

Public health assessment Draft document for TVA Kingston Fossil Plant

TN Poison Center

General:

Page 19: The statement that “public health message to avoid contact was widely publicized.” May want to specify what measures were taken e.g. public service announcements on radio, television, or written media, information pamphlets, etc.

Page 23: Under EPA, second paragraph: for antimony, the units should include 6 ug/L

Page 56: second bulleted paragraph: “Chronic health effects from exposure take a long time to develop.” Consider rewording this so as to not imply that many of the effects are delayed. Consider a statement like “Chronic health effects from arsenic require exposures more long term than the type of exposure experienced in this setting.”

Page 57: Last sentence, last paragraph. May need to specify the plans that TVA, EPA, and TDEC have to assure that the fly ash does not become airborne.

Dose	The amount of a substance to which a person is exposed over some time period. Dose is a measurement of exposure. Dose is often expressed as milligram (amount) per kilogram (a measure of body weight) per day (a measure of time) when people eat or drink contaminated water, food, or soil. In general, the greater the dose, the greater the likelihood of an effect. An "exposure dose" is how much of a substance is encountered in the environment. An "absorbed dose" is the amount of a substance that actually got into the body through the eyes, skin, stomach, intestines, or lungs.
Duplicate	A second sample that may be analyzed along with the original sample in order to determine the precision of the analytical method.
EEP	Environmental Epidemiology Program, part of the Communicable & Environmental Disease Services Section of the Tennessee Department of Health
EIP:	Environmental Integrity Project
Embayment	A bay or bay-like shape in a body of water.
EMEG	Environmental Media Evaluation Guide; a health comparison value derived by ATSDR from minimal risk levels (MRLs), specific to soil, water, or air for periods of exposure up to 2 weeks (acute EMEG), for periods up to a year (intermediate EMEG), or for over a year (chronic EMEG)
Environmental Media	Soil, sediment, water, air, biota (plants and animals), or any other parts of the environment that can contain contaminants.
EPA	United States Environmental Protection Agency
Exposure	Contact with a substance by swallowing, breathing, or touching the skin or eyes. Exposure may be short-term [acute exposure], of intermediate duration, or long-term [chronic exposure].
FRM:	Federal Reference Method
Finished water	Water that has been through treatment at a water treatment plant and is distributed to customers.
Health comparison values	The concentration of a chemical that is not likely to cause harmful effects during a lifetime. An example is an Environmental Media Evaluation Guide for soil. Health comparison values are used as screening levels, not for absolute predictions of harm. may
Ingestion	The act of swallowing something through eating, drinking, or mouthing objects. A hazardous substance can enter the body this way. may
Inhalation	The act of breathing. A hazardous substance can enter the body this way.
Inorganic chemicals	Chemicals that do not contain carbon. Metals are inorganic chemicals. Coal is made of metals and organic compounds.
Intermediate exposure	Contact with a substance that occurs for more than 14 days and less than a year [compare with acute exposure and chronic exposure].

NAAQS	National Ambient Air Quality Standards. Standards for carbon monoxide, lead, nitrogen dioxide, PM10, PM2.5, ozone, and sulfur dioxide (criteria pollutants) in air set by the U.S. EPA.
NCEH	National Center for Environmental Health, part of the Centers for Disease Control and Prevention
NOAEL	The highest tested dose of a substance that has been reported to have no harmful (adverse) health effects on people or animals. <u>No</u> <u>O</u> bserved <u>A</u> dverse <u>E</u> ffect <u>L</u> evel
Organic compounds	Chemical compounds that contain carbon. Living organisms are made up of organic compounds, such as proteins, fats, and carbohydrates. Coal is made of many organic compounds, such as polyaromatic hydrocarbons, as well as metals. Other types of organic compounds, the volatile organic compounds, VOCs). are
PAH	Polyaromatic Hydrocarbon, a type of chemical that is found in tar, coal, charred food, and in organic material that has burned
²¹⁰ Pb:	Lead with an atomic number of 210 and containing 82 protons and 128 neutrons, also written as lead-210
²¹⁴ Pb:	Lead with an atomic number of 214 and containing 82 protons and 132 neutrons, also written as lead-214
Picocurie	One trillionth of a Curie. This can also be written as 1/1,000,000,000 Curies or 1×10^{-12} Curies.
PM50	Particulate matter with a diameter equal to or less than 50 microns
PM10	Particulate matter with a diameter equal to or less than 10 microns
PM4	Particulate matter with a diameter equal to or less than 4 microns
PM2.5	Particulate matter with a diameter equal to or less than 2.5 microns
Potable water	Water that is safe for drinking and cooking.
ppb	Part per billion, a unit of measure that is used to describe the micrograms of a chemical per kilogram of a solid substance, such as soil or ash. It can also be used to describe the micrograms of a chemical per gram of water.
ppm	Part per million, a unit of measure that is used to describe the milligrams of a chemical per kilogram of a solid substance, such as soil or ash. It can also be used to describe the milligrams of a chemical per gram of water.
Quality assurance	The sum total of all laboratory activities that are undertaken to ensure generation of accurate and reliable results. The objective is to ensure credibility of the laboratory and generate confidence in laboratory results. Laboratories have internal quality control and external quality assessment by independent agencies.

CONCLUSION 7 **The Tennessee Department of Health concludes that using well or spring water within four miles of the coal ash release will not harm people’s health from exposure to coal ash or metals in the coal ash because no evidence has been found of groundwater contamination with coal ash.**

BASIS FOR DECISION

Between December 30, 2008, and March 12, 2009, the U.S. Environmental Protection Agency, the Tennessee Department of Environment and Conservation, and the Tennessee Department of Health sampled and analyzed water from 102 privately owned wells and springs within a four-mile radius of the ash spill. None of the water tested had any contaminants above the national or state primary drinking water limits called Maximum Contaminant Levels (MCLs). There is no indication from groundwater sampling and analysis that coal ash has contaminated the groundwater.

