NITROGEN REMOVAL IN THE OPERATION OF THE MILILANI SEWAGE TREATMENT PLANT

by

Gordon L. Dugan
Reginald H.F. Young
Roy T. Tsutsui

Technical Memorandum Report No. 44

September 1974

A Project Completion Report
for
NITROGEN REMOVAL IN THE OPERATION OF THE
MILILANI SEWAGE TREATMENT PLANT

OWRT Project No. A-047-HI, Grant Agreement No. 14-31-0001-4011
Principal Investigator: Gordon L. Dugan
Project Period: July 1, 1973 to June 30, 1974

The programs and activities described herein were supported in part by funds provided by the United States Department of the Interior as authorized under the Water Resources Act of 1964, Public Law 88-379.

ABSTRACT

It had been observed over a one-year period, January 1972 to January 1973, that the Mililani Sewage Treatment Plant (STP), located in central Oahu, Hawaii, discharged in its effluent only approximately 30% of the total nitrogen it received in its predominantly domestic raw sewage influent. During the period that high nitrogen removal rates were observed, the STP was operated as a secondary plant with raw sewage, after comminution and aerated grit removal, going directly to the "Rapid Bloc" activated sludge unit. Sludge stabilization was by aerobic digestion. During the fall of 1973, a primary sedimentation tank and an anaerobic digester, which was to replace the aerobic digester, were added to the components of the STP. The plant was designed for an average waste water flow of 0.93 mgd capacity before modification and 1.81 mgd after modification.

Inasmuch as the relatively high removal rate (about 70% in 1972) rivals present expensive advanced waste water operations that were designed specifically for nitrogen removal, and considering the difficulty and expense of removing significant quantities of nitrogen in waste water, a study was initiated for a one-year period, 1 July 1973 to 30 June 1974, in an attempt to determine the cause for such a high nitrogen removal rate both before (Phase I) and after (Phase II) modifications to the STP occurred in the fall of 1973.

The waste water flow during Phase I, 9 July to 6 August 1973, averaged 0.665 mgd with an overall total nitrogen removal of about 54%. The major nitrogen loss, speculated to be by means of gaseous ammonia to the atmosphere, apparently occurred in the aeration unit, settling tank, and aerobic digester.

During Phase II studies, January through June 1974, the mean monthly flow increased to a range of 0.838 mgd to 0.904 mgd; however, the mean total nitrogen loss decreased to 29%, a range that is typical for conventional secondary activated sludge operations. In both Phases I and II, ammonia nitrogen was the predominant form showing major losses.

CONTENTS

FIGURES

TABLES

APPENDIX TABLES

INTRODUCTION

Need for Study

The concern over eutrophication of receiving waters has prompted national and worldwide inquiry into practical methods of limiting nutrient inputs, primarily nitrogen and phosphorus, from both point and nonpoint pollution sources. From several years of laboratory, pilot plant, and demonstration project studies, the conclusion generally reached has been that effective nitrogen removal is both difficult and expensive, whereas, phosphorus can be removed effectively at moderate cost.

Communities contemplating construction of nitrogen removal facilities, in an effort to meet existing and emerging effluent and/or receiving water standards, must not only face a high capital cost for plant facilities but also employ well-trained and educated operators to insure the plant is functioning at its design capacity. The cost for nitrogen removal in smaller communities can involve such a severe economic burden that it would limit consideration of any further type of waste water treatment additions. Thus, inexpensive techniques in operation or design in which the greater part of the nitrogen can be removed from the effluent will greatly enhance the utility of such treatment processes by the community.

Scope and Objective of Study

It had been observed that for a one-year period the Mililani Sewage Treatment Plant (STP) discharged only approximately 30% of the total nitrogen it received in raw sewage, which is primarily domestic, as shown in Table A-1, Appendix A. This relatively high removal rate rivals expensive advanced waste water operations that have been designed specifically for nitrogen removal (McGauhey, Porcella, and Dugan 1971; Federal Water Quality Administration 1970). At the initiation of this study, the Mililani STP was an activated sludge plant with aerobic digestion but without a primary clarifier; however, a primary clarifier and an anaerobic digester, then under construction, were placed in operation approximately two months after the study was begun.

The scope and objectives of the project were to monitor the fate of nitrogen through the existing facilities in order to ascertain at what phases nitrogen was removed, and if this removal was altered by (a) increasing sewage flow as more housing units were completed in the service area (Mililani Town), and/or (b) the design and mode of operations when the primary clarifier and an anaerobic digester replaced the aerobic digester.

MILILANI SEWAGE TREATMENT PLANT

The Mililani Sewage Treatment Plant (STP), located in central Oahu, Hawaii as shown in Figure 1, receives approximately 0.85 mgd of essentially domestic sewage from the nearby expanding Mililani Town development. The plant site is situated at an elevation of approximately 500 ft (152 m) and near the 40 in. (101.6 cm) average annual isohyet. In operation since 1969, the plant utilizes the "Rapid Bloc" activated sludge process, with sludge treatment by anaerobic digestion and chlorinated effluent disposal by discharge into a drainage channel that flows into Kipapa Stream, which converges with Waikele Stream before flowing into the West Loch of Pearl Harbor.

