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Robert S Kerr Environmental Research
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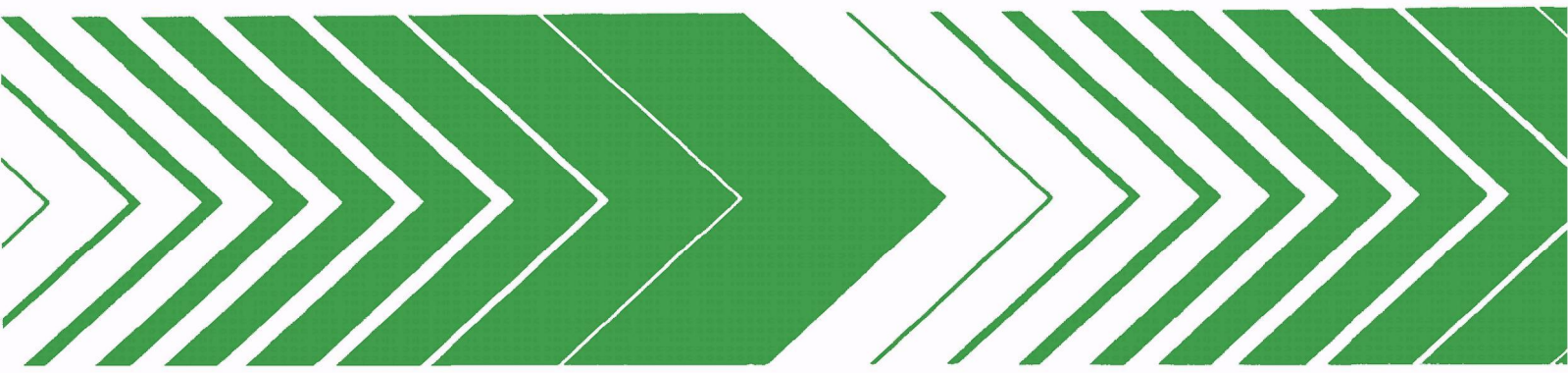
Research and Development

EPA

Indicatory Fate Study



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INDICATORY FATE STUDY

by

Leon H. Myers
Thomas E. Short, Jr.
Bill L. DePrater
Fred M. Pfeffer
Donald H. Kampbell
John E. Matthews
Source Management Branch
Robert S. Kerr Environmental Research Laboratory
Ada, Oklahoma 74820

ROBERT S. KERR ENVIRONMENTAL RESEARCH LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
ADA, OKLAHOMA 74820

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FOREWORD

The Environmental Protection Agency was established to coordinate administration of the major Federal programs designed to protect the quality of our environment.

An important part of the Agency's effort involves the search for information about environmental problems, management techniques and new technologies through which optimum use of the nation's land and water resources can be assured and the threat pollution poses to the welfare of the American people can be minimized.

EPA's Office of Research and Development conducts this search through a nationwide network of research facilities.

As one of these facilities, the Robert S. Kerr Environmental Research Laboratory is responsible for the management of programs to: (a) investigate the nature, transport, fate and management of pollutants in ground water; (b) develop and demonstrate methods for treating wastewaters with soil and other natural systems; (c) develop and demonstrate pollution control technologies for irrigation return flows; (d) develop and demonstrate pollution control technologies for animal production wastes; (e) develop and demonstrate technologies to prevent, control, or abate pollution from the petroleum refining and petrochemical industries; and (f) develop and demonstrate technologies to manage pollution resulting from combinations of industrial wastewaters or industrial/municipal wastewaters.

This report contributes to the knowledge essential if the EPA is to meet the requirements of environmental laws that it establish and enforce pollution control standards which are reasonable, cost effective and provide adequate protection for the American public.

William C. Galegar

W. C. Galegar
Director
Robert S. Kerr Environmental Research Laboratory

ABSTRACT

This report is concerned with media disposition of specific priority pollutants. Composite samples were obtained from the influent, effluent, residuals, and air from 12 industrial biological treatment systems. These samples were extracted and analyzed by gas chromatography for organic constituents, by atomic absorption for metals, and by EPA methodology for phenolics, cyanide, and mercury.

Participating industries include: (1) organics and plastics, (2) pharmaceuticals, (3) pesticides, (4) rubber, (5) wood preservative, and (6) petroleum refining. Each of the 12 cooperating companies reviewed and commented on the draft report for description of its biological treatment system, accuracy of the study conditions as well as comments on the completed analytical data. The data in this report represent potential disposition of specific priority pollutants during 3-day study periods and should not be construed to represent a mass balance study.

This work covers a period from May, 1978, to February, 1979, and work was completed as of March, 1979.

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ABBREVIATIONS AND SYMBOLS

ABBREVIATIONS

cfh	-- cubic feet per hour*
EGD	-- Effluent Guidelines Division
EPA	-- Environmental Protection Agency
gpm	-- gallons per minute*
IC	-- inorganic carbon
mg	-- million gallons*
mgd	-- million gallons per day*
mg/l	-- milligrams per liter
ml	-- milliliter
mm	-- million
pac	-- powdered activated carbon
RSKERL	-- Robert S. Kerr Environmental Research Laboratory
TOC	-- total organic carbon
VOA	-- volatile organics analysis

SYMBOLS

µ	-- micron
µg/l	-- micrograms per liter
µg/kg	-- micrograms per kilogram

*See Table 37, Metric Conversion Table, on page 90.

ACKNOWLEDGMENTS

To successfully complete any applied research study, the research team needs the full cooperation of all interested parties. Our sincere appreciation is extended to EPA's Office of Research and Development (OEMI and OALWU) and Office of Water and Hazardous Materials (EGD) for participation in planning and administrative tasks associated with the study. A special acknowledgement is due the industrial plants--their executives, supervisors, and operators--for the excellent cooperation extended to the RSKERL teams during this study.

SECTION 1

INTRODUCTION

In June 1978, the Robert S. Kerr Environmental Research Laboratory (RSKERL) began an applied research study at the request of EPA's Effluent Guidelines Division (EGD). The purpose of the study was to determine what happens to specific priority pollutants as they pass through a biological treatment system. A mass balance study on a biological treatment system would consume considerable time, manpower, and resources. It was therefore decided that an indication of the fate of specific priority pollutants would be conducted in lieu of a mass balance study. This "Indicatory Fate Study," planned and conducted by RSKERL, represents a screening study to view the removal of specific priority pollutants via air, water, or residuals routes.

Specific organic pollutants were analyzed by gas chromatography using methodology supplied by EGD. Quality control for the specific organic priority pollutants was provided by gas chromatograph/mass spectrometer analysis on one sample obtained from each plant site visited. Total metals, phenol, and cyanide analyses were conducted in accordance with EPA's April, 1977, Protocol.

Twelve industrial participants representing six industrial categories were selected by Effluent Guidelines: (1) organic chemicals, (2) petroleum refining, (3) pharmaceuticals, (4) wood preserving, (5) pesticides, and (6) rubber. Based on analytical data generated during previous screening studies, EGD requested sampling for specific priority pollutants from each participant.

Responsible company officials for each plant selected were notified by a letter from the Director, RSKERL, explaining the purpose of the proposed study and requesting their participation. Each of the plants visited cooperated fully in completing the field sampling portion of the study.

The data in this report provide only an indication of the route of removal of specific priority pollutants and are not intended to represent a mass balance across a biological treatment system.

SECTION 2

SAMPLING PROGRAM

The sampling program was designed to examine three possible removal routes for each type of treatment system: (1) air, (2) water, and (3) residuals.

SAMPLE LOCATIONS

Two basic types of biological treatment systems were studied: (1) activated sludge and (2) aerated lagoons.

Sampling points established to examine removal routes from activated sludge treatment systems were: (Figure 1)

	Sample Location	Sample Type	Media
1.	Primary Effluent	72-hr Composite, VOA Grab	Water
2.	Final Effluent	72-hr Composite VOA Grab	"
3.	Aeration Basin	Stripper Sampler Composite	Air
4.	Return Sludge	72-hr Composite	Residuals

Sampling points established for aerated lagoon treatment systems were: (Figure 2)

	Sample Location	Sample Type	Media
1.	Inlet to First Lagoon	72-hr Composite VOA Grab	Water
2.	Outlet from Last Lagoon	72-hr Composite VOA Grab	"
3.	Near first Lagoon Inlet	Stripper Sampler Composite	Air
4.	Bottom Deposits	72-hr Composite	Residuals

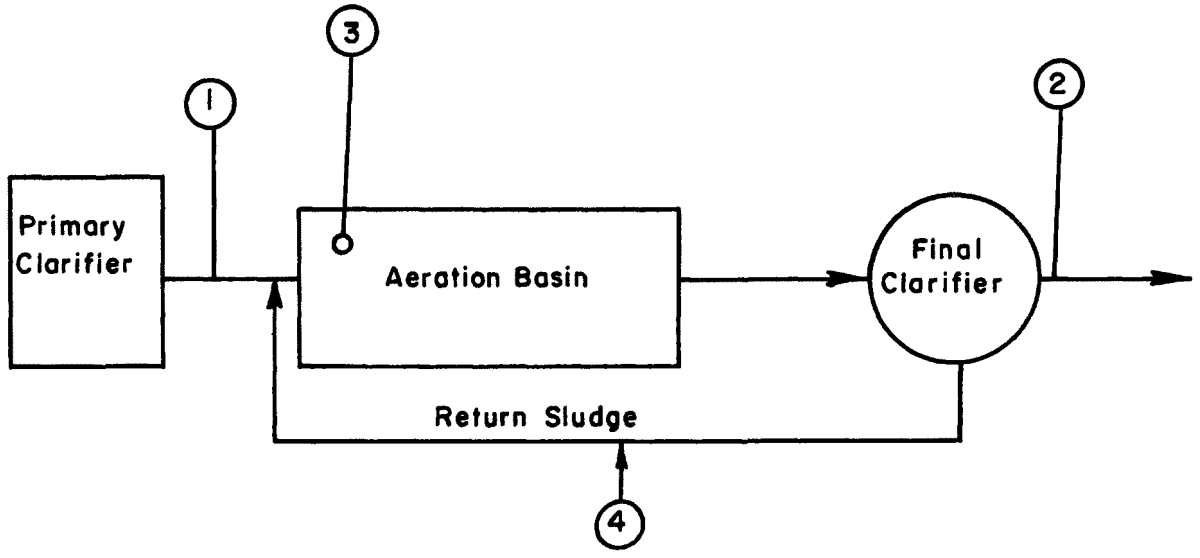

Figure 1. Activated Sludge Sampling Points

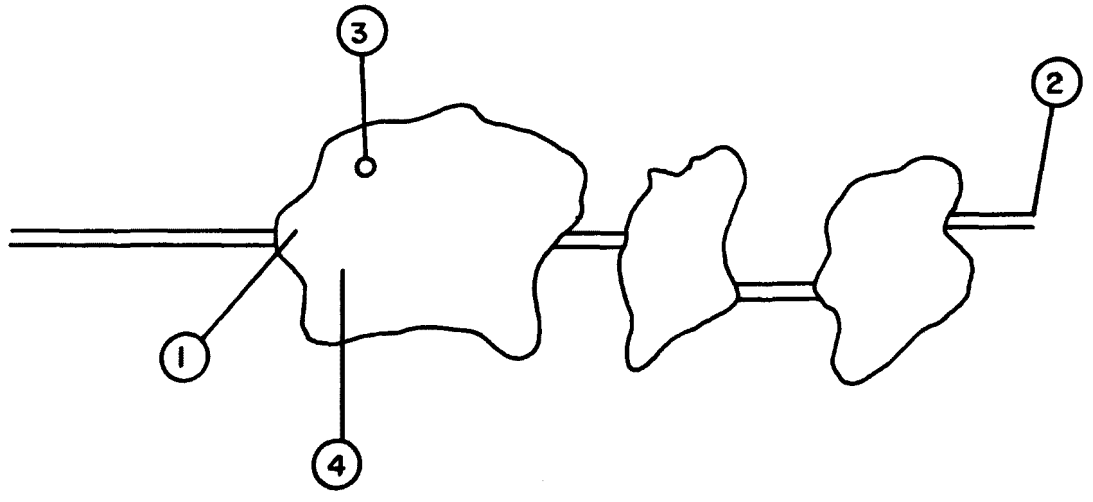

Figure 2. Aerated Lagoon Sampling Points

SAMPLE COLLECTION

Air (Figure 3)

At the beginning of the sampling program, an air sampler was installed in the aeration basin (mixed liquor) of the activated sludge treatment system or in the first lagoon of the aerated lagoon treatment system. The air sampler was designed at RSKERL for this study and is a combination stripper/adsorber. A 20-gallon/minute submersible pump continuously supplied a fresh sample of water to the stripper, while a carbon-filtered air supply was used to sparge volatile organic compounds from the water sample. The sparged air was fed to a slurry pot containing XAD-2(R) resin for adsorption of the air strippable polynuclear aromatic and phenolic compounds. The sparged air was also fed intermittently to a gas chromatograph column packed with Tenax(R) for adsorption of purgeable organic compounds.

Water

Water samples were collected at the inlet and effluent points of the biological treatment system. A 3-day composite sample was prepared at each sample point by collecting 24 aliquots at specified times during the 72-hour sampling period.

In addition, VOA grab samples were collected at the influent and effluent sampling points. These samples were collected in previously prepared 30-ml sample vials. Blank VOA vials containing Super Q water were uncapped prior to, and resealed following, collection of VOA samples at each location. The VOA samples were used to supplement samples collected using the air-stripper sampler.

Residuals

At plants employing an activated sludge system, the return sludge was sampled in the same mode as the water samples. At those plants where an aerated lagoon was being studied, a single dredge sample was obtained near the inlet to the first lagoon.

SAMPLE HANDLING

Samples were preserved in accordance with the April, 1977, Protocol. Water and residual samples were kept iced for the duration of the sampling program. In addition, metal samples were

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(R) Registered trademark - Rohm & Haas (XAD-2)

(R) Registered trademark - ENKA N.V., Holland (Tenax)

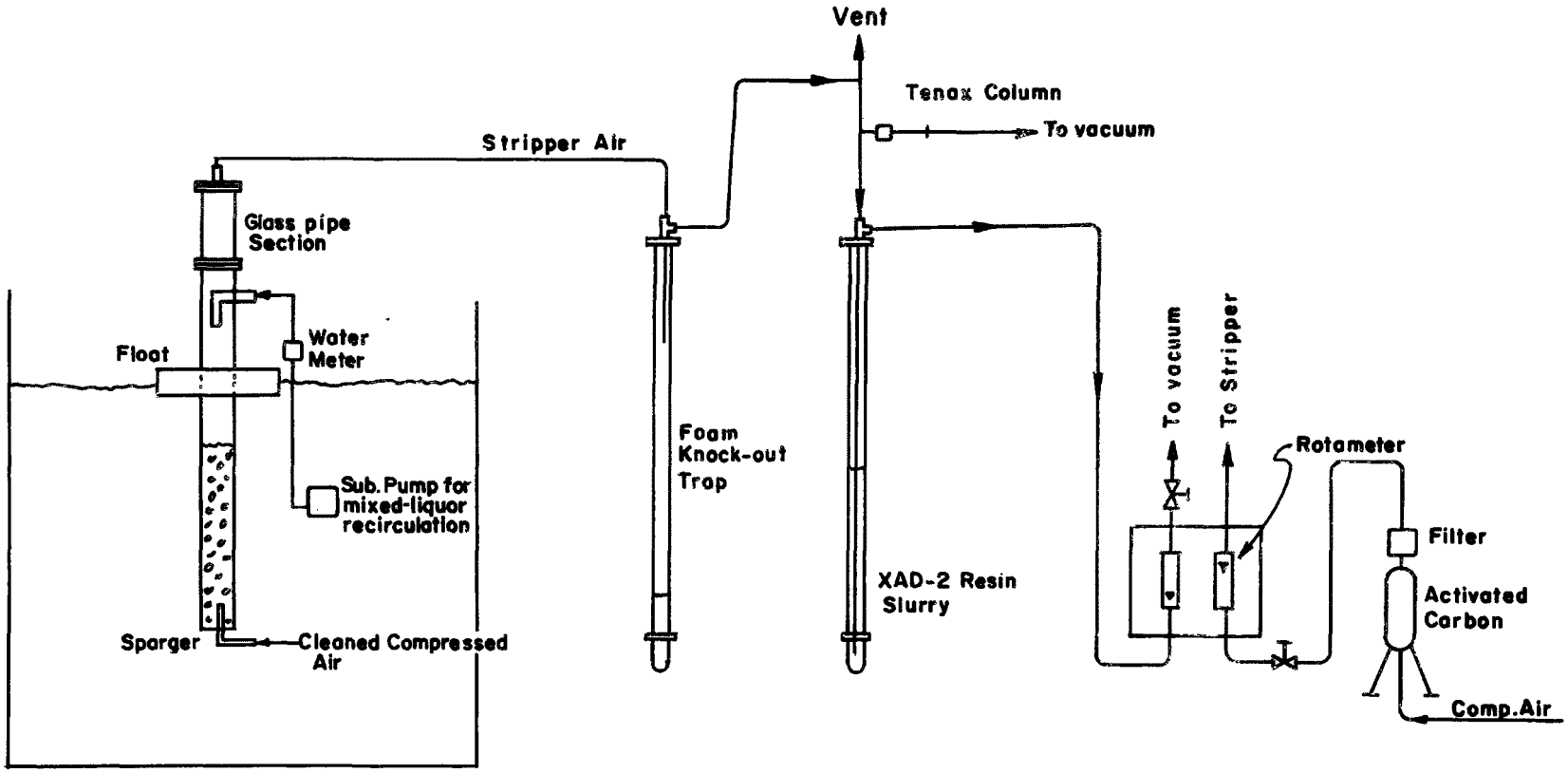

Figure 3 - AIR-STRIPPER SAMPLER

preserved with redistilled nitric acid; phenol samples were preserved with phosphoric acid; and cyanide samples were preserved with sodium hydroxide. No additional preservative was used for the organics samples.

After the sampling study was complete, sample chests, filled with ice, were transported to RSKERL, where they were transferred to a 4°C walk-in constant-temperature box. The samples remained in this environment until they were ready to be extracted and/or analyzed.

SECTION 3

PLANT STUDIES

ORGANICS AND PLASTICS INDUSTRY

Plant 1

Wastewater Treatment System--

A flow diagram of Plant 1's wastewater treatment system is shown in Figure 4. Wastewater generated by the manufacturing of organic chemicals and plastics is treated by a series of processes that generally consist of (1) neutralization, (2) denitrification, (3) aeration, and (4) nitrification. Sludge produced by the wastewater treatment process is digested aerobically, filtered in a dual-cell gravity unit, and landfilled. An approximate material balance for the treatment system is shown in Table 1.

Raw wastewater from the manufacturing process is first neutralized in a limestone reactor. Here the pH of the raw wastewater is increased from about 1.5 to about 4.8. From the neutralization pit, the wastewater flows to a 1-million-gallon denitrification pond. Here the wastewater is mixed with a portion of the return sludge. A single 75-horsepower (hp) aerator is used to mix the contents of the denitrification pond. Some aeration does occur; however, the amount of oxygen transferred is low enough that the pond remains essentially anaerobic.

From the denitrification section, the wastewater flows to a 1.1-million-gallon aeration basin, where another portion of the return sludge is added to the wastes, and is aerated using three mechanical aerators. One aerator is a variable speed, 150-hp aerator and is fixed mounted. The other two aerators are floating, high-speed, 50-hp aerators. From the aeration section, the wastewater flows to a 1.1-million-gallon nitrification pond, where the final portion of return sludge is added to the wastewater, and is aerated with three mechanical aerators. One aerator is a fixed speed, 150-hp aerator and is fixed mounted. The other two aerators are floating, high-speed, 50-hp aerators.

The wastewater is then clarified, and the effluent is discharged into a local river. The total retention time of the treatment system is 1.48 days at 1,500 gallons per minute (gpm), and it has a total volume of 3.2 million gallons.

