

Health Consultation

MARTIN COUNTY COAL SLURRY RELEASE

INEZ, MARTIN COUNTY, KENTUCKY

EPA FACILITY ID: KYN000407233

AUGUST 7, 2006

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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HEALTH CONSULTATION

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Prepared by:

Exposure Investigation and Consultation Branch
Division of Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry

Summary

On October 11, 2000, a Martin County Coal Company (MCCC) coal slurry impoundment located south of Inez, Kentucky, collapsed and released approximately 300 million gallons of slurry into area streams located under the impoundment, the Coldwater Fork of Rockcastle Creek and Wolf Creek, tributaries to the Tug Fork and the Big Sandy River. In April of 2001, a citizens group in Inez, Kentucky, petitioned the Agency for Toxic Substances and Disease Registry (ATSDR) to evaluate environmental data and address community health concerns related to the coal slurry spill. This Health Consultation is the product of that investigation.

More than 100 miles of streams and floodplains in and around Martin County were affected by the spill, which caused streams to overflow and flood the valleys and floodplains around the streams. Slurry covered the yards and property of approximately 30 residences in the Inez area. Citizens were concerned that (1) skin rashes, nausea, and headaches might be related to drinking and showering in contaminated public water, (2) growing vegetables in the floodplains of Wolf and Coldwater Creeks might now pose some safety issues, and (3) the recurrence of blackwater events (surface water appearing black due to suspended particles in water) during heavy rains near the municipal water intake might pose a contamination hazard to the public water supply.

Most of the slurry material had been removed from Coldwater Fork and the first 5 miles of Wolf Creek within one year of the spill. The levels of metals in the slurry were similar to those in area background soil, and those detected in the drinking water supply after the spill were below EPA's Maximum Contaminant Levels (MCLs). None of the volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs), including polycyclic aromatic hydrocarbons (PAHs), identified exceeded comparison values. Results were negative for acrylamide. (Polyacrylamide was used to flocculate the coal fines.) According to the information available to ATSDR, the Martin County Water District #1 did not take slurry materials into the water treatment system. Although, some private drinking water wells had elevated concentrations of some metals (arsenic, barium, and lead), they were unrelated to the slurry spill.

Direct contact with the slurry, contaminated stream water, or soil may have caused short-term effects (e.g., skin rashes) in sensitive residents in the past, but poses no public health hazard in present or in the future. Neither the Martin County Water District distribution system nor private drinking water wells were impacted by slurry material. Blackwater events may continue to occur, but the concentrations of metals currently found during these events are too low to cause adverse health effects. Nor would any adverse health effects be expected to occur as a result of eating vegetables grown in residential soil potentially contaminated by the slurry spill.

Using all available information, ATSDR concludes that although some exposure may have occurred or might be occurring as a result of the slurry spill, exposures are not at levels expected to cause adverse health effects. Therefore, ATSDR concludes that this site poses no apparent public health hazard.

Background and Statement of Issues

Background

In April 2001, the Agency for Toxic Substances and Disease Registry (ATSDR) was asked by a citizens group in Inez, Kentucky, to evaluate environmental data and address community health concerns related to a coal slurry spill that flooded area streams. In response to that petition, ATSDR conducted a site visit in January 2002 and collected available environmental data. In this health consultation, ATSDR evaluates the available site data and addresses community health concerns related to the spill.

On October 11, 2000, a Martin County Coal Company (MCCC) coal slurry impoundment located south of Inez, Kentucky, collapsed and released approximately 300 million gallons of slurry into two mines located under the impoundment [1]. An impoundment is a holding pond for coal “fines” and wastes from the coal washing process. The slurry moved through the mines and spilled out into the Coldwater Fork of Rockcastle Creek and Wolf Creek. Wolf Creek flows into Tug River and Levisa Fork, part of the Big Sandy River, which is a tributary to the Ohio River. More than 100 miles of streams and floodplains in and around Martin County were affected by the spill [1]. (See Appendix A, Figure 1.) Representatives from the Environmental Protection Agency (EPA), Region 4 and the Mine Safety and Health Administration (MSHA) responded to the spill. The slurry caused the streams to overflow, flooding the surrounding areas. This region of Kentucky is very mountainous; most towns and residential homes are located in the valleys and floodplains around the streams. Following the spill, slurry covered the yards and property of many of these homes.

