EPA 904/9/75/002

TECHNICAL ASSISTANCE PROJECT
AT THE
CALHOUN, GEORGIA
WASTEWATER TREATMENT PLANT

JULY - AUGUST 1975

Environmental Protection Agency
Region IV
Surveillance and Analysis Division
Athens, Georgia

TABLE OF CONTENTS

INTRODUCTION

A technical assistance study of operation and maintenance problems at the wastewater treatment plant serving Calhoun, Georgia was conducted during July 28 - August 3, 1975. This was the first in a series of studies to be conducted by the U.S. Environmental Protection Agency, Region IV, Technical Assistance Team. The purposes of the study are to assist local wastewater treatment plant operators in maximizing treatment efficiencies and in solving special operational problems.

The activated sludge plant, serving approximately 4,700 residents of the City of Calhoun and several tufted carpet mills, has been in operation for about three years. Industrial wastes constitute approximately 80 to 90 percent of the total plant flow. During September 1974, an efficiency study showed the plant to be in a poor state of repair with removal efficiencies similar to those of a primary plant. Under new plant supervision and a city ordinance requiring pretreatment, operation and maintenance has greatly improved; however, treatment efficiencies can be further improved by the elimination of some existing operational problems which this study addresses.

The cooperation and active participation of the Georgia Environmental Protection Division in planning and conducting the study is gratefully acknowledged. The team is especially appreciative of the cooperation and assistance received from Calhoun City officials and plant personnel.

SUMMARY OF STUDY FINDINGS

The 7.0 mgd activated sludge plant serving the city of Calhoun was operating at the hydraulic design capacity during weekdays, however, organic loadings and weekend hydraulic loadings were well below design capacities. A major problem since start-up of the facility has been an abundance of lint from the carpet industries served by the system. Although there are still significant amounts of lint throughout the system, the problem is improving because of a city ordinance now in effect which requires fine screening of wastewaters by the industries prior to discharge into the municipal sewerage system. Maintenance problems noted during a September 1974, efficiency study of plant operation have been corrected.

Another major problem at the start-up of the facility was the inability to produce a healthy activated sludge. In an effort to increase the mixed liquor suspended solids, a minimum amount of sludge has been wasted resulting in an old, overoxidized sludge. Increased wasting of sludge has been initiated in an effort to produce a healthier, younger sludge.

Screens on pumps located in the chlorine contact chamber, used to recirculate water for foam control in the aeration basins, must be cleaned periodically. Cleaning requires the chlorine contact chamber to be by-passed and drained, a process which should be performed on the weekend during low flow.

Dissolved oxygen profiles throughout the aeration basins were determined under each major flow condition and aerator usage configuration. These data indicated the need to use all aerators during normal weekday flows. Half of the aerators can be shut off during nightly and weekend low flow periods without causing serious dissolved oxygen deficiencies. When only half of the aerators are working, good mixing is not presently attained due to the high settling velocity of the mixed liquor solids. However, the mixed liquor solids should become less dense with the increased wasting program.

A portion of the chlorinated effluent is pumped back and sprayed onto the aeration basins for foam control. An oxygen uptake study indicated that the recirculated effluent should be limited to less than 20 percent of the plant flow to prevent reductions in treatment efficiencies.

Observations of laboratory procedures indicated some necessary modifications in the BOD_5 and COD analyses. Past laboratory data indicated significant fluctuations of BOD_5 values on the influent. This occasionally caused oxygen depletions in the BOD_5 test outside the 40-70% range recommended by the procedure. Recommendations were made related to standardization of laboratory procedures.

RECOMMENDATIONS

Based on observations and data collected during the study, it is recommended that the following measures be taken to improve treatment efficiencies and plant operation:

1. An increased volume of solids should be wasted daily from the system. Settling characteristics and volatile solids concentration of the mixed liquor should be closely monitored. Mixed liquor volatile suspended solids in the 2,200 to 2,500 mg/l range are suggested under present loading conditions.

2. All aerators should be operated during periods when influent flow exceeds 5 mgd. During low flow periods, at night and on weekends, half the aerators may be shutdown to conserve energy.

3. All aerators should not be shutoff simultaneously for servicing, unless it presents a safety hazard. At least two aerators should be operated in each basin at all times.

4. A fire hose may be used in breaking up the floating fiber and sludge mat in the return sludge pits before pumping to the digester.

5. The sand drying bed surface should be worked before pumping sludge.

6. The chlorine contact chamber recirculating pump screens should be cleaned during the weekend at low flow periods.

7. Recirculated chlorinated effluent for foam control should be limited to less than 20 percent of the plant flow.

8. Maintenance schedules and activities should be posted for the employees information and/or instructions.

The following laboratory procedures should be initiated to improve the quality of data from the BOD and COD analysis:

1. The sodium thiosulfate should be standardized against primary standard potassium biniodate at a minimum of twice weekly.

2. Blanks of the formula C dilution water should be run daily.

3. At least two dilutions of influent BOD_5 samples should be made in order to consistently obtain oxygen depletion within the 40 to 70 percent range recommended by the procedure.

4. Ferrous ammonium sulfate titrant used in the COD test should be standardized daily against primary standard potassium dichromate.

STUDY OBJECTIVES AND METHODS

Municipal wastewater treatment plants are selected for possible technical assistance studies after consultation with state pollution control authorities. Visits are made to each prospective plant prior to the study to determine if assistance is desired and if the study efforts will result in improved operational efficiencies.

At the Calhoun, Georgia Wastewater Treatment Plant, two specific questions by plant personnel were addressed. The first was to determine if the use of relatively large amounts of chlorinated effluent (1 mgd) for foam control in the aeration basins had a detrimental effect on microbial activity. This was accomplished by observing oxygen uptake rates using varying amounts of chlorinated effluent and mixed liquor. The other question was to determine if the 500 foot discharge line provided adequate contact time for chlorine disinfection when by-passing the contact chamber. This procedure is occasionally necessary when cleaning the two recirculating pump screens mounted on the bottom of the chlorine contact chamber. This situation was assessed by by-passing the chamber and making coliform MPN determinations. Dye was used to determine retention time in the by-pass line.

