UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 2
290 BROADWAY
NEW YORK, NY 10007-1866

Memorandum

Date: MAY 1 4 2019

Subject: National Priorities List Nomination of the Arsenic Mine Site

From: Pat Evangelista, Acting Director for
Superfund and Emergency Management Division

To: Brigid Lowery, Director
Office of Superfund Remediation and Technology Innovation (OSRTI)

This memorandum is a request for placement of the Arsenic Mine Site, Kent, Putnam County, New York on the National Priorities List (NPL) under the provisions in Section 300.425 (c) (3) of the National Contingency Plan (NCP). Attached are the following documents which support this action:

1. The Public Health Advisory for the Arsenic Mine Site prepared by the Agency for Toxic Substances and Disease Registry (ATSDR) (Attachment 1);

2. Memo from EPA documenting our determination of significant threat to public health posed by the site (Attachment 2);

3. A cost analysis of Remedial versus Removal actions at the site; which demonstrate that it will be more cost effective to use remedial authority rather than removal authority to respond to the release (Attachment 3);

4. A letter from the State of New York requesting placement of this site on the NPL (Attachment 4).

Background

The Arsenic Mine Site is located on a historic arsenopyrite/arsenical sulphate ore mine in Kent, Putnam County, New York. The facility was operated by various companies from the mid-1800s through approximately 1918 and is currently inactive and flooded. The mine's northern entrance is located on what is now the location of several private residential properties, north of Mt. Nimham Road at Gipsy Trail Road. The Arsenic Mine reportedly operated a mining and milling plant and the arsenical ore was used in the manufacturing of shot, flint, glass, pharmaceuticals, poisons and chemicals. The ore was concentrated by first passing through a jaw crusher, then through rolls, then onto jigs made of cast-iron plates. Once concentrated, the ore was then sent off for processing at an off-site location. In the 1950s, the landscape around the mine entrance may have been re-graded when the owner of the property built a small ski slope. The slope was serviced by a J-bar ski lift and was illuminated for nighttime skiing. The electrical lines could still be

observed today in the northwest area of the mine entrance. The property owner of the ski slope at the time, reportedly filled in the mine shaft due to safety concerns. Regrading of nearby properties may have occurred in the 20th century, changing the property appearance, and may have caused the mine tailings and other mine wastes to migrate.

The Site encompasses impacted areas comprised of 10 residential properties, which are bordered by wetlands and Pine Pond Creek to the east, Pine Pond to the northeast, additional residential properties to the north/northwest, and Nimham Mountain State Park to the west and south. To date, several investigation efforts have focused on the arsenic contamination in residential soils. However, the nature and extent of contaminants at the Arsenic Mine Site will be further investigated during the Remedial Investigation (RI).

The first known case of arsenic poisoning associated with this Site was in 1987, when residents living adjacent to the mine entrance were diagnosed with acute arsenic poisoning attributed to their drinking water well. The well was determined to be drilled into tailings from the historic mining operations. In 1988, New York State Department of Environmental Conservation (NYSDEC) referred this property to the EPA Removal Program. A Removal Action was conducted and provided the residents at the property bottled water delivery and the installation of a cistern water system (which later malfunctioned but was left in use as a water storage system for the homeowners who pay for water delivery) as a permanent remedy. In 1988-89, the Site was evaluated by the EPA's Pre-Remedial program, when it initiated a Site Investigation (SI) which included the collection of ground water and soil samples. These samples were used to evaluate the Site for possible inclusion on the National Priorities List (NPL). The Hazard Ranking System (HRS) scoring concluded the site did not meet the required threshold for listing and it was designated as a No Further Remedial Action Planned (NFRAP). In 1992, following the update to the HRS scoring procedures (40 CFR Part 300, Vol. 55, No. 241, December 14, 1990), the Site was re-evaluated for the NPL. The Site was again deemed a NFRAP.

In May 1988, the Putnam County Health Department (PCDOH) placed a warning sign near the northern mine entrance indicating the presence of elevated arsenic levels in soil. However, due to naturally elevated regional arsenic concentrations in soil, man-made deposition of arsenic-laden materials could not be delineated, and no additional action was taken with respect to potential soil contamination. For many years, PCDOH monitored nearby residential drinking water wells and a supply well for arsenic.

In 2016, the new owner of the property where the previous removal action was conducted requested assistance from EPA to repair a leak in the EPA-installed water system. While repairing the system, it was determined that sediments were entering through one of the tank lids. Sediments were analyzed and determined to contain high concentrations of arsenic. EPA determined that it was necessary to conduct a Removal Assessment of the surface soil surrounding previous mining operations in order to verify the direct threat to residents posed by elevated arsenic concentrations from the mine tailings.

In August 2017, EPA performed a Removal Assessment Phase I sampling event and collected 162 soil samples from four residential properties (identified as P001-P004) located near the vicinity of the mine. The soil samples were collected from depths of 0 to 6 inches

below ground surface (bgs). All 162 samples were screened off-site for arsenic, chromium, nickel and iron using Field Portable X-Ray Fluorescence (XRF) technology. The soil sampling activities were performed in accordance with EPA's Environmental Response Team/Scientific, Engineering, Response and Analytical Services (ERT/SERAS) Standard Operating Procedure (SOP) No. 2012: Soil Sampling. The XRF screening was performed in accordance with EPA's ERT/SERAS contractor's SOP No, 1720: *Operation of the Niton XLt92YW Field Portable X-Ray Fluorescence Field Operations Guide.* Each soil sample was screened for arsenic, chromium, nickel, and iron and the results were then averaged to determine the total concentrations of the target analytes. Based on the XRF screening results, approximately 18 percent or 30 of the 162 samples were selected by EPA for laboratory analysis by an EPA Contract Laboratory Program (CLP) laboratory for target analyte list (TAL) metals.

The XRF screening results from the August 2017 sampling event identified the highest arsenic concentration at 34,250 milligrams per kilogram (mg/kg), or parts per million (ppm), exceeding both the May 2016 EPA's Removal Management Levels (RML) of 35 ppm and December 2006 NYSDEC's Restricted Residential Use Soil Cleanup Objectives (RRUSCO) of 16 ppm. Additionally, a few samples had concentrations for nickel and iron exceeding the NYSDEC RRUSCO and the EPA RML. Chromium was detected in 20 samples at concentrations as high as 3,071 ppm at property P003. Since only a small percentage (approx. 18%) of the samples were submitted for laboratory analysis, it was necessary to verify that the XRF screening results were usable to assess site conditions. The analytical results identified the highest arsenic concentration at 56,000 mg/kg exceeding both the RML and RRUSCO. In some samples other metals such as antimony, cadmium, nickel, and cobalt exceeded the RML and/or the RRUSCO. Based on the correlation coefficient (R^2) values of the analytes utilized for regression analysis, it was verified that a correlation exists between the XRF screening results and the analytical results for arsenic; therefore, screening results were useable. The R^2 value for arsenic for this sampling event was 0.9618, with similar R^2 values for chromium, nickel, and iron.

Based on these results, historical information and residential reports, the EPA Removal program confirmed the contamination present in the surface and subsurface soils was from historical site operations. Additional site investigation was recommended in order to vertically delineate the extent of the contamination located in the vicinity of the historic mining operations.

In December 2017, EPA performed a Phase II soil sampling event at seven residential properties (identified as P004-P010). A total of 219 soil samples was collected from 0-6 inches below ground surface (bgs) and screened off-site for arsenic, chromium, nickel, and iron using a portable XRF analyzer. Approximately 20% or 45 of the 219 soil samples were sent to a CLP laboratory for TAL Metals analysis. The XRF screening results and laboratory results were compared with NYSDEC RRUSCOs from December 2006 and the EPA RMLs for residential soil from May 2016. The XRF screening results from the December 2017 sampling event identified the highest arsenic concentration at 3,090 ppm, exceeding both the RRUSCO and RML values of 16 ppm and 35 ppm, respectively. The laboratory analytical results identified the highest arsenic concentration at 20,600 ppm, exceeding both the RML and RRUSCO. Based on the correlation coefficient (R^2) values of the analytes utilized for

regression analysis, it was verified that a correlation exists between the XRF screening results and the analytical results for arsenic; therefore, arsenic screening results were useable. The R^2 value for arsenic for this sampling event was 0.9303.

In June 2018, EPA performed a Phase III sampling event of soils within the top two feet bgs within the previously identified Areas of Concern (AOC) [properties P001-P010]. This sampling effort consisted of collecting samples at depths of 0-6 inches, 6-12 inches, 12-18 inches, and 18-24 inches (bgs) and screened off-site for arsenic, chromium, nickel, and iron using a portable XRF analyzer.

A total of 412 soil samples were collected from 126 sample locations during this sampling event. Approximately 20% (84 of the 412) soil samples were sent to an EPA CLP laboratory for analysis. The XRF screening results from the June 2018 sampling event identified the highest arsenic concentrations at 54,177 ppm, exceeding both the EPA RML for residential soil from May 2018 and NYSDEC RRUSCO from December 2006. The laboratory analytical results identified the highest arsenic concentration at 54,900 ppm, exceeding both the RML and RRUSCO values of 35 ppm and 16 ppm, respectively. Based on the correlation coefficient (R^2) values of the analytes utilized for regression analysis, it was verified that a correlation exists between the XRF screening results and the analytical results for arsenic; therefore, arsenic screening results were useable. The R^2 value for arsenic for this sampling event was 0.9848.

All sampling events followed similar protocols for screening of soils using XRF (arsenic, iron, chromium, and nickel) and analytical methods.

Based on the 2016-2018 EPA Removal Assessment XRF screening and analytical results, it was determined there is arsenic present at the surface and subsurface soil at the Site in concentrations greater than the RRUSCO and RML values. All 10 identified impacted residential properties are considered part of the site. Based on this information, and in conjunction with a high health threat, it was determined that it is necessary that EPA conduct a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) action to address contaminated soils. Given the magnitude of this site, it was determined that EPA will conduct a removal action to address immediate concerns to reduce residential direct threat exposures to arsenic until a long-term solution can be implemented.

Public Health Advisory and Health Consultation Memorandum

On April 30, 2019, ATSDR and the New York State Department of Health (NYSDOH) released a health consultation report and ATSDR issued a health advisory, both based on the evaluation of residential soil data collected by EPA's Removal Program. Both agencies concluded that there is evidence of a complete exposure pathway where children can have an acute ingestion exposure to arsenic in surface soil from any of the 10 residential properties of the Arsenic Mine Site at levels that pose an immediate and significant threat to human health constituting an urgent public health hazard. Both agencies also concluded that long term ingestion and dermal exposure of children and adults to arsenic-contaminated surface soil pose a significant threat to human health constituting a public health hazard.

The ATSDR's Health Advisory recommended dissociation of residents from exposure to arsenic in soils from the Arsenic Mine Site. In its report, ATSDR concluded that children and adults residing on or accessing any of the 10 properties of the Arsenic Mine Site impacted areas were, are, and will continue to be exposed to arsenic at levels that may pose an immediate and significant threat to their health. ATSDR recommended that EPA take short- and long- term measures to dissociate persons, especially children, from exposure to arsenic in surface soils at the Arsenic Mine Site. In addition, ATSDR recognized that EPA has taken the necessary steps to inform property owners of their soil arsenic results and provided information to residents on best practices for avoiding exposures to arsenic in soil. ATSDR has only determined the threat of exposure from arsenic in the soil and other exposure routes that exist and these routes only strengthen the necessity to dissociate residents from the source (i.e., arsenic), which presents an immediate and significant threat.

Significant Threat to Public Health

The memo documenting the Agency's determination of significant threat can be found in Attachment 2. EPA's determination of significant threat is based on sampling performed by the removal program in the impacted areas or areas of concern (AOC). Based on sampling results, EPA determined that interim removal actions would be necessary to mitigate unacceptable risks to residents on the residential properties. The removal response was initiated based on the exceedance of the site-specific background or RML. Exceeding the RML or site-specific background values suggests that actual or potential exposure to arsenic on residential properties presents an unacceptable risk to all occupants.

It is important to note that the concentrations of arsenic used in the evaluation of contaminant levels in residential properties, and the potential need for a removal action, represent a discreet moment in time. EPA believes that there is the potential for recontamination due to surface runoff events. These events have the potential to become more pronounced or frequent due to wet weather conditions such as heavy rains that cause flooding. Based on the soil investigations conducted by the removal program, maximum arsenic concentrations greater than the site-specific background value used for comparison, 123.9 mg/kg or ppm, within the AOCs indicate the existence of significant contamination in soils. Therefore, actual and threatened releases of hazardous substances at the Arsenic Mine Site continue to present a significant threat to public health. This determination by EPA correlates with information present within both the health consultation and health advisory documents prepared by NYSDOH and ATSDR.

Cost Effectiveness

A cost effectiveness analysis shows that the remediation of the Arsenic Mine Site would be more appropriate and more cost effective if conducted under remedial authority rather than under removal authority.

Removal actions are designed to stabilize or clean up releases of hazardous substances that pose a threat to human health or the environment (42 USC §9601(23)). In contrast, remedial actions are those actions consistent with a permanent remedy taken instead of or in addition to removal actions (42 USC §9601(24)). As set out below, EPA believes it is more

appropriate to use its remedial authorities to address the significant threat to public health posed by releases from the Arsenic Mine Site. However, EPA cautions that the evaluation of the cleanup elements associated with the Arsenic Mine Site is for the purpose of listing the site on the NPL under the provisions in Section 300.425 (c) (3) of the NCP and not necessarily a definitive evaluation of cleanup alternatives to address the site. EPA anticipates it will conduct a complete evaluation of cleanup alternatives as part of the remedial process.

As indicated in the Cost Estimate for Remedial and Removal Actions report (Attachment 3), the removal action alternative consists of a series of actions intended to identify, mitigate, and monitor continued arsenic exposure to residents within the AOCs. This includes initial interim actions: installation of the barriers to reduce direct contact threat of contaminated soil in high-use areas, design of a knee wall between properties P001 and P002, cleaning or washing of boots to reduce arsenic migration to inside residences, installation of a retaining wall behind property P001, and the removal and replacement of soils on the impacted properties to prevent continued exposure. Continuous monitoring of residential properties within the AOCs is necessary, as long as the potential for recontamination of soils remains, to ensure that no additional contamination events occur that would present a human health hazard. Although the removal action alternative will temporarily mitigate the threat to public health posed by the arsenic contamination in residential soils, a significant threat would still exist, such as the potential for additional contaminated surface runoff to nearby homes which would continue to threaten the health of down slope residents.

In the event that additional contamination of residential properties occurs, EPA would conduct additional cleanup actions, as necessary. The removal action alternative presents only a temporary solution to address arsenic contamination in residential properties and does not address a permanent remedy of arsenic contaminated soils.

In contrast, a potential remedial alternative may include removing arsenic-contaminated soils, resulting from releases associated with the mining activities at the site and removing individuals from the contaminated properties. This alternative may include soil excavation, backfill, and disposal of arsenic-contaminated soils from impacted residential properties within the AOCs. The remedial approach provides an alternative that would mitigate the mass of arsenic in soils and eliminate the human health threat posed by the presence of arsenic contamination within the Arsenic Mine Site. EPA anticipates that a remedial alternative consisting of property buyouts, coupled with soil remediation, would be more effective in the long term.

Region 2 believes that using the remedial option represents a permanent solution which, in the long term, will be more cost effective and provide more comprehensive protection of human health and the environment than the removal option.[1]

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[1] EPA's determination is also informed by its guidance document, entitled *Use of Non-Time Critical Removal Authority in Superfund Response Actions,* dated February 14, 2000, which recommends the use of remedial authority at complex and costly sites to effectuate a comprehensive response.

Recommendation

Since the Arsenic Mine site meets the NPL listing criteria of Section 300.425 (c) (3) of the NCP, Region 2 recommends listing the site on the NPL. The ATSDR has recommended dissociation of residents or (individuals) from the release at the site. Region 2 and ATSDR concur that the release poses a significant threat to the public health, and Region 2 anticipates that it will be more cost effective to use the Remedial Authority of CERCLA than the Removal Authority to address the release at this site.

Attachments

Attachment 1

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES

Public Health Service

Centers for Disease Control
and Prevention (CDC)
Atlanta GA 30329-4027

April 26, 2019

The Honorable Andrew Wheeler
Administrator
U.S. Environmental Protection Agency
Ariel Rios Building
1200 Pennsylvania Avenue, NW
Washington, DC 20460

Dear Administrator Wheeler:

This letter is regarding the release of a public health advisory for arsenic exposure in shallow residential soils associated with the Arsenic Mine Site in Kent, Putnam County, New York. The Agency for Toxic Substances and Disease Registry (ATSDR) and the New York State Department of Health (NYSDOH) have evaluated the available information for the Arsenic Mine Site. We consider the site an urgent public health hazard under exposure scenarios related to the ingestion of arsenic-contaminated residential soils.

In accordance with Section 104(i)(6)(H) of the Comprehensive Environmental Response, Compensation, and Liability Act, we are notifying you of our position on the Arsenic Mine Site and request that you place the site on the National Priorities List.

Enclosed is the public health advisory and supporting health consultation, which will be released on our website on April 30, 2019. The ATSDR Region II Director has notified the U.S. Environmental Protection Agency Region II Administrator and the NYSDOH about the release of the Advisory.

Sincerely,

Robert R. Redfield MD

Robert R. Redfield, MD
Administrator, ATSDR and
Director, Centers for Disease
Control and Prevention

Enclosures

cc: Peter Lopez, Regional Administrator, EPA Region II
Walter Mugdan, Deputy Regional Administrator, EPA Region II
Howard Zucker, Commissioner, New York State Department of Health
Michael Ryan, Director, Division of Environmental Remediation, NYSDEC
Patrick Breysse, Director, NCEH (CDC) and ATSDR

Public Health Advisory

ARSENIC MINE SITE

TOWN of KENT, PUTNAM COUNTY, NEW YORK

EPA FACILITY ID: NYD982531469

April 30, 2019

Prepared By:

U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry
Division of Community Heath Investigations
Atlanta, Georgia 30333

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Introduction

ATSDR has determined that current and potential future exposures to arsenic in residential soil on the Arsenic Mine Site warrant the issuance of a Public Health Advisory. USEPA found that arsenic concentrations in surface soil on all ten properties of the Arsenic Mine Site greatly exceed state and federal residential soil screening values. Seven properties are occupied by children, adults, pets, and/or livestock. The remaining three unoccupied properties are accessed by property owners periodically.

In October 2018, the United States Environmental Protection Agency (USEPA) requested that the Agency for Toxic Substances and Disease Registry (ATSDR) evaluate surface soil samples collected at residential properties on the USEPA Arsenic Mine Site in Kent, Putnam County, New York, to determine if prompt action should be taken to reduce harmful exposures to arsenic-contaminated soils and mine tailings. The USEPA provided ATSDR validated residential soil data it had collected in 2017 and 2018. Concentrations of arsenic in soil collected from ten residential parcels ranged from 3.2 to 56,000 milligrams per kilogram (mg/kg). These data provided the basis for a health consultation to evaluate the public health implications of exposure to arsenic in shallow residential soils, conducted by the New York State Department of Health (NYSDOH) under a cooperative agreement with ATSDR[1] [ATSDR 2019a].

In the 2019 health consultation, the NYSDOH and ATSDR conclude that children at residential properties with the highest arsenic levels in shallow (zero to six inches below ground surface) soils on the Arsenic Mine Site can have short-term ingestion exposures to arsenic that pose an immediate and significant threat to human health, thus constituting an urgent public health hazard. If actions are not taken, these exposures could continue in the future. The NYSDOH and ATSDR also conclude that long-term ingestion and dermal exposure of children and adults to arsenic in shallow soil at residential properties on the Arsenic Mine Site pose a significant threat to human health and constitute a public health hazard. [ATSDR 2019a]

ATSDR recommends that the USEPA take short- and long-term measures as soon as feasible to quickly **dissociate** residents from exposure to arsenic in soils on the Arsenic Mine Site. In 2017 and 2018, USEPA took steps to inform property owners of their recent soil and drinking water sampling results and provided education on best practices for reducing soil arsenic exposure and maintaining their drinking water treatment systems. Additionally, USEPA has considered a removal action to reduce exposures to arsenic, such as soil cover and/or replacement, but has determined that such action would likely need to occur in stages over several years. Such an action likely would have only short-term effectiveness and would not be adequate to permanently prevent harmful exposures. Even if post-soil removal site controls were implemented, there is high potential for recontamination.

Over the longer term, USEPA should permanently remediate the source of arsenic in shallow soils at the Arsenic Mine Site. In the absence of a permanent solution, people,

[1] The interpretation, advice, and recommendations provided in this public health advisory are based on the data and information evaluated and referenced here and in the NYSDOH health consultation developed under a cooperative agreement with ATSDR [ATSDR, 2019a]. The conclusions, recommendations, and public health actions in this advisory are site-specific and are not intended as generally applicable to any other situation.

particularly children, could continue to be exposed to arsenic at levels that present an imminent and significant health threat. Until a permanent solution is in place, the USEPA should continue actions to prevent harmful exposures to arsenic in residential soils.

Background

The Arsenic Mine Site encompasses ten residential properties on and adjacent to the former Arsenic Mine located in the Town of Kent, in Putnam County, New York, near the intersection of Gipsy Trail Road and Mt. Nimham Court. The former arsenopyrite mine operated from the mid-1800s to approximately 1918. Rocks were crushed on-site to concentrate the ore. Former mine entrances and tailings piles (residual materials separated out during mining activities) exist on nearby residential properties and the Nimham Mountain Multiple Use Area (MUA). The Arsenic Mine Site includes ten residential properties, but not the Nimham Mountain MUA. There are two main mine entrances, northern and southern. The northern entrance is on private property on the Arsenic Mine Site. The southern entrance is located within the Nimham Mountain MUA. Areas of mine tailings remain at the surface in several places on both residential properties and the Nimham Mountain MUA. The area is sparsely populated, and the terrain is highly variable, with steep, forested hillsides. Occupied properties in the area generally consist of single-family residential homes. Public water is not available in the area, thus residents rely on private wells for their drinking water.

