WATER QUALITY IMPACTS OF COAL COMBUSTION WASTE DISPOSAL IN TWO WEST VIRGINIA COAL MINES

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ABBREVIATIONS

AMD	acid mine drainage
CCW	coal combustion waste
FBC	fluidized bed combustion
MCL	maximum contaminant level
MCLG	maximum contaminant level goal
MDL	method detection limit
MEA	Morgantown Energy Associates
NPDES	National Pollutant Discharge Elimination System
USEPA	United States Environmental Protection Agency
WQS	water quality standard
WVDEP	West Virginia Department of Environmental Protection
WVSMB	West Virginia Surface Mine Board

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SUGGESTED REFERENCE

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1. INTRODUCTION

Burning coal creates several kinds of waste, depending on the processes used. Some of these wastes include bottom ash, fly ash, flue-gas desulfurization byproducts, and fluidized bed combustion (FBC) ash, an alkaline ash disposed of extensively in West Virginia coal mines.

These coal combustion wastes (CCWs) are currently landfilled, slurried to surface impoundments, disposed in mines, or sometimes reused in construction materials. In general, disposal is costly, increasing the price of coal energy for consumers and decreasing the profits for producers. But because these materials contain certain toxic compounds, failure to dispose of them with due vigilance would be costly in terms of environmental health.

Some proponents of disposal in former coal mines suggest that returning alkaline CCWs to mines is beneficial and need not undergo careful, long-term water quality monitoring. Others suggest that CCWs introduce toxic metals into the environment and that, despite infrequent monitoring, these metals are detected downstream from disposal sites.

The National Academy of Sciences convened a committee within the National Research Council in 2004 to investigate this issue. The prospectus of that committee lists a number of points to be addressed, shown in Table 1. This report seeks to provide input into the points highlighted in bold.

Coal ash has been disposed on 88 coal mining sites across West Virginia. Almost two-thirds of these sites are located in Preston and Monongalia Counties, two adjacent counties in the north-central part of the state (WVDEP, 2004a). This report summarizes the water quality impacts of CCW disposal in two former mines in Preston County (Figure 1). The first location, the Stacks Run Refuse Site Extension, received up to 2.2 million tons of CCW. Up to 4 million tons have been placed at the Albright site.

Preston County was mined widely through approximately 1990. The most common coal mined was from the Upper Freeport seam, which contains high levels of sulfur. Many of the county's streams are impaired by acid mine drainage (AMD). There is a very clear correlation between impaired streams (identified using benthic macroinvertebrate community metrics) and the original location of mineable, Upper-Freeport coal (Mains et al., 1997). Both study areas were former coal mines where the acid-forming Upper Freeport as well as other types of coal were mined, stored, or processed. Both sites are surrounded by surface waters that are impaired by AMD. And at both sites, FBC ash was applied.

FBC is an alkaline, calcium-rich material produced when coal is burned in the presence of lime. It has been used extensively as an amendment for the refuse coal at both these sites, and at many other sites as well. It is often believed that the high pH values associated with this material prevent dissolution of many toxic chemicals found in the ash. Because the FBC process reduces emissions of sulfur dioxide, however, the process is usually used to burn coal with larger concentrations of impurities.

Instead of presenting data on all of the trace metals and other parameters monitored over the years at these sites, only certain parameters that show noticeable impacts are highlighted. This report uses self-monitoring data performed by permittees to satisfy requirements of their Surface Mining Control and Reclamation and National Pollutant Discharge Elimination System (NPDES) permits. Some data are from nearby streams; other data are from discharge points. These data were collected from the West Virginia Department of Environmental Protection (WVDEP) district office in Philippi, West Virginia and from the WVDEP headquarters in Charleston, West Virginia. Data were entered into an electronic database, data entry was spot-checked for accuracy against the original data sources, and data analysis was performed using the Microsoft Excel spreadsheet program.

Table 1: Points addressed by the Committee on Mine Placement of Coal Combustion Wastes

1. The adequacy of data collection from surface water and ground water monitoring points established at CCW sites in mines.

2. The impacts of aquatic life in streams draining CCW placement areas and the wetlands, lakes, and rivers receiving these drainage

3. The responses of mine operators and regulators to adverse or unintended impacts such as the contamination of ground water and pollution of surface waters

4. Whether CCWs and mine[s] they are being put in are adequately characterized for such placement to ensure that monitoring programs are effective and groundwater and surface waters are not degraded.

5. Whether there are clear performance standards set and regularly assessed for projects that use CCW for "beneficial purposes" in mines.

6. The status of isolation requirements and whether they are needed.

7. The adequacy of monitoring programs including:

- **a. The status of long-term monitoring and the need for this monitoring after CCW is placed in abandoned mines and active mines when placement is completed and bonds released.**
- **b. Whether monitoring is occurring from enough locations;**
- **c. Whether monitoring occurs for relevant constituents in CCW as determined by characterization of the CCW; and**
- **d. Whether there are clear, enforceable corrective actions standards regularly required in the monitoring.**

8. The ability of mines receiving large amounts of CCW to achieve economically-productive post mine land uses;

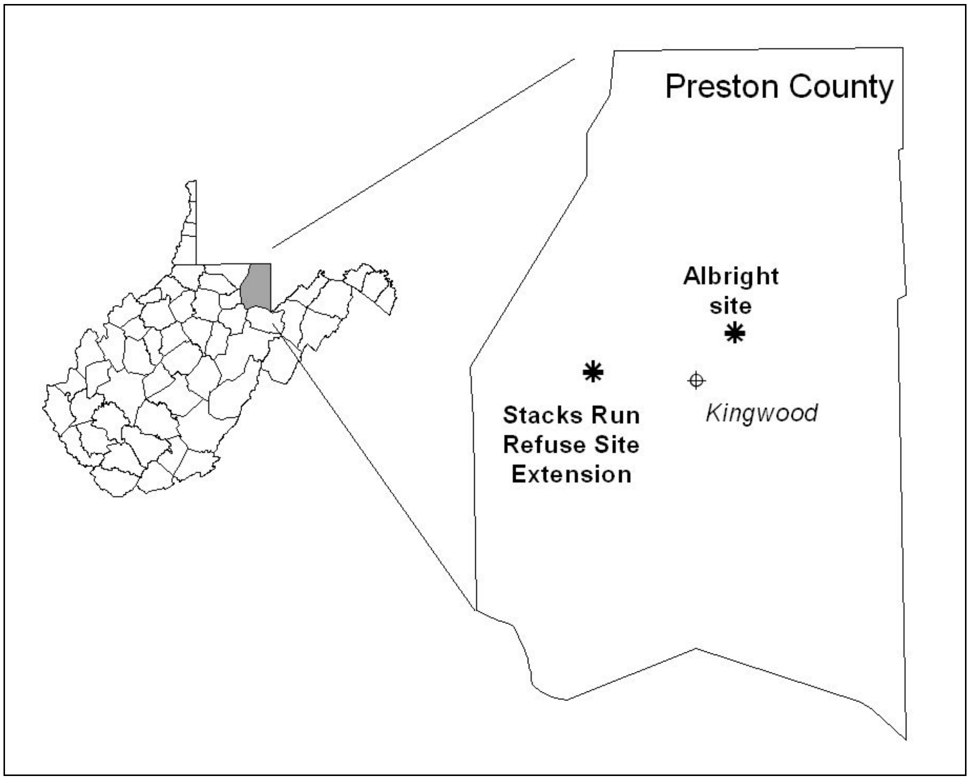
9. The need for upgraded bonding or other mechanisms to assure that adequate resources area available for adequate periods to perform monitoring and address impacts after CCW placement or disposal operations are completed in coalmines;

10. The provisions for public involvement in these questions at the permitting and policy-making levels and any results of that involvement;

11. Evaluate the risks associated with contamination of water supplies and the environment from the disposal or placement of coal combustion wastes in coal mines in the context of the requirements for protection of those resources by RCRA and SMCRA.

Source: National Research Council, 2004.

Figure 1: Location of coal combustion waste disposal sites considered in this report



In several subsequent tables, water monitoring results are compared with state standards. Table 2 compares the surface water, groundwater, and drinking water standards in effect in West Virginia.

