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An Evaluation of the Use of an Advanced Oxidation Process to Remove Chlorinated Hydrocarbons from Groundwater at the U.S. Department of Energy Kansas City Plant

Fiscal Year 1989 Annual Report

S. B. Garland II
G. R. Peyton

Environmental Sciences Division
Publication No. 3374

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ENVIRONMENTAL SCIENCES DIVISION

AN EVALUATION OF THE USE OF AN ADVANCED OXIDATION PROCESS TO REMOVE CHLORINATED HYDROCARBONS FROM GROUNDWATER AT THE U.S. DEPARTMENT OF ENERGY KANSAS CITY PLANT

Fiscal Year 1989
Annual Report

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EXECUTIVE SUMMARY

The U.S. Department of Energy Kansas City Plant selected an advanced oxidation process utilizing ozone (O_3), ultraviolet radiation, and hydrogen peroxide for the removal of trichloroethene from the underlying groundwater. Since the performance of this process for the removal of organics from groundwater is not well documented in the literature, this evaluation was initiated to determine the process performance, costs, and operating history.

During the course of the study, the flow rate has remained at approximately 16% of the design flow rate. Consequently, it was difficult to evaluate the true performance of the plant. Throughout FY 1989, all effluent standards were met, and all volatile organic compounds were reduced to below detectable limits; but two problems were seen. First, the removal of total organic carbon (TOC) and total halogenated organic compounds (TOX) was not as great as expected, and TOC and TOX persist in the reaction chamber even though the individual volatile organic compounds are removed to below detectable limits. Second, the TOX concentrations in the plant effluent were always greater than the concentrations in the final stage of the ozone reaction chamber and sometimes approached the effluent standard. There appears to be an artifact in the TOX measurement that at times exceeds half of the allowed value in the effluent, and its replacement as a process control parameter with one or more individual volatile organic compounds should be considered.

The O_3 generator would operate at only about 10% of its rated capacity until the treatment plant was given an extensive overhaul. After the overhaul the generator produced its rated capacity. The problem was at least partially due to inadequate drying of the feed gas. Since the full capacity of the O_3 generator is needed as other groundwater plumes are added, it is recommended that the O_3 generator yield and transfer efficiency be calculated daily to ensure that the O_3 yield is at its rated capacity.

Much of the trouble with O_3 transfer efficiency is due to clogging of the spargers, clogging of the O_3 rotameters and feed tubing, and releasing large O_3 bubbles. Additionally, the ultraviolet lights become coated rapidly with an apparent inorganic scale that may decrease the photolysis of O_3, lowering its use of O_3. The treatment plant as originally constructed had inadequate process control instrumentation, inadequate routine maintenance instructions, and an underestimated level of effort required for routine maintenance. A regular maintenance program should be established, and a detailed operations and maintenance manual should be prepared to minimize the problems.

By using a mechanistic model, the treatment plant should be able to treat the two additional groundwater plumes if the O_3 generator produces its rated yield, and the transfer efficiency is 60 to 80%. Because of the assumptions used and extrapolations made, after a new plume is added, the actual results should be compared to those predicted, and the model refined.

It appears that the O_3 and hydrogen peroxide reaction is responsible for the majority of the removal of organics. The apparent lack of effect of ultraviolet light may be due to the scale on the

lamps. Sparging and hydrogen peroxide photolysis were found to play relatively minor roles in the removal of organics.

The costs for operating the plant increased by an order of magnitude during FY 1989 and are an order of magnitude greater than those predicted by Ultrox International, the manufacturer of the plant. Because of the low flow rate, lack of operator's costs, and probable increased needs for maintenance, these costs are not definitive and must await an increased flow rate to be evaluated.

The discharge permit allows only 38 m^3/d (10,000 gal/day) to be discharged from the treatment plant. At the design flow rate of 0.0015 m^3/s (25 gal/min), 136 m^3/d (36,000 gal/day) could be discharged. This may present a problem when additional plumes are introduced to the plant. Either the permit should be revised, or the operating time will have to be limited.

In FY 1990, the study will emphasize optimizing the operating parameters, developing general design criteria for the treatment technology, and preparing a comparative cost evaluation with competing treatment technologies.

LIST OF ABBREVIATIONS

AOP	advanced oxidation process
BAT	best available technology
BOD	biochemical oxygen demand
DCE	1,2-*trans*dichloroethene
1,2-DCE	1,2-dichloroethene
DOE	U.S. Department of Energy
EFF	effluent
EPA	U.S. Environmental Protection Agency
H_2O_2	hydrogen peroxide
IAF	influent after the filter
IBF	influent before the filter
NEA	northeast area
O_3	ozone
O&G	oil and grease
O&M	operations and maintenance
ORNL	Oak Ridge National Laboratory
TCE	trichloroethene
TCESA	TCE still area
TOC	total organic carbon
TOX	total organic halogen
TSS	total suspended solids
UTF	underground tank farm
UV	ultraviolet
VOC	volatile organic compound

1. INTRODUCTION

The Allied-Signal Aerospace Company currently operates a production facility in Kansas City, Missouri, under contract with the U.S. Department of Energy (DOE). Over the years the operation of the DOE Kansas City Plant has resulted in the contamination of groundwater with chlorinated hydrocarbons, including trichloroethene (TCE). One of the plumes of contaminated groundwater, the underground tank farm (UTF) plume, was selected for remediation with an advanced oxidation process (AOP) consisting of simultaneous treatment by ozone (O_3), ultraviolet (UV) radiation, and hydrogen peroxide (H_2O_2). Since the use of AOPs is relatively new for the removal of organics from groundwater, information on design criteria, costs, performance, and operating experience is not well documented in the literature. Therefore, the Oak Ridge National Laboratory (ORNL) was requested to evaluate the treatment process.

This report documents the work performed through FY 1989. The results of the initial year of the evaluations, FY 1988, have been published previously (Garland 1989), and the evaluation will continue at least through FY 1990. This report first briefly describes the treatment plant and the mechanisms of the treatment process. Next, the methodology and the results from the evaluation are discussed. Finally, conclusions and recommendations are presented.

2. BACKGROUND

2.1 INTRODUCTION

Groundwater contamination by halogenated organic compounds, such as TCE, is of national concern. The U.S. Environmental Protection Agency (EPA) has specified two best available technologies (BATs) for the removal of halogenated organic compounds from drinking water: packed tower aeration and activated carbon filtration (EPA 1987). A disadvantage with these BATs is that they transfer the contaminant from the water medium to the air or to the carbon medium, respectively, rather than destroy it. In an effort to overcome this liability, chemical oxidation of halogenated organic compounds with AOPs is being considered.

The various AOPs that can be used are as follows (Glaze and Kang 1988):

- O_3 at high pH values,
- O_3 with H_2O_2,
- O_3 with UV radiation,
- H_2O_2 with UV radiation, and
- O_3 with UV radiation and H_2O_2.

The groundwater treatment plant at the DOE Kansas City Plant uses the last AOP. The remainder of this section describes the groundwater treatment plant and the process mechanisms.

2.2 PLANT DESCRIPTION

The groundwater treatment plant at the DOE Kansas City Plant uses the AOP of O_3, UV radiation, and H_2O_2 for the removal of TCE, 1,2-*trans*dichloroethene (DCE), and vinyl chloride. The plant was provided by Ultrox International (Ultrox International 1987) and was rated for a groundwater throughput of 0.1 m^3/min (25 gal/min) when purchased. A process flow diagram is shown in Fig. 1. The reaction chamber has a volume of 2.9 m^3 (90 ft^3 or 725 gal) and is divided by baffles into six stages, which cause a labyrinthine flowpath for the water. O_3 is supplied by a generator with a rated production of 9.51 kg (21 lb) of O_3 per day at 2% O_3 by weight and enters the reactor through porous diffusors located in each of the six stages. The air dryer is designed to supply clean, dry air [-65°C(-60°F)] to the O_3 generator at 83-103 KP_a (12 to 15 psig). The H_2O_2 feed system mixes up to 22.6 kg (50 lb/day) of H_2O_2 with the influent groundwater. Each of the 6 stages of the reactor contains 12 quartz-sheathed, low-pressure 222 BTU/hr (65-watt) UV lamps immersed in the water from the top of the reaction chamber. Details on the equipment are contained in the Operation and Maintenance Manual (Ultrox International 1987).

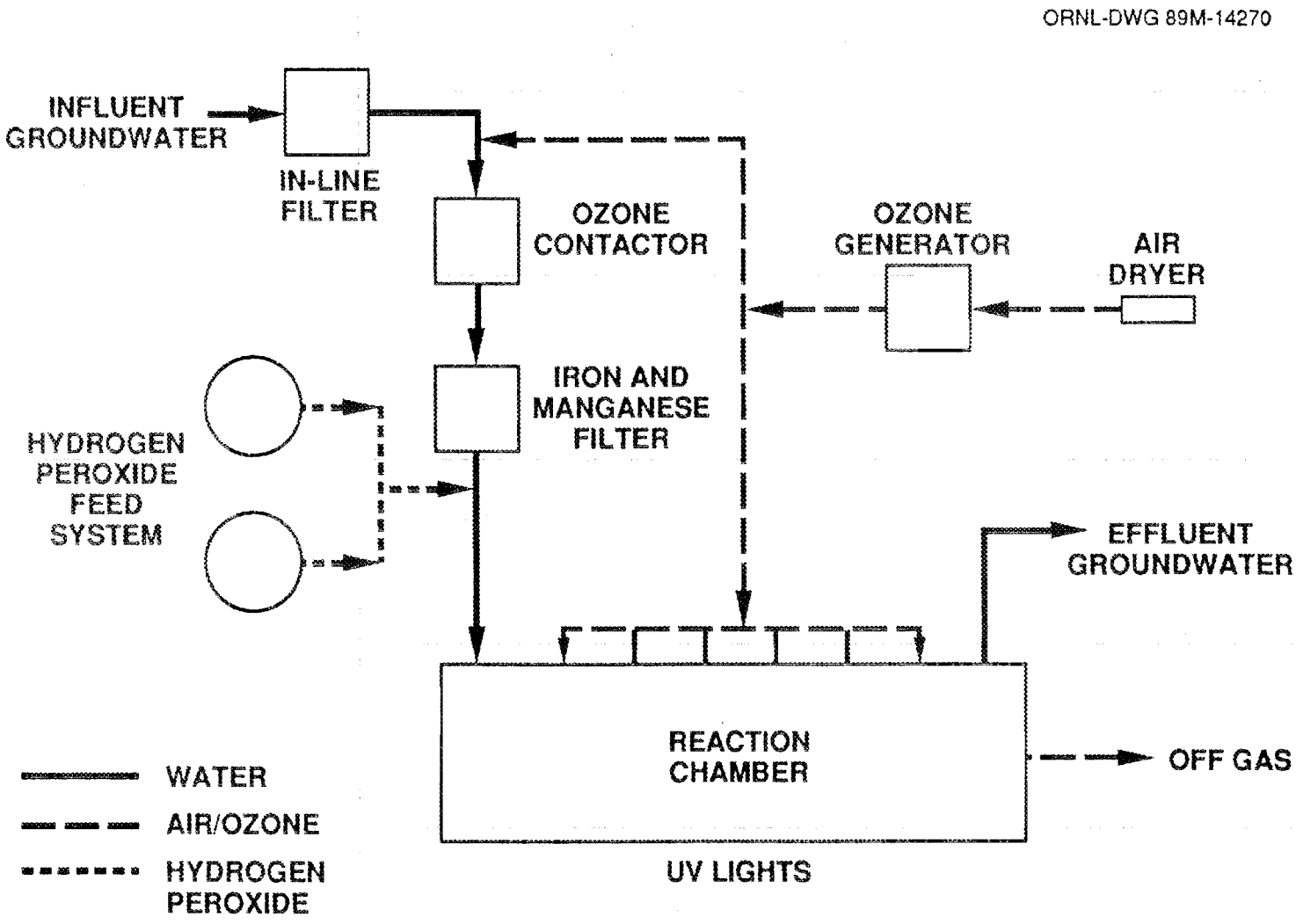

Fig. 1. Ultraviolet radiation/ozone/hydrogen peroxide groundwater treatment plant, U.S. Department of Energy Kansas City Plant.

The influent groundwater is extracted from the UTF plume at approximately .00025 m^3/s (4 gal/min). One in-line cartridge filter removes particulate matter, and a second one removes iron and manganese following oxidation by O_3. This second in-line filter was added during the summer of 1989 by Ultrox International during an intensive maintenance project to prevent the precipitation of iron and manganese in the reaction chamber. It was not really operational during FY 1989. The treated groundwater is discharged to Kansas City's municipal sewer system and must meet the city's pretreatment standards, shown in Table 1.

2.3 PROCESS MECHANISMS

The reactions that take place when AOPs are used to oxidize organics in groundwater can be explained on the basis of the mechanisms shown in Fig. 2 (Peyton and Glaze 1988). Reaction 1 is the photolytic production of H_2O_2 from aqueous O_3, and Reaction 2 is a secondary reaction producing the hydroxyl radical ($OH^\bullet$). Reaction 3 shows the photolytic production of $OH^\bullet$ from H_2O_2. In the presence of oxygen, many organic compounds react with $OH^\bullet$ in Reaction 4 to form superoxide (O_2^-) in Reaction 5 and/or H_2O_2 in Reaction 7. Both O_2^- in Reaction 6 and H_2O_2 in Reaction 8 react further with O_3 to produce more $OH^\bullet$, which is the active species for the destruction of organic compounds. The existence of multiple pathways for the production of $OH^\bullet$ is a major advantage of the O_3/UV radiation process because the reaction pathways can adjust to the situation.

Groundwater also contains other compounds, such as carbonates, bicarbonates, ammonia, iron, manganese, sulfides, and humic materials, that react with O_3 and $OH^\bullet$, exert a competing demand, and may preferentially consume the oxidants. Additional information on the process mechanisms, process selection, and process performance is contained in the FY 1988 report (Garland 1989).

Table 1. Effluent water quality standards for the groundwater treatment plant (in milligrams per liter unless otherwise noted)

Parameters[a]	Maximum discharge limit	Monitoring frequency
Cadmium	0.69	Monthly
Chromium	2.77	Monthly
Copper	3.38	Monthly
Lead	0.69	Monthly
Nickel	3.98	Monthly
Zinc	2.61	Monthly
Iron	100	Monthly
Manganese	20	Monthly
Boron	1	Monthly
BOD[b]	None	Daily
TSS[c]	None	Daily
Flow (gal/d)	10,000	Continuous
pH (units)	6-10	Continuous
Arsenic	0.25	Monthly
TOX[d]	0.16	Monthly
Sulfides	10.0	Monthly
Oil and grease	100	Monthly
Cyanide	2	Monthly

[a]Parameters refer to total where applicable.
[b]Biochemical oxygen demand.
[c]Total suspended solids.
[d]Total organic halogens.

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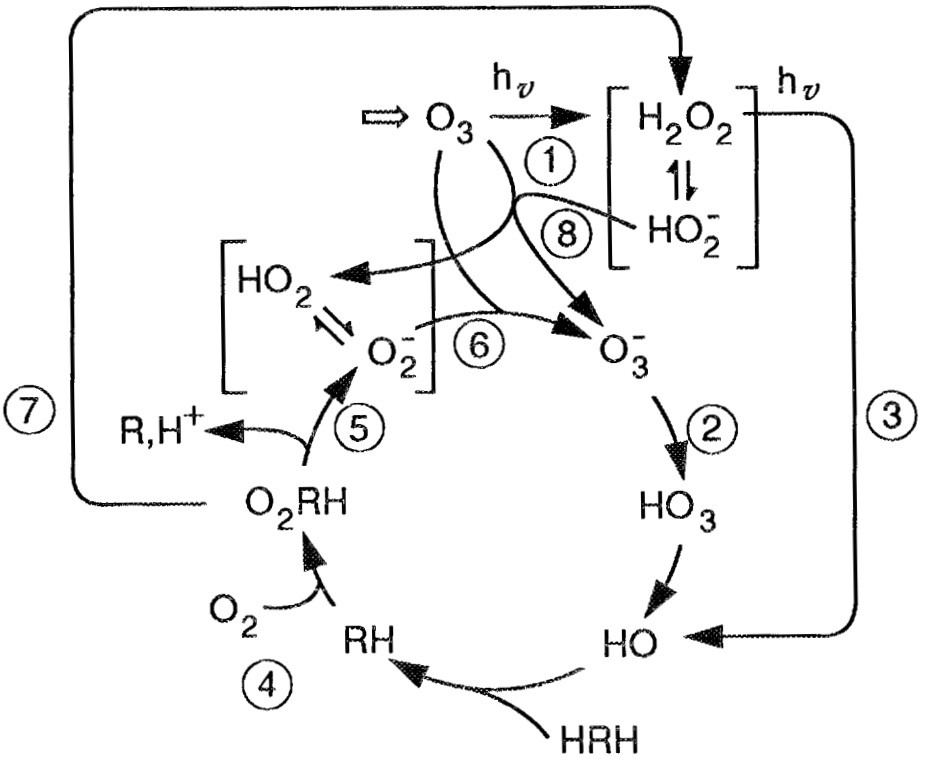

Fig. 2. Reaction cycles in advanced oxidation processes. Numbered reactions are explained in the text. Source: Peyton and Glaze 1988.

3. METHODOLOGY

The methodology for the FY 1989 evaluation, contained in Appendix 1, has the following objectives:

1. determine if the treatment plant can meet the pretreatment standards for discharge to the Kansas City municipal sewer system,
2. determine the operation and maintenance costs for the treatment plant,
3. compare the costs with competing technologies,
4. evaluate contaminant removal mechanisms,
5. assist in optimizing the operation of the treatment plant,
6. estimate the capacity of the treatment plant, and
7. predict the treatment plant size necessary to handle all three of the contaminated groundwater plumes.

Table 2 contains a summary of the monitoring plan.

A special study was conducted to achieve objectives 4, 6, and 7. The methodology used for this special study is summarized in the following discussion and detailed by Peyton (1989). Five experiments were conducted to determine if reactor performance can be improved so that increased treatment capacity can be made available without jeopardizing compliance with the pretreatment standards.

In Experiment 1 the O_3 generator was turned up to full power, all UV radiation lamps were turned on, and H_2O_2 was used at full dose to determine if operating the treatment plant at maximum capacity increases the removal of total organic halogen (TOX), total organic carbon (TOC), or volatile organic compounds (VOCs). These parameters were monitored both before and after the O_3 generator was turned up to 100% capacity to evaluate the impact. The O_3 gas-flow rate remained constant so that the effects of sparging were constant.

Experiment 2 determined what portion of VOC removal is from volatilization, or sparging, caused by the O_3 gas passing through the water in the reactor. The reactor was filled with groundwater with all treatment processes turned off. The reactor contents were sampled for TOC, TOX, and VOCs, and then the air flow was turned on with no O_3 production, H_2O_2 usage, or UV radiation. After 20 min and 40 min, the reactor contents were sampled again.

In Experiment 3 only the H_2O_2 and UV radiation treatment processes were used to determine what portion of the VOC removal is due to H_2O_2 photolysis.

During Experiment 4, O_3 and H_2O_2 were used, but the UV lamps were not used, in order to determine the extent to which UV radiation aids in the destruction of VOCs. Sampling for various VOCs was performed during the experiment to determine their removal rates.

Experiment 5 represents the normal operating conditions prior to the other four experiments. These data are compared with those from Experiments 1 through 4.

The overall goal of this project was to determine whether the existing reactor has the capacity to treat a waste stream that is approximately 5 times greater in flow rate and 2 to 5 times greater in

Table 2. Groundwater treatment plant monitoring plan, FY 1989

Frequency	Parameter[a]	Location[b]
Continuous	pH	E
	Flow	I
Daily	BOD	I, AF, E
	TSS	I, AF, E
Weekly	Sulfite	I, AF, E
	Sulfate	I, AF, E
	Sulfides	I, AF, E
	Nitrite	I, AF, E
	Nitrate	I, AF, E
	Ammonia	I, AF, E
	Iron	I, AF, E
	Ferrous ion	I, AF, E
	Manganous ion	I, AF, E
	Manganese	I, AF, E
	TOX	I, AF, E, ST
	Priority volatile pollutants	I, AF, E, ST
	TOC	I, AF, E, ST
Monthly	Cadmium	I, AF, E
	Chromium	I, AF, E
	Copper	I, AF, E
	Lead	I, AF, E
	Nickel	I, AF, E
	Zinc	I, AF, E
	Boron	I, AF, E
	Arsenic	I, AF, E
	Sulfides	I, AF, E
	Oil and grease	I, AF, E
	Total cyanide	I, AF, E
	UV absorbance at 254 nm[c]	I, AF, E, ST
	Hydrogen peroxide[c]	I, AF, E, ST
	Carbonate[c]	I, AF, E, ST
	Bicarbonate[c]	I, AF, E, ST
	Ozone[c]	I, AF, E, ST
	Total plate count	I, AF, E
	Off-gases (TOX, ozone)	T
Quarterly[d]	Particulates	In-line filter
	Sediment	Reaction chamber

Table 2. (continued)

Frequency	Parameter	Location[b]
Once[e]	Calcium	I, AF, E
	Magnesium	I, AF, E
	Sodium	I, AF, E
	Potassium	I, AF, E
	Chloride	I, AF, E
	Fluoride	I, AF, E
	Phosphate	I, AF, E
	Carbonate	I, AF, E
	Bicarbonate	I, AF, E

[a]BOD = biochemical oxygen demand; TSS = total suspended solids; TOX = total organic halogens; and TOC = total organic carbon.

[b]I = influent; AF = after the in-line filter; E = effluent from ozone reaction tank; ST = six sample taps on ozone reaction tank; and T = sample tap on air vent.

[c]These parameters will be monitored weekly for one month and then monthly thereafter.

[d]These analyses will be performed quarterly if possible. Sediments in the reaction chamber should be sampled whenever the plant is not operating.

[e]In addition to concentration, these results will be shown in a Stiff Diagram or in a similar graphical presentation.

contaminant concentration, which is the estimated impact of adding two additional contaminated groundwater plumes. A projection of this magnitude must be based on some mathematical model that can be used to predict results under the hypothetical conditions. The model must, in turn, be based on information that is available from an analysis of the present performance and capabilities of the reactor. This information was not available at the beginning of the project. It was therefore necessary to design experiments and adapt analytical techniques to acquire that information. It was hoped that the results from these experiments would also help to optimize the operation of the reactor.

4. RESULTS

4.1 PLANT PERFORMANCE

The results from the normal operation of the treatment plant are presented in this section. The results include FY 1988 as well as FY 1989 to assist in identifying trends. All of the data are contained in Appendix 2, and summaries are contained in this section. The flow data for the groundwater treatment plant for each month are in Table 3. Data for total suspended solids (TSS), pH, biochemical oxygen demand (BOD), sulfite, sulfide, sulfate, nitrite, nitrate, ammonia, total iron, ferrous iron, total manganese, manganous ion, total plate count, and oil and grease (O&G) are listed in Table 4. The values in Table 4 are averages of all analyses. Samples were taken at the influent before the filter (IBF), the influent after the filter (IAF), and the plant effluent (EFF).

The results for the trace metals are in Table 5. These values represent averages for all analyses. Samples were taken at the IBF, IAF, and EFF.

The TOC, TOX, and VOC results are provided in Table 6. These values represent averages for all analyses. The samples were collected at the IBF, IAF, EFF, and all six stages of the reaction chamber.

4.2 COSTS

The monthly operating and maintenance costs are in Table 7.

4.3 OPERATIONS

All of the UV lights were operated all the time. Instrumentation was not provided with the plant to monitor actual O_3 production, but it was operated at its maximum setting except during special experiments. H_2O_2 was used at its design rate throughout FY 1989.

The plant was shut down on numerous occasions during FY 1989. Table 8 shows the number of days the plant was shut down and the reasons for the downtime.

During June 1989 representatives from Ultrox International were on-site performing extensive maintenance and upgrading activities to determine the cause for the downtime and to correct it. Ultrox found the following and took the corrective actions described:

- The O_3 generator was not producing as much O_3 as it should have been. Indications were that it was producing only approximately 20% of the rated capacity. An O_3 monitor was installed to determine the O_3 production of the O_3 generator and the O_3 concentration in the off-gas from the reaction chamber.
- The air filters were dirty and partially clogged, and the two-stage filters were replaced with three-stage filters.

Table 3. **Flow data for the groundwater treatment plant**

Month	Flow (gal)	Average flow rate (gal/min)	Percentage of design flow[a]
		1988	
May	145,490	3.7	15
June	133,290	4.0	16
July	238,440	11.8	47
August	284,110	8.9	36
September	57,652	5.7	23
October	7,099	0.45	2
November	69,864	2.31	9
December	14,859	0.52	2
Average		4.7	
		1989	
January	0	0	0
February	83,976	2.2	9
March	25,725	1.1	4
April	101,302	2.6	10
May	48,737	1.1	4
June	101,990	71	283
July	0	0	0
August	63,805	2.5	10
September	111,903	2.6	10
Overall Average	107,508	4.1	16

[a]The design flow is 25 gal/min.

Table 4. Miscellaneous data for the groundwater treatment plant[a] (in milligrams per liter unless otherwise noted)

Parameter	IBF[b] (Grab)	IAF[b] (Grab)	EFF[b]	
			Grab	Composite
TSS[c]	87	11	25	26
pH	6.9	7.1	8.1	8.2
BOD[d]	7	4	4	5
Sulfite	<0.5	<0.5	<0.5	NS[e]
Sulfide	0.98	0.68	<0.5	<0.5
Sulfate	71	75	68	NS
Nitrite	<0.1	<0.1	<0.1	NS
Nitrate	<0.1	<0.1	3.4	NS
Ammonia	0.85	0.89	0.79	NS
Total iron	17.3	4.0	4.0	3.9
Ferrous ion	0.9	0.5	0.33	NS
Total manganese	6.4	6.0	6.0	5.1
Manganous ion	6.6	96.8	3.1	NS
Total plate count (colonies/mL)	2602	488	463	NS
Oil and grease	2.2	0.58	0.62	0.60

[a]Values are averages for all analyses. All grab samples are collected weekly except for BOD, which is collected daily, and total plate count, which is collected monthly. All composite samples are 24-h composites collected monthly except for BOD, which is collected daily. Samples were collected from May 1988 through September 1989.

[b]IBF = influent before filter; IAF = influent after filter; and EFF = effluent.

[c]TSS = total suspended solids.

[d]BOD = biochemical oxygen demand.

[e]NS = not sampled.

Table 5. Trace metal results for the groundwater treatment plant[a] in milligrams per liter

Parameter	IBF[b] (Grab)	IAF[b] (Grab)	EFF[b]	
			Grab	Composite
Arsenic	0.045	0.024	0.022	0.023
Boron	0.136	0.111	0.095	0.110
Cadmium	0.012	0.004	0.003	0.003
Chromium	0.013	0.011	0.014	0.020
Copper	10.4	0.050	0.074	0.034
Lead	0.055	0.031	0.033	0.028
Nickel	0.027	0.015	0.016	0.021
Total cyanide	<0.001	<0.001	<0.001	<0.001
Zinc	1.05	0.06	0.07	0.04

[a]Values are averages for all analyses. All grab samples were collected once per month, and the composite samples were 24-h composites collected once per month. Samples were collected from May 1988 through September 1989.

[b]IBF = influent before filter; IAF = influent after filter; and EFF = effluent.

Table 6. Results for total organic carbon, total chlorinated hydrocarbons, and volatile organic compounds at the groundwater treatment plant[a] (in milligrams per liter)

Parameter[b]	IBF[c] (grab)	IAF[c] (grab)	Reaction chamber stages (grab)						EFF[c]	
			1	2	3	4	5	6	Grab	Composite
TOC	4.3	4.2	3.7	3.9	3.5	3.7	3.7	3.4	3.3	NS[d]
TOX	0.354	0.341	0.124	0.090	0.078	0.073	0.055	0.055	0.078	0.074
TOX (filtered)	NS	NS	NS	NS	NS	NS	NS	NS	0.058	NS
1,2-Dichloroethane	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	NS
Methylene chloride	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	NS
Carbon disulfide	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	NS
Acetone	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	NS
Chloroform	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	NS
1,1-Dichloroethene	0.012	0.014	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	NS
1,1-Dichloroethane	0.015	0.017	0.008	0.006	<0.005	<0.005	<0.005	<0.005	<0.005	NS
1,2-Dichloroethene	0.697	0.838	0.088	0.029	<0.005	<0.005	<0.005	<0.005	<0.005	NS
Tetrachloroethene	0.032	0.042	0.008	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	NS
1,1,1-Trichloroethane	0.018	0.013	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	NS
Bromomethane	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	NS
Chloromethane	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	NS
Chloroethane	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	NS
Toluene	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	NS
Carbon tetrachloride	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	NS
2-Butanone	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	NS
trans-1,3-Dichloropropene	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	NS
Vinyl acetate	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	NS
Bromodichloromethane	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	NS
1,2-Dichloropropane	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	NS
cis-1,3-Dichloropropene	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	NS
Dibromochloromethane	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	NS
1,1,2-Trichloroethane	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	NS
Benzene	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	NS
Bromoform	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	NS
4-Methyl-2-pentanone	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	NS

Table 6. (continued)

Parameter[b]	IBF[c] (grab)	IAF[c] (grab)	Reaction chamber stages (grab)						EFF[c]	
			1	2	3	4	5	6	Grab	Composite
2-Hexanone	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	NS
1,1,2,2-Tetrachloroethane	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	NS
Chlorobenzene	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	NS
Ethylbenzene	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	NS
Styrene	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	NS
Xylene	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	NS
Trichloroethene	0.329	0.401	0.053	0.018	<0.005	<0.005	<0.005	<0.005	<0.005	NS
Vinyl chloride	0.042	0.041	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	NS

[a]All values are averages for all analyses performed from May 1988 through September 1989. All grab samples were collected weekly, and the composite sample is a monthly 24-h composite.

[b]TOC = total organic carbon, and TOX = total chlorinated hydrocarbons.

[c]IBF = influent before filter; IAF = influent after filter; and EFF = effluent.

[d]NS = not sampled.

Table 7. Operation and maintenance costs for the groundwater treatment plant

Month	Sampling and analysis ($)		Electricity		Filters		H_2O_2		Total($)[a]
	Routine	Evaluation	Cost ($)	kWh	Cost ($)	No. used	Cost ($)	No. drums	
1988									
February	NM[b]	3,295	NM	NM	NM	NM	NM	NM	0
March	NM	3,784	NM	NM	NM	NM	NM	NM	0
April	NM	280	NM	NM	NM	NM	295	NM	0
May	1,525	14,185	359	8,620	176	NM	0	NM	2,060
June	1,696	13,908	262	NR[c]	125	NM	0	NM	2,083
July	1,347	12,341	353	NR	100	NM	295	NM	2,095
August	1,428	13,950	280	NR	50	NM	147	NM	1,905
September	415	3,732	35	NR	13	NM	0	NM	463
October	1,000	4,514	212	5,100	25	4	74	0.25	1,311
November	3,407	26,625	478	11,500	0	0	147	0.5	4,032
December	1,867	26,393	124	2,980	0	0	75	0.25	2,066
1989									
January	0	0	260	6,260	0	0	38	0.125	298
February	1,671	17,601	298	7,160	13	2	100	0.333	2,082
March	1,690	11,695	454	10,920	0	0	150	0.5	2,294
April	1,923	17,073	459	11,020	0	0	0[d]	1	2,682
May	2,227	18,980	508	12,220	25	4	300	1	3,060
June	711	778	28	660	0	0	0	0	739
July	1,134	3,648	173	4,120	6	2	0	0	1,312
August	821	11,315	310	7,380	0	0	0[d]	1	1,131
September	1,023	12,635	386	9,180	12	2	0[d]	1	1,421
Total	23,064	162,150	4,979		545	14	1,621		181,992

[a]The total cost excludes the evaluation costs for sampling and analysis because they do not contribute to ongoing long-term operation and maintenance costs. The H_2O_2 costs in April 1988 are not included in the total cost because they were incurred prior to startup.

[b]NM = costs not monitored prior to startup in May 1988.

[c]NR = not reported.

[d]Utilized out-of-shelf-life material from plant operations.

Table 8. Groundwater treatment plant downtime

Month	Shutdown period (d)	Reason for downtime
		1988
May	1	Spargers cleaned
June	5	Excessive ozone in building caused shutdown; operator out of town
July	8	Operator on vacation
August	13	Excessive ozone in building caused shutdown; spargers cleaned and replaced
September	22	Escape of excessive ozone in the exhaust; spargers replaced
October	17	Spargers replaced
November	0	
December	21	Special study conducted one week; ozone generator malfunctioned
		1989
January	24	Ozone generator repaired; cold weather caused shutdown twice
February	9	Ozone generator repaired; spargers cleaned
March	14	Air dryer serviced
April	0	
May	0	
June	30	Maintenance and modification to the equipment
July	29	Ozone leaks and wet compressed air
August	3	Ozone leaks
September	0	The plant operated every day but experienced almost daily shutdowns due to a faulty ambient air ozone monitor

- The glass and stainless steel dielectrics in the O_3 generator were cemented together with dark orange-brown particles with a cement-like consistency. The color and nature of the substance suggested that nitric acid may have been generated from wet, contaminated air. The dielectric cells were cleaned by immersion in an alcohol-acetone bath to loosen the particles and then brushing with a fine-bristle brush to remove them.
- The O_3 rotameters on the inlet manifold of the reaction chamber and the O_3 feed tubing were coated with a dark orange-black material that severely limited flow. This also suggests the production of nitric acid in the O_3 generator. The rotameters were cleaned.
- The sight windows and UV lamps were severely coated. The sight windows had become opaque from the residue. All 72 of the UV lamps were covered with a light-brown metallic oxide coating approximately 0.79 mm (1/32 in.) thick that reduced if not blocked the UV transmission. The UV lamps were cleaned in a 5% HCl acid bath.
- Water drained from the reactor was black in color and contained a large quantity of sediment and precipitate. This sediment was removed from the reactor with a hand shovel, bucket, and wet-dry shop vacuum.
- The O_3 diffuser in stage 6 was broken and coated similarly to the sight windows and UV lamps. The other diffusers were not coated. The diffuser was repaired.
- The water level gauges were extremely dirty and were cleaned.
- The effluent sampling port was relocated.
- A pretreatment system was installed to remove iron and manganese. O_3 is used to oxidize the iron and manganese, and a filter is used to remove the precipitate.
- A digital dew point monitor was installed to determine moisture content of the air supply.

In October 1988 an analysis of the in-line filter and the water from well number 2 found iron bacteria, which could restrict flow.

In January 1989 the equipment in the O_3 generator that converts C to D malfunctioned and was replaced.

In April 1989 the air supply for the O_3 generator was sampled before and after the air dryer. The results showed that the air dryer was not reducing the moisture content for the inlet air sufficiently. An additional air dryer was installed in May 1989 to reduce the moisture content further. This appears to be helping. All of the UV lamps were operated all of the time.

4.4 PLANT CAPACITY STUDY

The results of Experiment 1 are summarized in Figs. 3 and 4. On November 23 and 28, 1988, the power settings on the O_3 generator were 50% (Experiment 1a) and 100% (Experiment 1b), respectively.

The results for Experiments 2 and 3 are summarized in Figs. 5 and 6, respectively. The results for Experiment 4 are displayed in Fig. 7.

