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Coal Combustion Waste in Pennsylvania

The Case of the Hatfield's Ferry Landfill

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Executive Summary

Improper disposal of coal combustion waste (CCW) can cause serious surface and groundwater contamination with heavy metals and other toxins such as arsenic. Some polluting CCW disposal facilities are located near drinking water sources, which poses a public health risk. Pennsylvania produced 9.5 million tons of coal combustion waste (CCW) in 2004. Seventy percent (6.6 million tons) was disposed in landfills and surface impoundments, and the remainder (2.9 million tons) was placed in coal mines[1] or put to various uses such as structural fill or raw material for construction products.

The U.S. Environmental Protection Agency has recognized 24 proven damage cases and 51 potential damage cases caused by CCW disposal across the country. These cases are probably only a small fraction of the total number of actual cases, but the agency has not attempted a comprehensive review of disposal sites. There is evidence, however, of surface and groundwater contamination at additional sites that EPA has not acknowledged as damage cases.

This paper discusses one Pennsylvania site with evidence of water contamination from CCW: the Hatfield's Ferry Power Station site in Monongahela Township (Greene County). There are many other CCW disposal and use sites in the state: At least 20 landfills and three surface impoundments received coal ash for disposal in 2004, and there were 112 finished and ongoing minefill projects. There are also numerous inactive disposal sites in the state.

This paper identifies several shortcomings in Pennsylvania residual waste regulations and National Pollutant Discharge Elimination System (NPDES) permit requirements that must be addressed to reduce the environmental and public health risks created by CCW disposal. These shortcomings include groundwater monitoring requirements that call only for annual monitoring for heavy metals and other toxic constituents of CCW, and effluent monitoring requirements in NPDES permits for disposal facilities that omit effluent limitations for leachable toxic constituents of coal ash.

Recommendations for Disposal of Coal Combustion Waste

To address the environmental risks associated with CCW, we urge the Pennsylvania Department of Environmental Protection to adopt the following changes to regulations governing residual waste disposal and NPDES permit requirements:

- Require at least quarterly monitoring of groundwater and of any surface water body receiving water discharges from landfills for total and dissolved concentrations of the following parameters: antimony, aluminum, arsenic, barium, boron, cadmium, chromium, copper, lead, mercury, molybdenum, nickel, selenium, silver, and zinc. These parameters should be monitored in addition to those parameters for which quarterly monitoring is already required.
- Require at least monthly monitoring of point source effluents at CCW landfills for total concentrations of the following parameters: antimony, aluminum, arsenic, boron, cadmium, chromium, iron, manganese, lead, mercury, molybdenum, nickel, and selenium.[2]
- Require effluent limitations in NPDES permits of CCW landfills for all of the above contaminants.

Introduction

Coal combustion produced more than 9.5 million tons of coal combustion waste (CCW) in Pennsylvania in 2004. According to the Department of Energy (DOE), approximately 2.9 million tons were employed for "beneficial uses," leaving 6.6 million tons to be disposed.[3] Pennsylvania Department of Environmental Protection (PA DEP) *Residual Waste Biennial Report* data account for the fate of only 5.6 million tons of CCW in 2004: 2.5 million tons disposed in 20 landfills and three surface impoundments in the state, 782 tons landfilled out of state, 1.3 million tons used for land or mine reclamation, and 1.8 million tons used for other purposes.[4, 5]

The term "coal combustion waste" refers to wastes such as coal ash (fly ash, bottom ash), flue gas desulfurization waste (waste created when the exhaust from smokestacks at coal-burning facilities is treated to remove sulfur), and boiler slag (molten coal ash collected from the bottom of coal-burning furnaces). Management and disposal of CCW raise concerns because heavy metals and other toxins can leach out of the waste and contaminate groundwater and surface waters. Laboratory tests of leachate obtained from coal ash from Pennsylvania coal-burning facilities have found average concentrations of several contaminants above EPA Maximum Contaminant Levels (MCLs): antimony (47 times the MCL), arsenic (10 times the MCL), cadmium (8 times the MCL), chromium (1.4 times the MCL), lead (11 times the MCL), mercury (5 times the MCL), nickel (1.5 times the MCL) and selenium (2 times the MCL). Concentrations of boron and molybdenum also exceeded their respective Health Advisory Levels (HALs) in some tests. While the leachate is not required to comply with drinking water standards (Maximum Contaminant Levels or MCLs), these are a useful point of comparison to determine whether coal ash leachate may degrade water quality. There is no MCL for boron or molybdenum.