The slurry spill impacted two streams, the Coldwater Fork of Rockcastle Creek and Wolf Creek, tributaries to the Tug Fork and the Big Sandy River (See the dark blue lines in Figures 1 and 2, Appendix A.) The volume of released material caused the streams to overflow into the surrounding floodplains. Slurry materials were deposited as sediment, on stream banks, and in the floodplains, including residential yards. Overall, more than 100 miles of streams and floodplains in and around Martin County were affected by the spill [1].

Most of the slurry material had been removed from Coldwater Fork and the first 5 miles of Wolf Creek within one year of the spill [2]. The slurry materials were removed using long-boom excavators, dredges, vacuum trucks, tractor pumps, and pumping systems in the stream channel and excavators and front-end loaders on the floodplains [3]. Slurry deposits directly affected approximately 30 residences in the Inez area (personal communication with R. Penix of The Martin County Sun, Inez, Ky., May 2001). The slurry in residential yards was either removed or covered with a layer of topsoil. No soil samples were taken from residences either before or after clean-up activities for comparison. Stream banks and floodplain areas were re-seeded to assist in restoring the area [4]. Residual slurry deposits may still remain farther downstream in areas of Wolf Creek, Rockcastle Creek, and the Big Sandy River that are difficult to access [2].

The city of Inez is located in eastern Kentucky's Appalachian Mountains, approximately 9 miles north of the Martin County Coal Company impoundment. According to Census Bureau 2000 data, there are 466 residents in Inez and 12,578 residents in 4,776 households in Martin County (see Figure 3)[5]. According to the mayor, as a result of slurry depositing in their yards, approximately 30 residences located on the flood plain were directly affected by the spill. The Martin County Water District provides water to 10,246 (~80%) residents, including those in the city of Inez [6]. The remaining 2,332 (20%) residents rely on private wells or cisterns [7].

Community Concerns

The citizens' concerns included skin rashes, nausea, and headaches believed to be related to drinking and showering in contaminated public water; safety issues in growing vegetables in the floodplains of Wolf and Coldwater Creeks; continuing occurrences of surface water appearing black due to suspended particles in water (blackwater events) during flood events that may cause recurrent problems for the municipal water intake

Activities at the Site

MCCC has taken responsibility for cleaning up slurry in the watersheds and surrounding floodplains. As of October 2001, most of the slurry had been removed [2]. Slurry deposited in residential yards was either removed or covered with a layer of topsoil. Slurry deposits may still remain farther downstream in areas of Wolf Creek, Rockcastle Creek, and the Big Sandy River that are difficult to access [2].

The Martin County Water District supplies water to Inez. Its water source is an intake on the Tug Fork. (See Appendix A, Figure 2). Information provided by the Water District Superintendent indicated that before the spill the intake was closed for maintenance. After the spill, a temporary intake was placed on an unaffected part of the Middle Fork of Rockcastle Creek to supply water for the area [8]. Concern was expressed that contaminated water may have been taken in during the spill, or may be taken in during future blackwater events.

Extensive sediment sampling was performed along the Tug Fork at Kermit, Inez, and Fort Gay to determine the depth of slurry deposits [9]. Deposits ranged from 1 to 36 inches in depth, with the thickest deposits at the Big Sandy Lock #3 at Fort Gay and a few other pools on the Big Sandy River. The depth of slurry in most of the river system was estimated to be 3-4 inches [9]. Sampling revealed that slurry deposits were washing downstream over time, minimizing the slurry in the creeks and upper Tug Fork.

Following the spill incident, ATSDR's Emergency Response Section assisted EPA Region 4 in evaluating available drinking water data. Also, in response to a request from the mayor of Inez, ATSDR provided a written evaluation of the raw water data and tap water samples collected by the Inez Waste Water Department [10]. The metals concentrations detected were below maximum contaminant levels (MCLs) and not expected to cause health effects due to ingestion. The water may be considered "hard," indicating that some of the metals in the water may leave residues and affect taste and odor. The evaluation is available at the mayor's office, where a repository has been established.

Environmental Data

Slurry Materials

According to the MSHA, there are more than 600 impoundments throughout the Appalachian region [11]. Mined coal often has impurities and small pieces unsuitable for use that are known as “fines”. The coal is “washed” with water and flocculants, starches, or lime to settle out the fines [12]. The slurry that escaped from the impoundment contained coal fines and residual flocculant. The slurry consisted primarily of coal fines, containing elemental carbon, some hydrocarbons, complex organic compounds, sulfur, silica, iron oxide, calcium oxide, sodium, and traces of metals [13]. In addition, the slurry was expected to contain traces of the flocculant used to settle out the coal fines in the impoundment. MCCC used a polyacrylamide flocculant, which also contains some hydrocarbons and traces of acrylamide.