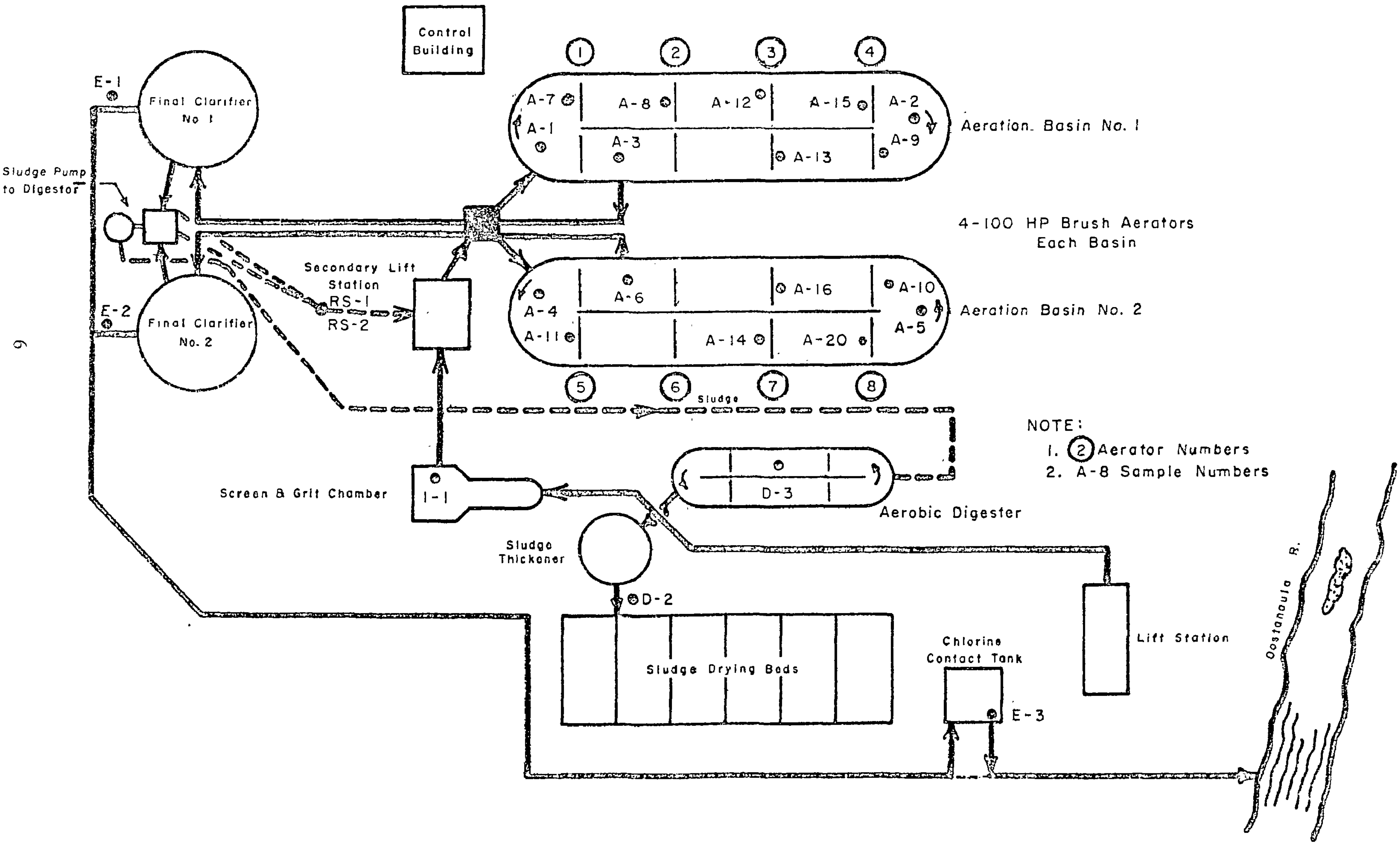
Influent and effluent sample stations, I-1 and E-3 respectively, (Figure 1) were sampled for five 24-hour periods with ISCO model 1392-X automatic samplers. The samplers were set to pump aliquots of sample at hourly intervals into individual glass bottles packed in ice. Individual aliquots were composited proportional to flows at the end of each 24-hour sampling period. The samples were used to characterize the influent and to determine overall plant efficiency. An additional ISCO model 1392-X automatic sampler was installed at station I-1 and the individual hourly samples were analyzed for pH and conductivity.

Daily dissolved oxygen profiles were obtained throughout the two aeration basins employing a YSI model 51A dissolved oxygen meter. Profile locations were selected in order to represent expected low DO areas. These areas varied depending on the number of aerators operating.

Sludge activity was determined by the oxygen uptake procedure presented in Appendix D. The rate of oxygen uptake for fed and unfed sludge was determined and a load factor was calculated. The load factor is a ratio which is a function of microorganism acclimation and the biodegradability of the waste.

A series of standard operational control tests were run twice daily; once in the morning and once in the afternoon for five days. The control tests consisted of:

FIGURE I
CALHOUN SEWAGE TREATMENT PLANT
CALHOUN, GA.



- Settleability of the mixed liquor suspended solids as determined by the 60 minute settlometer test;

- percent solids by centrifuge on the mixed liquor and return sludge;

- complete solids analysis on mixed liquor, digester and return sludge;

- depth of clarifier sludge blanket in final clarifiers, and

- turbidity of the effluent from both final clarifiers.

Physical observations of individual unit processes and flow meter readings were recorded during each test sampling period.

A follow-up assessment of plant operations and maintenance will be made at a later date. This will be accomplished by utilizing control data generated by plant personnel and, if necessary, subsequent visits to the facility will be made. The follow-up assessment will determine if recommendations were successful in improving plant operations and if further assistance is required.

TREATMENT FACILITIES

The wastewater treatment plant is an activated sludge facility with a hydraulic design capacity of 7.0 mgd. Construction of the $2,600,000 facility was started in 1969 and completed in the fall of 1972.

Unit processes include bar screens, an aerated grit chamber, aeration basins, final clarifiers, aerobic digester, chlorine contact tank, gravity sludge thickener, and sludge drying beds (Figure 1).

Wastewaters flow to the plant by gravity along two major interceptor lines. One is located along the Oostanaula River on the north side of the city and the other along Oothcaloga Creek on the south. The raw waste flows into a deep wetwell in the primary lift station where it is lifted by three spiralift pumps to ground level.

Wastewater flows into the treatment plant through two parallel mechanically cleaned bar screens and Parshall flumes, and an aerated grit chamber. From this point, the waste is again lifted by spiralift pumps to the aeration basins.

Wastewater then flows through a splitter flume into two parallel aeration basins. Air is supplied by four 100 hp electric motor driven brush aerators. After a 10 to 30 hour retention time, depending on plant inflow and recirculated sludge rate, mixed liquor flows from the bottom of each basin through separate pipes to two clarifiers. Each pipe is equipped with a Venturi meter for flow measurement and a hydraulically operated (water pressure) butterfly valve which controls the water level in each aeration basin. Regulation of each valve is controlled by a water level sensor in each basin.

Waste from the aeration basins flows to the two center feed, circular clarifiers for final settling. Overflow from the clarifiers flows into a discharge sewer where chlorine gas is applied for disinfection. The treated wastewater then flows through a baffled rectangular chlorine contact chamber with subsequent discharge into the Oostanaula River. Return activated sludge flows via gravity from the clarifiers to the raw waste secondary lift station. Waste sludge is pumped from the sludge pit at the clarifiers to the aerobic digester.

The digester is a rectangular basin with rounded ends similar in geometry and operation to the aeration basins. Sludge is circulated and aerated with two brush aerators turning in opposite directions on each side of the basin, forcing a counterclockwise circulation pattern. As sludge is pumped into the digester, overflow from the digester flows into a gravity thickener. Sludge can be recycled from the thickener to the digester when discharge to the drying beds is not required.

Digested sludge is pumped from the thickener to one of twelve uncovered sand drying beds. The beds are filled from a single stand pipe located in one corner of each bed.

Design criteria for the wastewater treatment plant are enumerated in Appendix A.

DISCUSSION OF OPERATION AND MAINTENANCE PROBLEMS

Effective start-up of the plant has been extremely slow due to numerous problems. One of the major problems has been excessive lint entering the plant from the area carpet mills. This resulted in plugging of all moving parts and unmanageable floating masses of fiber and sludge. Fins were broken off the brush aerators by accumulated lint resulting in greatly reduced efficiency. Butterfly valves on each of the aeration basin discharge and return sludge lines presented continual problems. Motors and brush aerator bearings were inoperative due to lint accumulation, fluctuating water levels in the aeration basin and inadequate servicing. The following is an excerpt from the Organic Characterization Study, Coosa River Basin - Northwest Georgia, September 30-October 3, 1974, prepared by the U.S. Environmental Protection Agency, Surveillance and Analysis Division, Athens, Georgia, and describes operations as they existed:

> Removal efficiencies are:
>
> - o Five-day Biochemical Oxygen Demand (BOD_5) - 38 percent
> - o Total Suspended Solids (TSS) - 20 percent
> - o Chemical Oxygen Demand (COD) - 13 percent
>
> Another evidence of ineffective treatment is the low level of sludge produced.
>
> Operation and maintenance is almost nonexistent. The operation of the plant and upkeep of existing equipment have been victims of neglect. Only two of 16 aerators were working at most; and on one day, none were operating. Several fins had been broken off the aerators. The overall appearance of the plant was poor. Lint was piled up at the side of the aeration basin and the grass needed cutting.

In the past year, city officials have made a determined effort to repair equipment and get the plant into satisfactory operation. This effort has shown significant results. In the recent study period (July 28 - August 3, 1975), removal efficiencies were:

- o BOD_5 - 91 percent
- o TSS - 77 percent
- o COD - 72 percent

Steps taken by city officials have included:

- Hiring a new engineer who has devoted essentially all of his time to maintenance and operational problems at the wastewater treatment plant. Activated sludge was hauled from the wastewater treatment plant at Dalton, Georgia, for seed and all aerators were repaired and placed in operation.

