THIRD ANNUAL REPORT ON OPERATIONS OF RUSSELL COUNTY REGIONAL TREATMENT PLANT AND ASSOCIATED ENVIRONMENTAL MONITORING

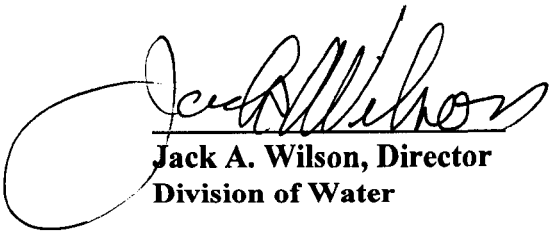
Natural Resources and
Environmental Protection Cabinet
Division of Water

December 1996

Third Annual Report on Operations of Russell County Regional Wastewater Treatment Plant and Associated Environmental Monitoring May 1995 - May 1996

Kentucky Department for Environmental Protection
Division of Water
Water Quality Branch

This report has been approved for release:



Jack A. Wilson, Director
Division of Water

Dec, 12, 1996
Date

This report was printed with state funds on re-cycled paper.

TABLE OF CONTENTS

List of Tables and Figures

EXECUTIVE SUMMARY

The third year of operation of the Russell County Regional Wastewater Treatment Plant following an expansion and upgrade of treatment facilities and relocation of the discharge to the main body of Lake Cumberland in April 1993 was marked by compliance with all regulatory requirements and no demonstratable impacts to the environment detected by water quality, sediment quality, and biological monitoring conducted by the Town of Jamestown and the Division of Water. Operations at the treatment plant were rated satisfactory by the Division in several compliance inspections, and all discharge monitoring data submitted by Jamestown to the Division, including those for copper, chloride, and whole effllluent toxicity, were less than permit limits. In fact, final effluent concentrations of chloride, copper, and toxicity were generally lower than in the previous two years.

Sampling in 1995 by Jamestown and the Division during worst-case conditions for effluent mixing, the thermally stratified conditions of late summer and early fall, indicated that pollutant concentrations were low and that the effluent remains well below the surface. These plume surveys detected chloride at concentrations between 20 - 30 mg/l in a layer usually less than one meter thick at distances of almost 1000 feet out from the diffuser, lower than in previous sampling efforts. The levels of chlorides were substantially less than the chronic criterion of 600 mg/l listed in Kentucky's Water Quality Standards. Near-field samples were taken for the second consecutive year by both the Division and Jamestown by means of divers. Samples were collected directly out of the pipe and at 7 feet (edge of the zone of initial dilution or ZID) to compare field results to earlier modeling predictions from which several permit limits were derived. Chloride concentrations in the 7-foot samples were again highly variable, ranging from 3 to 332 mg/l, probably because of the turbulent nature of the plume at close proximity to the discharge ports. These concentrations were much less than Kentucky's acute aquatic life chloride criterion of 1200 mg/l that is applicable at the edge of the ZID. Chloride samples taken from the edge of the mixing zone (70 ft) ranged from 3 to 30 mg/l. Upstream control station concentrations ranged from less than 3 to 6 mg/l. Total recoverable copper concentrations were less than 0.010 mg/l at the water quality monitoring sites, including the mixing zone, except in several samples obtained by Jamestown, mostly in November 1995. The chronic copper criterion of 0.010 mg/l and acute criterion of 0.014 mg/l were often exceeded in the November samples, when levels as high as 0.013 and 0.022 mg/l were found at the edge of the mixing zone and at the edge of the ZID, respectively. These results do not reflect the dilution indicated by chloride samples and no other copper data from this or previous years' reports exceeded criteria.

Samples collected during thermally unstratified conditions of February 1996 again did not detect any increase in chlorides outside the mixing zone. Concentrations within the mixing zone were also much lower than during stratified conditions. These results were not surprising because the lack of density differences in the receiving water allows more complete mixing of the effluent.

Although copper concentrations in sediment samples collected in May and August 1995 were slightly higher than in the previous two years, there were no significant differences between samples collected upstream and downstream of the diffuser. In fact, slightly higher levels were found at the control station location about one mile up-lake of the diffuser as compared to samples taken in the area of the diffuser. Therefore, effects on sediments from the diffuser appear to be negligible.

Fish tissue results were similar to previous years in that no differences were detected in pollutant concentrations from fish taken five miles above and those collected in the area of and downstream of the diffuser. Mercury was again detected in fairly high concentrations in several fish but, as in previous years, the higher concentrations were as likely to be found in fish taken from the control site five miles upstream of the diffuser as from the area around the diffuser. Therefore, Jamestown's effluent is not the cause of the elevated mercury concentrations found in the lake's fish.

Studies by the Division did not detect any appreciable differences in nutrient levels or phytoplankton biomass downstream of the diffuser compared to an upstream control station. Zooplankton densities in the area of the diffuser were significantly higher than at either the upstream control or downstream stations, but species richness was not affected. Further decreases of nutrients and biomass in the Lily Creek embayment, which previously received the effluent via Lily Creek, were also found in the 1995 growing season.

Division biologists surveyed Lily Creek upstream of the lake in June 1995 to assess changes since the discharge was relocated to the lake. While quantitative results are not yet available, it was evident that a greater diversity of macroinvertebrates was present.

INTRODUCTION

The Russell County Regional Wastewater Treatment Plant (RCRWWTP), operated by the City of Jamestown, was issued a Kentucky Pollutant Discharge Elimination System (KPDES) permit in October 1989 by the Kentucky Department for Environmental Protection (DEP), Division of Water (Division). The permit contained limits for typical components of sanitary wastewater and several constituents found in the large contribution from Union Underwear (Table 1). The limits applied to a discharge from a submerged multiport diffuser in the main body of Lake Cumberland. Final permit limits were to have taken effect on June 1, 1992. This date was required by Section 304(l) of the Clean Water Act following the Division's decision to place Lily Creek on the list of streams not meeting a water quality standard for a priority pollutant (copper) from a point source discharge (RCRWWTP). Until June 1, 1992, the plant was to continue discharging to Lily Creek about three miles above the lake, the same location at which it had discharged since 1981 (Figure 1).

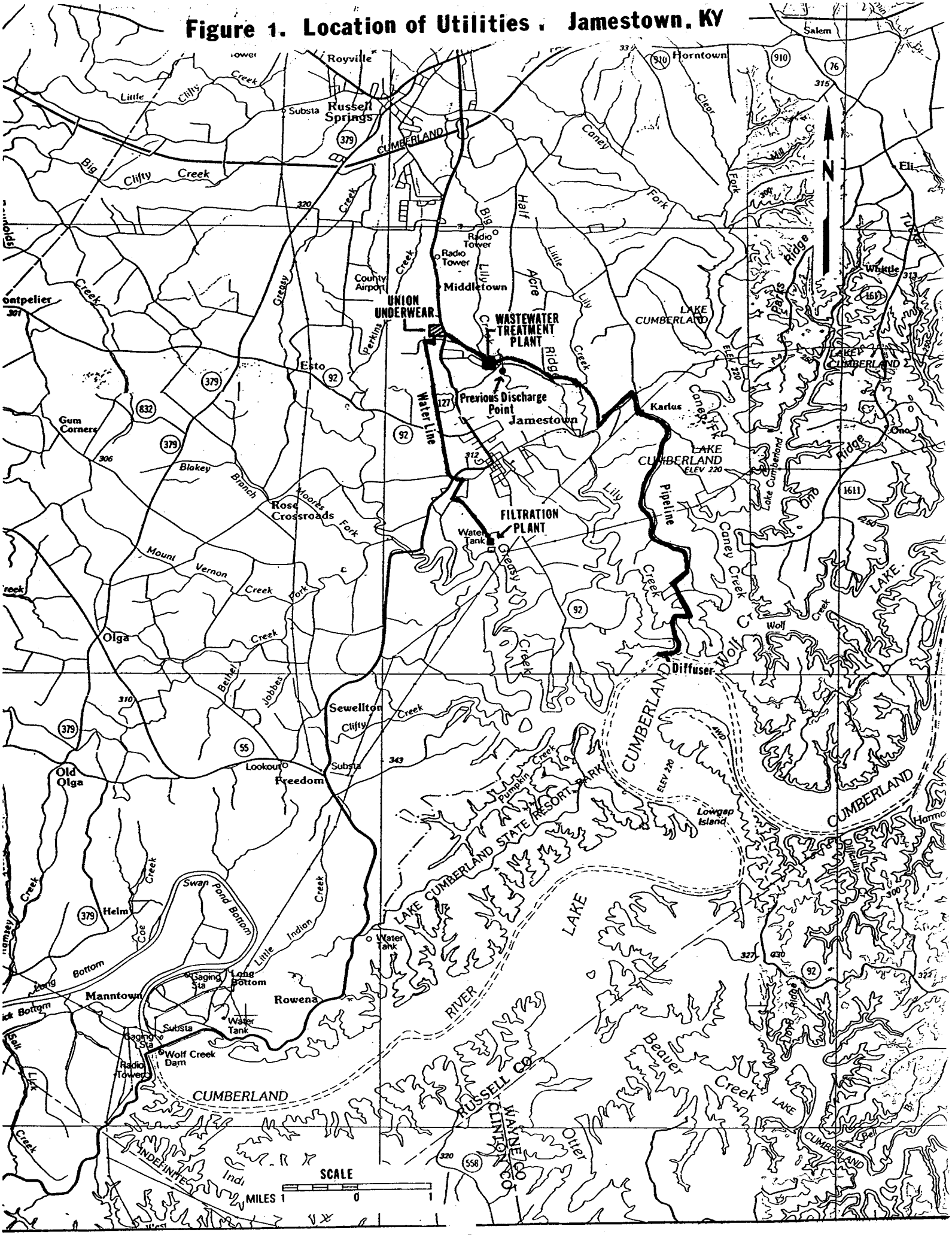
The change in location of the discharge was brought about because water quality criteria for chloride, copper, and several other constituents became effective after Jamestown's previous permit was issued in 1982. The RCRWWTP could not meet the revised chronic aquatic life criteria for chloride, copper, or whole effluent toxicity because no dilution was available in Lily Creek during low flow conditions. Because of the cost and technical difficulty of removing salt from the wastewater, the RCRWWTP applied for a permit to discharge into the main body of Lake Cumberland, taking advantage of the large volume of dilution water available.

The Lake Cumberland Trust, a coalition of environmental organizations, appealed the permit, and the issue was placed before a Natural Resources and Environmental Protection Cabinet hearing officer in 1991. After lengthy testimony, the hearing officer recommended to the cabinet Secretary that the copper limit be re-evaluated by the Division. The hearing officer's final opinion also stated that no significant testimony was presented indicating that the chloride allowed in the final permit would in any way degrade the water quality of the lake. An Agreed Order was signed in January 1992 that placed the issue in the hands of a Technical Advisory Committee (TAC) made up of two members of the Lake Cumberland Trust, one member each from the Town of Jamestown and Union Underwear, and the Assistant Director of the Division. In February, a consent decree was issued by the Franklin Circuit Court that incorporated the Agreed Order by reference and dismissed Jamestown and Union Underwear. Claims against the cabinet and hearing officer were reserved based on certain stipulated legal issues. After a year of extensive work, the TAC concluded that the final permit as initially issued by the Division was the proper course of action. This decision was based on evaluations of alternative treatment technologies, engineering reliability, costs, pollution prevention measures, and environmental considerations. It was noted that progress had been made toward improving effluent quality, especially copper and color. Other recommendations were that the Division prepare at least three annual reports and that Union Underwear continue waste minimization efforts. The TAC report was accepted by the Division, and the Secretary issued an order in February 1993 that the permit become effective with conditions as recommended by the TAC. Because of the time involved for the assessment by the TAC, the effective date of the final permit was delayed one year until June 1, 1993.

Table 1. Final Permit Limits [a]			
Constituent	**Monthly Average**	**Weekly Average**	**Sampling Frequency**
CBOD - 5[b]	30	45	Weekly
Ammonia - nitrogen	4[c]-11[d]	6[c]/16.5[d]	Weekly
Dissolved Oxygen	Not less than 7	Not less than 7	Weekly
Total Suspended Solids	30	45	Weekly
Color (ADMI Units)	100	100[e]	4/Day
pH (Standard Units)	6-9	6-9	Daily
Total Residual Chlorine	0.010	0.019[e]	4/Day
Fecal Coliform Bacteria (Colonies/100 ml)	200	400	Weekly
Chloride	2531	5062[e]	Daily
Copper	0.176	0.176[e]	Weekly
Toxicity (Acute Toxicity Units)		4.8	Quarterly

a = mg/l unless noted otherwise
b = Five day carbonaceous biochemical oxygen demand
c = May - October
d = November - April
e = Daily maximum

Figure 1. Location of Utilities, Jamestown, KY



Discharge through the pipeline began on April 2, 1993, and the system operated without problems until a break in the pipeline occurred on October 22, 1993. Evidence indicated that air was drawn into the pipeline, causing the pipe to flex and eventually break. The submerged portion of the pipeline was refitted with additional weights and an air trap and 8-inch vent line to ensure that any air in the pipe would be vacated. Treated wastewater was discharged at the former discharge location on the free-flowing reaches of Lily Creek for nearly four months. Union Underwear reduced dyeing operations during this time period to minimize impact to Lily Creek. The plant resumed discharge to the main lake through the diffuser on February 15, 1994, and the pipeline and diffuser have operated without problems since that time.