The US EPA and an environmental consultant working for MCCC collected slurry samples to determine what chemicals were released. EPA took additional slurry material samples in December, and an independent consulting firm took samples in January 2001. (See Appendix B, Table 1). EPA also took several soil samples in unaffected areas, and the consulting firm took sediment samples in Coldwater creek and the Curtis Crum reservoir.

Samples were analyzed for metals, volatile organic compounds (VOCs), and semi-volatile organic compounds (SVOCs), which includes polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs). Additionally, the first samples taken for MCCC were analyzed for compounds that were leachable. Other major constituents of the coal (e.g. carbon, sulfur) were not analyzed as they are understood to be present in the slurry.

Analyses for acrylamide or polyacrylamide, the chemicals that make up flocculent, were not performed on slurry samples. However, neither was expected to be found in slurry or soil at significant levels. Polyacrylamides bind strongly with soil particles and are used commercially to improve soil quality. Binding to soil reduces the bioavailability of a contaminant [14]. Acrylamide does not bind to soil and instead moves into soil rapidly and is degraded by microbes within a few days [15].

The sampling results confirmed that the slurry contained metals that are natural constituents of coal. These results were fairly consistent for the different slurry samples taken. Although metals were released to the environment with the coal slurry, they are similar to those in area background soil [16, 17]. (See Appendix B, Table 2.) Aluminum and arsenic levels were above screening values, however, both were within the background range for Kentucky soils. The sediment sample taken from the Curtis Crum Reservoir, not impacted by the coal slurry, had lower metal concentrations than were seen in the slurry.

The slurry material also contained some VOCs and SVOCs which are consistent with the expected hydrocarbon content of coal. (See Appendix B, Table 3.) Napthalene, toluene and xylenes, were hydrocarbons found in three of the slurry samples. Additionally, 2-

methylnaphthalene and phenanthrene were identified in most slurry samples. Polycyclic aromatic hydrocarbons (PAHs) were identified in the impacted Coldwater creek sediment sample. No leachable compounds or polychlorinated biphenyls (PCBs) were identified in the slurry samples. Also, none of the VOCs and SVOCs (including PAHs) identified exceeded comparison values. No residential soil samples were taken from yards and property after the coal slurry spill. Therefore, ATSDR based its evaluation on the conservative assumption that metal concentrations in residential soil were the same as those found in slurry.

Surface water samples

Surface water quality was directly impacted by slurry materials. More than 300 surface water samples were taken from the surface waters in Martin County between October 2000 and February 2001. Analyses were completed for metals, SVOCs, flocculant, and oil and grease (HEM- n-hexane extractable material). Also, more than 300 samples to monitor turbidity were collected in Wolf and Coldwater creeks between November 2000 and May 2001. Surface water quality samples were collected by the Kentucky Department of Environmental Protection (KDEP) according to their standard operating procedures for quality assurance and quality control (QA/QC) data. These were evaluated based on the assumption that they were collected and analyzed according to proper methods and procedures. Additional results received from the MCCC contractors had acceptable QA/QC and were used in the evaluation.

Surface water contained elevated concentrations of various metals following the spill event. (See Appendix B, Table 4.) Metal types seen in the surface water were similar to those found in slurry. The highest metal concentrations were measured in the first 2 weeks following the spill. Sample results indicate that the concentration of metals in surface water decreased over the following months as the slurry was diluted in water, settled out, and washed downstream.

Slurry material remaining in stream sediment may be resuspended during blackwater events. Blackwater events occur when sediments, including coal fines, are stirred up from heavy rains, causing the streams to look black. To evaluate the effect that blackwater events may have on metal concentrations, data on turbidity and metal concentrations were compared. Turbidity is a measure of the amount of particles suspended in water, which causes the water to look muddy or black. ATSDR evaluated the data to compare the metal concentrations in surface water during dates of increased turbidity to concentrations during dates of low turbidity and to concentrations immediately following the spill event. The metal concentrations were higher during blackwater events than during times of clear water, but were still much lower than the concentrations found during the weeks after the spill. Additionally, the metal concentrations found during these events continued to decrease over time. (See Appendix A, Figure 4.) Therefore, the maximum metal levels observed after the October 2000 slurry release can be considered the highest concentrations that would be found.

