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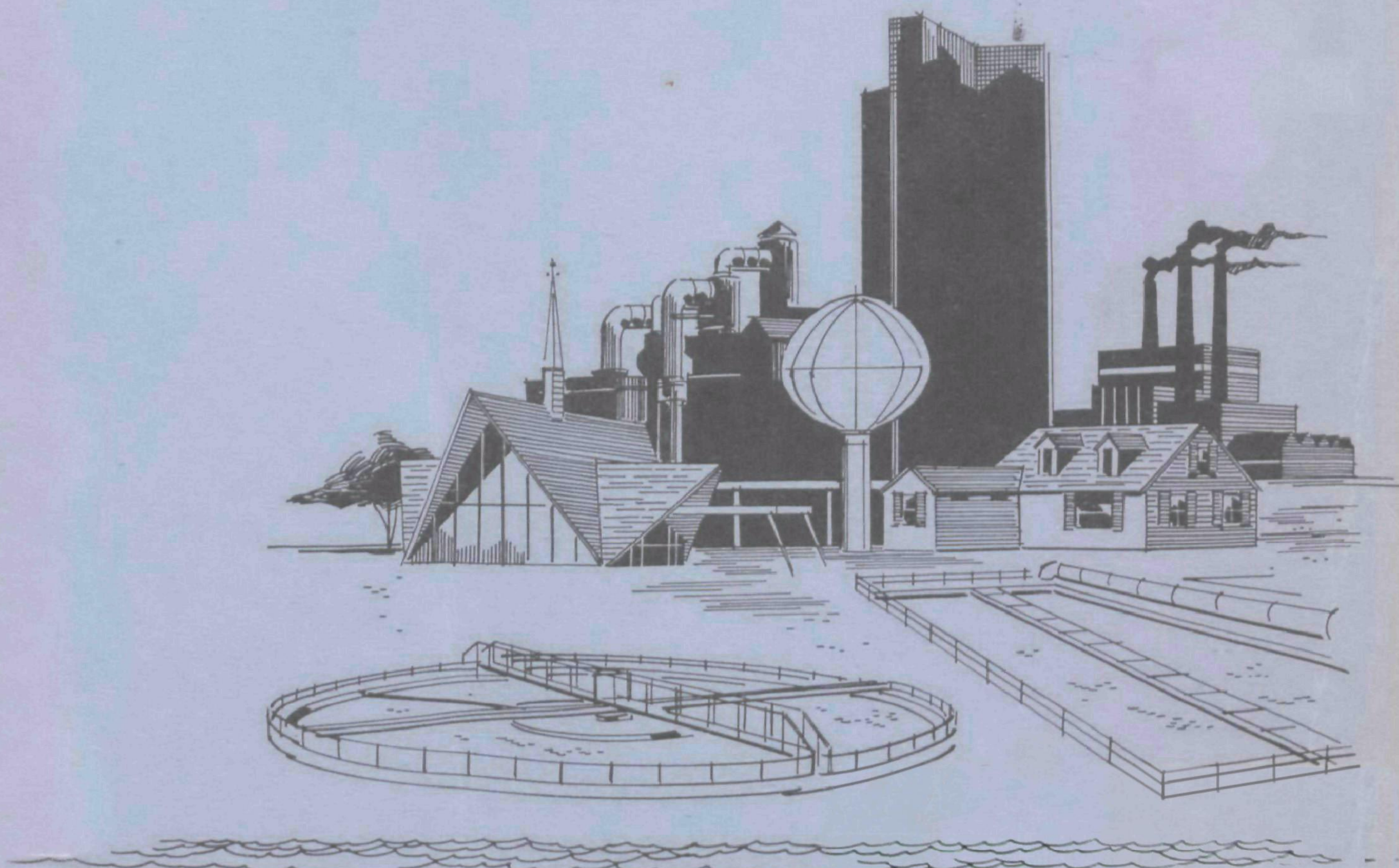

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FEASIBILITY OF JOINT TREATMENT IN A LAKE WATERSHED

"FEASIBILITY OF JOINT MUNICIPAL AND INDUSTRIAL WASTEWATER TREATMENT IN THE ONONDAGA LAKE WATERSHED, ONONDAGA COUNTY, NEW YORK"

FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
DEPARTMENT OF THE INTERIOR

BY

ROY F. WESTON, INC.
WEST CHESTER, PENNA.

PROGRAM NO. 11060 FAE
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FWPCA Review Notice

This report has been reviewed by the Federal Water Pollution Control Administration and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the Federal Water Pollution Control Administration, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

ABSTRACT

Onondaga County, New York undertook a feasibility study of joint treatment of municipal and industrial wastewaters. Industries were contacted to assess their wastewater situation, and major wastewater contributors were sampled. Influent wastewaters to the two major sewage treatment plants were also sampled. With practically all industry connected to the municipal systems and within the constraint of a pump station and force main to transfer wastewater from the Ley Creek to the Metropolitan Sewage Plant, the number of feasible treatment alternatives was reduced. Bench-scale activated sludge studies were conducted on the feasible alternatives.

The initial plant interviews showed that practically all industries in the watershed were connected to the municipal sewer system, with one of them contributing approximately 60 percent of the organic load on the Ley Creek Plant. While metals concentrations, from various metal-plating shops, were high at different times, the concentrations measured in the Ley Creek Plant influent were generally acceptable for biological treatment. Total organic loads at the Ley Creek and Metropolitan Sewage Plants were about equal; flow at the latter plant was approximately three times as great. Raw, pretreated, or secondary-treated wastewater from the Ley Creek Plant was shown to be amenable to combination with raw Metropolitan Sewage Plant influent for secondary treatment. A full-scale joint treatment plant should obtain BOD removals of more than 85 percent during winter operation.

This report was submitted in fulfillment of Grant No. WPRD 66-01-68 between the Federal Water Pollution Control Administration and Onondaga County Department of Public Works.

Key Words:

Activated Sludge - Contact Stabilization - Cost Analysis - Industrial Wastes - Joint Systems - Lake Watershed - Municipal Wastes - Process Design - Sampling Survey - Waste Treatment.

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Conclusions

Conclusions regarding the wastewater situation at individual industries have been presented in the appropriate company sections of the Appendix of the Interim Report, *Industrial Discharges in the Ley Creek Sanitary District*, dated March 1, 1969. The conclusions presented herein relate to the overall project and are based on the industrial interviews, wastewater sampling and analysis programs, laboratory treatability study, process design investigations, preliminary cost estimates, and related discussions.

1. Of the 139 industries initially contacted, 113 are within the Ley Creek Sanitary District. Twenty-four of these 113 industries were discharging wastewaters (including clean cooling water) to Ley Creek.

2. Of the twenty-four industries discharging to the creek, only two (Crouse-Hinds Co. and Syracuse China Corp.) showed a need for installation of treatment facilities. The remaining industries either discharged acceptable effluents or could produce acceptable effluent by the in-plant changes recommended in the Interim Report.

3. A number of industries discharge significant concentrations of metals and cyanides to the Ley Creek Sewerage System. Because dilution in the overall wastewater flow generally lowers the concentrations of metals and cyanides to tolerable levels, these discharges normally will not adversely affect biological treatment. Nevertheless, the potential for such interference exists.

4. 80 - 90 percent of the industrial organic pollution discharged to the Ley Creek Sewerage System comes from the Bristol Laboratories plant. This same source contributed 50 - 60 percent of the total organic load of the Ley Creek Sewage Treatment Plant.

5. The existing Ley Creek Collection system is adequate in geographical coverage for all currently recommended additions of industrial wastewater.

6. The biological treatability studies indicated the following selections of activated sludge process modifications for various wastewater combinations:

Wastewater	Process Modification
Ley Creek S.T.P. Influent (1-A)	Conventional
LCSTP Secondary Effluent and Metropolitan Influent (1-B)	Contact-Stabilization
LCSTP and MSTP Influents (2)	Conventional
LCSTP Plain Aeration Effluent and MSTP Influent (3-B)	Contact-Stabilization

7. Removal of suspended solids (through primary clarification) from the combined raw wastewater of the Ley Creek and Metropolitan Sewage Treatment Plants should change the indicated treatment for this alternative from conventional activated sludge to contact-stabilization.

8. Within the frame of reference of the constraints imposed, treatment required, and total annual costs involved, contact-stabilization treatment of the combined raw Ley Creek and Metropolitan S.T.P. influent wastewaters is preferable to any of the other treatment alternatives.

9. The total capital cost for this selected treatment system is estimated to be $26,109,000; the total annual cost is estimated to be $3,455,000.

10. Pretreatment by industry to reduce its BOD loading to the acceptable level (300 mg/L) would not significantly reduce the total annual costs of the proposed municipal treatment system.

Recommendations

1. Accept the discharge of Crouse-Hinds wastewater into the Ley Creek sewerage system after satisfactory pretreatment for removal of oil, solids, and dissolved metals.

2. Permit Syracuse China Corporation to discharge suitably clarified wastewater to Ley Creek.

3. Implement the wastewater management recommendations for individual industries outlined in the Interim Report.

4. Initiate a program requiring industries discharging potentially toxic materials or high concentrations of organics or other undesirable materials to begin a wastewater sampling and analysis program.

5. Monitor industrial wastewater discharges, to protect the collection and treatment system.

6. Implement the design and construction of a contact-stabilization treatment plant for the combined Ley Creek S.T.P. and Metropolitan S.T.P. influent wastewaters, to be located at the site of the present Metropolitan plant.

INTRODUCTION

General Background

Onondaga Lake and its watershed are located in Onondaga County, New York and are a part of the larger Oswego River Basin Drainage Area. The southern portion of the lake lies within the City of Syracuse, with the larger northern area of the lake being located in the towns of Salina and Geddes. Onondaga Lake is about 4.5 miles long and about a mile across at its widest point. The most suitable uses of the waters of the southern end of Onondaga Lake are for agriculture and process cooling.

A number of studies have been made on Onondaga Lake and its watershed over the years. These studies have indicated that the major problems affecting Onondaga Lake are the result of: municipal plant effluents entering the lake and its tributaries, industrial wastewater discharges in the watershed, stormwater overflows from the various interceptor sewers, and the existing organic deposits in the lake. In addition, the lake has a high natural background level of chlorides.

There are two sanitary districts for the collection and treatment of wastewaters around the lower end of Onondaga Lake: Ley Creek Sanitary District and Metropolitan Sanitary District. The locations of these districts and their treatment plants are shown on Drawing B-1. The Ley Creek Sanitary District covers approximately the drainage area of Ley Creek, one of the major tributaries of Onondaga Lake. This Sanitary District lies generally to the north and east of the City of Syracuse and includes the Village of East Syracuse, a small section of the City of Syracuse, several highly concentrated industrial sites, and a large area of undeveloped land; the major concentration of industries in and around the City of Syracuse is within the Ley Creek Sanitary District. The initial Ley Creek Sewage Treatment Plant (S.T.P.), located approximately one mile upstream of the outlet of Ley Creek to Onondaga Lake, was designed as a standard-rate activated sludge plant for a population of 30,000 and an average flow of 4.5 MGD. These facilities were placed into operation early in 1940, and in less than five years the plant was overloaded, primarily because of unexpected industrial development. Duplicate facilities were designed and put into operation in March of 1951. Since that time, the flow and organic load on the treatment plant have increased to such an extent that the plant is again overloaded. Effluent from the treatment plant has been discharged into Ley Creek near the plant. The waters of this creek have been classified as acceptable for agricultural use and industrial water supply, but unacceptable for fishing, bathing, or drinking water supply.

Following World War 1, a primary-treatment plant was constructed in the general vicinity of the present Metropolitan Plant on the southern tip of Onondaga Lake. This plant became overloaded, and in September 1960 the present intermediate treatment system (chemical flocculation in a primary-treatment system) was put into operation. Effluent from this treatment plant is discharged to the southern tip of Onondaga Lake. Two large industrial complexes in the Metropolitan Sanitary District discharge industrial wastewaters directly to Onondaga Lake.

Onondaga County, in the early stages of its overall program to improve the quality of Ley Creek and Onondaga Lake, conducted pilot plant operations at the Ley Creek Sewage Treatment Plant utilizing a plastic-media trickling filter alone and also followed by activated sludge. The results of these studies were reported to be successful, but the effluent was still unacceptable to Onondaga County for year-round discharge to Ley Creek. Subsequently, the County's consultants investigated the feasibility of pumping this treated wastewater to Onondaga Lake or to the Seneca River, with the former indicated as the more economical. With the construction of a lake outfall as the indicated solution, it then became an attractive alternative to transfer the Ley Creek Treatment Plant effluent to the Metropolitan Treatment Plant. This would permit utilization of the Ley Creek Treatment Plant as the first step in a two-step treatment system, with partial or pretreatment at the Ley Creek Treatment Plant to reduce organic shock loads or mitigate possible toxicity factors and with final treatment at the Metropolitan Treatment Plant.

The two major industries in the Metropolitan Drainage Area (Solvay Process Division of Allied Chemical Company and Crucible Steel Company), although not directly involved in the current study, are a definite factor in Onondaga County's overall study. The County has been working with Solvay Process on a combined treatment system which in effect will reduce the contamination in Solvay's wastewater and provide tertiary treatment (phosphate removal) for the municipal wastewater. The site tentatively selected for this treatment facility is at the Metropolitan Sewage Treatment Plant. This proposed tertiary treatment facility will not be considered a part of this report except as its location may affect the location of the proposed biological treatment system. Crucible Steel is also working with Onondaga County on the solution of its wastewater problems.

Disposal of digested sludge from the present Metropolitan Sewage Treatment Plant is to the Solvay Process waste beds. Although ultimate sludge disposal was not considered a part of this study, it is anticipated that the present method of disposal will be used in the expanded plant, and therefore, would have an effect upon treatment plant location.

Scope and Objectives

Onondaga County, in an attempt to reduce the pollution load on Onondaga Lake and its tributaries and in anticipation of stricter treatment requirements, had initiated a number of programs leading to an upgrading of treatment facilities. As part of this program, Onondaga County in December 1966 applied to the Federal Water Pollution Control Administration for a research and development grant to demonstrate the feasibility and practicality of joint municipal-industrial wastewater treatment in the Onondaga Lake Watershed. Subsequently, FWPCA Grant No. WPRD 66-01-68 was awarded.

Onondaga County retained ROY F. WESTON early in 1968 for two phases of the Onondaga Lake Watershed Study: 1) to determine the present state of industrial discharges within the Ley Creek Drainage Area; and 2) subsequently to develop a Master Plan of wastewater collection and treatment for this area. The scope of work as outlined in Onondaga County - ROY F. WESTON Contract No. P-112 of 13 February 1968 - includes the following:

1. Determination of the sources, quantities, and characteristics of the wastewater through sampling and analysis of the wastewaters of all industries in the Ley Creek Sanitary District with significant discharges.

2. Evaluation of operating practices at these industrial plants (including inspection of wastewater treatment facilities) to provide recommendations relative to: reduction of wastewater discharges by in-plant changes; segregation of clean wastewaters not requiring treatment; reduction of total water usage; recovery of waste constituents or by-products, as applicable; improvement of on site waste control programs, and need for on-site pretreatment of wastewaters.

3. Sampling survey of the influent to the Ley Creek S.T.P. for comparison with the total industrial wastewater discharged to the Ley Creek system. Data from this survey was included in an interim report to Onondaga County dated 1 March 1969.

4. Laboratory-scale treatability and related studies of the wastewater generated in the Ley Creek Drainage Area and of wastewater from selected industrial plants to determine design parameters. These studies were to cover: physical/chemical treatment, biological treatability, determination of quantities and characteristics of the sludges produced, and the effects of combining various wastewaters.

5. Preparation of a Master Plan for wastewater collection, including alternative methods of collecting industrial wastewater separately from sanitary wastewaters.

6. Development of a process design based on the results of the treatability studies and the wastewater collection Master Plan, including plot plan, process flow sheet, and schedule of estimated capital and operating costs for the recommended treatment alternative.

7. Preparation of a report covering discussion of the treatment alternatives, the recommended solutions, and the supporting reasons. This report was intended to include recommendations for improving water pollution control practices for individual industries whenever appropriate.

Treatment of Ley Creek wastewaters (raw or pretreated) in conjunction with the influent to the Metropolitan Treatment Plant became a real possibility with the construction of a pumping station and force main to transfer all wastewaters to the Metropolitan Treatment Plant. The original scope of the treatability studies was thus expanded to include the Metropolitan wastewater.

PROBLEM DEFINITION

Wastewater Sources, Quantities and Characteristics

General Basis of Data

The wastewater survey of the Ley Creek Drainage Area basically consisted of two phases: industrial interviews, and a sampling and analysis program. In preparation for the industrial interviews, a list of 139 industries either served by the Ley Creek Seweraqe System or within the drainage area of Ley Creek was obtained from Onondaga County. This list was based on information provided in *Directory of Manufacturers and Products - 1965* prepared by the Manufacturers Association of Syracuse.

Each industry was asked to cooperate in the wastewater survey and was notified of the type of information which would be requested in the interview. Subsequently, the industries were visited, the production facilities toured, and wastewater handling facilities inspected. At the conclusion of each preliminary visit, a file memorandum was prepared describing the wastewater problem and indicating the need for sampling and analysis. The industrial plants visited were sent letters expressing appreciation for their cooperation and informing them of future sampling and analysis plans.

Prior to the inception of the industrial sampling and analysis program, a random grab sampling survey of the Ley Creek Sewage Treatment Plant influent was conducted to obtain an estimate of the magnitude of the problem and to prepare baseline figures for use in determining the significance of individual industrial wastewater discharges. Forty-two random grab samples were collected during the period 6/13/68 through 6/20/68 and were analyzed in the engineer's laboratories in Syracuse, New York, for 5-day and Ultimate Carbonaceous Biochemical Oxygen Demand (BOD_5, BOD_{uc}), Chemical Oxygen Demand (COD), suspended solids (SS), volatile suspended solids (VSS), pH, and alkalinity or acidity. A portion of each of these samples was appropriately preserved, shipped to the ROY F. WESTON laboratory in West Chester, Pennsylvania, and analyzed for phenol, oil and grease, cyanide (CN), chromium (Cr), copper (Cu), nickel (Ni), cadmium (Cd), zinc (Zn), ammonia (NH_3), total organic nitrogen (TON), orthophosphate ($O\text{-}PO_4$), and total phosphate ($T\text{-}PO_4$). Flow measurements were recorded from the influent flow meter at the time of sample collection.

The industrial sampling and analysis survey was based on the premise that samples would be collected from all industries fulfilling any of the following criteria: 1) major industry not presently included in the Ley Creek Sewerage System; 2) industry with significant potential toxicity problems, e.g., metals, cyanides, phenols; and 3) industry whose organic load was considered to be a significant fraction of the present Ley Creek Treatment Plant organic load. The information would be used to assess the contribution of each sampled industry to the wastewater treatability problem in the Ley Creek Drainage Area and also to provide information helpful to each industry's waste management program.

Grab and composite (up to 24 hours) samples were collected from the selected industries. Flows over the sampling period were obtained by water meter readings, lithium dilution technique, bucket and stopwatch, orifices, or combinations thereof. The most common method used was the lithium dilution technique, in which a known standard solution of lithium chloride is added at a constant rate to the wastewater upstream of the sampling point. The lithium concentration measured in the collected samples is the basis for the calculation of the wastewater flow rate. Average loadings during the compositing period were estimated as the product of the measured contaminant concentration and the average flow during the sampling period.

With the expansion of the scope to include the Metropolitan Sewage Treatment Plant wastewater, a sampling survey was conducted on the plant influent to obtain an estimate of the magnitude of flow and of contaminant concentrations in order to determine the significance of combining Ley Creek and Metropolitan wastewaters. Twenty-eight random grab samples were collected on the influent wastewater during the period from September 3 through September 10, 1968 and were analyzed for the same contaminants outlined in the Ley Creek Treatment Plant survey. Influent flows were measured concurrently with sampling.

Survey Results

Discussions of each industry known to be within the Ley Creek Sanitary District (and extensions) are presented in the Interim Report, *Industrial Discharges in the Ley Creek Sanitary District*, dated 1 March 1969. Included for each industry are a brief outline of manufacturing process, a description of wastewater production and disposal, and recommendations for wastewater management procedures. Nineteen industries were considered to have wastewater characteristics which required sampling and analysis. Descriptions of these sampling and analysis surveys are included in the respective industrial discussions. The locations of those industries sampled are shown in Drawing B-2.

The estimated wastewater characteristics of all industries contacted are summarized in Table 1. Also included in Table 1 are the points of discharge (Ley Creek Treatment Plant, Ley Creek, or other) and the potentials for clean-water segregation.

Within the Ley Creek Drainage Area, approximately 9.1 mgd of wastewater were accounted for in the survey. Approximately 3.3 mgd of wastewater are being discharged directly to Ley Creek or its tributaries; of this total, approximately 2.7 mgd are the total process wastewaters of the Crouse-Hinds Co., Will and Baumer Candle Company, General Motors-Ternstedt Division, and Syracuse China Corporation. Approximately 5.8 mgd of industrial wastewaters go to the Ley Creek Sewage Treatment Plant, of which 0.2 mgd are relatively uncontaminated (of could be made so) and could be diverted to storm sewers.

The results of the Ley Creek Sewage Treatment Plant influent sampling and analysis survey are contained in Appendix A. The raw, ranked raw, extended, and ranked extended data are listed in Tables A-1 through A-4, respectively. A summary of these results is presented in Table 2. The sampling survey defined a wastewater highly variable in organic load but without significant toxicity problems. BOD_5 concentrations ranged from 117 mg/L to 1,620 mg/L during the 7-day survey, with a median concentration of 389 mg/L; the median BOD_5 loading was 47,800 pounds per day. Metal concentrations were generally quite low; the maximum metal level, obtained by adding the maximum observed concentrations of chromium, copper, zinc, cadmium, and nickel, was less than 4 mg/L.