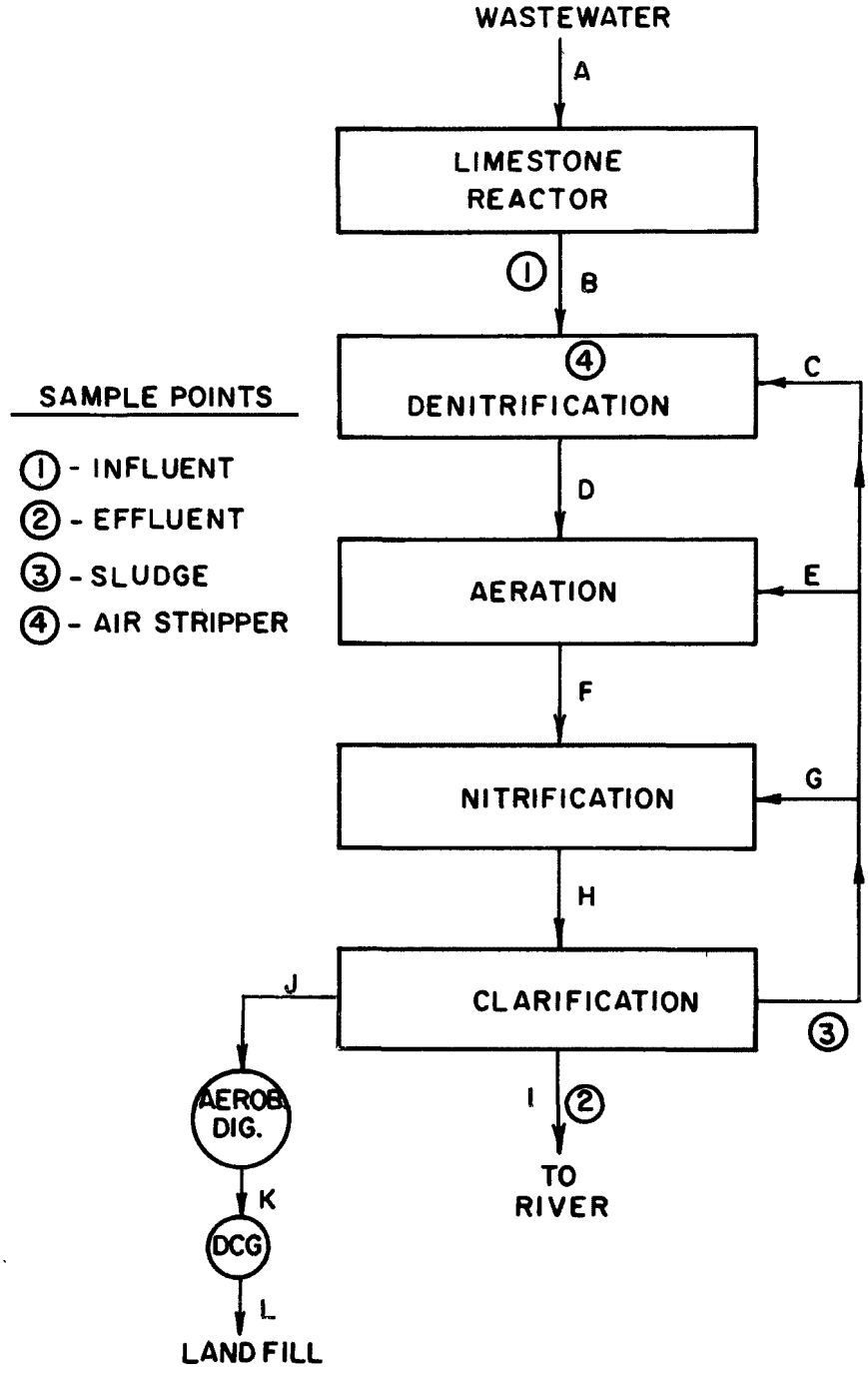

Figure 4 - WASTEWATER TREATMENT SYSTEM - PLANT I

TABLE 1. BIOLOGICAL TREATMENT PLANT MATERIAL BALANCE--PLANT 1

	Stream #	Flow #/hr.	TOC #/hr.	IC #/hr.	NH_3-N #/hr.	NO_3-N #/hr.	TSS #/hr.	pH	O_2 #/hr.
Total Influent	A	952,000	490	9	84	350	180	1.5	-
Limestone Reactor	B	952,700	490	85	84	350	180	4.8	-
Clarifier Recycle	C	605,000	24	163	9	36	9,070	8.0	-
Denitrification	D	1,545,700	190	480	93	42	9,250	8.2	-
Clairfier Recycle	E	305,000	12	82	5	18	4,570	8.0	-
Aeration	F	1,850,700	74	594	65	77	7,570	8.1	230
Clarifier Recycle	G	460,000	18	124	7	28	6,900	8.0	-
Nitrification	H	2,310,700	92	62	35	139	20,914	8.0	150
Effluent	I	937,700	37	250	14	56	60	8.0	-
Wasted Sludge	J	15,000	-	-	-		211	8.0	-
Aerobic Digestor	K	15,000	-	-	-	-	211	7.5	-
Land-Fill	L	3,000	-	-	-		210	7.5	-

Sample Collection--

Based on previous screening conducted at Plant 1 under the direction of EPA's Effluent Guidelines Division, a list of priority pollutants was compiled for investigation in this study (Table 4). This list represents the priority pollutants which have been identified in Plant 1's influent to the treatment system. From this list, it was determined that six 1-gallon samples of composite were required for specific organic compound analysis.

The sampling point locations are shown in Figure 4. The influent sample was taken immediately following the limestone reaction pit. The effluent sample was taken out of the clarifier overflow channel. The return sludge sample was taken off the discharge side of the recycle pump. The air-stripper sampler was placed just off the walkway in the denitrification pond.

Samples of the influent, effluent, and return sludge were composited. Every 3 hours, beginning at 9 pm on July 10, 1978, six 130-milliliter (ml) aliquots were taken at each sample point for specific organic analysis. In addition, three 40-ml aliquots were taken for cyanide, phenolics, and metals. Each metals, cyanide, and phenolics sample was "preserved" at 10:30 am on July 11, by adding 5 ml of nitric acid to the metals samples, 1 ml of sodium hydroxide to the cyanide, and 2 ml of phosphoric acid to the phenolics samples. At all times each of the samples taken was kept on ice. At 5 pm on July 13, 1978, VOA grab samples were taken from the influent and effluent. A detailed sampling schedule is presented in Table 2.

The air-stripper sampler was placed into operation at 9:30 pm on July 10, 1978, and operations were concluded at 6 pm on July 13, 1978, for a total operating time of 68 1/2 hours. Air charged to the stripper averaged 60 cubic feet per hour (cfh), and the quantity of air to the XAD-2 scrubber was 30 cfh. Stripped air was collected on the Tenax columns for 10 minutes each day. At this plant two Tenax columns were used. On the first day one column was used; for the second and third days another column was used.

Table 3 contains flow data for this plant's treatment system on the days sampled.

Analytical Results--

Priority pollutants for which samples were collected and analyzed are presented in Table 4. All extractions and analyses of samples were conducted at RSKERL.

TABLE 2. SAMPLING SCHEDULE (PLANT 1)

Date	Time	Samples taken	Remarks
7/10/78	9:00 pm	Composites*	
"	12:00 Midnight	"	
7/11/78	3:00 am	"	
"	6:00 am	"	
"	9:00 am	"	Added 5 ml HNO_3, 2 ml NaOH, 2 ml H_3PO_4 to metals, cyanide, and phenolics composites
"	10:30 am	"	
"	12:00 Noon	Composites	
"	3:00 pm	"	Tenax col. 5, 10 min.
"	6:00 pm	"	
"	9:00 pm	"	
"	12:00 Midnight	"	
7/12/78	3:00 am	"	
"	6:00 am	"	
"	9:00 am	"	
"	12:00 Noon	"	
"	3:00 pm	"	Tenax col. 6, 10 min.
"	6:00 pm	"	
"	9:00 pm	"	
"	12:00 Midnight	"	
7/13/78	3:00 am	"	
"	6:00 am	"	
"	9:00 am	"	
"	12:00 Noon	"	
"	3:00 pm	"	
"	5:00 pm	VOA	Tenax col. 6, 10 min.
"	6:00 pm	Composites	

*Composites consist of six 130-ml aliquots for organics, three 40-ml aliquots for metals, cyanide, and phenols.

TABLE 3. DAILY FLOW DATA (PLANT 1)

Date	Time	Flow (gpm)
7/10/78	Daily average	1,623
7/11/78	"	1,404
7/12/78	"	1,698
7/13/78	8 am	1,590
7/13/78	12 Noon	2,340
7/13/78	4 pm	2,280

TABLE 4. ANALYTICAL DATA (PLANT 1)

Priority Pollutant	Sparged Air, XAD-2 (µg)	Sparged Air, Tenax (µg)	
POLYNUCLEAR AROMATICS			
Naphthalene	5,910		
2-Chloronaphthane	4,410		
Acenaphthalene	4,890		
Acenaphthene	7,590		
Fluorene	<7		
Phenanthrene/Anthracene	<6		
Fluoranthene	10		
Pyrene	57		
1,2-Benzanthracene	<3		
Chrysene	<3		
3,4-Benzopyrene	<18		
1,2:5,6-Dibenzanthracene	<38		
PHENOLICS			
2-Chlorophenol	1,060		
2-Nitrophenol	360		
Phenol	2,400		
2,4-Dimethylphenol	304		
2,4-Dichlorophenol	13,300		
2,4,6-Trichlorophenol	530		
4-Chloro-m-cresol	1,880		
2,4-Dinitrophenol	366		
4,6-Dinitro-o-cresol	507		
Pentachlorophenol	225		
4-Nitrophenol			
PURGEABLES		T_1	T_2
Methylene chloride		.7	.7
1,1-Dichloroethane		<.01	14
1,2-Trans-dichloroethylene		8	<.25
Chloroform		<.1	<.1
1,2-Dichloroethane		.7	<.1
1,1,1-Trichloroethane		<.05	48
Carbon tetrachloride		380	<.1
Dichlorobromomethane		.6	<.05
1,2-Dichloropropane		.4	<.08
Benzene		<.025	<.025
Trichloroethylene		<.01	<.01
Chlorodibromomethane		<.01	<.01
1,1,2-Trichloroethane		<.05	<.05
Methyl bromide		<.25	<.25
Bromoform		17	2
1,1,2,2-Tetrachloroethane		1.1	<.025
Tetrachloroethylene		.06	.4
Toluene		.08	<.01
Chlorobenzene		<.01	.07
Ethylbenzene		<.01	.03

TABLE 4. (Continued)

Priority Pollutant	Influent (µg/l)	Return Sludge (µg/l)	Effluent (µg/l)
CLASSICAL			
TOTAL CYANIDES (mg/l)*	.62	.16	<.08
TOTAL PHENOL	21	<50	<20
TOTAL METALS			
Arsenic	12	200	<10
Selenium	<10	<10	<10
Cadmium	3	48	1
Beryllium	<3	11	<3
Copper	160	4,000	17
Antimony	<10	<10	<10
Chromium	650	18,000	50
Nickel	81	3,900	65
Zinc	770	15,000	89
Silver	<10	13	<10
Thallium	<10	<10	<10
Lead	10	530	<10
Mercury	<1.0	<5.0	<.05
ORGANICS (GAS CHROMATOGRAPHY)			
PURGEABLES			
1,4-Dichlorobenzene	<10	N.A.	<10
Benzene	405	N.A.	<40
1,3-Dichlorobenzene	<10	N.A.	<10
Chloroform	<10	N.A.	<10
1,2-Dichloropropane	<10	N.A.	<10
Methylene chloride	<10	N.A.	<10
Ethylbenzene	<10	N.A.	<10
Trans-dichloroethylene	<10	N.A.	<10
DINITROTOLUENE			
Nitrobenzene	N.P.	N.P.	N.P.
HALOETHER			
2-Chloroethyl vinyl ether	<49	<43	<47
POLYNUCLEAR AROMATICS			
Phenanthrene/Anthracene	<50	<50	<50
Fluorene	<64	<64	<64
Naphthalene	<22	<22	<22

(Continued)

TABLE 4. (Continued)

Priority Pollutant	Influent (µg/l)	Return Sludge (µg/l)	Effluent (µg/l)
PHENOLICS			
Phenol	25	20	2
4-Nitrophenol	40	N.D.	5
2-Nitrophenol	1,780	N.D.	566
2,4,6-Trichlorophenol	N.D.	44	N.D.
Pentachlorophenol	53	115	41.2
PHTHALATE ESTERS			
Bis(2-ethylhexyl) phthalate	<49	<43	<47

*Note: Total Cyanides expressed in mg/l.

**Key: N.D. - Not Detectable, or less than detectable limits
N.A. - Not Applicable
N.S. - No Standard Available
N.P. - No Procedure Available

Plant 2

Wastewater Treatment System--

A flow diagram of Plant 2's biological wastewater treatment system is shown in Figure 5. The biological system has been in operation since August, 1971, and has incorporated powdered carbon in the mixed liquor since May, 1977. Stormwater meeting permit limits is combined with final effluent, both of which ultimately enter an estuary.

Specifically, Plant 2 process wastewater receives primary clarification in a separator, is neutralized, and is then fed to an equalization basin having a volume of 2.1 million gallons (mg) and a retention time of approximately 2 days. Wastewater in the equalization basin is lifted to two identical activated sludge bays employing surface-type extended aeration and incorporating PAC added on a batch basis to maintain an estimated 1,800 pounds of PAC in both basins. The operational result is 3,500 milligrams per liter (mg/l) of mixed-liquor volatile suspended solids (MLVSS), of which approximately 5-6 percent is PAC.

The total volume of the aeration basins is 1.1 million gallons, and the retention time is 31 hours. Mixed liquor flows by gravity to one final clarifier having a diameter of 50 feet and a retention time of 3.4 hours.

Sample Collection--

The study period at Plant 2 was from July 31-August 3, 1978. Based on screening conducted under the direction of EPA's Effluent Guidelines Division, a list of priority pollutants and two common wastewater parameters (total cyanide and total phenols) was compiled for investigation in this study (Table 7). Three-liter samples were composited in 1-gallon glass bottles for analyses of specific organic compounds (no preservative added). Samples of approximately 1-liter volume were composited for the total metals (acid preservation), total cyanide (alkaline preservation), and total phenols (acid preservation).

Referring to Figure 5, the bioinfluent (point 1) was collected from a tap on the discharge side of the lift pump transferring equalization pond wastewater to the aeration basins. Return sludge (point 2) was sampled from a tap on the discharge side of the return sludge pump. Final effluent (point 3) was sampled at the weir used in monitoring for permit parameters (prior to introduction of stormwater). An air-stripper sampler equipped with both XAD and Tenax traps was floated in a corner of the south aeration bay adjacent to the point where bioinfluent and return sludge are introduced. Volatile organics were sampled in the bioinfluent and final effluent using the standard 28-ml VOA (volatile organics analysis) septum vials.

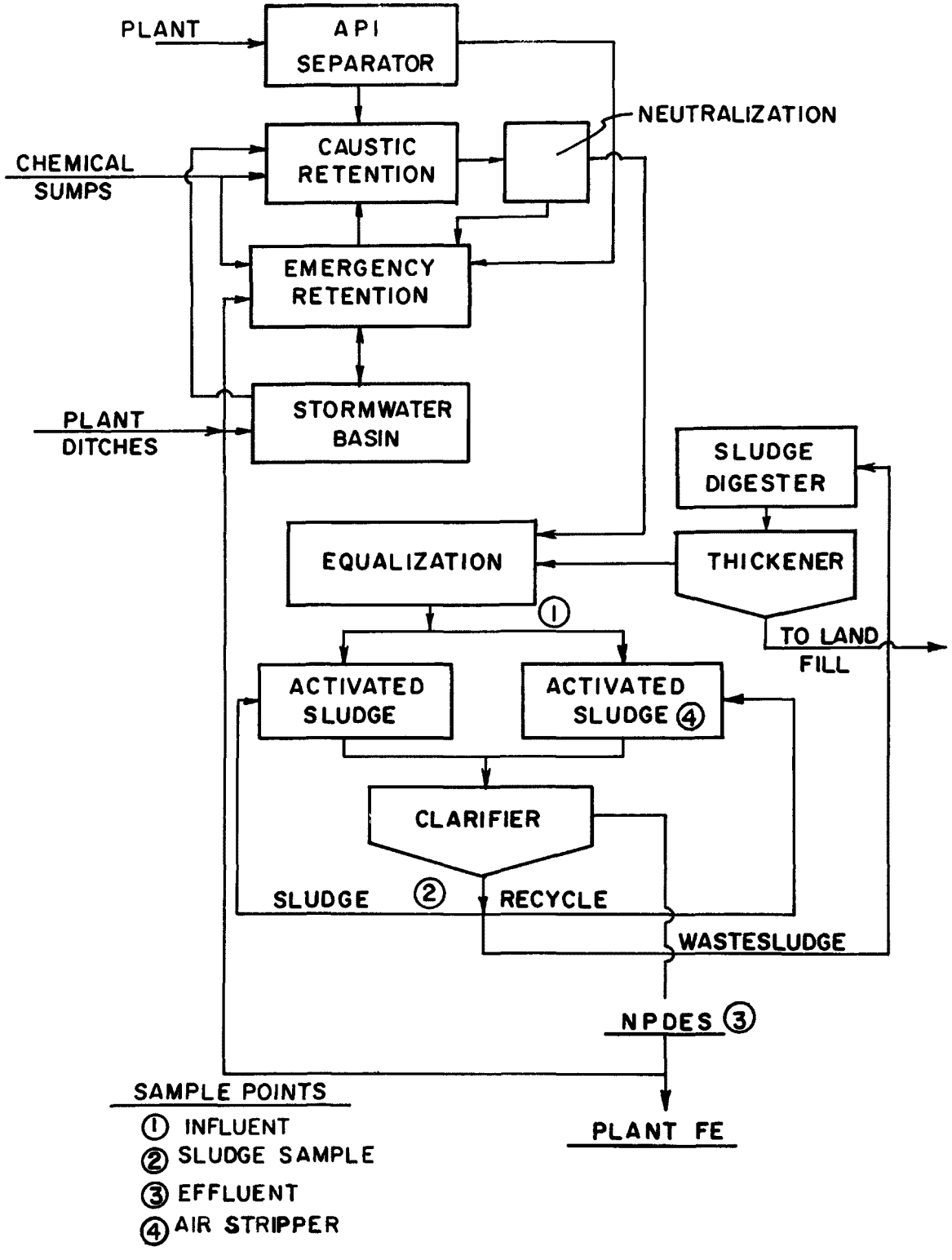

Figure 5 - WASTEWATER TREATMENT SYSTEM - PLANT 2

Samples of bioinfluent, return sludge, and final effluent were composited every 3 hours, beginning at 6 pm on July 31, 1978, and ending at 3 pm on August 3, 1978. Preservatives were added at the initiation of sampling. Preservatives used were concentrated phosphoric acid to achieve a final pH $\leq$ 4 (total phenols), 50-percent sodium hydroxide solution to pH $\geq$ 12 (total cyanide), and glass-redistilled nitric acid to pH $\leq$ 2 (total metals). The compositing procedure for each of these parameters was 40 ml of grab sample every 3 hours to obtain 1 liter of composite. For organics, no preservative was used, and final sample of 3 liters was obtained by compositing 125 ml every 3 hours. All sample containers were iced throughout the period of compositing. A detailed sampling schedule is presented in Table 5.

TABLE 5. SAMPLING SCHEDULE (PLANT 2)

Date	Time	Sample taken	Remarks
7/31/78	3:30 pm		Air stripper on
	6 pm	Composite	
	9 pm	"	
	12 Midnight	"	
8/1/78	3 am	"	
	6 am	"	
	9 am	"	Forward flow stopped
	12 Noon	"	Forward flow resumed
	2 pm	Tenax	
	3 pm	Composite	
	6 pm	"	
	9 pm	"	
	12 Midnight	"	
8/2/78	3 am	"	
	6 am	"	
	9 am	"	
	12 Noon	"	
	2 pm	Tenax	
	3 pm	Composite	
	6 pm	"	
	9 pm	"	
	12 Midnight	"	
8/3/78	2 am		Air stripper off
	3 am	Composite	
	6 am	"	
	9 am	"	
	12 Noon	Composite; VOA	
	3 pm	Composite	

The air-stripper sampler was placed in operation at 3:30 pm, July 31, and continued uninterrupted until 2 am on August 3, for a total operating time of 58 hours. Air charged to the stripper averaged 60 cfh, and the quantity of air to the XAD-2 scrubber was 30 cfh. Duplicate Tenax traps each received a slipstream from the stripper sampler for 15 minutes on two of the three sampling days, at 2 pm on August 1 and at 2 pm on August 2. One of the Tenax traps was left with Plant 2. The VOA samples were collected at 12 noon on August 3.

Two operational anomalies were noted which could result in atypical results for Plant 2. At 9 am on August 1, the forward feed pumps to the aeration basins were shut down, resulting in noticeable reduction in final effluent flow. The pumps resumed in 2 hours, and final flow was "normal" by 12 noon. During the morning of August 2, wastewater containing a high concentration of aniline was diverted to the emergency retention basin and bled slowly to the equalization basin. The normal 24-hour composite value for aniline in the discharge from the equalization basin is 0-5 mg/1 as $C_6H_5NH_2$. The value for the last 24-hour period of the study (August 3) was 86 mg/1, as determined by the Plant 2 laboratory.

The daily average flows for this period are found in Table 6. Sludge wastage is not normal at this facility and did not occur during the study; therefore, the forward flow to the aeration basins equals the effluent flow.

TABLE 6. DAILY FLOW DATA (PLANT 2)

Date	Return Sludge (mgd)	Effluent (mgd)
7/31/78	0.3283	1.3450
8/01/78	0.3283	0.9915
8/02/78	0.3283	0.6828
8/03/78	0.3010	1.1199

Analytical Results--

Priority pollutants, total cyanide, and total phenolics for which samples were collected and analyzed are presented in Table 7. All extractions and analyses of samples were conducted at RSKERL.