Surface water samples were also collected from November 2000 to February 2001 to determine whether acrylamide was present in the water. Results were negative for acrylamide.

Groundwater quality

The impact of the slurry on groundwater and private wells in the floodplains of Martin County was a concern for the community of Inez. The geology in some regions of Kentucky allows surface water and groundwater to mix fairly easily. Hand-dug wells are particularly susceptible to contamination [18]. Following the spill, Kentucky Department of Environmental Protection (KDEP) and a private contractor collected samples and reported the results for private well water in the area.

Between October 18, 2000, and March 14, 2001, 70 private well water samples from 38 different wells were collected by the KDEP and 2 additional wells were sampled by the private consultant. Samples collected by KDEP were gathered according to their standard operating procedures for QA/QC. These results were evaluated assuming that KDEP followed the proper sample-collection procedures. An analysis of the QA/QC information provided by the contractor indicated that the sample results were valid and of good quality. Samples were analyzed for SVOCs and metals. Well-water samples contained metals that naturally occur in groundwater in this region of Kentucky and were similar to historical samples. SVOCs were found at very low levels in some of the wells. However, the SVOCs detected in slurry were not the same as those detected in the private well water. Overall, private well-water conditions are consistent with regional groundwater quality and none of the wells appears to be impacted by the slurry spill.

Pathway Analysis

An exposure pathway is the route by which an individual is exposed to contaminants originating from a contamination source. Although a large amount of material was released during this incident, a potential public health issue only exists for people who were exposed to slurry materials. An exposure pathway consists of the following five elements: 1) a *source* of contamination; 2) a *medium* such as air or soil through which the contaminant is transported; 3) a *point of exposure* where people can contact the contaminant; 4) a *route of exposure* by which the contaminant enters or contacts the body; and 5) a *receptor population*. A pathway is considered complete if all five elements are present and connected. If one of the elements is missing, the pathway is considered incomplete because no exposure can occur. (See Appendix B, Table 5.)

Residential Yards and Property

Following the spill, slurry covered the yards and property of many homes in Martin County. (See Appendix A, Figure 1.) It is likely that residents came into contact with slurry material during the time period it was present in their yards. People may have ingested small amounts of soil (incidental ingestion) during various activities: playing in the yard, gardening or working in the yard, eating unwashed vegetables grown in slurry contaminated soil or by materials brought indoors on hands and shoes. The potential for exposures to residential slurry-contaminated soil occurred during the year following the spill. Because the slurry material was removed from the yards or covered within a year, this exposure pathway no longer exists.

Recreational Use of Streams

The spill released a large amount of slurry into the streams, and materials were deposited in and on the banks and floodplains. People may have come into contact with the slurry material in the water and with sediment materials on the banks of the streams during recreational activities. Small amounts of slurry may have been accidentally ingested (incidental) during these activities.

Local residents were aware of the slurry-release event, and the material was visually different than normal stream conditions and the surrounding soils. Any contact with slurry materials would, most likely, have been both brief and intermittent. The spill incident caused streams to flood, limiting community use of the streams for recreation. Interestingly, despite the huge influx of coal slurry into the Tug Fork of the Big Sandy River, no apparent fish kill resulted from the pollution, possibly because the fish swam ahead of the sludge. (The Herald-Dispatch, Tuesday, October 24, 2000.) Most of the slurry material was removed within a year of the incident. Only residents who accessed the streams during that first year would have been exposed through this pathway.

Blackwater Events

Blackwater events occur when sediments are disturbed and brought into the water column. This pathway is limited to times when an increase in turbidity occurs. These events are episodic and correspond with increased precipitation in the area. Residents are not normally expected to use the stream for recreational purposes during blackwater events, because of the poor weather conditions and increase in water flow. Therefore, this is a potential pathway of exposure. (See Appendix B, Table 7).

Public Water System

The community was particularly concerned about the potential for slurry materials from the coal slurry spill event to enter the local drinking water treatment reservoir and then be ingested by residents that use public water. Investigation indicated that slurry materials did not directly enter the water treatment plants during the spill incident. According to Martin County Water District representatives, the permanent water intake on Tug Fork was closed for maintenance before the slurry release. The plant used a temporary water intake on the Middle Fork of Rockcastle Creek before and after the spill event [6]. The evidence available to ATSDR suggests that the Martin County Water District #1 did not take any slurry materials into the water treatment system. Therefore, municipal drinking water was not a pathway of exposure for residents of Martin County.

