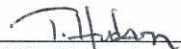


**Bayou Creek and Little Bayou Creek
Watershed Monitoring Plan
Paducah Gaseous Diffusion Plant,
Paducah, Kentucky**

This document is approved for public release per review by:



LATA Kentucky Classification Support

6-8-2011
Date

DRAFT

**Bayou Creek and Little Bayou Creek
Watershed Monitoring Plan
Paducah Gaseous Diffusion Plant,
Paducah, Kentucky**

Date Issued—June 2011

Prepared for the
U.S. DEPARTMENT OF ENERGY
Office of Environmental Management

Prepared by
LATA ENVIRONMENTAL SERVICES OF KENTUCKY, LLC
managing the
Environmental Remediation Activities at the
Paducah Gaseous Diffusion Plant
under contract DE-AC30-10CC40020

DRAFT

CONTENTS

FIGURES.....	iii
TABLE.....	iii
ACRONYMS.....	iv
EXECUTIVE SUMMARY	v
1. INTRODUCTION.....	1
1.1 SITE DESCRIPTION.....	1
1.2 STUDY AREA	1
1.3 GEOHYDROLOGY.....	1
1.4 BAYOU AND LITTLE BAYOU CREEK DRAINAGE BASINS.....	3
1.5 FLOW CHARACTERISTICS.....	3
1.6 LAND USE.....	4
2. BACKGROUND INFORMATION FOR THE WATERSHED MONITORING PROGRAM	4
3. OBJECTIVES OF THE WATERSHED MONITORING PROGRAM.....	6
4. EFFLUENT INFORMATION	6
5. GENERAL REQUIREMENTS FOR SAMPLING AND ANALYSIS FOR TOXICITY.....	8
6. QUALITY ASSURANCE STATEMENT.....	9
7. REFERENCES.....	9

FIGURES

1. Map of Paducah Site in Relation to the Geographic Region.....	2
2. Location of KPDES Outfalls for PGDP	7

TABLE

1. KPDES Outfalls at the Paducah Gaseous Diffusion Plant	8
--	---

ACRONYMS

BMP	Biological Monitoring Program
<i>CFR</i>	<i>Code of Federal Regulations</i>
DOE	U.S. Department of Energy
KDOW	Kentucky Division of Water
KPDES	Kentucky Pollutant Discharge Elimination System
ORNL	Oak Ridge National Laboratory
PGDP	Paducah Gaseous Diffusion Plant
QAPP	Quality Assurance Project Plan
RGA	Regional Gravel Aquifer
SWMU	solid waste management unit
USEC	United States Enrichment Corporation
USGS	U.S. Geological Survey
WKWMA	Western Kentucky Wildlife Management Area
WMP	Watershed Monitoring Plan

EXECUTIVE SUMMARY

In November 2009, the Kentucky Division of Water (KDOW) issued to the U.S. Department of Energy and its contractors, a renewed Kentucky Pollutant Discharge Elimination System (KPDES) permit for Paducah Gaseous Diffusion Plant (PGDP) with an effective date of December 1, 2009.

The renewed permit also specified that a revision to the Watershed Monitoring Plan (WMP) be submitted to KDOW by February 1, 2010. As specified, the revised WMP was submitted to KDOW on February 1, 2010. The revised WMP stipulated that the watershed monitoring program was comprised of the toxicity analysis at the outfalls, as well as annual aquatic organism sampling in the two watersheds (Bayou Creek and Little Bayou Creek). Although the WMP stipulated the aquatic organism sampling, the renewed permit stated that over the previous years Bayou Creek and Little Bayou Creek had been extensively sampled to the point that further collection of aquatic organisms could result in a deleterious effect on the aquatic community; therefore, biological sampling was not a monitoring requirement. In order to provide data for future ecological assessments, however, as a very conservative approach, the aquatic organism sampling was continued in the order of benthic macroinvertebrate monitoring.

Upon further review of the data sets generated from the historical sampling campaigns conducted over the years, it was determined that these historical sampling campaigns have provided sufficient data to perform future ecological assessments.