TABLE 7. ANALYTICAL DATA (PLANT 2)

Priority Pollutant	Sparged Air, XAD-2 (µg)	Sparged Air, Tenax (µg)
POLYNUCLEAR AROMATICS		
Naphthalene	40	
2-Chloronaphthane	<10	
Acenaphthalene	<10	
Acenaphthene	<10	
Fluorene	<13	
Phenanthrene/Anthracene	<10	
Fluoranthene	14	
Pyrene	<10	
1,2-Benzanthracene	<10	
Chrysene	<10	
3,4-Benzopyrene	<35	
1,2:5,6-Dibenzanthracene	N.D.	
PHENOLICS		
2-Chlorophenol	<25	
2-Nitrophenol	<25	
Phenol	11	
2,4-Dimethylphenol	<25	
2,4-Dichlorophenol	<50	
2,4,6-Trichlorophenol	<10	
4-Chloro-m-cresol	60	
2,4-Dinitrophenol	<100	
4,6-Dinitro-o-cresol	80	
Pentachlorophenol	<25	
4-Nitrophenol	<25	
PURGEABLES		
Methylene chloride		Undefinable results because of high background interference.
1,1-Dichloroethane		
1,2-Trans-dichloroethylene		
Chloroform		
1,2-Dichloroethane		
1,1,1-Trichloroethane		
Carbon tetrachloride		
Dichlorobromomethane		
1,2-Dichloropropane		
Benzene		
Trichloroethylene		
Chlorodibromomethane		
1,1,2-Trichloroethane		
Methyl bromide		
Bromoform		
1,1,2,2-Tetrachloroethane		
Tetrachloroethylene		
Toluene		
Chlorobenzene		
Ethylbenzene		

TABLE 7. (Continued)

Priority Pollutant	Influent (µg/l)	Return Sludge (µg/l)	Effluent (µg/l)
CLASSICAL			
TOTAL CYANIDES (mg/l)*	<.08	.43	.23
TOTAL PHENOL	372	1,300	263
TOTAL METALS			
Arsenic	60	90	60
Selenium	10	10	20
Cadmium	<1	80	<1
Beryllium	<5	8	<5
Copper	32	1,700	14
Antimony	<10	<10	<10
Chromium	260	31,000	61
Nickel	36	4,200	<10
Zinc	530	39,000	300
Silver	<10	<10	<10
Thallium	<10	<10	<10
Lead	27	1,500	<10
Mercury	<5	18	<5
ORGANICS (GAS CHROMATOGRAPHY)			
NITROTOLUENES/NITROBENZENE			
Nitrobenzene	N.P.	N.P.	N.P.
2,4-Dinitrotoluene	N.S.	N.S.	N.S.
2,6-Dinitrotoluene	N.S.	N.S.	N.S.
POLYNUCLEAR AROMATICS			
Naphthalene	<10	<10	<10
Fluorene	63	<25	<25
Phenanthrene/Anthracene	<10	320	<10
Benzo-a-pyrene	<70	<70	<70
Acenaphthene	<10	<10	<10
PURGEABLES			
Benzene	<40	N.A.	<40
Chloroform	<10	"	<10
1,2-Dichloropropane	<10	"	<10
Ethylbenzene	<10	"	<10
Toluene	<10	"	<10
Chlorobenzene	<10	"	<10
1,2-Dichloroethane	<10	"	<10
1,1,2,2-Tetrachloroethane	<10	"	<10
DICHLOROBENZENES			
1,3-Dichlorobenzene	<10	<10	<10
1,4-Dichlorobenzene	<10	<10	<10
1,2-Dichlorobenzene	<10	<10	<10

(Continued)

TABLE 7. (Continued)

Priority Pollutant	Influent (µg/l)	Return Sludge (µg/l)	Effluent (µg/l)
PHENOLICS			
2-Nitrophenol	5	53	62
4-Nitrophenol	24	N.D.	N.D.
Phenol	20	8	2
2,4-Dinitrophenol	39	16	4
2,4-Dimethylphenol	35	11	22
2-Chlorophenol	24	6	24
Pentachlorophenol	14	36	27
ACRYLONITRILE		-No sample-	

*Note: Total Cyanides expressed in mg/l.

**Key: N.D. - Not Detectable, or less than detectable limits
N.A. - Not Applicable
N.S. - No Standard Available
N.P. - No Procedure Available

Plant 3

Wastewater Treatment System--

A flow diagram of Plant 3's wastewater treatment system is shown in Figure 6. Wastewaters generated by the manufacturing of organic chemicals are treated by a process consisting of (1) grit removal, (2) primary API, (3) compositing and neutralization, (4) secondary API, (5) aeration lagoon, (6) flocculation, and (7) clarification.

The typical inlet feed from the chemical sewer to the grit chamber is 1,100 gallons per minute. Wastewater flows from the grit chamber through a primary API separator into a compositing pond. The pond has a volume of about 2.5 million gallons and contains two 2-horsepower mechanical agitators. Detention time is about 1 day. The wastewater then flows through a secondary API separator before being pumped into a large aerated lagoon. Additional lagoon loading is from waste acid transferred to the compositing pond, and belt press wash water, landfill pumpout, and occasionally surface pond water transferred to the aerated lagoon.

The aerated lagoon has a volume of 26 million gallons, a depth of 22 feet, and surface area of 160,000 $feet^2$. The lagoon is equipped with 32 mechanical aerators, each with a horsepower of either 50 or 75. The average detention time in the lagoon is 10 days. Effluent from the aerated lagoon at the typical rate of 1,700 gallons per minute is pumped to a flocculator, then to a final clarifier before final discharge. The final clarifier also receives wastewaters from a surface sewer which have been treated by a trickling filter.

In addition to the described wastewater treatment system, this facility employs an activated sludge treatment system for treating wastewaters generated by specific process units.

Sample Collection--

The survey of this facility was conducted during the period August 28-31, 1978. Composite samples were collected within a 72-hour period at three locations in the biological treatment system (Figure 6):

(1) Influent to aerated lagoon (water phase)
(2) Effluent from aerated lagoon (water phase)
(3) Air-stripper samples (air phase)

The air-stripper sampler was located in the aerated lagoon near the influent point. The stripper sampler was placed in operation at 11 am, August 28, and operation was concluded at 7 am, August 31, for a total operating time of 68 hours. Air charged to the stripper averaged 60 cfh, and the quantity of air to the XAD-2 scrubber was 30 cfh. Two samples were collected using the stripper sampler. Stripped air was collected on the Tenax column for 10 minutes on each of the three days the sampler was operated.

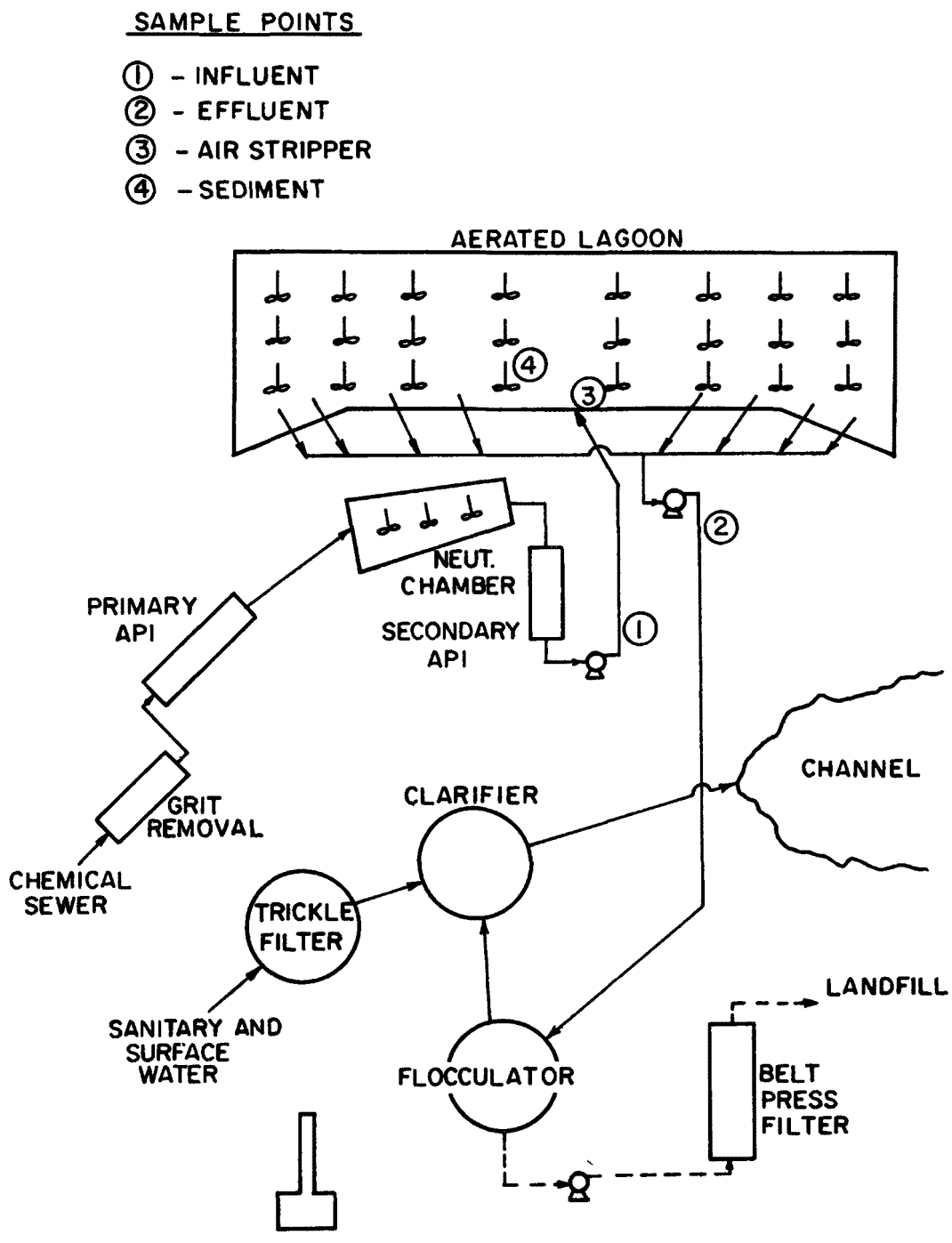

Figure 6 - WASTEWATER TREATMENT SYSTEM - PLANT 3

Twenty-four aliquots were collected manually from the water-phase sampling points beginning at 12 noon, August 28. Aliquots were collected at intervals of approximately 3 hours. The final aliquot was collected at 9 am, August 31. A detailed sampling schedule is presented in Table 8.

TABLE 8. SAMPLING SCHEDULE (PLANT 3)

Date	Time	Sample taken	Remarks
8/28/78	12:00 Noon	1st Composite aliquot	Started stripper at 11 am. Added preservative as needed
	3:00 pm	Composite aliquot	
	6:00 pm	"	, 10" Tenax
	9:00 pm	"	
	12:00 Midnight	"	
8/29/78	3:00 am	"	
	6:00 am	"	
	9:00 am	"	
	12:00 Noon	"	
	3:00 pm	"	, 10" Tenax
	6:00 pm	"	
	9:00 pm	"	
	12:00 Midnight	"	
8/30/78	3:00 am	"	
	6:00 am	"	
	9:00 am	"	
	12:00 Noon	"	, 10" Tenax
	3:00 pm	"	
	6:00 pm	"	
	9:00 pm	"	
	12:00 Midnight	"	
8/31/78	3:00 am	"	
	6:00 am	"	, VOA grab, bottom sample
	8:00 am	24th"	Stripper sampler shut off at 7:30 am.

Samples were collected for those priority pollutants which were found in the previous priority pollutants screening survey or which might be expected to be found if all plant processes were in operation (Table 10). Samples were preserved by prescribed EPA methods. All samples were kept on ice throughout the sample period. Duplicate metals, cyanide, and phenolics samples were provided to plant personnel.

At the end of the sample period, grab samples for VOA analyses were collected from the water-phase sampling points. At this time, a grab sample for the residual phase was collected from the bottom of the aerated lagoon.

Daily flow data for the sampling period are presented in Table 9.

TABLE 9. DAILY FLOW DATA* (PLANT 3)

Date	Influent (gpm)	Effluent (gpm)
8/28/78	1,100	1,700
8/29/78	1,100	1,700
8/30/78	1,100	1,700

*These are typical flow rates under normal operating conditions.

Analytical Results--

Priority pollutants for which samples were collected and analyzed are presented in Table 10. All extractions and analyses of samples were conducted at RSKERL.

TABLE 10. ANALYTICAL DATA (PLANT 3)

Priority Pollutants	Sparged Air, XAD-2 (µg)	Sparged Air, Tenax (µg)
POLYNUCLEAR AROMATICS		
Naphthalene	70	
2-Chloronaphthane	16	
Acenaphthalene	<10	
Acenaphthene	<10	
Fluorene	<13	
Phenanthrene/Anthracene	15	
Fluoranthene	50	
Pyrene	40	
1,2-Benzanthracene	<10	
Chrysene	<10	
3,4-Benzopyrene	<35	
1,2:5,6-Dibenzanthracene	N.D.	
PHENOLICS		
2-Chlorophenol	<25	
2-Nitrophenol	<25	
Phenol	18	
2,4-Dimethylphenol	<25	
2,4-Dichlorophenol	<50	
2,4,6-Trichlorophenol	12	
4-Chloro-m-cresol	<25	
2,4-Dinitrophenol	<100	
4,6-Dinitro-o-cresol	<25	
Pentachlorophenol	<25	
4-Nitrophenol	<25	
PURGEABLES		
Methylene chloride		Undefinable results because of extraneous matrix.
1,1-Dichloroethane		
1,2-Trans-dichloroethylene		
Chloroform		
1,2-Dichloroethane		
1,1,1-Trichloroethane		
Carbon tetrachloride		
Dichlorobromomethane		
1,2-Dichloropropane		
Benzene		
Trichloroethylene		
Chlorodibromomethane		
1,1,2-Trichloroethane		
Methyl bromide		
Bromoform		
1,1,2,2-Tetrachloroethane		
Tetrachloroethylene		
Toluene		
Chlorobenzene		
Ethylbenzene		

TABLE 10. (Continued)

Priority Pollutant	Influent (µg/l)	Bottom Sediment Dry Weight (µg/kg)	Effluent (µg/l)
CLASSICAL			
TOTAL CYANIDES (mg/l)*	4.76*	N.P.	6.70*
TOTAL PHENOL	4,730	N.P.	<40
TOTAL METALS			
Arsenic	17	10,000	34
Selenium	11	<930	20
Cadmium	2	670	2
Beryllium	<3	1,300	<3
Copper	1,100	360,000	960
Antimony	<10	<970	<10
Chromium	1,400	250,000	1,400
Nickel	1,600	1,400,000	3,300
Zinc	2,000	420,000	1,900
Silver	<10	<880	<10
Thallium	<10	<880	<10
Lead	380	30,000	250
Mercury	<0.1	3	<0.5
ORGANICS (GAS CHROMATOGRAPHY)			
ACROLEIN	<10,000	N.P.	<10,000
ACRYLONITRILE	<10,000	N.P.	<10,000
PURGEABLES			
Benzene	<40	N.A.	<40
Chloroform	<10	N.A.	<10
1,2-Dichloropropane	<10	N.A.	<10
Methylene chloride	26	N.A.	<10
Dichlorodibromomethane	N.D.	N.A.	N.D.
Chlorodibromomethane	<10	N.A.	<10
Toluene	<10	N.A.	<10
PHENOLICS			
Phenol	680	N.P.	<10
2-Nitrophenol	<10	N.P.	<10
4-Nitrophenol	<10	N.P.	<10
2,4-Nitrophenol	<50	N.P.	<50

(Continued)

TABLE 10. (Continued)

Priority Pollutant	Influent (µg/l)	Bottom Sediment Dry Weight (µg/kg)	Effluent (µg/l)
POLYNUCLEAR AROMATICS			
Benzo(a)anthracene	<60	N.P.	<60
Benzo(a)pyrene	<30	"	<30
3,4-Benzofluoranthene	N.D.	"	N.D.
Benzo(k)fluoranthane	N.D.	"	N.D.
Chrysene	<20	"	<20
Acenaphthylene	<10	"	<10
Benzo(g,h,i)perylene	N.D.	"	N.D.
Fluorene	<10	"	<10
Phenanthrene/Anthracene	<10	"	<10
Dibenzo(a,h)anthracene	<30	"	<30
Indeno(1,2,3-cd)pyrene	N.D.	"	N.D.
Pyrene	126	"	<10
Acenaphthene	<10	"	<10
Naphthalene	980	"	<10

*Note: Total Cyanides expressed in mg/l.

**Key: N.D. - Not Detectable, or less than detectable limits
N.A. - Not Applicable
N.S. - No Standard Available
N.P. - No Procedure Available

PHARMACEUTICALS INDUSTRY

Plant 4

Wastewater Treatment System--

A flow diagram of Plant 4's wastewater treatment system is shown in Figure 7. Wastewater generated by the manufacturing of pharmaceuticals is treated by a process that generally consists of (1) primary clarification, (2) equalization, (3) activated sludge, and (4) chlorine contact. Sludge produced by the wastewater treatment process is thickened, aerobically digested, and finally landfilled. In addition to the manufacturing wastewater, the treatment system also handles sanitary waste from the plant. As part of the treatment, approximately 80-100 pounds of granular activated carbon are added to the aeration basin or equalization tanks every three to four weeks.

Treatment of the manufacturing wastewater begins when about 90,000 gallons per day of the water flows into the primary clarifier, which has a volume of 20,000 gallons (37.5 feet long by 9.0 feet wide by 7.9 feet deep). From the primary clarifier, the wastewater flows to two parallel equalization basins, each with a volume of 90,000 gallons. Then the water is combined with about 20,000 gallons per day of sanitary wastewater and flows to a 100,000-gallon aeration basin (64 feet long by 22 feet wide by 9.5 feet deep). Two-hundred twenty-five cubic feet per minute of air is supplied to the aeration basin through 18 helix air diffusers. From the aeration basin, wastewater then flows to two parallel final clarifiers, each one being 26.5 feet long by 6.0 feet wide by 8.4 feet deep. The final effluent is treated in a 7,500-gallon chlorine contact tank (13.0 feet long by 13.0 feet wide by 5.9 feet deep) prior to final discharge. The total residence time of the treatment system is 2 to 2 1/2 days. Both sludges from the primary clarifier and waste secondary sludge are treated in an aerobic digestor and then thickened. Supernatant from the thickener is returned to the primary clarifier. The sludge is then finally disposed of in a contract or municipal landfill.

Sample Collection--

Based on the previous Effluent Guidelines Division screening survey study, the list of compounds in Table 13 was compiled. This list represents the priority pollutants that have been identified in Plant 4's influent to the treatment system. From this list, it was determined that four 1-gallon samples of composite were required for specific organic compound analysis.

The sampling point locations are shown in Figure 7. The influent sample was taken immediately preceding the primary clarifier. The effluent sample was taken just prior to chlorine contact. The return sludge sample was taken at the point where it

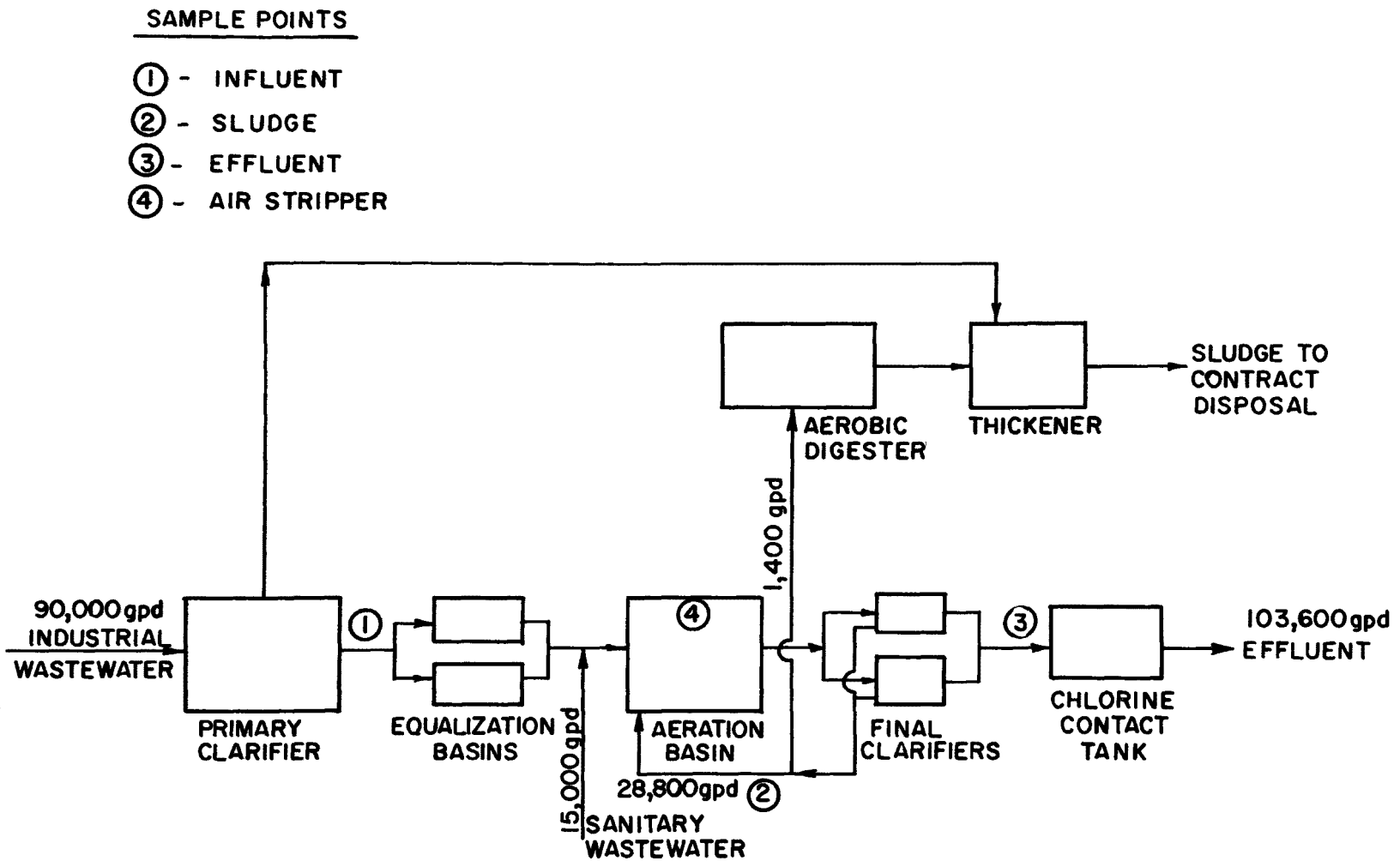

Figure 7 - WASTEWATER TREATMENT SYSTEM - PLANT 4

returns to the aeration basin. The air-stripper sampler was placed in the aeration basin near the side closest to the control house.

Samples of the influent, effluent, and return sludge were composited every 4 hours beginning at 4 pm, November 6, 1978. Four 170-ml aliquots were taken for cyanide, phenolics, and metals. Each cyanide, metals, and phenolics sample was "preserved" at about 4 pm on November 6, 1978. These samples were preserved by adding 5 ml of nitric acid to the metals samples and 2 ml of phosphoric acid to the phenolics samples. At all times each of the samples taken was kept on ice. At 8 am on November 9, 1978, VOA grab samples were taken for the influent and effluent. A detailed sampling schedule is presented in Table 11.

The air-stripper sampler was placed into operation at 10 pm on November 6, 1978, and operations were concluded at 10:30 am on November 9, 1978, for a total operating time of 58 1/2 hours. Air charged to the stripper averaged 60 cubic feet per hour, and the quantity of air to the XAD-2 scrubber was 30 cubic feet per hour. Stripped air was collected on the Tenax columns for 3 1/2 hours on November 8. Tenax sampling began at 8:40 am on November 8, 1978, and ended at 12:10 pm that day. Tenax column No. 14 was used for this sampling.

Daily flow data for the sampling period are presented in Table 12.