Environmental monitoring and plant operations from March 1993 through April 1995 were presented in the first two annual reports (Kentucky Division of Water, 1995, 1994a). This report covers the period of May 1995 to May 1996, the third year of operation following the plant upgrade and relocation of the discharge to the main lake.

RUSSELL COUNTY REGIONAL WASTEWATER TREATMENT PLANT

Description of Treatment Facilities and Pipeline

The RCRWWTP upgrade and expansion was completed in the summer of 1992, well before the effective date of the final permit and relocation of the discharge to the main lake. A decolorization/ dechlorination basin (where chlorine is added to remove color and sulfur dioxide is then added to remove excess chlorine), a new chemical feed building, additional aeration equipment in the biological treatment (carrousel) units, floating aerators to increase dissolved oxygen in the effluent, an effluent pump station, two belt filter presses for sludge dewatering, a backup power generator, and a new operations and laboratory building were constructed (Figure 2). The new basins allowed one of the four existing biological treatment units that had been used for chlorination and decolorization to be returned to biological treatment. The effect of this construction was to increase the hydraulic capacity from 2.5 to 3.6 million gallons per day (mgd) and the retention time from 30 to 38 hours when all basins are in use.

The 24-inch pipeline was completed in the spring of 1991 but was not put into operation for two years. It follows road right-of-ways for much of its length before entering the lake near the mouth of the Lily Creek embayment (Figure 1). The pipeline then crosses the embayment and terminates in a 300-foot multiport diffuser in the main lake. The diffuser lies on the steeply sloping lake bottom and angles out slightly into the lake at an elevation of 650 feet MSL on the upstream end and 620 feet MSL on the downstream end. At normal pool elevation of 723 feet MSL, the diffuser is 73 to 103 feet deep and lies less than 100 feet horizontally from the shoreline. During the late summer and fall, the depth is usually reduced by 30 - 40 feet as the lake is gradually drawn to generate hydro-electricity. Sixteen 2-inch diameter ports spaced at 20-foot intervals distribute the wastewater in both horizontal and vertical dimensions. Following repair of the pipeline in the winter of 1994, an 8-inch vent line was added where the pipeline enters the lake to release any accumulated air (Figure 3).

Influent from Industrial Sources

Jamestown is required to have a pretreatment program approved by the Division because industrial wastewaters are discharged into the sanitary sewer system. Industries in the pretreatment program are Union Underwear, Garment Finishers, and, within the past year, Tri-K Landfill.

During the past year, Jamestown performed a re-evaluation of its local pretreatment limits. The re-evaluation demonstrated that the existing local limits were affording adequate protection, provided that Union Underwear continues its practice of adding polymer to its discharge in order to enhance metals removal. The re-evaluation was approved by the Division in November 1995.

Union Underwear, a subsidiary of Fruit of the Loom, has a textile facility in Russell County with manufacturing, bleaching, dyeing, and sewing operations. The facility employs more than 3000 persons and supplies other Fruit of the Loom plants in the state with colored fabric. The plant has

Figure 2. Schematic of Wastewater Flow (1993)
Russell County Regional Wastewater Treatment Plant
Jamestown, Kentucky
(Prepared by Kenvirons, Inc.)

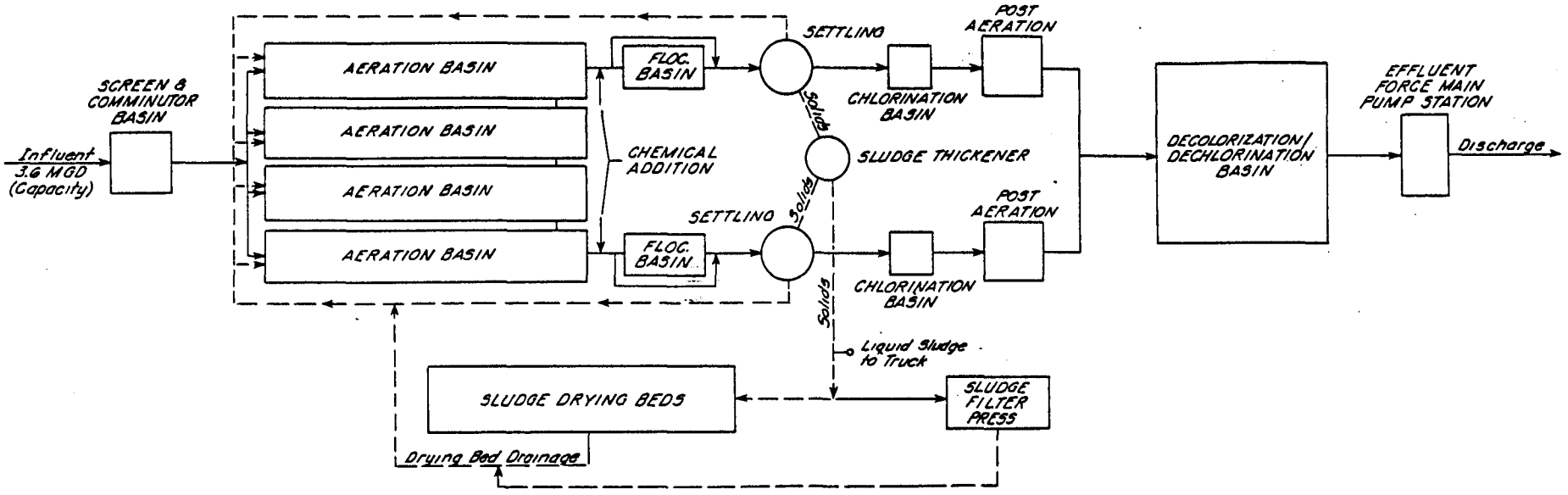
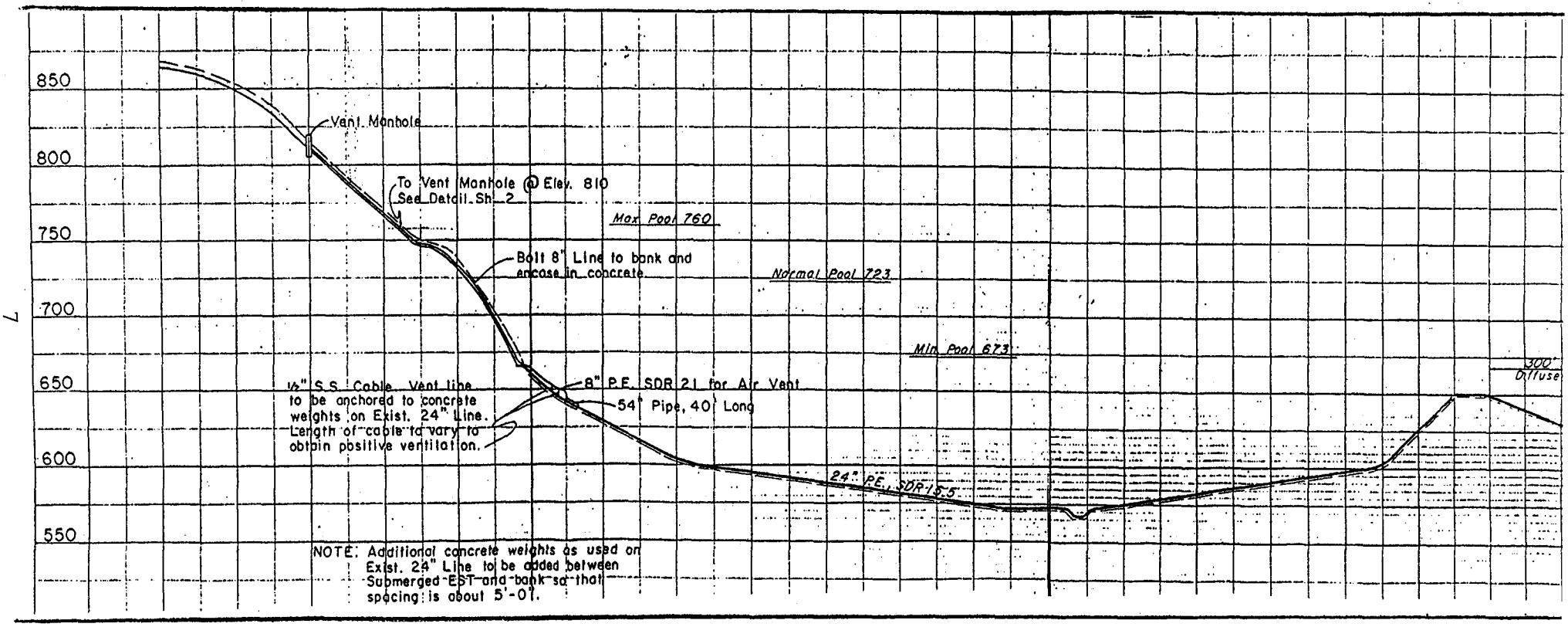


Figure 3. Jamestown Effluent Force Main Modifications
Air Vent Manhole and Pipeline Prepared by:
Kenvirons, Inc.



been in operation since 1981, when the RCRWWTP was constructed at its present location to handle the large volume of wastewater from Union Underwear. As in similar facilities worldwide, the dyeing operations use large amounts of salt (sodium chloride) to fix dyes in fabric. The salt then becomes a component of the wastewater, from which it is difficult and costly to remove. Copper, a component of several of the azo-dyes, is also found in the wastewater in moderately high amounts. However, the copper is tightly bound within the dye molecule and generally not bioavailable to exert toxic effects on aquatic organisms.

Expansion of the Union Underwear facility took place in 1987-88. Influent to the RCRWWTP increased from 1.5 to 2.0 mgd. Average salt use was expected to increase to about 35 tons per day, but the installation of several high-pressure dye pads and careful selection and use of dyes that require lower amounts of salt has lowered average salt use to about 15 tons per day. This continues the declining trend in the use of salt from an average of more than 20 tons per day in 1993-94 to about 18 tons per day in 1994-95. Union Underwear continues to explore alternative dyes and dyeing methods to further reduce the use of salt in the dyeing process. The addition of polymers to Union Underwear's wastewater beginning early in 1993 resulted in much lower levels of total copper passed on to the RCRWWTP. Through operational improvements, chlorine use has also been substantially reduced, with a corresponding reduction in the use of sulfur dioxide required for dechlorination.

Garment Finishers, a jean washing facility, generates about 0.03 mgd of wastewater. It has not experienced problems with solids and color typical of this type of facility because of the recent innovation of using enzyme solution instead of stone washing to fade jeans.

Tri-K Landfill entered the pretreatment program in the second half of 1995. However, they have not yet contributed any wastewater (leachate) to the RCRWWTP because they also are permitted to haul leachate to either the Stanford or Lebanon publicly owned treatment works.

Monitoring and Inspections

The RCRWWTP is required to conduct regular sampling of constituents listed in Table 1. Results are submitted monthly to the Division in discharge monitoring reports (DMRs). Semiannual compliance sampling inspections (CSIs) and periodic compliance evaluation inspections (CEIs) are also performed by Division regional office personnel. Biomonitoring results are obtained by personnel of the Division's Bioassay Section in conjunction with the CSIs.

Pretreatment audits or inspections are performed by personnel from the Division's KPDES Branch on an annual basis to determine compliance with the program. Pretreatment reports are also submitted semiannually by Jamestown to the Division's Pretreatment Section. A more intensive characterization of the influent and effluent is performed annually and reported by Jamestown in one of the semiannual reports.

Results. The DMR data from May 1995 through May 1996 are shown in Table 2. In no instances were permit limits exceeded. Monthly average concentrations ranged from 689 - 1385 mg/l for

chloride and 46 - 84 ADMI units for color. Daily maximum copper concentrations ranged from 0.02 to 0.11 mg/l; the average copper concentration was less than 0.03 mg/l for the year. All test results for whole effluent toxicity were less than the permit limit of 4.8 acute toxicity units, and all total residual chlorine data were less than 0.010 mg/l. Chloride and copper concentrations were generally lower for the 12-month period covered by this report compared to the previous two twelve month periods assessed in the first two annual reports.