During the fall of 1973, a primary sedimentation tank and an anaerobic digester were added to the sewage treatment components of the Mililani STP. Prior to these additions raw sewage flowed, after pretreatment by a bar screen, Barminutor, and aerated grit chamber, directly to the "Rapid Bloc"

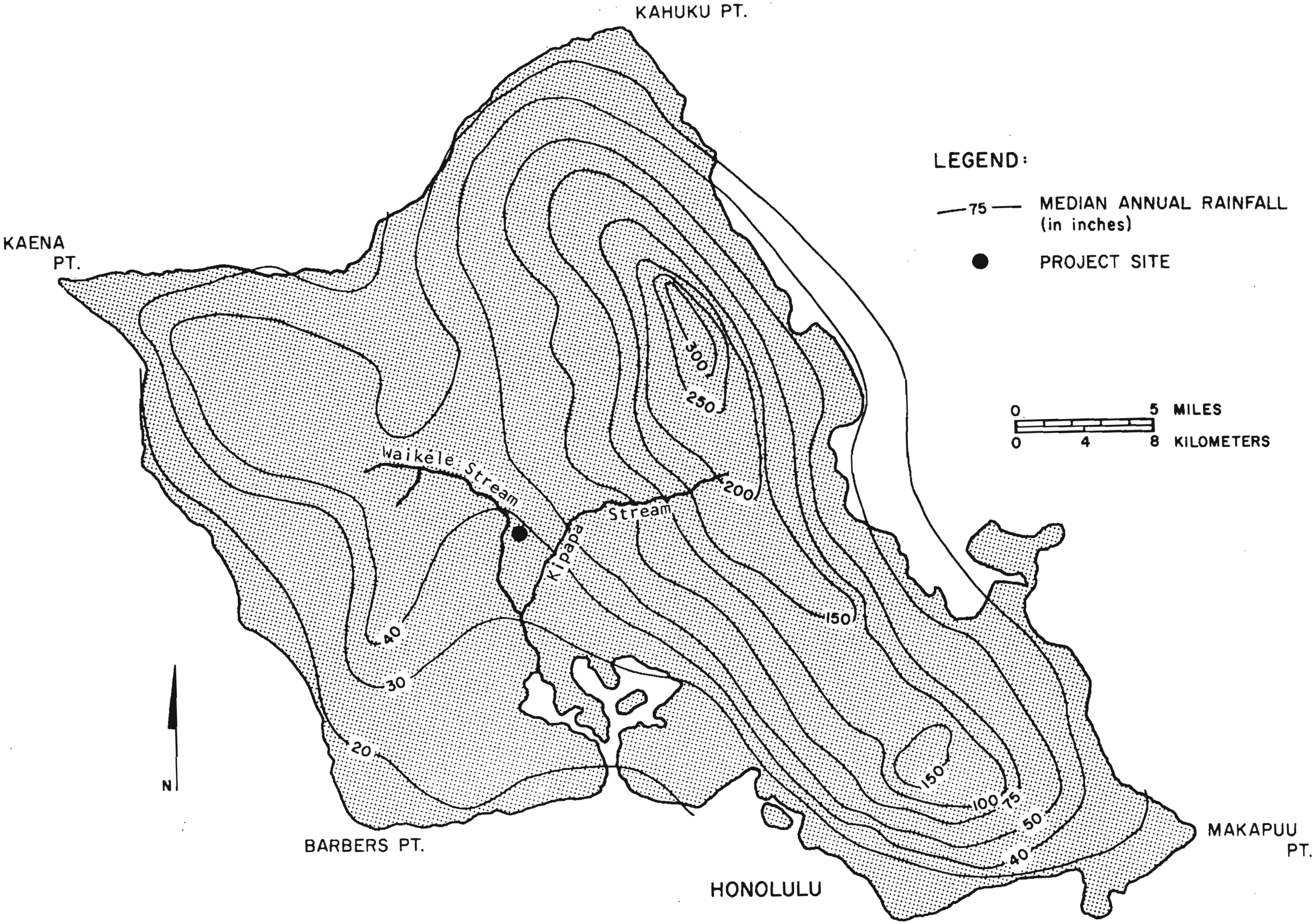

FIGURE 1. GENERAL HYDROLOGIC AND GEOLOGIC CHARACTERISTICS OF OAHU, HAWAII

activated sludge unit. Sludge stabilization was by means of an aerobic digester. After the anaerobic digester was placed in service, the physical structure serving as the aerobic digester was then converted to aeration and final settling tanks. The plant was designed for an average waste water flow of 0.93 mgd capacity before modification and 1.81 mgd after modification.

The project period of study, 1 July 1973 to 30 June 1974, encompassed by design, the transition period when the new components were placed on-line. Because of this sequence of events, the project was segregated into two phases: Phase I to represent STP component conditions before modification up to the fall of 1973, and Phase II to represent STP components after modification and the transition period. The purpose of the transition period was to allow sufficient time to achieve somewhat "steady state" conditions. A schematic of the major components for Phases I and II is shown in Figures 2 and 3, respectively, with a written description of the location of the sampling sites presented in Table 1.

Median flow and the typical parameters for measuring the oxygen demanding removal efficiency of waste water, BOD_5, and suspended solids, collected and analyzed by the City and County of Honolulu for the period of July 1972 to June 1974, are shown on Appendix Table A-2. The basic data for the values presented in Appendix Table A-2 were obtained from the City and County of Honolulu. The parameters presented in Table A-2 are plotted on Figure 4. As can be seen in Figure 4, the median monthly flow rate more than doubled over the two-year period, whereas with minor exceptions, the BOD_5 and suspended solids secondary effluent concentration and removal efficiencies remained approximately the same. The somewhat spasmodic behavior of the BOD_5 and suspended solids secondary effluent concentration and the