In December 1987, residents at a single property living adjacent to the northern mine shaft were hospitalized with arsenic poisoning from their drinking water well [NYSDOH 1987]. Putnam County Department of Health sampling determined that the residential drinking water well was contaminated with arsenic much above state and federal drinking water standards. Soil samples collected on the residential property confirmed that the home was built upon mine tailings/mine wastes. Due to arsenic poisoning, three residents in the home required hospitalization and chelation therapy. In consultation with New York State Departments of Environmental Conservation and Health, the USEPA requested that ATSDR evaluate the health risk associated with arsenic contaminated drinking water for residents. ATSDR recommended the residents of this property be put on a permanent acceptable water supply totally disconnected from any source of arsenic [ATSDR 1988]. At that time, the USEPA installed an alternate drinking water system at the property, and both USEPA and Putman County Health Department provided health education information to the family residing at the property. Two additional private drinking water wells and one public supply well sampled by Putnam County Health Department in 1987 were found to contain arsenic at concentrations approaching or slightly above the state and federal drinking water standards. A limited drinking water sampling event was conducted by the USEPA, and the Putnam County Health Department performed routine sampling through 1992. Installation of filter systems on the drinking water wells proved to be effective in removing arsenic.

The 1987 sampling event identified a need for additional information about the potential for arsenic exposures in the area. On March 24, 1988, the Putnam County Health Department and the USEPA conducted limited soil sampling at properties near the northern mine entrance to evaluate the potential for exposures. They found high levels of arsenic in shallow soils. In May

1988, the Putnam County Health Department placed warning signs near the northern mine entrance to alert persons to the high arsenic levels in soil and tailing piles.

In 2016, arsenic contaminated sediments were found in the holding tanks of the alternate drinking water supply installed by the USEPA in 1988, which resulted in an additional site investigation. In August 2017, a USEPA contractor conducted a soil investigation of four properties. In December 2017, samples were collected at six additional properties and one previously sampled property, for a total of ten properties sampled between the two events [Weston Solutions, Inc. 2017; 2018a]. In June 2018, the USEPA collected additional soil samples from all ten properties [Weston Solutions, Inc. 2018b]. One neighboring property did not respond to USEPA outreach and was not sampled during any of the sampling events. The 2018 soil data were obtained using an X-ray fluorescence (XRF) screening tool and analyzed by a USEPA approved contract laboratory for total arsenic. However, the XRF is a screening tool and accuracy can vary based on the composition of the sample, so the NYSDOH only used the approved laboratory validated soil data to evaluate exposures and risks [ATSDR 2019a]. Concentrations of total arsenic in shallow soil samples ranged from 3.2 to 56,000 mg/kg. The mean concentrations of arsenic in shallow soil samples, by property, ranged from 34.6 to 12,734 mg/kg.

In October 2018, the USEPA collected drinking water samples (before and after water treatment systems) at the seven properties with occupied homes. These samples showed that filter systems installed and maintained by residents to remove contaminants from their drinking water continue to be effective with the exception of one property [Weston Solutions, Inc. 2018c]. The USEPA recommended that the homeowner follow the manufacturer's suggested maintenance requirements to replace the filter or install a system capable of removing contaminants. The USEPA continues to monitor drinking water on a quarterly basis. Since the October 2018 samples, two new treatment systems have been installed [personal communication, Sandra Richards, USEPA, March 2019].

Under a cooperative agreement with ATSDR, NYSDOH developed a health consultation to evaluate the potential public health implications from exposure to arsenic-contaminated residential soils based on USEPA's 2017 and 2018 soil sampling investigations. The health consultation does not evaluate other possible sources of arsenic exposure, such as inhalation of arsenic contaminated soil or dust, consumption of untreated drinking water, consumption of home raised animal products, or consumption of fruits and vegetables grown in contaminated soil. Consideration of these additional potential exposure pathways would not change the conclusions and recommendations provided in the health consultation but may likely support and strengthen them. The 2019 Arsenic Mine health consultation forms the basis for this public health advisory and is summarized below [ATSDR 2019a].

Basis for the Public Health Advisory

Table 1 summarizes the USEPA August and December 2017 and June 2018 shallow soil sample results. Concentrations of arsenic were detected in shallow soil on all ten residential properties. The concentrations ranged from 3.2 to 56,000 mg/kg.

Table 1. Summary of arsenic in residential property shallow soils

Property/ Occupied	Number of Samples	Minimum Concentration (mg/kg)	Maximum Concentration (mg/kg)	Mean Concentration (mg/kg)	95% UCL (mg/kg)[b]
1 / Yes	13	19.7	49,300	10,690	48,071
2 / Yes	9	10.3	6,050	873	4,247
3 / No	8	26.6	56,000	12,734	25,406
4 / No	5	19.6	20,600	4,142	NC
5 / Yes	7	24.3	181	79	NC
6 / Yes[a]	10	3.2	687	193	512
7 / No	6	22	317	116	NC
8 / Yes	7	9	99.5	35	NC
9 / Yes	8	66.5	1,520	298	1,398
10 / Yes	7	3.6	841	199	NC

Data Source: Arsenic Mine Site Health Consultation [ATSDR 2019]
mg/kg = milligrams of arsenic per kilogram of soil; NC = Not calculated; UCL = Upper Confidence Limit
[a]The residents, including a young child, reside at the property *part-time*, thus reducing their potential for long-term exposure.
[b]95% UCL was calculated for properties with eight or more samples.

The method for assessing the presence of a health hazard in a community is to determine whether a completed exposure pathway connects a contaminant source to a receptor population, and whether exposures to that contamination are sufficiently high to be of health concern. As described in the 2019 health consultation, an exposure pathway was and is complete for ingestion of, and dermal contact with, the shallow soil containing arsenic for seven occupied properties [ATSDR 2019a]. The exposure pathway is potentially completed for the remaining three vacant residential properties. Exposed persons may include children and adults residing on or accessing any of the ten Arsenic Mine Site properties.

For specific details of exposure pathway determination, screening of the data, and the non-cancer and cancer evaluation for residential soil exposures, please refer to the accompanying health consultation [ATSDR 2019a]. A summary of the major findings are included in this advisory.

Public Health Implications of Completed and Potential Exposure Pathways

The maximum arsenic concentrations in shallow soil on all properties exceed the ATSDR child chronic environmental media evaluation guide (16 mg/kg), as well as the New York State Residential Soil Clean Up Objective (16 mg/kg) for arsenic in soil [ATSDR 2019b; NYSDEC/NYSDOH 2006]. The exceedance of these values prompted further evaluation of arsenic.

ATSDR and NYSDOH evaluated the risk for acute pica and non-pica[2] exposures and chronic non-cancer health effects for seven age ranges by comparing the estimated arsenic exposures from soil to ATSDR's acute minimal risk level (MRL) of 0.005 mg/kg/day and chronic MRL (0.0003 mg/kg/day), respectively [ATSDR 2007]. The ATSDR chronic MRL is the same value as the USEPA chronic reference dose (RfD) [USEPA 1991]. Consistently, the 1 to 2-year-old child is estimated to receive the highest dose of arsenic; therefore, this age group is the focus of the evaluation.

When an MRL or RfD is exceeded, the estimated exposure dose is compared with the dose known to cause health effects to determine the margin of exposure (MOE). The higher the MOE, the greater the difference—and margin of protection—between the estimated soil exposure and the human effect level. An MOE equal to one means that the estimated soil exposure is the same as the human effect level. An MOE less than one means that the estimated exposure in soil is higher than the exposure that has caused health effects. An MOE of more than 1 means that the estimated exposure in soil is lower than the exposure that has caused health effects. For example, if the margin of exposure is 10, this means that the exposure is 10 times below levels that cause harmful, non-cancerous effects.

ATSDR and NYSDOH estimated lifetime cancer risks by multiplying the estimated arsenic exposure by the USEPA arsenic cancer potency factor [USEPA 1995]. The cancer potency factor[3] is a numerical estimate of the carcinogenic strength (potency) of a contaminant.

Non-cancer Health Effects – Incidental Ingestion and/or Dermal Absorption of Contaminated Residential Shallow Soil

Short-Term Exposure

For each property, ATSDR and NYSDOH evaluated the health risks associated with a one-time episode in which a 1 to 2-year-old child is assumed to ingest both an unusually large amount of soil (5 grams, representing pica behavior) or the daily amount of soil specified in

[2] Pica is defined by behavior that involves eating and ingesting non-food substances, such as soil.

[3] EPA defines cancer slope factor (CSF) as "An upper bound, approximating a 95% confidence limit, on the increased cancer risk from a lifetime oral exposure to an agent. This estimate, usually expressed in units of proportion (of a population) affected per mg/kg-day, is generally reserved for use in the low-dose region of the dose-response relationship, that is, for exposures corresponding to risks less than 1 in 100." See also https://www.epa.gov/fera/risk-assessment-carcinogenic-effects.

ATSDR's reasonable maximum exposure (RME) scenario (200 milligrams per day). In each scenario, the soil concentration used to estimate the exposure dose is assumed to be the highest level of arsenic found in shallow soil samples at the property. The arsenic exposure doses in these short-term scenarios (estimated using current ATSDR guidance [ATSDR 2018]) are compared to the ATSDR acute MRL for arsenic of 0.005 mg/kg/day [ATSDR 2007]. The acute MRL is based on swelling (edema) of the face, and gastrointestinal and upper respiratory symptoms in people exposed to arsenic-contaminated soy sauce for 2-3 weeks, with a short-term observed effect level of 0.05 mg/kg/day [ATSDR 2007].

Short-Term Exposure from Pica Behavior

A single ingestion of a large amount of soil (5 grams) containing the maximum arsenic soil level found at each property by a 1 to 2-year-old pica child is estimated to result in exposures that exceed the ATSDR acute MRL of 0.005 mg/kg/day at all ten properties (indicated by hazard quotient greater than 1, Table 2). The estimated pica behavior doses range from 0.03 to 13 mg/kg/day. For three properties (properties 1, 3, and 4), the estimated exposure exceeds the short-term observed effect level (0.05 mg/kg/day [ATSDR 2007]) more than 100-fold. The estimated doses at five other properties (properties 2, 6, 7, 9, and 10) also exceeded the short-term observed effect level, but to a lesser degree. Possible health effects resulting from these pica exposures might be nausea, vomiting, headaches, stomach cramps, diarrhea, fatigue, chills, sore throat, and nasal discharge. These effects are usually temporary provided exposure to arsenic is stopped. However, exposures, particularly between 1 and 13 mg/kg/day—expected from a pica child scenario—could lead to serious, and potentially deadly health effects because they approach or exceed exposures that are reported to cause death [ATSDR 2007].

Short-Term Exposure from Non-Pica Behavior

Using the RME soil ingestion rate (200 milligrams/episode) for a 1 to 2-year-old child, the estimated exposure at seven properties exceeds the ATSDR acute MRL (hazard quotient greater than 1, Table 2). The estimated arsenic exposure from soil exceeds the short-term observed effect level on properties 1, 2, 3, and 4 (MOE less than 1, Table 2). For properties 6, 9, and 10, the short-term arsenic exposure from soil in the RME scenario exceeds ATSDR's acute MRL and results in a margin of exposure which is indicative of inadequate protection against short-term non-cancer health effects.

Based on both pica and non-pica acute exposure scenarios for young children, exposure to arsenic in soil on these residential properties shown in Table 2 constitutes a significantly elevated risk for the short-term non-cancer arsenic health effects previously described.

Table 2. Non-cancer hazard quotients for short-term exposure to arsenic in shallow soil for a 1 to 2- year-old child on residential properties on the Arsenic Mine Site

Property	Arsenic Soil Conc.[a] (mg/kg)	Estimated Pica Behavior Exposure[b] (mg/kg/day)	Estimated RME Exposure[b] (mg/kg/day)	Short-Term HQ[c] Pica	Short-Term HQ[c] RME	Short-Term MOE[d] Pica	Short-Term MOE[d] RME
1	49,300	13	0.52	2,595	104	< 1	< 1
2	6,050	1.6	0.064	318	13	< 1	< 1
3	56,000	15	0.59	2,947	118	< 1	< 1
4	20,600	5.4	0.22	1,084	43	< 1	< 1
5	181	0.048	0.0019	9.5	0.38	1.0	26
6	687	0.18	0.0072	36	1.4	< 1	6.9
7	317	0.083	0.0033	17	0.7	< 1	15
8	100	0.026	0.0011	5.2	0.2	1.9	47
9	1,520	0.4	0.016	80	3.2	< 1	3.1
10	841	0.22	0.0089	44	1.7	< 1	5.7

Data source: Arsenic Mine Site Health Consultation [ATSDR 2019]

HQ = hazard quotient; mg/kg = milligrams of arsenic per kilogram of soil; mg/kg/day = milligram of arsenic per kilogram of body weight per day; MOE = margin of exposure; RME = reasonable maximum exposure

[a] The highest arsenic concentration in soil on each property is used as the exposure point concentration to evaluate short-term exposure risks.

[b] Exposure estimates are for 1 to 2-year-old child weighing 11.4 kilograms who ingests 5,000 milligrams (pica) or 200 milligrams (RME) of soil per episode [ATSDR 2019a].

[c] The hazard quotient is calculated by dividing the estimated contaminant exposure by the ATSDR acute arsenic MRL of 0.005 mg/kg/day [ATSDR 2007].

[d] The margin of exposure is calculated by dividing the short-term human observed effect level for arsenic (0.05 mg/kg/day [ATSDR 2007]) by the estimated arsenic exposure from soil. A margin of exposure less than 1 means the estimated exposure is higher than the short-term human arsenic exposure reported to have caused health effects. On the other hand if MOE is 10, this means that the exposure is 10 times below levels that cause harmful, non-cancerous effects.

Long-Term Exposure

The estimated long-term exposure dose to the arsenic in residential shallow soil exceeded the ATSDR chronic MRL and USEPA arsenic RfD (0.0003 mg/kg/day [USEPA 1991; ATSDR 2007]) for all ten properties. Because the exposure exceeds the chronic MRL and RfD (hazard quotient greater than 1, Table 3), the NYSDOH evaluated the MOE for long-term health effects.

The arsenic reference dose is based on skin darkening (hyperpigmentation) and localized overgrowth of skin (keratosis) in humans exposed to high levels of arsenic in their drinking water over long periods of time [USEPA 1991]. The estimated long-term exposure to arsenic in soil on four properties is greater than the arsenic exposure level that caused hyperpigmentation in humans (MOE less than 1; properties 1, 2, 3, and 4; Table 3). This observed effect level (0.014 mg/kg/day [USEPA 1991]) is exceeded by 27-fold on Property 1, 14-fold on Property 3, 11-fold on Property 4, and 2-fold on Property 2. Long-term exposure to arsenic in soil on these properties poses a significantly elevated risk for non-cancer health effects, such as hyperpigmentation and keratosis, as well as other adverse health effects [USEPA 1991; ATSDR 2007].

For the other properties, the margin of exposure ranges from about 2 to 51 (Table 3). On Property 9, the soil exposure is about equal to the human observed effect level (margin of exposure of 1.3). This means that exposure to arsenic in soil on these properties reduces the margin of protection (as indicated by the small margins of exposure), and the difference between the arsenic exposure from soil and the arsenic observed effect level in humans indicates inadequate protection against non-cancer health effects. Long-term exposure to soil arsenic at these residential properties constitutes a significantly elevated risk for long-term non-cancer health effects.

Table 3. Non-cancer hazard quotients for long-term exposure to arsenic in soil for an infant on residential properties on the Arsenic Mine Site

Property	Arsenic Soil Concentration (mg/kg)[a]	Estimated Exposure (mg/kg/day)[b]	Long-Term HQ[c]	Long-Term MOE[d]
1	48,071	0.38	1,269	< 1
2	4,247	0.034	112	< 1
3	25,406	0.20	671	< 1
4	20,600 (maximum)	0.16	544	< 1
	4,142 (mean)	0.033	109	< 1
5	181 (maximum)	0.0014	4.7	10
	79 (mean)	0.0006	2	22
6	512	0.0041	14	3.5
7	317 (maximum)	0.0025	8	6
	116 (mean)	0.00091	3	15
8	100 (maximum)	0.00078	2.6	18
	35 (mean)	0.00027	0.9	51
9	1,398	0.011	37	1.3
10	841 (maximum)	0.0066	22	2.1
	199 (mean)	0.0016	5	9

Data source: Arsenic Mine Site Health Consultation [ATSDR 2019]

HQ = hazard quotient; mg/kg = milligrams of arsenic per kilogram of soil; mg/kg/day = milligram arsenic per kilogram body weight per day; MOE = margin of exposure; RME = reasonable maximum exposure

[a] For properties having 8 or more shallow soil samples, the arsenic exposure concentration is the 95% UCL of the mean. For properties having less than 8 shallow soil samples, both the maximum and average arsenic concentrations are used as exposure point concentrations and denoted in the table.

[b] Exposure estimates are for an infant, for whom the soil ingestion rate and body weight yield the largest contaminant dose among the seven life stages evaluated [ATSDR 2019a]. Contaminant exposure is assumed to occur via soil ingestion and dermal exposure.

[c] The hazard quotient is calculated by dividing the estimated contaminant exposure by the USEPA arsenic reference dose for oral exposure of 0.0003 mg/kg/day [USEPA 1991]. The USEPA RfD and ATSDR MRL [2007] are the same value (0.0003 mg/kg/day). The highest hazard quotient, calculated using ATSDR's reasonable maximum exposure parameters for infants [ATSDR 2019a].

[d] The margin of exposure is calculated by dividing the human observed effect level for arsenic (0.014 mg/kg/day [USEPA 1991]) by the estimated arsenic exposure from soil. A margin of exposure less than 1 means the estimated exposure is higher than the human arsenic exposure reported to have caused health effects, on the other hand if MOE is 10, this means that the exposure is 10 times below levels that cause harmful, non-cancerous effects.

Cancer Health Effects-Incidental Ingestion and/or Dermal Absorption of Contaminated Shallow Soil

Based on convincing evidence from scientific studies of people exposed to high levels of arsenic in drinking water, ingestion of arsenic increases the risk for skin, lung, and bladder cancer [ATSDR 2007; NRC 2001; NTP 2016]. The USEPA and US Department of Health and Human Services classify arsenic as a known human carcinogen [USEPA 1991; NTP 2016].

The estimated increased lifetime cancer risk posed by long term-exposure to arsenic in shallow soil on the residential properties ranged from 4 in 100,000 to 6 in 100 (Table 4). All ten properties have estimated lifetime cancer risk levels that typically trigger measures to reduce exposure (i.e., 1 in 10,000 or higher). For six properties the estimated lifetime cancer risk is 1 in 1,000 or higher, which is unusually high for environmental exposures. USEPA's generally acceptable risk for environmental exposures ranges from 1 in 10,000 to 1 in 1,000,000 as discussed in the National Contingency Plan (NCP), 40 CFR 300.430.

Overall, the arsenic on the residential properties poses a significantly elevated risk for cancer health effects. ATSDR's and NYSDOH's concern about the significance of the estimated cancer risk is increased by evidence from studies of people and animals that suggests the very young may be more sensitive to the carcinogenic effects of arsenic than adults [Ahlborn et al. 2009; Marshall et al. 2007; Smith et al. 2006; Tokar et al. 2011; Waalkes et al. 2003, 2006, 2007, 2009].

Table 4. Estimated lifetime cancer risk for long-term exposure to arsenic in shallow soil on residential properties on the Arsenic Mine Site

Property	Arsenic Soil Concentration (mg/kg)[a]	Estimated Lifetime Cancer Risk[b]
1	48,071	6 in 100
2	4,247	5 in 1,000
3	25,406	3 in 100
4	20,600 (maximum)	3 in 100
	4,142 (mean)	5 in 1,000
5	181 (maximum)	2 in 10,000
	79 (mean)	1 in 10,000
6	512	6 in 10,000
7	317 (maximum)	4 in 10,000
	116 (mean)	1 in 10,000
8	100 (maximum)	1 in 10,000
	35 (mean)	4 in 100,000
9	1,398	2 in 1,000
10	841 (maximum)	1 in 1,000
	199 (mean)	2 in 10,000

Data Source: Arsenic Mine Site Health Consultation [ATSDR 2019]
mg/kg = milligrams of arsenic per kilogram of soil

[a] For properties having 8 or more shallow soil samples, the arsenic exposure concentration is the 95% UCL of the mean. For properties having less than 8 shallow soil samples, both the maximum and average arsenic concentrations are used as exposure point concentrations, as denoted in the table.

[b] The lifetime estimated cancer risk is calculated by multiplying the estimated arsenic exposure from soil for each of seven age groups by the USEPA cancer potency factor for arsenic [USEPA 1995]. The cancer risks for each age group are then added to obtain an estimate of the lifetime cancer risk for 33 years of exposure to arsenic in soil at each property. Cancer risks estimates at higher exposures have additional uncertainty because the assumed shape of the dose-response curve used to derive the cancer potency factor may no longer hold. See the health consultation for additional details [ATSDR 2019a].

Conclusions

ATSDR has determined that current and potential future exposures to arsenic in residential soil on the Arsenic Mine Site warrant the issuance of a Public Health Advisory. In a 2019 health consultation, ATSDR and NYSDOH concluded that children at residential properties on the Arsenic Mine Site with the highest arsenic levels in shallow soils can have short-term ingestion exposures to arsenic that pose an immediate and significant threat to human health, constituting an urgent public health hazard. People can be exposed to harmful levels of arsenic by incidental ingestion of and/or dermal contact with contaminated soil. The observed concentrations of arsenic at the ten residential properties pose an urgent public health hazard.

