PRELIMINARY STUDIES ON A BIOLOGICAL FILTER

by

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Milwaukee, Wisconsin

for the

Environmental Protection Agency

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E.P.A. REVIEW NOTICE

ABSTRACT

A pilot horizontal biological filter similar to a trickling filter was constructed on Jackson Creek near Lake Delavan, Wisconsin. The filter consisted of a graded rock filter in three sections of four feet wide by two feet high by six feet long. Water was pumped through the filter with a retention time of seven minutes for each section, or twenty-one minutes for the whole eighteen feet of the filter.

Analyses were run before and after the filter. There was little or no effect of the filter on the bacteria or chemical elements tested which included the major nutrients. There was a substantial improvement in the B.O.D. and C.O.D. levels during the daylight hours when the biological activity in the filter improved the dissolved oxygen content of the water.

During the night there was no reduction of the B.O.D. and this may have been because of the extremely low dissolved oxygen content in the influent water ($<$1mg/L).

This report was submitted in fulfillment of Project Number 16080FTO, under the (partial) sponsorship of the Water Quality Office, Environmental Protection Agency.

CONTENTS

FIGURES

TABLES

TABLES (continued)

SECTION I

CONCLUSIONS

The water chemistry survey, both on a weekly basis for an eight week period and an hourly basis for a 36 hour period, showed little change between the input and output parameters. Similarly, there was little change between the input and output of the bacteriological parameters.

The B.O.D. was considerably reduced and reductions of 30% - 40% occurred but only during the daylight hours. The influent water contained less than 1 mg/L of oxygen and B.O.D. reductions at night could not be expected. However, during the day the biological activity of the photosynthetic organisms on the filter produced sufficient oxygen to raise the dissolved oxygen content of the water and provide the excess necessary for the "biological slime" on the rocks to reduce the B.O.D.

The primary advantage of the biological filter over other methods of stream purification is that the capital costs are low and the operating costs negligible.

Owing to time and budget restrictions, only limited data was collected on the horizontal biological filter concept. The optimum growth on the filter media occurred somewhat after the tests on the filter. However, the evaluation program was completed on a preliminary basis.

SECTION II

RECOMMENDATIONS

Further evaluation of the horizontal biological filter should be undertaken and the analysis evaluation should be centered around the B.O.D. removal possibilities. Tests on the filter should be designed so that the filter size, and flow rate and retention times within the filter are thoroughly investigated. Also, attention should be focused on the diurnal and seasonal aspects and the type of biological growth on the filter. Any future evaluation should also include the use of influent water with a substantial amount of dissolved oxygen present in the water and this could be achieved by cascading the water into the filter trough.

SECTION III

INTRODUCTION

During the summer of 1968 Limnetics, Inc., was retained by the Lake Delavan Fish and Game Association, Inc., to undertake an environmental survey of Lake Delavan, Walworth County, Wisconsin. The purpose of the survey was to ascertain the probable causes of the eutrophication of Lake Delavan. The report (Limnetics, Inc., 1968) was published in December, 1968, and several recommendations were made as to the causes and possible remedies to the eutrophication of Lake Delavan. Among the recommendations was a plan to form a sanitary district to correct the local septic tank problem and also to resolve the problems created by the inflowing water which contains both improperly treated sewage effluent and agricultural run-off. The problem of the sewage effluent has been partially resolved during the period of the study because of the upgrading of the City of Elkhorn sewage treatment plant.

However, despite various efforts to improve the inflow to Lake Delavan the water quality was still too poor to aid or allow any significant regeneration of the water quality of Lake Delavan.

The Lake Delavan Fish and Game Association, Inc., then asked Limnetics, Inc., to request a grant from the then Federal Water Pollution Control Administration to research the possibility of using a new technique to improve the water quality of the inflowing water. There were certain constraints on the mechanism to be used and these were:

1) Low capital costs.

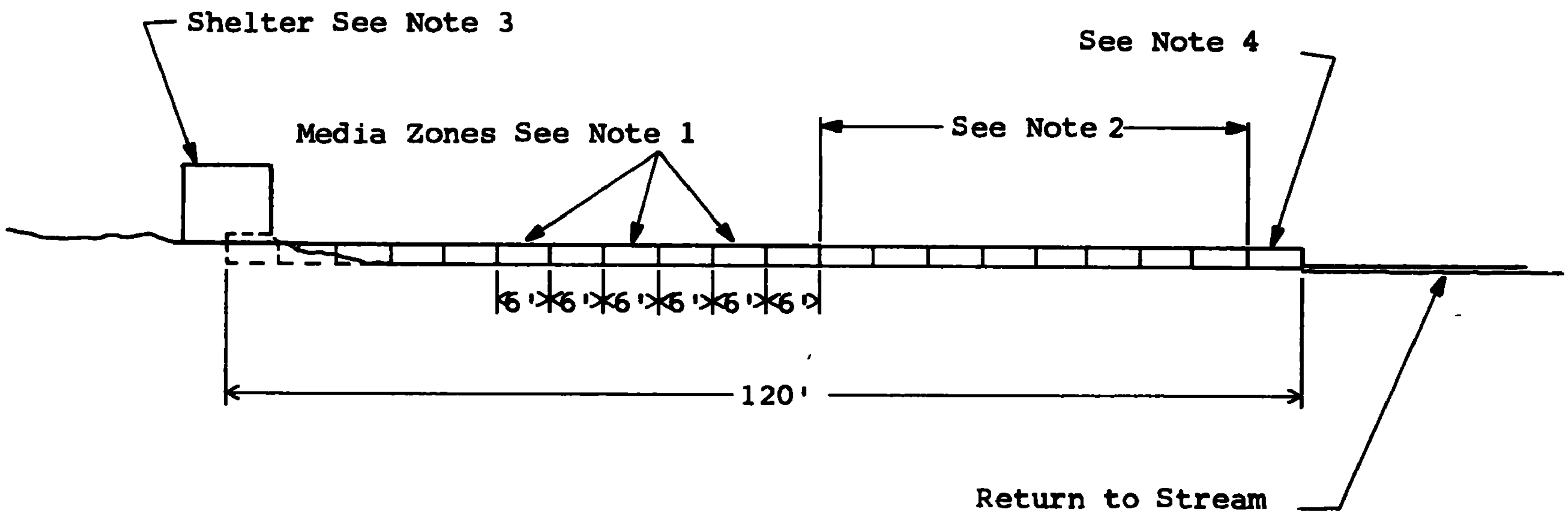
2) Low operational costs.

3) Ability to handle high volumes of water.

4) The mechanism must be applicable on a national basis.

With these constraints in mind, Mr. Jose Villate, Sanitary Engineer, with Limnetics, Inc., suggested that a horizontal version of the trickling filter could be built _in situ_ in a stream. From this concept a small pilot scale filter was designed, (figures 1-6).

A grant was received from the Environmental Protection Agency and the construction of a pilot scale horizontal biological filter undertaken. Photographs of the filter are presented in the appendices on page 104.



Notes:

1) Media Zones 1 thru 3 - See Fig. 2 For Detail

2) Space For Additional Media Zones

3) Experimental Station Shelter - See Fig. 1-C For Detail

4) Filter Discharge - See Fig. 1-B For Detail

FIGURE 1

Diagrammatic Sketch of the Biological Filter

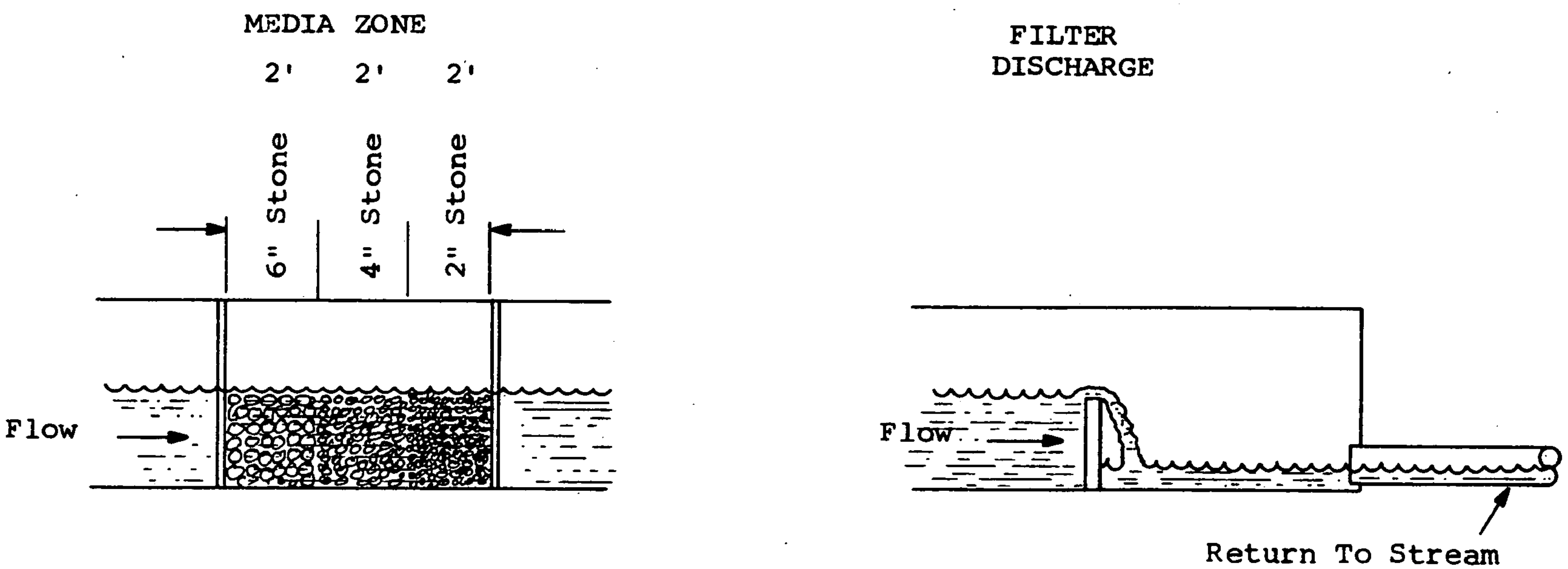


FIGURE 2

Longitudinal Crossection of the Media and the Discharge

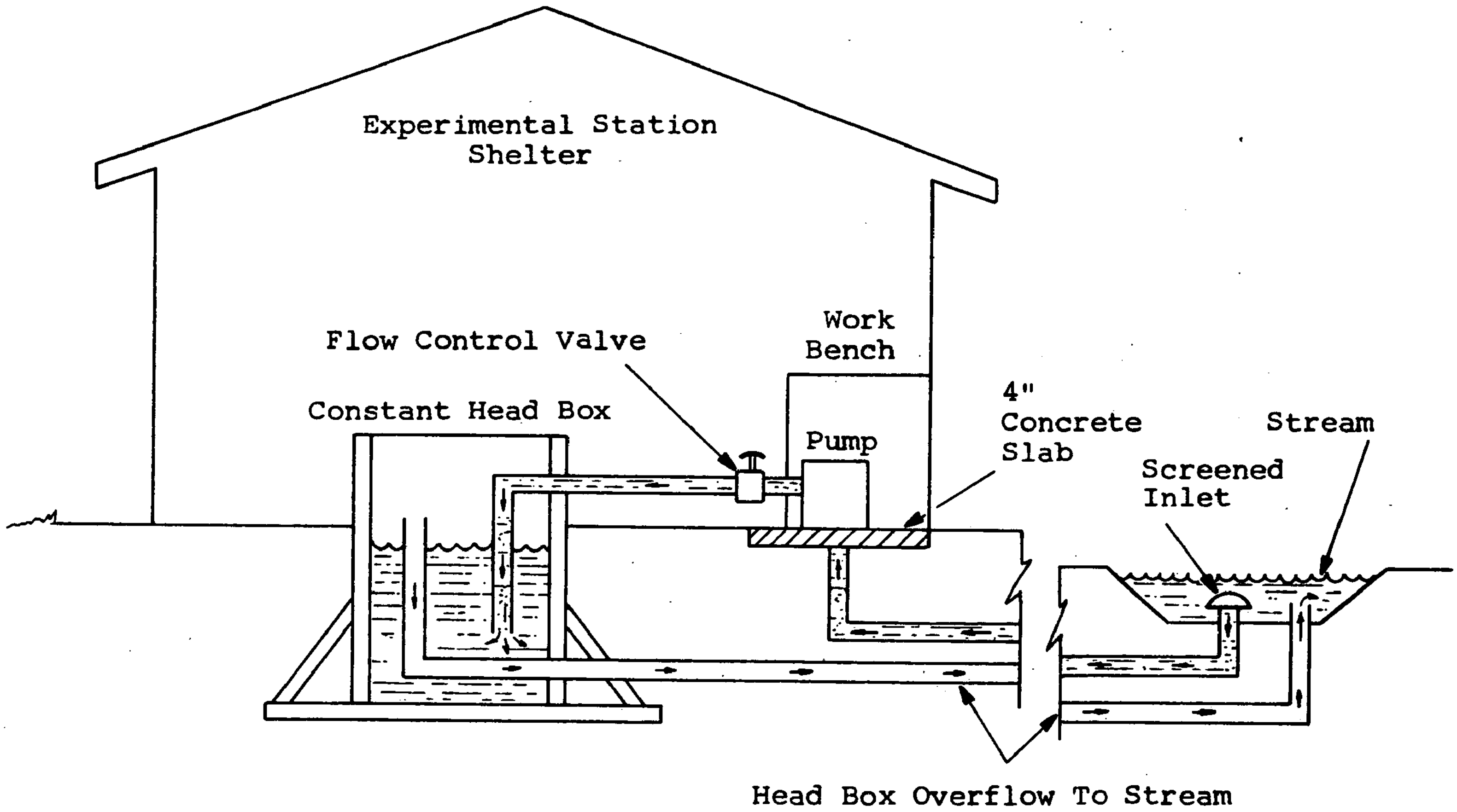
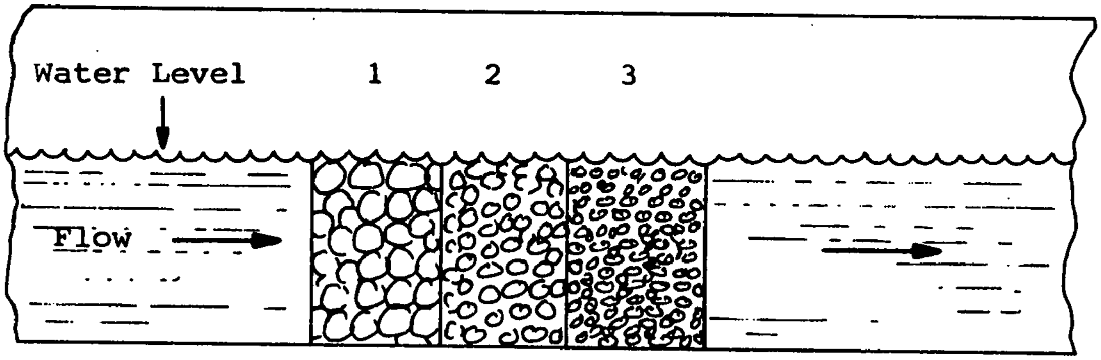


FIGURE 3

The Experimental Station Shelter and Pump System.



Size = 6 5/8" 4 3/8" 1 5/8"
Porosity = 0.50 0.45 0.37

FIGURE 4 Rock Size and Porosity Configuration

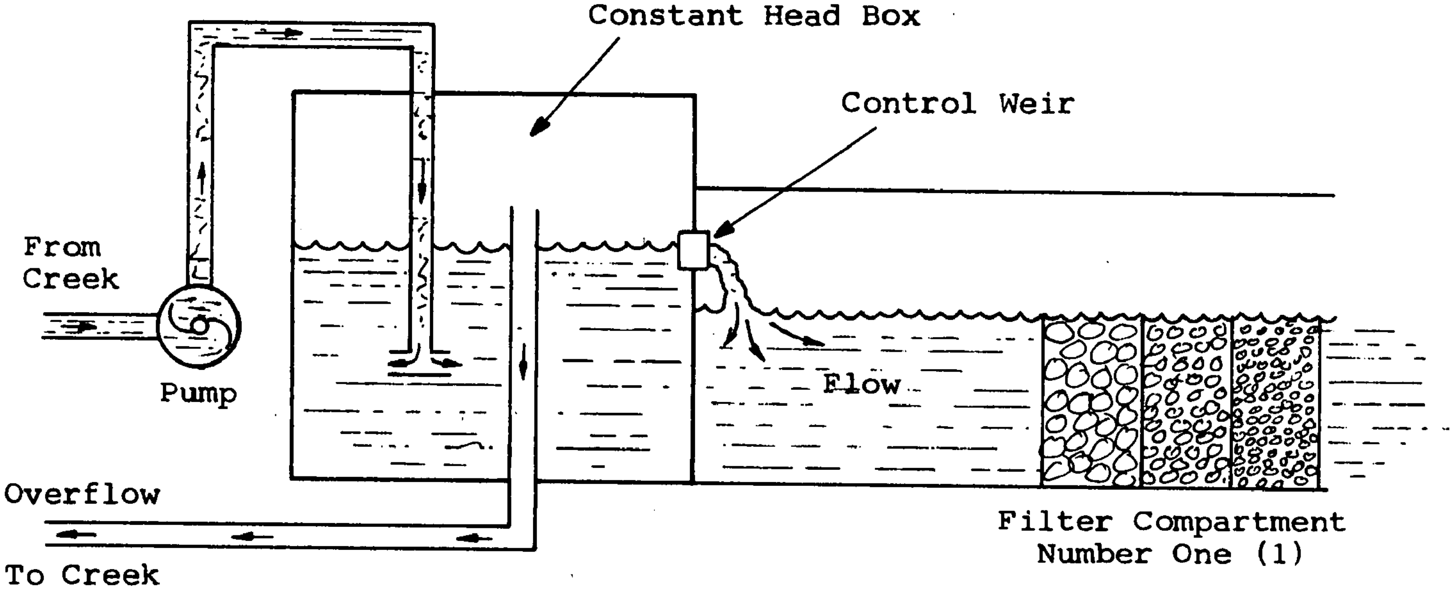


FIGURE 5 Pumping and Control System

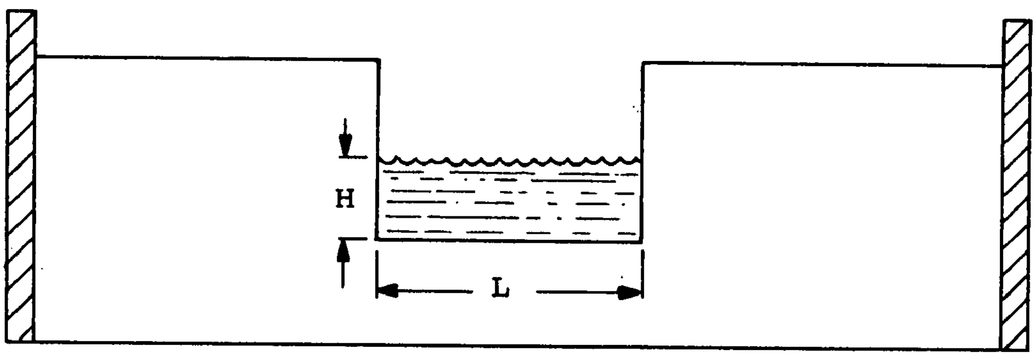


FIGURE 6 Weir Dimensions

SECTION IV

METHODS

All of the methods used in this report come from Standard Methods, 12th Edition, with the following exceptions:

Oxygen and temperature were measured using a Yellow Springs Instrument Company oxygen-temperature meter. The pH was measured with an Orion pH meter. Total phosphorus was measured according to the method in the 13th Edition of Standard Methods. All metals were run by atomic absorption. The bacteriological tests were undertaken according to the 13th Edition of Standard Methods using the millipore filter technique.

All results in the tables and figures are reported as milligrams per litre of sample except pH which is reported as pH units, temperature which is reported as degrees centigrade, and specific conductance which is reported as micro mhos per square centimeter at 20 degrees centigrade. Alkalinity is reported as milligrams per litre as calcium carbonate and hardness was calculated from the calcium and magnesium content and is reported as milligrams per litre as calcium carbonate.

All of the tests were run on the filter with the flow rate adjusted to a retention time of 21 minutes in the 18 feet of rock media.

SECTION V

THE BIOLOGICAL FILTER - HYDRAULICS

1. Physical Description

The pilot biological filter consists of a wooden flume 100 feet long with provisions for nine rock compartments, each consisting of three different sections. In the experiments conducted during this reporting period, only three compartments were used. A pump, constant head box, and control weir are employed to maintain a constant flow of water through the filter. The water is pumped up from Jackson Creek through an underground pipe system and is returned to the creek through an above ground pipe system. The filter is illustrated in figures 1-6.

2. Filter

The filter media are ordinary graded rocks as commonly used in vertical trickling filter sewage treatment systems. Rock compartments I, II, and III are identical in structure. Section 1 of rock compartment I through which the water flows first is identical to section 1 of compartments II and III, etc. However, sections 1, 2, and 3 of each rock compartment contain rocks of different sizes which were intended to be six, four, and two inch diameters, respectively. The actual rock sizes and shapes were measured on a random sampling basis and the results are given in tables 1, 2, and 3.

A summary of the data given in the tables indicates that the rocks are essentially "egg" shaped with the short dimension approximately 0.6 times the longer dimension. Assuming that the longer dimension characterizes the rocks, then approximately average sizes can be assigned to the rocks as follows:

Section Number:	1	2	3
Rock Size:	6-1/2 inches	4-3/8 inches	1-5/8 inches

3. Porosity Measurement

Porosity is a measurement of the void space within a porous medium relative to the bulk volume. A few simple tests were conducted on the graded rocks to determine the approximate porosities of the aggregated rock sections. In each case, a two and one-half gallon (10 quart) container was filled with the differently graded rocks and then filled up with water. The ratio of the amount of water required to fill the container divided by the container volume was used to characterize the porosity, P, of each rock section. The results are given below:

Section Number:	1	2	3
Section Porosity:	0.50	0.45	0.37

A diagram of one rock compartment illustrating the rock size, porosity, and configuration is presented in figure 2.

For porous media of different porosities in series, and of equal length sections, an effective porosity of the entire compartment can be determined from the harmonic mean, by equation (1) below:

$$P_{eff} = \frac{N}{\sum_{i=1}^{N} \frac{1}{P_i}} \qquad (1)$$

P_{eff} = total effective porosity of compartment

P_i = individual porosities of each section

$$P_{eff} = \frac{3}{\frac{1}{0.50} + \frac{1}{0.45} + \frac{1}{0.37}} = \frac{3}{6.95}$$

$$P_{eff} = \underline{\underline{0.43}}$$

Therefore, each rock compartment can be represented as a homogeneous aggregate of rocks with an effective porosity of 0.43. Consequently, each rock compartment when filled with water to its top, will have a volume of water equal to 0.43 times its bulk volume. Each rock compartment is 6' x 4' x 2' or 48 ft^3 in bulk volume and contains 0.43 x 48 ft^3 = 20.64 ft^3 of water flowing through its pores when filled to the top of the rocks (2 ft. high).

4. Flow Through the Filter

The horizontal flow of water through the filter is accomplished by maintaining a very slight pressure gradient between the front and end sections of the filter. Water is continuously pumped up from the creek and discharged into a constant head box through a low velocity diffuser system to prevent turbulence and encourage desiltation. Water is discharged from the constant head box through a measurement and control weir. The entire pumping and flow control system is illustrated in fugure 3.

5. Weir Data

For rectangular weirs with sharp crests, the discharge Q is:

$$Q = \frac{2}{3} \; CL \sqrt{2 \; q \; H^3} \qquad (2)$$

Q = discharge, ft^3/sec

C = weir coefficient

L = width, ft

g = grav. accel., 32.174 ft/sec^2

H = height of crest, ft.

$$\therefore Q = \frac{2}{3} C \; (.5) \sqrt{2(32.174) \;\; H^3}$$

$$= \frac{C}{3} \sqrt{64.248 \; H^3}$$

$$= \frac{8.02}{3} C \; H^{3/2} \; ft^3/sec$$

$$= 20 \; C \; H^{3/2} \;\; \text{gallon/sec}$$

C_{ave} found to be = 0.55 by calibration (figure 5).

$Q = 11 \;\; H \frac{3}{2}$ gallons/sec.

