EPA 904/9/75/003

TECHNICAL ASSISTANCE PROJECT AT THE DANVILLE, KENTUCKY WASTEWATER TREATMENT PLANT

AUGUST 1975

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

TECHNICAL ASSISTANCE PROJECT
AT THE
DANVILLE, KENTUCKY
WASTEWATER TREATMENT PLANT

AUGUST 1975

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

TABLE OF CONTENTS

INTRODUCTION

A technical assistance study of operation and maintenance problems at the wastewater treatment plant serving Danville, Kentucky was conducted during August 19-22, 1975, by the U.S. Environmental Protection Agency, Region IV. Operation and maintenance technical assistance studies are designed to assist local wastewater treatment plant operators in maximizing treatment efficiencies as well as assist with special operational problems. Municipal wastewater treatment plants are selected for technical assistance studies after consultation with state pollution 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.

The specific study objectives were to:

- Optimize treatment via control testing and recommended operation and maintenance modifications,
- Determine influent and effluent waste characteristics,
- Assist laboratory personnel with any possible laboratory procedure problems, and
- Compare design and current loadings.

A follow-up assessment of plant operations 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.

The cooperation of the Kentucky Department for Natural Resources and Environmental Protection (KY-DNREP), Division of Water Quality in planning the study is gratefully acknowledged. The technical assistance team is especially appreciative of the cooperation and assistance received from Danville City officials and plant personnel.

SUMMARY

The general mechanical condition and appearance of the Danville Wastewater Treatment Plant was poor. Previous studies by the KY-DNREP (January 1973 and May 1975) indicated that the plant was poorly operated and maintained.

Specific operation and maintenance problems documented during this study are enumerated below:

- The mechanically cleaned bar screen required replacement of missing side plates. In addition, the shoes on the mechanical cleaning device had been installed backwards.

- The flow recorder and totalizer were not operating.

- The comminutor on one of the two parallel grit channels would not run for extended periods without shutting off. This condition not only allowed large solids to enter subsequent treatment units but unbalanced the flow into the parallel grit channels.

- Due to clogging of the auxiliary bar screens, at the entrance of each grit channel wastewater backed into the throat of the Parshall flume and grit material was deposited due to the reduced velocity.

- Only one grit channel is equipped with a mechanical cleaning device. The second channel must be cleaned manually.

- The motor operated skimmer and sludge collector on the #1 primary clarifier was out of service. This problem occurs frequently due to age of equipment and difficulty in obtaining parts. Excessive scum and solids collected and remained for days on the effluent weirs of both primary clarifiers.

- According to a KY-DNREP report (May 13-14, 1975), the recirculation of plant effluent back to TF #2 must be discontinued when the flow from primary clarifier #2 exceeds about 600 gpm. This is done to prevent flooding the primary clarifier and backing the flow up and out of the overflow by-pass. In addition, the recirculation pump for the #2 TF is temporarily out of service.

- Trickling filter #1 contained no zoogleal film and the growth was sparse on TF #2. Distributor arms on both filters were not level and many nozzles were missing or completely plugged. Filter flies were abundant.

- Approximately one month prior to the study, the primary digester was pumped too low and the gas seal was broken. The digester was being slowly refilled. The recirculation pump in the primary digester was out of order.

- Industrial wastes appear to have a significant detrimental effect on plant operation as evidenced by the lack of zoogleal growth on either trickling filter, BOD_5/COD ratio's, large range of pH values, and high concentrations of heavy metals in the plant influent and digester.

- The facility was under-staffed.
- General housekeeping was poor.

RECOMMENDATIONS

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

HEADWORKS

- Mechanically cleaned bar screen shoes should be removed and properly mounted.
- Screens on each grit channel should be cleaned regularly to prevent water backing up into the throat of the Parshall flume.
- The comminutor on the right grit chamber should be repaired in order that sustained, reliable operation is accomplished.
- The left grit chamber should be equipped with a mechanical cleaning device and a comminutor.
- Grit and detritus collected from the grit chamber screens should be removed and buried regularly.

PRIMARY CLARIFIER

- The motor operating the skimmer and sludge scrapper on the #1 primary clarifier should be repaired or replaced.
- The overflow weirs on both primary clarifiers should be cleaned daily.

TRICKLING FILTERS

- The trickling filter distributor arms should be kept level and all nozzles cleaned.
- All nozzles on the trickling filter distributor arms which are not operating properly should be replaced.

SECONDARY CLARIFIER

- A new sludge pump for the secondary clarifier should be installed immediately.

- The apparent blockage in the pipe line between the #1 primary clarifier and trickling filter should be located and eliminated.

MAINTENANCE AND SAFETY

- A routine housekeeping and maintenance schedule should be initiated and maintained.

- Grass cutting and trimming should be maintained completely around all units and buildings including grit chamber and final clarifier.

- The wooden walkway to the digester is hazardous and should be rebuilt.

- Permanent stable steps into the bar screen house should be constructed.

- Safety gratings should be placed over the top of the Parshall flume and stilling wells.

- Discarded equipment and parts left laying around the grounds and in the bar screen house should either be stored or thrown away.

- Walkway and safety rails on the secondary clarifier should be painted.

LABORATORY

- Chemical analyses at the wastewater treatment plant should be done according to "EPA Methods for Chemical Analysis of Water and Wastes."

- When performing dissolved oxygen and BOD analyses, some type of stirring mechanism should be used with the DO probe.

- Improved temperature control on the muffle furnace is needed.

OTHER

- All industries discharging to the municipal sewerage system should be investigated and their discharges characterized. Those industrial dischargers whose wastes are found to be incompatible with plant operations should be required to provide adequate pretreatment or remove their wastes from the sewerage system.

- One or two additional personnel should be hired to operate the plant.

- Chlorine should be applied more uniformly throughout the clarifier instead of along a single radius.

- Construction of a chlorine contact chamber should be considered in order to reduce chemical costs and improve chlorine disinfection.

- Drainage from the drying beds should be recycled to the head of the plant.

