GUAM WATERWORKS AUTHORITY

Government of Guam
Post Office Box 3010, Agana, Guam 96932
Phone: (671)479-7823 Fax: (671)479-7879

MAR 27 1998

Lily Ning Lee
Guam Program Manager
U.S. Environmental Protection Agency
Pacific Insular Areas Program
75 Hawthorne Street (CMD-5)
San Francisco, Ca. 94105

Re: 301 (h) Modified Permit Application for Northern District STP

Dear Lily:

Enclosed is the Guam Waterworks Authority's 301(h) Modified Permit Application for the Northern District Sewage Treatment Plant.

This package contains a certification of veracity, a signed, completed NPDES application and a completed application questionnaire.

Included in the revised application package are the A/E and construction schedules for the Northern District outfall extension. The A/E work - inclusive of the baseline study - has begun, and funding has been secured to construct the Northern District outfall extension at the earliest. GWA is committed to extending the outfall to a point sufficient to demonstrate that no decrease in receiving water quality will occur and that water currents will not carry material back into the inner reef areas or to shore.

Copies of the attached will be forwarded to the local EPA office, Bureau of Planning and Department of Agriculture. These particular agencies oversee programs which may be impacted by GWA's discharge at Tanguisson Point. As such, in sections of the Application Questionnaire where input regarding their programs are requested, reference will be made to these letters of determination and forthcoming comments from these respective agencies.

The results of the Priority Pollutant Scan and the Industrial User Survey will be forwarded to your office as soon as GWA receives them and has completed its review of the resulting data.

ND 1598

Please advise me if additional information is needed to complete the application process.

Sincerely,

Richard A. Quintanilla
General Manager

cc: Director, Bureau of Planning
Administrator, Guam EPA
Director, Department of Agriculture

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GUAM WATERWORKS AUTHORITY

Government of Guam

Post Office Box 3010, Agana, Guam 96932

Phone: (671)479-7823 Fax: (671)479-7879

Statement of Veracity

I certify that under penalty of law that I have personally examined and am familiar with the information submitted in the attached document(s) and, based on my inquiry of those individuals immediately responsible for obtaining the information. I am convinced that the information is true, accurate and correct. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

Richard A. Quintanilla
General Manager

NPDES Application

A

ND 1608

NPDES APPLICATION

Form Approved.
OMB No. 2040-0086
Approval expires 7-31-88

FOR AGENCY USE

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM
APPLICATION FOR PERMIT TO DISCHARGE WASTEWATER

STANDARD FORM A – MUNICIPAL

SECTION I. APPLICANT AND FACILITY DESCRIPTION

Unless otherwise specified on this form all items are to be completed. If an item is not applicable indicate 'N.A.'

ADDITIONAL INSTRUCTIONS FOR SELECTED ITEMS APPEAR IN SEPARATE INSTRUCTION BOOKLET AS INDICATED. REFER TO BOOKLET BEFORE FILLING OUT THESE ITEMS.

Please Print or Type

1. Legal Name of Applicant (see instructions)	101	Public Utility Agency of Guam
2. Mailing Address of Applicant (see instructions) Number & Street	102a	Post Office Box 3010
City	102b	Agana
State	102c	Guam
Zip Code	102d	96910
3. Applicant's Authorized Agent (see instructions) Name and Title	103a	Joseph F. Mesa Chief Officer
Number & Street	103b	Post Office Box 3010
City	103c	Agana
State	103d	Guam
Zip Code	103e	96910
Telephone	103f	671 (Area Code) 646-8891-5 (Number)
4. Previous Application If a previous application for a permit under the National Pollutant Discharge Elimination System has been made, give the date of application.	104	___ ___ ___ YR MO DAY

I certify that I am familiar with the information contained in this application and that to the best of my knowledge and belief such information is true, complete, and accurate.

JOSEPH F. MESA, Chief Officer, PUAG Printed Name of Person Signing	102e	Title
Signature of Applicant or Authorized Agent	102f	28 DEC 1990 YR MO DAY Date Application Signed

18 U.S.C. Section 1001 provides that:

Whoever, in any matter within the jurisdiction of any department or agency of the United States knowingly and wilfully falsifies, conceals or covers up by any trick, scheme, or device a material fact, or makes any false, fictitious or fraudulent statement or representation, or makes or uses any false writing or document knowing same to contain any false, fictitious or fraudulent statement or entry, shall be fined not more than $10,000 or imprisoned not more than five years, or both.

FOR AGENCY USE

OFFICE: ___ EPA Region Number
___ State

Received ___ ___ ___ YR MO DAY

FORM APPROVED
OMB No. 158-R0100

FOR AGENCY USE

		Number of Discharge Points		Total Volume Discharged, Million Gallons Per Day
To: Surface Water	107a1	1	107a2	
Surface Impoundment with no Effluent	107b1	N.A.	107b2	N.A.
Underground Percolation	107c1	N.A.	107c2	N.A.
Well (injection)	107d1	N.A.	107d2	N.A.
Other	107e1	N.A.	107e2	N.A.
Total Item 7	107f1	1	107f2	
If 'other' is specified, describe	107g1	N.A.		

If any of the discharges from this facility are intermittent, such as from overflow or bypass points, or are seasonal or periodic from lagoons, holding ponds, etc., complete item 8.

8. Intermittent Discharges

a. Facility bypass points — Indicate the number of bypass points for the facility that are discharge points. (see instructions) — 108a: N.A.

b. Facility Overflow Points — Indicate the number of overflow points to a surface water for the facility (see instructions). — 108b: N.A.

c. Seasonal or Periodic Discharge Points — Indicate the number of points where seasonal discharges occur from holding ponds, lagoons, etc. — 108c: N.A.

9. Collection System Type — Indicate the type and length (in miles) of the collection system used by this facility. (see instructions) — 109a

- Separate Storm: ☐ SST
- Separate Sanitary: ☒ SAN
- Combined Sanitary and Storm: ☐ CSS
- Both Separate Sanitary and Combined Sewer Systems: ☐ BSC
- Both Separate Storm and Combined Sewer Systems: 109b ☐ SSC
- Length: 38 miles

10. Municipalities or Areas Served (see instructions)

	Name		Actual Population Served
110a	Dededo (Civilian)	110b	36,250
110a	Yigo (Civilian)	110b	13,600
110a	Anderson Air Force Base (Air Force)	110b	2,470
110a	Finegayan Hosuing (Navy) Federal Avaiation Admin. (FAA)	110b	2,950
110a	Tumon	110b	9,000
110a	Barrigada Mangilao	110b	9,334
Total Population Served		110b	

ND 1611

FOR AGENCY U

11. Average Daily Industrial Flow — 111 — N.A. mgd

Note: All major industries (as defined in Section IV) discharging to the municipal system must be listed in Section IV.

12. Permits, Licenses and Applications

List all existing, pending or denied permits, licenses and applications related to discharges from this facility. (see instructions)

112	Issuing Agency (a)	For Agency Use (b)	Type of Permit or License (c)	ID Number (d)	Date Filed YR/MO/DA (e)	Date Issued YR/MO/DA (f)	Date Denied YR/MO/DA (g)	Expiration Date YR/MO/DA (h)
1.	G.E.P.A.		Operating Permit	GEPA-M08	90/12	86/06/30	N.A.	91/06/30
2.								
3.								

13. Maps and Drawings

Attach all required maps and drawings to the back of this application. (see instructions)

14. Additional Information

114 Item Number	Information

ND 1612

Form Approved
OMB No. 2040-0086
Approval expires 7-31-88

STANDARD FORM A—MUNICIPAL

FOR AGENCY USE

SECTION II. BASIC DISCHARGE DESCRIPTION

Complete this section for each present or proposed discharge indicated in Section I, Items 7 and 8, that is to surface waters. This includes discharges to other municipal sewerage systems in which the waste water does not go through a treatment works prior to being discharged to surface waters. Discharges to wells must be described where there are also discharges to surface waters from this facility. Separate descriptions of each discharge are required even if several discharges originate in the same facility. All values for an existing discharge should be representative of the twelve previous months of operation. If this is a proposed discharge, values should reflect best engineering estimates.

ADDITIONAL INSTRUCTIONS FOR SELECTED ITEMS APPEAR IN SEPARATE INSTRUCTION BOOKLET AS INDICATED. REFER TO BOOKLET BEFORE FILLING OUT THESE ITEMS.

1. Discharge Serial No. and Name a. Discharge Serial No. (see instructions)	201a	001
b. Discharge Name Give name of discharge, if any (see instructions)	201b	Northern District Wastewater Treatment Plant Outfall
c. Previous Discharge Serial No If a previous NPDES permit application was made for this discharge (Item 4, Section I) provide previous discharge serial number.	201c	GU-0020141
2. Discharge Operating Dates a. Discharge to Begin Date If the discharge has never occurred but is planned for some future date, give the date the discharge will begin.	202a	91 06 YR MO
b. Discharge to End Date If the discharge is scheduled to be discontinued within the next 5 years, give the date (within best estimate) the discharge will end. Give reason for discontinuing this discharge in item 17.	202b	N. A. YR MO
3. Discharge Location Name the political boundaries within which the point of discharge is located:		Agency Use
State	203a	Guam — 203d —
County	203b	N.A. — 203e —
(if applicable) City or Town	203c	Dededo — 203f —
4. Discharge Point Description (see instructions) Discharge is into (check one)		
Stream (includes ditches, arroyos, and other watercourses)	204a	☐ STR
Estuary		☐ EST
Lake		☐ LKE
Ocean		☒ OCE
Well (injection)		☐ WEL
Other		☐ OTH
If "other" is checked, specify type	204b	
5. Discharge Point — Lat/Long. State the precise location of the point of discharge to the nearest second. (see instructions)		
Latitude	205a	13 DEG. 33 MIN. 7.36 SEC
Longitude	205b	144 DEG. 48 MIN. 24.03 SEC

ND 1613

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DISCHARGE SERIAL NUMBER

001

FOR AGENCY USE

c. **Overflow Duration** Give the average overflow duration in hours.

Wet weather	209a1	N.A. hours
Dry weather	209a2	N.A. Hours

d. **Overflow Volume** Give the average volume per overflow incident in thousand gallons.

Wet weather	209d1	N.A. thousand gallons per incident
Dry weather	209d2	N.A. thousand gallons per incident

Proceed to Item 11

10. **Seasonal/Periodic Discharges**

a. **Seasonal/Periodic Discharge Frequency** If discharge is intermittent from a holding pond, lagoon, etc., give the actual or approximate number of times this discharge occurs per year. — 210a: N.A. times per year

b. **Seasonal/Periodic Discharge Volume** Give the average volume per discharge occurrence in thousand gallons. — 210b: _____ thousand gallons per discharge occurrence

c. **Seasonal/Periodic Discharge Duration** Give the average duration of each discharge occurrence in days. — 210c: _____ days

d. **Seasonal/Periodic Discharge Occurrence—Months** Check the months during the year when the discharge normally occurs. — 210d:

☐ JAN ☐ FEB ☐ MAR
☐ APR ☐ MAY ☐ JUN
☐ JUL ☐ AUG ☐ SEP
☐ OCT ☐ NOV ☐ DEC

11. **Discharge Treatment**

a. **Discharge Treatment Description** Describe waste abatement practices used on this discharge with a brief narrative. (See Instructions) — 211a:

Treatment will consist of communition and rag removal followed by preservation using diffused air and aeration tanks followed by degritting in an aerated grid chamber, followed by primary sedimentation using clarifier and chlorination. Sludge is treated by anaerobic digestion and dewatering by centrifugation.

ND 1614

DISCHARGE SERIAL NUMBER

001

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14. Description of Influent and Effluent (see instructions)

Parameter and Code 214	Influent	Effluent					
	Annual Average Value (1)	Annual Average Value (2)	Lowest Monthly Average Value (3)	Highest Monthly Average Value (4)	Frequency of Analysis (5)	Number of Analyses (6)	Sample Type (7)
Flow Million gallons per day 50050	2.25	2.25	2.15	3.0	7 days a week	365	com-posite
pH Units 00400			7.00	7.25	205/365		grab
Temperature (winter) °F 74028	N.A.						
Temperature (summer) °F 74027	N.A.						
Fecal Streptococci Bacteria Number/100 ml 74054 (Provide if available)				N.A.			
Fecal Coliform Bacteria Number/100 ml 74055 (Provide if available)				N.A.			
Total Coliform Bacteria Number/100 ml 74056 (Provide if available)				N.A.			
BOD 5-day mg/l 00310	95.2	79.6	22.3	122	41/365		com-posite
Chemical Oxygen Demand (COD) mg/l 00340 (Provide if available)	N.A.			N.A.			
OR							
Total Organic Carbon (TOC) mg/l 00680 (Provide if available) *Either analysis is acceptable)	N.A.			N.A.			
Chlorine–Total Residual mg/l 50060	N.A.			N.A.			

ND 1615

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DISCHARGE SERIAL NUMBER
001

FOR AGENCY USE

15. Additional Wastewater Characteristics
Check the box next to each parameter if it is present in the effluent. (see instructions)

Parameter (215)	Present	Parameter (215)	Present	Parameter (215)	Present
Bromide 71870		Cobalt 01037		Thallium 01059	
Chloride 00940		Chromium 01034		Titanium 01152	
Cyanide 00720		Copper 01042		Tin 01102	
Fluoride 00951		Iron 01045		Zinc 01092	
Sulfide 00745		Lead 01051		Algicides* 74051	
Aluminum 01105		Manganese 01055		Chlorinated organic compounds* 74052	
Antimony 01097		Mercury 71900		Oil and grease 00550	X
Arsenic 01002		Molybdenum 01062		Pesticides* 74053	
Beryllium 01012		Nickel 01067		Phenols 32730	
Barium 01007		Selenium 01147		Surfactants 38260	
Boron 01022		Silver 01077		Radioactivity* 74050	
Cadmium 01027					

*Provide specific compound and/or element in Item 17, if known.

Pesticides (Insecticides, fungicides, and rodenticides) must be reported in terms of the acceptable common names specified in *Acceptable Common Names and Chemical Names for the Ingredient Statement on Pesticide Labels*, 2nd Edition, Environmental Protection Agency, Washington, D.C. 20250, June 1972, as required by Subsection 162.7(b) of the Regulations for the Enforcement of the Federal Insecticide, Fungicide, and Rodenticide Act.

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FOR AGENCY USE

STANDARD FORM A—MUNICIPAL

SECTION III. SCHEDULED IMPROVEMENTS AND SCHEDULES OF IMPLEMENTATION

This section requires information on any uncompleted implementation schedule which has been imposed for construction of waste treatment facilities. Requirement schedules may have been established by local, State, or Federal agencies or by court action. IF YOU ARE SUBJECT TO SEVERAL DIFFERENT IMPLEMENTATION SCHEDULES, EITHER BECAUSE OF DIFFERENT LEVELS OF AUTHORITY IMPOSING DIFFERENT SCHEDULES (ITEM 1b) AND/OR STAGED CONSTRUCTION OF SEPARATE OPERATIONAL UNITS (ITEM 1c), SUBMIT A SEPARATE SECTION III FOR EACH ONE.

1. Improvements Required

FOR AGENCY USE
Sched. No. _____

a. Discharge Serial Numbers Affected — List the discharge serial numbers, assigned in Section II, that are covered by this implementation schedule — 300

b. Authority Imposing Requirement — Check the appropriate item indicating the authority for the implementation schedule. If the identical implementation schedule has been ordered by more than one authority, check the appropriate items. (see instructions) — 301a — GEPA USEPA _____ _____

301b

- ☐ Locally developed plan — LOC
- ☐ Areawide Plan — ARE
- ☐ Basin Plan — BAS
- ☐ State approved implementation schedule — SQS
- ☐ Federal approved water quality standards implementation plan — WQS
- ☐ Federal enforcement procedure or action — ENF
- ☐ State court order — CRT
- ☐ Federal court order — FED

c. Improvement Description — Specify the 3-character code for the General Action Description in Table II that best describes the improvements required by the implementation schedule. If more than one schedule applies to the facility because of a staged construction schedule, state the stage of construction being described here with the appropriate general action code. submit a separate Section III for each stage of construction planned. Also, list all the 3-character (Specific Action) codes which describe in more detail the pollution abatement practices that the implementation schedule requires.

3-character general action description	301c	INT
3-character specific action descriptions	301d	SEC / / / /

2. Implementation Schedule and 3. Actual Completion Dates

Provide dates imposed by schedule and any actual dates of completion for implementation steps listed below. Indicate dates as accurately as possible. (see instructions)

Implementation Steps	2. Schedule (Yr /Mo /Day)	3. Actual Completion (Yr /Mo /Day)
a. Preliminary plan complete	302a ___/___/___	___/___/___
b. Final plan complete	302b ___/___/___	___/___/___
c. Financing complete & contract awarded	302c ___/___/___	___/___/___
d. Site acquired	302d ___/___/___	___/___/___
e. Begin construction	302e ___/___/___	___/___/___
f. End construction	302f ___/___/___	___/___/___
g. Begin Discharge	302g ___/___/___	___/___/___
h. Operational level attained	302h ___/___/___	___/___/___

ND 1617

This section contains 1 page.

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OMB No. 158-R0100

FOR AGENCY USE

STANDARD FORM A–MUNICIPAL

SECTION IV. INDUSTRIAL WASTE CONTRIBUTION TO MUNICIPAL SYSTEM

Submit a description of each major industrial facility discharging to the municipal system, using a separate Section IV for each facility description. Indicate the 4 digit Standard Industrial Classification (SIC) Code for the industry, the major product or raw material, the flow (in thousand gallons per day), and the characteristics of the wastewater discharged from the industrial facility into the municipal system. Consult Table III for standard measures of products or raw materials. (see instructions)

1. **Major Contributing Facility** (see instructions)

Name	401a	N.A.
Number & Street	401b	
City	401c	
County	401d	
State	401e	
Zip Code	401f	

2. **Primary Standard Industrial Classification Code** (see instructions) — 402

3. **Principal Product or Raw Material** (see instructions)

			Quantity		Units (See Table III)
Product	403a	403c		403e	
Raw Material	403b	403d		403f	

4. **Flow** Indicate the volume of water discharged into the municipal system in thousand gallons per day and whether this discharge is intermittent or continuous.

404a	_____ thousand gallons per day
404b	☐ Intermittent (int) ☐ Continuous (con)

5. **Pretreatment Provided** Indicate if pretreatment is provided prior to entering the municipal system — 405 ☐ Yes ☐ No

6. **Characteristics of Wastewater** (see instructions)

406a	Parameter Name							
406b	Parameter Number							
406c	Value							

ND 1618

APPLICATION QUESTIONNAIRE

GENERAL INFORMATION

AND

BASIC DATA REQUIREMENTS

Treatment System Description

B

A. Treatment System Description

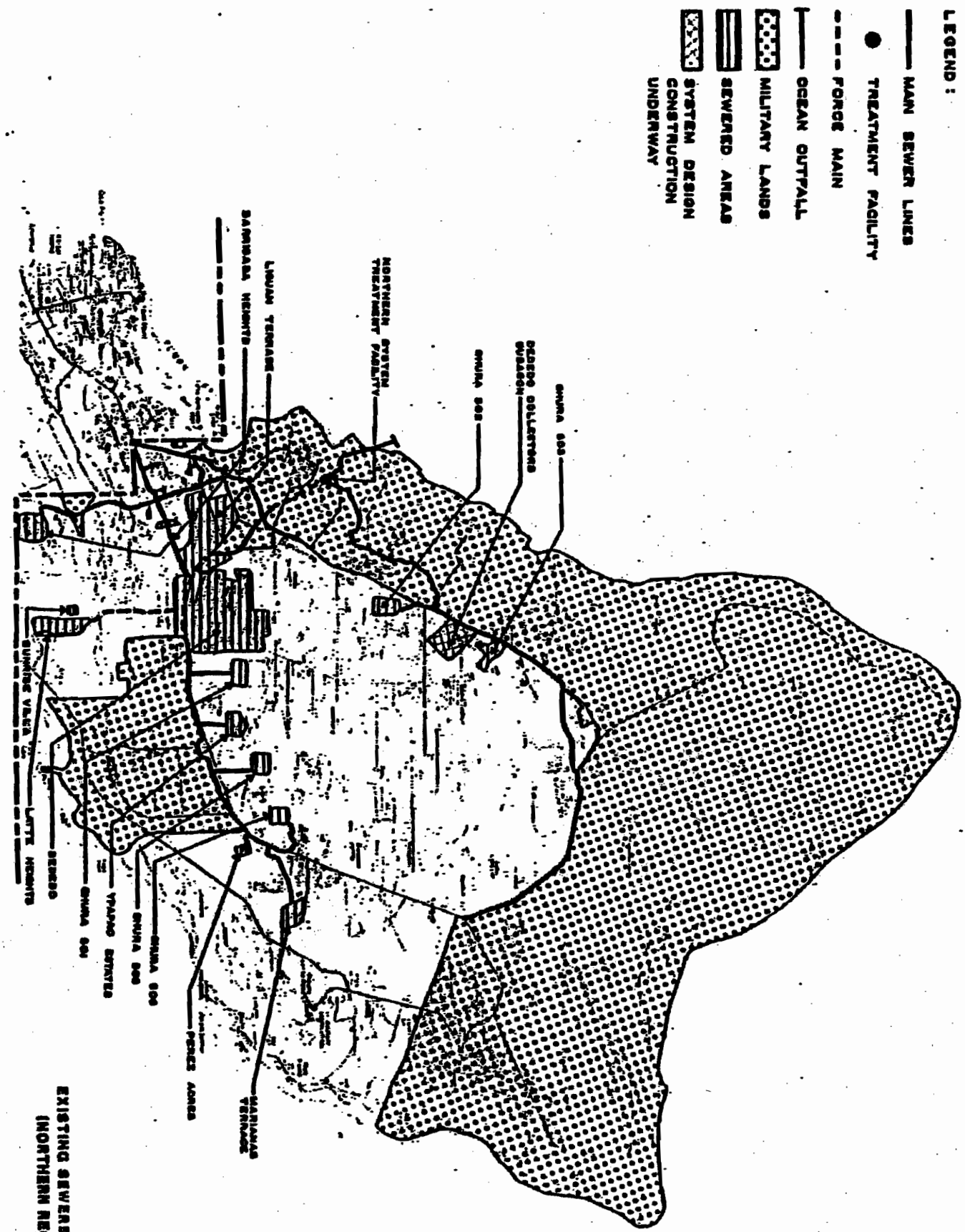
1. Description of the Treatment/Outfall System

The Northern District Sewerage System (NDSS) is the only community wastewater facility serving the civilian population in northern Guam. As shown on Figure 1 the system serves the developed area of Dededo, the subdivision of Latte Heights, Perez Acres, Ypaopao, and Marianas Terrace, Yigo Collector System, and the various GHURA Subdivisions scattered throughout the Yigo and Dededo municipalities. In addition, under an agreement with the U.S. Air Force and U.S. Navy, the system also collects domestic waste generated at Andersen Air Force Base, the Naval Communication Systems area (NCS) and other military housing areas on military lands in northern Guam.

The northern treatment facility was completed in 1979. It provides primary treatment And removes most of the settleable solids contained in the wastewater. It is designed to handle an average flow of 12 million gallons per day (mgd) with peak flows of up to 27 mgd. The treatment process include screening of raw sewage, prearetion for odor control, grit removal, comminution of large solids, primary sedimentation and chlorination. Presently, the treated effluent is discharged through a 7,272 foot ocean outfall to a point approximately 500 feet beyond the reef line west of Tanguison Point and at a depth of 60 feet. The sludge that is collected from the primary clarifiers is stabilized in a two-staged anaerobic digester. The primary stage is heated and mixed while the second stage quiscent digestion allowing sludge to settle out. The sludge is then collected and dewatered by centrifuges.

The average flow between January 1997 and December 1997, at the NDSS treatment facility was 6.3 mgd. This is considerably less than the 12 mgd design flow.

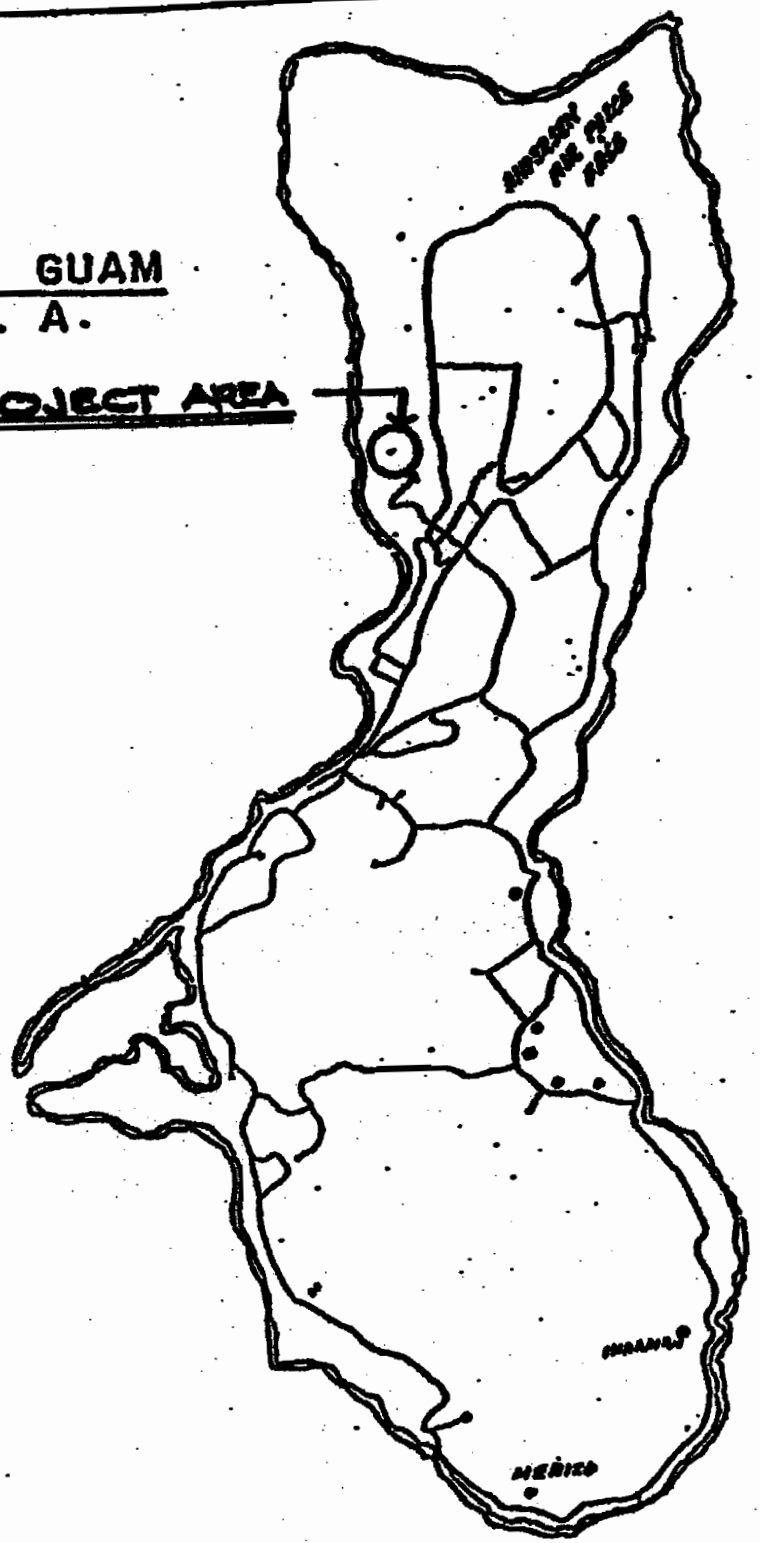
Figure 1



EXISTING SEWERED AREAS
(NORTHERN REGION)

ND 1623

Figure 2

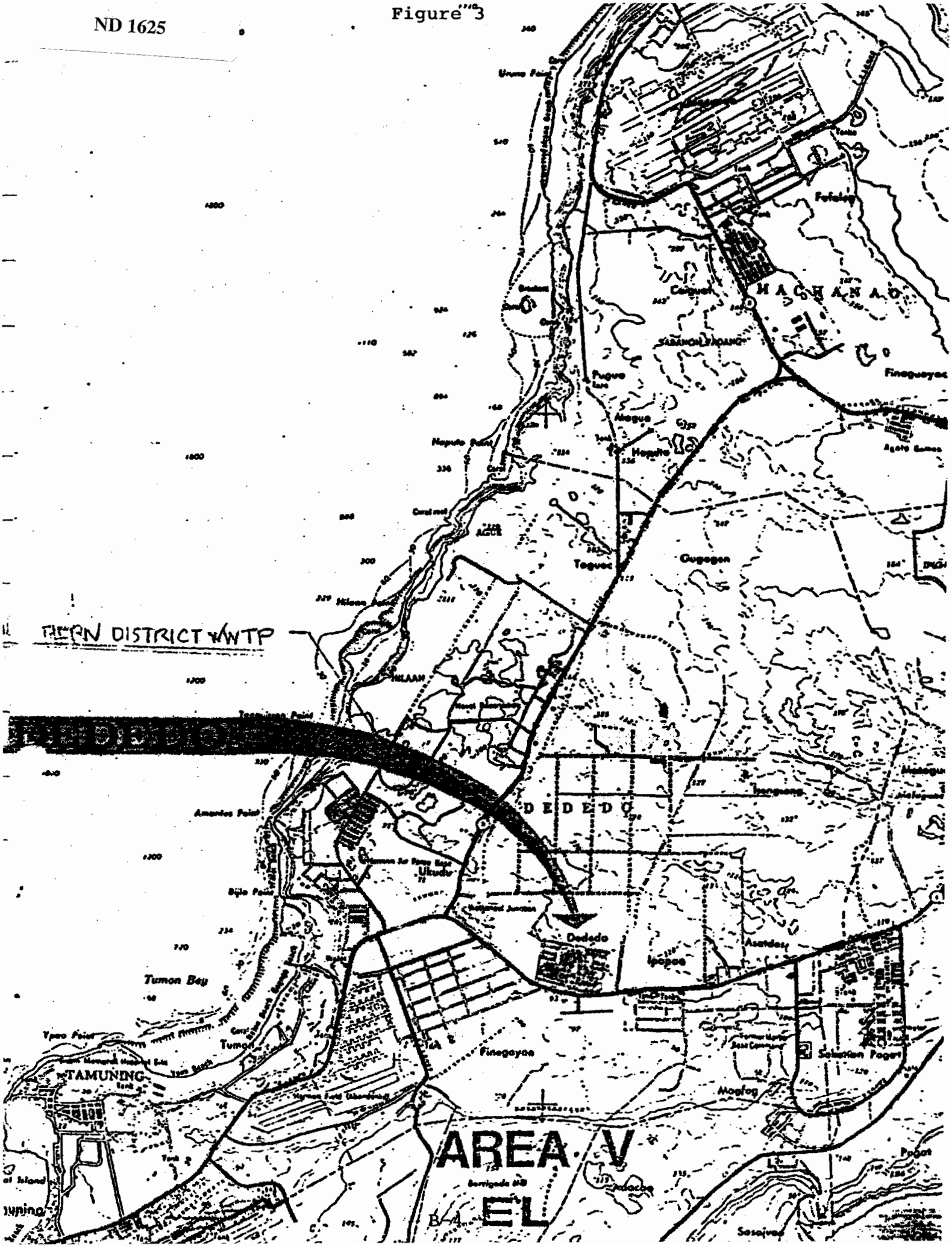


NORTHERN DISTRICT WWTP
APPLICATION BY: PUBLIC UTILITY AGENCY OF GUAM

ND 1624

ND 1625

Figure 3



Additional flows are expected from three sources in the future:

- Future connection of homes adjacent to existing sewers
- Construction of new sewer collection systems to serve densely populated areas
- Rerouting of sewer systems presently connected into the Agana Sewer System

It is anticipated that the NDSS treatment facility will have more than sufficient capacity to handle flows from its service area in the foreseeable future. Based upon population projections and U.S. Navy and U.S. Air Force wastewater flow projections, the maximum average flow that can be expected in the year 2000 is around 10 mgd. This would occur only if military flows reach the projected 5.6 mgd level and the entire civilian population is sewered, including the completion of San Vitores Reversion project.

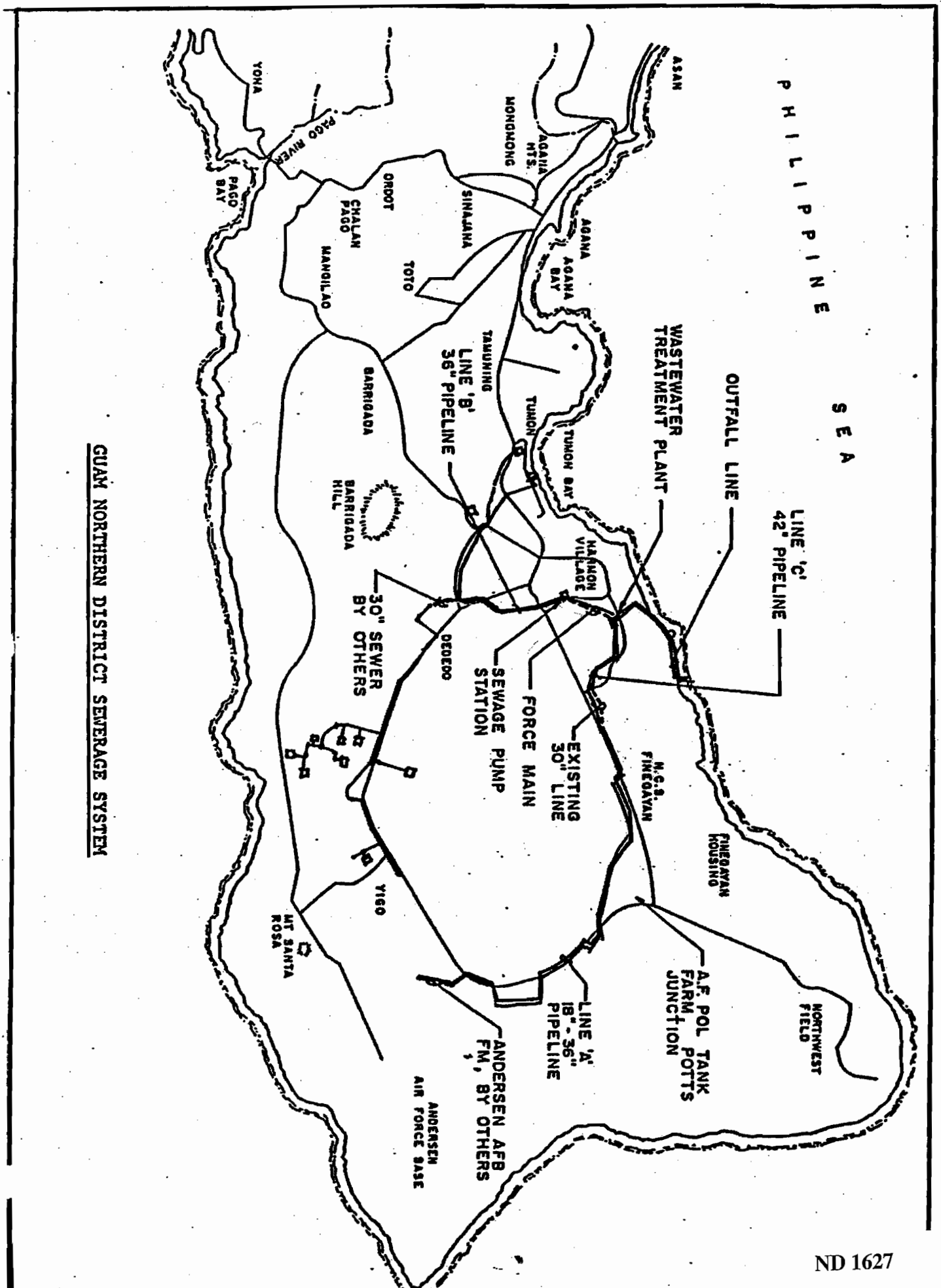
2. Facilities

The collection system consists of a network of gravity sewers. As Figure 2 shows, sewage is collected from the northern district, including Andersen Air Force Base and the Southern Link. Some of the collected sewage flows directly to the WWTP and the remainder flows to the SPS, where it is pumped through a force main to the WWTP.

The SPS includes the following major processes: Flow measurement, comminution, storage and pumping.

Figure 5 is a schematic flow diagram of the SPS. Sewage flowing into the SPS is first measured with a Parshall flume and then flows to a comminutor. The comminutor is provided to cut up large solids in the sewage that flows to the SPS to minimize the chances of clogging the pumps and to prepare the sewage for treatment

Figure 4



GUAM NORTHERN DISTRICT SEWERAGE SYSTEM

ND 1627

at the WWTP. The wet well of the SPS provides storage of the sewage so that, during periods of low sewage flows, the pumps can operate only intermittently. Three pumping units are provided to pump the sewage from the wet well to the WWTP. The design data of the SPS are given in Table 1. The Parshall flume, the comminutor, and the wet well are designed for the ultimate peak flow of 11.5 mgd.

At the WWTP, which is designed to provide advanced primary treatment of all incoming sewage flows before discharge into the ocean through an outfall, the following processes are included: Comminution, preaeration, grit removal, primary clarification, chlorination, anaerobic digestion, and centrifugation.

More specifically, the unit and facilities provided include the following:

1. A comminutor unit to cut up large solids in the incoming sewage from the gravity sewer (the sewage from the SPS that has been comminuted bypasses this unit).