The increase of particles in the water during a blackwater event may result in slurry materials being taken into the water treatment plant. The Martin County Water District #1 treatment process removes most of suspended sediment and therefore any associated metals from drinking water. Water quality is tested on a quarterly basis to ensure that the treatment plant is working correctly. This is not considered a completed pathway of exposure to slurry materials. A properly operating water treatment plant would not allow exposures of significance.

Residents were drinking water from a temporary intake immediately following the spill incident and noticed changes in their water quality. An evaluation of the water quality results for the Martin County Water District #1 are discussed in the public health implications section.

Groundwater

In addition to the public water system, private wells provide water to about 20% of the Martin County population. Residents who ingest water from private wells would be exposed to any contaminants found in groundwater. Some of the wells have elevated metal concentrations (arsenic, barium, and lead) that are unrelated to the slurry spill. The public health significance of this is discussed in the public health implications section. Private wells do not appear to have been impacted by the slurry spill. Therefore, this was considered an eliminated exposure pathway. (See Appendix B, Table 6.)

Public Health Implications

The Public Health Implications section will address the completed pathways of exposure, which were determined in the previous section. These pathways include: residential yards and property and the recreational use of streams. (See Appendix B, Table 5.) In addition, the water quality of Martin County Water District #1 and the groundwater quality is discussed to address the community's concerns.

Residential Yards and Property

ATSDR is unaware of any residential soil samples taken from homes impacted by the slurry release in Martin County. Therefore, ATSDR evaluated a worst-case scenario that assumed the metal concentrations found in slurry would also be found at the same concentration in residential soil. This is very unlikely because the slurry was diluted in the stream water and most of deposited slurry has been removed from yards.

Ingestion of small amounts of soil is the primary exposure of concern in this scenario. Children may eat soil while playing or get soil on their hand/clothes and inadvertently get it in their mouths. Working and gardening may also result in incidental ingestion of soil. Also a very small percentage of children aggressively eat soil and other inert materials. Although most children eat more than 200 mg of soil only once or twice a year, less than 2% of children (so-called 'pica children') may eat more than 5000 mg (5 grams) of soil 35- 40 days out of the year, or 2-3 times per month, on average [19].

Although the slurry contained several organic compounds and heavy metals, the amount one may eat through gardening or playing in the yard is much less than would be needed to pose a potential health hazard, especially for only one year of exposure. This would still be true, even if one assumed that a local pica child ingested 5 grams of slurry twice a week for a year. The remaining bulk of the slurry is not toxic, consisting as it does of water, coal fines, silt, sand, and clay particles [20].

Plants can take up a limited amount of metals from soil. The amount of metal that can accumulate in a plant depends on the plant type, the chemical form of the metal, soil type and pH, and the concentration of metal in the soil [21]. Metals typically do not bio-

accumulate in vegetables to such an extent that they could pose a health risk to humans. (Metal-accumulating plants do exist, but they tend to be small, wild species that pose a health hazard only to their natural enemies and to wandering cattle.) Even if crop plants could absorb toxic doses of metals from the soil, that toxicity would prevent the production of fruits or vegetables, thereby eliminating vegetable consumption as a potential route of exposure for humans [21-23]. Good public health practice includes washing all fruits and vegetables before eating them to remove dirt that may contain environmental contaminants. Eating vegetables grown in areas impacted by the slurry deposits does not pose a public health hazard.

Direct exposure to contaminated soil can cause skin irritation in sensitive individuals. If sensitive residents came into direct contact with the slurry material during the spill event, they may have experienced some irritation. Such skin rashes or allergic-type reactions would be only short-term events.

Recreational Use of Streams

Recreational exposures are brief or intermittent exposures that would have occurred for residents that accessed the streams or floodplain areas while slurry material was present. These exposures are considered to be even less frequent than those of residents, because the area would only be accessed occasionally. The concentrations of contaminants found in the water or slurry material were not at levels that would pose a health hazard if accidentally ingested during these activities. Direct contact with metals can cause skin irritation in sensitive individuals. Some residents may have experienced such irritation after coming into contact with slurry during the spill event. The concentration of metals in sediment and water decreased over time, therefore, any current or future exposures to stream water or sediments are expected to be even less and do not pose a potential health hazard.

