BASIS OF DESIGN

NORTHERN DISTRICT TREATMENT PLANT OUTFALL EXTENSION

TUMON BAY INFRASTRUCTURE AND BEAUTIFICATION PROJECT

Prepared for:
Guam Waterworks Authority
and
Department of Public Works

SEPTEMBER 2001

ASSOCIATES, INC.
ENGINEEERS/ARCHITECTS

TABLE OF CONTENTS

TABLE OF CONTENTS

Section	Title	Page
1	PROJECT	1-1
	1.1 Northern District Wastewater Plant	1-1
	1.2 Existing Outfall	1-2
	1.3 Proposed Outfall	1-3
2	OUTFALL PERFORMANCE REQUIREMENTS	2-1
	2.1 Hydraulic Capacity	2-1
	2.2 Initial Dilution	2-6
	2.2.1 Water Quality Standards	2-6
	2.2.2 Receiving Water Condition	2-7
	2.2.3 Wastewater Effluent Concentrations	2-7
	2.2.4 Required Dilution	2-8
3	OUTFALL DESIGN	3-1
	3.1 Alignment and Terminus	3-1
	3.2 Diffuser Design	3-2
4	CONSTRUCTION METHODOLOGY	4-1
	4.1 Outfall Pipeline	4-1
	4.2 Pipeline Size and Material	4-2
	4.3 Diffuser	4-3

REFERENCES

APPENDICES

A Water Quality Survey West Agana Bay

B Ocean Density, Dissolved Oxygen, and Current Surveys

C Sediment Analysis

D Geotechnical Survey

LIST OF FIGURES

Figure	Title	Page
2-1	NORTHERN DISTRICT WASTEWATER TREATMENT PLANT MONTHLY FLOW OVER A SIX YEAR SPAN	2-4
2-2	NORTHERN DISTRICT WASTEWATER TREATMENT PLANT MONTHLY FLOW OVER A SIX YEAR SPAN	2-5

LIST OF TABLES

Table	Title	Page
1-1	NORTHERN SEWER DISTRICT OUTFALL DIFFUSER ARRANGEMENT	1-3
2-1	NORTHERN DISTRICT WASTEWATER TREATMENT PLANT INFLUENT	2-3
2-2	SURVEY OF EFFLUENT LEAD CONCENTRATIONS AT VARIOUS WASTEWATER TREATMENT PLANTS	2-8
2-3	REQUIRED DILUTION CALCULATION FOR NORTHERN DISTRICT WWTP OUTFALL	2-10
3-1	INITIAL DILUTION CALCULATION	3-2
3-2	FREQUENCY OF EXCEEDENCE OF FECAL COLIFORM WQS NORTHERN DISTRICT WWTP OUTFALL RECEIVING WATER	3-5

SECTION 1

SECTION 1

PROJECT

1.1 NORTHERN DISTRICT WASTEWATER PLANT

The Northern District Wastewater Plant (NDWWTP) is the only publicly operated treatment plant in northern Guam. When the plant was commissioned in 1980, it's service area was made up of the developed areas and various subdivisions in the Dededo and Yigo Municipalities, Andersen Air Force Base, Naval Communications facilities, and military personnel housing in north and south Finegayan. In late 1991, the service area was expanded by diverting wastewater from the Agana Treatment Plant Collection System. This expansion included the subdivisions, Barrigada Heights, Liguan Terrace, USN Marbo Annex and the Fujita Pump Station which services all of the major hotels, except the Guam Hilton located in Tumon. The plant has been designed to treat an average daily flow of 12 mgd with peak hourly flow of 28.6 mgd. As of September 1998, the average daily flow was 6.3 mgd and the peak hourly flow 15.9 mgd.

The plant is designed to provide advanced primary treatment. The unit operations in the liquid process stream are comminution, pre-aeration, aerated grit removal, primary clarification, and chlorine disinfection. Primary sludge can be recycled to the pre-aeration tanks to enhance settling in the clarifiers. It has been the practice not to chlorinate the effluent. The liquid process unit operations are arranged in parallel which provides redundancy at current flowrates. The solids process stream operations are primary and secondary anaerobic digestion and sludge

dewatering with two solid bowl centrifuges. Recent improvements to the plant include replacement of clarifier weirs, baffles sludge collectors and drives, replacement of primary scum and sludge pumps, repairs of digester covers and substitution of the primary digester gas mixing equipment with a mechanical mixer in the primary digester.

1.2 EXISTING OUTFALL

The treatment plant is located on a plateau approximately 300 feet above the Philippine Sea. Primary effluent is transported from the chlorination contact chamber to the cliff edge 1,160 feet away by a reinforced concrete gravity sewer, 48 inches in diameter. The transmission line then changes to a 30 inch diameter polyethylene-lined ductile iron pipe for the route down the cliff to the shoreline. The descent is 272 feet over a distance of 3,915 feet. This section of the transmission line was replaced in 1998. Twelve feet from the high water line, the transmission line changes to 30 inch diameter reinforced plastic mortar pipe encased in concrete for the 1,150 feet transition across the reef flat. The descent from the reef edge to the diffuser 60 feet below is made with 30 inch ductile iron pipe encased in a concrete trench for the distance of 590 feet. The diffuser lies 60 feet below the surface in a south to north orientation that is approximately parallel to the shoreline. The diffuser is constructed from flexible joint ductile iron pipe in five segments of decreasing diameter as listed in Table 1.1 Pipe segments were laid in a trench and backfilled with Tremie concrete. Twenty two risers capped with 4 inch 90 degree elbows were installed on the five segments at approximately 18 feet centers. The five segments total 422 feet.

TABLE 1.1
NORTHERN SEWER DISTRICT
OUTFALL DIFFUSER ARRANGEMENT

Section Diameter	30"	24"	20"	16"	12"
No. Of Ports	4	5	4	4	5

An underwater inspection by E.K. Noda and Associates determined the following conditions in November 1998.

1) At the south end, the first three risers on the 30 inch diameter segment are blind flanged.

2) Effluent was observed discharging from the next thirteen ports plus the first port on the 12 inch diameter segment.

3) Blockages in four risers was found to be in the header, while the fifth was in the riser.

4) Two risers were missing elbows.

5) Most risers discharged offshore.

The underwater inspection was videotaped.

1.3 PROPOSED OUTFALL

Section 301 (h) of the Clean Water Act allows the USEA administrator to issue National Pollution Discharge Elimination System (NPDES) permits for the discharge of less than secondary treated effluent by a publicly owned treatment works (POTW) to marine waters. The plant had received a 301 (h) modified permit which expired on June 30, 1998. Guam Waterworks Authority (GWA) applied for a renewal. This application included the intent to

construct a new outfall with a discharge further offshore. The new pipeline would be installed under the sea floor by Horizontal Directional Drilling (HDD). This construction method has shown to provide superior protection from storm surge and to be more cost effective than cut and cover placement, as evidenced by the outfall installed at Tipalao Point in 1996.

GWA also requested that the end of permit term flow be increased from 6 to 10 mgd and that the allowable mass loadings for BOD and Suspended Solids be likewise increased proportionally with flow.

SECTION 2

SECTION 2

OUTFALL PERFORMANCE REQUIREMENTS

The design begins with determination of required hydraulic capacity and initial dilution.

2.1 HYDRAULIC CAPACITY

Plant flow records were analyzed from January 1992 to November 1998. The initial date was selected because the first significant diversion of sewage collected in the northern Tumon service area from the Agana to Northern District plant occurred in late 1991. This analysis examined:

1) Maximum, average, and minimum daily flows

2) Seasonal variations in daily flows against corresponding rainfall data; and

3) Diurnal flow cycles on weekdays and weekends.

Figure 2.1 shows the average monthly flow over a six-year span while Figure 2.2 shows the maximum monthly flow. Over the term, average flow is observed to increase because of the aforementioned sewer diversion and continue to grow. Over the last decade, four major hotels have opened in the service area, while the population in the largest residential district, "Dededo" has expanded 35% to 42,980[1]. The average daily flow has exceeded the flow limit set by the last NPDES permit at 6 mgd.

Guam experiences distinct wet and dry seasons with August throughout November receiving more rainfall, while July and December are transition months. The flow records for

each year were grouped according to season, as defined by the rainfall distribution for that year.

Comparisons were made between groups on both a group average basis and graphically on a year by year basis. The difference between seasons was observed to have been indistinguishable. Hence, it is concluded that season variations are not a factor in the selection of design flows.

Hourly flow records were examined for the week of November 9 to 15, 1998. The diurnal cycle was modest with minimum flow at 9% below average occurring in the early morning between 2 to 4 a.m., and maximum flows at 9% above average at noon and early evening. Otherwise, this cycle was not observed to shift from weekday to weekend. Diurnal variations are within the range observed on an average daily basis and, therefore, will not effect the selection of design flows.

In 1994 Guam Island wide Wastewater Facilities Plan[2] projects an average daily flow of 10.9 mgd with a peak hourly flow of 28.6 mgd in the year 2014; i.e. the 20 year planning horizon.

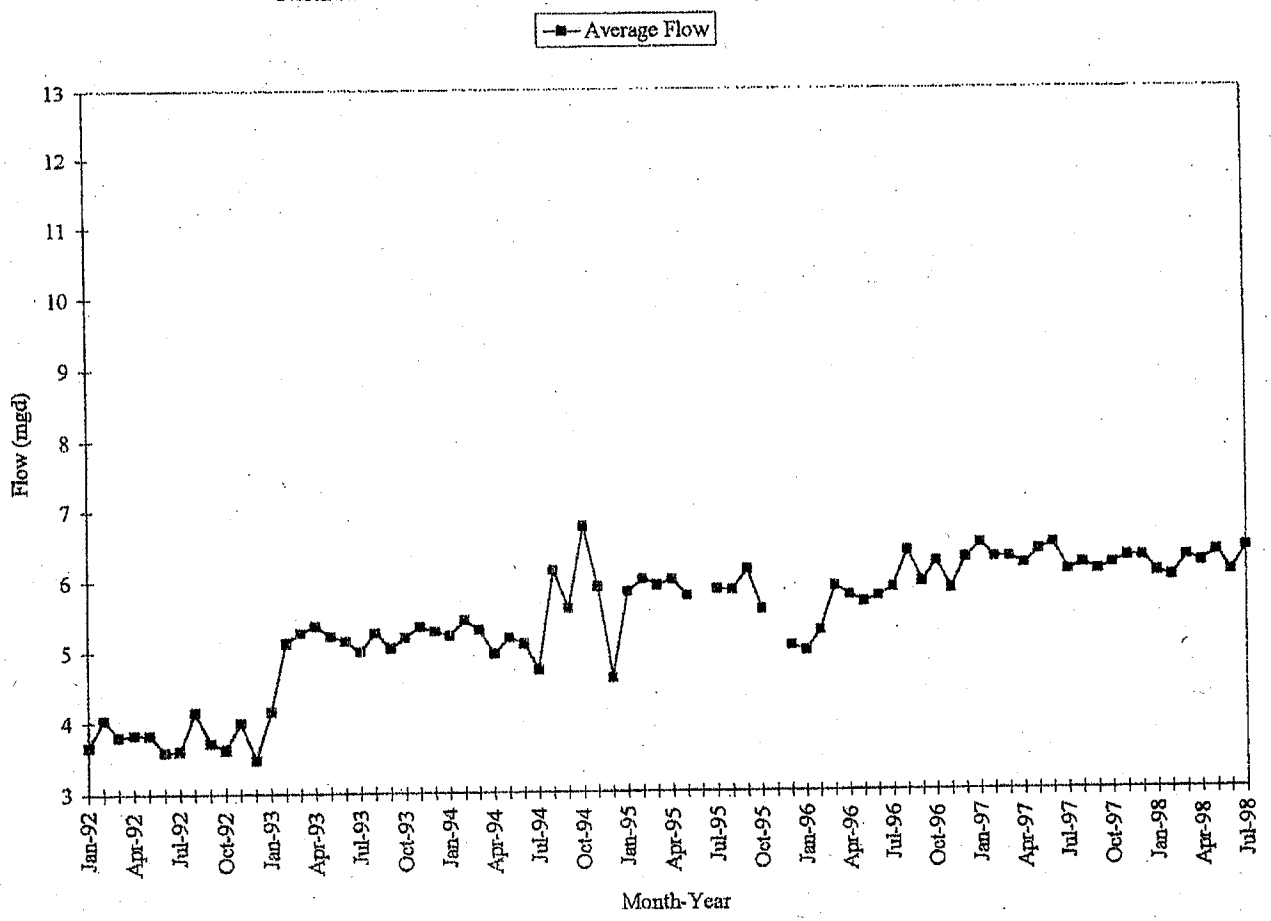
It has been concluded from the foregoing analysis that the Northern District outfall should be able to operate successfully for a range of flows from 5 mgd to 28.6 mgd. This range will encompass the variations normally experienced on both daily and seasonal cycles. As seen in Table 2.1.

Table 2.1

NORTHERN DISTRICT WASTEWATER TREATMENT PLANT INFLUENT

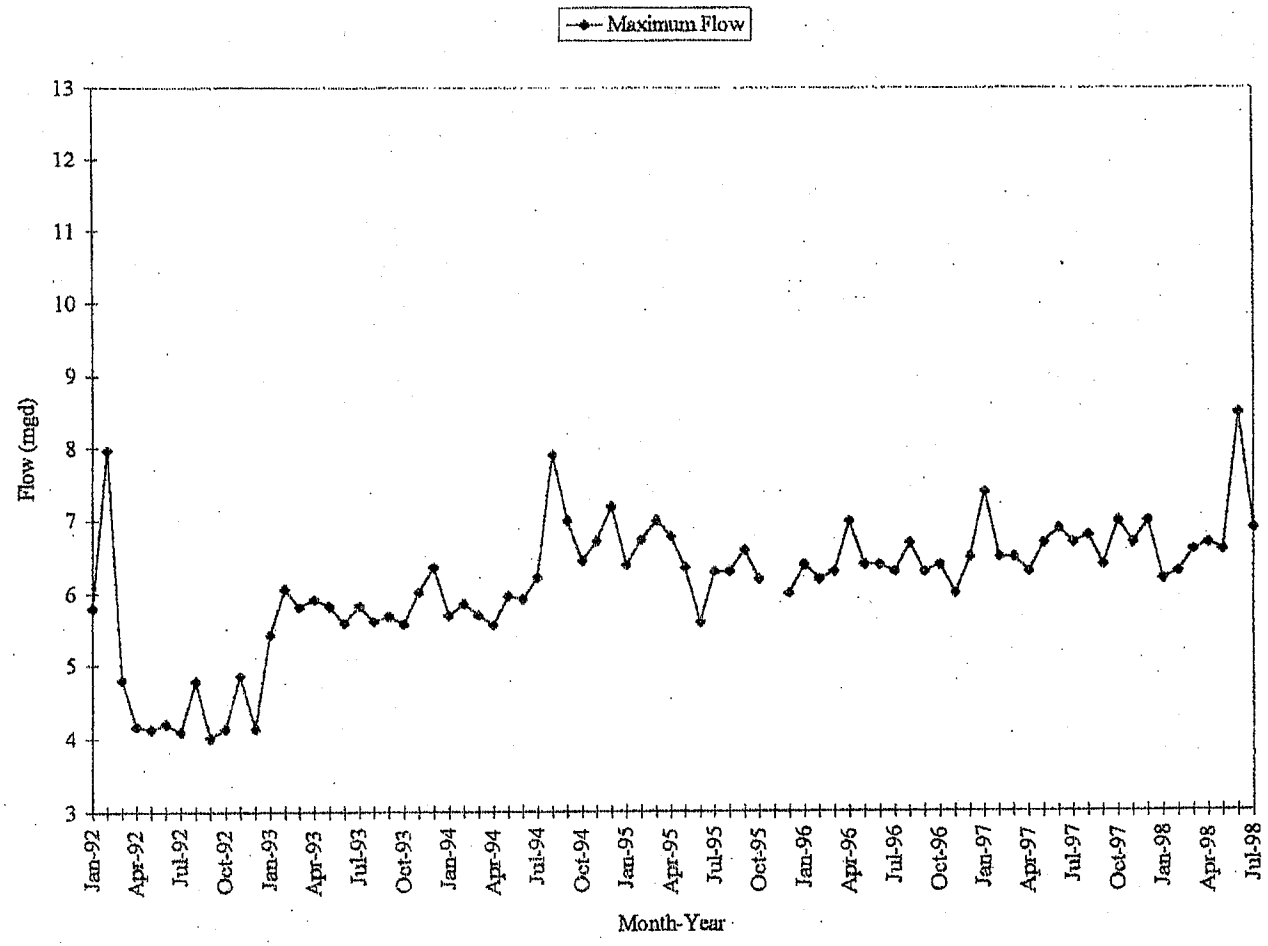
Classification	flow (mgd)	Occurrence
Annual:		
Average Daily	6.31	
Max. Daily	8.5	Jun-98
Min Daily	5	Oct-97
Peak Hour	15.9	1/30/97
Wet Season:		
Average Daily	6.37	
Max. Daily	7.3	Sep-98
Min Daily	5.1	Oct-98
Dry Season:		
Average Daily	6.27	
Max. Daily	8.5	Jun-98
Min. Daily	5.1	Jun-98
Projected (2014):		
Average Daily	10.9	
Peak Hour	28.6	
Design:		
Average Daily	12	
Peak Hour	27	

Figure 2.1
Northern District Wastewater Treatment Plant Monthly Flow Over a Six Year Span



ND 1903

Figure 2.2
Northern District Wastewater Treatment Plant Monthly Flow Over a Six Year Span



2.2 INITIAL DILUTION

The initial required dilution for a specific compound or indicator is a function of water quality standard for the receiving water, ambient concentration in the receiving water, and the concentration in the wastewater treatment plant effluent.

2.2.1 WATER QUALITY STANDARDS

The water quality standards applicable to the receiving waters off Tangussion Point are established by the Revised Guam Water Quality Standards adopted on January 2, 1992. These standards have undergone a triennial review resulting in a draft final revision[3]. Final adoption is subject to the approval of the Guam EPA Board of Directors, Attorney General, Governor, Senate, and USEPA. Both the adopted standards and draft final revision were consulted for this analysis.

The outfall will discharge into marine waters classified as M-2, Good.

Water in this category must be of sufficient quality to allow for the propagation and survival of marine organisms, particularly shellfish and recreation. Other similarly harvested aquatic organisms, corals and other reef related resources, and whole body contact recreation. Other important and intended uses include mariculture activities, aesthetic enjoyment and related activities.[3]

The numerical criteria for those water quality standards that are likely to be impacted by sewage effluent are listed in Table 2.3.

2.2.2 RECEIVING WATER CONDITION

A water quality survey was conducted on September 22 at the four corners of the mixing zone for the proposed outfall site. Water samples were taken at surface, mid-depth and bottom. The analytical results are tabulated in Appendix A, while values averaged over depth and four locations are listed in Table 2.3. Water quality is consistent with the standards for M-2 waters.

2.2.3 WASTEWATER EFFLUENT CONCENTRATIONS

The plant effluent is routinely analyzed for the following constituents to comply with the monthly reporting requirements of its discharge permit:

a) Suspended Solids (SS)

b) Biochemical Oxygen Demand (BOD)

c) Settable Solids

d) Oil & Grease

e) pH

A composite effluent sample was taken on March 9, 1998 and subjected to a priority toxic pollutant scan. Four pollutants out of a possible 126 were detected and are listed in Table 2.3 Two additional chemical constituents that are not yet regulated were also detected in the parts per billion range.

The concentration reported for lead at 2,900 ug/l in the toxic pollutant scan appears to be

concentrations in the range of 4 to 19 ug/l with one household reporting 30 ug/l. Table 2.2 lists lead concentrations measured in the effluents of three treatment plants on Guam and two plants on Oahu, Hawaii. These collaborative results support the conclusion that the lead concentration reported in the pollutant scan is overstated by at least one order of magnitude and possibly two.

Table 2.2

SURVEY OF EFFLUENT LEAD CONCENTRATIONS AT VARIOUS WASTEWATER TREATMENT PLANTS

Plant & Locations	Effluent	Date Sampled	Lead Conc. ug/l
Agana WWTP, Guam	Primary	3/10./98	nd[1]
Apra Harbor WWTP COMNAVMAR, Guam	Primary	8/91 to 7/92	14 to 56[2]
Agat WWTP, Guam	Secondary	7/90 to 10/9	5.6[2]
Sand Island WWTP, Oahu	Primary		42[3]
Honouliuli WWTP, Oahu	Primary		186[3]
Ft. Kam WWTP, Oahu	Secondary		28[3]

[1] Laboratory Report #41239, Montgomery Watson Laboratories, Pasadena Ca, March 1998
[2] Feasibility Study Tipalao Bay Outfall , CH2M Hill, October 1992
[3] Stevenson, M., O'Connor, J., & Aldrich, J.,
Pollutant Source Identification, *Mamala Bay Study*, (July 1995).

2.2.4 REQUIRED DILUTION

Required dilution is the volume ratio of ambient seawater plus wastewater effluent to wastewater effluent that will not allow exceedance of the water quality standards for that particular constituent. Generally, the required dilution is calculated with the expression taken for

USEPA (1994)[5]:

$$Sa = (Ce-Ca) \ / \ (Cs-Ce)$$

Where Ce = effluent concentration

Cs = water quality standard

Ca = receiving water concentration

Sa = dilution

Values for the three parameters and resulting dilution are listed in Table 2.3 for the constituents found in the wastewater effluent.

The indicator bacteria "Enterococci" requires the largest dilution of 8000. However, this dilution is beyond the performance of an outfall that could be constructed at reasonable cost. The second highest required dilution is for suspended solids 170. The design criterion for intail dilution is selected at 200.

Table 2.3

REQUIRED DILUTION CALCULATION
FOR NORTHERN DISTRICT WASTEWATER TREAMENT PLANT OUTFALL

Constituent Regulated by Guam Water Quality Standards	Unit	Water Quality Std.	Ambient Conc.	Effluent Conc.	Required Dilution
Enterococci	#/100ml	104	0	**830,000**	7,7981
pH		6.5 to 8.5	8.2	7.2	10
Orthophosplate	ug/l	50	0	**4240**	85
Nitrate-Nitrogen	ug/l	200	0	29	0
Dissolved Oxygen	mg/l	4.6	6	0	6
Salinity	ppt	0%+ambient	32	0.8	0
Suspended	ug/l	20000	19000	190000	170
Turbidity	NTU	1+ambient	0.27		
Temperature	°C	1+ambient	29.7	30	0
Priority Toxic Pollutants					
p-Dichlorobenzene	ug/l	2600	0	1.1	0
Toluene	ug/l	5000	0	1.9	0
Copper	ug/l	3.1	0	53	17
Zinc	ug/l	86	0	2110	2
Additional Toxic Pollutants					
Ammonia	ug/l	20	0	**1045**	52
Sulfide	ug/l	5	0	**110**	22
Nonregulated Chemical Constituents					
Acetone	ug/l			86	
4-Methylphenol	ug/l			45	

Table 2.3 (cont'd)

FOOTNOTES

* Effluent Values in bold Italics are estimated from analyses of primary effluent form Oahu wastewater treatment plant
* Ammonia and orthophosphate are averaged from grab samples
* Application factor of 0.05 applied to total NH_3 conc. of 20.9 mg/l.
* Sulfide conc. is from an inplant survey at Sand Is. WWTP.
* Enterococci is from a five plant survey of primary effluent.
* Effluent suspended solids conc. is the maximum average value recorded from Jan. 1997 to Sept. 1998
* Required Dilution for dissolved oxygen assumes 3 mg/l immediate demand.

SECTION 3

SECTION 3

OUTFALL DESIGN

3.1 ALIGNMENT AND TERMINUS

The outfall terminus or discharge location is determined by three factors. First. A seafloor slope of 8% but not more than 12% is needed for constructability of the diffuser. Second, the terminus shall be beyond the near shore water -- i.e. beyond 10 fathom depth (60 ft., 18.3 m). Third, the depth at the diffuser shall provide the required initial dilution.

The bathymetric survey for the receiving water off Tanguisson Pt. Shows two potential sites (1) a canyon located between the 125 and 150 ft contours, and (2) a plateau between the 200 and 250 ft contours.

The feasibility of constructing a shallow outfall with multiport diffuser at depths between 135 to 150 ft versus a deep outfall with a single point discharge at depths ranging from 225 to 325 ft was evaluated on the basis of initial dilution, farfield dilution at the shoreline, and construction cost. E.K. Noda and Associates (EKNA) estimated initial dilutions under the various conditions listed in Table 3.1 Two alternatives were selected for further study; 1) an outfall at 150 ft with a multi-port 400 ft diffuser and 2) an outfall at 250 ft with a single discharge port.

Table 3.1

INITIAL DILUTION CALCULATION

Deep Outfall with Single Point Discharge			
Average Dilution Q max = 28.6 mgd			
Discharge Depth (ft)	UM	Point Plume	Approximate Distance for Shoreline (ft)
225	94-97	91	
250	108-112	109	2,300
275	124-129	128	2,400
300	139-146	148	2,450
325	155-164	169	

Shallow Outfall with 40 Port Diffuser				
Diffuser Length at 100ft				
Average Dilutions Q max = 28.6 mgd				
Discharge Depth (ft)	UM	RSB	2D	Approximate Distance from Shoreline
135	92	84	85	1,390
150	99	106	94	1,550

Diffuser Length at 200ft				
Average Dilutions Q max = 28.6 mgd				
Discharge Depth (ft)	UM	RSB	2D	Approximate Distance from Shoreline
135	140	149	134	1,390
150	153	163	149	1,550

Table 3.1

INITIAL DILUTION CALCULATION (cont.)

Diffuser Length at 300ft				
Average Dilutions, Q max = 28.6 mgd				
Discharge Depth (ft)	UM	RSB	2D	Approximate Distance from Shoreline
135	182	192	176	1,390
150	198	212	196	1,550
Diffuser Length at 400ft				
Average Dilutions, Q max = 28.6 mgd				
Discharge Depth (ft)	UM	RSB	2D	Approximate Distance from Shoreline
135	220	226	213	1,390
150	239	254	237	1,550
Diffuser Length at 100ft				
Average Dilutions, Q min = 5.0 mgd				
Discharge Depth (ft)	UM	RSB	2D	Approximate Distance from Shoreline
135	244	294	271	1,390
150	266	327	301	1,550
Diffuser Length at 200ft				
Average Dilutions, Q min = 5.0 mgd				
Discharge Depth (ft)	UM	RSB	2D	Approximate Distance from Shoreline
135	380	467	430	1,390
150	416	482	478	1,550

Table 3.1

INITIAL DILUTION CALCULATION (cont.)

Diffuser Length at 300ft				
Average Dilutions, Q min = 5.0 mgd				
Discharge Depth (ft)	UM	RSB	2D	Approximate Distance from Shoreline
135	491	592	564	1,390
150	538	563	626	1,550
Diffuser Length at 400ft				
Average Dilutions, Q min = 5.0 mgd				
Discharge Depth (ft)	UM	RSB	2D	Approximate Distance from Shoreline
135	584	678	683	1,390
150	644	615	759	1,550

Dilutions estimated by the UM and RSB models are based on the density profiles measured in the November 1998 survey.

Dilutions estimated by the Point Plume model used the average density of the aforementioned profiles.

From March 1990 through 1993, GWA sampled and analyzed for fecal coliform bacteria monthly at two shoreline location generally known as Tanguisson Point and NCS Beach.

The results listed in Table 3.2 show that the water quality standard for this indicator -- i.e. 400 mpn/100 ml was exceeded with increasing frequency in the last two years of the survey.

Table 3.2

FREQUENCY OF EXCEEDENCE OF FECAL COLIFORM WQS NORTHERN DISTRICT WWTP OUTFALL RECEIVING WATER

Year	Tanguisson Point	NCS Beach
1990	0	1 in 11
1991	2 in 12	1 in 12
1992	7 in 12	1 in 12
1993	6 in 12	3 in 12

Therefore, EKNA were asked to determined if the deeper outfall being 880 ft further offshore resulted in a greater farfield dilution. Their preliminary evaluation based upon the current study conducted in November 1998 (Appendix B) placed the dilution of the deeper outfall at 550 and the shallower multi port diffuser at 520.

The third issue in this feasibility study is construction cost, -- i.e. will the additional cost for HDD and pipeline to the deeper discharge be offset by the cost for installing the simpler diffuser.

The preliminary construction cost estimate for the deeper outfall was $480,000 or 11 percent greater than the outfall with the multi-port diffuser.

The alignment selected for the new outfall is from the existing force main at Tanguisson Point to the underwater canyon at the 140 ft. contour with a heading of 316 degrees northwest.

