Health Consultation

Evaluation of Surface Soil Sampling Results

Swan Pond Recreation Areas

Kingston, Roane County, Tennessee

SWAN POND ROAD

KINGSTON, ROANE COUNTY, TENNESSEE, 37763

Prepared by the Tennessee Department of Health

September 5, 2019

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Foreword

This document summarizes an environmental public health investigation performed by the State of Tennessee Department of Health's Environmental Epidemiology Program. Our work is conducted under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry. The process to answer an environmental public health questions includes many steps, including the following:

Evaluate exposure: Tennessee health assessors begin by reviewing available information about environmental conditions at a site. We interpret environmental data, review site reports, and talk with environmental officials. Usually, we do not collect our own environmental sampling data. We rely on information provided by the Tennessee Department of Environment and Conservation, U.S. Environmental Protection Agency, other government agencies, businesses, and the public. We work to understand how much contamination might be present, where it is located on a site, and how people might be exposed to it. We look for evidence that people might have been, are being, or in the future could be exposed to harmful substances.

Evaluate health effects: If people could be exposed to contamination, then health assessors take steps to determine if it could be harmful to human health. We base our health conclusions on routes of exposure, risk assessments, toxicology, clean-up actions, and the scientific literature.

Make recommendations: Based on our conclusions, we will recommend that any potential health hazard posed by a site be reduced or eliminated. These actions will prevent possible harmful health effects. Environmental Epidemiology serves as an advisor in dealing with hazardous waste sites. Often, our recommendations will be action items for other agencies. However, the Tennessee Department of Health can issue a public health advisory warning people of the danger of an urgent public health hazard and will work with other agencies to resolve the problem.

If you have questions or comments about this report, we encourage you to contact us.

Please write to: Environmental Epidemiology Program
Tennessee Department of Health
3rd Floor, Andrew Johnson Tower
710 James Robertson Parkway
Nashville TN 37243

Call: 615-741-7247 or toll-free 1-800-404-3006 during normal business hours

Email: eep.health@tn.gov

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Summary: Responding to a Community Concern

Roane County citizens were concerned about coal ash at the Swan Pond Recreation Areas. In order to evaluate this concern, two questions needed to be answered (1) was coal ash in soils of the soccer fields of the Swan Pond Sports Complex, the festival field, the nearby walking trail, or Lakeshore Park and (2) could exposure to chemicals within coal ash or soils harm children who used these public areas for recreation? The Roane County Environmental Review Board (RCERB) brought these concerns to the Tennessee Department of Environment and Conservation's (TDEC) and Tennessee Department of Health (TDH). The RCERB wanted TDEC and TDH to prepare a work plan and perform soil sampling to respond to their community's concern.

TDEC and TDH prepared a work plan for sampling soil in the areas of concern. It was reviewed by both the RCERB and the Tennessee Valley Authority (TVA). The work plan was a prudent, cautious approach to collect environmental data. TDEC staff followed the work plan and collected soil samples from 23 locations in the soccer fields, 6 soil samples from the festival field, 3 soil samples along the walking trail west of the soccer fields, and 3 soil samples from areas in Lakeshore Park for a total of 35 surface soil sample locations. Each soil sample was made up of 9 separate soil sub-samples mixed together to form a composite sample. All composite samples were collected from the 0 to 3-inch deep soil layer just beneath the grass cover. All surface soil samples were tested for percent coal ash, metals, radioactivity, and general chemistry properties.

The soil below the grass cover was sampled as it represented the layer of soil children might be exposed to during recreational activities like running in cleats, kicking, and sliding or otherwise playing.

Tennessee Department of Environment and Conservation staff sample soil on the Swan Pond Recreation Areas soccer fields on May 7, 2019.

Less than 1% coal ash was found in each of the soil samples.

We looked at materials other than coal ash present in the soil, such as metals and radionuclides. All metal and radionuclide levels in the soil were below levels that would be a health hazard.

Our recommendation is to use the Swan Pond Recreation Areas which include the soccer fields, the festival field, the walking trail, and Lakeshore Park for their intended purposes. Children recreating at these areas should not have health concerns.

Conclusion

The Tennessee Department of Health's Environmental Epidemiology Program reached one important conclusion about the Swan Pond Sports Complex, the festival field, the walking trail, and Lakeshore Park. These areas will be referred to collectively as the Swan Pond Recreation Areas in this health consultation.

Conclusion	Surface soils were tested from the Swan Pond Recreation Areas to protect the children who play there. All 35 soil sample locations tested had less than 1% coal ash. All soil sample test results were below health comparison values used to determine unacceptable risk. All surface soil sampling test results were similar to what would be expected for Tennessee soil background levels. Therefore, exposure to surface soil by accidentally swallowing, breathing dust, or skin contact at the Swan Pond Recreation Areas is not expected to harm the health of children using these areas.
Basis for Decision	An extensive amount of work was done to ease the community's concern about the presence of coal ash at the Swan Pond Recreation Areas. Less than 1% coal ash was found in all soil samples tested. There is widespread, thick grass cover on the Swan Pond soccer fields. There should be no exposure to the soil beneath the grass at the fields. To be thorough, we looked at the possibility of exposure to several chemicals in soil if the grass cover was damaged or somehow became less widespread. We tested soil beneath the grass for metals and radionuclides. The highest metal and radionuclide levels in each of the areas were all below published or calculated health comparison values. Radionuclide levels were also below excess lifetime cancer risk criteria established by the U.S. Environmental Protection Agency.
Next Steps	There are no health concerns due to coal ash in the surface soil in the recreation areas. Our recommendation is to use the Swan Pond Recreation Areas for their intended purposes.

For More Information	If you have any questions or concerns about your health, contact your healthcare provider. For more information about this health report, please call the TDH Environmental Epidemiology Program at 615-741-7247 or 1-800-404-3006 during normal business hours. You can also email the TDH Environmental Epidemiology Program at eep.health@tn.gov. For more information about the Tennessee Valley Authority Kingston coal ash release, call the Tennessee Department of Environment and Conservation toll free at 615-532-0900.

Statement of Issues and Background

The Tennessee Department of Health's (TDH) Environmental Epidemiology Program (EEP) evaluated the soil for the presence of coal ash at the Swan Pond Recreation Areas. These areas include the Swan Pond soccer fields, festival field, along a walking trail leading to a birdwatching area, and Lakeshore Park. TDH EEP prepared this public health consultation under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR), a federal program that protects the public from harmful health exposures at environmental sites throughout the United States.

On December 22, 2008, a coal ash storage pond at the Kingston TVA Fossil Plant failed spilling coal ash over about 300 acres. The coal ash spilled into the slough next to where the Swan Pond Recreation Areas are now located. The recreation areas created by the Tennessee Valley Authority (TVA) after the coal ash spill was cleaned up were created to restore the areas and to be used as community amenities.

The Roane County community questioned if coal ash remained in the Swan Pond Recreation Areas used by Roane County citizens. The community was concerned about possible coal ash in soil in the sports complex, along the walking trail, and in Lakeshore Park. The Roane County Environmental Review Board (RCERB) approached the Tennessee Department of Environment and Conservation's (TDEC) and the TDH to ask what could be done. The RCERB wanted to know if TDH and TDEC could prepare a work plan and perform soil sampling to answer two questions: (1) was coal ash present in soils of the recreation areas, and (2) could chemicals within coal ash and soils harm children who used these areas for recreation?

TDH and TDEC prepared a work plan for the soil sampling at the sports complex and other recreation areas. The focus of our work was to answer the questions posed and most importantly determine if children using these areas for recreation could be harmed by what could be in the shallow soil when running, sliding, kicking, or otherwise playing.

Site Location and Details

The Swan Pond Recreation Areas are located on Swan Pond Road in Kingston, Tennessee 37763. TVA owns the land and leases these areas to Roane County.

The soccer fields and walking trail are located north of TVA's main electricity generating plant and coal ash storage area. The sports complex is accessible by the public seasonally as soccer games and practices are held on the grounds. A locked gate discourages access when the fields are not in use. The soccer field complex has a concessions and rest room building and a picnic pavilion. The walking trail west and north of the soccer fields is readily accessible at all times by those using the fields or other nearby walking trails.

Lakeshore Park is located north-northeast of the plant. Lakeshore Park was an area of single-family homes before the coal ash spill. TVA purchased most of these properties and created the park. Lakeshore Park has picnic tables, a canoe launch, a boat ramp, walking trails, fishing platforms, parking, and rest room facilities. The park is readily accessible by the public at all times.

Photo 1. Soccer fields at the Swan Pond Sports Complex. Even in winter the soccer fields have widespread and thick grass cover (Source: TDH, January 3, 2019).

Photo 2. Picnic area in Lakeshore Park. An example of one of the areas where soil samples were collected in the park (Source: TDH, January 3, 2019).

Soil Sampling Methods, Locations, Collection, Storage, and Testing

TDH and TDEC prepared a work plan for soil sampling at the Swan Pond Recreation Areas [TDH/TDEC 2019]. The work plan is presented in Appendix A. The work plan outlined why the soil samples were collected, where the samples were collected, how the samples were collected, how the samples were handled and stored, and what laboratory methods were used to test the samples. Maps showing the areas of concern and the general areas where the samples were collected are in Appendix A. TDEC prepared a detailed report about the soil sampling. It presents how the field sampling was done, includes location coordinates for the samples, with pictures documenting the field work. It follows in Appendix B.

The RCERB and TVA reviewed the work plan to understand how soil samples were going to be collected and tested. TVA provided access to the areas for the TDEC field sampling team. Roane County Parks and Recreation provided specific access to the soccer and festival fields for the sampling team.

Soil from 0 to 3 inches below the grass cover was sampled as it represents the layer of soil children might be exposed to during recreational activities like running in cleats, kicking, sliding, or otherwise playing.

TVA split soil samples with TDEC. A large portion of soil was collected at each grid or location. TDEC took some for testing and TVA was given some for testing. TVA sent the samples to their own contracted laboratories. These laboratories were different from those used for soil testing by TDEC. TDEC and TDH analyzed and evaluated their soil sample results separately from TVA. We did not include or evaluate TVA soil sample results in this health consultation.

Staff from the Tennessee Department of Environment and Conservation's Knoxville, Oak Ridge, and Chattanooga Field Offices performed the soil sampling field work over three days from May 6 through May 8, 2019. Representatives from the Roane County Health Department, TDH's Nashville Central Office, TDEC's Nashville Central Office, the RCERB, Roane County Parks and Recreation, and TVA observed the field work.

Soil was collected from under the sod, organic, or grass layer at a depth of 0 to 3 inches. Each soil sample tested was mixed together from nine sub-samples of equal amount to obtain the appropriate amount of soil needed for both TDEC samples and TVA samples. Both TDEC and TVA samples were acquired from the same bulk soil sample. This method of soil sampling created composite soil samples. The soil samples were not chosen completely at random as there was a focus on distressed areas, places where children play, and places where families congregate. The GPS coordinates of the general middle of each block where a composite sample was collected were recorded. This information can be found in TDEC's report in Appendix B.

More soil samples were collected from the soccer fields than other locations. Both large soccer fields were divided into eight approximately equal blocks to make sure soil sampling was performed in all parts of each field. The process made sure smaller soccer fields will have been evaluated as the fields can be configured for different age players. Samples were collected from the general areas where midfield or goal areas would be located and throughout each field. Off-field and sideline samples were focused in areas where children were expected to play or sit. A total of 25 surface soil samples which included two duplicate samples, were collected from 23 locations in the soccer fields.

According to TVA, the source of the soil for the soccer fields was from an onsite borrow pit once called Gupton Farms, near where the soccer fields are now. TVA used about 1 million yards of borrow soils from Gupton Farms for closing of an ash cell and the creating the sports complex [Georgia Caruthers 2019].

Introduction to Chemical Exposure

To determine whether persons have been or are likely to be exposed to chemicals, TDH EEP evaluates pathways that could lead to human exposure. Chemicals released into the environment have the potential to cause harmful health effects. Nevertheless, a release of a chemical does not always result in exposure. People can only be exposed to a chemical if they come into contact with it. If no one comes into contact with a chemical, then no exposure occurs, and thus, no health effects could occur.

The five elements to consider when deciding if a person could be exposed to a chemical are:

1. Where is the chemical coming from (source)?
2. What in a person's environment has been contaminated (environmental medium)?
3. Is there a way a person might come into contact with the chemical (exposure point)?
4. How they might come into contact with the chemical (exposure route)?
5. Who might be exposed to the chemical (exposed population)?

An exposure pathway is the way a person can be exposed. Exposure can happen through inhalation (breathing) of a chemical, from ingesting (eating or drinking) a chemical, or by dermal contact (touching) a chemical. An exposure pathway is considered complete if there is evidence that all five of the elements above have been, are, or will be present. An exposure pathway is considered incomplete if one of the five elements above is missing. A potentially completed exposure pathway is when all five elements might have occurred in the past or might occur in the future. A completed exposure pathway is when all five elements of the pathway are either expected to occur or are occurring (Table 1).

The source of contamination would have been from the place where the coal ash was released. For the Swan Pond Recreation Areas, the source for possible coal ash in the soils would be the TVA coal ash release. The coal ash might have spilled on, blown onto, or was buried in the land where the Swan Pond Recreation Areas are now located.

Certain population groups might have a different or enhanced response to hazardous chemicals than will most persons exposed to the same level of hazardous chemicals in the environment. Reasons for sensitivity might include genetic makeup, age, gender, health and nutritional status, and exposure to other toxic substances. In general the elderly, with declining organ function, and the young, with immature and developing organs, are more vulnerable to toxic substances than are healthy adults. The health of children who use the Swan Pond Recreation Areas for recreational opportunities was the main focus of this health consultation. While grounds keepers were also mentioned by the RCERB, by evaluating the exposure to children playing on the soccer fields we have also adequately protected coaches and field groundskeepers. TDH EEP used cautious, protective estimates for the amount of time and length of soil exposure to any contamination found in the soil.

Potential Exposure Pathways

Overall, onsite soils and dust in air are the possible points of exposure for this site. Children who used the Swan Pond Recreation Areas are the potentially exposed population. Table 1 summarizes these potential exposure pathways.

Table 1. Potential exposure pathways for children at the Swan Pond Recreation Areas.

Source	Environmental Medium	Exposure Point	Exposure Route	Potentially Exposed Population	Time Frame	Exposure Pathway
Coal Ash	Soil	Contact with soil and dust particles	Ingestion, or Dermal contact	Sport players	Past	Incomplete
					Present	Incomplete
					Future	Incomplete
			Ingestion or Dermal contact	Young siblings of players	Past	Incomplete
					Present	Incomplete
					Future	Incomplete

Incomplete = indicates at least one element of the exposure was or is not present

Potential = indicates all five elements of the exposure pathway might have occurred in the past or might occur in the future.

Completed = indicates all five elements of the exposure pathway are either occurring or are expected to occur in the future.

