Underground Injection of Coal Slurry

Water, Health, and Alternatives

A Sludge Safety Project Citizens' Report

March 19, 2009

ABSTRACT

Underground injection of coal slurry is a serious threat to public health. Billions of gallons have been pumped underground in West Virginia, and poisonous chemicals found in this waste have been found in nearby well water and in hair samples of local citizens. As coalfield residents voice concerns about contaminated water and health problems, the DEP continues to grant underground injection permits and to excuse companies for violating water standards at injection sites. Our state can be a model of transforming public health and chose alternative means of processing coal, which have been utilized in West Virginia and are utilized across the globe.

TABLE OF CONTENTS

What is Coal Slurry?

Before coal is sent to market it is washed in a mixture of water and chemicals to remove particles of slate, dirt, and trace elements found in the coal seam. The waste slurry is pumped underground into abandoned mines or pumped behind earthen dams into coal waste impoundments, some of which hold billions of gallons of sludge.

EPA reported in one case that slurry injected underground "…contains harmful contaminants which are likely to enter the public water supply, and may present and imminent and substantial endangerment to human health."[1]

"… slurry's path through the underground mine system is unpredictable… it is likely that slurry will flow to points where water is being withdrawn from the mine by domestic users." [2]

Standards for Underground Injection Control (UIC)

"In West Virginia, all ground water is considered to be existing or potential drinking water.

"In fact, if an existing mine pool is being used as a potable water source for even one person, no permit will be issued for injection into it, notwithstanding the requirement that all UIC injection must meet Federal Safe Drinking Water Standards, also called Primary Drinking Water Maximum Contaminant Levels, or MCLs, at the point of injection.

In all other cases, the mine pool is regarded as a potential drinking water source, regardless of its present quality. Therefore, the proposed injection is carefully screened to ensure that the injected material (injectate) is capable of meeting MCLs. If the applicant cannot demonstrate that the injectate can meet these standards, the permit is denied."[3]

---

[1] EPA Docket No. IV-85-UIC-101. "Determination and Consent Order in the Matter of Eastern Coal Corporations." United Sates Environmental Protection Agency Region IV. August 30, 1985. Online at http://www.sludgesafety.org/coal_slurry_inj.html.

[2] EPA Docket No. IV-85-UIC-101.

[3] Pettigrew, Pavanne L. "History and Status of Mining Underground Injection Control at the WVDEP Division of Water and Waste Management." Presented at the 2008 West Virginia Mine Drainage Task Force Symposium, Morgantown, WV.

Enforcement of Standards

West Virginia Department of Environmental Protection (DEP) enforcement of these standards is questionable, and the DEP is unsure whether coal slurry injected underground is contaminating residential wells.[4] The foundation of the "careful screening" process is the reports issued by the coal companies to the DEP regarding the make-up of the coal slurry injectate. The DEP does not employ inspectors through the Underground Injection Control Office of the Division of Water and Waste Management to inspect underground injection sites into abandoned mines or to sample and analyze the slurry.

Preliminary Results from SCR 15[5]

Senate Concurrent Resolution 15 (SCR 15) passed the 2007 West Virginia Legislature and mandated that the DEP study coal slurry contaminants and impact to ground water.

Though the DEP has missed deadlines for the report mandated by SCR 15, the DEP was willing to share their data with SSP and independent scientists as well as split samples from three of the six test sites. The slurry samples were allowed to settle and were then separated into the solid and liquid portions, which were tested separately.

The independent scientists found that both their test results and the DEP's results showed high metal concentrations in the solid portions of the slurry. Arsenic, for example was found at 159,000 ppb, nearly 16,000 times the Primary Drinking Water Standard. The solids portion however, while injected underground, does not fall under the regulations of the Safe Drinking Water Act.

The liquid portion of the slurry, which does need to be in compliance with the Primary Drinking Water Standards, was also in violation. The heavy metals Antimony, Arsenic, Lead, Barium, Cadmium and Chromium where all found in the samples sometimes in levels over 100 times the legal limit.

The Drinking Water Standards also set secondary standards, which are not legally binding. Iron, Aluminum, Manganese, Zinc and Copper were found in levels exceeding the recommended concentrations.

---

[4] "DEP Unsure if Coal Slurry Poisons Water Supplies: Agency to Ignore Deadline for Study." Charleston Gazette, February 7, 2009. Online at http://www.wvgazette.com/News/200902070209.

[5] Preliminary report written by Dr. Ben Stout and Mary Ellen Cassidy both of Wheeling Jesuit University. *See Appendix 1 for the full report. The WV DEP has not approved this report.*

Chemical Constituents of Coal Slurry

The harmful content in coal slurry comes from two sources: chemicals used in the processing facility and from the coal and rock itself. Because of this, the contaminants in coal slurry can vary from place to place depending on the chemical make-up of the coal being processed and the chemicals the processing company used.

Contaminants from Coal

All the heavy metals found in coal and associated rock are found in slurry. These elements are naturally occurring, but the remain safely locked away in the buried rock and coal seem until exposed to air and water at which point they may become mobile.

Coal seams act as filters for drinking water supplies, which provides a useful analogy for coal slurry injections. Imagine taking out a used water filter, grinding up, and pumping it into the water supply. Contaminants are now able to travel through the water supply.

According to the US Geological Survey, "Coal contains toxic organic and inorganic compounds which, if mobilized into the environment, have the potential to impact human health and environmental quality."[6]

Metal	Concentration (ppm)
Antimony	0.35 to 2.3
Beryllium	1.0 to 13
Cadmium	0.0027 to 0.52
Chlorine	130 to 2,300
Chromium	6.5 to 33
Cobalt	1.5 to 11
Lead	2.7 to 25
Manganese	1.9 to 43
Nickel	3.7 to 24
Selenium	1.3 to 7.3
Arsenic	0.7 to 53
Mercury	0.005 to 0.3

Table 1. Concentration of Heavy Metals in Coal
Source: USGS Professional Paper 1625-C Chapter F

Mercury

Slurry samples analyzed at WVU Tech have found slurry to contain 30 ppb of mercury, which is significantly beyond the Safe Drinking Water Act standard of 2 ppb.[7,8] All forms of Mercury pose a level of threat to human health, though that

[6] Orem, William H. Coal Slurry: Geochemistry and Impacts on Human Health and Environmental Quality. (Power Point Presentation). United States Geological Survey. Viewed online March 9, 2009 at http://www.sludgesafety.org/misc/wm_orem_powerpoint/

[7] Schoening, Richard. West Virginia University Institute of Technology, Chemistry Department. Phone correspondence with Matt Noerpel of Coal River Mountain Watch. October 30, 2008.

level can greatly vary. In the environment Mercury can easily change forms from a relatively safe form to a highly toxic one. Depending on what form it takes, mercury can have a range of effects, including neurological disorders in newborns. There is a need to know more about the composition of mercury in slurry.

Known Exceedances of Heavy Metals in Coal Slurry and Residential Wells

See Appendix 2 for table.

Priority Hazardous Materials

Seven of the top 10 Priority Hazardous Materials outlined by the ATSDR in 2007 are found in coal slurry. These top seven are arsenic, lead, mercury, cadmium, polycyclic aromatic hydrocarbons (PAH), benzo(a)pyrene, and benzo(b)fluoranthene. This list was developed by taking into account the material's impact on human health based on its toxicity and likelihood that it will found on sites on the National Priorities List.[9]

Chemicals used in Processing Coal

Chemicals include coagulants, flocculants, and surfactants, which are sometimes made up of a blend of polymers, which serve to separate the coal from the rock. When ponds are used, the water is recycled, increasing the concentration of these polymers.

According to USGS, "Toxic organic substances used to wash coal include acrylamide, PAHs, aromatic amines, cholorinated hydrocarbons, etc."[10]

"Even if a toxic chemical to be used in the process will not be present in the waste stream by the time it reaches the injection point under normal operating conditions, the UIC protocols forbid such substances being used at all to prevent accidents or malfunctions allowing toxic materials to reach the groundwater system." [11]

---

[8] Darst, Paul. "Team Finds New Ways to Strip Mercury from Water." The State Journal. January 3, 2008. Viewed online March 9, 2009 at www.statejournal.com/story.cfm?func=viewstory&storyid=33130.

[9] CERCLA 2007 Priority List of Hazardous Substances. Agency for Toxic Substances and Disease Registry. Viewed March 9, 2009 online at www.atsdr.cdc.gov/cercla/07list.html.

[10] Orem, William H.

[11] Pettigrew, Pavanne L.