Elevated concentrations of metals are not limited to laboratory-generated ash leachate. Tests of actual landfill leachate from the Hatfield's Ferry Power Station in Pennsylvania also have shown average levels of some toxins above their respective MCL or HAL: boron (13 times the HAL), molybdenum (8 times the HAL), and nickel (1.4 times the MCL).

Water monitoring data from the Hatfield's Ferry Power Station disposal site in Monongahela Township suggest that coal ash leachate is contaminating groundwater and surface water. Despite evidence of degraded water quality, monitoring for contaminants at this facility is too infrequent. Pennsylvania residual waste regulations call for quarterly testing of groundwater for parameters such as pH, chloride, sulfate, total alkalinity, total dissolved solids, iron, and manganese, among others. However, they require only one annual sampling for toxic contaminants associated with coal ash leachate such as arsenic, barium, cadmium, chromium, copper, lead, mercury, selenium, silver, and zinc.[6] Such infrequent monitoring may fail to detect signs of groundwater quality degradation, particularly if there are seasonal variations in contaminant concentrations or if unusually dry or wet weather has upset steady-state conditions. Furthermore, annual sampling makes it difficult to detect meaningful trends and is insufficient for the timely detection of water contamination.

Point source discharges to surface water from CCW landfills are regulated under the Clean Streams Law and National Pollution Discharge Elimination System (NPDES) requirements. The parameters that have to be monitored in permitted discharges of landfill leachate are not necessarily the same as those that must be monitored in groundwater. However, Pennsylvania regulations allow the results of water monitoring required by residual waste regulations to be used to determine whether amendments to an NPDES water discharge permit are necessary.[7] Therefore, PA DEP could require facilities to test their water discharges for a wider variety of coal ash constituents found in surface water and groundwater around the CCW landfills.[8]

Water Pollution at One CCW landfill

Hatfield's Ferry Power Station landfill, Monongahela Township, PA

Surface water. Problems of surface water contamination have been documented at CCW landfills in Pennsylvania. For example, the Allegheny Energy Hatfield's Ferry Power Station CCW landfill in Monongahela Township (Greene County) has contaminated surface water around the facility with elevated levels of boron and molybdenum. This Class II landfill has a single liner and a leachate collection system that directs captured leachate to a sedimentation pond and a passive wetland treatment system built in 2001. Treated landfill leachate is discharged into an unnamed tributary of Little Whiteley Creek. The creek discharges into the Monongahela River. The landfill is less than a quarter of a mile from the water intake for the Masontown Borough Water Authority public water system on the Monongahela River.

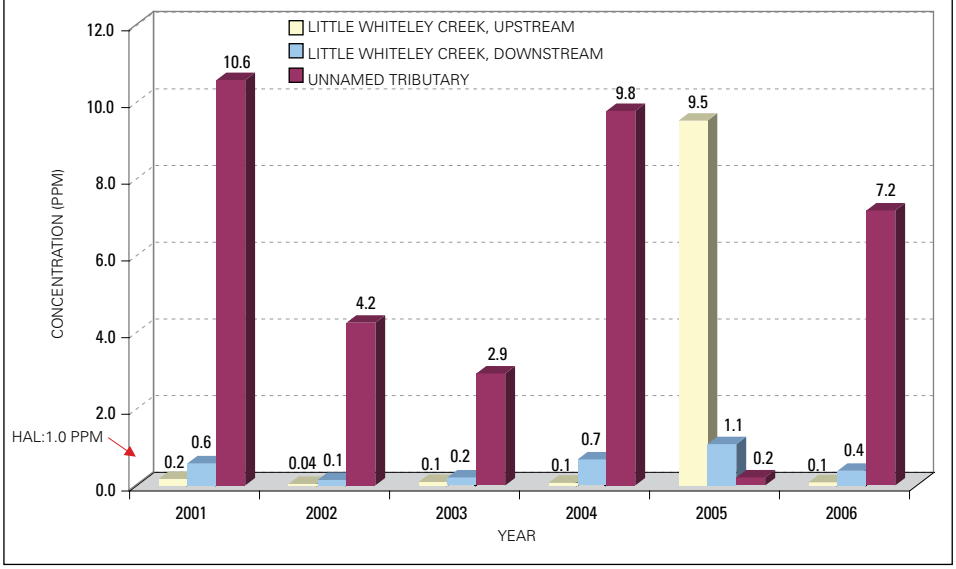
Annual monitoring has found that Little Whiteley Creek contains high levels of boron, which is characteristic of coal ash leachate. Levels are generally highest in the unnamed tributary to Little Whiteley Creek and the portion of the creek downstream of the tributary (see Table 1). From 2001 to 2006, the average boron concentration in the tributary was more than five times the EPA HAL of 1.0 ppm. The maximum concentration of 10.6 ppm was more than 10 times the HAL.