Table 2: Surface water, groundwater, and drinking water standards

Parameter	West Virginia water quality standard	West Virginia groundwater standard	Federal drinking water maximum contaminant levels
Antimony	0.014	0.006	0.006
Arsenic	0.05	0.01	0.01
Lead	0.05	0.015	0.015 (action level) (MCLG=0)
Lead (dissolved)	Depends on hardness and conversion factor on formula	None	None
Selenium	0.005	0.05	0.05
Thallium	0.0017	0.002	0.002 (MCLG = 0.0005)

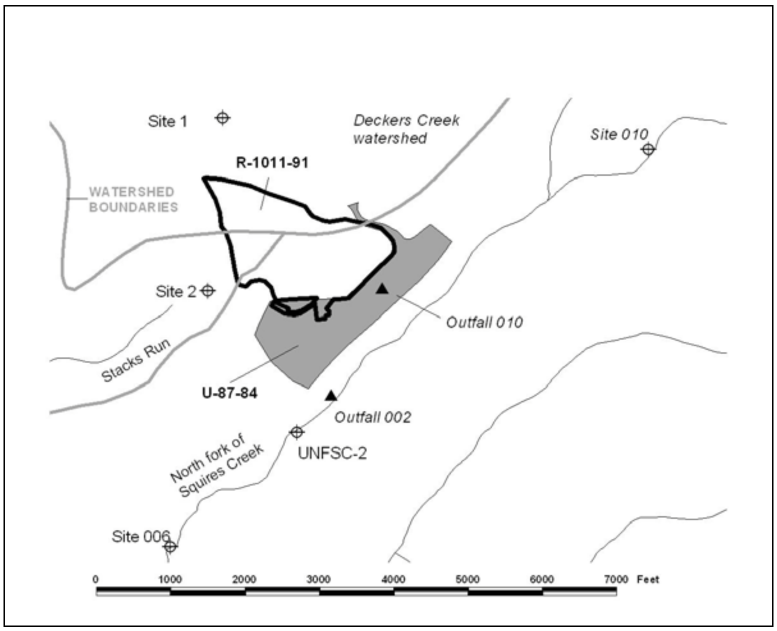
Note: West Virginia water quality standards from 46 Code of State Rules 1 and groundwater standards from 46 Code of State Rules 12. Federal drinking water MCLs from USEPA (2005). The value listed for West Virginia water quality standards are the most stringent standard among all uses for the parameter. The arsenic MCL takes effect January 23, 2006.

2. STACKS RUN REFUSE SITE EXTENSION

2.1 <u>Site description</u>

Patriot Mining Company's 59 acre Stacks Run Refuse Site Extension (Mining permit number R-1011-91) was permitted in 1991 (Figures 2 and 3). No coal was removed; instead, the site was to be used to dispose of coal refuse and power plant ash. According to the permit file, coal refuse was to be brought from Patriot's nearby cleaning plant and ash was to come from the nearby Morgantown Energy Associates (MEA) coal-fired power plant (WVDEP, 2005a).

Figure 2: Stacks Run Refuse Site Extension



Ash was first applied at this site in early 1992 (WVSMB, 1997), and continued for about seven to ten years (Hamric, 2005 and Dixon, 2005). Virtually all of the ash came from the MEA circulating fluidized bed plant. Exact amounts of ash actually applied were not reported; therefore, the total amount is not known (Hamric, 2005). However, the 1991 permit allows up to 220 thousand tons of ash to be disposed at the site each year (WVDEP, 2005a). If this amount were placed each year for seven to ten years, then, as a first approximation, an estimated 1.5 to 2.2 million tons of ash may have been disposed of at this site.

Although the permit application states that the refuse and ash were not anticipated to be commingled (WVDEP, 2005a), this is apparently not what took place. Instead, generally, about ten feet of ash was used as a liner directly on the soil. On top of the ash, about 25 to 30 inches of refuse was deposited. Another six to eight feet of ash was then used as a cap. The site was then reclaimed using short paper fiber mixed with topsoil in 2004 (Dixon, 2005).

The permitted area lies on top of a hill and drains in three different directions. The northern side flows to Deckers Creek via an unnamed tributary. The southwestern portion flows to Three Forks Creek via Stacks Run. The southeastern portion flows to Three Forks Creek via Squires Creek. Ash was stored on the portions draining to Deckers Creek and Squires Creek. The portion of the permit draining to Stacks Run was a loading and staging area.

A pond bordering the permitted area is known as the Blue Pond. In March 1993, a local resident reported a fish kill in this pond to a WVDEP mine inspector. The inspector found that this pond had become acidic, and issued a notice of violation to the permittee. The violation was appealed to the West Virginia Surface Mine Board, which found that the permitted site was the most likely source of the acidity that impaired this pond (WVSMB, 1997).

2.1.1 Other nearby permits

As shown in Figure 4, CCW was also disposed on other nearby Patriot sites, including two surface mines (S-119-82 and S-36-84), an underground mine (U-87-84), and an adjacent operation (O-1012-86) (WVDEP, 2004a). Water discharges from these sites are regulated under a single NPDES permit: WV0066885. CCW was not placed on the other nearby sites shown in Figure 4 (WVDEP, 2004a).

At the S-119-82 surface mine, coal was removed from the Upper Freeport seam in a long strip of land along the north side of the North Branch of Squires Creek. Underground mine (U-87-84), described below, has a portal opening onto the surface mine. The surface mine was to encompass 267 disturbed acres according to its permit application, which was approved in 1982. By 1987, planting had been completed. In 1988, when its Phase I bond release was approved, 197 acres had been disturbed. Although four ponds still required treatment, only Pond #1 remained bonded by this permit as the other three ponds were overbonded with other adjacent permits (WVDEP, 2005b).

In 1992, Revision #4 waived the groundwater monitoring requirements since the permit had been reclaimed for six years and there had been no reported impacts to groundwater. One year later, in 1993, Revision #5 was approved to allow the utilization of FBC ash as a soil amendment. A total of 182 thousand tons of ash were to be mixed in a 1:4 ratio with host material and were to be placed on all areas where vegetation was lacking. North Fork of Squires Creek is the only stream listed as receiving leachate from the ash disposal. Ash was to be placed on 75 acres, and was to originate from the Thames River Plant in Montville, Connecticut, a circulating FBC plant. Approximately 12 inches of ash was to be mixed with the soil on barren areas before seeding and mulching (WVDEP, 2005b). Contrary to the information in the permit file, WVDEP (2004a) states that MEA ash was applied here.

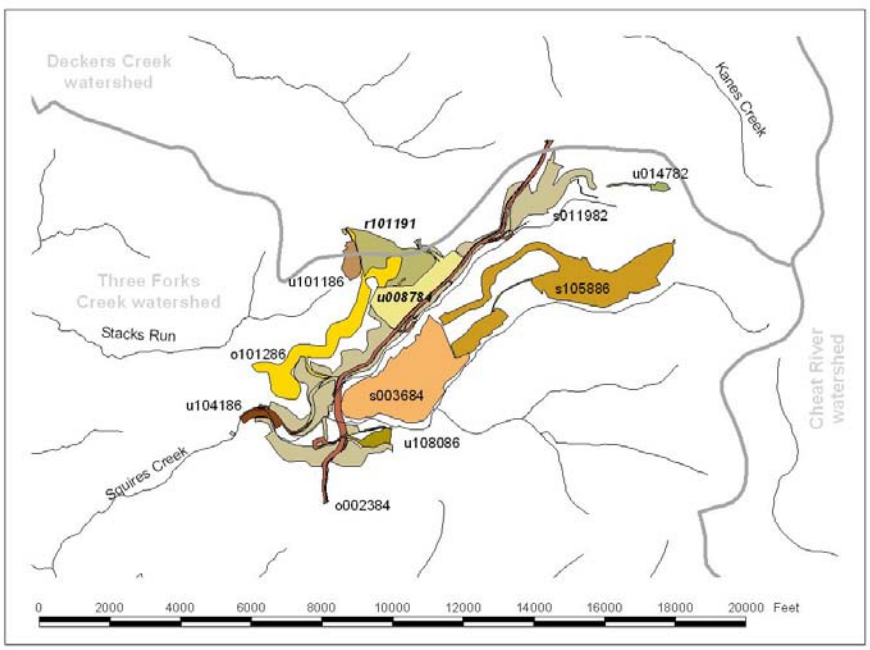
Underground coal mine U-87-84 is also permitted to Patriot and sits below the Stacks Run Refuse Site Extension. Conversations with WVDEP's environmental inspector and the person overseeing Patriot's environmental compliance through the 1990s suggest that a pit in U-87-84 was filled with ash over a very short time, probably between 1998 and 1999. FBC ash from the MEA plant was used to fill this pit (Dixon, 2005 and Hamric, 2005).

Permits S-36-84 and O-1012-86 also belong to Patriot. According to WVDEP (2004a), ash from the Thames River Plant was applied on these sites as well.

Figure 3: Aerial view of Stacks Run Refuse Site Extension

Note: The road intersection in the foreground corresponds to the northwest corner of the Stacks Run Refuse Site Extension (R-1011-91). Photo taken April 2005.

Figure 4: Stacks Run Refuse Site Extension and nearby permits



Source: WVDEP, 2004b.

2.2 Results

This analysis focuses on four instream monitoring points near the Stacks Run Refuse Site Extension. Site #1 is located in the unnamed tributary of Deckers Creek and drains the site to the north. Site #2 is located in Stacks Run and drains the staging area.[1] Two additional sites—Site #010 and Site #006—are located on Squires Creek. Site #010 is located above the Stacks Run Refuse Site Extension site but below part of Patriot's adjacent surface mine (S-119-82), on which CCW was disposed. Site #006 is located 1.6 miles downstream from Site #010 on Squires Creek, well below the Stacks Run Refuse Site Extension. Table 3 summarizes the results that are discussed in detail in the following sections.