2. Two preaeration tanks to aerate the incoming sewage and to flocculate the sewage solids.

3. A mechanical screw conveyor unit to dewater the grit removed from the grit chamber.

4. Two circular primary settling tanks to gravity settle sewage solids.

5. A chlorine contact tank and chlorine feed facilities to disinfect effluent prior to disposal.

6. Air blowers to provide air to the preaeration tanks and grit chambers.

Figure 5

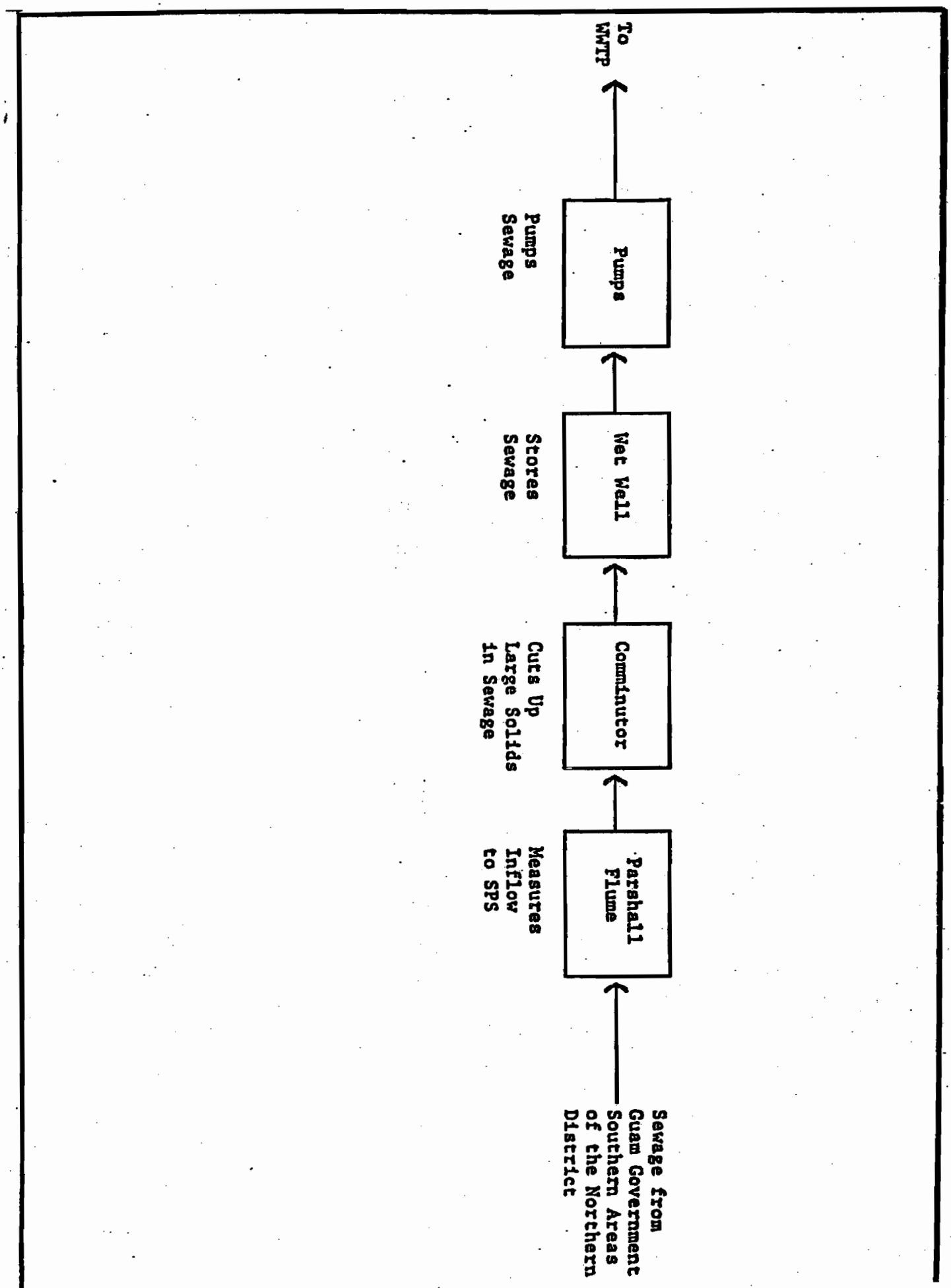

Sewage from Guam Government Southern Areas of the Northern District
Parshall Flume
Measures Inflow to SPS
Comminutor
Cuts Up Large Solids in Sewage
Wet Well
Stores Sewage
Pumps
Pumps Sewage
To WWTP

TABLE 1

DESIGN DATA FOR SEWAGE PUMP STATION

Design Peak Flow (gpm)	22,500
Number of Raw Sewage Pumps (each)	4
Pump Capacities (gpm each)	7,500 gpm
Total Discharge Head	108
Normal Power Source	Guam Power Authority
Standby Power Source	Diesel Generator

7. Sludge recirculation pumps to return sludge from the primary settling tanks to the preaeration tanks.

8. Waste sludge pumps to convey waste sludge from the primary settling tanks to the sludge heater and/or digestion tanks.

9. One primary and one secondary digestion tank.

10. A sludge heating unit to heat waste sludge.

11. Two centrifuge units with related chemical feed facilities to mechanically dewater digested sludge.

12. Laboratory facilities.

Basically, all incoming sewage is first passed through comminution, preaeration, and grit removal units. It then flows through the primary settling tanks to the chlorine contact tank before final discharge to the ocean through the outfall sewer.

The raw waste sludge that settles in the primary settling tanks is collated and pumped to the primary digester, which is designed to be gas mixed, heated to constant temperature, and operated nearly full. Most of the breakdown of organic matter occurs in this digester. Sludge should be transferred from the primary digester to the secondary digester at the same volumetric rate as the raw sludge loading so that the primary digester volume is maintained at its maximum. Further breakdown occurs in the secondary digester, although not as much as in the primary stage. Here the sludge is also allowed to settle and thicken to aid the dewatering process. Supernatant from the secondary digester is returned to the preaeration tanks.

Digested sludge is mechanically dewatered by centrifuges. The centrifuges are compact and completely enclosed, thereby minimizing odor and nuisance problems during solids processing.

3. Treatment Efficiencies

Efficiencies for sewage treatment plants are usually measured by the suspended solids (SS) and biological oxygen demand (BOD) removals. According to the design for this plant, which has advanced primary treatment, SS removal in the range of 50 to 75 percent and BOD removal of 40 to 60 percent may be expected.

The treatment plant is intended to meet the requirements of the permit to discharge sewage into the ocean. GWA's current discharge permit (No. GU0020141) requires that the effluent meet certain requirements which are given in Figure 6. Please note that the plant's Effluent Limitation requirements need to be adjusted to represent the plant's design capacity of 12 MGD.

4. Flow Pattern and Design Criteria

The flow pattern through the STP and the design criteria for the unit processes are shown and summarized on Figure 7 and in Table 2.

5. Sewer Materials and Construction

All of the sewer in the collection system including the forcemain are reinforced plastic mortar (RPM) pipe. The RPM that was installed in the NDSS was manufactured by the Amoco Reinforced Plastics Company and is known by the brand name Techite pipe. It is made from siliceous sand, glass fibers and polyester resin and has a smooth resin finish on the interior. The ocean outfall was constructed of PVC lined reinforced concrete pipe from WWTP to station 11+60.45, Techite pipe

EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS based upon an end of permit term flow of 0.26 m3/sec (6 mgd)

1. During the period beginning with the effective date of this permit and lasting through June 30, 1998, the permittee is authorized to discharge from outfall serial number 001.

   a. Such discharges shall be limited and monitored by the permittee as specified below:

EFFLUENT CHARACTERISTIC	DISCHARGE LIMITATIONS				MONITORING REQUIREMENTS	
	kg/day (lbs/day)		Other Units (Specify)			
	Monthly Average	Daily Max	Monthly Average	Daily Max	Measurement Frequency	Sample Type
Flow - m3/day (MGD)	-	-	-	(6 mgd)	Continuous	-
Biochemical Oxygen Demand (5-Day) *	1,930 (4,256)	3,860 (8,512)	85 mg/L	170 mg/L	Once/week	Composite
Suspended Solids *	1,136 (2,504)	2,272 (5,008)	50 mg/L	100 mg/L	Once/week	Composite
Settleable Solids	-	-	1 ml/L	2 ml/L	Once/week	Discrete
Oil and Grease **	-	-	-	-	Once/month	Discrete
Oil ***	Not less than 7.0 standard units nor greater than 9.0 standard units				Once/week	Discrete

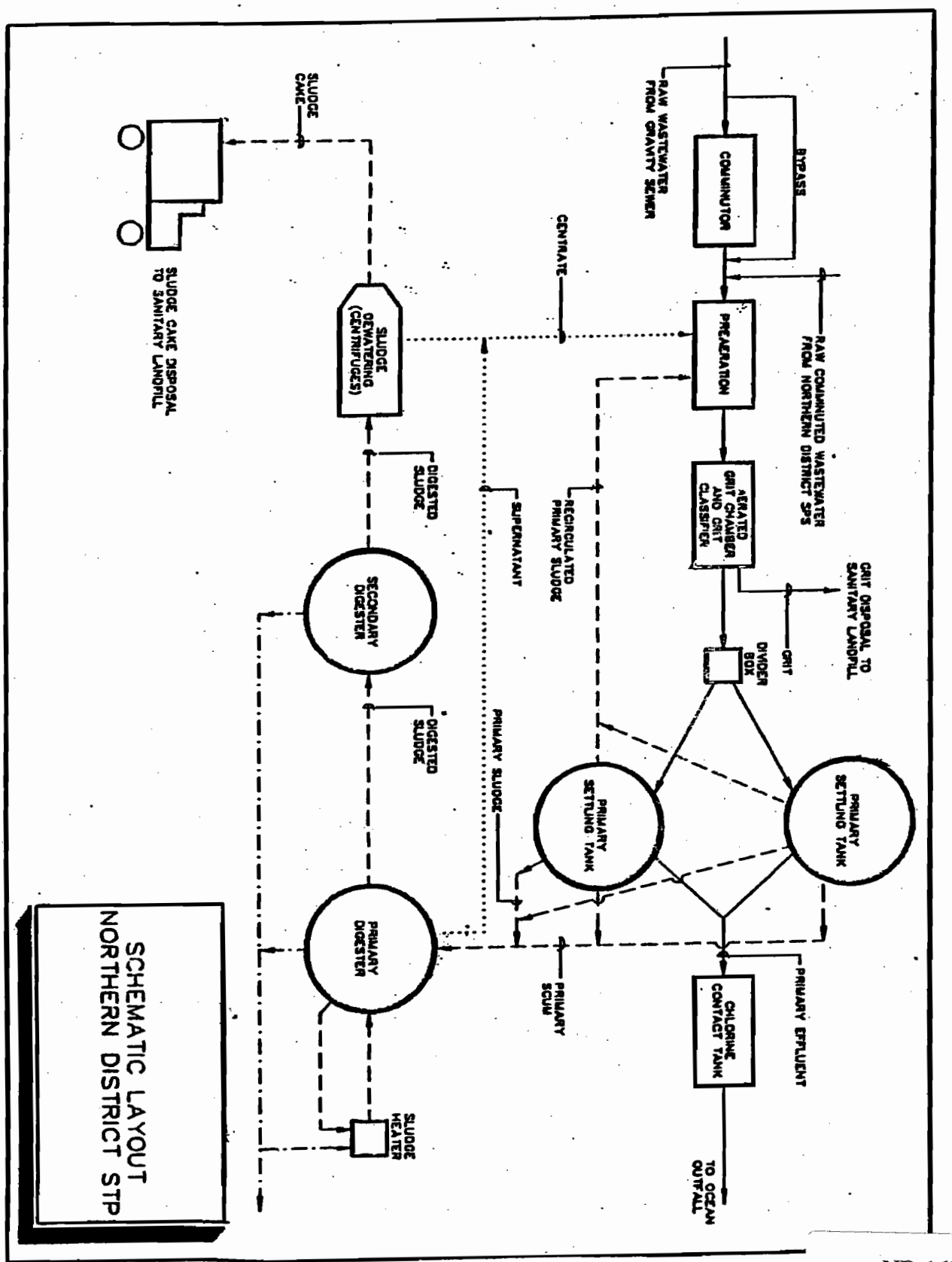
* Both the influent and effluent shall be monitored.

** Oil and grease shall be monitored in the effluent on a monthly basis over a six month period since many toxic organic pollutants partition into this fraction. If the level of oil and grease is found to be unacceptable, this permit shall be modified to include an effluent limitation and monitoring requirements for this parameter.

*** The discharger shall not cause the pH of the receiving water to deviate more than 0.5 pH units of that which would occur naturally.

Figure 6

Figure 7



ND 1634

TABLE 2

WASTEWATER TREATMENT PLANT DESIGN DATA

Design Flow	
Average	12.0 mgd
Peak	27.0 mgd
Sewage Characteristics	
5-Day BOD	300 mg/1
Suspended Solids	275 mg/1
Preaeration Tanks (two)	
Volume, each	9,250 cf
Air Requirement	240 cfm
Ozone	68 grams/hr
Aerated Grit Chambers (two)	
Volume, each	16,650 cf
Air requirement	440 cfm
Primary Settling Tanks (two)	
Volume, each	696,000 gal
Surface Loading @ Qave	455 gpsfd
Weir Overflow Rate @ Qave	14,700 gpfd
Detention Time @ Qave	2.79 hrs
Chlorination	
Dosage at mg/l	
Average demand	1,800 lbs.day
Peak demand	4,050 lbs/day
Chlorine Contact Tank (one)	
Volume	296,000 gal
Detention Time @ Qpk	16.0 min
Sludge Digestion Tanks (two)	
Volume, each	115,450 CF
Centrifuges (two)	
Capacity, each	2,100 lbs/hr @ 10% incoming sludge

from Station 11+60.45 to the end of the shallow reef area to the end of the outfall. All of the outfall sewer from the shoreline to the end is encased in concrete to protect it from the heavy seas that may occur during typhoons.

6. Outfall System

The NDSTP discharges effluent at Tanguisson Point in the Philippine Sea. This discharge point is at latitude 13 degrees 33 minutes 7.36 seconds, longitude 144 degrees 48 minutes 24.03 seconds. The outfall pipe is 2,160 feet from shore with discharge depth at 60 feet below the water surface. The current total volume discharged is between 6 and 7 mgd. However, at the end of the proposed permit period, the total volume is expected to be 10 mgd.

The present outfall system consists of 5,500 linear feet of 30-inch diameter pipe. Twenty-three (23) diffusers are part of the outfall system. Specific information about the diffusers is provided in Table 3. Appendices K, L, and N provides drawings of the treatment plant pipelines, outfall sewer and diffusers. Figures 8, 9, and 10 also show profiles of the outfall and diffusers.

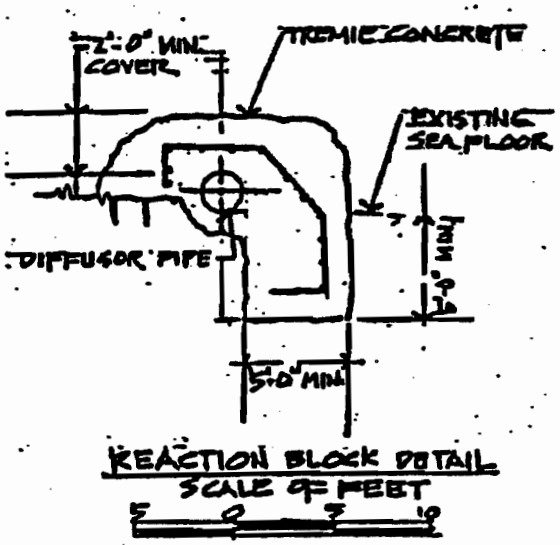
GWA has recently contracted with a local A/E firm to conduct a baseline study of the area immediately around and beyond the existing ocean outfall as a precursor to either extending the existing outfall or constructing an all-new outfall that is longer and deeper. This phase of the work has started and the resulting optimal design will be an outfall that extends to a point were no decrease in receiving water quality will occur and that water currents will not carry material back into the inner reef areas or to shore. (See Appendices H, I and J)

TABLE 3

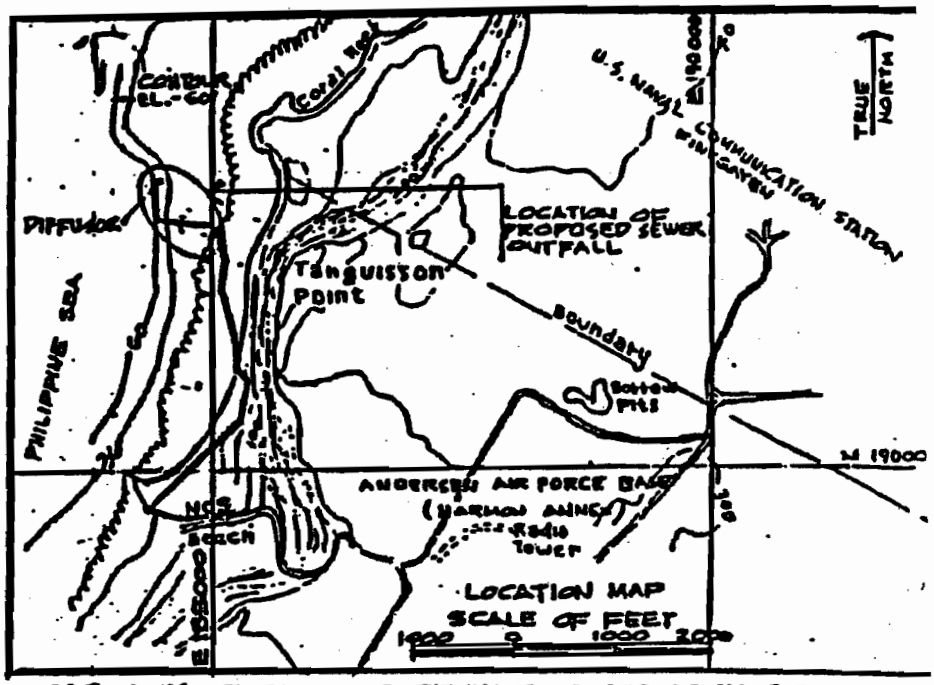
OUTFALL DATA

Outfall Diameter (meters)	-	1.219 + 0.762
Length	-	2,216.46
Diffuser Diameter	-	0.762, 0.609, 0.508, 0.406, 0.305
Length	-	128.659
4s of Port of Orientations from Horizontal (degrees)	-	90 degrees
Port Diameters	-	0.1016
Orifice Contraction co-efficient	-	
Vertical Distance from mean lower low water surface to (meters) Centerline of the port	-	18.293
Number of ports	-	23

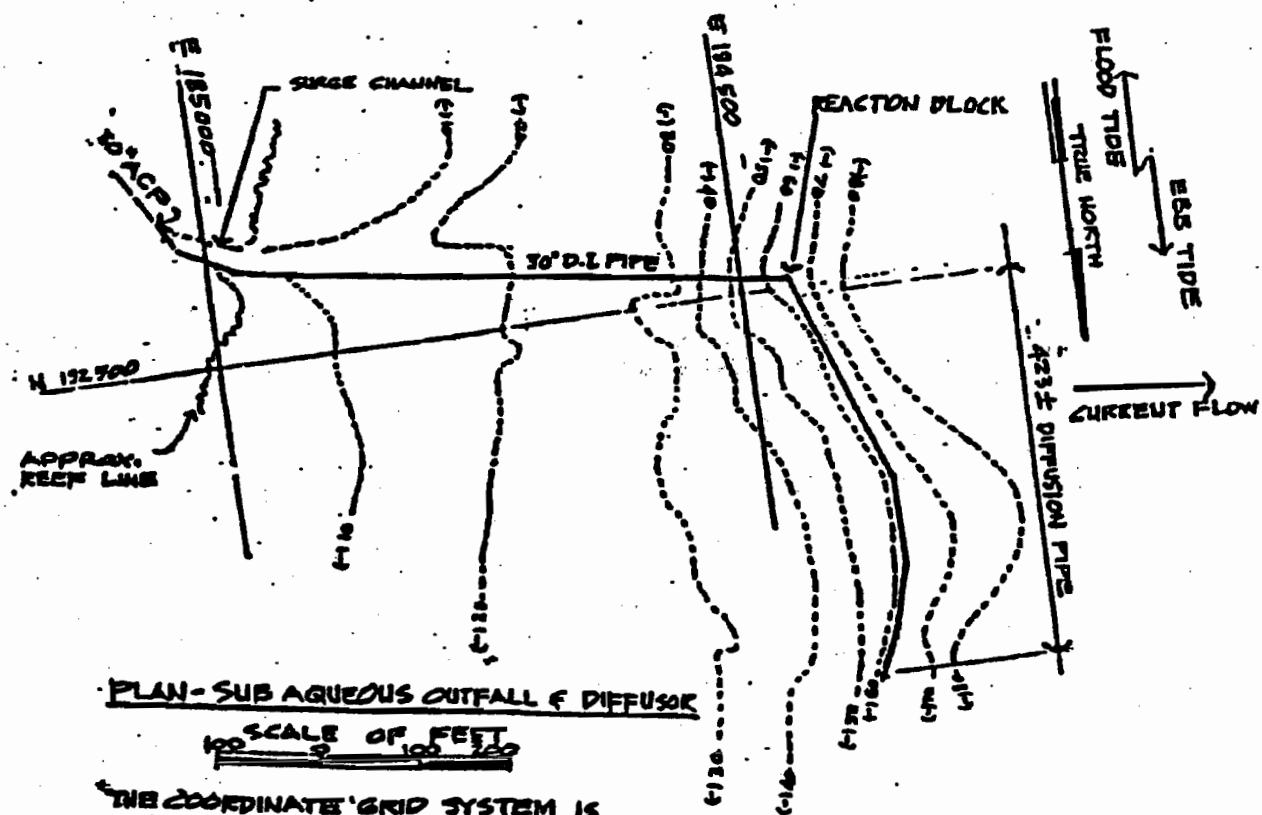
Figure 8



REACTION BLOCK DETAIL
SCALE OF FEET
0 5 10



FROM U.S. DEPARTMENT OF THE INTERIOR GEOLOGICAL SURVEY MAP DATED 1968, PORTIONS OF FITIDIAN PT. & DEDEDO QUADRANGLE

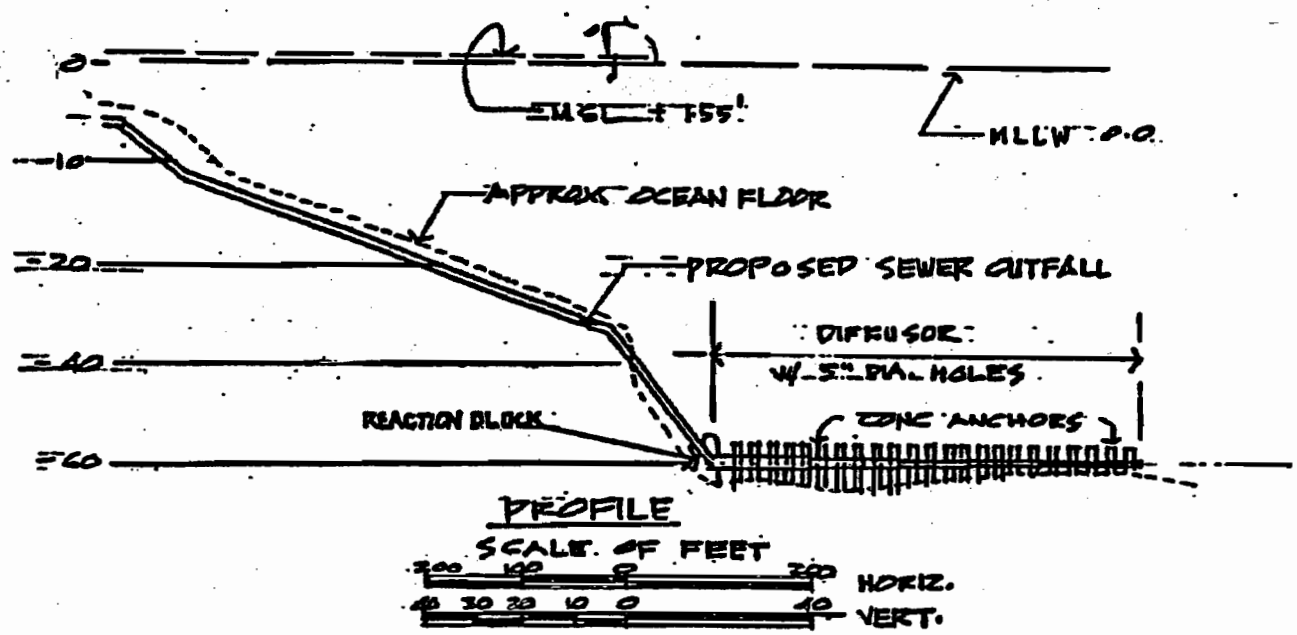


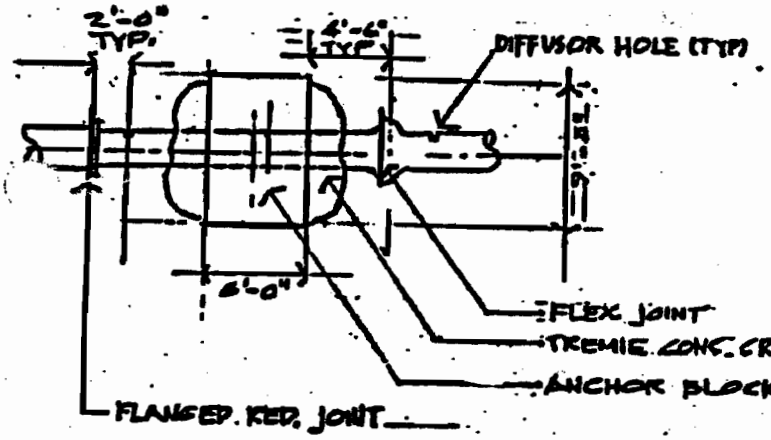
PLAN - SUB AQUEOUS OUTFALL & DIFFUSOR
SCALE OF FEET
100 0 100 200

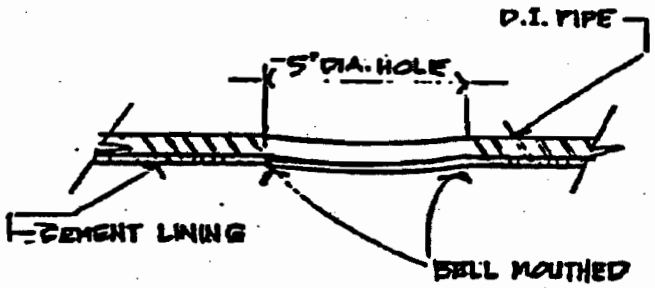
*THE COORDINATE GRID SYSTEM IS BASED ON THE GUAM GEODETIC TRIANGULATION NETWORK 1963

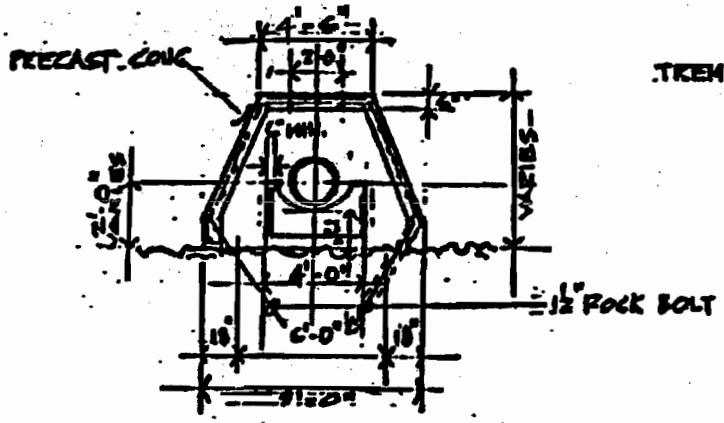
EXISTING SEWER OUTFALL
AT TANGUISSON POINT
GUAM, MARIANA ISLANDS
APPLICATION BY: GWA
SHEET 1 OF 3 DATED 10-28-97

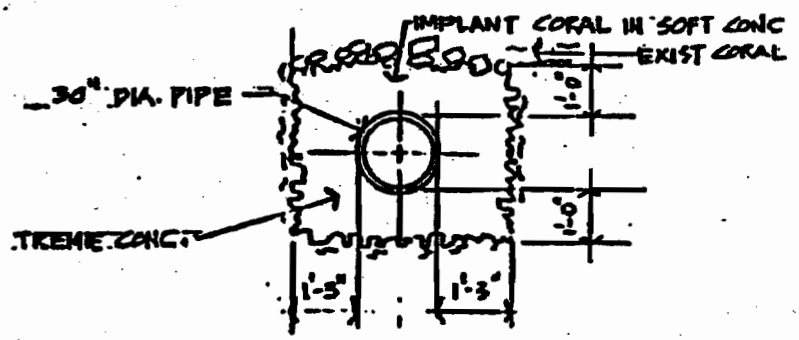
ND 1638



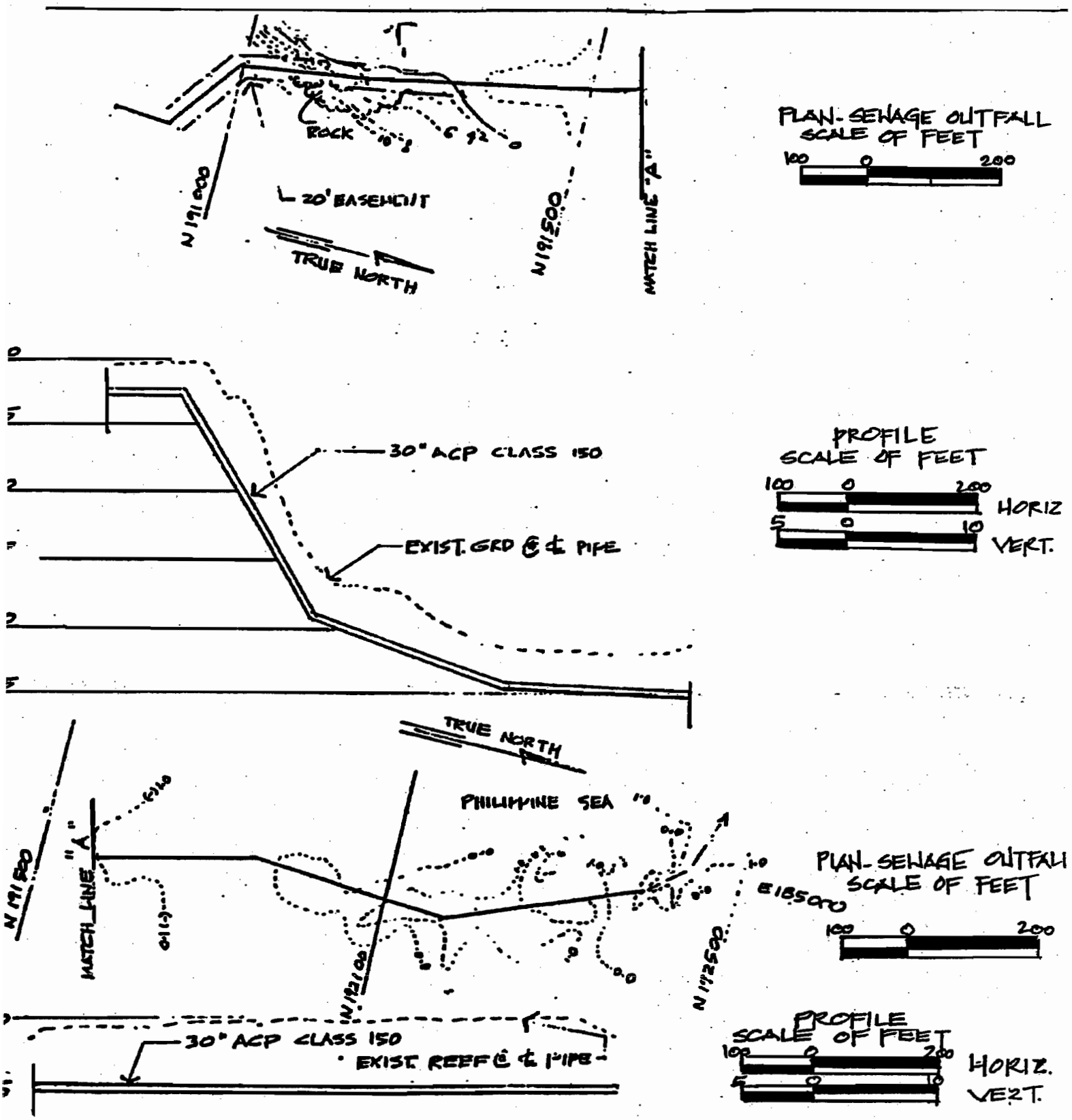








EXISTING SEWER OUTFALL AT TANGUISSON POINT, GUAM
APPLICATION BY: GWA
SHEET 2 OF 3 DATED OCT. 28 '97



EXISTING SEWER OUTFALL
AT TANGUISSON POINT
GUAM MARIANA ISLANDS
APPLICATION BY: GWA

7. Changes in Service Area

The area served by NDSS is primarily an urban zone which continues to be a region of major expansion.

In addition to the civilian population, there are major Federal Government installations in the area, including Andersen Air Force Base (AAFB) and the Marbo Annex, Naval Communication Station and FAA facilities at Finegayan. All of the Federal facilities have personnel housing.

The villages of Dededo and Yigo were previously cited as the areas served by the northern wastewater facility. The service area now includes Tumon Bay, the site of most of the hotels on Guam, and sections of Barrigada and Mangilao. Supporting the commercial, governmental and residential communities is a number of elementary and high schools\, churches, fire stations, and community centers.

Population estimates for the aforementioned areas are listed below:

Area	Population
Dededo	36,250
Yigo	13,600
AAFB	2,470
Finegayan/FAA	6,018
Tumon	9,000
Barrigada/Mangilao	9,334

Figures for the villages of Dededo, Yigo, Tumon and Barrigada/Mangilao were taken from the GWA Rural Island wide Wastewater Facilities Plan and are the projected population estimates for the year 2014. The military area population equivalents

were calculated based upon an average contribution of 100 gallons per capita per day; military utility consumption figures (1998) available to GWA were used in this computation. See Appendix O.

The change in the expense of this service area is significantly attributed to a project called the Sewage Reversion Project.
Integrated components of this project include:

- the Mamajanao Pumping Stations
- Fujita/Tumon Pumping Stations
- Harmon Industrial Park Pumping Stations
- Liguan Terrace/Barrigada Heights Pumping Station

Appendix M contains site plans from which the aforementioned stations may be located. As the project title infers, sewage flows will be "reversed". On October 1992, the actual activation period for the project, flows from Tumon, Barrigada Heights and Dededo Village were diverted northward for disposal at the Northern District Treatment Plant. Such discharges are currently treated at the Agana facility. Within the next 3-5 years, flows from the Mamajanao Pump Station will be reversed to the Liguan Terrace/Barrigada Heights Pump Station for disposal and treatment at the Northern facility. Table 4 presents a flow summary for the Sewage Reversion project.

8. Effluent Limitations and Characteristics

GWA is requesting that the effluent limitations presented in Figure 4 be reexamined and calculated to represent the plant's 12 MGD design. Discharge Monitoring Reports (DMRs) for the period January 1997 to December 1997 are attached as Appendix B. These routine compliance reports summarize the quality and/or quantity of GWA's NDSTP discharge and compares them with the current permit effluent limitations.

WHAT? Math doesn't add up or make sense in most cases here—

TABLE 4

FLOW SUMMARY

SEWAGE FLOW REVERSION PROJECT

Flow Summary: Flow does not balance

Mamajanao WWPS Maximum Capacity 4 pumps; 2,130 gpm each	6,400 gpm
Fujita/Tumon WWPS Maximum Capacity 4 pumps; 2,000 gpm each	8,000 gpm
Harmon Industrial Park WWPS Maximum Capacity 2 pumps; 500 gpm each	500 gpm
Maximum Gravity Flow to Liguan Terrace WWPS	4,060 gpm
Maximum Capacity of Gravity Line to North /Harmon WWPS (Minimum capacity is immediately downstream of the discharge manhole and also near the North Harmon WWPS)	10,400 gpm
Current maximum capacity of North Harmon WWPS 4 pumps; 7,800 gpm each	22,500 gpm
Average flow capacity of Northern District WWTP	18,750 gpm (27 mgd)
Maximum flow capacity of Northern District WWTP	13,890 gpm (20 mgd)

9. Toxic pollutants and Pesticides in Effluent

Samples for the required Toxicity and Priority Pollutant Scan were collected on the 9th of March for the Northern Wastewater Treatment Plant. The samples were sent off island to the Montgomery & Watson Labs in Pasadena California. GWA has received E-Mail confirmation that the analysis of the samples are presently in progress. The sampling was performed to provide GWA with information to address effluent toxicity concern in 301 (h) permit applications. The results along with GWA's responses to the relevant sections of the application questionnaire will be sent to your office at the earliest.

10. Effluent Volume

For the term of the modified permit being requested, the projected effluent flow is 10 mgd. The current effluent flow is 7.00 mgd, the activation of the sewer reversion project and the additional connections of more homes and commercial developments will increase flow to the NDSTP to the projected 10 mgd. Daily and Monthly Flow Reports for the period January 1997 to December 1997 are attached as Appendix F.

Flow to this plant is expected to reach 10 mgd by the year 2000 based on the Rural Island wide Wastewater Facilities Plan, (Barrett, Harris & Associates, Inc., October 1982) and the Tumon Bay Infrastructure Study, (Duenas & Swavely, Inc., July 1990)

Receiving Water Description

C

II. B. Receiving Water Description

II.B.1. Are you applying for a modification based on a discharge into the ocean or to saline estuary?

GWA is applying for a modification based on a discharge to the ocean. The receiving waters are coastal waters off Tanguisson Point, on the western coast of Guam.

II.B.2. Is your current discharge or modified discharge to stressed waters as defined by 40 CFR 125.58(z)?

The receiving waters at Tanguisson Point are not stressed. GEPA's Revised Water Quality Standards 1992, classifies the waters in this area as good marine water (M-2). Water in this category must be sufficient to allow for the propagation and survival of marine organisms, particularly shellfish, corals and other reef related resources. Other important and intended uses include mariculture activities, aesthetic enjoyment and compatible recreation inclusive of whole body contact and related activities.

II.B.3. Provide a description and data on the seasonal circulation patterns in the vicinity of your current or modified discharge(s).

For the island of Guam as with most islands in the Central Pacific, the prevalent northeast tradewinds of the area play a major role in generating the enormous North Equatorial Drift Current that sweeps by Guam from east to west (Jones and Randall 1973a). This current is responsible for much of the energy that transports water along the coasts. The North Equatorial Current splits on the northeast corner of the island and streams around the South of Guam at Cocos Island and around the North at Ritidian Point. These two currents then move along the west coast and are joined off Apra Harbor and move out into the Philippine Sea. During the rainy season on Guam, the tradewinds often break down and the strength of the North Equatorial Current may be reduced. The typical tradewinds current pattern for Guam's coastal waters is depicted in Figure 1.

Jones and Randall, 1973a, concluded from measurements recorded by fixed current meters (5m, 10m-14m, 23m, 30m) that the general current direction is on a northeast and southwest axis with average speeds of 0.4 knots (0.21 m/sec). The mean frequency diagrams of current direction for these meters are shown in figures 12-16. The current direction and velocity is thought to correlate with Guam's semidiurnal tides, and that in general currents ran north to north east on an ebb tide and on flood tides ran southerly. Data from 1 m, 5 m and 10 m drift crosses also approximated a northerly drift on ebb tides and a southerly one on flood tides. Drift cross observations indicated a current speed from 0.1 to 0.6 knots, with a mean of 0.2 knots (0.1 m/sec). The drift cross tracks from the 1 m, 5 m, and 10 m are shown in figures 17, 18 and 19 respectively, and show that the currents would tend to transport the effluent offshore.