Additionally, recent remediation efforts by DOE and its contractors have targeted large scale removal of sediment and soil that eliminated sources of contaminants that had potential contact with aquatic organisms; therefore, the historical sampling campaigns would have produced data that would be biased high relative to current conditions.

In summary, the purpose of this revision to the WMP is to remove the aquatic organism sampling from the WMP. The WMP will be implemented by following the approved KPDES permit for toxicity analysis at all outfall locations.

1. INTRODUCTION

1.1 SITE DESCRIPTION

The Paducah Gaseous Diffusion Plant (PGDP) is located in Western Kentucky and owned by the U.S. Department of Energy (DOE). PGDP is an active uranium enrichment facility consisting of a diffusion cascade and extensive support facilities. In July 1993, DOE leased the gaseous diffusion plant production facilities to the United States Enrichment Corporation (USEC). USEC is responsible for the operation of the cascade and support facilities. The two DOE remediation contractors for DOE are responsible for environmental restoration and waste management activities at the site and cylinder management operation of the depleted uranium hexafluoride (DUF_6) conversion facility.

1.2 STUDY AREA

PGDP is located in the Tennessee/Mississippi/Cumberland Basin Management unit per the Kentucky Watershed Management Framework (see Figure 1). The confluence of the Ohio River with the Tennessee River is approximately 24 kilometers (km) (14.9 miles) upstream of the site. The confluence of the Ohio River with the Mississippi River is approximately 56 km (34.8 miles) downstream of the site. Surface drainage from PGDP enters Bayou Creek and Little Bayou Creek, two small tributaries to the Ohio River.

In terms of the U.S. Geological Survey (USGS) areas, Bayou Creek and Little Bayou Creek are located in the Heath (N3700-W8845) and Joppa (N3707.5-W8845) USGS quadrangles. Massac Creek and West Fork of Massac Creek, which have been utilized as upstream reference locations in historical sampling campaigns, are located in the Paducah West (N3700-W8837.5) USGS quadrangle.

1.3 GEOHYDROLOGY

PGDP lies in the northern margin of the Mississippi Embayment of the Gulf Coastal Plain Province. The shallow Mississippi Embayment formations in the vicinity of PGDP consist mainly of fine to medium-grained clastic materials, including (from oldest to youngest) the Cretaceous McNairy Formation, the Paleocene Porters Creek Clay, and undifferentiated Eocene Sands (Olive 1980).

Following deposition of the embayment sediments, the region either was uplifted and/or sea level lowered, resulting in the development of an erosional surface that partially truncated the sediments. Subsequently, during the late Tertiary and Quaternary periods, a sedimentary unit locally designated as the Continental Deposits was laid down over the region. The Continental Deposits consist of a lower gravel unit and an upper silt or clay unit. Immediately overlying the Continental Deposits, Pleistocene loess (originating as windblown material generated by glacial activity) was deposited in a layer of variable thickness [from 3 to 10 m (9.8 to 32.8 ft)]. Recent Ohio River alluvial deposits occur at lower elevations along the river's floodplain.

The local groundwater hydrology in the vicinity of PGDP is dominated by the Continental Deposits. Groundwater flow in the loess and the upper member of the Continental Deposits is primarily downward to the lower member of the Continental Deposits, which form the Regional Gravel Aquifer (RGA). The RGA is the uppermost aquifer underlying most of PGDP and the contiguous area north of PGDP. Flow within the RGA is north to the Ohio River. Terrace escarpments of the ancestral Tennessee River occurring under the south end of PGDP form the southern limit of the RGA.

