

Total Maximum Daily Load Development Paducah Gaseous Diffusion Plant: Water Budget

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WATER BUDGET

Introduction

The Kentucky Research Consortium for Energy and the Environment (KRCEE) was created to support Department of Energy (DOE) efforts to complete expeditious and economical environmental restoration of the Paducah Gaseous Diffusion Plant (PGDP) and surrounding areas such as the Western Kentucky Wildlife Management Area. General activities include the following:

- Application of technical expertise to assess, and accelerate implementation of cost effective technologies and methodologies that result in accelerated clean-up and risk reduction.
- Establishment of problem-specific project teams drawn from disciplines of expertise at participating universities that work with DOE and its contractors to accelerate implementation of project concepts and plans. Project team focus is on risk prioritization and accelerated implementation of cost-effective remedial activities to minimize impacts on public health and the environment.
- Technical review of proposed remediation plans and any non-consensus technical issues associated with their implementation.
- Use of project teams to interface directly with DOE national laboratories, the United States Environmental Protection Agency (EPA), and state regulatory agencies to help forge consensus solutions to technical problems related to clean-up and ongoing operations of the PGDP site.
- Accomplishment of targeted long-term and short-term projects tasks designed to support the accelerated clean-up at PDGP.

KRCEE is administered through the University of Kentucky Tracy Farmer Center for the Environment (TFCE). Annual work plans, deliverables, and associated project budgets address short-term and long-term tasks relevant to ongoing remediation efforts. Project teams made up of faculty and professional staff were drawn from the University of Kentucky (the main campus and the Paducah campus), the University of Louisville, and Murray State University.

Currently, broad projects and issues related to DOE's activities at PGDP include the following: 1) Scrap metal removal and remediation of underlying surface soils, 2) Surface water remediation and release control including sediment control and Total Maximum Daily Load (TMDL) issues, 3) Groundwater remediation including groundwater modeling and proposed remediation technologies, 4) Waste disposal including C-746-U landfill issues, 5) Burial grounds including assessment remedial action feasibility, 6) Site wide soils and drainage ditch clean up using real-time characterization and remediation, 7) Demolition and debris including disposition of volumetrically contaminated metals, 8) seismic issues, and 9) risk assessment issues.

Specific Scope of Work

In support of the general goals of the KRCEE, Murray State University agreed to conduct work related to surface water issues.

To assess the surface water, a hydrologic characterization of the PGDP facility was conducted. The tasks for the project included developing and calibrating continuous simulation hydrologic models for Bayou Creek and Little Bayou Creek watersheds using the HSPF watershed model. Another task included developing a water budget for the PGDP facility identifying and incorporating significant water inputs and outputs. Finally, available chemical data from PGDP outfalls and from sampling sites along both creeks were compiled, reviewed, and summarized.

The deliverables for the project included quarterly progress reports, quarterly presentations, and a summary report describing the development and calibration of the models, the plant water budget, and the chemical data.

Bayou Creek and Little Bayou Creek are on the Kentucky 2002 303(d) list of impaired waters. Under the provisions of the Clean Water Act, individual TMDLs must be developed for each creek. Constituents of concern for Bayou Creek include metals (iron, lead, copper, and mercury) and Technetium (^{99}Tc). Constituents of concern for Little Bayou Creek include metals (iron, lead, copper) and (^{99}Tc). The work included assessing which of these parameters might require TMDL development and may include actual TMDL development once agreement is reached between DOE and state regulatory agencies on how to proceed.

Acknowledgments

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Location and Site Description

The Paducah Gaseous Diffusion Plant (PGDP) is located on a 3,400-acre site in McCracken County approximately 15 miles west of Paducah, Ky., and approximately 3 miles south of the Ohio River. The PGDP was completed in 1953 with production starting as early as 1952. The facility enriches uranium through a diffusion cascade process that requires extensive support facilities. The diffusion process encompasses five buildings with approximately 740 acres fenced. Support facilities at the plant include cooling towers, a chemical cleaning and decontamination facility, water and wastewater treatment plants, a phosphate reduction facility, four electrical switchyards, a steam plant, and a laboratory. Including various contractors located on the site, the facility employed approximately 2,000 people at its peak. The PGDP is surrounded by a buffer of land owned by the Department of Energy (DOE) and leased to the Commonwealth of Kentucky.