Huddell *et al.* 1971, reported that current speed measured at a depth of 50 ft in the vicinity of the discharge were most frequently between 0.05 and 0.25 knots, but up to 0.75 knots. Most of the currents flowed NE and SW, with NE been most predominant. Surface currents measured using dye traces during February, August and September 1971, indicated currents flowing up to 0.4 knots, usually parallel the shoreline. The current flow off shore from NCS Beach and Tanguisson Pt. was

almost equally divided between NE and SW. Studies were conducted in the winter from 4 Feb. to 3 Mar. 1971, and in the summer from 19 Aug to 15 Sep, 1971. They concluded that current does not appear to be affected tidally or seasonally. However, Jones and Randall, 1973a, suggest that some of the drogue and meter data collected by Huddell *et al.* does indicate an influence from tidal phase, but note that neither study have satisfactorily answered the question of tidal influence on currents.

Huddell *et al.* reports that NE tradewinds are dominant in all seasons, but are especially pronounced in the winter (Jan- May). During the summer (July - Oct) the effect of the trade winds are diminished and winds from every direction are not uncommon (Figure 11). For the most part the discharge should not be transported across the reef by surface currents that are wind driven. However, on occasion high fecal coliform numbers have been found at the shoreline at monitoring station A, situated perpendicular to the outfall. There is no other known source of fecal pollution in the area, and high fecal coliform numbers may be a result of the discharge been transported over the reef. Jones and Randall 1973b, noted that at times with heavy wave assault, currents are inshore and create a strong flushing action on the reef flats. Stating that this flushing would tend to minimize any concentration of sewage that does find its way to the reef flat.

GEPA conducted an environmental assessment of the Northern District WWTP receiving waters (Borja and Wood 1986). They note that dominant currents along the western shoreline of Guam move to the south at speeds averaging 0.5 to 0.8 knots. Therefore prevailing currents would tend to carry the wastewater plume offshore.

Hudell et al concluded from information gathered from meters stationed at Cabras Island, Hilaan Point and Orote Point, that an offshore southwesterly flow persists along the western coast of Guam. Nearshore flow is controlled by a complicated series of eddies generated from the offshore flow. The location and shape of the eddies is controlled by several factors; wind speed and direction, tidal phase, configuration of the coastline, topography of the bottom, wave height and direction, and the speed and direction of the offshore flow. The extention of the Agana and Tanguission outfalls farther from shore my reduce the influence of these nearshore eddies on the effluent plume. A series of hydrodynamic studies will be conducted to establish the fate of the effluent plume.

Borja, M. and H. Wood. 1986. Environmental Impact of Sewage Effluent at the Marine Outfall of the Northern District Sewage Treatment Plant, Guam. Guam Environmental Protection Agency, Technical Report.

Jones, R. S. and R. H. Randall. 1973a. A Study of Biological Impact caused by Natural and Man-Induced Changes on a Tropical Reef. University of Guam, Marine Laboratory Technical Report No.7.

Jones, R. S. and R. H. Randall. 1973b. A Preliminary Marine Survey for the Northern District Sewage System. University of Guam, Marine Laboratory, Environmental Survey Report No.8.

Huddell, H. D., J. G. Willett and G. Marchand. 1974. Nearshore currents and Coral Reef Ecology of the West coast Of Guam, Mariana Islands. Naval Oceanographic Office, Washington, D.C.

II.B.4. Oceanographic conditions in the vicinity of the current and proposed modified discharge(s). Provide the following:

- ***Lowest percentile current speed***

0.05 knots

- ***Predominant current speed and direction during four seasons***

Predominant current speed 0.2 to 0.4 knots. Currents direction are equally divided between NE and SW through the north.

- ***Periods of maximum stratification (months)***

In the ocean waters around Guam there is a year round permanent thermocline, extending from 120m to more than 400m, in which water temperatures drop from 27° to 8° C (Amesbury, S. S. and M. Babin 1990). Water temperature measured at depths of 0m and 50m did not vary from each other, or vary through out the year by more than 1°C (Figure 24). The thermocline is well below the discharge depths, therefore stratification doesn't effect the effluent plume.

Amesbury, S. S. and M. Babin. 1990. Ocean Temperature Structure and the Seasonality of Pelagic Fish Species Near Guam, Mariana Islands. Micronesica 23(2):131-138).

- ***Density profiles during periods of maximum stratification***

No stratification, see explanation above.

II.B.5. Do the receiving waters for your discharge contain significant amounts of effluent previously discharged from treatment works for which you are applying for a section 301(h) modified permit?

The receiving waters for the discharge do contain significant amounts of effluent previously discharged from the treatment works. Water quality standards and water quality criteria are met at and beyond the ZID boundary. However, a reading of greater than >400 fecal coliform/ 100 mL were recorded at site D one out of 19 times that waters have been sampled since 1989. The effluent currently discharged is rapidly diluted, and ambient water conditions generally occur outside the ZID for those parameters presently monitored. Water quality data will be collected as part of the baseline study in the area of any proposed sites for the extension of the Tanguisson outfall to determine if the waters are impacted by the current discharge.

II.B.6. Ambient water quality conditions during the period(s) of maximum stratification: at the zone of initial dilution (ZID) boundary, at other areas of potential impact and at control stations. a. Provide profiles with depth on the following for the current discharge location and for the modified discharge location, if different from the current discharge:

- ***BOD_5 (mg/L)*** (not measured)
- ***Dissolved oxygen***
- ***Suspended solids (mg/L)*** (not measured)
- ***pH***
- ***Temperature (°C)***

- ***Salinity***
- ***Turbidity***
- ***Other significant variables***

As explained above there is no period of stratification. The results presented are from semi-quarterly sampling periods, March 1989 to July 1997, Table 5. The minimum, average and maximum values for each parameter are given on the third page of Table 5. Sampling stations are depicted in Figure 22, and locations are described below. The stations, water quality and bacteriological parameters measured were determined, and required, by the USEPA and Guam EPA. Samples were taken at 3 depths, surface (0m) mid (8m), and Bottom (16m). Sample were collected and analyzed by UOG Marine Lab, from March 1989 until December 1989, after which they were collected and analyzed by GWA staff.

RECEIVING WATER SAMPLING STATIONS

Onshore

ND A: 13° 32' 55" N x 144° 48' 15" E
shoreline station 0.4 km NE of C.

ND B: 13° 33' 30" N x 144° 48' 8" E
shoreline station at NCS beach

Offshore

ND C: 13° 33' 4" N x 144° 48' 10" E
situated above diffusers in 60 feet (18.29m) of water
Samples taken at surface, mid (10m), and bottom (20m)

ND D: 13° 33' 42" N x 144° 48' 10" E
100m south of the elbow in the diffuser pipe. In 60 ft of water
Samples taken at surface, mid (8m), and bottom (16m)

ND E: 13° 33' 20" N x 144° 48' 10" E
1000m north of C, in 600 ft of water.
Samples taken at surface, mid (8m), and bottom (16m)

From the Jan 1997 these stations were located in waters at the same depth as station C, and samples were taken at surface, mid (5m), and bottom (15m).

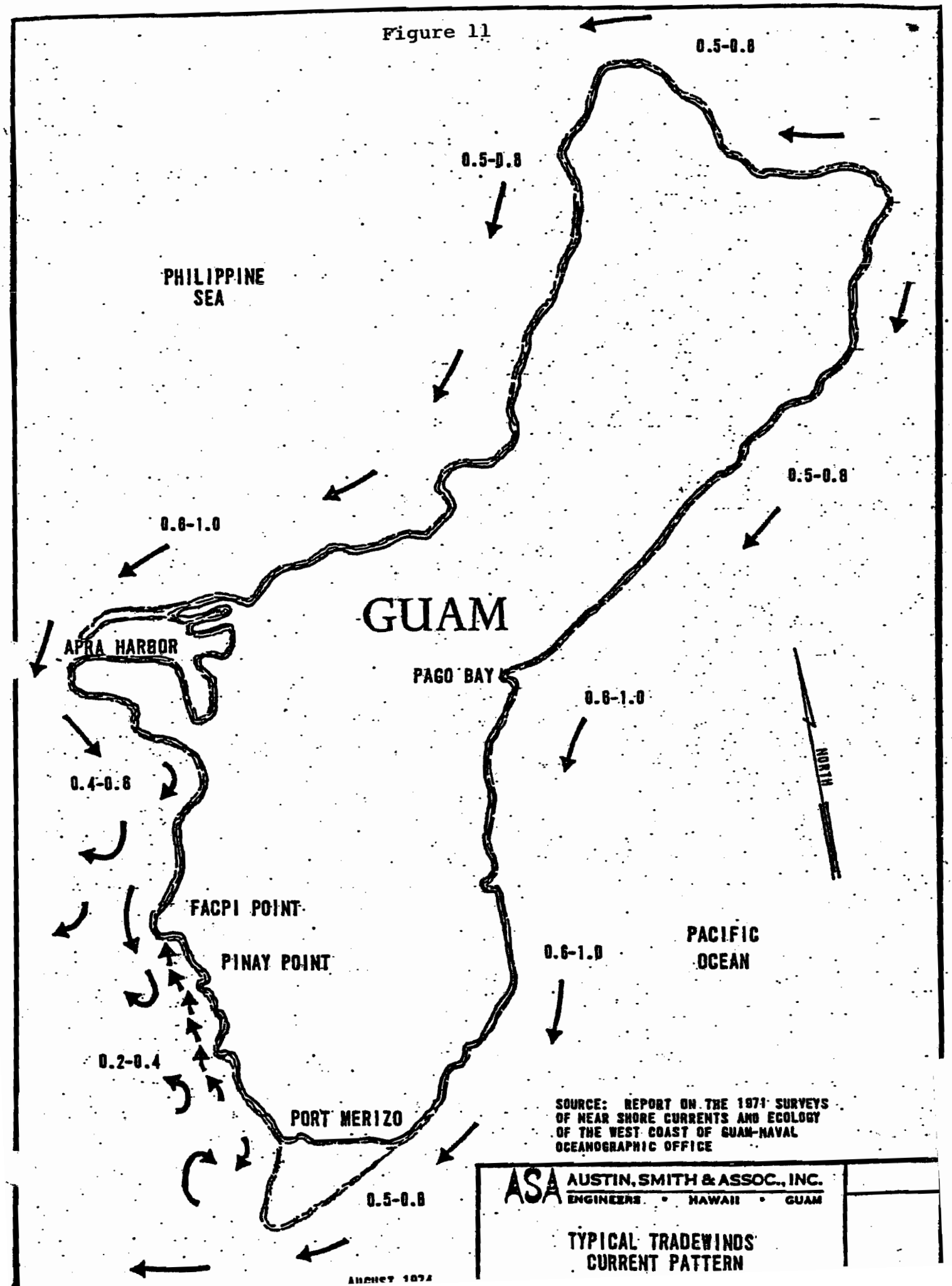
c. Are there other periods when receiving water quality conditions may be more critical than period(s) of maximum stratification?

No.

II.B.7 provide data on steady state sediment dissolved oxygen demand and oxygen demand due to resuspension of sediments in the vicinity of the discharge. (mg/L/day).

There has been no studies done to date on sediment dissolved oxygen demand.

Figure 11



SOURCE: REPORT ON THE 1971 SURVEYS OF NEAR SHORE CURRENTS AND ECOLOGY OF THE WEST COAST OF GUAM-NAVAL OCEANOGRAPHIC OFFICE

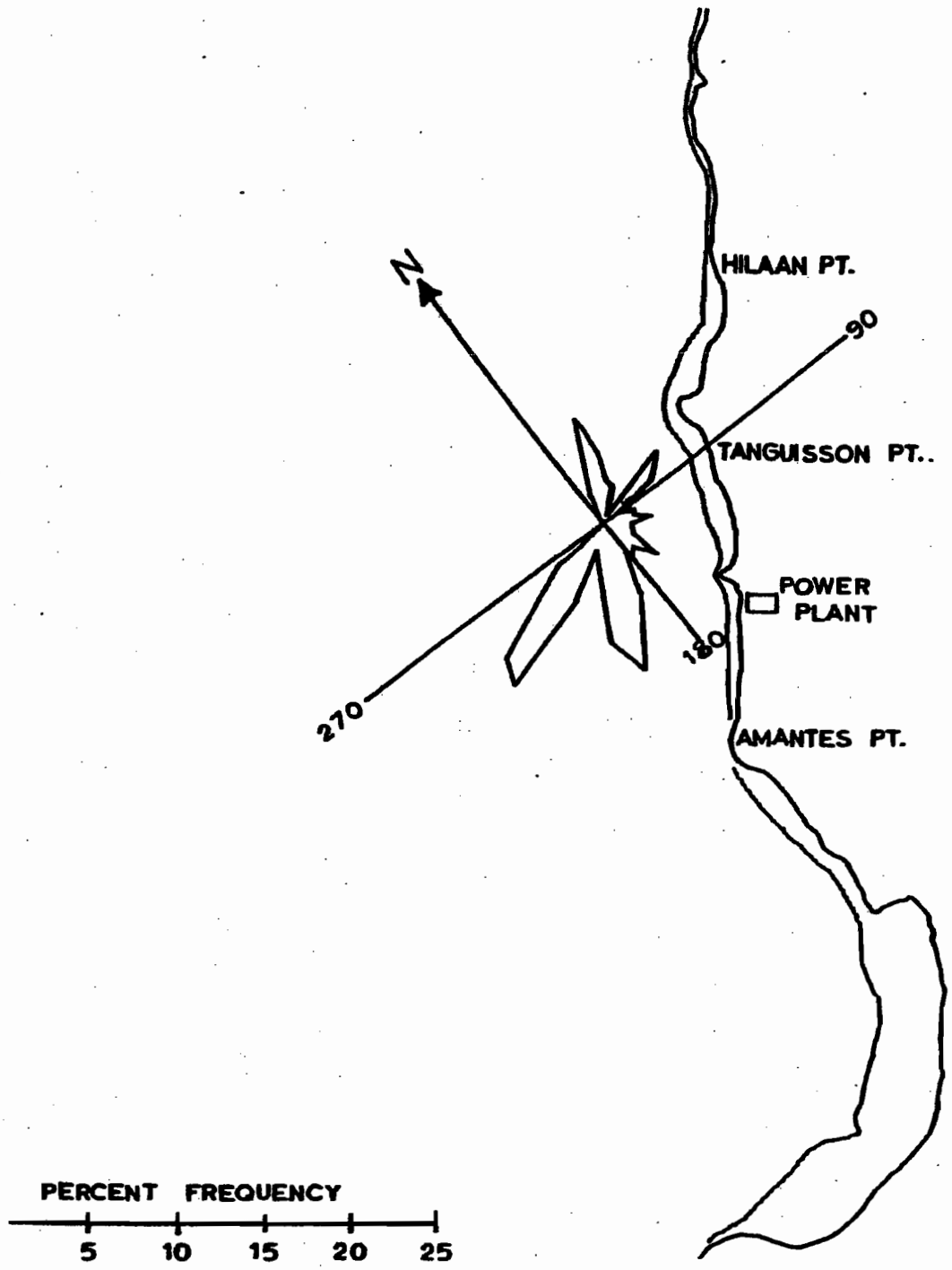
ASA AUSTIN, SMITH & ASSOC., INC.
ENGINEERS • HAWAII • GUAM

TYPICAL TRADEWINDS CURRENT PATTERN

AUGUST 1974

ND 1650

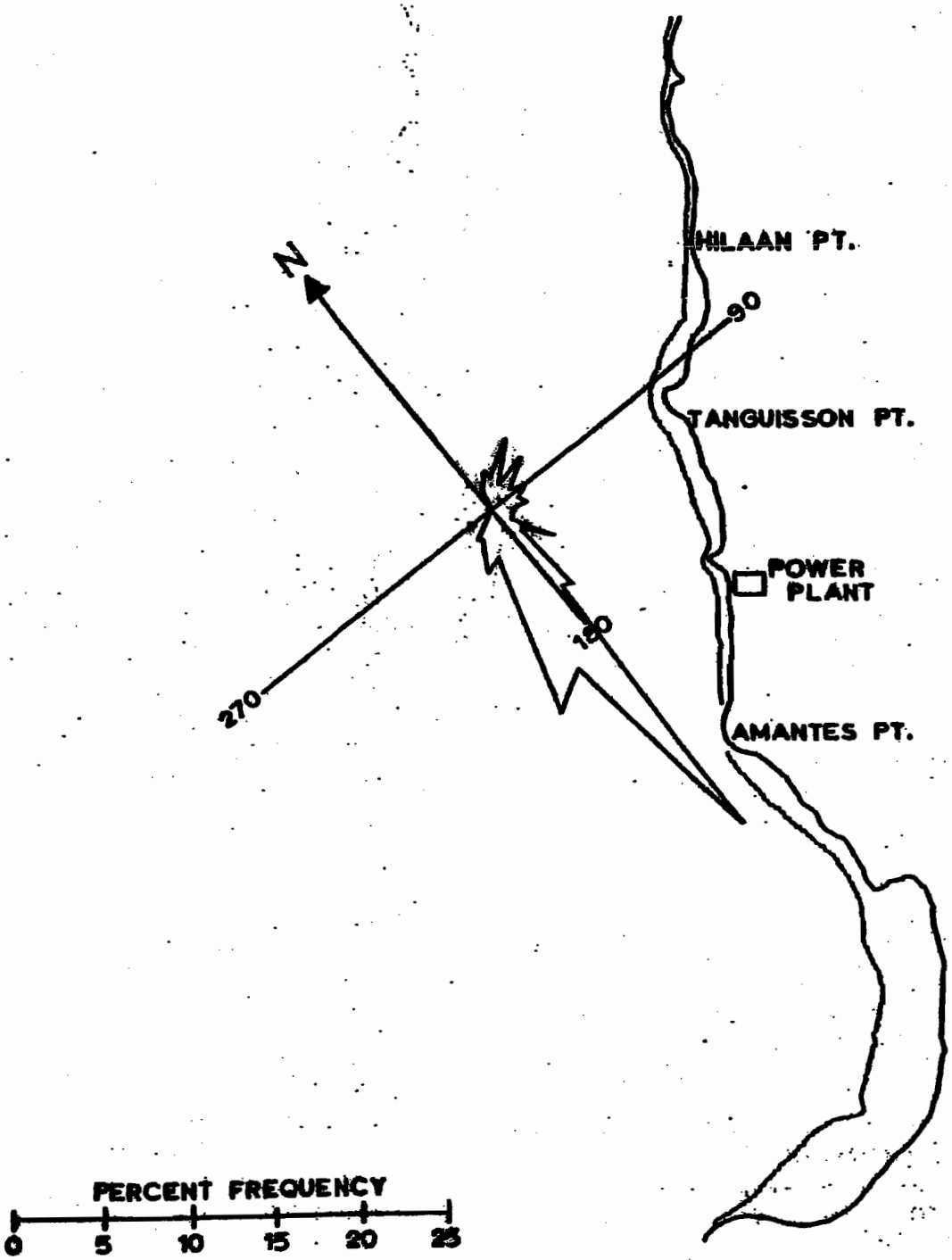
Figure 12



Mean frequency diagram for current direction at 5 m (TSK meter).

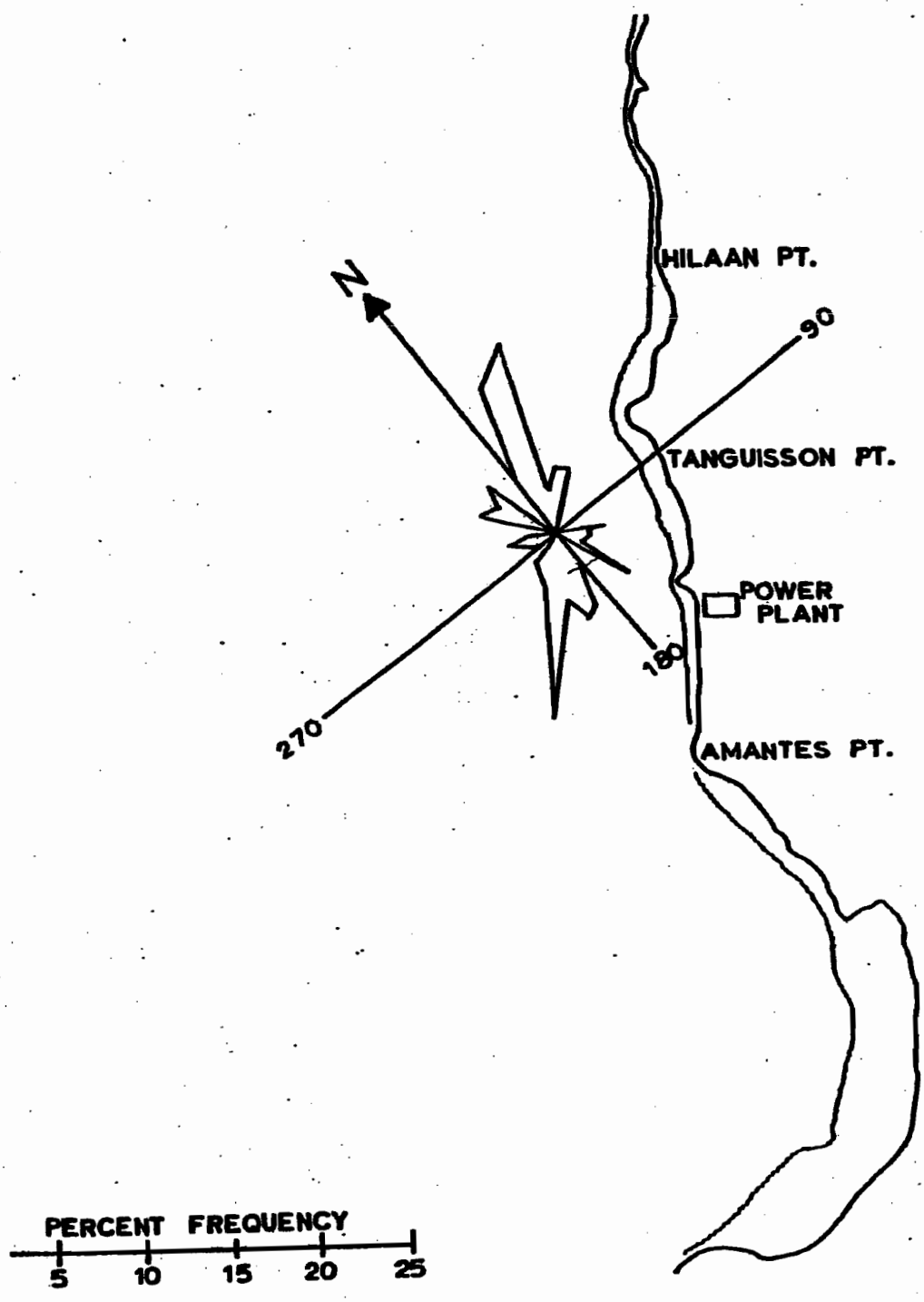
ND 1651

Figure 13



Mean frequency diagram for current direction at 10 to 14 m (Hydroproducts meter).

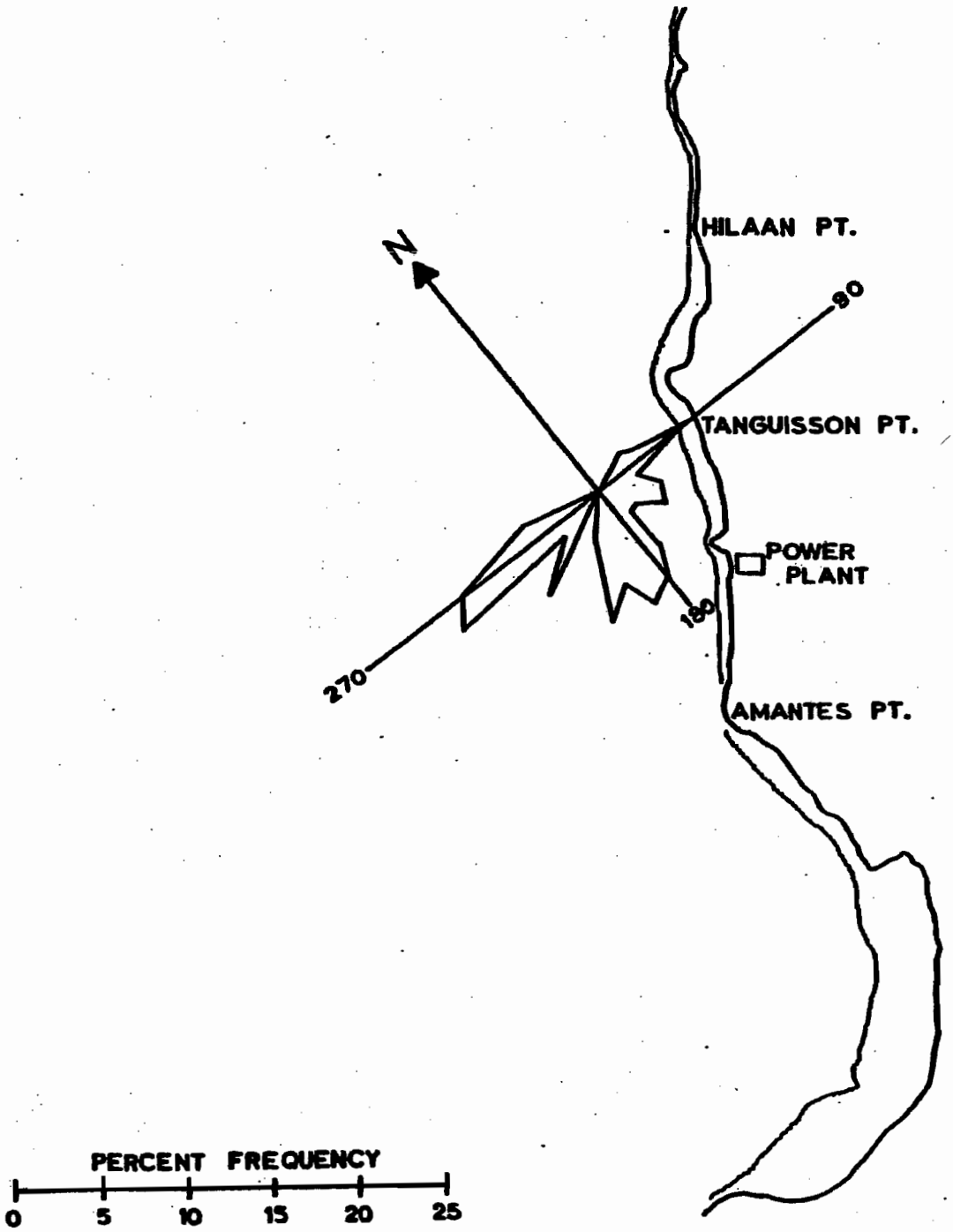
Figure 14



Mean frequency diagram for current direction at 23 m (TSK meter).

ND 1653

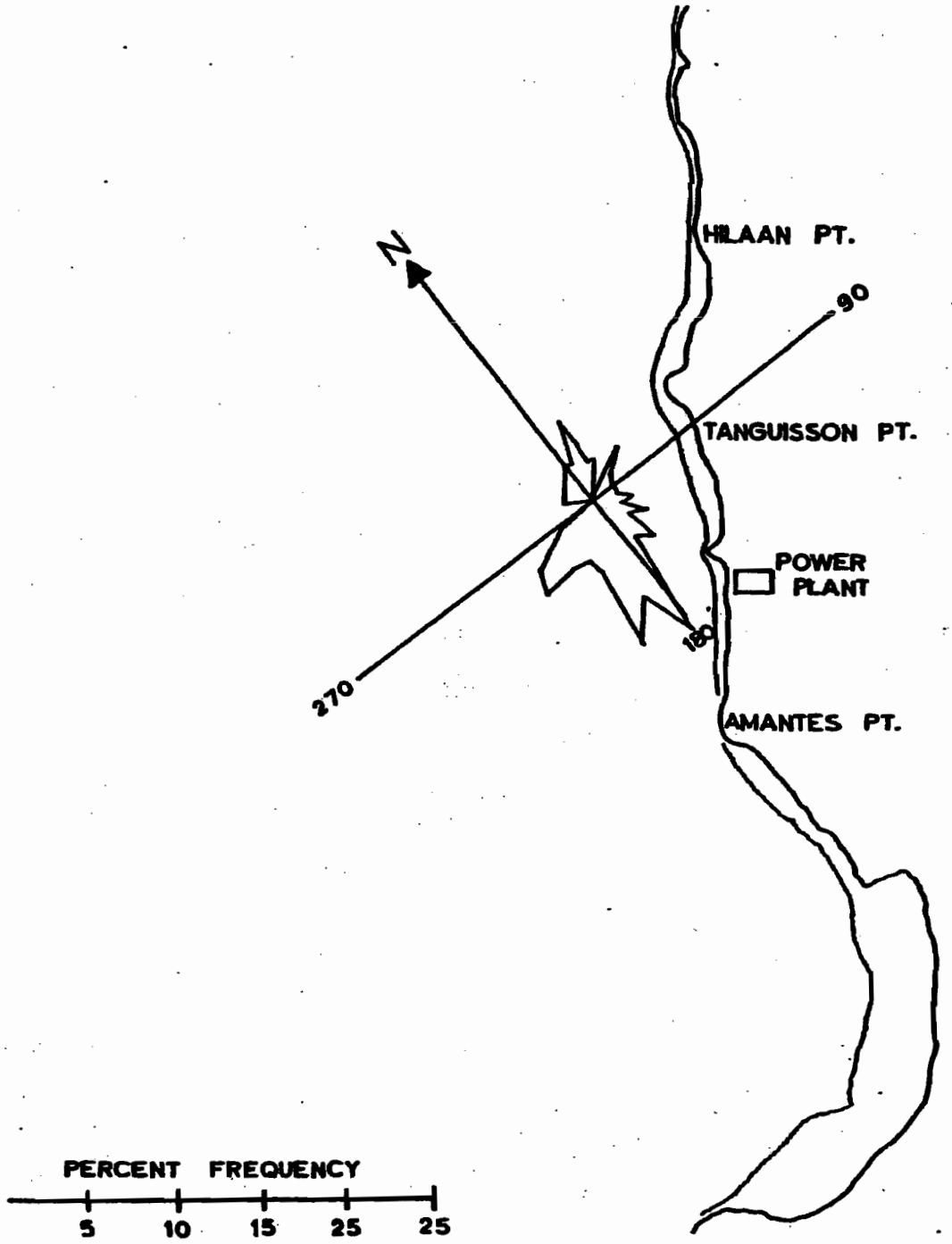
Figure 15



Mean frequency diagram for current direction at 30 m (Hydroproducts meter).

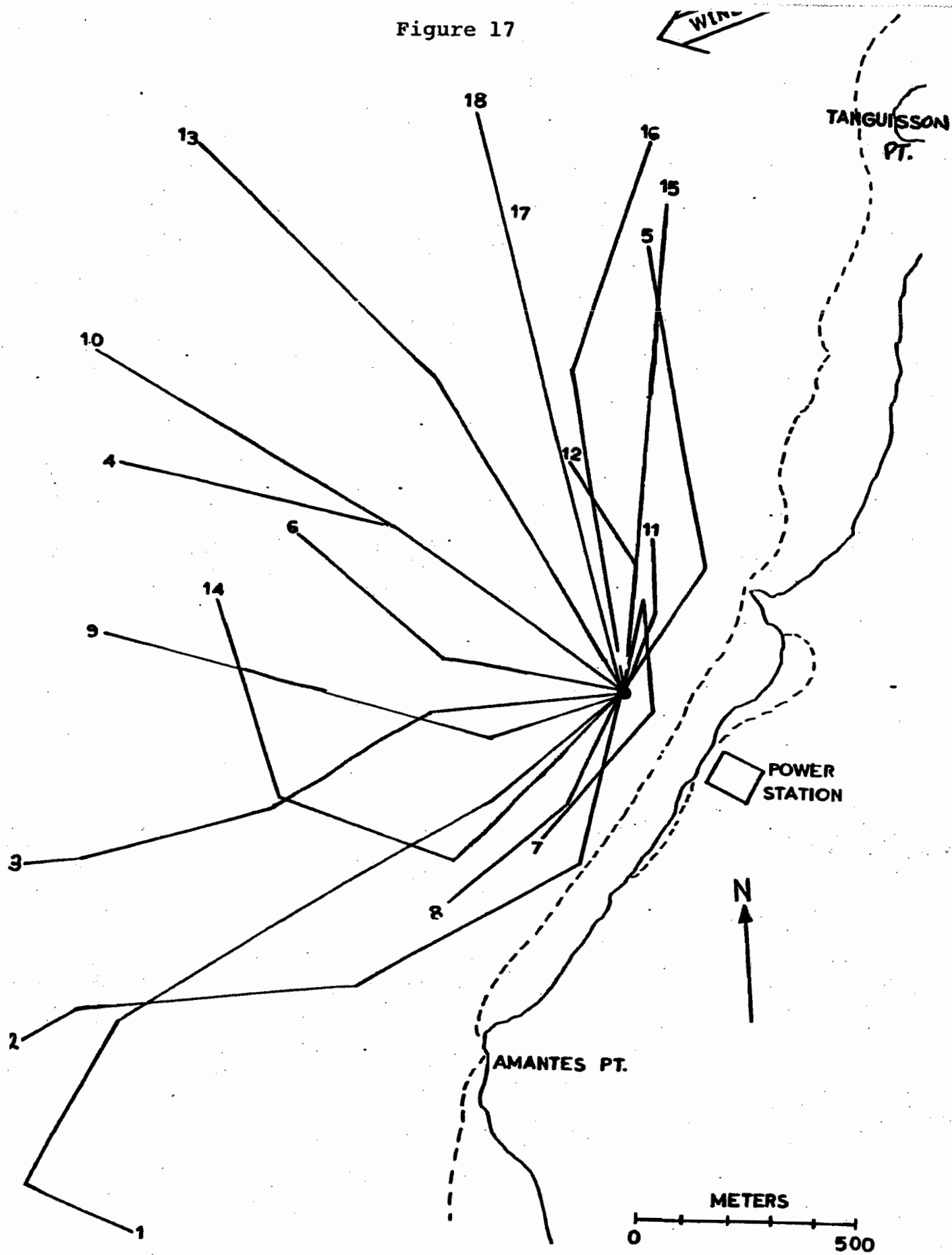
ND 1654

Figure 16



Mean frequency diagram for current direction, all stations combined. The data are biased by the inclusion of the truncated pattern produced by the Hydroproducts meter.

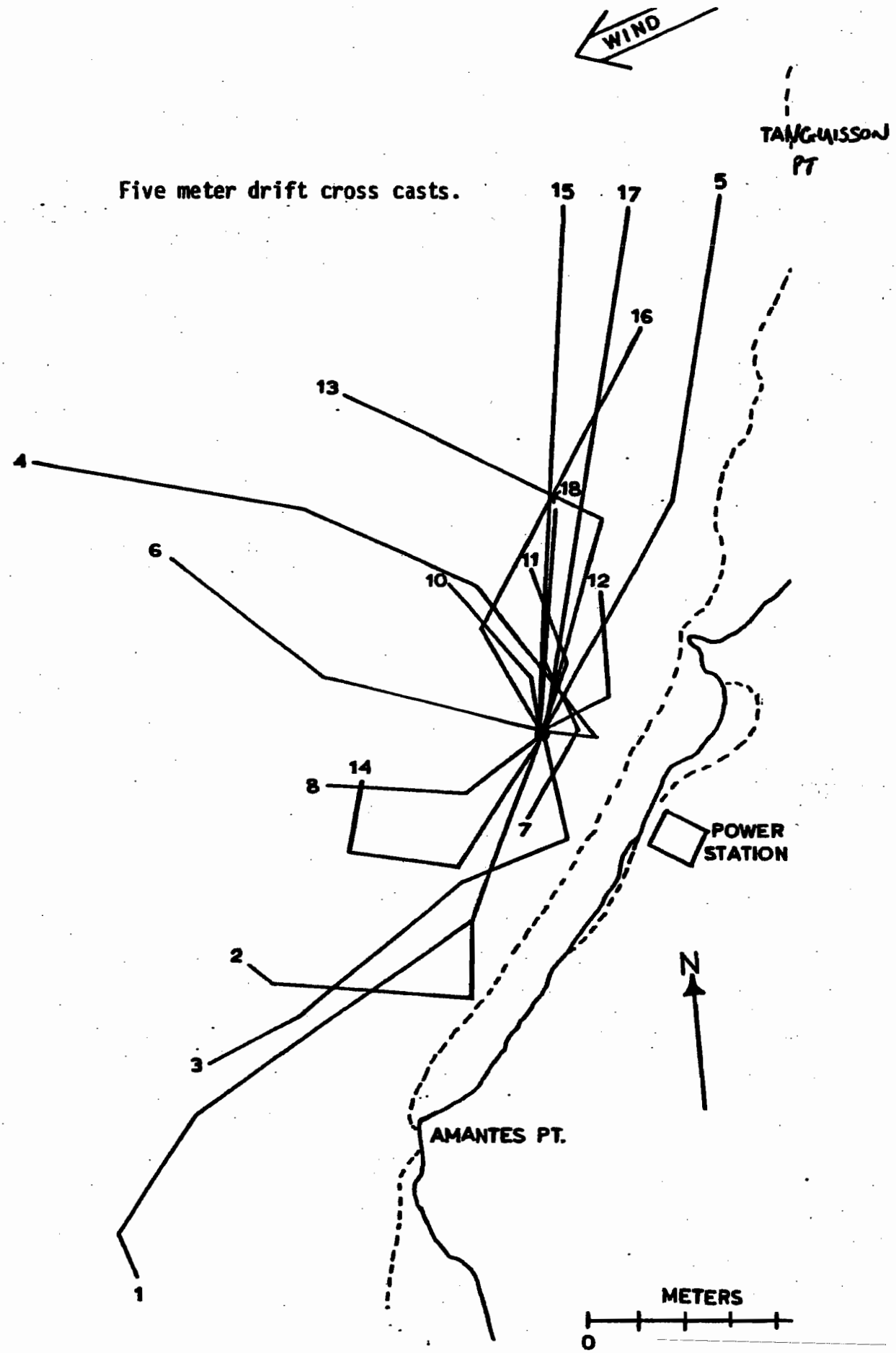
Figure 17



One meter drift cross casts.

