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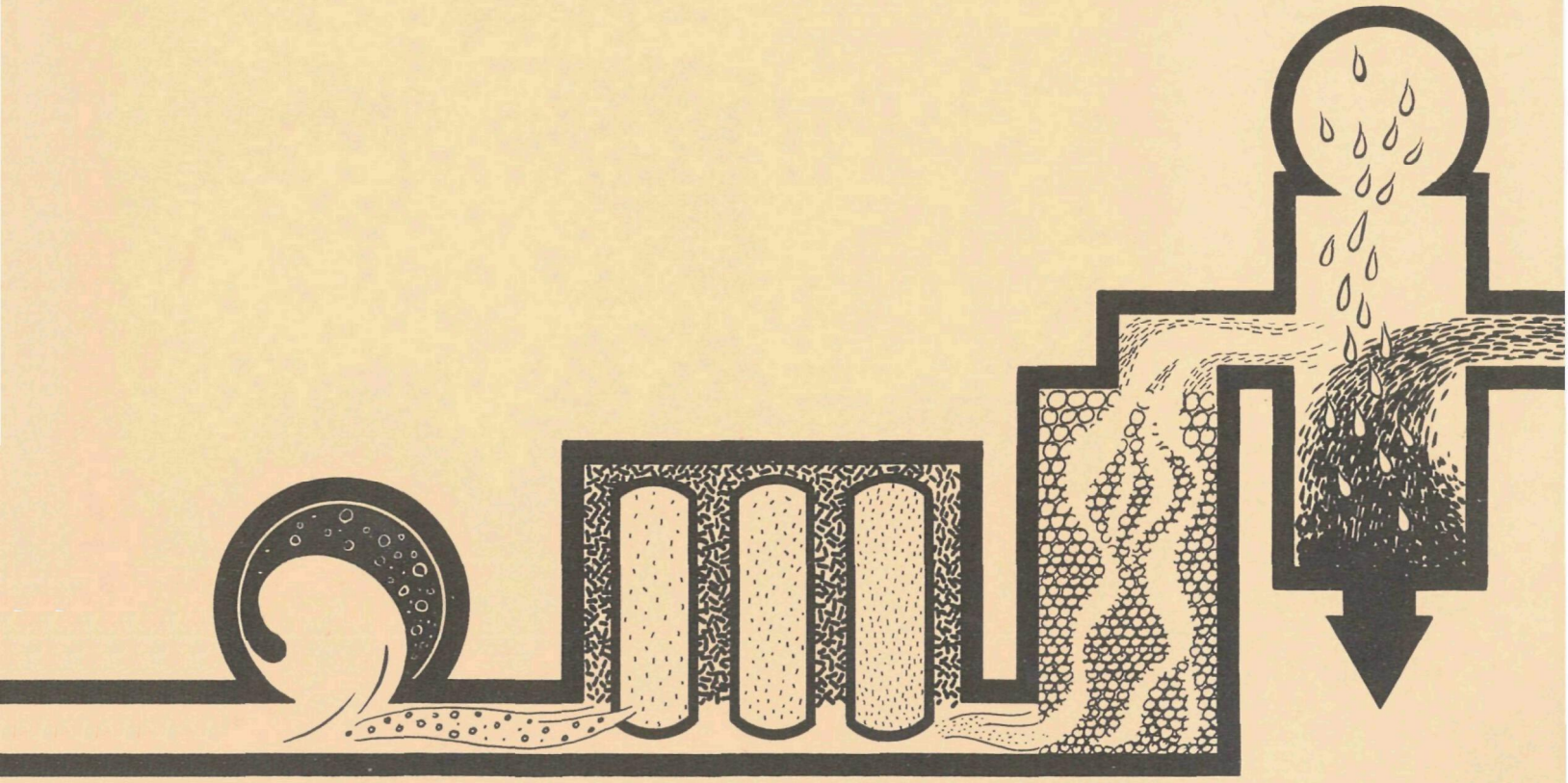
AEROBIC DIGESTION OF ORGANIC WASTE SLUDGE



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AEROBIC DIGESTION OF ORGANIC WASTE SLUDGE

by

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for the

Office of Research and Monitoring

ENVIRONMENTAL PROTECTION AGENCY

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ABSTRACT

Pilot plant aerobic sludge digesters were used for aerobic treatment of sludges at the Stillwater sewage treatment plant. They have a two stage trickling filter plant. Three different sludges were used in the aerobic reactors: (1) primary sludge alone, (2) mixed primary and secondary sludge, and (3) secondary sludge alone. Various detention periods from two days to 36 days were used. The air was applied through air diffusers near the bottom of the aeration tanks. Physical and chemical analyses were made on the feed, mixed liquor, four hour settled sludge, and filtered (paper and sand bed) sludge. Most of this work on aerobic sludge digestion was performed with feeding the reactors once or twice daily, although the first runs were fed with measuring pumps activated by a time clock. One run was made on a batch basis. The measuring pumps clogged so frequently that the actual loading of the aeration tanks were not accurate enough to obtain meaningful data. The data obtained indicated considerable variation in the concentration of the various parameters with time of aeration and with source of the sludge. General trends indicate that the active organisms are in a state of flux. The pilot plant results indicate as shown by some full scale operating plants that good conditioning of the sludge by aerobic digestion is economical, while in other cases the results leave much to be desired.

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SECTION I

CONCLUSIONS

1. Sludge from waste treatment plants has proven to be one of the most difficult problems for those intimately involved with waste treatment plants. The difficulties involved are found in both small and large plants. In full scale plants and in pilot plants used in this investigation drying of sludge has proven to be rather difficult and costly.

2. Dewatering and drying on sand beds were influenced by the detention time in the reactor. Settling four hours in a two liter graduate cylinder before placing on drying beds did not always improve drainability. Generally the primary sludge without treatment drained more rapidly than aerated sludge. Four to eight days of aeration usually produced a sludge with lower solids concentrations than other aeration times.

3. For the batch aerobic digester a lower total solids concentration was obtained for a 30 day detention period than for any lesser time.

4. Aerobic digestion of primary, mixed primary and secondary, and secondary waste sludges are feasible, although results of some tests show great variations.

5. Aerobic digestion of the above three sludges to acceptable end products can be accomplished at 4 to 30 days detention time.

6. Maximum reduction in total solids and volatile solids in the mixed liquor occurs at 4 to 30 days detention time.

7. Drainage of aerobically digested sludge surpassed the drainage of anaerobically digested sludge. This is in complete agreement with results reported by Quon (15) and Randall (17).

8. Sludge digested 4 to 12 days out-performed all other sludges used for most of the time and for most of the parameters considered.

9. Evaporation had a very insignificant effect on the dewatering process under the conditions to which the sand filters were exposed.

10. The drainage phase on sand beds was responsible for removing most of the total volume of water removed.

11. Drainability of sludge on sand beds correlates fairly well with filterability of primary sludge as measured by the capillary suction automatic instrument. For mixed primary and secondary sludges there was little correlation. With a simple test performed, this instrument can provide the plant operator with a general idea of whether or not

the sludge in the aerobic digester is ready for application on the drying beds.

12. The drainability of the sludges tested showed a drainability ratio over 25 except for the mixed primary and secondary sludge with detention times of 8 and 18 days and for the anaerobic digested sludge.

13. The settling characteristics had no correlation whatsoever with the drainage behavior of sludge.

14. After filtration through paper or sand beds, ammonia-N tends to decrease; nitrate-N tends to increase; orthophosphate tends to decrease and COD tends to increase.

15. COD values of the three sludges varied widely with detention time and in relation to each other. The filtrates through paper and sand beds show much lower COD values than the mixed liquors.

16. Filtrate (paper) liquors from the aerobic digestion showed higher COD values than filtrate (paper) liquors from anaerobic digestion.

17. Free ammonia was generally less for the filtrates than for mixed liquors for each of the three sludges. The concentrations generally fluctuated with detention time.

18. There were erratic changes in the nitrates and phosphates for both the mixed liquors and the filtrates. The filtrates showed a decrease in the nitrates and phosphates as compared to the mixed liquors.

19. In the batch study, the total solids and volatile solids reductions were a function of digestion time.

20. Efforts to obtain metering pumps for feeding the digesters or reactors were unsuccessful. Some pumps clogged as many as four times in one day. Thereafter, the reactors were fed once daily to obtain each particular detention time. From previous experience with feeding reactors it was shown that more continuous feeding would obtain about five percent greater reductions in the magnitude of the various parameters determined.

21. More consistent and more favorable results would probably occur with a higher dissolved oxygen residual in the reactors.

22. According to information by correspondence with Tennessee Health Department, they have had no odor problems at sewage treatment plants utilizing the aerobic sludge digestion process in many full scale plants. A higher oxygen content maintained in the aerobic digesters of this project might have produced lower odor intensities in the reactors of this project. In Oklahoma at two aerobic digesters at sewage treatment plants odors are still a problem while at one plant odors are not a serious problem.

SECTION II

RECOMMENDATIONS

Studies are needed on the structural properties of aerobically digested sludge to promote a greater understanding of what affects the drainage rates. Dewatering of aerobically digested sludge utilizing mechanical dewatering methods, such as vacuum filtration, centrifugation, filter press dewatering, and the hydroclone need evaluation. The addition of chemical conditioners to aerobically digested sludge may improve sludge dewatering substantially. More studies are needed on the usage of coarser sand as a drainage medium.

Pilot studies on the response of various mixes of primary and secondary sludges to aerobic digestion are needed. Studies utilizing two-stage aerobic digesters might be valuable. Further batch studies are needed to substantiate the response of aerobic digestion of primary and/or secondary sludges under more closely controlled conditions. Pilot studies utilizing pure oxygen rather than diffused air as the oxygen source might produce more consistant and better results.

SECTION III

INTRODUCTION

For many years, the sanitary engineer has been plagued with the problems of sludge disposal. The problem was noticed in England in 1857 with a proposal to remove part of the "filth" in sewage prior to its discharge into a receiving stream. Methods for disposal of this filth, now referred to as sludge, accounts for about 40 percent of the total treatment cost.

Many new ideas for sludge treatment and disposal have been proposed and put into use in recent years. Tighter effluent criteria, increasing land costs, and population pressures have combined to make sludge disposal more difficult and expensive. The increasingly large quantities of sludge resulting from growth of industry increases the disposal problems.

The method most commonly used today is that of anaerobic digestion followed by dewatering of sludge. Dewatering practices include sand drying beds, vacuum filtration, and pressure filtration. For at least the last 10 or 15 years aerobic sludge digestion has been used or experimented with in an attempt to provide better treatment at a lower cost. Aerobic sludge digestion is a process in which waste sludges are subjected to aeration by various means to reduce the amount of sludge and to make it less objectionable estheticly.

To accomplish this, sludge dewatering must be performed in the most economical method possible. Along with drying of sludges various physical and chemical determinations have been made on primary sludge, mixed primary and secondary sludge, and secondary sludge. A pilot plant with four separate but identical units was set up at the Stillwater, Oklahoma sewage treatment plant, and two at the laboratories of Oklahoma State University. The separation of the units was made because there was room for only four at the sewage treatment plant.

SECTION IV

OBJECTIVES

The basic objectives of the investigation were to determine the usefulness and effectiveness of aerobic digestion of municipal sewage sludge on a pilot plant basis. Comparisons were made of the various parameters of the aerobically digested sludges including primary sludge, mixed primary and secondary sludge, secondary sludge, and of the anaerobic digested sludge.

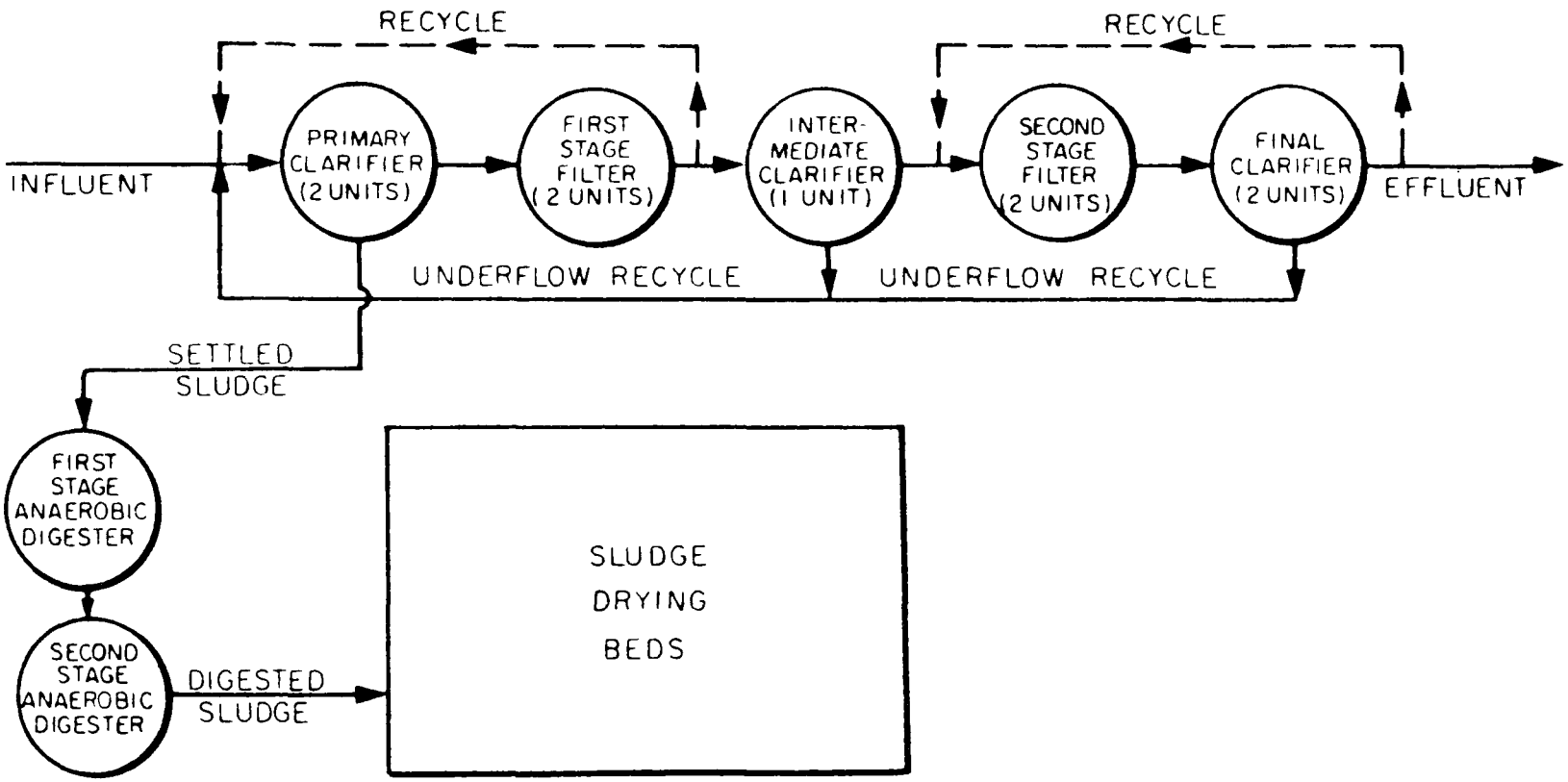
SECTION V

DESCRIPTION OF PILOT PLANT

AND EQUIPMENT

The Stillwater, Oklahoma, sewage treatment plant consists of an aerated grit chamber, a preaeration tank, two primary clarifiers, a primary trickling filter, an intermediate clarifier, a secondary trickling filter, two final clarifiers, a primary digester, a secondary digester and sludge drying beds, along with the auxillaries that normally go with treatment plants of this type. A schematic drawing of the pertinent features of the plant are shown in Figure 1. The piping of the sewage treatment plant was installed so that the sludge from the intermediate clarifier and from the final clarifier would be returned to the primary clarifier. Modifications of the piping were made so that the primary sludge alone could be obtained for the pilot plant. Then valves were changed so that the primary and secondary sludge could be obtained for the pilot plant. Finally secondary sludge alone was piped to the pilot plant. The sludge for use in the units at the Civil Engineering School's laboratory were trucked in from the sewage treatment plant.

The pilot plant was set up with four complete units at the Stillwater Sewage Treatment Plant in the main pump house, and two complete units at the Oklahoma State University, Civil Engineering laboratories. Each unit consisted of one 200 gallon polyethylene tank (180 gallon capacity) placed inside of a 250 gallon tank. The first tank had a smaller diameter than the second providing an annular space so that water could be circulated from a constant temperature control unit to the reactor and back again to the temperature control unit. This arrangement provided essentially a constant temperature in the reactors as soon as the controls were properly adjusted. The sludges were placed in the aerobic reactors or digesters at specific intervals usually once a day. Any overflow was discarded. Samples were taken after the reactors approached equilibrium. A flow diagram of the pilot plant is shown in Figure 2A and a schematic drawing is shown in Figure 2B. Other features are shown in Figures 3, 4, 5, 6, and 7. Flow to the reservoir from the primary clarifier was regulated by an automatic valve which, in turn, was controlled by the sludge level in the reservoir. The system was operated as a completely mixed semi-continuous flow operation. The same amount of waste was discharged as was fed to the reactor; i.e., inflow was equal to outflow. Detention times of 2, 4, 8, 12, 18, 24, and 30 days were investigated at a temperature of 25°C. Air was supplied to the reactors through diffusers located several inches from the bottom of each reactor. Air flow rate was set at 88 cfm/1000 cu ft of digester space, and was measured by calibrated flowmeters. Each reactor capacity was 180 gallons and was placed inside a 250 gallon tank. The larger tanks were used for temperature control. Heated or cooled water was pumped through the bottom of the outside tank, between the walls of the outside tank and

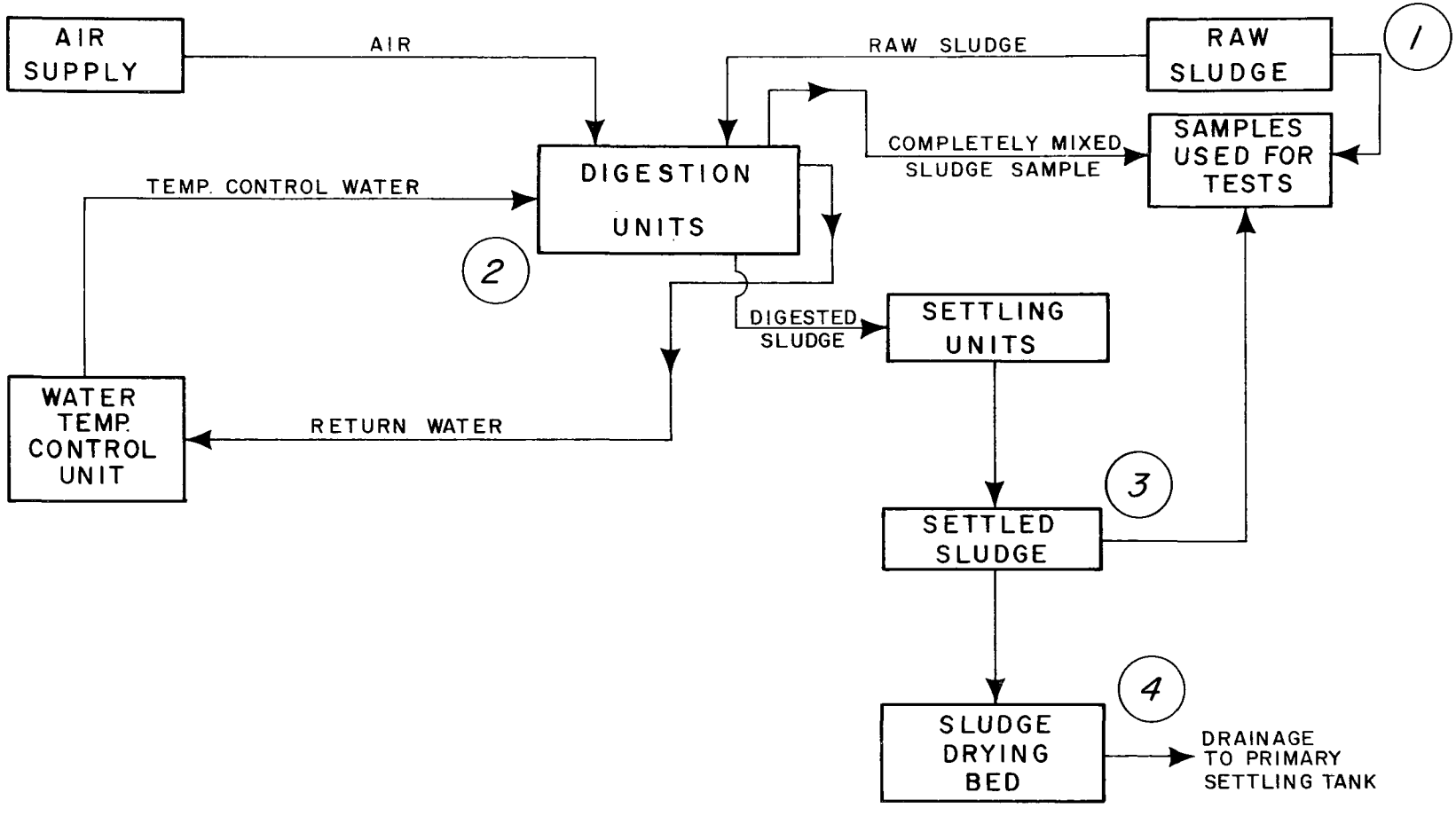


SCHEMATIC DIAGRAM

OF

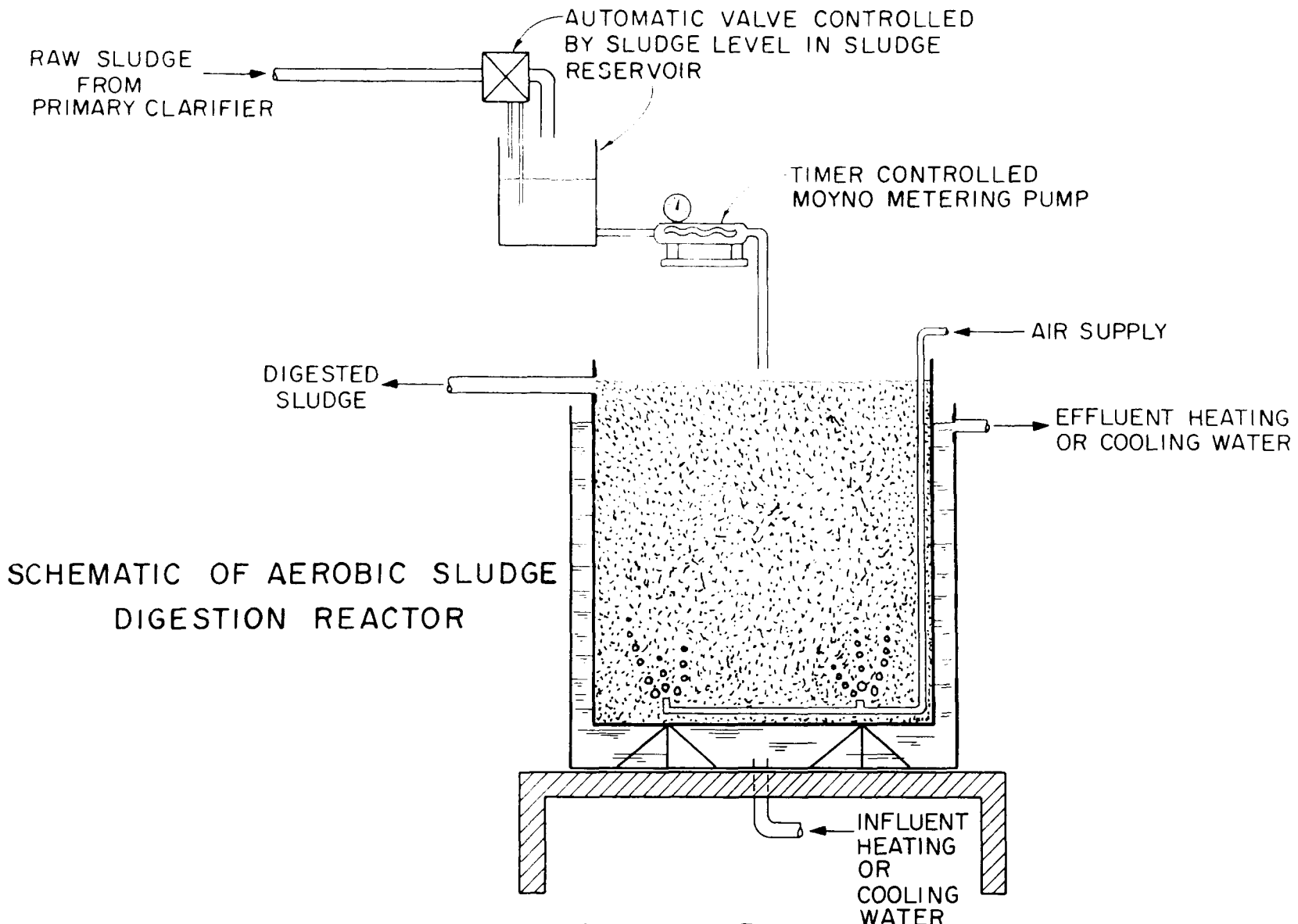
STILLWATER SEWAGE TREATMENT PLANT

Figure 1



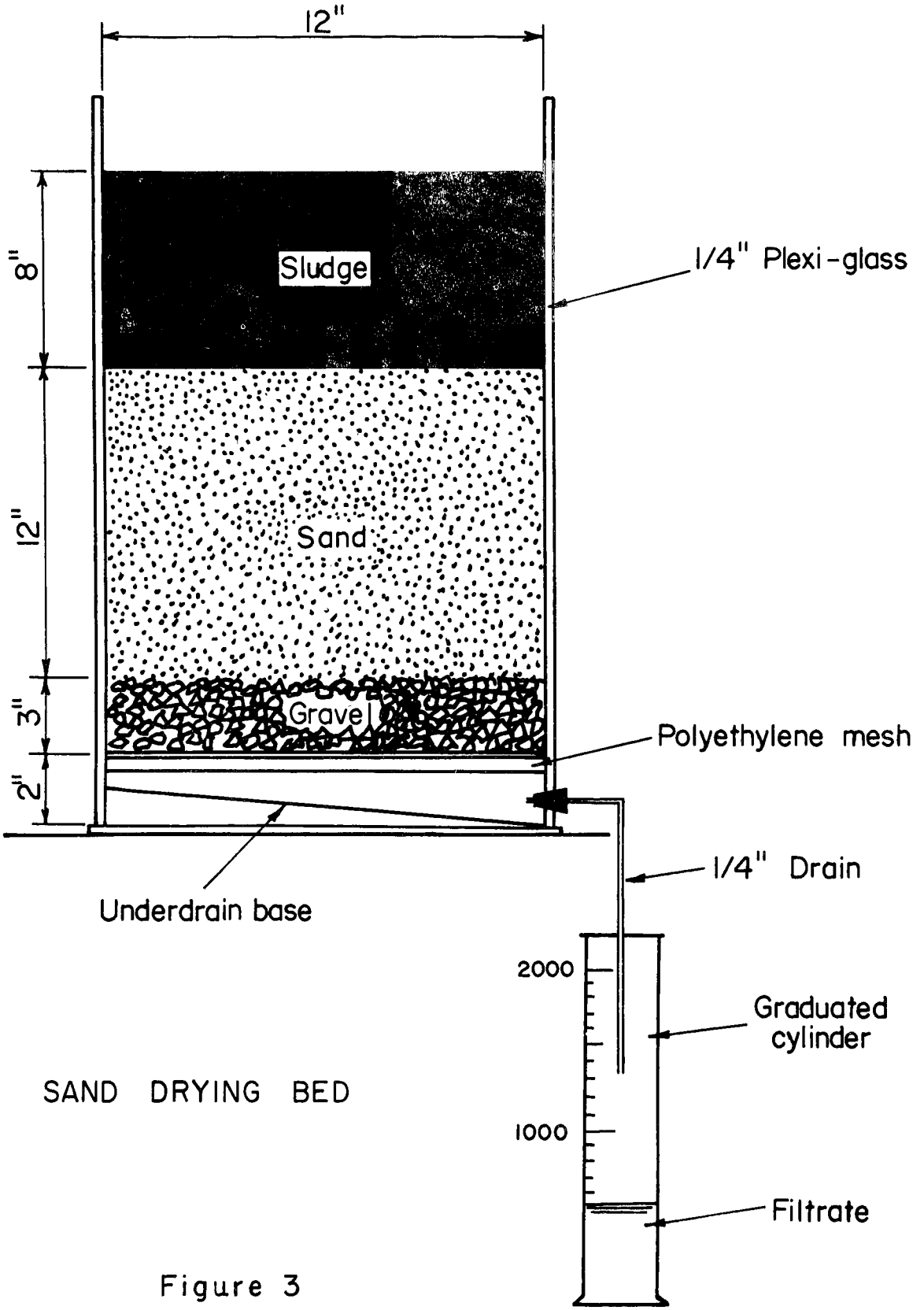
FLOW DIAGRAM FOR
AEROBIC SLUDGE DIGESTION SYSTEM

FIGURE 2-A



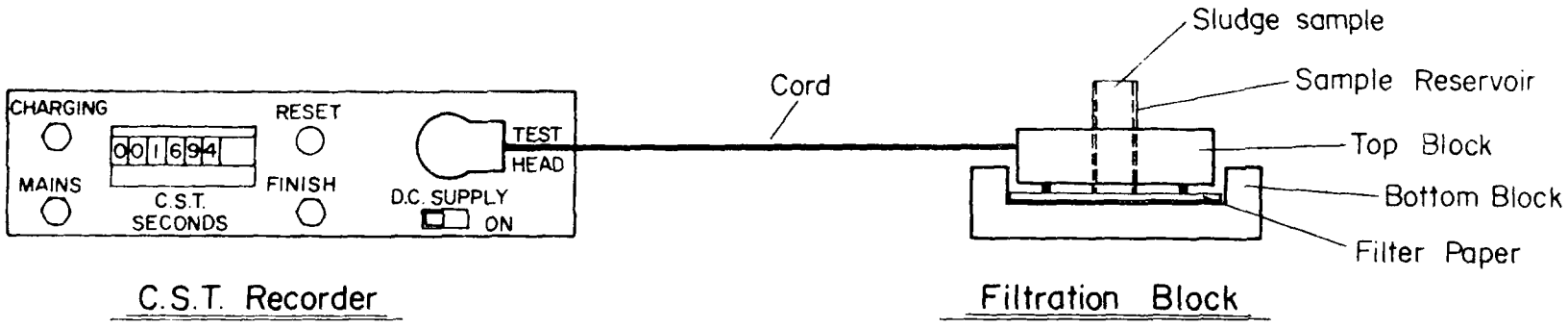
SCHEMATIC OF AEROBIC SLUDGE DIGESTION REACTOR

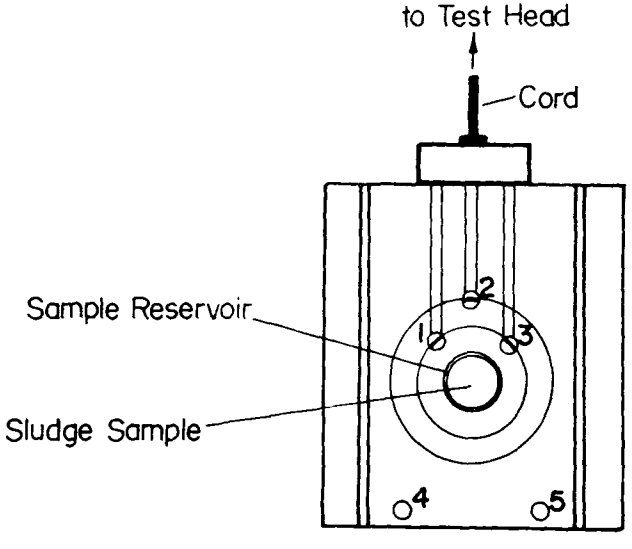
Figure 2-B



SAND DRYING BED

Figure 3





Filtration Block
(top view)

SCHEMATIC DIAGRAM OF FILTERABILITY INSTRUMENT

Figure 4

the reactor to maintain the desired temperature in the reactors.

The sludge drying beds used for this study are illustrated schematically in Figure 3. They are the portable, model-size type, made of 1/4-inch thick plexiglass with a length of one foot, width of one foot, and a depth of three feet.

Six of the above mentioned containers were used in this study. Each contained a three-inch depth of gravel sieved through a 1/4-inch sieve and retained on a 1/8-inch sieve; and a 12-inch depth of sand sieved through sieve No. 20 and retained on sieve No. 40.

Both the gravel and the sand were supported by a strong polyethelene mesh fitted to the base of each bed. A galvanized wire mesh was inserted between the gravel and the sand layer to keep the sand particles from penetrating through the gravel to the underdrain base.

A sloping base to each bed permitted the drainage to be removed through a 1/2-inch drain for collection in a graduated cylinder.

The only unique apparatus used on this project was the Capillary Suction Time (CST) instrument manufactured in England by Triton Electronics Ltd. This instrument is illustrated in Figures 4 and 5. It is used as a measure of the filterability of the sludge. Filterability was used for comparing with the drainability of the sludge. This was determined by using the above simple automatic instrument for determining the filterability of sludge. Six of these instruments were imported from England and were used throughout this study. It consists of two separate components: the filtration segment and the automatic time recorder.

The filtration segment consists of two 7 cm by 9 cm pieces of plexiglass where a Whatman rectangular filter paper was placed between the two blocks. The upper block had a 1.9 cm circular hole, where a stainless steel collar which served as a sludge reservoir, was tightly placed through the hole resting on the filter paper uniformly.

On the underside of the upper plexiglass block are two engraved circles with diameters of 3.2 cm and 4.5 cm concentric with the reservoir. This plexiglass block stands clear of the filter paper by resting on five stainless steel supports (1, 2, 3, 4, and 5 in Figure 4).

Electrical connections are made to probes 1, 2, and 3 which lead to the other component, the automatic time recorder. Terminals 4 and 5 are provided to hold the upper block parallel with the filter paper.

A photograph of this apparatus is shown in Figure 5. The apparatus for determining the four hour settling of solids is shown in Figure 6, while a digestion unit together with a temperature control unit are shown in Figure 7.

Other items such as analytical equipment and procedures are those commonly used in testing for physical and chemical components of the wastes. Tests were made also on anaerobic digested sludge samples including anaerobic digested sludge which was aerated for four days.

Digested sludge was collected from the reactors periodically for chemical and physical analyses. Samples were split into three fractions for analyses. One fraction, the mixed liquor, was tested for the following parameters: COD, BOD, ammonia nitrogen, nitrate nitrogen, total phosphates, total solids, volatile solids, and pH. A second fraction was the filtrate from the mixed liquor. "Filtrate" here means that liquid which passes through No. 40 Whatman filter paper. COD, BOD, PO_4, Kjeldahl-nitrogen, and nitrate nitrogen were run on this fraction.

The third fraction was the mixed liquor after settling for four hours. The supernatant was drawn off and the concentrated mixed liquor was applied to the sand beds for determination of dewatering characteristics. That liquid portion passing through the sand beds was then analyzed for COD, PO_4, and nitrogen

A summary of observations and tests made is given in Table 1.

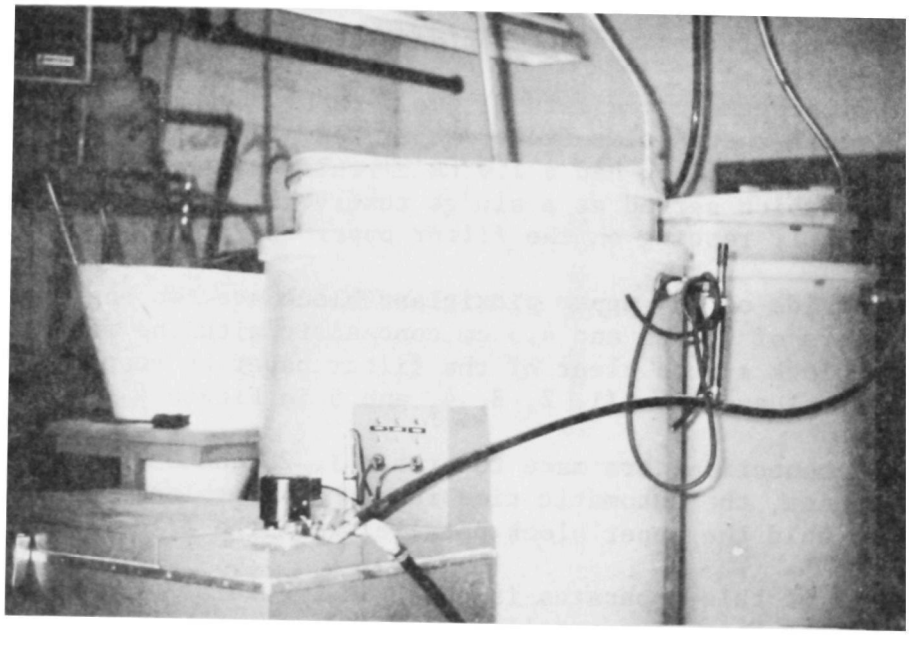


FIGURE 5

FILTERABILITY APPARATUS

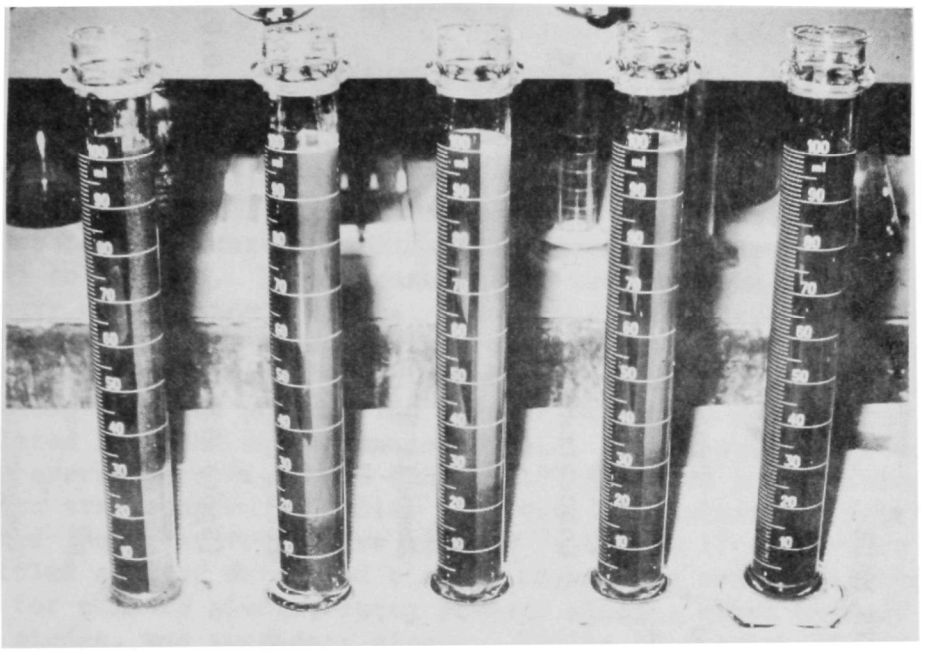


FIGURE 6

APPARATUS FOR DETERMINING THE

4-HOUR SETTLING OF SOLIDS

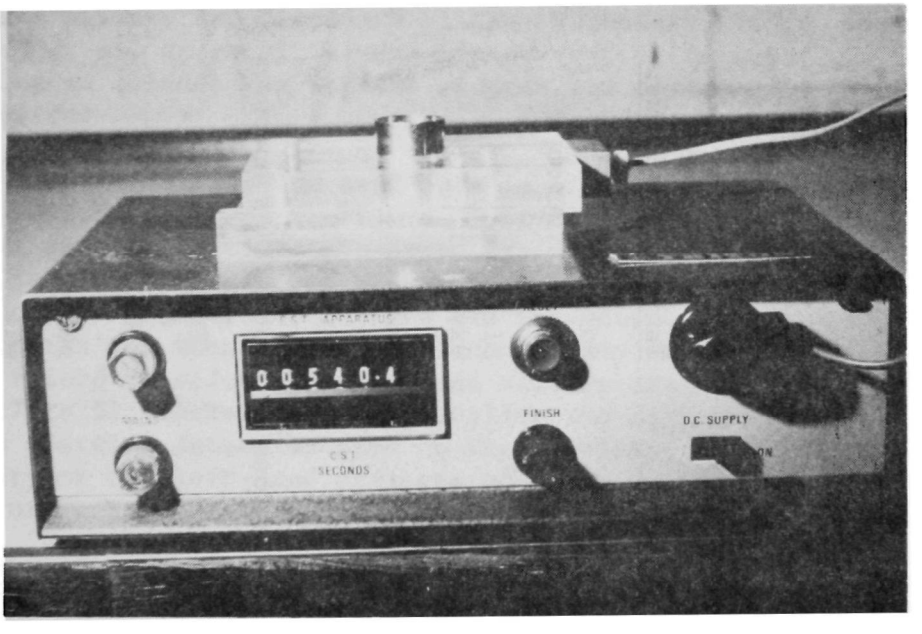


FIGURE 7

DIGESTION UNITS WITH TEMPERATURE CONTROL UNIT

TABLE 1

SUMMARY OF OBSERVATIONS AND TESTS MADE

1 Raw Sludge	2 Sludge Aeration Tank, Mixed Liquor	3 Process Aerated Settled Sludge	4 Process Effluent	5 Dried Sludge
Solids Concentration	Solids Concentration	Solids Concentration	Solids Concentration	% Moisture
	Dissolved Oxygen	Filterability	Dissolved Oxygen	Drainability
Ammonia N	Ammonia N	Ammonia N	Ammonia N	
	Nitrate N	Nitrate N	Nitrate N	
Total Phosphorous	Total Phosphorous	Total Phosphorous	Total Phosphorous	
(Spot) B.O.D.	(Spot) B.O.D.	(Spot) B.O.D.	(Spot) B.O.D.	(Spot) B.O.D.
C.O.D.	C.O.D.	C.O.D.	C.O.D.	C.O.D.
pH	pH	pH	pH	
Temperature	Temperature	Temperature	Temperature	

SECTION VI

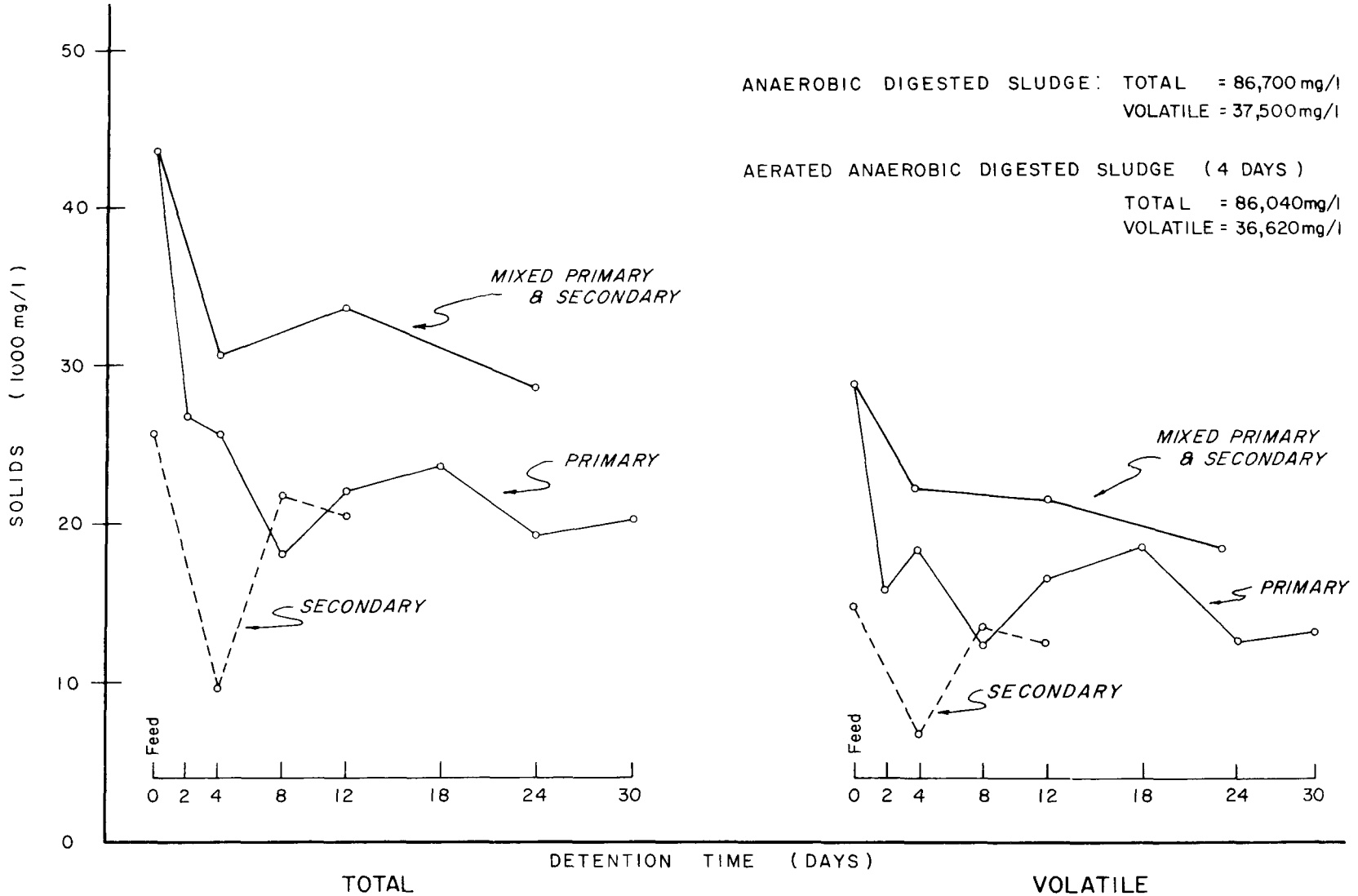
PHYSICAL PARAMETERS

The solids, including daily feed and batch feed, in this project are total and volatile mixed liquor sludge solids, and total and volatile mixed liquor four hour settled solids for detention times ranging from zero (feed) to 36 days. These measurements were made on primary sludge, mixed primary and secondary sludge, and secondary sludges. The batch unit was used on primary sludge only. The anaerobic digested sludge and anaerobic sludge aerated for a detention period of four days were included along with the above. The percent water for each of the above was calculated from the above mentioned data. The above values are plotted as averages on Figures 8 through 16 inclusive and individual test results are recorded in Tables 2 through 15 inclusive. Settleability of mixed liquor at four hours plotted in Figure 17 as percent by volume settled against detention time in days. The settleabilities are shown for primary sludge, batch primary sludge, mixed primary and secondary sludge, and secondary sludge. Tables 55 through 64, inclusive show the percent by volume for all the sludges. Most of the physical parameters for the batch reactor are tabulated in Tables 53 and 54.