TREATMENT FACILITY

TREATMENT PROCESSES

A schematic diagram of the Danville Wastewater Treatment Plant (WTP) is presented in Figure 1, and the design data are enumerated in Table I. The original plant was constructed in 1941 and consisted of the #1 primary clarifier and trickling filter (TF), secondary digester and final clarifier. The additional units were constructed in the expansion which was completed in 1960.

The 1.8 mgd trickling filter plant serves approximately 13,240 persons in Danville. Plant personnel reported that industrial wastes constitute approximately 10 percent of the total plant flow with a population equivalent of about 5,100 (based on BOD_5).

The grit chamber is divided into two parallel basins equipped with proportional weirs designed to maintain a constant velocity through the chambers. The right grit chamber is equipped with a comminutor and mechanical cleaning device; the left chamber contains neither.

Flow from the grit chamber combines with return sludge from the final clarifier and is split to the two primary clarifiers operated in parallel. Hydraulic capacity of the primary clarifiers requires 38 and 62 percent of the incoming flow to be split to the #1 and #2 clarifiers, respectively.

FIGURE I
WASTEWATER TREATMENT PLANT
DANVILLE, KY.

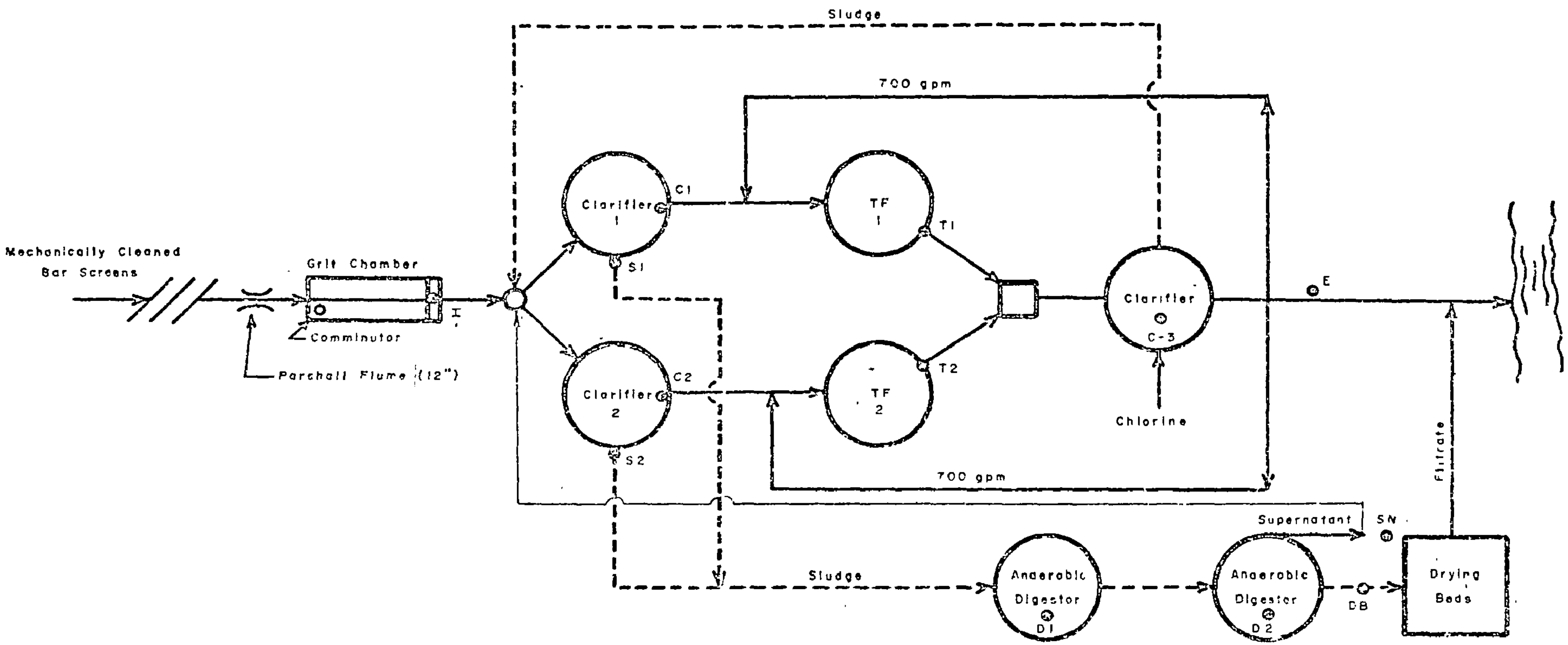


TABLE I
DESIGN DATA
WASTEWATER TREATMENT PLANT
DANVILLE, KENTUCKY

Grit Channels

Number	2
Width	2.0 ft.
Depth	1.25 ft.
Type	Both equipped with proportional weirs; one channel mechanically cleaned and contains a 3/4-hp comminutor; second channel manually cleaned, contains bar screen.

Primary Clarifiers - Circular Center Feed

Unit #1

Diameter	40 ft.		
Area	1,257 sq. ft.	Capacity @ 800 gpd/sq.ft.	= 1.005 mgd
Weir length	125 ft.	Capacity @ 10,000gpd/ft.	= 1.25 mgd
Volume	63,000 gallons	Capacity @ 2 hrs. detention	= 0.756 mgd

Unit #2

Diameter	50 ft.		
Area	1963 sq. ft.	Capacity @ 800 gpd/sq.ft.	= 1.57 mgd
Weir length	157 ft.	Capacity @ 10,000 gpd/ft.	= 1.57 mgd
Volume	112,900 gallons	Capacity @ 2 hrs. detention	= 1.35 mgd

Trickling Filters

Number	2
Type	High Rate
Diameter	105 ft.
Area	8,659 sq. ft. (.199 ac.)
Depth	5.67 ft.
Volume	49,096 cu. ft.
Capacity @ 25 lb BOD/day/1000 cu ft =	1,225 lb BOD
Distributors	Gravity feed

Final Clarifier - Circular Center Feed

Number	1		
Diameter	55 ft.		
Area	2375 sq. ft.	Capacity @ 800 gpd/sq.ft.	= 1.90 mgd
Weir length	172 ft.	Capacity @ 10,000 gpd/ft.	= 1.72 mgd
Volume	142,400 gallons	Capacity @ 2 hrs. detention	= 1.71 mgd

TABLE I - Con't

Digesters

Primary (Unit #1)

Volume	33,300 cu. ft.

