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TECHNICAL ASSISTANCE PROJECT AT THE ALBANY METROPOLITAN WASTEWATER TREATMENT PLANT ALBANY, GEORGIA

April 1976

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

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

A technical assistance study of operation and maintenance problems at the Albany Metropolitan Wastewater Treatment Plant (WTP), Albany, Georgia was conducted March 29 - April 2, 1976 by the Region IV, Surveillance and Analysis Division, U. S. Environmental Protection Agency. Operation and maintenance technical assistance studies are designed to assist wastewater treatment plant operators in maximizing treatment efficiencies as well as assisting with special operational problems. Municipal wastewater treatment plants are selected for 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 study efforts would be productive.

This plant was selected because of the low BOD_5 and solids removal efficiencies and the sludge bulking problems. The specific study objectives were to:

- Optimize treatment through control testing and recommended operation and maintenance modifications,
- Introduce and instruct plant personnel in new operational control techniques,
- Determine influent and effluent wastewater characteristics,
- Assist laboratory personnel with any possible laboratory procedure problems, and
- Compare design and current loadings.

A follow-up assessment of plant operation and maintenance practices will be made at a later date. This will be accomplished by utilizing 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. Contact has been maintained with plant personnel since the study in order to relate preliminary study findings and stay abreast of process changes and results. Most of the recommendations in this report have been implemented since the study and recent reports have shown significant improvements in removal efficiencies.

The cooperation of the Georgia Environmental Protection Division is gratefully acknowledged. The technical assistance team is especially appreciative of the cooperation and assistance received from personnel of the Albany WTP.

SUMMARY

The Albany, Georgia Metropolitan Wastewater Treatment Plant (WTP) was designed to treat 20 mgd of combined industrial and domestic wastewaters with a total BOD_5 loading of 45,420 lbs. for the project design year. Currently, the plant is operating at 67 percent of hydraulic design loading and 113 percent of organic design loading. The heavy organic loading (avg. influent BOD_5 concentration - 460 mg/l) is due to unregulated industrial discharges. An active industrial monitoring program plus better in-plant laboratory process control monitoring is needed, which will require additional field and laboratory staff. Currently, there is a shortage of qualified operators at the WTP. Plans have been made and approved by the city to hire additional staff.

The WTP is designed to use the Krauss Process; however, it is currently being operated in the plug flow mode. For the first time the plant now seems to be responsive to operator control; and hopefully, within a period of months a good, stable operational record can be established. After it has been established that the WTP can be satisfactorily operated in the current plug flow mode, start-up of the Krauss Process should be considered.

Two of the four anaerobic digesters were out of service, causing severe overloading of the two units in service. Detention time in each digester was approximately five days. This heavy loading produced highly acid conditions, poor digestion and low quality gas production. Parts for the digesters were on order, and were scheduled for delivery and installation in May. Poor digestion and the lack of the use of polymer in centrifuges, resulted in a very poor quality centrate returned to the aeration (nitrification) basins. This return stream alone required 1/3 of the total aeration capacity of the plant, since two of six aeration basins were utilized solely for oxidation of the centrate.

During the study, severe bulking conditions were occurring in the final clarifiers resulting in a large volume of solids discharged in the effluent. It was observed that a major portion of the aeration basin contents contained very low dissolved oxygen levels, the final clarifiers were septic and the mixed liquor solids (MLSS) was composed largely of filamentous growths. Settleability of the MLSS was very poor. The compressed air supply to the aeration basins was stepped up in increments until adequate DO concentrations existed throughout the basins. The amount of air required was excessive due to the very young age of the sludge, excessive filamentous growth, and residual septic conditions. As the sludge quality improved the air demand decreased. Settleability, after three weeks of adequate air, exhibitied almost ideal settling characteristics. This corrected one of the problems; however, severe carryover of solids still occurred in the clarifiers. This indicated problems with the sludge collection and return systems.

RECOMMENDATIONS

Based on observations and data collected during the study, the following suggestions are made for improved operations:

1. The dissolved oxygen (DO) concentrations in the aeration basins should be monitored and maintained at a minimum of 1.5 mg/l at all times. Clarifier DO should also be checked frequently and aeration basin DO should be sufficient to maintain a residual DO in the clarifier overflow and return sludge.

2. An industrial monitoring program should be initiated immediately to assure compliance with the city sewer ordinance. Excessively strong wastes are currently being discharged to the system.

3. The return sludge system including pumps, valves, meters, and vacuum pickup systems should be checked for proper operation.

4. Laboratory control testing and plotting of trend charts should be performed daily. One individual should then be in charge of interpreting the data and making decisions on process control changes.

5. An active program should be developed for recruiting additional staff and training the existing staff. A one or two hour meeting and training session each week for operators, laboratory staff, and supervisors may be useful. These meetings could be used to train the operating staff in the significance and methods of control testing. The importance of making visual observations, and what to look for in clarifier, aeration basins, etc. emphasized. The meetings would also help to promote better espirit de corps which is absolutely essential for good operations.

6. Installation should be completed and repairs made to place all flow measuring devices and recorders in service.

7. The two aeration basins now being used for oxidation of the centrate should be converted to parallel operation, with the other four basins, for treatment of raw waste. The quality of the centrate stream should be improved by the addition of polymer in the centrifuges and the stream diverted to manhole #5. The centrate stream may be removed temporarily from the system by storing in an on-site lagoon. This flow scheme makes more efficient use of the plant aeration capacity and eliminates the uneven flow split into the two nitrification tanks.

8. The WTP should be operated in the plug flow mode until a good performance record is established or until information indicates that this mode will not produce satisfactory results. Start-up of the Krauss process may be advisable at a later date.

9. The intake line for the effluent composite sampler should be moved to collect a sample from the total plant effluent rather than from only clarifier #2. Relocation or modification of the influent sampler is also needed to prevent clogging.

TREATMENT FACILITY

TREATMENT PROCESSES

A schematic diagram of the 20 mgd WTP is presented in Figure 1. Plant design data are shown in Appendix F. The WTP was originally designed in 1955 as a 10 mgd primary treatment facility, and expanded in 1975 to a 20 mgd activated sludge system.

The collected wastewaters are introduced into the treatment facility by a 54 inch west side interceptor sewer, a 36 inch river road interceptor sewer, and two 20 inch force mains. Wastewaters enter the preliminary treatment structure containing bar screen and aerated grit chamber, with flow measurement by two parallel 54 inch Parshall flumes. Chlorine is applied to the incoming raw wastewaters to freshen the waste and control odors. Following preliminary treatment, a raw sewage pump station, consisting of eight centrifugal pumps with maximum pumping rates of 60 mgd, lifts the wastewater to four primary sedimentation tanks. Settled solids are collected mechanically and pumped to the digesters.

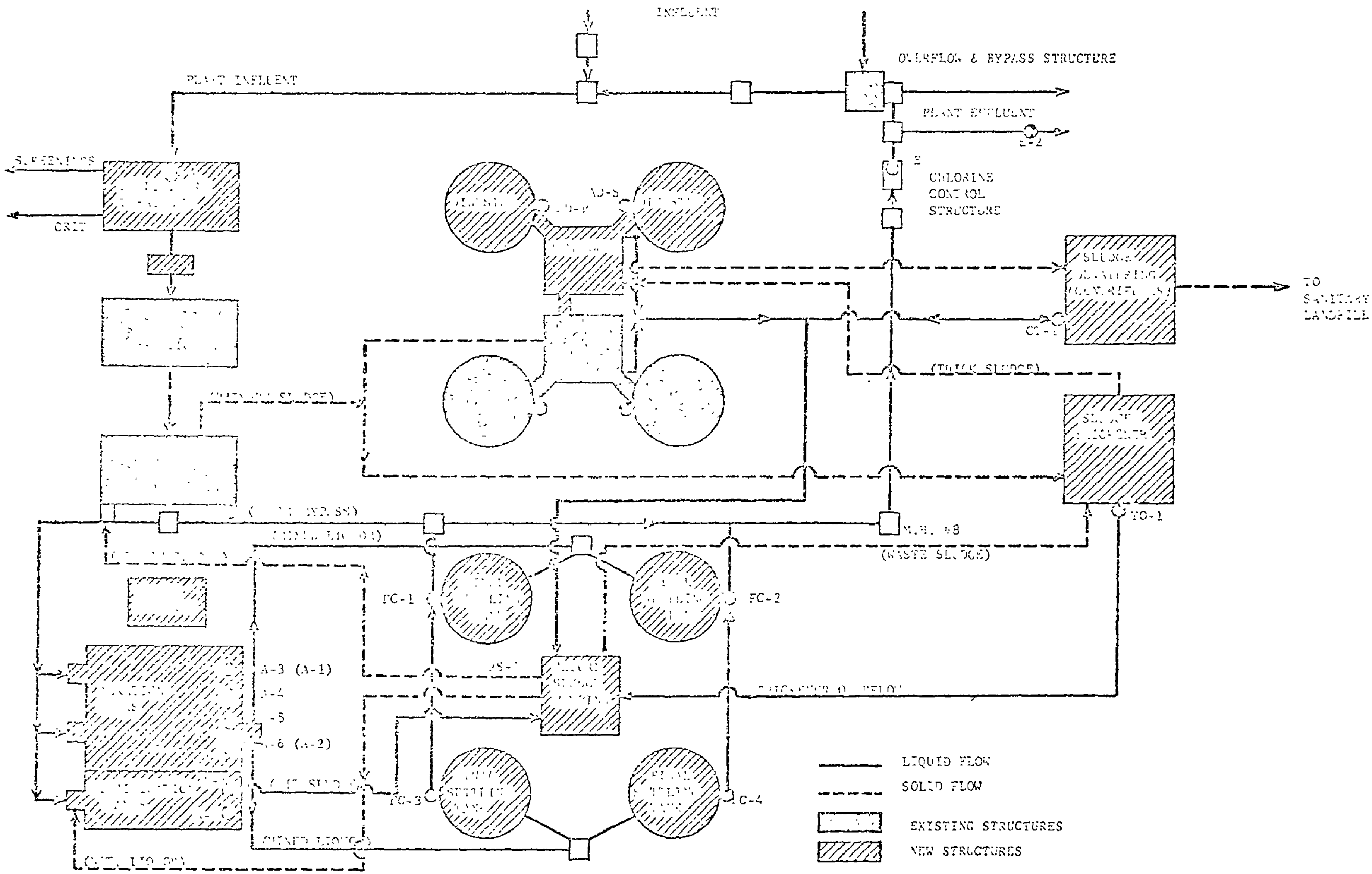
The patented Krauss Process was provided in the addition to the WTP. This process is designed for nitrogen limiting situations where digester supernatant nitrogen is oxidized in nitrification tanks and reintroduced into the aeration basins to support the biological growth. This process also has the advantage of providing a large volume of well acclimated activated sludge in the nitrification tanks. The system at Albany consists of six rectangular aeration basins with air diffusers located along each side of the tanks. The diffusers are located near the bottom on one side and near the midpoint on the other side, which produces a rolling countercurrent circulation in the tanks. Currently, two of the six tanks are used for nitrification of the digester centrate.