NEXT STEPS

The Tennessee Department of Environment and Conservation should continue to take samples of groundwater from private wells and springs for analysis on a regular schedule to make sure that the coal ash is not affecting groundwater. If elevated concentrations of any of the metals from the coal ash are found in groundwater, the Tennessee Department of Environment and Conservation will take immediate action to protect the health of the community. If site conditions at the Kingston Fossil Plant coal ash release should change, then the groundwater sampling timeframe should be re-evaluated.

for how long?
months, years,
etc? Is there a
plan?

CONCLUSION 8 **The Tennessee Department of Health concludes that no harm to people’s health should result from recreational use of the Emory, Clinch, and Tennessee Rivers outside the area of the lower Emory River down to the confluence of the Emory and Clinch Rivers as long as previous fish advisories are followed.**

BASIS FOR DECISION

Sampling and analysis for metals associated with coal ash indicated that metals in all other areas of the Emory River and the Clinch River have remained below any health comparison values. Concentrations of total suspended solids have remained low in all areas of the Emory and Clinch Rivers except at the site of the coal ash release. The Tennessee Department of Environment and Conservation and the Tennessee Valley Authority will continue to sample and analyze surface water in the Emory, Clinch, and Tennessee Rivers. If any at any time, violations of water quality are detected, the Tennessee Department of Environment and Conservation will take immediate action to protect the health of people using the rivers for recreation.

The Tennessee Department of Environment and Conservation and the Tennessee Wildlife Resources Agency advise avoiding consumption of striped bass and limiting consumption of catfish and sauger. The pollutants of concern are polychlorinated biphenyls (PCBs) and mercury from historical activities.

NEXT STEPS

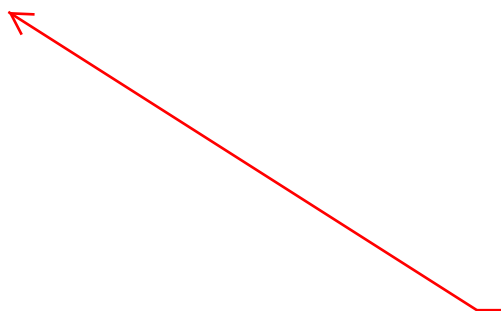
The Tennessee Valley Authority should continue to clean up the site of the coal ash release as fast as possible while, at the same, protecting both public health and the health of the river and its aquatic life. The Tennessee Department of Environment and Conservation should continue to monitor the Emory and Clinch Rivers to make sure it remains safe for recreational activities. The Tennessee Wildlife Resources Agency and the Tennessee Department of Environment and Conservation are sampling fish to make sure the coal ash does not affect them and indirectly harm people who eat the fish.

Will these levels in water rise due to the clean-up / dredging effort?
Will they be monitored?

CONCLUSION 9 **The Tennessee Department of Health cannot conclude whether breathing coal ash from December 22, 2008, through December 27, 2008, harmed people’s health.**

BASIS FOR DECISION No agencies took air samples in this period. However, with the wetness of the ash from the ponds and three days of rain, TDH believes that it is unlikely that coal ash dried out enough to become airborne.

NEXT STEPS The U.S. Environmental Protection Agency, the Tennessee Valley Authority, and the Tennessee Department of Environment and Conservation had begun to take air samples by December 27, 2008. There can be no recommendation that would provide air data for the time-period between December 22 and December 27, 2008. All emergency operations were actively working to protect the public from released coal ash, derailed trains, ruptured gas lines, destroyed homes, and destroyed roads. Air monitoring was a priority for all agencies. Air monitoring was started as soon as possible after the release.



However, any dust that may have been inhaled could certainly aggravate symptoms of those people at most risk: people with asthma, emphysema, and like disorders.

**CONCLUSION
10a**

The Tennessee Department of Health concludes that breathing ambient air near the coal ash release is not expected to harm people’s health as long as adequate dust suppression measures are in place.

**CONCLUSION
10b**

The Tennessee Department of Health concludes that no harm to people’s health is expected from occasionally breathing coal ash if it should become airborne for short periods of time.

**CONCLUSION
10c**

If dust suppression measures should fail and particulate matter is present in concentrations greater than National Ambient Air Quality Standards due to the coal ash becoming airborne for periods longer than one day, the Tennessee Department of Health concludes that particulate matter from airborne coal ash could harm people’s health, especially for those persons with pre-existing respiratory or heart conditions.

**BASIS FOR
DECISION**

Sampling and analysis of particulate matter by all agencies indicated that particulate matter, less than or equal to 2.5 microns in diameter (PM2.5) and less than or equal to 10 microns in diameter (PM10), in ambient air surrounding the coal ash release met all National Ambient Air Quality Standards.

Coal ash is considered a nuisance dust because of the size range of the particulate matter. Metals in the ash are not at high enough concentrations to cause harm if they are breathed in. If the coal ash were breathed in for longer periods or more frequently, the particulate matter in the airborne coal ash would cause the same harm as breathing in other dusts.

Metals in total particulate matter from the Tennessee Valley Authority (TVA) were often not detected by the air monitors. Most measurements were below health comparison values. Arsenic and chromium detected by TVA in total particulates on-site were within the range found in the United States for metals on particulate matter. Sampling and analysis of ambient air off-site was done by using temporary monitors that sampled total particulate matter, not just respirable or inhalable particulates. One sample taken on January 26, 2009, had cadmium in total particulates above the health comparison value. This sample represents just one sampling result within results for five sampling stations each with daily sampling from January 1 through March 10, 2009 (345 samples).

Metals in total suspended particulates measured by the Tennessee Department of Environment and Conservation are all below health

Harm, or aggravate pre-existing conditions?

Such as upper airway irritation, and aggravation of pre-existing problems such as asthma, emphysema, etc.