The filterability of sludges was measured on the mixed liquor by the English instrument previously mentioned and is referred to as filterability, capillary suction time, or C.S.T. in seconds. Filterability of sludges is summarized in Figure 18 on mixed liquors for primary sludge, mixed primary and secondary sludge, secondary sludge, batch primary sludge, and anaerobic sludge for several different times. The C.S.T. values in seconds for various sludges are recorded in Tables 55 to 64 inclusive.

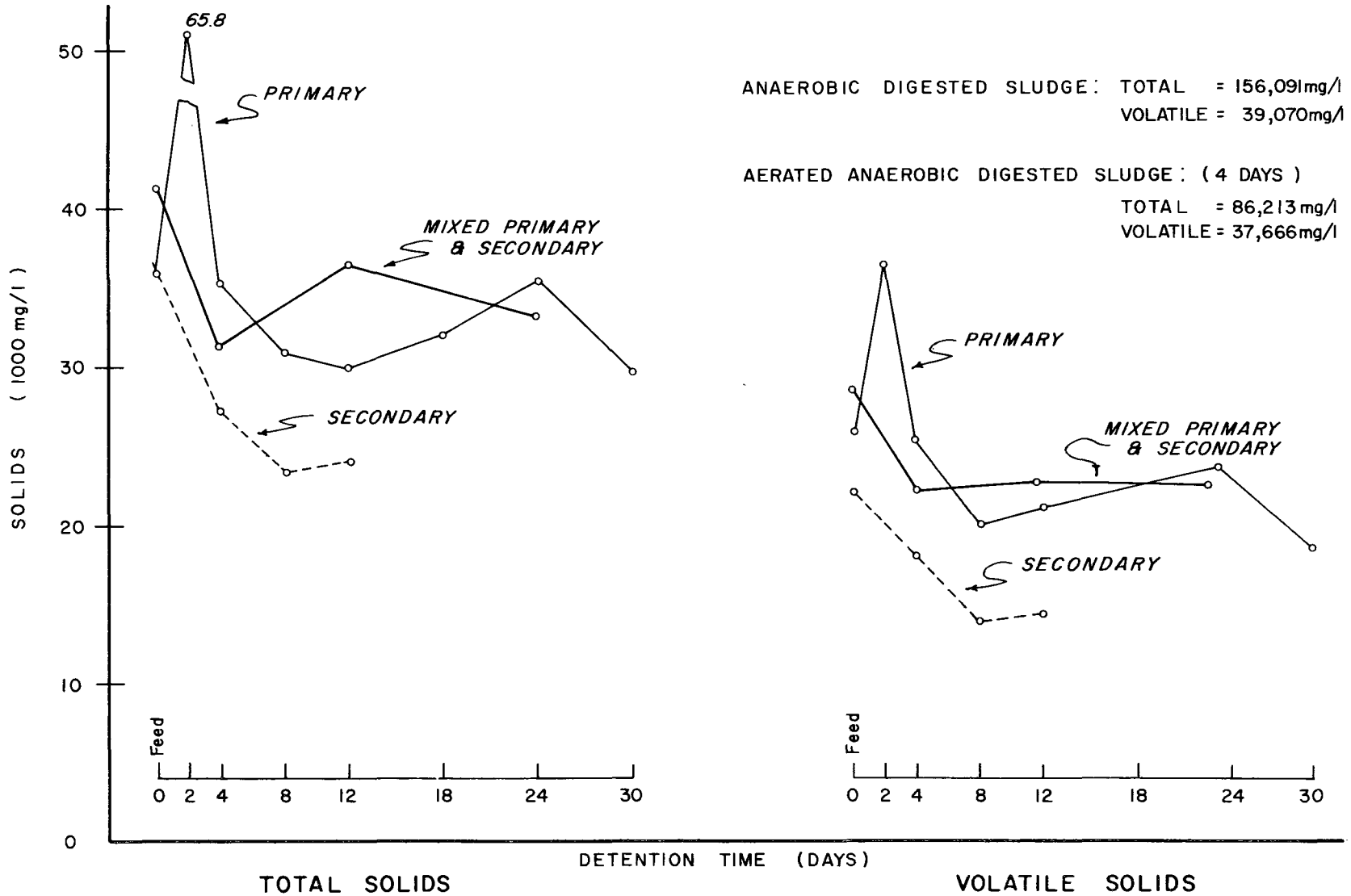
The drainability of sludges on sand beds is defined as the volume of water drained (the filtrate in Figure 3) from the sludge at intervals over various periods of time. The mean drainability of any given sludge is defined here as the ratio of volume drained to the volume applied after 180 hours. Mean drainabilities are recorded in Figure 19. Table 16 records the mean or average drainability of sludges on sand beds. The record of volumes applied and volumes drained are recorded in Tables 17 to 52, inclusive. Drainability and filterability are compared by plotting detention time on the abscissa, against mean filterability on the left-hand ordinate and mean drainability on the right-hand ordinate. These relationships are plotted in Figures 20, 21, and 22. Temperatures are recorded in Tables 17 to 64 inclusive and values for settleability and filterability are recorded in Figure 23 for primary, mixed primary and secondary, secondary, and anaerobic sludge. These values for settleability and filterability are also shown in Tables 55 to 64, inclusive.

Figures 24 to 27, inclusive, are photographs of the primary sludge feed on sand drying beds for draining and drying. Figures 28 to 31,



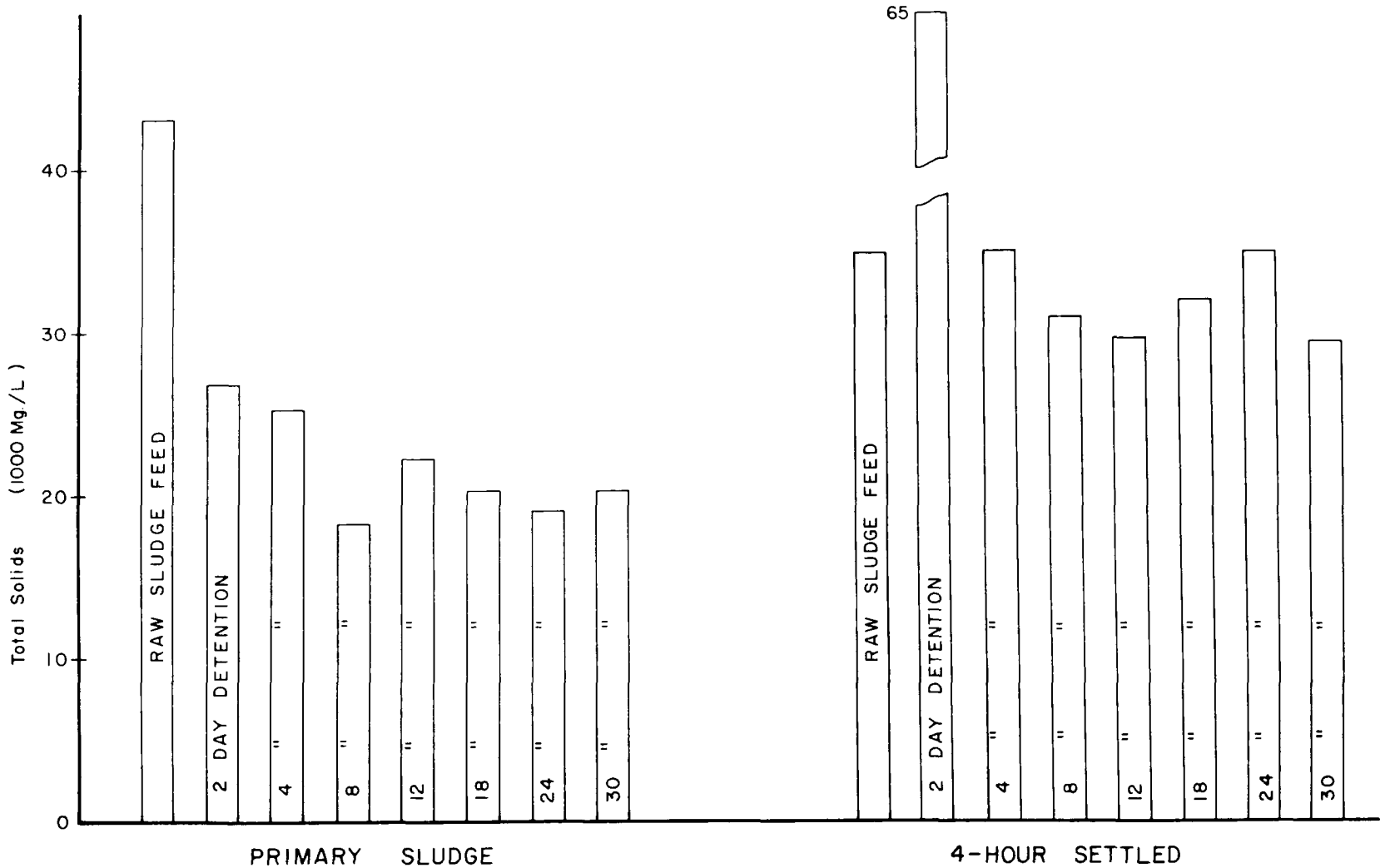
AVERAGE VALUES – MIXED LIQUOR – SLUDGE SOLIDS

FIGURE 8



AVERAGE VALUES - MIXED LIQUOR - 4 HOUR SETTLED SLUDGE SOLIDS

FIGURE 9



MIXED LIQUOR — TOTAL SOLIDS

FIGURE 10

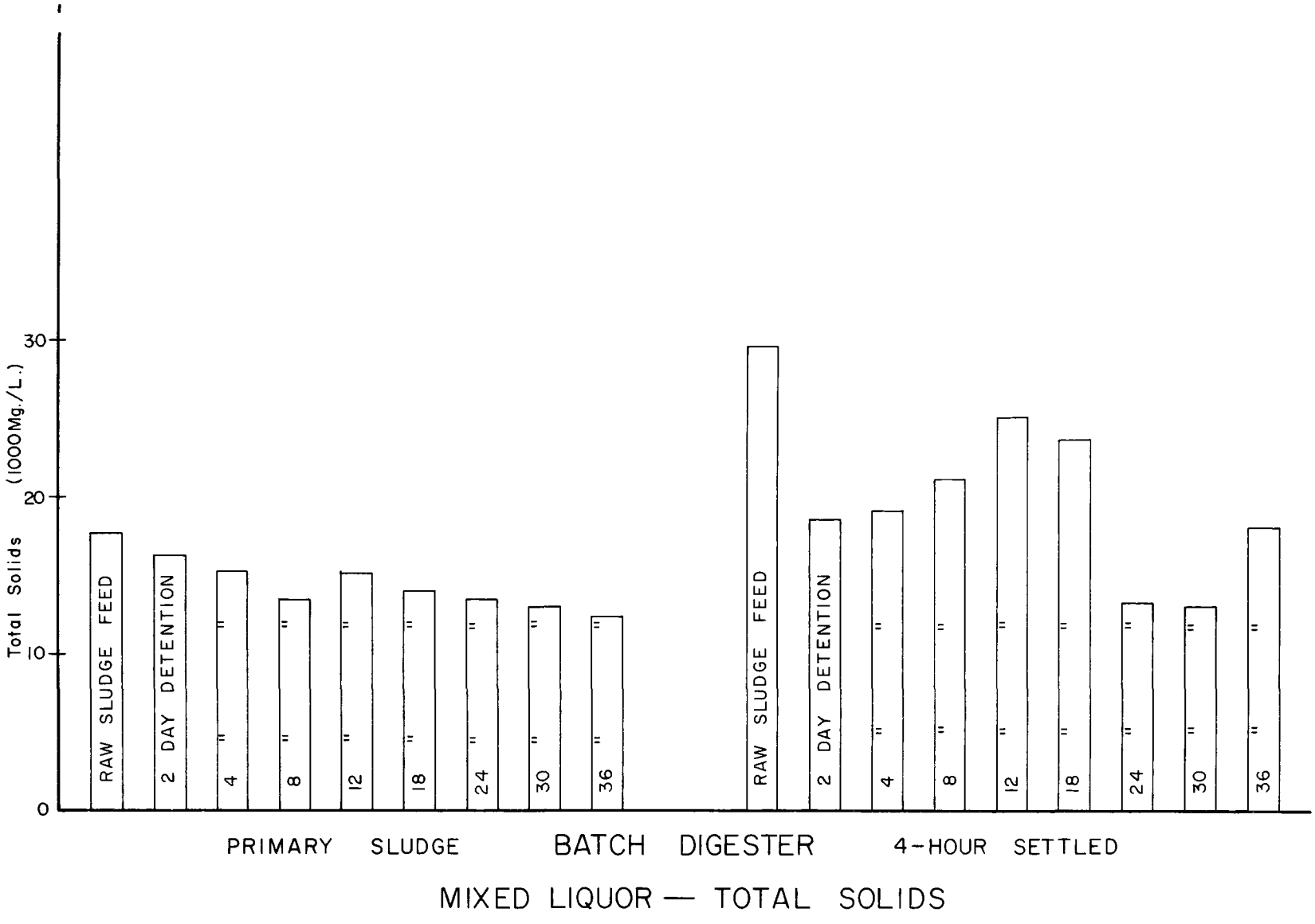
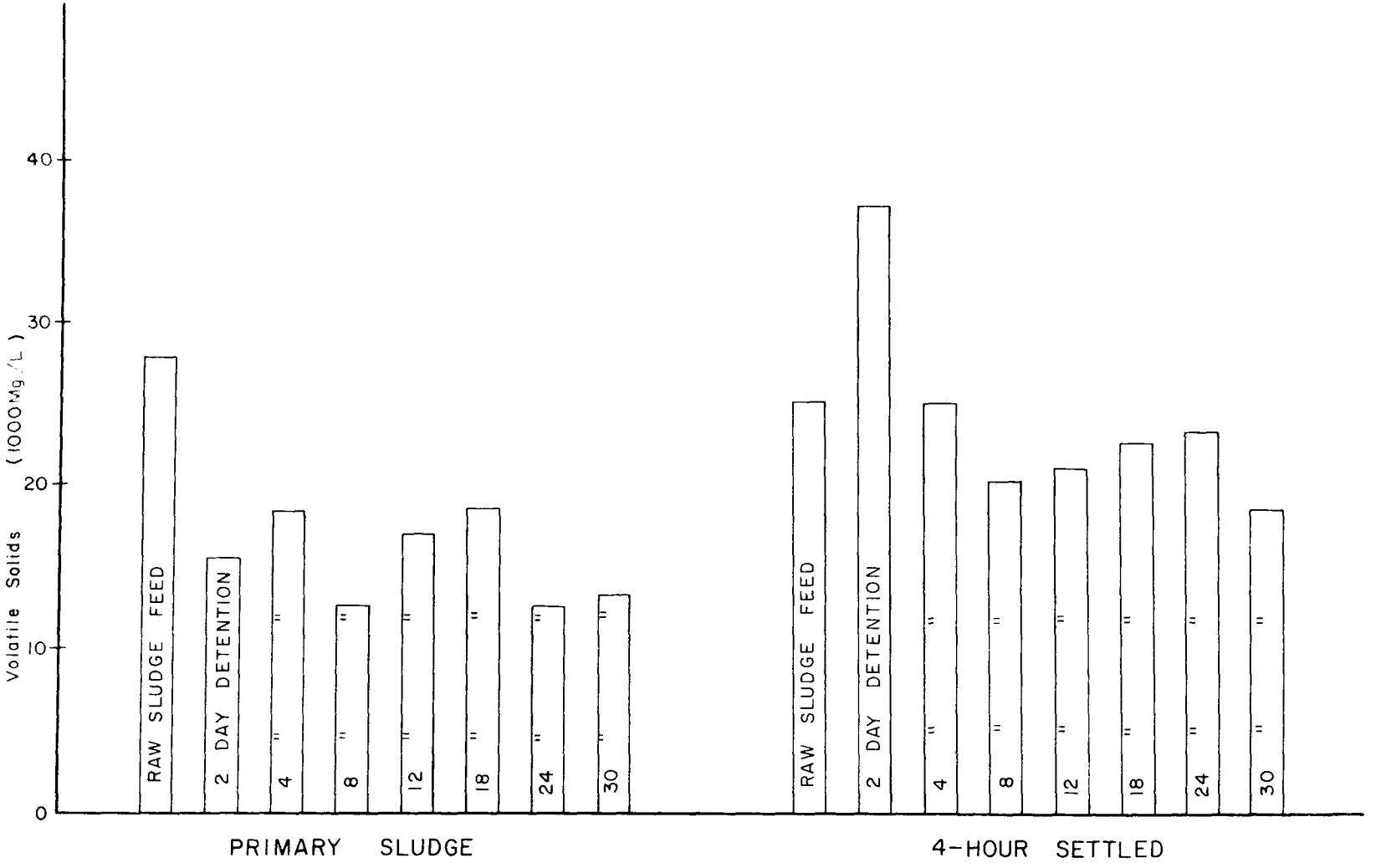

Total Solids (1000Mg./L.)
30
20
10
0
RAW SLUDGE FEED
2 DAY DETENTION
4 "
8 "
12 "
18 "
24 "
30 "
36 "
RAW SLUDGE FEED
2 DAY DETENTION
4 "
8 "
12 "
18 "
24 "
30 "
36 "
PRIMARY SLUDGE
BATCH DIGESTER
4-HOUR SETTLED
MIXED LIQUOR — TOTAL SOLIDS

FIGURE 11



MIXED LIQUOR — VOLATILE SOLIDS

FIGURE 12

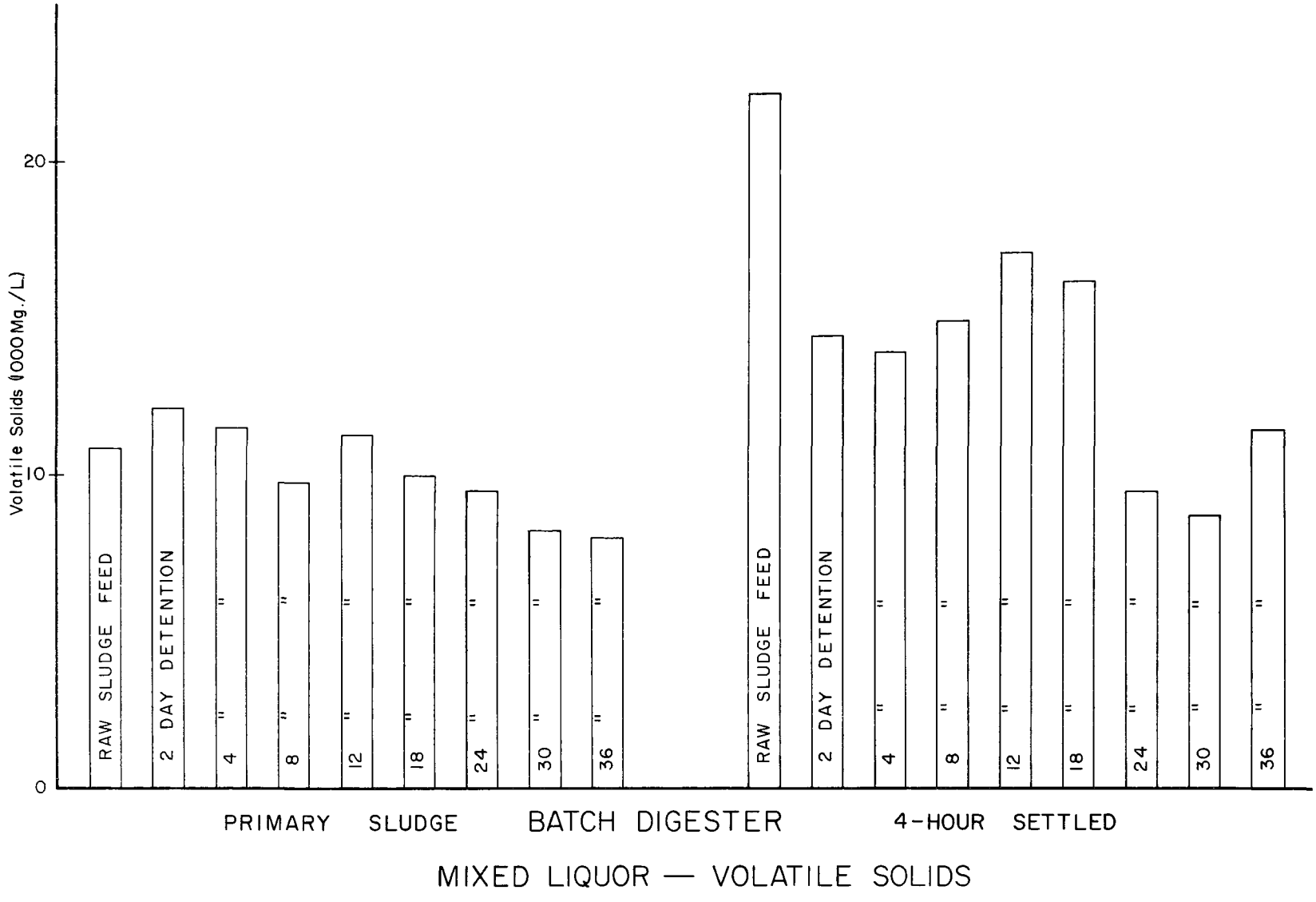

Volatile Solids (1000 Mg./L)
20
10
0
RAW SLUDGE FEED
2 DAY DETENTION
4 "
8 "
12 "
18 "
24 "
30 "
36 "
RAW SLUDGE FEED
2 DAY DETENTION
4 "
8 "
12 "
18 "
24 "
30 "
36 "
PRIMARY SLUDGE
BATCH DIGESTER
4-HOUR SETTLED
MIXED LIQUOR — VOLATILE SOLIDS

FIGURE 13

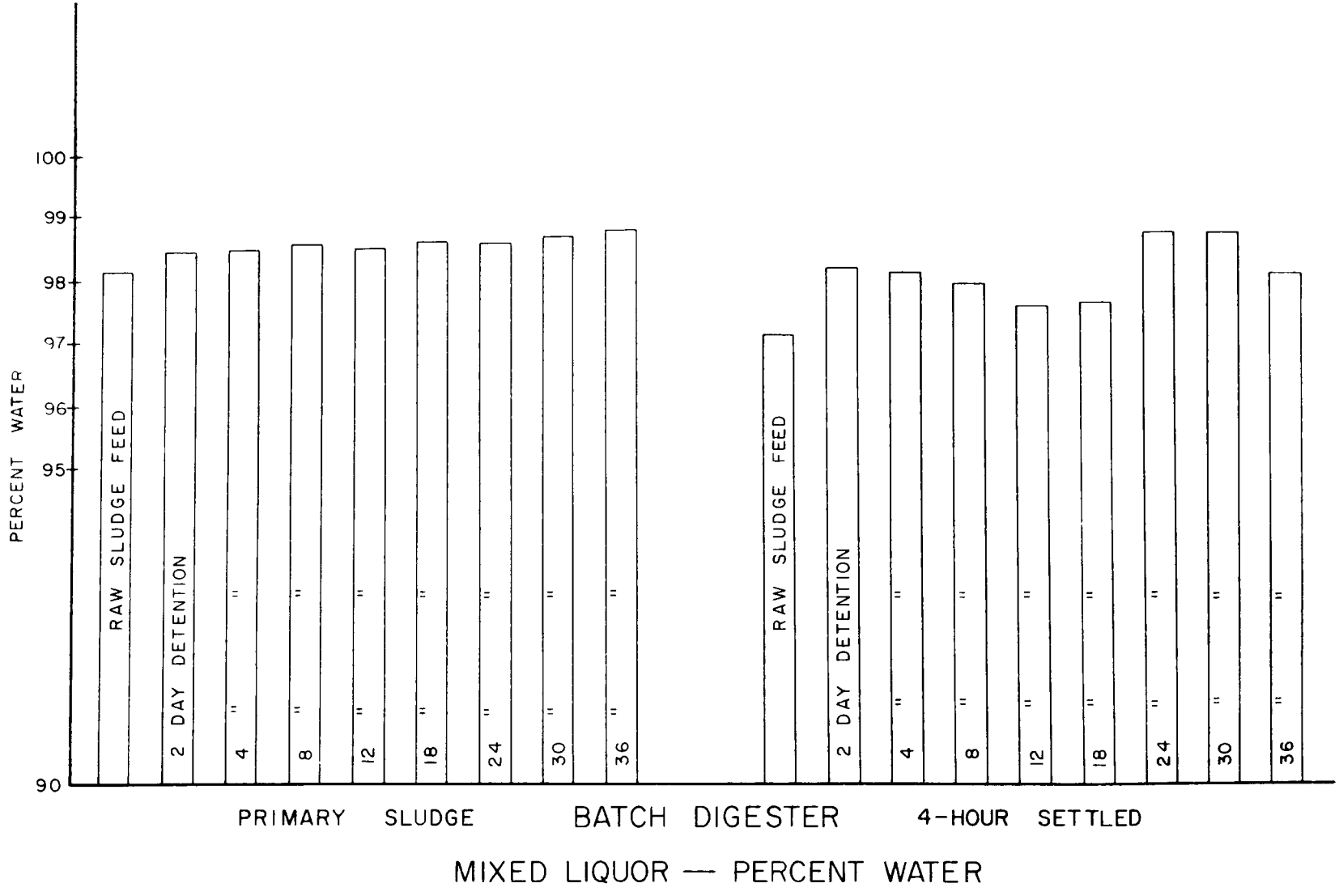
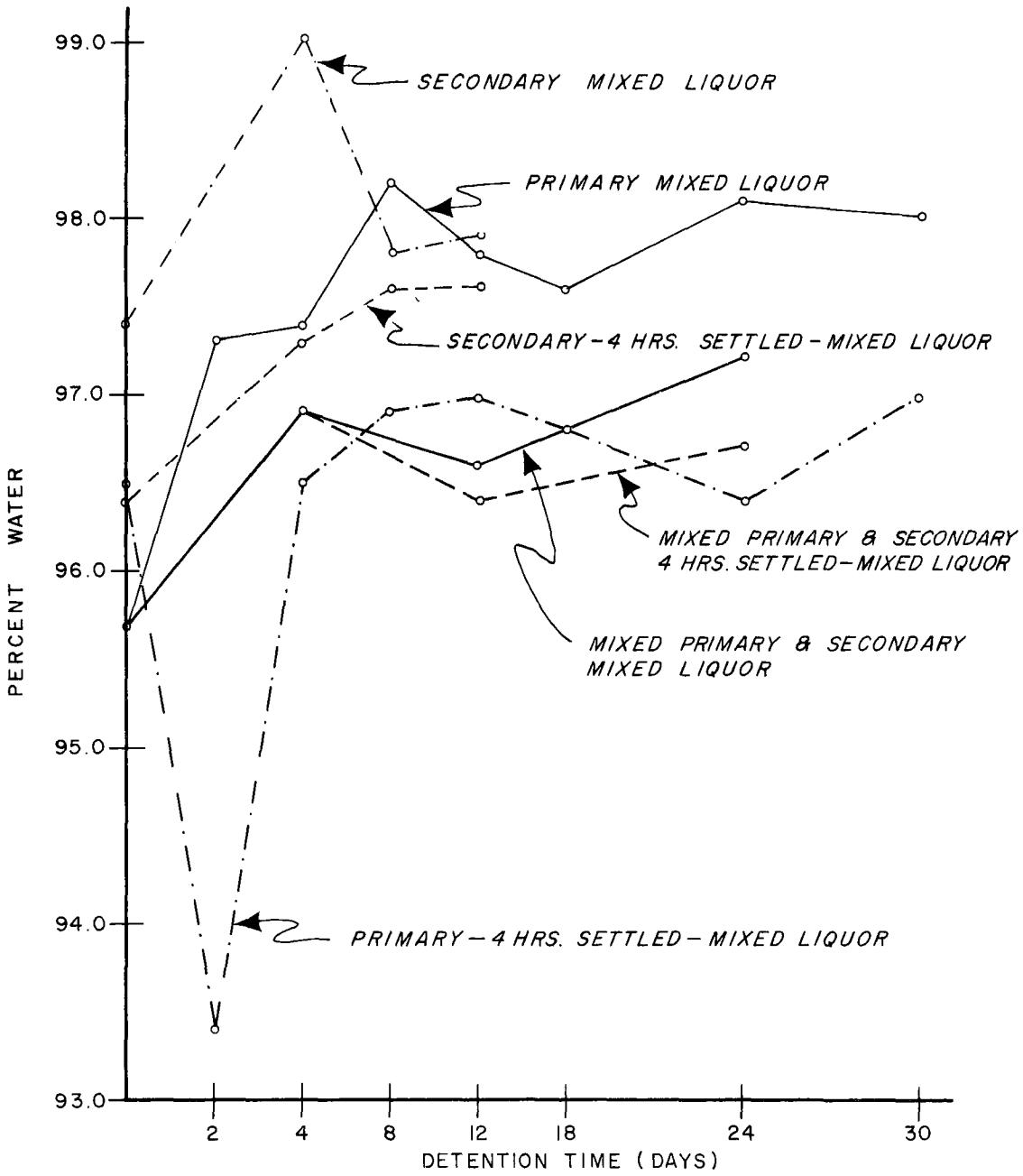
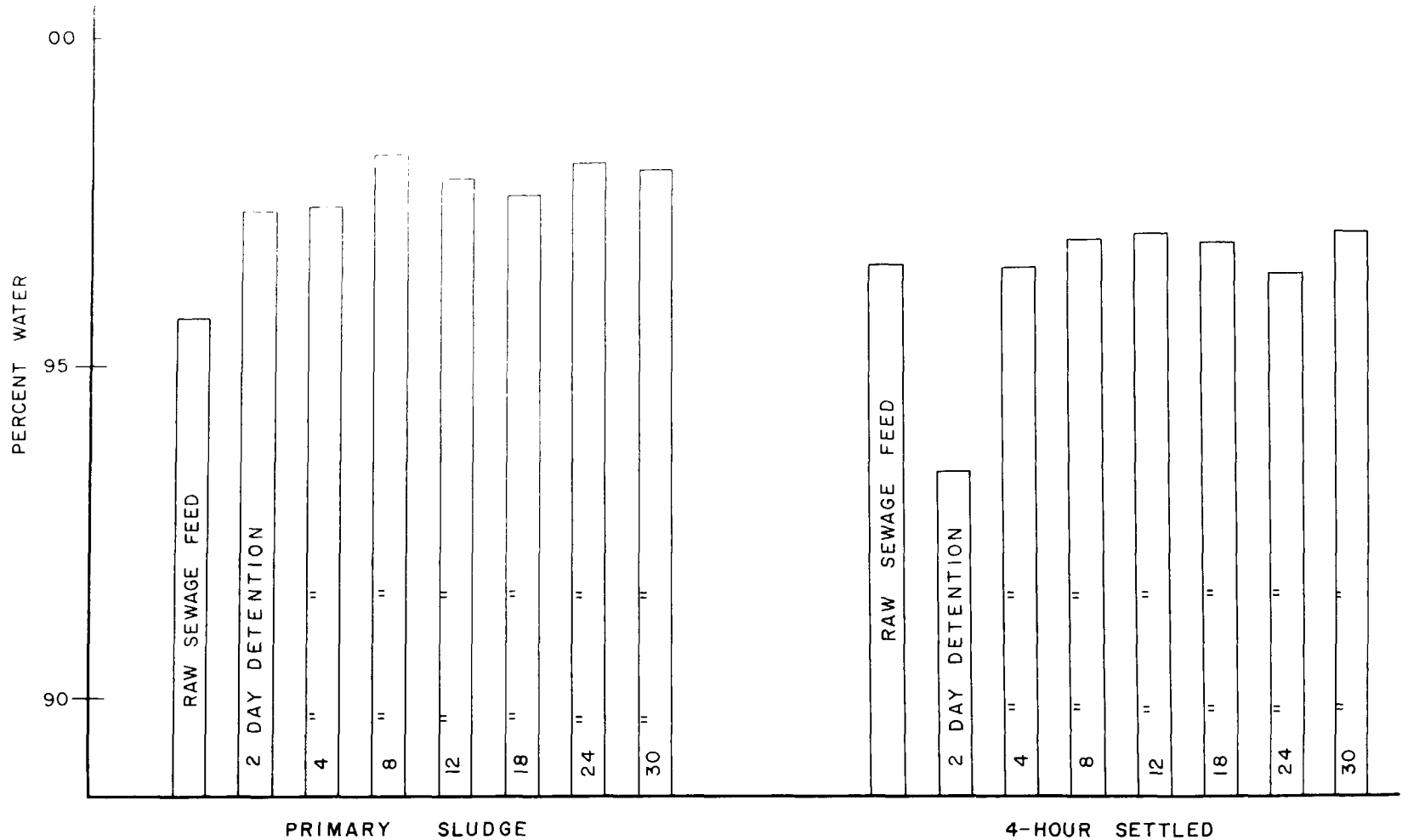

PERCENT WATER
100
99
98
97
96
95
90
RAW SLUDGE FEED
2 DAY DETENTION
4
8
12
18
24
30
36
RAW SLUDGE FEED
2 DAY DETENTION
4
8
12
18
24
30
36
PRIMARY SLUDGE
BATCH DIGESTER
4-HOUR SETTLED
MIXED LIQUOR — PERCENT WATER

FIGURE 14



WATER CONTENT-SLUDGE MIXED LIQUOR

FIGURE 15



MIXED LIQUOR —— PERCENT WATER

FIGURE 16

TABLE 2

PRIMARY SLUDGE

SOLIDS -- FEED

Date: 1970-71

	Total	Volatile	Fixed	% Water	Total	Volatile	Fixed	% Water
	SLUDGE FEED				SLUDGE FEED 4-HOURS SETTLED			
6-9	71,289	46,474	24,815	92.9	------	------	------	-----
8-31	111,000	55,000	56,000	88.9	------	------	------	-----
10-13	34,000	18,000	16,000	96.6	36,000	28,000	8,000	96.4
11-9	22,000	18,000	4,000	97.8	28,000	26,000	2,000	97.2
11-24	32,000	30,000	2,000	96.8	------	------	------	-----
1-7	37,500	24,000	13,500	96.2	43,800	28,000	15,800	95.6
1-21	33,275	18,047	15,228	96.7	37,314	23,193	14,121	96.3
1-27	27,495	20,408	7,087	97.3	39,906	30,046	9,860	96.0
2-16	33,600	27,000	6,600	96.7	30,400	25,000	5,400	97.0
2-24	31,500	23,000	8,500	96.8	30,000	21,500	8,500	97.0
AVG	43,366	27,993	15,373	95.7	35,060	25,963	9,097	96.5

TABLE 3

PRIMARY SLUDGE

SOLIDS -- 2-DAY DETENTION

Date: 1970-71

	Total	Volatile	Fixed	% Water	Total	Volatile	Fixed	% Water
	MIXED LIQUOR				MIXED LIQUOR 4-HOURS SETTLED			
6-5	62,138	27,953	34,188	93.8	------	------	------	-----
6-9	49,333	21,333	28,000	95.1	------	------	------	-----
8-31	27,000	20,000	7,000	97.3	------	------	------	-----
10-13	14,000	8,000	6,000	98.6	26,000	18,000	8,000	97.4
11-9	26,000	22,000	4,000	97.4	30,000	26,000	4,000	97.0
11-24	14,000	12,000	2,000	98.6	------	------	------	-----
1-7	16,700	11,000	5,700	98.3	146,600	59,400	87,200	85.3
1-21	17,215	8,853	8,362	98.3	44,155	24,053	20,102	95.6
1-27	15,048	10,422	4,626	98.5	82,270	55,750	26,520	91.8
AVG	26,826	15,729	11,097	97.3	65,805	36,641	29,164	93.4

TABLE 4

PRIMARY SLUDGE

SOLIDS -- 4-DAY DETENTION

Date: 1970-71

	Total	Volatile	Fixed	% Water	Total	Volatile	Fixed	% Water
	MIXED LIQUOR				MIXED LIQUOR 4-HOURS SETTLED			
6-5	38,580	19,522	19,058	96.1	------	------	------	-----
6-9	32,000	18,000	14,000	96.8	------	------	------	-----
8-31	28,000	21,000	7,000	97.2	------	------	------	-----
10-13	------	------	------	----	36,000	22,000	14,000	96.4
11-9	28,000	22,000	6,000	97.2	32,000	28,000	4,000	96.8
11-24	22,000	18,000	4,000	97.8	------	------	-------	-----
1-7	14,800	9,500	5,300	98.5	26,000	16,000	10,000	97.4
1-21	17,481	10,770	6,711	98.3	41,568	25,901	15,667	95.8
1-27	13,315	9,352	3,963	98.7	45,337	31,241	14,096	95.5
2-16	30,000	24,400	5,600	97.0	28,400	23,000	5,400	97.2
2-16	27,800	22,600	5,200	97.2	28,200	22,400	5,800	97.2
2-24	23,500	18,500	5,000	97.6	47,500	35,500	12,000	95.2
2-24	32,000	24,500	7,500	96.8	33,000	24,500	8,500	96.7
AVG	25,623	18,179	7,444	97.4	35,334	25,394	9,940	96.5

TABLE 5

PRIMARY SLUDGE

SOLIDS -- 8-DAY DETENTION

Date: 1970-71

	Total	Volatile	Fixed	% Water	Total	Volatile	Fixed	% Water
	MIXED LIQUOR				MIXED LIQUOR 4-HOURS SETTLED			
6-9	13,333	8,000	5,333	98.7	------	------	------	-----
8-31	22,000	17,000	5,000	97.8	------	------	------	-----
10-13	18,000	4,000	14,000	98.2	26,000	12,000	14,000	97.4
11-9	18,000	14,000	4,000	98.2	26,000	22,000	4,000	97.4
11-24	18,000	16,000	2,000	98.2	------	------	------	-----
1-7	21,900	14,700	7,200	97.8	24,000	15,200	8,800	97.6
1-21	17,616	11,033	6,583	98.2	30,977	15,988	14,989	96.9
1-27	11,786	8,321	3,465	98.8	37,417	25,500	11,917	96.3
2-16	21,000	16,400	4,600	97.7	32,400	23,200	9,200	96.8
2-24	18,500	13,500	5,000	98.2	40,000	27,000	13,000	96.0
AVG	18,014	12,296	5,718	98.2	30,971	20,127	10,844	96.9

TABLE 6

PRIMARY SLUDGE

SOLIDS -- 12-DAY DETENTION

Date: 1970-71

	Total	Volatile	Fixed	% Water	Total	Volatile	Fixed	% Water
	MIXED LIQUOR				MIXED LIQUOR 4-HOURS SETTLED			
6-9	12,000	6,000	6,000	98.8	------	------	------	-----
10-13	------	------	------	-----	16,000	10,000	6,000	98.4
11-9	14,000	12,000	2,000	98.6	28,000	24,000	4,000	97.2
11-24	14,000	12,000	2,000	98.6	------	------	------	-----
1-7	18,500	12,500	6,000	98.2	32,400	22,000	10,400	96.8
1-21	14,777	5,559	9,218	98.5	14,800	9,377	5.423	98.5
1-27	13,773	9,024	4,749	98.6	20,514	13,800	6,774	97.9
2-16	20,000	16,200	3,800	98.0	------	------	------	-----
2-24	21,500	16,000	5,500	97.8	37,000	26,000	11,000	96.3
4-3	21,000	16,125	4,875	97.9	29,250	23,125	6,125	97.1
4-20	63,500	55,000	8,500	93.6	51,500	34,500	17,000	94.8
4-25	30,000	20,750	9,250	97.0	39,250	26,500	12,750	96.1
AVG	22,095	16,469	5,626	97.8	29,864	21,034	8,830	97.0

TABLE 7

PRIMARY SLUDGE

SOLIDS -- 18-DAY DETENTION

Date: 1971

	Total	Volatile	Fixed	% Water	Total	Volatile	Fixed	% Water
	MIXED LIQUOR				MIXED LIQUOR 4-HOURS SETTLED			
4-20	15,000	9,000	6,000	98.5	27,500	19,500	8,000	97.2
4-25	29,000	20,000	9,000	97.1	32,500	23,250	9,250	96.8
5-1	27,500	26,700	800	97.2	36,000	25,000	11,000	96.4
AVG	23,833	18,567	5,266	97.6	32,000	22,583	9,417	96.8
	SOLIDS 24-DAY DETENTION							
4-20	21,000	14,750	6,250	97.9	31,500	21,500	10,000	96.8
4-25	22,000	15,500	6,500	97.8	37,000	24,000	13,000	96.3
5-1	14,500	7,500	7,000	98.6	38,000	25,000	13,000	96.2
AVG	19,167	12,583	6,584	98.1	35,500	23,500	12,000	96.4
	SOLIDS 30-DAY DETENTION							
4-25	20,750	14,250	6,500	97.9	30,500	19,500	11,000	97.0
5-1	19,500	12,500	7,000	98.0	29,000	17,500	11,500	97.1
AVG	20,125	13,375	6,750	98.0	29,750	18,500	11,250	97.0

TABLE 8

MIXED PRIMARY AND SECONDARY SLUDGE

SOLIDS -- 4-DAY DETENTION

Date: 1971

	Total	Volatile	Fixed	% Water	Total	Volatile	Fixed	% Water
	SLUDGE FEED				SLUDGE FEED 4-HOURS SETTLED			
5-28	47,800	32,000	15,800	95.2	46,400	30,000	16,400	95.4
5-29	48,400	------	------	95.2	30,000	21,200	8,800	97.0
AVG	48,100	32,000	15,800	95.2	38,200	25,600	12,600	96.2
	MIXED LIQUOR				MIXED LIQUOR 4-HOURS SETTLED			
5-27	30,200	22,000	8,200	97.0	31,200	22,200	9,000	96.9
5-28	32,800	24,000	8,800	96.7	33,600	22,600	11,000	96.6
5-29	29,200	21,600	7,600	97.1	29,200	21,600	7,600	97.1
AVG	30,733	22,533	8,200	96.9	31,333	22,133	9,200	96.9

TABLE 9

MIXED PRIMARY AND SECONDARY SLUDGE

SOLIDS -- 12-DAY DETENTION

Date: 1971

	Total	Volatile	Fixed	% Water	Total	Volatile	Fixed	% Water
		SLUDGE FEED				SLUDGE FEED 4-HOURS SETTLED		
6-4	38,600	24,000	14,600	96.1	39,400	24,800	14,600	96.1
6-5	52,000	29,600	22,400	94.8	51,600	29,600	22,000	94.8
AVG	45,300	26,800	18,500	95.5	45,500	27,200	18,300	95.4
		MIXED LIQUOR				MIXED LIQUOR 4-HOUR SETTLED		
6-4	33,600	20,800	12,800	96.6	38,400	24,400	14,000	96.2
6-5	33,600	21,200	12,400	96.6	34,000	22,000	12,000	96.6
6-6	33,600	21,200	12,400	96.6	36.400	21,800	14,600	96.4
6-16	34,000	22,000	12,000	96.6	36,200	23,340	12,860	96.4
AVG	33,700	21,300	12,400	96.6	36,250	22,885	13,365	96.4

TABLE 10

MIXED PRIMARY AND SECONDARY SLUDGE

SOLIDS -- 24-DAY DETENTION

Date: 1971

	Total	Volatile	Fixed	% Water	Total	Volatile	Fixed	% Water
	SLUDGE FEED				SLUDGE FEED 4-HOUR SETTLED			
7-12	40,400	31,200	9,200	96.0	46,800	32,600	14,200	95.3
7-13	39,200	29,200	10,000	96.1	38,000	28,000	10,000	96.2
7-14	31,200	23,280	7,920	96.9	35,200	22,800	12,400	96.5
AVG	36,933	27,893	9,040	96.3	40,000	27,800	12,200	96.0
	MIXED LIQUOR				MIXED LIQUOR 4-HOURS SETTLED			
7-12	28,400	17,600	10,800	97.2	33,600	22,320	11,280	96.6
7-13	28,000	18,320	9,680	97.2	31,200	22,800	8,400	96.9
7-14	29,200	19,600	9,600	97.1	35,200	22,800	12,400	96.5
AVG	28,533	18,507	10,027	97.2	33,333	22,640	10,693	96.7

TABLE 11

SECONDARY SLUDGE

SOLIDS -- 4-DAY DETENTION

Date: 1971

	Total	Volatile	Fixed	% Water	Total	Volatile	Fixed	% Water
	SLUDGE FEED				SLUDGE FEED 4-HOURS SETTLED			
6-1	20,400	14,400	6,000	98.0	26,800	18,400	8,400	97.3
6-2	25,600	16,000	9,600	97.4	33,000	20,200	12,800	96.7
6-3	24,800	16,400	8,400	97.5	30,400	20,200	10,200	97.0
AVG	23,600	15,600	8,000	97.6	30,067	19,600	10,467	97.0
	MIXED LIQUOR				MIXED LIQUOR 4-HOURS SETTLED			
6-1	8,400	5,600	2,800	99.1	28,400	18,800	9,600	97.2
6-2	9,200	6,200	3,000	99.1	28,400	19,200	9,200	97.2
6-3	11,600	8,000	3,600	98.8	25,200	16,400	8,800	97.5
AVG	9,733	6,600	3,133	99.0	27,333	18,133	9,200	97.3

TABLE 12

SECONDARY SLUDGE

SOLIDS -- 8-DAY DETENTION

Date: 1971

	Total	Volatiles	Fixed	% Water	Total	Volatiles	Fixed	% Water
	SLUDGE FEED				SLUDGE FEED 4-HOURS SETTLED			
6-15	26,400	16,000	10,400	97.4	40,000	23,600	16,400	96.0
6-16	25,600	16,000	9,600	97.4	40,200	24,600	15,600	96.0
AVG	26,000	16,000	10,000	97.4	40,100	24,100	16,000	96.0
	MIXED LIQUOR				MIXED LIQUOR 4-HOURS SETTLED			
6-13	20,800	12,400	8,400	97.9	23,400	13,800	9,600	97.7
6-15	22,600	13,400	9,200	97.7	23,600	13,600	10,000	97.6
6-16	22,200	13,600	8,600	97.8	23,520	14,200	9,320	97.6
AVG	21,867	13,133	8,734	97.8	23,507	13,867	9,640	97.6

TABLE 13

SECONDARY SLUDGE

SOLIDS -- 12-DAY DETENTION

Date: 1971

	Total	Volatile	Fixed	% Water	Total	Volatile	Fixed	% Water
	SLUDGE FEED				SLUDGE FEED 4-HOURS SETTLED			
6-25	26,600	16,000	10,600	97.3	40,000	24,600	15,400	96.0
6-28	29,680	19,000	10,680	97.0	35,600	21,280	14,320	96.4
AVG	28,140	17,500	10,640	97.2	37,800	22,940	14,860	96.2
	MIXED LIQUOR				MIXED LIQUOR 4-HOURS SETTLED			
6-25	20,200	12,120	8,080	98.0	24,800	15,760	9,040	97.5
6-28	20,800	12,320	8,480	97.9	25,840	14,880	10,960	97.4
7-1	21,000	12,400	8,600	97.9	21,200	12,480	8,720	97.9
AVG	20,667	12,280	8,387	97.9	23,947	14,373	9,573	97.6

TABLE 14

ANAEROBIC DIGESTED SLUDGE

SOLIDS

Date: 1970-71

	Total	Volatile	Fixed	% Water	Total	Volatile	Fixed	% Water
	MIXED LIQUOR				MIXED LIQUOR 4-HOURS SETTLED			
6-9	102,559	42,256	60,303	89.7	-------	------	-------	-----
1-21	138,499	36,710	101,789	86.2	156,091	39,070	117,021	84.4
2-16	66,000	31,400	34,600	93.4	-------	------	-------	-----
2-24	68,500	30,500	38,000	93.2	-------	------	-------	-----
AVG	93,890	35,217	58,673	90.6	-------	------	-------	-----

TABLE 15

AERATED ANAEROBIC DIGESTED SLUDGE

SOLIDS -- 4-DAY DETENTION

Date: 1971

	Total	Volatile	Fixed	% Water	Total	Volatile	Fixed	% Water
	SLUDGE FEED NOT SETTLED				MIXED LIQUOR 4-HOURS SETTLED			
6-25	83,6000	35,680	47,920	91.6	85,600	38,000	47,600	91.4
6-28	88,480	37,560	50,920	91.2	85,040	35,800	49,240	91.5
7-4	------	------	------	----	88,000	39,200	48,800	91.2
AVG	86,040	36,620	49,420	91.4	86,213	37,666	48,547	91.4

TABLE 16

SUMMARY

MEAN DRAINABILITY OF SLUDGES ON SAND BEDS

Ratio of Volume Drained to Volume Applied at 180 Hours

Unless Otherwise Noted

		Detention Time of Aerobic Sludge Digestion							
Identification	Feed	2-Day	4-Day	8-Day	12-Day	18-Day	24-Day	30-Day	Anaerobic
Batch Primary Sludge		34.96			32.86			46.16	
Primary Sludge	55.10	67.53	61.96	51.25	60.41	52.42	47.61	46.50	
Mixed Primary & Secondary Sludge	82.70		82.57	18.01		22.5			
Mixed Primary & Secondary Sludge Settled 4 Hours		29.5							
Secondary Sludge		56.35	45.00	46.34					
Anaerobic Sludge									23.69

TABLE 17

PRIMARY SLUDGE

FEED

DRAINABILITY ON SAND BEDS -- TOTAL VOLUME APPLIED = 9439 ML.