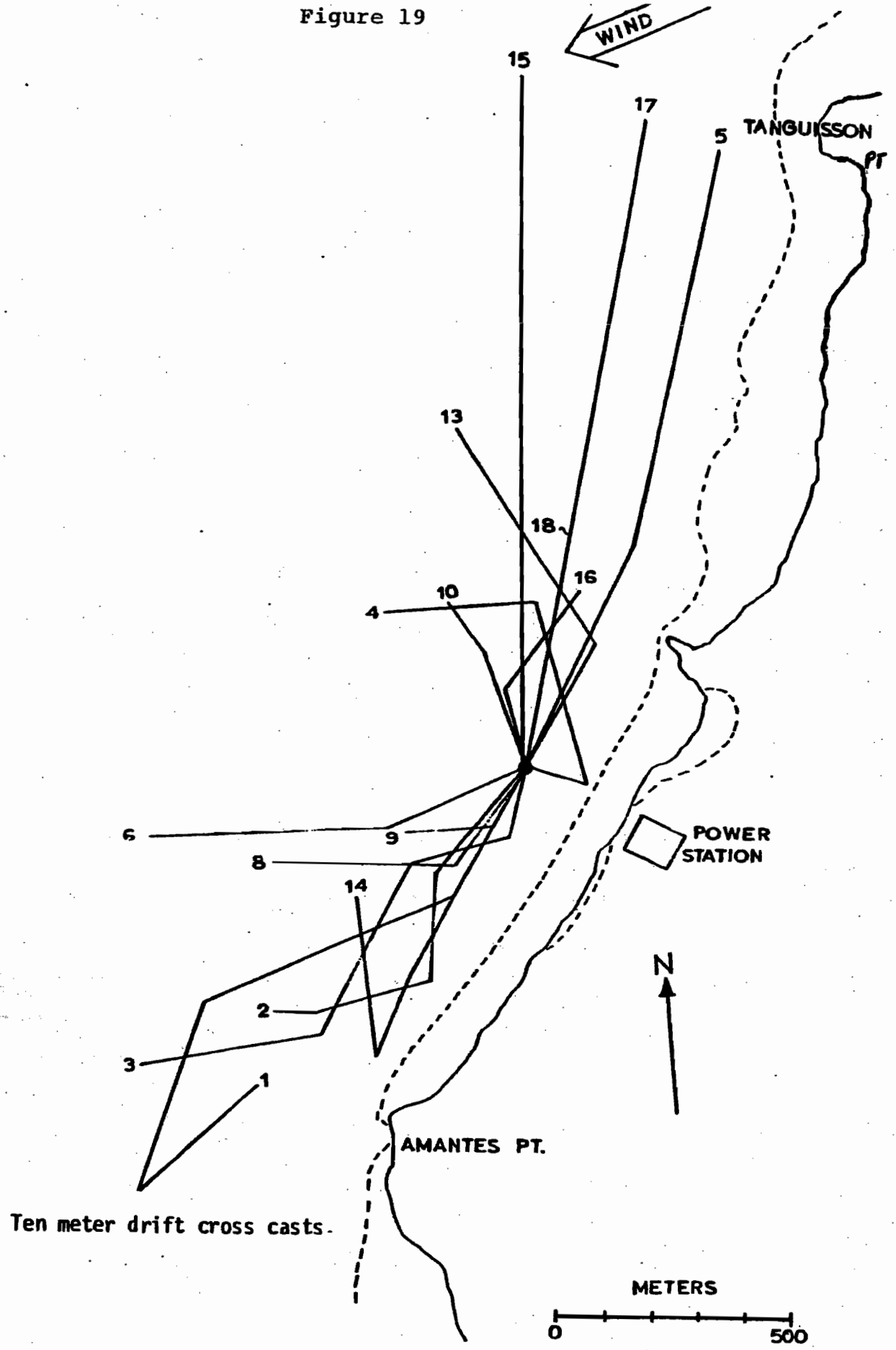
ND 1656

Figure 18



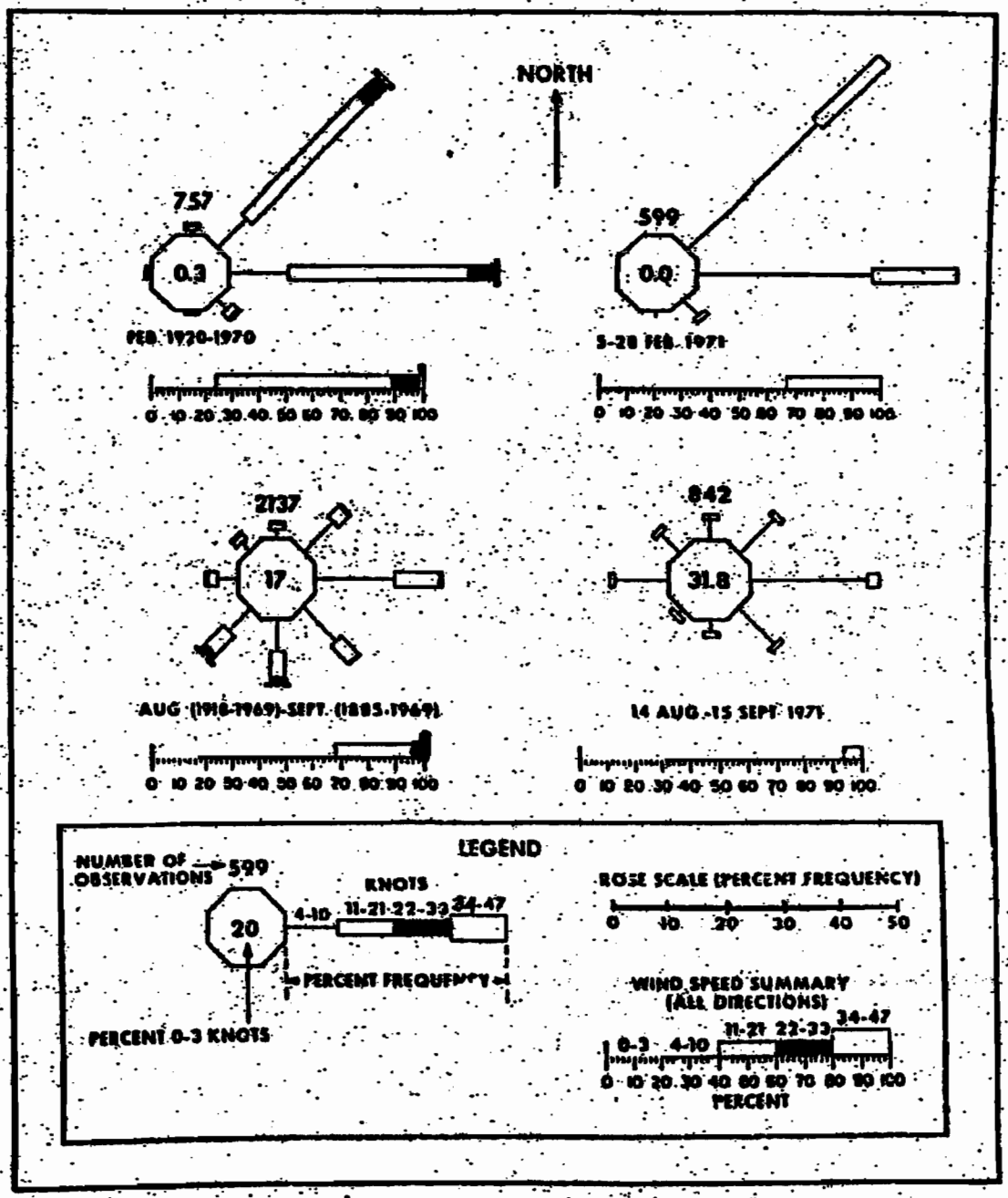
ND 1657

Figure 19



ND 1658

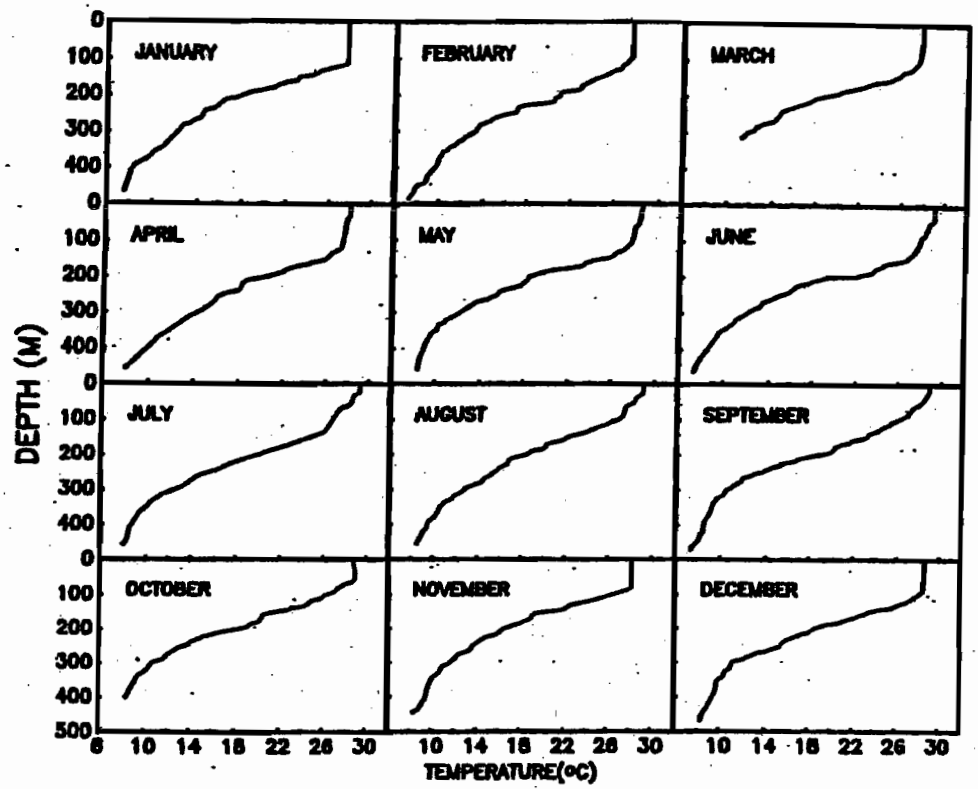
Figure 20.



Wind roses of historical data and 1971 data.

Figure 21

Amesbury & Babin: Ocean Temperature and Pelagic Fish



Monthly temperature-depth relationships for the ocean waters near Guam. Individual plots are from years with temperature conditions most nearly approximating longterm average conditions for that month: Jan–1972, Feb–1974, Mar–1976, Apr (0–250 m)–1982, Apr (250–475 m) –1981, May–1975, Jun–1970, Jul–1979, Aug–1974, Sep–1974, Oct–1976, Nov–1979, Dec–1971.

Table 5

Water Quality Data for Northern District WWTP Receiving Waters 1989-1997.

PARAMETER	STATION	DEPTH	DATE SAMPLE COLLECTED									
			3/89	6/89	9/89	12/89	7/90	10/90	4/91	5/91	8/91	12/91
Fecal coliform	C	surface	6310		100	9120	10	0	10	60	0	400
FC/100mL *	D	surface	0		0	5	0	0	0	10	0	18
	E	surface	0		0	0	0	0	0	1	0	0
temperature	C	surface	27.5	28.0	29.1	30.4	30.2	29.0	26.5	27.3	29.4	26.5
oC		mid		27.2	29.0	30.4	30.4	29.0	26.5	27.5	29.5	26.5
		bottom		27.2	28.9	30.4	30.3	28.5	26.5	27.5	29.4	26.5
	D	surface	26.8	27.7	29.9	30.8	30.7	29.5	26.5	27.5	29.3	26.4
		mid		27.3	29.0	30.2	30.5	28.5	26.5	27.5	29.4	26.6
		bottom	26.8	27.2	28.9	30.2	30.6	28.0	26.5	27.4	29.3	26.6
	E	surface	26.8	27.7	29.0	29.5	30.5	29.5	26.4	27.1	29.4	26.3
		mid	27.0	27.4	29.0	29.5	30.4	28.0	26.5	27.0	29.4	26.3
		bottom	27.0	27.4	28.8	29.5	29.8	28.0	26.6	27.0	29.3	26.3
salinity	C	surface	32.8	35.1	35.8	35.1	34.0	33.0	35.0	34.0	33.0	35.0
ppt		mid		35.7	35.8	34.6	32.0	34.0	35.0	34.0	31.0	35.0
		bottom		16.7	2.2	35.9	32.5	33.0	35.0	34.0	31.0	34.0
	D	surface	32.9	35.8	35.1	34.9	32.0	34.0	35.0	35.0	35.0	35.0
		mid		36.0	36.0	34.6	30.0	34.0	34.0	35.0	35.0	35.0
		bottom	32.9	36.0	36.0	33.5	30.0	34.0	34.0	35.0	35.0	35.0
	E	surface	34.0	35.9	35.5	34.9	34.0	34.0	35.0	35.0	35.0	35.0
		mid	34.0	36.0	35.5	34.6	34.0	34.0	35.0	35.0	35.0	35.0
		bottom	34.0	35.7	35.7	33.9	34.0	34.0	35.0	35.0	35.0	35.0
pH	C	surface	8.40	8.48	8.18	8.21	7.95	8.10	8.22	9.47	9.21	7.99
		mid		8.28	8.17	8.20	8.34	8.29	8.37	9.28	9.18	8.04
		bottom		7.42	7.32	8.19	8.33	8.29	8.38	9.28	9.16	8.03
	D	surface	8.40	8.34	8.25	8.25	8.29	8.31	8.79	9.07	9.71	8.01
		mid		8.30	8.18	8.18	8.33	8.28	8.65	8.96	9.56	8.04
		bottom	8.39	8.30	8.16	8.18	8.34	8.31	8.66	8.87	9.49	8.04
	E	surface	8.38	8.30	8.17	8.17	8.48	8.29	8.39	9.10	9.45	8.02
		mid	8.39	8.30	8.16	8.18	8.40	8.30	8.29	9.27	9.53	8.03
		bottom	8.38	8.10	8.16	8.18	8.39	8.31	8.35	9.51	9.55	8.04
D. O.	C	surface		7.60	6.60	6.90	5.74	8.40	5.68	2.71	3.15	4.63
mg/L		mid		6.20	6.40	5.90	5.63	7.90	5.95	3.11	3.29	5.78
		bottom		6.20	6.40	5.90	5.34	7.80	5.32	3.73	3.76	6.28
	D	surface		6.30	6.70	6.30	5.40	9.00	5.32	2.46	3.17	4.85
		mid		6.20	6.20	5.80	5.79	8.70	4.72	3.45	3.47	5.75
		bottom		6.10	6.20	5.80	5.90	8.80	4.48	3.52	3.58	7.03
	E	surface		6.20	6.20	5.80	5.08	9.20	4.98	2.11	3.85	5.04
		mid		6.40	6.10	5.90	5.34	9.10	4.87	3.25	3.76	5.78
		bottom		6.40	6.10	5.90	5.51	9.30	5.51	3.50	3.77	5.98
Turbidity	C	surface	3.00	11.00	11.00	0.35	0.25	0.30	0.22	0.60	0.18	0.18
NTU		mid		11.00	11.00	0.35	0.30	0.35	0.25	0.85	0.15	0.10
except for		bottom		3.00	3.00	0.38	0.30	0.40	0.25	0.85	0.27	0.20
3/89, 6/89, 9/89	D	surface	11.00	11.00	11.00	0.55	0.10	0.15	0.20	0.15	0.15	0.10
when secci		mid	11.00	11.00	11.00	0.28	0.15	0.15	0.35	0.15	0.11	0.10
disc was used		bottom	11.00	11.00	11.00	0.25	0.15	0.15	0.35	0.15	0.14	0.35
	E	surface	11.00	11.00	11.00	0.25	0.18	0.15	0.01	0.10	0.21	0.10
		mid	11.00	11.00	11.00	0.20	0.25	0.15	0.01	0.10	0.26	0.15
		bottom	11.00	11.00	11.00	0.15	0.30	0.15	0.01	0.10	0.14	0.20
NOx	C	surface	0.032	0.018	0.044	0.0033						
		mid	ns	0.0029	0.0082	0.0025						
		bottom	ns	0.013	0	0.0009						
	D	surface	0.038	0.0058	0.089	0.0068						
		mid	ns	0.0035	0.011	0.0008						
		bottom	0.03	0.0024	0.037	0.0012						
	E	surface	0.0015	0.0021	0.04	0.0009						
		mid	0.0011	0.0015	0.013	0.0002						
		bottom	0.0023	0.0012	0.0056	0.0004						
FRP	C	surface	0.013	0.0003	0.012	0.025						
		mid	ns	0.03	0.0084	0.0085						
		bottom	ns	1.6	2.7	0.011						
	D	surface	0.008	0.0074	0.0091	0.0085						
		mid	ns	0.0003	0.01	0.0046						
		bottom	0.0076	0.0003	0.0028	0.0046						
	E	surface	0.0066	0.0003	0.0011	0.0052						
		mid	0.0097	0.0003	0.0011	0.0026						
		bottom	0.0035	0.0003	0.0011	0.0036						
Treatment Plant Average Flow (MGD			2.01	2.13	2.16	2.23	2.23	2.05	2.36	3.32	2.57	2.96

* values of 400 for fecal coliform represent reports of >400FC/100mL

continued over page

Table 5

Water Quality Data :Northern Districts WWTP Receiving Waters 1989-1997

PARAMETER	STATION	DEPTH	DATE SAMPLE COLLECTED									
			5/92	8/92	1/93	4/93	9/93	10/93	6/94	1/97	5/97	7/97
Fecal coliform	C	surface	400	10	400	10	36	400	400	400	400	85
FC/100mL *	D	surface	0	0	0	0	20		0	400	32	0
	E	surface	0	0	0	0	0	5	0	0	0	0
temperature	C	surface	27.3	28.5	26.4	27.7	28.3	27.5	28.9	32.0	28.0	29.0
oC		mid	27.2	28.3	25.8	27.6	28.2	27.5	28.7	31.0	29.0	29.0
		bottom	27.2	28.3	26.0	27.6	28.1	27.8	28.6	31.0	29.0	29.0
	D	surface	27.2	28.5	25.9	27.7	28.4	28.6	28.8	31.0	30.0	29.0
		mid	27.3	28.6	25.9	27.6	28.2	28.2	28.7		30.0	29.0
		bottom	27.2	28.5	26.0	27.7	28.2	28.2	28.7		30.0	29.0
	E	surface	27.4	28.5	26.1	27.6	28.6	28.0	28.8	31.0	28.0	29.0
		mid	27.0	28.5	26.1	27.7	28.1	28.0	28.6		28.0	29.0
		bottom	27.2	28.4	26.1	27.7	28.1	27.9	28.6	32.0	28.0	29.0
salinity	C	surface	35.0	35.0	34.0	35.0	34.0	29.0	24.0	26.0	32.0	29.0
ppt		mid	35.0	32.0	34.0	35.0	34.0	29.1	24.0	25.0	30.0	27.5
		bottom	35.0	33.0	34.0	35.0	34.0	29.5	25.0	23.0	30.0	28.0
	D	surface	35.0	34.0	35.0	35.0	35.0	28.5	24.0	23.0	30.0	29.0
		mid	35.0	34.0	35.0	35.0	35.0	29.0	24.0		31.0	28.5
		bottom	35.0	33.0	35.0	35.0	35.0	29.1	25.5		30.0	28.5
	E	surface	35.0	33.0	35.0	35.0	35.0	28.5	24.0	28.0	30.0	29.0
		mid	35.0	33.0	35.0	35.0	35.0	29.1	24.0		30.0	28.5
		bottom	35.0	34.0	35.0	35.0	35.0	29.1	24.0	24.0	29.5	28.5
pH	C	surface	7.52	8.44	8.42	7.89	9.23	9.81	8.50	8.34	8.17	8.29
		mid	7.53	8.67	8.97	7.94	9.20	9.67	8.50	8.33	8.21	8.29
		bottom	7.55	8.66	9.12	7.97	9.25	9.50	8.51	8.34	8.22	8.30
	D	surface	7.65	8.69	9.17	8.00	9.11	8.80	8.49	8.34	8.26	8.30
		mid	7.62	8.68	9.14	7.99	9.08	8.92	8.50		8.25	8.29
		bottom	7.62	8.66	9.05	8.00	9.13	8.97	8.58		8.25	8.30
	E	surface	7.69	8.69	8.57	7.98	9.26	9.36	8.46	8.35	8.21	8.30
		mid	7.65	8.70	8.72	7.98	9.17	9.31	8.50		8.25	8.30
		bottom	7.65	8.72	8.83	7.97	9.16	9.32	8.51	8.36	8.25	8.30
D. O.	C	surface	2.80	2.68	4.55	4.56	4.99	1.12**	7.80	8.40	5.80	5.50
mg/L		mid	3.12	3.73	4.80	4.90	5.84	1.17**	7.30	5.80	5.60	5.80
		bottom	3.20	3.84	4.76	4.58	6.10	1.18**	7.20	5.25	5.50	5.00
	D	surface	3.64	3.68	4.34	4.50	4.37	1.06**	6.40	7.50	6.60	6.00
		mid	3.62	3.66	4.72	4.86	4.86	1.18**	6.40		6.00	4.80
		bottom	3.62	3.72	4.48	4.59	5.13	1.07**	6.40		6.00	5.10
	E	surface	3.71	3.75	4.68	4.55	5.19	1.14**	6.80	7.80	5.60	6.50
		mid	3.99	3.71	4.62	5.95	6.26	1.20**	7.40		5.70	5.20
		bottom	4.00	3.85	5.01	4.95	6.55	1.13**	7.30	7.60	5.50	6.40
Turbidity	C	surface	0.55	0.43	0.90	0.25	0.30	0.46	0.41	0.51	0.46	0.25
NTU		mid	0.60	0.34	0.20	0.26	0.30	0.54	0.73	0.48	0.97	0.46
except for		bottom	0.85	0.39	0.30	0.35	0.35	0.34	1.00	0.42	1.59	0.99
3/89, 6/89, 9/89	D	surface	0.15	0.31	0.10	0.20	0.20	0.27	0.40	0.27	0.51	0.19
when secci		mid	0.15	0.29	0.40	0.20	0.30	0.40	0.48		0.36	0.31
disc was used		bottom	0.25	0.30	0.30	0.25	0.30	0.49	0.30		0.64	0.29
	E	surface	0.10	0.65	0.20	0.25	0.25	0.39	0.33	0.24	0.34	0.24
		mid	0.10	0.27	0.20	0.25	0.20	0.29	0.50		0.35	0.30
		bottom	0.10	0.29	0.20	0.20	0.20	0.27	0.60	0.71	0.49	0.16
NOx	C	surface										
		mid										
		bottom										
	D	surface										
		mid										
		bottom										
	E	surface										
		mid										
		bottom										
FRP	C	surface										
		mid										
		bottom										
	D	surface										
		mid										
		bottom										
	E	surface										
		mid										
		bottom										
Treatment Plant Average Flow (MGD			3.82	4.06	4.15	5.36	5.04	5.19	4.61	6.5	6.4	6.1

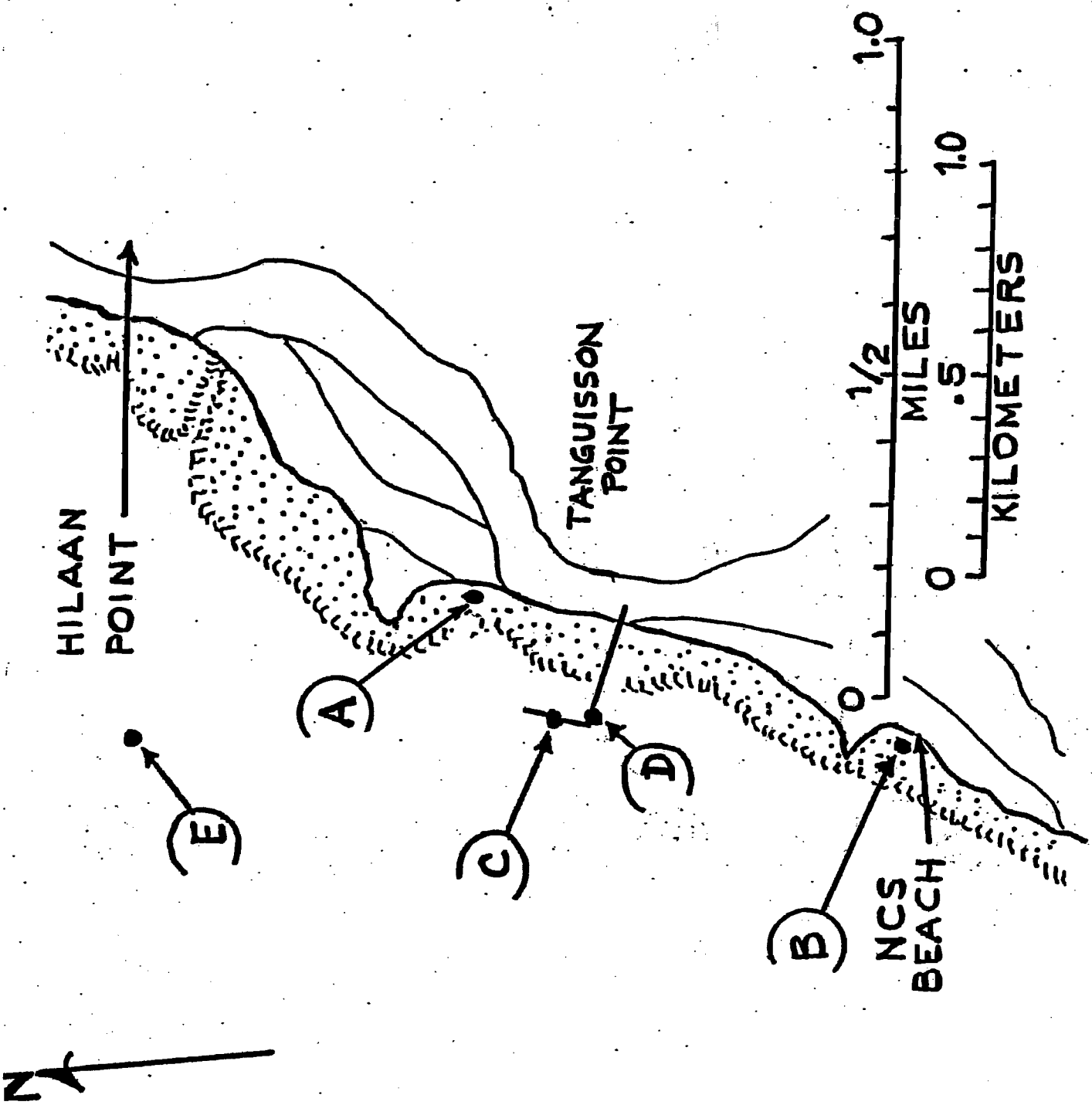
** values not included in calculations or graphs. These values are too low, the control site also has the same low readings. Probably due to incorrect use or calibration of the DO meter.

Table 5

Water Quality Data : Northern Districts WWTP Receiving Waters 1989-1997

PARAMETER	STATION	DEPTH	STATISTICAL DATA		
			MIN.	AVG.	MAX.
Fecal coliform	C	surface			
FC/100mL *	D	surface			
	E	surface			
temperature	C	surface	26.4	28.4	32.0
oC		mid	25.8	28.3	31.0
		bottom	26.0	28.3	31.0
	D	surface	25.9	28.5	31.0
		mid	25.9	28.3	30.5
		bottom	26.0	28.2	30.6
	E	surface	26.1	28.3	31.0
		mid	26.1	28.0	30.4
		bottom	26.1	28.1	32.0
salinity	C	surface	24.0	32.8	35.8
ppt		mid	24.0	32.3	35.8
		bottom	2.2	29.5	35.3
	D	surface	23.0	32.7	35.8
		mid	24.0	33.1	36.0
		bottom	25.5	33.0	36.0
	E	surface	24.0	33.0	35.9
		mid	24.0	33.3	36.0
		bottom	24.0	32.8	35.7
pH	C	surface	7.5	8.4	9.8
		mid	7.5	8.5	9.7
		bottom	7.3	8.4	9.5
	D	surface	7.7	8.5	9.7
		mid	7.6	8.5	9.6
		bottom	7.6	8.5	9.5
	E	surface	7.7	8.5	9.5
		mid	7.7	8.5	9.5
		bottom	7.7	8.5	9.6
D. O.	C	surface	2.7	5.5	8.4
mg/L		mid	3.1	5.4	7.9
		bottom	3.2	5.3	7.8
	D	surface	2.5	5.4	9.0
		mid	3.5	5.2	8.7
		bottom	3.5	5.3	8.8
	E	surface	2.1	5.4	9.2
		mid	3.3	5.5	9.1
		bottom	3.5	5.7	9.3
Turbidity	C	surface	0.2	1.6	11.0
NTU		mid	0.1	1.5	11.0
except for		bottom	0.2	0.8	3.0
3/89, 6/89, 9/89	D	surface	0.1	1.9	11.0
when secci		mid	0.1	2.0	11.0
disc was used		bottom	0.1	2.0	11.0
	E	surface	0.0	1.8	11.0
		mid	0.0	1.9	11.0
		bottom	0.0	1.9	11.0
NOx	C	surface			
		mid			
		bottom			
	D	surface			
		mid			
		bottom			
	E	surface			
		mid			
		bottom			
FRP	C	surface			
		mid			
		bottom			
	D	surface			
		mid			
		bottom			
	E	surface			
		mid			
		bottom			
Treatment Plant Average Flow (MGD					

Figure 22



Northern District Water Quality Monitoring Stations.

ND 1664

Biological Conditions

D

II.C. Biological Conditions

II.C.1 Provide a detailed description of representative biological communities in the vicinity of your current and modified discharge(s)

Jones and Randall, 1973 conducted a preliminary reef survey for the Northern District Sewage System. They noted that the submarine terrace in the area of the current outfall was fairly uniform. Former coral growth was extensively developed on the terrace prior to the 1968-1969 Acanthaster planci (Crown of Thorns Starfish) infestation that killed 90% to 99% of the living corals. They note that recolonization was starting to take place, but at a slow rate. The percent coverage by living coral was 2% to 10%

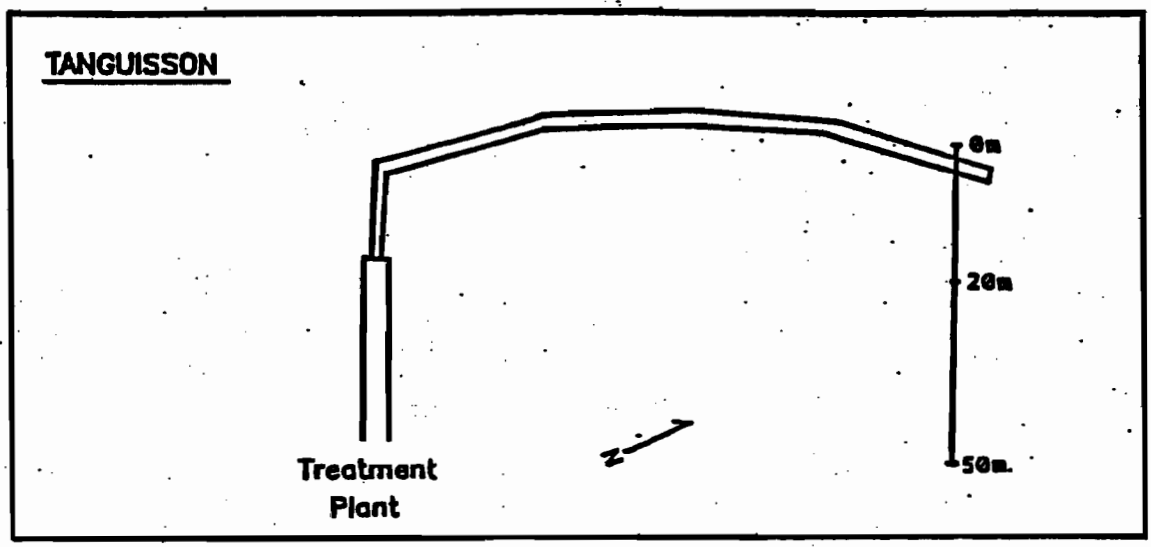
Biological monitoring of the Northern District WWTP's was contracted to the University of Guam Marine Laboratory. The surveys were conducted quarterly, from August 1989 until September 1994, with quarterly reports and yearly summaries submitted to GWA. Three 10 m transects were run parallel to shore, one immediately at the diffusers (0 m) and the other two at 20 m and 50 m distances towards shore from the diffusers (Figure 23). The transects were therefore at progressively shallower depths. However, the individual transect depths are unknown. Transect sites were permanently marked for long term monitoring. No control site surveys were conducted for comparison.

Qualitative observations were made to determine the composition of each site. An estimate of substrate cover was done by using a 10 m chain-link transect method, and the percent cover of various species and benthic groups were estimated. The species of fish present were recorded by a diver swimming the 50 meter line connecting each of the three transects. The reports did not state whether the fish observations were restricted to a distance either side of the 50 m line or whether it was a timed observation, and quantities of each species were not recorded. The GWA biologist conducted a Review and Analysis of Past Biological Monitoring Data for the Northern District WWTP, Guam. This report is located in ITEM N. The information below is taken from that report.

A summary of the surveys to estimate percent cover by individual species or benthic groups (*i.e.* Bare Substrate, Turf Algae, Macro Algae, Coralline Algae, Corals and other) along the 0m, 20m and 50m transects are given in Table 6, 7 and 8 respectively. The area surrounding the diffusers (0 - 50m) was predominantly covered by either Bare Substrate, Turf Algae, or Coral, most commonly Porites rus and Porites lutea. These three groups in general made up greater than 75% of the cover. Coralline Algae, Macro Algae or other live sessile organisms (sponges, ascidians, vermetid molluscs, etc) made up the remaining benthic cover. Regression analysis was performed on the data to establish if there had been any significant changes in the benthic community over the period of time that the surveys took place. Results of the analysis are summarized in Table 6. There were significant increases in Bare Substrate along the 0m, 20m and 50m transects. A significant decreases in the percent cover of Turf Algae along the 0m and 50m transects and an increase in Coral along the 0m transect. Coral cover had increased from that reported by Jones and Randall in 1973, which was 2% to 10%. The 0m transect had 1%-30% coral cover, and the 20m and 50m transects had approximately 10% to 60% coral cover. All other changes in percentage over cover were non significant.

A summary of the fish species observed over the study period is given in Table 9. Species diversity and number of species in each trophic level did not change significantly over the

Figure 23



Location of Biological Monitoring Transects, with sample loctions at 0, 20 and 50 meters.

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period of biological monitoring, and are believed to be representative of other coral reef fish communities around Guam (personal communication; Dr Steve Amesbury, Prof. of Ichthyology, UOG Marine Laboratory).

Jones, R. S. and R. H. Randall. 1973. A Preliminary Marine Survey for the Northern District Sewage System. University of Guam, Marine Laboratory, Environmental Survey Report No.8.

II.C.2. a. Are distinctive habitats of limited distribution (such as kelp beds or coral reef) located in areas potentially affected by the modified discharge?

Yes, coral reefs encircle almost the entire island of Guam.

II.C.3. a. Are commercial or recreational fisheries located in areas potentially affected by the discharge?

Yes.

b. If yes, provide information on types, location and value of fisheries

Attached information (Table 11) is from surveys conducted by the Department of Aquatics and Wildlife Resources (DAWR) during 1997.