This conclusion is based on the following five points:

1. Short-term exposure to arsenic in residential soil could result in adverse health effects. For all ten residential properties, a single ingestion of a large amount of soil (i.e., 5 grams) containing the maximum arsenic soil level found at each property, by a 1 to 2-year old child exhibiting pica behavior, results in an arsenic dose that either exceeds or approaches the arsenic exposure level which causes short-term health effects.

2. On seven properties a single ingestion of a smaller amount of soil (i.e., 200 milligrams) containing the maximum arsenic level results in an arsenic dose that either exceeds or approaches short-term arsenic exposure level which causes health-effects.

3. Long-term ingestion and dermal exposures of children and adults to arsenic in shallow soil at the Arsenic Mine Site residential properties pose a significant threat to human health and constitute a public health hazard. Long-term exposure to arsenic in residential soil could result in adverse cancer and non-cancer health effects. For all ten residential properties, long-term arsenic exposure in soil results in an estimated lifetime cancer risk of over 1 in 10,000. For six of the residential properties, the estimated cancer risk is over 1 in 1,000, which is unusually high for environmental exposures. Regarding non-cancer health risks, long-term exposure to arsenic in soil at all properties results in an arsenic dose that either exceeds or approaches the long-term arsenic exposure levels which cause health effects.

4. Neither the health consultation [ATSDR 2019a] nor this advisory evaluate other possible sources of arsenic exposure, such as inhalation of arsenic contaminated soil or dust, consumption of untreated drinking water, home raised animal products, or fruits and vegetables grown in contaminated soil. Consideration of these additional potential exposure pathways would not change the conclusions and recommendations provided in this advisory, but may likely support and strengthen them.

5. For decades, health risks at this site have been difficult to manage. Short-term remedies (e.g., cistern, water filters) have been implemented to address drinking water concerns; however, the soil remains contaminated with arsenic at levels that may cause serious health effects. As long as shallow soils remain contaminated with elevated levels of arsenic, children and adults will continue to be at risk of exposure to levels of arsenic posing an immediate and significant threat to human health. The amount of exposure to arsenic and consequent health risk depend, in part, on the degree to which residents access the contaminated properties and the activities they conduct there. These risks are considerable for all residents and for persons using the Arsenic Mine Site properties. If no permanent remedy is undertaken to address arsenic contamination of the Arsenic Mine Site, this risk can potentially affect all future residents and persons, particularly children, accessing the ten Arsenic Mine Site properties.

Recommendations and Proposed Actions

ATSDR recommends that the USEPA take immediate short- and long-term measures to **dissociate** persons, especially children, from exposure to arsenic in shallow soils at the Arsenic Mine Site. USEPA took steps to inform property owners of their soil arsenic results, investigate residential drinking water sources for potential arsenic contamination, and provide information to residents on best practices for avoiding exposures to arsenic in soil and drinking water. Additionally, USEPA should continue to investigate the potential impact on residential drinking water sources from arsenic releases related to historic mining activities at the Arsenic Mine Site and take appropriate actions to prevent harmful arsenic exposures.

Over the longer term, USEPA should permanently remediate the source of arsenic in shallow soils at the Arsenic Mine Site. Until completion of a permanent solution, all residents and persons accessing the Arsenic Mine Site properties may continue to be exposed to arsenic at levels that present an imminent and significant health threat. The USEPA should continue taking actions to prevent harmful exposures to arsenic in residential soils and other possible routes of exposure, such as consumption of contaminated drinking water.

Until a long-term remedial action can be put in place, ATSDR recommends that people take practical measures to reduce exposure to arsenic in soil:

- People, especially children, should minimize direct and repeated contact with bare soils.
- Maintain a grass or mulch cover wherever possible to help reduce direct contact with the soil.
- Wipe shoes on doormat or remove shoes before entering the home. Apply general good housekeeping practices by periodically damp mopping floors, vacuuming (using a HEPA filter if available), and cleaning furniture to help reduce exposure to outdoor soil that might be tracked indoors. Avoid the use of brooms.
- Avoid unnecessary digging in the dirt.
- Children and adults should wash hands after outdoor activities to help reduce the potential for exposure.
- Wash children's toys regularly.
- Refrain from landscaping activities that increase exposure to soil and create bare areas of soil.
- Refrain from eating food or smoking when working in the yard.
- Refrain from consumption of home raised fruits, vegetables, and animal products. If residents choose to garden, they grow crops in raised bed gardens and containers with clean soil imported from a non-contaminated area or bagged soil bought commercially instead of the existing soil. Residents should wear gloves when gardening and dispose or wash gloves thoroughly after each use.
- Regularly wash pets that may go outdoors and contact the soil.
- Properly maintain water treatment systems in accordance with the manufacturer's specification.

Additional public health actions are planned by ATSDR:

1. Immediately, ATSDR will coordinate with the NYSDOH, NYSDEC, Putnam County Health Department, USEPA, and the Town of Kent to provide health education to residents whose properties are affected by arsenic contamination on how to reduce arsenic exposure. Activities may include public meetings, public availability sessions, preparation of factsheets, and information sessions and mailings for local physicians to assist them in addressing their patients' concerns.

2. ATSDR will advise area health care providers, particularly pediatricians and family care practitioners, of this report's findings. ATSDR will make available materials related to arsenic exposure and health effects.

3. The ATSDR and NYSDOH will continue to coordinate with the USEPA, NYSDEC, and Putnam County Health Department to implement the recommendations contained in the accompanying health consultation [ATSDR 2019a].

4. The NYSDOH and ATSDR will review additional USEPA-collected data (e.g., drinking water, other contaminants of concern in soil), evaluate the public health implications of additional sampling results, and recommend public health actions as needed.

5. ATSDR will respond to requests involving the Arsenic Mine Site as necessary.

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Attachment 2

U.S. ENVIRONMENTAL PROTECTION AGENCY, REGION II
Superfund and Emergency Management Division
290 Broadway, 18th Fl
New York, NY 10007

MEMORANDUM

TO: Sandra Richards, On-Scene Coordinator (SEMD/RAB/RAES)

FROM: Abbey States (SEMD/PSB/TSS)

DATE: April 30, 2019

RE: Arsenic Mine Site – Determination of Significant Threat

Introduction

The purpose of this memo is to document the U.S. Environmental Protection Agency's (EPA) determination of significant threat for the Arsenic Mine site (the Site). This document is consistent with 40 CFR Section 300.425(c)(3) of the National Oil and Hazardous Substances Contingency Plan. The Arsenic Mine Site consists of ten residential properties in the Town of Kent, Putnam County, New York in the vicinity of a historic mine, which was previously known as Pine Pond Mine, Silver Mine, and Brown's Serpentine Mine. The mine contains arsenopyrite, a metal ore that was used in ammunition, pesticides, pigments, and other industries. The two former entry shafts to the mine are located near Mt. Nimham Court and Gipsy Trail Road; the northern, main mine shaft is located on private property and the southern mine shaft is in Nimham Mountain Multi-Use Area; this Site focuses only on the area around the northern mine shaft as well as down slope properties. The area has naturally high levels of arsenic in the soil and groundwater. Due to the historic mining activities and residual tailings, arsenic concentrations are present on residential properties in surficial soils (up to a depth of 2 feet) above naturally-occurring background levels. EPA conducted extensive sampling in the area in 2017-2018 and determined CERCLA actions were necessary based on exceedances of the natural background level. Exposure to these elevated arsenic concentrations in soil presents an unacceptable risk to residents of these properties. Therefore, actual and threatened releases of hazardous substances from the Site present a significant threat to public health and welfare.

Determination of Natural Background

In August 2017, New York State Department of Environmental Conservation (NYSDEC) conducted a background study of surface soils in Nimham Mountain Multi-Use Area. Ten circular study areas, each approximately 100 meters in diameter, were identified as background study areas. Five study areas were located in the vicinity of historic mining activity, but outside

of known source areas. The remaining five, background areas, are at a higher elevation within the Multi-Use Area, but within one mile of the historic mining activity. Six surface soil samples (0-6") were collected from each circular area and analyzed ex-situ using an x-ray fluorescence (XRF) device.

NYSDEC's background study was used in the calculation of statistical site-specific background threshold values (BTVs) through EPA's Site Characterization and Monitoring Technical Support Center in the Office of Research and Development (ORD). BTVs are "not to exceed" values which are used to compare measurements in areas of concern with background measurements. The ORD report calculated four potential BTVs using different statistical methods that could potentially be applied at the Site. The lowest and most-conservative BTV, which excluded one sampling area determined to be an outlier in different geologic setting, was 123.9 mg/kg arsenic based on a 95% Hawkins-Wixley Gamma Upper Tolerance Limit and was selected for comparison. The full report, titled "Development of Statistically-Defensible Background Values for Arsenic in Surface Soils, Arsenic Mine Background Determination" is included in this memo as Attachment 1.

Risk Evaluation

EPA conducted a screening-level risk evaluation using data from the most recent and comprehensive sampling event in June 2018. Consistent with the background study, samples were analyzed ex-situ via XRF; all samples collected from 0-24" were included in the screening evaluation. Approximately 20% of the collected samples for this sampling event were submitted for Target Analyte List (TAL) Metals analysis in a laboratory setting. Confirmatory lab samples resulted in a 96% correlation with the XRF results for arsenic. Conservative estimates of the average arsenic concentration in surface soil that a resident could be exposed to, known as exposure point concentrations (EPCs), were statistically determined for each property using the 95% Upper Confidence Limit (UCL) in ProUCL 5.1 (Attachment 2). EPCs and maximum concentrations for each property were compared to both EPA's Removal Management Level (RML) for arsenic, set at a cancer risk of 10^{-4} (a one in ten thousand excess cancer risk) and hazard of 1, as well as the site-specific background concentration determined by ORD. RMLs are risk-based screening level concentrations derived from exposure assumptions and risk assessment methods presented in the Risk Assessment Guidance for Superfund (EPA, 1991). While RMLs are not necessarily intended to be protective for long-term exposures, they support the decision for EPA to undertake a Removal Action to achieve short-term protectiveness. The maximum sample concentrations and EPCs for all ten properties exceeded EPA's RML of 35 mg/kg arsenic. Eight properties contained maximum concentrations above the site-specific background value of 124 (rounded up from 123.9). Exposure point concentrations for five properties (P001, P002, P003, P009, and P010) exceeded the background value.

Table 1

Property ID	EPA Arsenic RML (mg/kg)	Site-Specific Arsenic BTV (mg/kg)	Max concentration (mg/kg)	EPC (mg/kg)	EPC Statistic
P001	35	124	54,177	20,304	97.5% Chebyshev (Mean, Sd) UCL
P002			2,313	715	95% Chebyshev (Mean, Sd) UCL
P003			30,822	6,598	95% Chebyshev (Mean, Sd) UCL
P004			159	85.2	95% Chebyshev (Mean, Sd) UCL
P005			136	69.4	95% Chebyshev (Mean, Sd) UCL
P006			83	39.7	95% Chebyshev (Mean, Sd) UCL
P007			232	80.6	95% Chebyshev (Mean, Sd) UCL
P008			97	55.4	95% H-UCL
P009			4,072	579	95% Chebyshev (Mean, Sd) UCL
P010			582	120	95% Adjusted Gamma UCL

Numerical value highlighted in yellow - Exceedance of EPA RML
Numerical value highlighted in red – Exceedance of EPA RML and BTV

Results

Using the 95% UCL for each property, the cancer risk and noncancer hazards were determined using EPA's RML calculator (EPA, 2018). Results of the screening evaluation are summarized in Table 2 below; all RML calculator outputs are included in Attachment 3. Calculated EPCs for five properties resulted in unacceptable cancer risk to residents exceeding the unacceptable risk threshold of 10^{-4}. Three additional properties had a cancer risk equal to 10^{-4} to one significant figure. EPCs for nine properties resulted in hazards for child residents above the threshold of one, and the remaining property (P006) had a hazard index equal to one rounded to one significant figure. Four properties contain EPCs resulting in unacceptable hazards to adult residents.

Table 2

Property ID	EPC (mg/kg)	Cancer Risk	Child Hazard Index	Adult Hazard Index
P001	20,304	3.0E-02	582	60
P002	715	1.1E-03	20.5	2.0
P003	6,598	9.8E-03	189	20
P004	85.2	1.3E-04	2.4	0.3
P005	69.4	1.0E-04	2	0.2
P006	39.7	5.9E-05	1.1	0.1
P007	80.6	1.2E-04	2.3	0.2
P008	55.4	8.2E-05	1.6	0.2
P009	579	8.6E-04	17	1.7
P010	120	1.8E-04	3.5	0.4

Numerical value highlighted in red – Exceeds EPA's acceptable risk threshold (cancer risk > 10^{-4} and hazard > 1)
Numerical value highlighted in yellow – At EPA's acceptable risk threshold (rounded to one significant figure)

Conclusions

All residential properties that are considered part of the Arsenic Mine site contain exposure point concentrations that result in calculated risks or hazards to residents that are at or above the threshold for unacceptable risk. Exposure to arsenic in surface soils at the Site presents a significant threat to public health and welfare.

In April 2019, NYSDOH and ATSDR issued a health consultation which assessed the potential arsenic exposures to area residents based on EPA's previous sampling investigations on the affected properties. Both agencies concluded that there is evidence of a complete exposure pathway for ingestion of and dermal contact with arsenic in surface soils. The health consultation determined that current and potential future short-term ingestion exposure of arsenic in contaminated soil by children at the Site represents an urgent public health hazard. Both agencies also concluded that long term ingestion and dermal exposure of children and adults to arsenic-contaminated surface soil poses a significant threat to human health, constituting a public health hazard. In April 2019, ATSDR issued a Public Health Advisory for the site, recommending that EPA take short- and long-term measures to dissociate residents, especially children, from properties with the highest concentrations of arsenic in soil to prevent continued exposure.

A Removal Action for the affected properties is planned for the coming months to interrupt the immediate exposure pathway to contaminated surface soils for current residents. These interim actions include the installation of barriers to contaminated soil in high-use areas, boot washes to reduce arsenic migration inside residences, and removal/replacement of soils that are used for gardening, pets, and livestock. While these actions should reduce overall exposure to and indoor migration of contaminated soils temporarily, there will remain a high potential for rapid

recontamination from uncapped contaminated soils via overland transport. Additional action is needed to protect the long-term human health of affected residents.

References

EPA, 1991. Risk Assessment Guidance for Superfund: Volume 1, Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals) (RAGS Part B), Office of Emergency and Remedial Response, Washington D. C. EPA/540/R-92/003

EPA, 2018. Regional Removal Management Level Calculator, Available at https://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search?tool=rml. Accessed: October 22, 2018, January 31, 2019 and April 30, 2019.

Attachment 1 - Leidos-SERAS, 2018. Development of Statistically-Defensible Background Values for Arsenic in Surface Soils, Arsenic Mine Background Determination, SERAS-106 Work Order #94.

Attachment 2 - ProUCL outputs (P001-P010)

Attachment 3 - RML calculator output (P001-P010)

Attachment 1

Leidos-SERAS, 2018. Development of Statistically-Defensible Background Values for Arsenic in Surface Soils, Arsenic Mines Background Determination, SERAS-106 Work Order #94

Leidos-SERAS
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DATE: July 23, 2018

TO: Felicia Barnett, Director SCMTSC, EPA Work Assignment Manager

FROM: Donna Getty, SERAS Statistician

THROUGH: Richard Leuser, SERAS Deputy Program Manager/Task Leader

SUBJECT: DEVELOPMENT OF STATISTICALLY-DEFENSIBLE BACKGROUND VALUES FOR ARSENIC IN SURFACE SOILS, ARSENIC MINES BACKGROUND DETERMINATION, SERAS-106 WORK ORDER #94

INTRODUCTION

Arsenic Mines or the Ninham Mine Site is the location of historic arsenic mining from the late 1800s to 1918. It consists of approximately 50 acres of mountains and forested lands located in Putnam County, New York (NY) in the town of Kent. The land is currently owned by New York State and is maintained as a recreational Multiple Use Area. The U.S. Environmental Protection Agency (EPA) and New York State Department of Environmental Conservation (NYSDEC) are currently conducting a soil characterization investigation of private parcels near the site to delineate the potential impact of historic mining activities. A surface soil background study was completed in August 2017 to assist in establishing a defensible background arsenic-level that can be used to guide a Removal Action (RA) in adjacent areas of privately owned property.

Six surface (0 to 6 inch interval) soil samples were collected from each of ten identified background study areas. Background study areas are approximately circular and 100 meters in diameter. Five of the areas are located in the vicinity of historic mining activities but outside of known source areas. The remaining five areas are located further up Ninham Mountain. The background samples were analyzed ex-situ using an x-ray fluorescence (XRF) analyzer. Twelve samples were submitted for laboratory analysis to verify the XRF results.

BACKGROUND

EPA Region 2 has requested statistical support from the EPA Site Characterization and Monitoring Technical Support Center (SCMTSC) in developing statistically-based background threshold values (BTVs). BTVs are “not-to-exceed” values which are used to compare measurements in areas of concern with background measurements. These values are estimated by computing decision statistics such as 95 percent (%) upper confidence limits (95UCLs), upper percentiles, upper prediction limits (UPLs) or upper tolerance limits (UTLs) from representative background data sets. A defensible BTV is based on a background data set, representing a single environmental and statistical population, free of outliers and of

sufficient size. For this project, surface soil arsenic concentrations collected from the adjacent privately owned land, can be compared to the computed BTVs as a point-by-point comparison to establish whether arsenic concentrations exceed the estimated background levels. An alternate approach is a two-sample hypothesis test, such as a t-test, which would compare the background population with arsenic concentrations collected from each pre-defined decision unit (DU). Delineation of DUs can be based on property lines, geographic features, land use, etc. Sample results from each DU are compared to the background data set with a final decision being made that the entire DU exceeds or does not exceed background levels.

This technical memorandum (TM) provides a summary of the data analysis performed, includes recommendations regarding the computation of arsenic BTVs in surface soil, and details statistical methods which can be applied to determine if arsenic surface soil concentrations on the privately-owned land parcels exceed background arsenic levels. Data used in the statistical analyses was provided by EPA Region 2 and is assumed to have been collected using an appropriate representative sampling design. It is also assumed that the XRF analysis was performed in accordance with documented standard operating procedures (SOPs).

The background data evaluated in this TM was collected as a part of a surface soil background study conducted by NYSDEC to determine if arsenic concentrations found in surface soil outside of source areas is due to historic mining operations. Two groups of background areas were sampled:

- Site_BKGD Group: Consists of five areas located near historical mining activities which have been labeled as "Site BKGD_Area 1" through "Site BKGD_Area 5", and
- BKGD Group: Consists of five areas located further up Ninham Mountain which have been labeled as "BKGD Area 1" through "BKGD Area 5".

Statistical software packages ProUCL version 5.1.002 and SAS version 9.4 were used to evaluate the background data consisting of both ex-situ XRF results (N=60) and paired XRF and laboratory analytical results (n=12).

EXPLORATORY DATA ANALYSIS

Descriptive summary statistics were computed per background study area (e.g, Site BKGD Area 1, BKGD Area3, etc.) and per group (Site_BKGD and BKGD) for the ex-situ XRF arsenic measurements. Statistical graphs including box plots and quantile-quantile (Q-Q) plots were created to examine the data distribution of the individual background areas and groups and for the identification of potential outliers, to support the selection of an appropriate BTV to guide the proposed RA. Additionally, the data was examined to ensure that the arsenic measurements from the ten Areas represent a single background population, not multiple populations.

Table 1 is a summary of basic descriptive statistics for background XRF arsenic concentrations for each group, BKGD and Site_BKGD. Table 2 contains tabulated descriptive statistics per Area.