Aniline Acenaphthene Acenapthylene Anthracene Benzidine Benzo(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Benzo(ghi)perylene Benzo(k)fluoroanthene Benzyl alcohol bis(2-ethylhexyl)phthalate bis(2-chloroethoxy)-methane bis(2-chloroethyl)ether bis(2-chloroisopropyl)ether Butyl benzyl phthalate Chrysene Dibenzo(a,h)anthracene	Dibenzofuran Dibutyl phtalate Diethyl phthalate Dimethyl phthalate Dioctylphthalate Fluoranthene Fluorene Hexachlorobenzene Hexachloroethane Indeno(1,2,3-c,d)pyrene Isophorone N-Nitrosodi-n-propylamine N-Nitrosodiphenylamine Naphthalene Nitrobenzene Phenanthrene Pyrene 4-Nitroaniline Acrilamide	Hexachloro-1,3-Butadiene Hexa-Cl-1,3-Cyclopentadiene 1,2,4-trichlorobenzene 1,2-Dichlorobenzene 1,3-Dichlorobenzene 1,4-Dichlorobenzene 2,4-Dinitrotoluene 2,6-Dinitrotoluene 2-Chloronaphtalene 2-Methylnapthalene |2-Nitroaniline 3-3'-Dichlorobenzidine 3-Nitroaniline 4-Bromophenyl phenyl ether 4-Chloroaniline 4-Chhlorophenyl phenyl ether

Table 2: Organic Compounds Found in Coal Slurry
Source: Kentucky Division of Water. DOW-DES Analytical Data File.

Polyacrylamide

Polyacrylamide is a commonly used chemical in the coal washing process and the subject of to lawsuits brought by sick prep plant workers. Unfortunately Polyacrylamide is not a stable molecule and is difficult and expensive to test for. It is made up of many smaller molecules called monoacrylamides. Polyacrylamide has a tendency to easily break down into monoacrylamides, which are highly toxic.[12]

Health Concerns

- "At low dose coal-derived toxic organic compounds in water produce excessive cell proliferation (consistent with mutagenic effect); and at high dose, these compounds produce cell death."[13]
- USGS researchers learned that liver cells exposed to coal slurry water have a higher mortality rate that liver cells exposed to clean drinking water.[14]

[12] Personal Correspondence with Dr. Michael Kostenko, M.D.
[13] Orem, William H.
[14] Bunnell, Joseph E. "Preliminary Toxicological Analysis of the Effect of Coal Slurry Impoundment Water on Human Liver Cells" United States Geological Survey. Open-File Report 2008-1143. Reston, VA. 2008.

- "…water quality studies documented contaminated well water in WV and KY communities are consistent with coal slurry toxins."[15]
- At one site, "The injection operation caused waste water to be distributed over 1,020 acres of abandoned mine working and into the surrounding groundwater system."[16]
- A community survey found abnormally high levels of gall bladder disease in Prenter, WV.[17]
- Community concerns in Rawl, Mingo County and Prenter, Boone County report similar health issues of skin rashes, cancer, gastrointestinal problems, kidney, liver and gallbladder disease.
- Results of recent well water testing in Prenter, Boone County are not yet available, though houses smell of hydrogen sulfide gas and water comes out of the tap black, brown and red.
- Residents of Prenter sent in samples of their hair for analysis and found arsenic, beryllium, alluminum, mercury, cadmium, lead, sodium, copper, iron, boron, cobalt and molybdenum.
- Using home test kits, hydrogen sulfide gas has been detected at high levels in houses in Rawl, and in Prenter as high as 30ppm. Hydrogen sulfide gas is highly corrosive. Personal safety detectors used by petrochemical workers are set to alarm at 5 to 10ppm.
- Hundreds of millions of gallons of coal slurry have been injected into abandoned mines near Rawl and Prenter.
- "I am concerned for the health of my family and our community. We know there was slurry injected underground within 3 miles of our home. With what I know about geology I see every reason how slurry could have migrated underground to our wells and drinking water supplies." Maria Lambert, Prenter Resident.
- Physicians are very rarely trained to diagnose for long term chronic toxic exposure. As you can see in the above information, many of these chemicals manifest a wide range of health effects depending on the individual and other environmental factors.[18]
- Two communities have filed lawsuits in West Virginia in the past two years claiming that slurry injected underground has contaminated well water and affected their health. Others have as well over the years, but, due to settlement agreements, much of that information is not accessible.
- At least two groups of prep plant workers have filed lawsuits regarding exposure to and health impacts from harmful chemicals in slurry.

[15] Hendryx, Michael. "Hospitalization Patterns Associated with Appalachian Coal Mining." Journal of Toxicology and Environmental Health. Taylor and Francis, 2008. ISSN: 1528-7394 print/ 1087-2620 online.

[16] Spadaro, Jack. Report of Investigation Larry Brown Et. Al. v. Rawl Sales and Processing Company. Mingo County, West Virginia. Contact: PO Box 442, Hamlin, WV 25523.

[17] Community Health Survey, Coal River Mountain Watch.

[18] Personal Correspondence with Dr. Michael Kostenko, MD

- **Life expectancy in West Virginia counties is declining. Women especially in southern West Virginia counties are losing a decade of their lives compared to the national average.**[19]

[19] "Early Deaths: West Virginians Have Some of the Shortest Life Expectancies in the United States." West Virginians for Affordable Health Care. Based on a 2008 Report from Harvard Researchers. Online at www.wvahc.org.

Heavy Metals***	Possible Health Effects**
Aluminum	Irritation of skin, upper respiratory tract. Damage to liver, kidneys, and lungs. Inflammation of the gastrointestinal tract. Skin or tooth discoloration.*
Arsenic	Cancer (liver, bladder, lung, kidney, and skin). Skin Damage, problems with circulatory systems, increased risk of cancer.* As has been recently linked to Alzheimer's.****
Barium	Respiratory paralysis, muscle twitching or paralysis, may effect pacemaker or the heart muscle. Increase in Blood Pressure.*
Beryllium	Lung tumors and lesions, weight loss. Intestinal lesions.*
Cadmium	Causes cancer, anemia, discoloration of teeth, & bone changes. Kidney Damage.*
Chromium	Irritation to nasal cavity and upper respiratory tract, some compounds may cause cancer. Skin problems.*
Copper	Irritation of upper respiratory tract, corneal ulcers and skin irritation, green hair. Short term: Gastrointestinal distress. Long term exposure: liver or kidney damage.*
Iron	Decreased blood pressure, bloody diarrhea or coma, vomiting, mild lethargy.
Lead	May cause cancer. Problems with joints, kidneys, and nervous system. Infertility and birth defects Delays in physical or mental development, deficits in attention span and learning ability. Kidney problems, high blood pressure.*
Manganese	Loss of controlled movement; weakness, stiff muscles, and trembling hands, hallucinations, forgetfulness and nerve damage, Parkinson, lung embolism and bronchitis.
Selenium	Hair loss, deformed nails; rashes and redness in skin; numbness in arms or legs. Fingernail loss; numb fingers or toes, circulatory problems*
Sodium	Could interfere with blood pressure medication
Zinc	Stomach cramps, nausea, vomiting, anemia, damage to the pancreas, and decreased levels of high-density lipoprotein (HDL) cholesterol.

Table 3: Heavy Metals Found in Coal Slurry and Potential Health Effects of Exposure

(The health effects included in this table are potential effects that may be caused after long term exposure at certain concentrations. Little is know about low-dose, long term chronic exposure. If you have any of these symptoms, talk to your doctor. The purpose here is to share what we do know about exposure to these metals.)

Health information from: United States Environmental Protection Agency. Office of Water. June 2003. Poster: *National Primary Drinking Water Standards

****Health information from: Hazardous Substances Databank of the National Library of Medicine online at http://toxnet.nlm.nih.gov/cgi-bin/sis/search, Unless otherwise noted by (*).**

