHill American Samoa 11419 96 Hour A-NOEC
File: 11419Ab96 Transform: ARC SINE(SQUARE ROOT(Y))

Shapiro - Wilk's Test for Normality

D = 0.3158
W = 0.9310

Critical W = 0.9000 (alpha = 0.01 , N = 30)
W = 0.9270 (alpha = 0.05 , N = 30)

Data PASS normality test (alpha = 0.01). Continue analysis.

Title: CH2MHill American Samoa 11419 96 Hour A-NOEC
File: 11419Ab96 Transform: ARC SINE(SQUARE ROOT(Y))

Hartley's Test for Homogeneity of Variance
Bartlett's Test for Homogeneity of Variance

These two tests can not be performed because at least one group has zero variance.

Data FAIL to meet homogeneity of variance assumption.
Additional transformations are useless.

Title: CH2MHill American Samoa 11419 96 Hour A-NOEC
File: 11419Ab96 Transform: ARC SINE(SQUARE ROOT(Y))

Summary Statistics on Transformed Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Lab	5	1.2490	1.4120	1.3468
2	3.1%	5	1.4120	1.4120	1.4120
3	6.25%	5	1.2490	1.4120	1.3794
4	12.5%	5	1.2490	1.4120	1.3468
5	25%	5	1.1071	1.4120	1.3185
6	50%	5	0.1588	0.6847	0.3901

Title: CH2MHill American Samoa 11419 96 Hour A-NOEC
File: 11419Ab96 Transform: ARC SINE(SQUARE ROOT(Y))

Summary Statistics on Transformed Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	Lab	0.0080	0.0893	0.0399	6.6278
2	3.1%	0.0000	0.0000	0.0000	0.0000
3	6.25%	0.0053	0.0729	0.0326	5.2837
4	12.5%	0.0080	0.0893	0.0399	6.6278
5	25%	0.0189	0.1376	0.0615	10.4362
6	50%	0.0388	0.1969	0.0881	50.4677

Title: CH2MHill American Samoa 11419 96 Hour A-NOEC
File: 11419Ab96 Transform: ARC SINE(SQUARE ROOT(Y))

Steel's Many-One Rank Test - Ho: Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	RANK SUM	CRIT. VALUE	DF	SIG 0.05
1	Lab	1.3468				
2	3.1%	1.4120	32.50	16.00	5.00	
3	6.25%	1.3794	30.00	16.00	5.00	
4	12.5%	1.3468	27.50	16.00	5.00	
5	25%	1.3185	26.50	16.00	5.00	
6	50%	0.3901	15.00	16.00	5.00	*

Critical values are 1 tailed (k = 5)

EnviroSystems, Incorporated
Organism Culture and Acclimation Data

I. Organism Information

Species: Americamysis bahia

Age: 1-5 days

Client: American Samoa

ESI#: 11419

Culturist: ESI

Date: 8/13/03

II. Culture Maintenance Information

Flow Through _____

Recirc / Mass Static _____

Brood Board _____

Static Renewal _____

Hatch Date: 8/10-12/03

Lot #: 081203AB

Brood Origin: ARO

III. Acclimation History

Temperature: 24.2 °C

Salinity: 29.7 ppt

Hardness: _____ mg/L as CaCO3

pH: 7.56 SU

DO: 7.1 mg/L

Water Type: Natural Salt H_2O

SITE WATER ACCLIMATION (If applicable)

Start: _____

End: _____

PREPARATION OF DILUTIONS

STUDY:	CLIENT: CH2M HILL - American Samoa
SPECIES: *A. bahia*	

Diluent: Lab Salt	Day: 0 Sample: EOA		Day: 2 Sample: EOA	
Concentration	Vol. Eff.	Final Vol	Vol. Eff.	Final Vol
LAB	0	1000	0	1000
3.1%	31	↓	31	↓
6.25%	62.5	↓	62.5	↓
12.5%	125	↓	125	↓
25%	250	↓	250	↓
50%	500	↓	500	↓

HRS	Date	Time	Initials
0	8/13/03	1200	RC
48	8/15/03	1630	✓

Comments:

RECORD OF METERS USED FOR WATER QUALITY MEASUREMENTS

STUDY:	CLIENT: CH2M HILL - American Samoa					
WATER QUALITIES - A. bahia						
HOURS:	0	24	48 - old	48 - new	72	96
Water Quality Station #	1	2	2	2		2
Initials	RC	BM				RC
Date	8/13/03	8/14	8/15/03	8/15/03		8/17/03

Water Quality Station #1		Water Quality Station #2		COMMENTS
DO meter #		DO meter #	3	
DO probe #		DO probe #	6	
pH meter #		pH meter #	1138	
pH probe #		pH probe #	31	
S/C meter #		S/C meter #	330i	
S/C probe #		S/C probe #	330i	
Salinity meter #		Salinity meter #	330i	

ESI

SAMPLE RECEIPT RECORD

EnviroSystems, Inc.
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ESI STUDY NUMBER: 11419 CLIENT: CH2MHill; American Samoa

SAMPLE RECEIPT:
DATE: 8/13/03 TIME: 1045 BY: RC

DELIVERED VIA: ☒ FEDEX ☐ CLIENT ☐ ESI ☐ UPS ☐ OTHER

LOGGED INTO LAB:
DATE: 8/13/03 TIME: 1045 BY: RC

SAMPLE CONDITION:

CHAIN OF CUSTODY:	☒ YES	☐ NO
CHAIN OF CUSTODY SIGNED:	☒ YES	☐ NO
CHAIN OF CUSTODY COMPLETE:	☒ YES	☐ NO
SAMPLE DATE:	☒ YES	☐ NO
SAMPLE TIME RECORDED:	☒ YES	☐ NO
SAMPLE TYPE IDENTIFIED:	☒ YES	☐ NO
CUSTODY SEAL IN PLACE:	☒ YES	☐ NO
SHIPPING CONTAINER INTACT:	☒ YES	☐ NO

SAMPLE TEMPERATURE (AT ARRIVAL): 19 °C

DOES CLIENT NEED NOTIFICATION OF TEMPERATURE?	☐ YES	☒ NO
SAMPLE ARRIVED ON ICE:	☐ YES	☒ NO

COMMENTS: 1x5gal Eff

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RECEIVING WATER QUALITY MONITORING REPORT

Pago Pago Harbor
American Samoa

2003 Non-tradewind Season
March 2003

Submitted by:

StarKist Samoa

NPDES Permit AS0000019

COS Samoa Packing

NPDES Permit AS0000027

Submitted to:

U.S. Environmental Protection Agency

American Samoa Environmental Protection

CH2M HILL

January 2004

RECEIVING WATER QUALITY MONITORING REPORT

Pago Pago Harbor, American Samoa
2002 Tradewind Season Sampling

March 2003

Prepared for

StarKist Samoa
NPDES Permit AS0000019
and
COS Samoa Packing
NPDES Permit AS0000027

Submitted to

U.S. Environmental Protection Agency
and
American Samoa Environmental Protection Agency

Prepared by

CH2M HILL

30 January 2004

EXECUTIVE SUMMARY

The NPDES permits held by StarKist Samoa and COS Samoa Packing to discharge treated wastewater into Pago Pago Harbor, American Samoa, require semiannual receiving water quality monitoring. The monitoring is required in the tradewind and non-tradewind oceanographic seasons. This report presents the results of the monitoring conducted in the 2003 non-tradewind season (March 2003). The required monitoring includes nutrients for which a mixing zone is approved, associated biological health and oceanographic parameters, specific parameters for which toxic mixing zones are approved, and certain metals for informational purposes. The parameters measured include:

- Nutrient, biological, and associated oceanographic parameters include total nitrogen, total Kjeldahl nitrogen, nitrate+nitrite, total phosphorous, chlorophyll-a, total suspended solids, turbidity, light penetration, dissolved oxygen, salinity, and pH. A nutrient mixing zone is established for total nitrogen and total phosphorous.

- Mixing zone parameters include ammonia, copper, and zinc.

- Informational parameters include the trace metals arsenic, mercury, and lead.

The March 2003 non-tradewind monitoring results indicate that the American Samoa Water Quality Standards (ASWQS), for the parameters measured, are generally met throughout the Harbor. The primary exceptions were: is arsenic, which appears to exceed the criteria based on human health (consumption of organisms) because of naturally high levels in the marine waters, and chlorophyll-a because of a regional scale, apparently naturally occurring, plankton bloom coincident with the sampling period. Neither the arsenic or chlorophyll-a levels can be attributed to anthropogenic activities associated with the canneries discharge.

Some of the sampling stations and parameters normally required under the NPDES permit receiving water monitoring were suspended in favor of conducting stream mouth sampling. This was done in cooperation with ASEPA and USEPA. Samples were collected at the mouths of the five permanent streams discharging into Pago Pago Harbor at low tide. Samples were analyzed for total nitrogen, total Kjeldahl nitrogen, nitrate+nitrite, total phosphorous, chlorophyll-a, total suspended solids, dissolved oxygen, conductivity, pH, arsenic, lead, and mercury.

The canneries are in compliance with all receiving water NPDES permit conditions specified in the permits with the exception of chlorophyll-a. However, elevated values of chlorophyll-a were not caused by the canneries discharge and are attributed to a natural occurrence. Elevated near bottom turbidity was also measured using a backscatterance instrument on a vertical profiling instrument platform. These elevated values appear to be natural near bottom levels and are not associated with the JCO discharge. Laboratory measured turbidity clearly indicate compliance with ASWQS in Pago Pago Harbor.

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1. INTRODUCTION

This report describes the semi-annual Pago Pago Harbor water quality monitoring required by National Pollution Discharge Elimination System (NPDES) permit Special Condition E for COS Samoa Packing and StarKist Samoa. Both tuna canneries discharge through a single Joint Cannery Outfall (JCO): COS Samoa Packing holds NPDES permit AS0000027 and StarKist Samoa holds NPDES permit AS0000019.

The overall purpose of the monitoring program, the purpose of the report, a description of the study site, a brief background of the water quality monitoring work done in the Harbor, and the scope and organization of the report are described in this section of the report.

Following sections of the report describe the field data collection, the results of laboratory analysis of samples, and conclusions and recommendations based on the results. Supporting data and information are provided in the Appendices.

1.1 Purpose

The monitoring study is conducted as an element of the Receiving Water Quality Monitoring Program. The purpose of the Receiving Water Quality Monitoring Program, as described in the NPDES permit, is "to determine compliance with water quality standards". To achieve this objective the monitoring conducted under the program must "document water quality at the outfall, at areas near the zone of initial dilution (ZID) and zone of mixing (ZOM) boundaries, at areas beyond these zones where discharge impacts might reasonably be expected, and at reference/control areas". The permit requires monitoring twice a year, during the non-tradewind and the tradewind oceanographic seasons. The purpose of this report is to document and present the data collected during the 2003 non-tradewind season (March 2003) and to evaluate these data in terms of compliance with water quality standards.

1.2 Study Location

Water quality measurements and samples were obtained throughout Pago Pago Harbor, Tutuila Island, American Samoa. The island is located approximately 2300 miles southwest of Hawaii, 1600 miles northeast of New Zealand, and 1000 miles south of the equator at latitude 14° 17′ S and longitude 171° 40′ W. The general location is shown in Figure 1-1[1]. The Harbor is approximately 15,000 feet long with the entrance facing to the south. The Outer Harbor trends north-south with widths varying between 3000 and 6000 feet. The Inner Harbor turns 90° and trends east-west, with the head of the Harbor to the west, and ranges from less than 1000 to about 3000 feet wide. Figure 1-2 shows the general Harbor morphology. Maximum depths along a longitudinal section of the Harbor range from less than 60 to over 200 feet, with fringing reefs periodically exposed at low tide along the

[1] Figures and tables for each section of the report follow the text of each section.

shoreline throughout the middle and Outer Harbor areas. Submerged rock and reef outcrops occur in the inner and outer sections of the Harbor.

The climate is tropical with about 200 inches of rainfall annually. Air temperatures are typically between 70 and 90°F with generally high humidity. Orographic effects create higher rainfall in the vicinity of the Harbor than at other locations on the Island. The watershed of the Harbor is small relative to the Harbor size with about 4.9 mi^2 of drainage area compared to about 2.4 mi^2 of water surface area. Therefore, the Harbor is a marine dominated system with depressed salinities normally found only very close to stream mouths, and occasionally in a thin surface layer.

Tides are semi-diurnal with a range of about 2.5 feet and little diurnal inequality. The circulation in the Harbor is mainly wind driven with small tidal and freshwater influences except in limited localized areas. Winds are usually from the east and southeast and are from this direction most of the time during the tradewind season, which is typically April/May through October/November. During November/December through March/April east to southeast winds still predominate but a northwest to northeast component becomes more prevalent (the non-tradewind season).

The tuna canneries discharge through the JCO, which terminates in a mulitport diffuser at a depth of approximately 176 feet in the Outer Harbor (Figure 1-3). Typical flows through the outfall are approximately 2 mgd. The discharge is in the center of a mixing zone for total nitrogen (TN) and total phosphorous (TP) as shown in Figure 1-4. Small mixing zones for ammonia, copper, and zinc have also been established within the region of rapid initial dilution.

1.3 Background

Prior to the implementation of high strength waste segregation and outfall relocation, the canneries discharged treated wastewater into the Inner Harbor though two outfalls. These outfalls terminated in about 80 feet of water in open-ended pipes without diffusers. In August 1990 both canneries started high strength waste segregation and offshore ocean disposal of the high strength waste streams (those process streams that are highest in nitrogen, phosphorous, suspended solids, and BOD). In February 1992 both canneries began discharging treated wastewater (without the high strength waste component) through a single outfall, relocated approximately 8400 feet seaward from the previous discharge point, at about the 180-foot contour, in the Outer Harbor. The new outfall terminates in a diffuser consisting of four active and two inactive (intentionally blocked) ports.

The current NPDES permits for both canneries require a receiving water monitoring program. This program extends the previously required monitoring with some modifications to the number of stations, number of depths sampled, and the parameters monitored. The permit condition (Special Condition E) requiring receiving water monitoring is identical for both canneries and is provided in Appendix I. The permit condition allows the canneries to

cooperate and perform the required monitoring concurrently and this report reflects concurrent monitoring.

The previous Harbor water quality monitoring results have consistently indicated compliance with the American Samoa Water Quality Standards (ASWQS) in the Harbor, and have demonstrated that the cannery discharge is in compliance with NPDES permit requirements based on Harbor water quality criteria. Based on this information, the monitoring stations were modified for the March 2003 sampling in consultation with the U.S. Environmental Protection Agency (USEPA) and the American Samoa Environmental Protection Agency (ASEPA). The modified sampling was done to collect water quality data from the mouths of the five permanent streams that flow into the Harbor. The modification involved reducing the number of water quality analyses conducted in the Harbor and adding samples and analyses at the stream mouths. The modifications are described in Section 2. The results of this modified sampling provide USEPA and ASEPA with important information for developing and implementing future water quality monitoring strategies.

1.4 Scope and Organization of the Report

The following sections of this report describe the field data collection and results of the monitoring:

- Section 2 includes specific information on sample station locations and times, field methods, and describes any deviations from the intended study plan, including the sampling plan modifications developed in consultation with ASEPA and USEPA.

- Section 3 presents summaries of field measurements and laboratory results with detailed information referenced to appendices when appropriate.

- Section 4 includes an evaluation of compliance with American Samoa Water Quality Standards (ASWQS) based on the data collected, and presents recommendations for changes in methodology, sampling strategies, or other requirements as appropriate.

- References are provided (Section 5) and appendices are included describing the specifics of the permit conditions and detailed data supplements for field measurements and laboratory analyses.

The procedures used for sampling and analysis are as required in Special Condition E of the NPDES permits and are the same as specified for the monitoring done under the previous permit. The sampling and analysis plan (SAP) and standard operating procedures (SOP) were presented in previous Receiving Water Quality Monitoring Reports and are not included with this report.

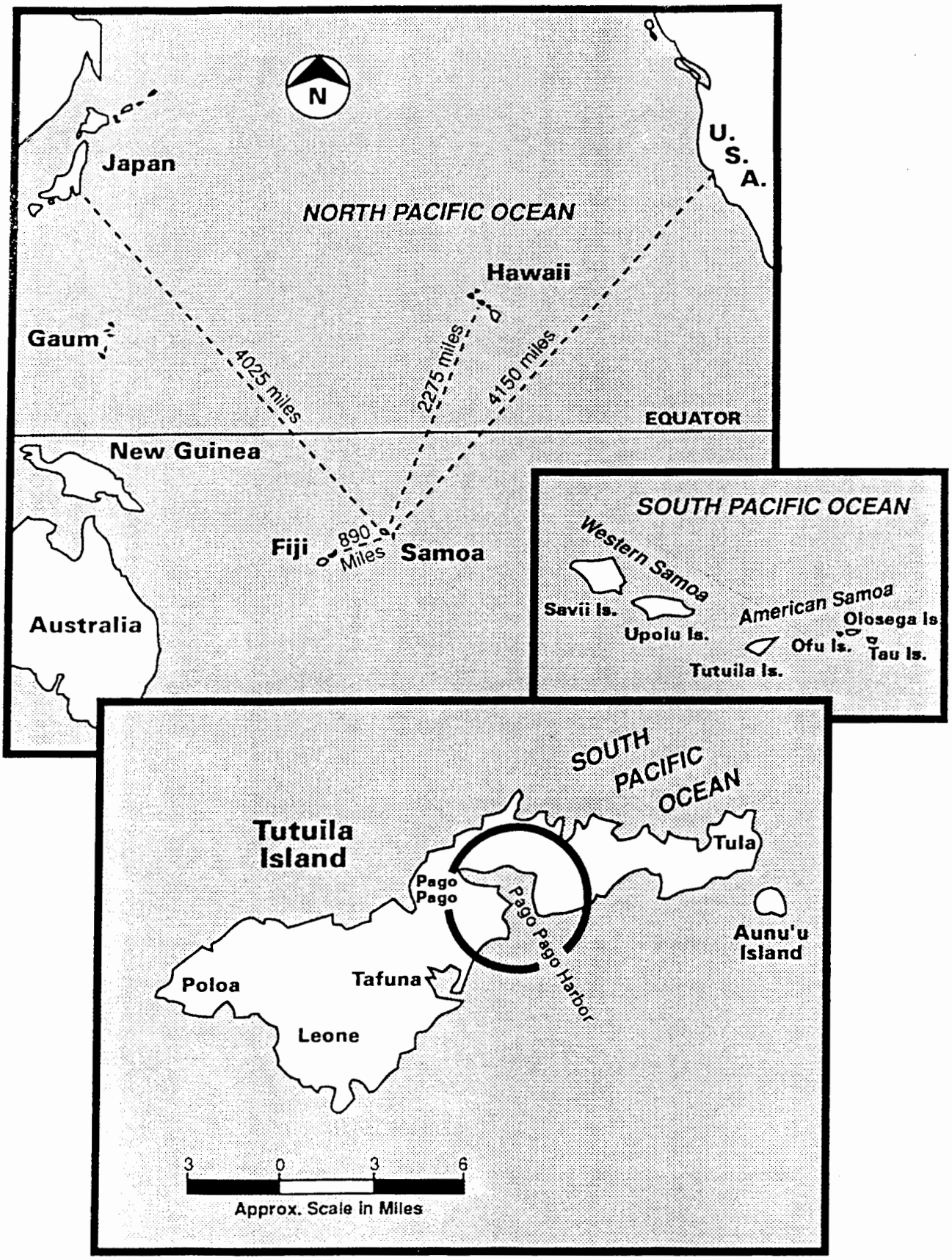

Figure 1-1.
Overview of Study Site

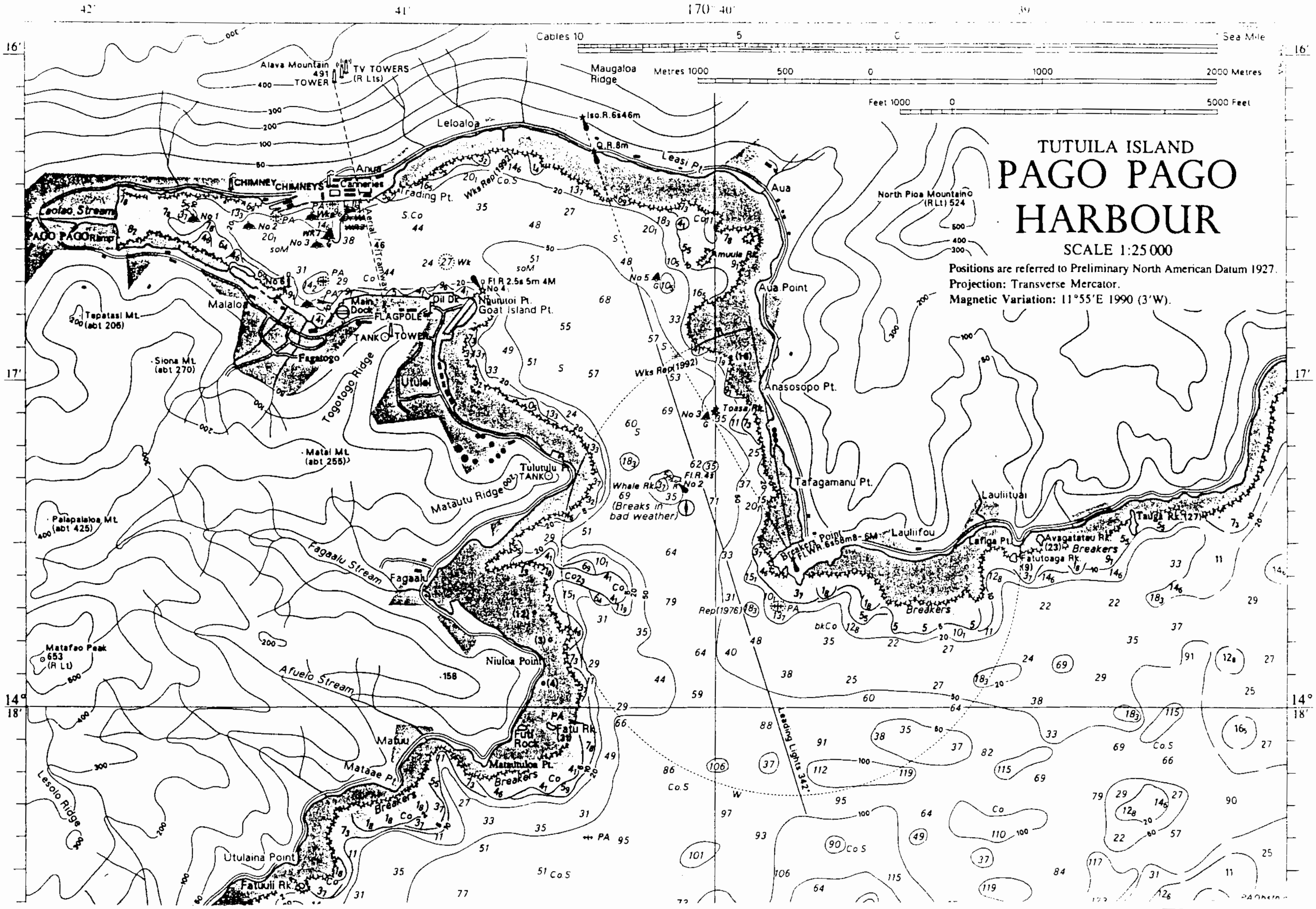

Figure 1-2.
Pago Pago Harbor

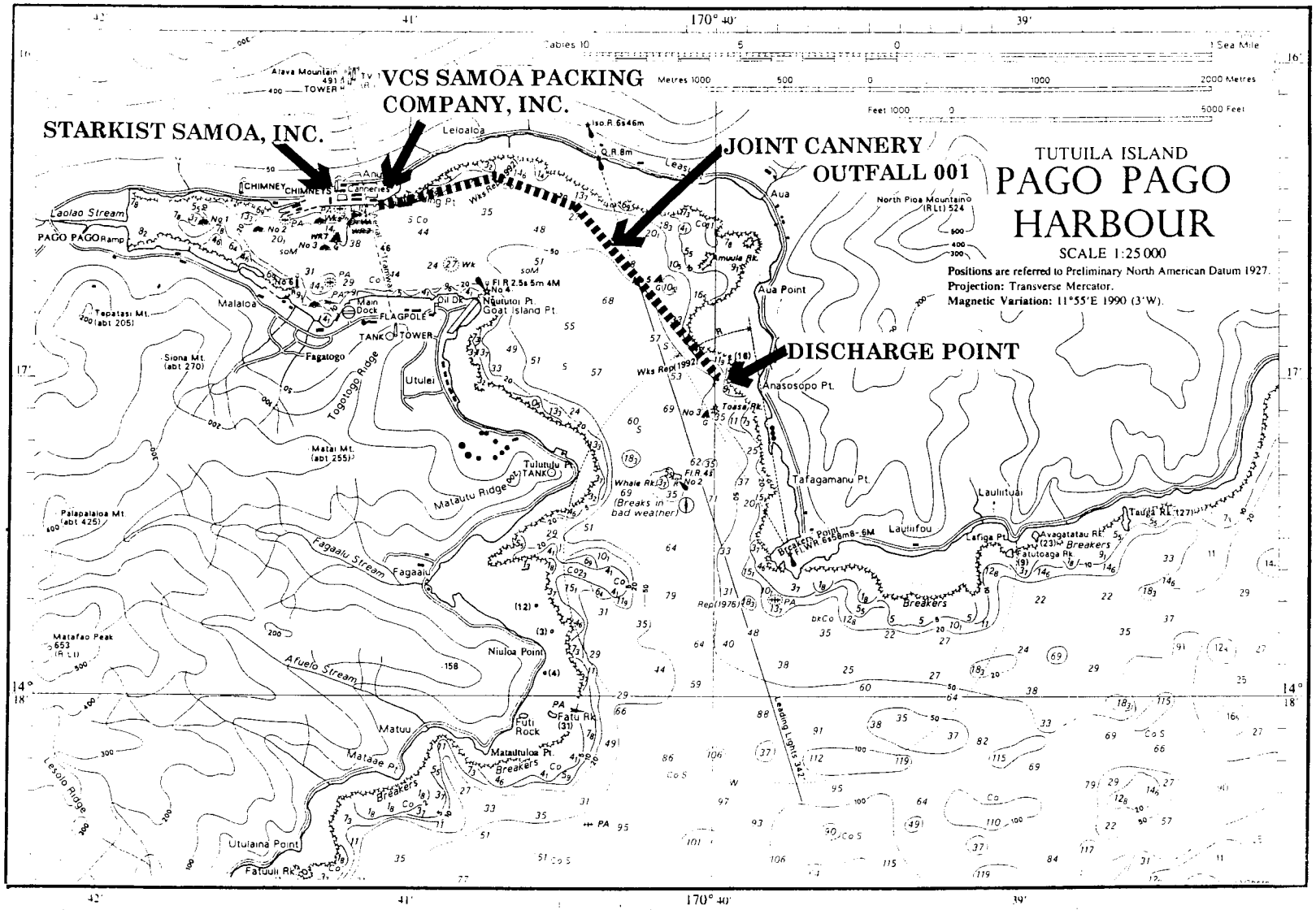

Figure 1-3.
JCO Outfall and Diffuser Location

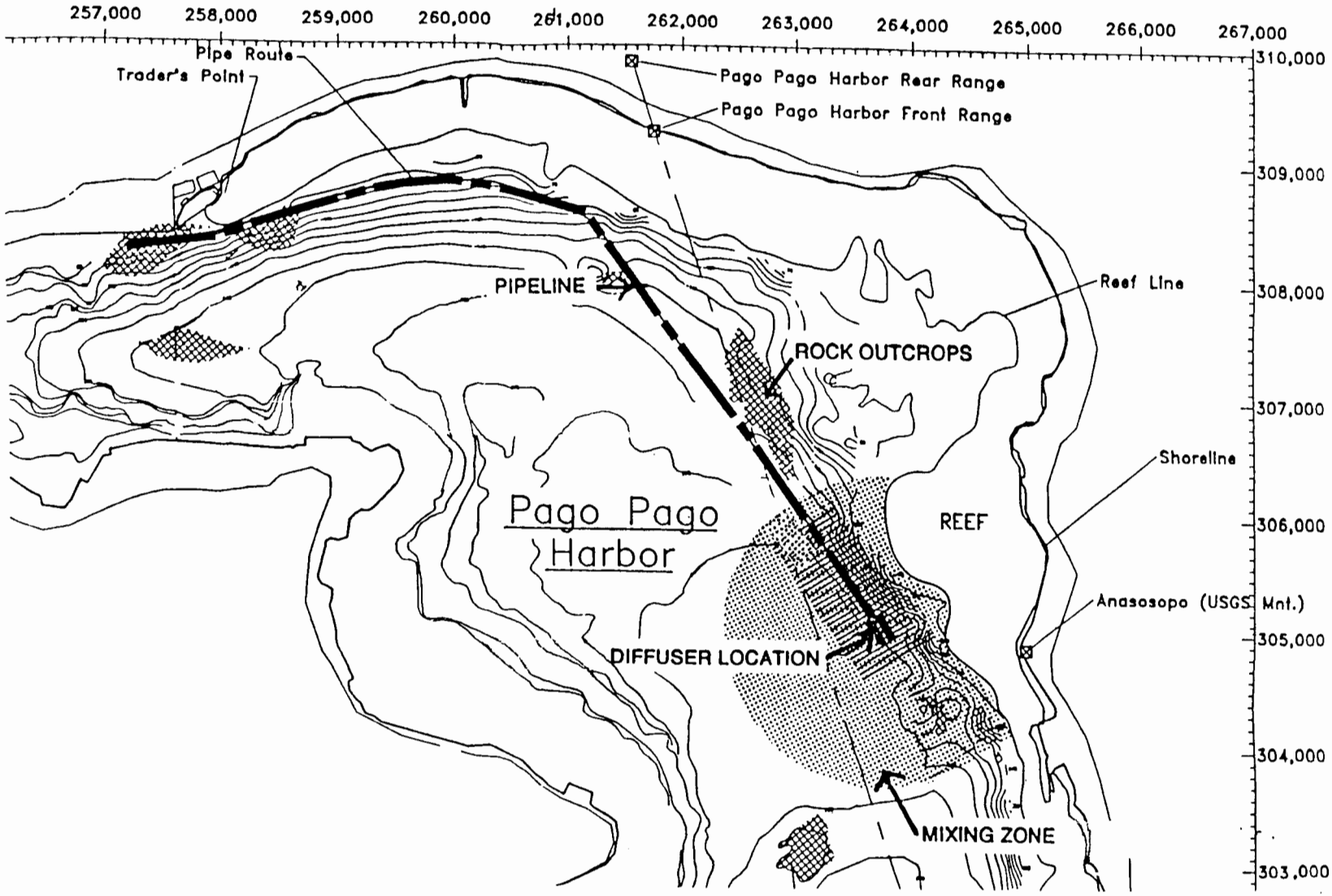

Figure 1-4.
Outfall and Mixing Zone Location

2. FIELD DATA COLLECTION

A description of the field data collection during March 2003 is presented in this section. The methods used for field measurements and sample collection are described. The types of data collected and the locations, dates, and times of measurements and sample collection are summarized. Deviations from the study plan are listed and discussed.

2.1 General Description

The sampling activities were conducted between 18 and 23 March 2003 and the samples were collected on 19, 20 and 21 March 2003. The activities conducted during this time period included:

- 18 March – Equipment calibration and testing
- 19 March – Sampling at Stations 8, 8A, 14, A1, B1, C[1]
- 20 March – Sampling at Stations 5, 11, 13, 15, 16, 18, and U[2]
- 21 March – Sampling at stream mouth stations S1, S2, S3, S4, S5[3]
- 22 March – Final sample preparation
- 24 March – Sample and equipment packing and shipping

During sampling at designated stations water samples were collected for laboratory analysis using standard water sampling bottles. Secchi depth and total water depth were measured at each station. Measurements of salinity, temperature, pH, and dissolved oxygen (DO) were made in the field using splits from each grab sample as each sample was collected. In addition, vertical CTD profile casts were made at the time of grab sample collection and included measurement of conductivity, temperature, depth, DO, pH, and backscatterance (turbidity). The readings from the DO and pH probes on the CTD profiling instrument were compared to the results of measurement from grab samples at selected stations and depths to check the accuracy and, if necessary, field calibrate the probes on the profiling instrument.[4] The backscatterance measurements in the field (as turbidity) were compared to the results

---

[1] Stations A1, B1, and C are not a part of the JCO monitoring requirements, but samples and measurements are collected concurrently and some results are provided in this report to provide a more complete description of Harbor water quality during the sampling period.

[2] Station U is not a part of the JCO monitoring requirements, but samples and measurements are collected concurrently and some results are provided in this report to provide a more complete description of Harbor water quality during the sampling period.

[3] Stream mouth stations are not a routine part of the monitoring and are not required by the NPDES permits. These samples were collected as a demonstration in consultation with USEPA and ASEPA.

[4] Salinity and temperature from the grab samples and the profiling instrument were also compared. The profiling instrument measurements of salinity and temperature are typically more accurate and more precise than the grab sample measurements and corrections would not normally be considered necessary.

from the laboratory analysis of grab samples measured for turbidity. Corrections to Do, pH, and turbidity, if required, are described in Section 3 below.

The meteorological conditions during sampling were as follows:

- 19 March (AM) – Overcast, calm seas, light wind from SW; heavy rain just prior to sampling (Stations C, B1, A1)
- 19 March (PM) – Cloudy, swell from south at 2-3 feet but otherwise calm seas, light wind from SW (Stations14, 8, 8A)
- 20 March (AM) – Sunny turning overcast by 10:30, wind about 5 knots from NNE shifting to N by 11:00, swells of 5 to 6 feet outside the Harbor and 2-4 feet in Outer Harbor decreasing throughout the morning (Stations 5, 18, 16)
- 20 March (PM) – Overcast, wind 5 to 10 knots from NE, swell dropped to less than 1 foot in Outer Harbor (Stations U, 11, 13, 15)
- 21 March (PM) – Stream mouth sampling done at low tide (16:00 to 17:30). Rain showers occurred in the morning and the previous evening.

A heavy plankton bloom was noted in the Inner Harbor and developed and grew in size over the 19th and 20th of March. Station 11 was sampled on 20 March in the middle of a heavy patch of the bloom, which extended across 50 to 75 percent of the width of the Inner Harbor. The bloom was not an isolated feature in Pago Pago[5] Harbor but was regional in scale. Patches were observed from the air between Tutuila and Mauna, approximately 70 miles to the east.

The sampling and analysis were performed according to the study plan previously submitted to, and approved by, ASEPA and USEPA. Station locations are specified in the permit by latitude and longitude and graphically. The problems with station specification associated with the differences between various map datums and the use of GPS was described in a previous report for the March 1996 water quality sampling episode. In March 2001, the WGS 1984 coordinates of the stations actually occupied for the JCO sampling were recorded and permanently stored in the GPS instrument and on data sheets. The same coordinates are used for all future sampling episodes including the March 2003 sampling episode, unless corrections are required. Such corrections are reported in the discussion on deviations to the study plan.

The WGS coordinates of the stations in the Harbor that were occupied, and the times of station occupation, for the March 2003 sampling are given in Tables 2-1 and 2-2. Figure 2-1 shows the locations of the stations occupied in the Harbor for the March 2003 sampling. The stream mouth stations that were sampled are described in Table 2-3.

[5] Personal communication, Peter Peshut (ASEPA).

2.2 Description of Field and Analytical Methods

The water quality monitoring study requires direct *in situ* field measurements, collection of water samples, direct measurements of certain parameters in the samples, vertical profiles, and laboratory analysis of the samples for specified chemical constituents. The results of the measurements and analysis are provided in Section 3. Field logs are kept for each station on which sample location, time, depth, Secchi depth, direct field measurements, profile cast numbers, sample bottle fills, and other information is recorded.

2.2.1 Sample Collection

Harbor Sampling: Water samples from the Harbor were collected using a standard oceanographic sampling bottle[6] from each depth specified in the permit (depths of collection, for the March 2003 samples, at each station, are shown in Table 2-1). The collection bottle was lowered to the appropriate depth using a measured line and allowed to hang for a minimum of 1 minute. The collection bottle was flushed with ambient water at depth by raising and lowering it a few feet around the collection depth. A messenger was dropped down the line and the bottle was retrieved after being tripped by the messenger.

Sample bottles, as described in Table 2-4, were stored on ice on board the vessel, immediately after being filled. Samples were preserved as indicated in Table 2-4 when brought ashore, prepared for shipment to the laboratory, and kept on ice until shipped. In addition, two liters was collected for chlorophyll-a analysis. The chlorophyll samples were stored in the dark and on ice and processed later at a shore-side location. These samples were filtered through a Whatman grade GF/F glass fiber filter (0.7 microns) using a vacuum pump apparatus. The filters were treated with manganese sulfate as a preservative, folded, wrapped in foil, frozen, shipped to the U.S. mainland in an insulated leak proof container with water samples packed in ice, and delivered to the laboratory for analysis.

Stream Sampling: Water samples from the stream mouths were collected by direct submersion of the sample bottles in the stream. The samples were collected in free flowing water of sufficient depth so that bottom sediments were not disturbed. Based on consultation with USEPA and ASEPA, two samples were collected a few minutes apart for analysis of nutrients. Single samples were collected for metals analysis. Samples were collected as close to the mouth of the stream as practical and were collected at low tide to avoid sampling harbor water or a mixture of harbor and stream water. Conductivity was measured at the time of sample collection to verify that the samples were fresh water.

2.2.2 Direct Field Measurements

Harbor Sampling: Direct field measurements included water depth, Secchi depth, salinity, temperature, pH, and DO using sub-samples of each grab sample. These measurements were conducted as follows:

---

[6] Sample collection was done with a "Beta-plus, low-metals, sampler" supplied by WildCo.

- Water depth was measured using a non-recording fathometer, which is occasionally checked by observing the signal produced as the Secchi disk or the SeaBird CTD vertical profiler was lowered and raised through the water column.
- Secchi depth was determined by using a 12" diameter alternating black and white (quartered) Secchi disk lowered through the water column on a measured line.
- DO was measured in the samples collected in the field using a YSI Model 95 meter following the manufactures instructions for use of the meter; the meter was calibrated before, during, and after the sampling.
- pH was measured using aliquots of each sample in the field as samples were collected with an Orion Model 260A pH meter. The meter was calibrated before and after the sampling.
- Salinity was measured using in the same samples used for DO and pH sample as collected in the field using a YSI Model 30 conductivity, salinity, temperature (CST) meter. The meter was calibrated using a standard solution at a specific conductance of 50 mS/cm.
- Temperature probes are included with the DO, pH, and CST meters. Temperature was recorded from the conductivity meter.

Calibration methodology for the meters used in the field is described, and results provided, in Appendix II.

Stream Sampling: Direct field measurements included conductivity, temperature, pH, and DO measured directly in the stream at the same location from which the samples were collected. These measurements were conducted using the same instruments and calibration methods described above for measurements in the Harbor of these parameters.

2.2.3 Vertical Profile Measurements

Vertical profiles of conductivity, temperature, depth (pressure), DO, pH and turbidity (backscatterance) were measured in the Harbor at the same stations where water samples were collected. The data were collected using an internally recording profiling instrument (SeaBird SBE 19 SEACAT Profiler), which had been calibrated by the manufacturer. The instrument is equipped with a pump to provide continuous flow past the conductivity and DO sensors. Data are recoded and stored internally every 0.5 seconds.

The instrument package was tested in air prior to field data collection. During field data collection the instrument was turned on, "soaked" for three minutes at each station, and then lowered and raised through the water column by hand. The operator kept the rate of lowering and raising approximately constant.[7] The rate of decent was slowed approaching the bottom. After recovery at each station the instrument was turned off to maintain battery life and internal memory. The cast numbers, time, and water depth indicated on the fathometer were recorded on field data sheets kept for each station.

---

[7] The on board pump eliminates the need for maintaining a minimum speed of the instrument through the water column. The accurate depth sensor automatically tracks the instrument location.

Data from the profiler are processed using the manufactures software for downloading, checking, and processing the data. Salinity and seawater density were calculated from conductivity and temperature using the SeaBird supplied software. Calibration information is provided in Appendix II. Station times and locations are listed in Table 2-1.

2.3 Deviations From the Study Plan

As in any field data collection, problems are encountered in the field that require immediate solution, such as weather, equipment malfunctions, and a variety of other factors that may lead to deviations from the study plan. There were only minor unplanned deviations during this episode of field data collection, which had no substantial effect on the data recovered. There were two planned (intentional) deviations:

- The standard procedure for delivering the chlorophyll samples to the laboratory is to hand carry, as carry-on or checked baggage, the samples in an insulated container from Samoa to Seattle for delivery to the laboratory. Because of travel schedules during the March 2003 sampling this was not possible. The samples were kept frozen and then packed in an insulated container, which was packed in an ice chest with water quality samples packed in ice. The samples were received and analyzed by the laboratory as usual. This deviation is not considered to have affected the quality of the samples or the data.

- As described above a number of samples were collected at the mouths of the five permanent streams that flow into Pago Pago Harbor. Sampling at these stations is not required in the NPDES permits. The stations were included as a demonstration of potential modifications to the permit condition that would provide useful data to the USEPA and ASEPA for developing long term water quality monitoring strategies. To balance the cost and effort involved in the stream mouth sampling, a number of analyses of Harbor water column samples were not conducted with the agreement of USEPA and ASEPA[8]. The changes in sampling and analysis, compared to the permit requirements, are presented in Table 2-5.

  The changes in sampling stations and analysis are not considered to have compromised the results or usefulness of the NPDES receiving water monitoring program. The previous monitoring results have consistently indicated that the Harbor water quality is generally in compliance with the ASWQS and that the cannery discharge does not result in non-compliance. In addition, the stations closest to the cannery discharge were fully sampled with all analyses included, and these are the most critical monitoring stations required to assess effects of the cannery discharge.

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[8] Samples were collected at all NPDES permit-required stations. The laboratories held those samples not analyzed for specified parameters until the results of the analyses were reviewed. These samples were available for additional analyses if the initial results had indicated potential for non-compliance with ASWQS for those parameters that were not constrained by holding time requirements. Th samples have now been discarded.

Table 2-1
Pago Pago Harbor Water Quality Monitoring
Harbor Sampling Station Occupation Summary
March 2003

Station No.	Grab Sample Collection			Latitude 14° S		Longitude 170° W		Water Depth	Secchi Depth[1]	Sampling Depths
	Date 2003	Time Start	Time End	Start	End	Start	End	(feet)	(feet)	(feet)
		(Local Time)		(minutes)		(minutes)				
Transition Zone (Reference Station)										
5	20 Mar	10:05	10:25	17.707	17.735	39.752	39.781	140	62/S	3, 60, 120
TN/TP Mixing Zone Boundary										
15	20 Mar	14:40	15:10	16.580	16.576	40.182	40.176	95	41/O	3, 45, 90
16	20 Mar	11:35	11:50	16.964	16.885	40.340	40.351	200	65/O	3, 60, 120
18	20 Mar	10:50	11:10	17.220	17.174	40.086	40.155	198	76/O	3, 60, 120
Near Diffuser										
8	19 Mar	14:50	15:05	16.932	16.953	40.103	40.087	178	41/O	3, 60, 120
8A	19 Mar	13:30	13:50	16.767	16.750	40.172	40.169	170	45/S	3, 60, 120
14	19 Mar	14:00	14:25	16.803	16.812	40.078	40.079	176	45/C	3, 60, 120
Inner Harbor										
11	20 Mar	16:45	17:00	16.477	16.482	40.941	40.963	160	8[2]/O	3, 60, 120
13	20 Mar	17:15	17:30	16.332	16.332	41.894	41.894	26	22/S[3]	3. 13. 22
Near Utulei Outfall										
A1	19 Mar	11:20	11:40	16.974	16.979	40.526	40.497	120	55/C	3, 60, 110
B1	19 Mar	12:00	12:15	17.059	17.032	40.410	40.403	180	53/C	3, 60, 120
C	19 Mar	10:30	10:50	16.747	16.724	40.814	40.730	90[4]	45/O	3. 45. 85
U	20 Mar	13:35	13:50	16.997	16.993	40.459	40.467	136	48/O	3, 60, 120

[1] S = sunny conditions, O = overcast, C = partly cloudy with sampling location out of direct sunlight
[2] This station in the center of an intense plankton bloom (see Section 2.1)
[3] Also measured during overcast conditions at 17 feet.
[4] Water depth variable from 70 to 90 in a region of a rugged bottom with many coral heads.

Table 2-2 Pago Pago Harbor Water Quality Monitoring Vertical Profile Station Occupation Summary March 2003				
Sample Collection			Latitude 14° S	Longitude 170° W
Station No.	Date	Time (Local Time)	(minutes)	(minutes)
Transition Zone (Reference Station)				
5	20 March	09:55	17.701	39.749
TN/TP Mixing Zone Boundary				
15	20 March	14:20	16.591	40.191
16	20 March	11:25	16.914	40.328
18	20 March	10:45	17.159	40.077
Near Diffuser				
8	19 March	14:45	16.954	40.096
8A	19 March	15:25	16.754	40.173
14	19 March	13:45	16.799	40.086
Inner Harbor				
11	20 March	16:00	16.446	40.909
13	20 March	17;10	16.341	41.895
Near Utulei Outfall				
A1	19 March	11:15	16.964	40.516
B1	19 March	11:50	17.077	40.395
C	19 March	09:55	16.728	40.842
U	20 March	15:30	17.006	40.466

Table 2-3 Pago Pago Harbor Stream Mouth Sampling Locations 21 March 2003 Sampling		
Station	**Stream Name**	**Description of Sampling Site**
S-1	Fagaalu Stream	Approximately 50 ft upstream of bridge crossing main road, accessed stream from north bank to sample in center part of channel.
S-2	Vailoa Stream	Stream located at Utulei next to south driveway used to access ASEPA parking lot. Sample site approximately 2 ft upstream of box culvert under main road on south bank.
S-3	Fagatogo Drainage	Drainage immediately adjacent and south of food establishments at vegetable/fruit market place. Sample site located approximately 2 feet upstream of downstream most bridge crossing next to blue pipe crossing, in center of channel.
S-4	Pago Pago Stream Mouth	Sample site downstream of the confluence of the streams that enter at the head of Pago Pago Harbor. The sample site located along south side of the mouth, about 400 ft upstream of the Harbor shoreline. Sample site was next to the end of the rock slope protection and just before the beginning of the vertical rock concrete bulkhead wall. The sample site was immediately down the bank from the single palm tree located north of the west end of the boathouse.
S-5	Aua Stream	Downstream of the confluence of the streams running through the Village of Aua. The sample site was located approximately 10 ft upstream of the bridge crossing the main road. The sample site was at the toe of rock slope protection at the northwest bridge abutment.

Table 2-4
Pago Pago Harbor Water Quality Monitoring
Sample Analysis And Handling Procedures
March 2003

PARAMETER	REQUESTED ANALYTICAL METHOD	REQUESTED REPORTING DETECTION LIMIT	SAMPLE HOLDING TIME	SAMPLE CONTAINER	SAMPLE PRESERVATION
Temperature	Field Probe	0.1°C	N/A	N/A	none
Salinity	Field Probe	0.1 PSU	N/A	N/A	none
Dissolved O_2	Field Probe	0.1 mg/l	N/A	N/A	none
pH	Field Probe	0.1 SU	N/A	N/A	none
Turbidity	Field Probe	0.2 NTU	N/A	N/A	none
Turbidity[1]	EPA 180.1	0.01 NTU	48 hours [2]	500 ml plastic	none
Total Suspended Solids	EPA 160.2	1.0 mg/l			
Nitrate + Nitrite	EPA 353.2	0.010 mg/l	28 days	500 ml plastic	4°C - H_2SO_4
Ammonia Nitrogen	EPA 350.1	0.005 mg/l	28 days		
Total Kheldal Nitrogen	EPA 351.3	0.025 mg/l	28 days		
Total Phosphorus	EPA 365.2	0.005 mg/l	28 days		
Chlorophyll-a	SM 1002 G	0.03 mg/m^3	3 months	Whatman (0.7 micron) GF/F filter	manganese sulfate, and then frozen
Arsenic	EPA 200.8	0.14 µg/l	7 days	500 ml plastic	4°C
Copper		1.0 µg/l			
Lead		5 µg/l			
Zinc		20 µg/l			
Mercury	EPA1631	0.025		500 ml plastic	4°C

Notes: [1] Turbidity samples sent to lab from selected stations to verify and supplement probe readings. Stations are specified in the NPDES permit, additional stations selected at discretion of field team leader.

[2] Holding time for turbidity is unavoidably exceeded because of logistics involved in shipping from American Samoa. The laboratory (AMTEST) agreed to test for these constituents immediately upon receipt of the samples.

Table 2-5
Pago Pago Harbor Water Quality Monitoring
Changes in Sampling and Analyses
March 2003

Station	Hydrographic Parameters[1]		Biological Parameters [2]		Zn and Cu		As, Pb, and Hg	
	Typical	Mar 2003	Typical	Mar 2003	Typical	Mar 2003	Typical	Mar 2003
Harbor Samples – Samples at Three Depths								
5 (S, M, B)	X	X	X	X	X	X	X	X
15 (S, M, B)	X	X	X		X			
16 (S, M, B)	X	X	X	X				
18 (S, M, B)	X	X	X	X				
8 (S, M, B)	X	X	X	X	X	X		
8A (S, M, B)	X	X	X	X	X	X		
14 (S, M, B)	X	X	X	X	X	X	X	
11 (S, M, B)	X	X	X	X[3]	X		X	
13 (S, M, B)	X	X	X	X	X	X	X	X
Stream Mouth Samples – Two Sequential Samples								
S1 - A		X		X				X[4]
S1 - B		X		X				
S2 - A		X		X				X[4]
S2 - B		X		X				
S3 - A		X		X				X[4]
S3 - B		X		X				
S4 - A		X		X				X[4]
S4 - B		X		X				
S5 - A		X		X				X[4]
S5 -B		X		X				

[1] Turbidity not included in stream mouth sample analyses

[2] Chlorophyll-a not included in stream mouth sample analyses

[3] Chlorophyll-a sample collected to document visible plankton bloom, but no other biological parameters were analyzed

[4] As and Pb analyses done on sample A, Hg analysis done on sample B

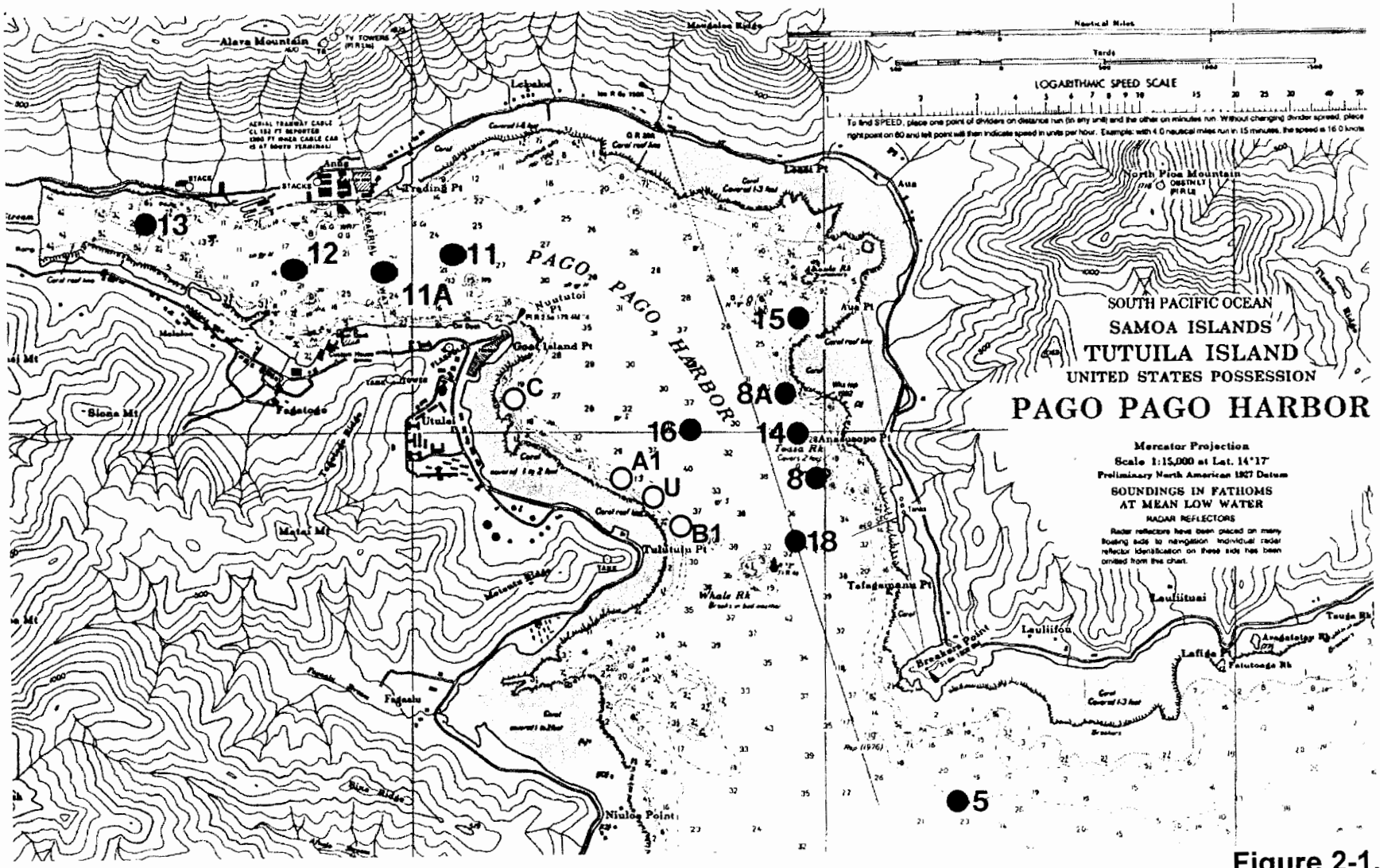

Figure 2-1.
Station Locations

3. DATA SUMMARY

The parameters measured in the field and analyzed in laboratory can be conveniently categorized into four classes:

- Physical, chemical, and hydrographic parameters that are measured directly in the field as samples are collected and that generally describe the water column structure
- Hydrographic and chemical parameters that are measured as continuous vertical profiles
- Nutrient and biological parameters that are sampled and analyzed in the laboratory and that relate to the overall biological health of the Harbor
- Trace metals that are sampled and analyzed in the laboratory and that provide information on potential toxicity in the water body

Physical and hydrographic parameters include temperature, salinity, density, DO, pH, turbidity, and Secchi depth (used as an indicator of light penetration). Nutrient and biological parameters include the various types of nitrogen, phosphorous, and chlorophyll-a. Arsenic, copper, lead, mercury, and zinc were the trace metals of specific interest for this field campaign. Zinc and copper are discharged by the canneries at levels that require a small initial dilution to achieve water quality standards. The other three metals are being measured for informational purposes. Ammonia is measured both as a component of the nitrogen cycle and because it is a toxic substance that requires a small initial dilution within an approved mixing zone. Ammonia is presented with the nutrient and biological parameters in the discussions below. The results of the March 2003 tradewind sampling episode for each class of parameters are presented in this section.

3.1 Physical and Hydrographic Parameters

The physical and hydrographic parameters measured in the field during the March 2003 Harbor monitoring included (in addition to station location and total water depth): temperature, salinity, dissolved oxygen (DO), pH, turbidity, and light penetration by means of Secchi depth. These parameters, except for light penetration, were measured both in discrete grab samples and as vertical profiles. Turbidity was measured at selected stations in the laboratory using the water samples collected as described above in Section 2[1]. This section describes the measurement results from using the discrete grab samples. The results for the stream mouth samples are summarized separately in Section 3.1.7. Section 3.2 describes vertical profile results in the Harbor.

[1] Turbidity sample data are presented in the description of nutrient and biological parameters in Section 3.3. Vertical profile turbidity data are discussed in Section 3.2.

3.1.1 Temperature

Temperature summaries are given in Table 3-1A. There were three temperature measurements done for each grab sample, since each of the hand-held instruments (salinity, DO, and pH) measures temperature independently[2]. In general, the various instruments agree with a few tenths of a degree. The temperature readings from the conductivity meter were recorded and are reported in Table 3-1A. There was very little variation in temperature throughout the Harbor during the sample collection with an average value of 30.0 °C (measurements ranged from 29.4 to 31.0 °C). Temperatures throughout the Harbor, from the mouth to the Inner Harbor, were remarkably similar with little variation. The surface temperatures were about 0.5 °C to 1 °C warmer than the near bottom temperatures at most stations. There was no identifiable temperature effect of the JCO discharge observable in or around the boundary of the mixing zone or near the diffuser location.

3.1.2 Salinity

Salinity summaries provided in Table 3-1A indicate a well-mixed water column with little variability. Average salinity for the Harbor was 35.0 PSU, ranging from 34.3 to 35.3 PSU. Inner Harbor salinity (Station 13) was similar to the reference station (Station 5) value. Vertical variability was typically no more than about 0.5 PSU with a maximum of about 1 PSU between near surface and near bottom samples. There is no discernible influence from the JCO discharge.

3.1.3 Dissolved Oxygen

There is both vertical and longitudinal spatial variability and temporal variability of DO indicated in the data provided in Table 3-1A, as expected. There is, however, no indication of a reduction of DO in the mixing zone or near the diffuser. Average DO was 5.9 mg/l and the discrete values ranged from 4.6 mg/l (Station 13, near-bottom) to 10.7 mg/l (Station 11, near surface). The value in the near surface water at Station 11 was anomalous and was sampled in a distinct plankton bloom, as discussed in Sections 3.3.4 and 4. The highest DO measured, not including the Station 11 value, was 6.5 at Station U (near surface). The measured DO was above the numerical American Samoa Water Quality Standard (ASWQS) of 5.0 mg/l on a water column average basis at every station and on a point-by-point basis at every station and depth except at the far head of the Inner Harbor (Station 13). As provided below in the description of the vertical profiles in Section 3.2, the DO levels are all above the 78% of saturation.[3]

3.1.4 pH Measurements

Table 3-1A summarizes the pH readings obtained during the study. There are extremely small differences observed along the Harbor axis, but no distinct trends. The natural value for

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[2] Some variability between temperature probes is because of response times. Each instrument is calibrated consistently with the internal temperature probe on that instrument and the primary parameters measured by each instrument are unaffected by these small temperature variations.

[3] The ASWQS is that DO shall be "*Not less than 70 percent of saturation or less than 5.0 mg/l. If the natural level of dissolved oxygen is less than 5.0 mg/l, the natural level will become the standard.*" The saturation value at the temperatures and salinities observed is in the range of 6.1 to 6.3 mg/l.

marine waters is generally considered to be in the range of 7.5 to 8.4. For near surface waters (water in equilibrium with atmospheric CO_2), pH is typically about 8.1 to 8.2. Variability in coastal waters will be more extreme if freshwater inflows are present, which will tend to depress the marine values. The average pH for all measurements was 8.1 with a range between 8.0 and 8.5 and a standard deviation of 0.07. The value in the near surface water at Station 11, within the visible plankton bloom appears to be anomalously higher (8.45). If the reading at Station 11 (near surface) is removed, the maximum value was 8.2. These values and variability are as expected for marine water and consistent with past monitoring data. Surface and deeper water column values do not exhibit any trend. Depth averaged values at all stations ranged from 8.06 to 8.20. Many of the lower values appear to be associated with freshwater introduced by a heavy rainfall occurring just prior to the second day of sampling. Measured pH values meet the ASWQS numerical standard at all locations.[4]

3.1.5 Turbidity

Samples from all stations were collected and sent to the laboratory for analysis of turbidity. The data are presented in Section 3.3 below and indicate compliance with ASWQS (an average value 0.75 NTU). The average value was 0.26 NTU and the highest value was 0.67 NTU.

3.1.6 Secchi Depth

Secchi depths are presented in Table 2-1 above and ranged from 22 feet in the Inner Harbor (Station 13) to 76 feet in the Outer Harbor (Station 18). At the head of the Inner Harbor the Secchi disk was visible near the bottom at 22 feet below the surface in 26 feet of water. It is noted that the Secchi depth observed at Station 11 in the middle of a visible plankton bloom (Station 11) was only 8 feet, but this is considered an anomalous condition in the Harbor. Data collection during overcast sky conditions may understate Secchi depths compared to those collected under "standard" clear sky conditions. For the March 2003 monitoring campaign the skies were generally overcast, so the observations may predict lower light penetration than actually present in the water column.

The ASWQS is in terms of light penetration, which cannot be directly converted from Secchi depth or turbidity readings. However, some estimates can be made with light penetration being estimated by Secchi depth using the following approximation:

$$\chi = \kappa \cdot D^{-1}$$

where,

χ = extinction coefficient for visible light

κ = a constant

and

D = Secchi depth in meters for a 30 cm Secchi disk.

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[4] The ASWQS is the "*The pH range shall be 6.5 to 8.6 and be within 0.2 pH unit of that which would occur naturally.*"

The constant κ is not easily determined but is often taken as 1.7 based on data from the English Channel (Sverdrup, 1942). Using the above approximation, light penetration of 1 percent at 65 feet corresponds to a Secchi depth of 24 feet. Such a calculation corresponds to Secchi readings taken at high sun angles and in full sunlight. This is not always possible during times of data collection in Pago Pago Harbor, and some of the data from March 2003 was acquired during poor conditions for reading Secchi depths.

The ASWQS state that light penetration of 1 percent of the incident light should penetrate to a depth of 65 feet 50 percent of the time. As calculated above this corresponds to Secchi depth of approximately 24 feet (under appropriate conditions). Even under poor conditions for observing the Secchi depth, only two measurements were lower than 24 feet: the measurement at Station 11 in the middle of a visible plankton bloom, and the measurement at Station 13, in the far Inner Harbor. Although the data cannot be directly used to evaluate compliance, experience and judgment would indicate that ASWQS for light penetration are being satisfied throughout the Harbor.

3.1.7 Stream Mouth Samples

As mentioned in Section 2, samples were also collected at the mouths of the five permanent streams that discharge into the Harbor. The data are presented in Table 3-1B and are summarized as follows:

- Temperatures were slightly cooler than the harbor water, ranging from 26.7 to 29.0 °C. The temperature at Station S4 (Pago Pago Stream Mouth) was warmer than the other four streams.

- Conductivity ranged from 171 to 1225 μmho/cm (μS/cm) which indicates fresh water. The streams were sampled on a low tide and the conductivity was measured to confirm that the stream flow samples were of upland origin and not remnant seawater from the previous high tide.

- DO ranged form 4.4 to 6.9 mg/l. The low value was measured at Station S2 (Vailoa Stream). The next lowest value was 5.3 mg/l at Station S3 (Fagatogo Drainage).

- The pH ranged from 6.9 to 7.4, again the lowest value was observed at Station S2.

3.2 Vertical Profiles

Vertical profiles taken of temperature, conductivity, DO, pH, and turbidity (as measured by backscatterance) were collected. Salinity and density profiles were calculated from the vertical profile data using the SeaBird supplied software. Data were collected both as the instrument was lowered through the water column (downcast) and as it was raised back to the vessel (upcast). Data are recorded every 0.5 seconds. The data were downloaded from the SeaBird and then converted to engineering units, filtered (low pass filter), aligned (response time for various sensors adjusted), and finally averaged over one-meter intervals following the

calculation of derived variables and the removal of recordings before and after the actual cast. The processed data are provided in Appendix III. The data are summarized in Table 3-2.

Variability in all the parameters was very small, and the water column was generally well mixed with little stratification. There was a slight lower density surface layer observed throughout the Harbor, extending no more than about 5 meters below the surface. A constant density layer with very little gradient was observed down to about 30 to 35 meters, and a slight gradient (about 1 sigma–t unit or 0.001 g/cm^3) from this depth to the bottom.

The sensors on the profiling instrument are calibrated by the manufacturer, and there is no method available to field calibrate them at the study site. To address this situation, the measurements from the profiling instrument sensors were compared to those taken from the grab samples by hand-held field instruments that were pre- and post-calibrated on site. The comparison was done using the SeaBird readings from the depths at which the grab samples were taken. Some variability is expected, but in general the results should be consistent and agree within the natural variability encountered in the water body over the space and time scales involved. In some cases the profiler data is adjusted based on the grab sample data. This "field calibration" of the sensors is described for each variable in the discussion below, and, detailed results of the comparison are provided in Appendix II.C.

3.2.1 Temperature

SeaBird temperature measurements, summarized in Table 3-2, are generally consistent with those from the hand-held field measurements (see Appendix II, Table II.C.1). There was little variation observed in the vertical profile temperature data throughout the Harbor. Slightly warmer temperatures were observed at the surface compared to the bottom and in the Inner Harbor compared to the reference station (Station 5). Differences between stations and depths were typically no more than a few tenths of a degree. Depth averaged temperatures were typically observed above the ASWQS of 85 °F (29.44 °C) throughout the Harbor However, this is considered a natural condition during this time of year, and does not indicate non-compliance with ASWQS. There is no evidence that the JCO discharge results in elevated temperatures in the vicinity of the discharge.

The YSI instrument recorded temperatures were slightly higher in the grab samples than the SeaBird, with an average difference of about 0.1 °C (Appendix II, Table II.C.1). The temperature sensor on the Seabird instrument is known to be very precise and accurate and no corrections to the SeaBird data are considered necessary. The profiler data is considered more accurate than the hand-held instrument.

3.2.2 Salinity

As in the case of temperature, SeaBird salinity measurements (summarized in Table 3-2) are also consistent with those from the hand-held field measurements (Appendix II, Table II.C.2). There was little variation throughout the Harbor. Slightly less saline water was often observed at the surface compared to the bottom but only minor variations were observed between stations throughout the Harbor. Differences between stations and depths were typically no more than a few tenths of a PSU.

The salinities recorded by the profiling instrument differed from the handheld YSI meter measurements of grab samples by about 0.3 PSU on average. The Seabird instrument conductivity and temperature sensors, from which salinity is calculated, are designed for oceanographic work requiring very precise and accurate data and no corrections to the SeaBird data are considered necessary. The profiler data is considered more accurate than the hand-held instrument.

3.2.3 Density

Density was calculated as sigma-t from the temperature and salinity recorded by the SeaBird profiler and provides a measure of water column stratification. The vertical density gradient is an important parameter controlling the behavior of the JCO discharge plume and the potential for vertical mixing. As summarized in Table 3-2, and shown in Figure 3-1, there was little variation in density through the water column or longitudinally along the Harbor. There is a discernable surface layer and a deep (below 35 meters) density gradient. The surface layer is relatively weak and the overall density variation is less than 0.002 g/cm^3. The measured stratification throughout the Harbor, and at the diffuser location, was relatively weak and represents a stable water column. The density gradient is sufficient to keep the plume from surfacing, based on previous analyses done for the JCO diffuser design and during dye studies done to verify plume behavior following construction of the diffuser. The density gradient is not considered strong enough to set up distinct hydrodynamic layering in the Harbor, or have a major influence on Harbor circulation.

The Harbor sometimes has a shallow water surface layer of lower density associated with warmer and less saline surface water and occasionally has a near-bottom layer of higher density. These layers are formed in response to meteorological factors and are not always present. In the March 2003 data presented here, these features are evident, but the persistence and seasonality are not well understood. The non-tradewind season often displays a more structured water column as evident in this data set.

3.2.4 Dissolved Oxygen

The SeaBird profiler measured DO levels that were consistently lower than the YSI measurements. The average difference was about 3.12 mg/l. The calibration information for both instruments, and the summary of the comparison, is included in Appendix II (Table II.C-3). The YSI measurements could be biased high because of oxygen introduced during sample handling on the vessel, however such a bias is generally less than 0.1 mg/l when proper sampling handling is practiced. The difference between the two data sets is attributed to a low bias in the SeaBird data and the SeaBird data were adjusted by adding 3.12 to all values.[5]

The DO trends and levels, corrected as described above, indicated by the vertical profile data (Table 3-2) is essentially the same as that indicated by the field measurements of the grab samples. Vertical and longitudinal spatial variability and temporal variability of DO are similar

[5] Both the raw and corrected values are provided in Appendix III for the DO measurements obtained from the profiling instrument.

for both data sets. All DO values are greater than 5.00 mg/l, with an average of 5.83 mg/l for all measurements. The profile data for DO in Table 3-2 is also presented in terms of percent saturation, and the SeaBird data indicate that the Harbor water is consistently above 80% of saturation, with an average of 93.5% for all measurements. The ASWQS is 70% saturation as a minimum, so both on an absolute and percent saturation basis the ASWQS appears to be met.

3.2.5 pH

The values measured by the sensor on the SeaBird profiler averaged 1.51 SU higher than the values obtained from grab samples with the Orion pH meter. The calibration information for both instruments, and the summary of the comparison, is included in Appendix II (Table II.C-4). Therefore, the SeaBird data were corrected by subtracting 1.51 from all readings.[6] Table 3-2 summarizes the corrected pH readings obtained from the SeaBird profiler deployments at each station. The average pH for all of the stations was 8.1 with a range of 7.98 to 8.4 (Table 3-2). There are extremely small differences observed along the Harbor axis, but no distinct trends. As in the grab samples, there was no distinct trend with depth or location in the Harbor.

3.2.6 Turbidity

Turbidity was measured throughout the water column using a SeaPoint optical sensor mounted on the SeaBird profiler. The turbidity sensor was set for the highest resolution and lowest range and threshold possible. The values recorded by the SeaBird were quite variable. Vertical profiles often indicated higher turbidity levels near the bottom of the water column. The average value of the station depth averages of turbidity throughout the Harbor was 1.42 NTU. This value is biased by higher bottom elevated turbidity levels.

The samples analyzed in the laboratory typically showed significantly lower turbidity than the comparable measurements recorded by the SeaBird (see Appendix II, Table II.C-5). All of the laboratory measured turbidity values are below the ASWQS of 0.75 NTU. Variability between the laboratory samples and the SeaBird readings was of the same order of magnitude as the readings themselves at the lower end of the range reported, with no observable correlation between the two data sets. The differences between the laboratory results and the SeaBird readings were typically less than 0.4 NTU, except where the SeaPoint sensor measured higher turbidity layers, generally near the bottom of the water column, that were not detected in the laboratory measurements of the grab samples.

There is no indication that the SeaBird data should be corrected. The turbidity values from both the laboratory-analyzed samples and the SeaBird are considered reliable indicators of the water body characteristics. However, the differences in measurement techniques must be noted. The SeaPoint sensor measures backscatterance over a very small volume of water and is quite sensitive to very small-scale changes that could be caused by momentary interruptions by organisms or temporary fouling of the sensor. The SeaPoint turbidity sensor is not

[6] Both the raw and corrected values are provided in Appendix III for the pH measurements obtained from the profiling instrument.

calibrated against a standard. The laboratory samples are representative of the mixed sample collected with a 6-liter grab sampler and thus tend to integrate results for a larger volume of water (although only a small portion of the sample is actually collected and analyzed). The laboratory data is considered more representative of actual levels of turbidity in the ambient water. The SeaPoint data are considered good indicators of water column structure.

3.3 Nutrient and Biological Parameters

Parameters measured to evaluate potential impacts of biological productivity included nutrients, suspended solids, and chlorophyll-a. Nutrients included total phosphorus, total Kheldal nitrogen (TKN), ammonia nitrogen, and nitrate plus nitrite. The ASWQS apply to total nitrogen (TN), which was calculated by adding the nitrogen components (note ammonia is included in TKN). Ammonia is monitored since the JCO discharge requires initial dilution to achieve compliance with the ASWQS. Table 2-2 indicates the nutrient constituents measured and the methods used in the laboratory. Each of the nutrient and related parameters are discussed below based on the data as summarized in Table 3-3A. Laboratory chain-of-custody forms and results are provided in Appendices IV and V, respectively.

3.3.1 Ammonia

The highest ammonia concentration reported was 0.079 mg/l at the offshore reference station (Station 5) at mid-depth. The average of the values reported was 0.035 mg/l. The ASWQS for ammonia is stated in terms of the un-ionized fraction, which is approximately 10 to 15 percent of the total ammonia measured in seawater at the temperature, salinity, and pH found in Pago Pago Harbor. The ASWQS is 0.233 mg/l. Thus the Harbor water clearly met the ASWQS during the sampling period.