- The passing and enforcement of a new city ordinance requiring industries to fine screen wastes before discharge into the city sewerage system.

STUDY RESULTS AND OBSERVATIONS

FLOW

Raw wastewater flow into the plant is determined by a two-foot Parshall flume, totalizer and recorder. The flume was checked for proper calibration and was found to be accurate.

The raw waste flow during the study period is presented in Figure 2. Weekday influent flow averaged 6.2 mgd and varied from approximately 9 mgd during the day to about 4 mgd at night. The average weekend flow, determined during a 24 hour period beginning 9:00 AM Saturday and ending 8:00 AM Sunday, was 2.1 mgd. The minimum weekend flow was approximately 1.2 mgd.

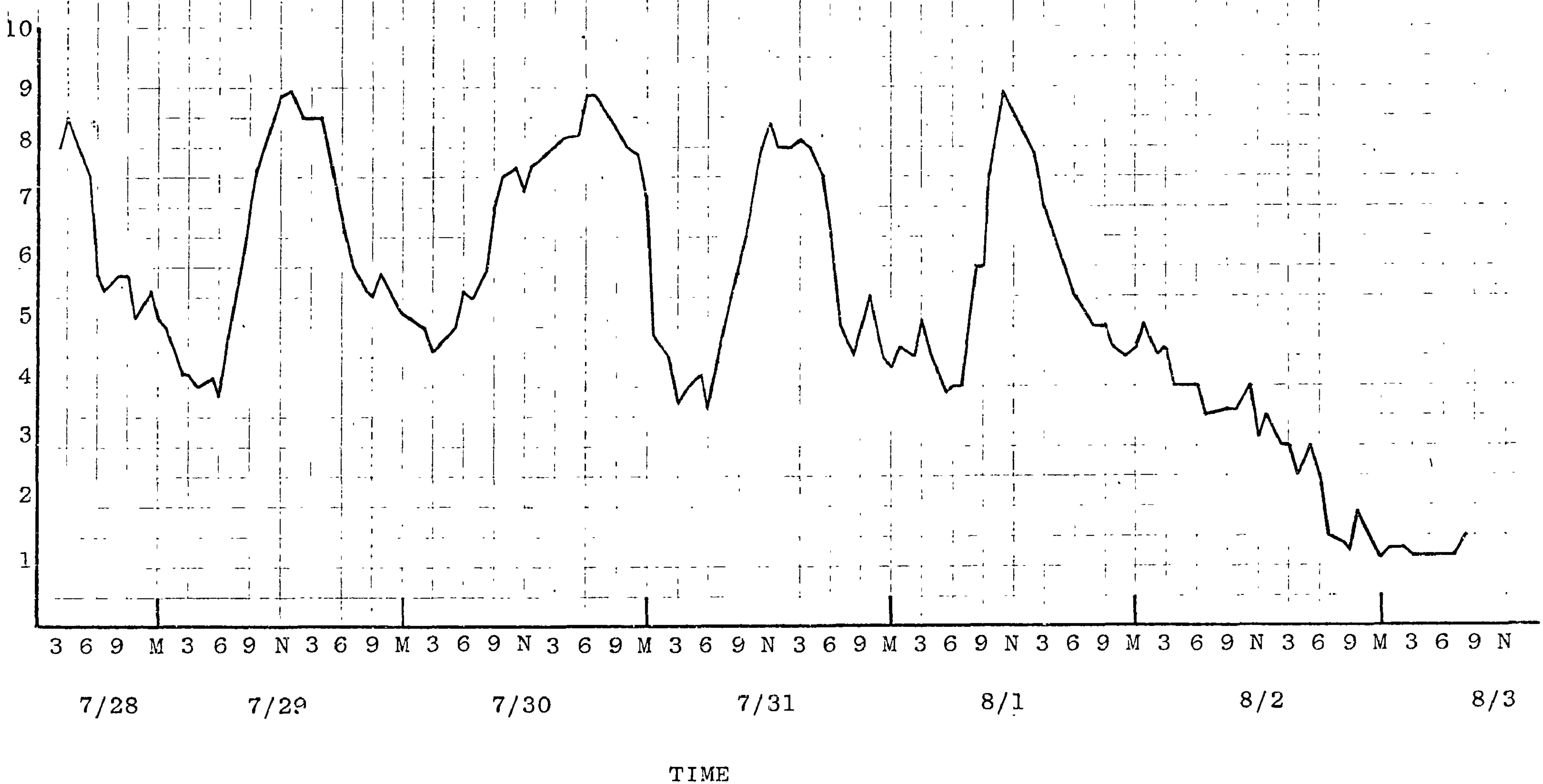
Return sludge flow (RSF) from the final clarifiers back to the aeration basins varied from zero to about 4 mgd during the study period. During the weekend, the RSF was greater than the raw waste flow entering the plant.

WASTE CHARACTERISTICS AND REMOVAL EFFICIENCIES

A chemical description of the influent, effluent and percent reduction through the plant is listed below.

PARAMETER	INFLUENT	EFFLUENT	% REDUCTION
BOD_5 (Avg. of 3 Days)	142 mg/l	13 mg/l	91
COD (Avg. of 5 Days)	496 mg/l	140 mg/l	72
Total Suspended Solids (Avg. of 5 Days)	70 mg/l	16 mg/l	77
TKN (Avg. of 5 Days)	8.38 mg/l	2.80 mg/l	67
NH_3 (Avg. of 5 Days)	1.92 mg/l	0.19 mg/l	91
NO_3 - NO_2 (Avg. of 5 Days)	0.20 mg/l	1.75 mg/l	-
Total Nitrogen (Avg. of 5 Days)	8.58 mg/l	4.55 mg/l	47
Total-P (Avg. of 5 Days)	10.2 mg/l	8.7 mg/l	15
Pb (Avg. of 3 Days)	<80 µg/l	<80 µg/l	-
Cd (Avg. of 3 days)	<80 µg/l	<80 µg/l	-

FIGURE 2
RAW WASTE FLOW
CALHOUN WASTEWATER TREATMENT PLANT
CALHOUN, GA



PARAMETER	INFLUENT	EFFLUENT	% REDUCTION
Cr (Avg. of 3 Days)	<80 μg/l	<80 μg/l	-
Cu (Avg. of 3 Days)	36 μg/l	18.6 μg/l	48
Zn (Avg. of 3 Days)	1368 μg/l	856 μg/l	37
Temp. range (^{o}C)	34-42	29-32	-
pH range	6.0-7.5	6.4-6.8	-
Conductivity range (μmhos cm^{2})	573-2290	-	-

A complete listing of all laboratory data is presented in Appendix B.

DISSOLVED OXYGEN PROFILES

A profile of dissolved oxygen concentrations at various locations within the aeration basins was determined under each major flow condition and aerator usage configuration (Appendix C and Figures 3 and 4).

During normal weekday flows, a minimum DO concentration of 3 mg/l was maintained in both basins with all aerators in use; however, when operating only half the aerators under these flow conditions extremely low DO concentrations occurred. Dissolved oxygen, during low flow periods, remained at a satisfactory level with only half the aerators in use.

These data indicate the need to use all aerators during weekday normal flow. Half of the aerators can be shut off during nightly and weekend low flow periods without encountering low dissolved oxygen levels. However, with only half of the aerators operating, solids deposition may be expected, as evidenced from the settlometer test data and samples collected from the basin bottom. These solids are resuspended when all aerators are turned back on.