Table1. Descriptive Statistics of Background XRF Arsenic (mg/kg) Measurements per Group

General Statistics for Censored Data Set (with NDs) using Kaplan Meier Method

Variable	Num Obs	# Missing	Num Ds	Num NDs	% NDs	Min ND	Max ND	KM Mean	KM Var	KM SD	KM CV
BKGD	30	0	29	1	3.33%	5.96	5.96	40.12	1140	33.76	0.841
Site BKGD	30	0	30	0	0.00%	N/A	N/A	49.77	516.9	22.74	0.457

General Statistics for Raw Data Sets using Detected Data Only

Variable	Num Obs	# Missing	Minimum	Maximum	Mean	Median	Var	SD	MAD/ 0.675	Skewness	CV
BKGD	29	0	6.1	119.5	41.3	26.1	1178	34.32	27.65	0.939	0.831
Site BKGD	30	0	16.45	104.6	49.77	46.82	516.9	22.74	22.16	0.709	0.457

Percentiles using all Detects (Ds) and Non-Detects (NDs)

Variable	Num Obs	# Missing	10%ile	20%ile	25%ile (Q1)	50%ile (Q2)	75%ile (Q3)	80%ile	90%ile	95%ile	99%ile
BKGD	30	0	6.454	8.658	16.15	25.99	61.53	75.2	94.79	103.4	116.7
Site BKGD	30	0	27.37	30.37	31.62	46.82	60.91	63.92	82.54	91.22	102.3

Table2. Descriptive Statistics XRF Arsenic (mg/kg) Measurements per Area

General Statistics for Censored Data Set (with NDs) using Kaplan Meier Method

Variable	Num Obs	# Missing	Num Ds	Num NDs	% NDs	Min ND	Max ND	KM Mean	KM Var	KM SD	KM CV
BKGD Area 1	6	0	6	0	0.00%	N/A	N/A	38.57	1037	32.21	0.835
BKGD Area 2	6	0	5	1	16.67%	5.96	5.96	6.489	0.228	0.478	0.0736
BKGD Area 3	6	0	6	0	0.00%	N/A	N/A	66.79	1229	35.06	0.525
BKGD Area 4	6	0	6	0	0.00%	N/A	N/A	23.18	40.08	6.331	0.273
BKGD Area 5	6	0	6	0	0.00%	N/A	N/A	65.59	1195	34.57	0.527
Site_BKGD Area 1	6	0	6	0	0.00%	N/A	N/A	74.46	550.8	23.47	0.315
Site_BKGD Area 2	6	0	6	0	0.00%	N/A	N/A	47.45	424.8	20.61	0.434
Site_BKGD Area 3	6	0	6	0	0.00%	N/A	N/A	54.58	109.1	10.44	0.191
Site_BKGD Area 4	6	0	6	0	0.00%	N/A	N/A	29.96	142.2	11.92	0.398
Site_BKGD Area 5	6	0	6	0	0.00%	N/A	N/A	42.4	469.6	21.67	0.511

General Statistics for Raw Data Sets using Detected Data Only

Variable	Num Obs	# Missing	Min	Max	Median	Var	SD	MAD / 0.675	Skewness	CV
BKGD Area 1	6	0	8.96	95.64	26.38	1037	32.21	19.37	1.372	0.835
BKGD Area 2	5	0	6.1	7.45	6.46	0.258	0.508	0.156	1.567	0.0771
BKGD Area 3	6	0	25.87	109.7	70.08	1229	35.06	47.59	-0.0785	0.525
BKGD Area 4	6	0	15.65	34.54	22.4	40.08	6.331	3.473	1.179	0.273
BKGD Area 5	6	0	24.92	119.5	68.64	1195	34.57	35.5	0.4	0.527
Site_BKGD Area 1	6	0	47.44	104.6	71.2	550.8	23.47	29.13	0.22	0.315
Site_BKGD Area 2	6	0	27.91	73.85	46.28	424.8	20.61	25.42	0.184	0.434
Site_BKGD Area 3	6	0	38.54	70.28	53.68	109.1	10.44	6.208	-0.0391	0.191
Site_BKGD Area 4	6	0	16.45	46.2	30.2	142.2	11.92	16.88	0.099	0.398
Site_BKGD Area 5	6	0	22.55	84.57	36.75	469.6	21.67	6.731	1.933	0.511

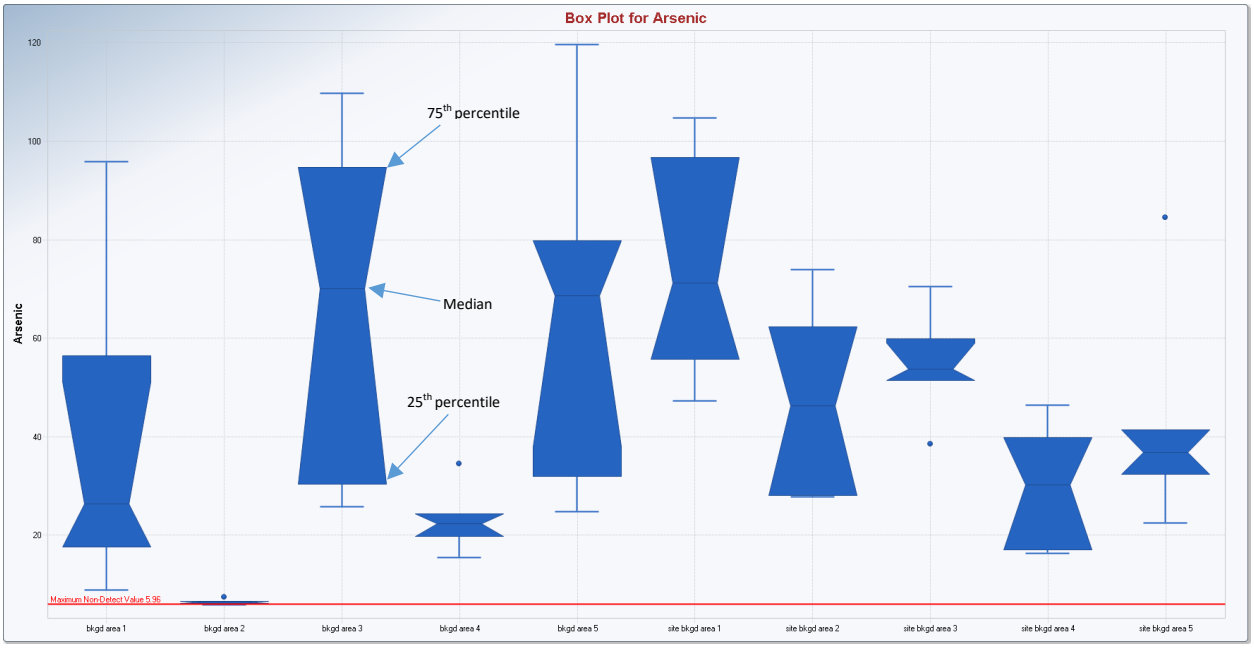
Percentiles using all Detects (Ds) and Non-Detects (NDs)

Variable	Num Obs	# Missing	10%ile	20%ile	25%ile (Q1)	50%ile (Q2)	75%ile (Q3)	80%ile	90%ile	95%ile	99%ile
BKGD Area 1	6	0	13.31	17.66	19.77	26.38	48.98	56.42	76.03	85.83	93.67
BKGD Area 2	6	0	6.03	6.1	6.175	6.43	6.539	6.565	7.008	7.229	7.406
BKGD Area 3	6	0	28.12	30.37	36.32	70.08	92.52	94.7	102.2	105.9	108.9
BKGD Area 4	6	0	17.68	19.71	20.37	22.4	23.9	24.39	29.46	32	34.03
BKGD Area 5	6	0	28.44	31.96	39.78	68.64	78.4	79.85	99.69	109.6	117.5
Site_BKGD Area 1	6	0	51.55	55.67	56.77	71.2	93.08	96.66	100.6	102.6	104.2
Site_BKGD Area 2	6	0	27.97	28.04	28.87	46.28	62.04	62.33	68.09	70.97	73.27
Site_BKGD Area 3	6	0	44.99	51.45	51.73	53.68	58.57	59.83	65.05	67.67	69.76
Site_BKGD Area 4	6	0	16.72	16.98	20.21	30.2	37.44	39.76	42.98	44.59	45.87
Site_BKGD Area 5	6	0	27.45	32.36	32.88	36.75	40.84	41.44	63	73.78	82.41

It can be seen in Table 2, that the mean, median, and upper percentiles of surface soil arsenic concentrations (milligram per kilogram [mg/kg]) collected from BKGD Area 2 are an order of magnitude smaller than all of the other Areas. For example, the 95th percentile of arsenic in BKGD Area 2 is 7.229 mg/kg while the 95th percentiles for the other Areas range from 32 mg/kg to 109.6 mg/kg. Additionally, variability is significantly less for BKGD Area 2 (standard deviation of 0.508 mg/kg for detected values; coefficient of variation [CV] = 0.0771) than for the other nine Areas, where standard deviations ranged from 6.331 mg/kg to 34.57 mg/kg and CVs, ranged from 0.191 to 0.835.

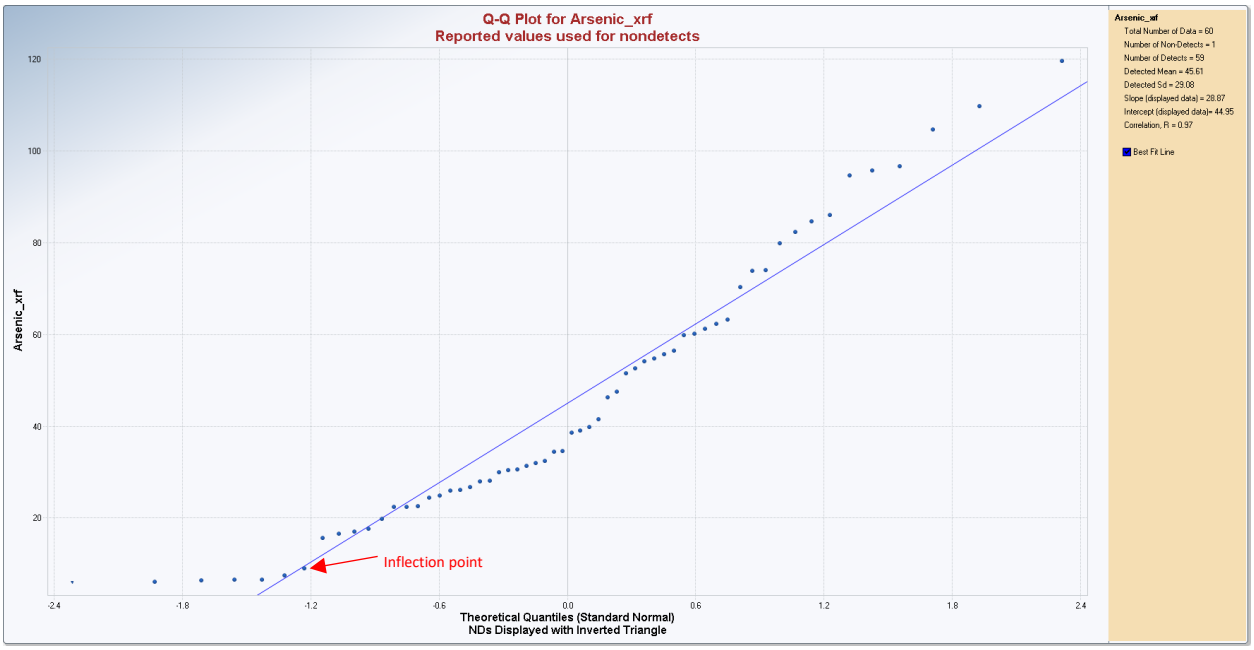
Side-by-side box plots of the XRF arsenic measurements by Area provides a graphical comparison of the background data. Box plots depict the highest and lowest values, the median (50th percentile, shown where the dark blue box pinches inwards), the 25th percentile (bottom of the box and beginning of bottom whisker), 75th percentile (top of the box and beginning of the upper whisker), the degree of dispersion (length of the blue box) and potential outliers (dots that extend beyond the whiskers).

Figure 1. Side-by-Side Box Plots of XRF Arsenic (mg/kg) Per Background Area



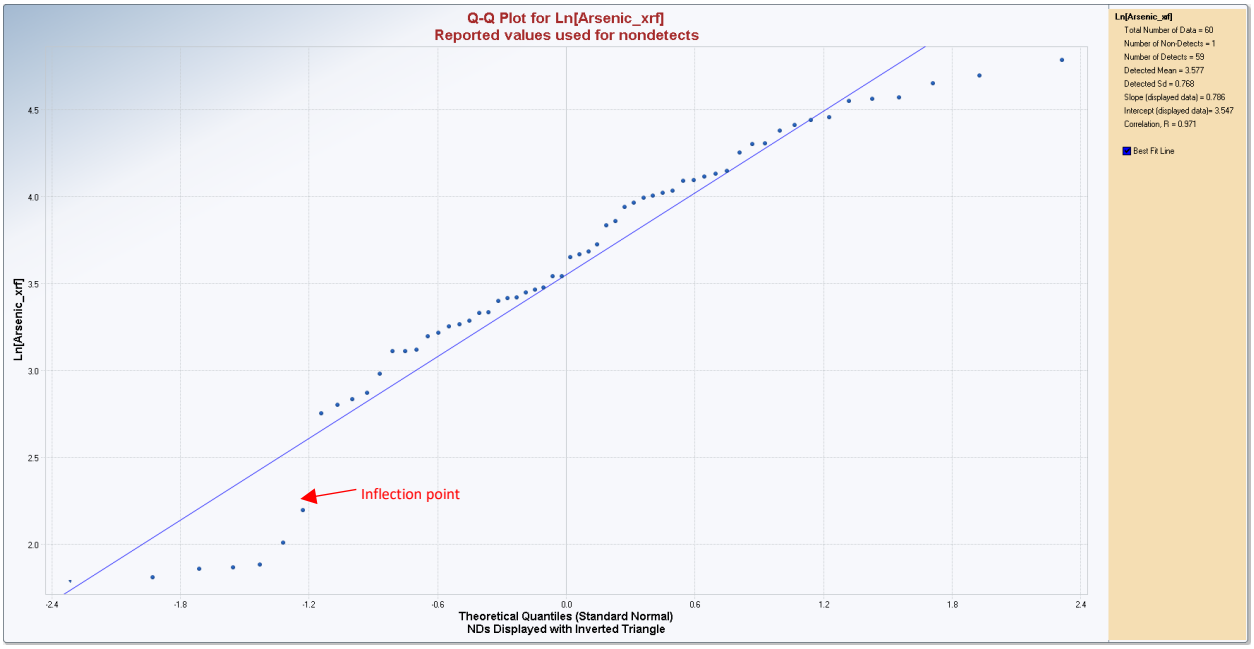
From the side-by-side box plots, it can be seen that the XRF arsenic measurements collected from BKGD Area 2 follow a much different "pattern" or data distribution than the measurements from the other nine Areas. Q-Q plots were generated to further investigate the background data distribution. Q-Q plots are graphs of the observations ordered from smallest to largest (y-axis), and plotted against the quantiles/percentiles of an assumed statistical distribution, such as a normal or log-normal distribution. Jumps and breaks, inflection points, in the data pattern of a Q-Q plot can suggest the presence of multiple populations within a single data set (EPA 2015) and points well-separated from the majority of the data may represent potential outliers. Figure 2 contains a Q-Q plot of the entire background data set (N=60) of XRF arsenic measurements assuming a normal distribution. The six lowest points (6 to 7 mg/kg) on the Q-Q plot are XRF concentrations from BKGD Area 2 including one non-detect (6 mg/kg). The next lowest value was measured in BKGD Area 1, arsenic = 9 mg/kg. These observations are separated from the remaining arsenic measurements, with an identifiable break in the pattern. A multiple Q-Q plot of the arsenic measurements by Area (Figure A1) and another by Group (Figure A2) were also created and examined. These plots can be found in the Appendix.

Figure 2. Q-Q Plot of XRF Arsenic (mg/kg) for all Areas



Goodness of Fit (GOF) tests were run on the XRF arsenic measurements to determine the expected distribution of the data. GOF tests with and without the BKGD Area 2 measurements indicate the data could follow an approximate lognormal (Ln) distribution or gamma distribution. The break in the data pattern becomes more obvious when depicted as a lognormal distribution (Figure 3). Rosner's Outlier test did not identify any outliers at the 0.05 significance level for the lognormally transformed XRF arsenic measurements, when including or excluding the BKGD Area 2 data.

Figure 3. Q-Q Plot of Ln[XRF Arsenic (mg/kg)] for all Areas



Both parametric (analysis of variance [ANOVA]) and nonparametric (Kruskal-Wallis [KW]) statistical analyses were performed to compare the measures of central tendency, means/medians, of the ten background areas. One assumption of a classical one-way ANOVA is that the variances of the populations being looked at are comparable, also known as homoscedasticity of the populations. As was seen in the box plots and the descriptive statistics, the variance for BKGD Area 2 is an order of magnitude different from the arsenic XRF measurements collected within the other areas. Therefore, a K-W non-parametric ANOVA was also performed to support the results of the ANOVA. These tests were conducted with a significance level, alpha, set to 0.05 therefore, a computed probability-value (p-value) of less than (<) 0.05 indicates a significant difference between the arsenic populations. A summary of the ANOVA and KW test statistics can be found in Tables 3 and 4. Detailed statistical output can be found in the Appendix. Both the ANOVA and KW Test indicated a statistically significant difference exists between the arsenic measurements with p-values <0.0001. Multiple comparisons of the means (Fischer's Least Square Difference, Tukey's and Student-Newman-Keuls), which are post-hoc tests utilized when a statistically significant difference is found between observations by ANOVA, compare each Area against all other Areas while controlling Type 1, Type 2 and/or experiment-wise errors that would be affected if multiple t-tests were conducted. The post hoc tests identified the mean arsenic XRF measurements of BKGD Area 2 as significantly different from the other nine Areas. Detailed statistical output for these tests can be found in the Appendix.

Table 3. Analysis of Variance of XRF Arsenic (mg/kg) Measurements between Areas

The ANOVA Procedure

Dependent Variable: lnas_xrf

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	9	26.27613000	2.91957000	13.12	<.0001
Error	50	11.12521551	0.22250431		
Corrected Total	59	37.40134551			

R-Square	Coeff Var	Root MSE	lnas_xrf Mean
0.702545	13.29773	0.471704	3.547250

Source	DF	Anova SS	Mean Square	F Value	Pr > F
Area	9	26.27613000	2.91957000	13.12	<.0001

Table 4. Nonparametric ANOVA of XRF Arsenic (mg/kg) Measurements between Areas

Nonparametric Oneway ANOVA (Kruskal-Wallis Test)

Group	Obs	Median	Ave Rank	Z
bkgd area 1	6	26.38	25.83	-0.69
bkgd area 2	6	6.43	3.5	-3.992
bkgd area 3	6	70.08	41.5	1.626
bkgd area 4	6	22.4	15.5	-2.218
bkgd area 5	6	68.64	42	1.7
site bkgd area 1	6	71.2	48	2.587

Group		Obs	Median	Ave Rank	Z
site bkgd area 2		6	46.28	34.83	0.641
site bkgd area 3		6	53.68	39.5	1.331
site bkgd area 4		6	30.2	22.5	-1.183
site bkgd area 5		6	36.75	31.83	0.197
Overall		60	36.54	30.5	
K-W (H-Stat)		DOF	P-Value	(Approx. Chisquare)	
33.46		9	1.11E-04		
33.46		9	1.11E-04	(Adjusted for Ties)	

Discussion: A statistically defensible background data set should be representative of a single background statistical population. The presence of multiple populations within a background data set can potentially negatively impact the computation of a BTV. Both formal statistical testing and statistical graphs were used to examine the data distributions and evaluate the potential presence of multiple populations within the background XRF measurements collected at the Arsenic Mine Site. BKGD Area 2 appears to belong to a different statistical population than the other nine background areas, however it is the field team and decision-makers with expert Site knowledge who should determine whether BKGD Area 2 represents true background conditions at the Arsenic Mine Site and if the corresponding data should be included in the computation of a BTV.

COMPUTATION OF A BTV

Selection of an appropriate and defensible BTV is based on the data distribution, the percentage of nondetects (ND), and the size of the background data set, as well as, the project objectives. Exploratory data analysis indicated the data follow either a gamma or an approximate lognormal distribution with a single ND value located in BKGD Area 2. Typically, the point-by-point comparison approach (e.g., comparison to a BTV) is used when a small number (< 6) of comparisons will be made or confidence levels associated with the comparisons can be affected. Because a larger number of point-by-point comparisons are expected for this project, a BTV based on a UTL is recommended. Use of a UTL instead of a UCL, UPL, or upper percentile, assists in controlling the Type 1 or false positive error rate (EPA 2015), which is the probability of falsely determining whether an arsenic concentration collected on the private property exceeds background levels. Based on the findings discussed earlier in this TM, BTVs were computed using Pro UCL 5.1 for two scenarios: both including and excluding the BKGD Area 2 XRF measurements for comparative purposes (Table 5). Because of the presence of the single ND when BKGD Area 2 is included in the computations, the KM method (EPA 2015), which provides adjusted estimates of the mean and standard deviation for data sets with ND observations was used when computing the UTL for this scenario. UTLs are a confidence limit on a percentile of the population and are dependent on the variability of the background population and the size of the background dataset. A UTL95-95 based on a background data set is the value below which 95% of the background data are expected to fall with 95% confidence.

Table 5. Summary of Background Threshold Calculations

Data Used in the Computations	Assumed Population Distribution	Method for Computing BTV	BTV (mg/kg)
All Areas (N=60)	Gamma	95% Approximate Gamma UTL with 95% Coverage based on KM Estimates	126.4
	Approximately Lognormal	95% KM UTL (Lognormal) 95% Coverage	170.6
Excluding BKGD Area 2 (N=54)	Gamma	95% HW Approximate Gamma UTL with 95% Coverage based on KM Estimates	123.9
	Lognormal	95% UTL with 95% Coverage	140

KM = Kaplan-Meier, UTL = Upper Tolerance Limit, HW = Hawkins-Wixley, % = percent

Discussion: Based on the inspection of Q-Q plots, side-by-side box plots, results of the K-W Test and multiple comparisons of the means and examination of the general summary statistics, the arsenic concentrations collected from BKGD Area 2 appear to be a part of a different statistical and environmental population than those collected from the other nine Areas. Exclusion of the arsenic concentrations from BKGD Area 2 lowers the BTVs from 126.4 and 170.6 mg/kg to 123.9 and 140 mg/kg, which results in a BTV that is more protective of the environment. As stated earlier in this TM, the project team and those decision-makers with expert Site knowledge should determine whether BKGD Area 2 represents true background conditions at the Arsenic Mine Site and if the corresponding data should be included in the computation of a BTV and therefore more representative of background conditions.

HYPOTHESIS TESTING

An alternate approach to the comparison of individual XRF arsenic measurements on the private properties being investigated with a computed BTV is a two-sample hypothesis test, such as a parametric (t-test) or non-parametric (Gehan, Tarone-Ware or Wilcoxon Mann Whitney) test, which compare the background population mean/median and distribution with the mean/median and distribution of arsenic concentrations collected from a pre-defined DU. Hypothesis testing controls both the Type 1 and Type 2 error rates, and is preferable when sample sizes for the background data set and DU data set are greater than (>) 10. Delineation of DUs can be based on property lines, geographic features, land use, etc. Sample results from within a DU are compared to the background data set, with a final conclusion that the entire DU exceeds or does not exceed background levels. For this project, should this methodology be implemented, the samples collected within the DU must be discrete samples, not composite, because the background data set is based on discrete samples and collected following the same field and analytical methodologies (ex-situ XRF measurement utilizing the same model XRF instrument, measurement time, etc.). Samples should be collected based on a random sampling design (systematic random, simple random, etc.) with a sufficient number of samples collected within each DU.