Children and adolescents running and sliding during games played on the athletic fields would come into contact with soil particles from the shallow soil. Coaches and parents would also potentially come into contact with soil particles but less frequently than children and adolescents actively participating in sporting events held on the fields. Children who are younger siblings of players might come into contact with soil particles if they are playing on the sidelines or near the concessions and pavilion areas at the sports complex.

Community members using the walking trail would not likely come into contact with shallow soil as the walking trails are paved with asphalt. This of course would change if they wandered off the trail and onto bare ground.

Community members recreating at Lakeshore Park should not come into contact with soil. There are paved walking trails, abundant grass cover in unpaved areas, and large paved parking areas. Children could find spots lacking grass cover and contact shallow soil if they were playing near a picnic table.

Roane County Parks and Recreation groundskeepers could be exposed to soil particles while performing normal activities such as grass mowing and other above ground activities. Their exposure frequency and duration should be less than a child and therefore the results of our evaluation for children would adequately protect them as well. We did not evaluate deeper soils.

Health Comparison Values (CVs) Explained

TDH evaluated the test results of the soil samples from the sports complex and other areas. TDH EEP does this routinely for sites we work on throughout Tennessee. TDH EEP evaluates environmental contamination through a two-tiered approach: (1) a screening analysis and (2) a more in-depth analysis to determine public health implications of site-specific exposures [ATSDR 2005]. First, the highest level of a detected chemical is compared to media-specific environmental guideline comparison values (CVs). This is a cautious, protective approach because (1) the highest level of a chemical would unlikely be distributed evenly throughout a site and (2) CVs are established based on a 24-hour per day, 365 day per year, lifetime exposure. If concentrations exceed a CV, chemicals are evaluated further to find out if those chemicals could pose a health threat to exposed or potentially exposed people. If chemical levels are found above environmental guideline CVs, it does not mean harmful health effects are likely.

A number of health CVs are available for screening environmental contaminants to determine if an additional in-depth analysis is needed [ATSDR 2005]. These include ATSDR environmental media evaluation guides (EMEGs) and reference dose media evaluation guides (RMEGs). EMEGs are estimated levels of chemicals to which humans might be exposed to over a certain period without experiencing adverse non-cancer health effects, based on ATSDR's minimal risk level (MRL). A MRL is an ATSDR estimate of daily human exposure to a hazardous substance at or below which that substance is unlikely to pose a measurable risk of harmful (adverse), noncancerous effects. Exposure might be for up to 2 weeks (acute), 2 weeks to less than a year (intermediate), or more than a year (chronic). RMEGs represent the level of a chemical in water or soil at which a chronic human exposure is not likely to result in adverse non-carcinogenic effects, based on the U.S. Environmental Protection Agency's (EPA's) reference dose. A reference dose is an EPA estimate, with uncertainty or safety factors built in, of the daily lifetime dose of a substance that is unlikely to cause harm in humans.

If the substance is a known or a probable carcinogen, ATSDR's cancer risk evaluation guides (CREGs) were considered as CVs. CREGs are estimated contaminant concentrations that would be expected to cause no more than one excess cancer in a million persons exposed during their lifetime (78 years). The background lifetime risk for cancer, as measured from 2012 to 2014 is about one in three for both men and women [ACS 2018]. All cancer risk values we used express the additional chance of developing cancer above this baseline. If contaminant levels are found above environmental guideline CVs, it does not mean adverse health effects are likely.

If there were no ATSDR CVs established for a chemical, then the EPA Regional Screening Levels (RSLs) for a residential exposure scenario were used as the CV [EPA 2019a]. These levels were calculated by EPA using the latest toxicity values, default exposure assumptions, and physical and chemical properties. For radium-226/228 and cesium-137, EPA Preliminary Remedial Goals (PRGs) were estimated based on site-specific information such as the size of the fields, amount of time people will be on the fields, and other factors [EPA 2019b]. The PRGs for radionuclides are another form of CV. A PRG is an isotope concentration that corresponds to a certain level of risk from exposure to air or soil in our case. In risk assessment, an excess lifetime cancer risk of 1 excess cancer in 100,000 people ($1x10^{-5}$ additional risk) is standard. This risk would be in addition to the background cancer rates noted above. All chemical-specific CVs used are shown in the tables in Appendix C.

Discussion of Soil Results

Soil Sampling Results Discussion and Evaluation

Each soil sample collected was tested for percent coal ash (% ash); 20 different metals; chemical properties which included pH, chloride, fluoride, and sulfate; and 3 radionuclides: radium-226, radium-228, and cesium-137. The laboratory provided test results for cesium-137 although cesium-137 was not required by the work plan (Appendix A). The pH and anions were referred to as general chemistry properties in this report. Photos 3 through 6 show how the soil samples were collected. Test results are summarized in Appendix C. TDEC supplied a separate compact disc containing the laboratory data reports submitted by the contract laboratories for all samples.

Numerous metals and radionuclides occur naturally in soil. Soil is made up of minerals that can contain various metals, organic matter, and small fragments of rock that also contain metals and radionuclides. Typically, the type and amount of each metal and radionuclide present in soil is related to its original rock type.

Percent Coal Ash Test Results and Evaluation

A laboratory tested the soil samples for coal ash using polarized light microscopy (PLM). The laboratory reported there was less than 1% coal ash in each of the surface soil samples. The laboratory's detection limit for the analysis was about 1%. This means the testing laboratory could determine if as little as 1% of the soil sample was coal ash. All PLM results were reported as non-detect, meaning all samples were at least 99% free of coal ash.

Metals Test Results and Evaluation

In addition to testing for coal ash, the soil samples were tested for other chemicals that might have been present in the soils. The soil samples were tested for levels of various metals such as:

antimony	cadmium	lead	selenium
arsenic	calcium	lithium	silver
barium	chromium	molybdenum	thallium
beryllium	cobalt	mercury	vanadium
boron	copper	nickel	zinc

The metals found in the soil samples and the range of amounts is presented in Appendix C. All metals results are reported in milligrams of the metal per kilograms of soil (mg/kg).

Soil samples had very low to low levels of 20 metals (Appendix C). The fact there was less than 1% coal ash found and there were no elevated levels of metals in any of the soil samples, suggests typical normal soil. The amounts of each metal are naturally occurring. There were no areas where measured levels of any metal were high. Measured levels of metals in the soil in the Swan Pond Recreation Areas were in a small range with no indication of contamination. As mentioned before, according to TVA, the source of the soil for the soccer fields was from an onsite borrow pit once called Gupton Farms, near where the soccer fields are now. TVA used about 1 million yards of borrow soils from Gupton Farms for closing of an ash cell and the creating the sports complex [Georgia Caruthers 2019].

Photo 3. Tennessee Department of Environment and Conservation field sampling staff, TVA field sampling personnel, and a Roane County Environmental Review Board representative look on as an equipment field blank is collected from a sample collection and mixing bowl at the sample management station set up in the onsite pavilion (Source: TDH, May 7, 2019).

Levels of 18 of the 20 metals were below their non-cancer and cancer health CVs [ATSDR 2019, EPA 2019a]. Arsenic and chromium were evaluated further because these two metals have been shown to be carcinogenic to humans. Therefore, arsenic and chromium have lower cancer CVs. The lowest and highest values for each metal in each area are reported in Appendix C. An arithmetic mean was also calculated for each metal and reported for each area. The tables have the naturally occurring levels of metals in Tennessee [Kopp 2001] and the corresponding health-based comparison value for each metal.

For evaluation of the metals results we assumed children using the Swan Pond Recreation Areas could have either an acute, intermediate, or chronic exposure. An example of an acute exposure would be if a child played in a weekend tournament. An example of an intermediate exposure would be if a child played soccer on the fields between 15 and 364 days per year. An example of a chronic exposure would be greater than 365 days, such as if children played soccer many seasons or visited the recreation areas frequently.

There is extensive grass cover on the fields that will prevent exposure to soil. Furthermore, the results of the soil testing matched well with typical Tennessee soil background levels [Kopp

2001, Dragun and Chekiri 2005]. To be cautious, we thoroughly evaluated the metals to make sure children using the soccer fields and other areas were protected. Because arsenic and chromium are carcinogenic to humans, we further evaluated the potential cancer risk to children from the levels found of these two metals.

Arsenic is naturally occurring in soil and rocks throughout Tennessee. Arsenic in all areas was above ATSDR's CREG of 0.26 mg/kg for one lifetime excess cancer in one million people. Measured naturally occurring levels of arsenic in Tennessee soils are above the ATSDR CREG. Again, a CREG is a cancer screening value and not used to identify health outcomes. The arsenic CREG value is based on a continuous lifetime exposure to the chemical which is a situation that would not be realistic for the children using the Swan Pond Recreation Areas.

Measured levels of arsenic were below ATSDR's non-cancer comparison value of 16 mg/kg for a chronic exposure of more than 365 days. Average Tennessee naturally occurring background soil arsenic values are actually higher than those measured in the Swan Pond Recreation Areas.

Photo 4. Tennessee Department of Environment and Conservation personnel collect soil samples from one of the soccer fields (Source: TDH, May 7, 2019).

Photo 5. Tennessee Department of Environment and Conservation personnel collect a portion of one of the soil samples from the soccer fields (Source: TDH, May 7, 2019).

Photo 6. A Tennessee Department of Environment and Conservation geologist mixes the 9 sub-samples at the sample management station in the sports complex pavilion before placing the soil in laboratory-supplied sample containers (Source: TDH, May 7, 2019).

Because studies have identified effects from breathing or touching arsenic on every organ or tissue in the body [ATSDR 2007], we evaluated the arsenic results further. We did so by calculating the excess cancer risk for incidental ingestion or inhalation of the highest measured amount of arsenic in the soccer fields. We used an exposure of a child accidentally ingesting soil or inhaling dust containing arsenic 3 times per week, 24 weeks per year, for 16 years. Using this cautious approach, we found the highest an exposure of a child accidentally ingesting soil or inhaling dust containing arsenic 3 times per theoretical excess cancer risk is about three excess cancers in one million children (expressed exponentially as $3x10^{-6}$). Although this theoretical additional excess cancer risk is not zero, EPA considers one additional cancer case among 10,000 people to one additional cancer in one million people to generally not warrant action as discussed in the National Contingency Plan (NCP), 40 CFR 300.430 [EPA 1994].

Levels of chromium were also measured at the Swan Pond Recreation Areas. Chromium is naturally occurring in soil and rocks throughout Tennessee. Chromium exists in trivalent (Cr^{+3}) and hexavalent (Cr^{+6}) forms. Trivalent chromium mainly exists in nature. Hexavalent chromium is usually present from industrial processes. In general, Cr^{+6} is more toxic than Cr^{+3} [ATSDR 2012]. Cellular uptake of Cr^{+6} in the human body is more effective than the uptake of Cr^{+3}. The primary effects associated with Cr^{+6} are on the respiratory, gastrointestinal, immunological, hematological, reproductive, and developmental systems of the human body. The primary effects of Cr^{+3}compounds are on the respiratory and immunological systems of the body [ATSDR 2012].

For a very cautious approach, we assumed all chromium was Cr^{+6}. The measured levels of chromium in soil were below ATSDR's non-cancer Cr^{+6} comparison value of 47 mg/kg for a chronic exposure of more than 365 days. As mentioned before, there was less than 1% coal ash measured in any of the soil samples. Therefore, the soil has not been influenced by industrial processes. Because there was less than 1% coal ash measured, it is unlikely there is hexavalent chromium present in the soccer field soil.

Measured naturally occurring levels of chromium in Tennessee soils are higher than the ATSDR Cr^{+6} CREG. Average Tennessee soil chromium values are in many cases actually higher than those measured in the Swan Pond Recreation Areas. Background soil chromium levels for the East Tennessee Technology Park area are higher than levels measured in the soils of the Swan Pond Recreation Areas. Averaged chromium levels found in the soccer fields and along the sidelines and concessions and restroom areas were lower than average naturally occurring Tennessee background levels.

Chromium levels were above ATSDR's CREG for Cr^{+6}, the most cautious comparison value of 0.22 mg/kg. The Cr^{+6} CREG value is also based on a continuous lifetime exposure to the chemical. To be overly cautious, we used the highest level of chromium found in the soccer field soil of 24.7 mg/kg to calculate cancer risk. We also assumed that all chromium in the soccer field soil was Cr^{+6}, an overly cautious assumption. We used the same exposure timeframe as we did for arsenic exposure of 3 days per week for 24 weeks for 16 years. Again, the highest theoretical excess cancer risk was 2 excess cancers in 100,000 children, expressed exponentially as $2x10^{-5}$. This excess cancer risk is in addition to the normal cancer risk of 1 in 3 for both men and women throughout their lifetime. Again, although this theoretical excess cancer risk is not zero, EPA considers one additional cancer case among 10,000 people to one additional cancer in one million people no apparent increased risk.

Radium-226/228 and Cesium-137 Test Results and Evaluation

In addition to coal ash and metals testing, each soil sample was tested for isotopes of radium and cesium commonly found in coal ash. The reason for this test was coal contains naturally occurring radionuclides. Burning coal for power leaves behind significant amounts of coal ash. Radium-226 and radium-228 in the coal become concentrated in coal ash, as does cesium-137. The lowest and highest activity value for radium-226, radium-228, and cesium-137 is reported in Appendix C. all radionuclide activity values were reported as a number in picoCuries per gram (pCi/g).

Radium-226

Radium-226 levels measured at the 35 locations ranged from 0.390 ±0.25 pCi/g to 0.954 ±0.38 pCi/g. The test results were compiled in Appendix C. Published naturally occurring background radium-226 levels in Tennessee soils ranged between 0.65 to 1.4 pCi/g with a mean value of 1.1 pCi/g [Dragun and Chekiri 2005]. A radiation subject matter expert with ATSDR was consulted to understand normal background levels of radium-226/228 and cesium-137. Typical radium-226 levels in soils are about 1 pCi/g [Charp 2019]. Therefore, there are no elevated levels of radium-226 in the Swan Pond Recreation Areas.

An additional cautious, site-specific comparison was done to further evaluate the radium-226/228 levels. The radium measured in the different areas were compared to EPA Preliminary Remedial Goals, calculated based on a site-specific set of parameters for number of years and hours per visit for child recreators, size of the fields, and other characteristics [EPA 2019b].

At a target lifetime excess cancer risk of one in 100,000 people for the radium-226 exposure, the calculated PRG for ingestion is 8.7 pCi/g; for inhalation is $6.2x10^{+7}$ pCi/g; for external exposure is 3.5 pCi/g; and for overall exposure is 2.5 pCi/g. Radium-226 levels measured are below these calculated PRGs in all samples tested. There should be no harmful health effects from exposure to the low levels of radium-226 to children.

Radium-228

For a target lifetime excess cancer risk of one in 100,000 people for radium-228, the calculated PRG for ingestion is 18.3 pCi/g; for inhalation is $1.9x10^{+7}$ pCi/g; for external exposure is 2.55 pCi/g; and for overall exposure is 2.24 pCi/g. All radium-228 results were below these calculated, PRGs. This also indicates the levels of radium-228 in the Swan Pond Recreation Areas are normal background levels.