CONCLUSION 11 **The Tennessee Department of Health cannot conclude whether breathing dust near the quarry and along the routes of the quarry trucks has or will harm people’s health.**

BASIS FOR DECISION

Of the 47,909 real-time measurements of particulate matter less than or equal to 10 microns in diameter (PM10) in the community near the ash release, 0.1% were above 150 µg/m³, the 24-hour average National Ambient Air Quality Standard for PM10. Many of these samples were taken near the quarry and along the quarry truck routes. Because the samples were collected during a short time period, three to five minutes, we cannot make any predictions about the 24-hour average concentrations. We can say that the quarry dust does not typically contain heavy metals like the coal ash. Quarry dust contains chemicals present in limestone, such as calcium, magnesium, and carbonates.

NEXT STEPS

If the rock dust from the quarry was a health problem, it was because it is particulate in nature. The Tennessee Department of Environment and Conservation is working with the quarry and with the Tennessee Valley Authority to lessen the dust at the quarry and along the truck routes.

But these "nuisance" dusts can certainly be irritating to upper airway and aggravate pre-existing conditions such as asthma and emphysema.

CONCLUSION 14 **Based on the Community Health Survey, the Tennessee Department of Health concludes that many residents living in the area of the coal ash release experienced stress and anxiety. Some residents reported respiratory symptoms after the ash release.**

BASIS FOR DECISION Analysis of questions from the Community Health Survey indicated that 52 percent of the persons who answered questions for the survey experienced stress and anxiety. Symptoms of stress and anxiety are natural and to be expected since the coal ash release destroyed homes, disrupted lives, and drastically changed the landscape. Since the coal release occurred just before Christmas, even more stress was added to the lives of the people living near the coal ash release. Forty percent of the persons who answered questions for the survey reported a change in health status since the spill, primarily either worsening of cough or headaches, wheezing, or shortness of breath.

NEXT STEPS The Department of Mental Health and the Tennessee Valley Authority worked with Ridgeview Community Mental Health Center in Oak Ridge and Harriman to provide services to people affected by the coal ash release. In addition, the Tennessee Department of Health has continually encouraged people to see their primary care provider for any mental health concerns. The Tennessee Department of Health has offered education to area health care providers.

type of education?
Psychiatric or
toxicologic or
other?

CONCLUSION 15 **Community complaints specific to dust received at the Tennessee Valley Authority’s Community Involvement Center were located near the quarry and along the routes that quarry trucks traveled. Complaints about respiratory symptoms were widespread and were not oriented toward either the site of the coal ash release or the quarry.**

BASIS FOR DECISION The Tennessee Department of Health analyzed written complaints to the Tennessee Valley Authority’s Community Involvement Center related to health concerns. The Tennessee Department of Health performed geographical analysis that indicated that dust concerns are strongly oriented to the location of the quarry and to routes traveled by the quarry trucks. Geographical analysis indicated that respiratory concerns were not geographically related to either the quarry or the coal ash release site.

NEXT STEPS The Tennessee Department of Environment and Conservation is continuing to work with the quarry to control dust. TVA has implemented many dust control measures at the site of the coal ash release and for trucks leaving the site. Dust controls will continue to be required of trucks driving on county roads.

, but rather the route that quarry trucks took.

CONCLUSION 16 **The Tennessee Department of Health concluded that screening people’s blood or urine for metals would not be helpful.**

BASIS FOR DECISION

Based on environmental test results, the Tennessee Department of Health does not expect harm to health from touching, eating, drinking, or breathing the metals in coal fly ash. No harm is expected from breathing the air as long as adequate dust suppression measures are in place. We do not recommend testing.

NEXT STEPS

If people chose to have testing, and they are concerned about their results from metals testing, they should talk with their primary care provider or talk with a [clinical toxicologist](#) at the clinics set up in the area by Oak Ridge Associated Universities and Vanderbilt University Medical Center.

The Future

The Tennessee Department of Health understands that people are concerned about whether the coal ash may be a health hazard in the future. The Tennessee Department of Health will continue to consult with the Tennessee Department of Environment and Conservation and the U.S. Environmental Protection Agency to make sure that future sampling will be adequate in all respects to make determinations about the health of the people living near the coal ash release. The Tennessee Department of Health will continue to follow all sampling and analysis activities and will inform the Tennessee Department of Environment and Conservation immediately if any results might be a cause of health concern. The Tennessee Department of Health, the Agency for Toxic Substances and Disease Registry, the U.S. Environmental Protection Agency, the Tennessee Department of Environment and Conservation, and the Tennessee Valley Authority should continue to work together to see that the public health is protected during the long cleanup process.

The Tennessee Department of Health will continue to keep people informed about any new issues or any new findings.

FOR MORE INFORMATION

If you have concerns about your health, as it relates to the coal ash release, you should contact your local health care provider. You can also call the Tennessee Department of Health at 1-800-404-3006 and ask to speak with the person handling the TVA coal ash response, or email the Department of Health at TN.Health@tn.gov, or you can obtain information from the Tennessee Department of Health website <http://health.state.tn.us/>.

Should something be added that the Tennessee Poison Center can also work with these other groups in determining public health protection and information dissemination?

Analytical Results

EEP received environmental data in a variety of formats from the various government agencies responding to the coal ash release. EEP treated data for the coal ash itself in the following way. If a data point was listed as MDL (method detection limit) or with a U (undetected) designation, the data point was considered to be zero for statistical purposes. This was because EEP was not always provided the method detection limits (MDLs). If a data point was listed with a less than (<) character or a J (estimated) designation, the data point concentration was treated as the number listed for statistical purposes. This does not lend to complete consistency in EEP's treatment of data from different agencies, but was necessary considering the various formats in which the volumes of data were received. This had no effect on the conclusions about health hazards.

Soil

Soil was tested to find out if the coal ash had contaminated soil. Analysis of the EPA shoreline soil samples (Table 3) collected from December 28, 2008, to January 5, 2009, and TDEC's soil samples indicated that all metals in the samples were below health comparison values for all constituents, including arsenic. No VOCs or PAHs were detected.