Analytical Results--

Priority pollutants for which samples were collected and analyzed are presented in Table 13. All extractions and analyses of samples were conducted at RSKERL.

TABLE 11. SAMPLING SCHEDULE (PLANT 4)

Date	Time	Sample taken	Remarks
11/06/78	4:00 pm	Composites*	Added 5 ml HNO_3,
	8:00 pm	"	2 ml NaOH, 2 ml H_3PO_4 to
	12 Midnight	"	metals, cyanide, and phenolics composites
11/07	4:00 am	"	
	8:00 am	"	
	12 Noon	"	
	4:00 pm	"	
	8:00 pm	"	
	12 Midnight	"	
11/08	4:00 am	"	
	8:00 am	"	
	12 Noon	"	
	4:00 pm	"	
	8:00 pm	"	
	12 Midnight	"	
11/09	4:00 am	"	
	8:00 am	"	& VOA
	12 Midnight	"	

*Composites consist of four 170-ml aliquots for organics and three 50-ml aliquots for cyanides, phenolics, and metals.

TABLE 12. DAILY FLOW DATA (PLANT 4)

Date	Influent* (gpd)	Effluent (gpd)
11/6/78	66,910	90,640
11/7	72,450	93,850
11/8	71,830	92,070
11/9	72,490	92,230

*Does not include sanitary wastes

TABLE 13. ANALYTICAL DATA (PLANT 4)

Priority Pollutant	Sparged Air, XAD-2 µgrams	Sparged Air, Tenax µgrams
POLYNUCLEAR AROMATICS		
Naphthalene	90	
2-Chloronaphthane	<10	
Acenaphthalene	<10	
Acenaphthene	<10	
Fluorene	<13	
Phenanthrene/Anthracene	<10	
Fluoranthene	<10	
Pyrene	<10	
1,2-Benzanthracene	<10	
Chrysene	<10	
3,4-Benzopyrene	<35	
1,2:5,6-Dibenzanthracene	N.D.	
PHENOLICS		
2-Chlorophenol	<25	
2-Nitrophenol	<25	
Phenol	<10	
2,4-Dimethylphenol	<25	
2,4-Dichlorophenol	80	
2,4,6-Trichlorophenol	<10	
4-Chloro-m-cresol	110	
2,4-Dinitrophenol	100	
4,6-Dinitro-o-cresol	<25	
Pentachlorophenol	<25	
4-Nitrophenol	<25	
PURGEABLES		
Methylene chloride		No results - sample lost. Analytical equipment malfunction.
1,1-Dichloroethane		
1,2-Trans-dichloroethylene		
Chloroform		
1,2-Dichloroethane		
1,1,1-Trichloroethane		
Carbon tetrachloride		
Dichlorobromomethane		
1,2-Dichloropropane		
Benzene		
Trichloroethylene		
Chlorodibromomethane		
1,1,2-Trichloroethane		
Methyl bromide		
Bromoform		
1,1,2,2-Tetrachloroethane		
Tetrachloroethylene		
Toluene		
Chlorobenzene		
Ethylbenzene		

TABLE 13. (Continued)

Priority Pollutant	Influent (µg/l)	Return Sludge (µg/l)	Effluent (µg/l)
CLASSICAL			
TOTAL CYANIDES (mg/l)*	<.05 *	<.05*	<.05 *
TOTAL PHENOL	350	74	18
TOTAL METALS			
Arsenic	<10	<10	<10
Selenium	<10	33	<10
Cadmium	2	59	<1
Beryllium	3	<3	<3
Copper	120	8,300	29
Antimony	<10	<10	<10
Chromium	12	740	11
Nickel	<10	110	12
Zinc	620	7,700	260
Silver	<10	160	<10
Thallium	<10	<10	<10
Lead	12	810	<10
Mercury	<0.8	62	<0.5
ORGANICS (GAS CHROMATOGRAPHY)			
PURGEABLES			
1,2-Dichloroethane	<10	N.A.	<10
Toluene	<10	N.A.	<10
Chloroform	<10	N.A.	<10
Methylene chloride	<10	N.A.	48
Benzene	<40	N.A.	<40
Ethylbenzene	<10	N.A.	<10
Tetrachloroethylene	10	N.A.	<10
Trichloroethylene	<10	N.A.	<10
PHENOLICS			
Phenol	17	9	19
Pentachlorophenol	18	38	26
PHALATES			
Bis(2-ethylhexyl) phthalate	<10	<21	<10
Di-n-butyl phthalate	<10	<10	<10

*Note: Total Cyanides expressed in mg/l.
**Key: N.D. - Not Detectable, or less than detectable limits
N.A. - Not Applicable
N.S. - No Standard Available
N.P. - No Procedure "

Plant No. 5

Wastewater Treatment System--

A flow diagram of Plant 5's wastewater treatment system is shown in Figure 8. Sanitary wastes from the plant flow into a grinder, then into a clarifier and digestor. After treatment in a chlorination basin, these wastes are added to the process stream just after the neutralization basin.

Process wastes from the manufacturing first flow into an equalization basin, from which they enter a neutralization basin of about 19,400 gallons. Acid and alkali are added as needed to adjust pH prior to the flow entering the sedimentation basin. Wastes from the sanitary system enter between the neutralization basin and the sedimentation basin.

The sedimentation basin effluent is fed to a roughing trickling filter, then into an activated sludge system which consists of two tanks in series which have a combined volume of 240,000 gallons. Biological sludge for the activated sludge unit comes from skimmings from the dissolved air flotation unit (DAF), which is in line just after the activated sludge tank. At present, none of the skimmings are wasted. From the DAF unit, the waste is pumped through a lift station into two parallel final trickling filters of 73,500 gallons each. After treatment by the trickling filters, the waste enters a splitter and from there flows into two parallel final clarifiers. The effluent from these clarifiers is combined, then mixed with cooling water and surface runoff before discharge to the receiving stream. The sludge from the final clarifiers is dewatered by centrifugation, and the solids are incinerated.

The flow through the treatment system averages about 1.2 to 1.4 million gallons a day. The treatment effluent is mixed in a ratio of approximately 1:9 with cooling water before discharge.

Sample Collection--

The survey of Plant 5 was conducted September 11-14, 1978. Composite samples were collected within a 72-hour period at four points. At the final clarifiers, the discharge was mixed underground with no provision for sample-taking prior to the effluent's being mixed with surface and cooling water. For this reason, samples were taken at each final clarifier overflow, then mixed in equal proportions prior to compositing so as to produce one sample for the two locations. The samples taken were from:

(1) The sedimentation basin effluent was sampled as bio-influent due to the inaccessibility of effluent from the roughing trickling filter.

(2) The final clarifier sludge taken from a valve on the discharge side of the pump that lifts sludge to the sludge aeration bays.

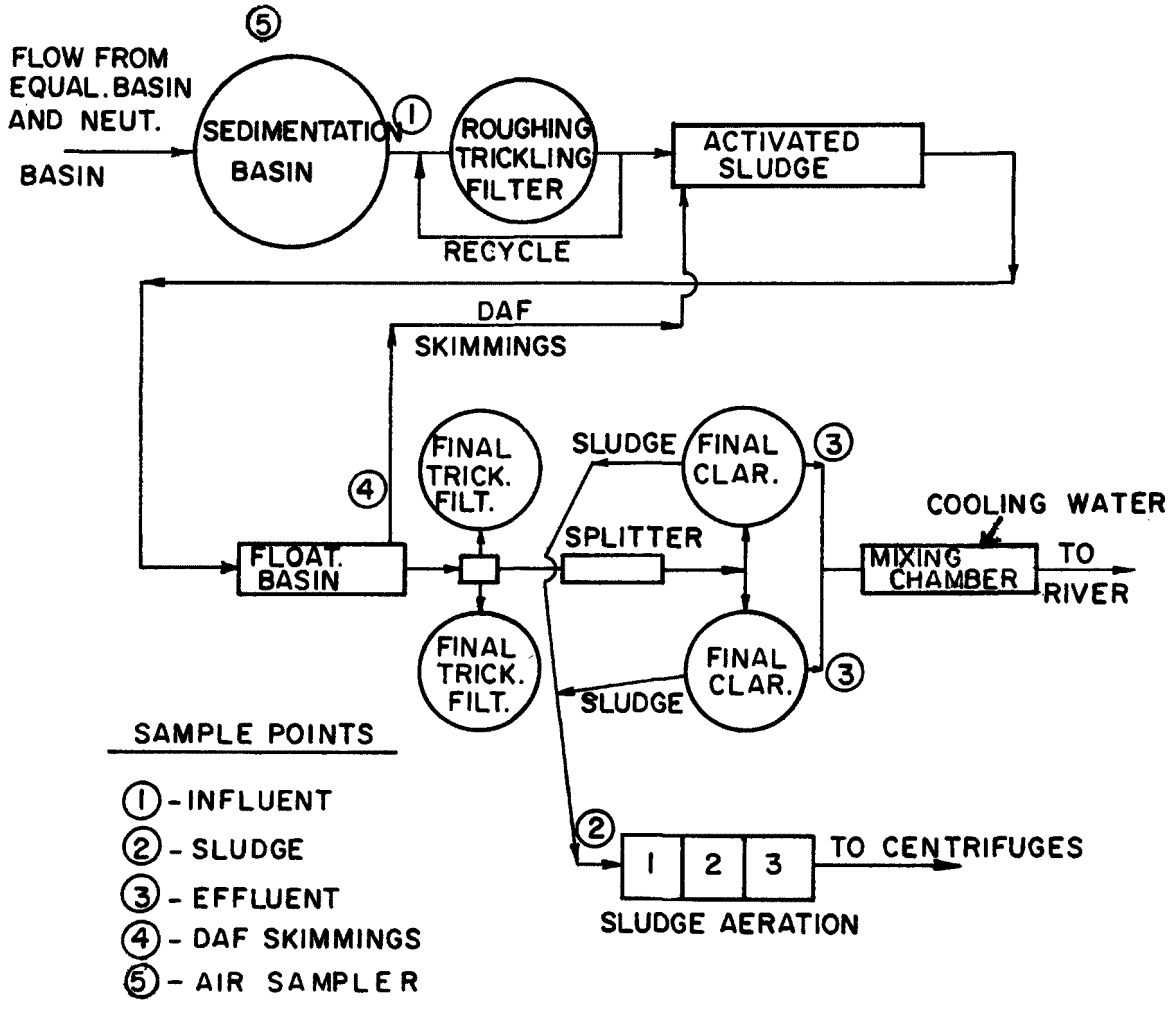

Figure 8 - WASTEWATER TREATMENT SYSTEM - PLANT 5

(3) The final clarifier effluents flowing into the weir trough at each final clarifier.

(4) The DAF skimmings which were taken at a valve located on the lift pump to the head end of the aeration tank.

Due to the inaccessibility, the air stripper was placed in the sedimentation basin between the skimmer rail and the overflow weir. The stripper was started at 12 Noon, September 11, and operation was concluded at 9 am on September 14, for a total operating time of 69 hours. The system was shut down 2 3/4 hours prior to the prescribed 72-hour time period because of failure of both the vacuum pump and the water meter that measured flow into the air stripper. Stripped air was collected on the Tenax column for 15 minutes three times while the sampler was in operation.

Twenty-four aliquots were collected from the four sampling points, beginning at 12 Noon, September 11. Aliquots were collected at intervals of 3 hours. The final aliquot was collected at 8 am, September 14. A detailed sampling schedule is presented in Table 14.

TABLE 14. SAMPLING SCHEDULE (PLANT 5)

Date	Time	Sample taken	Remarks
9/11/78	12 Noon	Composite aliquots	
	3:00 pm	"	
	6:00 pm	"	
	9:00 pm	"	
	12 Midnight	"	
9/12/78	3:00 am	"	
	6:00 am	"	
	9:00 am	"	
	12 Noon	"	
	3:00 pm	"	
	6:00 pm	"	
	9:00 pm	"	
	12Midnight	"	
9/13/78	3:00 am	"	
	6:00 am	"	Tenax, 15 min.
	9:00 am	Composite & VOA grab samples	
	12 Noon	Composite aliquots	
	3:00 pm	"	
	6:00 pm	"	Tenax, 15 min.
	9:00 pm	"	
	12 Midnight	"	
9/14/78	3:00 am	"	
	6:00 am	"	
	8:00 am	"	Tenax 15 min.

Samples were collected for the priority pollutants which were found in the priority pollutants survey or which might be expected to be found in plant wastewater operations. The samples were preserved by prescribed EPA methods. All samples were kept on ice throughout the sampling period.

VOA samples were taken of the sedimentation basin effluent and the final clarifier effluent on September 13 at 9 am. Duplicate samples for cyanides and phenol analyses were taken from the final clarifier effluent for company personnel.

Throughout the sampling period, the underflow in the DAF unit was approximately 1.185 to 1.275 million gallons per day, while the skimmings or DAF sludge that was pumped varied between 151,910 to 179,940 gallons per day. The final clarifier sludge removed to aeration was about .078 million gallons per day, and the final clarifier effluent was 1.107 to 1.197 million gallons per day.

Daily flow data for the sampling period are presented in Table 15.

TABLE 15. DAILY FLOW DATA (PLANT 5)

Date	DAF skimmings returned (mgd)	Influent (mgd)	Return sludge (mgd)	Effluent (mgd)
9/11/78	.178	1.2-1.4	.078	1.11-1.20
9/12/78	.152	"	"	"
9/13/78	.114	"	"	"
9/14/78	.118	"	"	"

Analytical Results--

A list of the priority pollutants for which samples were collected is presented in Table 16. All extractions and analyses were done at RSKERL. Results of these analyses are presented in Table 16.

TABLE 16. ANALYTICAL DATA (PLANT 5)

Priority Pollutant	Sparged Air, XAD-2 (µg)	Sparged Air, Tenax (µg)
POLYNUCLEAR AROMATICS		
Naphthalene	940	
2-Chloronaphthane	5,000	
Acenaphthalene	<60	
Acenaphthene	60	
Fluorene	<78	
Phenanthrene/Anthracene	150	
Fluoranthene	<60	
Pyrene	<60	
1,2-Benzanthracene	<60	
Chrysene	<60	
3,4-Benzopyrene	<210	
1,2:5,6-Dibenzanthracene	N.D.	
PHENOLICS		
2-Chlorophenol	<150	
2-Nitrophenol	<150	
Phenol	<60	
2,4-Dimethylphenol	<150	
2,4-Dichlorophenol	1,500	
2,4,6-Trichlorophenol	<10	
4-Chloro-m-cresol	1,800	
2,4-Dinitrophenol	<600	
4,6-Dinitro-o-cresol	600	
Pentachlorophenol	<150	
4-Nitrophenol	<150	
PURGEABLES		
Methylene chloride		Sample lost - Analytical apparatus malfunction.
1,1-Dichloroethane		
1,2-Trans-dichloroethylene		
Chloroform		
1,2-Dichloroethane		
1,1,1-Trichloroethane		
Carbon tetrachloride		
Dichlorobromomethane		
1,2-Dichloropropane		
Benzene		
Trichloroethylene		
Chlorodibromomethane		
1,1,2-Trichloroethane		
Methyl bromide		
Bromoform		
1,1,2,2-Tetrachloroethane		
Tetrachloroethylene		
Toluene		
Chlorobenzene		
Ethylbenzene		

TABLE 16. (Continued)

Priority Pollutant	Influent (µg/l)	DAF Skimmings (µg/l)	Clarifier Effluent (µg/l)	Clarifier Sludge (µg/l)
CLASSICAL				
TOTAL CYANIDES (mg/l)*	.25*	.22*	.17*	.23*
TOTAL PHENOL	945	107	39	201
TOTAL METALS				
Arsenic	<10	16	<10	21
Selenium	<10	<10	<10	<10
Cadmium	<01	11	<1	16
Beryllium	3	<3	<3	<3
Copper	120	1,900	34	2,800
Antimony	10	<10	<10	<10
Chromium	12	1,500	34	2,100
Nickel	39	42	38	32
Zinc	41	5,600	9	7,800
Silver	<10	17	<10	72
Thallium	<10	<10	<10	56
Lead	22	12	<10	30
Mercury	<2.0	<10	<2.0	<10.0
ORGANICS (GAS CHROMATOGRAPHY)				
PURGEABLES				
Benzene	127	N.A.	<40	N.A.
Chloroform	<10	"	<10	"
Methylene chloride	47	"	<10	"
Toluene	<10	"	<10	"
Ethylbenzene	150	"	<10	"
1,1,1-trichloroethane	<10	"	<10	"
1,2-dichloroethane	<10	"	<10	"
PHENOLICS				
4-Nitrophenol	N.D.	381	N.D.	N.A.
2-Nitrophenol	123	387	21	N.A.
PHTHALATE ESTERS				
Bis(2-ethylhexyl) phthalate	Matrix interferences not sufficiently removed by procedure cleanup.			

*Note: Total Cyanides expressed in mg/l.

**Key: N.D. - Not Detectable, or less than detectable limits
N.A. - Not Applicable
N.S. - No Standard Available
N.P. - No Procedure Available

PESTICIDES INDUSTRY

Plant 6

Wastewater Treatment System--

A flow diagram of Plant 6's wastewater treatment system is shown in Figure 9. Wastewater generated by the manufacturing of pesticides and organic chemicals is collected centrally after several streams have been pretreated. The central system consists of (1) neutralization, (2) equalization, (3) activated sludge, (4) followed by a polishing lagoon. Excess sludge produced by the wastewater treatment process is disposed of in a sludge pit with a metal process waste solid. The supernatant from the sludge pit is chemically oxidized and fed to the feed of the central organic wastewater system at the pump station.

Approximately 1.7 mgd of process water from the manufacturing process is pumped to a 2.1-million-gallon equalization basin. The wastewater is mixed with return sludge from the activated sludge clarifier. This mixture is split and flows to two parallel 2.4-million-gallon aeration basins. Each basin has five 50-horsepower mechanical aerators. The mixed liquor flow from the two aeration basins is combined and flows to a single 250,000-gallon clarifier. This system operates with a return sludge flow rate of about 750 gallons per minute (gpm) and a sludge wasting rate of about 3 gpm. Figure 9 indicates the average flow through the activated sludge unit for a 6-month period in 1978. Overflow of treated water from the clarifier flows through the polishing lagoon for final solids removal and then is mixed with combine non-contact and inorganic process water streams before discharge into the bay.

Sample Collection--

Based on the previous screening survey studies of the Effluent Guidelines Division, the list of 24 organic compounds in Table 19 was compiled. This list represents the priority pollutants that were anticipated to be in Plant 6's influent to the treatment system.

The locations of the sampling points are shown in Figure 9. The influent sample (No. 1) was taken from the channel leading from the equalization basin just before the return sludge is mixed with the influent. The effluent sample (No. 2) was taken from the overflow channel of the clarifier. The return sludge sample (No. 3) was taken from the sump for the recycle pump. The air-stripper sampler (No. 4) was placed in the southeast corner of the south aeration basin due to inaccessibility.

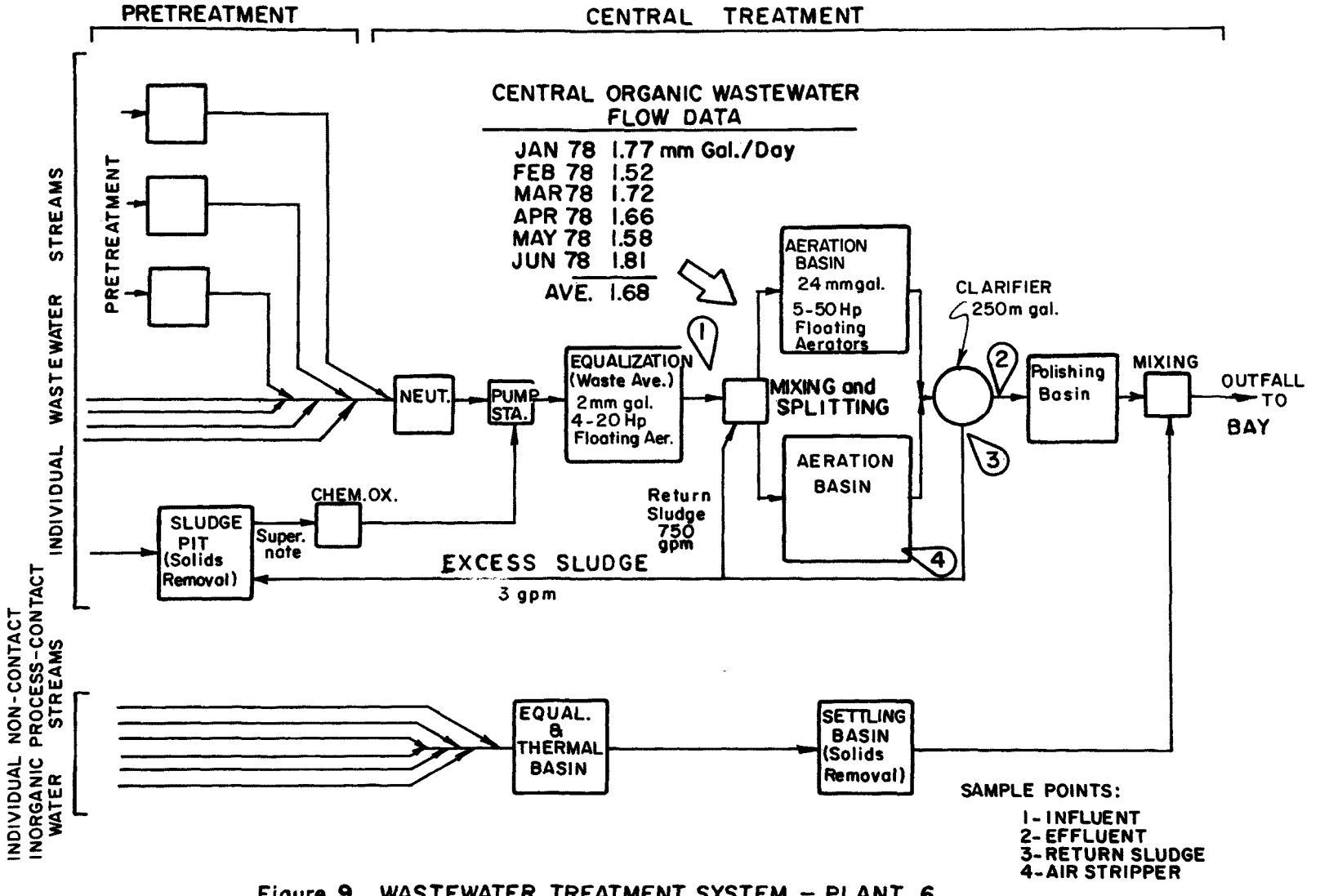

Figure 9. WASTEWATER TREATMENT SYSTEM – PLANT 6

Samples of the influent, effluent, and return sludge were composited over a period of about 3 days. Every 3 hours beginning at 9 am on the first day, July 25, 1978, four 130-ml aliquots were taken at each sample point for specific organics analysis. Then, beginning at 8 am on the second day, July 26, composites were taken again every 3 hours. Finally, beginning at 7 am on the third day, July 27, composites were taken about every 3 hours. In addition, three 40-ml aliquots were taken for metals, cyanides, and phenolics at the same time as the organic samples were taken. These samples were preserved by adding 5 ml of nitric acid to the metals samples, 2 ml of sodium hydroxide to the cyanides samples, and 2 ml of phosphoric acid to the phenolics samples. At all times, each of the samples was kept on ice. At 2 pm, July 27, VOA samples were taken for the influent and effluent. A detailed sampling schedule is presented in Table 18.