96% INITIAL MOISTURE

Date 1971	Time	Time Elapsed Hours	Temp. °C	Depth of Sludge Inches	Vol. of Filt. ml.	Cumm. Volume ml.	Volume Applied %
1-27	2:45 p.m.	0	19	4	0	0	0
	3:15 p.m.	.5	19	1.3	2260	2260	23.94
	4:00 p.m.	1.2	17	0.8	2120	4380	46.40
	5:00 p.m.	2.2	17	0.8	290	4670	49.48
	10:00 p.m.	7.2	17	0.8	280	4950	52.44
1-28	10:00 a.m.	19.2	24	0.8	140	5090	53.92
	10:00 p.m.	31.2	25	0.8	36	5126	54.31
1-29	10:00 a.m.	43.2	24	0.8	20	5146	54.52
	10:00 p.m.	55.2	26	0.8	15	5161	54.68
1-30	10:00 a.m.	67.2	25	0.8	13	5174	54.81
	10:00 p.m.	79.2	24	0.8	7	5181	54.89
1-31	10:00 a.m.	91.2	21	0.8	7	5188	54.96
	10:00 p.m.	103.2	23	0.8	5	5193	55.02
2-1	10:00 a.m.	115.2	22	0.8	5	5198	55.07
	10:00 p.m.	127.2	23	0.8	2	5200	55.09
2-2	10:00 a.m.	139.2	23	0.8	2	5202	55.10
2-14	10:00 p.m.	439.2	23	0.8	0	5202	55.10

TABLE 18

PRIMARY SLUDGE

4-DAY BATCH AEROBIC SLUDGE DIGESTION

DRAINABILITY ON SAND BEDS -- TOTAL VOLUME APPLIED = 18,878 ML.

98.1% INITIAL MOISTURE

Date 1971	Time	Time Elapsed Hours	Temp. °C	Depth of Sludge Inches	Vol. of Filt. ml.	Cumm. Volume ml.	Volume Applied %
3-26	4.00 p.m.	0	26	8.00	0		0
	5:00 p.m.	1	26	6.50	1630	1630	8.60
	6:00 p.m.	2	26.5	6.25	630	2260	11.97
	8:00 p.m.	4	27	6.20	375	2635	13.95
	10:30 p.m.	6.5	27	6.06	350	2985	15.81
	12:15 p.m.	8.3	27	6.00	120	3105	16.44
3-27	12:00 noon	20	27	5.87	410	3515	18.61
	12:00 mdnt	32	29	5.69	380	3895	20.63
3-28	12:00 noon	44	28	5.44	290	4185	22.16
	12:00 mdnt	56	27	5.38	240	4425	23.43
3-29	12:00 noon	68	27	5.20	240	4665	24.71
	12:00 mdnt	80	27	5.13	160	4825	25.55
3-30	12:00 noon	92	29	5.00	175	5000	26.48
	12:00 mdnt	104	28	4.87	140	5140	27.22
3-31	12:00 noon	116	25	4.75	170	5310	28.12
4-1	12:00 noon	140	26	4.31	520	5830	30.88
4-2	12:00 noon	164	27	4.00	610	6440	34.11
4-3	12:00 noon	188	26	3.81	240	6680	35.38
4-4	7:00 p.m.	219	26	3.50	280	6960	36.86
4-5	10:00 a.m.	234	24	3.38	180	7140	37.82
4-6	10:00 a.m.	258	18	3.20	280	7420	39.30
4-7	10:00 p.m.	294	27	3.00	320	7740	41.00
4-8	1:00 p.m.	309	27	2.75	300	8040	42.58
4-9	2:00 p.m.	334	27	2.50	480	8520	45.13

TABLE 19

PRIMARY SLUDGE

12-DAY BATCH AEROBIC SLUDGE DIGESTION

DRAINABILITY -- TOTAL VOLUME APPLIED = 18878 ML.

92.5% INITIAL MOISTURE

Date 1971	Time	Time Elapsed Hours	Temp. °C	Depth of Sludge Inches	Vol. of Filt. ml.	Cumm. Volume ml.	Volume Applied %
4-3	5:00 p.m.	0	27	8.00	0	0	0
	6:00 p.m.	1	27	6.87	890	890	4.71
	7:00 p.m.	2	27	6.81	540	1430	7.57
	8:00 p.m.	3	27	6.75	350	1780	9.42
	10:00 p.m.	5	27	6.69	390	2170	11.49
	12:00 mdnt	7	25	6.69	240	2410	12.76
4-4	7:00 p.m.	26	26	6.25	930	3340	17.69
4-5	10:00 p.m.	53	24	6.00	560	3900	20.65
4-6	10:00 a.m.	65	18	5.75	580	4480	23.73
4-7	10:00 a.m.	89	26	5.50	500	4980	26.37
4-8	1:00 p.m.	116	27	5.31	375	5355	28.36
4-9	2:00 p.m.	141	27	5.00	370	5725	30.32
4-11	7:00 p.m.	194	30	4.69	690	6415	33.98
4-13	8:00 p.m.	243	26	4.25	520	6935	36.73
4-14	2:00 p.m.	261	26	4.00	150	7085	37.53

TABLE 20

PRIMARY SLUDGE

30-DAY BATCH AEROBIC SLUDGE DIGESTION

DRAINABILITY -- TOTAL VOLUME APPLIED = 18878 ML.

98.7% INITIAL MOISTURE

Date 1971	Time	Time Elapsed Hours	Temp. °C	Depth of Sludge Inches	Vol. of Filt. ml.	Cumm. Volume ml.	Volume Applied %
4-21	4:30 a.m.	0	25	8.00	0	0	0
	5:30 a.m.	1	25	6.93	730	730	3.86
	6:30 a.m.	2	25	6.81	520	1250	6.62
	8:30 a.m.	4	26	6.75	550	1800	9.53
	10:30 a.m.	6	26	6.62	310	2110	11.17
	8:30 p.m.	16	26	6.25	840	2950	15.62
4-22	11:00 a.m.	30.5	25	5.69	1150	4100	21.71
	9:30 p.m.	41	25	5.44	665	4765	25.24
4-23	9:30 a.m.	53	25	5.06	730	5495	29.10
	9:30 p.m.	65	25	4.75	590	6085	32.23
4-24	9:30 p.m.	89	25	4.31	1135	7220	38.24
4-25	9:30 p.m.	113	26	3.87	760	7980	42.27
4-26	9:30 p.m.	137	26	3.50	780	8960	46.40
4-28	3:00 p.m.	178.5	25	2.5	1230	9990	52.91
4-29	6:00 p.m.	205.5	24	2.25	450	10440	55.30
4-30	10:00 a.m.	221.5	24	2.25	470	10910	57.79
5-1	5:30 p.m.	253	25	2.00	480	11390	60.33
5-2	12:30 p.m.	272	25	1.75	235	11625	61.57
5-3	12:30 p.m.	296	25	1.62	250	11865	62.29
5-4	12:30 p.m.	320	42	1.50	225	12100	64.09
5-5	12:30 p.m.	344	25	1.38	200	12300	65.15

TABLE 21

PRIMARY SLUDGE

2-DAY AEROBIC SLUDGE DIGESTION

DRAINABILITY ON SAND BEDS -- TOTAL VOLUME APPLIED = 14159 ML.

85.3% INITIAL MOISTURE

Date 1971	Time	Time Elapsed Hours	Temp. °C	Depth of Sludge Inches	Vol. of Filt. ml.	Cumm. Volume ml.	Volume Applied %
1-7	6:00 p.m.	0	22	6.0	0	0	0
	7:00 p.m.	1	22	4.1	2880	2880	20.34
	8:00 p.m.	2	22	3.9	570	3450	24.37
	9:00 p.m.	3	22	3.6	580	4030	28.46
	10:00 p.m.	4	22	3.3	610	4640	32.77
	11:00 p.m.	5	22	3.1	550	5190	36.66
1-8	12:00 mdnt	6	22	2.9	450	5640	39.83
	6:00 a.m.	12	21	2.6	860	6500	45.91
	12:00 noon	18	22	2.4	560	7060	49.86
	6:00 p.m.	24	23	2.3	480	7540	53.25
1-9	12:00 mdnt	30	23	2.1	300	7840	55.37
	12:00 noon	42	23	2.0	610	8450	59.68
1-10	12:00 mdnt	54	24	2.0	350	8800	62.15
	12:00 noon	66	24	2.0	250	9050	63.92
1-11	12:00 mdnt	78	23	1.9	170	9220	65.12
	12:00 noon	90	25	1.9	140	9360	66.11
1-12	12:00 noon	114	24	1.8	280	9640	68.08
1-13	12:00 noon	138	24	1.6	150	9790	69.14
1-14	12:00 noon	162	23	1.6	70	9860	69.64
1-15	12:00 noon	186	24	1.6	30	9890	69.85
1-16	12:00 noon	210	25	1.5	30	9920	70.06
1-17	12:00 noon	234	25	1.2	50	9970	70.41
1-19	12:00 noon	282	23	1.2	65	10035	70.87
1-21	12:00 noon	330	25	1.2	105	10140	71.62

TABLE 22

PRIMARY SLUDGE

2-DAY AEROBIC SLUDGE DIGESTION

DRAINABILITY ON SAND BEDS -- TOTAL VOLUME APPLIED = 9439 ML.

91.8% INITIAL MOISTURE

Date 1971	Time	Time Elapsed Hours	Temp. °C	Depth of Sludge Inches	Vol. of Filt. ml.	Cumm. Volume ml.	Volume Applied %
1-27	2:45 p.m.	0	19	4	0	0	0
	3:15 p.m.	.5	19	2.9	610	610	6.46
	4:00 p.m.	1.25	17	2.1	1160	1770	18.75
	5:00 p.m.	2.25	17	2.0	780	2550	27.01
	10:00 p.m.	7.25	17	1.9	980	3530	37.39
1-28	10:00 a.m.	19.25	24	1.3	1550	5080	53.81
	10:00 p.m.	31.25	25	1.1	580	5660	59.95
1-29	10:00 a.m.	43.25	24	1.1	290	5950	63.02
	10:00 p.m.	55.25	26	1.1	170	6120	64.83
1-30	10:00 a.m.	67.25	25	1.1	130	6250	66.20
	10:00 p.m.	79.25	24	1.1	60	6310	66.84
1-31	10:00 a.m.	91.25	21	1.1	60	6370	67.47
	10:00 p.m.	103.25	23	1.1	35	6405	67.84
2-1	10:00 a.m.	115.25	22	1.1	32	6437	68.18
	10:00 p.m.	127.25	23	1.0	17	6456	68.36
2-2	10:00 a.m.	139.25	23	1.0	17	6471	68.54
	10:00 p.m.	151.25	23	1.0	15	6486	68.70
2-3	10:00 p.m.	175.25	24	1.0	21	6507	68.92
2-4	10:00 p.m.	199.25	21	0.9	13	6520	69.06
2-5	10:00 p.m.	223.25	22	0.9	9	6529	69.16
2-7	10:00 p.m.	271.25	23	0.8	7	6536	69.23
2-10	10:00 p.m.	343.25	24	0.8	5	6541	69.28
2-14	10:00 p.m.	439.25	23	0.8	15	6556	69.40

TABLE 23

PRIMARY SLUDGE

4-DAY AEROBIC SLUDGE DIGESTION

DRAINABILITY ON SAND BEDS -- TOTAL VOLUME APPLIED = 14159 ML.

97.4% INITIAL MOISTURE

Date 1971	Time	Time Elapsed Hours	Temp. °C	Depth of Sludge Inches	Vol. of Filt. ml.	Cumm. Volume ml.	Volume Applied %
1-7	6:00 p.m.	0	22	6.0	0	0	0
	7:00 p.m.	1	22	3.6	3060	3060	21.61
	8:00 p.m.	2	22	2.6	1410	4470	31.57
	9:00 p.m.	3	22	1.9	1800	6270	44.28
	10:00 p.m.	4	22	1.8	1180	7450	52.62
	11:00 p.m.	5	22	1.6	300	7750	54.74
1-8	12:00 mdnt	6	22	1.5	360	8110	57.28
	6:00 a.m.	12	21	1.4	910	9020	63.71
	12:00 noon	18	22	1.3	440	9460	66.81
	6:00 p.m.	24	23	1.3	336	9796	69.19
1-9	12:00 mdnt	30	23	1.2	105	9901	69.93
	12:00 noon	42	23	1.1	270	10171	71.83
1-10	12:00 mdnt	54	24	1.0	165	10336	73.00
	12:00 noon	66	24	1.0	75	10411	73.53
1-11	12:00 mdnt	78	23	1.0	70	10481	74.02
	12:00 noon	90	25	1.0	60	10541	74.45
1-12	12:00 noon	114	24	1.0	80	10621	75.01
1-13	12:00 noon	138	24	1.0	11	10632	75.09
1-15	12:00 noon	186	24	1.0	0	10632	75.09
1-16	12:00 noon	210	25	1.0	23	10655	75.25
1-17	12:00 noon	234	25	1.0	10	10665	75.32
1-19	12:00 noon	282	23	1.0	38	10703	75.59
1-21	12:00 noon	330	25	1.0	35	10738	75.84

TABLE 24

PRIMARY SLUDGE

4-DAY AEROBIC SLUDGE DIGESTION

DRAINABILITY ON SAND BEDS -- TOTAL VOLUME APPLIED = 9439 ML.

95.5% INITIAL MOISTURE

Date 1971	Time	Time Elapsed Hours	Temp. °C	Depth of Sludge Inches	Vol. of Filt. ml.	Cumm. Volume ml.	Volume Applied %
1-27	2:45 p.m.	0	19	4	0	0	0
	3:15 p.m.	.5	19	2.3	950	950	10.06
	4:00 p.m.	1.25	17	1.9	1340	2290	24.26
	5:00 p.m.	2.25	17	1.7	1660	3950	41.84
	10:00 p.m.	7.25	17	1.3	930	4880	51.69
1-28	10:00 a.m.	19.25	24	0.7	1700	6580	69.70
	10:00 p.m.	31.25	25	0.7	460	7040	74.57
1-29	10:00 a.m.	43.25	24	0.5	190	7230	76.58
	10:00 p.m.	55.25	26	0.5	110	7340	77.75
1-30	10:00 a.m.	67.25	25	0.5	100	7440	78.81
	10:00 p.m.	79.25	24	0.4	35	7475	79.16
1-31	10:00 a.m.	91.25	21	0.5	36	7511	79.56
	10.00 p.m.	103.25	23	0.5	20	7531	79.77
2-1	10:00 a.m.	115.25	22	0.5	19	7550	79.97
	10:00 p.m.	127.25	23	0.5	17	7567	80.15
2-2	10:00 a.m.	139.25	23	0.3	21	7588	80.37
	10:00 p.m.	151.25	23	0.3	16	7604	80.54
2-3	10:00 p.m.	175.25	24	0.3	24	7628	80.80
2-4	10:00 p.m.	199.25	21	0.3	31	7659	81.12
2-5	10:00 p.m.	223.25	22	0.3	12	7671	81.25
2-7	10:00 p.m.	271.25	23	0.3	25	7696	81.52
2-10	10:00 p.m.	343.25	24	0.3	30	7726	81.83
2-14	10:00 p.m.	439.25	23	0.3	4	7730	81.88

TABLE 25

PRIMARY SLUDGE

4-DAY AEROBIC SLUDGE DIGESTION

DRAINABILITY ON SAND BEDS -- TOTAL VOLUME APPLIED = 18878 ML.

97.7% INITIAL MOISTURE

Date 1971	Time	Time Elapsed Hours	Temp. °C	Depth of Sludge Inches	Vol. of Filt. ml.	Cumm. Volume ml.	Volume Applied %
2-24	7:40 p.m.	0	23	8.0	0	0	0
	8:00 p.m.	0.3	23	7.3	1110	1110	5.87
	10:00 p.m.	2.3	23	6.7	1150	2260	11.97
2-25	10:00 a.m.	14.3	23.5	6.0	1700	3960	20.97
	10:00 p.m.	26.3	25	6.0	400	4360	23.09
2-26	10:00 a.m.	38.3	24	6.0	220	4580	24.26
	10:00 p.m.	50.3	26	6.0	180	4760	25.21
2-27	10:00 a.m.	62.3	24	6.0	200	4960	26.27
	10:00 p.m.	74.3	24	6.0	150	5110	27.06
2-28	10:00 a.m.	86.3	23	6.0	160	5270	27.91
	10:00 p.m.	98.3	22	6.0	100	5370	28.44
3-1	10:00 a.m.	110.3	23.5	5.7	100	5470	28.97
	10:00 p.m.	122.3	24	5.7	90	5560	29.45
3-2	11:00 p.m.	147.3	24	5.3	130	5690	30.14
3-3	10:00 a.m.	158.3	24.5	4.9	160	5850	30.98
3-4	12:00 noon	184.3	25	4.7	190	6040	31.99
3-5	1:00 p.m.	209.3	24.5	4.6	320	6360	33.69
3-6	10:00 a.m.	230.3	24	4.5	310	6670	35.33
3-8	10:30 a.m.	278.8	23	4.3	430	7100	37.60
3-10	12:00 noon	328.3	26	3.9	260	7360	38.98

TABLE 26

PRIMARY SLUDGE

4-DAY AEROBIC SLUDGE DIGESTION

DRAINABILITY ON SAND BEDS -- TOTAL VOLUME APPLIED = 18878 ML.

96.7% INITIAL MOISTURE

Date 1971	Time	Time Elapsed Hours	Temp. °C	Depth of Sludge Inches	Vol. of Filt. ml.	Cumm. Volume ml.	Volume Applied %
2-24	7:40 p.m.	0	23	8.0	0	0	0
	8:00 p.m.	.3	23	3.3	6020	6020	31.88
	10:00 p.m.	2.3	23	2.6	2600	8620	45.66
2-25	10:00 a.m.	14.3	23.5	2.6	1640	10260	54.34
	10:00 p.m.	26.3	25	2.6	88	10348	54.81
2-26	10:00 a.m.	38.3	24	2.6	290	10638	56.35
	10:00 p.m.	50.3	26	2.5	230	10868	57.56
2-27	10:00 a.m.	62.3	24	2.5	170	11038	58.47
	10:00 p.m.	74.3	24	2.5	100	11138	58.99
2-28	10:00 a.m.	86.3	23	2.4	72	11210	59.38
	10:00 p.m.	98.3	22	2.4	35	11245	59.56
3-1	10:00 a.m.	110.3	23.5	2.4	27	11272	59.70
	10:00 p.m.	122.3	24	2.4	22	11294	59.82
3-2	11:00 a.m.	147.3	24	2.2	14	11308	59.90
3-3	10:00 a.m.	158.3	24.5	2.0	0	11308	59.90
3-10	12:00 noon	328.3	26	2.0	0	11308	59.90

TABLE 27

PRIMARY SLUDGE

8-DAY AEROBIC SLUDGE DIGESTION

DRAINABILITY ON SAND BEDS -- TOTAL VOLUME APPLIED = 14159 ML.

97.6% INITIAL MOISUTRE

Date 1971	Time	Time Elapsed Hours	Temp. °C	Depth of Sludge Inches	Vol. of Filt. ml.	Cumm. Volume ml.	Volume Applied %
1-7	6:00 p.m.	0	22	6.0	0	0	0
	7:00 p.m.	1	22	3.9	1980	1980	13.98
	8:00 p.m.	2	22	3.8	180	2160	15.26
	9:00 p.m.	3	22	3.6	175	2335	16.49
	10:00 p.m.	4	22	3.5	170	2505	17.69
	11:00 p.m.	5	22	3.5	210	2715	19.18
1-8	12:00 mdnt	6	22	3.4	265	2980	21.05
	6:00 a.m.	12	21	3.3	600	3580	25.26
	12:00 noon	18	22	3.1	340	3920	27.69
	6:00 p.m.	24	23	3.0	330	4250	30.02
1-9	12:00 mdnt	30	23	3.0	150	4400	31.08
	12:00 noon	42	23	2.9	250	4650	32.84
1-10	12:00 mdnt	54	24	2.8	190	4840	34.18
	12:00 noon	66	24	2.8	130	4970	35.10
1-11	12:00 mdnt	78	23	2.5	130	5100	36.02
	12:00 noon	90	25	2.5	120	5220	36.87
1-12	12:00 noon	114	24	2.3	250	5470	38.63
1-13	12:00 noon	138	24	2.2	200	5670	40.05
1-14	12:00 noon	162	23	2.0	290	5960	42.09
1-15	12:00 noon	186	24	1.9	130	6090	43.01
1-16	12:00 noon	210	25	1.8	240	6330	44.71
1-17	12:00 noon	234	25	1.8	190	6520	46.05
1-19	12:00 noon	282	23	1.5	230	6750	47.67
1-21	12:00 noon	330	25	1.3	260	7010	49.51

TABLE 28

PRIMARY SLUDGE

8-DAY AEROBIC SLUDGE DIGESTION

DRAINABILITY ON SAND BEDS -- TOTAL VOLUME APPLIED = 9439 ML.

96.3% INITIAL MOISTURE

Date 1971	Time	Time Elapsed Hours	Temp. °C	Depth of Sludge Inches	Vol. of Filt. ml.	Cumm. Volume ml.	Volume Applied %
1-27	2:45 p.m.	0	19	4	0	0	0
	3:15 p.m.	.5	19	1.8	1420	1420	15.04
	4:00 p.m.	1.25	17	1.5	1645	3065	32.46
	5:00 p.m.	2.25	17	1.3	980	4045	42.85
	10:00 p.m.	7.25	17	1.3	660	4705	49.84
1-28	10:00 a.m.	19.25	24	0.8	870	5575	59.05
	10:00 p.m.	31.25	25	0.7	600	6175	65.41
1-29	10:00 a.m.	43.25	24	0.7	210	6385	67.63
	10:00 p.m.	55.25	26	0.7	130	6515	69.01
1-30	10:00 a.m.	67.25	25	0.5	105	6620	70.12
	10:00 p.m.	79.25	24	0.5	50	6670	70.65
1-31	10:00 a.m.	91.25	21	0.4	77	6747	71.46
	10:00 p.m.	103.25	23	0.4	62	6809	72.12
2-1	10:00 a.m.	115.25	22	0.3	58	6867	72.74
	10:00 p.m.	127.25	23	0.3	66	6933	73.43
2-2	10:00 a.m.	139.25	23	0.3	67	7000	74.14
	10:00 p.m.	151.25	23	0.3	34	7034	74.50
2-3	10:00 p.m.	175.25	24	0.3	14	7048	74.65
2-4	10:00 p.m.	199.25	21	0.3	40	7088	75.07
2-5	10:00 p.m.	223.25	22	0.3	6	7094	75.14
2-7	10:00 p.m.	271.25	23	0.2	55	7149	75.72
2-10	10:00 p.m.	343.25	24	0.1	135	7284	77.15
2-14	10:00 p.m.	439.25	23	0.1	120	7404	78.42

TABLE 29

PRIMARY SLUDGE

8-DAY AEROBIC SLUDGE DIGESTION

DRAINABILITY ON SAND BEDS -- TOTAL VOLUME APPLIED = 18878 ML.

98.2% INITIAL MOISTURE

Date 1971	Time	Time Elapsed Hours	Temp. °C	Depth of Sludge Inches	Vol. of Filt. ml.	Cumm. Volume ml.	Volume Applied %
2-24	7:40 p.m.	0	23	8.0	0	0	0
	8:00 p.m.	.3	23	6.9	200	200	1.05
	10:00 p.m.	2.3	23	6.6	580	780	4.13
2-25	10:00 a.m.	14.3	23.5	6.0	750	1530	8.10
	10:00 p.m.	26.3	25	5.7	1200	2730	14.46
2-26	10:00 a.m.	38.3	24	5.4	1080	3810	20.18
	10:00 p.m.	50.3	26	4.9	630	4440	23.51
2-27	10:00 a.m.	62.3	24	4.8	520	4960	26.27
	10:00 p.m.	74.3	24	4.7	410	5370	28.44
2-28	10:00 a.m.	86.3	23	4.5	340	5710	30.24
	10:00 p.m.	98.3	22	4.5	170	5880	31.14
3-1	10:00 a.m.	110.3	23.5	4.3	170	6050	32.04
	10:00 p.m.	122.3	24	4.3	160	6210	32.89
3-2	11:00 a.m.	135.3	24	4.1	190	6400	33.90
3-3	10:00 a.m.	158.3	24.5	3.9	220	6620	35.06
3-4	12:00 noon	184.3	25	3.6	230	6850	36.28
3-5	1:00 p.m.	209.3	24.5	3.4	400	7250	38.40
3-6	10:00 a.m.	230.3	24	3.3	410	7660	40.57
3-8	10:30 a.m.	254.8	23	3.1	510	8170	43.27
3-10	12:00 noon	304.3	26	2.8	265	8435	44.68

TABLE 30

PRIMARY SLUDGE

12-DAY AEROBIC SLUDGE DIGESTION

DRAINABILITY ON SAND BEDS -- TOTAL VOLUME APPLIED = 14159 ML.

96.8% INITIAL MOISTURE

Date 1971	Time	Time Elapsed Hours	Temp. °C	Depth of Sludge Inches	Vol. of Filt. ml.	Cumm. Volume ml.	Volume Applied %
1-7	6:00 p.m.	0	22	6.0	0	0	0
	7:00 p.m.	1	22	4.0	1300	1300	9.18
	8:00 p.m.	2	22	3.9	160	1460	10.31
	9:00 p.m.	3	22	3.9	0	1460	10.31
	10:00 p.m.	4	22	3.8	170	1630	11.51
	11:00 p.m.	5	22	3.8	200	1830	12.92
1-8	12:00 mdnt	6	22	3.7	240	2070	14.62
	6:00 a.m.	12	21	3.7	400	2470	17.44
	12:00 noon	18	22	3.5	250	2720	19.21
	6:00 p.m.	24	23	3.5	230	2950	20.83
1-9	12:00 mdnt	30	23	3.4	140	3090	21.82
	12:00 noon	42	23	3.1	405	3495	24.68
1-10	12:00 mdnt	54	24	3.0	360	3855	27.23
	12:00 noon	66	24	2.8	350	4205	29.70
1-11	12:00 mdnt	78	23	2.5	340	4545	30.10
	12:00 noon	90	25	2.4	410	4955	35.00
1-12	12:00 noon	114	24	2.0	810	5765	40.72
1-13	12:00 noon	138	24	1.8	400	6165	43.54
1-14	12:00 noon	162	23	1.5	460	6625	46.79
1-15	12:00 noon	186	24	1.4	190	6815	48.13
1-16	12:00 noon	210	25	1.3	290	7105	50.18
1-17	12:00 noon	234	25	1.2	200	7305	51.59
1-19	12:00 noon	282	23	1.0	410	7715	54.49
1-21	12:00 noon	330	25	1.3	240	7955	56.18

TABLE 31

PRIMARY SLUDGE

12-DAY AEROBIC SLUDGE DIGESTION

DRAINABILITY ON SAND BEDS -- TOTAL VOLUME APPLIED = 9439 ML.

97.1% INITIAL MOISTURE

Date 1971	Time	Time Elapsed Hours	Temp. °C	Depth of Sludge Inches	Vol. of Filt. ml.	Cumm. Volume ml.	Volume Applied %
1-27	2:45 p.m.	0	19	4	0	0	0
	3:15 p.m.	.5	19	2.8	310	310	3.28
	4:00 p.m.	1.25	17	2.4	500	810	8.58
	5:00 p.m.	2.25	17	2.3	760	1570	16.63
	10:00 p.m.	7.25	17	2.0	800	2370	25.10
1-28	10:00 a.m.	19.25	24	1.7	930	3300	34.95
	10:00 p.m.	31.25	25	1.3	700	4000	42.37
1-29	10:00 a.m.	43.25	24	0.9	620	4620	48.94
	10:00 p.m.	55.25	26	0.8	390	5010	53.07
1-30	10:00 a.m.	67.25	25	0.7	290	5300	56.14
	10:00 p.m.	79.25	24	0.5	120	5420	57.41
1-31	10:00 a.m.	91.25	21	0.4	110	5530	58.57
	10:00 p.m.	103.25	23	0.4	59	5589	59.20
2-1	10:00 a.m.	115.25	22	0.4	40	5629	59.62
	10:00 p.m.	127.25	23	0.3	22	5651	59.86
2-2	10:00 a.m.	139.25	23	0.3	16	5667	60.03
	10:00 p.m.	151.25	23	0.3	10	5677	60.13
2-3	10:00 p.m.	175.25	24	0.3	14	5691	60.28
2-4	10:00 p.m.	199.25	21	0.3	24	5715	60.53
2-5	10:00 p.m.	223.25	22	0.3	22	5737	60.77
2-7	10:00 p.m.	271.25	23	0.2	77	5814	61.58
2-10	10:00 p.m.	343.25	24	0.1	73	5887	62.36
2-14	10:00 p.m.	439.25	23	0.1	100	5987	63.41

TABLE 32

PRIMARY SLUDGE

12-DAY AEROBIC SLUDGE DIGESTION

DRAINABILITY ON SAND BEDS -- TOTAL VOLUME APPLIED = 18878 ML.

97.9% INITIAL MOISTURE

Date 1971	Time	Time Elapsed Hours	Temp. °C	Depth of Sludge Inches	Vol. of Filt. ml.	Cumm. Volume ml.	Volume Applied %
2-24	7:40 p.m.	0	23	8.0	0	0	0
	8:00 p.m.	.3	23	6.1	2440	2440	12.92
	10:00 p.m.	2.3	23	4.3	4300	6740	35.70
2-25	10:00 a.m.	14.3	23.5	2.4	4970	11710	62.02
	10:00 p.m.	26.3	25	2.4	910	12620	66.85
2-26	10:00 a.m.	38.3	24	2.4	310	12930	68.49
	10:00 p.m.	50.3	26	2.4	230	13160	69.71
2-26	10:00 a.m.	62.3	24	2.4	220	13380	70.87
	10:00 p.m.	74.3	24	2.4	190	13570	71.88
2-28	10:00 a.m.	86.3	23	2.4	200	13770	72.94
	10:00 p.m.	98.3	22	2.4	110	13880	73.52
3-1	10:00 a.m.	110.3	23.5	2.4	110	13990	74.10
	10:00 p.m.	122.3	24	2.4	100	14090	74.63
3-2	11:00 a.m.	135.3	24	2.4	82	14172	75.07
3-3	10:00 a.m.	158.3	24.5	1.6	110	14282	75.65
3-4	12:00 noon	184.3	25	1.4	80	14362	76.07
3-5	1:00 p.m.	209.3	24.5	1.2	150	14512	76.87
3-6	10:00 a.m.	230.3	24	1.2	115	14627	77.48
3-8	10:30 a.m.	278.8	23	1.2	105	14732	78.03
3-10	12:00 noon	328.3	26	1.2	5	14737	78.06

TABLE 33

PRIMARY SLUDGE

12-DAY AEROBIC SLUDGE DIGESTION

DRAINABILITY ON SAND BED -- TOTAL VOLUME APPLIED = 18878 ML.

97.1% INITIAL MOISTURE

Date 1971	Time	Time Elapsed Hours	Temp. °C	Depth of Sludge Inches	Vol. of Filt. ml.	Cumm. Volume ml.	Volume Applied %
4-3	9:00 p.m.	0	24	8.00	0	0	0
	9:30 p.m.	.5	24	6.50	750	750	3.97
	10:00 p.m.	1	24	6.25	780	1530	8.10
	11:00 p.m.	2	25	6.20	740	2270	12.0
4-4	1:00 a.m.	4	25	6.06	600	2870	15.20
	3:00 a.m.	6	25	6.06	330	3200	16.95
	9:00 a.m.	12	24	6.06	520	3720	19.70
	9:00 p.m.	24	26	5.62	1850	5570	29.50
4-5	11:00 a.m.	38	25	2.87	3030	8600	45.55
	9:30 p.m.	48.5	25	2.62	1020	9620	50.95
4-6	9:30 a.m.	60.5	24	2.38	390	10010	53.02
	9:30 p.m.	72.5	25	2.20	220	10230	54.19
4-7	9:30 p.m.	96.5	25	1.93	300	10530	55.77
4-8	9:30 p.m.	120.5	25	1.87	150	10680	56.57
4-9	9:30 p.m.	144.5	26	1.81	115	10795	57.18
4-11	3:00 p.m.	186	24	1.81	120	10915	57.81
4-13	10:00 a.m.	229	22	1.81	75	10990	58.21
4-14	5:00 p.m.	260	24	1.81	65	11055	58.56
4-15	10:00 a.m.	277	24	1.81	60	11115	58.87
4-16	10:00 a.m.	301	25	1.81	35	11150	59.06
4-17	10:00 a.m.	325	26	1.81	15	11165	59.14

TABLE 34

PRIMARY SLUDGE

12-DAY AEROBIC SLUDGE DIGESTION

DRAINABILITY ON SAND BED -- TOTAL VOLUME APPLIED = 18878 ML.

94.9% INITIAL MOISTURE

Date 1971	Time	Time Elapsed Hours	Temp. °C	Depth of Sludge Inches	Vol. of Filt. ml.	Cumm. Volume ml.	Volume Applied %
4-20	6:30 p.m.	0	27	8.00	0	0	0
	7:30 p.m.	1	27	4.56	4280	4280	22.67
	8:30 p.m.	2	27	4.50	600	4880	25.85
	10:30 p.m.	4	27	4.38	450	5330	28.23
	12:30 p.m.	6	25	4.31	310	5640	29.87
4-21	7:00 p.m.	36.5	26	4.00	1020	6660	35.27
4-22	10:00 a.m.	51.5	24	3.87	470	7130	37.76
4-23	10:00 a.m.	75.5	18	3.87	480	7610	40.31
4-24	10:00 a.m.	99.5	26	3.87	420	8030	42.53
4-25	1:00 p.m.	126.5	27	3.87	375	8405	44.52
4-26	1:00 p.m.	150.5	27	2.50	1420	9825	52.04
4-28	7:00 p.m.	204.5	30	1.50	2850	12675	67.14
4-30	8:00 p.m.	253.5	26	1.00	450	13125	69.52
5-1	1:30 p.m.	271	26	0.87	55	13180	69.81
5-3	1:30 p.m.	319	25	0.75	30	13210	69.97

TABLE 35

PRIMARY SLUDGE

18-DAY AEROBIC SLUDGE DIGESTION

DRAINABILITY ON SAND BED -- TOTAL VOLUME APPLIED = 18878 ML.

97.3% INITIAL MOISTURE

Date 1971	Time	Time Elapsed Hours	Temp. °C	Depth of Sludge Inches	Vol. of Filt. ml.	Cumm. Volume ml.	Volume Applied %
4-20	9:00 p.m.	0	24	8.00	0	0	0
	9:30 p.m.	.5	24	6.56	1850	1850	9.79
	10:00 p.m.	1	24	6.31	1200	3050	16.15
	11:00 p.m.	2	25	6.13	880	3930	20.81
4-21	1:00 a.m.	4	25	6.00	750	4680	24.79
	3:00 a.m.	6	25	5.93	380	5060	26.80
	9:00 a.m.	12	24	5.81	570	5630	29.82
	9:00 p.m.	24	26	5.69	620	6250	33.10
4-22	11:00 a.m.	38	25	5.56	400	6650	35.22
	9:30 p.m.	48.5	25	5.62	195	6845	36.25
4-23	9:30 a.m.	60.5	24	5.50	165	7010	37.13
	9:30 p.m.	72.5	25	5.62	130	7140	37.82
4-24	9:30 p.m.	96.5	25	5.56	250	7390	39.14
4-25	9:30 p.m.	120.5	25	5.56	190	7580	40.15
4-26	9:30 p.m.	144.5	26	5.56	170	7750	41.05
4-28	3:00 p.m.	186	24	5.50	290	8040	42.58
4-30	10:00 a.m.	229	22	4.50	270	8310	44.01
5-1	5:00 p.m.	260	24	4.13	220	8530	45.18
5-2	1:00 p.m.	280	25	4.06	85	8615	45.63
5-3	1:00 p.m.	304	25	4.00	95	8714	46.10
5-4	1:00 p.m.	328	24	3.87	85	8795	46.58

TABLE 36

PRIMARY SLUDGE

18-DAY AEROBIC SLUDGE DIGESTION

DRAINABILITY ON SAND BED -- TOTAL VOLUME APPLIED = 18878 ML.

96.4% INITIAL MOISTURE

Date 1971	Time	Time Elapsed Hours	Temp. °C	Depth of Sludge Inches	Vol. of Filt. ml.	Cumm. Volume m.	Volume Applied %
5-1	3:00 p.m.	0	25	8.00	0	0	0
	4:00 p.m.	1	24	6.81	1340	1340	7.09
	4.30 p.m.	1.5	24	6.81	1340	2680	14.19
	5:30 p.m.	2.5	24	6.62	890	3570	18.91
	9:30 p.m.	6.5	25	6.50	800	4370	23.14
5-2	12:30 p.m.	9.5	25	6.50	400	4770	25.26
5-2	1:00 p.m.	22	25	6.44	460	5230	27.70
5-3	1:00 p.m.	46	25	7.38	1030	6260	33.16
5-4	1:00 p.m.	70	24	6.25	550	6810	36.07
5-5	1:00 p.m.	94	26	5.13	1320	8130	43.06
5-6	1:00 p.m.	118	26	2.87	2250	10380	54.98
5-7	1:00 p.m.	142	26	2.56	960	11340	60.06
5-8	1:00 p.m.	166	26	2.25	340	11680	61.87
5-9	2:00 p.m.	191	24	2.00	200	11880	62.93
5-10	3:00 p.m.	216	24	2.00	130	12010	63.61
5-11	8:00 p.m.	245	25	1.75	100	12110	64.14
5-13	3:00 p.m.	288	24	1.75	75	12185	64.54
5-14	8:00 p.m.	317	25	1.75	55	12240	64.84

TABLE 37

PRIMARY SLUDGE

24-DAY AEROBIC SLUDGE DIGESTION

DRAINABILITY ON SAND BED -- TOTAL VOLUME APPLIED = 18878 ML.

96.9% INITIAL MOISTURE

Date 1971	Time	Time Elapsed Hours	Temp. °C	Depth of Sludge Inches	Vol. of Filt. ml.	Cumm. Volume ml.	Volume Applied %
4-20	9:00 p.m.	0	24	8.0	0	0	0
	9:30 p.m.	.5	24	7.20	80	80	0.42
	10:00 p.m.	1	24	7.06	420	500	2.64
	11:00 p.m.	2	25	7.00	500	1000	5.29
4-21	1:00 a.m.	4	25	6.87	530	1530	8.10
	3:00 a.m.	6	25	6.87	360	1890	10.01
	9:00 a.m.	12	24	6.81	580	2470	13.08
	9:00 p.m.	24	26	6.81	510	2980	15.78
4-22	11:00 a.m.	38	25	6.75	380	3360	17.79
	9:30 p.m.	48.5	25	6.50	260	3620	19.17
4-23	9:30 a.m.	60.5	24	6.13	360	3980	21.08
	9:30 p.m.	72.5	25	5.87	290	4270	22.61
4-24	9:30 p.m.	96.5	25	5.62	490	4760	25.21
4-25	9:30 p.m.	120.5	25	5.44	350	5110	27.06
4-26	9:30 p.m.	144.5	26	5.13	260	5370	28.44
4-28	3:00 p.m.	186	24	4.75	340	5710	30.24
4-30	10:00 a.m.	229	22	4.50	410	6120	32.41
5-1	5:00 p.m.	260	24	4.38	380	6500	34.43
5-2	1:00 p.m.	280	25	4.25	140	6640	35.17
5-3	1:00 p.m.	304	25	4.13	120	6760	35.80
5-4	1:00 p.m.	328	24	4.06	110	6870	36.39

TABLE 38

PRIMARY SLUDGE

24-DAY AEROBIC SLUDGE DIGESTION

DRAINABILITY ON SAND BED -- TOTAL VOLUME APPLIED = 18878 ML.