COMPARISON OF XRF AND LABORATORY MEASUREMENTS

Regression analysis was performed on the twelve pairs of laboratory (lab) and field XRF measurements as part of the background surface soil study of arsenic concentrations. Samples were collected from BKGD Areas 1 through 4 and Site_BKGD Areas 1 through 5. ProUCL and SAS software were used to investigate the relationship between the XRF and the laboratory measurements using classical simple linear regression analysis. Detailed statistical output can be found in the Appendix. A statistically significant relationship was found to exist between the lab and XRF arsenic measurements with a coefficient of determination (R^2) = 0.9449 and regression equation:

Lab arsenic = (1.0071 * XRF arsenic) + 1.4557

The equation indicates an almost 1 to 1 (:) relationship between the two sets of measurements with the slope of the model=1.0071. Follow-up diagnostic testing was conducted to examine what appears to be an outlier from the model (Figure 4).

Figure 4. Regression of Surface Soil Background XRF Arsenic Measurements versus Laboratory Measurements (mg/kg)

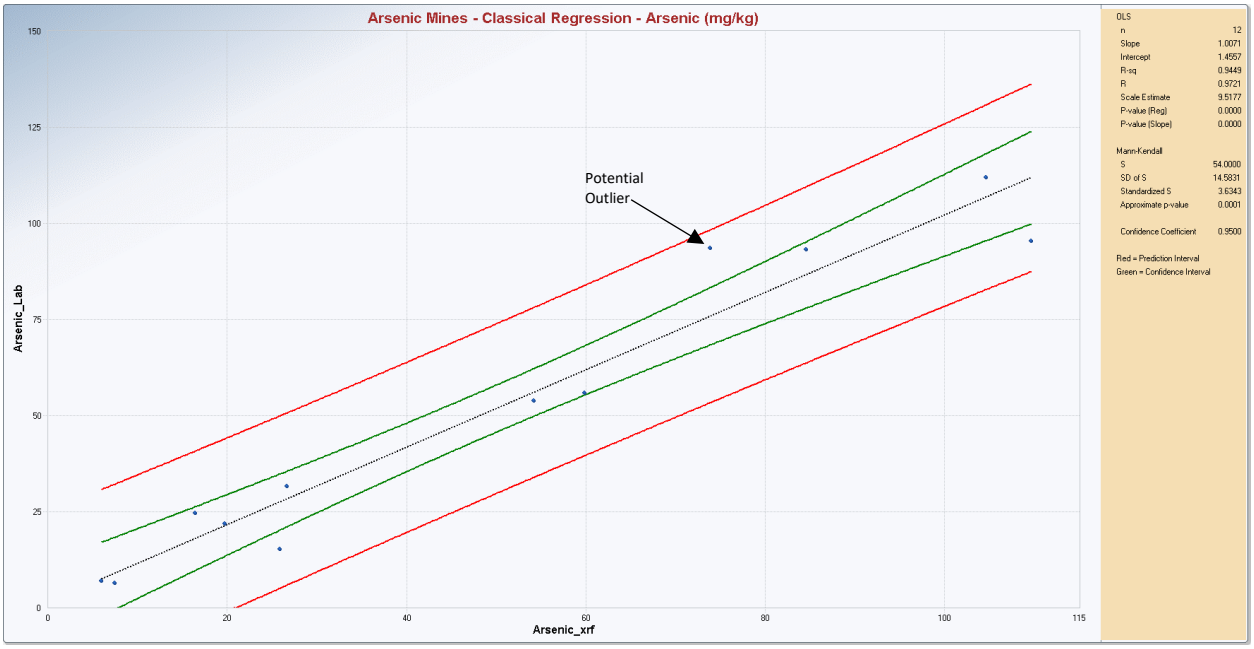


Figure 5. Regression Model Diagnostic Testing for Surface Soil Background XRF Arsenic Measurements versus Laboratory Measurements (mg/kg)

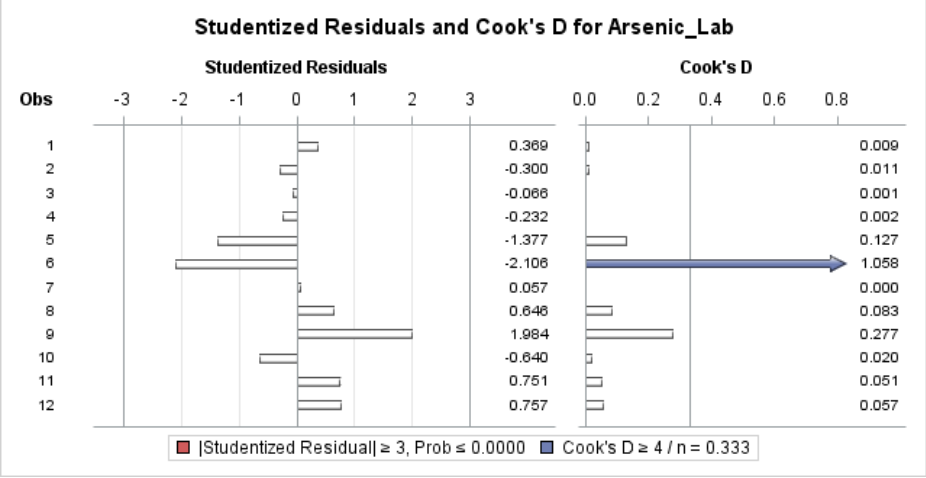
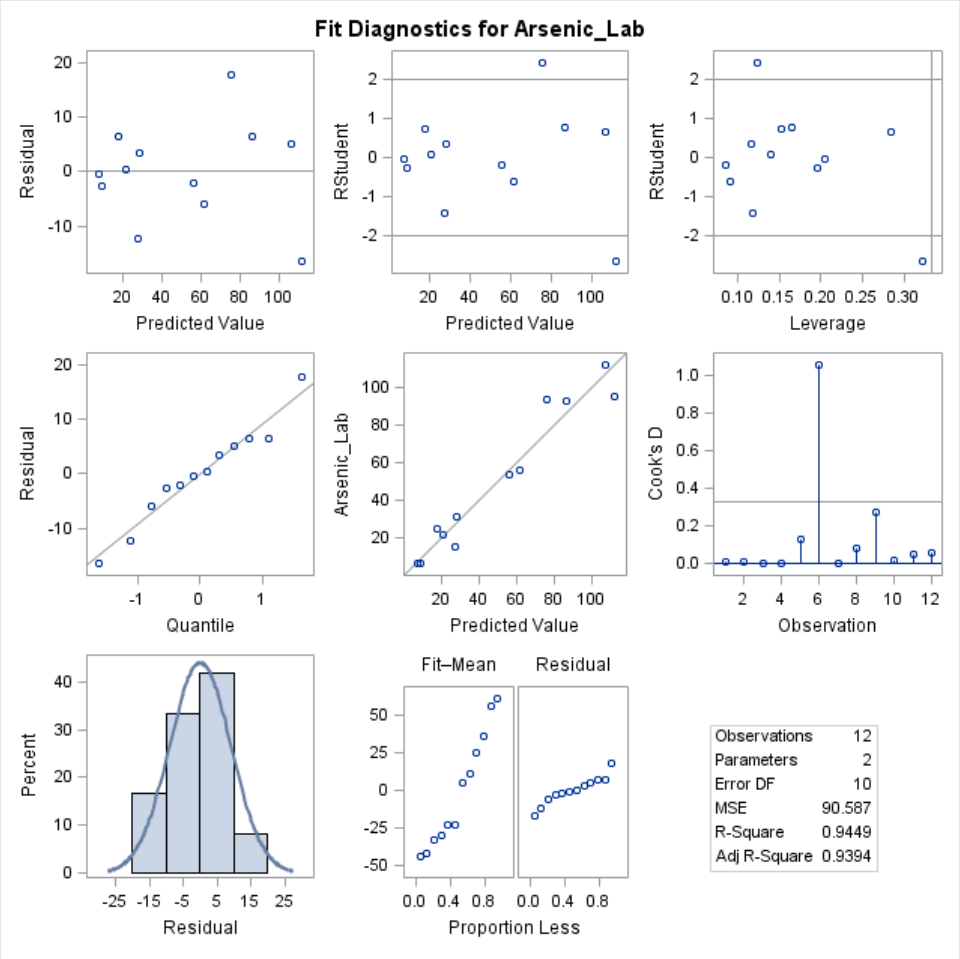
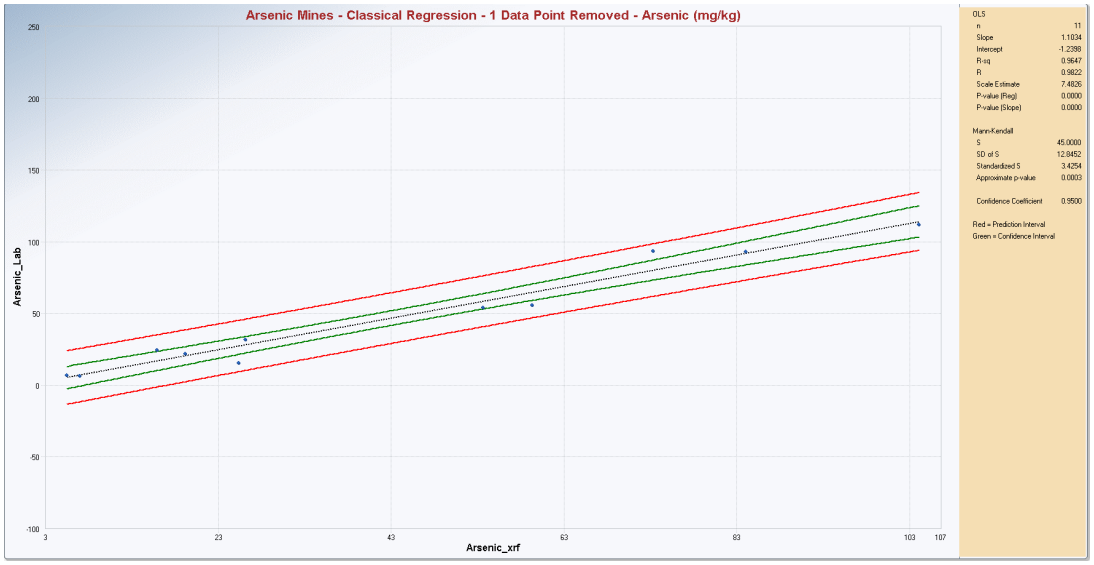


Figure 6. Regression Model Fit Statistics for Surface Soil Background XRF Arsenic Measurements versus Laboratory Measurements (mg/kg)



Plots of fit statistics (Figures 5 and 6) indicate the potential outlier is leveraging the placement of the regression line and therefore the model. This data point represents an arsenic concentration collected in BKGD Area 3 with an XRF result = 110 mg/kg and a laboratory result = 95.4 mg/kg. The regression analysis was re-run with this data point removed (n=11) to evaluate the effect on the overall model. Figure 6 depicts the revised model.

Figure 7. Regression of Surface Soil Background XRF Arsenic Measurements versus Laboratory Measurements (mg/kg) – 1 Potential Influential Data Point Removed



Removal of the influential data point shifts the regression line and still results in a statistically significant relationship between the lab and XRF arsenic measurements. R^2 increases to 0.9647 and the regression equation becomes:

Lab arsenic = (1.1034 * XRF arsenic) - 1.2398

The equation still demonstrates an almost 1 to 1 relationship between the two sets of measurements with the slope of the model=1.1034.

Discussion: The high R^2 and narrow confidence and prediction limits indicates a strong relationship exists between the laboratory measurements and XRF measurements in the background surface soils for the range of concentrations (6.4 mg/kg to 112 mg/kg) present in this data set.

Varying soil types and therefore variable precision/accuracy is expected from the XRF measurements which will be collected from the adjacent private lands under investigation. The regression models discussed in this TM indicate that XRF measurements can, in general, be a good indication of what laboratory analysis will produce, however, there are many influencing environmental factors which may add uncertainty to the cleanup decisions. Because XRF measurements will be used to confirm and/or delineate removal actions, post analysis of the data collected during these phase of the project should be conducted to confirm the relationship between the laboratory and XRF measurements.

REFERENCES

U.S. Environmental Protection Agency (EPA). 2006. *On the Computation of a 95% Upper Confidence Limit of the Unknown Population Mean Based Upon Data Sets with Below Detection Limit Observations.* Prepared by Singh, A., Maichle, R., and Lee, S. Contract No. 68-W-04-005. EPA/600/R-06/022. March 2006.

U.S. Environmental Protection Agency (EPA). ProUCL Version 5.1 Technical Guide. *Statistical Software for Environmental Applications for Data Sets with and without Nondetect observations*. EPA/600/R-07/041. October 2015.

cc: Central File - WA # SERAS-106 (w/attachment)
Electronic File - I:/Archive/SERAS/106/D/TM/070618
Kevin Taylor, SERAS Program Manager (cover page only)

APPENDIX

STATISTICAL OUTPUT

Figure A1. Multiple Q-Q Plot of XRF Arsenic (mg/kg) by Area

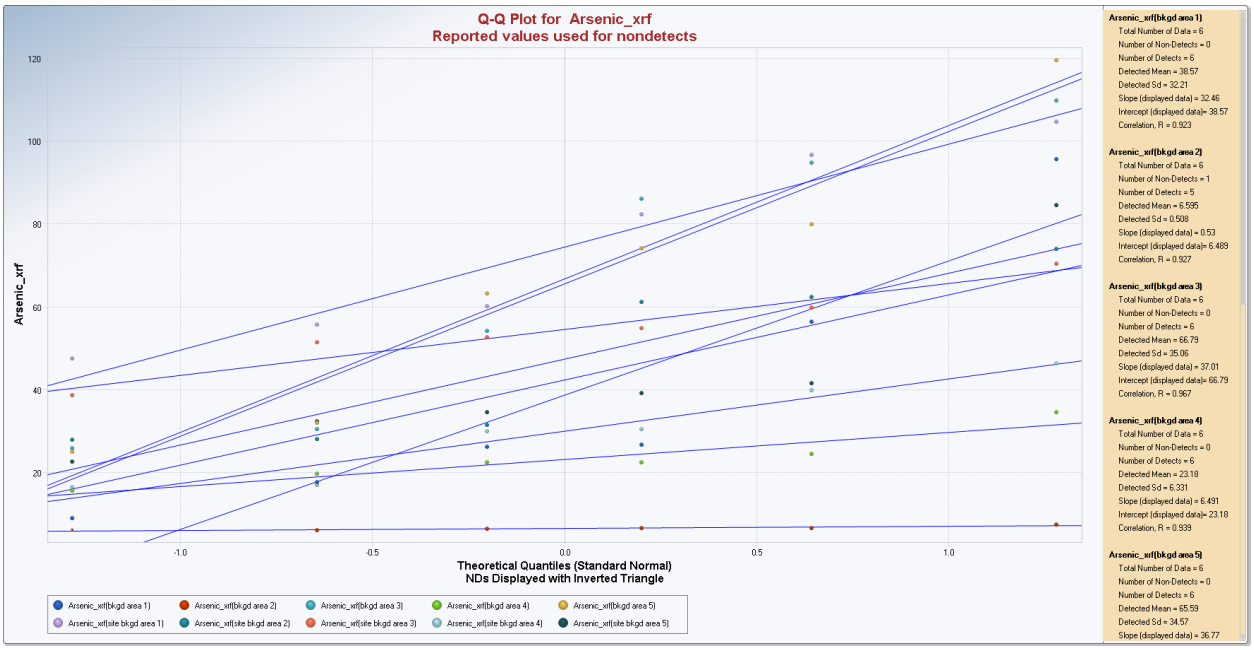
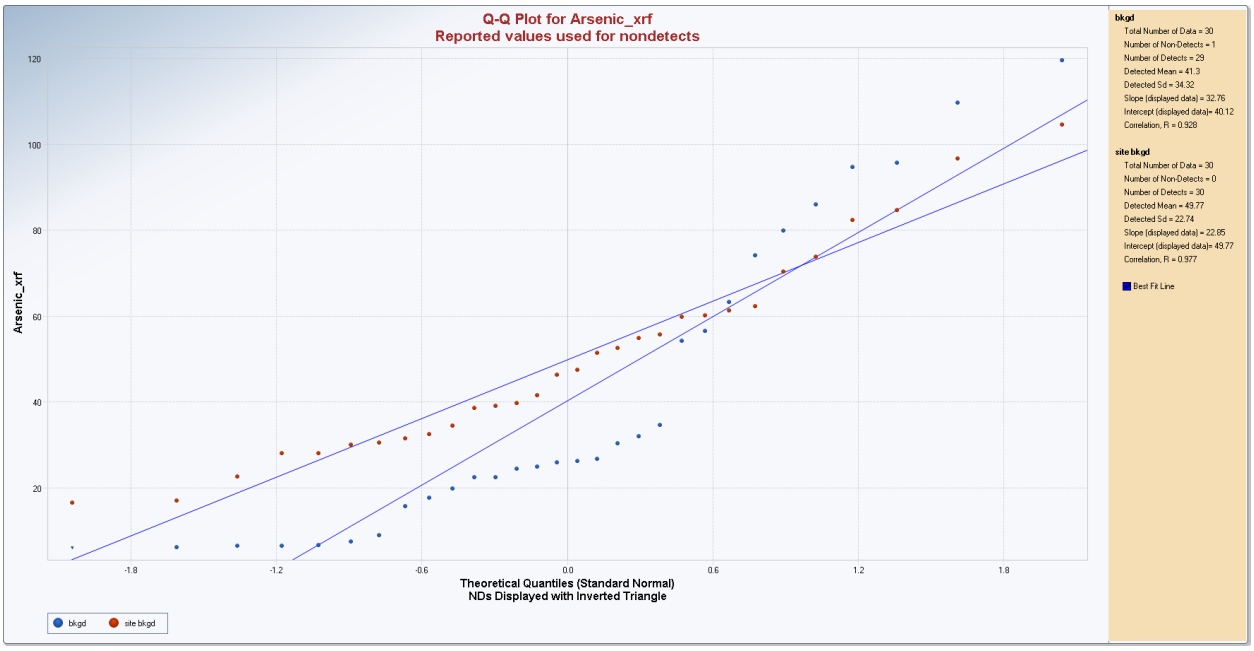


Figure A2. Multiple Q-Q Plot of XRF Arsenic (mg/kg) by Group



The ANOVA Procedure

Class Level Information

Class	Levels	Values
Area	10	BKGD AREA 1 BKGD AREA 2 BKGD AREA 3 BKGD AREA 4 BKGD AREA 5 SITE BKGD AREA 1 SITE BKGD AREA 2 SITE BKGD AREA 3 SITE BKGD AREA 4 SITE BKGD AREA 5

Number of Observations Read	60
Number of Observations Used	60

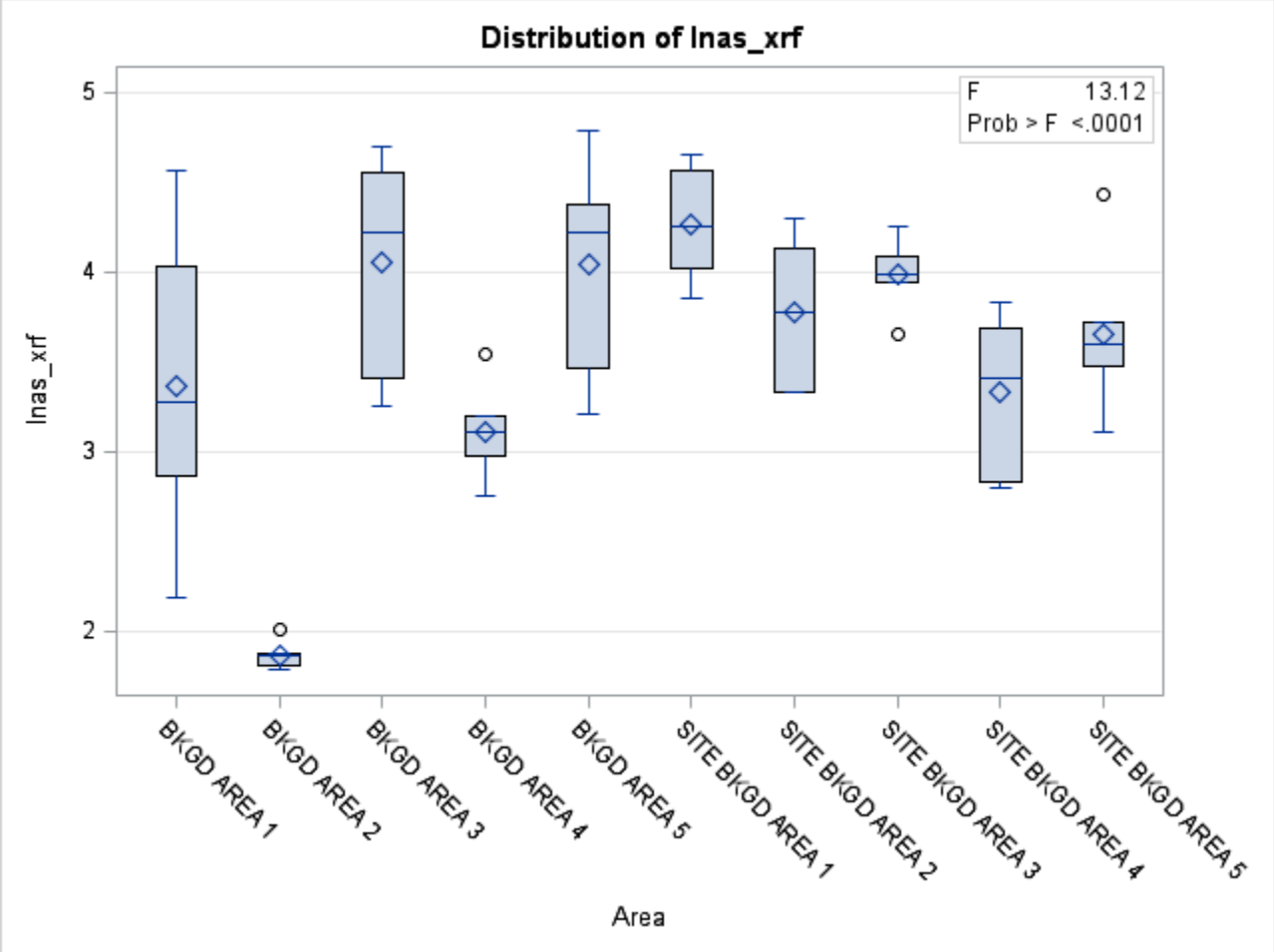
The ANOVA Procedure

Dependent Variable: lnas_xrf

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	9	26.27613000	2.91957000	13.12	<.0001
Error	50	11.12521551	0.22250431		
Corrected Total	59	37.40134551			

R-Square	Coeff Var	Root MSE	lnas_xrf Mean
0.702545	13.29773	0.471704	3.547250

Source	DF	Anova SS	Mean Square	F Value	Pr > F
Area	9	26.27613000	2.91957000	13.12	<.0001



The ANOVA Procedure

t Tests (LSD) for lnas_xrf

Note: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.05
Error Degrees of Freedom	50
Error Mean Square	0.222504
Critical Value of t	2.00856
Least Significant Difference	0.547

Means with the same letter are not significantly different.

t Grouping			Mean	N	Area
	A		4.2677	6	SITE BKGD AREA 1
	A				
B	A		4.0601	6	BKGD AREA 3
B	A				
B	A		4.0492	6	BKGD AREA 5
B	A				
B	A		3.9836	6	SITE BKGD AREA 3
B	A				
B	A	C	3.7761	6	SITE BKGD AREA 2
B		C			
B	D	C	3.6598	6	SITE BKGD AREA 5
	D	C			
	D	C	3.3670	6	BKGD AREA 1
	D	C			
	D	C	3.3273	6	SITE BKGD AREA 4
	D				
	D		3.1142	6	BKGD AREA 4
	E		1.8675	6	BKGD AREA 2

The ANOVA Procedure

Student-Newman-Keuls Test for lnas_xrf

Note: This test controls the Type I experimentwise error rate under the complete null hypothesis but not under partial null hypotheses.