Four circular Rex clarifiers follow the aeration basins. The clarifiers are center feed with a single unitube sludge vacuum pickup system. Each clarifier has a single peripheral overflow weir.

After final clarification, wastewaters flow to the chlorination facilities. The chlorine application rate is controlled by the flow rate over the 40 foot effluent weir. The outfall line was constructed to provide a 30 minute contact time, at a flow of 20 mgd.

Thickened primary and waste activated sludge is pumped to four anaerobic digesters (two out of service for repairs). Supernatant was returned to the head end of the aeration basins via manhole #5. Digested sludge is processed in three centrifuges, with the centrate returned to the nitrification tanks and the solids hauled to a landfill.

FIGURE I
ALBANY METROPOLITAN WTP



PERSONNEL

The City of Albany employs a wastewater treatment staff of 28 persons. At the time of the study, there were eight certified operators--seven at the Albany plant and one at the Naval Air Station wastewater treatment facility. A shortage of qualified operators and full time laboratory staff

exists. Additional laboratory staff will be required if plant operational control testing and industrial discharge monitoring functions are adequately performed.

STUDY RESULTS AND OBSERVATIONS

A complete listing of all analytical data and study methods are presented in Appendices A, B, and C. Formulae used for general calculations are enumerated in Appendix D. Signficant results and observations made during the study are discussed in the following sections.

FLOW

Due to operational problems with the level recorder on the influent Parshall flumes, influent flow records are not reliable. Better flow data was obtained by installing a recorder on the forty foot sharp crested effluent weir. The sensitivity (head to discharge relationship) of this weir could be greatly improved by blocking off about half of the weir length. Figure 2 is a plot of the influent and effluent flows during the study. The large discrepancy (6 mgd vs 15 mgd) at the start of the study was due to clogging of the bubble tube and stilling well on the influent Parshall flumes. On the second day of the study, the system was flushed out and performance of the recorder improved; however, clogging occurred again. On March 30, 1976 the head was measured on each of the flumes and the flow rate was determined to be 13.4 mgd vs a flume recorder reading of 8.2 mgd. The 13.4 mgd value agreed closely with the effluent recorder reading.

The average daily effluent flow was calculated at 13.4 mgd from the stage recorder charts on the effluent weir. Mean hourly flows varied from 8.6 mgd to a maximum of 19.2 mgd, which occurred during a heavy rain.

Approximately 40 percent of the total plant flow was industrial wastewater from varied sources, i.e., meat packing, paper processing, food processing, textiles, laundry, agrichemical, distillery, etc.

Return sludge flow (RSF) from the final clarifiers to manhole #5 can be varied, but was controlled at approximately 5 mgd (Figure 2) during the study period, and was measured with a magnetic flow meter equipped with a recorder and totalizer.

WASTE CHARACTERISTICS AND REMOVAL EFFICIENCIES

Table I presents a chemical description of the influent and effluent wastewater with calculated average percent reductions. Analyses were made on 24 hour proportional-to-flow composite samples.

FIGURE 2
WASTEWATER AND RETURN SLUDGE
FLOWS, ALBANY, GA.

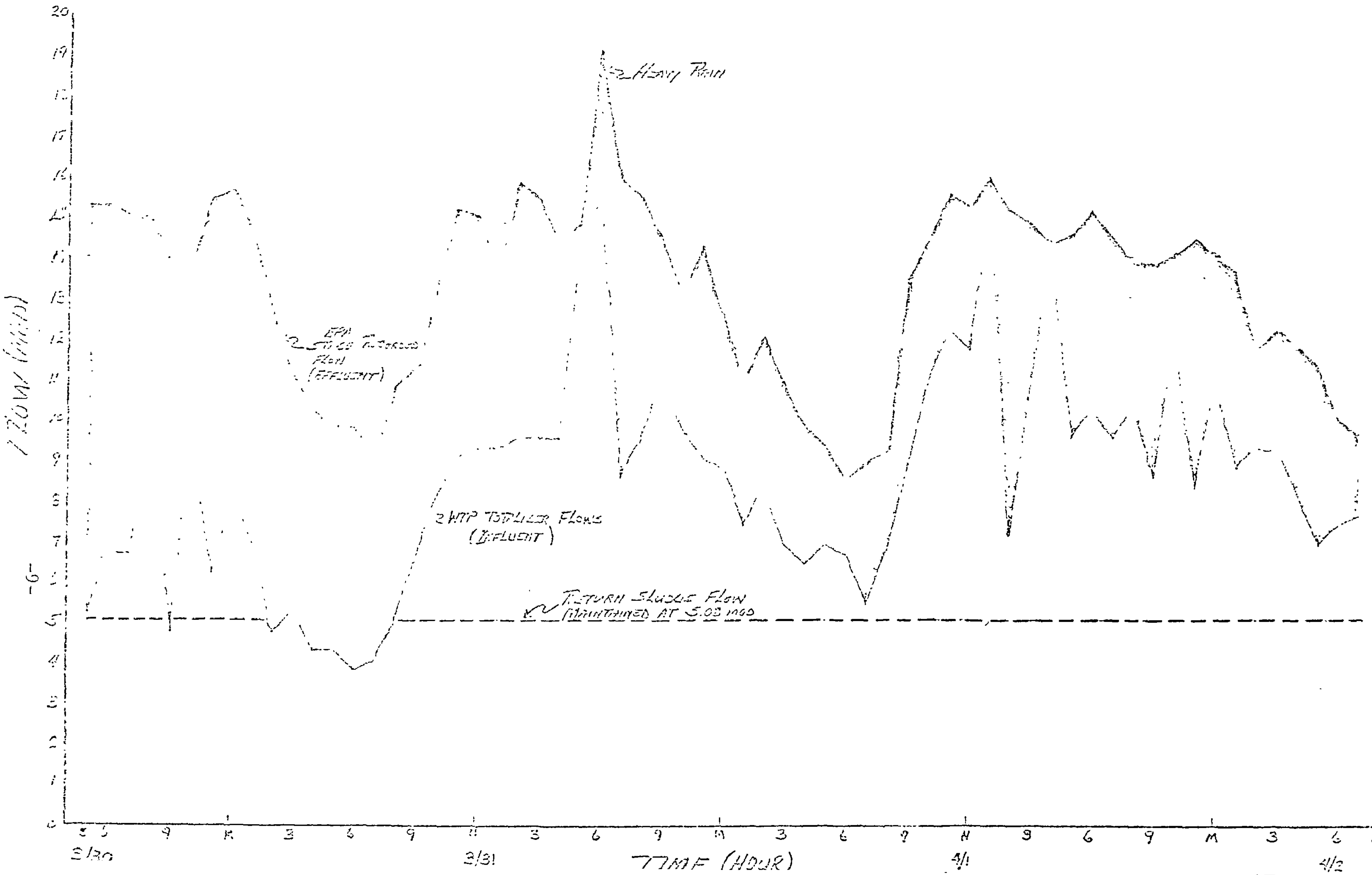


TABLE I
WASTE CHARACTERISTICS AND REMOVAL EFFICIENCIES
ALBANY, GA WTP

Parameter	Influent (mg/l)	Effluent (mg/l)	% Reduction
BOD_5	460	88	81
COD	834	371	55
Suspended Solids	293	224	23
Total Solids	1015	842	17
TKN-N	28	19.4	31
NH_3-N	18.9	10	47
NO_3-NO_2	.02	.04	--
Total Nitrogen	28.02	19.44	31
Total-P	14.8	10.5	29
Pb	.093	.150	--
Cr	.153	.183	--
Cd	<.02	<.020	
Cu	.077	.095	--
Zn	.337	.327	--