The air-stripper sampler was placed into operation at 10 am on July 25, 1978, and operations were concluded at 7:30 pm, July 27, for a total operating time of 57 hours and 20 minutes. Air charged to the stripper averaged 60 cfh, and the quantity of air to the XAD-2 scrubber was 30 cfh. Stripped air was collected on the Tenax columns for 10 minutes on each day of sampling. At this plant two Tenax columns were taken. One column was retained; the other column was left with the company for its own separate analysis.

Average flow data for this plant are presented in Table 17.

TABLE 17. AVERAGE FLOW DATA (PLANT 6)

Date	Influent (mgd)	Return Sludge (mgd)
1/78	1.77	-
2/78	1.52	-
3/78	1.72	-
4/78	1.66	-
5/78	1.58	-
6/78	1.81	-
Average	1.68	750

Analytical Results--

Priority pollutants for which samples were collected and analyzed are presented in Table 19. All extractions and analyses were conducted at RSKERL.

TABLE 18. SAMPLING SCHEDULE (PLANT 6)

Date	Time	Sample taken	Remarks
7/25/78	9:00 am	Composites	
	12 Noon	"	
	1:00 pm	"	Added 5 ml HNO_3, 2 ml NaOH, 2 ml H_3PO_4 to metals, cyanides, and phenolics.
	3:00 pm	Composites	
	6:00 pm	"	
	9:00 pm	"	
7/26/78	12 Midnight	"	
	3:00 am	"	
	6:00 am	"	
	8:00 am	"	
	11:00 am	"	
	2:00 pm	"	
	5:00 pm	"	
	8:00 pm	"	
	11:00 pm	"	
7/27/78	2:00 am	"	
	5:00 am	"	
	7:00 am	"	
	10:00 am	"	
	1:00 pm	"	
	2:00 pm	VOA	
	4:00 pm	Composites	
	5:30 pm	Effluent grabs	
	7:00 pm	Composites	
	10:00 pm	"	
	11:00 pm	"	
	12 Midnight	"	

TABLE 19.. ANALYTICAL DATA (PLANT 6)

Priority Pollutant	Sparged Air, XAD-2 (µg)	Sparged Air, Tenax (µg)
POLYNUCLEAR AROMATICS		
Naphthalene	.12	
2-Chloronaphthane	<5	
Acenaphthalene	7	
Acenaphthene	<3	
Fluorene	<13	
Phenanthrene/Anthracene	10	
Fluoranthene	5	
Pyrene	<4	
1,2-Benzanthracene	<6	
Chrysene	<4	
3,4-Benzopyrene	<35	
1,2:5,6-Dibenzanthracene	N.D.	
PHENOLICS		
2-Chlorophenol	1,380	
2-Nitrophenol	250	
Phenol	520	
2,4-Dimethylphenol	500	
2,4-Dichlorophenol	340	
2,4,6-Trichlorophenol	3,200	
4-Chloro-m-cresol	240	
2,4-Dinitrophenol	<.1	
4,6-Dinitro-o-cresol	100	
Pentachlorophenol	290	
4-Nitrophenol	<.02	
PURGEABLES		
Methylene chloride		No results available because of instrument malfunction.
1,1-Dichloroethane		
1,2-Trans-dichloroethylene		
Chloroform		
1,2-Dichloroethane		
1,1,1-Trichloroethane		
Carbon tetrachloride		
Dichlorobromomethane		
1,2-Dichloropropane		
Benzene		
Trichloroethylene		
Chlorodibromomethane		
1,1,2-Trichloroethane		
Methyl bromide		
Bromoform		
1,1,2,2-Tetrachloroethane		
Tetrachloroethylene		
Toluene		
Chlorobenzene		
Ethylbenzene		

TABLE 19. (Continued)

Priority Pollutant	Influent (µg/l)	Return Sludge (µg/l)	Effluent (µg/l)
CLASSICAL			
TOTAL CYANIDES (mg/l)*	.26*	.28*	.13*
TOTAL PHENOL	190	198	273
TOTAL METALS			
Arsenic	20	50	20
Selenium	<10	<10	<10
Cadmium	<1	5	<1
Beryllium	<5	30	<5
Copper	130	36,000	120
Antimony	<10	<10	<10
Chromium	88	12,000	48
Nickel	23	1,400	13
Zinc	130	5,800	110
Silver	<10	<10	<10
Thallium	<10	<10	<10
Lead	<10	590	<10
Mercury	<2.0	8.0	<2.0
ORGANICS (GAS CHROMATOGRAPHY)			
PURGEABLES			
Benzene	<40	N.A.	<40
Chloroform	2,240	"	<10
Methylene Chloride	10,400	"	<10
Bromoform	56	"	<10
Toluene	37	"	<10
Trichloroethylene	1,620	"	<10
Chlorobenzene	N.D.	"	N.D.
1,1,1-trichloroethane	<10	"	<10
1,2-dichloroethane	<10	"	<10
1,1,2,2-tetrachloroethane	<10	"	<10
POLYNUCLEAR AROMATICS			
Naphthalene	<10	<10	<10
2-Chloronaphthalene	<10	<10	<10
Benzo(a)anthracene	<10	<10	<10
Benzo(a)pyrene	<43	<44	<22
3,4-Benzofluoranthene	N.D.	N.D.	N.D.
Benzo(k)fluoranthene	N.D.	N.D.	N.D.
Chrysene	<10	<10	<10
Acenaphthylene	<10	<10	<10
Anthracene/Phenanthrene	<10/<10	<10/<10	<10/<10
Benzo(g,h,i)perylene	N.D.	N.D.	N.D.
Fluorene	<16	<16	<10
Dibenzo(a,h)anthracene	<92	<94	<48
Indeno(1,2,3-cd)pyrene	N.D.	N.D.	N.D.
Pyrene	<10	<10	<10

(Continued)

TABLE 19. (Continued)

Priority Pollutant	Influent (µg/l)	Return Sludge (µg/l)	Effluent (µg/l)
PHENOLICS			
Phenol	23	12	1.3
PESTICIDES			
Lindane	<10	105	<10

*Note: Total Cyanides expressed in mg/l.

**Key: N.D. - Not Detectable, or less than detectable limits
N.A. - Not Applicable
N.S. - No Standard Available
N.P. - No Procedure Available

Plant 7

Wastewater Treatment System--

A flow diagram of Plant 7's wastewater treatment system is shown in Figure 10. Wastewaters generated by the manufacturing of agricultural chemicals, including pesticides, are treated by a process consisting of (1) lime precipitation, (2) equalization, (3) acid/base neutralization, (4) activated sludge treatment, and (5) polishing in an aerated lagoon. Normally the activated sludge unit is operated without wasting sludge.

The average wastewater flow entering the treatment system is 200 gpm. The flow may be split to enter two parallel equalization basins. Normally equalization basin No. 1 receives 134 gpm, and equalization basin No. 2 receives 66 gpm. The average detention time for each basin is 3 days. Flows from the two basins are recombined for acid/base neutralization prior to being fed into the aeration basin of the activated sludge unit.

The aeration basin has a volume of 956,000 gallons, a depth of 15 feet, and a surface area of 16,800 feet^2. The basin is equipped with five 75-hp mechanical aerators. Each aerator is rated for an oxygen transfer rate of 240 pounds per hour. The average detention time in the basin is 3 days.

The final clarifier is 30 feet in diameter and 12 feet deep, with an average detention time of 5 hours. The treated water flows from the clarifier to an aerated polishing lagoon containing five 30-hp mechanical aerators prior to final discharge. Little additional biological removal as measured by TOC occurs in this lagoon. The average detention time in the lagoon is 13 days.

In addition to the described wastewater system, this facility employs two deep-well systems for disposal of wastewaters from specific process units. The plant currently produces only two pesticide products; a third pesticide producing unit has been idle since October, 1977. Wastewater from only one of the operating pesticide units goes to the biological treatment system; wastewater from the other unit goes into one of the deep-well systems.

Sample Collection--

The survey of this facility was conducted during the period June 27-30, 1978. Composite samples were collected within a 72-hour period at four locations in the biological treatment system (Figure 9):

(1) Influent to aeration basin (water phase)
(2) Effluent from final clarifier (water phase)
(3) Return sludge (residual phase)
(4) Air-stripper sampler (air phase)

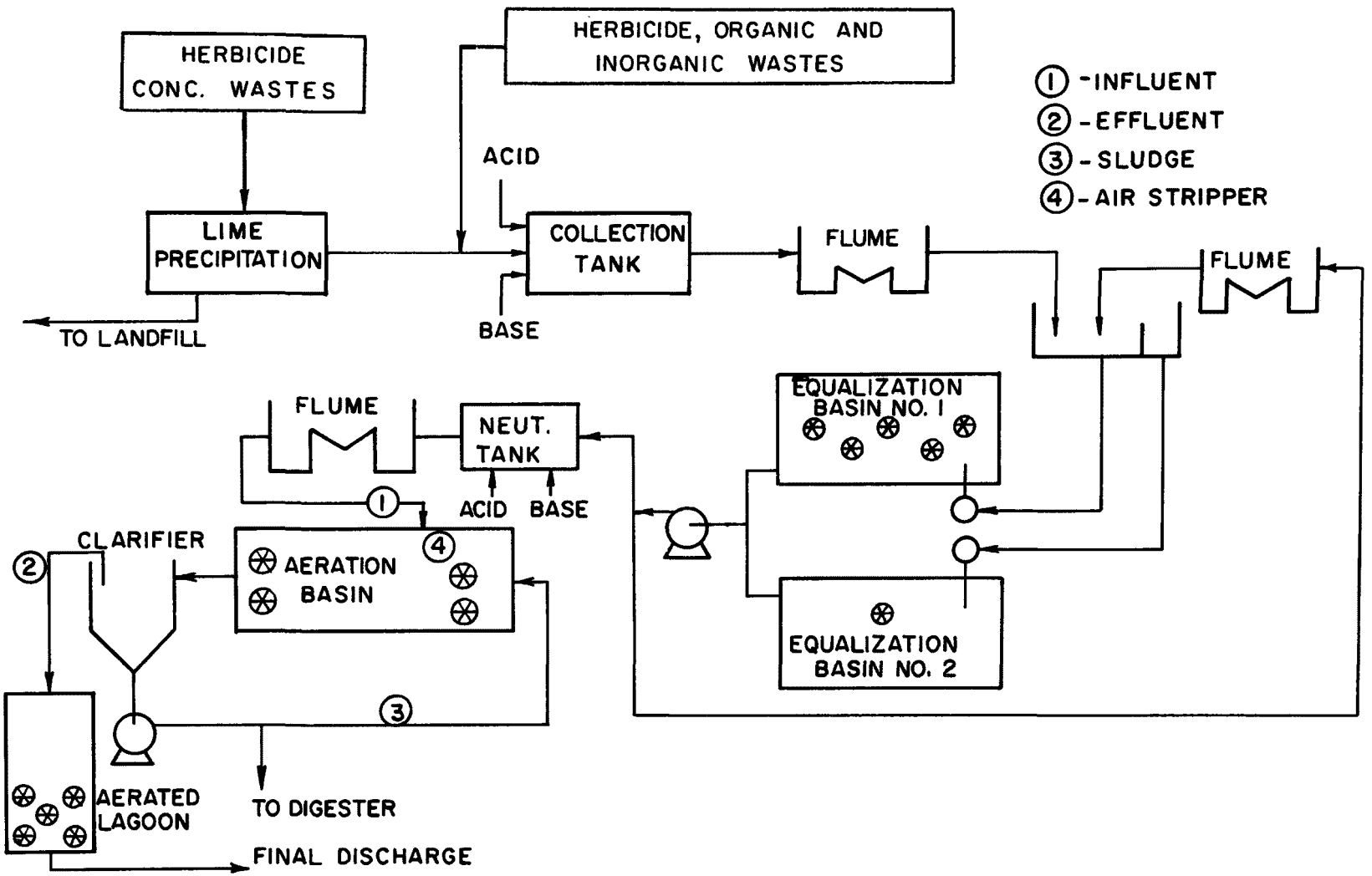

Figure 10 - WASTEWATER TREATMENT SYSTEM - PLANT 7

The air-stripper sampler was located in the aeration basin near the influent point. The air-stripper sampler was placed in operation at 8:30 am, June 27, and operations concluded at 3:30 pm, June 29, for a total operating time of 55 hours. Air charged to the stripper averaged 60 cfh, and the quantity of air to the XAD-2 scrubber was 30 cfh. Stripped air was collected on the Tenax column for 10 minutes on each of the 3 days the sampler was operating.

Twenty-four equal aliquots were collected manually from the water and residual phase sampling points beginning at 8:45 am, June 27. Aliquots were collected at intervals of approximately 3 hours. The final aliquot was collected at 3 am, June 30.

Samples were collected for those priority pollutants which were found in the previous priority pollutant screening survey, or which might be expected to be found if all plant processes were in operation. Samples were preserved by prescribed EPA methods. All samples were kept on ice throughout the sampling period. At the end of the sampling period, grab samples for VOA analyses were collected from the water-phase sample points. A detailed sampling schedule is presented in Table 20.

TABLE 20. SAMPLING SCHEDULE (PLANT 7)

Date	Time	Sample taken	Remarks
6/27/78	8:45 am	Composite aliquots	
	12:00 Noon	"	
	3:00 pm	"	Tenax, 10 min.
	6:00 pm	"	each
	12:00 Midnight	"	
6/28/78	3:00 am	"	
	6:00 am	"	
	9:00 am	"	
	12:00 Noon	"	
	3:00 pm	"	Tenax, 10 min.
	6:00 pm	"	each
	9:00 pm	"	
	12:00 Midnight	"	
6/29/78	3:00 am	"	
	6:00 am	"	
	9:00 am	"	
	12:00 Noon	"	Tenax, 10 min.
	3:00 pm	VOA grab samples	each
	6:00 pm	Composite aliquots	
	9:00 pm	"	
	12:00 Midnight	"	
6/30/78	2:00 am	"	
	4:00 am	"	

Duplicate sets of all samples, with the exception of the XAD slurry and Tenax columns, were collected and given to plant representatives.

Influent and effluent flow data for the sample period are presented in Table 21.

TABLE 21. DAILY FLOW DATA (PLANT 7)

Date	Influent* (mgd)	Return Sludge (mgd)	Effluent** (mgd)
June 27, 1978	0.25	Not Available	0.13
June 28, 1978	0.27	"	0.13
June 29, 1978	0.38	"	0.14

*Flows entering the bio system before equalization.
**Flows exiting aerated lagoon (final plant discharge).

Analytical Results--

Priority pollutants for which samples were collected and analyzed are presented in Table 22. All extractions and analyses were conducted at RSKERL.

TABLE 22. ANALYTICAL DATA (PLANT 7)

Priority Pollutant	Sparged Air, XAD-2 (μg)	Sparged Air, Tenax (μg)
POLYNUCLEAR AROMATICS		
Naphthalene	<.005	
2-Chloronaphthane	<.005	
Acenaphthalene	<.006	
Acenaphthene	.5	
Fluorene	<.013	
Phenanthrene/Anthracene	6	
Fluoranthene	2	
Pyrene	<.004	
1,2-Benzanthracene	<.006	
Chrysene	<.005	
3,4-Benzopyrene	<.035	
1,2:5,6-Dibenzanthracene	N.D.	
PHENOLICS		
2-Chlorophenol	74	
2-Nitrophenol	<.02	
Phenol	260	
2,4-Dimethylphenol	8	
2,4-Dichlorophenol	39	
2,4,6-Trichlorophenol	16	
4-Chloro-m-cresol	<.1	
2,4-Dinitrophenol	100	
4,6-Dinitro-o-cresol	11	
Pentachlorophenol	14	
4-Nitrophenol	<.02	
PURGEABLES		
Methylene chloride		<.02
1,1-Dichloroethane		<.01
1,2-Trans-dichloroethylene		<.25
Chloroform		1
1,2-Dichloroethane		.01
1,1,1-Trichloroethane		<.05
Carbon tetrachloride		<.1
Dichlorobromomethane		.3
1,2-Dichloropropane		<.01
Benzene		.01
Trichloroethylene		.002
Chlorodibromomethane		<.01
1,1,2-Trichloroethane		<.05
Methyl bromide		<.25
Bromoform		<.01
1,1,2,2-Tetrachloroethane		<.025
Tetrachloroethylene		<.05
Toluene		.006
Chlorobenzene		<.01
Ethylbenzene		<.01

TABLE 22. (Continued)

Priority Pollutant	Influent (µg/l)	Return Sludge (µg/l)	Effluent (µg/l)
CLASSICAL			
TOTAL CYANIDES (mg/l)*	.04	.25	.04
TOTAL PHENOL	13,700	79	<100
TOTAL METALS			
Arsenic	10	<10	10
Selenium	<10	<10	<10
Cadmium	2	11	<1
Beryllium	10	1	<5
Copper	40	230	<10
Antimony	220	350	60
Chromium	51	190	31
Nickel	1,600	2	510
Zinc	1,500	4,300	830
Silver	<5	<5	<5
Thallium	<5	<5	<5
Lead	5	110	5
Mercury	<5.0	Sample lost	<5.0
ORGANICS (GAS CHROMATOGRAPHY)			
PURGEABLES			
Benzene	<40	N.A.	<40
Toluene	<10	"	<10
Ethylbenzene	<10	"	<10
1,1,1-Trichloroethylene	<10	"	<10
PESTICIDES			
Aldrin	<10	<10	<10
Dieldrin	<10	<10	<10
Chlordane	<10	<10	<10
DDT	<10	<10	<10
4,4'-DDT	<10	<10	<10
4,4'-DDE	<10	<10	<10
4,4'-DDD	<10	<10	<10
a-endosulfan-Alpha	<10	<10	<10
b-endosulfan-Beta	<10	<10	<10
Endosulfan sulfate	<10	<10	<10
Endrin	<10	<10	<10
Endrinaldehyde	<10	<10	<10
Heptachlor	<10	<10	<10
Heptachlor epoxide	<10	<10	<10

(Continued)

TABLE 22. (Continued)

Priority Pollutant	Influent (µg/1)	Return Sludge (µg/1)	Effluent (µg/1)
PESTICIDES (Continued)			
a-BHC-Alpha	<10	<10	<10
b-BHC-Beta	<10	<10	<10
r-BHC (lindane)-Gamma	<10	<10	<10
g-BHC-Delta	<10	<10	<10
Toxaphene	<10	<10	<10
PHENOLICS			
Phenol	5,290	18	24
4-Nitrophenol	103	N.D.	N.D.
2-Nitrophenol	17	2	71
2,4-Dimethylphenol	N.D.	N.D.	N.D.
2,4-Dichlorophenol	2	3	20
2,4-Dinitrophenol	36	14	96
2,4,6-Trichlorophenol	4	1	4
NITROSAMINES			
N-nitrosodimethylamine	A nitroso specific thermal detector not available		
N-nitrosodiphenylamine			
N-nitrosodi-N-propylamine			

*Note: Total Cyanides expressed in mg/1.
**Key: N.D. - Not Detectable, or less than detectable limits
N.A. - Not Applicable
N.S. - No Standard Available
N.P. - No Procedure Available

RUBBER INDUSTRY

Plant 8

Wastewater Treatment System--

A flow diagram of Plant 8's wastewater treatment system is shown in Figure 11. Wastewater generated by the manufacturing of rubber and associated products is treated by a process consisting of (1) equalization, (2) neutralization, and (3) activated sludge treatment. Normally, the activated sludge unit is operated without wasting of sludge.

Treatment of the wastewater begins when process water from the various plant units enters the equalization basin at the design flow of 1,200 gpm. Volume of the basin is 8.0 million gallons with an average detention time of 110 hours at the design flow rate of 1,200 gpm.

From the equalization basin, wastewater is pumped to a neutralization basin for pH adjustment and addition of nutrients. An antifoaming agent is also added here if needed. Volume of the neutralization basin is 138,000 gallons with an average detention time of 2.0 hours at the design flow of 1,200 gpm.

From the neutralization basin, the wastewater is split to flow into two parallel aeration basins with a combined volume of 700,000 gallons. The design influent flow to each basin is 600 gpm. Each basin contains three 25-horsepower mechanical aerators. Average detention time in the aeration basins is 6.5 hours at the design flow rate.

Effluent from the aeration basins flows into a clarifier which has a diameter of 60 feet and a volume of 300,000 gallons. Retention time is 4 hours at the design flow of 1,200 gpm. Effluent from the clarifier merges with chlorinated effluent from the plant's sanitary waste treatment system for final discharge.

The plant has a 25-million-gallon stormwater basin to retain excess waters during heavy rainfall. Water from the basin is bled back through the treatment system.