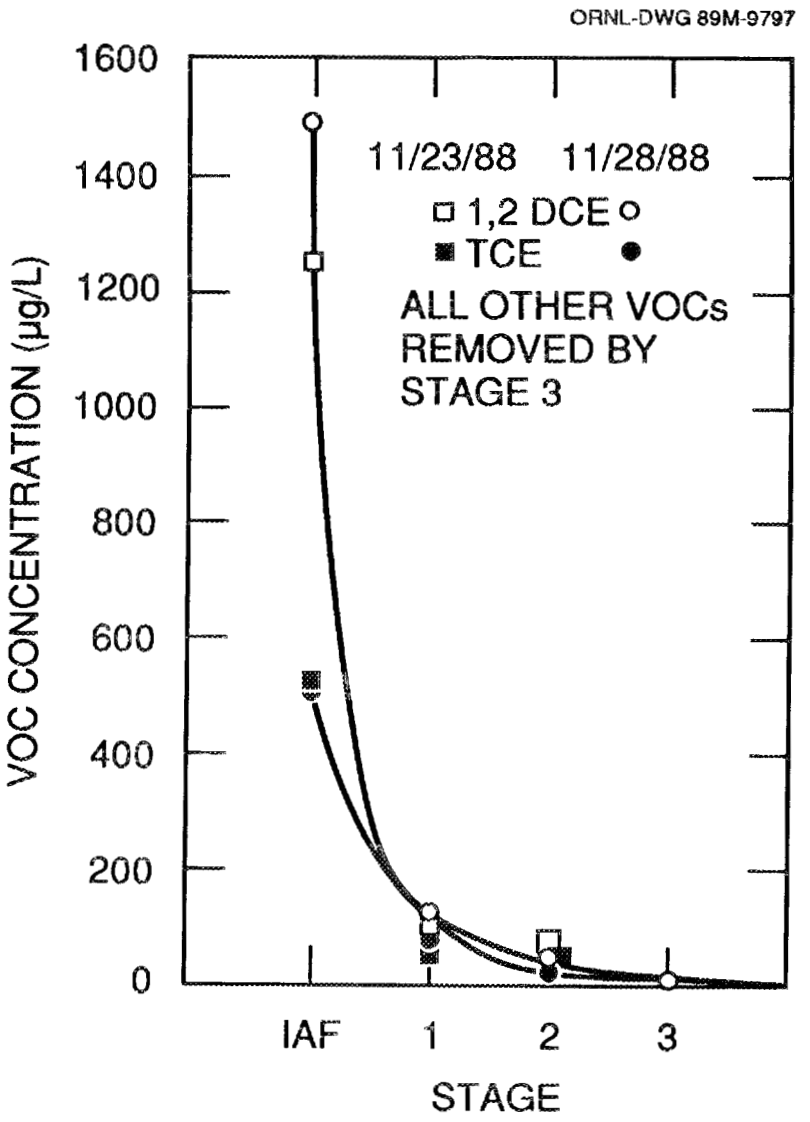

Fig. 3. Volatile organic compound (VOC) removal during Experiments 1a (11/23/88) and 1b (11/28/88). IAF = influent after filter. Source: Peyton 1989.

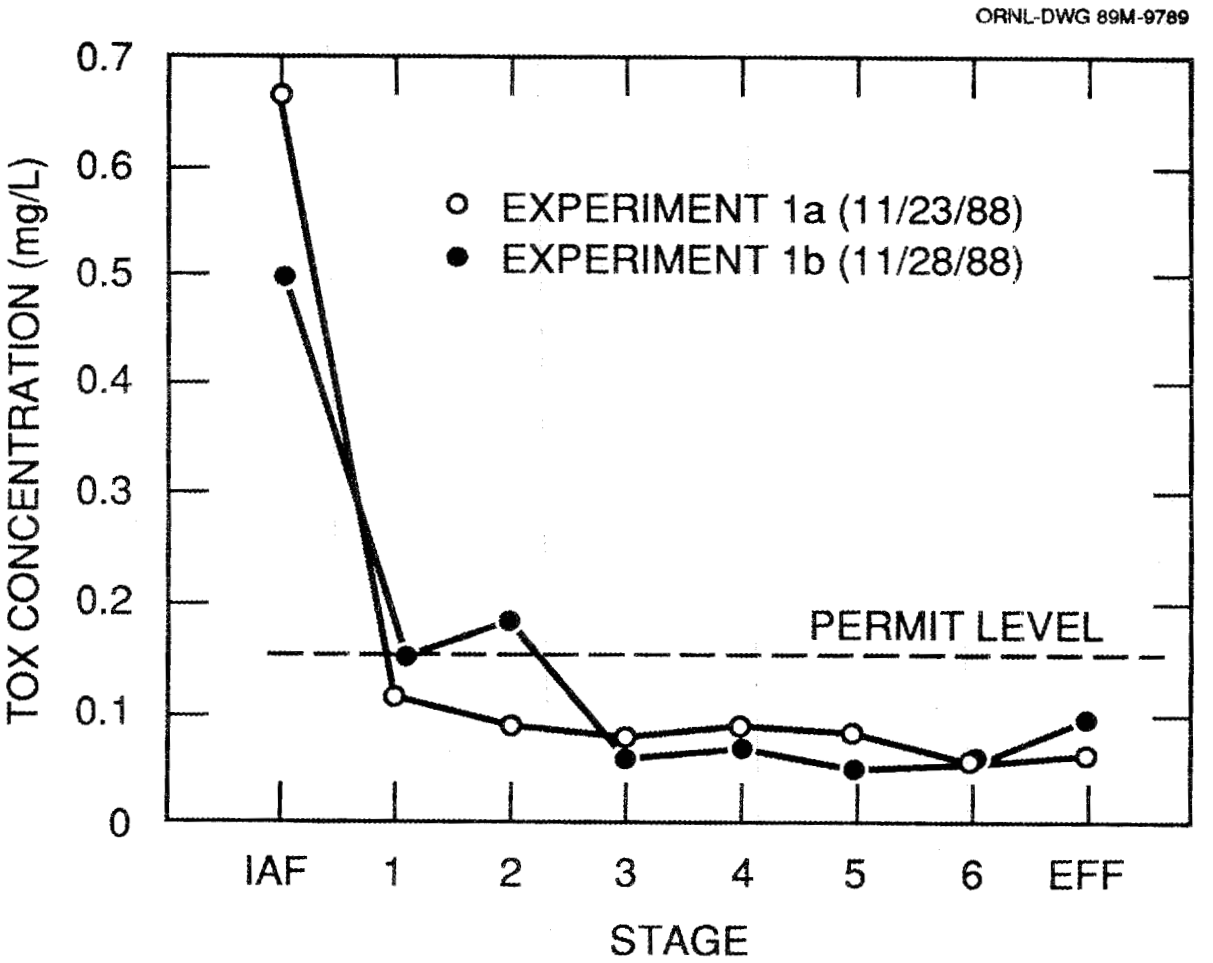

Fig. 4. Total organic halogen (TOX) levels in Experiments 1a (11/23/88) and 1b (11/28/88). IAF = influent after filter, and EFF = effluent. Source: Peyton 1989.

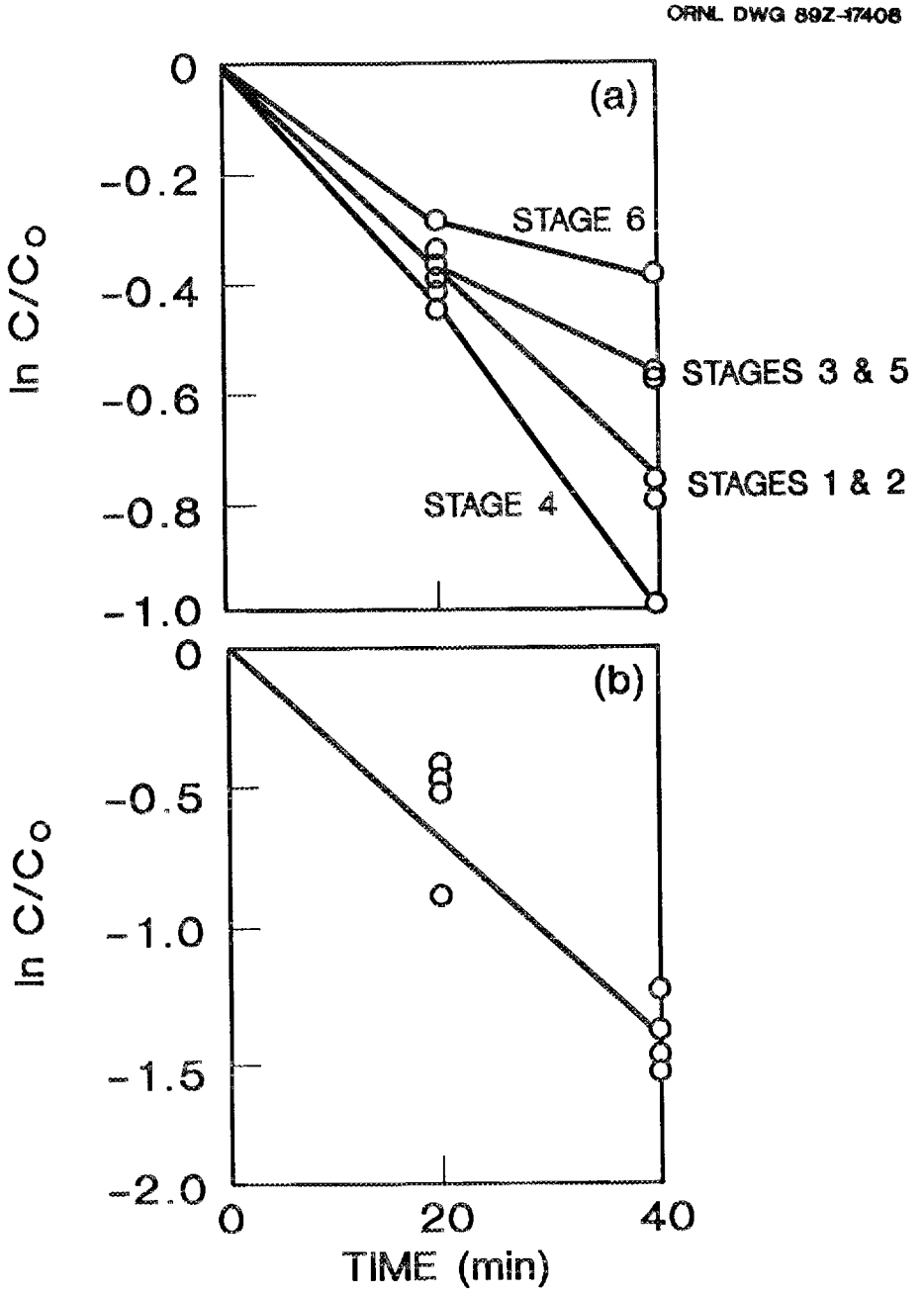

Fig. 5. First-order plots of (a) 1,2-dichloroethene sparging and (b) 1,1,2-trichloroethene sparging for Experiment 2. For plot (a) the initial concentration, stages 1 and 2, was 765 ppb; for plot (b) the initial concentration was 300 ppb (data shown for stages 1 through 4). C_o is initial concentration, and C is the concentration at any subsequent time.

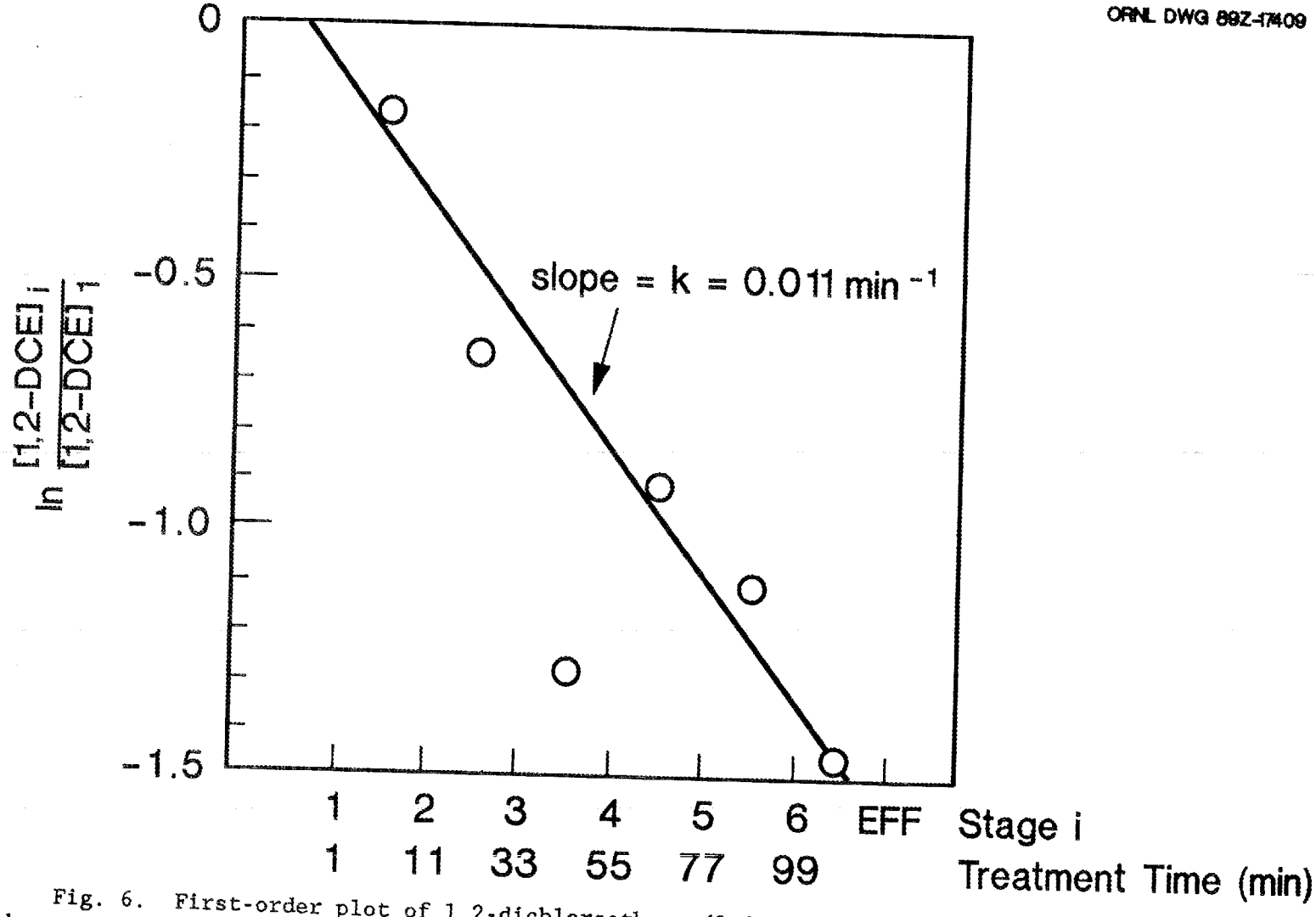

Fig. 6. First-order plot of 1,2-dichloroethene (1,2-DCE) during hydrogen peroxide/ultraviolet radiation treatment (Experiment 3). No ultraviolet radiation was used in stage 1. EFF = effluent.

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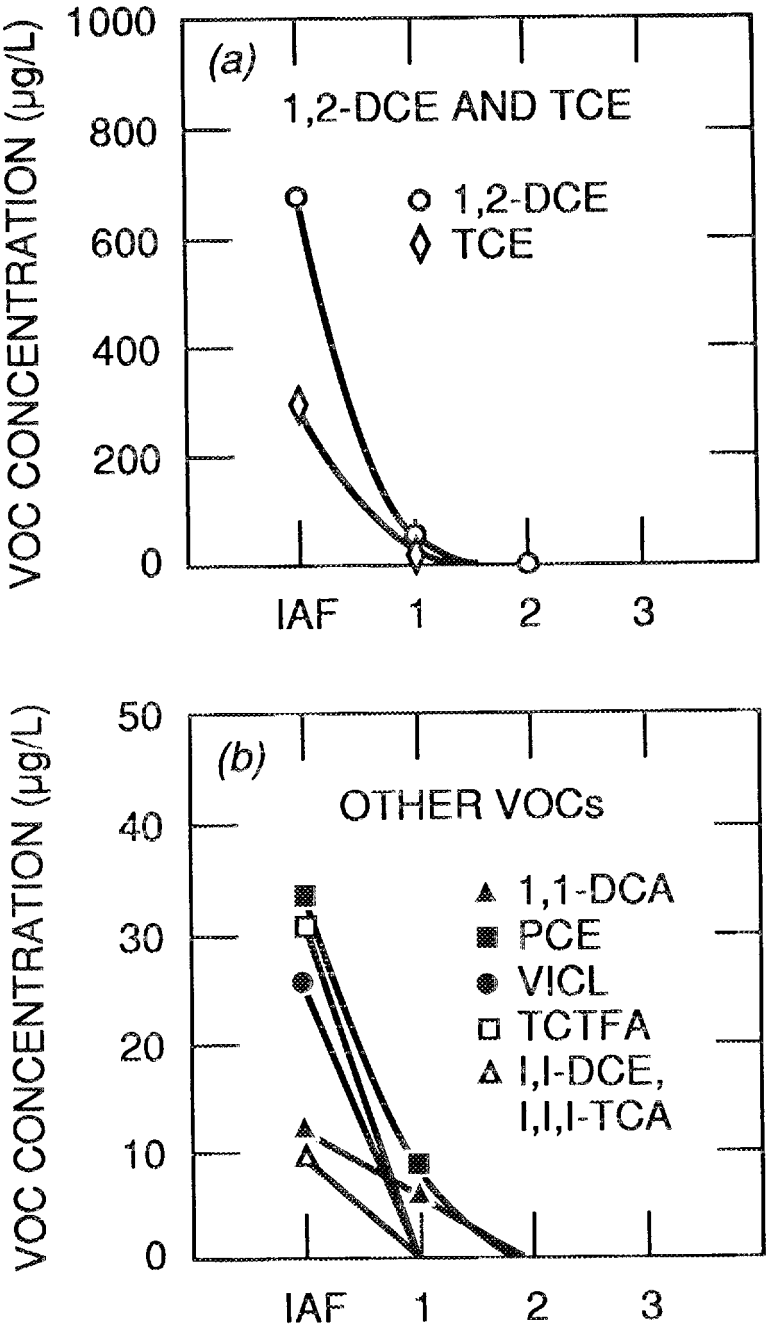

Fig. 7. Disappearance of volatile organic compounds (VOCs) during ozone/hydrogen peroxide treatment (Experiment 4). IAF = influent after filter; DCE = 1,2-transdichloroethene; TCE = trichloroethene; 1,1-DCE, 1,1-dichloroethene; DCE = tetrachloroethane; Vicl = vinyl chloride; 1,1-DCE = 1,1-dichloroethene; 1,1,1-TCA = 1,1,1-trichloroethene. Source: Peyton 1989.

The results for Experiment 5, the normal operation of the treatment plant, are presented in Sects. 4.1 and 4.3.

5. DISCUSSION

5.1 INTRODUCTION

A major effort during FY 1989 was the evaluation of the capacity of the plant, and the discussion initially deals with the findings of this evaluation. Next, the discussion evaluates the ability of the plant to meet its permit. Following that, the treatment plant's effect on other parameters is described. Finally, operations and maintenance experience is discussed, and a study plan for FY 1990 is proposed.

5.2 PLANT CAPACITY STUDY

5.2.1 Introduction

The purpose of this study was to determine if the existing groundwater treatment plant can accommodate flow from the TCE still area (TCESA) and the northeast area (NEA) plumes in addition to that from the UTF plume. Currently, the average flow rate from the UTF plume is approximately 0.00025 m^3/s (4 gal/min).

The TCESA plume will consist of approximately .0009 m^3/s (14 gal/min). Some wells from the TCESA average as high as 7400 $\mu g/L$ of 1,2-dichloroethene (1,2-DCE) and 12,100 $\mu g/L$ of TCE, although the overall average should be lower. Addition of this stream to the treatment plant influent therefore represents an increase in flow of 2 to 2.5 times as well as a possible concentration increase.

The other plume to be added to the treatment plant is the NEA. The NEA plume was estimated at the time of the study to be an additional 0.0007 m^3/s (11 gal/min). Samples from these wells have shown 1,2-DCE concentrations of 13 mg/L and TCE concentrations of 17 mg/L. Addition of this stream constitutes a 200% increase in flow being treated and a tenfold increase in VOC concentration.

Addition of both the TCESA and the NEA plumes corresponds to a flow increase of 400 to 500% and a concentration increase by a factor of 2 to 5.

5.2.2 Ozone Output of Unit

A critical factor in estimating the maximum capability of the existing treatment plant is the projection of the amount of O_3 that the existing generator will be able to produce, because oxidation of organics is directly related to the number of $OH^{\bullet}$ radicals formed from the O_3. The first step in that projection is the determination of the O_3 yield under present conditions.

The calculated values of O_3 yield and utilized dose are shown in Table 9. During the period of operation at 100% power, the O_3 yield varied between (.816 and 2.63 kg/g) (1.8 and 5.8 lb/day), which is only 9 to 28% of the rated output [9.53 kg/g (21 lb/day)]. A considerable

Table 9. Ozone yield and utilized dose

Date	Transfer efficiency (%)	Utilized ozone dose (mg/L)	Ozone yield (lbs/day)
2/23/89	31	15.1	3.3
2/22/89	13	5.0	2.6
2/21/89	35	15.8	3.0
2/10/89	58	17.5	2.0
12/19/88	51	27.0[a]	3.6[a]
11/28/88	76	34.2	3.0
11/23/88	38	10.7	1.8
11/22/88	62	33.8	3.6
11/21/88	54	24.9	3.1
11/20/88	83	71.9	5.8
11/19/88	87	64.6	5.0
11/18/88	84	52.3	4.1
11/12/88	97	71.7	5.0

[a]Calculated using extrapolated data.

Source: G. R. Peyton, Feasibility of adding TCE still area and northeast area plumes to ultraviolet radiation ozone, hydrogen peroxide groundwater treatment plant, Department of Energy Kansas City Plant, ORNL/Sub/89-SD212V/1, Oak Ridge National Laboratory, Oak Ridge, Tennessee, 1989.

increase in yield will have to be realized to treat the combined flows from all three areas in order to oxidize the total organic concentrations.

It is most likely that the poor performance is the result of wet air being supplied to the O_3 generator. The moisture content of the supply air was measured as reported in Sect. 4.3 and found to be above the maximum specified for supply air to the O_3 generator. Another drying unit was installed to eliminate this problem, and a dew point monitor was installed to determine moisture content in the future. The findings from Ultrox International's work (see Sect. 4.3) also are consistent with wet air being the major cause of low O_3 generator yield. Moisture content before and after the air dryers should be monitored in the future.

5.2.3 Transfer Efficiency of Ozone

Another crucial factor in estimating the capacity of the existing treatment plant is its ability to transfer the generated O_3 into solution. Only the fraction of O_3 that is transferred into solution participates in the groundwater treatment process.

The transfer efficiency of O_3 is the fraction of the applied dose that is transferred into the liquid phase. For AOPs a low transfer efficiency is usually indicative of poor mass transfer resulting from bubbles that are too large and/or clogged spargers.

Transfer efficiencies calculated for operation of the existing treatment plant are shown in Table 9. These values are also plotted in Fig. 8. A general deterioration of O_3 transfer efficiency occurred, and transfer efficiencies dropped to approximately 50% after 1 1/2 months of operation. This was accompanied by operator reports of clogging spargers and reduced flow through the individual stage rotameters. This was verified during the work by Ultrox International (Sect. 4.3), in which the O_3 rotameters and feed tubing were clogged and the O_3 spargers in stage 6 of the reactor were broken and coated. Since the spargers were broken, large bubbles were released, which reduced the transfer efficiency. It is also possible that the coated UV lamps decreased the photolysis to O_3, lowering the utilization of O_3.

Cleaning of the spargers, the O_3 rotameters, the feed tubing, and the UV lamps may become frequent routine maintenance items because the amount of O_3 that can be transferred into solution will be the determining factor in whether the treatment goals can be met.

5.2.4 Treatment Experiments

Experiment 1—Turning the O_3 Generator up to Full Power and Using the UV Lamps and Hydrogen Peroxide

The results of Experiment 1 are summarized in Figs. 3 and 4. Fig. 3 shows the removal of TCE and 1,2-DCE between successive reactor stages, both before and after increasing the power at the O_3 generator from 50 to 100%. Most of the other VOCs not shown in Fig. 3 are removed by the time that the water reaches stage 3. Although removal of the

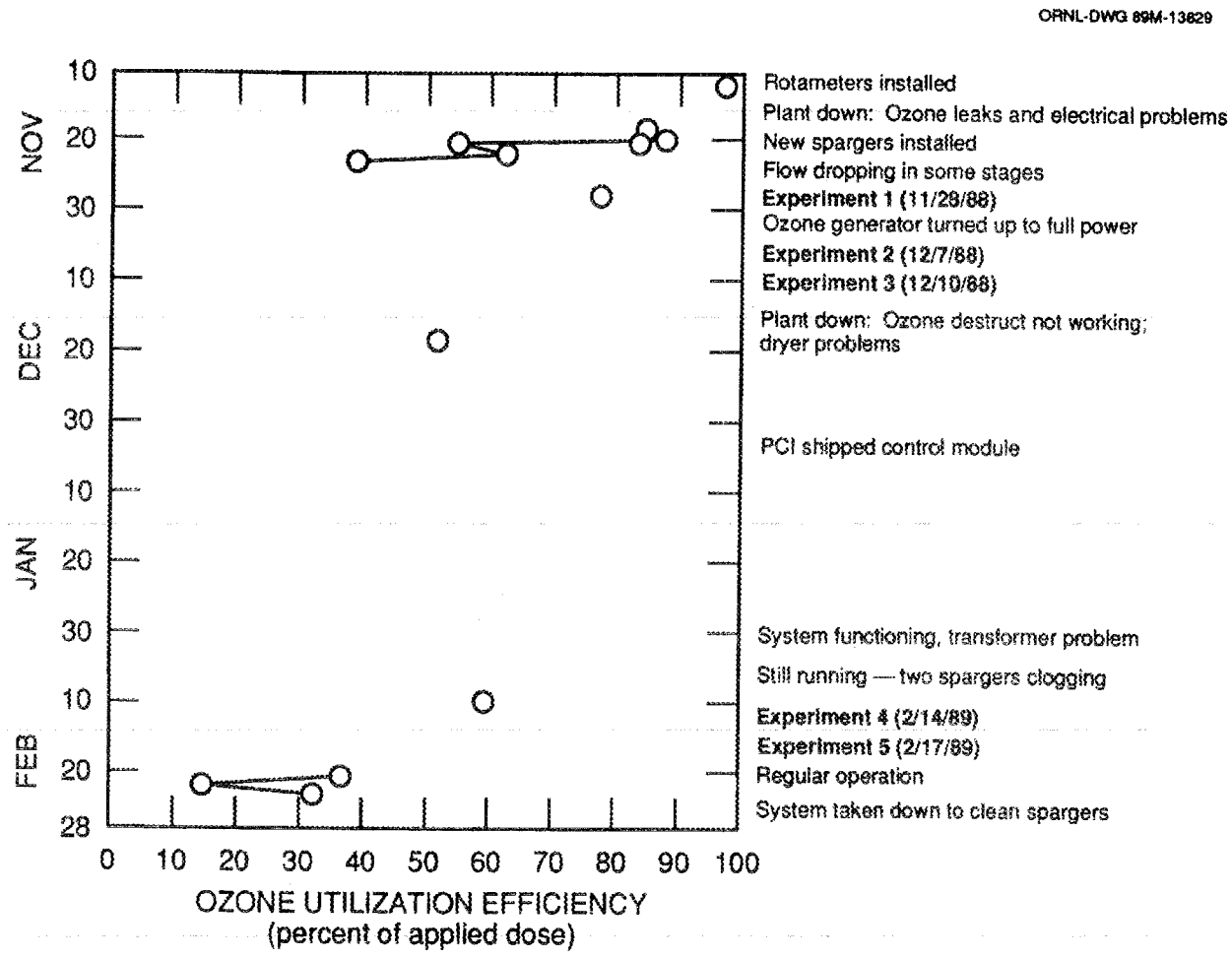

Fig. 8. Ozone transfer efficiency in reactor.
Source: Peyton 1989.

VOCs is seen to be rapid, no significant difference in the removal rate of 1,2-DCE and TCE was seen between 50 and 100% power.

Of interest is the parallel between the VOC concentrations shown in Fig. 3 and the TOX values shown in Fig. 4. It is of significance that when the VOCs are removed, reduction in TOX ceases. It is highly unlikely that some form of TOX that is totally refractory to $OH^{\bullet}$ remains. Much more likely is the possibility that the residual value seen in stages 3 through 6 of Fig. 4 is an analytical artifact. An approximate first-order rate constant of $k_1 \approx 9.5 \times 10^{-2}$ min^{-1} was determined for the removal of 1,2-DCE.

Experiment 2—Sparging of VOCs.

Removal by sparging was found to account for a relatively low percentage of the total VOC removal. A logarithmic plot (Fig. 5) of the data vs time is linear, indicating a first-order process, as expected, with a sparging rate constant of 1.9×10^{-2} min^{-1} for 1,2-DCE and 3.1×10^{-2} min^{-1} for TCE. Calculations show that, if no other treatment were occurring, approximately 90% removal of 1,2-DCE would occur due to sparging alone. This should be compared with 95% removal in only two stages by O_3/UV radiation/H_2O_2 in Experiment 1. Thus, sparging accounted for only 13 to 14% of VOC removal during Experiment 2.

Experiment 3—H_2O_2/UV Radiation

This experiment was run to determine what portion of VOC removal was due to H_2O_2 photolysis, which also produces $OH^{\bullet}$ radicals. In addition, since the photolysis properties of H_2O_2 are well known, its disappearance was to serve as a measure of actual UV intensity inside the reactor. Unfortunately, the H_2O_2 samples were not analyzed immediately as instructed but were taken back to the laboratory before the colorimetric reagent was added, thereby nullifying the H_2O_2 data. It was discovered at this point that this had also been the case for the liquid-phase oxidant measurements made during Experiment 1.

The VOC data from Experiment 3, however, provided valuable insight into the process. Removal of VOCs by H_2O_2/UV radiation was found to be slower than preliminary calculations had predicted. This was probably due to coating that forms on the UV lamp wells and reduces the UV intensity reaching the solution and/or a lower actual applied H_2O_2 dose than that which was thought. As is the case with O_3, the operator can only adjust a power setting to the pump that is supposed to furnish a predetermined H_2O_2 dose rate. There is, in practice, very little that the operator can do to confirm that the dose is actually what he sets it to be.

The first-order rate constant calculated for 1,2-DCE removal by H_2O_2/UV radiation during this experiment was 1.1×10^{-2} min^{-1}. This was slower than the sparging rate found in Experiment 2.

Experiment 4—O_3/H_2O_2

The purpose of Experiment 4 was to determine the extent to which UV radiation aids in the destruction of the VOCs, compared with the O_3/H_2O_2

destruction rate. The disappearance of 1,2-DCE and TCE is shown in Fig. 7. As in Experiment 1, the concentration of these two VOCs is reduced by about an order of magnitude between the influent and the stage 1 point. Unfortunately, no O_3 feed gas or off-gas concentration measurements were made by the contract laboratory during this experiment, so more-detailed comparisons with H_2O_2/UV radiation and O_3/UV radiation are not possible.

The first-order rate constant calculated for 1,2-DCE destruction during this experiment was 1.4×10^{-1} min^{-1}.

Experiment 5—Normal Operation

Data obtained during operation following startup have been compared with those obtained during the prior experiments. For these purposes, these data are referred to as Experiment 5. The reactor performed better than during Experiment 1, achieving greater than one order of magnitude more removal between the IAF and the stage 1 sampling point. This is probably because the reactor performance was not yet adversely affected by poor O_3 generation, clogged spargers, O_3 rotameters, feed tubing, and scaling. The first-order rate constant for 1,2-DCE removal between IAF and stage 2 was 1.5×10^{-1} min^{-1}.

Summary and Discussion of Rate Constant Data

The approximate first-order rate constants obtained in Experiments 1 through 5 are collected in Table 10 for comparison. From these data it is possible to interpret the relative rate constant data and draw the following inferences concerning the treatment that is taking place in the reactor:

1. Sparging is not the major VOC removal mechanism during O_3/UV radiation/H_2O_2 and O_3/H_2O_2 treatment. Since sparging is a first-order process (proportional to VOC concentration), it will remove more VOCs as the concentration of VOCs in the feed stream increases upon addition of groundwater from the TCESA and NEA plumes. Since an increase in O_3 generation and transfer efficiency is required for the treatment of those streams, sparging is still not expected to be the major removal mechanism.
2. Peroxide photolysis (H_2O_2/UV radiation) is not very important presently. This may be because of the coating on the lamp wells, which frequently occurs when treating groundwater with high levels of iron and manganese (Glaze et al. 1984). The reactor has no provision such as the "wipers" found on UV radiation disinfection reactors for lamp well cleaning. Thus, periodic cleaning of the lamp wells will require shutting down and emptying the reactor, acid cleaning of the lamps, disposal of the acid, and restart of the reactor. Experience has indicated that lamp well cleaning may be required as frequently as once per week (Glaze et al. 1984). The cleaning process described previously would require about 1 day, which results in 14% downtime just for lamp cleaning. This time could be decreased considerably, as could the operator time required, by the regular use of acid cleaning, either on a batch

Table 10. First-order reaction rate constants for 1,2-DCE destruction during Experiments 1 through 5

Experiment	Treatment[a]	Rate constant, k (min^{-1})
1	$O_3/UV/H_2O_2$	0.095
2	Sparging	0.019
3	H_2O_2/UV	0.011
4	O_3/H_2O_2	0.14
5	$O_3/UV/H_2O_2$	0.15

[a]O_3 = ozone; UV = ultraviolet radiation; and H_2O_2 = hydrogen peroxide.

Source: G. R. Peyton, Feasibility of adding TCE still area and northeast area plumes to ultraviolet radiation, ozone, hydrogen peroxide groundwater treatment plant, Department of Energy Kansas City Plant, ORNL/Sub/89-SD212V1, Oak Ridge National Laboratory, Oak Ridge, Tennessee, 1989.

basis or in a recirculating system. The data in Table 10 indicate that such a system is not presently justified, but the possibility should be kept in mind for consideration after the results from addition of the other groundwater streams are obtained.

3. The O_3/H_2O_2 reaction appears to be responsible for the major portion of VOC removal, possibly because of the scale on the UV lamps, which limits their usefulness. This should be checked when another plume is added. It is also possible that O_3 alone would effect removal of the VOCs. It has been observed that O_3 treatment of some natural waters gives results equivalent to that of the AOPs, due presumably to free-radical reaction promoters that are naturally present in the water (Peyton et al. 1989). No ozonation experiments were performed in the present project.

5.2.5 Treatment Capability of the Existing Plant

Validity of the Extrapolation

Rigorous interpretation of the data obtained in the treatment experiments was not possible because of the lack of good oxidant concentration data. It was therefore necessary to use a more empirical model for extrapolation of the data to the projected treatment situation. The need for such a model is illustrated in Fig. 9. The present operating conditions in terms of flow rate and concentration are represented by the box in the lower left corner of the figure. The conditions after addition of the TCESA and NEA plumes are represented by the box at the lower right edge of the figure, and the conditions after a concentration excursion of three times the average concentration are represented by the box at the upper right corner of the figure. The amount of VOCs to be treated is actually given by the concentration times of the flow rate, so that the box on the right represents a greater than 80-fold increase in the loading of the reactor.

Projections of this magnitude are extremely uncertain, particularly in view of the lack of characterization of the reactor with respect to engineering variables such as photon and O_3 transfer coefficients. Furthermore, the calculations to be described represent the first application of this model to real-world treatment systems. Therefore, the conclusions drawn by such extrapolation should be recognized as estimates and taken with reservation. It is recommended that further testing be conducted after either the TCESA or the NEA plumes are added to the treatment plant, in order to recalibrate the model and confirm and/or modify the conclusions.

Model Description

The model is based on the known properties of free radicals, which are the species responsible for organic compound destruction by the AOPs. It is well known that the $OH^{\bullet}$ radical reacts so quickly with most organic compounds that its half-life is usually measured in fractions of microseconds. Under these conditions, the fate of the radicals is determined by the kinetics, that is, by the rates of the reactions.