Cesium-137

The laboratory measured cesium-137 in only 4 of the 35 soil sample locations. Cesium-137 was identified in 3 of the 23 locations in the soccer fields and in 1 of 6 locations in the festival field. Cesium-137 levels for the three athletic field composite samples were 0.229 ± 0.17 pCi/g, 0.191 ±0.09 pCi/g, and 0.132 ±0.09 pCi/g, respectively. The single cesium-137 result from the festival field sample was 0.140 ±0.08 pCi/g. The four cesium-137 levels that were above laboratory detection limits were low.

Cesium-137 levels found in the 4 of 35 locations were lower than typical cesium-137 background values found in the United States of 0.6 pCi/g [Charp 2019]. Cesium-137 levels are also lower than the 0.68 pCi/g background level estimated by Moscovitch et al 1994.

The cesium-137 levels found were also considerably lower than EPA PRGs calculated for a cautious and protective, site-specific comparison. Calculated cesium-137 PRGs are 1,170 pCi/g for ingestion, $3.25x10^{+10}$ pCi/g for inhalation, and 11.4 pCi/g for external exposure, for an overall total PRG of 11.3 pCi/g for child and adult recreators [EPA 2019]. Therefore, there should not be harmful health effects from cesium-137 to those using the athletic fields and festival fields for recreational activities. Cesium-137 results for the four composite samples are below its respective calculated EPA PRGs at a target lifetime excess cancer risk of one in 100,000 people.

Additionally, all testing results were below the 5 pCi/g total radioactivity level, above site background, in accordance with Code of Federal Regulations 40 CFR 192 which is used to regulate radium and thorium concentrations at mill and mining sites under the Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings, Uranium Mill Tailings Radiation Control Act [EPA 1998]. Site background was established at about 1 pCi/g. Based on the federal determination above, levels of these radionuclides appear normal and there should be no harmful health effects from levels of radium-226/228 or cesium-137 found in the soils of the Swan Pond Recreation Areas.

General Chemistry Properties Test Results and Evaluation

The pH and chloride, fluoride, and sulfate levels of the soil were tested. The pH of the soil is typically tested to understand its acidity or alkalinity and is a characteristic of the soils in an area. Soil pH is measured on a scale of 1 to 14 with 7 as the neutral mark. Any reading below 7 is considered acidic and any above 7 is considered alkaline. Many plants grow best when the pH is between 6 and 7 because most nutrients are available to them in this range [SUNY 2019]. The pH values reported in all soil samples within the range between 6.08 and 7.13 pH units.

Chloride, fluoride and sulfate are all anions that can be an indication of soil health. The levels of these anions are dependent on soil pH levels, clay content, and calcium content. These anions occur naturally in the soil and are released from the slow natural breakdown of minerals in the parent rock. The amounts of these anions in soil can also be used to understand if soil has been impacted by environmental contamination such as coal ash.

The lowest and highest values for each of these general chemistry properties are reported in Appendix C. An arithmetic mean was calculated for each parameter for each area. There are no established naturally occurring background levels for these anions in Tennessee. There are no corresponding health-based comparison values for these parameters as they are simply a measure of the acidity of the soil and specific characteristics of the soil. These general chemistry properties provide further evidence soil in the recreation areas is uncontaminated.

Conclusion

The Tennessee Department of Health's Environmental Epidemiology Program reached one important conclusion about the Swan Pond Recreation Areas:

- Surface soils were tested from the Swan Pond Recreation Areas to protect the children who play there. All 35 soil sample locations tested had less than 1% coal ash. All soil sample test results were below health comparison values used to determine unacceptable risk. All surface soil sampling test results were similar to what would be expected for Tennessee soil background levels. Therefore, exposure to surface soil by accidentally swallowing, breathing dust, or skin contact at the Swan Pond Recreation Areas is not expected to harm the health of children using these areas.

Recommendation

Our recommendation is to use the Swan Pond Recreation Areas for their intended purposes.

Public Health Action Plan

This public health action plan for the Swan Pond Recreation Areas contains a list of actions that have been or are planned to be taken by TDH EEP and other agencies. The purpose of the public health action plan is to offer a plan of action designed to mitigate and prevent harmful health effects that result from exposure to hazardous substances in the environment. Included is a commitment on the part of TDH EEP to follow up on this plan to ensure it is implemented.

TDH EEP Actions Completed:

- Attended two RCERB meetings to understand the requests of the community and the RCERB to investigate the soccer fields for the potential for coal ash to exist beneath the grass fields and in other nearby areas. Representatives from TDH along with TDEC met with RCERB members on January 3, and April 4, 2019, to discuss ways to investigate and respond to questions about the proposed work plan to investigate soil at the in the areas of concern.

- Prepared a soil investigation work plan jointly with TDEC to find out if coal ash was present in soil at the Swan Pond Recreation Areas.

- Prepared this health consultation to evaluate and explain surface soil test results from the Swan Pond Recreation Areas. TDH EEP also evaluated the levels of metals and radionuclides in the soil against health comparison values.

TDH EEP Actions Planned:

- Provide copies of this health consultation to Roane County citizens, the Roane County Environmental Review Board, TDEC, state and local governmental officials, and TVA.

- Be available to and maintain dialogue with Roane County citizens, the Roane County Environmental Review Board, TDEC, the Roane County Health Department, Roane County public officials, and TVA should they have questions about this health consultation.

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Report Preparation

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Prior to publication, this health consultation was reviewed and comments provided by staff in the Tennessee Department of Health listed below. Similarly, staff from the Tennessee Department of Environment and Conservation listed below reviewed and provided comments.

Neither the Tennessee Valley Authority nor the Roane County Environmental Review Board reviewed, provided input, or was given the opportunity to provide comments about this health consultation. We thank Roane County Parks and Recreation for providing access to the soccer fields for the soil sampling. We also thank TVA for allowing access to TDEC and TDH staff for the soil sampling.

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Appendix A.

Sampling and Analysis Work Plan for the Roane County Athletic Fields and Associated Areas

Surface Soil Sampling

Work Plan

Roane County Athletic Fields and Associated Areas

Swan Pond Circle Road

Kingston, Tennessee

Prepared for the Roane County Environmental Review Board

by the

TN Department of Health

and the

TN Department of Environment & Conservation

Nashville, Tennessee

May 2, 2019

Introduction

This Surface Soil Sampling Work Plan (Work Plan) was prepared by the Tennessee Department of Health (TDH) and the Tennessee Department of Environment and Conservation (TDEC) to protect the health of children who use Roane County's Swan Pond Sports Complex and nearby areas. This Work Plan is an outcome of a meeting of the Roane County Environmental Review Board (RCERB) with TDH and TDEC on January 3, 2019. The RCERB shared citizen concerns about the safety of the Athletic Fields and Associated Areas being close to where the Tennessee Valley Authority (TVA) Kingston Coal Ash Release happened on December 22, 2008, covering approximately 300 acres as shown in Figures 1 and 3.

As part of the cleanup and rehabilitation of the areas affected by coal ash, TVA created:

- Athletic Fields,
- a Festival Field,
- Walking Trails,
- a Birdwatching Area, and
- Lakeshore Park.

These community amenities are shown in Figures 2, 3, and 4. Some people expressed concern coal ash could have spilled onto these areas or have been blown by the wind onto these areas. Testing surface soils of 0 to 3 inches depth will generate data that will be used to assess soil-related exposure to children using the fields. The 0 to 3 inch layer of soil represents the layer of soil children may be exposed to during recreational activities like running in cleats, kicking, and sliding.

Both TDH and TDEC are charged with protecting the health of the citizens of Tennessee. This Work Plan provides a sampling, collection, and analysis recommendation that will provide the environmental data needed to evaluate the Roane County Athletic Fields and Associated Areas for public recreational use. This Work Plan was designed to allow for flexibility in case adjustments and changes need to be made as field work progresses. As this Work Plan was written by both agencies, changes to this Work Plan will also be agreed to by TDH and TDEC.

Health and Safety

Prior to the collection of environmental samples, a Health and Safety Plan (HASP) consistent with OSHA requirements will be created. At a minimum, the HASP will detail safe operating guidelines and personal protective equipment (PPE). Personnel will be made aware of the HASP and provided appropriate PPE for all work activities. Personnel conducting field sampling will be qualified to collect samples, have completed safety training, understand safety procedures, and wear PPE. Additional HASP Supplements will be prepared about changes in the scope of work

or site conditions. The HASP and Supplements will be reviewed and acknowledged by all personnel involved.

Figure 1. TVA's Kingston Coal Ash Release in December 2008. View is looking south at the breached containment dike area. Note the coal ash spilled into the Emory River toward where Roane County's Swan Pond Sports Complex is now located. Image source: TVA

Figure 2. Athletic Field in January 2019. Note the proximity to TVA Kingston. Source: TDH

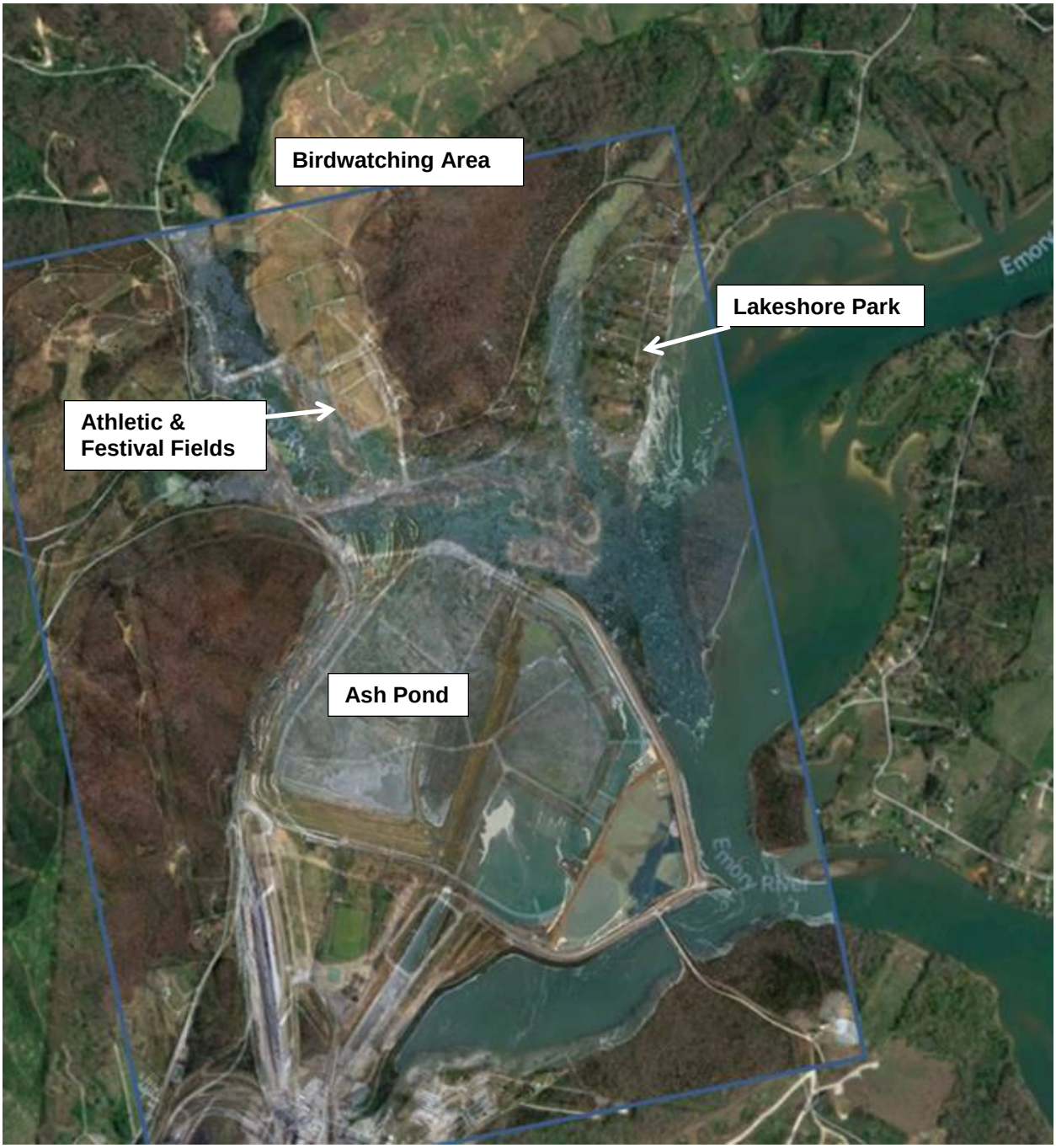

Figure 3. Overlay of the extent of TVA Coal Ash Release with the closed coal ash pond and Athletic & Festival Fields, Birdwatching Area, and Lakeshore Park areas noted.
Sources: TVA 2008 and Google Earth 2019

Figure 4. Aerial view of Festival Field (green area in lower center) and Athletic Fields (tan areas in center). Walking Trail is to the left and Birdwatching Area at top. Source: Google Earth 2019

Soil Sampling Equipment Decontamination

Before the collection of soil samples, equipment will be decontaminated in accordance with at least these generally-accepted environmental industry procedures. Decontamination may be performed offsite. If field decontamination of sampling equipment is required, a decontamination area will be established away from and upwind from the sampling area. Plastic sheeting or a similar barrier will be placed on the ground to protect this area assuring that it will not be spoiled by site work. Personnel will don appropriate PPE for decontamination activities, including clean nitrile gloves. Equipment will be washed with potable water and laboratory grade detergent using a brush to remove particulates or films. Equipment will be triple rinsed with deionized water.

Surface Soil Sampling and Analysis

This Work Plan describes collection of surface soil samples at the two Athletic Fields, the Festival Field, along the Walking Trail, and at Lakeshore Park to evaluate these places for public recreational use. Surface soil sampling details provided in Table 1.

Table 1. Suggested Surface Soil Sampling Locations and Sampling Details

Location	Minimum Number of Samples	Sample Type	Sample Depth	Description
Athletic Fields	24	Composite (minimum of 5 aliquots)	0-3 inches	Divide the Athletic Fields into 16 blocks and collect a soil sample per block. Bias sample aliquots to distressed and high activity areas such as centerfield and in front of goals. Collect 6 more samples from sidelines where spectators watch, restrooms, and concessions area. Includes 2 duplicate samples for quality control.
Festival Field	6	Composite (minimum of 5 aliquots)	0-3 inches	Divide the field into 6 blocks and collect a composite soil sample in each block.
Walking Trail	3	Composite (minimum of 5 aliquots)	0-3 inches	Collect 3 soil samples along Walking Trail from Swan Pond Road to Birdwatching Area.
Lakeshore Park	3	Composite (minimum of 5 aliquots)	0-3 inches	Collect 3 soil samples in areas frequented by visitors near picnic tables, at canoe launch, along walking trails, or fishing areas.

It would be beneficial to determine if coal ash is present in surface soils at the recreational areas. Polarized light microscopy (PLM) can determine the percent of ash in a soil sample. A separate soil sample for PLM will be made from the composited soil from each individual location at all soil sample locations.