3.3.2 Total Nitrogen

The ASWQS (average value) for total nitrogen (TN) is 0.200 mg/l. The highest value measured was 0.363 mg/l at Station U, near bottom. The average value was 0.160 mg/l. Stations on the west side of the Outer Harbor were consistently higher than the numerical criterion for total nitrogen. This could be attributable to the high TKN values associated with the plankton bloom described under the chlorophyll-a discussion in Section 3.3.4 below. There was no other definitive trend in values, and there was no indication of elevated values within the mixing zone or at the diffuser site attributable to the JCO discharge. Since the ASWQS are based on average levels it is clear that the ASWQS for TN was met in Pago Pago Harbor and within and at the edge of the JCO mixing zone, at the time of sampling. Compliance with NPDES Permit conditions is discussed in Section 4.

3.3.3 Total Phosphorus

The ASWQS (average value) for total phosphorus (TP) is 0.030 mg/l. As shown in Table 3-3A, the average measured value was 0.015 mg/l and the maximum was 0.0.90 mg/l (Station 8, mid-depth) only two (out of 39) measurements were above 0.030 mg/l. The ASWQS for TP was met throughout the Harbor at the time of sampling.

3.3.4 Chlorophyll-a

The numerical median ASWQS for chlorophyll-a is 1 μg/l (mg/m^3). Seventeen of 39 values were above this value and the average for the Harbor was 1.24 mg/m^3. In addition, a sample taken in the middle of the visible plankton bloom at Station 11 had a measured chlorophyll-a value of 25 mg/m^3. The elevated chlorophyll-a values were attributable to a naturally occurring regional scale plankton bloom that affected not only Pago Pago Harbor, but open ocean waters throughout the Samoan Islands. Visible patches were observed from aircraft traveling from Tutuila to Manua at the same time as the Harbor water quality samples were being collected (Peter Peshut, ASEPA, personal communication). The elevated chlorophyll-a was not directly attributable to anthropogenic factors and certainly not an effect of discharges in Pago Pago Harbor.

3.3.5 Suspended Solids and Turbidity

There is no numerical ASWQS for total suspended solids (TSS) in Pago Pago Harbor. The permit requires monitoring for this parameter and the values are shown in Table 3-3A. Reported suspended solids ranged from 78 to 100 mg/l, with no distinct spatial trends[7]. The values are consistent with past monitoring results. Suspended solids are one component of turbidity and the turbidity values discussed in Section 3.1 above are provided in Table 3-3A. Examination of the data shows no correlation between suspended solids and turbidity.

3.3.6 Stream Mouth Nutrient and Biological Parameters

Ammonia, nitrogen, phosphorus, and TSS were measured at the mouths of the five permanent streams discharging into the Harbor. Two samples were taken at each stream mouth station, approximately five minutes apart. The results are shown in Table 3-3B and are summarized as follows:

- Ammonia (as N) ranged from a high value 0.1 mg/l to a not detected level at 0.005 μg/l

- TKN ranged from 0.27 mg/l to 9 mg/l. These values are substantially higher than those measured throughout the Harbor. The highest values (an order of magnitude higher than any of the other streams) were measured in samples from the stream from the Fagatogo Drainage (Station S3).

- Total nitrogen (TN = TKN plus nitrate+nitrite) values ranged from 0.66 mg/l to 9.49 mg/l. The nitrate+nitite values were similar for all streams, ranging from 0.30 to 0.50 mg/l.

- Total phosphorus ranged from 0.14 to 0.72 mg/l. The highest values were measured in the two samples from (Station S1) and one of the samples from the Fagatogo Drainage (Station S3), which were two to four times higher than in other samples.

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[7] These levels of suspended solids appear unrealistically high compared to the turbidity, chlorophyll-a, and water clarity data. The data should be viewed as potentially flawed. Laboratory methods are being investigated.

- TSS values were generally very low, from 1 to 12 mg/l except for Station S1 (Fagaalu Stream) which had values of 130 and 140 mg/l.

3.4 Trace Metal Concentrations

Five trace metals were measured at specified stations and depths. Zinc and copper were measured in samples from five stations (three depths) in the Harbor to monitor the JCO discharge, since these metals require a small initial dilution to achieve the respective ASWQS. The available initial dilution is an order of magnitude higher than required by the JCO discharge to reduce the concentrations of zinc and copper to levels below the water quality standards. Arsenic, lead, and mercury were measured in samples from the Harbor, for informational purposes, collected at three stations (three depths). Samples were collected, preserved, and analyzed as described in Section 2. Arsenic, lead, and mercury were also measured in samples from the five stream mouths. Table 3-4 summarizes the results of the trace metals analyses. The chain-of-custody forms and laboratory results are provided in Appendices IV and VI, respectively.

All analyses for copper, lead, mercury, and zinc, resulted in reporting values well below the ASWQS. Arsenic was reported at values well below the ASWQS for protection of marine organisms (36 μg/l) and freshwater aquatic life (150 μg/l). The numerical concentrations of arsenic reported were typically about 10 times higherthe ASWQS for human health (0.14 μg/l).

The reported concentrations of arsenic were found consistently throughout the stations sampled, and were also found at similar levels during the previous (March 2001, October 2001, March 2002, August 2002) sampling campaigns. The levels at the references station outside the Harbor are the same as within the Harbor. Within the Harbor there was no discernable trend of arsenic concentration with location or depth. The levels of arsenic reported appear to be natural background concentrations and are well within the range of arsenic reported for oceanic waters worldwide.

The ASWQS are based on the EPA Recommended National Water Quality Criteria and are stated in terms of inorganic arsenic. The arsenic in surface waters, including marine waters, is typically almost all in the inorganic form, so it is unlikely that testing the speciation between forms of arsenic would lead to compliance with the HHC. The levels of arsenic in marine water are typically higher than the ASWQS based on HHC, and the values observed in Pago Pago Harbor are consistent with the expected levels in marine waters.

Natural levels of arsenic in seawater are documented in many references; a few are listed as follows:

Reference	Arsenic (μg/l)
Furness, R. W. and P. S. Rainbow, 1990. Heavy Metals in the Marine Environment, CRC Press, Boca Raton, Florida	1.35 – 2.5
Myers, J. J., C. H. Holm, and R. F. McAllister, 1969. Handbook of Ocean and Underwater Engineering, McGraw-Hill Book Company, New York, New York.	3
Smith, F .G. W., 1974. Handbook of Marine Science: Volume 1, CRC Press, Cleveland, Ohio.	3 - 6
Sverdrup, H. U., M. W. Johnson, R. H. Fleming, 1942. The Oceans: Their Physics, Chemistry, and General Biology, Prentice-Hall, Englewood Cliffs, New Jersey.	20

The Sverdrup reference is quite dated and the values appear higher than more recent reported levels. The Furness reference reports open ocean values, which are likely to be lower than for near coastal waters, where suspended arsenic-bearing sediments (e.g., from river runoff) may contribute to relatively higher local arsenic values. Recent work in Puerto Rico, representative of tropical waters in mid-oceanic environments, shows arsenic concentrations of 1.0 to 5.0 μg/l. There are many other sources of information concerning arsenic in marine waters in the literature, two recent sources are:

Neff, J.M. 1997. Ecotoxicology of arsenic in the marine environment. Environmental Toxicology and Chemistry, 16 (5): 917-927

Ellwood, M.J., Maher, W.A. 2002. Arsenic and antimony species in surface transects and depth profiles across a frontal zone: The Chatham Rise, New Zealand. Deep-Sea Research Part I-Oceanographic Research Papers. 49 (11): 1971-1981

The levels of arsenic measured in the stream samples are similar, but somewhat lower overall, than those measured in the marine Harbor and offshore water. This probably reflects natural levels in the volcanic material of which the island is composed.

Table 3-1A
Hydrographic Parameters Measured in Discrete Grab Samples – March 2003

Harbor Station	Depth (feet)	Temp (°C)	Salinity (PSU)	DO (mg/l)	pH (SU)
Transition Zone (Reference Station)					
5	3	30.3	34.3	6.23	8.18
	60	29.9	35.1	5.89	8.18
	120	29.8	35.1	5.58	8.14
	Average	30.0	34.8	5.90	8.17
TN/TP Mixing Zone Boundary					
15	3	30.3	34.9	6.27	8.18
	45	29.9	35.1	6.10	8.16
	85	29.9	35.1	5.77	8.10
	Average	30.0	35.0	6.05	8.15
16	3	30.2	34.3	6.05	8.12
	60	29.9	35	6.09	8.18
	120	29.8	35.2	5.86	8.15
	Average	30.0	34.8	6.00	8.15
18	3	30.1	34.7	6.17	8.17
	60	29.9	35.0	6.05	8.17
	120	29.8	35.1	5.90	8.14
	Average	29.9	34.9	6.04	8.16
Near Diffuser					
8	3	30.2	34.9	6.21	8.16
	60	29.6	35.1	5.48	8.10
	120	29.5	35.1	5.23	8.07
	Average	29.8	35.0	5.64	8.11
8A	3	30.6	34.7	6.29	8.15
	60	30.1	34.9	5.24	8.10
	120	29.7	35.1	4.73	8.11
	Average	30.1	34.9	5.42	8.12
14	3	30.6	34.7	5.90	8.08
	60	29.8	35.0	5.58	8.11
	120	29.4	35.1	4.70	8.06
	Average	29.9	34.9	5.39	8.08
Inner Harbor					
11	3	31.0	34.6	10.67	8.45
	60	29.9	35.1	5.88	8.11
	120	29.7	35.1	5.44	8.10
	Average	30.2	34.9	7.33	8.22
13	3	30.2	34.6	--	8.08
	12	30.0	35.1	5.22	8.11
	22	30.0	35.1	4.59	8.06
	Average	30.1	34.9	4.91	8.08
Near Utulei Outfall					
A1	3	30.4	34.9	6.36	8.15
	60	30.0	35.1	5.85	8.11
	120	29.9	35.2	5.64	8.05
	Average	30.1	35.1	5.95	8.10
B1	3	30.5	34.9	6.11	8.10
	60	29.8	35.1	5.89	8.15
	120	29.4	35.1	5.08	8.07
	Average	29.9	35.0	5.69	8.11
C	3	29.6	35.2	5.86	8.06
	35	29.7	35.2	5.84	8.06
	70	29.6	35.3	5.67	7.96
	Average	29.6	35.2	5.79	8.03
U	3	30.6	34.6	6.52	8.16
	60	29.9	35.1	6.18	8.18
	120	29.7	35.0	5.78	8.15
	Average	30.1	34.9	6.16	8.16
Summary of All Stations					
All Stations	Minimum	29.4	34.3	4.6	8.0
	Maximum	31.0	35.3	10.7	8.5
	Average	30.0	35.0	5.9	8.1
	Std. Dev.	0.36	0.24	0.92	0.07

Table 3-1B

Hydrographic Parameters Measured in Discrete Grab Samples

(Stream Mouth Stations - March 2003)

Stream Mouth Station	Temp (°C)	Conductivity µmho/cm	DO (mg/l)	pH (SU)
S1	27.2	194	6.94	7.35
S2	27.8	171	4.37	6.89
S3	26.7	307	5.28	6.97
S4	29.0	1225	5.66	7.42
S5	27.2	840	5.99	7.33
Summary of Steam Mouth Stations				
Minimum	26.7	171.0	4.4	6.9
Maximum	29.0	1225.0	6.9	7.4
Average	27.6	547.4	5.6	7.2
Std. Dev.	0.88	466.13	0.94	0.24

Table 3-2
Summary of Vertical Profile Data – March 2003

Station		Temp (°C)	Salinity (PSU)	Sigma-t (kg/m^3)	DO (mg/l)	DO (% Sat)	pH (SU)	Turbidity (NTU)
Transition Zone (Reference Station)								
5	Minimum	29.22	35.06	21.80	5.86	93.6	8.16	0.00
	Maximum	29.96	35.45	22.33	6.00	96.5	8.20	1.50
	Average	29.80	35.28	22.00	5.95	95.5	8.18	0.34
	Std. Dev.	0.20	0.09	0.13	0.04	0.8	0.01	0.18
TN/TP Mixing Zone Boundary								
15	Minimum	29.87	35.12	21.70	5.84	93.8	8.14	0.37
	Maximum	30.35	35.31	22.00	6.28	101.7	8.19	2.64
	Average	29.99	35.26	21.93	6.03	97.1	8.16	0.67
	Std. Dev.	0.11	0.05	0.07	0.11	1.9	0.01	0.36
16	Minimum	28.20	34.87	21.50	5.47	86.8	8.14	0.22
	Maximum	30.37	35.64	22.81	6.08	98.2	8.22	7.44
	Average	29.57	35.33	22.12	5.87	93.9	8.19	1.58
	Std. Dev.	0.63	0.15	0.32	0.18	3.5	0.02	2.07
18	Minimum	27.96	34.96	21.63	5.42	86.2	8.14	0.01
	Maximum	30.17	35.68	22.92	6.12	98.4	8.25	4.85
	Average	29.45	35.33	22.16	5.86	93.6	8.20	1.20
	Std. Dev.	0.67	0.19	0.36	0.23	4.1	0.03	1.31
Near Diffuser								
8	Minimum	28.00	35.00	21.56	5.39	86.1	8.00	0.40
	Maximum	30.48	35.67	22.90	6.18	100.0	8.11	7.99
	Average	29.37	35.37	22.22	5.78	92.1	8.06	1.56
	Std. Dev.	0.66	0.15	0.33	0.19	3.4	0.02	1.86
8A	Minimum	28.26	35.04	21.62	5.25	83.5	8.00	0.37
	Maximum	30.39	35.63	22.78	6.12	99.0	8.10	13.17
	Average	29.44	35.36	22.19	5.65	90.3	8.05	2.88
	Std. Dev.	0.58	0.12	0.29	0.29	5.3	0.03	3.20
14	Minimum	28.43	34.94	21.54	5.27	83.7	8.01	0.43
	Maximum	30.44	35.57	22.68	6.19	100.1	8.11	9.19
	Average	29.52	35.32	22.13	5.63	90.1	8.05	2.28
	Std. Dev.	0.54	0.13	0.27	0.28	5.0	0.03	2.36
Inner Harbor								
11	Minimum	28.63	34.71	21.37	5.59	87.8	8.12	0.37
	Maximum	30.90	35.54	22.58	7.41	120.8	8.37	12.36
	Average	29.71	35.30	22.05	5.96	95.5	8.16	2.71
	Std. Dev.	0.57	0.14	0.28	0.39	6.9	0.04	2.93
13	Minimum	30.15	34.96	21.64	5.00	80.72	8.06	0.30
	Maximum	30.44	35.50	22.05	5.67	91.84	8.13	4.59
	Average	30.27	35.18	21.77	5.39	87.09	8.10	1.99
	Std. Dev.	0.10	0.11	0.10	0.22	3.69	0.02	1.05
Near Utulei Outfall								
A1	Minimum	29.16	35.05	21.61	5.55	88.4	8.01	0.16
	Maximum	30.46	35.44	22.34	6.18	100.2	8.15	2.60
	Average	29.75	35.31	22.04	5.87	94.2	8.09	0.88
	Std. Dev.	0.35	0.09	0.19	0.18	3.3	0.02	0.76
B1	Minimum	27.85	35.05	21.60	5.57	88.7	8.03	0.32
	Maximum	30.49	35.70	22.97	6.27	101.7	8.14	10.54
	Average	29.33	35.39	22.25	5.92	94.4	8.09	0.88
	Std. Dev.	0.75	0.16	0.37	0.13	2.6	0.02	1.06
C	Minimum	29.83	35.04	21.55	5.74	93.2	7.98	0.42
	Maximum	30.61	35.34	22.04	6.01	96.9	8.09	1.58
	Average	29.94	35.30	21.97	5.98	96.2	8.08	0.68
	Std. Dev.	0.18	0.06	0.10	0.05	0.6	0.02	0.27
U	Minimum	29.03	35.11	21.69	5.68	90.1	8.14	0.16
	Maximum	30.37	35.47	22.41	6.18	99.9	8.20	2.61
	Average	29.77	35.27	22.00	5.94	95.4	8.17	0.86
	Std. Dev.	0.34	0.08	0.16	0.16	3.1	0.02	0.54
Summary of All Stations								
All Stations	Minimum	27.85	34.71	21.37	5.00	80.7	7.98	0.00
	Maximum	30.90	35.70	22.97	7.41	120.8	8.37	13.17
	Average[1]	29.69	35.31	22.06	5.83	93.5	8.12	1.42

[1] Average is average of station averages, not individual readings

Table 3-3A
Nutrient and Biological Parameters – March 2003
(**bold font** entries indicate values below detection limit)

Station	Depth	Ammonia Nitrogen	TKN	Nitrate + Nitrite	TN	Total Phosphorus	Chlorophyll-a	Pheophytin	Total Suspended Solids	Turbidity
Method		350.1	351.3M	353.2	Calculated	365.1	1002G	1002G	160.2	2130B
Units		mg/l	mg/l	mg/l	mg/l	mg/l	mg/m3	mg/m3	mg/l	NTU
Detection Limit		0.005	0.025	0.010		0.005	0.03	0.15	1.0	0.01
WQ Standard					0.2	0.03	1			0.75
Transition Zone (Reference Station)										
5	3	**0.005**	0.120	**0.010**	0.130	**0.005**	0.78	**0.15**	78.0	0.12
	60	0.079	0.050	0.010	0.060	**0.005**	0.73	**0.15**	91.0	0.24
	120	0.040	**0.025**	0.026	0.051	**0.005**	0.74	**0.15**	100.0	0.14
	Average	0.041	0.065	0.015	0.080	0.005	0.75	**0.15**	89.7	0.17
TN/TP Mixing Zone Boundary										
16	3	0.036	0.050	**0.010**	0.060	**0.005**	0.91	**0.15**	85.0	0.15
	60	0.035	0.050	**0.010**	0.060	**0.005**	0.64	**0.15**	82.0	0.13
	120	0.041	0.035	**0.010**	0.045	**0.005**	0.74	**0.15**	85.0	0.10
	Average	0.037	0.045	0.010	0.055	0.005	0.76	**0.15**	84.0	0.13
18	3	0.030	**0.025**	**0.010**	0.035	0.073	1.10	**0.15**	83.0	0.40
	60	0.032	0.050	**0.010**	0.060	**0.005**	0.49	**0.15**	83.0	0.11
	120	0.031	0.280	**0.010**	0.290	**0.005**	0.74	**0.15**	81.0	0.12
	Average	0.031	0.118	**0.010**	0.128	0.028	0.78	**0.15**	82.3	0.21
Near Diffuser										
8	3	0.033	0.086	0.016	0.102	**0.005**	3.00	**0.15**	83.0	0.18
	60	0.036	0.073	0.020	0.093	0.090	1.70	**0.15**	86.0	0.19
	120	0.045	0.110	0.015	0.125	0.007	0.69	**0.15**	84.0	0.12
	Average	0.038	0.090	0.017	0.107	0.034	1.80	**0.15**	84.3	0.16
8A	3	0.027	0.120	**0.010**	0.130	0.011	1.90	**0.15**	85.0	0.19
	60	0.026	0.050	0.012	0.062	0.006	1.40	**0.15**	94.0	0.29
	120	0.030	0.066	0.023	0.089	0.013	0.36	**0.15**	85.0	0.31
	Average	0.028	0.079	0.015	0.094	0.010	1.22	**0.15**	88.0	0.26
14	3	0.045	0.058	0.010	0.068	0.006	2.00	**0.15**	81.0	0.13
	60	0.031	0.050	**0.010**	0.060	0.014	1.60	**0.15**	86.0	0.49
	120	0.039	0.075	0.025	0.100	0.020	0.49	**0.15**	82.0	0.07
	Average	0.038	0.061	0.015	0.076	0.013	1.36	**0.15**	83.0	0.23
Inner Harbor										
11	3						25	**0.15**		
13	3	0.030	0.120	**0.010**	0.130	0.023	1.40	**0.15**	80.0	0.56
	12	0.035	0.120	**0.010**	0.130	0.032	1.10	**0.15**	83.0	0.25
	22	0.034	0.130	**0.010**	0.140	0.027	1.20	**0.15**	82.0	0.58
	Average	0.033	0.123	**0.010**	0.133	0.027	1.23	**0.15**	81.7	0.46

Table continued on next page

Table 3-3A (Continued)
Nutrient and Biological Parameters – March 2003
(**bold font** entries indicate values below detection limit)

Station	Depth	Ammonia Nitrogen	TKN	Nitrate + Nitrite	TN	Total Phosphorus	Chlorophyll-a	Pheophytin	Total Suspended Solids	Turbidity
Method		350.1	351.3M	353.2	Calculated	365.1	1002G	1002G	160.2	2130B
Units		mg/l	mg/l	mg/l	mg/l	mg/l	mg/m3	mg/m3	mg/l	NTU
Detection Limit		0.005	0.025	0.010		0.005	0.03	0.15	1.0	0.01
WQ Standard					0.2	0.03	1			0.75
Near Utulei Outfall										
A1	3	--	0.240	**0.010**	0.250	**0.005**	2.10	**0.15**	--	0.22
	60	--	0.300	**0.010**	0.310	**0.005**	1.20	**0.15**	--	0.38
	120	--	0.250	**0.010**	0.260	0.005	1.10	**0.15**	--	0.14
	Average		0.263	0.010	0.273	0.005	1.47	**0.15**		0.24
B1	3	--	0.270	**0.010**	0.280	**0.005**	3.10	**0.15**	--	0.25
	60	--	0.200	**0.010**	0.210	**0.005**	0.94	**0.15**	--	0.30
	120	--	0.250	0.026	0.276	0.016	0.86	**0.15**	--	0.16
	Average		0.240	0.015	0.255	0.009	1.63	**0.15**		0.41
C	3	--	0.230	**0.010**	0.240	**0.005**	1.40	**0.15**	--	0.29
	35	--	0.220	**0.010**	0.230	0.028	0.82	**0.15**	--	0.67
	70	--	0.300	**0.010**	0.310	**0.005**	0.79	**0.15**	--	0.36
	Average		0.250	0.010	0.260	0.013	1.00	**0.15**		0.40
U	3	--	0.310	**0.010**	0.320	**0.005**	2.80	**0.15**	--	0.48
	60	--	0.210	0.016	0.226	0.006	1.50	**0.15**	--	0.22
	120	--	0.330	0.033	0.363	0.024	0.72	**0.15**	--	0.38
	Average		0.283	0.020	0.303	0.012	1.67	**0.15**		0.14
Summary of All Stations										
All Stations	Minimum	**0.005**	**0.025**	**0.010**	0.035	**0.005**	0.36	**0.15**	78.0	0.07
	Maximum	0.079	0.330	0.033	0.363	0.090	3.10	**0.15**	100.0	0.67
	Average	0.035	0.147	0.013	0.160	0.015	1.24	**0.15**	84.7	0.26
	Std. Dev	0.013	0.100	0.006	0.101	0.019	0.71	0.00	5.0	0.15
	Median	0.034	0.120	0.010	0.130	0.005	1.10	**0.15**	83.0	0.22

Table 3-3B

Nutrient and Biological Parameters – Stream Mouth Stations March 2003

Station	Sample	Ammonia Nitrogen	TKN	Nitrate + Nitrite	TN	Total Phosphorus	Total Suspended Solids
Method		350.1	351.3M	353.2	Calculated	365.1	160.2
Units		mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
Detection Limit		0.005	0.025	0.010		0.005	1.0
WQ Standard					0.200	0.030	
Transition Zone (Reference Station)							
S1	A	**0.005**	0.500	0.300	0.800	0.720	140.0
	B	**0.005**	0.600	0.300	0.900	0.680	130.0
S2	A	**0.005**	0.480	0.420	0.900	0.240	**1.0**
	B	**0.005**	0.570	0.440	1.010	0.220	1.0
S3	A	0.070	9.000	0.490	9.490	0.610	6.0
	B	0.028	5.600	0.490	6.090	0.250	12.0
S4	A	**0.005**	0.590	0.410	1.000	0.160	4.0
	B	**0.005**	0.270	0.390	0.660	0.140	7.0
S5	A	0.100	0.640	0.510	1.150	0.150	**1.0**
	B	0.080	0.560	0.530	1.090	0.150	**1.0**
Summary of All Stream Mouth Stations							
Minimum		**0.005**	0.270	0.300	0.660	0.140	**1.0**
Maximum		0.100	9.000	0.530	9.490	0.720	140.0
Average		0.031	1.881	0.428	2.309	0.332	30.3
Std. Dev		0.038	2.968	0.081	3.001	0.238	55.3
Median		**0.005**	0.580	0.430	1.005	0.230	5.0

Table 3-4
Results of Metals Sample Analysis - March 2003
All values in µg/l

Station	Depth (feet)	Sample	Sample Date	Copper	Zinc	Arsenic	Lead	Mercury
Reporting Detection Limit				0.1	0.3	0.5	0.02	0.0010
American Samoa Water Quality Standard [1]				3.1	81	36 (CCC) 0.14 (HCC)	8.1	0.94
Reference Station - Transition Zone								
5	3	5-S	20 Mar 03	0.3	4.2	1.6	0.05	0.0055
	60	5-M	20 Mar 03	0.2	3.8	1.5	0.04	0.0062
	120	5-B	20 Mar 03	0.2	4.1	1.6	0.03	0.0139
Inner Harbor Stations								
13	3	13-S	20 Mar 03	0.7	6.5	1.5	0.12	0.0032
	12	13-M	20 Mar 03	0.5	5.5	1.5	0.07	0.0031
	22	13-B	20 Mar 03	0.5	4.5	1.4	0.09	0.0025
Diffuser Stations								
14	3	14-S	19 Mar 03	0.6	6.5	Analysis Not Required		
	60	14-M	19 Mar 03	0.3	3.8			
	120	14-B	19 Mar 03	0.3	5.5			
8	3	8-S	19 Mar 03	0.5	5.5	Analysis Not Required		
	60	8-M	19 Mar 03	0.2	3.1			
	120	8-B	19 Mar 03	0.2	4.5			
8A	3	8A-S	19 Mar 03	0.6	5.5	Analysis Not Required		
	60	8A-M	19 Mar 03	0.3	3.3			
	120	8A-B	19 Mar 03	0.3	4.6			
Stream Mouth Stations								
Station		**Sample**	**Date**	**Copper**	**Zinc**	**Arsenic**	**Lead**	**Mercury**
Reporting Detection Limit				Analysis Not Required		0.5	0.02	0.0010
American Samoa Water Quality Standard [1]						150 (CCC) 0.14 (HCC)	2.5	0.77
S1		S1-A	21 Mar 03			**0.5**	1.16	0.0055
S2		S2-A	21 Mar 03			1.3	0.96	0.0023
S3		S3-A	21 Mar 03			**0.5**	1.59	0.0051
S4		S4-A	21 Mar 03			1.4	0.58	0.0018
S5		S5-A	21 Mar 03			0.8	0.31	0.0017

[1] ASWQS based on the EPA national Recommended Water Quality Criteria; 2002
Note: **Bold** values are method-reporting limit (MRL) and sample concentration is below the MRL.

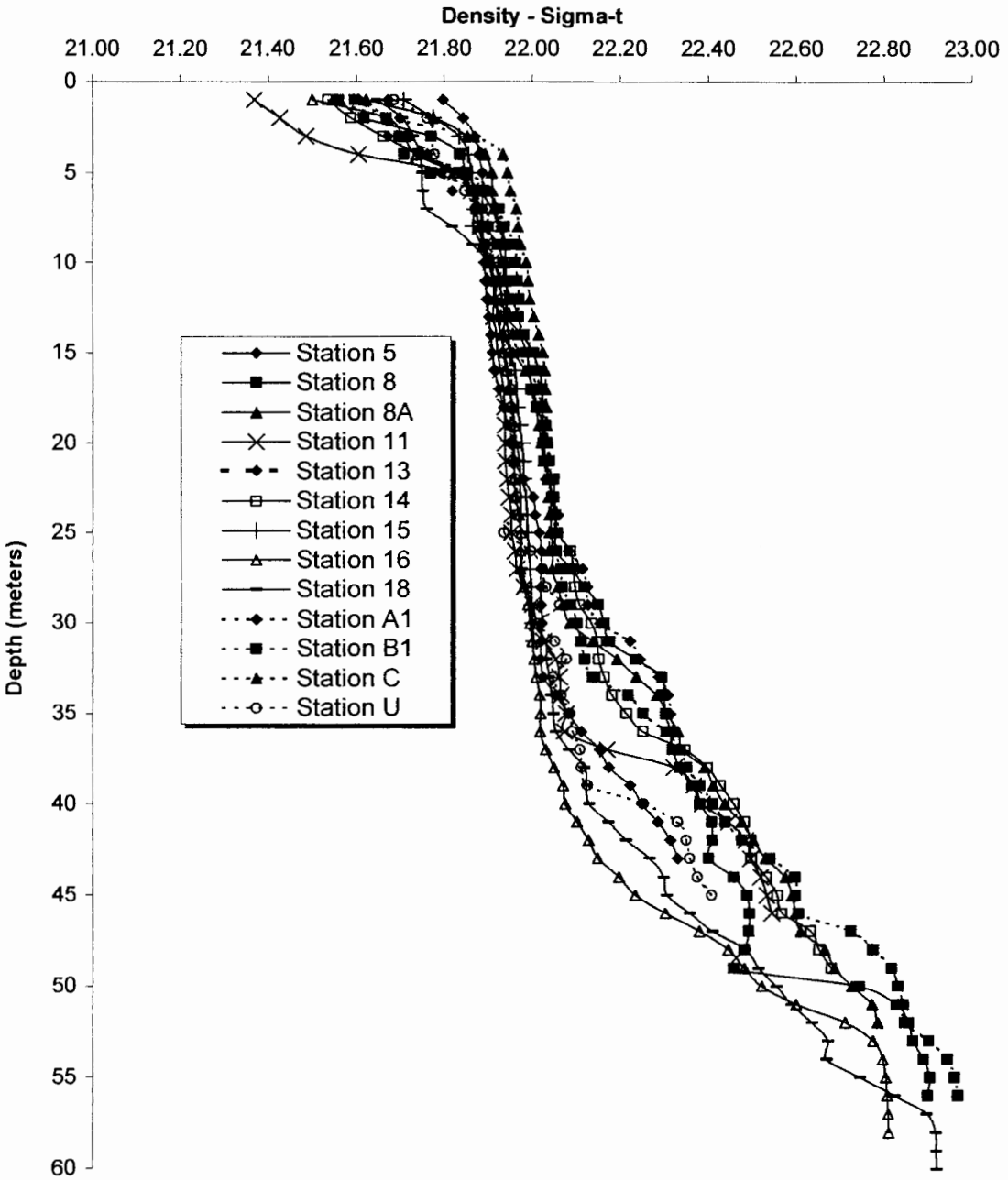

Figure 3-1.
Density Profiles, Pago Pago Harbor, March 2003

4. CONCLUSIONS AND RECOMMENDATIONS

The March 2003 non-tradewind season Receiving Water Quality Monitoring was successfully completed with only minor, unintended, deviations from the study plan. Intentional deviations in Stations and parameters were done as described in Section 2. The requirements stated in the NPDES permit were satisfied, with the modifications described in Section 2 and agreed to by USEPA and ASEPA. The data indicate compliance with ASWQS throughout the Harbor. The ASWQS are based on average values of many constituent concentrations, and the ASWQS were fully achieved on this basis. The numerical criteria, on which some of the ASWQS are based, were occasionally exceeded at individual stations, although this does not mean that the ASWQS are violated. In no instance outside the mixing zone can individual excursions above the criteria be attributed to the JCO discharge. The canneries are in compliance with the applicable conditions of their NPDES permits.

4.1 Evaluation of Compliance

The results of the March 2003 tradewind water quality monitoring indicate that the canneries are in compliance with their NPDES permit conditions applicable to the receiving water. The permit conditions and compliance are summarized in Table 4-1. Elevated levels of turbidity and nitrogen were measured at some stations in the outer Harbor, but do not appear to be associated with the JCO discharge. These parameters are discussed in more detail below.

4.1.1 Turbidity

A parameter that may be of concern for this sampling episode was turbidity as measured in vertical profiles. The relatively high level of turbidity in the lower portion of the water column may be a transient, seasonal, or semi-permanent phenomenon. The same patterns have been observed and reported for previous water quality monitoring episodes. However, the measurement of turbidity is instrument dependent, as described below, and is also known to be site-specific. Turbidity is not an absolute physical quantity and is only meaningful when associated with a specific instrument.[1] Interpretation of compliance with ASWQS is therefore uncertain since the instrument and process associated with the turbidity standard is not specified.

As mentioned in Section 3, samples analyzed for turbidity in the laboratory from grab samples indicated overall compliance with the ASWQS. The differences in measurement methods between the *in situ* measurements by the profiling instrument and the laboratory measurements account for at least some of the differences in results. The profiling instrument measures a very small region of water immediately adjacent to the sensor and the sensor is subject to fouling and interference. At very low levels of turbidity, as found in Pago Pago Harbor, the sensor on the profiling instrument is operating near the limit of

[1] See, for example, Davies-Colley, R. J. and D. G. Smith, 2001. "Turbidity, Suspended Sediment, and Water Clarity: A Review, Journal of the American Water Resources Association. Vol. 37, No. 5.

its useful range and resolution[2]. The unavoidable sources of error inherent in the use of the sensor at low levels of turbidity make the results somewhat qualitative. Thus it is considered that the laboratory results provide a better measurement of actual, repeatable, levels of turbidity and the profiling instrument provides a semi-quantitative measurement that provides a good indication of the vertical structure of turbidity in the water column.

Figures 4-1 through 4-4 present the vertical profiles of turbidity from the profiling instrument for the March 2003 sampling. Keeping the comments on the data discussed above in mind, the following points are evident in the figures:

- Figure 4-1 shows the turbidity profiles for the reference station (Station 5) and the three stations around the periphery of the established JCO mixing zone for nutrients. The reference station is below 0.75 NTU (the ASWQS) over the entire water column. The depth-averaged values are shown in the figure legends in parentheses for the three stations around the mixing zones (Stations 15, 16, and 18) are above 0.75 NTU at Stations 16 and 18, and below 0.75 NTU at Station 15. The average value is strongly influenced by high values in the lower part of the water column. At Stations 16 and 18 the turbidity is below 0.75 NTU over most of the water column down to about 35 meters, with the exception of a few isolated points near the surface. A high turbidity level is observed in deeper water. Since this is observed at multiple stations and at other locations throughout the Harbor, it is unlikely that this high turbidity layer can be related to anthropogenic discharges.

- Figure 4-2 shows the turbidity profiles in the vicinity of the JCO outfall, and the profile from the reference station. The profiles at Station 8 (south of the discharge), Station 14 (at the diffuser) and Station 8A (north of the diffuser) are similar to the mixing zone stations in Figure 4-1, but with a small increase at mid-level in the turbidity that may be caused by the discharge plume. There is no other signature in this part of the Harbor that indicates any other affect of the JCO discharge.

- Figure 4-3 shows the turbidity profiles west of the JCO discharge. These profiles are similar to the profiles shown in Figure 4-1 with low turbidities throughout most of the water column and a higher turbidity near bottom layer. But the level of the turbidity in the lower portion of the water column is not as high as at the other stations discussed. The depth-average values are skewed by the high near bottom levels at Stations A1, B1, and U but are only slightly higher than 0.75 NTU and are below 0.75 over much of the upper 30 meters of the water column. The depth average value at Station C is below 0.75 NTU

- Figure 4-4 shows the turbidity profiles at the Inner Harbor stations (Stations 11 and 13). The higher near surface turbidities are probably associated with high productivity and the plankton bloom observed at the time of sampling and

[2] This is the case for all *in situ* sensors of this type and not a characteristic unique to the SeaPoint sensor being used.

described previously. This pattern has generally been observed in almost all previous sampling episodes. Turbidity is below 0.75 NTU over most of the water column in these locations. The higher turbidity layer at depth at Station 11 is similar to those at other locations in the Harbor.

The vertical structure of turbidity is similar throughout the Harbor and no discrete signature of the JCO discharge is observed. The water depth within the Harbor is somewhat deeper than the water depth in the ocean at the Harbor entrance, possibly inhibiting exchange between the bottom layer of the Harbor and the ocean during certain periods.

The high turbidity layers appear to be consistent with natural processes and do not indicate any obvious effects of the JCO discharge. Near bottom layers of high turbidity, below 65 feet, will not affect compliance with ASWQS for light penetration and are not expected to adversely affect the coral communities. Recent coral reef surveys indicate improving conditions in the vicinity of the JCO and show no degradation (CH2M HILL, 2003b).

The laboratory data for turbidity as measured from samples, described in Section 3, shows a lower overall level of turbidity throughout the Harbor, and clearly indicates compliance. Considering nature of the two sets of measurements, it appears that the ASWQS for turbidity in Pago Pago Harbor are being met.

4.1.2 Nitrogen and Phosphorous

Samples from Stations 16, and 18 on the edge of the nutrient mixing zone had levels below the criteria of 0.200 mg/l[3] of total nitrogen (TN) except for the near bottom sample from Station 18 (0.290 mg/l). The depth averaged value for Station 18 was 0.128 mg/l This single elevated measurement does not appear to be related to the JCO discharge. The concentrations of total nitrogen at Stations 14, 8, and 8A were not similarly elevated, and these stations are closer to the discharge and more representative of any effects of the discharge. Elevated levels were not found in the Inner Harbor, which often is observed, but values at Stations A1, B1, C, and U were consistently, but not greatly, higher than the criteria. This may be attributable to the plankton bloom, since it was not observed previously.

The ASWQS criteria for total phosphorous is 0.030 mg/l. Total phosphorous (TP) concentrations exceeded this numerical criteria of 0.030 mg/l only in two samples (mid-depth at Station 8 and in the surface sample from Station 18. The depth averaged value at Station 18 was below 0.030 mg/l. The average value for the entire Harbor is below the ASWQS for TN (see Table 3-3), and thus ASWQS are complied with on an average basis as required.

[3] The ASWQS for Pago Pago Harbor is 0.200 mg/l for TN and 0.030 mg/l for TP as average values (all Stations reported except Station 5) and 0.130 mg/l for TN and 0.015 mg/l for TP for open coastal waters (Station 5). The specific averaging period or spatial extent is not defined in the ASWQS.

4.2 Recommendations

No new recommendations for changes in the monitoring procedures or methods are identified. Some non-critical recommendations have been presented in previous reports, some of which have been addressed. Previous reports recommended more turbidity measurements based on laboratory measurements of grab samples and this recommendation has been implemented. General recommendations based on data collected during the March 2003 monitoring include:

- Future revisions of the ASWQS should recognize and address the natural background levels of arsenic

- Additional investigations of the potentially high turbidity bottom layer during certain seasonal or meteorological conditions should be considered. If this is a natural phenomenon, future revisions of the ASWQS should recognize and address this condition.

It was previously recommend that consideration be given to modifying the monitoring in the future since the results have consistently shown compliance with the ASWQS in the Harbor. Areas and parameters of specific concern could be targeted and those areas and parameters that are obviously not of concern could be dropped from future monitoring, or monitoring could be reduced. Based on this observation some changes were made to the March 2003 sampling episode to reduce harbor water column monitoring and include some stream mouth monitoring. This action will provide information needed to better understand the physical process in the Harbor and the effects of various watershed activities on the Harbor water quality.

Table 4-1
Receiving Water Permit Conditions

Permit Discharge Specifications (Special Condition B) for Receiving Water	Applicable Stations Listed in NPDES Permits (X)						Comments
	8	8A	14	15 [1]	16	18	
Chlorophyll-a not above 1.0 μg/l	X	X	X	X	X	X	Chlorophyll-a concentrations exceeded 1.0 g/l in the surface and mid-depth samples from these stations. However, this appears to have been a natural regional scale plankton bloom and is not attributable to the JCO discharge.
Light penetration not less than 65 feet	X	X	X	X	X	X	Compliance with permit requirements demonstrated.
No objectionable color, odor, or taste	X	X	X	X	X	X	Compliance with permit requirements observed.
No visible floating material, grease, oil, scum, foam	X	X	X	X	X	X	Compliance with permit requirements observed.
No materials that will produce visible turbidity or form objectionable deposits	X	X	X	X	X	X	Compliance with permit requirements observed.
DO not below 5.0 mg/l or 70% saturation	X	X		X	X	X	Compliance with permit requirements demonstrated.
Turbidity not in excess of 0.75 NTU	X	X		X	X	X	Compliance with permit requirements demonstrated based on laboratory measurements from grab samples. Average for all stations was well below the ASWQS.
No toxicity to marine life	X	X		X	X	X	Bioassay testing done independently of water quality monitoring demonstrates compliance. Compliance with permit requirements observed.
Temperature no more than 1.5 °C from natural conditions				X	X	X	Compliance with permit requirements demonstrated.
Total nitrogen no higher than 200 μg/l				X	X	X	One measurement was above the ASWQS of 200 μg/l at these stations. However, the levels at the Stations closer to the discharge were all at or below the ASWQS. The depth averaged values were below 200 μg/l. The ASWQS throughout the Harbor was met, and the elevated levels do not appear to be associated with the discharge.
Total phosphorus no higher than 30 μg/l				X	X	X	One of the individual measurements was above 30 μg/l. However, the depth average value at that station was below 30 μg/l. The levels at the Stations closer to the discharge were typically at or below the ASWQS (with one exception). The ASWQS throughout the Harbor was met, and the elevated levels do not appear to be associated with the discharge.

[1] Station 15 was not sampled, based on agreements reached with USEPA and ASEPA, to substitute stream mouth sampling in place of some Harbor sampling.

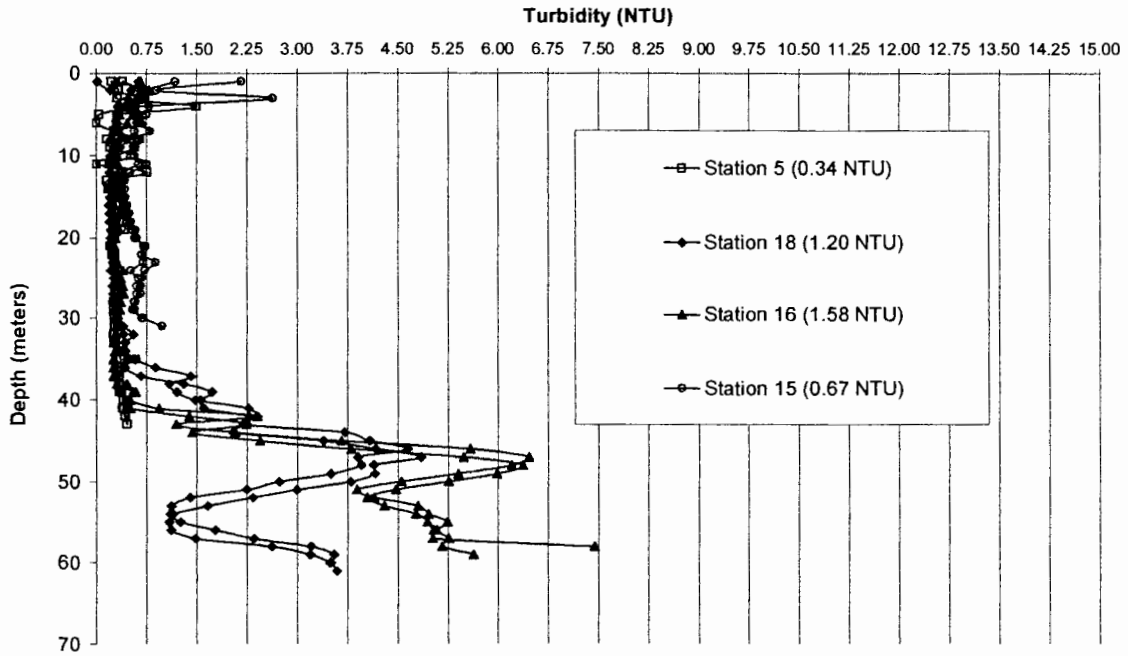

Figure 4-1
Turbidity Profiles at Reference Station and at Mixing Zone Stations
(depth-average values shown in legend)

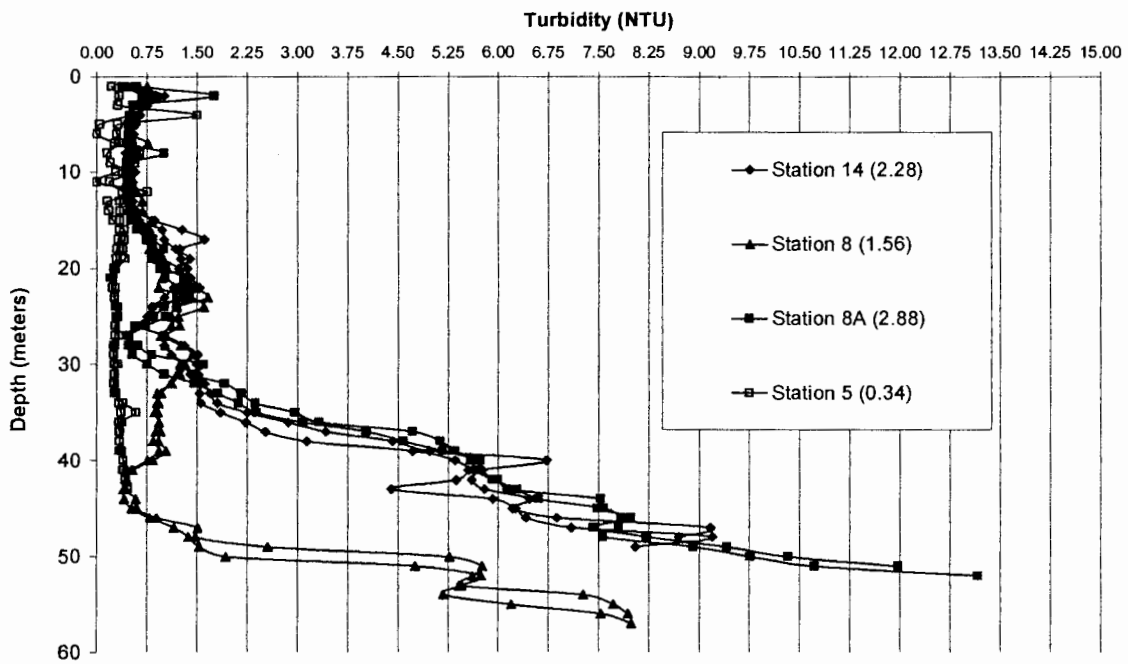

Figure 4-2
Turbidity Profiles at Reference and JCO Diffuser Stations - March 2003
(depth-average values shown in legend)

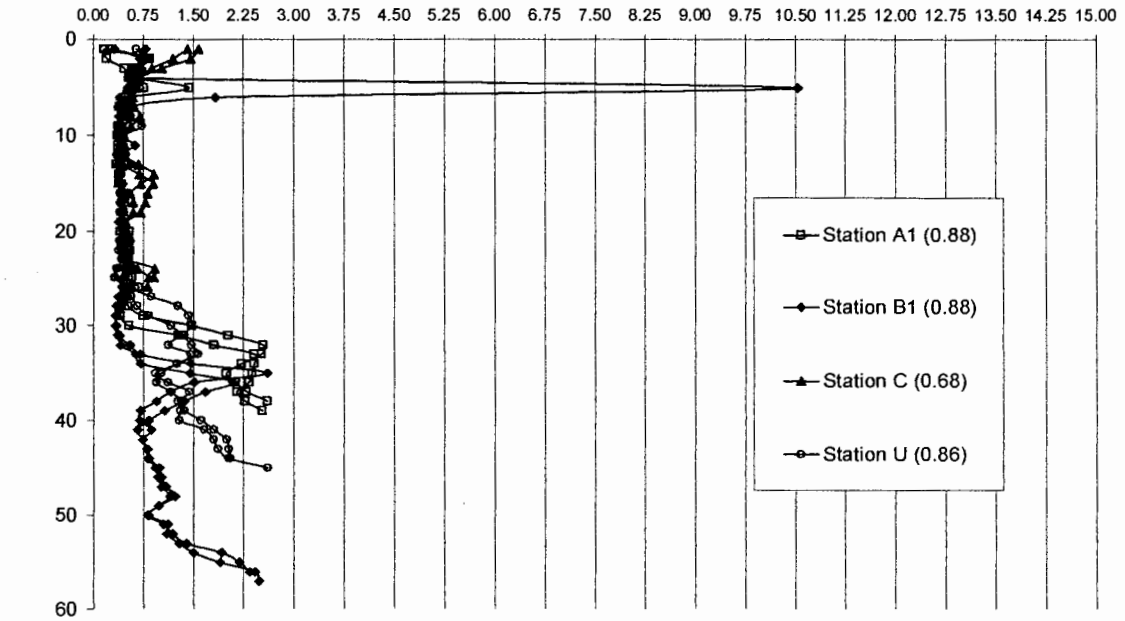

Figure 4-3
Turbidity Profiles in Vicinity of Utulei Outfall - March 2003
(depth-average values shown in legend)

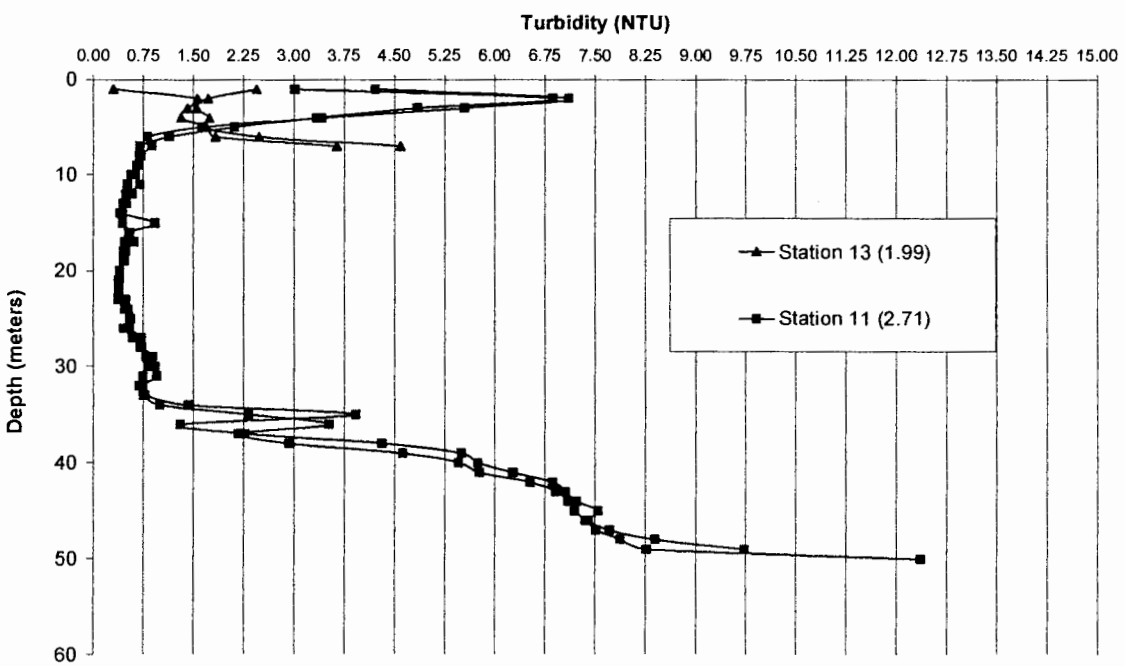

Figure 4-4
Turbidity Profiles in Inner Harbor - March 2003
(depth-average values shown in legend)

5. REFERENCES

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Environmental Protection Agency, Region 10, 1992. Authorization to Discharge Under the National Pollution Discharge Elimination System; Permit No. AS0000027, Issued to COS Samoa packing Company, 22 December 2000.

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Appendix I

NPDES Permit Special Condition E

**(Shown for StarKist Samoa permit,
permit condition for COS Samoa Packing is identical)**

E. RECEIVING WATER QUALITY MONITORING PROGRAM

To determine compliance with water quality standards, the receiving water quality monitoring program must document water quality at the outfall, at areas near the zone of initial dilution (ZID) and zone of mixing (ZOM) boundaries, at areas beyond these zones where discharge impacts might reasonably be expected, and at reference control areas. The canneries (StarKist Samoa and COS Samoa Packing) shall cooperatively perform, or cause to be performed, water quality monitoring at the specified stations at regular frequencies as detailed below.

Temperature, dissolved oxygen (DO), pH, conductivity, and turbidity shall be measured as continuous vertical profiles at each station. Salinity shall be calculated from temperature and conductivity. In the event of malfunctions of the sensors used to measure the continuous vertical profile parameters, direct measurement of grab samples, in the field, will be acceptable. Light penetration shall be measured at all stations by measurement of sechi depth. All other required parameters shall be measured in grab samples taken at one (1) meter below the surface, mid-depth, and one meter above the bottom. In locations where the depth is greater than 40 meters, samples shall be taken at one meter below the surface, 20 meters, and 40 meters.

The following parameters shall constitute the Water Quality Monitoring Program:

Parameter	Units	Stations	Sample Type
Temperature	F	5,8,18,14,15,16,8A,11,13	Vertical Profile
Salinity	PSU	5,8,18,14,15,16,8A,11,13	Vertical Profile
pH	SU	5,8,18,14,15,16,8A,11,13	Vertical Profile
Dissolved Oxygen	mg/l and %Sat	5,8,18,14,15,16,8A,11,13	Vertical Profile
Turbidity	NTU	5,8,18,14,15,16,8A,11,13	Vertical Profile
Turbidity	NTU	18, 14, 15, 16	Grab
Light Penetration	feet	5,8,18,14,15,16,8A,11,13	Direct Reading
Suspended Solids	mg/l	5,8,18,14,15,16,8A,11,13	Grab
Chlorophyll-a	mg/l	5,8,18,14,15,16,8A,11,13	Grab
Total Ammonia	mg/l	5,8,18,14,15,16,8A,11,13	Grab
Total Nitrogen	mg/l	5,8,18,14,15,16,8A,11,13	Grab
Total Phosphorous	mg/l	5,8,18,14,15,16,8A,11,13	Grab
Copper	g/l	5, 8, 8A,11,13,14,15	Grab
Zinc	g/l	5, 8, 8A,11,13,14,15	Grab
Lead	g/l	5,11,13,14	Grab
Mercury	g/l	5,11,13,14	Grab
Arsenic	g/l	5,11,13,14	Grab

The water quality analyses shall be expanded for one of the water quality monitoring events during the first year of the permit as described in Section H below.

Appendix II

Field Instrument Calibration Records

Appendix II.A.
Calibration of Instruments used for Grab Sample Measurements

Appendix II.B.
Calibration of SBE 19 Vertical Profiling Instrument

Appendix II.C.
Comparison of SBE 19 Vertical Profiling Instrument and Grab Sample Measurements

Appendix II.A

Calibration of Instruments Used for Grab Sample Measurements

II.A.1 Dissolved Oxygen Meter Calibration

The YSI Model 95 DO meter is calibrated by using the internally programmed routine to set the correct value of measured dissolved oxygen assuming the probe is in a saturated oxygen environment. Sealing the probe in a small chamber with a water soaked sponge creates the saturation environment. Altitude and salinity are set based on the appropriate conditions of the media being measured. The probe reads in % saturation or mg/l. The mg/l reading can be checked against the known value of DO saturation at the appropriate conditions.

The probe was cleaned according to manufactures specifications and the membrane and electrolyte was replaced prior to sampling. The instrument is recalibrated prior to measurements at every station. The instrument was successfully calibrated and the drift over the sampling period was acceptable. Calibration results are shown in Table II.A-1.

Table II.A-1
Calibration of YSI Model 95 Dissolved Oxygen Meter [A]
March 2002 Non-tradewind Harbor Water Quality Monitoring

Action	Altitude (feet)	Salinity (PSU)	Meter DO (% Saturation)	Actual Saturation DO (mg/l)	Difference (% Saturation)	Comments
Pre-deployment calibration: 18 March 2003	0	35	99%	100%	1%	Repeated attempts failed to improve.
Pre-deployment calibration following installation of a new membrane: 18 March 2003	0	35	100.5%	100%	0.5%	Accepted.
Post-sampling drift check: 21 March 2003	0	35	98.0%	100%	2.0%	Drift of 2% over approximately 4 hours. This is an acceptable result since each sample is completed in about 5 minutes. [B]
Post-sampling calibration: 21 March 2003	0	35	100%	100%	0.00	Accepted, meter working correctly.

[A] The meter is recalibrated in the field before readings at every station.
[B] The drift during use is less than the 2% over 4 hours as indicted by the bench test done after the sampling was complete. If the sampling takes as long as 15 minutes the drift would be 0.125% or approximately 0.006 mg/l which is undetectable.

II.A.2 Salinity Meter Calibration

The YSI Model 30 CST meter is calibrated by using the internally programmed routine and a 50000 μS/cm standard conductivity solution purchased from YSI. This standard used is to be consistent with the full strength seawater samples to be measured. Using the internally programmed calibration routine and manually adjusting the reading to correspond to the known conductivity when the probe is placed in the standard solution is the process used to accomplish the calibration.

The probe was cleaned according to manufactures specifications. The instrument was successfully calibrated and the drift over the sampling period was acceptable. Calibration results are shown in Table II.A-2.

Table II.A-2
Calibration of YSI Model 30 Conductivity, Temperature, Salinity (SCT) Meter
March 2002 Non-tradewind Harbor Water Quality Monitoring

Action	Specific Conductance of Standard Solution used (mS/cm)	Specific Conductance Measured by Meter (mS/cm)	Difference (mS/cm)	Comments
Pre-deployment check: 18 March 2003	50	50	0.0	Accepted, no additional calibration needed.
Post-sampling drift check: 21 March 2003	50.1	50	0.1	Drift over 3 days acceptable, no corrections required. [A]
Post-sampling calibration: 21 March 2003	50	50	0.0	Accepted, meter working correctly.

[A] 0.1 mS/cm corresponds to a salinity difference less than the resolution of the SCT meter (0.1 ppt).

II.A.3 pH Meter Calibration

The Orion Model 260A pH/mV meter is calibrated by using the internally programmed routine and appropriate standard solutions of known pH. A two point calibration was used, based on pH = 7 and pH = 10 standard solutions. The standards used are consistent with the full strength seawater samples to be measured, which are expected to have a pH in the range of 7.5 to 8.5. An internally programmed calibration routine is used to accomplish the calibration.

The probe was stored and cleaned according to manufactures specifications. The instrument was successfully calibrated and the drift over the sampling period was acceptable. Calibration results are shown in Table II.A-3.

Table II.A-3
Calibration of Orion Model 260A pH Meter
March 2002 Non-tradewind Harbor Water Quality Monitoring

Action	Meter reading at pH = 7	Meter reading at pH = 10	Difference at pH = 7	Difference at pH = 10	Comments
Pre-deployment calibration: 19 March 2003	7.01	10.01	0.01	0.01	Accepted
Post-sampling drift check: 21 March 2003	7.00	10.00	0.00	0.00	Drift of about 0.01 over 3 days is acceptable, no corrections applied
Post-sampling calibration: 21 March 2003	--	--	--	--	Not required

II.A.4 Temperature Consistency

All three meters described above have temperature probes. A consistency check indicated the following values when all probes were immersed in the same sample:

DO meter temperature = 29.8 °C
SCT meter temperature = 29.6 °C
PH meter temperature = 29.8 °C

Each meter references its own internal temperature reading, and all three meters calibrate acceptably when compared to a standard. Therefore, the small differences in temperature among the meters are acceptable for the purposes of the study. Comparison of the three meters to a thermometer traceable to a primary standard indicates that the SCT meter is the most accurate (although all appear to be quite precise).

II.A.5 Fathometer Calibration

A small battery powered fathometer is used to determine the depth at each station. The instrument is checked by lowering a target (Secchi disk or Profiling CTD instrument) to a measured depth and noting the reading for the target. The distance of the transducer below the surface is accounted for. The fathometer is consistently found to be accurate within about 2% of the reading at the depths of interest in Pago Pago Harbor.

Appendix II.B

Calibration of SBE 19 Vertical Profiling Instrument

The SeaBird CTD profiler with DO, pH, and backscatterance sensors was calibrated by the manufacturer shortly before the March 2002 field campaign. The calibration information provided by the manufacturer is included below.

Sea-Bird Electronics, Inc. FAX: (425) 643-9954
1808 136th Place NE, Bellevue, Washington 98005 USA Tel:(425)643-9866
Website: http://www.seabird.com Email: seabird@seabird.com

Service Report

SBE Job Number: 28268R Date: 08 February 2002

Customer: CH2M Hill

Customer Identified Problem:

1. Calibrate SBE 18 pH sensor, S/N 180356.

2. Calibrate SBE 19 SEACAT Profiler, S/N 1912448-0904X

3. Calibrate SBE 23 DO sensor, S/N 230552.

Problems Found:

1. SBE 18 pH sensor, S/N 180356.
   The pH electrode was found to have reached the end of its life expectancy.

Services Performed:

1. Calibrations performed on SBE 18 pH sensor, S/N 180356
   Post calibrated the sensor.

2 Calibrations performed on SBE 19 SEACAT Profiler, S/N 1912448-0904X
   Post calibrated the temperature and conductivity sensors.
   Calibrated the pressure sensor.

3. Calibrations and services performed on SBE 23 DO sensor, S/N 230552.
   Post calibrated the sensor.
   Replaced the oxygen module.
   Recalibrated the sensor.

Sea-Bird Electronics, Inc.
1808 136th Place N.E., Bellevue, Washington 98005 USA
Telephone: (425) 643-9866 Telex: 292915 SBEI UR Fax: (425) 643-9954

PRESSURE TEST CERTIFICATE

Date: 28 Jan 02

Job # 28268R

Model # 23-01-Y

S/N 230522

Pressure test results:

Low pressure (psi)	50	psi
Time (minutes)	15	min
High pressure (psi)	5000	psi
Time (minutes)	30	min

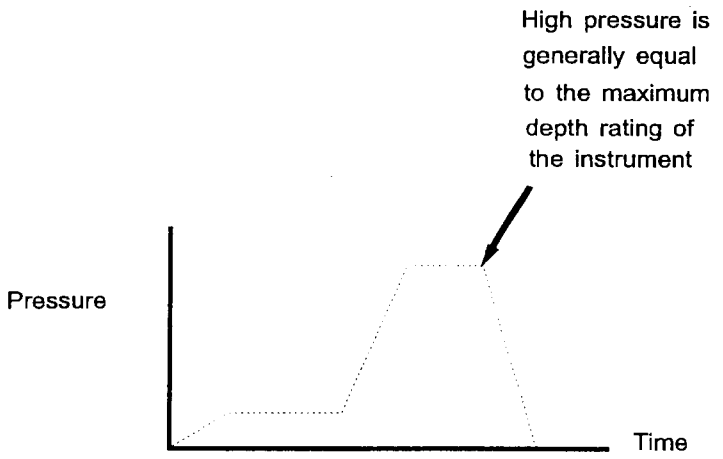
Pass Yes

Fail _____

Comments:

Replaced the YSI DO sensor module.

Tested by: JR



typical Test Profile

Sea-Bird Electronics, Inc.
1808 136th Place N.E., Bellevue, Washington 98005 USA
Telephone: (425) 643-9866 Telex: 292915 SBEI UR Fax: (425) 643-9954

PRESSURE TEST CERTIFICATE

Date: 28 Jan 02

Job # 28268R

Model # 18-I

S/N 180356

Pressure test results:

Low pressure (psi) 50 psi
Time (minutes) 15 min

High pressure (psi) 2000 psi
Time (minutes) 30 min

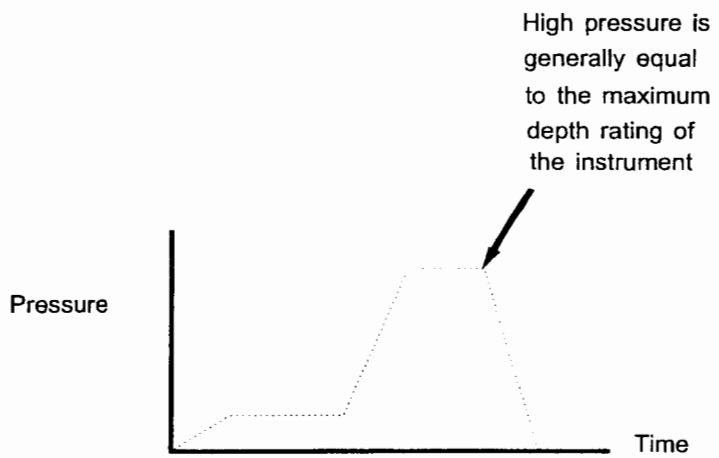
Pass Yes

Fail _____

Comments:

Replaced the Innovative PH electrode.

Tested by: JR



typical Test Profile

SBE SEA-BIRD ELECTRONICS, INC.
1808 - 136th Place Northeast, Bellevue, Washington 98005 USA
Phone: (425) 643-9866 Fax: (425) 643-9954 www.seabird.com

APPLICATION NOTE NO. 42 Revised - November 1996

ITS-90 TEMPERATURE SCALE

Beginning January 1995, Sea-Bird temperature calibration certificates list a new set of coefficients labelled g, h, i, j, and F0. These coefficients correspond to ITS90 (T90) temperatures and should be entered by those researchers working with SEASOFT Versions 4.208 and higher. For the convenience of users who prefer to use older SEASOFT versions, the new certificates also list a, b, c, d, and F0 coefficients corresponding to IPTS68 (T68) temperatures as required by SEASOFT versions older than 4.208.

It is important to note that the international oceanographic research community will continue to use T68 for computation of salinity and other seawater properties; therefore, following the recommendations of Saunders (1990) and as supported by the Joint Panel on Oceanographic Tables and Standards (1991), SEASOFT 4.200 and all subsequent SEASOFT versions convert between T68 and T90 according to the linear relationship:

$$T_{68} = 1.00024 * T_{90}$$

The use of T68 for salinity and other seawater calculations is automatic in all SEASOFT programs. However, when selecting **temperature** as a display variable, you will be promped to specify which standard (T90 or T68) is to be used to compute temperature. SEASAVE or other programs will recognize whether you have entered T90 or T68 coefficients in SEACON, and will either compute T90 temperature directly or calculate it from the Saunders linear approximation, depending on which coefficients were used and which display variable type is selected. For example, if you wish to display temperature according to the T68 standard, and g, h, i, j, F0 coefficients (T90) are entered in SEACON, select the temperature variable type as T68 and SEASAVE, DATCNV, or other modules will compute T90 temperature directly and multiply by 1.00024 to display T68. Conversley, if a, b, c, d, and F0 coefficients (T68) are entered in SEACON and the temperature variable type is selected as T90, SEASAVE, DATCNV, or other modules will compute T68 directly and divide by 1.00024 to display T90.

Also beginning January 1995, Sea-Bird's own temperature metrology laboratory (based upon water triple-point and gallium melt cell, SPRT, and ASL F18 Temperature Bridge) converted to T90. These T90 standards are now employed in calibrating *all* Sea-Bird temperature sensors, and as the reference temperature used in conductivity calibrations. Accordingly, all calibration certificates show T90 (g,h,i,j) coefficients that result directly from T90 standards, and T68 coefficients (a,b,c,d) computed using the Saunders linear approximation.

SEA-BIRD ELECTRONICS, INC.

1808 136th Place N.E., Bellevue, Washington 98005 USA
Phone: (425) 643 - 9866 Fax: (425) 643 - 9954 Internet: seabird@seabird.com

SENSOR SERIAL NUMBER = 904x
CALIBRATION DATE: 27-Jan-02

CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Siemens/meter

GHIJ COEFFICIENTS

g = -3.97508712e+00
h = 4.72772305e-01
i = 1.74100415e-03
j = -5.63046914e-05
CPcor = -9.57e-08 (nominal)
CTcor = 3.25e-06 (nominal)

ABCDM COEFFICIENTS

a = 5.03964562e-02
b = 4.21034308e-01
c = -3.97237939e+00
d = -2.13793994e-04
m = 2.1
CPcor = -9.57e-08 (nominal)

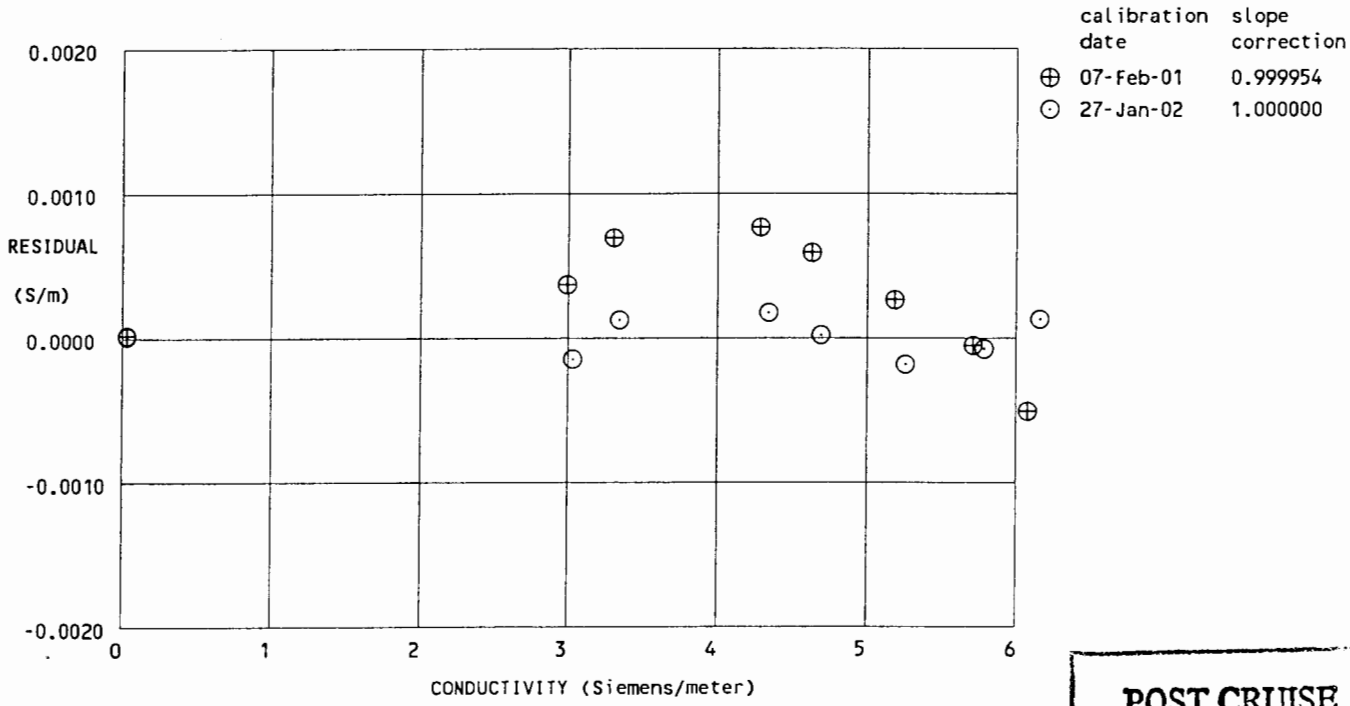
BATH TEMP (ITS-90 °C)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2.88581	0.00000	0.00000
1.0000	35.1754	3.00371	8.38781	3.00356	-0.00015
4.4999	35.1744	3.31515	8.76118	3.31527	0.00012
15.0000	35.1774	4.31119	9.85910	4.31136	0.00017
18.4999	35.1779	4.66112	10.21646	4.66113	0.00001
24.0001	35.1768	5.22629	10.76853	5.22610	-0.00019
29.0000	35.1713	5.75387	11.25966	5.75379	-0.00008
32.5000	35.1620	6.12941	11.59669	6.12953	0.00012

Conductivity = $(g + hf^2 + if^3 + jf^4) / [10(1 + \delta t + \epsilon p)]$ Siemens/meter

Conductivity = $(af^m + bf^2 + c + dt) / [10(1 + \epsilon p)]$ Siemens/meter

t = temperaure [deg C]; p = pressure [decibars]; δ = CTcor; ϵ = CPcor;

Residual = (instrument conductivity - bath conductivity) using g, h, i, j coefficients



POST CRUISE CALIBRATION

SEA-BIRD ELECTRONICS, INC.