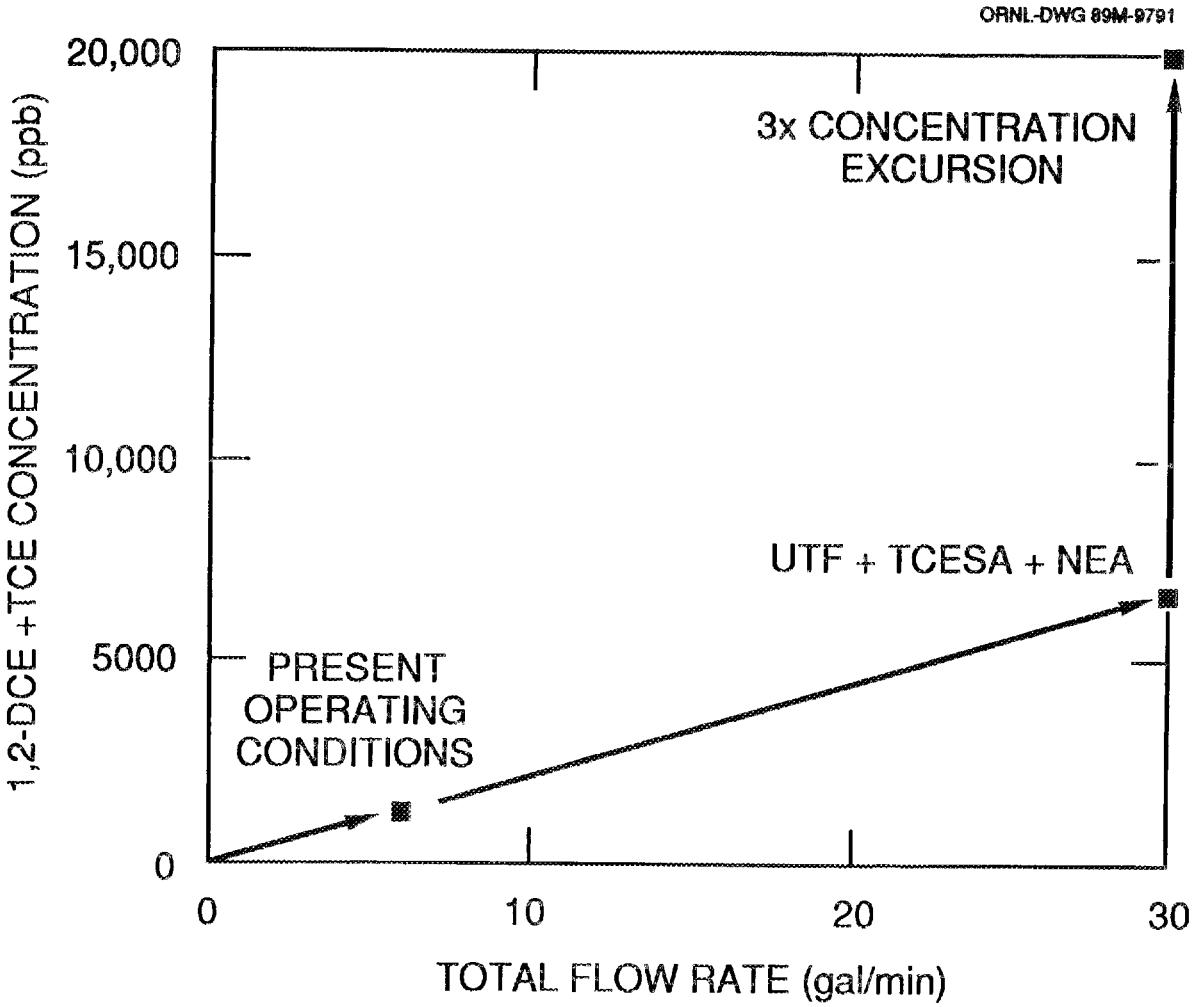

Fig. 9. Extent of extrapolation required to achieve the goals of the present study. UTF = Underground tank farm; TCESA = TCE still area; and NEA = northeast area. Source: Peyton, 1989.

When material other than the contaminant is present in the groundwater to be treated, this material can compete for the $OH^{\bullet}$ radical, so that not all of the radicals are used for contaminant destruction. Examples of these materials, called scavengers, are the metals and natural humic substances that are present in surface water and groundwater. Under these conditions, the relative amounts of $OH^{\bullet}$ radicals that attack contaminants and innocuous scavengers are determined by the relative rates at which the various species can react with the $OH^{\bullet}$ radical.

Because the model contains empirical parameters, it must be calibrated with data taken from operations. The data used were from normal operation and from the five special Experiments described above.

The model was calibrated with the performance data from Experiments 1 through 5. Comparison of the VOC destruction calculated from the model with that actually observed in Experiments 1, 4, and 5 is shown in Figs. 10 and 11. The calculated VOC destruction closely predicts the actual VOC destruction. The model is described in detail by Peyton (1989).

Extrapolation of Present Operating Data to Conditions of Increased Reactor Loading

The model that has been developed is a conservative estimate of reactor performance. However, the question of whether the model correctly extrapolates such a long distance as is required by the goals of this study is a matter that must still be determined. It should be noted that any method of extrapolation over such a range would suffer the same uncertainty.

Performance of the reactor under increased loading has been evaluated for three scenarios:

1. TCESA plume added to that of the UTF plume (UTF + TCESA),
2. both TCESA and NEA plumes added to that of the UTF plume (UTF + TCESA + NEA), and
3. three times the concentration obtained in scenario 2.

The last scenario is included because of the following uncertainties in determining the concentration in the combined flow:

1. Concentration data are limited in many cases.
2. Existing data are for samples taken from sampling wells, whereas the actual flow will be from production wells. The concentrations in the sampling wells vary widely with depth and location, so there is no reason to believe that they accurately represent the concentration of the composite production well flows.
3. Concentrations will vary as the plume or plumes move through the well field.

Inclusion of all of the VOCs in the model would have resulted in a very complicated calculation. The process can be simplified considerably by noting that the trace VOCs are always removed long before the more concentrated ones, based on the existing data.

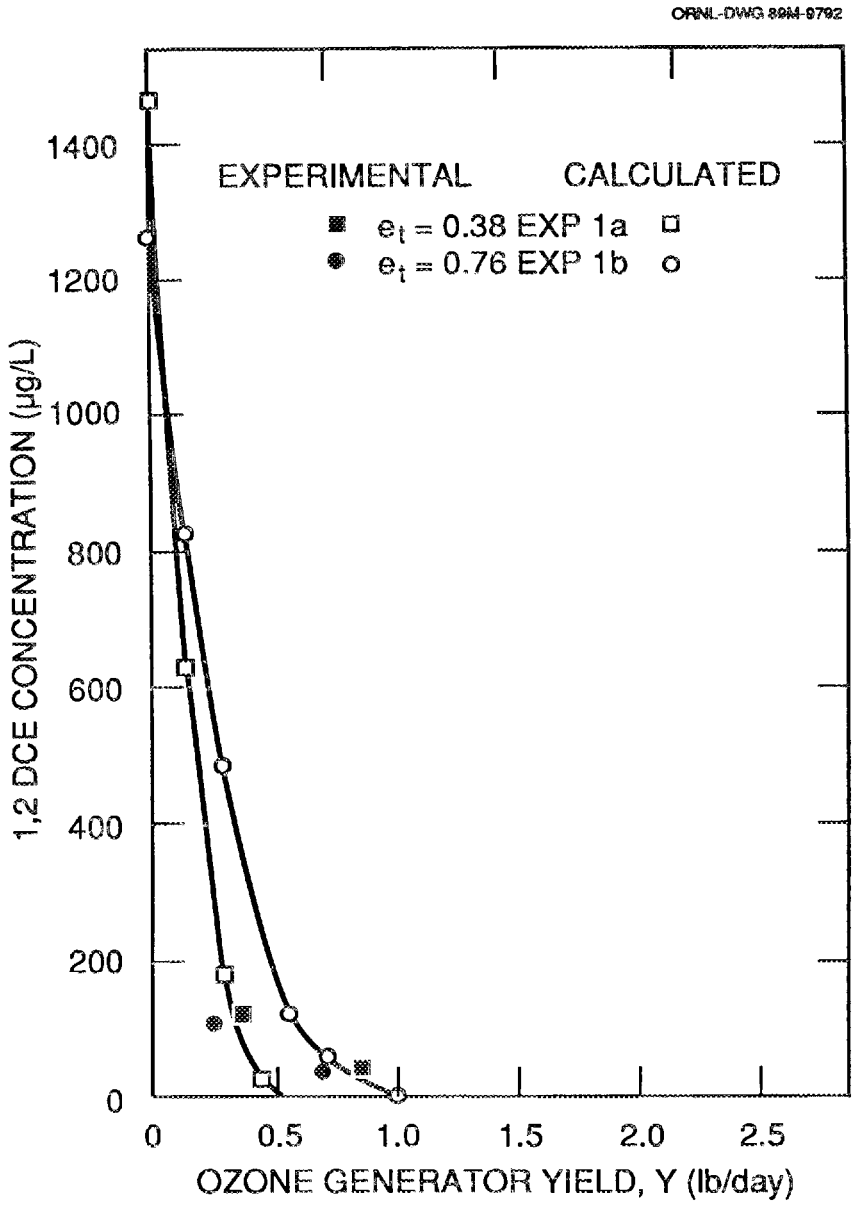

Fig. 10. Comparison of experimental volatile organic compound disappearance with that calculated from the model: Experiments 1a and 1b. Source: Peyton 1989.

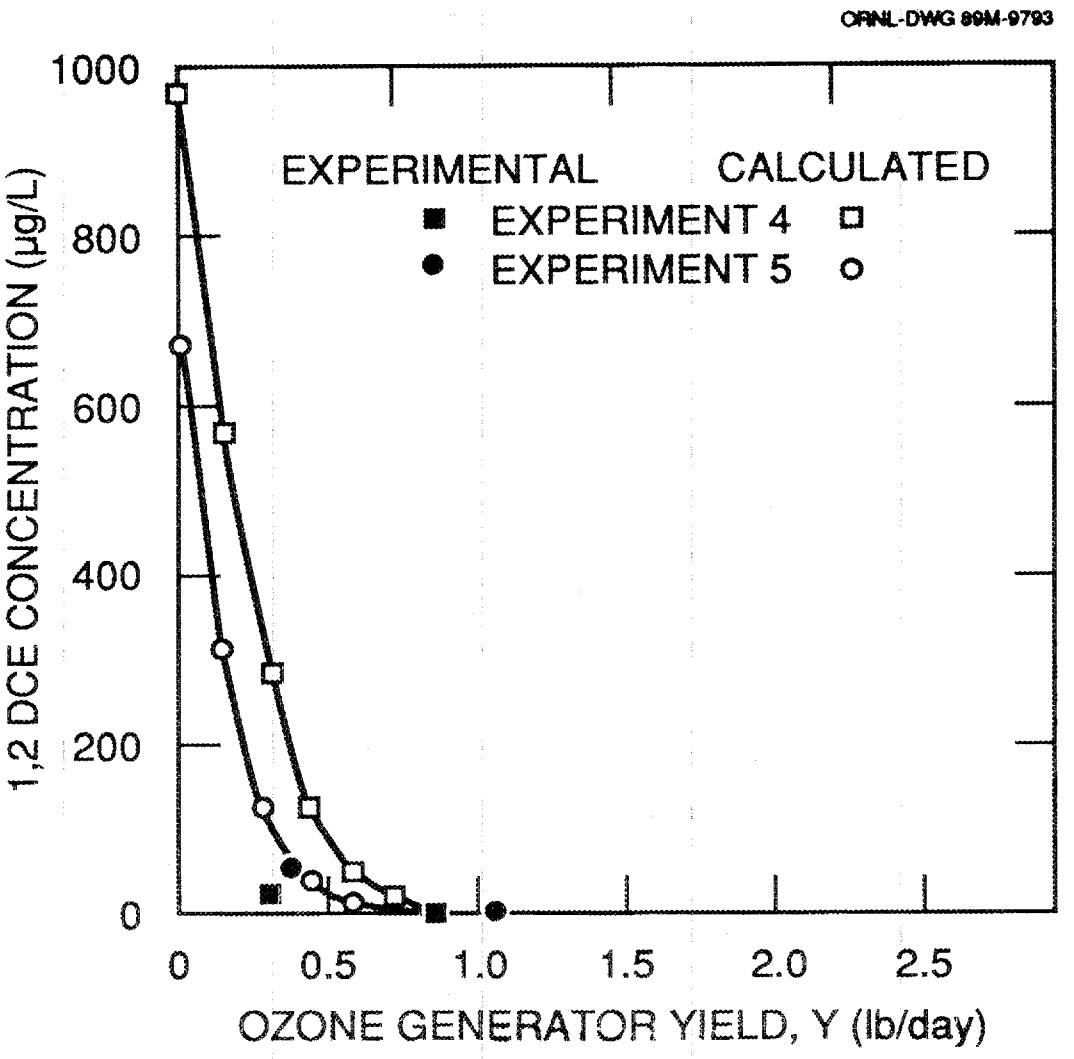

Fig. 11. Comparison of experimental volatile organic compound disappearance with that calculated from the model: Experiments 4 and 5. Source: Peyton 1989.

The results of the calculations are shown in Figs. 12 through 14. Fig. 12 shows the decrease in VOC concentration as a function of O_3 generator yield. It is apparent that even with the O_3 generator operating at 20% of its capacity, adequate treatment can be expected if a transfer efficiency of 50% is maintained.

Fig. 13 shows the calculated destruction of VOCs from the combined UTF + TCESA + NEA plumes. The calculation predicts that the groundwater can be adequately treated with the O_3 generator producing at half of its rated capacity, even with a relatively low mass transfer efficiency (50%). With full O_3 generator capacity, there is a large margin of safety, even at very low transfer efficiency.

Shown in Fig. 14 are the calculated disappearance curves, assuming a concentration excursion of three times the calculated average concentration. Whereas the calculation predicts that at full generator capacity [9.53 kg/d (21 lbs/day)] the treatment goals can be met if 50% transfer efficiency can be maintained, the rated generator capacity may not be adequate if the transfer efficiency drops to a lower value.

At this point it should again be stressed that an unproven extrapolation technique has been used to estimate the performance of the system at the projected operating conditions and that a recalculation and a model calibration check after the next plume has been brought on line are essential.

Results of Ultrox Overhaul and Significance to the Present Extrapolation

While overhauling the treatment plant, the Ultrox International technicians found extensive deposits inside the O_3 generator. These deposits were attributed to moisture in the feed air, primarily because of the color of the deposits (see Sect. 4.3).

When the unit was tested immediately after the overhaul, it was operated at the recommended flow rate and 92.5% of full power. At the concentration and flow rate achieved during that test, the O_3 generator produced its rated output, or about 9.53 kg/d (21 lbs/day) of O_3. Reference to Fig. 14 shows that loss of efficiency below the rated output may be significant and could result in the inability of the plant to treat the combined flows. It is recommended that careful attention be given to the daily calculation of transfer efficiency and generator yield in order to anticipate performance problems before they become too severe.

Summary

The model predicts that if the treatment plant, particularly the O_3 generator, is operating properly and the O_3 transfer efficiency is 60 to 80%, the plant should be capable of handling the combined flows from all three plumes. After either the TCESA or the NEA plumes are connected to the treatment plant, the model calculations should be refined.

The O_3 generator appears to produce at its rated capacity after the overhaul by Ultrox International. The O_3 generator yield and transfer efficiency should be calculated daily to anticipate performance problems.

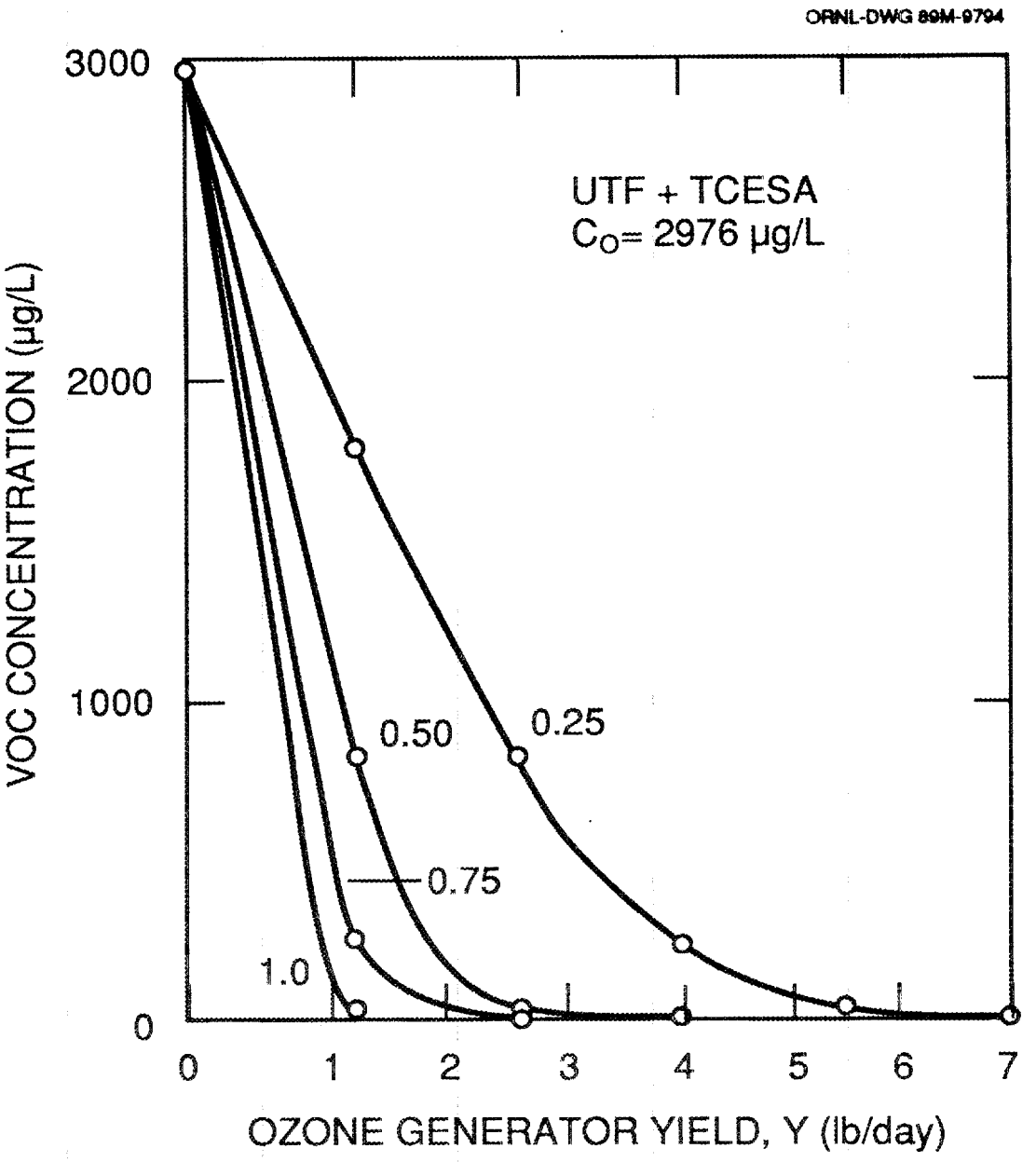

Fig. 12. Predicted volatile organic compound (VOC) destruction for combined underground tank farm (UTF) and trichloroethylene still area (TCESA) pumpage at three ozone transfer efficiencies (25, 50, and 75%). Source: Peyton 1989.

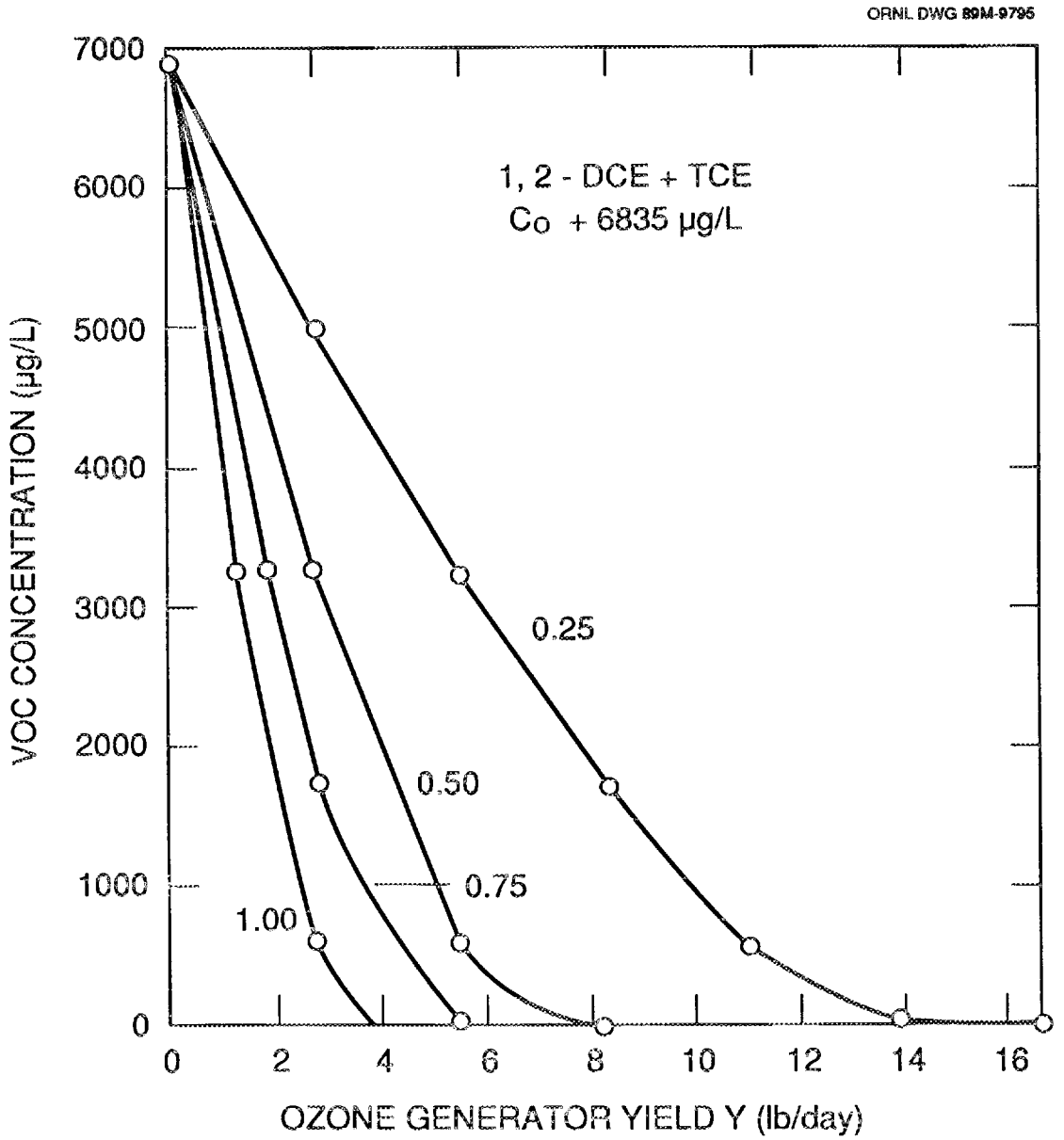

Fig. 13. Destruction of volatile organic compounds (VOCs) in combined underground tank farm, trichloroethylene still area, and northeast area pumpages at various ozone transfer efficiencies (25, 50, 75, and 100%. C_o is the initial concentration of VOCs. Source: Peyton 1989.

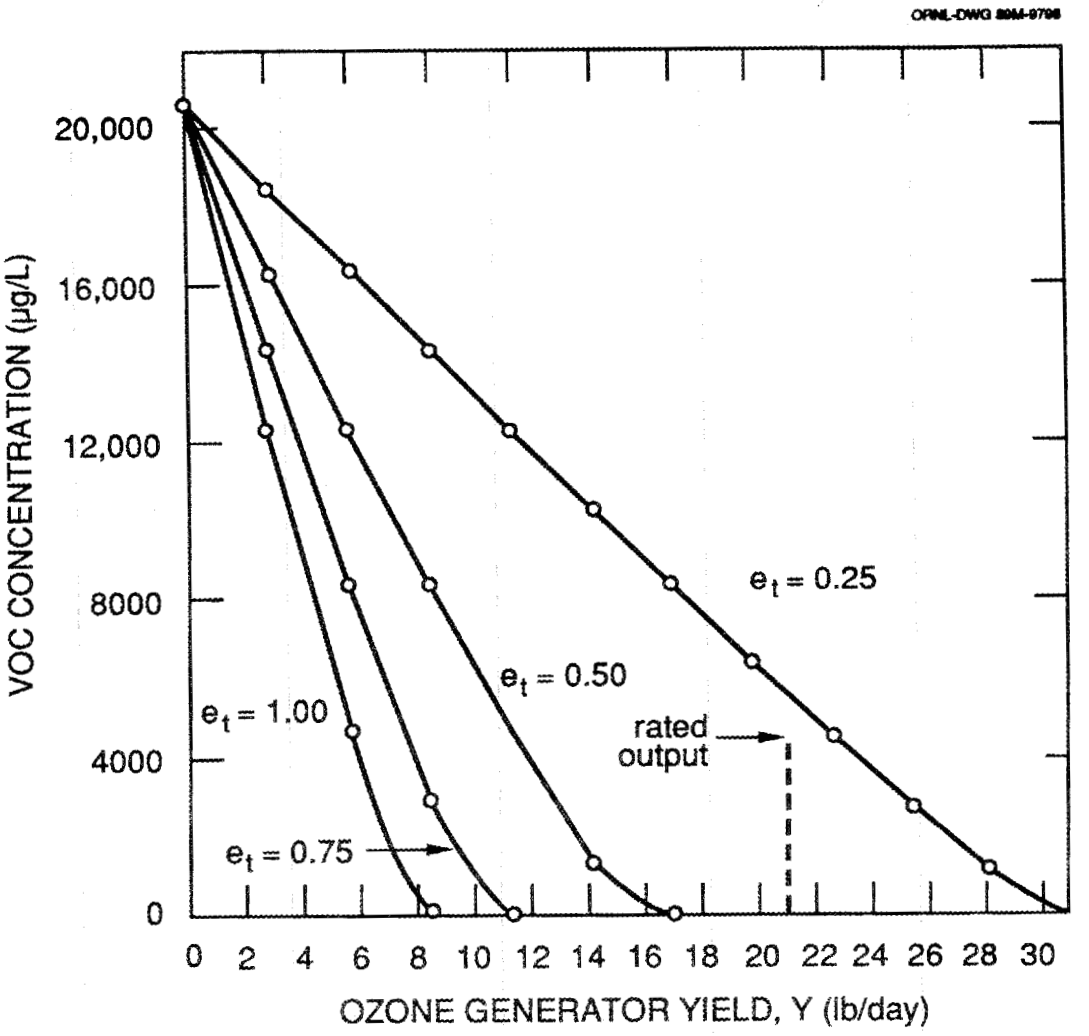

Fig. 14. Destruction of volatile organic compounds (VOCs) in combined underground tank farm, trichloroethylene still area, and northeast area plumes, with 3X concentration excursions at various ozone transfer efficiencies (e_t). Source: Peyton 1989.

5.3 DISCHARGE STANDARDS

Table 11 compares the plant discharge standards, the average plant effluent quality, and the average plant influent quality. As seen from this table, the effluent from the treatment plant meets all of the discharge standards. In fact, all of the plant influent (untreated groundwater) meets the discharge standards except for copper and TOX. Consideration should be given to revising the discharge permit to eliminate unnecessary monitoring after the two additional plumes are added to the treatment plant and sufficient data are available to show that the influent quality has not changed significantly.

What is masked in the average values of Table 11 but can be seen in Tables 6 and 12 and Appendix 2 is the increase of TOX concentrations between stage 6 of the reaction chamber and the effluent. This increase has been observed in virtually every sample. Even though the discharge standard has not been exceeded, the trend is disturbing. The cause of this increase is not known, but it is expected to be an analytical artifact. As seen in Table 6, filtering the effluent sample prior to analysis for TOX reduces the TOX concentrations, so certainly some of the TOX is associated with particulate matter. However, this does not explain the increase between stage 6 and the effluent.

Figs. 3 and 4 show the VOC and TOX removal, respectively, during two days in November 1988. After dropping during the first two stages, the TOX value stays essentially constant throughout the last four, despite the fact that treatment continues in those stages as well. This pattern is mirrored in the TOC data (Table 6). The reason for the increase in TOX between stage 6 and the effluent is not known but appears to be an artifact. TOX is a surrogate parameter that, while sometimes useful, is often subject to artifacts and interferences.

Comparison of the TOX values of samples from any stage with the TOX that can be calculated from the sum of the VOCs shows that the TOX value does not give a true representation of the amount of carbon-bound halogen present in the sample. The TOX is low by a factor of almost 4 in the IAF, whereas it is about 60 $\mu g/L$ higher than the sum of the volatiles in the latter stages. It should be recalled that semivolatiles and PCBs were found to be absent from these groundwaters, making it unlikely that the remaining 60 $\mu g/L$ of apparent TOX is real. This quantity, which may be an artifact, represents 38% of the value allowed by the discharge permit. Furthermore, the value in the effluent jumps to 63% of the permit limit.

TOX is used as a means to detect a broad range of compounds, and it is successful at achieving its purpose of screening for a large number of compounds. However, the fact that the test is a broad generic screening test makes it inappropriate for accurately quantifying the actual concentrations of compounds or for identifying specific compounds. Appendix 3 contains a discussion of the problems inherent with the TOX analysis.

Because of these factors, TOX appears to be inappropriate for regulatory purposes, and another parameter such as TCE and/or 1,2-DCE should be substituted. Future work should stress the inappropriateness of TOX rather than why it increases.

Table 11. Discharge standards, average effluent quality, and average influent quality for the groundwater treatment plant in milligrams per liter (unless otherwise noted)

Parameter[a]	Discharge standards	Average effluent[b]		Average influent[b]
		Grab	Composite	
Arsenic	0.25	0.022	0.023	0.045
Boron	1.0	0.095	0.110	0.136
Cadmium	0.69	0.003	0.003	0.012
Chromium	2.77	0.014	0.020	0.013
Copper	3.38	0.074	0.034	10.4
Cyanide	2.0	<0.001	<0.001	<0.001
Iron	100	4.0	3.9	17.3
Lead	0.69	0.033	0.028	0.055
Manganese	20	6.0	5.1	6.4
Nickel	3.98	0.016	0.021	0.027
O&G[c]	100	0.62	0.60	2.2
pH (units)	6-10	8.1	8.2	6.9
Sulfides	10	<0.5	<0.05	0.98
TOX[c]	0.16	0.078	0.074	0.354
TOX (filtered)	NS[d]	0.058	ND[e]	ND
Zinc	2.61	0.07	0.04	1.05

[a]Parameters refer to total where applicable.

[b]The single monthly 24-h composite samples are used to determine compliance with the standards, while the weekly grab samples are used for evaluation purposes.

[c]O&G = oil and grease, and TOX = total halogenated hydrocarbons.

[d]NS = no standard.

[e]ND = no data collected.

Table 12. Total organic halogens in stage 6 and in the effluent at the groundwater treatment plant in milligrams per liter

	Stage 6	Effluent	
		Grab	Composite
Average	0.055	0.078	0.074
Maximum	0.125	0.147	0.137
Minimum	0.010	0.010	0.040
Discharge standard	NS[a]	ND[b]	0.16

[a]NS = no standard.
[b]ND = no data collected.

5.4 ORGANICS REMOVAL

From Table 6 it can be seen that only seven of the VOCs are detectable in the influent, that the VOC concentrations decrease through the reactor, and that all VOC concentrations are below detectable limits by stage 3. Table 13 shows the VOCs detected in the plant influent and their average concentration through the reaction chamber. They are essentially the same ones found last year and at similar concentrations. The monitoring program should eliminate all of those VOCs not listed in Table 13. Furthermore, sampling for VOCs after the in-line filter should be eliminated.

The TOX increase in the effluent was discussed previously. TOC concentrations persist in the reactor and are reduced by only 23%, whereas TOX is reduced by 77%, and the VOCs are reduced to below detectable limits. The reason for the persistence of TOC is not known, but it could be related to adherence of organics to particulate matter, sampling and analytical error, treatment inefficiency, recalcitrant organics, or the fact that TOC removal takes more radicals for oxidation than does VOC removal, which requires only one. During the next year the question may be answered because the O_3 generator is now working properly, the UV lamps are clean, and improved maintenance should keep them clean.

In February 1989, several of the VOC concentrations were higher in the IAF samples than in the IBF samples. These VOCs are 1,1-dichloroethene, 1,1-dichloroethane, 1,2-DCE, tetrachloroethane, 1,1,1-trichloroethane, TCE, and vinyl chloride. This finding is unexpected and is attributed to sampling and/or analytical error.

In May 1989, TCE and 1,2-DCE persisted throughout the treatment plant and were detected in the effluent (Appendix 2). This may be an indication of a general deterioration of treatment capability due to poor O_3 generation, poor O_3 transfer efficiency, and coated UV lamps as found during the treatment plant capacity study and Ultrox International's maintenance program. Since this persistence is not seen in the TOC or TOX concentrations, the use of TCE and/or 1,2-DCE as process control parameters and discharge permit parameters is recommended. Analyses for TOC and TOX should be continued because they are indications of the general trend of organics removal (Table 6) in the treatment plant.

Since the continuous TOX increase in the effluent and the February increase in VOCs through the in-line filter may be attributed to sampling and/or analytical error, the sampling of VOCs was observed in April 1989. The report (Appendix 6) on the sampling found that the valves used to collect the IBF and EFF samples are too restricted, which causes the sample stream to be turbulent and foam. On this occasion the VOC vial was not filled immediately, so the sample continued to degas. The IBF sample is collected by mixing equal sample volumes from each of the three wells. This mixing step causes a loss of VOCs. These problems certainly contribute to the anomalies in the VOC results and may explain them. New valves should be installed so that VOC samples can be collected without turbulence.

Table 13. Destruction of organics at the groundwater treatment plant[a] in milligrams per liter (mg/L)[a]

Parameter	IBF[b]	IAF[b]	Reaction chamber						EFF[b]
			1	2	3	4	5	6	
TOX	0.354	0.341	0.124	0.090	0.078	0.073	0.055	0.055	0.078
TOC	4.3	4.2	3.7	3.9	3.5	3.7	3.7	3.4	3.3
VOCs									
1,1-Dichloroethene	0.012	0.014	ND[c]	ND	<0	ND	ND	ND	ND
1,1-Dichloroethane	0.015	0.017	0.008	0.006	ND	ND	ND	ND	ND
1,2-Dichloroethene	0.697	0.838	0.088	0.029	ND	ND	ND	ND	ND
Tetrachloroethene	0.032	0.042	0.008	ND	ND	ND	ND	ND	ND
1,1,1-Trichloroethane	0.018	0.013	ND	ND	ND	ND	ND	ND	ND
Trichloroethene	0.329	0.401	0.053	0.018	ND	ND	ND	ND	ND
Vinyl chloride	0.042	0.041	ND	ND	ND	ND	ND	ND	ND

[a]These are average values for all analyses.

[b]IBF = influent before in-line filter; IAF = influent after in-line filter; and EFF = plant effluent.

[c]ND = below detectable limits.

5.5 MISCELLANEOUS PARAMETERS

The average groundwater flow rate for the entire study is 0.0003 m^3/s (4 gal/min), which is 16% of the design flow rate of .0016 m^3/s (25 gal/min) (Table 3). This low flow rate makes the optimization of the plant and the comparison of operating costs with other treatment technologies difficult. The study to determine the treatment plant capacity (Peyton 1989) assumed flow rates similar to those seen in FY 1988. Therefore, the findings of the study are conservative in terms of flow rate, but they may underestimate the combined TCE and 1,2-DCE concentrations because the new plumes appear to have greater concentrations. This is another reason to perform the capacity study after either the TCESA or NEA plume is added to the treatment plant.

One cause for this low flow rate is probably well clogging. Iron bacteria were found in the wells, and they should be dosed with chlorine for removal. The operator needs to monitor flow rates regularly so that changes can be seen early and action taken to correct the problem and to adjust the operating parameters of the treatment plant. Flow and flow rate should be reported by the operator in gallons per month and gallons per minute, respectively, per well and overall so that actual operating time can be considered more easily in determining the flow rate.

The discharge permit for the plant allows 37.9 m^3/d (10,000 gal/day) to be discharged. However, if the plant were operating at its design capacity of 0.0016 m^3/s (25 gal/min), then 137 m^3/d (36,000 gal/day) would be discharged. This is not a problem now but could become one when the new plumes are introduced to the plant. Either the permit should be revised, or the operating time each day should be limited.

Approximately 87% of the TSS is removed by the in-line filter, as expected (Table 4). On an average bases, the TSS concentration in the IBF is generally lower in FY 1989 than in FY 1988 (Appendix 2), and the trend appears to be downward. On an average basis, the TSS concentration in the EFF sample is greater than that in the IAF sample. However, this is due to the high effluent TSS concentration during the first 6 months of plant operation. Since October 1988, the TSS concentrations in the effluent have decreased and are similar to the concentrations in the IAF samples. This may be from precipitation in the reactor, as evidenced by the sediment removal required by Ultrox International. Now that the diffusers in stage 6 are repaired and the iron and manganese filter is installed, the impact on TSS should be examined. In FY 1990 TSS sampling should be reduced to monthly for evaluation purposes, and a sampling point after the new iron and manganese filter should be added.