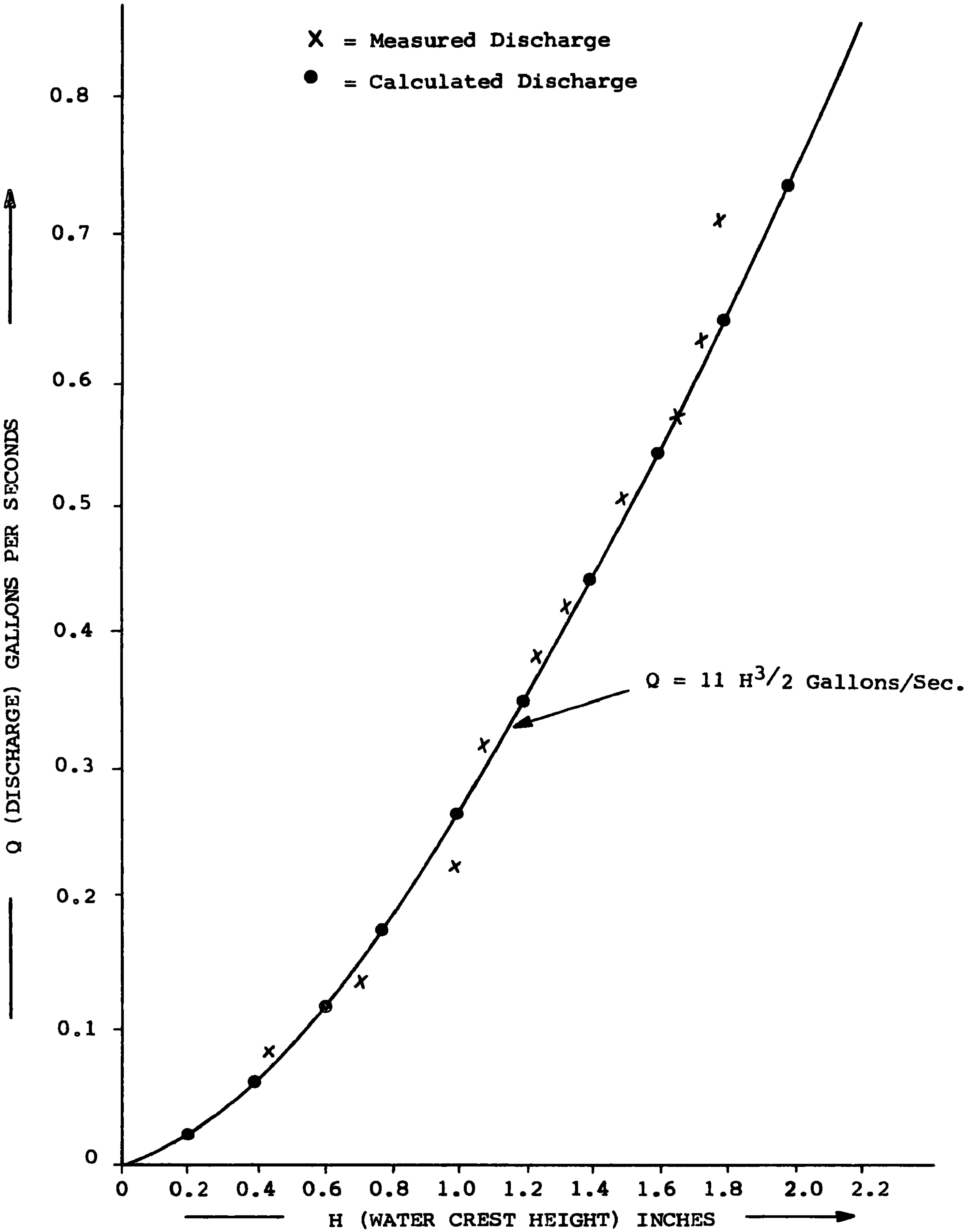


Figure 7 The Weir Calibration Curve

6. Weir Calibration Tests

Calibration tests were run on the weir by adjusting the pump control valve for various crest heights (H) and then recording the time for the discharged flow over the weir to fill a two and one-half gallon container. The results are tabulated in table 4 and illustrated in figure 5.

7. Velocities and Retention Times

Each rock compartment is six feet long (see figure 1) and the distance between each rock compartment is also six feet. The cross sectional area of the rock compartment is 4 ft x 2 ft = 8 ft^2, but the rocks reduce the available flow area by the average porosity. Therefore, the effective flow area is equal to:

$$A_{eff} = P \times \text{area} = .43 \times 8\ ft^2 = 3.45\ ft^2 \quad (4)$$

Assume a flow adjustment of H = 1.25 inches:

$$Q = 11\ H^{3/2}\ \text{gallons/sec}$$

$$= .365\ \text{gallons/sec}$$

$$= 31{,}500\ \text{gallons/day}$$

$$Q = .049\ ft^3/sec$$

$$V = Q/A$$

In open channel spaces between compartments where A = 8 ft^2:

$$V_{OC} = \frac{.049 \text{ ft}^3/\text{sec}}{8 \text{ ft}^2} = \underline{\underline{.0061 \text{ ft/sec}}}$$

In the rock compartments where the effective area is restricted to 3.45 ft^2:

$$V_{RC} = \frac{.049 \text{ ft}^3/\text{sec}}{3.45 \text{ ft}^2} = \underline{\underline{.0142 \text{ ft/sec}}}$$

Time to flow through one rock compartment:

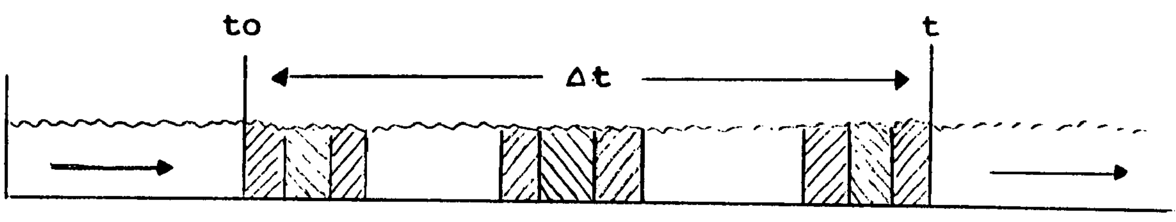
$$T_{RC} = \frac{\text{length} \quad (6 \text{ ft})}{\text{velocity} \ (.0142 \text{ ft/sec})}$$
$$= 420 \text{ seconds} \quad = \quad 7 \text{ minutes}$$

and total retention time = 3 x 7 = 21 minutes,

but total travel time includes open channel flow:

$$T_{OC} = \frac{6 \text{ ft}}{.0061 \text{ ft/sec}} = 980 \text{ seconds}$$
$$= 16.3 \text{ minutes}$$

time to travel through entire filter = t - to = Δt



$$\Delta t = 3 \times 7 \text{ minutes} + 2 \times 16.3 \text{ minutes}$$
$$= 21 + 32.6 = \underline{\underline{53.6 \text{ minutes}}}$$

but time to travel entire filter (100 ft) $= \Delta T$

$$\Delta T = 21 \text{ minutes} + \frac{82 \text{ ft}}{.0061 \text{ ft/sec}}$$

$$= 21 \text{ minutes} + 224 \text{ minutes} = 245 \text{ minutes}$$

$$\approx \underline{\underline{4 \text{ hours}}}$$

8. Reynolds Number Considerations

The Reynolds number for the filter flow is defined below:

$$R = \frac{VD}{\nu} \qquad (5)$$

V = velocity, ft/sec

D = rock diameter, ft

ν = kinematic water viscosity, ft^2/sec

For water at 60°F., $\nu = 1.217 \times 10^{-5}$ ft^2/sec. Therefore, for rock diameters of four inches average, and rock compartment velocities as previously computed:

$$R = \frac{(6.1 \times 10^{-3} \text{ ft/sec})\ (.33 \text{ ft})}{1.217 \times 10^{-5} \text{ ft}^2\text{/sec}}$$

$$R = \frac{201}{1.217} = \underline{\underline{165}}$$

For applications of the linear Darcy Flow equation, R should not be greater than 10. Consequently, this Reynolds number is too high for Darcy's equation to be applied for the filter flow. The maximum flow rate can be computed which would allow applying the Darcy equation for describing the filter flow.

Assuming a generous critical Reynolds number of 10, then:

$$V \text{ critical} = \frac{(R \text{ critical})\ (\nu)}{D} \qquad (6)$$

$$= \frac{(10)\ (1.217 \times 10^{-5}\ ft^2/sec)}{.33\ ft}$$

$$= \frac{121.7 \times 10^{-6}}{.33\ ft} = \underline{\underline{3.7 \times 10^{-4}\ ft/sec}}$$

This velocity would correspond with a flow rate Q of approximately 800 gallons/day through the pilot filter, which is not practical, since it is too small for consideration.

9. Conclusion

The flow in the filter can possibly be described by modified open channel flow equations or by one of the high velocity corrections to Darcy's equation. Lindquist (1933) carried out many experiments on this subject and concluded that for Reynolds numbers between four and 180, a modified equation could be used:

$$RF = aR + b$$

where F = a flow friction factor

a = 40

b = 2500

Further work into applying the above equation, or some other high velocity correction for porous media flow, should be performed during a second year program to further evaluate the hydraulics of the filter.

SECTION VI

HYDROLOGIC BACKGROUND

1. Jackson Creek Watershed

Jackson Creek is located in Walworth County in the southeastern corner of Wisconsin. This creek drains a watershed of approximately 20 square miles or 12,800 acres and provides the major flow into Lake Delavan, an 1800 acre residential and recreational lake. The outflow of Lake Delavan enters into Turtle Creek which eventually is tributary to the Rock River. Lake Delavan has become eutrophied due to local septic tank drainage, sewage effluents and agricultural run-off drained by Jackson Creek. Accordingly, the research performed on the feasibility of improving the water quality of Jackson Creek is appropriate. In addition, the Jackson Creek-Lake Delavan water quality improvement feasibility study should act as a pilot study for many other localities with similar problems.

2. Hydrological Measurements

Discharge measurements and stream height gauging of Jackson Creek were performed during this program over the period September 27, 1970 to July 28, 1971. Measurements were not made from December through April due to the stream being frozen over.

The discharge measurements were calculated by the Velocity-Area method with the use of a Price Current Meter (AA type). A minimum flow velocity of 0.07 ft/sec. or approximately 4 mgd discharge could be detected. All flow measurements were taken from the Mound Road Bridge (Downstream side). This bridge is about 100 ft. from the Pilot Filter. Depth measurements were taken with standard staff gage which had divisions to the nearest one hundredth of a foot.

Reference to Table 5 indicates that the range of discharges for Jackson Creek was from less than 4 million gallons per day (mgd) to a high of 20.2 mgd which occurred on September 27, 1970 when the total rainfall during the previous three day period was about 2 inches. The precipitation was not observed at the Mound Road site, but at the nearest official Weather Bureau Service Station at Lake Geneva which is about 5 miles southeast.

A gage ht.-discharge curve to calculate annual discharge could not be constructed since the current meter could only measure to 0.07 ft./sec. and on numerous occasions (as indicated in Table 5 for <4.0 mgd flow) the velocities were below this figure. Also, it was determined that the Mound Road site should have a better control downstream so that the velocities would always stay above 0.07 ft./sec.

The Delavan Lake level readings correlated with the gage readings at Mound Road. The lake readings (in inches) are reference to a Ø datum which is the summer level; the extreme is the winter level which is -9 inches or 9 inches below summer level. As can be seen from Table 5, this occurred on November 29, 1970.

The gates at the dam which is at the outlet of Lake Delavan are opened and closed accordingly to maintain the summer or winter levels.

3. Conclusions

The hydrological measurements, although very limited, indicate that an average annual discharge in Jackson Creek is between 4 mgd and 20 mgd. Wisconsin streams have an average discharge of approximately .5 mgd per square mile of drainage. Based on this average value, Jackson Creek should have an average discharge of 10 mgd which appears high. In addition, average discharge values are not meaningful for a full scale filter design since the actual discharge is usually below this value for dry weather and can greatly exceed this value during peak flows after rains.

Based on the very limited hydrological measurements taken to date, it would seem appropriate to plan a full scale filter capable of treating approximately 5 to 15 mgd normal flow. Allowances should be incorporated into the design to by-pass peak flows around the filter which exceed 15 mgd. The capacities for stream treatment by horizontal filters as discussed above are definitely feasible, but much more peak flow information is needed.

As can be seen from the above discussion of results, much more is to be done and improved upon in the study of the hydraulic-hydrologic aspects of Jackson Creek. During the second year of the project, a continuous monitoring of precipitation and depth at the discharge measurement site should be performed. Also a control weir should be constructed downstream to get more reliable discharge data. If this were done, a gage ht.-discharge curve could be constructed and annual discharge could be reliably calculated. Also, a water budget study utilizing the hydrologic equation (Inflow=Outflow+Δ Storage) should be carried out. Finally, a complete mapping of Jackson Creek should be done to measure its width, depth and slope in order to determine possible backwater effects.

SECTION VII

CHEMICAL AND BACTERIOLOGICAL DATA FROM THE DRAINAGE AREA

1. General

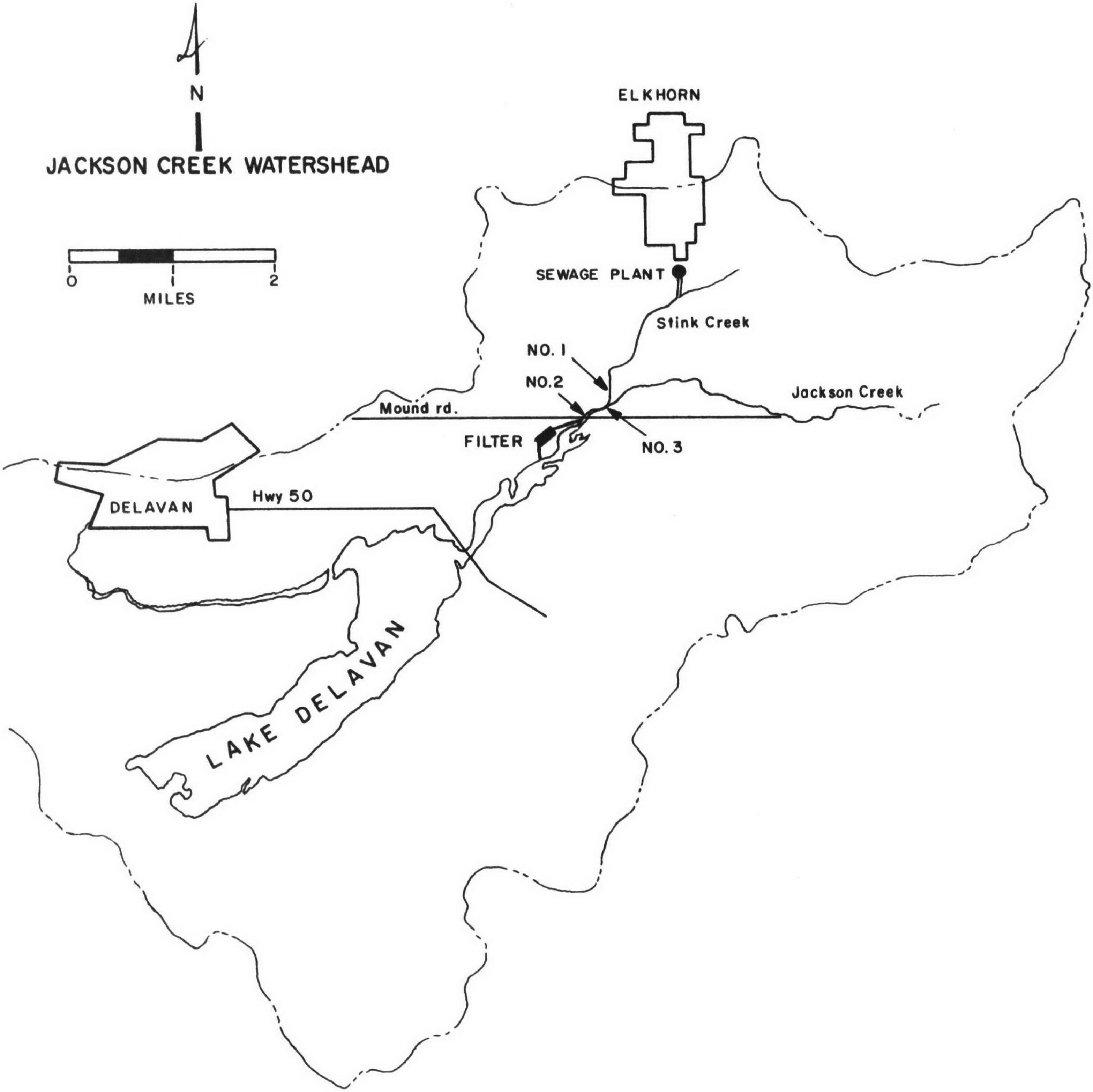
The drainage basin, Jackson Creek Watershed, figure 8, to Lake Delavan contains two main creeks, Jackson Creek and Stink Creek. Jackson Creek receives primarily agricultural drainage from pasture land although some sewage effluent from the Walworth County Institutions sewage plant also enters the creek. Stink Creek, which is tributary to Jackson Creek, consists primarily of sewage effluent from the City of Elkhorn and some agricultural drainage from arable land.

During the construction period of the pilot horizontal biological filter, samples were taken at three sites, Stink Creek #1, Jackson Creek #2, and Jackson Creek at Mound Road Bridge #3, (figure 6). The samples were tested for water chemistry parameters and bacteriological quality to establish the natural variation and provide background data for the experiments.

2. Water Chemistry Data

The water chemistry data are shown in tables 6 through 11 for Stink Creek, tables 12 through 17 for Jackson Creek, and tables 18 through 23 for Jackson Creek at Mound Road Bridge.

FIGURE 8


N
JACKSON CREEK WATERSHEAD
0
1
2
MILES
ELKHORN
SEWAGE PLANT
Stink Creek
NO. 1
NO. 2
NO. 3
Jackson Creek
Mound rd.
FILTER
DELAVAN
Hwy 50
LAKE DELAVAN

The approximately weekly samples show a considerable variability in the individual water parameters from week to week. Much of the variation in the water chemistry parameters can probably be attributed to the variation in rainfall since the flow in the creek is highly dependent upon recent rain.

Stink Creek which primarily carries sewage effluent, especially during dry periods, and storm water overflow from combined sewers during wet periods, tends to be higher in nitrogen, phosphorus, sodium and potassium. The differences in the character of the waters from Stink Creek and Jackson Creek are a reflection of their different origins. The phosphorus content of the water at Mound Road Bridge is high and undoubtedly contributes to the eutrophication of Lake Delavan when the creek is flowing.

3. Bacteriological Data

Samples for bacteriological testing were taken at the same time as the water chemistry samples. The data are shown in table 24 for Stink Creek, table 25 for Jackson Creek, and tables 26 and 27 for Jackson Creek at Mound Road Bridge. The data from Jackson Creek show few total coliforms, fecal coliforms, fecal streptococci, or Pseudomonas during most of the sampling period, although on six of the occasions, there were over 1,000 coliforms/100 mls.

The Stink Creek samples showed very high figures for all bacteria with the coliform bacteria numbering several thousands/100 mls.

until 23 March, 1971, when the numbers dropped from the thousands to the hundreds. The cause of the reduction in the bacteria appeared to be the new chlorination unit which went on stream during March. The samples from Jackson Creek at the Mound Road Bridge essentially reflect the influence of Stink Creek.

SECTION VIII

EVALUATION OF THE BIOLOGICAL FILTER

1. General

The construction of the filter was completed in late March, 1971, and the first tests on the hydraulic characteristics were run, including the measurement of flow rates. The rock media were seeded with algae and micro invertebrates from nearby temporary pools and with rocks from the trickling filter at the City of Elkhorn sewage treatment plant.

The growth of the various slimes and attached flora and fauna on the rock media was slow in the initial stages, but increased considerably when the temperature warmed up in early May.

The growth on the filter was judged to be sufficient by mid-May to start the first phase of the evaluation program. The program was to be split into five sections:

a. Water chemistry evaluation
b. Bacteriological evaluation
c. B.O.D. reduction evaluation
d. Effect of flow rates on B.O.D. reduction
e. Analysis of the flora and fauna of the filter media

Only the first three phases of the evaluation program were started.

2. Weekly Water Chemistry Data

Samples were taken from the filter on an approximately weekly basis at the intake and at the discharge. The samples were analyzed for various water chemistry parameters and the results show in tables 28, 29, and 30.

The results showed no consistent patterns in the parameters measured during the eight week period investigated. Both decreases and increases were seen in the suspended solids. The decreases were attributed to the settling out of solids in the constant head box and the increases to the sloughing off of the biological growth from the rocks.

The weekly evaluation period appears to be much too long in view of the natural variability of the creeks from which the filter was fed.

3. Water Chemistry Thirty-six Hour Evaluation

Samples were taken each hour for 36 hours to provide an evaluation of the filter with a lower input variability. However, inspection of the results, tables 31 through 43 and figures 9 through 27, show that for many of the parameters such as ammonia and dissolved solids, the natural variability of the input was still high even on an hourly sampling basis.

Some parameters which one would expect to be conservative elements such as sodium, chloride, and sulphate also show high variabilities. A few parameters such as potassium, iron, and magnesium showed a more limited variability than other parameters.

Comparison of the input and output figures show that there is little effect of the filter on the quality of the output water.

4. Weekly Bacteriological Data

The weekly bacteriological data are shown in table 44 for the period 23 March to 13 May, 1971. The input and output waters of the filter show essentially no change in total coliform, fecal coliform, fecal streptococci, or *Pseudomonas sp*.

5. Bacteriological Data Thirty-six Hour Evaluation

During the period when the water chemistry samples were collected, bacteriological samples were also collected and analyzed. The results of the bacteriological analyses are shown in tables 45 and 46. The results show that, like the weekly evaluation data, there was almost no effect of the filter on the bacterial populations.

6. Twenty-four Hour B.O.D. and C.O.D. Reduction Evaluation

Table 47 shows the results of a 24 hour evaluation of the filter on 7 September and 8 September. Samples of the influent and effluent were tested each hour for dissolved oxygen, biochemical oxygen demand, and chemical oxygen demand. During the 24 hour period there was less than 1 mg/L of dissolved oxygen present in the influent water. After passage through the filter the dissolved oxygen content of the effluent increased to a maximum of 7mg/L during the daylight hours.

The B.O.D. was reduced significantly during the daylight hours. At 2:00 p.m. there was a reduction of B.O.D. by 50% which is the maximum for the period. Generally, the reduction was in the order of 20% to 30%.

Residual B.O.D. from sewage treatment plants is the most difficult to remove and the results show that a significant percentage of this residual B.O.D. can be removed when the conditions are right. The efficiency of the removal may have been better had the stream contained more oxygen. Also, improvement in the efficiency may have resulted from different flow rates and retention times in the filter.

The information provided by a single survey must be considered preliminary but the results are encouraging.

SECTION IX

ACKNOWLEDGEMENTS

The following organizations participated in the funding of this program:

Environmental Protection Agency	90.59%
Lake Delavan Fish and Game Association	5.54%

Limnetics, Inc. would like to extend its sincere thanks to Mr. Ralph Christensen, the project administrator, Environmental Protection Agency, Chicago, Illinois, and the Lake Delavan Fish and Game Association, Inc. Special thanks go to Mr. Kurt Mauritz on whose land the pilot filter was built.

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The Limnetics, Inc. personnel who participated in this project include Jose Villate, Sanitary Engineer; Neil Johansen, Chemist; David Lange, Chemist; Dick Meir, Chemist; Loretta Kimmet, Chemist; Dick Wehland, Bacteriologist; Ronald Krupinski, Environmental Engineer, Dick Wamser, Environmental Engineer; Brian Gallagher, Water Resources Engineer; Rodney Harmsworth, Limnologist.

