Effluent Monitoring by the Paducah Gaseous Diffusion Plant (PGDP), 1987-1996[a]

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Introduction

Previously, ten-year trends or patterns in the discharges of certain metals (*e.g.* Al, Fe) and uranium were presented for selected PGDP effluents based on analysis of their data submitted to the State under the KPDES effluent monitoring program. This report addresses chromium, copper and zinc, specifically. Results of the July, 1997 FFOU sampling event indicated a reduction of chromium contamination in Big Bayou Creek compared with 1987-1990 data, with a reverse trend in Little Bayou Creek (Birge and Price, 1997). Also noted were prospects for sustained or possibly increased contamination by copper, zinc and other metals, especially at and below station BB6, which is downstream of effluent 001. Therefore, it would be of interest to know if the KPDES data for these metals show similar trends.

Lead and PCBs will be treated in the next report. Prior to this submission, it is important that the UK laboratory obtain all PGDP effluent monitoring data through 1996 and 1997, as well as any outstanding data for the years 1987 through 1995. We would appreciate your help.

Monitoring Under the KPDES Program

In the Commonwealth of Kentucky, certain provisions of the Clean Water Act are administered under the Kentucky Pollutant Discharge Elimination System (KPDES). The KPDES program requires regular monitoring of permitted effluents for various parameters. These are specified for each effluent, usually as numerical limits. There are eighteen KPDES permitted effluents at the Paducah Gaseous Diffusion Plant (PGDP), seventeen of which are monitored on a weekly, monthly or quarterly basis for as many as twenty-nine parameters collectively.

KPDES Permit Number KY0004049 became effective November 1, 1992 and extended through October 31, 1997 (KPDES, 1992). It authorized discharge of the following effluents at PGDP: Big Bayou Creek, continuously flowing final - 001, 006, 008, 009; Big Bayou Creek, intermittent - 005, 014, 015, 016, and 017; Little Bayou Creek, continuously flowing final - 002, 010, 011, 012; Little Bayou Creek, intermittent - 003, 013 and 018; 004 (discharge into 008); and 007 (no discharge, no monitoring requirements).

[a] work under scope account

Objectives

The principal objectives of this report are 1) to compare KPDES data with surface water monitoring data from other studies (*e.g*. UK) to establish the accuracy and dependability of their results; 2) to report any consistent long-term trends in metal pollution, *i.e*. whether pollution attributable to effluent outfalls increases, decreases or remains the same over time; and 3) to evaluate the effectiveness of chemical monitoring by PGDP with regard to developing remediation strategies to curtail pollution by chemicals of concern.

RESULTS

KPDES mean chromium, copper and zinc measurements for continuously flowing effluents for the period 1987-1996 are presented in Tables 1, 2 and 3, respectively. We were looking primarily at metal concentrations and detection frequencies. The latter are given in the tables directly below their respective metal concentrations. The available information was limited somewhat by data gaps and variable detection limits. However, except for some possible long-term reduction of chromium and copper in effluent 001, there were no clear, discernable trends of overall reduction in pollution for these metals, which tended to fit with general assumptions stated by Birge and Price in the December, 1997 report. We are summarizing the more pertinent observations under five points given below -

1) Lack of a consistent monitoring policy over the 10-year period.
Given the number of effluents involved and the voluminous industrial metal pollution they discharge, it would seem that PGDP could have undertaken a more rigorous monitoring program.

2) Lack of reported data.
No data was available for 1991 and much of 1990 and 1992. Perhaps this information exists and has yet to be received.

3) Insufficient monitoring.
It does not appear that monthly monitoring has been consistently observed.

4) Detection limits, which varied over time for the three metals, were not sufficiently exacting to provide a full characterization of metal pollution.
The detection limits varied throughout the study and ranged from 0.006 to 0.012 mg/L for copper, and from 0.005 to 0.020 mg/L for both chromium and zinc. In order to provide meaningful measurements for assessing chronic and possible additive effects of metals, detection limits at least should approximate 0.1 to 0.2 times the chronic freshwater criterion for aquatic life. Using atomic adsorption spectrophotometry with a graphite furnace, the UK laboratory has consistently achieved optimum levels of detection.

5) Changes in detection frequencies.
The detection frequency decreased for copper in effluent 001 after 1990 and the detection frequencies decreased for all three metals in effluent 006. There also were 0 detections in 10 measurements in 1993 for 009 (Table 2). However, there were detection frequencies of 100% for copper in effluent 008 during 1993 and 1995, and 92% frequency for effluent 009 in 1994. This illustrates rather high variability from year-to-year and effluent-to-effluent.

Conclusions

As it has been implemented thus far, PGDP KPDES monitoring has generated data which provide no clear indication of metal reduction or effluent improvement for chromium, copper or zinc over time, with the possible exception of effluent 001. In addition, the monitoring program has not been sufficiently intensive or comprehensive to provide reliable estimates of instream input. The results presented in the UK report submitted in December are suggestive of overall metal pollution to the Bayou Creek system that was relatively unchanged from earlier years. Additional water column sampling for Big and Little Bayou Creeks is recommended 1) to provide a more comprehensive profile of metal pollution, 2) to evaluate temporal fluctuations in pollution, and 3) to allow some statistical comparisons.

Table 1. Mean Values (mg/L) and Detection Frequencies [a] for Chromium [b] in PGDP Effluents, 1987-1996.