Table 1. Boron concentrations in surface water around Hatfield's Ferry landfill

Monitoring point	Concentration range, 2001–2006, (ppm)	Concentration range excluding 2005 samples* (ppm)	Average concentration, 2001–2006 (ppm)	Average concentration, excluding 2005 samples* (ppm)
Little Whiteley Creek, upstream	0.04 – 9.51	0.04 – 0.17	1.70	0.09
Unnamed tributary	0.21 – 10.6	2.92 – 10.6	5.80	6.93
Little Whiteley Creek, downstream	0.14 – 1.08	0.14 – 0.68	0.50	0.4

*Concentrations of several contaminants, including boron and molybdenum, were uncharacteristically high in Little Whiteley Creek upstream of the tributary in 2005. A comparison of monitoring results excluding 2005 samples shows that the highest concentrations were typically found in the unnamed tributary that receives landfill discharges and the portion of the creek downstream of the tributary.

Figure 1: Total Boron in Surface Water Around Hatfield's Ferry Landfill



An unusually high concentration of boron—9.51 ppm—detected in the upstream portion of Little Whiteley Creek in 2005 is also the likely result of contamination by coal ash.[9] It is also indicative that direct discharges into the tributary are not the only way the landfill affects surface water quality at the site. Groundwater transport of pollutants may also play a role. Groundwater monitoring wells 202B, 204B, 206A, and 207A all had boron concentrations above 10 ppm (more than 10 times the 1.0 ppm HAL) during the period 2003–2006. Groundwater flow is toward the area north of a sedimentation pond[10] close to Little Whiteley Creek, which suggests the possibility that groundwater contaminated by coal ash leachate may have been the source of the high boron concentration in the creek upstream of the tributary. Changing hydrological conditions in the groundwater aquifer may have caused the spike in boron concentrations in Little Whiteley Creek in 2005. A similar spike in concentrations of molybdenum and several other contaminants occurred at the same time. Unfortunately, the information available is not sufficient to determine the extent of groundwater contribution to the observed increase in boron in the creek. Without more frequent monitoring it would be impossible to determine the full magnitude or duration of such concentration spikes.