OXYGEN UPTAKE

General sludge activity can be measured by determining the difference in oxygen uptake rates of the sludge before and after introduction of the raw waste. The ratio of these two variables or "load ratio" is calculated as follows:

FIGURE 3
DISSOLVED OXYGEN PROFILES
AERATION BASIN I

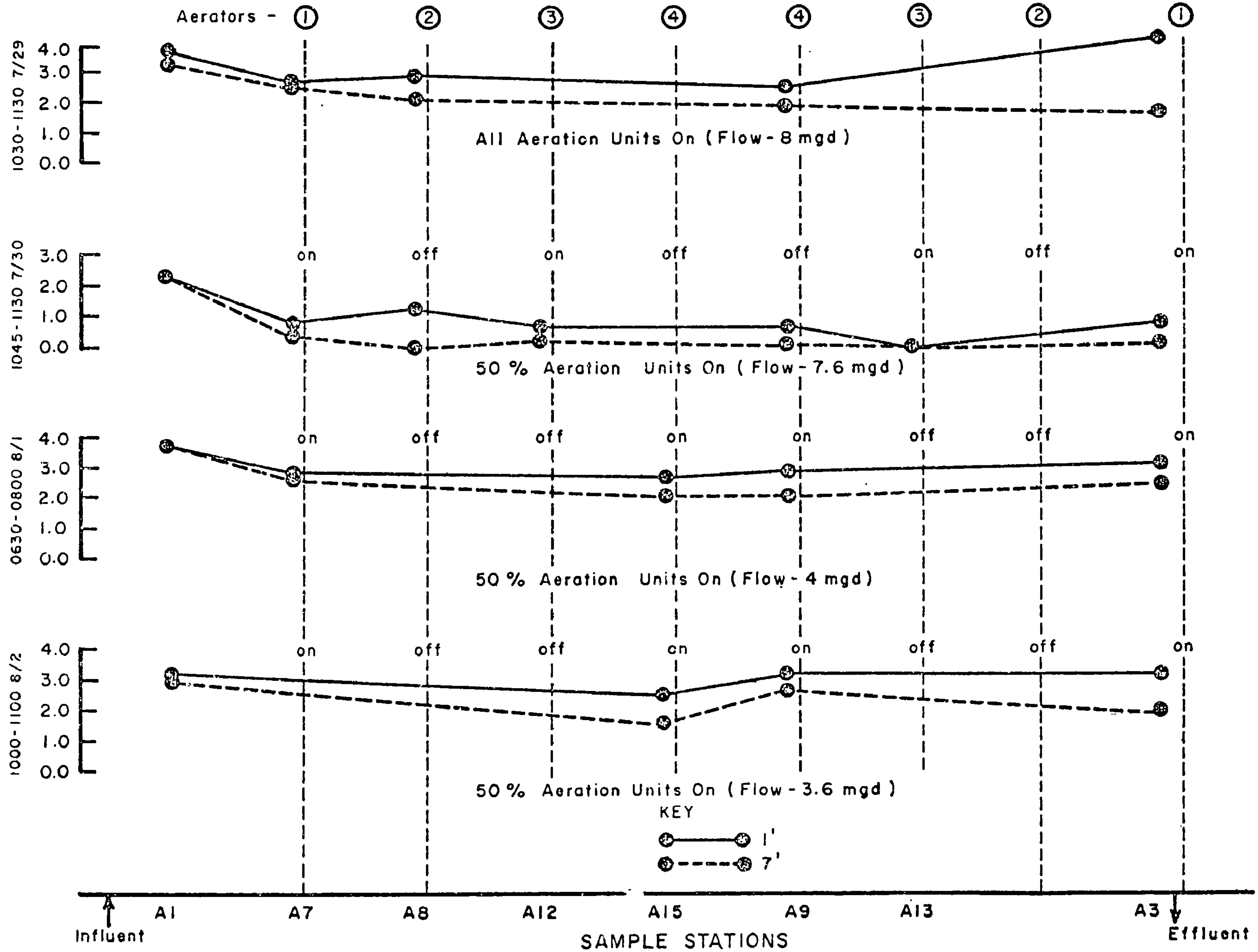
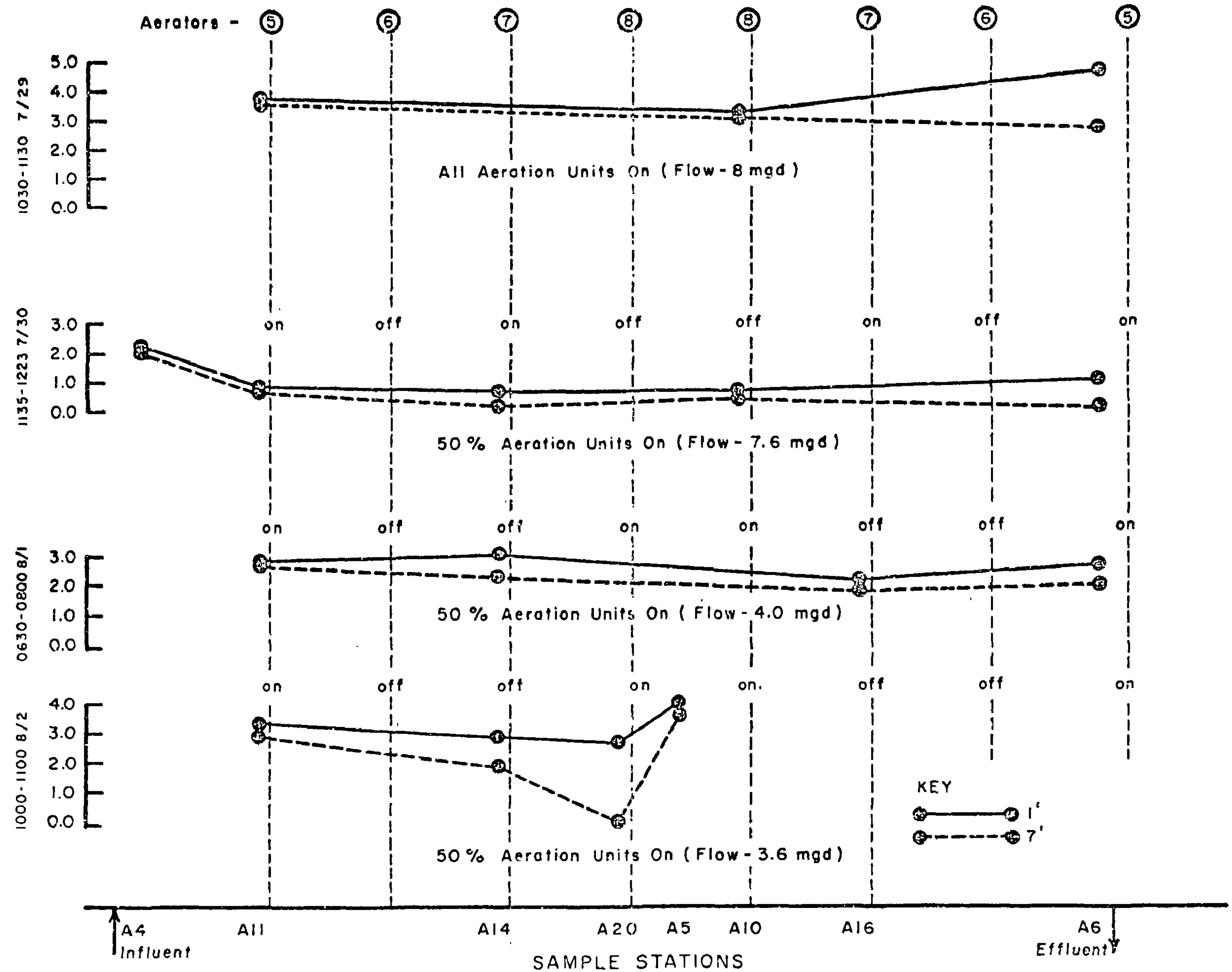


FIGURE 4
DISSOLVED OXYGEN PROFILES
AERATION BASIN 2



$$\text{Load ratio} = \frac{\Delta\ \text{DO/min of fed sludge}}{\Delta\ \text{DO/min of unfed sludge}}$$

OXYGEN UPTAKE RATES

DATE	TIME	% RS	Avg. O_2 Uptake (ppm/min) URS 1/	Avg. O_2 Uptake (ppm/min) FRS 2/	LOAD RATIO FRS/URS
7/29	-	38.5	0.45	1.6	3.55
7/30	-	40.0	0.60	1.4	2.33
7/31	1100	37.5	0.70	1.8	2.57
7/31	1430	7.0	0.25	0.5	2.0
8/1	-	27.8	0.70	2.35	3.4
8/1	1530	77.6	0.90	2.10	2.3

1/ - URS - Unfed Return Sludge

2/ - FRS - Fed Return Sludge

The step by step procedures and significance of the test are presented in Appendix D.

