

SECTION 6: WATER QUALITY

ANALYSIS OF SEAWATER SAMPLES FROM KAGMAN/LAULAU BAY AREAS FOR CERTAIN PHYSICAL AND CHEMICAL PARAMETERS

Introduction

The Division of Fish and Wildlife, Saipan, CNMI provided a scope of work for the analysis of certain physical and chemical parameters of the inshore and offshore waters of Unai Laulau Kattan, Unai Baput, and Unai Laulau sites in Saipan, CNMI to establish a baseline of these parameters during the dry season months of January to May, 1991. Results of these analyses will be incorporated into the overall assessment of the natural resources in the Kagman/Laulau Bay area which Shimizu Corporation is planning to develop into a golf course and resort.

All analyses were done by Ravi Chandran of Cheenis Pacific Company, Saipan using laboratory equipment, reagents and supplies of Cheenis Pacific Company.

Scope of Work

The following scope of work items related to water quality assessment has been taken from the original scope of work provided to Cheenis Pacific Company by the Division of Fish and Wildlife. Analysis of water samples was done only for the dry season 1991 i.e. from January 1991 to May 1991.

Study Location A: East of Tank Beach (Unai Laolao Kattan)

Water quality assessment:

- a) one sample site with two sample stations at each site: (1) within 10 feet of the shoreline (nearshore site) and (2) at the spur and groove, one foot under the surface (spur and groove site).
- b) monthly sampling starting in January and terminating in May, 1991.
- c) analyze water samples for the following parameters: Conductivity/TDS, nitrate, DO, phosphate, salinity, temperature, and turbidity.

Study Location B: Unai Baput

- a) one sample station at each of the three biological assessment sites. Water samples will be taken from (1) within 10 feet of the shoreline (nearshore site) and (2) at the spur and groove, one foot under the surface (spur and groove site).
- b) monthly sampling starting in January and terminating in May, 1991.
- c) analyze water samples for the following parameters: Conductivity/TDS, nitrate, DO, phosphate, salinity, temperature, and turbidity.

Study Location C: Unai Laulau

- a) one sample station at each of the three biological assessment sites. Water samples will be taken from (1) within 10 feet of the shoreline (nearshore site) and (2) at the spur and groove, one foot under the surface (spur and groove site).
- b) monthly sampling starting in January and terminating in May, 1991.

c) analyze water samples for the following parameters: Conductivity/TDS, nitrate, DO, phosphate, salinity, temperature, and turbidity.

Essentially, the above scope of work requires collection of fourteen water samples from three study locations. Each of the fourteen water samples is analyzed for eight parameters listed above.

Methods and Materials:

Sample Collection and Storage:

All water samples were collected between 8:00 am and 2:00 pm each month. Water samples were collected in plastic bottles with plastic caps. Temperature and dissolved oxygen measurements were taken at the site immediately after sample collection. Samples were then stored in an ice-chest and brought to the laboratory where they were frozen at 4°C. Further analyses of samples for other parameters were made at room temperature. All samples were analyzed within 48 hours after collection.

Conductivity/TDS:

Conductivity and Total Dissolved Solids (TDS) were measured by using a HACH Model 44600 Conductivity/TDS Meter. This meter measures conductivity in millisemens/cm (mS/cm) which value is then converted into micromhos/cm using the following equations:

From	To	Equation
mS/cm	microS/cm	mS/cm x 1000
microS/cm	micromhos/cm	microS/cm x 1

The HACH Model 44600 meter automatically adjusts for temperature differences.

A 10 ml sample was diluted to 100 ml with demineralized water and conductivity of this diluted sample was measured on the instrument mentioned above. Conductivity of the dilution water was taken into account in the calculations as follows:

$$\text{Cond. of sample} = \frac{(100 \times \text{indicated cond.}) - [\text{cond. if dil. H}_2\text{O} \times (100 - \text{sample volume})]}{\text{sample volume}}$$

TDS was measured by using a HACH Model 44600 conductivity/TDS meter. TDS, the reciprocal of conductivity, is assigned a factor value of 0.5 to the conductivity measurement. TDS values were measured in mg/L of various ions. Since the probe was not ion selective, only the total of the concentrations of the inorganic components of the samples was measured to indicate the TDS of the samples.

Temperature:

Temperature measurements were taken using a field thermometer, HACH Model 44600 Conductivity/TDS meter, HACH Model 16046 Dissolved Oxygen meter or YSI Model 51B dissolved oxygen meter. All measurements were made in °Celsius.