***** List of heavy metals in coal slurry: Mine Safety and Health Administration**

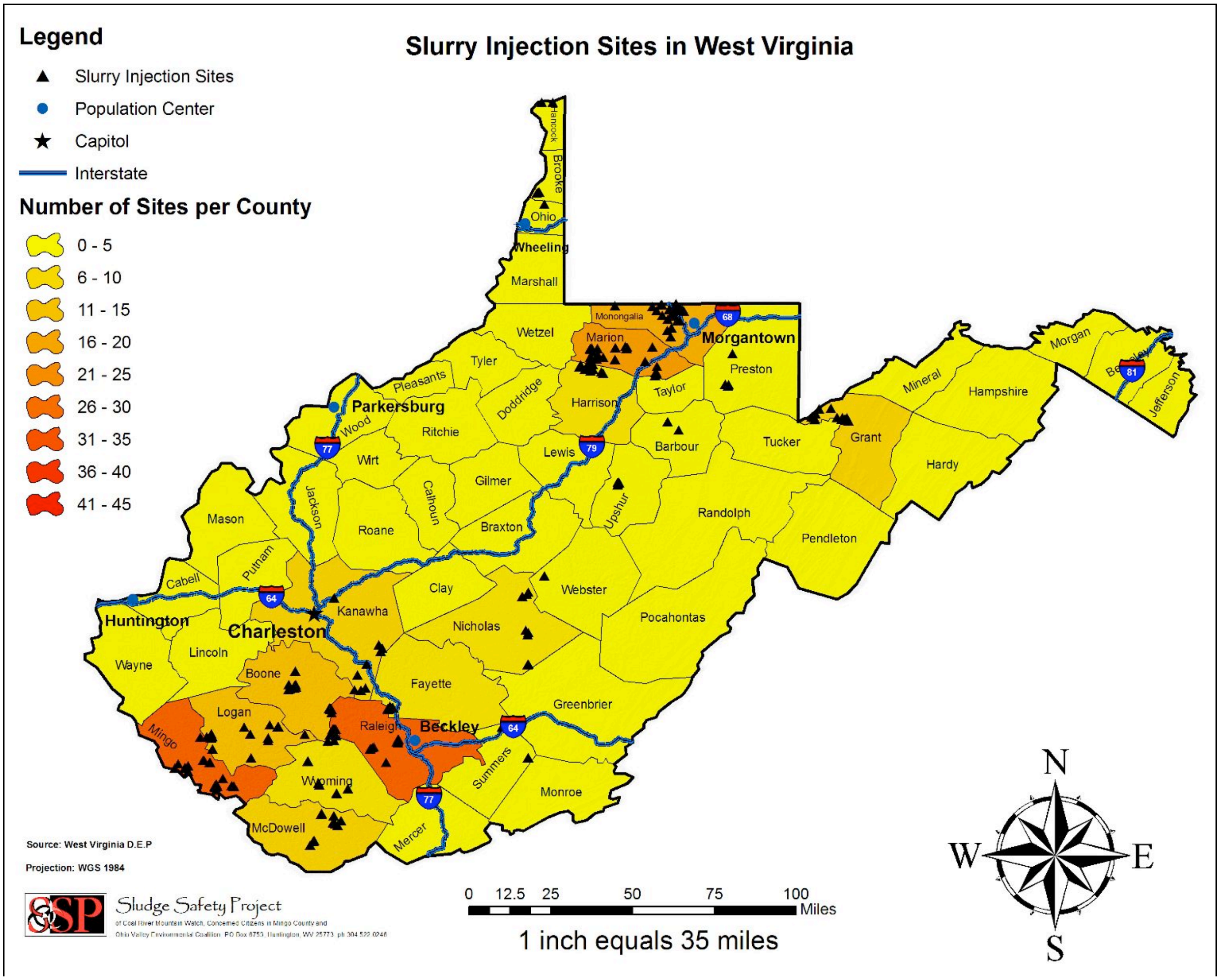
****** Gharibzadeh, Shahriar. "Arsenic Exposure May be a Risk Factor for Alzheimer's Disease."**

Mine Sites Known, Suspected or Proposing to Inject Underground	80
Injection Points Known, Suspected, or Proposed as of 2008	649
Injection Points Known, Suspected, or Proposed as of 2006*	478
Injection Points Known, Suspected, or Proposed as of 2004**	430
Sites Presently in the Application/Permitting Process	27
Permits (or Modifications) Issued or Reissued (2006 – 2008)	38
Injection Points Permitted (2006 – 2008)	114
Permits/Injection Points Closed/Abandoned (2006 – 2008)	5/32
Permits/Injection Points Denied (2006 – 2008)	5/34
Permits/Injection Points Invalidated (2006 – 2008)	0
Applications Voluntarily Withdrawn (2006 – 2008)	2
Applications/Injection Points presently "On Hold" (Pending Resolution of Groundwater Problems)	3/6

Table 4. WV DEP's Underground Injection Statistics as of 2008
All data from WV DEP's 2008 Biennial Report to the Legislature on Groundwater Programs and Activities unless otherwise noted: http://www.wvdep.org/show_blob.cfm?ID=14320&Name=2008_106_Report.pdf
* WV DEP's 2006 Biennial Report to the Legislature on Groundwater Programs and Activities http://www.wvdep.org/show_blob.cfm?ID=10274&Name=Biennial_Report_2006full.pdf
** WV DEP's 2004 Biennial Report to the Legislature on Groundwater Programs and Activities http://www.wvdep.org/show_blob.cfm?ID=10545&Name=2004_Biennial_Groundwater_Report.pdf

	Company	County
1	Black Wolf	McDowell
2	Brooks Run Mining	Webster
3	Coresco, Inc.	Monongalia
4	Eagle Energy	Boone
5	Gatling Coal	Mason
6	ICG Beckly	Raleigh
7	Independence Coal Co.	Boone
8	Kanawha Eagle Coal, LLC	Boone & Kanawha
9	Power Mountain	Nicholas
10	Power Mountain	Nicholas
11	Remington,LLC	Kan/Boone
12	Rockspring Development	Wayne
13	Southern Minerals	McDowell

Table 5. West Virginia Counties with Active Injection Permits
Source: DEP email correspondence sent March 11,2009



Map 1. Injection sites documented by SSP from WVDEP Archive

Alternatives to Coal Slurry

"Dry cleaning methods should generate fewer environmental problems and require less energy than wet washing methods."

– **University of Arkansas**[20]

Many options are available to process coal without creating coal slurry including de-watering and cleaning coal without water.

Latest Development in Dewatering

Virginia Tech scientists have developed a technology that removes water from coal slurry, lowering the amount of toxic waste potentially seeping into the water table and poisoning wells. ***http://www.collegiatetimes.com/stories/13009***

Wet cleaning process without the slurry

If coal is washed using a wet process, which creates the coal slurry, the slurry does not need to be disposed of immediately into impoundments or injected into abandoned mines. Dewatering processes press or filter the water from the waste. Several methods are available and fairly widely used. The most appropriate method depends on the slurry composition and planned disposal method.[21]

Companies in West Virginia have already utilized dry press filters. This technology relies on a closed loop of water to wash the coal. Waste slurry is pressed and dry filter cakes are created. These dry filter cakes may then be stored appropriately and more safely in lined landfills.

Marrowbone Development in Mingo County used a dry press filter well into the 1980s. Other dry press systems, and dewatering systems have been utilized in West Virginia.

Existing coal processing plants can be paired with a filter press that will dry the slurry into filter cakes that can be disposed of in a lined landfill. The cost is slightly higher (50 cents to one dollar per ton) for a conventional plant to

---

[20] University of Arkansas, Published by US Department of Energy http://www.netl.doe.gov/publications/proceedings/99/99ucr/mazumder.pdf

[21] Mohanty, M.K.; Wang, Z.; Huang, Z.; Hirschi, J. "Optimization of the Dewatering Performance of a Steel Belt Filter" Coal Preparation, Jan-Apr 2004, Vol. 24 Issue 1/2, p53-68, 16p; (AN 14117371)

operate with a filter press than without.[22] This method has been used in West Virginia.

Dry Cleaning Processes

Other methods of coal processing don't involve water at all. Such methods are popular in the Western United States where water resources are scarce and, therefore, highly valued. Dry processes vary from using air and motion to electromagnetism to separate out the coal without water and many have been around for decades. The initial capital expenditure on a dry plant is less than a wet plant and since dry processes use less energy and do away with the need for chemical input and large waste disposal areas, the operating cost is also lower.[23]

Advantages of Dry Cleaning[24]

- No tailings slurry is created.
- No expensive dewatering process, such as screening, pumping, vacuum filtration or centrifuging, are necessary
- Other high cost processes such as thickeners, froth flotation and expensive reagents such as flocculants, collectors and frothers are not required
- Coal prep plants would be smaller, cheaper, require less electrical energy and would have lower operating costs
- Freight payload would be greater and subsequently, freight costs per gigajoule less, due to low levels of moisture.
- Absence of tailing ponds is ecologically attractive and rehabilitation costs of mining areas would be reduced
- Yields of "clean coal" will be relatively higher as ultrafine coal will be included in the product. Many coal preparation plants waste fine coal to tailings due to the cost of recovering it by wet methods and its disproportionate contribution to product moistures.
- Monitoring and control of effluent is not required.[25]

Electrostatic separation: Mineral matter is relatively conducting, does not retain an electric charge, and is thrown from the drum. Coal is relatively non-conducting and does retain a charge, and it adheres to the drum until being swept off with a brush. Research is being conducted to refine the process and make it more cost-effective.

---

[22] Phone conversation with prep plant company rep.
[23] Donnelly, Jim. "Potential Revival of Dry Cleaning of Coal." The Australian Coal Review. October 1999.
[24] Donnelly, Jim.
[25] "The Production and Management of Dry Tailings in Coal and Uranium." A. MacG. Robertson P. Eng, Ph.D (President, Steffen Robertson and Kirsten (B.C.) Inc. and J.W. Fisher P. Eng. Draft of Paper. September 1981.

Magnetic Separators: The process is somewhat similar to electrostatic separation, using magnets rather than electrical charge. Research suggests that some versions of magnetic separators will reduce costs significantly—the Rare Earth Magnetic Separator (REM) can handle 4-5 tons/hour, offers 13% lower capital cost, and 50% of the operating costs compared to wet system for production of a fine coal product of equivalent energy level. [26]

Sources of Information

Relatively little is know about the make up of coal slurry. Scientists, including those with the authorization and funding through the U.S. Geological Survey have been denied access to sampling and testing coal slurry impoundments.

The Martin County Coal Slurry spill in Kentucky in 2000 was about 30 times as big as the Exxon Valdez and covered 75 miles of streams. Only a handful of samples were taken.