From Table 4 it can be seen that the pH increases from approximately 7 to 8 in the reactor. This was also seen during FY 1988. As stated then (Garland 1989), a pH decrease was expected from the formation of organic acids. The reason for the pH increase is not known.

Approximately 43% of the BOD is removed by the in-line filter, and it is unaffected in the reactor (Table 4). Since TOC and TOX are unaffected by the filter, the BOD appears to have a large particulate

component. BOD is not really an appropriate monitoring parameter for this treatment plant, and the discharge permit should be revised to delete it. It should not be continued for evaluation purposes.

The concentrations of sulfites and sulfates were unaffected by the treatment plant whereas sulfides were reduced in the in-line filter and in the reaction chamber (Table 4). These analyses should be performed monthly next year to assess the impact of the new wells.

The nitrate concentration increases from below detectable limits (<0.1 mg/L) to 3.4 mg/L in the treatment plant, whereas nitrite and ammonia are not affected (Table 4). This was found last year as well and was expected. Nitrite analyses should be eliminated, and nitrate and ammonia should be reduced to monthly monitoring at the IBF and EFF only in FY 1990. If the same trends continue when the new wells are added to the treatment plant, then nitrate and ammonia may be eliminated.

Total iron (Table 4) is removed by approximately 77% in the in-line filter and is unaffected in the reaction chamber. The ferrous ion (Table 4) is removed in both the in-line filter and the reaction chamber. This is consistent with last year's findings. However, the average values do not reflect the trend started in early 1989 of in-let ferrous ion concentrations below detection limits (0.05 mg/L). This trend is also carried over to the IAF and EFF samples. In FY 1990 a sample should be taken after the iron and manganese filter.

Total manganese is not affected by the treatment plant (Table 4), whereas last year it was removed about equally by the in-line filter and the reaction chamber. The manganous ion is reduced by approximately 54% in the reaction chamber and is unaffected in the in-line filter. In FY 1988 the manganous ion was reduced by 80%. Both manganese and manganous ion started decreasing in concentration in the plant influent in May 1989. During FY 1990 an additional sample should be collected after the iron and manganese filter.

During the maintenance and upgrade effort by Ultrox International, a pretreatment process for the removal of iron and manganese was implemented. Because of the sediment in the reaction chamber and the coating on the UV lamps, it was presumed that this pretreatment process was needed. The pretreatment process uses O_3 for oxidation of the iron and manganese in a reactor tank and then a filter to remove the iron and manganese floc. Based on the results described previously, the precipitation of iron and manganese may not be a problem, so an evaluation of the impact of the pretreatment process should be performed. When the TCESA and NEA plumes are added to the treatment plant, the iron and manganese concentrations are expected to increase, and an enlarged pretreatment process should be needed. An evaluation was performed to determine the best process, and the conclusion was to oxidize the iron and manganese with O_3 and to remove them in a filter. However, a laboratory study should be performed to determine the O_3 dose and reaction time. The details of this evaluation are in Appendix 4. If the pretreatment process is implemented, its performance should be evaluated to develop performance criteria. The filter installed by Ultrox International should be analyzed during FY 1990 to determine if it is a hazardous waste.

From the data in Table 4, bacteria are reduced by approximately 81% in the in-line filter and approximately 5% in the reaction chamber for an overall removal of 82%. This rate is worse than last year's overall removal rate of 99.9%, a decrease that is expected. Starting in late 1988, the influent bacteria quantity began declining, whereas the effluent bacteria quantity began increasing, typically to values greater than the influent. The cause for this discrepancy has not been determined. Bacteria determination should be discontinued in FY 1990.

O&G concentrations are removed in the in-line filter but are not affected by the reaction chamber (Table 4). This analysis should be discontinued next year for evaluation purposes and should be eliminated from the permit because of its inapplicability and the low concentrations (2.2 mg/L) in the groundwater compared with those in the standard (100 mg/L). Since October 1988, O&G concentrations in the influent have been below detectable limits.

As expected, all of the trace metals are reduced by the filter but not affected by the reaction chamber (Table 5). Removal percentages for the trace metals are as follows:

arsenic–47%	lead–48%
boron–18%	nickel–44%
cadmium–67%	total cyanide–N/A
chromium–15%	zinc–94%
copper–99%	

In Table 11 the plant discharge standards are compared with the average plant influent for trace metals. Only copper exceeds the discharge standard, and the other parameters are well below the standard. During FY 1990 only the plant influent and effluent should be sampled for trace metals. If the influent trace metals quality stays the same after the addition of the new plumes, then the discharge permit should be revised to eliminate all trace metals except copper.

In February 1989, the IBF samples contained elevated concentrations of Cd, Pb, Zn, Ni, and Cu (see Appendix 2). The most elevated were Cd, Pb, and Cu. The samples collected after the in-line filter contained normal concentrations. Zinc appears to have started an upward trend in October 1988 that peaked in February 1989. The monthly analysis for these selected trace metals is shown in Table 14.

A review of sampling procedures that was conducted in April 1989 (Appendix 5) revealed that the valves on the treatment plant were made of brass and were badly and variably corroded. This corrosion may explain some of the increased trace metals concentrations. It was recommended that the valves be replaced with noncorrosive materials such as plastic or stainless steel. Table 14 also shows the average value for the trace metals, with the elevated analyses excluded for purposes of comparison.

5.6 OPERATIONS AND MAINTENANCE

By combining the operations and maintenance (O&M) costs (Table 7) with the flow data (Table 3), the average O&M cost for the groundwater

Table 14. Elevated trace metals results for the plant influent at the groundwater treatment plant (in milligrams per liter)

Month	Cadmium	Copper	Lead	Nickel	Zinc
		1988			
May	0.010	0.230	0.100	0.016	0.540
June	0.004	0.180	0.068	0.019	0.263
July	0.004	1.070	0.089	0.026	0.464
August	0.005	0.298	0.012	0.033	0.722
September	NA[a]	NA	NA	NA	NA
October	0.008	1.240	0.033	0.047	1.320
November	0.007	3.760	0.049	0.025	1.880
December	0.005	0.160	0.022	0.013	1.420
		1989			
January					
February	0.049	18.50	0.154	0.049	3.140
March	0.006	9.22	0.023	0.013	0.419
April	0.008	2.25	0.080	0.011	0.952
May	0.006	1.71	0.016	0.024	0.136
June	NA	NA	NA	NA	NA
July	NA	NA	NA	NA	NA
August	NA	NA	NA	NA	NA
September	0.025	94.2	0.033	0.037	1.53
Average	0.011	11.07	0.057	0.028	1.066
Average without high values[b]	0.008	1.21	0.048	0.023	0.499

[a]NA = not analyzed.
[b]The values underlined are excluded from this average.

treatment plant is found to be approximately $32.5/m^3 ($122/1000 gal) (Table 15). Because this cost is associated with a very low flow rate (Table 3) and 38% downtime (Table 8) and because the cost should not increase significantly as the flow rate approaches the design flow rate of 0.0016 m^3/s (25 gal/min) with little downtime (5%), it should be corrected for purposes of comparison with other treatment processes. Assuming the design flow rate of 0.0016 m^3/s (25 gal/min), 5% downtime, and no sampling and analysis costs, the cost would be $3.9/m^3 ($12.7/1000 gal). Since O_3 and H_2O_2 doses are already at maximum, they will not be affected by a change in flow rate. This cost is still an order of magnitude greater than the costs predicted by Ultrox International and those of last year (Garland 1989). In looking at Tables 3 and 7 for flow rates and costs, respectively, it is seen that costs have remained fairly constant but that flow rate has decreased considerably during FY 1989. Personnel costs are not being reported, so they are not included in the treatment cost. In the future they should be reported. Based upon the amount of time and effort spent by Ultrox International in performing maintenance on the plant, the effort spent on routine maintenance should be increased, which will increase the costs further. Also, the analytical costs are not included in the routine cost figures, but some amount of process control analyses is required, which will increase the costs further. For all of these reasons, the treatment costs are not considered definitive and must be reevaluated as flow rates increase.

In reviewing the operations history of the treatment plant described in Sect. 4.3, it is clear that the plant has inadequate process control instrumentation, inadequate routine maintenance instructions, and an underestimated level of effort required for routine operations and maintenance. Now that the instrumentation is available and the flow will increase from additional wells, operating conditions should result that will allow a better appraisal of O&M costs and the level of effort needed. In order to ensure that the plant operates as intended as the new wells are added and that it continues to meet discharge standards, it is recommended that the plant be operated by a contractor for at least 1 year. In addition to operating the plant, the contractor will determine optimum operating conditions, prepare an operations manual and routine maintenance plan, and determine plant modifications, if any, that are needed. Now that the treatment plant has undergone a major maintenance and upgrade program, sufficient effort should be expended to keep it operating properly and find out if the problems being experienced are inherent in the technology.

5.7 STUDY PLAN

The Study Plan contained in Appendix 1 and summarized in Table 2 should be revised to reflect the monitoring changes recommended previously above and to reorient its principal thrust from organics removal to design criteria, operating conditions, and operating costs. Due to the low flows and the maintenance problems experienced so far, these issues have not been evaluated adequately. Table 16 summarizes the proposed sampling plan for FY 1990, and Appendix 6 contains a

Table 15. Groundwater treatment plant operation and maintenance (O&M) costs based on total flow

O&M costs ($)	Flow		Cost per volume	
	(m^3)	(gal)	($/$m^3$)	($/1000 gal)
181,992	5604	1,488,242	32.5	122

Table 16. Comprehensive monitoring plan, FY 1990

Frequency	Parameter	Location[a]
Continuous	pH	EFF
	Flow	I
	Gas flow rate	Ozone generator and each reactor stage with rotameters
	Pressure	Ozone generator
	Hydrogen peroxide dose rate	Hydrogen peroxide pump
Daily	BOD[b]	EFF
	TSS[b]	E
Weekly	Iron	IBF, IAF, IASF, EFF
	Ferrous ion	IBF, IAF, IASF, EFF
	Manganous ion	IBF, IAF, IASF, EFF
	Manganese	IBF, IAF, IASF, EFF
	TOX[b]	IBF, IAF, IASF, ST, EFF
	Priority volatile pollutants[c]	IBF, EFF, IASF, ST
	TOC[b]	IBF, IAF, IASF, ST, EFF
Monthly	Cadmium	IBF, EFF
	Chromium	IBF, EFF
	Copper	IBF, EFF
	Lead	IBF, EFF
	Nickel	IBF, EFF
	Zinc	IBF, EFF
	Boron	IBF, EFF
	Arsenic	IBF, EFF
	Oil and grease	IBF, EFF
	Total cyanide	IBF, EFF
	Hydrogen peroxide	IAF, IASF (before H_2O_2 injection), IASF (before reactor but after H_2O_2 injection), ST
	Carbonate alkalinity	IASF, EFF
	Bicarbonate alkalinity	IASF, EFF
	TSS[b]	IBF, IAF, IASF, EFF
	Sulfides	IBF, EFF
	Ozone	IAF, IASF, ST, FG, OG
Quarterly[d]	Particulates	Both filters
	Sediment	Reaction chamber

[a]IBF = influent before the in-line filter; IAF = influent after the in-line filter; IASF = influent after second filter for removal of iron and manganese; EFF = effluent from ozone reaction tank; ST = six sample taps on ozone reaction tank; OG = off-gas; and FG = feed gas from ozone generator to reactor.

[b]BOD = biochemical oxygen demand; TSS = total suspended solids; TOX = total chlorinated hydrocarbons; and TOC = total organic carbon.

[c]The following volatile organic compounds will be analyzed: chloroform, 1,1-dichloroethene, 1,1-dichloroethane, 1,2-dichloroethene, tetrachloroethene, 1,1,1-trichloroethane, trichloroethene, and vinyl chloride.

[d]These analyses will be performed quarterly if possible. Sediments in the reaction chamber should be sampled whenever the plant is not operating.

6. CONCLUSIONS/RECOMMENDATIONS

6.1 DISCHARGE STANDARDS

The treatment plant meets the discharge permit for all parameters. However, the effluent TOX concentration is consistently higher than the stage 6 concentration, and there is a persistence of TOC and TOX in the plant. These may indicate a treatment problem that will cause permit violations later. It is hoped that the maintenance work compiled by Ultrox International identified the causes and corrected the situation.

The data indicate that TOX is not an appropriate monitoring parameter for the discharge permit. There appears to be an artifact in the TOX measurements that at times exceeds half of the allowed value in the effluent. Evidence that this residual TOX is an artifact follows:

- The TOX drops as the VOCs are removed, either by sparging or by oxidation. Once the VOCs have been removed, no further decrease in TOX is seen. It is highly unlikely that the residual TOX is due to some halogenated species that is totally refractory to $OH^{\bullet}$ radical.

- Complete priority pollutant analysis has confirmed that no halogenated priority pollutants are present other than the VOCs.

The data also show that all of the trace metals except copper are well below the discharge standards prior to treatment. This is also true for sulfides. If this holds true after the TCESA and NEA plumes are added to the treatment plant, then the discharge permit should be renegotiated to eliminate them entirely or to reduce the level of monitoring to annually or semiannually for verification purposes.

BOD and O&G are inappropriate parameters to be used for this discharge and should be eliminated from the permit. By monitoring VOCs as proposed above, a more appropriate measure of the organics being released will be used. It is recommended that a renegotiation of the permit monitoring parameters be attempted, with TOX being replaced by a comparable limit on the VOCs or limits on TCE and/or 1,2-DCE.

The operating plan for the treatment plant following the introduction of the two additional plumes should be prepared to determine if the discharge permit should be revised to increase the maximum discharge from 37.9 m^3/d (10,000 gal/day), but the design flow rate of 0.0016 m^3/sec (25 gal/min) will discharge 137 m^3/d (36,000 gal/day).

6.2 OZONE GENERATOR CAPACITY

Before the overhaul by Ultrox International, the O_3 generator was operating at about 10% of its rated capacity, even though the power was turned up to 100%. This was probably at least partially due to inadequate drying of the feed gas, and new air dryers were installed to remedy this situation. Moisture content of the air should be monitored and reported routinely. After the overhaul by Ultrox International, the

generator has produced its rated yield. Because it is essential that the full capacity of this O_3 generator be available as the other groundwater streams are added, it is recommended that the O_3 generator yield and transfer efficiency be calculated daily to monitor performance and to anticipate performance problems.

In order to make these calculations, the O_3 monitor must be installed in such a manner that feed gas and off-gas may be monitored. This will allow the operator to determine O_3 generator yield and O_3 mass transfer efficiency on a daily basis. This information will provide the means to anticipate difficulties, schedule routine maintenance at optimum intervals, and avoid being out of compliance with the permit requirements.

6.3 MAINTENANCE PROGRAM

The existing data indicate that much of the trouble with transfer efficiency is due to clogging of the spargers, the O_3 rotameters, and the feed tubing and that the problem with O_3 generation is caused by wet air. Additionally, the UV lights become coated very rapidly. It is recommended that a routine maintenance program be established to minimize the effects of clogging and scaling in order to avoid serious deterioration in the performance of the reactor.

Indications are that some of the wells contain iron bacteria, which may account for the reduced flow rate. The wells should be dosed with chlorine to eliminate the bacteria.

A regular maintenance program should be set up to anticipate difficulties and keep the treatment plant performing up to specifications. It is recommended that a contractor operate the treatment plant for 1 year while the additional flow is brought to the plant. This contractor will also prepare a detailed operating manual and routine maintenance plan and recommend equipment modifications.

6.4 ADDITION OF TCE STILL AREA AND NORTHEAST AREA PUMPAGE TO TREATMENT STREAM

The model predicts that if the plant is operating properly (i.e., if the O_3 generator produces the rated yield and the transfer efficiency is 60 to 80%), the treatment plant should be capable of treating the additional streams from the TCESA and the NEA plumes. Under these conditions, the treatment plant should also be able to handle a concentration excursion of three times the predicted combined stream concentration.

Numerous assumptions have been made in arriving at these conclusions. The uncertainty of the results of such a large extrapolation should be kept in mind when using these conclusions for planning purposes, particularly since this is the first use of this model. After the addition of flow from either the TCESA or NEA plumes to the treatment plant, correspondence of the results to the predicted

values should be checked, and the model refined if necessary. This will allow anticipation of problems that may occur when the third stream is added.

6.5 OPERATIONS AND MAINTENANCE

The treatment plant flow rate is only approximately 16% of the design flow rate, and the plant has been inoperable 38% of the time. Because of this the estimated O&M costs of ($0.38/$m^3$) ($1.22/1000 gal) are suspect and should be verified during FY 1990 as the flow increases. Greater attention needs to be paid to O&M following the extensive maintenance and upgrading performed by Ultrox International. It is clear that the treatment plant when originally constructed had inadequate process control instrumentation, inadequate routine maintenance instructions, and an underestimated level of effort required for routine O&M. These deficiencies should be corrected.

6.6 TREATMENT MECHANISMS

From the rate constants (Table 10) calculated during the experiments to determine the capacity of the treatment plant, it appears that the O_3 and H_2O_2 reaction is responsible for the majority of VOC removal. The apparent lack of need for UV radiation may be due to the scale on the UV lamps, which limited their usefulness. This is another reason to conduct the experiments again after one of the new plumes is added to the groundwater treatment plant. If the lack of need for UV radiation is again confirmed, then consideration should be given to eliminating it from the treatment process. Sparging and H_2O_2 photolysis were found to be relatively minor reactions.

6.7 FY 1990 WORK PLAN

A work plan for 1990 is contained in Appendix 6. The emphasis is on shifting from compliance with discharge standards to developing design criteria and operating parameters and to comparing costs with those for other technologies.

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APPENDIX 1

STUDY PLAN, FY 1989

UV/OZONE HYDROGEN PEROXIDE GROUNDWATER TREATMENT PLANT EVALUATION

DEPARTMENT OF ENERGY KANSAS CITY PLANT STUDY PLAN

SIDNEY B. GARLAND II, PE

ENVIRONMENTAL SCIENCES DIVISION

OAK RIDGE NATIONAL LABORATORY

OAK RIDGE, TENNESSEE

NOVEMBER, 1988

FOR FISCAL YEAR 1989

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I. PURPOSE

The purposes of this evaluation are to:

- determine if the technology can meet the discharge standards,
- determine if the technology can meet its specifications,
- determine the operation and maintenance costs of the technology,
- compare the capital, operation, and maintenance costs with other technologies,
- evaluate contaminant removal mechanisms,
- assist in optimizing the operation of the process,
- estimate the capacity of the existing plant, and
- predict the treatment plant size necessary to handle all three of the contaminated groundwater plumes.

II. OPERATING PHASES

Operation of the ultraviolet (UV) radiation/ozone (O_3)/hydrogen peroxide (H_2O_2) groundwater treatment plant will take place in several phases. Phase 1 is the start-up and commissioning performed by and for the vendor to insure that the treatment system works. The second operational phase is the batch operation necessary to demonstrate that the plant can meet its discharge standards. Treated water from the plant cannot be discharged to the community sanitary sewer until this is demonstrated. When the ability of the treatment plant to meet the discharge standards has been demonstrated, then Phase 3 of the operation will start. During this phase the plant will be operated continuously at a flowrate of approximately 6 gallons per minute (gpm). It will be necessary during this phase to perform optimization studies to determine how far the treatment system can be turned-down from its design flowrate of 25 gpm to the actual flow of 6 gpm. This should be done incrementally by decreasing the ozone flow and then decreasing the number of UV lights that are turned-on. When these levels are selected, then the H_2O_2 dose can be decreased. it will be helpful during this phase to sample along the length of the O_3 reaction chamber to see where the discharge standards are being met. If they are met prior to the end of the reaction chamber, then the UV lights and possibly the O_3 flow to the remainder of the tank can be stopped. In order to perform this sampling, the sample taps should be installed in all six sections of the reaction chamber. Phase 4 will then begin following the optimization study when steady state conditions at approximately 6 gpm will prevail.

Phase 5 will occur when the flowrate is increased to the design flowrate of 25 gpm. At this time the optimization study will be redone to determine the amount of O_3, number of UV lights, and amount of H_2O_2 necessary. This should be done as discussed above. When the optimization is complete, and a steady state is reached, then phase 6 will begin which will be the long-term operation at 25 gpm.

If the flowrate increases incrementally to 25 gpm, then at each level the optimization study will have to take place.

III. EVALUATION PLAN

A. Introduction

In order to evaluate the performance of the groundwater treatment plant and achieve the objectives stated above, a plan for sampling and analysis, data collection, and data interpretation is necessary. Therefore, the following evaluation plan will be discussed in terms of sampling, operations and maintenance, and design and construction.

B. Sampling

During Phase 1 a certain amount of sampling and analysis was performed to check the equipment and instrumentation and determine if the contaminants were being removed. This information should be provided to the evaluator.

The batch testing of the treatment facility was conducted as Phase 2 to demonstrate its ability to meet the discharge standards. During this Phase samples were collected from the reaction chamber at various time intervals for analysis of those parameters regulated by the discharge permit. This information should be provided to the evaluator also.

During Phases 3 through 6 operations will be continuous, and three types of monitoring will be performed-routine, evaluation, and geochemical. Routine monitoring will be conducted continuously, daily, or monthly and primarily involves those parameters regulated by the discharge permit. Sampling will take place at the influent, after the in-line filter, and after the O_3 reaction tank. The parameters to be monitored as part of routine monitoring are shown in Table I.

Evaluation monitoring involves those parameters that are of more interest to evaluating the actual performance of the groundwater treatment plant. This monitoring will take place weekly for most parameters at the influent, after the in-line filter, and after the O_3 reaction tank. The off gases will be sampled at the vent prior to the O_3 destruct unit and analyzed for total organic halogens and O_3. Total organic halogens and priority volatile pollutants also will be sampled at each of the six sampling taps along the O_3 reaction tank. The monitoring at the six sampling taps is to determine the rate of organic removal along the length of the O_3 reaction tank.

UV absorbance at 254 nanometers, H_2O_2, O_3, carbonate, and bicarbonate will be sampled at all sampling locations once per week for a month and then monthly thereafter. The particulate matter retained by the in-line filter and precipitated in the reaction chamber will be analyzed quarterly or whenever samples can be collected. These analyses will include bacteria and inorganics, e.g., iron and manganese. The parameters to be monitored as part of evaluation monitoring are shown in Table II.

A geochemical analysis of the water will be determined of the influent, after the filter, and after the O_3 reaction tank once during the project. These parameters are shown in Table III.

A comprehensive monitoring plan showing the parameters to be monitored, the frequency of monitoring, and the location of sampling is contained in Table IV.

As the monitoring is taking place, and the results are analyzed, then the above sampling schedule may change to reflect what is found. Also, some additional analyses may be needed to determine the degradation products of the treatment process.

Quality control of the sample collection, handling, transportation, and analysis is critical to the reliability of the results and their interpretation. Therefore, the quality control plan of the laboratory should be provided to the evaluator.

C. Operations and Maintenance

Any observations concerning operations and maintenance made during Phase 1 when the manufacturer's representatives were starting-up the treatment plant should be reported so that the ease of start-up and any problems encountered can be documented. This should also be done for Phase 2 during the batch operation.

For Phases 3 through 6 emphasis should be placed on maintaining a record of operations and maintenance expenses and time and an operations log. The operations log should be a checklist of what is to be done each day during the operator's visit, should document the amount of time spent and any special maintenance performed, and should record any observations made, e.g., the color of the water, the amount of foaming, and the amount of scaling on the UV lights.

Since O_3 generation and UV radiation are energy intensive operations, the amount of electricity used at the treatment plant should also be documented. Some means of measuring the power usage should be installed. Chemical costs and spare parts costs should be available from purchase orders, but their quantity and costs should be gathered and summarized on a regular basis, perhaps as part of a monthly operations report. Also, the cost of monitoring should be maintained since this will represent an on-going cost. Depending upon the length of time a water treatment plant is operational, the operations cost can amount to 40-80% of the total cost, so it is important to document these costs. The monthly operations report also should contain the gas flow rate, the percentage of O_3 in the gas, the amount of H_2O_2 used, the number and location of UV lights used, the duration and reasons for any downtime, and any other unusual happenings.

D. Design and Construction

The cost associated with the design and construction of the groundwater treatment plant need to be reported so that they can be factored into the cost of this type of treatment. This should include any bench and pilot testing that was performed. This information should be collected and provided to the evaluator.

IV. REQUIRED ACTIONS

In order to complete the evaluation plan described above, it is necessary that the operations check list and log be developed, the sample taps be installed along the O_3 reaction chamber, a method of measuring and recording power usage be installed, arrangements for the monitoring be made, design and construction cost data be gathered, and the laboratory's quality control plan be obtained. These actions must be done by personnel at the plant.

V. PROJECT DURATION

At the end of Fiscal Year 1988 an annual report will be issued that will summarize the findings during that year and make recommendations and conclusions based upon those findings. Since the plant will not be operating at the design flow rate of 25 gpm, a thorough evaluation of the plant's performance will not be possible during the first year.

A letter report will be issued in December 1988 that will estimate the capacity of the existing plant, predict the size of plant necessary to treat all three contaminated groundwater plumes, and predict optimum operating conditions.

In November, 1989, a second year annual report will be published, and in April, 1990, a final report will be issued. Subsequent operational evaluation may be performed if deemed necessary.

VI. PROJECT MANAGEMENT

Sidney B. Garland II is the Principal Investigator for this project, and Nic Korte will be the Project Manager. The primary point of contact with the Bendix Kansas City Plant is Denise Miller.

Table I. Routine monitoring plan parameters

Cadmium	BOD
Total suspended solids	Chromium
Copper	Flow
Lead	pH
Nickel	Arsenic
Zinc	Sulfides
Iron	Oil and grease
Manganese	Total cyanide
Boron	Total organic Halogens

Table II. Evaluation monitoring plan parameters

Sulfite
Nitrite
Nitrate
Ammonia
Sulfate
Priority volatile pollutants
Ferrous ion
Manganous ion
Total organic carbon
Total plate count
Ultraviolet absorbance at 254 nanometers
Hydrogen peroxide
Carbonate
Bicarbonate
Ozone
Particulate in filter and reaction Chamber
Off gases[a]

[a]The off gases will be analyzed for total organic halogens and ozone.

Table III. Geochemical monitoring plan parameters[a]

Calcium
Magnesium
Sodium
Potassium
Sulfate
Chloride
Fluoride
Phosphate
Carbonate
Bicarbonate
Iron

[a]In addition to concentration, the results for these analyses will also be shown in a Stiff Diagram, or similar graphical presentation.

Table IV. Comprehensive monitoring plan

Frequency	Parameter	Location[a]
Continuous	pH	E
	Flow	I
Daily	BOD	I, AF, E
	TSS	I, AF, E
Weekly	Sulfite	I, AF, E
	Sulfate	I, AF, E
	Sulfides	I, AF, E
	Nitrite	I, AF, E
	Nitrate	I, AF, E
	Ammonia	I, AF, E
	Iron	I, AF, E
	Ferrous Ion	I, AF, E
	Manganous Ion	I, AF, E
	Manganese	I, AF, E
	TOX	I, AF, E, ST
	Priority Volatile Pollutants	I, AF, E, ST
	TOC	I, AF, E, ST
Monthly	Cadmium	I, AF, E
	Chromium	I, AF, E
	Copper	I, AF, E
	Lead	I, AF, E
	Nickel	I, AF, E
	Zinc	I, AF, E
	Boron	I, AF, E
	Arsenic	I, AF, E
	Sulfides	I, AF, E
	Oil & Grease	I, AF, E
	Total Cyanide	I, AF, E
	UV Absorbance at 254 Nanometers[b]	I, AF, E, ST
	Hydrogen peroxide[b]	I, AF, E, ST
	Carbonate[b]	I, AF, E, ST
	Bicarbonate[b]	I, AF, E, ST
	Ozone[b]	I, AF, E, ST
	Total plate count	I, AF, E
	Off gases (TOX, ozone)	T
Quarterly[c]	Particulates	In-line filter
	Sediment	Reaction

Table IV. (continued)

Frequency	Parameter	Location[a]
Chamber		
Once[d]	Calcium	I, AF, E
	Magnesium	I, AF, E
	Sodium	I, AF, E
	Potassium	I, AF, E
	Chloride	I, AF, E
	Fluoride	I, AF, E
	Phosphate	I, AF, E
	Carbonate	I, AF, E
	Bicarbonate	I, AF, E

[a]I = influent; AF = after the inline filter; E = effluent from ozone reaction tank; ST = 6 sample taps on ozone reaction tank; and T = sample tap on air vent.

[b]These parameters will be monitored weekly for one month and then monthly thereafter.

[c]These analyses will be performed quarterly, if possible. For the sediments in the reaction chamber the sediment should be sampled whenever the plant is not operating.

[d]In addition to concentration, these results will be shown in a Stiff Diagram or in a similar graphical presentation.

APPENDIX 2

PERFORMANCE DATA
MAY 1988 THROUGH OCTOBER 1989

MONTHLY FLOWS

	GROUNDWATER TREATMENT PLANT		
	FLOW MONITORING		
MONTH	FLOW	FLOW	PERCENT OF
	GALLONS	GAL/MIN	DESIGN FLOW
AVERAGE	91,946	3.30	13%
MAXIMUM	284,110	11.83	47%
MINIMUM	688	0.45	2%
MAY '88	145,490	3.74	15%
JUNE	133,290	4.02	16%
JULY	238,440	11.83	47%
AUGUST	284,110	8.97	36%
SEPTEMBER	57,652	5.72	23%
OCTOBER	7,099	0.45	2%
NOVEMBER	69,864	2.31	9%
DECEMBER	14,859	0.52	2%
JANUARY '89	system down no data reported		
FEBRUARY	83,976	2.24	9%
MARCH	25,725	1.12	4%
APRIL	101,302	2.61	10%
MAY	48,737	1.09	4%
JUNE	688	0.48	2%
JULY	system down no data reported		
AUGUST	63,805	2.46	10%
SEPTEMBER	111,903	2.59	10%
OCTOBER	84,196	2.66	11%

				GROUNDWATER TREATMENT PLANT									
					TOTAL ORGANIC HALOGENS								
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	PERCENT REMOVAL BY FILTERING %	REACTION CHAMBER STAGE 1 MG/L	REACTION CHAMBER STAGE 2 MG/L	REACTION CHAMBER STAGE 3 MG/L	REACTION CHAMBER STAGE 4 MG/L	REACTION CHAMBER STAGE 5 MG/L	REACTION CHAMBER STAGE 6 MG/L	EFFLUENT A-GRAB MG/L	PERCENT REMOVAL BY CHAMBERS %	PERCENT REMOVAL TOTAL MG/L	EFFLUENT COMPOSITE MG/L
AVERAGE	0.354	0.341	4%	0.124	0.090	0.078	0.073	0.055	0.055	0.078	77%	78%	0.074
MAXIMUM	0.760	0.845	-11%	0.417	0.297	0.328	0.370	0.113	0.125	0.147	83%	81%	0.137
MINIMUM	0.119	0.085	29%	0.030	0.021	0.016	0.015	0.014	0.010	0.010	88%	92%	0.040
05/06/88	0.312	0.488	-56%	0.049	0.055	0.058	0.025	0.047	0.058	0.061	88%	80%	
05/13/88	0.269	0.275	-2%	0.180	0.177	0.266	0.175	0.080	0.072	0.093	66%	65%	
05/20/88	0.240	0.273	-14%	0.176	0.130	0.132	0.107	0.059	0.065	0.042	85%	83%	
05/27/88	0.583	0.178	69%	0.231	0.087	0.081	0.069	0.058	0.074	0.097	46%	83%	0.090
06/03/88	0.374	0.194	48%	0.157	0.118	0.082	0.094	0.033	0.022	0.071	63%	81%	
06/10/88	0.520	0.377	28%	0.102	0.059	0.057	0.046	0.059	0.020	0.044	88%	92%	
06/24/88	0.331	0.133	60%	0.083	0.032	0.041	0.024	0.022	0.027	0.073	45%	78%	0.085
06/30/88	0.307	0.166	46%	0.086	0.046	0.063	0.045	0.053	0.044	0.066	60%	79%	
07/15/88	0.119	0.131	-10%	0.116	0.110	0.087	0.111	0.038	0.010	0.025	81%	79%	
07/22/88	0.228	0.220	4%	0.093	0.094	0.097	0.143	0.072	0.087	0.073	67%	68%	
07/29/88	0.210	0.167	20%	0.120	0.096	0.078	0.075	0.074	0.056	0.023	86%	89%	0.048
08/05/88	0.274	0.304	-11%	0.159	0.142	0.078	0.095	0.050	0.067	0.070	77%	74%	
08/12/88	0.275	0.298	-8%	0.215	0.139	0.064	0.051	0.043	0.010	0.010	97%	96%	
08/19/88	0.247	0.390	-58%	0.218	0.129	0.061	0.061	0.088	0.083	0.095	76%	62%	
08/30/88	0.387	0.369	5%	0.161	0.155	0.072	0.062	0.055	0.051	0.147	60%	62%	0.137
09/02/88	0.318	0.268	16%	0.177	0.145	0.110	0.114	0.103	0.095	0.120	55%	62%	
10/28/88	0.235	0.263	-12%	0.030	0.035	0.034	0.034	0.028	0.025	0.121	54%	49%	<.025
11/04/88	0.193	0.153	21%	0.060	0.065	0.072	0.057	0.040	0.047	0.145	5%	25%	
11/18/88	0.667	0.556	17%	0.055	0.055	0.070	0.015	0.014	0.020	0.072	87%	89%	0.050
11/25/88	0.549	0.545	1%	0.102	0.034	0.053	0.038	0.046	0.088	0.085	84%	85%	
12/02/88	0.484	0.506	-5%	0.065	0.060	0.025	0.035	0.067	0.066	0.046	91%	90%	0.061
12/10/88	0.714	0.672	6%	0.083	0.028	<.025	0.037	0.030	<.025	0.045	93%	94%	
12/16/88	0.472	0.443	6%	0.030	<.025	<.025	0.033	0.033	<.025	0.071	84%	85%	
02/03/89	0.314	0.263	16%	0.091	0.048	0.039	0.036	0.045	0.042	0.100	62%	68%	0.040
02/10/89	0.357	0.364	-2%	0.085	0.023	0.016	0.035	0.041	0.025	0.100	73%	72%	
02/17/89	0.180	0.220	-22%	0.126	0.078	0.051	0.099	0.054	0.075	0.118	46%	34%	
02/23/89	0.380	0.224	41%	0.074	0.074	0.034	0.023	0.021	0.021	0.040	82%	89%	
03/17/89	0.266	0.569	-114%	0.089	0.074	0.103	0.092	0.103	0.085	0.099	83%	63%	0.074
03/24/89	0.274	0.242	12%	0.090	0.092	0.083	0.095	0.079	0.082	0.099	59%	64%	
03/31/89	0.139	0.239	-72%	0.061	0.059	0.030	0.083	0.076	0.066	0.067	72%	52%	
04/07/89	0.286	0.146	49%	0.313	0.297	0.328	0.370	0.051	0.053	0.096	34%	66%	0.075
04/14/89	0.163	0.150	8%	0.417	0.136	0.111	0.088	0.046	0.081	0.087	42%	47%	
04/21/89	0.414	0.345	17%	0.186	0.158	0.132	0.119	0.100	0.073	0.060	83%	86%	
04/28/89	0.400	0.275	31%	0.176	0.126	0.122	0.096	0.099	0.075	0.067	76%	83%	
05/05/89	0.172	0.261	-52%	0.044	0.045	0.081	0.049	0.058	0.027	0.074	72%	57%	0.103
05/12/89	0.249	0.235	6%	0.075	0.070	0.059	0.056	0.051	0.044	0.076	68%	69%	
05/19/89	0.421	0.336	20%	0.167	0.083	0.057	0.059	0.048	0.105	0.070	79%	83%	
05/26/89	0.385	0.463	-20%	0.133	0.093	0.055	<.025	0.032	0.045	0.103	78%	73%	
06/01/89													0.106
06/30/89													0.041
08/11/89	0.407	0.414	-2%	0.097	0.086	0.039	0.037	0.034	0.040	0.067	84%	84%	
08/18/89	0.350	0.628	-79%	0.073	0.066	0.057	0.060	0.050	0.049	0.062	90%	82%	
08/25/89	0.465	0.085	82%	0.107	0.061	0.074	0.063	0.063	0.063	0.061	28%	87%	
09/08/89	0.760	0.730	4%	0.109	0.077	0.091	0.065	0.051	0.051	0.084	88%	89%	0.084
09/15/89	0.725	0.845	-17%	0.079	0.112	0.073	0.078	0.113	0.125	0.070	92%	90%	
09/22/89	0.436	0.342	22%	0.073	0.120	0.050	#	#	#	0.127	63%	71%	
09/29/89	#	#		#	#	#	#	#	#	0.098			
10/06/89	0.188	0.321	-71%	0.224	0.039	0.044	0.043	0.028	0.039	0.087	73%	54%	0.047
10/09/89													
10/20/89	0.253	0.622	5%	0.045	0.021	0.027	0.036	0.027	0.018	<0.010			