Nitrate:

Nitrate nitrogen (NO_3^- -N) was measured using a HACH DR-2000 Spectrophotometer that uses the Cadmium reduction method. HACH NitraVer[®] 5 powder pillows were added to samples. Mixed samples were then allowed to react for 5 minutes and then the nitrate nitrogen content was determined on the spectrophotometer at 400 nanometers.

Dissolved Oxygen:

Dissolved oxygen measurements in January and February were made using a YSI Model probe. In March and April, DO was measured by using a HACH Model 16046 portable Dissolved Oxygen meter. This meter uses a Clark type dissolved oxygen sensor with a gold cathode and silver anode surrounded by KCl electrolyte solution.

Further cross check of DO was made using the modified Winkler method using HACH dissolved oxygen powder pillows and titrating the treated sample with sodium thiosulfate solution. In this method, samples are treated with manganous sulfate and alkaline iodide-azide reagent (HACH dissolved oxygen powder pillows 1, 2, and 3) to form an orange-brown precipitate. Upon acidification of the sample, this floc reacts with iodide to produce free iodine as I_3^- , in proportion to the oxygen concentration. The iodine is titrated with sodium thiosulfate to the starch-iodide end point. Triplicate titrations were made to get the average value. Titrations were done using a HACH Model 16900-01 digital titrator and cartridges.

Phosphate:

Reactive phosphorus was measured (mg/L PO_4^{3-}) by using the Ascorbic acid method on a HACH DR-2000 spectrophotometer. PhosVer[®] 3 powder was added to the sample, allowed to react for two minutes, and then read on the spectrophotometer at 890 nanometers.

Salinity:

Salinity was determined by titrimetric method using mercuric nitrate solution. Diphenylcarbazone powder was added to samples which were then titrated to a pale pinkish end point using a HACH Model 16900-01 digital titrator. Samples were also titrated using the same reagents (diphenylcarbazone powder and mercuric nitrate solution) to determine mg/L chloride which is also indicative of salinity of the sample. The second titration was done for comparative reasons only.

Turbidity:

Turbidity was measured on a HACH Model 2100 A Turbidimeter which gives results in Nephelometric Turbidity Units (NTU). Turbidity was also measured using a HACH DR 2000 spectrophotometer which uses a formazin turbidity standard. This test was done only for cross reference and was not used in reporting since formazin turbidity values are not reported in nephelometric units.

A set of samples collected during January was given to the Division of Environmental Quality (DEQ) for cross check and quality control. Results of CPC laboratory analyses were also provided to DEQ for concurrence. Samples collected in February through May were not given to DEQ upon DEQ's suggestion that such submittals were unnecessary.

Results and Discussion:

Results of physical and chemical analyses are provided in Table 1. This Table contains results of the eight parameters measured from January to May, 1991.

The Division of Environmental Quality (DEQ) has established water quality criteria and ranges for various parameters of the seawater around Saipan. The type of waters found in the sampling sites of the present analyses have been classified as Class AA - indicative of their high quality. The following are the DEQ criteria and ranges for Class AA waters for the parameters analyzed:

<i>Parameter</i>	<i>DEQ criteria and/or range</i>
Conductivity	None
TDS, Salinity	No change in channels, geometry or freshwater influx shall be made which would cause permanent changes in isohaline patterns of more than 10% from the natural conditions or which would otherwise adversely affect the indigenous biota and natural sedimentary patterns.
Turbidity (NTU)	Turbidity shall not be greater than 2 NTU at any time.
Temperature	Water temperature shall not vary by more than 0.9°C from the ambient conditions.
DO	Not less than 6.0 mg/L
Total Nitrogen	shall not exceed 0.4 mg/L
Nitrate nitrogen	Not greater than 0.014 mg/L (From Pring, 1989)
Total phosphorus	shall not exceed 0.025 mg/L

Violations of DEQ established criteria and ranges are given in Table 2.

Turbidity violations were recorded only in January at three locations B1, C1, and C2 all in the nearshore areas. During the sample collection, these beaches were heavily used by swimmers and divers and this may have been a cause of increased turbidity in these locations.