Ash

TVA ash samples collected on December 23, 27, and 28, 2008, and on January 6, 2009, contained average arsenic concentrations above the health comparison value of 20 mg/kg. Arsenic concentrations ranged from 22.7 mg/kg to 166 mg/kg, with an average of 67.6 mg/kg. All other samples contained metals at concentrations below health comparison values.

Analysis of the EPA ash samples collected from December 23, 2008, to January 5, 2009, indicated that all KIF ash samples exceeded the health comparison value for arsenic of 20 milligrams per kilogram (mg/kg). Arsenic concentrations in the ash ranged from 44.8 mg/kg to 81.3 mg/kg. Table 4 contains validated summary data of the ash samples collected during these dates.

TDEC's analytical results for ash showed that, except for arsenic, all samples contained metals at concentrations below health comparison values. Arsenic was detected in all samples at concentrations above the health comparison value of 20 mg/kg. Arsenic concentrations in the ash ranged from 56 mg/kg to 100 mg/kg, with an average concentration of 78 mg/kg.

Environmental regulatory agencies have a special way to look at wastes containing metals. They use a concept called the toxicity characteristic leaching procedure, called TCLP for short. Title 40: Protection of the Environment, Section 261.24 – Toxicity Characteristic defines TCLP. Waste with metals is treated in the laboratory in a way that will remove metals from

EEP:
Environmental
Epidemiology
Program

MDL: method
detection limit

EPA: U.S.
Environmental
Protection
Agency

TDEC: TN
Department of
Environment &
Conservation

VOC: volatile
organic
compound

PAH:
polyaromatic
hydrocarbon

TVA: TN Valley
Authority

mg/kg: milligram
per kilogram

TCLP: toxicity
characteristic
leaching
procedure

Dermal Contact

None of the metals in the coal ash will be absorbed through the skin from touching the ash or getting the ash on skin. However, prolonged contact with the coal ash could result in local skin irritation (ATSDR 2007). The ash that is along the shorelines has been fenced off. Since the ash is not easily accessible and because the public health message to avoid contact with the ash has been widely publicized, no continued dermal contact with ash is expected for residents of the area.

Incidental Ingestion

Incidental ingestion (accidentally eating) occurs through hand-to-mouth behaviors. That is, when playing or working in the soil, people may get dust or dirt on their hands and then put their hands in their mouth. Children and adults may eat without washing their hands. Adults do not usually wash their hands before smoking. EPA has determined that, on average, a child will accidentally ingest about 100 mg to 200 mg of dust or dirt each day.

Concentrations of metals, except arsenic, were below health comparison values.

The concentrations of arsenic in some ash samples and the average concentration of arsenic in ash samples were higher than the ATSDR chronic EMEG for a child (20 mg/kg). The average concentration of arsenic in ash samples varied between 30 mg/kg for TVA ash samples and 78 mg/kg for TDEC ash samples. Arsenic was the only metal in the fly ash found above health comparison values (see Tables 2, 3, 4, 5, and 6) by all three agencies, TVA, EPA, and TDEC.

Because arsenic was found at levels above the health comparison values, more detailed analysis was needed to determine if the arsenic found in the coal ash posed a health hazard. We did this by looking at how much arsenic a sensitive member of the population (a child) would ingest (the dose). Additionally, we needed to estimate how much of the ingested arsenic would be absorbed from the child's gastrointestinal tract into his blood. Experiments in animals have shown that between about 5% to 50% of arsenic in soil is bioavailable (ATSDR 2007). EPA generally assumes for risk assessments that children will incidentally ingest from 100 mg to 200 mg of soil per day. We assumed that young children would not play in the ash unattended except for very brief periods. We assumed that 50% of the daily ingestion would be ash and 50% would be soil.

EPA: U.S. Environmental Protection Agency

mg: milligram

ATSDR: Agency for Toxic Substances & Disease Registry

EMEG: ATSDR environmental media evaluation guide

mg/kg: milligram per kilogram

TVA: TN Valley Authority

TDEC: TN Department of Environment & Conservation

May want to define this term:
bioavailable - after ingestion only a percent would be absorbed by the body and could react with body organs.

The equation used to estimate an oral dose from ingestion of contaminated soil (or ash in this case) is as follows:

$$\text{Oral dose} = \frac{CA \times \text{abs} \times IR \times CF \times FI}{BW}$$

Where:

CA = concentration in ash, for arsenic, we used the highest mean, 78 mg/kg, for TDEC data

abs = percent likely to be absorbable, assume 50% (0.5)

IR = ingestion rate, 200 mg/day for a child

CF = conversion factor, 10^{-6} kg/mg or 1 kg/1,000,000 mg

FI = fraction ingested, assume 0.5, half of the incidental ingestion is ash

BW = body weight, 16 kg for a child ← which is approximately the weight of a typical 2 year old.

$$\text{Oral dose} = \frac{78 \frac{\text{mg}}{\text{kg}} \times 0.5 \times \frac{200\text{mg}}{\text{day}} \times 1 \text{ kg} \times 0.5}{16 \text{ kg} \times 1,000,000 \text{ mg}}$$

$$\text{Oral dose} = 0.0002 \text{ mg/kg} \cdot \text{day}$$

The oral dose calculates to be about to be 0.0002 mg/kg·day. This theoretical calculated arsenic dose is less than the ATSDR MRL and the EPA RfD of 0.0003 mg/kg·day.

This mathematical computation for calculating a dose of arsenic is an example of a worst case scenario. The highest mean concentration of arsenic found in sampling and analysis was used. The percent absorption from the gastrointestinal tract used in this example (50%) is the maximum absorption found in experiments. The exposure period was during the winter months when most small children would not be playing outside near the water for long periods. People with ash in their yards were moved quickly, making the exposure time short.