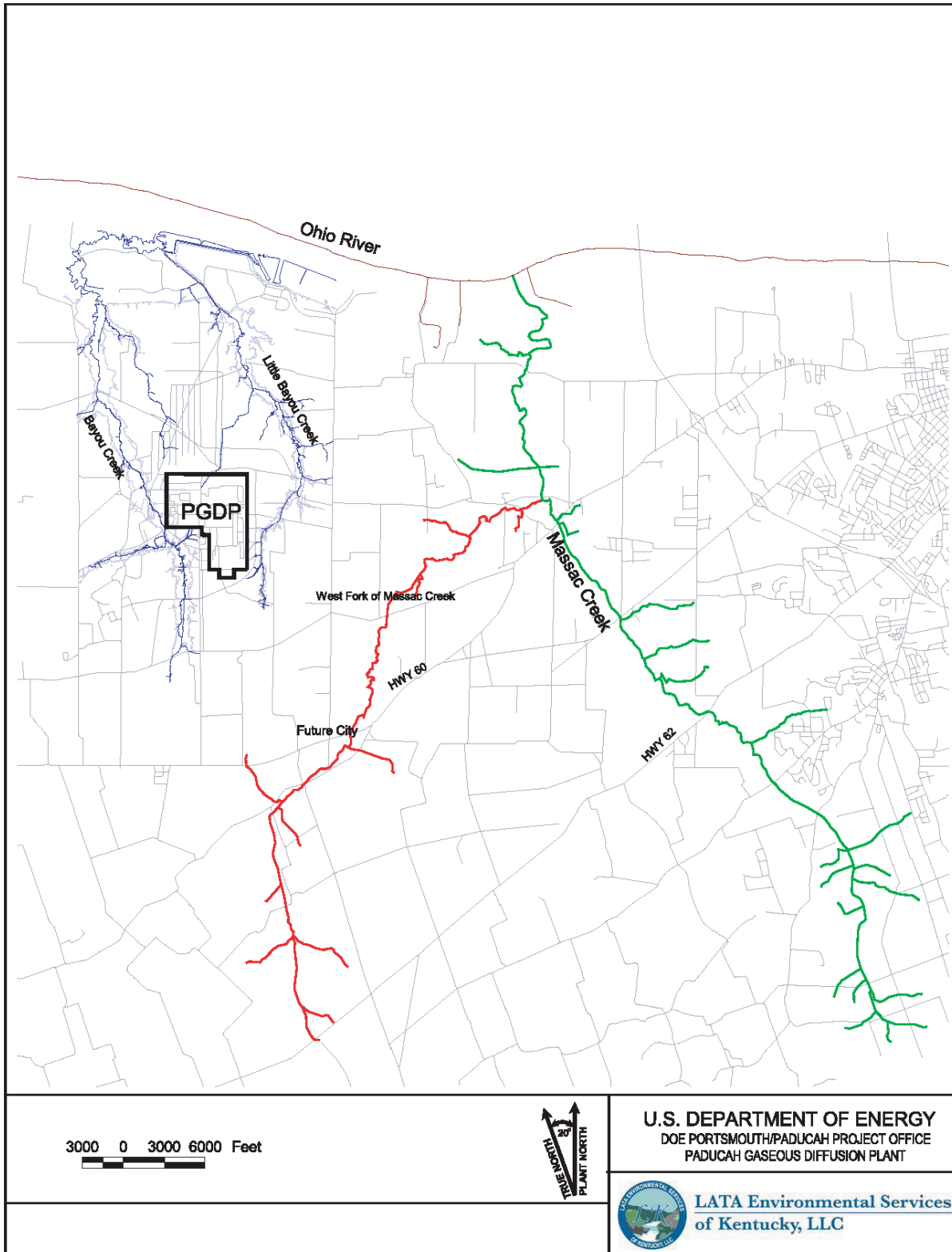


FIGURE No. c5ac90002sk091.pdf
DATE 6/7/11

Figure 1. Map of Paducah Site in Relation to the Geographic Region

1.4 BAYOU AND LITTLE BAYOU CREEK DRAINAGE BASINS

PGDP is located on a local drainage divide; surface flow is east-northeast toward Little Bayou Creek and west-northwest toward Bayou Creek. (Figure 1). These streams meet 4.8 km (3 miles) north of the site and discharge to the Ohio River.

Bayou Creek is a perennial stream with a drainage basin extending from 4 km (2.5 miles) south of PGDP to the Ohio River; part of its 14.5-km (9-mile) course flows along the western boundary of the plant. Little Bayou Creek originates in the West Kentucky Wildlife Management Area (WKWMA) and flows for 10.5-km (6.5 miles) north toward the Ohio River. Little Bayou Creek's course includes part of the eastern boundary of the plant. The watershed areas for Bayou Creek and Little Bayou Creek are about 4,819 and 2,428 hectares (11,908 and 6,000 acres), respectively.