Sample Collection--

The survey of this facility was conducted during the period July 10-13, 1978. Composite samples were collected within a 72-hour period at four locations in the biological treatment system:

1. Influent to aeration basin (water phase)
2. Effluent from final clarifier (water phase)
3. Return sludge (residual phase)
4. Air-stripper (air phase)

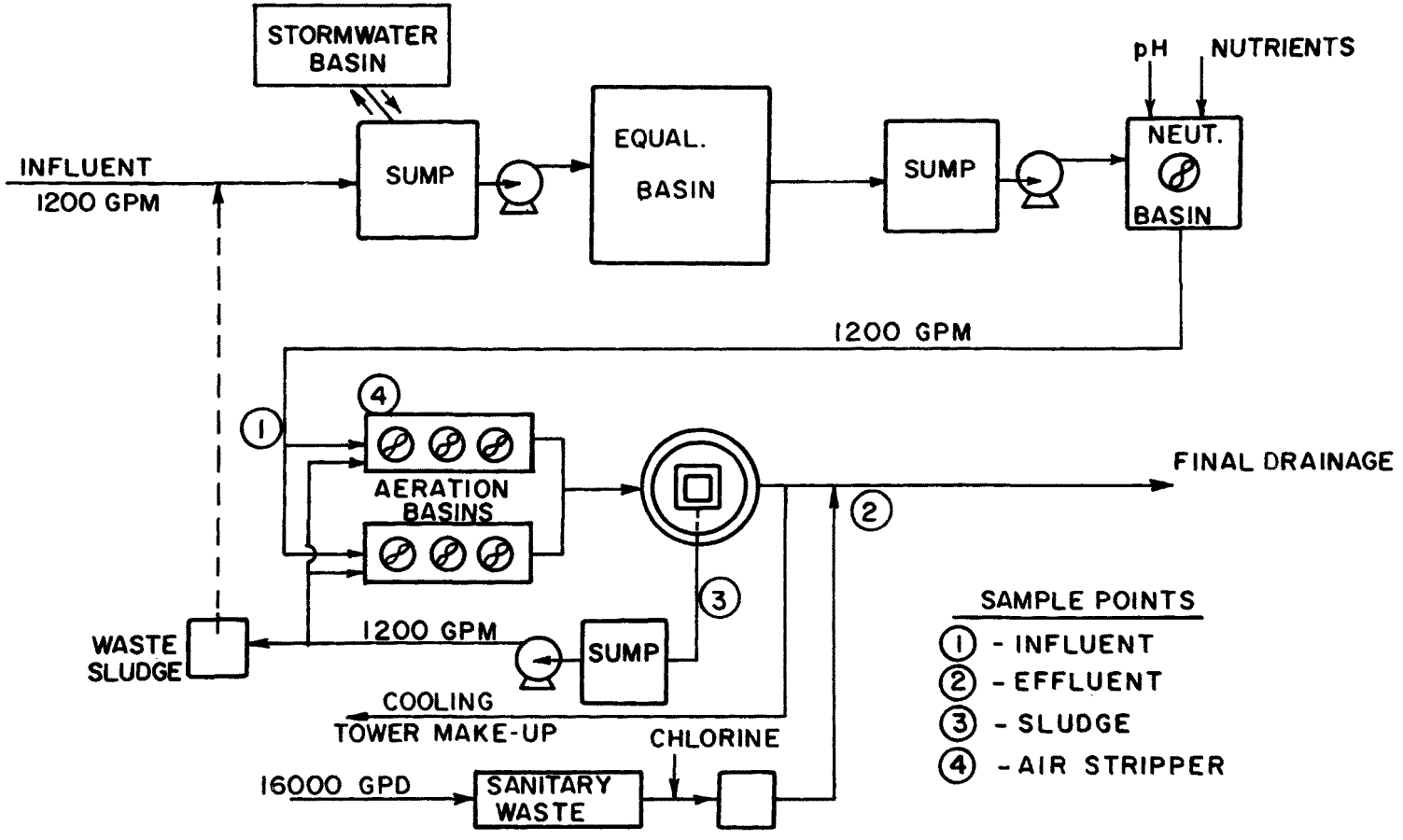

Figure 11 - WASTEWATER TREATMENT SYSTEM - PLANT 8

The air-stripper sampler was located in one of the aeration basins as near the influent point as possible. The air-stripper sampler was placed in operation at 5:30 pm, July 10, 1978, and operation was concluded at 1:30 pm on July 13, for a total operating time of 68 hours. Air charged to the stripper averaged 60 cfh, and the quantity of air to the XAD-2 scrubber was 30 cfh. Stripped air was collected on the Tenax column for 15 minutes on each of the three days the sampler was operating.

Twenty-four equal aliquots were collected manually from the water- and residual-phase sampling points beginning at 5:30 pm, July 10. Aliquots were collected at intervals of approximately 3 hours. The final aliquot was collected at 2:30 pm, July 13. A detailed sampling schedule is presented in Table 23.

TABLE 23. SAMPLING SCHEDULE (PLANT 8)

Date	Time	Sample taken	Remarks
7/10/78	5:30 pm	Composite aliquots	
	8:30 pm	"	
	11:30 pm	"	
7/11/78	2:30 pm	"	
	5:30 am	"	
	8:30 am	"	
	11:30 am	"	
	2:30 pm	"	Tenax, 15 minutes each
	5:30 pm	"	
	8:30 pm	"	
	11:30 pm	"	
7/12/78	2:30 am	"	
	5:30 am	"	
	8:30 am	"	
	11:30 am	"	
	2:30 pm	"	Tenax, 15 minutes each
	5:30 pm	"	
	8:30 pm	"	
	11:30 pm	"	
7/13/78	2:30 am	"	
	5:30 am	"	
	8:30 am	"	
	11:30 am	"	
	2:30 pm	"	+ VOA grab samples Tenax, 15 minutes each

Samples were collected for those priority pollutants which were found in the previous priority pollutant screening survey or which might be expected to be found if all plant processes were in operation. All samples were preserved by prescribed EPA methods and kept on ice throughout the sampling period. At the end of the sampling period, grab samples for VOA analyses were collected from the water-phase sample points. Duplicate samples from the water- and residual-phase sample points were furnished to company personnel as requested.

Flow measurements are not taken routinely at the points where samples were collected; however, plant personnel estimated that throughput during the sampling period averaged approximately 2.4 mgd with a feed rate of 1.9 mgd and return sludge rate of 0.7 mgd.

Analytical Results--

The priority pollutants for which samples were collected and analyzed are presented in Table 24. All extractions and analyses were performed at RSKERL.

TABLE 24. ANALYTICAL DATA (PLANT 8)

Priority Pollutant	Sparged Air, XAD-2 (µg)	Sparged Air, Tenax (µg)
POLYNUCLEAR AROMATICS		
Naphthalene	2,560	
2-Chloronaphthane	<5	
Acenaphthalene	66	
Acenaphthene	<3	
Fluorene	<13	
Phenanthrene/Anthracene	17	
Fluoranthene	<4	
Pyrene	<4	
1,2-Benzanthracene	<6	
Chrysene	<5	
3,4-Benzopyrene	<35	
1,2:5,6-Dibenzanthracene	N.D.	
PHENOLICS		
2-Chlorophenol	54	
2-Nitrophenol	1,100	
Phenol	7,800	
2,4-Dimethylphenol	2,100	
2,4-Dichlorophenol	950	
2,4,6-Trichlorophenol	1,800	
4-Chloro-m-cresol	660	
2,4-Dinitrophenol	7,000	
4,6-Dinitro-o-cresol	910	
Pentachlorophenol	940	
4-Nitrophenol	1,200	
PURGEABLES		
Methylene chloride		Lost sample - Analytical equipment malfunction
1,1-Dichloroethane		
1,2-Trans-dichloroethylene		
Chloroform		
1,2-Dichloroethane		
1,1,1-Trichloroethane		
Carbon tetrachloride		
Dichlorobromomethane		
1,2-Dichloropropane		
Benzene		
Trichloroethylene		
Chlorodibromomethane		
1,1,2-Trichloroethane		
Methyl bromide		
Bromoform		
1,1,2,2-Tetrachloroethane		
Tetrachloroethylene		
Toluene		
Chlorobenzene		
Ethylbenzene		

TABLE 24. (Continued)

Priority Pollutant	Influent (µg/1)	Return Sludge (µg/1)	Effluent (µg/1)
CLASSICAL			
TOTAL CYANIDES (mg/1)*	<.08	<.08	<.08
TOTAL PHENOL	1,190	139	24
TOTAL METALS			
Arsenic	<10	220	<10
Selenium	<10	<10	<10
Cadmium	1	67	<1
Beryllium	<3	16	<3
Copper	22	2,100	<10
Antimony	<10	<10	<10
Chromium	230	28,000	49
Nickel	89	3,500	54
Zinc	1,200	150,000	180
Silver	<10	14	<10
Thallium	<10	<10	<10
Lead	13	2,600	<10
Mercury	<1.5	<5.0	<5.0
ORGANICS (GAS CHROMATOGRAPHY)			
PURGEABLES			
Benzene	<40	N.A.	<40
Toluene	624	N.A.	<10
Ethylbenzene	<10	N.A.	<10
PHENOLICS			
Phenol	1	15	3
2-Nitrophenol	26	52	25
2,4-Dinitrophenol	185	483	102
4-Nitrophenol	86	485	103
2-Chlorophenol	N.D.	18	N.D.
2,4,6-Trichlorophenol	N.D.	43	N.D.
NITROSAMINES			
N-nitrosodiphenylamine	A nitroso specific thermal detector not available.		

*Note: Total Cyanides expressed in mg/1.
**Key: N.D. - Not Detectable, or less than detectable limits
N.A. - Not Applicable
N.S. - No Standard Available
N.P. - No Procedure Available

Plant 9

Wastewater Treatment System--

A flow diagram of Plant 9's wastewater treatment system is shown in Figure 12. Wastewater generated by the manufacturing of rubber and other products is treated by a process that generally consists of (1) equalization, (2) dissolved air flotation, (3) cooling, and (4) activated sludge treatment. Normally this activated sludge unit is operated without any wasting of sludge. The plant has operated this system for a number of years and has not found a need for sludge-wasting.

Treatment of the wastewater begins when water from the rubber plant is split into two 1,000-gpm streams and flows into two parallel equalization basins. Each basin has a 4-hour detention time at 1,250 gpm. Wastewater from the equalization basins is flash-mixed with cationic coagulant aid in a 7,500-gallon tank. The wastewater then flows to a dissolved air flotation (DAF) unit with anionic coagulant aid added as needed in line to the DAF.

From the DAF unit, a portion of the wastewater (approximately 1,500 gpm) flows to a cooling tower for temperature conrol. After cooling, caustic, acid, and/or ammonia are added to the wastewater as required. Also, wastewaters from an oil separator and oil-skimming basin are combined with the wastewater.

Next, the wastewater flows into the aeration basin of the activated sludge unit. The aeration basin has a volume of 1.48 x 10^6 gallons, a depth of 17 feet, and a surface area of 16,870 $feet^2$. The aeration basin is equipped with four 50-horsepower mechanical aerators. These aerators are rated for an oxygen transfer rate of 450-500 pounds per hour. The clarifier is about 85 feet in diameter and 18 feet deep. Treated water (effluent) flows from the clarifier to the bayou.

Sample Collection--

Based on Effluent Guidelines Division's previous screening survey studies, the list of compounds in Table 27 was compiled. This list represents the priority pollutants that were expected to be present in Plant 9's influent to the treatment system. From this list, it was determined that four 1-gallon samples of composites were required for specific organic compound analysis.

The locations of the sampling points are shown in Figure 12. The influent sample was taken just before the wastewater flows into the aeration basin. The influent sample was taken from the plant's sample pump. The return sludge sample was taken from the return sludge pump. The air-stripper sampler was placed in the aerator basin just in front of the point where influent enters the basin.

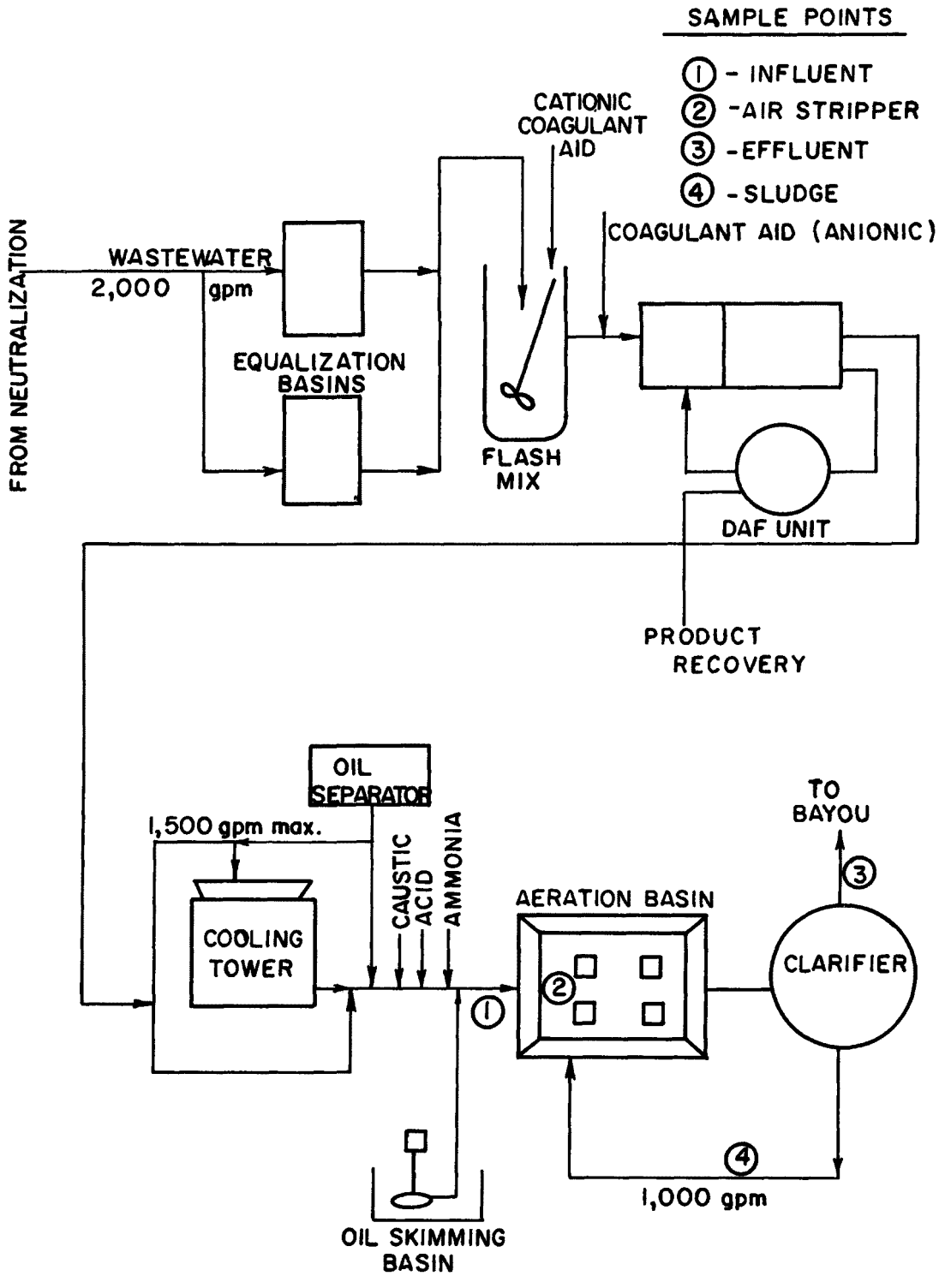

Figure 12 - WASTEWATER TREATMENT SYSTEM - PLANT 9

Samples of the influent, effluent, and return sludge were composited. Every 3 hours beginning at 3 pm on July 17, 1978, the first day, four 130-milliliter aliquots were taken at each sample point for specific organics analysis. Then, beginning at 2 pm on July 18, the second day, composites were taken every 3 hours. In addition, three 40-milliliter aliquots were taken for cyanide, phenolics, and metals at the same time as the organics samples were taken. Each cyanide, phenolics, and metals sample was preserved at 8 pm on July 17. These samples were preserved by adding 5 ml of nitric acid to the metals sample, 2 ml of sodium hydroxide to the cyanides sample, and 2 ml of phosphoric acid to the phenolics sample. At all times, each of the samples was kept on ice. At 7:30 pm on July 19, VOA samples were taken for the influent and effluent. A detailed sampling schedule is presented in Table 25.

TABLE 25. SAMPLING SCHEDULE (PLANT 9)

Date	Time	Sample taken	Remarks
7/17/78	3:00 pm	Composites*	
	6:00 pm	"	
	8:00 pm	"	Added 5 ml HNO_3, 2 ml
	9:00 pm	Composites	NaOH, 2 ml H_3PO_4 to
	12 Midnight	"	metals, cyanide, and
7/18/78	3:00 am	"	phenolics
	6:00 am	"	
	9:00 am	"	
	12 Noon	"	
	2:00 pm	"	
	5:00 pm	"	
	8:00 pm	"	
	11:00 pm	"	
7/19/78	2:00 am	"	
	5:00 am	"	
	8:00 am	"	
	11:00 am	"	
	1:00 pm	"	
	4:00 pm	"	
	7:00 pm	"	
	7:30 pm	VOA	
	10:00 pm	Composites	
7/20/78	1:00 am	Composites	
	4:00 am	"	
	6:00 am	"	
	7:30 am	"	

*Composites consist of four 130-ml aliquots for organics, three 40-ml aliquots for cyanide, phenolics and metals.

The air-stripper sampler was placed in operation at 7 pm on July 18, 1978, and operations were concluded at 7:40 am on July 20, for a total operating time of 60 hours and 40 minutes. Air charged to the stripper averaged 60 cfh, and the quantity of air to the XAD-2 scrubber was 30 cfh. Stripped air was collected on the Tenax column for 10 minutes three times while the sampler was in operation.

Daily flow data for the sample period are presented in Table 26.

TABLE 26. DAILY FLOW DATA (PLANT 9)

Date	Time	Influent (gpm)
7/18/78	9:00 am	2,190
7/19/78	9:00 am	2,220
7/19/78	6:30 pm	2,340

Analytical Results--

Priority pollutants for which samples were collected and analyzed are presented in Table 27. All extractions and analyses of samples were conducted at RSKERL.

TABLE 27. ANALYTICAL DATA (PLANT 9)

Priority Pollutant	Sparged Air, XAD-2 (µg)	Sparged Air, Tenax (µg)
POLYNUCLEAR AROMATICS		
Naphthalene	Undefinable gas chromatogram obtained because of matrix interferences	
2-Chloronaphthane		
Acenaphthalene		
Acenaphthene		
Fluorene		
Phenanthrene/Anthracene		
Fluoranthene		
Pyrene		
1,2-Benzanthracene		
Chrysene		
3,4-Benzopyrene		
1,2:5,6-Dibenzanthracene		
PHENOLICS		
2-Chlorophenol	Undefinable gas chromatogram obtained because of matrix interferences	
2-Nitrophenol		
Phenol		
2,4-Dimethylphenol		
2,4-Dichlorophenol		
2,4,6-Trichlorophenol		
4-Chloro-m-cresol		
2,4-Dinitrophenol		
4,6-Dinitro-o-cresol		
Pentachlorophenol		
4-Nitrophenol		
PURGEABLES		
Methylene chloride		.01
1,1-Dichloroethane		.5
1,2-Trans-dichloroethylene		.2
Chloroform		.2
1,2-Dichloroethane		<.1
1,1,1-Trichloroethane		<.05
Carbon tetrachloride		<.1
Dichlorobromomethane		<.05
1,2-Dichloropropane		<.01
Benzene		<.02
Trichloroethylene		.07
Chlorodibromomethane		<.01
1,1,2-Trichloroethane		<.05
Methyl bromide		<.25
Bromoform		<.01
1,1,2,2-Tetrachloroethane		<.02
Tetrachloroethylene		<.05
Toluene		<.01
Chlorobenzene		<.01
Ethylbenzene		<.01

TABLE 27. (Continued)

Priority Pollutant	Influent (µg/l)	Return Sludge (µg/l)	Effluent (µg/l)
CLASSICAL			
TOTAL CYANIDES (mg/l)*	<.05	<.05	<.05
TOTAL PHENOL	778	<20	<20
TOTAL METALS			
Arsenic	<10	17	<10
Selenium	<10	<10	<10
Cadmium	1	2	1
Beryllium	<3	<3	<3
Copper	24	410	440
Antimony	<10	<10	<10
Chromium	36	1,300	30
Nickel	<10	36	<10
Zinc	120	250	300
Silver	<10	<10	<10
Thallium	<10	10	<10
Lead	10	70	10
Mercury	<1.2	3.5	<0.5
ORGANICS (GAS CHROMATOGRAPHY)			
PURGEABLES			
Chloroform	<10	N.A.	<10
Carbon tetrachloride	<10	"	<10
Methylene chloride	<10	"	<10
Toluene	35	"	<10
Ethylbenzene	29	"	<10
1,1,1-Trichloroethane	<10	"	<10
ACRYLONITRILE	<10,000	N.A.	<10,000
POLYNUCLEAR AROMATICS			
Phenanthrene/Anthracene	235	110	<10
Naphthalene	155	<10	<10
Pyrene	<10	12	<10
PHENOLICS			
Phenol	322	1,802	3
2-Chlorophenol	7	207	3
2,4,6-Trichlorophenol	15	72	1
2,4-Dinitrophenol	183	N.D.	140
Pentachlorophenol	252	N.D.	142
4-Nitrophenol	70	133	224

(Continued)

TABLE 27. (Continued)

Priority Pollutant	Influent (µg/l)	Return Sludge (µg/l)	Effluent (µg/l)
NITROSAMINES			
N-nitrosodiphenylamine	A nitroso specific thermal detector not available.		

*Note: Total Cyanides expressed in mg/l.