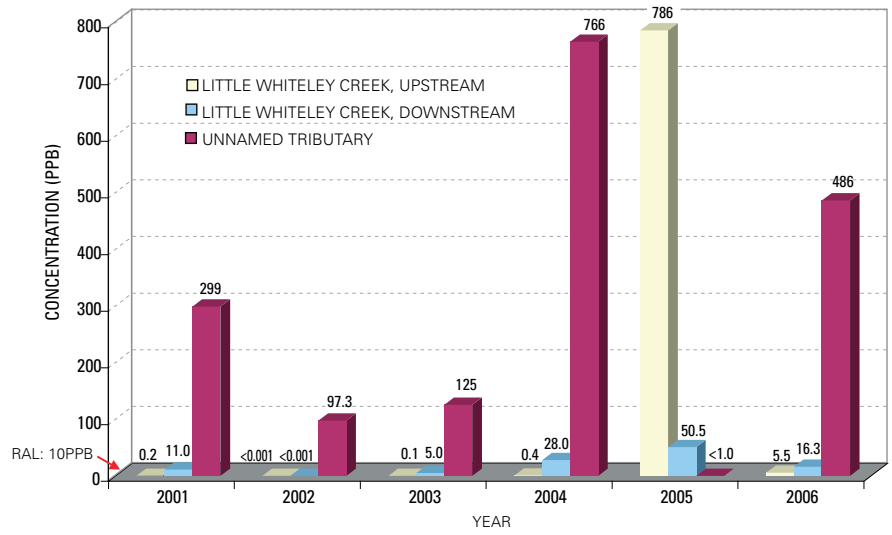
Molybdenum concentrations were usually lower in the upstream portion of the creek, with results ranging from <0.001 ppb to 5.5 ppb in five of the six samples, and one sample with 786 ppb. As in the case of boron, the unusually high molybdenum concentration upstream of the tributary was found in the 2005 sampling. The average for all six samples was 132 ppb (the average drops to 1.2 ppb if the 2005 sample is not considered). Concentrations in the downstream portion ranged from <0.001 ppb to 50.5 ppb, with an average of 18.5 ppb (12.1 ppb if the 2005 sample is excluded). Levels in the tributary were generally higher and ranged from <1.0 ppb to 766.1 ppb, with an average of 295.7 ppb. EPA has established a Superfund Removal Action Level (RAL) for molybdenum of 10 ppb and a Drinking Water Equivalent Level (DWEL) of 200 ppb, both of which have been exceeded in the tributary. The average concentration in Little Whiteley Creek downstream of the tributary also exceeded the RAL. These results indicate that discharges of landfill leachate into the tributary are degrading water quality in Little Whiteley Creek.

Table 2. Molybdenum concentrations in surface water around Hatfield's Ferry landfill

Monitoring point	Concentration range, 2001–2006 (ppb)	Concentration range, excluding 2005 samples* (ppb)	Average concentration, 2001–2006 (ppb)	Average concentration, excluding 2005 samples* (ppb)
Little Whiteley Creek, upstream	<0.001 – 786.4	<0.001 – 5.5	132.1	1.24
Unnamed tributary	<1.0 – 766.1	97.3 – 766.1	295.7	354.8
Little Whiteley Creek, downstream	<0.001 – 50.5	<0.001 – 28.0	18.5	12.1

*Concentrations of several contaminants, including boron and molybdenum, were uncharacteristically high in Little Whiteley Creek upstream of the tributary in 2005. A comparison of monitoring results excluding 2005 samples shows that the highest concentrations were typically found in the unnamed tributary and the portion of the creek downstream of the tributary.

Figure 2: Total molybdenum in surface water around Hatfield's Ferry landfill



Hatfield's Ferry is not required to monitor surface water near the landfill for thallium, although it has exceeded permitted effluent levels for thallium in its water discharges. There have been three violations of the 0.0042 ppm thallium limit at the landfill outfall since this limit became effective in September 2003. In addition, data submitted to PA DEP by Allegheny Energy in May 2003 show that 10 of the 24 effluent samples taken from August 2002 to April 2003 were above 0.0042 ppm.[11] Since those samples predated the new permit limit, the exceedances are not permit violations. However, they show that landfill leachate frequently contains excessive thallium levels. In addition, the Hatfield's Ferry landfill has had at least seven other violations of NPDES permit limits since the leachate treatment system was constructed: four for aluminum and three for manganese.[12]

The water discharge permit for the Hatfield's Ferry plant does not contain effluent limits or monitoring requirements for arsenic, molybdenum, or boron.[13] Of these, the pollutant of most concern is arsenic, because it is a carcinogen and is commonly present in significant amounts in coal ash.[14] In May 2000 the arsenic level in the unnamed tributary to Little Whiteley Creek that receives discharges from outfall 007 (which discharges treated landfill leachate into the tributary) was 12.3 ppb; the current drinking water standard, which came into effect in 2006, is 10 ppb. Even so, monitoring requirements and permit limits for this outfall include only aluminum, iron, thallium, manganese, and pH. Given the previous finding of arsenic, boron, and molybdenum, it is inappropriate for PA DEP and Hatfield's Ferry to rely on a single annual water sample to determine whether the wetland treatment system is adequately removing arsenic and other contaminants from the landfill's water discharges. Limits for outfall 006, which receives flow of treated ash transport water and coal pile runoff, include only oil and grease and pH. The lack of monitoring and effluent limits for coal ash constituents in the NPDES permit and the infrequent monitoring of surface water required by residual waste disposal rules are inappropriate and unjustified, especially in light of existing evidence of contamination caused by CCW.