Inspections by Division personnel have found the plant to be operating satisfactorily. CSIs were performed in May and December 1995 (Appendix A). Biomonitoring results obtained in May 1995 and May 1996 showed toxicity well below the permit limit (Appendix A). In fact, samples of 100 percent effluent did not cause acute toxicity to either test species. CEIs conducted in November 1995 and January, February, and May 1996 also gave satisfactory ratings.

The annual toxics scan of influent and effluent wastewater, performed in December 1995, showed an unacceptable level of lead (0.65 mg/l compared to the city's pretreatment limit of 0.104 mg/l). However, the laboratory performing the analysis reported some matrix interference, and follow-up sampling was well below the pretreatment limit.

A Pretreatment Compliance Inspection conducted by the Division in November 1995 (Appendix A) and two pretreatment semi-annual reports submitted by Jamestown showed that the RCRWWTP has continued to meet the requirements of all federal and state pretreatment requirements over the past year. The city has performed annual industrial user inspections as well as semiannual compliance monitoring at Union Underwear and Garment Finishers. The industrial contributors achieved consistent compliance with their discharge limitations with the exception of one copper violation by Garment Finishers.

Table 2. Discharge Monitoring Report Data, May 1995-May 1996

	Flow (mgd)	Total Residual Chlorine (mg/l)		Chloride (mg/l)		Ammonia-N (mg/l)		Copper (mg/l)		CBOD-5 (mg/l)		Fecal Coliform Bacteria (#/100ml)		Color (ADMI Units)	Toxicity (Tu_a)	Dissolved Oxygen (mg/l)	pH (Std. Units)	
Date	Mo. Ave.	Mo. Ave.	Daily Max.	Mo. Ave.	Daily Max.	Mo. Ave.	Wk. Ave.	Mo. Ave.	Daily Max.	Mo. Ave.	Wk. Ave.	Mo. Ave.	Wk. Ave.	Daily Max.	Max.	Min.	Min.	Max.
5/95	2.3	<0.01	<0.01	1123	1700	0	0	0.03	0.04	6	8	3	5	81		7.6	6.6	8.1
6/95	2.0	<0.01	<0.01	1090	1500	0	0	0.03	0.05	8	13	30	114	66	<4.8	7.4	6.5	8.1
7/95	1.3	<0.01	<0.01	1011	1750	0	0	0.03	0.04	8	17	13	47	81		7.0	6.9	8.0
8/95	2.2	<0.01	<0.01	1385	1700	0	0	0.03	0.03	6	7	21	37	71		7.1	7.1	8.3
9/95	1.7	<0.01	<0.01	1051	1350	0	0	0.02	0.03	6	6	10	41	64	<4.8	7.2	6.8	7.8
10/95	1.7	<0.01	<0.01	1057	1600	0	0	0.02	0.03	6	7	4	14	68		7.1	6.5	7.6
11/95	1.8	<0.01	<0.01	964	1300	0	0	0.04	0.11	6	11	2	6	48		7.9	6.3	7.6
12/95	1.2	<0.01	<0.01	918	1700	0	0	0.02	0.02	9	14	0	2	84	<4.8	9.0	6.8	7.9
1/96	2.2	<0.01	<0.01	689	1250	0.06	0.22	0.01	0.02	8	13	0.3	2	47		8.2	6.5	7.6
2/96	2.2	<0.01	<0.01	1145	1750	4	7	0.02	0.02	6	12	1	3	46		8.1	6.3	7.6
3/96	2.7	<0.01	<0.01	1137	1500	0.1	0.45	0.03	0.04	5	7	0	0	77	<4.8	7.7	6.3	7.8
4/96	2.3	<0.01	<0.01	1089	1450	0	0.01	0.03	0.03	7	7	0	0	69		7.3	6.5	7.9
5/96	2.5	<0.01	<0.01	1219	1900	0	0	0.03	0.04	6	7	1.8	3	76		7.1	7.2	8.5

ENVIRONMENTAL MONITORING

Lily Creek

The free-flowing portion of Lily Creek was sampled in March 1993 just before relocation of the outfall. Severe impacts to the creek were observed and discussed in the first annual report (Kentucky Division of Water, 1994a). Another survey was to have taken place in the spring of 1994 to document anticipated recovery of the creek after the outfall was relocated to the main body of the lake, but the pipeline break and discharge to Lily Creek at the old discharge location from October 1993 to February 1994 caused a postponement of that survey. The survey finally was made in June 1995 by Division biologists after two attempts were canceled earlier in the spring because of heavy rains. Quantitative results are not yet available, but it was evident to the field investigators that a greater diversity of macroinvertebrates was present as compared to the March 1993 survey.

Lake Cumberland

Water Quality

Monitoring of the lake environment was a condition of the final permit. A study plan was submitted by Jamestown and approved by the Division prior to relocation of the outfall. The study plan was revised in September 1994 based on the experience and findings of the first year of sampling. The original study plan called for quarterly water, sediment, and fish tissue samples to be collected by Jamestown at an upstream control station and several downstream stations and for the biological community to be assessed in the vicinity of the discharge. Background conditions prior to the discharge relocation to the lake were also assessed. The revised study plan reduced fish tissue and sediment sampling to semiannually, phytoplankton sampling was deleted because the first year's sampling turned up mostly dead cells descending from the photic zone, and water quality sampling in the near- and far-field areas was re-evaluated. It was agreed that the 7-foot edge-of-ZID samples can be accurately collected only by SCUBA diving and that diving is practical only in the late summer and fall when the most favorable lake conditions are present (i.e. lower lake levels and better visibility). Also, far-field plume work was performed quarterly for the second consecutive year by Jamestown.

The Division continued its independent assessment of environmental conditions by sampling in the near-field zone in late summer and early fall and in the far-field zone in late summer. Thermally stratified conditions found during these times represent the worst-case scenario for mixing of the effluent.

Model Verification. The first (upstream), middle, and last (downstream) ports of the 300-foot long diffuser were sampled in 1995 by Jamestown in August and November and by the Division in August and October. Different methods have been employed by the Division and Jamestown in the two years in which this sampling has been done. Jamestown used a water hose held in the sampling locations by a diver and pumped samples to the surface; the Division filled rigid plastic bottles underwater. Daily composite chloride sample results were obtained from the city for comparison

purposes.

Results of the near-field sampling are presented in Table 3. As was found in the 1994 sampling, results (3 - 160 mg/l) were highly variable from the samples taken at seven feet directly out from the ports because of the turbulent nature of the plume at close proximity to the ports. The variable nature of these data complicate efforts to calibrate the model. The samples taken directly from the ports have little variability and were usually in fairly good agreement with (although slightly lower than) composite samples taken by the city at the RCRWWTP. The samples taken at the edge of the mixing zone (70 ft) ranged from 3 - 30 mg/l and had moderate variability. The number of dilutions at the edge of the mixing zone ranged from 45 to more than 1000, corresponding to chloride concentrations at 70 feet of 30 and 3 mg/l, respectively. Model predictions used by the Division to derive certain permit limits estimated 64 dilutions at the edge of the mixing zone. However, the model estimates average dilutions along the center line of the effluent plume, which results in a very conservative prediction of dilution when applied to the plume as a whole. The variability of the sampling results makes comparisons to model predictions difficult, but model predictions generally appear to be consistent with the lower number of dilutions indicated by some of the data collected in 1994 and 1995.

Plume Surveys. During the past year, Jamestown performed quarterly plume surveys in May (spring period), August (late summer), November (fall), and February (winter) at locations shown on Figure 4. Data for chloride are presented in Table 4 for all quarters and depicted graphically for the spring, summer, and fall quarters in Figure 5. Appendix B contains all of the data collected.

Upstream control station data for chloride ranged from 3 - 6 mg/l, except for one observation of 24 mg/l found near the shore in September. This phenomenon of an "upstream" dispersion of the plume has been found on more than occasion during low flow conditions typically found in late summer and fall.

Chloride levels of 20 - 26 mg/l were found in August at distances of 200 - 1000 feet out from the diffuser. At 400 feet downstream of the diffuser, about 20 mg/l was detected in both May and August. No other observations were greater than 12 mg/l at any other locations on any of the four dates. These levels of chloride were lower than were found in the previous two years.

In February 1996, copper was below the detection limit of 0.006 mg/l at all sampling locations (Appendix B). In August 1995, copper concentrations were slightly elevated (between detection limit and 0.010 mg/l) at several locations, including the upstream control station. In November, copper was found at levels from 0.010 - 0.019 mg/l at several sites in the area and downstream of the diffuser. Most of these values were greater than the chronic copper criterion, and many were greater than the acute criterion. These copper data were unexpected because of the much greater dilution indicated by the chloride data and the fact that copper levels of this magnitude have not been found previously.

Mercury was always less than the detection limit of 0.001 mg/l, including samples of 100 percent effluent taken from the end of the pipe.

Table 3. Water Quality Data (mg/l) from Diffuser and Near-Field Sampling by Town of Jamestown, August and November 1995, and by Kentucky Division of Water, August and October, 1995

Date	Port	Constituent	Effluent	7-ft	70-ft
8/07/95	Upper	Chloride	1160	3.1	7.0
(Division)		Copper	0.019	0.002	0.001
	Middle	Chloride	1070	15.0	17.1
		Copper	0.015	0.001	0.002
	Lower	Chloride	998	34.6	8.1
		Copper	0.017	0.002	0.002
8/29/95	Upper	Chloride	1100	8.1	3.0
(Jamestown)		Copper	0.018	0.005	0.007
	Middle	Chloride	1125	8.0	8.5
		Copper	0.018	0.005	0.006
	Lower	Chloride	1225	13.5	7.5
		Copper	0.022	0.005	0.005
10/12/95	Upper	Chloride	1050	36.8	8.8
(Division)		Copper	0.016	0.002	0.002
	Middle	Chloride	1060	13.3	29.5
		Copper	0.008	0.002	0.002
	Lower	Chloride	913	15.5	20.4
		Copper	0.007	0.002	ND
11/13/95	Upper	Chloride	800	305	12.0
(Jamestown)		Copper	0.016	0.012	0.013
	Middle	Chloride	900	160	11
		Copper	0.020	0.029	0.011
	Lower	Chloride	1050	45	9.0
		Copper	0.022	0.012	0.013