3.2 DIFFUSER DESIGNER

A 400 ft multiport diffuser was selected to provide the required dilution with an adequate margin. Design criteria are;

1) Maximum port velocity is between 15 to 20 fps

2) Maximum velocity in the header is 20 fps

3) Minimum velocity in the header is greater than 1 fps

4) Area ratio is between 1/3 to 2/3

5) Maximum effluent flow is 44.25 cfs (28.6 mgd)

6) Minimum effluent flow is 7.73 cfs (5 mgd)

7) Port spacing is at 10 ft centers

Preliminary sizing based on the above sets the port diameter at 3.35 inches resulting in a maximum port velocity of 18 fps. An initial header diameter of 30" sets the maximum velocity at 9 fps and minimum velocity at 1.6 fps. The header diameter decrease in five segments: 1)30in, 2)24in, 3)20in, 4)16in, and 5)12in. Each segment will be joined by a reducing transition.

Each port will have a two foot riser with a 90 degree elbow. The utility of using a duckbill check valve and riser fabricated from molded rubber with nylon reinforcement and manufactured by Red Valve Co., Inc. will be evaluated.

Header will be fabricated from HDPE pipe with polyethylene lined ductile iron pipe as an alternative.

SECTION 4

SECTION 4

CONSTRUCTION METHODOLOGY

4.1 OUTFALL PIPELINE

The selected construction method is horizontal directional drilling (HDD). The selection is based upon:

1) The pipeline length and diameter are within the capability of this method, i.e. up to 6000 feet and 48-inch pipe diameter.
2) The method minimizes underwater construction
3) The method has proven successful in similar consolidated limestone strata found at Tipalao Pont.
4) The method is compatible with the seafloor bathymetry in the receiving waters off Tanguisson Point. Conversely, pipeline installation by cut and cover would be difficult.
5) The method provides adequate cover and protection from storm surge.
6) The method has proven to be more economical than the cut and cover method.
7) The method causes less impact to the marine environment during construction.

Construction begins with drilling a 12-inch diameter pilot hole from Tanguisson Point. The project site is a terrace between the beach and toe of the Northern plateau. The entry point was selected to provide sufficient space for the drilling operation while segregating this operation from the more environmentally sensitive beach area. The pilot hold should exit within a 30-foot

square of the proposed location at the 135 foot depth. The cutting head is directed by manipulating its orientation relative to the drill string. Cutting head location is monitored continuously by measuring the magnetic field to determine latitude and longitude and inclination to determine depth.

Upon exiting, the cutting head and drill string are retrieved by a barge onstation. The pilot hole is then reamed to succeeding larger diameters until suitably sized for the pipeline. This operation is accomplished by replacing the cutting head with a reamer and pulling the reamer and additional string back to the entry point.

After the hole is sufficiently enlarged, the pipeline is pulled through it. The pipeline is prefabricated at a designated staging area and pulled through the hole by the drill string to the barge onstation. In all three operations, large quantities of bentonite slurry are used to maintain hole integrity, remove cuttings, and drive the cutting head motors.

The pipeline profile is determined by the entry angle, radius of curvature, and exit angle. Initially, a shallow 12° entry angle has been selected to clear the beach strand and provide adequate cover at the reef flat. The radius of curvature is 3400 feet to accommodate a 34-inch diameter pipe. A shallow exit angle of 6° at the exit is used to clear the seafloor.

4.2 PIPELINE SIZE AND MATERIAL

High-density polyethylene (HDPE) is selected because:

1) It is impervious to seawater environment,

2) Strength and flexibility properties are suited to construction method, and

3) It is cost competitive to epoxy-coated steel pipe.

A 34-inch diameter pipe with an SDR=17 (standard ratio pipe diameter to wall thickness) is selected to accommodate the peak hourly flow of 28.6 mgd.

4.3 DIFFUSER

The multiport diffuser has been described in Section 3.2. The diffuser will be fabricated from HDPE pipe with polyethylene lined ductile iron as are alternative.

The diffuser header will be held in place as a gravity structure, -.i.e. with ballast supports and/or pedestal . The header will be accessible for inspection, maintenance, and repair if necessary. Both header and ballast components will be fabricated onshore, transported to the site, and lowered into place. Construction divers would direct alignment and fasten header segments. The header will be aligned along the 140 ft contour, south to north. This location allows flexibility for the pipeline exit point and provides a uniform bottom grade of 8 to 9% along the header length to set the diffusers on.

REFERENCES

REFERENCES

1. 2000 Guam Census.

2. Duenas & Associates & CH2MHill, *Guam Island Wastewater Facilities Plan, Vol. I,* Public Utility Agency of Guam (Dec. 1994).

3. Guam Water Quality Standards (Final Draft Revision) (Dec. 1999).

4. Joanne Boyd, Guam Waterworks Authority, Memorandum (1998).

5. Office and Coastal Protection Division (4504F), Office of Wetlands, Oceans and Watersheds, *Amended Section 301(h) Technical Document,* EPA 842-B-94-007 (Sept. 1994).

MONTGOMERY WATSON LABORATORIES
535 East Walnut Street
Pasadena, California 91101
818 568 6400; Fax: 818 568 6324;
1 800 566 LABS (1 800 566 5227)

Laboratory
Report
#41239

Guam Water Authority
(continued)

Prepared	Analyzed	QC Batch#	Method	Analyte	Result	Units	MDL	Dilution
OMP12 NDSS (980311002) Sampled on 03/09/98								
03/13/98	03/16/98	74594	(S3113B/E200.9)	Arsenic, Total, GF	ND	mg/l	0.005	1
	03/11/98		(ML/EPA 100.1)	Asbestos by TEM	<3.3	MFL	3.3	1
03/19/98	03/20/98	74822	(E335.2/E335.3)	Cyanide by manual distillation	ND	mg/l	0.005	1
03/13/98	03/13/98	74456	(EPA/ML 245.1)	Mercury	ND	ug/l	0.20	1
03/13/98	03/16/98	74596	(S3113B/200.9)	Lead, Total, GF	2.9	mg/l	0.002	1
03/13/98	03/16/98	74598	(S3113B/E200.9)	Selenium, Total, GF	ND	mg/l	0.005	1
03/23/98	03/25/98	75332	(SUBCONTRACTED)	2,3,7,8-TCDD	ND	ng/l	7.9	1
03/13/98	03/16/98	74597	(ML/EPA 279.2)	Thallium, Total, GF	ND	mg/l	0.005	1
			BNA Extractable					
03/12/98	03/16/98	74668	(ML/EPA 625)	1,2,4-Trichlorobenzene	ND	ug/l	25	5
03/12/98	03/16/98	74668	(ML/EPA 625)	o-Dichlorobenzene (1,2-DCB)	ND	ug/l	25	5
03/12/98	03/16/98	74668	(ML/EPA 625)	1,2-Diphenylhydrazine	ND	ug/l	50	5
03/12/98	03/16/98	74668	(ML/EPA 625)	m-Dichlorobenzene (1,3-DCB)	ND	ug/l	25	5
03/12/98	03/16/98	74668	(ML/EPA 625)	p-Dichlorobenzene (1,4-DCB)	ND	ug/l	25	5
03/12/98	03/16/98	74668	(ML/EPA 625)	2,4,5-Trichlorophenol	ND	ug/l	25	5
03/12/98	03/16/98	74668	(ML/EPA 625)	2,4,6-Trichlorophenol	ND	ug/l	25	5
03/12/98	03/16/98	74668	(ML/EPA 625)	2,4-Dichlorophenol	ND	ug/l	25	5
03/12/98	03/16/98	74668	(ML/EPA 625)	2,4-Dimethylphenol	ND	ug/l	25	5
03/12/98	03/16/98	74668	(ML/EPA 625)	2,4-Dinitrophenol	ND	ug/l	250	5
03/12/98	03/16/98	74668	(ML/EPA 625)	2,4-Dinitrotoluene	ND	ug/l	25	5
03/12/98	03/16/98	74668	(ML/EPA 625)	2,6-Dinitrotoluene	ND	ug/l	25	5
03/12/98	03/16/98	74668	(ML/EPA 625)	2-Chloronaphthalene	ND	ug/l	25	5
03/12/98	03/16/98	74668	(ML/EPA 625)	2-Chlorophenol	ND	ug/l	25	5
03/12/98	03/16/98	74668	(ML/EPA 625)	2-Methylnaphthalene	ND	ug/l	25	5
03/12/98	03/16/98	74668	(ML/EPA 625)	2-Methylphenol	ND	ug/l	25	5
03/12/98	03/16/98	74668	(ML/EPA 625)	2-Nitroaniline	ND	ug/l	50	5
03/12/98	03/16/98	74668	(ML/EPA 625)	2-Nitrophenol	ND	ug/l	25	5
03/12/98	03/16/98	74668	(ML/EPA 625)	3,3'-Dichlorobenzidine	ND	ug/l	250	5
03/12/98	03/16/98	74668	(ML/EPA 625)	3-Nitroaniline	ND	ug/l	100	5
03/12/98	03/16/98	74668	(ML/EPA 625)	4,6-Dinitro-o-cresol	ND	ug/l	250	5
03/12/98	03/16/98	74668	(ML/EPA 625)	4-Bromophenylphenylether	ND	ug/l	25	5
03/12/98	03/16/98	74668	(ML/EPA 625)	4-Chloroaniline	ND	ug/l	25	5
03/12/98	03/16/98	74668	(ML/EPA 625)	4-Chlorophenylphenylether	ND	ug/l	25	5

MONTGOMERY WATSON LABORATORIES
555 East Walnut Street
Pasadena, California 91101
818 568 6490; Fax: 818 568 6324;
1 800 566 LABS (1 800 566 5227)

Laboratory Report #41239

Guam Water Authority
(continued)

Prepared	Analyzed	QC Batch#	Method	Analyte	Result	Units	MDL	Dilution
03/12/98	03/16/98	74668	(ML/EPA 625)	4-Methylphenol	46	ug/l	25	5
03/12/98	03/16/98	74668	(ML/EPA 625)	4-Nitroaniline	ND	ug/l	100	5
03/12/98	03/16/98	74668	(ML/EPA 625)	4-Nitrophenol	ND	ug/l	50	5
03/12/98	03/16/98	74668	(ML/EPA 625)	Acenaphthene	ND	ug/l	25	5
03/12/98	03/16/98	74668	(ML/EPA 625)	Acenaphthylene	ND	ug/l	25	5
03/12/98	03/16/98	74668	(ML/EPA 625)	Aniline	ND	ug/l	25	5
03/12/98	03/16/98	74668	(ML/EPA 625)	Anthracene	ND	ug/l	25	5
03/12/98	03/16/98	74668	(ML/EPA 625)	Benzo(a)anthracene	ND	ug/l	25	5
03/12/98	03/16/98	74668	(ML/EPA 625)	Benzo(a)pyrene	ND	ug/l	25	5
03/12/98	03/16/98	74668	(ML/EPA 625)	Benzo(b)fluoranthene	ND	ug/l	25	5
03/12/98	03/16/98	74668	(ML/EPA 625)	Benzo(g,h,i)perylene	ND	ug/l	50	5
03/12/98	03/16/98	74668	(ML/EPA 625)	Benzo(k)fluoranthene	ND	ug/l	25	5
03/12/98	03/16/98	74668	(ML/EPA 625)	bis(2-Chloroethyl)ether	ND	ug/l	50	5
03/12/98	03/16/98	74668	(ML/EPA 625)	bis(2-Chloroethoxy)methane	ND	ug/l	50	5
03/12/98	03/16/98	74668	(ML/EPA 625)	bis(2-Chloroisopropyl)ether	ND	ug/l	50	5
03/12/98	03/16/98	74668	(ML/EPA 625)	Di(2-Ethylhexyl)phthalate	ND	ug/l	20	5
03/12/98	03/16/98	74668	(ML/EPA 625)	Butylbenzylphthalate	ND	ug/l	25	5
03/12/98	03/16/98	74668	(ML/EPA 625)	Benzidine	ND	ug/l	250	5
03/12/98	03/16/98	74668	(ML/EPA 625)	Benzoic Acid	ND	ug/l	250	5
03/12/98	03/16/98	74668	(ML/EPA 625)	Benzyl Alcohol	ND	ug/l	25	5
03/12/98	03/16/98	74668	(ML/EPA 625)	Chrysene	ND	ug/l	25	5
03/12/98	03/16/98	74668	(ML/EPA 625)	Dibenzo(a,h)anthracene	ND	ug/l	50	5
03/12/98	03/16/98	74668	(ML/EPA 625)	Dibenzofuran	ND	ug/l	25	5
03/12/98	03/16/98	74668	(ML/EPA 625)	Diethylphthalate	ND	ug/l	25	5
03/12/98	03/16/98	74668	(ML/EPA 625)	Dimethylphthalate	ND	ug/l	25	5
03/12/98	03/16/98	74668	(ML/EPA 625)	Di-n-butylphthalate	ND	ug/l	50	5
03/12/98	03/16/98	74668	(ML/EPA 625)	Di-n-octylphthalate	ND	ug/l	50	5
03/12/98	03/16/98	74668	(ML/EPA 625)	Fluoranthene	ND	ug/l	25	5
03/12/98	03/16/98	74668	(ML/EPA 625)	Fluorene	ND	ug/l	25	5
03/12/98	03/16/98	74668	(ML/EPA 625)	Hexachlorobenzene	ND	ug/l	25	5
03/12/98	03/16/98	74668	(ML/EPA 625)	Hexachlorobutadiene	ND	ug/l	50	5
03/12/98	03/16/98	74668	(ML/EPA 625)	Hexachlorocyclopentadiene	ND	ug/l	50	5
03/12/98	03/16/98	74668	(ML/EPA 625)	Hexachloroethane	ND	ug/l	25	5
03/12/98	03/16/98	74668	(ML/EPA 625)	Indeno(1,2,3-c,d)pyrene	ND	ug/l	50	5
03/12/98	03/16/98	74668	(ML/EPA 625)	Isophorone	ND	ug/l	25	5
03/12/98	03/16/98	74668	(ML/EPA 625)	Naphthalene	ND	ug/l	25	5

MONTGOMERY WATSON LABORATORIES
555 East Walnut Street
Pasadena, California 91101
818 568 6400; Fax: 818 568 6324;
1 800 566 LABS (1 800 566 5227)

Laboratory Report #41239

Guam Water Authority
(continued)

Prepared	Analyzed	QC Batch#	Method	Analyte	Result	Units	MDL	Dilution
03/12/98	03/16/98	74668	(ML/EPA 625)	Nitrobenzene	ND	ug/l	25	5
03/12/98	03/16/98	74668	(ML/EPA 625)	N-Nitrosodimethylamine	ND	ug/l	25	5
03/12/98	03/16/98	74668	(ML/EPA 625)	N-Nitrosodi-N-propylamine	ND	ug/l	25	5
03/12/98	03/16/98	74668	(ML/EPA 625)	N-Nitrosodiphenylamine	ND	ug/l	25	5
03/12/98	03/16/98	74668	(ML/EPA 625)	p-Chloro-m-cresol	ND	ug/l	25	5
03/12/98	03/16/98	74668	(ML/EPA 625)	Pentachlorophenol	ND	ug/l	50	5
03/12/98	03/16/98	74668	(ML/EPA 625)	Phenanthrene	ND	ug/l	25	5
03/12/98	03/16/98	74668	(ML/EPA 625)	Phenol	ND	ug/l	25	5
03/12/98	03/16/98	74668	(ML/EPA 625)	Pyrene	ND	ug/l	25	5
			(Surrogate)	2,4,6-Tribromophenol	82	% Rec		
			(Surrogate)	2-Fluorobiphenyl	76	% Rec		
			(Surrogate)	2-Fluorophenol	74	% Rec		
			(Surrogate)	Nitrobenzene-d5	79	% Rec		
			(Surrogate)	Phenol-d5	151	% Rec		
			(Surrogate)	Terphenyl-d14	37	% Rec		
Pesticides/PCBs								
03/14/98	03/24/98	74999	(ML/EPA 608)	PCB 1016 Aroclor	ND	ug/l	5.0	10
03/14/98	03/24/98	74999	(ML/EPA 608)	PCB 1221 Aroclor	ND	ug/l	5.0	10
03/14/98	03/24/98	74999	(ML/EPA 608)	PCB 1232 Aroclor	ND	ug/l	5.0	10
03/14/98	03/24/98	74999	(ML/EPA 608)	PCB 1242 Aroclor	ND	ug/l	5.0	10
03/14/98	03/24/98	74999	(ML/EPA 608)	PCB 1248 Aroclor	ND	ug/l	5.0	10
03/14/98	03/24/98	74999	(ML/EPA 608)	PCB 1254 Aroclor	ND	ug/l	5.0	10
03/14/98	03/24/98	74999	(ML/EPA 608)	PCB 1260 Aroclor	ND	ug/l	5.0	10
03/14/98	03/24/98	74999	(ML/EPA 608)	Alpha-BHC	ND	ug/l	0.20	10
03/14/98	03/24/98	74999	(ML/EPA 608)	Aldrin	ND	ug/l	0.20	10
03/14/98	03/24/98	74999	(ML/EPA 608)	Beta-BHC	ND	ug/l	0.20	10
03/14/98	03/24/98	74999	(ML/EPA 608)	Chlordane	ND	ug/l	2.0	10
03/14/98	03/24/98	74999	(ML/EPA 608)	Delta-BHC	ND	ug/l	0.20	10
03/14/98	03/24/98	74999	(ML/EPA 608)	p,p' DDD	ND	ug/l	0.20	10
03/14/98	03/24/98	74999	(ML/EPA 608)	p,p' DDE	ND	ug/l	0.20	10
03/14/98	03/24/98	74999	(ML/EPA 608)	p,p' DDT	ND	ug/l	0.20	10
03/14/98	03/24/98	74999	(ML/EPA 608)	Dieldrin	ND	ug/l	0.20	10
03/14/98	03/24/98	74999	(ML/EPA 608)	Endrin Aldehyde	ND	ug/l	0.20	10
03/14/98	03/24/98	74999	(ML/EPA 608)	Endrin	ND	ug/l	0.10	10
03/14/98	03/24/98	74999	(ML/EPA 608)	Endosulfan I (alpha)	ND	ug/l	0.20	10

MONTGOMERY WATSON LABORATORIES
555 East Walnut Street
Pasadena, California 91101
818 568 6400; Fax: 818 568 6324;
1 800 566 LABS (1 800 566 5227)

Laboratory
Report
#41239

Guam Water Authority
(continued)

Prepared	Analyzed	QC Batch#	Method	Analyte	Result	Units	MDL	Dilution
03/14/98	03/24/98	74999	(ML/EPA 608)	Endosulfan II (beta)	ND	ug/l	0.20	10
03/14/98	03/24/98	74999	(ML/EPA 608)	Endosulfan sulfate	ND	ug/l	0.20	10
03/14/98	03/24/98	74999	(ML/EPA 608)	Gamma-BHC	ND	ug/l	0.20	10
03/14/98	03/24/98	74999	(ML/EPA 608)	Heptachlor	ND	ug/l	0.10	10
03/14/98	03/24/98	74999	(ML/EPA 608)	Heptachlor Epoxide	ND	ug/l	0.10	10
03/14/98	03/24/98	74999	(ML/EPA 608)	Methoxychlor	ND	ug/l	2.0	10
03/14/98	03/24/98	74999	(ML/EPA 608)	Toxaphene	ND	ug/l	5.0	10
			(Surrogate)	Dibutyl Chlorendate	32	% Rec		
				Priority Pollutant Metals - IC				
03/12/98	03/13/98	74588	(EPA/ML 200.7)	Silver, Total, ICAP	ND	mg/l	0.010	1
03/12/98	03/13/98	74588	(EPA/ML 200.7)	Beryllium, Total, ICAP	ND	mg/l	0.0010	1
03/12/98	03/13/98	74588	(EPA/ML 200.7)	Cadmium, Total, ICAP	ND	mg/l	0.005	1
03/12/98	03/13/98	74588	(EPA/ML 200.7)	Chromium, Total, ICAP	ND	mg/l	0.010	1
03/12/98	03/13/98	74588	(EPA/ML 200.7)	Copper, Total, ICAP	0.053	mg/l	0.010	1
03/12/98	03/13/98	74588	(EPA/ML 200.7)	Nickel, Total, ICAP	ND	mg/l	0.010	1
03/12/98	03/13/98	74588	(EPA/ML 200.7)	Antimony, Total, ICAP	ND	mg/l	0.050	1
03/12/98	03/13/98	74588	(EPA/ML 200.7)	Zinc, Total, ICAP	0.21	mg/l	0.020	1
				Volatile Organics HSL				
	03/13/98	74719	(ML/EPA 624)	1,1,2-Trichloroethane (1,1,2-T	ND	ug/l	0.50	1
	03/13/98	74719	(ML/EPA 624)	1,1-Dichloroethylene (1,1DCE)	ND	ug/l	0.50	1
	03/13/98	74719	(ML/EPA 624)	1,1-Dichloroethane	ND	ug/l	0.50	1
	03/13/98	74719	(ML/EPA 624)	o-Dichlorobenzene (1,2-DCB)	ND	ug/l	0.50	1
	03/13/98	74719	(ML/EPA 624)	1,2-Dichloroethane	ND	ug/l	0.50	1
	03/13/98	74719	(ML/EPA 624)	1,2-Dichloropropane	ND	ug/l	0.50	1
	03/13/98	74719	(ML/EPA 624)	m-Dichlorobenzene (1,3-DCB)	ND	ug/l	0.50	1
	03/13/98	74719	(ML/EPA 624)	p-Dichlorobenzene (1,4-DCB)	1.1	ug/l	0.50	1
	03/13/98	74719	(ML/EPA 624)	2-Butanone (MEK)	ND	ug/l	10	1
	03/13/98	74719	(ML/EPA 624)	2-Hexanone	ND	ug/l	10	1
	03/13/98	74719	(ML/EPA 624)	4-Methyl-2-Pentanone (MIBK)	ND	ug/l	10	1
	03/13/98	74719	(ML/EPA 624)	Acetone	86	ug/l	10	1
	03/13/98	74719	(ML/EPA 624)	Acrolein	ND	ug/l	200	1
	03/13/98	74719	(ML/EPA 624)	Acrylonitrile	ND	ug/l	50	1
	03/13/98	74719	(ML/EPA 624)	Benzene	ND	ug/l	0.50	1
	03/13/98	74719	(ML/EPA 624)	cis-1,2-Dichloroethene	ND	ug/l	0.50	1

MONTGOMERY WATSON LABORATORIES
595 East Walnut Street
Pasadena, California 91101
818 568 6400; Fax: 818 568 6324;
1 800 566 LABS (1 800 566 5227)

Laboratory Report #41239

Guam Water Authority
(continued)

Prepared	Analyzed	QC Batch#	Method	Analyte	Result	Units	MDL	Dilution
	03/13/98	74719	(ML/EPA 624)	Chlorobenzene	ND	ug/l	0.50	1
	03/13/98	74719	(ML/EPA 624)	cis-1,3-Dichloropropene	ND	ug/l	0.50	1
	03/13/98	74719	(ML/EPA 624)	Bromoform	ND	ug/l	0.50	1
	03/13/98	74719	(ML/EPA 624)	Chloroform (Trichloromethane)	ND	ug/l	0.50	1
	03/13/98	74719	(ML/EPA 624)	Chloroethane	ND	ug/l	0.50	1
	03/13/98	74719	(ML/EPA 624)	Carbon disulfide	ND	ug/l	0.50	1
	03/13/98	74719	(ML/EPA 624)	Carbon Tetrachloride	ND	ug/l	0.50	1
	03/13/98	74719	(ML/EPA 624)	Dibromochloromethane	ND	ug/l	0.50	1
	03/13/98	74719	(ML/EPA 624)	Dichlorobromomethane	ND	ug/l	0.50	1
	03/13/98	74719	(ML/EPA 624)	Ethyl benzene	ND	ug/l	0.50	1
	03/13/98	74719	(ML/EPA 524.2)	Dichlorodifluoromethane	ND	ug/l	0.50	1
	03/13/98	74719	(ML/EPA 624)	Methyl Bromide	ND	ug/l	1.0	1
	03/13/98	74719	(ML/EPA 624)	Methyl Chloride	ND	ug/l	1.0	1
	03/13/98	74719	(ML/EPA 624)	Methylene Chloride	ND	ug/l	3.0	1
	03/13/98	74719	(ML/EPA 624)	m,p-Xylenes	ND	ug/l	0.50	1
	03/13/98	74719	(ML/EPA 624)	o-Xylene	ND	ug/l	0.50	1
	03/13/98	74719	(ML/EPA 624)	1,1,2,2-Tetrachloroethane	ND	ug/l	0.50	1
	03/13/98	74719	(ML/EPA 624)	Tetrachloroethylene (PCE)	ND	ug/l	0.50	1
	03/13/98	74719	(ML/EPA 624)	Styrene	ND	ug/l	0.50	1
	03/13/98	74719	(ML/EPA 624)	trans-1,2-Dichloroethene	ND	ug/l	0.50	1
	03/13/98	74719	(ML/EPA 624)	1,1,1-Trichloroethane	ND	ug/l	0.50	1
	03/13/98	74719	(ML/EPA 624)	Trichloroethylene (TCE)	ND	ug/l	0.50	1
	03/13/98	74719	(ML/EPA 624)	Trichlorofluoromethane	ND	ug/l	0.50	1
	03/13/98	74719	(ML/EPA 624)	trans-1,3-Dichloropropene	ND	ug/l	0.50	1
	03/13/98	74719	(ML/EPA 624)	Tetrahydrofuran	ND	ug/l	10	1
	03/13/98	74719	(ML/EPA 624)	Toluene	1.9	ug/l	0.50	1
	03/13/98	74719	(ML/EPA 624)	Vinyl Chloride (VC)	ND	ug/l	0.50	1
	03/13/98	74719	(ML/EPA 624)	Vinyl Acetate	ND	ug/l	10	1
			(Surrogate)	1,2-Dichloroethane-d4	125	% Rec		
			(Surrogate)	4-Bromofluorobenzene	83	% Rec		
			(Surrogate)	Toluene-d8	103	% Rec		

REPORT

GEOTECHNICAL INVESTIGATION
NORTHERN DISTRICT SEWER OUTFALL EXTENSION
and AGANA SEWAGE TREATMENT PLANT OUTFALL EXTENSION
DEDEDO and HAGATNA, GUAM

Prepared for

GMP ASSOCIATES, INC.
ITC BUILDING, 3rd FLOOR
MARINE DRIVE
TAMUNING, GUAM 96931

By

GEO-ENGINEERING & TESTING, INC.
POST OFFICE BOX 8170
TAMUNING, GUAM 96931

18 AUGUST 2001

353.21(B)

INTRODUCTION

This report presents the results of the geotechnical investigation we performed for the Northern District Sewer Outfall Extension and the Agana Sewage Treatment Plant Sewer Outfall Extension.

The Northern District Outfall Extension Pipe Line will be constructed from the existing manhole at Tanguisson Point which is at Elevation +22 feet (Mean Lower Low Water = 0.00 feet), crossing the beach and reef flat directly in front and into the deep sea floor to discharge at approximately Elev. -150 feet deep below the sea will serve the nearby Northern District Sewage Treatment Plant. The total length of the outfall pipeline is approximately 2000 feet.

The Agana (or Hagatna) site will be an extension of the Agana Sewage Treatment Plant Outfall Line, for a total length of approximately 2200 linear feet. The new pipe line surface elevations will be from approximately Elevation +12.00 at the treatment plant site to Elevation –275 feet.

The purpose of our investigation was to perform limited subsurface exploration along the two new pipe lines, so as to provide discussion, opinions and recommendations concerning the two pipe lines, generally as follows:

1. General subsurface soil and rock conditions along the two new, pipe lines, as interpreted from the subsurface conditions found from the new test borings.

2. Feasibility of horizontal directional drilling method of installing the new pipe lines, from geotechnical engineering stand point.

3. Possible difficulties, from geotechnical engineering view point, concerning the installation of the new pipe lines, such as unsuitable

material for the horizontal directional drilling and piping, caving soils that may affect the stability of the drilling, and cavities.

SUBSURFACE EXPLORATION

We explored the subsurface conditions at both the Tanguisson and Agana sites by drilling test borings with a trailer-mounted, rotary wash drilling equipment. The drill rig was mounted on a floating support platform for the over-the-water drilling.

Our limited set-up for this investigation could not drill in the deep-water portions of the two outfall lines beyond the reef-flat due to the high wave conditions. However, the information obtained from the test borings under this investigation appears to be adequate for interpolation into or estimating the subsurface conditions for the remaining portions of the outfall lines for design and bid purposes.