SECTION X

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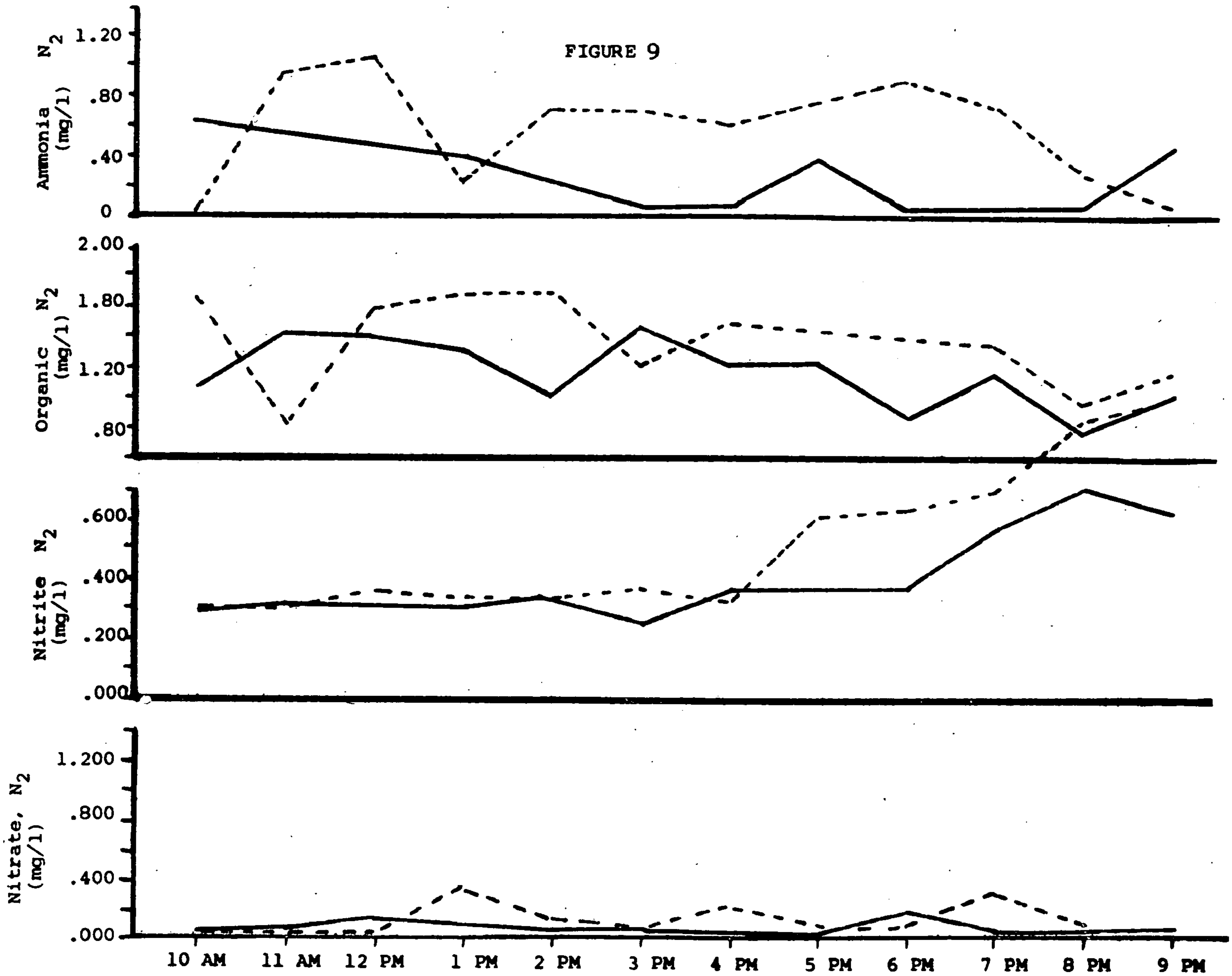
SECTION XI

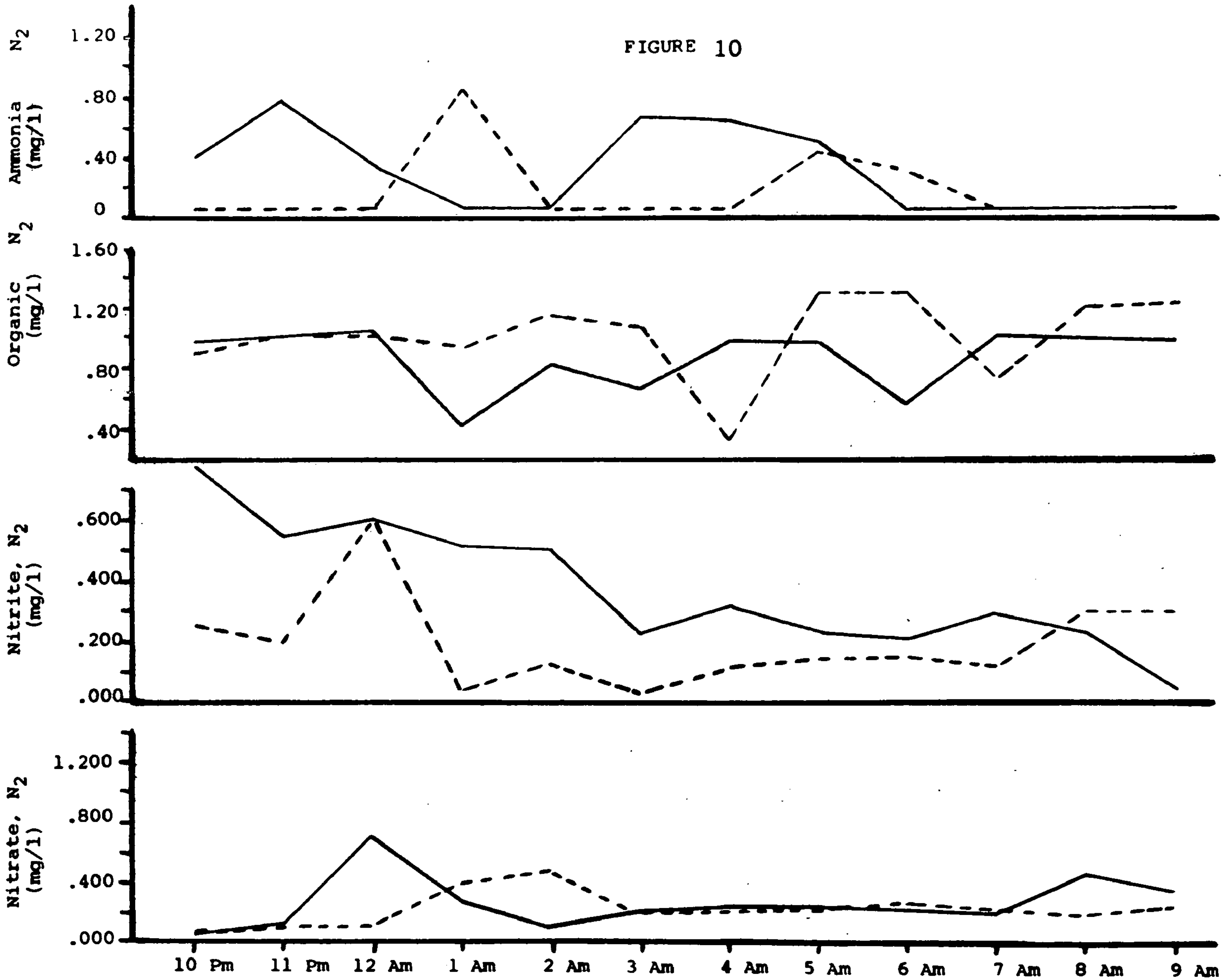
APPENDICES

FIGURE 9



Water Chemistry Data 36 Hour Evaluation
Influent ———— Effluent - - - -

FIGURE 10



Water Chemistry Data 36 Hour Evaluation
Influent ———— Effluent ---------

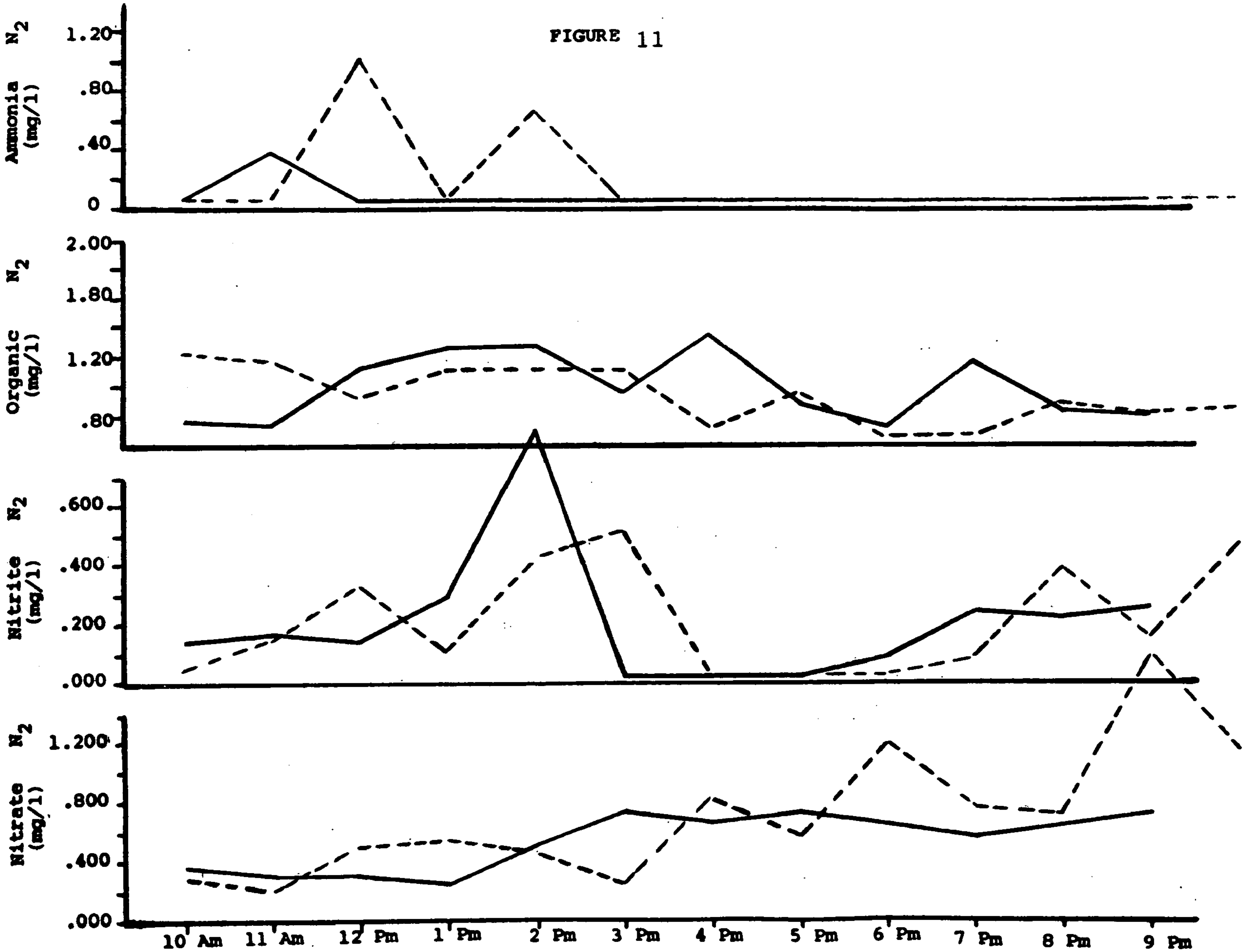
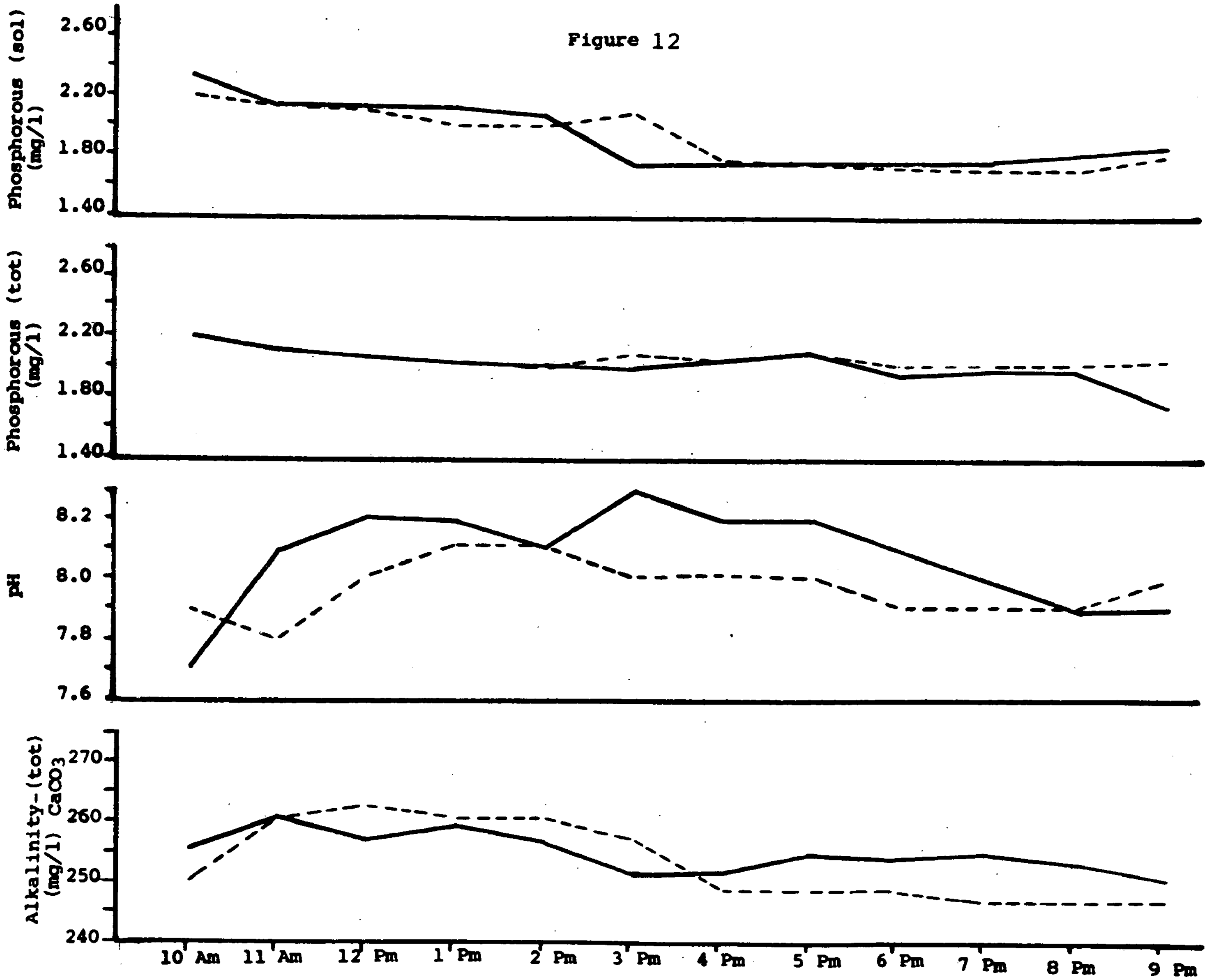