For all soil samples, sample depth will be 0 to 3 inches under the sod, organic, or grass layer. This depth represents the layer of soil children may be exposed to during recreational activities like running in cleats, kicking, and sliding. Soil samples will contain soil; not grass or gravel. Soil samples will be composited from at least five aliquots of equal volume. The soil samples need not be completely random, there should be a focus on distressed areas, places where children play, or places where people congregate. The GPS coordinates of the general middle of each composite sample will be recorded.

The Athletic Fields will have the most surface soils tested. Both large athletic fields will be divided into eight approximately equal blocks to ensure soil sampling was performed in all parts of each field. This will ensure the smaller soccer fields will have been evaluated as the fields are configured for different age players. Samples will be collected from any worn areas such as centerfield or in front of the goal areas. Off-field samples will be focused in areas where children may play or sit. Note that TDEC will not rehabilitate the athletic fields after soil samples have been collected.

A minimum of one (1) soil sample per block, or sixteen (16) composite surface soil samples, will be collected from the Athletic Fields. Six (6) additional composite surface soil samples will be collected near high foot traffic areas such as the sidelines where children sit or stand, by the restrooms, and concessions area. Figure 5 illustrates this sampling plan.

The Festival Field will be divided into blocks with a minimum of six (6) composite surface soil samples collected across the area.

Walking Trail composite surface soil will be sampled at a minimum of three (3) locations along the trail from Swan Pond Road northward toward the Birdwatching Area.

Lakeshore Park composite surface soil samples will be collected at a minimum of three (3) locations in high use areas such as near picnic tables, canoe launch, walking trails, or fishing areas.

Composite surface soil samples should be easy to collect, though environmental samples may be adjusted based on observations and physical conditions encountered and the ability for personnel to safely collect a sample.

Sample Homogenization

TDEC will collect the composite samples and homogenize the samples prior to filling TDEC's and TVA's sample bottles. The TDEC sampler will collect at least 5 similarly sized aliquots which will be thoroughly mixed to ensure that the composite sample is as representative as possible prior to filling sample jars. Field homogenization will be done by TDEC according to United States Environmental Protection Agency Region 4's Soil Sampling Operating Procedure Number SESDPROC-300-R3 using the method of quartering (also known as pan mixing).

For the composites, the aliquots are to be placed in a glass or plastic HDPE homogenization container. For the quartering method, place each aliquot separately in a glass, ceramic or plastic HDPE mixing pan. Thoroughly mix each aliquot separately with a plastic scoop until the appearance is consistent across the entire aliquot. Thoroughly mix the collected aliquots together in a glass, ceramic, plastic HDPE mixing pan until the appearance is consistent across the entire sample. Separate the mixed sample into four quarters and repeat the process two more times.

This homogenization procedure is consistent with TVA's Soil and Sediment Sampling Technical Instruction (ENV-TI-05.80.50) used for Environmental Investigation Plan (EIP) work occurring at Kingston Fossil Plant.

The homogenized sample should then be placed in TDEC's and TVA's appropriate labeled containers by using the alternate shoveling method which involves placing a spoonful of soil in each container in sequence and repeating until the containers are full or the sample volume has been exhausted. Threads on the container and lid should be cleaned to ensure a tight seal when closed.

Soil Sample Description and Photography

The lithology, observed particle size, color and other observations of one aliquot per composite sample will be described in detail and color photographed. If the sample includes several layers, identify and describe each layer separately. In addition, a clean cut exposing in place lithology and layers for all aliquots in a composite sample will be made and color photographed noting any layering, change in lithology, and thickness of observed layers in detailed field notes. Observations from the in-place description will be correlated with the detailed sample description described above to assure each layer is individually identified and described. If there are observed changes in lithology between aliquots of an individual composite sample, describe and photograph additional aliquot samples and in place lithology sufficient to demonstrate the variability.

Figure 5. Orange dots represent approximate suggested surface soil sampling locations for Athletic Fields, Festival Field, and Walking Trail to ensure areas are safe for public recreational use. Image source: Google Earth 2019

Figure 6. Orange dots represent approximate suggested surface soil sampling locations for Lakeshore Park. Image Source: Google Earth 2019

Both the GPS coordinates and the rationale for the locations for the three samples in Lakeshore Park are provided below in Table 2.

Table 2. GPS Coordinates and Location Rationale for Proposed Lakeshore Park Samples

Sample ID	GPS Coordinates	Sampling Rationale
Lakeshore Park Sample #1	35° 54'55.1" N 84° 30'13.6" W	Area where shore fishing is possible; evidence of recent fishing activity (i.e., discarded trash and bare soil)
Lakeshore Park Sample #2	35° 55'04.9" N 84° 30'16.9" W	Shore fishing/swimming access near trail bridge; evidence of recent activity (i.e., discarded trash and bare soil)
Lakeshore Park Sample #3	35° 55'01.2" N 84° 30'10.0" W	Picnic table area located near walking trail close to road

Soil Sample Collection, Storage, and Analysis

Clean nitrile gloves will be donned prior to collection of each new soil sample. Soil samples will be collected from the 0 to 3 inches under the sod, organic, or grass layer using a decontaminated stainless steel trowel, spoon, or hand auger. Samples will be composites of at least 5 aliquots. The bulk soil sample will contain only soil. Rocks, sticks, or grass will be removed. Samples will be collected in laboratory-supplied sample jars appropriate for analysis. Sample location GPS coordinates will be recorded. Sampling holes will be backfilled and tamped with clean soil similar to original material.

Sample containers will be filled as much as possible. Once filled, the rim and threads will be wiped with a clean paper towel and capped, ensuring the cap is secure. Following collection, the sample will be labeled using a waterproof marker. Sample labels will include the sampler's initials, location, collection time and date, and custody seals. This information will also be recorded in field notes and on chain-of-custody sheets.

All samples will be placed in re-sealable plastic zipper-type bags then placed in an upright position on wet ice in a poly lined cooler. Ice will be sealed in double plastic bags. Sample temperature will be maintained below 4°C. Samples will be transported under chain-of-custody in sealed coolers to the designated laboratory. The temperature of the samples will be recorded upon arrival at the laboratory to assure that the appropriate sample temperature was maintained during shipment. Samples will be analyzed within their respective holding times.

A list of metals, metalloids, and radionuclides for which the surface soil samples will be analyzed is provided in Appendix A. This list matches the Federal Coal Combustion Residuals rule framework for the TDEC Commissioner's Order No. OGC15-0177. Adherence to this framework aligns with investigative studies being conducted by TVA as part of the Environmental Investigation Plan and would allow soil analysis results to be compared to TVA data generated through these collection efforts.

TVA will use the laboratories in Table 3 for the soil analysis.

Table 3: TVA Contracted Analytical Laboratories

Parameter	Laboratory	Facility Address
Metals, General Chemistry Parameters	Test America Laboratories, Inc.	2960 Foster Creighton Drive, Nashville, TN 37204
Radiological Parameters	Test America Laboratories, Inc.	13715 Rider Trail North, Earth City, MO 63045
Percent Ash	R.J. Lee Group	50 Hochberg Road, Monroeville, PA 15146

TDEC will use the laboratories in Table 4 for the soil analysis.

Table 4: TDEC Contracted Analytical Laboratories		
Parameter	**Laboratory**	**Facility Address**
Metals, General Chemistry Parameters	Pace Analytical	1241 Bellevue Street, Suite 9 Green Bay, WI 54302
Radiological Parameters	GEL Laboratories	2040 Savage Road Charleston, SC 29407
Percent Ash	Subcontract to EMSL Analytical, Inc.	200 Route 130 North Cinnaminson, NJ 08077

Comparative Results Analysis to Historical Background Data

In addition to comparing soil analysis results to Kingston Fossil Plant EIP background soil results, the composite sampling results will be compared to data collected for Department of Energy – Oak Ridge National Laboratory (DOE-ORNL) Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) site Remedial Investigations and Feasibility Studies. The DOE-ORNL data has been accepted by TDEC previously as representative to the area around Kingston.

Soil Sampling Quality Assurance / Quality Control (QA/QC)

Quality Assurance / Quality Control for soil samples will include two (2) duplicate samples collected from locations in the Athletic Fields. Two equipment blanks will be included. TVA's Field Sampling Quality Control Technical Instruction (ENV-TI-05.80.04) requires one equipment blank for twenty samples and there are thirty-six samples that will be collected. One field blank will be collected. This will be done by pouring deionized water into a certified clean, laboratory-provided container as close to a sampling area as is reasonable. This QC is consistent with Kingston EIP. One equipment blank will be included. All soil samples will be submitted to the laboratory under chain-of-custody control and analyzed within the respective holding time for each method. TDEC will require a Level 3 data package for the laboratory analysis of the surface soil samples. This is the typical data package provided by the state of Tennessee's Health Department Laboratory, who will perform the analysis of the soil samples. TVA will require a Level 4 data package for the laboratory analysis of their split samples, which is consistent with all data validation done for the Kingston EIP. Level 4 data review increases confidence in the reported results. A Level 3 data package will be completed for the laboratory analysis of the surface soil samples.

Inhalation Exposure

Analytical soil results will be screened to determine whether sampled soils can be an inhalation threat to recreational users of the athletic fields and associated areas. For many of the inorganics on the Appendix A analyte list USEPA residential inhalation soil screening levels are available. The USEPA's inhalation soil screening levels for inorganics are back-calculated from acceptable outdoor ambient air concentrations using the Particulate Emission Factor (PEF). The use of residential soil screening levels will be protective of recreational users of the athletic fields and associated areas.

If soil concentrations are above residential inhalation soil screening levels then additional assessment of soil data will be conducted to determine site related inhalation risk to recreational users of the park. In addition, collected polarized light microscopy (PLM) data will be examined from all soil samples. If it is determined that potentially unacceptable inhalation risk to recreational users is present and if percentage ash exceeds 20% in any sample (indicating ash is present above background levels), TDEC's Division of Air Pollution Control will be consulted to determine if air sampling is warranted.

Site Report

A site report will be written to describe the scope of work performed. At a minimum, the site report will present sample collection and analytical methods, field observations, any changes to the sampling plan, map of sampling locations, photographs, sample GPS locations, data tables of analytical results with comparisons to detection and reporting limits, as well as comparisons to inhalation soil screening levels and background concentrations, and basic interpretation. Data tables will also include laboratory notations, statistical ranges, means, and 95% upper confidence levels of each area sampled.

Next Steps

The Tennessee Department of Health's Environmental Epidemiology Program will prepare a written evaluation of the environmental data.

Soil testing described in this Work Plan checks for exposure to those using the fields for recreational use like running in cleats, kicking, and sliding. If deeper soil testing is desired by Roane County, then the same methodology may be used by Roane County to collect deeper soil samples.

Appendix A – List of Analytes For Surface Soil

Matches List of Federal Coal Combustion Residuals (CCR) Investigation Constituents

40 CFR Part 257 Appendix III Constituents – Limits for TVA Contracted lab

Analyte	Method	Method Detection Limit	Units
Boron	SW-846 6020A	1.35	mg/kg
Calcium	SW-846 6020A	8.95	mg/kg
Chloride	SW-846 9056A Modified	3.88	mg/kg
Fluoride	SW-846 9056A Modified	0.68	mg/kg
pH	SW-846 9045D Modified	0.1	Standard Units
Sulfate	SW-846 9056A Modified	6.79	mg/kg

40 CFR Part 257 Appendix IV Constituents – Limits for TVA Contracted lab

Analyte	Method	Method Detection Limit	Units
Antimony	SW-846 6020A	0.062	mg/kg
Arsenic	SW-846 6020A	0.026	mg/kg
Barium	SW-846 6020A	0.128	mg/kg
Beryllium	SW-846 6020A	0.0075	mg/kg
Cadmium	SW-846 6020A	0.0170	mg/kg
Chromium	SW-846 6020A	0.083	mg/kg
Cobalt	SW-846 6020A	0.0083	mg/kg
Fluoride	SW-846 9056A Modified	0.68	mg/kg
Lead	SW-846 6020A	0.035	mg/kg
Lithium	SW-846 6020A	0.276	mg/kg
Mercury	SW-846 7471 B	0.0143	mg/kg
Molybdenum	SW-846 6020A	0.163	mg/kg
Selenium	SW-846 6020A	0.122	mg/kg
Thallium	SW-846 6020A	0.025	mg/kg
Radium 226 and 228, Combined	EPA 901.1/Calculated	1.00	pCi/g

TN Rule 0400-11-01-.04 Appendix 1 Inorganic Constituents* – Limits for TVA Contracted Lab

Analyte	Method	Method Detection Limit	Units
Copper	SW-846 6020A	0.113	mg/kg
Nickel	SW-846 6020A	0.0610	mg/kg
Silver	SW-846 6020A	0.0270	mg/kg
Vanadium	SW-846 6020A	0.0640	mg/kg
Zinc	SW-846 6020A	0.334	mg/kg

* Constituents not listed in Federal CCR Appendices III and IV

Include Polarized Light Microscopy (PLM) for all soil-sampling locations (reporting limit 1%).

TDEC's Contracted Laboratory Analytes with Test Method and Laboratory Analysis

Analyte	Method	Method Detection Limit	Units
Chloride	EPA 300.0	5	mg/kg
Fluoride	EPA 300.0	1	mg/kg
Sulfate	EPA 300.0	10	mg/kg
Antimony	EPA 6020	0.16	mg/kg
Arsenic	EPA 6020	0.27	mg/kg
Barium	EPA 6020	0.22	mg/kg
Beryllium	SW-8466020A	0.140	mg/kg
Boron	EPA 6020	7.49	mg/kg
Cadmium	EPA 6020	0.10	mg/kg
Calcium	EPA 6020	185.521	mg/kg
Chromium	EPA 6020	0.60	mg/kg
Cobalt	EPA 6020	0.087	mg/kg
Copper	EPA 6020	0.39	mg/kg
Lead	EPA 6020	.018	mg/kg
Lithium	EPA 6020	0.14	mg/kg
Molybdenum	EPA 6020	0.20	mg/kg
Nickel	EPA 6020	0.26	mg/kg
Selenium	EPA 6020	0.18	mg/kg
Silver	EPA 6020	0.09	mg/kg
Thallium	EPA 6020	0.11	mg/kg
Vanadium	EPA 6020	0.42	mg/kg
Zinc	EPA 6020	6.97	mg/kg
Mercury	SW-846 7471B	0.003126	mg/kg
pH at 25 Degrees C	SW-8469045 D	0.01	Std. Units
% Coal Ash	R.J. Lee SOP OPT23.02	1.0	%

Appendix B.

TDEC Swan Pond Soil Sampling Report

Introduction

Following a request received from the Roane County Mayor through the Roane County Environmental Review Board (ERB) about the safety of the fields for children playing AYSO soccer, TDEC worked with the Tennessee Department of Health (TDH) to create a sampling plan to assess inhalation exposure to children playing on or around the athletic and festival fields.