At the Tanguisson outfall site, we drilled four test borings up to the edge of the reef flat. The depth of the test bored holes ranged from 18 feet at the entrance of the outfall pipe line to 60 feet below the existing sea floor. Boring 4 at the edge of the reef-flat area could not drill deeper due to existence of hard coralline limestone and crashing waves. However, all the four test borings penetrated significant depths in to the hard to very hard, underlying coralline limestone rock formation which is judged to extend at least several hundred feet beneath the sea floor.

At the Agana Sewage Treatment Plant outfall site, we also drilled four test borings with the same equipment set-up. The boring depth ranged from 32 to 90 feet below the existing surface (Boring 1) and the shallow sea floor (remaining bored holes). All the four test borings penetrated significantly into the underlying coralline limestone rock formation.

During the drilling of the test borings, we logged the subsurface conditions encountered in the test bored holes and obtained subsurface soil and rock samples for visual examination, classification, and laboratory testing. The test boring locations and the logs of the test borings are presented in Appendix A for the Tanguisson outfall site and in Appendix B for the Agana outfall site.

While obtaining the subsurface soil and rock samples, we also performed the standard penetration test or obtaining the N-values. The N-value is defined as the number of blows required to drive a 2.0-inch diameter, split spoon soil sampler 12 inches deep into the underlying soil or rock with a 140-pound drop weight free falling 30 inches per each blow. The collected N-values are shown on the boring logs at their respective depths. The N-values are commonly used for empirically estimating the unconfined compressive strength and consistency of soils and rocks.

In addition to the above, we performed rock coring in Borings 2, 3 and 4 at the Tanguisson site and Boring 4 at the Agana site. The rock cores were conducted with a Nx series core barrel having 3.0-inch outside diameter and 5 feet in length. Due to the nature of coralline limestone formations, the rock core recoveries ranged from zero to the 61 percent. The rock core depths and

recoveries, as well as rock quality RQD are shown on the boring logs at their respective depths. Plate 6 in the Appendix A presents the Unified Soil Classification System that is commonly used for describing soils.

LABORATORY TESTING

In our testing laboratory, we re-examined the subsurface soil and rock samples obtained from the test bored holes and tested selected samples. The tests we performed included in-situ moisture content and dry density (unit weight), particle size distribution (sieve analysis), specific gravity and absorption and unconfined compressive strength of rock cored samples. The test results are shown on the boring logs at the depths where the tested samples were obtained. The test name abbreviations are explained on a Key to Test Data shown on Plate 6 of the Appendix A.

SUBSURFACE CONDITIONS

Tanguisson Outfall Site

The Tanguisson outfall pipe line is essentially underlain with near-surface to shallow coralline limestone rock formation. Boring 1 at the entrance of the pipe line and beach area encountered approximately 5-1/2 feet thick of loose to medium dense, light color gravelly sand of beach deposits overlying very dense to hard coral fingers and cobbles to approximately 14 feet deep, and hard

coralline limestone formation beneath 14 feet. The remaining three test borings encountered hard coralline limestone formation from the sea floor to the full depths of the test borings (30 to 60 feet deep). Laboratory unconfined compressive strength test results on the rock core samples from these test bored holes ranged from 1038 pounds per square inch (psi) to as high as 3148 psi, which are equivalent to masonry block strength to regular 3000 psi ready-mixed concrete. These strengths are considered relatively high for coralline limestone and an indication of existence of relatively hard rock. The coralline limestone formation should extend to at least several hundred feet to more than a thousand feet before reaching the basaltic basement rock.

Agana Outfall Site

Boring 1 at the entrance of the pipe line inside the treatment plant compound encountered several inches of silty topsoil and very dense to hard limestone gravel and cobble rock fill material to approximately 13 feet deep, overlying approximately 5 feet thick of very dense, formerly beach deposit of gravelly sand. Hard coralline limestone formation exists below approximately 14 feet deep in this bored hole. Ground water in Boring 1 was gauged at 11.3 feet deep; it could fluctuated with tidal changes.

Boring 2 at this site encountered approximately 8 feet thick of loose, relatively fine-grained beach sand, overlying approximately 8 more feet thick of medium dense sandy coral gravel and loose to dense gravelly sand to approximately 33 feet deep. Moderately hard to hard coralline limestone exists

below 33 feet deep to the 50-foot depth of this bored hole. It is expected that the limestone would be hard below 50 feet.

Boring 3 and 3A further out on the reef flat encountered moderately hard to hard coralline limestone; but Boring 3 is also underlain with approximately 28 feet thick of dense to very dense sand which could have been a pocket within the irregular surface of the reef flat.

In general, the coralline limestone formation at the Agana Sewage Treatment Plant outfall site is moderately hard in the upper few to several feet and becomes hard with increasing depth.

DISCUSSION AND OPINIONS

The results of our investigation indicate that both the Tanguisson and the Agana sewer outfall pipe line sites are underlain with favorable, generally shallow and relatively hard coralline limestone rock formation, particularly within the depth range of the proposed pipe lines. However, the entrance points of the pipe lines at the beach area and the treatment plant site are underlain with beach sand and gravelly soil but should not have significant effect on the over-all pipe line installation by horizontal, directional drilling.

We did not encounter caverns or cavities of noticeable sizes, and the limestone in the test bored holes appear to be consistent and relatively uniform. Therefore, although existence of under-surface, significant size cavities and even caverns can not be completely ruled out, the chance of such occurrence within

the two outfall project sites should be very unlikely or remote. It is also possible that there may be sand pocket(s) existing within the upper 50 or 60 feet or so; but any such sand pockets would likely be dense to very dense and could hold together (by its adhesion or light cementation effects) even if it is encountered in the underground directional drilling.

Based on our findings and the above discussion, it is our opinion that the proposed horizontal, directional drilling for the installation of the new sewer outfall pipe lines is feasible and is superior over the conventional cut-and-fill method of installing sewer outfall pipe lines.

The following appendices complete our preliminary report for the geotechnical investigation performed for the Tanguisson and Agana sewer outfall pipeline project.

APPENDIX A - Tanguisson Outfall Site

Plate 1	-	Test Boring Location
Plates 2 through 5	-	Logs of Borings 1 through 4
Plate 6	-	Soil Classification Chart and Key to Test Data
Plate 7	-	Summary of Laboratory Test Data

APPENDIX B - Agana Outfall Site

Plate 1	-	Test Boring Location
Plates 2 through 5	-	Logs of Borings 1, 2, 3 and 3A
Plate 6	-	Soil Classification Chart and Key to Test Data
Plate 7	-	Particle Size Distribution
Plate 8	-	Summary of Test Data

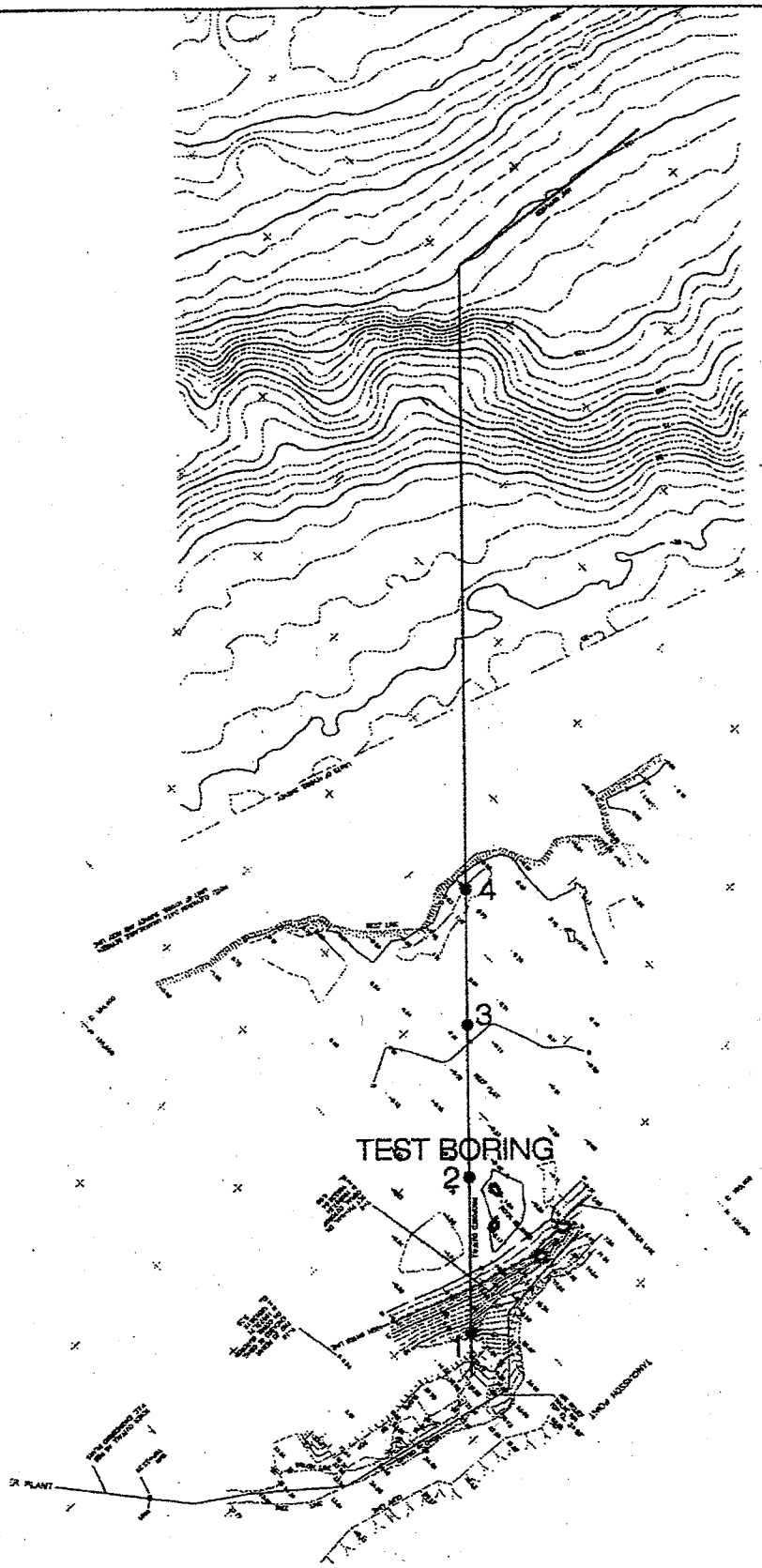
Respectfully submitted,

GEO-ENGINEERING & TESTING, INC.

Ukrit Siriprusanan
Civil Engineer - 360

APPENDIX A

TANGUISSON OUTFALL SITE



GEO-ENGINEERING & TESTING, INC. Geotechnical & Material Testing Engineers	**TEST BORING LOCATION** TANGUISSON SEWER OUTFALL	PLATE **1A**
Job No. 353.21(B) Appr. US/ Date 8/10/01	TANGUISSON GUAM	

SC3250AE 08/23/01 13:49

ND 1939

LABORATORY TESTS	DRILL RATE(min/ft)	BLOWS/FT	MOISTURE CONT(%)	DRY DENSITY (pcf)	DEPTH, (FT)	SAMPLE SYMBOL	
		13			0		LIGHT BROWN-WHITE GRAVELLY SAND (SP) - loose to medium dense, slightly moist, with coral cobbles, boulders and short grass on surface
		10/0"			5		LIGHT BROWN-WHITE CORAL FINGERS AND COBBLES (GP) - very dense, saturated
		39/3"			10		
					15		LIGHT BROWN-WHITE CORALLINE LIMESTONE - hard
					20		(Bottom of hole at 18')
					25		
					30		
					35		
					40		

LOG OF BORING 1

EQUIPMENT 8" Hollow Stem Auger

DATE 6/22/00

GEO-ENGINEERING & TESTING, INC.
Geotechnical & Material Testing Engineers

Job No. 353.21 Appr. US/ Date 8/10/01

LOG OF BORING 1
TANGUISSON SEWER OUT FALL
TANGUISSON GUAM

PLATE **2A**

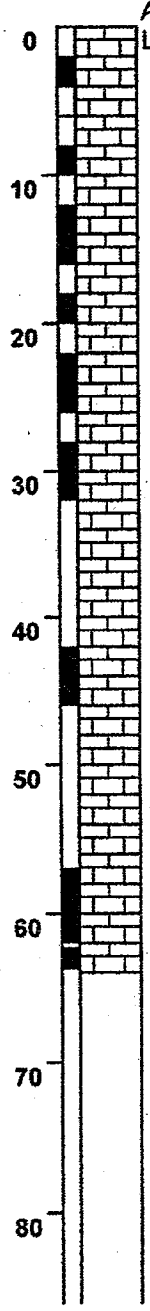
ND 1940

LABORATORY TESTS	DRILL RATE(min/ft)	BLOWS/FT	MOISTURE CONT(%)	DRY DENSITY (pcf)	DEPTH, (FT)	SAMPLE SYMBOL

LOG OF BORING 2

EQUIPMENT 3-7/8" Dia. Rotary Wash

DATE 6/27/00



Approximate depth of water = 4'

LIGHT BROWN-WHITE CORALLINE LIMESTONE - hard

(Nx rock coring at 2' - 7'; Recovery = 36"; RQD = 23%)

(Nx rock coring at 7' - 12'; Recovery = 36"; RQD = 12%)

(Nx rock coring at12' - 17'; Recovery = 56"; RQD = 27%)

UC = 1906 psi
Gs
UC = 1038 psi
UC = 1387 psi

(Nx rock coring at17' - 22'; Recovery = 24"; RQD = 7%)

(Nx rock coring at 22' - 27; Recovery = 51"; RQD = 45%)

(Nx rock coring at 27' - 32'; Recovery = 54"; RQD = 77%)

(Rotary wash at 32' - 42')

(Nx rock coring at 42' - 47'; Recovery = 49"; RQD = 67%)

(Rotary wash at 47' - 57')

(Nx rock coring at 57' - 62'; Recovery = 58%; RQD = 98%)

UC = 3148 psi
Gs
UC = 2629 psi

(Nx rock coring at 62' - 64'; Recovery = 20%; RQD = 48%)
(Bottom of hole at 64')

GEO-ENGINEERING & TESTING, INC.
Geotechnical & Material Testing Engineers

Job No. 353.21 Appr. US/ Date 8/10/01

LOG OF BORING 2
TANGUISSON SEWER OUTFALL
TANGUISSON GUAM

PLATE
3A

ND 1941

LABORATORY TESTS	DRILL RATE(min/ft)	BLOWS/FT	MOISTURE CONT(%)	DRY DENSITY (pcf)	DEPTH, (FT)	SAMPLE SYMBOL	LOG OF BORING 3 EQUIPMENT 3-7/8" Dia. Rotary wash DATE 6/30/00
					0		LIGHT BROWN-WHITE CORALLINE LIMESTONE - hard
							(Nx rock coring at 2' - 7'; Recovery = 58"; RQD = 36%)
							(Nx rock coring at 7' - 12'; Recovery = 60"; RQD = 33%)
UC = 2830 psi Gs UC = 1942 psi					10		(Nx rock coring at 12' - 17'; Recovery = 39"; RQD = 22%)
							(Nx rock coring at 17' - 22'; Recovery = 41"; RQD = 20%)
					20		(Rotary wash at 22' - 27')
							(Nx rock coring at 27' - 32'; Recovery = 37"; RQD = 8%)
					30		(Rotary wash at 32' - 37')
UC = 1144 psi UC = 1579 psi Gs							(Nx rock coring at 37' - 42'; Recovery = 35"; RQD = 20%)
					40		(Rotary wash at 42' - 47')
UC = 2656 psi UC = 1447 psi							(Nx rock coring at 47' - 52'; Recovery = 31"; RQD = 0%)
					50		(Rotary wash at 52' - 62')
UC = 2723 psi Gs					60		(Nx rock coring at 62' -67'; Recovery = 58'; RQD = 8%)
							(Bottom of hole at 67')
					70		
					80		

GEO-ENGINEERING & TESTING, INC.
Geotechnical & Material Testing Engineers

Job No. 352.21 Appr. US/ Date 8/10/01

LOG OF BORING 3
TANGUISSON SEWER OUTFALL
TANGUISSON GUAM

PLATE **4A**

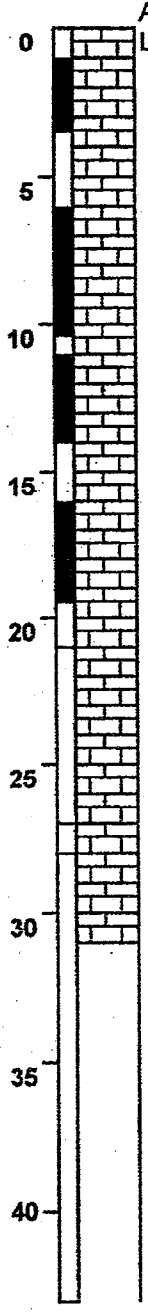
ND 1942

LABORATORY TESTS	DRILL RATE(min/ft)	BLOWS/FT	MOISTURE CONT(%)	DRY DENSITY (pcf)	DEPTH, (FT)	SAMPLE SYMBOL

LOG OF BORING 4

EQUIPMENT 3-7/8" Dia. Rotary Wash

DATE 7/4/00



Approximate depth of water = 5'

LIGHT BROWN-WHITE CORALLINE LIMESTONE - hard

(Nx rock coring at 1' - 6'; Recovery = 30"; RQD =28%)

(Nx rock coring at 6' - 11'; Recovery = 51"; RQD =44%)

(Nx rock coring at 11' - 16'; Recovery = 37"; RQD =10%)

(Nx rock coring at 16' - 21'; Recovery = 41"; RQD = 8%)

(Bottom of hole at 31')

GEO-ENGINEERING & TESTING, INC.
Geotechnical & Material Testing Engineers

Job No. 353.21 Appr. US/ Date 8/10/01

LOG OF BORING 4
TANGUISSON SEWER OUTFALL
TANGUISSON GUAM

PLATE
5A

ND 1943

MAJOR DIVISIONS			SYMBOL		TYPICAL NAMES
COARSE GRAINED SOILS (MORE THAN HALF IS LARGER THAT # 200 SIEVE)	GRAVELS (MORE THAN HALF COARSE FRACTION IS LARGER THAN No. 4 SIEVE SIZE)	CLEAN GRAVELS WITH LITTLE OR NO FINES	GW		WELL GRADED GRAVELS, GRAVEL - SAND MIXTURES
			GP		POORLY GRADED GRAVELS, GRAVEL - SAND MIXTURES
		GRAVELS WITH OVER 12 % FINES	GM		SILTY GRAVELS, POORLY GRADED GRAVEL - SAND - SILT MIXTURES
			GC		CLAYEY GRAVELS, POORLY GRADED GRAVEL - SAND - CLAY MIXTURES
	SANDS (MORE THAN HALF COARSE FRACTION IS SMALLER THAN No. 4 SIEVE SIZE)	CLEAN SANDS WITH LITTLE OR NO FINES	SW		WELL GRADED SANDS, GRAVELLY SANDS
			SP		POORLY GRADED SANDS, GRAVELLY SANDS
		SANDS WITH OVER 12 % FINES	SM		SILTY SANDS, POORLY GRADED SAND - SILT MIXTURES
			SC		CLAYEY SANDS, POORLY GRADED SAND - CLAY MIXTURES
FINE GRAINED SOILS (MORE THAN HALF IS SMALLER THAN # 200 SIE	SILTS AND CLAYS (LIQUID LIMIT LESS THAN 50)		ML		INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS, OR CLAYEY SILT WITH SLIGHTLY PLASTICITY
			CL		INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
			OL		ORGANIC CLAYS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS (LIQUID LIMIT GREATER THAN 50)		MH		INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS, ELASTIC SILTS
			CH		INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
			OH		ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS			Pt		PEAT AND OTHER HIGHLY ORGANIC SOILS

UNIFIED SOIL CLASSIFICATION SYSTEM

SA	=	Sieve Analysis
UC	=	Unconfined Compressive Strength
Gs	=	Specific Gravity

■ "UNDISTURBED SAMPLE ☒ DISTURBED SAMPLE

KEY TO TEST DATA

GEO-ENGINEERING & TESTING, INC. Geotechnical & Material Testing Engineers	**SOIL CLASSIFICATION CHART AND KEY TO TEST DATA** TANGUISSON SEWER OUTFALL	PLATE **6A**
Job No. 353.21 Appr. US/ Date: 8/10/01	TANGUISSON GUA	

ND 1944

SPECIFIC GRAVITY AND ABSORPTION
(ASTM C-127)

Sample No.	Boring No.	Depth (ft)	Bulk Sp. Gr. Dry	Bulk Sp. Gr. (SSD)*	Apparent Sp. Gr.	Absorption (%)
1	2	17	2.06	2.21	2.42	7.26
2	2	57	2.26	2.33	2.44	3.29
3	3	12	2.18	2.32	2.54	6.40
4	3	37	2.35	2.43	2.54	3.16
5	3	62	2.34	2.41	2.52	3.07

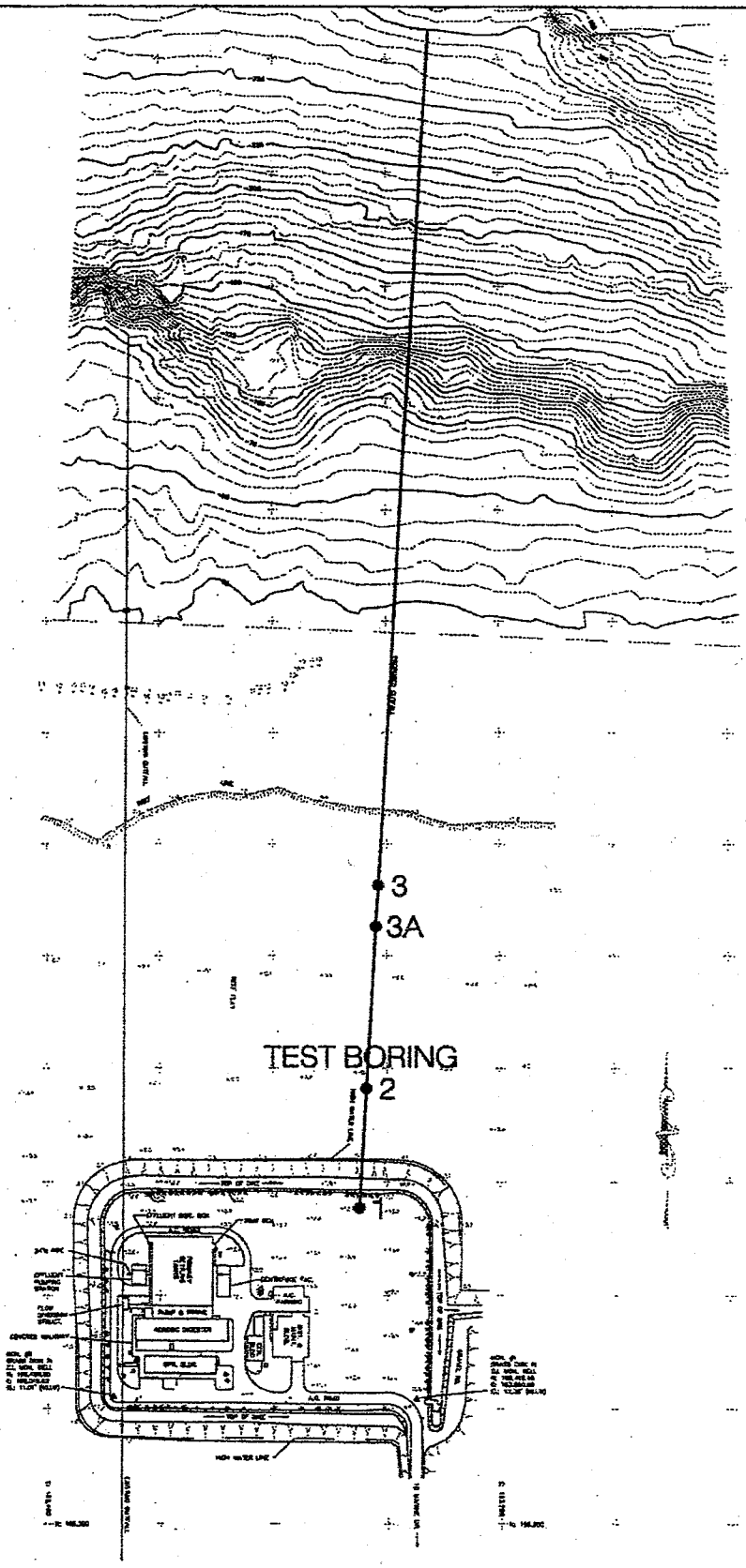
* SSD = Saturated Surface Dry

GEO-ENGINEERING & TESTING, INC. Geotechnical & Material Testing Engineers	SUMMARY OF TEST DATA TANGUISSON SEWER OUTFALL	PLATE 7A
Job No. 353.21 Appr. Date	TANGUISSON GUAM	

ND 1945

APPENDIX B

AGANA OUTFALL SITE



GEO-ENGINEERING & TESTING, INC.
Geotechnical & Material Testing Engineers

TEST BORING LOCATION
AGANA SEWER OUTFALL

PLATE
1B

Job No. 353.21(A) Appr. US/ Date

AGANA GUAM

SC3250AD 08/23/01 13:29

ND 1947

LOG OF BORING 1

EQUIPMENT 8" Hollow Stem Auger

DATE 8/2/00

LABORATORY TESTS	DRILL RATE(min/ft)	BLOWS/FT	MOISTURE CONT(%)	DRY DENSITY (pcf)	DEPTH, (FT)	SAMPLE SYMBOL	
					0		DARK BROWN CLAYEY SANDY SILT (MH) - soft, slightly moist
		17/0"					LIGHT BROWN-WHITE SANDY LIMESTONE GRAVEL/ COBBLES (GP) - very dense to hard, moist
					5		
		40/4"					
					10		
SA		96/9"	12.9	117			water level at 11.3'; 1:17 pm; 8/2/2000
					15		LIGHT BROWN-WHITE GRAVELLY SAND (SP) - very dense, saturated, with fragments of sea shells
SA		61/6"	13.3	115			
					20		LIGHT BROWN-WHITE CORALLINE LIMESTONE - hard
		20/1					
					25		
		10/0"					
					30		
		14/0.5"					(Bottom of hole at 32')
					35		
					40		

GEO-ENGINEERING & TESTING, INC.
Geotechnical & Material Testing Engineers

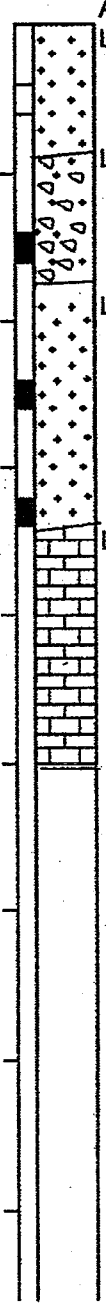
Job No. 353.21 Appr. US/ Date 8/10/01

LOG OF BORING 1
AGANA SEWER OUTFALL
AGANA GUAM

PLATE **2B**

ND 1948

LABORATORY TESTS	DRILL RATE(min/ft)	BLOWS/FT	MOISTURE CONT(%)	DRY DENSITY (pcf)	DEPTH, (FT)	SAMPLE SYMBOL	LOG OF BORING 2
							EQUIPMENT 3-7/8" Dia. Rotary Wash
							DATE 8/2/00



Approximate depth of water = 5'

0 — LIGHT GREYISH WHITE FINE SAND (SP) - loose, saturated

10 — LIGHT BROWN-WHITE SANDY CORAL GRAVEL (GP) - loose to medium dense, saturated

19

20 — LIGHT BROWN-WHITE GRAVELLY SAND (SP) - loose saturated, with fragments of sea shells

7

dense from 28'

30

30 — LIGHT BROWN-WHITE CORALLINE LIMESTONE - moderately hard , highly fractured, with sand pockets (Nx rock coring at 37' - 47', no recovery)

40

hard from 48'

10/0"

50 — (Bottom of hole at 50')

60

70

80

GEO-ENGINEERING & TESTING, INC.
Geotechnical & Material Testing Engineers

Job No. 353.21 Appr. US/ Date 8/10/01

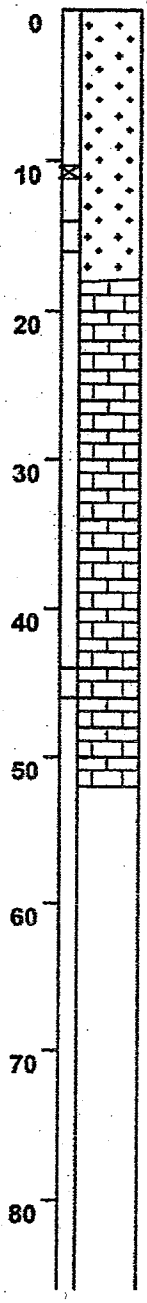
LOG OF BORING 2
AGANA SEWER OUTFALL
AGANA GUAM