Groundwater Quality

Although the private groundwater wells sampled on March 14, 2001, were not believed to be impacted by the slurry spill, the results for some individual wells indicated that the water may not be suitable for drinking. Metals were detected at levels that could affect the taste, smell, or look of the water. Specifically, aluminum, chloride, iron, manganese and zinc were above Secondary Drinking Water Standards set to avoid adverse taste, smell, or appearance of the water. These metals were not above any health screening values and would not be expected to affect health.

Arsenic, barium, and lead were above screening values or EPA drinking water standards in some of the wells tested. Individuals whose wells tested above the maximum contaminant level (MCL) for any of these metals were notified by the KDEP that their water was not suitable for drinking. The MCL is the highest level of a contaminant that is allowed in a public drinking water system. MCLs are enforceable standards but only apply to public drinking water systems. The KDEP also provided information on what could be done to improve the water quality in these wells.

In two of the wells sampled, lead was detected at levels of 0.020 parts per million (ppm) and 0.023 ppm, which is only slightly above EPA's action level of 0.015 ppm. (ATSDR does not have a comparison value for lead [24]. But, the dose that would result from chronic consumption of drinking water that always contained 0.023 ppm lead is lower than all of the LOAELs published in ATSDR's Toxicological Profile for Lead [25].) The lead that was detected in these two wells probably leached into the water from the plumbing, because (a) the majority of the wells sampled showed no evidence of lead contamination and (b) when it was re-sampled, one of the two wells that were previously identified as containing elevated levels of lead also showed no signs of lead contamination. The average lead concentration from multiple samples from the re-tested well was 0.005 ppm, below the action level. Therefore, ATSDR considers that lead in private well water at this site does not pose a public health hazard. Flushing out pipes by allowing water to run until cold will reduce the chance of ingesting any lead that may have leached into the water through corrosion of the pipes.

Arsenic was found in two private wells above the MCL of 10 ppb; the maximum concentration detected 16 ppb. However, adverse health effects, including cancer, are not expected at this level of exposure. EPA's MCL for arsenic in drinking water is based on a large Taiwanese study in which consumption of arsenic-contaminated well water (170-800 ppb) was associated with increased skin cancer. However, in the United States, where levels of arsenic in drinking water are much lower (average 5 ppb or less), no excess skin cancer incidence has ever been observed in people consuming relatively high levels of arsenic (100-200 ppb) in drinking water [26]. It has been suggested that total arsenic exposure was underestimated in the Tseng study, leading to an overestimation of risk. It is also possible that the protein- and methionine-deficient population studied in Taiwan was more sensitive than typical U.S. populations, because of a compromised ability to detoxify (i.e., methylate) ingested arsenic [26, 27, 28].

Depending on the region of Kentucky being considered, barium levels above the MCL of 2 ppm are not necessarily unusual in the state's groundwater. The 6,170 barium measurements in the Kentucky Groundwater Data Repository indicate that, *on a statewide basis*, less than 1.6% of recorded levels of barium in groundwater exceed the MCL of 2 ppm [29]. However, that percentage increases sharply as one focuses on selected areas *within* the state. In an apparent reference to the coal-mining regions of eastern Kentucky, one official of the Kentucky Division of Water estimated that barium concentrations in well water are above the MCL roughly 10% of the time (J. Webb, Kentucky Division of Water, personal communication, 2002). (The maximum barium concentration for three study sites in eastern Kentucky was 15 ppm [29].) In high-barium areas of eastern Kentucky such as Martin County, where barium is a naturally-occurring metal found in rock and coal, relatively high concentrations of barium can also occur in well water [13]. This is especially true for older wells that may have been constructed without complete protective casings, because the latter are more subject to contamination by naturally occurring minerals and chemicals leaching from the earth. Considering only the data collected for this health assessment, barium levels exceeded the 2 ppm MCL in approximately 20% of the private wells tested. Nevertheless, none of the barium concentrations found in these private well water samples would pose any health hazard to people who may have drunk that water [30]. Even the highest level of barium detected in private wells (24.9 ppm) would result in a daily barium intake (0.71 mg/kg/day, assuming a 70-kg person drinking 2 liters of water every day) that would exceed EPA's 2005 oral

reference dose for barium (0.2 mg/kg/day) by a factor of only 3.6, which is insignificant from a public health standpoint, compared to the 300-fold safety factor that is built into this RfD.