**Key: N.D. - Not Detectable, or less than detectable limits
N.A. - Not Applicable
N.S. - No Standard Available
N.P. - No Procedure Available

WOOD-PRESERVATIVES INDUSTRY

Plant No. 10

Wastewater Treatment System--

A flow diagram of Plant 10's wastewater treatment system is shown in Figure 13. Wastewater generated by the wood-treating process flows into a cooling-water pond and is recirculated from the pond through the condensor and back to the pond. As the level of the pond rises as a result of the addition of wastewater, a portion of the water is removed and treated. The treatment system generally consists of (1) chemical flocculation, (2) nutrient addition, (3) aeration, (4) spray pond evaporation, and (5) total retention.

Treatment begins when the flocculation tank is filled with an approximately 5,000-gallon batch of water from the pond. A Bentonitic clay is then mixed in a drum with water and added to the tank. This is well mixed into the water, and then a cationic liquid polymer is added, which serves only to gather the floc particles together to increase their size and speed settling of the floc. The tank is allowed to settle for 1 1/2 to 3 hours, after which the clarified water is pumped from the tank to the aeration basin. The tank (7 feet high) is decanted to within only 18 inches of the bottom. The sludge from the first batch will all be below this point and is not removed at this time; instead, the tank for the next batch flocculation is refilled as needed. The sludge will react with the new floc in the same way as did the clay in the first mix; so no more clay is added, only the polymers. Again, the tank is allowed to settle. Afterwards it is decanted and remixed until the sludge is near the decant level, at which time the sludge is pumped to drying beds. The sludge has excellent drying characteristics, unlike some others, and when dry is seemingly unaffected by rainfall. When dry, the sludge from 60 to 80 thousand gallons of water will be approximately 3 cubic yards and can easily be handled for disposal at a landfill. The next step in the process is aeration and nutrient addition. Ammonium nitrate and phosphate fertilizers are added daily at the rate of approximately 20 pounds of nitrogen and 1 pound of phosphate for each 100 pounds of COD. Clarified water is transferred to a 1-million-gallon aerated lagoon.

Air is supplied by two 10-hp positive displacement blowers with a rated capacity of 150 cfm each. These blowers supply air through a pipe system at a depth of 4 feet. After the aeration basin, the effluent flows to a smaller settling pond where most of the biological sludge settles and is returned to the aeration basin. The effluent then flows to a large pond, where it is extensively sprayed into the air for evaporation and aeration purposes. Following the spray lagoon, the wastewater finally

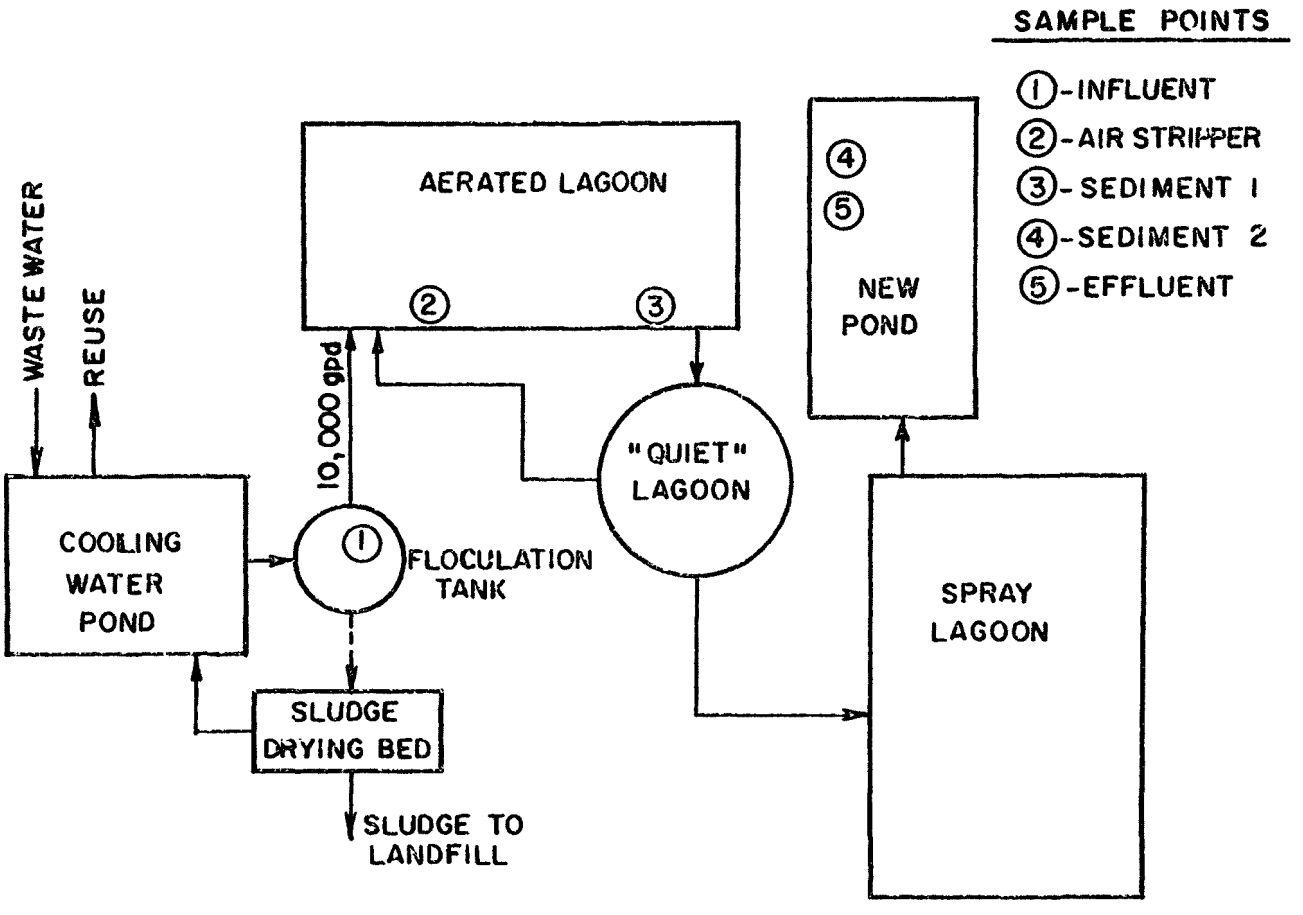

Figure 13 - WASTEWATER TREATMENT SYSTEM - PLANT 10

flows to a 1-million-gallon retention pond. One notable feature of this plant is the fact that it does not discharge any effluent. Normally the wastewater is disposed of entirely by evaporation.

Sample Collection--

Based on the previous Effluent Guidelines Division Screening Survey study, the list of compounds in Table 30 was compiled. This list represents the priority pollutants that have been identified in Plant No. 10's influent to the aerated lagoon. From this list, it was determined that four 1-gallon samples of composite were required for specific organic compound analysis. The locations of the sampling points are shown in Figure 12. The sample of the influent to the treatment system was taken directly out of the top of the flocculation tank. The "effluent" sample was taken from the new pond (or retention pond) at a point farthest from its influent. It should be noted that this plant does not normally discharge any effluent; however, the "effluent" sample point represents the water that would be discharged if an effluent were allowed.

Two sediment samples were taken. One sample was taken from the aerated lagoon, and the other was taken from the final retention pond. The aerated lagoon sediment sample was taken near the point where the wastewater flows from this lagoon to the "quiet" lagoon." The final lagoon sediment sample was taken near the "effluent" sampling point. The air-stripper sampler was set up in the aerated lagoon just off the walkway located approximately 60 feet from the point where the influent enters the system.

Clarified water from the flocculation tank was added twice daily (during daylight hours) to the aeration lagoon; thus sampling times were coordinated to the operation of the flocculation tank. All liquid samples were taken during the times influent was being added to the treatment system. One-sixth of the total volume of composite required was collected for each batch of influent. Effluent samples were collected at the same time as were influent samples. A detailed sampling schedule is presented in Table 28.

The air-stripper sampler was placed in operation at 2:58 pm on June 20, 1978, and operation was concluded at 10:50 am on June 22 (for a total operating time of 12 hours). The air-stripper sampler was operated during daylight hours to correspond roughly to the liquid sampling. Air charged to the stripper averaged 60 cfh, and the quantity of air to the XAD-2 scrubber was 30 cfh. Stripped air was collected on the Tenax column for 10 minutes each day the stripper was in operation.

Daily flow data for the sample period are presented in Table 29.

TABLE 29. DAILY FLOW DATA (PLANT 10)

Date	Influent (gal.)	Effluent (gal.)
6/20/78	10,000	0
6/21/78	10,000	0
6/22/78	10,000	0

Analytical Results--

Priority pollutants for which samples were collected and analytical results are presented in Table 30. All extractions and analyses were conducted at RSKERL.

TABLE 28. SAMPLING SCHEDULE (PLANT 10)

Date	Time	Sample taken	Remarks
6/20/78	10:30 am	Influent[1] composites "Effluent" composites	
	3:30 pm	Influent composites "Effluent" composites	Added 2 ml NaOH[2] to cyanides; added 2 ml H_3PO_4 to phenolics samples.
	5:03 pm	Tenax (10 min)[3]	
6/21/78	9:30 am	Influent composites "Effluent" composites	
	1:38 pm	Tenax (10 min)	
	2:30 pm	Influent composites "Effluent" composites	
6/22/78	9:15 am	Sediment samples	
	9:30 am	Influent composites Influent VOA and Blank "Effluent" composites "Effluent" VOA and Blank	
	10:20 am	Tenax (10 min)	
	2:30 pm	Influent composites "Effluent" composites	

1/Influent and effluent composites consisted of 500 ml each for three organics samples, 500 ml for metals, 150 ml for cyanides, and 150 ml for phenolics.

2/Nitric acid was not available for metals preservation.

3/Column No. 4

TABLE 30. ANALYTICAL DATA (PLANT 10)

Priority Pollutant	Sparged Air, XAD-2 (µg)	Sparged Air, Tenax (µg)
POLYNUCLEAR AROMATICS		
Naphthalene	286	
2-Chloronaphthane	46	
Acenaphthalene	<3	
Acenaphthene	54	
Fluorene	28	
Phenanthrene/Anthracene	55	
Fluoranthene	<4	
Pyrene	<4	
1,2-Benzanthracene	<28	
Chrysene	<9	
3,4-Benzopyrene	<15	
1,2:5,6-Dibenzanthracene	N.D.	
PHENOLICS		
2-Chlorophenol	390,000	
2-Nitrophenol	61,000	
Phenol	47,000	
2,4-Dimethylphenol	48,000	
2,4-Dichlorophenol	74,000	
2,4,6-Trichlorophenol	42,000	
4-Chloro-m-cresol	4,500	
2,4-Dinitrophenol	540	
4,6-Dinitro-o-cresol	3,000	
Pentachlorophenol	630	
4-Nitrophenol	5,100	
PURGEABLES		
Methylene chloride		2
1,1-Dichloroethane		.9
1,2-Trans-dichloroethylene		.1
Chloroform		.1
1,2-Dichloroethane		.5
1,1,1-Trichloroethane		.06
Carbon tetrachloride		3
Dichlorobromomethane		2
1,2-Dichloropropane		.2
Benzene		3
Trichloroethylene		<.01
Chlorodibromomethane		.1
1,1,2-Trichloroethane		<.05
Methyl bromide		<.02
Bromoform		.03
1,1,2,2-Tetrachloroethane		<.02
Tetrachloroethylene		4
Toluene		<.01
Chlorobenzene		<.01
Ethylbenzene		<.01

TABLE 30. (Continued)

Priority Pollutant	Influent (µg/l)	Bottom Sediment Dry Weight (µg/kg) Aer. Lag.	Final Pond	Effluent (µg/l)
CLASSICAL				
TOTAL CYANIDE (mg/l)*	<.02*	N.P.	N.P.	<.02*
TOTAL PHENOL	170,000	"	"	<100
TOTAL METALS				
Arsenic	60	9,300	7,600	20
Selenium	<10	<4,500	<1,600	<10
Cadmium	<1	2,100	<1,300	<1
Beryllium	<5	<1,900	3,200	<5
Copper	<10	40,000	4,300	<10
Antimony	<10	<3,700	<1,100	<10
Chromium	16	5,600	3,100	<10
Nickel	30	19,000	18,000	<10
Zinc	160	310,000	48,000	<10
Silver	<5	<2,100	<690	<5
Thallium	8	6,300	<690	<5
Lead	<5	<2,100	27,000	<5
Mercury	<.5	<136	<3.4	<.5
ORGANICS (GAS CHROMATOGRAPHY)				
PURGEABLES				
Benzene	187	N.P.	N.P.	<40
Chloroform	<10	"	"	<10
Methylenechloride	<10	"	"	<10
Ethylbenzene	450	"	"	<10
Dichlorobromomethane	<10	"	"	<10
Toluene	300	"	"	<10
POLYNUCLEAR AROMATICS				
Benzo(a)anthracene	<20	3,700	149	<20
Benzo(a)pyrene	<10	<310	<310	<10
3,4-benzofluoranthene	N.S.	N.S.	N.S.	N.S.
Chrysene	<10	4,500	2,060	<10
Acenaphthylene	<10	<100	<100	<10
Benzo(g,h,i)perylene	N.S.	N.S.	N.S.	N.S.
Fluorene	<10	17,600	210	<10
Phenanthrene/Anthracene	<10	19,500	3,390	<10/10
Dibenzo(a,h)anthracene	<10	N.D.	N.D.	<10
Indeno(1,2,3-cd)pyrene	N.S.	N.S.	N.S.	N.S.
Pyrene	<10	5,300	4,140	<10
Acenaphthene	13	5,110	<250	<10
Naphthalene	14,300	<104	<104	<10

TABLE 30. (Continued)

Priority Pollutant	Influent (µg/l)	Bottom Sediment Dry Weight (µg/kg) Aer. Lag.	Final Pond	Effluent (µg/l)
PHENOLICS				
Phenol	47,000	9,030	16,000	N.D.
2,4-dimethylphenol	N.D.	4,398	3,418	N.D.
2-chlorophenol	N.D.	396,000	1,200	N.D.
2,4,6-trichlorophenol	112	N.D.	25,000	116
Pentachlorophenol	1,660	302,010	58,000	663

*Note: Total Cyanide expressed in mg/l.

**Key: N.D. - Not Detectable or less than detectable limits
N.A. - Not Applicable
N.S. - No Standard Available
N.P. - No Procedure Available

Plant 11

Wastewater Treatment System--

A flow diagram of Plant 11's wastewater treatment system is presented in Figure 14. Wastewaters generated by a wood-preserving (creosote) plant are treated by a combined biological/land irrigation process. The process consists of (1) settling, (2) storage, (3) aerated treatment, (4) spray irrigation, and (5) runoff storage. Rainfall runoff water is collected in a storage pond, recycled through 10 spray nozzles, and then bled into the settling basin for treatment.

The average wastewater flow entering the treatment system is 50,000 gallons a day. Wastewater flows from the settling basin to a storage pond prior to entering the aerated lagoon. Detention time in the storage pond and aerated lagoon is 40 to 60 days each.

The aerated lagoon contains four 7.5-hp mechanical aerators. The wastewater is intermittently pumped from the lagoon and sprayed through 18 spray nozzles in three sections onto an eight-acre field growing fescue and sericea lespedeza. Runoff from the field is collected in a runoff storage pond.

Water from the storage pond is recycled to the plant, where it is treated and used as boiler feedwater, cooling water, etc. The plant has no wastewater discharge.

Sample Collection--

The survey of this facility was conducted during the period August 7-10, 1978. Samples were collected at four locations in the treatment system (Figure 14):

(1) Influent to aerated treatment (water phase)
(2) Runoff storage pond (water phase)
(3) Air-stripper sampler (air phase)
(4) Aerated lagoon bottom sediment, grab (residual phase)

The air-stripper sampler was located in the aerated lagoon. The air-stripper sampler was placed into operation at 2:50 pm, August 7, and operation was concluded at 6:50 am on August 10, 1978, for a total operating time of 64 hours. Air charged to the stripper averaged 60 cfh, and the quantity of air to the XAD-2 scrubber was 30 cfh. Stripped air was collected on the Tenax column for 10 minutes on each of the three days the sampler was operated.

Twenty-four aliquots were collected manually from the water-phase sampling points, beginning at 3 pm, August 7. Aliquots were collected at intervals of approximately 3 hours. The final aliquot was collected at 10 am, August 10. A detailed sampling schedule is presented in Table 31.

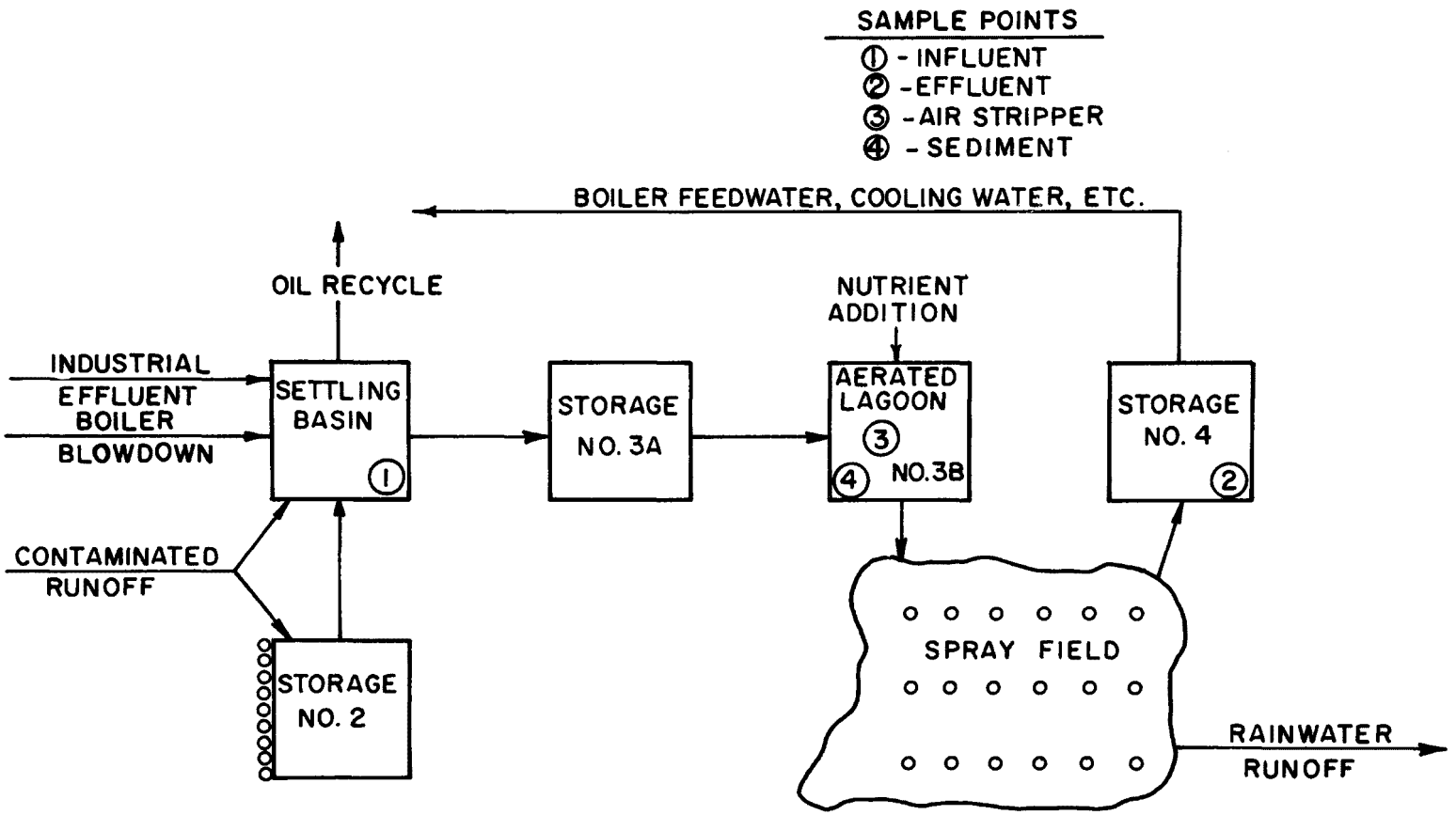

Figure 14 - WASTEWATER TREATMENT SYSTEM - PLANT II

TABLE 31. SAMPLING SCHEDULE (PLANT 11)

Date	Time	Sample taken	Remarks
8/7/78	3:00 pm	Composite aliquots	Rain showers
	6:00 pm	"	"
	9:00 pm	"	"
	12 Midnight	"	"
8/8/78	3:00 am	"	"
	6:00 am	"	"
	9:00 am	"	No rain
	12 Noon	"	"
	3:00 pm	"	Tenax, 20 min.
	6:00 pm	"	
	9:00 pm	"	
	12 Midnight	"	
8/9/78	3:00 am	"	
	6:00 am	"	
	9:00 am	"	
	12 Noon	"	
	3:00 pm	"	Tenax, 20 min.
	6:00 pm	"	
	9:00 pm	"	
	12 Midnight	"	
8/10/78	3:00 am	"	Rain showers
	6:00 am	"	Tenax, 20 min.
	9:00 am	VOA grab samples, bottom sediment sample	
	10:00 am	Final composite aliquot	

Samples were collected for those priority pollutants which were found in the previous priority pollutants screening survey. Samples were preserved by prescribed EPA methods. All samples were kept on ice throughout the sample period.

At the end of the sample period, grab samples for VOA analyses were collected from the water-phase sample points. At this time, a grab sample for the residual phase was collected from the bottom of the aerated lagoon.

Daily flow data for the sample period are presented in Table 32.

TABLE 32. DAILY FLOW DATA (PLANT 11)

Date	Influent* (mgd)	Return Sludge (mgd)	Effluent (mgd)
8/7/78	Not available for these dates	N.A.	0.05
8/8/78		N.A.	0.05
8/9/78		N.A.	0.05

*Average influent flow: 0.05 mgd

Analytical Results--

Priority pollutants for which samples were collected and analyzed are presented in Table 33. All extractions and analyses were conducted at RSKERL.