A comparison of the wastewater characteristics observed at the Ley Creek Sewage Treatment Plant influent with the summation of estimated industrial and municipal discharges is presented in Table 3. Samples of the Ley Creek influent were taken to reflect the loading

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Table 2

Wastewater Characteristics[1]
Ley Creek Sewage Treatment Plant Influent

	mg/L			Pounds/Day		
Probability of Occurrence	10%	50%	90%	10%	50%	90%
Flow, MGD	9.6	14.0	17.3	9.6	14.0	17.3
BOD_5	202	389	725	25,400	47,800	72,800
BOD_{uc}	272	560	908	31,500	69,600	103,000
COD	441	944	1,510	54,800	102,000	188,600
pH	6.3	7.0	7.8	6.3	7.0	7.8
Acidity[2]	0	0	28.0	0	0	3,340
Alkalinity[2]	0	0	50.0	0	0	4,780
S.S.	191	456	1,293	21,000	54,200	164,000
V.S.S.	137	260	547	14,400	29,500	64,400
Oil and Grease	45.5	79.5	153.0	4,700	8,600	20,000
Cyanide	0.001	0.019	0.18	0.1	2.0	27.0
Phenol	0.04	0.17	0.66	3.4	19.5	80.0
Chromium	0.14	0.26	0.56	11.7	30.4	76.9
Copper	0.12	0.26	0.50	11.3	32.5	62.9
Zinc	0.33	0.74	1.09	33.6	93.8	129.6
Cadmium	0.02*	0.05	0.15	1.6	5.9	19.6
Nickel	0.032	0.145	0.235	4.0	15.6	28.4
NH_3-N	10.5	15.4	23.9	1,000	1,775	2,730
Org-N	15.8	26.5	44.4	1,560	3,110	5,120
Ortho-PO_4	11.0	25.0	40.0	1,080	2,960	4,840
Total PO_4	22.0	54.0	80.0	1,970	6,760	10,390

[1]Dry Weather
[2]To pH 7

Table 3

Comparison of Observed and Estimated
Ley Creek Sewage Plant
Influent Characteristics

Parameter[3]	Observed Ley Creek Influent			Industrial Survey	Municipal[2] Estimates	Estimated Total Ley Creek Influent
	Mean	Median	Range	Mean	Mean	Mean
Flow (MGD)	13.7	14.0	8.7-18.8	5.8	4.0	9.8
BOD_5	51,100	47,800	15,400-202,000	32,900	8,000	40,900
Suspended Solids	74,800	54,200	1,600-326,000	51,400	8,000	60,000
Oil and Grease[1]	10,300	8,600	2,600-22,500	1,300	1,330	2,600
Cyanide	8.7	2.0	0.1-96.0	51.6	---------	51.6
Chromium	39.9	30.4	10.2-199	28.1	---------	28.1
Copper	34.6	32.5	9.1-76.2	45.9	---------	45.9
Zinc	84.8	93.8	18.1-183.2	69.0	---------	69.0
Cadmium	8.4	5.9	1.5-40.5	23.9	---------	23.9
Nickel	16.2	15.6	2.0-38.2	26.0	---------	26.0

[1] CCl_4 Extractables.
[2] Assuming population of 40,000.
[3] Pounds per day except as noted.

over a 24-hour period. However, the majority of industries sampled operate on a one- or two- shift basis. In those instances where samples were mainly representative of the working shifts only, the values obtained were adjusted so that they could be compared to the Ley Creek influent on a more equitable basis. This adjustment consisted of dividing the mean values by the fraction of the day that the waste producing processes were in operation. For the municipal discharge, the flow, BOD_5, suspended solids, and oil and grease loadings were estimated for the approximately 40,000 people within the Ley Creek Sanitary District. Estimated and observed loadings generally were in agreement, the only notable exception being the oil and grease (carbon tetrachloride extractables) values; only 30 percent of the mean oil and grease content in the Ley Creek Sewage Treatment Plant influent could be accounted for in the estimated industrial and municipal discharges. It should be noted that samples were taken for oil and grease only in those industrial wastewaters where it was considered very likely to be present (i.e., slaughter houses, rendering plants, processes using lubricating or cutting oils).

The information obtained from the industrial interviews and from the sampling and analysis surveys indicates that most of the organic loading discharged to the Ley Creek Sewage Treatment Plant is contributed by Bristol Laboratories.

Although there does not appear to be a toxicity problem at the treatment plant, unacceptable concentrations of metals and cyanides were noted at some industries. Definite restrictions must be placed on these industries to prevent the batch dumping of metals and cyanides; these restrictions should be consistent with the *Rules and Regulations Governing the Use of Public Sewers* promulgated by the Onondaga County Division of Drainage and Sanitation. A copy of these rules and regulations is attached in Appendix C.

The results of the influent sampling survey on the Metropolitan Treatment Plant, along with the corresponding flow measurements, were statistically analyzed. The raw, ranked raw, extended, and ranked extended data from this survey are listed in Tables A-5 through A-8, respectively. A summary of the 50 and 90 percent occurrence values from this statistical analysis is shown in Table 4. The sampling survey defined a wastewater relatively weak in organic concentration (compared to normal domestic sewage) and generally containing only trace concentrations of heavy metals. BOD_5 concentrations ranged from 30 mg/L to 183 mg/L during the 7-day survey, with a median concentration of 101 mg/L; the median BOD_5 loading was 37,600 pounds per day. Heavy metals generally were present only in trace amounts; however, there were a few occurrences of measurable concentrations. The maximum level, obtained by adding the maximum observed concentrations of chromium, copper, zinc, cadmium, and nickel, was less than 5 mg/L. Oil and grease concentrations were at normal levels; however, Onondaga County personnel have on occasion observed significant amounts of floating oil entering the treatment plant.

The wastewater characteristics observed at the Ley Creek and Metropolitan Sewage Treatment Plants are shown in Table 5. These two wastewaters contain approximately the same organic and total metals loadings (in pounds/day), but the wastewater volume at the Metropolitan Plant is about 3 times the volume at the Ley Creek Treatment Plant.

Future Expansion in Wastewater Flow and Loads

The results of the influent surveys conducted on both treatment plants represent the present flow and organic loadings. Since a treatment plant should be designed for some future design period (generally 20 years), and since it is anticipated that both the sanitary and

Table 4

Wastewater Characteristics[1]
Metropolitan Sewage Treatment Plant Influent

	mg/L			Pounds/Day		
Probability of Occurrence	10%	50%	90%	10%	50%	90%
Flow, MGD	29.7	46.0	58.6	29.7	46.0	58.6
BOD_5	36.0	101	155	10,200	37,600	78,600
BOD_{uc}	59.0	131	196	18,000	48,800	96,000
COD	78.0	261	458	23,600	108,100	221,900
pH	6.3	6.8	7.0	6.3	6.8	7.0
Acidity[2]	5.0	10.0	48.0	1,790	0	20,700
Alkalinity[2]	0	0	0	0	3,230	0
S.S.	40.0	128	217	10,200	48,000	100,000
V.S.S.	36.0	99.0	171	9,200	40,000	74,000
Oil and Grease	4.7	27.3	55.5	1,300	9,500	30,100
Cyanide	0.010	0.017	0.061	2.8	6.4	27.2
Phenol	0.010	0.025	0.140	2.8	8.4	69.4
Chromium	0.10	0.16	0.60	27.7	63.5	255.1
Copper	0.058	0.110	0.242	11.2	41.5	110.8
Zinc	0.11	0.25	0.93	29.7	97.9	417.2
Cadmium	0.05	0.05	0.05	12.2	18.9	24.4
Nickel	0.05	0.08	0.16	12.2	27.7	63.8
NH_3-N	4.9	8.4	14.4	1,360	3,290	5,475
Org-N	1.3	5.5	9.4	480	1,565	4,540
Ortho-PO_4	6.4	18.5	28.6	1,565	7,390	13,600
Total PO_4	10.1	32.6	61.7	2,490	13,000	23,750

[1] Dry Weather.
[2] To pH 7.

Table 5

Comparison of Ley Creek and Metropolitan Sewage Treatment Plant Influent Wastewater Characteristics

Parameter[1]	Ley Creek STP Influent			Metropolitan STP Influent		
	Mean	Median	Range	Mean	Median	Range
Flow (MGD)	13.7	14.0	8.7-18.8	44.5	46.0	21.0-76.0
BOD_5	51,100	47,800	15,400-202,400	39,300	37,600	9,100-87,400
BOD_{uc}	71,100	69,600	19,900-251,100	53,400	48,800	13,500-125,000
COD	116,000	102,000	26,300-342,000	103,800	108,100	14,700-255,000
pH	------------	7.0	6.0-8.8	6.7	7.0	6.2-7.2
Acidity	840	0	0-6,650	5,560	3,415	0-26,300
Alkalinity	1,320	0	0-23,100	115	0	0-3,200
S.S.	74,800	54,200	8,500-326,000	50,300	48,000	3,500-160,000
V.S.S.	36,400	29,500	7,700-106,000	40,800	40,000	2,500-109,000
Oil and Grease	10,300	8,600	2,600-22,500	13,700	9,500	1,300-30,100
Cyanide	8.7	2.0	0.1-96.0	10.9	6.4	2.2-74.2
Phenol	29.4	19.5	0.8-114.0	16.6	8.4	2.9-69.4
Chromium	39.9	30.4	10.2-199.0	115.6	63.5	15.7-649
Copper	34.6	32.5	9.1-76.2	50.1	41.5	10.8-127
Zinc	84.8	93.8	18.1-183.2	168.1	97.9	17.5-984
Cadmium	8.4	5.9	1.5-40.5	18.5	18.9	8.7-31.6
Nickel	16.2	15.6	2.0-38.2	33.6	27.7	8.7-105
NH_3-N	1,870	1,775	864-3,540	3,300	3,290	980-7,910
Org-N	3,280	3,110	980-6,820	2,110	1,565	0-5,160
Ortho-PO_4	3,240	2,960	730-15,300	7,130	7,390	1,100-16,600
Total PO_4	6,400	6,760	1,200-19,500	14,300	13,000	1,550-57,500

[1] Pounds per day except as noted.

industrial wastewater loads should increase, the projected increases in flow and organic loadings should be determined. Personnel at Onondaga County have indicated that the population increases over the next 20 years in the Ley Creek and Metropolitan Sanitary Districts should be almost 5,000 and 25,000, respectively. A reasonable basis for estimating the increases in flow and BOD loading is average per capita contribution of 100 gallons/day of flow and 0.2 lbs/day of BOD_5. At the present time, there are a few industries (listed in Table 1) which are discharging contaminated wastewaters to surface waters but which, with appropriate control, should be included in the collection system. This flow is estimated at 2 mgd, with the BOD estimated at 200 pounds/day. In addition, it is anticipated that new industries will discharge wastewaters to both the Ley Creek and Metropolitan Sanitary Districts, and that those already located in these areas may increase both their water usage and their organic discharge. An expansion factor of approximately 15 percent (2 mgd) has been allowed for the Ley Creek Sanitary District for this potential increase in average flow at an organic concentration of 300 mg/L BOD_5. The concentration used is the allowable limit established by Onondaga County's Sewer Ordinance. Similar increases in flow and organic concentration have been projected for the Metropolitan Sanitary District. The projected increases in flow and BOD_5 loadings are shown in Table 6.

Stormwaters

The collection system serving the Metropolitan Sanitary District is a combined sewer system, while the Ley Creek System is a separate sewer system. The combined sewer system

Table 6

Projected Increase in Flow and Organic Loading

Ley Creek Sanitary District	Flow MGD	Average BOD_5 lbs/day
Sanitary	0.5	1,000
Industry Not Presently Connected	2.0	200
Other Industrial Expansion	2.0	4,500
Total	4.5	5,700

Metropolitan Sanitary District	Flow MGD	Average BOD_5 lbs/day
Sanitary	2.5	5,000
Industrial Expansion	2.0	4,500
Total	4.5	9,500

collects not only municipal and industrial wastewaters, but also stormwater runoff. However, during and shortly after a heavy rainfall, flow through both these sewer systems increases. No attempt was made during the survey to determine the frequency or magnitude of stormwater runoff. However, estimates of the maximum storm flow that could be accommodated in the existing interceptor sewers have been made in previous studies for Onondaga County. These estimates (see Table 7) indicate the Metropolitan system could handle 175 mgd of storm flow and the Ley Creek system could handle 40 mgd.

Table 7

Storm Flow Capacity of the Major Interceptor Sewers

Sewer	Capacity MGD
Main Interceptor	120
Harbor Brook Interceptor	30
West Side Sanitary	20
Liverpool Sanitary	5
Metropolitan Sub-total	175
Ley Creek Sanitary Districts	40
Total	215

Summary of Wastewater Quantities and Characteristics

For use in design of facilities to handle the combined dry weather wastewater flow to both treatment plants, the 50 and 90 percent probability of occurrence values of flow and BOD_5 (with appropriate expansion factors) were computed by adding the respective values derived from the influent surveys at the two treatment plants. Addition of two 90 percent probabilities does not represent a true 90 percent probability for the combined system; such an addition would give a probability somewhere between 90 and 99 percent, because of the unlikelihood of simultaneous occurrence of the two individual 90 percent values. The design flows and BOD_5 loadings for the Metropolitan and Ley Creek Sewage Treatment Plants and the combined wastewaters are shown in Table 8.

The maximum stormwater flow is established by the maximum capacity of the sewer lines and has been estimated at 215 mgd. The organic loading during stormwater flow was not determined, but it will not affect the 90 percent occurrence design value, since storm flow conditions occur less than 10 percent of the time.

Existing Treatment Facilities

The duplicate facilities presently in operation at the Ley Creek Sewage Treatment Plant consist of bar screens, grit chambers, pre-aeration tanks, primary settling tanks, aeration tanks, final settling tanks, and chlorination facilities. A portion of the excess sludge is handled through digestion tanks and sludge-drying beds, with the remainder being pumped to the Metropolitan Sewage Treatment Plant for disposal.

A portion of the recent contract covering the construction of the pump station and force main contained provisions for additional modifications to the Ley Creek Sewage Treatment Plant. One of these modifications was the installation of baffles in the primary clarifiers for better flow distribution and for prevention of short circuiting through the tanks. Even though these tanks are hydraulically overloaded, this modification should result in better removal efficiencies.

Another modification being made includes the installation of four 5-horsepower mechanical aerators in each aeration basin of the original treatment plant, to supplement the existing aeration equipment. Prior to this modification, a portion of the flow had to be bypassed around the aeration tanks, since the available aeration capacity was not adequate to maintain the desired dissolved oxygen level. Preliminary observations made by Onondaga County personnel indicate that this modification can maintain dissolved oxygen in the system at the desired level without any bypassing of the influent wastewater.

The present intermediate treatment system at the Metropolitan Sewage Treatment Plant consists of a grit chamber, flocculation and settling tanks, chlorine contact tanks, and chlorine feed facilities. At the present time, an organic polymer is added to increase solids capture and BOD removal. The sludge solids removed from this wastewater are digested; the major portion of sludge is then pumped to the Solvay waste beds for disposal, while the remaining solids are centrifuged and stockpiled on-site.

Effects of Effluent on Ley Creek and Onondaga Lake

More than 90 percent of the present contamination in Ley Creek is traceable to the effluent from the Ley Creek Sewage Treatment Plant. Thus the effluent from the treatment plant is the major factor in making the waters of Ley Creek unsuitable for drinking water supply

Table 8

Summary of Design Flow and Organic Loadings

Ley Creek Wastewater	50 Percent Occurrence	90 Percent Occurrence
Flow, MGD		
Present	14.0	17.3
Projected Expansion[1]	4.5	4.5
Future Design	18.5	21.8
BOD, lbs/day		
Present	47,800	72,800
Projected Expansion[1]	5,700	5,700
Future Design	53,500	78,500
Metropolitan Wastewater		
Flow, MGD		
Present	46.0	58.6
Projected Expansion[1]	4.5	4.5
Future Design	50.5	63.1
BOD, lbs/day		
Present	37,600	78,600
Projected Expansion[1]	9,500	9,500
Future Design	47,100	88,100
Combined Ley Creek and Metropolitan Wastewaters		
Design Flow, MGD	69.0	84.9
Design BOD_5 Loading, lbs/day	100,600	166,600

[1]90% occurrence value increased by 50% over the 50% occurrence value.

and for other uses with high water quality requirements. Upon final completion of the pumping stations and force main, raw or treated wastewater will be discharged to the Metropolitan Sewage Treatment Plant, thereby alleviating the wastewater discharge to Ley Creek. The removal of this effluent discharge should significantly improve the quality of Ley Creek downstream of the present Treatment Plant discharge.

Before the installation of primary treatment at the present Metropolitan Sewage Treatment Plant location, the water quality in Onondaga Lake was poor. According to the results of samples collected by Onondaga County, the construction of the original primary treatment facilities and the subsequent upgrading to the present "intermediate" treatment facility have improved the water quality in the lake. A formal sampling survey was started during the summer of 1968 (under FWPCA Contract No. WPRD 66-01-68) to determine the condition of Onondaga Lake, but the results are not yet available. However, with the combination of Ley Creek and Metropolitan wastewaters for treatment and the addition of tertiary treatment, the water quality in Onondaga Lake is expected to show additional improvement.

Stream Classification

The Water Pollution Control Board of the New York State Department of Health has established water quality standards for surface waters in the Onondaga Lake Drainage Area. The Board has issued a report entitled *Onondaga Lake Drainage Basin* (Oswego River Drainage Basin Survey, Series Report No. 1), in which it recommended water quality criteria. The southern section of Onondaga Lake (and that portion of Ley Creek below the treatment plant outfall) have been given a D classification. Highlights of the water quality criteria suggested by the New York State Department of Health for this stream classification and applicable to the combined discharge from the Metropolitan Sewage Treatment Plant are given in Appendix D.

The best usage of class D waters is agricultural or as a source of industrial cooling or process water. Class D waters are not acceptable for fishing, bathing, or as a source of water supply for drinking, culinary, or food-processing purposes. Special treatment may be required under particular circumstances to make the water satisfactory for industrial process use, and natural impurities may be present at various locations. Otherwise, the waters without treatment should be satisfactory for agricultural uses and for industrial process cooling water.

Treatment Requirements

The New York State Department of Health requires a minimum of secondary treatment for municipal effluents discharging into Ley Creek or Onondaga Lake. Secondary treatment is defined as that degree of treatment which will remove from 75 to 95 percent (depending upon local conditions) of the organic pollution load, as measured by the 5-day Biochemical Oxygen Demand test. Communications between Onondaga County personnel and the New York State Department of Health have indicated that a BOD_5 removal efficiency of 85 percent based on the average results of thirty consecutive 24-hour composite samples will be required.

The New York State Department of Health also requires chlorination and the removal of settleable solids as the minimum acceptable treatment of excess stormwater flow entering the treatment plant.

It is further anticipated that future regulatory requirements may recommend additional treatment to achieve an orthophosphate reduction of eighty percent. A tertiary treatment facility at the Metropolitan Treatment Plant is currently under consideration by Onondaga County to meet these requirements.

4

WASTEWATER COLLECTION MASTER PLAN

In the initial planning stages of this project, it was thought that a number of industrial plants in the Ley Creek Sanitary District were discharging wastewater directly to surface waters. The initial plant interviews and related sampling survey, however, disclosed that all plants with significant flow and/or contamination were discharging at least their sanitary wastewater to the Ley Creek system and the great majority were discharging both sanitary and industrial wastewaters to the system. Nevertheless, a number of these plants still discharge some contaminated wastewaters, along with cooling water and stormwater, directly to surface streams.

Industrial Wastewater

A compilation of the estimated industrial discharges to Ley Creek is presented in Table 9. Of the approximately 1,980,000 gallons per day discharged, two industries account for practically all of the wastewater. General Motors-Turnstedt Division discharges approximately 1 mgd of treated wastewater to Ley Creek, while Crouse-Hinds discharges approximately 745,000 gpd to a tributary of Ley Creek. Each month General Motors submits the results of daily (5 days/week) analyses of wastewater samples to the State Department of Health. Recent discussions between Onondaga County and the State Department of Health indicated that discharge of this treated wastewater to Ley Creek can be tolerated. Based upon the samples collected during our survey, the wastewater contained minimal amounts of organics and low concentrations of heavy metals. Therefore, it appears that this wastewater will not impair the quality of Ley Creek.

Crouse-Hinds is in the process of installing pretreatment systems and in-plant modifications to make its wastewater acceptable for discharge to the Ley Creek Collection System. The other industries listed on Table 9 discharge less than 235,000 gallons per day to surface drainage systems. These industries should comply with the recommendations made in the Interim Report, and in general should discharge their contaminated industrial wastewater to the Ley Creek Collection system. A hydraulic capacity of 2 mgd has been provided specifically for these industries in the projected expansion; however, the inclusion of these wastewaters is not expected to significantly change the characteristics of the total wastewaters. From the information obtained during the initial interviews, all of these industries (with the exception of Clicquot Club Bottling Company) presently discharge sanitary wastewater to the Ley Creek Collection System.

Sanitary Wastewater

During the initial plant interviews, a number of small industries (generally with less than 50 employees) indicated that they discharge sanitary wastewaters to on-site septic tank systems. These industries (listed in Table 10) discharge a total of approximately 2,200 gallons per day. Therefore, as long as this treatment system (septic tank and tile field) is effective and appropriate, it does not appear economically feasible to tie these plants into the municipal system. If they are connected later, the quantity and characteristics of their discharges should have no noticeable effect on the quantity and characteristics of the overall system wastewater.