Public Water System

Some residents noticed differences in the water quality during the change of locations of the water intake and were concerned that the slurry spill had an adverse impact. Because material from the slurry spill did not enter the drinking water plant, ATSDR examined monitoring results from the drinking water plant to determine what may have been the cause of altered water quality. In ATSDR's report to Mayor Penix in April 2001, Emergency Response personnel evaluated three water samples taken by the Inez Waste Water Department that included analyses for metals and SVOCs [10]. Additionally, routine water analyses from the plant for calcium, hardness, and turbidity were reviewed.

The Kentucky Geological Survey rates as "hard" or "very hard" most of the groundwater in Kentucky (<http://www.uky.edu/KGS/water/gnet/kentuckygeologyspring2001.pdf>). Calcium levels and total hardness were both higher in the temporary water supply. The iron, manganese, sulfate, and total dissolved solid results are also all higher. These are above the secondary drinking water standards (SDWS) set by EPA based on water color, taste, and smell quality. The SDWS values are non-enforceable and do not represent health screening values. None of the constituents tested was above screening values based on health effects. Conversations with the water district superintendent indicated that they did not adjust for the difference in alkalinity when the temporary intake was first used [8]. The increased mineral content of the water may have left noticeable residues on pipes, pots, and pans during this time. The changes in drinking water quality are associated with taste, smell, and scaling properties of the water. None of these parameters is expected to affect public health or be associated with the community health concerns, such as skin rashes, nausea, and headaches.

A review of historical and recent water quality data for the Martin County water system indicates that the water is generally of good quality. Results for past monitoring events provided by KDEP for 1995, 1998, 2000, 2001, and 2002 were all below MCLs for the parameters monitored. A few trace metals were found in the drinking water, but they were within standards set for public drinking water systems. The results were consistent with the geology of the area and were expected in this type of water source.

Children's Health Considerations

Children are at a greater risk than adults from certain kinds of exposure to hazardous substances emitted from waste sites. They are more likely to be exposed for several reasons (e.g., they play outdoors more often than adults do, increasing the likelihood that they will come into contact with chemicals in the environment). Because of their smaller stature, they may breathe dust, soil, and heavy vapors close to the ground. Children are also smaller, resulting in higher doses of chemical exposure per body weight. The developing body systems of children can sustain permanent damage if certain toxic exposures occur during critical growth stages. Most importantly, children depend completely on adults for risk identification and management decisions, housing decisions, and access to medical care.

The slurry spill did not pose a significant health hazard to children or young adults. ATSDR specifically evaluated children's exposures to site contaminants in their evaluation of this site.

Conclusions

ATSDR categorized this site currently as a No Apparent Public Health Hazard.

1. Direct contact with the slurry, contaminated stream water, or soil *does not currently pose a public health hazard*.
2. Although the possibility that some individuals may have experienced short-term hypersensitivity reactions such as contact dermatitis cannot be entirely ruled out, direct contact with the slurry, contaminated stream water, or soil would generally not have been expected to produce adverse health effects in residents.
3. The Martin County Water District distribution system was not contaminated by the spill event. Changes in water quality at the time of the spill and shortly after were most likely due to a change in water source. No adverse health effects are expected to occur as a result of drinking water from the alternate water source.
4. Well-water sampling indicates that private drinking water wells were not impacted by slurry material.
5. Private wells in the area do contain naturally occurring heavy metals such as arsenic, iron, manganese, barium, and cadmium, but not at levels that would be expected to cause any adverse health effects in residents who drink water from those wells.
6. No adverse health effects are expected to occur as a result of residents ingesting vegetables grown in residential soil potentially contaminated by the slurry spill.
7. Blackwater events may continue to occur, but the concentrations of metals currently found during these events are not expected to cause adverse health effects.

Recommendations

None.

Public Health Action Plan

- Kentucky Division of Water continues to collect water samples during wet-weather events for analyses including turbidity and some metals.

For More Information: Two good sources of information are the Kentucky Division of Water's Web site, <http://water.nr.state.ky.us/dow/domwell.htm>, and EPA's Web site, <http://www.epa.gov/safewater/pwells1.html>. Both of these Web sites offer important information for well owners and contact numbers for additional assistance.

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Appendix A - Figures

Appendix B - Data Tables