The PGDP discharges treated wastewater and storm water runoff to both Bayou and Little Bayou Creeks, which drain northerly through privately owned land and the West Kentucky Wildlife Management Area (WKWMA) to the Ohio River. Effluent from the PGDP is a major source of flow in both Little Bayou Creek and Bayou Creek during low-flow periods.

Data Evaluation

Measured outfall flows were examined and compared with permitted flows and overall plant water usage to assess whether or not the water usage and plant discharges balanced. Since outfall flows were typically monitored no more than twice per month, variations in flow could only be approximated. Furthermore, actual plant water usage data could not be obtained. Hence, the average flows calculated for the water budget are estimates and may reflect unusual rather than typical conditions.

Figure 12 illustrates the average plant raw water intake, anticipated cooling water evaporation, typical water uses, and anticipated overall outfall discharge quantities obtained from a Kentucky Pollutant Elimination System (KPDES) permit. Sources of the permit data and additional data showing hourly, daily, or monthly flow and evaporation quantities were not available. Figure 12 does not include any precipitation runoff. Overall, the plant uses about 17 million gallons per day (MGD) of raw water. Over two thirds of the raw water (12.2 MGD) is expected to be lost as evaporation. Figure 13, from a separate KPDES permit written later is similar, but incorporates the groundwater treatment system. The reason for the differences in evaporation from the cooling towers and other discrepancies between each permit are unknown.