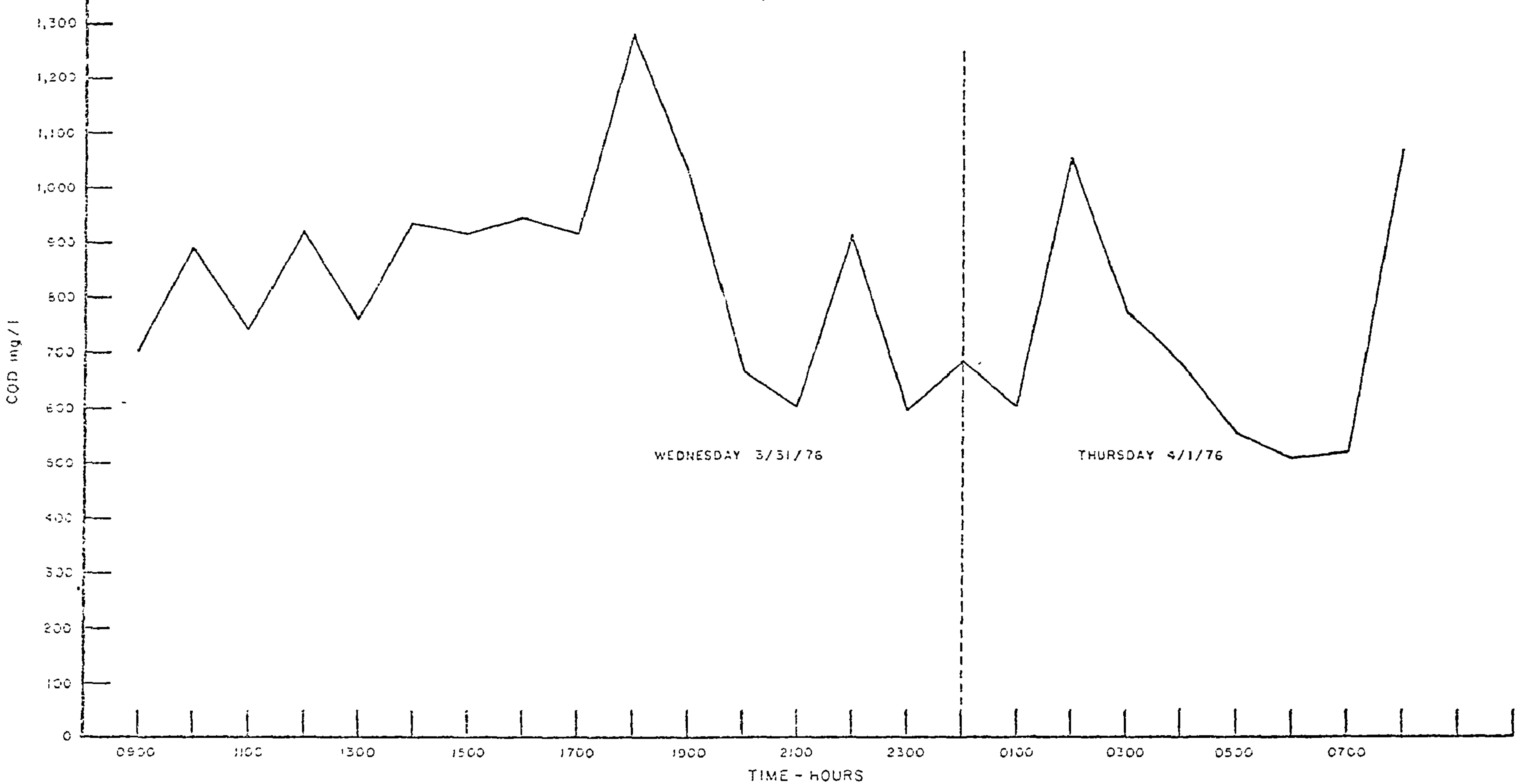
Based on these BOD_5 and COD analyses, it is apparent that the Albany WTP receives a strong organic waste. In fact, the plant was designed to treat 20 mgd of combined industrial and domestic waste with a total BOD_5 loading of 45,420 lbs/day. Currently the hydraulic loading is 67 percent and the organic loading is 113 percent of the project design loading. Fortunately, this plant has the aeration capacity to handle this overload; however, it points out the urgent need to monitor and control industrial discharges to the system.

Because of the high carbon content of the wastewater and the presence of filamentous bulking, a careful look was taken at the nutrient ratio of carbon (BOD_5), nitrogen and phosphorus. This ratio was calculated to be 100/10.5/5 for BOD_5/N/P which is near the recommended limits of 10/12/2 (5) Based on these data, it appears that there are no problems with the nutrient balance of the waste.

Average solids removal during the three day period was very poor (23%), due to the heavy loss of solids on March 31, 1976, because of bulking sludge. This situation had been occurring at regular intervals (about weekly) for the past few months. On this particular date, the situation was aggravated because one of four air compressors went out the previous night, producing septic conditions in the final clarifiers.

In order to determine the hourly variation in organic loading, an additional composite sampler was placed at the influent on March 31, 1976, to collect hourly samples for COD analysis. Figure 3 is a graph of this data with values ranging from 514 to 1,280 mg/l. The highest peak, observed at 6:00 p.m. was probably due to infiltration, since it coincides with the high plant flow, caused by heavy rain. Other peaks at 2:00 a.m. and at

FIGURE 3
SPECIAL COD ANALYSES
ALBANY, GEORGIA WTP



8:00 a.m. on April 1, may indicate industrial process startup or slug discharges. The average for the 24 hour period was 804 mg/l. This data did not show the presence of excessively strong slug discharges; however, a review of plant data revealed that BOD_5 influent values exceed 1000 mg/l once or twice per month, with smaller peaks to 500-600 mg/l. On one occasion, during a dry period, the flow rate entering the plant was 60 mgd for a two hour period.

Hourly pH readings were taken on the influent flow (data in Appendix A). These readings ranged from 5.0 to 7.8, which indicates the possibility that acid wastes are discharged to the system. Wastewaters outside of the pH 6.5-7.5 range, for any significant period of time, may have a detrimental effect on the activated sludge. Larger pH variations may kill the biological process.

AERATION BASINS

Grab samples were collected at the discharge from each of the four aeration basins (Stations A3, A4, A5, and A6). Dissolved oxygen (DO) concentrations were measured at various locations in the aeration basins, and the results are presented in Appendix B. Settlometer, TSS, VSS, and percent suspended solids by centrifuge were run on each sample. Samples for microscopic examination were grab samples, collected at the effluent collection box.

The average mixed liquor suspended solids (MLSS) and mixed liquor volatile suspended solids (MLVSS) concentrations were 2,866 and 2,610 mg/l, respectively. The percent solids by volume, as determined by centrifuge, ranged from 5.0 to 6.0 percent.

Presented in Table II are various activated sludge operating parameters calculated during the study, and corresponding recommended values for the conventional, plug-flow activated sludge process.

TABLE II

OBSERVED AND RECOMMENDED PARAMETERS FOR THE MODIFIED CONVENTIONAL ACTIVATED SLUDGE PROCESS

	Actual	Recommended (5)(6)
Hydraulic Detention Time (hours)	5.0	4-8
Sludge Age (days)	4.6	3.5-10
Lbs. BOD/day/lb MLVSS	0.45	0.2-0.4
Lb. COD/day/lb MLVSS	0.91	0.5-1.0
Lb. BOD/1000 cu. ft. Aeration Basin	73.2	40
MCRT (days)	2.9	5-15
Air (cu. ft./lb BOD)	1,393	800-1,500

Settlometer test results are presented in Appendix A. The average volume of settled mixed liquor sludge from all four basins after 60 minutes of settling was 75-80 percent which indicated a very slow settling sludge. Figure 4 is a plot of settling curves from each basin and is discussed in the clarifier section of this report.

Data for dissolved oxygen (DO) profiles are presented in Appendix B. Prior to the study, plant personnel were attempting to maintain DO levels in the aeration basins at about 0.5 mg/1. This was being done to conserve electricity and possibly to control the high concentration of filamentous growth in the MLSS.

The first DO profile through each basin was conducted on March 30, 1976. The data indicated that the major portion of all aeration basins was at essentially zero mg/1 DO concentration. An exception to this condition was observed in nitrification tank #1 where the DO level was high. This was because tank #1 was receiving a very small portion of the centrate return, due to poor flow splitting into tanks N-1 and N-2. It was also determined that the electronic DO meter used at the WTP was reading 0.5 mg/1 in a 0.0 mg/1 DO solution. The very low concentrations in the basins did not provide sufficient air for the MLSS, and the clarifier contents and return sludge was septic. This resulted in a poor quality return sludge and a predominance of filamentous growth in the MLSS which produced a classic bulking sludge.

The air flow delivered to the aeration basins on March 29, 1976 was 14,000 cu. ft./min. in the 8 psi diffuser system and 17,000 cu. ft./min. in the 4 psi system with an even split between the head and discharge ends of the aeration basins. After running the DO profiles, the air flow rates were increased to 17,500 and 20,000 cu. ft./min. in the respective systems; however, compressor problems prevented maintaining a sustained supply. On March 31, 1976 blower problems were corrected and a sustained supply was maintained. At a rate of 17,500 and 20,000 cu. ft./min the air to BOD_5 ratio was 1500 cu. ft./lb of BOD_5 removed. Additional DO measurements (Appendix B) dictated increased air supplies, so on April 1, 1850 cu. ft./lb of BOD_5 was added. This level finally brought the DO concentrations in the aeration basins up to an acceptable level. This excessive air demand was probably due to the partially septic conditions which had existed, the large concentration of filamentous growths and to the high demand of a young, overloaded sludge. After the study, as a better quality sludge was developed, the air requirement dropped considerably. Table III is a tabulation of aeration basin DO concentrations at selected stations.