Table 9

Summary of
Discharge of Contaminated Industrial Wastewaters
to Surface Drainage Systems

Industry	Volume Discharged to Surface Drain gpd	Type of Wastewater Discharged: Industrial	Cooling	Stormwater	Is Industry On Sewer System	Approximate Volume of Contaminated Wastewater	Remarks
Bristol Laboratories	23,000	X	X	X	Yes	< 5,000	Some contamination observed in storm sewer - segregate to industrial sewer.
Carrier Corp.	50,000[1]	X	X	X	Yes	< 50,000	Contamination observed in outfall to creek - segregate to industrial sewer.
Chrysler Corp.	40,000	X	X	X	Yes	< 10,000	Traces of oil observed in storm sewer - remove to industrial sewer.
Clicquot Club Bottling Co.	2,300	X			No	2,300	Industrial and sanitary wastewater should be discharged to sewer system.
Continental Can Co.	20,600	X			Yes	20,600	Discharge contaminants on plant site - should be discharged with sanitary wastewater to Metropolitan S.T.P.
Crouse-Hinds	745,000	X			Yes	745,000	Will be connecting to sewer system
Franklin Engine Co.	68,500	X	X		Yes	< 20,000	Contaminated wastewater should be discharge to sewer.
G. E. - Electronics Park	200,000	X	X	X	Yes	< 10,000	Trace contaminants should be removed from storm sewer.
General Motors Corp. - Ternstedt Div.	1,470,000	X	X	X	Yes	1,000,000	Contaminants reduced in G.M. treatment plant - May be required to discharge to other than Ley Creek.
Liberty Combustion Corp.	1,020	X	X		Yes	< 1,000	Contaminants should be discharged to sewer.
Prestolite Div. - Eltra Corp.	40,000[1]	X	X	X	Yes	< 20,000	Contaminants observed in storm sewer - should be segregated to industrial sewer.
Syracuse China Corp.	164,000	X	X		Yes	< 50,000	Solids should be removed or recycled in plant - Clean waters can be discharged to Ley Creek.
Syracuse Concrete Pipe and Products Corp.	5,000	X		X	Yes	< 5,000	Remove solids-discharge uncontaminated wastewaters to creek.
Syracuse Ready Mix Co.	950	X		X	Yes	< 1,000	Remove contaminants-discharge clean waters to stream.
Union Carbide Corp., Linde Div.	10,000	X		X	Yes	10,000	Discharging to settling pond - supernatent will enter creek when pond is full-should be investigated at that time.
Will and Baumer Candle Co.	418,000	X	X		Yes	< 20,000	Saline cooling water should be discharged to creek - Contaminated wastewater should be discharged to collection system.
TOTAL	3,209,000					1,970,000[2]	

Note: Less than 185,000 GPD of contaminated wastewater discharged if Crouse-Hinds and General Motors are excluded.
[1]Estimate
[2]Approximate total ± 10% of average values.

Table 10

Summary of
Industrial Discharge of Sanitary Wastewaters
to On-Site Septic Tank Systems

Industry	Estimated Volume of Sanitary Wastewaters gpd
Advanced Welding Company	40
Allied Tool Corporation	190
Barnes and Cone, Incorporated	220
Bomac, Incorporated	140
Clicquot Club Bottling Company	70
Cook, E. F. Company	50
Frey's Pattern Shop	70
Iroquois Door Company	500
Sanitary Process Equipment Corporation	120
Sawyer Industries, Incorporated	160
Steps and Rails, Incorporated	140
Super Heat Treating, Incorporated	130
Syracuse Pharmacal Company, Incorporated	140
Thomas Foundry, Incorporated	90
Wickhardt Company, Incorporated	140
Total	2,200

Discussion of Wastewater Collection System

The existing major trunk sewers for the Ley Creek and Metropolitan systems are shown on Drawing B-3, along with the locations of those industries sampled. Based on the available information, essentially all of the sanitary and industrial wastewater generated in the Ley Creek Sanitary District is discharged to the collection system. There are a few industries (shown in Table 9) that discharge industrial wastewaters to surface drainage systems; however, all except Clicquot Club Bottling Company discharge at least sanitary wastewaters to a municipal collection system. It is expected that the municipal collection system will be able to handle this additional wastewater flow through the existing facilities. Clicquot Club Bottling Company, however, will require a new sewer lateral to discharge its wastewaters to the municipal system.

Those industries listed in Table 10 should also be connected to the closest municipal collection system as soon as discharge of sanitary wastewater to a septic tank system is no longer adequate or appropriate. Should all of the industrial wastewater presently discharged to surface drainage and all the sanitary wastewater presently discharged to septic tanks be discharged to the collection system, the increase in flow would be less than 2.0 mgd. This projected increase is not expected to change the characteristics of the total wastewater influent to the treatment plants.

5

POTENTIAL TREATMENT ALTERNATIVES

General Considerations

A great number of factors were involved in the determination of the treatment alternatives available for meeting the State's requirements for wastewater discharges in the Ley Creek-Metropolitan area. Numerous combinations of new and existing treatment facilities, treatment methods, effluent discharge points, etc., with varying potentials for accomplishment of the desired objectives were developed and subjected to a preliminary evaluation. The results of this evaluation are shown in Table 11. The principal factors involved were: utilization of the existing Ley Creek and Metropolitan S.T.P. facilities. effluent discharge to Ley Creek, Onondaga Lake, and/or the Seneca River; pretreatment by appropriate industries; and the constraints imposed by modifications to the overall sewerage system recently implemented or well along in the planning stage. This preliminary evaluation disclosed that several of the potential treatment alternatives involved obvious economical or technical disadvantages, and therefore, did not warrant further investigation. The remaining alternatives, which did appear to be feasible and consequently worthy of further investigation, furnish the basis for the planning for the laboratory treatability studies and the subsequent process design and cost estimating activities. The following discussions highlight the effects or the involvement of the major factors in the various alternative treatment systems.

Utilization of the Ley Creek Sewage Treatment Plant

With the pump station and force main for transfer of wastewater to the Metropolitan Treatment Plant, it is possible to convert the Ley Creek Sewage Treatment Plant to a pretreatment facility. The heavy concentration of industry in the Ley Creek Sanitary District results in the discharge of highly variable concentrations of organic materials, solids, oil, grease, and heavy metals; any one of these contaminants which could be reduced in a properly designed pretreatment system.

The existing activated sludge treatment facilities at the Ley Creek Treatment Plant are designed to handle normal concentrations of BOD_5, oil and grease, solids, and alkalinity or acidity. Inadequate biological treatment in this plant has been attributed partly to metal toxicity, but the results of the influent sampling survey at this plant did not show concentrations of heavy metals sufficient to cause biological toxicity. If metal toxicity subsequently becomes a problem, extensive modifications of the Ley Creek Treatment Plant would be required, since treatment of significant concentrations of heavy metals generally cannot be accomplished in a biological system.

The existing hydraulically-overloaded primary clarifiers at the Ley Creek Sewage Treatment Plant are equipped to remove floating materials, such as oil and grease; however, at the present time these facilities are manually operated and require considerable maintenance. The plant's capacity to handle suspended solids is limited by the anaerobic digestion and sludge disposal facilities. Removal of contaminants such as oil and grease, inorganic solids, and alkalinity or acidity could be handled in the Ley Creek Plant; however, sewer ordinances (including that of Onondaga County) generally preclude discharge of large quantities of these materials due to potential detrimental effects on the collection system.

Table 11

Summary of
Wastewater Treatment Alternatives

Alternative	Wastewater Treatment at L.C.S.T.P.	L.C.S.T.P. Effluent Destination	Wastewater Treatment at M.S.T.P.	M.S.T.P. Effluent Destination	Positive Factors	Negative Factors	Constraints	Future Consideration
A	Secondary	M.S.T.P.	Secondary[1]	Onondaga Lake	1. Meets N.Y.S. treatment requirement of 85% BOD_5 removal 2. L.C.S.T.P. effluent organic load eliminated from Ley Creek 3. Dilution available in Onondaga Lake much greater than in Ley Creek 4. L.C.S.T.P. effluent will receive tertiary treatment 5. Present M.S.T.P. outfall can be utilized	1. Would require additional facilities at both L.C.S.T.P. and M.S.T.P. 2. Minimum land area available for expansion at L.C.S.T.P. 3. Additional labor force required at both L.C.S.T.P. and M.S.T.P.	1. A pump station and force main to transfer wastewater from the L.C.S.T.P. to the M.S.T.P. has been installed. 2. Tertiary treatment facilities have tentatively been designed at the present M.S.T.P. location.	Yes
B	Secondary	Ley Creek	Secondary	Onondaga Lake	1. Meets N.Y.S. treatment requirement of 85% BOD_5 removal 2. M.S.T.P. need not be designed for L.C.S.T.P. effluent 3. Present outfalls can be utilized	1. Same as Negative Factors 1, 2, and 3 in Alternative A 2. Ley Creek quality would no doubt be unacceptable under low stream flow conditions	Same as Alternative A	No
C	Secondary	Onondaga Lake	Secondary	Onondaga Lake	1. Same as Positive Factors 1, 2, 3 and 5 of Alternative A	1. Same as Negative Factors 1, 2 and 3 in Alternative A 2. New L.C.S.T.P. outfall to Onondaga Lake would be required 3. L.C.S.T.P. effluent would not receive tertiary treatment	Same as Alternative A	No
D	Secondary	Onondaga Lake[2]	Secondary	Onondaga Lake	1. Same as Positive Factors 1, 2, 3 and 5 of Alternative A 2. Secondary facilities at M.S.T.P. need not be designed for L.C.S.T.P. effluent 3. Pump station and force main installed	1. Same as Negative Factors 1, 2, and 3 in Alternative A 2. Nominal 85% BOD_5 removal of organic matter from L.C.S.T.P. influent may not be acceptable 3. L.C.S.T.P. effluent would not receive tertiary treatment	Same as Alternative A	No
E	Partial[3]	M.S.T.P.	Secondary[1]	Onondaga Lake	1. Same as Positive Factors 1 through 5 in Alternative A 2. Minimum expansion and optimum utilization of L.C.S.T.P. facilities	1. Secondary facilities at M.S.T.P. must be designed for additional flow and organic load	Same as Alternative A	Yes
F	None	M.S.T.P.	Secondary[1]	Onondaga Lake	1. Same as Positive Factors 1 through 5 in Alternative A 2. Manpower at L.C.S.T.P. would be available for M.S.T.P. 3. L.C.S.T.P. operating costs eliminated	1. Secondary facilities at M.S.T.P. must be designed for additional flow and organic load 2. L.C.S.T.P. bond issue still outstanding	Same as Alternative A	Yes
G	Secondary[1]	Ley Creek	Primary	L.C.S.T.P.	1. Meets N.Y.S. treatment requirement of 85% BOD_5 removal 2. Uses existing facilities at M.S.T.P.	1. A new pump station and force main would be required. The recently completed facility does not have the required capacity 2. Would require additional facilities and manpower at the L.C.S.T.P. 3. Effluent from the L.C.S.T.P. would probably impair the quality of Ley Creek 4. Adequate land area and sludge disposal site not available at the L.C.S.T.P.	Same as Alternative A	No
H	Secondary[1]	Onondaga Lake[2]	Primary	L.C.S.T.P.	1. Same as Positive Factors 1 through 3	1. Same as Negative Factors 1, 2 and	Same as Alternative A	No

The concentrations of organic material in the effluent to the secondary treatment section of the Ley Creek S.T.P. are high and variable. Since this section of the plant is overloaded, it could not be expected to consistently produce an effluent suitable for discharge to surface waters, but it could be used effectively for pretreatment of organic contaminants. The decision concerning the use of the existing Ley Creek S.T.P. for the pretreatment of organics is essentially a matter of economics, i.e. whether it is more economical for the County to treat the total organic load with industry paying a surcharge for contaminant discharges in excess of specified levels, or for the appropriate industries to pretreat to meet these specified sewer discharge requirements. An important factor affecting this decision is the availability of Federal and/or State aid for municipal facilities, but not for private industrial facilities.

Utilization of the Metropolitan Sewage Treatment Plant

As indicated in Table 11, there are a number of options involving the Metropolitan S.T.P. facilities. Many of these options include secondary treatment at the Metropolitan S.T.P. of various combinations of Metropolitan raw wastewater with Ley Creek wastewater already subjected to various degrees of treatment. The force main (and pump station) between the two treatment plants provides flexibility and increases the number of options, but the greater volume of the Metropolitan wastewater and the greater dilution available at the Metropolitan outfall favor transfer from Ley Creek to Metropolitan over transfers in the reverse direction. The tentative selection of the Metropolitan S.T.P. as the location of future tertiary treatment facilities also tends to favor Metropolitan as a terminal rather than an intermediate point for treatment of wastewaters from the two districts.

Industrial Pretreatment

Discharge limits on a number of contaminants have been set forth by Onondaga County in their *Rules and Regulations Governing the Use of Public Sewers*. These restrictions prohibit the discharge of toxic substance in sufficient quantity to interfere with the treatment process. Although no toxic concentrations were observed at either treatment plant, the potential does exist for an occasional high concentration of heavy metal. If metal toxicity does become a problem in the future, the most economical solution would be to eliminate the problem at the source. It would be more reasonable to treat a low volume of a relatively high metal-content wastewater at the source than to treat the high volume (approximately 15 mgd) at the treatment plant. Almost all industries using large amounts of any of the heavy metals have the potential to discharge these materials at toxic concentrations. Therefore, in-plant measures should be taken to minimize the occurrence of accidental toxic discharges. The need for surveillance and related protective measures by individual industries was indicated in the Interim Report.

The first concern of any wastewater system should be the protection of the collection system. Therefore, the discharge of high concentrations of contaminants such as oil, grease, inorganic solids, and extremes of alkalinity or acidity, which will cause problems in the collection system, should be reduced to those concentrations set forth in Onondaga County's Rules and Regulations.

Since the average influent BOD_5 concentration to the Ley Creek Sewage Treatment Plant exceeds the allowable discharge of 300 mg/L, it is logical to assume that at least one industry is exceeding its discharge limit. During the ROY F. WESTON survey, samples were collected at selected industries that were felt to contain high organic concentrations or other contaminants that could cause a potential problem in a biological treatment plant. The survey indicated the four industries were discharging mean BOD_5 concentrations in excess of 300 mg/L. These industries are listed in Table 12. It is interesting to note that of those four industries exceeding the limit, practically all of the excess BOD_5 (approximately 25,000 lbs/day) accounted for originates from Bristol Laboratories. It should be stated, however, that the Onondaga County Sewer Regulations provide that organic concentrations higher than the limit of 300 mg/L BOD_5 may be discharged upon approval by the County.

Table 12

Organic Discharges Exceeding Allowable Limits

Industry	Mean Flow gpd	Mean BOD_5	Allowable BOD_5[1]	Excess BOD lbs/day
Bristol Laboratories	1,890,000	29,085 lbs/day	4,740 lbs/day	24,345
Corenco	131,000	575 mg/L	300 mg/L	300
Crispy Maid	8,000	59 lbs/day	24 lbs/day	35
Ralph Packing Company	40,000	325 lbs/day	100 lbs/day	225
Total				24,905

[1] Allowable BOD_5 discharge is 300 mg/L.

Summary of Potential Treatment Alternatives

A summary of potential treatment alternatives was shown in Table 11. Not all of the potential alternatives received serious consideration because of pre-imposed constraints or obvious economical or technical disadvantages. Those alternatives justifying further consideration and investigated in laboratory treatability studies were secondary treatment, partial or pretreatment, and no treatment of the Ley Creek Treatment Plant influent wastewater, followed by secondary treatment of these three different Ley Creek effluent wastewaters in combination with the Metropolitan wastewaters.

PROCESS INVESTIGATION

General Planning Considerations

Since practically all major industries in the area are connected to the municipal sewerage systems, the influent wastewaters to the Ley Creek and Metropolitan Sewage Treatment Plants are the major concern in this process investigation. Industrial wastewater pre-treatment methods require attention only to the extent that specific discharges would affect either the municipal collection system or the surface waters.

The low metal concentrations and relatively high organic concentrations observed in the survey of the treatment plant influent wastewaters indicated that organic loading is the major pollutant characteristic which will require treatment. Experience has shown the activated sludge process to be an economical, flexible, and dependable method for reducing the organic content of wastewaters. Various alternative treatment systems, based on the preliminary evaluation of the potential treatment alternatives discussed in the previous section, were investigated in the laboratory. Table 13 identifies three alternative systems (and the major components of two of them) by code numbers which will be used in this report for laboratory treatability systems and subsequently for the corresponding process design and cost estimate discussions.

Table 13

Identification of Alternative Treatment Systems

System Number	Treatment Involved
1-A	Secondary treatment of Ley Creek S.T.P. influent
1-B	Secondary treatment of the combination of clarified Ley Creek S.T.P. secondary effluent and the raw wastewater influent to the Metropolitan S.T.P.
2	Secondary treatment of the combined Ley Creek and Metropolitan raw wastewaters
3-A	Partial treatment (Plain Aeration) of Ley Creek S.T.P. influent
3-B	Secondary treatment of the combination of the clarified effluent from the Ley Creek Plain Aeration system and raw wastewater influent to the Metropolitan S.T.P.

Laboratory investigations were planned to obtain the essential design parameters required for plain aeration, conventional activated sludge, and the contact-stabilization modification of the activated sludge process. Complementary studies of filtration were included to determine the extent of BOD associated with the solids in the wastewaters and to indicate the applicability of biofloccuation or initial contact removal.

The plain aeration system was operated in a complete-mix reactor over a range of hydraulic loadings while the influent and clarified effluent organic concentrations were being measured. There was no sludge recycle, and no batch test was performed on this system.

The other laboratory programs included operation of continuous-feed activated sludge systems over a wide range of loadings to generate operating data and develop acclimated biological sludges. The acclimated sludges developed in this manner were used in performing a "Tube Run", which is a batch test used to develop process parameters, such as BOD removal rate kinetics, oxygen requirements, sludge production rates, and loading characteristics. The acclimated sludge from two pre-selected systems (1-A and 2) remaining after the Tube Runs, was used to start a pilot-scale contact-stabilization system on each of the selected wastewaters. Additional tests were conducted to determine the oxygen transfer and saturation characteristics, and the activated sludge settling and compaction requirements. The results of the investigations are the basis of the process design parameters.

A schematic flow diagram of various laboratory-scale activated sludge treatability systems is shown in Drawing B-4; the contact-stabilization pilot units operated on Systems 1-A and 2 are shown in Drawing B-5.

Wastewaters used in the biological treatability studies were daily composite (but not flow-proportioned) samples of the influent flow at the Ley Creek and Metropolitan Sewage TReatment Plants. Suspended solids in these wastewater samples were kept in suspension during operation of the laboratory system, because at the time these studies were initiated, discussions with Onondaga County indicated that primary clarifiers would not be included in any plant design.

Investigative Program and Results

Industrial Pretreatment

The only industrial wastewater situation where a pretreatment investigation was considered significant was at Crouse-Hinds, which was discharging directly to a small drainage ditch flowing into Ley Creek. A brief treatability study was conducted at the Crouse-Hinds plant for oil removal. STS (Susceptibility to Separation) tests were conducted on two grab samples taken from an oily sewer. In the STS test, the concentration of oil (Carbon Tetrachloride Extractables) is determined in the wastewater at the start of the test and in the subnatant liquid after 30 minutes quiescent settling. the results of these tests are shown below:

Date	Time	Sample	Oil, mg/L
11/19/68	1130	Raw	287
	1200	Subnatant	38.6
11/19/68	1415	Raw	150
	1445	Subnatant	25.0

These preliminary results indicate that the subnatant oil concentration can be reduced to acceptable levels in a properly designed gravity separation system.

Filtration Studies

The filtration studies for investigation of the association of organics with suspended solids and of the applicability of bioflocculation were conducted on random samples of the influent to the Ley Creek Sewage Treatment Plant. Ten grab samples were taken and filtered through No. 4 Whatman paper to remove the suspended solids. Data collected during this experiment, shown in Table 14, indicate that suspended solids removal resulted in an average COD reduction of 56.2 percent. However, in a full-scale plant even under ideal conditions and with optimum polymer (or inorganic chemical) dosage, the degree of removal expected would be less than that obtained in the laboratory tests.

Table 14

Comparison of Raw and Filtered Wastewater Samples
Ley Creek S.T.P. Influent

Date	Time	Raw Wastewater SS mg/L	Raw Wastewater VSS mg/L	Raw Wastewater COD mg/L	Filtered Wastewater COD mg/L	COD Removal Percent
8/21/69	0200	594	394	700	280	60.0
8/21/69	0600	384	224	680	360	47.1
8/21/69	1200	772	428	800	360	55.0
8/21/69	1600	908	564	1,320	660	50.0
8/21/69	2200	1,332	984	1,540	760	50.7
8/22/69	0400	354	138	920	480	47.8
8/22/69	0900	1,652	556	1,360	840	38.2
8/22/69	1400	472	148	828	374	54.8
8/22/69	1900	1,596	772	1,258	278	78.0
8/22/69	2400	3,212	384	1,236	238	80.6
Average						56.2

Biological Treatability

General Discussion - Laboratory investigation of the biological treatability of regular domestic sewage generally is not justified. However, the Ley Creek S.T.P. influent wastewater (or any combined wastewater stream which includes the LCSTP wastewater) contains enough industrial wastewater to affect significantly the organic-removal rates and other parameters involved in development of a sound process design. The following sections cover the general principles of interpretation of the activated sludge process and the design information developed from the various laboratory studies.