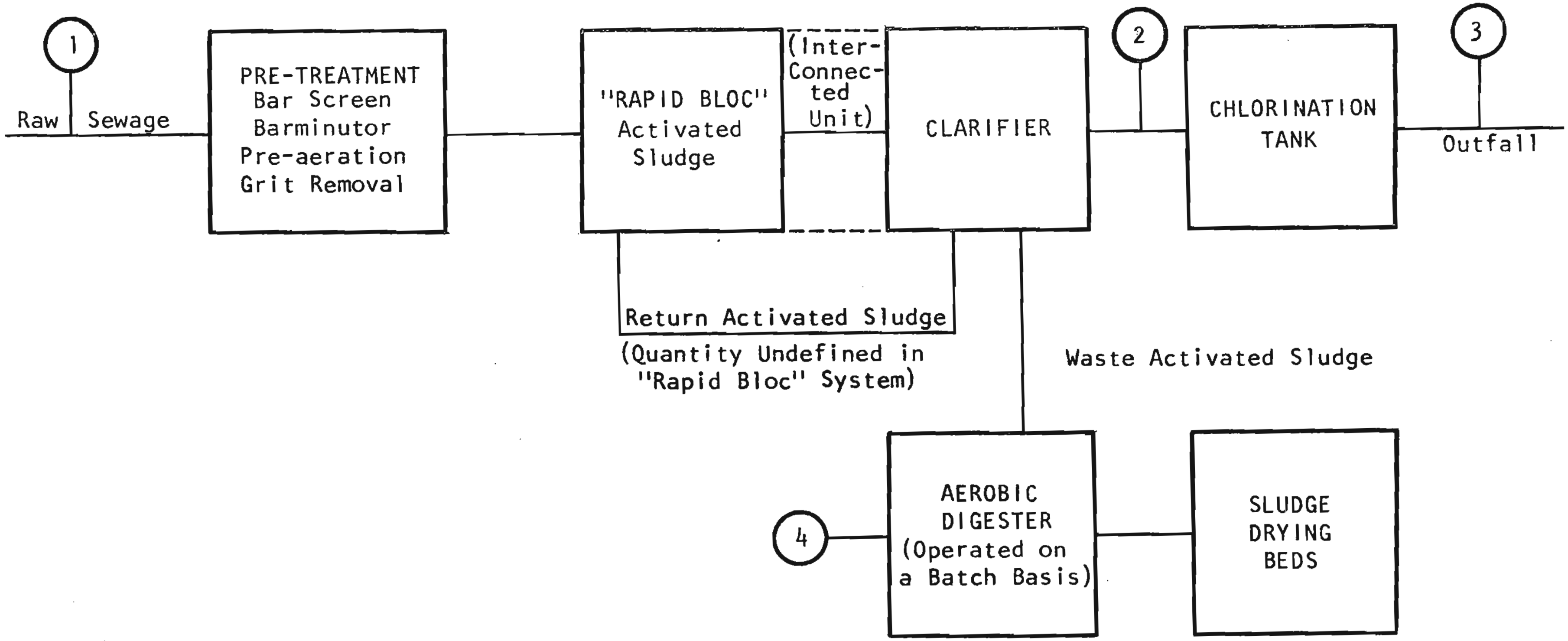

FIGURE 2. PHASE I, MILILANI SEWAGE TREATMENT PLANT

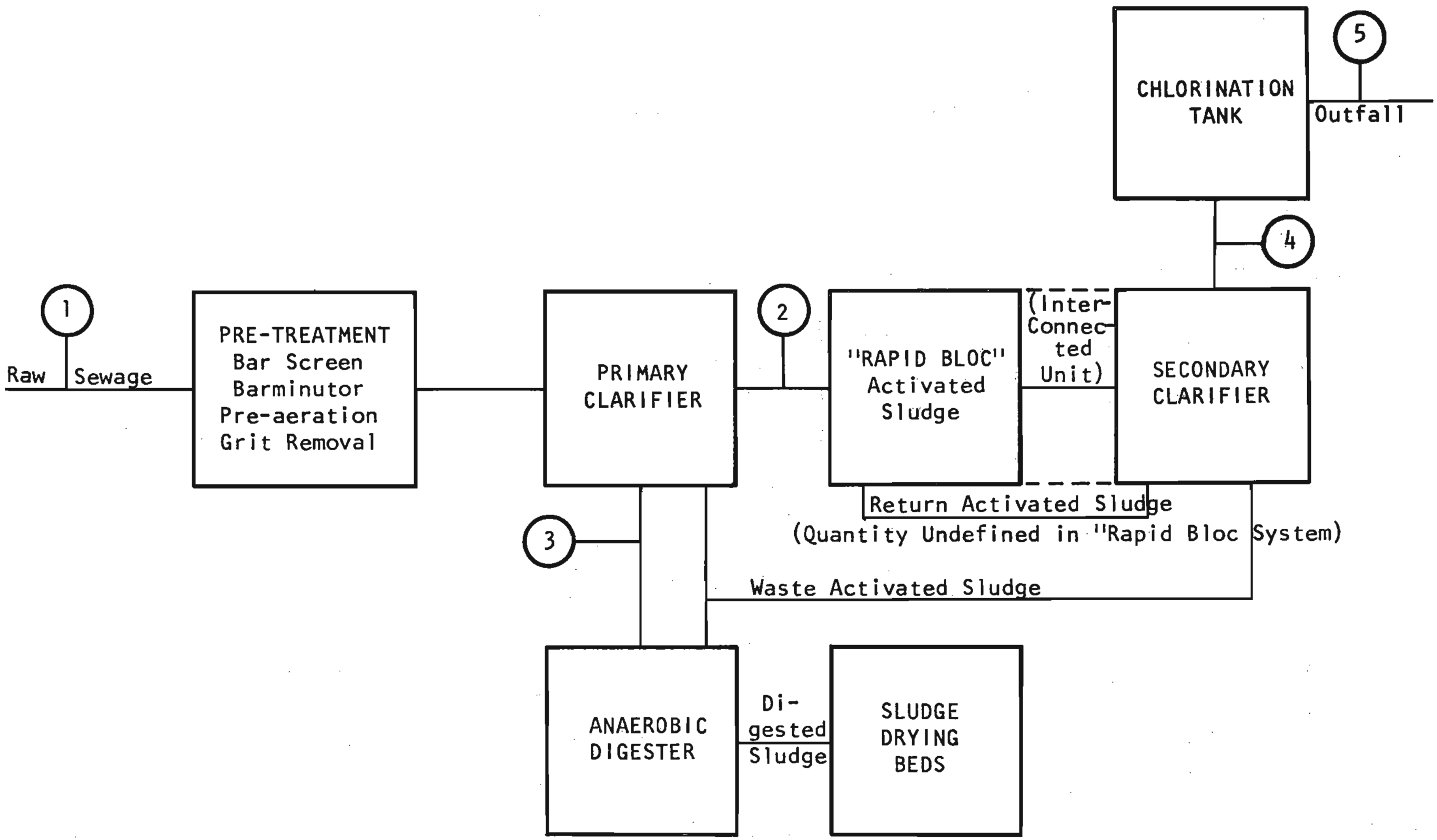

FIGURE 3. PHASE II, MILILANI SEWAGE TREATMENT PLANT

TABLE 1. SAMPLING LOCATIONS: MILILANI STP

SAMPLE NO.	COMPONENT	SAMPLING SITE
		PHASE I
1	RAW SEWAGE	INFLOW CHANNEL APPROXIMATELY 5 FT FROM INLET PIPE
2	SECONDARY CLARIFIER EFFLUENT	ADJACENT TO OVERFLOW WEIR
3	CHLORINATED EFFLUENT	ADJACENT TO OVERFLOW WEIR
4	AEROBIC DIGESTER	UNDER THE LIQUID SURFACE OF EACH DIGESTER
		PHASE II
1	RAW SEWAGE	INFLOW CHANNEL APPROXIMATELY 5 FT FROM INLET PIPE
2	PRIMARY CLARIFIER EFFLUENT	CHANNEL AFTER OVERFLOWING WEIR