Our understanding of coal slurry comes from this disaster in Martin County as reported by the Mine Safety and Health Administration and from a 1985 consent order from the US EPA that was based on slurry injection site about 4 miles south of Williamson, WV.[27]

Since the US EPA sued one coal company, Massey Energy, for thousands of Clean Water Act violations, the DEP has been allowing coal companies to settle past water pollution violations in-state. However, rather than enforcing the law and collecting overdue fines, the WVDEP is settling for much less and only reviewing violations since 2006.[28] [29]While we have not reviewed all consent orders from these settlements, the ones we have seen have allowed us access to a fraction of the violation history of companies that have likely lead to slurry contamination.

We are awaiting the results of a SCR-15, which is a 2007 mandate from the West Virginia Legislature to the WVDEP to study coal slurry and its constituents. After 2 years, the DEP has sampled 5 underground injection sites and one impoundment and not produced a report.[30] While the DEP originally agreed to

---

[26] Donnelly, Jim.

[27] EPA Docket No. IV-85-UIC-101. "Determination and Consent Order in the Matter of Eastern Coal Corporations." United Sates Environmental Protection Agency Region IV. August 30, 1985. Online at http://www.sludgesafety.org/coal_slurry_inj.html.

[28] Ward, Ken Jr. "Foundation Coal Hit with Pollution Fines." Charleston Gazette. November 22, 2008. Viewed online March 17, 2009 online at www.wvgazette.com/news/200811210964

[29] "Coal Producer Pays $20M Pollution Fine." Associated Press. Filed January 17, 2008.

[30] "DEP Unsure if Coal Slurry Poisons Water Supplies: Agency to Ignore Deadline for Study."

split the samples with independent scientists, they have reneged on that promise and only provided split samples from three sites in the state. However, the DEP has graciously provided us with their data, which has been interpreted by scientists at Wheeling Jesuit University.

We have worked with universities to test citizen wells and streams near coal sludge storage where we have found correlations in water supplies with contents of slurry. We have pieced together information about individual components of coal slurry, though we do not know how these chemicals interact with each other under certain conditions underground, and we have not had the resources to adequately test for many parameters that are of concern, such as organics.

In a 2002 report, the National Research Council of the National Academy of Sciences recommended further study to identify chemical constituents contained in liquid and solid fractions of slurry and to characterize the hydrogeologic conditions near coal sludge storage. The report also stressed the need for research on alternative waste disposal methods.[31]

Recommendations

The Sludge Safety Project urges the WV 2009 Legislature to pass a moratorium on all sludge until studies can prove it is not a public health hazard.

We make the following additional recommendations:

Municipal water and, more immediately, emergency drinking water be provided to residents near coal slurry sites, including Prenter in Boone County, Jones Branch in Nicholas County, Mud River and Harts in Lincoln County, and Bridge Fork in Fayette County.

The WV Department of Health and Human Resources initiate the health portion of SCR-15 with a renewed mandate to focus research where the DEP and DHHR have received complaints of black water, bad water, and health problems near where coal slurry is stored.

Require the DHHR to submit a budget and timeline for the health portion of the SCR-15 study.

---

[31] Committee on Coal Waste Impoundments, National Academy of Sciences. "Coal Waste Impoundments: Risks, Responses, and Alternatives." National Academy Press. Washington, DC. 2002. Online at http://www.nap.edu/openbook.php?record_id=10212&page=R1

Cease all settlements for UIC violations and require companies to pay full fines. These fines may be used to provide drinking water projects to impacted communities. One company that settled on Clean Water Act violations was required to pay $20 Million. Full back fines totaled $2.4 Billion. The state didn't see a cent.

Expand the coal slurry study, SCR-15 to consider the toxicity and leaching potential of coal slurry impoundments, as ground water and surface waters can be highly interconnected.

WVDEP must employ a minimum of 4 inspectors specifically for enforcement of UIC regulations in regard to coal mines.

Require best practices regarding coal processing, which would only produce dry waste.

Works Cited

Bunnell, Joseph E. "Preliminary Toxicological Analysis of the Effect of Coal Slurry Impoundment Water on Human Liver Cells" United States Geological Survey. Open-File Report 2008-1143. Reston, VA. 2008.

CERCLA 2007 Priority List of Hazardous Substances. Agency for Toxic Substances and Disease Registry. Viewed March 9, 2009 online at www.atsdr.cdc.gov/cercla/07list.html.

"Coal Producer Pays $20M Pollution Fine." Associated Press. Filed January 17, 2008.

Committee on Coal Waste Impoundments, National Academy of Sciences. "Coal Waste Impoundments: Risks, Responses, and Alternatives." National Academy Press. Washington, DC. 2002. Online at http://www.nap.edu/openbook.php?record_id=10212&page=R1

Community Health Survey, Coal River Mountain Watch.

Darst, Paul. "Team Finds New Ways to Strip Mercury from Water." The State Journal. January 3, 2008. Viewed online March 9, 2009 at www.statejournal.com/story.cfm?func=viewstory&storyid=33130.

DEP Consent Order No. M-08-023. Consent Order Issued Under Water Pollution Control Act, West Virginia Code, Chapter 22, Article 11. Department of Environmental Protection, Division of Water and Waste Management. September 18, 2008.

"DEP Unsure if Coal Slurry Poisons Water Supplies: Agency to Ignore Deadline for Study." Charleston Gazette, February 7, 2009. Online at http://www.wvgazette.com/News/200902070209.

Donnelly, Jim. "Potential Revival of Dry Cleaning of Coal." The Australian Coal Review. October 1999.

"Early Deaths: West Virginians Have Some of the Shortest Life Expectancies in the United States." West Virginians for Affordable Health Care. Based on a 2008 Report from Harvard Researchers. Online at www.wvahc.org.

EPA Docket No. IV-85-UIC-101. "Determination and Consent Order in the Matter of Eastern Coal Corporations." United Sates Environmental Protection Agency Region IV. August 30, 1985. Online at http://www.sludgesafety.org/coal_slurry_inj.html.

Gharibzadeh, Shahriar. "Arsenic Exposure May be a Risk Factor for Alzheimer's Disease." The Journal of Neuropsychiatry and Clinical Neurosciences. 20:501, November 2008.

Hendryx, Michael. "Hospitalization Patterns Associated with Appalachian Coal Mining." Journal of Toxicology and Environmental Health. Taylor and Francis, 2008. ISSN: 1528-7394 print/ 1087-2620 online.

Kostenko, Michael M.D. Personal correspondence.

Mohanty, M.K.; Wang, Z.; Huang, Z.; Hirschi, J. "Optimization of the Dewatering Performance of a Steel Belt Filter" Coal Preparation, Jan-Apr 2004, Vol. 24 Issue 1/2, p53-68, 16p; (AN 14117371)

Orem, William H. ***Coal Slurry: Geochemistry and Impacts on Human Health and Environmental Quality. (Power Point Presentation).*** **United States Geological Survey. Viewed online March 9, 2009 at http://www.sludgesafety.org/misc/wm_orem_powerpoint/**

Pettigrew, Pavanne L. "History and Status of Mining Underground Injection Control at the WVDEP Division of Water and Waste Management." Presented at the 2008 West Virginia Mine Drainage Task Force Symposium, Morgantown, WV.

Schoening, Richard. West Virginia University Institute of Technology, Chemistry Department. Phone correspondence with Matt Noerpel of Coal River Mountain Watch. October 30, 2008.

Spadaro, Jack. Report of Investigation Larry Brown Et. Al. v. Rawl Sales and Processing Company. Mingo County, West Virginia. Contact: PO Box 442, Hamlin, WV 25523.

Stout, Ben M. "Well Water Quality in the Vicinity of a Coal Slurry Impoundment Near Williamson, West Virginia" Wheeling Jesuit University. December 10, 2004. Online at www.sludgesafety.org/what_me_worry/wju_report.pdf.

Stout, Ben M. and Mary Ellen Cassidy. "West Virginia DEP and Wheeling Jesuit University Underground Injection Collaborative Study" Unpublished. Attached as Appendix 1

"The Production and Management of Dry Tailings in Coal and Uranium." A. MacG. Robertson P. Eng, Ph.D (President, Steffen Robertson and Kirsten (B.C.) Inc. and J.W. Fisher P. Eng. Draft of Paper. September 1981.

University of Arkansas, Published by US Department of Energy http://www.netl.doe.gov/publications/proceedings/99/99ucr/mazumder.pdf

Ward, Ken Jr. "Foundation Coal Hit with Pollution Fines." Charleston Gazette. November 22, 2008. Viewed online March 17, 2009 online at www.wvgazette.com/news/200811210964

Other Resources

Hendryx, Michael. and Melissa M. Ahem. "Relations Between Health Indicators and Residential Proximity to Coal Mining in West Virginia." American Journal of Public Health. April 2008, Vol. 98, No. 4.