The reactions occurring in an aerobic biological system, although complex, are based on fundamental reactions. Biodegradable organic matter is consumed by the micro-organisms which comprise the activated sludge mass. In the process of assimilating the organic matter, a fraction of the organic waste material is biochemically oxidized to obtain energy necessary for motility, growth, and cell maintenance. After the organic food material is removed from solution into the biological mass, it must be "stabilized". Stabilization involves conversion of all food material into energy and new-cell synthesis reactions. Energy to support synthesis comes from oxidation of a portion of the available food supply and conversion to CO_2, water, and other stable, innocuous end-products. Throughout these assimilation reactions, the biomass undergoes a basal metabolism reaction called endogenous respiration.

In the activated sludge treatment of some wastewaters which are readily biodegradable, the stabilization reactions occur almost as rapidly as the transfer of BOD to the organisms. However, when a wastewater contains several or many complex organic compounds which are not rapidly degraded, BOD transfer can occur at a much faster rate than stabilization. The rate of stabilization relative to the rate of BOD transfer is a primary factor in designing an activated sludge system. When the two rates are nearly equal, the "conventional" approach is applicable. When stabilization occurs at a slower rate than BOD transfer, the "contact-stabilization" (BOD transfer and stabilization accomplished in separate facilities) approach may be beneficial in minimizing aeration basin volume requirements.

Nutrient Requirements - A proper balance of nutrients is necessary to develop and maintain a healthy biological population. The two most important nutrient materials are nitrogen and phosphorus. Generally, five pounds of nitrogen and one pound of phosphorus are required for every 100 pounds of BOD_5 removed. Other nutrients, required by activated sludge in trace amounts, are normally present in most wastewaters.

From the influent surveys conducted on both wastewaters, it was apparent that adequate phosphorus was present in the wastewaters, however, on occasion there was not enough nitrogen (as ammonia) in the Ley Creek wastewater for the expected amount of BOD_5 removal. Therefore, in the laboratory treatability investigations, nitrogen was added, regardless of the amount ini ially present in the wastewater, to make sure that the nutrient supply was adequate for proper growth of the biological organisms.

BOD Removal Kinetics - The rate of removal of BOD from the influent wastewater is an essential factor in the design of an activated sludge treatment facility. The development of BOD removal kinetics by evaluation of individual reactions is impractical, because of the complexity of the biological system. Therefore, the evaluation of the removal kinetics has been approached on a simplified overall basis.

A laboratory-scale technique reported by Weston and Stack[1] was used to develop the fundamental information about the progress of biological oxidation kinetics. The technique involves the growth and acclimation of an activated sludge system in a continuous-flow,

[1] *Prediction of the Performance of Completely-Mixed Continuous Biological Systems from Batch Data, R. F. Weston and V. T. Stack, Conference on Biological Waste Treatment, Manhattan College, April 20-22, 1960.*

laboratory-scale unit, and the use of the biological sludge in a batch test, called a "Tube Run". During the acclimation period, composite wastewater samples are fed to the continuous-flow unit, with daily measurement of the operational parameters. The activated sludge, after acclimation to the particular wastewater in the continuous-flow system, is harvested, concentrated by settling, and used in the Tube Run procedure. The Tube Run study consists of operating four batch systems (tubes) in which the BOD_5-to-biological-solids (VSS) ratio is varied over a range observed in the operation of the continuous-flow systems. By observing the rate of BOD removal, COD removal, and oxygen consumption, the kinetics of biological treatment for the particular wastewater are developed.

The theoretical interpretations applied to the batch tube run data include the following steps:

1. Calculation of BOD and COD transfer coefficients for each activated sludge mixture in the tube run study.

2. Correlation of the transfer coefficients with the corresponding loading, as food-to-organism ratios.

3. Translation of the batch kinetics to a prediction of the performance of a completely-mixed, continuous-feed system utilizing a "completion of reaction" curve. The curve is calculated from the proper BOD or COD transfer data and from a pre-defined mixing theory relationship.

Operating data from the plain aeration, conventional activated sludge, and contact-stabilization systems are presented in Tables A-9 through A-15. Tube run data from Systems 1-A, 1-B, 2, and 3-B are presented in Drawings B-6 through B-9, respectively.

The kinetics, interpreted from the tube run procedure and from the daily operating data from the continuous laboratory or pilot units, form the basis for the prediction of performance of a full-scale activated sludge facility and for selection of the conventional process or the contact-stabilization modification. Graphical representations of the BOD removal kinetics vs organic loading ratio (i.e. the concentration of organics in the influent to the concentration of volatile suspended solids in the aerated mixed liquor) for Systems 1-A, 1-B, 2, and 3-B are presented in Drawings B-10 through B-13, respectively. Interpretation of the stabilization kinetics of the contact-stabilization pilot unit has not been included in these drawings. These data indicate conventional activated sludge for System 1-A, and the contact-stabilization modification for Systems 1-B and 3-B. System 2, which was operated in the laboratory without primary solids removal, would appear to call for conventional activated sludge; however, if primary solids are removed, it is expected that the kinetics would shift to favor contact-stabilization. Since primary solids removal is now anticipated in the eventual full-scale system, contact-stabilization kinetics were derived for System 2. The following tabulation is a summary of the BOD removal kinetics for the various systems:

	Removal Rate,* Hours^{-1}		
System No.	Overall	Contact	Stabilization
1-A	1.6	-----	-------
1-B	-----	1.8	0.55
2	-----	1.1	0.45
3-B	-----	3.7	1.3

*at $20^{o} \pm 2^{o}C$.

The plain aeration system for the Ley Creek influent wastewater (System 3-A) was interpreted in a different manner than the other systems. It was operated on a homogeneous raw wastewater, which was fed to a complete-mix aeration system varied to give a range of detention times; the overflow was clarified before discharge. There was no solids recycle, and the mixed liquor had a low concentration of solids. Drawing B-14 shows the percent BOD removal efficiency obtained with various aeration detention times. The average BOD removal by clarification along, without aeration, was approximately 30 percent.

Oxygen Requirements - Oxygen is consumed by the activated sludge in the energy reactions which support synthesis of organic materials into new cell material and in endogenous respiration or autooxidation (self-destruction) of cell material. The requirements for energy and endogenous oxygen can be predicted from the oxygen consumption observed in the batch tube run system. Energy oxygen requirements are usually stated in terms of pounds of oxygen consumed per pound of BOD_5 removed, while the endogenous oxygen requirements are stated in pounds of oxygen per 1,000 pounds of VSS under aeration per hour. Oxygen requirement data obtained from the continuous systems were comparable to the oxygen requirements measured in the batch system.

The following is a summary of the oxygen requirements measured both on the Tube Run systems and on the continuous flow units:

System No.	Energy Oxygen lbs. O_2/lb. BOD_5 removed	Endogenous Oxygen lbs. O_2/1,000 lbs. VSS/hr.
1-A	1.0	6.9
1-B	0.9	13.0
2	0.85	11.6
3-B	0.9	9.5

Oxygen Transfer - The sizing of aeration equipment for the transfer of required amounts of oxygen into the aeration mixture requires an understanding of the interfacial resistances to oxygen transfer. Aeration equipment manufacturers generally base the performance of equipment on the rate of oxygen transfer into tap water under "standard conditions", Therefore, resistances to oxygen transfer into the activated sludge aeration mixture must be compared to the corresponding resistances for tap water to assure the selection of adequately sized equipment. This relationship is called the alpha (α) value, and is defined as the oxygen transfer coefficient of the wastewater divided by the oxygen transfer coefficient of tap water.

Another important ratio is the beta factor (β), which accounts for the difference in DO saturation levels between activated sludge mixed liquor and tap water.

The alpha and beta factors calculated on the activated sludge grown in the four continuous-unit systems did not vary greatly.

System No.	Alpha	Beta
1-A	0.66	0.94
1-B	0.68	0.93
2	0.77	0.91
3-B	0.70	0.95

Production of Excess Activated Sludge - The activated sludge system normally produces an excess of biological solids, which are the result of the synthesis of soluble organic material to insoluble bacterial protoplasm and of the inclusion of inorganic and organic insoluble solids into the biological mass.

The amount of sludge synthesis can be estimated by several methods from the operation of the laboratory units. The theoretical approach consists of comparing the oxygen requirements and the BOD and COD removal data with a predetermined sludge production coefficient. The monitoring of actual production rates is the second approach to estimating excess activated sludge quantities.

The rate of sludge synthesis was calculated from relationships that combine the theoretical approach and actual data. The gross sludge production rate calculated from both the Tube Run data and the continuous flow systems are presented below.

System No.	Gross Sludge Production[1] lbs. VSS/ lb. BOD_5 removed
1-A	1.0
1-B	0.9
2	1.2
3-B	1.0

[1]At 20° ± 2°C.

Sludge Settling Characteristics - During the operation of the laboratory continuous-flow and batch systems, gravity settling tests were conducted on mixed liquor to determine the subsidence rate of the activated sludge solids. These observed data were analyzed to determine the practical settling rate for designing secondary clarifiers. In addition, the settled solids concentration was estimated for the purpose of approximating clarifier activated sludge recycle flows and concentrations.

The clarifier overlfow rates and the corresponding underflow solid concentrations for the various activated sludge systems are shown below:

System No.	Overflow Rates, gal/day/sq.ft.	Underflow Solids Concentration mg/L
1-A	600	17,000
1-B	800	13,000
2	650	14,000
3-B	500	10,000

Gravity Thickening - Additional settling tests were conducted to evaluate the compaction characteristics of the excess activated sludge solids. Interpretations of the data obtained in the thickening studies indicate the following mass (solids) loadings and underflow solids concentrations for the individual systems:

System No.	Overflow Rates lbs/day/sq.ft.	Underflow Solids Concentration mg/L
1-A	40	30,000
1-B	23	28,000
2	25	25,000
3-B	16	19,000

Summary of Investigative Results

The design parameters for the optimum activated sludge modification as determined from laboratory treatability investigations on the individual systems are summarized in Table 15.

Table 15

Summary of Observed Laboratory Results

	System 1-A	System 1-B	System 2	System 3-B
	Secondary treatment of Ley Creek S. T.P. influent	Secondary treatment of Ley Creek S.T.P. secondary effluent and Metropolitan S.T.P. influent	Secondary treatment of the combined Ley Creek and Metropolitan raw wastewaters	Secondary treatment of Ley Creek Plain Aeration effluent and Metropolitan S.T.P. influent
Design BOD_5 Removal Kinetics				
Total Kinetics[1]	1.6 hours^{-1}	0.55 hours^{-1}	0.45 hours^{-1}	1.3 hours^{-1}
Contact Kinetics		1.8 hours^{-1}	1.1 hours^{-1}	3.7 hours^{-1}
Oxygen Requirements				
Energy, lbs O_2/lb. BOD_5 removed	1.0	0.9	0.85	0.9
Endogeneous, lbs O_2/hr./1000 lbs. MLVSS	6.9	13.0	11.6	9.5
Oxygen Transfer Coefficient,	0.66	0.68	0.77	0.7
Oxygen Saturation in Wastewater,	0.94	0.93	0.91	0.95
Temperature of test, °C	23	18	21	18
Laboratory Sludge Settling Rate				
Clarifier Overflow Rate, gpd/sq.ft.	600	800	650	500
Underflow Concentration, mg/L	17,000	13,000	14,000	10,000
Thickener Loading, ppd/sq.ft.	40	23	25	16
Min. Underflow Concentration, mg/L	30,000	28,000	25,000	19,000
Gross Sludge Production[2], lbs/lb. BOD_5 removed	1.0	0.9	1.2	1.0
Sludge Destruction Rate[2], % VSS/day	3.0	10.0	7.0	4.0

[1]Stabilization kinetics in Contact-Stabilization system or overall kinetics in Conventional Activated Sludge system
[2]At 20 ± 2°C

Note: Results for System No. 3-A (Partial treatment - Plain Aeration - of Ley Creek S.T.P. influent) shown in Drawing No. B-14

PROCESS DESIGN

General Basis of Design

The principal consideration or objective in the development of the process design was to establish a sound base for preliminary estimates of the capital and total annual costs of the several treatment alternatives considered technically feasible. Since these estimates would then be used for comparison and selection purposes, certain elements were excluded from the process design, such as the existing collection systems, the pump station and force main between Ley Creek S.T.P. and Metropolitan S.T.P., the existing pumping stations and grit chambers at both treatment plants, and sludge digestion and disposal facilities. The principal types of treatment operations considered are primary clarification, activated sludge, final clarification, and sludge thickening.

The factors which constitute the basis for process design are as follows:

1. The treatability parameters established by the laboratory process investigations and related discussions, particularly the 50 percent probabilities of occurrence of projected daily dry-weather flow and BOD_5 loading. (For the design of certain facilities where peak loadings would affect performance, the 90 percent probabilities of occurrence values are relevant.)

2. The requirement of 85 percent BOD_5 removal (30 consecutive-day average) under cold-temperature conditions (10°C).

3. A minimum of primary clarification for all wastewaters, including excess stormwater.

Since the studies were conducted with a mixed wastewater feed and the present design includes the installation of primary clarifiers, it is anticipated that the removal of the settleable solids will have an effect on the removal kinetics. Therefore, the treatability parameters established during the laboratory-scale investigations have been adjusted to reflect this change in removal rate kinetics.

Removal rate kinetics are affected by the operating temperature. Since cold-temperature operation is not critical for the biological treatment process, the kinetics were adjusted for ambient-air operating temperature of 10°C.

Design of the hydraulic capacity for a combined treatment plant under maximum storm flow conditions has been established by Onondaga County's consultants in prior studies. It has been estimated that the maximum capacity of the various collection systems entering the plant will be 215 mgd. These collection systems are combined wastewater and stormwater systems.

Excess stormwater flow has been excluded from consideration for treatment at the Ley Creek S.T.P. because in each of the feasible treatment alternatives all the LCSTP wastewater would be transferred to the Metropolitan S.T.P. for some kind of additional treatment. During heavy stormwater flow conditions, the wastewater influent to the Metropolitan S.T.P. will, according to Onondaga County's consultants, enter a diversion chamber ahead of the primary clarifiers. This diversion chamber will bypass that volume of wastewater in excess of the MSTP design capacity around the primary clarifiers to a second diversion chamber. This second chamber will be designed so that all the wastewater that has bypassed primary clarification will be routed to the activated sludge tank, while a like volume of primary-treated wastewater will be discharged directly to chlorination facilities and thence to the final effluent line.

At the present time there are six primary clarifiers at the Metropolitan S.T.P., but Onondaga County's consultants have indicated that these clarifiers should be used in the tertiary treatment system currently under consideration. Therefore, new primary clarifiers would be required for the biological treatment system.

The type of construction to be employed in the treatment facilities will depend on a number of conditions, such as available land area, subsurface conditions, cost, and other related factors which ROY F. WESTON was not in a position to investigate fully. Onondaga County's consultants have investigated these conditions for this particular location, and their proposed vertical, common-wall, concrete tank design will be used for construction.

Since additional raw wastewater pumping should not be required in any of the various proposed biological treatment systems, pump facilities are not included in the designs.

Wastewater from the two treatment plants was found to have phosphorus concentrations adequate for biological treatment. Wastewater at the Ley Creek Sewage Treatment Plant was occasionally deficient in nitrogen, but there should be adequate nitrogen for the expected BOD concentrations for all alternatives except activated sludge treatment of the Ley Creek influent wastewater. Nitrogen storage and feed facilities therefore will be included only in the design of this system.

Development of Process Designs for the Alternative Treatment Systems

In the following sections the facilities to be included in each of the technically feasible treatment systems are discussed in light of the rationale presented in the General Basis of Design section.

Secondary Treatment of Ley Creek S.T.P. Influent

From the laboratory treatability data, conventional activated sludge appeared to be more advantageous than the contact-stabilization modification. The existing LCSTP pump station, grit chamber, and primary clarifiers would be suitable for use in the proposed system. Since the primary clarifiers are overloaded, the suspended solids removal should be minimal, and the BOD removal rate coefficient would probably not vary from that observed in the laboratory studies, which were conducted on wastewater feed from which the solids had not been removed. The existing LCSTP aeration basins and final clarifiers would require modifications of such an extent as to rule out their use in the proposed system. To summarize, the treatment plant design for this alternative includes two new complete-mix activated sludge tanks, three new final clarifiers, a new sludge thickener, and pumps and other auxiliary equipment. No stormwater would be treated at Ley Creek S.T.P., because LCSTP is not equipped to handle stormwater and because the overall treatment system calls for pumping of the wastewater to Metropolitan S.T.P. for further treatment.

Secondary Treatment of LCSTP Effluent and MSTP Influent

The contact-stabilization modification of activated sludge was indicated as the most advantageous method for this particular wastewater. The pump station and force main for transporting wastewater from the Ley Creek Plant to the Metropolitan Plant and the existing grit chamber and pump station at the Metropolitan Treatment Plant are considered to be adequate. The new facilities required would therefore include new primary clarifiers and pumps, contact and stabilization tanks, final clarifiers and pumps, and sludge thickeners and pumps.

Secondary Treatment of Combined LCSTP and MSTP Influents

The treatability data for the unsettled wastes indicated conventional activated sludge to be the optimum biological treatment system. However, with primary clarification, the solids removal should change the kinetics so that contact-stabilization would be preferable to the conventional system. Therefore, the new facilities required for the system would include primary clarifiers, contact and stabilization tanks, final clarifiers, sludge thickeners, and pumps and other auxiliary equipment.

Plain Aeration of LCSTP Influent

The plain aeration system for the Ley Creek wastewater would use the existing treatment plant, with modifications. Minimal modifications to the existing plant have already been made under a recent contract. Additional modifications could be made to this plant to improve performance, but no such additional modifications have been incorporated into the design of this system.

Secondary Treatment of LCSTP Plain-Aeration Effluent and MSTP Influent

The process design for this system would use the contact-stabilization process. The existing grit chambers and pump station at the Metropolitan Sewage Plant could be utilized; new primary clarifiers, contact and stabilization tanks, final clarifiers, sludge thickeners, and pumps and other auxiliary equipment are included in the process design.

Summary of Design Basis and Major Unit Sizes

The unit tank sizes, aeration requirements, and estimates of sludge production determined from the process design and the treatability investigations are summarized in Table No. 16.

Table 16

Summary of Unit Sizes for Various Treatment Alternatives

	System 1		System 2	System 3	
	1-A	1-B		3-A	3-B
DESIGN BASIS					
Flow, MGD	18.5	69.0	69.0	18.5	69.0
BOD, lbs/day	53,500	55,100	100,600	53,500	73,850
(BOD, lbs/day for aerator design)	78,600	96,100	166,600	78,600	127,350
Max. Stormwater Flow, MGD	----------	215	215	----------	215
PRIMARY CLARIFIERS	Use existing tanks			Use existing tanks	
Design Overflow Rate, gpd/sq.ft.	----------	650[1]	650[1]		650[1]
Total Area Required, sq.ft.	----------	106,000	106,000		106,000
Pump Capacity each, MGD	----------	50	50		50
AERATION BASINS				Use existing tanks	
Contact Tanks	None				
Total Volume, 10^6 gallons		12.45	12.55		6.85
Oxygen Transfer, lbs/hr.		3,500	4,060		3,500
Aerators		20 at 100-HP	20 at 100-HP		16 at 100-HP
Stabilization Tanks	None				
Total Volume, 10^6 gallons		5.75	4.9		5.6
Oxygen Transfer, lbs/hr.		2,500	2,190		2,500
Aerators		16 at 90-HP	12 at 90-HP		12 at 100-HP
Conventional Activated Sludge Tanks		None	None		None
Total Volume, 10^6 gallons	4.3				
Oxygen Transfer, lbs/hr.	3,500				
Aerators	20 at 90-HP				
FINAL CLARIFIERS				Use existing tanks (or convert to aeration tanks)	
Design Overflow Rates, gpd/sq.ft.	600	800	650		700
Total Area Required, sq.ft.	30,900	86,300	106,000		98,600
Recycle Pump Capacity each, MGD	20	70	70		70
SLUDGE THICKENERS				None	
Sludge Produced, lbs/day	75,000	76,800	133,000		101,200
Total Area Required, sq.ft.	1,900	3,400	6,860		5,300
Pump Capacity each, MGD	0.5	1.25	1.25		1.25

[1] Overflow Rate approximately 1,370 gpd/sq.ft. at peak storm flow conditions.

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COST ESTIMATES

Preliminary estimates of capital and total annual (including both fixed and operating) costs for the various treatment alternatives are presented in Tables 17 and 18. Table 17 covers the capital and annual costs for the three overall alternative systems on the basis of the projected BOD_5 loading. Table 18 covers the costs for the same systems on the basis of a reduced BOD_5 loading; this reduced loading represents the effect of the estimated 25,000 lbs/day of BOD_5 that would be kept out of the municipal system if Bristol Laboratories pretreated its wastewater to produce an effluent in compliance with the sewer discharge limit of 300 mg/L.

Amortization costs of existing treatment facilities at the Ley Creek and Metropolitan Sewage Treatment Plants have been excluded from the calculation of fixed annual costs. In like manner, the fixed and operating costs do not include costs associated with the collection systems, the pump station and force main, the proposed tertiary treatment system, or sludge digestion and disposal.