The original request from the Roane County mayor indicated that community complaints were focused on residual coal ash being present on the fields, either remaining following the remediation activities or blowing from trucks that were hauling the released coal ash after the spill. The community was concerned that children could be exposed to coal ash and its many components while playing on or using the Swan Pond Complex Recreational Area.

Employees from TDEC's Division of Remediation (DoR) conducted a site visit in March 2019 to view the complex and determine how the area should be divided for sampling. During this visit, the Swan Pond Recreational Complex was walked, including the bird watching area, adjacent trail and the athletic and festival fields. Each area was observed for worn patches of grass, bare soil or other indications of heavy use.

On April 29, prior to the start of sampling activities, employees from DoR visited Lakeshore Park in an effort to determine where the three samples would be collected. The entire park was canvassed and three potential sampling areas were marked based on use and activity in the area.

The sampling event occurred Monday, May 6 through Wednesday, May 8, 2019; representatives from both Tennessee Valley Authority (TVA) and TDEC were onsite during all sampling activities; however, only TDEC staff collected samples in the field. Following collection, samples were brought back to the pavilion for processing, which included splitting samples with TVA.

This document describes the sampling methodology, including selection of sampling locations, obtaining GPS coordinates and the collection of samples, as well as the splitting and shipment of samples to respective laboratories for analysis and the results. As appropriate, pictures taken during the collection of the samples will be included to provide additional perspective and context.

Sampling Methodology

To evaluate the safety of the area, a comprehensive approach was taken. This approach divided the larger area into smaller activity areas. A pre-determined number of soil samples were collected from each activity area, based on the frequency of use as well as the potential for exposure; these areas included the athletic fields, the festival fields, the birdwatching trail and Lakeshore Park. Each area will be described in additional detail below.

Clean nitrile gloves were used for the collection of each new soil sample. Soil samples were collected from the 0 to 3 inches under the sod, organic, or grass layer using a decontaminated stainless steel trowel. Samples were composites of nine aliquots. The bulk soil sample will contain only soil; all rocks, sticks, or grass were removed. Samples were collected in laboratory-supplied sample jars appropriate for analysis. All sampling holes were backfilled with any remaining soil after all sampling vials had been filled or clean soil similar to original material (i.e., playground sand).

All samples collected were composed of 9-point composite aliquots, each aliquot being collected from within the sample grid. As each aliquot was collected using a stainless steel trowel and added to the stainless steel bowl, the sample was continuously mixed to homogenize the aliquots.

Field sampling was conducted by four DoR staff, working in two teams of two. This allowed one person to remove the top layer of grass and collect the sample, while another person maintained the composite sample in a stainless steel bowl and counted the aliquot number. The second person was also responsible for capturing the time the sample was collected and ensuring the sample was taken back to the pavilion where two additional DoR staff were waiting to transfer the collected soil into laboratory approved sampling vials and complete chain of custody forms.

Sample teams changed gloves between the collection of each 9-point composite sample and a new stainless steel bowl and trowel were used for each sample. Highly colorful and reflective safety vests were also worn by all staff (DoR and TVA) on the fields at any time. Additionally, TVA requested that staff collecting samples within 6 feet of a body of water also wear a life preserver; life preservers were worn during the collection of Samples #33 and 34 in Lakeshore Park.

Additionally, each morning prior to the start of sampling, TVA hosted a safety briefing where the inherent dangers associated with sampling were discussed. All persons at the complex during sampling activities were asked to sign in to account for their attendance. On the first day of sampling (Monday, May 6) representatives from TVA, DoR, the Roane County ERB and Roane County Parks and Recreational Department were on site; representatives from the ERB were there to watch sampling activities. On Tuesday, representatives from TVA, DoR (both field staff and Central Office staff), TDH and Roane County Parks and Recreational Department were present. On Wednesday, only representatives from TVA and DoR field staff were on site.

Following the completion of the safety briefing, DoR field staff began gridding off the athletic field with brightly colored nylon twine. The field was gridded into 16 equal areas, approximately 90 feet by 150 feet each. Once gridded, sampling commenced with the collection of Sample # 1.

Athletic Fields

Sixteen samples (Samples #1-16) were collected on the athletic fields. These fields were used for AYSO soccer during the season until January 2019, when Roane County determined the fields needed to be closed to the public until they could be evaluated for any risk to children playing on

the fields. At that time, the fields were closed off to the public and only the walking trail connecting the bird watching area to Lakeshore Park was available for use by the public.

During a visit to the site in March to perform reconnaissance in preparation for sampling, TDEC observed the athletic fields were separated into two larger fields- the first one had at least five different smaller soccer field configurations (for various youth age groups) while the second field looked to be used as a practice field or full-size field for older players. During that visit, it was determined that sampling would be biased to areas where children would reside for longer periods during games (i.e., goals as well as worn patches of grass). However, when sampling actually occurred in May, the growth of the grass on the field prevented the team from identifying areas of high use; therefore, it was decided to just grid off the athletic fields into 16 equal areas and collect 9-point composites from each area. The numbering of the sampling squares following gridding of the fields is depicted in Figure 1 and the GPS coordinates collected from each sampling location are included in Table 1.

Photo 1. *Picture of soil following collection of a single aliquot for Sample # 1 on the Swan Pond Complex Athletic Fields on Monday, May 6, 2019.*

Photo 2. *Photo of soil attached to grass following the removal of the surface layer at the Swan Pond Complex Athletic Field on Monday, May 6, 2019.*

Photo 3. *Bowl following collection and homogenization of 9-point composite sample # 1. Photo taken on Monday, May 6, 2019.*

Photo 4. *Pin flag marked for sample #1.Photo taken on Monday, May 6, 2019.*

Photo 5. *Collection of sample #2 on the Swan Pond Complex Athletic Field on May 6, 2019. A second sampling team collects another sample in the background.*

Photo 6. *Samples in lab analysis jars during sample splitting with TVA. Each sample was sent for analysis of the following contaminants- metals, Radium 226 and 228, fluoride, sulfide and chloride and Polarized Light Microscopy (PLM). Photo taken Monday, May 6, 2019.*

High Traffic Areas

Eight additional samples (Samples #17-24) were collected around the athletic fields in high traffic areas, or areas where children or adults may gather. This includes areas near or around the concession stand, the restrooms, the pavilion as well as the sidelines for the athletic fields. Depending on the configuration of the fields during play, parents and younger siblings may watch from the sidelines; therefore, these areas were considered high traffic areas and were sampled to evaluate safety from the presence of coal ash or any of its constituents to those not playing soccer but still spending time at the Swan Pond complex Athletic Fields.

For each sample collected in a high traffic area, the 9-point composite sample was collected across the length of the sideline; this ensured an evaluation of the actual exposure could be assessed.

Photo 7. *Determination of GPS coordinates for Sample #21. Photo taken Tuesday, May 7, 2019.*

Photo 8. *Sampling team collecting composite sample # 22, in the drainage swale on the western most boundary of the athletic field. Photo taken Tuesday, May 7, 2019.*

Festival Fields

Six samples (samples #25-30) were collected from the festival field area. Prior to the collection of samples, the festival field was broken down into six equal areas and gridded off using twine. A flag pin with the sample number clearly marked was visually set at the approximate center of each grid area. The GPS coordinates for each sample was collected from this flag pin location.

As the festival field was overgrown due to not being maintained since the closure of the park at the beginning of the year, which made identifying worn areas difficult; therefore, 9-point composite samples were randomly collected from each area.

Photo 9. *Bowl following 9-point composite sample collected for Sample #25. Photo taken Tuesday, May 7, 2019.*

Walking Trail (from Swan Pond Road to Birdwatching area)

Three samples (samples #31-33) were taken from along the entire distance of the walking trail. The trail runs adjacent to the southern border of the athletic and festival fields and runs approximately a mile between the entrance to the Swan Pond Recreational complex and the bird watching area. After walking the trail and looking for any obvious signs of wear/use adjacent to the trail, TDEC settled on three locations- the first (Sample #31) was taken directly around a park bench placed behind the festival field; a second sample (Sample #32) was collected in between the athletic and festival field, in a level area that can be accessed from both the fields and walking trail. This area was selected as there was evidence that it is used frequently (i.e., bike tire tracks and dog paw prints); finally, a third sample (Sample #33) was collected from a second park bench directly off the trail closer to the bird watching area.

Similar sampling procedures were followed with the collection of these samples. Any additional details from the sampled areas are included in the notes section of Table 1.

Photo 10. *Location for collection of Sample #31. This is the eastern most park bench on the walking trail, closest to the entrance to the Swan Pond Athletic Complex. Directly behind the park bench is the Festival Field that was also sampled during this event. Photo taken Wednesday, May 8, 2019.*

Photo 11. *Scenery directly in front of the park bench where Sample #31 was collected. There is water, fish and birds to watch from the park bench. Photo taken Wednesday, May 8, 2019.*

Photo 12. *Location for collection of Sample # 32. This is an area approximately at the midpoint of the walking trail (between the entrance to the Swan Pond Athletic Complex and the bird watching area). This area included bare spots and is easily accessible to people coming from the athletic fields following games. Photo taken Wednesday, May 8, 2019.*

Photo 13. *Flag indicating the area for collecting Sample #32. In the background, both the concession stand/restrooms (left) and the pavilion (right) on the other side of the Athletic Fields are observed. Photo taken Wednesday, May 8, 2019.*

Photo 14. *Close up of the bare dirt surrounding Sample #32. Bicycle tracks and dog paw prints were observed in the dirt, providing evidence that this area is frequented by people using the athletic fields. Photo taken Wednesday, May 8, 2019.*

Photo 15. *Location for the collection of Sample #33. This is the most west park bench along the walking trail; it is also the closest to the Bird Watching Trail area. Photo taken Wednesday, May 8, 2019.*

Photo 16. *View from the park bench location of Sample #33. The view is of the bird watching area with a parking lot in the back left portion of the photo. Photo taken Wednesday, May 8, 2019.*

Lakeshore Park

Three samples were collected in Lakeshore Park. Because the park was impacted by the release of coal ash following the release, TDEC staff wanted to ensure sites were chosen where people would be spending significant time and could potentially be exposed. As this park is large, with walking trails, fishing areas, boat launches and picnic areas, reconnaissance was performed to determine areas most commonly utilized by visitors that would result in exposure from residual coal ash constituents. The first area chosen for sampling (Sample #34) included the end of the paved walking trail, which culminated at the water. Evidence of shore fishing was identified here (i.e., discarded cans and food wrappers) as well as expended bait, proving that this area is popular with fishermen. GPS coordinates were taken and a yellow flag left to mark the sampling location.

A second area to the right of the bridge over the water was identified as another area where shore fishing is popular (Sample # 35). This area consisted of a flat, barren area of ground adjacent to the water. Evidence of recent fishing activities was also observed here. Finally, the last area identified for sample collection was the picnic area right off the main walking trail near the parking lot. This area (Sample # 36) could be used for picnics and grilling, as it is in close proximity to the water as well as the trail. A grill is nearby and the area looked like it had been used for this purpose recently.

Photo 17. *Lakeshore Park trail leading to the shore fishing where Sample #34 was collected. Photo taken Wednesday, May 8, 2019.*

Photo 18. *Sampling location for Sample # 34 in Lakeshore Park (targeted following evidence of shore fishing). The TVA Kingston Fossil Plant can be observed in the background. Photo taken on Monday, April 29, 2019.*

Photo 19. *Reconnaissance for sampling locations in Lakeshore Park. This area, adjacent to the bridge on the walking trail, was selected for Sample #35. There was also access to the water for shore fishing and evidence that the area had been utilized recently (discarded refuse found along shoreline). Photo taken on Monday, April 29, 2019.*

Photo 20. *GPS Coordinates to identify sampling location #36, around picnic table and area directly off of walking trail in Lakeshore Park. Photo taken on Monday, April 29, 2019.*

Figure 1. *Schematic showing the sampling numbers for all samples collected at the Swan Pond Athletic and Festival Fields in Harriman, TN.*

Table 1. *Samples collected during Swan Pond Athletic Complex sampling event May 6 to May 8, 2019 in Roane County. Reporting information includes the sample name, GPS coordinates, the time each sample was collected and any notes that assist in identifying the sampling locations.*

Sample ID	GPS Coordinates (± error)	Sample Collection Time	Notes
Day 1 (May 6, 2019)- Athletic Field			
RAF 01-0519 SF	N 35° 91'94.2" W 84° 51'19.4" (±23 ft)	12:00 pm	First sample collected
RAF 02-0519 SF	N 35° 91'92.8" W 84° 51'22.5" (±9 ft)	12:39 pm	
RAF 03-0519 SF	N 35° 91'92.2" W 84.51260° (±6 ft)	12:41 pm	Also collected an MS/MSD
RAF 04-0519 SF	N 35° 91'91.2" W 84° 51'27.8" (±11 ft)	13:01 pm	
RAF 05-0519 SF	N 35° 91'97.4" W 84° 51'21.3" (±17 ft)	13:11 pm	
RAF 06-0519 SF	N 35° 91'96.9" W 84° 51'24.4" (±6 ft)	14:33 pm	
RAF 07-0519 SF	N 35° 91'96.0" W 84° 51'27.5" (±7 ft)	14:32 pm	
RAF 08-0519 SF	N 35° 91'95.1" W 84° 51'30.4" (±8 ft)	15:15 pm	
Day 2 (May 7, 2019)- Athletic Field			
RAF 09-0519 SF	N 35° 92'01.6" W 84° 51'22.9" (±15 ft)	07:10 am	
RAF 10-0519 SF	N 35° 92'01.0" W 84° 51'26.1" (±24 ft)	07:12 am	
RAF 11-0519 SF	N 35° 92'00.2" W 84° 51'29.2" (±18 ft)	07:35 am	
RAF 12-0519 SF	N 35° 91'99.3" W 24° 51'32.1" (±20 ft)	07:38 am	
RAF 13-0519 SF	N 35° 92'08.8" W 84° 51'24.5" (±27 ft)	08:48 am	
RAF 14-0519 SF	N 35° 92'04.1" W 84° 51'28.2" (±20 ft)	08:49 am	
RAF 15-0519 SF	N 38° 92'03.6" W 84° 51'31.5" (±18 ft)	09:09 am	
RAF 16-0519 SF	N 35° 92'02.7" W 84° 51'33.4" (±16 ft)	09:08 am	Rinsate Bowl used for sample collection
RAF 17-0519 SF	N 38° 92'03.6" W 84° 51'31.5" (±18 ft)	10:30 am	Duplicate for RAF 15-0519
High Traffic Areas (near Pavilion, Concession Stand, Restrooms and watching areas along the sideline)			
RAF 18-0519 SF	N 35° 91'99.0" W 84° 51'18.6" (±14 ft)	10:37 am	Pavilion; GPS coordinates taken from SE corner of cement pad for pavilion