These streams exhibit widely fluctuating discharge characteristics that are closely tied to local precipitation and facility effluent discharge rates. Precipitation in the region averages about 120 cm (47.24 inches) per year. Natural runoff makes up a small portion of the flow. During dry weather, effluents from PGDP operations can constitute about 85% of the normal base flow in Bayou Creek and 100% in Little Bayou Creek. During the dry season, which extends from summer to early fall, no-flow conditions may occur in the upper section of Little Bayou Creek.

The lower Bayou Creek and Little Bayou Creek drainage has a low to moderate gradient. The lower reaches are within the flood plain of the Ohio River. The drainage basin is included in ecoregion 72 (Interior River Lowland) of the contiguous United States (Omenik 1987). Vegetation is a mosaic of forest, woodland, pasture, and cropland. Additional information on vegetative cover, bank structure, channel morphology, substrate and cover variables, and flow conditions obtained during a 1991 survey are published in Kszos (1994).

1.5 FLOW CHARACTERISTICS

Historical flow data is available through the USGS. The USGS Water Resources Division collected data through the use of gauging stations that were positioned on Little Bayou and Bayou Creek, which were downstream of PGDP.

The Kentucky Pollutant Discharge Elimination System (KPDES) permit¹ issued on November 24, 2009, details some specifics regarding receiving waters, stream segment use, stream segment antidegradation, and low-flow conditions. Flow information is detailed in this KPDES permit.

The KPDES permit explains the receiving waters as follow:

Outfalls 001, 015, and 017 discharges [sic] to Bayou Creek at mile points 5.6, 6.2, and 7.1, respectively. Outfalls 019 and 020 discharges [sic] to an Unnamed Tributary of Little Bayou Creek at mile point 0.25.

¹ This is a reference to the KPDES permit issued on November 24, 2009. This referenced information is not expected to be changed in subsequent permit revisions because the information describes general site information; therefore, a revision to the KPDES permit should not warrant a change to this plan unless the content of the information is revised within the permit.

The fact sheet issued with the KPDES permit explains the stream segment use classifications as follow:

Bayou Creek and Little Bayou Creek are classified as Warmwater Aquatic Habitat, Primary Contact Recreation, Secondary Contact Recreation, and Domestic Water Supply.

The fact sheet issued with the KPDES permit describes the stream segment antidegradation categorization as follow:

The segment of Bayou Creek from the mouth, mile point 0.0, to mile point 6.5 is listed as impaired on the 2004 303(d) List of Waters For Kentucky. Impairments include nonsupport of aquatic life, nonsupport of swimming, and partial support of minimum criteria. Pollutants of concern are Mercury, Radiation, and Metals. Suspected sources are industrial point sources and land disposal. Bayou Creek is listed as a 1st Priority. Bayou Creek has been delisted as being impaired for pH and Thermal modifications. The segment of Little Bayou Creek from the mouth, mile point 0.0, to mile point 6.5 is listed as impaired on the 2004 303(d) List of Waters For Kentucky. Impairments include nonsupport of aquatic life, nonsupport of fish consumption, and partial support of minimum criteria.

The fact sheet issued with the KPDES permit describes the stream low-flow condition as follow:

At the point of discharges, the 7Q10 and the Harmonic Mean for the Bayou Creek are 0.00 and 0.50 cfs, respectively. At the point of discharges, the 7Q10 and the Harmonic Mean for the Little Bayou Creek are 0.00 and 0.10 cfs, respectively. At the city of Cairo, Illinois intake, the nearest downstream public water supply intake, the 7Q10 and the Harmonic Mean for the Ohio River are 46,300 and 198,238 cfs, respectively.

1.6 LAND USE

The area surrounding PGDP is mostly rural, with residences and farms surrounding the plant. Immediately adjacent to PGDP is WKWMA, 2,760 hectares (6,817 acres) of managed habitat licensed to the Commonwealth of Kentucky.