Figure 4. Sampling Locations for Water, Fish, and Tissue, Town of Jamestown

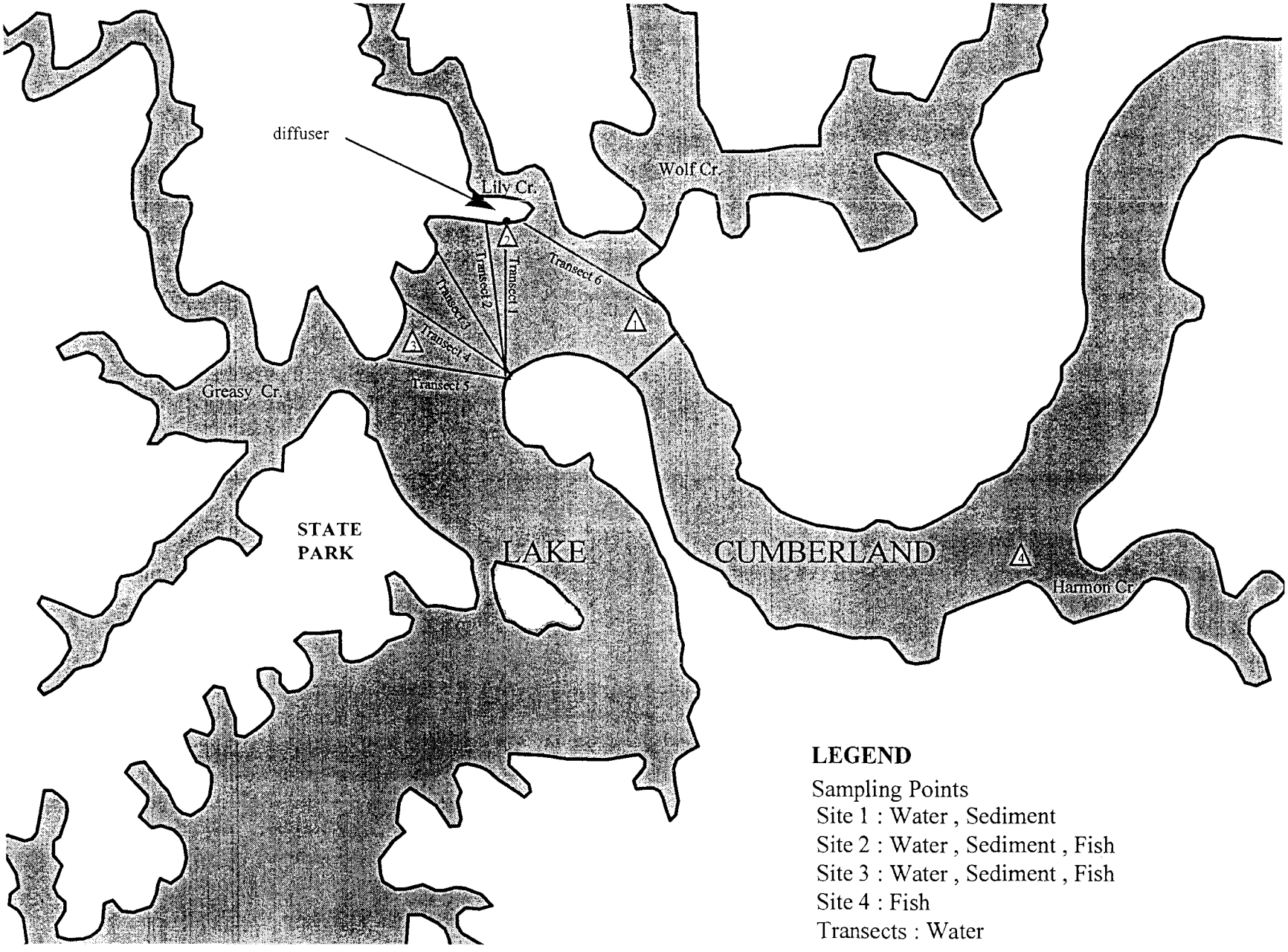
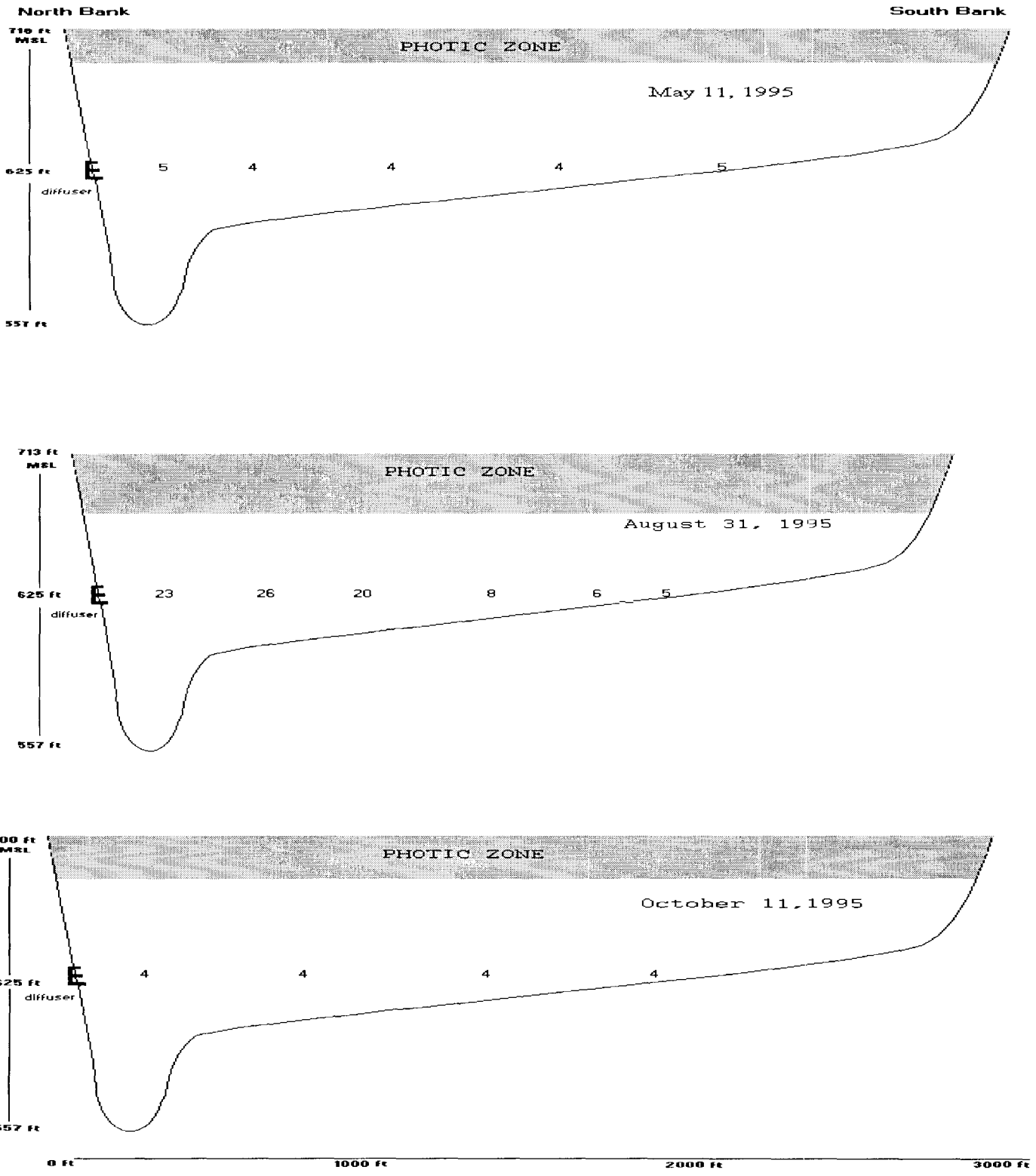


Table 4. Chloride Concentrations (mg/l) at Depth of the Effluent Plume, Town of Jamestown Surveys, February, May, September and October, 1995

Distance from shoreline	Upstream Control Site Transect 6				At diffuser Transect 1				400 ft downstream of diffuser Transect 2				2000 ft downstream of diffuser Transect 3				4000 ft downstream of diffuser Transect 4				Nr mouth of Greasy Ck. Transect 5			
	2/14	5/11	9/01	10/11	2/14	5/11	8/31	10/11	2/14	5/11	8/31	10/11	2/14	5/11	8/31	10/11	2/14	5/11	8/31	10/11	2/14	5/11	9/01	10/11
200 ft	3		24	4	3	5	23	4																
500 ft		4	4	4	3	4	26	4	3	20	22	4	3	8	6	4	3	6	8	4	3	6	4	4
1000 ft		6	4			4	20	4	3	6	12	3	3	4	10	4	3	4	4	3	3	4	4	4
1500 ft			4			4	8	4	3	4	4	4	3	4	4	4	3	4	5	4	3			
2000 ft		6	5			5	6			4	4	3		5	5	4		4	5	4				
2500 ft							5			4			6											
3000 ft							6			4			4											
3500 ft							4																	

Figure 5. Chloride Concentrations (mg/l) in Lake Cumberland at Depth of Effluent Plume, Town of Jamestown Surveys



The Division performed limited plume work in August 1995. The lake level during the survey was about 714 feet MSL, placing the diffuser at a depth of 64-94 feet. Chloride concentrations taken from 24-hour composite samples of the effluent from August 8 - 9 were 1250-1300 mg/l, and flow was in the range of 2.8 to 2.9 mgd (Town of Jamestown, 1996). Because of the large overall capacity of the treatment units, these concentrations should be relatively unchanged throughout the day.

As Jamestown's plume studies found, chloride concentrations were lower than in previous years in the area around and downstream of the diffuser. Only 18 mg/l was found at a distance of 300 feet out from the diffuser, and all other locations sampled had less than 10 mg/l chloride (Table 5 and Figure 6). Upstream of the discharge, chloride concentrations were about 3 mg/l at three sites across the lake. Copper was never detected above the level of 0.001 mg/l at the three locations sampled by the Division.

Corps of Engineers Profile Data. Another data source confirms that the chloride plume has not impacted Lake Cumberland and that there has been no buildup of chloride in the lake. The U.S. Army Corps of Engineers (COE) performs vertical profile surveys at several sites on the lake. From downstream to upstream, these sites are: near the Wolf Creek dam (MP 461.4), MP 469.7 (5.8 miles downstream of the diffuser), MP 487.0 (11.5 miles upstream of the diffuser), and much further upstream near Somerset. Conductivity measurements taken at 5-foot intervals have revealed no discernible differences at the sites up- and downstream of the diffuser (U.S. Army Corps of Engineers, 1996).

Sediment

Results from sediment sampling by Jamestown at three sites are presented for May and August 1995 (Table 6a and 6b). Neither set of samples indicated elevated copper or other metal levels in the sediments near the diffuser (Site 2) or 400 feet downstream of the diffuser (Site 3) compared to the upstream control site (Site 1). Although the sediment copper concentrations in the area of the diffuser were slightly higher in 1995 (32.2 mg/kg) than in previous years (24.5 mg/kg in March 1993, prior to diffuser operation, and 26.9 mg/kg in 1994), there was no difference between the upstream site and the lower two sites that could potentially be affected by the discharge. In fact, the control site had slightly higher copper in the sediments than the samples near the diffuser in the 1995 samples.

Fish Tissue

Fish tissue samples were collected by Jamestown in the spring and fall of 1995 by gill nets placed at the depth of the diffuser and at a depth mid-way between the diffuser and the surface. The upstream control station (Station 4) was located nearly five miles up the lake near the mouth of Harmon Creek. Samples were also collected on both dates from fish taken in the area of the diffuser (Station 2) and at a site located about 4000 feet downstream of the diffuser (Station 3). Whole body samples were used for forage fish such as alewives and shad, and several of these fish were

Table 5. Chloride and Copper Concentrations (mg/l) at Depth of Effluent Plume, Division of Water Survey, August 1995								
Distance from Shoreline (ft)	Upstream Control		At Diffuser		500 ft Downstream of Diffuser		2600 ft Downstream of Diffuser	
	Chloride	Copper	Chloride	Copper	Chloride	Copper	Chloride	Copper
150	2.8	<0.001					3.3	
300			17.8	0.001				
400					3.4	0.001		
1000			3.4		8.8		3.8	
1800	3.3		3.3		3.0		2.8	
2400					2.6		2.8	
3300			3.4				3.9	
3450	2.8							

Figure 6. Chloride Concentrations (mg/l) in Lake Cumberland at Depth of Effluent Plume, Division of Water Survey

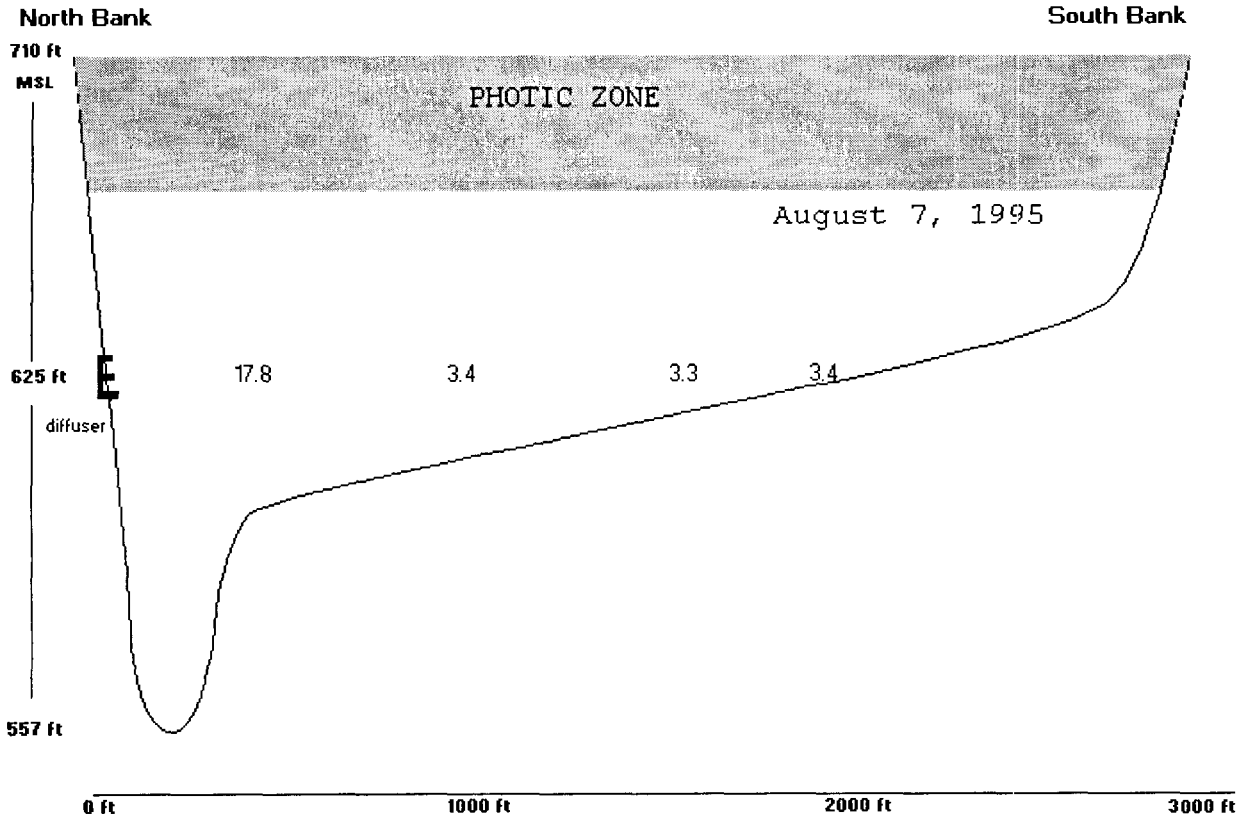


Table 6. Analysis of Sediment Samples Taken by the Town of Jamestown on Selected Dates					
Lake Cumberland Sediment Sample	ARSENIC mg/kg	COPPER mg/kg	NICKEL mg/kg	LEAD mg/kg	MERCURY mg/kg
Site 1 Rep 1	14.17	34.84	66.96	21.52	<0.608
Site 1 Rep 2	14.00	34.11	64.35	22.49	<0.330
Site 1 Rep 3	10.97	32.27	75.34	24.20	<0.485
Site 2 Rep 1	24.33	34.20	74.69	18.88	<0.402
Site 2 Rep 2	8.17	30.23	63.72	21.10	<0.584
Site 2 Rep 3	10.91	32.39	60.48	18.51	<0.462
Site 3 Rep 1	12.82	34.88	65.43	19.82	<0.690
Site 3 Rep 2	13.33	35.26	57.52	25.81	<0.614
Site 3 Rep 3	11.73	35.01	57.03	23.46	<0.526