FIGURE 7
MLSS SETTLEABILITY
ALBANY, GEORGIA

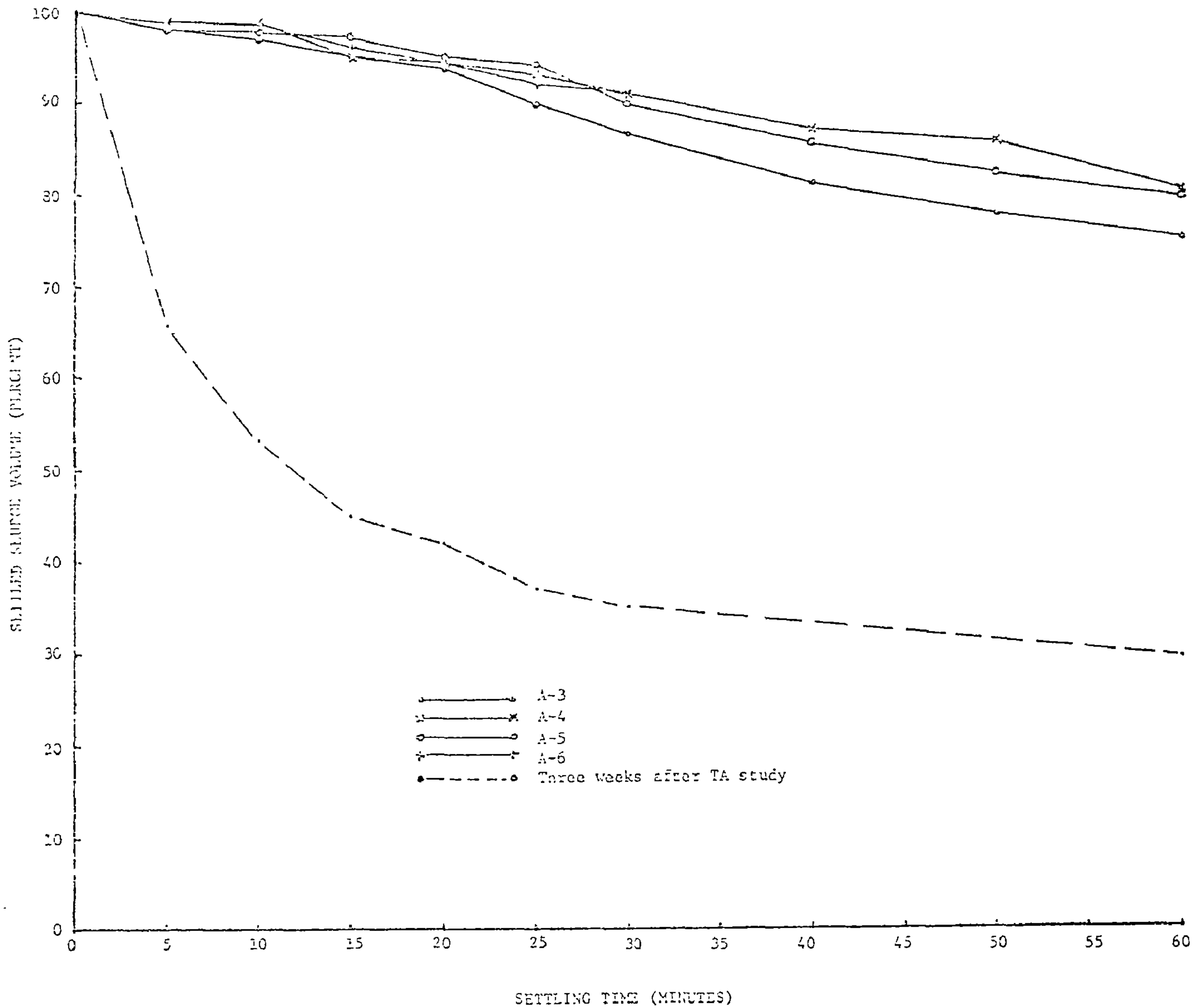


TABLE III

DO CONCENTRATIONS AT SELECTED STATIONS*

Stations	DO (mg/l)							
	3/30		3/31		4/1		4/2	
	1 ft.	5 ft.	1 ft.	5 ft.	1 ft.	5 ft.	1 ft.	5 ft.
			(28,600 ft^3/min)		(38,800 ft^3/min)		(48,500 ft^3/min)**	
A3-1	0.8	0.6	1.8	1.1	2.6	2.4	4.6	4.2
A3-9	0.4	0.0	1.8	1.4	2.0	1.0	3.0	2.7
A4-17	0.3	--	0.2	0.1	0.2	0.1	0.6	0.4
A4-26	--	--	0.5	0.7	0.5	0.3	3.6	3.6
A5-18	0.4	--	0.2	0.1	0.7	0.5	1.6	1.4
A5-25	--	--	0.2	0.1	1.4	1.4	3.8	3.7
A6-19	0.4	--	1.2	0.7	0.6	0.4	2.8	2.8
A6-24	--	--	0.6	0.8	2.4	2.5	4.2	4.4
N1-20	3.9	--	0.6	0.4	2.7	2.2	5.2	5.0
N1-23	5.7	--	5.1	5.0	4.2	4.0	6.6	6.4
N2-21	0.2	--	0.2	0.1	0.2	0.1	0.4	0.1
N2-22	0.6	--	0.5	0.2	0.4	0.2	2.2	2.2

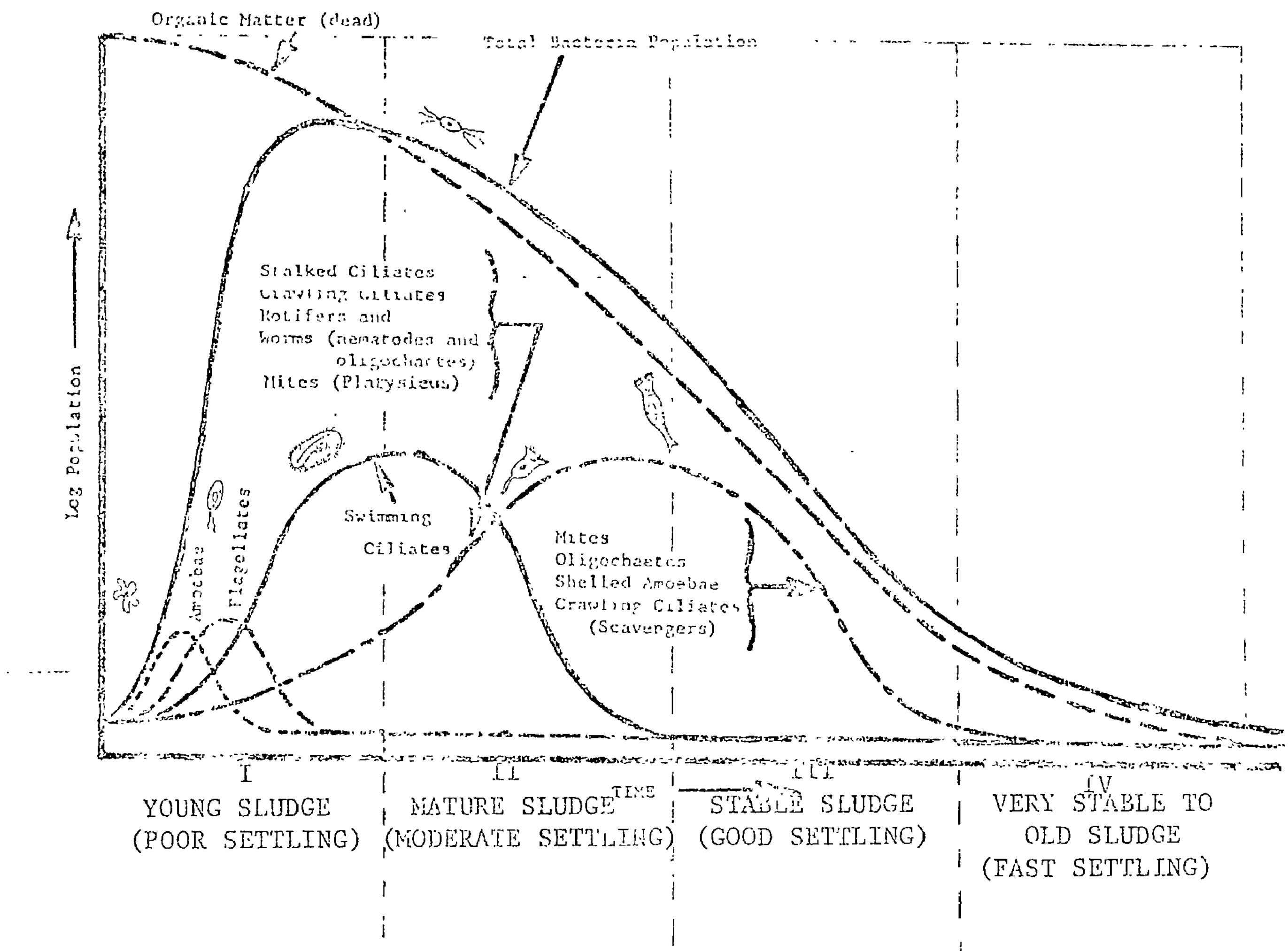
*See Appendix B for station locations and additional data
**Air flow rate supplied to the aeration basins.

EXAMINATION OF MICROSCOPIC ORGANISMS

A determination of the quality of an activated sludge can be made by a microscopic observation of the sludge appearance and of observed changes in Protozoa species as bacterial floc develops. Figure 5 is a graphic generalization of what is to be observed when making a microscopic examination of different phases of the aeration process.

FIGURE 5

POPULATION DYNAMICS IN AEROBIC WASTEWATER TREATMENT (9)
PROCESS



A particular sludge can be classified into the following general groups according to age and predominant groups of organisms.

I. Young Sludge - Solids dispersed, fluffy, light tan in color, protozoa population heavy with a good mixture of flagellates, free-swimming ciliates and amoebae. Solids settleability poor.

II. Mature Sludge - Individual solid particles flocculating, settleability fair with spongy blanket. Protozoa population consist of a sparse population of flagellates, numerous stalked ciliates, rotifers, oligochaetes, and crawling ciliates.

III. Stable sludge - Solids compact, tan to dark brown in color, forming a good, heavy flocculant mass that settles uniformly >50% by volume. Protozoa populations consisting of stalked ciliates, rotifers, crawling ciliates, and oligochaetes.

IV. Very stable to old sludge - Solids very heavy, clumped, black to dark grey in color, settles very fast, leaving straggler solids dispersed throughout the supernatant. The protozoa population consist primarily of crawling ciliates.

The activated sludge system (mixed liquor and return sludge) at the Albany WTP can be characterized as having similar conditions as Groups I and II of Figure 5. Compounding the problem of poor settleability was the presence of a very heavy growth of filamentous organisms. Filamentous growth may be caused by variable pH, nutritional deficiencies, low dissolved oxygen (DO) or other conditions. Control of these growths may normally be accomplished by correcting one or more of the forementioned causes. Low dissolved oxygen concentrations were measured in the aeration basins. As the dissolved oxygen concentrations were increased, sludge settleability increased, the concentration of filaments decreased and the sludge was aged slightly with stalked ciliates becoming rather common.

Similar conditions were observed in the nitrification basin, with one basin containing adequate DO (N-1) and one with low DO (N-2). Conditions in the nitrification basin with adequate DO demonstrated populations similar to Group III plus heavy filamentous growth, but the solids concentration was low.

To determine if the filamentous growth was being continually introduced into the aeration system, samples of raw influent and primary effluent were examined. Samples from each source revealed the presence of the filamentous growth. Tufts of fungal filaments were found in the raw wastewater stream, while only small fragments of filaments were found in the primary effluent. Numerous fungal filaments were returned in the thickener overflow and digester supernatant.

OXYGEN UPTAKE RATES

The oxygen uptake rate is a measure of the general sludge activity, i.e., the biodegradability of a particular waste by a particular activated sludge. This activity is measured by mixing return activated sludge with influent (fed) and nonchlorinated effluent (unfed) and determining the uptake rates and calculating the load ratio.

$$\text{Load Ratio} = \frac{\Delta DO \text{ (ppm/min) fed sludge}}{\Delta DO \text{ (ppm/min) unfed sludge}}$$

The detailed procedure for this test is contained in Appendix E. In general, a load ratio in the 2 to 5 range indicates a readily biodegradable waste. It also indicates that the sludge is well acclimated to the waste and that pH, temperature and other environmental conditions are favorable.

Lower ratios may indicate toxic waste or unfavorable environmental conditions. A very young, actively growing sludge produces a high ratio due to the high rate of oxygen uptake. Table IV shows the results of the uptake tests.