Alpha	0.05
Error Degrees of Freedom	50
Error Mean Square	0.222504

Number of Means	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Critical Range	0.5469876	0.6578005	0.7237625	0.7706647	0.8069416	0.8364771	0.8613164	0.8827244	0.9015133

Means with the same letter are not significantly different.

SNK Grouping			Mean	N	Area
	A		4.2677	6	SITE BKGD AREA 1
	A				
B	A		4.0601	6	BKGD AREA 3
B	A				
B	A		4.0492	6	BKGD AREA 5
B	A				
B	A		3.9836	6	SITE BKGD AREA 3
B	A				
B	A	C	3.7761	6	SITE BKGD AREA 2
B	A	C			
B	A	C	3.6598	6	SITE BKGD AREA 5
B		C			
B		C	3.3670	6	BKGD AREA 1
B		C			
B		C	3.3273	6	SITE BKGD AREA 4
		C			
		C	3.1142	6	BKGD AREA 4
	D		1.8675	6	BKGD AREA 2

The ANOVA Procedure

Tukey's Studentized Range (HSD) Test for lnas_xrf

Note: This test controls the Type I experimentwise error rate, but it generally has a higher Type II error rate than REGWQ.

Alpha	0.05
Error Degrees of Freedom	50
Error Mean Square	0.222504
Critical Value of Studentized Range	4.68143
Minimum Significant Difference	0.9015

Means with the same letter are not significantly different.

Tukey Grouping			Mean	N	Area
	A		4.2677	6	SITE BKGD AREA 1
	A				
B	A		4.0601	6	BKGD AREA 3
B	A				
B	A		4.0492	6	BKGD AREA 5
B	A				
B	A	C	3.9836	6	SITE BKGD AREA 3
B	A	C			
B	A	C	3.7761	6	SITE BKGD AREA 2
B	A	C			
B	A	C	3.6598	6	SITE BKGD AREA 5
B	A	C			
B	A	C	3.3670	6	BKGD AREA 1
B		C			
B		C	3.3273	6	SITE BKGD AREA 4
		C			
		C	3.1142	6	BKGD AREA 4
	D		1.8675	6	BKGD AREA 2

Nonparametric Oneway ANOVA (Kruskal-Wallis Test)

Group		Obs	Median	Ave Rank	Z
bkgd area 1		6	26.38	25.83	-0.69
bkgd area 2		6	6.43	3.5	-3.992
bkgd area 3		6	70.08	41.5	1.626
bkgd area 4		6	22.4	15.5	-2.218
bkgd area 5		6	68.64	42	1.7
site bkgd area 1		6	71.2	48	2.587
site bkgd area 2		6	46.28	34.83	0.641
site bkgd area 3		6	53.68	39.5	1.331
site bkgd area 4		6	30.2	22.5	-1.183
site bkgd area 5		6	36.75	31.83	0.197
Overall		60	36.54	30.5	
K-W (H-Stat)		DOF	P-Value	(Approx. Chisquare)	
33.46		9	1.11E-04		
33.46		9	1.11E-04	(Adjusted for Ties)	

Note: A p-value <= 0.05 (or some other selected level) suggests that there are significant differences in mean/median characteristics of the various groups at 0.05 or other selected level of significance

A p-value > 0.05 (or other selected level) suggests that mean/median characteristics of the various groups are comparable.

Background XRF Arsenic Results vs. Laboratory Arsenic Results
Arsenic Mines - SERAS-106

The REG Procedure
Model: MODEL1
Dependent Variable: Arsenic_Lab Arsenic_Lab

Number of Observations Read 12

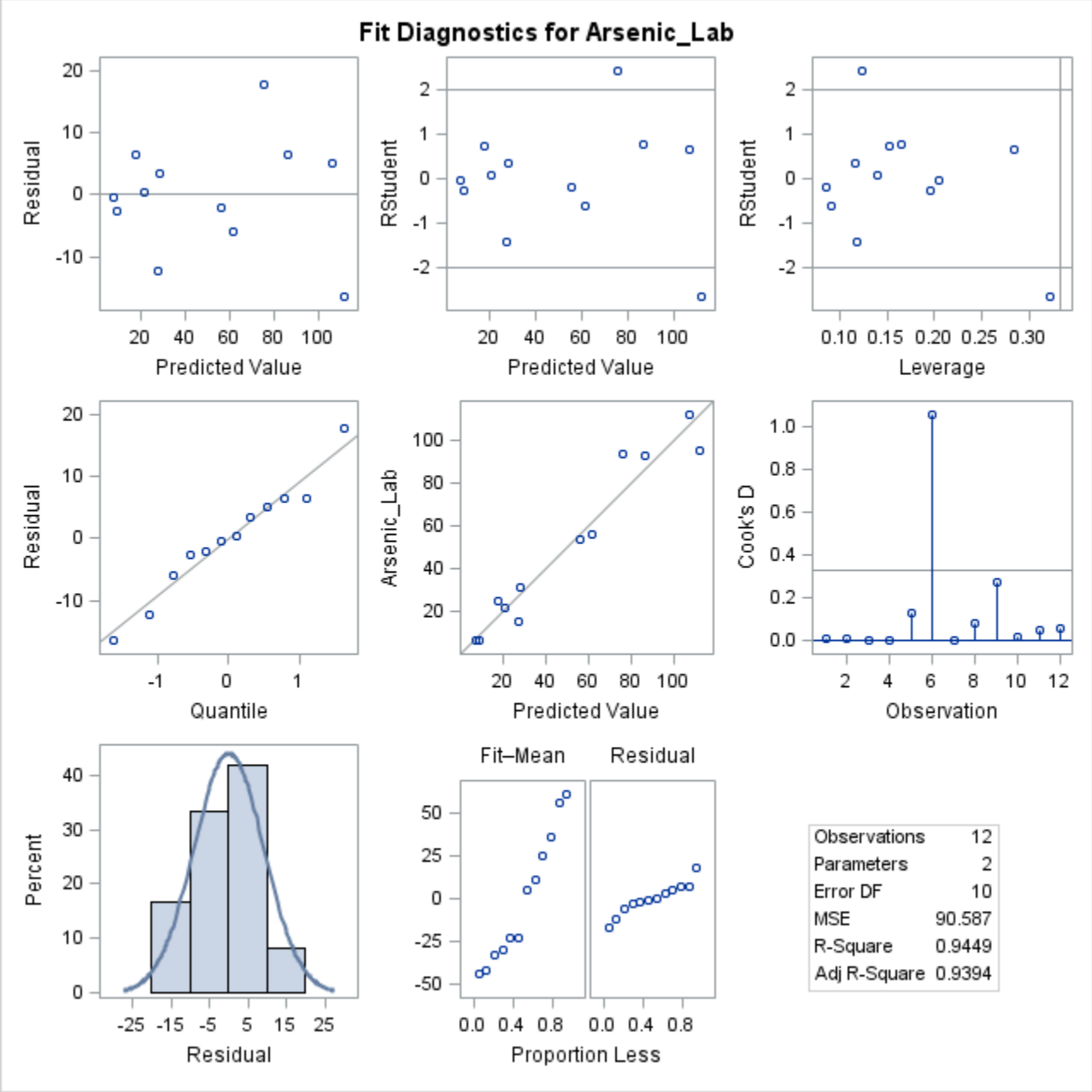
Number of Observations Used 12

Analysis of Variance					
Source	**DF**	**Sum of Squares**	**Mean Square**	**F Value**	**Pr > F**
Model	1	15547	15547	171.63	<.0001
Error	10	905.87411	90.58741		
Corrected Total	11	16453			

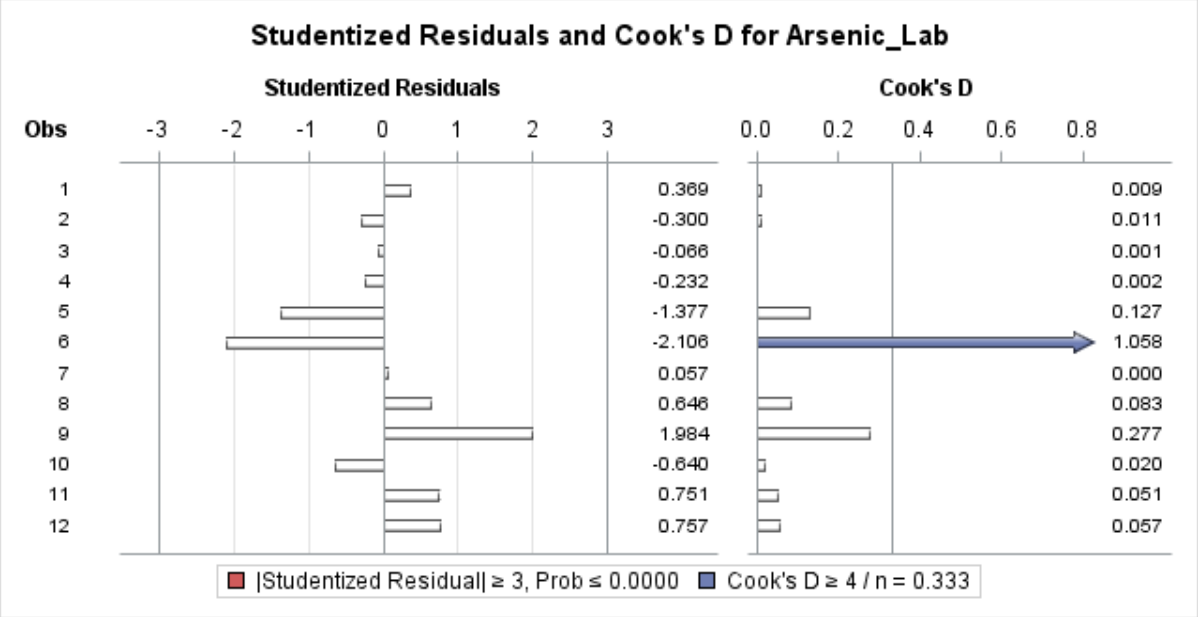
Root MSE	9.51774	**R-Square**	0.9449
Dependent Mean	50.86667	**Adj R-Sq**	0.9394
Coeff Var	18.71116		

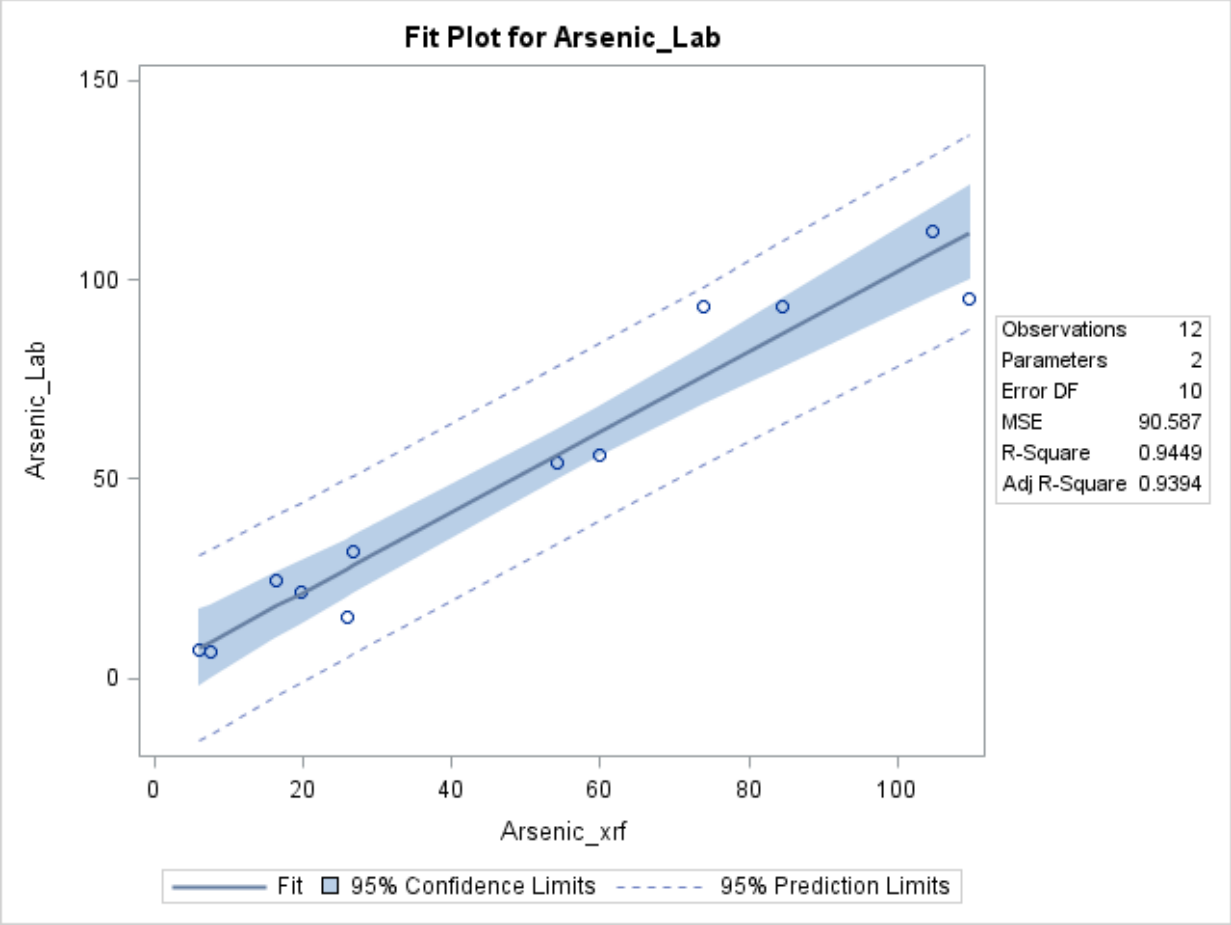
Parameter Estimates						
Variable	**Label**	**DF**	**Parameter Estimate**	**Standard Error**	**t Value**	**Pr > |t|**
Intercept	Intercept	**1**	1.45565	4.66628	0.31	0.7615
Arsenic_xrf	Arsenic_xrf	**1**	1.00708	0.07687	13.10	<.0001

The REG Procedure
Model: MODEL1
Dependent Variable: Arsenic_Lab Arsenic_Lab



Output Statistics							
Obs	**Dependent Variable**	**Predicted Value**	**Std Error Mean Predict**	**Residual**	**Std Error Residual**	**Student Residual**	**Cook's D**
1	31.6	28.2944	3.2431	3.3056	8.948	0.369	0.009
2	6.4	8.9584	4.2169	-2.5584	8.533	-0.300	0.011
3	6.9	7.4579	4.3044	-0.5579	8.489	-0.066	0.001
4	53.9	56.0094	2.7754	-2.1094	9.104	-0.232	0.002
5	15.2	27.5089	3.2753	-12.3089	8.936	-1.377	0.127
6	95.4	111.8975	5.4085	-16.4975	7.832	-2.106	1.058
7	21.8	21.3002	3.5556	0.4998	8.829	0.057	0.000
8	112.0	106.8033	5.0774	5.1967	8.050	0.646	0.083
9	93.5	75.8237	3.3434	17.6763	8.911	1.984	0.277
10	55.9	61.7044	2.8694	-5.8044	9.075	-0.640	0.020
11	24.6	18.0222	3.7195	6.5778	8.761	0.751	0.051
12	93.2	86.6197	3.8726	6.5803	8.694	0.757	0.057





Remove Potential Outlier:

The REG Procedure
Model: MODEL1.1
Dependent Variable: Arsenic_Lab Arsenic_Lab

Number of Observations Read 12

Number of Observations Used 11

Weight: REWEIGHT

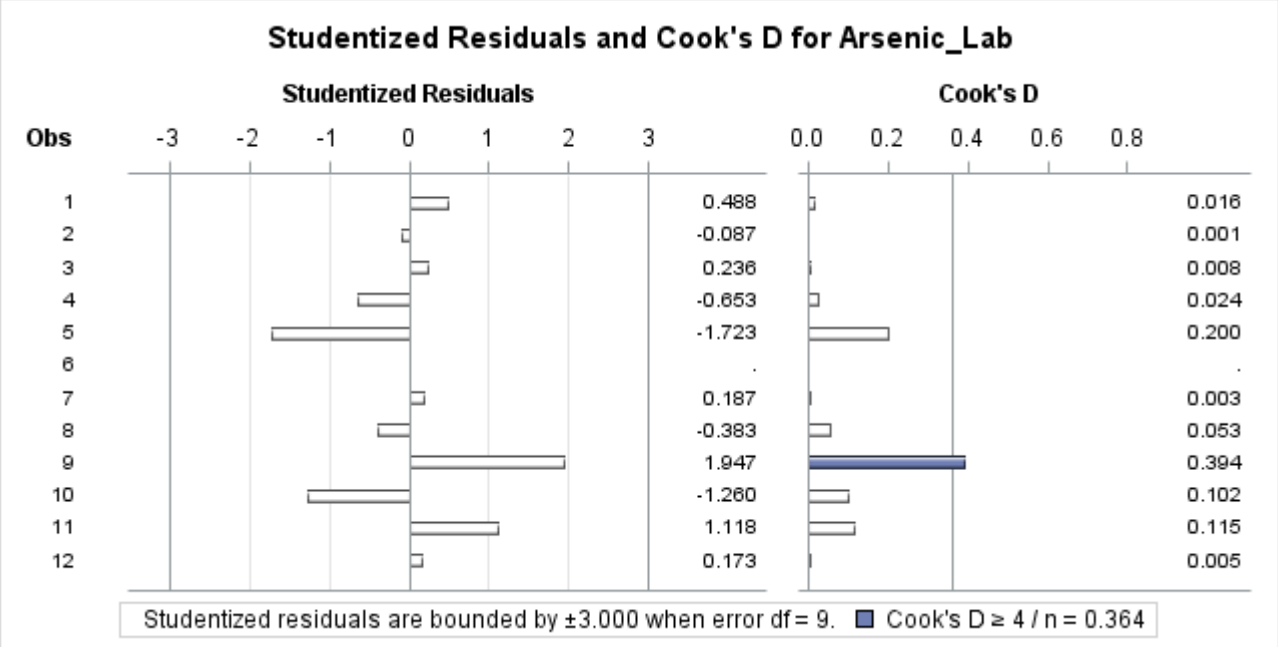
Analysis of Variance					
Source	**DF**	**Sum of Squares**	**Mean Square**	**F Value**	**Pr > F**
Model	1	13786	13786	246.22	<.0001
Error	9	503.91016	55.99002		
Corrected Total	10	14290			

Root MSE	7.48265	**R-Square**	0.9647
Dependent Mean	46.81818	**Adj R-Sq**	0.9608
Coeff Var	15.98235		

Parameter Estimates						
Variable	**Label**	**DF**	**Parameter Estimate**	**Standard Error**	**t Value**	**Pr > |t|**
Intercept	Intercept	**1**	-1.23983	3.80397	-0.33	0.7519
Arsenic_xrf	Arsenic_xrf	**1**	1.10341	0.07032	15.69	<.0001