FIGURE 11

Water Chemistry Data 36 Hour Evaluation

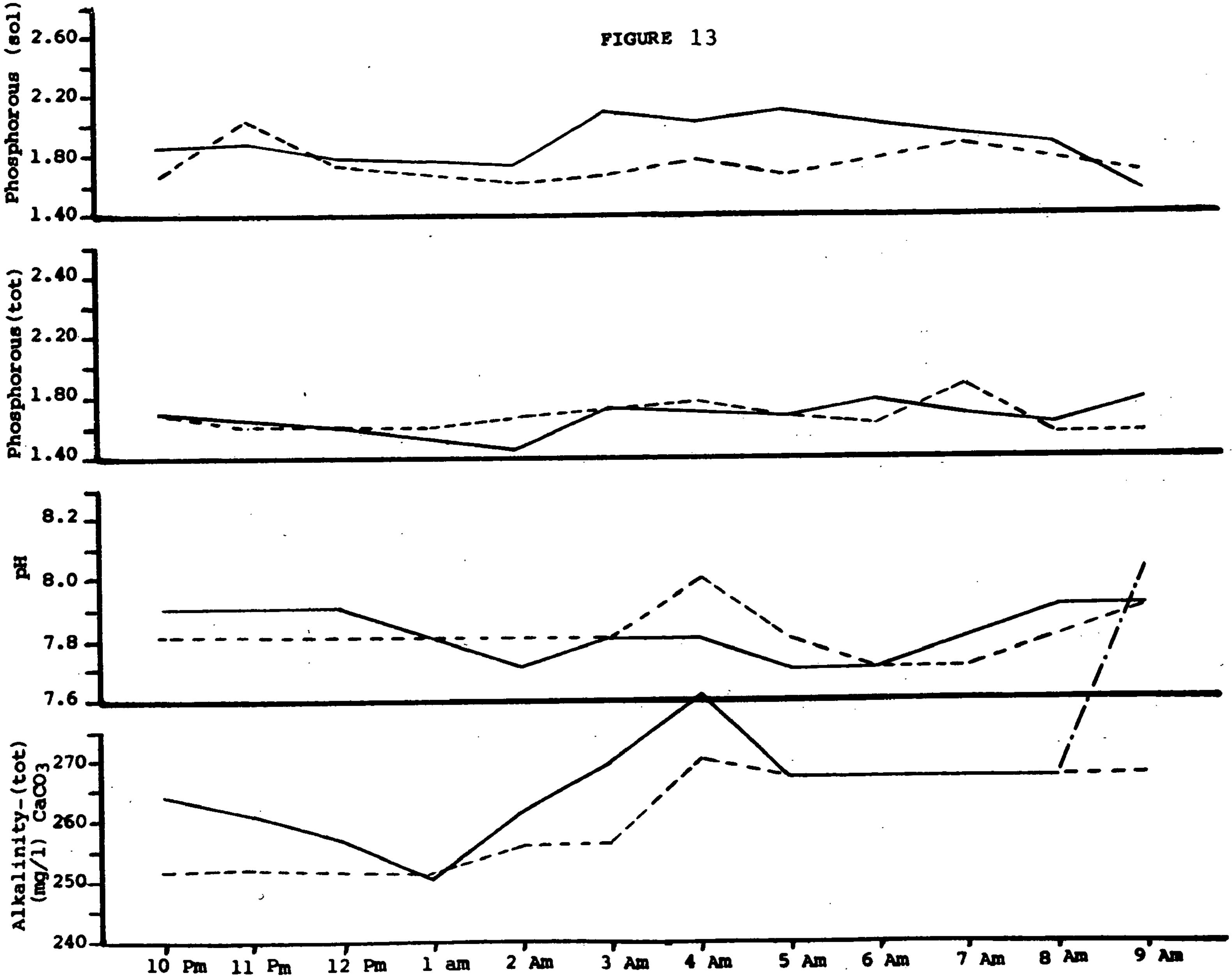
Influent ______ Effluent ------

Figure 12

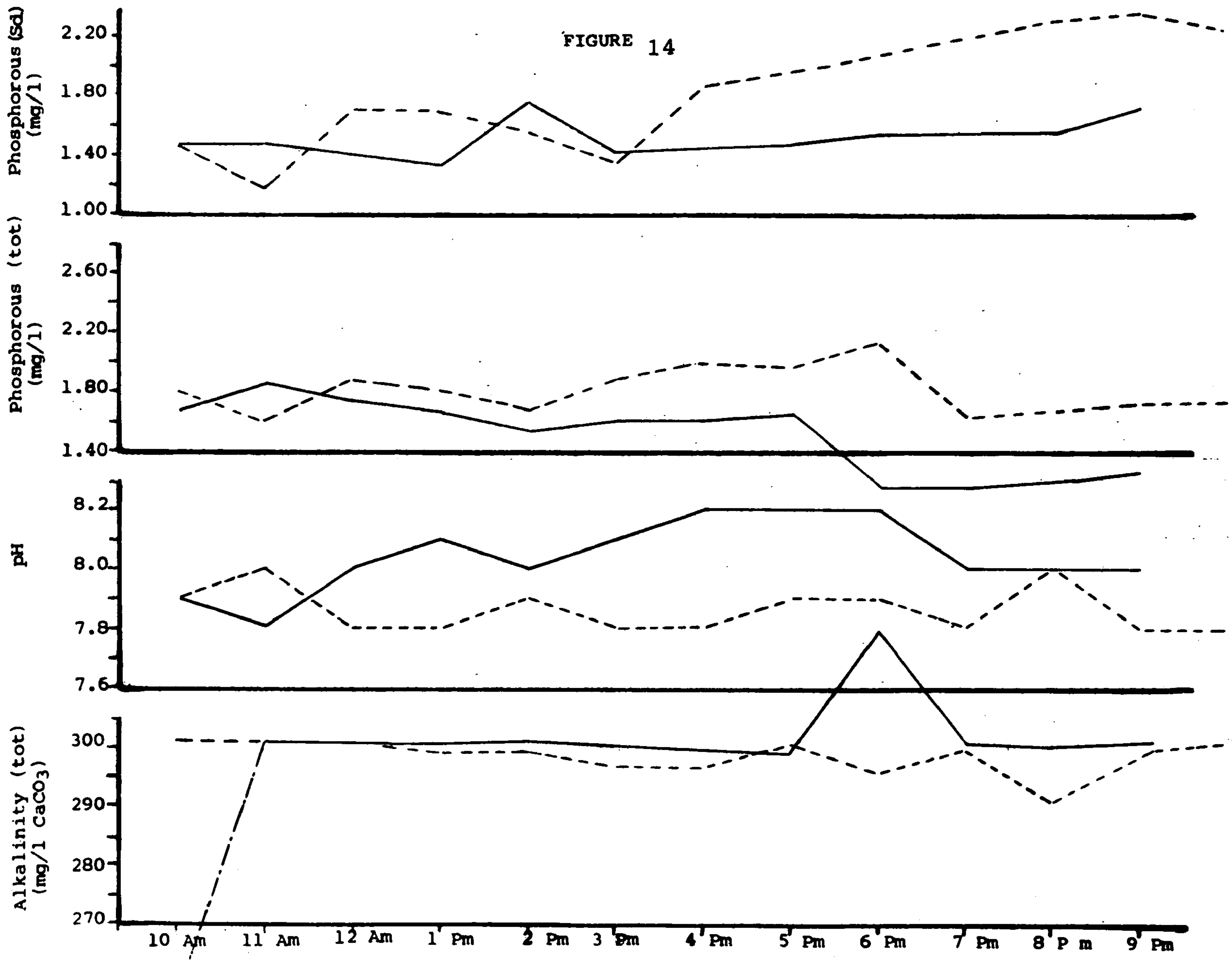


Water Chemistry Data 36 Hour Evaluation
Influent _______ Effluent -------

FIGURE 13

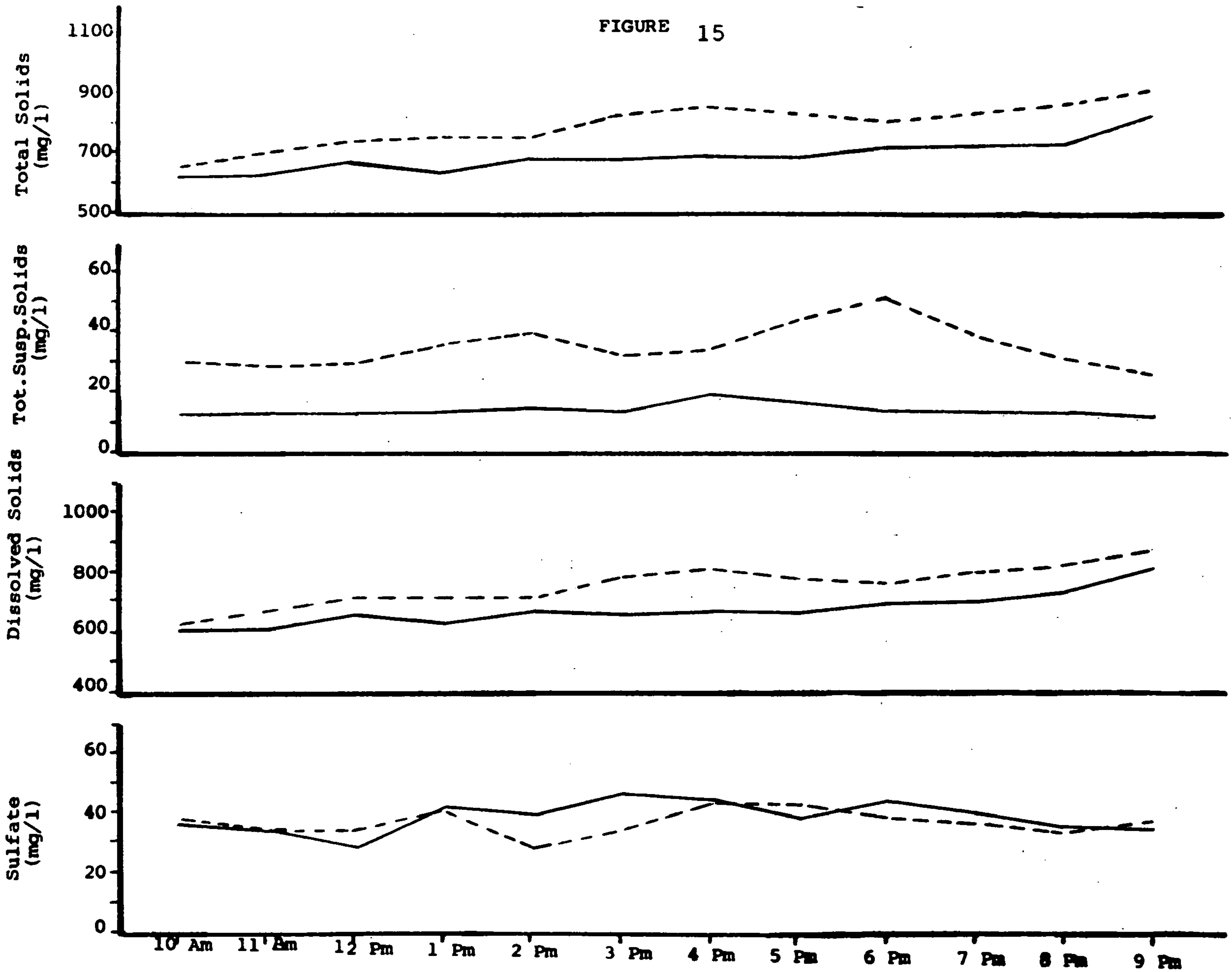


Water Chemistry Data 36 Hour Evaluation
Influent ______ Effluent ------



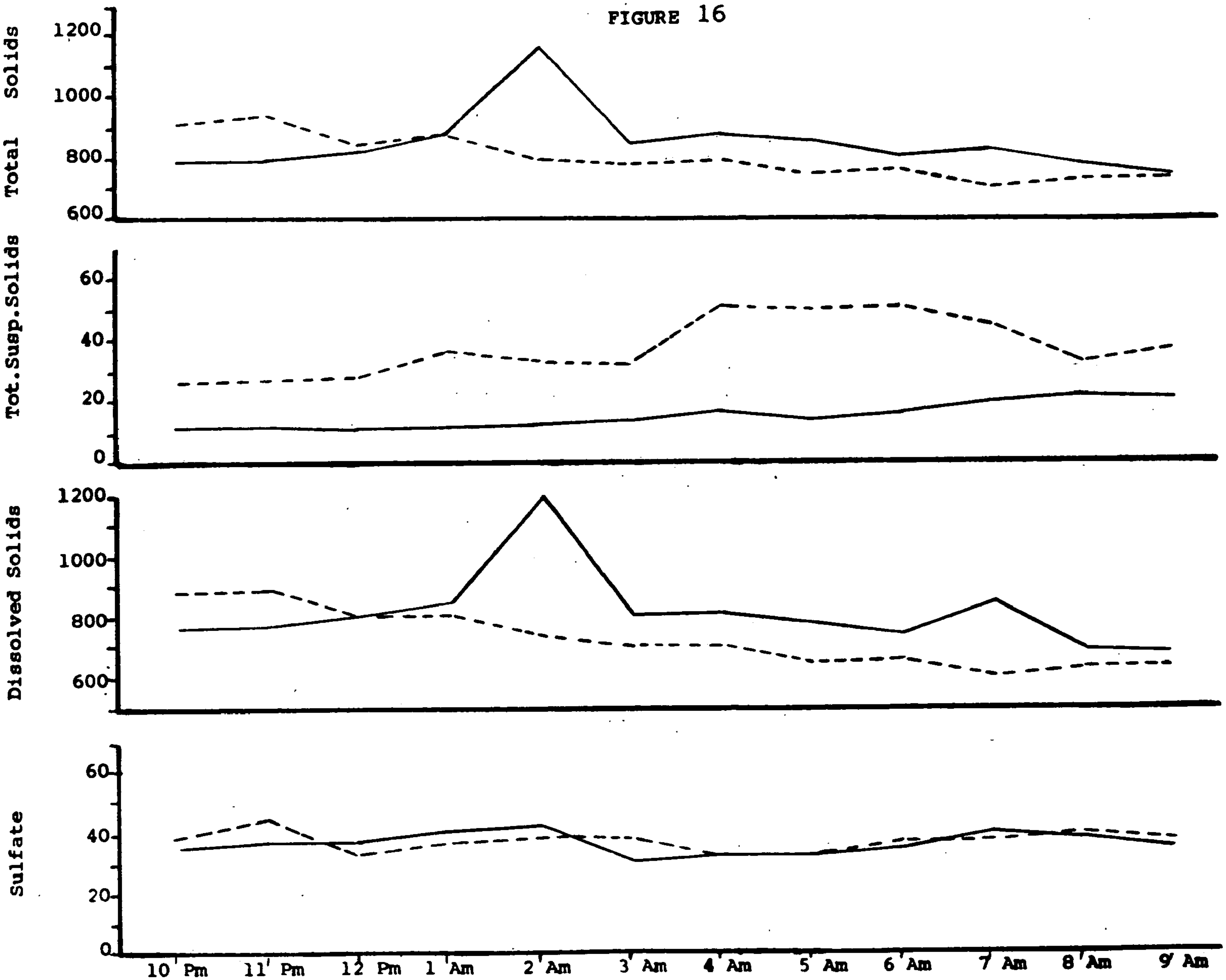
Water Chemistry Data 36 Hour Evaluation
Influent ______ Effluent ------

FIGURE 15



Water Chemistry Data 36 Hour Evaluation
Influent ______ Effluent ------

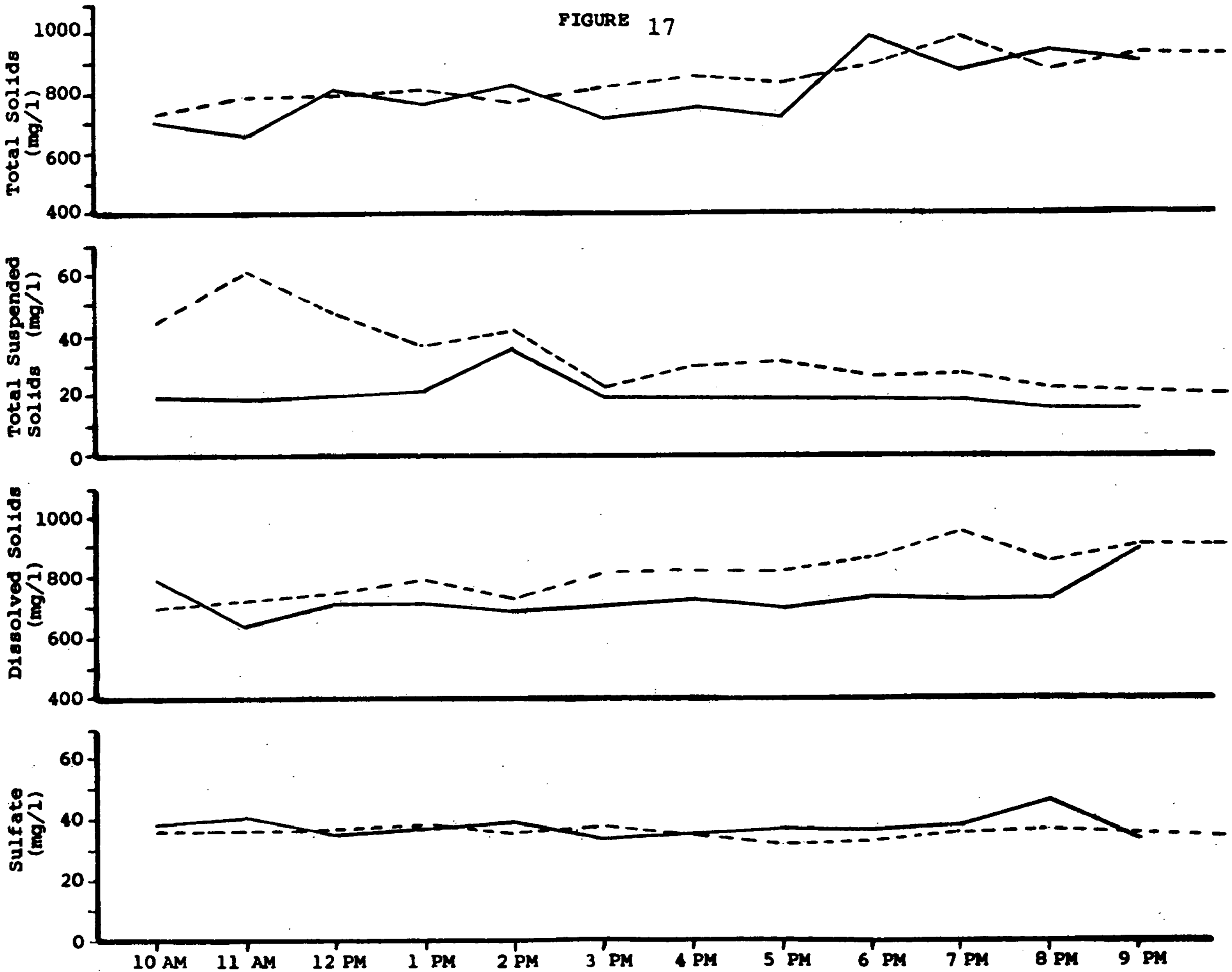
FIGURE 16



Water Chemistry Data 36 Hour Evaluation

Influent ____ Effluent ------

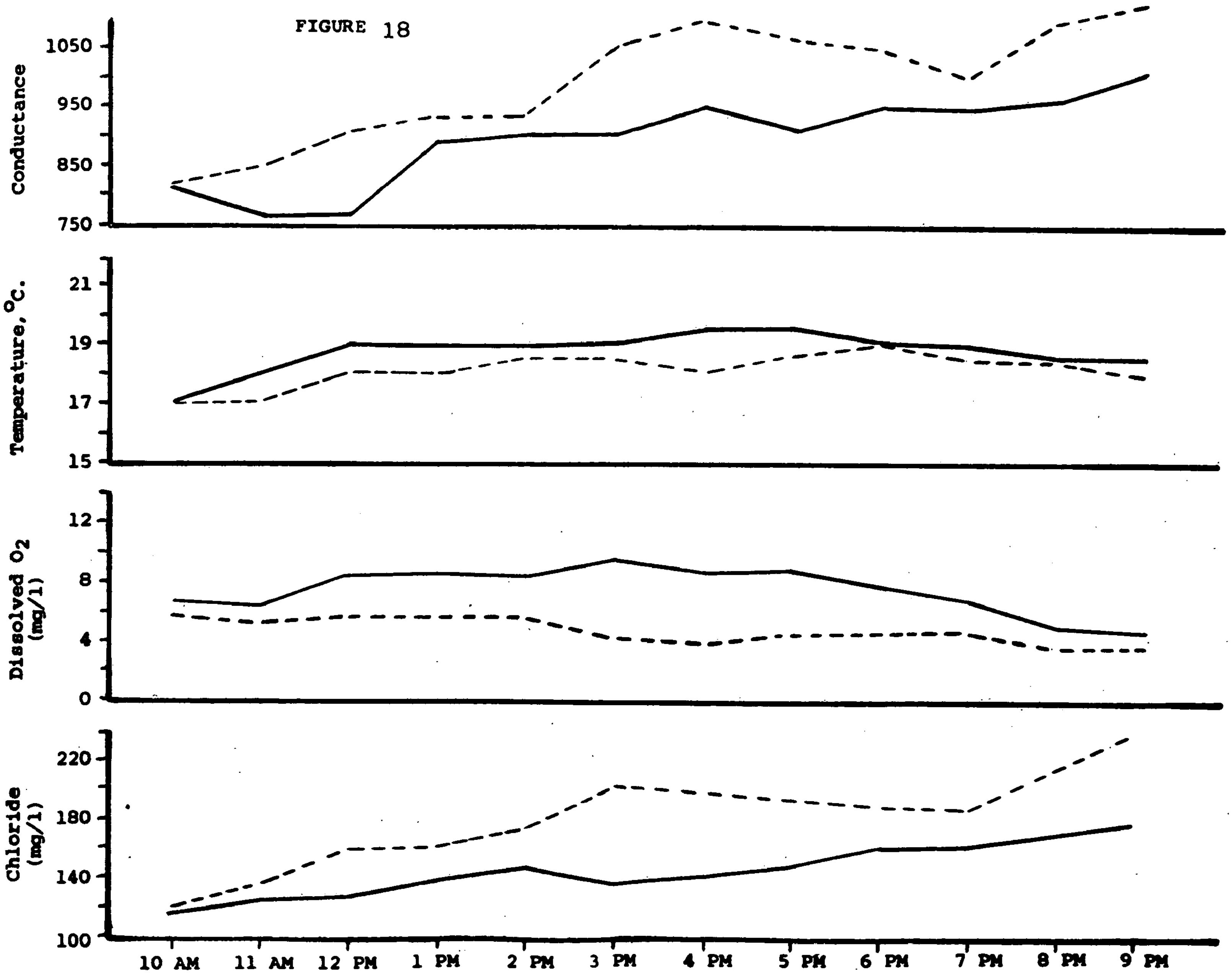
FIGURE 17



Water Chemistry Data 36 Hour Evaluation

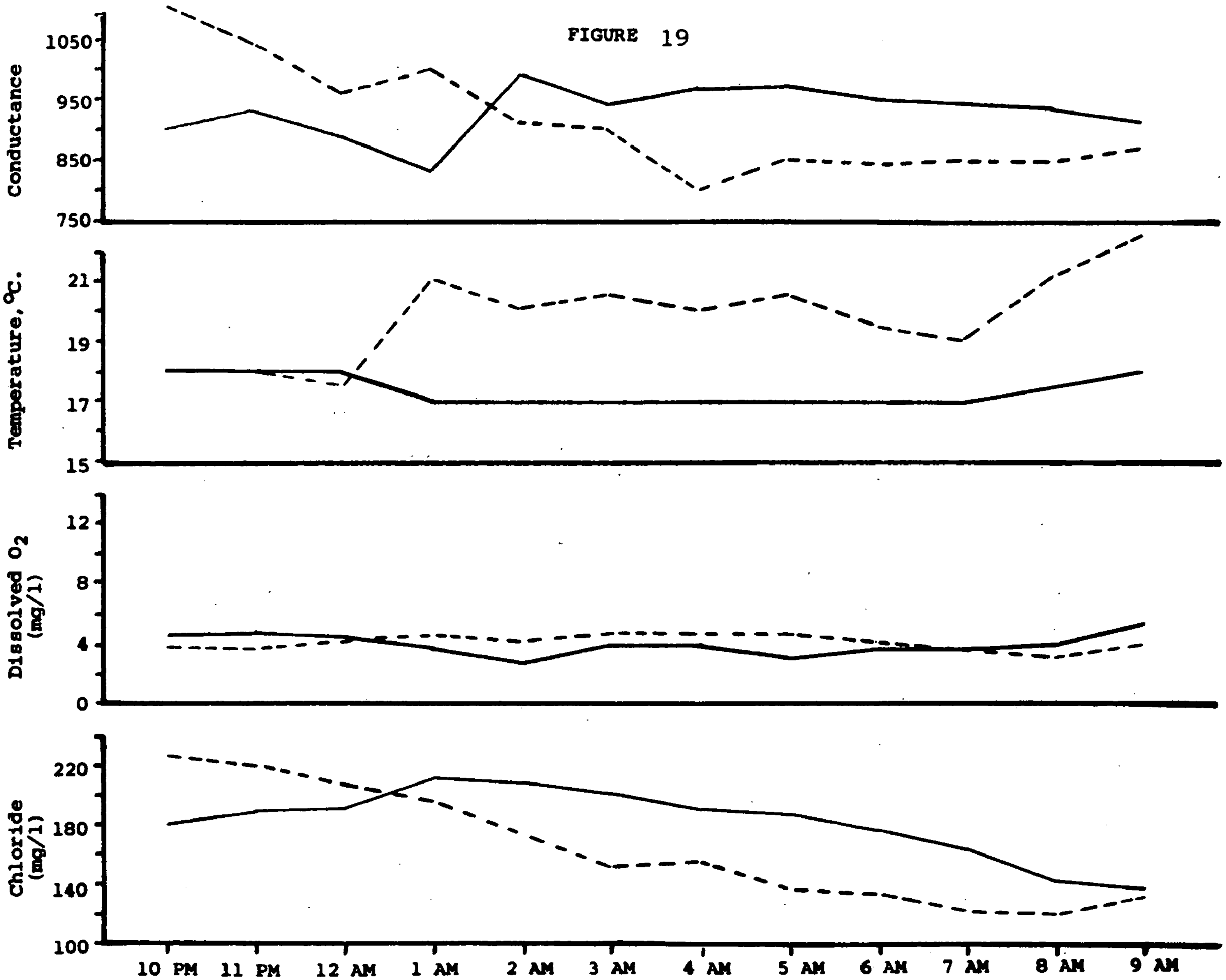
Influent ______ Effluent ------

FIGURE 18



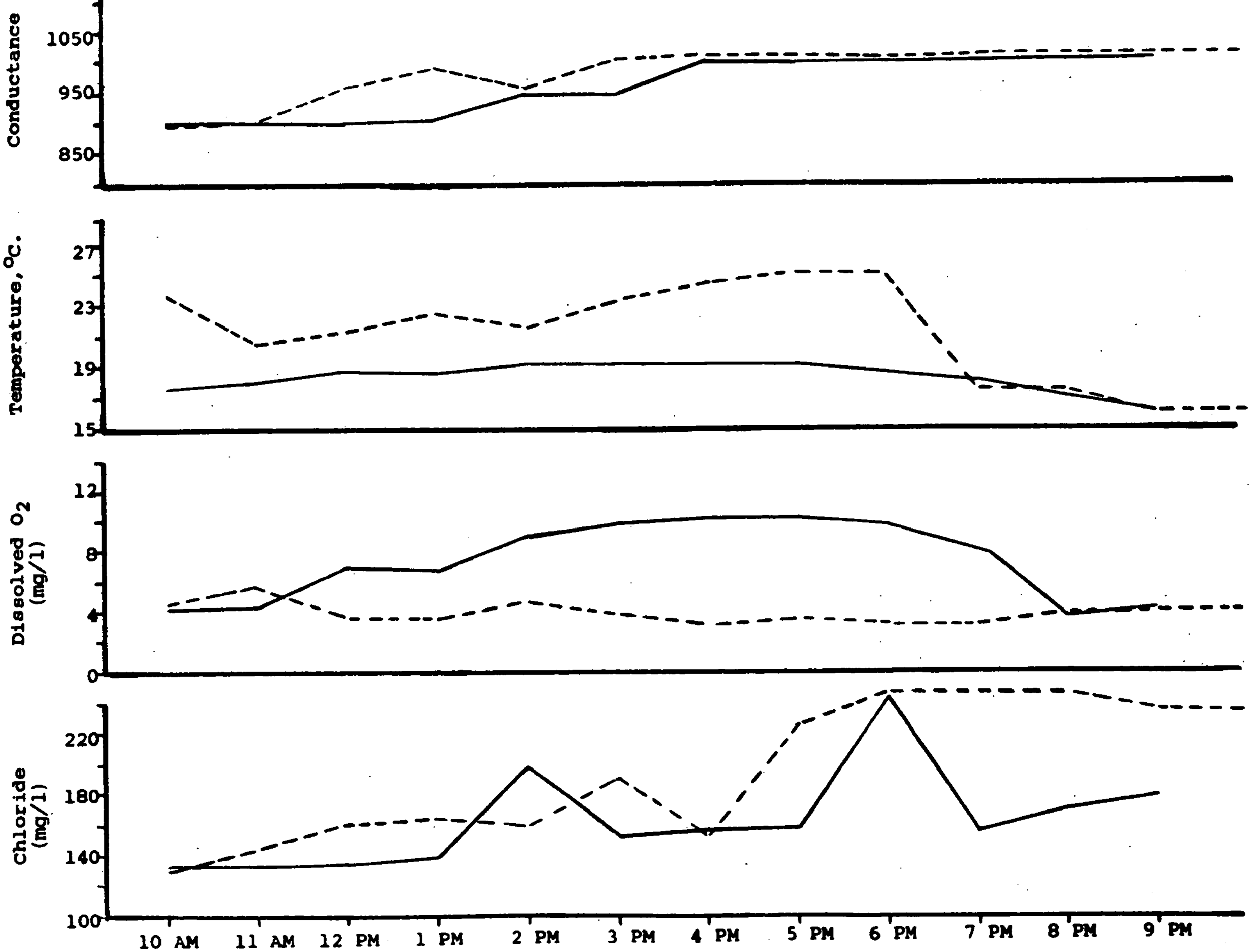
Water Chemistry Data 36 Hour Evaluation
Influent ______ Effluent ------

FIGURE 19



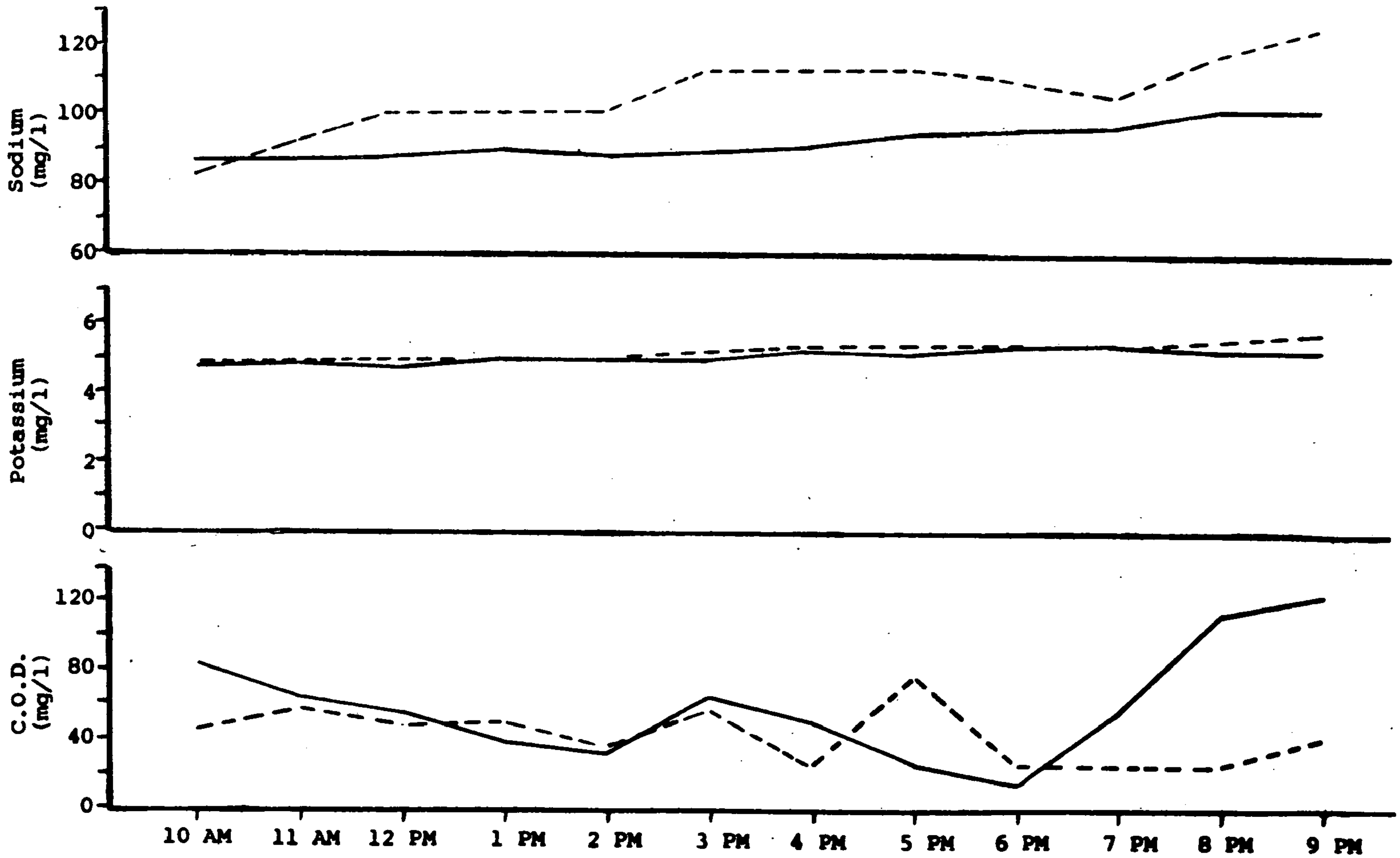
Water Chemistry Data 36 Hour Evaluation
Influent ______ Effluent ------