3	PRIMARY SLUDGE	VALVE AFTER A SLUDGE PUMP ON PIPELINE BETWEEN THE PRIMARY CLARIFIER AND ANAEROBIC DIGESTER
4	SECONDARY CLARIFIER EFFLUENT	ADJACENT TO OVERFLOW WEIR
5	CHLORINATED EFFLUENT	ADJACENT TO OVERFLOW WEIR

NOTE: REFER TO FIGS. 2 AND 3 FOR PHASES I AND II, RESPECTIVELY.

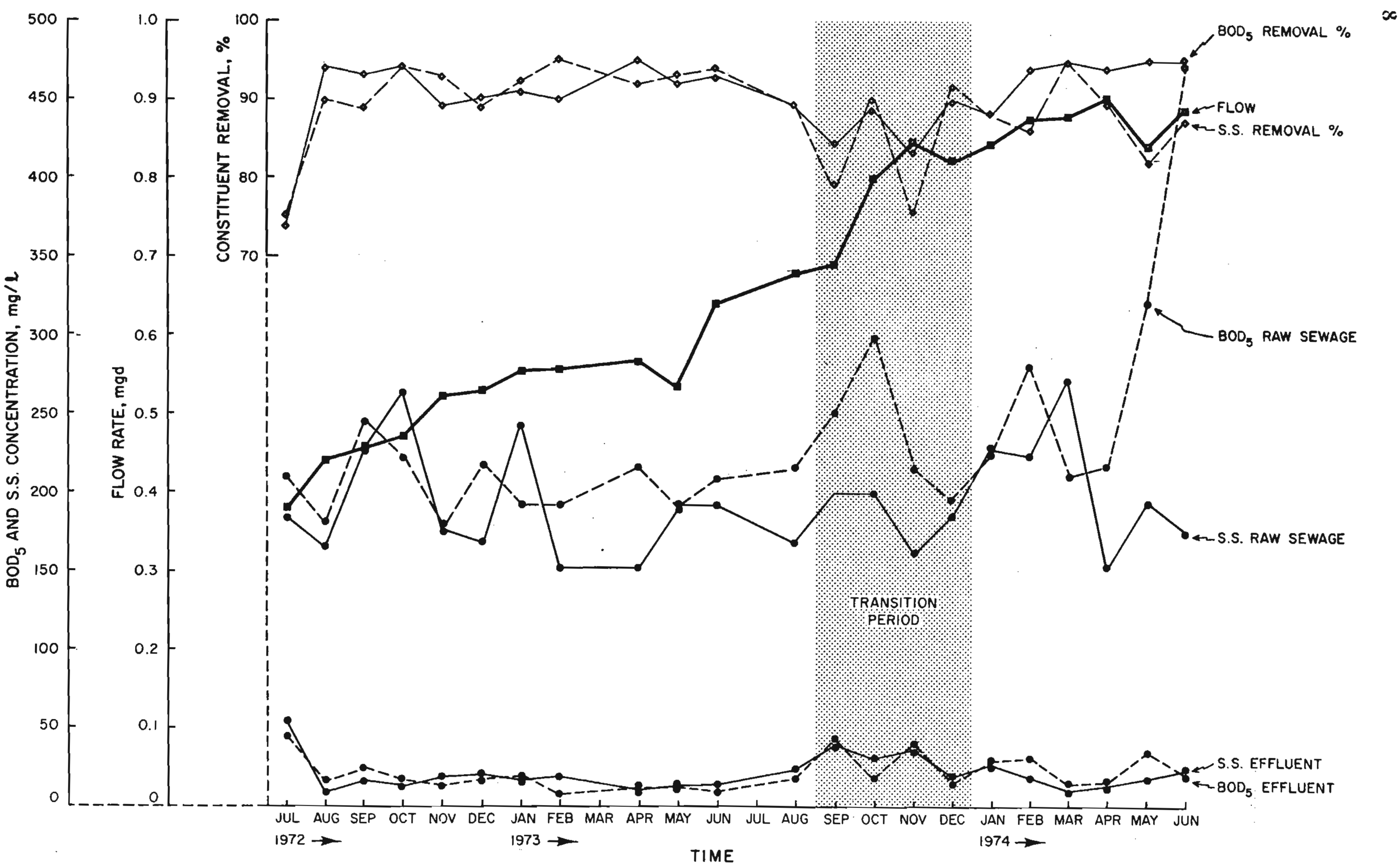

FIGURE 4. FLOW RATE, BOD_5, AND SUSPENDED SOLIDS PARAMETERS FOR MILILANI STP

consequent effect on their respective removal efficiencies during the transition period is quite evident and not unexpected. The rather sharp increase in raw sewage BOD_5 near the termination of the study period, notably June 1974, is considered an anomaly.