Table 17

Preliminary Cost Estimate
Wastewater Treatment Facilities

Onondaga County
Syracuse, New York

SUMMARY OF CAPITAL COSTS AT PROJECTED BOD LOADING

	System 1		System 2	System 3	
	1-A	1-B		3-A	3-B
Primary Clarifiers - pumps and mechanisms	--------------	$ 4,170,000	$ 3,930,000		$ 4,270,000
Contact Tanks with aerators	$2,410,000[1]	5,900,000	6,080,000		3,530,000
Stabilization Tanks with aerators	--------------	2,895,000	2,450,000		2,870,000
Secondary Clarifiers - pumps and mechanisms	1,044,000	3,205,000	3,990,000		4,010,000
Thickeners and Pumps	69,000	324,000	247,000		168,000
Sub-Total	$3,523,000	$16,494,000	$16,697,000		$14,848,000
Piping at 15%	529,000	2,470,000	2,500,000		2,230,000
Electrical at 12%	424,000	1,980,000	2,000,000		1,782,000
Instrumentation at 8%	282,000	1,320,000	1,335,000		1,188,000
Site Work at 1%	35,200	165,000	167,000		148,500
Sub-Total	$4,793,200	$22,429,000	$22,699,000		$20,196,500
Construction Contingency at 15%	718,000	3,380,000	3,410,000		3,030,000
TOTAL CAPITAL COST[2]/PLANT	$5,511,200	$25,809,000	$26,109,000	No additional costs	$23,226,500
TOTAL CAPITAL COST[2]/SYSTEM	$31,320,000		$26,109,000	$23,226,000	

SUMMARY OF ANNUAL COSTS AT PROJECTED BOD LOADING

	System 1		System 2	System 3	
	1-A	1-B		3-A	3-B
Operating Costs for Biological Treatment Units					
Labor					
number of man-hours/day	296	488	536	272	488
cost at $5.00/man-hour, 365 days/yr.	$ 540,000	$ 890,000	$ 978,000	$496,000	$ 890,000
Maintenance				100,000[3]	
Mechanical at 6%	46,100	179,500	213,000		175,000
Structural at 1%	31,400	150,000	146,700		133,000
Piping and Electrical at 2.5%	23,800	111,200	112,500		100,500
Utilities					
number of HP-hr.	1,400	2,400	3,000	400	2,400
cost at $0.012/KWH	109,000	188,000	235,000	31,100	188,000
Total Annual Operating Costs	$ 750,800	$ 1,518,700	$ 1,685,200	$627,100	$ 1,486,500
Fixed Costs for Biological Treatment Units					
Amortization Cost at 5%, 30 years, 20% coverage	374,000	1,750,000	1,770,000	------------	1,575,000
TOTAL ANNUAL COST/PLANT	$1,138,800	$ 3,268,700	$ 3,455,200	$627,100	$ 3,061,500
TOTAL ANNUAL COST/SYSTEM	$ 4,407,500		$ 3,455,200	$ 3,688,600	

[1]Conventional Activated Sludge
[2]Engineering Design Fee not included
[3]Estimate

Table 18

Preliminary Cost Estimate
Wastewater Treatment Facilities

Onondaga County
Syracuse, New York

SUMMARY OF CAPITAL COSTS AT REDUCED[1] BOD LOADING

	System 1		System 2	System 3	
	1-A	1-B		3-A	3-B
Primary Clarifiers - pumps and mechanisms	....	$ 4,170,000	$ 3,930,000		$ 4,270,000
Contact Tanks with aerators	$1,493,000[2]	5,900,000	6,030,000		3,530,000
Stabilization Tanks with aerators		2,895,000	2,450,000		2,870,000
Secondary Clarifiers - pumps and mechanisms	1,044,000	3,205,000	3,990,000		4,010,000
Thickeners and Pumps	69,000	324,000	247,000		168,000
Sub-Total	$2,606,000	$16,494,000	$16,647,000		$14,848,000
Piping at 15%	391,000	2,470,000	2,500,000		2,230,000
Electrical at 12%	313,000	1,980,000	2,000,000		1,782,000
Instrumentation at 8%	208,000	1,320,000	1,330,000		1,188,000
Site Work at 1%	26,000	165,000	166,000		148,000
Sub-Total	$3,544,000	$22,429,000	$22,643,000		$20,196,000
Construction Contingency at 15%	532,000	3,380,000	3,400,000		3,030,000
TOTAL CAPITAL COST[3]/PLANT	$4,076,000	$25,809,000	$26,043,000	No additional costs	$23,226,000
TOTAL CAPITAL COST[3]/SYSTEM	$29,885,000		$26,043,000	$23,226,000	

SUMMARY OF ANNUAL COSTS AT REDUCED BOD LOADING

	System 1		System 2	System 3	
	1-A	1-B		3-A	3-B
Operating Costs for Biological Treatment Units					
Labor					
number of man-hours/day	296	488	536	272	488
cost at $5.00/man-hour, 365 days/yr.	$ 540,000	$ 890,000	$ 978,000	$496,000	$ 890,000
Maintenance				100,000[4]	
Mechanical at 6%	30,400	179,500	210,000		175,000
Structural at 1%	22,900	150,000	146,700		133,000
Piping and Electrical at 2.5%	17,600	111,200	112,500		100,500
Utilities					
number of HP-hr.	890	2,400	2,865	320	2,400
cost at $0.012/KWH	69,600	188,000	224,500	24,900	188,000
Total Annual Operating Costs	680,500	1,518,700	1,671,700	620,900	1,486,500
Fixed Costs for Biological Treatment Units					
Amortization Cost at 5%, 30 years, 20% coverage	277,000	1,750,000	1,768,000	....	1,575,000
TOTAL ANNUAL COST/PLANT	$ 957,500	$ 3,268,700	$ 3,439,700	$620,900	$ 3,061,500
TOTAL ANNUAL COST/SYSTEM	$ 4,226,200		$ 3,439,700	$ 3,682,400	
Annual Savings at Reduced BOD Load	$ 181,300		$ 15,500	$ 6,200	

[1]BOD Load on LCSTP reduced by 25,000 lbs/day.
[2]Conventional Activated Sludge.
[3]Engineering Design Fee not included.
[4]Estimate.

SELECTION OF TREATMENT SYSTEM

As shown in the Cost Estimate tables, three total system alternatives were compared to determine which one was most advantageous. System 1 includes secondary treatment of the Ley Creek S.T.P. influent wastewater (1-A), followed by secondary treatment of the combination of that effluent and the raw wastewater influent to the Metropolitan S.T.P. (1-B). System 2 is secondary treatment of the combined Ley Creek and Metropolitan S.T.P. raw wastewaters. System 3 is another two-part system, which includes Plain Aeration of the Ley Creek S.T.P. influent (3-A), followed by secondary treatment of that effluent and the raw wastewater influent to the Metropolitan S.T.P. (3-B).

The total annual costs, based on the design at either the projected or the reduced BOD load, indicate that System 2, which combines the two raw wastewaters in a contact-stabilization process, will cost considerably less per year than either System 1 or System 3. Although amortization costs for existing treatment facilities have not been included in these calculations, it is evident that their inclusion would not change the cost relationships between the alternative treatment systems.

Further advantage for System 2 is recognized by considering that the present treatment plants are understaffed due to a lack of qualified manpower. The operation of the proposed secondary and tertiary treatment systems at the Metropolitan Treatment Plant would require additional manpower. Therefore, phasing out the Ley Creek S.T.P. in the near future should not only reduce the total annual costs but should also provide a good source of manpower for the additional operations at the Metropolitan Sewage Treatment Plant.

The total annual cost savings achieved by the reduced BOD_5 loading are not significant. If industry should be required to pretreat its wastewaters to achieve this reduced loading, industry would spend considerably more than the indicated savings to the municipal system. This appears to be adequate justification for Onondaga County to accept the high industrial BOD loads provided that the affected industries pay an equitable share of the treatment costs.

Onondaga County should secure commitments from the industries which contribute a significant portion of the flow and/or organic load regarding their intentions about future wastewater discharge. This will increase the likelihood that adequate capacity for expansion will be designed into the treatment facilities, and that industry will utilize the capacity reserved for them in the proposed expansion. These commitments should be obtained before the County begins detailed design of the proposed facilities.

System 2, secondary treatment of the combined raw wastewaters influent to the Ley Creek and Metropolitan Sewage Treatment Plants, is recommended for installation by Onondaga County, because it will achieve the desired wastewater effluent at a more reasonable cost than any of the other available alternative systems. A preliminary flow diagram and tentative plot plan for this system are shown on Drawings B-15 and B-16, respectively.

SUMMARY

This evaluation of joint municipal-industrial wastewater treatment is part of a comprehensive continuing series of studies of environmental conditions in and around Onondaga Lake. The general objectives of the overall program are to reduce the pollution load on Onondaga Lake and its tributaties and to develop a good foundation for meeting the anticipated stricter water quality regulations and their consequently increased treatment requirements.

The present study originated as a determination of the status of industrial wastewater discharged in the Ley Creek drainage area and development of a master plan of wastewater collection and treatment for this area. Subsequent developments, particularly other aspects of the overall pollution abatement program, resulted in expansion of this study to cover certain considerations of the Metropolitan Sanitary District wastewater and treatment plant facilities.

After an extensive biological treatment pilot unit program at the Ley Creek S.T.P. failed to produce an effluent acceptable for year-round discharge to Ley Creek, Onondaga County shifted its attention to investigation of the feasibility of transferring the LCSTP-treated wastewater to Onondaga Lake or to the Seneca River for discharge. The determination of Onondaga Lake as the more economical discharge point led to the design and construction of a pump station and force main to transfer wastewater from the Ley Creek plant to the Metropolitan treatment plant. The existence of these pumping facilities has a significant impact on the development of an overall wastewater treatment system that makes optimum use of existing treatment facilities. It increases the number of feasible alternatives for wastewater treatment and consequently increases the wastewater combinations justifying laboratory treatability investigation.

The first major phase of the present study was the survey of industrial wastewater discharges in the Ley Creek Drainage area. Onondaga County furnished a comprehensive list of industries either served by the Ley Creek sewerage system or within the drainage area of Ley Creek. With the cooperation of the County and the individual industries, the Engineer's personnel evaluated the wastewater situation at each industry by interview, by inspection of production and wastewater handling facilities, and, where appropriate, by sampling and analysis of wastewaters. The principal criteria for determining that a particular industry warranted inclusion in the sampling and analysis survey were: 1) a major industry not currently connected to the Ley Creek sewerage system; 2) an industry with significant potential toxicity problems; and 3) an industry whose organic wastewater load constituted a significant portion of the total organic loading on the Ley Creek Sewage Treatment Plant. The information obtained from the interviews, visits, and wastewater surveys was used to assess the contribution of each industry and to provide guidance to each industry's wastewater management program. The findings and related recommendations were included in the appropriate industry sections of the Interim Report of 1 March 1969, *Industrial Discharges in the Ley Creek Sanitary District*. The most important of these findings were:

1. Twenty-four industries were discharging wastewaters (including clean cooling water) to Ley Creek, but only two of them showed a need for treatment facilities. The others either discharged acceptable effluents or could do so by the in-plant processing changes recommended in the Interim Report.

2. A number of industries were discharging metals and cyanides at significant concentrations to the Ley Creek sewage system. Apparently there has been sufficient dilution in the system to avoid any adverse effects on the biological treatment operations, but the potential for such interference is there.

3. One industry, Bristol Laboratories, contributed 80-90 percent of the industrial organic wastewater loading to the Ley Creek sewerage system and 50-60 percent of the total organics loading on the Ley Creek S.T.P.

Complementing the industrial wastewater investigation was a random grab sampling survey of the Ley Creek S.T.P. influent wastewater. Forty-two random grab samples were collected between 13 June and 20 June 1968 and analyzed at ROY F. WESTON laboratories. Flow measurements were recorded (from the treatment plant's influent flowmeter) at the time of each sample collection. With the expansion of the scope of the study to include the Metropolitan S.T.P. wastewater, a similar survey was conducted of that treatment plant's influent wastewater. Twenty-eight random grab samples were collected between 3 September and 10 September 1968 and were analyzed for the same contaminants as in the Ley Creek S.T.P. survey. Complete analytical results of the two treatment plant wastewater surveys are presented in Tables A-1 through A-8, and are summarized along with the specific industry surveys in Tables 1 through 5.

These data constitute the basis for definition of the wastewater quantities, sources, and characteristics and for planning of wastewater treatability investigations and development of a treatment system.

Development of a wastewater collection master plan for the Ley Creek Sanitary District and consideration of potential treatment alternatives were required before the treatability investigations and process design studies could be carried out in a reasonably efficient manner to produce meaningful results. The principal focus in the development of the wastewater collection master plan was the question of the adequacy of the existing Ley Creek collection system for handling present and anticipated future wastewater flows resulting from addition of industries not currently connected and from projected increases from sources already connected. The adequacy of the geographical coverage of the existing collection system was substantiated by the finding that all industries with significant wastewater flow and/or contaminant load were discharging at least their sanitary wastewater to the Ley Creek system, and most were discharging both industrial and sanitary wastewaters. Nevertheless, a few plants were discharging some contaminated wastewaters, along with cooling water and stormwater, directly to surface streams, and the impact of an eventual tie-in of these discharges on the municipal system had to be evaluated. Of the approximately 2 million gallons per day discharged directly to streams, practically all came from two industries, Crouse-Hinds and the General Motors Ternstedt Division. Crouse-Hinds is in the process of installing pretreatment facilities and in-plant processing modifications that will make its wastewater effluent suitable for discharge to the Ley Creek collection system, Ternstedt Division has demonstrated through periodic wastewater analytical reports that its treated effluent is acceptable for discharge to surface waters.

Connection of the few plants discharging sanitary wastewaters through on-site septic tank systems would be no big problem, primarily because the flows involved are quite small and because the collection system is reasonably accessible. However, there is no need to connect these sanitary discharges as long as the septic tank systems remain effective and appropriate.

Stormwater flow is another factor in assessing the hydraulic adequacy of the existing collection system because the Metropolitan sewers are combined sewers, i.e. they collect both wastewater and stormwater. Although the Ley Creek Sewer System is a separated sewer system, increases in flow are evident during periods of rainfall. The scope of the current study did not include determination of the frequency or magnitude of stormwater runoff. However, previous Onondaga County studies indicated that the Metropolitan system could handle about 175 mgd of storm flow and the Ley Creek system 40 mgd.

Many factors were involved in the determination of treatment systems capable of meeting the requirements for wastewater discharges in the Ley Creek-Metropolitan area. Numerous combinations of new and existing treatment facilities, treatment processes, effluent discharge points, pretreatment by individual industries, etc. with varying potentials for accomplishment of the desired objectives were developed and subjected to a preliminary screening, the results of which are presented in Table 11. This preliminary evaluation disclosed that several of the potential treatment schemes involved obvious economic or technical disadvantages. The remaining alternatives shown in the following tabulations furnished the basis for planning of the laboratory treatability studies and subsequent process design and cost estimating activities:

System Number	Treatment Involved
1-A	Secondary treatment of Ley Creek S.T.P. influent
1-B	Secondary treatment of the combination of clarified Ley Creek S.T.P. secondary effluent and the raw wastewater influent to the Metropolitan S.T.P.
2	Secondary treatment of the combined Ley Creek and Metropolitan raw wastewaters
3-A	Partial treatment (Plain Aeration) of Ley Creek S.T.P. influent
3-B	Secondary treatment of the combination of the clarified effluent from the Ley Creek Plain Aeration system and raw wastewater influent to the Metropolitan S.T.P.

Systems 1 and 3 were divided into two parts to facilitate identification and comparison of the alternatives. Each of the three systems utilizes the force main between the Ley Creek and Metropolitan Sewage Treatment Plants, and each involves the Metropolitan S.T.P. as the end of the treatment train. MSTP is preferred over LCSTP as the terminal point because there is more dilution available at an Onondaga Lake outfall, because the MSTP influent wastewater flow is about 3 times as much as the LCSTP influent, and because of the proposed location of future tertiary treatment facilities at MSTP. each system is applicable either to the entire projected wastewater load of the combined sanitary districts or to the wasteload reduced by industry pretreatment.

Since practically all major industries in the area are connected to the municipal sewerage systems, the influent wastewaters to the Ley Creek and Metropolitan Sewage Treatment Plants were the major concern in the process investigation. The relatively high organic concentrations and relatively low metals concentrations determined in the surveys indicated that organic loading is the major pollutant characteristic requiring treatment. Experience has shown the activated sludge process to be an economical, flexible, and dependable method for reducing the organic content of wastewaters.

Normally, domestic sewage does not require specific laboratory investigation to determine reaction rate and process design parameters, but in the present case there is a large enough proportion of industrial wastewater in the total wastewater flow to modify the normal characteristics of domestic sewage. Thus, laboratory investigations were conducted to obtain the design parameters required for conventional activated sludge and for the contact-stabilization modification of the activated sludge for various combinations of LCSTP and MSTP influent and partially-treated wastewaters. Plain aeration (essentially conventional activated sludge without sludge recycle) was investigated for preliminary treatment of the LCSTP influent. Complementary filtration studies were included to determine the extent of organic material associated with the solids in the wastewaters and to indicate the applicability of bioflocculation or initial contact removal. One industrial wastewater was investigated to determine the feasibility of oil removal in attaining an effluent acceptable for discharge to the municipal sewage system.

The laboratory programs included: operation of continuous-feed activated sludge systems over a wide range of organic pollutant loadings; several "Tube Runs" (a batch test to derive process design parameters); and related investigations of oxygen transfer and saturation characteristics and activated sludge settling and compaction requirements. The design parameters determined from the laboratory treatability investigations are summarized in Table 15. The process modifications selected on the basis of these tests are summarized below:

Wastewater	Process Modification
LCSTP Influent (1-A)	Conventional
LCSTP Secondary Effluent and MSTP Influent (1-B)	Contact-Stabilization
LCSTP and MSTP Influents (2)	Conventional
LCSTP Plain Aeration Effluent and MSTP Influent (3-B)	Contact-Stabilization

The laboratory investigation of System 2 (combined LCSTP and MSTP influent wastewaters) was conducted on a sample which was not subjected to primary clarification. A subsequent decision to include primary clarification in the overall treatment scheme stimulated a re-examination of the laboratory data. This showed that removal of suspended solids through primary clarification would change the indicated mode of treatment for System 2 from conventional to contact-stabilization.

The principal objective in the development of the process design was to establish a sound base for preliminary estimates of the capital and total annual costs of the several technically feasible treatment alternatives. The principal bases of design were: 1) the treatability parameters established in the laboratory investigations; 2) the requirement for 85 percent BOD (organic) removal under cold temperature conditions; and 3) a minimum of primary clarification for all wastewaters, including stormwaters. The latter requirement is met by the provision of two diversion chambers at the Metropolitan S.T.P.; the first diverts that volume of wastewater in excess of MSTP's design capacity to by-pass the primary clarifiers, while the second routes all the by-passed wastewater to the activated sludge tank and diverts a like volume of primary-treated wastewater directly to the final chlorination facilities. Major unit sizes, aeration requirements, estimated sludge production, and other design data are summarized in Table 16.

Preliminary estimates of the capital and total annual costs for the three alternative systems are presented in Tables 17 and 18; Table 17 covers capital and annual costs based on the total projected organic loading, while Table 18 covers the costs based on a reduced loading. This reduced loading represents the effects of the estimated 25,000 pounds per day of BOD_5 (roughly half the LCSTP loading) that would be kept out of the municipal system if Bristol Laboratories pretreated its wastewater.

The total annual costs include both operating and fixed costs, but do not include amortization of existing treatment facilities nor the costs associated with the collection systems, the pump station and force main, the proposed tertiary treatment facilities, or sludge digestion and disposal. The capital costs include a construction contingency but no engineering design fee. The overall costs for the three alternative systems are summarized as follows:

	Projected BOD Loading	
System	Capital Cost	Total Annual Costs
1	$30,300,000	$4,410,000
2	$26,100,000	$3,460,000
3	$23,200,000	$3,690,000
	Reduced BOD Loading	
1	$29,900,000	$4,230,000
2	$26,000,000	$3,440,000
3	$23,200,000	$3,680,000

These figures indicate the economic advantages of System 2, which treats the combined raw wastewaters of the Ley Creek and Metropolitan Sewage Treatment Plants. Further advantage for System 2 accrues from consideration of the current under-staffing at the present treatment plants due to a general lack of qualified manpower; phasing out the Ley Creek S.T.P. would provide a good source of manpower for proposed secondary and future tertiary treatment operations at the Metropolitan Sewage Treatment Plant.

Total annual cost savings achieved by operation on the basis of the reduced BOD loading are not significant. If industry should be required to pretreat its wastewater to attain this reduced loading, industry would spend considerably more than the municipal system would save. It would be mutually beneficial for Onondaga County to accept the full projected organic load provided that the affected industries pay an equitable share of the treatment costs.

ACKNOWLEDGEMENTS

The cooperation of industry participants in this study, especially those who permitted samples of their effluent to be taken and the results reported, is acknowledged with sincere thanks.

Mr. E. F. Gilardi and Mr. M. L. Woldman of ROY F. WESTON, INC., West Chester, Pennsylvania, who with their associates, guided the overall project, conducted initial plant interviews, supervised the sampling surveys and the biological treatability studies, designed the various biological treatment systems, and wrote the interim and final reports.

The field sampling surveys, analytical work, bench-scale treatability studies and report editing were performed by a team from ROY F. WESTON, INC. consisting of Mr. G. W. Berman, Mr. A. B. Chandler, Mr. T. F. Rooney and Mr. J. L. Simons.

The assitance and cooperation of employees of Onondaga County at both the Metropolitan and Ley Creek Sewage Plants is greatly appreciated.

The support of the project by the Federal Water Pollution Control Administration and the help provided by Mr. George Rey, Mr. Edward Dulaney, and Mr. L. E. Townsend is acknowledged with sincere appreciation.