96.2% INITIAL MOISTURE

Date 1971	Time	Time Elapsed Hours	Temp. °C	Depth of Sludge Inches	Vol. of Filt. ml.	Cumm. Volume ml.	Volume Applied %
5-1	3:30 p.m.	0	25	8.00	0	0	0
	4:30 p.m.	1	24	7.25	490	490	2.59
	5:30 p.m.	2	24	7.20	560	1050	5.56
	9:30 p.m.	6	24	7.00	600	1650	8.74
5-2	12:30 a.m.	9	25	7.00	240	1890	10.01
5-2	1:30 p.m.	22	25	6.75	700	2590	13.71
5-3	1:30 p.m.	46	25	6.50	760	3350	17.74
5-4	1:30 p.m.	70	25	6.00	820	4170	22.08
5-5	1:30 p.m.	94	25	5.50	1110	5280	27.96
5-6	1:30 p.m.	118	26	4.87	1060	6340	33.58
5-7	1:30 p.m.	142	26	4.38	860	7200	38.13
5-8	1:30 p.m.	166	26	3.87	1100	8300	43.96
5-9	2:00 p.m.	190.5	24	3.25	1240	9540	50.53
5-10	3:00 p.m.	215.5	24	3.00	860	10400	55.09
5-11	8:00 p.m.	244.5	25	2.87	520	10920	57.84
5-13	3:00 p.m.	263.5	24	2.75	440	11360	60.17
5-14	8:00 p.m.	292.5	25	2.75	220	11580	61.34

TABLE 39

PRIMARY SLUDGE

30-DAY AEROBIC SLUDGE DIGESTION

DRAINABILITY ON SAND BED -- TOTAL VOLUME APPLIED = 18878 ML.

96.9% INITIAL MOISTURE

Date 1971	Time	Time Elapsed Hours	Temp. °C	Depth of Sludge Inches	Vol. of Filt. ml.	Cumm. Volume ml.	Volume Applied %
4-25	12:30 p.m.	0	25	8.00	0	0	0
	1:00 p.m.	.5	25	6.25	1800	1800	9.53
	2:00 p.m.	1.5	25	6.13	850	2650	14.03
	4:00 p.m.	3.5	26	6.00	410	3060	16.20
	9:30 p.m.	9	25	5.87	460	3520	18.64
4-26	9:30 p.m.	33	26	5.25	1320	4840	25.63
4-27	9:30 a.m.	45	24	4.31	2025	6865	36.36
4-28	3:00 p.m.	74.5	24	3.00	3200	10065	53.31
4-29	6:00 a.m.	89.5	23	2.50	1550	11615	61.52
4-30	10:00 a.m.	117.5	22	2.38	620	12235	64.81
5-1	5:30 p.m.	149	24	2.25	470	12705	67.30
5-2	1:30 p.m.	169	25	2.20	215	12920	68.40
5-3	1:30 p.m.	193	25	2.13	155	13075	69.26
5-4	1:30 p.m.	217	25	2.06	130	13205	69.94
5-5	1:30 p.m.	241	25	2.00	125	13330	70.61
5-6	1:30 p.m.	265	26	1.50	100	13430	71.14
5-7	1:30 p.m.	289	26	1.25	80	13510	71.56
5-8	1:30 p.m.	313	26	1.25	55	13565	71.85
5-9	2:00 p.m.	337.5	24	1.25	52	13617	72.13

TABLE 40

PRIMARY SLUDGE

30-DAY AEROBIC SLUDGE DIGESTION

DRAINABILITY ON SAND BED -- TOTAL VOLUME APPLIED = 18878 ML.

97.1% INITIAL MOISTURE

Date 1971	Time	Elapsed Hours	Temp. °C	Depth of Sludge Inches	Vol. of Filt. ml.	Cumm. Volume ml.	Volume Applied %
5-1	11:30 p.m.	0	25	8.00	0	0	0
	12:00 mdnt	.5	25	6.5	1450	1450	7.68
5-2	12:30 a.m.	1	25	6.25	180	1630	8.63
	2:00 a.m.	2.5	25	6.25	380	2010	10.64
	1:30 p.m.	14	25	5.87	1300	3310	17.53
5-3	1:30 p.m.	38	25	5.25	160	3470	18.38
5-4	1:30 p.m.	62	25	5.20	100	3570	18.91
5-5	1:30 p.m.	86	25	5.13	140	3710	19.65
5-6	1:30 p.m.	110	26	4.87	140	3850	20.39
5-7	1:30 p.m.	134	26	4.69	210	4060	21.50
5-8	1:30 p.m.	158	26	4.50	200	4260	22.56
5-9	2:00 p.m.	182.5	23	4.50	100	4360	23.09
5-10	3:00 p.m.	207.5	24	4.5	50	4410	23.36
5-11	8:00 p.m.	236.5	25	4.3	80	4490	23.78
5-13	3:00 p.m.	255.5	24	4.0	45	4535	24.02
5-14	8:00 p.m.	284.5	25	3.75	130	4665	24.71

TABLE 41

MIXED PRIMARY AND SECONDARY SLUDGE

FEED FOR AEROBIC SLUDGE DIGESTERS

DRAINABILITY ON SAND BEDS -- TOTAL VOLUME APPLIED = 15,928 ML.

Date 1971	Time	Time Elapsed Hours	Temp. °C	Depth of Sludge Inches	Vol. of Filt. ml.	Cumm. Volume ml.	Volume Applied %
7-15	10:00 a.m.		26	6 3/4	0	0	0
	10:30 a.m.	0.5	26	6 1/2	2000	2000	12.5
	11:00 a.m.	1	27	5 5/8	2200	4200	26.4
	12:00 noon	2	26	5 1/4	1200	5600	35.2
	3:30 p.m.	5.5	26	4 3/8	2250	7850	49.3
7-16	7:00 a.m.	21.0	27	3 1/4	2300	10150	63.7
7-17	7:30 a.m.	45.5	27	2 7/8	2300	12450	78.2
7-18	9:30 a.m.	71.5	26	2 11/16	700	13150	82.6
7-19	8:30 a.m.	94.5	27	2 3/8	15	13165	82.7
7-21	8:30 a.m.	142.5	27	1 7/8	0	13165	82.7
7-22	8:30 a.m.	166.5	26	1 9/16	0	Dry	----
7-23	8:30 a.m.	190.5	27	1 1/2	0	Dry	----
7-26	8:30 a.m.	262.5	26	1 7/16	0	Dry	----

TABLE 42

MIXED PRIMARY AND SECONDARY SLUDGE

4-DAY AEROBIC SLUDGE DIGESTION

DRAINABILITY ON SAND BEDS -- TOTAL VOLUME APPLIED = 18878 ML.

96.9% INITIAL MOISTURE

Date 1971	Time	Time Elapsed Hours	Temp. °C	Depth of Sludge Inches	Vol. of Filt. ml.	Cumm. Volume ml.	Volume Applied %
5-27	2:00 p.m.		26	8.0	0	0	0
	3:00 p.m.	1	26	6.5	1270	1270	6.7
	4:00 p.m.	2	26	6.25	800	2070	11.0
	5:00 p.m.	3	25	6.25	350	2420	12.8
	7:30 p.m.	5.5	25	6.13	820	3240	17.2
	10:00 p.m.	8	25	6.0	500	3740	19.8
5-28	10:00 a.m.	20	23	6.0	1400	5140	27.2
	10:00 p.m.	32	25	5.8	1100	6240	33.1
5-29	10:00 a.m.	44	23	4.0	2900	9140	48.4
	12:30 p.m.	46.5	24	3.5	1170	10310	54.6
	2:30 p.m.	48.5	25	3.0	1420	11730	62.1
	5:00 p.m.	51	25	2.75	1000	12730	67.4
	10:00 p.m.	56	25	2.50	660	13390	70.9
5-30	10:30 a.m.	68.5	25	2.50	780	14170	75.1
	8:30 p.m.	78.5	26	2.25	300	14470	76.7
5-31	11:00 a.m.	93	25	2.0	300	14770	78.2
6-1	12:00 noon	106	25	1.75	340	15110	80.0
6-2	12:00 noon	130	26	1.5	220	15330	81.2
6-3	6:00 p.m.	160	26	1.25	180	15510	82.2
6-5	1:00 p.m.	203	25	1.0	160	15670	83.0
6-6	12:00 noon	226	25	1.0	50	15720	83.3
6-9	11:00 a.m.	297	26	0.8	100	15820	83.8
6-11	12:00 noon	346	26	0.5	60	15880	84.1

TABLE 43

MIXED PRIMARY AND SECONDARY SLUDGE

4-DAY AEROBIC SLUDGE DIGESTION

DRAINABILITY ON SAND BEDS -- TOTAL VOLUME APPLIED = 17,698 ML.

24-DAY MIXED REACTOR 4-HRS. SETTLING

Date 1971	Time	Time Elapsed Hours	Temp. °C	Depth of Sludge Inches	Vol. of Filt. ml.	Cumm. Volume ml.	Volume Applied %
7-16	12:00 noon	0	26	7.5	0	0	0
	2:00 p.m.	2	26	7.31	100	100	0.6
	4:00 p.m.	4	27	7.25	320	420	2.4
7-17	7:30 a.m.	19.5	26	6.86	1100	1520	8.6
7-18	9:30 a.m.	45.5	27	6.25	1220	2740	15.5
7-19	8:30 a.m.	68.5	26	5.75	960	3700	20.9
7-21	8:30 a.m.	116.5	26	5.50	900	4600	26.0
7-22	8:30 a.m.	140.5	26	5.19	300	4900	27.7
7-23	8:30 a.m.	164.5	27	5.0	190	5090	28.8
7-26	9:30 a.m.	237.5	26	4.31	590	5680	32.1
7-27	8:30 a.m.	260.5	27	4.19	220	5900	33.3
7-28	9:30 a.m.	285.5	26	4.0	200	6100	34.5

TABLE 44

MIXED PRIMARY AND SECONDARY SLUDGE

12-DAY AEROBIC SLUDGE DIGESTION

DRAINABILITY ON SAND BEDS -- TOTAL VOLUME APPLIED = 18878 ML.

96.4% INITIAL MOISTURE

Date 1971	Time	Time Elapsed Hours	Temp. °C	Depth of Sludge Inches	Vol. of Filt. ml.	Cumm. Volume ml	Volume Applied %
6-6	2:00 p.m.	0	26	8.0	0	0	0
	3:00 p.m.	1	26	7.6	0	0	0
	5:00 p.m.	3	26	7.5	160	160	.8
	8:00 p.m.	6	25	7.5	350	510	2.7
6-7	9:00 a.m.	19	25	7.4	720	1230	6.5
6-8	9:00 a.m.	43	25	7.0	600	1830	9.7
6-9	12:00 noon	70	26	6.5	420	2250	11.9
6-10	9:00 a.m.	91	25	6.4	280	2530	13.4
6-11	10:00 a.m.	116	25	6.3	300	2830	15.0
6-12	10:00 a.m.	140	24	6.0	240	3070	16.3
6-13	10:00 a.m.	164	25	5.8	210	3280	17.4
6-14	3:00 p.m.	193	25	5.7	220	3500	18.5
6-15	1:00 p.m.	215	26	5.5	140	3640	19.3
6-17	4:00 p.m.	266	26	5.3	310	3950	20.9
6-18	3:00 p.m.	289	27	5.0	155	4105	21.7
6-22	2:00 p.m.	384	26	4.5	490	4595	24.3
6-24	11:00 a.m.	429	27	4.3	180	4775	25.3

TABLE 45

MIXED PRIMARY AND SECONDARY SLUDGE

24-DAY AEROBIC SLUDGE DIGESTION

DRAINABILITY ON SAND BEDS -- TOTAL VOLUME APPLIED = 17403 ML.

Date 1971	Time	Time Elapsed Hours	Temp. °C	Depth of Sludge Inches	Vol. of Filt. ml.	Cumm. Volume ml.	Volume Applied %
7-15	10:30 p.m.	0		7.375	0	0	0
	12:00 noon	1.5	25	7.250	200	200	1.1
	3:30 p.m.	5.0	26	7.125	480	680	3.9
7-16	7:00 a.m.	20.5	26	6.750	780	1260	7.2
7-17	7:30 a.m.	45.0	27	6.375	670	1930	11.1
7-18	9:30 a.m.	71	26	6.063	520	2450	14.1
7-19	8:30 a.m.	94	25	5.875	390	2840	16.3
7-21	8:30 a.m.	142	26	5.250	600	3440	19.8
7-22	8:30 a.m.	166	25	5.000	360	3800	21.8
7-23	8:30 a.m.	190	25	4.875	210	4010	23.0
7-26	9:30 a.m.	263	26	4.188	600	4610	26.5
7-27	8:30 a.m.	286	25	4.063	230	4840	27.8
7-28	9:30 a.m.	311	25	3.938	210	5050	29.0

TABLE 46

SECONDARY SLUDGE

4-DAY AEROBIC SLUDGE DIGESTION

DRAINABILITY ON SAND BEDS -- TOTAL VOLUME APPLIED = 18878 ML.

97.5% INITIAL MOISTURE

Date 1971	Time	Time Elapsed Hours	Temp. °C	Depth of Sludge Inches	Vol. of Filt. ml.	Cumm. Volume ml.	Volume Applied %
6-3	5:00 p.m.	0	26	8.0	0	0	0
	6:00 p.m.	1	26	8.0	440	440	2.3
	8:00 p.m.	3	26	7.75	460	900	4.8
6-4	12:00 mdnt	7	25	7.50	1170	2070	11.0
	10:00 a.m.	17	26	7.25	800	2870	15.2
6-5	1:00 a.m.	32	25	7.0	690	3560	18.9
	1:00 p.m.	44	25	6.87	320	3880	20.6
6-6	12:00 noon	67	25	6.25	900	4780	5.3
6-6	11:00 p.m.	78	25	5.75	740	5520	29.2
6-7	1:00 p.m.	92	25	5.5	850	6370	33.7
6-9	11:00 a.m.	138	26	4.5	1800	8170	43.3
6-10	12:00 noon	163	26	3.75	1580	9750	51.6
6-11	12:00 noon	187	27	3.3	1250	11000	58.3
6-12	2:00 p.m.	213	26	3.2	840	11840	62.7
6-13	2:00 p.m.	237	26	2.75	520	12360	65.5
6-14	12:00 noon	259	26	2.6	320	12680	67.2
6-15	7:00 p.m.	290	26	2.3	350	13030	69.0
6-16	2:00 p.m.	309	26	2.15	180	13210	70.0
6-17	2:00 p.m.	333	25	2.10	20	13230	70.1

TABLE 47

SECONDARY SLUDGE

8-DAY AEROBIC SLUDGE DIGESTION

DRAINABILITY ON SAND BEDS -- TOTAL VOLUME APPLIED = 18878 ML.

Date 1971	Time	Time Elapse Hours	Temp. °C	Depth of Sludge Inches	Vol. of Filt. ml.	Cumm. Volume ml.	Volume Applied %
6-16	2:00 p.m.	0	26	8.0	0	0	0
	3:00 p.m.	1	26	7.1	0	0	0
	5:00 p.m.	3	26	7.0	380	380	2.0
	8:00 p.m.	6	25	6.8	740	1120	5.9
6-17	9:00 a.m.	19	25	6.3	1260	2380	12.6
6-18	10:00 a.m.	44	25	6.0	920	3300	17.5
6-19	10:00 a.m.	68	24	5.5	770	4070	21.6
6-20	10:00 a.m.	92	25	4.75	1440	5510	29.2
6-21	3:00 p.m.	121	25	4.0	1420	6930	36.7
6-22	1:00 p.m.	143	26	3.75	660	7590	40.2
6-24	4:00 p.m.	194	27	3.1	1240	8830	46.8
6-25	3:00 p.m.	217	27	2.8	460	9290	49.2
6-27	11:00 a.m.	261	26	2.7	620	9910	52.5
6-29	2:00 p.m.	312	27	2.0	720	10630	56.3
7-1	11:00 a.m.	357	27	2.0	520	11150	59.1

TABLE 48

SECONDARY SLUDGE

12-DAY AEROBIC SLUDGE DIGESTION

DRAINABILITY ON SAND BEDS -- TOTAL VOLUME APPLIED = 18878 ML.

Date 1971	Time	Time Elapsed Hours	Temp. °C	Depth of Sludge Inches	Vol. of Filt. ml.	Cumm. Volume ml.	Volume Applied %
7-1	3:00 p.m.	0	27	8.0	0	0	0
	4:00 p.m.	1	27	7.6	280	280	1.5
7-2	8:00 a.m.	16	26	6.75	2910	3190	16.9
7-3	1:00 p.m.	45	26	6.25	1360	4550	24.1
7-4	12:00 noon	68	25	6.0	580	5130	27.2
7-5	12:00 noon	92	25	5.75	425	5555	29.4
7-6	8:00 a.m.	112	25	5.50	360	5915	31.3
7-7	8:00 a.m.	136	26	5.1	580	6495	34.4
7-9	9:00 a.m.	185	24	4.8	560	7055	37.4
7-13	9:00 a.m.	281	29		1080	8135	43.0

TABLE 49

SECONDARY SLUDGE -- NOT SETTLED

12-DAY AEROBIC SLUDGE DIGESTION

DRAINABILITY ON SAND BEDS -- TOTAL VOLUME APPLIED = 18878 ML.

Date 1971	Time	Time Elapsed Hours	Temp. °C	Depth of Sludge Inches	Vol. of Filt. ml.	Cumm. Volume ml.	Volume Applied %
7-1	2:30 p.m.	0	27	8.0	0	0	
	3:30 p.m.	1.0	27	7.5	340	340	1.8
	4:30 p.m.	2.0	27	7.25	320	660	3.5
7-2	8:00 a.m.	17.5	27	6.6	1740	2400	12.7
7-3	1:00 p.m.	46.5	26	6.25	1000	3400	18.0
7-4	12:00 noon	69.5	25	5.80	520	3920	20.8
7-5	10:00 a.m.	91.5	25	4.6	1880	5800	30.7
7-6	8:00 a.m.	113.5	25	3.7	2280	8080	42.8
7-6	11:00 p.m.	128.5	26	3.25	910	8990	47.6
7-7	8:00 p.m.	149.5	27	2.9	820	9810	52.0
7-9	9:00 a.m.	186.5	25	2.5	840	10650	56.4

TABLE 50

ANAEROBIC SLUDGE

FROM ANAEROBIC SLUDGE DIGESTER

DRAINABILITY ON SAND BEDS -- TOTAL VOLUME APPLIED = 14159 ML.

98.2% INITIAL MOISTURE

Date 1971	Time	Time Elapsed Hours	Temp. °C	Depth of Sludge Inches	Vol. of Filt. ml.	Cumm. Volume ml.	Volume Applied %
1-7	6:00 p.m.	0	22	6.0	0	0	0
	7:00 p.m.	1	22	5.4	0	0	0
	10:00 p.m.	4	22	5.4	0	0	0
	11:00 p.m.	5	22	5.3	0	0	0
1-8	12:00 mdnt	6	22	5.3	110	110	0.78
	6:00 a.m.	12	21	5.3	260	370	2.61
	12:00 noon	18	22	5.3	190	560	3.96
	6:00 p.m.	24	23	5.1	240	800	5.65
1-9	12:00 mdnt	30	23	5.1	120	920	6.50
	12:00 noon	42	23	5.1	330	1250	8.83
1-10	12:00 mdnt	54	24	5.1	270	1520	10.74
	12:00 noon	66	24	5.1	210	1730	12.22
1-11	12:00 mdnt	78	23	5.0	220	1950	13.77
	12:00 noon	90	25	5.0	190	2140	15.11
1-12	12:00 noon	114	24	4.9	440	2580	18.22
1-13	12:00 noon	138	24	4.8	270	2850	20.13
1-14	12:00 noon	162	23	4.0	380	3230	22.81
1-15	12:00 noon	186	24	4.5	170	3400	24.01
1-16	12:00 noon	210	25	4.4	250	3650	25.78
1-17	12:00 noon	234	25	4.4	190	3840	27.12
1-19	12:00 noon	282	23	4.2	250	4090	28.89
1-21	12:00 noon	330	25	3.3	255	4345	30.69

TABLE 51

ANAEROBIC SLUDGE

DRAINABILITY ON SAND BEDS -- TOTAL VOLUME APPLIED = 9439 ML.

98.2% INITIAL MOISTURE

Date 1971	Time	Time Elapsed Hours	Temp. °C	Depth of Sludge Inches	Vol. of Filt. ml.	Cumm. Volume ml.	Volume Applied %
1-27	2:45 p.m.	0	19	4	0	0	0
	3:15 p.m.	.5	19	4	0	0	0
	4:00 p.m.	1.25	17	3.5	0	0	0
	5:00 p.m.	2.25	17	3.5	100	100	1.06
	10:00 p.m.	7.25	17	3.4	180	280	2.01
1-28	10:00 a.m.	19.25	24	3.3	280	560	6.04
	10:00 p.m.	31.25	25	3.3	240	800	8.58
1-29	10:00 a.m.	43.25	24	3.1	185	985	10.54
	10:00 p.m.	55.25	26	3.1	150	1135	12.13
1-30	10:00 a.m.	67.25	25	3.1	140	1275	13.61
	10:00 p.m.	79.25	24	3.1	130	1405	15.00
1-31	10:00 a.m.	91.25	21	3.0	120	1525	16.26
	10:00 p.m.	103.25	23	2.9	150	1675	17.85
2-1	10:00 a.m.	115.25	22	2.9	70	1745	18.59
	10:00 p.m.	127.25	23	2.8	130	1875	19.97
2-2	10:00 a.m.	139.25	23	2.7	105	1980	21.08
	10:00 p.m.	151.25	23	2.5	95	2075	22.08
2-3	10:00 p.m.	175.25	24	2.5	130	2205	23.46
2-4	10:00 p.m.	199.25	21	2.5	120	2325	24.73
2-5	10:00 p.m.	223.25	22	2.4	100	2425	25.79
2-7	10:00 p.m.	271.25	23	2.1	130	2555	27.17
2-10	10:00 p.m.	343.25	24	1.5	155	2710	28.81
2-14	10:00 p.m.	439.25	23	1.1	110	2820	29.98

TABLE 52

ANAEROBIC SLUDGE

FROM ANAEROBIC SLUDGE DIGESTER

DRAINABILITY ON SAND BEDS -- TOTAL VOLUME APPLIED = 18878 ML.

93.2% INITIAL MOISTURE

Date 1971	Time	Time Elapse Hours	Temp. °C	Depth of Sludge Inches	Vol. of Filt. ml.	Cumm. Volume ml.	Volume Applied %
2-24	7:40 p.m.	0	23	8.0	0	0	0
	10:00 p.m.	2.3	23	7.4	0	0	0
2-25	10:00 a.m.	14.3	23.5	7.3	450	450	2.38
	10:00 p.m.	26.3	25	7.2	200	650	3.44
2-26	10:00 a.m.	38.3	24	7.2	220	870	4.60
	10:00 p.m.	50.3	26	7.2	320	1190	6.30
2-27	10:00 a.m.	62.3	24	7.1	530	1720	9.11
	10:00 p.m.	74.3	24	7.1	390	2110	11.17
2-28	10:00 a.m.	86.3	23	7.1	460	2570	13.61
	10:00 p.m.	98.3	22	7.1	270	2840	15.04
3-1	10:00 a.m.	110.3	23.5	7.1	320	3160	16.73
	10:00 p.m.	122.3	24	7.1	285	3446	18.24
3-2	11:00 a.m.	135.3	24	6.9	290	3735	19.78
3-3	10:00 a.m.	158.3	24.5	6.4	410	4145	21.95
3-4	12:00 noon	184.3	25	6.3	375	4520	23.94
3-5	1:00 p.m.	209.3	24.5	6.2	700	5220	27.65
3-6	10:00 a.m.	230.3	24	5.5	600	5820	30.82
3-8	10:30 a.m.	278.8	23	4.9	640	6460	34.21
3-10	12:00 noon	328.3	26	4.7	400	6860	36.33

TABLE 53

PRIMARY SLUDGE -- BATCH DIGESTER

Date: March 22 to April 27, 1971, Incl.

TESTS	DAYS DETENTION 0	2	4	8	12	18	24	30	36
Mixed Liquor									
Total Solids	17,875	16,125	15,250	13,625	15,375	14,000	13,625	13,000	12,250
Total Volatile Solids	10,875	12,125	11,500	9,875	11,300	10,000	9,500	8,250	8,000
Total Fixed Solids	7,000	4,000	3,750	3,750	4,075	4,000	4,125	4,750	4,250
4 Hrs. Settled									
Total Solids	29,375	18,250	19,125	21,250	25,125	23,750	13,375	13,250	18,000
Total Volatile Solids	22,250	14,500	14,000	15,000	17,125	16,250	9,500	8,750	11,500
Total Fixed Solids	7,125	4,500	5,125	6,250	8,000	7,500	3,875	4,500	6,500
Percent Water									
Mixed Liquor	98.2	98.4	98.5	98.6	98.5	98.6	98.6	98.7	98.8
4 Hrs. Settled	97.1	98.2	98.1	97.9	97.5	97.6	98.7	98.7	98.2
Temperature ^{o}C	24.5	24.5	25.0	24.0	23.5	24.5	26.8	25.0	----
Dissolved Oxygen	----	0.50	0.66	1.02	1.02	1.44	1.68	1.64	----
COD Mixed Liquor	24,800	25,000	22,133	20,600	19,400	19,055	18,420	8,333	14,060
COD Filtrate	1,046	1,893	3,253	4,480	2,940	2,911	2,410	367	740
COD Sand Bed Filtrate	------	------	4,573	------	1,480	------	------	1,303	------

TABLE 54

PRIMARY SLUDGE -- BATCH DIGESTER

Date: March 22 to April 27, 1971, Incl.

TESTS	DAYS DETENTION 0	2	4	8	12	18	24	30	36
Nitrates Mixed Liquor	69	59	62	48	46	80	64	62	--
Nitrates Filtrate	9	2	2	4	2	2	3	2	--
Nitrates Sand Bed Filtrate	--	--	7	--	2	--	--	--	--
Ammonia on Mixed Liquor	168	112	90	60	84	98	140	91	102
Ammonia on Filtrate	63	73	70	78	76	77	75	83	76
Ammonia on Sand Bed Filtrate	--	--	59	--	20	--	--	27	--
Phosphate Mixed Liquor	300	275	275	300	300	325	325	325	275
Phosphate Filtrate	55	45	80	105	75	75	80	30	--
Phosphate Sand Bed Filtrate	---	---	120	---	6	---	---	12	--
pH on Mixed Liquor	6.87	6.74	6.27	6.25	6.87	6.75	7.57	8.00	7.50
Filterability CST Units									
Mixed Liquor	350	488	556	474	468	513	372	269	413
4 Hrs. Settled	374	395	487	447	450	460	367	304	390
Settleability Percent	63	80	76	53	43	49	99	99	54

TABLE 55

PRIMARY SLUDGE

FEED

Date 1970-71	Temperature °C	Settleability at 4 Hours % by Volume	Filterability C.S.T. Seconds
8-13	29	--	365.6
9-17/18	30	99	-----
9-23	30	--	-----
10-5/6	30	85	393.3
10-12/13	30	98	228.2
10-16	30	91	179.2
11-9	30	55	124.9
11-24	30	99	205.7
12-8/9	--	93	151.5
1-7	30	88	149.2
1-21	30	99	196.0
1-27	30	75	161.2
2-16	30	98	124.8
2-24	30	94	215.0
AVG	29.9	89.5	207.8

TABLE 56

PRIMARY SLUDGE

2-DAY DETENTION

Date 1970-71	Temperature °C	Settleability at 4 Hours % by Volume	Filterability C.S.T. Seconds Mixed Liquor	4 Hour Settled
8-13	26	--	-----	-----
8-23	26	--	-----	-----
8-31	25	--	451.9	-----
9-17	--	67	-----	-----
10-5	17	74	334.7	-----
10-12	16	78	270.5	-----
10-16	25	72	369.4	-----
11-9	--	53	409.8	648.3
11-24	--	31	777.7	606.2
12-9	--	73	725.4	693.1
1-7	--	31	534.8	524.5
1-21	--	26	436.5	270.5
1-27	--	20	471.6	376.0
AVG	22.5	52.5	478.2	519.7

TABLE 57

PRIMARY SLUDGE

4-DAY DETENTION

Date 1970-71	Temperature °C	Settleability at 4 Hours % by Volume	Filterability C.S.T. Seconds Mixed Liquor	4 Hour Settled
8-23	24	--	-----	-----
8-31	24	--	386.8	-----
9-17	--	69	-----	-----
10-5	20	69	373.3	-----
10-12	18	80	287.9	-----
10-16	--	60	343.2	-----
11-9	--	71	429.8	357.5
11-24	--	58	787.9	589.8
12-9	--	41	732.0	705.4
1-7	--	46	631.9	587.0
1-21	--	28	590.8	520.6
1-27	--	25	714.0	506.5
2-11	24	--	-----	-----
2-11	24	--	-----	-----
2-16	24	86	832.0	731.0
2-16	22	92	600.0	582.0
2-24	--	36	1113.0	1048.0
2-24	--	98	294.0	253.0
AVG	22.5	68.5	613.6	588.1

TABLE 58

PRIMARY SLUDGE

8-DAY DETENTION

Date 1970-71	Temperature °C	Settleability at 4 Hours % by Volume	Filterability C.S.T. Seconds Mixed Liquor	4 Hour Settled
8-23	26	--	-----	-----
8-31	26	--	363.0	-----
9-17	--	71	-----	-----
10-5	23	58	437.9	-----
10-12	22	61	390.0	-----
10-16	--	--	470.7	-----
11-9	--	63	442.0	355.1
11-24	--	83	540.0	475.4
12-9	--	83	527.0	452.5
1-7	--	90	603.7	621.0
1-21	--	50	476.8	389.4
1-27	--	35	500.3	370.1
2-11	26	--	-----	-----
2-11	25	--	-----	-----
2-16	--	48	623.0	529.0
2-24	--	31	902.0	561.0
AVG	24.7	61.2	523.0	469.2

TABLE 59

PRIMARY SLUDGE

12-DAY DETENTION

Date 1970-71	Temperature °C	Settleability at 4 Hours % by Volume	Filterability C.S.T. Seconds Mixed Liquor	4 Hour Settled
10-5	23	73	100.2	-----
10-12	22	90	100.0	-----
10-16	--	--	200.1	-----
11-9	--	48	455.7	497.4
11-24	--	51	456.4	401.9
12-9	--	49	401.2	422.8
1-7	--	66	609.9	480.7
1-21	--	99	186.0	191.0
1-27	--	95	151.4	162.1
2-11	26	--	-----	-----
2-16	24	65	440.0	433.0
2-24	--	56	590.0	551.0
3-17	24	--	-----	-----
4-3	23	67	653.0	660.0
4-20	25	64	683.0	551.0
4-25	--	66	714.0	716.0
AVG	23.9	68.4	410.1	460.6

TABLE 60

PRIMARY SLUDGE

18-DAY DETENTION

Date 1971	Temperature °C	Settleability at 4 Hours % by Volume	Filterability C.S.T. Seconds Mixed Liquor	4 Hour Settled
3-16	--	--	-----	-----
3-17	24	--	-----	-----
4-3	24	--	-----	-----
4-20	26	88	600	608
4-25	--	88	574	582
5-1	--	62	555	524
AVG	24.7	79.3	576.3	571.3
		24-DAY DETENTION		
4-20	--	51	633	586
4-25	--	56	596	537
5-1	--	43	681	653
AVG	--	50	636.7	592.0
		30-DAY DETENTION		
4-25	--	62	530	482
5-1	--	60	595	563
AVG	--	61	562.5	522.5

TABLE 61

MIXED PRIMARY AND SECONDARY SLUDGE

FEED

Date 1971	Temperature °C	Settleability at 4 Hours % by Volume	Filterability C.S.T. Seconds Mixed Liquor	4 Hour Settled
5-28	--	99	181.8	120.0
5-29	--	100	200.0	200.0
6-4	--	97	139.2	130.5
6-5	--	98	200.4	198.7
7-12	--	96	122.0	126.0
7-13	--	96	110.0	43.7
7-14	--	90	66.0	-----
AVG	--	96.6	145.6	136.5
		SECONDARY SLUDGE FEED		
6-1	--	61	51.5	90.1
6-2	--	63	54.5	88.5
6-3	--	72	84.3	126.2
6-15	--	74	101.8	140.9
6-16	--	69	113.4	129.0
6-25	--	73	91.8	137.5
6-28	--	87	148.7	172.4
AVG	--	71.3	92.4	126.4

TABLE 62

MIXED PRIMARY AND SECONDARY SLUDGE

4-DAY DETENTION

Date 1971	Temperature °C	Settleability at 4 Hours % by Volume	Filterability C.S.T. Seconds Mixed Liquor	4 Hours Settled
5-27	24	93	614.7	533.4
5-28	24	95	488.2	475.3
5-29	24	94	473.1	515.2
AVG	24	94	525.3	508.0
		12-DAY DETENTION		
6-4	25	81	448.7	405.5
6-5	24	82	486.1	430.5
6-6	26	89	499.1	476.9
AVG	25	84	478.0	437.6
		24-DAY DETENTION		
7-12	24	95	528.0	544.0
7-13	24	82	522.0	506.0
7-14	25	80	557.0	508.0
AVG	24.3	85.7	535.7	519.3

TABLE 63

SECONDARY SLUDGE

4-DAY DETENTION

Date 1971	Temperature °C	Settleability at 4 Hours % by Volume	Filterability C.S.T. Seconds Mixed Liquor	4 Hour Settled
6-1	26	24	16.1	125.9
6-2	24	28	31.5	135.2
6-3	24	44	42.0	165.0
AVG	24.7	32.0	29.9	142.0
8-DAY DETENTION				
6-13	26	93	213.8	241.2
6-15	26	93	245.9	233.3
6-16	25	94	240.4	238.1
AVG	25.7	93.3	233.4	237.5
12-DAY DETENTION				
6-25	24	85	132.2	149.1
6-28	24	90	232.3	200.2
7-1	24	93	296.2	258.9
AVG	24	89.3	220.2	202.7

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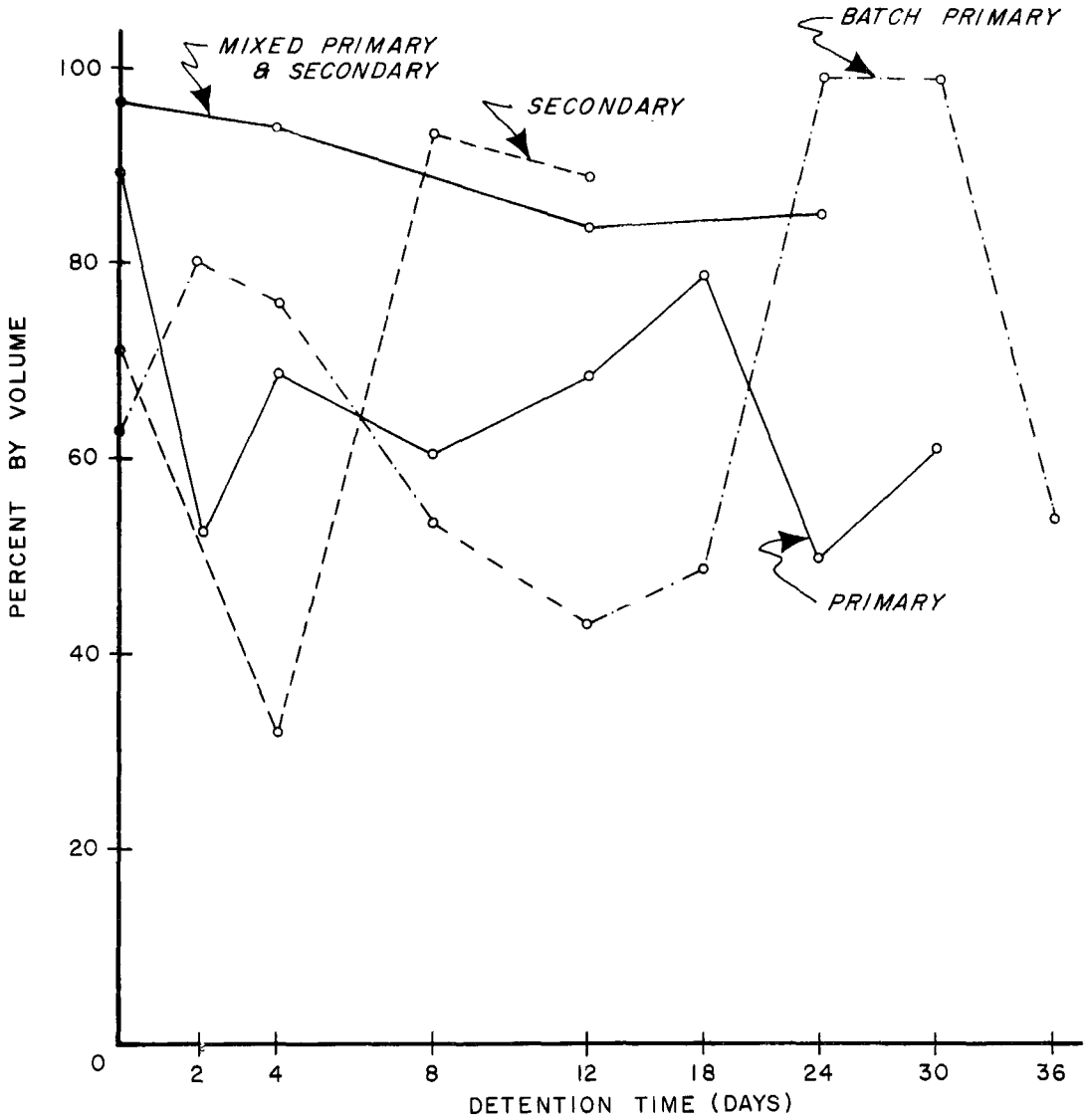
TABLE 64

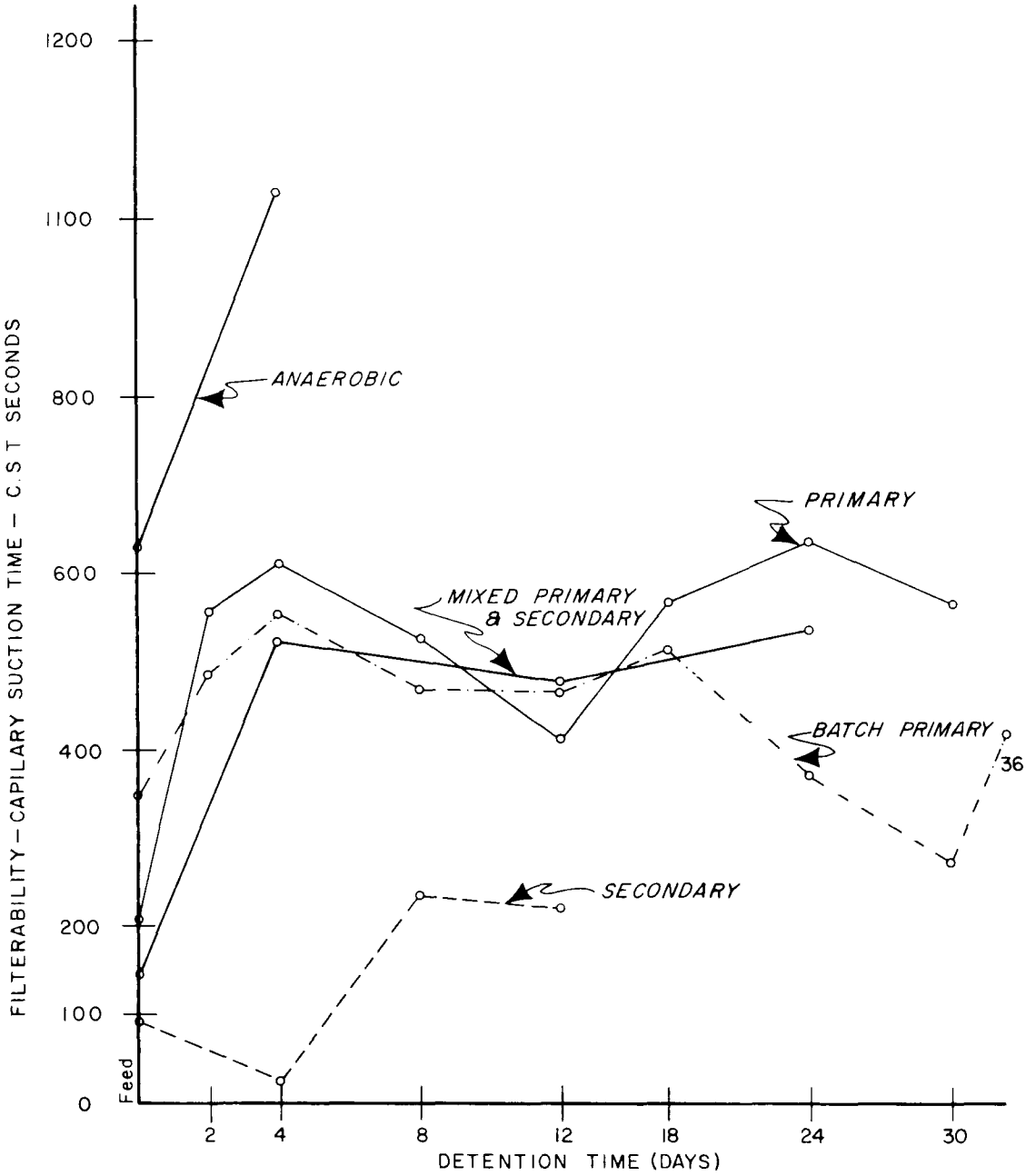
ANAEROBIC SLUDGE

Date	Temperature °C	Settleability at 4 Hours % by Volume	Filterability C.S.T. Seconds
6-10	32.5	---	-----
11-24	32.5	100	506.7
12-9	32.5	100	554.5
1-7	32.5	---	641.4
1-21	32.5	100	825.8
1-27	32.5	100	625.4
2-16	32.5	100	528.0
2-24	32.5	100	726.8
AVG	32.5	100.0	629.8
	FROM ANAEROBIC DIGESTORS		
6-25	----	100	714.3
6-28	----	100	711.4
AVG	----	100	712.8
	AERATION OF ANAEROBIC SLUDGE		
6-25	24	100	1094.5
6-28	25	98	993.6
7-4	26	100	1002.3
AVG	25	99.3	1030.1