Since the ash is not easily accessible and because the public health message to avoid contact with the ash has been widely publicized, no continued ingestion is ash is expected for residents of the area. No harm to the health of children or adults is expected from the possible very brief exposure time.

mg/kg: milligram per kilogram

mg/day: milligram per day

mg: milligram

kg: kilogram

mg/kg·day: milligram of substance per kilogram body weight per day

ATSDR: Agency for Toxic Substances & Disease Registry

MRL: ATSDR minimal risk level

EPA: U.S. Environmental Protection Agency

RfD: EPA Reference Dose

Surface Water

Introduction

As discussed in the Background section, surface waters are protected by the use of water quality criteria set by TDEC through the Tennessee Water Pollution Control Board. For this public health assessment, EEP is concerned with uses of domestic water supply and recreation. TDH values TDEC’s protection of fish and aquatic life, but TDH’s role is protection of public health.

EEP will only address concerns about public health and will not address any concerns ecological issues in this public health assessment. TDEC and TWRA sampled fish in the Emory and Clinch Rivers in order to detect any effect from the coal ash on fish and aquatic life and in order to detect any human health effects from eating fish that may have been effected by the coal ash. Fish samples were collected in January, February, March, and April. With the exception of two catfish samples, all levels of metals are below human health protection standards. The two catfish samples exceeded the standard of 0.3 ppm of mercury. Levels of selenium are well below EPA’s proposed toxicity standards for protection of fish and other aquatic life.

It is important to remember that there is an existing fish advisory on the lower Emory and Clinch Rivers that was in place before the coal ash release. TDEC and TWRA advise avoiding consumption of striped bass and limiting consumption of catfish and sauger. The pollutants of concern are polychlorinated biphenyls (PCBs) and mercury.

TDEC and TWRA will continue to sample fish for these pollutants harm the fish and that could accumulate in fish tissue causing human health effects.

Location on rivers is designated by river mile. Distance is measured from the mouth of a river, designated as river mile 0.0 and then going upstream. The mouth of a river is where the river enters another river, a lake, or the ocean.

Routes of Exposure

Routes of exposure for this section include contact with the river water, incidental ingestion during recreational activities, and ingestion of fish caught in the river. During the winter months, few people have any direct contact with river water. Any contact would be brief.

During the summer, many people have contact with the river water, including children. This issue was fully evaluated by TVA, EPA, TDEC, and TDH, resulting in fact sheets and advisories for the river system. Advisories stated that recreational activities were safe in all parts of the Watts Bar Reservoir except for the area around the coal ash release. Existing advisories for fish consumption in the Watts Bar Reservoir remain in effect.

TDEC: TN Department of Environment & Conservation

EEP: Environmental Epidemiology Program

TDH: Tennessee Department of Health

ppm: parts per million

TWRA: Tennessee Wildlife Resources Agency

TVA: TN Valley Authority

EPA: U.S. Environmental Protection Agency

will these be continued to be monitored?
Dredging and other operations may increase these pollutants

very small numbers (less than 30 in each polygon). Very small numbers make any statistical analyses less reliable.

A value for Moran's I that is close to zero means that the distribution is random, with no apparent pattern. A value for I that is positive means that similar values are clustered. A value for I that is close to +1 indicates complete clustering. A value for I that is negative means similar values are dispersed. A value of I that is close to -1 indicates complete dispersion.

At a confidence level of 0.05 (95%), a Z-score less than -1.96 or greater than +1.96 indicates a statistically significant result. A Z-score in between -1.96 and +1.96, indicates a statistically non-significant result.

Symptom	Before			After		
	Moran's I	Z-Score	Conclusion	Moran's I	Z-Score	Conclusion
Anxiety and Stress	NA	NA	NA	0.35	3.7	Clustered Less than 1% likelihood pattern due to chance.
Shortness of breath	-0.15	-1.77	Dispersed	0.15	1.98	Clustered Less than 1% likelihood pattern due to chance.
Vomiting	0	0.29	Random	0.27	3.53	Clustered Less than 1% likelihood pattern due to chance.

Symptom	Before			After		
	Moran's I	Z-Score	Conclusion	Moran's I	Z-Score	Conclusion
Cough	0.01	0.52	Random	0.14	1.87	Clustered 5-10% likelihood pattern due to chance
Diarrhea	-0.18	-1.76	Dispersed	0.08	1.09	Random
Headache	0.03	0.81	Random	0.01	0.34	Random
Nausea	-0.14	-1.55	Random	0.09	1.17	Random
Wheezing	-0.16	-1.82	Dispersed	0.02	0.48	Random

See Figures 12, 13, and 14 for pictorial representations of the analyses.

These results indicate that, for anxiety and stress and for vomiting, the after scores are highly significant. The result for shortness of breath is just barely significant.

this implies an OPINION! It is statistically significant. Would need further evaluation to determine if clinically significant.

EEP investigated whether the ‘after’ symptoms had different spatial distributions than the ‘before’ symptoms using a Directional Distribution (Standard Ellipse) tool in ArcGIS. This tool allowed EEP to create what are called standard ellipses, which show the distribution of symptoms as well as whether there is a directional trend or orientation in that distribution. This tool can be used to compare distributions (in this case, symptoms), examine distributions from different time periods, and show the compactness and orientation of distributions. If distributions closely resemble a circle, then there is not a strong orientation to the occurrence of the symptom. A large circle means the cases are widespread whereas a small circle means the cases are more localized (concentrated). The orientation of the circle/eclipse indicates the direction in which the cases are occurring. See Appendix C for more details about spatial analysis methodology.

Anxiety was clustered after the ash release; no questions were asked about anxiety before the ash release. Hot spots for anxiety occurred on the northwest side of the ash release area where there was much property damage. Anxiety and stress were tightly oriented around areas that were directly affected by the coal ash release, where the road was destroyed and where boats and boat docks were damaged or destroyed.

Shortness of breath was more localized after the ash release, although it was still rather widespread. Shortness of breath was clustered, with less than a 1% likelihood pattern due to chance. Hot spots for shortness of breath occurred along the southwest / northeast axis of the ash release area. The orientation of symptoms of shortness of breath changed somewhat after the coal ash release, moving closer to the spill. However, the shortness of breath was not strongly related to location and was still rather widespread.