APPENDICES

TABLE A-1

THIS TABULATION IS THE RAW DATA FROM THE SURVEY
FLOW IS IN MILLION GALLONS PER DAY
CONCENTRATIONS ARE IN MILLIGRAMS PER LITER

RANDOM GRAB SURVEY - INFLUENT

ID	DATE	TIME	FLOW	PH	ALK	ACID	BOD-5	BOD UC	COD	SS	VSS	OIL[1]	CN-	PHENOL	TOT CR	COPPER	ZINC	CADM	NICKEL	NH3-N	ORG-N	PO4-O	PO
001	06 13 68	1500	18.8	7.4	28	0	190	212	432	276	140	70.5	0.024	0.07	0.44	0.28	0.69	0.10	0.125	9.6	26.6	25	
002	06 13 68	2000	15.6	6.5	0	20	388	530	936	586	216	83.0	0.024	0.33	0.20	0.22	0.39	0.03	0.120	19.5	28.7	35	
003	06 13 68	2100	15.7	6.6	0	16	260	565	696	616	320	93.0	0.010	0.06	0.34	0.12	0.70	0.15	0.150	15.7	23.0	48	
004	06 13 68	2400	14.3	7.4	28	0	600	810	1248	1024	232	157.0	0.000*	0.20	0.27	0.35	0.68	0.05	0.115	11.9	26.0	35	
005	06 14 68	0600	10.2	6.2	0	60	450	600	792	420	224	63.0	0.009	0.00*	0.45	0.16	0.76	0.02	0.145	26.6	38.4	180	[illegible]
006	06 14 68	0800	13.3	6.5	0	30	19[illegible]	276	368	148	76	46.5	0.018	0.26	0.23	0.10	0.56	0.05	0.185	9.8	14.7	8	
007	06 14 68	1600	18.3	6.4	0	22	372	468	720	500	320	62.0	0.160	0.11	0.39	0.50	0.74	0.10	0.150	17.8	27.8	27	
008	06 14 68	1700	18.0	8.6	154	0	330	690	995	672	360	74.0	0.184	0.54	0.52	0.42	0.74	0.08	0.115	13.7	45.5	28	
009	06 14 68	2300	14.2	7.0	0	0	360	552	893	252	252	139.0	0.003	0.20	0.19	0.29	0.50	0.05	0.000*	14.6	23.4	20	
010	06 15 68	0100	13.2	6.3	0	24	432	660	838	448	268	62.5	0.003	0.31	0.15	0.39	0.58	0.10	0.000*	11.9	24.2	24	
011	06 15 68	0400	10.2	7.0	0	0	567	816	1150	464	220	98.5	0.001	0.15	0.12	0.20	0.50	0.04	0.150	11.3	21.2	13	
012	06 15 68	1200	15.6	7.0	0	0	288	420	597	332	224	52.5	0.092	0.15	0.15	0.25	1.41	0.04	0.045	11.0	26.3	26	
013	06 15 68	1300	15.6	7.0	0	0	270	399	731	360	228	45.0	0.226	0.04	0.22	0.40	0.47	0.05	0.040	14.8	35.0	20	
014	06 15 68	1600	13.3	6.0	0	60	336	477	770	256	200	53.5	0.002	0.00*	0.15	0.36	0.90	0.02	0.020	7.8	10.6	19	
015	06 15 68	2100	15.0	6.9	0	2	1620	2010	2735	1232	360	70.0	0.001	0.13	0.15	0.40	0.90	0.03	0.000*	24.6	42.0	32	
016	06 16 68	0200	10.5	6.7	0	6	1080	1410	2235	326	248	84.0	0.002	0.17	0.22	0.18	0.78	0.02	0.060	13.4	11.2	31	
017	06 16 68	0700	12.8	7.1	2	0	255	288	462	80	72	24.4	0.000*	0.15	0.14	0.10	0.17	0.02	0.000*	16.5	21.8	10	
018	06 16 68	1200	13.0	7.0	0	0	210	240	423	164	140	37.2	0.000*	0.19	0.14	0.14	0.22	0.02	0.000*	25.2	34.2	40	
019	06 16 68	1500	13.0	8.0	60	0	444	612	904	456	336	54.2	0.000*	0.27	0.12	0.23	0.31	0.02	0.000*	13.2	31.9	28	
020	06 16 68	1900	13.0	6.8	0	4	480	900	1230	724	336	126.0	0.000*	0.86	0.34	0.45	0.88	0.06	0.000*	16.8	27.7	33	
021	06 16 68	2100	11.0	6.8	0	4	276	396	1000	1016	432	105.0	0.000*	0.01	0.43	0.62	1.06	0.09	0.000*	18.5	29.4	38	
022	06 17 68	0300	8.7	8.8	130	0	696	768	1194	852	232	93.5	0.000*	0.15	0.15	0.16	0.25	0.03	0.000*	12.6	21.8	20	
023	06 17 68	0800	9.7	7.0	0	0	648	864	1079	2232	1312	144.0	0.000*	0.01	0.20	0.21	0.44	0.02	0.000*	15.4	22.4	9	
024	06 17 68	1000	17.3	7.1	2	0	177	270	500	456	180	64.5	0.000*	0.19	0.27	0.39	0.78	0.04	0.000*	18.5	26.8	15	
025	06 17 68	1300	17.3	7.0	0	0	396	528	800	468	264	142.0	0.001	0.47	1.38	0.50	0.88	0.08	0.265	15.7	20.9	20	
026	06 17 68	1900	15.7	7.0	0	0	510	696	1030	516	260	103.0	0.001	0.61	0.57	0.41	1.10	0.31	0.080	15.1	23.9	25	
027	06 17 68	2200	15.0	7.0	0	0	342	417	800	376	216	103.0	0.001	0.24	0.36	0.26	0.74	0.06	0.190	10.4	33.1	36	
028	06 18 68	0200	10.4	6.8	0	4	73[illegible]	864	1220	420	164	95.5	0.001	0.16	0.22	0.14	1.30	0.02	0.175	10.7	18.2	15	
029	06 18 68	0700	9.6	8.0	62	0	192	249	329	20	0*	41.5	0.002	0.30	0.14	0.14	0.42	0.02	0.135	22.4	25.2	10	
030	06 18 68	0900	12.3	7.4	28	0	684	912	1065	312	124	66.0	0.000*	0.12	0.34	0.16	0.58	0.02	0.020	15.4	22.4	15	
031	06 18 68	1600	15.2	6.3	0	24	438	606	1292	624	460	63.5	0.758	0.90	0.34	0.39	0.76	0.20	0.135	15.4	47.3	35	
032	06 18 68	1800	16.3	6.9	0	2	540	750	1253	1240	428	109.0	0.083	0.43	0.47	0.34	0.70	0.09	0.240	15.4	34.4	32	
033	06 18 68	2100	15.7	6.9	0	2	384	540	1004	1036	468	172.0	0.124	0.28	0.50	0.54	1.14	0.15	0.180	20.9	29.7	38	
034	06 19 68	0300	11.0	7.0	0	0	321	396	944	412	284	81.5	0.040	0.04	0.24	0.16	0.78	0.04	0.155	14.6	22.1	13	
035	06 19 68	0600	9.1	7.1	2	0	372	576	1310	436	328	59.5	0.[illegible]24	0.98	0.14	0.12	0.66	0.02	0.070	17.4	56.3	18	
036	06 19 68	0900	13.2	6.2	0	36	411	501	944	408	256	77.5	0.[illegible]0	0.14	0.22	0.19	0.90	0.06	0.240	13.4	23.8	16	
037	06 19 68	1400	17.2	7.0	0	0	420	510	914	412	344	85.5	0.01[illegible]	0.00*	0.50	0.40	0.88	0.09	0.200	20.7	33.6	22	
038	06 19 68	1900	15.8	7.0	0	0	270	555	1314	1820	776	165.0	0.0[illegible]4	0.10	0.64	0.44	0.96	0.20	0.175	20.7	35.0	34	
039	06 19 68	2100	15.7	7.0	0	0	456	624	1545	2492	604	134.0	0.058	0.00*	0.50	0.48	1.00	0.08	0.215	20.7	35.0	45	
040	06 20 68	0100	13.8	7.1	2	0	390	615	1430	856	568	63.5	0.000*	0.02	0.29	0.20	0.92	0.06	0.195	30.8	46.8	22	
041	06 20 68	0500	9.2	7.0	0	0	1440	1950	2784	1316	468	286.0	0.014	0.00*	0.22	0.18	0.44	0.02	0.060	19.6	25.4	25	
042	06 20 68	1100	15.5	7.0	0	0	282	438	705	320	136	65.0	0.019	0.[illegible]4	0.64	0.10	0.80	0.10	0.030	16.8	13.7	14	

*=NO ANALYSIS

[1] Total oil and grease

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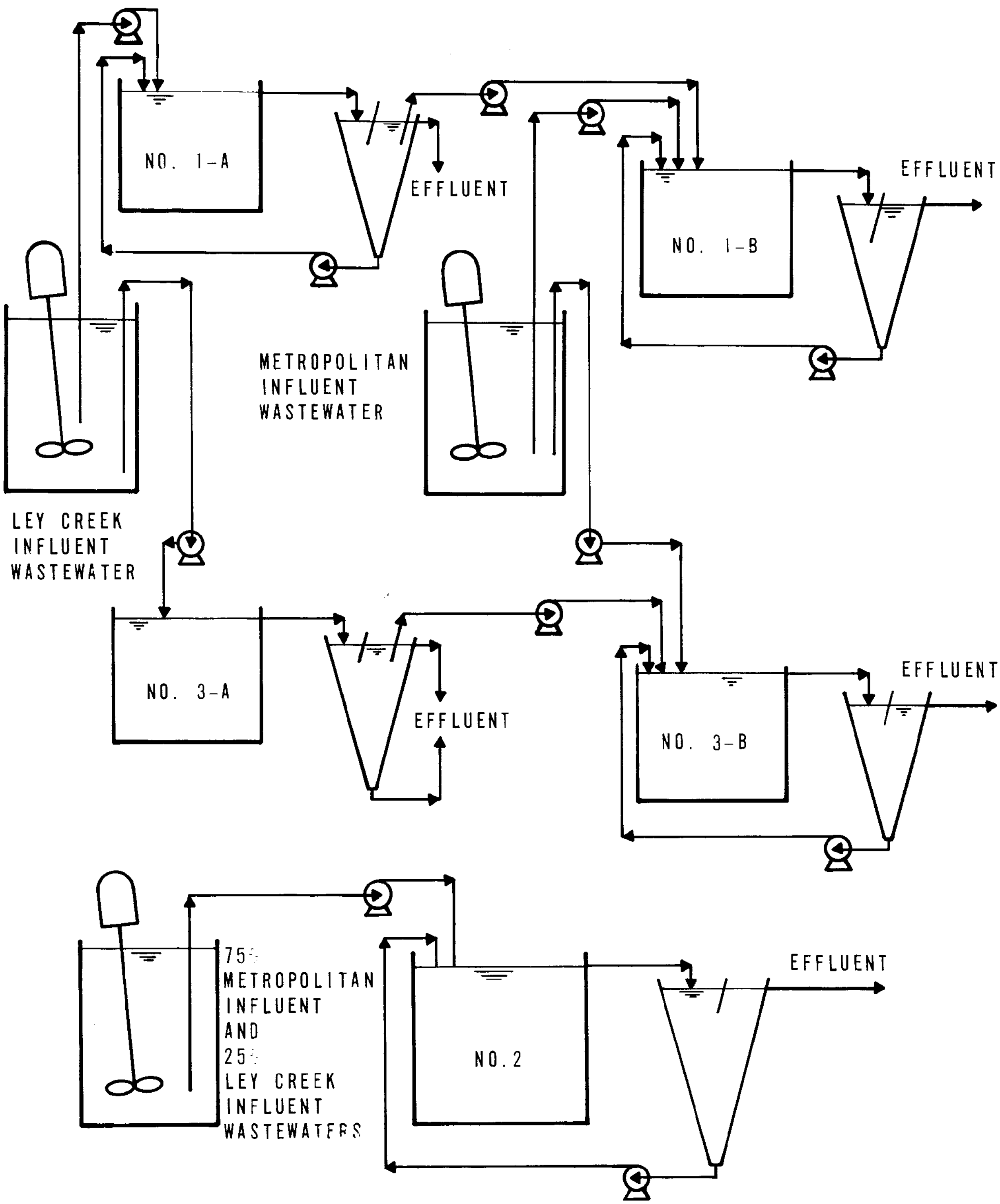
ONONDAGA COUNTY
BIOLOGICAL TREATABILITY STUDIES

CONVENTIONAL ACTIVATED SLUDGE SYSTEMS



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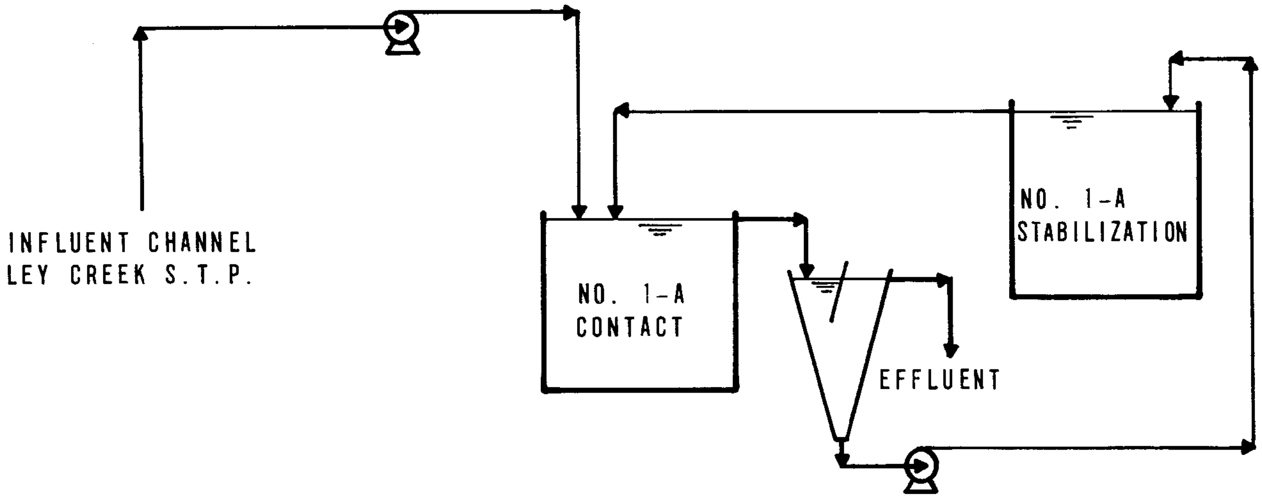
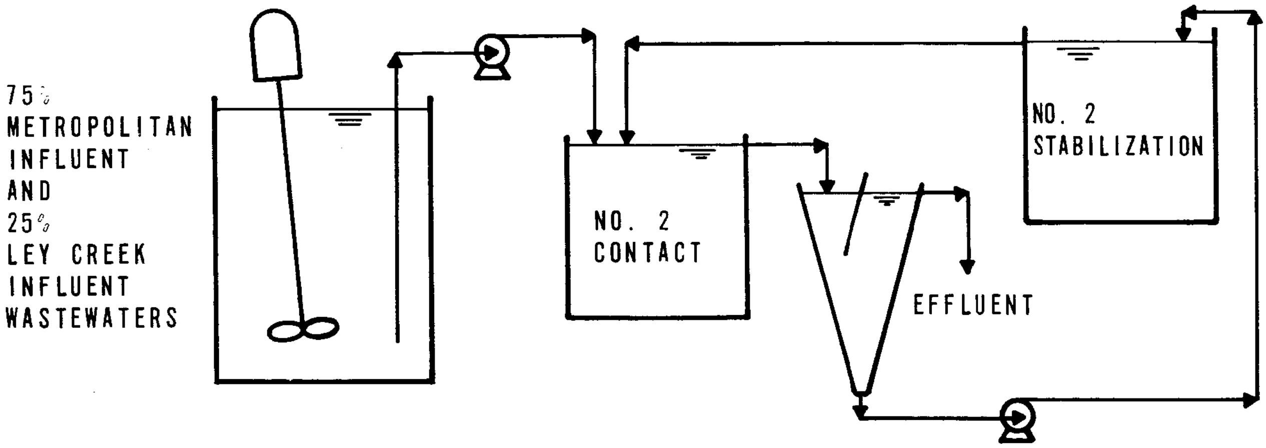
BIOLOGICAL TREATABILITY STUDIES

CONTACT STABILIZATION SYSTEMS





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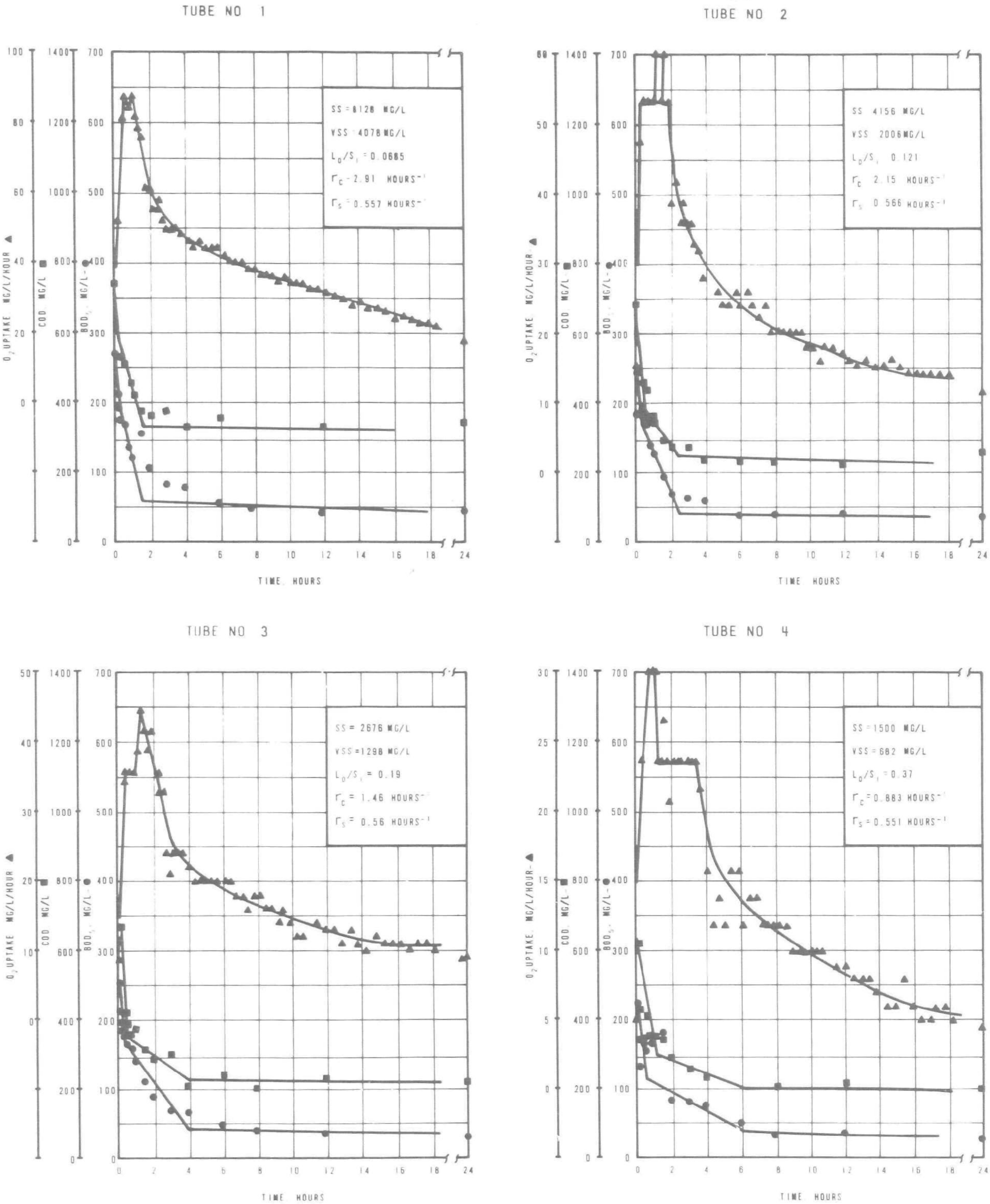
ONONDAGA COUNTY
SYSTEM 1-A
BATCH ACTIVATED SLUDGE DATA



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ONONDAGA COUNTY
SYSTEM 1-B
BATCH ACTIVATED SLUDGE DATA

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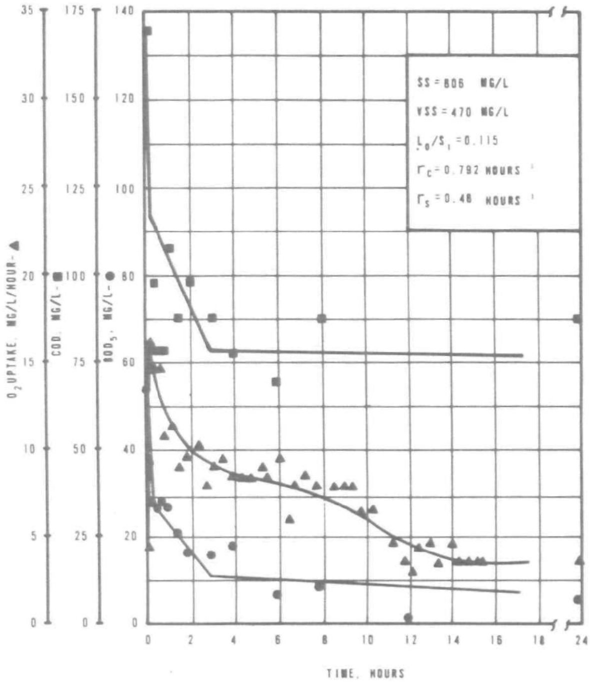