TABLE 33. ANALYTICAL DATA (PLANT 11)

Priority Pollutant	Sparged Air, XAD-2 (µg)	Sparged Air, Tenax (µg)
POLYNUCLEAR AROMATICS		
Naphthalene	4,230	
2-Chloronaphthane	7	
Acenaphthalene	<3	
Acenaphthene	2	
Fluorene	<5	
Phenanthrene/Anthracene	7	
Fluoranthene	15	
Pyrene	13	
1,2-Benzanthracene	70	
Chrysene	24	
3,4-Benzopyrene	<15	
1,2:5,6-Dibenzanthracene	N.D.	
PHENOLICS		
2-Chlorophenol	<25	
2-Nitrophenol	2,410	
Phenol	24	
2,4-Dimethylphenol	3	
2,4-Dichlorophenol	<50	
2,4,6-Trichlorophenol	<5	
4-Chloro-m-cresol	<25	
2,4-Dinitrophenol	<25	
4,6-Dinitro-o-cresol	<25	
Pentachlorophenol	<25	
4-Nitrophenol	<25	
PURGEABLES		
Methylene chloride		Undefinable GC results because of inaccurate retention time of internal standard
1,1-Dichloroethane		
1,2-Trans-dichloroethylene		
Chloroform		
1,2-Dichloroethane		
1,1,1-Trichloroethane		
Carbon tetrachloride		
Dichlorobromomethane		
1,2-Dichloropropane		
Benzene		
Trichloroethylene		
Chlorodibromomethane		
1,1,2-Trichloroethane		
Methyl bromide		
Bromoform		
1,1,2,2-Tetrachloroethane		
Tetrachloroethylene		
Toluene		
Chlorobenzene		
Ethylbenzene		

TABLE 33. (Continued)

Priority Pollutant	Influent (µg/l)	Bottom Sediment Dry Weight (µg/kg)	Effluent (µg/l)
CLASSICAL			
TOTAL CYANIDE (mg/l)*	<.08*	N.P.	<.08*
TOTAL PHENOL	79,000	N.P.	16
TOTAL METALS			
Arsenic	530	51,000	<50
Selenium	<10	940	<10
Cadmium	< 1	200	< 1
Beryllium	< 5	2,500	< 5
Copper	44	99,000	16
Antimony	<10	<990	<10
Chromium	260	56,000	<10
Nickel	22	18,000	<10
Zinc	70	280,000	100
Silver	<10	<910	<10
Thallium	<10	910	<10
Lead	<10	20,000	15
Mercury	<.5	<20	<.5
ORGANICS (GAS CHROMATOGRAPHY)			
PURGEABLES			
Benzene	<40	N.P.	<40
Chloroform	<10	"	<10
Methylene Chloride	32	"	16
Ethylbenzene	156	"	<10
Dichlorodibromomethane	N.S.	"	N.S.
Toluene	31	"	<10
POLYNUCLEAR AROMATICS			
Benzo (a) anthracene	<20	1250	<20
Benzo (a) pyrene	<10	5980	<10
3,4-benzofluoranthene	N.S.	N.S.	N.S.
Chrysene	67	9280	<10
Acenaphthylene	670	1400	<10
Benzo (g,h,i) perylene	N.S.	N.S.	N.S.
Fluorene	42	547	<10
Phenanthrene/Anthracene	1900	43,700	<10/10
Dibenzo (a,h)anthracene	<10	N.D.	<10
Indeno (1,2,3-cd) pyrene	N.S.	N.S.	N.S.
Pyrene	570	4250	10
Acenaphthene	400	1840	<10
Naphthalene	<10	<104	<10

TABLE 33 (Continued)

Priority Pollutants	Influent (ug/l)	Bottom Sediment Dry Weight (ug/kg)	Effluent (ug/l)
ORGANICS (GAS CHROMATOGRAPHY)			
PHENOLICS			
Phenol	10,900	4,500	2
2,4-dimethylphenol	N.D.	N.D.	26
2-chlorophenol	200	300	N.D.
2,4,6-trichlorophenol	420	N.D.	37
Pentachlorophenol**	6,820	4,800	105

*Note: Total Cyanide expressed in mg/l.
**Pentachlorophenol is questionable.
***Key: N.D. - Not Detectable, or less than detectable limits
N.A. - Note Applicable
N.S. - No Standard Available
N.P. - No Procedure Available

PETROLEUM REFINING INDUSTRY

Plant 12

Wastewater Treatment System--

A flow diagram of Plant 12's biological wastewater treatment system including sample points is shown in Figure 15. The biological system consists of two completely separated bays receiving overflow from two dissolved air flotation units. The two bays are identical in hydraulic characteristics and operation; but bay A utilizes powdered activated carbon in the mixed liquor, while bay B does not. At the time of the study, both bays were operating at steady state. The type of biological treatment utilized in each bay is extended aeration with surface aerators. Waste sludges, including wasted return sludge, receive thickening by filtration prior to land disposal.

Specifically, Plant 12 process wastewater (approximately 4.0 mgd) receives primary clarification with two API separators (each having a volume of 0.084 mg; dimensions, 80 feet long by 20 feet wide by 7 feet deep). The API effluents are fed to respective dissolved air flotation (DAF) units (each having a volume of 0.060 mg; dimensions, 55 feet long by 20 feet wide by 7.25 feet deep). The DAF effluents are combined and lifted to two identical aeration bays and split equally between the bays. Each bay consists of an aeration basin and final clarifier in concentric configuration, the clarifier being innermost. Each aeration basin has a volume of 2.28 mg and dimensions of 184 feet OD, 89 feet ID, and 15 feet deep. Each clarifier has a volume of 0.56 mg and dimensions of 89 feet in diameter by 12 feet deep. The average daily forward flow for the study period (November 5-8, 1978) was 3.6 mgd. The return sludge pumping rate for each bay was 0.72 mgd.

Sampling Program--

Based on previous screening of the refining industry by the EPA's Effluent Guidelines Division, a list of priority pollutant compounds was compiled for investigation in this study (Table 22). In addition, two common wastewater parameters were measured: total cyanides and total phenol. Three-liter samples for analyses of specific organic compounds were composited in 1-gallon glass containers (no preservative added). Samples of approximately 1 liter volume were composited for T-metals (nitric acid added); T-cyanide (sodium hydroxide added); and T-phenols (phosphoric acid added).

Sample locations can be found in Figure 15. DAF effluent (sample point 1) was collected atop the aeration bays. Final clarifier effluents (points 4 and 5) were sampled from separate taps located beneath the bioreactors. Return sludge samples (points 2 and 3) were collected on the discharge sides of the

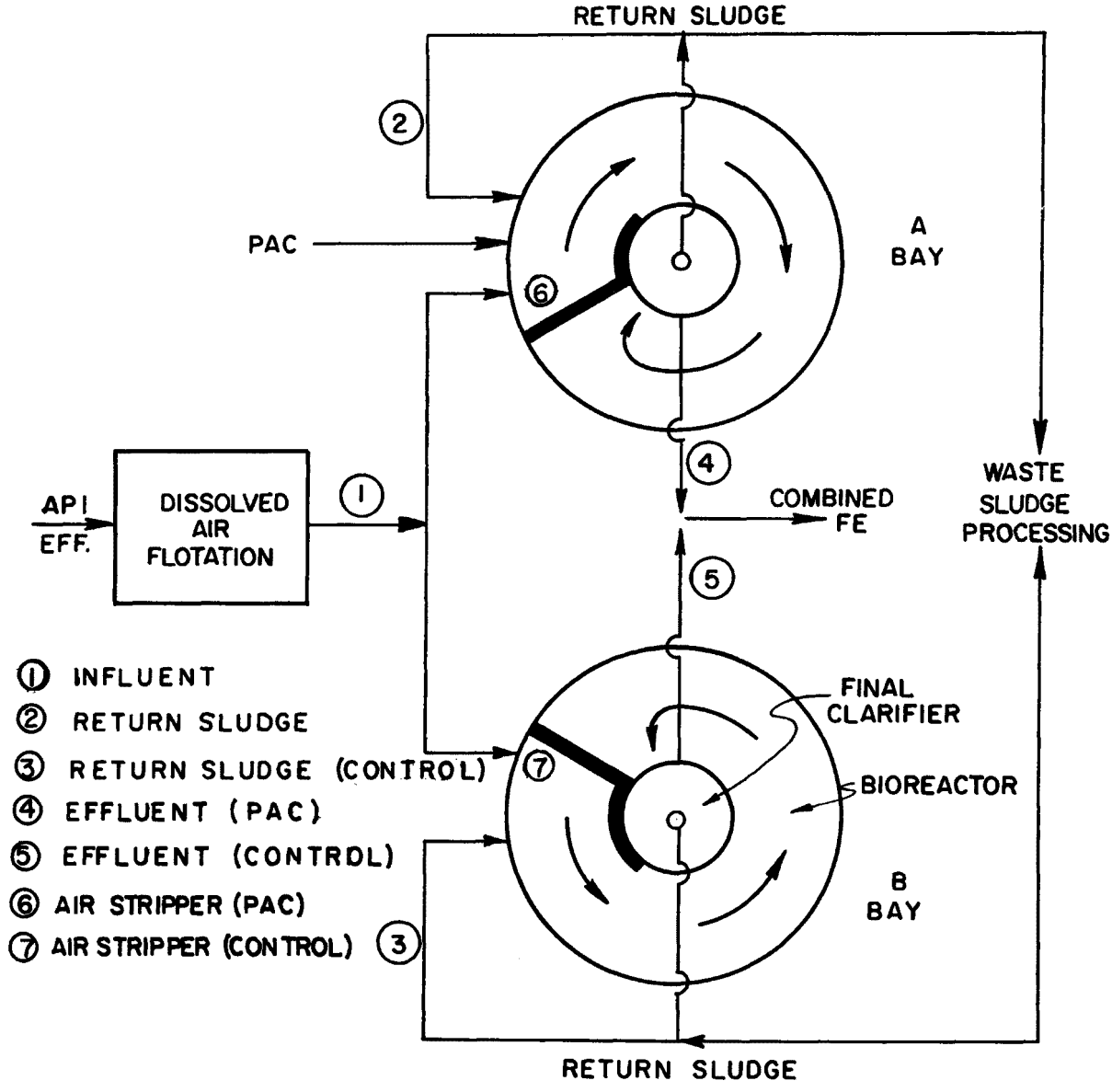

Figure 15 - WASTEWATER TREATMENT SYSTEM - PLANT 12

respective lift pumps. An air-stripper sampler equipped with XAD resin trap was placed in each aeration basin at a point after entry of the DAF effluent (points 6 and 7). Volatile organics were sampled in the DAF and final clarifier effluents using the standard 28-ml VOA septum vials. The VOA grab samples were collected at 2 pm on November 8.

Samples of DAF effluent, return sludges, and final effluents were composited every 4 hours beginning at 6 pm on November 5, 1978, and ending at 2 pm on November 8, 1978. Preservatives were added at the initiation of sampling. Preservatives used were concentrated phosphoric acid to achieve a final pH $\leq$4 (total phenol); sodium hydroxide pellets to achieve a final pH $\geq$12 (total cyanides); and redistilled nitric acid to achieve a final pH $\leq$2 (total metals). The compositing procedure for these samples was 55 ml every 4 hours. No preservative was used for organics sampling; a 170-ml grab sample was composited every 4 hours. All sample containers were iced throughout the sampling period.

The air-stripper samplers were placed in operation at 9 am, November 6, and performed adequately until 2 pm, November 8, 1978, with the exception of a 4-hour stoppage on November 7 (i.e., 49 hours total operational time). Air charged to the strippers averaged 60 cfh, and the quantity of air to the XAD-2 scrubber was 30 cfh. A detailed sampling schedule is presented in Table 34. Flow data are found in Table 35.

Analytical Results--

Pollutants for which samples were collected and analyzed are presented in Table 36. All extractions and analyses of samples were conducted at RSKERL.

TABLE 34. SAMPLING SCHEDULE (PLANT 12)

Date	Time	Sample taken	Remarks
11/5/78	6:00 pm	Composite	Preservatives added for T-metals, T-cyanide, and T-phenols.
	10:00 pm	"	
11/6/78	2:00 am	"	
	6:00 am	"	
	9:00 am		Air-stripper on at 9 am.
	10:00 am	"	
	2:00 pm	"	
	6:00 pm	"	
	10:00 pm	"	
11/7/78	2:00 am	"	
	6:00 am	"	Air-stripper off at 6:00 am.
	10:00 am	"	Air-stripper on at 10:00 am.
	2:00 pm	"	
	6:00 pm	"	
	10:00 pm	"	
11/8/78	2:00 am	"	
	6:00 am	"	
	10:00 am	"	
	2:00 pm	"	Air-stripper off at 2:00 pm; VOA grabs collected at 2:00 pm.

TABLE 35. DAILY FLOW DATA (PLANT 2)

Date	Return Sludge (PAC) (gpm)	Combined Return Sludge (gpm)	Final Effluent (mgd)
11/4-5/78*	500	500	2.9
11/5-6/78	500	500	4.2
11/6-7/78	500	500	3.5
11/7-8/78	500	500	3.4

*Twenty-four hour period, from 6:00 am to 6:00 am.

Note: Sludge wasteage was ~25 gpm, meaning that combined FE flows approximated bioinfluent (DAF) flow during the study.

TABLE 36. ANALYTICAL DATA (PLANT 12)

Priority Pollutant	Sparged Air, XAD-2 (µg)		Sparged Air, Tenax (µg)
POLYNUCLEAR AROMATICS	PAC	Control	
Naphthalene	N.D.	N.D.	
2-Chloronaphthane	30	220	
Acenaphthalene	<10	<10	
Acenaphthene	<10	<10	
Fluorene	<13	<13	
Phenanthrene/Anthracene	<10	<10	
Fluoranthene	<10	<10	
Pyrene	<10	<10	
1,2-Benzanthracene	20	<10	
Chrysene	20	<10	
3,4-Benzopyrene	<35	<35	
1,2:5,6-Dibenzanthracene	N.D.	N.D.	
PHENOLICS			
2-Chlorophenol	<25	<25	
2-Nitrophenol	<25	<25	
Phenol	<10	<10	
2,4-Dimethylphenol	<25	<25	
2,4-Dichlorophenol	<50	<50	
2,4,6-Trichlorophenol	<10	200	
4-Chloro-m-cresol	80	30	
2,4-Dinitrophenol	<100	<100	
4,6-Dinitro-o-cresol	<25	<25	
Pentachlorophenol	<25	<25	
4-Nitrophenol	<25	<25	
PURGEABLES			
Methylene chloride			No samples taken due to equipment malfunction.
1,1-Dichloroethane			
1,2-Trans-dichloroethylene			
Chloroform			
1,2-Dichloroethane			
1,1,1-Trichloroethane			
Carbon tetrachloride			
Dichlorobromomethane			
1,2-Dichloropropane			
Benzene			
Trichloroethylene			
Chlorodibromomethane			
1,1,2-Trichloroethane			
Methyl bromide			
Bromoform			
1,1,2,2-Tetrachloroethane			
Tetrachloroethylene			
Toluene			
Chlorobenzene			
Ethylbenzene			

TABLE 36. (Continued)

Priority Pollutant	Influent (µg/l)	PAC Return Sludge (µg/l)	Return Sludge (µg/l)	PAC Effluent (µg/l)	Final Effluent (µg/l)
CLASSICAL					
TOTAL CYANIDES (mg/l)*	<.05	<.05	<.05	<.05	<.05
TOTAL PHENOL	417	386	67	42	29
TOTAL METALS					
Arsenic	<10	260	150	<10	<10
Selenium	<10	400	280	<10	<10
Cadmium	<1	31	24	<1	<1
Beryllium	<3	20	9	< 3	<3
Copper	45	5,800	4,900	18	16
Antimony	<10	<10	<10	<10	<10
Chromium	280	64,000	60,000	100	72
Nickel	17	1,200	1,100	14	17
Zinc	390	37,000	28,000	140	130
Silver	<10	22	22	<10	<10
Thallium	<10	<10	<10	<10	<10
Lead	40	12,000	11,000	18	14
Mercury	<0.6	<10	<10	<1.0	<0.8
ORGANICS (GAS CHROMATOGRAPHY)					
PURGEABLES					
Methylene chloride	<10	N.A.	N.A.	<10	<10
Chloroform	<10	"	"	<10	<10
Benzene	320	"	"	<40	<40
1,1,2,2-Tetrachloroethylene	<10	"	"	<10	<10
Toluene	695	"	"	<10	<10
Ethylbenzene	56	"	"	<10	<10
POLYNUCLEAR AROMATICS					
Pyrene	<10	<12	<13	<10	<10
Benzo-a-pyrene	<44	<106	<110	<13	<11
Chrysene	<10	<14	<14	<10	<10
Fluoranthrene	<10	<12	<13	<10	<10
Phenanthrene/Anthracene	<10/<10	<14/<16	<14/<17	<10/<10	<10/<10
Naphthalene	282	<14	<14	<10	<10
Acenaphthene	24	<10	<10	<10	<10
Fluorene	<16	<39	<41	<10	<10
PHENOLS					
2,4-dimethylphenol	142	10	N.D.	N.D.	N.D.

(Continued)

TABLE 36. (Continued)

Priority Pollutant	Influent (µg/l)	PAC Return Sludge (µg/l)	Return Sludge (µg/l)	PAC Effluent (µg/l)	Final Effluent (µg/l)
PHTHALATE ESTERS					
Dimethyl phthalate	<10	<10	<10	<10	<10
Diethyl phthalate	<10	<10	<10	<10	<10
Di-n-butyl phthalate	<10	<10	<10	<10	<10
Bis(2-ethylhexyl) phthalate	<16	<16	<19	<16	<19

*Note: Total Cyanides expressed in mg/l.

**Key: N.D. - Not Detectable, or less than detectable limits
N.A. - Not Applicable
N.S. - No Standard Available
N.P. - No Procedure Available

TABLE 37. ENGLISH-TO-METRIC UNIT CONVERSIONS

Multiply This	By This	To Obtain This	
lbs	0.4536	kg	kilograms
short tons	0.9072	metric tons	metric tons (1000 kg)
short tons	907.2	kg	kilograms
inches	2.54	cm	centimetres
feet	0.3048	m	metres
statute miles	1.609	km	kilometres
gallons	3.785	l	litres (1000 litres = 1 m^3)
barrels	0.1590	m^3	cubic metres
Btu	0.252	kcal	kilocalories
SCF	0.02679	nm^3	normal cubic metres
Btu/lb	0.5556	kcal/kg	kilocalories/kilogram
Btu/CF	8.899	kcal/m^3	kilocalories/cubic metre
Btu/SCF	9.406	kcal/nm^3	kilocalories/normal cubic metre
10^9 Btu/day	252	Gcal/day	gigacalories/day
10^6 Btu/day	252	Mcal/day	megacalories/day
MM Btu/hr	252	Mcal/hr	megacalories/hour
SCFD	0.02679	nm^3/day	normal cubic metres/day
MM SCFD	0.02679	10^6 nm^3/day (Mnm^3/day)	million normal cubic metres/day (mega normal cubic metres/day)
SCF/MM Btu	0.1063	nm^3/Gcal	normal cubic metres/gigacalorie
lbs/MM Btu	1.8	kg/Gcal	kilograms/gigacalorie
lbs/CF	16.02	kg/m^3	kilograms/cubic metre
psi	0.07031	kg/cm^2	kilograms/square centimetre
gpm	0.227	m^3/hr	cubic metres/hour
acre-ft/year	0.1408	m^3/hr	cubic metres/hour
horsepower	745.7	W	watts
nautical miles	1.852	km	kilometres
knot	1.852	km/hr	kilometres/hour

SECTION 4

OBSERVATIONS

1. There are five metals that tend to concentrate in the residuals samples. These metals are: (1) copper, (2) chromium, (3) zinc, (4) nickel, and (5) lead.

2. For samples showing the presence of phenols by the 4-aminoantipyrine procedure, individual phenolic compounds were identified by the gas chromatographic procedure. However, minimal correlation was found between the sum of the concentrations of individual phenolics determined by gas chromatograms and the concentration of total phenols by the 4-aminoantipyrine method.

3. The study required strict adherence to a clearly defined set of analytical procedures. These procedures did not have provisions for eliminating matrix interferences. This resulted in difficulty in quantitating individual compounds identified in the gas chromatograms.

4. Priority pollutants of the polynuclear aromatics and phenolics groups are subject to air stripping in biological treatment systems under the sampling conditions employed in the study.

5. There is an indication that many of the nonvolatile organics concentrate in bottom sediment samples.

6. The chromatographic procedures showed the presence of many unidentified organic compounds in addition to the priority pollutants specified for each industrial category.

7. The study conditions implemented for 3 days did not account for process variations and do not represent a mass balance across a biological treatment system. It appears necessary to conduct a long-term study, perhaps incorporating additional techniques, to obtain a mass balance.

8. A surprisingly large number of industrial activated sludge treatment systems studied did not waste excess sludge.

9. One of the plants studied employed parallel activated sludge systems, one of which was "enhanced" by the use of powdered

activated carbon. The analytical results showed no significant differences between the control and bioenhanced systems.

10. The experimental Tenax column used during the study shows promise in adsorbing volatile compounds. There does need to be additional research to alleviate the mechanical problems associated with this system.

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(Please read Instructions on the reverse before completing)

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15. SUPPLEMENTARY NOTES

16. ABSTRACT

This report is concerned with media disposition of specific priority pollutants. Composite samples were obtained from the influent, effluent, residuals, and air from 12 industrial biological treatment systems. These samples were extracted and analyzed by gas chromatography for organic constituents, by atomic absorption for metals, and by EPA methodology for phenolics, cyanide, and mercury.

Participating industries included: (1) organics and plastics, (2) pharmaceuticals, (3) pesticides, (4) rubber, (5) wood preservative, and (6) petroleum refining. The data in this report represent potential disposition of specific priority pollutants during 3-day study periods and should not be construed to represent a mass balance study.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Activated sludge process Plastics Industry Petroleum Refining Pharmaceuticals Pesticides Rubber	Priority pollutants Aerated Lagoons Organic Chemicals Industry Wood Preservatives Air stripping	13B

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