1808 136th Place N.E., Bellevue, Washington 98005 USA
Phone: (425) 643 - 9866 Fax: (425) 643 - 9954 Internet: seabird@seabird.com

SENSOR SERIAL NUMBER = 904x
CALIBRATION DATE: 27-Jan-02

TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

g = 4.23088702e-03
h = 6.01001738e-04
i = 6.25259448e-06
j = -1.36918372e-06
f_0 = 1000.000

IPTS-68 COEFFICIENTS

a = 3.64763833e-03
b = 5.84886305e-04
c = 1.03138499e-05
d = -1.36860192e-06
f_0 = 2671.562

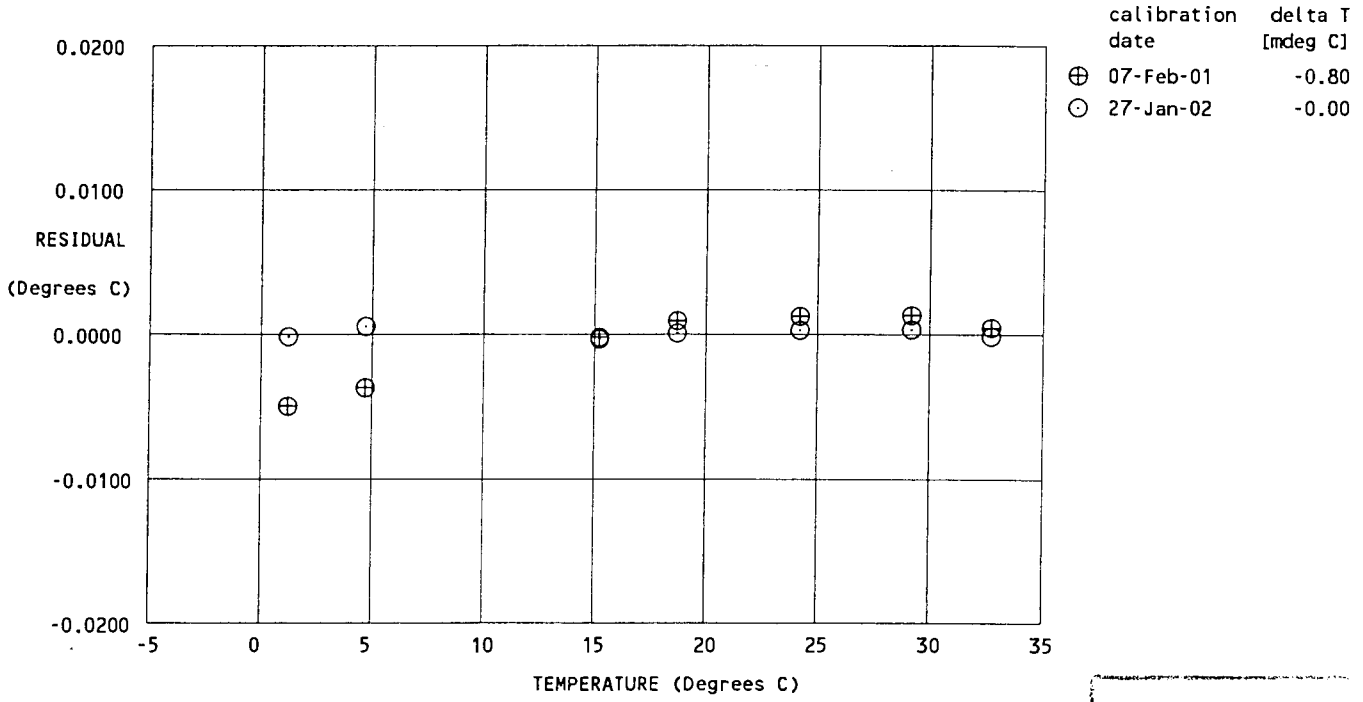
BATH TEMP (ITS-90 °C)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90 °C)	RESIDUAL (ITS-90 °C)
1.0000	2671.562	0.9997	-0.00025
4.4999	2890.479	4.5004	0.00047
15.0000	3623.491	14.9996	-0.00044
18.4999	3894.605	18.4999	-0.00000
24.0001	4349.043	24.0003	0.00020
29.0000	4793.315	29.0002	0.00024
32.5000	5122.526	32.4998	-0.00022

Temperature ITS-90 $= 1/\{g + h[\ell n(f_0/f)] + i[\ell n^2(f_0/f)] + j[\ell n^3(f_0/f)]\} - 273.15$ (°C)

Temperature IPTS-68 $= 1/\{a + b[\ell n(f_0/f)] + c[\ell n^2(f_0/f)] + d[\ell n^3(f_0/f)]\} - 273.15$ (°C)

Following the recommendation of JPOTS: T_{68} is assumed to be 1.00024 * T_{90} (-2 to 35 °C).

Residual = instrument temperature - bath temperature



POST CRUISE CALIBRATION

SEA-BIRD ELECTRONICS, INC.
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Phone: (425) 643-9866 Fax: (425) 643-9954 www.seabird.com

Conductivity Calibration Report

Customer:	CH2M Hill		
Job Number:	28268R	*Date of Report:*	29-Jan-02
Model Number:	SBE 19	*Serial Number:*	1912448-0904X

Conductivity sensors are normally calibrated 'as received', without cleaning or adjustments, allowing a determination of sensor drift. If the calibration identifies a problem or indicates cell cleaning is necessary, then a second calibration is performed after work is completed. The 'as received' calibration is not performed if the sensor is damaged or non-functional, or by customer request.

An 'as received' calibration certificate is provided, listing the coefficients used to convert sensor frequency to conductivity. Users must choose whether the 'as received' calibration or the previous calibration better represents the sensor condition during deployment. In SEASOFT enter the chosen coefficients using the program SEACON. The coefficient 'slope' allows small corrections for drift between calibrations (consult the SEASOFT manual). Calibration coefficients obtained after a repair or cleaning apply only to subsequent data.

'AS RECEIVED' CALIBRATION ☑ *Performed* ☐ *Not Performed*

Date: 27-Jan-02 *Drift since last cal:* -.00010 *PSU/month**

Comments:

'CALIBRATION AFTER CLEANING & REPLATINIZING' ☐ *performed* ☑ *Not Performed*

Date: *Drift since last cal:* *PSU/month**

Comments:

**Measured at 3.0 S/m*

Cell cleaning and electrode replatinizing tend to 'reset' the conductivity sensor to its original condition. Lack of drift in post-cleaning-calibration indicates geometric stability of the cell and electrical stability of the sensor circuit.

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Phone: (425) 643-9866 Fax: (425) 643-9954 www.seabird.com

Temperature Calibration Report

Customer:	CH2M Hill		
Job Number:	28268R	*Date of Report:*	29-Jan-02
Model Number:	SBE 19	*Serial Number:*	1912448-0904X

Temperature sensors are normally calibrated 'as received', without adjustments, allowing a determination sensor drift. If the calibration identifies a problem, then a second calibration is performed after work is completed. The 'as received' calibration is not performed if the sensor is damaged or non-functional, or by customer request.

An 'as received' calibration certificate is provided, listing coefficients to convert sensor frequency to temperature. Users must choose whether the 'as received' calibration or the previous calibration better represents the sensor condition during deployment. In SEASOFT enter the chosen coefficients using the program SEACON. The coefficient 'offset' allows a small correction for drift between calibrations (consult the SEASOFT manual). Calibration coefficients obtained after a repair apply only to subsequent data.

'AS RECEIVED' CALIBRATION ☑ *Performed* ☐ *Not Performed*

Date: 27-Jan-02 *Drift since last cal:* +.00082 *Degrees Celsius/year*

Comments:

'CALIBRATION AFTER REPAIR' ☐ *performed* ☑ *Not Performed*

Date: *Drift since last cal:* *Degrees Celsius/year*

Comments:

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Email: seabird@seabird.com

SBE S/N 1912448-0904x 30 January 2002

Pressure calibration: PAINE 211-75-710-03 1500 psia S/N 165479

Temperature Compensation (TC) value = -99

Straight Line Fit:

Pressure(psia) = M * N + B (N = Binary output)

M = -0.19621 B = 754.69

Quadratic Fit:

Pressure(psia) = A0 + A1 * N + A2 * N * N (N = binary output)

A0 = 752.08898 A1 = -1.961840e-001 A2 = 3.815523e-007

		Straight Line Fit		Quadratic Fit	
Pressure (psi)	Output (N)	error, psi	error, %FS	error, psi	error, %FS
14.70	3788.00	-3.256	-0.22	-0.281	-0.02
314.54	2243.00	0.053	0.00	-0.568	-0.04
614.39	706.00	1.773	0.12	-0.619	-0.04
914.28	-825.00	2.285	0.15	-0.079	-0.01
1214.38	-2344.99	0.418	0.03	-0.147	-0.01
1514.35	-3856.00	-3.074	-0.20	-0.104	-0.01
1214.29	-2347.01	0.910	0.06	0.348	0.02
914.22	-827.50	2.834	0.19	0.472	0.03
614.26	702.00	2.693	0.18	0.299	0.02
314.29	2240.00	0.889	0.06	0.262	0.02
14.23	3786.29	-2.450	-0.16	0.521	0.03

Output binary values are averages of 101 samples taken at 2 Hz.

SEASOFT Versions 3.3M and higher will prompt for A0, A1, and A2

SEASOFT Versions 3.3L and lower will prompt for M and B

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pH SENSOR CALIBRATION: S/N 180356 29 January 2002

Sensor type : Innovative

The following values of Vout were measured at a temperature of 20.5 deg C using +/-0.02 pH buffer solutions:

pH	Vout	Residual (pH units)
4	1.700	0.020
7	2.449	-0.041
10	3.168	0.020

Using phfit (version 2.0), the calibration coefficients for this sensors are:

pHslope = 4.1779
pHoffset = 2.4390

pH is calculated as:

pH = 7 + (Vout - pHoffset) / (pHslope * °K * 1.98416E-4)

where:

Vout is the output of the pH sensor in volts
pHoffset and pHslope are the calibration coefficients generated above
°K is the water temperature in degress Kelvin

(°K = degrees centigrade (°C) + 273.15)

CALIBRATION AFTER MODIFICATIONS

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Website: http://www.seabird.com Email: seabird@seabird.com

pH SENSOR CALIBRATION: S/N 180356 24 January 2002

Sensor type : Innovative

The following values of Vout were measured at a temperature of 20.5 deg C using +/-0.02 pH buffer solutions:

pH	Vout	Residual (pH units)
4	1.934	0.034
7	2.697	-0.068
10	3.410	0.034

Using phfit (version 2.0), the calibration coefficients for this sensors are:

pHslope = 4.2006
pHoffset = 2.6803

pH is calculated as:

pH = 7 + (Vout - pHoffset) / (pHslope * °K * 1.98416E-4)

where:

Vout is the output of the pH sensor in volts
pHoffset and pHslope are the calibration coefficients generated above
°K is the water temperature in degress Kelvin

(°K = degrees centigrade (°C) + 273.15)

POST CRUISE CALIBRATION

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Website: http://www.seabird.com Email: seabird@seabird.com

DISSOLVED OXYGEN SENSOR CALIBRATION: S/N 230522 08 February 2002

Sensor type:
YSI

Sensor Current

m = 1.0024 E-5
b = -5.4129 E-9

The use of these constants in a linear equation of the form

$$I = mV + b$$

will yield DO sensor membrane current as a function of sensor output voltage.

Sensor Compensation Temperature

k = 6.4808
c = -1.8642

The use of these constants in a linear equation of the form

$$T = kV + c$$

will yield membrane temperature as a function of temperature channel voltage with a maximum error of about 0.5 deg C. The correction to dissolved oxygen resulting from the use of this calibration should be sufficient to achieve the precision of which the sensor is capable.

SEASOFT Coefficients based on Oxfit Calibration Results

Soc	0.0860	
Boc	-0.0047	
tcor	-0.033	(nominal)
pcor	1.50e-4	(nominal)
tau	2.0	(nominal)
wt	0.85	(nominal)

barometer	=	1016.294	mB
Twater	=	1.508	deg C
Tcomp	=	1.570	deg C
Isat	=	11.659	uA
Iair	=	25.565	uA
Izero	=	0.055	uA

CALIBRATION
AFTER
MODIFICATIONS

Sea-Bird Electronics, Inc. FAX: (425) 643-9954
1808 136th Place NE, Bellevue, Washington 98005 USA Tel:(425)643-9866
Website: http://www.seabird.com Email: seabird@seabird.com

DISSOLVED OXYGEN SENSOR CALIBRATION: S/N 230522 24 January 2002

Sensor type:

YSI

Sensor Current

m = 1.0024 E-5
b = -5.4129 E-9

The use of these constants in a linear equation of the form

$$I = mV + b$$

will yield DO sensor membrane current as a function of sensor output voltage.

Sensor Compensation Temperature

k = 6.4808
c = -1.8642

The use of these constants in a linear equation of the form

$$T = kV + c$$

will yield membrane temperature as a function of temperature channel voltage with a maximum error of about 0.5 deg C. The correction to dissolved oxygen resulting from the use of this calibration should be sufficient to achieve the precision of which the sensor is capable.

SEASOFT Coefficients based on Oxfit Calibration Results

Soc	0.0918	
Boc	-0.0188	
tcor	-0.033	(nominal)
pcor	1.50e-4	(nominal)
tau	2.0	(nominal)
wt	0.85	(nominal)

barometer	=	1011.392	mB
Twater	=	5.684	deg C
Tcomp	=	6.502	deg C
Isat	=	13.326	uA
Iair	=	21.756	uA
Izero	=	0.205	uA

POST CRUISE CALIBRATION

Appendix II.C

Comparison of SBE 19 Vertical Profiling Instrument and Grab Sample Measurements

Table II.C-1.
Comparison of Temperature (°C) Measurements from Grab Samples and SeaBird Profiler (March 2003)

Station	Depth	CTDdwn	CTDup	CTDave	GRAB	Delta	|Delta|
5	s	29.93	29.94	29.94	30.3	-0.36	0.36
5	m	29.93	29.91	29.92	29.9	0.02	0.02
5	b	29.38	29.35	29.36	29.8	-0.44	0.44
8	s	30.48	30.45	30.46	30.2	0.26	0.26
8	m	29.77	29.74	29.75	29.6	0.15	0.15
8	b	29.10	29.09	29.10	29.5	-0.40	0.40
8A	s	30.39	30.20	30.29	30.6	-0.31	0.31
8A	m	29.77	29.75	29.76	30.1	-0.34	0.34
8A	b	28.93	28.89	28.91	29.7	-0.79	0.79
11	s	30.90	30.83	30.86	31.0	-0.14	0.14
11	m	30.00	29.99	30.00	29.9	0.10	0.10
11	b	29.07	28.94	29.00	29.7	-0.70	0.70
13	s	30.44	30.40	30.42	30.2	0.22	0.22
13	m	30.28	30.23	30.25	30.0	0.25	0.25
13	b	30.15	30.15	30.15	30.0	0.15	0.15
14	s	30.44	30.42	30.43	30.6	-0.17	0.17
14	m	29.76	29.75	29.75	29.8	-0.05	0.05
14	b	28.83	28.80	28.82	29.4	-0.59	0.59
15	s	30.35	30.34	30.34	30.3	0.04	0.04
15	m	29.97	29.96	29.97	29.9	0.07	0.07
15	b	29.87	29.88	29.87	29.9	-0.03	0.03
16	s	30.37	30.35	30.36	30.2	0.16	0.16
16	m	29.94	29.93	29.94	29.9	0.04	0.04
16	b	29.67	29.63	29.65	29.8	-0.15	0.15
18	s	30.17	30.17	30.17	30.1	0.07	0.07
18	m	29.93	29.92	29.93	29.9	0.03	0.03
18	b	29.55	29.47	29.51	29.8	-0.29	0.29
A1	s	30.46	30.45	30.45	30.4	0.05	0.05
A1	m	29.82	29.79	29.81	30.0	-0.19	0.19
A1	b	29.19	29.19	29.19	29.9	-0.71	0.71
B1	s	30.49	30.46	30.48	30.5	-0.02	0.02
B1	m	29.80	29.78	29.79	29.8	-0.01	0.01
B1	b	29.05	29.04	29.05	29.4	-0.35	0.35
C	s	30.61	30.50	30.55	29.6	0.95	0.95
C	m	29.86	29.85	29.85	29.7	0.15	0.15
C	b	29.83	29.83	29.83	29.6	0.23	0.23
U	s	30.37	30.33	30.35	30.6	-0.25	0.25
U	m	29.97	29.94	29.95	29.9	0.05	0.05
U	b	29.27	29.15	29.21	29.7	-0.49	0.49
Minimum		28.83	28.80	28.82	29.4	-0.79	0.01
Maximum		30.90	30.83	30.86	31.0	0.95	0.95
Average		29.90	29.87	29.88	30.0	-0.10	0.25
Std. Dev.		0.51	0.51	0.51	0.4	0.33	0.23
90%		30.47	30.45	30.46	30.5	-	0.61
10%		29.09	29.08	29.09	29.6	-	0.03

Table II.C-2
Comparison of Salinity (PSU) Measurements from YSI and SeaBird Profiler (March 2003)

Station	Depth	CTDdwn	CTDup	CTDave	YSI	Delta	|Delta|
5	s	35.06	35.09	35.07	34.3	0.8	0.8
5	m	35.27	35.28	35.28	35.1	0.2	0.2
5	b	35.41	35.42	35.42	35.1	0.3	0.3
8	s	35.00	35.02	35.01	34.9	0.1	0.1
8	m	35.30	35.28	35.29	35.1	0.2	0.2
8	b	35.47	35.45	35.46	35.1	0.4	0.4
8A	s	35.04	35.15	35.09	34.7	0.4	0.4
8A	m	35.29	35.28	35.28	34.9	0.4	0.4
8A	b	35.46	35.45	35.46	35.1	0.4	0.4
11	s	34.93	34.94	34.94	34.6	0.3	0.3
11	m	35.28	35.27	35.28	35.1	0.2	0.2
11	b	35.46	35.47	35.46	35.1	0.4	0.4
13	s	35.13	35.14	35.14	34.6	0.5	0.5
13	m	35.18	35.19	35.18	35.1	0.1	0.1
13	b	34.96	35.50	35.23	35.1	0.1	0.1
14	s	34.95	34.94	34.94	34.7	0.2	0.2
14	m	35.29	35.27	35.28	35.0	0.3	0.3
14	b	35.45	35.44	35.45	35.1	0.3	0.3
15	s	35.14	35.12	35.13	34.9	0.2	0.2
15	m	35.29	35.28	35.28	35.1	0.2	0.2
15	b	35.31	35.31	35.31	35.1	0.2	0.2
16	s	34.87	35.02	34.94	34.3	0.6	0.6
16	m	35.29	35.28	35.28	35.0	0.3	0.3
16	b	35.32	35.30	35.31	35.2	0.1	0.1
18	s	34.97	34.96	34.96	34.7	0.3	0.3
18	m	35.29	35.28	35.28	35.0	0.3	0.3
18	b	35.33	35.35	35.34	35.1	0.2	0.2
A1	s	35.05	35.09	35.07	34.9	0.2	0.2
A1	m	35.31	35.31	35.31	35.1	0.2	0.2
A1	b	35.43	35.43	35.43	35.2	0.2	0.2
B1	s	35.05	35.08	35.06	34.9	0.2	0.2
B1	m	35.32	35.30	35.31	35.1	0.2	0.2
B1	b	35.48	35.46	35.47	35.1	0.4	0.4
C	s	35.04	35.08	35.06	35.2	-0.1	0.1
C	m	35.33	35.33	35.33	35.2	0.1	0.1
C	b	35.34	35.34	35.34	35.3	0.0	0.0
U	s	35.11	35.11	35.11	34.6	0.5	0.5
U	m	35.29	35.27	35.28	35.1	0.2	0.2
U	b	35.37	35.43	35.40	35.0	0.4	0.4
Minimum		34.87	34.94	34.94	34.3	-0.1	0.0
Maximum		35.48	35.50	35.47	35.3	0.8	0.8
Average		35.23	35.25	35.24	35.0	0.3	0.3
Std. Dev.		0.17	0.16	0.16	0.24	0.2	0.2
90%		35.45	35.45	35.45	35.2	-	0.4
10%		34.97	35.02	35.00	34.6	-	0.1

Table II.C-3
Comparison of DO (mg/l) Measurements from YSI and SeaBird Profiler (March 2003)

Station	Depth	CTDdwn	CTDup	CTDave	YSI	Delta	|Delta|
5	s	2.85	2.86	2.86	6.23	-3.38	3.38
5	m	2.84	2.85	2.85	5.89	-3.05	3.05
5	b	2.75	2.78	2.77	5.58	-2.82	2.82
8	s	3.00	3.03	3.02	6.21	-3.20	3.20
8	m	2.62	2.49	2.56	5.48	-2.93	2.93
8	b	2.68	2.78	2.73	5.23	-2.50	2.50
8A	s	3.00	2.97	2.99	6.29	-3.31	3.31
8A	m	2.52	2.42	2.47	5.24	-2.77	2.77
8A	b	2.17	2.24	2.21	4.73	-2.53	2.53
11	s	4.29	4.26	4.28	10.67	-6.40	6.40
11	m	2.97	2.85	2.91	5.88	-2.97	2.97
11	b	2.48	2.47	2.48	5.44	-2.97	2.97
13	s	2.55	2.50	2.53	--	--	--
13	m	2.38	2.23	2.31	5.22	-2.92	2.92
13	b	2.01	1.88	1.95	4.59	-2.65	2.65
14	s	3.06	3.07	3.07	5.90	-2.84	2.84
14	m	2.46	2.45	2.46	5.58	-3.13	3.13
14	b	2.24	2.31	2.28	4.70	-2.43	2.43
15	s	3.16	3.14	3.15	6.27	-3.12	3.12
15	m	2.94	2.90	2.92	6.10	-3.18	3.18
15	b	2.75	2.73	2.74	5.77	-3.03	3.03
16	s	2.96	2.91	2.94	6.05	-3.12	3.12
16	m	2.91	2.88	2.90	6.09	-3.20	3.20
16	b	2.51	2.45	2.48	5.86	-3.38	3.38
18	s	2.97	2.98	2.98	6.17	-3.20	3.20
18	m	2.97	2.90	2.94	6.05	-3.12	3.12
18	b	2.37	2.33	2.35	5.90	-3.55	3.55
A1	s	3.06	2.98	3.02	6.36	-3.3	3.3
A1	m	2.85	2.82	2.83	5.85	-3.0	3.0
A1	b	2.48	2.48	2.48	5.64	-3.2	3.2
B1	s	3.15	2.92	3.04	6.11	-3.1	3.1
B1	m	2.85	2.80	2.83	5.89	-3.1	3.1
B1	b	2.63	2.75	2.69	5.08	-2.4	2.4
C	s	2.62	2.75	2.68	5.86	-3.2	3.2
C	m	2.87	2.88	2.88	5.84	-3.0	3.0
C	b	2.86	2.86	2.86	5.67	-2.8	2.8
U	s	3.06	3.04	3.05	6.52	-3.5	3.5
U	m	2.96	2.90	2.93	6.18	-3.3	3.3
U	b	2.58	2.59	2.59	5.78	-3.2	3.2
Minimum		2.01	1.88	1.95	4.59	-6.40	2.39
Maximum		4.29	4.26	4.28	10.67	-2.39	6.40
Average		2.78	2.75	2.77	5.89	-3.12	3.12
Std. Dev.		0.37	0.37	0.37	0.92	0.61	0.61
90%		3.06	3.03	3.04	6.28	-	3.38
10%		2.38	2.33	2.34	5.18	-	2.61

Table II.C-4
Comparison of pH (SU) Measurements from Orion and SeaBird Profiler (March 2003)

	Depth	CTDdwn	CTDup	CTDave	Orion	Delta
5	s	9.67	9.67	9.67	8.18	1.49
5	m	9.70	9.70	9.70	8.18	1.52
5	b	9.70	9.70	9.70	8.14	1.56
8	s	9.61	9.57	9.59	8.16	1.43
8	m	9.59	9.55	9.57	8.10	1.47
8	b	9.59	9.58	9.59	8.07	1.52
8A	s	9.61	9.58	9.60	8.15	1.45
8A	m	9.58	9.53	9.56	8.10	1.46
8A	b	9.53	9.53	9.53	8.11	1.42
11	s	9.88	9.82	9.85	8.45	1.40
11	m	9.69	9.66	9.68	8.11	1.57
11	b	9.65	9.64	9.65	8.10	1.55
13	s	9.63	9.63	9.63	8.08	1.55
13	m	9.63	9.60	9.62	8.11	1.51
13	b	9.58	9.57	9.58	8.06	1.52
14	s	9.62	9.58	9.60	8.08	1.52
14	m	9.57	9.54	9.56	8.11	1.45
14	b	9.53	9.53	9.53	8.06	1.47
15	s	9.70	9.65	9.68	8.18	1.50
15	m	9.69	9.67	9.68	8.16	1.52
15	b	9.67	9.66	9.67	8.10	1.57
16	s	9.73	9.68	9.71	8.12	1.59
16	m	9.73	9.70	9.72	8.18	1.54
16	b	9.70	9.65	9.68	8.15	1.53
18	s	9.75	9.70	9.73	8.17	1.56
18	m	9.75	9.71	9.73	8.17	1.56
18	b	9.68	9.65	9.67	8.14	1.53
A1	s	9.66	9.58	9.62	8.15	1.47
A1	m	9.62	9.60	9.61	8.11	1.50
A1	b	9.58	9.58	9.58	8.05	1.53
B1	s	9.65	9.55	9.60	8.10	1.50
B1	m	9.62	9.57	9.60	8.15	1.45
B1	b	9.60	9.58	9.59	8.07	1.52
C	s	9.49	9.55	9.52	8.06	1.46
C	m	9.59	9.60	9.60	8.06	1.54
C	b	9.60	9.60	9.60	7.96	1.64
U	s	9.71	9.66	9.69	8.16	1.53
U	m	9.70	9.68	9.69	8.18	1.51
U	b	9.66	9.66	9.66	8.15	1.51
Minimum		9.49	9.53	9.52	7.96	1.40
Maximum		9.88	9.82	9.85	8.45	1.64
Average		9.65	9.62	9.63	8.13	1.51
Std. Dev.		0.07	0.06	0.07	0.07	0.05
90%		9.73	9.70	9.71	8.18	1.56
10%		9.58	9.55	9.56	8.06	1.45

Table II.C-5
Comparison of Turbidity (NTU) Measurements from Laboratory Analysis and SeaBird Profiler (March 2003)

Station	Depth	CTDdwn	CTDup	CTDave	Lab	Delta	
5	s	0.40	0.22	1.50	0.12	1.38	Removed
5	m	0.28	9.70	0.81	0.24	0.57	0.57
5	b	0.40	9.70	0.81	0.14	0.67	0.67
8	s	0.46	0.75	0.61	0.18	0.43	0.43
8	m	1.05	1.23	1.14	0.19	0.95	0.95
8	b	0.76	0.83	0.80	0.12	0.68	0.68
8A	s	0.60	0.37	0.49	0.19	0.30	0.30
8A	m	0.94	1.03	0.99	0.29	0.70	0.70
8A	b	5.73	5.59	5.66	0.31	5.35	Removed
11	s	3.02	4.22	3.62			
11	m	0.40	0.40	0.40			
11	b	5.46	5.75	5.61			
13	s	2.44	0.30	1.37	0.56	0.81	0.81
13	m	1.32	1.74	1.53	0.25	1.28	1.28
13	b	3.64	4.59	4.12	0.58	3.54	Removed
14	s	0.52	0.52	0.52	0.13	0.39	0.39
14	m	1.35	1.22	1.29	0.49	0.80	0.80
14	b	5.35	6.72	6.04	0.07	5.97	Removed
15	s	2.17	1.18	1.68			
15	m	0.43	0.42	0.43			
15	b	0.70	0.68	0.69			
16	s	0.29	0.66	0.48	0.15	0.33	0.33
16	m	0.26	0.28	0.27	0.13	0.14	0.14
16	b	0.45	0.50	0.48	0.10	0.38	0.38
18	s	0.01	0.63	0.32	0.40	-0.08	-0.08
18	m	0.20	0.22	0.21	0.11	0.10	0.10
18	b	1.56	1.47	1.52	0.12	1.40	Removed
A1	s	0.28	0.16	0.22	0.24	-0.02	-0.02
A1	m	0.40	0.54	0.47	0.20	0.27	0.27
A1	b	2.13	2.13	2.13	0.22	1.91	Removed
B1	s	0.32	0.79	0.56	0.38	0.18	0.18
B1	m	0.44	0.47	0.46	0.14	0.32	0.32
B1	b	0.83	0.69	0.76	0.24	0.52	0.52
C	s	1.58	1.42	1.50	0.30	1.20	Removed
C	m	0.90	0.71	0.81	0.16	0.65	0.65
C	b	0.81	0.81	0.81	0.41	0.40	0.40
U	s	0.65	0.16	0.41	0.67	-0.27	-0.27
U	m	0.45	0.40	0.43	0.36	0.07	0.07
U	b	1.29	1.61	1.45	0.40	1.05	Removed
Minimum		0.01	0.16	0.21	0.07	-0.27	-0.27
Maximum		5.73	6.72	6.04	0.67	5.97	1.28
Average		1.37	1.42	1.37	0.26	0.98	0.42
Std. Dev.		1.51	1.71	1.53	0.15	1.40	0.35
90%		3.33	4.41	3.72	0.47	1.81	0.80
10%		0.29	0.29	0.38	0.12	0.07	0.01

Appendix III

Vertical Profile Data for Each Station

Station C Vertical Profile Data (Cast 1)											
Pago Pago Harbor Water Quality Monitoring											
19 March 2003 - Non Tradewind											
Depth	Temp	Salinity	Sigma-t	DO (mg/l)		DO (% Sat)		pH (SU)		Turbidity	No. Scans
(m)	°C	PSU	kg/m^3	Raw	Corrected	Raw	Corrected	Raw	Corrected	NTU	Averaged
Downcast Data - Bin Averaged at 1 meter Intervals											
1	30.610	35.038	21.545	2.62	5.74	42.59	93.2	9.49	7.98	1.58	4
2	30.513	35.163	21.672	2.77	5.89	44.99	95.6	9.54	8.03	1.46	18
3	30.144	35.254	21.867	2.79	5.91	44.94	95.3	9.54	8.03	1.03	2
4	30.045	35.296	21.932	2.80	5.92	45.17	95.4	9.55	8.04	0.70	2
5	30.022	35.299	21.943	2.81	5.93	45.31	95.6	9.57	8.06	0.64	3
6	30.001	35.299	21.950	2.83	5.95	45.61	95.9	9.57	8.06	0.53	2
7	29.976	35.307	21.965	2.85	5.97	45.88	96.1	9.57	8.06	0.61	3
8	29.969	35.308	21.967	2.86	5.98	46.06	96.3	9.58	8.07	0.70	2
9	29.955	35.309	21.974	2.87	5.99	46.20	96.4	9.58	8.07	0.56	3
10	29.933	35.316	21.986	2.87	5.99	46.20	96.4	9.59	8.08	0.46	2
11	29.922	35.317	21.991	2.87	5.99	46.23	96.4	9.59	8.08	0.47	3
12	29.914	35.317	21.993	2.87	5.99	46.16	96.3	9.59	8.08	0.46	2
13	29.896	35.322	22.003	2.86	5.98	46.05	96.2	9.59	8.08	0.44	3
14	29.875	35.327	22.015	2.87	5.99	46.07	96.2	9.59	8.08	0.69	3
15	29.858	35.332	22.024	2.87	5.99	46.12	96.3	9.59	8.08	0.90	2
16	29.850	35.335	22.028	2.88	6.00	46.24	96.4	9.59	8.08	0.81	3
17	29.846	35.334	22.029	2.89	6.01	46.36	96.5	9.60	8.09	0.78	3
18	29.841	35.335	22.031	2.89	6.01	46.46	96.6	9.60	8.09	0.71	2
19	29.840	35.334	22.031	2.89	6.01	46.43	96.6	9.60	8.09	0.48	3
20	29.834	35.335	22.034	2.89	6.01	46.38	96.5	9.60	8.09	0.45	2
21	29.832	35.336	22.035	2.88	6.00	46.32	96.4	9.60	8.09	0.43	2
22	29.832	35.336	22.035	2.88	6.00	46.24	96.4	9.60	8.09	0.49	2
23	29.830	35.337	22.037	2.87	5.99	46.12	96.2	9.60	8.09	0.52	2
24	29.828	35.338	22.038	2.86	5.98	46.02	96.1	9.60	8.09	0.66	3
25	29.828	35.339	22.039	2.86	5.98	45.91	96.0	9.60	8.09	0.83	2
26	29.834	35.338	22.037	2.86	5.98	45.92	96.0	9.60	8.09	0.81	5
Upcast Data - Bin Averaged at 1 meter Intervals											
25	29.831	35.338	22.037	2.86	5.98	45.90	96.0	9.60	8.09	0.91	2
24	29.832	35.336	22.036	2.86	5.98	45.86	96.0	9.60	8.09	0.92	6
23	29.834	35.335	22.034	2.85	5.97	45.86	96.0	9.60	8.09	0.50	2
22	29.830	35.336	22.036	2.86	5.98	45.96	96.1	9.60	8.09	0.44	4
21	29.831	35.333	22.033	2.87	5.99	46.03	96.1	9.60	8.09	0.42	3
20	29.832	35.334	22.034	2.87	5.99	46.06	96.2	9.60	8.09	0.47	3
19	29.833	35.334	22.034	2.87	5.99	46.16	96.3	9.60	8.09	0.47	4
18	29.838	35.332	22.031	2.88	6.00	46.23	96.4	9.60	8.09	0.60	3
17	29.844	35.332	22.028	2.88	6.00	46.27	96.4	9.60	8.09	0.60	3
16	29.846	35.330	22.026	2.88	6.00	46.26	96.4	9.60	8.09	0.55	3
15	29.848	35.328	22.024	2.88	6.00	46.30	96.4	9.60	8.09	0.71	3
14	29.859	35.326	22.019	2.88	6.00	46.23	96.4	9.60	8.09	0.91	3
13	29.877	35.321	22.009	2.87	5.99	46.13	96.3	9.60	8.09	0.68	3
12	29.892	35.316	22.000	2.87	5.99	46.21	96.4	9.60	8.09	0.44	3
11	29.906	35.312	21.992	2.88	6.00	46.34	96.5	9.60	8.09	0.42	3
10	29.916	35.310	21.987	2.89	6.01	46.44	96.6	9.60	8.09	0.44	2
9	29.937	35.302	21.975	2.89	6.01	46.50	96.7	9.60	8.09	0.44	4
8	29.953	35.299	21.966	2.89	6.01	46.45	96.7	9.59	8.08	0.57	2
7	29.965	35.297	21.961	2.89	6.01	46.53	96.7	9.59	8.08	0.49	3
6	29.974	35.294	21.956	2.88	6.00	46.41	96.6	9.59	8.08	0.59	4
5	29.997	35.286	21.942	2.88	6.00	46.41	96.6	9.58	8.07	0.51	3
4	30.018	35.285	21.934	2.89	6.01	46.61	96.9	9.58	8.07	0.65	3
3	30.082	35.256	21.890	2.89	6.01	46.62	96.9	9.58	8.07	0.88	3
2	30.261	35.204	21.790	2.85	5.97	46.08	96.5	9.56	8.05	1.20	3
1	30.495	35.079	21.615	2.74	5.86	44.49	95.1	9.55	8.04	1.42	3
Summary (Includes Downcast and Upcast)											
Min	29.828	35.038	21.545	2.62	5.74	42.59	93.25	9.49	7.98	0.42	Min
Max	30.610	35.339	22.039	2.89	6.01	46.62	96.91	9.60	8.09	1.58	Max
Average	29.944	35.303	21.972	2.86	5.98	46.01	96.20	9.59	8.08	0.68	Average
Std. Dev.	0.176	0.060	0.105	0.05	0.05	0.65	0.56	0.02	0.02	0.27	Std. Dev.

Station A1 Vertical Profile Data (Cast 2)											
Pago Pago Harbor Water Quality Monitoring											
19 March 2003 - Non Tradewind											
Depth	Temp	Salinity	Sigma-t	DO (mg/l)		DO (% Sat)		pH (SU)		Turbidity	No. Scans
(m)	°C	PSU	kg/m^3	Raw	Corrected	Raw	Corrected	Raw	Corrected	NTU	Averaged
Downcast Data - Bin Averaged at 1 meter Intervals											
1	30.462	35.050	21.605	3.06	6.18	49.63	100.2	9.66	8.15	0.28	3
2	30.443	35.124	21.667	2.92	6.04	47.36	97.9	9.64	8.13	0.85	3
3	30.358	35.091	21.672	2.83	5.95	45.81	96.3	9.62	8.11	0.60	2
4	30.211	35.119	21.743	2.85	5.97	45.98	96.3	9.58	8.07	0.54	2
5	30.103	35.218	21.854	2.88	6.00	46.43	96.7	9.57	8.06	0.76	2
6	30.056	35.260	21.902	2.90	6.02	46.65	96.9	9.61	8.10	0.48	2
7	30.033	35.277	21.923	2.91	6.03	46.89	97.1	9.62	8.11	0.39	2
8	30.020	35.278	21.928	2.92	6.04	47.03	97.3	9.63	8.12	0.45	3
9	30.006	35.279	21.933	2.92	6.04	47.07	97.3	9.63	8.12	0.37	2
10	30.000	35.280	21.936	2.93	6.05	47.13	97.4	9.63	8.12	0.37	2
11	29.994	35.282	21.939	2.93	6.05	47.15	97.4	9.63	8.12	0.37	2
12	29.981	35.286	21.947	2.92	6.04	47.08	97.3	9.63	8.12	0.41	1
13	29.971	35.286	21.950	2.91	6.03	46.87	97.1	9.63	8.12	0.34	2
14	29.955	35.286	21.956	2.90	6.02	46.63	96.8	9.63	8.12	0.38	2
15	29.929	35.290	21.968	2.89	6.01	46.44	96.6	9.63	8.12	0.42	2
16	29.885	35.305	21.994	2.89	6.01	46.40	96.6	9.62	8.11	0.44	2
17	29.852	35.315	22.013	2.88	6.00	46.32	96.4	9.62	8.11	0.47	2
18	29.838	35.316	22.019	2.88	6.00	46.24	96.4	9.62	8.11	0.44	2
19	29.830	35.315	22.020	2.87	5.99	46.10	96.2	9.62	8.11	0.42	2
20	29.821	35.313	22.022	2.85	5.97	45.77	95.9	9.62	8.11	0.40	2
21	29.798	35.316	22.032	2.83	5.95	45.49	95.6	9.62	8.11	0.42	2
22	29.786	35.308	22.030	2.81	5.93	45.17	95.2	9.62	8.11	0.53	2
23	29.755	35.318	22.048	2.80	5.92	44.99	95.0	9.62	8.11	0.53	2
24	29.740	35.324	22.058	2.80	5.92	44.84	94.9	9.61	8.10	0.57	1
25	29.730	35.319	22.058	2.78	5.90	44.54	94.6	9.62	8.11	0.48	2
26	29.675	35.328	22.083	2.76	5.88	44.16	94.1	9.62	8.11	0.68	2
27	29.618	35.342	22.113	2.72	5.84	43.60	93.6	9.61	8.10	0.46	2
28	29.596	35.347	22.124	2.69	5.81	43.01	92.9	9.61	8.10	0.43	2
29	29.582	35.343	22.126	2.64	5.76	42.24	92.2	9.61	8.10	0.41	2
30	29.518	35.349	22.152	2.57	5.69	41.02	90.9	9.60	8.09	0.53	2
31	29.396	35.387	22.221	2.50	5.62	39.93	89.7	9.59	8.08	1.28	3
32	29.343	35.393	22.244	2.48	5.60	39.55	89.3	9.58	8.07	1.81	2
33	29.272	35.417	22.286	2.48	5.60	39.50	89.2	9.57	8.06	2.41	2
34	29.234	35.429	22.308	2.48	5.60	39.55	89.2	9.58	8.07	2.41	2
35	29.220	35.430	22.313	2.49	5.61	39.64	89.3	9.59	8.08	2.37	2
36	29.205	35.434	22.322	2.48	5.60	39.47	89.1	9.58	8.07	2.33	2
37	29.194	35.433	22.325	2.48	5.60	39.37	89.0	9.58	8.07	2.15	2
38	29.169	35.441	22.339	2.47	5.59	39.33	88.9	9.58	8.07	2.27	1
39	29.161	35.442	22.342	2.47	5.59	39.21	88.8	9.58	8.07	2.53	12

Station A1 Vertical Profile Data (Cast 2)											
Pago Pago Harbor Water Quality Monitoring											
19 March 2003 - Non Tradewind											
Depth	Temp	Salinity	Sigma-t	DO (mg/l)		DO (% Sat)		pH (SU)		Turbidity	No. Scans
(m)	°C	PSU	kg/m^3	Raw	Corrected	Raw	Corrected	Raw	Corrected	NTU	Averaged
Upcast Data - Bin Averaged at 1 meter Intervals											
38	29.168	35.444	22.341	2.47	5.59	39.22	88.8	9.58	8.07	2.60	3
37	29.173	35.441	22.337	2.47	5.59	39.26	88.9	9.58	8.07	2.30	4
36	29.191	35.434	22.326	2.48	5.60	39.38	89.0	9.58	8.07	2.13	3
35	29.208	35.428	22.316	2.48	5.60	39.49	89.1	9.58	8.07	1.99	4
34	29.227	35.424	22.306	2.48	5.60	39.50	89.2	9.58	8.07	2.22	4
33	29.239	35.419	22.298	2.47	5.59	39.34	89.0	9.58	8.07	2.52	4
32	29.270	35.405	22.278	2.44	5.56	38.80	88.5	9.57	8.06	2.54	3
31	29.327	35.386	22.244	2.43	5.55	38.66	88.4	9.56	8.05	2.02	4
30	29.378	35.374	22.218	2.46	5.58	39.31	89.1	9.57	8.06	1.48	4
29	29.485	35.345	22.160	2.53	5.65	40.46	90.3	9.58	8.07	0.75	5
28	29.535	35.346	22.144	2.60	5.72	41.63	91.5	9.59	8.08	0.52	6
27	29.574	35.332	22.120	2.65	5.77	42.36	92.3	9.59	8.08	0.48	3
26	29.622	35.319	22.094	2.68	5.80	42.94	92.9	9.59	8.08	0.55	4
25	29.660	35.313	22.077	2.72	5.84	43.60	93.6	9.60	8.09	0.58	5
24	29.704	35.318	22.066	2.75	5.87	44.16	94.2	9.59	8.08	0.53	8
23	29.738	35.308	22.046	2.77	5.89	44.45	94.5	9.59	8.08	0.53	3
22	29.755	35.309	22.041	2.78	5.90	44.61	94.7	9.60	8.09	0.55	6
21	29.773	35.305	22.032	2.80	5.92	44.86	94.9	9.60	8.09	0.54	4
20	29.790	35.306	22.027	2.82	5.94	45.24	95.3	9.60	8.09	0.54	5
19	29.810	35.302	22.018	2.84	5.96	45.57	95.7	9.60	8.09	0.42	3
18	29.822	35.305	22.016	2.85	5.97	45.81	95.9	9.60	8.09	0.45	7
17	29.830	35.304	22.012	2.86	5.98	45.99	96.1	9.60	8.09	0.43	4
16	29.847	35.300	22.004	2.86	5.98	46.01	96.1	9.60	8.09	0.50	4
15	29.872	35.291	21.988	2.87	5.99	46.09	96.2	9.60	8.09	0.38	4
14	29.911	35.283	21.969	2.88	6.00	46.33	96.5	9.60	8.09	0.38	4
13	29.942	35.277	21.954	2.90	6.02	46.69	96.9	9.60	8.09	0.39	5
12	29.962	35.275	21.945	2.92	6.04	46.92	97.1	9.61	8.10	0.37	3
11	29.973	35.276	21.942	2.92	6.04	47.07	97.3	9.61	8.10	0.37	4
10	29.982	35.273	21.937	2.92	6.04	47.08	97.3	9.60	8.09	0.36	4
9	29.989	35.271	21.933	2.92	6.04	47.06	97.3	9.60	8.09	0.38	6
8	30.000	35.270	21.929	2.92	6.04	47.03	97.3	9.60	8.09	0.42	8
7	30.013	35.267	21.922	2.92	6.04	47.09	97.3	9.60	8.09	0.41	5
6	30.041	35.249	21.899	2.90	6.02	46.78	97.0	9.59	8.08	0.54	4
5	30.086	35.194	21.843	2.84	5.96	45.73	96.0	9.57	8.06	1.44	3
4	30.176	35.095	21.738	2.77	5.89	44.64	95.0	9.52	8.01	0.64	4
3	30.324	35.084	21.678	2.81	5.93	45.40	95.8	9.54	8.03	0.47	4
2	30.411	35.108	21.666	2.90	6.02	46.90	97.4	9.57	8.06	0.20	3
1	30.447	35.092	21.641	2.98	6.10	48.25	98.8	9.58	8.07	0.16	4
Summary (Includes Downcast and Upcast)											
Min	29.161	35.050	21.605	2.43	5.55	38.66	88.39	9.52	8.01	0.160	Min
Max	30.462	35.444	22.342	3.06	6.18	49.63	100.17	9.66	8.15	2.600	Max
Average	29.753	35.306	22.039	2.75	5.87	44.15	94.19	9.60	8.09	0.881	Average
Std. Dev.	0.353	0.093	0.187	0.18	0.18	3.08	3.32	0.02	0.02	0.761	Std. Dev.

Station B1 Vertical Profile Data (Cast 3)											
Pago Pago Harbor Water Quality Monitoring											
19 March 2003 - Non Tradewind											
Depth	Temp	Salinity	Sigma-t	DO (mg/l)		DO (% Sat)		pH (SU)		Turbidity	No. Scans
(m)	°C	PSU	kg/m^3	Raw	Corrected	Raw	Corrected	Raw	Corrected	NTU	Averaged
Downcast Data - Bin Averaged at 1 meter Intervals											
1	30.492	35.051	21.595	3.15	6.27	51.09	101.7	9.65	8.14	0.32	25
2	30.428	35.119	21.668	2.97	6.09	48.15	98.7	9.62	8.11	0.70	2
3	30.387	35.140	21.698	2.94	6.06	47.57	98.1	9.61	8.10	0.73	1
4	30.362	35.142	21.708	2.93	6.05	47.40	97.9	9.61	8.10	0.62	1
5	30.252	35.173	21.770	2.94	6.06	47.43	97.8	9.60	8.09	10.54	2
6	30.081	35.254	21.889	2.94	6.06	47.47	97.8	9.61	8.10	1.83	2
7	30.023	35.274	21.924	2.95	6.07	47.47	97.7	9.61	8.10	0.49	1
8	29.996	35.278	21.936	2.95	6.07	47.46	97.7	9.62	8.11	0.39	1
9	29.956	35.295	21.963	2.95	6.07	47.45	97.7	9.62	8.11	0.37	2
10	29.954	35.293	21.962	2.94	6.06	47.36	97.6	9.62	8.11	0.39	1
11	29.945	35.294	21.966	2.94	6.06	47.25	97.4	9.62	8.11	0.39	2
12	29.935	35.294	21.969	2.93	6.05	47.11	97.3	9.63	8.12	0.35	1
13	29.932	35.290	21.967	2.92	6.04	46.98	97.2	9.62	8.11	0.56	2
14	29.905	35.296	21.981	2.91	6.03	46.86	97.0	9.62	8.11	0.39	1
15	29.867	35.309	22.003	2.90	6.02	46.67	96.8	9.62	8.11	0.42	2
16	29.852	35.311	22.010	2.90	6.02	46.53	96.7	9.62	8.11	0.41	1
17	29.839	35.314	22.017	2.89	6.01	46.35	96.5	9.62	8.11	0.40	1
18	29.826	35.313	22.020	2.87	5.99	46.03	96.1	9.62	8.11	0.42	2
19	29.807	35.318	22.030	2.85	5.97	45.82	95.9	9.62	8.11	0.38	1
20	29.796	35.317	22.033	2.85	5.97	45.70	95.8	9.62	8.11	0.44	2
21	29.784	35.320	22.039	2.84	5.96	45.63	95.7	9.61	8.10	0.46	1
22	29.780	35.319	22.040	2.84	5.96	45.55	95.6	9.61	8.10	0.46	2
23	29.771	35.320	22.044	2.84	5.96	45.49	95.6	9.62	8.11	0.46	1
24	29.758	35.323	22.051	2.84	5.96	45.53	95.6	9.62	8.11	0.45	2
25	29.758	35.321	22.049	2.84	5.96	45.51	95.6	9.61	8.10	0.44	1
26	29.753	35.318	22.049	2.83	5.95	45.39	95.4	9.62	8.11	0.43	2
27	29.725	35.326	22.065	2.82	5.94	45.18	95.2	9.62	8.11	0.37	1
28	29.710	35.323	22.067	2.79	5.91	44.80	94.8	9.62	8.11	0.38	2
29	29.668	35.330	22.087	2.77	5.89	44.30	94.3	9.62	8.11	0.34	1
30	29.628	35.331	22.101	2.72	5.84	43.49	93.4	9.61	8.10	0.33	2
31	29.588	35.324	22.110	2.65	5.77	42.46	92.4	9.61	8.10	0.40	1
32	29.556	35.321	22.118	2.59	5.71	41.48	91.4	9.61	8.10	0.41	2
33	29.508	35.324	22.137	2.54	5.66	40.52	90.4	9.60	8.09	0.63	1
34	29.385	35.377	22.218	2.52	5.64	40.19	90.0	9.59	8.08	0.71	2
35	29.321	35.392	22.251	2.53	5.65	40.27	90.0	9.57	8.06	1.45	1
36	29.238	35.426	22.304	2.56	5.68	40.68	90.3	9.57	8.06	2.09	2
37	29.187	35.444	22.334	2.59	5.71	41.16	90.8	9.58	8.07	1.68	1
38	29.156	35.450	22.350	2.61	5.73	41.53	91.1	9.59	8.08	1.36	2
39	29.103	35.467	22.380	2.63	5.75	41.71	91.3	9.60	8.09	1.07	2
40	29.052	35.482	22.408	2.63	5.75	41.78	91.3	9.60	8.09	0.83	1
41	28.998	35.495	22.437	2.65	5.77	41.98	91.5	9.61	8.10	0.66	2
42	28.913	35.509	22.475	2.67	5.79	42.27	91.7	9.61	8.10	0.74	2
43	28.772	35.531	22.539	2.66	5.78	42.12	91.4	9.61	8.10	0.80	2
44	28.670	35.561	22.595	2.67	5.79	42.07	91.3	9.61	8.10	0.82	2
45	28.648	35.553	22.597	2.68	5.80	42.23	91.5	9.61	8.10	0.93	1
46	28.600	35.541	22.604	2.70	5.82	42.64	91.8	9.61	8.10	0.97	2
47	28.387	35.605	22.722	2.76	5.88	43.41	92.5	9.61	8.10	1.02	2
48	28.286	35.628	22.773	2.80	5.92	43.93	92.9	9.62	8.11	1.15	2
49	28.207	35.650	22.816	2.81	5.93	44.02	92.9	9.62	8.11	0.98	1
50	28.169	35.652	22.830	2.79	5.91	43.76	92.6	9.63	8.12	0.83	2
51	28.136	35.654	22.842	2.78	5.90	43.60	92.5	9.62	8.11	1.12	2
52	28.106	35.644	22.844	2.78	5.90	43.57	92.4	9.62	8.11	1.10	2
53	28.001	35.672	22.900	2.79	5.91	43.54	92.3	9.61	8.10	1.29	1
54	27.910	35.689	22.942	2.79	5.91	43.59	92.3	9.62	8.11	1.50	2
55	27.873	35.694	22.958	2.80	5.92	43.64	92.3	9.62	8.11	1.90	2
56	27.851	35.696	22.966	2.80	5.92	43.70	92.3	9.62	8.11	2.42	1
57	27.862	35.633	22.916	2.80	5.92	43.72	92.3	9.61	8.10	2.48	12

Station B1 Vertical Profile Data (Cast 3)											
Pago Pago Harbor Water Quality Monitoring											
19 March 2003 - Non Tradewind											
Depth	Temp	Salinity	Sigma-t	DO (mg/l)		DO (% Sat)		pH (SU)		Turbidity	No. Scans
(m)	°C	PSU	kg/m^3	Raw	Corrected	Raw	Corrected	Raw	Corrected	NTU	Averaged
Upcast Data - Bin Averaged at 1 meter Intervals											
56	27.862	35.702	22.968	2.81	5.93	43.84	92.5	9.61	8.10	2.34	4
55	27.861	35.695	22.963	2.81	5.93	43.88	92.5	9.61	8.10	2.19	6
54	27.875	35.689	22.954	2.82	5.94	43.98	92.6	9.61	8.10	1.92	3
53	27.940	35.673	22.920	2.83	5.95	44.13	92.8	9.60	8.09	1.40	6
52	28.016	35.656	22.883	2.83	5.95	44.30	93.1	9.60	8.09	1.19	4
51	28.088	35.648	22.853	2.85	5.97	44.65	93.5	9.61	8.10	1.05	5
50	28.144	35.639	22.828	2.89	6.01	45.31	94.2	9.61	8.10	0.81	4
49	28.208	35.629	22.800	2.92	6.04	45.71	94.6	9.62	8.11	0.98	6
48	28.285	35.603	22.755	2.90	6.02	45.54	94.5	9.61	8.10	1.23	4
47	28.336	35.594	22.731	2.88	6.00	45.20	94.2	9.60	8.09	1.09	4
46	28.496	35.554	22.648	2.83	5.95	44.58	93.7	9.59	8.08	1.02	6
45	28.613	35.525	22.587	2.80	5.92	44.10	93.3	9.59	8.08	0.99	3
44	28.637	35.537	22.588	2.79	5.91	44.03	93.3	9.59	8.08	0.84	7
43	28.729	35.504	22.533	2.80	5.92	44.24	93.5	9.59	8.08	0.81	2
42	28.868	35.474	22.464	2.79	5.91	44.11	93.5	9.59	8.08	0.74	6
41	28.983	35.454	22.411	2.76	5.88	43.81	93.3	9.58	8.07	0.87	6
40	29.043	35.459	22.394	2.75	5.87	43.72	93.2	9.58	8.07	0.69	5
39	29.062	35.454	22.384	2.75	5.87	43.66	93.2	9.58	8.07	0.71	5
38	29.093	35.446	22.368	2.73	5.85	43.37	92.9	9.58	8.07	0.95	6
37	29.147	35.423	22.333	2.68	5.80	42.61	92.2	9.57	8.06	1.16	3
36	29.175	35.423	22.323	2.62	5.74	41.64	91.3	9.56	8.05	1.51	6
35	29.239	35.397	22.282	2.53	5.65	40.27	89.9	9.56	8.05	2.60	35
34	29.301	35.384	22.251	2.45	5.57	38.98	88.7	9.54	8.03	1.46	34
33	29.413	35.329	22.172	2.49	5.61	39.67	89.5	9.54	8.03	0.70	33
32	29.498	35.305	22.126	2.54	5.66	40.63	90.5	9.55	8.04	0.55	32
31	29.526	35.321	22.128	2.64	5.76	42.12	92.0	9.57	8.06	0.36	6
30	29.581	35.312	22.103	2.67	5.79	42.78	92.7	9.56	8.05	0.34	5
29	29.611	35.319	22.098	2.72	5.84	43.55	93.5	9.57	8.06	0.33	5
28	29.653	35.314	22.080	2.78	5.90	44.46	94.4	9.58	8.07	0.34	4
27	29.687	35.312	22.067	2.80	5.92	44.82	94.8	9.58	8.07	0.45	2
26	29.725	35.308	22.051	2.82	5.94	45.15	95.2	9.58	8.07	0.45	8
25	29.748	35.299	22.036	2.81	5.93	45.11	95.2	9.58	8.07	0.45	3
24	29.756	35.303	22.036	2.81	5.93	45.10	95.1	9.58	8.07	0.48	5
23	29.769	35.302	22.031	2.81	5.93	45.07	95.1	9.58	8.07	0.48	4
22	29.772	35.305	22.033	2.81	5.93	45.02	95.1	9.58	8.07	0.47	5
21	29.778	35.304	22.030	2.80	5.92	44.86	94.9	9.57	8.06	0.55	7
20	29.782	35.302	22.027	2.80	5.92	44.92	95.0	9.57	8.06	0.47	5
19	29.792	35.303	22.024	2.80	5.92	44.98	95.1	9.58	8.07	0.45	5
18	29.796	35.305	22.025	2.82	5.94	45.22	95.3	9.58	8.07	0.41	4
17	29.810	35.306	22.021	2.84	5.96	45.57	95.7	9.58	8.07	0.40	6
16	29.824	35.305	22.015	2.86	5.98	45.85	96.0	9.58	8.07	0.42	4
15	29.841	35.299	22.005	2.87	5.99	46.10	96.2	9.58	8.07	0.44	4
14	29.872	35.289	21.986	2.88	6.00	46.27	96.4	9.58	8.07	0.39	3
13	29.894	35.286	21.977	2.90	6.02	46.57	96.7	9.58	8.07	0.36	7
12	29.918	35.281	21.965	2.91	6.03	46.81	97.0	9.59	8.08	0.36	5
11	29.933	35.279	21.959	2.92	6.04	46.98	97.2	9.59	8.08	0.63	4
10	29.942	35.279	21.955	2.93	6.05	47.11	97.3	9.59	8.08	0.36	4
9	29.945	35.281	21.956	2.93	6.05	47.18	97.4	9.59	8.08	0.39	5
8	29.953	35.277	21.951	2.94	6.06	47.25	97.4	9.59	8.08	0.38	5
7	29.989	35.262	21.927	2.93	6.05	47.24	97.5	9.58	8.07	0.37	4
6	30.000	35.267	21.926	2.95	6.07	47.42	97.7	9.58	8.07	0.40	6
5	30.035	35.255	21.906	2.96	6.08	47.62	97.9	9.58	8.07	0.52	3
4	30.194	35.200	21.810	2.94	6.06	47.44	97.8	9.57	8.06	0.56	5
3	30.343	35.138	21.712	2.93	6.05	47.42	97.9	9.56	8.05	0.61	6
2	30.387	35.118	21.682	2.93	6.05	47.48	98.0	9.56	8.05	0.73	5
1	30.463	35.075	21.623	2.92	6.04	47.32	97.9	9.55	8.04	0.79	5
Summary (Includes Downcast and Upcast)											
Min	27.851	35.051	21.595	2.45	5.57	38.98	88.69	9.54	8.03	0.320	Min
Max	30.492	35.702	22.968	3.15	6.27	51.09	101.66	9.65	8.14	10.540	Max
Average	29.333	35.393	22.245	2.80	5.92	44.67	94.40	9.60	8.09	0.884	Average
Std. Dev.	0.747	0.159	0.369	0.13	0.13	2.23	2.55	0.02	0.02	1.059	Std. Dev.

Station 14 Vertical Profile Data (Cast 4)											
Pago Pago Harbor Water Quality Monitoring											
19 March 2003 - Non Tradewind											
Depth	Temp	Salinity	Sigma-t	DO (mg/l)		DO (% Sat)		pH (SU)		Turbidity	No. Scans
(m)	°C	PSU	kg/m^3	Raw	Corrected	Raw	Corrected	Raw	Corrected	NTU	Averaged
Downcast Data - Bin Averaged at 1 meter Intervals											
1	30.441	34.947	21.535	3.06	6.18	49.48	100.0	9.62	8.11	0.52	3
2	30.406	35.000	21.587	3.01	6.13	48.66	99.1	9.62	8.11	1.01	2
3	30.326	35.062	21.661	2.97	6.09	48.05	98.5	9.62	8.11	0.69	2
4	30.235	35.126	21.740	2.95	6.07	47.64	98.0	9.62	8.11	0.64	2
5	30.125	35.202	21.835	2.94	6.06	47.42	97.7	9.61	8.10	0.58	1
6	30.070	35.237	21.880	2.94	6.06	47.38	97.7	9.60	8.09	0.54	2
7	30.037	35.258	21.907	2.94	6.06	47.37	97.6	9.61	8.10	0.52	2
8	30.016	35.269	21.923	2.94	6.06	47.37	97.6	9.61	8.10	0.43	1
9	29.995	35.278	21.937	2.93	6.05	47.22	97.5	9.61	8.10	0.44	2
10	29.988	35.278	21.939	2.91	6.03	46.86	97.1	9.61	8.10	0.45	2
11	29.980	35.277	21.941	2.88	6.00	46.39	96.6	9.61	8.10	0.45	1
12	29.971	35.274	21.941	2.83	5.95	45.55	95.8	9.61	8.10	0.56	2
13	29.953	35.263	21.940	2.75	5.87	44.30	94.5	9.61	8.10	0.54	2
14	29.874	35.276	21.976	2.68	5.80	43.10	93.2	9.60	8.09	0.58	2
15	29.820	35.284	22.001	2.63	5.75	42.18	92.3	9.58	8.07	0.86	2
16	29.787	35.289	22.016	2.59	5.71	41.49	91.6	9.58	8.07	1.27	2
17	29.773	35.291	22.022	2.55	5.67	40.97	91.0	9.57	8.06	1.61	2
18	29.768	35.290	22.023	2.52	5.64	40.48	90.5	9.57	8.06	1.24	2
19	29.764	35.289	22.023	2.49	5.61	39.95	90.0	9.57	8.06	1.25	2
20	29.756	35.287	22.024	2.46	5.58	39.48	89.5	9.57	8.06	1.35	2
21	29.744	35.289	22.030	2.47	5.59	39.61	89.6	9.57	8.06	1.40	2
22	29.741	35.298	22.038	2.51	5.63	40.30	90.3	9.57	8.06	1.53	2
23	29.742	35.306	22.044	2.56	5.68	41.04	91.1	9.57	8.06	1.27	2
24	29.733	35.312	22.051	2.58	5.70	41.31	91.3	9.59	8.08	0.85	2
25	29.710	35.310	22.057	2.55	5.67	40.84	90.9	9.59	8.08	0.76	2
26	29.657	35.323	22.085	2.51	5.63	40.25	90.2	9.59	8.08	0.62	2
27	29.636	35.324	22.093	2.47	5.59	39.50	89.5	9.57	8.06	0.99	2
28	29.625	35.323	22.096	2.42	5.54	38.71	88.7	9.57	8.06	1.01	2
29	29.597	35.324	22.106	2.36	5.48	37.80	87.7	9.57	8.06	1.11	3
30	29.541	35.336	22.134	2.31	5.43	36.89	86.8	9.56	8.05	1.28	2
31	29.514	35.340	22.146	2.27	5.39	36.25	86.1	9.55	8.04	1.40	2
32	29.501	35.339	22.150	2.24	5.36	35.78	85.6	9.55	8.04	1.54	2
33	29.473	35.343	22.163	2.22	5.34	35.39	85.2	9.54	8.03	1.53	2
34	29.436	35.351	22.181	2.18	5.30	34.81	84.6	9.54	8.03	1.56	2
35	29.373	35.366	22.214	2.16	5.28	34.40	84.2	9.54	8.03	1.85	3
36	29.293	35.379	22.251	2.15	5.27	34.33	84.0	9.54	8.03	2.23	2
37	29.122	35.429	22.345	2.15	5.27	34.19	83.8	9.55	8.04	2.52	2
38	29.013	35.448	22.396	2.16	5.28	34.24	83.7	9.54	8.03	3.14	2
39	28.915	35.445	22.427	2.20	5.32	34.92	84.3	9.54	8.03	4.72	3
40	28.834	35.449	22.457	2.24	5.36	35.49	84.8	9.53	8.02	5.35	2
41	28.824	35.477	22.481	2.26	5.38	35.73	85.1	9.54	8.03	5.55	2
42	28.824	35.496	22.495	2.26	5.38	35.80	85.2	9.55	8.04	5.37	2
43	28.801	35.488	22.497	2.27	5.39	35.90	85.2	9.56	8.05	4.40	2
44	28.711	35.494	22.532	2.28	5.40	36.04	85.3	9.55	8.04	5.92	2
45	28.644	35.495	22.555	2.30	5.42	36.32	85.5	9.55	8.04	6.26	2
46	28.587	35.485	22.566	2.33	5.45	36.79	86.0	9.55	8.04	6.41	3
47	28.479	35.524	22.631	2.37	5.49	37.36	86.4	9.54	8.03	7.09	2
48	28.467	35.544	22.650	2.40	5.52	37.68	86.8	9.55	8.04	9.19	2
49	28.430	35.567	22.679	2.42	5.54	38.03	87.1	9.56	8.05	8.05	4

Station 14 Vertical Profile Data (Cast 4)											
Pago Pago Harbor Water Quality Monitoring											
19 March 2003 - Non Tradewind											
Depth	Temp	Salinity	Sigma-t	DO (mg/l)		DO (% Sat)		pH (SU)		Turbidity	No. Scans
(m)	°C	PSU	kg/m^3	Raw	Corrected	Raw	Corrected	Raw	Corrected	NTU	Averaged
Upcast Data - Bin Averaged at 1 meter Intervals											
48	28.480	35.541	22.644	2.42	5.54	38.15	87.2	9.56	8.05	8.69	4
47	28.483	35.532	22.636	2.43	5.55	38.28	87.4	9.56	8.05	9.16	4
46	28.520	35.498	22.598	2.42	5.54	38.11	87.2	9.55	8.04	6.88	3
45	28.601	35.481	22.558	2.40	5.52	37.76	86.9	9.54	8.03	6.22	4
44	28.685	35.482	22.532	2.36	5.48	37.24	86.5	9.55	8.04	6.47	4
43	28.774	35.479	22.499	2.32	5.44	36.66	86.0	9.54	8.03	5.79	3
42	28.800	35.484	22.494	2.30	5.42	36.41	85.7	9.54	8.03	5.60	4
41	28.824	35.473	22.478	2.28	5.40	36.10	85.4	9.54	8.03	5.76	16
40	28.796	35.443	22.465	2.31	5.43	36.53	85.9	9.53	8.02	6.72	3
39	28.844	35.419	22.431	2.29	5.41	36.16	85.5	9.52	8.01	4.97	4
38	28.917	35.421	22.408	2.24	5.36	35.50	84.9	9.52	8.01	4.42	3
37	29.005	35.422	22.379	2.21	5.33	35.04	84.5	9.52	8.01	3.42	4
36	29.092	35.413	22.343	2.21	5.33	35.07	84.6	9.52	8.01	2.86	5
35	29.229	35.366	22.263	2.19	5.31	34.87	84.5	9.52	8.01	2.25	3
34	29.328	35.347	22.215	2.18	5.30	34.69	84.4	9.52	8.01	1.80	3
33	29.378	35.341	22.193	2.18	5.30	34.72	84.5	9.52	8.01	1.69	7
32	29.437	35.321	22.158	2.18	5.30	34.78	84.6	9.52	8.01	1.61	3
31	29.451	35.328	22.159	2.18	5.30	34.85	84.7	9.52	8.01	1.52	5
30	29.486	35.319	22.140	2.20	5.32	35.12	85.0	9.52	8.01	1.49	4
29	29.515	35.318	22.130	2.21	5.33	35.35	85.2	9.52	8.01	1.51	4
28	29.534	35.317	22.123	2.24	5.36	35.77	85.6	9.52	8.01	1.31	5
27	29.552	35.318	22.117	2.29	5.41	36.61	86.5	9.53	8.02	1.01	4
26	29.610	35.309	22.091	2.38	5.50	38.06	88.0	9.54	8.03	0.62	5
25	29.660	35.306	22.072	2.49	5.61	39.84	89.8	9.56	8.05	0.76	4
24	29.698	35.295	22.050	2.53	5.65	40.48	90.5	9.56	8.05	0.82	4
23	29.714	35.289	22.040	2.52	5.64	40.44	90.4	9.55	8.04	1.01	2
22	29.719	35.288	22.038	2.50	5.62	40.09	90.1	9.55	8.04	1.15	5
21	29.731	35.278	22.027	2.46	5.58	39.45	89.5	9.54	8.03	1.35	3
20	29.751	35.267	22.012	2.45	5.57	39.23	89.3	9.54	8.03	1.22	4
19	29.765	35.266	22.006	2.45	5.57	39.36	89.4	9.54	8.03	1.39	19
18	29.773	35.266	22.003	2.47	5.59	39.57	89.6	9.54	8.03	1.18	18
17	29.794	35.261	21.992	2.49	5.61	40.02	90.1	9.54	8.03	1.00	17
16	29.817	35.262	21.985	2.52	5.64	40.45	90.5	9.54	8.03	0.97	16
15	29.857	35.255	21.966	2.59	5.71	41.65	91.8	9.55	8.04	0.63	6
14	29.927	35.244	21.934	2.69	5.81	43.22	93.4	9.56	8.05	0.53	2
13	29.955	35.249	21.928	2.74	5.86	44.16	94.3	9.57	8.06	0.54	4
12	29.969	35.252	21.925	2.79	5.91	44.88	95.1	9.57	8.06	0.55	4
11	29.973	35.251	21.924	2.81	5.93	45.17	95.4	9.57	8.06	0.54	4
10	29.976	35.253	21.924	2.83	5.95	45.50	95.7	9.57	8.06	0.57	4
9	29.984	35.252	21.921	2.85	5.97	45.92	96.1	9.57	8.06	0.49	5
8	29.995	35.251	21.916	2.88	6.00	46.38	96.6	9.58	8.07	0.44	4
7	30.012	35.247	21.908	2.90	6.02	46.73	97.0	9.58	8.07	0.48	4
6	30.040	35.235	21.889	2.91	6.03	46.85	97.1	9.58	8.07	0.55	17
5	30.068	35.215	21.864	2.92	6.04	47.02	97.3	9.57	8.06	0.53	4
4	30.120	35.182	21.822	2.95	6.07	47.50	97.8	9.57	8.06	0.61	4
3	30.246	35.091	21.710	2.99	6.11	48.32	98.7	9.58	8.07	0.75	3
2	30.374	34.989	21.589	3.04	6.16	49.20	99.7	9.59	8.08	0.80	5
1	30.415	34.941	21.540	3.07	6.19	49.62	100.1	9.58	8.07	0.52	8
Summary (Includes Downcast and Upcast)											
Min	28.430	34.941	21.535	2.15	5.27	34.19	83.73	9.52	8.01	0.430	Min
Max	30.441	35.567	22.679	3.07	6.19	49.62	100.09	9.62	8.11	9.190	Max
Average	29.523	35.321	22.128	2.51	5.63	40.21	90.07	9.56	8.05	2.284	Average
Std. Dev.	0.538	0.125	0.272	0.28	0.28	4.68	4.99	0.03	0.03	2.360	Std. Dev.