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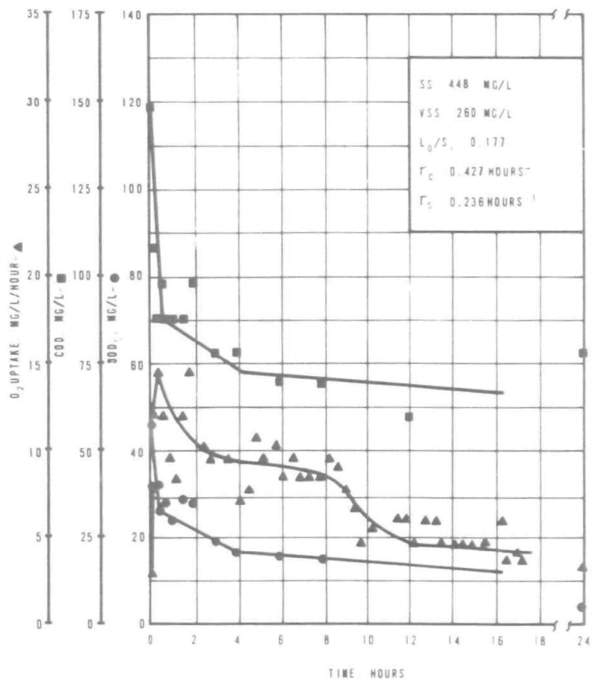

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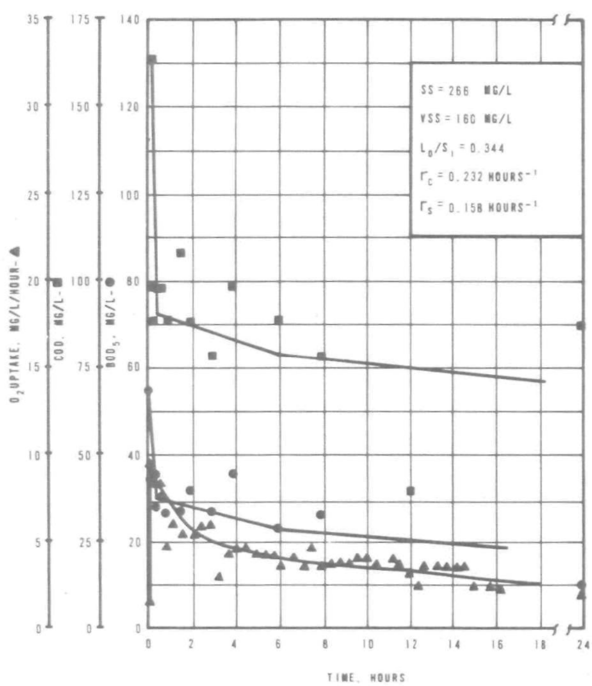

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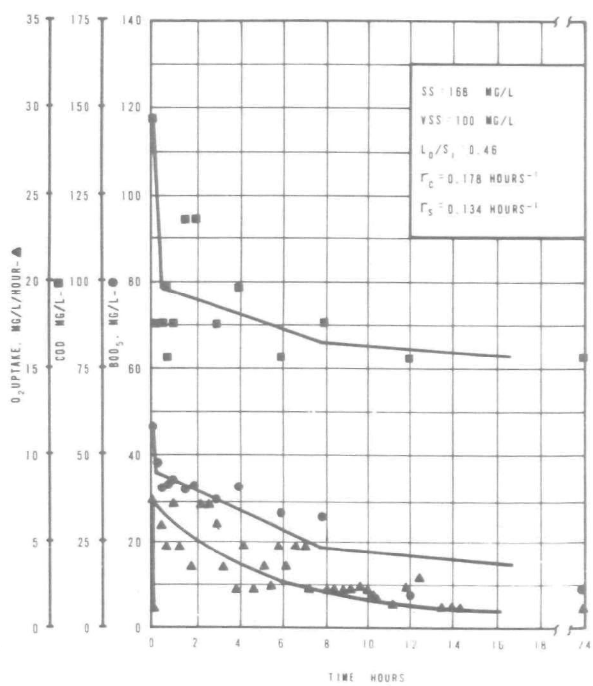

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ONONDAGA COUNTY
SYSTEM 2
BATCH ACTIVATED SLUDGE DATA

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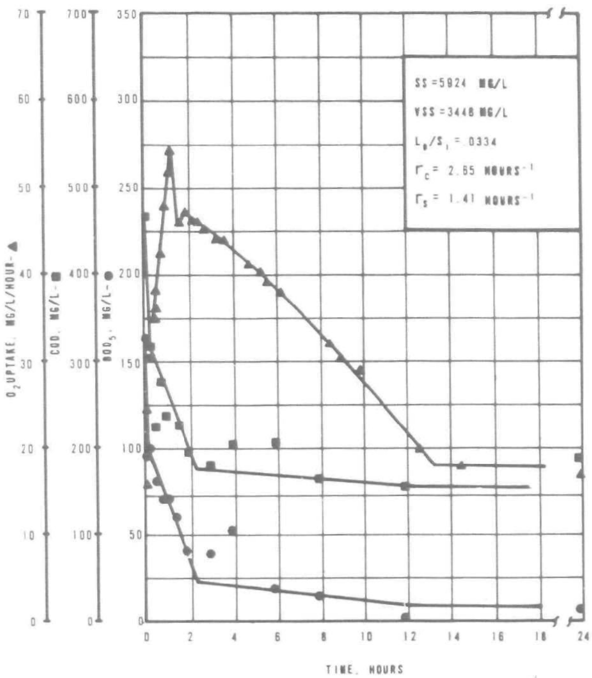

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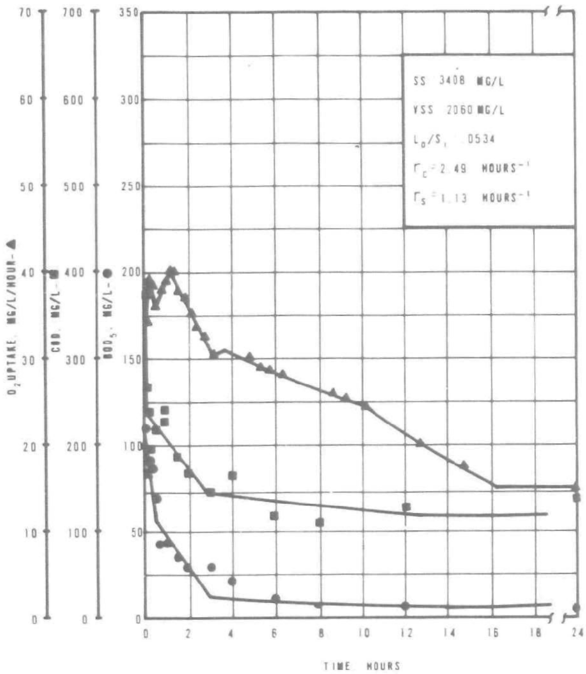

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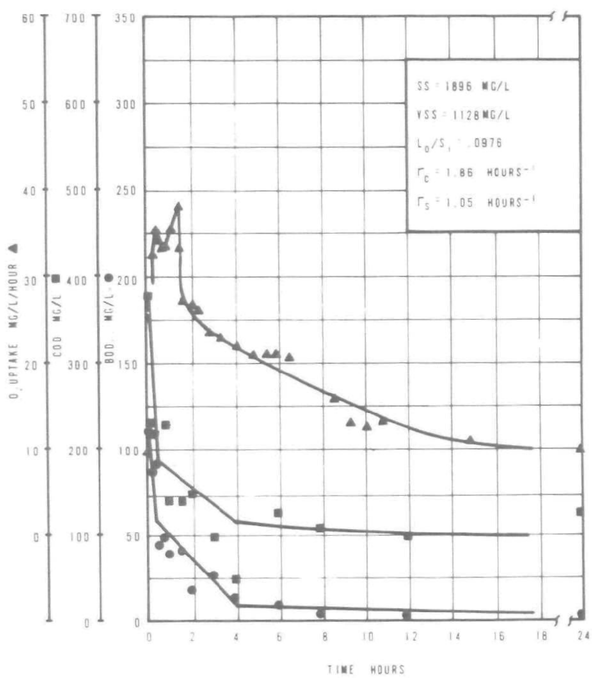

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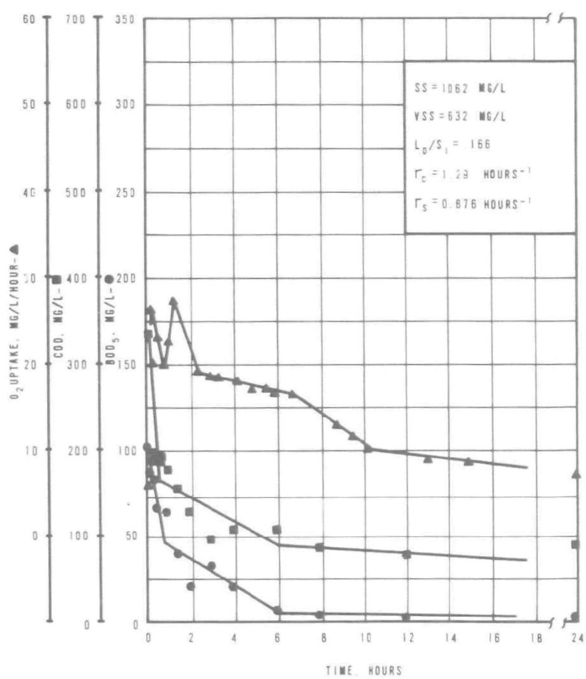

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ONONDAGA COUNTY

SYSTEM 3-B

BATCH ACTIVATED SLUDGE DATA

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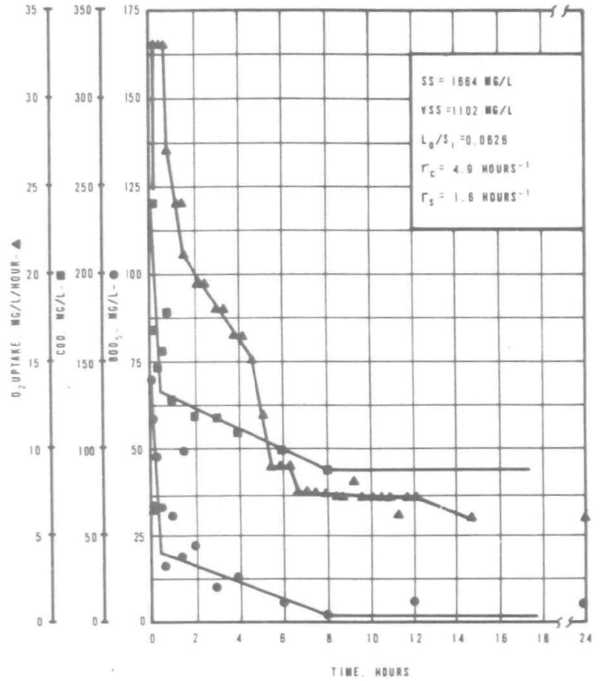

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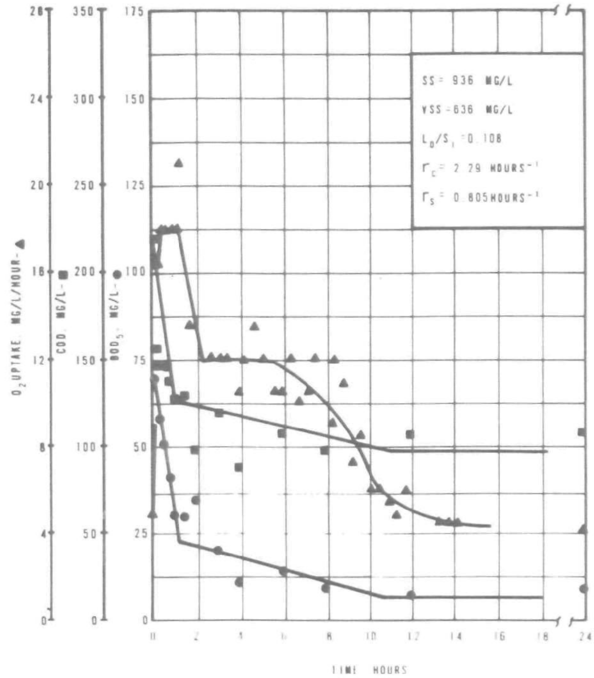

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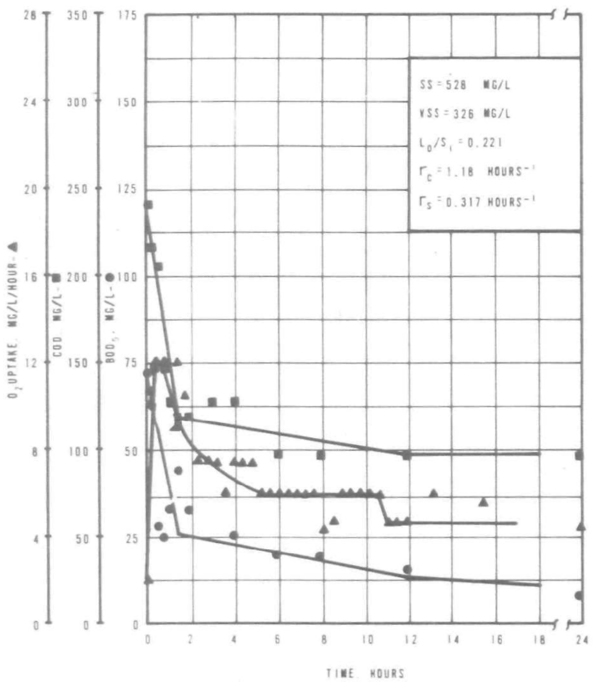

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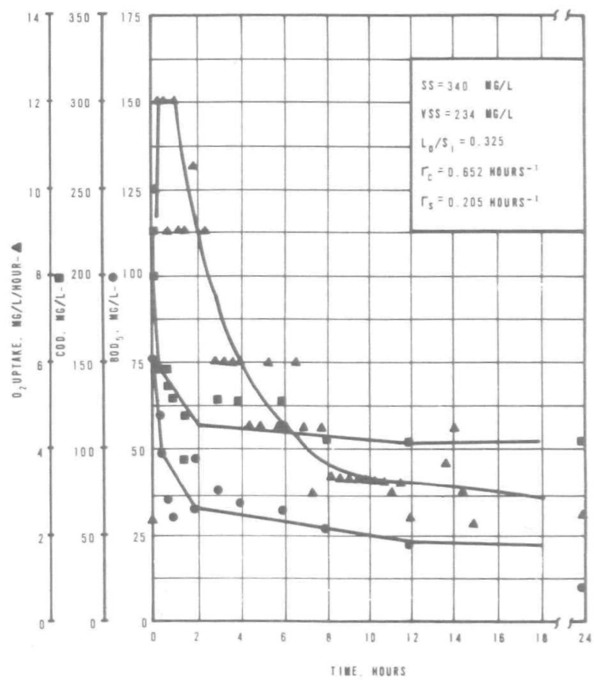

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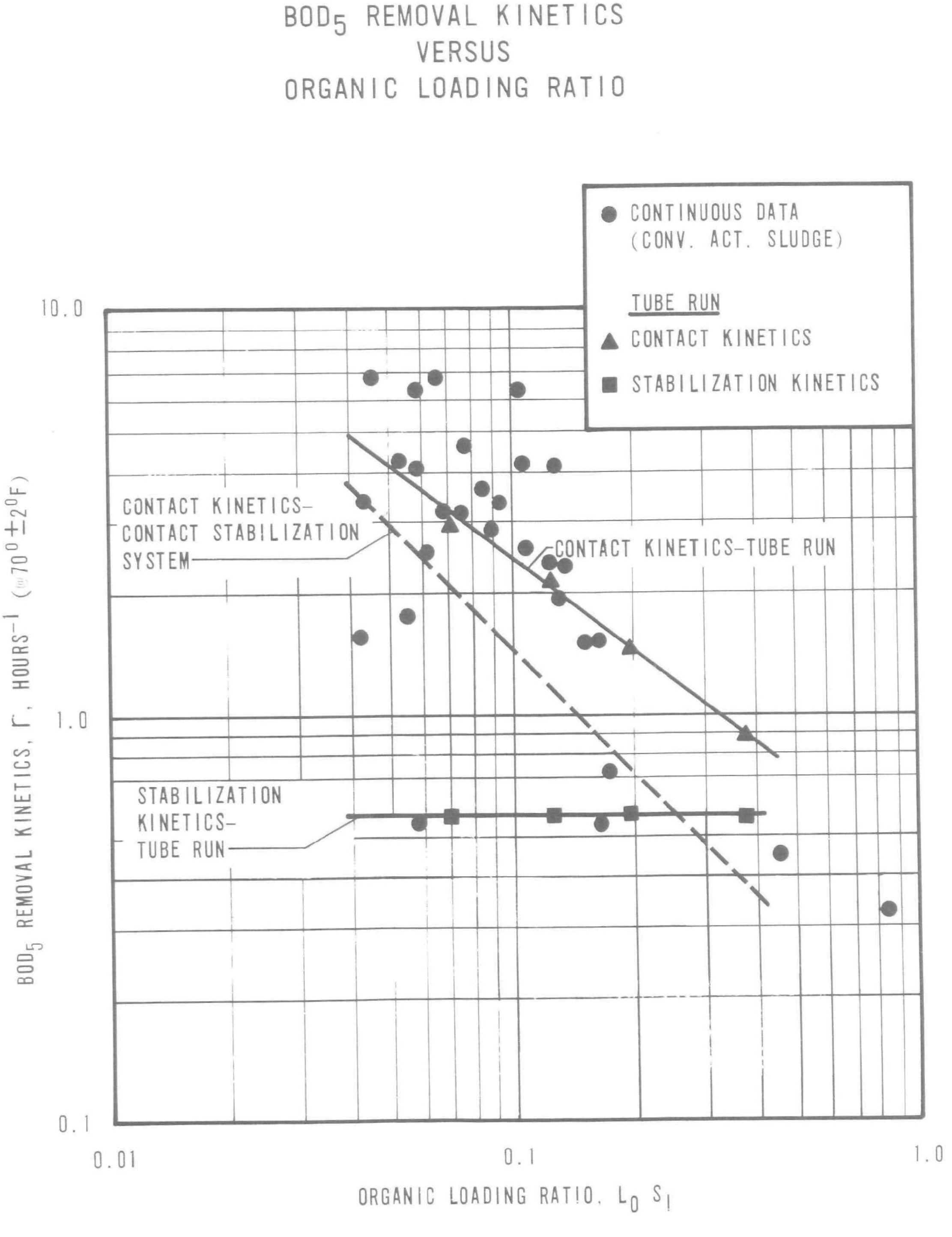
ONONDAGA COUNTY

SYSTEM 1-A



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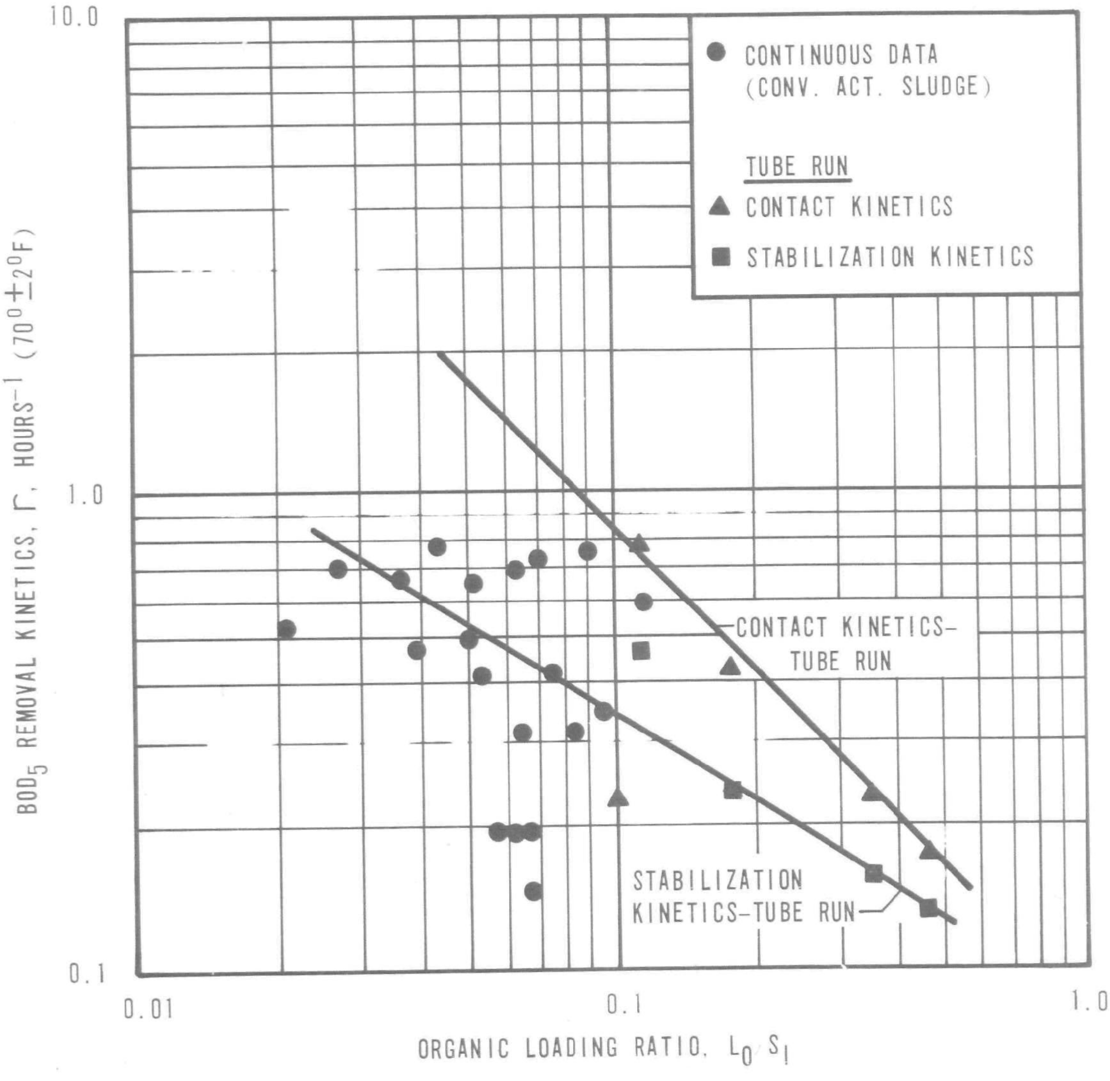
ONONDAGA COUNTY