PLATE 3B

ND 1949

LABORATORY TESTS	DRILL RATE(min/ft)	BLOWS/FT	MOISTURE CONT(%)	DRY DENSITY (pcf)	DEPTH, (FT)	SAMPLE SYMBOL

LOG OF BORING 3
EQUIPMENT 8" Hollow Stem Auger
DATE 8/3/01



Approximate depth of water = 5'

LIGHT BROWN-WHITE SAND (SP) - dense to very dense, saturated

39

LIGHT BROWN-WHITE CORALLINE LIMESTONE - hard

10/0.5"

20/0"

(Nx rock coring at 37' - 47', no recovery)

(Bottom of hole at 52')

GEO-ENGINEERING & TESTING, INC.
Geotechnical & Material Testing Engineers

Job No. 353.21 Appr. US/ Date 8/10/01

LOG OF BORING 3
AGANA SEWER OUTFALL
AGANA GUAM

PLATE
4B

LOG OF BORING 3A

EQUIPMENT 3-7/8" Dia. Rotary Wash

DATE 8/9/00

LABORATORY TESTS	DRILL RATE(min/ft)	BLOWS/FT	MOISTURE CONT(%)	DRY DENSITY (pcf)	DEPTH, (FT)	SAMPLE SYMBOL	
							Approximate depth of water = 5'
					0		LIGHT BROWN-WHITE CORALLINE LIMESTONE - moderately hard to hard
							(Nx rock coring at 0' - 5'; Recovery = 2'-2"; RQD =17%)
							(Rotary wash from 5' - 15')
					10		hard from 10'
							(Nx rock coring at 15' - 20'; Recovery =60"; RQD = 48%)
Gs							
					20		(Rotary wash from 20' - 30')
					30		(Nx rock coring at 30' - 35'; Recovery = 18"; RQD = 0%)
							(Rotary wash at 35' - 45')
					40		
							(Nx rock coring at 45' - 50'; Recovery =33"; RQD = 27%
UC = 3960psi Gs					50		(Rotary wash at 50' - 60')
					60		(Nx rock coring at 60' - 70'; No recovery)
					70		(Nx rock coring at 70' - 75' ; Recovery = 12", RQD= 0%)
							(Nx rock coring at 75' - 80', Recovery = 36"; RQD = 25%)
UC = 1690 psi Gs					80		(Nx rock coring at 80' - 85', Recovery = 28"; RQD = 14%)
							(Nx rock coring at 85' - 90', No recovery)
					90		(Bottom of hole at 90')

GEO-ENGINEERING & TESTING, INC.
Geotechnical & Material Testing Engineers

Job No. 353.21 Appr. US/ Date 8/10/01

LOG OF BORING 3A
AGANA SEWER OUTFALL
AGANA GUAM

PLATE **5B**

ND 1951

MAJOR DIVISIONS			SYMBOL		TYPICAL NAMES
COARSE GRAINED SOILS (MORE THAN HALF IS LARGER THAT # 200 SIEVE)	GRAVELS (MORE THAN HALF COARSE FRACTION IS LARGER THAN No. 4 SIEVE SIZE)	CLEAN GRAVELS WITH LITTLE OR NO FINES	GW		WELL GRADED GRAVELS, GRAVEL - SAND MIXTURES
			GP		POORLY GRADED GRAVELS, GRAVEL - SAND MIXTURES
		GRAVELS WITH OVER 12 % FINES	GM		SILTY GRAVELS, POORLY GRADED GRAVEL - SAND - SILT MIXTURES
			GC		CLAYEY GRAVELS, POORLY GRADED GRAVEL - SAND - CLAY MIXTURES
	SANDS (MORE THAN HALF COARSE FRACTION IS SMALLER THAN No. 4 SIEVE SIZE)	CLEAN SANDS WITH LITTLE OR NO FINES	SW		WELL GRADED SANDS, GRAVELLY SANDS
			SP		POORLY GRADED SANDS, GRAVELLY SANDS
		SANDS WITH OVER 12 % FINES	SM		SILTY SANDS, POORLY GRADED SAND - SILT MIXTURES
			SC		CLAYEY SANDS, POORLY GRADED SAND - CLAY MIXTURES
FINE GRAINED SOILS (MORE THAN HALF IS SMALLER THAN # 200 SIE	SILTS AND CLAYS (LIQUID LIMIT LESS THAN 50)		ML		INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS, OR CLAYEY SILT WITH SLIGHTLY PLASTICITY
			CL		INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
			OL		ORGANIC CLAYS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS (LIQUID LIMIT GREATER THAN 50)		MH		INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS, ELASTIC SILTS
			CH		INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
			OH		ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS			Pt		PEAT AND OTHER HIGHLY ORGANIC SOILS

UNIFIED SOIL CLASSIFICATION SYSTEM

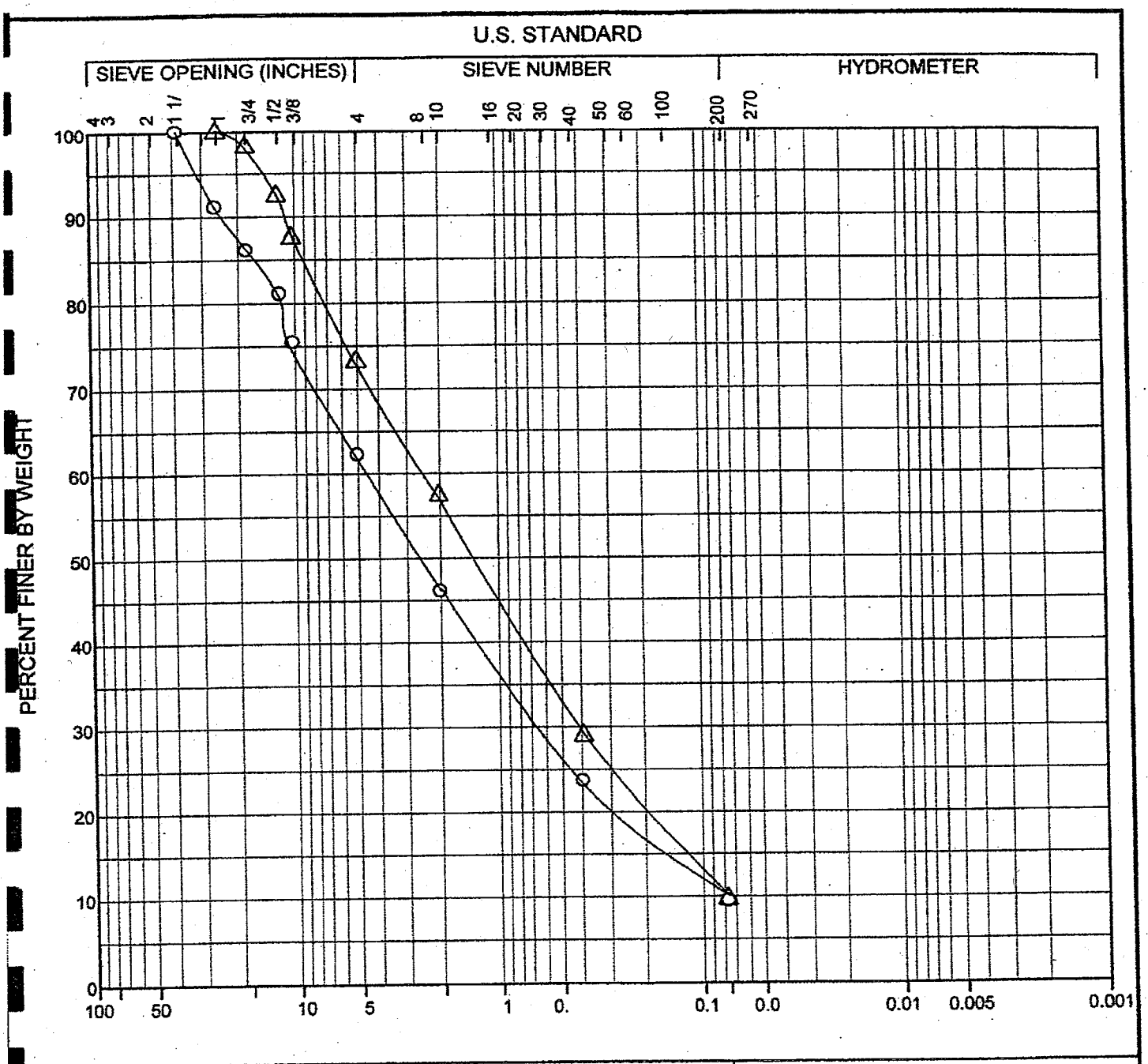
SA	=	Sieve Analysis
UC	=	Unconfined Compressive Strength
Gs	=	Specific Gravity
RQD	=	Rock Quality Designation

■ "UNDISTURBED SAMPLE ☒ DISTURBED SAMPLE

KEY TO TEST DATA

GEO-ENGINEERING & TESTING, INC. Geotechnical & Material Testing Engineers	**SOIL CLASSIFICATION CHART AND KEY TO TEST DATA** AGANA SEWER OUTFALL	PLATE **6B**
Job No. 353.21 Appr. US/ Date: 8/10/01	AGANA GU	

ND 1952



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

SYMBOL	SAMPLE SOURCE	CLASSIFICATION
O	B-1 @ 12'	LIGHT BROWN-WHITE SANDY LIMESTONE GRAVEL (GP)
Δ	B-1 @ 17.5'	LIGHT BROWN-WHITE GRAVELLY SAND (SP)

GEO-ENGINEERING & TESTING, INC.
Geotechnical & Material Testing Engineers

Job No. 353.21 Appr. S/ Date

PARTICLE SIZE DISTRIBUTION
AGANA SEWER OUTFALL

AGANA GUAM

PLATE **7B**

ND 1953

SPECIFIC GRAVITY AND ABSORPTION
(ASTM C-127)

Sample No.	Boring No.	Depth (ft)	Bulk Sp. Gr. Dry	Bulk Sp. Gr. (SSD)*	Apparent Sp. Gr.	Absorption (%)
1	3A	15	2.17	2.37	2.73	9.49
2	3A	45	2.11	2.34	2.73	10.7
3	3A	55'	2.13	2.31	2.59	8.48

* SSD = Saturated Surface Dry

GEO-ENGINEERING & TESTING, INC. Geotechnical & Material Testing Engineers	SUMMARY OF TEST DATA AGANA SEWER OUTFALL	PLATE 8B
Job No. 353.21 Appr. Date	AGANA GUAM	

ND 1954

Preliminary

Construction Cost Estimate

Northern District Wastewater Treatment Plant

Outfall

CONSTRUCTION COST MODEL for OUTFALL EXTENSION

Northern District Treatment Plant

Horizontal Directional Drilling Component

Item	Quantity		Labor	Material	Subtotal
Mobilization Materials & Equipment	LS		$ 575,000		$ 575,000
Site Preparation & Setup	LS		$ 153,000		$ 153,000
34" HDPE pipe	1950	ft		$ 80	$ 156,000
Drill Pilot Hole	1950	ft	$ 233	$ 57	$ 565,500
Ream Pilot Hole	1950	ft	$ 351	$ 69	$ 819,000
34" HDPE Pipe Installation	1950	ft	$ 307	$ 60	$ 715,650
Permits & Insurance	LS		$ 45,000		$ 45,000
Site Cleanup & Restoration	LS		$ 48,000	$ 12,000	$ 60,000
Demobilization	LS		$ 193,000		$ 193,000
Administration & Quality Control	LS		$ 85,000		$ 85,000
Total HDD					$ 3,367,150
Diffuser Component					
34" Header Segment	72	ft	$ 80	$ 30	$ 7,920
24" Header Segment	90	ft	$ 49	$ 30	$ 7,110
20" Header Segment	72	ft	$ 39	$ 30	$ 4,968
16" Header segment	72	ft	$ 35	$ 30	$ 4,680
12" Header Segment	90	ft	$ 28	$ 30	$ 5,220
Pedestals	25	ct	$ 83	$ 150	$ 5,825
Risers	40	ct	$ 300	$ 80	$ 15,200
Work Platform onsite	22	day	$ 6,600		$ 145,200
Tremie Concrete	5	yd		$ 216	$ 1,080
Dive Crew	15	day	$ 5,102		$ 76,530
Mob/Demob Dive Crew	LS		$ 18,620		$ 18,620
Total Diffuser					$ 292,353
Grand Total					**$ 3,659,503**

APPENDICES

APPENDIX A

WATER QUALITY SURVEY

PHILIPPINE SEA OFF TANGUISSON POINT

APPENDIX A

WATER QUALITY SURVEY

A-1 PURPOSE

The water quality survey conducted on September 22, 2000 provided a baseline condition prior to construction and set the ambient conditions for the required dilution calculations.

A-2 PROCEDURE

Video inspection and record of the bottom community structure was conducted simultaneously with the water sampling. A panoramic view was recorded at the center of the mixing zone, i.e outfall discharge, and along 25m transects at the four corners. Generally, the camera and light assembly was held 24 to 15 inches off the seafloor. Vessel was navigated by GPS.

At each outfall corner, water samples were taken at the surface, mid depth and near the bottom with a vertical polycarbonate sampler. The temperature, pH and dissolved oxygen were measured onboard with portable instruments. Remaining water sample was poured into the appropriate sampling bottles, kept at 4°C and shipped to Pace Analytical Services, Inc., Long Beach, California for analysis.

A-3 RESULTS

The analytical results are listed in table A.1 along with the coordinates, date, time, and depth of sampling. All values are better quality than the water quality standards. See figure A.1 for sampling locations.

The suspended solids data reported by the laboratory was approximately two orders of magnitude too large and contradicted both turbidity measurements and visual observations. Since this discrepancy could not be resolved with the laboratory, the area will be resampled.

The priority pollutant scan report on a composite sample of treatment plant effluent is also enclosed to reference to the types and methods of analyses.

Figure A.1

WATER QUALITY DATA FOR THE PROPOSED NORTHERN DISTRICT OUTFALL

LOCATION	SITE & WATER QUALITY PARAMETERS												
Northern District	GPS Coordinates	Date	Time of Day	Depth ft	Turbidity NTU	Fecal Col. MPN	Temp.°F	pH	D.O.	Salinity mg/l	P mg/l	Nitrate-N mg/l	O & G mg/l
TA-1	N: 13 33.182	9/22/00	8:03 AM	3	0.24	<10	29.9	8.13	5.18	32,000	ND	ND	ND
TA-2	E: 144 48.403	9/22/00	7:59 AM	85	0.23	<10	29.9	8.13	6.05	32,000	ND	ND	ND
TA-3		9/22/00	7:50 AM	170	0.31	<10	29.9	8.13	6.02	32,000	ND	ND	ND
TB-1	N: 13 33.178	9/22/00	9:52 AM	3	0.25	<10	29.9	8.17	6	32,000	ND	ND	ND
TB-2	E: 144 48.453	9/22/00	9:47 AM	65	0.17	<10	29.7	8.21	6.31	32,000	ND	ND	ND
TB-3		9/22/00	9:40 AM	130	0.24	<10	29.9	8.16	6.05	32,000	ND	ND	ND
TC-1	N: 13 33.067	9/22/00	9:02 AM	3	0.21	<10	30	8.16	5.74	32,000	ND	ND	ND
TC-2	E: 144 48.392	9/22/00	8:56 AM	80	0.24	<10	29.9	8.15	6.05	32,000	ND	ND	ND
TC-3		9/22/00	8:46 AM	150	0.21	<10	29.7	8.15	5.88	32,000	ND	ND	ND
TD-1	N: 13 33.0687	9/22/00	10:48 AM	3	0.22	<10	30.2	8.18	6.13	31,000	ND	ND	ND
TD-2	E: 144 48.442	9/22/00	10:40 AM	40	0.24	<10	29.8	8.21	6.06	33,000	ND	ND	ND
TD-3		9/22/00	10:30 AM	80	0.26	<10	29.9	8.15	5.98	32,000	ND	ND	ND

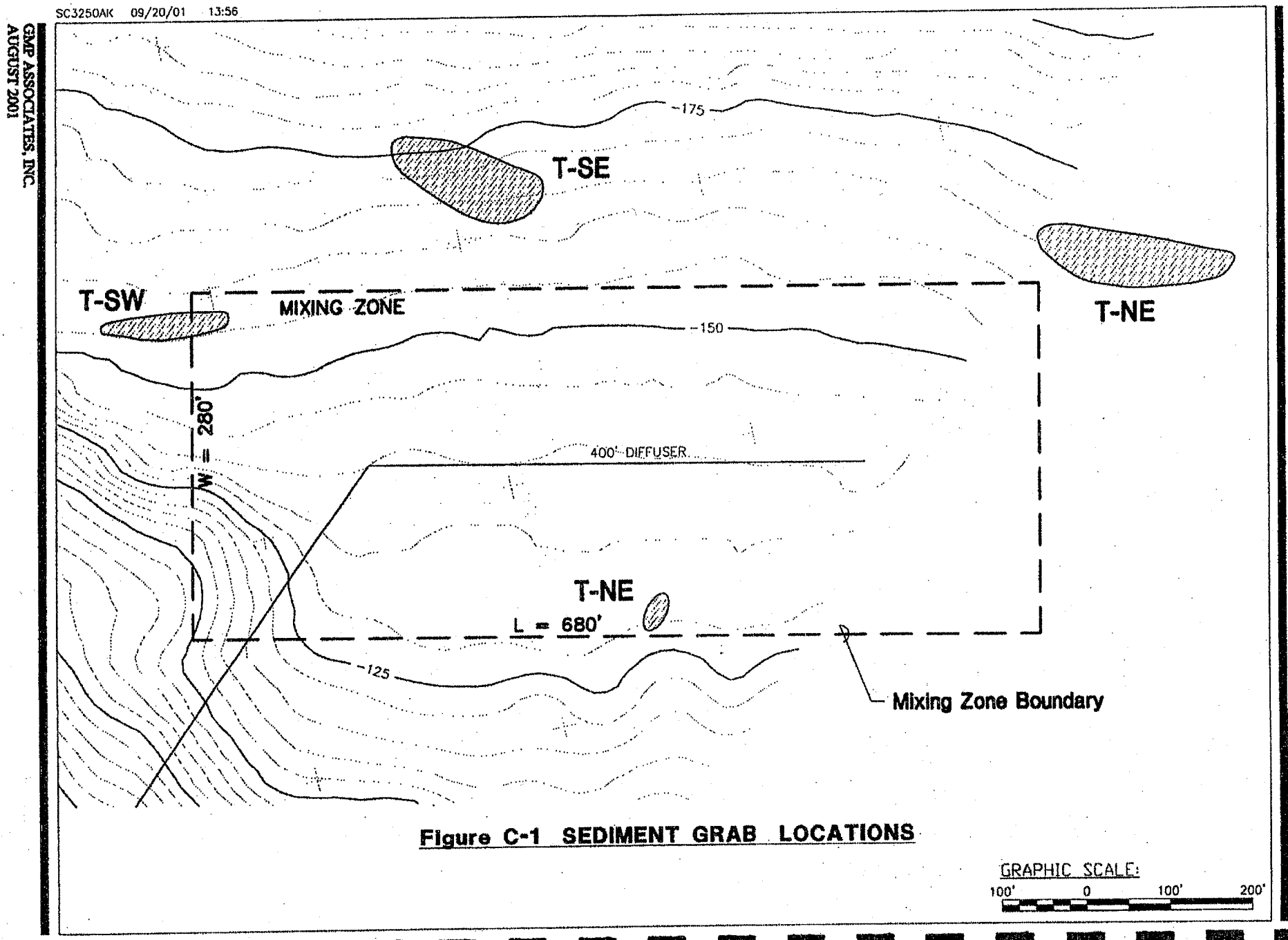
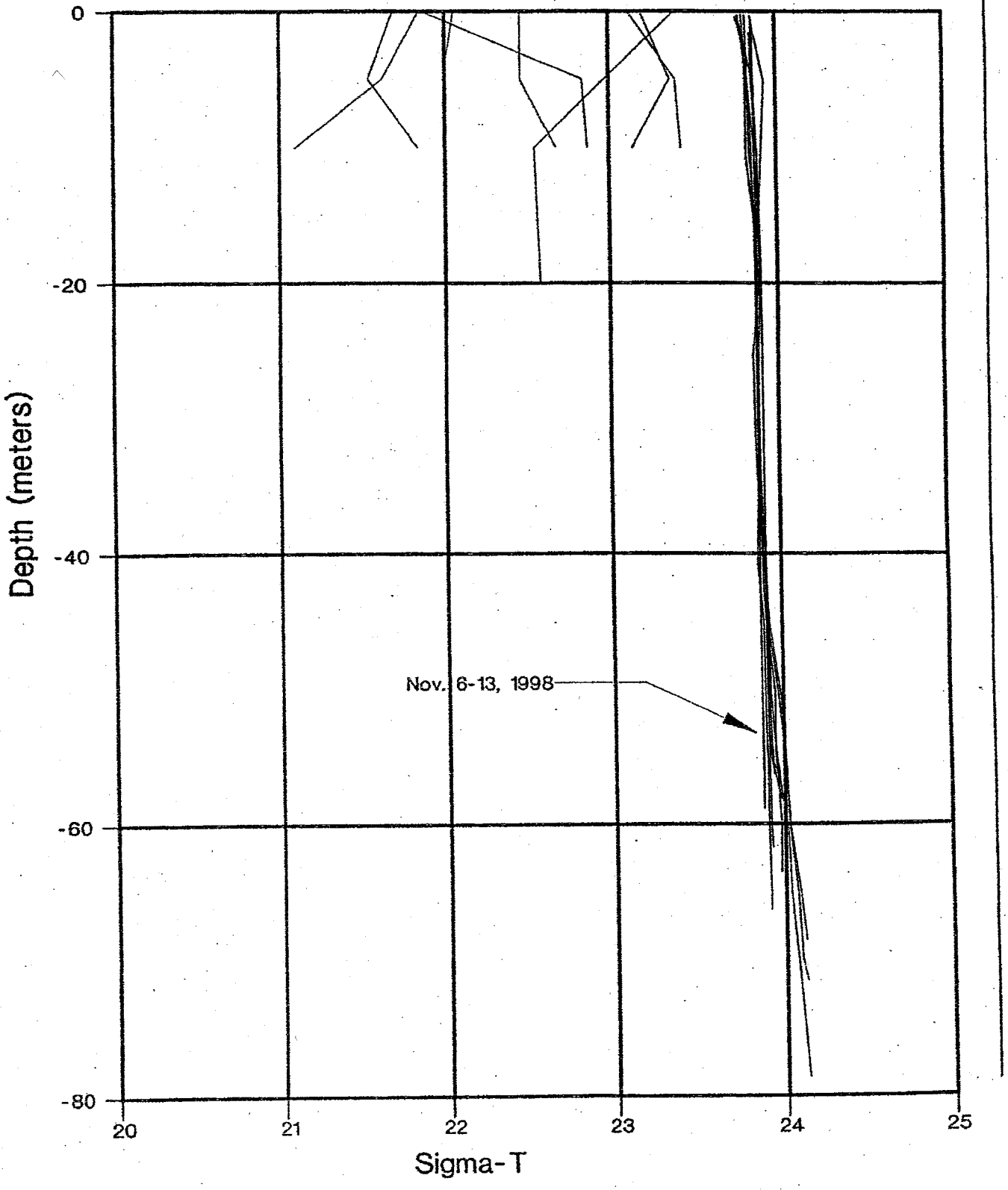


Figure C-1 SEDIMENT GRAB LOCATIONS

NORTHERN DISTRICT WWTP DIFFUSER SITE DENSITY DATA

MONTH	DEPTH (meters)	DENSITY gm/cm^3	TEMP (C)	SAL 0/00	DAY	YEAR	DATA SOURCE	STATION
4	0	1.02205	26.8	34.0	25	89	Matson, A. E. (1990)	E
4	5	1.02199	27.0	34.0	25	89	Matson, A. E. (1990)	E
4	10	1.02199	27.0	34.0	25	89	Matson, A. E. (1990)	E
4	0	1.02340	27.3	36.0	6	98	Gov. of Guam, Water Quality Data	TANG
4	10	1.02255	27.6	35.0	6	98	Gov. of Guam, Water Quality Data	TANG
4	20	1.02258	27.5	35.0	6	98	Gov. of Guam, Water Quality Data	TANG
4	10	1.02173	27.8	34.0	27	98	Gov. of Guam, Water Quality Data	TANG
4	20	1.02167	28.0	34.0	27	98	Gov. of Guam, Water Quality Data	TANG
6	0	1.02312	27.7	35.8	13	89	Matson, A. E. (1990)	D
6	5	1.02340	27.3	36.0	13	89	Matson, A. E. (1990)	D
6	10	1.02343	27.2	36.0	13	89	Matson, A. E. (1990)	D
6	0	1.02319	27.7	35.9	13	89	Matson, A. E. (1990)	E
6	5	1.02337	27.4	36.0	13	89	Matson, A. E. (1990)	E
6	10	1.02314	27.4	35.7	13	89	Matson, A. E. (1990)	E
9	0	1.02186	29.9	35.1	21	89	Matson, A. E. (1990)	D
9	5	1.02284	29.0	36.0	21	89	Matson, A. E. (1990)	D
9	10	1.02287	28.9	36.0	21	89	Matson, A. E. (1990)	D
9	0	1.02246	29.0	35.5	21	89	Matson, A. E. (1990)	E
9	5	1.02246	29.0	35.5	21	89	Matson, A. E. (1990)	E
9	10	1.02268	28.8	35.7	21	89	Matson, A. E. (1990)	E
12	0	1.02169	30.4	35.1	12	89	Matson, A. E. (1990)	C
12	5	1.02154	30.4	34.9	12	89	Matson, A. E. (1990)	C
12	10	1.02184	30.4	35.3	12	89	Matson, A. E. (1990)	C
12	0	1.02140	30.8	34.9	12	89	Matson, A. E. (1990)	D
12	5	1.02138	30.2	34.6	12	89	Matson, A. E. (1990)	D
12	10	1.02056	30.2	33.5	12	89	Matson, A. E. (1990)	D
12	0	1.02184	29.5	34.9	12	89	Matson, A. E. (1990)	E
12	5	1.02162	29.5	34.6	12	89	Matson, A. E. (1990)	E
12	10	1.02109	29.5	33.9	12	89	Matson, A. E. (1990)	E



Edward K. Noda and Associates, Inc.	NORTHERN DISTRICT SEWAGE TREATMENT PLANT OUTFALL EXTENSION	Northern District STP Historic Sigma-T Profiles	FIGURE