Calculated load factors indicate a well acclimated sludge with a good supply of acceptable food under favorable conditions. It has been stated by Ludzack, et al that extended aeration plants normally perform best at a load ratio of less than two; however, each plant will have its own optimum operation range. The load ratios in the table reflect conditions typical of conventional activated sludge plants.

MIXED LIQUOR IN AERATION BASIN

Samples were taken from each basin at the point of discharge to the clarifiers (sample stations A-3, A-6 Figure 1). Settleability was determined using the 60 min. settleometer test with both basins exhibiting similar settling characteristics. Near maximum compaction was attained in about two minutes. The average five minute reading was 12 percent with an average final reading of eight percent by volume. A slow settling straggler pen floc was left in the supernatant. The samples were allowed to sit undisturbed to see if the sludge would swell (denitrification) and float to the surface as would be expected; however, no change was observed after 24 hours. Suspended solids, volatile suspended solids and percent solids by the centrifuge test were run on these samples to further determine the amount and condition of the solids in the aeration basin.

The centrifuge values for percent solids ranged from 1.0% to 3.0% in Basin #1 (Station A-3) and from 0.8 to 3.9% in Basin #2 (Station A-6). The suspended solids concentrations ranged from about 1100 mg/l up to 3500 mg/l. The fast settling characteristics of the solids led to difficulty in obtaining a representative sample. The amount of solids in suspension at the five foot depth, where the samples were taken, was dependent upon the amount of mixing in each aeration basin. During periods when half of the aerators were off, some of the mixed liquor solids settled to the bottom producing much lower TSS concentrations than when all aerators were running. (Based on past plant data and data collected during periods of good mixing, the actual TSS values were 3500 mg/l or greater).

Calculated sludge volume index (SVI) values ranged from 17 to 83. The median value was 36 reflecting the very dense compact nature of the settled sludge.

Sludge age calculations using a MLSS concentration of 3500 mg/l, an influent TSS of 70 mg/l and an average flow rate of 5.0 mgd indicated a value of 51 days. This value appears to be much too high and indicates the need to remove solids from the system.

Current BOD_5 and COD loading parameters were calculated by using a MLTSS value of 3500 mg/l with 66 percent volatile. The BOD_5 loading was .06 lbs BOD_5 per day/lb of MLVSS with the recommended range falling between .05 to 0.10. COD loadings averaged .21 lbs COD per day/lb of MLVSS. The recommended range for COD is less than 0.2. These loading factors appear to be at or near the recommended loadings for the extended aeration process; however, the sludge is very old and over oxidized.

SLUDGE BLANKET IN CLARIFIERS

The sludge blanket depth in each clarifier was measured on several occasions during the study by using an optical viewer constructed from aluminum pipe and equipped with a lense and light on the bottom. This procedure enables the operator to observe clarifier operating conditions below the surface and to obtain advance warning when operational problems such as bulking, etc. may be imminent.

Because of the high rate of sludge return and the dense nature of the sludge at the Calhoun plant, the sludge blanket was less than 2 feet thick on all occasions. On several occasions, there was essentially no blanket.

RETURN SLUDGE

Return sludge from each clarifier flows through telescoping valves into separate sludge pits and thence into a common manhole where it flows by gravity into the secondary raw waste lift station. Each return line was constructed with a Venturi meter and butterfly valve. Excessive clogging of one of the valves with lint caused plant personnel to remove the valve. Lint also caused continual problems in the sludge sumps by plugging the telescoping valves and also by forming thick mats on the sludge surface. Plant personnel are currently removing lint from the sumps by hand which is a difficult and time-consuming task.

As a result of valve clogging problems and in an effort to prevent clogging by increasing flow rate, the rate of return sludge is highly variable. As shown in Appendix B, TSS concentrations vary from 6,000 to 42,000 mg/l with a corresponding variable flow rate of from near zero to 4 mgd. An increased hydraulic loading is placed on the aeration basins by returning excessive water with the sludge.

DIGESTER, THICKENER AND DRYING BEDS

During the initial years of plant operations, the sludge handling facilities were not used due to the lack of sludge production. After repairs were made and the plant reseeded, operators concentrated on retaining the maximum amount of solids in the system in order to build MLSS up to the 3000 to 3500 mg/l level. When the predetermined level of solids was reached, a gradual wasting program was started and the sludge handling system is now in full operation. At the conclusion of the study digested sludge had been pumped to two drying beds. One bed was pumped during the survey and the other bed was pumped about three weeks before. The first bed had cracked to a depth of two to three inches and appeared to be drying rather slowly; however, drying conditions had been poor. Considerable quantities of carpet fibers could be seen in the partially dried surface layer.

A sample was collected for solids determination as the sludge was pumped onto the second bed. The solids content was 8% by weight and 58% volatile.

Samples collected from the digester contained a volatile fraction of 62%. Although the volatile contents are somewhat higher than would normally be expected, the sludge appeared to be well stabilized and there were no offensive odors from either drying bed.

FECAL COLIFORM DENSITIES

Fecal coliform densities in the wastewater treatment plant effluent (Station E-3) were 50/100 ml (MPN) or less for all samples as shown below:

STATION	DATE	TIME	FC/100 ml	RESIDUAL CHLORINE mg/1
E-3	7/29	1015	20	1.20
		1330	20	0.27
	7/30	0825	20	1.40
		1215	50	1.38
	7/31	0845	50	0.35

BACTERIAL CHARACTERISTICS OF ACTIVATED SLUDGE

Microscopic slide examinations were made on both return sludge and mixed liquor samples. Return sludge slides showed a dark sediment with limited observable microbial activity. Protozoans were in mixed population, with ciliates being the predominant organisms. Mixed liquor from the aeration basins contained numerous fibers and chaining bacterial cells. In each examination stalked ciliates were observed, but in lesser numbers than free swimming rotifiers and nematodes. The majority of the bacteria cells were non-motile, with little flock formation, and few new cell formations on established flocs. Total bacteria analysis showed the following densities in the aeration basins:

STATION	DATE	TIME	TOTAL BACTERIA/100 ml
A-1	7/30	1545	23,000,000
A-2	7/30	1600	23,000,000
A-3	7/30	1552	33,000,000

CHLORINE CONTACT TANK BY-PASS

Samples were collected from the plant effluent while the chlorine contact chamber was by-passed. Dye was used to determine the retention time in the 500 foot outfall line. The dye was poured into the No. 2 clarifier discharge and reached the river in four minutes. Chlorine gas is injected into the outfall line a short distance downstream of the clarifiers. Grab samples were collected from the plant effluent and analyzed for fecal coliform concentrations with the following results:

TIME	FC/100 ml (MPN)	CONTACT TIME	PLANT FLOW	CHLORINE RESIDUAL (mg/1)
1600	192,000	4 min.	8 mgd	0.22
1605	17,200	4 min.	8 mgd	-
1610	22,100	4 min.	8 mgd	-

The study shows that during normal weekday flow conditions proper disinfection cannot be attained while by-passing the chlorine contact tank. It would be advisable, therefore, to by-pass the tank only on weekends when the flow rate is at a minimum. This would in effect give a longer contact time and should provide more efficient disinfection.

USE OF CHLORINATED EFFLUENT FOR FOAM CONTROL

Chlorinated effluent is sprayed on the aeration basins for foam control. The effect of this procedure on microbial activity was determined using the oxygen uptake procedure.

An experimental return sludge to raw waste ratio was determined using the following data:

Assume: One mgd chlorinated effluent for foam control
Six mgd raw waste influent to plant
Two mgd returned sludge to aerators.

Varying volumes of chlorinated effluent containing 1.4 mg/l residual chlorine were mixed with a constant volume of the experimental mixed liquor. The following data show the amount of chlorinated effluent (as percent of total volume) and the corresponding oxygen uptake rate.

% Chlorinated Effluent	Average O_2 Uptake Rate (mg/l/min)
0.5	1.05
1.0	0.92
10.0	1.00
20.0	0.88
60.0	0.36

These data indicate that effluent waters containing 1.4 mg/l residual chlorine can be used for foam control without inhibiting biological activity, as long as the amount used is limited to 20 percent of plant influent.