Station 8 Vertical Profile Data (Cast 5)											
Pago Pago Harbor Water Quality Monitoring											
19 March 2003 - Non Tradewind											
Depth	Temp	Salinity	Sigma-t	DO (mg/l)		DO (% Sat)		pH (SU)		Turbidity	No. Scans
(m)	°C	PSU	kg/m^3	Raw	Corrected	Raw	Corrected	Raw	Corrected	NTU	Averaged
Downcast Data - Bin Averaged at 1 meter Intervals											
1	30.484	34.998	21.559	3.00	6.12	48.61	99.2	9.61	8.10	0.46	4
2	30.405	35.040	21.617	2.99	6.11	48.33	98.8	9.61	8.10	0.88	2
3	30.228	35.162	21.770	2.97	6.09	48.01	98.4	9.61	8.10	0.71	2
4	30.145	35.211	21.834	2.96	6.08	47.78	98.1	9.60	8.09	0.56	1
5	30.125	35.217	21.846	2.95	6.07	47.60	97.9	9.61	8.10	0.49	2
6	30.101	35.228	21.862	2.95	6.07	47.54	97.8	9.61	8.10	0.48	2
7	30.083	35.237	21.875	2.95	6.07	47.51	97.8	9.61	8.10	0.76	2
8	30.059	35.252	21.895	2.94	6.06	47.43	97.7	9.61	8.10	0.61	1
9	30.025	35.270	21.920	2.93	6.05	47.21	97.5	9.61	8.10	0.49	2
10	30.004	35.278	21.933	2.91	6.03	46.91	97.1	9.62	8.11	0.49	1
11	29.988	35.274	21.936	2.88	6.00	46.41	96.6	9.61	8.10	0.44	2
12	29.951	35.279	21.952	2.85	5.97	45.87	96.1	9.61	8.10	0.43	1
13	29.915	35.285	21.969	2.81	5.93	45.16	95.3	9.61	8.10	0.50	2
14	29.893	35.282	21.974	2.76	5.88	44.31	94.5	9.60	8.09	0.58	1
15	29.867	35.287	21.987	2.73	5.85	43.89	94.0	9.60	8.09	0.61	2
16	29.848	35.288	21.994	2.70	5.82	43.43	93.6	9.59	8.08	0.77	1
17	29.836	35.286	21.997	2.69	5.81	43.12	93.2	9.59	8.08	0.79	2
18	29.810	35.290	22.008	2.67	5.79	42.90	93.0	9.59	8.08	0.78	2
19	29.780	35.299	22.026	2.66	5.78	42.71	92.8	9.59	8.08	0.90	1
20	29.770	35.299	22.029	2.62	5.74	42.10	92.2	9.59	8.08	1.05	2
21	29.758	35.290	22.026	2.58	5.70	41.34	91.4	9.59	8.08	0.98	1
22	29.710	35.299	22.049	2.55	5.67	40.90	90.9	9.59	8.08	0.92	2
23	29.710	35.299	22.049	2.54	5.66	40.67	90.7	9.58	8.07	1.41	1
24	29.709	35.304	22.054	2.53	5.65	40.50	90.5	9.58	8.07	1.60	2
25	29.710	35.303	22.052	2.50	5.62	40.07	90.1	9.58	8.07	1.22	2
26	29.690	35.298	22.055	2.45	5.57	39.21	89.2	9.58	8.07	1.11	2
27	29.625	35.313	22.089	2.39	5.51	38.30	88.2	9.58	8.07	0.95	1
28	29.560	35.325	22.120	2.34	5.46	37.45	87.3	9.57	8.06	1.02	2
29	29.507	35.341	22.150	2.31	5.43	36.90	86.8	9.55	8.04	1.11	1
30	29.481	35.347	22.163	2.29	5.41	36.65	86.5	9.55	8.04	1.32	2
31	29.451	35.349	22.174	2.32	5.44	37.11	86.9	9.55	8.04	1.24	3
32	29.348	35.383	22.235	2.38	5.50	37.96	87.7	9.55	8.04	1.12	1
33	29.261	35.422	22.293	2.42	5.54	38.53	88.2	9.56	8.05	0.90	2
34	29.252	35.422	22.296	2.45	5.57	38.97	88.6	9.57	8.06	0.92	2
35	29.240	35.423	22.301	2.47	5.59	39.36	89.0	9.57	8.06	0.91	1
36	29.221	35.430	22.313	2.49	5.61	39.69	89.3	9.58	8.07	0.93	2
37	29.207	35.430	22.318	2.53	5.65	40.31	90.0	9.58	8.07	0.88	2
38	29.177	35.438	22.334	2.59	5.71	41.15	90.8	9.58	8.07	0.84	1
39	29.134	35.456	22.362	2.64	5.76	42.00	91.6	9.58	8.07	0.93	2
40	29.102	35.466	22.380	2.68	5.80	42.65	92.2	9.59	8.08	0.76	1
41	29.062	35.482	22.405	2.71	5.83	43.01	92.6	9.60	8.09	0.51	2
42	29.053	35.480	22.407	2.73	5.85	43.27	92.8	9.61	8.10	0.45	2
43	29.046	35.467	22.400	2.73	5.85	43.40	92.9	9.61	8.10	0.40	1
44	28.949	35.500	22.457	2.73	5.85	43.25	92.7	9.61	8.10	0.41	2
45	28.890	35.514	22.487	2.70	5.82	42.74	92.2	9.61	8.10	0.52	1
46	28.873	35.513	22.492	2.63	5.75	41.66	91.1	9.60	8.09	0.79	2
47	28.867	35.510	22.492	2.57	5.69	40.75	90.1	9.60	8.09	1.15	2
48	28.865	35.495	22.481	2.56	5.68	40.56	90.0	9.59	8.08	1.37	1
49	28.821	35.444	22.457	2.57	5.69	40.58	89.9	9.59	8.08	1.53	2
50	28.332	35.606	22.741	2.59	5.71	40.64	89.6	9.58	8.07	1.93	2
51	28.160	35.643	22.826	2.60	5.72	40.78	89.6	9.58	8.07	4.76	2
52	28.100	35.654	22.854	2.62	5.74	40.98	89.8	9.58	8.07	5.74	1
53	28.072	35.655	22.864	2.64	5.76	41.22	90.0	9.58	8.07	5.45	2
54	28.027	35.668	22.888	2.65	5.77	41.41	90.2	9.58	8.07	5.18	1
55	27.999	35.674	22.902	2.66	5.78	41.54	90.3	9.59	8.08	6.19	2
56	27.996	35.666	22.897	2.67	5.79	41.65	90.4	9.59	8.08	7.53	2
57	28.006	35.569	22.821	2.67	5.79	41.71	90.4	9.59	8.08	7.99	7

Station 8 Vertical Profile Data (Cast 5)											
Pago Pago Harbor Water Quality Monitoring											
19 March 2003 - Non Tradewind											
Depth	Temp	Salinity	Sigma-t	DO (mg/l)		DO (% Sat)		pH (SU)		Turbidity	No. Scans
(m)	°C	PSU	kg/m^3	Raw	Corrected	Raw	Corrected	Raw	Corrected	NTU	Averaged
Upcast Data - Bin Averaged at 1 meter Intervals											
56	28.009	35.666	22.893	2.68	5.80	41.89	90.6	9.59	8.08	7.94	3
55	28.001	35.672	22.899	2.68	5.80	41.92	90.7	9.59	8.08	7.72	4
54	27.997	35.667	22.897	2.69	5.81	42.07	90.8	9.59	8.08	7.27	5
53	28.015	35.664	22.889	2.69	5.81	42.08	90.8	9.59	8.08	5.42	5
52	28.080	35.641	22.850	2.68	5.80	41.89	90.7	9.58	8.07	5.61	3
51	28.107	35.636	22.838	2.67	5.79	41.72	90.5	9.58	8.07	5.76	8
50	28.149	35.625	22.816	2.69	5.81	42.15	91.0	9.57	8.06	5.27	4
49	28.451	35.529	22.644	2.65	5.77	41.69	90.8	9.57	8.06	2.55	5
48	28.758	35.454	22.485	2.64	5.76	41.76	91.1	9.57	8.06	1.47	3
47	28.827	35.482	22.484	2.67	5.79	42.18	91.5	9.58	8.07	1.51	2
46	28.841	35.504	22.496	2.69	5.81	42.61	92.0	9.58	8.07	0.89	8
45	28.870	35.491	22.477	2.73	5.85	43.24	92.6	9.58	8.07	0.60	4
44	28.922	35.490	22.458	2.79	5.91	44.25	93.7	9.59	8.08	0.58	7
43	28.978	35.472	22.426	2.81	5.93	44.59	94.1	9.59	8.08	0.43	3
42	29.020	35.470	22.410	2.83	5.95	44.88	94.4	9.59	8.08	0.44	5
41	29.055	35.461	22.392	2.83	5.95	44.87	94.4	9.59	8.08	0.53	6
40	29.093	35.451	22.372	2.78	5.90	44.23	93.8	9.58	8.07	0.83	5
39	29.123	35.441	22.354	2.72	5.84	43.16	92.7	9.57	8.06	1.03	6
38	29.161	35.424	22.329	2.63	5.75	41.87	91.5	9.56	8.05	0.92	3
37	29.180	35.424	22.322	2.60	5.72	41.34	91.0	9.55	8.04	0.95	5
36	29.204	35.418	22.309	2.56	5.68	40.74	90.4	9.55	8.04	0.93	6
35	29.225	35.411	22.297	2.54	5.66	40.45	90.1	9.55	8.04	0.86	35
34	29.247	35.408	22.288	2.53	5.65	40.33	90.0	9.55	8.04	0.90	34
33	29.270	35.400	22.274	2.49	5.61	39.71	89.4	9.54	8.03	0.96	33
32	29.332	35.374	22.233	2.43	5.55	38.70	88.4	9.54	8.03	1.10	32
31	29.391	35.355	22.199	2.33	5.45	37.23	87.0	9.52	8.01	1.20	5
30	29.463	35.323	22.151	2.29	5.41	36.61	86.4	9.52	8.01	1.24	2
29	29.468	35.337	22.160	2.27	5.39	36.25	86.1	9.51	8.00	1.42	7
28	29.518	35.316	22.127	2.29	5.41	36.59	86.5	9.52	8.01	1.25	2
27	29.568	35.313	22.108	2.34	5.46	37.40	87.3	9.53	8.02	1.03	6
26	29.621	35.309	22.087	2.41	5.53	38.62	88.6	9.54	8.03	1.24	3
25	29.683	35.294	22.055	2.45	5.57	39.18	89.2	9.54	8.03	1.12	3
24	29.697	35.294	22.050	2.46	5.58	39.50	89.5	9.54	8.03	1.20	5
23	29.703	35.292	22.046	2.46	5.58	39.42	89.4	9.54	8.03	1.66	3
22	29.699	35.287	22.044	2.44	5.56	39.08	89.1	9.54	8.03	1.47	3
21	29.722	35.280	22.031	2.46	5.58	39.39	89.4	9.54	8.03	1.30	4
20	29.738	35.284	22.029	2.49	5.61	39.94	90.0	9.55	8.04	1.23	4
19	29.765	35.278	22.015	2.53	5.65	40.53	90.6	9.55	8.04	0.99	4
18	29.793	35.278	22.005	2.56	5.68	41.10	91.2	9.55	8.04	0.87	4
17	29.815	35.278	21.998	2.59	5.71	41.62	91.7	9.55	8.04	0.75	5
16	29.833	35.277	21.991	2.62	5.74	42.10	92.2	9.55	8.04	0.79	4
15	29.844	35.276	21.986	2.64	5.76	42.41	92.5	9.55	8.04	0.81	3
14	29.862	35.272	21.977	2.67	5.79	42.88	93.0	9.55	8.04	0.68	3
13	29.880	35.275	21.973	2.71	5.83	43.48	93.6	9.56	8.05	0.68	6
12	29.904	35.268	21.960	2.74	5.86	44.05	94.2	9.56	8.05	0.60	3
11	29.922	35.270	21.956	2.78	5.90	44.76	94.9	9.57	8.06	0.52	4
10	29.948	35.269	21.946	2.83	5.95	45.57	95.8	9.57	8.06	0.41	3
9	29.978	35.268	21.935	2.89	6.01	46.46	96.7	9.58	8.07	0.45	4
8	30.025	35.254	21.908	2.91	6.03	46.89	97.1	9.58	8.07	0.46	3
7	30.049	35.246	21.894	2.92	6.04	47.08	97.4	9.57	8.06	0.54	5
6	30.068	35.230	21.876	2.93	6.05	47.15	97.4	9.57	8.06	0.50	3
5	30.090	35.218	21.859	2.94	6.06	47.36	97.6	9.57	8.06	0.51	4
4	30.133	35.198	21.829	2.96	6.08	47.75	98.1	9.57	8.06	0.58	4
3	30.216	35.151	21.765	3.01	6.13	48.52	98.9	9.57	8.06	0.71	3
2	30.367	35.044	21.633	3.06	6.18	49.49	100.0	9.58	8.07	0.80	4
1	30.445	35.018	21.587	3.03	6.15	49.03	99.5	9.57	8.06	0.75	7
Summary (Includes Downcast and Upcast)											
Min	27.996	34.998	21.559	2.27	5.39	36.25	86.08	9.51	8.00	0.400	Min
Max	30.484	35.674	22.902	3.06	6.18	49.49	99.96	9.62	8.11	7.990	Max
Average	29.366	35.375	22.221	2.66	5.78	42.37	92.12	9.57	8.06	1.557	Average
Std. Dev.	0.663	0.150	0.334	0.19	0.19	3.21	3.43	0.02	0.02	1.858	Std. Dev.

Station 8A Vertical Profile Data (Cast 6)											
Pago Pago Harbor Water Quality Monitoring											
19 March 2003 - Non Tradewind											
Depth	Temp	Salinity	Sigma-t	DO (mg/l)		DO (% Sat)		pH (SU)		Turbidity	No. Scans
(m)	°C	PSU	kg/m^3	Raw	Corrected	Raw	Corrected	Raw	Corrected	NTU	Averaged
Downcast Data - Bin Averaged at 1 meter Intervals											
1	30.386	35.037	21.622	3.00	6.12	48.57	99.0	9.61	8.10	0.60	3
2	30.208	35.160	21.775	2.98	6.10	48.03	98.4	9.61	8.10	1.76	3
3	30.114	35.220	21.852	2.97	6.09	47.89	98.2	9.60	8.09	0.54	1
4	30.066	35.252	21.893	2.97	6.09	47.87	98.2	9.60	8.09	0.57	2
5	30.049	35.264	21.907	2.97	6.09	47.87	98.1	9.61	8.10	0.49	1
6	30.046	35.264	21.908	2.96	6.08	47.77	98.0	9.61	8.10	0.47	2
7	30.038	35.266	21.912	2.96	6.08	47.72	98.0	9.61	8.10	0.52	3
8	30.016	35.276	21.928	2.96	6.08	47.71	98.0	9.61	8.10	0.51	1
9	29.996	35.282	21.939	2.96	6.08	47.61	97.8	9.61	8.10	0.46	2
10	29.993	35.278	21.937	2.95	6.07	47.52	97.7	9.61	8.10	0.51	2
11	29.986	35.278	21.939	2.94	6.06	47.33	97.6	9.61	8.10	0.45	3
12	29.982	35.279	21.941	2.92	6.04	46.96	97.2	9.61	8.10	0.52	1
13	29.983	35.277	21.940	2.89	6.01	46.56	96.8	9.61	8.10	0.47	2
14	29.982	35.268	21.933	2.82	5.94	45.46	95.7	9.61	8.10	0.55	2
15	29.922	35.271	21.956	2.76	5.88	44.42	94.6	9.61	8.10	0.54	2
16	29.864	35.283	21.985	2.72	5.84	43.72	93.8	9.59	8.08	0.60	2
17	29.829	35.289	22.001	2.68	5.80	42.99	93.1	9.58	8.07	0.74	2
18	29.808	35.290	22.009	2.62	5.74	42.11	92.2	9.58	8.07	0.83	2
19	29.793	35.290	22.015	2.57	5.69	41.32	91.4	9.58	8.07	0.84	1
20	29.771	35.289	22.021	2.52	5.64	40.38	90.4	9.58	8.07	0.94	2
21	29.756	35.287	22.024	2.50	5.62	40.05	90.1	9.57	8.06	1.02	2
22	29.737	35.296	22.038	2.51	5.63	40.27	90.3	9.56	8.05	1.26	2
23	29.735	35.301	22.042	2.54	5.66	40.78	90.8	9.56	8.05	1.38	1
24	29.742	35.305	22.042	2.60	5.72	41.73	91.8	9.57	8.06	1.19	2
25	29.752	35.308	22.042	2.65	5.77	42.47	92.5	9.58	8.07	1.03	2
26	29.749	35.313	22.046	2.65	5.77	42.56	92.6	9.59	8.08	0.73	2
27	29.746	35.309	22.044	2.62	5.74	42.02	92.1	9.59	8.08	0.47	1
28	29.714	35.312	22.058	2.55	5.67	40.89	90.9	9.60	8.09	0.47	2
29	29.678	35.311	22.069	2.45	5.57	39.32	89.3	9.58	8.07	0.53	2
30	29.625	35.308	22.085	2.36	5.48	37.70	87.6	9.57	8.06	0.75	2
31	29.516	35.327	22.136	2.28	5.40	36.42	86.3	9.55	8.04	1.01	2
32	29.407	35.352	22.192	2.23	5.35	35.59	85.4	9.54	8.03	1.46	1
33	29.317	35.370	22.236	2.20	5.32	35.02	84.7	9.53	8.02	1.81	2
34	29.242	35.398	22.282	2.18	5.30	34.66	84.3	9.54	8.03	2.12	2
35	29.195	35.407	22.305	2.16	5.28	34.31	83.9	9.54	8.03	2.39	2
36	29.148	35.420	22.330	2.15	5.27	34.19	83.8	9.53	8.02	3.08	1
37	29.117	35.419	22.340	2.15	5.27	34.13	83.7	9.53	8.02	4.03	2
38	29.031	35.448	22.390	2.14	5.26	34.00	83.5	9.53	8.02	4.58	2
39	28.985	35.454	22.410	2.15	5.27	34.13	83.6	9.54	8.03	5.17	2
40	28.927	35.462	22.436	2.17	5.29	34.30	83.7	9.53	8.02	5.73	2
41	28.858	35.482	22.474	2.18	5.30	34.56	83.9	9.53	8.02	5.67	1
42	28.807	35.495	22.500	2.22	5.34	35.06	84.4	9.54	8.03	5.91	2
43	28.754	35.510	22.529	2.25	5.37	35.52	84.8	9.54	8.03	6.28	2
44	28.678	35.536	22.574	2.27	5.39	35.84	85.1	9.55	8.04	6.60	2
45	28.646	35.541	22.588	2.29	5.41	36.06	85.3	9.55	8.04	7.58	1
46	28.625	35.543	22.597	2.30	5.42	36.27	85.5	9.55	8.04	7.84	2
47	28.590	35.542	22.608	2.32	5.44	36.51	85.7	9.55	8.04	7.80	3
48	28.487	35.571	22.664	2.34	5.46	36.80	85.9	9.55	8.04	7.56	2
49	28.435	35.577	22.685	2.36	5.48	37.15	86.2	9.55	8.04	8.91	2
50	28.354	35.594	22.725	2.39	5.51	37.52	86.5	9.56	8.05	9.76	2
51	28.274	35.621	22.771	2.42	5.54	37.92	86.9	9.56	8.05	10.72	2
52	28.258	35.630	22.784	2.44	5.56	38.29	87.2	9.56	8.05	13.17	4

Station 8A Vertical Profile Data (Cast 6)											
Pago Pago Harbor Water Quality Monitoring											
19 March 2003 - Non Tradewind											
Depth	Temp	Salinity	Sigma-t	DO (mg/l)		DO (% Sat)		pH (SU)		Turbidity	No. Scans
(m)	°C	PSU	kg/m^3	Raw	Corrected	Raw	Corrected	Raw	Corrected	NTU	Averaged
Upcast Data - Bin Averaged at 1 meter Intervals											
51	28.312	35.612	22.753	2.43	5.55	38.22	87.2	9.56	8.05	11.97	2
50	28.326	35.612	22.748	2.44	5.56	38.31	87.3	9.56	8.05	10.32	5
49	28.374	35.595	22.719	2.44	5.56	38.27	87.3	9.56	8.05	9.41	3
48	28.425	35.582	22.692	2.43	5.55	38.21	87.3	9.55	8.04	8.22	4
47	28.487	35.563	22.658	2.42	5.54	38.03	87.1	9.55	8.04	7.42	4
46	28.556	35.547	22.623	2.40	5.52	37.84	87.0	9.55	8.04	7.98	4
45	28.613	35.533	22.594	2.39	5.51	37.63	86.8	9.55	8.04	7.48	3
44	28.642	35.527	22.579	2.37	5.49	37.44	86.7	9.55	8.04	7.53	3
43	28.687	35.518	22.558	2.35	5.47	37.08	86.3	9.54	8.03	6.14	3
42	28.760	35.495	22.516	2.31	5.43	36.44	85.7	9.54	8.03	5.99	4
41	28.816	35.481	22.487	2.27	5.39	35.97	85.3	9.53	8.02	5.68	5
40	28.894	35.448	22.436	2.24	5.36	35.39	84.8	9.53	8.02	5.59	3
39	28.946	35.447	22.417	2.20	5.32	34.88	84.3	9.52	8.01	5.35	5
38	28.992	35.434	22.393	2.19	5.31	34.66	84.1	9.52	8.01	5.13	3
37	29.017	35.440	22.389	2.18	5.30	34.66	84.2	9.52	8.01	4.72	6
36	29.070	35.420	22.356	2.16	5.28	34.30	83.8	9.52	8.01	3.32	4
35	29.130	35.402	22.322	2.14	5.26	34.00	83.6	9.51	8.00	2.96	6
34	29.184	35.387	22.293	2.13	5.25	33.87	83.5	9.52	8.01	2.37	4
33	29.212	35.386	22.283	2.13	5.25	33.94	83.6	9.52	8.01	2.16	7
32	29.279	35.358	22.239	2.13	5.25	33.98	83.7	9.51	8.00	1.91	2
31	29.339	35.351	22.214	2.13	5.25	33.99	83.7	9.51	8.00	1.44	4
30	29.431	35.337	22.173	2.18	5.30	34.76	84.6	9.52	8.01	1.60	6
29	29.540	35.311	22.116	2.26	5.38	36.17	86.0	9.52	8.01	0.82	3
28	29.601	35.311	22.095	2.36	5.48	37.84	87.8	9.54	8.03	0.61	5
27	29.647	35.308	22.078	2.48	5.60	39.78	89.7	9.55	8.04	0.48	4
26	29.698	35.304	22.057	2.59	5.71	41.50	91.5	9.56	8.05	0.57	4
25	29.727	35.301	22.045	2.64	5.76	42.31	92.3	9.56	8.05	0.84	25
24	29.738	35.302	22.042	2.67	5.79	42.74	92.8	9.56	8.05	1.01	24
23	29.736	35.297	22.038	2.61	5.73	41.84	91.9	9.55	8.04	1.19	23
22	29.732	35.290	22.035	2.52	5.64	40.42	90.4	9.54	8.03	1.40	22
21	29.732	35.284	22.030	2.44	5.56	39.08	89.1	9.53	8.02	1.30	4
20	29.745	35.279	22.022	2.42	5.54	38.86	88.9	9.53	8.02	1.03	3
19	29.755	35.281	22.020	2.43	5.55	39.00	89.0	9.54	8.03	0.94	6
18	29.774	35.281	22.014	2.49	5.61	39.93	90.0	9.54	8.03	1.00	4
17	29.802	35.281	22.004	2.56	5.68	41.02	91.1	9.55	8.04	0.83	6
16	29.836	35.274	21.988	2.60	5.72	41.80	91.9	9.55	8.04	0.70	3
15	29.875	35.269	21.971	2.68	5.80	43.06	93.2	9.56	8.05	0.51	4
14	29.947	35.250	21.931	2.76	5.88	44.46	94.6	9.56	8.05	0.49	3
13	29.967	35.266	21.937	2.83	5.95	45.57	95.8	9.58	8.07	0.48	4
12	29.976	35.269	21.936	2.87	5.99	46.22	96.4	9.58	8.07	0.46	3
11	29.982	35.269	21.934	2.89	6.01	46.58	96.8	9.58	8.07	0.49	4
10	29.985	35.271	21.935	2.91	6.03	46.81	97.0	9.58	8.07	0.51	8
9	29.985	35.272	21.935	2.92	6.04	47.04	97.3	9.58	8.07	0.44	5
8	29.996	35.270	21.930	2.93	6.05	47.22	97.5	9.58	8.07	1.00	3
7	30.005	35.270	21.927	2.95	6.07	47.42	97.7	9.59	8.08	0.45	5
6	30.026	35.260	21.912	2.95	6.07	47.48	97.7	9.58	8.07	0.48	4
5	30.035	35.256	21.906	2.95	6.07	47.51	97.8	9.58	8.07	0.47	4
4	30.047	35.249	21.897	2.96	6.08	47.62	97.9	9.58	8.07	0.50	4
3	30.089	35.222	21.862	2.95	6.07	47.52	97.8	9.58	8.07	0.59	4
2	30.125	35.201	21.834	2.95	6.07	47.63	97.9	9.57	8.06	0.68	5
1	30.196	35.151	21.772	2.97	6.09	47.93	98.3	9.58	8.07	0.37	9
Summary (Includes Downcast and Upcast)											
Min	28.258	35.037	21.622	2.13	5.25	33.87	83.48	9.51	8.00	0.370	Min
Max	30.386	35.630	22.784	3.00	6.12	48.57	99.05	9.61	8.10	13.170	Max
Average	29.442	35.361	22.185	2.53	5.65	40.45	90.26	9.56	8.05	2.876	Average
Std. Dev.	0.582	0.123	0.288	0.29	0.29	4.91	5.25	0.03	0.03	3.203	Std. Dev.

Station 5 Vertical Profile Data (Cast 7)											
Pago Pago Harbor Water Quality Monitoring											
20 March 2003 - Non Tradewind											
Depth	Temp	Salinity	Sigma-t	DO (mg/l)		DO (% Sat)		pH (SU)		Turbidity	No. Scans
(m)	°C	PSU	kg/m^3	Raw	Corrected	Raw	Corrected	Raw	Corrected	NTU	Averaged
Downcast Data - Bin Averaged at 1 meter Intervals											
1	29.933	35.063	21.796	2.85	5.97	45.77	95.9	9.67	8.16	0.40	3
2	29.937	35.126	21.842	2.86	5.98	46.02	96.2	9.68	8.17	0.67	2
3	29.953	35.169	21.869	2.87	5.99	46.17	96.3	9.69	8.18	0.73	2
4	29.963	35.185	21.878	2.87	5.99	46.21	96.4	9.69	8.18	0.49	1
5	29.959	35.193	21.885	2.88	6.00	46.25	96.4	9.70	8.19	0.04	2
6	29.955	35.193	21.886	2.88	6.00	46.25	96.4	9.69	8.18	0.00	2
7	29.955	35.193	21.886	2.88	6.00	46.24	96.4	9.69	8.18	0.26	2
8	29.953	35.192	21.886	2.87	5.99	46.22	96.4	9.69	8.18	0.64	1
9	29.950	35.192	21.887	2.87	5.99	46.20	96.4	9.69	8.18	0.57	2
10	29.946	35.193	21.890	2.87	5.99	46.21	96.4	9.69	8.18	0.28	1
11	29.944	35.196	21.892	2.87	5.99	46.14	96.3	9.69	8.18	0.00	2
12	29.944	35.200	21.896	2.86	5.98	45.98	96.1	9.69	8.18	0.76	1
13	29.944	35.207	21.900	2.85	5.97	45.82	96.0	9.69	8.18	0.16	2
14	29.941	35.212	21.905	2.84	5.96	45.74	95.9	9.69	8.18	0.18	2
15	29.937	35.214	21.908	2.84	5.96	45.67	95.8	9.69	8.18	0.24	2
16	29.937	35.220	21.913	2.84	5.96	45.63	95.8	9.69	8.18	0.41	2
17	29.937	35.235	21.924	2.84	5.96	45.62	95.8	9.69	8.18	0.41	2
18	29.941	35.250	21.934	2.84	5.96	45.64	95.8	9.69	8.18	0.39	1
19	29.938	35.262	21.944	2.84	5.96	45.65	95.8	9.69	8.18	0.42	2
20	29.931	35.274	21.955	2.84	5.96	45.67	95.8	9.70	8.19	0.28	2
21	29.926	35.277	21.959	2.84	5.96	45.63	95.8	9.70	8.19	0.21	2
22	29.892	35.290	21.980	2.83	5.95	45.49	95.6	9.70	8.19	0.23	3
23	29.859	35.303	22.001	2.83	5.95	45.45	95.6	9.70	8.19	0.26	1
24	29.849	35.305	22.006	2.83	5.95	45.44	95.6	9.70	8.19	0.28	2
25	29.834	35.311	22.016	2.83	5.95	45.42	95.5	9.70	8.19	0.32	2
26	29.828	35.313	22.020	2.83	5.95	45.43	95.5	9.70	8.19	0.27	1
27	29.828	35.313	22.019	2.83	5.95	45.44	95.6	9.70	8.19	0.27	2
28	29.828	35.313	22.019	2.83	5.95	45.50	95.6	9.70	8.19	0.25	2
29	29.827	35.314	22.020	2.83	5.95	45.47	95.6	9.70	8.19	0.25	2
30	29.827	35.314	22.021	2.82	5.94	45.36	95.5	9.71	8.20	0.26	1
31	29.827	35.314	22.021	2.81	5.93	45.21	95.3	9.71	8.20	0.26	2
32	29.827	35.311	22.019	2.79	5.91	44.88	95.0	9.71	8.20	0.25	1
33	29.811	35.312	22.024	2.78	5.90	44.59	94.7	9.71	8.20	0.26	2
34	29.758	35.324	22.052	2.76	5.88	44.30	94.4	9.70	8.19	0.39	2
35	29.699	35.337	22.081	2.75	5.87	44.04	94.0	9.70	8.19	0.58	1
36	29.641	35.351	22.111	2.75	5.87	43.98	93.9	9.70	8.19	0.33	2
37	29.567	35.370	22.151	2.75	5.87	43.94	93.9	9.70	8.19	0.34	2
38	29.517	35.377	22.173	2.75	5.87	43.90	93.8	9.70	8.19	0.34	1
39	29.430	35.402	22.221	2.74	5.86	43.82	93.6	9.70	8.19	0.34	2
40	29.376	35.411	22.247	2.75	5.87	43.89	93.7	9.70	8.19	0.40	1
41	29.305	35.429	22.284	2.75	5.87	43.84	93.6	9.69	8.18	0.39	2
42	29.252	35.443	22.312	2.76	5.88	43.99	93.7	9.70	8.19	0.42	2
43	29.221	35.451	22.329	2.77	5.89	44.15	93.8	9.70	8.19	0.46	5

Station 5 Vertical Profile Data (Cast 7)											
Pago Pago Harbor Water Quality Monitoring											
20 March 2003 - Non Tradewind											
Depth	Temp	Salinity	Sigma-t	DO (mg/l)		DO (% Sat)		pH (SU)		Turbidity	No. Scans
(m)	°C	PSU	kg/m^3	Raw	Corrected	Raw	Corrected	Raw	Corrected	NTU	Averaged
Upcast Data - Bin Averaged at 1 meter Intervals											
42	29.291	35.432	22.291	2.78	5.90	44.22	93.9	9.70	8.19	0.43	4
41	29.312	35.433	22.285	2.78	5.90	44.31	94.0	9.70	8.19	0.41	3
40	29.350	35.423	22.264	2.78	5.90	44.28	94.0	9.70	8.19	0.40	3
39	29.391	35.409	22.240	2.78	5.90	44.39	94.2	9.69	8.18	0.37	7
38	29.423	35.403	22.224	2.80	5.92	44.66	94.5	9.69	8.18	0.34	2
37	29.511	35.365	22.166	2.79	5.91	44.66	94.5	9.69	8.18	0.35	2
36	29.553	35.356	22.145	2.79	5.91	44.64	94.5	9.69	8.18	0.37	2
35	29.582	35.364	22.142	2.79	5.91	44.66	94.6	9.69	8.18	0.36	6
34	29.629	35.363	22.125	2.80	5.92	44.88	94.8	9.69	8.18	0.33	3
33	29.740	35.316	22.052	2.81	5.93	45.01	95.0	9.69	8.18	0.29	3
32	29.781	35.316	22.038	2.82	5.94	45.26	95.3	9.70	8.19	0.26	4
31	29.802	35.311	22.027	2.83	5.95	45.43	95.5	9.70	8.19	0.27	3
30	29.815	35.310	22.022	2.83	5.95	45.48	95.6	9.70	8.19	0.31	4
29	29.820	35.308	22.019	2.83	5.95	45.46	95.6	9.70	8.19	0.25	4
28	29.823	35.307	22.017	2.83	5.95	45.44	95.5	9.70	8.19	0.27	4
27	29.826	35.307	22.016	2.83	5.95	45.43	95.5	9.70	8.19	0.33	2
26	29.827	35.307	22.016	2.83	5.95	45.40	95.5	9.70	8.19	0.28	5
25	29.827	35.308	22.016	2.82	5.94	45.36	95.5	9.70	8.19	0.29	3
24	29.830	35.307	22.014	2.83	5.95	45.38	95.5	9.70	8.19	0.31	6
23	29.840	35.303	22.008	2.83	5.95	45.44	95.6	9.70	8.19	0.27	2
22	29.857	35.297	21.997	2.84	5.96	45.56	95.7	9.69	8.18	0.28	4
21	29.893	35.283	21.975	2.84	5.96	45.70	95.9	9.70	8.19	0.24	3
20	29.907	35.281	21.969	2.85	5.97	45.85	96.0	9.70	8.19	0.25	5
19	29.929	35.267	21.951	2.85	5.97	45.83	96.0	9.70	8.19	0.29	3
18	29.934	35.261	21.945	2.85	5.97	45.81	96.0	9.69	8.18	0.30	4
17	29.937	35.245	21.931	2.84	5.96	45.66	95.8	9.69	8.18	0.32	4
16	29.935	35.228	21.919	2.83	5.95	45.55	95.7	9.68	8.17	0.34	4
15	29.935	35.216	21.910	2.83	5.95	45.50	95.7	9.68	8.17	0.34	4
14	29.937	35.211	21.906	2.83	5.95	45.49	95.7	9.68	8.17	0.35	3
13	29.937	35.211	21.906	2.83	5.95	45.50	95.7	9.68	8.17	0.34	4
12	29.937	35.210	21.905	2.83	5.95	45.58	95.7	9.68	8.17	0.39	4
11	29.940	35.203	21.899	2.85	5.97	45.79	96.0	9.68	8.17	0.19	3
10	29.942	35.197	21.893	2.86	5.98	45.93	96.1	9.68	8.17	0.51	2
9	29.945	35.191	21.889	2.86	5.98	45.99	96.2	9.69	8.18	0.20	3
8	29.944	35.189	21.887	2.87	5.99	46.15	96.3	9.69	8.18	0.15	5
7	29.944	35.190	21.888	2.87	5.99	46.15	96.3	9.69	8.18	0.33	7
6	29.947	35.190	21.887	2.87	5.99	46.18	96.3	9.69	8.18	0.30	6
5	29.950	35.191	21.886	2.88	6.00	46.24	96.4	9.69	8.18	0.31	5
4	29.956	35.193	21.886	2.88	6.00	46.27	96.5	9.69	8.18	1.50	4
3	29.959	35.179	21.874	2.88	6.00	46.27	96.4	9.69	8.18	0.31	4
2	29.943	35.128	21.842	2.87	5.99	46.18	96.3	9.68	8.17	0.33	4
1	29.940	35.086	21.811	2.86	5.98	45.98	96.1	9.67	8.16	0.22	4
Summary (Includes Downcast and Upcast)											
Min	29.221	35.063	21.796	2.74	5.86	43.82	93.57	9.67	8.16	0.00	Min
Max	29.963	35.451	22.329	2.88	6.00	46.27	96.45	9.71	8.20	1.50	Max
Average	29.802	35.276	22.001	2.83	5.95	45.38	95.46	9.69	8.18	0.34	Average
Std. Dev.	0.203	0.085	0.129	0.04	0.04	0.71	0.84	0.01	0.01	0.18	Std. Dev.

Station 18 Vertical Profile Data (Cast 8)											
Pago Pago Harbor Water Quality Monitoring											
20 March 2003 - Non Tradewind											
Depth	Temp	Salinity	Sigma-t	DO (mg/l)		DO (% Sat)		pH (SU)		Turbidity	No. Scans
(m)	°C	PSU	kg/m3	Raw	Corrected	Raw	Corrected	Raw	Corrected	NTU	Averaged
Downcast Data - Bin Averaged at 1 meter Intervals											
1	30.171	34.971	21.646	2.97	6.09	47.95	98.2	9.75	8.24	0.01	3
2	30.072	35.004	21.705	2.99	6.11	48.05	98.3	9.75	8.24	0.20	2
3	30.013	35.009	21.728	2.99	6.11	48.14	98.3	9.76	8.25	0.72	1
4	29.948	35.003	21.746	3.00	6.12	48.12	98.2	9.76	8.25	0.32	2
5	29.922	34.995	21.749	3.00	6.12	48.17	98.3	9.76	8.25	0.59	1
6	29.928	35.001	21.751	3.00	6.12	48.22	98.3	9.76	8.25	0.68	2
7	29.935	35.015	21.760	3.00	6.12	48.16	98.3	9.75	8.24	0.28	1
8	29.913	35.083	21.818	3.00	6.12	48.14	98.3	9.75	8.24	0.45	2
9	29.931	35.152	21.864	2.99	6.11	48.12	98.3	9.75	8.24	0.35	1
10	29.961	35.211	21.898	2.99	6.11	48.12	98.3	9.75	8.24	0.21	1
11	29.971	35.231	21.910	2.99	6.11	48.15	98.3	9.76	8.25	0.29	2
12	29.976	35.244	21.917	3.00	6.12	48.20	98.4	9.76	8.25	0.21	1
13	29.976	35.251	21.922	2.99	6.11	48.17	98.4	9.76	8.25	0.22	2
14	29.970	35.254	21.927	2.99	6.11	48.07	98.3	9.76	8.25	0.20	1
15	29.957	35.261	21.936	2.99	6.11	48.04	98.2	9.76	8.25	0.20	2
16	29.953	35.266	21.942	2.99	6.11	48.04	98.2	9.75	8.24	0.18	1
17	29.950	35.273	21.948	2.98	6.10	48.01	98.2	9.75	8.24	0.19	2
18	29.945	35.278	21.953	2.98	6.10	47.97	98.2	9.75	8.24	0.19	2
19	29.940	35.281	21.957	2.98	6.10	47.90	98.1	9.75	8.24	0.21	1
20	29.932	35.285	21.963	2.97	6.09	47.83	98.0	9.75	8.24	0.20	2
21	29.923	35.290	21.970	2.97	6.09	47.78	98.0	9.75	8.24	0.22	2
22	29.920	35.291	21.972	2.97	6.09	47.74	97.9	9.75	8.24	0.23	2
23	29.919	35.292	21.973	2.97	6.09	47.69	97.9	9.75	8.24	0.29	1
24	29.918	35.292	21.973	2.96	6.08	47.60	97.8	9.75	8.24	0.21	2
25	29.918	35.292	21.973	2.95	6.07	47.39	97.6	9.75	8.24	0.25	2
26	29.915	35.293	21.975	2.93	6.05	47.11	97.3	9.75	8.24	0.23	2
27	29.912	35.292	21.975	2.91	6.03	46.73	96.9	9.75	8.24	0.24	1
28	29.889	35.296	21.986	2.87	5.99	46.10	96.3	9.74	8.23	0.24	2
29	29.865	35.299	21.997	2.82	5.94	45.28	95.4	9.74	8.23	0.26	2
30	29.841	35.293	22.000	2.76	5.88	44.35	94.5	9.73	8.22	0.29	1
31	29.786	35.308	22.030	2.74	5.86	43.90	94.0	9.73	8.22	0.36	2
32	29.777	35.306	22.032	2.72	5.84	43.63	93.7	9.72	8.21	0.40	2
33	29.765	35.310	22.039	2.70	5.82	43.38	93.4	9.71	8.20	0.42	2
34	29.755	35.312	22.044	2.67	5.79	42.86	92.9	9.72	8.21	0.42	1
35	29.738	35.310	22.048	2.61	5.73	41.89	91.9	9.72	8.21	0.45	2
36	29.709	35.304	22.054	2.53	5.65	40.51	90.5	9.72	8.21	0.42	1
37	29.648	35.315	22.082	2.47	5.59	39.48	89.4	9.71	8.20	0.66	2
38	29.583	35.333	22.118	2.41	5.53	38.58	88.5	9.69	8.18	1.30	1
39	29.572	35.334	22.123	2.38	5.50	38.08	88.0	9.68	8.17	1.73	2
40	29.552	35.333	22.128	2.37	5.49	37.89	87.8	9.68	8.17	1.56	2
41	29.474	35.356	22.172	2.38	5.50	38.05	87.9	9.68	8.17	1.60	2
42	29.395	35.375	22.213	2.37	5.49	37.88	87.7	9.68	8.17	2.28	2
43	29.298	35.401	22.266	2.34	5.46	37.21	86.9	9.69	8.18	2.25	2
44	29.230	35.414	22.298	2.30	5.42	36.63	86.3	9.69	8.18	2.04	1
45	29.195	35.407	22.304	2.31	5.43	36.75	86.4	9.68	8.17	3.39	2
46	29.102	35.434	22.356	2.35	5.47	37.27	86.8	9.67	8.16	4.17	2
47	29.002	35.460	22.409	2.38	5.50	37.83	87.3	9.68	8.17	4.85	1
48	28.879	35.504	22.484	2.42	5.54	38.38	87.8	9.69	8.18	4.14	2
49	28.808	35.513	22.513	2.47	5.59	39.04	88.4	9.69	8.18	4.16	2
50	28.727	35.530	22.553	2.52	5.64	39.83	89.1	9.70	8.19	3.80	2
51	28.655	35.543	22.587	2.57	5.69	40.60	89.8	9.71	8.20	2.99	2
52	28.566	35.567	22.634	2.60	5.72	41.01	90.2	9.72	8.21	2.34	2
53	28.495	35.584	22.671	2.62	5.74	41.19	90.3	9.72	8.21	1.66	1
54	28.469	35.567	22.667	2.63	5.75	41.43	90.5	9.72	8.21	1.14	2
55	28.314	35.600	22.743	2.66	5.78	41.76	90.7	9.72	8.21	1.09	3
56	28.142	35.629	22.821	2.69	5.81	42.18	91.0	9.72	8.21	1.11	3
57	28.004	35.667	22.895	2.72	5.84	42.55	91.3	9.73	8.22	1.48	2
58	27.962	35.677	22.917	2.73	5.85	42.68	91.4	9.72	8.21	2.62	2
59	27.957	35.676	22.917	2.74	5.86	42.78	91.5	9.72	8.21	3.19	2
60	27.958	35.678	22.918	2.75	5.87	42.89	91.6	9.72	8.21	3.49	2
61	27.983	35.672	22.906	2.76	5.88	43.13	91.9	9.72	8.21	3.59	7

Station 18 Vertical Profile Data (Cast 8)											
Pago Pago Harbor Water Quality Monitoring											
20 March 2003 - Non Tradewind											
Depth	Temp	Salinity	Sigma-t	DO (mg/l)		DO (% Sat)		pH (SU)		Turbidity	No. Scans
(m)	°C	PSU	kg/m3	Raw	Corrected	Raw	Corrected	Raw	Corrected	NTU	Averaged
Upcast Data - Bin Averaged at 1 meter Intervals											
60	27.979	35.673	22.908	2.76	5.88	43.14	91.9	9.72	8.21	3.50	3
59	27.972	35.670	22.908	2.76	5.88	43.14	91.9	9.72	8.21	3.55	3
58	27.966	35.671	22.911	2.77	5.89	43.21	91.9	9.72	8.21	3.20	4
57	27.992	35.661	22.895	2.78	5.90	43.39	92.1	9.72	8.21	2.35	9
56	28.012	35.665	22.891	2.79	5.91	43.64	92.4	9.72	8.21	1.78	3
55	28.189	35.633	22.809	2.79	5.91	43.77	92.7	9.72	8.21	1.25	8
54	28.342	35.592	22.728	2.78	5.90	43.69	92.7	9.71	8.20	1.10	3
53	28.441	35.581	22.686	2.78	5.90	43.66	92.7	9.71	8.20	1.12	7
52	28.497	35.572	22.661	2.77	5.89	43.56	92.7	9.71	8.20	1.40	5
51	28.573	35.560	22.627	2.73	5.85	43.00	92.2	9.70	8.19	2.25	5
50	28.663	35.532	22.576	2.68	5.80	42.24	91.5	9.70	8.19	2.73	3
49	28.724	35.518	22.545	2.62	5.74	41.39	90.7	9.69	8.18	3.50	7
48	28.785	35.506	22.516	2.57	5.69	40.57	89.9	9.68	8.17	3.96	4
47	28.891	35.485	22.465	2.51	5.63	39.74	89.1	9.67	8.16	3.90	6
46	29.031	35.444	22.387	2.42	5.54	38.37	87.9	9.66	8.15	4.65	5
45	29.096	35.426	22.352	2.31	5.43	36.68	86.2	9.65	8.14	4.08	6
44	29.172	35.405	22.311	2.30	5.42	36.55	86.2	9.65	8.14	3.71	3
43	29.254	35.404	22.283	2.36	5.48	37.60	87.3	9.66	8.15	2.19	43
42	29.362	35.378	22.226	2.42	5.54	38.58	88.3	9.67	8.16	2.40	42
41	29.390	35.367	22.209	2.37	5.49	37.79	87.6	9.66	8.15	2.27	41
40	29.471	35.349	22.168	2.33	5.45	37.14	87.0	9.65	8.14	1.47	40
39	29.536	35.331	22.132	2.31	5.43	36.91	86.8	9.65	8.14	1.20	4
38	29.566	35.326	22.118	2.31	5.43	36.97	86.9	9.65	8.14	1.08	5
37	29.580	35.323	22.111	2.32	5.44	37.12	87.0	9.65	8.14	1.41	5
36	29.627	35.307	22.084	2.36	5.48	37.74	87.7	9.66	8.15	0.88	4
35	29.676	35.307	22.067	2.46	5.58	39.48	89.5	9.67	8.16	0.58	5
34	29.717	35.307	22.053	2.55	5.67	40.91	90.9	9.69	8.18	0.43	4
33	29.743	35.303	22.041	2.58	5.70	41.38	91.4	9.68	8.17	0.43	5
32	29.763	35.298	22.030	2.59	5.71	41.51	91.6	9.68	8.17	0.55	5
31	29.771	35.297	22.027	2.59	5.71	41.60	91.7	9.68	8.17	0.39	3
30	29.806	35.293	22.012	2.64	5.76	42.39	92.5	9.68	8.17	0.32	5
29	29.845	35.295	22.000	2.73	5.85	43.87	94.0	9.70	8.19	0.29	6
28	29.874	35.291	21.987	2.79	5.91	44.80	94.9	9.70	8.19	0.29	4
27	29.895	35.290	21.980	2.84	5.96	45.71	95.9	9.71	8.20	0.25	8
26	29.906	35.287	21.973	2.87	5.99	46.16	96.3	9.71	8.20	0.25	5
25	29.912	35.286	21.970	2.88	6.00	46.25	96.4	9.71	8.20	0.26	3
24	29.913	35.286	21.971	2.88	6.00	46.35	96.5	9.71	8.20	0.27	7
23	29.913	35.287	21.971	2.89	6.01	46.46	96.6	9.71	8.20	0.24	4
22	29.914	35.288	21.971	2.89	6.01	46.47	96.6	9.71	8.20	0.24	6
21	29.915	35.287	21.970	2.90	6.02	46.56	96.7	9.71	8.20	0.24	3
20	29.922	35.284	21.966	2.90	6.02	46.62	96.8	9.71	8.20	0.22	6
19	29.931	35.279	21.959	2.91	6.03	46.77	96.9	9.71	8.20	0.26	5
18	29.937	35.277	21.955	2.91	6.03	46.83	97.0	9.71	8.20	0.21	4
17	29.943	35.274	21.951	2.91	6.03	46.86	97.0	9.71	8.20	0.23	7
16	29.948	35.266	21.943	2.91	6.03	46.87	97.1	9.71	8.20	0.20	3
15	29.950	35.259	21.937	2.92	6.04	46.91	97.1	9.71	8.20	0.19	7
14	29.955	35.256	21.934	2.92	6.04	47.00	97.2	9.72	8.21	0.20	3
13	29.967	35.255	21.928	2.92	6.04	47.05	97.3	9.72	8.21	0.23	5
12	29.974	35.252	21.924	2.92	6.04	47.06	97.3	9.72	8.21	0.19	5
11	29.977	35.242	21.915	2.92	6.04	47.00	97.2	9.72	8.21	0.21	5
10	29.956	35.186	21.881	2.91	6.03	46.82	97.0	9.72	8.21	0.26	3
9	29.918	35.080	21.814	2.92	6.04	46.90	97.0	9.71	8.20	0.31	6
8	29.906	35.008	21.764	2.92	6.04	46.83	96.9	9.71	8.20	0.35	4
7	29.905	34.987	21.749	2.92	6.04	46.93	97.0	9.71	8.20	0.31	4
6	29.904	34.977	21.742	2.93	6.05	47.10	97.2	9.71	8.20	0.32	4
5	29.904	34.972	21.738	2.94	6.06	47.23	97.3	9.71	8.20	0.30	10
4	29.925	34.965	21.726	2.96	6.08	47.60	97.7	9.71	8.20	0.36	4
3	30.002	34.971	21.704	2.98	6.10	47.91	98.1	9.71	8.20	0.47	4
2	30.120	34.970	21.663	2.99	6.11	48.18	98.4	9.71	8.20	0.52	4
1	30.173	34.956	21.634	2.98	6.10	48.04	98.3	9.70	8.19	0.63	6
Summary (Includes Downcast and Upcast)											
Min	27.957	34.956	21.634	2.30	5.42	36.55	86.16	9.65	8.14	0.010	Min
Max	30.173	35.678	22.918	3.00	6.12	48.22	98.42	9.76	8.25	4.850	Max
Average	29.453	35.330	22.158	2.74	5.86	43.74	93.55	9.71	8.20	1.202	Average
Std. Dev.	0.667	0.189	0.356	0.23	0.23	3.88	4.13	0.03	0.03	1.307	Std. Dev.

Station 16 Vertical Profile Data (Cast 9)											
Pago Pago Harbor Water Quality Monitoring											
20 March 2003 - Non Tradewind											
Depth	Temp	Salinity	Sigma-t	DO (mg/l)		DO (% Sat)		pH (SU)		Turbidity	No. Scans
(m)	°C	PSU	kg/m^3	Raw	Corrected	Raw	Corrected	Raw	Corrected	NTU	Averaged
Downcast Data - Bin Averaged at 1 meter Intervals											
1	30.367	34.865	21.499	2.96	6.08	47.77	98.2	9.73	8.22	0.29	6
2	30.315	35.067	21.668	2.84	5.96	45.98	96.4	9.70	8.19	0.79	2
3	30.263	35.095	21.707	2.87	5.99	46.42	96.8	9.69	8.18	0.64	2
4	30.184	35.096	21.736	2.90	6.02	46.80	97.1	9.70	8.19	0.58	2
5	30.045	35.147	21.821	2.92	6.04	47.07	97.3	9.71	8.20	0.54	2
6	30.002	35.185	21.864	2.93	6.05	47.09	97.3	9.73	8.22	0.46	1
7	30.005	35.197	21.872	2.92	6.04	47.00	97.2	9.73	8.22	0.30	2
8	30.006	35.205	21.878	2.92	6.04	46.97	97.2	9.73	8.22	0.22	1
9	30.004	35.216	21.886	2.91	6.03	46.81	97.0	9.73	8.22	0.24	2
10	29.985	35.225	21.900	2.90	6.02	46.74	97.0	9.73	8.22	0.26	1
11	29.966	35.237	21.916	2.91	6.03	46.77	97.0	9.72	8.21	0.31	2
12	29.976	35.241	21.915	2.91	6.03	46.89	97.1	9.72	8.21	0.39	1
13	29.980	35.249	21.920	2.91	6.03	46.90	97.1	9.72	8.21	0.33	2
14	29.975	35.258	21.928	2.92	6.04	47.01	97.2	9.73	8.22	0.30	2
15	29.971	35.264	21.934	2.92	6.04	47.04	97.3	9.73	8.22	0.31	1
16	29.968	35.270	21.940	2.92	6.04	46.99	97.2	9.73	8.22	0.25	2
17	29.959	35.277	21.948	2.92	6.04	46.96	97.2	9.73	8.22	0.25	1
18	29.951	35.282	21.954	2.92	6.04	46.94	97.1	9.73	8.22	0.24	2
19	29.945	35.284	21.958	2.91	6.03	46.89	97.1	9.73	8.22	0.24	1
20	29.943	35.285	21.959	2.91	6.03	46.81	97.0	9.73	8.22	0.26	2
21	29.943	35.283	21.958	2.90	6.02	46.70	96.9	9.73	8.22	0.25	1
22	29.940	35.282	21.958	2.89	6.01	46.47	96.7	9.73	8.22	0.25	2
23	29.933	35.284	21.962	2.87	5.99	46.19	96.4	9.73	8.22	0.26	1
24	29.919	35.288	21.970	2.86	5.98	45.95	96.1	9.73	8.22	0.26	2
25	29.913	35.290	21.974	2.85	5.97	45.81	96.0	9.72	8.21	0.29	2
26	29.913	35.290	21.973	2.84	5.96	45.66	95.8	9.72	8.21	0.34	1
27	29.914	35.290	21.973	2.83	5.95	45.53	95.7	9.72	8.21	0.33	2
28	29.902	35.294	21.980	2.83	5.95	45.49	95.7	9.72	8.21	0.34	1
29	29.887	35.300	21.990	2.84	5.96	45.60	95.8	9.71	8.20	0.35	2
30	29.879	35.304	21.995	2.84	5.96	45.69	95.8	9.71	8.20	0.32	1
31	29.873	35.306	21.999	2.85	5.97	45.82	96.0	9.72	8.21	0.30	2
32	29.865	35.308	22.004	2.85	5.97	45.80	95.9	9.72	8.21	0.28	2
33	29.854	35.310	22.009	2.85	5.97	45.74	95.9	9.72	8.21	0.26	1
34	29.839	35.314	22.017	2.83	5.95	45.54	95.7	9.72	8.21	0.27	2
35	29.832	35.314	22.019	2.81	5.93	45.13	95.2	9.73	8.22	0.27	1
36	29.824	35.309	22.018	2.76	5.88	44.38	94.5	9.73	8.22	0.26	2
37	29.786	35.308	22.030	2.71	5.83	43.53	93.6	9.72	8.21	0.25	2
38	29.740	35.312	22.049	2.66	5.78	42.66	92.7	9.70	8.19	0.30	1
39	29.699	35.321	22.070	2.59	5.71	41.48	91.5	9.70	8.19	0.54	2
40	29.674	35.316	22.074	2.51	5.63	40.28	90.3	9.70	8.19	0.45	1
41	29.619	35.326	22.100	2.47	5.59	39.60	89.5	9.69	8.18	0.50	2
42	29.564	35.338	22.128	2.44	5.56	39.10	89.0	9.67	8.16	1.38	2
43	29.517	35.344	22.149	2.41	5.53	38.57	88.4	9.67	8.16	2.24	1
44	29.429	35.368	22.196	2.38	5.50	37.95	87.8	9.68	8.17	1.43	2
45	29.344	35.379	22.233	2.35	5.47	37.54	87.3	9.67	8.16	2.44	2
46	29.209	35.410	22.301	2.35	5.47	37.34	87.0	9.67	8.16	3.80	2
47	29.067	35.449	22.379	2.35	5.47	37.30	86.8	9.66	8.15	5.48	1
48	28.941	35.480	22.444	2.36	5.48	37.38	86.8	9.66	8.15	6.37	2
49	28.860	35.493	22.481	2.39	5.51	37.80	87.2	9.67	8.16	5.98	2
50	28.765	35.503	22.520	2.44	5.56	38.52	87.8	9.68	8.17	5.26	1
51	28.605	35.535	22.598	2.49	5.61	39.25	88.4	9.68	8.17	4.47	2
52	28.396	35.592	22.710	2.54	5.66	39.98	89.0	9.69	8.18	4.05	2
53	28.278	35.625	22.773	2.58	5.70	40.52	89.5	9.70	8.19	4.30	2
54	28.232	35.634	22.795	2.61	5.73	40.90	89.8	9.70	8.19	4.77	2
55	28.214	35.635	22.802	2.63	5.75	41.23	90.1	9.70	8.19	4.94	2
56	28.205	35.636	22.805	2.64	5.76	41.43	90.3	9.70	8.19	5.03	1
57	28.199	35.636	22.808	2.65	5.77	41.59	90.5	9.70	8.19	5.26	2
58	28.196	35.636	22.809	2.67	5.79	41.77	90.7	9.70	8.19	5.16	2
59	28.205	35.634	22.804	2.67	5.79	41.88	90.8	9.70	8.19	5.63	7

Station 16 Vertical Profile Data (Cast 9)											
Pago Pago Harbor Water Quality Monitoring											
20 March 2003 - Non Tradewind											
Depth	Temp	Salinity	Sigma-t	DO (mg/l)		DO (% Sat)		pH (SU)		Turbidity	No. Scans
(m)	°C	PSU	kg/m^3	Raw	Corrected	Raw	Corrected	Raw	Corrected	NTU	Averaged
Upcast Data - Bin Averaged at 1 meter Intervals											
58	28.204	35.632	22.803	2.68	5.80	42.08	91.0	9.70	8.19	7.44	7
57	28.199	35.634	22.806	2.69	5.81	42.18	91.1	9.70	8.19	5.02	3
56	28.203	35.630	22.802	2.69	5.81	42.18	91.1	9.70	8.19	5.08	6
55	28.211	35.626	22.797	2.69	5.81	42.19	91.1	9.70	8.19	5.24	3
54	28.214	35.625	22.795	2.70	5.82	42.27	91.2	9.70	8.19	4.96	4
53	28.220	35.624	22.792	2.71	5.83	42.46	91.4	9.70	8.19	4.80	4
52	28.270	35.611	22.765	2.72	5.84	42.60	91.6	9.69	8.18	4.15	4
51	28.408	35.566	22.687	2.69	5.81	42.31	91.4	9.69	8.18	3.89	3
50	28.658	35.490	22.546	2.63	5.75	41.44	90.7	9.68	8.17	4.55	4
49	28.790	35.483	22.497	2.56	5.68	40.41	89.7	9.67	8.16	5.40	3
48	28.868	35.473	22.464	2.50	5.62	39.65	89.0	9.66	8.15	6.20	5
47	28.982	35.443	22.403	2.44	5.56	38.68	88.2	9.66	8.15	6.46	5
46	29.134	35.391	22.313	2.40	5.52	38.21	87.8	9.65	8.14	5.58	3
45	29.243	35.361	22.254	2.40	5.52	38.23	87.9	9.65	8.14	3.66	3
44	29.346	35.358	22.217	2.42	5.54	38.51	88.3	9.65	8.14	2.07	6
43	29.469	35.336	22.158	2.45	5.57	39.07	88.9	9.66	8.15	1.19	4
42	29.527	35.319	22.127	2.43	5.55	38.86	88.7	9.66	8.15	2.40	3
41	29.570	35.313	22.107	2.40	5.52	38.32	88.2	9.66	8.15	0.93	5
40	29.629	35.304	22.081	2.45	5.57	39.21	89.2	9.65	8.14	0.50	4
39	29.668	35.311	22.072	2.53	5.65	40.54	90.5	9.66	8.15	0.58	39
38	29.725	35.292	22.039	2.59	5.71	41.56	91.6	9.67	8.16	0.45	38
37	29.757	35.292	22.028	2.64	5.76	42.38	92.4	9.67	8.16	0.29	37
36	29.795	35.300	22.021	2.74	5.86	43.95	94.0	9.68	8.17	0.25	36
35	29.818	35.298	22.012	2.79	5.91	44.86	95.0	9.69	8.18	0.25	3
34	29.824	35.306	22.016	2.82	5.94	45.34	95.4	9.70	8.19	0.28	4
33	29.830	35.304	22.012	2.83	5.95	45.52	95.6	9.70	8.19	0.25	4
32	29.842	35.303	22.007	2.84	5.96	45.70	95.8	9.70	8.19	0.28	5
31	29.856	35.298	21.999	2.85	5.97	45.78	95.9	9.70	8.19	0.30	4
30	29.862	35.300	21.998	2.84	5.96	45.69	95.8	9.70	8.19	0.30	4
29	29.868	35.299	21.996	2.83	5.95	45.47	95.6	9.69	8.18	0.34	5
28	29.873	35.297	21.993	2.82	5.94	45.33	95.5	9.69	8.18	0.36	4
27	29.883	35.293	21.986	2.81	5.93	45.23	95.4	9.69	8.18	0.41	4
26	29.896	35.289	21.978	2.81	5.93	45.17	95.3	9.69	8.18	0.39	5
25	29.907	35.286	21.973	2.81	5.93	45.22	95.4	9.69	8.18	0.36	3
24	29.907	35.286	21.972	2.81	5.93	45.25	95.4	9.69	8.18	0.39	6
23	29.907	35.286	21.972	2.82	5.94	45.29	95.5	9.69	8.18	0.30	4
22	29.914	35.283	21.968	2.84	5.96	45.61	95.8	9.70	8.19	0.26	5
21	29.930	35.281	21.961	2.86	5.98	46.04	96.2	9.70	8.19	0.27	5
20	29.934	35.281	21.960	2.88	6.00	46.32	96.5	9.70	8.19	0.28	5
19	29.937	35.280	21.958	2.89	6.01	46.45	96.6	9.70	8.19	0.25	3
18	29.940	35.280	21.957	2.89	6.01	46.55	96.7	9.70	8.19	0.26	5
17	29.942	35.280	21.956	2.90	6.02	46.65	96.8	9.70	8.19	0.26	5
16	29.947	35.279	21.954	2.91	6.03	46.74	96.9	9.70	8.19	0.27	6
15	29.958	35.270	21.943	2.91	6.03	46.82	97.0	9.70	8.19	0.26	6
14	29.966	35.262	21.935	2.91	6.03	46.88	97.1	9.70	8.19	0.26	3
13	29.970	35.258	21.930	2.91	6.03	46.90	97.1	9.70	8.19	0.27	4
12	29.974	35.253	21.925	2.91	6.03	46.82	97.0	9.70	8.19	0.32	6
11	29.972	35.240	21.916	2.90	6.02	46.65	96.9	9.70	8.19	0.32	6
10	29.988	35.220	21.896	2.89	6.01	46.54	96.7	9.70	8.19	0.31	3
9	29.999	35.219	21.890	2.90	6.02	46.61	96.8	9.70	8.19	0.28	6
8	30.004	35.207	21.881	2.91	6.03	46.82	97.0	9.70	8.19	0.25	6
7	30.004	35.196	21.872	2.92	6.04	47.06	97.3	9.70	8.19	0.24	3
6	30.002	35.185	21.864	2.93	6.05	47.22	97.4	9.71	8.20	0.29	4
5	30.002	35.158	21.844	2.94	6.06	47.37	97.6	9.70	8.19	0.35	6
4	30.020	35.136	21.821	2.94	6.06	47.38	97.6	9.70	8.19	0.47	5
3	30.137	35.121	21.770	2.91	6.03	46.95	97.2	9.68	8.17	0.59	5
2	30.292	35.058	21.670	2.88	6.00	46.56	97.0	9.67	8.16	0.66	4
1	30.351	35.018	21.619	2.91	6.03	47.09	97.5	9.68	8.17	0.66	5
Summary (Includes Downcast and Upcast)											
Min	28.196	34.865	21.499	2.35	5.47	37.30	86.83	9.65	8.14	0.220	Min
Max	30.367	35.636	22.809	2.96	6.08	47.77	98.18	9.73	8.22	7.440	Max
Average	29.567	35.330	22.120	2.75	5.87	43.95	93.85	9.70	8.19	1.577	Average
Std. Dev.	0.631	0.150	0.321	0.18	0.18	3.21	3.53	0.02	0.02	2.070	Std. Dev.

Station 15 Vertical Profile Data (Cast 10)											
Pago Pago Harbor Water Quality Monitoring											
20 March 2003 - Non Tradewind											
Depth	Temp	Salinity	Sigma-t	DO (mg/l)		DO (% Sat)		pH (SU)		Turbidity	No. Scans
(m)	°C	PSU	kg/m^3	Raw	Corrected	Raw	Corrected	Raw	Corrected	NTU	Averaged
Downcast Data - Bin Averaged at 1 meter Intervals											
1	30.347	35.135	21.708	3.16	6.28	51.20	101.7	9.70	8.19	2.17	3
2	30.234	35.171	21.775	3.11	6.23	50.27	100.7	9.69	8.18	0.90	1
3	30.141	35.208	21.834	3.09	6.21	49.80	100.1	9.69	8.18	2.64	1
4	30.100	35.217	21.855	3.07	6.19	49.52	99.8	9.69	8.18	0.59	2
5	30.086	35.219	21.861	3.06	6.18	49.27	99.6	9.69	8.18	0.75	2
6	30.078	35.221	21.865	3.04	6.16	48.96	99.2	9.69	8.18	0.63	2
7	30.074	35.222	21.868	3.02	6.14	48.73	99.0	9.69	8.18	0.57	1
8	30.077	35.220	21.865	3.02	6.14	48.63	98.9	9.69	8.18	0.62	2
9	30.051	35.235	21.885	3.01	6.13	48.45	98.7	9.69	8.18	0.58	2
10	30.021	35.256	21.911	3.00	6.12	48.28	98.5	9.69	8.18	0.56	2
11	30.007	35.267	21.924	2.99	6.11	48.16	98.4	9.69	8.18	0.62	1
12	30.002	35.271	21.929	2.98	6.10	48.00	98.2	9.69	8.18	0.37	2
13	29.989	35.279	21.939	2.97	6.09	47.79	98.0	9.69	8.18	0.39	2
14	29.980	35.283	21.945	2.95	6.07	47.55	97.8	9.69	8.18	0.42	1
15	29.973	35.285	21.949	2.94	6.06	47.31	97.5	9.69	8.18	0.43	2
16	29.956	35.292	21.960	2.92	6.04	47.05	97.3	9.69	8.18	0.41	2
17	29.950	35.294	21.964	2.91	6.03	46.77	97.0	9.69	8.18	0.45	2
18	29.944	35.294	21.966	2.88	6.00	46.39	96.6	9.69	8.18	0.46	1
19	29.934	35.297	21.971	2.87	5.99	46.12	96.3	9.68	8.17	0.58	2
20	29.924	35.300	21.977	2.85	5.97	45.81	96.0	9.68	8.17	0.57	2
21	29.917	35.301	21.980	2.84	5.96	45.63	95.8	9.68	8.17	0.73	1
22	29.916	35.300	21.980	2.83	5.95	45.48	95.7	9.68	8.17	0.68	2
23	29.906	35.304	21.986	2.82	5.94	45.39	95.6	9.68	8.17	0.88	2
24	29.902	35.305	21.988	2.82	5.94	45.28	95.4	9.68	8.17	0.72	1
25	29.899	35.305	21.989	2.82	5.94	45.30	95.5	9.68	8.17	0.67	2
26	29.894	35.308	21.993	2.82	5.94	45.33	95.5	9.68	8.17	0.66	1
27	29.890	35.308	21.995	2.81	5.93	45.21	95.4	9.68	8.17	0.60	2
28	29.885	35.308	21.997	2.80	5.92	44.97	95.1	9.68	8.17	0.58	1
29	29.879	35.308	21.999	2.77	5.89	44.57	94.7	9.68	8.17	0.54	2
30	29.872	35.309	22.001	2.75	5.87	44.18	94.3	9.67	8.16	0.70	2
31	29.869	35.309	22.003	2.72	5.84	43.70	93.8	9.66	8.15	0.98	13
Upcast Data - Bin Averaged at 1 meter Intervals											
30	29.875	35.308	22.000	2.73	5.85	43.94	94.1	9.66	8.15	0.68	6
29	29.881	35.307	21.997	2.76	5.88	44.44	94.6	9.66	8.15	0.57	6
28	29.886	35.307	21.995	2.78	5.90	44.73	94.9	9.67	8.16	0.56	6
27	29.886	35.306	21.994	2.79	5.91	44.77	94.9	9.67	8.16	0.66	5
26	29.886	35.307	21.995	2.80	5.92	45.00	95.2	9.66	8.15	0.60	5
25	29.891	35.304	21.991	2.81	5.93	45.16	95.3	9.66	8.15	0.62	2
24	29.893	35.303	21.990	2.82	5.94	45.32	95.5	9.67	8.16	0.51	7
23	29.901	35.301	21.986	2.82	5.94	45.39	95.6	9.66	8.15	0.69	3
22	29.914	35.295	21.977	2.82	5.94	45.30	95.5	9.66	8.15	0.67	3
21	29.923	35.293	21.972	2.82	5.94	45.30	95.5	9.66	8.15	0.70	5
20	29.931	35.291	21.968	2.82	5.94	45.41	95.6	9.66	8.15	0.60	4
19	29.937	35.290	21.965	2.83	5.95	45.57	95.8	9.66	8.15	0.54	4
18	29.944	35.288	21.962	2.85	5.97	45.78	96.0	9.66	8.15	0.51	4
17	29.948	35.287	21.959	2.86	5.98	46.03	96.2	9.66	8.15	0.49	4
16	29.952	35.287	21.958	2.87	5.99	46.25	96.5	9.67	8.16	0.46	4
15	29.959	35.283	21.952	2.90	6.02	46.61	96.8	9.67	8.16	0.42	5
14	29.972	35.277	21.944	2.91	6.03	46.83	97.0	9.67	8.16	0.42	2
13	29.980	35.274	21.939	2.92	6.04	47.07	97.3	9.67	8.16	0.42	5
12	29.987	35.272	21.934	2.94	6.06	47.25	97.5	9.67	8.16	0.50	4
11	29.999	35.264	21.924	2.95	6.07	47.44	97.7	9.67	8.16	0.75	3
10	30.009	35.255	21.914	2.95	6.07	47.57	97.8	9.66	8.15	0.57	3
9	30.024	35.237	21.896	2.96	6.08	47.69	97.9	9.67	8.16	0.55	6
8	30.041	35.214	21.873	2.97	6.09	47.83	98.1	9.66	8.15	0.51	3
7	30.054	35.204	21.861	2.97	6.09	47.89	98.1	9.66	8.15	0.80	3
6	30.073	35.203	21.853	2.97	6.09	47.92	98.2	9.66	8.15	0.61	5
5	30.083	35.205	21.851	2.98	6.10	47.98	98.3	9.66	8.15	0.64	3
4	30.096	35.203	21.845	2.98	6.10	48.08	98.4	9.66	8.15	0.79	4
3	30.135	35.190	21.822	3.01	6.13	48.56	98.9	9.65	8.14	0.70	4
2	30.232	35.155	21.763	3.08	6.20	49.68	100.1	9.65	8.14	0.73	3
1	30.336	35.119	21.701	3.14	6.26	50.80	101.3	9.65	8.14	1.18	4
Summary (Includes Downcast and Upcast)											
Min	29.869	35.119	21.701	2.72	5.84	43.70	93.84	9.65	8.14	0.370	Min
Max	30.347	35.309	22.003	3.16	6.28	51.20	101.67	9.70	8.19	2.640	Max
Average	29.989	35.265	21.928	2.91	6.03	46.83	97.05	9.67	8.16	0.670	Average
Std. Dev.	0.109	0.048	0.073	0.11	0.11	1.80	1.87	0.01	0.01	0.357	Std. Dev.