TOC

				GROUNDWATER TREATMENT PLANT								
					TOTAL ORGANIC CARBON							
DATE	INFLUENT BEFORE FILTERING	INFLUENT AFTER FILTERING	PERCENT REMOVAL BY FILTERING	REACTION CHAMBER STAGE 1	REACTION CHAMBER STAGE 2	REACTION CHAMBER STAGE 3	REACTION CHAMBER STAGE 4	REACTION CHAMBER STAGE 5	REACTION CHAMBER STAGE 6	EFFLUENT GRAB	PERCENT REMOVAL BY CHAMBERS	PERCENT REMOVAL TOTAL
	MG/L	MG/L	%	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	%	%
AVERAGE	4.33	4.23	2%	3.71	3.95	3.46	3.69	3.71	3.43	3.28	23%	24%
MAXIMUM	17.60	9.10	48%	12.80	14.20	10.40	8.80	11.80	12.20	15.30	-68%	13%
MINIMUM	2.10	2.10	0%	1.80	1.60	1.40	1.50	1.00	1.10	1.00	52%	52%
05/06/88	7.30	6.80	7%	7.40	8.00	6.90	6.70	6.40	5.60	5.10	25%	30%
05/13/88	17.60	7.20	59%	4.40	6.40	5.80	2.30	3.50	2.70	15.30	-113%	13%
05/20/88	5.90	4.60	22%	4.80	2.40	5.60	6.00	4.00	3.20	4.70	-2%	20%
05/27/88	4.10	2.50	39%	3.00	2.70	3.00	3.10	3.20	2.50	3.60	-44%	12%
06/03/88	3.70	4.20	-14%	4.60	3.70	2.50	3.90	1.90	3.00	3.60	14%	3%
06/10/88	3.50	9.10	-160%	2.80	2.10	1.80	6.60	1.70	2.00	4.30	53%	-23%
06/24/88	4.20	3.50	17%	4.10	2.80	2.60	4.30	3.80	4.30	2.30	34%	45%
06/30/88	4.20	5.60	-33%	5.10	4.10	10.40	3.30	4.30	3.50	3.30	41%	21%
07/15/88	4.40	7.10	-61%	4.40	3.50	3.70	3.90	3.20	2.60	5.20	27%	-18%
07/22/88	4.20	2.80	33%	3.70	3.10	3.10	2.60	4.00	2.40	3.00	-7%	29%
07/29/88	2.30	4.50	-96%	2.20	2.60	2.50	2.90	2.20	2.20	3.50	22%	-52%
08/05/88	3.80	4.60	-21%	3.70	2.80	2.60	4.20	3.10	2.80	2.60	43%	32%
08/12/88	5.50	4.90	11%	4.80	5.10	3.00	3.80	2.70	6.00	1.70	65%	69%
08/19/88	12.80	4.20	67%	3.40	3.50	3.80	4.60	3.90	4.10	3.60	14%	72%
08/30/88	3.70	4.30	-16%	5.60	4.10	3.80	4.90	4.90	3.80	4.70	-9%	-27%
09/02/88	3.30	4.40	-33%	3.30	6.80	5.40	3.60	6.20	4.40	2.80	36%	15%
10/28/88	3.30	6.80	-106%	2.90	5.80	5.30	2.40	3.70	4.60	3.80	44%	-15%
11/04/88	2.60	2.50	4%	2.40	2.50	7.10	2.90	3.10	3.70	3.40	-36%	-31%
11/18/88	2.10	2.20	-5%	2.00	5.10	3.50	2.60	3.10	5.20	1.60	27%	24%
11/25/88	2.60	3.70	-42%	4.40	2.60	2.70	1.60	2.00	5.50	4.80	-30%	-85%
12/02/88	2.40	2.80	-17%	2.70	2.60	2.50	1.70	1.40	2.90	2.80	0%	-17%
12/10/88	2.60	3.40	-31%	5.10	3.50	2.80	3.70	4.00	2.20	2.30	32%	12%
12/16/88	3.10	6.00	-94%	3.30	3.00	2.60	2.70	2.80	1.80	1.40	77%	55%
02/03/89	3.50	5.10	-46%	2.40	5.80	3.10	7.00	1.70	3.60	2.40	53%	31%
02/10/89	6.40	6.20	3%	3.00	2.60	5.20	5.20	6.60	2.40	3.50	44%	45%
02/17/89	7.50	7.10	5%	3.50	13.40	2.70	8.40	7.90	7.20	7.50	-6%	0%
02/23/89	6.70	3.30	51%	3.70	14.20	3.60	8.80	10.00	12.20	3.30	0%	51%
03/17/89	3.30	4.60	-39%	2.70	3.30	2.60	3.10	3.10	2.80	3.30	28%	0%
03/24/89	3.10	3.20	-3%	3.80	3.60	4.00	4.20	3.60	4.30	3.50	-9%	-13%
03/31/89	2.50	2.90	-16%	3.10	2.50	2.40	3.70	4.40	2.40	2.30	21%	8%
04/07/89	2.60	3.30	-27%	3.20	4.60	2.60	3.40	3.50	2.60	2.40	27%	8%
04/14/89	2.70	2.40	11%	7.20	2.70	2.20	1.90	2.00	2.70	2.20	8%	19%
04/21/89	2.70	2.40	11%	2.60	2.50	2.40	2.10	4.50	2.50	2.20	8%	19%
04/28/89	10.20	6.40	37%	12.80	8.10	5.80	7.00	5.30	4.20	7.10	-11%	30%
05/05/89	3.40	3.70	-9%	4.10	4.30	4.40	3.00	3.60	4.10	2.20	41%	35%
05/12/89	4.70	3.60	23%	2.70	1.70	3.70	4.20	<.6	3.00	2.90	19%	38%
05/19/89	2.50	3.60	-44%	2.30	2.30	2.30	2.50	2.40	2.80	2.30	36%	8%
05/26/89	3.90	2.60	33%	2.50	2.10	1.90	2.30	3.10	3.80	2.40	8%	38%
08/11/89	3.20	4.00	-25%	3.40	3.20	3.10	3.80	1.90	2.10	1.40	65%	56%
08/18/89	3.30	2.20	33%	2.20	2.70	2.00	2.10	1.50	1.50	2.70	-23%	18%
08/25/89	2.70	2.10	22%	1.90	2.10	1.60	1.50	2.20	3.10	1.70	19%	37%
09/08/89	2.9	2.3	21%	2.0	1.8	1.6	2.1	1.0	1.8	1.2	48%	59%
09/15/89	3.5	3.8	430%	4.3	1.6	1.4	1.8	2.1	1.1	1.0	74%	71%
09/22/89	2.4	3.0	-25%	1.8	2.2	1.8	#	#	#	1.8	40%	25%
09/29/89	#	#		#	#	#	#	#	#	1.3		
10/06/89	3.9	6.7	-72%	2.5	1.9	3.3	1.7	11.8	1.3	1.8	73%	54%
10/20/89	2.4	2.4	0%	2.9	3.6	2.4	2.1	1.9	2.0	2.2	8%	8%

TRICHLOROETHENE

			GROUNDWATER TREATMENT PLANT							
			TRICHLOROETHENE							
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	PERCENT REMOVAL BY FILTERING %	REACTION CHAMBER STAGE 1 MG/L	REACTION CHAMBER STAGE 2 MG/L	REACTION CHAMBER STAGE 3 MG/L	REACTION CHAMBER STAGE 4 MG/L	REACTION CHAMBER STAGE 5 MG/L	REACTION CHAMBER STAGE 6 MG/L	EFFLUENT GRAB MG/L
AVERAGE	0.329	0.401	-22%	0.053	0.018	<.005	<.005	<.005	<.005	<.005
MAXIMUM	1.050	1.240	-18%	0.238	0.083	<.005	<.005	<.005	<.005	<.005
MINIMUM	<.005	<.005		<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/06/88	0.440	0.650	-48%	0.055	0.007	<.005	<.005	<.005	<.005	<.005
05/13/88	0.310	0.400	-29%	0.040	0.006	<.005	<.005	<.005	<.005	<.005
05/20/88	0.380	0.390	-3%	0.038	0.007	<.005	<.005	<.005	<.005	<.005
05/27/88	0.416	0.500	-20%	0.044	0.013	<.005	<.005	<.005	<.005	<.005
06/03/88	0.850	0.840	1%	0.035	<.005	<.005	<.005	<.005	<.005	<.005
06/10/88	0.266	0.270	-2%	0.039	0.008	<.005	<.005	<.005	<.005	<.005
06/24/88	0.591	0.248	58%	0.072	0.015	<.005	0.005	<.005	<.005	<.005
06/30/88	0.574	0.451	21%	0.048	0.010	<.005	<.005	<.005	<.005	<.005
07/15/88	0.420	0.600	-43%	0.094	0.024	<.005	<.005	<.005	<.005	<.005
07/22/88	0.510	0.490	4%	0.080	0.016	<.005	<.005	<.005	<.005	<.005
07/29/88	0.632	0.647	-2%	0.063	0.018	<.005	<.005	<.005	<.005	<.005
08/05/88	0.578	0.696	-20%	0.099	0.033	0.007	0.006	<.005	<.005	<.005
08/12/88	0.540	0.830	-54%	0.114	0.047	0.010	0.009	<.005	<.005	<.005
08/19/88	0.956	1.240	-30%	0.101	0.045	0.009	0.008	<.005	<.005	<.005
08/30/88	0.320	0.480	-50%	0.188	0.083	0.028	0.012	<.005	<.005	<.005
09/02/88	0.540	0.440	19%	0.238	0.068	0.026	0.011	<.005	<.005	<.005
10/28/88	0.400	0.420	-5%	0.037	0.018	0.012	0.005	<.005	<.005	<.005
11/04/88	0.360	0.412	-14%	0.030	0.014	0.008	<.005	<.005	<.005	<.005
11/18/88	0.290	0.037	87%	0.011	<.005	<.005	<.005	<.005	<.005	<.005
11/25/88	0.590	0.446	24%	0.064	0.021	<.005	<.005	<.005	<.005	<.005
12/02/88	<.005	0.308		0.008	<.005	<.005	<.005	<.005	<.005	<.005
12/10/88	0.222	0.329	-48%	0.070	0.011	<.005	<.005	<.005	<.005	<.005
12/16/88	0.289	0.255	12%	0.022	<.005	<.005	<.005	<.005	<.005	<.005
02/03/89	0.013	0.313	-2308%	0.014	<.005	<.005	<.005	<.005	<.005	<.005
02/10/89	0.018	0.331	-1739%	0.028	0.007	<.005	<.005	<.005	<.005	<.005
02/17/89	0.015	0.326	-2073%	0.029	0.008	<.005	<.005	<.005	<.005	<.005
02/23/89	0.025	0.327	-1208%	0.030	0.008	<.005	<.005	<.005	<.005	<.005
03/17/89	0.043	0.560	-1202%	0.083	0.027	0.009	<.005	<.005	<.005	<.005
03/24/89	<.005	<.005		0.008	<.005	<.005	<.005	<.005	<.005	<.005
03/31/89	0.043	0.530	-1133%	0.050	0.024	0.008	0.005	<.005	<.005	<.005
04/07/89	0.690	0.208	70%	0.038	0.015	0.010	<.005	<.005	<.005	<.005
04/14/89	1.050	0.541	48%	0.054	0.020	0.008	0.006	<.005	<.005	<.005
04/21/89	0.064	0.450	-603%	0.083	0.030	0.012	0.006	<.005	<.005	<.005
04/28/89	0.039	0.293	-651%	0.043	0.010	<.005	<.005	<.005	<.005	<.005
05/05/89	0.093	0.198	-113%	0.024	0.013	0.006	<.005	<.005	<.005	0.006
05/12/89	0.423	0.360	15%	0.107	0.048	0.017	0.009	<.005	<.005	0.005
05/19/89	0.359	0.335	7%	0.082	0.040	0.015	0.009	<.005	<.005	<.005
05/26/89	0.265	0.250	6%	0.067	0.043	0.009	0.012	0.005	<.005	<.005
08/11/89	0.115	0.207	-80%	0.019	<.005	<.005	<.005	<.005	<.005	<.005
08/18/89	0.187	0.175	6%	0.017	<.005	<.005	<.005	<.005	<.005	<.005
08/25/89	0.252	0.102	60%	0.010	<.005	<.005	0.005	<.005	<.005	<.005
09/08/89	0.315	0.275	13%	0.010	0.006	<.005	<.005	<.005	<.005	<.005
09/15/89	0.012	0.348	-2800%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/22/89	0.215	0.291	-35%	<.005	<.005	<.005	#	#	#	<.005
09/29/89	#	#		#	#	#	#	#	#	<.005
10/06/89	0.217	0.330	-52%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
10/20/89	0.178	0.300	-69%	0.023	<.005	<.005	<.005	<.005	<.005	<.005

SULFITE

GROUNDWATER TREATMENT PLANT			
	SULFITE		
	INFLUENT	INFLUENT	EFFLUENT
DATE	BEFORE	AFTER	GRAB
	FILTERING	FILTERING	
	MG/L	MG/L	MG/L
AVERAGE	<0.5	<0.5	<0.5
05/06/88	<.5	<.5	<.5
05/13/88	<.5	<.5	<.5
05/20/88	<.5	<.5	<.5
05/27/88	<.5	<.5	<.5
06/03/88	<.5	<.5	<.5
06/10/88	<.5	<.5	<.5
06/24/88	<.5	<.5	<.5
06/30/88	<.5	<.5	<.5
07/15/88	<.5	<.5	<.5
07/22/88	<.5	<.5	<.5
07/29/88	<.5	<.5	<.5
08/05/88	<.5	<.5	<.5
08/12/88	<.5	<.5	<.5
08/19/88	<.5	<.5	<.5
08/30/88	<.5	<.5	<.5
09/02/88	<.5	<.5	<.5
10/28/88	<.5	<.5	<.5
11/04/88	<.5	<.5	<.5
11/18/88	<.5	<.5	<.5
11/25/88	<.5	<.5	<.5
12/02/88	<.5	<.5	<.5
12/10/88	<.5	<.5	<.5
12/16/88	<.5	<.5	<.5
02/03/89	<.2	<.2	<.2
02/10/89	<.2	<.2	<.2
02/17/89	<.2	<.2	<.2
02/23/89	<.5	<.5	<.5
03/17/89	<.5	<.5	<.5
03/24/89	<.5	<.5	<.5
03/31/89	<.5	<.5	<.5
04/07/89	<.5	<.5	<.5
04/14/89	<.5	<.5	<.5
04/21/89	<.5	<.5	<.5
04/28/89	<.5	<.5	<.5
05/05/89	<.5	<.5	<.5
05/12/89	<.5	<.5	<.5
05/19/89	<.5	<.5	<.5
05/26/89	<.5	<.5	<.5
08/11/89	<.5	<.5	<.5
08/18/89	<.5	<.5	<.5
08/25/89	<.5	<.5	<.5
09/08/89	<.5	<.5	<.5
09/15/89	<.5	<.5	<.5
09/22/89	<.5	<.5	<.5
09/29/89	#	#	<.5
10/06/89	1.0	<.5	<.5
10/20/89	<.5	<.5	<.5

NITRITE

GROUNDWATER TREATMENT PLANT			
	NITRITE		
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	EFFLUENT GRAB MG/L
AVERAGE	<0.1	<0.1	<0.1
05/06/88	<.10	<.10	<.10
05/13/88	<.10	<.10	<.10
05/20/88	<.10	<.10	<.10
05/27/88	<.10	<.10	<.10
06/03/88	<.10	<.10	<.10
06/10/88	<.10	<.10	<.10
06/24/88	<.10	<.10	<.10
06/30/88	<.10	<.10	<.10
07/15/88	<.10	<.10	0.90
07/22/88	<.10	<.10	0.80
07/29/88	0.60	<.10	<.10
08/05/88	<.10	<.10	<.10
08/12/88	<.10	<.10	<.10
08/19/88	<.10	<.10	<.10
08/30/88	<.10	<.10	<.10
09/02/88	<.10	<.10	<.10
10/28/88	<.10	<.10	<.10
11/04/88	<.10	<.10	<.10
11/18/88	<.10	<.10	<.10
11/25/88	<.10	<.10	<.10
12/02/88	<.10	<.10	<.10
12/10/88	<.10	<.10	<.10
12/16/88	<.10	<.10	<.10
02/03/89	<.10	<.10	<.10
02/10/89	<.10	<.10	<.10
02/17/89	<.10	<.10	<.10
02/23/89	<.10	<.10	<.10
03/17/89	<.10	<.10	<.10
03/24/89	<.10	<.10	<.10
03/31/89	<.10	<.10	<.10
04/07/89	<.10	<.10	<.10
04/14/89	<.10	<.10	<.10
04/21/89	<.10	<.10	<.10
04/28/89	<.10	<.10	<.10
05/05/89	<.10	<.10	<.10
05/12/89	<.10	<.10	<.10
05/19/89	<.10	<.10	<.10
05/26/89	<.10	<.10	<.10
08/11/89	<.10	<.10	<.10
08/18/89	<.10	<.10	<.10
08/25/89	<.10	<.10	<.10
09/08/89	<0.01	<0.01	<0.01
09/15/89	<0.01	<0.01	<0.01
09/22/89	<0.01	<0.01	<0.01
09/29/89	#	#	0.015
10/06/89	<0.01	<0.01	<0.01
10/20/89	<0.1	<0.1	<0.1

TOTAL IRON

		GROUNDWATER TREATMENT PLANT				
			TOTAL IRON			
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	PERCENT REMOVAL BY FILTERING %	EFFLUENT GRAB MG/L	PERCENT REMOVAL TOTAL MG/L	MONTHLY COMPOSITE EFFLUENT MG/L
AVERAGE	17.31	4.00	77%	4.02	77%	3.93
MAXIMUM	130.00	18.40	86%	8.53	93%	7.89
MINIMUM	1.54	0.45	71%	0.52	66%	2.30
05/06/88	23.40	2.68	89%	3.98	83%	
05/13/88	130.00	2.06	98%	2.57	98%	
05/20/88	16.50	2.84	83%	3.97	76%	
05/27/88	16.50	3.73	77%	3.37	80%	3.30
06/03/88	86.00	2.25	97%	4.65	95%	
06/10/88	77.90	2.42	97%	3.80	95%	
06/24/88	22.70	2.45	89%	2.80	88%	2.63
06/30/88	48.10	1.96	96%	2.69	94%	
07/15/88	115.00	4.93	96%	6.25	95%	
07/22/88	7.72	6.48	16%	7.32	5%	
07/29/88	8.25	6.60	20%	6.42	22%	2.72
08/05/88	5.92	2.87	52%	6.51	-10%	
08/12/88	1.54	0.45	71%	0.78	49%	
08/19/88	11.10	3.74	66%	8.53	23%	
08/30/88	7.48	4.66	38%	4.89	35%	5.21
09/02/88	7.58	4.63	39%	5.61	26%	
10/28/88	5.93	3.90	34%	4.15	30%	3.80
11/04/88	10.90	3.30	70%	3.98	63%	
11/18/88	10.10	4.59	55%	4.09	60%	4.22
11/25/88	8.62	3.62	58%	4.70	45%	
12/02/88	4.66	3.00	36%	2.66	43%	5.23
12/10/88	13.60	3.57	74%	3.68	73%	
12/16/88	5.24	3.61	31%	3.15	40%	
02/03/89	6.80	2.71	60%	2.18	68%	4.01
02/10/89	5.03	3.50	30%	3.50	30%	
02/17/89	5.39	4.60	15%	5.08	6%	
02/23/89	3.12	6.65	-113%	4.51	-45%	
03/17/89	3.28	3.47	-6%	3.89	-19%	2.52
03/24/89	4.43	7.31	-65%	4.12	7%	
03/31/89	3.16	3.76	-19%	3.42	-8%	
04/07/89	8.55	3.84	55%	3.48	59%	3.05
04/14/89	8.40	4.36	48%	4.81	43%	
04/21/89	10.40	4.27	59%	5.08	51%	
04/28/89	3.41	4.05	-19%	4.25	-25%	
05/05/89	1.68	2.55	-52%	2.89	-72%	3.15
05/12/89	8.38	2.23	73%	2.39	71%	
05/19/89	5.21	3.82	27%	4.28	18%	
05/26/89	11.30	3.93	65%	4.56	60%	
06/01/89						4.06
06/30/89						7.89
08/11/89	8.76	3.07	65%	3.19	64%	
08/18/89	5.21	4.86	7%	3.07	41%	
08/25/89	5.41	18.40	-240%	2.78	49%	
09/08/89	7.93	2.61	67%	2.69	66%	2.30
09/15/89	6.51	3.54	46%	2.97	54%	
09/22/89	5.88	3.81	35%	3.84	35%	
09/29/89	#	#		5.41		
10/06/89	21.40	5.65	74%	5.51	74%	4.85
10/20/89	2.09	0.463	78%	0.521	75%	

MANGANESE

		GROUNDWATER TREATMENT PLANT				
			MANGANESE			
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	PERCENT REMOVAL BY FILTERING %	EFFLUENT GRAB MG/L	PERCENT REMOVAL TOTAL MG/L	MONTHLY COMPOSITE EFFLUENT MG/L
AVERAGE	6.35	5.96	6%	5.99	6%	5.13
MAXIMUM	8.11	7.76	4%	9.92	-22%	8.34
MINIMUM	2.63	2.63	0%	1.25	52%	1.65
05/06/88	5.54	5.18	6%	6.27	-13%	
05/13/88	7.46	6.54	12%	8.73	-17%	
05/20/88	7.46	6.22	17%	7.27	3%	
05/27/88	7.39	6.55	11%	2.65	64%	6.07
06/03/88	7.50	5.15	31%	8.50	-13%	
06/10/88	5.16	5.31	-3%	7.68	-49%	
06/24/88	6.13	6.80	-11%	6.32	-3%	1.65
06/30/88	5.65	5.35	5%	5.48	3%	
07/15/88	6.36	4.97	22%	5.94	7%	
07/22/88	7.05	7.01	1%	7.77	-10%	
07/29/88	6.62	6.94	-5%	6.64	0%	2.67
08/05/88	5.57	5.30	5%	6.24	-12%	
08/12/88	5.73	6.21	-8%	7.00	-22%	
08/19/88	5.59	4.89	13%	7.18	-28%	
08/30/88	5.55	5.40	3%	5.67	-2%	4.97
09/02/88	5.91	5.87	1%	5.65	4%	
10/28/88	7.04	7.04	0%	6.88	2%	5.89
11/04/88	6.76	6.38	6%	9.92	-47%	
11/18/88	7.52	6.67	11%	5.98	20%	8.34
11/25/88	5.12	5.46	-7%	5.33	-4%	
12/02/88	6.92	6.88	1%	1.25	82%	5.75
12/10/88	6.06	6.01	1%	5.63	7%	
12/16/88	7.37	7.05	4%	6.10	17%	
02/03/89	8.11	6.89	15%	7.85	3%	4.23
02/10/89	7.82	6.56	16%	7.47	4%	
02/17/89	8.08	6.78	16%	6.45	20%	
02/23/89	7.95	6.57	17%	6.08	24%	
03/17/89	7.85	6.77	14%	6.82	13%	5.90
03/24/89	6.49	5.67	13%	5.86	10%	
03/31/89	5.95	5.32	11%	4.61	23%	
04/07/89	6.58	6.93	-5%	6.19	6%	5.14
04/14/89	5.52	5.69	-3%	4.36	21%	
04/21/89	6.25	5.40	14%	5.59	11%	
04/28/89	6.53	5.79	11%	5.13	21%	
05/05/89	6.58	6.62	-1%	6.08	8%	5.66
05/12/89	2.77	2.92	-5%	2.74	1%	
05/19/89	2.67	2.63	1%	2.40	10%	
05/26/89	2.63	2.67	-2%	2.79	-6%	
06/01/89						3.96
06/30/89						6.05
08/11/89	2.74	2.64	4%	2.77	-1%	
08/18/89	6.69	7.03	-5%	8.07	-21%	
08/25/89	6.84	6.85	0%	2.29	67%	
09/08/89	7.45	7.76		7.60		4.24
09/15/89	7.34	7.35	0%	7.85	-7%	
09/22/89	7.31	7.24	1%	6.90	6%	
09/29/89	#	#		6.92		
10/06/89	7.50	6.75	10%	6.55	13%	6.5
10/20/89	7.12	6.25	12%	5.98	16%	

TSS AVERAGES

	GROUNDWATER TREATMENT PLANT			
AVERAGE TOTAL SUSPENDED SOLIDS FOR MONTH				
	INFLUENT	INFLUENT	EFFLUENT	EFFLUENT
	BEFORE	AFTER	GRAB	COMPOSITE
MONTH	FILTERING	FILTERING		
	MG/L	MG/L	MG/L	MG/L
AVERAGE	87	11	25	26
MAY '88	169	10	62	32
JUNE	272	7	49	30
JULY	149	17	37	29
AUGUST	139	13	33	23
SEPTEMBER	79	11	16	8
OCTOBER	140	17	68	23
NOVEMBER	40	15	18	15
DECEMBER	80	11	18	16
JANUARY '89	system down no data reported			
FEBRUARY	53	10	13	12
MARCH	39	9	9	7
APRIL	66	16	5	8
MAY	41	10	7	7
JUNE	24	13	3	27
JULY	system down no data reported			
AUGUST	21	9	26	20
SEPTEMBER	27	5	18	144
OCTOBER	54	9	21	15

pH AVERAGES

	GROUNDWATER TREATMENT PLANT			
	AVERAGE pH FOR MONTH			
MONTH	INFLUENT	INFLUENT	EFFLUENT	EFFLUENT
	BEFORE	AFTER	GRAB	COMPOSITE
	FILTERING	FILTERING		
AVERAGE	6.95	7.08	8.08	8.18
MAY '88	6.8	6.9	8.0	8.1
JUNE	7.1	7.2	7.9	8.0
JULY	6.9	6.9	7.9	8.0
AUGUST	6.9	7.1	8.0	8.1
SEPTEMBER	6.9	7.0	8.3	8.3
OCTOBER	6.9	6.9	7.9	8.1
NOVEMBER	7.0	7.2	8.2	8.3
DECEMBER	7.1	7.4	8.1	8.2
JANUARY '89	system down no data reported			
FEBRUARY	6.9	7.1	8.0	8.2
MARCH	7.0	7.2	8.1	8.2
APRIL	7.0	7.0	8.1	8.3
MAY	7.0	7.0	8.2	8.3
JUNE	7.0	7.1	8.3	8.1
JULY	system down no data reported			
AUGUST	7.0	7.1	8.0	8.2
SEPTEMBER	6.9	6.9	8.2	8.4
OCTOBER	6.9	7.1	8.0	8.2

BOD AVERAGES

	GROUNDWATER TREATMENT PLANT			
	AVERAGE BOD FOR MONTH			
	INFLUENT	INFLUENT	EFFLUENT	EFFLUENT
	BEFORE	AFTER	GRAB	COMPOSITE
MONTH	FILTERING	FILTERING		
	MG/L	MG/L	MG/L	MG/L
AVERAGE	7	4	4	5
MAY '88	5	4	4	4
JUNE	2 3	6	3	3
JULY	8	5	7	4
AUGUST	9	5	6	6
SEPTEMBER	7	2	BELOW DETECT.	BELOW DETECT.
OCTOBER	1 1	4	7	4
NOVEMBER	5	1	2	3
DECEMBER	2	1	1	2
JANUARY '89	system down no data reported			
FEBRUARY	3	3	4	7
MARCH	4	3	4	3
APRIL	6	4	4	9
MAY	8	4	7	8
JULY	system down no data reported			
JUNE	6	4	BELOW DETECT.	6
AUGUST	5	6	5	2
SEPTEMBER	4	3	<1	<1
OCTOBER	8	6	5	6

GROUNDWATER TREATMENT PLANT					
		MANGANOUS ION			
	INFLUENT	INFLUENT	PERCENT	EFFLUENT	PERCENT
DATE	BEFORE	AFTER	REMOVAL BY	GRAB	REMOVAL
	FILTERING	FILTERING	FILTERING		TOTAL
	MG/L	MG/L	%	MG/L	%
AVERAGE	6.64	6.78	-2%	3.12	53%
MAXIMUM	8.39	8.92	-6%	5.66	33%
MINIMUM	2.28	2.91	-28%	0.18	92%
05/06/88	5.91	<.2		<.2	
05/13/88	3.90	6.85	-76%	<.2	
05/20/88	6.90	6.50	6%	1.09	84%
05/27/88	7.39	6.50	12%	0.26	96%
06/03/88	6.82	7.58	-11%	<.2	
06/10/88	6.63	6.88	-4%	<.2	
06/24/88	6.82	7.50	-10%	<.2	
06/30/88	5.65	5.68	-1%	4.05	28%
07/15/88	3.51	4.87	-39%	<.2	
07/22/88	7.47	7.88	-5%	1.22	84%
07/29/88	8.39	2.91	65%	7.66	9%
08/05/88	2.28	8.92	-291%	6.51	-186%
08/12/88	7.63	8.06	-6%	5.13	33%
08/19/88	7.68	8.03	-5%	4.50	41%
08/30/88	8.13	7.88	3%	6.47	20%
09/02/88	7.88	8.28	-5%	6.13	22%
10/28/88	7.67	7.90	-3%	<.2	
11/04/88	4.84	6.50	-34%	0.30	94%
11/18/88	7.32	6.05	17%	3.81	48%
11/25/88	6.10	6.04	1%	5.66	7%
12/02/88	6.23	6.34	-2%	0.63	90%
12/10/88	5.90	5.77	2%	2.83	52%
12/16/88	7.25	7.27	0%	4.74	35%
02/03/89	8.00	6.66	17%	0.18	98%
02/10/89	7.62	6.43	16%	4.81	37%
02/17/89	7.56	6.41	15%	2.99	60%
02/23/89	7.78	6.56	16%	5.27	32%
03/17/89	7.93	6.65	16%	4.62	42%
03/24/89	6.25	2.97	52%	4.36	30%
03/31/89	7.45	6.53	12%	5.61	25%
04/07/89	6.58	6.70	-2%	4.84	26%
04/14/89	5.47	5.20	5%	3.30	40%
04/21/89	6.33	5.28	17%	3.84	39%
04/28/89	6.72	5.77	14%	3.21	52%
05/05/89	6.68	6.62	1%	6.08	9%
05/12/89	2.45	2.98	-22%	2.72	-11%
05/19/89	2.42	2.61	-8%	2.46	-2%
05/26/89	2.54	2.65	-4%	2.52	1%
08/11/89	2.70	2.54	6%	0.11	96%
08/18/89	6.50	6.71	-3%	0.23	96%
08/25/89	6.52	5.90	10%	0.37	94%
09/08/89	7.43	7.20	3%	0.026	100%
09/15/89	7.25	7.25	0%	1.62	78%
09/22/89	6.98	7.24	-4%	1.31	81%
09/29/89	#	#		0.75	
10/06/89	6.12	6.53	-7%	1.00	84%
10/20/89	6.07	6.00	1%	2.48	59%

1,2-DICHLOROPROPANE

			GROUNDWATER TREATMENT PLANT						
				1,2-DICHLOROPROPANE					
DATE	INFLUENT BEFORE FILTERING	INFLUENT AFTER FILTERING	REACTION CHAMBER STAGE 1	REACTION CHAMBER STAGE 2	REACTION CHAMBER STAGE 3	REACTION CHAMBER STAGE 4	REACTION CHAMBER STAGE 5	REACTION CHAMBER STAGE 6	EFFLUENT GRAB
	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L
05/06/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/13/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/20/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/27/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/03/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/24/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/15/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/22/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/29/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/05/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/12/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/19/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
10/28/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/04/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/18/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/25/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/16/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/03/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/10/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/17/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/23/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/17/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/24/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/31/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/07/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/14/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/21/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/28/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/05/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/12/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/19/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/26/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/11/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/18/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/25/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/08/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/15/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/22/89	<.005	<.005	<.005	<.005	<.005	#	#	#	<.005
09/29/89	#	#	#	#	#	#	#	#	<.005
10/06/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
10/20/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005

SULFIDES

		GROUNDWATER TREATMENT PLANT				
			SULFIDES			
	INFLUENT	INFLUENT	PERCENT	EFFLUENT	PERCENT	MONTHLY
DATE	BEFORE	AFTER	REMOVAL	GRAB	REMOVAL	COMPOSITE
	FILTERING	FILTERING	FILTERING		FILTERING	EFFLUENT
	MG/L	MG/L	%	MG/L	%	MG/L
AVERAGE	0.98	0.68	30%	<.5		<.5
MAXIMUM	8.50	4.00	53%	<.5		<.5
MINIMUM	<.5	<.5		<.5		<.2
05/06/88	<.5	<.5		<.5		
05/13/88	<.5	<.5		<.5		
05/20/88	<.5	4.00		<.5		
05/27/88	<.5	2.90		<.5		<.5
06/03/88	<.5	<.5		<.5		
06/10/88	<.5	<.5		<.5		
06/24/88	<.5	<.5		<.5		<.5
06/30/88	<.5	<.5		<.5		
07/15/88	<.5	<.5		<.5		
07/22/88	<.5	<.5		<.5		
07/29/88	0.60	<.5		<.5		<.5
08/05/88	<.5	<.5		<.5		
08/12/88	<.5	<.5		<.5		
08/19/88	<.5	<.5		<.5		
08/30/88	<.5	<.5		<.5		<.5
09/02/88	0.70	<.5		<.5		
10/28/88	<.5	<.5		<.5		<.5
11/04/88	<.5	<.5		<.5		
11/18/88	<.5	<.5		<.5		<.5
11/25/88	<.5	<.5		<.5		
12/02/88	1.00	<.5		<.5		<.5
12/10/88	8.50	0.60	93%	<.5		
12/16/88	1.80	0.60	67%	<.5		
02/03/89	<.2	0.60		<.2		<.2
02/10/89	<.2	0.20		<.2		
02/17/89	0.40	0.30	25%	<.2		
02/23/89	0.20	0.20		<.2		
03/17/89	2.00	<.5		<.5		<.5
03/24/89	<.5	1.20		<.5		
03/31/89	4.70	<.5		0.80	83%	
04/07/89	<.5	<.5		<.5		<.5
04/14/89	<.5	<.5		<.5		
04/21/89	<.5	<.5		<.5		
04/28/89	4.00	<.5		<.5		
05/05/89	<.5	<.5		<.5		<.5
05/12/89	<.5	<.5		3.80		
05/19/89	<.5	<.5		1.10		
05/26/89	<.5	<.5		<.5		
06/01/89						<.5
06/30/89						<.5
08/11/89	0.80	<.5		<.5		
08/18/89	0.80	<.5		<.5		
08/25/89	<.5	<.5		<.5		
09/08/89	<.5	2		<.5		<.5
09/15/89	2.95	0.7	76%	<.5		
09/22/89	<.5	<.5		<.5		
09/29/89	#	#		<.5		
10/06/89	1.0	1.0	0%	<0.05		<.5
10/20/89	<.5	<.5		<.5		