Temperature controlled at approximately 90°F by heat exchanger
Digester mixed by recirculating pump

Secondary (Unit #2)

Volume	17,000 cu. ft.

No temperature control or mixing

Drying Beds

Number (new beds)	3
Area (total)	14,100 sq. ft.
Number (old beds)	5
Area (total)	10,000 sq. ft.
Total Drying Area	24,100 sq. ft.

The two trickling filters are designed as high rate filters. A 700 gpm pump for each filter recirculates final effluent back to each of the trickling filters. Distributor arms operate by gravity under approximately a 3.7-foot head.

Effluent from the trickling filters discharges to the final clarifier for clarification and chlorination. Approximately 100 pounds/day of liquid chlorine is discharged at various points along a single radius in the final clarifier. A separate chlorine contact chamber is not provided.

Sludge is discharged to two anaerobic digesters operated in series. The primary digester is mixed and heated by a recirculation pump and heat exchanger. The primary fuel for the heat exchanger is digester gas. The secondary digester is not mixed or heated and serves primarily as a holding tank prior to discharging sludge to drying beds. Supernatant from the #2 digester discharges back to the primary clarifier splitter box.

PERSONNEL

The plant is staffed by one Class IV operator who works eight hours per day (7am-4pm). Any additional help must be drawn from other sources, primarily lift station maintenance men, two of which have a Class III operators certification. The city has had problems hiring and retaining adequate staff to operate the plant. Hired help frequently quit, leaving the plant understaffed.

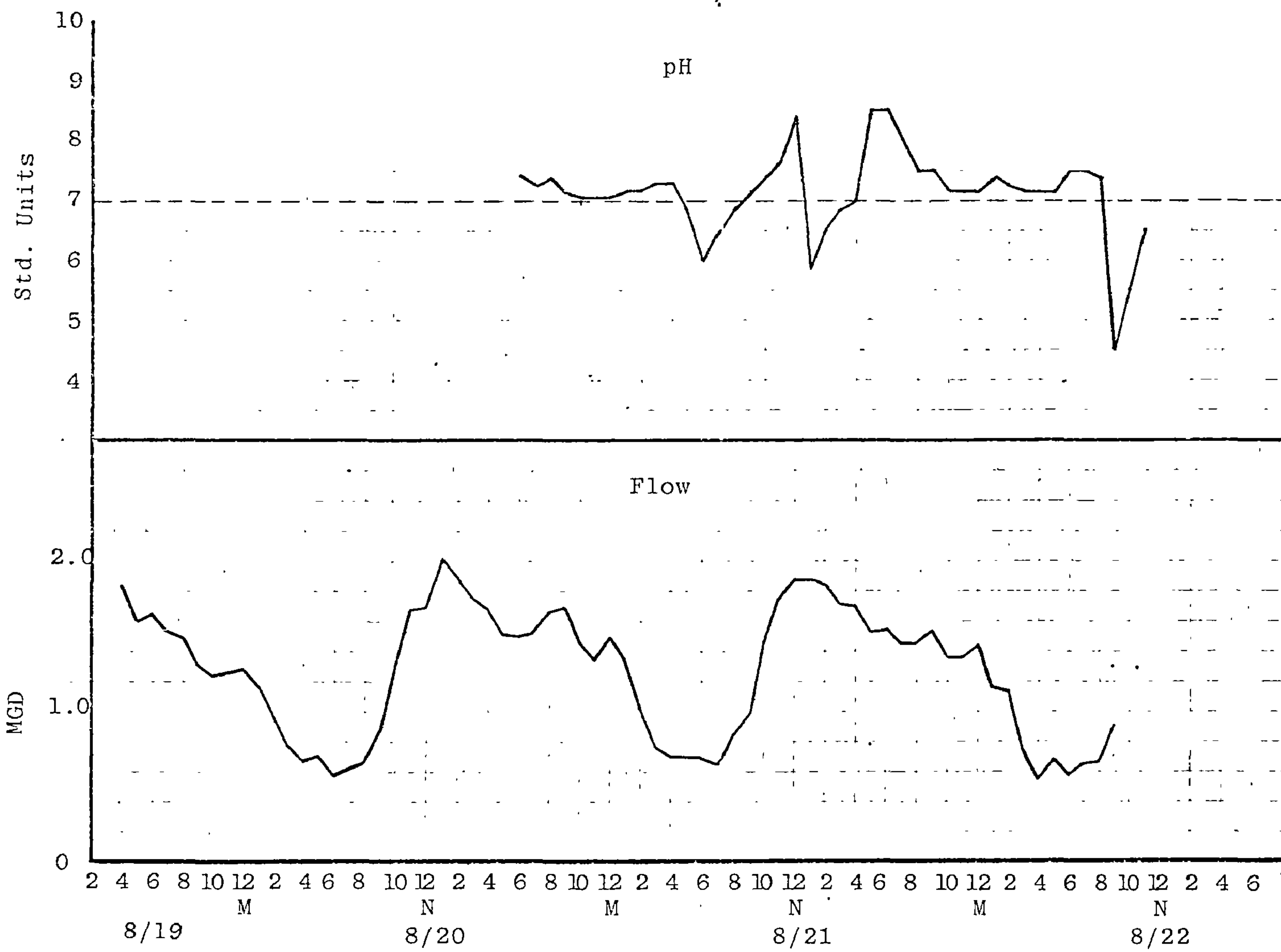
STUDY RESULTS AND OBSERVATIONS

A complete listing of all analytical data is presented in Appendix A. Study methods are presented in Appendix B. Significant results and observations made during the study are presented in the following sections.