GENERAL OBSERVATIONS

The following are general observations related to the operation and maintenance of the plant:

- One problem with brush aerators is the water spray and wind drift which causes a very dangerous film of sludge to accumulate on walkways near the aerators. This problem exists at the Calhoun Wastewater Treatment Plant. However, plant personnel are in the process of installing a water system to permit periodic hose washdown of the aerators and digester. This action will greatly improve safety conditions and the general appearance of the basins.

o As plant influent flow rates build up during the day to the eight or nine mgd rate, fluffy 1/4 inch sludge particles can be observed rising to the surface near the clarifier walls and flowing over the weirs. On one occasion when flow to the clarifiers was in the 12 to 14 mgd range, the problem was particularly noticeable. This carry over is caused by scouring on the clarifier bottom at the walls as the flow direction turns upward.

o All aerators in each basin are normally shut off once per week for one hour periods for servicing aerator and motor bearing. This permits most of the mixed liquor solids to settle and oxygen levels to be depleted.

o A fire hose was used to break up the lint mat in the sludge sumps to permit pumping of the sump contents to the digester. A large portion of the lint goes through the sludge handling system and is pumped to the drying beds.

o Butterfly valves control the water level in each aeration basin. Proper operation of the valves is absolutely critical to plant operation. If the valves open too much, the clarifiers flood causing washout of solids with a resulting drop in water level in the aeration basins. A drop of a few inches results in loss of ability to aerate and mix the contents of the basin. Conversely, improper restriction in the valve results in a water level rise in the aeration basin, which overloads the aerators causing reduced oxygen transfer, poor mixing and possible mechanical failure.

o Laboratory facilities at the Calhoun Wastewater Treatment Plant were very well equipped and maintained. The equipment was neatly arranged and evidenced conscientious care. General lab techniques of the operators were good. Data generated by the operators were well organized for easy reference.

o For quality control purposes, total suspended solids samples from Basin No. 1 and No. 2 were split and analyzed by plant personnel and EPA. The results are as follows:

	EPA	PLANT
Basin No. 1	4,500	4,100
Basin No. 2	5,770	5,710

Duplication was obviously very good.

Other Parameters

Hourly variation of influent pH and conductivity is presented in Appendix E. The pH varied from 6.0 to 7.4 and the conductivity ranged from 573 to 2290 μmhos/cm^2.

Influent and effluent samples were analyzed for chlorides. Chloride concentrations varied from 220-292 mg/l in influent samples (I-1) and 215-270 mg/l in effluent samples (E-3).

Appendix A
Treatment Facilities
Calhoun S.T.P., Calhoun, GA

I. Plant Design Capacities

a. Design Flow - 7.0 mgd average daily
b. Population Equivalent (Solids) - 30,000
c. Population Equivalent (BOD) - 66,000

II. Treatment Units

a. Primary Lift Station

3 spiralift pumps with a rated capacity of 10 mgd each.
Lift - 29.5 ft.

b. Mechanically Cleaned Bar Screens

85° Industrial, 2 units, 20 mgd capacity each, 1" spacing.

c. Two parallel Parshall Flumes

Influent throat width 2 feet. Only one flume normally in use.

d. Grit Tank

1 unit, mechanically cleaned, aerated (diffused air)
surface loading at design flow 15,800 gpd/sf
detention period - 60 sec.
disposal of grit - burial

e. Secondary Lift Station

3 units, spiral pump, 15 mgd each, Lift - 12 ft.

f. Aeration Tanks

number - 2 units
type - rectangular with rounded ends
dimensions, rectangular area - 343' length
84' width
circular area - 43' radius
surface area - 34,620 sq. ft. each
volume - 340,000 cu. ft. each
detention time - 8.75 hours including 100% returned sludge
17.5 hours at no return sludge

g. Aeration Equipment

number aerators per basin (100 HP) - 4
lineal feet, aerators (brush area) - 296 feet per basin
type - constant speed surface-brush
theoretical capacity - 2960 lbs. oxygen/hour or
7 lbs O_2/lb. BOD/day
provision for foam control--spray (treated effluent)

h. Secondary Clarifiers

number - 2 (circular) center-fed
dimensions - 86 ft. diameter
8 feet depth (outside)
13.4" depth (center)
surface area - 5,809 sq. ft. each
design loading

	Flow MGD	Detention Period, hours	Surface Loading gpd/sf	Overflow Rate gpd/ft weir
Min.	3.5	6.0	300	6,500
Design	7.0	3.0	600	13,000
Peak	21.0	1.0	1,800	39,000

sludge removal - mechanical - gravity flow

i. Waste Sludge Pumps (to aerobic digester)

number - 2
capacity of each - 350 gpm

j. Return Sludge

gravity flow controlled by telescoping valves
sludge returned to secondary lift station, 14 MGD max. return rate

k. Aerobic Digester

number - 1
volume - 92,000 cu ft.
aeration, brush aerators, 48 linear feet capacity - 240 lbs. oxygen/hr.

l. Sludge Thickener

number - 1
size - 25' diameter
491 sq. ft.
15' 9" depth
mechanically mixed

m. Sludge Beds

number - 12
size - 96' x 26'
total area of 12 beds - 30,000 sq. ft.
sludge drying bed area/capita - 1 sq. ft.
underflow - returned to influent

n. Chlorine Contact Chamber

size - 19,500 cu. ft.
detention time (avg. flow) - 30 min.
type - gas
max. capacity - 68 ppm (based on design flow)

o. Flow Measuring Devices

Location & Method:
influent - Parshall flume 2 ft. throat
mixed liquor - two Venturi meters
waste sludge - Venturi meter
return sludge - two Venturi meters

Appendix B
Chemical Laboratory Data
Calhoun, Georgia

STATION	MONTH	DAY	YEAR	TIME	% Solids Centrifuge	SETTLEOMETER % by volume 5 min	10	15	20	25	30	40	50	60	SETTLEOMETER COMMENTS	Total Suspended Solids mg/l	Volatile Suspended Solids mg/l	% Volatile Solids	SVI
A-3	7	28	75	1530	2.8	12	9	8	8	8	8	8	8	8	Entire Week Sludge				
	7	29		0855	2.8	13	10	10	10	10	9	8	8	8	very heavy - almost				
	7	29		1530	2.5	15	11	10	10	10	10	10	10	10	immediate settling				
	7	30		0830	1.4	13	10	10	10	10	9	9	9	9	occurred	1080*	750*	69	83
	7	30		1415	2.0	5	4	4	4	4	4	4	4	4		1890	1270	67	21
	7	31		0900	1.0	3	3	3	3	3	3	3	3	3		1770	1240	70	17
	7	31		1320	1.8	10	9	8	8	8	8	8	8	8		1920	1360	71	42
	7	31		1530	–	9	8	7	7	7	7	7	7	7		2030	1330	66	34
	8	1		0930	2.5	10	10	10	9	9	9	9	9	9		2270	1480	65	44
	8	1		1445	3.0	12	10	10	10	10	9	9	9	9					
	8	2		0918	3.0	18	15	13	12	11	11	11	10	10		3180	2100	66	36
	8	2		1335	3.5	20	15	14	14	13	13	12	12	12					
↓	8	3	↓	0900	2.9	15	12	11	10	10	10	10	10	10		2770	1840	66	36

*Problem with sampling makes data suspect

Appendix B (Cont)