Additional monthly median constituent values for the period, February 1972 through the termination of the project June 1974, are presented in Table 2 together with overall medians of monthly median values. The data for these values originated from the University of Hawaii Water Resources Research Center (WRRC) study, *Recycling of Sewage Effluent by Irrigation: A Field Study on Oahu* (Dugan et al. 1974; Lau et al. 1972, 1974). The increase in nitrogen, and to a lesser degree phosphorus, over this time period is very apparent. The relatively low concentration of the other constituents is a reflection of the high quality of municipal water that the service area receives.

METHODS AND PROCEDURES

The sample collection procedure for Phases I and II consisted of collecting grab samples on a weekly to biweekly basis from the influent and effluent of key components of the Mililani STP. All collected samples were transported unrefrigerated to the University of Hawaii Sanitary Engineering Laboratory on the Manoa Campus with analysis commencing within one hour from time of collection. All analyses were performed in accordance with Standard Methods (Amer. Public Health Assoc. et al. 1971) except for the analysis of nitrite and nitrate which followed the procedures outlined by Strickland and Parsons (1972).

TABLE 2. MEDIAN CONSTITUENT VALUES OF SECONDARY EFFLUENT, MILILANI STP

DATE	TOT-N	PO_4-P	K	Na	Ca	Mg	SO_4	SiO_2	TDS	Cl	COND. µmhos /cm
	Median, mg/ℓ										
1972											
FEB.	8.4	--	8.5	41	--	--	57	60	372	52	--
MAR.	14.8	8.72	8.7	40	--	--	41	60	344	47	--
APR.	6.5	9.74	9.1	47	--	--	40	60	340	50	--
MAY	15.5	10.54	10.8	46	--	--	41	59	339	52	--
JUNE	12.5	10.85	9.8	50	--	--	59	56	350	47	380
JULY	14.5	9.98	9.8	49	8	6	50	60	390	50	395
AUG.	7.9	7.10	9.5	51	8	8	51	57	354	50	400
SEPT.	9.7	3.43	7.9	52	9	8	58	56	302	49	395
OCT.	9.5	3.31	8.9	53	12	7	48	61	328	48	395
NOV.	13.4	3.66	8.9	51	12	7	43	65	310	47	390
DEC.	11.8	5.10	8.3	56	10	7	30	60	283	49	445
1973											
JAN.	16.3	9.39	10.2	51	12	6	39	63	386	49	490
FEB.	14.2	8.36	10.0	47	9	6	40	71	327	48	380
MAR.	11.8	--	10.0	60	8	6	40	65	--	51	400
APR.	17.4	--	10.8	55	14	7	43	63	--	49	400
MAY	23.2	12.55	10.6	55	8	9	42	64	--	55	420
JUNE	20.7	11.16	9.5	58	16	4	52	67	354	48	420
JULY	18.1	10.74	9.7	48	14	4	43	64	327	54	370
AUG.	20.3	9.95	10.0	48	12	1	38	70	290	66	345
SEPT.	19.6	10.57	9.0	50	17	5	38	66	198	45	410
OCT.	23.2	10.83	9.6	50	17	7	38	67	311	48	400
NOV.	22.2	12.67	11.2	50	7	12	46	71	353	48	420
DEC.	20.9	13.22	9.4	63	10	10	40	73	311	50	480
1974											
JAN.	24.7	14.27	10.0	61	11	10	42	70	232	48	500
FEB.	17.3	13.54	10.4	59	10	9	35	75	324	48	440
MAR.	20.1	12.82	9.8	57	10	9	36	74	315	50	455
APR.	24.6	10.82	9.6	62	9	9	41	74	337	48	520
MAY	26.7	11.15	10.2	53	10	8	40	74	383	46	580
JUNE	19.3	10.31	10.2	54	8	9	44	73	360	52	485
MEDIAN OF MONTHLY MEDIANS	16.8	10.56	9.8	51	10	7	41	65	333	49	410

SOURCE: LAU ET AL. 1972.

RESULTS AND DISCUSSIONS

The mean flow and nitrogen series concentrations at key locations for Phase I, covering the period 9 July to 6 August 1973, and Phase II, for the months January through June 1974, are tabulated on Tables 3 and 4, respectively. Also shown in the tables are the number of samples for each time period. The numbers in parentheses under the heading sample locations are shown in Figures 2 and 3.

TABLE 3. MEAN FLOW AND NITROGEN SERIES CONCENTRATIONS AT KEY LOCATIONS OF THE MILILANI STP, PHASE I

DATE (No. of Samples) 1973	NITROGEN FORM	SAMPLE LOCATION[a] (1) RAW SEWAGE	(2) PRE-CHL. EFFLUENT	(3) CHL. EFFLUENT	(4) AEROBIC DIGESTER	MEAN EFFL. FLOW
		mg/ℓ				mgd
JULY 9	Org. N	7.60	1.54	1.41	50.13	0.665
to	NH_3-N	20.93	15.19	11.61	34.63	0.665
AUG. 6	NO_2 + NO_3-N	0.01	0.07	0.21	0.20	0.665
	Total N	28.54	16.80	13.23	84.96	0.665

[a]REFER TO FIG. 2.

The recorded flow measurements at the Mililani STP are performed on a continuous basis for only the effluent of the plant. Thus, net nitrogen loadings to individual waste water treatment components cannot be accurately performed, however, indirect flow determinations are being investigated, together with an expanded sampling program by R.T. Tsutsui for incorporation into a Master of Science thesis. The mean flow of 0.838 mgd to 0.904 mgd for Phase II (Jan. to June 1974), presented in Table A-2, Appendix A, is shown graphically in Figure 4. The relatively steady increase in waste water is a direct reflection of the number of new housing units being placed on-line in Mililani Town.