Species list and percent cover along the 0 meter transect at Northern District Outfall

SPECIES OR GROUP	PERCENT COVER															
0m	8/25/89	11/14/89	4/2/90	6/13/90	9/24/90	12/11/90	8/27/91	12/26/91	3/19/92	8/6/92	12/4/92	3/30/93	8/17/93	1/10/94	5/27/94	8/28/94
Dictiota	0	0	0	0	0	0	0	0	0	0	0	0	0	0.13	0	0
Favid	0	0.14	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Acanthastrea	0	0	0	0	0.26	0	0	0	0	0	0	0	0	0	0	0
Coscinarea columna	0.26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pavona varians	0	0	0	0	0.26	0	0	0	0	0	0	0	0	0	0	0
Stylococeonella sp	0	0	0	0.26	0	0	0	0	0	0	0	0	0	0	0	0
Leptoria	0	0	0	0	0	0.26	0	0	0	0	0	0	0	0	0	0
Halymenia	0	0	0.39	0	0	0	0	0	0	0	0	0	0	0	0	0
Scolymia sp.	0	0	0	0.39	0	0	0	0	0	0	0	0	0	0	0	0
zooanthid	0	0	0	0	0.39	0	0	0	0	0	0	0	0	0	0	0
Pocillopora	0	0	0	0.39	0	0	0	0	0	0	0	0	0	0	0	0
Chrysophyceae	0	0	0.52	0	0	0	0	0	0	0	0	0	0	0	0	0
Pleiastrea	0	0	0	0.65	0	0	0	0	0	0	0	0	0	0	0	0
Schizotrix sp.	0.39	0	0	0	0.26	0	0	0	0	0	0	0	0	0	0	0
Milliopora	0	0	0	0	0	0	0	0	0	0	0	0	0	0.78	0	0
Liagora	0	0	0.78	0	0	0	0	0	0	0	0	0	0	0	0	0
Asytreopora	0	0	0	0.39	0	0	0	0	0	0	0	0	0	0.13	0	0.39
Red tuff	0	0	0	1.04	0	0	0	0	0	0	0	0	0	0	0	0
Garcillaria	0	0	0	0	0	0	0.26	0	0.79	0	0	0	0	0	0	0
Neomeris sp.	0	0	0	0	0	0	0.13	0.53	0	0.52	0	0	0	0	0	0
Blue green micro algae	0	1.41	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fungia	0	0	0	0	0	0.78	0	0	0.26	0	0	0	0	0.26	0	0.39
Sinulara	0	0	0	0	1.95	0	0	0	0	0	0	0	0	0	0	0
Goniastrea sp.	0	0	0.26	0	0	0	0	0	0	0	0	0.39	0.52	0.26	0	0.78
Cyptastrea	0	0	0	0	1.04	0	0	0	0	0	0	1.56	0	0	0	0
Halimeda discoidea	1.32	0.56	0.91	0	0	0	0	0	0	0	0	0	0	0	0	0
Favities sp.	0	0	0	0	0	0	0.13	0	0	0	0	0	0	2.47	0.39	0
Montipora	0	0	0	0	0	0	0	0.53	0	0.26	0	0.26	0.26	0	0	1.95
Leptastrea	0	0	0	0	0	0	0	0	0	0.52	1.00	1.95	1.04	1.95	3.12	0.52
Favia sp.	0	0	0	0.26	0	0.26	0	0	0	0	1.00	1.30	2.08	0.91	2.21	2.99
Halimeda opuntia	0	0.84	0.91	2.6	0	0.52	0.53	2.10	1.84	0.65	0.08	0	1.17	0.52	0	0.52
Porites sp.	0	0	3.77	0.91	0.65	0	0	0	0	0	0	2.86	0.26		1.04	2.99
Porites lutea	3.16	2.67	0	0	8.18	0.39	0	0	0	0	0	0	0	0	0	0
Galaxaura sp.	0	0.14	1.04	0	0	0	0	0.13	9.21	3.38	0.15	2.27	0.52	0	0	0
Coralline Algae	5.53	1.97	0	0.91	0	0	6.19	0	0	0	0.46	0.91	2.08	0.91	0.26	5.45
Porites rus	1.32	1.27	0.26	1.04	37.79	1.95	7.76	0	0	0	0.15	0	0	9.61	1.04	22.21
Turf Algae	75.14	81.02	82.86	79.48	37.92	72.21	74.60	26.57	11.58	42.21	14.63	8.31	7.01	10.78	5.84	14.68
Bare	13.10	10.02	8.32	11.69	11.30	23.38	10.40	68.96	76.32	52.46	82.52	79.74	83.38	71.30	86.10	47.14

Table 6

Species list and percent cover along the 20 meter transect at Northern District Outfall

SPECIES OR GROUP 20m	8/25/89	11/14/89	4/2/90	6/13/90	9/24/90	12/11/90	8/27/91	12/26/91	3/19/92	8/6/92	12/4/92	3/30/93	8/17/93	1/10/94	5/27/94	8/28/94
Polychaete	0	0	0	0	0	0.13	0	0	0	0	0	0	0	0	0	0
Asteopora	0	0	0	0	0	0.26	0	0	0	0	0	0	0	0	0	0
Padina	0	0	0	0	0	0	0	0.26	0	0	0	0	0	0	0	0
Alveopora sp.	0	0	0.39	0	0	0	0	0	0	0	0	0	0	0	0	0
Galaxea sp.	0	0	0	0.39	0	0	0	0	0	0	0	0	0	0	0	0
Spiro branchus gigantea	0	0	0	0	0	0	0.40	0	0	0	0	0	0	0	0	0
Favid	0	0	0.52	0	0	0	0	0	0	0	0	0	0	0	0	0
Amphiroa sp.	0	0	0.65	0	0	0	0	0	0	0	0	0	0	0	0	0
Stichopus chloronotus.	0	0	0	0	0	0	0	0	0	0	0	0	0	0.91	0	0
Garcillaria	0	0	0	0	0	0	0	0.39	0	0	0	0	0	0	0.52	0
Neomeris	0	0	0	0	0	0	0	0.66	0	0	0	0.26	0	0	0	0
Holothuria noblis	0	0	0	0	0	0	0	0	0	0	0	1.04	0	0	0	0
favities sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.04	0
Sinularia	0	0	0	0	0	0	0	0	0	1.04	0	0	0	0	0	0
Halimeda discoidea	1.18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pocillopora	0	0	0	0	0	0	0	0	0	1.30	0	0	0	0	0	0
Leptastrea sp.	0	0.39	0	0.13	0	0	0	0	0	0	0	0	0	0.78	0	0
Sponge	1.45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hypnea sp.	0	0	0	0	0	0	1.71	0	0	0	0	0	0	0	0	0
Amphiroa Fragili	2.23	0	0	0	0	0		0	0	0	0	0	0	0	0	0
Soft coral	0	2.24	0	0	0	0	0	0	0	0	0.62	0	0	0	0	0
Ralfsia sp.	0	0	0	0	0	0	0	0	0	0	3.47	0	0	0	0	0
Goniastrea	0	0	0	0	0	0	0	1.05	0.79	2.86	0	0	0	0	0.39	0.26
Dictiota sp.	0	0	0	0	0	0	0	0	0	2.99	0	2.86	0	0	0	0
Caulerpa	0	0	0	0	0	0.39	0	0	0	0	5.78	0	0	0	0	0
Liagora sp.	0	0	0	0	0	0	0	0	6.45	0	0	0	0	0	0	0
Favia	0	0	0	0	0	0.91	0.40	0	0	2.34	0.85	0.78	0	0	1.69	0.26
Porites sp.	0	0	3.51	2.08	0	0.39	0	0	0	0	0	0	0	0	1.30	0.39
Montipora sp.	0	0	0	0	0	0	0	0	0.79	0	0	0	0	6.75	0.65	0
Galaxaura sp.	0.26	0	0.13	0.91	0	1.17	0.53	3.16	0	0	0	0	3.51	1.69	0.52	0.65
Halimeda opuntia	0	1.32	0.13	0.13	0	0.78	1.84	0	1.71	3.90	0.15	0	0	3.12	0.65	0.39
Porites lutea	2.50	1.58	0	0	0	0	1.32	1.32	4.61	6.32	0	0.52	0	0	0	0
Coralline Algae	7.24	10	1.82	0	0	0	0	0	0	9.49	2.23	2.21	9.09	5.32	2.99	6.04
Bare	7.50	4.87	5.2	0	0	35.72	0.263	16.43	64.61	28.04	14.47	4.29	68.05	52.47	62.08	23.83
Porites rus	39.48	29.08	26.88	28.57	50.78	29.66	60.79	2.89	16.84	26.63	21.02	48.05	17.79	13.25	24.29	60.39
Turf Algae	38.16	50.53	59.75	67.79	49.22	30.78	32.49	73.83	4.21	15.19	50.34	40.00	1.56	15.71	3.90	7.79

Species list and percent cover along the 60 meter transect at Northern District Outfall

SPECIES OR GROUP	PERCENT COVER															
50m	8/25/89	11/14/89	4/2/90	6/13/90	9/24/90	12/11/90	8/27/91	12/26/91	3/19/92	8/6/92	12/4/92	3/30/93	8/17/93	1/10/94	5/27/94	8/28/94
Vermetid	0.13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
macro algae	0	0	0	0	0	0.13	0	0	0	0	0	0	0	0	0	0
Valonia	0	0	0	0	0	0	0	0	0.13	0	0	0	0	0	0	0
Fungia sp.	0	0	0	0	0	0	0	0	0	0	0.15	0	0	0	0	0
Codium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.26	0
Cyptastrea	0	0	0	0	0	0	0	0	0	0	0	0.26	0	0	0	0
Poritid	0	0	0.26	0	0	0	0	0	0	0	0	0	0	0	0	0
Pocillopora	0	0	0	0	0	0	0	0	0	0	0	0	0	0.39	0	0
desmea	0	0	0	0	0	0.39	0	0	0	0	0	0	0	0	0	0
Alveopora sp.	0	0	0.39	0	0	0	0	0	0	0	0	0	0	0	0	0
Dictyota	0	0	0	0	0	0.39	0	0	0	0	0	0	0	0	0	0
Neomeris sp.	0	0	0	0	0	0	0	0	0.13	0.13	0	0	0	0	0	0.13
Goniastrea pectina	0	0	0.39	0	0	0	0	0	0	0	0	0	0	0	0	0
Echinostrephus	0	0	0	0	0	0	0	0	0	0	0	0	0	0.65	0	0
Schizotrix mexica	0	0	0.91	0	0	0	0	0	0	0	0	0	0	0	0	0
Goniastrea edwards	0	0	0.39	0	0.52	0	0	0	0	0	0	0	0	0	0	0
Stylophora	0	0	0	0	0	0	0	0	0.92	0	0	0	0	0	0	0
Sponge	0.26	0	0	0	0.78	0	0	0	0	0	0	0	0	0	0	0
Montipora	0	0	0	0	0	0.13	1.32	0	0	0	0	0	0	0	0	0
Garcilaria	0	0	0	0	0	0	1.45	0	0	0	0	0	0	0	0	0
Stichopus chloronotus.	0.26	0	0	0	0	0	0	0	0	1.17	0.15	0	0	0	0	0
Platygyra sp.	0	0	0	0	0	0	0	0	0	0.65	0	0	0.65	0	0.39	0
Jania sp.	0	0	0	0	0	0	0	0	1.71	0	0	0	0	0	0	0
Pavona	0	0	0	0	0	0	0	0	1.84	0	0	0	0	0	0	0
Favites	0	0	0	0	0	0.39	0.66	0	0	0.65	0	0	0	0.52	0.26	0
Amphiroa Fragill	2.37	0	0.26	0	0	0	0	0	0	0	0	0	0	0	0	0
Favid	2.64	0.13	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Astreopora	0	0	0	0	0	0	0	0	0	0.39	0	0	0.91	0.52	0	1.30
Halimeda sp	0.13	0	0.65	0.26	0	0.39	0.26	1.05	0	0.52	0	0	0	0.26	0	0
Favia	0	0	0	0	0	0.13	0.26	0.13	0	2.60	0	0	0	0	0	0.52
Soft coral	0	0	0	0	0	0	4.34	0	0	0	0	0	0	0	0	0
Lutea	0	0	5.32	0	0	0	0	0	0	0	0	0	0	0	0	0
Goniastrea sp.	0.92	0.66	0	0	0	0	0	0	0.92	3.77	0	0.65	0	0	0	0
Leptastrea	0	0	0.26	0	0	0	0	0	0	0	0.15	0.39	1.56	0.91	3.79	0
Galaxea sp.	0	0	0	3.64	0	0	0	0	0	0.26	0	8.57	4.42	0	0	0
Porites sp.	0	1.45	2.6	4.68	0	6.1	0	0	0	0	0	0	0	0	0	2.08
Porites lutea	5.53	1.32	0	0	0	0	0	0	0.79	0	0	3.51	4.94	5.19	1.95	0
Galaxaura sp.	0	0.26	1.04	0.26	0	0	0	0.26	3.95	0.71	0.62	0	0	8.05	3.77	4.68
Coralline Algae	4.08	0	1.82	0	0	0	8.95	0	1.71	5.98	0.23	0	1.82	0.52	0	1.04
Porites rus	28.29	25	20	30.52	2.99	40.76	17.37	21.25	21.32	13.37	8.86	16.62	5.84	12.86	15.45	31.04
Bare	8.95	8.81	20.39	15.2	23.38	4.16	5.26	6.55	6.32	16.37	80.98	68.70	74.42	68.83	72.32	43.38
Turf Algae	46.45	63.42	45.33	44.16	72.34	39.52	60.13	70.75	60.27	53.43	8.86	1.30	5.45	1.30	1.56	14.94

Table 8

Table 9

Northern District Outfall Fish Species.

shaded boxes represent that species been present

Fiscal Year	1990				1991				1992				1993				1994				Total
quarter	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	n/16
Acanthuridae (surgeonfishes)	subfamily Acanthurinae (Surgeonfishes)																				
Acanthurus blochii						ns					ns				ns				ns		11
Acanthurus lineatus						ns					ns				ns				ns		1
Acanthurus nigricans						ns					ns				ns				ns		16
Acanthurus nigrofuscus						ns					ns				ns				ns		13
Acanthurus pyroferus						ns					ns				ns				ns		12
Acanthurus xanthopterus						ns					ns				ns				ns		3
Ctenochaetus binotatus						ns					ns				ns				ns		4
Ctenochaetus hawaiiensis						ns					ns				ns				ns		2
Ctenochaetus striatus						ns					ns				ns				ns		6
Zebrasoma flavescens						ns					ns				ns				ns		11
Zebrasoma scopas						ns					ns				ns				ns		3
Zebrasoma veliferum						ns					ns				ns				ns		1
Acanthuridae (Unicornfishes)	subfamily Nasinae (Unicornfishes)																				
Naso annulatus						ns					ns				ns				ns		1
Naso lituratus						ns					ns				ns				ns		16
Naso hexacanthus						ns					ns				ns				ns		1
Naso tuberosus						ns					ns				ns				ns		6
Naso vlamingii						ns					ns				ns				ns		1
Aulostomidae (Trumpetfishes)																					
Aulostomus chinensis						ns					ns				ns				ns		1
Balistidae (Triggerfishes)																					
Balistapus undulatus						ns					ns				ns				ns		13
Balistidae sp.						ns					ns				ns				ns		1
Balistoides virdescens						ns					ns				ns				ns		4
Melichthys vidua						ns					ns				ns				ns		4
Melichythys niger						ns					ns				ns				ns		9
Odonus niger						ns					ns				ns				ns		6
Rhinecanthus rectangulus						ns					ns				ns				ns		1
Sufflamen bursa						ns					ns				ns				ns		10
Blenniidae (Blennies)																					
Meiacantus atrodorsalis						ns					ns				ns				ns		9
Caesionidae (Fusiliers)																					
Caesio carulaureus						ns					ns				ns				ns		2
Carangidae (Jacks; Trevallys)																					
Caranx melampygus						ns					ns				ns				ns		1
Gnathanodon speciosus						ns					ns				ns				ns		1
Chaetodontidae (butterflyfishes)																					
Chaetodon bennetti						ns					ns				ns				ns		10
Chaetodon citrinellus						ns					ns				ns				ns		16
Chaetodon ephippium						ns					ns				ns				ns		1
Chaetodon lunula						ns					ns				ns				ns		11
Chaetodon mertensii						ns					ns				ns				ns		11
Chaetodon ornatissimus						ns					ns				ns				ns		6
Chaetodon punctatofasciatus						ns					ns				ns				ns		1
Chaetodon reticulatus						ns					ns				ns				ns		8
Chaetodon trifasciatus						ns					ns				ns				ns		11
Chaetodon ulietensis						ns					ns				ns				ns		2
Chaetodon unimaculatus						ns					ns				ns				ns		2
Forcipiger flavissimus						ns					ns				ns				ns		2
Hemitauricthys polylepis						ns					ns				ns				ns		4
Heniochus acuminatus						ns					ns				ns				ns		1
Heniochus chrysostomus						ns					ns				ns				ns		5
Heniochus singularis						ns					ns				ns				ns		1
Cirrhitidae (Hawkfish)																					
Cirrhitichthys falco						ns					ns				ns				ns		5
Paracirrhites arcatus						ns					ns				ns				ns		2
Paracirrhitus forsteri						ns					ns				ns				ns		11
Gobiidae (Gobies)																					
Amblygobius sp.						ns					ns				ns				ns		1
Valenciennea strigatus						ns					ns				ns				ns		2
Haemulidae (Sweetlips and Grunts)																					
Scolopsis lineatus						ns					ns				ns				ns		1
Holocentridae	subfamily Myripristinae (Solderfishes)																				
Myripristis spp.						ns					ns				ns				ns		1
Holocentridae	subfamily Holocentrinae (Squirrelfishes)																				

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Northern District Outfall Fish Species.

shaded boxes represent that species been present

Fiscal Year	1990				1991				1992				1993				1994				Total
quarter	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	n/16
Sargocentron sp.						ns					ns				ns				ns		2
Labridae (Wrasses)																					
Anampses twisti						ns					ns				ns				ns		1
Bodianus axillaris						ns					ns				ns				ns		12
Bodianus mesothorax						ns					ns				ns				ns		1
Cheilinus bimaculatus						ns					ns				ns				ns		5
Cheilinus chlorourus						ns					ns				ns				ns		3
Cheilinus fasciatus						ns					ns				ns				ns		11
Cheilinus orientalis						ns					ns				ns				ns		2
Cheilinus oxycephalus						ns					ns				ns				ns		11
Cheilinius undulatus						ns					ns				ns				ns		7
Cheilinus unifasciatus						ns					ns				ns				ns		5
Cheilio inermis						ns					ns				ns				ns		1
Cirrhilabrus sp.						ns					ns				ns				ns		5
Coris aygula						ns					ns				ns				ns		2
Coris gaimard						ns					ns				ns				ns		14
Epinephelus sp.						ns					ns				ns				ns		1
Epibulus insidiator						ns					ns				ns				ns		2
Epiephelus merra						ns					ns				ns				ns		1
Gomphosus varius						ns					ns				ns				ns		11
Halichoeres biocellatus						ns					ns				ns				ns		1
Halichoeres hortulanus						ns					ns				ns				ns		14
Halichoeres margaritaceus						ns					ns				ns				ns		11
Halichoeres marginatus						ns					ns				ns				ns		2
Halichoeres trimaculatus						ns					ns				ns				ns		1
Hemigymnus melapterus						ns					ns				ns				ns		11
Hologymnosus annulatus						ns					ns				ns				ns		1
Labrichthys unilineatus						ns					ns				ns				ns		4
Labroides dimidiatus						ns					ns				ns				ns		12
Macropharyngogon meleagris						ns					ns				ns				ns		3
Navoculichthys taeniourus						ns					ns				ns				ns		3
Stethojulis bandanensis						ns					ns				ns				ns		1
Stethojulis strigiventor						ns					ns				ns				ns		11
Thalassoma hardwickii						ns					ns				ns				ns		11
Thalassoma lutescens						ns					ns				ns				ns		15
Thalassoma purpureum						ns					ns				ns				ns		1
Thalassoma quinquevittatum						ns					ns				ns				ns		1
Thallasoma lunare						ns					ns				ns				ns		2
Lethrinidae (Emperors)																					
Gnathodentex aureolineatus						ns					ns				ns				ns		2
Lethrinus harak						ns					ns				ns				ns		1
Lethrinus xanthochilus						ns					ns				ns				ns		4
Monotaxis grandoculus						ns					ns				ns				ns		4
Lutjanidae (Snappers)																					
Aphareus furca						ns					ns				ns				ns		3
Lutjanus bohar						ns					ns				ns				ns		1
Macolor niger						ns					ns				ns				ns		9
Malcolor macularis						ns					ns				ns				ns		1
Microdesmidae (Dartfishes)																					
Nemateleotris magnifica						ns					ns				ns				ns		3
Ptereleotris evides						ns					ns				ns				ns		12
Ptereleotris zebra						ns					ns				ns				ns		7
Mugilidae (Mullets)																					
Parupeneus barberinus						ns					ns				ns				ns		3
Parupeneus multifasciatus						ns					ns				ns				ns		12
Mullidae (Goatfishes)																					
Parapeneus bifasciatus						ns					ns				ns				ns		1
Muraenidae (Moray eels)																					
Gymnothorax meleagris						ns					ns				ns				ns		1
Ostracildae (Trunkfish)																					
Ostracion meleagris						ns					ns				ns				ns		2
Pinguipedidae (Sandperches)																					
Parapercis clatherata						ns					ns				ns				ns		9
Parapercis millipunctata						ns					ns				ns				ns		1
Pomacanthidae (Angelfishes)																					
Centropyge flavissimus						ns					ns				ns				ns		13

Table 9

Northern District Outfall Fish Species.

shaded boxes represent that species been present

Fiscal Year	1990				1991				1992				1993				1994				Total
quarter	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	n/16
Centropyge shepardi						ns					ns				ns				ns		5
Pygoplites diacantus						ns					ns				ns				ns		3
Pomacentridae (Damselfishes) subfamily Amphiprioninae (Anemonefishes)																					
Amphiprion chrysopterus						ns					ns				ns				ns		10
Amphiprion periderion						ns					ns				ns				ns		6
Chromis acares						ns					ns				ns				ns		1
Pomacentridae (Damselfishes) subfamily Pomacentrinae																					
Abudefduf saxatalis						ns					ns				ns				ns		2
Chryiptera traceyi						ns					ns				ns				ns		4
Chrysiptera leucopoma						ns					ns				ns				ns		1
Plectroglyhididodon leucozona						ns					ns				ns				ns		1
Plectroglyphidodon dickii						ns					ns				ns				ns		9
Plectroglyphidodon johnstonianus						ns					ns				ns				ns		2
Plectroglyphidodon lacrymatus						ns					ns				ns				ns		13
Plectroglyphidodon sp.						ns					ns				ns				ns		1
Pomacentrus amboinensis						ns					ns				ns				ns		10
Pomacentrus grammorhynchus						ns					ns				ns				ns		11
Pomacentrus vaiuli						ns					ns				ns				ns		4
Pomachromis guamensis						ns					ns				ns				ns		5
Stegastes albifasciatus						ns					ns				ns				ns		3
Scaridae (Parrotfishes)																					
Calototomus carolinus						ns					ns				ns				ns		1
Scaras altipinnus						ns					ns				ns				ns		3
Scarus frenatus						ns					ns				ns				ns		9
Scarus frontalis						ns					ns				ns				ns		1
Scarus ghobban						ns					ns				ns				ns		2
Scarus gibbus						ns					ns				ns				ns		4
Scarus globiceps						ns					ns				ns				ns		2
Scarus schlegeli						ns					ns				ns				ns		11
Scarus sordidus						ns					ns				ns				ns		16
Scorpaenidae (Scorpionfishes)																					
Scorpaenopsis verrucosa						ns									ns				ns		1
Serrandiae (Grouper)																					
Cepahlopholis argus						ns					ns				ns				ns		10
Cephalopholis urodeta						ns					ns				ns				ns		7
Variola louti						ns					ns				ns				ns		2
Siganidae (Rabbitfish)																					
Siganus aregenteus						ns					ns				ns				ns		1
Siganus spinus						ns					ns				ns				ns		1
Sphyraenidae (Barracudas)																					
Sphyraena forsteri						ns					ns				ns				ns		7
Syngnathidae subfamily Syngnathinae (Pipefishes)																					
Corythoichthys intestinalis						ns					ns				ns				ns		1
Synodontidae (Lizardfishes)																					
Saurida gracilis						ns					ns				ns				ns		1
Synodus spp.						ns					ns				ns				ns		1
Tetraodontidae (puffers)																					
Arothron nigropunctatus						ns					ns				ns				ns		1
Canthigaster solandri						ns					ns				ns				ns		14
Zanclidae (Moorish Idol)																					
Zancluls cornutus						ns					ns				ns				ns		15
total number of species	44	38	41	48	44	ns	65	67	59	56	ns	55	51	43	ns	49	42	36		42	

Number of fish species that fall under each food group.

Herbivore	12	11	15	17	16	ns	18	20	16	16	ns	15	14	14	ns	15	13	11	ns	14	
Carnivore	19	16	21	20	19	ns	30	29	27	26	ns	25	22	21	ns	23	21	17	ns	19	
Invertivore	18	14	21	19	19	ns	28	27	25	24	ns	23	20	20	ns	21	20	16	ns	18	
Planktivore	4	3	1	4	4	ns	5	6	5	4	ns	5	5	2	ns	4	2	2	ns	2	
Omnivore	4	1	2	2	2	ns	4	3	3	2	ns	2	2	2	ns	2	2	2	ns	2	
Corallivore	5	7	2	5	3	ns	8	9	8	8	ns	8	8	5	ns	5	4	4	ns	4	

Table 10

Regression analysis results for Northern District. Significance of change in % cover of the six benthic categories over the 61 months that the area was surveyed.

Transect	Bare	Turf Algae	Macro Algae	Coral	Coralline	Other
0 m	+s	-s	-	+s	+	-
ts	4.072	5.805	-0.699	2.653	0.047	-0.995
20 m	+s	-	+	-	+	+
ts	2.23	-1.52	1.02	-0.72	0.65	0.4
50 m	+s	-s	+	-	-	-
ts	3.361	-3.842	0.854	-1.78	-0.434	-0.903

ts 0.05[15] =2.131
s = significant at 95%
+ = positive regression
- = negative regression

FACSIMILE TRANSMITTAL SHEET

DATE: 12 Dec 1997

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****

TO:

NAME: Joanne Boyd

ROUTING: PUAG

TELEPHONE: 472-1338 **(FAX)**

(COMMERCIAL)

SUBJECT: FY97 Inshore Catch Survey Results

****

FROM:

NAME: Todd Pitlik

ROUTING: Division of Aquatic & Wildlife Resources (DAWR)

TELEPHONE: (671) 734-6570 **(FAX)**

(671) 735-3986 **(COMMERCIAL)**

****

MESSAGE: Dear Joanne,

I am including the FY97 results I promised to you. If you have any questions, pls let me know. In addition, I may be able to expand specific areas to get the results you are looking for.

Sincerely,

Todd J. Pitlik

Todd J. Pitlik
Fisheries Biologist

Table 11

Combined estimated inshore participation, effort, and total harvest (kg) for all methods during the day and night in FY97.

METHOD	Persons	Gears	Trips	Per-Hrs	Gear-Hrs	Catch	Finfish	Inverts	CPUE**
Hook & Line	44,774	44,158	25,697	155,038	153,318	15,033	14,940	93	0.15 wd
Cast Net	10,055	8,826	7,734	23,063	20,246	7,518	7,500	18	0.78 wen
Gill Net	7,637	3,581	2,410	28,103	13,138	6,111	5,763	347	0.87 wed
Surround Net	0	0	0	0	0	0	0	0	0.0
Spear Snorkel	2,829	2,455	1,370	5,910	5,083	3,410	2,594	815	0.84 wn
Spear Scuba	36	36	32	37	37	39	36	3	1.32 wen
Drag Net	160	29	29	267	49	79	79	0	1.67 wn
Hooks & Gaffs	731	938	469	1,376	1,659	433	0	433	0.28 wd
Other*	2,323	2,323	1,407	3,996	3,996	4,864	647	4,217	2.12 wd
TOTAL	68,545	62,344	39,147	217,789	197,525	37,486	31,560	5,925	0.16

*Other methods typically includes: gleaning, hand nets, traps, and spears.
**CPUE (kg/gh) summary includes either the greatest weekday (wd) or weeknight (wn) or weekend day (wed), weekend night (wen) values listed in Tables 2 and 3. The greatest CPUE value for hook and line was region 3.

Table 2. Estimated inshore participation, effort, and total harvest (kg) for all methods during the day in FY97.

METHOD	Persons	Gears	Trips	Per-Hrs	Gear-Hrs	Catch	Finfish	Inverts	CPUE**
Hook & Line	30,180	30,148	18,361	110,557	110,652	12,098	12,008	90	0.15 wd
Cast Net	9,989	8,759	7,672	22,932	20,115	7,457	7,456	1	0.54 wd
Gill Net	5,628	2,660	1,626	19,567	9,253	4,686	4,447	239	0.87 wed
Surround Net	0	0	0	0	0	0	0	0	0.0
Spear Snorkel	1,348	1,063	785	2,959	2,304	1,473	829	644	0.69 wed
Spear Scuba	0	0	0	0	0	0	0	0	0.0
Drag Net	0	0	0	0	0	0	0	0	0.0
Hooks & Gaffs	731	938	469	1,376	1,659	433	0	433	0.28 wd
Other*	1,668	1,668	928	2,572	2,572	4,664	616	4,048	2.12 wd
TOTAL	49,545	45,235	29,841	159,962	146,555	30,812	25,357	5,454	0.21

*Other methods typically includes: gleaning, hand nets, traps, and spears.
**CPUE (kg/gh) summary includes either the greatest weekday (wd) or weekend day (wed) values. The greatest CPUE value for hook and line was region 3

Table 11

Estimated inshore participation, effort, and total harvest (kg) for all methods during the night in FY97.

METHOD	Persons	Gears	Trips	Per-Hrs	Gear-Hrs	Catch	Finfish	Inverts	CPUE**
Hook & Line	14,593	14,010	7,336	44,481	42,666	2,935	2,932	3	0.12 wn
Cast Net	66	66	61	131	131	61	44	17	0.78 wen
Gill Net	2,009	921	784	8,536	3,886	1,424	1,316	108	0.63 wn
Surround Net	0	0	0	0	0	0	0	0	0.0
Spear Snorkel	1,481	1,392	585	2,951	2,778	1,936	1,765	171	0.84 wn
Spear Scuba	36	36	32	37	37	39	36	3	1.32 wen
Drag Net	160	29	29	267	49	79	79	0	1.67 wn
Hooks & Gaffs	0	0	0	0	0	0	0	0	0.0
Other*	655	655	479	1,423	1,423	200	31	169	0.14 wd
TOTAL	19,000	17,109	9,306	57,826	50,970	6,674	6,203	471	0.13

*Other methods typically includes: gleaning, hand nets, traps, and spears.

**CPUE (kg/gh) summary includes either the greatest weeknight (wn) or weekend night (wen) values. The greatest value for hook and line was region 3.

Table 11

FY97 combined day and night catch composition for the top ten species and families of finfish harvested. Juvenile *Caranx ignobilis, C. melampygous, C. papuensis,* and *C. sexfasciatus* (i'e' ≤ 200mm), *Mulloides flavolineatus* (ti'ao ≤ 100mm), and *Siganus spinus* (mañåhak), are listed separately from the intermediate to adult size classes. Finfish harvest percentages were derived from the day and night catch (31,560 kg).

SPECIES	Harvest	
	kg	%
Naso unicornis	3,454.57	10.95
Siganus spinus	3,397.28	10.76
Acanthurus triostegus	1,973.18	6.25
Lethrinus harak	1,170.58	3.71
Caranx i'e'	1,047.54	3.32
Selar crumenophthalmus	994.94	3.15
Liza vaigiensis	963.62	3.05
Mulloides ti'ao	798.58	2.53
Mulloides flavolineatus	768.74	2.44
Caranx ignobilis	618.85	1.96
TOTAL ANNUAL COMBINED CATCH	15,187.88	48.12

FAMILY	Harvest	
	kg	%
Acanthuridae	6,835.24	21.66
Carangidae	4,662.48	14.77
Siganidae	3,650.93	11.57
Lethrinidae	2,193.78	6.95
Mullidae	1,943.47	6.16
Mugilidae	1,785.86	5.66
Lutjanidae	1,437.95	4.56
Gerreidae	1,049.82	3.33
Labridae	1,006.37	3.19
Scaridae	854.19	2.71
	25,420.09	80.55

Table 5. FY97 day catch composition for the top ten species and families of finfish harvested. Juvenile *Caranx ignobilis, C. melampygous, C. papuensis,* and *C. sexfasciatus* (i'e' ≤ 200mm), *Mulloides flavolineatus* (ti'ao ≤ 100mm), and *Siganus spinus* (mañåhak), are listed separately from the intermediate to adult size classes. Finfish harvest percentages were derived from the total day catch (25,357 kg).

SPECIES	Harvest	
	kg	%
Naso unicornis	3,154.85	12.44
Siganus spinus	2,976.54	11.74
Acanthurus triostegus	1,689.77	6.66
Lethrinus harak	944.00	3.72
Liza vaigiensis	880.03	3.47
Mulloides ti'ao	764.30	3.01
Caranx i'e'	742.14	2.93
Mulloides flavolineatus	652.82	2.57
Gerres oblongus	563.68	2.22
Caranx ignobilis	558.11	2.20
TOTAL ANNUAL DAY CATCH	12,926.24	50.98

FAMILY	Harvest	
	kg	%
Acanthuridae	6,110.36	24.10
Siganidae	3,187.36	12.57
Carangidae	3,005.71	11.85
Lethrinidae	1,728.74	6.82
Mullidae	1,726.38	6.81
Mugilidae	1,615.97	6.37
Lutjanidae	963.25	3.80
Gerreidae	876.82	3.46
Labridae	822.45	3.24
Scaridae	617.89	2.44
	20,654.93	81.46

Table 11

FY97 night catch composition for the top ten species and families of finfish harvested. Juvenile *Caranx ignobilis*, *C. melampygous*, *C. papuensis*, and *C. sexfasciatus* (i'e' ≤ 200mm), *Mulloides flavolineatus* (ti'ao ≤ 100mm), and *Siganus spinus* (mañåhak), are listed separately from the intermediate to adult size classes. Finfish harvest percentages were derived from the total night catch (6,203 kg).

SPECIES	Harvest	
	kg	%
Selar crumenophthalmus	840.55	13.55
Siganus spinus	420.74	6.78
Caranx i'e'	305.40	4.92
Naso unicornis	299.72	4.83
Acanthurus triostegus	283.41	4.57
Lutjanus argentimaculatus	243.27	3.92
Lethrinus harak	226.58	3.65
Caesio caerulaurea	203.32	3.28
Caranx sexfasciatus	200.25	3.23
Lutjanus fulvus	189.89	3.06
TOTAL ANNUAL NIGHT CATCH	3,213.13	51.80

FAMILY	Harvest	
	kg	%
Carangidae	1,656.77	26.71
Acanthuridae	724.88	11.69
Lutjanidae	474.70	7.65
Lethrinidae	465.04	7.50
Siganidae	463.57	7.47
Holocentridae	293.43	4.73
Scaridae	237.19	3.82
Mullidae	217.09	3.50
Caesionidae	207.33	3.34
Labridae	183.92	2.97
	4,923.92	79.38

Table 11

Comparison of the combined day and night catch composition for the top species and families of finfish harvested in FY93 and FY97. Juvenile *Caranx ignobilis, C. melampygous, C. papuensis,* and *C. sexfasciatus* (i'e' ≤ 200mm), *Mulloides flavolineatus* (ti'ao ≤ 100mm), and *Siganus spinus* (mañāhak), are listed separately from the intermediate to adult size classes.

SPECIES	Harvest (kg)		% Δ
	FY93	FY97	
Mulloides flavolineatus	4,438.47	768.74	↓83
Acanthurus triostegus	2,305.25	1,973.18	↓14
Lethrinus xanthochilus	2,154.46	436.07	↓80
Siganus spinus	2,143.29	3,397.28	37↑
Myripristis berndti	2,041.87	96.20	↓95
Naso unicornis	1,971.48	3,454.57	43↑
Crenimugil crenilabis	1,675.97	377.73	↓77
Kyphosus cinerascens	1,482.58	226.19	↓85
Lethrinus obsoletus	1,298.21	222.40	↓83
Mulloides ti'ao	1,196.56	798.58	↓14
TOTAL ANNUAL COMBINED CATCH	20,708.14	11,750.94	↓43

FAMILY	Harvest (kg)		% Δ
	FY93	FY97	
Acanthuridae	7,296.15	6,835.24	↓06
Mullidae	6,818.88	1,943.47	↓72
Lethrinidae	4,539.39	2,193.78	↓52
Mugilidae	3,609.74	1,785.86	↓51
Siganidae	3,239.59	3,650.93	37↑
Holocentridae	2,801.69	545.64	↓81
Carangidae	2,189.94	4,662.48	43↑
Scaridae	1,659.54	854.19	↓49
Kyphosidae	1,507.71	472.61	↓69
Lutjanidae	1,480.96	1,437.95	↓03
	35,143.59	24,382.15	↓47

% Δ reduction (↓)or % Δ increase (↑) of species and family totals (kg) from FY93-97.

Table 11

FY97 day and night catch composition for the top ten species of finfish harvested by hook and line method. Juvenile *Caranx ignobilis, C. melampygous, C. papuensis,* and *C. sexfasciatus* (i'e' ≤ 200mm), are listed separately from the intermediate to adult size classes. Finfish harvest percentages were derived from the total day (12,008 kg) and night (2,932 kg) hook and line catch.

Day Species	Harvest	
	kg	%
Naso unicornis	2,997.31	24.96
Lethrinus harak	758.63	6.32
Liza vaigiensis	631.76	5.26
Caranx ignobilis	558.11	4.65
Caranx melampygous	530.69	4.42
Caranx i'e'	518.60	4.32
Decapterus macrosoma	430.47	3.58
Abudefduf sexfasciatus	419.54	3.49
Aprion virescens	391.25	3.26
Lethrinus xanthochilus	368.81	3.07
Total Top Ten Hook & Line Catch	7,605.17	63.33
Total Combined Hook & Line Catch	9,719.95	65.06

Night Species	Harvest	
	kg	%
Selar crumenophthalmus	840.55	28.67
Caranx i'e'	277.65	9.47
Lutjanus argentimaculatus	234.05	7.98
Caranx sexfasciatus	189.47	6.46
Lethrinus harak	143.42	4.89
Lutjanus fulvus	142.80	4.87
Decapterus macrosoma	103.68	3.54
Lethrinus obsoletus	62.92	2.15
Caranx ignobilis	60.74	2.07
Sphyraena barracuda	59.50	2.03
	2,114.78	72.13

Table 10. FY97 day and night catch composition for the top ten species of finfish harvested by gill net method. Juvenile *Caranx ignobilis, C. melampygous, C. papuensis,* and *C. sexfasciatus* (i'e' ≤ 200mm), *Mulloides flavolineatus* (ti'ao ≤ 100mm), and *Siganus spinus* (mañåhak), are listed separately from the intermediate to adult size classes. Percentages were derived from the total day (4,447 kg) and night (1,316 kg) gillnet catch.

Day Species	Harvest	
	kg	%
Siganus spinus	597.84	13.44
Gerres oblongus	561.85	12.63
Valamugil seheli	328.24	7.38
Mulloides flavolineatus	323.19	7.27
Liza vaigiensis	242.71	5.46
Leiognathus equulus	219.24	4.93
Crenimugil crenilabis	214.31	4.82
Gerres acinaces	190.18	4.28
Myripristis murdjan	189.20	4.25
Caranx papuensis	178.94	4.02
Total Top Ten Gill Net Catch	3,045.70	68.49
Total Combined Gill Net Catch	4,008.35	61.41

Night Species	Harvest	
	kg	%
Acanthurus triostegus	187.66	14.26
Caesio caerulaurea	167.79	12.75
Gerres acinaces	147.82	11.23
Siganus spinus	100.06	7.60
Mulloides flavolineatus	84.18	6.40
Crenimugil crenilabis	71.86	5.46
Liza vaigiensis	56.55	4.30
Hyporhamphus acutus	56.55	4.30
Lethrinus harak	54.25	4.12
Diodon hystrix	35.93	2.73
	962.65	73.15

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Table 11

FY97 day and night catch composition for the top ten species of finfish harvested by snorkel spear method. Finfish harvest percentages were derived from the total day (829 kg) and night (1,765 kg) snorkel spear catch.

Day Species	Harvest	
	kg	%
Naso tuberosus	108.10	13.04
Scarus sordidus	92.48	11.16
Scarus microrhinos	83.69	10.10
Kyphosus cinerascens	74.62	9.00
Diodon hystrix	62.77	7.57
Synancela verrucosa	62.77	7.57
Naso lituratus	57.12	6.89
Acanthurus triostegus	47.42	5.72
Lutjanus fulvus	41.29	4.98
Naso unicornis	35.50	4.28
Total Top Ten Spear Snorkel Catch	665.76	100.00
Total Combined Spear Snorkel Catch	1,843.68	71.07

Night Species	Harvest	
	kg	%
Siganus spinus	312.53	17.71
Naso unicornis	299.56	16.97
Cheilinus trilobatus	127.38	7.22
Acanthurus triostegus	95.75	5.42
Epinelphelus merra	89.56	5.07
Scarus psitticus	73.41	4.16
Naso lituratus	54.57	3.09
Scarus ghobban	49.44	2.80
Parupeneus barberinus	39.53	2.24
Acanthurus lineatus	36.19	2.05
	1,177.92	66.74

State and Federal Laws

E.

ND 1684

II. D. State and Federal Laws [40 CFR 125.61 and 125.62(a)(1)]

II.D.1. Are there water quality standards applicable to the following pollutants for which a modification is requested:

- Biochemical oxygen demand or dissolved oxygen?
- Suspended solids, turbidity, light transmission, light scattering' or maintenance of the euphotic zone?
- pH of the receiving water?

Yes, for all listed.

II.D.2. If yes, what is the water use classification for your discharge area?

Good marine water (M-2)

What are the applicable standards for your discharge area for each of the parameters for which a modification is requested?

See II.B.2.

Provide a copy of all applicable water quality standards or a citation to where they can be found.

Revised Guam Water Quality Standards, 1992 (Appendix C)

II.D.3. Will the modified discharge: [40 CFR 125.59(b)(3)]

- Be consistent with applicable State coastal zone management program(s) approved under the Coastal Zone Management Act as amended, 16 U.S.C. 1451 et seq? [See 16 U.S.C. 1456(c)(3)(A)]

Yes.

- Be located in a marine sanctuary designated under Title III of the Marine Protection, Research, and Sanctuaries Act (MPRSA) as amended, 16 U.S.C. 1431 et seq., or in an estuarine sanctuary designated under the Coastal Zone Management Act as amended, 16 U.S.C. 1461?

No.

- Be consistent with the Endangered Species Act as amended, 16 U.S.C. 1531 et seq.? Provide the names of any threatened or endangered species that inhabit or obtain nutrients from waters that may be affected by the modified discharge. Identify any critical habitat that may be affected by the modified discharge and evalute whether the modified discharge will affect threatened or endangered species or modify a critical habitat. [See 16 U.S.C. 1536(a)(2)]

None.