Sample ID	GPS Coordinates (± error)	Sample Collection Time	Notes
RAF 19-0519 SF	N 35° 92’03.7” W 84° 51’20.9” (±17 ft)	10:36 am	Coordinates taken from slab between concession stand and field
RAF 20-0519 SF	N 35° 92’03.7” W 84° 51’20.9” (±17 ft)	11:56 am	Duplicate for RAF 19-0519
RAF 21-0519 SF	N 35° 92’06.5” W 84° 51’30.5” (±18 ft)	12:31 pm	North Sideline
RAF 22-0519 SF	N 35° 91’98.6” W 84° 51’26.7” (±15 ft)	12:50 pm	Drainage Swell
RAF 23-0519 SF	N 35° 91’90.0” W 84° 51’24.0” (±15 ft)	12:55 pm	South Sideline
RAF 24-0519 SF	N 35° 92’00.4” W 84° 51’20.2” (±10 ft)	12:58 pm	East Sideline between Athletic and Festival Fields
Festival Field			
RAF 25-0519 SF	N 35° 91’87.2” W 84° 51’20.2” (±43 ft)	13:45 pm	Northeast corner of Festival Field
Day 3 (May 8, 2019)- Festival Field			
RAF 26-0519 SF	N 35° 91’86.0” W 84° 51’25.0” (±24 ft)	07:20 am	Northwest corner of Festival Field
RAF 27-0519 SF	N 35° 91’82.5” W 84° 51’19.2” (±15 ft)	07:22 am	North middle of Festival Field
RAF 28-0519 SF	N 35° 91’82.1” W 84° 51’24.4” (±21 ft)	07:45 am	South middle of Festival Field
RAF 29-0519 SF	N 35° 91’87.8” W 84° 51’18.0” (±20 ft)	07:46 am	Southeast corner of Festival Field
RAF 30-0519 SF	N 35° 91’78.4” W 84° 51’23.1” (±31 ft)	08:12 am	Southwest corner of Festival Field
Walking Trail (from Swan Pond Road to Bird Watching Area)			
RAF 31-0519 SF	N 35° 91’85.6” W 84° 51’31.1” (±16 ft)	09:08 am	Park Bench close to Swan Pond Road
RAF 32-0519 SF	N 35° 92’05.9” W 84° 51’38.5” (±15 ft)	09:10 am	Culvert from Athletic Field/North Parking Lot
RAF 33-0519 SF	N 35° 92’51.6” W 84° 51’49.7” (±24 ft)	09:37 am	Northern most park bench (close to birdwatching area)
Lakeshore Park			
RAF 34-0519 SF	N 35° 54’55.1” W 84° 30’13.6” (±22 ft)	11:40 am	Area where shore fishing is possible; evidence of recent fishing activity (i.e., discarded trash and bare soil)
RAF 35-0519 SF	N 35° 55’04.9” W 84° 30’16.9” (±7 ft)	11:54 am	Shore fishing/swimming access near trail bridge;

			evidence of recent activity (i.e., discarded trash and bare soil)
Sample ID	**GPS Coordinates (± error)**	**Sample Collection Time**	**Notes**
RAF 36-0519 SF	35° 55’01.2” N 84° 30’10.0” W (±12 ft)	12:03 pm	Picnic table area located near walking trail close to road

Sample Lithology

Each sample was characterized using lithology as the soils were collected. Initially, the goal was to photograph each sample and provide a written lithology; however, the soils were so similar in areas that this activity became redundant. Therefore, the lithology of the soils associated with areas (i.e., the athletic fields, high traffic areas, festival field and walking trail and Lakeshore Park will be discussed as entire areas, as the lithology was similar across samples.

Athletic Fields and High Traffic Areas

The 16 samples collected on the Athletic Fields at the Swan Pond Complex were all composed of brown to dark brown silty clay/clay silt, slightly sandy with minor amounts of rock fragments and/or gravel, and organics (Bermuda grass thatch and roots). This was also consistent with the six samples collected in the high traffic areas, as all were in close proximity to the athletic fields. Soils encountered during the collection of soil samples from soccer field’s soil surface to approximately 4 inches depth were sandy and apparently anthropogenic in nature, typical of a material that would be used to establish and maintain turf-grass for an athletic playing field. In some areas of the soccer fields this layer of sandy material was very thin and the material encountered beneath resembled the clayey subsurface soil materials typical of the sub-horizons of the soil series mapped in this area by the USDA-NRCS and presented in the Custom Soil Resource Report (U.S. Department of Agriculture 2019).

Festival Fields, Walking Trail and Lakeshore Park

Soil samples collected from the festival field (6 samples), walking trail (3 samples) and park area (3 samples) appeared to be comprised of the same clayey sub-horizon material described above and in some instances what appeared to be imported topsoil (possibly sourced on site). It is not possible to conclude if the materials observed represent a cut and/or filled area based upon such a small observational area to a depth of only 4 inches.

Sample Processing

As each sample was collected, it was brought to the pavilion at the Swan Pond Athletic Complex and processed into sampling containers for laboratory analysis. Each sample was also split with TVA, who had representatives at the site to process their individual samples. Sample containers

were filled with sampled material in a random pattern until all containers were filled after which the container threads were wiped with a clean paper towel and labeled. Sample labels included the sampler's initials, location, collection time and date, and custody seals. This information was also recorded in both field notes and on chain-of-custody sheets with a waterproof marker.

All samples were placed in re-sealable plastic zipper-type bags then placed in an upright position on wet ice in a poly lined cooler. Ice was sealed in double plastic bags. Sample temperature was maintained below 4°C. Samples were transported under chain-of-custody in sealed coolers to the designated laboratory. The temperature of the samples was recorded upon arrival at the laboratory to assure that the appropriate sample temperature was maintained during shipment. Labs confirmed receipt of the samples the next morning via email to TDEC. Samples were then analyzed within their respective holding times.

TDEC samples were analyzed by the laboratories described in Table 2 below.

Table 2. *TDEC Contracted Analytical Laboratories for analysis of the Swan Pond Athletic Complex samples.*

Parameter	Laboratory	Facility Address
Metals, General Chemistry Parameters	Pace Analytical	1241 Bellevue Street, Suite 9 Green Bay, WI 54302
Radiological Parameters	GEL Laboratories	2040 Savage Road Charleston, SC 29407
Percent Ash	Subcontract to EMSL Analytical, Inc.	200 Route 130 North Cinnaminson, NJ 08077

Samples split were analyzed by TVA for the same constituents of concern (COC) by contracted laboratories. Following the reporting of results, both TDEC and TVA had a data sharing meeting where analytical results from both agencies were shared and discussed prior to the drafting of the Health Consultation document by TDH.

References

United States Department of Agriculture (USDA). 2019. Natural Resources Conservation Service. Custom Soil Resource Report for Roane County, TN. TVA Athletic Fields and Park Area. August 12, 2019.

Appendix C.

Introduction to and Tables of Soil Results Compared to Tennessee Background Levels and ATSDR and EPA Comparison Values

Explanation of Soil Sampling Methods and Testing

One of the tests performed on the soil samples used polarized light microscopy (PLM). This test was done by EMSL Analytical, Inc. of Cinnaminson, NJ, to understand what percent, if any, of coal ash was present in the areas represented by each soil sample. Using the results of this test, we can tell how much coal ash has been mixed with the soil. Each soil sample was also tested for twenty (20) different metals commonly found in coal ash by Pace Analytical, Inc., of Green Bay, WI. The results were compared to average levels of these metals found in soils throughout Tennessee and the local area. Four other general chemistry properties tests were also performed on the samples. Tests for radium-226, radium-228, and cesium-137 were done by GEL Laboratories of Charleston, SC.

One (1) soil sample per block, or sixteen (16) separate composite soil samples, was collected from the athletic fields. Sample numbers were RAF-01 to RAF-16. RAF-17 is a duplicate sample of RAF-15. Seven (7) additional composite soil samples were collected near high foot traffic areas such as the sidelines where children could sit or stand and by the restrooms and concessions areas. RAF-20 is a duplicate of sample RAF-19. These samples were labeled RAF-18 to RAF-24. Sample RAF-20 was a duplicate for RAF-19 and was collected from the concession and rest room building area.

The festival field was divided into six (6) blocks with six composite soil samples collected across the area. These sample designations were RAF-25 to RAF-30.

Three (3) composite soil samples were collected at locations along the walking trail from Swan Pond Road northward toward the birdwatching area. Sample designations were RAF-31 to RAF-33.

Composite soil samples were collected from three locations in Lakeshore Park. Sample locations were labeled RAF-34 to RAF-36.

Each soil sample was tested for the list of parameters provided in Appendix A. This list matches the Federal Coal Combustion Residuals rule (CCR Rule) framework for the TDEC Commissioner's Order No. OGC15-0177 for the TVA site. Adherence to the CCR Rule framework aligns with investigative studies being conducted by TVA as part of the Environmental Investigation Plan for the site and would allow TDEC soil analysis results to be compared to TVA data produced through these collection efforts.

Metals test results were reported on a dry weight basis meaning the moisture content of the sample was measured by the testing laboratory. The testing laboratory then calculates test results based on the percent solids in the soil sample. Laboratories typically report soil test results on a dry weight basis.

The amounts of some metals in some samples are estimated and are “flagged” by the laboratory with a “J” next to the reported amount present. These “J-flagged” amounts mean the metal is present in the sample but the exact or specific amount of the metal could not be determined.

For a few metals, the results were reported as below the laboratory detection limit. This means the particular metal was either not present in the sample or it was present at very low levels, below the laboratory calibration level for the test. The levels of these metals are reported as less than the detection limit for the test (e.g. <0.19 mg/kg), with the detection limit for the test as the number noted.

Radionuclide test results are also reported on a dry weight basis. The result is a measure of the sample’s activity. The lowest and highest activity value for radium-226 and radium-228 for each area tested is reported. The radium-226 and radium-228 activities are reported as a number in picoCuries per gram (pCi/g) with a plus or minus value attached. The plus or minus value is the uncertainty value which can be added or subtracted from the reported value. The uncertainty indicates there is a 95% probability that the actual amount of activity in the sample is in the range of the activity result plus or minus the uncertainty value. An arithmetic mean was also calculated for each radionuclide for each area.

The laboratory also reported levels of cesium-137 even though it was not required by the work plan. Cesium-137 activity results are reported similar to those for radium-226 and radium-228.

Reported results were compiled and minimum and maximum levels were tabulated, and the arithmetic mean calculated and shown. Results were compared to naturally occurring Tennessee soil background levels (Kopp 2001), East Tennessee Technology Park soil background levels (Bechtel-Jacobs 2003), or mean published Tennessee background levels (Dragun and Chekiri 2005). Results were then compared to ATSDR or EPA comparison values to determine if results need further evaluation.

Tables of Soil Results Compared to Tennessee Background Levels and ATSDR and EPA Comparison Values

Table B-1. **Swan Pond Sports Complex Soccer Fields soil testing results.** Results are for radionuclides, total metals, and general chemistry properties in 17 samples. The highest levels for each radionuclide and metal measured were compared to background or naturally occurring levels and health comparison values published by ATSDR or EPA.

Chemical in Soil	Minimum Concentration Measured	Maximum Concentration Measured	Boring Location of Maximum Concentration	Arithmetic Mean	Tennessee Background Level[1]	ETTP Soil Background Values[2]	Selected Comparison Value (CV)	Source of Selected CV	Number of Locations at or above CV	Failed Screening Test
Radionuclides (pCi/g)										
radium-226	0.390±0.25	0.881±0.27	RAF-06	0.639±0.30	1.1*	1.25	2.48	EPA Total PRG[+]	0/17	No
radium-228	0.00±0.95 UI	1.87±0.62	RAF-11	0.932±0.53	NL	NL	2.24	EPA Total PRG	0/17	No
cesium-137	0.132±0.09	0.229±0.17	RAF-11	0.184±0.12	NL	NL	11.3	EPA Total PRG	0/17	No
Metals (mg/kg)										
antimony	<0.20	<0.22	RAF-09, RAF-13, RAF-17	<0.21	6.2	1.52	21	ATSDR Chronic RMEG (c)	0/17	No
arsenic	4.0	8.1	RAF-13	5.2	10	14.95	16 / 0.26	ATSDR Chronic EMEG (c) and CREG	17/17	Yes
barium	61.0	110	RAF-11	78.5	144	124.93	10,000	ATSDR Chronic EMEG (c)	0/17	No
beryllium	0.40 J	0.74 J	RAF-13	0.54	1.0	2.20	100	ATSDR Chronic EMEG (c)	0/17	No
boron	<8.9	<9.9	RAF-04	<9.4	55*	NL	10,000	ATSDR Chronic EMEG (c)	0/17	No
cadmium	<0.12	<0.37	RAF-06	<0.17	1.0	0.22 U	5.2	ATSDR Chronic EMEG (c)	0/17	No
calcium	912	2,070	RAF-11	1,410	NL	2,400	NA	(calcium is a requirement for the human body)	0/17	No
chromium	12.0	24.7	RAF-13	16.4	20	44.88	47 / 0.22	ATSDR Cr^{+6} Chronic EMEG (c) and CREG	17/17	Yes
cobalt	5.0	8.6	RAF-13	6.1	13	42.00	520	ATSDR Interm. EMEG (c)	0/17	No
copper	7.5	10.9	RAF-10	8.9	25	22.48	520	ATSDR Interm. EMEG (c)	0/17	No

Table B-1 continued. **Swan Pond Sports Complex Soccer Fields soil testing results.** Results are for radionuclides, total metals, and general chemistry properties in 17 samples. The highest levels for each radionuclide and metal measured were compared to background or naturally occurring levels and health comparison values published by ATSDR or EPA.

Chemical in Soil	Minimum Concentration Measured	Maximum Concentration Measured	Boring Location of Maximum Concentration	Arithmetic Mean	Tennessee Background Level[1]	ETTP Soil Background Values[2]	Selected Comparison Value (CV)	Source of Selected CV	Number of Locations at or above CV	Failed Screening Test
Metals										
lead	8.6	14.0	RAF-13	11.2	45	37.91	400	EPA Residential RSL	0/17	No
lithium	7.3	12.2	RAF-13	9.3	30*	48.94	160	EPA Residential RSL	0/17	No
molybdenum	0.35 J	0.70 J	RAF-09	0.59 J	0.79*	NL	260	ATSDR Chronic EMEG (c)	0/17	No
mercury	0.023 J	0.052	RAF-06	0.034 J	0.18	0.17	11	EPA Residential RSL	0/17	No
nickel	7.6	11.0	RAF-13	8.8	18	26.07	1,000	ATSDR Chronic RMEG (c)	0/17	No
selenium	2.1	3.4	RAF-07	2.5	1.2	1.47	260	ATSDR Chronic EMEG (c)	0/17	No
silver	<0.11	1.4	RAF-11	0.28 J	1.2	0.6 U	260	ATSDR Chronic RMEG (c)	0/17	No
thallium	<0.14	0.35 J	RAF-10	0.20 J	1.9	0.4 U	0.78	EPA Residential RSL	0/17	No
vanadium	18.9	34.2	RAF-13	24.7	31.8	65.47	520	ATSDR Interm. EMEG (c)	0/17	No
zinc	37.4	90.6	RAF-13	48.7	94	89.70	16,000	ATSDR Chronic EMEG (c)	0/17	No
General Chemistry Properties (mg/kg)										
pH	6.5	7.03	RAF-14	6.71	NA	NA	NA	NA	NA	No
chloride	<6.2	9.2 J	RAF-10	<6.6	NA	NA	NA	NA	NA	No
fluoride	1.4 J	2.8 J	RAF-08, RAF-12	2.4 J	NA	NA	NA	NA	NA	No
sulfate	<12.4	<13.5	RAF-13	<12.2	NA	NA	NA	NA	NA	No

Notes:

ATSDR EMEG = Agency for Toxic Substances and Disease Registry Environmental Media Evaluation Guide (ATSDR 2019). Chronic non-cancer exposure comparison values for an exposure greater than 365 days used to determine if chemical concentrations warrant further health-based screening.