FIGURE 20



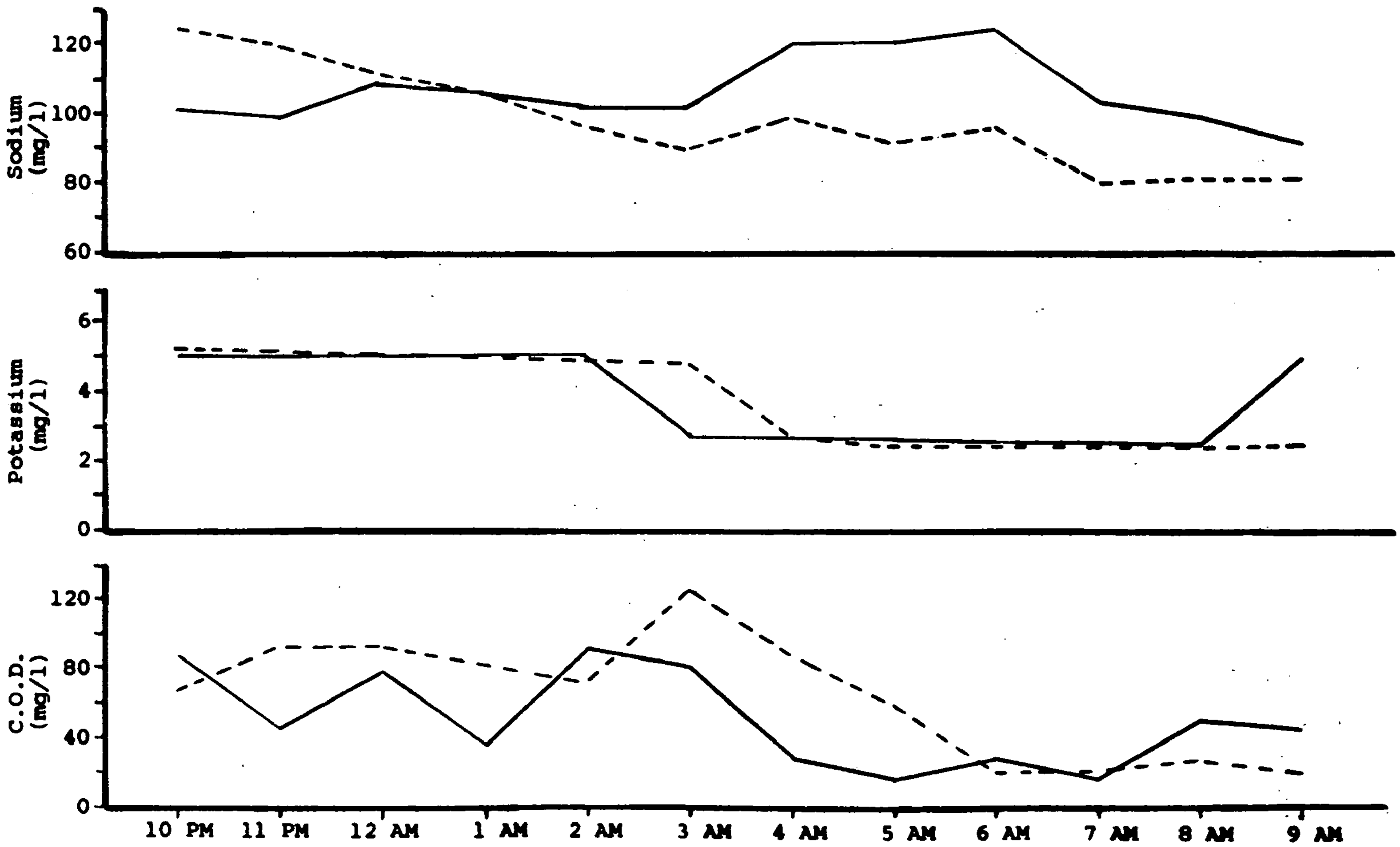
Water Chemistry Data 36 Hour Evaluation
Influent ______ Effluent ------

FIGURE 21



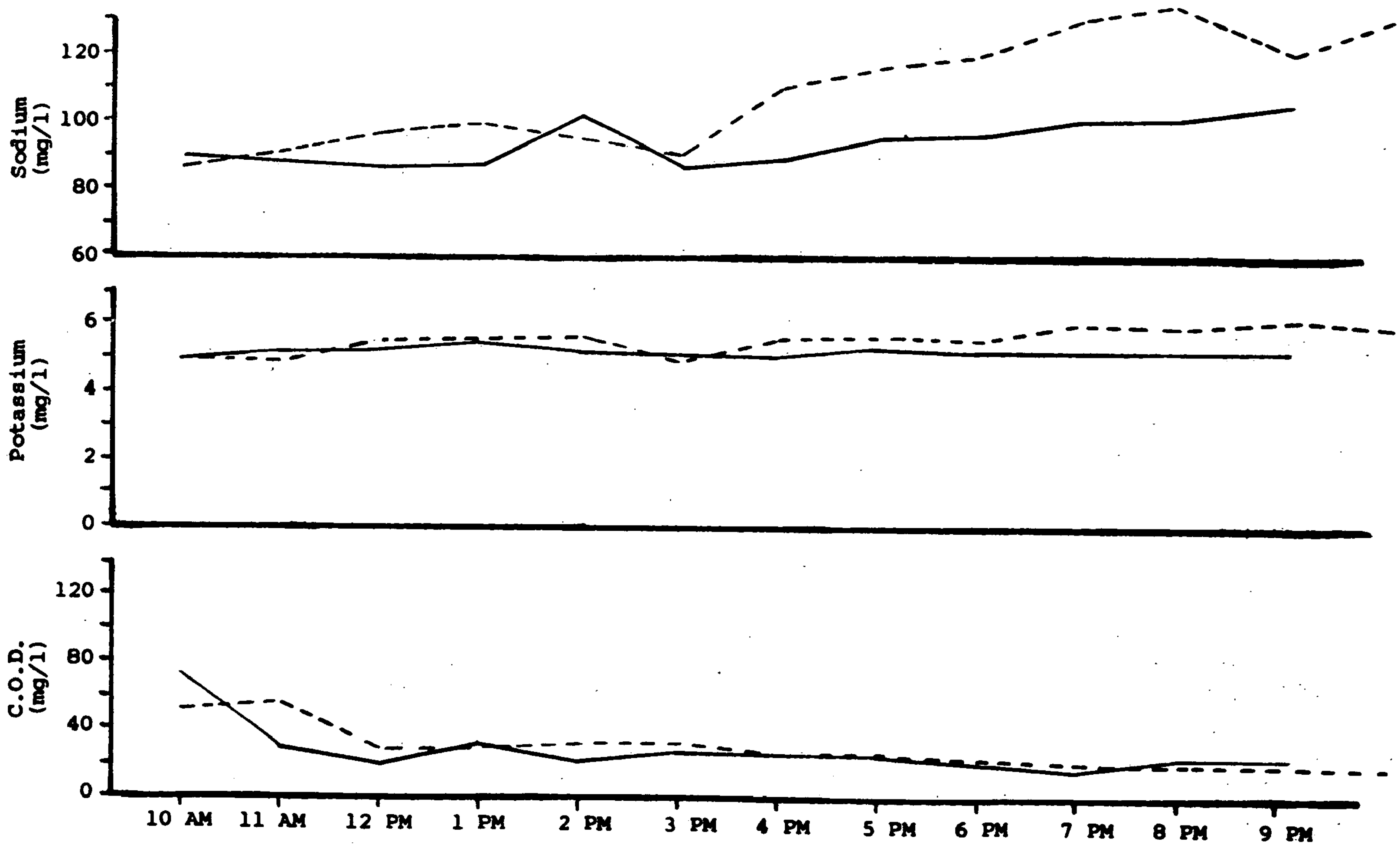
Water Chemistry Data 36 Hour Evaluation
Influent ______ Effluent ------

FIGURE 22



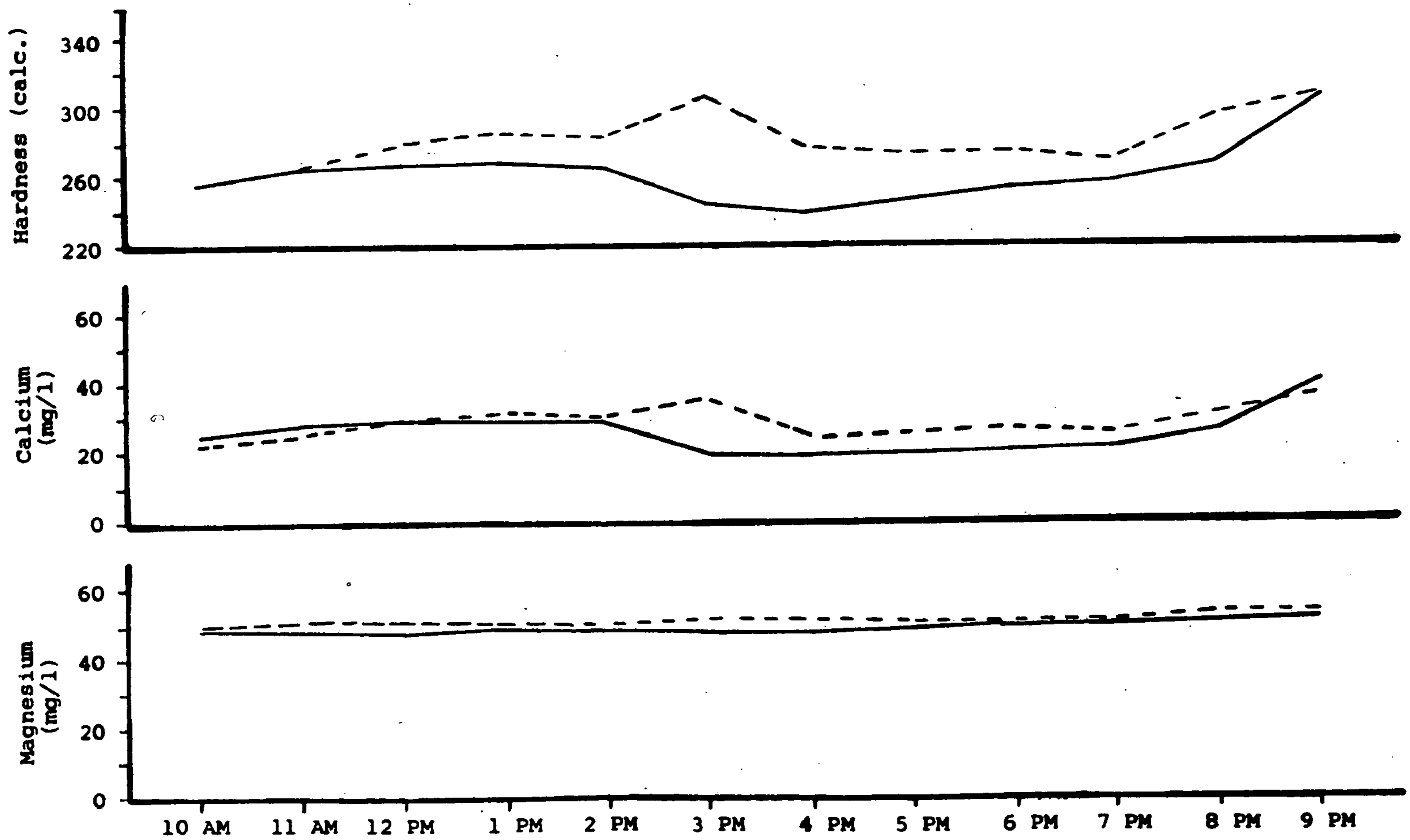
Water Chemistry Data 36 Hour Evaluation
Influent ______ Effluent ------

FIGURE 23



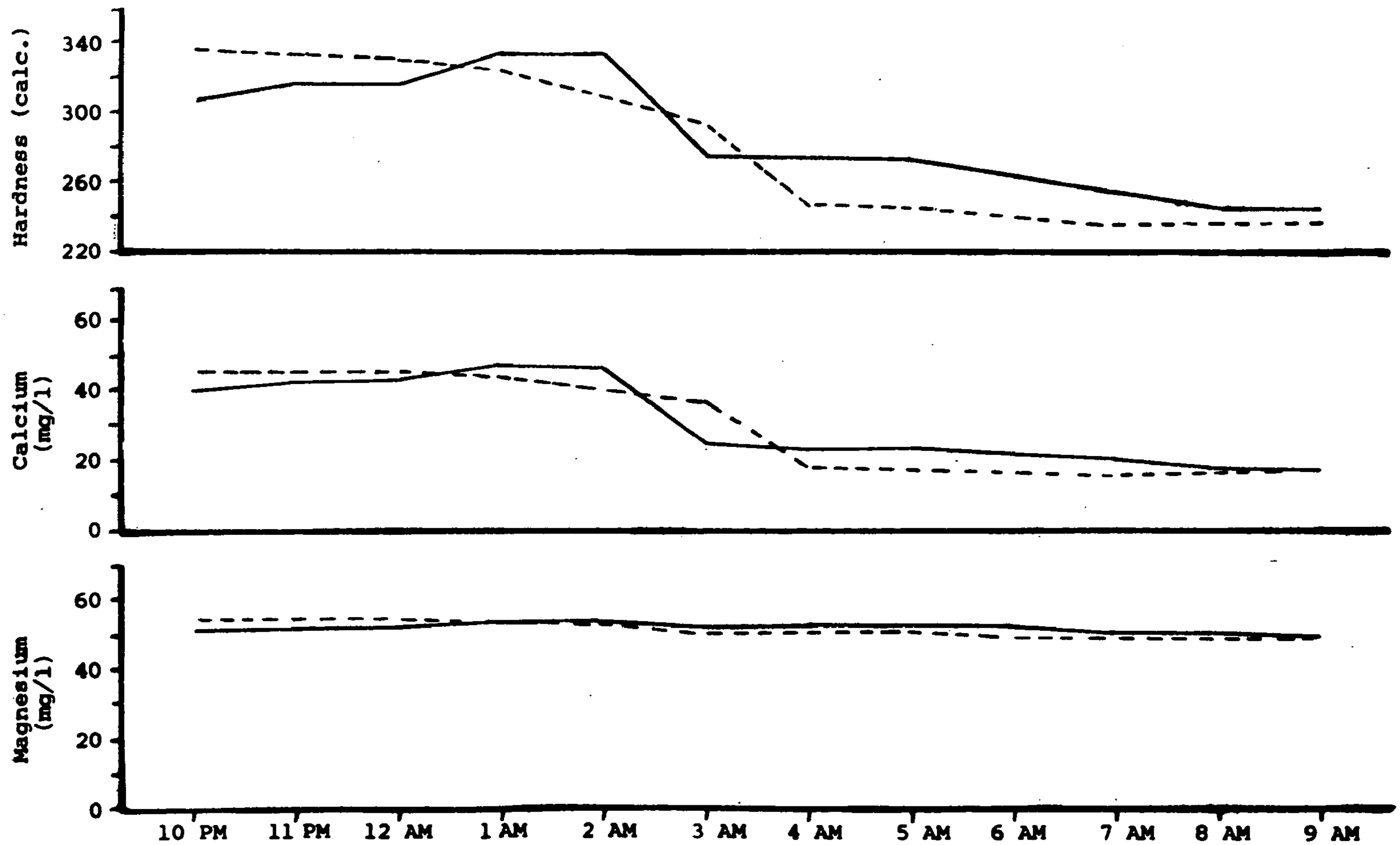
Water Chemistry Data 36 Hour Evaluation
Influent ______ Effluent ------

FIGURE 24



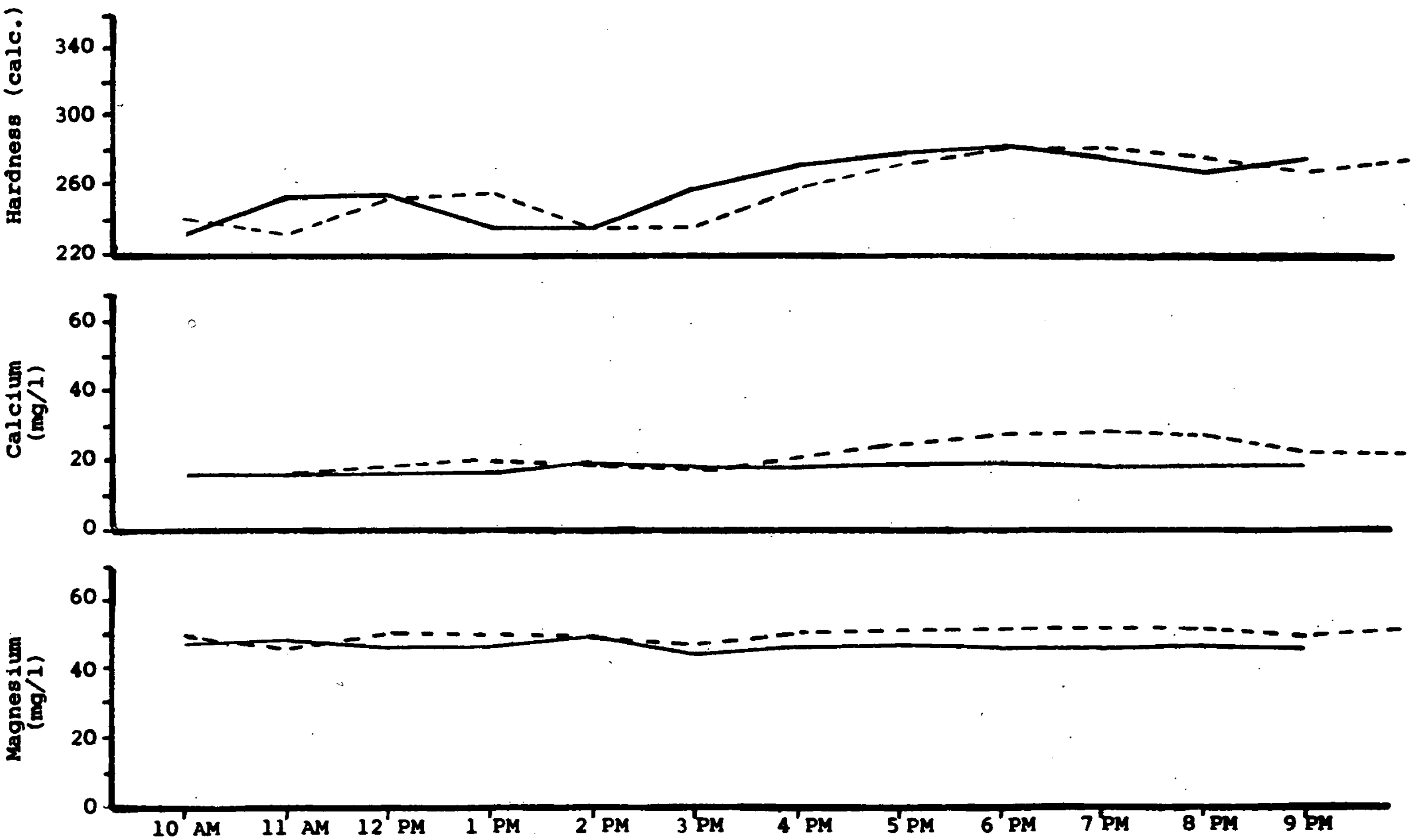
Water Chemistry Data 36 Hour Evaluation
Influent ______ Effluent ------

FIGURE 25



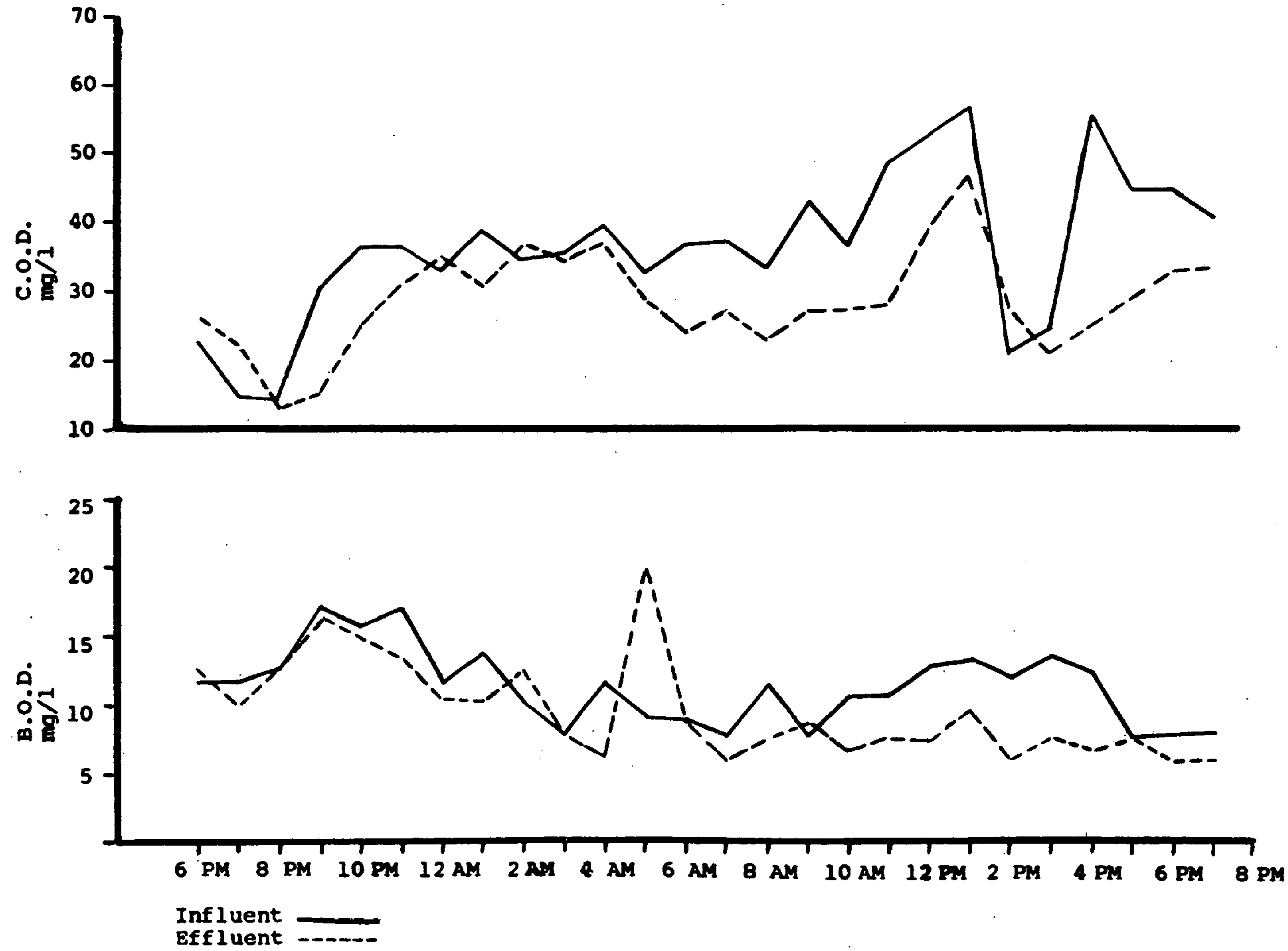
Water Chemistry Data 36 Hour Evaluation
Influent ______ Effluent ------

FIGURE 26



Water Chemistry Data 36 Hour Evaluation
Influent ______ Effluent ------

FIGURE 27



Twenty four hour B.O.D. and C.O.D. reduction evaluation

Influent ______ Effluent ------

TABLE 1

SECTION 1 ROCK SIZES

SAMPLE NUMBER	L (longest dim) INCHES	S (shortest dim) INCHES
1	7.0	4.0
2	5.5	4.5
3	9.0	5.5
4	7.5	3.0
5	6.0	4.5
6	6.5	4.0
7	5.5	4.0
8	5.5	2.0
9	5.0	5.0
10	7.0	3.5
AVERAGE SIZE	6.45	4.0
AVERAGE SIZE RATIO S/L = 0.62		

TABLE 2

SECTION 2 ROCK SIZES

SAMPLE NUMBER	L (longest dim) INCHES	S (shortest dim) INCHES
1	3.0	2.5
2	3.5	2.75
3	5.0	2.6
4	4.0	2.75
5	4.5	3.0
6	4.5	2.0
7	4.1	2.6
8	5.5	4.0
9	5.0	2.5
10	4.5	2.5
AVERAGE SIZE	4.36	2.72
AVERAGE SIZE RATIO S/L = 0.62		

TABLE 3

SECTION 3 ROCK SIZES

SAMPLE NUMBER	L (longest dim) INCHES	S (shortest dim) INCHES
1	1.5	1.25
2	2.25	1.5
3	1.75	1.0
4	2.0	1.0
5	1.5	0.8
6	1.5	1.0
7	1.5	1.0
8	1.5	0.6
9	1.25	0.6
10	1.8	1.0
AVERAGE SIZE	1.65	0.93
AVERAGE SIZE RATIO $^{S}/L$ = 0.56		

TABLE 4

SHARP CRESTED RECTANGULAR WEIR
DISCHARGE MEASUREMENT CALIBRATION*

Weir Crest Height (inches) H	Ave. Time to fill 2½ gal. container (sec.)** T	Discharge (gal. per second) Q	Discharge (gal. per day) Q
.45	29	.086	7,430
.70	18	.139	12,010
1.00	11	.227	19,613
1.10	8	.313	27,043
1.25	6.5	.385	33,264
1.35	6	.416	35,942
1.50	5	.500	43,200
1.65	4.5	.555	47,952
1.75	4	.625	54,000
1.80	3.5	.715	61,776