Vomiting was more localized after the ash release and was clustered, with less than a 1% likelihood pattern due to chance. Hot spots for vomiting occurred in a tight cluster to the northwest of the spill. Because of the tight clustering, vomiting could have been a result of a viral outbreak, which is common in winter, rather than a result of the ash release.

EEP:
Environmental
Epidemiology
Program

ArcGIS: ArcGIS
is a group of
geographical
information
system
software that is
used for
mapping and
statistical
analysis of data
that is
geographically
related.

could this be related to transport routes of response vehicles/dump trucks as opposed to just the release point?

Physician Education

In response to the TVA Kingston coal ash release and following the community health assessment, TDH hosted an informational meeting for local physicians and other healthcare providers. Invitations were sent by fax to approximately 100 medical practices and clinics. This represented over 250 healthcare providers from Roane County and the surrounding area. Three meetings were conducted on January 21 and 22, 2009. Presentations were given by the Deputy State Epidemiologist of TDH and an Environmental Epidemiologist of EEP. Information covered included:

- Environmental testing plan and test results
- Exposure routes and risks associated with coal ash
- Syndromic surveillance results
- Community health survey
- Recommendations that testing of people was not necessary
- Public health recommendations
- Contact information for ~~clinical~~ toxicologists.

Attendees comprised a cross section of medical expertise. The following specialties and organizations were represented:

- Roane County Family Practices
- Individual General Practices
- Individual Internal Medicine Practices
- Roane Eye Center
- Kingston Family Practice
- Cumberland Neurology Group
- Oak Ridge Pediatric Clinic
- Chiropractic Health Center
- Roane County Medical Center including Chief Executive Officer, Directors of Nursing, Laboratory, Respiratory Care, Pathology, and Infection Control
- Roane County Public Health
- East Tennessee Regional Health Office
- Roane County Emergency Medical Staff
- Roane County Emergency Management Agency

Providers were urged to report any coal ash exposures or disease they considered associated with the coal ash release. ← to whom?

Follow up

Because TDH had received no reports of illness associated with the coal ash from healthcare providers, follow-up visits were done on March 17 and 18, 2009. The Deputy State Epidemiologist interviewed 24 healthcare providers in and around Roane County. The interviews included pediatric and family

TVA: TN Valley Authority

TDH: Tennessee Department of Health

EEP: Environmental Epidemiology Program

than the cluster for respiratory symptoms. The ellipse for higher real-time readings is not oriented with the quarry. See Figure 16 for the location of the ellipses.

Analysis of 47,908 real-time air sampling results and 216 results greater than 100 $\mu\text{g}/\text{m}^3$, most levels greater than or equal to 100 $\mu\text{g}/\text{m}^3$ are related to fires or the cause is unknown. See Table o below. Only about 8% of higher readings can be attributed to visible dust or truck/car traffic.

Notation summary	Number >100 $\mu\text{g}/\text{m}^3$	Percent
Visible fire, active fireplace, or wood-burning odor	115	53
No visible dust or odor	47	22
Hazy, foggy, or high humidity conditions	34	16
Visible dust/ truck traffic	18	8
In a work area	4	2
Other	4	2
More than 1 notation was included with some sample results		

Other Concerns

Immediately after the ash release a non-governmental agency, United Mountain Defense (UMD), began working in the community. UMD is an organization that works to stop mountain top removal coal mining. UMD provided bottled water to residents even though all sampling for municipal drinking water and well water have continuously met all EPA and TDEC regulations. UMD also worked to have 30 members of the community tested for heavy metals at a Tennessee company called Internal Balance. Internal Balance advocates wellness and detoxification strategies. TDH did not recommend metals testing because the community is not exposed to elevated levels of metals from coal ash.

Some community members who were tested for heavy metals are concerned about abnormal results they received, but have had no medical follow up. Some health care providers in the area are uncomfortable interpreting these test results. Several community members have reported abnormal laboratory results for porphyrins testing done through UMD. People are concerned about their health, about exposures, and about proper diagnosis and treatment.

TVA has contracted with Oak Ridge Associated Universities (ORAU) to provide services to individuals with health concerns relating to the coal ash release. ORAU has subcontracted with Vanderbilt University Medical Center (VUMC) to provide expertise in [clinical toxicology](#) to area health care providers and to individuals. ORAU and VUMC [clinical toxicologists](#) have prepared a protocol for acceptance into the medical program and for appropriate testing of individuals. TVA will pay the costs associated with these examinations. In addition, if an individual's health has been adversely impacted by exposure to the released coal ash, TVA will pay for treatment (personal communication, Joseph J. Hoagland, TVA, September 9, 2009).

$\mu\text{g}/\text{m}^3$:
microgram per
cubic meter of
air

UMD: United
Mountain
Defense

EPA: U.S.
Environmental
Protection
Agency

TDEC: TN
Department of
Environment &
Conservation

TDH:
Tennessee
Department of
Health

ORAU: Oak
Ridge
Associated
Universities

VUMC:
Vanderbilt
University
Medical Center

TVA: TN Valley
Authority

Conclusions

← see my comments in summary conclusions.

1. When the coal ash was released from the failed retention wall of one of the coal ash storage ponds, people in the path of the ash could have been harmed by the magnitude and suddenness of the ash release. If the release had occurred during a summer day when people were on the river or riverbanks, many people could have been harmed or killed.

An enormous amount of ash quickly filled the Emory River and two coves, moving one house from its foundation and causing two other homes to be uninhabitable. The force of the release ruptured a gas line and disrupted power, causing the evacuation of the neighborhood along Swan Pond Road and Emory River Drive. A train derailed when it ran into the huge pile of coal ash. People driving home during the night found that Swan Pond Circle Road was impassable due to the ash. Fortunately, no one on the road or river was buried by the coal ash release.

2. The Tennessee Department of Health concludes that it is unlikely that harm occurred to people from touching the coal ash when they had to climb out of their damaged houses on the morning of December 22, 2008, and who had to return to retrieve personal property.