Station U Vertical Profile Data (Cast 11)											
Pago Pago Harbor Water Quality Monitoring											
20 March 2003 - Non Tradewind											
Depth	Temp	Salinity	Sigma-t	DO (mg/l)		DO (% Sat)		pH (SU)		Turbidity	No. Scans
(m)	°C	PSU	kg/m^3	Raw	Corrected	Raw	Corrected	Raw	Corrected	NTU	Averaged
Downcast Data - Bin Averaged at 1 meter Intervals											
1	30.366	35.113	21.685	3.06	6.18	49.45	99.9	9.71	8.20	0.65	2
2	30.260	35.165	21.761	3.03	6.15	48.88	99.3	9.70	8.19	0.82	2
3	30.236	35.168	21.771	3.01	6.13	48.66	99.1	9.70	8.19	0.70	1
4	30.224	35.170	21.777	3.00	6.12	48.47	98.9	9.70	8.19	0.60	2
5	30.169	35.190	21.811	2.99	6.11	48.24	98.6	9.70	8.19	0.57	2
6	30.108	35.210	21.847	2.98	6.10	48.09	98.4	9.70	8.19	0.57	2
7	30.065	35.222	21.871	2.98	6.10	47.98	98.3	9.70	8.19	0.55	1
8	30.052	35.224	21.876	2.98	6.10	47.95	98.2	9.70	8.19	0.56	2
9	30.037	35.240	21.893	2.98	6.10	48.03	98.3	9.70	8.19	0.73	2
10	30.023	35.259	21.913	2.99	6.11	48.14	98.4	9.70	8.19	0.45	1
11	30.008	35.272	21.928	2.99	6.11	48.08	98.3	9.70	8.19	0.43	2
12	29.995	35.282	21.939	2.98	6.10	47.98	98.2	9.71	8.20	0.41	2
13	29.988	35.284	21.943	2.98	6.10	47.94	98.2	9.71	8.20	0.42	2
14	29.979	35.283	21.946	2.97	6.09	47.84	98.1	9.70	8.19	0.38	2
15	29.974	35.285	21.949	2.97	6.09	47.80	98.0	9.70	8.19	0.38	3
16	29.972	35.288	21.951	2.97	6.09	47.84	98.1	9.70	8.19	0.40	2
17	29.974	35.288	21.951	2.97	6.09	47.84	98.1	9.70	8.19	0.44	2
18	29.974	35.288	21.951	2.97	6.09	47.82	98.0	9.70	8.19	0.43	2
19	29.971	35.289	21.953	2.97	6.09	47.73	97.9	9.70	8.19	0.41	2
20	29.968	35.287	21.952	2.96	6.08	47.59	97.8	9.70	8.19	0.45	2
21	29.957	35.287	21.956	2.94	6.06	47.34	97.5	9.70	8.19	0.41	2
22	29.947	35.290	21.962	2.92	6.04	47.02	97.2	9.70	8.19	0.42	3
23	29.944	35.292	21.965	2.89	6.01	46.53	96.7	9.70	8.19	0.42	2
24	29.942	35.288	21.962	2.86	5.98	46.06	96.2	9.70	8.19	0.37	2
25	29.928	35.245	21.935	2.82	5.94	45.35	95.5	9.70	8.19	0.33	2
26	29.738	35.242	21.997	2.78	5.90	44.62	94.6	9.69	8.18	0.53	3
27	29.627	35.227	22.023	2.76	5.88	44.13	94.1	9.68	8.17	0.87	1
28	29.580	35.216	22.031	2.73	5.85	43.63	93.5	9.68	8.17	1.27	3
29	29.520	35.232	22.063	2.71	5.83	43.30	93.1	9.67	8.16	1.43	2
30	29.593	35.197	22.012	2.70	5.82	43.18	93.1	9.67	8.16	1.47	2
31	29.524	35.218	22.051	2.70	5.82	43.17	93.0	9.67	8.16	1.37	3
32	29.501	35.242	22.077	2.71	5.83	43.24	93.1	9.67	8.16	1.47	2
33	29.561	35.229	22.047	2.70	5.82	43.19	93.1	9.67	8.16	1.57	2
34	29.594	35.268	22.065	2.69	5.81	43.09	93.0	9.67	8.16	1.25	3
35	29.580	35.288	22.085	2.68	5.80	42.81	92.7	9.68	8.17	1.02	2
36	29.540	35.277	22.091	2.66	5.78	42.47	92.3	9.67	8.16	0.95	2
37	29.476	35.272	22.108	2.62	5.74	41.82	91.6	9.66	8.15	1.16	3
38	29.473	35.275	22.111	2.59	5.71	41.42	91.2	9.67	8.16	1.32	2
39	29.444	35.280	22.125	2.58	5.70	41.19	91.0	9.66	8.15	1.31	2
40	29.270	35.371	22.252	2.58	5.70	41.07	90.7	9.66	8.15	1.29	1
41	29.164	35.427	22.329	2.58	5.70	40.96	90.6	9.66	8.15	1.66	3
42	29.132	35.437	22.348	2.57	5.69	40.78	90.4	9.66	8.15	1.80	2
43	29.116	35.441	22.357	2.56	5.68	40.66	90.2	9.66	8.15	1.87	2
44	29.077	35.447	22.374	2.56	5.68	40.60	90.1	9.66	8.15	2.03	2
45	29.031	35.469	22.406	2.56	5.68	40.59	90.1	9.66	8.15	2.61	6

Station U Vertical Profile Data (Cast 11)											
Pago Pago Harbor Water Quality Monitoring											
20 March 2003 - Non Tradewind											
Depth	Temp	Salinity	Sigma-t	DO (mg/l)		DO (% Sat)		pH (SU)		Turbidity	No. Scans
(m)	°C	PSU	kg/m^3	Raw	Corrected	Raw	Corrected	Raw	Corrected	NTU	Averaged
Upcast Data - Bin Averaged at 1 meter Intervals											
44	29.086	35.448	22.372	2.56	5.68	40.65	90.2	9.66	8.15	2.05	5
43	29.105	35.443	22.362	2.56	5.68	40.65	90.2	9.66	8.15	2.03	3
42	29.097	35.443	22.364	2.56	5.68	40.70	90.3	9.66	8.15	2.00	8
41	29.130	35.433	22.345	2.57	5.69	40.82	90.4	9.66	8.15	1.81	3
40	29.153	35.433	22.338	2.59	5.71	41.15	90.8	9.66	8.15	1.61	4
39	29.279	35.359	22.240	2.60	5.72	41.42	91.1	9.66	8.15	1.37	4
38	29.419	35.285	22.137	2.60	5.72	41.50	91.3	9.66	8.15	1.27	2
37	29.440	35.275	22.123	2.61	5.73	41.65	91.4	9.66	8.15	1.44	4
36	29.454	35.262	22.108	2.63	5.75	41.95	91.7	9.66	8.15	1.12	4
35	29.523	35.249	22.075	2.65	5.77	42.31	92.2	9.66	8.15	0.93	4
34	29.555	35.260	22.073	2.66	5.78	42.59	92.5	9.66	8.15	1.26	2
33	29.514	35.263	22.088	2.67	5.79	42.67	92.5	9.66	8.15	1.46	4
32	29.566	35.226	22.043	2.69	5.81	42.97	92.8	9.65	8.14	1.13	6
31	29.633	35.213	22.011	2.70	5.82	43.27	93.2	9.66	8.15	1.29	3
30	29.605	35.226	22.030	2.73	5.85	43.63	93.5	9.66	8.15	1.17	4
29	29.695	35.201	21.981	2.76	5.88	44.18	94.2	9.66	8.15	0.83	4
28	29.756	35.215	21.970	2.80	5.92	44.85	94.9	9.66	8.15	0.66	4
27	29.830	35.217	21.947	2.82	5.94	45.23	95.3	9.67	8.16	0.57	2
26	29.853	35.251	21.965	2.83	5.95	45.48	95.6	9.67	8.16	0.48	5
25	29.885	35.258	21.959	2.85	5.97	45.85	96.0	9.67	8.16	0.32	5
24	29.918	35.264	21.952	2.87	5.99	46.10	96.3	9.67	8.16	0.35	5
23	29.931	35.275	21.956	2.88	6.00	46.28	96.5	9.68	8.17	0.44	3
22	29.935	35.275	21.955	2.88	6.00	46.35	96.5	9.68	8.17	0.38	3
21	29.937	35.274	21.953	2.89	6.01	46.45	96.6	9.68	8.17	0.39	2
20	29.940	35.274	21.952	2.90	6.02	46.65	96.8	9.68	8.17	0.40	3
19	29.950	35.272	21.947	2.91	6.03	46.83	97.0	9.68	8.17	0.41	3
18	29.957	35.274	21.946	2.92	6.04	47.04	97.2	9.68	8.17	0.40	4
17	29.961	35.273	21.944	2.93	6.05	47.17	97.4	9.68	8.17	0.43	3
16	29.964	35.273	21.943	2.93	6.05	47.20	97.4	9.68	8.17	0.40	4
15	29.964	35.273	21.943	2.94	6.06	47.26	97.5	9.68	8.17	0.39	3
14	29.968	35.271	21.940	2.94	6.06	47.39	97.6	9.68	8.17	0.42	3
13	29.979	35.270	21.936	2.95	6.07	47.56	97.8	9.68	8.17	0.40	5
12	29.990	35.267	21.930	2.97	6.09	47.77	98.0	9.68	8.17	0.49	3
11	30.004	35.257	21.917	2.97	6.09	47.86	98.1	9.68	8.17	0.45	11
10	30.016	35.245	21.905	2.97	6.09	47.77	98.0	9.68	8.17	0.41	10
9	30.025	35.231	21.891	2.96	6.08	47.65	97.9	9.67	8.16	0.54	9
8	30.026	35.219	21.881	2.95	6.07	47.53	97.8	9.67	8.16	0.56	8
7	30.040	35.203	21.865	2.95	6.07	47.53	97.8	9.67	8.16	0.57	6
6	30.066	35.197	21.852	2.96	6.08	47.67	97.9	9.67	8.16	0.58	4
5	30.094	35.192	21.838	2.97	6.09	47.85	98.1	9.67	8.16	0.60	3
4	30.143	35.180	21.812	2.98	6.10	48.01	98.3	9.66	8.15	0.56	4
3	30.198	35.159	21.778	2.99	6.11	48.19	98.6	9.66	8.15	0.64	3
2	30.248	35.147	21.751	3.01	6.13	48.58	99.0	9.66	8.15	0.80	4
1	30.325	35.113	21.700	3.04	6.16	49.21	99.7	9.66	8.15	0.16	3
Summary (Includes Downcast and Upcast)											
Min	29.031	35.113	21.685	2.56	5.68	40.59	90.11	9.65	8.14	0.160	Min
Max	30.366	35.469	22.406	3.06	6.18	49.45	99.93	9.71	8.20	2.610	Max
Average	29.772	35.268	22.005	2.82	5.94	45.30	95.36	9.68	8.17	0.860	Average
Std. Dev.	0.341	0.076	0.164	0.16	0.16	2.81	3.07	0.02	0.02	0.540	Std. Dev.

Station 11 Vertical Profile Data (Cast 12)											
Pago Pago Harbor Water Quality Monitoring											
20 March 2003 - Non Tradewind											
Depth	Temp	Salinity	Sigma-t	DO (mg/l)		DO (% Sat)		pH (SU)		Turbidity	No. Scans
(m)	°C	PSU	kg/m^3	Raw	Corrected	Raw	Corrected	Raw	Corrected	NTU	Averaged
Downcast Data - Bin Averaged at 1 meter Intervals											
1	30.897	34.933	21.367	4.29	7.41	69.93	120.8	9.88	8.37	3.02	3
2	30.803	34.968	21.426	3.96	7.08	64.52	115.3	9.84	8.33	6.87	1
3	30.705	35.003	21.486	3.74	6.86	60.85	111.6	9.81	8.30	4.85	2
4	30.519	35.076	21.605	3.55	6.67	57.63	108.2	9.78	8.27	3.34	1
5	30.206	35.226	21.825	3.44	6.56	55.63	106.0	9.73	8.22	2.12	2
6	30.139	35.241	21.860	3.37	6.49	54.32	104.7	9.70	8.19	1.14	1
7	30.100	35.255	21.883	3.31	6.43	53.38	103.7	9.70	8.19	0.70	1
8	30.099	35.253	21.882	3.26	6.38	52.60	102.9	9.69	8.18	0.72	2
9	30.084	35.259	21.892	3.22	6.34	51.85	102.1	9.69	8.18	0.68	2
10	30.063	35.268	21.905	3.18	6.30	51.22	101.5	9.69	8.18	0.63	1
11	30.053	35.271	21.911	3.14	6.26	50.66	100.9	9.69	8.18	0.70	2
12	30.049	35.270	21.912	3.12	6.24	50.24	100.5	9.69	8.18	0.49	1
13	30.044	35.266	21.910	3.09	6.21	49.85	100.1	9.69	8.18	0.50	2
14	30.025	35.267	21.918	3.07	6.19	49.39	99.6	9.69	8.18	0.44	1
15	30.020	35.268	21.920	3.05	6.17	49.10	99.4	9.69	8.18	0.93	2
16	30.013	35.273	21.927	3.04	6.16	48.89	99.1	9.69	8.18	0.53	1
17	30.006	35.280	21.934	3.02	6.14	48.67	98.9	9.69	8.18	0.47	2
18	30.005	35.282	21.936	3.01	6.13	48.46	98.7	9.69	8.18	0.49	1
19	30.004	35.283	21.937	2.99	6.11	48.20	98.4	9.69	8.18	0.46	2
20	30.004	35.283	21.937	2.97	6.09	47.82	98.1	9.69	8.18	0.40	1
21	30.002	35.284	21.938	2.94	6.06	47.29	97.5	9.69	8.18	0.38	1
22	29.994	35.286	21.942	2.90	6.02	46.64	96.9	9.69	8.18	0.38	2
23	29.984	35.286	21.946	2.85	5.97	45.94	96.2	9.68	8.17	0.37	1
24	29.970	35.288	21.952	2.80	5.92	45.08	95.3	9.68	8.17	0.47	2
25	29.963	35.285	21.953	2.76	5.88	44.37	94.6	9.68	8.17	0.57	1
26	29.945	35.287	21.960	2.73	5.85	43.92	94.1	9.67	8.16	0.46	2
27	29.930	35.286	21.965	2.72	5.84	43.70	93.9	9.66	8.15	0.59	1
28	29.901	35.295	21.981	2.72	5.84	43.78	93.9	9.66	8.15	0.71	2
29	29.869	35.307	22.001	2.73	5.85	43.90	94.0	9.66	8.15	0.79	1
30	29.848	35.309	22.010	2.74	5.86	43.99	94.1	9.67	8.16	0.93	2
31	29.815	35.315	22.025	2.73	5.85	43.76	93.9	9.67	8.16	0.96	1
32	29.765	35.329	22.054	2.69	5.81	43.12	93.2	9.68	8.17	0.75	2
33	29.740	35.329	22.062	2.62	5.74	41.97	92.0	9.68	8.17	0.75	1
34	29.725	35.326	22.065	2.57	5.69	41.29	91.3	9.67	8.16	1.00	2
35	29.694	35.328	22.077	2.54	5.66	40.77	90.8	9.66	8.15	2.33	1
36	29.668	35.312	22.073	2.53	5.65	40.53	90.5	9.66	8.15	3.53	2
37	29.472	35.352	22.170	2.51	5.63	40.05	89.9	9.66	8.15	2.18	2
38	29.216	35.439	22.321	2.50	5.62	39.77	89.4	9.66	8.15	2.93	1
39	29.121	35.456	22.365	2.49	5.61	39.54	89.1	9.65	8.14	4.63	2
40	29.065	35.456	22.385	2.48	5.60	39.34	88.9	9.65	8.14	5.46	1
41	28.958	35.488	22.445	2.47	5.59	39.23	88.7	9.64	8.13	5.77	2
42	28.884	35.508	22.484	2.48	5.60	39.22	88.6	9.65	8.14	6.53	1
43	28.857	35.510	22.495	2.48	5.60	39.19	88.6	9.65	8.14	6.92	2
44	28.813	35.520	22.517	2.48	5.60	39.19	88.6	9.65	8.14	7.10	2
45	28.780	35.525	22.532	2.48	5.60	39.16	88.5	9.65	8.14	7.20	1
46	28.749	35.526	22.543	2.47	5.59	39.10	88.4	9.65	8.14	7.36	2
47	28.743	35.492	22.519	2.48	5.60	39.14	88.4	9.65	8.14	7.52	1
48	28.694	35.349	22.428	2.47	5.59	39.02	88.2	9.65	8.14	7.88	2
49	28.632	34.707	21.966	2.47	5.59	38.85	87.8	9.65	8.14	8.27	1
50	28.647	35.203	22.334	2.47	5.59	38.87	88.0	9.65	8.14	12.36	7

Station 11 Vertical Profile Data (Cast 12)											
Pago Pago Harbor Water Quality Monitoring											
20 March 2003 - Non Tradewind											
Depth	Temp	Salinity	Sigma-t	DO (mg/l)		DO (% Sat)		pH (SU)		Turbidity	No. Scans
(m)	°C	PSU	kg/m^3	Raw	Corrected	Raw	Corrected	Raw	Corrected	NTU	Averaged
Upcast Data - Bin Averaged at 1 meter Intervals											
49	28.659	35.511	22.561	2.48	5.60	39.11	88.3	9.65	8.14	9.73	3
48	28.685	35.541	22.575	2.49	5.61	39.28	88.5	9.65	8.14	8.40	6
47	28.695	35.537	22.569	2.49	5.61	39.28	88.5	9.64	8.13	7.72	4
46	28.724	35.529	22.554	2.48	5.60	39.24	88.5	9.64	8.13	7.41	5
45	28.745	35.524	22.542	2.48	5.60	39.19	88.5	9.64	8.13	7.55	3
44	28.755	35.521	22.537	2.48	5.60	39.24	88.6	9.64	8.13	7.23	4
43	28.789	35.512	22.519	2.48	5.60	39.18	88.5	9.64	8.13	7.06	5
42	28.835	35.501	22.495	2.47	5.59	39.13	88.5	9.64	8.13	6.87	6
41	28.869	35.494	22.479	2.48	5.60	39.19	88.6	9.64	8.13	6.27	5
40	28.943	35.469	22.436	2.47	5.59	39.22	88.7	9.64	8.13	5.75	4
39	29.022	35.453	22.397	2.47	5.59	39.24	88.7	9.63	8.12	5.51	6
38	29.097	35.431	22.355	2.50	5.62	39.68	89.2	9.63	8.12	4.32	5
37	29.303	35.357	22.230	2.53	5.65	40.32	90.0	9.63	8.12	2.27	3
36	29.541	35.301	22.108	2.56	5.68	41.00	90.9	9.64	8.13	1.31	5
35	29.652	35.304	22.073	2.58	5.70	41.26	91.2	9.64	8.13	3.93	4
34	29.685	35.301	22.059	2.57	5.69	41.16	91.2	9.63	8.12	1.43	4
33	29.721	35.299	22.045	2.60	5.72	41.76	91.8	9.64	8.13	0.78	4
32	29.739	35.301	22.041	2.66	5.78	42.70	92.7	9.65	8.14	0.69	3
31	29.766	35.299	22.030	2.70	5.82	43.39	93.4	9.65	8.14	0.75	4
30	29.805	35.294	22.013	2.72	5.84	43.70	93.8	9.65	8.14	0.82	4
29	29.832	35.289	22.000	2.71	5.83	43.55	93.7	9.65	8.14	0.89	3
28	29.861	35.280	21.983	2.68	5.80	43.08	93.2	9.65	8.14	0.73	3
27	29.892	35.271	21.966	2.64	5.76	42.50	92.6	9.64	8.13	0.72	3
26	29.916	35.265	21.954	2.61	5.73	42.03	92.2	9.63	8.12	0.55	4
25	29.938	35.261	21.943	2.62	5.74	42.18	92.4	9.63	8.12	0.55	3
24	29.949	35.264	21.942	2.67	5.79	42.89	93.1	9.63	8.12	0.53	4
23	29.960	35.266	21.940	2.71	5.83	43.57	93.8	9.64	8.13	0.49	4
22	29.973	35.264	21.934	2.75	5.87	44.21	94.4	9.65	8.14	0.38	4
21	29.983	35.266	21.931	2.80	5.92	45.08	95.3	9.65	8.14	0.39	21
20	29.989	35.267	21.930	2.85	5.97	45.80	96.0	9.66	8.15	0.40	20
19	29.994	35.264	21.926	2.87	5.99	46.28	96.5	9.66	8.15	0.47	19
18	29.998	35.262	21.924	2.89	6.01	46.53	96.8	9.66	8.15	0.45	18
17	30.000	35.260	21.921	2.89	6.01	46.60	96.8	9.66	8.15	0.61	4
16	30.002	35.259	21.919	2.90	6.02	46.73	97.0	9.66	8.15	0.55	4
15	30.008	35.256	21.915	2.91	6.03	46.89	97.1	9.66	8.15	0.44	5
14	30.012	35.250	21.910	2.93	6.05	47.15	97.4	9.66	8.15	0.41	5
13	30.016	35.247	21.906	2.95	6.07	47.48	97.7	9.67	8.16	0.45	5
12	30.033	35.244	21.898	2.95	6.07	47.58	97.8	9.67	8.16	0.58	4
11	30.044	35.245	21.895	2.95	6.07	47.59	97.9	9.66	8.15	0.51	5
10	30.050	35.247	21.894	2.96	6.08	47.64	97.9	9.66	8.15	0.57	3
9	30.064	35.242	21.886	2.96	6.08	47.75	98.0	9.66	8.15	0.66	6
8	30.080	35.234	21.874	2.97	6.09	47.93	98.2	9.66	8.15	0.69	4
7	30.087	35.228	21.868	2.98	6.10	48.07	98.4	9.66	8.15	0.88	5
6	30.103	35.221	21.857	2.99	6.11	48.29	98.6	9.66	8.15	0.82	5
5	30.133	35.211	21.839	3.03	6.15	48.91	99.2	9.66	8.15	1.64	4
4	30.278	35.156	21.748	3.16	6.28	51.13	101.6	9.68	8.17	3.42	5
3	30.525	35.060	21.591	3.45	6.57	55.97	106.6	9.73	8.22	5.55	6
2	30.701	34.985	21.474	3.88	7.00	63.05	113.8	9.77	8.26	7.11	6
1	30.830	34.938	21.394	4.26	7.38	69.29	120.1	9.82	8.31	4.22	7
Summary (Includes Downcast and Upcast)											
Min	28.632	34.707	21.367	2.47	5.59	38.85	87.84	9.63	8.12	0.370	Min
Max	30.897	35.541	22.575	4.29	7.41	69.93	120.79	9.88	8.37	12.360	Max
Average	29.713	35.299	22.047	2.84	5.96	45.50	95.52	9.67	8.16	2.707	Average
Std. Dev.	0.572	0.144	0.283	0.39	0.39	6.56	6.91	0.04	0.04	2.930	Std. Dev.

Station 13 Vertical Profile Data (Cast 13)											
Pago Pago Harbor Water Quality Monitoring											
20 March 2003 - Non Tradewind											
Depth	Temp	Salinity	Sigma-t	DO (mg/l)		DO (% Sat)		pH (SU)		Turbidity	No. Scans
(m)	°C	PSU	kg/m^3	Raw	Corrected	Raw	Corrected	Raw	Corrected	NTU	Averaged
Downcast Data - Bin Averaged at 1 meter Intervals											
1	30.443	35.131	21.672	2.55	5.67	41.30	91.8	9.63	8.12	2.44	2
2	30.392	35.143	21.699	2.54	5.66	41.09	91.6	9.64	8.13	1.72	3
3	30.346	35.153	21.722	2.46	5.58	39.82	90.3	9.64	8.13	1.41	2
4	30.279	35.175	21.762	2.38	5.50	38.40	88.8	9.63	8.12	1.32	3
5	30.222	35.190	21.792	2.26	5.38	36.56	86.9	9.61	8.10	1.69	3
6	30.175	35.202	21.817	2.14	5.26	34.47	84.8	9.60	8.09	1.83	2
7	30.147	34.958	21.644	2.01	5.13	32.39	82.7	9.58	8.07	3.64	4
Upcast Data - Bin Averaged at 1 meter Intervals											
7	30.151	35.501	22.050	1.88	5.00	30.31	80.7	9.57	8.06	4.59	8
6	30.162	35.215	21.832	1.97	5.09	31.84	82.2	9.58	8.07	2.48	7
5	30.181	35.202	21.816	2.10	5.22	33.85	84.2	9.60	8.09	1.65	7
4	30.226	35.190	21.791	2.23	5.35	35.96	86.4	9.60	8.09	1.74	10
3	30.280	35.176	21.762	2.32	5.44	37.57	88.0	9.62	8.11	1.55	6
2	30.353	35.153	21.720	2.43	5.55	39.24	89.7	9.62	8.11	1.56	6
1	30.396	35.143	21.697	2.50	5.62	40.48	91.0	9.63	8.12	0.30	5
Summary (Includes Downcast and Upcast)											
Min	30.147	34.958	21.644	1.88	5.00	30.31	80.72	9.57	8.06	0.300	Min
Max	30.443	35.501	22.050	2.55	5.67	41.30	91.84	9.64	8.13	4.590	Max
Average	30.268	35.181	21.770	2.27	5.39	36.66	87.09	9.61	8.10	1.994	Average
Std. Dev.	0.102	0.111	0.099	0.22	0.22	3.63	3.69	0.02	0.02	1.049	Std. Dev.

Appendix IV

Chain-of-Custody Records

AMTEST
AmTest Inc. Professional Analytical Services
14603 N.E. 87th St. Redmond, WA 98052
Fax: 206 883 3495
Tel: 206 885 1664

CHAIN OF CUSTODY RECORD

PROJ. NO.: 147323.JC.03.NT

PROJECT NAME: SAMOA JOINT CANNERY OUTFALL

SAMPLERS: (Signature)
STEVE COSTA
PO BOX 1238
TRINIDAD, CA 95570
707-677-0123

Analysis Requested

AMTEST I.D. NO.	CLIENT SAMPLE I.D. (25 Characters)	DATE	TIME	MATRIX	No. of Containers	AMMONIA	TKN	NITRATE+NITRITE	TOTAL PHOSPHORUS	TSS	TURBIDITY	CHLOROPHYLL-A
	5-S	3/20/03		SEA WATER	3*							
	5-M											
	5-B											
	8-S	3/14/03										
	8-M											
	8-B											
	8A-S											
	8A-M											
	8A-B											
	11-S	3/20/03										
	11-M											
	11-B											
	13-S											
	13-M											
	13-B											

2 LITERS FILTERED

ANALYSIS PER SEPARATE INSTRUCTIONS

Remarks: FOR EACH SAMPLE:
1 BOTTLE PRESERVED
1 BOTTLE NOT PRESERVED
1 FILTER
USE METHODS AND DETECTION LIMITS USED IN ~~[illegible]~~ AUGUST 2002 FOR SAME PROJECT
SAMPES ARE SALT WATER @ 35 ppt

2 LITERS FILTERD FOR CHLOROPHYLL-A SAMPLES

Relinquished by: (Signature)	Date/Time	Received by: (Signature)
S A Costa	3/24/03	
Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Relinquished by: (Signature)	Date/Time	Received for Laboratory by: (Signature)
	3/27/03	

Client Name

Client Address

SHIPPED DHL # 819 0660 155

Client Phone | Fax

Contact Person | P.O. No.

Distribution: Original Accompanies Shipment; Copy to Coordinator Field Files

AMTEST
AmTest Inc. Professional Analytical Services
14603 N.E. 87th St. Redmond, WA 98052
Fax: 206 883 3495
Tel: 206 885 1664

CHAIN OF CUSTODY RECORD

PROJ. NO. 147323.JC.03.NT

PROJECT NAME: SAMOA JOINT CANNER OUTFALL

SAMPLERS: (Signature) See p. 1 of 4

Analysis Requested: No. of Containers; AMMONIA; TKN; NITRATE+NITRITE; TOTAL PHOSPHORUS; TSS; TURBIDITY; CHLOROPHYLL A

2 LITERS FILTERED FOR CHLOROPHYLL SAMPLE

AMTEST I.D. NO.	CLIENT SAMPLE I.D. (25 Characters)	DATE	TIME	MATRIX	No. of Containers	Remarks
	14-S	3/19/13		SEA WATER	3	
	14-M					
	14-B					
	15-S	3/20/13				
	15-M					
	15-B					
	16-S					
	16-M					
	16-B					
	18-S					
	18-M					
	18-B					
	[redacted]					

Remarks: SEE PAGE 1

Relinquished by: (Signature)	Date/Time	Received by: (Signature)
[signature]	3/24/13	
Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Relinquished by: (Signature)	Date/Time	Received for Laboratory by: (Signature)
	3/25/13	[signature]

Client Name
Client Address
Client Phone
Fax
Contact Person
P.O. No.

Distribution: Original Accompanies Shipment; Copy to Coordinator Field Files

AMTEST

AmTest Inc.
Professional
Analytical
Services

14603 N.E. 87th St.
Redmond, WA
98052

Fax: 206 883 3495
Tel: 206 885 1664

CHAIN OF CUSTODY RECORD

PROJ. NO.: 147323.JC.03.NT

PROJECT NAME: SAMOA JOINT CANNERY OUTFALL

SAMPLERS: (Signature) See p. 1

Analysis Requested

AMTEST I.D. NO.	CLIENT SAMPLE I.D. (25 Characters)	DATE	TIME	MATRIX	No. of Containers	TKN	NITRATE + NITRITE	TOTAL PHOSPHORUS	TURBIDITY	CHLOROPHYLL-A							Remarks
	A1-S	3/14/03		SEA WATER	3												See page 1
	A1-M																
	A1-B																
	B1-S																
	B1-M																
	B1-B																
	C-S																
	C-M																
	C-B																
	U-S	3/20/03															
	U-M																
	U-B																

2 LITERS FILTERED FOR CHLOROPHYLL SAMPLE

Relinquished by: (Signature)	Date/Time	Received by: (Signature)
[signature]	3/24/03	
Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Relinquished by: (Signature)	Date/Time	Received for Laboratory by: (Signature)
	3/27/03	[signature]

Client Name

Client Address

Client Phone

Fax

Contact Person

P.O. No.

Distribution: Original Accompanies Shipment; Copy to Coordinator Field Files

AMTEST

AmTest Inc. Professional Analytical Services
14603 N.E. 87th St.
Redmond, WA 98052
Fax: 206 883 3495
Tel: 206 885 1664

CHAIN OF CUSTODY RECORD

PROJ. NO.

PROJECT NAME

SAMPLERS: (Signature)

SEE PAGE 1 of 4

Analysis Requested

AMTEST I.D. NO.	CLIENT SAMPLE I.D. (25 Characters)	DATE	TIME	MATRIX	No. of Containers	TKN	NITRATE + NITRITE	TOTAL PHOSPHORUS	TSS	Remarks
	S1-A	3/21/03		FRESH WATER	2					FOR EACH SAMPLE
	S1-B									1 BOTTLE PRESERVED
	S2-A									1 BOTTLE NOT PRESERVED
	S2-B									
	S3-A									USE METHODS AND
	S3-B									DETECTION LIMITS AS
	S4-A									FOR AUGUST 2002
	S4-B									SAMPLES
	S5-A									
	S5-B									NOTE: THESE
										SAMPLES ARE
										FRESH WATER

Relinquished by: (Signature)	Date/Time	Received by: (Signature)
[signature]		
Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Relinquished by: (Signature)	Date/Time 3/27/03	Received for Laboratory by: (Signature) [signature]

Client Name

Client Address

Client Phone

Fax

Contact Person

P.O. No.

Distribution: Original Accompanies Shipment; Copy to Coordinator Field Files

Columbia Analytical Services INC.
An Employee-Owned Company

CHAIN OF CUSTODY

1317 South 13th Ave. • Kelso, WA 98626 • (360) 577-7222 • (800) 695-7222 • FAX (360) 636-1068

SR#: Y230 2324

PAGE 1 OF 4 COC #

PROJECT NAME: SAMOA JOINT CANNERY OUTFALL
PROJECT NUMBER: 147 323. JC. 03. NT
PROJECT MANAGER: STEVE COSTA
COMPANY/ADDRESS: BOX 1238
TRINIDAD, CA 95570
PHONE #: 707-677-0123 FAX #: (707) 677-9210
SAMPLER'S SIGNATURE:

SAMPLE I.D.	DATE	TIME	LAB I.D.	MATRIX	NUMBER OF CONTAINERS	Semivolatile Organics by GC/MS 625☐ 8270☐	Volatile Organics 624☐ 8260☐ 8021☐ BTEX☐	Hydrocarbons (*see below) Gas☐ Diesel☐ Oil☐ ☐ Fuel Fingerprint (FIQ) ☐ NW-HCID Screen	Oil & Grease/TRPH 413.1☐ 418.1☐ 1664 SGT☐ 1664 HEM☐	PCB's Aroclors☐ Congeners☐	Pesticides/Herbicides 608☐ 8081A☐ 8141A☐ 8151A☐	Chlorophenolics - 8151M Tri☐ Tetra☐ PCP☐	PAHS 8310☐ SIM☐	GC/MS-SIM PAH☐ Phenol☐ Phthalates☐	Metals, Total or Dissolved (See list below)	Cyanide☐ Hex-Chrom☐	pH, Cond., Cl, SO_4, PO_4, F, NO_2, NO_3, BOD, TSS, TDS (circle)	NH_3-N, COD, Total-P, TKN, TOC, DOC (circle)	TOX 9020☐ AOX 1650☐ 506☐				REMARKS
5-S	3/26/03		1	SEA WATER	2																			SEA WATER
5-M			2																					
5-B			3																					
11-S	3/26/03		4																					
11-M			5																					
11-B			6																					
13-S			7																					
13-M			8																					
13-B			9																					

00007

REPORT REQUIREMENTS

___ I. Routine Report: Method Blank, Surrogate, as required
X II. Report Dup., MS, MSD as required
___ III. Data Validation Report (includes all raw data)
___ IV. CLP Deliverable Report
___ V. EDD

INVOICE INFORMATION

P.O. #
Bill To:

TURNAROUND REQUIREMENTS

___ 24 hr. ___ 48 hr.
___ 5 Day
___ Standard (10-15 working days)
___ Provide FAX Results

Requested Report Date

Circle which metals are to be analyzed:

Total Metals: Al As Sb Ba Be B Ca Cd Co Cr Cu Fe Pb Mg Mn Mo Ni K Ag Na Se Sr Tl Sn V Zn Hg

Dissolved Metals: Al As Sb Ba Be B Ca Cd Co Cr Cu Fe Pb Mg Mn Mo Ni K Ag Na Se Sr Tl Sn V Zn Hg

*INDICATE STATE HYDROCARBON PROCEDURE: AK CA WI NORHTWEST OTHER:_____ (CIRCLE ONE)

SPECIAL INSTRUCTIONS/COMMENTS:

ANALYZE FOR LOW LEVEL MERCURY, SAMPLES AS DIRECTED
ANALYZE FOR As, Pb, Cu, Zn SAMPLES AS DIRECTED
METHODS & DETECTION LIMITS USE IN AUGUST 2002 SAMPLES

SHIPED DHL 819-0660-284

RELINQUISHED BY:	RECEIVED BY:	RELINQUISHED BY:	RECEIVED BY:
Signature: 24 MAR 03	Signature: 3/27/03	Signature: 1130	Signature
Date/Time	Date/Time	Date/Time	Date/Time
Printed Name	Printed Name	Printed Name	Printed Name
Firm	Firm CAS	Firm	Firm

Columbia Analytical Services INC.
An Employee-Owned Company

CHAIN OF CUSTODY

1317 South 13th Ave. • Kelso, WA 98626 • (360) 577-7222 • (800) 695-7222 • FAX (360) 636-1068

SR#: V230 2324

PAGE 2 OF 4 COC #

00008

PROJECT NAME: SAMOA JOINT CANNER OUTFALL
PROJECT NUMBER: 147323, JC, 03, NT
PROJECT MANAGER:
COMPANY/ADDRESS: SEE PAGE 1
PHONE #: FAX #:
SAMPLER'S SIGNATURE:

SAMPLE I.D.	DATE	TIME	LAB I.D.	MATRIX	NUMBER OF CONTAINERS	Semivolatile Organics by GC/MS 625☐ 8270☐	Volatile Organics 624☐ 8260☐ 8021☐ BTEX☐	Hydrocarbons (*see below) Gas☐ Diesel☐ Oil☐ ☐ Fuel Fingerprint (FIQ) ☐ NW-HCID Screen	Oil & Grease/TRPH 413.1☐ 418.1☐ 1664 SGT☐ 1664 HEM☐	PCB's Aroclors☐ Congeners☐	Pesticides/Herbicides 608☐ 8081A☐ 8141A☐ 8151A☐	Chlorophenolics - 8151M Tri☐ Tetra☐ PCP☐	PAHS 8310☐ SIM☐	GC/MS-SIM PAH☐ Phenol☐ Phthalates☐	Metals, Total or Dissolved (See list below)	Cyanide☐ Hex-Chrom☐	pH, Cond, Cl, SO_4, PO_4, F, NO_2, NO_3, BOD, TSS, TDS (circle)	NH_3-N, COD, Total-P, TKN, TOC, DOC (circle)	TOX 9020☐ AOX 1650☐ 506☐					REMARKS
14-S	3/19/03		10	SOA WATER	2																				SOA WATER
14-M			11																						
14-B			12																						
8-S			13																						
8-M			14																						
8-B			15																						
8A-S			16																						
8A-M			17																						
8A-B			18																						

REPORT REQUIREMENTS

___ I. Routine Report: Method Blank, Surrogate, as required
X II. Report Dup., MS, MSD as required
___ III. Data Validation Report (includes all raw data)
___ IV. CLP Deliverable Report
___ V. EDD

INVOICE INFORMATION
P.O. #
Bill To:

TURNAROUND REQUIREMENTS
___ 24 hr. ___ 48 hr.
___ 5 Day
___ Standard (10-15 working days)
___ Provide FAX Results
Requested Report Date

Circle which metals are to be analyzed:
Total Metals: Al As Sb Ba Be B Ca Cd Co Cr Cu Fe Pb Mg Mn Mo Ni K Ag Na Se Sr Tl Sn V Zn Hg
Dissolved Metals: Al As Sb Ba Be B Ca Cd Co Cr Cu Fe Pb Mg Mn Mo Ni K Ag Na Se Sr Tl Sn V Zn Hg

*INDICATE STATE HYDROCARBON PROCEDURE: AK CA WI NORHTWEST OTHER:_____ (CIRCLE ONE)

SPECIAL INSTRUCTIONS/COMMENTS:
SEE PAGE 1

RELINQUISHED BY:	RECEIVED BY:	RELINQUISHED BY:	RECEIVED BY:
Signature: [signature] Date/Time: 3/24/03	Signature: [signature] Date/Time: 3/27/03 1130	Signature: Date/Time:	Signature: Date/Time:
Printed Name: Firm:	Printed Name: [signature] Firm: CAS	Printed Name: Firm:	Printed Name: Firm:

RCOC #1 04/01

Columbia Analytical Services INC.
An Employee-Owned Company

CHAIN OF CUSTODY

1317 South 13th Ave. • Kelso, WA 98626 • (360) 577-7222 • (800) 695-7222 • FAX (360) 636-1068

SR#: K230 2324

PAGE 3 OF 4 COC #

00009

PROJECT NAME: SAMOA JOINT CANNER OUTFALL
PROJECT NUMBER: 147323. JC.03 NT
PROJECT MANAGER:
COMPANY/ADDRESS: SEE PAGE 4
PHONE #: FAX #:
SAMPLER'S SIGNATURE:

SAMPLE I.D.	DATE	TIME	LAB I.D.	MATRIX	NUMBER OF CONTAINERS	Semivolatile Organics by GC/MS 625 ☐ 8270 ☐	Volatile Organics 624 ☐ 8260 ☐	Hydrocarbons (*see below) Gas ☐ 8021 ☐ BTEX ☐ Diesel ☐ Oil ☐ ☐ Fuel Fingerprint (FIQ) ☐ NW-HCID Screen	Oil & Grease/TRPH 413.1 ☐ 418.1 ☐ 1664 SGT ☐ 1664 HEM ☐	PCB's Aroclors ☐ Congeners ☐	Pesticides/Herbicides 608 ☐ 8081A ☐ 8141A ☐ 8151A ☐	Chlorophenolics - 8151M Tri ☐ Tetra ☐ PCP ☐	PAHS 8310 ☐ SIM ☐	GC/MS-SIM PAH ☐ Phenol ☐ Phthalates ☐	Metals, Total or Dissolved (See list below)	Cyanide ☐ Hex-Chrom ☐	pH, Cond., Cl, SO4, PO4, F, NO2, NO3, BOD, TSS, TDS (circle)	NH3-N, COD, Total-P, TKN, TOC, DOC (circle)	TOX 9020 ☐ AOX 1650 ☐ 506 ☐				REMARKS
15-S	3/20/03		19	SEA WATER	2																				SEA WATER
15-M			20																						
15-B			21																						
S1-A	3/21/03		22	FRESH WATER	1																				FRESH WATER
S1-B			23																						
S2-A			24																						
S2-B			25																						
S3-A			26																						
S3-B			27																						

REPORT REQUIREMENTS

___ I. Routine Report: Method Blank, Surrogate, as required
X II. Report Dup., MS, MSD as required
___ III. Data Validation Report (includes all raw data)
___ IV. CLP Deliverable Report
___ V. EDD

INVOICE INFORMATION

P.O. #
Bill To:

TURNAROUND REQUIREMENTS

___ 24 hr. ___ 48 hr.
___ 5 Day
___ Standard (10-15 working days)
___ Provide FAX Results

Requested Report Date

Circle which metals are to be analyzed:

Total Metals: Al As Sb Ba Be B Ca Cd Co Cr Cu Fe Pb Mg Mn Mo Ni K Ag Na Se Sr Tl Sn V Zn Hg

Dissolved Metals: Al As Sb Ba Be B Ca Cd Co Cr Cu Fe Pb Mg Mn Mo Ni K Ag Na Se Sr Tl Sn V Zn Hg

*INDICATE STATE HYDROCARBON PROCEDURE: AK CA WI NORHTWEST OTHER:_____ (CIRCLE ONE)

SPECIAL INSTRUCTIONS/COMMENTS: SEE PAGE 1

RELINQUISHED BY:	RECEIVED BY:	RELINQUISHED BY:	RECEIVED BY:
Signature: [signature] Date/Time: 3/24/03	Signature: [signature] Date/Time: 3/27/03 1100	Signature: Date/Time:	Signature: Date/Time:
Printed Name: Firm:	Printed Name: Firm: CAS	Printed Name: Firm:	Printed Name: Firm:

RCOC #1 04/01

Columbia Analytical Services INC.
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PAGE 4 OF 4 SR#: K230 2324 COC #

PROJECT NAME: SAMOA JOINT CANNERY OUTFALL
PROJECT NUMBER: 147323.JC.03.NT
PROJECT MANAGER:
COMPANY/ADDRESS: SEE PAGE 1
PHONE #: FAX #:
SAMPLER'S SIGNATURE:

SAMPLE I.D.	DATE	TIME	LAB I.D.	MATRIX	NUMBER OF CONTAINERS	Semivolatile Organics by GC/MS 625☐ 8270☐	Volatile Organics 624☐ 8260☐ 8021☐ BTEX☐	Hydrocarbons (*see below) Gas☐ Diesel☐ Oil☐ ☐ Fuel Fingerprint (FIQ) ☐ NW-HCID Screen	Oil & Grease/TRPH 413.1☐ 418.1☐ 1664 SGT☐ 1664 HEM☐	PCB's Aroclors☐ Congeners☐	Pesticides/Herbicides 608☐ 8081A☐ 8141A☐ 8151A☐	Chlorophenolics - 8151M Tri☐ Tetra☐ PCP☐	PAHS 8310☐ SIM☐	GC/MS-SIM PAH☐ Phenol☐ Phthalates☐	Metals, Total or Dissolved (See list below)	Cyanide☐ Hex-Chrom☐	pH, Cond., Cl, SO4, PO4, F, NO2, NO3, BOD, TSS, TDS (circle) NH3-N, COD, Total-P, TKN, TOC, DOC (circle)	TOX 9020☐ AOX 1650☐ 506☐					REMARKS
S4-A	3/24/03		28	FRESH WATER	1																				FRESH WATER
S4-B	↓		29	↓	↓																				↓
S5-A	↓		30	↓	↓																				↓
S5-B	↓		31	↓	↓																				↓

REPORT REQUIREMENTS

___ I. Routine Report: Method Blank, Surrogate, as required
X II. Report Dup., MS, MSD as required
___ III. Data Validation Report (includes all raw data)
___ IV. CLP Deliverable Report
___ V. EDD

INVOICE INFORMATION
P.O. #
Bill To:

TURNAROUND REQUIREMENTS
___ 24 hr. ___ 48 hr.
___ 5 Day
___ Standard (10-15 working days)
___ Provide FAX Results
Requested Report Date

Circle which metals are to be analyzed:
Total Metals: Al As Sb Ba Be B Ca Cd Co Cr Cu Fe Pb Mg Mn Mo Ni K Ag Na Se Sr Tl Sn V Zn Hg
Dissolved Metals: Al As Sb Ba Be B Ca Cd Co Cr Cu Fe Pb Mg Mn Mo Ni K Ag Na Se Sr Tl Sn V Zn Hg

*INDICATE STATE HYDROCARBON PROCEDURE: AK CA WI NORHTWEST OTHER:_____ (CIRCLE ONE)

SPECIAL INSTRUCTIONS/COMMENTS:
SEE PAGE 1

RELINQUISHED BY:	RECEIVED BY:	RELINQUISHED BY:	RECEIVED BY:
Signature: [signature] Date/Time: 3/24/03	Signature: [signature] Date/Time: 3/27/03 1130	Signature: Date/Time:	Signature: Date/Time:
Printed Name: Firm:	Printed Name: Firm:	Printed Name: Firm:	Printed Name: Firm:

RCOC #1 04/01

Appendix V

Laboratory Report for Nutrients and Biological Parameters

Am Test Inc.
14603 N.E. 87th St.
Redmond, WA
98052

Tel: 425.885.1664
Fax: 425.883.3495
www.amtestlab.com

AMTEST
LABORATORIES

Professional Analytical Services

Apr 23 2003
CH2M Hill
PO Box 1238
Trinidad, CA 95570
Attention: Steve Costa

Dear Steve Costa:

Enclosed please find the analytical data for your Somoa Joint Cannery project.

The following is a cross correlation of client and laboratory identifications for your convenience.

CLIENT ID	MATRIX	AM TEST ID	TEST
5-S	Water	03-A003262	CONV,
5-M	Water	03-A003263	CONV,
5-B	Water	03-A003264	CONV,
8-S	Water	03-A003265	CONV,
8-M	Water	03-A003266	CONV,
8-B	Water	03-A003267	CONV,
8A-S	Water	03-A003268	CONV,
8A-M	Water	03-A003269	CONV,
8A-B	Water	03-A003270	CONV,
11-S	Water	03-A003271	CONV,
13-S	Water	03-A003272	CONV,
13-M	Water	03-A003273	CONV,
13-B	Water	03-A003274	CONV,
14-S	Water	03-A003275	CONV,
14-M	Water	03-A003276	CONV,
14-B	Water	03-A003277	CONV,
16-S	Water	03-A003278	CONV,
16-M	Water	03-A003279	CONV,
16-B	Water	03-A003280	CONV,
18-S	Water	03-A003281	CONV,
18-M	Water	03-A003282	CONV,
18-B	Water	03-A003283	CONV,
A1-S	Water	03-A003284	CONV,
A1-M	Water	03-A003285	CONV,
A1-B	Water	03-A003286	CONV,
B1-S	Water	03-A003287	CONV,
B1-M	Water	03-A003288	CONV,
B1-B	Water	03-A003289	CONV,
C-S	Water	03-A003290	CONV,
C-M	Water	03-A003291	CONV,
C-B	Water	03-A003292	CONV,
U-S	Water	03-A003293	CONV,
U-M	Water	03-A003294	CONV,
U-B	Water	03-A003295	CONV,
S1-A	Water	03-A003296	CONV,

AMTEST
LABORATORIES

CH2M Hill
Steve Costa

CLIENT ID	MATRIX	AM TEST ID	TEST
S1-B	Water	03-A003297	CONV,
S2-A	Water	03-A003298	CONV,
S2-B	Water	03-A003299	CONV,
S3-A	Water	03-A003300	CONV,
S3-B	Water	03-A003301	CONV,
S4-A	Water	03-A003302	CONV,
S4-B	Water	03-A003303	CONV,
S5-A	Water	03-A003304	CONV,
S5-B	Water	03-A003305	CONV,

This was a total of 120 hours (5 days) after sample collection (3/21/03). At the time of receipt, the samples were logged in and properly maintained prior to their subsequent analyses.

The analytical procedures used at Am Test are well documented, and are typically derived from the protocols of the EPA, USDA, FDA or the Army Corps of Engineers.

Following the analytical data you will find the QC results and "Methodology Report". This table includes information relative to the detection limits, analyses dates and method references.

Please note that the detection limits that are listed in the body of the report refer to the Method Detection Limits (MDL's), as opposed to Practical Quantitation Limits (PQL's).

If you should have any questions pertaining to the data package, please feel free to contact me.

Sincerely,

Kathy Fugiel
Director of Inorganic Laboratory

Project #: 147323.JC.03.NT

BACT = Bacteriological
CONV = Conventionals
MET = Metals
ORG = Organics

AMTEST LABORATORIES

METHODOLOGY REPORT

AM TEST ID 03-A003262
CLIENT ID 5-S

MATRIX : Water
SAMPLED: 3/20/03

ANALYTE	UNITS	METHOD NUMBER	METHOD REFERENCE	DETECTION LIMIT *	DATE OF ANALYSIS
Chlorophyll a	mg/m3	1002G	SM	0.03	3/28/03
Pheophytin	mg/m3	1002G	SM	0.03	3/28/03
Ammonia Nitrogen	mg/l	350.1	EPA	0.005	3/28/03
Total Nitrogen	mg/l	351.3M	EPA	0.025	4/ 4/03
Nitrate + Nitrite	mg/l	353.2	EPA	0.010	3/28/03
Total Phosphorus	mg/l	365.1	EPA	0.005	4/ 1/03
Total Suspended Solids	mg/l	160.2	EPA	1.0	4/ 1/03
Turbidity	NTU	2130B	SM	0.01	3/27/03

SM = Standard Methods for the Examination of Water and Wastewater 18th ed.
SW-846 = Test Methods for Evaluating Solid Waste Physical/Chemical Methods
EPA = Methods for Chemical Analysis of Water and Wastes 1983
* Instrument Detection Limit

Am Test Inc.
14603 N.E. 87th St.
Redmond, WA
98052

Tel: 425.885.1664
Fax: 425.883.3495
www.amtestlab.com

AMTEST LABORATORIES

Professional Analytical Services

ANALYSIS REPORT

CH2M Hill
PO Box 1238
Trinidad, CA 95570
Attention: Steve Costa

Date Received: 3/26/03
Date Reported: 4/23/03

Project Name: Somoa Joint Cannery
Project #: 147323.JC.03.NT
Date Sampled: 3/20/03

Water Samples

PARAMETER	UNITS	RESULT
03-A003262		
Client ID: 5-S		
Date Sampled: 3/20/03,		
Chlorophyll a	mg/m3	0.78
Pheophytin	mg/m3	< 0.15
Ammonia Nitrogen	mg/l	< 0.005
Total Nitrogen	mg/l	0.12
Nitrate + Nitrite	mg/l	< 0.01
Total Phosphorus	mg/l	< 0.005
Total Suspended Solids	mg/l	78.
Turbidity	NTU	0.12
03-A003263		
Client ID: 5-M		
Date Sampled: 3/20/03,		
Chlorophyll a	mg/m3	0.73
Pheophytin	mg/m3	< 0.15
Ammonia Nitrogen	mg/l	0.079
Total Nitrogen	mg/l	0.050
Nitrate + Nitrite	mg/l	0.010
Total Phosphorus	mg/l	< 0.005
Total Suspended Solids	mg/l	91.
Turbidity	NTU	0.24

Am Test Inc.
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www.amtestlab.com

AMTEST LABORATORIES

Professional Analytical Services

ANALYSIS REPORT

CH2M Hill
PO Box 1238
Trinidad, CA 95570
Attention: Steve Costa

Date Received: 3/26/03
Date Reported: 4/23/03

Project Name: Somoa Joint Cannery
Project #: 147323.JC.03.NT
Date Sampled: 3/20/03

Water Samples

PARAMETER	UNITS	RESULT
03-A003262		
Client ID: 5-S		
Date Sampled: 3/20/03,		
Chlorophyll a	mg/m3	0.78
Pheophytin	mg/m3	< 0.15
Ammonia Nitrogen	mg/l	< 0.005
Total Nitrogen	mg/l	0.12
Nitrate + Nitrite	mg/l	< 0.01
Total Phosphorus	mg/l	< 0.005
Total Suspended Solids	mg/l	78.
Turbidity	NTU	0.12
03-A003263		
Client ID: 5-M		
Date Sampled: 3/20/03,		
Chlorophyll a	mg/m3	0.73
Pheophytin	mg/m3	< 0.15
Ammonia Nitrogen	mg/l	0.079
Total Nitrogen	mg/l	0.050
Nitrate + Nitrite	mg/l	0.010
Total Phosphorus	mg/l	< 0.005
Total Suspended Solids	mg/l	91.
Turbidity	NTU	0.24

AMTEST
LABORATORIES
ANALYSIS REPORT

CH2M Hill

Date Received: 3/26/03
Date Reported: 4/23/03

Attention: Steve Costa

Water Samples

PARAMETER	UNITS	RESULT
03-A003264		
Client ID: 5-B		
Date Sampled: 3/20/03,		
Chlorophyll a	mg/m3	0.74
Pheophytin	mg/m3	< 0.15
Ammonia Nitrogen	mg/l	0.040
Total Nitrogen	mg/l	< 0.025
Nitrate + Nitrite	mg/l	0.026
Total Phosphorus	mg/l	< 0.005
Total Suspended Solids	mg/l	100
Turbidity	NTU	0.14
03-A003265		
Client ID: 8-S		
Date Sampled: 3/19/03,		
Chlorophyll a	mg/m3	3.0
Pheophytin	mg/m3	< 0.15
Ammonia Nitrogen	mg/l	0.033
Total Nitrogen	mg/l	0.086
Nitrate + Nitrite	mg/l	0.016
Total Phosphorus	mg/l	< 0.005
Total Suspended Solids	mg/l	83.
Turbidity	NTU	0.18
03-A003266		
Client ID: 8-M		
Date Sampled: 3/19/03,		
Chlorophyll a	mg/m3	1.7
Pheophytin	mg/m3	< 0.15
Ammonia Nitrogen	mg/l	0.036
Total Nitrogen	mg/l	0.073
Nitrate + Nitrite	mg/l	0.020
Total Phosphorus	mg/l	0.090
Total Suspended Solids	mg/l	86.
Turbidity	NTU	0.19

AMTEST
LABORATORIES
ANALYSIS REPORT

CH2M Hill

Date Received: 3/26/03
Date Reported: 4/23/03

Attention: Steve Costa

Water Samples

PARAMETER	UNITS	RESULT
03-A003267		
Client ID: 8-B		
Date Sampled: 3/19/03,		
Chlorophyll a	mg/m3	0.69
Pheophytin	mg/m3	< 0.15
Ammonia Nitrogen	mg/l	0.045
Total Nitrogen	mg/l	0.11
Nitrate + Nitrite	mg/l	0.015
Total Phosphorus	mg/l	0.007
Total Suspended Solids	mg/l	84.
Turbidity	NTU	0.12
03-A003268		
Client ID: 8A-S		
Date Sampled: 3/19/03,		
Chlorophyll a	mg/m3	1.9
Pheophytin	mg/m3	< 0.15
Ammonia Nitrogen	mg/l	0.027
Total Nitrogen	mg/l	0.12
Nitrate + Nitrite	mg/l	< 0.01
Total Phosphorus	mg/l	0.011
Total Suspended Solids	mg/l	85.
Turbidity	NTU	0.19
03-A003269		
Client ID: 8A-M		
Date Sampled: 3/19/03,		
Chlorophyll a	mg/m3	1.4
Pheophytin	mg/m3	< 0.15
Ammonia Nitrogen	mg/l	0.026
Total Nitrogen	mg/l	0.050
Nitrate + Nitrite	mg/l	0.012
Total Phosphorus	mg/l	0.006
Total Suspended Solids	mg/l	94.
Turbidity	NTU	0.29

AMTEST
LABORATORIES
ANALYSIS REPORT

CH2M Hill

Date Received: 3/26/03
Date Reported: 4/23/03

Attention: Steve Costa

Water Samples

PARAMETER	UNITS	RESULT
03-A003270		
Client ID: 8A-B		
Date Sampled: 3/19/03,		
Chlorophyll a	mg/m3	0.36
Pheophytin	mg/m3	< 0.15
Ammonia Nitrogen	mg/l	0.030
Total Nitrogen	mg/l	0.066
Nitrate + Nitrite	mg/l	0.023
Total Phosphorus	mg/l	0.013
Total Suspended Solids	mg/l	85.
Turbidity	NTU	0.31
03-A003271		
Client ID: 11-S		
Date Sampled: 3/20/03,		
Chlorophyll a	mg/m3	25.
Pheophytin	mg/m3	< 0.15
03-A003272		
Client ID: 13-S		
Date Sampled: 3/20/03,		
Chlorophyll a	mg/m3	1.4
Pheophytin	mg/m3	< 0.15
Ammonia Nitrogen	mg/l	0.030
Total Nitrogen	mg/l	0.12
Nitrate + Nitrite	mg/l	< 0.01
Total Phosphorus	mg/l	0.023
Total Suspended Solids	mg/l	80.
Turbidity	NTU	0.56
03-A003273		
Client ID: 13-M		
Date Sampled: 3/20/03,		
Chlorophyll a	mg/m3	1.1
Pheophytin	mg/m3	< 0.15
Ammonia Nitrogen	mg/l	0.035
Total Nitrogen	mg/l	0.12
Nitrate + Nitrite	mg/l	< 0.01
Total Phosphorus	mg/l	0.032
Total Suspended Solids	mg/l	83.
Turbidity	NTU	0.25

AMTEST
LABORATORIES
ANALYSIS REPORT

CH2M Hill

Date Received: 3/26/03
Date Reported: 4/23/03

Attention: Steve Costa

Water Samples

PARAMETER	UNITS	RESULT
03-A003274		
Client ID: 13-B		
Date Sampled: 3/20/03,		
Chlorophyll a	mg/m3	1.2
Pheophytin	mg/m3	< 0.15
Ammonia Nitrogen	mg/l	0.034
Total Nitrogen	mg/l	0.13
Nitrate + Nitrite	mg/l	< 0.01
Total Phosphorus	mg/l	0.027
Total Suspended Solids	mg/l	82.
Turbidity	NTU	0.58
03-A003275		
Client ID: 14-S		
Date Sampled: 3/19/03,		
Chlorophyll a	mg/m3	2.0
Pheophytin	mg/m3	< 0.15
Ammonia Nitrogen	mg/l	0.045
Total Nitrogen	mg/l	0.058
Nitrate + Nitrite	mg/l	0.010
Total Phosphorus	mg/l	0.006
Total Suspended Solids	mg/l	81.
Turbidity	NTU	0.13
03-A003276		
Client ID: 14-M		
Date Sampled: 3/19/03,		
Chlorophyll a	mg/m3	1.6
Pheophytin	mg/m3	< 0.15
Ammonia Nitrogen	mg/l	0.031
Total Nitrogen	mg/l	0.050
Nitrate + Nitrite	mg/l	< 0.01
Total Phosphorus	mg/l	0.014
Total Suspended Solids	mg/l	86.
Turbidity	NTU	0.49

AMTEST
LABORATORIES
ANALYSIS REPORT

CH2M Hill

Date Received: 3/26/03
Date Reported: 4/23/03

Attention: Steve Costa

Water Samples

PARAMETER	UNITS	RESULT
03-A003277		
Client ID: 14-B		
Date Sampled: 3/19/03,		
Chlorophyll a	mg/m3	0.49
Pheophytin	mg/m3	< 0.15
Ammonia Nitrogen	mg/l	0.039
Total Nitrogen	mg/l	0.075
Nitrate + Nitrite	mg/l	0.025
Total Phosphorus	mg/l	0.020
Total Suspended Solids	mg/l	82.
Turbidity	NTU	0.07
03-A003278		
Client ID: 16-S		
Date Sampled: 3/20/03,		
Chlorophyll a	mg/m3	0.91
Pheophytin	mg/m3	< 0.15
Ammonia Nitrogen	mg/l	0.036
Total Nitrogen	mg/l	0.050
Nitrate + Nitrite	mg/l	< 0.01
Total Phosphorus	mg/l	< 0.005
Total Suspended Solids	mg/l	85.
Turbidity	NTU	0.15
03-A003279		
Client ID: 16-M		
Date Sampled: 3/20/03,		
Chlorophyll a	mg/m3	0.64
Pheophytin	mg/m3	< 0.15
Ammonia Nitrogen	mg/l	0.035
Total Nitrogen	mg/l	0.050
Nitrate + Nitrite	mg/l	< 0.01
Total Phosphorus	mg/l	< 0.005
Total Suspended Solids	mg/l	82.
Turbidity	NTU	0.13

AMTEST
LABORATORIES
ANALYSIS REPORT

CH2M Hill

Date Received: 3/26/03
Date Reported: 4/23/03

Attention: Steve Costa

Water Samples

PARAMETER	UNITS	RESULT
03-A003280		
Client ID: 16-B		
Date Sampled: 3/20/03,		
Chlorophyll a	mg/m3	0.74
Pheophytin	mg/m3	< 0.15
Ammonia Nitrogen	mg/l	0.041
Total Nitrogen	mg/l	0.035
Nitrate + Nitrite	mg/l	< 0.01
Total Phosphorus	mg/l	< 0.005
Total Suspended Solids	mg/l	85.
Turbidity	NTU	0.10
03-A003281		
Client ID: 18-S		
Date Sampled: 3/20/03,		
Chlorophyll a	mg/m3	1.1
Pheophytin	mg/m3	< 15
Ammonia Nitrogen	mg/l	0.030
Total Nitrogen	mg/l	< 0.025
Nitrate + Nitrite	mg/l	< 0.01
Total Phosphorus	mg/l	0.073
Total Suspended Solids	mg/l	83.
Turbidity	NTU	0.40
03-A003282		
Client ID: 18-M		
Date Sampled: 3/20/03,		
Chlorophyll a	mg/m3	0.49
Pheophytin	mg/m3	< 0.15
Ammonia Nitrogen	mg/l	0.032
Total Nitrogen	mg/l	0.050
Nitrate + Nitrite	mg/l	< 0.01
Total Phosphorus	mg/l	< 0.005
Total Suspended Solids	mg/l	83.
Turbidity	NTU	0.11

AMTEST
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ANALYSIS REPORT

CH2M Hill

Date Received: 3/26/03
Date Reported: 4/23/03

Attention: Steve Costa

Water Samples

PARAMETER	UNITS	RESULT
03-A003283		
Client ID: 18-B		
Date Sampled: 3/20/03,		
Chlorophyll a	mg/m3	0.74
Pheophytin	mg/m3	< 0.15
Ammonia Nitrogen	mg/l	0.031
Total Nitrogen	mg/l	0.28
Nitrate + Nitrite	mg/l	< 0.01
Total Phosphorus	mg/l	< 0.005
Total Suspended Solids	mg/l	81.
Turbidity	NTU	0.12

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AMTEST LABORATORIES

Professional Analytical Services

ANALYSIS REPORT

CH2M Hill
Po Box 1238
Trinidad, CA 95570
Attention: Steve Costa

Date Received: 3/26/03
Date Reported: 4/23/03

Project Name: Somaoa Joint Cannery
Project #: 147323.JC.03.NT
Date Sampled: 3/19/03

Water Samples

PARAMETER	UNITS	RESULT
03-A003284		
Client ID: A1-S		
Date Sampled: 3/19/03,		
Chlorophyll a	mg/m3	2.1
Pheophytin	mg/m3	< 0.15
Total Nitrogen	mg/l	0.24
Nitrate + Nitrite	mg/l	< 0.01
Total Phosphorus	mg/l	< 0.005
Turbidity	NTU	0.24
03-A003285		
Client ID: A1-M		
Date Sampled: 3/19/03,		
Chlorophyll a	mg/m3	1.2
Pheophytin	mg/m3	< 0.15
Total Nitrogen	mg/l	0.30
Nitrate + Nitrite	mg/l	< 0.01
Total Phosphorus	mg/l	< 0.005
Turbidity	NTU	0.20
03-A003286		
Client ID: A1-B		
Date Sampled: 3/19/03,		
Chlorophyll a	mg/m3	1.1
Pheophytin	mg/m3	< 0.15
Total Nitrogen	mg/l	0.25
Nitrate + Nitrite	mg/l	< 0.01
Total Phosphorus	mg/l	0.005
Turbidity	NTU	0.22

AMTEST
LABORATORIES
ANALYSIS REPORT

CH2M Hill

Date Received: 3/26/03
Date Reported: 4/23/03

Attention: Steve Costa

Water Samples

PARAMETER	UNITS	RESULT
03-A003287		
Client ID: B1-S		
Date Sampled: 3/19/03,		
Chlorophyll a	mg/m3	3.1
Pheophytin	mg/m3	< 0.15
Total Nitrogen	mg/l	0.27
Nitrate + Nitrite	mg/l	< 0.01
Total Phosphorus	mg/l	< 0.005
Turbidity	NTU	0.38
03-A003288		
Client ID: B1-M		
Date Sampled: 3/19/03,		
Chlorophyll a	mg/m3	0.94
Pheophytin	mg/m3	< 0.15
Total Nitrogen	mg/l	0.20
Nitrate + Nitrite	mg/l	< 0.01
Total Phosphorus	mg/l	< 0.005
Turbidity	NTU	0.14
03-A003289		
Client ID: B1-B		
Date Sampled: 3/19/03,		
Chlorophyll a	mg/m3	0.86
Pheophytin	mg/m3	< 0.15
Total Nitrogen	mg/l	0.25
Nitrate + Nitrite	mg/l	0.026
Total Phosphorus	mg/l	0.016
Turbidity	NTU	0.24
03-A003290		
Client ID: C-S		
Date Sampled: 3/19/03,		
Chlorophyll a	mg/m3	1.4
Pheophytin	mg/m3	< 0.15
Total Nitrogen	mg/l	0.23
Nitrate + Nitrite	mg/l	< 0.01
Total Phosphorus	mg/l	< 0.005
Turbidity	NTU	0.30

AMTEST
LABORATORIES
ANALYSIS REPORT

CH2M Hill

Date Received: 3/26/03
Date Reported: 4/23/03

Attention: Steve Costa

Water Samples

PARAMETER	UNITS	RESULT
03-A003291		
Client ID: C-M		
Date Sampled: 3/19/03,		
Chlorophyll a	mg/m3	0.82
Pheophytin	mg/m3	< 0.15
Total Nitrogen	mg/l	0.22
Nitrate + Nitrite	mg/l	< 0.01
Total Phosphorus	mg/l	0.028
Turbidity	NTU	0.16
03-A003292		
Client ID: C-B		
Date Sampled: 3/19/03,		
Chlorophyll a	mg/m3	0.79
Pheophytin	mg/m3	< 0.15
Total Nitrogen	mg/l	0.30
Nitrate + Nitrite	mg/l	< 0.01
Total Phosphorus	mg/l	0.005
Turbidity	NTU	0.41
03-A003293		
Client ID: U-S		
Date Sampled: 3/20/03,		
Chlorophyll a	mg/m3	2.8
Pheophytin	mg/m3	< 0.15
Total Nitrogen	mg/l	0.31
Nitrate + Nitrite	mg/l	< 0.01
Total Phosphorus	mg/l	< 0.005
Turbidity	NTU	0.67
03-A003294		
Client ID: U-M		
Date Sampled: 3/20/03,		
Chlorophyll a	mg/m3	1.5
Pheophytin	mg/m3	< 0.15
Total Nitrogen	mg/l	0.21
Nitrate + Nitrite	mg/l	0.016
Total Phosphorus	mg/l	0.006
Turbidity	NTU	0.36

AMTEST
LABORATORIES
ANALYSIS REPORT

CH2M Hill

Date Received: 3/26/03
Date Reported: 4/23/03

Attention: Steve Costa

Water Samples

PARAMETER	UNITS	RESULT
03-A003295		
Client ID: U-B		
Date Sampled: 3/20/03,		
Chlorophyll a	mg/m3	0.72
Pheophytin	mg/m3	< 0.15
Total Nitrogen	mg/l	0.33
Nitrate + Nitrite	mg/l	0.033
Total Phosphorus	mg/l	0.024
Turbidity	NTU	0.40

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AMTEST LABORATORIES

Professional Analytical Services

ANALYSIS REPORT

CH2M Hill
PO Box 1238
Trinidad, CA 95570
Attention: Steve Costa

Date Received: 3/26/03
Date Reported: 4/23/03

Project Name: Samoa Joint Cannery
Project #: 147323.JC.03.NT
Date Sampled: 3/21/03

Water Samples

PARAMETER	UNITS	RESULT
03-A003296		
Client ID: S1-A		
Date Sampled: 3/21/03,		
Ammonia Nitrogen	mg/l	< 0.005
Total Nitrogen	mg/l	0.50
Nitrate + Nitrite	mg/l	0.30
Total Phosphorus	mg/l	0.72
Total Suspended Solids	mg/l	140
03-A003297		
Client ID: S1-B		
Date Sampled: 3/21/03,		
Ammonia Nitrogen	mg/l	< 0.005
Total Nitrogen	mg/l	0.60
Nitrate + Nitrite	mg/l	0.30
Total Phosphorus	mg/l	0.68
Total Suspended Solids	mg/l	130
03-A003298		
Client ID: S2-A		
Date Sampled: 3/21/03,		
Ammonia Nitrogen	mg/l	< 0.005
Total Nitrogen	mg/l	0.48
Nitrate + Nitrite	mg/l	0.42
Total Phosphorus	mg/l	0.24
Total Suspended Solids	mg/l	< 1

AMTEST LABORATORIES

ANALYSIS REPORT

CH2M Hill
PO Box 1238
Trinidad, CA 95570
Attention: Steve Costa

Date Received: 3/26/03
Date Reported: 4/28/03

Project Name: Samoa Joint Cannery
Project #: 147323.JC.03.NT
Date Sampled: 3/21/03

Water Samples

PARAMETER	UNITS	RESULT
03-A003299		
Client ID: S2-B		
Date Sampled: 3/21/03,		
Ammonia Nitrogen	mg/l	< 0.005
Total Nitrogen	mg/l	0.57
Nitrate + Nitrite	mg/l	0.44
Total Phosphorus	mg/l	0.22
Total Suspended Solids	mg/l	1.0
03-A003300		
Client ID: S3-A		
Date Sampled: 3/21/03,		
Ammonia Nitrogen	mg/l	0.070
Total Nitrogen	mg/l	9.0
Nitrate + Nitrite	mg/l	0.49
Total Phosphorus	mg/l	0.61
Total Suspended Solids	mg/l	6.0
03-A003301		
Client ID: S3-B		
Date Sampled: 3/21/03,		
Ammonia Nitrogen	mg/l	0.028
Total Nitrogen	mg/l	5.6
Nitrate + Nitrite	mg/l	0.49
Total Phosphorus	mg/l	0.25
Total Suspended Solids	mg/l	12.

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LABORATORIES
ANALYSIS REPORT

CH2M Hill

Date Received: 3/26/03
Date Reported: 4/28/03

Attention: Steve Costa

Water Samples

PARAMETER	UNITS	RESULT
03-A003302		
Client ID: S4-A		
Date Sampled: 3/21/03,		
Ammonia Nitrogen	mg/l	< 0.005
Total Nitrogen	mg/l	0.59
Nitrate + Nitrite	mg/l	0.41
Total Phosphorus	mg/l	0.16
Total Suspended Solids	mg/l	4.0
03-A003303		
Client ID: S4-B		
Date Sampled: 3/21/03,		
Ammonia Nitrogen	mg/l	< 0.005
Total Nitrogen	mg/l	0.27
Nitrate + Nitrite	mg/l	0.39
Total Phosphorus	mg/l	0.14
Total Suspended Solids	mg/l	7.0
03-A003304		
Client ID: S5-A		
Date Sampled: 3/21/03,		
Ammonia Nitrogen	mg/l	0.10
Total Nitrogen	mg/l	0.64
Nitrate + Nitrite	mg/l	0.51
Total Phosphorus	mg/l	0.15
Total Suspended Solids	mg/l	< 1
03-A003305		
Client ID: S5-B		
Date Sampled: 3/21/03,		
Ammonia Nitrogen	mg/l	0.080
Total Nitrogen	mg/l	0.56
Nitrate + Nitrite	mg/l	0.53
Total Phosphorus	mg/l	0.15
Total Suspended Solids	mg/l	< 1

AMTEST LABORATORIES

Quality Control Summary

QC for 337508

03-A003262
03-A003263
03-A003264
03-A003265
03-A003266
03-A003267
03-A003268
03-A003269
03-A003270
03-A003271
03-A003272
03-A003273
03-A003274
03-A003275
03-A003276
03-A003277
03-A003278
03-A003279
03-A003280
03-A003281
03-A003282
03-A003283

DUPLICATES			sample value	duplicate value	RPD %
03-A003242	DUP: Chlorophyll a	mg/m3	1.8	1.8	0.00
03-A003242	DUP: Pheophytin	mg/m3	< 0.3	< 0.3	
03-A003177	DUP: Ammonia Nitrogen	mg/l	< 0.005	< 0.005	
03-A003187	DUP: Ammonia Nitrogen	mg/l	< 0.005	< 0.005	
03-A003265	DUP: Ammonia Nitrogen	mg/l	0.033	0.027	20.
03-A003277	DUP: Ammonia Nitrogen	mg/l	0.039	0.040	2.5
Known	DUP: Ammonia Nitrogen	mg/l	0.54	< 0.005	
03-A003262	DUP: Total Nitrogen	mg/l	0.12	0.10	18.
03-A003273	DUP: Total Nitrogen	mg/l	0.12	0.14	15.
03-A003283	DUP: Total Nitrogen	mg/l	0.28	0.29	3.5
03-A003293	DUP: Total Nitrogen	mg/l	0.31	0.23	30.
03-A003303	DUP: Total Nitrogen	mg/l	0.27	0.26	3.8
03-A003265	DUP: Nitrate + Nitrite	mg/l	0.016	0.013	21.
03-A003275	DUP: Nitrate + Nitrite	mg/l	0.010	< 0.01	
03-A003282	DUP: Nitrate + Nitrite	mg/l	< 0.01	< 0.01	
03-A003305	DUP: Nitrate + Nitrite	mg/l	0.53	0.47	12.