SULFATE

GROIUNDWATER TREATMENT PLANT					
		SULFATE			
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	PERCENT REMOVAL BY FILTERING %	EFFLUENT GRAB MG/L	PERCENT REMOVAL TOTAL %
AVERAGE	71	75	-5%	68	4%
MAXIMUM	99	286	-189%	94	5%
MINIMUM	28	30	-7%	26	7%
05/06/88	72	84	-17%	62	14%
05/13/88	66	70	-6%	66	0%
05/20/88	74	60	19%	53	28%
05/27/88	68	75	-10%	66	3%
06/03/88	75	65	13%	63	16%
06/10/88	56	57	-2%	56	0%
06/24/88	72	79	-10%	63	13%
06/30/88	70	56	20%	70	0%
07/15/88	50	39	22%	61	-22%
07/22/88	53	49	8%	42	21%
07/29/88	60	67	-12%	45	25%
08/05/88	63	47	25%	60	5%
08/12/88	60	61	-2%	94	-57%
08/19/88	77	87	-13%	74	4%
08/30/88	58	55	5%	48	17%
09/02/88	70	51	27%	42	40%
10/28/88	61	57	7%	59	3%
11/04/88	75	71	5%	68	9%
11/18/88	87	85	2%	69	21%
11/25/88	67	53	21%	44	34%
12/02/88	28	33	-18%	26	7%
12/10/88	38	30	21%	33	13%
12/16/88	38	41	-8%	38	0%
02/03/89	91	80	12%	90	1%
02/10/89	88	88	0%	86	2%
02/17/89	85	88	-4%	86	-1%
02/23/89	72	83	-15%	87	-21%
03/17/89	78	82	-5%	89	-14%
03/24/89	62	65	-5%	60	3%
03/31/89	70	286	-309%	62	11%
04/07/89	69	68	1%	53	23%
04/14/89	84	84	0%	88	-5%
04/21/89	80	80	0%	77	4%
04/28/89	78	89	-14%	91	-17%
05/05/89	97	88	9%	84	13%
05/12/89	83	91	-10%	79	5%
05/19/89	87	83	5%	73	16%
05/26/89	90	69	23%	58	36%
08/11/89	86	79	8%	85	1%
08/18/89	71	69	3%	74	-4%
08/25/89	67	68	-1%	64	4%
09/08/89	73	69	5%	81	-11%
09/15/89	76	89	-17%	81	-7%
09/22/89	99	98	1%	87	12%
09/29/89	#	#		90	
10/06/89	85	92	-8%	89	-5%
10/20/89	59	79	-34%	73	-24%

NITRATE

GROUNDWATER TREATMENT PLANT					
		NITRATE			
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	PERCENT REMOVAL BY FILTERING %	EFFLUENT GRAB MG/L	PERCENT REMOVAL TOTAL %
AVERAGE	<.10	<.10		3.35	
05/06/88	<.10	<.10		3.21	
05/13/88	0.20	0.29	-45%	3.66	-1730%
05/20/88	<.10	0.14		3.70	
05/27/88	<.10	<.10		3.55	
06/03/88	0.20	0.20	0%	3.90	-1850%
06/10/88	<.10	<.10		3.50	
06/24/88	<.10	<.10		2.90	
06/30/88	<.10	<.10		<.10	
07/15/88	<.10	<.10		2.00	
07/22/88	<.10	<.10		1.70	
07/29/88	0.60	<.10		2.80	-367%
08/05/88	0.20	0.10	50%	3.40	-1600%
08/12/88	<.10	6.90		2.40	
08/19/88	0.20	<.10		2.40	-1100%
08/30/88	<.10	<.10		2.50	
09/02/88	<.10	<.10		2.40	
10/28/88	<.10	<.10		4.00	
11/04/88	<.10	0.20		2.00	
11/18/88	<.10	<.10		1.69	
11/25/88	0.30	0.30	0%	3.80	-1167%
12/02/88	<.10	<.10		4.00	
12/10/88	<.10	<.10		4.10	
12/16/88	<.10	<.10		4.30	
02/03/89	<.10	<.10		3.60	
02/10/89	<.10	<.10		4.00	
02/17/89	<.10	<.10		5.40	
02/23/89	<.10	<.10		3.90	
03/17/89	<.10	<.10		3.90	
03/24/89	0.20	2.00	-900%	4.10	-1950%
03/31/89	<.10	<.10		3.10	
04/07/89	<.10	0.30		5.70	
04/14/89	<.10	<.10		3.32	
04/21/89	<.10	<.10		2.79	
04/28/89	<.10	<.10		3.80	
05/05/89	<.10	<.10		3.30	
05/12/89	<.10	<.10		1.90	
05/19/89	<.10	<.10		5.00	
05/26/89	0.20	<.10		4.10	-1950%
08/11/89	<.10	<.10		2.20	
08/18/89	0.10	0.10	0%	3.90	-3800%
08/25/89	<.10	0.50		3.40	
09/08/89	<.10	<.10		3.5	
09/15/89	<.10	<.10		0.9	
09/22/89	<.10	<.10		0.6	
09/29/89	#	#		2.9	
10/06/89	<.10	<.10		5.3	
10/20/89	<.10	<.10		5.6	

AMMONIA

	GROIUNDWATER TREATMENT PLANT				
		AMMONIA			
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	PERCENT REMOVAL BY FILTERING %	EFFLUENT GRAB MG/L	PERCENT REMOVAL TOTAL %
AVERAGE	0.85	0.89	-6%	0.79	7%
MAXIMUM	2.14	2.65	-24%	4.20	-98%
MINIMUM	0.02	0.56	-2700%	0.01	50%
05/06/88	0.78	0.74	3%	0.70	8%
05/13/88	0.83	0.73	12%	0.63	24%
05/20/88	0.77	0.89	-16%	0.76	1%
05/27/88	0.95	0.83	13%	0.69	27%
06/03/88	0.74	1.24	-68%	0.69	7%
06/10/88	0.92	0.80	13%	0.83	10%
06/24/88	0.81	0.85	-5%	0.90	-11%
06/30/88	0.90	0.77	14%	0.77	14%
07/15/88	1.00	0.68	32%	<0.01	
07/22/88	0.65	0.65	0%	0.28	57%
07/29/88	0.72	0.73	-1%	0.71	1%
08/05/88	0.82	0.77	6%	0.70	15%
08/12/88	0.72	0.83	-15%	0.74	-3%
08/19/88	0.74	0.79	-7%	0.66	11%
08/30/88	0.83	0.68	18%	0.83	0%
09/02/88	0.83	0.86	-4%	0.86	-4%
10/28/88	0.91	0.88	3%	0.88	3%
11/04/88	0.75	0.76	-1%	0.69	8%
11/18/88	0.58	0.56	3%	0.55	5%
11/25/88	0.62	0.60	3%	0.62	0%
12/02/88	0.85	0.89	-5%	0.89	-5%
12/10/88	0.77	0.72	6%	0.72	6%
12/16/88	0.75	0.72	4%	1.06	-41%
02/03/89	2.14	2.65	-24%	4.20	-96%
02/10/89	0.82	1.88	-129%	0.85	-4%
02/17/89	0.79	0.73	8%	0.70	11%
02/23/89	0.83	0.76	8%	0.68	18%
03/17/89	0.59	0.62	-5%	0.65	-10%
03/24/89	0.89	1.22	-37%	1.01	-13%
03/31/89	0.02	0.87	-4250%	0.69	-3350%
04/07/89	0.87	0.83	5%	0.82	6%
04/14/89	0.78	0.88	-13%	0.87	-12%
04/21/89	0.88	1.01	-15%	0.92	-5%
04/28/89	0.86	0.95	-10%	0.88	-2%
05/05/89	0.85	0.78	8%	0.98	-15%
05/12/89	0.78	0.80	-3%	0.98	-26%
05/19/89	0.86	0.83	3%	0.91	-6%
05/26/89	1.72	1.23	28%	1.05	39%
08/11/89	0.88	0.82	7%	0.53	40%
08/18/89	MISSING	MISSING		MISSING	
08/25/89	1.09	0.85	22%	0.68	38%
09/08/89	0.83	0.81		0.23	
09/15/89	0.85	0.91	-7%	0.26	69%
09/22/89	0.81	0.84	-4%	0.33	59%
09/29/89	#	#		0.49	
10/06/89	0.72	0.83	-15%	0.26	64%
10/20/89	0.96	1.11	-16%	0.97	-1%

FERROUS ION

GROIUNDWATER TREATMENT PLANT					
	FERROUS ION				
DATE	INFLUENT BEFORE FILTERING	INFLUENT AFTER FILTERING	PERCENT REMOVAL BY FILTERING	EFFLUENT GRAB	PERCENT REMOVAL TOTAL
	MG/L	MG/L	%	MG/L	%
AVERAGE	0.90	0.47	47%	0.33	64%
MAXIMUM	6.13	5.31	13%	5.42	12%
MINIMUM	<.05	<.05		<.05	
05/06/88	0.17	0.18	-5%	0.04	79%
05/13/88	0.48	0.14	71%	0.03	94%
05/20/88	1.61	0.69	57%	0.25	85%
05/27/88	1.75	2.66	-52%	0.32	82%
06/03/88	1.62	0.42	74%	0.25	85%
06/10/88	5.36	1.86	65%	0.51	90%
06/24/88	1.63	1.33	18%	0.51	69%
06/30/88	2.05	0.20	90%	0.23	89%
07/15/88	1.30	<.05		<.05	
07/22/88	3.53	0.50	86%	1.17	67%
07/29/88	5.71	5.31	7%	5.42	5%
08/05/88	6.13	2.53	59%	1.65	73%
08/12/88	<.05	<.05		<.05	
08/19/88	<.05	<.05		<.05	
08/30/88	<.05	<.05		<.05	
09/02/88	1.39	<.05		<.05	
10/28/88	<.05	0.05		<.05	
11/04/88	2.63	0.14	95%	<.05	
11/18/88	<.05	<.05		<.05	
11/25/88	<.05	<.05		<.05	
12/02/88	<.05	<.05		<.05	
12/10/88	0.10	0.07	30%	0.17	-70%
12/16/88	0.06	0.10	-67%	0.18	-200%
02/03/89	0.28	<.05		<.05	
02/10/89	<.05	<.05		<.05	
02/17/89	<.05	<.05		<.05	
02/23/89	0.36	<.05		<.05	
03/17/89	<.05	<.05		<.05	
03/24/89	<.05	<.05		<.05	
03/31/89	<.05	<.05		<.05	
04/07/89	1.25	0.10	92%	0.13	90%
04/14/89	<.05	<.05		<.05	
04/21/89	<.05	<.05		<.05	
04/28/89	<.05	<.05		<.05	
05/05/89	<.05	<.05		<.05	
05/12/89	<.05	<.05		<.05	
05/19/89	<.05	<.05		<.05	
05/26/89	<.05	<.05		<.05	
08/11/89	0.16	0.11	31%	0.14	13%
08/18/89	<.05	<.05		0.90	
08/25/89	2.65	1.49	44%	0.80	70%
09/08/89	<0.010	<0.010		<0.010	
09/15/89	<0.010	<0.01		0.41	
09/22/89	0.13	0.13	0%	<0.10	
09/29/89	#	#		0.49	
10/06/89	<0.10	<0.10		0.24	
10/20/89	<0.01	2.50		0.14	

TOTAL PLATE COUNT

	GROUNDWATER TREATMENT PLANT		
	TOTAL PLATE COUNT		
	INFLUENT	INFLUENT	MONTHLY
DATE	BEFORE	AFTER	GRAB
	FILTERING	FILTERING	EFFLUENT
	PER ML	PER ML	PER ML
AVERAGE	2602	488	463
MAXIMUM	13000	3700	3400
MINIMUM	33	<1	<1
05/27/88	13,000	1,100	12
06/24/88	2,900	60	2
07/29/88	4,200	580	7
08/30/88	4,700	3,700	181
10/26/88	38	3	8
11/18/88	530	3	160
12/02/88	1,000	45	3,400
02/03/89	4500	<1	32
03/17/89	150	12	910
04/07/89	130	5	840
05/05/89	MISSING	MISSING	MISSING

OIL AND GREASE

	GROUNDWATER TREATMENT PLANT			
	OIL AND GREASE			
	INFLUENT	INFLUENT	EFFLUENT	MONTHLY
DATE	BEFORE	AFTER	GRAB	COMPOSITE
	FILTERING	FILTERING		EFFLUENT
	MG/L	MG/L	MG/L	MG/L
AVERAGE	2.15	0.58	0.62	0.60
MAXIMUM	21.0	1.2	1.8	2.0
MINIMUM	<.5	<.5	<.5	<.5
05/27/88	21.00	1.00	1.80	2.00
06/24/88	1.80	1.20	0.60	<.5
07/29/88	<.5	<.5	<.5	<.5
08/30/88	3.40	0.50	<.5	<.5
10/28/88	<.5	<.5	<.5	<.5
11/18/88	<.5	<.5	<.5	<.5
12/02/88	<.5	<.5	<.5	<.5
02/03/89	<.5	<.5	<.5	<.5
03/17/89	<.5	<.5	<.5	<.5
04/07/89	<.5	<.5	<.5	<.5
05/05/89	<.5	<.5	<.5	<.5
06/01/89	<.5	<.5		<.5
06/30/89	<.5	<.5		<.5
09/08/89	<.5	<.5	0.6	<.5
10/06/89	<.5	<.5	<.5	<.5

ARSENIC

	GROUNDWATER TREATMENT PLANT			
		ARSENIC		
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	MONTHLY GRAB EFFLUENT MG/L	MONTHLY COMPOSITE EFFLUENT MG/L
AVERAGE	0.045	0.024	0.022	0.023
MAXIMUM	0.079	0.048	0.039	0.039
MINIMUM	0.014	0.010	0.009	0.001
05/27/88	0.064	0.013	0.018	0.020
06/24/88	0.014	0.010	0.016	0.001
07/29/88	0.051	0.047	0.039	0.031
08/30/88	0.018	0.017	0.021	0.020
10/28/88	0.028	0.014	0.009	0.012
11/18/88	0.072	0.012	0.013	0.015
12/02/88	0.079	0.022	0.023	0.037
02/03/89	0.050	0.028	0.016	0.039
03/17/89	0.030	0.024	0.019	0.015
04/07/89	0.057	0.048	0.033	0.023
05/05/89	0.029	0.032	0.038	0.036
06/01/89	MISSING	MISSING	MISSING	0.026
06/30/89	MISSING	MISSING	MISSING	0.023
09/08/89	0.055	0.028	0.023	0.018
10/06/89	0.039	0.018	0.019	0.022

BORON

	GROUNDWATER TREATMENT PLANT			
		BORON		
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	MONTHLY GRAB EFFLUENT MG/L	MONTHLY COMPOSITE EFFLUENT MG/L
AVERAGE	0.136	0.111	0.095	0.110
MAXIMUM	0.209	0.182	0.123	0.219
MINIMUM	0.014	0.072	0.068	0.063
05/27/88	0.209	0.133	0.068	0.115
06/24/88	0.164	0.125	0.079	0.094
07/29/88	0.014	0.085	0.121	0.087
08/30/88	0.098	0.106	0.101	0.100
10/28/88	0.180	0.174	0.102	0.097
11/18/88	0.109	0.091	0.075	0.086
12/02/88	0.096	0.087	0.086	0.219
02/03/89	0.196	0.103	0.077	0.169
03/17/89	0.135	0.090	0.079	0.084
04/07/89	0.111	0.182	0.104	0.084
05/05/89	0.109	0.104	0.105	0.063
06/01/89	MISSING	MISSING	MISSING	0.088
06/30/89	MISSING	MISSING	MISSING	0.137
09/08/89	0.162	0.093	0.123	0.115
10/06/89	0.185	0.072	0.111	0.116

CADMIUM

	GROUNDWATER TREATMENT PLANT			
		CADMIUM		
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	MONTHLY GRAB EFFLUENT MG/L	MONTHLY COMPOSITE EFFLUENT MG/L
AVERAGE	0.012	0.004	0.003	0.003
MAXIMUM	0.049	0.008	0.008	0.008
MINIMUM	0.004	<0.001	<0.001	<0.001
05/27/88	0.010	0.002	<0.001	0.002
06/24/88	0.004	0.002	0.002	0.004
07/29/88	0.004	0.003	0.003	0.002
08/30/88	0.005	0.006	0.004	0.004
10/28/88	0.008	0.003	<0.001	<0.001
11/18/88	0.007	0.002	0.002	0.003
12/02/88	0.005	<0.001	<0.001	0.004
02/03/89	0.049	0.002	0.003	0.001
03/17/89	0.006	0.002	0.003	0.003
04/07/89	0.008	0.003	0.004	0.005
05/05/89	0.006	0.006	0.006	<0.001
06/01/89	MISSING	MISSING	MISSING	0.003
06/30/89	MISSING	MISSING	MISSING	0.008
09/08/89	0.025	0.007	0.008	0.003
10/06/89	0.013	0.008	0.006	0.006

CHROMIUM

	GROUNDWATER TREATMENT PLANT			
		CHROMIUM		
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	MONTHLY GRAB EFFLUENT MG/L	MONTHLY COMPOSITE EFFLUENT MG/L
AVERAGE	0.013	0.011	0.014	0.020
MAXIMUM	0.023	0.015	0.025	0.080
MINIMUM	<.010	<.010	<.010	<.010
05/27/88	0.016	<.010	0.025	0.026
06/24/88	0.023	<.010	0.011	0.012
07/29/88	0.013	0.011	0.012	0.011
08/30/88	0.016	0.015	0.013	0.012
10/28/88	0.010	0.010	<.010	<.010
11/18/88	0.011	<.010	<.010	0.011
12/02/88	<.010	<.010	<.010	<.010
02/03/89	0.012	<.010	<.010	0.012
03/17/89	<.010	<.010	<.010	<.010
04/07/89	<.010	<.010	<.010	<.010
05/05/89	0.013	0.012	0.014	0.014
06/01/89	MISSING	MISSING	MISSING	0.010
06/30/89	MISSING	MISSING	MISSING	0.080
09/08/89	0.013	0.015	0.024	0.034
10/06/89	0.016	0.013	0.018	0.033

COPPER

	GROUNDWATER TREATMENT PLANT			
		COPPER		
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	MONTHLY GRAB EFFLUENT MG/L	MONTHLY COMPOSITE EFFLUENT MG/L
AVERAGE	10.389	0.050	0.074	0.034
MAXIMUM	94.200	0.140	0.336	0.148
MINIMUM	0.160	<.010	<.010	<.010
05/27/88	0.230	0.140	0.035	<.010
06/24/88	0.180	<0.01	0.033	<.010
07/29/88	1.070	<0.01	0.058	<.010
08/30/88	0.298	0.014	0.011	<.010
10/28/88	1.240	0.023	<.010	<.010
11/18/88	3.760	0.031	0.063	0.022
12/02/88	0.160	0.082	0.120	0.028
02/03/89	18.500	0.046	0.016	0.033
03/17/89	9.220	0.049	0.336	0.065
04/07/89	2.250	0.038	0.019	0.016
05/05/89	1.710	0.136	0.148	0.148
06/01/89	MISSING	MISSING	MISSING	0.022
06/30/89	MISSING	MISSING	MISSING	0.091
09/08/89	94.2	0.052	0.062	0.017
10/06/89	2.24	0.014	0.052	0.022

LEAD

	GROUNDWATER TREATMENT PLANT			
		LEAD		
	INFLUENT	INFLUENT	MONTHLY	MONTHLY
DATE	BEFORE	AFTER	GRAB	COMPOSITE
	FILTERING	FILTERING	EFFLUENT	EFFLUENT
	MG/L	MG/L	MG/L	MG/L
AVERAGE	0.055	0.031	0.033	0.028
MAXIMUM	0.154	0.062	0.110	0.090
MINIMUM	0.012	0.013	0.013	0.010
05/27/88	0.100	0.060	0.110	0.040
06/24/88	0.068	0.030	0.051	0.090
07/29/88	0.089	0.051	0.054	0.034
08/30/88	0.012	0.013	0.016	0.018
10/28/88	0.033	0.024	0.022	0.026
11/18/88	0.049	0.017	0.013	0.021
12/02/88	0.022	0.062	0.022	0.020
02/03/89	0.154	0.027	0.037	0.027
03/17/89	0.023	0.029	0.021	0.022
04/07/89	0.080	0.029	0.029	0.030
05/05/89	0.016	<.010	0.030	0.014
06/01/89	MISSING	MISSING	MISSING	0.028
06/30/89	MISSING	MISSING	MISSING	0.033
09/08/89	0.033	0.013	0.014	0.012
10/06/89	0.033	0.020	0.016	0.010

NICKEL

	GROUNDWATER TREATMENT PLANT			
		NICKEL		
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	MONTHLY GRAB EFFLUENT MG/L	MONTHLY COMPOSITE EFFLUENT MG/L
AVERAGE	0.027	0.015	0.016	0.021
MAXIMUM	0.049	0.029	0.036	0.090
MINIMUM	0.011	<.010	<.010	<.010
05/27/88	0.016	<.010	0.012	0.015
06/24/88	0.019	<.010	<.010	0.016
07/29/88	0.026	0.015	0.013	<.010
08/30/88	0.033	0.022	0.020	0.020
10/28/88	0.047	0.029	0.010	<.010
11/18/88	0.025	<.010	<.010	<.010
12/02/88	0.013	<.010	<.010	0.015
02/03/89	0.049	0.014	0.016	0.033
03/17/89	0.013	<.010	0.015	<.010
04/07/89	0.011	<.010	<.010	<.010
05/05/89	0.024	0.013	0.018	<.010
06/01/89	MISSING	MISSING	MISSING	<.010
06/30/89	MISSING	MISSING	MISSING	0.090
09/08/89	0.037	0.011	0.036	0.018
10/06/89	0.037	0.025	0.027	0.033

TOTAL CYANIDE

	GROUNDWATER TREATMENT PLANT			
	TOTAL CYANIDE			
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	MONTHLY GRAB EFFLUENT MG/L	MONTHLY COMPOSITE EFFLUENT MG/L
AVERAGE	<.001	<.001	<.001	<.001
MAXIMUM	<.001	<.001	<.001	<.001
MINIMUM	<.001	<.001	<.001	<.001
05/27/88	<.001	<.001	0.002	<.001
06/24/88	<.001	<.001	<.001	<.001
07/29/88	<.001	<.001	<.001	<.001
08/30/88	0.001	<.001	0.001	<.001
10/28/88	<.001	<.001	<.001	<.001
11/18/88	0.004	0.002	<.001	<.001
12/02/88	0.005	<.001	<.001	<.001
02/03/89	0.004	<.001	<.001	0.001
03/17/89	<.001	<.001	0.001	0.001
04/07/89	<.001	<.001	<.001	0.001
05/05/89	<.001	<.001	<.001	0.001
06/01/89	MISSING	MISSING	MISSING	<.001
06/30/89	MISSING	MISSING	MISSING	0.004
09/08/89	<.001	<.001	<.001	<.001
10/06/89	0.002	0.002	0.002	0.002

ZINC

	GROUNDWATER TREATMENT PLANT			
		ZINC		
	INFLUENT	INFLUENT	MONTHLY	MONTHLY
DATE	BEFORE	AFTER	GRAB	COMPOSITE
	FILTERING	FILTERING	EFFLUENT	EFFLUENT
	MG/L	MG/L	MG/L	MG/L
AVERAGE	1.045	0.062	0.069	0.039
MAXIMUM	3.140	0.140	0.234	0.105
MINIMUM	0.136	<0.010	0.023	<0.01
05/27/88	0.540	0.140	0.025	0.021
06/24/88	0.263	0.021	0.033	0.027
07/29/88	0.464	0.058	0.045	0.021
08/30/88	0.722	0.040	0.141	0.011
10/28/88	1.320	0.080	0.096	0.058
11/18/88	1.880	0.025	0.032	0.055
12/02/88	1.420	0.110	0.234	0.095
02/03/89	3.140	0.080	0.033	0.076
03/17/89	0.419	0.096	0.023	0.012
04/07/89	0.952	0.033	0.072	0.012
05/05/89	0.136	0.088	0.104	0.029
06/01/89	MISSING	MISSING	MISSING	<0.01
06/30/89	MISSING	MISSING	MISSING	0.105
09/08/89	1.530	<0.010	0.026	0.013
10/06/89	0.804	0.020	0.031	0.036

1,2-DICHLOROETHANE

			GROUNDWATER TREATMENT PLANT						
				1,2-DICHLOROETHANE					
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	REACTION CHAMBER STAGE 1 MG/L	REACTION CHAMBER STAGE 2 MG/L	REACTION CHAMBER STAGE 3 MG/L	REACTION CHAMBER STAGE 4 MG/L	REACTION CHAMBER STAGE 5 MG/L	REACTION CHAMBER STAGE 6 MG/L	EFFLUENT GRAB MG/L
05/06/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/13/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/20/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/27/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/03/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/24/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/15/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/22/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/29/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/05/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/12/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/19/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/02/88	<.005	<.005	<.005	<.005	0.026	0.034	<.005	<.005	<.005
10/28/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/04/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/18/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/25/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/16/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/03/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/10/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/17/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/23/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/17/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/24/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/31/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/07/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/14/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/21/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/28/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/05/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/12/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/19/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/26/89	<.005	<.005	0.076	0.040	0.010	<.005	<.005	<.005	<.005
08/11/89	<.005	<.005	0.007	<.005	<.005	<.005	<.005	<.005	<.005
08/18/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/25/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/08/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/15/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/22/89	<.005	<.005	<.005	<.005	<.005	#	#	#	<.005
09/29/89	#	#	#	#	#	#	#	#	<.005
10/06/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
10/20/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005

METHYLENE CHLORIDE

			GROUNDWATER TREATMENT PLANT						
				METHYLENE CHLORIDE					
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	REACTION CHAMBER STAGE 1 MG/L	REACTION CHAMBER STAGE 2 MG/L	REACTION CHAMBER STAGE 3 MG/L	REACTION CHAMBER STAGE 4 MG/L	REACTION CHAMBER STAGE 5 MG/L	REACTION CHAMBER STAGE 6 MG/L	EFFLUENT GRAB MG/L
05/06/88	0.160	<.005	0.170	0.140	<.005	<.005	<.005	<.005	<.005
05/13/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/20/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/27/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/03/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/24/88	0.100	0.035	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/15/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/22/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/29/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/05/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/12/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/19/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
10/28/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/04/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/18/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/25/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/16/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/03/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/10/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/17/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/23/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/17/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/24/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/31/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/07/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/14/89	0.200	0.150	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/21/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/28/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/05/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/12/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/19/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/26/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/11/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/18/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/25/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/08/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/15/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/22/89	<.005	<.005	<.005	<.005	<.005	#	#	#	<.005
09/29/89	#	#	#	#	#	#	#	#	<.005
10/06/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
10/20/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005

CARBON DISULFIDE

			GROUNDWATER TREATMENT PLANT						
				CARBON DISULFIDE					
DATE	INFLUENT BEFORE FILTERING	INFLUENT AFTER FILTERING	REACTION CHAMBER STAGE 1	REACTION CHAMBER STAGE 2	REACTION CHAMBER STAGE 3	REACTION CHAMBER STAGE 4	REACTION CHAMBER STAGE 5	REACTION CHAMBER STAGE 6	EFFLUENT GRAB
	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L
05/06/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/13/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/20/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/27/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/03/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/24/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/15/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/22/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/29/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/05/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/12/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/19/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
10/28/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/04/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/18/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/25/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/16/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/03/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/10/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/17/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/23/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/17/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/24/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/31/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/07/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/14/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/21/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/28/89	<.005	0.016	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/05/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/12/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/19/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/26/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/11/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/18/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/25/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/08/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/15/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/22/89	<.005	<.005	<.005	<.005	<.005	#	#	#	<.005
09/29/89	#	#	#	#	#	#	#	#	<.005
10/06/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
10/20/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005

ACETONE

			GROUNDWATER TREATMENT PLANT						
					ACETONE				
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	REACTION CHAMBER STAGE 1 MG/L	REACTION CHAMBER STAGE 2 MG/L	REACTION CHAMBER STAGE 3 MG/L	REACTION CHAMBER STAGE 4 MG/L	REACTION CHAMBER STAGE 5 MG/L	REACTION CHAMBER STAGE 6 MG/L	EFFLUENT GRAB MG/L
05/06/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/13/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/20/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/27/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/03/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/24/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/15/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/22/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/29/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/05/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/12/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/19/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
10/28/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/04/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/18/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/25/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/16/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/03/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/10/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/17/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/23/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/17/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/24/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/31/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/07/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/14/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/21/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/28/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/05/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/12/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/19/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/26/89	<.005	0.120	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/11/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/18/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/25/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/08/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/15/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/22/89	<.005	<.005	<.005	<.005	<.005	#	#	#	<.005
09/29/89	#	#	#	#	#	#	#	#	<.005
10/06/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
10/20/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005

CHLOROFORM

			GROUNDWATER TREATMENT PLANT						
					CHLOROFORM				
	INFLUENT	INFLUENT	REACTION	REACTION	REACTION	REACTION	REACTION	REACTION	EFFLUENT
DATE	BEFORE	AFTER	CHAMBER	CHAMBER	CHAMBER	CHAMBER	CHAMBER	CHAMBER	GRAB
	FILTERING	FILTERING	STAGE 1	STAGE 2	STAGE 3	STAGE 4	STAGE 5	STAGE 6	
	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L
AVERAGE	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
MAXIMUM	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
MINIMUM	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/06/88	0.013	<.005	0.007	0.005	<.005	<.005	<.005	<.005	<.005
05/13/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/20/88	0.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/27/88	<.005	0.007	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/03/88	0.020	0.014	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/10/88	<.005	<.005	<.005	0.017	<.005	<.005	<.005	<.005	<.005
06/24/88	<.005	0.005	0.005	<.005	0.005	<.005	<.005	<.005	<.005
06/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/15/88	<.005	<.005	0.010	0.005	<.005	<.005	<.005	<.005	<.005
07/22/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/29/88	<.005	<.005	0.005	0.006	<.005	<.005	<.005	<.005	<.005
08/05/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/12/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/19/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/30/88	<.005	0.007	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
10/28/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/04/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/18/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/25/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/16/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/03/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/10/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/17/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/23/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/17/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/24/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/31/89	<.005	<.005	0.023	0.005	0.012	<.005	<.005	<.005	<.005
04/07/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/14/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/21/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/28/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/05/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/12/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/19/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/26/89	<.005	<.005	0.005	<.005	<.005	<.005	<.005	<.005	<.005
08/11/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/18/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/25/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/08/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/15/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/22/89	<.005	<.005	<.005	<.005	<.005	#	#	#	<.005
09/29/89	#	#	#	#	#	#	#	#	<.005
10/06/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
10/20/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005

1,1-DICHLOROETHENE

GROUNDWATER TREATMENT PLANT
1,1-DICHLOROETHENE

DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	PERCENT REMOVAL BY FILTERING %	REACTION CHAMBER STAGE 1 MG/L	REACTION CHAMBER STAGE 2 MG/L	REACTION CHAMBER STAGE 3 MG/L	REACTION CHAMBER STAGE 4 MG/L	REACTION CHAMBER STAGE 5 MG/L	REACTION CHAMBER STAGE 6 MG/L	EFFLUENT GRAB MG/L
AVERAGE	0.012	0.014	-13%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
MAXIMUM	0.033	0.025	24%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
MINIMUM	<.005	<.005		<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/06/88	0.007	0.013	-86%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/13/88	0.009	0.013	-44%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/20/88	0.013	0.013	0%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/27/88	0.019	0.024	-26%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/03/88	0.010	0.010	0%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/10/88	0.012	0.013	-8%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/24/88	0.033	0.012	64%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/30/88	0.008	0.008	0%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/15/88	0.013	0.020	-54%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/22/88	0.020	0.016	20%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/29/88	0.017	0.019	-12%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/05/88	0.015	0.018	-20%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/12/88	0.011	0.023	-109%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/19/88	0.010	0.014	-40%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/30/88	0.010	0.018	-80%	0.005	<.005	<.005	<.005	<.005	<.005	<.005
09/02/88	0.020	0.018	10%	0.007	<.005	<.005	<.005	0.005	<.005	<.005
10/28/88	0.021	0.020	5%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/04/88	0.011	0.014	-27%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/18/88	0.007	<.005	#VALUE!	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/25/88	0.021	0.019	10%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/02/88	<.005	0.010		<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/10/88	0.008	0.010	-25%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/16/88	0.010	0.008	20%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/03/89	<.005	0.010		<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/10/89	<.005	0.010		<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/17/89	<.005	0.011		<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/23/89	<.005	0.010		<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/17/89	<.005	0.016		<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/24/89	0.012	<.005		<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/31/89	<.005	0.015		<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/07/89	0.014	0.005	64%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/14/89	0.016	0.011	31%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/21/89	<.005	0.010		<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/28/89	<.005	0.014		<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/05/89	<.005	<.005		<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/12/89	0.029	0.025	14%	0.006	0.015	0.026	<.005	<.005	<.005	<.005
05/19/89	0.013	0.012	8%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/26/89	0.015	0.013	13%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/11/89	0.020	0.022	-10%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/18/89	0.018	0.020	-11%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/25/89	0.016	<.005		<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/08/89	0.017	0.012	29%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/15/89	0.016	0.022	-38%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/22/89	0.010	0.017	-70%	<.005	<.005	<.005	#	#	#	<.005
09/29/89	#	#		#	#	#	#	#	#	<.005
10/06/89	0.011	0.016	-45%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
10/20/89	0.011	0.025	-127%	<.005	<.005	<.005	<.005	<.005	<.005	<.005

1,1-DICHLOROETHANE

			GROUNDWATER TREATMENT PLANT							
				1,1-DICHLOROETHANE						
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	PERCENT REMOVAL BY FILTERING %	REACTION CHAMBER STAGE 1 MG/L	REACTION CHAMBER STAGE 2 MG/L	REACTION CHAMBER STAGE 3 MG/L	REACTION CHAMBER STAGE 4 MG/L	REACTION CHAMBER STAGE 5 MG/L	REACTION CHAMBER STAGE 6 MG/L	EFFLUENT GRAB MG/L
AVERAGE	0.015	0.017	-15%	0.008	0.006	<.005	<.005	<.005	<.005	<.005
MAXIMUM	0.049	0.032	35%	0.019	0.013	<.005	<.005	<.005	<.005	<.005
MINIMUM	<.005	<.005		<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/06/88	0.014	0.017	-21%	0.010	0.005	<.005	<.005	<.005	<.005	<.005
05/13/88	0.006	0.007	-17%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/20/88	0.016	0.018	-13%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/27/88	0.020	0.025	-25%	0.009	0.006	<.005	<.005	<.005	<.005	<.005
06/03/88	0.020	0.014	30%	0.006	<.005	<.005	<.005	<.005	<.005	<.005
06/10/88	0.017	0.016	6%	0.009	<.005	<.005	<.005	<.005	<.005	<.005
06/24/88	0.049	0.016	67%	0.007	<.005	<.005	<.005	<.005	<.005	<.005
06/30/88	0.015	0.013	13%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/15/88	0.018	0.030	-67%	0.011	0.006	<.005	<.005	<.005	<.005	<.005
07/22/88	0.020	0.020	0%	0.011	0.007	<.005	<.005	<.005	<.005	<.005
07/29/88	0.022	0.021	5%	0.012	0.009	<.005	<.005	<.005	<.005	<.005
08/05/88	0.024	0.031	-29%	0.016	0.012	0.006	0.006	<.005	<.005	<.005
08/12/88	0.017	0.032	-88%	0.014	0.011	<.005	0.005	<.005	<.005	<.005
08/19/88	0.017	0.021	-24%	0.014	0.011	<.005	<.005	<.005	<.005	<.005
08/30/88	0.015	0.026	-73%	0.019	0.013	0.008	0.006	<.005	<.005	<.005
09/02/88	0.025	0.024	4%	0.019	0.012	0.008	0.006	0.006	<.005	<.005
10/28/88	0.024	0.020	17%	0.010	0.008	0.007	0.006	<.005	<.005	<.005
11/04/88	0.014	0.018	-29%	0.008	0.006	0.005	<.005	<.005	<.005	<.005
11/18/88	0.014	0.010	29%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/25/88	0.026	0.023	12%	0.007	<.005	<.005	<.005	<.005	<.005	<.005
12/02/88	<.005	0.013		0.007	<.005	<.005	<.005	<.005	<.005	<.005
12/10/88	0.012	0.015	-25%	0.012	0.006	<.005	<.005	<.005	<.005	<.005
12/16/88	0.011	0.011	0%	0.006	<.005	<.005	<.005	<.005	<.005	<.005
02/03/89	<.005	0.015		<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/10/89	<.005	0.015		<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/17/89	<.005	0.017		0.006	<.005	<.005	<.005	<.005	<.005	<.005
02/23/89	<.005	0.015		0.006	<.005	<.005	<.005	<.005	<.005	<.005
03/17/89	<.005	0.016		0.007	0.006	<.005	<.005	<.005	<.005	<.005
03/24/89	0.015	<.005		<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/31/89	<.005	<.005		0.006	<.005	<.005	<.005	<.005	<.005	<.005
04/07/89	0.017	0.015	12%	0.006	<.005	<.005	<.005	<.005	<.005	<.005
04/14/89	0.017	0.013	24%	0.006	<.005	<.005	<.005	<.005	<.005	<.005
04/21/89	<.005	0.012		0.009	<.005	<.005	<.005	<.005	<.005	<.005
04/28/89	<.005	0.015		<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/05/89	<.005	0.008		<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/12/89	0.028	0.024	14%	0.015	0.011	0.007	0.006	<.005	<.005	<.005
05/19/89	0.016	0.017	-6%	0.009	0.006	<.005	<.005	<.005	<.005	<.005
05/26/89	0.015	0.014	7%	0.009	0.006	<.005	<.005	<.005	<.005	<.005
08/11/89	0.017	0.019	-12%	0.007	0.006	<.005	<.005	<.005	<.005	<.005
08/18/89	0.014	0.014	0%	0.007	<.005	<.005	<.005	<.005	<.005	<.005
08/25/89	0.016	0.016	0%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/08/89	0.014	0.012	14%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/15/89	0.017	0.020	-18%	0.006	<.005	<.005	<.005	<.005	<.005	<.005
09/22/89	0.013	0.016	-23%	0.007	<.005	<.005	#	#	#	<.005
09/29/89	#	#		#	#	#	#	#	#	<.005
10/06/89	0.013	0.020	-54%	0.006	<.005	<.005	<.005	<.005	<.005	<.005
10/20/89	0.015	0.030	-100%	0.013	<.005	<.005	<.005	<.005	<.005	<.005