FLOW

Raw influent flow was determined by use of the facility's 12-inch Parshall flume, recorder and totalizer. The flow recorder was not operating at the beginning of the study but was calibrated and placed in operation by the study team. A Stevens stage recorder was also installed on the Parshall flume to check the plant's flow recorder and totalizer, which were subsequently determined to be operating satisfactorily. Variation of wastewater flow into the plant is presented in Figure 2. The average hourly flow varied from approximately 0.55 mgd to 2.0 mgd. However, instantaneous flows as high as 2.4 mgd were observed. When the flow reached approximately 2.4 mgd, excess wastewater by-passed treatment via a standpipe located in the splitter chamber following the grit chamber.

FIGURE 2
FLOW AND pH
DANVILLE, KENTUCKY



Flow from each of the trickling filters was determined by measuring flow depth in the discharge pipe from each filter and using Kutter's formula for vitrified clay pipe. The instantaneous flow and percent of total flow from each filter is presented in Table II.

TABLE II
Trickling Filter Flow

Date (1975)	Time (24-hr. clock)	TF #1 (mgd)	TF #1 (%)	TF #2 (mgd)	TF #2 (%)
8/19	1030	1.58	68	0.73	32
8/20	1030	1.74	66	0.90	34
8/20	1130	1.70	61	1.1	39
8/21	1145	1.09	50	1.09	50
8/21	1430	1.09	46	1.28	54
8/22	0920	1.09	48	1.17	52

The different hydraulic capacities of the two primary clarifiers (Table I) results in an unequal flow split to the remainder of the plant. Theoretically, 38 percent of the raw flow into the plant is split to the #1 clarifier and 62 percent to the #2 clarifier, resulting in unequal hydraulic loading to the two trickling filters. This split is accomplished by two flat gates in the splitter box located above the two clarifiers.

According to a May 13-14, 1975 report by Mr. Paul K. Wood, Principal Sanitary Engineer with the KY-DNREP, when the flow from the #2 clarifier exceeds 600 gpm, recirculation to the #2 trickling filter must be discontinued due to flooding of the #2 primary clarifier. A possible cause is blockage in the pipe line connecting the clarifier and trickling filter.

WASTE CHARACTERISTICS AND REMOVAL EFFICIENCIES

A chemical description of the influent, effluent and percent reduction through the plant is presented in Table III. Figures 3 and 4 depict efficiency of individual units. The results presented in Table III indicate poor BOD_5, COD and TSS removal and negligible nitrification. The BOD/COD ratio of .32 indicates a significant quantity of industrial waste. The concentration of metals (Pb, Zn and Cu) entering the plant is also indicative of industrial wastewater discharges.

TABLE III
Waste Characteristics and Removal Efficiencies

Parameter	Influent (mg/l)	Effluent (mg/l)	% Reduction
BOD_5	142	39	72
COD	446	212	52
TSS	314	126	60
TKN	24	19.6	18
NH_3	16.2	13.5	17
NO_3-NO_2	5.7	6.1	N/A
Total-N	29.7	25.6	14
Total-P	9.0	3.8	58
Lead	3.45	1.96	43
Zinc	2.63	.54	79
Copper	1.19	.72	39
Temp. Range (^{o}C)	23-24	22.0-23.5	N/A
pH range (std. units)	3.0-9.0	6.7-7.3	N/A
Turbidity (JTU)	-	43	

The hourly influent pH variation during a continuous 42-hour period is presented in Figure 2. The pH fluctuated significantly on a number of occasions for short durations of time. Table IV presents the range in instantaneous pH observations for the indicated time periods. The wide range of influent pH values is also indicative of industrial wastewater discharges.

TABLE IV
Instantaneous Influent pH Variations

Date	Time	pH
8/20/75	0800	5.8
8/21/75	0200-0500	4.6-7.3
8/21/75	1110	5.8
8/21/75	1415-1700	7.0-9.0

FIGURE 3
TREATMENT EFFICIENCY - NO. I UNITS
DANVILLE, KY.