Smith, Barbara J. "Health Consultation: Williamson Sites. Williamson, Mingo County, West Virginia." Agency for Toxic Substances and Disease Registry, West Virginia Department of Health and Human Resources. February 13, 2004. Online at http://www.atsdr.cdc.gov/hac/PHA/williamson/wil_p1.html.

Appendix 1:

"West Virginia DEP and Wheeling Jesuit University Underground Injection Collaborative Study"

Dr. Ben Stout
Mary Ellen Cassidy

WHEELING JESUIT UNIVERSITY

Biology Department

March 9, 2009

Senator C. Randy White
Natural Resource Committee
212 River Drive
Webster Springs, West Virginia

Dear Senator White,

Attached please find the preliminary summary and database of selected metal results from the Underground Injection Control Study as compiled by Dr. Ben Stout and Mary Ellen Cassidy of Wheeling Jesuit University.

In a meeting with OSM and WVDEP on February 17th, there was some confusion as to which standards apply to injected slurry. We have used Primary Drinking Water Standards in our analysis based on information found in WVDEP reports, one being WVDEP's use of Primary Drinking water standards for the Southern Minerals UIC report and another being a statement from "History and Status of Mining Underground Injection Control at the WVDEP Division of Water and Waste Management" presented at the 2008 West Virginia Surface Mine Task Force Symposium - "In fact, if an existing mine pool is being used as a potable water source for even one person, no permit will be issued for injection into it, notwithstanding the requirement that all UIC injection must meet Federal Safe Drinking Water Standards, also called Primary Drinking Water Maximum Contaminant Levels, or MCLs, at the point of injection."

Based on Primary Drinking Water standards the following metals were present in the liquid faction of the UIC slurry samples in concentrations above the Primary Drinking Water Standards: antimony, arsenic, lead, barium, cadmium, and chromium.

Antimony exceeded Primary Drinking Water Standards at all but one (Power Mountain) of the six sites with as high as 3x the standard at the Southern Minerals site. Lead exceeded Primary Drinking Water Standards at two of the six sites (Marfork and Panther) with values at 5x the standard at the Panther site and over 300 x the standard at the Marfork site. Barium, cadmium, and chromium also far exceeded the drinking water standards at the Marfork site with concentrations 100x, 24x, and 55x the accepted levels respectively.

Exceptionally high concentrations of metals were found in the solid faction of the slurry at all six locations. For example the solids from Marfork had concentrations of arsenic at 159 000 ppb. Although solids are not regulated under Drinking Water Standards metal concentrations are relevant due to the fact that changes in pH, redox potential and other unknown underground conditions can mobilize metals from the solid to the liquid faction of the slurry.

WJU analyzed samples for selected metals only (inorganic constituents). However, WVDEP tested for other parameters including organic compounds. In their organic analysis section of the Southern Minerals UIC report, WVDEP notes that "Total Petroleum Hydrocarbon (TPH) values should not exceed the threshold limit

(100 mg/L) set by the WVDEP's Division of Solid Waste Management for their Special Waste designation...The TPH issue should be corrected since this slurry is being injected into the groundwater of the state of West Virginia". Based on this concern, it should be noted that all but one (Power Mountain) of the UIC sites show TPH values above these threshold limits. Especially high concentrations were recorded at the Coresco site with TPH levels above 700 mg/L. According to the WVDEP, "Coal Slurry containing TPH values above 100 mg/L should not be injected into groundwater aquifers in West Virginia. This practice may be in violation of the WVDEP Division of Solid Waste policy, unless an exclusion or exemption has been granted by the WVDEP." (West Virginia Coal Slurry Study: Southern Minerals/Welch Sample Results Discussion).

The attached database was sent to WVDEP for review. Upon receipt of comments a comprehensive final report will be compiled by WJU. There are questions as to identity of comparable samples and discrepancies between WVDEP and WJU findings that are still unresolved (see attached documents). Therefore, without review and comment from the WVDEP, the remarks included in this letter along with the attached analysis are preliminary findings and are not yet considered verified and reliable. Please feel free to contact us with any further questions you may have.

Sincerely,

Mary Ellen Cassidy

Mary Ellen Cassidy
Dr. Ben Stout
Wheeling Jesuit University
316 Washington Avenue
Wheeling, West Virginia
304-232-2316
mcassidy@wju.edu
bens@wju.edu

Barium (Ba) was found in exceedence of 2000 ppb DWS at *one of the six sites.*
Marfork (Slurry = 304 000 ppb reported by WVDEP)

Cadmium (Cd) was found in exceedence of 5 ppb DWS at *one of the six sites.*
Marfork (Slurry = 123 ppb reported by WVDEP)

Chromium (Cr) was found in exceedence of 100 ppb DWS at one of the six sites.
Marfork (Slurry = 5 550 ppb reported by WVDEP)

According to WVDEP reports Power Mountain shows no primary water standard exceedence for metals tested. (WJU analysis not yet available)

In general, both WVDEP and WJU results showed high metal concentrations in the solid faction. The potential solubility and mobility of these metals from the solid to liquid faction depends on the stability of several parameters such as pH, redox and surrounding chemistry.

Attached Database: Notes of Interest
In several instances, there were discrepancies between WVDEP results compared to WJU results with no clear pattern of consistently higher results from either. (For instance, for the split samples from Loadout, the total liquid antimony (Sb) concentration is given as 11.32 ppb by WJU compared to 5.90 ppb by WVDEP. In contrast, for the split samples from Panther, the total liquid arsenic (As) concentration is given as 4.26 ppb by WJU compared to 11.30 ppb from WVDEP.)

In several instances WJU reconstituted samples showed higher concentrations than the WJU original supernatants. For example, for Panther, the total liquid antimony (Sb) concentration for slurry supernatant was 1.35 ppb while the reconstituted (diluted) sample is 1.95 ppb.

The table below includes a more detailed description of the metal concentrations. The last column indicates whether the values are from WJU or WVDEP reports. Secondary Drinking water contaminants are listed. Contaminant Candidate Listed (CCL) metals are also listed below with respective Drinking Water Equivalency Limits (DWEL). However, both Secondary and CCL metals although assigned suggested limits are not enforceable standards.

LOADOUT, LLC.

Metals Exceeding EPA Primary Drinking Water Standards

Metal	Sample	EPA STD	Concentrations (ppb)	Report
Sb	Slurry Supernatant Total (2008)	6 ppb	11.32	WJU
	Reconstituted Slurry Liquid Total (2008))	Primary	1.04	WJU
	LL-Slurry-Liquids Total		5.90	WVDEP

Metals Exceeding EPA Secondary Drinking Water Standards

Metal	Sample	EPA STD	Concentrations (ppb)	Report
Al	Reconstituted Slurry Liquid Total (2008)	200 ppb	2477.77	WJU
	Slurry Supernatant Total (2008)		10.86	WJU
	LL-Slurry-Liquids Total		2370.00	WVDEP
Fe	Reconstituted Slurry Liquid Total (2008))	300 ppb	1881.11	WJU
	Slurry Supernatant Total (2008)		141.99	WJU
	LL-Slurry-Liquids Total		828.00	WVDEP
	Slurry Supernatant Soluble (2007)		318.57	WJU
	LL Slurry Liquid Dissolved		ND	WVDEP
	Slurry Supernatant soluble (2008)		131.53	WJU
	Reconstituted Slurry Liquid Soluble (2008)		87.05	WJU
Mn	Slurry Supernatant Total (2008)	50 ppb	BDL	WJU
	Reconstituted Slurry Liquid Total (2008)		21.24	WJU
	LL-Slurry-Liquids Total		97.00	WVDEP
	Slurry Supernatant Soluble (2007)		86.92	WJU
	LL Slurry Liquid Dissolved		86.00	WVDEP

Metals on the Contaminant Candidate List – not regulated

Metal	Sample	DWEL *	Concentrations (ppm)	Report
Na	Slurry Supernatant Total (2008)	20 ppm	117.53	WJU
	LL-Slurry-Liquids Total		267.00	WVDEP
	Reconstituted Slurry Liquid Total (2008)		62.23	WJU
	LL Slurry Liquid Dissolved		265.00	DEP
	Slurry Supernatant soluble (2008)		287.49	WJU
	Reconstituted Slurry Liquid Soluble (2008)		78.78	WJU
	Slurry Supernatant Soluble (2007)		BDL	WJU

* DWEL = Drinking Water Equivalency Level According the EPA website: " This low level of concern is compounded by the legitimate criticisms of EPA's 20 milligrams per liter (mg/l) Drinking Water Equivalency Level (DWEL or guidance level) for sodium. EPA believes this guidance level for sodium needs updating and is probably low. If a health benchmark for drinking water were established using current information and current drinking water health assessment procedures, it would likely be higher. This revision could establish a new level at which sodium occurrence would not meet the criteria for inclusion on the CCL as a drinking water contaminant of concern. There was insufficient time to complete a reassessment of the sodium guidance in advance of the CCL issuance."

WJU Reconstituted Samples = Slurry samples were well mixed and allowed to settle for 37 days. Then 100 mL supernatant was decanted and diluted with 250 mL deionized water.