MIXED LIQUOR
SETTLEABILITY AT 4-HOURS

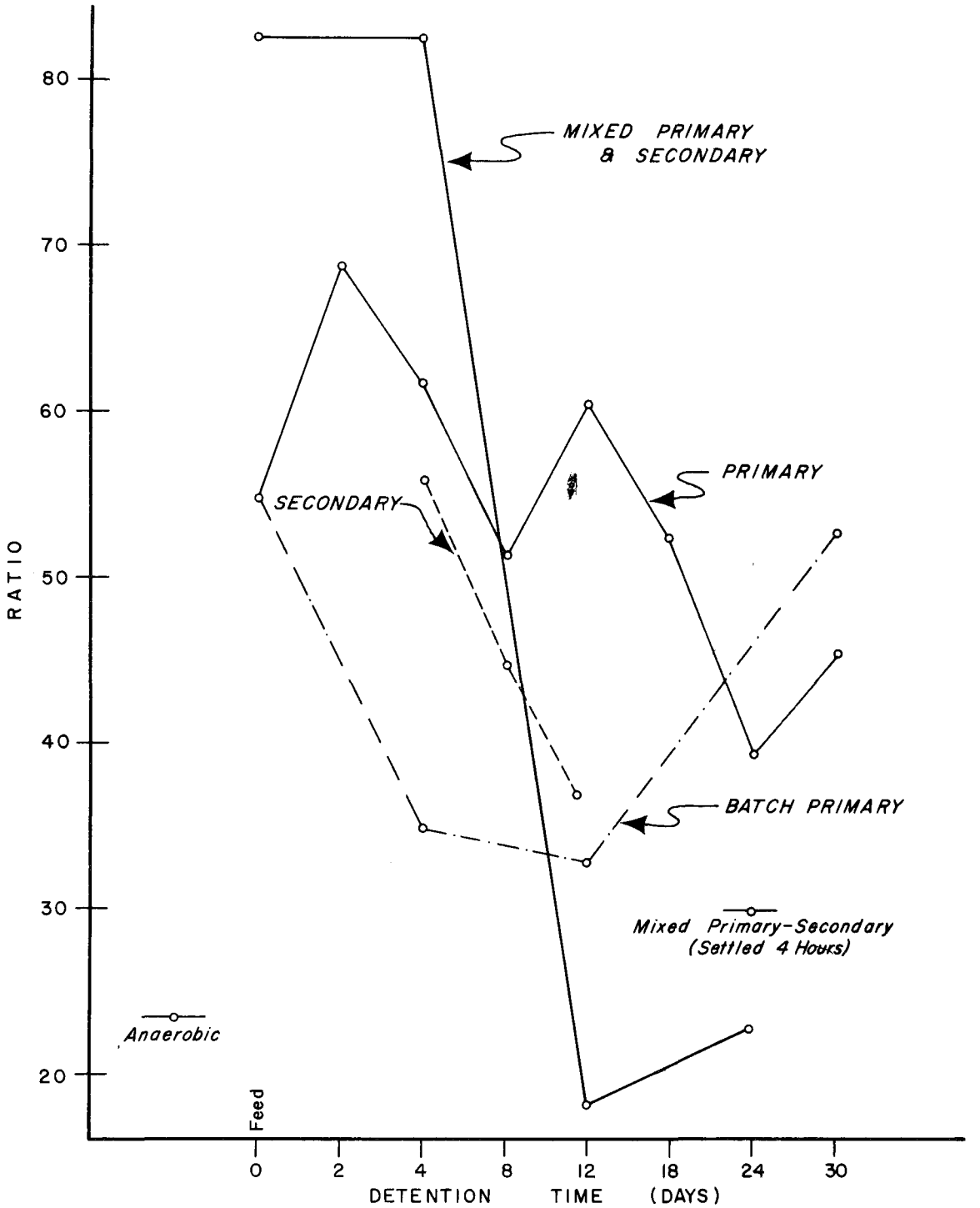
FIGURE 17



MIXED LIQUOR

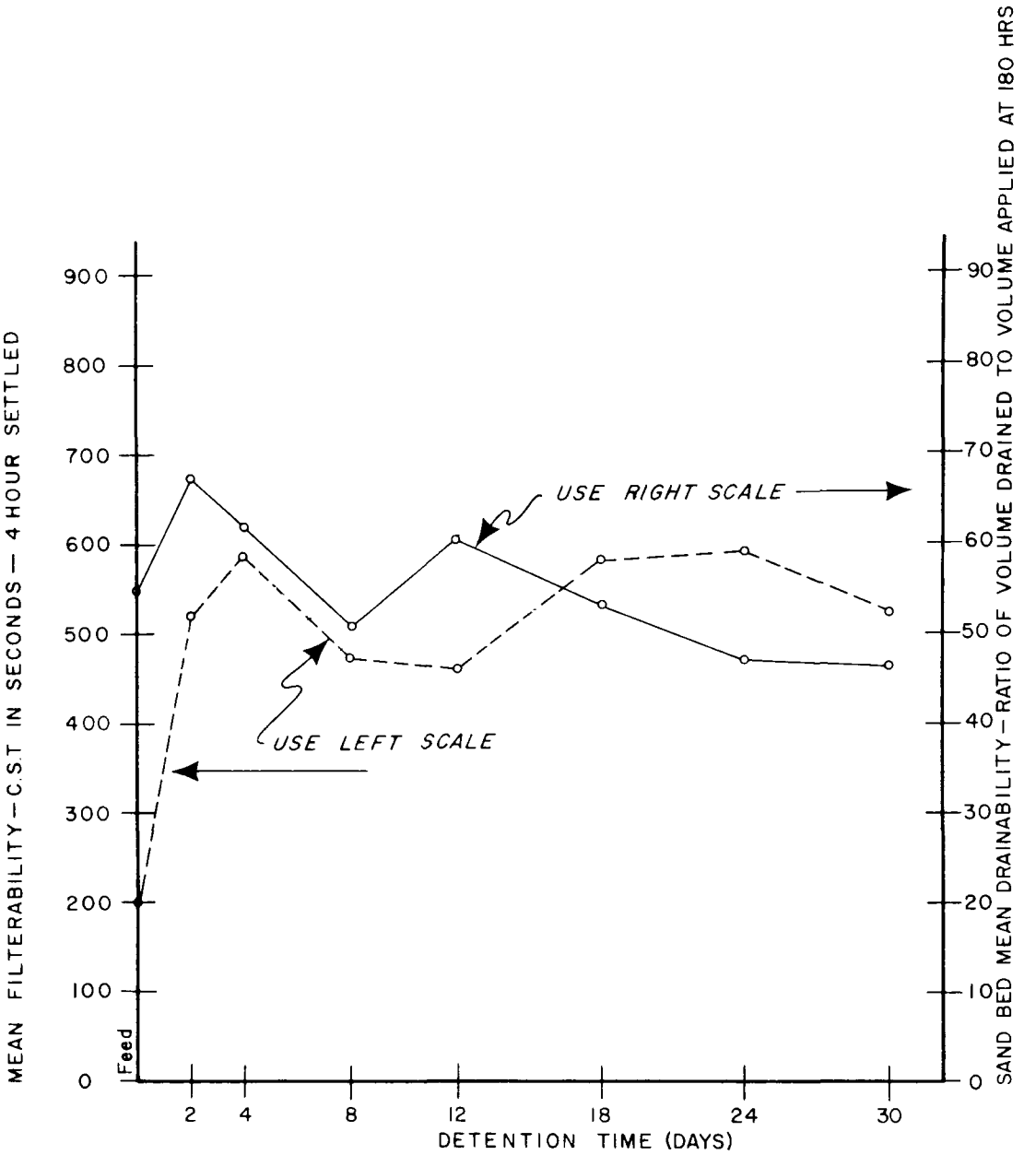
FILTERABILITY OF SLUDGES

FIGURE 18



MEAN DRAINABILITY OF SLUDGES ON SAND BEDS
(RATIO OF VOLUME DRAINED – AFTER 180 HOURS – TO VOLUME APPLIED)

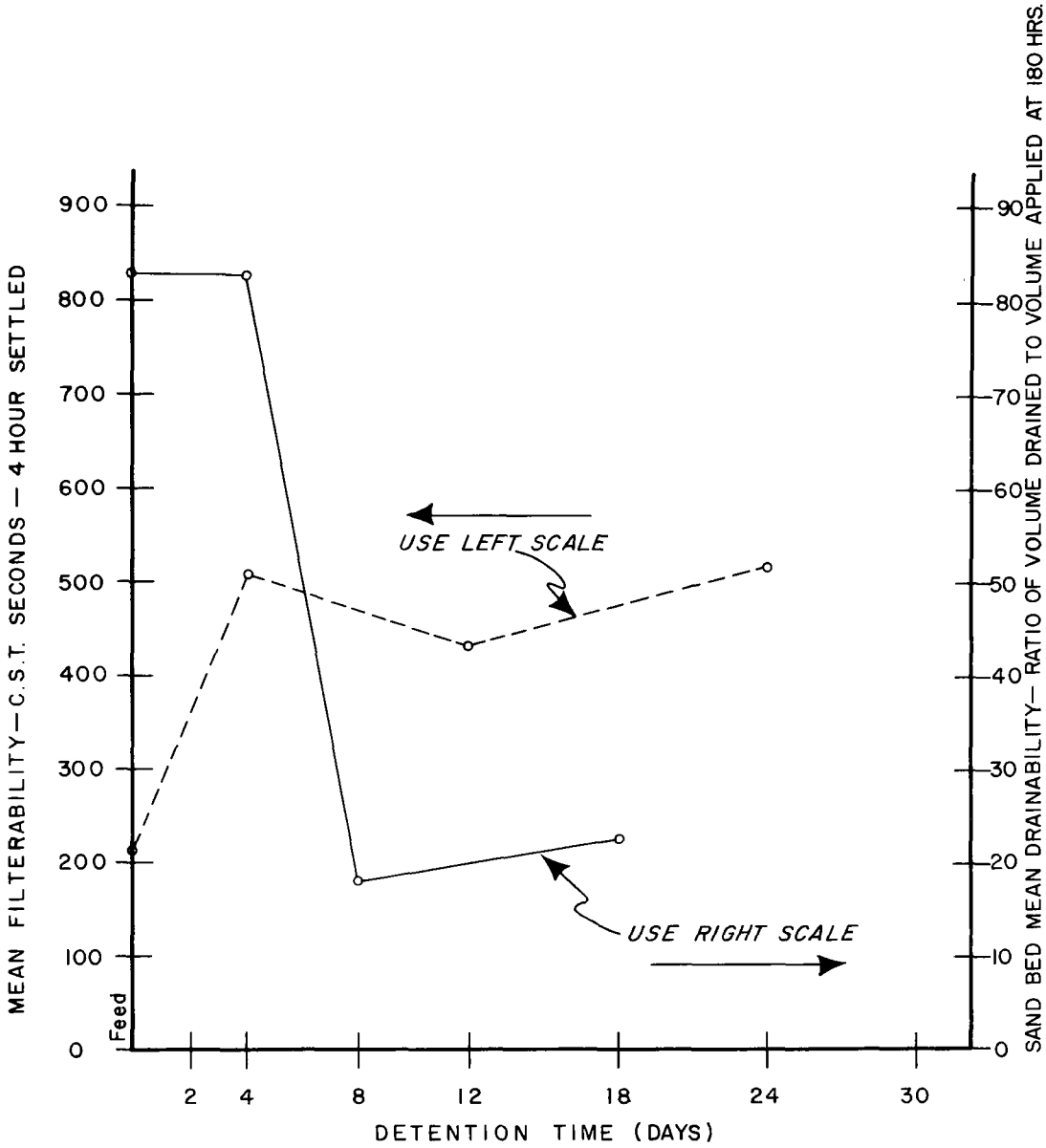
FIGURE 19



PRIMARY SLUDGE

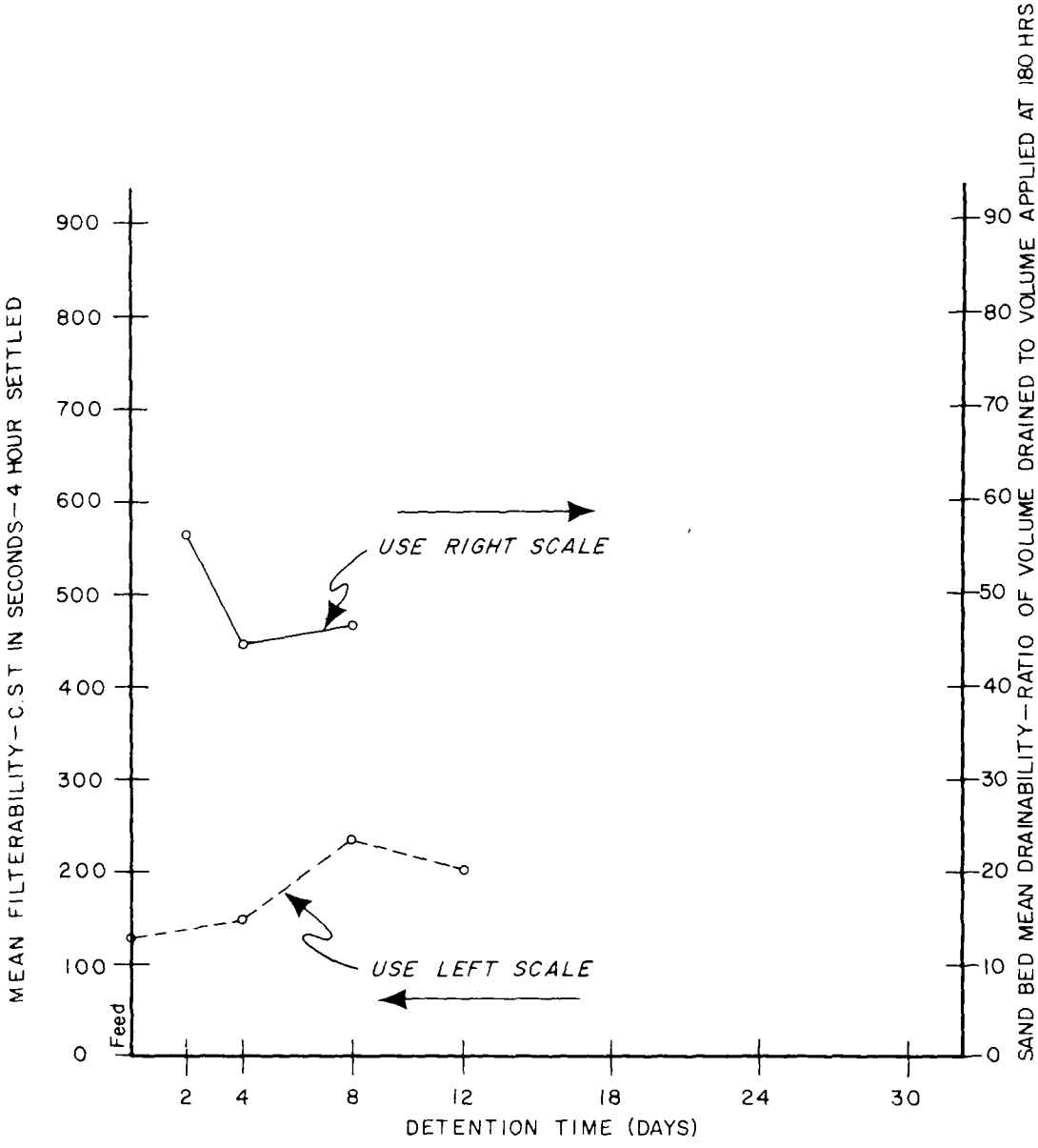
DRAINABILITY— FILTERABILITY

FIGURE 20



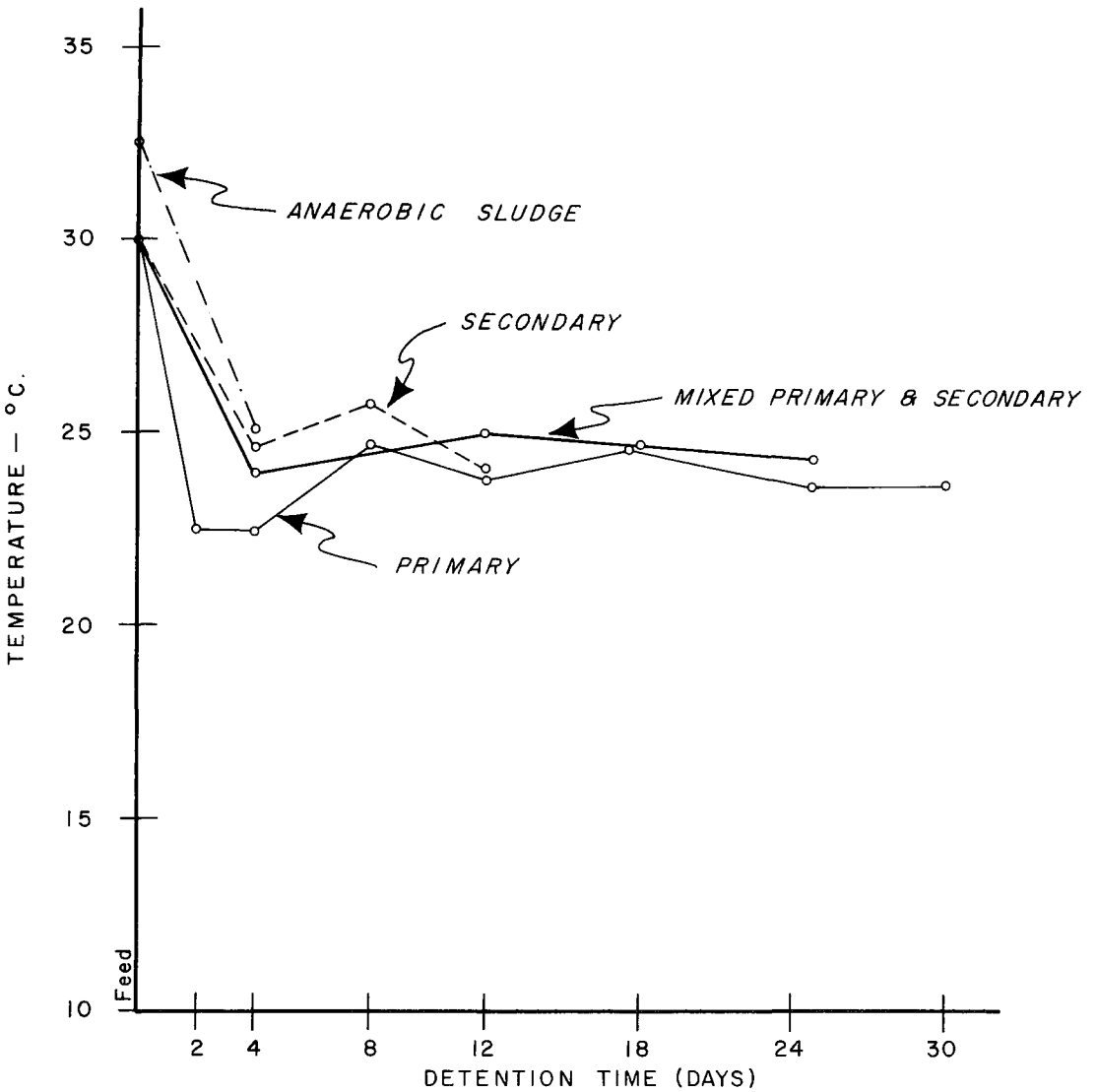
MIXED PRIMARY & SECONDARY SLUDGES
DRAINABILITY-FILTERABILITY

FIGURE 21



SECONDARY SLUDGE
DRAINABILITY-FILTERABILITY

FIGURE 22



MIXED LIQUOR
TEMPERATURE—°C.

FIGURE 23

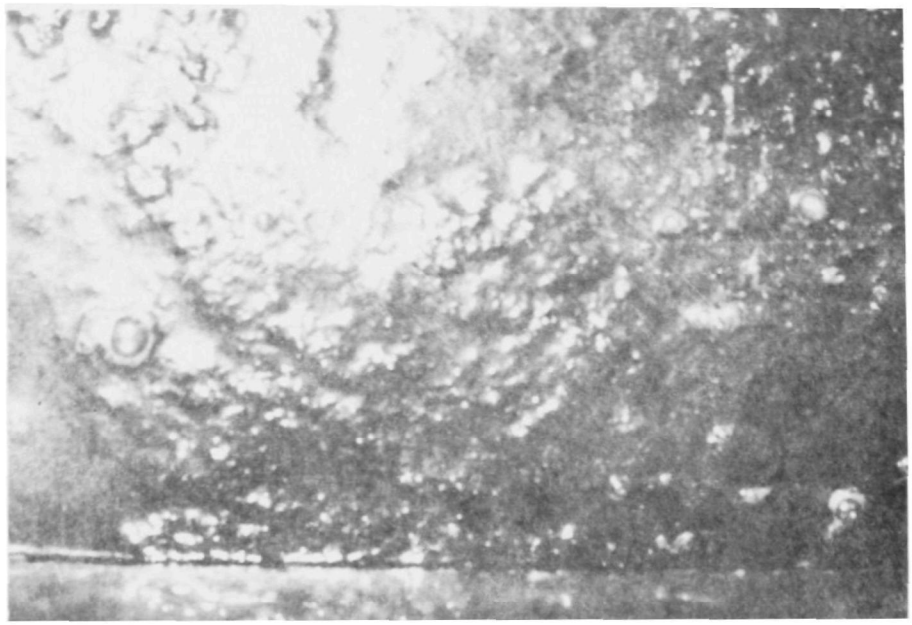


FIGURE 24
PRIMARY SLUDGE ON SAND - FEED SLUDGE - 7 HOURS

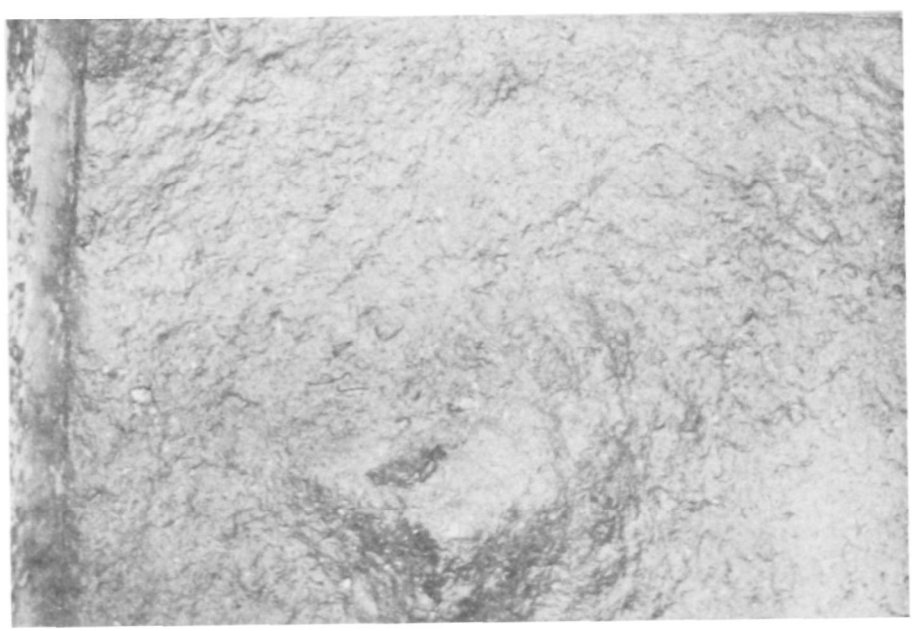


FIGURE 25
PRIMARY SLUDGE ON SAND - FEED SLUDGE - 30 HOURS

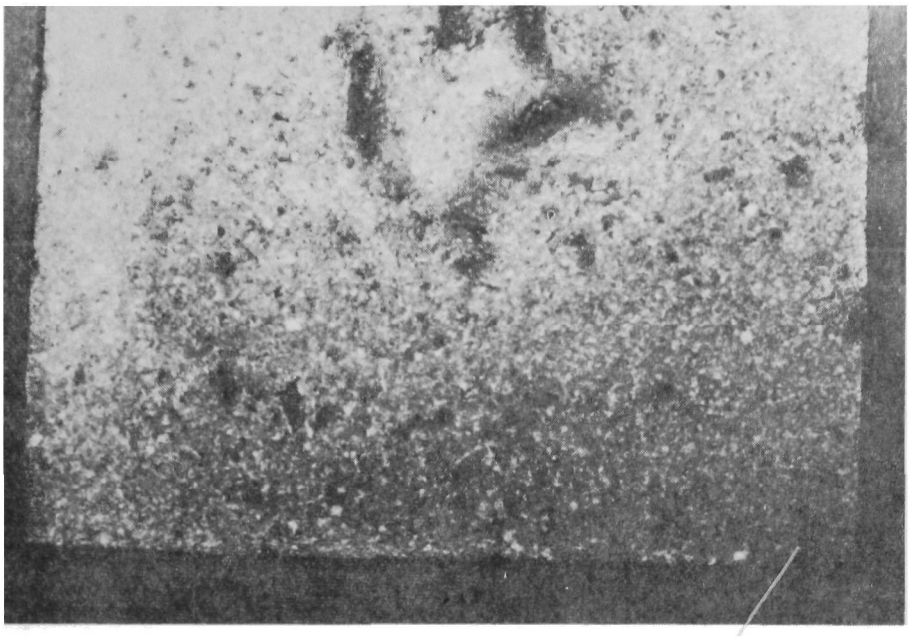


FIGURE 26
PRIMARY SLUDGE ON SAND - FEED SLUDGE - 40 HOURS

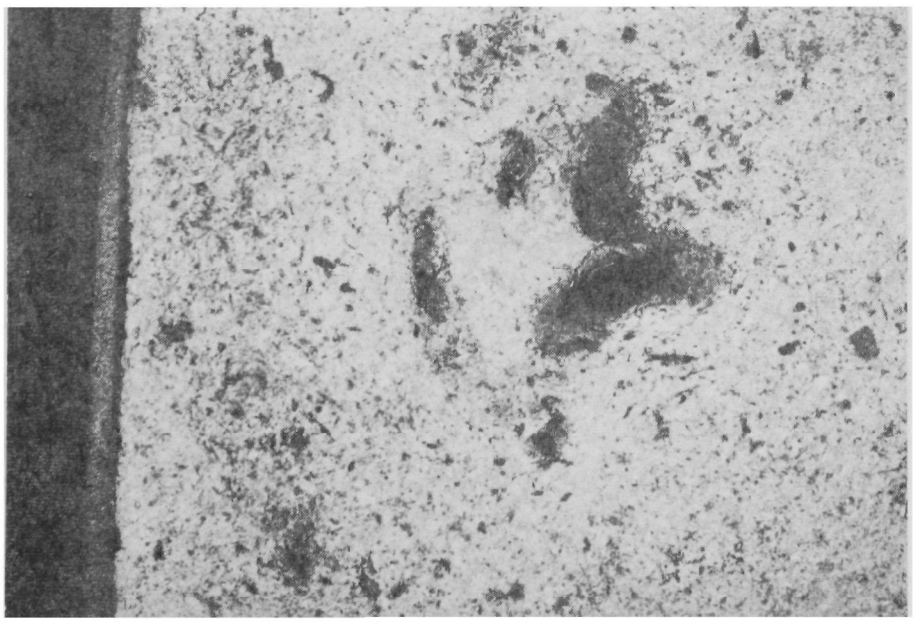


FIGURE 27
PRIMARY SLUDGE ON SAND - FEED SLUDGE - 180 HOURS

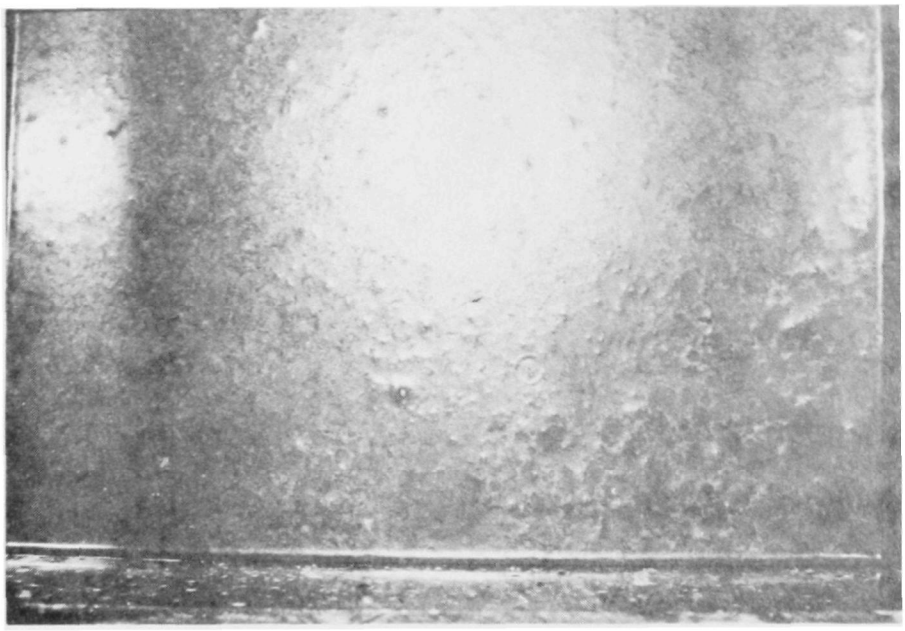


FIGURE 28
PRIMARY SLUDGE ON SAND 2 DAY DETENTION - 7 HOURS

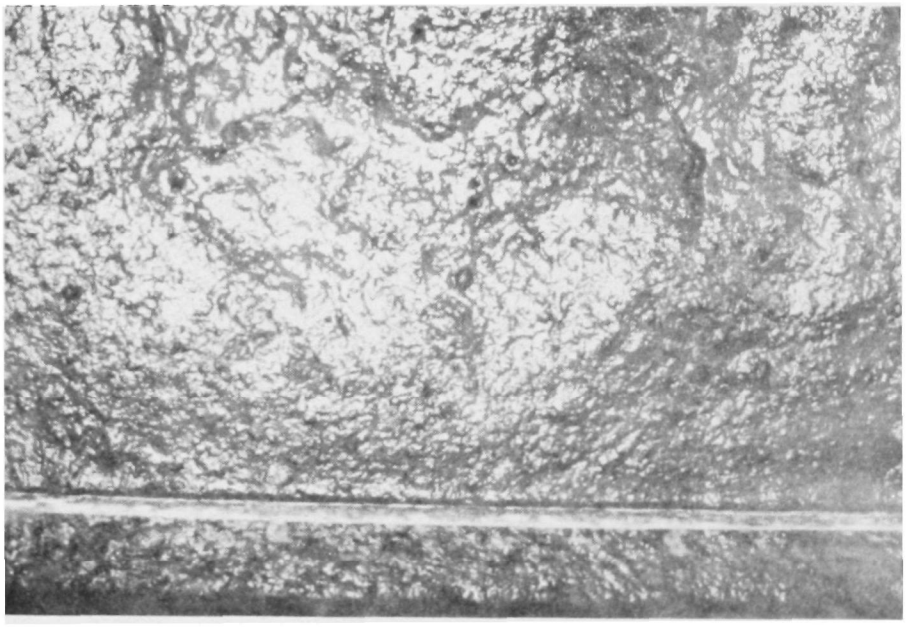


FIGURE 29
PRIMARY SLUDGE ON SAND 2 DAY DETENTION - 50 HOURS

FIGURE 30
PRIMARY SLUDGE ON SAND 2 DAY DETENTION - 120 HOURS

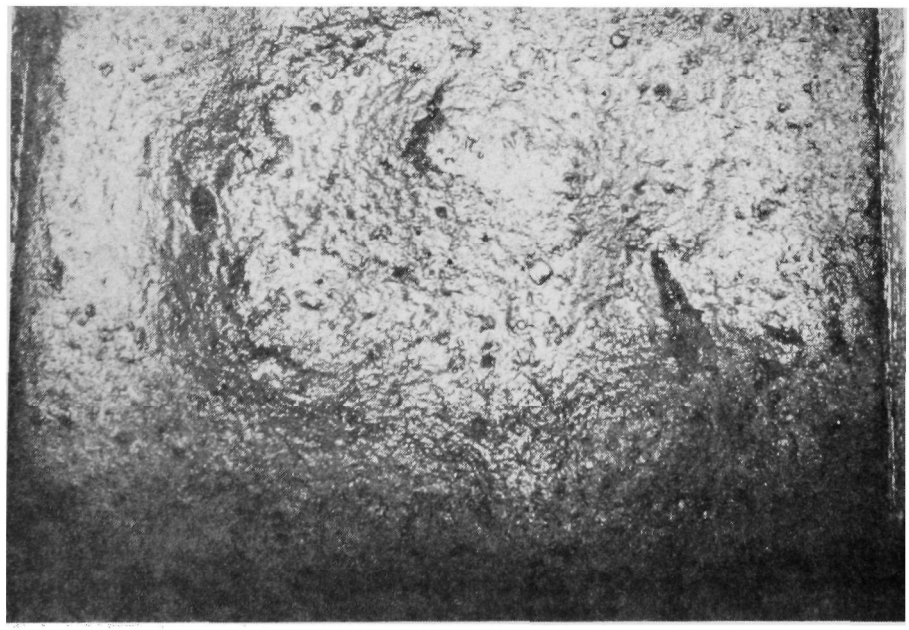


FIGURE 31
PRIMARY SLUDGE ON SAND 2 DAY DETENTION - 220 HOURS

inclusive are photographs of the primary sludge with a two day detention time, on sand drying beds. Figures 32 to 35, inclusive, are photographs of primary sludge with a four day detention time on sand drying beds. Figures 36 to 39, inclusive, are photographs of primary sludge with an eight day detention time on sand drying beds. Figures 40 to 43, inclusive, are photographs of primary sludge with a 12 day detention time on sand drying beds. Figures 44 to 47, inclusive, are photographs of anaerobic sludge on sand drying beds. Figure 48 shows two photographs of secondary sludge feed on sand drying beds at end of run. Figure 49 shows two photographs of mixed liquor secondary sludge on sand drying beds at end of run. Figure 50 shows two photographs of four hours settled secondary sludge on sand drying beds at end of run.