ND 1964

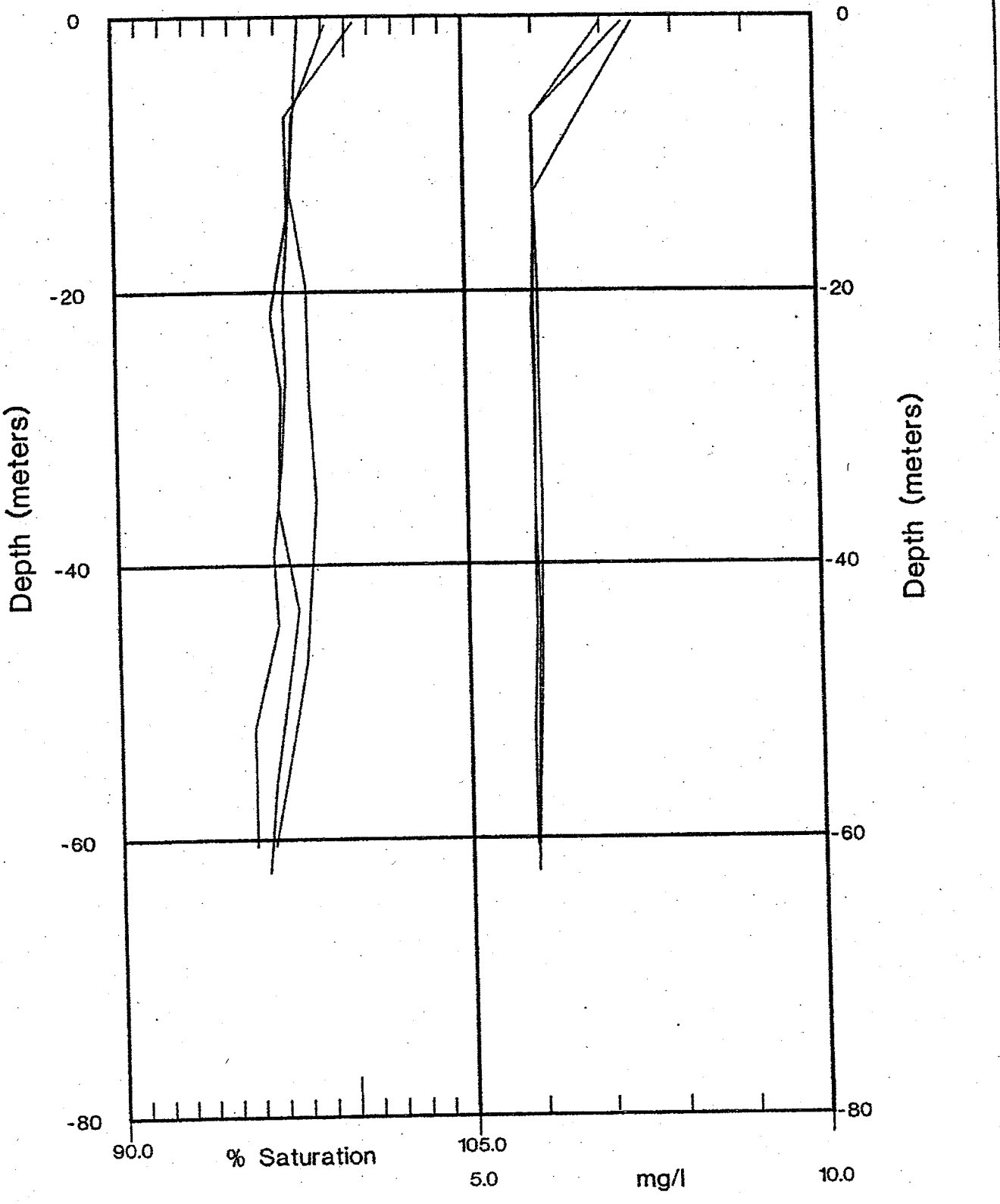
NORTHERN DISTRIC WWTP DENSITY PROFILE DATA BTAINED DURING NOV. 6-13, 1998 BY EDWARD K. NODA AND ASSOCIATES, INC. (Lat. and Long. in WGS 83)

MONTH	DAY	YEAR	DEPTH (meters)	DENSITY gm/cm^3	TEMP (C)	SAL 0/00	Lat.	Long.
11	6	98	0.17	1.02380	29.21	37.40	13 32 45.88N	144 48 9.72E
11	6	98	5.25	1.02381	29.18	37.41	13 32 45.88N	144 48 9.72E
11	6	98	10.62	1.02382	29.16	37.40	13 32 45.88N	144 48 9.72E
11	6	98	15.50	1.02386	29.08	37.42	13 32 45.88N	144 48 9.72E
11	6	98	20.04	1.02388	29.06	37.44	13 32 45.88N	144 48 9.72E
11	6	98	25.22	1.02385	29.12	37.42	13 32 45.88N	144 48 9.72E
11	6	98	30.41	1.02385	29.08	37.41	13 32 45.88N	144 48 9.72E
11	6	98	35.59	1.02387	29.09	37.44	13 32 45.88N	144 48 9.72E
11	6	98	40.65	1.02386	29.05	37.41	13 32 45.88N	144 48 9.72E
11	6	98	45.13	1.02389	29.01	37.43	13 32 45.88N	144 48 9.72E
11	6	98	50.02	1.02389	29.01	37.43	13 32 45.88N	144 48 9.72E
11	6	98	55.52	1.02390	28.99	37.43	13 32 45.88N	144 48 9.72E
11	6	98	60.31	1.02390	28.97	37.43	13 32 45.88N	144 48 9.72E
11	6	98	65.09	1.02391	28.96	37.44	13 32 45.88N	144 48 9.72E
11	6	98	66.42	1.02391	28.97	37.44	13 32 45.88N	144 48 9.72E
11	8	98	0.92	1.02378	29.21	37.38	13 33 13.58N	144 48 23.23E
11	8	98	5.55	1.02387	29.10	37.44	13 33 13.58N	144 48 23.23E
11	8	98	10.02	1.02387	29.09	37.44	13 33 13.58N	144 48 23.23E
11	8	98	15.36	1.02387	29.08	37.44	13 33 13.58N	144 48 23.23E
11	8	98	20.27	1.02387	29.08	37.44	13 33 13.58N	144 48 23.23E
11	8	98	25.32	1.02387	29.09	37.45	13 33 13.58N	144 48 23.23E
11	8	98	30.20	1.02387	29.10	37.45	13 33 13.58N	144 48 23.23E
11	8	98	35.59	1.02387	29.10	37.44	13 33 13.58N	144 48 23.23E
11	8	98	40.37	1.02387	29.09	37.44	13 33 13.58N	144 48 23.23E
11	8	98	45.03	1.02387	29.08	37.44	13 33 13.58N	144 48 23.23E
11	8	98	50.43	1.02387	29.08	37.44	13 33 13.58N	144 48 23.23E
11	8	98	55.52	1.02387	29.08	37.44	13 33 13.58N	144 48 23.23E
11	8	98	56.02	1.02387	29.08	37.44	13 33 13.58N	144 48 23.23E
11	8	98	0.37	1.02376	29.23	37.35	13 33 14.45N	144 48 22.43E
11	8	98	5.45	1.02386	29.10	37.44	13 33 14.45N	144 48 22.43E
11	8	98	10.79	1.02386	29.09	37.43	13 33 14.45N	144 48 22.43E
11	8	98	15.10	1.02387	29.08	37.43	13 33 14.45N	144 48 22.43E
11	8	98	20.34	1.02387	29.08	37.44	13 33 14.45N	144 48 22.43E
11	8	98	25.42	1.02387	29.08	37.44	13 33 14.45N	144 48 22.43E
11	8	98	30.41	1.02387	29.10	37.45	13 33 14.45N	144 48 22.43E
11	8	98	35.16	1.02387	29.10	37.45	13 33 14.45N	144 48 22.43E
11	8	98	40.57	1.02387	29.10	37.45	13 33 14.45N	144 48 22.43E
11	8	98	45.26	1.02387	29.10	37.45	13 33 14.45N	144 48 22.43E
11	8	98	50.33	1.02387	29.08	37.44	13 33 14.45N	144 48 22.43E
11	8	98	55.53	1.02388	29.08	37.44	13 33 14.45N	144 48 22.43E
11	8	98	58.87	1.02387	29.08	37.44	13 33 14.45N	144 48 22.43E
11	9	98	0.27	1.02377	29.06	37.30	13 33 16.16N	144 48 20.25E
11	9	98	5.25	1.02383	29.09	37.38	13 33 16.16N	144 48 20.25E
11	9	98	10.02	1.02385	29.09	37.41	13 33 16.16N	144 48 20.25E
11	9	98	15.10	1.02386	29.08	37.42	13 33 16.16N	144 48 20.25E
11	9	98	20.04	1.02386	29.08	37.43	13 33 16.16N	144 48 20.25E
11	9	98	25.22	1.02387	29.08	37.43	13 33 16.16N	144 48 20.25E
11	9	98	30.20	1.02387	29.08	37.44	13 33 16.16N	144 48 20.25E
11	9	98	35.06	1.02387	29.05	37.43	13 33 16.16N	144 48 20.25E
11	9	98	40.27	1.02389	29.02	37.44	13 33 16.16N	144 48 20.25E
11	9	98	45.26	1.02393	28.91	37.44	13 33 16.16N	144 48 20.25E
11	9	98	50.14	1.02398	28.78	37.45	13 33 16.16N	144 48 20.25E

MONTH	DAY	YEAR	DEPTH (meters)	DENSITY gm/cm^3	TEMP (C)	SAL 0/00		Long.
11	9	98	55.11	1.02401	28.70	37.45	13 33 16.16N	144 48 20.25E
11	9	98	60.10	1.02403	28.65	37.46	13 33 16.16N	144 48 20.25E
11	9	98	65.39	1.02409	28.50	37.47	13 33 16.16N	144 48 20.25E
11	9	98	68.65	1.02412	28.47	37.49	13 33 16.16N	144 48 20.25E
11	9	98	0.57	1.02386	29.10	37.43	13 33 16.48N	144 48 19.88E
11	9	98	5.04	1.02386	29.09	37.43	13 33 16.48N	144 48 19.88E
11	9	98	10.28	1.02387	29.09	37.43	13 33 16.48N	144 48 19.88E
11	9	98	15.30	1.02387	29.08	37.43	13 33 16.48N	144 48 19.88E
11	9	98	20.44	1.02387	29.08	37.44	13 33 16.48N	144 48 19.88E
11	9	98	25.32	1.02387	29.08	37.44	13 33 16.48N	144 48 19.88E
11	9	98	30.30	1.02387	29.08	37.44	13 33 16.48N	144 48 19.88E
11	9	98	35.19	1.02388	29.06	37.44	13 33 16.48N	144 48 19.88E
11	9	98	40.25	1.02389	29.02	37.44	13 33 16.48N	144 48 19.88E
11	9	98	45.26	1.02392	28.93	37.43	13 33 16.48N	144 48 19.88E
11	9	98	50.14	1.02397	28.85	37.46	13 33 16.48N	144 48 19.88E
11	9	98	55.01	1.02400	28.71	37.45	13 33 16.48N	144 48 19.88E
11	9	98	60.31	1.02403	28.67	37.46	13 33 16.48N	144 48 19.88E
11	9	98	65.20	1.02407	28.52	37.46	13 33 16.48N	144 48 19.88E
11	9	98	70.09	1.02409	28.48	37.47	13 33 16.48N	144 48 19.88E
11	9	98	71.61	1.02412	28.47	37.50	13 33 16.48N	144 48 19.88E
11	9	98	1.42	1.02386	29.09	37.43	13 33 16.70N	144 48 18.98E
11	9	98	5.25	1.02386	29.09	37.43	13 33 16.70N	144 48 18.98E
11	9	98	10.28	1.02387	29.09	37.44	13 33 16.70N	144 48 18.98E
11	9	98	15.20	1.02387	29.08	37.44	13 33 16.70N	144 48 18.98E
11	9	98	20.14	1.02387	29.08	37.44	13 33 16.70N	144 48 18.98E
11	9	98	25.22	1.02387	29.08	37.44	13 33 16.70N	144 48 18.98E
11	9	98	30.20	1.02387	29.08	37.44	13 33 16.70N	144 48 18.98E
11	9	98	35.19	1.02388	29.05	37.44	13 33 16.70N	144 48 18.98E
11	9	98	40.15	1.02390	29.01	37.44	13 33 16.70N	144 48 18.98E
11	9	98	45.16	1.02391	28.98	37.45	13 33 16.70N	144 48 18.98E
11	9	98	50.12	1.02395	28.88	37.45	13 33 16.70N	144 48 18.98E
11	9	98	55.31	1.02395	28.85	37.44	13 33 16.70N	144 48 18.98E
11	9	98	60.31	1.02402	28.69	37.46	13 33 16.70N	144 48 18.98E
11	9	98	65.18	1.02403	28.64	37.45	13 33 16.70N	144 48 18.98E
11	9	98	70.09	1.02407	28.52	37.45	13 33 16.70N	144 48 18.98E
11	9	98	75.28	1.02411	28.45	37.47	13 33 16.70N	144 48 18.98E
11	9	98	78.64	1.02413	28.41	37.48	13 33 16.70N	144 48 18.98E
11	10	98	0.47	1.02380	29.16	37.38	13 33 3.73N	144 48 15.88E
11	10	98	5.25	1.02382	29.16	37.41	13 33 3.73N	144 48 15.88E
11	10	98	10.28	1.02384	29.12	37.41	13 33 3.73N	144 48 15.88E
11	10	98	15.20	1.02386	29.09	37.44	13 33 3.73N	144 48 15.88E
11	10	98	20.24	1.02387	29.09	37.44	13 33 3.73N	144 48 15.88E
11	10	98	25.25	1.02387	29.08	37.44	13 33 3.73N	144 48 15.88E
11	10	98	30.00	1.02387	29.08	37.44	13 33 3.73N	144 48 15.88E
11	10	98	35.09	1.02388	29.07	37.44	13 33 3.73N	144 48 15.88E
11	10	98	40.05	1.02388	29.05	37.44	13 33 3.73N	144 48 15.88E
11	10	98	45.16	1.02390	29.01	37.45	13 33 3.73N	144 48 15.88E
11	10	98	50.24	1.02391	29.01	37.45	13 33 3.73N	144 48 15.88E
11	10	98	55.01	1.02392	28.97	37.45	13 33 3.73N	144 48 15.88E
11	10	98	58.26	1.02398	28.87	37.49	13 33 3.73N	144 48 15.88E
11	10	98	0.57	1.02385	29.28	37.50	13 33 7.57N	144 48 16.14E
11	10	98	5.14	1.02393	29.11	37.53	13 33 7.57N	144 48 16.14E
11	10	98	10.22	1.02391	29.11	37.50	13 33 7.57N	144 48 16.14E
11	10	98	15.30	1.02389	29.11	37.47	13 33 7.57N	144 48 16.14E
11	10	98	20.27	1.02389	29.09	37.46	13 33 7.57N	144 48 16.14E
11	10	98	25.32	1.02388	29.08	37.45	13 33 7.57N	144 48 16.14E
11	10	98	30.10	1.02388	29.06	37.44	13 33 7.57N	144 48 16.14E

MONTH	DAY	YEAR	DEPTH (meters)	DENSITY gm/cm^3	TEMP (C)	SAL 0/00		Long.
11	10	98	35.06	1.02389	29.03	37.44	13 33 7.57N	144 48 16.14E
11	10	98	40.17	1.02390	28.99	37.44	13 33 7.57N	144 48 16.14E
11	10	98	45.16	1.02392	28.95	37.45	13 33 7.57N	144 48 16.14E
11	10	98	50.22	1.02393	28.93	37.45	13 33 7.57N	144 48 16.14E
11	10	98	55.11	1.02395	28.86	37.45	13 33 7.57N	144 48 16.14E
11	10	98	60.10	1.02397	28.81	37.45	13 33 7.57N	144 48 16.14E
11	10	98	63.66	1.02397	28.81	37.45	13 33 7.57N	144 48 16.14E
11	12	98	1.58	1.02384	29.10	37.41	13 33 27.54N	144 48 8.97E
11	12	98	5.14	1.02385	29.09	37.41	13 33 27.54N	144 48 8.97E
11	12	98	10.12	1.02388	29.06	37.44	13 33 27.54N	144 48 8.97E
11	12	98	15.10	1.02388	29.04	37.44	13 33 27.54N	144 48 8.97E
11	12	98	20.34	1.02389	29.02	37.44	13 33 27.54N	144 48 8.97E
11	12	98	25.12	1.02390	29.01	37.45	13 33 27.54N	144 48 8.97E
11	12	98	30.10	1.02391	29.00	37.45	13 33 27.54N	144 48 8.97E
11	12	98	35.29	1.02391	28.99	37.45	13 33 27.54N	144 48 8.97E
11	12	98	40.05	1.02391	28.99	37.45	13 33 27.54N	144 48 8.97E
11	12	98	45.05	1.02391	28.98	37.45	13 33 27.54N	144 48 8.97E
11	12	98	50.33	1.02392	28.97	37.45	13 33 27.54N	144 48 8.97E
11	12	98	55.21	1.02393	28.93	37.45	13 33 27.54N	144 48 8.97E
11	12	98	56.65	1.02397	28.89	37.48	13 33 27.54N	144 48 8.97E
11	12	98	0.27	1.02382	29.09	37.37	13 33 32.24N	144 48 14.25E
11	12	98	5.14	1.02383	29.09	37.38	13 33 32.24N	144 48 14.25E
11	12	98	10.32	1.02387	29.06	37.42	13 33 32.24N	144 48 14.25E
11	12	98	15.10	1.02387	29.04	37.43	13 33 32.24N	144 48 14.25E
11	12	98	20.14	1.02389	29.02	37.44	13 33 32.24N	144 48 14.25E
11	12	98	25.15	1.02390	29.00	37.44	13 33 32.24N	144 48 14.25E
11	12	98	30.00	1.02390	29.00	37.44	13 33 32.24N	144 48 14.25E
11	12	98	35.19	1.02391	28.99	37.44	13 33 32.24N	144 48 14.25E
11	12	98	40.27	1.02391	28.98	37.45	13 33 32.24N	144 48 14.25E
11	12	98	45.16	1.02392	28.96	37.45	13 33 32.24N	144 48 14.25E
11	12	98	50.33	1.02393	28.94	37.45	13 33 32.24N	144 48 14.25E
11	12	98	55.01	1.02396	28.86	37.45	13 33 32.24N	144 48 14.25E
11	12	98	57.95	1.02398	28.82	37.47	13 33 32.24N	144 48 14.25E
11	12	98	0.31	1.02385	29.11	37.42	13 33 7.58N	144 48 3.04E
11	12	98	5.35	1.02386	29.09	37.43	13 33 7.58N	144 48 3.04E
11	12	98	10.12	1.02388	29.05	37.44	13 33 7.58N	144 48 3.04E
11	12	98	15.26	1.02389	29.03	37.44	13 33 7.58N	144 48 3.04E
11	12	98	20.24	1.02390	29.02	37.45	13 33 7.58N	144 48 3.04E
11	12	98	25.02	1.02391	29.01	37.45	13 33 7.58N	144 48 3.04E
11	12	98	30.30	1.02391	29.01	37.45	13 33 7.58N	144 48 3.04E
11	12	98	35.19	1.02390	29.01	37.45	13 33 7.58N	144 48 3.04E
11	12	98	40.17	1.02391	29.00	37.45	13 33 7.58N	144 48 3.04E
11	12	98	45.13	1.02391	28.99	37.45	13 33 7.58N	144 48 3.04E
11	12	98	50.14	1.02391	28.98	37.45	13 33 7.58N	144 48 3.04E
11	12	98	55.01	1.02393	28.95	37.46	13 33 7.58N	144 48 3.04E
11	12	98	56.33	1.02394	28.95	37.46	13 33 7.58N	144 48 3.04E
11	12	98	1.08	1.02385	29.10	37.42	13 33 8.23N	144 48 3.20E
11	12	98	5.00	1.02386	29.09	37.42	13 33 8.23N	144 48 3.20E
11	12	98	10.32	1.02387	29.07	37.43	13 33 8.23N	144 48 3.20E
11	12	98	15.30	1.02389	29.03	37.44	13 33 8.23N	144 48 3.20E
11	12	98	20.17	1.02389	29.03	37.44	13 33 8.23N	144 48 3.20E
11	12	98	25.22	1.02390	29.02	37.45	13 33 8.23N	144 48 3.20E
11	12	98	30.00	1.02390	29.01	37.45	13 33 8.23N	144 48 3.20E
11	12	98	35.26	1.02390	29.01	37.45	13 33 8.23N	144 48 3.20E
11	12	98	40.15	1.02391	29.01	37.45	13 33 8.23N	144 48 3.20E
11	12	98	45.03	1.02391	29.00	37.45	13 33 8.23N	144 48 3.20E
11	12	98	50.12	1.02391	29.00	37.45	13 33 8.23N	144 48 3.20E

MONTH	DAY	YEAR	DEPTH (meters)	DENSITY gm/cm^3	TEMP (C)	SAL 0/00	- --	Long.
11	12	98	55.21	1.02391	28.99	37.45	13 33 8.23N	144 48 3.20E
11	12	98	60.09	1.02392	28.97	37.45	13 33 8.23N	144 48 3.20E
11	12	98	61.83	1.02392	28.97	37.46	13 33 8.23N	144 48 3.20E



DISSOLVED OXYGEN

ND 1969

Edward K. Noda and Associates, Inc.	NORTHERN DISTRICT SEWAGE TREATMENT PLANT OUTFALL EXTENSION	Northern District STP Dissolved Oxygen Profiles Measured During Nov. 6-13, 1998	FIGURE

NORTHERN DISTRICT _ _SSOLVED OXYGEN(DO) PROFIL_ _ATA OBTAINED DURING NOV. 12-13, 1998 BY EDWARD K. NODA AND ASSOCIATES, INC. (Lat. and Long. in WGS 83)

MONTH	DAY	YEAR	DEPTH (meters)	DO Pct Sat	DO mg/l	TEMP (C)	Cond mS/cm	Turb NTUs	pH	ORP mV	Lat.	Long.
11	12	98	0.57	99.2	6.99	28.53	3.06	5	8.11	252	13 33 31.90N	144 48 15.78E
11	12	98	7.33	97.7	6.00	29.13	2.70	0	8.19	246	13 33 31.90N	144 48 15.78E
11	12	98	14.42	97.5	6.00	29.09	2.80	0	8.20	246	13 33 31.90N	144 48 15.78E
11	12	98	20.88	97.2	5.98	29.07	2.78	0	8.20	245	13 33 31.90N	144 48 15.78E
11	12	98	26.17	97.3	5.99	29.04	2.80	0	8.20	245	13 33 31.90N	144 48 15.78E
11	12	98	32.10	97.1	5.97	29.03	2.80	0	8.20	244	13 33 31.90N	144 48 15.78E
11	12	98	39.35	96.7	5.95	29.03	2.80	0	8.20	244	13 33 31.90N	144 48 15.78E
11	12	98	44.30	96.9	5.96	29.02	2.80	0	8.20	243	13 33 31.90N	144 48 15.78E
11	12	98	51.93	95.8	5.91	28.91	2.80	0	8.20	244	13 33 31.90N	144 48 15.78E
11	12	98	60.56	95.8	5.91	28.90	2.80	0	8.19	245	13 33 31.90N	144 48 15.78E
11	12	98	0.43	100.4	7.32	28.28	5.06	7	7.71	276	13 33 8.45N	144 48 27.14E
11	12	98	7.36	97.4	5.98	29.13	2.75	0	8.19	240	13 33 8.45N	144 48 27.14E
11	12	98	14.53	97.4	5.99	29.09	2.74	0	8.19	240	13 33 8.45N	144 48 27.14E
11	12	98	21.70	96.7	5.95	29.08	2.78	0	8.19	240	13 33 8.45N	144 48 27.14E
11	12	98	27.14	97.1	5.97	29.07	2.79	0	8.19	239	13 33 8.45N	144 48 27.14E
11	12	98	35.90	96.9	5.96	29.06	2.79	0	8.19	238	13 33 8.45N	144 48 27.14E
11	12	98	43.27	97.7	6.01	29.05	2.80	0	8.19	237	13 33 8.45N	144 48 27.14E
11	12	98	56.10	96.7	5.95	29.03	2.80	0	8.18	238	13 33 8.45N	144 48 27.14E
11	12	98	62.43	96.3	5.93	28.98	2.80	0	8.17	240	13 33 8.45N	144 48 27.14E
11	13	98	0.43	98.0	7.46	27.25	8.21	39	7.89	253	13 33 22.88N	144 48 11.38E
11	13	98	12.80	97.6	6.00	29.06	2.80	0	8.16	238	13 33 22.88N	144 48 11.38E
11	13	98	19.65	98.2	6.04	29.05	2.80	0	8.16	241	13 33 22.88N	144 48 11.38E
11	13	98	27.81	98.3	6.04	29.06	2.80	0	8.15	246	13 33 22.88N	144 48 11.38E
11	13	98	35.24	98.5	6.06	29.05	2.80	0	8.15	251	13 33 22.88N	144 48 11.38E
11	13	98	46.98	98.1	6.03	29.03	2.80	0	8.14	256	13 33 22.88N	144 48 11.38E
11	13	98	60.52	96.6	5.95	28.99	2.80	0	8.13	265	13 33 22.88N	144 48 11.38E

GUAM NORTHERN DISTRICT WWTP DIFFUSER -- 1

CURRENT METER S/N -- 0831

METER POSITION ----- 2

DATA ACQUISITION
   DEPLOYMENT DATE(GST) - NOV. 7 ,1998
   DEPLOYMENT TIME(GST) - 1715

   RETRIEVAL DATE(GST) --- NOV. 13,1998
   RETRIEVAL TIME(GST) --- 0935

MOORING LOCATION
   LATITUDE -------- 13-33.13N
   LONGITUDE ------- 144-48.26E

SENSOR DEPTH(M) ---- 27

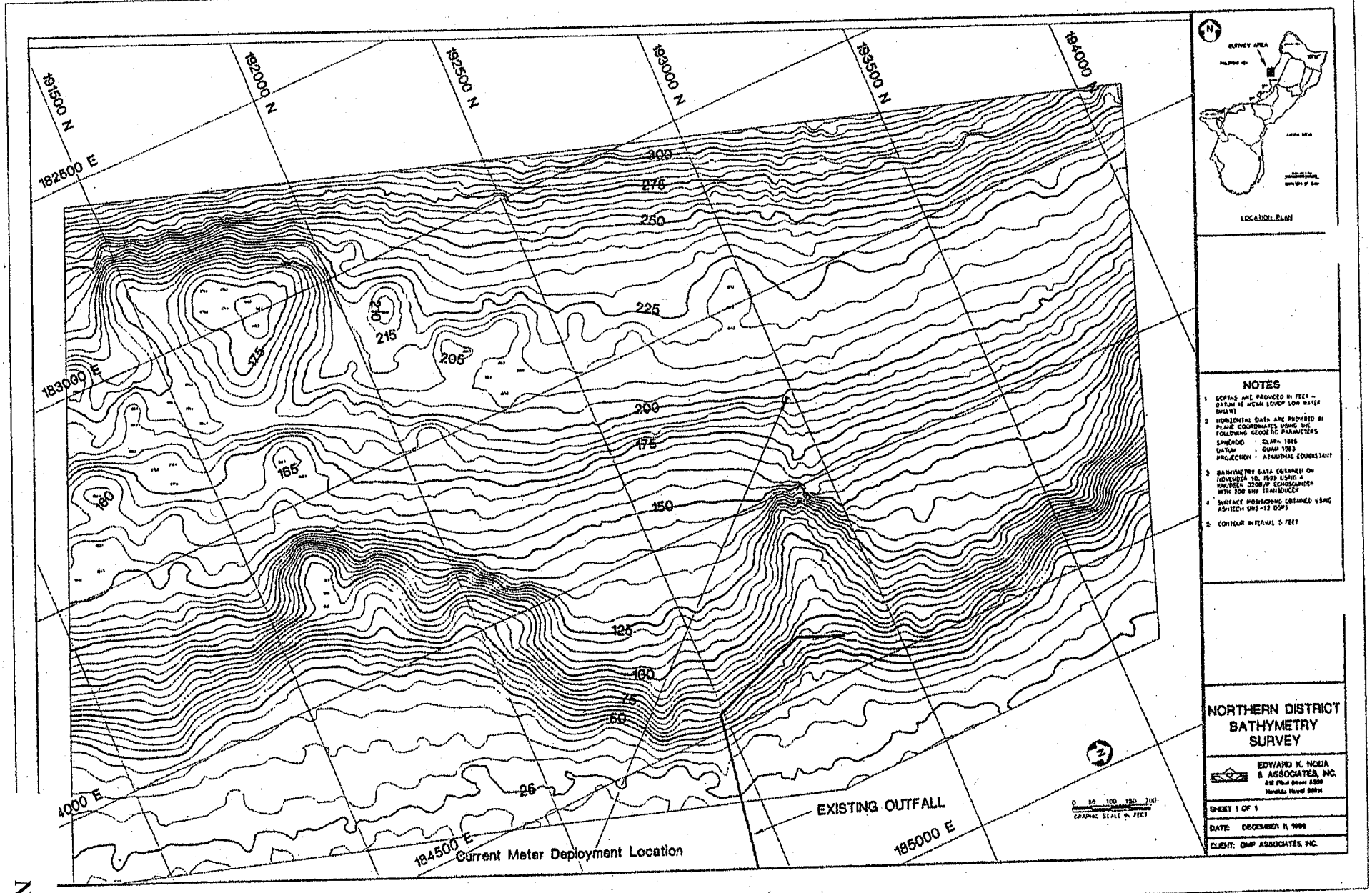
BOTTOM DEPTH(M) ---- 58

MAGNETIC DECLINATION(DEGREES) -- 1.8

DATA ANALYSIS
   START DATE(GST) - NOV. 7 ,1998
   START TIME(GST) - 1715

   ENDING DATE(GST) - NOV. 13,1998
   ENDING TIME(GST) - 0935

TIME INTERVAL(MIN) - 10.00


191500 N
192000 N
192500 N
193000 N
193500 N
194000 N
182500 E
183000 E
184000 E
184500 E
185000 E
300
275
250
225
215
205
200
175
165
150
125
100
75
60
25
180
Current Meter Deployment Location
EXISTING OUTFALL
SURVEY AREA
LOCATION PLAN
NOTES
1 SOUNDINGS ARE REDUCED IN FEET -- DATUM IS MEAN LOWER LOW WATER (MLLW)
2 HORIZONTAL DATA ARE REDUCED TO PLANE COORDINATES USING THE FOLLOWING GEODETIC PARAMETERS
SPHEROID : CLARK 1866
DATUM : GUAM 1963
PROJECTION : AZIMUTHAL EQUIDISTANT
3 BATHYMETRY DATA OBTAINED ON NOVEMBER 10, 1998 USING A HYDROTECH 320KF/F ECHOSOUNDER WITH 200 kHz TRANSDUCER
4 SURFACE POSITIONING OBTAINED USING ASHTECH DHS-12 GPS
5 CONTOUR INTERVAL 5 FEET
NORTHERN DISTRICT BATHYMETRY SURVEY
EDWARD K. NODA & ASSOCIATES, INC.
SHEET 1 OF 1
DATE: DECEMBER 11, 1998
CLIENT: BMP ASSOCIATES, INC.