II. FLOWS, SOURCES OF POLLUTION, AND TREATMENT TECHNOLOGIES

A. Continued

1. Plant Water Balance and Outfall 006

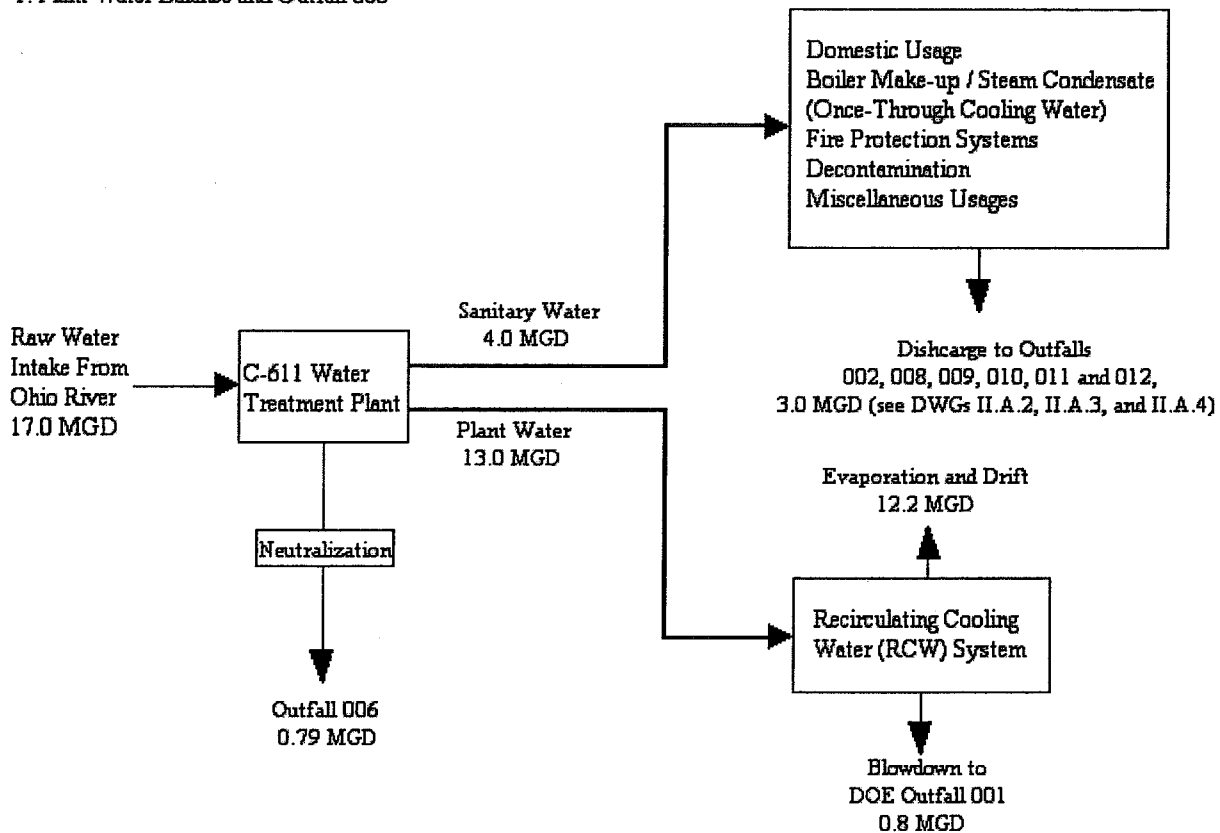


Figure 1 - Flows, sources of pollution, and treatment technologies

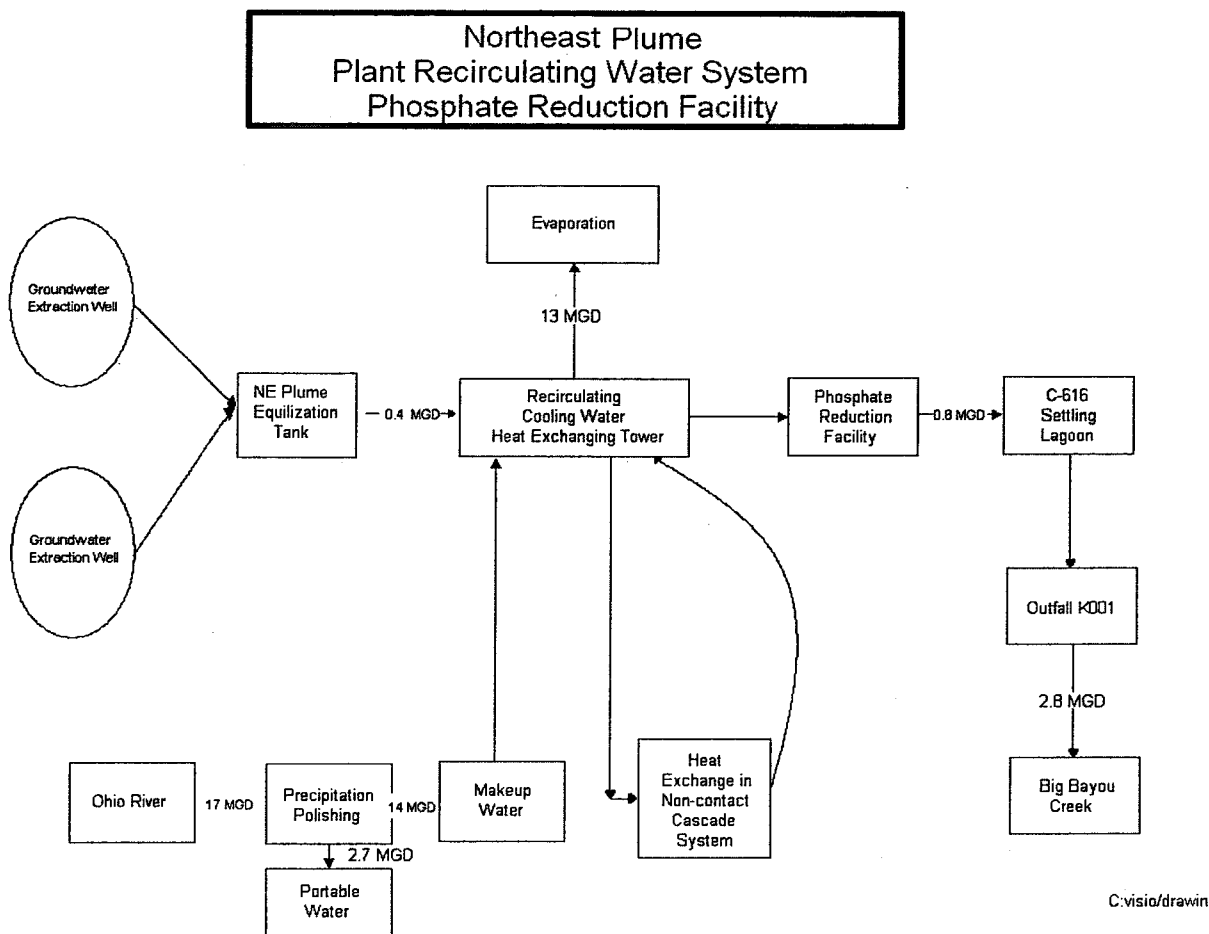


Figure 2 - Plant re-circulating water system

Figure 3 summarizes the water budget using permit limits. The permit limits total 6.94 MGD compared to the 4.6 MGD anticipated discharge shown in Figure 1. This difference would allow approximately 30 to 40 inches of runoff from the plant process area, which is reasonable. Measured average flows for the period 1993 to 2003 compared to the permitted levels for the outfalls discharging to Bayou Creek and Little Bayou Creek are shown in Table 1. If the measured flows, rather than permitted flows are incorporated into the water budget (Figure 4), the discrepancy would amount to 7 to 10 feet of runoff from the process area.

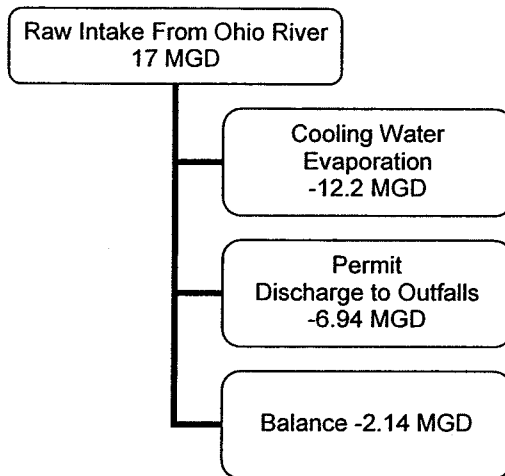


Figure 3 - Water budget by permit

Table 1 - Average flows of Bayou and Little Bayou Creek, 1993-2003

Average Flows 1993-2003 Bayou Creek				(Permitted Outfalls) Little Bayou Creek			
Outfall	Observed	Permit		Outfall	Observed	Permit	