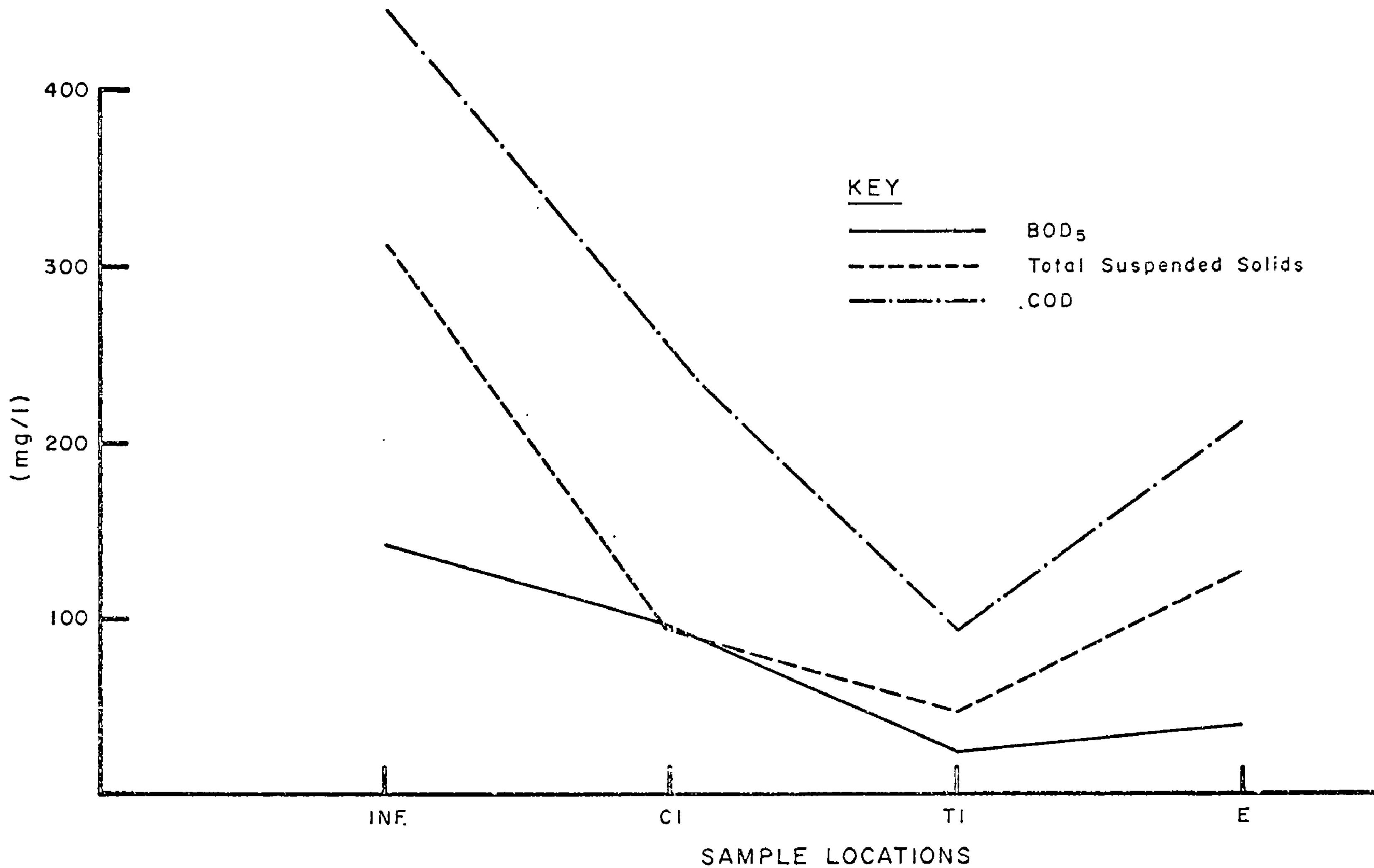


FIGURE 4
TREATMENT EFFICIENCY - NO. 2 UNITS
DANVILLE, KY.

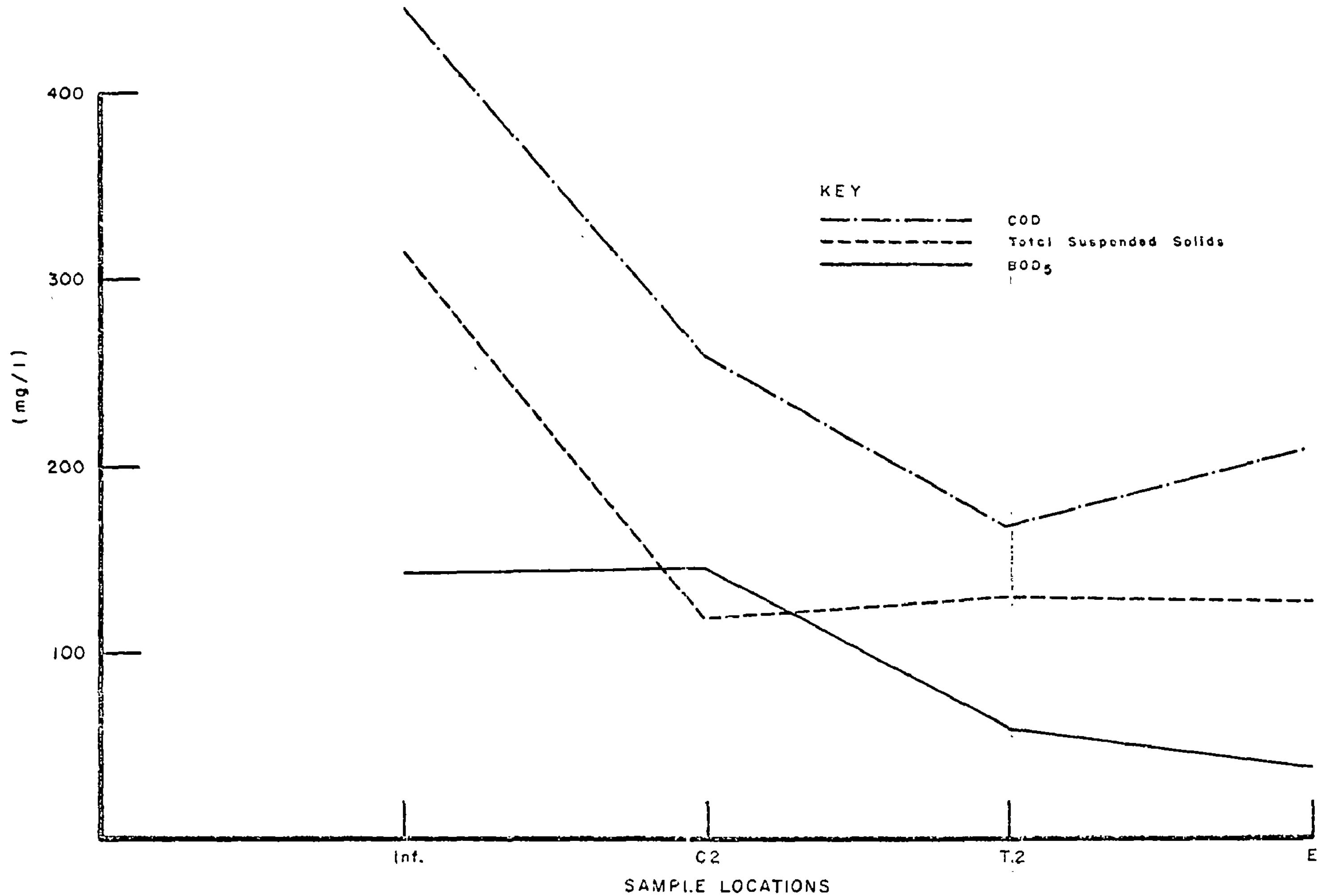


TABLE IV (Cont.)
Instantaneous Influent pH Variations

Date	Time	pH
8/21/75	2200-2400	7.1-8.5
8/22/75	0600-0730	3.0-6.4

On August 20 at 8:00 am, the plant influent contained flocculent solids (settleable solids - 24 ml/l) with a pH of 5.8. This was probably due to batch industrial discharges.