Groundwater. Groundwater quality at the Hatfield's Ferry Power Station disposal site is also affected by coal ash disposal, not only in the landfill but also in a surface coal mine pit at the site. Strip-mining activities in the area produced coal that was used by the Hatfield's Ferry Power Station. Before the station's landfill was put into service in 1984, coal ash was disposed in the mine pit together with mine spoil as a reclamation measure.[15] The lower portion of the mine spoil is in contact with the water table and forms the Mine Spoil Aquifer, the uppermost aquifer at the site. This aquifer is connected with other aquifers at the site.[16] This connection makes it possible for groundwater contamination to spread to the other aquifers.

The Pennsylvania DEP is well aware that the co-disposal of coal ash and mine spoil has polluted the groundwater. In its comments on a 1996 *Application for Permit Modification* submitted by Allegheny Energy, PA DEP noted that:

"It also appears that the upgradient wells for the [landfill] have been located downgradient from this previously strip mined area. As a result, the groundwater data from these wells is the most degraded on site making significant comparisons between up/downgradient water quality difficult." [17]

In its response to PA DEP's comments, Allegheny Energy acknowledged that the backfilled mine pit was the likely source of boron contamination in the upgradient groundwater monitoring wells.[18] The leaching of toxins from the co-disposed ash and mine spoil may also explain why, like boron, elevated molybdenum levels have been found not just in downgradient monitoring wells, but also in upgradient wells.

The monitoring well with the highest average boron level during the period 2003–2006 had a concentration of 13.6 ppm, or 13 times the EPA HAL of 1.0 ppm (see Figure 3). Five of the 11 tested wells exceeded the boron HAL: three downgradient wells (202B, 203B, and 204B, which are screened in the Mine Spoil Aquifer) and two upgradient wells (wells 206A and 207A, which are screened in the Uniontown Aquifer that underlies the Mine Spoil Aquifer).

The highest average molybdenum concentration was 13.2 ppb, which exceeded the Superfund Removal Action Level (RAL) of 10 ppb.[19] Two of the 11 wells had average concentrations above the molybdenum RAL (see Figure 4). Four of the wells also had maximum concentrations above the RAL (maximum values are not shown in Figure 4). Two of these wells (202B and 205B) are screened in the Uniontown aquifer. Well 201C, screened in the Benwood Limestone aquifer that underlies the Uniontown aquifer, had a maximum concentration of 21.4 ppb, or over twice the RAL.

The presence of high boron and molybdenum concentrations in the Mine Spoil, Benwood and Uniontown Aquifers indicates that contaminated groundwater from the Mine Spoil Aquifer has penetrated and contaminated the deeper aquifers.