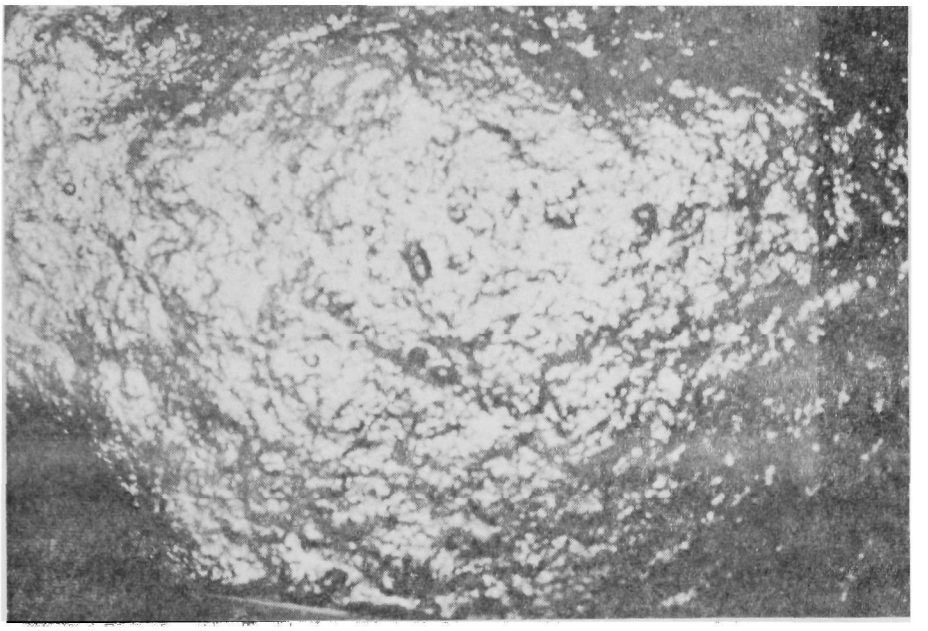


FIGURE 32
PRIMARY SLUDGE ON SAND 4 DAY DETENTION - 30 HOURS

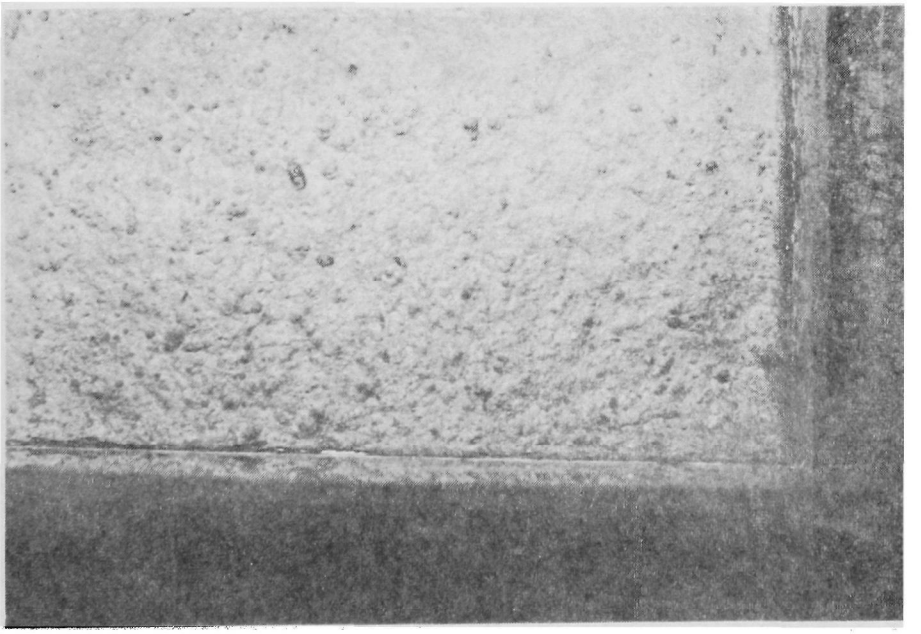


FIGURE 33
PRIMARY SLUDGE ON SAND 4 DAY DETENTION - 70 HOURS

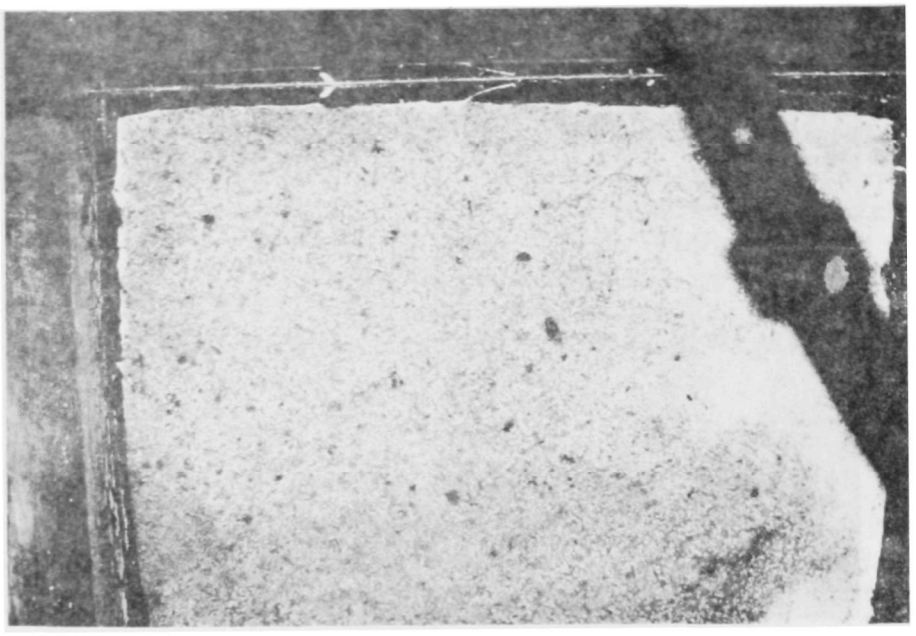


FIGURE 34
PRIMARY SLUDGE ON SAND 4 DAY DETENTION - 145 HOURS

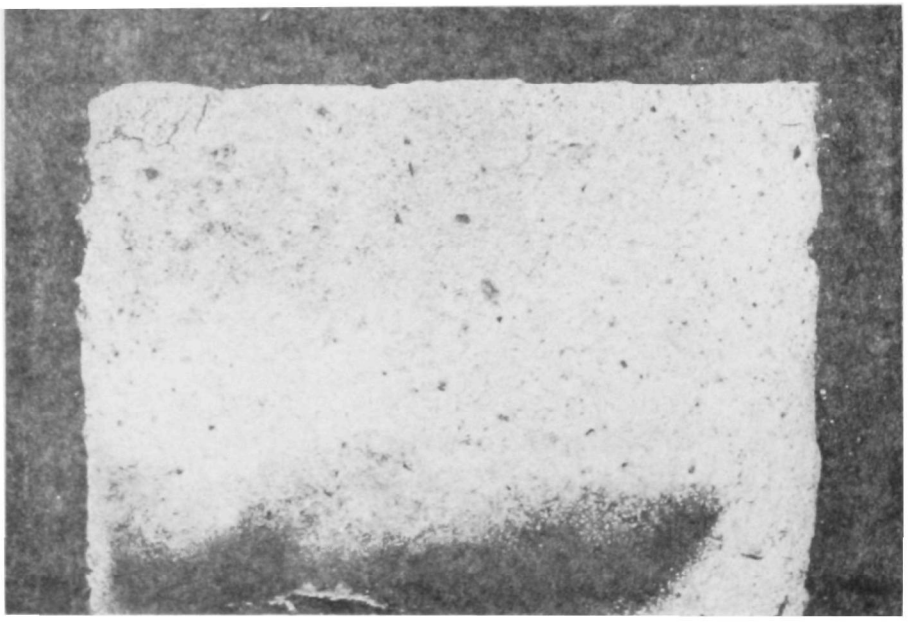


FIGURE 35
PRIMARY SLUDGE ON SAND 4 DAY DETENTION - 220 HOURS

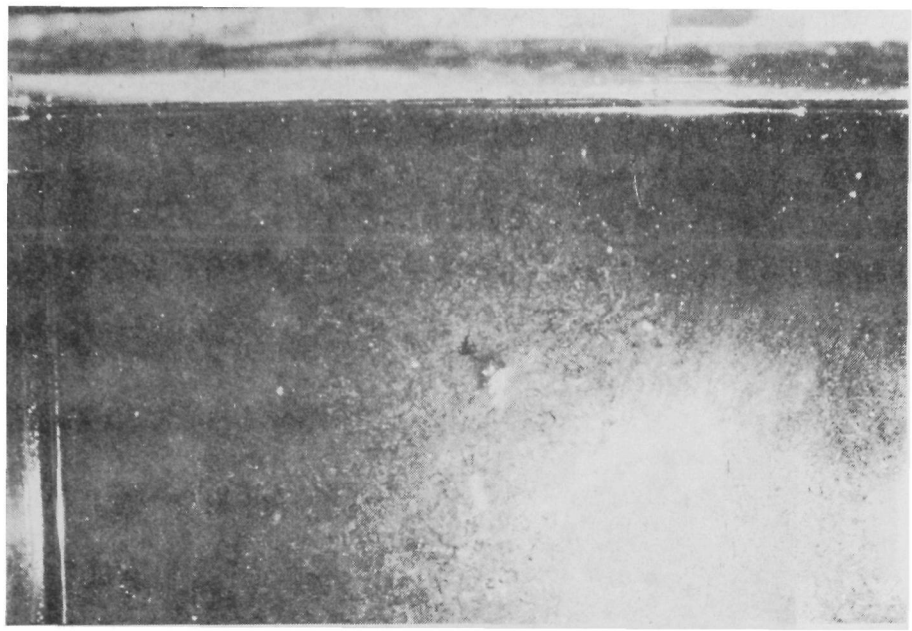


FIGURE 36
PRIMARY SLUDGE ON SAND 8 DAY DETENTION - 7 HOURS

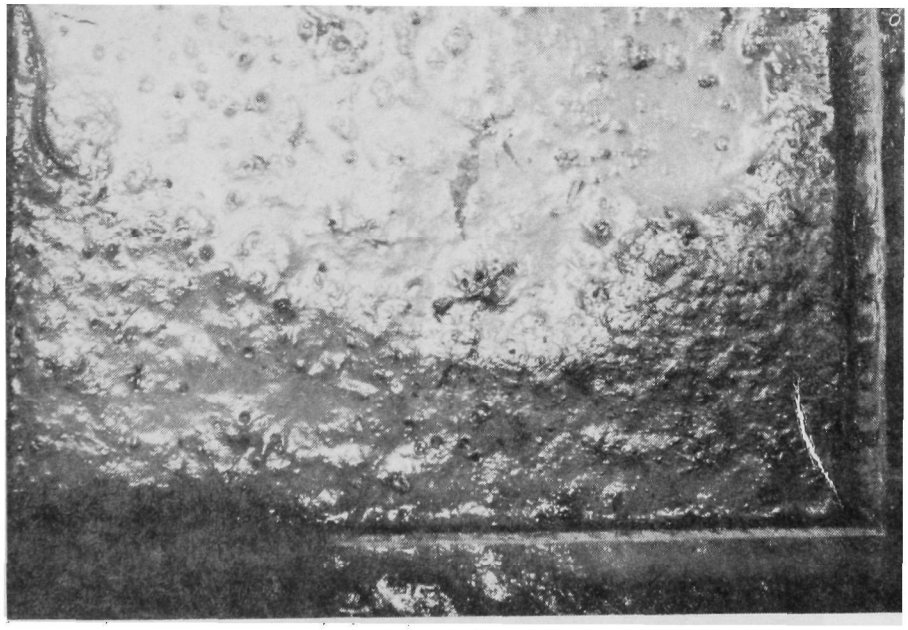


FIGURE 37
PRIMARY SLUDGE ON SAND 8 DAY DETENTION - 70 HOURS

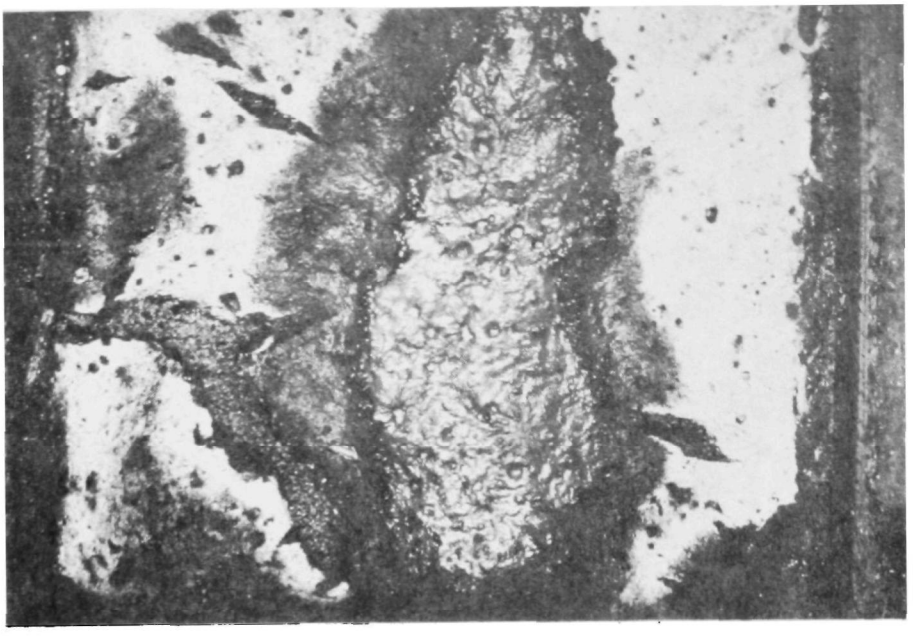


FIGURE 38
PRIMARY SLUDGE ON SAND 8 DAY DETENTION - 175 HOURS

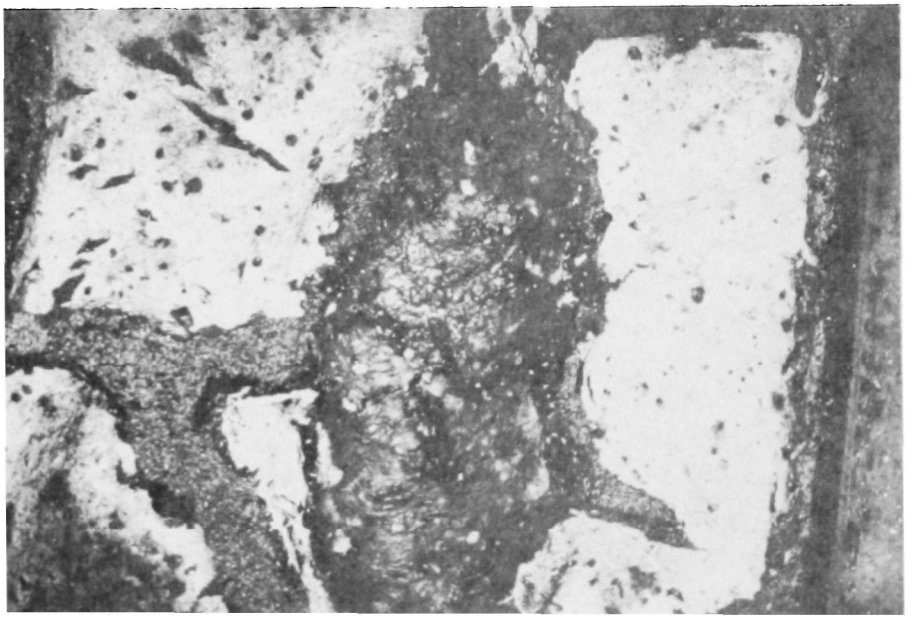


FIGURE 39
PRIMARY SLUDGE ON SAND 8 DAY DETENTION - 250 HOURS

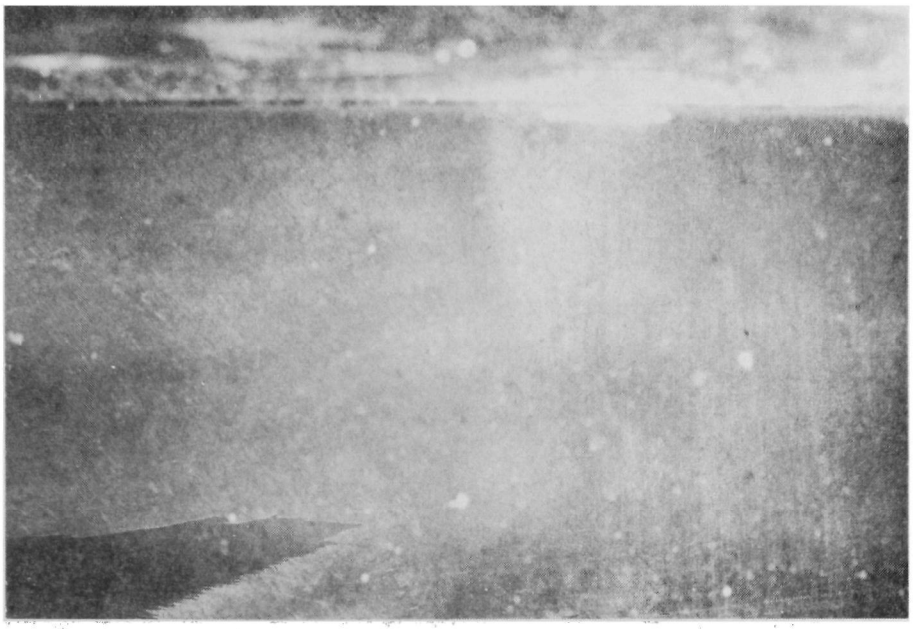


FIGURE 40
PRIMARY SLUDGE ON SAND 12 DAY DETENTION - 7 HOURS

FIGURE 41
PRIMARY SLUDGE ON SAND 12 DAY DETENTION - 70 HOURS

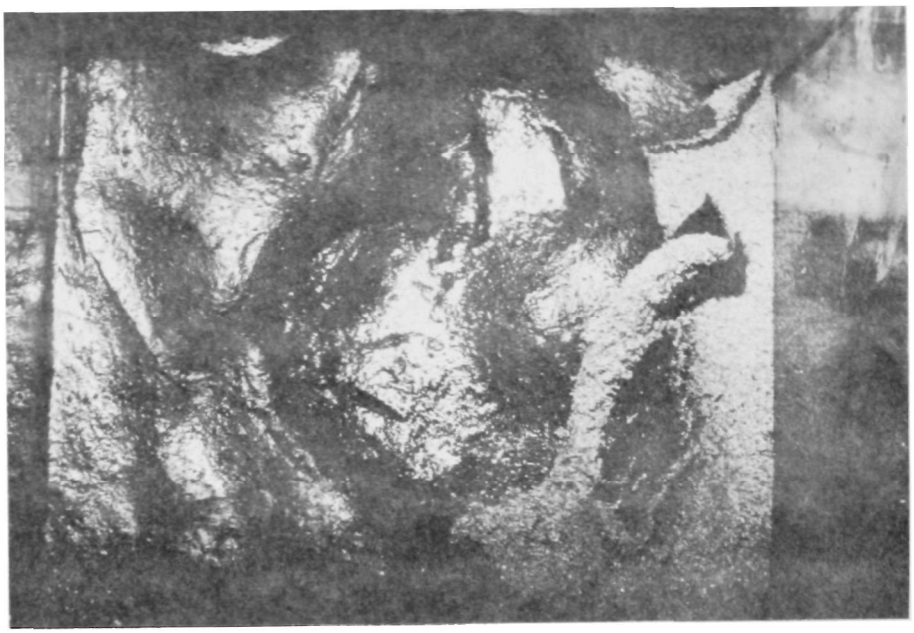


FIGURE 42
PRIMARY SLUDGE ON SAND 12 DAY DETENTION - 120 HOURS

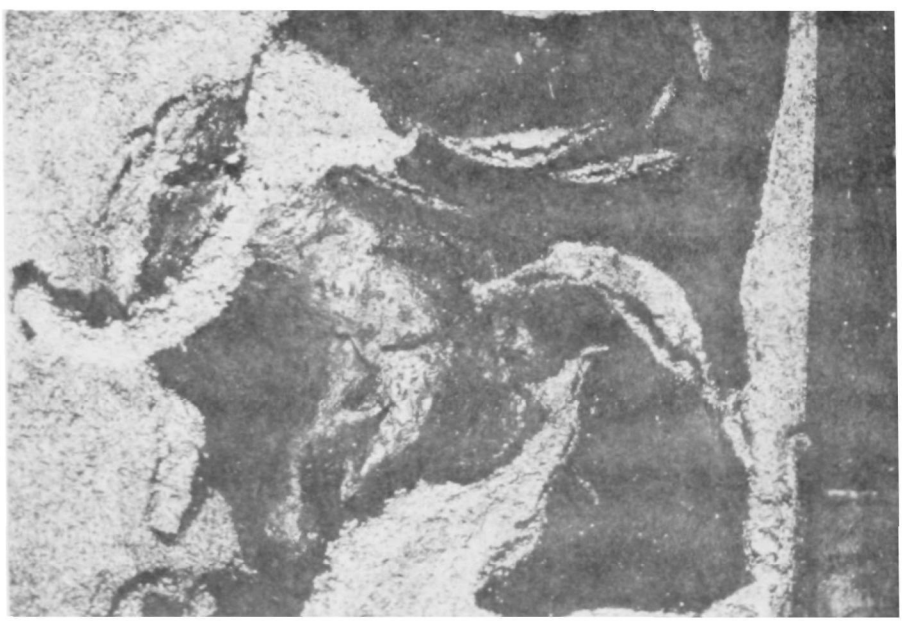


FIGURE 43
PRIMARY SLUDGE ON SAND 12 DAY DETENTION - 220 HOURS

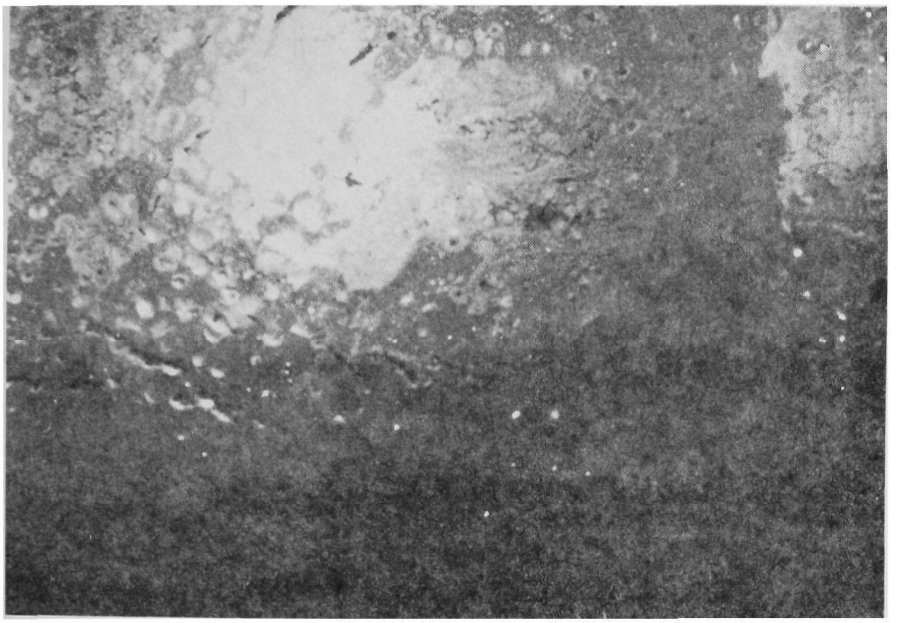


FIGURE 44
ANAEROBIC SLUDGE ON SAND - 25 HOURS

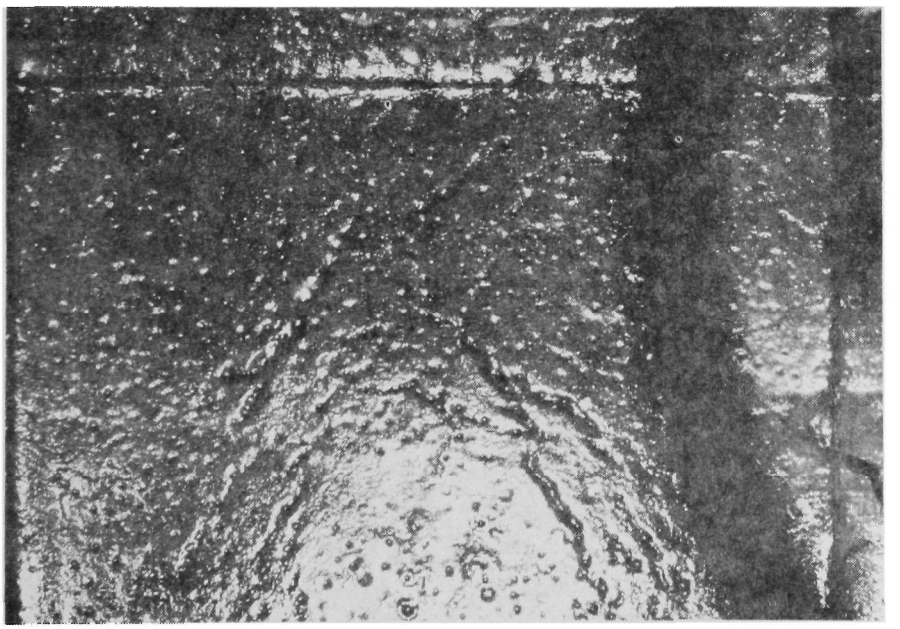


FIGURE 45
ANAEROBIC SLUDGE ON SAND - 70 HOURS

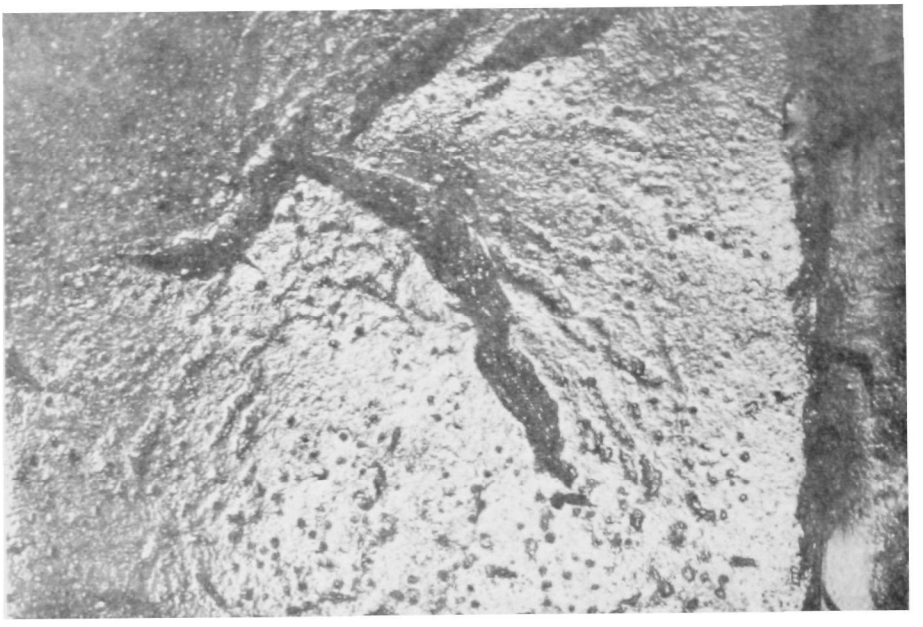


FIGURE 46
ANAEROBIC SLUDGE ON SAND - 175 HOURS

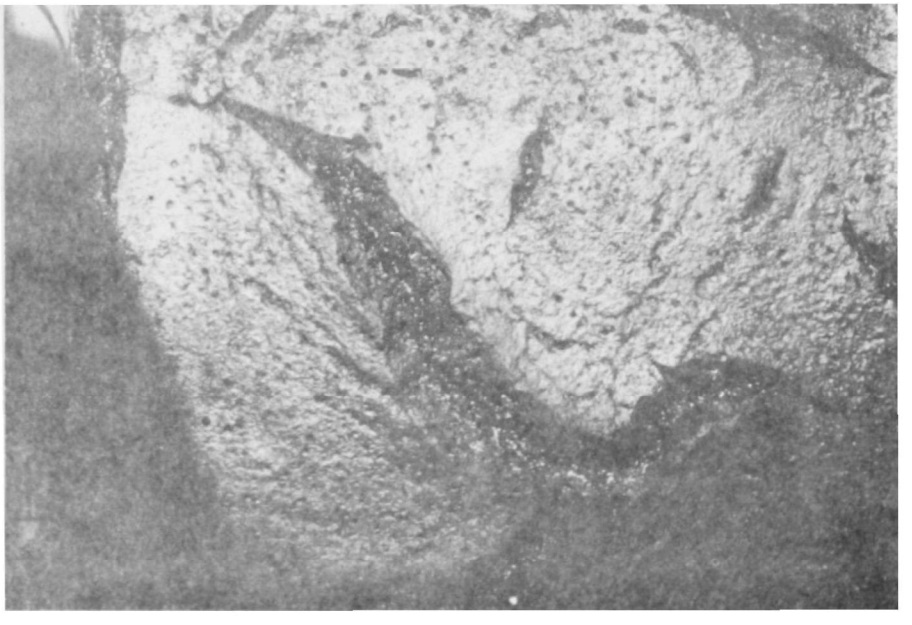
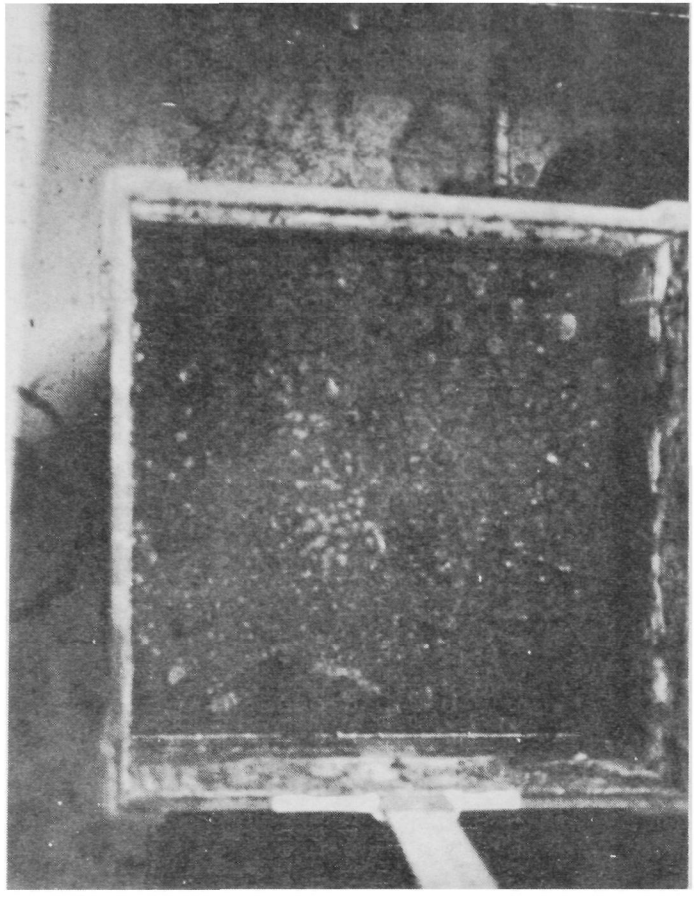


FIGURE 47
ANAEROBIC SLUDGE ON SAND - 250 HOURS



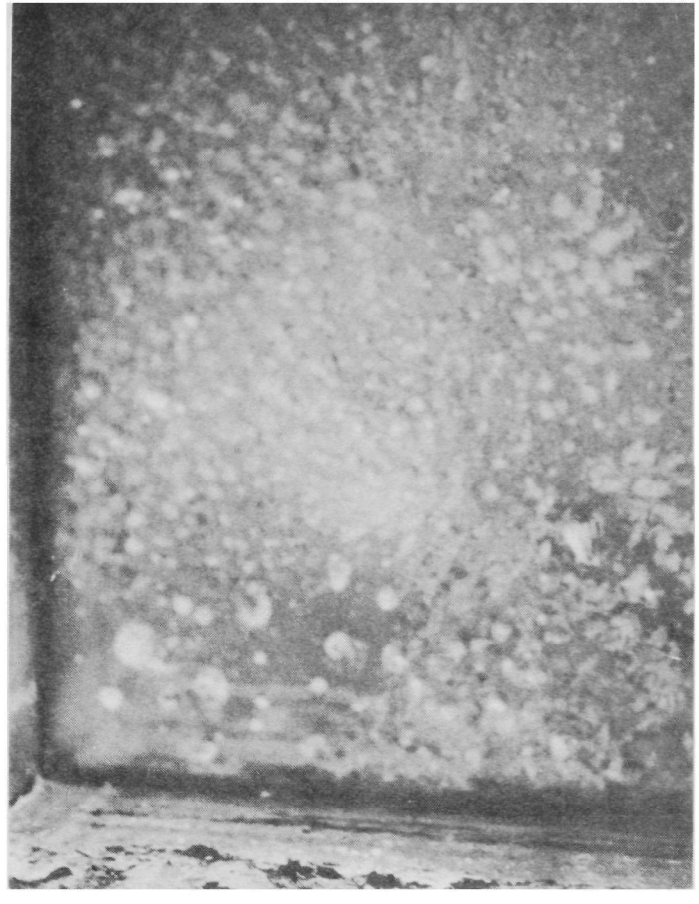


FIGURE 48

SECONDARY SLUDGE ON SAND BED

4-DAY DETENTION

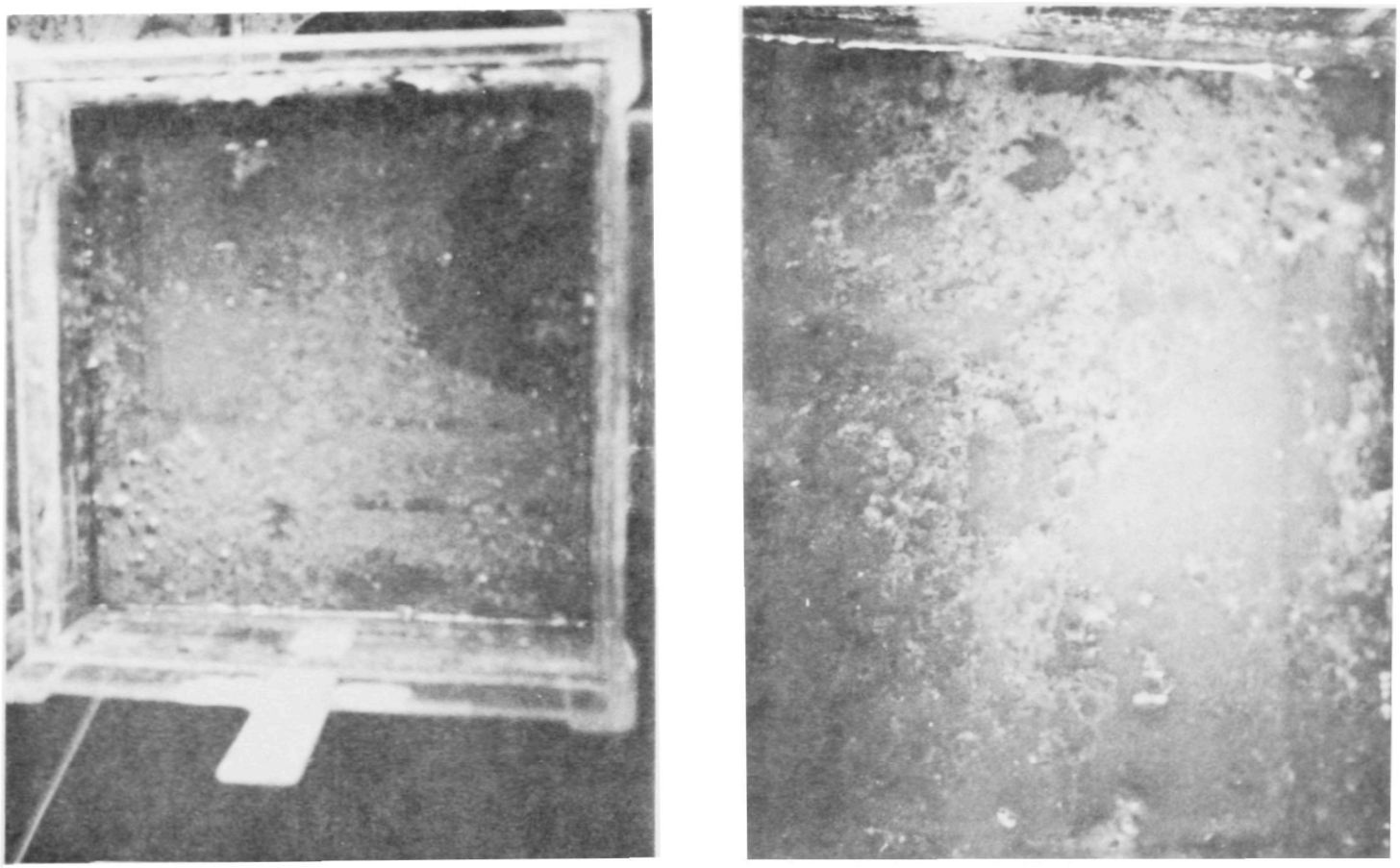


FIGURE 49

SECONDARY SLUDGE ON SAND BED

8-DAY DETENTION

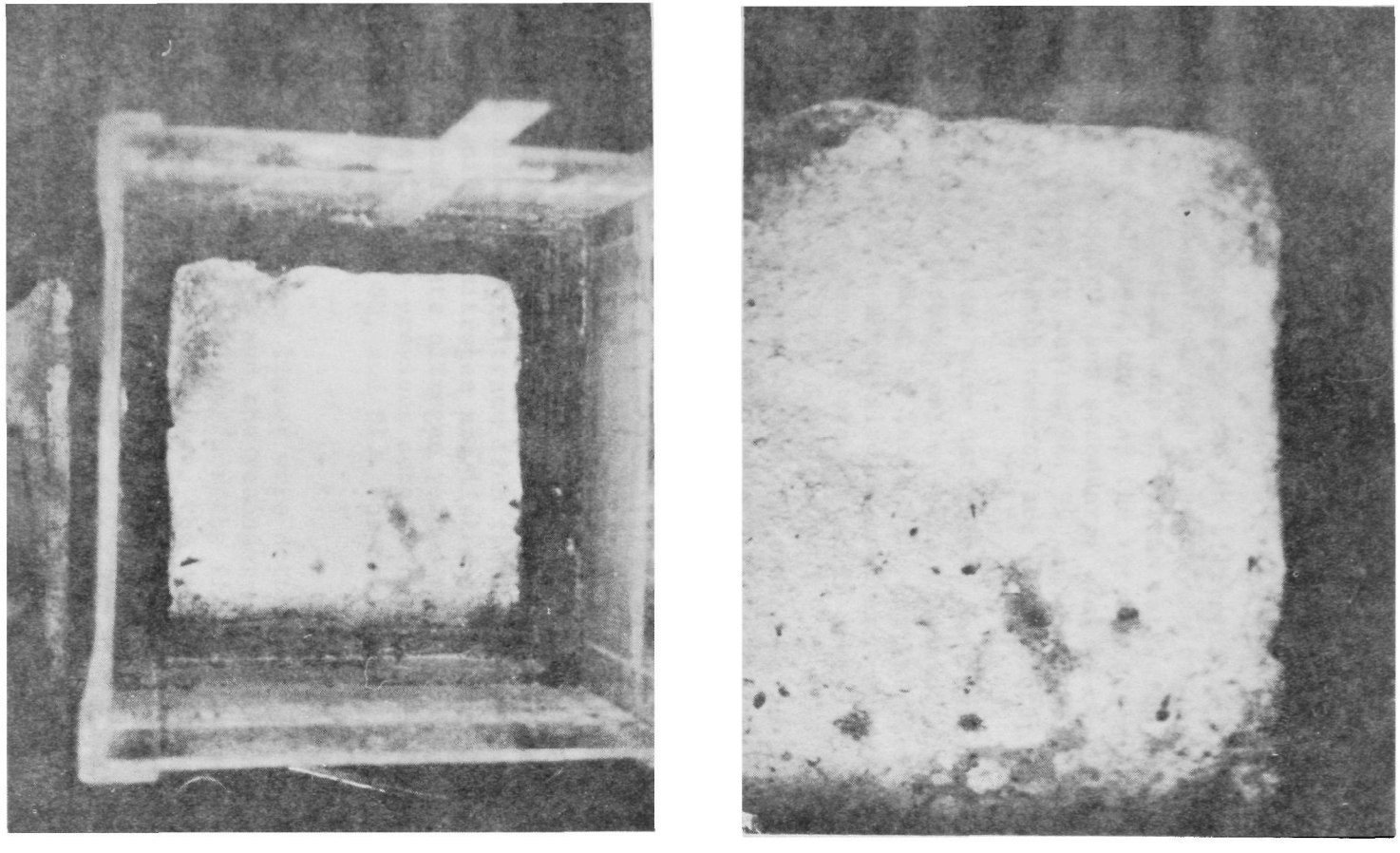


FIGURE 50

SECONDARY SLUDGE ON SAND BED

12-DAY DETENTION

SECTION VII

CHEMICAL PARAMETERS

The chemicals in the sludge and in filtrates of the sludge are needed to determine what method, and location may be used for final disposal. Figure 51 shows how the mean pH values vary with detention times from zero (feed) to 30 days, and for the three sludges, primary, mixed primary and secondary, and secondary. Values of pH for individual samples are listed in Tables 94, 95, and 96. Most of the chemical parameters for the batch reactor are tabulated in Tables 53 and 54.

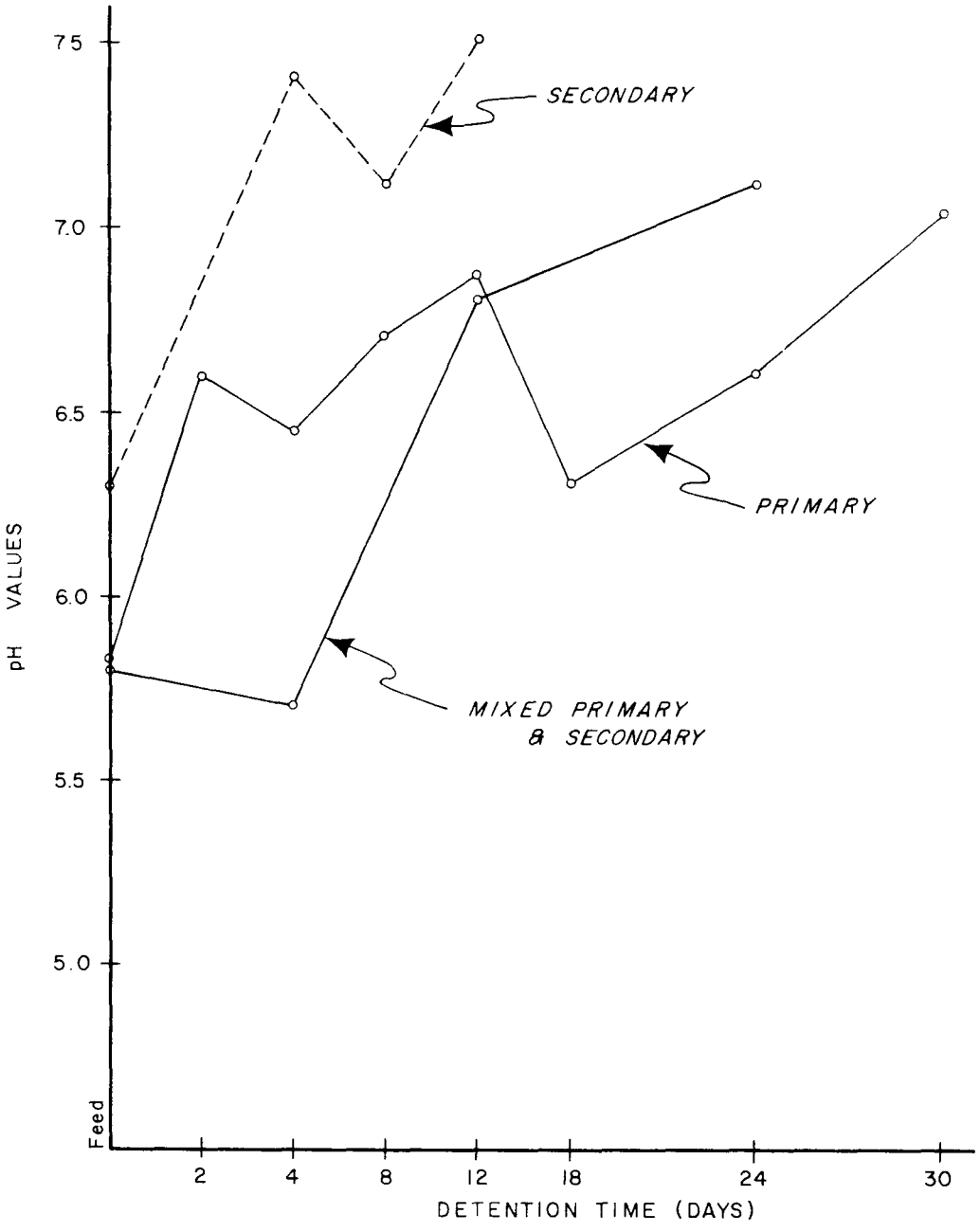
Dissolved oxygen values were determined for the batch unit and for all three of the flow through units. The values of dissolved oxygen for the batch unit are shown in Table 53. For the flow through units the means of each of the three sludges used are plotted in Figure 52. Individual sample test results are listed in Tables 65, 66, and 67.

Nitrogens for which test values are available are ammonia nitrogen, nitrate nitrogen, and ammonia plus nitrate nitrogen. Ammonia nitrogen mean values are plotted in Figure 53 for mixed liquor from primary, mixed primary and secondary, and secondary sludges. For filtrates of the above sludges Figure 54 shows the ammonia nitrogen values. The individual test values for ammonia nitrogen are listed in Tables 68, 69, 70, and 71. Ammonia nitrogen values for the anaerobic digester sludge are shown in Tables 68 and 70. Nitrate nitrogen mean values are shown in Figures 55 and 56 for the mixed liquor of each of the three sources of sludge and of the filtrate from these same sources. The individual values for nitrate nitrogen are listed in Tables 72 through 78. The sum of ammonia and nitrate nitrogen values were computed, tabulated, and plotted from the two previous sets of tests. The individual values are shown in Tables 79, 80, and 81. The mean values were then plotted in Figures 57 and 58.

Phosphates in the mixed liquor were determined for the primary, mixed primary and secondary, and the secondary sludges and are plotted in Figure 59. The same was done for the filtrates through paper and are shown on Figure 60. In addition, the data for primary filtrate through the sand bed are shown in Figure 60. The detailed data for phosphates are listed on Tables 82 through 86.

Chemical oxygen demands in the mixed liquor were determined for primary, the mixed primary and secondary, and the secondary sludges and are plotted in Figure 61. Also filtrate through paper and through sand beds of these three sludges are plotted in Figure 62 and 63. The detailed data for COD are listed on Tables 87 through 92.

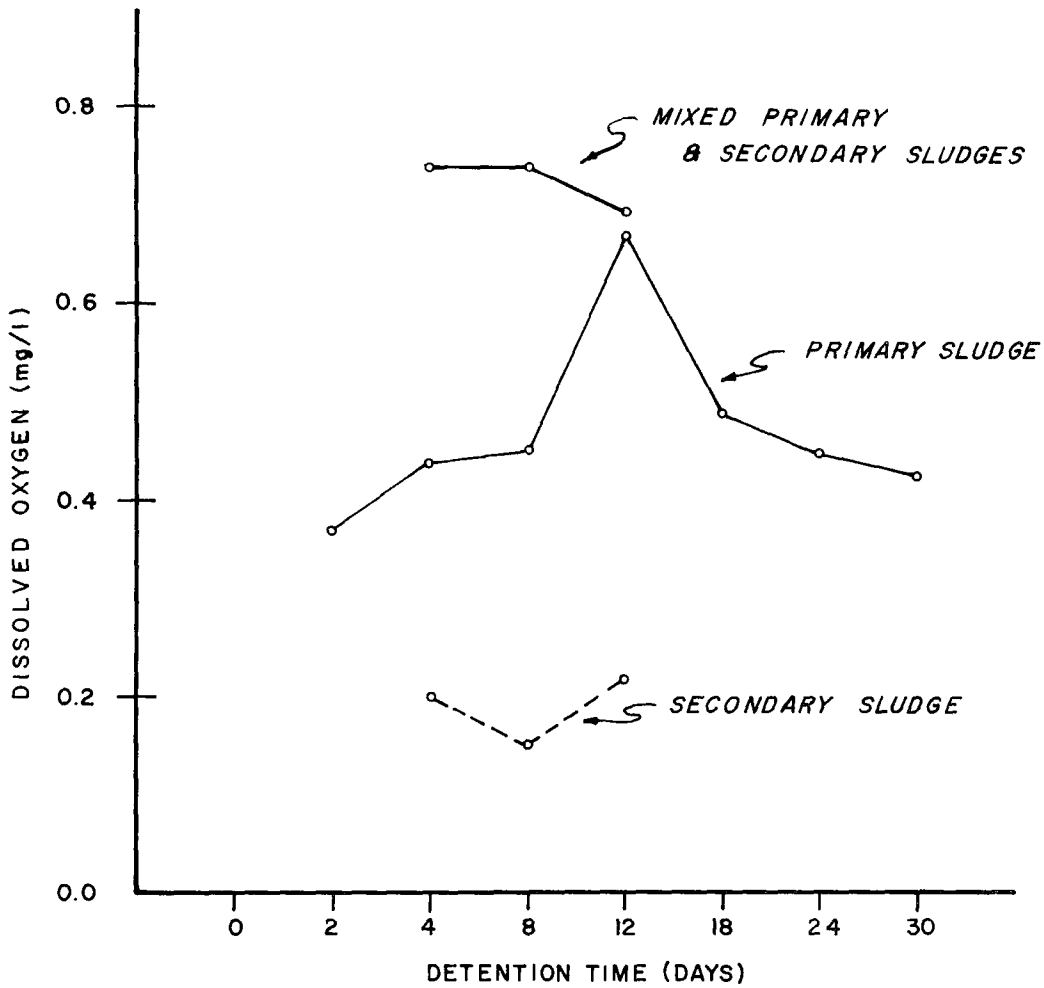
Biochemical oxygen demands in the mixed liquor were determined for the primary sludge only. The mean values for each detention time are shown in Figure 64, and detailed data are listed on Table 93.



MIXED LIQUOR

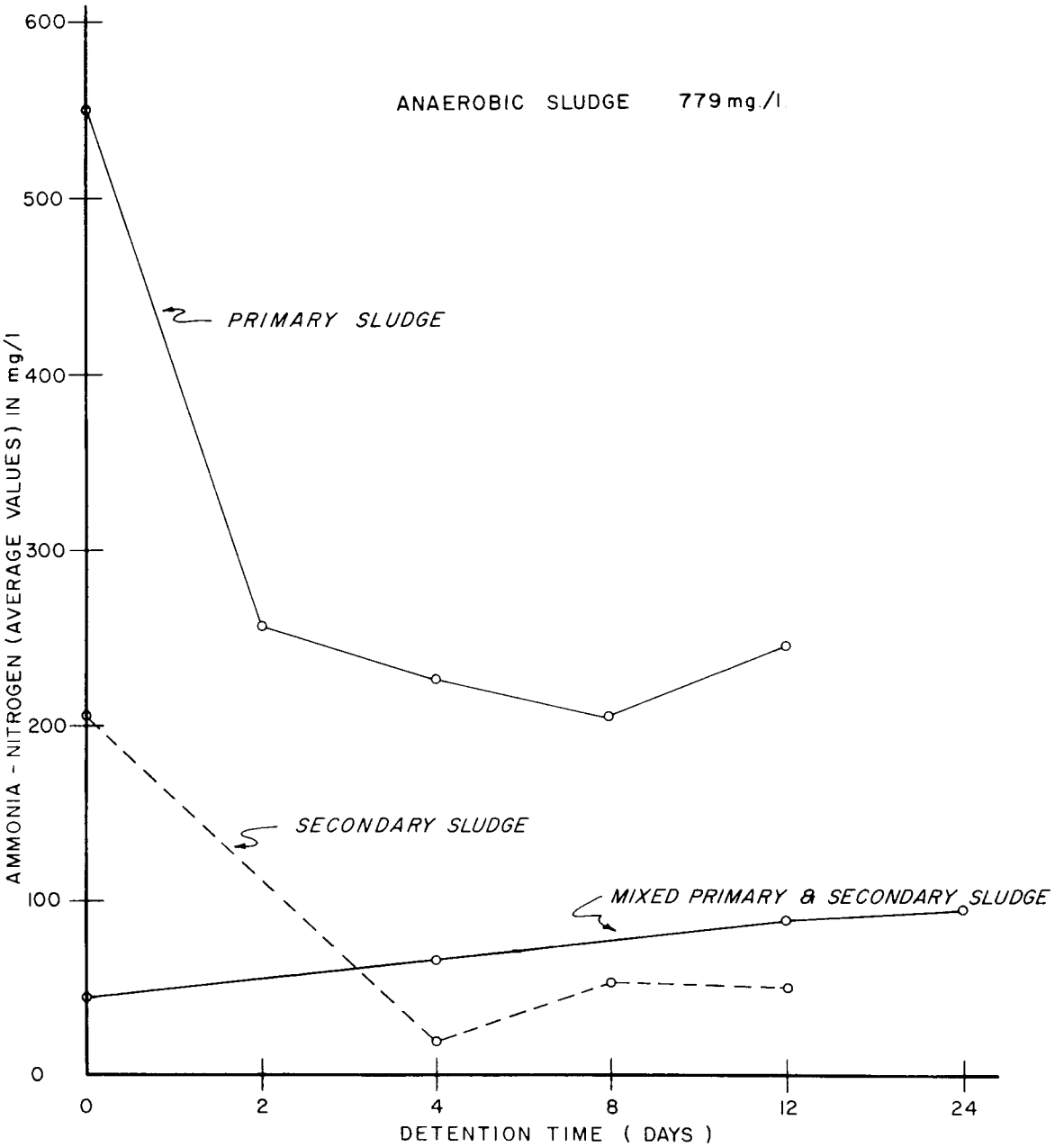
pH

FIGURE 51



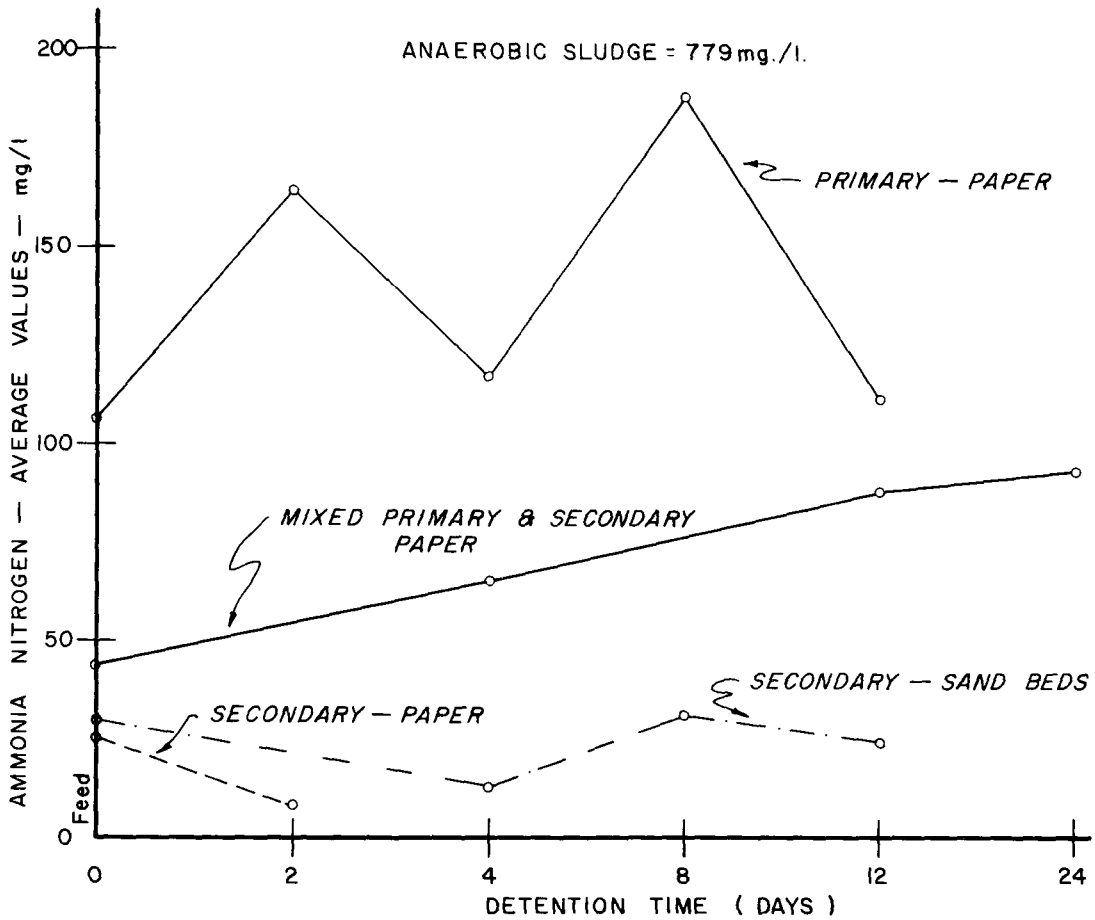
-MIXED LIQUOR-
DISSOLVED OXYGEN
(AVERAGE VALUES)