TABLE 4. MONTHLY MEAN FLOW AND NITROGEN SERIES CONCENTRATIONS AT KEY LOCATIONS OF THE MILILANI STP, PHASE II

MONTH (No. of Samples) 1974	NITROGEN FORM	SAMPLE LOCATION[a] (1) Raw Sewage	(2) Settled Sewage	(3) Raw Sludge	(4) Pre-Chl. Effl.	(5) Chl. Effl.	(6) EFFL. FLOW
		mg/ℓ					mgd
JAN. (2)	Org-N	0.60	0.60	28.0	0.60	1.12	
	NH_4-N	24.08	35.19	86.64	24.92	17.77	
	NO_2-N	0.00	0.00	0.00	0.40	0.94	0.842
	NO_3-N	0.00	0.00	0.00	0.32	3.47	
	Tot-N	24.68	35.79	114.64	26.24	23.30	
FEB. (4)	Org-N	1.31	1.87	79.8	1.12	1.12	
	NH_4-N	24.76	40.17	123.38	18.27	19.18	
	NO_2-N	0.00	0.00	0.00	1.40	0.92	0.875
	NO_3-N	0.00	0.00	0.00	0.21	0.72	
	Tot-N	26.07	42.04	203.18	21.00	21.94	
MAR. (3)	Org-N	2.11	1.87	27.07	1.12	1.49	
	NH_4-N	39.45	43.14	102.36	22.22	17.93	
	NO_2-N	0.00	0.00	0.00	1.07	0.96	
	NO_3-N	0.00	0.00	0.00	2.62	1.86	0.879
	Tot-N	41.56	45.01	129.43	27.03	22.24	
APR. (2)	Org-N	3.92	1.96	93.8	0.56	0.84	
	NH_4-N	36.35	52.64	123.13	31.76	31.19	0.904
	NO_2-N	0.00	0.00	0.00	0.38	0.58	
	NO_3-N	0.00	0.00	0.00	0.18	0.67	
	Tot-N	40.27	54.60	216.93	32.88	33.28	
MAY (1)	Org-N	2.24	1.68	221.2	1.12	1.12	
	NH_4-N	28.65	47.63	135.41	28.39	21.89	
	NO_2-N	0.00	0.00	0.00	0.00	0.41	0.838
	NO_3-N	0.00	0.00	0.00	0.01	0.30	
	Tot-N	30.89	49.31	356.61	29.52	23.72	
JUNE (2)	Org-N	1.96	1.96	694.4	0.84	0.56	
	NH_4-N	36.91	49.92	149.16	12.83	16.24	
	NO_2-N	0.00	0.00	0.00	3.79	0.52	0.887
	NO_3-N	0.00	0.00	0.00	3.63	2.28	
	Tot-N	38.87	51.88	843.56	21.09	19.60	
MONTHLY MEAN	Tot-N	33.72	46.44	310.73	26.29	24.01	0.871

[a]REFER TO FIG.3.

One apparent difference in the composition of the raw sewage is the relatively high organic nitrogen content of the total nitrogen in Phase I (27%) in comparison to those tabulated for Phase II (6%). Although several explanations for this phenomenon could be advanced, a most probable reason is not apparent, except possibly for the theory that it was related to the quantity of flow and the residence time of waste water in the sewer lines. A longer residence time would tend to promote a higher degree of transformation of organic nitrogen to ammonia nitrogen. As is readily apparent in Tables 3 and 4, ammonia nitrogen is the dominant form. The possible pathways for the various forms of nitrogen are presented in Figure 5.