TABLE IV

OXYGEN UPTAKE RATES

Date	Time	%RS	Average O_2 Uptake mg/l URS1/	mg/l FRS2/	Load Ratio FRS/URS
3/30/76	1100	63	0.96	2.9	3.02
3/31/76	1525	53	0.74	2.4	3.24
4/1/76	1030	42	0.46	1.78	3.86

1/ - URS - United Return Sludge using clarifier effluent

2/ - FRS - Fed Return Sludge using raw influent from primary settling basin.

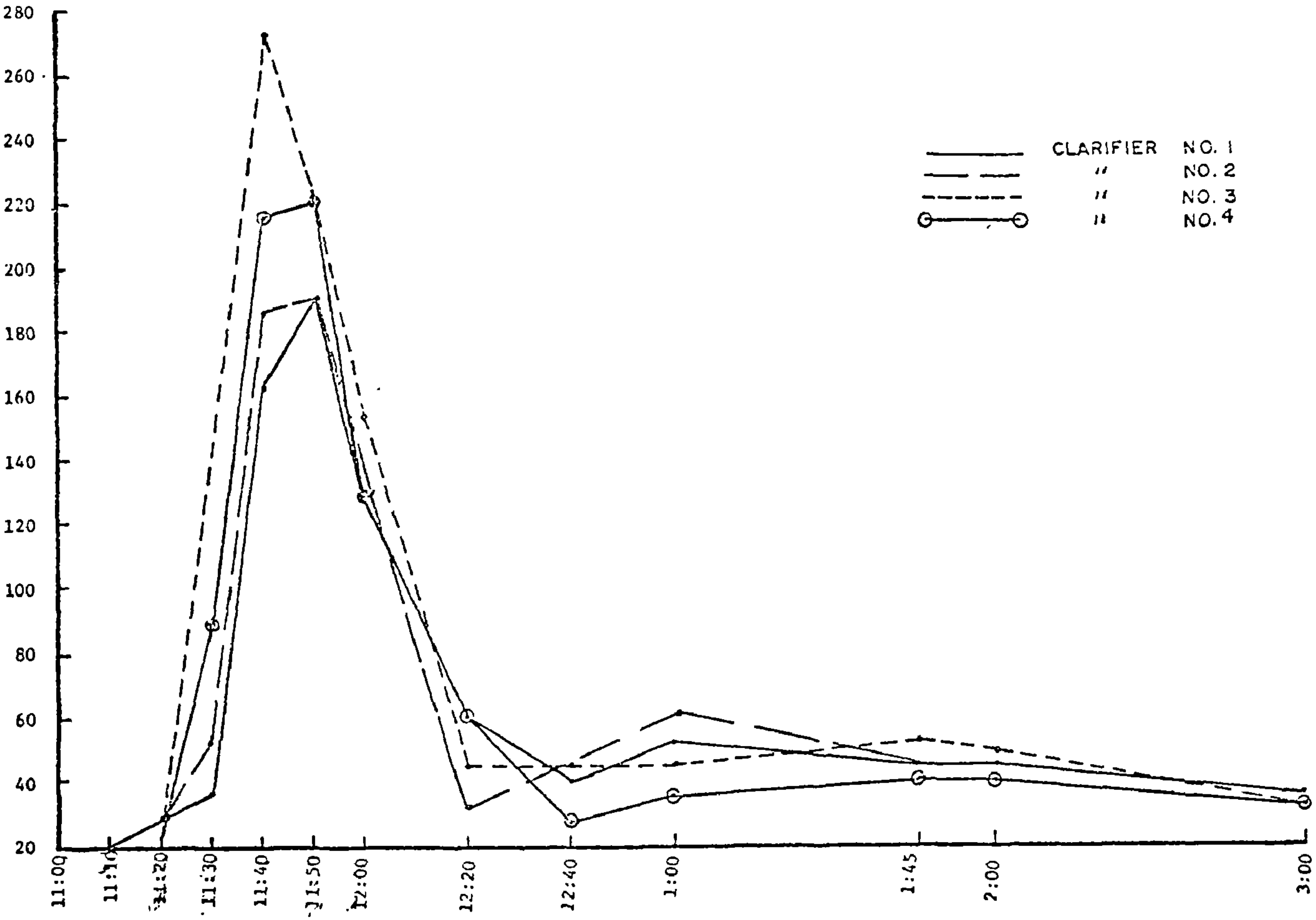
These data show a rather high load ratio which is a result of rapid oxygen uptake. This is typical of young sludge. Thus, it should be expected that a rather large amount of air would be required in the aeration basins and that an unusually high demand would be present at the head end of the tanks due to the very rapid growth.

CLARIFIERS

The primary problem encountered with the clarifiers was bulking sludge resulting in excessive solids carryover. This situation was partially due to the heavy filamentous growth in the sludge producing very poor settling characteristics (Figure 4). Turbidity of the clarifier effluents ranged from 6-10 NTU when there was no solids carryover to 1,260 NTU during bulking. Plant effluent settleable solids for the 24 hour composite sample collected on April 1 were 250 ml/l. This is typical of the cyclic loss of solids which had been experienced at the plant for the past several months.

Dye was injected into the aeration basin effluent in order to determine the flow split and detention time in each clarifier. Concentration curves are shown in Figure 6. These curves indicate that the flow split to each clarifier is very good with very similar concentration curves for each clarifier. Clarifiers #3 and #4 received slightly more flow than #1 and #2. The centroid of each dye curve was approximately 1.3 hrs. after the dye was introduced into the clarifiers. This figure represents the average detention time. Plant flow during the dye study was 11 mgd, and the return sludge flow rate was 5 mgd.

FIGURE 6
CLARIFIER DYE TRACER STUDY



Time

The observed and recommended hydraulic loading, solids loading, and weir overflow rates for final clarifiers following activated sludge are presented in Table V.

TABLE V

OBSERVED AND RECOMMENDED PARAMETERS FOR SECONDARY CLARIFIERS

	Observed	Recommended (2)(3)(6)
Hydraulic Loading (gpd/sq. ft.)	526	400-800
Solids Loading (lbs/day/sq. ft.)	12.5	20-30
Weir Overflow Rate (gpd/ft.)	11,828	<15,000
Detention Time (hrs.)	2.75*	2.5

*Calculated based on displacement - dye study revealed 1.3 hrs.

As shown in Table V, the clarifiers are sized to adequately handle existing loads.

The data presented in Figure 4 indicates that the poor settling sludge may be responsible for the excessive solids in the effluent. The lower curve in this figure also shows that with increased air supply, an almost perfect settleability curve was obtained after a three week period. This, however, did not produce a satisfactory effluent, indicating problems with the sludge collection and removal mechanism in the clarifiers.

DISINFECTION

Chlorine gas is used to disinfect the treated wastewater effluent, to disinfect excessive storm water inflow and to control odors in the raw sewage influent. The chlorine is fed by use of a system of four chlorinators--three are automatically controlled by the WTP flows, and one is manually operated.

Chlorine gas is fed into the final clarifier effluent at Manhole No. 8. From Manhole No. 8, the effluent flows to the chlorine contact structure which provides a 30-minute detention time at 20 mgd. The plant outfall line is of sufficient length to provide the additional detention time needed at higher flows.

At a dosing rate of 1000 lbs/day, a total residual chlorine of <.05 mg/l was measured on March 31 and 5.27 mg/l on April 1. This difference was due to a tremendous solids carry-over taking place when the March 31 samples were collected.

SLUDGE HANDLING

Two digesters were out of service for repairs during the study, and a third was unheated. Parts for the heat exchangers had been on order for several months, and interior piping was being replaced in one of the digesters. All repairs were expecked to be completed by May 1976.

With two digesters out of service, all sludge was pumped into the two remaining operational digesters. They were operated in series with the heated unit as a primary, and the unheated unit as a secondary digester. The units were overloaded, with a sludge detention time of less than ten days, and a pH of 5.4 in the primary and 6.4 in the secondary. Gas production was very low and of poor quality.

Primary and waste activated sludge is passed through an air flotation sludge thickener where the solids concentration is brought up to seven or eight percent before putting it into the digesters. The thickener overflow is returned to manhole #5 where it flows into the aeration basins. This sidestream is a significant load amounting to approximately 1 mgd with a 1000 mg/l BOD_5 concentration.

Sludge is dewatered by centrifuge with the centrate returned to the aeration basins. Due to poor digester operation and the lack of polymer use, the centrate quality was very poor (COD averaged 40,000 mg/l). Dewatered sludge is trucked to a landfill. A few old sand drying beds are available for use as needed.

LABORATORY

The laboratory at the Albany WTP is staffed by a chemist and two technicians. The chemist's duties were divided between plant operations and laboratory work. As a result, problems could arise with the more complicated analytical procedures. It would be best if the chemist could spend more time in the laboratory to insure the highest quality sample handling and analytical techniques, especially since critical plant controls depend on the laboratory data.

Obtaining a representative sample is an important part of laboratory quality control. At present, the influent and effluent composite samples are of little or no value. The influent sampler is either clogged or inoperative most of the time. The effluent composite sampler is positioned on only one of the four secondary clarifiers. In order to obtain a true evaluation of the effluent, it will be necessary to get a sample after the flows have combined from all four clarifiers. Care should also be exercised in selecting sampling stations within the plant for process control.

At the time of the study, the settleability of the solids in the aeration basins was being determined in a one liter graduated cylinder. It was suggested that the 2 liter settlometer be used since this reduces side wall interference and more closely represents clarifier conditions. At the conclusion of the study, the settlometer test was being initiated in the daily plant control routine.

During the study, dissolved oxygen in the aeration basins was being monitored by plant personnel with a portable electronic DO meter. The WTP DO meter was checked and found to be very unstable yielding questionable data. Since the study was completed, WTP personnel have related by telephone that the instability was due to weak batteries, and that this had been corrected.

REFERENCES

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8. "Modernization of the BOD Test for Determining the Efficiency of Sewage Treatment Processes", Sawyer and Bradney, Reprinted from Sewage Work Journal, Vol. XVIII, No. 6, November, 1946.