Dissolved oxygen levels in January and April were significantly lower than expected levels of more than 6.0 mg/L. February and March levels were relatively higher and approached expected levels when compared to January and April. Since dissolved oxygen was consistently lower in all sampling points in January and April and nearly all stations in February and March, it is possible that the lower range was caused by natural conditions. No unusual biological or meteorological conditions were noticed at the sampling points during any of these months.

Nitrate nitrogen limits were obtained from Pring, C.K. 1989 Marine Monitoring Program Assessment and Recommendations. The set level is 0.014 mg/L. In January four sampling points (B1 inner, B2 inner, B3 inner and C1 inner) had excess nitrate nitrogen. In February all except three sampling points contained excess levels; In March all except five sampling points contained excessive amounts of nitrate nitrogen and in April all stations except Study Location A East of Unai Laolao Kattan. Some of the possible sources of nitrate nitrogen are the farm in

Unai Bapot (inland from Sample station B1 inner). In 1988, total nitrogen levels were high near the access road in Unai Bapot (Pring, 1989). Runoff from upland areas is another possible source although rainfall during the sampling months has been sparse to completely absent.

The Division of Environmental Quality considers the Laulau Bay, Unai Bapot, and East of Unai Laolao Kattan areas as remote beaches and maintains that these areas should have a high quality of water. However, except for in 1988, no water quality analyses is done by DEQ at these three beach areas. This is the first time since 1988 these three beach waters have been analyzed. The present data would thus form the baseline for future comparisons. In this light information on conductivity and TDS has been collected for the first time and may prove to be valuable.

**KAGMAN/LAULAU BAY DRY SEASON WATER SAMPLE ANALYSIS RESULTS
CONDUCTIVITY DATA JANUARY THROUGH MAY 1991 (MICROMHOS/CM)**

STATION	JAN	FEB	MAR	APR	MAY
A OUTER	30130	64210	64245		
A INNER	19630	73110	64645	61830	60797
B1 OUTER	35030	55010	65345	62330	64097
B1 INNER	58630	61710	62545	63430	61397
B2 OUTER	47130	63010	64945	63330	63697
B2 INNER	74330	48110	63245	63230	63597
B3 OUTER	35030	52110	63545	63330	63897
B3 INNER	64030	63210	64545	61030	63697
C1 OUTER	30530	51910	62245	64230	59997
C1 INNER	26030	57810	59845	63830	64297
C2 OUTER	17530	48010	64545	59030	63897
C2 INNER	30630	62410	63745	62130	63397
C3 OUTER	32630	62210	62845	63630	62497
C3 INNER	23530	60010	63945	63330	63197

TDS DATA FROM JANUARY THROUGH MAY 1991 (MG/L)

STATION	JAN	FEB	MAR	APR	MAY
A OUTER	1.50	3.20	3.20		
A INNER	0.97	3.65	3.22	3.09	3.03
B1 OUTER	1.74	2.74	3.26	3.11	3.20
B1 INNER	2.92	3.08	3.18	3.17	3.06
B2 OUTER	2.35	3.14	3.24	3.16	3.18
B2 INNER	3.71	2.40	3.15	3.16	3.17
B3 OUTER	1.74	2.60	3.17	3.16	3.19
B3 INNER	3.19	3.15	3.22	3.05	3.17
C1 OUTER	1.52	2.59	3.10	3.21	2.99
C1 INNER	1.29	2.88	2.98	3.19	3.21
C2 OUTER	0.87	2.39	3.22	2.95	3.19
C2 INNER	1.52	3.11	3.18	3.10	3.16
C3 OUTER	1.62	3.10	3.13	3.18	3.12
C3 INNER	1.17	2.99	3.19	3.16	3.15

TURBIDITY DATA FROM JANUARY THROUGH MAY 1991 (NTU)

STATION	JAN	FEB	MAR	APR	MAY
A OUTER	0.20	0.02	0.01		
A INNER	1.06	1.00	0.70	1.00	0.30
B1 OUTER	0.70	0.10	0.12	0.16	0.15
B1 INNER	3.00	1.00	1.30	1.00	0.45
B2 OUTER	0.32	0.24	1.00	0.36	0.20
B2 INNER	0.30	0.17	2.00	0.24	0.25
B3 OUTER	0.18	0.14	0.01	0.25	0.20
B3 INNER	0.24	0.06	0.50	0.20	0.25
C1 OUTER	1.00	0.86	0.62	0.30	0.15
C1 INNER	2.76	1.00	0.90	1.00	0.35
C2 OUTER	0.16	0.42	1.00	0.25	0.15
C2 INNER	2.40	0.15	0.12	0.52	0.40
C3 OUTER	0.10	0.80	0.01	0.30	0.20
C3 INNER	0.12	1.00	0.04	0.90	0.35