These watersheds are already faced with severe environmental harms, making the effects of additional pollution sources hard to separate from the effects of legacy sources. Both Squires Creek and Stacks Run flow toward Three Forks Creek, which is heavily impacted by acid mine drainage. The northern slopes flow toward Deckers Creek. While much of the Deckers Creek watershed is also damaged by AMD, the unnamed tributary draining the site carries relatively little AMD. This particular subwatershed, however, does hold an inactive, unlined landfill, and substantial areas where metal-laden waste from a foundry was landfilled. This tributary is currently on West Virginia's 303(d) list as impaired by lead pollution (WVDEP, 2004c).

Table 3: Summary of results for selected metals at Stacks Run Refuse Site Extension

Metal	Site 1	Site 2	Site #010 vs. Site #006
Antimony	Samples mostly at MDL, but MDL sometimes substantially above WQS.	Samples all at MDL, but MDL sometimes substantially above WQS.	Most samples at both sites at MDL. Upstream peaks at 2 x WQS. Downstream peaks at 20 x WQS.
Arsenic	One sample at more than 2 x WQS.	All samples meet WQS.	Mostly at or close to MDL at both sites. Upstream peaks at 2 x WQS. Downstream meets WQS.
Lead	One sample just above WQS. Some MDLs at 3 x WQS.	Some MDLs at 3 x WQS.	Upstream meets WQS. Downstream peaks at 3 x WQS.
Selenium	Two samples near 8 x WQS. MDLs approach 4 x WQS.	Samples as high as 120 x WQS. MDLs approach 4 x WQS.	Upstream mostly at MDL, with one peak to 10 x WQS. Downstream peaks at 44 x WQS.
Thallium	Samples as high as 80 x WQS. Some MDLs at 22 x WQS.	Samples as high as 140 x WQS. Some MDLs at 22 x WQS.	Upstream all at MDL, but MDL sometimes about 20 x WQS. Downstream peaks at about 130 x WQS.

Note: WQS = water quality standard.

2.2.1 Impacts to Unnamed Tributary of Deckers Creek (Site #1)

Site #1 is an instream monitoring site on the unnamed tributary that drains north from the Stacks Run Refuse Site Extension to Deckers Creek. This site shows a distinct change in chemistry. Both lab and field pH measurements are available for this site, as shown in Figure 5. Starting in 1996, pH rises

[1] Sites #1 and #2 also drain the adjacent U-1011-86 site, but ash was not placed on this site (WVDEP, 2004a).

significantly, from measurements between 4 and 5 to a peak of 8.5. Most pH data points since late 1996 are in the 6 to 9 range. While iron levels are consistently relatively low, other AMD pollutants decrease significantly (Figure 6). No manganese measurements exceed about 5 mg/L after late 1996. The highest aluminum measurement after early 1998 was 2 mg/L. The increasing pH and decreasing AMD measurements suggest that the chemistry in this stream shifted in the mid-to-late 1990s, several years after FBC ash was first placed at the Stacks Run Refuse Site Extension.

Figure 5: Site #1, Unnamed tributary of Deckers Creek, pH

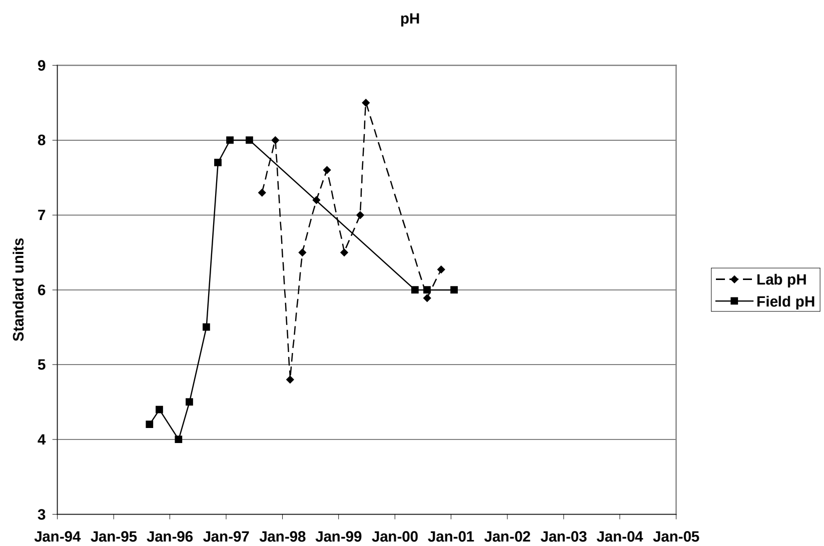
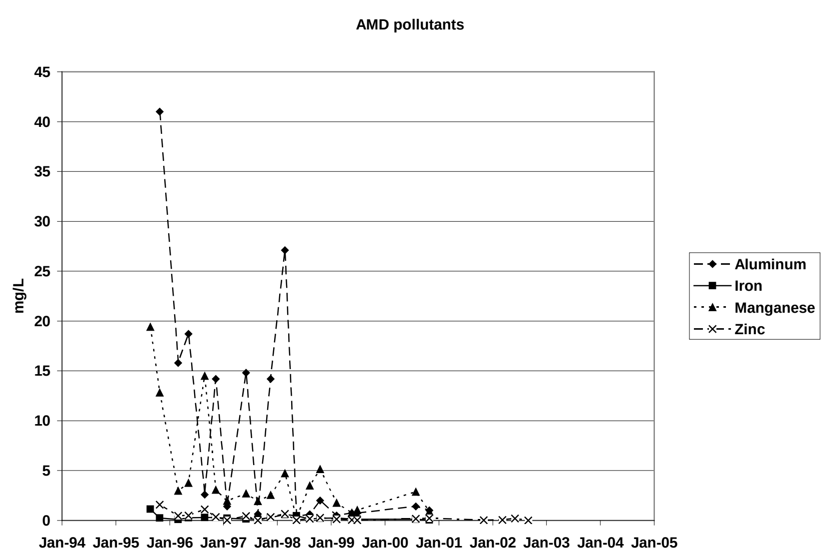


Figure 6: Site #1, Unnamed tributary of Deckers Creek, acid mine drainage pollutants



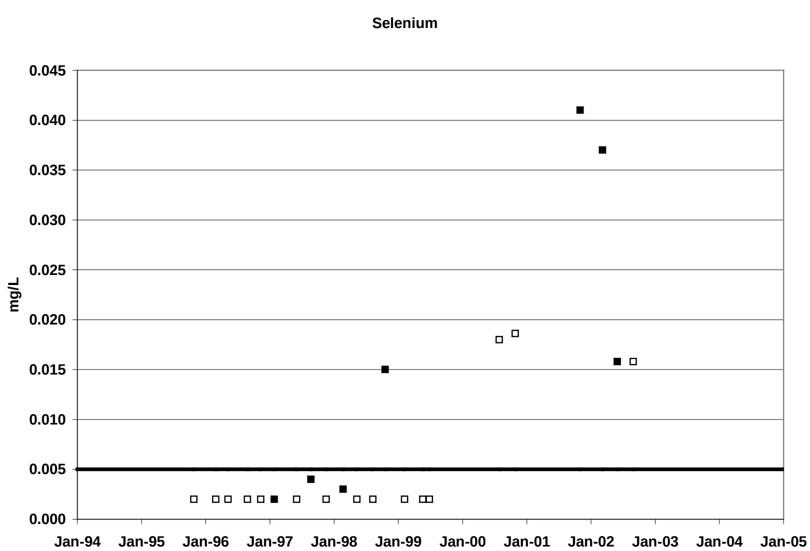
Some trace metal concentrations also increase, but somewhat later than the shifts in pH, aluminum, and manganese. Most notably, selenium and thallium levels increase substantially starting in the late 1990s and early 2000s (Figures 7 and 8). Arsenic and lead measurements also suggest an increase, but are not graphed.

On the selenium graph—and all subsequent trace metal graphs—measurements above the method detection limit (MDL) are shown as black squares. Measurements less than the MDL are shown as white squares equal to the MDL. All data points found in the permit files are included in these graphs. Dark black lines denote West Virginia's surface or groundwater quality criterion for the pollutant, as appropriate for the monitoring location.

Ten selenium measurements were found in the permittee's self-monitoring data on or after October 1998. Four of these ten measurements were significantly above the water quality criterion. In three other measurements, the MDL was more than triple the criterion, so it is not known whether the stream was meeting the selenium standard in those measurements. In only three of ten cases is it known that the selenium standard is met.

The permit file contains references to a few notices of violation that inspectors issued for this permit, but these notices identify problems related to fugitive dust and waters with low pH values. None cited the high readings of toxic metals. The permit file contained no record of enforcement actions to correct these violations.