1,2-DICHLOROETHENE

GROUNDWATER TREATMENT PLANT
1,2-DICHLOROETHENE (total)

DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	PERCENT REMOVAL BY FILTERING %	REACTION CHAMBER STAGE 1 MG/L	REACTION CHAMBER STAGE 2 MG/L	REACTION CHAMBER STAGE 3 MG/L	REACTION CHAMBER STAGE 4 MG/L	REACTION CHAMBER STAGE 5 MG/L	REACTION CHAMBER STAGE 6 MG/L	EFFLUENT GRAB MG/L
AVERAGE	0.697	0.838	-20%	0.088	0.029	<.005	<.005	<.005	<.005	<.005
MAXIMUM	3.230	2.057	36%	0.486	0.150	<.005	<.005	<.005	<.005	<.005
MINIMUM	<.005	<.005		<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/06/88	0.400	0.780	-95%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/13/88	0.490	0.630	-29%	0.047	0.006	<.005	<.005	<.005	<.005	<.005
05/20/88	0.570	0.570	0%	0.044	0.007	<.005	<.005	<.005	<.005	<.005
05/27/88	0.800	0.980	-23%	0.061	0.016	<.005	<.005	<.005	<.005	<.005
06/03/88	0.010	0.010	0%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/10/88	0.615	0.660	-7%	0.073	0.013	<.005	<.005	<.005	<.005	<.005
06/24/88	1.303	0.517	60%	0.080	0.017	0.006	0.007	<.005	<.005	<.005
06/30/88	0.879	0.704	20%	0.068	0.013	<.005	<.005	<.005	<.005	<.005
07/15/88	0.610	0.940	-54%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/22/88	0.790	0.770	3%	0.106	0.017	<.005	<.005	<.005	<.005	<.005
07/29/88	0.920	0.940	-2%	0.091	0.027	0.005	<.005	<.005	<.005	<.005
08/05/88	0.110	1.102	-902%	0.146	0.043	0.008	0.009	<.005	<.005	<.005
08/12/88	0.690	1.160	-68%	0.132	0.054	<.005	0.008	<.005	<.005	<.005
08/19/88	1.420	1.715	-21%	0.103	<.005	<.005	<.005	<.005	<.005	<.005
08/30/88	0.660	1.130	-71%	0.330	0.150	0.040	0.020	<.005	<.005	<.005
09/02/88	1.110	1.060	5%	0.486	0.150	0.054	0.018	0.006	<.005	<.005
10/28/88	1.200	1.064	11%	0.067	0.031	0.018	0.008	<.005	<.005	<.005
11/04/88	0.610	0.812	-33%	0.053	0.023	0.010	<.005	<.005	<.005	<.005
11/18/88	.005	.005	0%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/25/88	1.100	1.100	0%	0.123	0.036	<.005	<.005	<.005	<.005	<.005
12/02/88	<.005	0.828		0.010	<.005	<.005	<.005	<.005	<.005	<.005
12/10/88	0.628	0.794	-26%	0.182	0.020	<.005	<.005	<.005	<.005	<.005
12/16/88	0.613	0.611	0%	0.053	0.009	<.005	<.005	<.005	<.005	<.005
02/03/89	0.101	0.738	-631%	0.023	0.007	<.005	<.005	<.005	<.005	<.005
02/10/89	0.111	0.688	-520%	0.051	0.012	<.005	<.005	<.005	<.005	<.005
02/17/89	0.150	0.974	-549%	0.078	0.021	<.005	<.005	<.005	<.005	<.005
02/23/89	0.140	0.713	-409%	0.058	0.013	<.005	<.005	<.005	<.005	<.005
03/17/89	.210	1.640	-681%	0.110	0.055	0.016	0.006	<.005	<.005	<.005
03/24/89	1.384	<.005		<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/31/89	.220	1.827	-730%	0.106	0.052	0.015	<.005	<.005	<.005	<.005
04/07/89	2.226	0.625	72%	0.082	0.033	0.011	0.005	<.005	<.005	<.005
04/14/89	3.230	2.057	36%	0.135	0.045	0.016	0.011	<.005	<.005	<.005
04/21/89	0.222	1.348	-507%	0.210	0.075	0.027	0.013	0.005	<.005	<.005
04/28/89	0.178	0.812	-356%	0.045	<.005	<.005	<.005	<.005	<.005	<.005
05/05/89	.379	.434	-15%	<.005	<.005	<.005	<.005	<.005	<.005	0.012
05/12/89	1.260	1.181	6%	0.340	0.143	0.049	0.025	0.010	0.008	0.008
05/19/89	.650	.688	-6%	0.185	0.088	0.031	0.020	0.007	0.005	0.007
05/26/89	.400	.407	-2%	0.130	0.070	0.026	0.009	0.013	<.005	<.005
08/11/89	0.963	1.010	-5%	0.036	0.006	<.005	<.005	<.005	<.005	<.005
08/18/89	0.232	0.253	-9%	0.015	<.005	<.005	<.005	<.005	<.005	<.005
08/25/89	1.130	0.121	89%	0.026	0.008	<.005	0.005	<.005	<.005	<.005
09/08/89	0.670	0.600	10%	0.016	0.006	<.005	<.005	<.005	<.005	0.012
09/15/89	0.856	0.954	-11%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/22/89	0.587	0.739	-26%	<.005	<.005	<.005	#	#	#	<.005
09/29/89	#	#		#	#	#	#	#	#	<.005
10/06/89	0.630	0.900	-43%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
10/20/89	0.607	0.960	-58%	0.086	0.005	<.005	<.005	<.005	<.005	<.005

TETRACHLOROETHENE

			GROUNDWATER TREATMENT PLANT							
				TETRACHLOROETHENE						
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	PERCENT REMOVAL BY FILTERING %	REACTION CHAMBER STAGE 1 MG/L	REACTION CHAMBER STAGE 2 MG/L	REACTION CHAMBER STAGE 3 MG/L	REACTION CHAMBER STAGE 4 MG/L	REACTION CHAMBER STAGE 5 MG/L	REACTION CHAMBER STAGE 6 MG/L	EFFLUENT GRAB MG/L
AVERAGE	0.032	0.042	-33%	0.008	<.005	<.005	<.005	0.005	<.005	<.005
MAXIMUM	0.084	0.077	8%	0.023	<.005	<.005	<.005	0.005	<.005	<.005
MINIMUM	<.005	<.005		<.005	<.005	<.005	<.005	0.005	<.005	<.005
05/06/88	0.022	0.050	-127%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/13/88	0.029	0.045	-55%	0.008	<.005	<.005	<.005	<.005	<.005	<.005
05/20/88	0.038	0.048	-26%	0.007	<.005	<.005	<.005	<.005	<.005	<.005
05/27/88	0.050	0.066	-32%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/03/88	0.068	0.066	3%	0.008	<.005	<.005	<.005	<.005	<.005	<.005
06/10/88	<.005	<.005		0.011	<.005	<.005	<.005	<.005	<.005	<.005
06/24/88	0.084	0.029	65%	0.010	<.005	<.005	<.005	<.005	<.005	<.005
06/30/88	0.033	0.030	9%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/15/88	0.040	0.077	-93%	0.018	<.005	<.005	<.005	<.005	<.005	<.005
07/22/88	0.066	0.060	9%	0.013	0.005	<.005	<.005	<.005	<.005	<.005
07/29/88	0.058	0.068	-17%	0.011	<.005	<.005	<.005	<.005	<.005	<.005
08/05/88	0.041	0.064	-56%	0.013	<.005	<.005	<.005	<.005	<.005	<.005
08/12/88	0.024	0.054	-125%	0.011	0.005	<.005	<.005	<.005	<.005	<.005
08/19/88	0.043	0.065	-51%	0.006	<.005	<.005	<.005	<.005	<.005	<.005
08/30/88	0.023	0.038	-65%	0.023	0.011	<.005	<.005	<.005	<.005	<.005
09/02/88	0.040	0.034	15%	0.019	0.007	<.005	<.005	<.005	<.005	<.005
10/28/88	0.058	0.048	17%	0.008	<.005	<.005	<.005	<.005	<.005	<.005
11/04/88	0.047	0.060	-28%	0.007	<.005	<.005	<.005	<.005	<.005	<.005
11/18/88	0.030	<.005		<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/25/88	0.046	0.046	0%	0.009	0.005	<.005	<.005	<.005	<.005	<.005
12/02/88	<.005	0.040		<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/10/88	0.029	0.040	-38%	0.015	<.005	<.005	<.005	<.005	<.005	<.005
12/16/88	0.040	0.038	5%	0.006	<.005	<.005	<.005	<.005	<.005	<.005
02/03/89	<.005	0.049		<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/10/89	<.005	0.049		<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/17/89	<.005	0.031		0.005	<.005	<.005	<.005	<.005	<.005	<.005
02/23/89	<.005	0.038		0.006	<.005	<.005	<.005	<.005	<.005	<.005
03/17/89	<.005	0.064		0.013	0.006	<.005	<.005	<.005	<.005	<.005
03/24/89	<.005	<.005		<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/31/89	<.005	0.050		0.009	<.005	<.005	<.005	<.005	<.005	<.005
04/07/89	0.050	0.028	44%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/14/89	0.060	0.040	33%	0.008	0.045	<.005	<.005	<.005	<.005	<.005
04/21/89	<.005	0.033		0.012	0.005	<.005	<.005	0.005	<.005	<.005
04/28/89	<.005	0.044		0.007	<.005	<.005	<.005	<.005	<.005	<.005
05/05/89	<.005	0.016		<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/12/89	0.047	0.039	17%	0.014	0.007	<.005	<.005	<.005	<.005	<.005
05/19/89	0.039	0.037	5%	0.012	<.005	<.005	<.005	<.005	<.005	<.005
05/26/89	0.036	0.031	14%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/11/89	0.031	0.037	-19%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/18/89	0.038	0.040	-5%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/25/89	0.030	0.014	53%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/08/89	0.041	0.035	15%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/15/89	0.034	0.043	-26%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/22/89	0.023	0.034	-48%	<.005	<.005	<.005	#	#	#	<.005
09/29/89	#	#		#	#	#	#	#	#	<.005
10/06/89	0.026	0.039	-50%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
10/20/89	0.025	0.057	-128%	0.008	<.005	<.005	<.005	<.005	<.005	<.005

1,1,1-TRICHLOROETHANE

GROUNDWATER TREATMENT PLANT
1,1,1-TRICHLOROETHANE

DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	PERCENT REMOVAL BY FILTERING %	REACTION CHAMBER STAGE 1 MG/L	REACTION CHAMBER STAGE 2 MG/L	REACTION CHAMBER STAGE 3 MG/L	REACTION CHAMBER STAGE 4 MG/L	REACTION CHAMBER STAGE 5 MG/L	REACTION CHAMBER STAGE 6 MG/L	EFFLUENT GRAB MG/L
AVERAGE	0.018	0.013	28%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
MAXIMUM	0.304	0.030	90%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
MINIMUM	<.005	<.005	#VALUE!	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/06/88	<.005	<.005		0.007	<.005	<.005	<.005	<.005	<.005	<.005
05/13/88	0.013	0.017	-31%	0.007	<.005	<.005	<.005	<.005	<.005	<.005
05/20/88	0.018	0.021	-17%	0.007	<.005	<.005	<.005	<.005	<.005	<.005
05/27/88	0.017	0.023	-35%	0.006	<.005	<.005	<.005	<.005	<.005	<.005
06/03/88	<.005	<.005		<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/10/88	0.013	<.005		<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/24/88	<.005	<.005		0.007	<.005	<.005	<.005	<.005	<.005	<.005
06/30/88	<.005	<.005		<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/15/88	0.017	<.005		0.009	<.005	<.005	<.005	<.005	<.005	<.005
07/22/88	0.022	0.020	9%	0.010	0.005	<.005	<.005	<.005	<.005	<.005
07/29/88	<.005	<.005		<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/05/88	0.022	0.027	-23%	0.009	0.005	<.005	<.005	<.005	<.005	<.005
08/12/88	0.020	0.030	-50%	0.008	0.006	<.005	<.005	<.005	<.005	<.005
08/19/88	0.020	<.005		0.012	0.012	<.005	<.005	<.005	<.005	<.005
08/30/88	0.014	0.022	-57%	0.013	0.008	<.005	<.005	<.005	<.005	<.005
09/02/88	0.021	0.018	14%	0.013	0.006	<.005	<.005	<.005	<.005	<.005
10/28/88	<.005	<.005		0.007	0.005	<.005	<.005	<.005	<.005	<.005
11/04/88	0.018	0.020	-11%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/18/88	0.019	0.007	63%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/25/88	0.025	0.021	16%	0.006	<.005	<.005	<.005	<.005	<.005	<.005
12/02/88	<.005	0.013		<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/10/88	0.012	0.016	-33%	0.009	<.005	<.005	<.005	<.005	<.005	<.005
12/16/88	0.013	0.011	15%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/03/89	<.005	0.012		<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/10/89	<.005	0.015		<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/17/89	<.005	0.014		<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/23/89	<.005	0.016		0.005	<.005	<.005	<.005	<.005	<.005	<.005
03/17/89	<.005	0.021		0.012	<.005	<.005	<.005	<.005	<.005	<.005
03/24/89	0.017	<.005		0.012	<.005	<.005	<.005	<.005	<.005	<.005
03/31/89	<.005	0.014		0.005	<.005	<.005	<.005	<.005	<.005	<.005
04/07/89	0.013	0.010	23%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/14/89	0.016	0.011	31%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/21/89	<.005	0.012		0.005	<.005	<.005	<.005	<.005	<.005	<.005
04/28/89	<.005	0.014		<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/05/89	<.005	<.005		<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/12/89	0.022	0.021	5%	0.007	<.005	<.005	<.005	<.005	<.005	<.005
05/19/89	0.028	0.027	4%	0.007	<.005	<.005	<.005	<.005	<.005	<.005
05/26/89	0.015	0.013	13%	0.006	<.005	<.005	<.005	<.005	<.005	<.005
08/11/89	0.010	<.005		<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/18/89	<.005	<.005		<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/25/89	0.015	0.010	33%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/08/89	0.011	<.005		<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/15/89	0.304	0.014	95%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/22/89	0.007	0.011	-57%	0.005	<.005	<.005				<.005
09/29/89	#	#		#	#	#	#	#	#	<.005
10/06/89	0.010	0.015	-50%	<.005	<.005	<.005	<.005	<.005	<.005	<.005
10/20/89	0.011	0.024	-118%	0.007	<.005	<.005	<.005	<.005	<.005	<.005

BROMOETHANE

			GROUNDWATER TREATMENT PLANT						
				BROMOMETHANE					
DATE	INFLUENT BEFORE FILTERING	INFLUENT AFTER FILTERING	REACTION CHAMBER STAGE 1	REACTION CHAMBER STAGE 2	REACTION CHAMBER STAGE 3	REACTION CHAMBER STAGE 4	REACTION CHAMBER STAGE 5	REACTION CHAMBER STAGE 6	EFFLUENT GRAB
	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L
05/06/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
05/13/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
05/20/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
05/27/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
06/03/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
06/10/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
06/24/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
06/30/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
07/15/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
07/22/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
07/29/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
08/05/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
08/12/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
08/19/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
08/30/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
09/02/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
10/28/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
11/04/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
11/18/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
11/25/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
12/02/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
12/10/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
12/16/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
02/03/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
02/10/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
02/17/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
02/23/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
03/17/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
03/24/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
03/31/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
04/07/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
04/14/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
04/21/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
04/28/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
05/05/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
05/12/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
05/19/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
05/26/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
08/11/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
08/18/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
08/25/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
09/08/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
09/15/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
09/22/89	<.010	<.010	<.010	<.010	<.010	#	#	#	<.010
09/29/89	#	#	#	#	#	#	#	#	<.010
10/06/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
10/20/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010

CHLOROMETHANE

			GROUNDWATER TREATMENT PLANT						
				CHLOROMETHANE					
DATE	INFLUENT BEFORE FILTERING	INFLUENT AFTER FILTERING	REACTION CHAMBER STAGE 1	REACTION CHAMBER STAGE 2	REACTION CHAMBER STAGE 3	REACTION CHAMBER STAGE 4	REACTION CHAMBER STAGE 5	REACTION CHAMBER STAGE 6	EFFLUENT GRAB
	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L
05/06/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
05/13/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
05/20/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
05/27/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
06/03/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
06/10/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
06/24/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
06/30/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
07/15/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
07/22/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
07/29/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
08/05/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
08/12/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
08/19/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
08/30/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
09/02/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
10/28/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
11/04/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
11/18/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
11/25/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
12/02/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
12/10/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
12/16/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
02/03/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
02/10/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
02/17/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
02/23/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
03/17/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
03/24/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
03/31/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
04/07/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
04/14/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
04/21/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
04/28/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
05/05/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
05/12/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
05/19/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
05/26/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
08/11/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
08/18/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
08/25/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
09/08/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
09/15/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
09/22/89	<.010	<.010	<.010	<.010	<.010	#	#	#	<.010
09/29/89	#	#	#	#	#	#	#	#	<.010
10/06/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
10/20/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010

CHLOROETHANE

			GROUNDWATER TREATMENT PLANT						
			CHLOROETHANE						
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	REACTION CHAMBER STAGE 1 MG/L	REACTION CHAMBER STAGE 2 MG/L	REACTION CHAMBER STAGE 3 MG/L	REACTION CHAMBER STAGE 4 MG/L	REACTION CHAMBER STAGE 5 MG/L	REACTION CHAMBER STAGE 6 MG/L	EFFLUENT GRAB MG/L
05/06/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
05/13/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
05/20/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
05/27/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
06/03/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
06/10/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
06/24/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
06/30/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
07/15/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
07/22/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
07/29/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
08/05/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
08/12/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
08/19/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
08/30/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
09/02/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
10/28/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
11/04/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
11/18/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
11/25/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
12/02/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
12/10/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
12/16/88	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
02/03/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
02/10/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
02/17/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
02/23/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
03/17/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
03/24/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
03/31/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
04/07/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
04/14/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
04/21/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
04/28/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
05/05/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
05/12/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
05/19/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
05/26/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
08/11/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
08/18/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
08/25/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
09/08/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
09/15/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
09/22/89	<.010	<.010	<.010	<.010	<.010	#	#	#	<.010
09/29/89	#	#	#	#	#	#	#	#	<.010
10/06/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
10/20/89	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010

TOLUENE

			GROUNDWATER TREATMENT PLANT						
					TOLUENE				
DATE	INFLUENT BEFORE FILTERING	INFLUENT AFTER FILTERING	REACTION CHAMBER STAGE 1	REACTION CHAMBER STAGE 2	REACTION CHAMBER STAGE 3	REACTION CHAMBER STAGE 4	REACTION CHAMBER STAGE 5	REACTION CHAMBER STAGE 6	EFFLUENT GRAB
	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L
05/06/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/13/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/20/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/27/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/03/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/24/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/30/88	0.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/15/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/22/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/29/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/05/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/12/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/19/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
10/28/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/04/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/18/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/25/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/16/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/03/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/10/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/17/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/23/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/17/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/24/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/31/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/07/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/14/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/21/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/28/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/05/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/12/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/19/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/26/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/11/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/18/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/25/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/08/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/15/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/22/89	<.005	<.005	<.005	<.005	<.005	#	#	#	<.005
09/29/89	#	#	#	#	#	#	#	#	<.005
10/06/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
10/20/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005

CARBON TETRACHLORIDE

			GROUNDWATER TREATMENT PLANT						
				CARBON TETRACHLORIDE					
DATE	INFLUENT BEFORE FILTERING	INFLUENT AFTER FILTERING	REACTION CHAMBER STAGE 1	REACTION CHAMBER STAGE 2	REACTION CHAMBER STAGE 3	REACTION CHAMBER STAGE 4	REACTION CHAMBER STAGE 5	REACTION CHAMBER STAGE 6	EFFLUENT GRAB
	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L
05/06/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/13/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/20/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/27/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/03/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/24/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/15/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/22/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/29/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/05/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/12/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/19/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
10/28/88	0.02	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/04/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/18/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/25/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/16/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/03/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/10/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/17/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/23/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/17/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/24/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/31/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/07/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/14/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/21/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/28/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/05/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/12/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/19/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/26/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/11/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/18/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/25/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/08/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/15/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/22/89	<.005	<.005	<.005	<.005	<.005	#	#	#	<.005
09/29/89	#	#	#	#	#	#	#	#	<.005
10/06/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
10/20/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005

2-BUTANONE

			GROUNDWATER TREATMENT PLANT						
				2-BUTANONE					
DATE	INFLUENT BEFORE FILTERING	INFLUENT AFTER FILTERING	REACTION CHAMBER STAGE 1	REACTION CHAMBER STAGE 2	REACTION CHAMBER STAGE 3	REACTION CHAMBER STAGE 4	REACTION CHAMBER STAGE 5	REACTION CHAMBER STAGE 6	EFFLUENT GRAB
	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L
05/06/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/13/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/20/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/27/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/03/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/24/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/15/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/22/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/29/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/05/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/12/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/19/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
10/28/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/04/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/18/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/25/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/16/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/03/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/10/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/17/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/23/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/17/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/24/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/31/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/07/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/14/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/21/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/28/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/05/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/12/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/19/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/26/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/11/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/18/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/25/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/08/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/15/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/22/89	<.005	<.005	<.005	<.005	<.005	#	#	#	<.005
09/29/89	#	#	#	#	#	#	#	#	<.005
10/06/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
10/20/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005

TRANS-1,3-DICHLOROPROPENE

			GROUNDWATER TREATMENT PLANT						
			TRANS-1,3-DICHLOROPROPENE						
DATE	INFLUENT BEFORE FILTERING	INFLUENT AFTER FILTERING	REACTION CHAMBER STAGE 1	REACTION CHAMBER STAGE 2	REACTION CHAMBER STAGE 3	REACTION CHAMBER STAGE 4	REACTION CHAMBER STAGE 5	REACTION CHAMBER STAGE 6	EFFLUENT GRAB
	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L
05/06/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/13/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/20/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/27/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/03/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/24/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/15/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/22/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/29/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/05/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/12/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/19/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
10/28/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/04/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/18/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/25/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/16/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/03/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/10/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/17/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/23/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/17/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/24/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/31/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/07/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/14/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/21/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/28/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/05/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/12/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/19/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/26/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/11/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/18/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/25/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/08/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/15/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/22/89	<.005	<.005	<.005	<.005	<.005	#	#	#	<.005
09/29/89	#	#	#	#	#	#	#	#	<.005
10/06/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
10/20/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005

VINYL ACETATE

			GROUNDWATER TREATMENT PLANT						
				VINYL ACETATE					
DATE	INFLUENT BEFORE FILTERING	INFLUENT AFTER FILTERING	REACTION CHAMBER STAGE 1	REACTION CHAMBER STAGE 2	REACTION CHAMBER STAGE 3	REACTION CHAMBER STAGE 4	REACTION CHAMBER STAGE 5	REACTION CHAMBER STAGE 6	EFFLUENT GRAB
	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L
05/06/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/13/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/20/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/27/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/03/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/24/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/15/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/22/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/29/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/05/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/12/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/19/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
10/28/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/04/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/18/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/25/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/16/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/03/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/10/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/17/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/23/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/17/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/24/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/31/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/07/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/14/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/21/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/28/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/05/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/12/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/19/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/26/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/11/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/18/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/25/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/08/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/15/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/22/89	<.005	<.005	<.005	<.005	<.005	#	#	#	<.005
09/29/89	#	#	#	#	#	#	#	#	<.005
10/06/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
10/20/89	0.020	0.033	<.005	<.005	<.005	<.005	<.005	<.005	<.005

BROMODICHLOROMETHANE

			GROUNDWATER TREATMENT PLANT						
				BROMODICHLOROMETHANE					
DATE	INFLUENT BEFORE FILTERING	INFLUENT AFTER FILTERING	REACTION CHAMBER STAGE 1	REACTION CHAMBER STAGE 2	REACTION CHAMBER STAGE 3	REACTION CHAMBER STAGE 4	REACTION CHAMBER STAGE 5	REACTION CHAMBER STAGE 6	EFFLUENT GRAB
	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L
05/06/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/13/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/20/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/27/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/03/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/24/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/15/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/22/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/29/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/05/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/12/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/19/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
10/28/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/04/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/18/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/25/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/16/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/03/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/10/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/17/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/23/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/17/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/24/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/31/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/07/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/14/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/21/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/28/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/05/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/12/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/19/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/26/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/11/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/18/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/25/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/08/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/15/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/22/89	<.005	<.005	<.005	<.005	<.005	#	#	#	<.005
09/29/89	#	#	#	#	#	#	#	#	<.005
10/06/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
10/20/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005

cis-1,3-DICHLOROPROPENE

			GROUNDWATER TREATMENT PLANT						
				cis-1,3-DICHLOROPROPENE					
DATE	INFLUENT BEFORE FILTERING	INFLUENT AFTER FILTERING	REACTION CHAMBER STAGE 1	REACTION CHAMBER STAGE 2	REACTION CHAMBER STAGE 3	REACTION CHAMBER STAGE 4	REACTION CHAMBER STAGE 5	REACTION CHAMBER STAGE 6	EFFLUENT GRAB
	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L
05/06/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/13/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/20/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/27/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/03/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/24/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/15/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/22/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/29/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/05/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/12/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/19/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
10/28/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/04/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/18/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/25/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/16/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/03/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/10/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/17/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/23/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/17/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/24/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/31/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/07/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/14/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/21/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/28/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/05/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/12/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/19/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/26/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/11/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/18/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/25/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/08/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/15/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/22/89	<.005	<.005	<.005	<.005	<.005	#	#	#	<.005
09/29/89	#	#	#	#	#	#	#	#	<.005
10/06/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
10/20/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005

DIBROMOCHLOROMETHANE

			GROUNDWATER TREATMENT PLANT						
				DIBROMOCHLOROMETHANE					
DATE	INFLUENT BEFORE FILTERING	INFLUENT AFTER FILTERING	REACTION CHAMBER STAGE 1	REACTION CHAMBER STAGE 2	REACTION CHAMBER STAGE 3	REACTION CHAMBER STAGE 4	REACTION CHAMBER STAGE 5	REACTION CHAMBER STAGE 6	EFFLUENT GRAB
	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L
05/06/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/13/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/20/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/27/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/03/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/24/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/15/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/22/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/29/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/05/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/12/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/19/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
10/26/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/04/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/18/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/25/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/16/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/03/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/10/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/17/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/23/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/17/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/24/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/31/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/07/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/14/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/21/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/28/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/05/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/12/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/19/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/26/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/11/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/18/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/25/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/08/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/15/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/22/89	<.005	<.005	<.005	<.005	<.005	#	#	#	<.005
09/29/89	#	#	#	#	#	#	#	#	<.005
10/06/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
10/20/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005

1,1,2-TRICHLOROETHANE

			GROUNDWATER TREATMENT PLANT						
				1,1,2-TRICHLOROETHANE					
DATE	INFLUENT BEFORE FILTERING	INFLUENT AFTER FILTERING	REACTION CHAMBER STAGE 1	REACTION CHAMBER STAGE 2	REACTION CHAMBER STAGE 3	REACTION CHAMBER STAGE 4	REACTION CHAMBER STAGE 5	REACTION CHAMBER STAGE 6	EFFLUENT GRAB
	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L
05/06/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/13/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/20/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/27/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/03/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/24/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/15/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/22/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/29/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/05/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/12/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/19/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
10/28/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/04/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/18/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/25/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/16/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/03/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/10/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/17/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/23/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/17/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/24/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/31/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/07/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/14/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/21/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/28/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/05/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/12/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/19/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/26/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/11/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/18/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/25/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/08/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/15/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/22/89	<.005	<.005	<.005	<.005	<.005	#	#	#	<.005
09/29/89	#	#	#	#	#	#	#	#	<.005
10/06/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
10/20/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005

BENZENE

			GROUNDWATER TREATMENT PLANT						
					BENZENE				
DATE	INFLUENT BEFORE FILTERING	INFLUENT AFTER FILTERING	REACTION CHAMBER STAGE 1	REACTION CHAMBER STAGE 2	REACTION CHAMBER STAGE 3	REACTION CHAMBER STAGE 4	REACTION CHAMBER STAGE 5	REACTION CHAMBER STAGE 6	EFFLUENT GRAB
	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L
05/06/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/13/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/20/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/27/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/03/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/24/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/15/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/22/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/29/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/05/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/12/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/19/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
10/28/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/04/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/18/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/25/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/16/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/03/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/10/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/17/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/23/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/17/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/24/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/31/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/07/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/14/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/21/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/28/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/05/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/12/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/19/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/26/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/11/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/18/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/25/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/08/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/15/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/22/89	<.005	<.005	<.005	<.005	<.005	#	#	#	<.005
09/29/89	#	#	#	#	#	#	#	#	<.005
10/06/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
10/20/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005

BROMOFORM

			GROUNDWATER TREATMENT PLANT						
			BROMOFORM						
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	REACTION CHAMBER STAGE 1 MG/L	REACTION CHAMBER STAGE 2 MG/L	REACTION CHAMBER STAGE 3 MG/L	REACTION CHAMBER STAGE 4 MG/L	REACTION CHAMBER STAGE 5 MG/L	REACTION CHAMBER STAGE 6 MG/L	EFFLUENT GRAB MG/L
05/06/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/13/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/20/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/27/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/03/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/24/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/15/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/22/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/29/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/05/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/12/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/19/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
10/28/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/04/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/18/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/25/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/16/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/03/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/10/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/17/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/23/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/17/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/24/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/31/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/07/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/14/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/21/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/28/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/05/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/12/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/19/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/26/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/11/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/18/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/25/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/08/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/15/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/22/89	<.005	<.005	<.005	<.005	<.005	#	#	#	<.005
09/29/89	#	#	#	#	#	#	#	#	<.005
10/06/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
10/20/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005

4-METHYL-2-PENTANONE

			GROUNDWATER TREATMENT PLANT						
				4-METHYL-2-PENTANONE					
DATE	INFLUENT BEFORE FILTERING	INFLUENT AFTER FILTERING	REACTION CHAMBER STAGE 1	REACTION CHAMBER STAGE 2	REACTION CHAMBER STAGE 3	REACTION CHAMBER STAGE 4	REACTION CHAMBER STAGE 5	REACTION CHAMBER STAGE 6	EFFLUENT GRAB
	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L
05/06/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/13/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/20/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/27/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/03/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/24/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/15/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/22/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/29/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/05/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/12/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/19/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
10/28/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/04/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/18/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/25/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/16/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/03/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/10/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/17/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/23/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/17/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/24/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/31/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/07/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/14/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/21/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/28/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/05/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/12/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/19/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/26/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/11/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/18/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/25/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/08/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/15/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/22/89	<.005	<.005	<.005	<.005	<.005	#	#	#	<.005
09/29/89	#	#	#	#	#	#	#	#	<.005
10/06/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
10/20/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005

2-HEXANONE

			GROUNDWATER TREATMENT PLANT						
				2-HEXANONE					
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	REACTION CHAMBER STAGE 1 MG/L	REACTION CHAMBER STAGE 2 MG/L	REACTION CHAMBER STAGE 3 MG/L	REACTION CHAMBER STAGE 4 MG/L	REACTION CHAMBER STAGE 5 MG/L	REACTION CHAMBER STAGE 6 MG/L	EFFLUENT GRAB MG/L
05/06/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/13/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/20/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/27/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/03/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/24/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/15/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/22/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/29/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/05/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/12/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/19/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
10/28/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/04/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/18/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/25/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/16/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/03/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/10/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/17/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/23/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/17/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/24/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/31/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/07/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/14/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/21/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/28/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/05/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/12/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/19/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/26/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/11/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/18/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/25/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/08/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/15/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/22/89	<.005	<.005	<.005	<.005	<.005	#	#	#	<.005
09/29/89	#	#	#	#	#	#	#	#	<.005
10/06/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
10/20/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005

1,1,2,2-TETRACHLOROETHANE

			GROUNDWATER TREATMENT PLANT						
				1,1,2,2-TETRACHLOROETHANE					
DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	REACTION CHAMBER STAGE 1 MG/L	REACTION CHAMBER STAGE 2 MG/L	REACTION CHAMBER STAGE 3 MG/L	REACTION CHAMBER STAGE 4 MG/L	REACTION CHAMBER STAGE 5 MG/L	REACTION CHAMBER STAGE 6 MG/L	EFFLUENT GRAB MG/L
05/06/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/13/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/20/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/27/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/03/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/24/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/15/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/22/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/29/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/05/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/12/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/19/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
10/28/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/04/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/18/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/25/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/16/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/03/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/10/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/17/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/23/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/17/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/24/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/31/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/07/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/14/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/21/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/28/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/05/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/12/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/19/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/26/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/11/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/18/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/25/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/08/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/15/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/22/89	<.005	<.005	<.005	<.005	<.005	#	#	#	<.005
09/29/89	#	#	#	#	#	#	#	#	<.005
10/06/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
10/20/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005

CHLOROBENZENE

			GROUNDWATER TREATMENT PLANT						
				CHLOROBENZENE					
DATE	INFLUENT BEFORE FILTERING	INFLUENT AFTER FILTERING	REACTION CHAMBER STAGE 1	REACTION CHAMBER STAGE 2	REACTION CHAMBER STAGE 3	REACTION CHAMBER STAGE 4	REACTION CHAMBER STAGE 5	REACTION CHAMBER STAGE 6	EFFLUENT GRAB
	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L
05/06/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/13/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/20/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/27/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/03/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/24/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/15/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/22/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/29/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/05/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/12/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/19/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
10/28/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/04/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/18/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/25/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/16/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/03/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/10/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/17/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/23/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/17/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/24/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/31/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/07/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/14/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/21/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/28/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/05/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/12/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/19/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/26/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/11/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/18/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/25/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/08/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/15/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/22/89	<.005	<.005	<.005	<.005	<.005	#	#	#	<.005
09/29/89	#	#	#	#	#	#	#	#	<.005
10/06/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
10/20/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005

ETHYLBENZENE

			GROUNDWATER TREATMENT PLANT						
				ETHYLBENZENE					
DATE	INFLUENT BEFORE FILTERING	INFLUENT AFTER FILTERING	REACTION CHAMBER STAGE 1	REACTION CHAMBER STAGE 2	REACTION CHAMBER STAGE 3	REACTION CHAMBER STAGE 4	REACTION CHAMBER STAGE 5	REACTION CHAMBER STAGE 6	EFFLUENT GRAB
	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L
05/06/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/13/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/20/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/27/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/03/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/24/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/15/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/22/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/29/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/05/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/12/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/19/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
10/28/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/04/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/18/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/25/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/16/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/03/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/10/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/17/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/23/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/17/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/24/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/31/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/07/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/14/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/21/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/28/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/05/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/12/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/19/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/26/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/11/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/18/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/25/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/08/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/15/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/22/89	<.005	<.005	<.005	<.005	<.005	#	#	#	<.005
09/29/89	#	#	#	#	#	#	#	#	<.005
10/06/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
10/20/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005