Even though touching the coal ash could cause local skin irritation, the metals in the coal ash are not likely to get into people's bodies from touching the ash.

3. The Tennessee Department of Health concludes that no harm to the community's health is expected from touching the coal ash. This includes children who might touch the ash while playing.

Even though touching the coal ash could cause local skin irritation, the metals in the ash are not likely to get into people's bodies from touching the coal ash. The ash has been fenced, clearly marking the areas with coal ash. The opportunity for people, especially children, to touch the ash is minimal.

4. The Tennessee Department of Health concludes that no harm to people's health is expected from accidentally eating the coal ash.

The concentrations of metals in the coal ash, except arsenic, are below levels known to cause harm if eaten. Because exposure to the coal ash was brief and the arsenic in the coal ash is not completely available for absorption, no harm to health is expected even if the coal ash were accidentally eaten. The ash has been fenced, clearly marking the areas with coal ash.

5. The Tennessee Department of Health concludes that using the Emory River at the site of the coal ash release (near Emory River mile 2) could result in harm to residents or trespassers from physical hazards associated with cleanup efforts and from the volume of ash present, if residents or trespassers entered the area.

TVA is using heavy machinery to build dikes and weirs to contain the ash and to remove the ash. The boundary between land and water is blurred because of the ash, leading to a physical hazard to anyone walking in the area.

The Tennessee Department of Health will continue to keep people informed about any new issues or any new findings.



Suggest that TN DOH also include Tennessee Poison Center in future analysis and evaluation of people in this area to help protect the public health along with the above agencies.

Recommendations ← see my comments in the summary section.

1. The Roane County Office of Emergency Services and Homeland Security acted immediately to protect people. The Tennessee Valley Authority, the U.S. Environmental Protection Agency, the Tennessee Department of Environment and Conservation, and the Tennessee Department of Health began to assist through a unified command structure. Although the command center was demobilized in January 2009, the response from state and federal agencies has continued, and will continue until the area is returned to the conditions existing before the coal ash release.

TDH and TDEC should continue to widely publicize the following message: *If you do contact the ash, then practice good hygiene, especially washing your hands before eating or smoking. Wash thoroughly, including your hands, clothes and shoes if you, your children, or pets come in contact with the ash. Basically, wash the same way you would after mud exposure. Remember, the metals are bound to the ash. Occasional exposures for brief periods of time should not harm people's health.*

2. People whose homes were destroyed have been relocated. In addition, the Tennessee Valley Authority has relocated most of the families whose property fronts the affected portions of the Emory River and inlets.

The U.S. Environmental Protection Agency, the Tennessee Department of Environment and Conservation, and the Tennessee Valley Authority should continue to work cooperatively to clean up the ash as quickly as possible while protecting the people in the community from touching, accidentally eating, drinking, or breathing the coal ash.

3. The Tennessee Valley Authority should continue working in cooperation with the U.S. Environmental Protection Agency and the Tennessee Department of Environment and Conservation to clean up the coal ash while protecting the people in the community from touching the coal ash.
4. The Tennessee Valley Authority should continue working in cooperation with the U.S. Environmental Protection Agency and the Tennessee Department of Environment and Conservation to clean up the coal ash while protecting the people in the community from eating the coal ash.
5. The Tennessee Valley Authority is working in cooperation with the U.S. Environmental Protection Agency and the Tennessee Department of Environment and Conservation to clean up the coal ash while protecting the people in the community. While cleanup is underway, heavy machinery will be present. The Tennessee Valley Authority should continue to actively patrol the areas within the Emory River where operations are occurring so that unauthorized persons cannot enter the area. The U.S. Environmental Protection Agency, in conjunction with the Tennessee Departments of Health and Environmental Conservation and the Tennessee Valley Authority, issued a Recreational Advisory for Watts Bar Reservoir in June 2009. This advisory states, in part: *The public is cautioned to avoid recreational use of the lower Emory River in the vicinity of the ash release down to the confluence of the Emory and Clinch Rivers, which includes adjacent coves, inlets, islands, and sand bars. Small vessel traffic is currently channeled through a well-marked navigational lane, but swimming,*

Authors, Technical Advisors, Reviewers

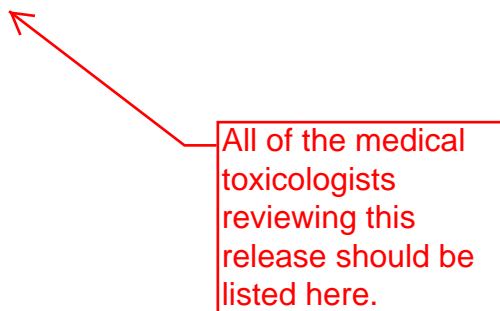
Authors

Bonnie Bashor, MS, Director of Environmental Epidemiology
Joseph George, MS, Health Assessor
Melissa Kranz, MPH, Environmental Epidemiologist
David Borowski, MS, Health Assessor/Assistant Director of Environmental Epidemiology
Tennessee Department of Health (TDH)
Division of Communicable and Environmental Disease Services (CEDs)
Environmental Epidemiology Program (EEP)
1st Floor Cordell Hull Building 425 5th Avenue North Nashville TN 37243

ATSDR Technical Project Officer

LCDR Trent LeCoulre, MSEH, REHS, Public Health Service Cooperative Agreement and
Program Evaluation Branch

Reviewers



References

(ATSDR 2007) Agency for Toxic Substances and Disease Registry. August 2007. Toxicological profile for Arsenic. Atlanta: US Department of Health and Human Services.

(ATSDR 2008a) Agency for Toxic Substances and Disease Registry. September 2008. Draft Toxicological profile for Chromium. Atlanta: US Department of Health and Human Services.

(ATSDR 2008b) Agency for Toxic Substances and Disease Registry. September 2008. Draft Toxicological profile for Manganese. Atlanta: US Department of Health and Human Services.