SAMPLE DATE = 10MAY1995

LOCATION	ARSENIC mg/kg	COPPER mg/kg	NICKEL mg/kg	LEAD mg/kg	MERCURY mg/kg
Site 1 Rep 1	15.89	33.21	55.63	22.12	<0.733
Site 1 Rep 2	14.72	33.25	60.63	22.80	<0.652
Site 1 Rep 3	14.94	33.52	61.02	20.22	<0.699
Site 2 Rep 1	18.10	32.47	61.19	18.89	<0.892
Site 2 Rep 2	16.63	31.74	58.12	17.59	<0.815
Site 2 Rep 3	15.78	31.90	59.38	18.83	<0.673
Site 3 Rep 1	16.37	32.92	61.00	21.76	<0.655
Site 3 Rep 2	15.71	31.74	57.26	19.31	<0.620
Site 3 Rep 3	21.29	31.64	60.08	23.12	<0.736

SAMPLE DATE = 30AUGUST1995

NOTE: ALL CONCENTRATIONS ARE BASED ON DRY WEIGHT OF SAMPLE
10,000 MG/KG = 1% BY WEIGHT FOR EACH ELEMENT

composited into a single sample when the fish were of small size. Right side fillets were taken from predator fish such as bass, gar, and walleye, and the remaining portion of the fish was used for whole body sample if the fish was of adequate size.

The sites were fished until samples were obtained, but not for more than three nights. Because some types of fish were not caught on all sample dates, the number of samples is not equal between sites and dates. Low numbers of fish, including forage fish such as shad, were taken from the lower nets on all sampling dates. (Also, very few fish were observed by divers in the vicinity of the diffuser.) This dates. Low numbers of fish, including forage fish such as shad, were taken from the lower nets on all sampling dates. (Also, very few fish were observed by divers in the vicinity of the diffuser.) This dates. Low numbers of fish, including forage fish such as shad, were taken from the lower nets on all sampling dates. (Also, very few fish were observed by divers in the vicinity of the diffuser.) This of the diffuser (Station 2), four samples (one forage fish composite, one small predator, and one predator with both fillet and whole body samples) were taken in May, and four forage fish composite samples were taken in October. Five miles upstream of the diffuser (Station 4), four whole body predators and one composite of forage fish were obtained in May, and 14 samples (five forage fish composites, one whole body predator, and four predators with both fillets and whole body) were collected in October. Nearly a mile downstream of the diffuser (Station 3), eight samples were taken in May and another thirteen in October.

There were there no apparent differences in tissue concentrations in fish from the up- and downstream sites (Tables 7 and 8). The city's data show mercury was present in high concentrations (between 0.5 and 1.0 mg/kg) in several fish, and one whole body sample of a gar exceeded the FDA action level of 1.0 mg/kg. Although all samples of sport fish were below the FDA action level, some walleye both at the control site and below the diffuser were in the range of 0.6 - 0.8 mg/kg. Relatively high levels of mercury in fish have been detected in previous sampling by both the Division and Jamestown in several areas of the lake (Kentucky Division of Water, 1995, 1994a, 1992a), but data have shown that the RCRWWTP discharge is not the source of the mercury. The various isomers of PCBs and chlordane were below detection levels.

Plankton

Phytoplankton sampling was deleted from the monitoring program beginning in the summer of 1994 based on the first year's results. There was no indication of any effects of the discharge of effluent on the algal community, and sampling at depth resulted mostly in dead cells descending from the photic zone. May 1994 results showed no difference in dominant species between the three sites, and mean cell density was low (<10 cells/ml) at all three sites.

Sampling for zooplankton in 1995 was conducted in January, May, August, and November. Since the daily vertical migration of zooplankton is affected by light levels, Station 3 (3500 feet below the discharge), which is below a high bluff and becomes shaded earliest in the afternoon, was always sampled first. The samples were obtained by pumping 1500 liters per replicate through a 35 micron plankton net. Sampling depth at each period was determined by the depth of the midpoint of the diffuser below the surface.

TABLE 7. FISH TISSUE DATA, TOWN OF JAMESTOWN, MAY 1995

LAB. I.D. - SOURCE/ LOCATION	STA. NO.	METALS					AROCHLORS							TECHNICAL CHLORDANE	PERCENT LIPIDS
		ARSENIC	COPPER	NICKEL	LEAD	MERCURY	1016	1221	1232	1242	1248	1254	1260		
		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	
4325 - STRIPED BASS (wb)	3	<0.99	1.21	0.57	1.47	<0.20	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	9.6
4326 - STRIPED BASS (filet)	3	<1.00	<0.10	1.93	0.79	<0.24	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	7.3
4327 - STRIPED BASS (wb)	3	<1.00	0.87	1.22	0.79	<0.21	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	8.9
4328 - STRIPED BASS (filet)	3	<1.00	0.20	3.55	0.45	<0.22	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	5.6
4329 - ALEWIVES (5)	3	<1.00	1.71	3.87	1.19	<0.22	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	1.9
4330 - WALLEYE (wb)	2	<0.98	1.54	2.95	0.79	0.34	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	4.6
4331 - WALLEYE (filet)	2	<1.00	<0.10	7.97	0.61	0.43	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	1.0
4332 - LONGNOSE GAR *	2	<1.00	8.61	12.41	1.69	1.38	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	9.8
4333 - ALEWIVES (10)	4	<1.00	<0.10	1.87	0.62	<0.25	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	2.7
4334 - ALEWIVES (24)	3	<1.00	0.93	0.88	2.19	<0.20	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	1.9
4335 - WALLEYE (wb)	3	<0.98	14.48	2.60	3.78	0.31	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	10.3
4336 - WALLEYE (filet)	3	<0.98	14.90	2.81	3.88	0.42	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	0.9
4337 - ALEWIVES	2	<1.00	0.61	0.91	0.50	<0.22	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	1.1
4338 - LONGNOSE GAR	4	<0.98	16.02	1.34	2.64	0.23	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	16.3
4339 - LONGNOSE GAR	4	<1.00	9.77	1.41	2.16	0.29	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	6.7
4340 - LONGNOSE GAR	4	<0.99	43.56	5.44	10.51	0.24	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	11.9
4341 - LONGNOSE GAR	4	<1.00	6.45	1.09	1.58	0.47	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	12.0

NOTE 1 : ALL CONCENTRATIONS ARE BASED ON ACTUAL OR "WET" WEIGHT OF SAMPLE AS RECEIVED.

* NOTE 2 : HEAD AND TAIL ABSENT FROM THIS SAMPLE.

TABLE 8. FISH TISSUE DATA, TOWN OF JAMESTOWN, AUGUST 1995

LAB. I.D. - SOURCE/ LOCATION	STA. NO.	METALS					AROCHLORS							TECHNICAL CHLORDANE	PERCENT LIPIDS
		ARSENIC	COPPER	NICKEL	LEAD	MERCURY	1016	1221	1232	1242	1248	1254	1260		
		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	
4675-SHAD	4	<1.00	1.10	0.27	0.40	<0.23	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	9.0
4676-SHAD	4	<1.00	0.46	<0.20	0.36	<0.27	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	9.5
4677-WALLEYE (WB)	4	<0.98	2.83	1.47	0.76	0.62	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	9.0
4678-WALLEYE (FILLET)	4	<0.93	0.52	1.75	0.36	0.71	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	1.2
4679-ST. BASS (FILLET)	4	<1.00	0.88	0.69	0.31	0.51	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	10.4
4680-ST. BASS (WB)	4	<0.98	10.88	0.66	1.73	0.42	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	13.7
4681-GARR (WB)	4	<1.00	27.30	1.51	5.74	0.95	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	13.3
4682-WALLEYE (WB)	4	<1.00	50.00	1.84	7.86	0.41	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	7.9
4683-WALLEYE (FILLET)	4	<1.00	0.76	<0.20	0.27	0.63	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	1.5
4684-WALLEYE (WB)	2	<0.98	25.39	<0.20	5.18	0.71	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	10.3
4685-WALLEYE (FILLET)	2	<0.98	1.74	<0.20	0.60	0.83	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	1.3
4686-ST. BASS (WB)	2	<0.98	5.20	0.35	0.80	<0.24	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	14.5
4687-ST. BASS (FILLET)	2	<1.00	1.38	1.31	0.92	0.25	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	6.9
4688-SHAD	2	<1.00	1.10	1.16	0.38	<0.27	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	9.7
4689-SHAD	2	<0.98	0.93	0.51	0.48	<0.22	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	8.2
4690-SHAD	2	<1.00	1.08	2.35	0.52	<0.27	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	9.4
4691-SHAD	3	<0.98	0.50	0.80	0.37	<0.27	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	9.6
4692-SHAD	3	<1.00	7.40	2.13	0.73	<0.24	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	8.4
4693-ST. BASS (WB)	3	<1.00	2.05	2.88	0.48	<0.23	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	1.0
4694-ST. BASS (FILLET)	3	<0.98	0.46	2.53	<0.10	<0.23	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	4.7
4695-SHAD/ALEWIVES	2	<0.98	1.29	0.53	0.15	<0.27	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	8.0
4696-ST.BASS (WB)	4	<0.98	38.43	1.97	3.78	<0.21	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	16.2
4697-ST. BASS (FILLET)	4	<1.00	43.40	4.25	7.72	0.28	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	7.7
4698-SHAD/ALEWIVES	4	<1.00	9.40	2.70	0.62	<0.22	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	7.8
4699-SHAD	4	<1.00	65.40	0.28	12.11	<0.21	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	7.9
4700-SHAD	4	<1.00	3.11	<0.20	1.47	<0.27	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	8.9
4701-ST.BASS (WB)	3	<0.98	6.08	1.88	1.06	<0.22	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	12.6
4702-ST. BASS (FILLET)	3	<1.00	0.17	2.48	0.07	0.26	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	9.4
4703-ALEWIVES	2	<0.98	41.67	<0.20	7.68	<0.19	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	6.7
4704-ALEWIVES	2	<1.00	51.30	<0.20	12.11	<0.20	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	7.6
4705-ALEWIVES	2	<1.00	21.50	<0.20	3.70	<0.20	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	<0.250	8.2

HC - Harmon Creek

B - Below

Analysis of the samples was done by examining five 1-ml subsamples from each replicate and then calculating the total organisms per cubic meter based on these subsamples. Mean species richness was calculated for each replicate by taking the mean for the five subsamples. This reduces the impact of a single individual of a species on the total species richness and allows a more realistic comparison between stations.

Analysis of variance was performed to determine if significant differences occurred between stations in either zooplankton abundance or species richness. There was no significant difference between any of the stations during the January sampling for either abundance or species richness. During May, there was a significantly higher zooplankton abundance at the 0.05 level at the diffuser site (Station 2) than at either of the other two stations, but there was no difference in species richness. The August samples showed both a greater abundance (at the 0.01 level) and species richness (at the 0.05 level) at the diffuser. The significantly greater abundance at the diffuser continued in November, but there was no difference in species richness between the stations.

Trophic State

The Division's Water Quality Branch has monitored the Lily Creek embayment of Lake Cumberland since 1985. Monitoring was initiated to assess the trophic state and the impacts to water quality from the RCRWWTP at a time when the discharge was into the free-flowing reaches of Lily Creek approximately seven miles above the lake.