ND 1972

DISTRIBUTION FREQUENCY

.17 HOUR AVERAGES
DEPLOYMENT 1 METER POSITION 2
FROM 1715 7 NOV 1998 TO 935 13 NOV 1998

DIRECTION DEGREES TRUE	27 METERS DEPTH									
0- 15	14	10	2	5	0	1	0	0	0	0
15- 30	18	46	39	34	7	4	3	0	0	0
30- 45	30	65	57	16	1	0	0	0	0	0
45- 60	39	27	6	0	0	0	0	0	0	0
60- 75	27	9	1	0	0	0	0	0	0	0
75- 90	19	2	0	0	0	0	0	0	0	0
90-105	30	5	0	0	0	0	0	0	0	0
105-120	10	8	0	0	0	0	0	0	0	0
120-135	11	4	0	0	0	0	0	0	0	0
135-150	15	11	1	0	0	0	0	0	0	0
150-165	17	13	4	0	0	0	0	0	0	0
165-180	31	24	24	1	0	0	0	0	0	0
180-195	38	24	17	7	2	0	0	0	0	0
195-210	10	4	1	0	0	0	0	0	0	0
210-225	3	3	0	0	0	0	0	0	0	0
225-240	2	1	0	0	0	0	0	0	0	0
240-255	2	0	0	0	0	0	0	0	0	0
255-270	1	0	0	0	0	0	0	0	0	0
270-285	4	0	0	0	0	0	0	0	0	0
285-300	1	0	0	0	0	0	0	0	0	0
300-315	0	0	0	0	0	0	0	0	0	0
315-330	0	1	0	0	0	0	0	0	0	0
330-345	1	0	0	0	0	0	0	0	0	0
345-360	5	1	0	0	0	0	0	0	0	0
SPEED	0	5	10	15	20	25	30	35	40	45
CM/SEC	| 5	| 10	| 15	| 20	| 25	| 30	| 35	| 40	| 45	| 50	

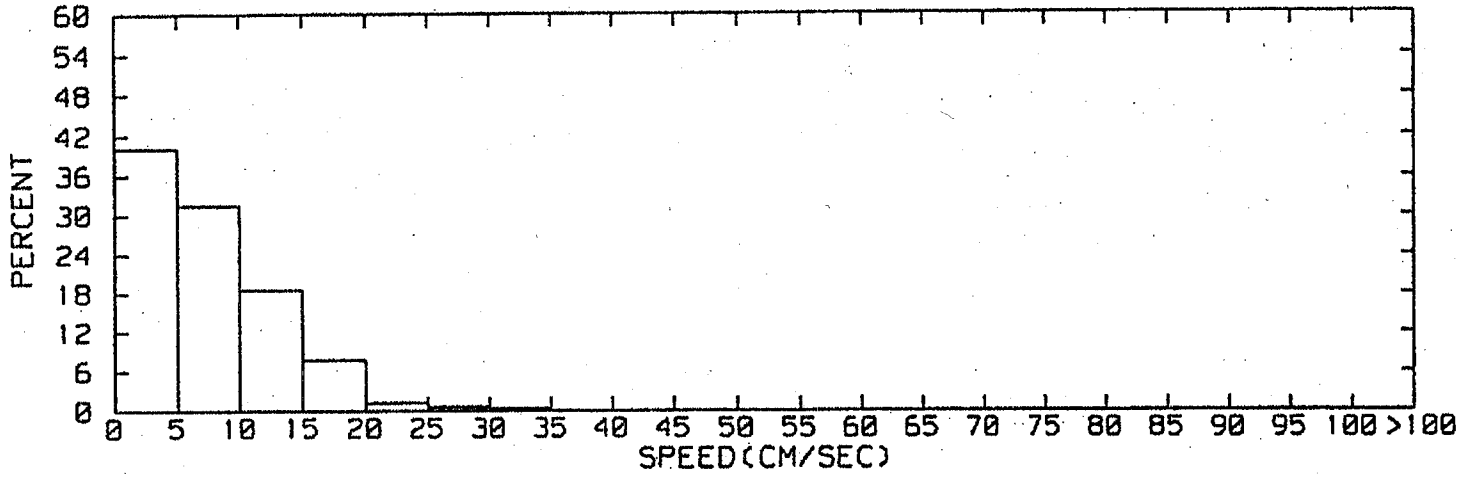
0- 15	0	0	0	0	0	0	0	0	0	0	0
15- 30	0	0	0	0	0	0	0	0	0	0	0
30- 45	0	0	0	0	0	0	0	0	0	0	0
45- 60	0	0	0	0	0	0	0	0	0	0	0
60- 75	0	0	0	0	0	0	0	0	0	0	0
75- 90	0	0	0	0	0	0	0	0	0	0	0
90-105	0	0	0	0	0	0	0	0	0	0	0
105-120	0	0	0	0	0	0	0	0	0	0	0
120-135	0	0	0	0	0	0	0	0	0	0	0
135-150	0	0	0	0	0	0	0	0	0	0	0
150-165	0	0	0	0	0	0	0	0	0	0	0
165-180	0	0	0	0	0	0	0	0	0	0	0
180-195	0	0	0	0	0	0	0	0	0	0	0
195-210	0	0	0	0	0	0	0	0	0	0	0
210-225	0	0	0	0	0	0	0	0	0	0	0
225-240	0	0	0	0	0	0	0	0	0	0	0
240-255	0	0	0	0	0	0	0	0	0	0	0
255-270	0	0	0	0	0	0	0	0	0	0	0
270-285	0	0	0	0	0	0	0	0	0	0	0
285-300	0	0	0	0	0	0	0	0	0	0	0
300-315	0	0	0	0	0	0	0	0	0	0	0
315-330	0	0	0	0	0	0	0	0	0	0	0
330-345	0	0	0	0	0	0	0	0	0	0	0
345-360	0	0	0	0	0	0	0	0	0	0	0
SPEED	50	55	60	65	70	75	80	85	90	95	
CM/SEC	| 55	| 60	| 65	| 70	| 75	| 80	| 85	| 90	| 95	| 100	>100

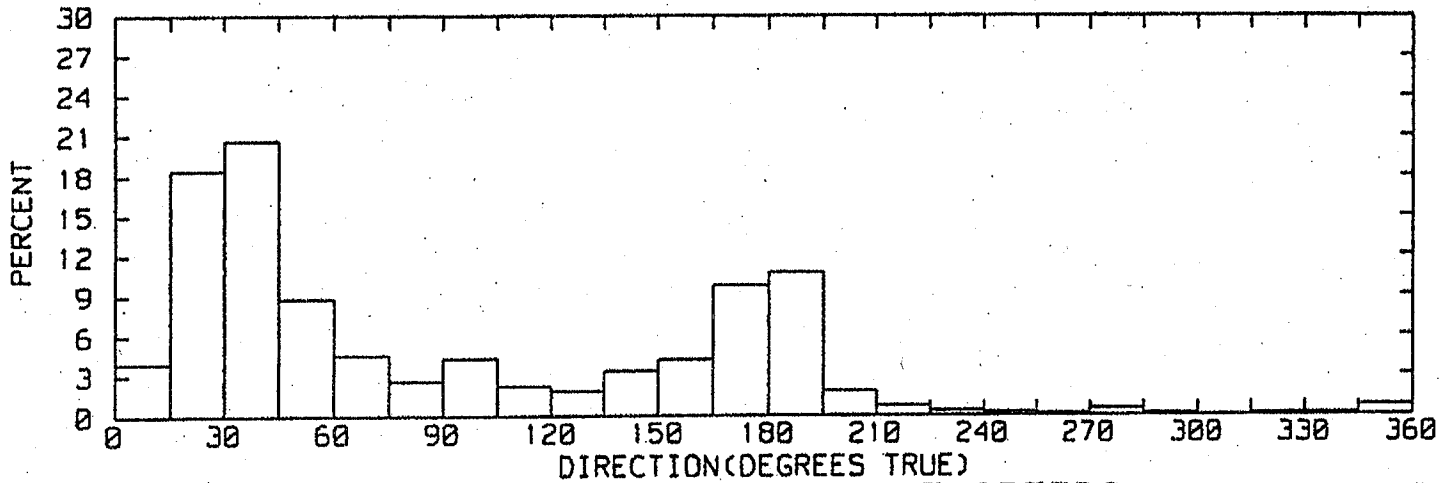
SUMMARY STATISTICS
DEPLOYMENT 1 METER POSITION 2
FROM 1715 7 NOV 1998 TO 935 13 NOV 1998

DIRECTION(DEGREES TRUE)	TOTAL OBSERVATIONS	PERCENT
0 TO 15	32	3.91
15 TO 30	151	18.44
30 TO 45	169	20.63
45 TO 60	72	8.79
60 TO 75	37	4.52
75 TO 90	21	2.56
90 TO 105	35	4.27
105 TO 120	18	2.20
120 TO 135	15	1.83
135 TO 150	27	3.30
150 TO 165	34	4.15
165 TO 180	80	9.77
180 TO 195	88	10.74
195 TO 210	15	1.83
210 TO 225	6	.73
225 TO 240	3	.37
240 TO 255	2	.24
255 TO 270	1	.12
270 TO 285	4	.49
285 TO 300	1	.12
300 TO 315	0	0.00
315 TO 330	1	.12
330 TO 345	1	.12
345 TO 360	6	.73

SPEED(CM/SEC)	TOTAL OBSERVATIONS	PERCENT
0.0 TO 5.0	328	40.05
5.0 TO 10.0	258	31.50
10.0 TO 15.0	152	18.56
15.0 TO 20.0	63	7.69
20.0 TO 25.0	10	1.22
25.0 TO 30.0	5	.61
30.0 TO 35.0	3	.37
35.0 TO 40.0	0	0.00
40.0 TO 45.0	0	0.00
45.0 TO 50.0	0	0.00
50.0 TO 55.0	0	0.00
55.0 TO 60.0	0	0.00
60.0 TO 65.0	0	0.00
65.0 TO 70.0	0	0.00
70.0 TO 75.0	0	0.00
75.0 TO 80.0	0	0.00
80.0 TO 85.0	0	0.00
85.0 TO 90.0	0	0.00
90.0 TO 95.0	0	0.00
95.0 TO 100.0	0	0.00
ABOVE 100	0	0.00

TOTAL NUMBER OF POINTS READ = 819
TOTAL NUMBER OF OBSERVATIONS USED IN THE DISTRIBUTIONS = 819
MEAN SPEED = 7.50 CM/SEC
STANDARD DEVIATION = 5.38 CM/SEC
MAXIMUM SPEED = 32.90 CM/SEC
MINIMUM SPEED = 0.00 CM/SEC
RANGE = 32.90 CM/SEC

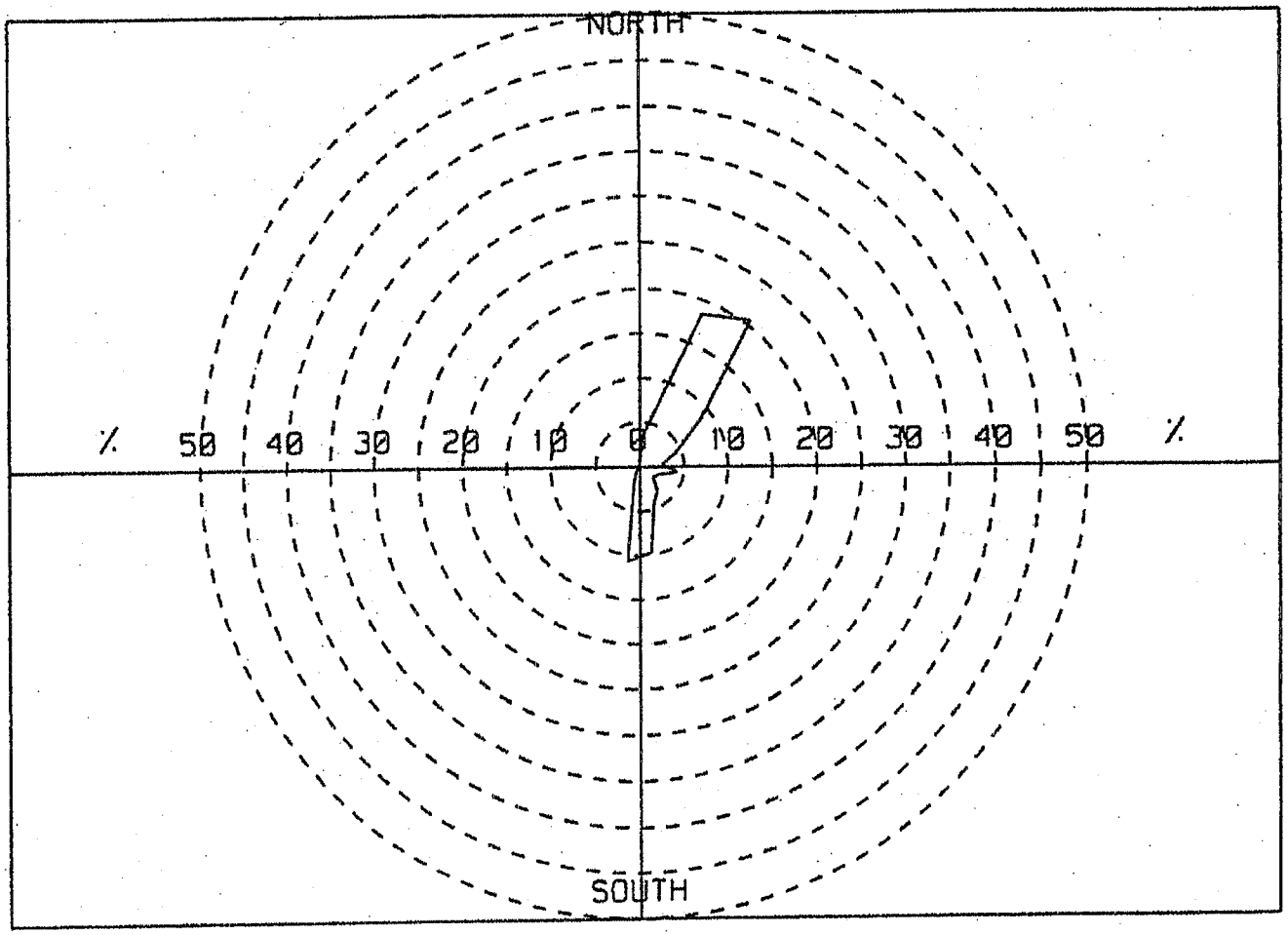




HISTOGRAMS OF CURRENT SPEEDS

(GST) 1715 NOV 7 1998 TO 0935 NOV 13 1998

LATITUDE: 13-33.13N LONGITUDE: 144-48.26E NOMINAL DEPTH(M): 27



PERCENT OCCURRENCE VS DIRECTION(DEG TRUE)

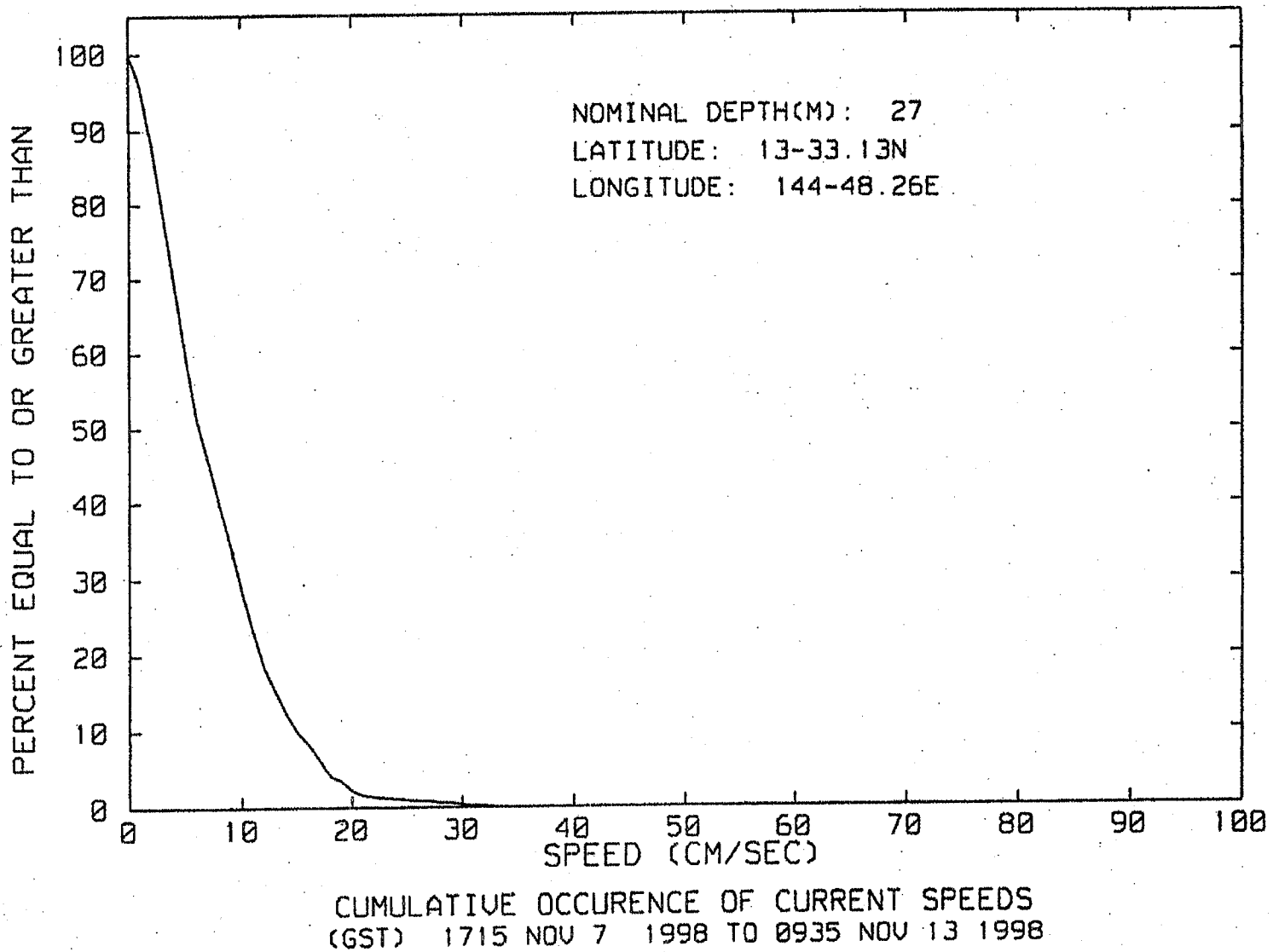
(GST) 1715 NOV 7 1998 TO 0935 NOV 13 1998

LATITUDE: 13-33.13N LONGITUDE: 144-48.26E NOMINAL DEPTH(M): 27

LATITUDE: 13-33.13N
LONGITUDE: 144-48.26E
NOMINAL DEPTH(METERS): 27
TIME SPAN(GST): 1715 NOV 7 1998 TO 0935 NOV 13 1998

CUMULATIVE OCCURENCE OF CURRENT SPEEDS

SPEED (CM/SEC)	PERCENT EQUAL TO OR GREATER THAN
0	100.000
3	78.999
6	51.282
9	34.554
12	18.437
15	9.890
18	4.151
21	1.587
24	1.099
27	.855
30	.366
33	0.000

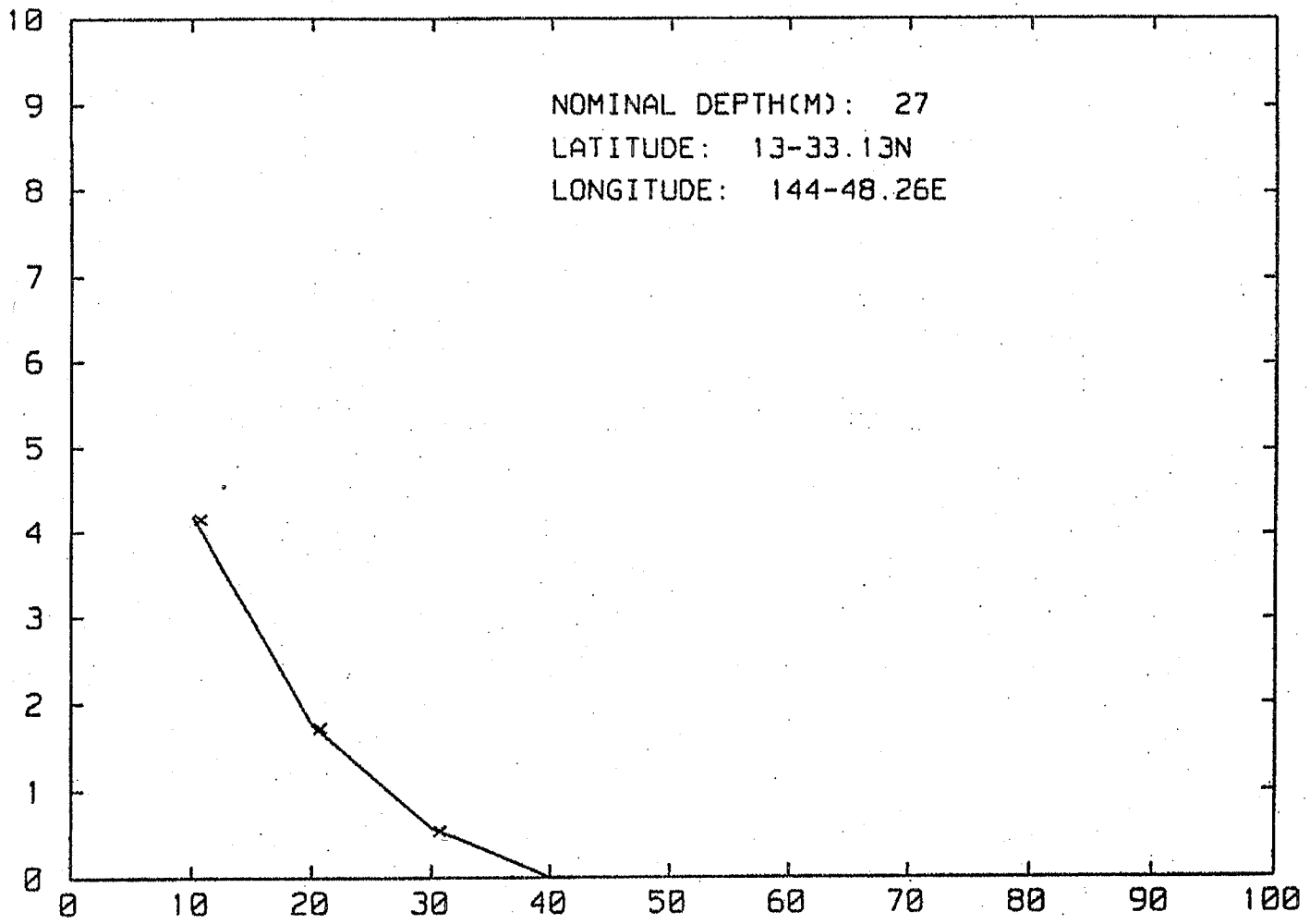


CUMULATIVE OCCURENCE OF CURRENT SPEEDS
(GST) 1715 NOV 7 1998 TO 0935 NOV 13 1998

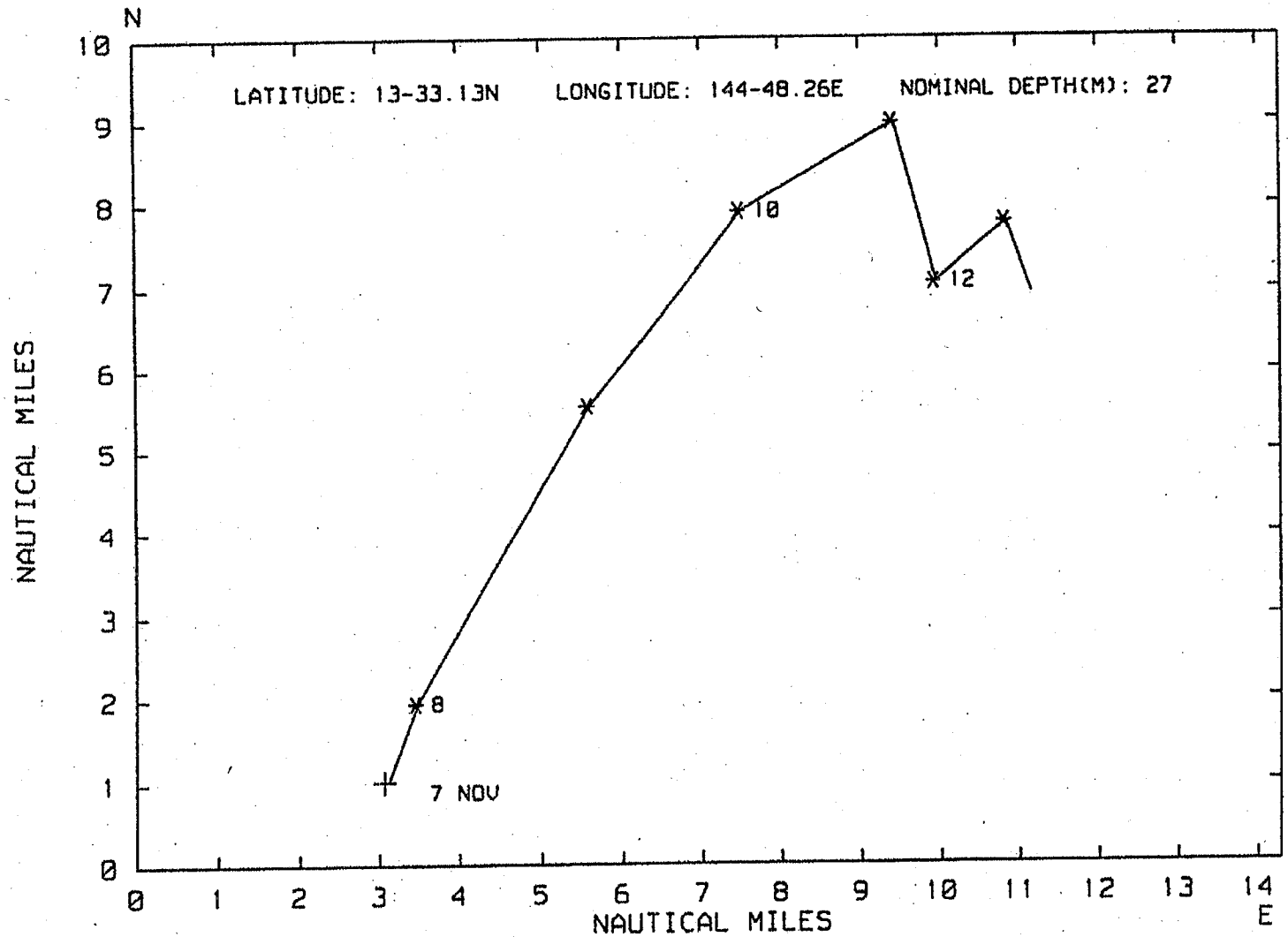
LATITUDE: 13-33.13N
LONGITUDE: 144-48.26E
NOMINAL DEPTH(METERS): 27
TIME SPAN(GST): 1715 NOV 7 1998 TO 0935 NOV 13 1998