PANTHER

Metals Exceeding EPA Primary Drinking Water Standards

Metal	Sample	EPA STD	Concentrations (ppb)	Report
Sb	PL-Slurry Liquids Total	6 ppb	16.00	WVDEP
	Slurry Supernatant Total (2008)		1.36	WJU
	Reconstituted Slurry Liquid Total (2008))		1.95	WJU
	PL-Slurry Liquids dissolved metals		14.60	WVDEP
	Slurry Supernatant Soluble (2008)		1.37	WJU
	Reconstituted Slurry Liquid Soluble (2008)		2.24	WJU
As	PL-Slurry Liquids Total	10 ppb	11.30	WVDEP
	Slurry Supernatant Total (2008)		4.26	WJU
	Reconstituted Slurry Liquid Total (2008))		2.91	WJU
	Slurry Supernatant Soluble (2008)		4.62	WJU
	Reconstituted Slurry Liquid Soluble (2008)		3.58	WJU
	PL-Slurry Liquids Dissolved Metals		10.40	WVDEP
Pb	Slurry Supernatant Total (2008)	15 ppb	27.88	WJU
	PL-Slurry Liquids total		77.50	WVDEP
	Reconstituted Slurry Liquid Total (2008)		6.58	WJU
	Reconstituted Slurry Liquid Soluble (2008)		5.13	WJU
	Slurry Supernatant Soluble (2008)		29.23	WJU
	PL-Slurry Liquids dissolved metals		76.20	WVDEP

Metals Exceeding EPA Secondary Drinking Water Standards

Metal	Sample	EPA STD	Concentrations (ppb)	Report
Al	Reconstituted Slurry Liquid Total (2008))	200 ppb	1988.29	WJU
	Slurry Supernatant Total (2008)		20.15	WJU
	PL-Slurry Liquids total		46.00	WVDEP
Fe	Slurry Supernatant Total (2008)	300 ppb	46.95	WJU
	PL-Slurry Liquids total		89.00	WVDEP
	Reconstituted Slurry Liquid Total (2008))		935.94	WJU
	Slurry Supernatant Soluble (2008)		28.48	WJU
	PL-Slurry Liquids dissolved		68.00	WVDEP
	Reconstituted Slurry Liquid Soluble (2008)		322.17	WJU

Metals on the Contaminant Candidate List – not regulated

Metal	Sample	DWEL *	Concentrations (ppm)	Report
Na	Slurry Supernatant Total (2008)	20 ppm	942.42	WJU
	PL-Slurry Liquids total		341.00	WVDEP
	Reconstituted Slurry Liquid Total (2008))		243.93	WJU
	Slurry Supernatant Soluble (2008)		1023.07	WJU
	PL-Slurry Liquids dissolved		266.00	WVDEP
	Reconstituted Slurry Liquid Soluble (2008)		268.37	WJU

* DWEL = Drinking Water Equivalency Level According the EPA website: " This low level of concern is compounded by the legitimate criticisms of EPA's 20 milligrams per liter (mg/l) Drinking Water Equivalency Level (DWEL or guidance level) for sodium. EPA believes this guidance level for sodium needs updati and is probably low. If a health benchmark for drinking water were established using current information and current drinking water health assessment procedures, it would likely be higher. This revision could establish a new level at which sodium occurrence would not meet the criteria for inclusion on the C(as a drinking water contaminant of concern. There was insufficient time to complete a reassessment of the sodium guidance in advance of the CCL issuanc

WJU Reconstituted Samples = Slurry samples were well mixed and allowed to settle for 37 days. Then 100 mL supernatant was decanted a

SOUTHERN MINERALS

Metals Exceeding EPA Primary Drinking Water Standards

Metal	Sample	EPA STD	Concentrations (ppb)	Report
Sb	SM-Slurry Liquids Dissolved SM-Slurry Liquids Total	6 ppb	22.0 ppm 21.5 ppm	WVDEP WVDEP

Metals Exceeding EPA Secondary Drinking Water Standards

Metal	Sample	EPA STD	Concentrations (ppb)	Report
Al	SM-Slurry Liquids	200 ppb	651	WVDEP
Fe	SM-Slurry Liquids	300 ppb	910	WVDEP

Metals on the Contaminant Candidate List – not regulated

Metal	Sample	DWEL *	Concentrations (ppm)	Report
Na	SM-Slurry Liquid Dissolved SM-Slurry Liquid Total	20 ppm	58.8 55.5	WVDEP WVDEP

* DWEL = Drinking Water Equivalency Level According the EPA website: " This low level of concern is compounded by the legitimate criticisms of EPA's 20 milligrams per liter (mg/l) Drinking Water Equivalency Level (DWEL or guidance level) for sodium. EPA believes this guidance level for sodium needs updating, and is probably low. If a health benchmark for drinking water were established using current information and current drinking water health assessment procedures, it would likely be higher. This revision could establish a new level at which sodium occurrence would not meet the criteria for inclusion on the CCL as a drinking water contaminant of concern. There was insufficient time to complete a reassessment of the sodium guidance in advance of the CCL issuance."

Coresco

Metals Exceeding EPA Primary Drinking Water Standards

Metal	Sample	EPA STD	Concentrations (ppb)	Report
Sb	CL-Slurry Liquid	6 ppb	7.1	WVDEP

Metals Exceeding EPA Secondary Drinking Water Standards

Metal	Sample	EPA STD	Concentrations (ppb)	Report
Al	CL-Slurry Liquid	200 ppb	644	WVDEP
Mn	CL-Slurry Liquid	50 ppb	138	WVDEP

Metals on the Contaminant Candidate List – not regulated

Metal	Sample	DWEL *	Concentrations (ppm)	Report
Na	CL-Slurry Liquid	20 ppm	279	WVDEP

* DWEL = Drinking Water Equivalency Level According the EPA website: " This low level of concern is compounded by the legitimate criticisms of EPA's 20 milligrams per liter (mg/l) Drinking Water Equivalency Level (DWEL or guidance level) for sodium. EPA believes this guidance level for sodium needs updatin and is probably low. If a health benchmark for drinking water were established using current information and current drinking water health assessment procedures, it would likely be higher. This revision could establish a new level at which sodium occurrence would not meet the criteria for inclusion on the CC as a drinking water contaminant of concern. There was insufficient time to complete a reassessment of the sodium guidance in advance of the CCL issuance

Marfork

Metals Exceeding EPA Primary Drinking Water Standards

Metal	Sample	EPA STD	Concentrations (ppb)	Report
Ba	MF-Slurry metals	2000 ppb	304 000	WVDEP
Cd	MF-Slurry metals	5 ppb	123	WVDEP
Cr	MF-Slurry metals	100 ppb	5 550	WVDEP
Pb	MF-Slurry metals	15 ppb	5860	WVDEP

Metals Exceeding EPA Secondary Drinking Water Standards

Metal	Sample	EPA STD	Concentrations (ppb)	Report
Al	MF-Slurry metals	200 ppb	3 130 000	WVDEP
Cu	MF-Slurry metals	1300 ppb	10 800	WVDEP
Fe	MF-Slurry metals	300 ppb	7 000 000	WVDEP
Mn	MF-Slurry metals	50 ppb	72 900	WVDEP
Zn	MF-Slurry metals	5 000 ppb	18 700	WVDEP

Metals on the Contaminant Candidate List – not regulated

Metal	Sample	DWEL *	Concentrations (ppm)	Report
Na	MF-Slurry metals	20 ppm	315	WVDEP
Ni	MF-Slurry metals	100 ppm	7 680	WVDEP

* DWEL = Drinking Water Equivalency Level According the EPA website: " This low level of concern is compounded by the legitimate criticisms of EPA's 20 milligrams per liter (mg/l) Drinking Water Equivalency Level (DWEL or guidance level) for sodium. EPA believes this guidance level for sodium needs updating, and is probably low. If a health benchmark for drinking water were established using current information and current drinking water health assessment procedures, it would likely be higher. This revision could establish a new level at which sodium occurrence would not meet the criteria for inclusion on the CCL as a drinking water contaminant of concern. There was insufficient time to complete a reassessment of the sodium guidance in advance of the CCL issuance."

Power Mountain

According to WVDEP Reports, there are no metals exceeding Primary Drinking Water Standards for Power Mountain.

Metals Exceeding EPA Secondary Drinking Water Standards

Metal	Sample	EPA STD	Concentrations (ppb)	Report
Al	PM – Slurry Liquid PM- Slurry Liquid Lab Filtered	200 ppb	564 509	WVDEP
Mn	PM – Slurry Liquid PM- Slurry Liquid Lab Filtered	50 ppb	921 921	WVDEP

Metals on the Contaminant Candidate List – not regulated

Metal	Sample	DWEL *	Concentrations (ppm)	Report
Na	PM – Slurry Liquid PM- Slurry Liquid Lab Filtered	20 ppm	237 236	WVDEP

* DWEL = Drinking Water Equivalency Level According the EPA website: " This low level of concern is compounded by the legitimate criticisms of EPA's 20 milligrams per liter (mg/l) Drinking Water Equivalency Level (DWEL or guidance level) for sodium. EPA believes this guidance level for sodium needs updating, and is probably low. If a health benchmark for drinking water were established using current information and current drinking water health assessment procedures, it would likely be higher. This revision could establish a new level at which sodium occurrence would not meet the criteria for inclusion on the CCL as a drinking water contaminant of concern. There was insufficient time to complete a reassessment of the sodium guidance in advance of the CCL issuance."