A comparison of chemical, physical, and biological data collected in the two years prior to the construction of the pipeline to data collected in 1993 and 1994, after the discharge had been relocated to the main lake, indicates a trend of improved water quality and overall aesthetics associated with the removal of the discharge from Lily Creek. For several years, the Division (1994b, 1992b, 1990, 1988, 1986) classified the Lily Creek embayment as eutrophic, and the Kentucky Department of Fish and Wildlife Resources (KDFWR) has recognized the embayment as supporting one of the better fisheries on Lake Cumberland. However, once the nutrient input ceased, chlorophyll-a, total phosphorus, and soluble reactive phosphorus decreased in 1993 - 1995 when compared to 1991 and 1992 (Table 9). In 1995, chlorophyll-a concentrations fell to less than 25 percent of levels found during years when the discharge was to the free-flowing reaches of Lily Creek. Secchi disk transparency and euphotic zone depths also increased, indicating that the embayment is less eutrophic.

In May, August, and October 1995, three stations below the diffuser and a control station above the diffuser were sampled to monitor the effects on phytoplankton biomass of the diffuser discharge. These stations were located at River Mile (RM) 475.9 (control), 475.6 (600 feet below the diffuser), 475.0, and 474.4 of Lake Cumberland.

No significant differences were found in chlorophyll-a concentrations in seasonal samples collected in May, August, and October at three stations downstream of the diffuser when compared to the control station (RM 475.9). Little or no differences in 1993, 1994, and 1995 were found in the concentrations of nutrients and other selected parameters sampled below the diffuser when

compared to the control station. Thus, after three years of trophic state and physical-chemical monitoring, there appears to be very little effect on the biomass in the main lake as a result of the discharge. This is because the concentrations of nutrients are rapidly diluted and remain below the photic zone. This was also demonstrated by higher conductivity measurements downstream of the diffuser at the depth of the diffuser throughout the growing season, indicating that the effluent remains almost entirely below the photic zone.

Table 9. Growing Season (April-October) Averages of Chemical, Physical and Biological Parameters at Milepoint 3.8 of the Lily Creek Embayment

	1991	1992	1993[a]	1994	1995
Chlorophyll-a (ug/l)	19.8	25.8	13.5	10.4	4.9
Total Phosphorus (mg/l)	0.17	0.08	0.05	<0.041	0.27
Soluable Reactive Phosphorus (mg/l)	0.117	0.021	<0.005	<0.021	<0.005
Euphotic Zone (ft)	13.1	13.5	16.4	15.1	13.6
Secchi Disk Transparency (ft)	3.0	3.1	4.2	4.3	4.7

[a] Discharge relocated to main lake prior to 1993 growing season

Creel Surveys

The Kentucky Department of Fish and Wildlife Resources (KDFWR) conducts creel surveys in the Lily Creek area of the lake in even numbered years. At the request of the Division, data from the Lily Creek embayment were separated from other survey areas in 1994 and submitted to the Division (KDFWR, 1995). The purpose of the request was to monitor the impact on the sport fishery of the Lily Creek embayment once the discharge was relocated to the main body of the lake. The embayment was one of the better fisheries on Lake Cumberland, but it is expected that the loss of nutrient input from the RCRWWTP discharge will decrease productivity (see discussion above on trophic state) and eventually adversely affect the sport fishery. Creel survey information presented in last year's report (Kentucky Division of Water 1995) was a baseline against which future data will be compared.

Conclusions

The third year of operation at the Russell County Regional Wastewater Treatment Plant (RCRWWTP) following an expansion and upgrade of treatment facilities and relocation of the discharge to Lake Cumberland in April 1993 was marked by compliance with all regulatory requirements and no demonstrable impacts to Lake Cumberland from environmental monitoring by both Jamestown and the Division of Water.

- Discharge monitoring data submitted by Jamestown for constituents limited by the permit and inspections conducted by the Division indicated that the facility operated satisfactorily.

- Chloride and copper loading from the RCRWWTP have declined in the past three years.

- Acute water quality criteria were often met at the end of the pipe, and chronic criteria usually were met within a very short distance of the pipe, well within the 70-foot mixing zone. Copper concentrations exceeded water quality criteria on several occasions, mostly in November samples collected by Jamestown, but these results were not validated by dilution seen for chloride or by any other data collected in this or previous years. Studies conducted by Jamestown and the Division of Water showed chloride concentrations in the lake were less than 200 mg/l at the edge of the zone of initial dilution (7 feet from the end of the nozzles) and less than 40 mg/l at the edge of the mixing zone (70 feet from the nozzles). Other constituents of the wastewater were found in very low or undetectable concentrations in the lake. As has been found in previous environmental monitoring, the highest concentrations of chloride in water were found in a thin layer (usually less than one meter thick) during thermally stratified lake conditions. During winter when the waters of the lake are not stratified by temperature and density differences, the plume was barely detectable outside the mixing zone.

- Zooplankton densities were found to be significantly higher in the area of the diffuser than at the control or downstream sites, indicating that some utilization of organic nutrients is occurring.

- This and other studies have found mercury levels in fish to be relatively high in several areas of the lake, but the RCRWWTP is not the source of the mercury.

- Copper levels in sediments were no higher in the area of the diffuser than at the upstream control site.

REFERENCES

Kentucky Department of Fish and Wildlife Resources. 1995. Unpublished creel survey data provided to Kentucky Division of Water, July 21, 1995.

Kentucky Division of Water. 1995. Second Annual Report on Operations of Russell County Regional Wastewater Treatment Plant and Associated Environmental Monitoring.

___ 1994a. Annual Report on Operations of Russell County Wastewater Treatment Plant and Associated Environmental Monitoring

____1994b. 1994 Kentucky Report to Congress on Water Quality.

____1992a. Lake Cumberland/Lily Creek Sediment and Fish Tissue Investigation. Technical Report No. 49.

____1992b. 1992 Kentucky Report to Congress on Water Quality.

____1990. 1990 Kentucky Report to Congress on Water Quality.

____1988. 1988 Kentucky Report to Congress on Water Quality.

____1986. 1986 Kentucky Report to Congress on Water Quality.

Town of Jamestown. 1996. Personal communication, October 1996.

U.S. Army Corps of Engineers. 1996. Personal communication, October 1996.

____1995. Unpublished profile data provided to Kentucky Division of Water, July 27, 1995.

APPENDIX A
DIVISION OF WATER COMPLIANCE
SAMPLING INSPECTIONS AND BIOMONITORING RESULTS

NATURAL RES IRCES AND ENVIRONMENTAL PROTECTI CABINET
DIVISION OF WATER

WASTEWATER TREATMENT PLANT INSPECTION REPORT

Facility Name Russell Co Reg. WWTP County Russell

TRANS. CODE		KPDES #	YR	MO	DA	TYPE	INSPECTOR	FAC. TYPE
N	5	KY0062995	96	05	10	R	S	1
1	2	3 — 11	12		17	18	19	20

RATING: S (22) REMARKS (30 — 57)

Reserved	DMR RELIABILITY	BI	QA	Reserved	EMPLOYEE NO.
58 — 66	67 — 69	70: 5	71	72	73 — 74	75 — 77: 061

RATING CODES: S = Satisfactory; U = Unsatisfactory; M = Marginal; OUT = Out of Operation

	CONDITION / APPEARANCE	RATING	COMMENTS
PRELIMINARY	Bar Screen	S	
	Disposal of Screenings	S	
	Comminutor		
	Grit Chamber		
	Disposal of Grit		
PRIMARY/ SECONDARY	Settling Tanks	S	
	Scum Removal / return	S	
	Sludge Removal / return	S	
	Effluent	S	
	Hydroseive		
SECONDARY/ TERTIARY	Trickling Filter / or RBC(s)		
	Aeration Tank(s)	S	
	Lagoon(s)		
	Filter(s)		
SLUDGE DISPOSAL	Digesters	S	
	Temperature & pH		
	Heating Equipment		
	Sludge Pumps		
	Drying Beds		
	Vacuum Filter		
	Incineration		
	Disposal of Sludge	S	
	Belt Press	S	
OTHER	Flowmeter and Recorder	S	
	Records	S	
	Laboratory Controls	S	
	Weir(s)	S	
	Pretreatment	S	
	Self-Monitoring Program	S	
CHLORINE	Effluent	S	
	Chlorinators	S	
	Effective Dosage	S	
	Contact Time	S	
	Contact Tank	S	
GENERAL	Grounds	S	
	Buildings	S	
	Stream		

SUMMARY OF FINDINGS / GENERAL COMMENTS

Discussed running a CSI on wk of 27th with Otis

RECEIVED
JUN 13 1996
KPDES BRANCH
ENTERED PCS

IDENTIFICATION SECTION

On-Site Representative / Title
Otis Skaggs

Owner or Responsible Party / Title
city of Jamestown

Person(s) Contacted
Same

Inspector's Signature James L Gooday

DEP4040 Distribution: White - Field Office Yellow - Central Office Pink - Operator Rev. 6/

James E. Bickford
SECRETARY

Paul E. Patton
GOVERNOR

COMMONWEALTH OF KENTUCKY
NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION CABINET
DEPARTMENT FOR ENVIRONMENTAL PROTECTION

March 21, 1996

Honorable Donnie Wilkerson
Mayor, City of Jamestown
Monument Square Box 587
Jamestown, Kentucky 42629

RE: Russell County Regional WWTP
KY0062995

Dear Mayor Wilkerson:

Please find enclosed your copy of the Compliance Sampling Inspection Report (including appropriate laboratory reports) conducted by James S. Woody of the Kentucky Division of Water at the Russell County Regional Wastewater Treatment Plant in Russell County, Kentucky on December 6, 1995. At the time of inspection your facility received a rating of Satisfactory. The analytical data from this inspection indicates compliance with your facility's KPDES permit.

If you have any questions regarding this report, please feel free to contact this office.

Sincerely,

Sara E. Gold, Supervisor
Division of Water
Columbia Regional Office
P. O. Box 335
Columbia, Kentucky 42728
Phone: (502) 384-4734

SEG/bjb

Enclosure

cc: KPDES Branch, Division of Water
Frankfort Central Office files
Columbia Regional Office files

NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION CABINET
DIVISION OF WATER

WASTEWATER TREATMENT PLANT INSPECTION REPORT

Facility Name: Russell Co Reg WWTP County: Russell

TRANS. CODE	KPDES #	YR	MO	DA	TYPE	INSPECTOR	FAC. TYPE
N	KY0062995	96	02	27	R	5	1

RATING: S REMARKS:

Reserved	DMR RELIABILITY	BI	QA	Reserved	EMPLOYEE NO.
	5				061

RATING CODES: S = Satisfactory; U = Unsatisfactory; M = Marginal; OUT = Out of Operation

	CONDITION / APPEARANCE	RATING	COMMENTS
PRELIMINARY	Bar Screen		
	Disposal of Screenings		
	Comminutor	/	
	Grit Chamber	/	
	Disposal of Grit	/	
PRIMARY/ SECONDARY	Settling Tanks	S	
	Scum Removal / return	S	
	Sludge Removal / return	S	
	Effluent	S	
	Hydroseive	/	
SECONDARY/ TERTIARY	Trickling Filter / or RBC(s)	/	
	Aeration Tank(s)	S	
	Lagoon(s)	/	
	Filter(s)	/	
SLUDGE DISPOSAL	Digesters	S	
	Temperature & pH	/	
	Heating Equipment	/	
	Sludge Pumps	/	
	Drying Beds	/	
	Vacuum Filter	/	
	Incineration	/	
	Disposal of Sludge	S	
	Belt Press	S	
OTHER	Flowmeter and Recorder	S	
	Records	S	
	Laboratory Controls	S	
	Weir(s)	S	
	Pretreatment	S	
	Self-Monitoring Program	S	
CHLORINE	Effluent	S	
	Chlorinators	S	
	Effective Dosage	S	
	Contact Time	S	
	Contact Tank	S	
GENERAL	Grounds	S	
	Buildings		
	Stream		

SUMMARY OF FINDINGS / GENERAL COMMENTS

observed Otis run color test on effluent

RECEIVED
MAR 2 2 1996
KPDES BRANCH
ENTERED PCS

IDENTIFICATION SECTION

On-Site Representative / Title: Otis Skaggs

Owner or Responsible Party / Title: city of Jamestown

Person(s) Contacted:

Inspector's Signature: James S. Gooding

DEP4040 Distribution: White - Field Office Yellow - Central Office Pink - Operator Rev. 6/8

NATURAL R OURCES AND ENVIRONMENTAL PROTEC ON CABINET
DIVISION OF WATER

WASTEWATER TREATMENT PLANT INSPECTION REPORT

Facility Name Russell Co Reg WWTP County Russell

TRANS. CODE		KPDES #	YR	MO	DA	TYPE	INSPECTOR	FAC. TYPE
N	5	KY0062945	96	01	04	R	S	1

RATING	REMARKS
S	

Reserved	DMR RELIABILITY	BI	QA	Reserved	EMPLOYEE NO.
	S				061

RATING CODES: S = Satisfactory; U = Unsatisfactory; M = Marginal; OUT = Out of Operation