The population within an 80-km (49.7-mile) radius of the plant is about 300,000 people. The incorporated communities of Grahamville and Heath are within 2 and 3 km (1.2 and 1.9 miles) and are located east of the facility. The nearest city in the region is Paducah, Kentucky.

2. BACKGROUND INFORMATION FOR THE WATERSHED MONITORING PROGRAM

The Commonwealth of Kentucky Natural Resources and Environmental Protection Cabinet issued a KPDES Agreed Order on September 24, 1987. The University of Kentucky developed the first biological monitoring plan (BMP) for PGDP. PGDP and Oak Ridge National Laboratory (ORNL) reviewed the PGDP BMP. Then DOE submitted the PGDP BMP to the Kentucky Division of Water (KDOW) and the PGDP BMP was implemented in 1987.

In March 1998, KDOW issued a renewed KPDES permits to DOE for PGDP with an effective date of April 1, 1998. The renewed DOE permit required chronic toxicity monitoring, on a quarterly basis, of one

continuous outfall (Outfall 001) and acute toxicity monitoring of three intermittent outfalls (Outfalls 015, 017, and 019). A Watershed Monitoring Plan (WMP) was submitted to KDOW in 1998. This plan was developed from previous monitoring efforts with guidance from “Methods for Assessing Biological Integrity of Surface Waters” [KDOW 2008 (formerly KDOW 1993)]. The WMP was implemented beginning in September 1999.

In February 2003, KDOW requested additional changes to the WMP. The changes included relocating sampling locations and parameters, reducing the sampling of fish for bioaccumulation studies to every other year, and eliminating one sampling location. These changes were incorporated into a revised 2003 WMP, which was implemented in June 2003.

In September 2006, KDOW issued a renewed KPDES permit with an effective date of November 1, 2006. The renewed permit required chronic and acute toxicity monitoring at KPDES Outfalls 001, 015, 017, and 019. It removed the fish community and the fish tissue sampling from the WMP. It also required that a revised WMP be submitted to KDOW by December 1, 2006, removing the fish sampling from the program due to previous extensive sampling. Further fish collection could have had a deleterious effect on the aquatic community. Although biological sampling of aquatic organisms was not required by the permit, a decision was made to continue the benthic macroinvertebrate monitoring for data collection for future ecological assessments.

In November 2009, KDOW issued a renewed KPDES permit for PGDP to DOE and its contractors with an effective date of December 1, 2009. This renewed permit added Outfall 020 as a monitoring location. Outfall 020 constitutes discharge of treated leachate from the C-746-U Contained Landfill and the C-746-S Closed Residential Landfill. This discharge was not a new effluent to the site but was added to clarify reporting conditions. Additionally, some reductions to the required chemical parameters were also reflected in the permit modification. The renewed permit specified chronic toxicity monitoring on a quarterly basis of one continuous outfall (Outfall 001) and acute toxicity monitoring on a quarterly basis for the remaining permitted, intermittent outfalls (Outfalls 015, 017, 019, and 020). Additionally, chronic toxicity monitoring was required on a monthly basis at Outfall 017, when discharge from operations begins at the DUF₆ conversion facility, a co-permittee of the permit.

The renewed permit also specified that a revision to the WMP be submitted to KDOW by February 1, 2010. As specified, the revised WMP was submitted to KDOW on February 1, 2010. The revised WMP stipulated that the watershed monitoring program was comprised of the toxicity analysis at the outfalls, as well as annual aquatic organism sampling in the two watersheds (Bayou Creek and Little Bayou Creek). Although the WMP stipulated the aquatic organism sampling, the renewed permit stated that, over the previous years, Bayou Creek and Little Bayou Creek had been extensively sampled to the point that further collection of aquatic organisms could result in a deleterious effect on the aquatic community; therefore, biological sampling was not a monitoring requirement. In order to provide data for future ecological assessments, however, as a very conservative approach, the aquatic organism sampling was continued in the order of benthic macroinvertebrate monitoring.

Upon further review of the data sets generated from the historical sampling campaigns conducted over the years, it was determined that these historical sampling campaigns have provided sufficient data to perform future ecological assessments. Additionally, recent remediation efforts by DOE and its contractors have targeted large scale removal of sediment and soil that eliminated sources of contaminants that had potential contact with aquatic organisms; therefore, the historical sampling campaigns would have produced data that would be biased high relative to current conditions.