TEMPERATURE DATA FROM JANUARY THROUGH MAY 1991 (CELCIUS)

STATION	JAN	FEB	MAR	APR	MAY
A OUTER	29.00	29.00	31.00		
A INNER	29.00	29.00	31.00	30.00	29.00
B1 OUTER	29.00	29.00	32.00	26.50	28.00
B1 INNER	32.00	31.00	29.00	27.00	29.00
B2 OUTER	29.50	29.00	32.00	27.00	28.50
B2 INNER	33.00	31.00	29.00	27.00	28.50
B3 OUTER	29.00	31.00	29.50	27.50	29.00
B3 INNER	32.00	31.00	29.50	27.50	29.00
C1 OUTER	28.50	30.00	28.00	26.50	28.00
C1 INNER	32.00	32.00	29.00	26.50	28.00
C2 OUTER	30.00	32.00	28.00	27.00	28.00
C2 INNER	30.00	31.00	29.00	26.50	28.00
C3 OUTER	28.50	32.00	28.00	26.50	28.00
C3 INNER	29.00	30.00	29.00	26.50	28.00

DISSOLVED OXYGEN DATA FROM JANUARY THROUGH MAY 1991 (MG/L)

STATION	JAN	FEB	MAR	APR	MAY
A OUTER	3.40	6.60	5.00		
A INNER	2.20	6.40	5.20	4.80	7.00
B1 OUTER	2.90	5.80	5.90	4.40	5.50
B1 INNER	2.20	6.30	6.30	4.50	6.60
B2 OUTER	2.60	5.80	5.80	4.40	5.60
B2 INNER	2.20	6.30	6.20	4.80	6.60
B3 OUTER	2.60	5.80	5.50	4.00	5.10
B3 INNER	2.10	6.50	6.40	4.80	6.40
C1 OUTER	2.60	5.40	5.80	3.30	4.60
C1 INNER	2.20	6.60	7.10	3.60	5.40
C2 OUTER	2.80	5.70	5.40	4.10	4.40
C2 INNER	2.10	6.70	6.30	4.40	5.50
C3 OUTER	2.80	5.70	5.20	4.00	4.40
C3 INNER	2.10	6.60	6.80	4.50	5.00

NITRATE NITROGEN DATA FROM JANUARY THROUGH MAY 1991 (MG/L)

STATION	JAN	FEB	MAR	APR	MAY
A OUTER	0.00	0.00	0.00		
A INNER	0.00	0.50	0.00	0.00	1.00
B1 OUTER	0.00	0.10	0.30	0.70	1.10
B1 INNER	0.40	0.70	0.40	0.90	0.80
B2 OUTER	0.00	0.40	0.70	0.60	0.90
B2 INNER	0.20	0.20	0.30	0.40	1.10
B3 OUTER	0.00	0.30	0.40	0.70	1.00
B3 INNER	0.20	0.40	0.00	0.70	0.80
C1 OUTER	0.00	0.10	0.40	0.40	0.90
C1 INNER	0.20	0.00	0.70	0.60	0.80
C2 OUTER	0.00	0.30	0.00	0.80	0.90
C2 INNER	0.00	0.30	0.50	0.90	1.10
C3 OUTER	0.00	0.00	0.60	0.60	1.10
C3 INNER	0.00	0.10	0.00	0.70	0.90

PHOSPHORUS DATA FROM JANUARY THROUGH MAY 1991 (MG/L)

STATION	JAN	FEB	MAR	APR	MAY
A OUTER	0.07	0.00	0.02		
A INNER	0.00	0.10	0.00	0.01	0.02
B1 OUTER	0.08	0.07	0.00	0.00	0.00
B1 INNER	0.68	0.00	0.00	0.00	0.00
B2 OUTER	0.01	0.01	0.00	0.02	0.00
B2 INNER	0.01	0.02	0.00	0.00	0.00
B3 OUTER	0.03	0.00	0.00	0.00	0.00
B3 INNER	0.14	0.01	0.00	0.00	0.00
C1 OUTER	0.03	0.06	0.00	0.02	0.00
C1 INNER	0.01	0.00	0.06	0.00	0.00
C2 OUTER	0.08	0.06	0.04	0.00	0.00
C2 INNER	0.00	0.00	0.13	0.00	0.00
C3 OUTER	0.06	0.02	0.01	0.01	0.00
C3 INNER	0.01	0.03	0.00	0.00	0.00