Figure3: Average Dissolved Boron Concentration in Groundwater

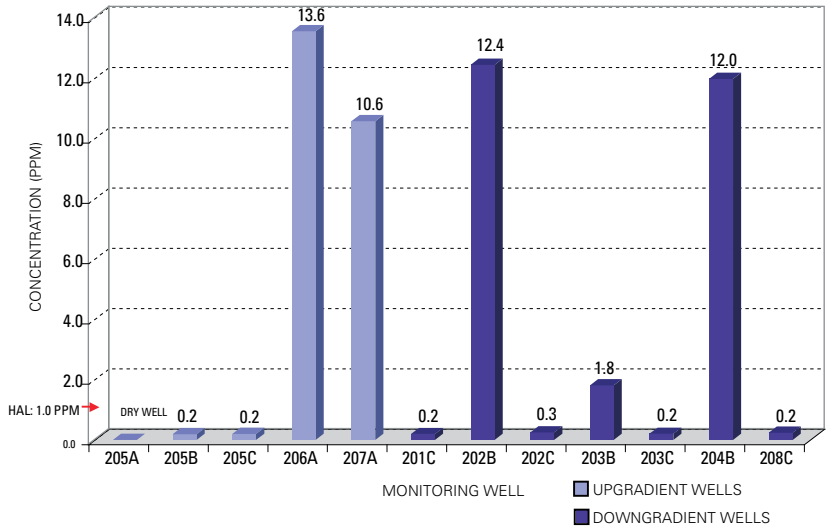
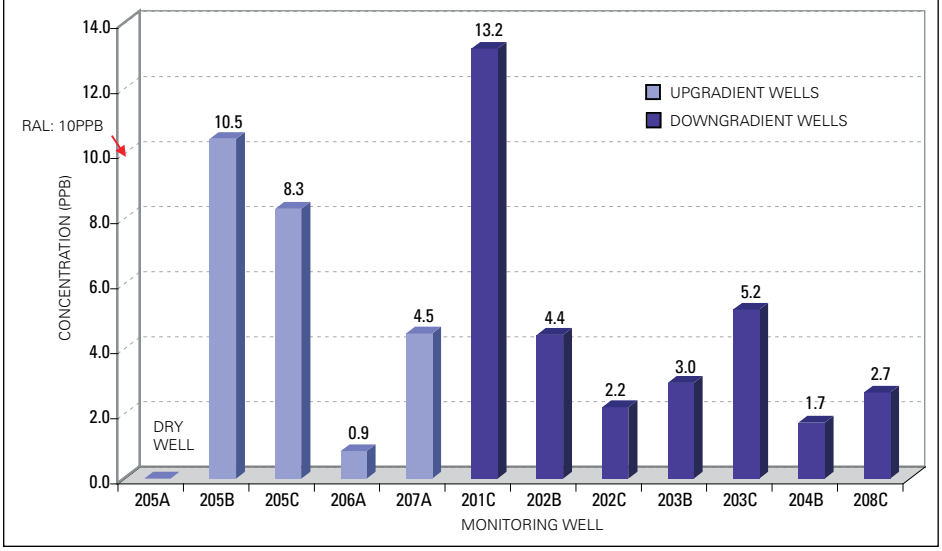


Figure 4: Average Dissolved Molybdenum Concentration in Groundwater at Hatfield's Ferry Landfill, 2003-06 Concentration



Conclusions and Recommendations

CCW management and disposal create environmental risks that need to be managed through effective pollution controls. Unfortunately, design and environmental monitoring requirements for disposal facilities do not provide sufficient protection from water contamination. Monitoring requirements for Class II landfills that receive CCW are inadequate since they call only for annual monitoring of the most toxic contaminants, making it difficult to analyze trends and detect contamination in a timely manner.

To reduce the risks posed by the management and disposal of CCW, we urge PA DEP to adopt the following changes to residual waste disposal regulations and NPDES water discharge permit requirements:

- Require at least quarterly monitoring of groundwater and of any surface water body receiving CCW landfill runoff or discharges of landfill leachate for total and dissolved concentrations of the following parameters: antimony, aluminum, arsenic, barium, boron, cadmium, chromium, copper, lead, mercury, molybdenum, nickel, selenium, silver, and zinc. These parameters should be monitored in addition to those parameters for which quarterly monitoring is already required.

- Require at least monthly monitoring of point source effluents at CCW landfills for total concentrations of the following parameters: antimony, aluminum, arsenic, boron, cadmium, chromium, iron, manganese, lead, mercury, molybdenum, nickel, and selenium.[20]

- Require effluent limitations in NPDES permits of CCW landfills for all of the above contaminants.

ENDNOTES

1 Coal mine placement of coal ash, often described as a "beneficial use" that can help improve water quality as part of mine reclamation projects, is most often just another form of disposal that carries its own pollution risks.

2 These contaminants have been found in excess of EPA Maximum Contaminant Levels (MCLs) or Health Advisory Levels (HALs) in TCLP tests of coal ash leachate and/or in surface and groundwater near CCW landfills.

3 U.S. Department of Energy (DOE) and U.S. Environmental Protection Agency (U.S. EPA), 2006, *Coal Combustion Waste Management at Landfills and Surface Impoundments*, 1994–2004. DOE/PI-0004.