PERSISTENCE OF CURRENT SPEEDS

SPEED (CM/SEC)	MAXIMUM DURATION (HOURS)
10	4.19
20	1.75
30	.57
40	0.00



PERSISTENCE OF CURRENT SPEED FROM:
(GST) 1715 NOV 7 1998 TO 0935 NOV 13 1998



PROGRESSIVE VECTOR DIAGRAM OF CURRENTS
(GST) 1715 NOV 7 1998 TO 0935 NOV 13 1998

TEMPERATURE STATISTICS

DEPLOYMENT 1 METER POSITION 2
FROM 1715 7 NOV 1998 TO 935 13 NOV 1998

TEMPERATURE(CENTIGRADE)	TOTAL OBSERVATIONS	PERCENT
0 TO 1	0	0.00
1 TO 2	0	0.00
2 TO 3	0	0.00
3 TO 4	0	0.00
4 TO 5	0	0.00
5 TO 6	0	0.00
6 TO 7	0	0.00
7 TO 8	0	0.00
8 TO 9	0	0.00
9 TO 10	0	0.00
10 TO 11	0	0.00
11 TO 12	0	0.00
12 TO 13	0	0.00
13 TO 14	0	0.00
14 TO 15	0	0.00
15 TO 16	0	0.00
16 TO 17	0	0.00
17 TO 18	0	0.00
18 TO 19	0	0.00
19 TO 20	0	0.00
20 TO 21	0	0.00
21 TO 22	0	0.00
22 TO 23	0	0.00
23 TO 24	0	0.00
24 TO 25	0	0.00
25 TO 26	0	0.00
26 TO 27	0	0.00
27 TO 28	0	0.00
28 TO 29	0	0.00
29 TO 30	819	100.00

TOTAL NUMBER OF POINTS READ = 819
TOTAL NUMBER OF OBSERVATION USED IN THE DISTRIBUTION = 819
MEAN TEMPERATURE = 29.2 DEGREES CENTIGRADE
STANDARD DEVIATION = 0.0 DEGREES CENTIGRADE
MAXIMUM TEMPERATURE = 29.2 DEGREES CENTIGRADE
MINIMUM TEMPERATURE = 29.0 DEGREES CENTIGRADE
RANGE = .2 DEGREES CENTIGRADE

Guam Northern District WWTP Diffuser Monthly Current-Temperature Statistics

DEPLOYMENT LOCATION: 2

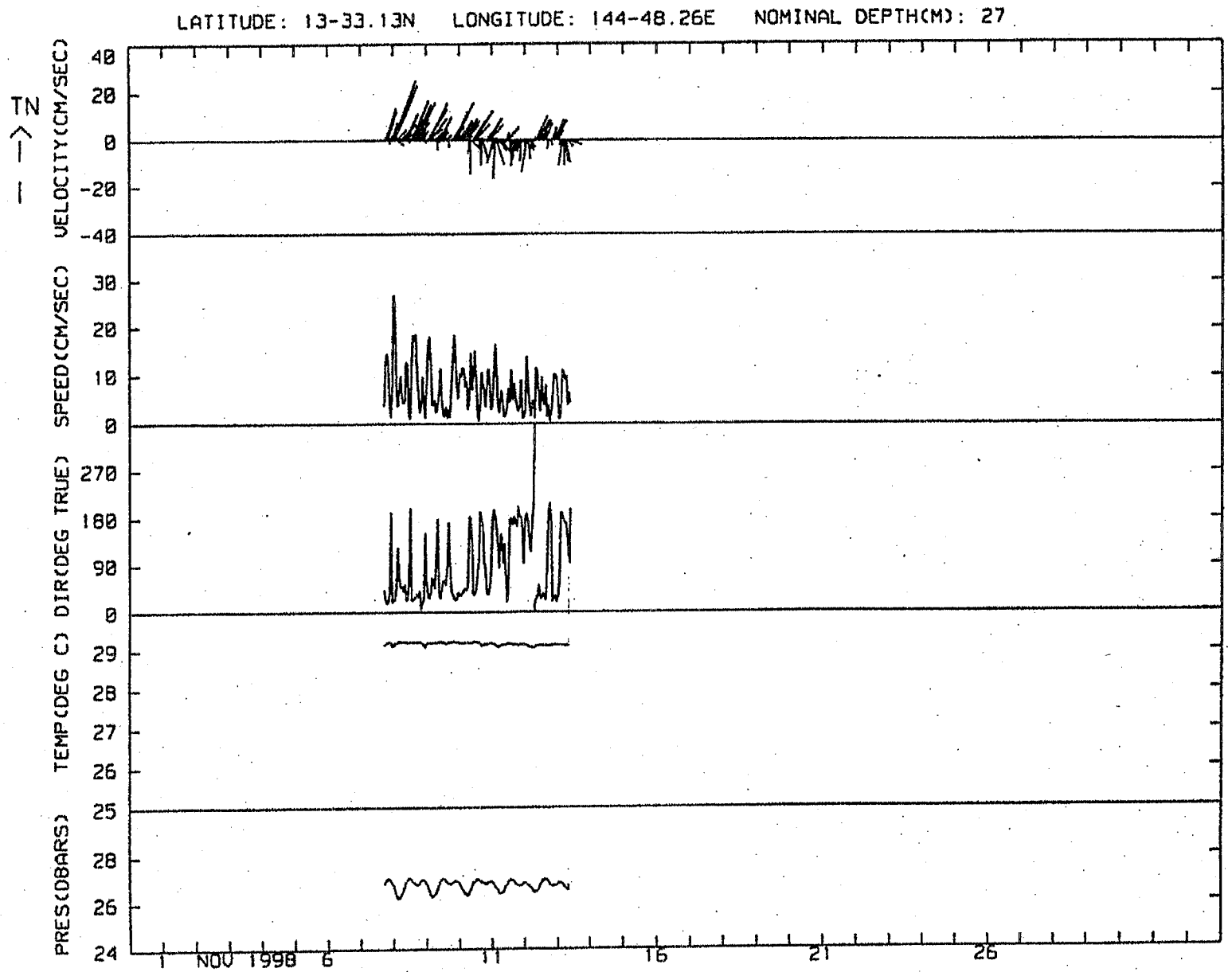
Latitude: 13-33.13N Longitude: 144-48.26E
Meter Depth(m): 27.0 Bottom Depth(m): 58.0

Period: NOVEMBER 1998

Mean Speed(cm/sec): 7.50
Maximum Speed(cm/sec): 32.90
Standard Deviation: 5.38
Average North Vector Component(cm/sec): 2.24
Average East Vector Component(cm/sec): 3.04
Resultant Magnitude(cm/sec): 3.77
Resultant Direction(°T): 54

Minimum Temperature(°C): 29.0
Maximum Temperature(°C): 29.2
Mean Temperature(°C): 29.2
Standard Deviation: 0.0

Day	Maximum Speed	Minimum Temperature	Maximum Temperature
7	16.90	29.0	29.2
8	32.90	29.0	29.2
9	22.40	29.1	29.2
10	17.80	29.1	29.2
11	21.10	29.1	29.2
12	19.00	29.1	29.2
13	15.50	29.1	29.1


LATITUDE: 13-33.13N LONGITUDE: 144-48.26E NOMINAL DEPTH(M): 27
TN
VELOCITY(CM/SEC)
SPEED(CM/SEC)
DIR(DEG TRUE)
TEMP(DEG C)
PRES(DBARS)
40
20
0
-20
-40
30
20
10
0
270
180
90
0
29
28
27
26
25
28
26
24
1 NOV 1998 6
11
16
21
26

APPENDIX B

OCEAN DENSITY, DISSOLVED OXYGEN, AND CURRENT SURVEYS

APPENDIX B

OCEAN DENSITY, DISSOLVED OXYGEN AND CURRENT SURVEYS

B-1 DENSITY PROFILE

Density profiles are calculated from the salinity-temperature-depth (S-T-D) data collected during the November 6-13, 1998 field survey and compared to profiles estimated from historical data. The field data indicates that the water column is uniform in density to the 70 m. depth (maximum extent of profiling), which is usual in Pacific waters where the upper mixed layer is usually 100 m. deep. The historical density data indicates a lower near surface density profile.

B-2 DISSOLVED OXYGEN PROFILE

Profile ranges from 95 to 105% saturation, which is in conformitywith historical data showing near 100% saturation.

B.3 CURRENT

The predominant current directions during the field survey were northeast (20% occurrence) and south (10%) occurrence. Current speed varied from 0 to 1.08 fps with an average value of .0.25 fps.

Water temperature measured concurrently proved to be uniform at 84.6°F.

APPENDIX C

SEDIMENT ANALYSIS

APPENDIX C

SEDIMENT ANALYSIS

C-1 INTRODUCTION

Sediment samples were collected at four locations shown in figure C.1 on July 22, 2001. Generally, these locations are in the center, and then north, south, and east of the mixing zone. The previous video survey of community structure on September 22, 2000 had shown the sea floor to be mostly bare substrate with occasional pockets of sediment or sand. Therefore, an underwater video camera and lights were mounted on an articulating arm so that potential sampling locations could be inspected before activating the sampler. A video record of searching and sampling was made.

C-2 PURPOSE

Samples were taken for four general classes of analysis; 1) Physical, Infauna, Sediment Chemistry, and Sediment Biochemical Oxygen Demand (SOD). These four classes can be further broken into;

Physical

Grain Size

Sediment Chemistry

Total Organic Carbon
Volatiles
Total Kjeldahl Nitrogen
Sulfide
Total Phosphorous
ICP Metals

Cyanide

Semivolatile Organics

Mercury

Asbestos

Organochlorine Pesticides

PCB's

Dioxin

Infauna

Polychaetes

Mollusks

C-3 SAMPLING PRODUCURE

Grab samples were taken with a Van Veen sampler, model No 214 WA, as manufactured by Kahl Scientific Instrument Corporation[1]. The sampler was outfitted with a video camera and light mounted on an articulating arm.

The survey boat was navigated by GPS to the general outfall area.

On-station, the Van Veen sampler and camera assembly were lowered until the sea floor became visible-i.e.24 to 15 inches from the bottom. Upon finding a potential site, the sampler was quickly dropped. Location and depth were immediately recorded. The samples was hoisted on deck and placed in a plastic basin. Sample was then inspected of suitable according to the criteria of:

a) fairly flat surface with overlying seawater

b) sides are not heavily sloped nor humped along midline

c) minimum sample depth at midline is 2 in (5cm) with 2 ¼ to 4 in. (7 to 10 cm) preferred as measured with a plastic ruler

[1] Kahlsico International Corporation
P.O. Box 947
El Cajon, California 92022

Physical characteristics were noted and recorded;

a) Composition – coarse sand, fine sand, silt/clay, gravel, or mixed shell hash

c) Color – brown, black, grey, olive, green or red

d) Odor – petroleum, hydrogen sulfide, other or none.

If sample was judged acceptable, infauna sample for polychaetes were taken with a PVC core sampler 7.6 cm dia. by 10 cm deep. Sample was transferred to a 500 ml wide mouth nalgene bottle with buffered formalin stained with rose bengal, additional formalin was added to insure penetration and coverage of sample. Second infauna sample for mollusks was taken with a 5 cm dia by 5 cm deep PVC core sampler and transferred to a 125 ml wide mouth nalgenc bottle with de-ionized water. The remaining sediment chemistry, grain size and SOD samples were taken with plastic scoops and transferred to the appropriate storage bottles with de-ionized water. Samples for ICP metals were taken at least 1 cm away from the sides and bottom of the sampler. All samples except the infauna samples preserved in formalin were stored at 4°C. Van Veen sampler and holding basin were washed before the next grab. Four successfully grabs were needed to fill all containers. Two and one half liters of seawater was also taken from near the seafloor with a vertical polycarbonate water samples to provide dilution water.

Samples were transferred with the appropriate chain of custody documents to

a) Geo-Engineering & Testing for grain size;

b) Water Resources Research center, University of Hawaii at Manoa for infauna analysis.

c) Oceanic analytical Laboratory, Inc. in Aiea, Hawaii for the sediment chemistry and SOD analysis.

C-4 ANALYTICAL PROCEDURES

The analytical procedures for the infauna[1] and sediment chemistry analysis[2] had been previously documented.

Measurement of SOD insitu is impractical given the 150 ft depth at the outfall location. SOD was measured in standard incubation bottles with the standard methodology modified as follows;

1) Incubation bottles were calibrated for their cross-sectional areas at the level corresponding to a volume of 55 ml and tared empty
2) 55 ml of wet sediment is carefully added to each bottle, allowed to settle and weighed
3) Saturated seawater is carefully added to minimize disturbance of sediment
4) Bottles are incubated in the dark at 29 C

1. Baily-Brock, J.H. "Defination of Indicator Species for Pollution Monitoring in Mamala Bay, Oahu, Hawaii". *Project MB-9, Mamala Bay Study Final Report, vol 2,* (1996)

2. USEPA "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW-846)

5) Bottles are opened consecutively on a schedule prorated as to D.O. depletion in the previous interval until the D.O in the saturation water has been depleted by 50% or incubation period has reached five days. Resuspended SOD is measured in the same manner except the sediment sample is reduced to 25 ml and the sediment is keep suspended during incubation with a platform shaker.

C-5 RESULTS

Under sediment chemistry, only five compounds were detected as listed in table C.1, all other analytes were not detected at the reporting limit. The laboratory report for the samples taken in the middle of mixing zone are attached to reference analytical methods and their respective reporting limits.

Table C.1

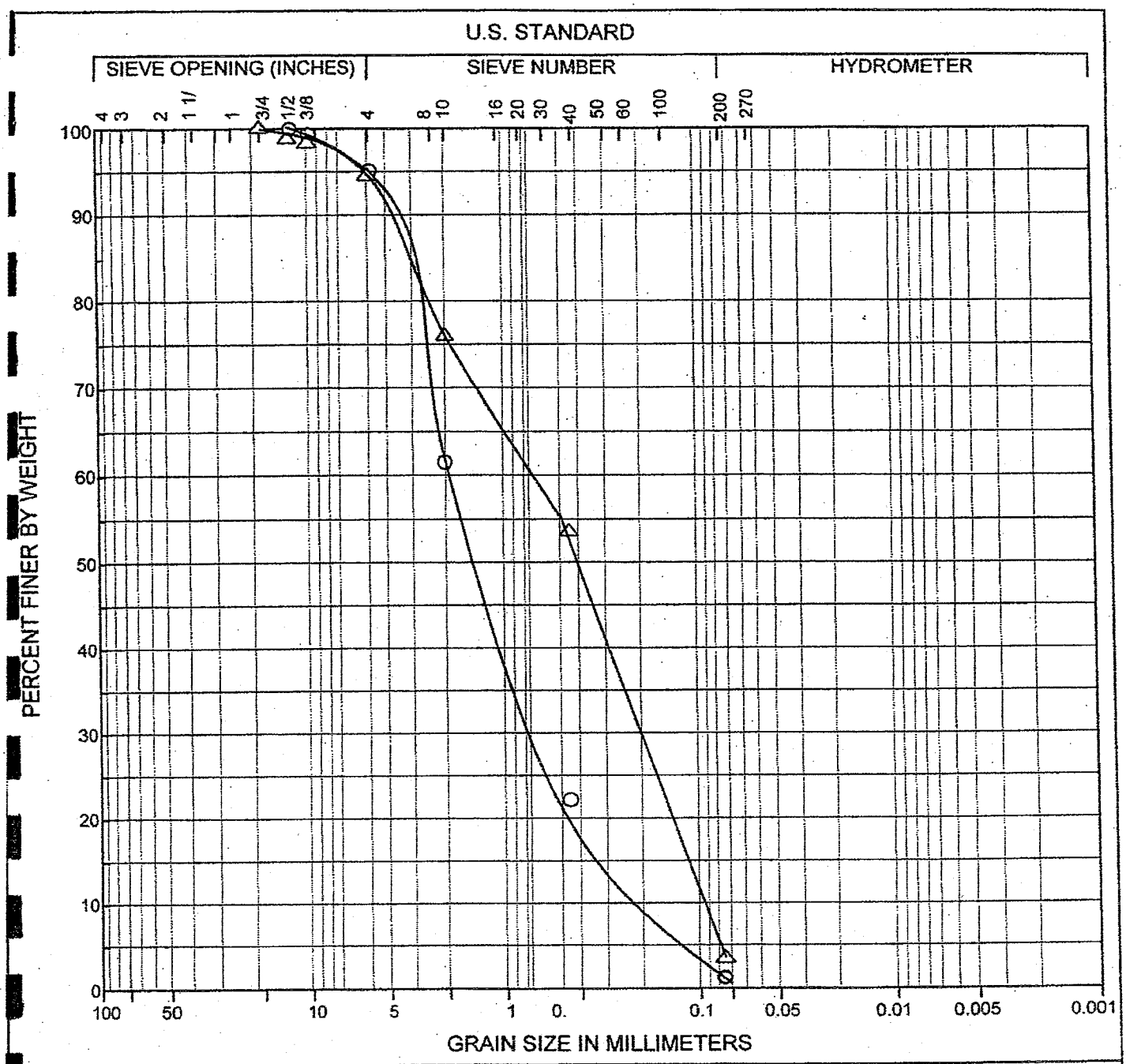
SEDIMENT CHEMISTRY

	Sample I.D.			
Analysis	T-SW	T-SE	T-NW	T-NE
Total Organic Carbon (mg/kg)	5,440	12,400	10,600	12,800
Total Phosphorous (mg/kg)	162	132	134	144
Acetone (mg/kg)	ND	0.223	0.549	ND
Cyanide (mg/kg)	ND	0.502	ND	ND
Methylene Chloride (mg/kg)	ND	0.165	ND	ND
Moisture (%)	35.9	34.4	33.3	36.2

OXYGEN SEDIMENT DEMAND

Quiesent g O_2/M^2 .day	0.8	0.47	0.41	0.13
Resuspended g O_2/g.day	2.5×10^{-4}	$9x10^{-5}$	6.6x10-5	$3.3x10^{-5}$

The classification and identification of infauna species is scheduled for completion in November 2001.



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

SYMBOL	SAMPLE SOURCE	CLASSIFICATION
○	T-SW-19	GREYISH BROWN SAND (SP) with shell fragments and odor
△	T-NE-19	LIGHT GREYISH BROWN SAND (SP) with coral fingers shell fragments and odor

GEO-ENGINEERING & TESTING, INC.
Geotechnical & Material Testing Engineers

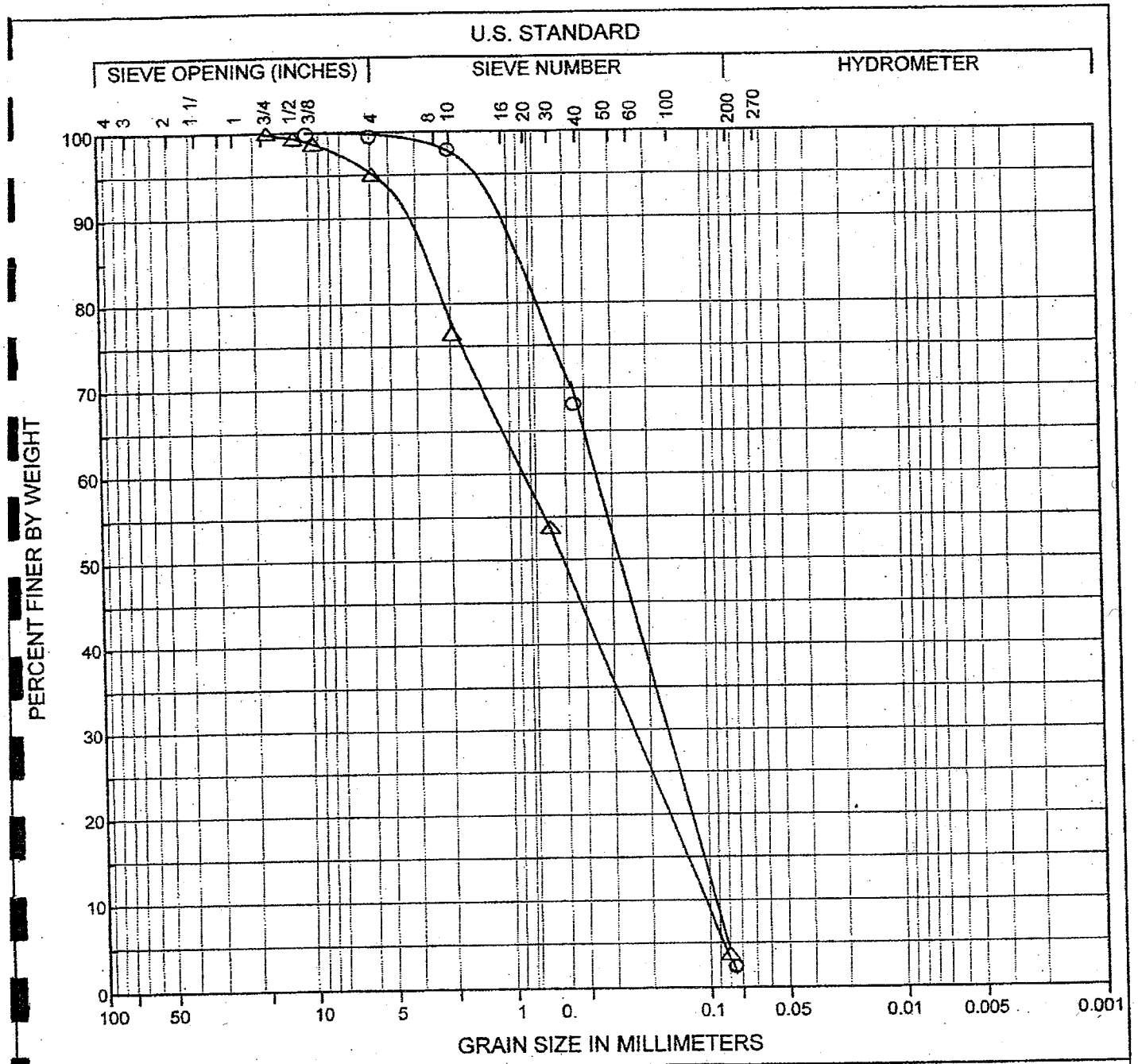
Job No. 353.21 Appr. U.S. Date

PARTICLE SIZE DISTRIBUTION

NORTHERN DISTRICT SEWER OUTFALL

PLATE 3

ND 1994



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

SYMBOL	SAMPLE SOURCE	CLASSIFICATION
○	T-SE-19	GREYISH BROWN SILTY SAND W/ DREDGE CORAL & FRAGMENTED SHELLS W/ STRONG ODOR
△	T-NW-19	LIGHT GREYISH BROWN DREDGE CORAL SAND W/CORAL FINGERS & FRAGMENTED SHELLS W/ STRONG ORDOR

GEO-ENGINEERING & TESTING, INC.
Geotechnical & Material Testing Engineers

Job No. 353.21 Appr. U.S. Date _____

PARTICLE SIZE DISTRIBUTION

NORTHERN DISTRICT SEWER OUTFALL

PLATE 4

ND 1995

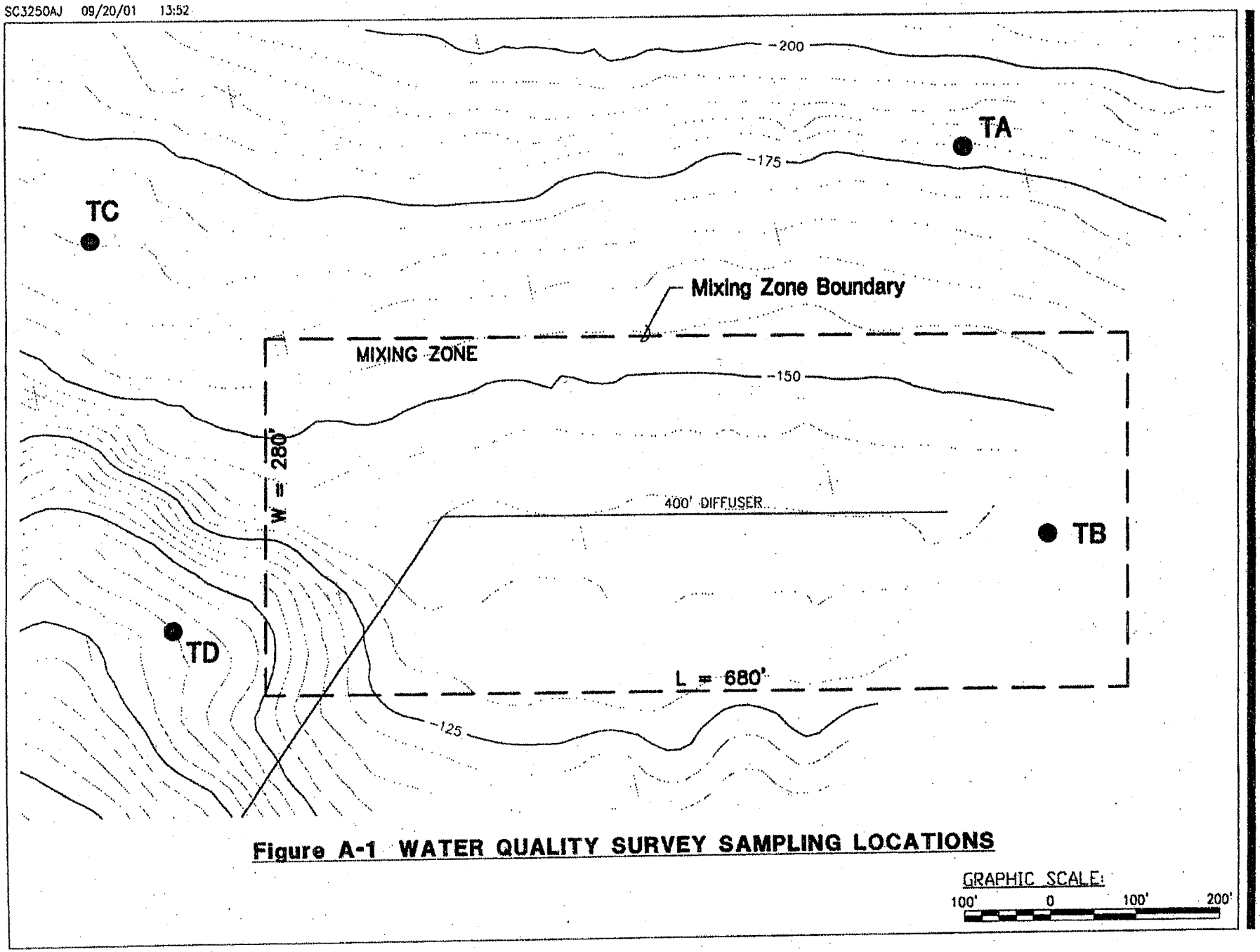


Figure A-1 WATER QUALITY SURVEY SAMPLING LOCATIONS

Oceanic Analytical Laboratory, Inc.

Date: *Aug 23, 2001*

Client:	GMP Associates Inc.	**Client Sample ID:**	T-SE
Lab Order:	0107159	**Tag Number:**	
Project:	Agana & NDSS Outfalls	**Collection Date:**	07/22/2001 8:10
Lab ID:	0107159-08A	**Matrix:**	SOLID

Analyses	Result	Reporting Limit	Units	Dilution Factor	Date Prepared	Date Analyzed	Batch ID	Analyst	Qual	Notes
CYANIDE, TOTAL			**SW9010**							
Cyanide	*0.502*	0.500	mg/Kg	1	8/3/2001	8/3/2001	1H02042	SUB		
ORGANIC CARBON, TOTAL			**SW9060**							
Total Organic Carbon	*12400*	1000	mg/Kg	1	7/30/2001	7/30/2001	1G27028	SUB		
PHOSPHOROUS, TOTAL			**SW6010B**							
Phosphorus, Total (As P)	*132*	8.20	mg/Kg	1	8/2/2001	8/6/2001	1H02028	SUB		

Qualifiers:

ND - Not Detected at the Reporting Limit
J - Analyte detected below quantitation limits
B - Analyte detected in the associated Method Blank
* - Value exceeds Maximum Contaminant Level
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
E - Value above quantitation range

Oceanic Analytical Laboratory, Inc.