AMTEST LABORATORIES

Quality Control Summary
(continued)

QC for 337508

03-A003169 DUP: Total Phosphorus	mg/l	0.079	0.086	8.5	
03-A003185 DUP: Total Phosphorus	mg/l	0.018	0.019	5.4	
03-A003243 DUP: Total Phosphorus	mg/l	0.089	0.092	3.3	
03-A003268 DUP: Total Phosphorus	mg/l	0.066	0.070	5.9	
03-A003279 DUP: Total Phosphorus	mg/l	0.11	0.12	8.7	
03-A003289 DUP: Total Phosphorus	mg/l	0.12	0.13	8.0	
03-A003299 DUP: Total Phosphorus	mg/l	0.22	0.22	0.00	
03-A003353 DUP: Total Phosphorus	mg/l	0.033	0.035	5.9	
03-A003269 DUP: Total Phosphorus	mg/l	0.006	< 0.005		
03-A003279 DUP: Total Phosphorus	mg/l	< 0.005	< 0.005		
03-A003289 DUP: Total Phosphorus	mg/l	0.016	0.016	0.00	
03-A003025 DUP: Total Suspended Solids	mg/l	1.0	< 1		
03-A003037 DUP: Total Suspended Solids	mg/l	310	310	0.00	
03-A003184 DUP: Total Suspended Solids	mg/l	2.0	1.0	67.	
03-A003252 DUP: Total Suspended Solids	mg/l	280	280	0.00	
03-A003270 DUP: Total Suspended Solids	mg/l	85.	84.	1.2	
03-A003281 DUP: Total Suspended Solids	mg/l	83.	82.	1.2	
03-A003303 DUP: Total Suspended Solids	mg/l	7.0	7.0	0.00	
03-A003184 SPIKE: Ammonia Nitrogen	mg/l	< 0.005	0.40	0.50	80.0
03-A003263 SPIKE: Ammonia Nitrogen	mg/l	0.079	0.47	0.50	78.2
03-A003274 SPIKE: Ammonia Nitrogen	mg/l	0.034	0.44	0.50	81.2
03-A003296 SPIKE: Ammonia Nitrogen	mg/l	< 0.005	0.50	0.50	100.
03-A003269 SPIKE: Nitrate + Nitrite	mg/l	0.012	0.52	0.60	84.7
03-A003280 SPIKE: Nitrate + Nitrite	mg/l	< 0.01	0.50	0.60	83.3
03-A003283 SPIKE: Nitrate + Nitrite	mg/l	< 0.01	0.21	0.25	84.0
03-A003300 SPIKE: Nitrate + Nitrite	mg/l	0.49	1.2	0.68	104.
03-A003184 SPIKE: Total Phosphorus	mg/l	0.037	0.27	0.25	93.2
03-A003242 SPIKE: Total Phosphorus	mg/l	0.081	0.33	0.25	99.6
03-A003266 SPIKE: Total Phosphorus	mg/l	0.078	0.28	0.25	80.8
03-A003276 SPIKE: Total Phosphorus	mg/l	0.090	0.29	0.25	80.0
03-A003288 SPIKE: Total Phosphorus	mg/l	0.099	0.30	0.25	80.4
03-A003298 SPIKE: Total Phosphorus	mg/l	0.24	0.50	0.25	104.
03-A003352 SPIKE: Total Phosphorus	mg/l	0.038	0.31	0.25	109.
03-A003268 SPIKE: Total Phosphorus	mg/l	0.011	0.28	0.25	108.
03-A003278 SPIKE: Total Phosphorus	mg/l	< 0.005	0.28	0.25	112.
03-A003291 SPIKE: Total Phosphorus	mg/l	0.028	0.29	0.25	105.

STANDARD REFERENCE MATERIALS			measured value	true value	Recovery %
Known	SRM: Chlorophyll a	mg/m3	38.	45.	84.4
Known	SRM: Chlorophyll a	mg/m3	38.	45.	84.4
Known	SRM: Ammonia Nitrogen	mg/l	0.61	0.61	100.
Known	SRM: Ammonia Nitrogen	mg/l	15.	14.	107.
Known	SRM: Ammonia Nitrogen	mg/l	0.56	0.61	91.8
Known	SRM: Ammonia Nitrogen	mg/l	15.	14.	107.
Known	SRM: Ammonia Nitrogen	mg/l	0.54	0.61	88.5
Known	SRM: Total Nitrogen	mg/l	0.85	1.1	77.3
Known	SRM: Total Nitrogen	mg/l	1.0	1.1	90.9
Known	SRM: Total Nitrogen	mg/l	0.80	1.1	72.7

AMTEST LABORATORIES

Quality Control Summary
(continued)

QC for 337508

Known	SRM: Nitrate + Nitrite	mg/l	9.0	8.6	105.
Known	SRM: Nitrate + Nitrite	mg/l	11.	10.	110.
Known	SRM: Nitrate + Nitrite	mg/l	8.7	8.6	101.
Known	SRM: Nitrate + Nitrite	mg/l	11.	10.	110.
Known	SRM: Total Phosphorus	mg/l	3.2	3.7	86.5
Known	SRM: Total Phosphorus	mg/l	3.5	3.7	94.6
Known	SRM: Total Phosphorus	mg/l	4.1	3.7	111.
Known	SRM: Total Phosphorus	mg/l	3.5	3.7	94.6
Known	SRM: Total Phosphorus	mg/l	0.59	0.61	96.7
Known	SRM: Total Phosphorus	mg/l	0.59	0.61	96.7
Known	SRM: Total Phosphorus	mg/l	3.3	3.7	89.2
Known	SRM: Total Phosphorus	mg/l	3.0	3.7	81.1
Known	SRM: Total Phosphorus	mg/l	4.1	3.7	111.
Known	SRM: Total Suspended Solids	mg/l	91.	100	91.0
Known	SRM: Total Suspended Solids	mg/l	96.	100	96.0
Known	SRM: Total Suspended Solids	mg/l	92.	100	92.0
Known	SRM: Total Suspended Solids	mg/l	96.	100	96.0
Known	SRM: Total Suspended Solids	mg/l	95.	100	95.0

BLANKS		Result
BLANK: Chlorophyll a	mg/m3	< 0.3
BLANK: Chlorophyll a	mg/m3	< 0.3
BLANK: Pheophytin	mg/m3	< 0.3
BLANK: Pheophytin	mg/m3	< 0.15
BLANK: Ammonia Nitrogen	mg/l	< 0.005
BLANK: Ammonia Nitrogen	mg/l	< 0.005
BLANK: Ammonia Nitrogen	mg/l	< 0.005
BLANK: Ammonia Nitrogen	mg/l	< 0.005
BLANK: Ammonia Nitrogen	mg/l	< 0.005
BLANK: Total Nitrogen	mg/l	< 0.025
BLANK: Total Nitrogen	mg/l	< 0.025
BLANK: Nitrate + Nitrite	mg/l	< 0.01
BLANK: Nitrate + Nitrite	mg/l	< 0.01
BLANK: Nitrate + Nitrite	mg/l	< 0.01
BLANK: Nitrate + Nitrite	mg/l	< 0.01
BLANK: Total Phosphorus	mg/l	< 0.005
BLANK: Total Phosphorus	mg/l	< 0.005
BLANK: Total Phosphorus	mg/l	< 0.005
BLANK: Total Phosphorus	mg/l	< 0.005
BLANK: Total Phosphorus	mg/l	< 0.005
BLANK: Total Phosphorus	mg/l	< 0.005
BLANK: Total Phosphorus	mg/l	< 0.005
BLANK: Total Phosphorus	mg/l	< 0.005
BLANK: Total Phosphorus	mg/l	< 0.005
BLANK: Total Phosphorus	mg/l	< 0.005
BLANK: Total Suspended Solids	mg/l	< 1
BLANK: Total Suspended Solids	mg/l	< 1
BLANK: Total Suspended Solids	mg/l	< 1
BLANK: Total Suspended Solids	mg/l	< 1

AMTEST LABORATORIES

Quality Control Summary
(continued)

QC for 337509

03-A003284
03-A003285
03-A003286
03-A003287
03-A003288
03-A003289
03-A003290
03-A003291
03-A003292
03-A003293
03-A003294
03-A003295

DUPLICATES		sample value	duplicate value	RPD %	
03-A003242 DUP: Chlorophyll a	mg/m3	1.8	1.8	0.00	
03-A003242 DUP: Pheophytin	mg/m3	< 0.3	< 0.3		
03-A003283 DUP: Total Nitrogen	mg/l	0.28	0.29	3.5	
03-A003293 DUP: Total Nitrogen	mg/l	0.31	0.23	30.	
03-A003303 DUP: Total Nitrogen	mg/l	0.27	0.26	3.8	
03-A003265 DUP: Nitrate + Nitrite	mg/l	0.016	0.013	21.	
03-A003275 DUP: Nitrate + Nitrite	mg/l	0.010	< 0.01		
03-A003282 DUP: Nitrate + Nitrite	mg/l	< 0.01	< 0.01		
03-A003305 DUP: Nitrate + Nitrite	mg/l	0.53	0.47	12.	
03-A003169 DUP: Total Phosphorus	mg/l	0.079	0.086	8.5	
03-A003185 DUP: Total Phosphorus	mg/l	0.018	0.019	5.4	
03-A003243 DUP: Total Phosphorus	mg/l	0.089	0.092	3.3	
03-A003268 DUP: Total Phosphorus	mg/l	0.066	0.070	5.9	
03-A003279 DUP: Total Phosphorus	mg/l	0.11	0.12	8.7	
03-A003289 DUP: Total Phosphorus	mg/l	0.12	0.13	8.0	
03-A003299 DUP: Total Phosphorus	mg/l	0.22	0.22	0.00	
03-A003353 DUP: Total Phosphorus	mg/l	0.033	0.035	5.9	
03-A003269 DUP: Total Phosphorus	mg/l	0.006	< 0.005		
03-A003279 DUP: Total Phosphorus	mg/l	< 0.005	< 0.005		
03-A003289 DUP: Total Phosphorus	mg/l	0.016	0.016	0.00	
03-A003290 DUP: Turbidity	NTU	0.30	0.28	6.9	
03-A003269 SPIKE: Nitrate + Nitrite	mg/l	0.012	0.52	0.60	84.7
03-A003280 SPIKE: Nitrate + Nitrite	mg/l	< 0.01	0.50	0.60	83.3
03-A003283 SPIKE: Nitrate + Nitrite	mg/l	< 0.01	0.21	0.25	84.0
03-A003300 SPIKE: Nitrate + Nitrite	mg/l	0.49	1.2	0.68	104.
03-A003184 SPIKE: Total Phosphorus	mg/l	0.037	0.27	0.25	93.2
03-A003242 SPIKE: Total Phosphorus	mg/l	0.081	0.33	0.25	99.6
03-A003266 SPIKE: Total Phosphorus	mg/l	0.078	0.28	0.25	80.8
03-A003276 SPIKE: Total Phosphorus	mg/l	0.090	0.29	0.25	80.0
03-A003288 SPIKE: Total Phosphorus	mg/l	0.099	0.30	0.25	80.4
03-A003298 SPIKE: Total Phosphorus	mg/l	0.24	0.50	0.25	104.
03-A003352 SPIKE: Total Phosphorus	mg/l	0.038	0.31	0.25	109.
03-A003268 SPIKE: Total Phosphorus	mg/l	0.011	0.28	0.25	108.
03-A003278 SPIKE: Total Phosphorus	mg/l	< 0.005	0.28	0.25	112.
03-A003291 SPIKE: Total Phosphorus	mg/l	0.028	0.29	0.25	105.

AMTEST LABORATORIES

Quality Control Summary
(continued)

QC for 337509

STANDARD REFERENCE MATERIALS			measured value	true value	Recovery %
Known	SRM: Chlorophyll a	mg/m3	38.	45.	84.4
Known	SRM: Chlorophyll a	mg/m3	38.	45.	84.4
Known	SRM: Total Nitrogen	mg/l	0.80	1.1	72.7
Known	SRM: Nitrate + Nitrite	mg/l	9.0	8.6	105.
Known	SRM: Nitrate + Nitrite	mg/l	11.	10.	110.
Known	SRM: Nitrate + Nitrite	mg/l	8.7	8.6	101.
Known	SRM: Nitrate + Nitrite	mg/l	11.	10.	110.
Known	SRM: Total Phosphorus	mg/l	3.2	3.7	86.5
Known	SRM: Total Phosphorus	mg/l	3.5	3.7	94.6
Known	SRM: Total Phosphorus	mg/l	4.1	3.7	111.
Known	SRM: Total Phosphorus	mg/l	3.5	3.7	94.6
Known	SRM: Total Phosphorus	mg/l	0.59	0.61	96.7
Known	SRM: Total Phosphorus	mg/l	0.59	0.61	96.7
Known	SRM: Total Phosphorus	mg/l	3.3	3.7	89.2
Known	SRM: Total Phosphorus	mg/l	3.0	3.7	81.1
Known	SRM: Total Phosphorus	mg/l	4.1	3.7	111.
Known	SRM: Turbidity	NTU	16.	17.	94.1

BLANKS		Result
BLANK: Chlorophyll a	mg/m3	< 0.3
BLANK: Chlorophyll a	mg/m3	< 0.3
BLANK: Pheophytin	mg/m3	< 0.3
BLANK: Pheophytin	mg/m3	< 0.15
BLANK: Total Nitrogen	mg/l	< 0.025
BLANK: Nitrate + Nitrite	mg/l	< 0.01
BLANK: Nitrate + Nitrite	mg/l	< 0.01
BLANK: Nitrate + Nitrite	mg/l	< 0.01
BLANK: Nitrate + Nitrite	mg/l	< 0.01
BLANK: Total Phosphorus	mg/l	< 0.005
BLANK: Total Phosphorus	mg/l	< 0.005
BLANK: Total Phosphorus	mg/l	< 0.005
BLANK: Total Phosphorus	mg/l	< 0.005
BLANK: Total Phosphorus	mg/l	< 0.005
BLANK: Total Phosphorus	mg/l	< 0.005
BLANK: Total Phosphorus	mg/l	< 0.005
BLANK: Total Phosphorus	mg/l	< 0.005
BLANK: Total Phosphorus	mg/l	< 0.005
BLANK: Turbidity	NTU	< 0.01

AMTEST LABORATORIES

Quality Control Summary
(continued)

QC for 337510

03-A003296
03-A003297
03-A003298
03-A003299
03-A003300
03-A003301
03-A003302
03-A003303
03-A003304
03-A003305

DUPLICATES			sample value	duplicate value	RPD %
03-A003177	DUP: Ammonia Nitrogen	mg/l	< 0.005	< 0.005	
03-A003187	DUP: Ammonia Nitrogen	mg/l	< 0.005	< 0.005	
03-A003265	DUP: Ammonia Nitrogen	mg/l	0.033	0.027	20.
03-A003277	DUP: Ammonia Nitrogen	mg/l	0.039	0.040	2.5
Known	DUP: Ammonia Nitrogen	mg/l	0.54	< 0.005	
03-A003283	DUP: Total Nitrogen	mg/l	0.28	0.29	3.5
03-A003293	DUP: Total Nitrogen	mg/l	0.31	0.23	30.
03-A003303	DUP: Total Nitrogen	mg/l	0.27	0.26	3.8
03-A003265	DUP: Nitrate + Nitrite	mg/l	0.016	0.013	21.
03-A003275	DUP: Nitrate + Nitrite	mg/l	0.010	< 0.01	
03-A003282	DUP: Nitrate + Nitrite	mg/l	< 0.01	< 0.01	
03-A003305	DUP: Nitrate + Nitrite	mg/l	0.53	0.47	12.
03-A003169	DUP: Total Phosphorus	mg/l	0.079	0.086	8.5
03-A003185	DUP: Total Phosphorus	mg/l	0.018	0.019	5.4
03-A003243	DUP: Total Phosphorus	mg/l	0.089	0.092	3.3
03-A003268	DUP: Total Phosphorus	mg/l	0.066	0.070	5.9
03-A003279	DUP: Total Phosphorus	mg/l	0.11	0.12	8.7
03-A003289	DUP: Total Phosphorus	mg/l	0.12	0.13	8.0
03-A003299	DUP: Total Phosphorus	mg/l	0.22	0.22	0.00
03-A003353	DUP: Total Phosphorus	mg/l	0.033	0.035	5.9
03-A003269	DUP: Total Phosphorus	mg/l	0.006	< 0.005	
03-A003279	DUP: Total Phosphorus	mg/l	< 0.005	< 0.005	
03-A003289	DUP: Total Phosphorus	mg/l	0.016	0.016	0.00
03-A003025	DUP: Total Suspended Solids	mg/l	1.0	< 1	
03-A003037	DUP: Total Suspended Solids	mg/l	310	310	0.00
03-A003184	DUP: Total Suspended Solids	mg/l	2.0	1.0	67.
03-A003252	DUP: Total Suspended Solids	mg/l	280	280	0.00
03-A003270	DUP: Total Suspended Solids	mg/l	85.	84.	1.2
03-A003281	DUP: Total Suspended Solids	mg/l	83.	82.	1.2
03-A003303	DUP: Total Suspended Solids	mg/l	7.0	7.0	0.00

03-A003184	SPIKE: Ammonia Nitrogen	mg/l	< 0.005	0.40	0.50	80.0
03-A003263	SPIKE: Ammonia Nitrogen	mg/l	0.079	0.47	0.50	78.2
03-A003274	SPIKE: Ammonia Nitrogen	mg/l	0.034	0.44	0.50	81.2
03-A003296	SPIKE: Ammonia Nitrogen	mg/l	< 0.005	0.50	0.50	100.
03-A003269	SPIKE: Nitrate + Nitrite	mg/l	0.012	0.52	0.60	84.7
03-A003280	SPIKE: Nitrate + Nitrite	mg/l	< 0.01	0.50	0.60	83.3
03-A003283	SPIKE: Nitrate + Nitrite	mg/l	< 0.01	0.21	0.25	84.0
03-A003300	SPIKE: Nitrate + Nitrite	mg/l	0.49	1.2	0.68	104.

AMTEST LABORATORIES

Quality Control Summary
(continued)

QC for 337510

03-A003184	SPIKE: Total Phosphorus	mg/l	0.037	0.27	0.25	93.2
03-A003242	SPIKE: Total Phosphorus	mg/l	0.081	0.33	0.25	99.6
03-A003266	SPIKE: Total Phosphorus	mg/l	0.078	0.28	0.25	80.8
03-A003276	SPIKE: Total Phosphorus	mg/l	0.090	0.29	0.25	80.0
03-A003288	SPIKE: Total Phosphorus	mg/l	0.099	0.30	0.25	80.4
03-A003298	SPIKE: Total Phosphorus	mg/l	0.24	0.50	0.25	104.
03-A003352	SPIKE: Total Phosphorus	mg/l	0.038	0.31	0.25	109.
03-A003268	SPIKE: Total Phosphorus	mg/l	0.011	0.28	0.25	108.
03-A003278	SPIKE: Total Phosphorus	mg/l	< 0.005	0.28	0.25	112.
03-A003291	SPIKE: Total Phosphorus	mg/l	0.028	0.29	0.25	105.

STANDARD REFERENCE MATERIALS			measured value	true value	Recovery %
Known	SRM: Ammonia Nitrogen	mg/l	0.61	0.61	100.
Known	SRM: Ammonia Nitrogen	mg/l	15.	14.	107.
Known	SRM: Ammonia Nitrogen	mg/l	0.56	0.61	91.8
Known	SRM: Ammonia Nitrogen	mg/l	15.	14.	107.
Known	SRM: Ammonia Nitrogen	mg/l	0.54	0.61	88.5
Known	SRM: Total Nitrogen	mg/l	0.80	1.1	72.7
Known	SRM: Nitrate + Nitrite	mg/l	9.0	8.6	105.
Known	SRM: Nitrate + Nitrite	mg/l	11.	10.	110.
Known	SRM: Nitrate + Nitrite	mg/l	8.7	8.6	101.
Known	SRM: Nitrate + Nitrite	mg/l	11.	10.	110.
Known	SRM: Total Phosphorus	mg/l	3.2	3.7	86.5
Known	SRM: Total Phosphorus	mg/l	3.5	3.7	94.6
Known	SRM: Total Phosphorus	mg/l	4.1	3.7	111.
Known	SRM: Total Phosphorus	mg/l	3.5	3.7	94.6
Known	SRM: Total Phosphorus	mg/l	0.59	0.61	96.7
Known	SRM: Total Phosphorus	mg/l	0.59	0.61	96.7
Known	SRM: Total Phosphorus	mg/l	3.3	3.7	89.2
Known	SRM: Total Phosphorus	mg/l	3.0	3.7	81.1
Known	SRM: Total Phosphorus	mg/l	4.1	3.7	111.
Known	SRM: Total Suspended Solids	mg/l	91.	100	91.0
Known	SRM: Total Suspended Solids	mg/l	96.	100	96.0
Known	SRM: Total Suspended Solids	mg/l	92.	100	92.0
Known	SRM: Total Suspended Solids	mg/l	96.	100	96.0
Known	SRM: Total Suspended Solids	mg/l	95.	100	95.0

BLANKS			Result
	BLANK: Ammonia Nitrogen	mg/l	< 0.005
	BLANK: Ammonia Nitrogen	mg/l	< 0.005
	BLANK: Ammonia Nitrogen	mg/l	< 0.005
	BLANK: Ammonia Nitrogen	mg/l	< 0.005
	BLANK: Ammonia Nitrogen	mg/l	< 0.005
	BLANK: Total Nitrogen	mg/l	< 0.025
	BLANK: Nitrate + Nitrite	mg/l	< 0.01
	BLANK: Nitrate + Nitrite	mg/l	< 0.01
	BLANK: Nitrate + Nitrite	mg/l	< 0.01
	BLANK: Nitrate + Nitrite	mg/l	< 0.01

AMTEST LABORATORIES

Quality Control Summary
(continued)

QC for 337510

BLANK: Total Phosphorus	mg/l	< 0.005
BLANK: Total Phosphorus	mg/l	< 0.005
BLANK: Total Phosphorus	mg/l	< 0.005
BLANK: Total Phosphorus	mg/l	< 0.005
BLANK: Total Phosphorus	mg/l	< 0.005
BLANK: Total Phosphorus	mg/l	< 0.005
BLANK: Total Phosphorus	mg/l	< 0.005
BLANK: Total Phosphorus	mg/l	< 0.005
BLANK: Total Phosphorus	mg/l	< 0.005
BLANK: Total Phosphorus	mg/l	< 0.005
BLANK: Total Suspended Solids	mg/l	< 1
BLANK: Total Suspended Solids	mg/l	< 1
BLANK: Total Suspended Solids	mg/l	< 1
BLANK: Total Suspended Solids	mg/l	< 1

Appendix VI

Laboratory Results for Metals Analysis

1317 South 13th Avenue P.O. Box 479 Kelso, Washington 98626 (360) 577-7222 ph (360) 425-9096 fax

Columbia Analytical Services INC.
An Employee - Owned Company

April 22, 2003 Service Request No: K2302324

Steve Costa
CH2M HILL
PO BOX 1238
Trinidad, CA 95570-1238

RE: Samoa Joint Cannery Outfall/147323.JC.03.NT

Dear Steve:

Enclosed are the results of the sample(s) submitted to our laboratory on March 27, 2003. For your reference, these analyses have been assigned our service request number K2302324.

All analyses were performed according to our laboratory's quality assurance program. The test results meet requirements of the NELAC standards except as noted in the case narrative report. All results are intended to be considered in their entirety, and Columbia Analytical Services, Inc. (CAS) is not responsible for use of less than the complete report. Results apply only to the items submitted to the laboratory for analysis and individual items (samples) analyzed, as listed in the report.

Please call if you have any questions. My extension is 3260.

Respectfully submitted,

Columbia Analytical Services, Inc.

Harvey Jacky
Project Chemist

HJ/afs

NELAP Accredited ACIL Seal of Excellence Award

Acronyms

ASTM	American Society for Testing and Materials
A2LA	American Association for Laboratory Accreditation
CARB	California Air Resources Board
CAS Number	Chemical Abstract Service registry Number
CFC	Chlorofluorocarbon
CFU	Colony-Forming Unit
DEC	Department of Environmental Conservation
DEQ	Department of Environmental Quality
DHS	Department of Health Services
DOE	Department of Ecology
DOH	Department of Health
EPA	U. S. Environmental Protection Agency
ELAP	Environmental Laboratory Accreditation Program
GC	Gas Chromatography
GC/MS	Gas Chromatography/Mass Spectrometry
LUFT	Leaking Underground Fuel Tank
M	Modified
MCL	Maximum Contaminant Level is the highest permissible concentration of a substance allowed in drinking water as established by the USEPA.
MDL	Method Detection Limit
MPN	Most Probable Number
MRL	Method Reporting Limit
NA	Not Applicable
NC	Not Calculated
NCASI	National Council of the Paper Industry for Air and Stream Improvement
ND	Not Detected
NIOSH	National Institute for Occupational Safety and Health
PQL	Practical Quantitation Limit
RCRA	Resource Conservation and Recovery Act
SIM	Selected Ion Monitoring
TPH	Total Petroleum Hydrocarbons
tr	Trace level is the concentration of an analyte that is less than the PQL but greater than or equal to the MDL.

Inorganic Data Qualifiers

*	The result is an outlier. See case narrative.
#	The control limit criteria is not applicable. See case narrative.
B	The analyte was found in the associated method blank at a level that is significant relative to the sample result.
E	The result is an estimate amount because the value exceeded the instrument calibration range.
J	The result is an estimated concentration that is less than the MRL but greater than or equal to the MDL.
U	The compound was analyzed for, but was not detected ("Non-detect") at or above the MRL/MDL.
i	The MRL/MDL has been elevated due to a matrix interference.
X	See case narrative.

Metals Data Qualifiers

#	The control limit criteria is not applicable. See case narrative.
B	The result is an estimated concentration that is less than the MRL but greater than or equal to the MDL.
E	The percent difference for the serial dilution was greater than 10%, indicating a possible matrix interference in the sample.
M	The duplicate injection precision was not met.
N	The Matrix Spike sample recovery is not within control limits. See case narrative.
S	The reported value was determined by the Method of Standard Additions (MSA).
U	The compound was analyzed for, but was not detected ("Non-detect") at or above the MRL/MDL.
W	The post-digestion spike for furnace AA analysis is out of control limits, while sample absorbance is less than 50% of spike absorbance.
i	The MRL/MDL has been elevated due to a matrix interference.
X	See case narrative.
*	The duplicate analysis not within control limits. See case narrative.
+	The correlation coefficient for the MSA is less than 0.995.

Organic Data Qualifiers

*	The result is an outlier. See case narrative.
#	The control limit criteria is not applicable. See case narrative.
A	A tentatively identified compound, a suspected aldol-condensation product.
B	The analyte was found in the associated method blank at a level that is significant relative to the sample result.
C	The analyte was qualitatively confirmed using GC/MS techniques, pattern recognition, or by comparing to historical data.
D	The reported result is from a dilution.
E	The result is an estimate amount because the value exceeded the instrument calibration range.
J	The result is an estimated concentration that is less than the MRL but greater than or equal to the MDL.
N	The result is presumptive. The analyte was tentatively identified, but a confirmation analysis was not performed.
P	The GC or HPLC confirmation criteria was exceeded. The relative percent difference is greater than 40% between the two analytical results (25% for CLP Pesticides).
U	The compound was analyzed for, but was not detected ("Non-detect") at or above the MRL/MDL.
i	The MRL/MDL has been elevated due to a chromatographic interference.
X	See case narrative.

Additional Petroleum Hydrocarbon Specific Qualifiers

F	The chromatographic fingerprint of the sample matches the elution pattern of the calibration standard.
L	The chromatographic fingerprint of the sample resembles a petroleum product, but the elution pattern indicates the presence of a greater amount of lighter molecular weight constituents than the calibration standard.
H	The chromatographic fingerprint of the sample resembles a petroleum product, but the elution pattern indicates the presence of a greater amount of heavier molecular weight constituents than the calibration standard.
O	The chromatographic fingerprint of the sample resembles an oil, but does not match the calibration standard.
Y	The chromatographic fingerprint of the sample resembles a petroleum product eluting in approximately the correct carbon range, but the elution pattern does not match the calibration standard.
Z	The chromatographic fingerprint does not resemble a petroleum product.

COLUMBIA ANALYTICAL SERVICES, INC.

Client:	CH2M Hill	**Service Request No.:**	K2302324
Project:	Samoa Joint Cannery Outfall / 147323.JC.03.NT	**Date Received:**	3/27/03
Sample Matrix:	Water		

CASE NARRATIVE

All analyses were performed consistent with the quality assurance program of Columbia Analytical Services, Inc. (CAS). This report contains analytical results for samples designated for Tier II data deliverables. When appropriate to the method, method blank results have been reported with each analytical test. Additional quality control analyses reported herein include: Laboratory Duplicate (DUP), Matrix Spike (MS), and Laboratory Control Sample (LCS).

Sample Receipt

Thirty-one water samples were received for analysis at Columbia Analytical Services on 3/27/03. The following discrepancy was noted upon initial sample inspection. All samples required addition of Nitric Acid for preservation. The exceptions are also noted on the cooler receipt and preservation form included in this data package. Except as noted, the samples were received in good condition and consistent with the accompanying chain of custody form. The samples were stored in a refrigerator at 4°C upon receipt at the laboratory.

Total Metals

Relative Percent Difference (RPD) Exceptions:
The RPD for the replicate analysis of Lead in sample S1-A was outside the normal CAS control limits. The variability in the results is attributed to particulate material in the sample. Standard mixing techniques were used, but were not sufficient for complete homogenization of this sample.

The RPD for the replicate analysis of Zinc in the batch QC sample was outside the normal CAS control limits. While the associated QA/QC results (e.g. method blank, control sample, matrix spike, calibration standards, etc.) indicate the analysis was in control, the high replicate value may be a result of background laboratory contribution. The batch QC sample did not contain visible particulate, which might account for the variability. Due to the volume requirements of the analysis, insufficient sample remained for reanalysis.

Approved by HLS Date 4/22/03

Columbia Analytical Services

METALS

- Cover Page -
INORGANIC ANALYSIS DATA PACKAGE

Client: CH2M Hill

Service Request: K2302324

Project No.: 147323.JC.03.NT

Project Name: Samoa Joint Cannery Outfall

Sample No.	Lab Sample ID.
Batch QC	K2301974-003D
Batch QC	K2301974-003S
5-S	K2302324-001
5-M	K2302324-002
5-B	K2302324-003
13-S	K2302324-007
13-M	K2302324-008
13-B	K2302324-009
14-S	K2302324-010
14-M	K2302324-011
14-B	K2302324-012
8-S	K2302324-013
8-M	K2302324-014
8-B	K2302324-015
8A-S	K2302324-016
8A-M	K2302324-017
8A-B	K2302324-018
Method Blank	K2302324-MB

Were ICP interelement corrections applied? Yes/No YES

Were ICP background corrections applied? Yes/No YES

If yes-were raw data generated before application of background corrections? Yes/No NO

Comments: Seawater Package

I certify that this data package is in compliance with the terms and conditions of the contract, both technically and for completeness, for other than the conditions detailed above. Release of the data contained in this hardcopy data package and in the computer-readable data submitted on diskette has been authorized by the Laboratory Manager or the Manager's designee, as verified by the following signature.

Signature: [signature]

Date: 4/15/03

METALS

-1-

INORGANIC ANALYSIS DATA SHEET

Client: CH2M Hill
Project No.: 147323.JC.03.NT
Project Name: Samoa Joint Cannery Outfall
Matrix: WATER

Service Request: K2302324
Date Collected: 03/20/03
Date Received: 03/27/03
Units: µG/L
Basis: NA

Sample Name: 5-S
Lab Code: K2302324-001

Analyte	Analysis Method	MRL	Dilution Factor	Date Extracted	Date Analyzed	Result	C	Q
Arsenic	200.8	0.5	1	4/4/03	4/9/03	1.6		
Copper	200.8	0.1	1	4/4/03	4/9/03	0.3		
Lead	200.8	0.02	1	4/4/03	4/9/03	0.05		
Zinc	200.8	0.3	1	4/4/03	4/9/03	4.2		*

% Solids: 0.0

Comments:

METALS

-1-

INORGANIC ANALYSIS DATA SHEET

Client: CH2M Hill
Project No.: 147323.JC.03.NT
Project Name: Samoa Joint Cannery Outfall
Matrix: WATER

Service Request: K2302324
Date Collected: 03/20/03
Date Received: 03/27/03
Units: µG/L
Basis: NA

Sample Name: 5-M
Lab Code: K2302324-002

Analyte	Analysis Method	MRL	Dilution Factor	Date Extracted	Date Analyzed	Result	C	Q
Arsenic	200.8	0.5	1	4/4/03	4/9/03	1.5		
Copper	200.8	0.1	1	4/4/03	4/9/03	0.2		
Lead	200.8	0.02	1	4/4/03	4/9/03	0.04		
Zinc	200.8	0.3	1	4/4/03	4/9/03	3.8		*

% Solids: 0.0

Comments:

METALS

-1-

INORGANIC ANALYSIS DATA SHEET

Client: CH2M Hill
Project No.: 147323.JC.03.NT
Project Name: Samoa Joint Cannery Outfall
Matrix: WATER

Service Request: K2302324
Date Collected: 03/20/03
Date Received: 03/27/03
Units: µG/L
Basis: NA

Sample Name: 5-B
Lab Code: K2302324-003

Analyte	Analysis Method	MRL	Dilution Factor	Date Extracted	Date Analyzed	Result	C	Q
Arsenic	200.8	0.5	1	4/4/03	4/9/03	1.6		
Copper	200.8	0.1	1	4/4/03	4/9/03	0.2		
Lead	200.8	0.02	1	4/4/03	4/9/03	0.03		
Zinc	200.8	0.3	1	4/4/03	4/9/03	4.1		*

% Solids: 0.0

Comments:

METALS

-1-

INORGANIC ANALYSIS DATA SHEET

Client: CH2M Hill
Project No.: 147323.JC.03.NT
Project Name: Samoa Joint Cannery Outfall
Matrix: WATER

Service Request: K2302324
Date Collected: 03/20/03
Date Received: 03/27/03
Units: µG/L
Basis: NA

Sample Name: 13-S
Lab Code: K2302324-007

Analyte	Analysis Method	MRL	Dilution Factor	Date Extracted	Date Analyzed	Result	C	Q
Arsenic	200.8	0.5	1	4/4/03	4/9/03	1.5		
Copper	200.8	0.1	1	4/4/03	4/9/03	0.7		
Lead	200.8	0.02	1	4/4/03	4/9/03	0.12		
Zinc	200.8	0.3	1	4/4/03	4/9/03	6.5		*

% Solids: 0.0

Comments:

METALS

-1-

INORGANIC ANALYSIS DATA SHEET

Client: CH2M Hill
Project No.: 147323.JC.03.NT
Project Name: Samoa Joint Cannery Outfall
Matrix: WATER

Service Request: K2302324
Date Collected: 03/20/03
Date Received: 03/27/03
Units: µG/L
Basis: NA

Sample Name: 13-M
Lab Code: K2302324-008

Analyte	Analysis Method	MRL	Dilution Factor	Date Extracted	Date Analyzed	Result	C	Q
Arsenic	200.8	0.5	1	4/4/03	4/9/03	1.5		
Copper	200.8	0.1	1	4/4/03	4/9/03	0.5		
Lead	200.8	0.02	1	4/4/03	4/9/03	0.07		
Zinc	200.8	0.3	1	4/4/03	4/9/03	5.5		*

% Solids: 0.0

Comments:

METALS

-1-

INORGANIC ANALYSIS DATA SHEET

Client: CH2M Hill
Project No.: 147323.JC.03.NT
Project Name: Samoa Joint Cannery Outfall
Matrix: WATER

Service Request: K2302324
Date Collected: 03/20/03
Date Received: 03/27/03
Units: µG/L
Basis: NA

Sample Name: 13-B
Lab Code: K2302324-009

Analyte	Analysis Method	MRL	Dilution Factor	Date Extracted	Date Analyzed	Result	C	Q
Arsenic	200.8	0.5	1	4/4/03	4/9/03	1.4		
Copper	200.8	0.1	1	4/4/03	4/9/03	0.5		
Lead	200.8	0.02	1	4/4/03	4/9/03	0.09		
Zinc	200.8	0.3	1	4/4/03	4/9/03	4.5		*

% Solids: 0.0

Comments:

METALS

-1-

INORGANIC ANALYSIS DATA SHEET

Client: CH2M Hill
Project No.: 147323.JC.03.NT
Project Name: Samoa Joint Cannery Outfall
Matrix: WATER

Service Request: K2302324
Date Collected: 03/19/03
Date Received: 03/27/03
Units: µG/L
Basis: NA

Sample Name: 14-S
Lab Code: K2302324-010

Analyte	Analysis Method	MRL	Dilution Factor	Date Extracted	Date Analyzed	Result	C	Q
Copper	200.8	0.1	1	4/4/03	4/9/03	0.6		
Zinc	200.8	0.3	1	4/4/03	4/9/03	6.5		*

% Solids: 0.0

Comments:

METALS

-1-

INORGANIC ANALYSIS DATA SHEET

Client:	CH2M Hill	Service Request:	K2302324
Project No.:	147323.JC.03.NT	Date Collected:	03/19/03
Project Name:	Samoa Joint Cannery Outfall	Date Received:	03/27/03
Matrix:	WATER	Units:	µG/L
		Basis:	NA

Sample Name: 14-M Lab Code: K2302324-011

Analyte	Analysis Method	MRL	Dilution Factor	Date Extracted	Date Analyzed	Result	C	Q
Copper	200.8	0.1	1	4/4/03	4/9/03	0.3		
Zinc	200.8	0.3	1	4/4/03	4/9/03	3.8		*

% Solids: 0.0

Comments:

METALS

-1-

INORGANIC ANALYSIS DATA SHEET

Client: CH2M Hill
Project No.: 147323.JC.03.NT
Project Name: Samoa Joint Cannery Outfall
Matrix: WATER

Service Request: K2302324
Date Collected: 03/19/03
Date Received: 03/27/03
Units: µG/L
Basis: NA

Sample Name: 14-B
Lab Code: K2302324-012

Analyte	Analysis Method	MRL	Dilution Factor	Date Extracted	Date Analyzed	Result	C	Q
Copper	200.8	0.1	1	4/4/03	4/9/03	0.3		
Zinc	200.8	0.3	1	4/4/03	4/9/03	5.5		*

% Solids: 0.0

Comments:

METALS

-1-

INORGANIC ANALYSIS DATA SHEET

Client: CH2M Hill
Project No.: 147323.JC.03.NT
Project Name: Samoa Joint Cannery Outfall
Matrix: WATER

Service Request: K2302324
Date Collected: 03/19/03
Date Received: 03/27/03
Units: µG/L
Basis: NA

Sample Name: 8-S
Lab Code: K2302324-013

Analyte	Analysis Method	MRL	Dilution Factor	Date Extracted	Date Analyzed	Result	C	Q
Copper	200.8	0.1	1	4/4/03	4/9/03	0.5		
Zinc	200.8	0.3	1	4/4/03	4/9/03	5.5		*

% Solids: 0.0

Comments:

METALS

-1-

INORGANIC ANALYSIS DATA SHEET

Client:	CH2M Hill	Service Request:	K2302324
Project No.:	147323.JC.03.NT	Date Collected:	03/19/03
Project Name:	Samoa Joint Cannery Outfall	Date Received:	03/27/03
Matrix:	WATER	Units:	µG/L
		Basis:	NA

Sample Name: 8-M Lab Code: K2302324-014

Analyte	Analysis Method	MRL	Dilution Factor	Date Extracted	Date Analyzed	Result	C	Q
Copper	200.8	0.1	1	4/4/03	4/9/03	0.2		
Zinc	200.8	0.3	1	4/4/03	4/9/03	3.1		*

% Solids: 0.0

Comments:

00024

METALS

-1-

INORGANIC ANALYSIS DATA SHEET

Client:	CH2M Hill	Service Request:	K2302324
Project No.:	147323.JC.03.NT	Date Collected:	03/19/03
Project Name:	Samoa Joint Cannery Outfall	Date Received:	03/27/03
Matrix:	WATER	Units:	µG/L
		Basis:	NA

Sample Name: 8-B Lab Code: K2302324-015

Analyte	Analysis Method	MRL	Dilution Factor	Date Extracted	Date Analyzed	Result	C	Q
Copper	200.8	0.1	1	4/4/03	4/9/03	0.2		
Zinc	200.8	0.3	1	4/4/03	4/9/03	4.5		*

% Solids: 0.0

Comments:

METALS

-1-

INORGANIC ANALYSIS DATA SHEET

Client:	CH2M Hill	Service Request:	K2302324
Project No.:	147323.JC.03.NT	Date Collected:	03/19/03
Project Name:	Samoa Joint Cannery Outfall	Date Received:	03/27/03
Matrix:	WATER	Units:	µG/L
		Basis:	NA

Sample Name: 8A-S Lab Code: K2302324-016

Analyte	Analysis Method	MRL	Dilution Factor	Date Extracted	Date Analyzed	Result	C	Q
Copper	200.8	0.1	1	4/4/03	4/9/03	0.6		
Zinc	200.8	0.3	1	4/4/03	4/9/03	5.5		*

% Solids: 0.0

Comments:

METALS

-1-

INORGANIC ANALYSIS DATA SHEET

Client:	CH2M Hill	Service Request:	K2302324
Project No.:	147323.JC.03.NT	Date Collected:	03/19/03
Project Name:	Samoa Joint Cannery Outfall	Date Received:	03/27/03
Matrix:	WATER	Units:	µG/L
		Basis:	NA

Sample Name: 8A-M Lab Code: K2302324-017

Analyte	Analysis Method	MRL	Dilution Factor	Date Extracted	Date Analyzed	Result	C	Q
Copper	200.8	0.1	1	4/4/03	4/9/03	0.3		
Zinc	200.8	0.3	1	4/4/03	4/9/03	3.3		*

% Solids: 0.0

Comments:

METALS

-1-

INORGANIC ANALYSIS DATA SHEET

Client:	CH2M Hill	Service Request:	K2302324
Project No.:	147323.JC.03.NT	Date Collected:	03/19/03
Project Name:	Samoa Joint Cannery Outfall	Date Received:	03/27/03
Matrix:	WATER	Units:	µG/L
		Basis:	NA

Sample Name: 8A-B Lab Code: K2302324-018

Analyte	Analysis Method	MRL	Dilution Factor	Date Extracted	Date Analyzed	Result	C	Q
Copper	200.8	0.1	1	4/4/03	4/9/03	0.3		
Zinc	200.8	0.3	1	4/4/03	4/9/03	4.6		*

% Solids: 0.0

Comments:

METALS

-1-

INORGANIC ANALYSIS DATA SHEET

Client: CH2M Hill
Project No.: 147323.JC.03.NT
Project Name: Samoa Joint Cannery Outfall
Matrix: WATER

Service Request: K2302324
Date Collected:
Date Received:
Units: µG/L
Basis: NA

Sample Name: Method Blank
Lab Code: K2302324-MB

Analyte	Analysis Method	MRL	Dilution Factor	Date Extracted	Date Analyzed	Result	C	Q
Arsenic	200.8	0.5	1	4/4/03	4/9/03	0.5	U	
Copper	200.8	0.1	1	4/4/03	4/9/03	0.1	U	
Lead	200.8	0.02	1	4/4/03	4/9/03	0.02	U	
Zinc	200.8	0.3	1	4/4/03	4/9/03	0.3	U	*

% Solids: 0.0

Comments:

METALS
- 5a -
SPIKE SAMPLE RECOVERY

Client: CH2M Hill
Project No.: 147323.JC.03.NT
Project Name: Samoa Joint Cannery Outfall
Matrix: WATER

Service Request: K2302324
Units: µg/L
Basis: NA
% Solids: 0.0

Sample Name: Batch QC
Lab Code: K2301974-003S

Analyte	Control Limit %R	Spike Result	C	Sample Result	C	Spike Added	%R	Q	Method
Arsenic	47 - 122	4.5		2.5		2.0	97		200.8
Copper		21.7		18.9		2.0	145		200.8
Lead	61 - 120	1.86		0.09		2.00	88		200.8
Zinc	36 - 143	7.5		5.4		2.0	103		200.8

An empty field in the Control Limit column indicates the control limit is not applicable.

METALS
- 6 -
DUPLICATES

Client: CH2M Hill
Project No.: 147323.JC.03.NT
Project Name: Samoa Joint Cannery Outfall
Matrix: WATER

Service Request: K2302324
Units: µg/L
Basis: NA
% Solids: 0.0

Sample Name: Batch QC
Lab Code: K2301974-003D

Analyte	Control Limit(%)	Sample (S)	C	Duplicate (D)	C	RPD	Q	Method
Arsenic	20	2.5		2.6		4		200.8
Copper	20	18.9		20.7		9		200.8
Lead		0.09		0.10		11		200.8
Zinc	20	5.4		6.8		23	*	200.8

An empty field in the Control Limit column indicates the control limit is not applicable.

Form VI - IN

METALS

- 7 -

LABORATORY CONTROL SAMPLE

Client: CH2M Hill

Service Request: K2302324

Project No.: 147323.JC.03.NT

Project Name: Samoa Joint Cannery Outfall

Aqueous LCS Source: Inorganic Ventures

Solid LCS Source:

Analyte	Aqueous ug/L True	Aqueous ug/L Found	Aqueous ug/L %R	Solid (mg/kg) True	Solid (mg/kg) Found	C	Limits		%R
Arsenic	2.00	1.78	89						
Copper	2.00	1.76	88						
Lead	2.00	1.87	94						
Zinc	2.00	2.55	127						

Columbia Analytical Services

METALS

- Cover Page -
INORGANIC ANALYSIS DATA PACKAGE

Client: CH2M Hill

Service Request: K2302324

Project No.: 147323.JC.03.NT

Project Name: Samoa Joint Cannery Outfall

Sample No.	Lab Sample ID.
S1-A	K2302324-022
S1-AD	K2302324-022D
S1-AS	K2302324-022S
S2-A	K2302324-024
S3-A	K2302324-026
S4-A	K2302324-028
S5-A	K2302324-030
Method Blank	K2302324-MB

Were ICP interelement corrections applied? Yes/No YES

Were ICP background corrections applied? Yes/No YES

If yes-were raw data generated before application of background corrections? Yes/No NO

Comments: Freshwater Package

I certify that this data package is in compliance with the terms and conditions of the contract, both technically and for completeness, for other than the conditions detailed above. Release of the data contained in this hardcopy data package and in the computer-readable data submitted on diskette has been authorized by the Laboratory Manager or the Manager's designee, as verified by the following signature.

Signature: [signature] Date: 4/15/03

METALS

-1-

INORGANIC ANALYSIS DATA SHEET

Client:	CH2M Hill	Service Request:	K2302324
Project No.:	147323.JC.03.NT	Date Collected:	03/21/03
Project Name:	Samoa Joint Cannery Outfall	Date Received:	03/27/03
Matrix:	WATER	Units:	µG/L
		Basis:	NA

Sample Name: S1-A Lab Code: K2302324-022

Analyte	Analysis Method	MRL	Dilution Factor	Date Extracted	Date Analyzed	Result	C	Q
Arsenic	200.8	0.5	1	4/9/03	4/10/03	0.5	U	
Lead	200.8	0.02	1	4/9/03	4/10/03	1.16		*

% Solids: 0.0

Comments:

METALS

-1-

INORGANIC ANALYSIS DATA SHEET

Client:	CH2M Hill	Service Request:	K2302324
Project No.:	147323.JC.03.NT	Date Collected:	03/21/03
Project Name:	Samoa Joint Cannery Outfall	Date Received:	03/27/03
Matrix:	WATER	Units:	µG/L
		Basis:	NA

Sample Name: S2-A Lab Code: K2302324-024

Analyte	Analysis Method	MRL	Dilution Factor	Date Extracted	Date Analyzed	Result	C	Q
Arsenic	200.8	0.5	1	4/9/03	4/10/03	1.3		
Lead	200.8	0.02	1	4/9/03	4/10/03	0.96		*

% Solids: 0.0

Comments:

00034 A

METALS

-1-

INORGANIC ANALYSIS DATA SHEET

Client: CH2M Hill
Project No.: 147323.JC.03.NT
Project Name: Samoa Joint Cannery Outfall
Matrix: WATER

Service Request: K2302324
Date Collected: 03/21/03
Date Received: 03/27/03
Units: µG/L
Basis: NA

Sample Name: S3-A
Lab Code: K2302324-026

Analyte	Analysis Method	MRL	Dilution Factor	Date Extracted	Date Analyzed	Result	C	Q
Arsenic	200.8	0.5	1	4/9/03	4/10/03	0.5	U	
Lead	200.8	0.02	1	4/9/03	4/10/03	1.59		*

% Solids: 0.0

Comments:

METALS

-1-

INORGANIC ANALYSIS DATA SHEET

Client: CH2M Hill
Project No.: 147323.JC.03.NT
Project Name: Samoa Joint Cannery Outfall
Matrix: WATER

Service Request: K2302324
Date Collected: 03/21/03
Date Received: 03/27/03
Units: µG/L
Basis: NA

Sample Name: S4-A
Lab Code: K2302324-028

Analyte	Analysis Method	MRL	Dilution Factor	Date Extracted	Date Analyzed	Result	C	Q
Arsenic	200.8	0.5	1	4/9/03	4/10/03	1.4		
Lead	200.8	0.02	1	4/9/03	4/10/03	0.58		*

% Solids: 0.0

Comments:

METALS

-1-

INORGANIC ANALYSIS DATA SHEET

Client:	CH2M Hill	Service Request:	K2302324
Project No.:	147323.JC.03.NT	Date Collected:	03/21/03
Project Name:	Samoa Joint Cannery Outfall	Date Received:	03/27/03
Matrix:	WATER	Units:	µG/L
		Basis:	NA

Sample Name: S5-A Lab Code: K2302324-030

Analyte	Analysis Method	MRL	Dilution Factor	Date Extracted	Date Analyzed	Result	C	Q
Arsenic	200.8	0.5	1	4/9/03	4/10/03	0.8		
Lead	200.8	0.02	1	4/9/03	4/10/03	0.31		*

% Solids: 0.0

Comments:

METALS

-1-

INORGANIC ANALYSIS DATA SHEET

Client: CH2M Hill
Project No.: 147323.JC.03.NT
Project Name: Samoa Joint Cannery Outfall
Matrix: WATER

Service Request: K2302324
Date Collected:
Date Received:
Units: µG/L
Basis: NA

Sample Name: Method Blank
Lab Code: K2302324-MB

Analyte	Analysis Method	MRL	Dilution Factor	Date Extracted	Date Analyzed	Result	C	Q
Arsenic	200.8	0.5	1	4/9/03	4/10/03	0.5	U	
Lead	200.8	0.02	1	4/9/03	4/10/03	0.02	U	*

% Solids: 0.0

Comments:

METALS
- 5a -
SPIKE SAMPLE RECOVERY

Client: CH2M Hill
Project No.: 147323.JC.03.NT
Project Name: Samoa Joint Cannery Outfall
Matrix: WATER

Service Request: K2302324
Units: µg/L
Basis: NA
% Solids: 0.0

Sample Name: S1-AS
Lab Code: K2302324-022S

Analyte	Control Limit %R	Spike Result	C	Sample Result	C	Spike Added	%R	Q	Method
Arsenic	70 - 130	17.5		0.5	U	20.0	88		200.8
Lead	70 - 130	22.0		1.16		20.0	104		200.8

An empty field in the Control Limit column indicates the control limit is not applicable.

METALS
- 6 -
DUPLICATES

Client: CH2M Hill
Project No.: 147323.JC.03.NT
Project Name: Samoa Joint Cannery Outfall
Matrix: WATER

Service Request: K2302324
Units: µg/L
Basis: NA
% Solids: 0.0

Sample Name: S1-AD
Lab Code: K2302324-022D

Analyte	Control Limit(%)	Sample (S)	C	Duplicate (D)	C	RPD	Q	Method
Arsenic		0.5	U	0.5	U			200.8
Lead	20	1.16		1.52		27	*	200.8

An empty field in the Control Limit column indicates the control limit is not applicable.

METALS
- 7 -
LABORATORY CONTROL SAMPLE

Client: CH2M Hill

Service Request: K2302324

Project No.: 147323.JC.03.NT

Project Name: Samoa Joint Cannery Outfall

Aqueous LCS Source: Inorganic Ventures

Solid LCS Source:

Analyte	Aqueous ug/L True	Aqueous ug/L Found	Aqueous ug/L %R	Solid (mg/kg) True	Solid (mg/kg) Found	Solid (mg/kg) C	Solid (mg/kg) Limits	Solid (mg/kg) %R
Arsenic	20.0	19.8	99					
Lead	20.0	20.3	101					

COLUMBIA ANALYTICAL SERVICES, INC.

Analytical Report

Client:	CH2M Hill	**Service Request:**	K2302324
Project:	Samoa Joint Cannery Outfall/147323.JC.03.NT	**Date Collected:**	3/20/03
Sample Matrix:	Water	**Date Received:**	3/27/03

Mercury, Total

Prep Method:	METHOD	Units:	ng/L
Analysis Method:	1631E	Basis:	NA
Test Notes:			

Sample Name	Lab Code	MRL	Dilution Factor	Date Extracted	Date Analyzed	Result	Result Notes
5-S	K2302324-001	1.0	1	4/7/03	4/8/03	5.5	
5-M	K2302324-002	1.0	1	4/7/03	4/8/03	6.2	
5-B	K2302324-003	1.0	1	4/7/03	4/8/03	13.9	
13-S	K2302324-007	1.0	1	4/7/03	4/8/03	3.2	
13-M	K2302324-008	1.0	1	4/7/03	4/8/03	3.1	
13-B	K2302324-009	1.0	1	4/7/03	4/8/03	2.5	
S1-B	K2302324-023	1.0	1	4/7/03	4/8/03	5.5	
S2-B	K2302324-025	1.0	1	4/7/03	4/8/03	2.3	
S3-B	K2302324-027	1.0	1	4/7/03	4/8/03	5.1	
S4-B	K2302324-029	1.0	1	4/7/03	4/8/03	1.8	
S5-B	K2302324-031	1.0	1	4/7/03	4/8/03	1.7	
Method Blank	K2302324-MB	1.0	1	4/7/03	4/8/03	ND	

Approved By: JC Date: 4/15/03

1A/052595

COLUMBIA ANALYTICAL SERVICES, INC.

QA/QC Report

Client:	CH2M Hill	**Service Request:**	K2302324
Project:	Samoa Joint Cannery Outfall/147323.JC.03.NT	**Date Collected:**	3/20/03
Sample Matrix:	Water	**Date Received:**	3/27/03
		Date Extracted:	4/7/03
		Date Analyzed:	4/8/03

Matrix Spike/Duplicate Matrix Spike Summary
Total Metals

Sample Name:	S5-B	Units:	ng/L
Lab Code:	K2302324-031S, K2302324-031SD	Basis:	NA
Test Notes:			

Analyte	Prep Method	Analysis Method	MRL	Spike Level MS	Spike Level DMS	Sample Result	Spike Result MS	Spike Result DMS	Percent Recovery MS	Percent Recovery DMS	CAS Acceptance Limits	Relative Percent Difference	Result Notes
Mercury	METHOD	1631E	1.0	5.0	5.0	1.7	6.8	6.8	102	102	71-125	<1	

Approved By: _____ Date: 4/15/03

DMS/052595

COLUMBIA ANALYTICAL SERVICES, INC.

QA/QC Report

Client:	CH2M Hill	**Service Request:**	K2302324
Project:	Samoa Joint Cannery Outfall/147323.JC.03.NT	**Date Collected:**	NA
Sample Matrix:	Water	**Date Received:**	NA
		Date Extracted:	4/7/03
		Date Analyzed:	4/8/03

Matrix Spike/Duplicate Matrix Spike Summary
Total Metals

Sample Name:	Batch QC		Units:	ng/L
Lab Code:	K2302130-003S,	K2302130-003SD	Basis:	NA
Test Notes:				

Analyte	Prep Method	Analysis Method	MRL	Spike Level MS	Spike Level DMS	Sample Result	Spike Result MS	Spike Result DMS	Percent Recovery MS	Percent Recovery DMS	CAS Acceptance Limits	Relative Percent Difference	Result Notes
Mercury	METHOD	1631E	1.0	5.0	5.0	1.7	6.8	6.8	102	102	71-125	<1	

Approved By: _____ Date: 4/15/03

DMS/052595

COLUMBIA ANALYTICAL SERVICES, INC.

QA/QC Report

Client:	CH2M Hill	**Service Request:**	K2302324
Project:	Samoa Joint Cannery Outfall/147323.JC.03.NT	**Date Collected:**	NA
LCS Matrix:	Water	**Date Received:**	NA
		Date Extracted:	4/7/03
		Date Analyzed:	4/8/03

Ongoing Precision and Recovery (OPR) Sample Summary
Total Metals

Sample Name: Ongoing Precision and Recovery (Initial)

Units: ng/L
Basis: NA

Test Notes:

Source: High Purity Stds. 908211

Analyte	Prep Method	Analysis Method	True Value	Result	Percent Recovery	CAS Percent Recovery Acceptance Limits	Result Notes
Mercury	METHOD	1631E	5.00	5.16	103	77-123	

Approved By: _____ Date: 4/15/03

LCS/032295

COLUMBIA ANALYTICAL SERVICES, INC.

QA/QC Report

Client:	CH2M Hill	**Service Request:**	K2302324
Project:	Samoa Joint Cannery Outfall/147323.JC.03.NT	**Date Collected:**	NA
LCS Matrix:	Water	**Date Received:**	NA
		Date Extracted:	4/7/03
		Date Analyzed:	4/8/03

Ongoing Precision and Recovery (OPR) Sample Summary
Total Metals

Sample Name: Ongoing Precision and Recovery (Final)

Units: ng/L
Basis: NA

Test Notes:

Source: High Purity Stds. 908211

Analyte	Prep Method	Analysis Method	True Value	Result	Percent Recovery	CAS Percent Recovery Acceptance Limits	Result Notes
Mercury	METHOD	1631E	5.00	5.33	107	77-123	

Approved By: _____ Date: 4/15/03

LCS/032295

Samoa Joint Cannery Outfall

2003 Tradewind Season

Effluent Bioassay Test Results

August 2003 Sampling

15 December 2003

CH2MHILL

CH2MHILL

TECHNICAL MEMORANDUM

BIOASSAY TESTING – JOINT CANNERY OUTFALL EFFLUENT AUGUST 2003 SAMPLING

Prepared For: StarKist Samoa (NPDES Permit AS0000019)
COS Samoa Packing (NPDES Permit AS0000027)

Prepared By: Steve Costa
Karen Glatzel

Date: 15 December 2003

Distribution: Carl Goldstein
United States Environmental Protection Agency, Region 9
Peter Peshut
American Samoa Environmental Protection Agency

Purpose

This memorandum presents the results of the bioassay testing of the Joint Cannery Outfall effluent sample that was collected in August 2003. The testing is required by the NPDES Permits that became effective in January 2001. This is the sixth required semiannual test required by the current permits and the twenty-second semiannual test conducted since testing for the Joint Cannery Outfall began in 1993.

Study Objectives

Section D.1 of the StarKist Samoa and COS Samoa Packing NPDES Permits requires that semiannual definitive acute bioassays (96-hour static bioassays) be conducted on the cannery effluent. The purpose of these tests is to determine whether, and at what effluent concentration, acute toxicity may be detected for the combined joint cannery effluent discharge into Pago Pago Harbor.

Study Approach

U.S. EPA has conducted a number of reviews of the effluent sampling, analysis, and bioassay tests conducted in the past. All comments from U.S. EPA have been incorporated into the sampling and sample handling standard operating procedures (SOP) or have been incorporated into the procedures used by the laboratory doing the test. The comments, responses, and SOP have been documented in previous reports.

The permit conditions require that the bioassay tests be conducted with the white shrimp, *Penaeus vannami* (postlarvae). In the event *Penaeus vannami* is not available at the time of the tests, the permit specifies the substitute species, *Mysidopsis bahia*, which now has been renamed *Americamysis bahia*. For the August 2003 sampling, *Penaeus vannami* was not available and *Americamysis bahia* was used.

Effluent samples were collected from the StarKist Samoa and COS Samoa Packing facilities as 24-hour composite samples. The acute effluent bioassay test was conducted using a combined, flow-weighted, composite effluent sample made up from the effluent samples from both canneries, as allowed by the permit condition. This combined effluent bioassay is representative of the wastewater discharged from the joint cannery outfall to Pago Pago Harbor.

Effluent Sampling Methods

Between 1200 noon on 6 August 2003 and 0900 on 7 August 2003, 24-hour flow-weighted composite samples of final effluent were collected from both the StarKist Samoa and COS Samoa Packing effluent discharges. Samples were collected from the established effluent sampling sites. Detailed sampling procedures are described in the established SOP for cannery effluent sampling.

A total of eight grab samples were collected into 1-gallon plastic cubitainers at each plant. Samples were collected at approximately three-hour intervals over a 24-hour period. The samples were stored on ice or in a refrigerator until the completion of the 24-hour sampling period. After all samples were collected a flow-proportioned composite sample was prepared. The grab sample collection times, effluent flow rates, and the relative effluent flow volumes calculated from plant flow records are summarized in Table 1. The relative effluent flow volumes were used to prepare the final composite sample, which was used to fill the sample container shipped to the laboratory for testing.

A 5-gallon cubitainer containing the composite sample was packed on ice in an ice chest for shipment to the laboratory. A chain-of-custody form for the sample was completed and sealed into a zip-lock bag and taped inside the lid of the ice chest. The sample was shipped via DHL to the testing laboratory. The chain-of-custody form and the DHL waybill are provided in Attachment I.

Table 1
StarKist Samoa and COS Samoa Packing
24-hour Composite Effluent Sample for Bioassay Testing
August 2003

Grab Sample Number	COS Samoa Packing		StarKist Samoa		COS Samoa Packing Percent of Total Flow	StarKist Samoa Percent Of Total Flow
	Sampling Date and Time	Effluent Flow Rate (mgd)	Sampling Date and Time	Effluent Flow Rate (mgd)		
1	06 Aug 0900 1200	0.860	06 Aug 0900 1200	1.75	3.9	8.0
2	1500	0.800	1500	2.61	3.6	11.9
3	1800	0.640	1800	1.85	2.9	8.4
4	2100	0.600	2100	2.70	2.7	12.3
5	07 Aug 2003 0000	0.460	07 Aug 2003 0000	2.10	2.1	9.5
6	0300	0.460	0300	2.10	2.1	9.5
7	0600	0.600	0600	2.16	2.7	9.8
8	0900	0.560	0900	1.77	2.5	8.0
Total		4.98		17.04	22.6	77.4
Mean		0.62		2.13	100.0	

Bioassay Testing Procedures

EnviroSystems, Inc. located in Hampton, New Hampshire conducted the bioassay tests. The testing procedures and results of the bioassay tests are provided in the Laboratory report included as Attachment II. This report summarizes the 96-hour acute bioassay test conducted with reference to U.S. EPA documents Methods for Measuring the Acute Toxicity of Effluents to Freshwater and Marine Organisms (EPA-821-R-02-012), 2002 as the sources of methods for conducting the test. The bioassay test was conducted considering and including U.S. EPA's comments on previous bioassay tests, as documented in previous reports.

The test organisms were ≤ 5 days old and the test temperature was to be held at 20 ±1°C, with actual temperatures ranging between 19°C and 23°C. Salinity was

adjusted to 25 ppt at the start of the test and ranged during the test between 24 and 26 ppt. Demonstrated potential for a lethal immediate dissolved oxygen demand (IDOD) had been discussed and documented in previous bioassay technical memoranda, which describe the first two tests conducted in 1993. Therefore, all of the bioassay test chambers were continuously aerated during the bioassay tests to maintain adequate levels of dissolved oxygen (DO). The test was renewed with oxygenated sample at 48 hours.

Bioassay tests were carried out for effluent concentrations of 50, 25, 12.5, 6.25, and 3.1 percent as vol:vol dilutions in seawater. Water quality was monitored daily and parameters measured included DO, pH, salinity, and temperature. Total residual chlorine and ammonia were measured. Reference toxicant tests using sodium dodecyl sulfonate (SDS) are conducted regularly by ESI with the last one completed on 26 August 2003 and results were within one standard deviation of the historic laboratory mean.

Summary Results: Americamysis bahia Effluent Bioassay

All results from the bioassay tests are included in Attachment II. The results of the mysid bioassay tests indicate the 96-hour LC_{50} for the effluent tested was 43.2 percent. The no observable effects concentration (NOEC) for the 96-hour bioassay was 25 percent and the least observable effects concentration (LOEC) was 50 percent. Results on a daily basis are summarized in Table 2.

Table 2
StarKist Samoa and COS Samoa Packing
Combined Effluent Bioassay Results August 2003 Sampling

Exposure Time	Parameter		
	LC_{50}	NOEC	LOEC
24 hours	50.0	50%	>50%
48 hours	50.0	50%	>50%
72 hours	50.0	50%	>50%
96 hours	43.2	25%	50%

Discussion

Table 3 summarizes the results of the effluent bioassay tests for the samples collected in the August 2003 sampling compared to the previous bioassay tests. The

LC_{50}, NOEC and LOEC are within the range obtained from previous reports where *Mysidopsis bahia* was used in place of *Penaeus vannami*. Figure 1 presents the range of results for LC_{50} for the mysid tests for all tests done since 1994. There is some variability observed in test results, and the August 2003 test results were the highest LC_{50} values recorded for this organism. Higher LC_{50} values indicate lower whole effluent toxicity. There is a possible trend toward lower toxicity (higher LC_{50}) with time, however the trend is not statistically significant.

Conclusions

The bioassay tests for the Joint Cannery Outfall effluent for August 2003 do not indicate effluent toxicity levels to be of concern. As discussed in the previous bioassay test reports on the effluent, the time scale of the mixing of the effluent with the receiving water is on the order of seconds to achieve dilutions that will eliminate possible toxic effects as reflected by the bioassay results. For example, an LC_{50} of 43.2%, which was observed in August 2003, corresponds to a dilution of 2.3:1, which is achieved within one second and within one meter of the discharge point. The discharge is located in about 180 feet of water and the effluent toxicity tests indicate that the discharge is diluted to non-toxic levels immediately after discharge and well within the initial dilution plume.

Table 3
StarKist Samoa and COS Samoa Packing
Combined Effluent Bioassay Results

Date	*Species*	Parameters		
		LC 50	NOEC	LOEC
2/93	*Penaeus vannami*	4.8%[1]	3.1%	6.25%
10/93	*Penaeus vannami*	15.67%	3.1%	6.25%
2/94	*Penaeus vannami*	15.76%	<1.6%	1.6%
10/94	*Mysidopsis bahia*[2]	31.2%	25%	50%
3/95	*Penaeus vannami*	14.8%	6.25%	12.5%
3/95	*Mysidopsis bahia*[3]	10.8%	6.25%	12.5%
2/96	*Penaeus vannami*	>50%	>50%	>50%
2/96	*Mysidopsis bahia*[3]	28.36%	12.5%	25%
3/96	*Penaeus vannami*	44.4%	25%	50%
11/96	*Penaeus vannami*	7.11%	3.1%	6.25%
03/97	*Penaeus vannami*	39.36%	12.5%	25%
09/97	*Penaeus vannami*[4]	12.3%	6.25%	12.5%
06/98	*Mysidopsis bahia*[2]	17.2%	6.25%	12.5%
11/98	*Mysidopsis bahia*[2]	15%	6.25%	12.5%
02/00	*Mysidopsis bahia*[2]	20%	6.25%	12.5%
08/00	*Mysidopsis bahia*[2]	17.1%	3.1%	6.25%
03/01	*Americamysis bahia*[5]	13.8%	12.5%	25%
10/01	*Americamysis bahia*[6]	37.5%	25.0%	50.0%
3/02	*Americamysis bahia*[6]	16.1%	12.5%	25%
8/02	*Americamysis bahia*[6]	10.23%	6.25%	12.5%
03/03	*Americamysis bahia*[6]	28.4%	25%	50%
08/03	***Americamysis bahia*[6]**	**43.2%**	**25.0%**	**50.0%**

[1]The February 1993 samples were not aerated until after the first day of the test. For subsequent tests the samples were aerated for the entire duration of the tests.
[2]*Mysidopsis bahia* used as substitutes because *Penaeus vannami* not available: as directed and approved by U. S. EPA.
[3]*Mysidopsis bahia* used in addition to *Penaeus vannami* as described in text of technical memorandums reporting test results. Only one species is required by the permit conditions.
[4]Stage 1 (3 mm) *Penaeus vannami* were used for testing because older Stage 7 and 8 (8-10 mm) *Penaeus vannami* were not available.
[5]*Mysidopsis bahia* renamed *Americamysis bahia*. Results indicate increased toxicity because of low DO in renewal concentrations as renewal water was not aerated prior to use
[6] *Mysidopsis bahia* renamed *Americamysis bahia*

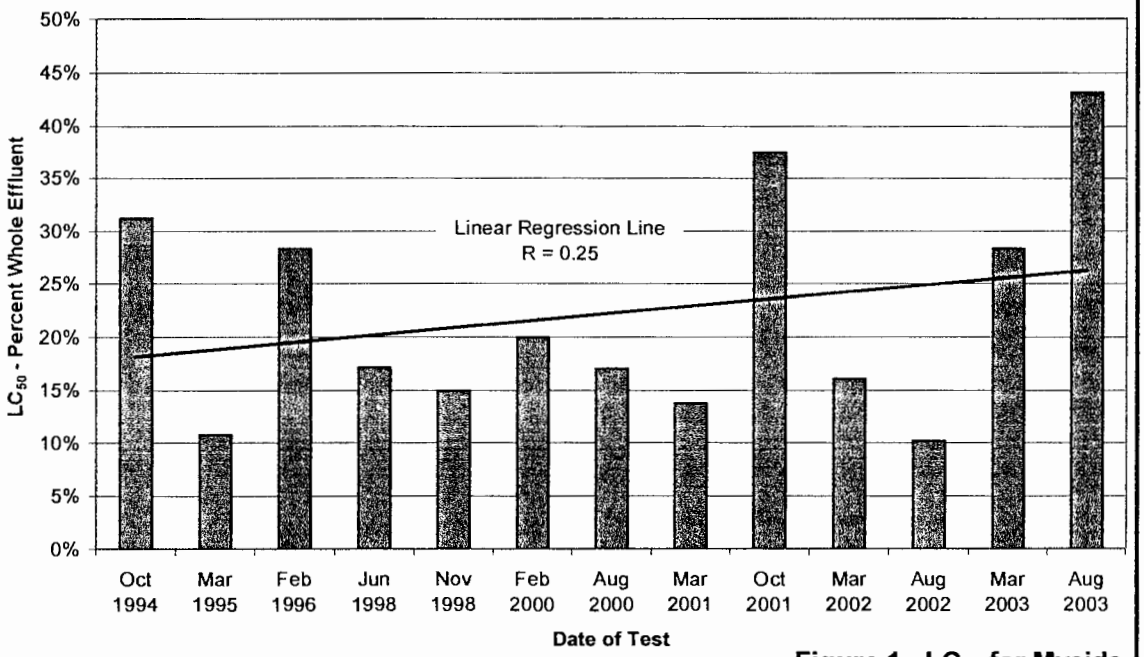

Figure 1. LC_{50} for Mysids

ATTACHMENT I

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ATTACHMENT II

EnviroSystems, Inc. Laboratory Report

TOXICOLOGICAL EVALUATION OF A TREATED EFFLUENT: BIOMONITORING SUPPORT FOR A NPDES PERMIT AUGUST 2003

American Samoa Joint Cannery Outfall

Prepared For

CH2M Hill, Incorporated
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By

EnviroSystems, Incorporated
One Lafayette Road
Hampton, New Hampshire 03842

August 2003
Reference Number CH2M-Samoa11419-03-08

STUDY NUMBER 11419

EXECUTIVE SUMMARY

The following summarizes the results of acute exposure bioassays performed from August 13-17, 2003 in support of the NPDES biomonitoring requirements of the American Samoa Joint Cannery Outfall. The 96 hour acute definitive assay was conducted using the marine species, *Americamysis bahia.*

Acute Toxicity Evaluation

Species	Exposure	LC-50	NOEC	LOEC
Americamysis bahia	24-Hours	>50.0%	50.0%	>50.0%
	48-Hours	>50.0%	50.0%	>50.0%
	72-Hours	50.0%	50.0%	>50.0%
	96-Hours	43.2%	25.0%	50.0%

TOXICOLOGICAL EVALUATION OF A TREATED EFFLUENT: BIOMONITORING SUPPORT FOR A NPDES PERMIT AUGUST 2003

American Samoa Joint Cannery Outfall

1.0 INTRODUCTION

Acute toxicity tests involve preparing a series of concentrations by diluting effluent with control water. Groups of test organisms are exposed to each effluent concentration and a control for a specified period. In acute tests, mortality data for each concentration are used to calculate (by regression) the median lethal concentration, or LC-50, defined as the effluent concentration which kills half of the test organisms. Samples with high LC-50 values are less likely to cause significant environmental impact. The acute no observed effect concentration (NOEC) and lowest observed effect concentration (LOEC) document the highest and lowest effluent concentrations that have no impact and a significant impact on the test species, respectively.