	CONDITION / APPEARANCE	RATING	COMMENTS
PRELIMINARY	Bar Screen		
	Disposal of Screenings		
	Comminutor		
	Grit Chamber		
	Disposal of Grit		
PRIMARY/ SECONDARY	Settling Tanks	S	
	Scum Removal / return	S	
	Sludge Removal / return	S	
	Effluent	S	
	Hydroseive	/	
SECONDARY/ TERTIARY	Trickling Filter / or RBC(s)	/	
	Aeration Tank(s)	S	
	Lagoon(s)	/	
	Filter(s)	/	
SLUDGE DISPOSAL	Digesters	S	
	Temperature & pH	/	
	Heating Equipment	/	
	Sludge Pumps	/	
	Drying Beds	/	
	Vacuum Filter	/	
	Incineration	/	
	Disposal of Sludge	S	
	Belt Press	S	
OTHER	Flowmeter and Recorder	S	
	Records	S	
	Laboratory Controls	S	
	Weir(s)		
	Pretreatment	S	
	Self-Monitoring Program	S	
CHLORINE	Effluent	S	clear to pipeline
	Chlorinators	S	
	Effective Dosage	S	
	Contact Time	/	
	Contact Tank	/	
GENERAL	Grounds		
	Buildings		
	Stream		

SUMMARY OF FINDINGS / GENERAL COMMENTS

Calvin Johnson leaving at lab tech. Has been training new person for the job

RECEIVED
JAN 18 1996
KPDES BRANCH
ENTERED PCS

IDENTIFICATION SECTION

On-Site Representative / Title
Otis Skaggs + Calvin Johnson

Owner or Responsible Party / Title
City of Jamestown

Person(s) Contacted

Inspector's Signature
James A. Woodey

DEP4040 Distribution: White - Field Office Yellow - Central Office Pink - Operator Rev. 6/85

NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION CABINET
DIVISION OF WATER

WASTEWATER TREATMENT PLANT INSPECTION REPORT

Facility Name Russell Co Reg WWTP County Russell

TRANS. CODE	KPDES #	YR	MO	DA	TYPE	INSPECTOR	FAC. TYPE
N	KY0062975	95	11	29	R	5	1

RATING: 5

REMARKS:

Reserved	DMR RELIABILITY	BI	QA	Reserved	EMPLOYEE NO.
	5				061

RATING CODES: S = Satisfactory; U = Unsatisfactory; M = Marginal; OUT = Out of Operation

	CONDITION / APPEARANCE	RATING	COMMENTS
PRELIMINARY	Bar Screen		
	Disposal of Screenings		
	Comminutor		
	Grit Chamber		
	Disposal of Grit		
PRIMARY/ SECONDARY	Settling Tanks	S	
	Scum Removal / return	S	
	Sludge Removal / return	S	
	Effluent	S	
	Hydroseive	/	
SECONDARY/ TERTIARY	Trickling Filter / or RBC(s)	/	
	Aeration Tank(s)	S	
	Lagoon(s)	/	
	Filter(s)	/	
SLUDGE DISPOSAL	Digesters	S	
	Temperature & pH	/	
	Heating Equipment	/	
	Sludge Pumps	/	
	Drying Beds	/	
	Vacuum Filter	/	
	Incineration	/	
	Disposal of Sludge	S	
	Belt Press	S	
OTHER	Flowmeter and Recorder	S	
	Records	S	
	Laboratory Controls	S	
	Weir(s)	S	
	Pretreatment	S	
	Self-Monitoring Program	S	
CHLORINE	Effluent	S	
	Chlorinators	S	
	Effective Dosage	S	
	Contact Time	S	
	Contact Tank	S	
GENERAL	Grounds		
	Buildings		
	Stream		

SUMMARY OF FINDINGS / GENERAL COMMENTS

Scheduled CSI sampling with plant for 12/5-6/95

Dye loading to plant reduced recently

everything running ok

RECEIVED
DEC 2 2 1995
KPDES BRANCH
ENTERED PCS

IDENTIFICATION SECTION

On-Site Representative / Title
Otis Skaggs

Owner or Responsible Party / Title
City of Jamestown

Person(s) Contacted
Same

Inspector's Signature
James L Goodly

DEP4040 Distribution: White - Field Office Yellow - Central Office Pink - Operator Rev. 6/85

PHILLIP J. SHEPHERD
SECRETARY

BRERETON C. JONES
GOVERNOR

COMMONWEALTH OF KENTUCKY
NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION CABINET
DEPARTMENT FOR ENVIRONMENTAL PROTECTION

July 25, 1995

Honorable Donnie Wilkerson
Mayor City of Jamestown
Monument Square Box 587
Jamestown, Kentucky 42629

RE: Russell County Regional WWTP
KY0062995

Dear Mayor Wilkerson:

Please find enclosed your copy of the Compliance Sampling Inspection Report (including appropriate laboratory reports) conducted by James S. Woody of the Kentucky Division of Water at the Russell County Regional Wastewater Treatment Plant in Russell County, Kentucky on May 24, 1995. At the time of inspection your facility received a rating of Satisfactory. The analytical data from this inspection indicates compliance with your facility's KPDES permit.

If you have any questions regarding this report, please feel free to contact this office.

Sincerely,

Sara E. Gold, Supervisor
Division of Water
Columbia Regional Office
P. O. Box 335
Columbia, Kentucky 42728
Phone: (502) 384-4734

SEG/bjb

Enclosure

cc: KPDES Branch, Division of Water
Frankfort Central Office files
Columbia Regional Office files

JAMES E. BICKFORD
SECRETARY

PAUL E. PATTON
GOVERNOR

COMMOMWEALTH OF KENTUCKY
NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION CABINET
DEPARTMENT FOR ENVIRONMENTAL PROTECTION
FRANKFORT OFFICE PARK
14 REILLY RD
FRANKFORT KY 40601

June 14, 1996

RECEIVED
JUN 18 1996
KPDES Branch

Mr. Terry Lawless, Supervisor
Public Works
City of Jamestown
PO Box 99
Jamestown KY 42629

RE: Jamestown WWTP (KY 0062995)
Biomonitoring Test Results

Dear Mr. Lawless:

Enclosed please find the biomonitoring results for your facility as determined by the Division of Water, Bioassay Section.

The enclosed data is the summary of the acute toxicity tests completed on May 31, 1996, using the fathead minnow (Pimephales promelas) and the daphnid (Ceriodaphnia dubia). Samples were grabs collected on May 28 at 21:00 and May 29 at 09:00. The results indicate no acute toxicity in either grab sample with both test species, $LC_{50} > 100\%$ ($Tu_a < 1.00$).

Please call if you have any questions regarding this report.

Sincerely,

Charles A. Roth

Charles A. Roth, Supervisor
Bioassay Section

CAR:dh

c: Sara Gold, Columbia Regional Office
Bob Rogers, Pretreatment Section
Tom VanArsdall, Standards and Specifications Section
DOW Files

PHILLIP J. SHEPHERD
SECRETARY

BRERETON C. JONES
GOVERNOR

COMMONWEALTH OF KENTUCKY
NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION CABINET
DEPARTMENT FOR ENVIRONMENTAL PROTECTION
FRANKFORT OFFICE PARK
14 REILLY ROAD
FRANKFORT, KENTUCKY 40601

June 5, 1995

Mr. Terry Lawless, Supervisor
Public Works
City of Jamestown
P. O. Box 99
Jamestown, KY 42629

RE: Jamestown/Russell County WWTP (KY 0062995) Biomonitoring Tests Performed by the Kentucky Division of Water, Bioassay Section

Dear Mr. Lawless:

Enclosed please find biomonitoring data for your facility, as determined by the Kentucky Division of Water, Bioassay Section.

The enclosed data is the summary of the acute toxicity tests completed on May 26, 1995 using the fathead minnow (Pimephales promelas) and the Daphnid (Ceriodaphnia dubia). Samples were four grabs collected on May 23 and 24, 1995. The results indicate no acute toxicity in any grab sample with both test species, LC_5 >21% (TU_a < 4.8). Samples were also tested at 100% effluent which again showed no toxicity to either species.

Please call if you have any questions regarding this report.

Sincerely,

Charles A. Roth, Supervisor
Bioassay Section
Water Quality Branch

Enclosure

CAR:dh
c: Sara Gold, Columbia Regional Office
Bob Rogers, Pretreatment Section
Tom VanArsdall, Water Quality Branch
[redacted]

APPENDIX B
QUARTERLY WATER QUALITY DATA
Collected By
Town of Jamestown

5/95

Location	Depth ft.	pH S.U.	Cond uhm/cm	Chloride mg/L	Temp. ^{0}C	Arsenic mg/L	Copper mg/L	Nickel mg/L	Lead mg/L	Mercury mg/L
Transect 1	49		184	4		<0.010	0.007	0.002	0.002	<0.001
Transect 2	84		240	20		<0.010	0.014	<0.002	0.002	<0.001
Transect 3	20		178	4		<0.010	0.012	0.003	0.002	<0.001
Transect 4	90		190	3.5		<0.010	0.006	0.002	0.002	<0.001
Transect 5	40		176	3.5		<0.010	0.008	0.002	0.002	<0.001
Transect 6	60		182	5		<0.010	0.005	<0.002	<0.001	<0.001
Site 1 Rep 1	62	8.8	188	7.5	8.1	<0.010	0.012	<0.002	0.001	<0.001
Site 1 Rep 2	62	8.8	188	7.5	8.1	<0.010	0.002	<0.002	0.001	<0.001
Site 1 Rep 3	62	8.8	188	7.5	8.1	<0.010	0.005	<0.002	0.001	<0.001
Site 2 D-1 0' Rep1										
Site 2 D-1 0' Rep2										
Site 2 D-1 0' Rep3										
Site 2 D-1 7' Rep1	67.3	8.69	370	49.5	10.1	<0.010	0.012	<0.002	0.002	<0.001
Site 2 D-1 7' Rep2	67.3	8.69	370	49.5	10.1	<0.010	0.011	<0.002	0.004	<0.001
Site 2 D-1 7' Rep3	67.3	8.69	370	49.5	10.1	<0.010	0.009	<0.002	0.004	<0.001
Site 2 D-1 70' Rep1	60	8.68	212	16	8.6	<0.010	0.009	<0.002	0.003	<0.001
Site 2 D-1 70' Rep2	60	8.68	212	16	8.6	<0.010	0.009	0.002	0.004	<0.001
Site 2 D-1 70' Rep3	60	8.68	212	16	8.6	<0.010	0.007	0.002	0.003	<0.001
Site 2 D-2 0' Rep1										
Site 2 D-2 0' Rep2										
Site 2 D-2 0' Rep3										
Site 2 D-2 7' Rep1	82.3	8.58	354	43.5	9.9	<0.010	0.009	<0.002	0.003	<0.001
Site 2 D-2 7' Rep2	82.3	8.58	354	43.5	9.9	<0.010	0.004	<0.002	0.003	<0.001
Site 2 D-2 7' Rep 3	82.3	8.58	354	43.5	9.9	<0.010	0.005	0.002	0.002	<0.001
Site 2 D-2 70' Rep1	70	8.69	264	23	7.7	<0.010	0.003	<0.002	0.002	<0.001
Site 2 D-2 70' Rep2	70	8.69	264	23	7.7	<0.010	0.004	0.002	0.002	<0.001
Site 2 D-2 70' Rep3	70	8.69	264	23	7.7	<0.010	0.003	<0.002	0.002	<0.001
Site 2 D-3 0' Rep1										
Site 2 D-3 0' Rep2										
Site 2 D-3 0' Rep3										
Site 2 D-3 7' Rep1	97.3	8.74	184	6	9.2	<0.010	0.004	0.002	0.005	<0.001
Site 2 D-3 7' Rep2	97.3	8.74	184	6	9.2	<0.010	0.003	<0.002	0.003	<0.001
Site 2 D-3 7' Rep3	97.3	8.74	184	6	9.2	<0.010	0.004	0.002	0.003	<0.001
Site 2 D-3 70' Rep1	65	8.63	216	12.5	7.3	<0.010	0.005	0.003	0.001	<0.001
Site 2 D-3 70' Rep2	65	8.63	216	12.5	7.3	<0.010	0.002	<0.002	0.002	<0.001
Site 2 D-3 70' Rep3	65	8.63	216	12.5	7.3	<0.010	0.003	0.002	0.001	<0.001
Site 3 Rep 1	70	8.64	190	5	7.3	<0.010	0.003	<0.002	0.001	<0.001
Site 3 Rep2	70	8.64	190	5	7.3	<0.010	0.003	0.002	0.002	<0.001
Site 3 Rep 3	70	8.64	190	5	7.3	<0.010	0.003	0.003	0.002	<0.001