Chemical Laboratory Data — Calhoun, Georgia

STATION	MONTH	DAY	YEAR	TIME	% Solids Centrifuge	SETTLEOMETER % BY VOLUME 5 min	10 min.	15 min.	20 min.	25 min.	30 min.	40 min.	50 min.	60 min.	SETTLEOMETER COMMENTS	Total Suspended Solids mg/l	Volatile Suspended Solids mg/l	% Volatile Suspended Solids
A-6	7	28	75	1535	2.8	19	15	14	13	13	13	13	13	13	Entire Week			
	7	29		0855	2.8	15	13	12	12	12	12	10	10	10	sludge very heavy -			
	7	29		1530	2.8	15	13	12	12	12	12	12	12	12	settling occurred			
	7	30		0830	2.1	15	12	11	10	10	10	10	10	10	almost immediately	1990*	1360*	68
	7	30		1415	1.2	9	8	8	7	7	7	7	7	7		1690	770	45
	7	30		1615	2.8	15	13	13	12	12	12	12	12	12				
	7	31		0900	0.8	7	6	6	6	6	6	6	6	6		1706	1227	72
	7	31		1320	1.8	10	9	9	9	9	8	8	8	8		1730	1240	72
	7	31		1532	-	10	9	9	9	9	9	9	9	9		1733	1200	69
	8	1		0930	2.7	15	12	11	10	10	10	10	10	10		2480	1720	69
	8	1		1445	2.9	16	13	13	12	11	11	11	11	11				
	8	2		0920	3.5	21	18	15	15	15	15	15	15	15		3540	3230	91
	8	2		1335	3.9	22	18	15	15	14	14	14	14	14				
	8	3		0900	3.2	19	15	14	14	13	13	13	13	13		2965	1955	66

*Problem with Sampling makes data suspect

Appendix B (Cont)

Chemical Laboratory Data Calhoun, Georgia

STATION	MONTH	DAY	YEAR	TIME	COD mg/l	Chlorides mg/l	Turbidity (Turb. units)	Settleable Solids ml/l	BOD_5 mg/l	Total Suspended Solids mg/l	Volatile Suspended Solids mg/l	Total Solids mg/l	Total Volatile Solids (mg/l)	% Volatile Suspended Solids	%Total Volatile Solids	TKN mg/l	NH_3-N mg/l	NO_3-NO_2-N mg/l	Total-P mg/l	Lead µg/l	Chromium µg/l	Copper µg/l	Cadmium µg/l	Zinc µg/l
I-1	7	28/29	75	24 hr. comp.	427	220	28	2.5	154	70	58	932	285	83	31	8.35	2.45	0.21	8.0	<80	<80	33	<10	1351
	7	29/30		24 hr. comp.	291	240	–	1.0	130	59	41	931	268	69	29	7.00	1.54	0.18	9.0	<80	<80	27	<10	1260
	7	30/31		24 hr. comp.	672	222	–	–	143	70	62	923	337	89	36	8.22	1.94	0.19	13.0	<80	<80	48	<10	1493
	7/8	31/1		24 hr. comp.	684	292	–	–	–	98	61	1035	301	62	29	10.00	1.55	0.32	9.1	–	–	–	–	–
	8	2/3		24 hr. comp.	405	–	–	–	–	54	42	676	220	78	33	8.35	2.11	0.11	12.0	–	–	–	–	–

Appendix B (Cont)
Chemical Laboratory Data Calhoun, Georgia

STATION	MONTH	DAY	YEAR	TIME	pH (Lab)	% Solids Centrifuge	Total Suspended Solids mg/l	Volatile Suspended Solids mg/l
RS-1	7	29	75	0930	6	21	18,400	11,960
	7	30		0850	-	4.2	6,120	4,040
	7	30		1515	-	27		
	7	31		0915		9	21,375	14,050
	7	31		1340		34	42,400	27,933
	8	1		0940		32	41,100	27,133
	8	1		1500		26		
	8	2		0919		7	7,560	4,860
	8	2		1340		10		
	8	3		0905		7	5,460	3,540

Appendix B (Cont)
Chemical Laboratory Data Calhoun, Georgia

STATION	MONTH	DAY	YEAR	TIME	pH (Lab)	% Solids Centrifuge	Total Suspended Solids mg/1	Volatile Suspended Solids mg/1
RS-2	7	29	75	0930	6.2	35.0	31,460	20,680
	7	30		1015		40.0		
	7	30		1515		14.0		
	7	31		0915		10.0	21,460	14,780
	7	31		1342		30.0	35,367	23,600
	8	1		0940		28.0	35,433	23,485
	8	1		1500		26.0		
	8	2		0920		11.0	12,440	8,180
	8	2		1340		14.0		
	8	3		0905		7.0	6,300	4,267

Appendix B (Cont)

Chemical Laboratory Data Calhoun, Georgia

STATION	MONTH	DAY	YEAR	TIME	pH (Lab)	Residual Chlorine mg/l	COD mg/l	Chlorides mg/l	Turbidity (Turb. units)	Settleable Solids ml/l	BOD_5 mg/l	BOD_5 mg/l * Eff. before Cl_2	Total Suspended Solids mg/l	Volatile Suspended Solids mg/l	Total Solids mg/l	Total Volatile Solids mg/l	% Volatile Suspended Solids	% Total Volatile Solids	% BOD Reduction	% COD Reduction	% Total Susp. Solids Reduction	TKN mg/l	NH_3-N mg/l	NO_3-NO_2-N mg/l	Total-P mg/l	Lead ug/l	Chromium ug/l	Copper ug/l	Cadmium ug/l	Zinc ug/l
E-3	7	29	75	1030	6.2	1.20	--	--	--	--	--																			
	7	29		1400	6.1	0.27	--	--	--	--	--																			
	7	28/29		24 hr. comp.	--	--	124	215	5	<.5	14	8.4	14	14	727	132	100	18	91	71	80	2.40	0.21	3.50	9.0	<80	<80	19	<10	1210
	7	30		0850	6.3	1.40	--	--	--	--	--																			
	7	29/30		24 hr. comp.	--	--	101	230	--	<.5	12	6.1	22	16	784	145	73	18	91	65	63	1.96	0.16	0.49	8.0	<80	<80	19	<10	650
	7	30		1215	6.0	1.38	--	--	--	--	--	--																		
	7	31		0845	6.3	0.35	--	--	--	--	--	--																		
	7	30/31		24 hr. comp.	--	--	158	270	--	<.5	13	6.0	10	10	755	135	100	19	91	76	86	2.35	0.21	0.10	9.0	<80	<80	18	<10	710
	7	31		1600	6.5	.22	--	--	--	--	--	--																		
	7	31/8-1		24 hr. comp.	--	--	173	270	--	--	--	--	20	13	799	140	65	18		75	80	3.65	0.21	0.16	9.0					
	8	2		0900	--	<.1	--	--	--	--	--	--																		
	8	2/3		24 hr. comp.	--	--	146	--	--	--	--	--	14	11	787	157	79	20		64	74	3.42	0.17	4.50	8.5					

* Effluent from plant taken from plant sampler before Chlorination by Plant personnel.

Appendix B (Cont)
Chemical Laboratory Data   Calhoun, Georgia

	MONTH	DAY	YEAR		% Solids Centrifuge	Total Suspended Solids mg/1	Volatile Suspended Solids mg/1	% Moisture	% Volatile Solids	Lead µg/1	Chromium µg/1	Copper µg/1	Cadmium µg/1	Zinc µg/1
D-3	7	30	75	1030	8.0	11840	7300	--	--	--	--	--	--	--
↓	7	31	↓	1400	11.0	12020	7160	--	--	--	--	---	--	--
D-2 Sludge to Dry Bed	7	31	↓	1430	64.0	—	—	92	58	--	--	--	--	--
*Sludge collected by plant personnel for metals					--	--	--	--	--	4592	3152	6480	160	252,400

* Sample very liquid - analyzed as water sample

Appendix B (Cont)

Chemical Laboratory Data Calhoun, Georgia

STATION	MONTH	DAY	YEAR	TIME	Turbidity (Turb. units)	Turb. after 30 min. settle time
E-1 #1 Clarifier Eff.	7	30	75	1030	22*	4.0**
	7	30		1500	5.3	--
	7	31		0915	7.4	--
	8	1		0940	6.4	--
	8	1		1600	37	--
	8	2		1200	21	--
	8	2		1515	6	--
	8	3		0910	5	--
E-2 #2 Clarifier Eff.	7	30		1030	2.2*	1.8
	7	30		1500	4.5	--
	7	31		0915	6.8	--
	8	1		0940	4.6	--
	8	1		1600	21	--
	8	2		1200	7.0	--
	8	2		1515	8.0	--
	8	3		0910	5.0	--

*Sample shaken **Allowed to sit 30 min. undisturbed and run again

Appendix B (Cont)