II.D.4. Are you aware of any State or Federal laws or regulations (other than the Clean Water Act or the three statutes identified in item 3 above) or an executive order which is applicable to your discharge? If yes, provide sufficient information to demonstrate that your modified discharge will comply with such law(s), regulation(s), or order(s). [40 CFR 125.59 (b)(3)]

No.

GWA has forwarded a copy of its permit application package (relevant sections) to the Bureau of Planning for review. The Bureau is the clearinghouse for all federally funded programs and as such, obtains comments from agencies who's programs may be impacted by planned activities such as wastewater discharges into ocean waters. Letters were delivered to Guam's Bureau of Planning, Department of Agriculture, and the Environmental Protection Agency requesting for consistency determinations with their respective programs. Responses to these letters will be forwarded to U.S.E.P.A. upon receipt. These comments will address consistency with applicable State Coastal Zone Management Program(s) approved under the Coastal Zone Management Act as amended, the modified discharge's consistency with marine sanctuary regulations and with the Endangered Species Act, and consistency with water quality standards. Copies of these letters are attached as Appendix D.

Regulations under Guam's Water Pollution Control Act are applicable. A copy of this Act is attached as Appendix E.

Physical Characteristics of Discharge

F

TECHNICAL EVALUATION

III.A. Physical Characteristics of the Discharge

III.A.1. What is the critical initial dilution for your current and modified discharge(s) during 1) the period(s) of maximum stratification? and 2) any other critical periods(s) of discharge volume/composition, water quality, biological seasons, or oceanographic conditions?

There is no significant periods of stratification or any other critical period. There is no stratification of the waters above the diffusers except that caused by the discharge itself. The effluent is low density (non saline) and because of this the effluent rises rapidly to the surface where it flows horizontally in the top 1m of surface water. The depth of water above the diffusers is 18.29 m.

Austin, Smith & Associates, Inc. Engineers projected the initial dilution of the plant effluent to be 100. (Table 7.) In the November 21, 1990 transmittal from Susan Cox (USEPA) regarding Priority Pollutant Scan Results, initial dilution values for the Northern District Plant was given as 118:1.

III.A.2. What are the dimensions of the zone of initial dilution for your modified discharge(s)

According to the Amended Section 301(h) Technical Support Document the dimensions for the zone of initial dilution (ZID) can be considered to include the bottom areas and water column above the area that circumscribed by the distance d from any point of the diffuser.

d = depth of water above deepest point of discharge = 18.29 m (60 ft)
L = length of diffuser section = 129 m (423 ft)

ZID width = 2d	ZID length = L	ZID area = 2d x L
= 36.58 m	= 129 m	= 4718.82 m^2

III.A.3. What are the effects of ambient currents and stratification on dispersion and transport of the discharge plume/wastefield ?

The effluent plume rises rapidly to the surface and dissipates over 1m depth. Matson (1990) concluded that complete dilution occurs in the top 1 meter of water, and that the effluent dissipates with the surface currents. Both Jones and Randall, 1973a and Huddell et al , 1971 current studies indicate that currents flowed NE and SW. Huddell states that NE currents were predominant. However, Jones and Randall indicated that they are tidally controlled and are equally split between NE and SW. Either way the currents are in a generally oblique offshore direction.

NE tradewinds are dominant in all seasons, but are especially pronounced in the winter (Jan.- May). During the summer (July - Oct.) the effect of the trade winds are diminished and winds from every direction are not uncommon. Transportation of the discharge across the reef by wind driven surface currents are in frequent. On occasion high fecal coliform numbers have been found at the shoreline monitoring station A, situated perpendicular to the outfall. This indicates that on some occasions currents are onshore. Jones and Randall (1973b) noted that at times with heavy wave assault, currents are inshore and create a strong flushing action on the reef flats. This flushing would tend to minimize any concentration of sewage that does find its way to the reef flat.

GEPA conducted an environmental assessment of the Northern District WWTP receiving

waters (Borja, and Wood, 1986). They note that dominant currents along the western shoreline of Guam move in a southerly direction, at speeds averaging 0.5 to 0.8 knots. Therefore prevailing currents and wind driven currents would tend to carry the wastewater plume offshore and out into the prevailing offshore current that flows in a southwesterly direction off Tanguisson Point.

Borja, M. and H. Wood. 1986. Environmental Impact of Sewage Effluent at the Marine Outfall of the Northern District Sewage Treatment Plant, Guam. Guam Environmental Protection Agency, Technical Report.

Jones, R. S. and R. H. Randall. 1973a. A Study of Biological Impact caused by Natural and Man-Induced Changes on a Tropical Reef. University of Guam, Marine Laboratory Technical Report No.7.

Jones, R. S. and R. H. Randall. 1973b. A Preliminary Marine Survey for the Northern District Sewage System. University of Guam, Marine Laboratory, Environmental Survey Report No.8.

Huddell, H. D., J. G. Willett and G. Marchand. 1974. Nearshore currents and Coral Reef Ecology of the West coast Of Guam, Mariana Islands. Naval Oceanographic Office, Washington, D.C.

Matson E.A. 1990. Effects of the Agat, Agana, and Northern District Wastewater Effluents on Receiving Water Quality. Marine Laboratory Technical Report No. 93.

III.A.4. **only small discharges must respond**

III.A.5. Sedimentation of Suspended Solids

- ***a. What fraction of the modified discharge's suspended solids will accumulate within the vicinity of the modified discharge?***
- ***b. What are the calculated area(s) and rate(s) of sediment accumulation within the vicinity of the modified discharge(s) ($g/m^2/yr$)?***
- ***c. What is the fate of settleable solids transported beyond the calculated sediment accumulation area?***

The tabulations for sediment deposition are based on the method for large discharges outlined in Appendix B-I of the Amended Section 301(h) Technical Support Document, EPA 842-b-94-007, Sept 1994. The quantitative prediction of seabed accumulation is based only on the processes of deposition and decay.

The Northern District WWTP has not had properly functioning anaerobic digesters for several years. These are currently under repair and we expect that the quality of the effluent will improve greatly from that of the past few years. Because of this suspended solids mass emission rate (kg/day) used was based on the best yearly percent removal. This was in FY90 when the plant averaged 66% removal. At present influent averages 218 mg/L. We are predicting a flow

of 10 MGD by the end of the permit.

Information current speeds for onshore, offshore and longshore directions were not directly available. Previous reports have given only average current speeds and predominant directions. The average speeds recorded in the Tanguisson area are between 0.2 kts and 0.4 kts (10 cm/sec to 20.6 cm/sec). Calculations to obtain suspended solids accumulation use the EPA default current speeds. This would give us a worse case scenario. Faster current speeds would mean that the area that the suspended solids would accumulate in over a period of time would be more. However, the amount of accumulated solids per square meter (g/m^2) would be less.

Prediction of Deposition

A portion of the settled solids is inert, the organic fraction of the settled solids is a primary concern. For primary or advanced primary discharge 80 percent of the suspended solids are organic and 20 percent are inorganic.

Settling velocities for the effluent were not available, therefor suggested values from appendix B-I were used.

primary or advance primary effluent

5 percent have $V_s \geq 0.1$
20 percent have $V_s \geq 0.01$
30 percent have $V_s \geq 0.006$
50 percent have $V_s \geq 0.001$

remainder of solids settle so slowly that they are assumed to remain suspended in the water column indefinitely.

Current speeds used were:

	default
Upcoast	5 cm/sec
Downcoast	5 cm/sec
Onshore	3 cm/sec
Offshore	3 cm/sec

Bottom Slope:

Onshore	0.12 m/m
Offshore	0.18 m/m

Height of rise of plume is 17.29 m

Mass emission Rate = 2802 kg/day

Results

Calculations based on default current speeds. The settleable organic components by group and maximum settling distances for each group are given in Table 12. The deposition rates and accumulation rates for each contour are given in Table 13. The highest steady state accumulation was 62 g/m^2 in a 0.25 km^2 area surrounding the outfall. A detailed bathymeteric map was not available to plot the predicted steady state sediment accumulation around the outfall.

Tabulations of Settleable Organic Components by Group and Maximum Settling Distance by Group. Calculations are made using default current speeds.

Mass emmission Rate = M_T = 2802 kg/day

Organic Component = M_o = 0.8 M_T for primary effluent

Percent by Settling Velocity Group	Organic Component by group	Maximum Settling Distance from Outfall[a] (meters) Upcoast	Downcoast	Onshore	Offshore
Primary Effluent					
5 (V_s = 0.1 cm/sec)	0.04 M_T = 112 kg/day	864	864	113	81
20 (V_s = 0.01 cm/sec)	0.16 M_T = 448 kg/day	8645	8645	140	94
30 (V_s = 0.006 cm/sec)	0.24 M_T = 672 kg/day	14408	14408	142	95
50 (V_s = 0.001 cm/sec)	0.40 M_T = 1121 kg/day	86450	86450	144	96
	sum = 0.84 M_T or 2353 kg/day				

[a] The distance D is calculated as: D =

where:

V_a = Ambient velocity = 5 cm/sec upcoast and downcoast (default), and 3 cm/sec onshore and offshore (default)

H_T = Average trapping level of plume, measured above the bottom = 17.29 m

V_s = Appropriate settling velocity by group for primary discharges.

If the bottom slope is 5 percent or greater, D should be calculated as follows:

$$D = \frac{H_T}{S + \frac{V_s}{V_a}}$$

where:

S = slope, m/m

Table 12

Tabulations of Deposition Rates and Accummulation Rates by Contour. Calculations are made using default current speeds.

Organic Mass Component by Group	Bottom Area	Mass Deposition Rate, by group	Total Organic Deposition Rate Within Area ($g/m^2/day$)	Accumulation (g/m^2) Steady-State	90-day
Primary Effluent					
0.04 M_T = 112 kg/day	251800 m^2	0.44 $g/m^2/day$	0.62 $g/m^2/day$	62 g/m^2	37 g/m^2
0.16 M_T = 448 kg/day	6467500 m^2	0.07 $g/m^2/day$	0.18 $g/m^2/day$	18 g/m^2	11 g/m^2
0.24 M_T = 672 kg/day	8647500 m^2	0.08 $g/m^2/day$	0.11 $g/m^2/day$	11 g/m^2	7 g/m^2
0.40 M_T = 1121 kg/day	31790000 m^2	0.04 $g/m^2/day$	0.04 $g/m^2/day$	4 g/m^2	2 g/m^2

Table 13

ND 1693

Compliance with Water Quality Standards

6

III.B. Compliance with Applicable Water Quality Standards and CWA 304(a)(1) water quality criteria [40 CFR 125.61(b) and 125.62(a)].

III.B.1. What is the concentration of dissolved oxygen immediately following initial dilution for the period(s) of maximum stratification and any other critical periods(s) of discharge volume/composition, water quality, biological seasons, or oceanographic conditions?

Dissolved oxygen has been measured directly in the effluent boil, at bottom, mid and surface depths, starting in 1989. The results of these measurements are given in Table 5, section II.B. The D.O. readings have varied during this time . From June 1989 until April 1991 readings were above 75% saturation after initial dilution (75% saturation ranges from 5.0 to 5.3 mg/L). However, from May 1991 until October 1993 D.O. readings ranged from 2.7 to 6.1 mg/L, averaging 3.9 mg/L in the surface water and 4.5 mg/L in the mid and bottom waters. The control site also had low D.O. readings, ranging from 3.7 to 6.6 mg/L, averaging 4.4 mg/L in the surface waters and 4.9 in the mid and bottom waters. During this period not only did the control station have low D.O. readings, but low D.O. readings were also recorded at both Agana and Agat receiving waters. It is likely that these readings are due to meter failure, poor calibration or sampling techniques. From June 1994 until present the readings have been well above 75% D.O. saturation. There is no indication that the D.O. in the waters in the zone of initial dilution (station C), or in the near fields (station D) have been adversely impacted by the discharge, when compared to the readings obtained from the control station (E).

III.B.2. What is the farfield dissolved oxygen depression and resulting concentration due to BOD exertion of the wastefield during period(s) of maximum stratification any other critical period(s) ?

There are no periods of maximum stratification or any other critical periods. The farfields have not been monitored in the past. However, the D.O. readings taken at station D, which is located approximately 200 m south of the boil, do not indicate that there has been any adverse dissolved oxygen depression due to the discharge (Table 5, section II.B.). Readings were similar to those found at the control station.

III.B.3. What are the dissolved oxygen depressions and resulting concentration near the bottom due to steady sediment demand and resuspension of sediments?

The water readings taken at the boil (station C) and in the nearfields (station D) do not indicate that there are adverse depressions in the D.O. of the waters near the bottom, when compared to the D.O. readings of bottom waters at the control site (Table 5, section II.B.). However, a study on D.O. depression due to steady sediment demand has not been conducted.

III.B.4. What is the increase in receiving water suspended solids concentration immediately following initial dilution of the modified discharge(s)?

Suspended solids have not been monitored in the receiving waters. However, turbidity has been measured at three depths, bottom, mid and surface, at the three monitoring stations since 1989.

There has been no incidences of adverse increases in turbidity (above 1 NTU of ambient), as outlined in the Guam Water Quality Standards.

III.B.5. What is the change in receiving water pH immediately following initial dilution of the modified discharge(s) ?

Again there has been little or no change in receiving water pH from that of the ambient waters. The receiving waters after initial dilution and the ambient waters average at around pH. 8.3 following initial dilution.

III.B.6. Does (will) the modified discharge comply with applicable water quality standards for:
- ***Dissolved Oxygen?***
- ***Suspended Solids or surrogate standards?***
- ***pH?***

Past monitoring of the receiving waters for these parameters has not indicated that the discharge has caused any adverse conditions when compared to the readings obtained from the ambient waters at the control station. There was a period when low D.O. readings that did not comply with the water quality standards (<75% D.O. saturation) were recorded from May 1991 until October 1993. However, the ambient waters were also recorded as having similar low D.O. levels. This leads me to believe that these readings were due to incorrect sampling, or meter operation. Low D.O. readings have not been recorded in the last year, and water quality standards have been meet. Suspended solids have not been part of the parameters measure in the past. However, turbidity readings at all locations and depths have been within the Guam Water Quality Standards (GWQS) as are pH.

III.B.7. Provide data to demonstrate that all applicable State water quality standards, and all applicable water quality criteria established under Section 304(a)(1) of the Clean Water Act for which there are no directly corresponding numerical applicable water quality standards approved by EPA, are met at and beyond the boundary of the ZID under critical environmental and treatment plant conditions in the waters surrounding or adjacent to the point at which your effluent is discharged.

The results of the water quality monitoring conducted since 1989 are given in Table 5. Section II.B There are occasions when readings indicate that water quality standards are not met, such as the period of D.O. readings below 75% saturation (May 1991 until October 1993), and a pH above 9 during 1991. However, when receiving water results are compared to the results of ambient waters at the control station, they are very similar. These readings may be a result of improper sampling, meter operation or analysis. All water quality parameters apart from fecal coliform have meet the water quality standards in the last year.

III.B.8. Provide the determination required by 40 CFR 125.61(b)(2) for compliance with all applicable provisions of State law, including water quality standards or, if the determination has not yet been received, a copy of a letter to the appropriate agency(s) requesting the required determination.

GWA has forwarded copies of its permit application package to the Bureau of Planning for review. The bureau is the clearinghouse for all federally funded programs and as such, obtains comments from agencies who's programs may be impacted by planned activities such as wastewater discharges into ocean waters. Letters have been transmitted to Guam's Bureau of Planning, department of Agriculture and the Environmental Protection Agency requesting for consistency determinations with their respective programs. Responses to these letters will be forwarded to U.S.E.P.A. upon receipt. These comments will address consistency with applicable State Coastal Zone Management Program(s) approved under the Coastal Zone Management Act as amended, the modified discharge's consistency with marine sanctuary regulations and with the Endangered Species Act, and consistency with water quality standards. Copies of these letters are attached as Appendix D.

Regulations under Guam's Water Pollution Control Act are applicable. A copy of this Act is attached as Appendix E.

Impact in Public Water Supplies

H

III. C. <u>Impact on Public Water Supplies.</u>

III.C.1. Is there a planned or existing public water supply (desalinization facility) intake in the vicinity of the current or modified discharge?

No.

Biological Impact of Discharge

I

III.D. Biological Impact of Discharge

III.D.1. Does (will) a balanced indigenous population of shellfish, fish, and existing wildlife exist:

- ***Immediately beyond the ZID of the current and modified discharge(s)?***

- ***In all other areas beyond the ZID where marine life is actually or potentially affected by the current and modified permit.***

Previous Biological Monitoring Surveys were conducted by UOG Marine Laboratory did not include sites beyond the ZID.

III.D.2. Have distinctive habitats of limited distribution been impacted adversely by the current discharge and will such habitats be impacted adversely by the modified discharge?

Coral reef communities are considered distinctive habitats of limited distribution. Guam is nearly completely surrounded by coastal coral reefs. A report on the Review and Analysis of Past Biological Monitoring Data for the Northern District WWTP Outfall, Guam is found in ITEM N .

III.D.3. Have commercial or recreational fisheries been impacted adversely by the current discharge (e.g. warnings, restrictions, closures, or mass mortalities) or will they be impacted adversely by the modified discharge?

There has been no evidence of mass mortalities or elevated toxic levels found in fish that are potentially impacted by the current discharge. However, due to loss of power after Supertyphoon Paka public warnings not to fish or bath in the waters from Tanguisson Beach to Shark's Hole (in the vicinty of the outfall) were issued by Guam EPA. Clippings from the local news paper, Pacific Daily News regarding these warnings are attached in figures 24 & 25.

III.D.4. Does the current or modified discharge cause the following within or beyond the ZID

- ***Mass mortality of fishes or invertebrates due to oxygen depletion, high concentrations of toxics, or other conditions?***
- ***An increase incidence of disease in marine organisms?***
- ***An abnormal body burden of any toxic material in marine organisms?***
- ***Any other extreme, adverse biological impacts?***

There are no reported incidences of fish or invertebrate mortality due to oxygen depletion, high concentration of toxics or other conditions. Monitoring results of dissolved oxygen in the receiving waters indicate >75% oxygen saturation. There is no reported incidences of an increase incidence of disease in marine organisms or any other extreme adverse biological impacts.

As previously stated, GWA has requested Letters of Determination from the Bureau of Planning, Department of Agriculture and Guam Environmental Protection Agency (See *State and Federal Laws*, Section II.D.4 of application questionnaire). Upon receipt of their letters, GWA will immediately forward their responses to your office.

Samples for the required *Toxicity and Priority Pollutant Scans* were collected on the 8th and 9th of March for the Northern District and Agana STPs. The samples were then immediately sent off to the Montgomery & Watson Labs in Pasadena California. GWA has received E-Mail confirmation that the analysis of the samples are presently in progress.

Needs to be done once priority pollutant scan completed
Evaluate potential for bioaccumulation is to compare the concentrations of toxic pollutants after initial dilution with EPA Aquatic life water quality criteria. Two types of information required:
(1) Concentration of the pollutant in the discharge effluent (scans need to be done)
(2) Critical initial dilution (= 100)
the value of (1) divided by (2) should then be compared with available criterion. Also important to study sediment accumulation patterns. Demonstrate adequate initial dilution and sufficient circulation to prevent localized accumulation of solids.
Only necessary to conduct tissue and sediment analysis if effluent and dilution analysis indicate potential for bioaccumulation.

Once the above computations are completed by GWA's Biologist, the computations along with the package containing the results of the scans will be immediately forwarded to your office.

III.D.5.
NA

III.D.6.
NA

III.D.7.
NA

III.D.8.
NA

Pacific Daily News

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HAFA ADAI, IT'S SATURDAY

75¢ on Guam

narajan mayor plans census

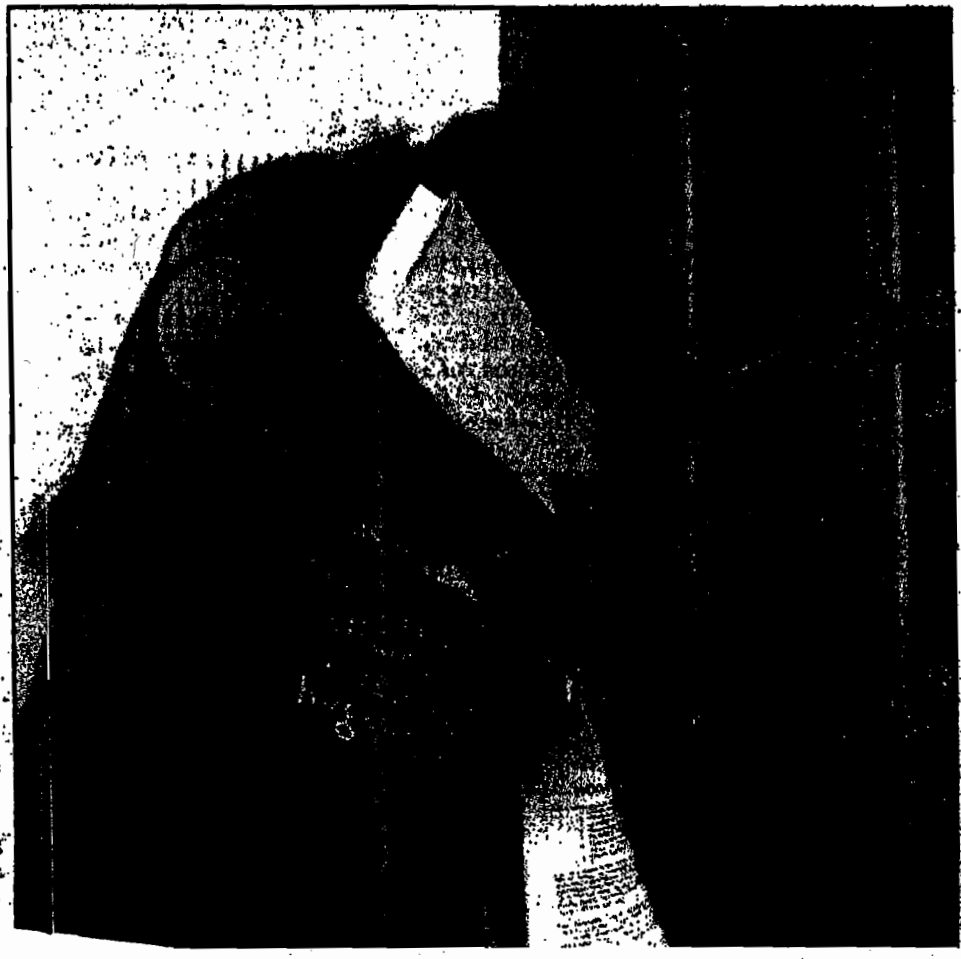
Lalaine Estella

cific Daily News

Teams of three spread out across rajan village yesterday, spreading news of an upcoming census the -fashioned way — on foot.

Betty Jo Camacho, who was as-ing the mayor in his effort to up-e the village's roll, said going se-to-house was the best way to ure that everyone was notified he head count, which begins next k.

"I think this is the way it's always n done," Camacho said as she ked down Victor P. San Nicolas Street.



PAKA

The last village census was conducted three years ago, Mayor e L.G. Perez said. At the time of last count, just over 2,300 peo-lived in Inarajan.

erez said the census is needed two reasons.

My community has prospered the past three years, and the ulation has increased," he said. ez said that having an accurate nber of residents will help him ... road and capital im-

Sewage floats to surface off Tanguisson

By Roya Camp

Pacific Daily News

Nearly raw sewage has been pouring into the ocean at Tanguisson Point since Supertyphoon Paka, environmental and water officials said yesterday.

The sewage is coming from the Northern District Sewage Treatment Plant through the plant's discharge pipe north of Tanguisson Beach.

No illnesses have been reported as a result of the contamination, according to Bert Johnston, Guam Waterworks Authority assistant general manager, and Michael Lee, an environmental engineer with the U.S. Environmental Protection Agency. Lee, of the agency's Region 9 San Francisco office, is on the island to help the Guam Environmental Protection Agency handle cleanup of typhoon debris sites and monitor other environmental matters.

People are being urged to avoid swimming or fishing in the area around the pipe, from Tanguisson Beach to Shark's Hole, Guam EPA spokeswoman Grace O. Garces said yesterday.

The plant, one of eight operated by the authority, serves Andersen Air Force Base and commercial and residential customers in Yigo, Dededo, Barrigada Heights and most of Tumon. The plant process-

▲ See **Sewage**, Page 5

ND 1703

Figure 24

Pacific Daily News, Saturday, January 24, 1998

Sewage: 'Didn't want to ... get all into it'

▲ Continued from Page 1

es between 6 million and 7 million gallons of sewage daily, Johnston said.

Guam Waterworks and the Guam EPA organized a Jan. 16 dive to check possible damage to the pipe, but called it off after they saw floating material and a plume of sewage, Lee said.

"When they went to the outfall, they saw evidence of the sewage and sewage rising to the surface," he said. "It was spreading all over the place. They didn't want to dive and get all into it."

The pipe is supposed to release treated sewer water about 1,000 feet from shore through a pipe under about 60 feet of seawater, Johnston said.

Sewage still is being screened at the northern district plant and some is being pumped out, dried and disposed of at the Ordot Landfill, but because the treatment plant isn't working properly, most of it is escaping into the ocean, Lee said.

The plant has been under a federal EPA order since 1988 to improve the sewage treatment level before piping the wastewater into the ocean.

BEACH ADVISORIES

The Guam Environmental Protection Agency is urging people to avoid swimming or fishing at the following beaches until further notice:

- ▲ Matapang Beach, Guma Trankilidat and Tanguisson Beach in Tumon.
- ▲ Sleepy Lagoon and Dungco's Beach in Tamuning.
- ▲ USS Beach in Piti.
- ▲ Family Beach in Cabras.
- ▲ East Agana Bay and the Agana Channel in Agana.
- ▲ Asan Bay in Asan.
- ▲ Bangi Island in Agat.
- ▲ Talofofo Bay and Togcha Bay in Talofofo.

The plant had been partially renovated to address problems caused when it was damaged in the 1993 earthquake. Additional work subsequently was performed, but two parts of the treatment system still aren't functioning, Lee said.

"I think the typhoon aggravated it, but the problem was already there," he said.

Guam Waterworks last week hired Detry Pumping Service, a local wastewater pumping company, to pump solid sewage out of the treatment units, keeping them clear for better treatment and preventing the material from escaping into the ocean.

The plant could be fully functioning after it is inspected and the additional equipment is brought on line. Johnston said yesterday he didn't know if the inspection has taken place yet.

The federal EPA could fine the authority for the ongoing sewage spill, but because the agency is making a good-faith effort to fix the situation, that isn't being considered now, Lee said.

"We know they're being pulled a lot of different ways as a result of this," he said. "It's been a long-term, longtime problem to get that plant back to the way it should be."

After the equipment is brought on line, it still will be a couple of weeks before the sewage will be treated to the level the federal EPA is requiring.

Johnston said yesterday he wasn't worried about the possibility of fines.

"My concern is the environment," he said. "I want to get this corrected as soon as possible."

Man arrested after attack on security guard

Pacific Daily News

A man who allegedly beat a Guam Premium Outlets security guard late Thursday night was arrested yesterday when he returned to the scene of the crime.

Police spokesman Larry Flores said the security guard was acquainted with Anthony S.A. Blas of Mangilao, who was arrested in connection with aggravated assault. Blas was later booked and released.

Blas apparently had asked the victim to fight, but the security guard refused, Flores said. Blas, 28, then grabbed a flashlight from his parked vehicle and struck the guard several times in the head and face, Flores said.

"The security guard managed to grab the flashlight from the suspect, who then fled on foot toward the back of the building," Flores said. The security guard's cuts were treat-

Figure 24

ND 1704

Pacific Daily News, Monday, February 23, 1998

NEWSTIP HOTLINE : Call *47*

e-mail: news@pdnguam.com

GUAM

Polluted beach warning

Samples taken by the Guam Environmental Protection Agency on Wednesday indicate that the following areas were polluted above acceptable bacteriological standards:

▲ Agat: Bangi Island and Namo Beach

▲ Talofofo: Talofofo Bay

▲ Dededo: Tanguisson Beach to Shark's Hole.

People are advised not to swim or fish in these waters. In addition, the public also is advised not to harvest or consume seaweed, fish or marine animals from Tanguisson Beach.

The Monitoring Laboratory Services Division of GEPA takes water samples every Wednesday to provide this service. For more information call 475-1658/9.

Pacific Daily News, Monday, March 16, 1998

Polluted beaches on EPA's hit list

Swimmers, fishermen and others are warned to avoid the following areas because of pollution:

▲ Agat: Namo Beach

▲ Asan: Asan Bay

▲ Tamuning: Dungca's Beach

▲ Dededo: Tanguisson Beach to Shark's Hole

Guam Environmental Protection Agency samples from those areas taken Wednesday indicate they were polluted above accepted bacteriological standards.

For more information contact the Monitoring Laboratory Services Division at 475-1664/5.

Pacific Daily News, Monday, February 9, 1998

Polluted beaches on EPA's hit list

Residents are advised not to swim, fish or play in the following areas:

▲ Agat: Bangi Island

▲ Talofofo: Talofofo Bay

▲ Dededo: Tanguisson Beach to Shark's Hole.

Tests by the Guam Environmental Protection Agency taken last Wednesday indicate the the waters in the above areas were polluted above accepted biological standards. In addition, no harvesting or consumption of seaweed, fish or marine organisms is allowed in Tanguisson.

Pacific Daily News

Clearing the record

We care about accuracy. If you would like to clear the record, call the Daily News at 477-9711, ext. 412.

Sewage 'particulates' float off Tanguisson

PDN 3/11/98

By Lalaine Estella
Pacific Daily News

Alarmed at finding solid waste floating off Tanguisson Beach yesterday, environmental and waterworks officials plan to conduct a dive inspection of the area on Friday.

For years, sewage from the Northern District Sewage Treatment Plant has spilled untreated from the plant's offshore pipes into the ocean. The pipes, or outfall, extends 1,000 feet out from the beach.

"A surveillance team went out (yesterday) to take surface samples of water emanating from the outfall," said Grace O. Garces, spokeswoman for the Guam Environmental Protection Agency. The bacteriological results won't be ready until tomorrow, she said.

"(But) according to the surveillance team, there are still solid particulates floating out there," Garces said. "It could be anything people put down their toilets and the plumbing system, including sewage," Garces said.

The beach area from the Tanguisson power plant to Shark's Hole remains on the agency's polluted recreational waters list. The public is urged not to swim or fish in the area.

The Guam Waterworks Authority plans to replace some pipes that carry treated sewage out to sea, but they won't be in place until the end of the year.

"The process in is progress," said utility spokesman Patrick Lujan, "The actual drilling (for the pipes) won't happen until next month. ... We're on target to meet our deadline."

Guam EPA and utility officials will conduct a dive inspection of the area on Friday. A similar inspection was scheduled in January but was canceled after officials saw what appeared to be floating sewage.

Guam EPA officials in the meantime have acquired special dive suits to safeguard inspectors in such polluted waters.

ND 1705

Impacts of Discharge

on

Recreational Activities

ND 1706

J

III.E. Impacts of Discharge on Recreational Activities

III.E.1. Describe the existing or potential recreational activities likely to be affected by the modified discharge(s) beyond the zone of initial dilution.

Fishing (shoreline: scuba, spear, net, rod and reel. Offshore: Boat; trolling and bottom fishing, scuba), swimming, snorkeling and diving.

III. E.2 What are the existing and potential impacts of the modified discharge(s) on recreational activities? Your answer should include, but not be limited to, a discussion of fecal coliform bacteria.

The results obtained from the biological and water quality monitoring the receiving waters indicate that the only potential impact on recreational activities would be from potential pathogens associated with the occurrence of high numbers of the indicator bacterial, fecal coliform. There have been no reports of illness resulting from recreational use of waters in the vicinity of the outfall

As previously stated, GWA has requested Letters of Determination from the Bureau of Planning, Department of Agriculture and Guam Environmental Protection Agency (See *State and Federal Laws*, Section II.D.4 of application questionnaire). Upon receipt of their letters, GWA will immediately forward their responses to your office. GWA is confident that the Letters of Determination from these agencies will show that no impact, i.e. no reported incidences of illness attributed to swimming in or consuming fish from the discharge area exist.

III.E.3. Are there any Federal, State, or local restrictions on recreational activities in the vicinity of the modified discharge(s). If yes, describe the restrictions and provide citations to available references.

Yes. Because of damage from Super typhoon Paka the Northern District treatment plant was with out power. Therefor untreated wastewater was been discharged. GEPA posted warnings to the public, not swim or fish in the waters in the vicinity of the outfall. See section III.D. for news paper clippings on these warnings.

III.E.4. If such restrictions exist, would such restrictions be lifted or modified if you were discharging a secondary treatment effluent

No these restrictions are only temporary.

Establishment of a Monitoring Program

ND 1708

III.F ***Establishment of a Monitoring Program***

III.F.1. Describe the biological, water quality and effluent monitoring programs which you propose to meet the criteria of 40 CFR 125.63. Only those scientific investigations that are necessary to study the effects of the proposed discharge should be included in the scope of the 301(h) monitoring program.

This section is divided into several parts. The first addresses the monitoring program of the existing outfall, both biological and water quality monitoring. The second addresses the monitoring of plant effluent. The third part addresses the baseline monitoring for the proposed outfall extensions. Once the location of the proposed extended outfalls is finalized new locations for the water quality and biological monitoring will be established. Water quality monitoring will include stations upcurrent and down current of the outfall, either side of the ZID (zone of initial dilution) and control stations at least 1000m upcurrent of the new outfall. Water quality stations will also include shoreline stations. The biological monitoring will be similar to what is outlined below, but will depend on final placement of the outfall. GWA will then work with EPA to design an appropriate biological monitoring plan. A proposed Quarterly Monitoring Program for the existing outfalls, and the proposed scope of work to obtain information needed to support the extension of the Agana WWTP and Northern District WWTP ocean outfalls, was faxed to USEPA September 9, 1997. They are described below. Also attached is the response letter from USEPA (dated: September 23, 1997).

1) QUARTERLY BIOLOGICAL MONITORING OF THE EXISTING GWA OCEAN OUTFALLS.

BIOLOGICAL MONITORING

Based on Design of 301(h) Monitoring Program for Municipal Wastewater Discharges to Marine Waters, EPA 430/9-82-010, November 1982 and Framework for 301(h) Monitoring Programs, EPA430/09-88-002, September 1987.

General Requirements

1) Conduct periodic surveys of biological communities most likely to be affected by the discharge and communities at reference sites.
2) Provide data to evaluate the impact of the discharge on marine biota.
3) Describe sampling and analytical techniques, sampling locations and schedules.
4) Surveys are to be conducted within the zone of initial dilution (ZID), and at a reference area unaffected by the discharge.

The monitoring objectives are translated into a series of testable hypotheses. These hypotheses focus the monitoring activities so that the studies are conducted efficiently and results are useful for evaluating statistically significant differences between areas. In most cases, multiple testable hypotheses will be required. One example of such a null hypothesis is that the abundance of corals does not differ between a sampling station within the ZID and a reference station.

Biomonitoring Techniques.

There are several technique use to obtain representative data on surface cover and species composition. I recommend using one of the below, or ideally a combination of both. A total of 20 replicates should be sampled at each station

1) Photograph permanently marked quadrats along 50 m transect, that runs parallel to shore, at each station. Photographs of at least $0.5m^2$ of the bottom should be taken at intervals along the transect. An underwater camera mounted on a rigid frame should be used. Each photograph should contain a small slate indicating the station, date, and position of the photograph along the line. To ensure that the same quadrat is photographed each quarter drive or cement stakes to the reef indicating at least two corners of each frame. Photographs should be developed as slides. These slides should be projected onto a grid having the same dimensions of the original quadrate, and the percent cover of living coral species, coralline algae, macro algae, turf algae, bare substrata and other organisms should be estimated.

2) Point quadrat sampling at each station, using a $0.5m^2$ quadrat that is subdivided by 4 evenly spaced lines in both directions, giving 16 intersecting points. Record what lies below each intersecting point for each replicate sample. Replicates should be randomly sampled.

Station Locations.

There should be at least two survey stations, one with in the ZID, and one at a reference site that is located in the opposite direction to the current. The selection of control or reference stations is important as all assessments of impacts will rely on comparisons made with the data from these locations. The stations should be located out side the traceable wastefield and not be affected by the wastewater discharge or other discharges. The monitoring stations for each discharge need to be at the same depth and approximately the same distance from shore.

Describe Community Structure.

Conduct at least quarterly surveys of the benthic flora and fauna each station.

- Percent coverage of the area should be quantified by breaking the cover down into six groups:
  - coral
  - macro algae
  - turf algae
  - coralline algae
  - bare substrate (dead coral, rubble, sand)
  - other (macro invertebrates, any foreign objects or material)

Note predominant species. Photographs of permanently marked quadrates are useful.

- Fish surveys should be conducted using timed visual counts at least by family categories. Several timed counts should be conducted at each site location. Reference depth, location and time period of each survey. From these counts provide a fish list.

Reports.

Compile quarterly reports the that discuss such aspects as station locations, sampling procedures, processing and analytical methods. Each report should include copies of field collection logs and laboratory sample counting forms. Data provided should include the actual numbers of each species or groups counted in each sample, and the calculated areal or volumetric abundance of each taxon. Sufficient detail should be provided to allow for verification of analyses conducted as part of the monitoring program, or for further analysis of the submitted data. Include data from each survey and analysis comparing the potentially impacted site(s) with the reference site(s). Provide an annual report that reviews all previous data, describe any naturally occurring phenomenon and conclusions as to the impact of the discharges on the surrounding community. Presentation of study results should include general characterization of the biological

communities sampled. Emphasis should be placed upon descriptions of spatial and temporal trends in community structure and function. Specific comparisons should be conducted for all biological criteria contained in the 301(h) regulations, (eg. ZID boundary vs reference communities).

WATER QUALITY MONITORING

GWA staff has been conducting water quality monitoring for the Northern District WWTP receiving water in accordance with the NPDES permit No. GU0020141. See attachment 1. indicating parameters to be measured and frequency of monitoring. A map of the site locations can be found in section II.B, figure 4. This monitoring program will continue as is until advised otherwise by EPA.

2) INFLUENT AND EFFLUENT MONITORING

Monitoring is conducted by GWA staff in accordance with NPDES permit requirements (Permit No. GU0020141). Monitoring parameters, limits and frequencies are outlined in attachment 2. Monitoring results are submitted to USEPA a via routine quarterly compliance report known as the Discharge Monitoring Report (DMR). The DMR summarizes the quality and/or quantity of the discharge, and compares sampling results to the discharge limitations authorized by the NPDES permit.

Toxic pollutant scans are included in this application and will be conducted annually or as otherwise stipulated in the permit.

3) PROPOSED SCOPE OF WORK FOR SUPPORT FOR OCEAN OUTFALL EXTENSIONS

The following is the *proposed scope of work* to obtain information needed to support extending the sewage outfalls for the Agana and Northern District WWTPs and their corresponding 301(h) applications due April 4, 1998.