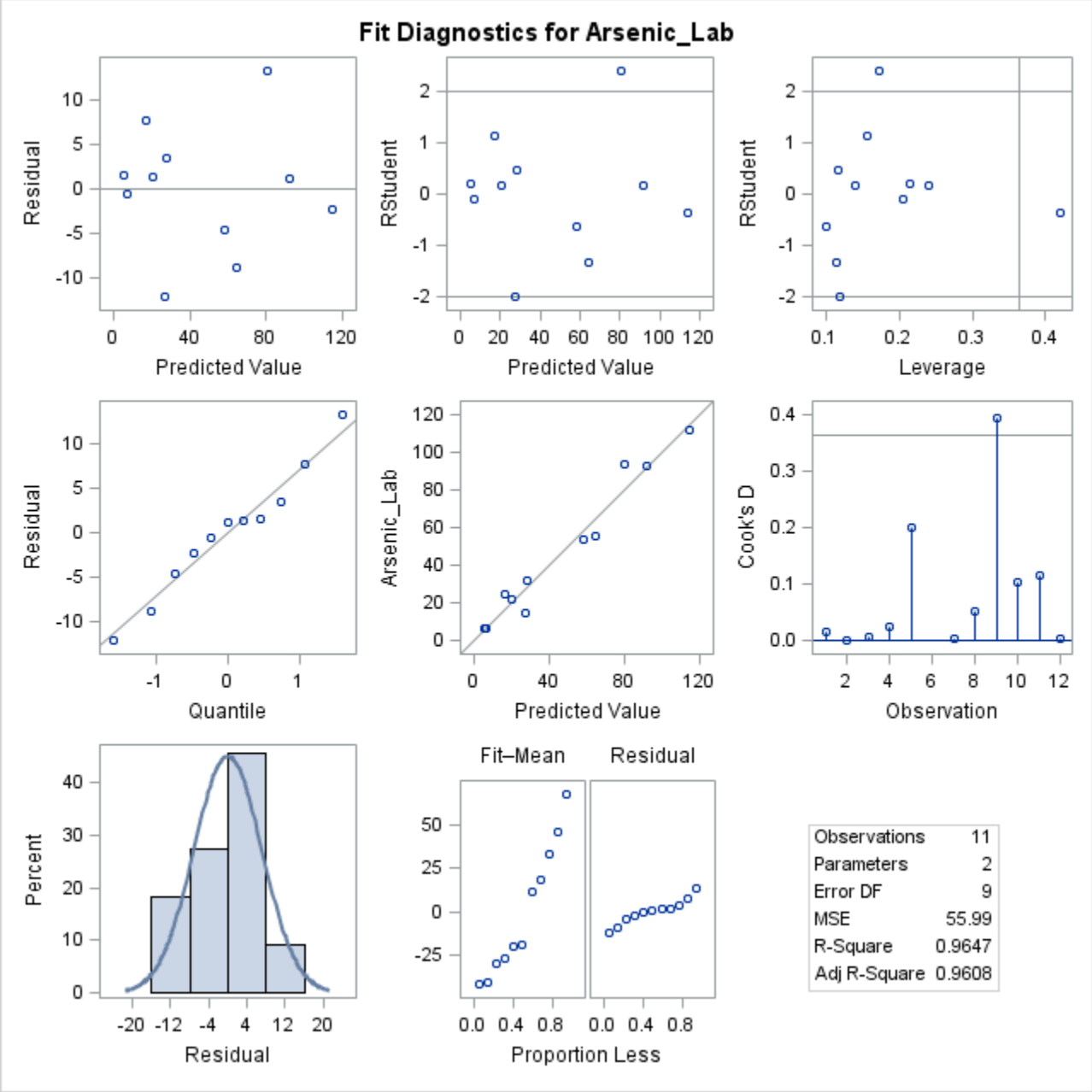
The REG Procedure
Model: MODEL1.1
Dependent Variable: Arsenic_Lab Arsenic_Lab

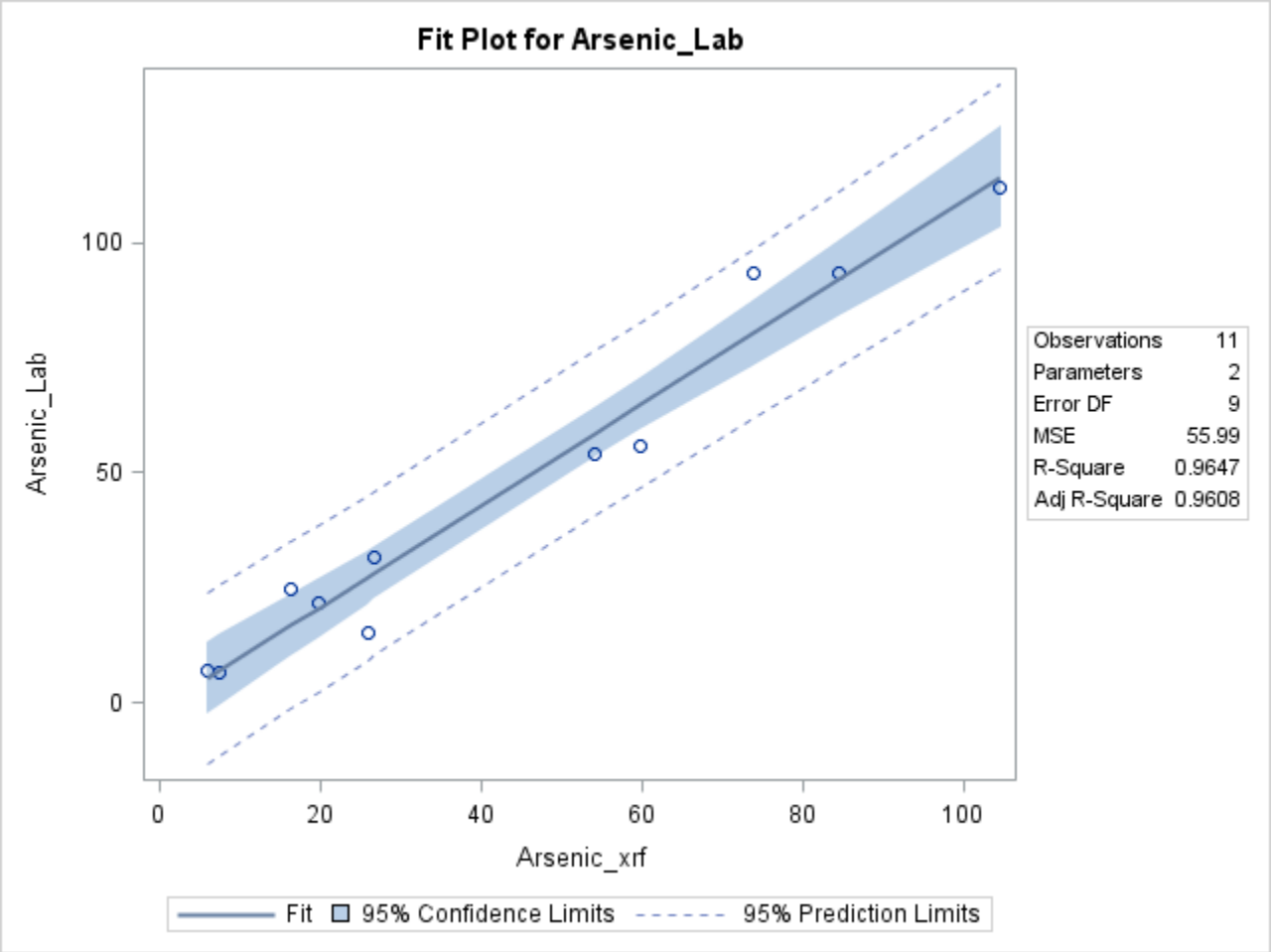
Output Statistics								
Obs	Weight	Dependent Variable	Predicted Value	Std Error Mean Predict	Residual	Std Error Residual	Student Residual	Cook's D
1	1	31.6	28.1659	2.5501	3.4341	7.035	0.488	0.016
2	1	6.4	6.9805	3.3964	-0.5805	6.667	-0.087	0.001
3	1	6.9	5.3365	3.4754	1.5635	6.627	0.236	0.008
4	1	53.9	58.5317	2.3764	-4.6317	7.095	-0.653	0.024
5	1	15.2	27.3053	2.5761	-12.1053	7.025	-1.723	0.200
6	0	95.4	119.7652	5.1674	-24.3652	.	.	.
7	1	21.8	20.5028	2.8111	1.2972	6.935	0.187	0.003
8	1	112.0	114.1838	4.8499	-2.1838	5.698	-0.383	0.053
9	1	93.5	80.2412	3.1027	13.2588	6.809	1.947	0.394
10	1	55.9	64.7714	2.5296	-8.8714	7.042	-1.260	0.102
11	1	24.6	16.9112	2.9534	7.6888	6.875	1.118	0.115
12	1	93.2	92.0697	3.6615	1.1303	6.526	0.173	0.005



Sum of Residuals	0
Sum of Squared Residuals	503.91016
Predicted Residual SS (PRESS)	693.06316

Note: The above statistics use observation weights or frequencies.




Fit Plot for Arsenic_Lab
Arsenic_Lab
100
50
0
0
20
40
60
80
100
Arsenic_xrf
Observations 11
Parameters 2
Error DF 9
MSE 55.99
R-Square 0.9647
Adj R-Square 0.9608
Fit
95% Confidence Limits
95% Prediction Limits

Attachment 2

ProUCL Outputs (P001-P010)

UCL Statistics for Uncensored Full Data Sets

User Selected Options	
Date/Time of Computation	ProUCL 5.110/22/2018 9:19:03 AM
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

C0

General Statistics

Total Number of Observations	47	Number of Distinct Observations	44
		Number of Missing Observations	0
Minimum	18	Mean	7994
Maximum	54177	Median	173
SD	13514	Std. Error of Mean	1971
Coefficient of Variation	1.69	Skewness	1.75

Normal GOF Test

Shapiro Wilk Test Statistic	0.654	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.946	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.311	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.128	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	11303	95% Adjusted-CLT UCL (Chen-1995)	11774
		95% Modified-t UCL (Johnson-1978)	11387

Gamma GOF Test

A-D Test Statistic	3.113	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.876	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.251	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.141	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.272	k star (bias corrected MLE)	0.268
Theta hat (MLE)	29432	Theta star (bias corrected MLE)	29777
nu hat (MLE)	25.53	nu star (bias corrected)	25.24
MLE Mean (bias corrected)	7994	MLE Sd (bias corrected)	15429
		Approximate Chi Square Value (0.05)	14.79
Adjusted Level of Significance	0.0449	Adjusted Chi Square Value	14.54

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	13638	95% Adjusted Gamma UCL (use when n<50)	13877

51	**Lognormal GOF Test**											
52					Shapiro Wilk Test Statistic	0.862	**Shapiro Wilk Lognormal GOF Test**					
53					5% Shapiro Wilk Critical Value	0.946	Data Not Lognormal at 5% Significance Level					
54					Lilliefors Test Statistic	0.187	**Lilliefors Lognormal GOF Test**					
55					5% Lilliefors Critical Value	0.128	Data Not Lognormal at 5% Significance Level					
56	**Data Not Lognormal at 5% Significance Level**											
57												
58	**Lognormal Statistics**											
59					Minimum of Logged Data	2.89	Mean of logged Data	6.406				
60					Maximum of Logged Data	10.9	SD of logged Data	2.734				
61												
62	**Assuming Lognormal Distribution**											
63					95% H-UCL	165067	90% Chebyshev (MVUE) UCL	52933				
64					95% Chebyshev (MVUE) UCL	68510	97.5% Chebyshev (MVUE) UCL	90131				
65					99% Chebyshev (MVUE) UCL	132601						
66												
67	**Nonparametric Distribution Free UCL Statistics**											
68	**Data do not follow a Discernible Distribution (0.05)**											
69												
70	**Nonparametric Distribution Free UCLs**											
71					95% CLT UCL	11236	95% Jackknife UCL	11303				
72					95% Standard Bootstrap UCL	11124	95% Bootstrap-t UCL	12067				
73					95% Hall's Bootstrap UCL	11640	95% Percentile Bootstrap UCL	11255				
74					95% BCA Bootstrap UCL	11732						
75					90% Chebyshev(Mean, Sd) UCL	13908	95% Chebyshev(Mean, Sd) UCL	16586				
76					97.5% Chebyshev(Mean, Sd) UCL	20304	99% Chebyshev(Mean, Sd) UCL	27607				
77												
78	**Suggested UCL to Use**											
79					97.5% Chebyshev (Mean, Sd) UCL	20304						
80												
81	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
82	Recommendations are based upon data size, data distribution, and skewness.											
83	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
84	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
85												

UCL Statistics for Uncensored Full Data Sets

User Selected Options	
Date/Time of Computation	ProUCL 5.110/22/2018 9:40:05 AM
From File	WorkSheet_a.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

C0

General Statistics

Total Number of Observations	38	Number of Distinct Observations	32
		Number of Missing Observations	1
Minimum	18	Mean	272.9
Maximum	2313	Median	68
SD	625.2	Std. Error of Mean	101.4
Coefficient of Variation	2.291	Skewness	2.798

Normal GOF Test

Shapiro Wilk Test Statistic	0.43	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.938	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.446	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.142	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	444.1	95% Adjusted-CLT UCL (Chen-1995)	489
		95% Modified-t UCL (Johnson-1978)	451.7

Gamma GOF Test

A-D Test Statistic	5.252	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.816	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.32	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.152	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.484	k star (bias corrected MLE)	0.464
Theta hat (MLE)	563.6	Theta star (bias corrected MLE)	588.7
nu hat (MLE)	36.81	nu star (bias corrected)	35.24
MLE Mean (bias corrected)	272.9	MLE Sd (bias corrected)	400.9
		Approximate Chi Square Value (0.05)	22.65
Adjusted Level of Significance	0.0434	Adjusted Chi Square Value	22.24

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	424.5	95% Adjusted Gamma UCL (use when n<50)	432.5

51	**Lognormal GOF Test**											
52					Shapiro Wilk Test Statistic	0.82	**Shapiro Wilk Lognormal GOF Test**					
53					5% Shapiro Wilk Critical Value	0.938	Data Not Lognormal at 5% Significance Level					
54					Lilliefors Test Statistic	0.165	**Lilliefors Lognormal GOF Test**					
55					5% Lilliefors Critical Value	0.142	Data Not Lognormal at 5% Significance Level					
56	**Data Not Lognormal at 5% Significance Level**											
57												
58	**Lognormal Statistics**											
59					Minimum of Logged Data	2.89	Mean of logged Data	4.291				
60					Maximum of Logged Data	7.746	SD of logged Data	1.358				
61												
62	**Assuming Lognormal Distribution**											
63					95% H-UCL	346.4	90% Chebyshev (MVUE) UCL	322.3				
64					95% Chebyshev (MVUE) UCL	388.6	97.5% Chebyshev (MVUE) UCL	480.6				
65					99% Chebyshev (MVUE) UCL	661.4						
66												
67	**Nonparametric Distribution Free UCL Statistics**											
68	**Data do not follow a Discernible Distribution (0.05)**											
69												
70	**Nonparametric Distribution Free UCLs**											
71					95% CLT UCL	439.8	95% Jackknife UCL	444.1				
72					95% Standard Bootstrap UCL	438	95% Bootstrap-t UCL	545.2				
73					95% Hall's Bootstrap UCL	410.8	95% Percentile Bootstrap UCL	450.9				
74					95% BCA Bootstrap UCL	489.3						
75					90% Chebyshev(Mean, Sd) UCL	577.2	95% Chebyshev(Mean, Sd) UCL	715				
76					97.5% Chebyshev(Mean, Sd) UCL	906.3	99% Chebyshev(Mean, Sd) UCL	1282				
77												
78	**Suggested UCL to Use**											
79					95% Chebyshev (Mean, Sd) UCL	715						
80												
81	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
82	Recommendations are based upon data size, data distribution, and skewness.											
83	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
84	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
85												

UCL Statistics for Uncensored Full Data Sets

User Selected Options	
Date/Time of Computation	ProUCL 5.110/22/2018 9:58:47 AM
From File	WorkSheet_b.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

C0

General Statistics

Total Number of Observations	59	Number of Distinct Observations	51
		Number of Missing Observations	1
Minimum	16	Mean	2694
Maximum	30822	Median	67
SD	6880	Std. Error of Mean	895.6
Coefficient of Variation	2.553	Skewness	3.296

Normal GOF Test

Shapiro Wilk Test Statistic	0.441	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.35	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.115	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	4191	95% Adjusted-CLT UCL (Chen-1995)	4578
		95% Modified-t UCL (Johnson-1978)	4256

Gamma GOF Test

A-D Test Statistic	5.391	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.879	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.262	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.127	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.269	k star (bias corrected MLE)	0.267
Theta hat (MLE)	10015	Theta star (bias corrected MLE)	10105
nu hat (MLE)	31.74	nu star (bias corrected)	31.46
MLE Mean (bias corrected)	2694	MLE Sd (bias corrected)	5218
		Approximate Chi Square Value (0.05)	19.65
Adjusted Level of Significance	0.0459	Adjusted Chi Square Value	19.41

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	4315	95% Adjusted Gamma UCL (use when n<50)	4367

51	**Lognormal GOF Test**											
52					Shapiro Wilk Test Statistic	0.844	**Shapiro Wilk Lognormal GOF Test**					
53					5% Shapiro Wilk P Value	3.5723E-8	Data Not Lognormal at 5% Significance Level					
54					Lilliefors Test Statistic	0.196	**Lilliefors Lognormal GOF Test**					
55					5% Lilliefors Critical Value	0.115	Data Not Lognormal at 5% Significance Level					
56	**Data Not Lognormal at 5% Significance Level**											
57												
58	**Lognormal Statistics**											
59					Minimum of Logged Data	2.773	Mean of logged Data	5.29				
60					Maximum of Logged Data	10.34	SD of logged Data	2.353				
61												
62	**Assuming Lognormal Distribution**											
63					95% H-UCL	12747	90% Chebyshev (MVUE) UCL	6604				
64					95% Chebyshev (MVUE) UCL	8373	97.5% Chebyshev (MVUE) UCL	10828				
65					99% Chebyshev (MVUE) UCL	15651						
66												
67	**Nonparametric Distribution Free UCL Statistics**											
68	**Data do not follow a Discernible Distribution (0.05)**											
69												
70	**Nonparametric Distribution Free UCLs**											
71					95% CLT UCL	4168	95% Jackknife UCL	4191				
72					95% Standard Bootstrap UCL	4125	95% Bootstrap-t UCL	5329				
73					95% Hall's Bootstrap UCL	4174	95% Percentile Bootstrap UCL	4281				
74					95% BCA Bootstrap UCL	4657						
75					90% Chebyshev(Mean, Sd) UCL	5381	95% Chebyshev(Mean, Sd) UCL	6598				
76					97.5% Chebyshev(Mean, Sd) UCL	8288	99% Chebyshev(Mean, Sd) UCL	11606				
77												
78	**Suggested UCL to Use**											
79					95% Chebyshev (Mean, Sd) UCL	6598						
80												
81	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
82	Recommendations are based upon data size, data distribution, and skewness.											
83	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
84	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
85												

UCL Statistics for Uncensored Full Data Sets

User Selected Options	
Date/Time of Computation	ProUCL 5.110/22/2018 10:05:52 AM
From File	WorkSheet_c.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

C0

General Statistics

Total Number of Observations	14	Number of Distinct Observations	11
		Number of Missing Observations	1
Minimum	18	Mean	41.14
Maximum	159	Median	25
SD	37.79	Std. Error of Mean	10.1
Coefficient of Variation	0.918	Skewness	2.661

Normal GOF Test

Shapiro Wilk Test Statistic	0.639	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.874	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.279	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.226	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	59.03	95% Adjusted-CLT UCL (Chen-1995)	65.43
		95% Modified-t UCL (Johnson-1978)	60.23

Gamma GOF Test

A-D Test Statistic	1.214	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.745	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.266	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.231	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.254	k star (bias corrected MLE)	1.818
Theta hat (MLE)	18.26	Theta star (bias corrected MLE)	22.63
nu hat (MLE)	63.1	nu star (bias corrected)	50.91
MLE Mean (bias corrected)	41.14	MLE Sd (bias corrected)	30.51
		Approximate Chi Square Value (0.05)	35.53
Adjusted Level of Significance	0.0312	Adjusted Chi Square Value	33.83

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	58.96	95% Adjusted Gamma UCL (use when n<50)	61.92

51	**Lognormal GOF Test**											
52					Shapiro Wilk Test Statistic	0.83	**Shapiro Wilk Lognormal GOF Test**					
53					5% Shapiro Wilk Critical Value	0.874	Data Not Lognormal at 5% Significance Level					
54					Lilliefors Test Statistic	0.233	**Lilliefors Lognormal GOF Test**					
55					5% Lilliefors Critical Value	0.226	Data Not Lognormal at 5% Significance Level					
56	**Data Not Lognormal at 5% Significance Level**											
57												
58	**Lognormal Statistics**											
59					Minimum of Logged Data	2.89	Mean of logged Data	3.479				
60					Maximum of Logged Data	5.069	SD of logged Data	0.641				
61												
62	**Assuming Lognormal Distribution**											
63					95% H-UCL	59.62	90% Chebyshev (MVUE) UCL	60.17				
64					95% Chebyshev (MVUE) UCL	69.69	97.5% Chebyshev (MVUE) UCL	82.89				
65					99% Chebyshev (MVUE) UCL	108.8						
66												
67	**Nonparametric Distribution Free UCL Statistics**											
68	**Data do not follow a Discernible Distribution (0.05)**											
69												
70	**Nonparametric Distribution Free UCLs**											
71					95% CLT UCL	57.75	95% Jackknife UCL	59.03				
72					95% Standard Bootstrap UCL	57.57	95% Bootstrap-t UCL	83.07				
73					95% Hall's Bootstrap UCL	115.9	95% Percentile Bootstrap UCL	59.29				
74					95% BCA Bootstrap UCL	66.21						
75					90% Chebyshev(Mean, Sd) UCL	71.44	95% Chebyshev(Mean, Sd) UCL	85.17				
76					97.5% Chebyshev(Mean, Sd) UCL	104.2	99% Chebyshev(Mean, Sd) UCL	141.6				
77												
78	**Suggested UCL to Use**											
79					95% Chebyshev (Mean, Sd) UCL	85.17						
80												
81	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
82	Recommendations are based upon data size, data distribution, and skewness.											
83	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
84	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
85												