Chemical Laboratory Data Calhoun, Georgia

Influent & Effluent samples for pH and temperature =

STATION	MONTH	DAY	YEAR		pH (Field)	Temp. (Field)
I-1	7	29	75	1400	6.7	42
	7	30		1110	6.8	39.5
	7	31		1130	6.2	39
	8	1		1200	6.0	34
	8	2		1200	6.9	--
	8	3		1000	7.4	28
E-3	7	29		1420	6.5	32
	7	30		1140	6.4	31
	7	31		1150	6.6	30.5
	8	1		--	6.8	29
	8	3		1030	6.5	29

Appendix C
DISSOLVED OXYGEN CONCENTRATION IN THE AERATION BASINS
CALHOUN, GA. STP. JULY 29 - AUGUST 2, 1975

BASIN #1	Date '75	Time	Station	Temperature	1 ft. DO	3 ft. DO	5 ft. DO	7 ft. DO	8 ft. DO				BASIN #2	Time	Station	Temperature	1 ft. DO	3 ft. DO	5 ft. DO	7 ft. DO	8 ft. DO	9 ft. DO		
	7/29 1/	1030 1130	A-1	34	3.7	3.5	3.5		3.3					1030 1130	A-6	34	4.6	4.1	3.3	2.7		<1.0		
			A-3	34	4.1	3.2	2.4	1.7	<1.0						A-10	34	3.2	3.3	3.0	3.0				
			A-7	34	2.7	2.7	2.5	2.6							A-11	34	3.7	3.6	3.6	3.6	3.6			
			A-8	34	2.9	2.8	2.5	2.2																
			A-9	34	2.5	2.0	2.0	1.9																
	7/30 2/	1045 1130	A-1	33.5	2.4	2.2	2.3	2.4	2.5					1135 1223	A-4	34	2.2	2.3	2.1	2.1				
			A-3	33.5	0.9	0.7	0.4	0.2							A-6	34	1.0	0.6	0.4	0.1				
			A-7	33.5	0.8	0.6	0.4	0.4							A-10	34	0.7	0.6	0.4	0.4				
			A-8	33.5	1.3	0.7	0.3	0.0							A-11	34	0.8	0.7	0.7	0.7				
			A-9	33.5	0.7	0.2	0.1	0.1							A-14	34	0.7	0.5	0.4	0.2				
			A-12	33.5	0.7	0.5	0.3	0.2																
			A-13	33.5	0.1	0.0	0.0	0.0																
	8/1 3/	0630 0800	A-1	33	3.8	3.8	3.9	3.8						0630 0800	A-6	33	2.7	2.5	2.3	2.0				
			A-3	33	3.1	2.7	2.7	2.5							A-11	33	2.8	2.6	2.7	2.7				
			A-7	33	2.8	2.7	2.7	2.7							A-14	33	3.1	2.7	2.5	2.3				
			A-9	33	2.9	2.9	2.6	2.0							A-16	33	2.2	1.9	2.2	1.8				
			A-15	33	2.7	2.5	2.3	2.1																
	8/2 3/	1000 1100	A-1	32	3.2	3.1	3.0	3.0						1000 1100	A-5	32	4.0	3.9	3.6	3.6				
			A-3	32	3.2	2.4	2.3	2.0							A-11	32	3.3	3.0	3.0	2.9				
			A-9	32	3.2	3.0	2.8	2.7							A-14	32	2.9	2.6	2.4	1.9				
			A-15	32	2.5	2.3	1.8	1.6							A-20	32	2.7	2.4	2.0	0.0				

1/ - All four aeration units operating in each basin
2/ - Only two aeration units per basin 1 & 3 Basin #1, 5 & 7 Basin #2 in operation
3/ - Only two aeration units per basin 1 & 4 Basin #1, 5 & 8 Basin #2 in operation
4/ - No thermal stratification was observed - Temperature was constant throughout each basin.

APPENDIX D

Oxygen Uptake Procedure[3]

A. Apparatus

1. Electronic DO analyzer and bottle probe
2. Magnetic stirrer
3. Standard BOD bottles (3 or more)
4. Three wide mouth sampling containers (approx. 1 liter each)
5. DO titration assembly for instrument calibration
6. Graduated cylinder (250 ml)
7. Adapter for connecting two BOD bottles

B. Procedure

1. Collect samples of return sludge, aerator influent and final clarifier overflow. Aerate the return sludge sample promptly.

2. Mix the return sludge and measure that quantity for addition to a 300 ml BOD bottle that corresponds to the return sludge proportion of the plant aerator, i.e. for a 40% return sludge percentage in the plant the amount added to the test BOD bottle is:

$$\frac{300 \times .4}{1.0 + .4} = \frac{120}{1.4} = 86 \text{ ml}$$

3. Carefully add final clarifier overflow to fill the BOD bottle and to dilute the return sludge to the plant aerator mixed liquor solids concentration.

4. Connect the filled bottle and an empty BOD bottle with the BOD bottle adapter. Invert the combination and shake vigorously while transferring the contents. Re-invert and shake again while returning the sample to the original test bottle. The sample should now be well mixed and have a high D.O.

5. Insert a magnetic stirrer bar and the previously calibrated DO probe. Place on a magnetic stirrer and adjust agitation to maintain a good solids suspension.

6. Read sample temperature and DO at test time t=0. Read and record the DO again at 1 minute intervals until at least 3 consistent readings for the change in DO per minute are obtained (Δ DO/min). Check the final sample temperature. This approximates sludge activity in terms of oxygen use after stabilization of the sludge during aeration (unfed sludge activity).

7. Repeat steps 2 through 6 on a replicate sample of return sludge that has been diluted with aerator influent (fed mixture) rather than final effluent. This Δ DO/minute series reflects sludge activity after mixing with the new feed. The test results indicate the degree of sludge stabilization and the effects of the influent waste upon that sludge.

The load factor (LF), a derived figure, is helpful in evaluating sludge activity. It is calculated by dividing the DO/min of fed sludge by the DO/min of the unfed return sludge. The load ratio reflects the conditions at the beginning and end of aeration. Generally, a large load factor means abundant, acceptable feed under favorable conditions. A small LF means dilute feed, sick sludge, poorly acceptable feed, incipient toxicity, or unfavorable conditions. A negative LR indicates that something in the wastewater shocked or poisoned the "bugs."

(3) Taken from "Dissolved Oxygen Testing Procedure," F. J. Ludzack and script for slide tape XT-43 (Dissolved Oxygen Analysis - Activated Sludge Control Testing) prepared by F. J. Ludzack, NERC, Cincinnati.

Appendix E

Influent pH and Conductivity Levels
Calhoun, GA STP

DATE / TIME	7/28 pH	7/29 pH	7/30 pH	7/31 pH	8/1 pH	7/31 µmhos Conductivity	8/1 µmhos Conductivity
0100		6.45	6.15	6.95	6.55		766
0200		6.7	6.15	6.7	6.9		573
0300		6.9	6.55	6.8	7.2		668
0400		6.8	6.95	7.2	7.45		668
0500		6.55	6.5	7.5	6.7		2290
0600		7.15	6.2	7.2	6.95		945
0700		6.75	6.5	7.0	7.1		831
0800		7.0	6.65	7.05	6.85		888
0900		6.6	6.65	6.8	6.0	973	1590
1000		6.75	6.7	6.5		1671	
1100		6.75	6.7	6.5		1376	
1200		6.8	6.8	6.8		1573	
1300		6.7	6.8	6.8		1671	
1400		6.75	6.8	6.7		1365	
1500	6.5	6.9	6.7	6.7		876	
1600	6.7	6.6	6.5	6.75		1460	
1700	6.6	6.5	6.8	6.75		1168	
1800	7.1	6.75	6.85	6.6		1362	
1900	6.5	6.5	7.1	6.5		1411	
2000	6.8	6.4	6.85	6.8		973	
2100	6.9	6.75	6.7	6.95		778	
2200	6.6	6.0	6.8	6.9		632	
2300	6.7	6.2	6.5	6.65		867	
2400	6.4	6.4	6.7	6.5		1156	