1	2.24	2.8	DOE	2	0.68	0.16	USEC
4	0.66	0.35	USEC	10	0.57	0.71	USEC
6	0.94	0.79	USEC	11	0.35	0.18	USEC
8	0.97	1.22	USEC	12	0.68	0.14	USEC
9	0.72	0.35	USEC	13	0.75		USEC
15	1.31		DOE	19	0.5		DOE
16	0.46	0.00	USEC				
17	1.22		DOE			0.24	not outfall specific
Total	8.52	5.51			3.53	1.43	
Actual Combined Total			12.05				
Permit Combined Total			6.94				
Difference			5.11				
Units in MGD							

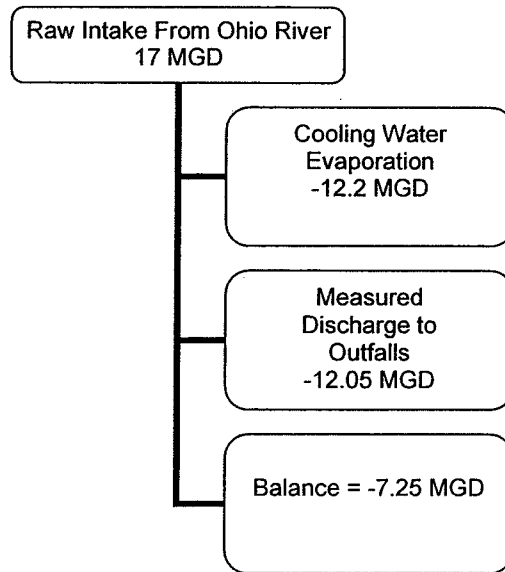


Figure 4 - Water Budget Observed for Outfalls

Median flows rather than average flows were also calculated for each outfall. The median flow is slightly less than the average flow, but the differences were negligible in comparison to the rather large imbalance in the water budget.

Outfall flows measured at a biweekly frequency or less are not sufficiently precise to support calculation or identification of average and median flows or accurate development of a water budget. Raw water intake and cooling water evaporation will vary seasonally and depending on changes in process operations. Use of a single number for each introduces additional error. Frequent monitoring of all outfalls and access to hourly or daily plant water use records would be necessary to complete an accurate water budget.