Maximum flow corresponds to Maximum H = 1.80 inches

therefore Q maximum = 0.715 gal/sec. = 61,776 gals/day

*On May 16, 1971

**Based on 3 trials

TABLE 5

Hydrological Measurements Taken At Mound Rd. Bridge

	Date	Flow (mgd)	Gage Ht. (ft.)	Lake Level (in.)	Precip. (in.)**	Dam Status
1.	Sept. 27, 1970	20.2	3.89	-3.00	2.09	4 gates open
2.	Oct. 10, 1970	< 4.0	4.22	-5.25	0.25	Ø gates open
3.	Oct. 18, 1970	< 4.0	4.28	-6.00	Ø	Ø gates open
4.	Oct. 30, 1970	11.5	4.12	-6.00	1.18	3 gates open
5.	Nov. 6, 1970	6.2	4.32	-8.75	0.37	1 gate open
6.	Nov. 15, 1970	5.4	4.40	-7.00	Trace	1 gate open
7.	Nov. 29, 1970	4.6	4.44	-9.00	0.28	1 gate open
8.	May 19, 1971	< 4.0	3.40	Ø	0.11	1 gate open
9.	June 3, 1971	< 4.0	3.62	Ø	0.80	1 gate open
10.	June 6, 1971	< 4.0	3.65	Ø	Ø	1 gate open
11.	June 13, 1971	< 4.0	3.65	Ø	0.41	1 gate open
12.	June 26, 1971	< 4.0	3.65	Ø	0.79	1 gate open
13.	July 1, 1971	< 4.0	3.70	Ø	Ø	1 gate open
14.	July 10, 1971	< 4.0	3.75	Ø	*	1 gate open
15.	July 17, 1971	< 4.0	3.75	Ø	*	1 gate open
16.	July 28, 1971	< 4.0	3.75	Ø	*	1 gate open

* no data available

** for previous 3 days

TABLE 6

Water Chemistry Data from Stink Creek

Test Parameters	29 July	3 Aug.	17 Aug.	19 Aug.	31 Aug.
Ammonia N	<0.03	<0.03	<0.03	<0.03	5.77
Organic N	7.56	0.64	0.48	<0.03	1.54
Nitrite N	0.250	0.350	0.092	0.018	0.200
Nitrate N	0.02	0.05	<0.01	0.02	0.04
Phosphorus-sol.	2.9	4.0	1.4	0.6	8.9
Phosphorus-tot.	3.1	3.4	1.0	0.5	9.8
pH	7.8	8.0	8.2	8.2	7.8
Conductance	650	840	1200	1080	1410
Temperature, °C	21	22	21	21	21
Dissolved O_2	2.4	2.0	1.7	1.4	2.1
Alkalinity-tot.	344	400	350	330	409
Total Solids	1099.2	749.2	814.8	739.0	808.4
Tot..Susp.Solids	603.2	107.6	12.0	4.6	24.4
Dissolved Solids	496.0	641.6	802.8	734.4	784.0
Chloride	< 1	1	1.5	< 1	<1
Sulfate	33.2	47.2	24.0	22.0	35.6
Calcium	12.5	14.4	14.6	16.6	12
Magnesium	34	46	49	50	39
Iron	0.3	0.1	0.1	0.2	0.1
Sodium	75	90	158	132	185
Potassium	9.5	9.0	4.1	4.0	-
Hardness (calc.)	171	225	238	247	190

All values as mg/L except pH and Specific Conductance (umhos/cm^2 at 20°C)

TABLE 7

Water Chemistry Data from Stink Creek

Test Parameters	17 Sept.	25 Sept.	2 Oct.	8 Oct.	13 Oct.	22 Oct.
Ammonia N	<0.03	0.92	0.67	0.92	1.33	3.48
Organic N	2.07	1.26	0.73	1.23	0.68	2.02
Nitrite N	0.024	.340	0.220	0.275	0.340	0.485
Nitrate N	0.09	0.08	0.07	0.04	0.05	0.05
Phosphorus-sol.	0.8	1.0	1.8	2.7	2.7	4.3
Phosphorus-tot.	1.1	1.6	1.8	3.2	2.6	4.1
pH	7.7	8.1	7.93	8.1	8.2	8.2
Conductance		740	785	850	880	920
Temperature, °C	20	18	12	15	14	10
Dissolved O_2	2.7	2.5	6.0	1.4	2.3	4.2
Alkalinity-tot.	126	329.0	355.6	372	360	398
Total Solids	423.2	620.4	333.4	572.0	588.4	651.2
Tot.Susp.Solids	154.3	85.93	48.2	9.33	9.20	32.3
Dissolved Solids	268.9	534.5	285.2	562.7	579.2	618.9
Chloride	1.0	1.0	1.0	1.5	1.5	1.5
Sulfate	29	49	55	52	37	45.2
Calcium	9.5	23.5	21	22.5	23.0	18.5
Magnesium	19	44	47	46	46	46
Iron	1.4	< 0.1	< 0.1	0.1	0.1	0.1
Sodium	8	26	37.5	65	63	75
Potassium	6.9	5.6	5.9	7.2	7.2	8.6
Hardness(calc.)	104.	240.	246	246	247	235

All values as mg/L except pH and Specific Conductance (umhos/cm^2 at 20°C)

TABLE 8

Water Chemistry Data from Stink Creek

Test Parameters	24 Oct.	29 Oct.	6 Nov.	11 Nov.	16 Nov.	27 Nov.
Ammonia N	0.70	1.74	0.62	0.28	2.8	1.40
Organic N	1.85	0.89	0.78	1.06	1.57	1.01
Nitrite N	0.250	0.460	0.365	0.585	0.675	0.360
Nitrate N	0.03	0.24	0.05	0.05	0.02	0.03
Phosphorus-sol.	2.7	1.0	1.3	0.6	1.6	1.6
Phosphorus-tot.	2.1	1.3	1.3	0.7	2.0	1.6
pH	8.2	8.0	8.0	8.1	8.0	8.0
Conductance	1530	710	880	750	1180	755
Temperature, °C	14	9	6	7	7	4
Dissolved O_2	3.5	3.7	5.2	6.5	4.0	4.8
Alkalinity-tot.	312	320	320	290	340	298
Total Solids	1250.8	548.8	696.0	564.4	928.8	565.6
Tot. Susp.Solids	19.3	19.6	8.73	6.93	10.2	7.8
Dissolved Solids	1231.5	529.2	687.3	557.5	918.6	557.8
Chloride	11.0	1.3	1.0	1.5	2.0	2.0
Sulfate	35.2	46.8	50.0	53.2	56.0	45.0
Calcium	55	18	51	46	58	42
Magnesium	63	45	55	49	60	46
Iron	< 0.1	< 0.1	< 0.1	< 0.1	0.1	< 0.1
Sodium	140	29	50	24	80	42
Potassium	10.4	4.9	5.2	4.2	7.4	5.8
Hardness (calc.)	397	230	354	316	392	294

All values as mg/L except pH and Specific Conductance (umhos/cm^2 at 20°C)

TABLE 9

Water Chemistry Data from Stink Creek

Test Parameters	30 Nov.	7 Dec.	14 Jan.	3 Feb.	25 Feb.
Ammonia N	1.40	1.2	3.64	9.77	0.29
Organic N	0.78	1.0	1.29	3.08	3.72
Nitrite N	0.110	0.340	0.160	0.071	0.063
Nitrate N	0.03	0.29	0.08	0.02	0.11
Phosphorus-sol.	1.0	2.4	3.7	4.6	1.0
Phosphorus-tot.	0.9	2.3	3.2	4.8	1.7
pH	8.0	8.2	7.7	7.6	7.3
Conductance	2400	695	865	1170	760
Temperature, °C	5	3	2	0	1
Dissolved O_2	6.0	5.2	4.3	5	5
Alkalinity-tot.	294	330	340	360	214
Total Solids	1722.4	599.6	623.2	835.6	823.2
Tot.Susp.Solids	1.7	4.9	11.2	11.3	262.3
Dissolved Solids	1720.7	594.7	612.0	824.3	560.9
Chloride	13.5	1.5	< 1.0	1.5	6.0
Sulfate	55.0	48.0	47.2	38.0	18.0
Calcium	67	51	24	25	22
Magnesium	73	50	46	70	41
Iron	0.2	0.1	< 0.1	0.1	< 0.1
Sodium	330	45	82	100	70
Potassium	9.2	6.0	6.8	9.0	5.1
Hardness(calc.)	468	333	249	600	234

All values as mg/L except pH and Specific Conductance ($umhos/cm^2$ at $20^{o}C$)

TABLE 10

Water Chemistry Data from Stink Creek

Test Parameters	23Mar.	25 Mar.	31 Mar.	5 Apr.	14 Apr.
Ammonia N	<0.05	3.02	0.62	3.08	1.90
Organic N	2.63	1.62	2.29	2.68	1.51
Nitrite N	0.150	0.102	0.005	0.130	0.204
Nitrate N	0.01	0.08	0.33	0.31	0.14
Phosphorus-sol.	0.7	1.0	3.3	1.6	1.4
Phosphorus-tot.	1.2	1.2	3.0	2.0	1.8
pH	7.2	7.8	2.6	7.6	7.6
Conductance	680	1800	2550	750	1000
Temperature, ^{o}C	7	7	7	9	11
Dissolved O_2	5.0	5.3	8.1	8.2	7.5
Alkalinity-tot.	258	264		271	257
Total Solids	557.2	1665.6	1127.2	579.2	790.8
Tot.Susp.Solids	12.8	8.2	13.5	11.9	13.8
Dissolved Solids	544.4	1657.4	1113.7	567.3	777.0
Chloride	61.0	606.0	636.0	68.0	166.0
Sulfate	54	52	51	42	45.0
Calcium	19.5	140	165	23	40.5
Magnesium	44	100	52	44	53
Iron	< 0.1	< 0.1	3.0	< 0.1	· 0.1
Sodium	40	240	26.5	41	94
Potassium	4.1	9.0	5.0	4.7	5.8
Hardness (calc.)	230	761	626	239	319

All values as mg/L except pH and Specific Conductance (umhos/cm^2 at $20^{o}C$)

TABLE 11

Water Chemistry Data from Stink Creek

Test Parameters	20 Apr.	30 Apr.	5 May	10 May
Ammonia N	1.79	1.40	1.84	1.15
Organic N	1.45	1.40	1.56	1.23
Nitrite N	0.205	0.200	0.624	0.332
Nitrate N	0.275	0.54	0.635	0.665
Phosphorus-sol.	2.0	2.3	2.9	3.0
Phosphorus-tot.	1.8	2.4	2.7	2.8
pH	7.9	8.0	8.2	8.2
Conductance	750	800	700	770
Temperature, ^{o}C	13	14	14	14
Dissolved O_2	5.0	5.1	6.1	10.0
Alkalinity-tot.	272	278	296	291
Total Solids	616.0	623.2	605.2	610.8
Tot.Susp.Solids	49.3	19.6	20.6	8.4
Dissolved Solids	566.7	603.6	584.6	602.4
Chloride	70.0	83.5	74.0	72.0
Sulfate	46.0	48.0	44.8	42.0
Calcium	27	17.5	27	25
Magnesium	47	47	46	44
Iron	< 0.1	< 0.1	0.1	< 0.1
Sodium	49	59	60	71
Potassium	5.0	6.0	5.8	6.2
Hardness (calc.)	261	237	257	243

All values as mg/L except pH and Specific Conductance ($umhos/cm^2$ at $20^{o}C$)

TABLE 12

Water Chemistry Data from Jackson Creek

Test Parameters	29 July	3 Aug.	17 Aug.	19 Aug.	31 Aug.
Ammonia N	< 0.03	0.03	< 0.03	0.03	0.03
Organic N	5.89	0.896	0.644	0.868	0.73
Nitrite N	< 0.005	0.005	0.006	< 0.005	0.100
Nitrate N	0.01	0.01	< 0.01	0.02	0.01
Phosphorus-sol.	0.33	0.33	0.33	0.32	1.00
Phosphorus-tot.	0.83	0.75	0.46	0.36	1.14
pH	7.9	8.0	8.3	8.2	7.9
Conductance	610	610	1280	1040	1330
Temperature, °C	21	22	22	22	22
Dissolved O_2	5.9	6.0	4.7	5.8	4.3
Alkalinity-tot.	314	343	332	321	332
Total Solids	1082.0	620.8	804.4	729.6	1059.2
Tot. Susp.Solids	606.4	185.6	6.1	5.6	16.0
Dissolved Solids	475.6	435.2	798.0	724.0	1043.0
Chloride	1.5	< 1	3.5	< 1	2.5
Sulfate	27.2	38.0	26.0	24.8	26.0
Calcium	12.5	13.6	16.7	18.0	28
Magnesium	37	44	49	49	56
Iron	0.2	0.1	0.1	0.2	0.1
Sodium	67	31	200	123	195
Potassium	10.5	3.1	9.4	3.6	5.3
Hardness (calc.)	184	215	243	247	300

All values as mg/L except pH and Specific Conductance (umhos/cm^2 at 20°C)

TABLE 13

Water Chemistry Data from Jackson Creek

Test Parameters	17 Sept.	25 Sept.	2 Oct.	8 Oct.	13 Oct.	22 Oct.
Ammonia N	< 0.03	0.03	0.03	0.03	0.03	0.03
Organic N	2.04	1.51	0.45	2.44	0.88	0.73
Nitrite N	0.02	.024	0.012	0.038	0.023	0.018
Nitrate N	0.095	0.06	0.01	0.02	0.01	0.02
Phosphorus-sol.	0.70	0.22	0.025	0.23	0.16	0.12
Phosphorus-tot.	0.90	0.40	0.80	0.36	0.36	0.16
pH	7.8	8.2	7.9	8.2	8.3	8.3
Conductance		595	705	820	920	890
Temperature, °C	19	19	12	15	14	8
Dissolved O_2	5.4	8.5	10.7	5.9	4.2	11.0
Alkalinity-tot.	127	232.4	319.8	322	320	338
Total Solids	391.6	544.0	330.2	700.4	687.6	630.0
Tot.Susp.Solids	127.2	53.27	13.2	238.2	41.80	21.1
Dissolved Solids	264.4	490.7	317.0	462.2	645.8	608.9
Chloride	1.0	1.1	0.8	2.5	3.5	2.0
Sulfate	36	40	43	49	47	34.4
Calcium	9.5	22	23	22.5	27.0	16
Magnesium	20	38	45	46	50	48
Iron	1.7	< 0.1	0.1	0.2	0.2	< 0.1
Sodium	7.0	11	21	44	58	53
Potassium	7.3	3.4	1.2	4.1	2.5	2.5
Hardness (calc.)	108	211	243	246	273	238

All values as mg/L except pH and Specific Conductance (umhos/cm^2 at 20°C)

TABLE 14

Water Chemistry Data from Jackson Creek

Test Parameters	24 Oct.	29 Oct.	6 Nov.	11 Nov.	16 Nov.	27 Nov.
Ammonia N	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	0.03
Organic N	0.56	0.78	0.73	0.73	0.45	0.90
Nitrite N	0.025	0.060	0.025	0.102	0.102	0.022
Nitrate N	0.02	0.09	0.03	0.03	0.02	0.03
Phosphorus-sol.	0.20	0.16	0.11	0.06	0.02	0.05
Phosphorus-tot.	0.32	0.24	0.11	0.09	0.02	0.06
pH	8.4	8.0	8.2	8.2	8.0	8.0
Conductance	760	635	700	680	710	820
Temperature, ^{o}C	14	10	6	7	5	2
Dissolved O_2	17.5	8.0	14.0	11.6	14.2	13.0
Alkalinity-tot.	360	283	286	280	304	282
Total Solids	553.6	488.0	540.0	493.2	530.8	615.2
Tot. Susp. Solids	3.3	7.5	9.67	3.20	2.0	7.8
Dissolved Solids	550.3	480.5	530.3	490.0	528.8	607.4
Chloride	0.5	1.0	1.0	1.0	1.0	1.5
Sulfate	34.4	42.0	42.0	32.8	26.8	45.0
Calcium	17.5	18.5	24	26	24	45
Magnesium	47	43	51	45	44	49
Iron	< 0.1	< 0.1	< 0.1	< 0.1	0.1	0.1
Sodium	40	13	22	15	17	48
Potassium	3.1	2.6	1.6	1.3	0.5	2.5
Hardness (calc.)	237	223	270	250	241	314

All values as mg/L except pH and Specific Conductance (umhos/cm^2 at $20^{o}C$)

TABLE 15

Water Chemistry Data from Jackson Creek

Test Parameters	30 Nov.	7 Dec.	14 Jan.	3 Feb.	25 Feb.
Ammonia N	< 0.03	< 0.03	< 0.03	< 0.03	0.05
Organic N	0.56	0.6	0.90	0.70	1.20
Nitrite N	< 0.005	0.028	0.005	0.023	0.005
Nitrate N	0.03	0.10	0.08	0.03	0.10
Phosphorus-sol.	< 0.01	0.08	0.17	0.64	0.50
Phosphorus-tot.	< 0.01	0.12	0.21	0.52	0.58
pH	8.1	8.2	7.9	7.9	7.6
Conductance	690	940	785	930	461
Temperature, ^{o}C	4	0	1	0	0
Dissolved O_2	11.8	13.2	11.7	13.8	12.1
Alkalinity-tot.	294	292	292	302	194
Total Solids	980.4	1185.6	569.6	616.4	469.6
Tot. Susp. Solids	0.2	3.3	10.5	2.7	115.5
Dissolved Solids	980.2	1182.3	559.1	613.7	354.1
Chloride	1.0	2.5	1.0	1.0	1.0
Sulfate	23.3	52.5	34.4	30.8	14.8
Calcium	59	39	31	23.5	20
Magnesium	49	51	47	60	35
Iron	0.2	< 0.1	< 0.1	0.1	0.1
Sodium	12	50	33	68	9.5
Potassium	1.0	1.8	1.3	3.7	2.3
Hardness (calc.)	349	302	271	306	194

All values as mg/L except pH and Specific Conductance (umhos/cm^2 at $20^{o}C$)

TABLE 16

Water Chemistry Data from Jackson Creek

Test Parameters	23 Mar.	25 Mar.	31 Mar.	5 Apr.	14 Apr.
Ammonia N	< 0.05	< 0.05	.45	< 0.05	0.16
Organic N	0.75	0.50	.62	0.22	0.42
Nitrite N	0.005	0.005	0.014	0.005	0.008
Nitrate N	0.09	0.08	0.27	0.36	0.07
Phosphorus-sol.	.10	.08	0.4	0.4	0.104
Phosphorus-tot.	0.16	0.16	0.16	0.24	0.360
pH	7.7	8.05	7.3	8.1	8.1
Conductance	510	640	355	540	590
Temperature, ^{o}C	6	6	7	7	12
Dissolved O_2	11.7	11.9	12.0	12.5	15
Alkalinity-tot.	216	234	180	204	222
Total Solids	398.0	412.0	359.6	410.0	431.2
Total Susp. Solids	8.6	6.4	18.8	4.4	2.8
Dissolved Solids	389.4	405.6	340.8	405.6	
Chloride	32.0	33.0	26.0	29.0	34.0
Sulfate	72	40	28	24	38.0
Calcium	19.5	19.0	21	23	29
Magnesium	38	39	32	39	42
Iron	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Sodium	12	11	8.5	8.5	14.5
Potassium	1.8	1.5	2.1	1.3	1.7
Hardness (calc.)	205	208	184	218	245

All values as mg/L except pH and Specific Conductance ($umhos/cm^2$ at $20^{o}C$)

TABLE 17

Water Chemistry Data from Jackson Creek

Test Parameters	20 Apr.	30 Apr.	5 May	10 May
Ammonia N	0.33	0.76	0.78	0.56
Organic N	1.23	0.78	0.89	0.64
Nitrite N	0.023	0.010	0.023	0.032
Nitrate N	0.08	0.14	0.115	0.025
Phosphorus-sol.	0.048	0.16	0.024	0.064
Phosphorus-tot.	0.096	0.20	0.078	0.102
pH	8.3	8.2	8.4	8.4
Conductance	690	735	590	730
Temperature, °C	13	12	12	14
Dissolved O_2	11.9	12.2	13.7	10.4
Alkalinity-tot.	240	236	246	255
Total Solids	508.8	600.4	485.2	577.6
Tot. Susp. Solids	3.8	4.6	9.0	5.1
Dissolved Solids	505.0	595.8	476.2	572.5
Chloride	75.0	112.0	70.0	114.2
Sulfate	44.0	38.0	32.8	36.0
Calcium	30	22	31	29
Magnesium	46	47	44	46
Iron	< 0.1	< 0.1	0.1	0.2
Sodium	36	51	30	54
Potassium	1.5	1.6	1.6	1.6
Hardness (calc.)	264	248	259	262

All values as mg/L except pH and Specific Conductance (umhos/cm^2 at 20°C)

TABLE 18

Water Chemistry Data from Jackson Creek at Mound Road Bridge

Test Parameters	29 July	3 Aug.	17 Aug.	19 Aug.	31 Aug.
Ammonia N	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Organic N	15.68	0.87	1.62	6.58	1.60
Nitrite N	0.120	0.270	0.320	< 0.005	0.27
Nitrate N	0.02	0.04	0.01	0.06	0.03
Phosphorus-sol.	2.8	1.5	3.4	3.3	4.7
Phosphorus-tot.	3.0	1.6	3.1	3.1	5.0
pH	7.8	7.9	8.3	7.7	8.0
Conductance	750	800	1320	1060	1220
Temperature, °C	21	22	21	21	22
Dissolved O_2	4.2	5.3	6.2	5.7	5.8
Alkalinity-tot.	298	354	362	297	372
Total Solids	1340.0	724.8	910.4	844.4	858.0
Tot. Susp. Solids	732.0	145.9	84.4	62.0	58.6
Dissolved Solids	608.0	578.9	826.0	782.4	799.4
Chloride	4	1	2	< 1	2.5
Sulfate	34.4	48.0	36.8	44.0	30.0
Calcium	13.5	14.8	14.7	13.5	13
Magnesium	38	47	48	42	48
Iron	0.2	0.1	0.1	0.1	0.1
Sodium	85	67	170	158	195
Potassium	9.0	6.2	5.0	9.8	8.0
Hardness (calc.)	190	230	234	207	230

All values as mg/L except pH and Specific Conductance (umhos/cm^2 at 20°C)

TABLE 19

Water Chemistry Data from Jackson Creek at Mound Road Bridge

Test Parameters	17 Sept.	25 Sept.	2 Oct.	8 Oct.	13 Oct.	22 Oct.
Ammonia N	< 0.03	< 0.03	0.28	< 0.03	0.81	0.20
Organic N	3.00	0.90	1.18	1.22	0.90	1.68
Nitrite N	0.026	.140	0.185	0.150	0.215	0.215
Nitrate N	0.12	0.06	0.04	0.03	0.03	0.06
Phosphorus-sol.	0.7	0.5	0.7	1.6	1.6	1.7
Phosphorus-tot.	1.4	0.8	0.9	1.9	1.7	2.0
pH	8.0	8.1	7.9	8.2	8.2	8.1
Conductance		640	705	830	890	830
Temperature, °C	20	19	13	15	14	9
Dissolved O_2	6.8	7.0	6.4	4.6	3.7	7.4
Alkalinity-tot.	128.0	256.0	316.8	280	340	358
Total Solids	559.6	526.4	318.6	548.0	622.0	624.8
Tot. Susp. Solids	275.8	92.87	20.4	34.87	20.67	68.3
Dissolved Solids	283.8	433.5	298.2	513.1	601.3	556.5
Chloride	1.0	1.0	0.7	1.5	2.0	2.0
Sulfate	26	41	54	49	49	45.2
Calcium	9.5	22.5	21	22.0	23.5	18.5
Magnesium	19	40	46	46	47	46
Iron	1.6	0.1	0.1	0.2	0.1	0.1
Sodium	9	15.5	28	53	60	57
Potassium	6.5	4.2	3.6	5.0	4.9	5.5
Hardness (calc.)	105	221	242	244	252	236

All values as mg/L except pH and Specific Conductance (umhos/cm^2 at 20°C)

TABLE 20

Water Chemistry Data from Jackson Creek at Mound Road Bridge

Test Parameters	24 Oct.	29 Oct.	6 Nov.	11 Nov.	16 Nov.	27 Nov.
Ammonia N	<0.03	0.75	<0.03	<0.03	0.28	<0.03
Organic N	2.24	2.89	0.45	0.59	0.62	0.84
Nitrite N	0.125	0.310	0.115	0.500	0.560	0.325
Nitrate N	0.05	0.13	0.04	0.03	0.02	0.02
Phosphorus-sol.	0.9	0.5	0.5	0.3	0.5	0.8
Phosphorus-tot.	1.4	0.6	0.5	0.4	0.7	0.8
pH	8.3	8.0	8.1	8.1	8.0	8.0
Conductance	730	640	1090	670	710	745
Temperature, °C	13	9	6	7	5	3
Dissolved O_2	9.6	8.2	10.4	9.4	11.5	6.2
Alkalinity-tot.	300	267	290	260	297	292
Total Solids	588.0	493.2	901.6	497.2	565.6	548.4
Tot. Susp.Solids	63.2	15.3	10.07	8.00	6.7	8.9
Dissolved Solids	524.8	477.9	891.5	489.2	558.9	539.5
Chloride	2.0	2.0	3.0	1.0	1.0	1.0
Sulfate	35.2	46.0	50.0	44.0	48.0	42.0
Calcium	16.5	17.5	64	43	45	42
Magnesium	44	42	61	46	50	46
Iron	<0.1	<0.1	<0.1	<0.1	<0.1	0.1
Sodium	36	20	68	17	26	37
Potassium	4.8	4.2	4.0	3.1	2.8	3.6
Hardness (calc.)	222	216	411	297	318	294