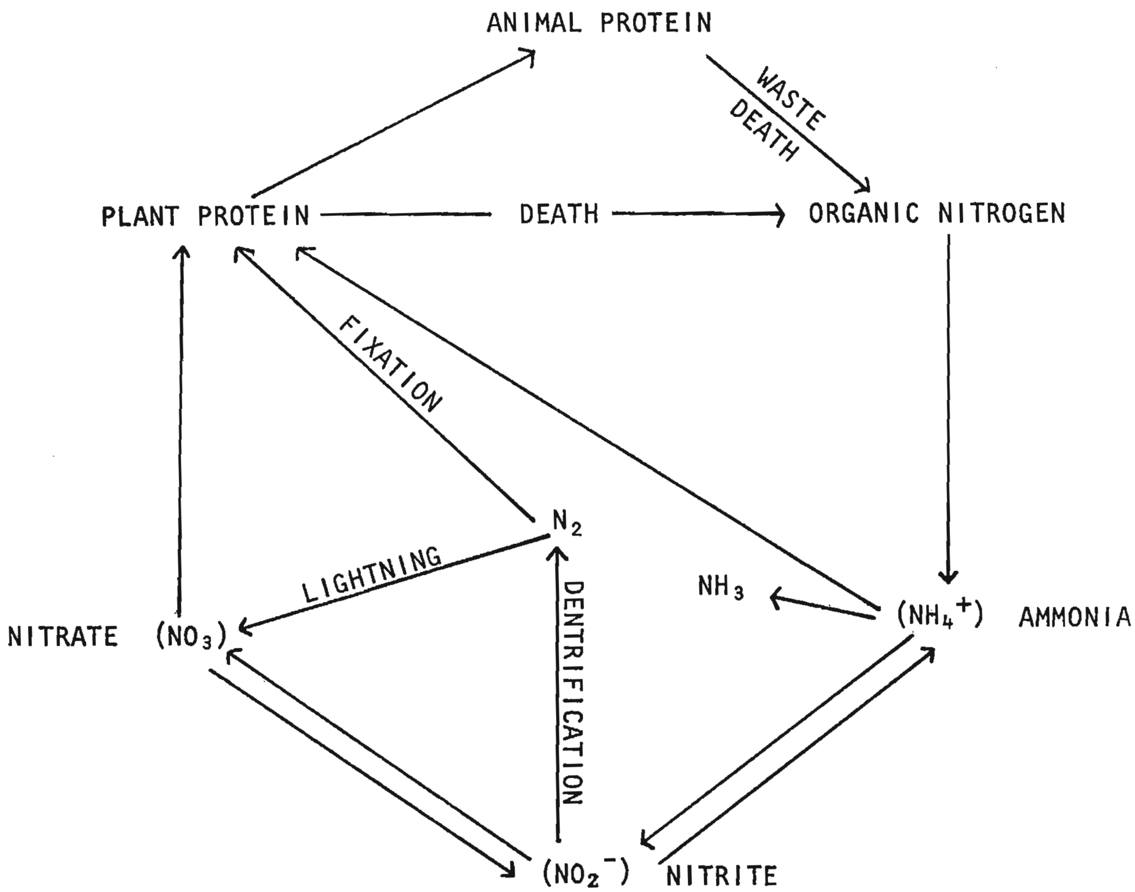

FIGURE 5. NITROGEN CYCLE

The mean daily nitrogen loading rates to the key components during Phase I, as can be observed in Table 3 with reference to Figure 2, show a major decrease in the integrated Rapid Bloc activated sludge unit and the final clarifier and the aerobic digester. The Rapid Bloc activated sludge unit is interconnected to the final clarifier by tubes at the bottom of the units with direct air-lift return of settled sludge solids without pumping, thereby eliminating determination of separate nitrogen loadings and possible losses. The aerobic digester received excess or waste activated sludge when the mixed liquor suspended solids (MLSS) load in the activated sludge unit approached or exceeded the upper concentration range as determined by the operator, and the aerobic digester in turn was operated on a batch basis with periodic decanting of the supernatant to the head of the plant and digested sludge draw-off to the sludge drying beds.

The major change in nitrogen forms between the raw sewage and the effluent from the secondary clarifier, or pre-chlorinated effluent is seen to be a decrease in the concentration of both organic and ammonia nitrogen, with very little increase in the oxidizable nitrogen forms of nitrite and nitrate. The major portion of the organic nitrogen decrease can probably be attributed to a breakdown of the organic nitrogen to ammonia nitrogen. A portion of the ammonia nitrogen decrease could be due to incorporation into the biological fraction of the MLSS and dissolved fraction that is carried over in the waste activated sludge, however, it appears likely that the major portion of the decrease is probably due to ammonia gas lost to the atmosphere in the aeration tank and secondary clarifier, and subsequent loss in the aerobic digester. The rationale for this assumption is that the daily decrease in nitrogen between the raw sewage and the pre-chlorinated effluent, in accordance with the values given in Table 3, is 65 lbs (30 kg), whereas for the same time period, the batch operated aerobic digester only contained an average of 87 lbs (39 kg), with a design residence time of 5 days.

A further decrease in nitrogen during Phase I occurred in the chlorination tank with an indicated loss of 21% in the chlorination component or 13% based on the raw sewage nitrogen content. The major portion of this decrease was probably due to the release of nitrogen gas from ammonia by oxidation through chlorination although a small portion is undoubtably contained in sludge that settles in the chlorination tank, which in turn requires periodic removal. As can be seen in Table 3, nearly all the nitrogen decrease occurred in the ammonia nitrogen portion which adds further credence to the assumption of oxidation by chlorine.

The overall decrease in nitrogen during Phase I (9 July to 6 August 1973) in Table 3 was 54%. As previously mentioned, this compares to a 70% decrease for January 1972 to January 1973, which is tabulated in Table A-1, Appendix A. The total nitrogen content in the raw sewage and treated effluent for the time period in Table 3 was 28.54 mg/ℓ and 13.23 mg/ℓ, respectively, while for the earlier time period, January 1972 to 1973 the median values were 36.2 mg/ℓ and 10.8 mg/ℓ, respectively. The sewage flow of 0.665 mgd in Table 3 is significantly greater than the earlier time period as shown in Figure 4, even though the apparent increasing flow records are only reported from July 1972. The lower flow during the earlier time periods, depending on the mode of operation, in all probability resulted in longer detention times in all components, which in turn presented a greater opportunity for the loss of gaseous forms of nitrogen.

The various nitrogen concentrations during Phase II (January through June 1974) as shown in Table 4, indicate an overall total nitrogen loss of nearly 29% which is in the typical range of most well-operated secondary sewage treatment plants. As can be observed, the ammonia form of nitrogen was by far predominant. The increase in the mean total nitrogen concentration of the settled sewage over the raw sewage, with reference to Figure 3, can be attributed to recirculation of the waste activated sludge and digester supernatant to the primary clarifier. The reduction in the mean nitrogen concentration in the chlorination tank is evident as it was for Phase I. The mean total nitrogen for the six-month Phase II time period of 24.01 mg/ℓ compares to an average of 13.23 mg/ℓ for the Phase I operation. The 24.01 mg/ℓ value for mean total nitrogen in Phase II is within 2 mg/ℓ of the median values reported for a corresponding time period by a different research project at the Mililani STP, as presented in Table 2.

As mentioned previously, a study is currently being conducted to determine a quantitative and qualitative inventory of the various nitrogen forms for each major component of the Mililani STP. The results of the forthcoming study should establish the apparent nitrogen pattern in the operation of the plant. It is apparent, however, that the component chain and mode of operation during the Phase I period, coupled with the lesser sewage flow, resulted in a nitrogen removal rate nearly twice as great as that experienced for the typical secondary sewage treatment plant design of Phase II. It is speculated that the higher nitrogen removal rates of Phase I were probably due to longer periods of aeration, in both the aeration tank and aerobic digester.

ACKNOWLEDGMENTS

The project is indebted to many individuals and agencies for information and assistance during the report period. Special acknowledgments are extended to Chew Lun Lau, George Richardson, George Uyema, and John Abreu, of the Division of Sewers, Dept. of Public Works, City and County of Honolulu, and to Frank Gaudet for the Phase I sampling and analysis.

REFERENCES

American Public Health Association, American Water Works Association, and Water Pollution Control Federation. 1971. *Standard methods for the examination of water and wastewater*. 13th ed. Washington, D.C.