1. Bathymetery of seafloor, from the reef crest out to the area surrounding the proposed outfall diffusers.

2. Hydrodynamic studies at the proposed outfall sites, in the nearfields and farfields to determine current and wind regimes, as well as stratification depths at each location.
These studies should include:
- current meter mooring
- dye and drogue releases
- continuous temperature-salinity-dissolved oxygen profiles

3. Baseline monitoring. This should include water quality data, community structure: quantitative information on the benthic flora and fauna, and sediment quality in the area of the proposed discharges.

a. *Water quality.* Collect quarterly data for at least four locations equally spaced around each of the proposed diffuser sites. (surface, mid and bottom depths).

these surveys must include:

- site location, and sample depth
- microbiology (fecal coliform / 100 ml)
- pH
- orthophosphate
- nitrate-nitrogen
- dissolved oxygen
- salinity
- total filterable suspended solids
- turbidity
- temperature
- oil & petroleum products

b. *Community structure.* Conduct quarterly survey of the benthic flora and fauna of the area of the proposed discharges that *quantify* coral, algae, macroinvertebrate and fish communities as follows:

- Provide a species list of flora and fauna, indicating abundance, (*i.e. rare, common, abundant etc.)* identifying predominant species.
- Percent coverage of the area should be quantified by breaking the type of cover down into six groups:
  - coral
  - macro algae
  - turf algae
  - coralline algae
  - bare substrate (dead coral, rubble, sand)
  - other (macro invertebrates, any foreign objects or material)
- Fish surveys done using timed visual counts at least by family categories, for at least four locations equally spaced around each of the proposed diffuser sites. Reference: depth, location and time period of each survey. Compile a report that includes the data from each survey, and a fish species list.

c. *Sediment samples.* Uniform, replicate grabs at four sites equally spaced surrounding each of the proposed diffuser sites should be obtained for analysis of :

- grain size
- total organic carbon
- total Kjeldahl nitrogen
- total phosphorus
- total sulfide
- priority pollutants
- infauna

See *Procedures for Handling and Chemical Analysis of Sediment and Water Samples,* EPA/CE-81-1 and see protocol in EPA's guidance document *Quality Assurance and Quality Control (QA/QC) for 301(h) Monitoring Programs: Guidance on Field and Laboratory Methods.*

Because of the deep depths, diving these sites may not be feasible and surveys may need to be done using remote equipment. All site and sample locations, depths, dates of collection, and methodology needs to be recorded. It is important that the data gathered be quantitative. The monitoring surveys 3a, 3b and 3c will need to be conducted again at a later date, after the outfalls have been constructed and are discharging.

III. F.2. Describe the sampling techniques, schedules, and locations, analytical techniques, quality control and verification procedures to be used.

Influent and effluent sample are obtained weekly by WWTP operators using composite and discrete sampling methods outlined in the NPDES permit. Characteristics investigated are: flow (mgd), BOD, suspended solids, settleable solids, pH, and oil and grease. Analysis is run in accordance with the Standard Methods for the Examination of Water and Wastewater. The forms used to record the influent and effluent characteristics are attached, along with a description of the sampling points. The GWA laboratory participates in the USEPA annual laboratory performance evaluation, and runs standard and checks along with routing samples. GWA will work with EPA to establish a split sampling and/or oversite plan to ensure the quality of the sample analysis.

III.F.3. Describe the personnel and financial resources available to implement the monitoring programs upon issuance of a modified permit and to carry it out for the life of the modified permit.

The monitoring program is implemented by GWA's Laboratory Support Services staff. GWA has an annual budget for the activities of these personnel and the laboratory facilities to conduct their work. The agency has its own boat, a 23-foot Sea Ox, which is used for the receiving water quality and biological monitoring. Other essential equipment owned by the laboratory include, but is not limited to, various meters (DO, pH, salinity), BOD incubators, Van Dorn samplers, muffle furnace, drying ovens, dessicators, and SCUBA equipment.

Adequate staffing is a dilemma. However, effective time management practices allow laboratory personnel to conduct the required monitoring activities for both water and wastewater systems. The laboratory personnel include a chemist, a biologist, a laboratory technician supervisor, and four laboratory technicians. Three of the laboratory personnel are certified divers and the technicians are certified as water treatment operators and/or water distribution operators. The agency is in the process of acquiring another biologist and an additional technician in order to meet the demanding biological monitoring requirements.

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

SEP 23 1997

Richard A. Quintanilla
General Manager
Guam Waterworks Authority
P.O. Box 3010
Agana, Guam 96910

Re: Agana and N. District STP

Dear Mr. Quintanilla:

This is in regards to your letter dated September 9, 1997, transmitting Guam Waterworks Authority's (GWA) draft Scope of Work for the Baseline Surveys to support the proposed extension of the Agana and Northern District Sewage Treatment Plants (STP) ocean outfalls.

We approve of the approach of the proposed Scope of Work for the Baseline Surveys relating to the proposed ocean outfall extensions. The Scope of Work appears comprehensive and should provide the necessary information to support GWA's proposed placement of both the Agana and Northern District's ocean outfalls as we discussed in our letter dated June 18, 1997.

We would also like to mention that we have received a fax copy of the proposed Scope of Work for Quarterly Biomonitoring of the existing Agana, Northern District and Agat STPs from Ms. Joanne Boyd, Biologist, GWA Monitoring Services Laboratory, dated September 10, 1997. Ms. Boyd has also put together a comprehensive proposed Scope of Work for quarterly biomonitoring. Although we have indicated to GWA the need for re-establishing biological monitoring at the existing outfalls in accordance with NPDES permit requirements we hereby request that GWA perform a statistical analysis using the existing biological data collected in place of developing and implementing the proposed biological monitoring plan at this time. GWA's statistical analysis of the existing biological data shall be submitted as part of the reapplications for the Agana and Northern District STPs. The analysis should look into whether the biological data shows a significant change or impact over time.

With respect to monitoring at the existing ocean outfalls receiving water quality monitoring at all three respective outfalls shall be continued, as required, at this time. We will be available to further discuss and comment on monitoring plan specifics once we know actual ocean outfall locations and other area characteristics.

ND 1714

With regard to the Agat STP we need to receive an official response from GWA regarding the type of NPDES permit renewal GWA will be seeking for the facility. GWA needs to clearly indicate if they will be pursuing a NPDES permit renewal for meeting secondary treatment requirements or applying for a waiver from meeting secondary treatment requirements under Section 301(h) of the Clean Water Act. Failure to respond in a timely and appropriate manner will result in us taking further actions and may result in us initiating actions similar to those taken with the Agana and Northern District 301(h) NPDES permit renewals.

If you have any further comments regarding this matter, please contact Mike Lee at (415) 744-1484 or Lily Lee at (415) 744-1592.

Sincerely,

Norman L. Lovelace
Program Manager
Pacific Insular Area Program

cc: T. Quan, GWA
H. Johnston, GWA
J. Boyd, GWA
J. Salas, GEPA
N. Custodio, GEPA

ND 1715

Effects of Discharge

in

Other Point and Non-Point Sources

ND 1716

III.G Effect of Discharge on Other Point and Nonpoint Sources

III.G.1. Does (will) your modified discharge(s) cause additional treatment or control requirements for any other point or nonpoint pollution source(s)?

There are no other pollution discharges within GWAs current outfall impact area or the proposed outfall extension discharge impact area.

III.G.2. Provide the determination required by 40 CFR 125.64(b) or, if the determination has not yet been received, a copy of a letter to the appropriate agency(s) requesting the required determination.

As previously stated, GWA has requested Letters of Determination from the Bureau of Planning, Department of Agriculture and Guam Environmental Protection Agency (See *State and Federal Laws*, Section II.4.D. of application questionnaire). Upon receipt of their letters, GWA will immediately forward their responses to your office.

Toxics Control Program

and

Urban Area Pretreatment Program

ND 1718

III. H. Toxics Control Program and Urban Area Pretreatment Program [40 CFR 125.65 and 125.66]

III.H.1. a. Do you have any known or susupected industrial sources of toxic pollutants or pesticides?

Guam has very little or no heavy industry and we have no suspected industrial sources of toxic pollutants or pesticides. However, we are waiting on responses from the industrial user surveys that were sent out on March 27, 1998. GWA remains optimistic that the resulting survey summary along with the *Priority Pollutant Scan* results will demonstrate concurrence with the previous statement.

b. If no, provide the certification required by 40 CFR 125.66(c)(2) for large discharges.

Must certify this fact based on the results of an industrial waste survey

c. Provide the results of wet and dry weather effluent analysis for toxic pollutants and pesticides as required by 40 CFR 125.66(a)(1).

Twenty four hour composite effluent samples were taken at the Northern District Wastewater Treatment Plant starting on the 8 th day of March, 1998, and Agana Wastewater Treatment Plant starting on the 9 th day of March, 1998. Samples have been sent off island for analysis at the Montgomery Watson Laboratories, and results are expected back mid April. These will be forwarded to you once received.

d. Provide analysis of known or suspected industrial sources of toxic pollutants and pesticides identified in 1(c) above in accordance with 40 CFR 125.66(b).

Pending results of effluent analysis for toxic pollutants and pesticides.

III.H.2. a. Are there any known or suspected water quality, sediment accumulation, or biological problems related to toxic pollutants or pesticides from your modified discharge?

b. If no provide the certification required by 40 CFR 125.66(d)(2) together with available supporting data.

c. If yes, provide a schedule for the development and implementation of nonindustrial toxics control programs to meet the requirements of 40 CFR 125.66(d)(3).

d. Provide a schedule for the development and implementation of nonindustrial toxics control programs to meet the requirements of 40 CFR 125.66(d)(3).

Nonindustrial source control program. (1) The applicant shall submit a proposed public education program designed to minimize the entrance of nonindustrial toxic pollutants and

pesticides into its POTW(s) which shall be implemented no later than 18 months after the issuance of a 301(h) modified permit.

(3)The applicants nonindustrial source control programs under paragraph (d)(2) of this section shall include the following schedules which are to be implemented no later than 18 months after the issuance of a 301(h) modified permit:
(i) A schedule of activities for identifying nonindustrial sources of toxic pollutants and pesticides; and
(ii) A schedule for the development and implementation of control programs, to extent practicable, for nonindustrial sources of toxic pollutants and pesticides.

III.H.3. Describe the public education program you propose to minimize the entrance of nonindustrial toxic pollutants and pesticides into your treatment system [40 CFR 125.66(d)(1)]

applicants for reissued 301(h) modified permits must have a public education program in place. Newspaper articles, poster, or radio and television announcements to increase public awareness of the need for proper disposal of waste oils, solvents, herbicides, pesticides and other substances that contain toxic pollutants.

The following schedule is GWA's plan of action to increase public awareness:

Action	Date
Mail out industrial user survey	Mar, 1998
Compile and analysis survey results	May, 1998
Publish results and their impacts in the local newspaper (PDN)	Jun, 1998
Investigate and identify significant toxic pollutant contributors	Jul, 1998
Establish programs i.e., posters, newspaper articles, radio/TV, etc. to advise public on proper disposal	Sep, 1998
Periodically publish or use electronic media to maintain public awareness previously established	Quarterly commencing December 1998

III.H.4. Do you have an approved industrial pretreatment program (40 CFR 125.66(c)(1)?

No. Have no known or suspected industrial sources of toxic pollutants. This status may change upon receipt of the user survey and toxic pollutant analysis.

a. If yes, provide the date of EPA approval.

b. If no, and if required by 40 CFR Part 403 to have an industrial pretreatment program, provide a proposed schedule for development and implementation of your industrial pretreatment program to meet the requirements of 40 CFR Part 403.

May not be needed

III.H.5. Urban area pretreatment requirement [40 CFR 125.65]
Discharges serving a population of 50,000 or greater must respond.

a. Provide data on all toxic pollutants introduced into the treatment works from industrial sources (categorical and noncategorical).

b. Note whether applicable pretreatment requirements are in effect for each toxic pollutant. Are industrial sources introducing such toxic pollutants in compliance with all of their pretreatment requirements? Are the pretreatment requirements being enforced? [40 CFR 125.65(b)(2)]

c. If applicable pretreatment requirements do not exist for each toxic pollutant in the POTW effluent introduced by industrial sources,

- ***provide a description and a schedule for your development and implementation of applicable pretreatment requirements [40 CFR 125.65(c)], or***

- ***describe how you propose to demonstrate secondary removal equivalency for each of those toxic pollutants, including a schedule for compliance, by using a secondary treatment pilot plant. [40 CFR 125.65(d)].***

Dependant on industrial user survey and toxic pollutant analysis. Used to characterize industrial sources by type, and types and concentrations of toxic pollutants in discharges, and flow into the plant.

Review and Analysis

Past Biological Monitoring Data

Northern District WWTP Outfall

N

ND 1722

REVIEW AND ANALYSIS OF PAST BIOLOGICAL MONITORING DATA FOR THE NORTHERN DISTRICT WASTEWATER TREATMENT PLANT OUTFALL, GUAM.

by

JOANNE BOYD,

BIOLOGIST III,

GUAM WATERWORKS AUTHORITY

JANUARY 1998

ND 1723

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INTRODUCTION

The Northern District Wastewater Treatment Plant discharges primary treated effluent through an ocean outfall into the coastal waters beyond the reef, on the leeward side of Guam at Tanguisson Pt. The outfall is located at latitude 13°33' 7.36", longitude 144°48' 24.03", and consists of twenty three (23) diffusers spaced along a 129 m length of pipe. The diffusers run parallel to the shore, at a depth of 18.29 m (60 ft) and are approximately 300 m from the shoreline.

Jones and Randall, 1973 conducted a preliminary reef survey for the Northern District Sewage System before the existing outfall was constructed. They noted that the submarine terrace where the current outfall is located was fairly uniform and that former coral growth was extensively developed on the terrace prior to the 1968-1969 Acanthaster planci infestation, which killed 90% to 99% of the living corals. Coral recolonization was starting to take place, but at a slow rate, and the percent coverage by living coral was 2% to 10%.

GWA contracted the University of Guam (UOG), Marine Laboratory, to conduct the Biological Monitoring of the three WWTP ocean outfalls, including the Northern District outfall. Surveys were conducted quarterly, with quarterly reports and yearly summaries submitted to GWA (then PUAG). Surveys were conducted from August 1989 until September 1994.

The data provided in the UOG Marine Laboratory quarterly reports were reviewed and analyzed by the GWA biologist. Regression analysis was performed to test if there was any significant change in percent coverage of each of six benthic categories or in fish species diversity over the 5 year survey period.

METHODS

Qualitative observations were made to determine the benthic composition and fish diversity in the area. Benthic cover was surveyed along three 10 m transects that ran parallel to shore and were permanently marked for long term monitoring. The first transect was located immediately at the diffusers (0 m) and the other two at 20 m and 50 m distances from the diffusers towards the shore (Figure 1). The transects were therefore at progressively shallower depths. However, the individual transect depths are unknown. The types of benthic cover were recorded along each transect using the chain-link transect method. The types of substrate were later grouped into 6 categories to facilitate data analysis, and percent cover was estimated. These groups are;

1) BARE: bare substrate is non-living surface which can either be attached or loose. This category includes sand, gravel, cobble, dead coral, and limestone pavement.
2) TURF: any substrate type which is covered by an unidentified turf algae. Turf algae are <1 cm in height.
3) MACRO ALGAE: any large fleshy algae (>1 cm). Includes chlorophytes, phaeopytes, fleshy rhodophytes and blue-greens.
4) CORALS: living corals of any taxonomic group
5) CORALLINES: coralline algae.
6) OTHERS: other live sessile organisms: sponges, ascidians, vermetid molluscs, etc.

Fish surveys were done by a diver who swam the 50 meter line connecting each of the three transects and recorded the species types. The number of fish in each species were not recorded. The reports did not state whether the fish observations were restricted to a certain distance either side of the 50 m line or whether it was a timed observation.

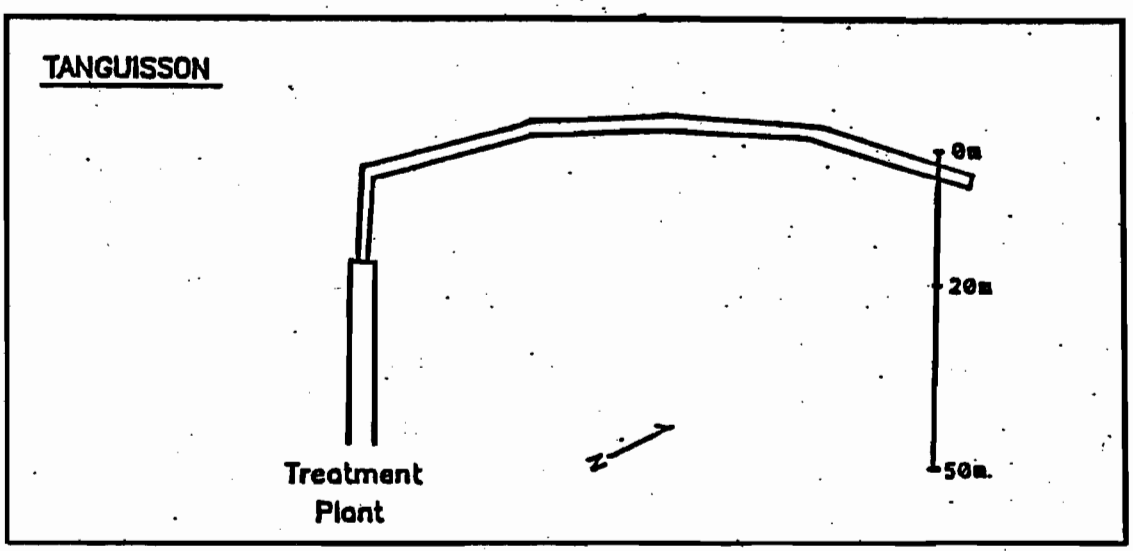

Figure 1. Location of the Biological Monitoring Transects. Sample stations located at 0, 20, and 50 meters.

RESULTS

In the first biological monitoring report, March 1990, which included results from August 1989 and November 1989 surveys, the Tanguisson study area was reported to have a high percent of coral cover. The 20 m and 50 m transects crossed portions of a well established colony of Porites lutea, a massive polymorphic species, with the majority of the remaining area being dominated by turf algae. The 0 m transect had little live coral cover and was dominated by turf algae. They concluded that macro-invertebrates were less abundant but more varied at the Tanguisson and Agana outfall sites than at the Agat outfall site. This larger diversity was attributed to the presence of deep water/low energy habitat species. Invertebrates commonly found in the area are seacucumber Holothuria atra, H. noblis, Stichopus chlorotus, and Bohadschia argus. The Asteroidea included Linka laevigata, L. guildingi, Culcita novaeguinea, and Acanthaster planci. Also present was the gastropod Trochus niloticus and the soft corals Sinularia spp. and Sacophyton spp. Species of fish found at Tanguisson were representative of these coral habitats. Large schools of herbivores (Acantruridae) and filter feeding or planktivorous fishes (i.e. Kyposidae) were often seen directly in the plume.

The results of percent cover by each of the six categories, August 1989 to September 1994, are summarized in Table 1, along with the numbers of recorded fish and invertebrate species. The highest percent cover is bolded. The list of recorded benthic species and their percent cover for each survey date are given in the appendix.

Results from the surveys indicate that the benthic cover along the 0 m transect (Fig. 2) was predominated by bare substrate on 10 of 17 sample dates, and turf algae on 7 of 17 dates. In general turf algae predominated up until mid 1991, after which bare substrate became the most predominant

Table 1. Survey of Benthic Community (percent cover) at three transect locations, including fish and invertebrate counts across the transects at the Northern District WWTP Outfall.

Date	Bare	Turf Algae	Macro Algae	Corals Live	Coralline Algae	Other
0 m						
8/25/89	13.1	75.1	1.7	4.7	5.5	0.0
11/14/89	10.0	81.0	3.1	3.9	2.0	0.0
4/2/90	8.3	83.4	4.6	4.3	0.0	0.0
6/13/90	11.7	79.5	4.6	4.3	0.0	0.0
9/24/90	23.4	72.3	0.0	3.5	0.0	0.8
12/11/90	23.4	72.2	0.5	3.6	0.0	0.0
5/20/91	92.1	4.6	0.0	1.3	1.7	0.4
7/27/91	10.6	74.6	0.8	7.8	6.2	0.0
12/27/91	68.9	26.6	3.9	0.5	0.0	0.0
3/19/92	76.3	11.6	11.8	0.3	0.0	0.0
8/6/92	52.4	42.2	4.5	0.7	0.0	0.0
12/4/92	82.5	14.6	0.3	2.2	0.5	0.0
3/30/93	79.7	8.3	2.7	8.3	0.9	0.0
8/17/93	83.4	7.0	1.7	5.8	2.1	0.0
1/10/94	71.3	10.8	0.6	16.4	0.9	0.0
5/27/94	86.1	5.8	0.0	7.8	0.3	0.0
8/28/94	47.1	14.7	0.5	32.2	5.5	0.0
20 m						
8/25/89	7.5	38.2	3.7	42.0	7.2	1.5
11/14/89	4.9	50.5	1.3	31.1	10.0	2.2
4/2/90	5.2	59.8	2.0	32.0	1.2	0.0
6/13/90	0.0	67.8	0.9	31.3	0.0	0.0
9/24/90	0.0	49.2	0.0	50.8	0.0	0.0
12/11/90	35.7	3.8	2.9	31.2	0.0	0.1
5/20/91	22.2	34.0	6.2	34.3	3.3	0.1
7/27/91	0.3	32.5	3.9	62.6	0.0	0.7
12/27/91	16.4	73.8	4.5	5.3	0.0	0.0
3/19/92	64.6	4.2	8.2	23.0	0.0	0.0
8/6/92	28.0	15.1	6.8	39.3	9.4	1.0
12/4/92	14.5	50.3	10.4	21.9	2.2	0.6
3/30/93	4.3	40.0	3.0	49.4	2.2	1.0
8/17/93	68.0	1.6	3.0	18.3	9.1	0.0
1/10/94	52.5	15.7	4.8	20.8	5.3	0.9
5/27/94	20.0	62.0	3.9	1.6	3.0	3.0
8/28/94	23.8	7.8	1.0	61.4	6.0	0.0
50 m						
8/25/89	9.0	46.6	2.5	37.4	4.1	0.7
11/14/89	8.8	63.4	0.4	28.4	0.0	0.0
4/2/90	20.4	45.3	2.9	29.6	1.8	0.0
6/13/90	15.2	44.2	5.4	35.2	0.0	0.0
9/24/90	13.4	37.9	0.3	48.2	0.0	2.3
12/11/90	4.2	39.7	1.2	47.5	0.0	0.0
5/20/91	8.5	39.4	1.8	48.0	0.8	1.6
7/27/91	5.3	60.1	1.7	19.7	8.9	4.3
12/27/91	6.6	70.7	1.3	21.4	0.0	0.0
3/19/92	6.3	60.3	5.9	25.8	1.7	0.0
8/6/92	16.3	53.4	1.3	21.6	5.9	1.1
12/4/92	80.9	8.8	1.0	9.0	0.1	0.2
3/30/93	68.7	1.3	0.0	30.0	0.0	0.0
8/17/93	74.4	5.5	4.4	13.9	1.8	0.0
1/10/94	68.8	1.3	8.9	20.5	0.5	0.0
5/27/94	72.3	1.6	4.1	22.0	0.0	0.0
8/28/94	43.4	15.0	0.1	40.5	1.0	0.0

Date	Fish	Invertebrates
8/25/89	44	2
4/2/90	38	10
6/13/90	41	
9/24/90	48	4
12/11/90	44	4
5/20/91	65	8
7/27/91	67	10
12/27/91	89	6
3/19/92	56	8
8/6/92	55	9
12/4/92	51	8
3/30/93	43	10
8/17/93	49	10
1/10/94	42	10
5/27/94	36	10
8/28/94	42	9

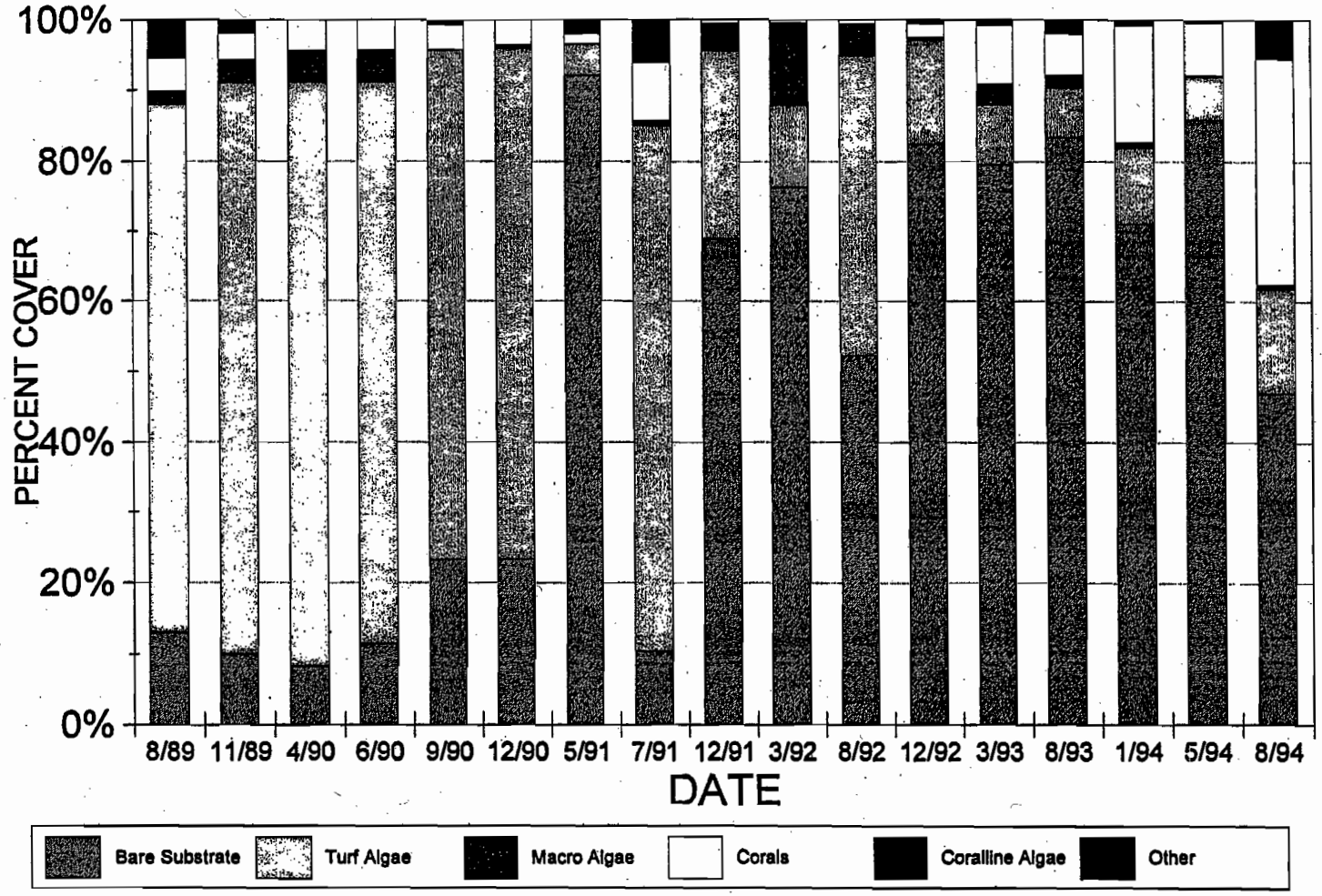

Figure 2. Benthic cover along the 0 meter transect.

ND 1732

cover. The 20 m transect (Fig. 3) had a very different benthic composition from that of the 0 m transect. Cover was predominated by three categories, live coral on 7 of 17 survey dates, turf algae on 6 of 17 dates and bare substrate on 4 of 17 dates. Percent cover by each of the two most predominant groups was similar and there did not appear to be a large shift from one predominant cover to another as seen in the 0 m transect. The percentage cover by live coral was in general quite high ranging from approximately 20 to 60 percent, except for two occasions when it was recorded at less than 6 percent. Turf algae ranged from 1.6 to 74 percent, and had a cover of greater than 15 percent 13 of 17 survey dates. Bare substrate had greater than 15 percent cover on 9 of 17 survey dates. The 50 m transect (Fig. 4) had similar benthic cover to the 20 m transect, in that it was predominated by the same three benthic groups, turf algae (8 out of 17 dates), bare substrate (6 out of 17 dates) and coral (3 out of 17 dates). In general, the benthic cover was equally predominated by live coral and turf algae, together making up greater than 75 percent of the cover. However, from the December 1992 survey until the last survey in August of 1994 the predominant cover was bare substrate, ranging from 40 to 80 percent. Live coral cover remained fairly constant around 20 to 50 percent, turf algae decreased after December 1992, from an average of 51 percent to an average of 6 percent. For all of the transects macro algae, coralline algae and other cover, each made up only a small percentage of the total benthic cover (average <5 percent)

Not all of the changes in percent cover for each of the categories were significant. The results of the regression analysis are summarized in Table 2. Significant changes (S) are at the 95% confidence level. There was a significant increase in percent coverage by bare substrate over the 5 year period along all three of the transects. There was also a significant increase in percent cover of live coral along the 0 m transect and a significant reduction in the percent cover of turf algae along

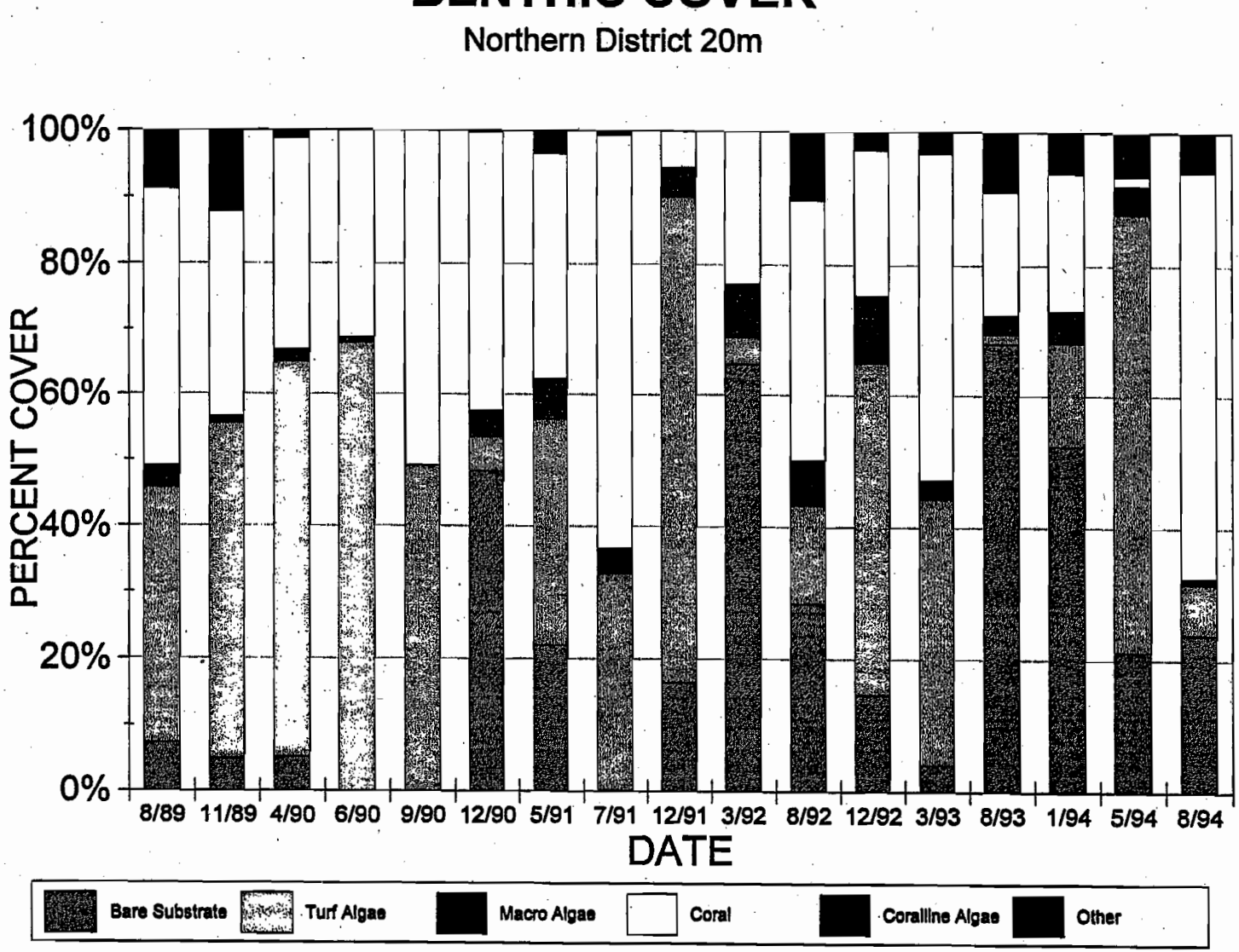

Figure 3. Benthic cover along the 20 meter transect.

ND 1734

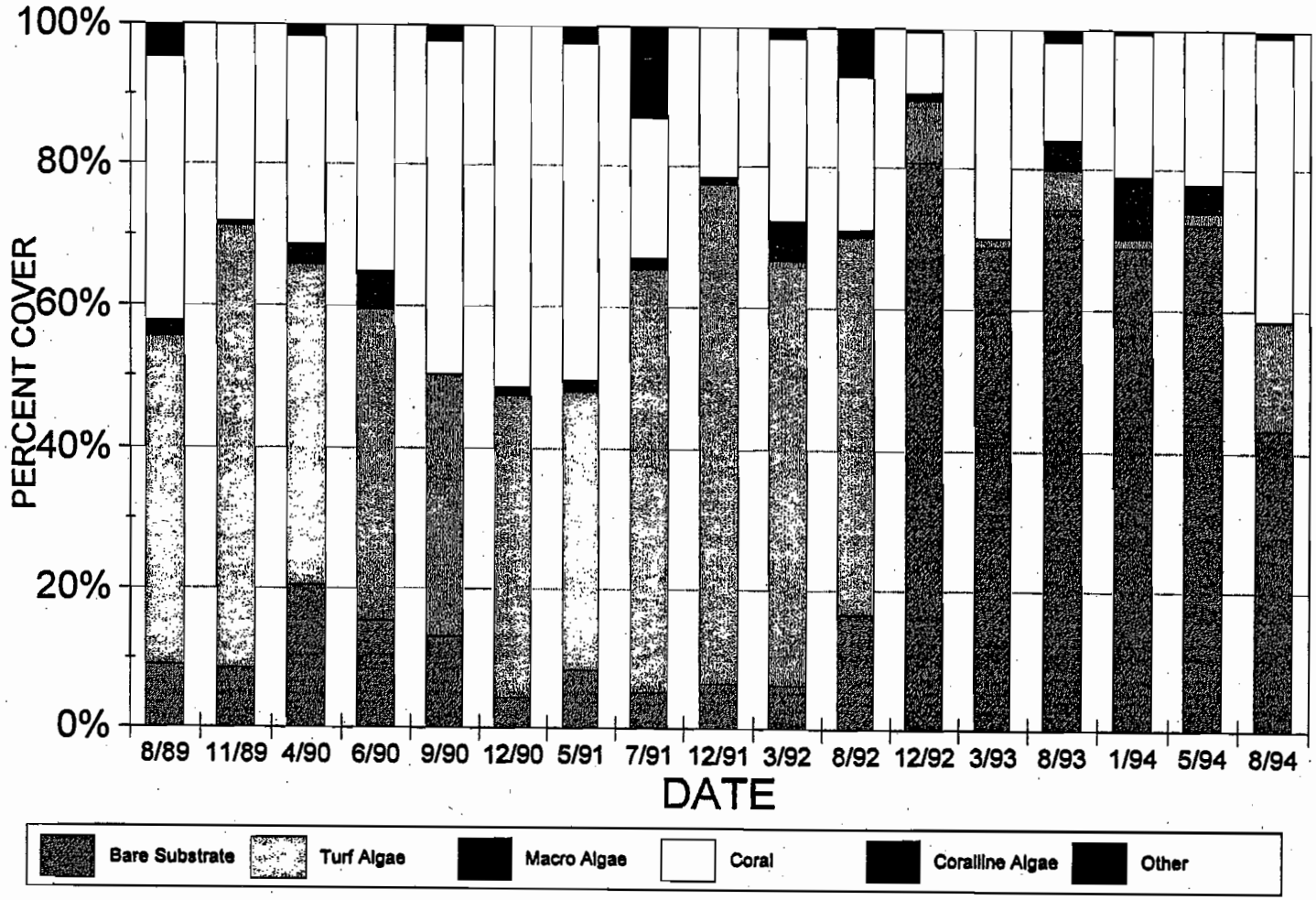

Figure 4. Benthic cover along the 50 meter transect.

Table 2. Regression analysis results for Northern District. Significance of change in % cover of the six benthic categories over the 61 months that the area was surveyed.

Transect	Bare	Turf Algae	Macro Algae	Coral	Coralline	Other
0 m	+s	-s	-	+s	+	-
ts	4.072	5.805	-0.699	2.653	0.047	-0.995
20 m	+s	-	+	-	+	+
ts	2.23	-1.52	1.02	-0.72	0.65	0.4
50 m	+s	-s	+	-	-	-
ts	3.361	-3.842	0.854	-1.78	-0.434	-0.903

ts 0.05[15] =2.131
s = significant at 95%
+ = positive regression
- = negative regression

the 0 m and 50 m transects. All other changes in percent cover were determined to be non-significant. A significant increase in the percent cover by bare substrate can be seen in Figure 5. The percent coverage by turf algae is seen to decrease along all of the transects, but was only significant for the 0 m and 50 m transects (Fig. 6) and coincided with the increase in bare substrate. The changes in percent cover for macro algae increased along the 20 m and 50 m transects and decreased along the 0 m transect, but these changes were not significant (Fig. 7). There was a non significant decrease of macro algae cover along the 0 m transect. Coral cover significantly increased along the 0 m transect. However, the percentage of coral cover along the 0 m transect was considerably lower than that of the 20 m and 50 m transects. Coral cover along the 20 m and 50 m transects had an overall non-significant decrease. The highest percent cover by coral for all transects was recorded on the last survey date, September 1994 (Fig. 8). The percent cover by coralline algae did not change significantly for any of the transects (Fig. 9), and there was also no significant changes in other cover (Fig. 10).

A fish species list arranged by Family is given in Table 3. The shaded boxes represent the presence of that species when the survey was conducted. There was no significant change in fish species diversity over the 5 year period that biological monitoring was conducted,. The number of species present in each trophic level remained relatively consistent through out this period and are representative of other coral reef fish communities around Guam (personal communication, Dr. Steven Amesbury, Prof. Ichthyology, UOG Marine Laboratory).