This report presents the results of an acute toxicity test conducted on an effluent sample collected from the American Samoa Joint Cannery Outfall. Testing was based on programs and protocols developed by the US EPA (2002) and involved conducting 96 hour acute static renewal toxicity tests with the marine species, *Americamysis bahia*. Testing was performed at EnviroSystems, Incorporated (ESI), Hampton, New Hampshire in accordance with the provisions of the NELAC Standards (2000).

2.0 MATERIALS AND METHODS

2.1 General Methods

Toxicological and analytical protocols used in this program follow procedures primarily designed by the EPA to provide standard approaches for the evaluation of toxicological effects of discharges on aquatic organisms, and for the analysis of water samples. See Section 4.0 for a list of references.

2.2 Test Species

Every attempt was made to acquire the species, *Penaeus vannami,* as this is the preferred organism under the Cannery's permit. ESI was unable to obtain reasonably priced *P. vannami*. Due to the exorbitant expense, the decision was made to use an alternate species, *Americamysis bahia*.

A. bahia, ≤5 days old, were from cultures maintained by ESI. Test organisms were transferred to test chambers by large bore pipet, minimizing the amount of water added to test solutions.

2.3 Effluent and Dilution Water

The effluent sample used in the assay was identified as "JCO-03-TW." Sample collection information is provided in Table 4. Upon receipt, the sample was stored at 4°C. All sample material used in the assay was warmed to 20±1°C prior to preparing test solutions. Total residual chlorine (TRC) was measured using amperometric titration (MDL 0.05 mg/L). As the effluent sample contained <0.05 mg/L, TRC dechlorination with sodium thiosulfate was not required (EPA 2002). Aliquots of the undiluted effluent sample were collected for ammonia analysis when the sample arrived and again prior to renewal. At arrival, the effluent sample had a salinity of 12‰. Salinity of the effluent was increased to 25‰ by the addition of artificial sea salts. Test concentrations for the assays were 50%, 25%, 12.5%, 6.25% and 3.1% effluent with a laboratory water diluent control.

The dilution water used in this assay was collected from the sea water system at ESI. The water is pumped in daily from the Hampton Estuary on the flood tide, filtered through a high volume sand filter, and stored in 3000 gallon polyethylene tanks. The water is classified as Class SA-1 by the State of New Hampshire, and has been used to culture test organisms for over 20 years. Sea water used in the assay had a salinity of 25±2‰ and a TRC of <0.05 mg/L.

2.4 Acute Toxicity Tests

The 96 hour acute static renewal toxicity test was conducted at 20±2°C with a photoperiod of 16:8 hours light:dark. Test chambers for the acute assays were 250 mL glass beakers containing 200 mL test solution in each of 5 replicates, with 10 organisms/replicate. Survival, dissolved oxygen, pH, salinity and temperature were measured daily in all replicates. Test solutions were renewed after 48 hours using effluent from the start sample. Mysid shrimp were fed daily with <24 hour old brine shrimp.

2.5 Data Analysis

At 24 hour intervals, survival data was analyzed to assess toxicity using a program developed by Stephan (1982). LC-50 values were computed using the Spearman-Karber, Binomial, and Probit methods. If survival in the highest test concentration was >50%, LC-50 values were obtained by direct observation of the raw data. The NOEC was determined as the highest test concentration which caused no significant mortality while the LOEC was determined as the lowest concentration that did cause significant mortality.

2.6 Quality Control

As part of the laboratory quality control program, standard reference toxicant assays are conducted on a regular basis for each test species. These results provide relative health and response data while allowing for comparison with historic data sets. See Table 2 for details.

3.0 RESULTS

Results of the acute exposure bioassay conducted using the mysid shrimp, *A. bahia*, are summarized in Table 1. A summary of reference toxicant data for the test species is presented in Table 2. Effluent and dilution water characteristics are presented in Table 3. Sample collection information is provided in Table 4. Table 5 provides a summary of historic data associated with the discharge. Support data are included in Appendix A.

3.1 Acute Toxicity Test - *Americamysis bahia*

Control survival was 100% after 24 hours exposure, and 96% after 48, 72 and 96 hours exposure. These results are an indication of healthy test organisms and that the dilution water had no adverse impact on the outcome of the assay.

Table 1 provides a summary of the acute exposure data and results.

3.2 Summary

The salinity adjusted effluent sample collected from the American Samoa Joint Cannery Outfall did exhibit signs of acute toxicity to the mysid shrimp, *Americamysis bahia,* during the 96 hour exposure period.

4.0 LITERATURE CITED

APHA. 1998. *Standard Methods for the Examination of Water and Wastewater*, 20th Edition. Washington D.C.

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Stephan, C. 1982. Documentation for Computing LC-50 Values with a Mini Computer. Unpublished.

US EPA. 2002. *Attachment G: NPDES Whole Effluent Toxicity Testing, Monitoring and Reporting Tips and Common Pitfalls.* Dated December 2002. US EPA Region I Offices, Boston, Massachusetts.

U.S. EPA. 2002. *Methods for Measuring the Acute Toxicity of Effluents to Freshwater and Marine Organisms.* Fifth Edition. EPA-821-R-02-012.

TABLE 1. Summary of Acute Evaluation Results. American Samoa Joint Cannery Outfall Effluent Evaluation. August 2003.

Concentration % Effluent	Exposure	Replicates A	B	C	D	E	Mean	Standard Deviation	Coefficient of Variation
Lab Control	Start	10	10	10	10	10	100%	0.000	0.00%
	24-Hours	10	10	10	10	10	100%	0.000	0.00%
	48-Hours	10	10	9	9	10	96%	0.548	5.71%
	72 Hours	10	10	9	9	10	96%	0.548	5.71%
	96-Hours	10	10	9	9	10	96%	0.548	5.71%
3.1%	24-Hours	10	10	10	10	10	100%	0.000	0.00%
	48-Hours	10	10	10	10	10	100%	0.000	0.00%
	72 Hours	10	10	10	10	10	100%	0.000	0.00%
	96-Hours	10	10	10	10	10	100%	0.000	0.00%
6.25%	24-Hours	10	10	10	10	10	100%	0.000	0.00%
	48-Hours	10	10	10	10	10	100%	0.000	0.00%
	72 Hours	10	10	10	10	10	100%	0.000	0.00%
	96-Hours	10	10	9	10	10	98%	0.447	4.56%
12.5%	24-Hours	10	10	10	10	10	100%	0.000	0.00%
	48-Hours	10	10	10	10	10	100%	0.000	0.00%
	72 Hours	10	10	10	10	10	100%	0.000	0.00%
	96-Hours	10	10	10	9	9	96%	0.548	5.71%
25%	24-Hours	10	10	10	10	10	100%	0.000	0.00%
	48-Hours	10	10	10	10	10	100%	0.000	0.00%
	72 Hours	10	10	10	10	10	100%	0.000	0.00%
	96-Hours	10	10	10	9	8	94%	0.894	9.52%
50%	24-Hours	10	10	10	10	10	100%	0.000	0.00%
	48-Hours	10	7	3	5	1	52%	3.493	67.17%
	72 Hours	10	7	3	5	0	50%	3.808	76.16%
	96-Hours	1	4	1	2	0	16%	1.517	94.79%

SUMMARY OF ENDPOINTS

Exposure Period	LC-50 (95% Limits)	METHOD	NOEC	LOEC
24 Hours	>50.0%	Direct Observation	50.0%	>50.0%
48 Hours	>50.0%	Direct Observation	50.0%	>50.0%
72 Hours	50.0%	Direct Observation	50.0%	>50.0%
96 Hours	43.2%	Binomial	25.0%	50.0%

TABLE 2. Summary of Reference Toxicant Data. American Samoa Joint Cannery Outfall Effluent Evaluation. August 2003.

Concentrations Expressed as mg/L Sodium Dodecyl Sulfate

Species	Date	LC-50	Historic Mean	Number of Tests	±1 STD Deviation	±2 STD Deviations
A. bahia	08/26/03	19.8	19.9	151	4.28	8.56

TABLE 3. Summary of Effluent and Diluent Characteristics. American Samoa Joint Cannery Outfall Effluent Evaluation. August 2003.

PARAMETER	UNITS	EFFLUENT	DILUENT
Salinity - Upon Arrival	‰	11	25
After Salinity Adjustment ‡	‰	25	-
pH - Upon Arrival	SU	6.50	7.95
After Salinity Adjustment ‡	SU	7.23	-
TRC	mg/L	<0.05	<0.05
Dissolved Oxygen - Upon Arrival	mg/L	0.9	6.9
After Aeration ‡	mg/L	4.4	6.9
Ammonia - at Start	mg/L as N	49.0	0.21
Unionized Ammonia	mg/L as N	0.06	0.01
Ammonia - at Start- Salinity Adjusted ‡	mg/L as N	25.0	-
Unionized Ammonia ‡	mg/L as N	0.17	-
Ammonia - at 48 Hours	mg/L as N	No Data	No Data

TABLE 4. Summary of Sample Collection Information. American Samoa Joint Cannery Outfall Effluent Evaluation. March 2003.

Sample Description	Type	Collection Date	Collection Time	Receipt Date	Receipt Time	Arrival Temp °C
EFFLUENT	Comp	08/07/03	ND	08/13/03	1045	19

COMMENTS:
‡ - Analysis conducted on 50% effluent, the highest concentration tested.
ND - No data was recorded on chain of custody.

TABLE 5. Summary of StarKist Samoa and COS Samoa Packing Combined Effluent Bioassay Results. American Samoa Joint Cannery Outfall Effluent Evaluation. March 2003.

Date	Species	96-Hour Endpoints		
		LC-50	NOEC	LOEC
02/93[1]	*Penaeus vannami*	4.8%	3.1%	6.25%
10/93[1]	*Penaeus vannami*	15.67%	3.1%	6.25%
02/94[1]	*Penaeus vannami*	15.76%	<1.6%	1.6%
10/94[1]	*Americamysis bahia*	31.2%	25.0%	50.0%
03/95[1]	*Penaeus vannami*	14.8%	6.25%	12.5%
03/95[1]	*Americamysis bahia*	10.8%	6.25%	12.5%
02/96[1]	*Penaeus vannami*	>50.0%	>50.0%	>50.0%
03/96[1]	*Penaeus vannami*	44.4%	25.0%	50.0%
11/96[1]	*Penaeus vannami*	7.11%	3.1%	6.25%
03/97[1]	*Penaeus vannami*	39.36%	12.5%	25.0%
09/97[1]	*Penaeus vannami*	12.3%	6.25%	12.5%
06/98[1]	*Americamysis bahia*	17.2%	6.25%	12.5%
11/98[1]	*Americamysis bahia*	15.0%	6.25%	12.5%
02/00[1]	*Americamysis bahia*	20.0%	6.25%	12.5%
08/00[1]	*Americamysis bahia*	17.1%	3.1%	6.25%
03/01[2]	*Americamysis bahia*	13.81%	12.5%	25.0%
03/02[2]	*Americamysis bahia*	16.13%	12.5%	25.0%
08/02[2]	*Americamysis bahia*	10.23%	6.25%	12.5%
03/03[2]	*Americamysis bahia*	28.4%	25.0%	50.0%
08/03[2]	*Americamysis bahia*	43.2%	25.0%	50.0%

Notes:

1. Assays conducted by Advanced Biological Testing, Inc., Rohnert Park, California
2. Assay conducted by EnviroSystems, Inc., Hampton, New Hampshire

APPENDIX A

DATA SHEETS

STATISTICAL SUPPORT

Contents	Number of Pages
Methods Used in NPDES Permit Biomonitoring Testing	1
A. bahia Acute Bioassay Data Summary	2
A. bahia Survival Statistics: LC-50, NOEC	10
A. bahia Organism Culture Sheet	1
Preparation of Dilutions	1
Record of Meters Used for Water Quality Measurements	1
Sample Receipt Record	1
Chain of Custody	1

METHODS USED IN NPDES PERMIT BIOMONITORING TESTING

Parameter	Method
Acute Exposure Bioassays	
Ceriodaphnia dubia, Daphnia pulex	EPA-821-R-02-012
Pimephales promelas	EPA-821-R-02-012
Americamysis bahia	EPA-821-R-02-012
Menidia beryllina, Cyprinodon variegatus	EPA-821-R-02-012
Chronic Exposure Bioassays	
Ceriodaphnia dubia	EPA-821-R-02-013, 1002.0
Pimephales promelas	EPA-821-R-02-013, 1000.0
Cyprinodon variegatus	EPA-821-R-02-014, 1004.0
Menidia beryllina	EPA-821-R-02-014, 1006.0
Arbacia punctulata	EPA-821-R-02-014, 1008.0
Champia parvula	EPA-821-R-02-014, 1009.0
Trace Metals:	
ICP Metals	EPA 200.7/SW 6010
Hardness	Standard Methods 20th Edition - Method 2340 B
Wet Chemistries:	
Alkalinity	EPA 310.2
Chlorine, Residual	Standard Methods 20th Edition - Method 4500CLD
Total Organic Carbon	Standard Methods 20th Edition - Method 5310C
Specific Conductance	Standard Methods 20th Edition - Method 2510B
Nitrogen - Ammonia	Standard Methods 20th Edition - Method 4500NH3G
pH	Standard Methods 20th Edition - Method 4500H+B
Solids, Total (TS)	Standard Methods 20th Edition - Method 2540.B
Solids, Total Suspended (TSS)	Standard Methods 20th Edition - Method 2540D
Dissolved Oxygen	Standard Methods 20th Edition - Method 4500-O G

ACUTE BIOASSAY DATA SUMMARY

STUDY: 11419

CLIENT: CH2M Hill | TEST ORGANISM: *A. bahia*

SAMPLE: American Samoa | ORGANISM SUPPLIER/BATCH/AGE: *See Organism Culture Sheet*

DILUENT: LAB SALT

"AS RECEIVED" EFFLUENT AND DILUENT CHEMISTRIES

	TRC	AMM 0 HR✖	AMM 48 HR✖	pH	DO	Salinity
EFFLUENT	<0.05	-002 (100%)/-002 (50%)		6.50	0.9	10.6
DILUENT	<0.05	11389-022		7.95	6.9	25

SALINITY ADJUSTMENT RECORD (IF APPLICABLE): 8,400 ML EFFLUENT + 135 G SEA SALTS = 100% ACTUAL PERCENTAGE

CONC	REP	SURVIVAL 0	24	48	72	96	✦DISSOLVED OXYGEN (MG/L)✦ 0	24	48◊	48☆	72	96	PH (SU) 0	24	48◊	48☆	72	96	TEMPERATURE (°C) 0	24	48◊	48	72	96	SALINITY (ppt) 0	24	48◊	48	72	96
LAB	A	10	10	10	10	10	6.9	7.7	7.2	6.8	7.0	7.6	7.95	7.85	7.94	7.91	7.83	7.81	21	20	19	22	20	19	25	26	26	24	25	26
	B	10	10	10	10	10	7.0	7.7	7.2	6.8	7.0	7.6	7.98	7.87	7.95	7.91	7.83	7.87	21	20	19	22	19	19	25	26	26	25	26	26
	C	10	10	9 ~~10~~	~~10~~ 9	9	7.0	7.7	7.2	6.8	7.0	7.6	7.98	7.87	7.98	7.92	7.84	7.86	21	20	19	22	19	19	25	26	26	24	25	26
	D	10	10	~~10~~ 9	~~10~~ 9	9	7.1	7.7	7.2	6.8	7.0	7.6	7.99	7.90	7.98	7.93	7.83	7.85	21	20	19	22	19	19	25	26	26	24	25	26
	E	10	10	10	10	10	7.1	7.8	7.2	6.8	7.0	7.5	7.98	7.80	7.96	7.93	7.83	7.84	21	20	19	22	19	19	25	26	26	24	25	26
3.1%	A	10	10	10	10	10	6.9	7.8	7.1	6.8	6.8	7.0	7.91	7.88	7.93	7.90	7.82	7.72	21	20	19	22	19	19	25	26	27	24	25	26
	B	10	10	10	10	10	6.9	7.7	7.1	6.7	6.8	7.6	7.92	7.86	7.91	7.87	7.80	7.87	21	20	19	22	19	19	25	26	26	24	25	26
	C	10	10	10	10	10	6.9	7.6	7.0	6.6	6.7	7.6	7.92	7.81	7.90	7.85	7.83	7.89	21	20	19	22	19	19	25	26	26	24	25	26
	D	10	10	10	10	10	6.9	7.6	7.0	6.6	6.8	7.6	7.93	7.85	7.85	7.84	7.83	7.88	21	20	19	22	19	19	25	26	26	24	25	26
	E	10	10	10	10	10	6.9	7.6	6.9	6.6	6.8	7.6	7.93	7.89	7.86	7.82	7.83	7.90	21	20	19	22	19	19	25	26	26	24	25	26
6.25%	A	10	10	10	10	10	6.6	7.7	7.0	6.6	6.9	7.6	7.85	7.84	7.89	7.82	7.87	7.94	21	19	19	23	19	19	25	26	26	24	25	26
	B	10	10	10	10	10	6.7	7.5	7.0	6.5	6.9	5.5	7.84	7.86	7.92	7.80	7.86	7.62	21	19	19	23	19	19	25	26	26	24	25	26
	C	10	10	10	10	9	6.7	7.5	6.9	6.5	6.9	7.4	7.84	7.87	7.90	7.79	7.86	7.89	21	19	19	23	19	19	25	26	26	24	25	26
	D	10	10	10	10	10	6.8	7.5	6.9	6.5	6.9	7.5	7.83	7.87	7.88	7.79	7.86	7.90	21	19	19	23	19	19	25	26	26	24	25	26
	E	10	10	~~10~~ 10	10	10	6.8	7.5	6.9	6.5	6.8	7.5	7.83	7.89	7.89	7.78	7.86	7.91	21	20	19	23	19	19	25	26	26	24	25	26

	0	24	48	72	96	0	24	48◊	48☆	72	96
DATE	8/13/03	8/14	8/15/03	8/16	8/17	8/13	8/14	8/15/03	8/15/03	8/16	8/17
TIME	1335	1440	1620	1330	1510	1230	1430	1600	1640	1320	1445
INITIALS	✓	BM	✓	BM	RC	RC	BM	✓	✓	BM	RC
FED?	✓	✓	✓	✓							

BM

: - Pull on 50% effluent also.
- "Old" water qualities (prior to renewal)

✦ - AERATE FROM START!
☆ - "New"water qualities (post renewal)

ACUTE BIOASSAY DATA SUMMARY

STUDY: 11419	SAMPLE RECEIVED:	"AS RECEIVED" EFFLUENT AND DILUENT CHEMISTRIES						
CLIENT: CH2M Hill	TEST ORGANISM: *A. bahia*		TRC	AMM 0 HR✖	AMM 48 HR✖	pH	DO	Salinity
SAMPLE: American Samoa	ORGANISM SUPPLIER:	EFFLUENT	See page 1 for details and salinity adjustment record.					
DILUENT: LAB SALT	ORGANISM BATCH/AGE:	DILUENT						

CONC	REP	SURVIVAL 0	24	48	72	96	✦DISSOLVED OXYGEN (MG/L)✦ 0	24	48◊	48☆	72	96	PH (SU) 0	24	48◊	48☆	72	96	TEMPERATURE (°C) 0	24	48◊	48	72	96	SALINITY (ppt) 0	24	48◊	48	72	96
12.5%	A	10	10	10	10	10	6.5	7.4	6.8	6.0	6.6	7.5	7.71	7.87	7.91	7.68	7.84	7.99	21	19	19	23	20	19	25	26	26	24	25	26
	B	10	10	10	10	10	6.5	7.3	6.8	6.0	6.7	7.6	7.71	7.88	7.87	7.67	7.84	7.99	21	19	19	23	20	19	25	26	26	24	25	26
	C	10	10	10	10	10	6.5	7.3	6.7	6.0	6.7	7.6	7.70	7.87	7.87	7.66	7.85	7.99	21	19	19	23	20	19	25	26	26	24	25	26
	D	10	10	10	10	9	6.5	7.3	6.7	5.9	6.7	7.6	7.70	7.87	7.89	7.66	7.85	7.98	21	19	19	22	19	19	25	26	26	24	25	26
	E	10	10	10	10	9	6.4	7.3	6.8	6.1	6.7	7.4	7.69	7.85	7.91	7.66	7.85	7.92	21	19	19	23	20	19	25	26	26	24	25	26
25%	A	10	10	10	10	10	5.8	6.9	6.8	6.1	6.3	7.3	7.47	7.86	7.92	7.64	7.81	7.98	21	19	19	23	20	20	25	26	26	24	25	26
	B	10	10	10	10	10	5.8	6.9	6.8	5.9	6.3	7.2	7.46	7.86	7.93	7.53	7.82	8.00	21	19	19	23	20	20	25	26	26	24	25	26
	C	10	10	10	10	10	5.7	6.3	6.7	5.6	6.4	7.1	7.45	7.85	7.94	7.50	7.83	7.96	21	19	19	23	20	19	25	26	27	24	25	26
	D	10	10	10	10	9	5.8	6.7	6.7	5.4	6.1	7.2	7.45	7.85	7.85	7.48	7.83	8.01	21	19	19	23	20	19	25	26	26	24	25	26
	E	10	10	10	10	8	5.8	6.9	6.7	5.3	6.1	7.2	7.45	7.85	7.90	7.46	7.83	8.00	21	19	19	23	20	20	25	26	27	24	25	26
50%	A	10	10	10	10	1	4.5	6.5	6.4	4.6	5.3	6.6	7.23	7.90	7.98	7.31	7.83	7.95	22	19	19	23	20	20	25	26	26	24	25	26
	B	10	10	7 ~~10~~	7	4	4.6	6.5	6.4	4.6	5.2	6.8	7.23	7.90	8.02	7.31	7.85	7.94	22	19	19	23	20	19	25	26	26	24	25	26
	C	10	10	3	3	1	4.4	6.0	6.4	4.6	5.2	6.8	7.22	7.88	8.05	7.31	7.81	7.99	22	19	19	23	20	20	25	26	26	24	25	26
	D	10	10	5	5	2	4.4	6.0	6.3	4.6	5.3	6.9	7.22	7.89	8.04	7.33	7.81	8.03	22	19	19	23	20	20	25	26	26	24	25	26
	E	10	10	1	0	—	4.4	6.6	6.3	3.6	5.1	—	7.23	7.88	8.04	7.35	7.82	—	22	19	19	23	20	~~20~~	25	26	26	24	25	~~26~~

	0	24	48	72	96	0	24	48◊	48☆	72	96
DATE	8/13/03	8/14	8/15/03	8/16	8/17	8/13	8/14	8/15/03	8/15/03		8/17
TIME	1335	1440	1620	1340	1510	1230	1430	1600	1640		1445
INITIALS	[illegible]	BM	[illegible]	BM	RC	RC	BM	[illegible]	[illegible]		RC
FED?	✓	✓	✓	✓							

- Pull on 50% effluent also.
- "Old" water qualities (prior to renewal)

✦ - AERATE FROM START!
☆ - "New"water qualities (post renewal)

Title: CH2MHill American Samoa 11419 48 hour A-NOEC
File: 11419Ab48 Transform: ARC SINE(SQUARE ROOT(Y))

Shapiro - Wilk's Test for Normality

D = 0.7189
W = 0.6409

Critical W = 0.9000 (alpha = 0.01 , N = 30)
W = 0.9270 (alpha = 0.05 , N = 30)

Data FAIL normality test (alpha = 0.01). Try another transformation.

Warning - The first three homogeneity tests are sensitive to non-normality and should not be performed with this data as is.

Title: CH2MHill American Samoa 11419 48 hour A-NOEC
File: 11419Ab48 Transform: ARC SINE(SQUARE ROOT(Y))

Hartley's Test for Homogeneity of Variance
Bartlett's Test for Homogeneity of Variance

These two tests can not be performed because at least one group has zero variance.

Data FAIL to meet homogeneity of variance assumption.
Additional transformations are useless.

Title: CH2MHill American Samoa 11419 48 hour A-NOEC
File: 11419Ab48 Transform: ARC SINE(SQUARE ROOT(Y))

Summary Statistics on Transformed Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Lab	5	1.2490	1.4120	1.3468
2	3.1%	5	1.4120	1.4120	1.4120
3	6.25%	5	1.4120	1.4120	1.4120
4	12.5%	5	1.4120	1.4120	1.4120
5	25%	5	1.4120	1.4120	1.4120
6	50%	5	0.3218	1.4120	0.8180

Title: CH2MHill American Samoa 11419 48 hour A-NOEC

File: 11419Ab48 Transform: ARC SINE(SQUARE ROOT(Y))

Summary Statistics on Transformed Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	Lab	0.0080	0.0893	0.0399	6.6278
2	3.1%	0.0000	0.0000	0.0000	0.0000
3	6.25%	0.0000	0.0000	0.0000	0.0000
4	12.5%	0.0000	0.0000	0.0000	0.0000
5	25%	0.0000	0.0000	0.0000	0.0000
6	50%	0.1717	0.4144	0.1853	50.6634

Title: CH2MHill American Samoa 11419 48 hour A-NOEC
File: 11419Ab48 Transform: ARC SINE(SQUARE ROOT(Y))

Steel's Many-One Rank Test - Ho: Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	RANK SUM	CRIT. VALUE	DF	SIG 0.05
1	Lab	1.3468				
2	3.1%	1.4120	32.50	16.00	5.00	
3	6.25%	1.4120	32.50	16.00	5.00	
4	12.5%	1.4120	32.50	16.00	5.00	
5	25%	1.4120	32.50	16.00	5.00	
6	50%	0.8180	18.50	16.00	5.00	

Critical values are 1 tailed (k = 5)

****

STUDY NO.: 11419 ASSAY START: 08/13/03

SPECIES: A. bahia EXPOSURE: 72 hours

SAMPLE: American Samoa

****

At a confidence level of 95 percent, the binomial test
shows that the LC50 is above 25

The usefulness of any LC50 calculated from this set of data
is questionable because a concentration-effect relationship
has not been demonstrated over a reasonable range (e.g.,
<37 to >63) of percent affected.
50 can be used as an approximate LC50 for this set of data.

When there are less than two concentrations at which the percent
affected is between 0 and 100, neither the Moving Average method
nor the probit method can give any statistically sound results.

---------RESULTS CALCULATED USING THE TRIMMED SPEARMAN-KARBER METHOD-------

Conc.	Dose =Ln (Conc)	Percent Dead	Monotonic Rel. Freq.	Trimmed Rel. Freq.
50	3.912023	50	.5	.5
25	3.218876	0	0	-.125 *
12.5	2.525729	0	0	-.125 *
6.25	1.832581	0	0	-.125 *
3.1	1.131402	0	0	-.125 *

Alpha = 10 %
Groups trimmed and therefore not used in estimating LC50
are marked with an asterisk above.
LC50 = 6.155722
Estimated 95 Percent Confidence Limits
Lower: 4.639187 Upper: 8.168005
Variance estimate = .02
Variance may be underestimated because all data were outside trimmed range.

****

STUDY NO.: 11419 ASSAY START: 08/13/03

SPECIES: A. bahia EXPOSURE: 72 hours

SAMPLE: American Samoa

****

SUMMARY TABLE

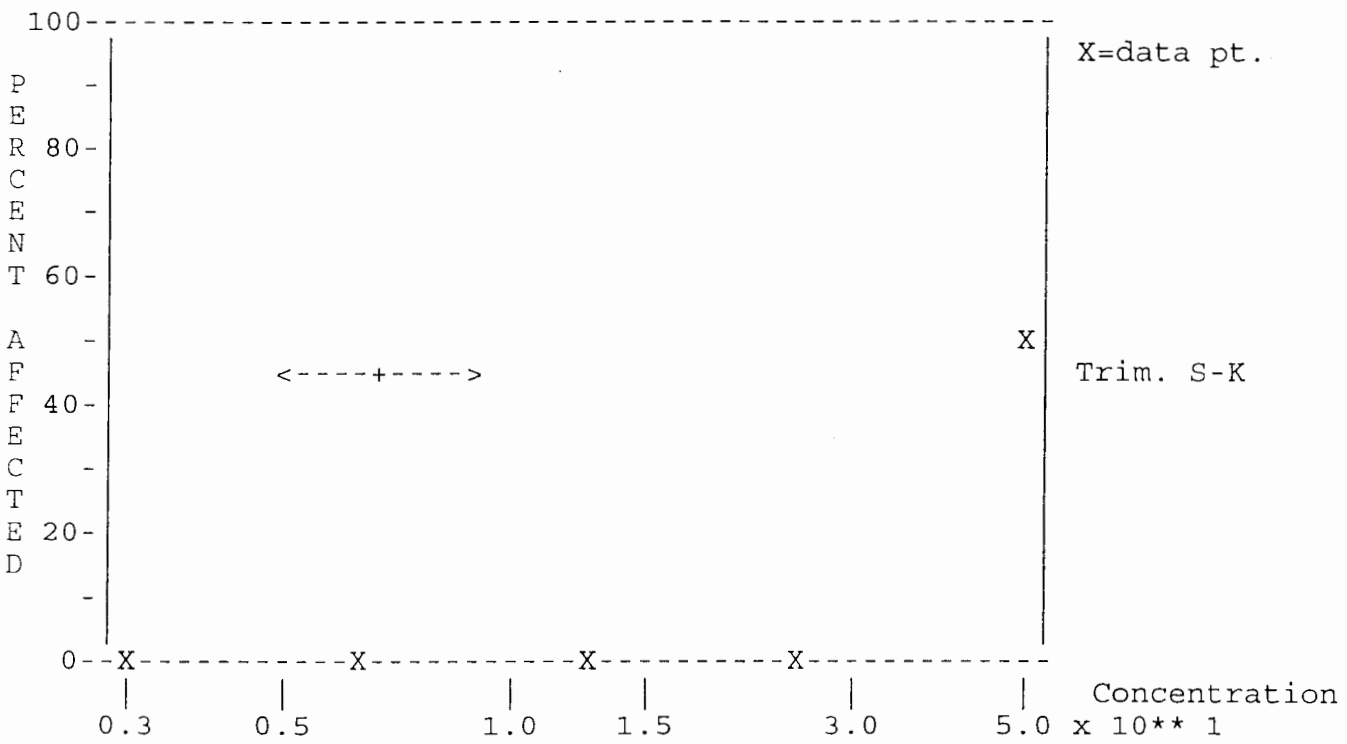
09-03-2003 12:30:15

Data:	Conc.	Exposed	Dead	Percent
	50	50	25	50
	25	50	0	0
	12.5	50	0	0
	6.25	50	0	0
	3.1	50	0	0

	LC50	Lower 95% Limit	Upper 95% Limit	
Probit Analysis	0	0	0	
Moving Average	0	0	0	Span= 0
Spearman-Karber	6.155722	4.639187	8.168005	Alpha= 10 %

Compare results with original data to see if they are reasonable.

****



Title: CH2MHill American Samoa 11419 72 Hour A-NOEC
File: 11419Ab72 Transform: ARC SINE(SQUARE ROOT(Y))

Shapiro - Wilk's Test for Normality

D = 0.9019
W = 0.6105

Critical W = 0.9000 (alpha = 0.01 , N = 30)
W = 0.9270 (alpha = 0.05 , N = 30)

Data FAIL normality test (alpha = 0.01). Try another transformation.

Warning - The first three homogeneity tests are sensitive to non-normality and should not be performed with this data as is.

Title: CH2MHill American Samoa 11419 72 Hour A-NOEC
File: 11419Ab72 Transform: ARC SINE(SQUARE ROOT(Y))

Hartley's Test for Homogeneity of Variance
Bartlett's Test for Homogeneity of Variance

These two tests can not be performed because at least one group has zero variance.

Data FAIL to meet homogeneity of variance assumption.
Additional transformations are useless.

Title: CH2MHill American Samoa 11419 72 Hour A-NOEC
File: 11419Ab72 Transform: ARC SINE(SQUARE ROOT(Y))

Summary Statistics on Transformed Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Lab	5	1.2490	1.4120	1.3468
2	3.1%	5	1.4120	1.4120	1.4120
3	6.25%	5	1.4120	1.4120	1.4120
4	12.5%	5	1.4120	1.4120	1.4120
5	25%	5	1.4120	1.4120	1.4120
6	50%	5	0.1588	1.4120	0.7854

Title: CH2MHill American Samoa 11419 72 Hour A-NOEC

File: 11419Ab72 Transform: ARC SINE(SQUARE ROOT(Y))

Summary Statistics on Transformed Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	Lab	0.0080	0.0893	0.0399	6.6278
2	3.1%	0.0000	0.0000	0.0000	0.0000
3	6.25%	0.0000	0.0000	0.0000	0.0000
4	12.5%	0.0000	0.0000	0.0000	0.0000
5	25%	0.0000	0.0000	0.0000	0.0000
6	50%	0.2175	0.4664	0.2086	59.3791

Title: CH2MHill American Samoa 11419 72 Hour A-NOEC
File: 11419Ab72 Transform: ARC SINE(SQUARE ROOT(Y))

Steel's Many-One Rank Test - Ho: Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	RANK SUM	CRIT. VALUE	DF	SIG 0.05
1	Lab	1.3468				
2	3.1%	1.4120	32.50	16.00	5.00	
3	6.25%	1.4120	32.50	16.00	5.00	
4	12.5%	1.4120	32.50	16.00	5.00	
5	25%	1.4120	32.50	16.00	5.00	
6	50%	0.7854	18.50	16.00	5.00	

Critical values are 1 tailed (k = 5)

****

STUDY NO.: 11419 ASSAY START: 08/13/03

SPECIES: A. bahia EXPOSURE: 96 Hours

SAMPLE: American Samoa

****

At a confidence level of 95 percent, the binomial test
shows that the LC50 is below 50
shows that the LC50 is above 25

An approximate LC50 of 43.20606 is obtained by
nonlinear interpolation between 25 and 50

----------RESULTS CALCULATED USING THE MOVING AVERAGE METHOD----------

Span	G	LC50	95 Percent Confidence Limits	
1	8.730414E-02	43.20603	38.85539	49.92278

An LC50 calculated using the Moving Average method may not be a very good estimate if the span is much less than the number of concentrations.

----------RESULTS CALCULATED USING THE PROBIT METHOD----------

Iterations	G	H	Chi-Square	Probability
7	1.502618	5.458608	16.37582	LESS THAN 0.001

As the probability associated with this value is <0.05, results should be used with caution.

Slope = 3.364528
95 Percent Confidence Limits =-.7597542 and 7.488811

LC50 = 45.79345
95 Percent Confidence Limits = 16.10194 and +INFINITY

---------RESULTS CALCULATED USING THE TRIMMED SPEARMAN-KARBER METHOD-------

Conc.	Dose =Ln (Conc)	Percent Dead	Monotonic Rel. Freq.	Trimmed Rel. Freq.
50	3.912023	64	.64	.675
25	3.218876	6	.06	-5.000001E-02 *
12.5	2.525729	4	.04	-.075 *
6.25	1.832581	2	.02	-9.999999E-02 *
3.1	1.131402	0	0	-.125 *

Alpha = 10 %
Groups trimmed and therefore not used in estimating LC50
are marked with an asterisk above.
LC50 = 11.27752
Estimated 95 Percent Confidence Limits
Lower: 9.432698 Upper: 13.48315
Variance estimate = 7.977126E-03
Variance may be underestimated because all data were outside trimmed range.

****

STUDY NO.: 11419 ASSAY START: 08/13/03

SPECIES: A. bahia EXPOSURE: 96 Hours

SAMPLE: American Samoa

****

SUMMARY TABLE

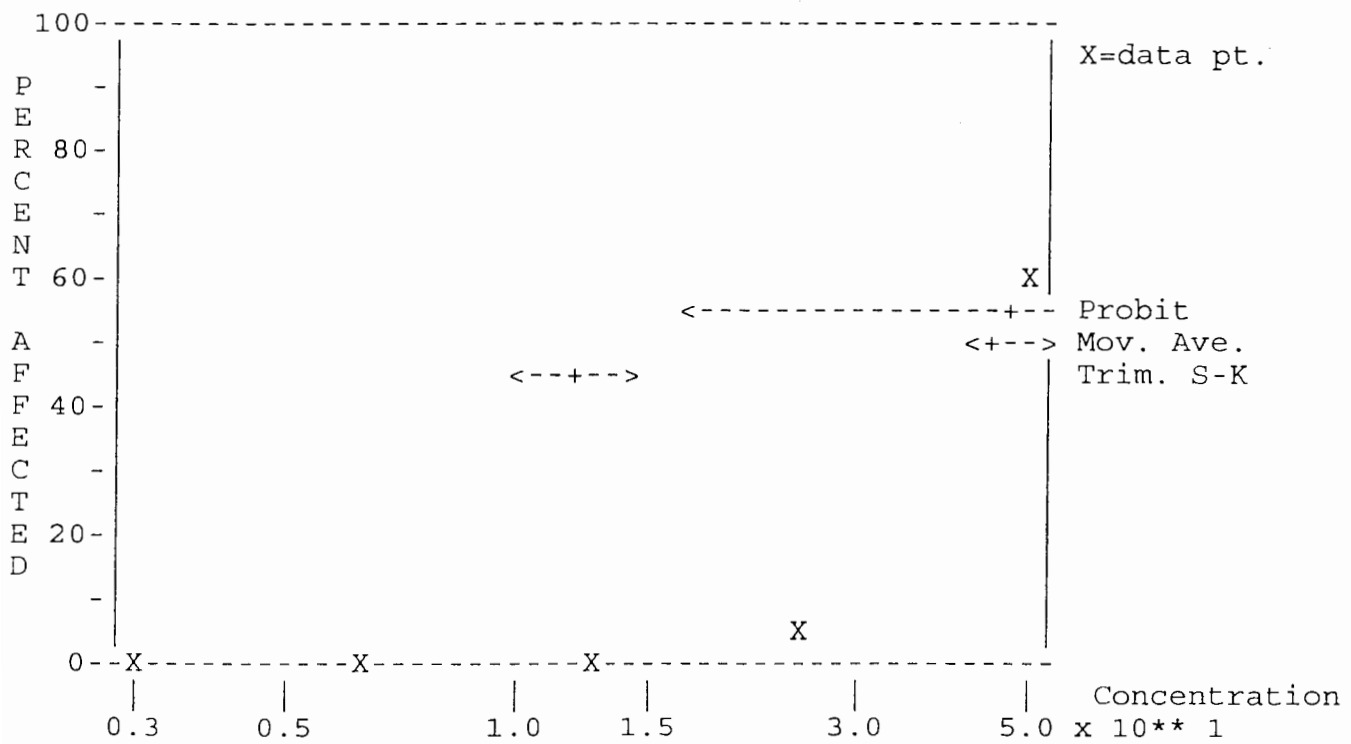
09-03-2003 12:31:43

Data:	Conc.	Exposed	Dead	Percent
	50	50	32	64
	25	50	3	6
	12.5	50	2	4
	6.25	50	1	2
	3.1	50	0	0

	LC50	Lower 95% Limit	Upper 95% Limit	
Probit Analysis	45.79345	16.10194	0	
Moving Average	43.20603	38.85539	49.92278	Span= 1
Spearman-Karber	11.27752	9.432698	13.48315	Alpha= 10 %
Binomial	43.20606			

Compare results with original data to see if they are reasonable.

****



Title: CH2MHill American Samoa 11419 96 Hour A-NOEC
File: 11419Ab96 Transform: ARC SINE(SQUARE ROOT(Y))

Shapiro - Wilk's Test for Normality

D = 0.3158
W = 0.9310

Critical W = 0.9000 (alpha = 0.01 , N = 30)
W = 0.9270 (alpha = 0.05 , N = 30)

Data PASS normality test (alpha = 0.01). Continue analysis.

Title: CH2MHill American Samoa 11419 96 Hour A-NOEC
File: 11419Ab96 Transform: ARC SINE(SQUARE ROOT(Y))

Hartley's Test for Homogeneity of Variance
Bartlett's Test for Homogeneity of Variance

These two tests can not be performed because at least one group has zero variance.

Data FAIL to meet homogeneity of variance assumption.
Additional transformations are useless.

Title: CH2MHill American Samoa 11419 96 Hour A-NOEC
File: 11419Ab96 Transform: ARC SINE(SQUARE ROOT(Y))

Summary Statistics on Transformed Data TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Lab	5	1.2490	1.4120	1.3468
2	3.1%	5	1.4120	1.4120	1.4120
3	6.25%	5	1.2490	1.4120	1.3794
4	12.5%	5	1.2490	1.4120	1.3468
5	25%	5	1.1071	1.4120	1.3185
6	50%	5	0.1588	0.6847	0.3901

Title: CH2MHill American Samoa 11419 96 Hour A-NOEC
File: 11419Ab96 Transform: ARC SINE(SQUARE ROOT(Y))

Summary Statistics on Transformed Data TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM	C.V. %
1	Lab	0.0080	0.0893	0.0399	6.6278
2	3.1%	0.0000	0.0000	0.0000	0.0000
3	6.25%	0.0053	0.0729	0.0326	5.2837
4	12.5%	0.0080	0.0893	0.0399	6.6278
5	25%	0.0189	0.1376	0.0615	10.4362
6	50%	0.0388	0.1969	0.0881	50.4677

Title: CH2MHill American Samoa 11419 96 Hour A-NOEC
File: 11419Ab96 Transform: ARC SINE(SQUARE ROOT(Y))

Steel's Many-One Rank Test - Ho: Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	RANK SUM	CRIT. VALUE	DF	SIG 0.05
1	Lab	1.3468				
2	3.1%	1.4120	32.50	16.00	5.00	
3	6.25%	1.3794	30.00	16.00	5.00	
4	12.5%	1.3468	27.50	16.00	5.00	
5	25%	1.3185	26.50	16.00	5.00	
6	50%	0.3901	15.00	16.00	5.00	*

Critical values are 1 tailed (k = 5)

EnviroSystems, Incorporated
Organism Culture and Acclimation Data

I. Organism Information

Species: Americamysis bahia

Age: 1-5 days

Client: American Samoa

ESI#: 11419

Culturist: ESI

Date: 8/13/03

II. Culture Maintenance Information

Flow Through _____

Recirc / Mass Static _____

Brood Board _____

Static Renewal _____

Hatch Date: 8/10-12/03

Lot #: 081203AB

Brood Origin: ARO

III. Acclimation History

Temperature: 24.2 °C

Salinity: 29.7 ppt

Hardness: _____ mg/L as CaCO3

pH: 7.56 SU

DO: 7.1 mg/L

Water Type: Natural Salt H_2O

SITE WATER ACCLIMATION (If applicable)

Start: _____

End: _____

PREPARATION OF DILUTIONS

STUDY:	CLIENT: CH2M HILL - American Samoa
SPECIES: *A. bahia*	

Diluent: Lab Salt	Day: 0 Sample: EOA		Day: 2 Sample: EOA					
Concentration	Vol. Eff.	Final Vol	Vol. Eff.	Final Vol	HRS	Date	Time	Initials
LAB	0	1000	0	1000	0	8/13/03	1200	RC
3.1%	31	↓	31	↓	48	8/15/03	1630	✓
6.25%	62.5	↓	62.5	↓	Comments:			
12.5%	125	↓	125	↓				
25%	250	↓	250	↓				
50%	500	↓	500	↓				

RECORD OF METERS USED FOR WATER QUALITY MEASUREMENTS

STUDY:	CLIENT: CH2M HILL - American Samoa					
WATER QUALITIES - A. bahia						
HOURS:	0	24	48 - old	48 - new	72	96
Water Quality Station #	1	2	2	2		2
Initials	RC	BM	[illegible]	[illegible]		RC
Date	8/13/03	8/14	8/15/03	8/15/03		8/17/03

Water Quality Station #1		Water Quality Station #2		COMMENTS
DO meter #		DO meter #	3	
DO probe #		DO probe #	6	
pH meter #		pH meter #	1138	
pH probe #		pH probe #	31	
S/C meter #		S/C meter #	330i	
S/C probe #		S/C probe #	330i	
Salinity meter #		Salinity meter #	330i	

ESI

SAMPLE RECEIPT RECORD

EnviroSystems, Inc.
One Lafayette Road
P.O. Box 778
Hampton, N.H. 03843-0778
(603) 926-3345 • (603) 926-3521 Fax
www.envirosystems.com

ESI STUDY NUMBER: 11419 CLIENT: CH2MHill; American Samoa

SAMPLE RECEIPT:
DATE: 8/13/03 TIME: 1045 BY: RC

DELIVERED VIA: ☒ FEDEX ☐ CLIENT ☐ ESI ☐ UPS ☐ OTHER

LOGGED INTO LAB:
DATE: 8/13/03 TIME: 1045 BY: RC

SAMPLE CONDITION:

CHAIN OF CUSTODY:	☒ YES	☐ NO
CHAIN OF CUSTODY SIGNED:	☒ YES	☐ NO
CHAIN OF CUSTODY COMPLETE:	☒ YES	☐ NO
SAMPLE DATE:	☒ YES	☐ NO
SAMPLE TIME RECORDED:	☒ YES	☐ NO
SAMPLE TYPE IDENTIFIED:	☒ YES	☐ NO
CUSTODY SEAL IN PLACE:	☒ YES	☐ NO
SHIPPING CONTAINER INTACT:	☒ YES	☐ NO

SAMPLE TEMPERATURE (AT ARRIVAL): 19 °C

DOES CLIENT NEED NOTIFICATION OF TEMPERATURE?	☐ YES	☒ NO
SAMPLE ARRIVED ON ICE:	☐ YES	☒ NO

COMMENTS: 1x5gal Eff

NPDES\FORMS\Labforms\Chem&LabLogBooks\ACUTE RECEIPT.FRM

gdc

COASTAL ENVIRONMENTAL ANALYSTS

31 December 2008

Mr. Carl Goldstein
Pacific Insular Area Programs
CMD-1
Environmental Protection Agency
75 Hawthorne Street
San Francisco, CA 94105

LCDR Matt Vojik
American Samoa Environmental
Protection Agency
American Samoa Government
P.O. Box PPA
Pago Pago, American Samoa 96799

RE: JCO Receiving Water Monitoring - August/September 2008 Sampling

Enclosed is the 2008 Tradewind Season JCO Water Quality Monitoring Report (August/September 2008 sampling period) required by the Joint Cannery Outfall (JCO) NPDES permits for StarKist Samoa and COS Samoa Packing.

The sampling and measurements at the required stations were completed without significant problems during the August/September 2008 campaign. Following the same format as the previous report we have provided all Attachments as electronic files on CD-ROM. This includes laboratory data previously provided as a paper copies and allows the inclusion of additional laboratory QA/QC material.

Please call us if you have any questions or comments on the enclosed report.

Sincerely,

Karen A. Glatzel

Karen A. Glatzel

Encl: Two copies to Mr. Carl Goldstein
One copy to LCDR Matt Vojik

Cc: Jim Cox, COS International; Willem Martines, COS Samoa Packing; Sam Augspurger, COS Samoa Packing; Tim Ruby, Del Monte Foods; Brett Butler, StarKist Samoa; Joe Carney, StarKist Samoa; Rob Darby (all with one copy of enclosure)

P.O. BOX 1238 • 216 DRIFTWOOD LANE • TRINIDAD, CA • 95570
PHONE: 707-677-0123 • FAX: 707-677-9210
EMAIL: GLATZELDACOSTA@SUDDENLINK.NET

JOINT CANNERY OUTFALL RECEIVING WATER QUALITY MONITORING REPORT

2008 Non-tradewind Season
May 2008

Prepared for:

StarKist Samoa
NPDES Permit AS0000019
COS Samoa Packing
NPDES Permit AS0020027

Submitted to:

U.S. Environmental Protection Agency
American Samoa Environmental Protection Agency

Prepared by:

gdc

glatzel da costa (gdc)
P.O. Box 1238
Trinidad, CA 95570

31 July 2008

TECHNICAL MEMORANDUM **gdc**

JOINT CANNERY OUTFALL RECEIVING WATER QUALITY MONITORING MAY 2008 SAMPLING

Prepared For: StarKist Samoa (NPDES Permit No. AS0000019)
and
COS Samoa Packing (NPDES Permit No. AS0000027)

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

Date: 31 July 2008

Distribution: Carl Goldstein
United States Environmental Protection Agency, Region 9
Matt Vojik
American Samoa Environmental Protection Agency

SUMMARY

The required semi-annual receiving water monitoring for the Joint Cannery Outfall (JCO) was conducted in May 2008. Sampling included direct measurement of light penetration, hydrographic parameters (vertical profiles of temperature, salinity, and dissolved oxygen), nutrients (total nitrogen and total phosphorus), and mixing zone parameters (ammonia, copper, zinc, and mercury). Exceedances of American Samoa Water Quality Standards criteria for TN throughout the Harbor and for DO in isolated segments of the water column at two locations were noted. However, these exceedances are obviously associated with a persistent, harbor-wide, and well documented algal bloom that appears to originate in the Inner Harbor and is not associated with the JCO discharge. The results of the sampling and analyses clearly indicate compliance with the NPDES permit required conditions for all parameters with the exception of exceedances for TN, and some small regions of the water column for DO at two stations. Although compliance with TN and DO requirements could not be demonstrated, exceedances appear to be directly related to algae blooms in the Inner Harbor. Previous sampling episodes indicate that the discharge is expected to be in compliance, and not responsible for elevated TN or depressed DO concentrations.

PURPOSE

This Technical Memorandum presents the results of the May 2008 Pago Pago Harbor receiving water quality monitoring conducted for the StarKist Samoa (SKS) and COS Samoa Packing (COS) Joint Cannery Outfall (JCO). The sampling and analysis is required semi-annually under the existing national pollution discharge elimination system (NPDES) permits for each cannery. This report documents the first of the two sampling events for 2008. The sampling and analysis conducted included all required stations and parameters.

STATION LOCATIONS

Both tuna canneries discharge through the JCO, which terminates in a multi-port diffuser at a depth of approximately 176 feet in the Outer Harbor (Station 14 in Figure 1 marks the diffuser location). Typical flows through the outfall are approximately 2 to 4 mgd. Approved zones of mixing (ZOMs) for specific parameters are centered on the diffuser. A ZOM for total nitrogen (TN) and total phosphorous (TP) has a circular boundary marked by Stations 15, 16, and 18 and the edge of the coral reef as shown in Figure 1. Smaller ZOMs for ammonia, mercury, copper, and zinc have also been established well within the zone of initial dilution (ZID) of the discharge and extend only a few meters from the discharge point.

Special Condition B of the NPDES permit specifies the sampling locations, depths, and parameters for analysis for the receiving water quality monitoring stations as shown in Table 1. Table 1 also indicates a summary of the stations that were occupied during May 2008 monitoring event. The stations occupied, sampled, and reported in this Technical Memorandum are shown in Figure 1.

Station locations are specified in the NPDES permits and are associated with historical stations monitored since the construction of the JCO. Problems with station specification associated with the differences between various map datums, previous station finding techniques, and the current use of GPS, resulted in uncertainty about actual station locations. In March 2001, the WGS 1984 coordinates of the stations actually occupied for the JCO sampling were recorded. Station locations for Stations 14, 8, and 8A were verified and adjusted during the May 2008 sampling based on information from diver inspection of the outfall. These coordinates are used for the May 2008 sampling episode, unless corrections are required and reported in the recommendations section below.

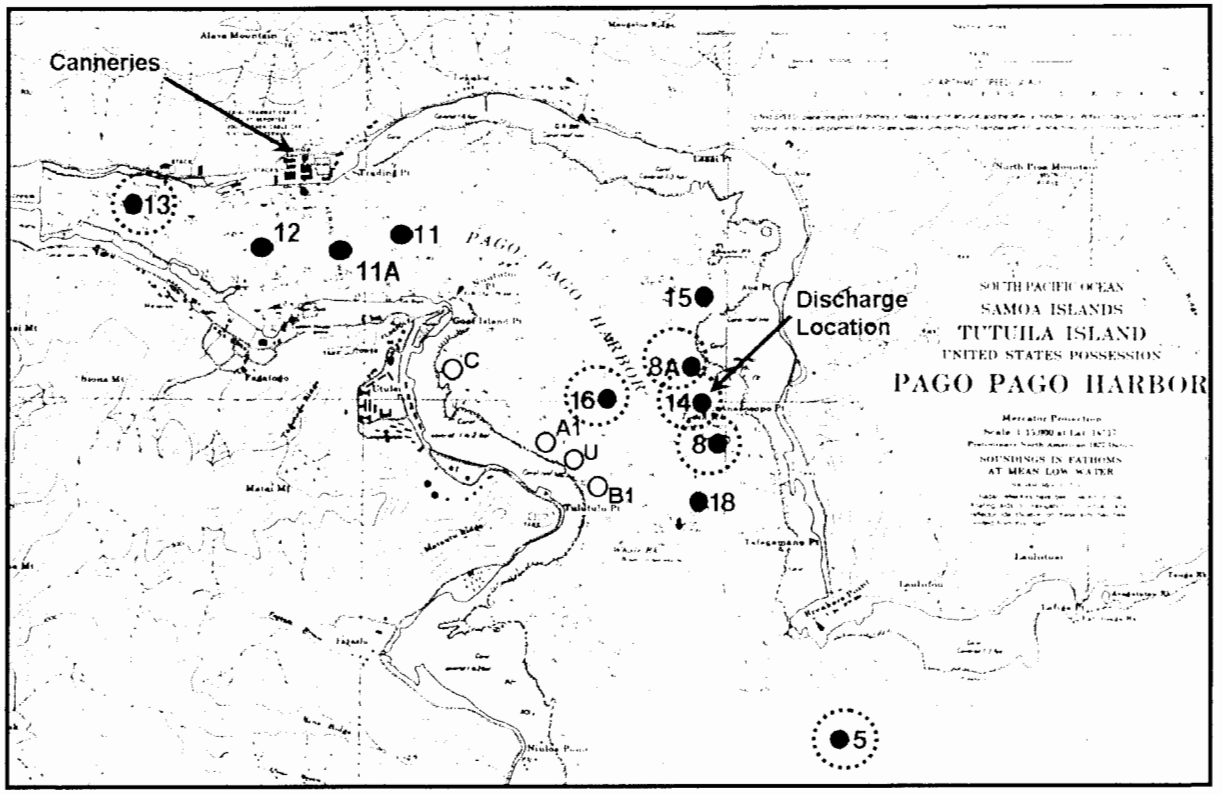


Figure 1

Station Locations (dashed circles indicate stations sampled in May 2008**)**

Table 1
JCO Sampling Stations
Pago Pago Harbor Water Quality Monitoring
NPDES Permits Effective 1 April 2008

Monitoring Stations	Vicinity[1]	Latitude	Longitude	Parameters								
				TN	TP	NH_3	Hg	Cu	Zn	LP	VP	Narr
5	Reference Site	S14º17.674'	W170º39.749'	X	X	X	X	X	X	X	X	X
14	End of Pipe	S14º16.824'	W170º40.133'			X	X	X	X	X	X	X
8	Zone of Initial	S14º16.957'	W170º40.105'			X	X	X	X	X	X	X
8A	Dilution	S14º16.708'	W170º40.212'			X	X	X	X	X	X	X
16	Zone of Mixing	S14º16.881'	W170º40.347'	X	X					X	X	X
13[2]	Inner Harbor	S14º16.347'	W170º41.901'	X	X							

[1] Listed as described in the NPDES permits
[2] Station 13 is not a permit required sampling station, but was occupied for selected parameters for information purposes.
LP = light penetration at 65 feet
VP = vertical profiles of temperature, salinity, and dissolved oxygen
Narr = visible floating materials, grease, oil, scum or foam

SAMPLING CONDITIONS AND METHODS

Table 2 provides a summary of weather conditions during the times of receiving water quality sampling. Light penetration measurements were made mid-day on May 4th. Receiving water quality sampling and measurements, including CTD casts, were conducted on May 3rd (Stations 5, 16, and 13) and May 4th (Stations 8, 14, and 8A).

Table 2
Weather and Times of Water Quality Station Occupation
JCO Pago Pago Harbor Receiving Water Quality Monitoring
May 2008

Time	Station	Depth* (feet)	Weather Conditions				
			Sky	Rain	Wind (mph)	Wind Waves (ft)	Swell (ft)
Water Quality Sampling – 3 May 2008							
11:30 – 11:42	5	131	Partly Cloudy[1]	--	ESE 5 to 10	< 1	SE 1 to 3
14:30 – 14:40	16	195	Partly Cloudy	--	SSE 8 to10	0.5	SE 1 to 2
16:23	13	24	Mostly Cloudy	--	SSE light	< 0.5	--
Water Quality Sampling – 3 May 2008							
09:16 – 09:20	8	188	Overcast	--[2]	Light/Variable	--	SE 1
09:43 – 09:49	14	177	Mostly Cloudy	--	Light/Variable	--	SE 1
10:06 -10:10	8A	169	Cloudy	--	SE <5	--	S 1
CDT Casts – 3 May 2008							
11:49	5	125	Partly Cloudy[1]	--	ESE 5 to 10	< 1	SE 1 to 3
14:40	16	158	Partly Cloudy	--	SSE 8 to10	0.5	SE 1 to 2
CDT Casts – 3 May 2008							
09:23	8	180	Overcast	--[2]	Light/Variable	--	SE 1
09:45	14	175	Mostly Cloudy	--	Light/Variable	--	SE 1
10:11	8A	165	Cloudy	--	SE <5	--	S 1
Light Penetration Measurements – 4 May 2008							
14:37	5	Light Penetration measured at 65 feet below surface	Partly Cloudy	--	SE 5 to 10	1 to 2	SSE 3 to 5[3]
14:20	16		Overcast	--	Light/variable	1	S 1 to 3
14:51	A1[5]		Overcast	--	Light/variable	1	S 1 to 3
13:44	8		Overcast	--[2]	Light/Variable	--	SE 1
13:57	14		Mostly Cloudy	--	SE <5	--	SE 1
14:09	8A		Overcast	--	SE 5	--	S 1
15:06	11[5]		Overcast	--	--	--	--
15:19	12[5]		Overcast	--	SE 5 to 20[4]	--	--

*Depth listed under water quality sampling is the total water depth at the time of sampling. Water samples were collected at 3, 60, and 120 feet below the surface when depth is greater than 120 feet. Samples are collected 3 feet below the surface, 3 feet above the bottom (as conditions allow), and at mid depth when total water depth is less than 120 feet. Depth listed under CDT casts is the depth to which the instrument was lowered.

[1] Full overcast at time of Secchi depth reading
[2] Squall passed just prior to sampling
[3] Period of 4 to 5 seconds
[4] Squall approaching
[5] Stations A1, 11, and 12 are not required, light penetration was measured at these stations for informational purposes

During the time of the sampling visible floating materials, grease, oil, scum or foam, were not observed at any station. However, a persistent Harbor wide plankton bloom was observed. Discussion with ASEPA staff indicated this had been persistent since the later part of 2007 (as reported in the September 2007 monitoring report). In the Outer Harbor the water color was noticeably less transparent than typically observed. In the Inner Harbor the water color was noticeably green to red-brown. Water transparency in the Inner Harbor was very low. The organism responsible for the bloom (a dinoflagellate), and a record of its persistence, was provided in a letter to the editor in the Samoa News on October 10, 2007

which was included in the September 2007 monitoring report. The conditions in May 2008 appear to be the same phenomena.

Table 3 presents the sample analysis and handling procedures used for the collection of water quality samples and measurements. Water quality samples were collected at three depths at each station: near-surface (3 feet), mid-depth (60 feet), and deep-water/near-bottom (120 feet)[1]. Samples were collected using a standard oceanographic sample-collecting bottle for low metals concentrations (WildCo Beta bottle). Water samples were placed in laboratory supplied bottles, preserved as required, stored on ice, and shipped to the laboratory by express shipment (DHL) in ice chests with double zip-lock bags of ice. Attachment I contains the Chain-of-Custody forms for the sample shipping and delivery to the laboratory.

Table 3
Sample Analysis And Handling Procedures
JCO Receiving Water Quality Monitoring
May 2007

Parameter	Method	Detection limit	Holding time	Container	Preservation
Temperature	In Field/Sonde	0.1°C	N/A	N/A	none
Salinity	In Field/Sonde	0.1 PSU			
Dissolved O_2	In Field/Sonde	0.1 mg/l			
Nitrate +Nitrite	EPA 353.2	0.004 mg/l	28 days	500 ml plastic	H_2SO_4 added to pH <2, stored 4°C
Ammonia (N)	EPA 350.1	0.006 mg/l			
TKN	EPA 351.3	0.1 mg/l			
Total Phosphorus	EPA 365.2	0.003 mg/l			
Copper	EPA 200.8	<0.1 µg/l	7 days	500 ml plastic	4°C
Zinc		<1µg/l			
Mercury	EPA1631	0.00005 µg/l		500 ml plastic	4°C

WATER QUALITY SAMPLING AND ANALYSIS RESULTS

Results of the water quality sampling and measurements are provided in Tables 4, 5, 6, and 7. These samples and measurements were collected and analyzed for light penetration, hydrographic parameters (temperature, salinity, dissolved oxygen), nutrients (TN and TP), and mixing zone parameters with approved mixing zones (ammonia, Cu, Zn, and Hg).

Light Penetration

The American Samoa Water Quality Standard[2] (ASWQS) criterion for water clarity is in terms of light penetration, which requires that extinction of light intensity be no more than

[1] When water depth is less than 120 feet samples are taken at mid-depth (between surface and bottom) and approximately 3 feet from the bottom.
[2] The ASWQS, 2005 revision, criteria for open coastal waters, are referenced in this Technical Memorandum.

99% at a depth of 65 feet at least 50% of the time[3]. Light penetration was measured using HOBO Pendant data loggers. Four loggers were suspended on a float just below the water surface and four were attached to a Secchi disk fixed to a YSI sonde. The sonde provides accurate measurements of the depth of the light measurement sensors. The sensors are left at depth for three minutes and the average values of light intensity of the surface and deep sensors are calculated over the three minute period. The results are summarized in Table 4, which includes Secchi depth recorded at the time of the light measurements. The ASWQS criterion for light penetration is clearly achieved in the Outer Harbor (Stations 16, A1, and 8) and degrades as one moves along the Harbor toward the Inner Harbor. This gradient cannot physically be attributed to the discharge and is undoubtedly caused by the algal bloom discussed above.

Table 4
Light Intensity Measurements
JCO Receiving Water Quality Monitoring
May 2008

Station	Time at 65 feet	Secchi Depth (feet)	Light Intensity at the Water Surface (lum/ft²)[1]	Light Intensity 65 feet below the water surface (lum/ft²)[1]	Percent ambient light remaining 65 feet below the surface
Transition Zone (Reference Station)					
5	14:38 – 14:43	38.2	1952	96	4.91
Farfield (Outer Harbor)					
16	14:22 – 14:25	21.2	2356	33	1.38
A1	14:55 – 14:59	23.7	1269	16	1.25
Diffuser and Nearfield					
8	13:48 – 13:51	21.2	1024	16	1.57
14	14:00 – 14:04	21.8	5235	60	1.15
8A	14:11 – 14:14	22.2	1865	16	0.86
Inner Harbor					
11	15:08 – 15:11	20.7	1907	12	0.63
12	15:21 – 15:24	13.7	951	0.24	0.03

[1] Average of data from 4 light meters for at least 3 minutes (180 readings/light meter)

Hydrographic Parameters

Table 5 provides a summary of temperature, salinity, and dissolved oxygen (DO) that were measured at the same depths at each station as the grab samples for the nutrient and metals analyses discussed below. These parameters were measured using a YSI 6600 sonde with depth, temperature, conductivity, and dissolved oxygen (DO) sensors. Sensor calibration

[3] The ASWQS for light extinction in Pago Pago Harbor is that light penetration depth will exceed 65 feet 50 percent of the time. Light penetration depth is defined as "the depth reached by 1 percent of the sunlight incident on the surface of a body of water".

records for this data collection event are provided in Attachment II. The parameters listed in Table 5 were recorded from the deck readout of the sonde during the vertical profile casts (recorded in the sonde memory). Table 6 summarizes the results of the vertical profiles over the water column depths noted in Table 2 for temperature, salinity and DO. Vertical profile data are provided in Attachment III.

Table 5
Hydrographic Parameters Recorded from Sonde Readout
JCO Receiving Water Quality Monitoring
May 2008

Station	Depth (feet)	Temp (ºC)	Salinity (PSU)	DO (mg/l)
Reference Station				
5	3	29.05	35.41	5.09
	60	29.02	35.41	5.24
	120	28.99	35.53	5.25
	Average	29.02	35.45	5.19
ZOM Station				
16	3	29.09	35.25	6.85
	59	29.03	35.42	6.57
	121	28.99	35.52	6.49
	Average	29.04	35.40	6.64
ZID Stations				
8	3	28.92	35.36	6.15
	61	29.02	35.49	5.67
	120	28.99	35.58	5.40
	Average	28.98	35.48	5.74
8A	3	28.90	35.21	5.99
	60	28.97	35.41	5.04
	120	29.00	35.56	5.23
	Average	28.96	35.43	5.42
End of Pipe Station				
14	3	28.93	35.28	5.77
	60	28.96	35.46	5.12
	120	28.92	35.52	4.92
	Average	28.94	35.42	5.27
Summary of All Stations				
All Stations	Minimum	28.90	35.21	4.92
	Maximum	29.09	35.58	6.85
	Median	28.99	35.43	5.65
	Average	28.99	35.42	5.40
	Std. Dev.	0.05	0.11	0.62

The results of the measurements of the hydrographic parameters are summarized as follows:

- Water temperatures at the monitoring stations were below the ASWQS numerical criteria of 85°F (29.44°C) throughout the water column at all stations as shown in Ta-

bles 5 and 6 and in Attachment III. The maximum temperature recorded was 29.09°C and the average was 28.97 °C for the vertical profiles (Table 6). Compliance with the ASWQS is demonstrated.

Table 6
Summary of Vertical Profile Data
JCO Receiving Water Quality Monitoring
May 2008

Station		Temperature (°C)	Salinity (PSU)	Dissolved Oxygen (mg/l)
Reference Station				
5	Maximum	29.05	35.68	5.41
	Minimum	28.72	35.37	5.07
	Average	29.02	35.45	5.26
	Std. Dev.	0.03	0.06	0.08
ZOM Station				
16	Maximum	29.09	35.63	6.93
	Minimum	28.95	35.24	5.82
	Average	29.02	35.45	6.46
	Std. Dev.	0.03	0.11	0.27
ZID Stations				
8	Maximum	29.02	36.26	6.49
	Minimum	27.16	35.27	5.17
	Average	28.95	35.58	5.55
	Std. Dev.	0.12	0.18	0.30
8A	Maximum	29.02	35.87	6.31
	Minimum	28.79	35.18	4.86
	Average	28.95	35.47	5.38
	Std. Dev.	0.05	0.19	0.43
End of Pipe Station				
14	Maximum	28.99	35.89	6.24
	Minimum	28.62	35.10	4.80
	Average	28.93	35.51	5.17
	Std. Dev.	0.05	0.18	0.38
Summary of All Stations				
All Stations	Maximum	29.09	36.26	6.93
	Minimum	27.16	35.10	4.80
	Average[1]	28.97	35.49	5.56

[1] Average is the average of station averages, not individual readings.

- Salinity ranged from 36.26 ppt to 35.10 ppt with an average of approximately 35.5 ppt. Slightly lower values and a small salinity gradient were recorded in the near surface water throughout the Harbor (Attachment III). These values are typical of Pago Pago Harbor water and are consistent with previous salinity measurements. There is no ASWQS for salinity, but there was no indication of reduced salinity caused by the discharge plume.

- The DO minimum value was 4.80 mg/l and the average was 5.56 mg/l. The lowest values were at Stations 14 and 8A well below the surface (Attachment III) and may

be a response to the algal bloom mentioned above. Excluding Stations 14 and 8A, the minimum value was 5.07 mg/l at the Station 5 (the reference station). Overall, the DO concentrations meet the ASWQS minimum criterion of not less than 5.0 mg/l and not less than 70% saturation[4] with the exceptions noted. Based on the similar trends in the light meter data described above, the DO depression below 5 mg/l is most likely a result of the algal bloom in the Inner Harbor, and cannot be associated with the discharge. It is noted that similar DO depressions were noted at a depth of 65 feet at Stations 11 and 12 when occupied for light penetration measurements.

Nutrients and Biological Parameters

Table 7 presents the results for the nutrients[5] measured in the samples. These parameters included total Kjeldahl nitrogen (TKN), nitrate+nitrite, and total phosphorus (TP). The ASWQS regulates total nitrogen (TN), which is calculated by adding the concentration values of TKN and nitrate+nitrite. Laboratory data are provided in Attachment IV.

The results of the sampling and analyses for the nutrient parameters are summarized as follows:

- Total nitrogen was measured or estimated higher than the ASWQS criterion in all samples. The ASWQS criterion is 200 µg/l (0.200 mg/l). This is a very low level and well below the method detection limits (MDLs) and reporting limits (RLs) of most analytical laboratories. For this set of samples a specialty laboratory was used to achieve very low level results for TKN with a detection level of 0.1 mg/l.

  Compliance with the ASWQS criterion for TN was not demonstrated. However, the high levels of TN are not consistent with previous monitoring results at these stations and appear to be related to the algal bloom mentioned above. Based on the water clarity and other parameters, such as DO and chlorophyll-a[6] there does not appear to be any impairment to the receiving waters in the vicinity of the discharge, and there is no apparent effect of the discharge in the data.