Figure 7: Site #1, Unnamed tributary of Deckers Creek, selenium

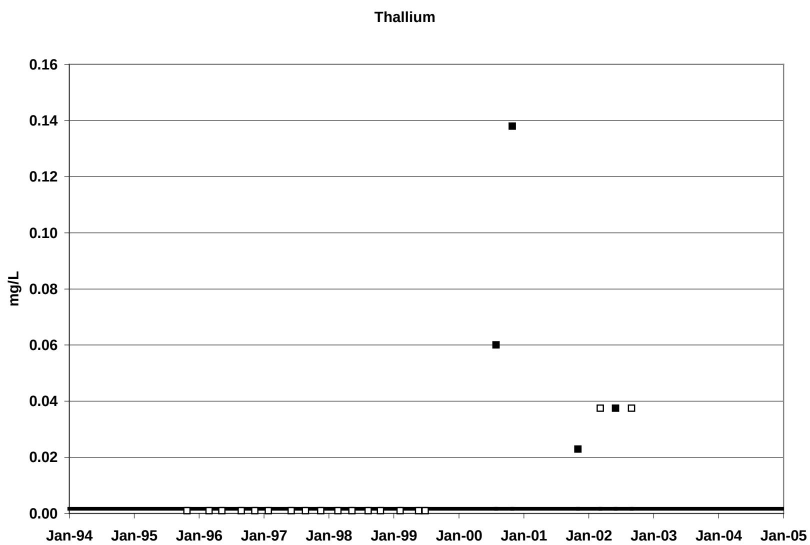


Thallium shows a similar pattern. Starting with the measurement in August 2000, four of six measurements are significantly above the water quality criterion. In the other two cases, measurements were below the MDL but the MDL of 0.0375 mg/L was more than 22 times the water quality criterion of 0.0017 mg/L.

These selenium and thallium measurements suggest that the chemistry in this stream shifted toward the end of the period when FBC ash was placed at the Stacks Run Refuse Site Extension. These increases in trace metals occurred after pH values were consistently in the 6 to 9 range.

These measurements also demonstrate the importance of using suitably low MDLs when measuring trace metals. Patriot shifted in the late 1990s from MDLs that were appropriately low, to MDLs that were too high to demonstrate compliance with standards. The shift was probably due to a change in the contract laboratory conducting the analyses (Hamric, 2005). The permit file contained no objections by WVDEP to the use of analyses with such high MDLs.

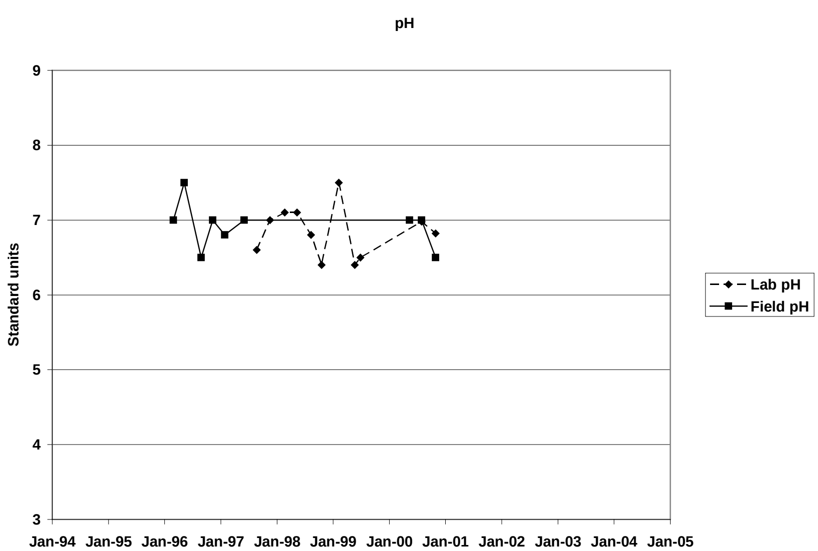
Figure 8: Site #1, Unnamed tributary of Deckers Creek, thallium



2.2.2 Impacts to Stacks Run (Site #2)

Site #2 is located in the headwaters of Stacks Run. As shown in Figure 9, pH measurements between 1995 and 2001 remained in the 6.5 to 7.5 range. Typical AMD pollutants show no clear pattern and are not graphed.

Figure 9: Site #2, Stacks Run, pH



Despite this relatively constant circum-neutral pH, selenium and thallium show a similar pattern as they did for Site #1. As shown in Figures 10 and 11, for the five samples collected since 2000, three exceed the selenium water quality criterion. Two of these samples exceed the criterion by huge amounts. As at Site #1, the other two samples were analyzed with MDLs that exceed the criterion. And again, thallium shows a similar pattern with two recent samples exceeding the water quality standard by many times. The other recent thallium samples were analyzed with MDLs that exceed the water quality standard.

Figure 10: Site #2, Stacks Run, selenium

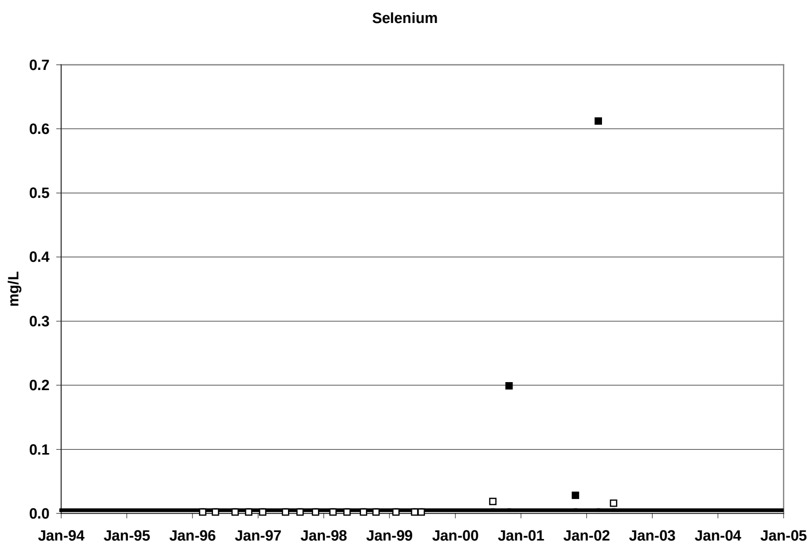
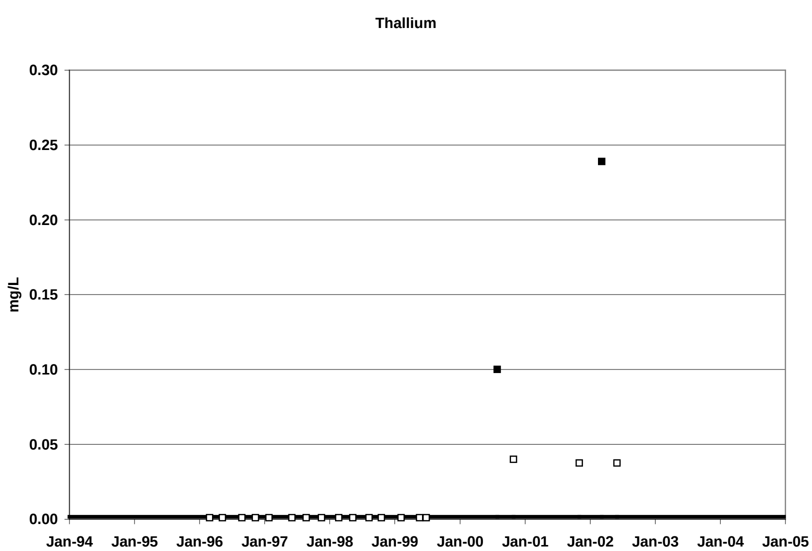


Figure 11: Site #2, Stacks Run, thallium



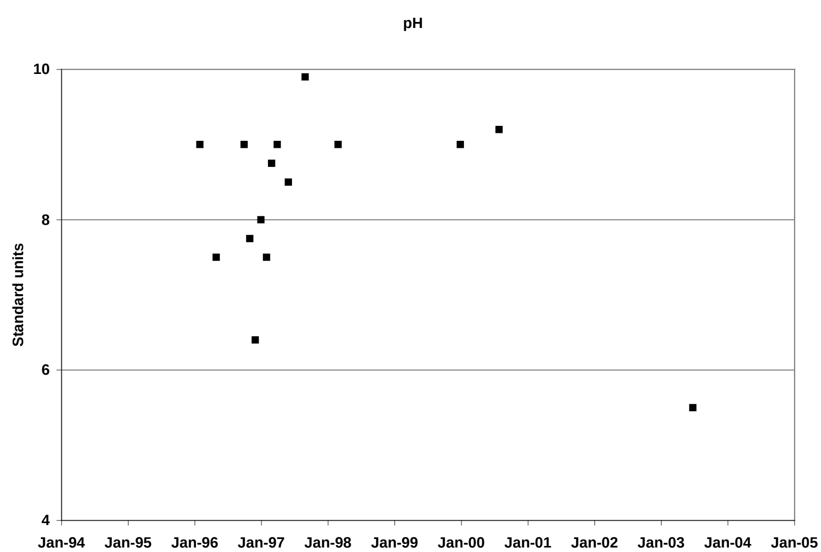
2.2.3 Impacts to North Branch Squires Creek (Sites #010 and #006)

Because of the large number of permitted sites surrounding the North Branch of Squires Creek, it is difficult to read the effect of CCW disposal sites draining in this direction. An instream monitoring point, Site #010, lies upstream of discharges from the Stacks Run Refuse Site Extension, as well as U-87-84 and most of S-119-82. Other instream monitoring points, Site #006 and UFSC-2, lie downstream of the Stacks Run Refuse Site Extension, U-87-84, and most of S-119-82.