ATSDR CREG = Estimated contaminant concentrations that would be expected to cause no more than one excess cancer in one million persons exposed during their lifetime. CREGs are calculated from EPA's cancer slope factors for oral exposures in this case. These values are based on EPA evaluations and assumptions about hypothetical cancer risks at low levels of exposure.

ATSDR RMEG = Reference Dose Media Evaluation Guide; ATSDR RMEG used as there was no Chronic EMEG available for the chemical.`

ATSDR Environmental Media Evaluation Guide (EMEG) and CREG for Hexavalent Chromium (Cr^{+6}) used to be cautious.

EPA Residential RSL = EPA residential Regional Screening Level for non-cancer hazard index of 1 and lifetime excess cancer risk of 1 in 1 million.

(c) = RMEG or EMEG represents that for a child exposure.

pCi/g = picoCuries per gram

mg/kg = milligrams per kilogram, equivalent to parts per million in soil

NA = not applicable

NL = no background level established for metal or compound

[1] = Tennessee naturally occurring background level as reported in Kopp 2001, Hazardous Trace Elements in Tennessee Soils. Values designated with * are mean of background soil values of compound in Tennessee soils from Dragun and Chekiri 2005, Elements in North American Soils 2nd Edition.

[2] = Soil Background Values from Soil Background Supplemental Data Set for the East Tennessee Technology Park, Oak Ridge, Tennessee, Bechtel Jacobs Company LLC, U.S. Department of Energy, September 2003

[+] = calculated EPA Preliminary Remediation Goal for radionuclide for 10^{-5} risk, or 1 in 100,000 lifetime excess risk of cancer

<6.3 = result is less than the detection limit (shown) of the test

J = estimated concentration of chemical

UI = results are considered a false positive due to high counting uncertainty

Table B-2. **Swan Pond Sports Complex Soccer Fields sidelines, concession, and pavilion areas soil testing results.** Results are for radionuclides, total metals, and general chemistry properties in 7 samples. The highest levels for each radionuclide and metal measured were compared to background or naturally occurring levels and health comparison values published by ATSDR or EPA.

Chemical in Soil	Minimum Concentration Measured	Maximum Concentration Measured	Boring Location of Maximum Concentration	Arithmetic Mean	Tennessee Background Level[1]	ETTP Soil Background Values[2]	Selected Comparison Value (CV)	Source of Selected CV	Number of Locations at or above CV	Failed Screening Test
Radionuclides (pCi/g)										
radium-226	0.353±0.23 U	0.741±0.26	RAF-18	0.551±0.25	1.1*	1.25	2.48	EPA Total PRG[+]	0/7	No
radium-228	0.782±0.50	1.37±0.49	RAF-20	0.988±0.48	NL	NL	2.24	EPA Total PRG	0/7	No
cesium-137	ND	ND	NA	NA	NA	NL	NA	NA	NA	NA
Metals (mg/kg)										
antimony	<0.19	<0.20	RAF-21, RAF-23, RAF-24	<0.19	6.2	1.52	21	ATSDR Chronic RMEG (c)	0/7	No
arsenic	3.8	5.1	RAF-19	4.6	10	14.95	16 / 0.26	ATSDR Chronic EMEG (c) and CREG	7/7	Yes
barium	51.9	97.1	RAF-19	74.7	144	124.93	10,000	ATSDR Chronic EMEG (c)	0/7	No
beryllium	0.28 J	0.51 J	RAF-23	0.41	1.0	2.20	100	ATSDR Chronic EMEG (c)	0/7	No
boron	<8.4	<9.1	RAF-21, RAF-23	<8.8	55*	NL	10,000	ATSDR Chronic RMEG (c)	0/7	No
cadmium	<0.11	<0.12	RAF-18, RAF-19, RAF-20, RAF-22	<0.11	1.0	0.22 U	5.2	ATSDR Chronic EMEG (c)	0/7	No
calcium	965	3,400	RAF-20	1,545	NL	2,400	NA	(calcium is a requirement for the human body)	0/7	No
chromium	14.4	18.1	RAF-20	16.5	20	44.88	47 / 0.22	ATSDR Cr^{+6} Chronic EMEG (c) and CREG	7/7	Yes
cobalt	3.8	7.1	RAF-23	5.0	13	42.00	520	ATSDR Interm. EMEG (c)	0/7	No
copper	7.6	10.8	RAF-19	9.2	25	22.48	520	ATSDR Interm. EMEG (c)	0/7	No

Table B-2 continued. **Swan Pond Sports Complex Soccer Fields sidelines, concession, and pavilion areas soil testing results continued.** Results are for radionuclides, total metals, and general chemistry properties in 7 samples. The highest levels for each radionuclide and metal measured were compared to background or naturally occurring levels and health comparison values published by ATSDR or EPA.

Chemical in Soil	Minimum Concentration Measured	Maximum Concentration Measured	Boring Location of Maximum Concentration	Arithmetic Mean	Tennessee Background Level[1]	ETTP Soil Background Values[2]	Selected Comparison Value (CV)	Source of Selected CV	Number of Locations at or above CV	Failed Screening Test
Metals										
lead	8.5	12.2	RAF-19	10.1	45	37.91	400	EPA Residential RSL	0/7	No
lithium	8.9	13.4	RAF-20	11.0	30*	48.94	160	EPA Residential RSL	0/7	No
molybdenum	0.39 J	0.63 J	RAF-21	0.46 J	0.79*	NL	260	ATSDR Chronic RMEG (c)	0/7	No
mercury	0.024 J	0.066	RAF-23	0.040 J	0.18	0.17	11	EPA Residential RSL	0/7	No
nickel	6.3	9.2	RAF-23	7.7	18	26.07	1,000	ATSDR Chronic RMEG (c)	0/7	No
selenium	1.4	1.9	RAF-22	1.7	1.2	1.47	260	ATSDR Chronic EMEG (c)	0/7	No
silver	<0.10	0.25 J	RAF-21	0.13 J	1.2	0.6 U	260	ATSDR Chronic RMEG (c)	0/7	No
thallium	0.16 J	0.21 J	RAF-21, RAF-23	0.19 J	1.9	0.4 U	0.78	EPA Residential RSL	0/7	No
vanadium	21.5	28	RAF-21	25.3	31.8	65.47	520	ATSDR Interm. EMEG (c)	0/7	No
zinc	22.7 J	45.4	RAF-22	34.5	94	89.70	16,000	ATSDR Chronic EMEG (c)	0/7	No
General Chemistry Properties (mg/kg)										
pH	6.3	7.13	RAF-22	6.73	NA	NA	NA	NA	NA	No
chloride	<5.7	9.4 J	RAF-22	7.5	NA	NA	NA	NA	NA	No
fluoride	1.4 J	2.1 J	RAF-21	1.7 J	NA	NA	NA	NA	NA	No
sulfate	<12.2	35.4	RAF-18	<23.2	NA	NA	NA	NA	NA	No

Notes:

ATSDR EMEG = Agency for Toxic Substances and Disease Registry Environmental Media Evaluation Guide (ATSDR 2019). Chronic non-cancer exposure comparison values for an exposure greater than 365 days used to determine if chemical concentrations warrant further health-based screening.

ATSDR CREG = Estimated contaminant concentrations that would be expected to cause no more than one excess cancer in one million persons exposed during their lifetime. CREGs are calculated from EPA's cancer slope factors for oral exposures in this case. These values are based on EPA evaluations and assumptions about hypothetical cancer risks at low levels of exposure.

ATSDR RMEG = Reference Dose Media Evaluation Guide; ATSDR RMEG used as there was no Chronic EMEG available for the chemical.

ATSDR Environmental Media Evaluation Guide (EMEG) and CREG for Hexavalent Chromium (Cr+6) used to be cautious.

EPA Residential RSL = EPA residential Regional Screening Level for non-cancer hazard index of 1 and lifetime excess cancer risk of 1 in 1 million.

(c) = RMEG or EMEG represents that for a child exposure.

mg/kg = milligrams per kilogram, equivalent to parts per million in soil

pCi/g = picoCuries per gram

NA = not applicable

NL = no background level established for metal or compound

ND = not detected in samples

[1] = Tennessee naturally occurring background level as reported in Kopp 2001, Hazardous Trace Elements in Tennessee Soils. Values designated with * are mean of background soil values of compound in Tennessee soils from Dragun and Chekiri 2005, Elements in North American Soils 2nd Edition.

[2] = Soil Background Values from Soil Background Supplemental Data Set for the East Tennessee Technology Park, Oak Ridge, Tennessee, Bechtel Jacobs Company LLC, U.S. Department of Energy, September 2003

[+] = calculated EPA Preliminary Remediation Goal for radionuclide for 10^{-5} risk, or 1 in 100,000 lifetime excess risk of cancer

<6.3 = result is less than the detection limit (shown) of the test

J = estimated concentration of chemical

U = analyte was analyzed for but not detected above method detection limits

Table B-3. **Swan Pond Festival Field soil testing results.** Results are for radionuclides, total metals, and general chemistry properties in 6 samples. The highest levels for each radionuclide and metal measured were compared to background or naturally occurring levels and health comparison values published by ATSDR or EPA.

Chemical in Soil	Minimum Concentration Measured	Maximum Concentration Measured	Boring Location of Maximum Concentration	Arithmetic Mean	Tennessee Background Level[1]	ETTP Soil Background Values[2]	Selected Comparison Value (CV)	Source of Selected CV	Number of Locations at or above CV	Failed Screening Test
Radionuclides (pCi/g)										
radium-226	0.646±0.30	0.954±0.38	RAF-25	0.788±0.32	1.1*	1.25	2.48	EPA Total PRG[+]	0/6	No
radium-228	0.719±0.65	1.70±0.65	RAF-29	1.08±0.60	NL	NL	2.24	EPA Total PRG	0/6	No
cesium-137	0.140±0.08	0.140±0.08	RAF-27	0.140±0.08	NL	NL	11.3	EPA Total PRG	0/6	No
Metals (mg/kg)										
antimony	<0.18	0.50 J	RAF-26	0.25	6.2	1.52	21	ATSDR Chronic RMEG (c)	0/6	No
arsenic	4.5	7.2	RAF-29	5.5	10	14.95	16 / 0.26	ATSDR Chronic EMEG (c) and CREG	6/6	Yes
barium	63.0	156	RAF-29	99.7	144	124.93	10,000	ATSDR Chronic EMEG (c)	0/6	No
beryllium	0.38 J	0.77 J	RAF-26	0.54	1.0	2.20	100	ATSDR Chronic EMEG (c)	0/6	No
boron	<8.2	<11.2	RAF-25	<8.9	55*	NL	10,000	ATSDR Chronic RMEG (c)	0/6	No
cadmium	<0.11	0.39 J	RAF-26	0.18 J	1.0	0.22 U	5.2	ATSDR Chronic EMEG (c)	0/6	No
calcium	1,380	4,800	RAF-27	2,271	NL	2,400	NA	(calcium is a requirement for the human body)	0/6	No
chromium	15.6	24.3	RAF-29	19.2	20	44.88	47 / 0.22	ATSDR Cr^{+6} Chronic EMEG (c) and CREG	6/6	Yes
cobalt	3.5	11.0	RAF-29	6.9	13	42.00	520	ATSDR Interm. EMEG (c)	0/6	No
copper	7.0	13.1	RAF-27	7.9	25	22.48	520	ATSDR Interm. EMEG (c)	0/6	No

Table B-3 continued. **Swan Pond Festival Field soil testing results.** Results are for radionuclides, total metals, and general chemistry properties in 6 samples. The highest levels for each radionuclide and metal measured were compared to background or naturally occurring levels and health comparison values published by ATSDR or EPA.

Chemical in Soil	Minimum Concentration Measured	Maximum Concentration Measured	Boring Location of Maximum Concentration	Arithmetic Mean	Tennessee Background Level[1]	ETTP Soil Background Values[2]	Selected Comparison Value (CV)	Source of Selected CV	Number of Locations at or above CV	Failed Screening Test
Metals										
lead	11.7	23.8	RAF-29	13.5	6.2	37.91	400	EPA Residential RSL	0/6	No
lithium	7.9	10.7	RAF-27, RAF-29	9.6	30*	48.94	160	EPA Residential RSL	0/6	No
molybdenum	0.57 J	0.97	RAF-26	0.61 J	0.79*	NL	260	ATSDR Chronic RMEG (c)	0/6	No
mercury	0.047	0.095	RAF-29	0.069	0.18	0.17	11	EPA Residential RSL	0/6	No
nickel	6.9	11.8	RAF-29	9.2	18	26.07	1,000	ATSDR Chronic RMEG (c)	0/6	No
selenium	1.7	2.6	RAF-27, RAF-29	2.2	1.2	1.47	260	ATSDR Chronic EMEG (c)	0/6	No
silver	<0.10	0.55	RAF-28	0.29	1.2	0.6 U	260	ATSDR Chronic RMEG (c)	0/6	No
thallium	0.20 J	0.69 J	RAF-26	0.32 J	1.9	0.4 U	0.78	EPA Residential RSL	0/6	No
vanadium	24.3	36.5	RAF-29	30.2	31.8	65.47	520	ATSDR Interm. EMEG (c)	0/6	No
zinc	36.2	165	RAF-27	63.3	94	89.70	16,000	ATSDR Chronic EMEG (c)	0/6	No
General Chemistry Properties (mg/kg)										
pH	6.08	6.94	RAF-27	6.58	NA	NA	NA	NA	NA	No
chloride	7.1 J	10.3 J	RAF-25	8.1 J	NA	NA	NA	NA	NA	No
fluoride	1.4 J	1.7 J	RAF-25, RAF-29	1.9 J	NA	NA	NA	NA	NA	No
sulfate	<11.1	<16.0	RAF-25	<12.2	NA	NA	NA	NA	NA	No

Notes:

ATSDR EMEG = Agency for Toxic Substances and Disease Registry Environmental Media Evaluation Guide (ATSDR 2019). Chronic non-cancer exposure comparison values for an exposure greater than 365 days used to determine if chemical concentrations warrant further health-based screening.

ATSDR CREG = Estimated contaminant concentrations that would be expected to cause no more than one excess cancer in one million persons exposed during their lifetime. CREGs are calculated from EPA's cancer slope factors for oral exposures in this case. These values are based on EPA evaluations and assumptions about hypothetical cancer risks at low levels of exposure.