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Appendix A
Laboratory Data
Albany Wastewater Treatment Plant
Albany, Georgia

Influent, Effluent and Primary Clarifier Effluent

Chem SRC #	STATION	MONTH	DAY	YEAR	TIME	BOD_5* (mg/l)	COD (mg/l)	TKN-N (mg/l)	NH_3-N (mg/l)	NO_3-NO_2-N (mg/l)	Total Phosphorus (mg/l)	Pb (µg/l)	Cr (µg/l)	Cd (µg/l)	Cu (µg/l)	Zn (µg/l)	Suspended Solids (mg/l)	Volatile Suspended Solids (mg/l)	Total Solids (mg/l)	Total Volatile Solids (mg/l)	Settleable Solids (ml/l)	Residual Cl_2 (mg/l)
0892	I	3	30/31	76	24 hr. comp.	500	933	32.3	19.5	.02	15	50	170	<20	80	390	280	245	1086	430	9.0	--
0909		3/4	31/1	76	24 hr. comp.	400	748	25.2	15.2	.03	14.4	130	170	<20	80	330	330	250	99[illegible]	406	7.0	--
0925		4	1/2	76	24 hr. comp.	480	821	26.5	22	.01	15	80	120	<20	70	270	270	215	964	380	--	--
0882	E	3	30	76	0915	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5.27
0893		3	30/31	76	24 hr. comp.	--	95	14.5	10.8	.03	13.8	<50	80	<20	30	60	19.5	15	627	303	0.4	--
0909		3/4	31/1	76	24 hr. comp.	162	952	35.0	11.2	.04	15	240	410	<20	160	860	640	530	1319	632	250	--
0927		4	1/2	76	24 hr. comp.	13.6	65	8.8	3.0	.04	2.8	60	60	<20	<20	60	15	12	590	72	--	--
0895	E-2	3	31	76	1030	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	<.05
0925		4	1	76	1450	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5.27
0881	PE	3	30	76	1545	--	--	--	15	--	--	--	--	--	--	--	--	--	--	--	--	--
0894		3	30/31	76	24 hr. comp.	290	545	24.2	17.9	.01	13.8	<50	145	<20	55	230	90	87	--	--	--	--
0910		3/4	31/1	76	24 hr. comp.	238	441	22.8	15.8	<.01	13	60	150	<20	50	190	132	112	944	200	--	--
0928		4	1/2	76	24 hr. comp.	280	543	29.7	23	.02	15	60	120	<20	50	190	140	114	--	--	--	--

*See study methods

Appendix A (continued)
Laboratory Data
Albany Wastewater Treatment Plant
Albany, Georgia

Special COD Analyses

[illegible]	STATION	MONTH	DAY	YEAR	TIME	COD (mg/l)
0930	1-1	3/4	31/1	76	0900	703
	2				1000	893
	3				1100	743
	4				1200	925
	5				1300	759
	6				1400	937
	7				1500	917
	8				1600	948
	9				1700	917
	10				1800	1280
	11				1900	1031
	12				2000	664
	13				2100	601
	14				2200	913
	15				2300	597
	16				2400	684
	17				0100	601
	18				0200	1059

[illegible] with each individual hourly sample being preserved for COD analysis as a check for high loading from batch discharging.

Appendix A (continued)
Laboratory Data
Albany Wastewater Treatment Plant
Albany, Georgia

Special COD Analyses

[illegible]	STATION	MONTH	DAY	YEAR	TIME	COD (mg/1)
0930 (cont'd)	19	3/4	31/1	76	0300	775
	20				0400	680
	21				0500	553
	22				0600	514
	23				0700	522
	24				0800	1074

Appendix A (continued)
Laboratory Data
Albany Wastewater Treatment Plant
Albany, Georgia

Aeration Basins

O+M SRD #	STATION	MONTH	DAY	YEAR	TIME	SETTLOMETER (settled sludge volume) 5 min	10 min	15 min	20 min	25 min	30 min	40 min	50 min	60 min	COMMENTS	% Solids Centrifuge	Suspended Solids (mg/l)	Volatile Suspended Solids (mg/l)		NH_3 (mg/l)
0876	A-1	3	30	76	0900	99	98	96	96	95	95	90	88	84	Fluffy; mounded	5.5	3300	2650		—
0877	A-2	3	30	76	0900	99	98	96	96	95	93	88	83	78	settled unevenly	5.5	3275	2650		—
0887	A-3	3	30	76	1545	—	—	—	—	—	—	—	—	—	— — —	—	—	—		13.5
0896		3	31	76	1115	99	99	97	95	95	94	90	86	83	fluffy, uneven	5.0	3125	2625		—
0913		4	1	76	0940	97	96	94	91	89	86	80	75	73	settling	--	3075	2475		—
0929		4	2	76	0850	98	95	95	95	85	80	73	70	68	clear supernatant	--	—	—		—
0888	A-4	3	30	76	1545	--	--	--	--	--	--	--	--	--	— — —	--	—	—		13.0
0897		3	31	76	1115	99	99	98	96	95	93	89	88	80		5.0	3200	2750		—
0914		4	1	76	0940	98	97	93	92	90	89	85	84	80		—	3075	2500		—
0889	A-5	3	30	76	1545	—	—	—	—	—	—	—	—	—		—	—	—		12.2
0898		3	31	76	1115	99	99	98	96	93	88	84	80	77		5.1	3075	2575		—
0916		4	1	76	0940	97	96	95	94	94	90	87	84	80		—	3180	2690		—
0890	A-6	3	30	76	1545	—	—	—	—	—	—	—	—	—		—	—	—		13.0
0899		3	31	76	1115	99	99	98	94	90	88	80	70	75		6.0	3150	2600		—
0917		4	1	76	0940	98	97	95	94	94	94	94	94	85		—	3275	2675		—

Appendix A (continued)
Laboratory Data
Albany Wastewater Treatment Plant
Albany, Georgia

Nitrification Basins and Final Clarifiers*

Lab No.	STATION	MONTH	DAY	YEAR	TIME	Suspended Solids (mg/l)	Volatile Suspended Solids (mg/l)	Total Solids (mg/l)	Total Volatile Solids (mg/l)	% Solids by Centrifuge	SETTLOMETER (Settled Sludge Volume)									COMMENTS	Turbidity NTU	NH3 (mg/l) by field probe	NH3 (mg/l)	Total-P (mg/l)
0883	N-1	3	30	76	1330					2.8	35	26	23	22	--	18	17	17	17	Turbid Supernatants				
0585	↓	3	30	76	1545															Floated		5.0	.68	34.0
0918	↓	4	1	76	0945	1840	1480	2431	1450	2.8	43	35	32	30	28	26	25			Floated at 44 min				
0584	N-2	3	30	76	1330					[illegible]	98	97	96	95	--	91	89	84	81	Fluff[illegible]				
*0919	↓	4	1	76	0945	4533	3700	4756	3354	6.0	97	97	91	82	75	70	60	58	56	clear supernatant				
0878	FC-1	3	30	76	0900																4.0			
0900	↓	3	31	76	1115																730			
0920	↓	4	1	76	1000																9.0			
0879	FC-2	3	30	76	0900																7.0			
0901	↓	3	31	76	1115																750			
0921	↓	4	1	76	1000																8.0			
0880	FC-3	3	30	76	0900																9.0			
0902	↓	3	31	76	1115																800			
0922	↓	4	1	76	1000																10.0			
0881	FC-4	3	30	76	0900																7.0			
0903	↓	3	31	76	1115																1260			
0923	↓	4	1	76	1000																8.0			
*0556	N-2	3	30	76	1545																	25.6	17	

Appendix A (continued)
Laboratory Data
Albany Wastewater Treatment Plant
Albany, Georgia

Thickener Overflow, Centrate, Anaerobic Digestors and Return Sludge

O&M SRD #	STATION	MONTH	DAY	YEAR	TIME	BOD_5 (mg/1)	COD (mg/1)	TKN-N (mg/1)	NH_3-N (mg/1)	NO_3-NO_2-N (mg/1)	Total Phosphorus (mg/1)	Pb (μg/1)	Cr (μg/1)	Cd (μg/1)	Cu (μg/1)	Zn (μg/1)	Suspended Solids (mg/1)	Volatile Suspended Solids (mg/1)	% Solids Centrifuge		Total Solids (mg/1)	Total Volatile Solids (mg/1)	Temperature	pH
0904	TO-1	3	31	76	1345	740	1675	59.0	29.2	.01	36.5	260	540	<20	220	910			1.0		—	—		
0911		4	1	76	1400	1320	2690	77	20	.02	42	500	810	<20	370	1730			—		—	—		
0905	CT-1	3	31	76	1400	7400	39754	780	440	--	300	7400	8400	<80	4800	29200			18.0		—	—		
0912		4	1	76	1430	10000	40147	700	455	--	300	6200	6400	<80	4160	24800			—		—	—		
0906	AD-P	3	31	76	1530			860	460	--	485	5800	16800	<80	10000	58400			—		—	—	32	5.
0907	AD-S	3	31	76	1530			650	350	--	285	15000	14400	<80	7200	34400			—		—	—	24	6
0924	RS-1	4	1	76	1400						--	--	--	--	--	--	10850	8784	20.0		10926	8338		
0931		4	2	76	1000						--	--	--	--	--	--	9433	7667	--		—	—		

APPENDIX A (continued)