In summary, the purpose of this revised WMP is to remove the aquatic organism sampling from the WMP. The WMP will be implemented by following the approved KPDES permit for toxicity analysis at all Outfall locations. By removing the aquatic organism sampling, DOE and its contractors will be following the suggested sampling approach issued by KDOW in the form of the KPDES permit [Part III, Section D] issued on November 24, 2009:

During the reissuance of the previous permit this program was imposed as permit condition to gauge the success of the DOE remediation of the Paducah Gaseous Diffusion Plant. Over the interim period the two watersheds have been extensively sampled to the point that further collection of aquatic organisms could result in a deleterious effect on the aquatic community. Therefore biological sampling will not be required as part of these programs, the permittee shall however continue with the physical/chemical assessment of these watersheds.

3. OBJECTIVES OF THE WATERSHED MONITORING PROGRAM

Bayou Creek and Little Bayou Creek are receiving streams for the PGDP effluents. Data collection activities through toxicity sampling are performed to meet the objectives of the watershed program. Data sets from historical sampling campaigns also are maintained as reference data that could be used to assess the impact of inadvertent spills or fish kills. To summarize, the objectives of the watershed monitoring program are as follows:

- (1) Evaluate potential changes to the overall ecological health of Bayou and Little Bayou Creeks by evaluating/trending the compliance monitoring results;
- (2) Determine whether discharges of process water and storm water runoff from PGDP and solid waste management units (SWMUs) associated with PGDP are adversely affecting the watershed by evaluating compliance monitoring results to permit limits; and
- (3) Provide data that could be used to assess the impact of inadvertent spills or fish kills.

Data summary information is presented in the Annual Site Environmental Report.

4. EFFLUENT INFORMATION

Monitoring of the outfalls is conducted in accordance with the KPDES permit. Per the KPDES permit, the permittees (DOE and its contractors) have responsibility for monitoring five outfalls (Outfalls 001, 015, 017, 019, and 020) at PGDP. Figure 2 shows the location of the DOE-operated outfalls.

USEC has responsibility for monitoring all of the remaining outfalls. Six of the 14 outfalls discharge continuously to the receiving streams. Outfalls 001, 004, 006, 008, and 009 discharge continuously to Bayou Creek, and Outfalls 002, 010, and 012 are combined at the C-617 pond and discharged through Outfall 010 continuously to Little Bayou Creek.

Table 1 lists the KPDES outfalls and their contributing processes.