SALINITY DATA FROM JANUARY THROUGH MAY 1991 (0/00; ppt)

STATION	JAN	FEB	MAR	APR	MAY
A OUTER	35.18	35.15	34.41		
A INNER	34.58	35.17	34.41	34.87	34.52
B1 OUTER	34.75	34.92	34.38	34.89	34.24
B1 INNER	34.75	34.94	34.75	34.94	33.85
B2 OUTER	34.90	35.08	34.80	35.17	34.17
B2 INNER	35.13	34.90	34.82	34.94	34.13
B3 OUTER	35.00	35.17	34.94	34.89	34.20
B3 INNER	35.10	35.11	34.78	34.83	34.31
C1 OUTER	35.11	35.18	34.97	35.13	34.52
C1 INNER	35.11	35.18	34.90	34.92	34.24
C2 OUTER	34.92	35.13	35.15	35.18	34.17
C2 INNER	34.89	34.90	35.13	35.11	33.08
C3 OUTER	34.94	34.76	35.20	34.87	34.20
C3 INNER	34.90	34.76	35.11	34.87	33.18

KAGMAN/LAULAU BAY DRY SEASON VIOLATIONS OF DEQ CRITERIA AND RANGES

TURBIDITY DATA FROM JANUARY THROUGH MAY (NTU)

STATION	JAN
B1 INNER	3.00
C1 INNER	2.76
C2 INNER	2.40

DISSOLVED OXYGEN DATA FROM JANUARY THROUGH MAY (MG/L)

STATION	JAN	FEB	MAR	APR	MAY
A OUTER	3.40		5.00		
A INNER	2.20		5.20	4.80	
B1 OUTER	2.90	5.80	5.90	4.40	5.50
B1 INNER	2.20			4.50	
B2 OUTER	2.60	5.80	5.80	4.40	5.60
B2 INNER	2.20			4.80	
B3 OUTER	2.60	5.80	5.50	4.00	5.10
B3 INNER	2.10			4.80	
C1 OUTER	2.60	5.40	5.80	3.30	4.60
C1 INNER	2.20			3.60	5.40
C2 OUTER	2.80	5.70	5.40	4.10	4.40
C2 INNER	2.10			4.40	5.50
C3 OUTER	2.80	5.70	5.20	4.00	4.40
C3 INNER	2.10			4.50	5.00

NITRATE NITROGEN DATA FROM JANUARY THROUGH MAY (MG/L)

STATION	JAN	FEB	MAR	APR	MAY
A OUTER					1.00
A INNER		0.50			1.10
B1 OUTER		0.10	0.30	0.70	0.80
B1 INNER	0.40	0.70	0.40	0.90	0.90
B2 OUTER		0.40	0.70	0.60	1.10
B2 INNER	0.20	0.20	0.30	0.40	1.00
B3 OUTER		0.30	0.40	0.70	0.80
B3 INNER	0.20	0.40		0.70	0.90
C1 OUTER		0.10	0.40	0.40	0.80
C1 INNER	0.20		0.70	0.60	0.90
C2 OUTER		0.30		0.80	1.10
C2 INNER		0.30	0.50	0.90	1.10
C3 OUTER			0.60	0.60	0.90
C3 INNER		0.10		0.70	

PHOSPHORUS DATA FROM JANUARY THROUGH MAY (MG/L)

STATION	JAN	FEB	MAR
A OUTER	0.07		
A INNER		0.10	
B1 OUTER	0.08	0.07	
B1 INNER	0.68		
B2 OUTER			
B2 INNER			
B3 OUTER	0.03		
B3 INNER	0.14		
C1 OUTER	0.03	0.06	
C1 INNER			0.06
C2 OUTER	0.08	0.06	0.04
C2 INNER			0.13
C3 OUTER	0.06	0.02	
C3 INNER			

REFER TO TEXT FOR DEQ SET CRITERIA AND RANGES FOR THE VARIOUS PARAMETERS. BLANKS INDICATE VALUES WITHIN SET CRITERIA. INFORMATION ON "NATURAL CONDITIONS" FOR CONDUCTIVITY, TDS, SALINITY, AND TEMPERATURE IS UNAVAILABLE.