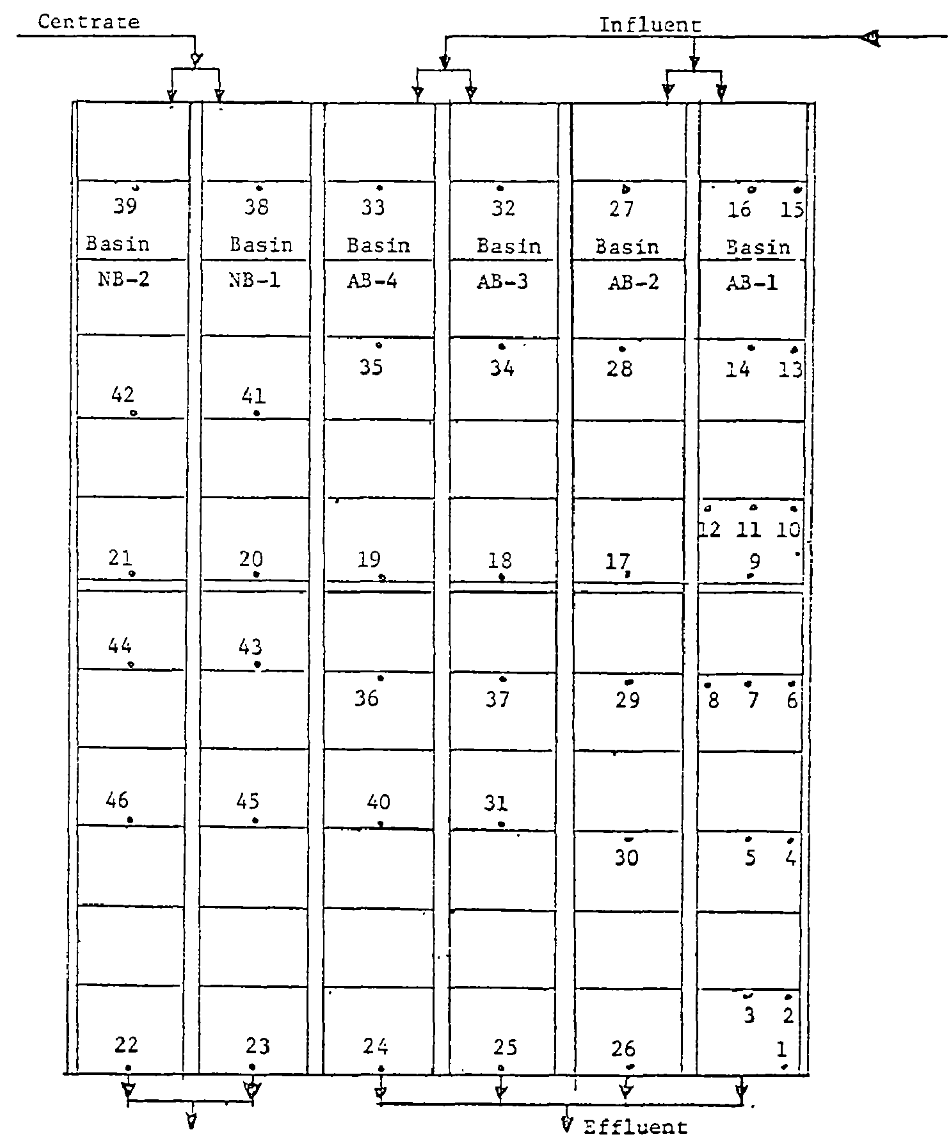
Hourly pH Reading on Influent Wastewater
Albany, Georgia

Date 1976	3/30		3/30		3/31		3/31		4/1		4/1		4/2	
	Time	pH	Time	pH	Time	pH	Time	pH	Time	pH	Time	pH	Time	pH
	AM 1:00		PM 1:00	5.9	AM 1:00	6.6	PM 1:00	6.6	AM 1:00	6.7	PM 1:00	6.4	AM 1:00	6.5
	2:00		2:00	7.0	2:00	7.1	2:00	6.9	2:00	6.9	2:00	6.6	2:00	6.5
	3:00		3:00	6.7	3:00	6.9	3:00	6.9	3:00	7.0	3:00	6.5	3:00	6.5
	4:00		4:00	6.4	4:00	6.8	4:00	6.8	4:00	6.9	4:00	6.5	4:00	6.5
	5:00		5:00	6.3	5:00	6.9	5:00	6.7	5:00	6.7	5:00	6.4	5:00	6.5
	6:00		6:00	7.1	6:00	6.9	6:00	6.3	6:00	6.7	6:00	6.5	6:00	6.6
	7:00		7:00	6.9	7:00	6.8	7:00	6.7	7:00	6.8	7:00	6.5	7:00	6.6
	8:00	6.6	8:00	7.1	8:00	6.7	8:00	6.8	8:00	6.3	8:00	6.5	8:00	
	9:00	7.0	9:00	7.4	9:00	6.6	9:00	6.5	9:00	6.3	9:00	6.5	9:00	
	10:00	6.2	10:00	7.7	10:00	6.8	10:00	6.8	10:00	6.6	10:00	6.6	10:00	
	11:00	5.0	11:00	6.5	11:00	6.5	11:00	6.9	11:00	6.3	11:00	6.5	11:00	
	Noon 12:00	6.3	12:00	7.8	Noon 12:00	6.8	12:00	6.9	12:00	6.6	12:00	6.4	Noon 12:00	

Appendix B
Dissolved Oxygen Profiles
Albany, Georgia

Basin	Station	Temp °C	3/30/76 1000 - 1100 D.O. mg/l @ specified depth 1 ft.	5 ft.	10 ft.	12 ft.	15 ft.
AB-1	1	26	0.8	0.6			
	2	26		0.6			
	3	26	0.7	0.4		0.2	0.2
	4	26		0.6	0.2		
	5	26	0.1	0.2		0.0	0.0
	6	26		0.2		0.2	
	7	26	0.1	0.0		0.1	0.0
	8	26	0.1	0.0		0.0	0.0
	9	26	0.4	0.0		0.0	0.0
	10	26	0.1	0.0		0.0	0.0
	11	26	0.0	0.0		0.0	0.0
	12	26	0.1			0.0	
	13	26	0.1	0.0		0.0	
	14	26	0.2	0.1		0.1	
	15	26	0.2	0.2		0.1	0.1
	16	26	0.2	0.1		0.1	0.1
AB-2	17	26	0.3			0.3	
	26						
	27						
	28						
	29						
	30						
AB-3	18	26	0.4			0.2	
	25						
	31						
	32						
	34						
	37						
AB-4	19	26	0.4			0.2	
	24						
	33						
	35						
	36						
	40						
NB-1	20	26	3.7			3.4	
	23	26	5.7				
	38						
	41						
	43						
	45						
NB-2	21	26	0.2			0.1	
	22	26	0.6				
	39						
	42						
	44						
	46						

Aeration Basin D.O. Profile Stations



Appendix B continued

Dissolved Oxygen Profiles

Albany, Georgia

		3/31/76 1450-1515			4/1/76 1115-1530			4/2/76 0945-1030		
			D.O. mg/1			D.O. mg/1			D.O. mg/1	
Basin	Station	Temp °C	1 ft.	5 ft.	Temp °C	1 ft.	5 ft.	Temp °C	1 ft.	5 ft.
AB-1	1	27	1.8	1.1	26	2.6	2.4	26	4.6	4.2
	2									
	3									
	4									
	5				26	1.7	1.4			
	6									
	7				26	0.6	0.4	26	3.2	3.0
	8									
	9	27	1.8	1.4	26	2.0	1.0		3.0	2.7
	10									
	11									
	12									
	13									
	14				26	0.1	0.0			
	15									
	16				26	0.1	0.0	26	0.4	0.3
AB-2	17	27	0.2	0.1	26	0.2	0.1	26	0.6	0.4
	26	27	0.5	0.7	26	0.5	0.3	26	3.6	3.6
	27				26	0.1	0.0	26	0.3	0.3
	28				26	0.1	0.1			
	29				26	0.4	0.2			
	30				26	0.3	0.2			
AB-3	18	27	0.2	0.1	26	0.7	0.5	26	1.6	1.4
	25	27	0.2	0.1	26	1.4	1.4	26	3.8	3.7
	31				26	0.2	0.1			
	32				26	0.4	0.2	26	0.1	0.0
	34				26	0.2	0.1	26	0.3	0.2
	37				26	0.2	0.1	26	2.9	2.7
AB-4	19	27	1.2	0.7	26	0.6	0.4	26	2.8	2.8
	24	27	0.6	0.8	26	2.4	2.5	26	4.2	4.4
	33				26	0.2	0.1	26	0.2	0.1
	35				26	0.6	0.6	26	0.8	1.2
	36				26	0.2	0.1	26	3.6	3.2
	40				26	0.4	0.1			
NB-1	20	28	0.6	0.4	26	2.7	2.2	24	5.2	5.0
	23	27	5.1	5.0	26	4.2	4.0	24	6.6	6.4
	38				26	0.2	0.1	25	0.6	0.8
	41				26	1.9	1.7			
	43				26	4.6	4.3			
	45				26	4.0	3.8			
NB-2	21	28	0.2	0.1	26	0.2	0.1	26	0.4	0.1
	22	28	0.5	0.2	26	0.4	0.2	26	2.2	2.2
	39				28	0.1	0.0	27	0.0	0.0
	42				28	2.2	0.1			
	44				28	0.4	0.2			
	46				28	0.2	0.1			

APPENDIX C
GENERAL STUDY METHODS

To accomplish the stated objectives, the study included extensive sampling, physical measurements and daily observations. Plant influent, primary effluent, and WTP effluent Stations I, PE, and E, respectively, were sampled for three consecutive, 24 hour periods with ISCO Model 1392-X automatic samplers. Aliquots of sample were pumped at hourly intervals into individual refrigerated glass bottles which were composited proportional to flow at the end of each sampling period.

An additional sampler was installed at Station I to collect individual hourly samples for COD analysis. A Steven stage recorder was installed on the WTP effluent to determine plant flows. An additional recorder was installed on the aeration basin influent. Hourly WTP totalizer flows were used for all inplant stream flows during the study period.

Dissolved oxygen was determined initially at all stations throughout the plant, and thence daily at stations in the aeration basins using a YSI Model 51A dissolved oxygen meter.

Hourly influent pH variations were determined from the individual samples of the 24 hour composites. Daily pH determinations were made at selected stations on the plant site.

Temperature was recorded while measuring the dissolved oxygen concentration. Individual samples of the two, 24 hour compositing periods were used to determine hourly influent pH variation.

Depth of the secondary clarifier sludge blankets was determined daily using equipment suggested by Alfred W. West, EPA, NFIC, Cincinnati.

Sludge activity was determined by the oxygen uptake procedure presented in Appendix E.

A series of standard operational control tests were run daily:

- Settleability of mixed liquor suspended solids (MLSS) as determined by the settlometer test.
- Percent solids of the mixed liquor and return sludge determined by centrifuge.
- Suspended solids and volatile suspended solids analysis on the aeration basin mixed liquor and return sludge.
- Turbidity of each final clarifier effluent.

Rhodamine WT fluorescent dye was used to determine the flow pattern and the actual detention time of the clarifiers.

The BOD_5 procedure deviated from standard methods (8). Samples were set up at the study site and transported within the incubator to Athens, GA. The samples were removed to an incubator at the laboratory facility. Time of travel was four hours, and incubator temperature on arrival at Athens was 21°C. Temperature determination was made using a calibrated thermometer placed in a BOD bottle of distilled water incubated along with the samples.