  Samples were also collected and analyzed at Station 13 in the far Inner Harbor and results indicate elevated levels, higher than those at Stations 5 and 16. This gradient is not physically consistent with a source at the discharge point. A heavy and persistent algal bloom has been observed in the Inner Harbor and may be responsible for

[4] 70% DO saturation is approximately 4.5 mg/l, for the observed temperature and salinity.

[5] Total ammonia (as N) is also measured and is presented with the mixing zone parameters in the following section.

[6] Chlorophyll-a was measured for the Utulei Wastewater Treatment Plant monitoring conducted at the same time as the sampling reported in this Technical Memorandum and reported separately.)

both elevated values of chlorophyll-a concentrations and associated values of TKN. This has been a persistent phenomenon in the Harbor for since the latter half of 2007 as documented in the sampling monitoring report describing the results of the September 2007[7]

- Total phosphorus was reported below the ASWQS criterion (0.030 mg/l) for all of the samples (see Table 7). It is noted that the TP values in the Station 13 samples are elevated.

Table 7.
Nutrient Parameters
JCO Receiving Water Quality Monitoring
May 2008

Station	Depth	TKN	Nitrate + Nitrite	Total Nitrogen[1]	Total Phosphorous
	Method	351.3	353.2	calculated	365.3
	Units	mg/l	mg/l	mg/l	mg/l
Detection Limit (values noted in bold in Table)		0.1	0.004	--	0.004
	WQ Standard	--	--	0.200	0.030
5	3	0.29	0.021 (J)	0.311	0.009 (J)
	60	0.25	**0.004**	0.254	0.01
	120	0.56	**0.004**	0.374	0.007 (J)
	Average	0.303	0.010	0.313	0.009
16	3	0.39	0.023 (J)	0.413	0.01
	60	0.72	0.022 (J)	0.742	0.01
	120	0.78	**0.004**	0.784	0.01
	Average	0.63	0.016	0.646	0.01
13	3	0.31	**0.004**	0.314	0.03
	20	1.4	**0.004**	1.404	0.02

[1] Total Nitrogen = TKN + (nitrate+nitrite)
J= The result is an estimated concentration that is less than the MRL but greater than or equal to the MDL.
Values in **BOLD** font indicate reported concentration was below the MDL

Mixing Zone Parameters

The NPDES permits for both canneries include effluent limitations for mixing zone parameters. The mixing zone is not the same as the nutrient mixing zone for TN and TP, and compliance with ASWQS criteria is required within the zone of initial dilution. These parame-

[7] Monitoring indicates relatively low ammonia levels, which means the high TKN values are the result of high organic nitrogen concentrations. The high TKN results are inconsistent with monitoring results over the last 20 years, and do not appear to be related to cannery or Utulei WWTP discharges. The higher observed levels of chlorophyll-a and TKN in the far Inner Harbor (Station 13) reported in the September 2007 Utulei WWTP report and this monitoring report, respectively, support the premise that the phenomena is either a regional scale plankton bloom or the result of local run off in the Inner Harbor.

ters include ammonia, copper, zinc, and mercury (Table 8). The results of the analyses for the mixing zone parameters show that all parameters are well below the respective ASWQS criteria.

Table 8.
Mixing Zone Parameters
JCO Receiving Water Quality Monitoring
May 2008

Station	Depth	Ammonia (N)	Copper	Zinc	Mercury
	Method	350.1	200.8	200.8	1631E
	Units	mg/l	µg/l	µg/l	µg/l
	WQ Standard	≅ 0.40[1]	3.1	81	0.050
Reference Station					
5	3	0.02	0.201 (J)	1.34	0.0031
	60	0.03	0.282	1.30	0.0031
	120	0.02	0.418	2.35	0.0067
	Average	0.02	0.300	1.66	0.0043
ZID Stations					
8	3	0.04	0.926	2.05	0.0017
	60	0.03	0.195 (J)	0.70 (J)	0.0017
	120	0.06	0.158	1.45	0.0022
	Average	0.04	0.426	1.40	0.0019
8A	3	0.02	0.421	1.23	0.0015
	60	0.02	0.352	0.87 (J)	0.0028
	120	0.02	0.181 (J)	0.68 (J)	0.0012
	Average	0.05	0.318	0.93	0.0018
End of Pipe Station					
14	3	0.01	0.372	1.14	0.0016
	60	0.08	0.432	1.13	0.0047
	120	0.06	0.219	2.40	0.0032
	Average	0.05	0.341	1.56	0.0032
Summary of All Stations					
All Stations	Minimum	0.01	0.158	0.68	0.0012
	Maximum	0.08	0.926	2.40	0.0067
	Average	0.03	0.320	1.28	0.0026
	Median	0.03	0.317	1.27	0.0025
	Std. Dev	0.02	0.209	0.59	0.0016

[1] Ammonia criterion is a function of pH, temperature, and salinity. This value is appropriate for the observed conditions
J: The result is an estimated concentration that is less than the MRL but greater than or equal to the MDL

CONCLUSIONS AND RECOMMENDATIONS

With the exception of exceedances for TN, and some small regions of the water column for DO at two stations, the JCO receiving water appears to be in compliance with the ASWQS. The exceedances of TN appear to be associated with a large persistent algal bloom and are not attributable to the discharge. DO depression was observed at Stations 14 and 8A, also associated with the algal bloom. A summary of compliance is provided in Table 9.

The ASWQS criteria for TN and TP are at and often below the typical limit of laboratory analyses. Based on the sampling during May 2008 and many previous sampling events it is recommended that the canneries, ASEPA, and USEPA discuss and develop, if possible, an approach that would provide more definitive assessments of compliance and appropriate environmental protection levels for these parameters.

Table 9
Receiving Water Permit Conditions and Compliance
JCO Pago Pago Harbor Water Quality Monitoring
September 2007

Permit Discharge Specifications for Receiving Water	Applicable Stations Listed in NPDES Permits (X)					Comments
	14	8	8A	16	5	
Part I.B. Except as authorized by specific effluent limitations, the discharge shall be substantially free of or shall not cause the following in the receiving water:						
No objectionable color, odor, or taste	X	X	X	X	X	Compliance with permit requirements observed during sampling of receiving water
No visible floating material, grease, oil, scum, foam	X	X	X	X	X	
No materials that will produce visible turbidity or form objectionable deposits	X	X	X	X	X	
Materials toxic to humans or aquatic life or produce undesirable aquatic life	X	X	X	X	X	
Temperature of receiving water more than 1.5 ºF from natural conditions or exceed 85 ºF (other than from natural causes)	X	X	X	X	X	Compliance with permit requirements measured
Toxic pollutants higher than the applicable criteria	X	X	X	X	X	Compliance with permit requirements measured for NH_3, Hg, Cu, and Zn
Mixing zone parameters higher than the applicable criteria outside the ZID		X	X	X	X	
Turbidity to exceed 0.75 NTU at or outside the ZID		X	X	X	X	Measurement of turbidity is not required. Compliance for light penetration measured at all stations except 8A. Noncompliance with ASWQS criterion at Station 8A is **not** attributable to the discharge (see text)
Light penetration depth less than 65 feet at or outside the ZID		X	X	X	X	
DO less than 70% saturation of less than 5.0 mg/l at or outside the ZID		X	X	X	X	Compliance for DO measured at all stations except 8A. Noncompliance with ASWQS criterion at Station 8A is **not** attributable to the discharge (see text)
Part I.C. The discharge shall not cause the following at the boundary of the mixing zone for mercury						
Mercury to exceed 0.05 µg/l		X	X			Compliance measured
Part 1.D. The discharge shall not cause the following at the boundary of the mixing zone for nutrients						
Total phosphorus no higher than 30 µg/l				X		Compliance measured
Total nitrogen no higher than 200 µg/l				X		Compliance with permit requirements could not be demonstrated because of conditions not associated with the discharge (see text).
Chlorophyll-a no higher than 1.0 µg/l				X		Measurement of Chlorophyll-a is not required. Light penetration data indicates the water column has a low chlorophyll-a level and compliance is inferred.

Attachments Provided on CD-ROM

ATTACHMENT I: Chain-of-Custody

ATTACHMENT II: Sonde Calibration Records

ATTACHMENT III: Vertical Profile Data

ATTACHMENT IV: Laboratory Results (Columbia Analytical Services, Inc. and AMTEST Laboratories)

TECHNICAL MEMORANDUM **gdc**

JOINT CANNERY OUTFALL DIFFUSER PERFORMANCE: EFFECT OF OPENING ADDITIONAL PORTS

Prepared For: StarKist Samoa (NPDES Permit AS0000019)
COS Samoa Packing (NPDES Permit AS0000027)

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

Date: 5 August 2008

Distribution: Carl Goldstein
United States Environmental Protection Agency, Region 9
Matt Vojik, Technical Services Department
American Samoa Environmental Protection Agency

SUMMARY

The joint cannery outfall is used by StarKist Samoa and Samoa Packing to discharge treated wastewater into Outer Pago Pago Harbor at a depth of approximately 176 feet. The diffuser was designed with six 5-inch ports at 50-foot spacing between ports. Currently only four ports are open. Opening additional ports will result in a lower head loss and reduce pumping requirements.

The effect of opening additional ports on dilution performance of the diffuser was evaluated using the same model used to define the existing mixing zones. The initial dilution increases as the number of open ports is increased from 4 to 6. The depth the plume is trapped below the surface remains almost the same for all cases.

More open ports result in increased susceptibility to seawater intrusion. Persistent seawater intrusion can compromise the operation of the diffuser. The results of the evaluation indicate the persistent seawater intrusion will not be a problem with additional open ports.

Based on the analysis presented in this TM, it is recommended that the canneries consider opening the two currently closed ports during the next planned outfall inspection and cleaning.

INTRODUCTION

The joint cannery outfall is used by StarKist Samoa (SKS) and COS Samoa Packing (COS) to discharge treated wastewater into Pago Pago Harbor under existing NPDES permits AS0000019 and AS0000027, respectively. The discharge is in Outer Pago Pago Harbor at a depth of approximately 176 feet. The diffuser was designed with six 5-inch ports at 50-foot spacing between ports. Currently only four ports are open. The other two ports are capped, and were provided to accommodate future increased flows. Wastewater flows have increased since the initial installation of the outfall 18 years ago, and opening additional ports is desirable to reduce the head loss, and concomitant pumping requirements, during high wastewater flows.

Three issues are addressed in this Technical Memorandum (TM) to determine if opening one or two of the currently blocked flows is consistent with outfall operation and compliance with American Samoa Water Quality Standards (ASWQS). The following sections of the TM discuss these issues:

- **Head loss:** The effect on head loss over the anticipated range of flows is evaluated using standard hydraulic calculations to determine the relative advantages of opening additional ports. Head loss through the outfall pipeline itself is not evaluated in this TM, because it will not be significantly affected by opening additional ports.

- **Initial Dilution:** SKS and COS (the canneries) have approved and permitted mixing zones within the zone of initial dilution (ZID) for ammonia, copper, mercury, and zinc based on various levels of initial dilution.[1] In particular the mixing zone for mercury is based on the critical initial dilution (CID) of 316:1. In addition, a special condition in each permit requires a chronic toxicity study that is based in part on a trigger point set by the CID of 313:1. Therefore, the effect on initial dilution by additional open ports is evaluated.

- **Seawater Intrusion:** Excessive total port area (too many open ports) can result in seawater intrusion and recirculation within the diffuser. This can compromise expected dilution performance and, more seriously, result in sedimentation and marine growth within the diffuser leading to permanent degradation, ultimately requiring repair or replacement. Normal flows must be sufficient to completely flush the diffuser after periods of low flows to

[1] The canneries also have mixing zones for nutrients that extend beyond the ZID and are based on farfield mixing process in addition to initial dilution.

avoid persistent seawater intrusion. Therefore, the potential for seawater intrusion with additional open ports is evaluated.

DIFFUSER AND DISCHARGE CHARACTERSITICS

The diffuser is an in-line series of six ports mounted on a uniform diameter barrel. The barrel is a 16-inch diameter HDPE pipe. Ports are 5 inches in diameter mounted on the barrel and oriented at a vertical angle of 15° upward from horizontal and discharging perpendicular to the barrel. Ports are spaced at 50-foot intervals along the diffuser barrel, alternating in direction of discharge.

The maximum expected discharge flows are based on the design hydraulic capacity of the wastewater treatment plants of the canneries. The SKS maximum flow is 2.9 mgd and the COS design flow is 1.4 mgd, for a possible total maximum flow of 4.3 mgd. Effluent temperature and salinity has a minor effect on dilution over the expected range. However, SKS uses seawater for thaw water and therefore the effluent salinity is not negligible. The original CID, used in the current permits and mixing zones, was based on a combined effluent temperature of 29.44°C and a salinity of 4.95 ppt. These values are used in this TM for consistency and comparison with previous results.

The water depth at the diffuser location is 176 feet. Tidal variations are minimal in Pago Pago Harbor. Effects of tidal variations are not considered since the plume is trapped well below the surface under critical conditions. The original mixing zone development was based on an established critical density profile, and the same profile is used in this TM.

EVALUATION OF DIFFUSER HEAD LOSS

The head loss through the diffuser, which is substantially all attributable to head loss arising from flow through the ports, was calculated using standard hydraulic equations for flow through a sharp-edged orifice:

$$Q_P = A_P C_D \sqrt{2gE}$$

where

Q_P = port discharge
A_P = port area
C_D = discharge coefficient
E = energy difference (between inside and outside of diffuser)

and

$$C_D = 0.63 - 0.58 \cdot \left(\frac{V^2}{2gE} \right)$$

where

V = port discharge velocity

Although the calculations may not fully represent the actual total head loss in the diffuser, the relative affects are considered accurately described. The results for 4, 5, and 6 open ports are summarized in Figure 1. At higher flows, the reduction in head loss is significant with additional open ports.

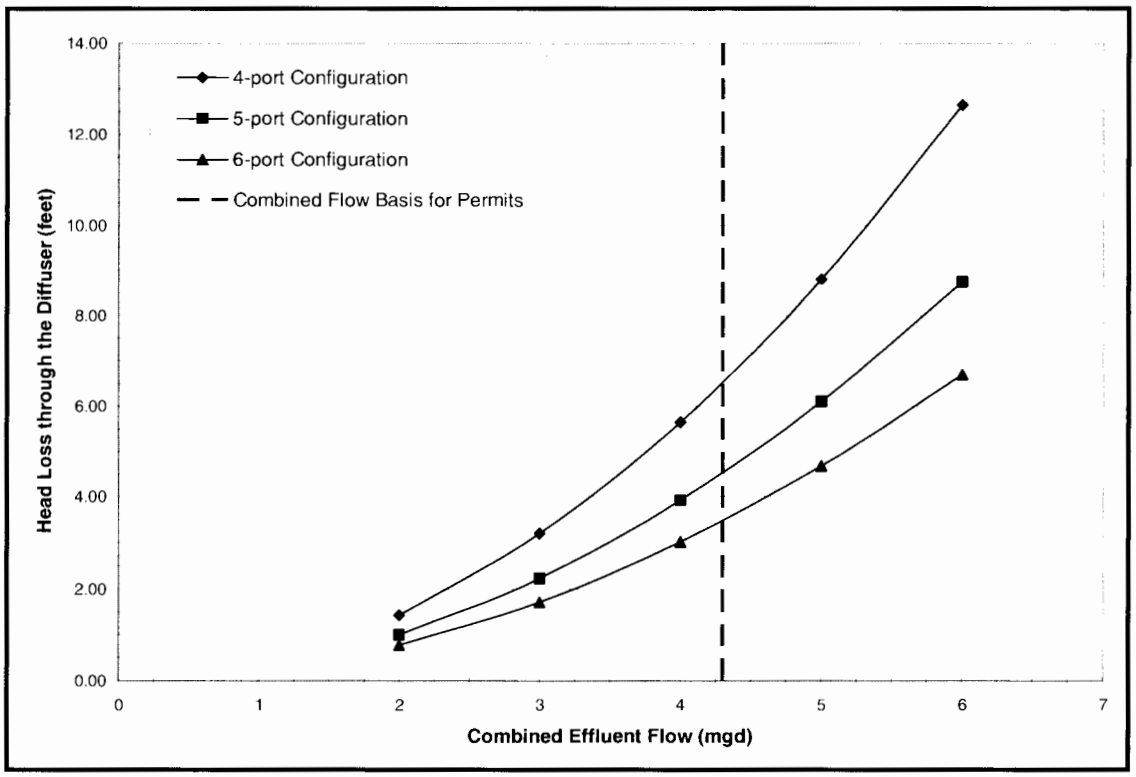


Figure 1. Head Loss versus Flow and Number of Open Ports

EVALUATION OF DILUTION PERFORMANCE

The same dilution model (UDKHDEN) with identical inputs, that was used to define the existing mixing zones, was used to determine the effect of increasing the number of open ports.[2] UDKHDEN is an EPA developed initial model[3] that was available

[2] The mixing zones are based on a dilution of 313:1 at a combined flow of 4.3 mgd. This value was extrapolated from previous model predictions for lower flows. When the model is run at 4.3 mgd, the predicted dilution is actually 317:1. The difference is negligible in the context of model accuracy.

[3] Initial Mixing Characteristics of Municipal Ocean Discharges: (Volume 1.Procedures and Applications; Volume II. Computer programs). EPA/600/3-85/073a and /073b. November 1985.

and routinely used at the time the JCO was designed and constructed. The model is still in wide use today, and is included in the EPA Visual Plumes model suite (the latest version of the PLUMES model specified in the ASWQS for mixing zone development).

Results of the model application are summarized in Figure 2, which shows that the initial dilution[4] increases approximately 20 percent as the number of open ports is increased from 4 to 6. The trapping level (the depth the plume traps below the surface) for the same cases is also shown in Figure 2. The trapping level remains almost the same for all cases, increasing less than 5 percent, and remains well below the water surface.

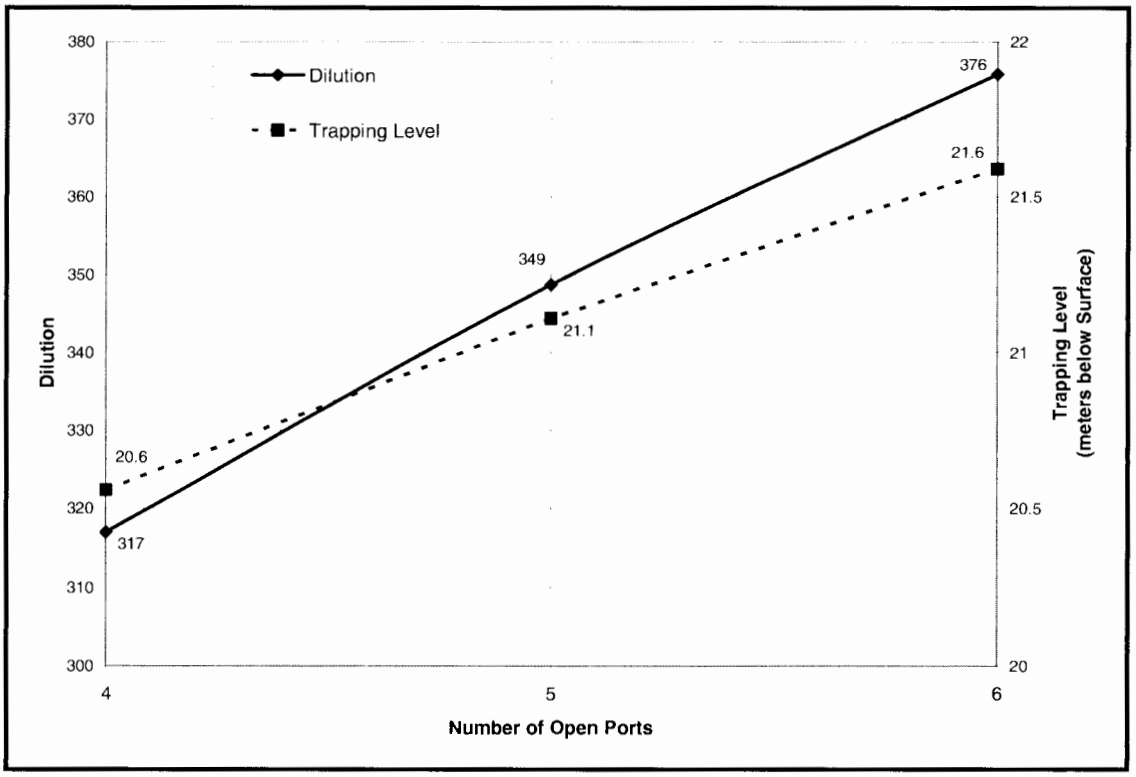


Figure 2. Dilution and Trapping Level at Combined Design Flow

[4] It is noted that the dilution shown in Figure 2 is identified as the critical initial dilution (CID). As the effluent plume rises through the water column, momentum typically carries it past the trapping level higher into the water column. Subsequently, the plume collapses back to the trapping level. During this time the rapid initial dilution process continues. Therefore, the CID may substantially understate the final initial dilution.

EVALUATION OF SEAWATER INTRUSION/FLUSHING

The most benefit with respect to reducing head loss, with no degradation in dilution performance, will be realized by opening all six ports on the existing diffuser. Since port velocities and internal pressures will be lower, the potential for seawater intrusion and the ability of the normal flow to flush the diffuser should be considered.

Seawater intrudes into a multiport diffuser under low effluent flow conditions, starting at the most seaward port, and may circulate within the diffuser. As flows drop more and more ports become inactive. Figure 3 is a schematic representation of this effect. The condition under which this happens is not precisely defined. The critical condition for seawater intrusion is generally described by the densimetric Froude number (Fr_ρ) which depends on port exit velocity and the density difference between the effluent and seawater. Seawater intrusion is assumed to begin at values of Fr_ρ of between 1 and 2. If the diffuser is on a downward slope the value of Fr_ρ for initiation of seawater intrusion is higher (intrusion will occur at higher port exit velocities).

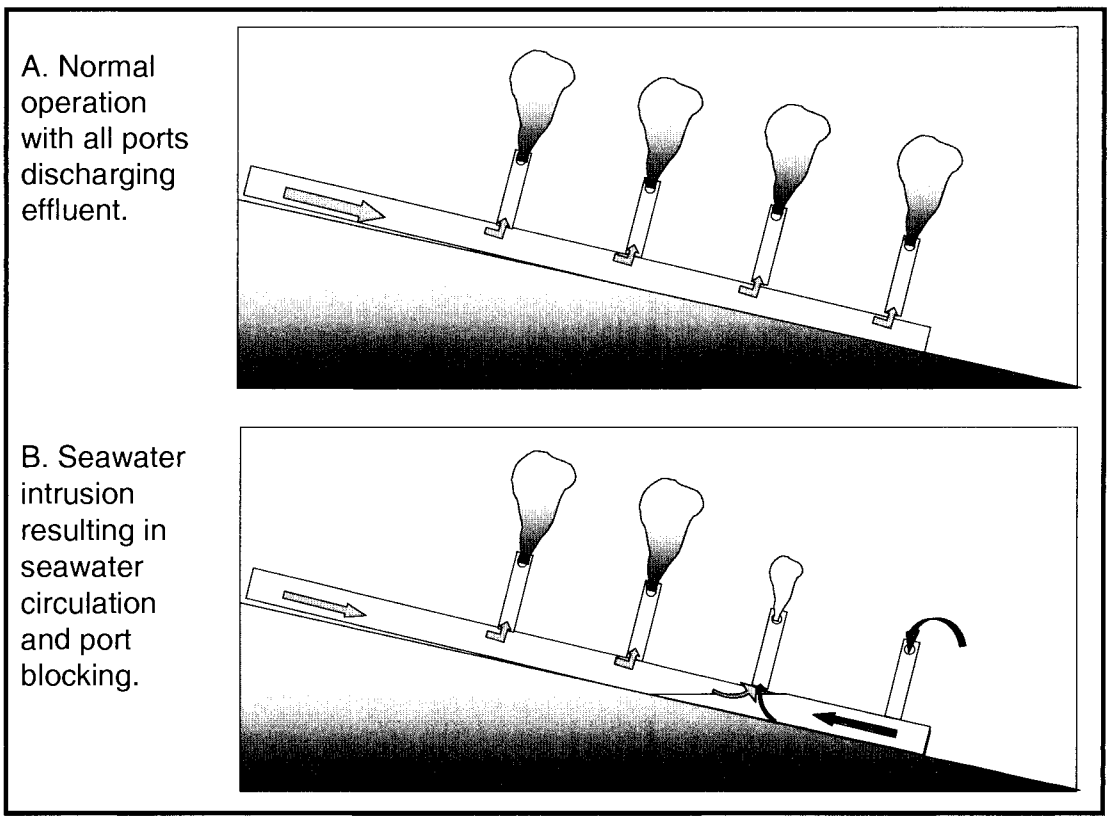


Figure 3. Schematic of Port Blocking by Seawater Intrusion and Circulation

The flow required to flush a diffuser, once seawater intrusion and recirculation has been initiated, is considerably higher than that required for the condition to initially occur. Flushing is typically achieved at Fr_ρ values of 5 to 10. If the diffuser is on a downward slope the value required to flush the seawater and restore effluent flow from all ports is typically higher.

Since the JCO diffuser is nearly level, and because the effluent is denser than freshwater because of the SKS thaw water contribution, the flows to both initiate intrusion and flush the diffuser once seawater intrusion is established are expected to be on the low end of the ranges stated above. The Fr_ρ as a function of flow for a six open port configuration is shown in Figure 4. The values are output from the UDKHDEN initial dilution model. The combined effluent flow would need to drop to approximately 0.5 mgd or lower before seawater intrusion would be expected. This might occur infrequently when both canneries are shutdown. At flows of about 1.5 to 2 mgd flushing of the diffuser would be expected.

Based on an examination of the daily maximum flows from the canneries over the last few years, (Figure 5), it is obvious that seawater intrusion would not be persistent. The diffuser would be flushed within a short period of time after any occurrence of seawater intrusion.

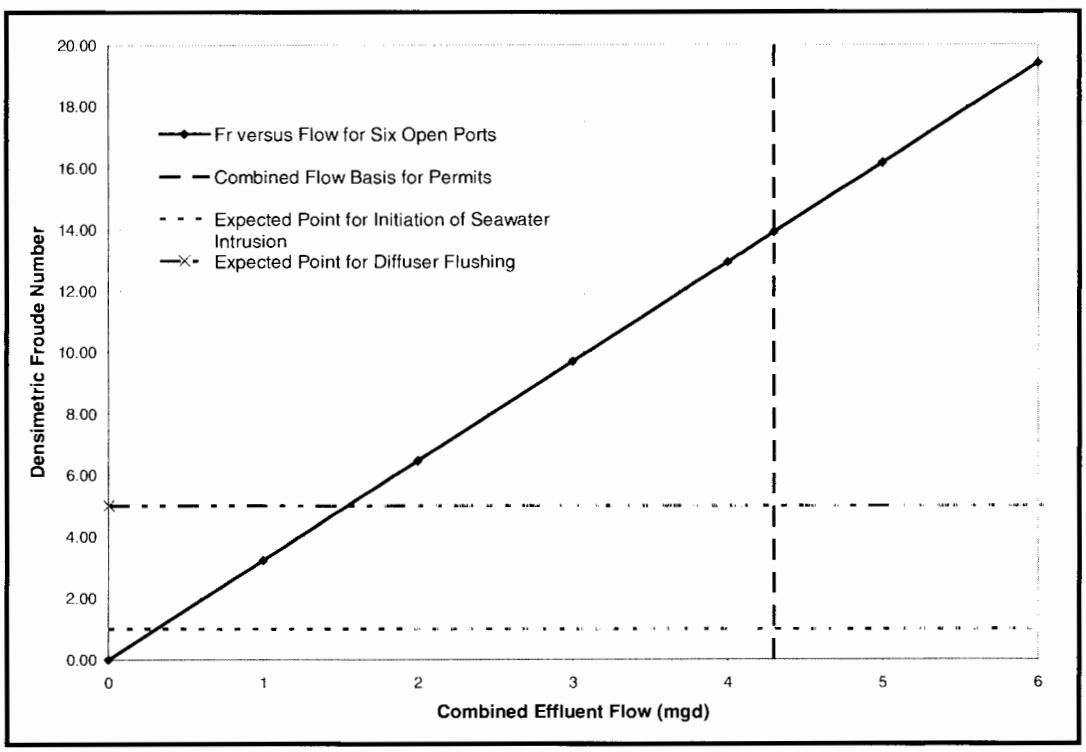


Figure 4. Froude Number versus Effluent Flow for Six Open Ports

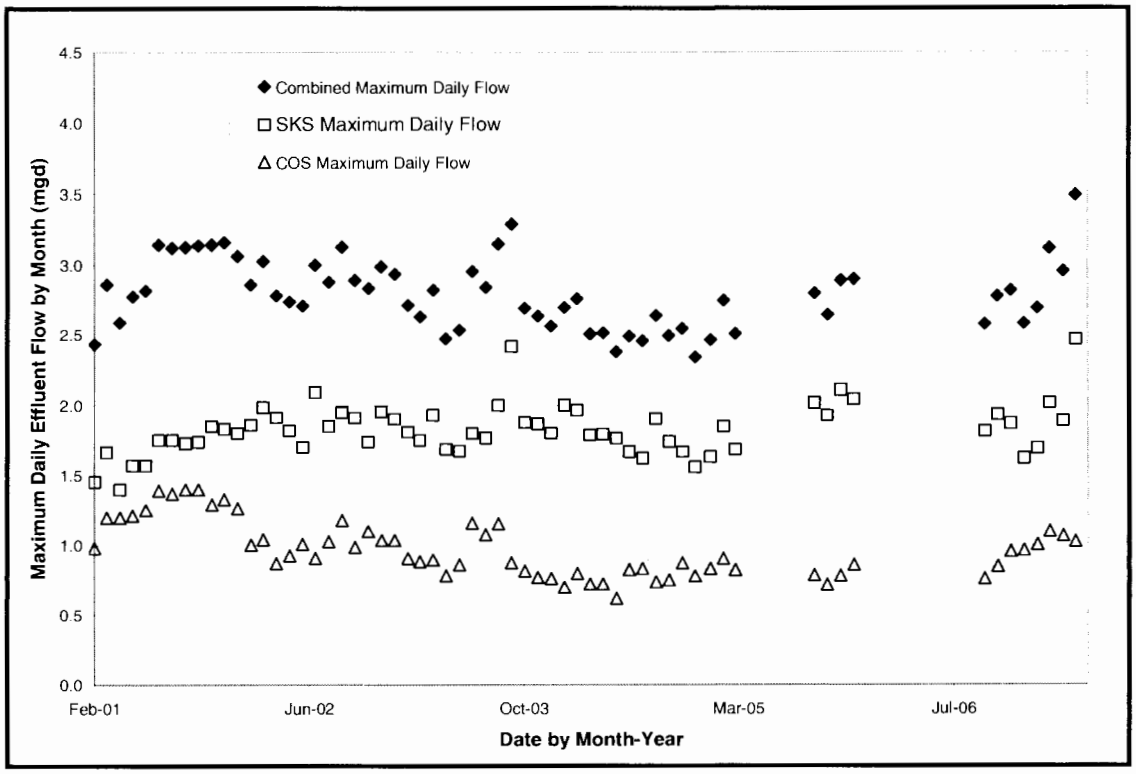


Figure 5. Maximum Daily Effluent Flow by Month for SKS and COS

CONCLUSIONS AND RECOMMENDATIONS

As the combined cannery effluent flow increases the changes in head loss through the diffuser become significant, particularly for peak instantaneous flows, which can be higher than the daily average flow. This head loss can be reduced by opening the two currently closed ports on the diffuser, resulting in six open ports compared to the current configuration of four open ports.

Under defined critical conditions the initial dilution will increase for six open ports compared to four open ports. The existing mixing zone calculations will remain valid and compliance with ASWQS criteria will be achieved within the ZID.

Opening more ports reduces the port exit velocity and increases the possibility of seawater intrusion. However, the potential for extended periods of seawater intrusion into the diffuser without effective flushing flows does not appear to be a concern under the existing cannery effluent discharge levels.

Based on the analysis presented in this TM, it is recommended that the canneries consider opening the two currently closed ports during the next planned outfall inspection and cleaning.

TECHNICAL MEMORANDUM **gdc**

JOINT CANNERY OUTFALL DIFFUSER PERFORMANCE: EFFECT OF OPENING ADDITIONAL PORTS

Prepared For: StarKist Samoa (NPDES Permit AS0000019)
COS Samoa Packing (NPDES Permit AS0000027)

Prepared By: **gdc**, P.O. Box 1238, Trinidad, CA 95570
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The effect of opening additional ports on dilution performance of the diffuser was evaluated using the same model used to define the existing mixing zones. The initial dilution increases as the number of open ports is increased from 4 to 6. The depth the plume is trapped below the surface remains almost the same for all cases.

More open ports result in increased susceptibility to seawater intrusion. Persistent seawater intrusion can compromise the operation of the diffuser. The results of the evaluation indicate the persistent seawater intrusion will not be a problem with additional open ports.

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DIFFUSER AND DISCHARGE CHARACTERSITICS

The diffuser is an in-line series of six ports mounted on a uniform diameter barrel. The barrel is a 16-inch diameter HDPE pipe. Ports are 5 inches in diameter mounted on the barrel and oriented at a vertical angle of 15° upward from horizontal and discharging perpendicular to the barrel. Ports are spaced at 50-foot intervals along the diffuser barrel, alternating in direction of discharge.

The maximum expected discharge flows are based on the design hydraulic capacity of the wastewater treatment plants of the canneries. The SKS maximum flow is 2.9 mgd and the COS design flow is 1.4 mgd, for a possible total maximum flow of 4.3 mgd. Effluent temperature and salinity has a minor effect on dilution over the expected range. However, SKS uses seawater for thaw water and therefore the effluent salinity is not negligible. The original CID, used in the current permits and mixing zones, was based on a combined effluent temperature of 29.44°C and a salinity of 4.95 ppt. These values are used in this TM for consistency and comparison with previous results.

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$$Q_P = A_P C_D \sqrt{2gE}$$

where

Q_P = port discharge
A_P = port area
C_D = discharge coefficient
E = energy difference (between inside and outside of diffuser)

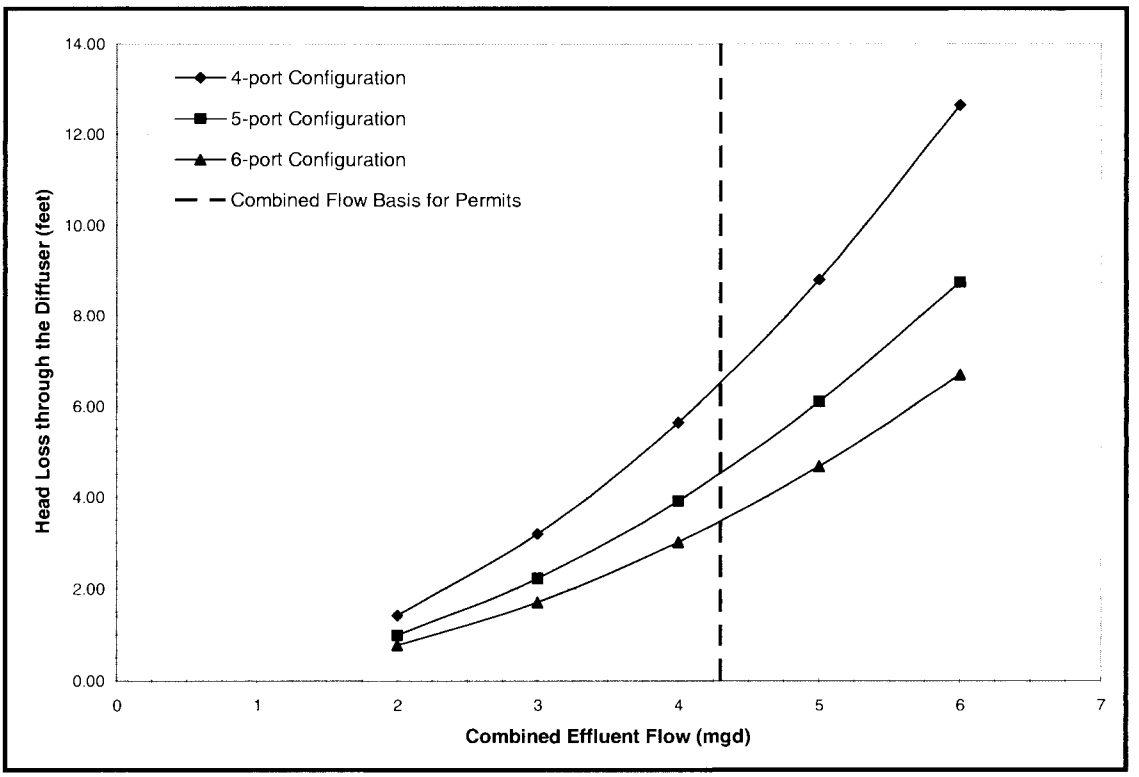
and

$$C_D = 0.63 - 0.58 \cdot \left(\frac{V^2}{2gE} \right)$$

where

V = port discharge velocity

Although the calculations may not fully represent the actual total head loss in the diffuser, the relative affects are considered accurately described. The results for 4, 5, and 6 open ports are summarized in Figure 1. At higher flows, the reduction in head loss is significant with additional open ports.



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[2] The mixing zones are based on a dilution of 313:1 at a combined flow of 4.3 mgd. This value was extrapolated from previous model predictions for lower flows. When the model is run at 4.3 mgd, the predicted dilution is actually 317:1. The difference is negligible in the context of model accuracy.

[3] Initial Mixing Characteristics of Municipal Ocean Discharges: (Volume 1.Procedures and Applications; Volume II. Computer programs). EPA/600/3-85/073a and /073b. November 1985.

and routinely used at the time the JCO was designed and constructed. The model is still in wide use today, and is included in the EPA Visual Plumes model suite (the latest version of the PLUMES model specified in the ASWQS for mixing zone development).

Results of the model application are summarized in Figure 2, which shows that the initial dilution[4] increases approximately 20 percent as the number of open ports is increased from 4 to 6. The trapping level (the depth the plume traps below the surface) for the same cases is also shown in Figure 2. The trapping level remains almost the same for all cases, increasing less than 5 percent, and remains well below the water surface.

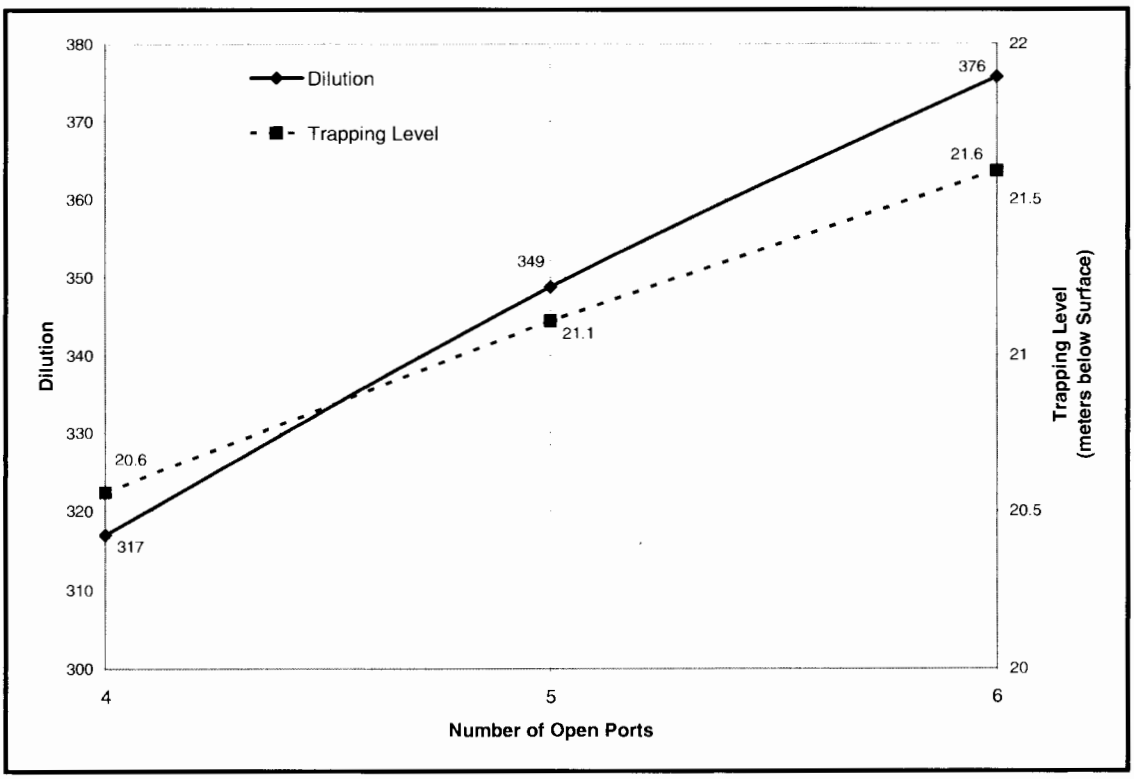

Figure 2. Dilution and Trapping Level at Combined Design Flow

[4] It is noted that the dilution shown in Figure 2 is identified as the critical initial dilution (CID). As the effluent plume rises through the water column, momentum typically carries it past the trapping level higher into the water column. Subsequently, the plume collapses back to the trapping level. During this time the rapid initial dilution process continues. Therefore, the CID may substantially understate the final initial dilution.

EVALUATION OF SEAWATER INTRUSION/FLUSHING

The most benefit with respect to reducing head loss, with no degradation in dilution performance, will be realized by opening all six ports on the existing diffuser. Since port velocities and internal pressures will be lower, the potential for seawater intrusion and the ability of the normal flow to flush the diffuser should be considered.

Seawater intrudes into a multiport diffuser under low effluent flow conditions, starting at the most seaward port, and may circulate within the diffuser. As flows drop more and more ports become inactive. Figure 3 is a schematic representation of this effect. The condition under which this happens is not precisely defined. The critical condition for seawater intrusion is generally described by the densimetric Froude number (Fr_ρ) which depends on port exit velocity and the density difference between the effluent and seawater. Seawater intrusion is assumed to begin at values of Fr_ρ of between 1 and 2. If the diffuser is on a downward slope the value of Fr_ρ for initiation of seawater intrusion is higher (intrusion will occur at higher port exit velocities).

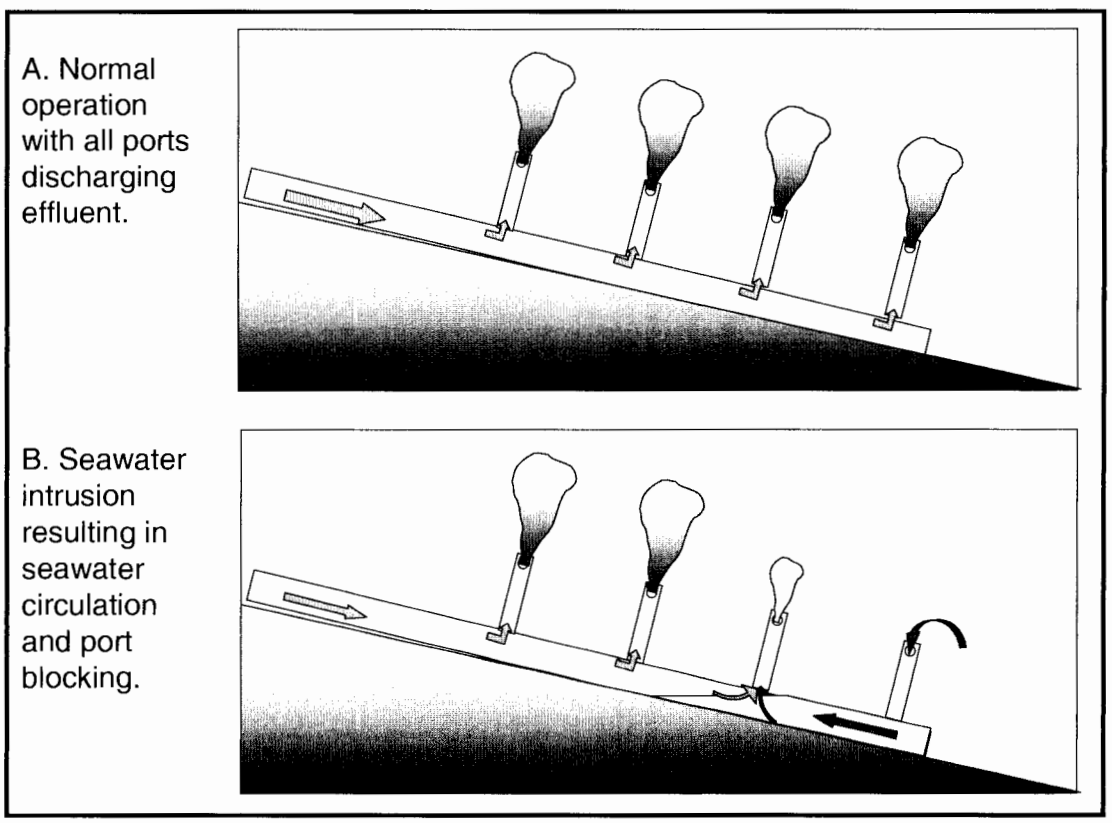

Figure 3. Schematic of Port Blocking by Seawater Intrusion and Circulation

The flow required to flush a diffuser, once seawater intrusion and recirculation has been initiated, is considerably higher than that required for the condition to initially occur. Flushing is typically achieved at Fr_ρ values of 5 to 10. If the diffuser is on a downward slope the value required to flush the seawater and restore effluent flow from all ports is typically higher.

Since the JCO diffuser is nearly level, and because the effluent is denser than freshwater because of the SKS thaw water contribution, the flows to both initiate intrusion and flush the diffuser once seawater intrusion is established are expected to be on the low end of the ranges stated above. The Fr_ρ as a function of flow for a six open port configuration is shown in Figure 4. The values are output from the UDKHDEN initial dilution model. The combined effluent flow would need to drop to approximately 0.5 mgd or lower before seawater intrusion would be expected. This might occur infrequently when both canneries are shutdown. At flows of about 1.5 to 2 mgd flushing of the diffuser would be expected.

Based on an examination of the daily maximum flows from the canneries over the last few years, (Figure 5), it is obvious that seawater intrusion would not be persistent. The diffuser would be flushed within a short period of time after any occurrence of seawater intrusion.

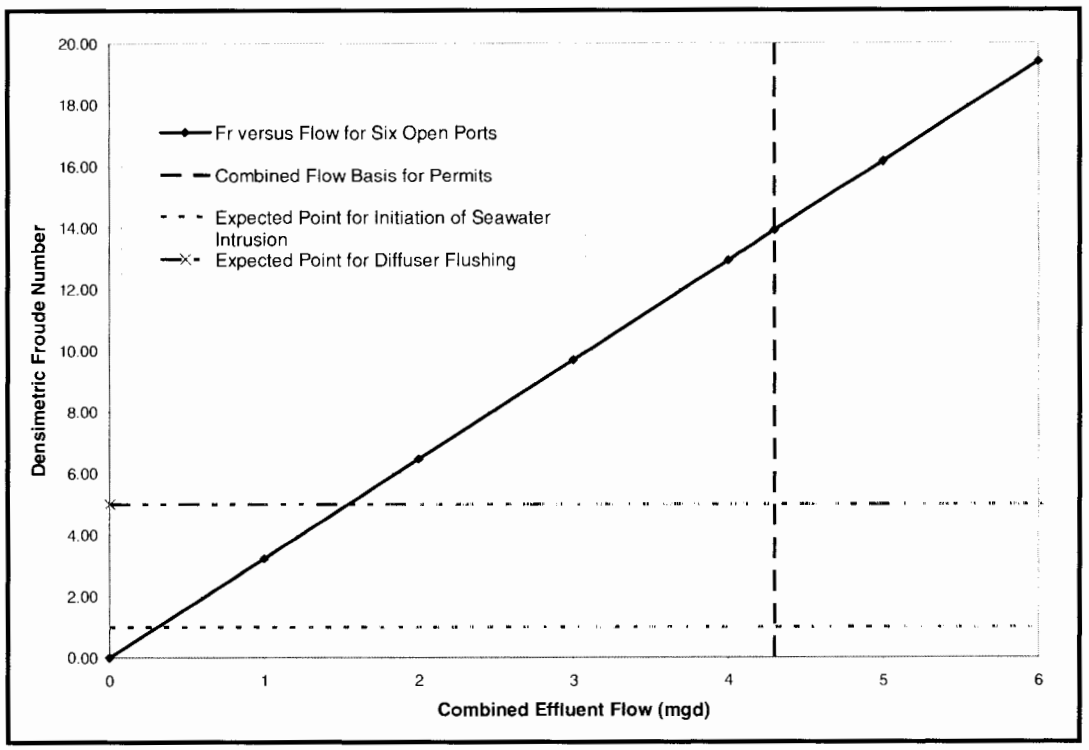

Figure 4. Froude Number versus Effluent Flow for Six Open Ports

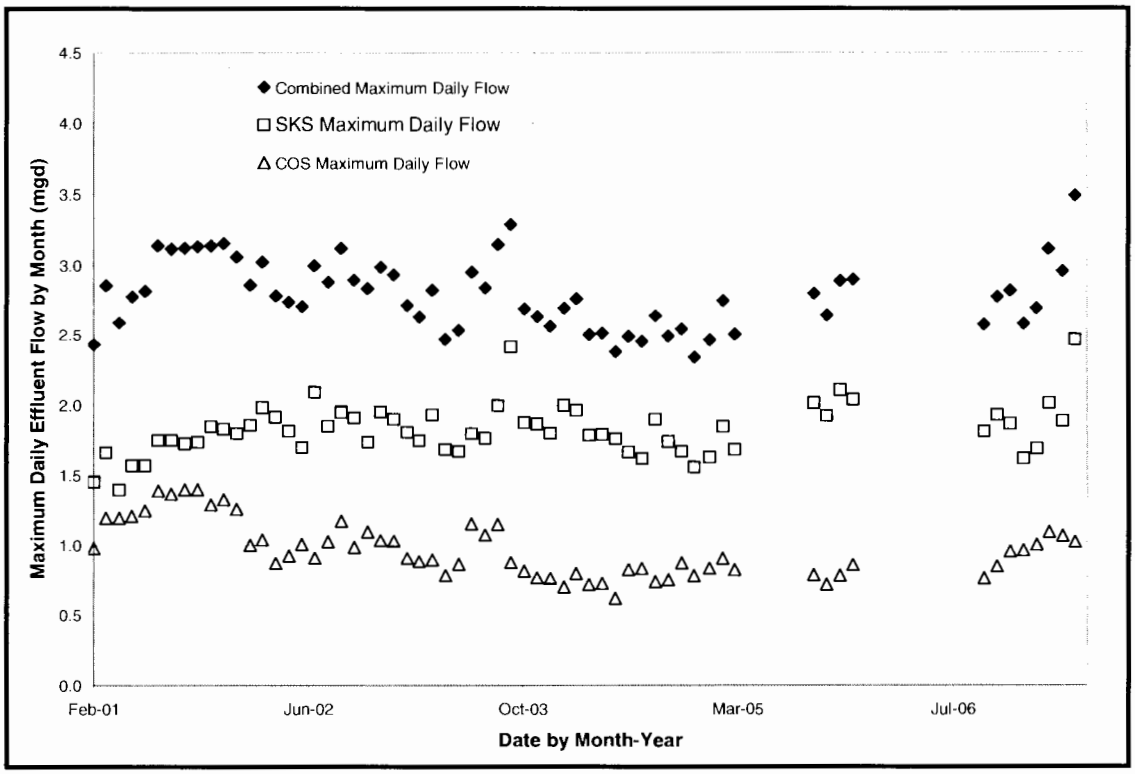

Figure 5. Maximum Daily Effluent Flow by Month for SKS and COS

CONCLUSIONS AND RECOMMENDATIONS

As the combined cannery effluent flow increases the changes in head loss through the diffuser become significant, particularly for peak instantaneous flows, which can be higher than the daily average flow. This head loss can be reduced by opening the two currently closed ports on the diffuser, resulting in six open ports compared to the current configuration of four open ports.

Under defined critical conditions the initial dilution will increase for six open ports compared to four open ports. The existing mixing zone calculations will remain valid and compliance with ASWQS criteria will be achieved within the ZID.

Opening more ports reduces the port exit velocity and increases the possibility of seawater intrusion. However, the potential for extended periods of seawater intrusion into the diffuser without effective flushing flows does not appear to be a concern under the existing cannery effluent discharge levels.

Based on the analysis presented in this TM, it is recommended that the canneries consider opening the two currently closed ports during the next planned outfall inspection and cleaning.

gdc

COASTAL ENVIRONMENTAL ANALYSTS

7 August 2008

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RE: Planned JCO Diffuser Modification

The Joint Cannery Outfall (JCO) outfall diffuser was originally constructed with six ports. At the time of the outfall installation four ports were opened to accommodate the effluent flows at that time. The other two ports were capped until needed for higher flows in the future. Overall effluent flows have increased over time, and opening additional ports may now be appropriate.

At the request of the canneries we performed an analysis of the effects of opening the two blocked ports. The results of our study indicate that opening the two ports, for a total of six open ports, will reduce head loss and pumping requirements, increase critical initial dilution by about 20%, and raise the plume trapping level only by about 3 feet in the water column (still more than 100 feet below the surface). Our analysis also indicates that with six open ports the current effluent flows are sufficient to prevent persistent seawater intrusion into the diffuser.

Based on this analysis the canneries are planning to open the two currently blocked ports during a future planned outfall inspection and maintenance episode. This letter, with the attached documentation is provided on behalf of, and at the request of, the canneries and is intended to notify EPA and ASEPA of the planned modification. Please call us, or contact the canneries directly, if you have any questions, comments, or concerns regarding this matter.

Sincerely,

Karen A. Glatzel

Karen A. Glatzel

Attachment: Technical Memorandum, "Joint Cannery Outfall Diffuser Performance: Effect of Opening Additional Ports", 5 August 2008, prepared by **gdc** for StarKist Samoa and COS Samoa Packing

Cc: Jim Cox, COS International; Willem Martines, COS Samoa Packing; Sam Augspurger, COS Samoa Packing; Tim Ruby, Del Monte Foods; Brett Butler, StarKist Samoa; Joe Carney, StarKist Samoa; Rob Darby (all with attachment)

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JOINT CANNERY OUTFALL EFFLUENT TESTING REPORT

2008 Non-tradewind Season
May 2008

Prepared for:

StarKist Samoa
NPDES Permit AS0000019
COS Samoa Packing
NPDES Permit AS0020027

Submitted to:

U.S. Environmental Protection Agency
American Samoa Environmental Protection Agency

Prepared by:

gdc

glatzel da costa (gdc)
P.O. Box 1238
Trinidad, CA 95570

4 July 2008

TECHNICAL MEMORANDUM **gdc**

JOINT CANNERY OUTFALL EFFLUENT TESTING: MAY 2008 SEMI-ANNUAL EFFLUENT SAMPLING

Prepared For: StarKist Samoa (NPDES Permit AS0000019)
COS Samoa Packing (NPDES Permit AS0000027)

Prepared By: Steve Costa
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Date: 4 July 2008

Distribution: Carl Goldstein
United States Environmental Protection Agency, Region 9
Technical Services Department
American Samoa Environmental Protection Agency
Attachment to Discharge Monitoring Reports
StarKist Samoa
COS Samoa Packing

SUMMARY

The NPDES permits for StarKist Samoa and COS Samoa Packing (the canneries) includes effluent limitations for copper, zinc, mercury, and ammonia which are discharged into approved mixing zones. Toxicity testing is required by the permits but is not listed as an effluent limitation. Although not explicitly required by the current NPDES permits at this time, effluent samples were collected in May 2008 and analyzed for the four chemical parameters and chronic toxicity. All chemical parameters were well below the NPDES permit specified effluent limitations. Chronic toxicity units were below the specified trigger point. Chronic toxicity appears to be attributable to ammonia concentrations in the effluent.

INTRODUCTION

The current NPDES permits for StarKist Samoa (SKS) and COS Samoa Packing (COS) became effective on April 1, 2008. The permits require semiannual testing and reporting for copper, zinc, and mercury, commencing in the second half of 2008. The permits require weekly testing and monthly reporting for ammonia, commencing at the effective date of the permit (EDP). In addition the permits require semiannual chronic toxicity testing following submission of a Workplan for a Chronic Toxicity Special Study within 180 days of the EDP. Although not required by the permit, samples were collected and analyzed in May 2008 for the three metals and chronic toxicity to facilitate development of the Chronic Toxicity Workplan. In addition, the samples used for the metals and toxicity testing were analyzed for ammonia because it is undoubtedly, based on previous testing, the primary cause of toxicity in the effluent.

The samples were collected before the SKS and COS effluents enter the Joint Cannery Outfall (JCO) shared by the canneries. Both SKS and COS process tuna and, after high strength waste segregation, the treated process wastewater is discharged to Outer Pago Pago Harbor. The discharge is through a pipeline terminating in an engineered diffuser in approximately 176 feet of water. The existing SKS and COS NPDES permits have permitted zones of mixing (ZOMs) for copper, zinc, mercury, and ammonia.

Effluent grab samples were collected over a 24-hour period and were used to create flow weighted composite samples. Composite samples were created for each cannery for chemical analysis and a composite sample of the combined effluents was created for the chronic toxicity test. This Technical Memorandum reports the results of the sampling and analyses.

APPROACH AND METHODS

Sampling and sample handling methods followed the standard operating procedures (SOP) that were previously developed and approved by the USEPA and ASEPA for cannery effluent sampling[1]. Between 09:00 on 7 May and 06:00 on 8 May 2008, samples of final effluent were collected from the SKS and COS effluent discharges at the established effluent sampling sites.

A total of eight grab samples were collected at each cannery into 1-liter plastic bottles. Samples were collected at three-hour intervals over the 24-hour period. Each cannery started the sampling at the same time to simulate the cannery effluent entering the JCO. The samples were stored on ice or in a refrigerator until the completion of the 24-hour sampling period.

After all samples were collected, flow weighted composite samples were prepared for each cannery. Using these composite samples, laboratory supplied bottles (one for mercury analysis, one for copper and zinc analysis, and one for ammonia analysis for each cannery) were filled. The individual cannery composite samples were also used to prepare a single combined cannery flow-proportioned composite sample for the bioassay test sample. The samples were packed on ice in an ice chest for shipment to the laboratories. Chain-of-

[1] This SOP is currently under review and a revised version will be incorporated into the Quality Assurance manual being developed as a requirement of the NPDES permits.

custody forms for the samples were completed and sealed into a zip-lock bag and taped inside the lid of the ice chest. The samples were shipped via DHL to the chemistry testing laboratory. The bioassay sample was hand-carried to Honolulu and then shipped Federal Express to the bioassay laboratory. The chain-of-custody forms are provided with the laboratory reports (Attachments 1 and 2).

COMPOSITE SAMPLE FORMULATION

Table 1 shows the effluent flows at the time of collection of each sample from which the composite samples were formulated. The chemistry samples for each cannery were composited using the percent of total flow for each effluent stream. The combined composite sample was then formulated based on the percentage of total combined flow (shown in the last row of Table 1).

Table 1. Composite Sample Formulation
May 2008 JCO Effluent Sampling

Sample Number	Date	Time	StarKist Samoa		COS Samoa Packing	
			Flow (mgd)	Percent of Total Flow	Flow (mgd)	Percent of Total Flow
1	5/7/2008	9:00	0.90	0.072	0.92	0.137
2	5/7/2008	12:00	1.39	0.111	0.84	0.125
3	5/7/2008	15:00	1.86	0.149	0.84	0.125
4	5/7/2008	18:00	1.91	0.153	0.84	0.125
5	5/7/2008	21:00	1.55	0.124	0.84	0.125
6	5/7/2008	0:00	1.81	0.145	0.84	0.125
7	5/8/2008	3:00	1.58	0.126	0.84	0.125
8	5/8/2008	6:00	1.48	0.119	0.76	0.113
Average Flow			1.56		0.84	
Percent of Combined Composite			65%		35%	

RESULTS AND DISCUSSION – CHEMICAL PARAMETERS

The results of the analyses for metals and ammonia are summarized in Tables 2, 3, and 4. The laboratory data report is provided in Attachment 1. Table 2 presents the results for the composite SKS sample analyses and indicates that all four parameters are below the permit limitations. Table 3 presents the results of the composite COS sample analyses and indicates that all four parameters are below the permit limitations. Table 3 presents the combined flow-weighted parameter concentrations and loadings calculated from the results in Tables 2 and 3.

The results for the combined sample (Table 4) compared to the EPA chronic criteria[2] for aquatic life in saltwater, show the following:

- Copper is slightly above the chronic toxicity criterion[3] of 3.1 µg/l.
- Zinc is 3.3 times the chronic toxicity criterion[3] of 81 µg/l

[2] Toxicity criteria are from the National Recommended Water Quality Criteria (NRWQC), U.S. Environmental Protection Agency.
[3] The American Samoa Water Quality Standard (ASWQS) criterion is identical to the EPA criterion.

- Mercury is well below the chronic criterion[4] of 0.94 µg/l
- Ammonia is the primary toxic component in the effluent and is approximately 73 times the chronic toxicity concentration[3,5] of approximately 0.44 mg/l

Table 2. StarKist Samoa – Chemical Parameters
May 2008 JCO Effluent Sampling

Parameter	Units	Result 05/08/08 Sample	Permit Limitation		Compliance
			Average Monthly	Daily Maximum	
Parameter Concentration					
Ammonia (N), Total	mg/l	23.8	83.36	167.26	Yes
Copper	µg/l	2.86	58.42	117.22	Yes
Zinc	µg/l	263	1138	2284	Yes
Mercury	µg/l	0.159	1.8	4.72	Yes
Parameter Loading					
Flow	mgd	1.56	MO	MO	Yes
Ammonia (N), Total	lbs/day	310	2016	4045	Yes
Copper	lbs/day	0.037	1.41	2.84	Yes
Zinc	lbs/day	3.42	27.52	55.24	Yes
Mercury	lbs/day	0.002	0.04	0.11	Yes

Table 3. COS Samoa Packing – Chemical Parameters
May 2008 JCO Effluent Sampling

Parameter	Units	Result 05/08/08 Sample	Permit Limitation		Compliance
			Average Monthly	Daily Maximum	
Parameter Concentration					
Ammonia, Total	mg/l	47.2	83.36	167.26	Yes
Copper	µg/l	3.85	58.42	117.22	Yes
Zinc	µg/l	280	1138	2284	Yes
Mercury	µg/l	0.162	1.8	4.72	Yes
Parameter Loading					
Flow	mgd	0.84	MO	MO	Yes
Ammonia, Total	lbs/day	331	2016	4045	Yes
Copper	lbs/day	0.027	1.41	2.84	Yes
Zinc	lbs/day	1.96	27.52	55.24	Yes
Mercury	lbs/day	0.001	0.04	0.11	Yes

[4] The ASWQS criterion is 0.050 µg/l and is based on human health criteria.
[5] Estimated for salinity of 30 g/kg, temperature of 30°C, and pH of 8.0, which are representative of the receiving waters.

Table 4 Combined Sample – Chemical Parameters
May 2008 JCO Effluent Sampling

Parameter	Units	SKS Sample	COS Sample	Combined Sample
Parameter Concentration				
Ammonia (N), Total	mg/l	23.8	47.2	32.0
Copper	µg/l	2.86	3.85	3.21
Zinc	µg/l	263	280	269
Mercury	µg/l	0.159	0.162	0.160
Parameter Loading				
Flow	mgd	1.56	0.84	2.4
Ammonia, Total	lbs/day	310	331	641
Copper	lbs/day	0.037	0.027	0.064
Zinc	lbs/day	3.42	1.96	5.39
Mercury	lbs/day	0.002	0.001	0.003

RESULTS AND DISCUSSION – TOXICITY TESTING

The NPDES permits for both canneries require semi-annual range-finding toxicity testing during the first three years of the permit. As mentioned above, bioassay testing was not explicitly required at this time, but was conducted to provide preliminary information to prepare a workplan for subsequent tests. The results of the initial tests, conducted with the combined composite effluent sample, are summarized in Table 5. The full report is included as Attachment 2. During the range-finding testing period the permit requires that additional testing be done if the results indicate an NOEC or IC_{25} of less than 0.39% (or TU_C of greater than 256). The test results are well above the trigger concentration (below the TU_C trigger point)[6].

Table 5. Summary Results of Chronic Toxicity Tests
May 2008 JCO Effluent Sampling

Test Endpoint	Percent Effluent	TU_C	Required TU_C
LOEC	3.12	--	--
NOEC	1.56	64.1	≤ 256
IC25	2.41	41.5	
IC50	3.12	--	--

LOEC = lowest observed effects concentration
NOEC = no observed effects concentration
IC_{25} = inhibition concentration, development was inhibited in 25% of the organisms
IC_{50} = inhibition concentration, development was inhibited in 50% of the organisms
TU_C = chronic toxicity units (= 100/NOEC or $100/IC_{25}$)

[6] Although the permit specifies both NOEC and IC_{25} as endpoints, EPA has recently indicated that "EPA recommends the use of point estimation techniques over hypothesis testing approaches for calculating endpoints for effluent toxicity tests under NPDES Permitting Program" (*Final Rule for Guidelines Establishing Test Procedure for the Analysis of Pollutants; Whole Effluent Toxicity Test Methods*, Fed. Reg. 69951-69972 (November 19, 2002). EPA Region 1 and EPA Region 2 have determined that the IC_{25} is a more appropriate endpoint because NOEC tends to provide inconsistent results when actual toxicity and biological effects are considered.

CONCLUSIONS

The indicated toxicity is substantially higher than that attributable to the zinc concentrations and is close to that attributable to the ammonia concentrations. This result is consistent with the result of acute toxicity testing done during the previous permit period. In that case the toxicity was correlated with, and attributable to, the ammonia concentrations in the effluent.

Attachments Provided On CD-ROM

ATTACHMENT 1
Columbia Analytical Systems Laboratory Report
Chemistry Analyses

ATTACHMENT 2

Weston Solutions Laboratory Report
Bioassay Testing

Summary of existing metals data off Southwest Marine Railway in American Samoa

metals in sediment(mg/kg dry weight)	4-5/90 data off swmarine	8/93 Site 4 (off swmarine)	McDonald 1992	Long and Morgan 1990
Lead	42.3	180	46.7-223	35-110
Mercury	0.02	0.26	.15-0.71	0.15-1.3
Copper	344	1120	34.0-270	70-390
Zinc	240	893	150-410	120-270
Arsenic	1.6	8.5	8.2-70	33-88.5

metals in water column ppm	thaw water 1/90	thaw water 6/90	thaw water 11/90	3/90 Site 4	10/90 Site 4	EPA acute	EPA chronic
Lead	0.700	0.37	.170	0.055	.062	0.22	0.0085
Mercury	.005	.002	.042	<.002	<.01	.0021	0.000025
Copper	N/A	N/A	N/A	0.09	0.1	0.0029	
Zinc	0.210	.220	.270	<.05	0.11	.095	.086
Arsenic	N/A	N/A	N/A	<.01	<.01		

"N/A" means that water was not sampled for that metal
"Thaw water" samples were taken by StarKist from intake structure adjacent to Southwest Marine Railway.

Site 4 is immediately adjacent to Southwest Marine.

Source of Site 4 samples from "A Preliminary Toxicity Study of Water, Sediment and Fish Tissues from Inner Pago Pago Harbor in American Samoa." July 1991.

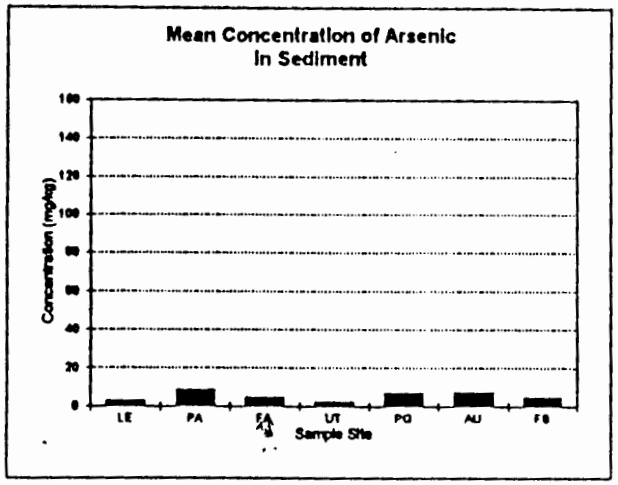
Data of spent grit blast material:

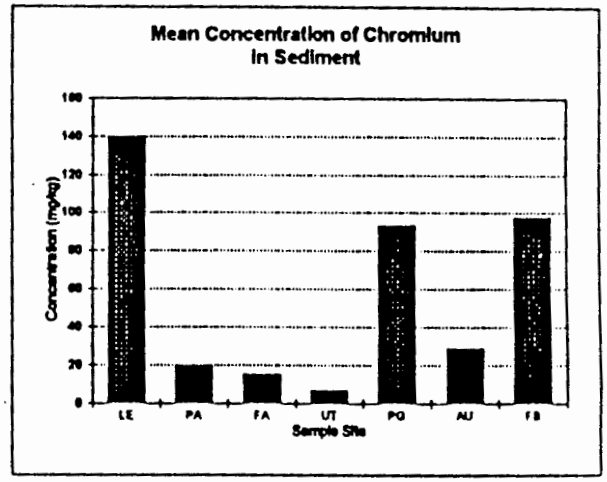
metals in spent grit blast ppm	sample 1 (6-16-94)	sample 2	Sample 3	Sample 4	Sample 5	TCLP
Lead	43.0	43.8	135.07.	43.88	13.44	5 ppm
Mercury	ND	ND	ND	ND	ND	
Copper	1402.00	4109.00	9972.0	6031.0	1516.00.	2500 for Ca.
Zinc	199.00	3905.00	3916.00	3905.00	425.00	
Arsenic	ND	ND	ND	ND	ND	

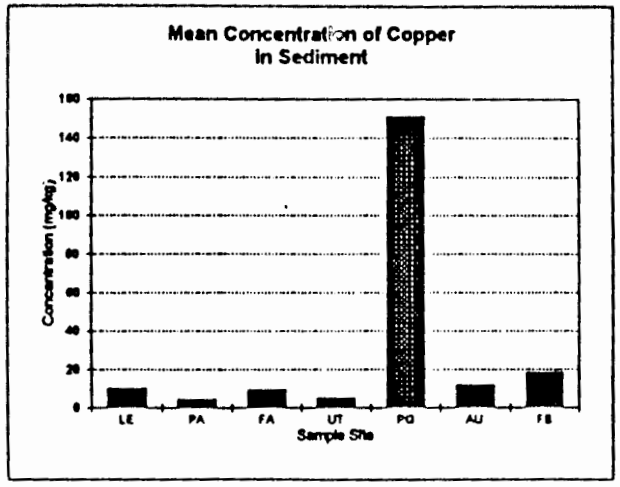
Grit blast analyzed for Soluble Threshold Limit Concentration (STLC). Samples taken from Southwest Marine in Samoa on June 16, 1994. Detection level for Mercury and Arsenic used was 0.05 ppm.

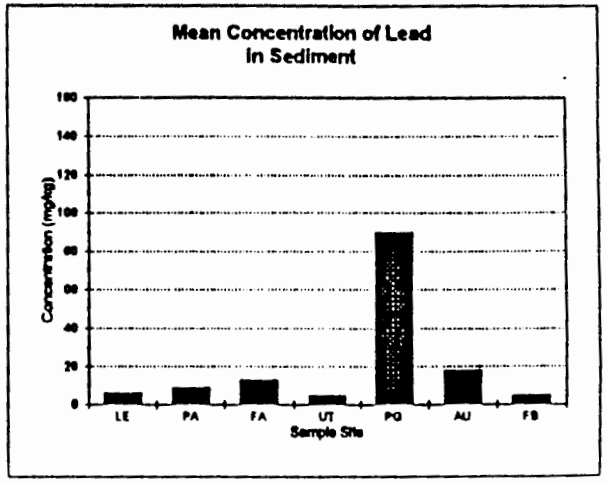
Only one TBT sample taken. Result was 264 ppm. (mg/kg dry weight).

Figure 3.9
Comparison of Mean Concentrations of Metals in Sediment from Seven Sample Locations









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