Date: *Aug 23, 2001*

Client: GMP Associates Inc.
Lab Order: 0107159
Project: Agana & NDSS Outfalls
Lab ID: 0107159-08B

Client Sample ID: T-SE
Tag Number:
Collection Date: 07/22/2001 8:10
Matrix: SOLID

Analyses	Result	Reporting Limit	Units	Dilution Factor	Date Prepared	Date Analyzed	Batch ID	Analyst	Qual	Notes
ICP METALS, TOTAL		**SW6010A**								
Antimony	ND	15.2	mg/Kg-dry	1	7/30/2001	7/30/2001	4147	TKL		
Arsenic	ND	7.62	mg/Kg-dry	1						
Beryllium	ND	0.762	mg/Kg-dry	1						
Cadmium	ND	3.05	mg/Kg-dry	1						
Chromium	ND	7.62	mg/Kg-dry	1						
Copper	ND	15.2	mg/Kg-dry	1						
Lead	ND	30.5	mg/Kg-dry	1						
Nickel	ND	15.2	mg/Kg-dry	1						
Selenium	ND	30.5	mg/Kg-dry	1						
Silver	ND	7.62	mg/Kg-dry	1						
Thallium	ND	30.5	mg/Kg-dry	1						
Zinc	ND	15.2	mg/Kg-dry	1						
MERCURY, TOTAL		**SW7471**								
Mercury	ND	0.305	mg/Kg-dry	1	8/6/2001	8/6/2001	4181	MFB		
ORGANOCHLORINE PESTICIDES		**SW8081**								
4,4'-DDD	ND	0.00498	mg/Kg-dry	1	8/3/2001	8/4/2001	4174	EDF		
4,4'-DDE	ND	0.00498	mg/Kg-dry	1						
4,4'-DDT	ND	0.00498	mg/Kg-dry	1						
Aldrin	ND	0.00257	mg/Kg-dry	1						
alpha-BHC	ND	0.00257	mg/Kg-dry	1						
beta-BHC	ND	0.00257	mg/Kg-dry	1						
Chlordane	ND	0.0498	mg/Kg-dry	1						
delta-BHC	ND	0.00257	mg/Kg-dry	1						
Dieldrin	ND	0.00498	mg/Kg-dry	1						
Endosulfan I	ND	0.00257	mg/Kg-dry	1						
Endosulfan II	ND	0.00498	mg/Kg-dry	1						
Endosulfan sulfate	ND	0.00498	mg/Kg-dry	1						
Endrin	ND	0.00498	mg/Kg-dry	1						
Endrin aldehyde	ND	0.00498	mg/Kg-dry	1						
gamma-BHC	ND	0.00257	mg/Kg-dry	1						
Heptachlor	ND	0.00257	mg/Kg-dry	1						
Heptachlor epoxide	ND	0.00257	mg/Kg-dry	1						
Methoxychlor	ND	0.0257	mg/Kg-dry	1						
Toxaphene	ND	0.257	mg/Kg-dry	1						
Surr: Decachlorobiphenyl	88.2	50-150	%REC	1						
Surr: Tetrachloro-m-xylene	84.0	50-150	%REC	1						

Qualifiers:

ND - Not Detected at the Reporting Limit
J - Analyte detected below quantitation limits
B - Analyte detected in the associated Method Blank
* - Value exceeds Maximum Contaminant Level
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
E - Value above quantitation range

Oceanic Analytical Laboratory, Inc.

Date: *Aug 23, 2001*

Client: GMP Associates Inc.
Lab Order: 0107159
Project: Agana & NDSS Outfalls
Lab ID: 0107159-08B

Client Sample ID: T-SE
Tag Number:
Collection Date: 07/22/2001 8:10
Matrix: SOLID

Analyses	Result	Reporting Limit	Units	Dilution Factor	Date Prepared	Date Analyzed	Batch ID	Analyst	Qual	Notes
PCBS IN SOIL OR SOLID WASTE		**SW8082**								
Aroclor 1016	ND	0.0503	mg/Kg-dry	1	8/3/2001	8/6/2001	4173	RTK		
Aroclor 1221	ND	0.101	mg/Kg-dry	1						
Aroclor 1232	ND	0.0503	mg/Kg-dry	1						
Aroclor 1242	ND	0.0503	mg/Kg-dry	1						
Aroclor 1248	ND	0.0503	mg/Kg-dry	1						
Aroclor 1254	ND	0.0503	mg/Kg-dry	1						
Aroclor 1260	ND	0.0503	mg/Kg-dry	1						
Surr: Decachlorobiphenyl	116	50-150	%REC	1						
Surr: Tetrachloro-m-xylene	62.5	50-150	%REC	1						
PERCENT MOISTURE		**SW3550**								
Percent Moisture	*34.4*	0.100	wt%	1	7/30/2001	7/31/2001	R11023	MFB		

Qualifiers:

ND - Not Detected at the Reporting Limit
J - Analyte detected below quantitation limits
B - Analyte detected in the associated Method Blank
* - Value exceeds Maximum Contaminant Level
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
E - Value above quantitation range

Oceanic Analytical Laboratory, Inc.

Date: *Aug 23, 2001*

Client:	GMP Associates Inc.	**Client Sample ID:**	T-SE
Lab Order:	0107159	**Tag Number:**	
Project:	Agana & NDSS Outfalls	**Collection Date:**	07/22/2001 8:10
Lab ID:	0107159-08B	**Matrix:**	SOLID

Analyses	Result	Reporting Limit	Units	Dilution Factor	Date Prepared	Date Analyzed	Batch ID	Analyst	Qual	Notes
SEMIVOLATILE ORGANICS		**SW8270A**								
1,2,4,5-Tetrachlorobenzene	ND	0.503	mg/Kg-dry	1	7/31/2001	8/8/2001	4152	EDF		
1,2,4-Trichlorobenzene	ND	0.503	mg/Kg-dry	1						
1,2-Dichlorobenzene	ND	0.503	mg/Kg-dry	1						
1,3-Dichlorobenzene	ND	0.503	mg/Kg-dry	1						
1,4-Dichlorobenzene	ND	0.503	mg/Kg-dry	1						
1-Chloronaphthalene	ND	0.503	mg/Kg-dry	1						
1-Naphthylamine	ND	0.503	mg/Kg-dry	1						
2,3,4,6-Tetrachlorophenol	ND	0.503	mg/Kg-dry	1						
2,4,5-Trichlorophenol	ND	0.503	mg/Kg-dry	1						
2,4,6-Trichlorophenol	ND	0.503	mg/Kg-dry	1						
2,4-Dichlorophenol	ND	0.503	mg/Kg-dry	1						
2,4-Dimethylphenol	ND	0.503	mg/Kg-dry	1						
2,4-Dinitrophenol	ND	2.59	mg/Kg-dry	1						
2,4-Dinitrotoluene	ND	0.503	mg/Kg-dry	1						
2,6-Dichlorophenol	ND	0.503	mg/Kg-dry	1						
2,6-Dinitrotoluene	ND	0.503	mg/Kg-dry	1						
2-Chloronaphthalene	ND	0.503	mg/Kg-dry	1						
2-Chlorophenol	ND	0.503	mg/Kg-dry	1						
2-Methylnaphthalene	ND	0.503	mg/Kg-dry	1						
2-Methylphenol	ND	0.503	mg/Kg-dry	1						
2-Naphthylamine	ND	0.503	mg/Kg-dry	1						
2-Nitroaniline	ND	2.59	mg/Kg-dry	1						
2-Nitrophenol	ND	0.503	mg/Kg-dry	1						
2-Picoline	ND	0.503	mg/Kg-dry	1						
3,3'-Dichlorobenzidine	ND	0.503	mg/Kg-dry	1						
3-Methylcholanthrene	ND	0.503	mg/Kg-dry	1						
3-Nitroaniline	ND	2.59	mg/Kg-dry	1						
4,6-Dinitro-2-methylphenol	ND	2.59	mg/Kg-dry	1						
4-Aminobiphenyl	ND	0.503	mg/Kg-dry	1						
4-Bromophenyl phenyl ether	ND	0.503	mg/Kg-dry	1						
4-Chloro-3-methylphenol	ND	0.503	mg/Kg-dry	1						
4-Chloroaniline	ND	0.503	mg/Kg-dry	1						
4-Chlorophenyl phenyl ether	ND	0.503	mg/Kg-dry	1						
4-Methylphenol	ND	0.503	mg/Kg-dry	1						
4-Nitroaniline	ND	0.503	mg/Kg-dry	1						
4-Nitrophenol	ND	2.59	mg/Kg-dry	1						
7,12-Dimethylbenz(a)anthracene	ND	0.503	mg/Kg-dry	1						
a,a-Dimethylphenethylamine	ND	2.59	mg/Kg-dry	1						
Acenaphthene	ND	0.503	mg/Kg-dry	1						
Acenaphthylene	ND	0.503	mg/Kg-dry	1						

Qualifiers:

ND - Not Detected at the Reporting Limit
J - Analyte detected below quantitation limits
B - Analyte detected in the associated Method Blank
* - Value exceeds Maximum Contaminant Level
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
E - Value above quantitation range

Oceanic Analytical Laboratory, Inc.

Date: *Aug 23, 2001*

Client:	GMP Associates Inc.	**Client Sample ID:**	T-SE
Lab Order:	0107159	**Tag Number:**	
Project:	Agana & NDSS Outfalls	**Collection Date:**	07/22/2001 8:10
Lab ID:	0107159-08B	**Matrix:**	SOLID

Analyses	Result	Reporting Limit	Units	Dilution Factor	Date Prepared	Date Analyzed	Batch ID	Analyst	Qual	Notes
Acetophenone	ND	0.503	mg/Kg-dry	1						
Aniline	ND	0.503	mg/Kg-dry	1						
Anthracene	ND	0.503	mg/Kg-dry	1						
Azobenzene	ND	0.503	mg/Kg-dry	1						
Benz(a)anthracene	ND	0.503	mg/Kg-dry	1						
Benzidine	ND	2.59	mg/Kg-dry	1						
Benzo(a)pyrene	ND	0.503	mg/Kg-dry	1						
Benzo(b)fluoranthene	ND	0.503	mg/Kg-dry	1						
Benzo(g,h,i)perylene	ND	0.503	mg/Kg-dry	1						
Benzo(k)fluoranthene	ND	0.503	mg/Kg-dry	1						
Benzoic acid	ND	2.59	mg/Kg-dry	1						
Benzyl alcohol	ND	0.503	mg/Kg-dry	1						
Bis(2-chloroethoxy)methane	ND	0.503	mg/Kg-dry	1						
Bis(2-chloroethyl)ether	ND	0.503	mg/Kg-dry	1						
Bis(2-chloroisopropyl)ether	ND	0.503	mg/Kg-dry	1						
Bis(2-ethylhexyl)phthalate	ND	0.503	mg/Kg-dry	1						
Butyl benzyl phthalate	ND	0.503	mg/Kg-dry	1						
Chrysene	ND	0.503	mg/Kg-dry	1						
Di-n-butyl phthalate	ND	0.503	mg/Kg-dry	1						
Di-n-octyl phthalate	ND	0.503	mg/Kg-dry	1						
Dibenz(a,h)anthracene	ND	0.503	mg/Kg-dry	1						
Dibenz(a,j)acridine	ND	0.503	mg/Kg-dry	1						
Dibenzofuran	ND	0.503	mg/Kg-dry	1						
Diethyl phthalate	ND	0.503	mg/Kg-dry	1						
Dimethyl phthalate	ND	0.503	mg/Kg-dry	1						
Ethyl methanesulfonate	ND	0.503	mg/Kg-dry	1						
Fluoranthene	ND	0.503	mg/Kg-dry	1						
Fluorene	ND	0.503	mg/Kg-dry	1						
Hexachlorobenzene	ND	0.503	mg/Kg-dry	1						
Hexachlorobutadiene	ND	0.503	mg/Kg-dry	1						
Hexachlorocyclopentadiene	ND	0.503	mg/Kg-dry	1						
Hexachloroethane	ND	0.503	mg/Kg-dry	1						
Indeno(1,2,3-cd)pyrene	ND	0.503	mg/Kg-dry	1						
Isophorone	ND	0.503	mg/Kg-dry	1						
Methyl methanesulfonate	ND	0.503	mg/Kg-dry	1						
N-Nitroso-di-n-butylamine	ND	0.503	mg/Kg-dry	1						
N-Nitrosodi-n-propylamine	ND	0.503	mg/Kg-dry	1						
N-Nitrosodimethylamine	ND	0.503	mg/Kg-dry	1						
N-Nitrosodiphenylamine	ND	0.503	mg/Kg-dry	1						
N-Nitrosopiperidine	ND	0.503	mg/Kg-dry	1						
Naphthalene	ND	0.503	mg/Kg-dry	1						

Qualifiers:

ND - Not Detected at the Reporting Limit

J - Analyte detected below quantitation limits

B - Analyte detected in the associated Method Blank

* - Value exceeds Maximum Contaminant Level

S - Spike Recovery outside accepted recovery limits

R - RPD outside accepted recovery limits

E - Value above quantitation range

Oceanic Analytical Laboratory, Inc.

Date: *Aug 23, 2001*

Client: GMP Associates Inc.
Lab Order: 0107159
Project: Agana & NDSS Outfalls
Lab ID: 0107159-08B

Client Sample ID: T-SE
Tag Number:
Collection Date: 07/22/2001 8:10
Matrix: SOLID

Analyses	Result	Reporting Limit	Units	Dilution Factor	Date Prepared	Date Analyzed	Batch ID	Analyst	Qual	Notes
Nitrobenzene	ND	0.503	mg/Kg-dry	1						
p-Dimethylaminoazobenzene	ND	0.503	mg/Kg-dry	1						
Pentachloronitrobenzene	ND	0.503	mg/Kg-dry	1						
Pentachlorophenol	ND	2.59	mg/Kg-dry	1						
Phenacetin	ND	0.503	mg/Kg-dry	1						
Phenanthrene	ND	0.503	mg/Kg-dry	1						
Phenol	ND	0.503	mg/Kg-dry	1						
Pronamide	ND	0.503	mg/Kg-dry	1						
Pyrene	ND	0.503	mg/Kg-dry	1						
Pyridine	ND	0.503	mg/Kg-dry	1						
Surr: 2,4,6-Tribromophenol	124	43.2-139	%REC	1						
Surr: 2-Fluorobiphenyl	77.6	43.6-137	%REC	1						
Surr: 2-Fluorophenol	71.4	20.5-124	%REC	1						
Surr: 4-Terphenyl-d14	119	53.9-131	%REC	1						
Surr: Nitrobenzene-d5	69.9	51.1-108	%REC	1						
Surr: Phenol-d6	84.5	23.9-132	%REC	1						
SULFIDE		**SW9030**								
Sulfide	ND	15.2	mg/Kg-dry	1	8/1/2001	8/1/2001	R11082	MFB		
TOTAL KJELDAHL NITROGEN		**E351.2**								
Nitrogen, Kjeldahl, Total	ND	381	mg/Kg-dry	1	7/25/2001	7/25/2001	R10930	JYD		

Qualifiers:

ND - Not Detected at the Reporting Limit
J - Analyte detected below quantitation limits
B - Analyte detected in the associated Method Blank
* - Value exceeds Maximum Contaminant Level
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
E - Value above quantitation range

ND 2002

Oceanic Analytical Laboratory, Inc.

Date: *Aug 23, 2001*

Client: GMP Associates Inc.
Lab Order: 0107159
Project: Agana & NDSS Outfalls
Lab ID: 0107159-08C

Client Sample ID: T-SE
Tag Number:
Collection Date: 07/22/2001 8:10
Matrix: SOLID

Analyses	Result	Reporting Limit	Units	Dilution Factor	Date Prepared	Date Analyzed	Batch ID	Analyst	Qual	Notes
Chloromethane	ND	0.0762	mg/Kg-dry	1						
cis-1,2-Dichloroethene	ND	0.0152	mg/Kg-dry	1						
cis-1,3-Dichloropropene	ND	0.0152	mg/Kg-dry	1						
Dibromochloromethane	ND	0.0152	mg/Kg-dry	1						
Dibromomethane	ND	0.0152	mg/Kg-dry	1						
Dichlorodifluoromethane	ND	0.0762	mg/Kg-dry	1						
Ethylbenzene	ND	0.0152	mg/Kg-dry	1						
Hexachlorobutadiene	ND	0.0762	mg/Kg-dry	1						
Iodomethane	ND	0.0762	mg/Kg-dry	1						
Isopropylbenzene	ND	0.0152	mg/Kg-dry	1						
m,p-Xylene	ND	0.0152	mg/Kg-dry	1						
Methyl tert-butyl ether	ND	0.0152	mg/Kg-dry	1						
Methylene chloride	*0.165*	0.0762	mg/Kg-dry	1						
n-Butylbenzene	ND	0.0152	mg/Kg-dry	1						
n-Propylbenzene	ND	0.0152	mg/Kg-dry	1						
Naphthalene	ND	0.0762	mg/Kg-dry	1						
o-Xylene	ND	0.0152	mg/Kg-dry	1						
sec-Butylbenzene	ND	0.0152	mg/Kg-dry	1						
Styrene	ND	0.0152	mg/Kg-dry	1						
tert-Butylbenzene	ND	0.0152	mg/Kg-dry	1						
Tetrachloroethene	ND	0.0152	mg/Kg-dry	1						
Toluene	ND	0.0152	mg/Kg-dry	1						
trans-1,2-Dichloroethene	ND	0.0152	mg/Kg-dry	1						
trans-1,3-Dichloropropene	ND	0.0152	mg/Kg-dry	1						
trans-1,4-Dichloro-2-butene	ND	0.0762	mg/Kg-dry	1						
Trichloroethene	ND	0.0152	mg/Kg-dry	1						
Trichlorofluoromethane	ND	0.0152	mg/Kg-dry	1						
Vinyl acetate	ND	0.0762	mg/Kg-dry	1						
Vinyl chloride	ND	0.0762	mg/Kg-dry	1						
Surr: 1,2-Dichloroethane-d4	118	81.6-153	%REC	1						
Surr: 4-Bromofluorobenzene	114	80-120	%REC	1						
Surr: Dibromofluoromethane	106	81.8-137	%REC	1						
Surr: Toluene-d8	114	70.7-129	%REC	1						

Qualifiers:

ND - Not Detected at the Reporting Limit
J - Analyte detected below quantitation limits
B - Analyte detected in the associated Method Blank
* - Value exceeds Maximum Contaminant Level
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
E - Value above quantitation range

Oceanic Analytical Laboratory, Inc.

Date: *Aug 23, 2001*

Client: GMP Associates Inc.
Lab Order: 0107159
Project: Agana & NDSS Outfalls
Lab ID: 0107159-08C

Client Sample ID: T-SE
Tag Number:
Collection Date: 07/22/2001 8:10
Matrix: SOLID

Analyses	Result	Reporting Limit	Units	Dilution Factor	Date Prepared	Date Analyzed	Batch ID	Analyst	Qual	Notes
VOLATILES BY GC/MS		**SW8260A**								
1,1,1,2-Tetrachloroethane	ND	0.0152	mg/Kg-dry	1	8/3/2001	8/3/2001	R11106	KAL		
1,1,1-Trichloroethane	ND	0.0152	mg/Kg-dry	1						
1,1,2,2-Tetrachloroethane	ND	0.0152	mg/Kg-dry	1						
1,1,2-Trichloroethane	ND	0.0152	mg/Kg-dry	1						
1,1-Dichloroethane	ND	0.0762	mg/Kg-dry	1						
1,1-Dichloroethene	ND	0.0152	mg/Kg-dry	1						
1,1-Dichloropropene	ND	0.0152	mg/Kg-dry	1						
1,2,3-Trichlorobenzene	ND	0.0152	mg/Kg-dry	1						
1,2,3-Trichloropropane	ND	0.0152	mg/Kg-dry	1						
1,2,4-Trichlorobenzene	ND	0.0762	mg/Kg-dry	1						
1,2,4-Trimethylbenzene	ND	0.0152	mg/Kg-dry	1						
1,2-Dibromo-3-chloropropane	ND	0.0152	mg/Kg-dry	1						
1,2-Dibromoethane	ND	0.0152	mg/Kg-dry	1						
1,2-Dichlorobenzene	ND	0.0762	mg/Kg-dry	1						
1,2-Dichloroethane	ND	0.0762	mg/Kg-dry	1						
1,2-Dichloropropane	ND	0.0152	mg/Kg-dry	1						
1,3,5-Trimethylbenzene	ND	0.0152	mg/Kg-dry	1						
1,3-Dichlorobenzene	ND	0.0762	mg/Kg-dry	1						
1,3-Dichloropropane	ND	0.0152	mg/Kg-dry	1						
1,4-Dichlorobenzene	ND	0.0762	mg/Kg-dry	1						
2,2-Dichloropropane	ND	0.0152	mg/Kg-dry	1						
2-Butanone	ND	0.0762	mg/Kg-dry	1						
2-Chlorotoluene	ND	0.0152	mg/Kg-dry	1						
2-Hexanone	ND	0.0762	mg/Kg-dry	1						
4-Chlorotoluene	ND	0.0152	mg/Kg-dry	1						
4-Isopropyltoluene	ND	0.0152	mg/Kg-dry	1						
4-Methyl-2-pentanone	ND	0.0762	mg/Kg-dry	1						
Acetone	*0.223*	0.0762	mg/Kg-dry	1						
Acrylonitrile	ND	0.0762	mg/Kg-dry	1						
Benzene	ND	0.0152	mg/Kg-dry	1						
Bromobenzene	ND	0.0152	mg/Kg-dry	1						
Bromochloromethane	ND	0.0762	mg/Kg-dry	1						
Bromodichloromethane	ND	0.0152	mg/Kg-dry	1						
Bromoform	ND	0.0152	mg/Kg-dry	1						
Bromomethane	ND	0.0762	mg/Kg-dry	1						
Carbon disulfide	ND	0.0152	mg/Kg-dry	1						
Carbon tetrachloride	ND	0.0152	mg/Kg-dry	1						
Chlorobenzene	ND	0.0152	mg/Kg-dry	1						
Chloroethane	ND	0.0762	mg/Kg-dry	1						
Chloroform	ND	0.0152	mg/Kg-dry	1						

Qualifiers:

ND - Not Detected at the Reporting Limit
J - Analyte detected below quantitation limits
B - Analyte detected in the associated Method Blank
* - Value exceeds Maximum Contaminant Level
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
E - Value above quantitation range

POLARIZED LIGHT MICROSCOPY
ANALYTICAL REPORT

EPA Method 600/R-93/116 or 600/M4-82-020 **Page: 1 of 1**

Contact: Kenneth Lee

Address: Oceanic Analytical Lab
99-193 Aiea Heights Dr., Ste.
Aiea, HI 96701-3900

Samples Indicated: 7
Reg. Samples Analyzed: 7
Split Layers Analyzed: 0

Job Site / No. Agana & NDSS Outfalls
0107159

Report No. 28157
Date Submitted: Jul-26-01
Date Reported: Aug-07-01

SAMPLE ID	ASBESTOS % TYPE	OTHER DATA 1) Non-Asbestos Fibers 2) Matrix Materials 3) Date/Time Collected 4) Date Analyzed	DESCRIPTION FIELD / LAB
0107159-01E. Lab ID # 570-005-001	None Detected	1) None Detected 2) 99-100% Shell, Calc, Other m.p. 3) Jul-20-01 12:00 pm 4) Aug-07-01	Solid Sand-Off-White
0107159-03E. Lab ID # 570-005-002	None Detected	1) None Detected 2) 99-100% Shell, Calc, Other m.p. 3) Jul-20-01 2:00 pm 4) Aug-07-01	Solid Sand-Off-White
0107159-04E. Lab ID # 570-005-003	None Detected	1) None Detected 2) 99-100% Shell, Calc, Other m.p. 3) Jul-20-01 9:00 am 4) Aug-07-01	Solid Sand-Off-White
0107159-05E. Lab ID # 570-005-004	None Detected	1) None Detected 2) 99-100% Shell, Calc, Other m.p. 3) Jul-20-01 11:30 am 4) Aug-07-01	Solid Sand-Off-White
0107159-06E. Lab ID # 570-005-005	None Detected	1) None Detected 2) 99-100% Shell, Calc, Other m.p. 3) Jul-20-01 10:30 am 4) Aug-07-01	Solid Sand-Off-White
0107159-07E. Lab ID # 570-005-006	None Detected	1) None Detected 2) 99-100% Shell, Calc, Other m.p. 3) Jul-20-01 1:00 pm 4) Aug-07-01	Solid Sand-Off-White
0107159-08E. Lab ID # 570-005-007	None Detected	1) None Detected 2) 99-100% Shell, Calc, Other m.p. 3) Jul-20-01 8:10 am 4) Aug-07-01	Solid Sand-Off-White
Lab ID #		1) 2) 3) 4)	
Lab ID #		1) 2) 3) 4)	
Lab ID #		1) 2) 3) 4)	

Detection Limit of Method is Estimated to be 1% Asbestos Using a Visual Area Estimation Technique

Lab Manager _____ **Analyst** _____

ASBESTOS TEM LABORATORIES, INC. 1409 FIFTH STREET, BERKELEY, CA 94710 (510) 528-0108
With Branch Offices Located At: 952 GREG STREET, SPARKS, NV 89431

ND 2005

Pace Analytical Services, Inc.
1700 Elm Street - Suite 200
Minneapolis, MN 55414

Tel: 612-607-1700
Fax: 612- 607-6444

Pace Analytical™

Method 1613B Analysis Results

Client - OCEANIC ANALYTICAL LAB

Client's Sample ID	0107159-08D (T-SE)		
Lab Sample ID	102883394		
Filename	U10810B_14		
Injected By	CVS		
Total Amount Extracted	15.02 g	Matrix	SOLID
% Moisture	32.8	Dilution	NA
Dry Weight Extracted	10.1 g	Collected	07/20/2001
ICAL Date	07/25/2001	Received	07/27/2001
CCal Filename(s)	U10810A_12	Extracted	08/02/2001
Method Blank ID	BLANK-1184	Analyzed	08/11/2001 07:01

Native Isomers	Conc ng/Kg	EMPC ng/Kg	PRL ng/Kg		Internal Standards	ng's Added	Percent Recovery
2,3,7,8-TCDF	ND	-----	0.99		2,3,7,8-TCDF-13C	2.00	70
Total TCDF	ND	-----	-----		2,3,7,8-TCDD-13C	2.00	76
					1,2,3,7,8-PeCDF-13C	2.00	84
2,3,7,8-TCDD	ND	-----	0.99		2,3,4,7,8-PeCDF-13C	2.00	83
Total TCDD	1.7	-----	-----	B	1,2,3,7,8-PeCDD-13C	2.00	93
					1,2,3,4,7,8-HxCDF-13C	2.00	93
1,2,3,7,8-PeCDF	ND	-----	5.00		1,2,3,6,7,8-HxCDF-13C	2.00	93
2,3,4,7,8-PeCDF	ND	-----	5.00		2,3,4,6,7,8-HxCDF-13C	2.00	85
Total PeCDF	ND	-----	-----		1,2,3,7,8,9-HxCDF-13C	2.00	84
					1,2,3,4,7,8-HxCDD-13C	2.00	84
1,2,3,7,8-PeCDD	ND	-----	5.00		1,2,3,6,7,8-HxCDD-13C	2.00	92
Total PeCDD	ND	-----	-----		1,2,3,4,6,7,8-HpCDF-13C	2.00	91
					1,2,3,4,7,8,9-HpCDF-13C	2.00	74
1,2,3,4,7,8-HxCDF	ND	-----	5.00		1,2,3,4,6,7,8-HpCDD-13C	2.00	85
1,2,3,6,7,8-HxCDF	ND	-----	5.00		OCDD-13C	4.00	63
2,3,4,6,7,8-HxCDF	ND	-----	5.00				
1,2,3,7,8,9-HxCDF	ND	-----	5.00		1,2,3,4-TCDD-13C	2.00	NA
Total HxCDF	ND	-----	-----		1,2,3,7,8,9-HxCDD-13C	2.00	NA
1,2,3,4,7,8-HxCDD	ND	-----	5.00		2,3,7,8-TCDD-37Cl4	0.20	73
1,2,3,6,7,8-HxCDD	ND	-----	5.00				
1,2,3,7,8,9-HxCDD	ND	-----	5.00				
Total HxCDD	ND	-----	-----				
1,2,3,4,6,7,8-HpCDF	ND	-----	5.00		Total 2,3,7,8-TCDD		
1,2,3,4,7,8,9-HpCDF	ND	-----	5.00		Equivalence: 0.00 ng/Kg		
Total HpCDF	ND	-----	-----		(Using ITE Factors)		
1,2,3,4,6,7,8-HpCDD	ND	-----	5.00				
Total HpCDD	ND	-----	-----				
OCDF	ND	-----	9.90				
OCDD	ND	-----	9.90				

Results reported on a dry weight basis

Conc = Concentration (Totals include 2,3,7,8-substituted isomers).
EMPC = Estimated Maximum Possible Concentration
PRL = Pace Analytical Reporting Limit.
A = Limit of Detection based on signal to noise
B = Less than 10 times higher than method blank level
P = Recovery outside of method 1613 control limits
Nn = Value obtained from additional analysis

I = Interference
E = PCDE Interference
ND = Not Detected
NA = Not Applicable
NC = Not Calculated
* = See Discussion

Report No.....01-1047090

REPORT OF LABORATORY ANALYSIS

ND 2006

APPENDIX D

GEOTECHNICAL SURVEY