NPDES Outfall 010 (distinct from instream Site #010) carries discharge from the Stacks Run Refuse Site Extension onto U-87-84 and toward the North Branch of Squires Creek. NPDES Outfall 002 carries discharge from U-87-84 to the same stream.

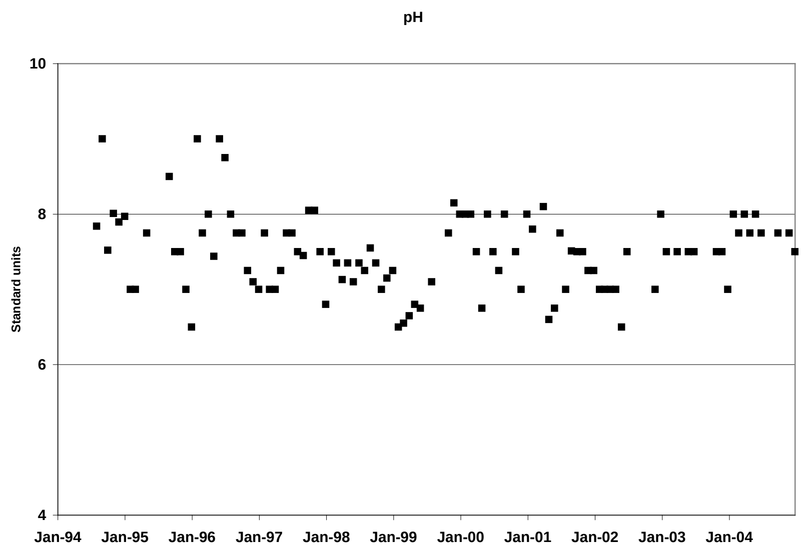
Control over the pH of water draining from the Stacks Run Refuse Site Extension toward U-87-84 and Squires Creek seems to be declining with time. As shown in Figure 12, pH was erratic and sometimes above the maximum discharge limit of 9 until 1999. Only values near 9 were found in 2000. A single data point in 2003 near the end of the reclamation period, however, suggests that pH values have fallen below 6.

Figure 12: NPDES Outfall 010, toward Squires Creek, pH



Outfall 002 to Squires Creek has a pH between 6 and 9, with little trend over the period of record (Figure 13). Selenium and thallium data are also absent for this site. The instream site just below this outfall, labeled “UNFSC-2” has no data concerning selenium or thallium.

Figure 13: NPDES Outfall 002, toward Squires Creek, pH



Monitoring results for instream Sites #006 and #010 both contain information on selenium and thallium. A comparison of the upstream site (#010) and the downstream site (#006) indicates that many chemical concentrations increase as the water flows from one to the other. However, these increases cannot necessarily be ascribed solely to ash. Approximately 1.6 miles separate these two monitoring points, and several mining and CCW-related sites may affect water quality between the sites.

Both upstream and downstream sites show a pattern of mostly non-detects for selenium and thallium, with a few very high measurements (Figures 14 through 17). For selenium, the measurable values found at the upstream site (Figure 14) were considerably lower than the measurable values at the downstream site (Figure 15). Similarly, the measurable concentrations of thallium detected at the upstream site (Figure 16) are substantially less than those found at the downstream site (Figure 17).

But there is a large increase in AMD pollutants across this segment as well (not shown in this report). pH values at the upstream site ranged from 3.4 to 6.6 (Figure 18), while those at the downstream site range from 2.8 to 4.9 (Figure 19).

The distance between these monitoring points illustrates the difficulty of clarifying exactly which sites, and exactly which substances, are causing changes in water quality. They are located so far apart from each other, in a complex with so many operations, that comparisons are not sufficient to draw definite conclusions.