STYRENE

			GROUNDWATER TREATMENT PLANT						
					STYRENE				
DATE	INFLUENT BEFORE FILTERING	INFLUENT AFTER FILTERING	REACTION CHAMBER STAGE 1	REACTION CHAMBER STAGE 2	REACTION CHAMBER STAGE 3	REACTION CHAMBER STAGE 4	REACTION CHAMBER STAGE 5	REACTION CHAMBER STAGE 6	EFFLUENT GRAB
	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L
05/06/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/13/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/20/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/27/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/03/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/24/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/15/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/22/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/29/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/05/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/12/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/19/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
10/28/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/04/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/18/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/25/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/16/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/03/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/10/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/17/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/23/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/17/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/24/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/31/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/07/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/14/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/21/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/28/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/05/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/12/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/19/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/26/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/11/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/18/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/25/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/08/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/15/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/22/89	<.005	<.005	<.005	<.005	<.005	#	#	#	<.005
09/29/89	#	#	#	#	#	#	#	#	<.005
10/06/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
10/20/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005

XYLENE

			GROUNDWATER TREATMENT PLANT						
					XYLENE				
DATE	INFLUENT BEFORE FILTERING	INFLUENT AFTER FILTERING	REACTION CHAMBER STAGE 1	REACTION CHAMBER STAGE 2	REACTION CHAMBER STAGE 3	REACTION CHAMBER STAGE 4	REACTION CHAMBER STAGE 5	REACTION CHAMBER STAGE 6	EFFLUENT GRAB
	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L
05/06/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/13/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/20/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/27/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/03/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/24/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
06/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/15/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/22/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
07/29/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/05/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/12/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/19/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/30/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
10/28/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/04/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/18/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
11/25/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/02/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/10/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
12/16/88	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/03/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/10/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/17/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
02/23/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/17/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/24/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
03/31/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/07/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/14/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/21/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
04/28/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/05/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/12/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/19/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
05/26/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/11/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/18/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
08/25/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/08/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/15/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
09/22/89	<.005	<.005	<.005	<.005	<.005	#	#	#	<.005
09/29/89	#	#	#	#	#	#	#	#	<.005
10/06/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
10/20/89	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005

VINYL CHLORIDE

GROUNDWATER TREATMENT PLANT
VINYL CHLORIDE

DATE	INFLUENT BEFORE FILTERING MG/L	INFLUENT AFTER FILTERING MG/L	PERCENT REMOVAL BY FILTERING %	REACTION CHAMBER STAGE 1 MG/L	REACTION CHAMBER STAGE 2 MG/L	REACTION CHAMBER STAGE 3 MG/L	REACTION CHAMBER STAGE 4 MG/L	REACTION CHAMBER STAGE 5 MG/L	REACTION CHAMBER STAGE 6 MG/L	EFFLUENT GRAB MG/L
AVERAGE	0.042	0.041	3%	<.010	<.010	<.010	<.010	<.010	<.010	<.010
MAXIMUM	0.235	0.290	-23%	<.010	<.010	<.010	<.010	<.010	<.010	<.010
MINIMUM	0.010	0.010	0%	<.010	<.010	<.010	<.010	<.010	<.010	<.010
05/06/88	<.010	<.010		<.010	<.010	<.010	<.010	<.010	<.010	<.010
05/13/88	<.010	<.010		<.010	<.010	<.010	<.010	<.010	<.010	<.010
05/20/88	<.010	<.010		<.010	<.010	<.010	<.010	<.010	<.010	<.010
05/27/88	<.010	<.010		<.010	<.010	<.010	<.010	<.010	<.010	<.010
06/03/88	<.010	<.010		<.010	<.010	<.010	<.010	<.010	<.010	<.010
06/10/88	<.010	<.010		<.010	<.010	<.010	<.010	<.010	<.010	<.010
06/24/88	<.010	<.010		<.010	<.010	<.010	<.010	<.010	<.010	<.010
06/30/88	<.010	<.010		<.010	<.010	<.010	<.010	<.010	<.010	<.010
07/15/88	<.010	<.010		<.010	<.010	<.010	<.010	<.010	<.010	<.010
07/22/88	0.030	0.020	33%	<.010	<.010	<.010	<.010	<.010	<.010	<.010
07/29/88	0.038	0.039	-3%	<.010	<.010	<.010	<.010	<.010	<.010	<.010
08/05/88	0.046	0.031	33%	<.010	<.010	<.010	<.010	<.010	<.010	<.010
08/12/88	<.010	<.010		<.010	<.010	<.010	<.010	<.010	<.010	<.010
08/19/88	<.010	<.010		<.010	<.010	<.010	<.010	<.010	<.010	<.010
08/30/88	<.010	<.010		<.010	<.010	<.010	<.010	<.010	<.010	<.010
09/02/88	<.010	<.010		<.010	<.010	<.010	<.010	<.010	<.010	<.010
10/28/88	0.214	0.156	27%	<.010	<.010	<.010	<.010	<.010	<.010	<.010
11/04/88	0.053	0.043	19%	<.010	<.010	<.010	<.010	<.010	<.010	<.010
11/18/88	<.010	<.010		<.010	<.010	<.010	<.010	<.010	<.010	<.010
11/25/88	<.010	<.010		<.010	<.010	<.010	<.010	<.010	<.010	<.010
12/02/88	<.010	0.024		<.010	<.010	<.010	<.010	<.010	<.010	<.010
12/10/88	0.032	0.027	16%	0.010	<.010	<.010	<.010	<.010	<.010	<.010
12/16/88	0.037	0.024	35%	<.010	<.010	<.010	<.010	<.010	<.010	<.010
02/03/89	0.012	0.041	-242%	<.010	<.010	<.010	<.010	<.010	<.010	<.010
02/10/89	<.010	0.027		<.010	<.010	<.010	<.010	<.010	<.010	<.010
02/17/89	<.010	0.029		<.010	<.010	<.010	<.010	<.010	<.010	<.010
02/23/89	0.011	0.033	-200%	<.010	<.010	<.010	<.010	<.010	<.010	<.010
03/17/89	0.235	0.290	-23%	<.010	<.010	<.010	<.010	<.010	<.010	<.010
03/24/89	<.010	<.010		<.010	<.010	<.010	<.010	<.010	<.010	<.010
03/31/89	0.026	0.044	-69%	<.010	<.010	<.010	<.010	<.010	<.010	<.010
04/07/89	<.010	<.010		<.010	<.010	<.010	<.010	<.010	<.010	<.010
04/14/89	<.010	<.010		<.010	<.010	<.010	<.010	<.010	<.010	<.010
04/21/89	<.010	<.010		<.010	<.010	<.010	<.010	<.010	<.010	<.010
04/28/89	0.045	0.064	-42%	<.010	<.010	<.010	<.010	<.010	<.010	<.010
05/05/89	0.056	0.051	9%	<.010	<.010	<.010	<.010	<.010	<.010	<.010
05/12/89	0.156	0.113	28%	0.020	0.010	<.010	<.010	<.010	<.010	<.010
05/19/89	0.097	0.071	27%	0.010	<.010	<.010	<.010	<.010	<.010	<.010
05/26/89	0.080	0.063	21%	0.010	<.010	<.010	<.010	<.010	<.010	<.010
08/11/89	0.112	0.130	-16%	<.010	<.010	<.010	<.010	<.010	<.010	#####
08/18/89	<.010	<.010		<.010	<.010	<.010	<.010	<.010	<.010	#####
08/25/89	0.057	<.010		<.010	<.010	<.010	<.010	<.010	<.010	#####
09/08/89	0.145	0.029	80%	<.010	<.010	<.010	<.010	<.010	<.010	<.010
09/15/89	0.041	0.054	-32%	<.010	<.010	<.010	<.010	<.010	<.010	<.010
09/22/89	0.051	0.080	-57%	<.010	<.010	<.010	<.010	#	#	<.010
09/29/89	#	#		#	#	#	#	#	#	<.010
10/06/89	0.061	0.079	-30%	<.010	<.010	<.010	<.010	<.010	<.010	<.010
10/20/89	0.070	0.113	-61%	<.010	<.010	<.010	<.010	<.010	<.010	<.010

APPENDIX 3

EVALUATION OF THE TOTAL ORGANIC HALOGEN TEST

AN EVALUATION OF THE TOTAL ORGANIC HALOGEN TEST

NOVEMBER 1989

PREPARED BY

R. GUY RIEFLER, ENVIRONMENTAL SCIENCES DIVISION

INTRODUCTION

The government is continually devising new standardized tests for water quality assessment. These tests seem to be very well researched and documented, and are, therefore, very reliable. Tests are, however, just a tool for specialists to utilize. When used in the wrong context or interpreted incorrectly, a test is no longer reliable. This report will discuss a commonly used water test, the organic halogen test, detail the problems associated with it, and display the ease with which it can be misinterpreted.

PURPOSE OF THE ORGANIC HALOGEN TEST

The organic halogen test, TOX, is used to check for hazardous waste contamination in water samples. One of the problems associated with detecting hazardous waste is the number of chemicals that fill that category. Testing for each individual contaminant, although very accurate, is extremely time consuming and expensive. The TOX test was developed as a means to detect a broad range of contaminants, namely all haloginated organic material, in one trial. The TOX test is successful at achieving its intended purpose of screening for a large array of contaminants. By the nature of the test however, as expected with any broad, generic test, TOX is inappropriate for accurately quantifying the actual concentration of contaminants or defining what specific contaminants are present.

The TOX test is described in Standard Methods: For the Examination of Water and Wastewater. In it, five possible uses for TOX are identified:

> "TOX measurement is an inexpensive and useful method for screening large numbers of samples before specific (and often more complex) analysis; for extensive field surveying for pollution by certain classes of synthetic organic compounds in natural waters; for mapping the extent of organohalide contamination in groundwater; for monitoring the breakthrough of some synthetic organic compounds in water treatment processes; and for estimating the levels of formation of chlorinated organic by-products after disinfection with chlorine."

The test is simply a contamination detection device and should not be used for actual numeric data. "In general, a positive TOX test result indicates the need for identifying and quantifying specific substances."

DETAILED DESCRIPTION OF TOX

The TOX test can be dissected into four basic steps: adsorption of the organic material on activated carbon, removal of residual inorganics

on the carbon, burning the carbon to convert all the organics into CO_2 and HX, and then measuring the amount of HX released.

The first step can be performed by using either a microcolumn or batch adsorption. When using the microcolumn, start by adding HNO_3 to the sample to achieve a pH of 2. The amount of volatile organic halides present should be measured, because they will be lost in the following filtration. This can be done directly by use of a special devise. Filter the sample through a glassfiber filter using vacuum, along with a filtration blank and a standard. Send the sample through two granular activated carbon adsorption columns set up in series at a filtration rate of 3 mL/min. The amount of sample filtered should vary depending on an estimate of the halogen concentration in the sample.

Batch adsorption is also started by adding HNO_3 to the sample until a pH of 2 is reached. The amount of volatile organic halides are then determined directly with a special instrument. Next, prepare a carbon suspension by adding high-quality carbon to high-purity, deionized, carbon filtered water to a density of 10 mg carbon/mL. Add the prepurged sample and an additional 20 g carbon, and stir for 45 minutes in a high-speed mixer. Filter through a membrane filter under vacuum and save the filtrate. Add 20 mg more of carbon to the filtrate, stir in the high-speed mixer, and filter that also. When the test is complete, if the halide content of the filtrate is greater than 10% of the halide content of the original sample, then repeat the process again with the second filtrate.

At this point the granular activated carbon has adsorbed all the organic and inorganic halides. The inorganic halides will be removed through competitive displacement by nitrate ions (NO_3^-). Wash the carbon samples in a NO_3^- solution, so that the sample and solution are in contact for at least 15 minutes. This will strip the carbon of all the inorganic halides.

The third step involves exposing the organic halide so that it can be detected. This is done by introducing the granular activated carbon into a furnace and pyrolyzing it. All the organic halide will be transformed into carbon dioxide (CO_2) and hydrogen halide (HX).

The final step is to measure the amount of HX released from pyrolysis by using a microcoulometric detector. This device has two solid silver electrodes in a titration cell that maintains a constant concentration of silver-ions. An electric potential is applied to an electrode to produce silver ions in the cell solution. As hydrogen halide enters the cell in the carrier gas, it is partitioned into the acetic acid solution where it precipitates as silver halide. This produces a current that is integrated over the period of pyrolysis. The integrated area under the curve is proportional to the number of moles of halogen recovered.

PROBLEMS WITH TOX

Because of the nature of chemistry, any procedure has certain pitfalls and drawbacks. TOX, being such a broad test, has many problems with accuracy and precision. Several of the more commonly noticed problems will be explained next.

The first inherent problem with TOX is its reliance on carbon filtering. Apparently, granular activated carbon can vary greatly in composition and purity. Standard Methods states:

> "Nonhomogeneous carbon or carbon with a high background value affects the method reliability at low concentrations of TOX. A high and/or variable blank value raises the minimum detectable concentration. Random positive bias, in part due to the ease of carbon contamination during use, necessitates analyzing duplicate of each sample."

This shows that although TOX can still prove that organic halogens are present, it is not that reliable at determining what their concentration is. Standard Methods goes on to say: "Granular activated carbon used to concentrate organic material from the sample is a major source of variability in the analysis and it has a dramatic effect on the minimum detectable concentration."

There is also an unavoidable source of error in the microcoulometric detector. This detector is based on the chloride ion, so any other halide will produce skewed results. Standard Methods explains:

> "The mass concentration of organic halides is reported as an equivalent concentration of organically bound chloride in micrograms per liter. As a consequence of this conversion from moles of halide to mass concentration in terms of chloride, the accuracy of the method is a function of the particular halides present."

Again, this is unimportant if one is only trying to determine if there is any contamination, as the test was intended. However, this error becomes significant when quantifying actual concentrations.

Another possible source of error could occur if too much water was sampled. If the suspected concentrations of organic halogens is suspected to be low, the chemist may be tempted to filter a lot of water through the carbon. This is cautioned against in Standard Methods:

> "...avoid filtering volumes greater than 100 mL because the maximum adsorptive capacity of the GAC [granular activated carbon] may be exceeded, leading to carbon breakthrough and loss of TOX. Larger sample volumes filtered lead to an increased quantity of inorganic halide accumulated on the GAC and may result in a positive interference."

The final chief cause of inaccuracy in TOX is inorganic halide interference. TOX obtains its final result by measuring the amount of halogen recovered. Unfortunately, the halogens are found not only in the organic molecules, but also in inorganic molecules and directly in the water. These other halogens are theoretically screened out before the reading is taken, but inorganic halides can end up in the product anyway. This results in a measured TOX reading that is higher than what is actually present.

One inaccuracy from the halide interference can occur if there is chlorine in the sample. The chlorine can react with organic compounds adjusting the final results. Standard Methods suggests:

> "...if the water contains residual chlorine, reduce it before adsorption to eliminate positive interference resulting from continued chlorination reactions with organic compounds adsorbed on the GAC [granular activated carbon] surface or with the GAC surface itself."

Further positive interference can result from not obtaining a pH of 2 in the first step. "Failure to acidify samples with nitric acid may result in reduced adsorption efficiency for some halogenated organic compounds and may intensify the inorganic halide interference."

The biggest problem occurs from a high concentration of inorganic halides in the sample. The screening mechanism using nitrate ions is simply not reliable enough to handle appreciable levels of inorganics.

> "...if the inorganic halide concentration is greater than 20,000 times the concentration of organic halides the TOX results may be affected significantly. In general, this procedure may not be applicable to samples with inorganic halide concentrations above 500 mg Cl^-/L, based on carbon quality testing results. Therefor, consider both the results of mineral analysis for inorganic halides and the results of the carbon quality test when interpreting results."

It is apparent that inorganics can play a large role in offsetting numerical data. Both precision and accuracy could be sacrificed depending on which set of errors occur. Standard Methods warns: "The possibility of overestimating TOX concentration because of inorganic halide interference always should be considered when interpreting results."

APPENDIX 4

IRON AND MANGANESE PRETREATMENT SYSTEM EVALUATION

EVALUATION OF IRON AND MANGANESE REMOVAL ALTERNATIVES

FOR THE

DEPARTMENT OF ENERGY KANSAS CITY PLANT

Prepared By

Sidney B. Garland II
Environmental Sciences Division
Oak Ridge National Laboratory

October, 1989

EXECUTIVE SUMMARY

The Department of Energy (DOE) Kansas City Plant operates a groundwater treatment plant. for the removal of organics. However, the process also oxidizes inorganics, such as iron and manganese, which can precipitate in the reaction chamber and clog the diffusers. When additional groundwater plumes with higher iron and manganese concentrations are introduced to the treatment plant, pretreatment for iron and manganese removal may be necessary.

Iron and manganese are normally soluble in groundwater, but they are oxidized and become insoluble when the groundwater is brought to surface and exposed to oxygen. The rate of oxidation is dependent upon the oxidizing agent, pH, alkalinity, organic content, and catalysts.

Iron and manganese can be removed by oxidation and filtration, ion exchange, stabilization to prevent precipitation, and precipitation. The most appropriate technique at the DOE Kansas City Plant is oxidation with ozone followed by filtration. However, since the groundwater characteristics are going to change and design criteria are site-specific, it is recommended that a bench scale study be conducted to determine ozone dose, reaction and contact time, and filter characteristics. It also needs to be proven that the removal of iron and manganese will significantly improve operation of the treatment plant.

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INTRODUCTION

The Department of Energy (DOE) Kansas City Plant operates a groundwater treatment plant to remove organic contaminants, primarily trichloroethene, 1-2, dichloroethene, and vinyl chloride. The treatment process utilizes ozone, ultraviolet radiation, and hydrogen peroxide to oxidize the organics. However, in addition to oxidizing organics, the treatment process also oxidizes inorganics, such as iron and manganese, which can precipitate in the reactor and scale on the ultraviolet lights. In order to reduce the problems with iron and manganese, a pretreatment system was installed that uses ozone for oxidation and filtration for removal of iron and manganese.

When two additional contaminated groundwater plumes are pumped to the groundwater treatment plant, the flowrate is expected to be 25 to 30 gal/min with iron and manganese concentrations of 25 to 30 mg/l and 8 to 10 mg/l, respectively. Because of the increased flow and iron and manganese concentrations, an evaluation of alternatives to remove iron and manganese was conducted.

The remainder of this report presents background information on iron and manganese, evaluates alternatives for iron and manganese removal, and describes the recommended course of action.

The Appendix contains a list of vendors and consultants contacted as part of this evaluation.

BACKGROUND

PROBLEMS WITH IRON AND MANGANESE

The presence of iron and manganese in water supplies is objectionable for aesthetic and operational reasons. Iron and manganese can discolor water, stain plumbing fixtures and clothes, cause tea to turn black, and darken vegetables.

Iron and manganese stimulate the growth of microorganisms in water distribution systems which causes unpleasant taste and odor and can clog pipelines, meters, and valves. At concentrations greater than

several milligrams per liter, iron and manganese impact a metallic taste to water.

Iron and manganese also precipitate in pipelines and water treatment processes which can reduce the flowrates or interfere with the operations. This is what appears to be occurring at the DOE Kansas City Plant.

CHEMISTRY OF IRON AND MANGANESE

Iron and manganese are naturally-occurring constituents in groundwater caused by the solution of rocks and minerals. In groundwater iron and manganese typically exist as ferrous iron and manganous manganese which are the reduced, soluble forms. When the groundwater is brought to the surface, carbon dioxide and hydrogen sulfide are released, the pH is therefore raised, and exposure to oxygen creates an oxidizing environment. The reduced forms of iron and manganese then transform to stable, oxidized, insoluble forms. The rate of oxidation is dependent upon the oxidizing agent, pH, alkalinity, organic content, and catalysts.

Iron is normally expected to precipitate as a hydroxide following oxidation. However at alkalinity concentrations greater than 250 mg/l as $CaCo_3$, it may precipitate as a carbonate (O'Connor 1989; Cleasby 1975). Cleasby's (1975) work indicates that if iron is oxidized rapidly with strong oxidants, the precipitate will be a hydroxide; whereas, if the iron is oxidized slowly with aeration, the precipitate will be carbonate if the alkalinity is high. Organic materials in the water can complex with iron and slow down oxidation. Therefore, sufficient oxidation must occur to break the complex and oxidize the iron. Until the organic material is oxidized, the rate of iron oxidation may be inhibited, and the precipitate may be held in solution (AWWA 1971).

Manganese appears to precipitate as MnOOH rather than MnO_2, as commonly expected (Kessick and Morado 1975). Oxidation of manganese is complicated by a misunderstanding of reaction chemistry, slow reaction rates, numerous oxidation states, and organic complexes (James M. Montgomery 1985). The organic complexes must be broken, as for iron, before manganese can be oxidized.

Increased pH values increase the rate of iron and manganese oxidation. (Stumm and Lee 1961) report that for every pH unit increases the rate of iron oxidation increases 100 fold.

Based on the above discussion, it is clear that the proper oxidant at the correct pH is necessary for total oxidation. With other demands on the oxidant, sufficient oxidant must be used to meet the total demand with a little excess.

REMOVAL OF IRON AND MANGANESE

Iron and manganese removal is accomplished by four techniques--oxidation and filtration, ion exchange, stabilization to prevent oxidation and precipitation.

Oxidation. The most common technique used in the United States is oxidation by aeration followed by detention and filtration. However, since the most important factor in the oxidation of iron and manganese is that adequate oxidation occurs for complete removal, stronger oxidants, such as chlorine, chlorine dioxide, potassium permanganate, and ozone, are sometimes used, particularly for manganese.

The detention time required for complete oxidation is also very important and often is underestimated. For aeration systems oxidation of iron and manganese requires 5 to 60 min to form a filterable floc (James M. Montgomery 1985). If chlorine is used as the oxidant, 30 to 60 minutes contact time may be required (James M. Montgomery 1985). A survey of 32 plants in Illinois indicated that a primary design deficiency is inadequate reaction time and recommended that reaction time be determined for each site (AWWA 1971). Since ozone is already available at the DOE Kansas City groundwater treatment plant, and aeration will strip volatile organics, the only oxidation process to be considered further is ozonation.

Ion Exchange. Ion exchange is a common and effective means of removing iron and manganese from groundwater. However, it is generally used for groundwater with iron and manganese concentrations much lower than those at the DOE Kansas City Plant because the exchange resin is exhausted too quickly. Zeolite exchange media has been reported as inappropriate when iron and manganese concentrations exceed 0.5 mg/l (AWWA 1971). If dissolved oxygen in the groundwater oxidizes iron and manganese, the media can become fouled and coated (James M. Montgomery 1985). The exchange capacity can be restored by dissolving the iron and manganese precipitate, but this also reduces the life of the resin. This technique will not be considered for the DOE Kansas City Plant.

Stabilization. Stabilization involves the use ot polyphosphates to react with and hold the iron and manganese in solution. The advantage of this technique is not worrying about how to remove the iron and manganese. However, this technique is expensive (James M. Montgomery, 1985) and is not suitable when the iron and manganese concentration exceeds 1.0 mg/l (O' Connor 1969 and AWWA 1971). This process will no longer be considered for the DOE Kansas City Plant either.

Precipitation. Iron and manganese can be precipitated as carbonates by the addition of lime or soda ash. Ferrous and manganous carbonate precipitate almost completely at pH valves above 8 and 8.5, respectively; while ferrous and manganous hydroxides require the pH to be 11 (AWWA 1971). Precipitation is generally more expensive than other processes because of the high capital costs (James M. Montgomery 1985). Therefore, it is usually considered only if the water is to be softened anyway. This technique will not be considered any further for the DOE Kansas City Plant.

ALTERNATIVES

INTRODUCTION

Based on the previous discussion of the iron and manganese removal techniques, oxidation of iron and manganese with ozone followed by filtration is the most appropriate technique for use at the DOE Kansas City Plant. Another alternative that must be considered, however, is to do nothing. The following discussion addresses these two alternatives and then draws some conclusions.

OXIDATION WITH OZONE

Since the DOE Kansas City Plant already generates ozone for the treatment of groundwater, it is reasonable to continue using ozone for the pretreatment of the groundwater for iron and manganese removal. Since the iron and manganese are exerting an ozone demand anyway, no additional ozone will be required. If another method of pretreatment were used, then additional ozone would be available for the removal of organics. But this disadvantage is far outweighted by

the operational problems and costs associated with the introduction of a new technology.

The principles of iron and manganese removal are well established, but practice shows that reaction times and removal efficiencies are dependent upon the water and the oxidant. Experience with ozone as the oxidant in groundwater contaminated with organics is sparse. Since the organics can complex the iron and manganese, it is possible that iron and manganese cannot be oxidized until the demand exerted by the organics, as well as other inorganic constituents, is met. Therefore, it is recommended that bench scale tests and possibly pilot tests be conducted prior to design of a pretreatment system to determine ozone dose, reaction and contact time, filter media selection, filtration rates, and filter backwash rates and frequency.

Rather than treat the filter backwash water, it is recommended that the backwash water be discharged to the sewer. The backwash water should not cause any violation of the pretreatment standards, nor should it be a hazardous waste. During the bench scale and pilot scale studies, this should be confirmed.

A component of the bench scale study should evaluate the use of hydrogen peroxide as the oxidant. Hydrogen peroxide is already available at the treatment, is less expensive than ozone, and would reduce the demand on the ozone generator.

DO NOTHING

It is possible that pretreatment of the groundwater for the removal of iron and manganese is neither necessary nor has a value that is commensurate with the effort. Other than circumstantial evidence and opinions, there is no confirmation that iron and manganese precipitation is the primary causes for clogging of the diffusers or coating of the ultraviolet lights. In fact, experience with pilot plant operations shows that the coating of the ultraviolet lights can continue even without iron and manganese in the water (personal communication, Gary R. Peyton). Operating data from the treatment plant does not show much iron and manganes removal occurring.

As the new groundwater plumes are brought to the treatment plant, the flowrate, iron and manganese concentrations, and general groundwater characteristics will change, and it may be prudent to do nothing until experience with the new operating conditions can be gained.

CONCLUSIONS

It is recommended that nothing be done immediately until the impact of the existing filter be assessed and a bench scale study be completed on the new combined flow streams. When these are completed, the need for iron and manganese removal can be assessed, and the necessity of a pilot scale study can be determined.

REFERENCES

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Kessick M. A. and J. J. Morado, "Mechanisms of Autodation of Manganese in Aqueous Solution," ES&T, 9(2) (February 1975)

Montgomery, James M., Consulting Engineers, Inc. Water Treatment Principles and Design, John Wiley & Sons, New York (1985).

O'Connor, J. T., "Iron and Manganese Removal: Methods and Practice," Water Sewage Works, 116, R-68 (1969).

Stumm, W. and T. Lee, "Oxygenation of Ferrous Iron," Ind. Engr., Chem., 53 (1961).

APPENDIX
VENORS CONTACTED

Carus Chemical Co.
(815)233-1500
Fe & Mg removal

Chemply Div. of United Chemicals Inc.
(412)384-5353
Fe & Mg removal

Capital Controls
(215)822-2901
Ozonators

Culligan
(312)498-2000
ion-exchange equipment

Hungerford & Terry
(609)881-3200
ion-exchange equipment

Infilco Degrement
(804)756-7600
ion-exchange equipment

Ionics
(617)926-2500
ion-exchange equipment

Johnson-Microfloc
(612)636-3900
Filters

Sweetwater Technologies
(714) 472-6020

Technical Products Corp.
(804) 483-7374

Western Water Management
(816)842-0560

Roberts Filter
(215)583-3131
Filters

Walker Process Corp.
(312)892-7921)
Filters

Ozone Research & Equip. Corp.
(602)-272-2681
Ozonator

Griffin Technics, Inc.
201-778-2131
Ozonator

Henkel Corp. Emery Group
513-530-7705
Ozonator

C. M. Kazmier & Associates, Inc.
(404)-475-2242
Equipment & Design

Nalco Chemical
(312)961-9500

J. Thomas Kirk
Consultant
Iron&Manganese Removal

Olin Corp.
(203)356-2000
ozonatos

Stiles-Kam Div. of Met-Pro Corp.
(312)746-8334

APPENDIX 5

REVIEW OF SAMPLING PROGRAM FOR THE TREATMENT PLANT
APRIL 1989

OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

GRAND JUNCTION OFFICE
PO BOX 2567
GRAND JUNCTION COLORADO 81502

RECEIVED
APR 28 1989
ENVIRONMENTAL SERVICES
D-144

April 24, 1989

Roma Jenkins
Senior Environmental Protection Specialist
Allied-Signal Corporation
Bendix Kansas City Division
2000 E. 95th Street
Kansas City, Missouri 64141

Dear Roma:

Review of Sampling Program of the UV/Ozone System

I have several comments concerning the sampling at the UV/ozone system.

1. The valves used to collect the IBF and Effluent samples are too restricted. Thus, the sample stream is so turbulent that the sample actually foams when collected. This severely compromises samples for volatiles. I also observed that the sampler did not immediately fill the volatiles vial. Meanwhile, the sample still appeared to be degassing because of the turbulence with which it was collected. When I questioned the sampler, he said that he usually filled the volatile vial first and had forgotten this time.

I believe these items explain the variable results obtained for volatiles for the IBF and the Effluent.

The IBF sample is collected by mixing equal volumes of sample collected from each of the three pump lines. Again, this mixing step will cause loss of volatiles.

Recommendation: New valves are needed such that the sample can be collected without turbulence.

2. The valves on the individual sections of the ozone tank do permit collection of a good volatiles sample. The flow is slow and steady and sample can be poured directly into the volatiles vial. However, these valves are made of brass and they are badly and variably corroded. This corrosion explains the variable and increasing results for some of the metals.

Recommendation: Replace all the sampling valves and associated lines with non-corrosive materials either PVC or stainless steel.

Please call if you have any questions.

Sincerely,

Nic Korte /kah

Nic Korte
Chemical Projects Manager

NEK/kah

cc: T. A. Cronk
S. B. Garland

APPENDIX 6

REVISED STUDY PLAN FOR FY 1990

STUDY PLAN FOR FISCAL YEAR 1990 FOR THE ULTRAVIOLET RADIATION, OZONE, AND HYDROGEN PEROXIDES GROUNDWATER TREATMENT PLANT EVALUATION AT THE DEPARTMENT OF ENERGY KANSAS CITY PLANT

PREPARED BY

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OAK RIDGE, TENNESSEE

SEPTEMBER 1989

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I. PURPOSE

The purposes of this evaluation are to:

- determine the operation and maintenance costs of the technology,
- compare the capital, operation, and maintenance costs with other technologies,
- evaluate contaminant removal mechanisms,
- develop design criteria,
- assist in optimizing the operation of the process, and
- verify that the existing treatment plant can handle all three of the contaminated groundwater plumes.

II. OPERATING PHASES

Operation of the ultraviolet (UV) radiation/ozone (O_3)/hydrogen peroxide (H_2O_2) groundwater treatment plant has taken place in several phases. Phase 1 was the start-up and commissioning performed by and for the vendor to insure that the treatment plant worked. The second operational phase was the batch operation necessary to demonstrate that the plant met its discharge standards. Treated water from the plant was not discharged to the community sanitary sewer until this was demonstrated. When the ability of the treatment plant to meet the discharge standards was demonstrated, then Phase 3 of the operation started. During this phase the plant was operated continuously at a flowrate of approximately 6 gallons per minute (gpm).

Phase 4 will occur in fiscal year 1990 when the flowrate is increased by the addition of one or two additional groundwater plumes. At this time the study will be oriented toward determining the appropriate operating parameters. Also, the plant capacity study will be redone to verify the predictions.

III. EVALUATION PLAN

A. Introduction

In order to evaluate the performance of the groundwater treatment plant and achieve the objectives stated above, a plan for sampling and analysis, data collection, and data interpretation is necessary. Therefore, the following evaluation plan will be discussed in terms of sampling data, operations and maintenance experience, and design and construction information.

B. Sampling Data

A comprehensive monitoring plan showing the parameters to be monitored, the frequency of sampling, and the location of sampling is contained in Table I. The thrust of the monitoring during fiscal year 1990 will switch from compliance with standards to optimization of the operation, verification of the plant capacity, and development of design criteria.

As the monitoring is taking place, and the results are analyzed, then the above sampling schedule may change to reflect what is found. Also, some additional analyses may be needed to determine the degradation products of the treatment process.

Quality control of the sample collection, handling, transportation, and analysis is critical to the reliability of the results and their interpretation. Therefore, the quality control plan of the laboratory should be provided to the evaluator.

C. Operations and Maintenance

Emphasis should be placed on maintaining a record of operations and maintenance expenses and time and an operations log. The operations log should be a checklist of what is to be done each day during the operator's visit, should document the amount of time spent and any special maintenance performed, and should record any observations made, e.g., the color of the water, the amount of foaming, and the amount of scaling on the UV lights.

The monthly operations report also should contain the gas flow rate, the percentage of O_3 in the gas, the amount of H_2O_2 used, the number and location of UV lights used, the duration and reasons for any downtime, and any other unusual happenings.

D. Design and Construction

The cost associated with any design and construction associated with the groundwater treatment plant needs to be reported so that they can be factored into the cost of this type of treatment.

IV. PROJECT DURATION

An annual report will be issued that will summarize the findings through September 1990, and will make recommendations and conclusions based upon those findings. Subsequent operational evaluation may be performed if deemed necessary.

V. PROJECT MANAGEMENT

Sidney B. Garland II is the Principal Investigator for this project, and Nic Korte will be the Project Manager. The primary point of contact with the DOE Kansas City Plant is Scott White. Gary Reyton will advise as a subcontractor to ORNL.

Table I. Comprehensive monitoring plan, FY 1990

Frequency	Parameter	Location[a]
Continuous	pH	EFF
	Flow	I
	Gas flow rate	Ozone generator and each reactor stage with rotameters
	Pressure	Ozone generator
	Hydrogen peroxide dose rate	Hydrogen peroxide pump
Daily	BOD[b]	EFF
	TSS[b]	E
Weekly	Iron	IBF, IAF, IASF, EFF
	Ferrous ion	IBF, IAF, IASF, EFF
	Manganous ion	IBF, IAF, IASF, EFF
	Manganese	IBF, IAF, IASF, EFF
	TOX[b]	IBF, IAF, IASF, ST, EFF
	Priority volatile pollutants[c]	IBF, EFF, IASF, ST
	TOC[b]	IBF, IAF, IASF, ST, EFF
Monthly	Cadmium	IBF, EFF
	Chromium	IBF, EFF
	Copper	IBF, EFF
	Lead	IBF, EFF
	Nickel	IBF, EFF
	Zinc	IBF, EFF
	Boron	IBF, EFF
	Arsenic	IBF, EFF
	Oil and grease	IBF, EFF
	Total cyanide	IBF, EFF
	Hydrogen peroxide	IAF, IASF (before H_2O_2 injection), IASF (before reactor but after H_2O_2 injection), ST
	Carbonate alkalinity	IASF, EFF
	Bicarbonate alkalinity	IASF, EFF
	TSS[b]	IBF, IAF, IASF, EFF
	Sulfides	IBF, EFF
	Ozone	IAF, IASF, ST, FG, OG
Quarterly[d]	Particulates	Both filters
	Sediment	Reaction chamber

[a]IBF = influent before the in-line filter; IAF = influent after the in-line filter; IASF = influent after second filter for removal of iron and manganese; EFF = effluent from ozone reaction tank; ST = six sample taps on ozone reaction tank; OG = off-gas; and FG = feed gas from ozone generator to reactor.

[b]BOD = biochemical oxygen demand; TSS = total suspended solids; TOX = total chlorinated hydrocarbons; and TOC = total organic carbon.

[c]The following volatile organic compounds will be analyzed: chloroform, 1,1-dichloroethene, 1,1-dichloroethane, 1,2-dichloroethene, tetrachloroethene, 1,1,1-trichloroethane, trichloroethene, and vinyl chloride.

[d]These analyses will be performed quarterly if possible. Sediments in the reaction chamber should be sampled whenever the plant is not operating.

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