WVDEP UIC STUDY First Draft Lab Results

Location	Report	Sb	As	Ba	Be	Cd	Cr	Pb	Hg	Se	Tl	Al	Cu	Fe
		ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb
Loadout: both (WJU) (WVDEP) Results														
Slurry Supernatant Total (2008)	WJU	11.32	BDL	25.13	BDL	BDL	BDL	BDL	BDL	4.02	BDL	10.86	BDL	141.99
LL-Slurry-Liquids Total Recov ICP Lab ID 0709F34 a	DEP	5.90	4.70	133.00	ND	ND	ND	1.60	ND	27.80	0.40	2370.00	3.40	826.00
Reconstituted Slurry Liquid Total (2008))	WJU	1.04	1.14	95.68	BDL	BDL	2.71	5.54	BDL	5.66	BDL	2477.77	9.40	1881.11
Slurry Supernatant Soluble (2007)	WJU	5.24	3.72	49.46	BDL	BDL	BDL	BDL	BDL	22.85	BDL	168.21	2.54	316.57
LL Slurry Liquid Dissolved ICP Lab ID 0709F34 and	DEP	5.70	4.20	97.40	ND	ND	ND	ND	ND	26.80	0.30	150.00	1.60	ND
Slurry Supernatant soluble (2008)	WJU	11.93	BDL	25.27	BDL	BDL	BDL	BDL	BDL	2.10	BDL	6.71	1.35	131.53
Reconstituted Slurry Liquid Soluble (2008)	WJU	1.19	BDL	62.59	BDL	BDL	BDL	BDL	BDL	6.38	BDL	18.65	2.19	87.05
Slurry Solids (2007)	WJU	BDL	6941.00	104181.00	1624.00	BDL	12102.50	18414.50	BDL	3335.50	BDL	3681632.50	29232.00	7405295.00
LL-Slurry Solids Lab ID 0709F34	DEP	ND	ND	638.00	ND	ND	ND	ND	ND	ND	ND	36100.00	ND	29700.00
Reconstituted Slurry Solids (2008)	WJU	BDL	5350.39	113407.15	1658.19	BDL	12404.88	19601.42	BDL	3427.19	BDL	3316696.33	29494.08	6282672.33
Panther LLC, both (WJU) (WVDEP) Results														
Slurry Supernatant Total (2008)	WJU	1.36	4.26	53.76	BDL	BDL	BDL	27.88	1.01	6.80	BDL	20.15	120.84	46.95
PL-Slurry Liquids total recoverable ICP Lab ID 0801C	DEP	16.00	11.30	269.00	ND	1.10	34.20	77.50		25.50	ND	46.00	27.80	89.00
Reconstituted Slurry Liquid Total (2008))	WJU	1.95	2.91	132.46	BDL	BDL	2.30	6.58	BDL	7.02	BDL	1988.29	34.46	935.94
Slurry Supernatant Soluble (2008)	WJU	1.37	4.62	54.63	BDL	BDL	BDL	29.23	BDL	4.52	BDL	8.82	129.91	28.48
PL-Slurry Liquids dissol metals ICP Lab ID 0801C90-	DEP	14.60	10.40	243.00	ND	ND	27.20	76.20		22.40	ND	29.00	24.80	68.00
Reconstituted Slurry Liquid Soluble (2008)	WJU	2.24	3.58	97.26	BDL	BDL	BDL	5.13	BDL	8.27	BDL	383.66	39.06	322.17
Reconstituted Slurry Solids Total (2008)	WJU	BDL	BDL	153184.20	1150.37	BDL	11717.75	13529.52	BDL	BDL	BDL	5825292.50	18351.71	8292584.00
PL -Slurry Solids Lab ID 0801C90-01S	DEP	ND	ND	52300.00	385.00	80.90	4820.00	4790.00	ND total	ND	ND	3600000.00	7540.00	6 080 000
Reconstituted Slurry Thickener Total (2008)	WJU	60.55	7.13	93.69	BDL	BDL	2.83	94.77	2.57	29.73	BDL	1057.82	49.05	1118.18
Reconstituted Slurry Thickener Soluble (2008)	WJU	63.09	7.40	59.57	BDL	BDL	BDL	82.63	BDL	25.86	BDL	23.47	45.77	41.99
Southern Minerals (WVDEP) Results only	DEP													
SM-Slurry Liquids Lab ID 0707930-12A dissol metals	DEP	22.0	3.9J	80.9	0.2J	ND	1.3J	ND		8.2	ND		1.2J	ND
SM-Slurry Liquids Lab ID 0707930-12A total recover	DEP	21.5	4.3J	114	0.4J	ND	1.6J	0.8J	ND	8.2	0.2J	651	1.8J	910
SM-Slurry Solids Lab ID 0707930-12B	DEP	550J	1200J	99200	425	ND	2770	2950J	ND	ND	ND	1910000	4590	2 060 000
Marfork (WVDEP) Results only	DEP													
MF-Slurry metals ICP Lab ID 0807680-01A	DEP	ND	ND	304 000	ND	123	5 550	5 860	ND	ND	ND	3 130 000	10 800	7 000 000
MF-Coal-Leachate metals ICPLab ID 0807680-02L ar	DEP	1.1	24.6	695	2	ND	5.4	21.7	ND	4	0.4	1 190	24.8	13 200
MF-Coal Solid Lab ID 0807680-02A	DEP	ND	159 000	152 000	ND	445	13 900	16 200	254	1 170	ND	8 720 000	27 400	28 200 000
Coresco(WVDEP) Results only	DEP													
CL-Slurry-Liquid ICP Lab ID 0806J41-01A and ICP-M	DEP	7.1	ND	71.3	ND	ND	ND	ND	ND	2.4	0.2	644	2.1	174
CL-Slurry-Solid ICP Lab ID 0806J41-01S	DEP	ND	4 630	38 900	525	145	7 470	4 090	34	617	ND	1 420 000	7960	8 160 000
CL-Coal-Solid ICP Lab ID 0806J41-02A	DEP	ND	10 600	34 900	1 400	312	10 700	8 060	158	ND	ND	1 820 000	10 500	19 900 000
Power Mountain (WVDEP) WJU has split sample bu	DEP													
PM-Slurry-Liquid Lab ID 0807583-01	DEP	0.5	ND	63.4	ND	ND	ND	0.4	ND	5.9	0.3	564	1.6	195
PM-Slurry-Liquid/Lab Filtered ID 0807583-01B	DEP	0.4	ND	52.3	ND	ND	ND	ND	ND	5.7	0.2	509	1.5	30
PM-Slurry-Solid Lab ID 0807583-01S	DEP	ND	2110	170000	289	149	4330	4890	112	ND	ND	1040000	6160	9890000
		6	10	2000	4	5	100	15	2	50	2	200	1300	300
yellow highlights indicate above drinking water standards			Primary Drinking Water Standards									Secondary Drinking Water Standards		

ND = Non Detect BDL = Below Detection Limits ppm = parts per million ppb = parts per billion