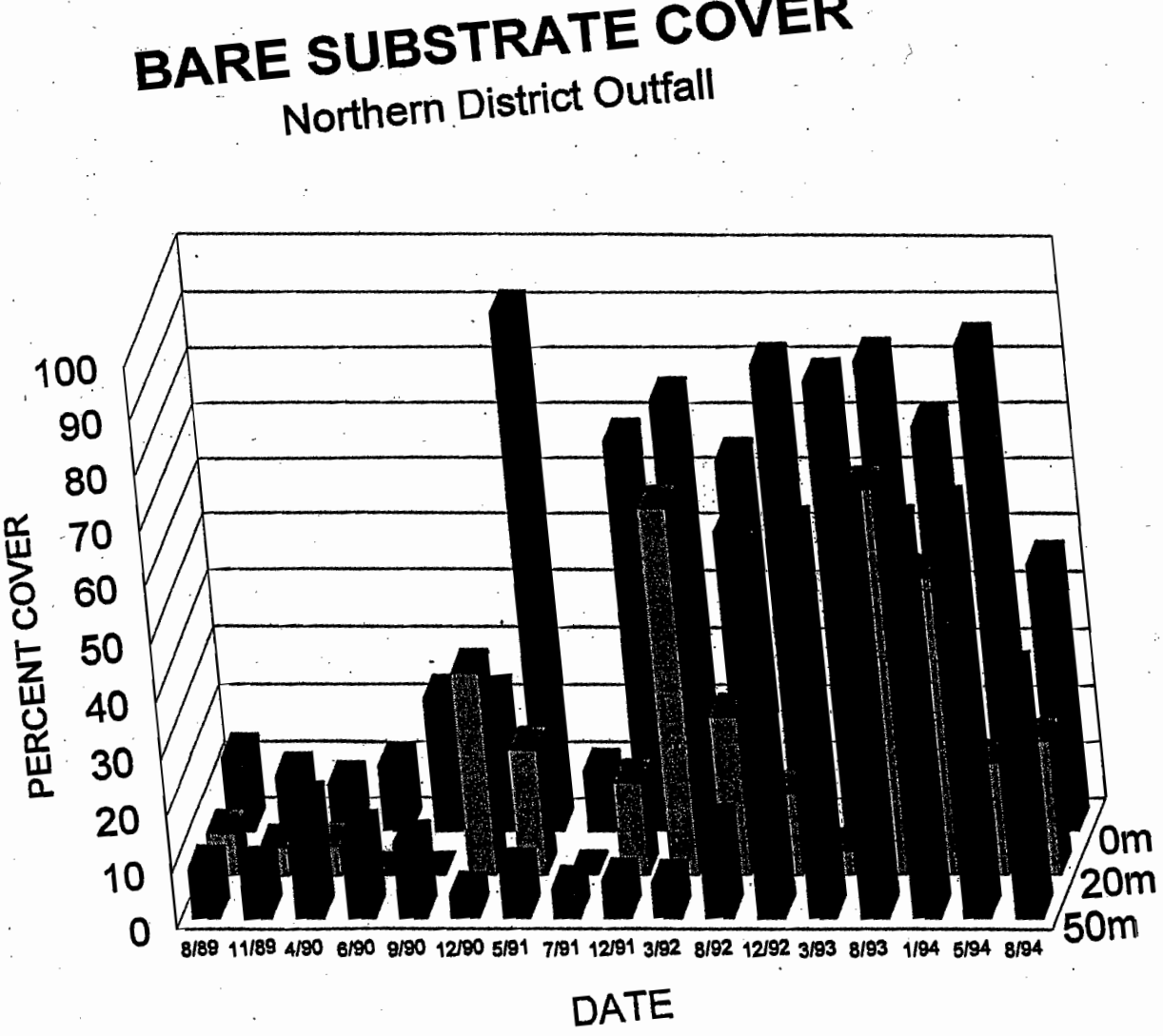

Figure 5. Bare substrate cover along the 0, 20 and 50m transects

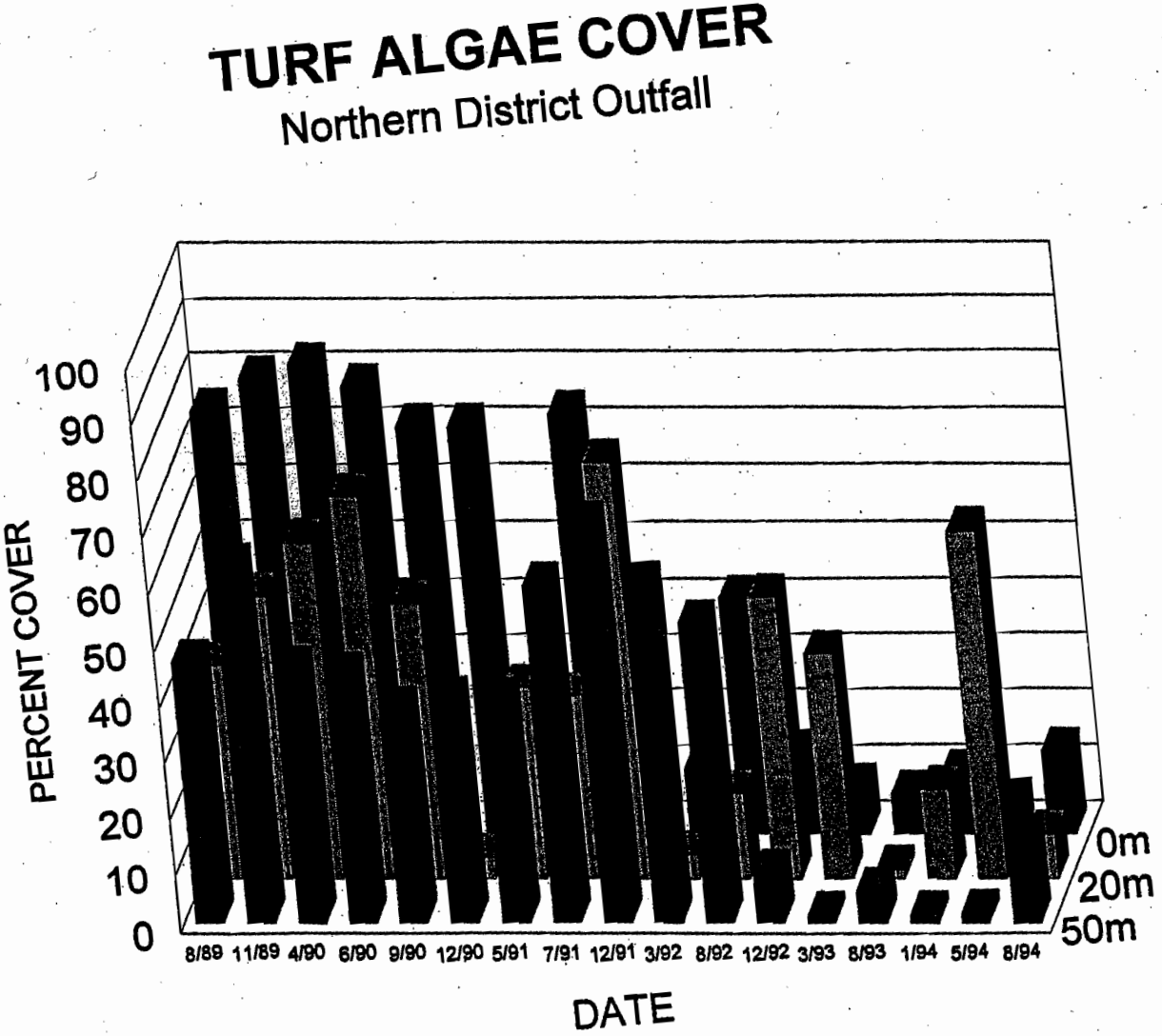

Figure 6. Turf Algae substrate cover along the 0, 20 and 50m transects

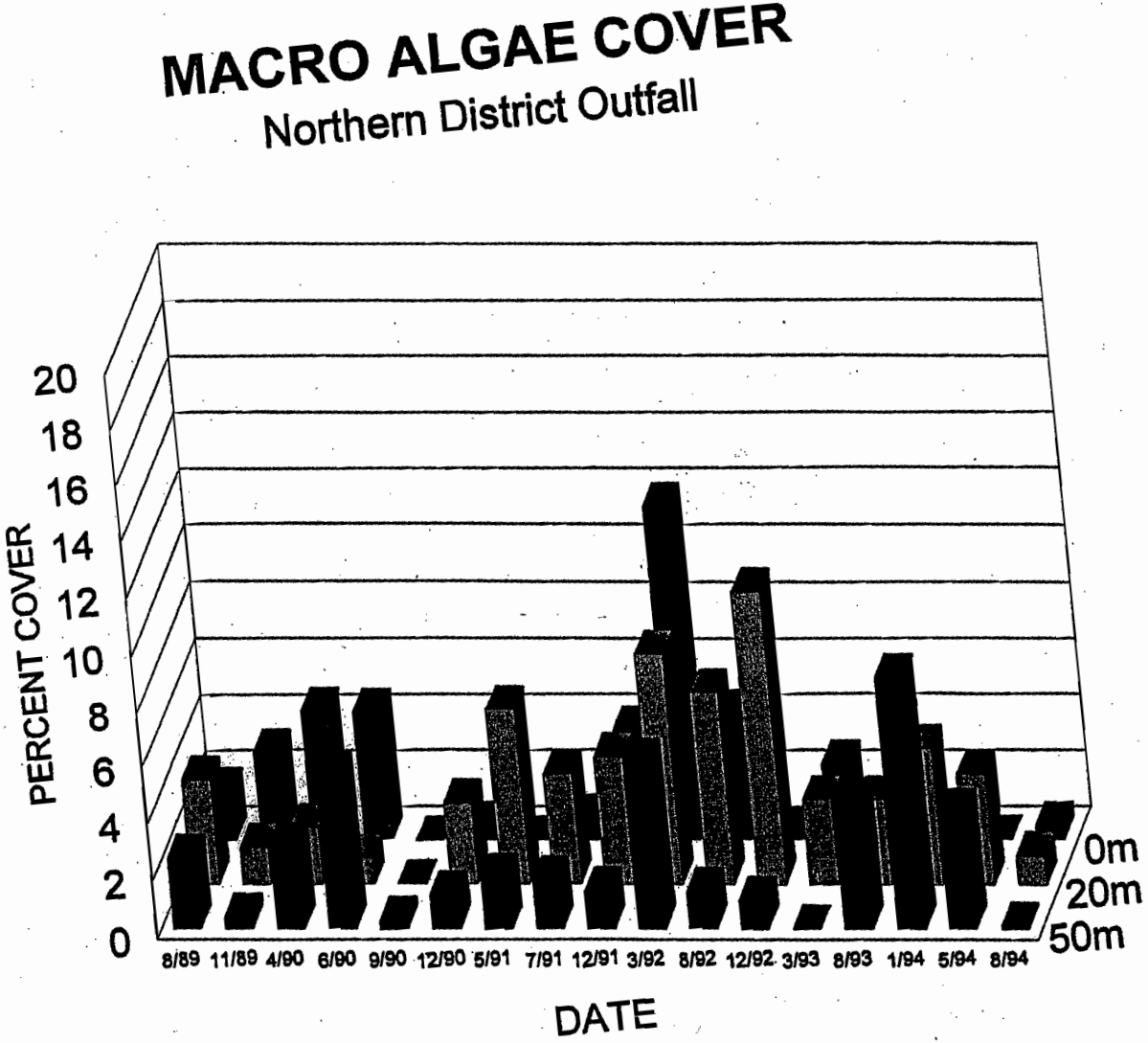

Figure 7. Macro Algae substrate cover along the 0, 20 and 50m transects

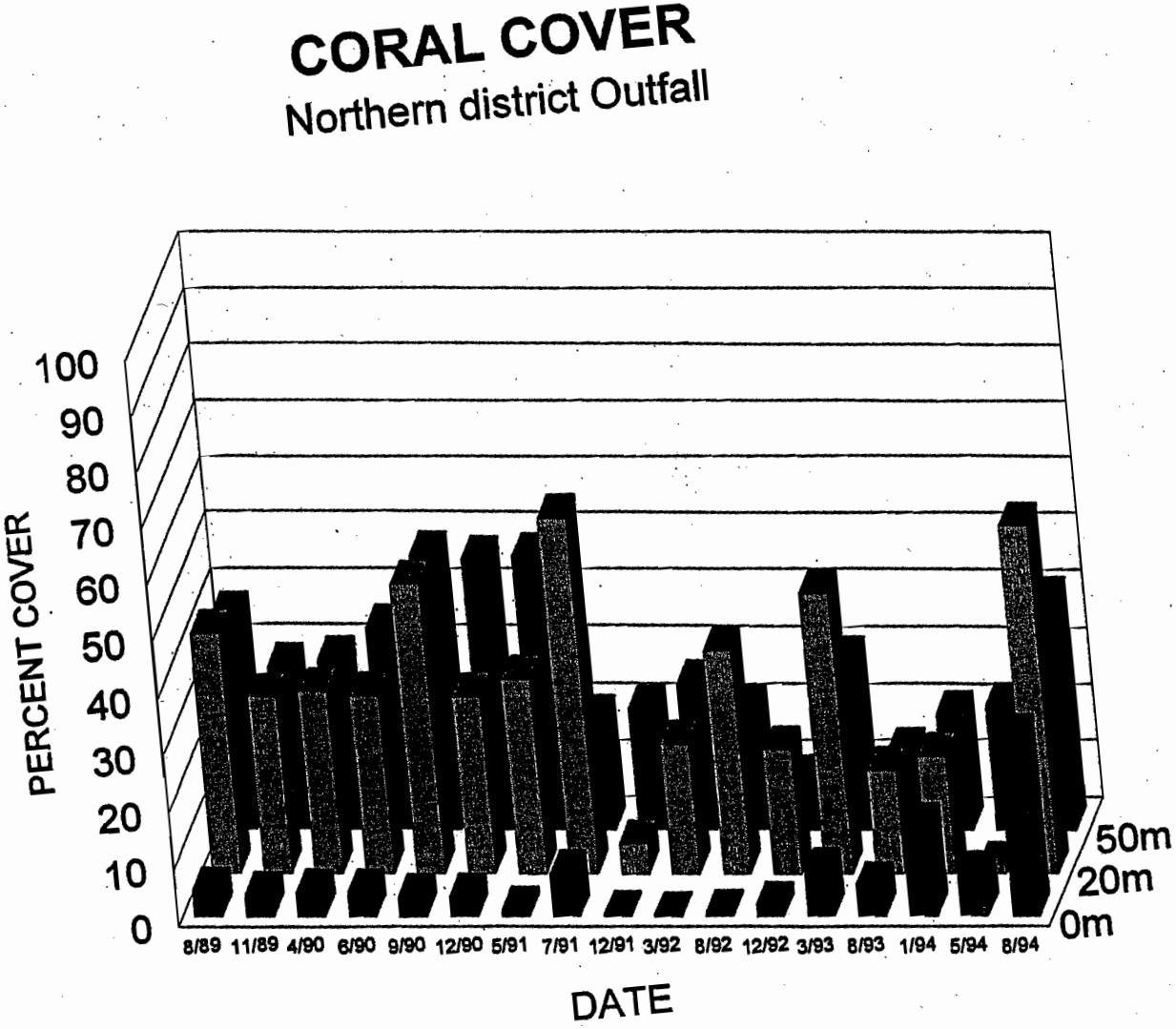

Figure 8. Coral cover along the 0, 20 and 50m transects

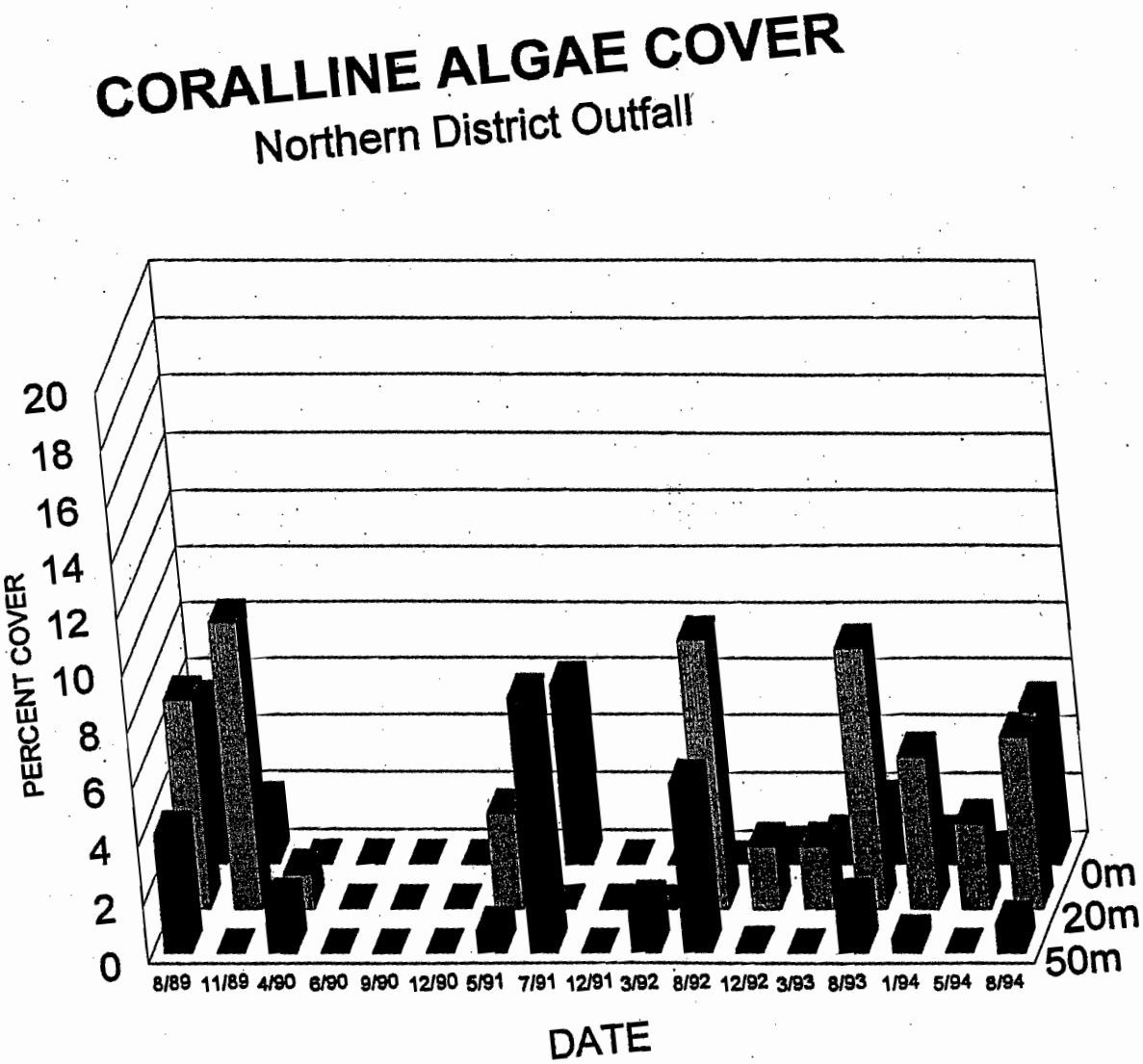

Figure 9. Coralline Algae subsrate cover along the 0, 20 and 50m transects

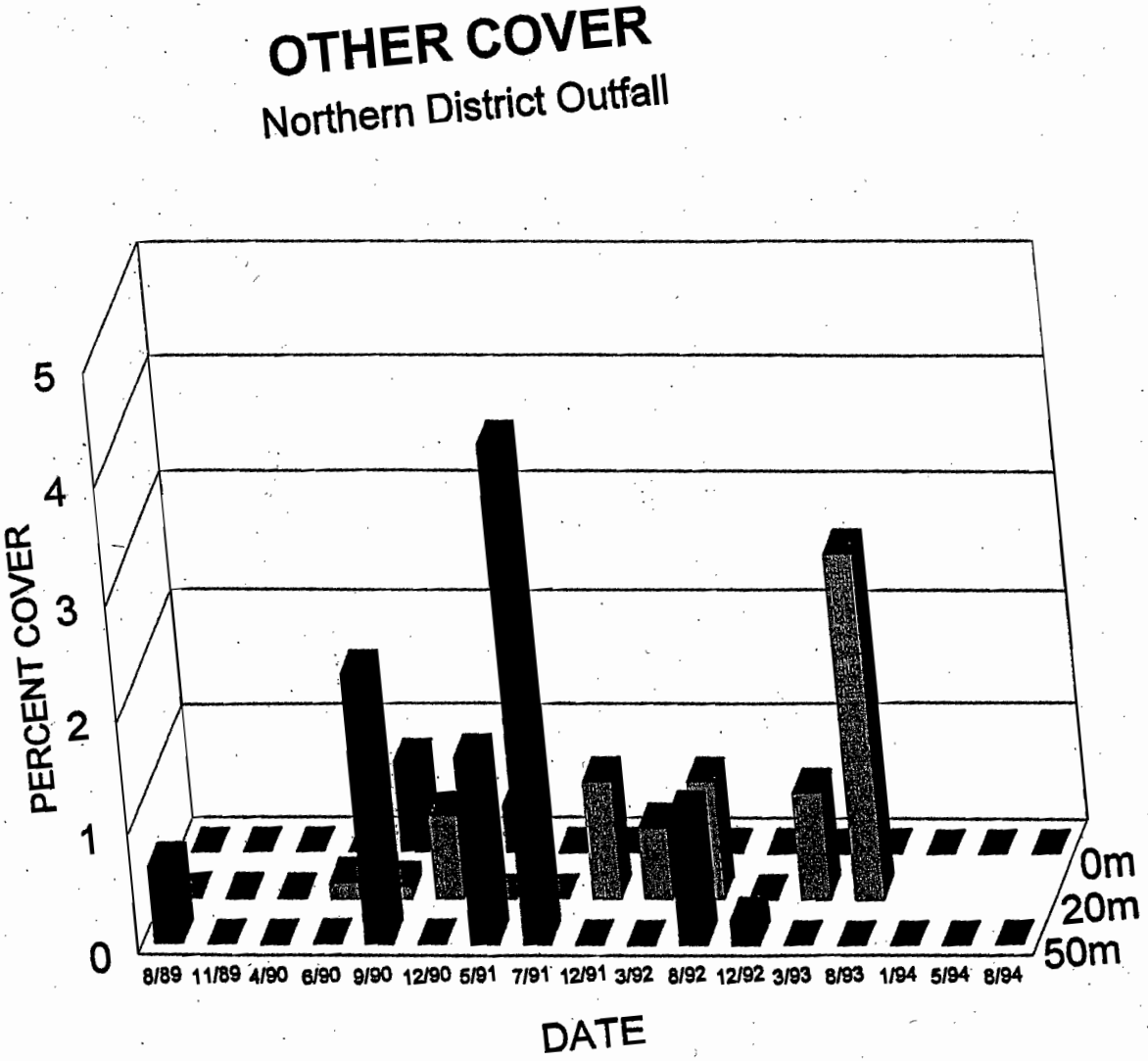

Figure 10. Other subsrate cover along the 0, 20 and 50m transects

Table 3. Northern District Outfall Fish Species.

shaded boxes represent that species were present

Fiscal Year	1990				1991				1992				1993				1994				Total
quarter	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	n/16
Acanthuridae (surgeonfishes)	subfamily Acanthurinae (Surgeonfishes)																				
Acanthurus blochii						ns					ns				ns				ns		11
Acanthurus lineatus						ns					ns				ns				ns		1
Acanthurus nigricans						ns					ns				ns				ns		16
Acanthurus nigrofuscus						ns					ns				ns				ns		13
Acanthurus pyroferus						ns					ns				ns				ns		12
Acanthurus xanthopterus						ns					ns				ns				ns		3
Ctenochaetus binotatus						ns					ns				ns				ns		4
Ctenochaetus hawaiiensis						ns					ns				ns				ns		2
Ctenochaetus striatus						ns					ns				ns				ns		6
Zebrasoma flavescens						ns					ns				ns				ns		11
Zebrasoma scopas						ns					ns				ns				ns		3
Zebrasoma veliferum						ns					ns				ns				ns		1
Acanthuridae (Unicornfishes)	subfamily Nasinae (Unicornfishes)																				
Naso annulatus						ns					ns				ns				ns		1
Naso lituratus						ns					ns				ns				ns		16
Naso hexacanthus						ns					ns				ns				ns		1
Naso tuberosus						ns					ns				ns				ns		6
Naso vlamingii						ns					ns				ns				ns		1
Aulostomidae (Trumpetfishes)																					
Aulostomus chinensis						ns					ns				ns				ns		1
Balistidae (Triggerfishes)																					
Balistapus undulatus						ns					ns				ns				ns		13
Balistidae sp.						ns					ns				ns				ns		1
Balistoides virdescens						ns					ns				ns				ns		4
Melichthys vidua						ns					ns				ns				ns		4
Melichythys niger						ns					ns				ns				ns		9
Odonus niger						ns					ns				ns				ns		6
Rhinecanthus rectangulus						ns					ns				ns				ns		1
Sufflamen bursa						ns					ns				ns				ns		10
Blenniidae (Blennies)																					
Meiacantus atrodorsalis						ns					ns				ns				ns		9
Caesionidae (Fusiliers)																					
Caesio carulaureus						ns					ns				ns				ns		2
Carangidae (Jacks; Trevallys)																					
Caranx melampygus						ns					ns				ns				ns		1
Gnathanodon speciosus						ns					ns				ns				ns		1
Chaetodontidae (butterflyfishes)																					
Chaetodon bennetti						ns					ns				ns				ns		10
Chaetodon citrinellus						ns					ns				ns				ns		16
Chaetodon ephippium						ns					ns				ns				ns		1
Chaetodon lunula						ns					ns				ns				ns		11
Chaetodon mertensii						ns					ns				ns				ns		11
Chaetodon ornatissimus						ns					ns				ns				ns		6
Chaetodon punctatofasciatus						ns					ns				ns				ns		1
Chaetodon reticulatus						ns					ns				ns				ns		8
Chaetodon trifasciatus						ns					ns				ns				ns		11
Chaetodon ulietensis						ns					ns				ns				ns		2
Chaetodon unimaculatus						ns					ns				ns				ns		2
Forcipiger flavissimus						ns					ns				ns				ns		2
Hemitaurichthys polylepis						ns					ns				ns				ns		4
Heniochus acuminatus						ns					ns				ns				ns		1
Heniochus chrysostomus						ns					ns				ns				ns		5
Heniochus singularis						ns					ns				ns				ns		1
Cirrhitidae (Hawkfish)																					
Cirrhitichthys falco						ns					ns				ns				ns		5
Paracirrhites arcatus						ns					ns				ns				ns		2
Paracirrhitus forsteri						ns					ns				ns				ns		11
Gobiidae (Gobies)																					
Amblygobius sp.						ns					ns				ns				ns		1
Valenciennea strigatus						ns					ns				ns				ns		2
Haemulidae (Sweetlips and Grunts)																					
Scolopsis lineatus						ns					ns				ns				ns		1
Holocentridae	subfamily Myripristinae (Solderfishes)																				
Myripristis spp.						ns					ns				ns				ns		1
Holocentridae	subfamily Holocentrinae (Squirrelfishes)																				

Table 3. Northern District Outfall Fish Species.

shaded boxes represent that species were present

Fiscal Year	1990				1991				1992				1993				1994				Total
quarter	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	n/16
Sargocentron sp.						ns					ns				ns				ns		2
Labridae (Wrasses)																					
Anampses twisti						ns					ns				ns				ns		1
Bodianus axillaris						ns					ns				ns				ns		12
Bodianus mesothorax						ns					ns				ns				ns		1
Cheilinus bimaculatus						ns					ns				ns				ns		5
Cheilinus chlorourus						ns					ns				ns				ns		3
Cheilinus fasciatus						ns					ns				ns				ns		11
Cheilinus orientalis						ns					ns				ns				ns		2
Cheilinus oxycephalus						ns					ns				ns				ns		11
Cheilinius undulatus						ns					ns				ns				ns		7
Cheilinus unifasciatus						ns					ns				ns				ns		5
Cheilio inermis						ns					ns				ns				ns		1
Cirrhilabrus sp.						ns					ns				ns				ns		5
Coris aygula						ns					ns				ns				ns		2
Coris gaimard						ns					ns				ns				ns		14
Epinephelus sp.						ns					ns				ns				ns		1
Epibulus insidiator						ns					ns				ns				ns		2
Epiephelus merra						ns					ns				ns				ns		1
Gomphosus varius						ns					ns				ns				ns		11
Halichoeres biocellatus						ns					ns				ns				ns		1
Halichoeres hortulanus						ns					ns				ns				ns		14
Halichoeres margaritaceus						ns					ns				ns				ns		11
Halichoeres marginatus						ns					ns				ns				ns		2
Halichoeres trimaculatus						ns					ns				ns				ns		1
Hemigymnus melapterus						ns					ns				ns				ns		11
Hologymnosus annulatus						ns					ns				ns				ns		1
Labrichthys unilineatus						ns					ns				ns				ns		4
Labroides dimidiatus						ns					ns				ns				ns		12
Macropharyngogon meleagris						ns					ns				ns				ns		3
Navoculichthys taeniourus						ns					ns				ns				ns		3
Stethojulis bandanensis						ns					ns				ns				ns		1
Stethojulis strigiventor						ns					ns				ns				ns		11
Thalassoma hardwickii						ns					ns				ns				ns		11
Thalassoma lutescens						ns					ns				ns				ns		15
Thalassoma purpureum						ns					ns				ns				ns		1
Thalassoma quinquevittatum						ns					ns				ns				ns		1
Thallasoma lunare						ns					ns				ns				ns		2
Lethrinidae (Emperors)																					
Gnathodentex aureolineatus						ns					ns				ns				ns		2
Lethrinus harak						ns					ns				ns				ns		1
Lethrinus xanthochilus						ns					ns				ns				ns		4
Monotaxis grandoculus						ns					ns				ns				ns		4
Lutjanidae (Snappers)																					
Aphareus furca						ns					ns				ns				ns		3
Lutjanus bohar						ns					ns				ns				ns		1
Macolor niger						ns					ns				ns				ns		9
Malcolor macularis						ns					ns				ns				ns		1
Microdesmidae (Dartfishes)																					
Nemateleotris magnifica						ns					ns				ns				ns		3
Ptereleotris evides						ns					ns				ns				ns		12
Ptereleotris zebra						ns					ns				ns				ns		7
Mugilidae (Mullets)																					
Parupeneus barberinus						ns					ns				ns				ns		3
Parupeneus multifasciatus						ns					ns				ns				ns		12
Mullidae (Goatfishes)																					
Parapeneus bifasciatus						ns					ns				ns				ns		1
Muraenidae (Moray eels)																					
Gymnothorax meleagris						ns					ns				ns				ns		1
Ostraciidae (Trunkfish)																					
Ostracion meleagris						ns					ns				ns				ns		2
Pinguipedidae (Sandperches)																					
Parapercis clatherata						ns					ns				ns				ns		9
Parapercis millipunctata						ns					ns				ns				ns		1
Pomacanthidae (Angelfishes)																					
Centropyge flavissimus						ns					ns				ns				ns		13

Table 3. Northern District Outfall Fish Species.

shaded boxes represent that species were present

Fiscal Year	1990				1991				1992				1993				1994				Total
quarter	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	n/16
Centropyge shepardi						ns					ns				ns				ns		5
Pygoplites diacantus						ns					ns				ns				ns		3
Pomacentridae (Damselfishes) subfamily Amphiprioninae (Anemonefishes)																					
Amphiprion chrysopterus						ns					ns				ns				ns		10
Amphiprion periderion						ns					ns				ns				ns		6
Chromis acares						ns					ns				ns				ns		1
Pomacentridae (Damselfishes) subfamily Pomacentrinae																					
Abudefduf saxatalis						ns					ns				ns				ns		2
Chryiptera traceyi						ns					ns				ns				ns		4
Chrysiptera leucopoma						ns					ns				ns				ns		1
Plectroglyhididodon leucozona						ns					ns				ns				ns		1
Plectroglyphidodon dickii						ns					ns				ns				ns		9
Plectroglyphidodon johnstonianus						ns					ns				ns				ns		2
Plectroglyphidodon lacrymatus						ns					ns				ns				ns		13
Plectroglyphidodon sp.						ns					ns				ns				ns		1
Pomacentrus amboinensis						ns					ns				ns				ns		10
Pomacentrus grammorhynchus						ns					ns				ns				ns		11
Pomacentrus vaiuli						ns					ns				ns				ns		4
Pomachromis guamensis						ns					ns				ns				ns		5
Stegastes albifasciatus						ns					ns				ns				ns		3
Scaridae (Parrotfishes)																					
Calototomus carolinus						ns					ns				ns				ns		1
Scaras altipinnus						ns					ns				ns				ns		3
Scarus frenatus						ns					ns				ns				ns		9
Scarus frontalis						ns					ns				ns				ns		1
Scarus ghobban						ns					ns				ns				ns		2
Scarus gibbus						ns					ns				ns				ns		4
Scarus globiceps						ns					ns				ns				ns		2
Scarus schlegeli						ns					ns				ns				ns		11
Scarus sordidus						ns					ns				ns				ns		16
Scorpaenidae (Scorpionfishes)																					
Scorpaenopsis verrucosa						ns									ns				ns		1
Serrandiae (Grouper)																					
Cepahlopholis argus						ns					ns				ns				ns		10
Cephalopholis urodeta						ns					ns				ns				ns		7
Variola louti						ns					ns				ns				ns		2
Siganidae (Rabbitfish)																					
Siganus aregenteus						ns					ns				ns				ns		1
Siganus spinus						ns					ns				ns				ns		1
Sphyraenidae (Barracudas)																					
Sphyraena forsteri						ns					ns				ns				ns		7
Syngnathidae subfamily Syngnathinae (Pipefishes)																					
Corythoichthys intestinalis						ns					ns				ns				ns		1
Synodontidae (Lizardfishes)																					
Saurida gracilis						ns					ns				ns				ns		1
Synodus spp.						ns					ns				ns				ns		1
Tetraodontidae (puffers)																					
Arothron nigropunctatus						ns					ns				ns				ns		1
Canthigaster solandri						ns					ns				ns				ns		14
Zanclidae (Moorish Idol)																					
Zancluls cornutus						ns					ns				ns				ns		15
total number of species	44	38	41	48	44	ns	65	67	59	56	ns	55	51	43	ns	49	42	36		42	

Number of fish species that fall under each trophic level.

Fiscal Year	1990				1991				1992				1993				1994			
quarter	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Herbivore	12	11	15	17	16	ns	18	20	16	16	ns	15	14	14	ns	15	13	11	ns	14
Carnivore	19	16	21	20	19	ns	30	29	27	26	ns	25	22	21	ns	23	21	17	ns	19
Invertivore	18	14	21	19	19	ns	28	27	25	24	ns	23	20	20	ns	21	20	16	ns	18
Planktivore	4	3	1	4	4	ns	5	6	5	4	ns	5	5	2	ns	4	2	2	ns	2
Omnivore	4	1	2	2	2	ns	4	3	3	2	ns	2	2	2	ns	2	2	2	ns	2
Corallivore	5	7	2	5	3	ns	8	9	8	8	ns	8	8	5	ns	5	4	4	ns	4

DISCUSSION

There were significant changes in percentage of cover by three of the groups (bare substrate, turf algae and coral) at the Northern District site from August 1989 until September 1994. The final Biological Monitoring Report of Three Sewage Outfalls on Guam, (Richmond et al., 1994) states that, "at the Tanguisson site, coral cover has noticeably decreased which is a cause for concern." However, statistical analysis did not show any significant decrease in coral cover. In fact, there was a significant increase in coral cover along the 0 m transect. These results indicate that the discharge has not had a detrimental effect the percent cover by coral in the vicinity of the diffusers. There is no indication as to whether this increase in coral cover is attributed to growth of existing coral colonies or due to the presence of new coral recruits. Coral cover was reported as been 2% to 10% in 1973 by Jones and Randall and from 1989 to 1994 coral cover in the vicinity of the outfall averaged between 20 and 60%.

There was a significant increase in bare substrate along all the transects, which appears to be correlated with the decrease in turf algae cover. The decrease in turf algae is likely to be a result of either grazing pressure by herbivorous fishes, or due to natural disturbances. The presence of an outfall would tend to increase the presence of turf and macro algae rather than cause a decrease in its cover, because of the possible increases in nutrients.

There were several Typhoons during the period that biological monitoring was conducted. Typhoons cause a physical assault on coral reefs from wave action, sediment laden runoff and a disruption in water quality. The monitoring reports from UOG have made no mention of these occurrences or what changes in percent cover may have resulted from them. A list of the typhoons, the month and year in which they occurred are given in Table 4. When comparing the changes in

Table 4. Typhoons within 100 miles of Guam from 1980 until 1993.

Typhoon Name	Month	Year	Maximum Intensity
Andy	April	1989	155 mph
Koryn	January	1990	75 mph
Russ	December	1990	140 mph
Yuri	November	1991	175 mph
Omar	August	1992	120 mph
Brian	October	1992	75 mph
Elsie	November	1992	105 mph
Hunt	November	1992	75 mph
Gay	November	1992	100 mph

source: National Weather Service, Tiyan, Guam.

percent cover of the six benthic categories after the occurrence of a single, or series of typhoons, it is possible to correlate some of these changes with the typhoons. Most obvious are the large increases in the percentage of bare substrate, and a reduction in the percentage of coral cover after typhoons have occured. Also, the reduction in turf algae after the series of 1992 typhoons, may be a result of typhoons cleaning out large portions of algae and grazing pressure keeping it at low levels. The same trends occured at the Agana Bay Outfall sites, which tends to support the hypothesis that these changes in benthic cover were as a result of natural disturbances rather than the discharge itself.. However, caution must be taken in making any assumptions as to how the typhoons, and grazing pressures have effected the benthic community in the area of the outfall, as there was no data from non impacted control sites with which to make a comparison.

Water quality monitoring of the receiving waters conducted on a quarterly basis since 1989 has not indicated that the discharge has had a detrimental impact on the quality of the receiving waters. The water quality parameters monitored include; pH, salinity, temperature, turbidity, dissolved oxygen, and fecal coliform. In general the results are within an acceptable range when compared to the control site, with the exception of the indicator bacteria fecal coliform, which was often elevated in the discharge area. There has been no reported incidences of mass fish or invertebrate mortalities, disease in organisms or any other adverse biological impacts related to the discharge.

In general results from both the water quality and biological monitoring have not indicated that there has been any adverse effects on the coral reef environment from the discharge at Tanguisson. The increase in the percentage of benthic cover by coral and the results of the fish surveys are positive signs of reef health. The increase in bare substrate occurred at both the Tanguisson and Agana sites, and is likely to be as a result of natural disturbances rather than the discharge itself.

REFERENCES

Jones, R. S. and R. H. Randall. 1973. A Preliminary Marine Survey for the Northern District Sewage System. University of Guam, Marine Laboratory Environmental Survey Report No. 8.

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