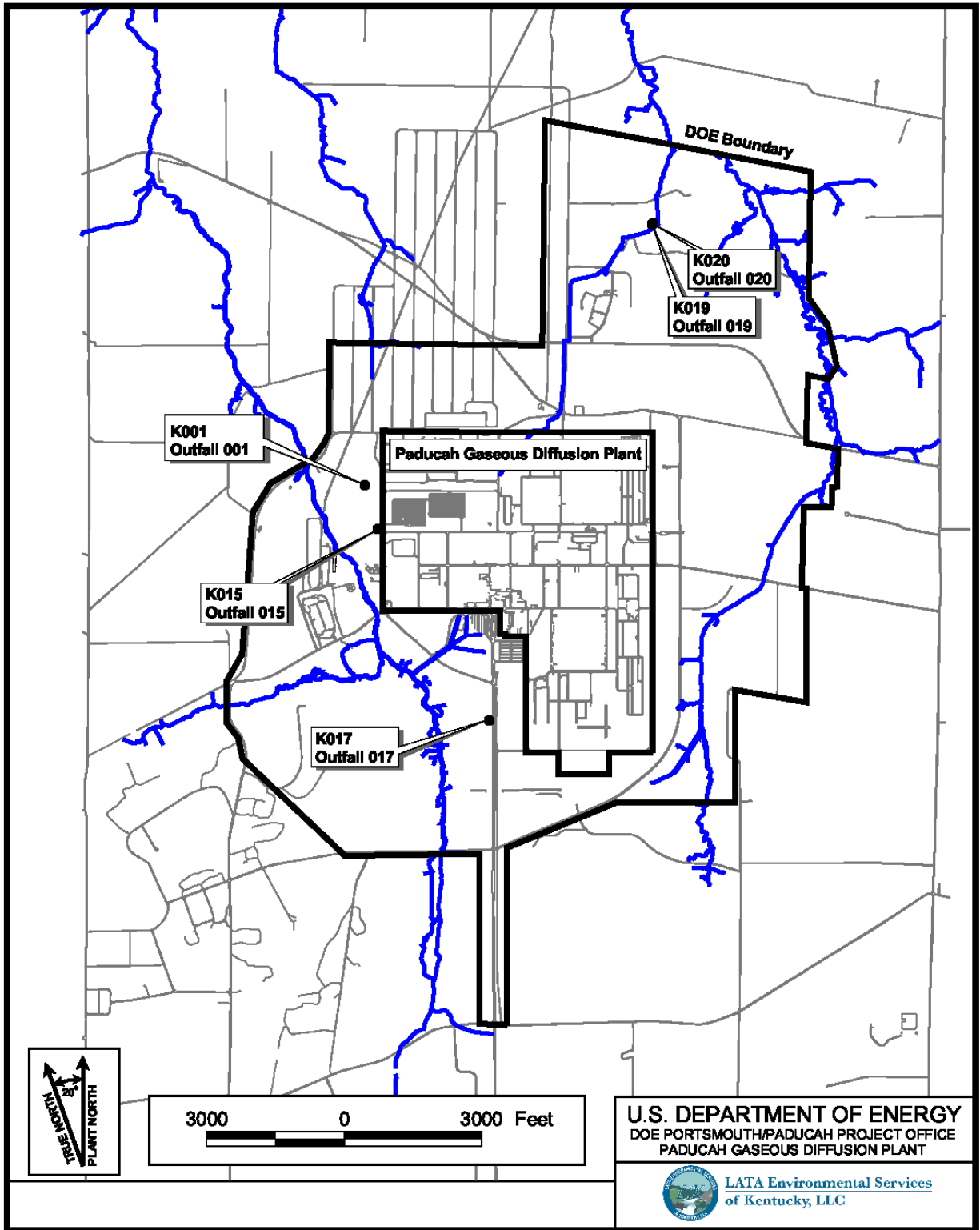


FIGURE No. c5ac90000sk881r2.apr
 DATE 06-7-11

Figure 2. Location of KPDES Outfalls for PGDP

Table 1. KPDES Outfalls at the Paducah Gaseous Diffusion Plant

Location ^a	Discharge Sources
001	The treated wastestreams of the C-752-A Waste Storage and Treatment Facility, C-752-C Decontamination Pad, C-753 Waste Treatment and Storage, C-616 Wastewater Treatment Facility currently leased to USEC, C-612 Northwest Plume Groundwater System, C-614 Northeast Plume Containment System, and C-613 Northwest Corner Storm Water Collection Basin and contributing sources of these units.
002	Cooling water, roof and floor drains, sink drains, and extended aeration sewage treatment system.
004	Domestic sewage, laboratory sink drains, motor cleaning, garage drains, laundry, machine coolant treatment filtrate, condensate blowdown, and cooling water.
006	Water treatment plant sludge, sand filter backwash, and laboratory sink drains from Outfall 005.
008	Surface drainage, roof and floor drains, cooling water, paint shop discharge, condensate, instrument shop cleaning area, metal cleaning rinse water, and sink drains.
009	Surface drainage, roof and floor drains, condensate, cooling water, and sink drains.
010	Switchyard runoff, roof and floor drains, and condensate sink drains.
011	Cooling water, roof and floor drains, switchyard runoff, condensate, and sink drain; currently rainfall runoff.
012	Roof, floor, and sink drains, condensate, surface runoff, and extended aeration sewage treatment system.
013	Storm water runoff from southeast corner of the plant.
015	Untreated storm water runoff from the C-749 Uranium Scrap Burial Yard, C-404 Low-Level Radioactive Waste Burial Ground, and the C-747 Burial Area.
016	Storm water runoff from the southwest corner of the plant.
017*	Untreated storm water runoff from the DUF ₆ conversion facility site and cylinder yards, and distilled water treatment reject stream and cooling tower blowdown from the conversion facility.
019	Storm water runoff from the covered and support areas of the C-746-U Landfill.
020	Treated leachate from the C-746-U contained landfill and the C-746-S closed residential landfill.