8/95

Location	Depth ft.	pH S.U.	Cond uhm/cm	Chloride mg/L	Temp. ^{0}C	Arsenic mg/L	Copper mg/L	Nickel mg/L	Lead mg/L	Mercury mg/L
Transect 1	52	7.71	288	23.0	17.1	<0.010	0.007	<0.002	0.010	<0.001
Transect 2	50	8.29	268	21.5	17.1	<0.010	0.006	<0.002	0.004	<0.001
Transect 3	50	8.11	230	10.0	17.2	<0.010	0.005	<0.002	0.002	<0.001
Transect 4	47.5	8.20	206	8.0	16.9	<0.010	0.006	<0.002	0.005	<0.001
Transect 5	10	7.98	194	4.0	29.5	<0.010	0.006	<0.002	0.004	<0.001
Transect 6	51	8.02	278	24.0	17.2	<0.010	0.009	<0.002	0.002	<0.001
Site 1 Rep 1	20	8.08	210	4.5	25.9	<0.010	0.007	0.002	0.038	<0.001
Site 1 Rep 2	20	8.08	210	4.5	25.9	<0.010	0.007	<0.002	0.038	<0.001
Site 1 Rep 3	20	8.08	210	4.5	25.9	<0.010	0.008	<0.002	0.043	<0.001
Site 2 D-1 0' Rep1	54.5	8.36	4290	1100.0	26.8	<0.010	0.018	<0.002	0.009	<0.001
Site 2 D-1 0' Rep2	54.5	8.36	4290	1100.0	26.8	<0.010	0.017	<0.002	0.008	<0.001
Site 2 D-1 0' Rep3	54.5	8.36	4290	1100.0	26.8	<0.010	0.018	0.003	0.009	<0.001
Site 2 D-1 7' Rep1	54.5	9.36	316	8.5	19.7	<0.010	0.006	<0.002	0.003	<0.001
Site 2 D-1 7' Rep2	54.5	9.36	316	8.5	19.7	<0.010	0.005	<0.002	0.003	<0.001
Site 2 D-1 7' Rep3	54.5	9.36	316	8.5	19.7	<0.010	0.004	<0.002	0.003	<0.001
Site 2 D-1 70' Rep1	54.5	8.72	168	3.0	16.3	<0.010	0.007	0.003	0.008	<0.001
Site 2 D-1 70' Rep2	54.5	8.72	168	3.0	16.3	<0.010	0.007	0.003	0.007	<0.001
Site 2 D-1 70' Rep3	54.5	8.72	168	3.0	16.3	<0.010	0.006	<0.002	0.007	<0.001
Site 2 D-2 0' Rep1	69.5	8.46	4350	1125.0	27.2	<0.010	0.020	<0.002	0.011	<0.001
Site 2 D-2 0' Rep2	69.5	8.46	4350	1125.0	27.2	<0.010	0.018	0.002	0.012	<0.001
Site 2 D-2 0' Rep3	69.5	8.46	4350	1125.0	27.2	<0.010	0.017	<0.002	0.010	<0.001
Site 2 D-2 7' Rep1	69.5	9.47	354	8.0	19.1	<0.010	0.004	<0.002	0.005	<0.001
Site 2 D-2 7' Rep2	69.5	9.47	354	8.0	19.1	<0.010	0.004	<0.002	0.004	<0.001
Site 2 D-2 7' Rep 3	69.5	9.47	354	8.0	19.1	<0.010	0.006	<0.002	0.003	<0.001
Site 2 D-2 70' Rep1	69.5	8.50	186	8.5	14.8	<0.010	0.006	<0.002	0.004	<0.001
Site 2 D-2 70' Rep2	69.5	8.50	186	8.5	14.8	<0.010	0.008	0.004	0.005	<0.001
Site 2 D-2 70' Rep3	69.5	8.50	186	8.5	14.8	<0.010	0.006	<0.002	0.005	<0.001
Site 2 D-3 0' Rep1	84.5	8.56	4440	1225.5	27.5	<0.010	0.022	<0.002	0.013	<0.001
Site 2 D-3 0' Rep2	84.5	8.56	4440	1225.5	27.5	<0.010	0.020	<0.002	0.012	<0.001
Site 2 D-3 0' Rep3	84.5	8.56	4440	1225.5	27.5	<0.010	0.023	<0.002	0.012	<0.001
Site 2 D-3 7' Rep1	84.5	9.62	260	13.5	20.1	<0.010	0.006	<0.002	0.003	<0.001
Site 2 D-3 7' Rep2	84.5	9.62	260	13.5	20.1	<0.010	0.004	<0.002	0.002	<0.001
Site 2 D-3 7' Rep3	84.5	9.62	260	13.5	20.1	<0.010	0.005	<0.002	0.003	<0.001
Site 2 D-3 70' Rep1	84.5	8.83	168	7.5	13.0	<0.010	0.005	<0.002	0.004	<0.001
Site 2 D-3 70' Rep2	84.5	8.83	168	7.5	13.0	<0.010	0.004	<0.002	0.003	<0.001
Site 2 D-3 70' Rep3	84.5	8.83	168	7.5	13.0	<0.010	0.005	<0.002	0.003	<0.001
Site 3 Rep 1	50	8.03	170	5.5	18.1	<0.010	0.003	<0.002	0.005	<0.001
Site 3 Rep2	50	8.03	170	5.5	18.1	<0.010	0.003	<0.002	0.005	<0.001
Site 3 Rep 3	50	8.03	170	5.5	18.1	<0.010	0.005	<0.002	0.006	<0.001

11/95

Location	Depth ft.	pH S.U.	Cond uhm/cm	Chloride mg/L	Temp. ^{0}C	Arsenic mg/L	Copper mg/L	Nickel mg/L	Lead mg/L	Mercury mg/L
Transect 1	80	8.87	200	4.5	14.9	<0.010	0.012	0.002	0.004	<0.001
Transect 2	80	8.87	190	5	14.9	<0.010	0.009	<0.002	0.003	<0.001
Transect 3	60	8.87	188	4.5	14.9	<0.010	0.010	<0.002	0.002	<0.001
Transect 4										
Transect 5										
Transect 6										
Site 1 Rep 1	50	8.97	190	5	14.5	<0.010	0.006	<0.002	0.003	<0.001
Site 1 Rep 2	50	8.97	190	5	14.5	<0.010	0.008	<0.002	0.003	<0.001
Site 1 Rep 3	50	8.97	190	5	14.5	<0.010	0.007	<0.002	0.004	<0.001
Site 2 D-1 0' Rep1	49.1	9.04	3060	800	15.2	<0.010	0.014	<0.002	0.007	<0.001
Site 2 D-1 0' Rep2	49.1	9.04	3060	800	15.2	<0.010	0.017	<0.002	0.007	<0.001
Site 2 D-1 0' Rep3	49.1	9.04	3060	800	15.2	<0.010	0.016	<0.002	0.007	<0.001
Site 2 D-1 7' Rep1	49.1	9.11	958	305	14.6	<0.010	0.012	<0.002	0.006	<0.001
Site 2 D-1 7' Rep2	49.1	9.11	958	305	14.6	<0.010	0.012	<0.002	0.005	<0.001
Site 2 D-1 7' Rep3	49.1	9.11	958	305	14.6	<0.010	0.011	<0.002	0.005	<0.001
Site 2 D-1 70' Rep1	49	9.14	188	12	14.9	<0.010	0.012	<0.002	0.004	<0.001
Site 2 D-1 70' Rep2	49	9.14	188	12	14.9	<0.010	0.013	<0.002	0.007	<0.001
Site 2 D-1 70' Rep3	49	9.14	188	12	14.9	<0.010	0.013	<0.002	0.005	<0.001
Site 2 D-2 0' Rep1	64.1	8.50	2230	900	14.3	<0.010	0.019	0.004	0.007	<0.001
Site 2 D-2 0' Rep2	64.1	8.50	2230	900	14.3	<0.010	0.021	0.003	0.007	<0.001
Site 2 D-2 0' Rep3	64.1	8.50	2230	900	14.3	<0.010	0.019	0.003	0.007	<0.001
Site 2 D-2 7' Rep1	64.1	9.20	686	160	14.4	<0.010	0.014	<0.002	0.005	<0.001
Site 2 D-2 7' Rep2	64.1	9.20	686	160	14.4	<0.010	0.015	<0.002	0.006	<0.001
Site 2 D-2 7' Rep 3	64.1	9.20	686	160	14.4	<0.010	0.058	0.056	0.004	<0.001
Site 2 D-2 70' Rep1	64	9.02	188	11	14.9	<0.010	0.011	<0.002	0.003	<0.001
Site 2 D-2 70' Rep2	64	9.02	188	11	14.9	<0.010	0.010	<0.002	0.003	<0.001
Site 2 D-2 70' Rep3	64	9.02	188	11	14.9	<0.010	0.012	<0.002	0.004	<0.001
Site 2 D-3 0' Rep1	79.1	9.02	3120	1050	15.3	<0.010	0.020	0.003	0.006	<0.001
Site 2 D-3 0' Rep2	79.1	9.02	3120	1050	15.3	<0.010	0.023	0.003	0.007	<0.001
Site 2 D-3 0' Rep3	79.1	9.02	3120	1050	15.3	<0.010	0.024	0.003	0.006	<0.001
Site 2 D-3 7' Rep1	79.1	9.18	332	45	14.5	<0.010	0.015	0.003	0.004	<0.001
Site 2 D-3 7' Rep2	79.1	9.18	332	45	14.5	<0.010	0.011	0.002	0.004	<0.001
Site 2 D-3 7' Rep3	79.1	9.18	332	45	14.5	<0.010	0.011	0.002	0.004	<0.001
Site 2 D-3 70' Rep1	79	8.91	212	9	14.9	<0.010	0.019	<0.002	0.011	<0.001
Site 2 D-3 70' Rep2	79	8.91	212	9	14.9	<0.010	0.013	<0.002	0.003	<0.001
Site 2 D-3 70' Rep3	79	8.91	212	9	14.9	<0.010	0.008	0.002	0.003	<0.001
Site 3 Rep 1	70	8.74	188	4	14.9	<0.010	0.015	0.002	0.003	<0.001
Site 3 Rep2	70	8.74	188	4	14.9	<0.010	0.009	0.003	0.002	<0.001
Site 3 Rep 3	70	8.74	188	4	14.9	<0.010	0.011	0.002	0.003	<0.001

2/96

Location	Depth ft.	pH S.U.	Cond uhm/cm	Chloride mg/L	Temp. °C	Arsenic mg/L	Copper mg/L	Nickel mg/L	Lead mg/L	Mercury mg/L
Transect 1	100	7.55	198	5.0	4.3	<0.010	0.057	0.044	0.006	<0.001
Transect 2	90	7.7	190	3.5	4.3	<0.010	0.007	0.003	0.003	<0.001
Transect 3	100	7.72	190	3.0	4.4	<0.010	0.006	0.002	0.002	<0.001
Transect 4	100	7.74	198	3.0	4.3	<0.010	0.007	0.003	0.002	<0.001
Transect 5	100	7.77	198	3.5	4.5	<0.010	0.008	0.003	0.002	<0.001
Transect 6	90	7.4	192	3.0	4.4	<0.010	0.007	<0.002	0.004	<0.001
Site 1 Rep 1										
Site 1 Rep 2	100	7.52	180	4.0	4.3	<0.010	0.005	0.002	0.002	<0.001
Site 1 Rep 3										
Site 2 D-1 0' Rep1										
Site 2 D-1 0' Rep2										
Site 2 D-1 0' Rep3										
Site 2 D-1 7' Rep1										
Site 2 D-1 7' Rep2										
Site 2 D-1 7' Rep3										
Site 2 D-1 70' Rep1										
Site 2 D-1 70' Rep2										
Site 2 D-1 70' Rep3										
Site 2 D-2 0' Rep1										
Site 2 D-2 0' Rep2										
Site 2 D-2 0' Rep3										
Site 2 D-2 7' Rep1										
Site 2 D-2 7' Rep2										
Site 2 D-2 7' Rep 3										
Site 2 D-2 70' Rep1										
Site 2 D-2 70' Rep2	100	7.67	194	4.0	4.4	<0.010	0.009	0.002	0.003	<0.001
Site 2 D-2 70' Rep3										
Site 2 D-3 0' Rep1										
Site 2 D-3 0' Rep2										
Site 2 D-3 0' Rep3										
Site 2 D-3 7' Rep1										
Site 2 D-3 7' Rep2										
Site 2 D-3 7' Rep3										
Site 2 D-3 70' Rep1										
Site 2 D-3 70' Rep2										
Site 2 D-3 70' Rep3										
Site 3 Rep 1										
Site 3 Rep2	100	6.41	190	4.0	4.3	<0.010	0.013	0.002	0.010	<0.001
Site 3 Rep 3										