All values as mg/L except pH and Specific Conductance (umhos/cm^2 at 20°C)

TABLE 21

Water Chemistry Data from Jackson Creek at Mound Road Bridge

Test Parameters	30 Nov.	7 Dec.	14 Jan.	3 Feb.	25 Feb.	9 Mar.
Ammonia N	< 0.03	0.4	1.85	2.63	< 0.05	< 0.05
Organic N	0.67	0.8	1.06	1.34	1.09	1.45
Nitrite N	0.025	0.220	0.085	0.080	0.015	0.075
Nitrate N	0.02	0.08	0.08	0.05	0.12	0.16
Phosphorus-sol.	0.4	1.0	1.7	1.7	0.7	0.7
Phosphorus-tot.	0.5	1.0	1.6	1.6	0.7	0.9
pH	8.1	8.2	7.6	8.2	7.4	7.6
Conductance	665	810	765	1300	600	650
Temperature, °C	3	1	1	1	1	0
Dissolved O_2	9.0	9.6	8.7	12	11.9	9.3
Alkalinity-tot.	272	306	308	562	205	190
Total Solids	485.6	551.6	560.4	918.8	574.0	501.6
Tot. Susp. Solids	2.9	3.4	6.1	5.4	31.9	77.8
Dissolved Solids	482.7	548.2	554.3	913.4	542.1	
Chloride	0.5	1.0	< 1.0	1.0	4.0	84.0
Sulfate	45.0	52.8	38.0	55.2	15.0	12
Calcium	51	34	24	27	26	20
Magnesium	49	49	46	120	41	39
Iron	0.2	0.1	< 0.1	0.1	< 0.1	< 0.1
Sodium	20	32	48.5	75	45	36
Potassium	3.2	3.4	4.1	7.4	3.6	2.5
Hardness (calc.)	329.0	287	249	561	234	210

All values as mg/L except pH and Specific Conductance (umhos/cm^2 at 20°C)

TABLE 22

Water Chemistry Data from Jackson Creek at Mound Road Bridge

Test Parameters	12 Mar.	16 Mar.	23 Mar.	25 Mar.	31 Mar.	5 Apr.
Ammonia N	< 0.05	< 0.05	< 0.05	< 0.05	1.12	< 0.05
Organic N	1.09	1.73	1.20	1.20	2.07	1.06
Nitrite N	0.062	0.044	0.024	0.032	0.240	0.026
Nitrate N	0.205	0.360	0.10	0.07	0.27	0.26
Phosphorus-sol.	0.9	0.6	0.4	0.5	0.7	0.8
Phosphorus-tot.	1.0	0.8	0.4	0.4	0.5	0.5
pH	7.9	7.5	7.6	7.7	7.3	7.9
Conductance	690	580	610	650	300	600
Temperature, °C	2	1	2	2	5	8
Dissolved O_2	9.1	9.2	11.0	11.2	11.3	11.2
Alkalinity-tot.	250	184	230	240	158	235
Total Solids	490.0	434.4	447.6	446.4	574.4	458.4
Tot. Susp. Solids	3.84	42.20	8.0	4.9	192.4	4.0
Dissolved Solids			439.6	441.5	382.0	454.4
Chloride	65.0	40.0	48.0	47.5	34.0	42.0
Sulfate	18	12	48	44	24	26
Calcium	20	19	20	19	22	23
Magnesium	41	38	40	41	34	41
Iron	< 0.1	< 0.1	< 0.1	< 0.1	0.1	< 0.1
Sodium	35.5	15	21	20	12.5	18.0
Potassium	3.0	2.9	2.5	2.4	2.6	2.3
Hardness (calc.)	219	204	215	216	195	226

All values as mg/L except pH and Specific Conductance (umhos/cm^2 at 20°C)

TABLE 23

Water Chemistry Data from Jackson Creek at Mound Road Bridge

Test Parameters	14 Apr.	20 Apr.	31 Apr.	5 May	10 May	13 May
Ammonia N	0.47	1.51	1.12	1.28	1.18	2.16
Organic N	0.56	1.23	1.12	1.23	2.18	1.57
Nitrite N	0.075	0.162	0.146	0.656	0.292	<0.010
Nitrate N	0.10	0.10	0.35	0.375	0.245	0.265
Phosphorus-sol.	0.6	1.0	1.2	1.6	1.4	1.8
Phosphorus-tot.	0.6	1.0	1.2	1.5	1.7	2.2
pH	7.8	8.1	7.7	8.2	8.3	8.7
Conductance	630	1080	650	950	930	1650
Temperature, ^{o}C	8	11	11	13	15	10
Dissolved O_2	10.5	8.5	9.8	9.5	5.2	7.7
Alkalinity-tot.	246	256	258	272	265	261
Total Solids	509.6	810.0	533.2	847.6	816.0	1236.8
Total Susp. Solids	24.3	15.6	8.5	8.1	115.8	8.0
Dissolved Solids		794.4	524.7	839.5	700.2	1228.8
Chloride	47.0	199.0	61.0	215.0	174.0	395.6
Sulfate	43.0	40.0	48.0	36.4	38.4	46.0
Calcium	29.5	50	17	48	36	55
Magnesium	44	56	44	54	50	59
Iron	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sodium	25	96	39	112	89	160
Potassium	2.8	4.1	3.5	5.0	4.8	6.9
Hardness (calc.)	255	355	224	342	296	380

All values as mg/L except pH and Specific Conductance (umhos/cm^2 at 20^{o}C)

TABLE 24

BACTERIOLOGICAL DATA FROM STINK CREEK

Date/Test	Total Coliform	Fecal Coliform	Fecal Streptococcus	Pseudomonas sp.
13 Oct. 1970	92,000	54,200	9,500	350
22 Oct. 1970	92,000	75,000	10,000	690
24 Oct. 1970	38,000	38,000	4,900	180
29 Oct. 1970	31,500	29,000	2,750	200
6 Nov. 1970	48,500	48,000	3,500	200
11 Nov. 1970	22,000	20,000	2,000	150
16 Nov. 1970	26,500	26,000	8,000	150
27 Nov. 1970	27,000	27,000	4,900	75
30 Nov. 1970	27,800	27,800	3,500	920
7 Dec. 1970	3,000	3,000	1,600	500
14 Jan. 1971	2,800	2,700	90	100
3 Feb. 1971	3,000	3,000	60	120
25 Feb. 1971	36,000	29,500	170	270
23 Mar. 1971	510	500	27	9
25 Mar. 1971	500	500	30	10
31 Mar. 1971	460	450	8	13
5 Apr. 1971	450	450	10	7
14 Apr. 1971	770	700	24	7
20 Apr. 1971	570	450	12	8
30 Apr. 1971	420	420	8	0
5 May 1971	420	375	16	2
10 May 1971	420	420	8	2

(Results expressed as numbers of bacteria per 100 mls.)

TABLE 25

BACTERIOLOGICAL DATA FROM JACKSON CREEK

Date/Test	Total Coliform	Fecal Coliform	Fecal Streptococcus	Pseudomonas sp.
13 Oct 1970	54,200	54,200	212	80
22 Oct 1970	38,000	23,500	100	35
24 Oct 1970	1,100	1,000	71	7
29 Oct 1970	800	700	50	15
6 Nov 1970	450	400	90	9
11 Nov 1970	200	50	35	7
16 Nov 1970	100	100	0	6
27 Nov 1970	300	300	130	19
30 Nov 1970	240	240	130	8
7 Dec 1971	300	240	23	2
14 Jan 1971	2,000	1,900	11	9
3 Feb 1971	1,000	900	0	10
25 Feb 1971	5,000	4,900	25	20
23 Mar 1971	100	100	1	9
25 Mar 1971	125	100	7	10
31 Mar 1971	150	140	0	7
5 Apr 1971	150	135	0	4
14 Apr 1971	160	155	24	5
20 Apr 1971	185	165	10	16
30 Apr 1971	200	200	12	0
5 May 1971	130	120	8	2
11 May 1971	170	150	10	3

(Results expressed as numbers of bacteria per 100 mls.)

TABLE 26

BACTERIOLOGICAL DATA FROM JACKSON CREEK AT MOUND ROAD BRIDGE

Date/Test	Total Coliform	Fecal Coliform	Fecal Streptococcus	Pseudomonas sp.
13 Oct 1970	100,000	92,000	9,500	240
22 Oct 1970	70,000	48,000	10,000	427
24 Oct 1970	39,000	39,000	8,000	100
29 Oct 1970	21,000	21,000	2,200	100
6 Nov 1970	15,500	15,000	2,000	125
11 Nov 1970	11,500	11,000	2,200	150
16 Nov 1970	9,000	9,000	1,500	100
27 Nov 1970	34,500	34,500	2,400	100
30 Nov 1970	34,500	34,500	2,400	130
7 Dec 1970	1,200	1,100	280	130
14 Jan 1971	750	700	8	65
3 Feb 1971	300	300	8	100
25 Feb 1971	600	400	12	35
9 Mar 1971	375	350	15	12
12 Mar 1971	210	200	25	5
16 Mar 1971	225	225	30	2
23 Mar 1971	150	150	20	0
25 Mar 1971	130	120	2	2
31 Mar 1971	150	140	0	7
5 Apr 1971	200	190	8	5
14 Apr 1971	420	400	20	9

(Results expressed as numbers of bacteria per 100 mls.)

TABLE 27

BACTERIOLOGICAL DATA FROM JACKSON CREEK
AT MOUND ROAD BRIDGE

Date/Test	Total Coliform	Fecal Coliform	Fecal Streptococcus	Pseudomonas sp.
20 Apr 1971	250	240	8	0
30 Apr 1971	250	240	8	1
5 May 1971	370	350	10	2
10 May 1971	320	300	8	0
13 May 1971	350	320	10	2

(Results expressed as numbers of bacteria per 100 mls.)

TABLE 28

Water Chemistry Data Weekly Evaluation
Pilot Unit Influent and Effluent

Test Parameters	In 23 Mar.	Out	In 25 Mar.	Out	In 14 Apr.	Out
Ammonia N	< 0.05	< 0.05	< 0.05	< 0.05	0.47	0.42
Organic N	1.20	1.68	1.20	1.68	0.56	0.65
Nitrite N	0.024	0.033	0.032	0.023	0.075	0.043
Nitrate N	0.10	0.11	0.07	0.08	0.10	0.10
Phosphorus-sol.	0.4	0.4	0.5	0.4	0.6	0.6
Phosphorus-tot.	0.4	0.4	0.4	0.4	0.6	0.6
pH	7.6	7.7	7.7	7.6	7.8	8.0
Conductance	610	650	650	650	630	630
Temperature °C	2	1	2	1	8	8
Dissolved O_2	11.2	10.5	11.2	10.7	10.5	10.0
Alkalinity-tot.	230	226	240	230	246	218
Total Solids	447.6	513.2	446.2	439.2	509.6	484.4
Total Susp. Solids	8.0	23.7	4.9	13.2	24.3	4.0
Dissolved Solids	439.6	489.5	441.5	426.0		480.4
Chloride	48.0	75.0	47.5	47.5	47.0	51.0
Sulfate	48	40	44	44	43.0	45.0
Calcium	20	20.5	19	19	29.5	29
Magnesium	40	41	41	40	44	45
Iron	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Sodium	21	35	20	19	25	29
Potassium	2.5	2.8	2.4	2.1	2.8	2.8
Hardness (calc.)	215	220	216	212	255	258

All values as mg/L except pH and Specific Conductance (umhos/cm^2 at 20°C)

TABLE 29

Water Chemistry Data Weekly Evaluation
Pilot Unit Influent and Effluent

Test Parameters	In 20 Apr.	Out	In 30 Apr.	Out	In 5 May	Out
Ammonia N	1.51	1.12	1.12	1.51	1.28	0.95
Organic N	1.23	1.00	1.12	1.40	1.23	1.23
Nitrite N	0.162	0.124	0.146	0.176	0.656	0.512
Nitrate N	0.10	0.11	0.35	0.42	0.375	0.36
Phosphorus-sol.	1.0	1.0	1.2	1.2	1.6	1.3
Phosphorus-tot.	1.0	1.0	1.2	1.2	1.5	1.5
pH	8.1	7.9	7.7	7.7	8.2	8.3
Conductance	1080	1040	650	1000	950	1010
Temperature °C	11	13	11	11	13	13
Dissolved O_2	8.5	11	9.8	9.5	9.5	9.5
Alkalinity-tot.	256	248	258	256	272	265
Total Solids	810.0	780.8	533.2	869.6	847.6	942.8
Total Susp. Solids	15.6	9.6	8.5	21.0	8.1	8.4
Dissolved Solids	794.4	771.2	524.7	848.6	839.5	934.4
Chloride	199.0	180.0	61.0	214.0	215.0	257.0
Sulphate	40.0	42.0	48.0	46.0	36.4	39.6
Calcium	50	46	17	33.5	48	54
Magnesium	56	55	44	54	54	56
Iron	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Sodium	96	94	39	96	112	128
Potassium	4.1	4.1	3.5	4.7	5.0	5.2
Hardness (calc.)	355	341.2	224	252.7	342	365.3

All values as mg/L except pH and Specific Conductance (umhos/cm^2 at 20°C)

TABLE 30

Water Chemistry Data Weekly Evaluation
Pilot Unit Influent and Effluent

Test Parameters	In 10 May	Out	In 13 May	Out
Ammonia N	1.18	1.01	2.16	1.74
Organic N	2.18	1.26	1.57	1.32
Nitrite N	0.292	0.234	<0.01	<0.01
Nitrate N	0.245	0.255	0.265	0.485
Phosphorus-sol.	1.4	1.4	1.8	1.8
Phosphorus-tot.	1.7	1.3	2.2	2.6
pH	8.3	8.4	8.7	8.7
Conductance	930	910	1650	770
Temperature °C	15	17	10	12
Dissolved O_2	5.2	9.0	7.8	8.2
Alkalinity-tot.	265	273	261	240
Total Solids	816.0	716.8	1236.8	1078.0
Total Susp. Solids	115.8	12.4	8.0	5.8
Dissolved Solids	700.2	704.4	1228.8	1072.2
Chloride	174.0	166.0	395.6	323.5
Sulphate	38.4	36.8	46.0	40
Calcium	36	34.5	55	50
Magnesium	50	50	59	55
Iron	0.1	0.1	< 0.1	< 0.1
Sodium	89	87	160	128
Potassium	4.8	4.6	6.9	6.5
Hardness (calc.)	296	219.9	380	351.2

All values as mg/L except pH and Specific Conductance ($umhos/cm^2$ at 20°C)

TABLE 31

WATER CHEMISTRY DATA 36 HOUR EVALUATION
Pilot Unit Influent and Effluent

TEST PARAMETERS	10 AM IN	10 AM OUT	11 AM IN	11 AM OUT	12 PM IN	12 PM OUT
Ammonia N	<0.05	0.70	0.98	0.64	1.09	0.56
Organic N	1.48	1.32	0.84	1.04	1.60	1.40
Nitrite N	0.310	0.300	0.310	0.300	0.360	0.310
Nitrate N	0.070	0.140	0.090	0.090	0.070	0.070
Phosphorus-sol.	2.24	2.40	2.16	2.36	2.12	2.24
Phosphorus-tot.	2.16	2.24	2.12	2.20	2.08	2.12
pH	7.9	7.8	7.8	7.7	8.0	8.1
Conductance	825	790	860	820	920	770
Temperature, °C	17	17	17	17	18	18
Dissolved O_2	6.0	6.4	5.6	6.8	6.0	6.3
Alkalinity-Tot.	249.2	253.3	260.3	256.3	262.3	261.3
Total Solids	655.6	595.2	704.0	618.0	748.4	621.1
Tot. Susp.Solids	30.6	12.6	29.0	12.6	29.9	13.2
Dissolved Solids	625.0	582.6	675.0	605.4	718.5	608.0
Chloride	120.0	107.5	137.5	115.0	160.0	127.5
Sulfate	38.0	36.0	34.8	36.0	34.8	34.0
Calcium	23	23	25.5	24.5	29.5	27.5
Magnesium	48	46	49	47	50	48
Iron	0.1	0.1	0.1	0.1	0.1	0.1
Sodium	82	78	92	82	100	86
Potassium	4.7	4.4	4.8	4.5	4.8	4.7
Hardness (calc.)	255	247	265	255	279	266
COD	44.4	55.8	57.0	82.4	48.0	63.4

All values as mg/L except pH and Specific Conductance (umhos/cm^2 at 20°C)

TABLE 32

WATER CHEMISTRY DATA 36 HOUR EVALUATION
Pilot Unit Influent and Effluent

TEST PARAMETERS	1 PM IN	1 PM OUT	2 PM IN	2 PM OUT	3 PM IN	3 PM OUT
Ammonia N	0.22	0.45	0.73	0.39	0.70	0.22
Organic N	1.71	1.40	1.71	1.32	1.23	1.04
Nitrite N	0.330	0.305	0.330	0.310	0.370	0.330
Nitrate N	0.345	0.170	0.190	0.150	0.100	0.070
Phosphorus-sol.	2.04	2.16	2.00	2.16	2.12	2.12
Phosphorus-tot.	2.04	2.08	1.96	2.04	2.08	2.04
pH	8.1	8.2	8.1	8.2	8.0	8.1
Conductance	940	770	940	890	1050	900
Temperature, °C	18	19	18.5	19	18.5	19
Dissolved O_2	5.8	8.4	5.7	8.7	4.2	8.1
Alkalinity-tot.	260.3	257.3	261.3	259.3	257.3	257.3
Total Solids	753.6	664.4	758.8	630.0	824.8	674.0
Tot. Susp. Solids	36.6	13.4	39.6	12.7	32.9	14.0
Dissolved Solids	717.0	651.0	719.2	617.3	791.9	660.0
Chloride	160.0	127.5	172.5	137.5	205.0	145.0
Sulfate	40.8	28.0	28.0	40.8	34.8	38.0
Calcium	32	29.5	30.5	27	36	27
Magnesium	50	47	50	49	52	48
Iron	0.1	0.1	0.1	0.1	0.1	0.1
Sodium	100	86	100	86	112	89
Potassium	4.8	4.7	4.8	4.6	5.0	4.8
Hardness (calc.)	286	267	282	269	304	265
COD	50.7	54.4	35.2	38.0	57.0	31.7

All values as mg/L except pH and Specific Conductance (umhos/cm^2 at 20°C)

TABLE 33

WATER CHEMISTRY DATA 36 HOUR EVALUATION
Pilot Unit Influent and Effluent

TEST PARAMETERS	4 PM IN	4 PM OUT	5 PM IN	5 PM OUT	6 PM IN	6 PM OUT
Ammonia N	0.62	<0.05	0.78	<0.05	0.90	0.36
Organic N	1.51	1.46	1.43	1.20	1.40	1.23
Nitrate N	.215	.090	.065	.050	.050	.035
Nitrite N	.320	.250	.600	.360	.635	.365
Phosphorus-sol.	1.78	1.76	1.76	1.76	1.72	1.76
Phosphorus-tot.	2.04	2.00	2.10	2.04	2.01	2.10
pH	8.0	8.3	8.0	8.2	7.9	8.2
Conductance	1090	900	1070	950	1040	910
Temperature, °C	18	19	18.5	19.5	19	19.5
Dissolved O_2	3.8	9.5	4.2	8.3	4.4	8.4
Alkalinity-tot.	248.2	252.3	248.2	252.3	248.2	255.3
Total Solids	854.4	662.8	828.0	677.6	810.8	666.8
Tot. Susp. Solids	34.4	13.3	44.5	18.0	52.4	15.2
Dissolved Solids	820.0	649.5	783.5	659.6	758.4	651.6
Chloride	197.3	135.4	192.9	140.2	189.4	145.9
Sulfate	42.8	44.0	43.2	42.8	38.4	37.2
Calcium	25	19	25	18	25.5	19
Magnesium	52	47	51	47	51	48
Iron	0.1	0.1	0.1	<0.1	<0.1	<0.1
Sodium	112	86	112	89	108	89
Potassium	5.1	4.8	5.1	4.8	5.2	5.0
Hardness (calc.)	276	241	272	238	274	245
COD	25.3	63.4	76.0	50.7	26.3	26.3

All values as mg/L except pH and Specific Conductance (umhos/cm^2 at 20°C)

TABLE 34

WATER CHEMISTRY DATA 36 HOUR EVALUATION
Pilot Unit Influent and Effluent

TEST PARAMETERS	7 PM IN	7 PM OUT	8 PM IN	8 PM OUT	9 PM IN	9 PM OUT
Ammonia N	0.73	<0.05	0.31	<0.05	<0.05	<0.05
Organic N	1.34	0.87	0.95	1.15	1.15	0.78
Nitrate N	.160	.180	.070	.045	.035	.040
Nitrite N	.680	.365	.940	.560	.980	.680
Phosphorus-sol.	1.70	1.78	1.70	1.80	1.80	1.86
Phosphorus-tot.	2.00	1.96	2.01	2.01	2.04	2.00
pH	7.9	8.1	7.9	8.0	8.0	7.9
Conductance	990	950	1090	940	1130	960
Temperature, °C	18.5	19	18.5	19	18	18.5
Dissolved O_2	4.3	7.6	3.6	6.7	3.6	4.9
Alkalinity-Tot.	247.2	254.3	247.2	255.3	246.2	251.3
Total Solids		700.0	861.2	708.4	904.4	716.4
Tot. Susp. Solids	39.0	13.6	31.1	12.6	26.4	11.6
Dissolved Solids		686.4	830.1	695.8	878.0	704.8
Chloride	186.4	160.9	212.5	161.7	234.3	169.7
Sulfate	36.0	42.8	33.2	38.8	36.0	33.2
Calcium	25	20	30	21	35.5	23.5
Magnesium	50	49	53	49	53	50
Iron	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sodium	104	95	116	95	123	95
Potassium	5.1	5.0	5.3	5.2	5.5	5.3
Hardness (Calc.)	268	252	293	254	307	264
COD	26.7	12.7	25.3	50.6	40.5	111.3

All values as mg/L except pH and Specific Conductance (umhos/cm^2 at 20°C)

TABLE 35

WATER CHEMISTRY DATA 36 HOUR EVALUATION
Pilot Unit Influent and Effluent

TEST PARAMETERS	10 PM IN	10 PM OUT	11 PM IN	11 PM OUT	12 Mid. IN	12 Mid. OUT
Ammonia N	< 0.05	0.45	<0.05	0.39	<0.05	0.78
Organic N	0.89	1.00	1.00	0.95	1.00	1.00
Nitrite N	0.250	0.610	0.185	0.780	0.600	0.540
Nitrate N	0.080	0.070	0.100	0.080	0.110	0.100
Phosphorus-sol.	1.68	1.84	2.12	1.84	1.72	1.88
Phosphorus-tot.	1.68	1.72	1.60	1.68		
pH	7.8	7.9	7.8	7.9	7.8	7.9
Conductance	1120	1010	1040	900	970	930
Temperature, °C	18	18.5	18	18	17.5	18
Dissolved O_2	3.9	4.6	3.6	4.5	4.0	4.3
Alkalinity-tot.	252.0	250.3	253.3	264.3	252.2	261.3
Total Solids	901.6	814.8	927.6	774.8	839.2	788.8
Tot. Susp. Solids	25.3	12.5	27.6	11.0	28.8	11.8
Dissolved Solids	876.3	802.3	900.0	763.8	810.4	777.0
Chloride	225.5	117.6	218.4	180.6	206.1	189.0
Sulfate	38.0	38.8	44.0	34.8	32.0	37.1
Calcium	46	38	45	39	45	42
Magnesium	54	51	54	51	53	52
Iron	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sodium	126	102	120	98	112	108
Potassium	5.3	5.1	5.1	5.0	5.1	5.0
Hardness (calc.)	337	305	335	307	330	319
COD	60.7	121.4	91.1	81.0	91.0	40.5

All values as mg/L except pH and Specific Conductance (umhos/cm^2 at 20°C)