FIGURE 52



MIXED LIQUOR — AMMONIA NITROGEN

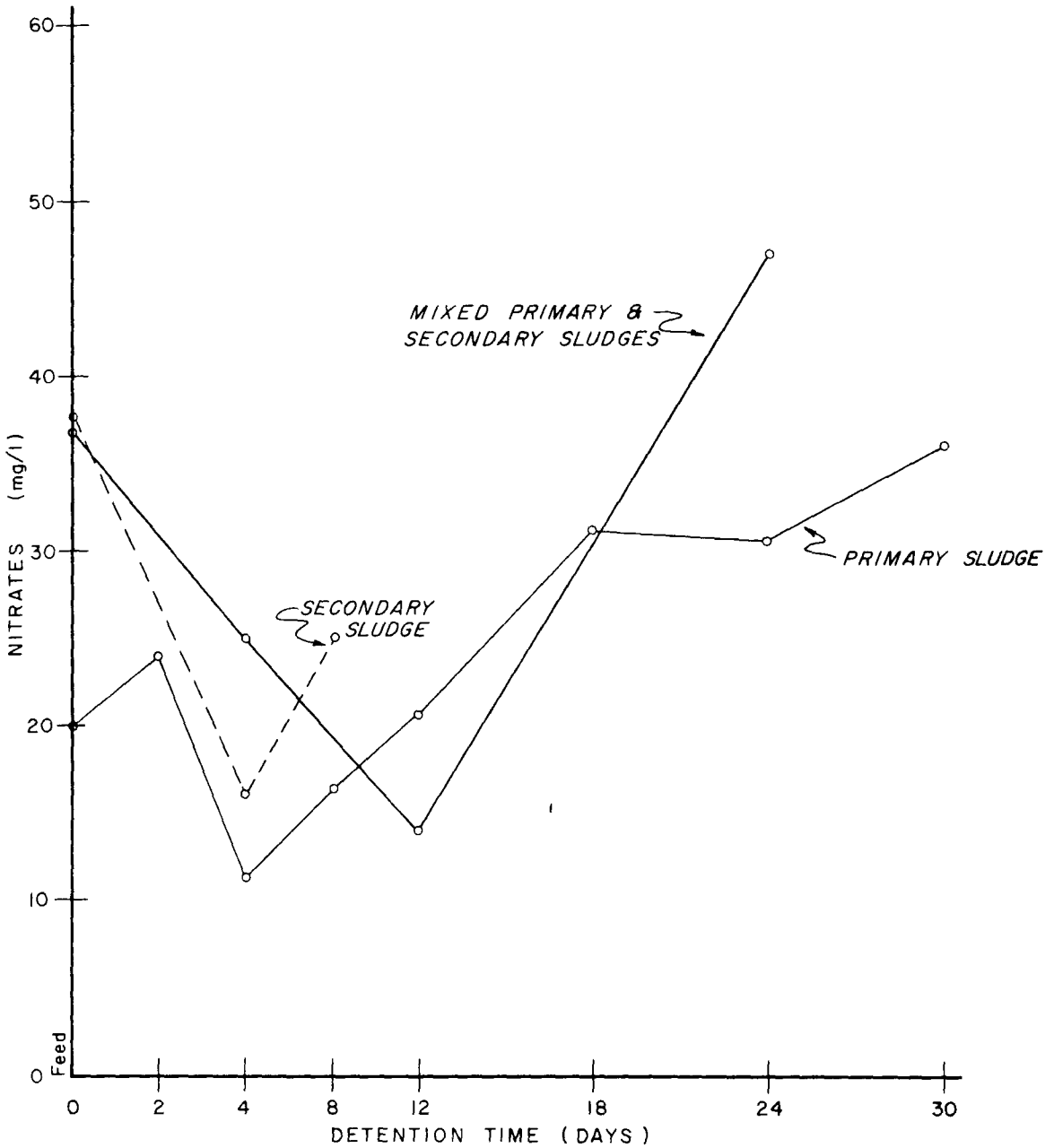
FIGURE 53



FILTRATE

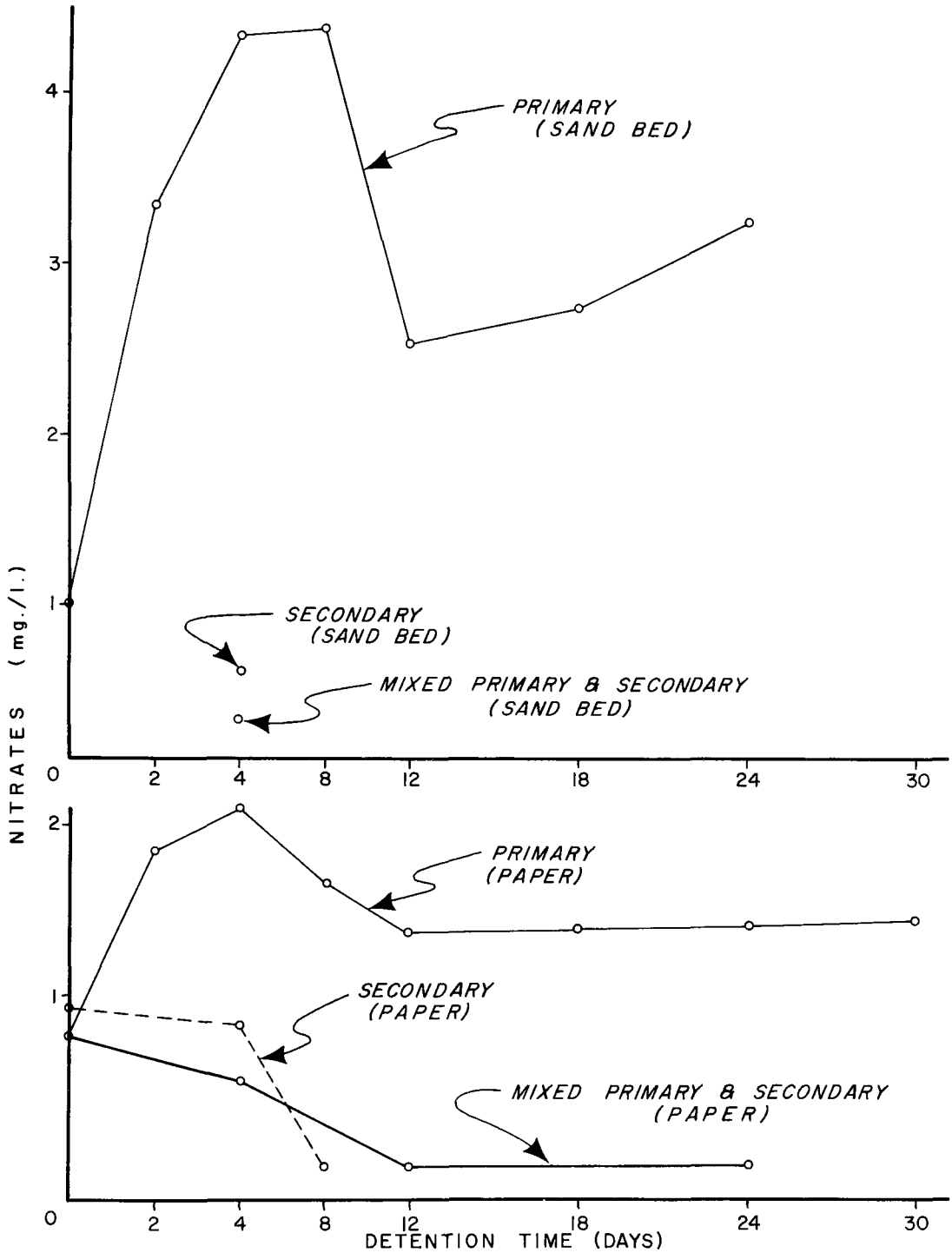
AMMONIA NITROGEN

FIGURE 54



MIXED LIQUOR — NITRATES

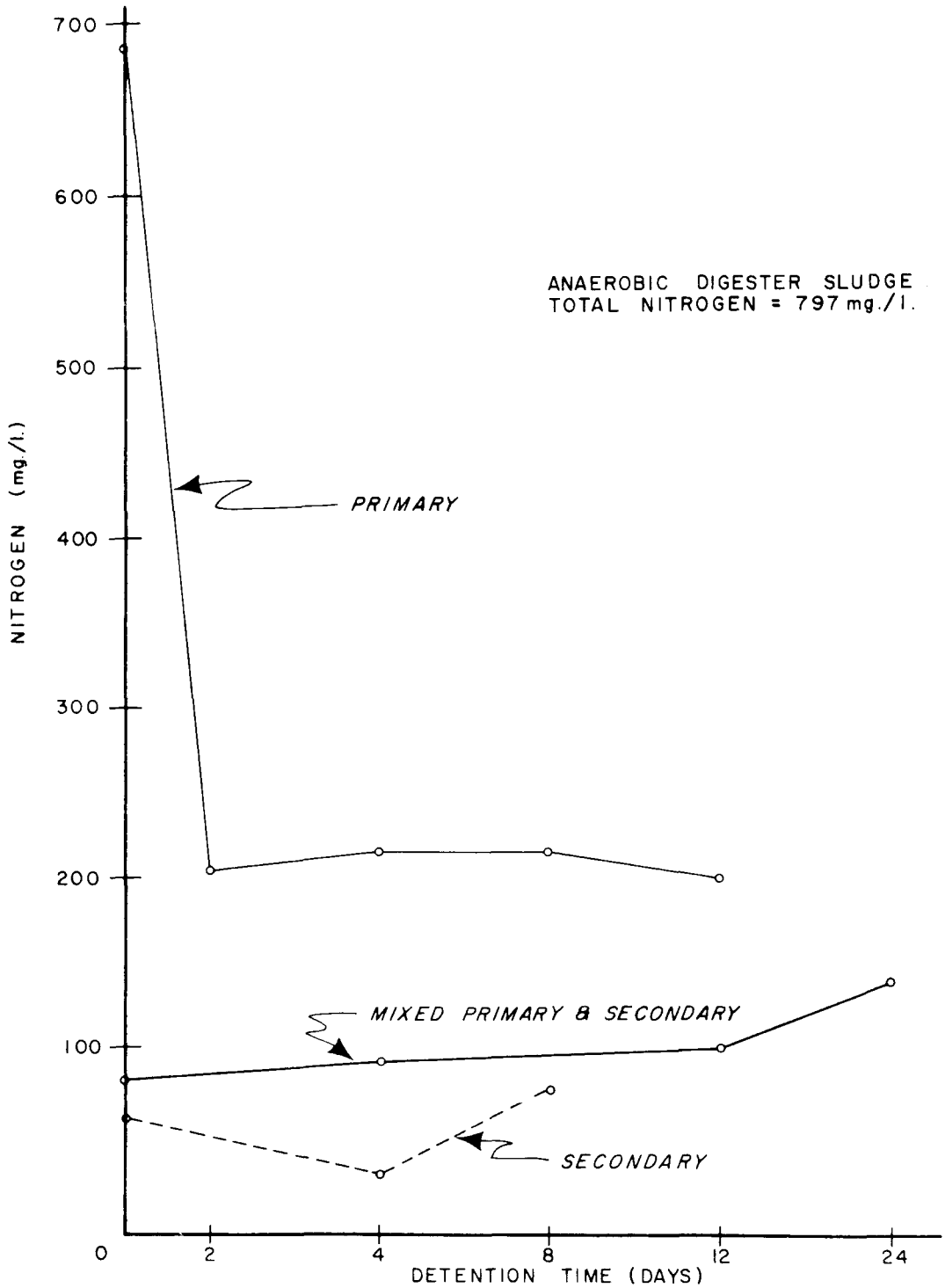
FIGURE 55



NITRATES

FILTRATES — PAPER AND SAND BED —

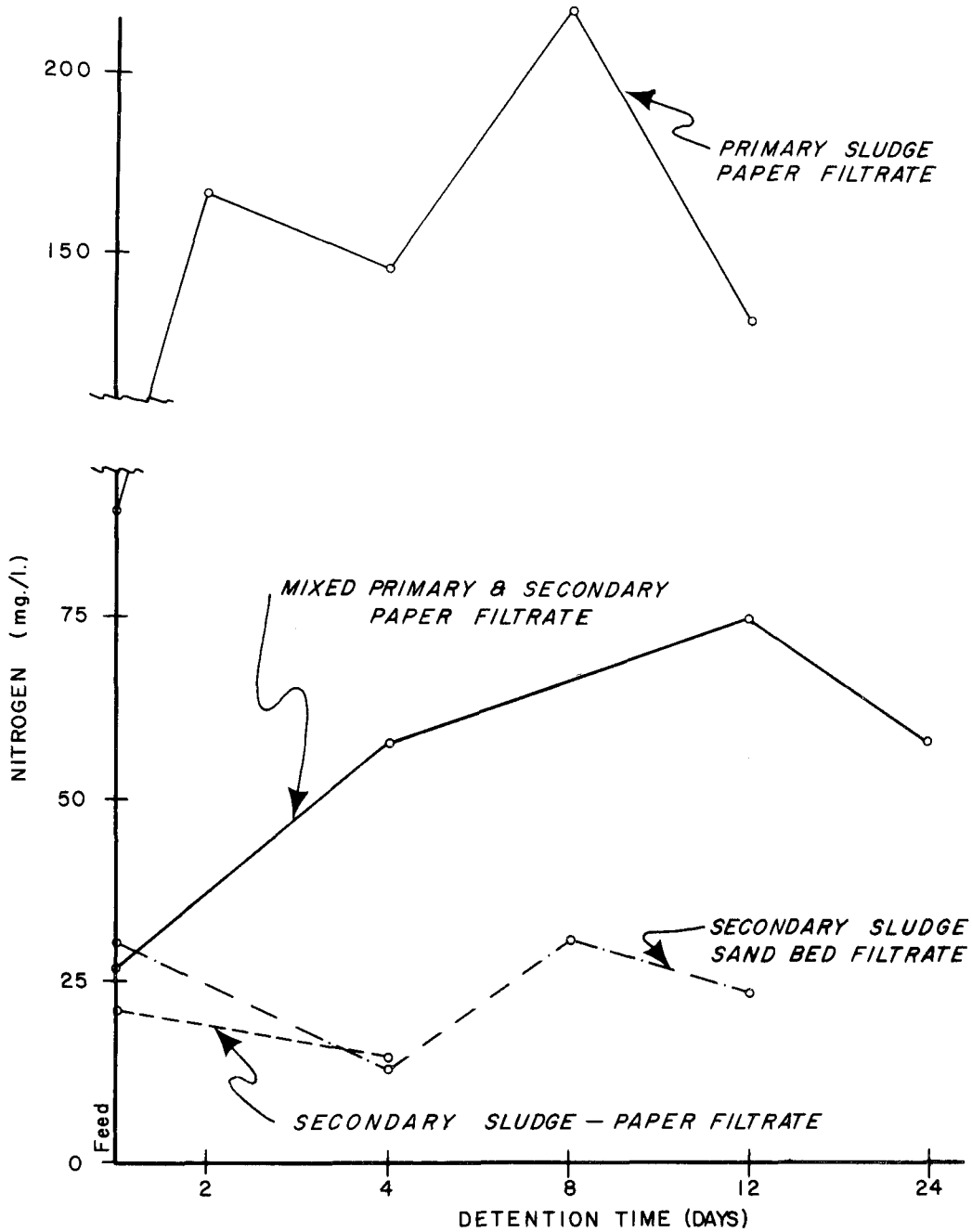
FIGURE 56



MIXED LIQUOR

SUM OF AMMONIA & NITRATE NITROGEN

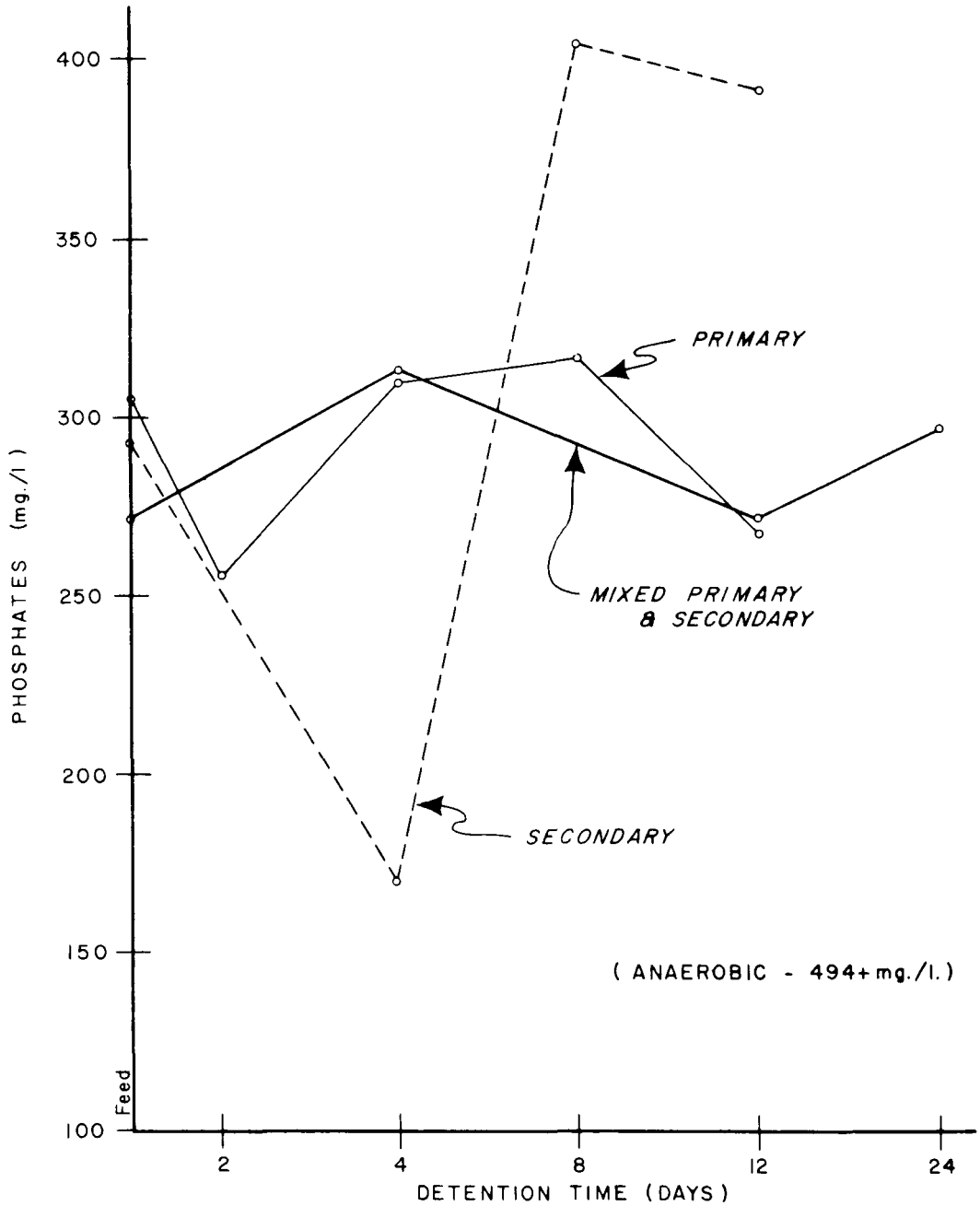
FIGURE 57



FILTRATE

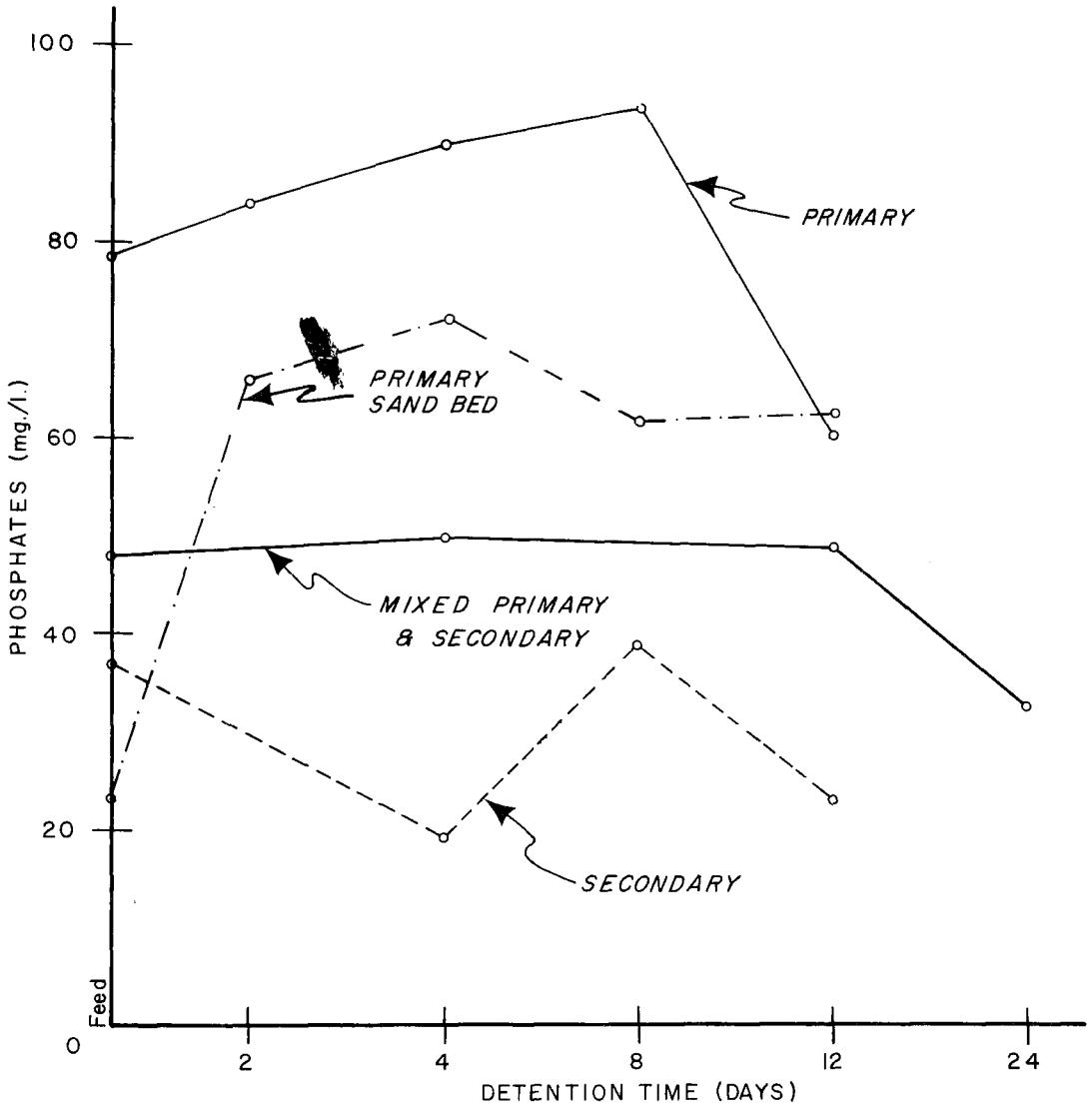
SUM OF AMMONIA & NITRATE NITROGEN

FIGURE 58



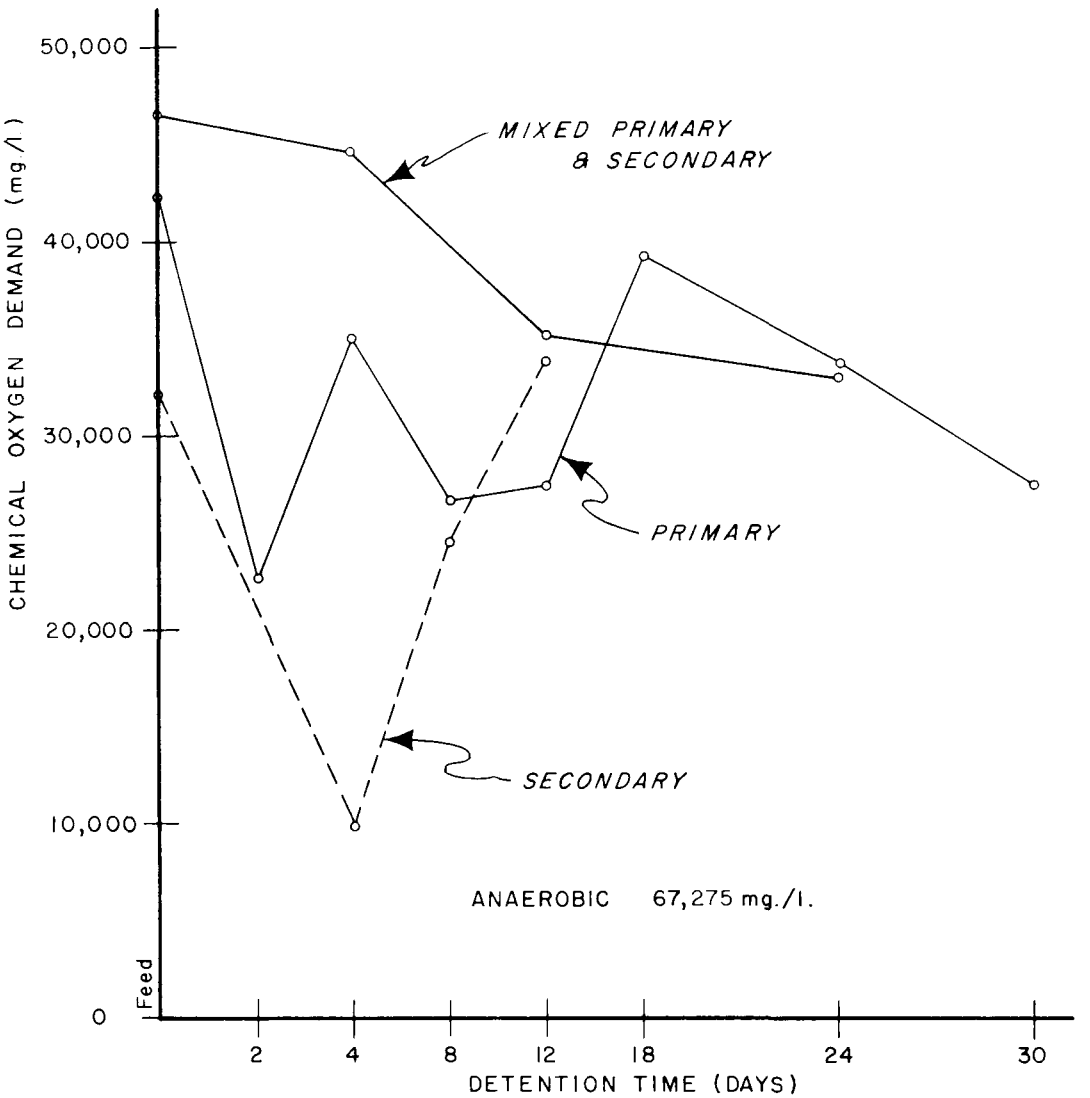
MIXED LIQUOR PHOSPHATES

FIGURE 59



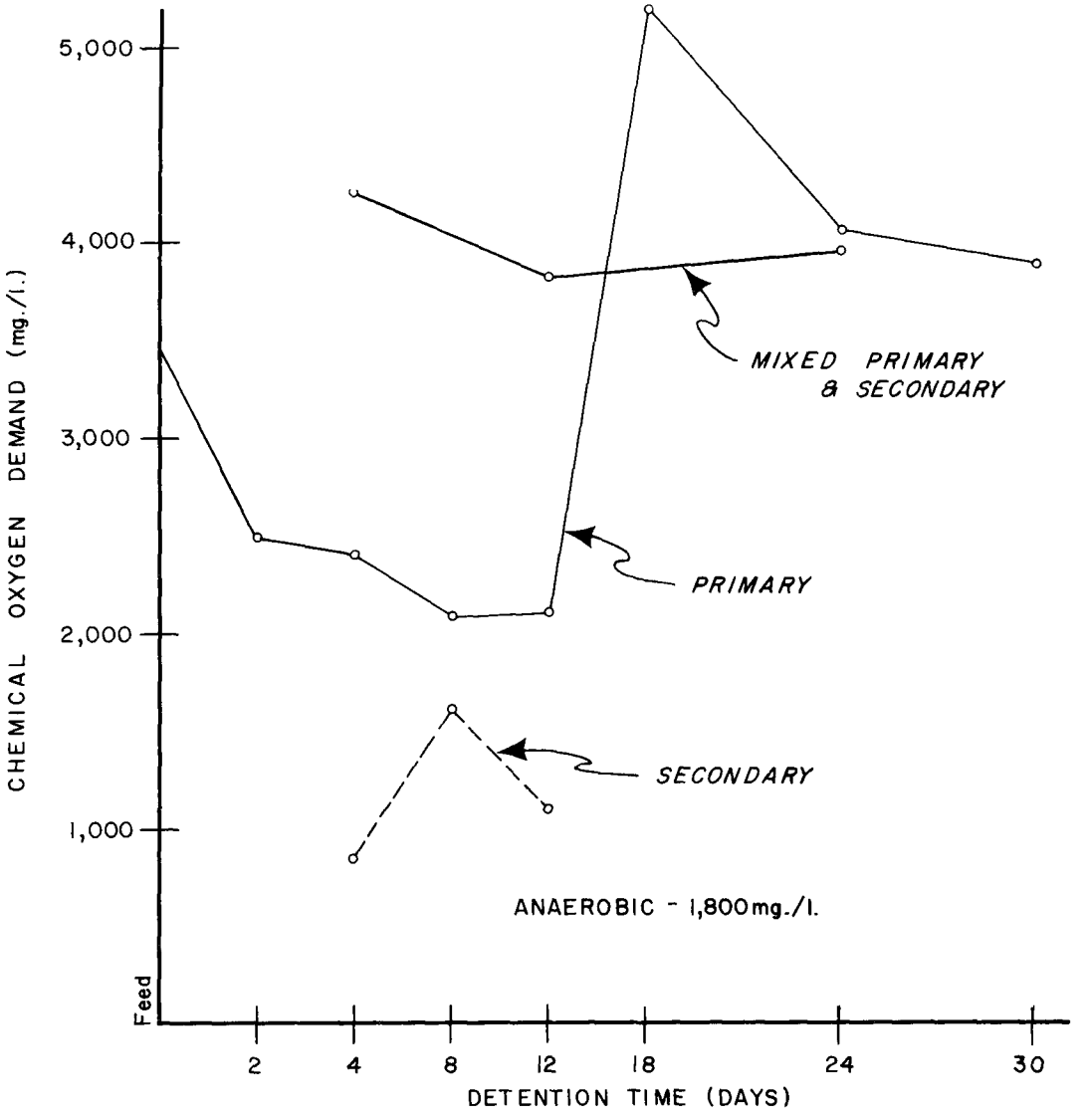
FILTRATE — PAPER
PHOSPHATES

FIGURE 60



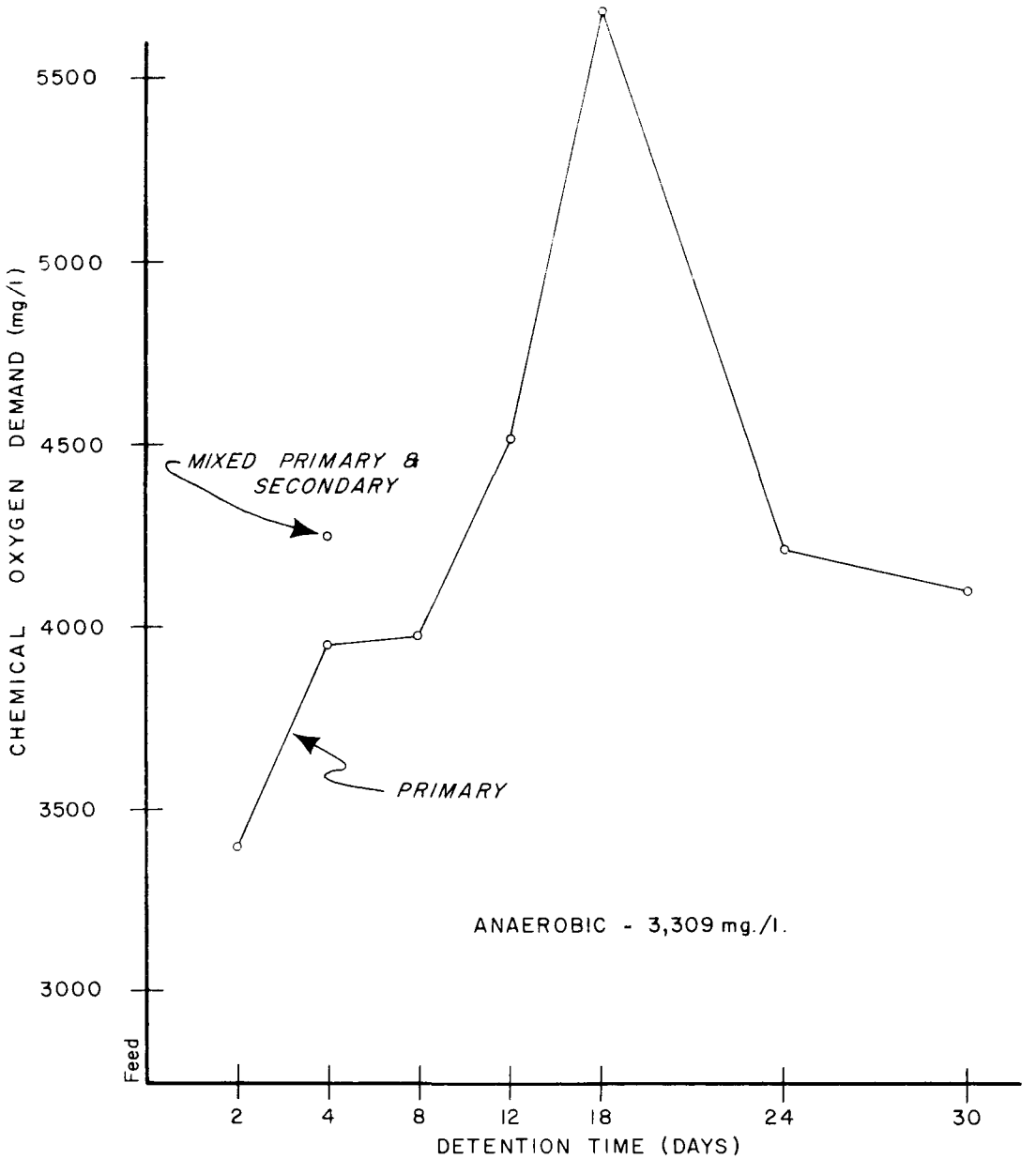
MIXED LIQUOR
CHEMICAL OXYGEN DEMAND

FIGURE 61



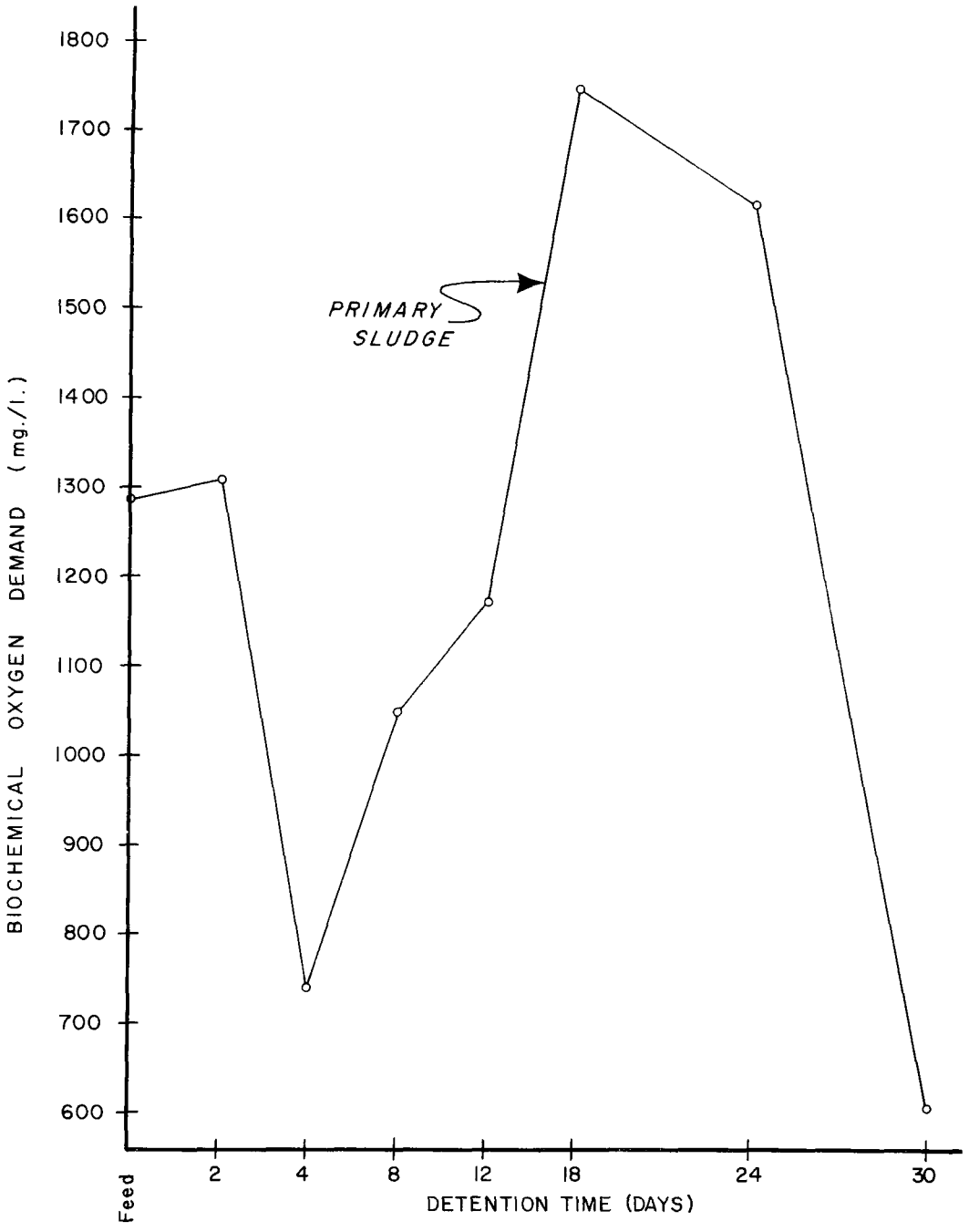
CHEMICAL OXYGEN DEMAND
FILTRATE—PAPER

FIGURE 62



CHEMICAL OXYGEN DEMAND
FILTRATE - SANDBED

FIGURE 63



MIXED LIQUOR

BIOCHEMICAL OXYGEN DEMAND

FIGURE 64

TABLE 65

PRIMARY SLUDGE

DISSOLVED OXYGEN -- MIXED LIQUOR

Date 1970	Hour	Detention Time Days 2	4	4	8	12	18	24	30
6-10	-------	0.44	0.59	----	0.42	0.42	----	----	----
6-19	-------	0.32	0.36	----	0.36	1.86	----	----	----
6-26	-------	0.29	0.44	----	0.32	1.76	----	----	----
8-13	-------	0.36	0.40	----	0.50	----	----	----	----
8-23	-------	0.33	0.41	----	0.49	----	----	----	----
8-31	-------	0.35	0.40	----	0.52	----	----	----	----
10-5	-------	0.67	0.57	----	0.67	0.66	----	----	----
10-12	-------	0.20	0.30	----	0.80	1.10	----	----	----
1971									
2-11	-------	----	0.25	0.08	0.14	0.15	----	----	----
2-16	-------	----	1.02	0.48	0.29	0.62	----	----	----
3-10	-------	----	----	----	----	0.24	0.23	0.30	0.29
3-11	12 noon	----	----	----	----	0.24	0.22	0.42	0.29
3-11	8 p.m.	----	----	----	----	0.25	0.31	0.27	0.28
3-12	12 noon	----	----	----	----	0.35	0.18	0.24	0.15
3-12	8 p.m.	----	----	----	----	0.50	0.42	0.36	0.30
3-13	12 noon	----	----	----	----	0.45	0.44	0.15	0.18
3-13	8 p.m.	----	----	----	----	0.55	0.64	0.40	0.48
3-14	12 noon	----	----	----	----	0.30	0.31	0.30	0.22
3-15	12 noon	----	----	----	----	0.30	0.30	0.32	0.28
3-15	8 p.m.	----	----	----	----	0.91	0.77	0.86	0.67
3-16	12 noon	----	----	----	----	0.75	0.60	0.47	0.45
2-17	8 p.m.	----	----	----	----	1.08	0.88	0.79	0.67
4-3	-------	----	----	----	----	0.61	0.59	0.58	0.64
4-20	-------	----	----	----	----	1.00	1.00	0.80	1.10
AVG	-------	0.37	0.44		0.45	0.67	0.49	0.45	0.43

TABLE 66

MIXED PRIMARY AND SECONDARY SLUDGE

DISSOLVED OXYGEN -- MIXED LIQUOR

Date 1971	Detention Time Days 4	8	12
5-27	0.73	----	----
5-28	0.75	----	----
5-29	0.75	----	----
6-4	----	0.77	----
6-5	----	0.82	----
6-6	----	0.64	----
7-12	----	----	0.76
7-13	----	----	0.70
7-14	----	----	0.65
AVG	0.74	0.74	0.70

TABLE 67

SECONDARY SLUDGE

DISSOLVED OXYGEN -- MIXED LIQUOR

Date 1971	4	8	12
6-1	0.21	----	----
6-2	0.18	----	----
6-3	0.20	----	----
6-13	----	0.15	----
6-15	----	0.19	----
6-16	----	0.12	----
6-25	----	----	0.20
6-28	----	----	0.25
7-1	----	----	0.20
AVG	0.20	0.15	0.22

TABLE 68A

PRIMARY SLUDGE

AMMONIA NITROGEN

Date	Feed	Anaerobic Digester	Detention Time Days 2	4	8	12
			Mixed Liquor 1971			
1-7	336.0	232.0	560.0	448.0	392.0	448.0
1-21	336.0	1,232.0	392.0	224.0	280.0	336.0
1-27	980.0	140.0	224.0	46.0	196.0	308.0
AVG	550.7	534.7	392.0	239.3	289.3	363.3
2-16	-----	1,512.0	504.0	448.0	420.0	364.0
2-24	-----	-------	152.0	350.0	112.0	98.0
AVG	-----	1,512.0	328.0	399.0	266.0	231.0
4-3	-----	-------	56.0	-----	-----	-----
4-20	-----	-------	98.0	101.5	70.0	-----
4-25	-----	-------	70.0	105.0	98.0	77.0
5-1	-----	-------	-----	105.0	84.0	77.0
AVG	-----	-------	74.7	103.8	84.0	77.0
			Filtrate (Paper) 1970-71			
9-17	165.2	-------	131.6	131.6	187.6	-----
10-5	162.0	-------	89.6	140.0	196.0	16.7
10-12	-----	-------	168.0	78.4	224.0	28.0
10-16	61.6	-------	145.0	156.8	218.4	28.0
11-24	91.0	-------	164.2	128.8	123.2	50.0
12-9	100.8	-------	179.2	240.8	246.4	22.4
AVG	116.1	-------	146.3	146.1	199.3	29.0
1-7	44.8	693.0	100.8	72.8	128.8	184.8
1-21	78.4	638.4	240.8	16.8	196.0	263.2
1-27	140.0	666.4	235.2	89.2	179.2	308.0
AVG	87.7	665.9	192.3	59.6	168.0	252.0

TABLE 68B

PRIMARY SLUDGE

AMMONIA NITROGEN

Date	Feed	Anaerobic Digester	Detention Time Days 2	4	8	12
			Filtrate (Paper) 1971			
2-16	73.0	731.0	258.0	286.0	297.0	252.0
2-24	90.0	627.0	146.0	35 .0	325.0	381.0
AVG	81.5	679.0	202.0	322.0	311.0	316.5
			12	18	24	30
4-3	-----	-------	63.0	-----	-----	-----
4-20	-----	-------	74.2	109.2	92.4	-----
4-25	-----	-------	47.6	67.2	92.4	100.8
5-1	-----	-------	-----	78.0	58.8	-----
AVG	-----	-------	61.6	84.8	81.2	100.8
			Sand Bed Filtrate 1971			
			2	4	8	12
1-7	-----	-------	140.0	134.0	184.0	140.0
1-27	117.6	330.4	156.8	56.0	145.6	201.6
AVG	117.6	330.4	148.4	95.0	164.8	170.8
			4	4	8	12
2-24	-----	224.0	280.0	336.0	336.0	336.0
			12	18	24	30
4-3	-----	-------	48.0	-----	-----	-----
4-20	-----	-------	62.3	73.9	12.3	-----
4-25	-----	-------	-----	-----	-----	84.7
5-1	-----	-------	-----	50.4	19.6	50.4
AVG	-----	-------	55.2	62.2	16.0	67.6

TABLE 69

MIXED PRIMARY AND SECONDARY SLUDGE

AMMONIA NITROGEN

Date 1971	Mixed Liquor Feed	Mixed Liquor Detention Time Days 4	12	24	Filtrate (Paper) Detention Time Days 4	12	24	Filtrate (Paper) Feed	Filtrate (Paper) Sand Bed
5-27	--	63	--	--	60	--	--	--	--
5-28	49	63	--	--	60	--	--	27	--
5-29	49	70	--	--	52	--	--	--	--
6-4	21	--	98	--	--	76	--	--	--
6-5	28	--	70	--	--	76	--	36	--
6-6	--	--	98	--	--	75	--	--	18
7-12	98	--	--	98	--	--	28	28	--
7-13	35	--	--	91	--	--	70	14	14
7-14	25	--	--	91	--	--	77	21	28
AVG	44	65	89	93	57	76	58	25	20

TABLE 70

SECONDARY SLUDGE

AMMONIA NITROGEN

Mixed Liquor

Date 1971	Feed	(Paper)	Detention Time Days 4	8	12
6-1	28	12	14	--	--
6-2	28	9	28	--	--
6-3	14	9	14	--	--
6-13	--	--	--	49	--
6-15	21	16	--	49	--
6-16	14	20	--	56	--
6-25	28	16	--	--	35
6-28	42	22	--	--	56
7-1	--	--	--	--	56
AVG	25	15	19	51	49

Anaerobic

6-25	210	39
6-28	231	41
AVG	220	40

TABLE 71

SECONDARY SLUDGE

AMMONIA NITROGEN

SAND BED

Date 1971	Feed	Detention Time Days 4	8	12
6-1	--	12	--	--
6-2	--	12	--	--
6-3	6	14	--	--
6-13	--	--	39	--
6-15	--	--	43	--
6-16	45	--	12	--
6-25	--	--	--	26
6-28	--	--	--	26
7-1	38	--	--	21
AVG	30	13	31	24