Figure 14: Upstream Site #010, Squires Creek, selenium

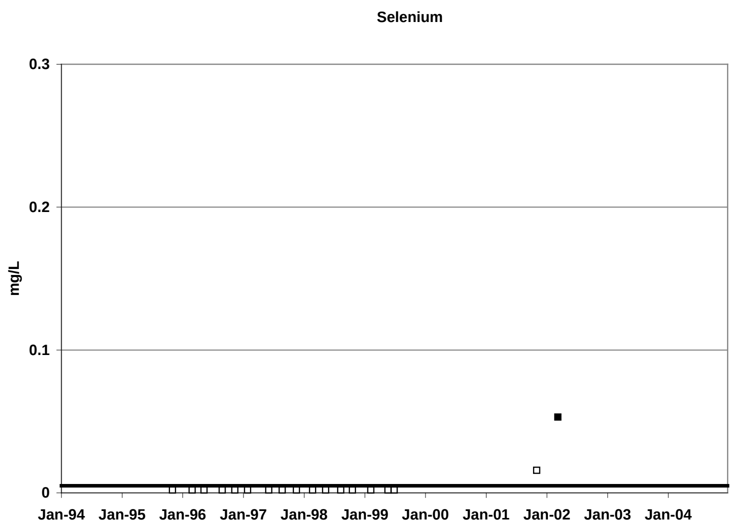


Figure 15: Downstream Site #006, Squires Creek, selenium

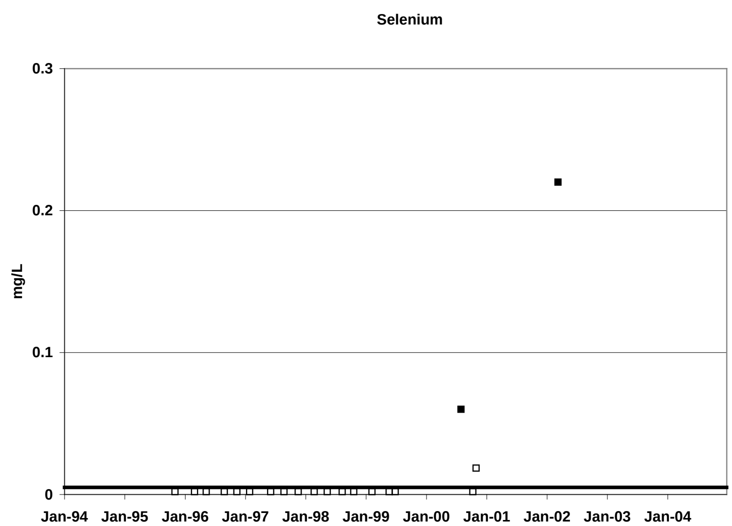


Figure 16: Upstream Site #010, Squires Creek, thallium

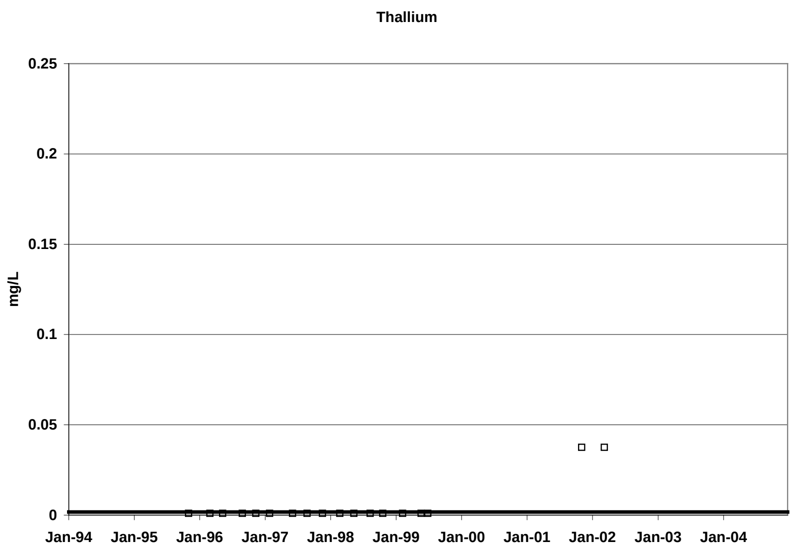


Figure 17: Downstream Site #006, Squires Creek, thallium

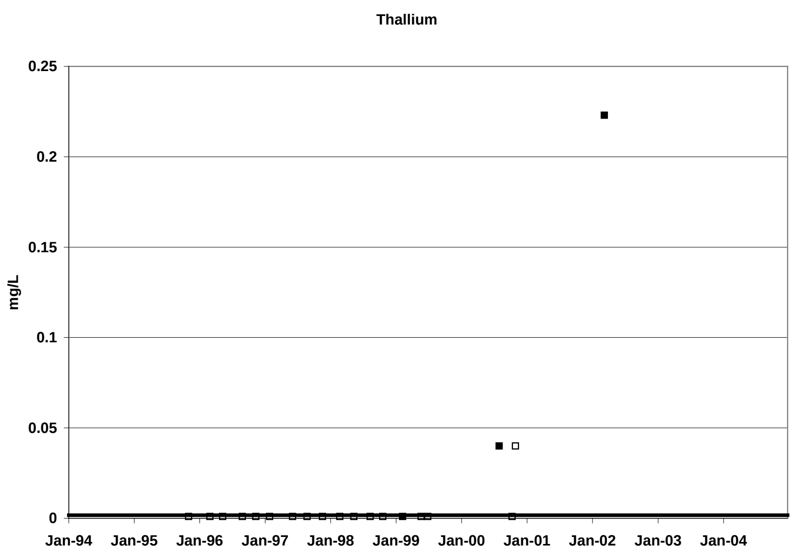


Figure 18: Upstream Site #010, Squires Creek, pH

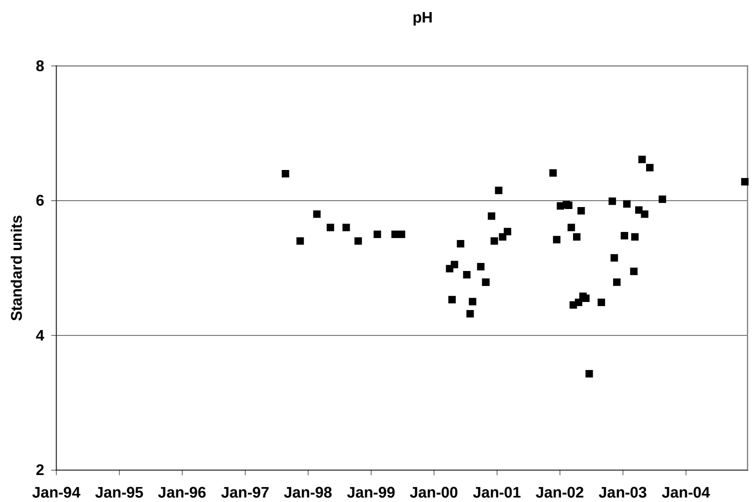
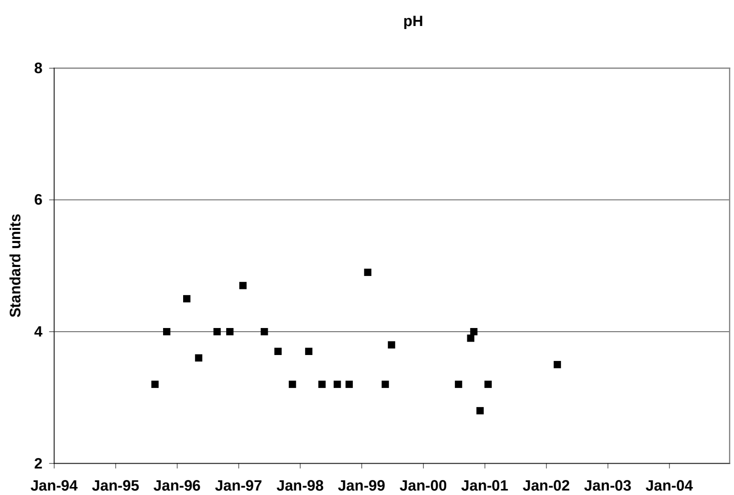


Figure 19: Downstream Site #006, Squires Creek, pH



3. ALBRIGHT SITE

3.1 Site description

The Albright site (S-1013-89) is comprised of a 47 acre surface mining operation in the Harlem, Bakerstown, Brush Creek, and Upper Freeport seams, which was then reclaimed with the use of CCW as backfill. Patriot received a permit for this site in 1989. According to the permit file, 4 million tons was to be disposed over the life of the project (WVDEP, 2005c). The site was not filled to capacity (Hamric, 2005), but because records were not kept, it is not known how much ash was actually placed at this site. As of 2000, ash placement was completed, and the site has now been reclaimed (Dixon, 2005 and Hamric, 2005).

According to the permit file, ash was to come from the Thames River plant in Montville, Connecticut (WVDEP, 2005c). Ash was also secured from a plant in Cedar Bay, Florida and a few other smaller sources. These two larger sources produced FBC ash, while the smaller sources did not (Hamric, 2005).

The choice of site location is consistent with low expectations of environmental vigilance and performance. The Albright site is situated next to a coal-fired power plant that discharges cooling water directly to the Cheat River, without passing through a cooling tower. The heated water is discharged under a Clean Water Act 316(a) variance first approved in 1977, because the heat was considered unlikely to cause additional degradation to the AMD-impacted river.

As shown in Figure 20, the site occupies a point between the Cheat River and its tributary, Greens Run. Instream Site #2 is on Greens Run, near its confluence with the Cheat. This is the most likely instream site to show impacts from CCW because Greens Run is much smaller than the Cheat, where other monitoring sites are located. Only one groundwater monitoring well, Site G-4, is monitored by Patriot. Table 4 summarizes the results for selected metals at this monitoring well.

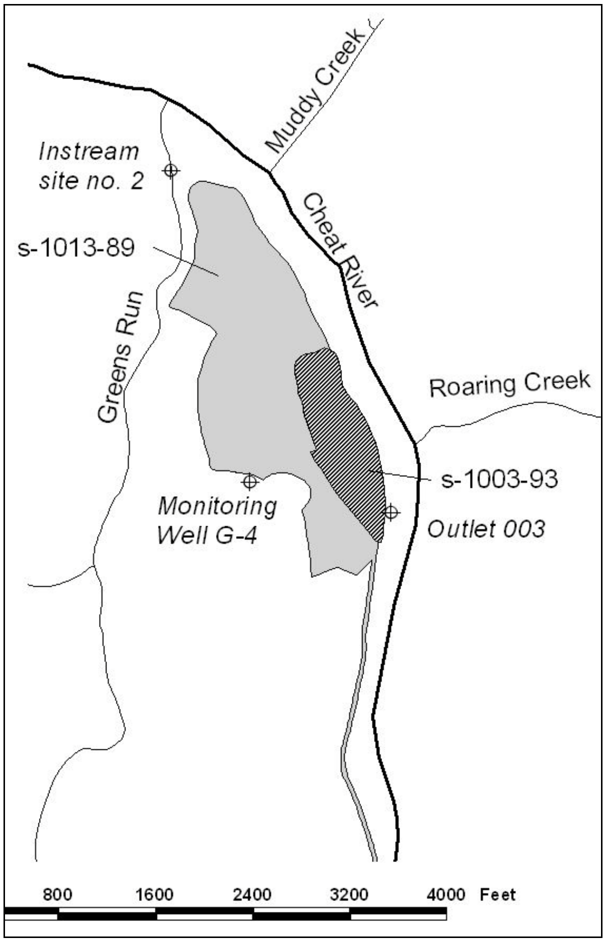
The Albright site also includes three NPDES outfalls. Outfall 001 drains a bench high up on the site, and flows toward Greens Run in the west. Outfall 002 drains a pond near the tip between Greens Run and the Cheat River. Outfall 003 was added as part of an additional permit (S-1003-93), in which refuse was excavated, ash was laid down as a liner, some gob was replaced, and additional ash was used as a cover.

Table 4: Summary of results for selected metals at the Albright site

Metal	Well G-4
Antimony	No data.
Arsenic	One sample at 484 x groundwater standard. Others up to 50 x standard.
Lead	No data.
Selenium	Samples at 1,000 x groundwater standard. Some samples at 125 x standard.
Thallium	No data.

Note: NPDES Outfall 003 is not compared with standards because it is not measured directly in surface or groundwater.

Figure 20: Albright site



3.2 Results

3.2.1 Impacts to groundwater (Site G-4)

Patriot monitored pH, trace metals, and other parameters at the groundwater monitoring well called Site G-4, although they apparently did not monitor thallium. As shown in Figure 21, pH has remained in the 5.5 to 7.5 range. The variability in pH does not match the changes in selenium and arsenic concentrations described below.

Norris (2004) documented high levels of selenium and arsenic in groundwater at this monitoring well. After a long period of low selenium measurements, higher values started to be measured after 2000. One of these values is so high as to raise suspicions about its accuracy. This point is included in Figure 22, but removed from Figure 23 to help illustrate the variability in the other data points. Note that the dark line in these figures shows the value of 0.05 mg/L, the groundwater standard, which is ten times higher than the surface water quality standard show in selenium graphs of instream sites.