SYSTEM 1-B

BOD5 REMOVAL KINETICS
VERSUS
ORGANIC LOADING RATIO



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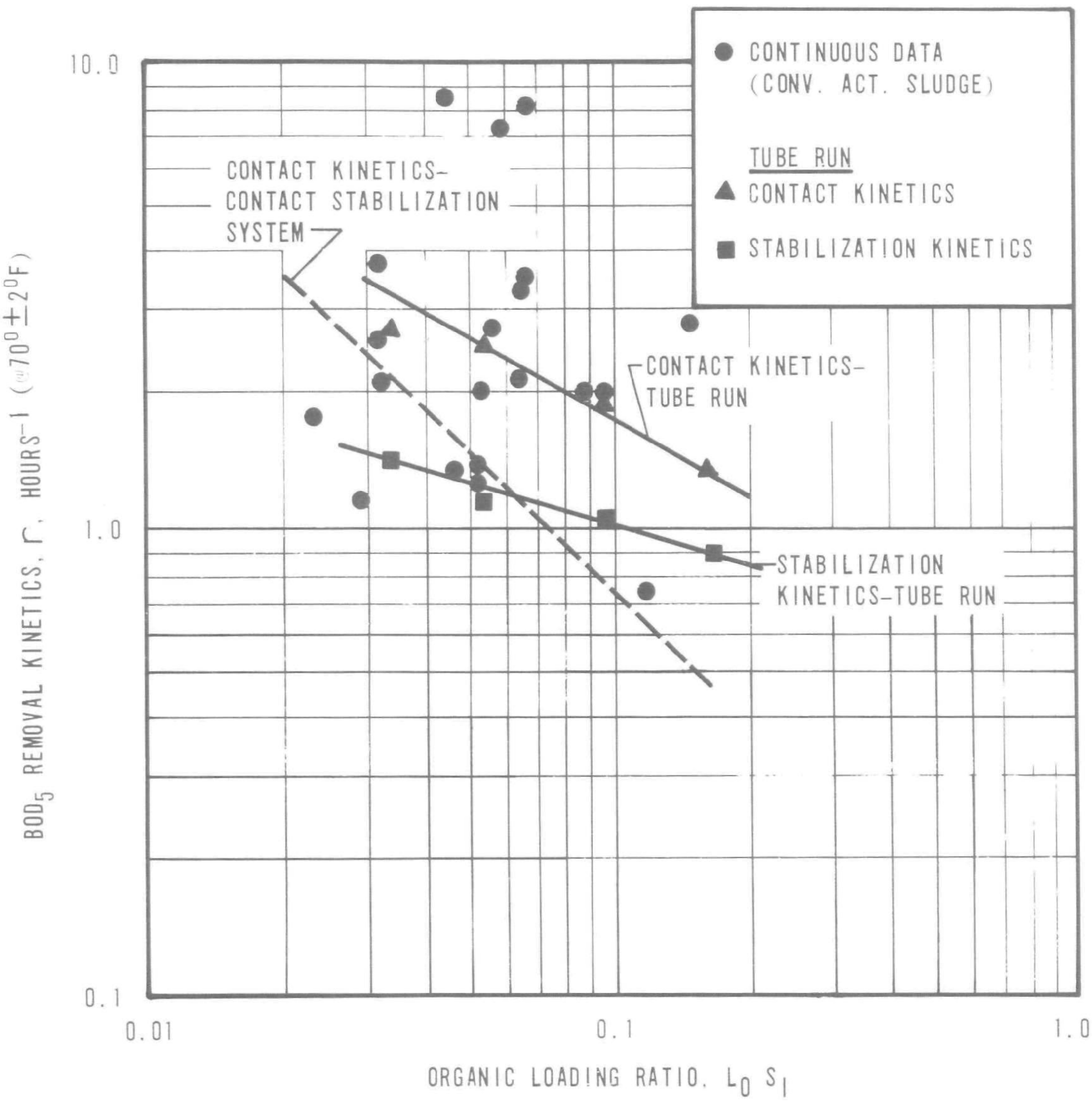
ONONDAGA COUNTY

SYSTEM 2

BOD5 REMOVAL KINETICS
VERSUS
ORGANIC LOADING RATIO



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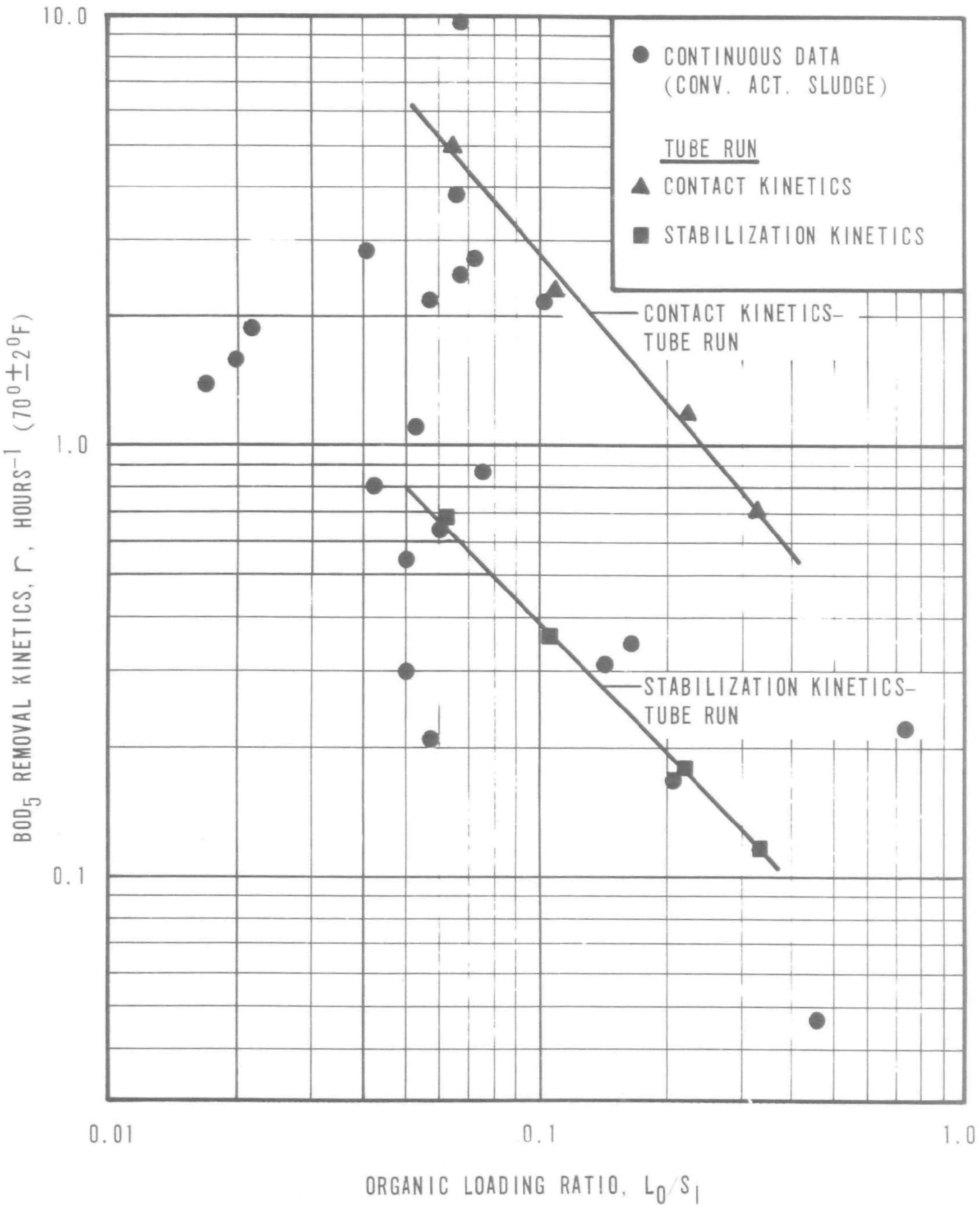
ONONDAGA COUNTY

SYSTEM 3-B

BOD_5 REMOVAL KINETICS VERSUS ORGANIC LOADING RATIO



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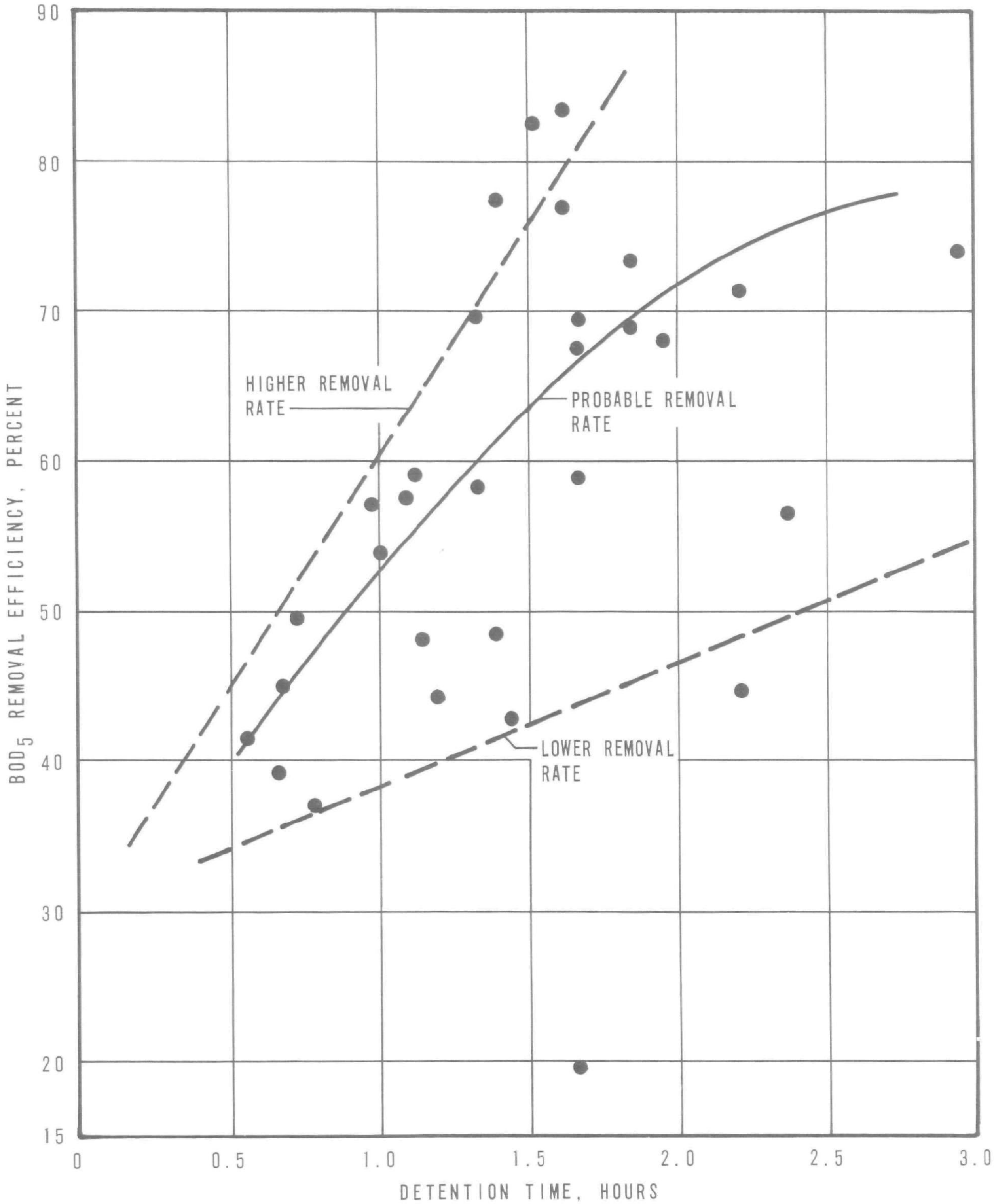
SYSTEM 3-A

BOD$_5$ REMOVAL EFFICIENCY VERSUS DETENTION TIME



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APPENDIX C

The following rules and regulations are hereby promulgated by the Commissioner of Public Works pursuant to sections 11.53g and 11.53j of Article 11A of the Onondaga County Administrative Code

Rules & Regulations Governing
the Use of Public Sewers

Section 1. No person shall discharge or cause to be discharged any storm water, surface water, ground water, roof runoff, subsurface drainage, cooling water or unpolluted industrial process waters to any sanitary sewer.

Section 2. Storm water and all other unpolluted drainage shall be discharged to such sewers as are specifically designated as combined sewers or storm sewers, or to a natural outlet approved by the Commissioner. Industrial cooling water or unpolluted process waters may be discharged, upon approval of the Commissioner, to a storm sewer, combined sewer or natural outlet.

Section 3. Except as hereinafter provided, no person shall discharge or cause to be discharged any of the following described waters or wastes to any public sewer:

a) Any liquid or vapor having a temperature higher than (150°F.).

b) Any water or waste which may contain more than (100) parts per million, by weight, of fat, oil, or grease.

c) Any gasoline, benzene, naphtha, fuel oil, or other flammable or explosive liquid, solid or gas.

d) Any garbage that has not been properly shredded.

e) Any ashes, cinders, sand, mud, straw, shavings, metal, glass, rags, feathers, tar, plastics, wood, paunch manure, or any other solid or viscous substance capable of causing obstruction to the flow in sewers or other interference with the proper operation of the sewage works.

f) Any waters or wastes having a pH lower than (5.5) or higher than (9.0), or having any other corrosive property capable of causing damage or hazard to structures, equipment, and personnel of the sewage works.

g) Any waters or wastes containing a toxic or poisonous or radioactive substance in sufficient quantity to injure or interfere with any sewage treatment process, constitute a hazard to humans or animals, or create any hazard in the receiving waters of the sewage treatment plant.

h) Any waters or wastes containing suspended solids of such character and quantity that unusual attention or expense is required to handle such materials at the sewage treatment plant.

i) Any noxious or malodorous gas or substance capable of creating a public nuisance.

Section 4. Grease, oil, and sand interceptors shall be provided when, in the opinion of the Commissioner, they are necessary for the proper handling of liquid wastes containing grease in excessive amounts, or any flammable wastes, sand, and other harmful ingredients; except that such interceptors shall not be required for private living quarters or dwelling units. All interceptors shall be of a type and capacity approved by the Commissioner, and shall be located as to be readily and easily accessible for cleaning and inspection.

Grease and oil interceptors shall be constructed of impervious materials capable of withstanding abrupt and extreme changes in temperature. They shall be of substantial construction, watertight, and equipped with easily removable covers which when bolted in place shall be gastight and watertight.

Section 5. Where installed, all grease, oil and sand interceptors shall be maintained by the owner, at his expense, in continuously efficient operation at all times.

Section 6. The admission into the public sewers of any waters or wastes having (a) a 5-day Biochemical Oxygen Demand greater than (300) parts per million by weight, or (b) containing more than (350) parts per million by weight of suspended solids, or (c) containing any quantity of substances having the characteristics described in Section 3, or (d) having an average daily flow greater than (2%) of the average daily sewage flow of the receiving treatment plant, shall be subject to the review and approval of the Commissioner. Where necessary in the opinion of the Commissioner, the owner shall provide, at his expense, such preliminary treatment as may be necessary to, (a) reduce the Biochemical Oxygen Demand to (300) parts per million and the suspended solids to (350) parts per million by weight, or (b) reduce objectionable characteristics or constituents to within the maximum limits provided for in Section 3, or (c) control the quantities and rates of discharge of such waters or wastes. Plans, specifications, and any other pertinent information relating to proposed preliminary treatment facilities shall be submitted for the approval of the Commissioner and no construction of such facilities shall be commenced until said approval is obtained in writing.

Section 7. Where preliminary treatment facilities are provided for any waters or wastes, they shall be maintained continuously in satisfactory and effective operation, by the owner at his expense.

Section 8. When required by the Commissioner, the owner of any property served by a building sewer carrying industrial wastes shall install a suitable control manhole in the building sewer to facilitate observation, sampling and measurement of the wastes. Such manhole, when required, shall be accessibly and safely located, and shall be constructed in accordance with plans approved by the Commissioner. The manhole shall be installed by the owner at his expense, and shall be maintained by him so as to be safe and accessible at all times.

Section 9. All measurements, tests, and analyses of the characteristics of waters and wastes to which reference is made in Sections 3 and 6 shall be determined in accordance with "Standard Methods for the Examination of Water and Wastewater", and shall be determined at the control manhole provided for in Section 8, or upon suitable samples taken at said control manhole. In the event that no special manhole has been required, the control manhole shall be considered to be the nearest downstream manhole in the public sewer to the point at which the building sewer is connected.

Section 10. No statement contained in this article shall be construed as preventing any special agreement or arrangement between the Commissioner and any industrial concern whereby an industrial waste of unusual strength or character may be accepted by the Commissioner for treatment, subject to payment therefor by the industrial concern.

Signed:

Edwin M. Baylard
Commissioner of Public Works

February 28, 1968

Approved:

John H. Mulroy
County Executive

February 28, 1968

APPENDIX D

Quality Standards for Class D Waters
New York State Department of Health

Items	Specifications
Floating solids, settleable solids, sludge deposits	None which are readily visible and attributable to sewage, industrial wastes or other wastes, or which deleteriously increase the amounts of these constituents in receiving waters after opportunity for reasonable dilution and mixture with the wastes discharged thereto.
pH	Range between 6.0 and 9.5
Dissolved Oxygen	Not less than 3.0 parts per million.
Toxic wastes, oil, deleterious substances, colored or other wastes, or heated liquids	None alone or in combination with other substances or wastes in sufficient amounts or at such temperatures as to prevent fish survival or impair the waters for agricultural purposes or any other best usage as determined for the specific waters which are assigned to this class.

Note: With reference to certain toxic substances as affecting fish life, the establishment of any single numerical standard for waters of New York State would be too restrictive. There are many waters, which because of poor buffering capacity and composition will require special study to determine safe concentrations of toxic substances. However, based on non-trout waters of approximately median alkalinity (80 p.p.m.) or above for the State, in which groups most of the waters near industrial areas in this State will fall, and without considering increased or decreased toxicity from possible combinations, the following may be considered as safe stream concentrations for certain substances to comply with the above standard for this type of water. Waters of lower alkalinity must be specially considered since the toxic effect of most pollutants will be greatly increased.

Ammonia or Ammonium Compounds	Not greater than 2.0 parts per million (NH_3) at pH of 8.0 or above.
Cyanide	Not greater than 0.1 parts per million (CN).
Ferro- or Ferricyanide	Not greater than 0.4 parts per million ($Fe(CN)_6$).
Copper	Not greater than 0.2 parts per million (Cu).
Zinc	Not greater than 0.3 parts per million (Zn).
Cadmium	Not greater than 0.3 parts per million (Cd)

BIBLIOGRAPHIC:

ROY F. WESTON, Feasibility of Joint Treatment in a Lake Watershed, Final Report FWPCA Grant No. WPRD 66-01-68, September, 1970.

ABSTRACT:

Onondaga County, New York undertook a feasibility study of joint treatment of municipal and industrial wastewaters. Industries were contacted to assess their wastewater situation, and major wastewater contributors were sampled. Influent wastewaters to the two major sewage treatment plants were also sampled. With practically all industry connected to the municipal systems and within the constraint of a pump station and force main to transfer wastewater from the Ley Creek to the Metropolitan Sewage Plant, the number of feasible treatment alternatives was reduced. Bench-scale activated sludge studies were conducted on the feasible alternatives.

ACCESSION NO.

KEY WORDS:

Activated Sludge
Contact Stabilization
Cost Analysis
Industrial Wastes
Joint Systems
Lake Watershed
Municipal Wastes
Process Design
Sampling Survey
Waste Treatment

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Process Design
Sampling Survey
Waste Treatment

The initial plant interviews showed that practically all industries in the watershed were connected to the municipal sewer system, with one of them contributing approximately 60 percent of the organic load on the Ley Creek Plant. While metals concentrations, from various metal-plating shops, were high at different times, the concentrations measured in the Ley Creek Plant influent were generally acceptable for biological treatment. Total organic loads at the Ley Creek and Metropolitan Sewage Plants were about equal; flow at the latter plant was approximately three times as great. Raw, pretreated, or secondary-treated wastewater from the Ley Creek Plant was shown to be amenable to combination with raw Metropolitan Sewage Plant influent for secondary treatment. A full-scale joint treatment plant should obtain BOD removals of more than 85 percent during winter operation.

This report was submitted in fulfillment of Grant No. WPRD 66-01-68 between the Federal Water Pollution Control Administration and Onondaga County Department of Public Works.

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