(ATSDR 2009) Agency for Toxic Substances and Disease Registry. Division of Health Assessment and Consultation Site and Radiologic Assessment Branch. Technical Assistance to the Tennessee Department of Health: Radiological Evaluation, Kingston fly ash spill, Kingston, Roane County, Tennessee, March 2009.

(ASU – WAUWRP 2009) Report of Appalachian State University and the Waterkeeper Alliances Upper Watauga Riverkeeper Program. The report can be found at URL:

<http://www.unitedmountaindefense.org/>.

(Babyak et. al 2009) Babyak C, George A, Lemly D, Lisenby D, Payne, B, and Tuberty S. Preliminary summary report from water, sediment and fish samples collected at the TVA ash spill by Appalachian State University, Appalachian Voices, Tennessee Aquarium and Wake Forest University. This report can be found at URL:

www.appvoices.org/index.php?/site/av_news/tva_ash_spill_results/.

Cancer Facts & Figures 2009. American Cancer Society. Atlanta 2009.

(Davis and DeWiest 1966) Davis SN and DeWiest RJM. 1966. Hydrology. John Wiley and Sons, New York.

(Deberardis et al.) De Berardis B, Incocciati E, Massera S, Gargaro G., Paolitti L. Airborne silica levels in an urban area. Science of the Total Environment, 382: p. 251-258, 2007.

(DeRosa 2002) De Rosa CT, Holler JS, Mehlman MA. 2002. Advances in modern environmental toxicology, Volume XXVI: Impact of hazardous chemicals on public health, policy, and service. International Toxicology Books, Inc. Princeton, New Jersey.

(EPA 1991) Clay DR. OSWER Directive 9355.0-30. Role of the baseline risk assessment in Superfund remedy selection decisions.

(EPA 1994) Methods for the determination of metals in environmental samples. Supplement I. EPA/600/R-94/111. May 1994.

(EPA 2005) Guidelines for carcinogenic risk assessment. EPA/6301/P-03/001F. Risk Assessment Forum, U.S. Environmental Protection Agency. March 2005.

(EPA 2009a) Private drinking water wells. URL: <http://www.epa.gov/privatewells/index2.html>.

(EPA 2009b) Air Quality Index: Particle Pollution, URL accessed on March 19, 2009, <http://www.airnow.gov/index.cfm?action=aqibroch.aqi#13>.

(EPA 2009c) AirNow. URL:<http://www.epa.gov/air/data/>.

(EPA 2009d) Regulatory limits for radium.
<http://www.epa.gov/superfund/health/conmedia/soil/cleanup.htm>

(Gabbard 2009) Gabbard, A. Coal Combustion: Nuclear Resource or Danger.
<http://www.ornl.gov/info/ornlreview/rev26-34/text/colmain.html>, accessed on February 25, 2009).

(Head 2006) Head C. Memorandum, *Management of Soils Containing Arsenic on TN Department of Transportation Right-of-Way Sites*, to Mike Apple and Jim Haynes. July 20, 2006.

(IRIS 2009). EPA's Integrated Risk Information System. URL: www.epa.gov/ncea/iris/.

(Meij 2000) Meij R. Composition and particle size of and exposure to coal fly ash. *J. Aerosol Sci.* Vol. 31, Suppl 1, pp. S 676-S677, 2000.

(Meij and te Winkle 2001) Meij R and te Winkel H. Health aspects of coal fly ash. 2001 International Ash Utilization Symposium, Center for Applied Energy Research, University of Kentucky, Paper #21.

(NIOSH 2002) NIOSH Hazard Review: Health Effects of Occupational Exposure to Respirable Crystalline Silica. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health. DHHS (NIOSH) Publication No. 2002-129 April 2002.

(ORAU 2009) Oak Ridge Associated Universities, Kingston Ash Release. URL:
<http://tva.gov/kingston/orau/index.htm>.

(RSL 2009) EPA Region 3 Mid-Atlantic States Risk Screening Level Tables. URL:
http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm

(Ruhl et. al 2009) Ruhl L, Vengosh A, Dwyer, GS, Hsu-Kim H, Deonarine A, Bergin M, Kravchenko J. Survey of the Potential Environmental and Health Impacts in the Immediate Aftermath of the Coal Ash Spill in Kingston, Tennessee. *Environ. Sci. Technol.*, Article ASAP. DOI 10.1021/es900714p. Publication Date (WEB): 04 May 2009.

(Shoji et. al 2002) Shoji T, Huggins FE, and Huffman GP. XAFS spectroscopy analysis of selected elements in fine particulate matter derived from coal combustion. *Energy & Fuels* 2002, 16, 325-329.

(Smith et. al 2006) Smith KR, Veranth JM, Kodavanti UP, Aust AE, and Pinderton KE. Acute pulmonary and systemic effects of inhaled coal fly ash in rates: comparison to ambient environmental particles. *Toxicological Sciences* 93(2), 390-399 (2006).

(Stranden 1985) Stranden, E. Sources of exposure to technologically enhanced natural radiation. *Science of the Total Environment*, 45: p. 27-45, 1985.

(Tetra Tech 2009) Tetra Tech EM Inc., Superfund Technical Assessment and Response Team Region 4. Final CERCLA Emergency Response Report, Kingston Fossil Plant Fly Ash

Response. Harriman, Roane County, Tennessee. EPA Contract No. EP-W-05-054 TDD NO. TTEMI-05-001-0084. Revision 0. Prepared for U.S. Environmental Protection Agency, Region 4, Emergency Response and Removal Branch.

(TDEC 2008) Rules of Tennessee Department of Environment and Conservation, Tennessee Water Quality Control Board, Division of Water Quality Control. Chapter 1200-4-3, General Water Quality Criteria. June 2008 (Revised).

(TVA 2009) Tennessee Valley Authority website. URL: <http://www.tva.gov/sites/kingston.htm>

(Zielinski et. al 1998). Zielinski, R.A. and J.R. Budahn, Radionuclides in fly ash and bottom ash: improved characterization based on radiography and low energy gamma-ray spectrometry. Fuel, 77(4): p. 259-267, 1998.