TABLE 36

WATER CHEMISTRY DATA 36 HOUR EVALUATION
Pilot Unit Influent and Effluent

TEST PARAMETERS	1 AM IN	1 AM OUT	2 AM IN	2 AM OUT	3 AM IN	3 AM OUT
Ammonia N	0.86	0.34	<0.05	<0.05	<0.05	<0.05
Organic N	0.92	1.03	1.14	0.42	1.06	0.81
Nitrite N	0.025	0.600	0.120	0.510	0.025	0.500
Nitrate N	0.380	0.700	0.450	0.270	0.180	0.100
Phosphorus-sol.	1.68	1.76	1.60	1.76	1.64	1.72
Phosphorus-tot.	1.60	1.60	1.64	1.44		
pH	7.8	7.9	7.8	7.8	7.8	7.7
Conductance	1000	880	920	830	900	990
Temperature, °C	21.0	18.0	20.0	17.0	20.5	17.0
Dissolved O_2	4.5	4.5	4.0	3.8	4.6	2.7
Alkalinity-tot.	251.2	257.3	256.3	251.3	257.3	262.3
Total Solids	864.0	819.6	788.8	865.6	760.8	1264.4
Tot. Susp. Solids	35.9	10.8	32.8	11.5	32.3	11.6
Dissolved Solids	828.1	808.8	756.0	854.1	728.5	1252.8
Chloride	194.3	190.3	171.4	210.1	160.3	208.8
Sulfate	36.0	36.0	38.0	39.6	37.2	42.0
Calcium	44	43	40	46	36	46
Magnesium	52	51	51	53	49	53
Iron	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sodium	106	106	96	102	90	102
Potassium	5.0	5.0	4.8	5.0	4.7	5.0
Hardness (calc.)	324	317	310	333	292	333
COD	81.0	70.8	70.8	30.4	121.4	91.0

All values as mg/L except pH and Specific Conductance (umhos/cm^2 at 20°C)

TABLE 37

WATER CHEMISTRY DATA 36 HOUR EVALUATION
Pilot Unit Influent and Effluent

TEST PARAMETERS	4 AM IN	4 AM OUT	5 AM IN	5 AM OUT	6 AM IN	6 AM OUT
Ammonia N	< 0.05	0.67	0.42	0.61	0.30	0.50
Organic N	0.33	0.64	1.28	0.95	1.17	0.95
Nitrite N	0.112	0.215	.140	.310	.135	.235
Nitrate N	.205	.200	.207	.215	.266	.217
Phosphorus-sol.	1.74	2.08	1.64	2.00	1.56	2.08
Phosphorus-tot.	1.76	1.72	1.64	1.68	1.60	1.64
pH	8.0	7.8	7.8	7.8	7.7	7.7
Conductance	800	940	850	980	830	990
Temperature, °C	20.0	17.0	20.5	17.0	19.5	17.0
Dissolved O_2	4.3	3.8	4.5	3.9	4.0	3.0
Alkalinity-tot.	270	268	268	286	269	268
Total Solids	782.4	841.2	724.4	856.4	748.8	830.4
Tot. Susp. Solids	50.5	13.9	49.0	16.2	50.0	13.6
Dissolved Solids	73.19	837.3	675.4	840.2	698.8	816.8
Chloride	156.5	200.4	138.4	189.9	133.1	186.8
Sulfate	32.2	30.2	32.0	32.2	36.2	32.2
Calcium	17	24	17	23	17	23
Magnesium	49	52	49	52	48	52
Iron	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Sodium	98	120	92	120	96	124
Potassium	2.6	2.6	2.4	2.6	2.4	2.6
Hardness (calc.)	244	274	244	271	240	271
COD	88.0	80.0	59.3	28.0	20.0	16.0

All values as mg/L except pH and Specific Conductance (umhos/cm^2 at 20°C)

TABLE 38

WATER CHEMISTRY DATA 36 HOUR EVALUATION
Pilot Unit Influent and Effluent

TEST PARAMETERS	7 AM IN	7 AM OUT	8 AM IN	8 AM OUT	9 AM IN	9 AM OUT
Ammonia N	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Organic N	0.72	0.58	1.20	1.00	1.23	0.98
Nitrite N	.115	.200	.290	.280	.290	.225
Nitrate N	.215	.205	.191	.191	.217	.423
Phosphorus-sol.	1.84	2.00	1.72	1.92	1.64	1.84
Phosphorus-tot.	1.84	1.76	1.68	1.68	1.52	1.60
pH	7.7	7.7	7.8	7.8	7.9	7.9
Conductance	850	950	850	930	880	920
Temperature, °C	19.0	17.0	21.2	17.0	22.6	17.5
Dissolved O_2	3.5	3.6	3.0	3.5	3.8	3.9
Alkalinity-tot.	267	267	269	269	271	268
Total Solids	693.6	793.2	709.2	806.8	719.2	763.2
Tot. Susp. Solids	44.2	15.4	33.1	19.8	36.1	21.1
Dissolved Solids	649.4	777.8	676.1	887.0	683.1	742.1
Chloride	121.7	174.5	120.9	163.1	130.1	142.4
Sulfate	36.0	34.2	38.2	38.2	36.0	36.2
Calcium	15	21	16	19	16	17
Magnesium	48	51	48	50	48	49
Iron	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sodium	80	104	82	98	82	92
Potassium	2.4	2.5	2.4	2.5	2.5	2.5
Hardness (calc.)	235	262	237	253	237	244
COD	20.0	28.0	28.0	16.0	20.0	50.1

All values as mg/L except pH and Specific Conductance (umhos/cm^2 at 20°C)

TABLE 39

WATER CHEMISTRY DATA 36 HOUR EVALUATION
Pilot Unit Influent and Effluent

TEST PARAMETERS	10 AM IN	10 AM OUT	11 AM IN	11 AM OUT	12 PM IN	12 PM OUT
Ammonia N	<0.05	<0.05	<0.05	<0.05	1.12	0.39
Organic N	1.23	0.95	1.174	0.784	0.92	0.73
Nitrite N	0.05	0.03	0.15	0.15	0.33	0.17
Nitrate N	0.30	0.31	0.20	0.36	0.45	0.30
Phosphorus-sol.	1.48	1.52	1.08	1.48	1.70	1.48
Phosphorus-tot.	1.80	1.76	1.60	1.68	1.88	1.84
pH	7.9	7.9	8.0	7.8	7.8	8.0
Conductance	880	920	906	890	960	890
Temperature, °C	23.7	18.0	20.4	17.5	21.3	18.0
Dissolved O_2	4.4	5.1	5.4	4.0	3.4	4.1
Alkalinity-tot.	309	308	309	256	302	302
Total Solids	738.4	726.0	786.0	703.2	785.6	652.4
Tot. Susp. Solids	44.1	20.0	60.4	19.4	46.9	18.0
Dissolved Solids	694.3	706.0	725.6	783.8	738.7	634.4
Chloride	126.6	137.1	142.9	132.3	159.5	133.2
Sulfate	36.0	37.0	37.0	37.0	36.0	40.0
Calcium	16.5	17	17	17	19	16.5
Magnesium	49	49	46	47	50	48
Iron	< 0.1	< 0.1	<0.1	<0.1	<0.1	<0.1
Sodium	86	88	90	90	96	87
Potassium	4.9	4.9	4.8	4.9	5.4	5.1
Hardness (calc.)	242	244	232	236	253	239
COD	50.1	44.5	55.7	72.4	27.6	29.2

All values as mg/L except pH and Specific Conductance (umhos/cm^2 at 20°C)

TABLE 40

WATER CHEMISTRY DATA 36 HOUR EVALUATION
Pilot Unit Influent and Effluent

TEST PARAMETERS	1 PM IN	1 PM OUT	2 PM IN	2 PM OUT	3 PM IN	3 PM OUT
Ammonia N	<0.05	<0.05	0.67	<0.05	<0.05	<0.05
Organic N	1.12	1.12	1.14	1.26	1.12	1.26
Nitrite N	0.11	0.14	0.42	0.28	0.52	0.87
Nitrate N	0.47	0.30	0.43	0.23	0.26	0.45
Phosphorus-sol.	1.70	1.40	1.54	1.32	1.34	1.76
Phosphorus-tot.	1.80	1.72	1.68	1.64	1.88	1.52
pH	7.8	8.1	7.9	8.0	7.8	8.1
Conductance	980	900	960	910	1010	940
Temperature, °C	22.4	18.5	21.5	18.5	23.3	19.0
Dissolved O_2	3.3	6.9	4.6	6.5	3.7	8.9
Alkalinity-tot.	298	302	298	301	297	303
Total Solids	812.0	724.4	765.2	738.4	827.6	713.2
Tot. Susp. Solids	36.0	20.2	40.7	21.2	22.0	35.8
Dissolved Solids	776.0	704.2	724.5	717.2	805.6	677.4
Chloride	163.9	134.0	157.3	138.0	190.0	198.0
Sulfate	38.0	34.0	35.0	37.0	37.0	38.0
Calcium	20	16.5	18.5	16.5	17	20
Magnesium	50	46	49	46	47	49
Iron	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sodium	98	86	95	87	90	102
Potassium	5.5	5.2	5.6	5.4	4.8	5.2
Hardness (calc.)	256	247	236	231	236	252
COD	28.5	19.0	31.7	31.7	31.7	20.4

All values as mg/L except pH and Specific Conductance (umhos/cm^2 at 20°C)

TABLE 41

WATER CHEMISTRY DATA 36 HOUR EVALUATION
Pilot Unit Influent and Effluent

TEST PARAMETERS	4 PM IN	4 PM OUT	5 PM IN	5 PM OUT	6 PM IN	6 PM OUT
Ammonia N	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Organic N	0.72	0.95	0.95	1.34	0.64	0.89
Nitrite N	0.020	0.010	0.010	0.010	0.010	0.020
Nitrate N	0.820	0.730	0.580	0.6[illegible]0	1.200	0.730
Phosphorus-sol.	1.86	1.40	1.94	1.42	2.06	1.46
Phosphorus-tot.	2.00	1.60	1.96	1.60	2.12	1.64
pH	7.8	8.2	7.9	8.2	7.9	8.2
Conductance	1030	940	1030	1000	1020	990
Temperature, °C	24.3	19.0	25.0	19.0	25.0	19.0
Dissolved O_2	3.0	9.8	3.4	10.6	3.0	10.0
Alkalinity-tot.	297	300	306	297	296	295
Total Solids	850.4	718.8	833.2	748.8	885.2	709.6
Tot. Susp. Solids	28.9	18.8	30.0	17.5	25.6	16.4
Dissolved Solids	821.5	700.0	803.2	731.3	859.6	693.2
Chloride	151.0	152.0	224.0	154.0	245.0	157.0
Sulfate	34.0	33.0	31.0	35.0	32.0	37.0
Calcium	21	18	25	18	28	19
Magnesium	50	44	51	46	51	47
Iron	0.1	0.1	0.1	0.1	0.1	0.1
Sodium	110	86	116	88	120	95
Potassium	5.5	5.0	5.7	5.0	5.6	5.3
Hardness (calc.)	258	226	272	234	279	241
COD	23.5	23.5	26.9	25.1	20.2	24.0

All values as mg/L except pH and Specific Conductance (umhos/cm^2 at 20°C)

TABLE 42

WATER CHEMISTRY DATA 36 HOUR EVALUATION
Pilot Unit Influent and Effluent

TEST PARAMETERS	7 PM IN	7 PM OUT	8 PM IN	8 PM OUT	9 PM IN	9 PM OUT
Ammonia N	$<$ 0.05	$<$ 0.05	$<$0.05	$<$ 0.05	$<$0.05	$<$0.05
Organic N	0.67	0.72	0.89	1.17	0.81	0.92
Nitrite N	0.080	0.080	.390	.240	.150	.220
Nitrate N	0.780	0.640	0. 710	0.560	1.800	.640
Phosphorus-sol.	2.18	1.52	2.30	1.52	2.35	1.54
Phosphorus-tot.	1.62	1.14	1.68	1.16	1.72	1.20
pH	7.8	8.0	8.0	8.0	7.8	8.0
Conductance	1030	1005	1030	1000	1025	1010
Temperature, °C	17.5	18.5	17.5	18.0	16.0	17.0
Dissolved O_2	3.0	9.5	3.8	7.5	3.9	3.5
Alkalinity-tot.	299	318	291	304	299	301
Total Solids	974.0	752.8	866.8	737.6	930.8	736.0
Tot. Susp. Solids	27.8	17.2	23.3	17.6	20.3	15.4
Dissolved Solids	946.2	735.6	843.5	720.0	910.5	720.6
Chloride	285.0	243.0	243.0	153.0	233.0	169.0
Sulfate	35.0	36.0	36.0	37.0	34.0	46.0
Calcium	29	19	27	18	25	18
Magnesium	51	46	51	46	50	47
Iron	0.1	0.1	0.1	0.1	0.1	0.1
Sodium	130	96	135	100	120	100
Potassium	6.0	5.1	5.9	5.1	6.1	5.2
Hardness (calc.)	282	237	277	234	268	238
COD	20.2	20.2	20.2	14.1	18.9	22.1

All values as mg/L except pH and Specific Conductance (umhos/cm^2 at 20°C)

TABLE 43

WATER CHEMISTRY DATA 36 HOUR EVALUATION
Pilot Unit Influent and Effluent

TEST PARAMETERS	10 PM IN	10 PM OUT
Ammonia N	< 0.05	< 0.05
Organic N	0.84	0.90
Nitrite N	.470	.260
Nitrate N	1.140	0.720
Phosphorus-sol.	2.22	1.70
Phosphorus-tot.	1.72	1.26
pH	7.8	8.0
Conductance	1025	1010
Temperature, °C	16.0	16.0
Dissolved O_2	4.0	4.0
Alkalinity-tot.	302	306
Total Solids	917.6	897.2
Tot. Susp. Solids	19.0	15.2
Dissolved Solids	898.6	882.0
Chloride	231.0	178.0
Sulfate	33.0	33.0
Calcium	24	19
Magnesium	52	47
Iron	0.1	0.1
Sodium	130	105
Potassium	5.9	5.2
Hardness (calc.)	274	241
COD	18.9	22.1

All values as mg/L except pH and Specific Conductance (umhos/cm^2 at 20°C)

TABLE 44

BACTERIOLOGICAL DATA WEEKLY EVALUATION

Date		Total Coliform	Fecal Coliform	Fecal Streptococcus	Pseudomonas sp.
23 Mar 71	In	150	150	20	0
	Out	150	135	15	0
25 Mar 71	In	130	120	2	2
	Out	125	125	0	15
14 Apr 71	In	420	400	20	9
	Out	400	350	20	9
20 Apr 71	In	250	240	8	0
	Out	230	200	10	0
30 Apr 71	In	250	240	8	1
	Out	250	250	8	1
5 May 71	In	370	350	10	2
	Out	250	210	21	4
10 May 71	In	320	300	8	0
	Out	200	200	12	2
13 Mau 71	In	350	320	10	2
	Out	270	250	12	0

(Results expressed as numbers of bacteria per 100 mls of sample.)

TABLE 45
BACTERIOLOGICAL DATA
36 HOUR EVALUATION

17 May 1971		Total Coliform	Fecal Coliform	Fecal Streptococcus	Pseudomonas sp.
10 AM	In	420	400	4	0
	Out	490	450	4	0
11 AM	In	300	300	0	0
	Out	300	300	8	0
1 PM	In	290	290	12	0
	Out	420	390	0	0
3 PM	In	310	300	4	0
	Out	370	310	0	0
5 PM	In	370	350	0	0
	Out	400	350	0	4
7 PM	In	510	500	0	0
	Out	700	650	0	0
9 PM	In	350	350	8	0
	Out	350	350	0	0
11 PM	In	400	400	0	0
	Out	570	550	0	0
18 May 1971					
1 AM	In	600	550	0	0
	Out	530	530	0	0
3 AM	In	400	400	0	4
	Out	470	410	0	0
5 AM	In	510	500	4	4
	Out	550	500	0	0
7 AM	In	500	500	4	0
	Out	590	550	0	0
9 AM	In	500	500	0	0
	Out	510	500	12	0
11 AM	In	470	450	4	0
	Out	500	500	0	0

(Results expressed as numbers of bacteria per 100 mls of sample)

TABLE 46

BACTERIOLOGICAL DATA
36 HOUR EVALUATION

18 May 1971		Total Coliform	Fecal Coliform	Fecal Streptococcus	Pseudomonas sp.
1 PM	In	470	470	4	0
	Out	510	500	4	0
3 PM	In	430	400	8	0
	Out	420	400	0	0
5 PM	In	370	370	35	4
	Out	500	420	0	0
7 PM	In	520	500	4	0
	Out	610	500	4	0
9 PM	In	320	320	8	0
	Out	290	250	0	0
10 PM	In	350	350	4	0
	Out	390	390	4	0

(Results expressed as numbers of bacteria per 100 mls of sample.)

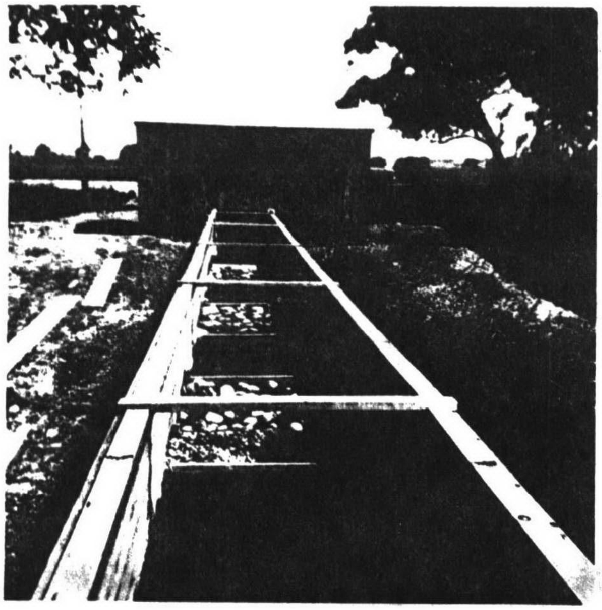
TABLE 47

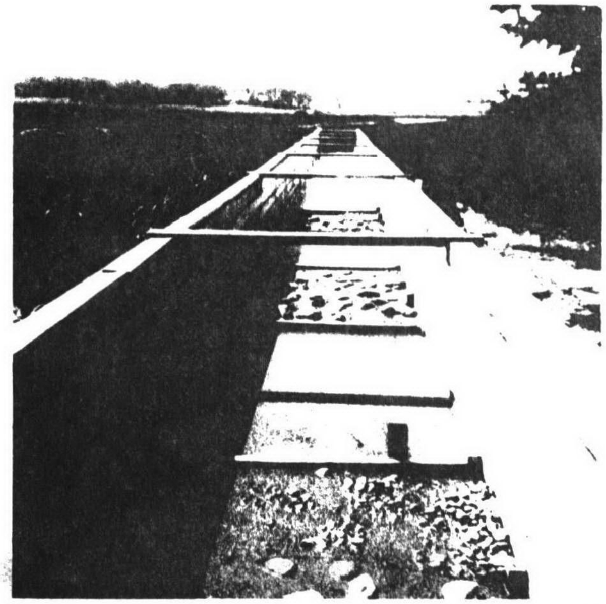
TWENTY-FOUR HOUR B.O.D. AND C.O.D. REDUCTION EVALUATION

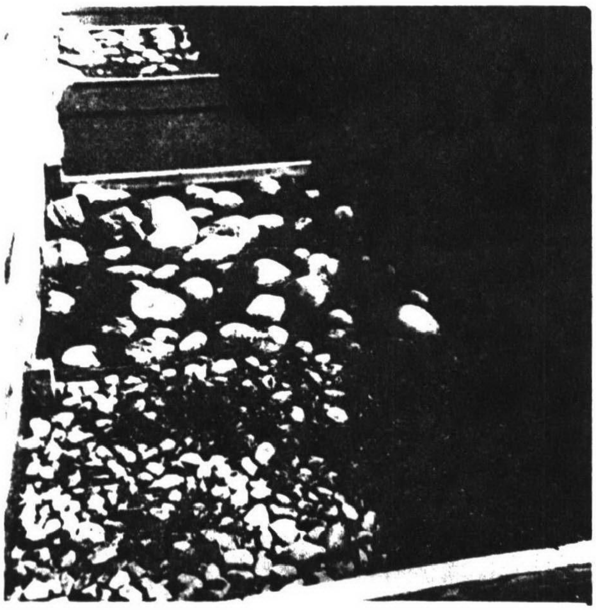
Time	Influent Temp. °C	Influent D.O.	Influent C.O.D.	Influent B.O.D.	Effluent Temp. °C	Effluent D.O.	Effluent C.O.D.	Effluent B.O.D.
6 PM	22.0	0.7	22.8	11.7	22.0	2.0	26.4	12.3
7 PM	22.0	0.5	15.6	11.7	22.0	1.5	22.6	10.0
8 PM	22.0	0.3	15.2	12.5	22.0	0.5	13.2	13.0
9 PM	22.0	0.3	30.8	17.1	22.0	0.5	15.0	16.8
10 PM	22.0	0.3	37.6	15.7	22.0	0.4	25.6	15.1
11 PM	22.0	0.3	37.6	17.1	22.0	0.4	31.6	13.3
12 AM	22.0	0.1	33.6	11.4	22.0	0.5	35.2	10.2
1 AM	22.0	0.2	39.6	13.9	20.5	0.3	31.2	10.2
2 AM	21.8	0.1	35.2	10.2	20.5	0.5	36.8	12.6
3 AM	21.8	0.2	35.8	7.8	20.5	0.5	35.2	7.8
4 AM	21.7	0.5	39.60	11.3	20.2	0.4	37.2	6.3
5 AM	21.8	0.5	33.2	9.0	20.2	0.3	29.0	20.0
6 AM	21.0	0.6	37.2	8.9	20.0	0.3	24.0	9.0
7 AM	21.5	0.5	37.6	7.6	20.5	0.5	27.8	6.0
8 AM	21.5	0.5	33.6	11.4	20.5	0.5	23.7	7.6
9 AM	21.5	0.3	43.6	7.4	20.5	0.3	27.6	8.7
10 AM	21.5	0.3	37.2	10.6	21.0	1.1	27.9	6.7
11 AM	21.5	0.4	48.8	10.6	21.0	1.6	29.2	7.7
12 PM	21.6	0.4	53.4	12.9	21.7	2.4	39.6	7.2
1 PM	21.7	0.3	57.4	13.2	22.0	4.6	47.5	9.6
2 PM	21.8	0.4	21.7	12.0	23.0	5.6	27.9	6.0
3 PM	22.0	0.5	25.7	13.6	23.0	7.3	21.7	7.8
4 PM	22.5	0.5	54.8	12.4	24.0	7.5	24.8	6.6
5 PM	22.3	0.5	45.0	7.8	24.0	7.0	29.8	8.6
6 PM	21.9	0.3	45.0	7.9	23.8	6.0	32.7	6.0
7 PM	21.5	0.3	40.7	8.0	23.7	5.2	37.7	6.0

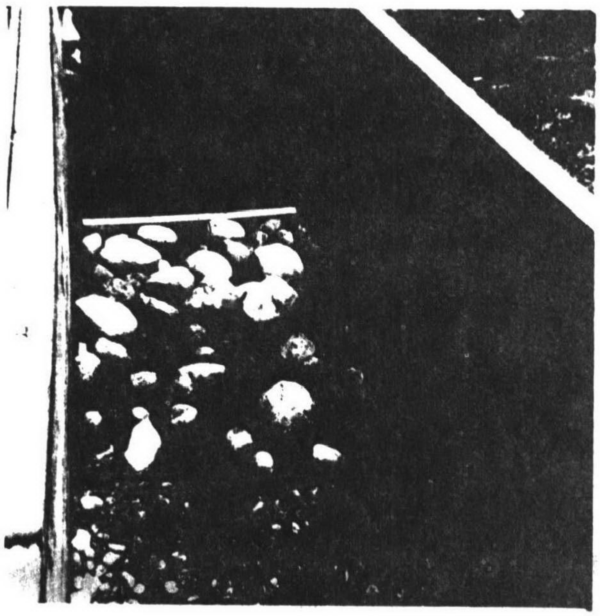
D.O. - Dissolved Oxygen mg/l
C.O.D. - Chemical Oxygen Demand mg/l
B.O.D. - Biochemical Oxygen Demand mg/l

PHOTOGRAPHS OF THE BIOLOGICAL FILTER









1 Accession Number	2 Subject Field & Group	
W		**SELECTED WATER RESOURCES ABSTRACTS** **INPUT TRANSACTION FORM**

5 *Organization*

LIMNETICS, INC. Milwaukee, Wisconsin

6 *Title*

Preliminary Studies on a Biological Filter

10 *Author(s)*

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16 *Project Designation*

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21 *Note*

22 *Citation*

23 *Descriptors (Starred First)*

*Sewage effluent, *Agricultural run-off, Water Chemistry, Bacteriology, Hydrology.

Jackson Creek, Lake Delavan, Wisconsin.

25 *Identifiers (Starred First)*

*Stream purification, Trickling Filter, B.O.D. reduction.

27 *Abstract*

A pilot horizontal biological filter similar to a trickling filter was constructed on Jackson Creek near Lake Delavan, Wisconsin. The filter consisted of graded rocks in three sections of four feet wide by two feet deep by six feet long. Water was pumped from Jackson Creek into the filter and water chemistry and bacteriological analyses were undertaken on the influent and effluent from the filter. There was little effect of the filter on the water chemistry or bacteriological content. Preliminary results indicate that substantial B.O.D. reduction occurred when the influent was well oxygenated.

Abstractor R.V. Harmsworth | *Institution* LIMNETICS, INC.