Figure 21: Site G-4, groundwater, pH

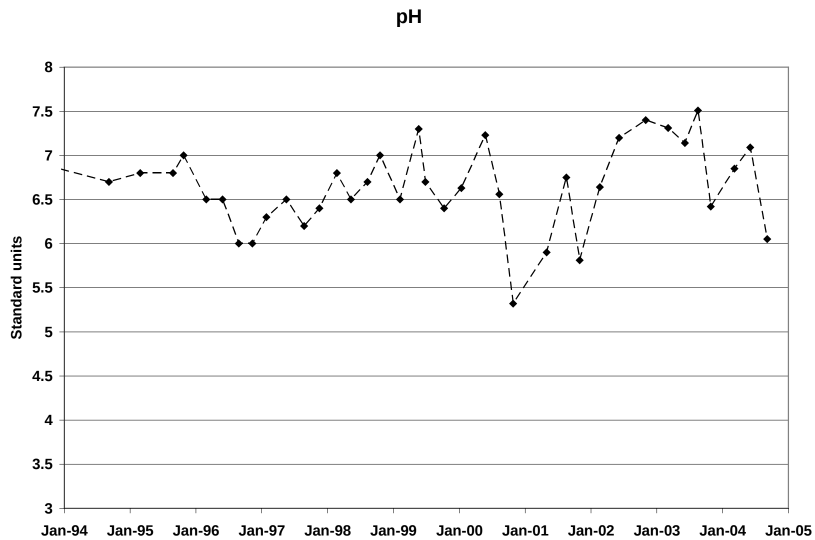


Figure 22: Site G-4, groundwater, selenium

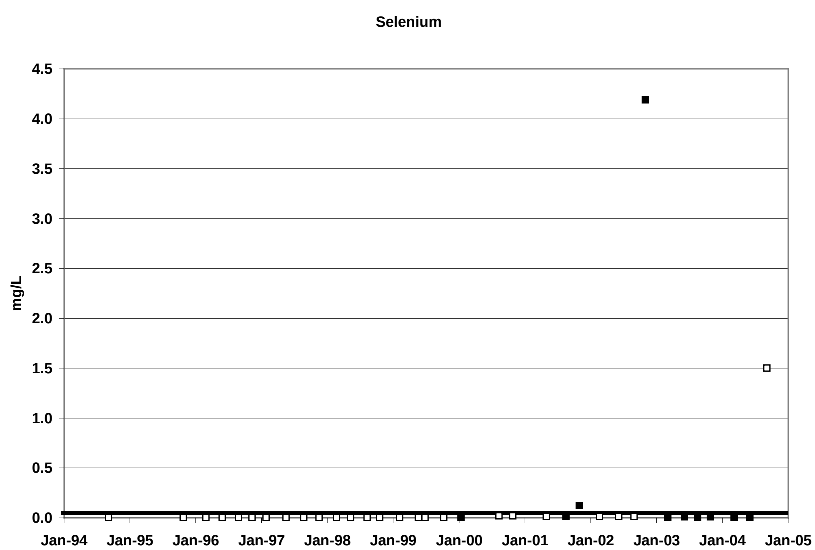
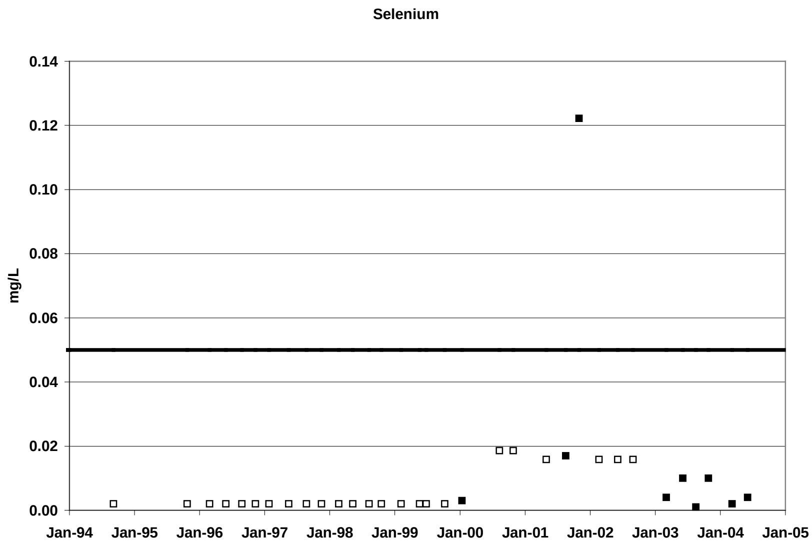


Figure 23: Site G-4, groundwater, selenium (with highest value removed)



Arsenic shows a more striking pattern. After a long period of time when arsenic values are at or near the groundwater standard of 0.01 mg/L, values start to increase in 1997 before returning back to similar values at or near the standard in 2000. The highest value shown in Figure 24 is left out Figure 25, in order to illustrate the other high values.

Figure 24: Site G-4, groundwater, arsenic

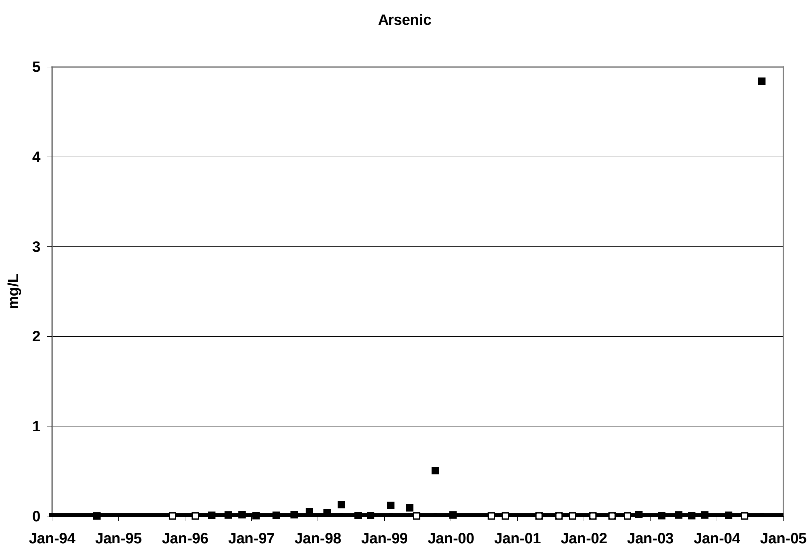
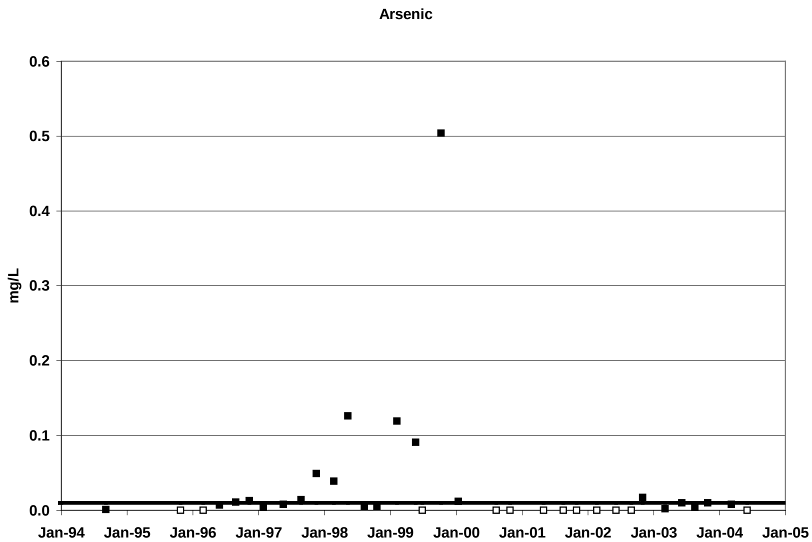


Figure 25: Site G-4, groundwater, arsenic (with highest value removed)



3.2.2 Impacts to Greens Run (Site #2)

Patriot did not monitor Site #2 for trace metals. pH generally ranges from 3 to 4, although there was one spike to 7.6 in 1994. Iron varies, but generally stays between 5 and 30 mg/L. This stream very polluted by AMD from upstream sites. Due to the lack of appropriate data collected for the Albright site, including data for signature parameters of coal ash that would differentiate its effects from AMD, it is difficult if not impossible to determine any effects from CCW placement at the Albright site on this stream.

3.2.3 Impacts to the Cheat River (NPDES Outfall 003)

The Cheat River is so large as it flows past the Albright site that trace metals would be nearly impossible to detect. NPDES Outfall 003 discharges to the Cheat River and drains the portion of the mining site in which a lot of ash was placed, and therefore can shed some light on whether trace metals are reaching the Cheat (Hamric, 2005). Because no selenium or thallium monitoring was performed on this discharge, it cannot be compared directly with the monitoring at the Stacks Run Refuse Site Extension. However, arsenic monitoring was performed at Outfall 003. Figures 26 and 27 illustrate arsenic concentrations in the discharge water that spike in recent years. These graphs do not include a dark line indicating the surface water standards because the discharge measurements need not necessarily meet instream standards. For comparison, however, West Virginia's surface water criterion equals 0.05 mg/L and the groundwater standard equals 0.01 mg/L.