HEAD WORKS

All wastewater entering the plant passess through a mechanically cleaned bar screen. The screen had been down for repairs since August 18, but was repaired and placed back in service on August 20. In addition, the shoes on the mechanical cleaning device were installed backwards resulting in screened material being pushed through the bars rather than being removed. Proper installation of the shoes began on August 20 and when completed should result in an immediate improvement in the bar screen efficiency.

The comminutor on the right channel of the grit chamber continually overheated and shut off. Consequently, the comminutor blocked flow into the right grit channel, increased flow in the other channel, and allowed large solids to enter subsequent treatment units. An electrician temporarily repaired the unit during the study. The existing comminutor should be repaired for permanent sustained use and the remaining grit channel also equipped with a comminutor. A new comminuter, acquired approximately one year ago, has been laying unused since delivery. There is some question concerning how it is to be mounted and used. The equipment manufacturer should be contacted.

The flow through velocity in the left and right parallel grit channels was determined and is presented in Table V. The comminutor was located at the entrance to the right grit channel. The difference in flow through velocities in the two channels was significant. Recommended velocities for grit chambers range from 0.7 to 1.4 feet per second (fps).1/

TABLE V
Grit Channel Velocities

	8/19	8/20
Right Channel (fps)	.67	.94
Left Channel (fps)	2.2	2.0

1/ "Operation of Wastewater Treatment Plants," by Sacramento State College for the U.S. Environmental Protection Agency, Technical Training Grant No. 5TT1-WP-16-03, 1970.

PRIMARY CLARIFIER

The motor operating the skimmer and sludge collector on the #1 primary clarifier was out of service. According to plant personnel, the motor is old, worn out, and new parts are difficult to obtain.

Excessive solids collected along the overflow weirs of both primary clarifiers clogged the v-notches and overflowed into the trickling filters. These weirs should be cleaned daily and the weirs brushed frequently.

Primary clarifier efficiencies are depicted in Figures 3 and 4. Clarifier overflow characteristics are based on grab samples while raw influent characteristics are based on 24-hour composite samples. Removal efficiencies for each primary clarifier are listed in Table VI. Typical BOD_5 and TSS removal efficiencies for primary clarifiers are 35 and 60 percent, respectively.

TABLE VI
Primary Clarifier Removal Efficiencies (%)

	BOD_5	COD	TSS
Clarifier #1	32	43	71
Clarifier #2	0	42	62

The BOD_5 concentrations from clarifier #2 on the two days of sampling were 78 and 213 mg/l. The latter value significantly affects the average removal efficiencies listed in Table VI.

TRICKLING FILTER

The trickling filters are designed as high rate filters (typical hydraulic loading range 8.7-44 mgad[1/]); however, the approximate dosing is 8 (mgad) for TF#1 and 5 mgad for TF#2. The poor mechanical condition of the trickling filters and final clarifier inhibited optimization of the filter operation. However, consideration should be given to installing pumps to increase filter recirculation capacity.

The two trickling filters contained little or no zoogleal film. On a reconnaissance to the plant on July 22, 1975, TF #1 contained no zooglea but TF #2 did. Plant personnel indicated that a local industrial discharge killed the growth in the filters the week previous to the study. Enzymes (Hydraulic Enzymes Bacteria Complex) were added to the influent of each filter to aid in reestablishing zoogleal growth; growth had improved some on TF #2 by August 22 but there was no improvement on TF #1. Trickling

---

1/ "Sewage Treatment Plant Design," ASCE - Manuals of Engineering Practice - No. 36.

Filter #1 had been shut down until approximately 1½ weeks before the study while waiting for a consultant to look at the #1 primary clarifier.

Distribution of primary effluent onto the filters was poor. Approximaterly 56 and 76 percent of the nozzles on TF #1 and TF #2, respectively, were completely or partially plugged. Many other nozzles were missing. Parts were distributed on the filter bed and the filter bed wall. The cap on the end of one distributor arm was missing. The distributor arms on both filters were out of level.

Trickling filter removal efficiencies are depicted in Figure 3 and 4. Removal efficiencies accomplished by each filter of primary effluent is presented in Table VII.

TABLE VII
Trickling Filter Removal Efficiencies (%)

	BOD_5	COD	TSS
TF #1	75	63	49
TF #2	60	36	0

All parameters measured were higher out of TF #2 than TF #1. Settleable solids results indicate sloughing from TF #2. On two of the three days of sampling, the TSS out of TF #2 was greater than the TSS entering the filter.

Filter flies were prevalent around the plant. Shrubbery, weeds, and tall grass provide a natural sanctuary for filter flies. Good grounds maintenance and cleanup practices will help to minimize fly problems.

FINAL CLARIFIER

The original diaphram sludge pump burned out approximately two years ago and a temporarily installed centrifugal pump has proved to be inadequate. Consequently, excessive sludge has accumulated and compacted causing anaerobic conditions which were evidenced by bubbles and frequent balls of solids floating to the clarifier surface.

The depth of the sludge blanket (DOB) below the water surface in the final clarifier was approximately 6.5 feet at all points along the radius. Consequently, the sludge blanket depth varied from about 1 foot at the outer wall to 3 feet at the center. The solids concentration of the sludge was 36 percent as determined by centrifuge (approximately 3 percent dry weight).

Chlorination of plant effluent was accomplished by discharging 100 pounds/day of chlorine at various points along a single radius in the final clarifier. A chlorine residual was observed each day of the study. Distribution of chlorine would be more efficient if it was applied at various points throughout the entire clarifier instead of along a single radius. A significant reduction in chlorine usage and chemical costs could be achieved by constructing a separate chlorine contact basin.

Two pumps, rated at 700 gpm each, recirculate effluent back to the high rate trickling filters. However, the recirculation pump to the #2 TF was out of service for repairs.

Figures 3 and 4 indicate an increase in BOD_5, TSS and COD from the effluent of the trickling filters to the final clarifier effluent. This phenomenon is attributable to the anaerobic conditions resulting in gas production and subsequent resuspension of previously settled solids.