An amperometric titrator (Fischer & Porter Model 17T1010) was used to determine effluent chlorine concentrations.

Visual observations of individual unit processes were recorded.

Mention of trade names or commercial product does not constitute endorsement or recommendation for use by the Environmental Protection Agency.

APPENDIX D
Activated Sludge
Formulae Used For General Calculations

Aeration Basin

1. lbs. of solids in aeration basin
   Basin volume = m.g.; MLSS (conc.) = mg/l
   (MLSS conc) x (Basin vol.) x 8.34 = lbs. of solids

2. Aeration basin loading (lbs. BOD or COD/day)
   Inf. flow to aeration basin = mgd
   Inf. BOD or COD = mg/l
   (BOD or COD) x flow x 8.34 = lbs. BOD or COD/day

3. Sludge Age (days)
   MLSS conc. (avg. of daily values) = mg/l
   Aeration Basin Vol. = m.g.
   TSS, Primary Eff. or Basin Inf. conc. = mg/l
   Plant Flow = mgd

$$\frac{(\text{MLSS}) \times (\text{Basin Vol.}) \times (8.34)}{(\text{TSS}) \times (\text{Flow}) \times 8.34}$$

4. Sludge Vol. Index (SVI)
   30 min. settleable solids (avg. of daily values) = %
   MLSS conc. = mg/l

$$\frac{(\%,\ 30\ \text{min. set. solids}) \times (10{,}000)}{\text{MLSS}}$$

5. Sludge Density Index (SDI)
   SVI Value $\frac{100}{\text{SVI}}$

6. Detention time (hours)
   Volume of basins = gal.
   Plant flow = gal./day
   Return sludge flow = gal./day

$$\frac{\text{Basin volume} \times 24}{(\text{Flow}) + (\text{Return sludge flow})}$$

7. F/M Ratio (Food/Microorganism) BOD or COD
   Basins Inf. BOD_5 conc. (avg. or daily value) = mg/l
   Basins Inf. COD conc. (avg. or daily value) = mg/l
   Plant Flow = mgd
   MLVSS conc. (avg. or daily value, note Volatile SS) = mg/l
   Basin Vol. = m.g.

$$\frac{(BOD_5\ \text{conc.}) \times (\text{plant flow}) \times (8.34)}{(\text{MLVSS}) \times (\text{Basin Vol.}) \times 8.34} = \text{lbs. BOD/lb. MLVSS}$$

$$\frac{(\text{COD conc.}) \times (\text{plant flow}) \times (8.34)}{(\text{MLVSS}) \times (\text{Basin Vol.}) \times (8.34)} = \text{lbs. COD/lb. MLVSS}$$

8. Mean cell residence time (MCRT) = days
   MLSS conc. (avg. or daily value) = mg/l
   Basin vol. = m.g.
   Clarifier vol. = m.g.
   Waste activated sludge conc. = mg/l
   Waste activated sludge flow rate = mgd
   Plant effl. TSS = mg/l
   Plant flow = mgd

$$\frac{(\text{MLSS}) \times (\text{Basin vol.} + \text{Clarifier vol.}) \times 8.34}{(\text{Waste activated sludge conc.}) \times (\text{waste flow}) \times 8.34 + (\text{Plant effl. TSS} \times \text{plant flow} \times 8.34)} = \text{days}$$

Clarifier

1. Detention time = hours
   Plant flow to each clarifier = gals/day
   Individual clarifier vol. = gals.

$$\frac{(\text{clarifier Vol. (each)}) \times 24}{\text{Plant flow} + \text{Return Sludge Flow}} = \text{hours}$$

2 Surface loading rate = gal./day/sq. ft.
   Surface area/clarifier = sq. ft.
   plant flow to clarifier = gal./day

$$\frac{\text{Plant flow to clarifier}}{\text{Clarifier surface area}} = \text{gal./day/sq. ft.}$$

3. Weir Overflow Rate (gal./day/lin. ft.)
   Weir Length = ft.
   Plant flow to clarifier = gal./day

$$\frac{\text{Plant flow}}{\text{Weir length}} = \text{gal./day/lin. ft.}$$

APPENDIX E

OXYGEN UPTAKE PROCEDURE 1/

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:

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

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 effect 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 factor means abundant, acceptable feed under favorable conditions. A small LF means dilute feed, incipient toxicity, or unfavorable conditions. A negative LR indicates that something in the wastewater shocked or poisoned the "bugs."

1/ 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 F
DESIGN DATA
THE METROPOLITAN ALBANY WASTEWATER TREATMENT PLANT
ALBANY, GEORGIA

DESIGN FLOW	
Average	20 mgd
Peak	60 mgd
PRELIMINARY TREATMENT	
Bar Screen	
Number	2 units, mechanically cleaned
Screening range	0.5 to 5.0 $ft.^3$/mg
Capacity	30 mgd
Bar Spacing	1 inch
Velocity	0-3 ft./sec.
Area	15.5 $ft.^2$
Slope	84 inches
Parshall Flumes	
Number	2 units
Dimension	
Width	4.5 ft.
Height	7.42 ft.
Throat	3 ft.
Capacity	0-30 mgd each
Grit Removal	
Number	2 units, aerated
Dimensions	
Length	53 ft.
Width	20 ft.
Depth	17 ft.
Capacity	30 mgd each
Velocity	1 ft./sec.
Blowers	3 units
Capacities	30 hp each, 757 CFM @ 7 psi
Surface Loading	14, 150 gal./day 1 $ft.^2$
Raw Sewage Pumping Station	
Number and Capacities	6 - 4900 gpm @ 75 hp
	2 - 2100 gpm @ 30 hp
PRIMARY CLARIFIER	
Number of tanks	4 rectangular
Dimensions	
Length	78.67 ft.
Width	40 ft.
Depth	11.42 ft.
Wetted Volume	35,936 $ft.^3$ each
	268,800 gal. each
	143,746 $ft.^3$ Total
	1,075,200 gal. Total

Detention Time @ 20 mgd	1.29 hours
Surface Loading Rate	1,589 gal./day/ft.^{2}
Sludge Collectors Ea. Tank	2' longitudinal 1 cross
Sludge Pumps	
Number Weirs	2 (plunger type)
Weir Overflow Rate	25,000 gal./day/LF
Number Weirs	twin sets of 6/tank
Length	8.25 ft.
AERATION BASINS	
Number of Basins	6 Total 2 nitrification 4 aeration
Dimensions	
Length	303 ft.
Depth	16 ft.
Width	30 ft.
Volume	136,350 ft.^{3} 1,022,625 gal. each 545,400 ft.^{3} Total (4) 4,090,500 gals. Total (4)
Detention Time w/o Recirculation	4.91 hours
with 50% or 10 mgd Recirculation	3.01 hours
Aeration	
Number of Blowers	7 w/total hp of 1650 2 piped to deliver 4 psi @ constant speed 3 piped to deliver 4 or 8 psi @ constant speed 2 piped to deliver 4 or 8 psi @ @ variable speed
Diffusers	72 units (B-4 swing)
Rate O_2 Transfer	1.04 cfm/lb. BOD
FINAL CLARIFIER	
Number	4 units circular, centerfed
Dimensions	
Diameter	90 ft.
Depth	11.08 ft.
Weir Length	1,130.4 ft.

Volume	70,450 $ft.^3$ each 528,390 gals. each 282,000 $ft.^3$ Total 2,114,000 gals. Total
Detention Time	2.5 hours
Surface Loading	786 $gal./day/ft.^2$
Overflow Rate	17,700 gal./day/ft.
Return Sludge Pumping Station	
Number	6 (centrifugal) 4 activated sludge 1 feed nitrification tank 1 waste sludge
Minimum Ratings	30-50 hp
Variable Capacities	1,500 - 2,400 gpm
Scum Removal	
Number	2 (simplex plunger pumps)
Capacities	2 hp @ 105 gpm
SLUDGE THICKENER	
Primary Holding Tank	2 units
Dimension	
Length	33.50 ft.
Width	5.75 ft.
Depth	11.50 ft.
Blowers	2 @ 240 CFM each
Sludge Withdrawal Pumps	2 - 2 hp variable speed @ 102 gpm
Sludge Feed Pumps	4 - 7.5 hp variable speed
Thickening Tanks	4 units
Dimension	
Length	70 ft.
Width	18 ft.
Thickened Sludge Pumps	2 - 7.5 hp duplex plungers @ 225 gpm
Pressure Water Pump Station	
Number Supply Pumps	3 turbine pumps, 15 hp @ 1200 gpm
Number Return Pumps	3 - 15 hp @ 1,400 gpm
SLUDGE DIGESTION	
Digestion Tanks	
Number	4 units
Old	2 each
New	2 each
Dimensions	
Diameter	80 ft. all units
Depth	26.5 ft. new units 24 ft. old units

Volume Old	140,900 $ft.^3$ 1,054,000 gals. each
Volume New	151,600 $ft.^3$ 1,134,000 gals. each
Total Volume	585,000 $ft.^3$ 4,379,000 gals.
Sludge Recirculation Pumps	
Number	4 units 2 old 2 new rated 350 gpm @ 15 hp
Sludge Transfer Pumps	
Number	2 constant speed plungers rated 235 gpm @ 10 hp
Macerating and Centrifuge Feed Pumps	
Number	3 variable speed range 50 - 170 gpm @ 7.5 hp pump and 10 hp macerator
SLUDGE DEWATERING	
Centrifuges	
Number	3 (bowl scroll type)
Capability of Dewater	80 gpm
Range of Dewatering Capability (% solids)	6 - 90
Polymer System	
Mixing Tank	1 @ 1,500 gals.
Storage Tank	1 @ 1,500 gals.
Pumps	1 - Solution transfer rated 100 gpm @ 5 hp 3 - Chemical feed rate 16 gpm @ 1.5 hp
Sludge Cake Conveyor	
Belts	24-ft. wide
Capability	9 tons/hour @ constant speed of 50 ft./min. using a 0.5 hp reversible motor
Chlorination	
Chlorinators	
Number	4 units 3 vacuum operated 1 manually operated
Capacities	2 @ 6,000 lbs./day 2 @ 2,000 lbs./day