Figure 26: NPDES Outfall 003, toward Cheat River, arsenic

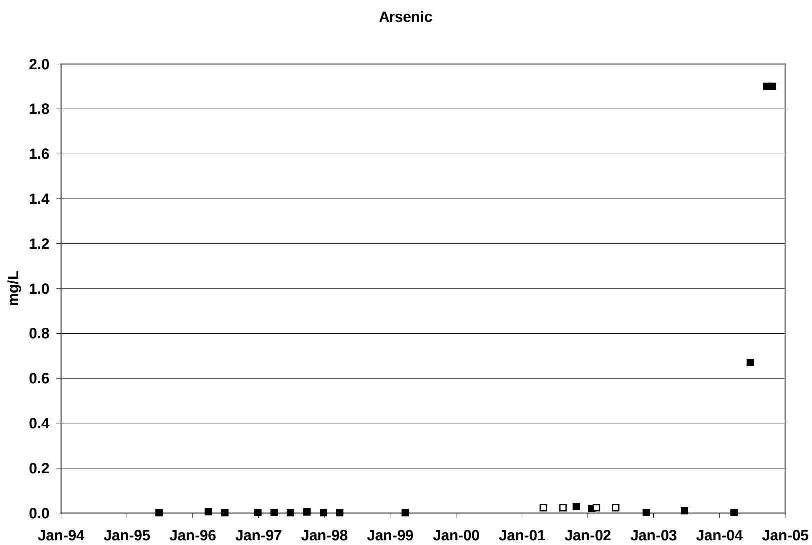
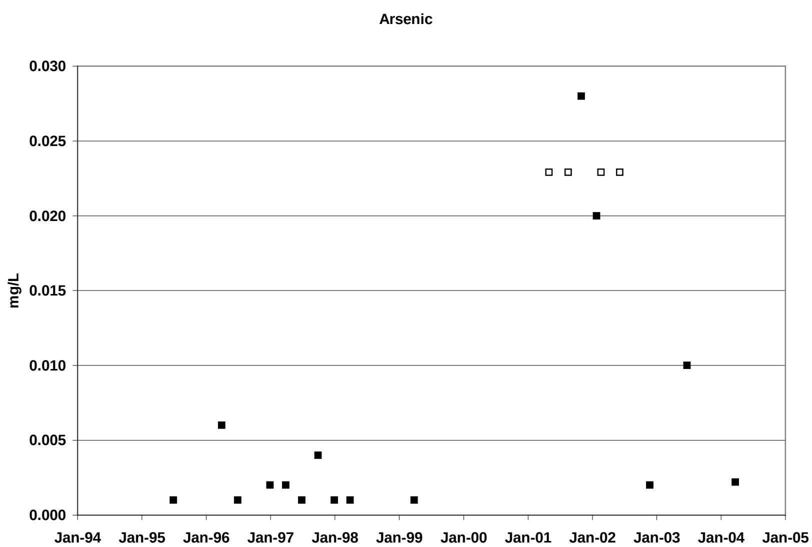


Figure 27: NPDES Outfall 003, toward Cheat River, arsenic (with highest values removed)



4. CONCLUSIONS AND RECOMMENDATIONS

Conclusions and recommendations are presented for each of the five questions guiding the Committee on Mine Placement of Coal Combustion Wastes that are highlighted in bold in Table 1.

4.1 The adequacy of data collection and monitoring programs

Question 1 on data collection and Question 7 on monitoring programs are similar and considered together.

- **Despite the issues identified below, monitoring was sufficient to document trace metal pollution in surface waters and groundwater.** In particular, very high selenium and thallium levels are documented in surface waters downstream from the Stacks Run Refuse Site Extension. At Site #1 in the Unnamed Tributary of Deckers Creek, high trace metal concentrations occurred after AMD parameters declined and after pH went up from the addition of FBC ash, suggesting that this ash is contributing to and/or mobilizing the metals into the receiving stream. Very high selenium and arsenic levels are also documented in groundwater beneath the Albright site.
- **No data whatsoever are reported on the amount of ash actually disposed in mines.** Although Coal Ash Disposal forms in the permit files specify maximum daily, monthly, and yearly ash disposal amounts, the permittees submit no records to WVDEP regarding how much was actually dumped. It is therefore difficult to make future policy and permitting decisions on how to minimize the impacts of CCW disposal sites.
- **Analysis methods used for toxic metals are often not sensitive enough to determine whether or not water quality standards are being met.** For many trace metals investigated in this report, MDLs were often many times higher than the surface or groundwater quality standards. It is therefore impossible to know whether standards are being met. For most of these metals, lower MDLs are available; these lower MDLs were often used in the early 1990s before trace metals appeared.
- **Monitoring of some pollutants from some sites ceased even though spikes had just occurred.** For some sites and pollutants investigated in this report, monitoring stopped before the duration of water quality standard violations could be determined. The time lag between burial of CCW and the appearance of high metal concentrations indicates that monitoring should continue for many years even after concentrations attain levels below water quality standards.
- **Quarterly monitoring may not be sufficient.** Permittees performed quarterly monitoring for most monitoring sites explored in this report. Although quarterly monitoring caught spikes in several trace metal pollutants, more frequent monitoring would make it easier for regulators to determine whether very high values are part of a trend or are isolated incidents.
- **Monitoring does not always take place at enough sites.** Even though several surface water sites were monitored near the Stacks Run Refuse Site Extension, the permittee was not required to monitor an unimpacted upgradient site and was not required to monitor a suitable pair of upstream and downstream locations to clarify how much instream pollution is being caused by that particular site. At the Albright site, a single monitoring well was monitored. More monitoring sites placed at strategic locations are needed to adequately characterize the impacts of CCW disposal sites on local waters. Particularly helpful would be wells placed directly in the CCW.
- **Monitoring was not always required for the relevant constituents.** At the Albright site, key CCW constituents were not monitored in Greens Run either up- or downstream from the ash placement site. Such monitoring would have made it possible to determine what quantities of which metals came out of the CCW and what quantities of which metals were already present in the AMD in Greens Run. While a wide variety of CCW constituents were measured at many sites, it is important to require monitoring for all parameters found in pre-disposal leach tests.

- **No correction action standards were found for the disposal of CCW wastes in coal mines.** In fact, the review of permit files indicates that CCW disposal was not tied in any way to improving or maintaining water quality. The form used to provide information on CCW sources and amounts, called a Coal Ash Disposal form, does not mention water quality. The most obvious corrective action standard would be an expectation that surface and groundwater quality standards must be met at instream and groundwater monitoring sites. Such standards would be useful for regulatory agencies and would also be an effective tool for citizens to use if agencies fail to enforce them. As discussed below, WVDEP did not take any corrective responses even when trace metal concentrations significantly exceeded standards.

4.2 The impacts of aquatic life in streams

Question 2 considers streams draining CCW placement areas and the wetlands, lakes, and rivers receiving CCW drainage. This report investigates whether aquatic life–based water quality standards are being met in several streams downgradient from CCW placement areas.

- **Very high levels of selenium, which harms aquatic life, have been documented downgradient from CCW disposal sites in mines.** Self-monitoring data document selenium concentrations up to 120 times the surface water quality standard in a stream near the Stacks Run Refuse Site Extension.
- **FBC ash does not dependably maintain the pH of water draining through mine refuse.** Even when use of ash was permitted, high pH was not always maintained. Acidic water was found just downstream from the Stacks Run Refuse Site Extension in Blue Pond, and pH values seemed to drop recently in this site’s NPDES Outfall 010.

4.3 The responses of mine operators and regulators to adverse impacts

Question 3 specifically mentions contamination of groundwater and pollution of surface waters.

- **WVDEP took no action even when water quality standards were being violated.** Even when self-monitoring data submitted to WVDEP showed significant violations of water quality standards, the agency took no corrective action. Inspectors were actively involved at these sites, having issued inspection reports that deal with fugitive dust and low pH discharges. But thorough reviews of the permit file revealed not one mention of high trace metal concentrations in local waters. It is not clear whether WVDEP reviewed the monitoring data. Corrective action standards, perhaps codified in regulations, would clarify when WVDEP staff should step in, and what actions they should take.
- **Mine operators and regulators assured concerned residents that CCW pollutant levels were low, despite data showing otherwise.** In response to an inquiry, the mining company and DEP both assured a local citizen that CCW-related pollutant levels were of no concern. This response mirrors the conventional wisdom encountered by the authors of this report in interviews with WVDEP and mining company staff that trace metals are not a problem. This conventional wisdom is not supported by the data.

4.4 Whether CCWs and mines are adequately characterized

Question 4 considers whether characterization is adequate to ensure that monitoring programs are effective and groundwater and surface waters are not degraded.

- **Better characterization of mines would help identify surface and groundwater monitoring sites.** Characterization should be sufficient to determine which portions of mining sites drain to which monitoring sites.
- **Water flowing to or from potential CCW disposal sites should be characterized before CCWs are added.** Documentation of concentrations of CCW chemicals before CCW disposal begins is required to distinguish the effects of CCW and AMD.
- **Unregulated disposal of CCWs in previous decades should be documented when possible.** WVDEP staff note that before Surface Mining Control and Reclamation Act permits were issued, CCWs were already routinely being disposed of at mining sites. Especially if this disposal took place on or near sites now being used to dispose of new CCWs, these practices might affect current conditions. To the extent possible, proper characterization of current sites should include research into past undocumented disposal of CCWs.

4.5 General conclusions and recommendations

Very high levels of several toxic metals are observed in surface and groundwater downgradient from CCW disposal sites. Toxic concentrations of these metals often occur at times when pH effects from FBC ash are observed, and may require several years before they appear in water. Ash disposal at mine sites does not appear to keep metals out of nearby waters.

To protect waters, monitoring must continue for many years. In the data examined in this report, high concentrations of selenium and thallium were found at the Stacks Run Refuse Site Extension almost a decade following the beginning of mine disposal of CCW.

Even though they were sufficient to identify several exceedances of toxic metal concentrations, the practices used now by WVDEP are insufficient. More stringent practices are required to properly monitor the disposal of CCWs in mines so that regulators actually review and use these data to ensure that water resources are protected. Enforceable regulations, rather than unenforceable policies now used, should be considered.

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