Mn ppb	Ag ppb	Zn ppb	Na ppm	Ni ppb	Ca ppm	Mg ppm	K ppm	Mo ppb	V ppb	Co ppb	Sr ppb	Ti ppb	Sn ppb	U ppb	Si ppm
BDL	BDL	BDL	117.53	BDL	28.26	8.54	6.01	65.46	BDL	BDL	BDL	5.34	BDL	BDL	1.36
97.00	ND	8.00	267.00	7.30	63.70	20.60	14.30	46.60	2.50	1.60	1470.00				8.54
21.24	1.34	13.71	62.33	5.17	36.94	7.90	8.46	23.69	4.32	2.19	BDL	23.14	BDL	3.22	5.17
86.92	BDL	4.39	BDL	3.95	BDL	BDL	BDL	48.95	BDL	1.14	N/A	9.63	BDL	8.93	
86.00	ND	ND	265.00	6.70	62.10	19.80	13.90	44.70	1.30	ND	1440.00				2.30
BDL	BDL	3.16	287.49	2.11	57.00	20.67	13.79	65.79	BDL	BDL	1.32	4.75	BDL	1.16	3.10
BDL	BDL	4.41	78.78	1.47	34.61	8.17	7.98	26.60	BDL	BDL	BDL	1.50	BDL	2.55	1.46
98297.50	BDL	37206.50		16493.00				1211.00	16981.00	8126.00	N/A	99223.50	BDL	1180.00	
498.00	ND	2700.00	217.00	ND	84.10	26.20	43.30	ND	ND	ND	1570.00				32.30
93944.76	BDL	31753.46	1009.10	15852.44	2113.19	2098.96	2559.09	BDL	16898.13	7976.31	2033.09	88710.07	BDL	1195.35	1079.19
13.39	BDL	121.88	924.42	60.82	5.12	2.64	16.37	187.90	BDL	23.36	BDL	5.19	BDL	5.48	2.17
28.00	ND	14.00	341.00	43.20	3.51	0.77	7.05	217.00	13.10	16.10	632.00				0.36
11.35	1.26	27.98	243.93	17.95	2.29	BDL	7.81	53.00	3.44	7.43	7.45	9.67	BDL	BDL	4.46
13.09	BDL	134.69	1023.07	64.75	3.49	3.23	18.19	190.25	BDL	26.84	BDL	2.85	BDL	5.56	2.30
21.00	ND	19.00	266.00	38.60	2.83	0.59	5.38	198.00	10.30	14.20	571.00				0.35
2.27	BDL	29.32	268.37	19.65	BDL	1.02	7.48	57.79	BDL	7.53	7.75	2.49	BDL	BDL	2.02
135328.90	BDL	43979.33	1761.75	12933.01	3276.03	2906.37	3924.66	BDL	15756.70	5315.99	1972.44	26791.69	BDL	BDL	1917.88
51900.00	ND	17400.00	754.00	5060.00	1220.00	908.00	1210.00	ND	6610.00	2310.00	13600.00				46.30
115.98	3.54	71.52	528.67	64.00	4.82	1.44	9.45	233.96	2.88	22.60	BDL	18.05	BDL	7.39	1.63
3.13	1.45	65.05	1422.15	61.36	5.87	3.66	22.67	185.29	BDL	21.51	BDL	4.31	BDL	6.85	2.50
14.1	ND		58.8	4.3J	51.4	20.80	6.90	17.6	1.8J	2.1J	1160				3.3
17.7	ND	27J	55.5	5.2J	51.7	21.00	7.07	17.8	2.1J	2.4J	1170				3.76
22500	ND	8600	44.3	4340	424	620	931	395J	3140	1990J	18800				453
						organics on orig datasheet									
72 900	ND	18 700	315	7 680	719	1 260	1 280 000	ND	8 220	3 810	34 600				317
142	ND	38	6.67	11	1.26	2.210	0.925	2.1		6.7	135				71
183 000	ND	49 100	593	21 500	951	2 680	2180	1 620	16 800	11 200	61 400				321
138	ND	ND	279	7.4	115	40	5.16	29.7	ND	2.9	3 270				3.91
48 700	ND	20 300	394	7 930	3 940	584	381	876	11 000	3 660	84 000/ND?				70.8
85 700	ND	23 900	415	11 100	2540	704	555	765	16 500	6 340	84 600				174
921	0.6	41	237	9.6	123	82.3	15.5	2.4	ND	3.9	1740				5.31
921	0.6	32	236	9.2	124	81.4	15.5	2.3	ND	3.7	1630				3.27
34300	ND	10300	85.7	6100	371	324	422	408	25600	3020	14400				250
50	100	5000	20	100											

Unregulated for Drinking Water: Sodium and Nickel have suggested limits

Heavy Metals	1985 EPA vs. Eastern Coal[1]	UIC 0317-00-001 DN M08-018	UIC 0318-00-061 DN M08-023	UIC 0299-00-061 DN M08-023	UIC 0645-03-023 DN M08-025	UIC 0457-02-023 DN M08-025	UIC 0286-00-023 DN M08-026	UIC 0279-00-009 DN M08-028	Rawl wells[2]
Aluminum									8.030
Arsenic	1.8		0.14 (1300%)	0.14 (1300%)	0.15 (1400%)	0.595 (1090%)			0.340
Barium	38.6								2.400
Beryllium		0.00683 (71%)	0.276 (6800%)	0.0156 (290%)	0.148 (3600%)	0.031 (675%)	0.173 (4225%)	0.03 (650%)	0.007
Cadmium	0.54		0.019 (280%)		0.013 (160%)	0.6 (11900%)			*Not detected*
Chromium	11.92		0.6 (500%)		1 (900%)	0.62 (520%)	0.2 (100%)		0.024 (within Limits)
Copper	5								0.758 (within Limits)
Iron	3833								57.588
Lead	3.89	0.046 (207%)				0.165 (1000%)	0.048 (220%)		0.030
Manganese	20								4.063
Nickel		0.672 (572%)	1.2 (1100%)		6.8 (6700%)		0.5 (400%)		0.285
Selenium	0.23					1.01 (1920%)			0.065
Sodium									189.100
Zinc									0.269 (within limits)

Appendix 2. Known Exceedances of Heavy Metal Standards at Underground Injection Sites and Residential Wells.

Notes:

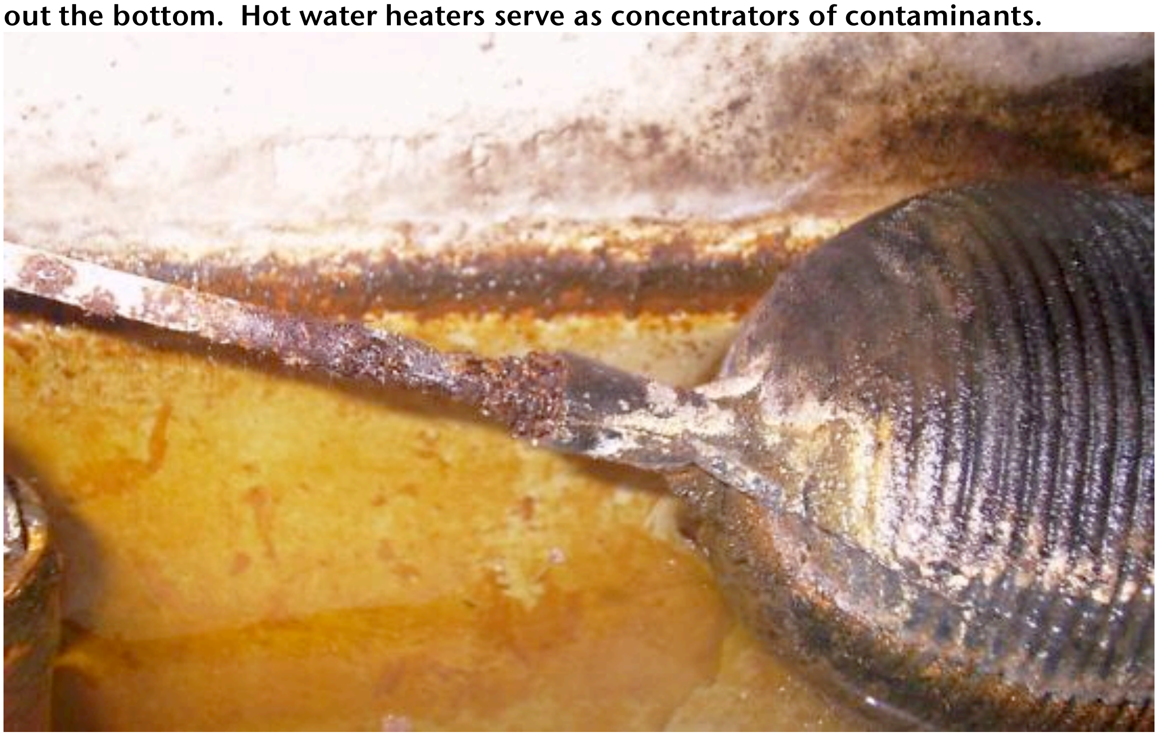
- All units in parts per million (ppm) with % exceedance in parenthesis where available.
- Values listed are the highest for each set of data. For most listed concentrations, there were multiple detections for the given contaminant. For the UIC Consent Orders, samples were reported monthly and the same metals would be found in exceedance for many consecutive months.
- A blank cell does not necessarily represent a non-detection as the data given for each site only lists exceedances. Blank cells may have been within the limits or not tested for.
- All data aside from Rawl Wells is self-reported by the company. Rawl wells sampled by Dr. Ben Stout.
- DN = Docket Number for West Virginia DEP Consent Orders.

1 United Sates Environmental Protection Agency Region IV. Docket No. IV-85-UIC-101.

2 Stout, Ben M. “Well Water Quality in the Vicinity of a Coal Slurry Impoundment Near Williamson, West Virginia” Wheeling Jesuit University. December 10, 2004.

Appendix 3: Photos

This water heater in Prenter, WV was approximately one year old when black water came out the bottom. Hot water heaters serve as concentrators of contaminants.



These toilet guts are one year old. Toilet guts, faucets, and hot water heaters and coils need to be replaced regularly due to corrosion.

The penny on the left (from 2007) sat in a bathroom in Prenter, WV where there are high levels of hydrogen sulfide. The penny on the right (from 1999) has not. Corrosion will take place within minutes of contact with Prenter's water. Photo taken in Spring 2008.

The black water filter was in use for 3 months on a well in Prenter, the white water filter is new. Despite the filter system, the water in the house in Prenter was not fit to drink.

This strange waxy substance appears in toilet tanks and varies in color from light pink to dark orange.

Tap water in Rawl, WV.
Photo By National Geographic from www.sludgesafety.org