DIGESTER AND DRYING BEDS

During the study, the anaerobic digesters were not operating under typical conditions. The primary digester was being refilled after being pumped too low and breaking the gas seal. In addition, the recirculation pump was broken which prohibited mixing and heating of the digester contents.

The secondary digester is used solely as a holding tank, prior to discharging sludge to the drying beds. The plant operator stated that sludge handling has never been a problem; the digesters have worked properly, sludge dries quickly and drying bed area is sufficient. Filtrate from the drying beds flows untreated to the receiving stream.

Analytical results of samples collected from the digesters are presented in Appendix A. These data are not representative of the total digester contents since the digester was unmixed.

Lead, zinc and copper are accumulating in the digester as indicated by analysis (Appendix A) of sample D1B obtained from the bottom of the primary digester. Cooper and zinc are quite toxic, and depending on the concentration of sulfides, could adversely affect digester performance.

SAFETY AND MAINTENANCE

Problems observed relating to safety and maintenance were:

- The stairway to the second floor of the laboratory was cluttered with miscellaneous items.
- The wooden walkway by the digester was rotten.
- Stacked concrete blocks used as steps into the bar screen house and top of grit chamber were unstable.

- Safety gratings were missing over the top of the Parshall flume and stilling wells.
- Discarded equipment and parts were left laying all over the grounds and in the building housing the bar screen and flow meter.
- The garbage can and bucket used to collect screened material are emptied infrequently.
- The walkway and safety rails on secondary clarifier were rusting and in general need of paint.
- The weirs on both primary clarifiers contained significant quantities of large solid "globs", paper and other materials. These should be inspected daily and cleaned as needed.
- Weeds were observed in both the new and old sludge drying beds.
- The effluent wells from both trickling filters contained a large number of filter flies. Routine hosing down of these chamber walls would help control filter flies around the plant.
- Grass and weeds around the plant were not cut. Grass cutting and trimming should be maintained completely around all units and buildings including grit chamber and final clarifier. In addition to improving working conditions, this should help control filter flies around the plant.
- Grit collected from the grit chamber was shovelled into the weeds adjacent to the chamber. This material along with detritus collected by the screens should be buried in the landfill located adjacent to the plant.

LABORATORY

In order to make space and equipment available for EPA personnel, chemical testing by the plant operator was temporarily discontinued. Consequently, the investigators were not able to observe and make first hand comments and suggestions concerning laboratory procedures.

A substantial temperature difference was observed between the BOD incubator temperature indicator and the actual temperature. Placing a thermometer in water inside the incubator should be standard practice.

The plant laboratory was equipped with a Y.S.I. dissolved oxygen meter; however, no provisions were made for stirring the sample. It is necessary to maintain a velocity by the probe to prevent erroneous readings. In a BOD bottle, a magnetic mixer can be used, but this can cause errors if not used carefully. A factory equipped probe with stirring device is another possibility.

The muffle furnace used for volatile solids analysis was controlled by a proportional timer rather than by a thermostate. This requires very close attention and frequent adjustment. A muffle furnace with an automatic thermostat control would relieve the operator for other duties.

A standard set of weights is used to check the analytical balance. This quality control procedure is encouraging and worthy of note. The EPA manual entitled "EPA Methods for Chemical Analysis of Water and Wastes" (EPA 625/6-74-003) is being sent to Mr. Paul Collins, plant operator.

PERSONNEL

Consideration should be given to the proper levels of staffing at the Danville Wastewater Treatment Plant. Staffing factors include plant site size, relative positions of each unit to the control center, complexity of operation, laboratory testing requirements and number of shifts. The following man years of effort are recommended as a minimum for this plant by categories of work.1/

Category		Man Years
Management/Supervision		0.5
Laboratory		0.3
Operations of Plant		1.4
Maintenance of Plant		0.9
Other Laborers		0.4
Other Clerical		0.1
	Total	3.6

Obviously, one person cannot be assigned to each individual task as indicated in the table. The duties will have to be combined and assigned to staff members at the plant. However, it is recommended that the laboratory work be emphasized. These staffing recommendations are for the plant only. Collection system activities require additional personnel.

1/ Estimating Staffing for Municipal Wastewater Treatment Facilities, EPA Contract No. 68-01-0328, March 1973.

APPENDIX A
CHEMICAL LABORATORY DATA
DANVILLE, KY

O & M SAD #	STATION	Month	Day	Year	TIME	pH (Lab)	Temp. (C°)	BOD_5 (mg/l)	COD (mg/l)	Total Solids (mg/l)	Total Volatile Solids (mg/l)	Total Susp. Solids (mg/l)	Total Vol. Susp. Solids (mg/l)	Settleable Solids (ml/l)	NH_3-N (mg/l)	NO_3+NO_2-N (mg/l)	TKN (mg/l)	Total-P (mg/l)	Lead µg/l	Zinc µg/l	Copper µg/l	Chromium µg/l	Cadmium µg/l	Centrifuge %, 15 min.		
	I	8	19	75	1500	7.3	23°							6.5										0.5%		
0084	I	8	19/20	75	Comp.	5.9	24°	135	406			312	163	24	17.2	12.0	24.8	8.8	3445	2630	1194	<80	<10			
0096	I	8	20/21	75	Comp.			150	435			395	175	13	15.7	1.0	24	8.6								
	I	8	21	75	1000	7.8	23°																			
	I	8	21	75	1110	5.8											23.5									
0110	I	8	21/22	75	Comp.				496	751	216	234	166		15.7	4.18		9.7								

Appendix A (Cont)