Dugan, G.L.; Young, R.H.F.; Lau, L.S.; Ekern, P.C.; and Loh, P.C.S. 1974. "Land disposal of sewage in Hawaii--A reality?" Paper presented to the 47th Annual Conference of the Water Pollution Control Federation, Denver, Colorado, 6-11 October 1974.

Federal Water Quality Administration. 1970. Nitrogen removal from waste waters. In *Advanced Waste Treatment Seminar, Session I*, Proceedings of the California State Water Resources Control Board and Pacific Southwest Regional Office, FWQA, San Francisco, California, 28 and 29 October 1970.

Lau, L.S.; Ekern, P.C.; Loh, P.; Young, R.H.F.; and Dugan, G.L. 1972. *Water recycling of sewage effluent by irrigation: A field study on Oahu*. Tech. Rep. No. 62, Water Resources Research Center, University of Hawaii.

_____; Ekern, P.C.; Loh, P.C.S.; Young, R.H.F.; Burbank, N.C., Jr.; and Dugan, G.L. 1974. *Recycling of sewage effluent by irrigation: A field study on Oahu--Second progress report for July 1972 to July 1973*. Tech. Rep. No. 79, Water Resources Research Center, University of Hawaii.

McGauhey, P.H.; Porcella, D.B.; and Dugan, G.L. 1971. *Eutrophication of surface waters: Lake Tahoe Indian Creek Reservoir*. Water Poll. Contr. Res. Series 16010 DNY, Environmental Protection Agency, Washington, D.C.

Strickland, J.D.H., and Parsons, T.R. 1972. *A practical handbook of seawater analyses*. 2d ed. Bull. No. 167, Fisheries Research Board of Canada, Ottawa.

Appendix A

TABLE A-1. MEDIAN, MINIMUM, AND MAXIMUM QUALITY PARAMETERS MILILANI STP, JANUARY 1972-JANUARY 1973

	RAW SEWAGE[1]			SECONDARY TREATED EFFLUENT[2]			CONSTITUENT REDUCTION
	Median	Minimum	Maximum	Median	Minimum	Maximum	
	mg/ℓ						%
TOTAL DISSOLVED SOLIDS	493	432	620	344	262	415	30
SUSPENDED SOLIDS	200	130	312	12	4	134	94
BIOCHEMICAL OXYGEN DEMAND$_5$	204	172	310	17	6	49	92
TOTAL ORGANIC CARBON	89	55	127	21	5	62	76
KJELDAHL NITROGEN	36.1	19.0	57.8	10.2	3.2	20.8	72
NITRITE + NITRATE NITROGEN	0.2	0.1	1.3	0.7	0.1	5.4	-250
TOTAL NITROGEN	36.2	19.1	58.5	10.8	5.0	21.9	70
TOTAL PHOSPHORUS	16.71	11.85	23.22	7.65	3.00	11.75	54
SODIUM	53	17	75	51	38	58	4
POTASSIUM	11.0	9.0	19.6	9.1	5.8	11.4	17
CHLORIDE	42	28	49	49	42	60	-17
SULFATE	69	33	109	50	28	94	28
SILICA DIOXIDE	62	52	82	59	53	73	5
BORON	0.53	0.29	1.15	0.35	0.21	0.75	34
GREASE	43.7	22.9	67	8.7	3.6	54.4	80
	#100 ml						
FECAL COLIFORM	--	--	--	2	0	37	--
TOTAL COLIFORM	--	--	--	4	0	160	--

SOURCE: Lau et al. 1974.

[1]GRAB SAMPLES COLLECTED DURING DAYLIGHT HOURS AT THE MILILANI STP RAW SEWAGE INLET.

[2]GRAB SAMPLES COLLECTED DURING DAYLIGHT HOURS FROM EITHER THE DISCHARGE POINT OF THE STP OR FROM THE TANK TRUCK THAT TRANSPORTS SECONDARY TREATED EFFLUENT TO THE TEST PLOT IN OSC SUGARCANE FIELD NO. 240.

TABLE A-2. MEDIAN FLOW, BOD_5, AND SUSPENDED SOLIDS VALUES FOR RAW SEWAGE AND SECONDARY EFFLUENT, MILILANI STP

DATE	AVG.[1] DAILY FLOW mgd	RAW SEWAGE		SECONDARY EFFLUENT		REMOVAL	
		BOD_5	SS	BOD_5	SS	BOD_5	SS
		mg/ℓ				%	
(1972)							
JULY	0.376	209	184	54	46	74	75
AUG.	0.442	180	164	10	17	94	90
SEPT.	0.458	245	228	17	24	93	89
OCT.	0.471	221	264	13	16	94	94
NOV.	0.523	176	176	19	12	89	93
DEC.	0.529	216	168	21	18	90	89
(1973)							
JAN.	0.555	192	244	17	19	91	92
FEB.	0.557	192	152	20	8	90	95
MAR.	--	--	--	--	--	--	--
APR.	0.567	216	152	11	12	95	92
MAY	0.535	181	180	14	12	92	93
JUNE	0.640	208	180	15	10	93	94
JULY	--	--	--	--	--	--	--
AUG.	0.678	216	168	24	18	89	89
SEPT.	0.690	252	200	40	44	84	78
OCT.	0.797	299	200	32	18	89	91
NOV.	0.845	215	160	37	40	83	75
DEC.	0.820	194	185	20	15	90	92
(1974)							
JAN.	0.842	224	228	27	28	88	88
FEB.	0.875	282	224	18	31	94	86
MAR.	0.879	210	274	11	14	95	95
APR.	0.904	217	152	14	15	94	90
MAY	0.838	333	194	18	34	95	82
JUNE	0.887	476	176	24	22	95	88
MEDIAN OF MONTHLY MEDIANS	0.659	216	182	18	18	92	90

NOTE: SAMPLES COLLECTED AND ANLYZED BY THE CITY AND COUNTY OF HONOLULU.
[1]QUANTITY MEASURED ONLY FOR EFFLUENT.