^a Numeral indicates outfall designation.

* Outfall 017 is controlled by the DUF₆ facility

Outfalls in large bold print indicate outfalls regulated by the KPDES permit issued to DOE and its contractors.

5. GENERAL REQUIREMENTS FOR SAMPLING AND ANALYSIS FOR TOXICITY

Toxicity is usually divided into two types, acute or chronic. These two types of toxicity are based on the number and length of exposures to a poison and the time it takes for toxic symptoms to develop. Acute toxicity is due to short-term exposure, whereas chronic exposure is due to repeated or long-term exposure and happens over a longer period.

Acute and chronic toxicity samples are collected at the designated KPDES outfall on a frequency designated by the KPDES permit. All samples are chilled and maintained at 0-6° Celsius until initiation of the tests.

The toxicity tests are conducted using *Pimephales promelas* (fathead minnows) and *Ceriodaphnia dubia* (daphnids) as the test species. Physical and chemical parameters utilized in toxicity analysis include pH, dissolved oxygen, conductivity, temperature, hardness, alkalinity, and total residual chlorine.

For chronic toxicity, three 24-hour composite samples are collected every other day. A 7-day fathead minnow larval survival and growth test and a 3-brood *Ceriodaphnia dubia* survival and reproduction test are conducted for each sample using both test species. The test methods are provided in the *Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Water to Freshwater Organisms* (EPA 2002a).

For acute toxicity, grab samples are collected during discharge events. A 48-hour static acute toxicity test is conducted for each sample on both test species. The test methods are provided in the *Methods for Measuring the Acute Toxicity of Effluents to Freshwater and Marine Organisms* (EPA 2002b).

Upon completion of each analysis and transmittal of data, results are compared to the KPDES permit criteria limits. The toxicity data reports are communicated to KDOW on a quarterly basis through the Discharge Monitoring Report.

6. QUALITY ASSURANCE STATEMENT

The quality of the data is assured by use of the quality assurance project plan (QAPP). The QAPP identifies requirements, assigns responsibilities for ensuring achievement of program objectives, and describes guidelines to be followed during sampling activities. The QAPP was developed to flow down the requirements of 10 *CFR* § 830.120 and DOE O 414.1, *Quality Assurance*. (Note: At the time that this WMP was authored, the QAPP was located as an attachment to the *Environmental Monitoring Plan*, PAD-ENM-0055; however, a sitewide QAPP is in review by regulatory agencies. Once approved, a sitewide QAPP will be issued as an independent performance document with a unique document number; a specific QAPP for environmental monitoring will not be necessary and will be removed as an appendix from future annual EMPs.)

7. REFERENCES

- EPA 2002a. *Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Water to Freshwater Organisms*, EPA/821/R/02/013, October.
- EPA 2002b. *Methods for Measuring the Acute Toxicity of Effluents to Freshwater and Marine Organisms*, EPA/821/R/02/012, U.S. Environmental Protection Agency, October.
- KDOW 2008. *Methods for Assessing Biological Integrity of Surface Waters*, Environmental and Public Protection Cabinet, Department for Environmental Protection, Frankfort, KY.
- Kszos, L. A. (ed.) 1994. *Report on the Biological Monitoring Program at the Paducah Gaseous Diffusion Plant*, December 1990 to November 1992, ORNL/TM-12338/R1, Oak Ridge National Laboratory, Oak Ridge, TN.

Olive, W. W. 1980. Geologic Maps of the Jackson Purchase Region, Kentucky. U.S. Geological Survey Miscellaneous Investigations Series, Map I-1217. U.S. Geological Survey, Reston, VA.

Omenik, J. M. 1987. *Annals of the Association of American Geographers*, "Ecoregions of the Conterminous United States," 77:118-125.