Stream System	Effluent	Year 87	88	89	90	91	92	93	94	95	96
Big Bayou											
	001	0.02	0.05	0.05	0.07	---[c]	0.05	0.01	0.01	0.02	0.03
		3/3	12/12	12/12	7/7		1/2	8/12	4/12	4/12	1/1
	006	---	---	---	---	---	0.01	0.01	0.01	0.01	0.09
							1/2	6/12	4/12	3/12	1/1
	008	0.05	0.03	0.04	0.07	---	0.02	0.08	0.08	0.03	0.03
		1/1	7/7	11/11	6/6		1/2	12/12	8/12	12/12	1/1
	009	0.03	0.05	0.06	0.05	---	0.01	0.03	0.02	0.01	0.05
		3/3	4/4	10/10	5/5		1/2	11/12	10/12	12/12	1/1
Little Bayou											
	002	0.06	0.09	0.11	0.09	---	0.02	0.05	0.25	0.01	0.03
		2/2	9/9	10/10	6/6		1/1	10/10	9/10	10/12	1/1
	010	0.09	0.06	0.44	0.14	---	0.04	0.04	0.04	0.03	0.06
		1/1	6/6	11/11	5/5		1/1	8/8	10/11	10/12	1/1
	011	0.08	0.02	0.02	0.02	---	0.03	0.02	0.03	0.04	0.04
		2/2	3/3	8/8	1/1		2/2	11/12	12/12	9/12	1/1
	012	0.05	0.03	0.03	0.52	---	0.05	0.05	0.09	0.02	0.40
		2/2	7/7	9/9	6/6		1/1	8/9	9/9	11/11	1/1

[a] Given as number of detections versus number of analytical values: 6/12 (*i.e.* 50% detection); 12/12 (*i.e.* 100% detection).
[b] Detection limit was 0.005 mg/L.
[c] --- indicates no values were reported.

Table 2. Mean Values (mg/L) and Detection Frequencies [a] for Copper [b] in PGDP Effluents, 1987-1996.

Stream System	Effluent	Year 87	88	89	90	91	92	93	94	95	96
Big Bayou											
	001	0.02	0.01	0.01	0.01	---[c]	<0.01	0.02	0.02	0.01	0.01
		3/3	12/12	12/12	7/7		0/4	1/12	1/12	3/12	1/1
	006	---	---	---	---	---	0.02	0.02	0.01	0.01	<0.01
							1/2	6/12	4/12	3/12	0/1
	008	---	0.05	0.01	0.01	---	0.01	0.01	0.02	0.01	0.01
			2/2	5/5	5/5		1/2	12/12	8/12	12/12	1/1
	009	---	0.01	0.01	0.01	---	0.01	<0.01	0.02	0.01	0.01
			4/4	10/10	5/5		1/2	0/10	11/12	3/12	1/1
Little Bayou											
	002	0.01	0.09	0.01	---	---	<0.01	0.01	0.03	0.02	<0.01
		1/1	1/1	1/1			0/1	6/10	9/10	10/12	0/1
	010	---	0.02	0.01	---	---	0.01	0.01	0.01	0.01	<0.01
			4/4	2/2			1/1	1/8	3/12	2/12	0/1
	011	---	0.01	0.02	---	---	<0.01	0.01	0.01	0.02	<0.01
			3/3	8/8			0/2	2/12	3/12	2/12	0/1
	012	---	---	<0.01	---	---	<0.01	0.01	0.02	0.02	<0.01
				0/1			0/1	1/9	2/9	3/11	0/1

[a] Given as number of detections versus number of analytical values: 6/12 (*i.e.* 50% detection); 12/12 (*i.e.* 100% detection).

[b] Detection limit was 0.005 mg/L.

[c] --- indicates no values were reported.

Table 3. Mean Values (mg/L) and Detection Frequencies [a] for Zinc [b] in PGDP Effluents, 1987-1996.

Stream System	Effluent	Year 87	88	89	90	91	92	93	94	95	96
Big Bayou											
	001	0.03	0.02	0.03	0.03	---[c]	0.05	0.05	0.02	0.01	0.03
		3/3	12/12	12/12	7/7		8/12	4/12	3/12	4/12	1/1
	006	---	---	---	---	---	0.02	0.02	0.02	0.01	0.01
							1/2	6/12	4/12	3/12	1/1
	008	0.05	0.03	0.04	0.03	---	0.02	0.02	0.02	0.03	0.03
		1/1	8/8	11/11	6/6		1/2	12/12	8/12	12/12	1/1
	009	0.06	0.02	0.03	0.02	---	0.02	0.02	0.03	0.03	0.05
		3/3	4/4	10/10	7/7		1/2	11/12	10/12	12/12	1/1
Little Bayou											
	002	0.06	0.04	0.03	0.02	---	0.02	0.02	0.04	0.07	0.07
		2/2	9/9	11/11	6/6		1/1	10/10	10/11	10/12	1/1
	010	0.07	0.06	0.03	0.03	---	0.04	0.04	0.04	0.03	0.06
		2/2	6/6	10/10	5/5		2/2	8/8	9/12	10/12	1/1
	011	0.08	0.02	0.02	0.02	---	0.03	0.06	0.03	0.02	0.04
		2/2	3/3	8/8	2/2		2/2	10/12	12/12	9/12	1/1
	012	0.05	0.03	0.03	0.03	---	0.05	0.05	0.11	0.09	0.11
		2/2	7/7	9/9	6/6		1/1	8/9	10/10	10/10	1/1

[a] Given as number of detections versus number of analytical values: 6/12 (*i.e.* 50% detection); 12/12 (*i.e.* 100% detection).
[b] Detection limit was 0.005 mg/L.
[c] --- indicates no values were reported.