CHEMICAL LABORATORY DATA
DANVILLE, KY

O & M SAD #	STATION	MONTH	DAY	YEAR	TIME	pH (Lab)	Temp. (C°)	BOD5 (mg/l)	COD (mg/l)	Total Susp. Solids (mg/l)	Tot. Vol. Susp. Solids (mg/l)	Settleable Solids (ml/l)	Centrifuge (15 min.) %	DOB (ft.)
	C1	8	19	75	1500	7.2	22°					0.2	0.4	
0086	C1	8	20	75	0930	6.8		70	188	90	45	<0.1		
0100	C1	8	21	75	1000	7.2	23°	173	387	134	84	<0.1		
0112	C1	8	22	75	0840				185	50	36			
	C2	8	19	75	1500	7.1	22					0.6		
0087	C2	8	20	75	0930	6.8		78	210	95	38	<0.1		
0102	C2	8	21	75	1000	7.1	23	213	476	210	126	<0.1		
0113	C2	8	22	75	0840				93	48	44			
	C3	8	19	75	0900									6.50
	C3	8	20	75	0900									6.75
	C3	8	21	75	1045									6.75
0090	C3S	8	20	75	1325								36	

Appendix A (Cont)

CHEMICAL LABORATORY DATA
DANVILLE, KY

O & M SAD #	STATION	Month	Day	Year	TIME	pH (Lab)	Temp. (°C)	BOD5 (mg/l)	COD (mg/l)	Tot. Susp. Solids (mg/l)	Vol. Susp. Solids (mg/l)	Settleable Solids (ml/l)	Centrifuge (15. min) %
	T1	8	19	75	1500	7.5	22°					<0.1	0.2
0088	T1	8	20	75	0930	7.4		24	85	32	15	0.1	
0099	T1	8	21	75	1000	7.2	22°	25	129	55	32	0.1	
0114	T1	8	22	75	0840				64	51	42		
	T2	8	19	75	1500	7.4	22°					0.9	0.2
0089	T2	8	20	75	0930	7.1		39	129	116	44	0.7	
0101	T2	8	21	75	1000	7.1	22°	76	262	168	128	1.4	
0115	T2	8	22	75	0840				109	106	82		

Appendix A (Cont)

CHEMICAL LABORATORY DATA
DANVILLE, KY

O & M SAD #	STATION	Month	Day	Year	TIME	pH (Lab)	Temp. C°	Turbidity S.T.U.	Chlorine Residual (mg/l)	BOD5 (mg/l)	COD (mg/l)	Total Solids (mg/l)	Total Volatile Solids (mg/l)	Total Susp. Solids (mg/l)	Total Vol. Susp. Solids (mg/l)	Settleable Solids (ml/l)	NH_3-N (mg/l)	NO_3+NO_2-N (mg/l)	TKN (mg/l)	Total-P (mg/l)	Lead µg/l	Zinc µg/l	Copper µg/l	Chromium µg/l	Cadmium µg/l	Centrifuge %, 15 min.
	E	8	19	75	1500	7.3	22°		0.22							0.7										0.2
0085	E	8	19/20	75	Comp.	6.7	23.5°			42	228			155	80	0.8	14.3	9.4	21.8	4.7	1960	535	722	<80	<10	
0095	E	8	20	75	1630			37	0.08		155															
0097	E	8	20/21	75	Comp.					36	214			124	66		13.4	5.1	19.2	3.0						
0098	E	8	21	75	1000	6.9	22°	50	0.52							0.9										
0116	E	8	22	75	0900			43	0.60																	
0111	E	8	21/22	75	Comp						193	646	135	100	66		12.8	3.84	18	3.7						

Appendix-A -(Cont)

CHEMICAL LABORATORY DATA
DANVILLE, KY

O&M SAD #	STATION	MONTH	DAY	YEAR	TIME	pH (Lab)	Temp (C°)	Total Solids (mg/l)	Total Volatile Solids (mg/l)	Lead (µg/l)	Zinc (µg/l)	Copper (µg/l)	Chromium (µg/l)	Cadmium (µg/l)	Volatile Acid as mg/l acetic acid	Total Alkalinity (mg/l)	Centrifuge %, 15 min.							
0093	S2	8	20	75	1400	6.3	25°								93	678	12							
0107	S2	8	21	75	1350	5.8	23°	102308	60186								39							
0094	D2	8	20	75	1400	6.3	24°								11.6	2700	0.5							
0106	D2	8	21	75	1350	6.8	21°	1019	746						291	2658	<0.5							
0092	SN	8	20	75	1400	7.2	26°								11.6	418								
0104	SN	8	21	75	1350	7.2	26°	353	116						11.6	398	<0.5							
0091	DB	8	20	75	1400	6.8	20°								175	3040	0.5							
0103	DB	8	21	75	1350	6.7	16°	2385	962	5567	1055	119	<80	<10	35	2958	<0.5							
0108	S1	8	21	75	1350	6.6	24°	723	104								<0.5							
0105	D1	8	21	75	1350	6.9	22°	3488	1672						70	2918	1.5							
0109	D1B	8	21	75	1350	5.8	21°	21600	12780	12000	151000	99000	2424	103	186	538	10.0							

Appendix E

STUDY METHODS

In order to accomplish the stated objectives, the study included extensive sampling, physical measurements and daily observations. The plant influent and effluent streams, sample stations I and E, respectively, were sampled for two 24-hour and one 18-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.

Dissolved oxygen was determined daily at all stations using a YSI model 51A dissolved oxygen meter.

A Stevens Model F stage recorder was installed on the influent stream to check accuracy of the installed plant flow meter and totalizer. Also on August 20, a recording pH meter was installed on the plant influent to record pH variations throughout the subsequent sampling periods.

Depth of the sludge blanket in the final clarifier was determined using an optical viewer system.

Instantaneous flows were determined daily on the influent waste stream at the Parshall flume. Also, trickling filter flows in the discharge pipes were determined daily using Kutter's formula for vitrified clay pipe.

Imhoff cones and the centrifuge were used daily to determine solids being discharged from each treatment unit.

Physical observations were made of the operation of individual units daily.

The mention of trade names or commercial products in this report does not constitue endorsement or recommendation for use by the Environmental Protection Agency.

APPENDIX C

Oxygen Uptake Procedure[3]

A. Apparatus

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

B. Procedure

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

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

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

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

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

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

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

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

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

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