ATSDR RMEG = Reference Dose Media Evaluation Guide; ATSDR RMEG used as there was no Chronic EMEG available for the chemical.

ATSDR Environmental Media Evaluation Guide (EMEG) and CREG for Hexavalent Chromium (Cr+6) used to be cautious.

EPA Residential RSL = EPA residential Regional Screening Level for non-cancer hazard index of 1 and lifetime excess cancer risk of 1 in 1 million.

(c) = RMEG or EMEG represents that for a child exposure.

mg/kg = milligrams per kilogram, equivalent to parts per million in soil.

NA = not applicable

NL = no background level established for metal or compound

pCi/g = picoCuries per gram

[1] = Tennessee naturally occurring background level as reported in Kopp 2001, Hazardous Trace Elements in Tennessee Soils. Values designated with * are mean of background soil values of compound in Tennessee soils from Dragun and Chekiri 2005, Elements in North American Soils 2nd Edition.

[2] = Soil Background Values from Soil Background Supplemental Data Set for the East Tennessee Technology Park, Oak Ridge, Tennessee, Bechtel Jacobs Company LLC, U.S. Department of Energy, September 2003

[+] = calculated EPA Preliminary Remediation Goal for radionuclide for 10-5 risk, or 1 in 100,000 lifetime excess risk of cancer

<6.3 = result is less than the detection limit (shown) of the test

J = estimated concentration of chemical

Table B-4. **Walking Trail soil testing results**. Results are for radionuclides, total metals, and general chemistry properties in 3 samples. The highest levels for each radionuclide and metal measured were compared to background or naturally occurring levels and health comparison values published by ATSDR or EPA.

Chemical in Soil	Minimum Concentration Measured	Maximum Concentration Measured	Boring Location of Maximum Concentration	Arithmetic Mean	Tennessee Background Level[1]	ETTP Soil Background Values[2]	Selected Comparison Value (CV)	Source of Selected CV	Number of Locations at or above CV	Failed Screening Test
Radionuclides (pCi/g)										
radium-226	0.681±0.35	0.761±0.25	RAF-31	0.708±0.30	1.1*	1.25	2.48	EPA Total PRG[+]	0/3	No
radium-228	0.685±0.53	1.28±0.57	RAF-32	0.918±0.54	NL	NL	2.24	EPA Total PRG	0/3	No
cesium-137	ND	ND	NA	NA	NL	NL	NA	NA	NA	NA
Metals (mg/kg)										
antimony	<0.18	<0.18	RAF-31, RAF-32, RAF-33	<0.18	6.2	1.52	21	ATSDR Chronic RMEG (c)	0/3	No
arsenic	5.1	10.3	RAF-33	7.5	10	14.95	16 / 0.26	ATSDR Chronic EMEG (c) and CREG	3/3	Yes
barium	50.2	71.8	RAF-33	63.9	144	124.93	10,000	ATSDR Chronic EMEG (c)	0/3	No
beryllium	0.19 J	0.41 J	RAF-31	0.33 J	1.0	2.20	100	ATSDR Chronic EMEG (c)	0/3	No
boron	<8.2	<8.3	RAF-31, RAF-33	<8.3	55*	NL	10,000	ATSDR Chronic RMEG (c)	0/3	No
cadmium	<0.11	<0.11	RAF-31, RAF-32, RAF-33	<0.11	1.0	0.22 U	5.2	ATSDR Chronic EMEG (c)	0/3	No
calcium	1,020	1,500	RAF-33	1,336	NL	2,400	NA	(calcium is a requirement for the human body)	0/3	No
chromium	19.2	28.1	RAF-32	22.9	20	44.88	47 / 0.22	ATSDR Cr^{+6} Chronic EMEG (c) and CREG	3/3	Yes
cobalt	3.9	10.8	RAF-33	6.3	13	42.00	520	ATSDR Interm. EMEG (c)	0/3	No
copper	8.6	12.7	RAF-32	10.9	25	22.48	520	ATSDR Interm. EMEG (c)	0/3	No

Table B-4 continued. **Walking Trail soil testing results**. Results are for radionuclides, total metals, and general chemistry properties in 3 samples. The highest levels for each radionuclide and metal measured were compared to background or naturally occurring levels and health comparison values published by ATSDR or EPA.

Chemical in Soil	Minimum Concentration Measured	Maximum Concentration Measured	Boring Location of Maximum Concentration	Arithmetic Mean	Tennessee Background Level[1]	ETTP Soil Background Values[2]	Selected Comparison Value (CV)	Source of Selected CV	Number of Locations at or above CV	Failed Screening Test
Metals										
lead	11.2	21.2	RAF-33	14.7	45	37.91	400	EPA Residential RSL	0/3	No
lithium	10.7	17.0	RAF-32	13.8	30*	48.94	160	EPA Residential RSL	0/3	No
molybdenum	0.53 J	0.96	RAF-33	0.69 J	0.79*	NL	260	ATSDR Chronic RMEG (c)	0/3	No
mercury	0.045	0.10	RAF-32	0.071	0.18	0.17	11	EPA Residential RSL	0/3	No
nickel	7.6	10.3	RAF-33	9.1	18	26.07	1,000	ATSDR Chronic RMEG (c)	0/3	No
selenium	1.5	2.2	RAF-33	1.9	1.2	1.47	260	ATSDR Chronic EMEG (c)	0/3	No
silver	<0.10	0.74	RAF-31	0.31	1.2	0.6 U	260	ATSDR Chronic RMEG (c)	0/3	No
thallium	0.18 J	0.25 J	RAF-33	0.22 J	1.9	0.4 U	0.78	EPA Residential RSL	0/3	No
vanadium	32.0	41.1	RAF-32	36.8	31.8	65.47	520	ATSDR Interm. EMEG (c)	0/3	No
zinc	39.9	52.1	RAF-33	46.1	94	89.70	16,000	ATSDR Chronic EMEG (c)	0/3	No
General Chemistry Properties (mg/kg)										
pH	6.18	6.74	RAF-31	6.52	NA	NA	NA	NA	NA	No
chloride	6.7 J	7.2 J	RAF-32	6.9 J	NA	NA	NA	NA	NA	No
fluoride	1.1 J	2.4 J	RAF-31	1.8 J	NA	NA	NA	NA	NA	No
sulfate	<11.2	20.8 J	RAF-32	<14.4	NA	NA	NA	NA	NA	No

Notes:

ATSDR EMEG = Agency for Toxic Substances and Disease Registry Environmental Media Evaluation Guide (ATSDR 2019). Chronic non-cancer exposure comparison values for an exposure greater than 365 days used to determine if chemical concentrations warrant further health-based screening.

ATSDR CREG = Estimated contaminant concentrations that would be expected to cause no more than one excess cancer in one million persons exposed during their lifetime. CREGs are calculated from EPA's cancer slope factors for oral exposures in this case. These values are based on EPA evaluations and assumptions about hypothetical cancer risks at low levels of exposure.

ATSDR RMEG = Reference Dose Media Evaluation Guide; ATSDR RMEG used as there was no Chronic EMEG available for the chemical.

ATSDR Environmental Media Evaluation Guide (EMEG) and CREG for Hexavalent Chromium (Cr+6) used to be cautious.

EPA Residential RSL = EPA residential Regional Screening Level for non-cancer hazard index of 1 and lifetime excess cancer risk of 1 in 1 million.

(c) = RMEG or EMEG represents that for a child exposure.

mg/kg = milligrams per kilogram, equivalent to parts per million in soil

pCi/g = picoCuries per gram

NA = not applicable

NL = no background level established for metal or compound

ND = not detected in samples

[1] = Tennessee naturally occurring background level as reported in Kopp 2001, Hazardous Trace Elements in Tennessee Soils. Values designated with * are mean of background soil values of compound in Tennessee soils from Dragun and Chekiri 2005, Elements in North American Soils 2nd Edition.

[2] = Soil Background Values from Soil Background Supplemental Data Set for the East Tennessee Technology Park, Oak Ridge, Tennessee, Bechtel Jacobs Company LLC, U.S. Department of Energy, September 2003

[+] = calculated EPA Preliminary Remediation Goal for radionuclide for 10^{-5} risk, or 1 in 100,000 lifetime excess risk of cancer

<6.3 = result is less than the detection limit (shown) of the test

J = estimated concentration of chemical

Table B-5. Lakeshore Park soil testing results. Results are for radionuclides, total metals, and general chemistry properties in 3 samples. The highest levels for each radionuclide and metal measured were compared to background or naturally occurring levels and health comparison values published by ATSDR or EPA.

Chemical in Soil	Minimum Concentration Measured	Maximum Concentration Measured	Boring Location of Maximum Concentration	Arithmetic Mean	Tennessee Background Level[1]	ETTP Soil Background Values[2]	Selected Comparison Value (CV)	Source of Selected CV	Number of Locations at or above CV	Failed Screening Test
Radionuclides (pCi/g)										
radium-226	0.617±0.48 U	0.903±0.33	RAF-34	0.762±0.36	1.1*	1.25	2.48	EPA Total PRG[+]	0/3	No
radium-228	0.712±0.70 U	1.47±0.63	RAF-36	1.02±0.64	NL	NL	2.24	EPA Total PRG	0/3	No
cesium-137	ND	ND	NA	NA	NL	NL	NA	NA	NA	NA
Metals (mg/kg)										
antimony	<0.18	0.39 J	RAF-36	0.25	6.2	1.52	21	ATSDR Chronic RMEG (c)	0/3	No
arsenic	6.3	9.5	RAF-36	8.3	10	14.95	16 / 0.26	ATSDR Chronic EMEG (c) and CREG	3/3	Yes
barium	42.9	87.6	RAF-36	66.8	144	124.93	10,000	ATSDR Chronic EMEG (c)	0/3	No
beryllium	0.30 J	0.60 J	RAF-36	0.42	1.0	2.20	100	ATSDR Chronic EMEG (c)	0/3	No
boron	<8.2	<9.3	RAF-36	<8.6	55*	NL	10,000	ATSDR Chronic RMEG (c)	0/3	No
cadmium	<0.11	0.35 J	RAF-36	<0.19	1.0	0.22 U	5.2	ATSDR Chronic EMEG (c)	0/3	No
calcium	1,290	3,710	RAF-36	2,137	NL	2,400	NA	(calcium is a requirement for the human body)	0/3	No
chromium	14.8	30.1	RAF-34	21.4	20	44.88	47 / 0.22	ATSDR Cr^{+6} Chronic EMEG (c) and CREG	3/3	Yes
cobalt	4.1	9.5	RAF-36	6.3	13	42.00	520	ATSDR Interm. EMEG (c)	0/3	No
copper	9.8	12.9	RAF-34	11.0	25	22.48	520	ATSDR Interm. EMEG (c)	0/3	No

Table B-5 continued. **Lakeshore Park soil testing results.** Results are for radionuclides, total metals, and general chemistry properties in 3 samples. The highest levels for each radionuclide and metal measured were compared to background or naturally occurring levels and health comparison values published by ATSDR or EPA.

Chemical in Soil	Minimum Concentration Measured	Maximum Concentration Measured	Boring Location of Maximum Concentration	Arithmetic Mean	Tennessee Background Level[1]	ETTP Soil Background Values[2]	Selected Comparison Value (CV)	Source of Selected CV	No. Locations at or above CV	Selected for Further Evaluation
Metals										
lead	9.0	24.9	RAF-36	15.8	45	37.91	400	EPA Residential RSL	0/3	No
lithium	8.7	21.0	RAF-34	13.8	30*	48.94	160	EPA Residential RSL	0/3	No
molybdenum	0.48 J	1.1	RAF-36	0.78	0.79*	NL	260	ATSDR Chronic EMEG (c)	0/3	No
mercury	0.040	0.14	RAF-34	0.084	0.18	0.17	11	EPA Residential RSL	0/3	No
nickel	7.4	14.0	RAF-34	10.1	18	26.07	1,000	ATSDR Chronic RMEG (c)	0/3	No
selenium	1.8	2.2	RAF-36	1.9	1.2	1.47	260	ATSDR Chronic EMEG (c)	0/3	No
silver	<0.10	0.13 J	RAF-36	<0.11	1.2	0.6 U	260	ATSDR Chronic RMEG (c)	0/3	No
thallium	<0.12	0.58 J	RAF-36	0.32 J	1.9	0.4 U	0.78	EPA Residential RSL	0/3	No
vanadium	22.9	49.1	RAF-34	35.9	31.8	65.47	520	ATSDR Interm. EMEG (c)	0/3	No
zinc	44.4	61.4	RAF-36	52.7	94	89.70	16,000	ATSDR Chronic EMEG (c)	0/3	No
General Chemistry Properties (mg/kg)										
pH	6.08	7.32	RAF-36	6.71	NA	NA	NA	NA	NA	No
chloride	<6.2	9.7 J	RAF-35	7.9 J	NA	NA	NA	NA	NA	No
fluoride	1.5 J	2.0 J	RAF-36	1.7 J	NA	NA	NA	NA	NA	No
sulfate	<12.4	65.2 J	RAF-34	31.3	NA	NA	NA	NA	NA	No

Notes:

ATSDR EMEG = Agency for Toxic Substances and Disease Registry Environmental Media Evaluation Guide (ATSDR 2019). Chronic non-cancer exposure comparison values for an exposure greater than 365 days used to determine if chemical concentrations warrant further health-based screening.

ATSDR CREG = Estimated contaminant concentrations that would be expected to cause no more than one excess cancer in one million persons exposed during their lifetime. CREGs are calculated from EPA's cancer slope factors for oral exposures in this case. These values are based on EPA evaluations and assumptions about hypothetical cancer risks at low levels of exposure.

ATSDR RMEG = Reference Dose Media Evaluation Guide; ATSDR RMEG used as there was no Chronic EMEG available for the chemical.

ATSDR Environmental Media Evaluation Guide (EMEG) and CREG for Hexavalent Chromium (Cr+6) used to be cautious.

EPA Residential RSL = EPA residential Regional Screening Level for non-cancer hazard index of 1 and lifetime excess cancer risk of 1 in 1 million.

(c) = RMEG or EMEG represents that for a child exposure.

mg/kg = milligrams per kilogram, equivalent to parts per million in soil

pCi/g = picoCuries per gram

NA = not applicable

NL = no background level established for metal or compound

ND = not detected in samples

[1] = Tennessee naturally occurring background level as reported in Kopp 2001, Hazardous Trace Elements in Tennessee Soils. Values designated with * are mean of background soil values of compound in Tennessee soils from Dragun and Chekiri 2005, Elements in North American Soils 2nd Edition.

[2] = Soil Background Values from Soil Background Supplemental Data Set for the East Tennessee Technology Park, Oak Ridge, Tennessee, Bechtel Jacobs Company LLC, U.S. Department of Energy, September 2003

[+] = calculated EPA Preliminary Remediation Goal for radionuclide for 10^{-5} risk, or 1 in 100,000 lifetime excess risk of cancer

<6.3 = result is less than the detection limit (shown) of the test

J = estimated concentration of chemical

U = not detected above method detection limits (shown)