TABLE 72

PRIMARY SLUDGE

NITRATES -- MIXED LIQUOR

Date 1971	Feed	Anaerobic Digester	Detention Time Days 2	4	8	12
1-21	38	138	32.0	24.0	34.0	30.0
1-27	18	84	16.0	12.0	11.0	15.0
AVG	28	111	24.0	18.0	22.5	22.5
			Detention Time Days 4	4	8	12
2-24	4.2	---	4.8	4.2	4.0	3.6
			Detention Time Days 12	18	24	30
4-3	----	---	18.0	----	----	----
4-20	----	---	29.0	22.0	35.0	----
4-25	----	---	29.0	29.0	23.0	34.0
5-1	----	---	----	43.0	34.0	38.0
AVG	----	---	25.3	31.3	30.7	36.0

TABLE 73

MIXED PRIMARY AND SECONDARY SLUDGE

NITRATES

MIXED LIQUOR

Date 1971	Feed	Detention Time Days 4	12	24
5-27	--	24	--	--
5-28	32	26	--	--
5-29	39	24	--	--
6-4	16	--	20	--
6-5	19	--	12	--
6-6	--	--	9	--
7-12	44	--	--	40
7-13	54	--	--	54
7-14	54	--	--	48
AVG	37	25	14	47

TABLE 74

SECONDARY SLUDGE

NITRATES

MIXED LIQUOR

Date 1971	Feed	Detention Time Days 4	8
6-1	34	15	--
6-2	60	17	--
6-3	40	17	--
6-13	--	--	18
6-15	30	--	32
6-16	26	--	24
AVG	38	16	25

TABLE 75

PRIMARY SLUDGE

NITRATES -- FILTRATE (PAPER)

Date 1970-71	Feed	Anaerobic Digester	Detention Time Days 2	4	8	12
10-5	0.4	----	1.4	2.0	1.8	0.4
10-12	0.5	----	1.3	2.0	0.6	1.0
10-16	0.9	----	1.3	3.0	2.2	1.6
11-9	1.3	----	4.4	1.4	2.2	0.9
11-24	0.5	1.0	4.0	2.0	1.2	1.2
12-9	0.4	0000	1.4	2.0	1.8	0.4
1-7	0.8	0.8	1.0	1.9	1.2	1.7
1-21	2.5	3.5	1.0	3.5	2.0	3.5
1-27	0.78	0.56	0.96	0.90	0.82	1.30
AVG	0.91	1.46	1.86	2.07	1.53	1.33
			Detention Time Days 4	4	8	12
2-16	0.25	0.38	1.75	4.75	3.25	2.25
2-24	0.3	0.3	0.8	1.6	1.4	0.7
AVG	0.27	0.34	1.27	3.17	2.33	1.47
			Detention Time Days 12	18	24	30
4-3	----	----	----	----	----	----
4-20	----	----	2.4	1.7	1.9	----
4-25	----	----	0.9	0.8	0.8	1.1
5-1	----	----	----	1.7	1.5	1.8
AVG	----	----	1.65	1.40	1.40	1.45

TABLE 76

PRIMARY SLUDGE

NITRATES -- SAND DRYING BEDS -- FILTRATES

Date 1971	Anaerobic Digester	Detention Time Days 2	4	8	12
1-7	---	4.1	6.3	6.5	4.0
1-27	0.7	2.6	3.1	3.0	2.7
AVG	0.7	3.35	4.70	4.75	3.35
		Detention Time Days 4	4	8	12
2-24	---	5.0	3.0	4.0	2.0
		Detention Time Days 12	18	24	30
4-3	---	2.2	----	----	----
4-20	---	2.4	3.2	1.9	----
4-25	---	1.8	1.7	----	1.1
5-1	---	----	3.4	4.6	4.0
AVG	---	2.13	2.76	3.25	2.55

TABLE 77

MIXED PRIMARY AND SECONDARY SLUDGE

NITRATES

Date 1971	Feed	Detention Time Days 4	12	24
		Filtrate (Paper)		
5-27	----	0.4	---	---
5-28	0.5	0.5	---	---
5-29	0.8	0.6	---	---
6-4	0.0	---	0.0	---
6-5	0.0	---	0.0	---
6-6	----	---	0.0	---
7-12	4.0	---	---	0.0
7-13	0.0	---	---	0.0
7-14	0.0	---	---	0.0
AVG	0.76	0.5	0.0	0.0
		Filtrate (Sand Bed)		
5-27	----	1.0	---	---
6-6	----	0.0	---	---
7-14	----	0.0	---	---
AVG	----	0.33	---	---

TABLE 78

SECONDARY SLUDGE

NITRATES

Date 1971	Feed	Detention Time Days 4	8
	Filtrate (Paper)		
6-1	0.2	0.7	---
6-2	0.6	0.2	---
6-3	3.8	1.6	---
6-13	----	----	0.0
6-15	0.0	----	0.0
6-16	0.0	----	0.0
AVG	0.92	0.83	0.0
	Filtrate (Sand Bed)		
6-3	----	1.2	---
6-16	----	0.0	---
AVG	----	0.60	---

TABLE 79

AMMONIA NITROGEN PLUS NITRATES

PRIMARY SLUDGE

Mixed Liquor

Date 1971	Feed	Anaerobic Digester	Detention Time Days 2	4	8	12
1-21	374	1370	424	236	314	351
1-27	998	224	240	58	219	323
2-24	---	----	157	354	116	102
4-3	---	----	116	---	---	---
4-20	---	----	---	---	---	---
4-25	---	----	---	---	---	111
5-1	---	----	---	---	---	115
AVG	686	797	205	216	216	200

Filtrate -- Paper

Date 1970-71	Feed	Anaerobic Digester	Detention Time Days 2	4	8	12
10-5	162	---	91	142	198	18
10-12	---	---	169	80	225	29
10-16	62	---	146	160	221	30
11-24	92	---	168	131	124	51
12-9	101	---	181	242	248	23
1-7	46	694	102	75	130	187
1-21	81	642	242	20	198	180
1-27	90	667	236	90	180	178
2-16	73	731	---	275	313	254
2-24	90	627	---	253	336	382
AVG	89	672	168	147	216	133

TABLE 80

AMMONIA NITROGEN PLUS NITRATES

MIXED PRIMARY AND SECONDARY

Mixed Liquor

Date 1971	Feed	Dention Time Days 4	12	24	Sand Bed
5-27	-----	87	----	----	
5-28	81	89	----	----	
5-29	88	94	----	----	
6-4	37	----	118	----	
6-5	47	----	82	----	
6-6	-----	----	107	----	
7-12	142	----	----	138	
7-13	89	----	----	145	
7-14	79	----	----	139	
AVG	80	90	102	141	

Filtrate -- Paper and Sand Bed Filtrate

5-27	-----	60.4	-----	----	----
5-28	27.4	60.5	-----	----	----
5-29	-----	52.6	-----	----	----
6-4	-----	----	76.0	----	----
6-5	36.0	----	76.0	----	----
6-6	-----	----	75.0	----	18.0
7-12	32.0	----	----	28.0	----
7-13	14.0	----	----	70.0	14.0
7-14	21.0	----	----	77.0	28.0
AVG	26.1	57.8	75.7	58.3	20.0

TABLE 81

AMMONIA NITROGEN PLUS NITRATES

SECONDARY SLUDGE

Date 1971	Feed	Detention Time Days 4	8	12
		Mixed Liquor		
6-1	62	29	--	
6-2	88	45	--	
6-3	54	31	--	
6-13	--	--	67	
6-15	51	--	81	
6-16	40	--	80	
AVG	59	35	76	
		Filtrate -- Paper		
6-1	28.2	12.7		
6-2	28.6	9.2		
6-3	17.8	12.8		
6-15	21.0	16.0		
6-16	14.0	20.0		
AVG	21.9	14.1		
		Sand Beds		
AVG	30.0	13.6	31.0	24.0

TABLE 82

PRIMARY SLUDGE

PHOSPHATE

Date 1970-71	Feed	Anaerobic Digester	Detention Time Days 2	4	8	12
			Mixed Liquor			
11-4	235	----	267	340	252	212
11-9	185	----	262	278	252	237
11-24	318	400+	252	280	255	235
12-8	239	571+	220	228	220	220
1-7	383	500+	272	294	330	274
1-21	400	500+	254	254	280	276
1-27	355	500+	249	231	227	286
AVG	302	494+	254	272	259	249
			Detention Time Days 4	4	8	12
2-16	324	415+	325	392	340	306
2-25	---	500+	350	426	345	348
AVG	324	458+	338	409	343	327
			Sand Bed Filtrate			
1970-71			Detention Time Days 2	4	8	12
12-8	---	----	51	62	37	103
1-7	---	24	75	60	66	30
1-27	---	15	72	46	78	28
AVG	---	20	66	56	60	54
			Detention Time Days 4	4	8	12
2-25	---	23	92	101	67	90

TABLE 83

PRIMARY SLUDGE

PHOSPHATE

Date 1970-71	Feed	Anaerobic Digester	Detention Time Days 2	4	8	12
		Filtrate (Paper)				
10-5	110	----	77	106	81	26
10-12	74	----	85	107	75	23
10-16	66	----	78	98	76	23
11-4	64	----	94	106	88	67
11-9	83	----	85	95	88	67
11-24	88	50	68	85	97	75
12-8	62	40	73	62	94	81
1-7	55	43	103	67	110	109
1-21	91	40	100	35	91	43
1-27	115	42	81	31	84	28
AVG	81	43	84	79	88	54
			Detention Time Days 4	4	8	12
2-16	51	44	115	125+	127	77
2-25	92	----	104	125+	118	112
AVG	72	44	110	125+	123	95

TABLE 84

MIXED PRIMARY AND SECONDARY SLUDGE

PHOSPHATE

Date 1971	Feed	Detention Time Days 4	12	24
		Mixed liquor		
5-27	----	275	---	---
5-28	426	270	---	---
5-29	460	390	---	---
6-4	130	---	240	---
6-5	160	---	310	---
6-6	----	---	260	---
7-12	300	---	---	310
7-13	160	---	---	285
7-14	267	---	---	290
AVG	272	312	270	295
		Filtrate (Paper)		
5-27	----	50	---	---
5-28	50+	51	---	---
5-29	50+	50	---	---
6-4	49	---	49	---
6-5	49	---	50+	---
6-6	----	---	49	---
7-12	47	---	---	42
7-13	47	---	---	28
7-14	43	---	---	29
AVG	48+	50	49	33

TABLE 85

SECONDARY SLUDGE

PHOSPHATE

Date 1971	Feed	Detention Time Days 4	8	12
		Mixed Liquor		
6-1	260	200	---	---
6-2	310	130	---	---
6-3	240	180	---	---
6-13	---	---	360	---
6-15	267	000	420	---
6-16	160	---	430	---
6-25	380	---	---	340
6-28	440	---	---	430
7-1	---	---	---	400
AVG	294	170	403	390
		Filtrate (Paper)		
6-1	35	17	---	---
6-2	47	13	---	---
6-3	26	28	---	---
6-13	---	---	33	---
6-15	41	---	42	---
6-16	34	---	43	---
6-25	47	---	---	28
6-28	30	---	---	24
7-1	---	---	---	17
AVG	37	19	39	23

TABLE 86

ANAEROBIC SLUDGE

PHOSPHATE

Date	Feed		Detention Time 4-Days	
1971	Mixed Liquor	Filtrate	Mixed Liquor	Filtrate
6-25	500+	50+	260	31
6-28	500+	50+	500+	31
AVG	500+	50+	380+	31

TABLE 87

PRIMARY SLUDGE

CHEMICAL OXYGEN DEMAND -- MIXED LIQUOR

Date 1970-71	Feed	Anaerobic Digester	Detention Time Days 2	4	8	12
10-24	------	------	------	------	23,800	18,000
11-24	33,600	------	14,400	54,400	29,600	30,000
1-7	59,740	79,928	40,788	35,844	44,496	37,080
1-21	40,000	75,600	8,800	12,800	15,600	17,600
1-27	28,400	76,000	27,200	22,000	16,000	7,200
AVG	40,435	77,176	22,797	31,261	25,899	21,976
			Detention Time Days 4	4	8	12
2-16	48,000	12,000	36,000	44,000	29,600	24,000
2-24	44,000	80,400	36,400	39,200	28,000	42,400
AVG	46,000	46,200	36,200	41,600	28,800	33,200
			Detention Time Days 12	18	24	30
4-3	------	------	27,600	------	------	------
4-20	------	------	33,335	40,245	33,335	------
4-25	------	------	35,320	36,130	30,040	23,140
5-1	------	------	------	42,110	38,350	31,590
AVG	------	------	32,085	39,495	33,908	27,365

TABLE 88

PRIMARY SLUDGE

CHEMICAL OXYGEN DEMAND -- FILTRATE (PAPER)

Date 1970		Anaerobic Digester	Detention Time Days 2	4	8	12
6-5	------	-----	2,200	1,800	800	1,200
6-6	------	-----	2,000	1,800	800	-----
6-7	------	-----	2,000	800	800	200
6-8	------	-----	2,600	400	2,000	1,200
6-9	10,600	2,000	600	1,000	1,600	1,800
6-10	------	-----	2,600	2,000	1,200	1,400
6-11	------	-----	200	1,600	1,200	800
8-14	4,000	-----	2,900	3,040	1,300	-----
8-15	4,080	-----	3,220	2,960	1,440	-----
8-23	3,960	-----	3,380	2,900	1,620	-----
8-24	4,040	-----	3,180	2,040	1,400	-----
8-25	3,980	-----	2,900	3,000	1,360	-----
8-31	3,800	-----	2,780	3,400	1,480	-----
9-18	3,873	-----	3,083	4,700	3,647	-----
10-6	3,440	-----	2,880	4,240	3,720	1,400
10-12	2,400	-----	2,520	3,520	2,080	1,120
10-16	1,960	-----	2,720	4,000	3,400	1,480
11-24	------	-----	3,120	2,080	1,200	1,200
12-9	2,638	-----	2,219	2,638	2,929	2,759
AVG	4,064	2,000	2,479	2,522	1,788	1,324

TABLE 89

PRIMARY SLUDGE

CHEMICAL OXYGEN DEMAND -- FILTRATE (PAPER)

Date 1971	Feed	Anaerobic Digester	Detention Time Days 2	4	8	12
1-7	1,180	384	2,768	1,664	1,984	2,256
1-21	2,640	128	2,976	656	2,144	1,712
1-27	3,472	400	2,176	1,184	-----	1,936
1-27	-----	---	2,400	-----	-----	-----
1-27	2,200	---	2,800	1,200	-----	2,400
AVG	2,373	304	2,624	1,176	2,064	2,076
			Detention Time Days 4	4	8	12
2-16	1,276	370	2,520	-----	3,041	3,209
2-24	2,680	784	1,440	5,840	2,920	3,960
AVG	1,978	577	1,980	5,840	2,980	3,585
			Detention Time Days 12	18	24	30
4-3	-----	---	3,000	-----	-----	-----
4-20	-----	---	6,430	5,780	3,870	-----
4-25	-----	---	3,250	4,950	3,650	3,170
4-30	-----	---	-----	4,880	4,700	4,630
AVG	-----	---	4,227	5,203	4,073	3,900

TABLE 90

PRIMARY SLUDGE

CHEMICAL OXYGEN DEMAND

Date 1970-71	Feed	Anaerobic Digester	Detention Time Days 2	4	8	12
			Supernatant			
10-22	----	---	12,200	11,200	7,600	5,760
11-24	----	---	11,840	11,040	12,080	5,360
AVG	----	---	12,020	11,120	9,840	5,560
			Sand Bed -- Filtrate			
			Detention Time Days 2	4	8	12
1-7	----	576	3,616	3,648	5,840	1,920
1-27	----	800	3,200	3,600	2,200	3,400
AVG	----	688	3,408	3,624	4,020	2,660
			Detention Time Days 4	4	8	12
2-24	----	400	4,020	4,600	3,920	3,560
			Detention Time Days 12	18	24	30
4-3	----	---	6,300	------	------	------
4-20	----	---	6,390	6,230	3,560	------
4-25	----	---	------	------	------	3,610
4-30	----	---	------	5,140	4,880	4,590
AVG	----	---	6,345	5,685	4,220	4,100

TABLE 91

MIXED PRIMARY AND SECONDARY SLUDGE

CHEMICAL OXYGEN DEMAND

Date 1971	Feed	Detention Time Days 4	8	12	24
		Mixed Liquor			
5-27	------	39,200	------	------	------
5-28	62,000	47,200	------	------	------
5-29	66,000	48,400	------	------	------
6-4	38,880	------	------	36,000	------
6-5	49,320	------	------	34,200	------
6-6	------	------	------	34,920	------
7-12	45,000	------	------	------	33,000
7-13	42,000	------	------	------	31,000
7-14	30,000	------	------	------	36,000
AVG	47,600	44,933	------	35,040	33,333
		Filtrate (Paper)			
5-27	------	4,400	------	------	------
5-28	3,640	4,440	------	------	------
5-29	3,840	4,000	------	------	------
6-4	2,770	------	------	3,850	------
6-5	3,240	------	------	3,925	------
6-6	------	------	------	3,815	------
7-12	2,300	------	------	------	3,900
7-13	2,200	------	------	------	4,100
7-14	1,800	------	------	------	4,200
AVG	2,827	4,280	------	3,863	4,067
		SAND BED FILTRATE			
5-27	------	5,880	------	------	------
7-12	------	2,600	------	------	------
AVG	------	4,240	------	------	------

TABLE 92

SECONDARY SLUDGE

CHEMICAL OXYGEN DEMAND

Date 1971	Feed	Anaerobic Digester	4	8	12	Sand Bed Filtrate
			MIXED LIQUOR			
6-1	30,800	------	5,600	------	------	------
6-2	41,200	------	10,800	------	------	------
6-3	26,800	------	13,600	------	------	640
6-13	------	------	------	24,400	------	------
6-15	34,400	------	------	23,600	------	------
6-16	28,400	------	------	26,000	------	------
6-25	29,000	75,000	------	------	48,000	------
6-28	35,000	72,000	------	------	28,000	------
7-1	------	------	------	------	26,000	------
AVG	32,229	73,500	10,000	24,667	34,000	640
			Filtrate (Paper)			
6-1	880	------	440	------	------	------
6-2	560	------	800	------	------	------
6-3	1,040	------	1,320	------	------	------
6-13	------	------	------	1,240	------	------
6-15	1,750	------	------	1,800	------	------
6-16	1,400	------	------	1,760	------	------
6-25	1,200	1,700	------	------	1,200	------
6-28	1,300	1,200	------	------	1,100	------
7-1	------	------	------	------	1,000	------
AVG	1,355	1,450	853	1,600	1,100	------

TABLE 93

PRIMARY SLUDGE

BIOCHEMICAL OXYGEN DEMAND

Date 1970-71	Feed	Anaerobic	Detention Time Days 2	4	8	12			
9-17	2563	--	1500	2125	1688	----	----	----	---
1-21	1100	67	1567	133	1200	900	----	----	---
1-21	1133	67	1633	133	1133	1100	----	----	---
1-27	1767	34	900	133	967	800	----	----	---
1-27	1567	34	967	67	1033	667	----	----	---
AVG	1626	51	1313	518	1204	867	----	----	---
			Detention Time Days 4	4	8	12			
2-16	267	67	1533	----	600	200	----	----	---
2-16	364	67	1121	----	364	121	----	----	---
2-24	----	--	727	----	1182	1756	----	----	---
2-24	1515	--	697	----	1273	1939	----	----	---
AVG	715	67	1020	----	855	1004	----	----	---
			Detention Time Days			12	18	24	30
4-8	----	--	----	----	----	1575	----	----	---
4-26	----	--	----	----	----	1975	1773	1667	---
5-1	----	--	----	----	----	1869	1727	1576	606
AVG	----	--	----	----	----	1806	1750	1621	606
AVG	1284	59	1313	741	1049	1173	1750	1621	606

TABLE 94

PRIMARY SLUDGE

pH

Date 1970-71	Feed	Anaerobic Digester	Detention Time Days 2	4	8	12
6-9	6.0	6.6	8.1	8.1	7.4	7.5
6-10	----	----	8.0	8.1	7.6	7.5
8-13	5.6	----	6.2	5.9	6.3	----
8-23	5.6	----	6.1	6.0	6.3	----
8-31	5.6	----	6.2	5.9	6.3	----
10-5	5.4	----	6.39	6.09	7.04	7.31
10-12	5.91	----	6.52	6.24	7.10	7.32
10-16	6.24	----	6.33	5.87	6.75	7.42
11-9	5.6	----	5.8	5.5	6.44	6.38
11-24	5.5	7.07	7.24	6.05	6.95	6.80
12-9	6.1	7.00	6.71	7.46	6.64	6.55
1-7	6.26	----	5.75	6.61	6.59	6.98
1-21	5.90	7.04	6.05	7.33	6.62	7.36
1-27	5.70	6.94	7.04	7.55	6.66	7.96
AVG	5.80	6.93	6.60	6.62	6.76	7.19
			Detention Time Days 4	4	8	12
2-16	6.02	6.82	6.22	5.10	6.53	5.90
2-24	5.90	6.92	6.22	5.94	6.36	6.16
AVG	5.96	6.87	6.22	5.52	6.45	6.03
			Detention Time Days 12	18	24	30
4-3	----	----	5.9	----	----	----
4-20	----	----	7.0	6.2	6.2	----
4-25	----	----	6.6	6.3	7.0	7.4
5-1	----	----	----	6.4	6.6	7.1
AVG	----	----	6.50	6.30	6.60	7.25

TABLE 95

MIXED PRIMARY AND SECONDARY SLUDGE

pH

Date 1971	Feed	Detention Time Days 4	12	24
5-27	---	5.8	---	---
5-28	5.6	5.6	---	---
5-29	5.7	5.8	---	---
6-4	5.7	---	6.9	---
6-5	5.7	---	6.8	---
6-6	---	---	6.8	---
7-12	6.3	---	---	7.2
7-13	5.8	---	---	6.9
7-14	5.9	---	---	7.1
AVG	5.8	5.7	6.8	7.1

TABLE 96

SECONDARY SLUDGE

pH

Date 1971	Feed	Detention Time Days 4	8	12
6-1	6.6	7.4	---	---
6-2	6.4	7.4	---	---
6-3	6.6	7.3	---	---
6-13	---	---	7.2	---
6-15	6.3	---	7.1	---
6-16	6.2	---	7.1	---
6-25	6.1	---	---	7.4
6-28	6.1	---	---	7.4
7-1	---	---	---	7.7
AVG	6.3	7.4	7.1	7.5

SECTION VIII

PILOT PLANT OPERATIONS

AND RESULTS

The pilot plant units were first used to determine the physical and chemical changes which would take place with aerobic digestion of primary sludge. This was followed by utilizing mixed primary and secondary sludge and then the secondary alone was utilized as the waste fed to the aerobic sludge digesters. For comparison sludge from the Stillwater Sewage Treatment Plant's anaerobic sludge digester was analyzed. Also one four day period of aerobic sludge digestion was made on the anaerobic sludge and analyzed. Both of the above were made for comparison. Figure 8 shows the average values of total and volatile solids with detention times ranging from the feed sludge or zero detention time to 30 days detention time. It should be noted that the detention time for each run was about one-fourth the dilute out time. This is true for all the digesters which were used on this project. It should be noted that for most of the different sludges under aerobic digestion the total solids and the volatile solids decreased, then increased and later decreased again as the detention time increased. The exception was the mixed primary and secondary sludge which showed a continuous decline in magnitude with detention. The mixed primary and secondary sludge was greater in all of the average values than either the primary sludge or secondary sludge. Detention times of four to eight days produce a sludge of lower total and volatile solids content for most of the plotted values. This indicates that a detention time in this region would be less costly for the solids removal attained than longer detention times. Figures 11 and 13, particularly for batch primary sludge, show that total solids continue to decrease with increasing detention times.

The values for anaerobic digested four hour settled (Figure 9) show a large reduction in total solids after four days detention of about 45 percent, while the volatile solids at the same time show a much lower decrease of about 3.6 percent. Figures 10 through 13 show the results in bar graph form.

The water contents, as percent water are shown in Figures 14, 15, and 16 for primary mixed liquor, mixed primary and secondary mixed liquor, secondary mixed liquor, primary four hour settled mixed liquor, mixed primary and secondary four hour settled mixed liquor, and secondary four hour settled mixed liquor. All of these increased in percent moisture for the two day detention time except the primary four hour settled mixed liquor which had a decrease of water from 96.3 to 93.3 percent. After the 8 hour detention period all stayed in the range of about 96 to 98 percent water for the longer detention times.

The settleability of the mixed liquor on settling for four hours is shown in Figure 17. The settleability was measured by placing a sludge in a graduate cylinder and noting the level after four hours had elapsed. The data on mixed primary and secondary sludge showed the greatest consistency of all the sludges. It varied from about 94 percent for the raw to 84 percent for the sludge with 12 days detention. The other sludges showed a very wide range of values but most of them were in a lower range indicating better settling characteristics.

The filterability of sludges from the primary, mixed primary and secondary, secondary, batch primary, and anaerobic mixed liquors were determined using the English instrument which measures capillary suction time (C.S.T.) in seconds. The mean values of C.S.T. for the various sludges are plotted in Figure 18. Low values of C.S.T. indicate a more rapid drainage of water from the mixed liquors. The secondary sludge showed better results than any of the other sludges having a low of about 30 C.S.T. seconds at four days detention and a high of 230. Each of the others recorded a low reading on the non-aerated aerated sludge except for the batch primary which had a low reading of 270 C.S.T. at a detention time of 30 days. For detention times of 2 days to 24 days inclusive, using mean values the range of C.S.T. varied from about 615 to 635 for the high value, and from about 370 to 410 for the low value for primary, batch primary, and mixed primary and secondary sludges.

The mean drainability of sludges on sand drying beds on the basis of the ratio of volume drained after 180 hours to the volume applied, see Figure 19, shows very little correlation with the filterability values. In general, ratios indicate that a short detention time under aeration will give better drainage of sludges on sand beds than longer detention times. Figures 20, 21, and 22 show detention time as the abscissa, with the right hand ordinate as sand bed drainage ratio and the left hand ordinate as C.S.T. The primary sludge values are plotted in Figure 20. This indicates a reverse correlation showing longer C.S.T. values with sand bed drainage ratios of volume drained also higher. Conversely, with shorter C.S.T. values the less the sand bed drainage ratio. Figure 21 for mixed primary and secondary sludge shows roughly that lower C.S.T. values correspond to higher drainability values. While there are not very many data available there is only a slight tendency toward correlation.

The temperatures for the aerobic sludge digesters were controlled within a range of 22°C to 26°C but most of the time the range was 23°C to 25°C as shown in Figure 23. The temperature control units described earlier, maintained a fairly constant temperature in the mixed liquor of the aerobic sludge digester. The room where the sludge drying beds were located were maintained at approximately the same range of temperature as the digesters.

The drainage and/or drying of the sludge on sand beds is well illustrated by photographs of the surface of the sludge on the beds. Feed or raw primary sludge is illustrated in Figures 24 through 27. Figure 24 shows

the sludge after it was on the bed for about 7 hours. Some of the water has drained but the surface is still very wet. Figure 25 shows the sludge surface after 40 hours on the bed where the sludge appears to be drying very well. Figure 26 is a picture of the same sludge after 50 hours showing good drying and a white growth which appears to be a mold. Figure 27 shows the same sludge with a heavier growth of mold together with more cracks and holes on the surface after 180 hours. Figure 19 shows that about 55 percent of the total volume of water has drained through the sand in 180 hours. Figure 18 shows the filterability to be 150 C.S.T. seconds.

Primary sludge from a reactor having a two day detention time was placed on a sand drying bed, and after seven hours looked rather watery as shown in Figure 28. After 50 hours it shows signs of draining in Figure 29 where fissures and mold begin to show. In Figure 30 the sludge has drained quite well with fissures and mold more predominate after 120 hours. Figure 31 shows greater cracking of the surface and further growth of mold after 220 hours. Figure 19 shows for a detention time of two days that the drainability of the sludge after 180 hours is 68 percent. From Figure 18 the filterability is 560 C.S.T. seconds.

Primary sludge from a reactor having a four day detention time was placed on a sand drying bed, after 30 hours it appeared to have dewatered a little as shown in Figure 32. After 70 hours, Figure 33 shows a heavy growth of mold and additional draining for the sludge. After 120 hours, Figure 34 shows a heavier growth of mold without much cracking. After 220 hours, Figure 35 shows a very heavy growth of mold and several small cracks. The sludge appeared to have pulled away from the side walls of the sand filter. Figure 19 for a four hour detention shows that the drainability of the sludge after 180 hours is 62 percent. From Figure 18 the filterability is 610 C.S.T. seconds.

Primary sludge from a reactor having an eight day detention time was placed on a sand drying bed. After seven hours it showed a dark mass with little drainage in Figure 36. There appeared to be an area of light on about one-sixth of the bed which may be a mold. Figure 37 shows the same bed after 70 hours with a very heavy growth of mold over about 60 percent of the surface. The sludge also appeared wet over the whole surface of the bed. The same bed is shown in Figure 38 after 175 hours with the mold still showing but with about five large deep cracks through the sludge and a much dryer appearance. Figure 39 shows the same bed after 250 hours with further cracking. The mold is beginning to peel and the sludge looks very dry. Figure 18 shows for a primary sludge and detention time of eight days a C.S.T. of 530 seconds and from Figure 19 a drainability ratio of 52 percent after 180 hours.

Primary sludge from a reactor having a 12 day detention time was placed on a sand drying bed. After seven hours it showed up as a watery mass, shown in Figure 40. After 70 hours, shown in Figure 41, it was still rather wet with a little pool of water showing. Molds showed up again on the sludge above the water. Figure 42 shows the same sludge after 120 hours on the sand bed. Here the sludge had begun to crack and dry, with the mold showing white with less coverage of the sludge.

Figure 43 shows this sludge after 220 hours with the mold appearing to be granular and large areas of black sludge showing. From Figure 18, the 12 day detention time for primary sludge, the filterability is found to be 410 C.S.T. seconds, and from Figure 19 a drainability ratio of 61 percent after 180 hours.

Anaerobic sludge was placed on a sand bed and its appearance after 25 hours was as shown in Figure 44. The sludge shows some mold concentrated on about 10 to 15 percent of the area. Some cracks were beginning to open but the sludge was still very wet. After 70 hours, Figure 45 shows one large crack and a few smaller cracks in the sludge. However, the sludge looks very wet in the photograph. At the end of 175 hours the sludge appeared dried and well cracked and appears to have many small holes spread over most of the area as shown in Figure 46. After 250 hours the sludge, shown in Figure 47, appeared to be dryer and was very well cracked. From Figure 18 the filterability of the anaerobic sludge is 630 C.S.T. seconds and from Figure 19 the drainability ratio is 23 after 180 hours.

Secondary sludge from an aerobic reactor having a four day detention time was placed on a sand bed to a depth of eight inches. After 1150 hours of drainage a photograph was taken of the sludge and is shown in Figure 48. The print at the top of the page is a closeup of the same sludge shown in the print at the bottom of the page. Molds show up in small separated areas. The appearance of the molds was diffused to a greater extent than in other sludges. The mass of sludge appeared to be less porous than in many of the other sludges, and to contain more moisture.

Secondary sludge from an aerobic reactor having an eight day detention time was placed on a sand bed to a depth of eight inches. After 880 hours of drainage a photograph was taken of the sludge and is shown in Figure 49. Again the print at the top of the page is a closeup of the same sludge shown in the print at the bottom of the page. Molds still appear but there are fewer large white areas as in previous photographs. This sludge appeared to be some what dryer than the sludge with only a four day detention time.

Figure 50 shows secondary sludge from an aerobic reactor on a sand bed. The aerobic reactor had a 12 day detention time. Eight inches of sludge was placed on the sand bed and after 528 hours on the bed the two prints of the surface of the bed were taken. This sludge appeared to have more openings through the bed than the previous two cases. There was still mold on the surface of the sludge with greater white mold coverage.

The pH of the mixed liquor tends to increase with detention time for each of the three sludges, primary, mixed primary and secondary, and secondary, see Figure 51. For each of these three there was one dip in pH values. Primary and mixed primary and secondary each had a dip in pH on the four day detention time compared to detention times before

and after this time. The secondary sludge exhibited higher pH values than either of the other two sludges. The mixed primary and secondary sludge had the lowest pH values for all detention times from the feed through the 12 day time. Thereafter, the primary had the lowest value.

The dissolved oxygen content of the three sludges is very low for the secondary sludge, relatively high for the mixed primary and secondary sludge, with a maximum value of 0.74 mg/l and inbetween and quite variable for the primary sludge as shown in Figure 52. None of the dissolved oxygen values were very high. Most of the time the rate of oxygen flow available for use was the maximum available. It appears that more oxygen applied to the sludges would have produced better results.

The concentration of the ammonia nitrogen as plotted in Figures 53 and 54 shows good correlation for the mixed liquor secondary sludge and the secondary filtrate (paper and sand beds) as well as for the mixed liquor, mixed primary and secondary sludge on paper filtrate. However, the mixed liquor primary, and primary on paper filtration show little correlation. As a generalization the filtration in each case reduced the ammonia nitrogen concentration.

The mixed liquor nitrate concentration values shown in Figure 55 are consistant relative to each of the sludges. For each of the sludges there is a general trend to loss of nitrate with a four day detention time and a 12 day detention time. Then the nitrogen content increases for all three sludges. In the case of the mixed primary and secondary sludge there is a decrease from 37 mg/l nitrate on the feed to 14 mg/l at 12 days detention, then an increase to 47 mg/l the last of which is above the recommended standard of 45 mg/l. The primary sludge showed a small rise in nitrate, then a moderate drop, a rapid rise, a plateau and another rise. The nitrogen filtrates contained very minor concentration for all sludges and for all detention times. Sludge filtrate concentrations ranged from a low of about 0.2 mg/l to a high of about 4.2 mg/l as presented in Figure 56. The highest value found here is less than 10 percent of the maximum value allowable in the Public Health Service Drinking Water Standards of 1962. The biological activity apparently varied significantly in the reactors giving unusual variations of concentration levels.

The mixed liquor sludge-sum of ammonia and nitrate nitrogen plotted in Figure 57 shows that the feed to the primary aerobic reactor has a high value of about 680 mg/l and that this decreases in a two day detention reactor to about 200 mg/l and remains nearly constant at 200 mg/l in 4, 8, and 12 day reactors. For the mixed primary and secondary sludge-sum of ammonia and nitrate nitrogen the plotted values from feed to 12 day detention reactor range from 80 to 90 mg/l, then the nitrogen value rises to 140 mg/l for the 24 day reactor. For the secondary sludge the feed had a content of about 60 mg/l, the four day detention reactor had about 26 mg/l and the eight day detention reactor had about 75 mg/l of ammonia and nitrate nitrogen.

The filtrate-sum of ammonia and nitrate nitrogen are shown on Figure 58 for primary filtrate, mixed primary and secondary filtrate, the secondary filtrate, all through paper, and secondary sand bed filtrate. The primary filtrate feed had a value of 90 mg/l of nitrogen, the two day detention time had a value of 158 mg/l, the four day detention had a value of 145 mg/l, the eight day detention had a value of 216 mg/l and the 12 day detention had a value of 142 mg/l. The mixed primary and secondary filtrate had a feed concentration of 22 mg/l, the four day detention had a nitrogen concentration of 57 mg/l, the 12 day detention had a nitrogen concentration of 75 mg/l and the 24 day detention had a nitrogen concentration of 56 mg/l. The secondary sludge filtrate through paper had a feed nitrogen concentration of about 21 mg/l, and a four day nitrogen concentration of 14 mg/l. The secondary filtrate through a sand bed had a feed nitrogen concentration of 30 mg/l, the four day detention had a concentration of 13 mg/l, the eight day detention had a concentration of 30 mg/l and the 12 day detention had a concentration of 23 mg/l. In all cases the filtration of a sludge through paper or sand shows that only a portion of the nitrogen is contained in the filtrate indicating that the sludge remaining has a substantial amount of nitrogen.

The phosphates in the mixed liquor show some irregularities in the concentrations present for the different detention times. As shown in Figure 59 the primary sludge and the mixed primary and secondary sludge show moderate variation for the different detention times, however, the secondary sludge had an extreme variation in the concentrations of phosphates for the feed (time zero) the concentration of phosphates was 293 mg/l, then for a four day detention time the concentration was 170 mg/l, for the eight day detention time the concentration was 403 mg/l, and for the 12 day detention time the concentration was 390. The primary sludge and the mixed primary and secondary concentrations stay within the limits of 256 to 316 mg/l for all of the detention times. The phosphates in the filtrate show greater consistency than the phosphates in the mixed liquor. The primary filtrate values were in the range of 60 mg/l to 94 mg/l. The mixed primary and secondary filtrate shows a range from 32 mg/l to about 50 mg/l. The secondary filtrate shows a range of 19 mg/l to 39 mg/l and with some irregularity. The primary on sand beds shows a steep climb from the feed filtrate with a concentration of 23 mg/l to a peak of about 72 mg/l at four days detention. In all cases the filtrates are less concentrated than the mixed liquors. The anaerobic sludge was 494 mg/l compared to maximum of 403 for the mixed liquor and a maximum of 94 for the filtrates. The concentrations of phosphates in the filtrate are plotted in Figure 60.

Figure 61 presents the chemical oxygen demand values for the mixed liquor. The chemical oxygen demand, or COD, is, in general, used as a measure of the strength of a waste. For the mixed liquor the COD of primary sludge, mixed primary and secondary sludge, and secondary sludge was measured. The COD for the feed sludge of the mixed liquor varied from about 32,000 to 46,500 mg/l. For detention times from two

days to 30 days the COD varied from 10,000 to 45,000 mg/l. The primary sludge showed considerable irregularity with a low COD of 10,000 to a high of 42,300 mg/l. The mixed primary and secondary sludge had a high of 46,500 and a low of 33,000 mg/l. The secondary sludge had a high of 34,000 and a low of 10,000 mg/l. The high COD for the secondary was greater than the feed COD. The anaerobic sludge had an average COD concentration of 67,275 mg/l. The COD of the filtrate (paper) shows that the primary sludge filtrate varied from a low of 2,090 to a high of 5,190 mg/l, the mixed primary, and secondary had a low of 3,820 and a high of 4,230 mg/l, and the secondary had a low of 830 and a high of 1,600 mg/l. The filtered (paper) anaerobic sludge had a COD concentration of 1,800 mg/l. Figure 62 presents the chemical oxygen demand values for the filtrate (paper). The primary sludge would normally have a higher chemical oxygen demand than either the mixed primary and secondary sludge or the secondary sludge alone. Since the different sludges had to be placed in the reactors at different times the chemical oxygen demands of the feed materials vary with the wastes entering the plant.

The sand bed filtrate in Figure 63 shows the complete range of detention times and corresponding COD values for primary sludge. For the feed sludge the COD was 3,440 mg/l. The COD then increased to 5,690 mg/l at a detention time of 18 days, then it dropped to 4,100 mg/l at a detention time of 30 days. These appear to be very radical changes.

The biochemical oxygen demands (BOD) for the mixed liquor are shown in Figure 64. The BOD tests were determined only on the primary sludge mixed liquor. For the feed or zero day the BOD was 1,287 mg/l and for the two day detention time the BOD was 1,310 mg/l. For the four day detention time the BOD was only 738 mg/l. From this low point the BOD rose by three steps to a peak of 1,750 mg/l for the 18 day detention time. Following this the BOD in two steps dropped to a low of 605 mg/l for a detention time of 30 days.

The COD does not have a constant ratio to the BOD, however, the ratios on highs, lows, and means compared separately are in the same general order of magnitude. For the feed samples the ratio of COD to BOD averages was about 33 to one and for the four day detention reactor the ratio was about 47 to one. For the low values the ratio on the feed samples was 106 to one, and for the four day detention reactor the ratio was about 191 to one. For the high values of the feed samples the ratio was about 23 to one and the four day detention reactor was about 26 to one.

SECTION IX

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The friendly cooperation of the city of Stillwater, Oklahoma, in providing space and facilities is gratefully appreciated. Mr. Fred C. Lewis, Plant Superintendent, was very helpful in providing space for the project. Mr. Gordon Hays, Assistant Superintendent, aided in checking on the pilot plant in sampling and helped in running tests.

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The efforts made by those engaged with the conduct of this project were essential for its successful completion. They include: Carl. L. Goldstein, David Scott, Y. A. Badra, D. F. Kincannon, Echol E. Cook, and Quintin B. Graves.

Without the efficient and patient typing of this report by Mrs. Mary Morrison, the project would not have been completed.

SECTION X

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While direct reference has not been made to the references listed below, they have had a very direct influence upon the conduct of this research.

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SECTION XI

PUBLICATIONS AND PATENTS

No patents have been requested and it is most probable that none will be requested.

Dr. E. E. Cook presented a talk, which he had written, to the 22nd Oklahoma Industrial Waste, and Water Pollution Control, and Advanced Water Conference. The authors listed were Cook, E. E., Graves, Q. B., Badra, Y.A., and Scott, D., "Effects of Detention Time on Aerobic Sludge Digestion on Primary Sludge." The role of the Water Quality Office of the Environmental Protection Agency in Supporting this project was acknowledged in the paper.

Y. A. Badra wrote his Master of Science thesis on the topic "Drainage Characteristics of Aerobically Digested Primary Sludge on Sand Beds" utilizing data obtained from this project. He acknowledged in his thesis the assistance of the Water Quality Office of the Environmental Protection Agency in the project.

D. Scott, Jr., wrote his Master of Science thesis on the topic "Chemical Characteristics of Aerobically Digested Organic Sludge" utilizing data obtained from this project. He acknowledged, in his thesis, the fine assistance of the Water Quality Office of the Environmental Protection Agency in the project.

Each of the above had a very limited distribution.

SECTION XII

GLOSSARY

Aeration - The bringing about of intimate contact between air and liquid containing solids by bubbling air through the mixture to promote biodegradition of the solids.

Acclimation - Period during which the microorganisms become accustomed to their new environment and substrate.

Aerobic Treatment - A biological treatment process in which bacteria stabilize organic in the presence of dissolved oxygen.

Anaerobic Treatment - A biological treatment process in which bacteria stabilize organic matter in the absence of dissolved oxygen.

Biochemical Oxygen Demand (BOD) - Utilization of organic materials by microorganisms expressed in terms of the oxygen used.

Chemical Oxygen Demand (COD) - A measure of the oxidation of organics using potassium dicromate as the oxidant.

Detention Time - The theoretical period of time required for a liquid to flow through a tank or unit.

Liquor - Water, sewage, and industrial wastes, or any combination of the three.

Liquor, Mixed - A mixture of sludge in the aeration tank or reactor undergoing aerobic digestion.

Mixed Liquor - The sludge in the aeration tank which is homogenous due to mixing with compressed air.

Oxygen, Dissolved (D.O.) - The oxygen dissolved in sewage sludge.

Reactor - A tank or vessel in which biological and/or chemical reactions or changes take place.

Settleable Solids - Suspended solids which will settle in sedimentation basins (clarifiers) in normal detention times.

Sludge - The accumulated settled solids separated from wastewater in clarifiers, and containing more or less water to form a semi-liquid mass.

Sludge, Primary - Sludge obtained from a primary settling tank.

Sludge, Secondary - Sludge that has had aerobic treatment followed by settling in a second tank.

Sludge, Mixed Primary and Secondary - A mixture of primary and secondary sludge.

Solids, Total - Obtained by evaporation and drying at a temperature of 103-105°C for one hour.

Solids, Volatile - The loss in total solids when ignited at 550°C in a muffle furnace.

Supernatant Liquor - The liquid overlying settled solids.

Total Solids - The solids in the wastewater, both suspended and dissolved.

Volatile Suspended Solids - The quantity of suspended solids in wastewater that are lost on ignition of the total suspended solids.

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16. Abstract

Pilot plant aerobic sludge digesters were used for aerobic treatment of sludges at the Stillwater Sewage Treatment Plant. They have a two stage trickling filter plant. Three different sludges were used in the aerobic reactors: 1. primary sludge alone, 2. Mixed primary and secondary sludge, and 3. secondary sludge alone. Various detention periods from two days to 36 days were used. The air was applied through air diffusers near the bottom of the aeration tanks. Physical and chemical analyses were made on the feed, mixed liquor, four hour settled sludge, and filtered (paper and sand bed) sludge. Most of this work on aerobic sludge digestion was performed with feeding the reactors once or twice daily, although the first runs were fed with measuring pumps activated by a time clock. One run was made on a batch basis. The measuring pumps clogged so frequently that the actual loading of the aeration tanks were not accurate enough to obtain meaningful data. The data obtained indicated considerable variation in the concentration of the various parameters with time of aeration and with source of the sludge. General trends indicate that the active organisms are in a state of flux. The pilot plant results indicate as shown by some full scale operating plants that good conditioning of the sludge by aerobic digestion is economical, while in other cases the results leave much to be desired.

17a. Descriptors

*Sludge digestion, *Sewage sludge, *Aerobic treatment, Sludge treatment, Sewage treatment, Domestic wastes, Waste disposal, Anaerobic digestion

17b. Identifiers

*Aerobic sludge digestion, digestion of primary sludge, digestion of mixed primary and secondary sludge, digestion of secondary sludge.

17c. COWRR Field & Group 05D

18. Availability

19. Security Class. (Report)

20. Security Class. (Page)

21. No. of Pages

22. Price

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