4 Pennsylvania Department of Environmental Protection (PA DEP), *2004 Pennsylvania Residual Waste Biennial Report Data*. Available at: http://www.depweb.state.pa.us/landrecwaste/lib/landrecwaste/residual_waste/2004_rw.xls. Last accessed May 2, 2007.

5 Only generators producing more than 13 tons are required to submit biennial report data to PA DEP. This may explain the discrepancy between DOE and PA DEP data.

6 25 Pa. Code § 288.254.

7 25 Pa. Code § 288.456(a)(2).

8 25 Pa. Code § 92.41(c)(2).

9 Allegheny Power, 1996, *Application for Permit Modification, PA DEP Solid Waste Permit No. 300370, Allegheny Power Hatfield Power Station Ash Disposal Site, Monongahela Township, Greene County, Pennsylvania*, Volume 1, October 1996 (Revision 1: August 20, 1997).

10 Bonetti, J.E., 2005, *Proposed Geology and Hydrogeology Investigation Plan for the Proposed 2005 Expansion of Hatfield's Ferry Power Station, Greene County, Pennsylvania.* Memorandum from Joseph E. Bonetti (GAI Consultants, Inc.) to Nancy D. Pointon (Allegheny Energy Supply), June 15, 2005.

11 Allegheny Energy Supply, 2003, *Little Whitely* [sic] *& Outfall 007 Data*. Memorandum from J. Lapcevic (Allegheny Energy) to cliff Dashti (PA DEP), May 14, 2003.

12 Allegheny Energy, *Discharge Monitoring Report*[s]. As of February 2007.

13 Pennsylvania Department of Environmental Protection (PA DEP), *Authorization to Discharge Under the National Pollutant Discharge Elimination System, NPDES Permit No. 0002941*. The NPDES permit does not require the testing of point source effluent discharges of landfill leachate for arsenic, molybdenum, or boron. These contaminants are monitored in surface water (but not in effluent) as per the Solid Waste Permit (Permit No. 300370).

14 Before the wetland treatment system was constructed in the spring of 2001, surface water also showed elevated arsenic levels. Four quarterly tests in the unnamed tributary to Little Whiteley Creek in 2000 found concentrations from 2.0 to 12.3 parts per billion (ppb), with an average of 7.1 ppb. The sample that contained 12.3 ppb exceeded the EPA 10 ppb MCL for arsenic. Arsenic concentrations in the tributary have since decreased, but monitoring is now done annually, not quarterly as in 2000. Despite the previous elevated arsenic levels in the tributary, DEP has not required Hatfield's Ferry to monitor its water discharges for arsenic.

15 Allegheny Power, 1996, *Application for Permit Modification, PA DEP Solid Waste Permit No. 300370, Allegheny Power Hatfield Power Station Ash Disposal Site, Monongahela Township, Greene County, Pennsylvania*, Volume 1, October 1996 (Revision 1: August 20, 1997).

16 Bonetti, J.E., 2005, *Proposed Geology and Hydrogeology Investigation Plan for the Proposed 2005 Expansion of Hatfield's Ferry Power Station, Greene County, Pennsylvania*. Memorandum from Joseph E. Bonetti (GAI Consultants, Inc.) to Nancy D. Pointon (Allegheny Energy Supply), June 15, 2005.

17 Allegheny Power, 1996, *Application for Permit Modification, PA DEP Solid Waste Permit No. 300370, Allegheny Power Hatfield Power Station Ash Disposal Site, Monongahela Township, Greene County, Pennsylvania*, Volume 1, October 1996 (Revision 1: August 20, 1997).

18 Allegheny Power, 1996, *Application for Permit Modification, PA DEP Solid Waste Permit No. 300370, Allegheny Power Hatfield Power Station Ash Disposal Site, Monongahela Township, Greene County, Pennsylvania*, Volume 1, October 1996 (Revision 1: August 20, 1997).

19 Allegheny Energy, *Form 14R, Quarterly Water Analyses Parameters*. Boron, molybdenum, and regulated metals are monitored once per year. The average reported here for the period 2003–2006 consists of four samples from each monitoring well (one for each year). Monitoring well 205A was dry and was not sampled.

20 These contaminants have been found in excess of MCLs or HALs in tests of coal ash leachate or in surface water near CCW landfills.