UCL Statistics for Uncensored Full Data Sets

User Selected Options	
Date/Time of Computation	ProUCL 5.110/22/2018 10:18:11 AM
From File	WorkSheet_d.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

C0

General Statistics

Total Number of Observations	37	Number of Distinct Observations	28
		Number of Missing Observations	1
Minimum	16	Mean	46.43
Maximum	136	Median	30
SD	32.07	Std. Error of Mean	5.272
Coefficient of Variation	0.691	Skewness	1.277

Normal GOF Test

Shapiro Wilk Test Statistic	0.83	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.936	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.209	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.144	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	55.33	95% Adjusted-CLT UCL (Chen-1995)	56.29
		95% Modified-t UCL (Johnson-1978)	55.52

Gamma GOF Test

A-D Test Statistic	1.205	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.756	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.185	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.146	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.61	k star (bias corrected MLE)	2.416
Theta hat (MLE)	17.79	Theta star (bias corrected MLE)	19.22
nu hat (MLE)	193.1	nu star (bias corrected)	178.8
MLE Mean (bias corrected)	46.43	MLE Sd (bias corrected)	29.87
		Approximate Chi Square Value (0.05)	148.9
Adjusted Level of Significance	0.0431	Adjusted Chi Square Value	147.7

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	55.77	95% Adjusted Gamma UCL (use when n<50)	56.21

	A	B	C	D	E	F	G	H	I	J	K	L
51	**Lognormal GOF Test**											
52					Shapiro Wilk Test Statistic	0.922	**Shapiro Wilk Lognormal GOF Test**					
53					5% Shapiro Wilk Critical Value	0.936	Data Not Lognormal at 5% Significance Level					
54					Lilliefors Test Statistic	0.158	**Lilliefors Lognormal GOF Test**					
55					5% Lilliefors Critical Value	0.144	Data Not Lognormal at 5% Significance Level					
56	**Data Not Lognormal at 5% Significance Level**											
57												
58	**Lognormal Statistics**											
59					Minimum of Logged Data	2.773	Mean of logged Data	3.634				
60					Maximum of Logged Data	4.913	SD of logged Data	0.631				
61												
62	**Assuming Lognormal Distribution**											
63					95% H-UCL	57.17	90% Chebyshev (MVUE) UCL	61.28				
64					95% Chebyshev (MVUE) UCL	68.23	97.5% Chebyshev (MVUE) UCL	77.87				
65					99% Chebyshev (MVUE) UCL	96.81						
66												
67	**Nonparametric Distribution Free UCL Statistics**											
68	**Data do not follow a Discernible Distribution (0.05)**											
69												
70	**Nonparametric Distribution Free UCLs**											
71					95% CLT UCL	55.1	95% Jackknife UCL	55.33				
72					95% Standard Bootstrap UCL	55.07	95% Bootstrap-t UCL	56.87				
73					95% Hall's Bootstrap UCL	56.5	95% Percentile Bootstrap UCL	55.38				
74					95% BCA Bootstrap UCL	55.54						
75					90% Chebyshev(Mean, Sd) UCL	62.25	95% Chebyshev(Mean, Sd) UCL	69.41				
76					97.5% Chebyshev(Mean, Sd) UCL	79.36	99% Chebyshev(Mean, Sd) UCL	98.89				
77												
78	**Suggested UCL to Use**											
79					95% Chebyshev (Mean, Sd) UCL	69.41						
80												
81	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
82	Recommendations are based upon data size, data distribution, and skewness.											
83	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
84	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
85												

UCL Statistics for Uncensored Full Data Sets

User Selected Options	
Date/Time of Computation	ProUCL 5.110/22/2018 10:32:55 AM
From File	WorkSheet_e.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

C0

General Statistics

Total Number of Observations	53	Number of Distinct Observations	28
		Number of Missing Observations	1
Minimum	12	Mean	28.66
Maximum	83	Median	21
SD	18.49	Std. Error of Mean	2.54
Coefficient of Variation	0.645	Skewness	1.573

Normal GOF Test

Shapiro Wilk Test Statistic	0.768	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	1.156E-10	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.263	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.121	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	32.91	95% Adjusted-CLT UCL (Chen-1995)	33.43
		95% Modified-t UCL (Johnson-1978)	33.01

Gamma GOF Test

A-D Test Statistic	2.939	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.756	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.23	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.123	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.312	k star (bias corrected MLE)	3.137
Theta hat (MLE)	8.654	Theta star (bias corrected MLE)	9.136
nu hat (MLE)	351.1	nu star (bias corrected)	332.5
MLE Mean (bias corrected)	28.66	MLE Sd (bias corrected)	16.18
		Approximate Chi Square Value (0.05)	291.3
Adjusted Level of Significance	0.0455	Adjusted Chi Square Value	290.2

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	32.72	95% Adjusted Gamma UCL (use when n<50)	32.84

	A	B	C	D	E	F	G	H	I	J	K	L
51	**Lognormal GOF Test**											
52					Shapiro Wilk Test Statistic	0.884	**Shapiro Wilk Lognormal GOF Test**					
53					5% Shapiro Wilk P Value	2.4215E-5	Data Not Lognormal at 5% Significance Level					
54					Lilliefors Test Statistic	0.201	**Lilliefors Lognormal GOF Test**					
55					5% Lilliefors Critical Value	0.121	Data Not Lognormal at 5% Significance Level					
56	**Data Not Lognormal at 5% Significance Level**											
57												
58	**Lognormal Statistics**											
59					Minimum of Logged Data	2.485	Mean of logged Data	3.197				
60					Maximum of Logged Data	4.419	SD of logged Data	0.537				
61												
62	**Assuming Lognormal Distribution**											
63					95% H-UCL	32.55	90% Chebyshev (MVUE) UCL	34.75				
64					95% Chebyshev (MVUE) UCL	37.74	97.5% Chebyshev (MVUE) UCL	41.88				
65					99% Chebyshev (MVUE) UCL	50.02						
66												
67	**Nonparametric Distribution Free UCL Statistics**											
68	**Data do not follow a Discernible Distribution (0.05)**											
69												
70	**Nonparametric Distribution Free UCLs**											
71					95% CLT UCL	32.84	95% Jackknife UCL	32.91				
72					95% Standard Bootstrap UCL	32.77	95% Bootstrap-t UCL	33.6				
73					95% Hall's Bootstrap UCL	33.43	95% Percentile Bootstrap UCL	32.91				
74					95% BCA Bootstrap UCL	33.26						
75					90% Chebyshev(Mean, Sd) UCL	36.28	95% Chebyshev(Mean, Sd) UCL	39.73				
76					97.5% Chebyshev(Mean, Sd) UCL	44.52	99% Chebyshev(Mean, Sd) UCL	53.94				
77												
78	**Suggested UCL to Use**											
79					95% Chebyshev (Mean, Sd) UCL	39.73						
80												
81	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
82	Recommendations are based upon data size, data distribution, and skewness.											
83	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
84	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
85												

UCL Statistics for Uncensored Full Data Sets

User Selected Options	
Date/Time of Computation	ProUCL 5.110/22/2018 10:49:52 AM
From File	WorkSheet_g.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

C0

General Statistics

Total Number of Observations	42	Number of Distinct Observations	23
		Number of Missing Observations	1
Minimum	15	Mean	43.21
Maximum	232	Median	21.5
SD	55.65	Std. Error of Mean	8.587
Coefficient of Variation	1.288	Skewness	2.445

Normal GOF Test

Shapiro Wilk Test Statistic	0.518	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.942	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.354	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.135	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	57.67	95% Adjusted-CLT UCL (Chen-1995)	60.8
		95% Modified-t UCL (Johnson-1978)	58.21

Gamma GOF Test

A-D Test Statistic	6.418	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.77	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.296	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.139	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.344	k star (bias corrected MLE)	1.264
Theta hat (MLE)	32.16	Theta star (bias corrected MLE)	34.2
nu hat (MLE)	112.9	nu star (bias corrected)	106.1
MLE Mean (bias corrected)	43.21	MLE Sd (bias corrected)	38.44
		Approximate Chi Square Value (0.05)	83.37
Adjusted Level of Significance	0.0443	Adjusted Chi Square Value	82.65

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	55.02	95% Adjusted Gamma UCL (use when n<50)	55.5

51	**Lognormal GOF Test**											
52					Shapiro Wilk Test Statistic	0.692	**Shapiro Wilk Lognormal GOF Test**					
53					5% Shapiro Wilk Critical Value	0.942	Data Not Lognormal at 5% Significance Level					
54					Lilliefors Test Statistic	0.255	**Lilliefors Lognormal GOF Test**					
55					5% Lilliefors Critical Value	0.135	Data Not Lognormal at 5% Significance Level					
56	**Data Not Lognormal at 5% Significance Level**											
57												
58	**Lognormal Statistics**											
59					Minimum of Logged Data	2.708	Mean of logged Data	3.35				
60					Maximum of Logged Data	5.447	SD of logged Data	0.769				
61												
62	**Assuming Lognormal Distribution**											
63					95% H-UCL	49.44	90% Chebyshev (MVUE) UCL	52.95				
64					95% Chebyshev (MVUE) UCL	59.73	97.5% Chebyshev (MVUE) UCL	69.15				
65					99% Chebyshev (MVUE) UCL	87.64						
66												
67	**Nonparametric Distribution Free UCL Statistics**											
68	**Data do not follow a Discernible Distribution (0.05)**											
69												
70	**Nonparametric Distribution Free UCLs**											
71					95% CLT UCL	57.34	95% Jackknife UCL	57.67				
72					95% Standard Bootstrap UCL	56.65	95% Bootstrap-t UCL	64.19				
73					95% Hall's Bootstrap UCL	56.41	95% Percentile Bootstrap UCL	57.83				
74					95% BCA Bootstrap UCL	63.69						
75					90% Chebyshev(Mean, Sd) UCL	68.98	95% Chebyshev(Mean, Sd) UCL	80.64				
76					97.5% Chebyshev(Mean, Sd) UCL	96.84	99% Chebyshev(Mean, Sd) UCL	128.7				
77												
78	**Suggested UCL to Use**											
79					95% Chebyshev (Mean, Sd) UCL	80.64						
80												
81	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
82	Recommendations are based upon data size, data distribution, and skewness.											
83	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
84	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
85												

UCL Statistics for Uncensored Full Data Sets

User Selected Options	
Date/Time of Computation	ProUCL 5.110/22/2018 11:00:51 AM
From File	WorkSheet_h.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

C0

General Statistics

Total Number of Observations	29	Number of Distinct Observations	22
		Number of Missing Observations	1
Minimum	17	Mean	44.17
Maximum	97	Median	33
SD	25.29	Std. Error of Mean	4.696
Coefficient of Variation	0.573	Skewness	0.672

Normal GOF Test

Shapiro Wilk Test Statistic	0.872	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.926	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.195	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.161	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	52.16	95% Adjusted-CLT UCL (Chen-1995)	52.52
		95% Modified-t UCL (Johnson-1978)	52.26

Gamma GOF Test

A-D Test Statistic	1.079	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.752	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.169	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.164	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.284	k star (bias corrected MLE)	2.967
Theta hat (MLE)	13.45	Theta star (bias corrected MLE)	14.89
nu hat (MLE)	190.4	nu star (bias corrected)	172.1
MLE Mean (bias corrected)	44.17	MLE Sd (bias corrected)	25.65
		Approximate Chi Square Value (0.05)	142.7
Adjusted Level of Significance	0.0407	Adjusted Chi Square Value	141.1

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	53.25	95% Adjusted Gamma UCL (use when n<50)	53.85

51	**Lognormal GOF Test**											
52					Shapiro Wilk Test Statistic	0.905	**Shapiro Wilk Lognormal GOF Test**					
53					5% Shapiro Wilk Critical Value	0.926	Data Not Lognormal at 5% Significance Level					
54					Lilliefors Test Statistic	0.153	**Lilliefors Lognormal GOF Test**					
55					5% Lilliefors Critical Value	0.161	Data appear Lognormal at 5% Significance Level					
56	**Data appear Approximate Lognormal at 5% Significance Level**											
57												
58	**Lognormal Statistics**											
59					Minimum of Logged Data	2.833	Mean of logged Data	3.628				
60					Maximum of Logged Data	4.575	SD of logged Data	0.578				
61												
62	**Assuming Lognormal Distribution**											
63					95% H-UCL	55.4	90% Chebyshev (MVUE) UCL	59.21				
64					95% Chebyshev (MVUE) UCL	66.02	97.5% Chebyshev (MVUE) UCL	75.46				
65					99% Chebyshev (MVUE) UCL	94.02						
66												
67	**Nonparametric Distribution Free UCL Statistics**											
68	**Data appear to follow a Discernible Distribution at 5% Significance Level**											
69												
70	**Nonparametric Distribution Free UCLs**											
71					95% CLT UCL	51.9	95% Jackknife UCL	52.16				
72					95% Standard Bootstrap UCL	51.86	95% Bootstrap-t UCL	52.76				
73					95% Hall's Bootstrap UCL	52.27	95% Percentile Bootstrap UCL	52.07				
74					95% BCA Bootstrap UCL	52.83						
75					90% Chebyshev(Mean, Sd) UCL	58.26	95% Chebyshev(Mean, Sd) UCL	64.64				
76					97.5% Chebyshev(Mean, Sd) UCL	73.5	99% Chebyshev(Mean, Sd) UCL	90.9				
77												
78	**Suggested UCL to Use**											
79					95% H-UCL	55.4						
80												
81	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
82	Recommendations are based upon data size, data distribution, and skewness.											
83	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
84	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
85												
86	**ProUCL computes and outputs H-statistic based UCLs for historical reasons only.**											
87	**H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.**											
88	**It is therefore recommended to avoid the use of H-statistic based 95% UCLs.**											
89	**Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.**											
90												

UCL Statistics for Uncensored Full Data Sets

User Selected Options	
Date/Time of Computation	ProUCL 5.110/22/2018 11:18:18 AM
From File	WorkSheet_i.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

C0

General Statistics

Total Number of Observations	47	Number of Distinct Observations	42
		Number of Missing Observations	1
Minimum	20	Mean	202.6
Maximum	4072	Median	76
SD	591.5	Std. Error of Mean	86.28
Coefficient of Variation	2.919	Skewness	6.369

Normal GOF Test

Shapiro Wilk Test Statistic	0.27	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.946	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.388	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.128	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	347.5	95% Adjusted-CLT UCL (Chen-1995)	430.2
		95% Modified-t UCL (Johnson-1978)	360.8

Gamma GOF Test

A-D Test Statistic	6.24	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.79	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.286	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.134	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.78	k star (bias corrected MLE)	0.744
Theta hat (MLE)	259.8	Theta star (bias corrected MLE)	272.2
nu hat (MLE)	73.33	nu star (bias corrected)	69.98
MLE Mean (bias corrected)	202.6	MLE Sd (bias corrected)	234.9
		Approximate Chi Square Value (0.05)	51.72
Adjusted Level of Significance	0.0449	Adjusted Chi Square Value	51.22

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	274.2	95% Adjusted Gamma UCL (use when n<50)	276.8

	A	B	C	D	E	F	G	H	I	J	K	L
51	**Lognormal GOF Test**											
52					Shapiro Wilk Test Statistic	0.844	**Shapiro Wilk Lognormal GOF Test**					
53					5% Shapiro Wilk Critical Value	0.946	Data Not Lognormal at 5% Significance Level					
54					Lilliefors Test Statistic	0.19	**Lilliefors Lognormal GOF Test**					
55					5% Lilliefors Critical Value	0.128	Data Not Lognormal at 5% Significance Level					
56	**Data Not Lognormal at 5% Significance Level**											
57												
58	**Lognormal Statistics**											
59					Minimum of Logged Data	2.996	Mean of logged Data	4.548				
60					Maximum of Logged Data	8.312	SD of logged Data	0.894				
61												
62	**Assuming Lognormal Distribution**											
63					95% H-UCL	188.8	90% Chebyshev (MVUE) UCL	201.6				
64					95% Chebyshev (MVUE) UCL	229.8	97.5% Chebyshev (MVUE) UCL	269				
65					99% Chebyshev (MVUE) UCL	345.9						
66												
67	**Nonparametric Distribution Free UCL Statistics**											
68	**Data do not follow a Discernible Distribution (0.05)**											
69												
70	**Nonparametric Distribution Free UCLs**											
71					95% CLT UCL	344.6	95% Jackknife UCL	347.5				
72					95% Standard Bootstrap UCL	349.6	95% Bootstrap-t UCL	918.2				
73					95% Hall's Bootstrap UCL	808.4	95% Percentile Bootstrap UCL	366.8				
74					95% BCA Bootstrap UCL	482.1						
75					90% Chebyshev(Mean, Sd) UCL	461.5	95% Chebyshev(Mean, Sd) UCL	578.7				
76					97.5% Chebyshev(Mean, Sd) UCL	741.5	99% Chebyshev(Mean, Sd) UCL	1061				
77												
78	**Suggested UCL to Use**											
79					95% Chebyshev (Mean, Sd) UCL	578.7						
80												
81	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
82	Recommendations are based upon data size, data distribution, and skewness.											
83	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
84	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
85												

UCL Statistics for Uncensored Full Data Sets

User Selected Options	
Date/Time of Computation	ProUCL 5.110/22/2018 11:29:58 AM
From File	WorkSheet_j.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

C0

General Statistics

Total Number of Observations	42	Number of Distinct Observations	38
		Number of Missing Observations	1
Minimum	17	Mean	97.21
Maximum	582	Median	74.5
SD	96.75	Std. Error of Mean	14.93
Coefficient of Variation	0.995	Skewness	3.42

Normal GOF Test

Shapiro Wilk Test Statistic	0.648	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.942	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.222	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.135	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	122.3	95% Adjusted-CLT UCL (Chen-1995)	130.2
		95% Modified-t UCL (Johnson-1978)	123.6

Gamma GOF Test

A-D Test Statistic	0.721	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.762	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.12	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.138	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.815	k star (bias corrected MLE)	1.702
Theta hat (MLE)	53.55	Theta star (bias corrected MLE)	57.13
nu hat (MLE)	152.5	nu star (bias corrected)	142.9
MLE Mean (bias corrected)	97.21	MLE Sd (bias corrected)	74.53
		Approximate Chi Square Value (0.05)	116.3
Adjusted Level of Significance	0.0443	Adjusted Chi Square Value	115.4

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	119.5	95% Adjusted Gamma UCL (use when n<50)	120.4

51	**Lognormal GOF Test**											
52					Shapiro Wilk Test Statistic	0.94	**Shapiro Wilk Lognormal GOF Test**					
53					5% Shapiro Wilk Critical Value	0.942	Data Not Lognormal at 5% Significance Level					
54					Lilliefors Test Statistic	0.0645	**Lilliefors Lognormal GOF Test**					
55					5% Lilliefors Critical Value	0.135	Data appear Lognormal at 5% Significance Level					
56	**Data appear Approximate Lognormal at 5% Significance Level**											
57												
58	**Lognormal Statistics**											
59					Minimum of Logged Data	2.833	Mean of logged Data	4.277				
60					Maximum of Logged Data	6.366	SD of logged Data	0.752				
61												
62	**Assuming Lognormal Distribution**											
63					95% H-UCL	122.3	90% Chebyshev (MVUE) UCL	131.1				
64					95% Chebyshev (MVUE) UCL	147.6	97.5% Chebyshev (MVUE) UCL	170.4				
65					99% Chebyshev (MVUE) UCL	215.3						
66												
67	**Nonparametric Distribution Free UCL Statistics**											
68	**Data appear to follow a Discernible Distribution at 5% Significance Level**											
69												
70	**Nonparametric Distribution Free UCLs**											
71					95% CLT UCL	121.8	95% Jackknife UCL	122.3				
72					95% Standard Bootstrap UCL	121.5	95% Bootstrap-t UCL	138.8				
73					95% Hall's Bootstrap UCL	237.6	95% Percentile Bootstrap UCL	122.2				
74					95% BCA Bootstrap UCL	132.5						
75					90% Chebyshev(Mean, Sd) UCL	142	95% Chebyshev(Mean, Sd) UCL	162.3				
76					97.5% Chebyshev(Mean, Sd) UCL	190.4	99% Chebyshev(Mean, Sd) UCL	245.7				
77												
78	**Suggested UCL to Use**											
79					95% Adjusted Gamma UCL	120.4						
80												
81	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
82	Recommendations are based upon data size, data distribution, and skewness.											
83	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
84	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
85												

Attachment 3

RML Calculator Outputs (P001-P010)

Site-specific
Resident Equation Inputs for Soil

*** Inputted values different from Resident defaults are highlighted.**

Variable	Resident Soil Default Value	Form-input Value
A (PEF Dispersion Constant)	16.2302	16.2302
A (VF Dispersion Constant)	11.911	11.911
A (VF Dispersion Constant - Mass Limit)	11.911	11.911
B (PEF Dispersion Constant)	18.7762	18.7762
B (VF Dispersion Constant)	18.4385	18.4385
B (VF Dispersion Constant - Mass Limit)	18.4385	18.4385
$City_{PEF}$ (Climate Zone) Selection	Default	Default
$City_{VF}$ (Climate Zone) Selection	Default	Default
C (PEF Dispersion Constant)	216.108	216.108
C (VF Dispersion Constant)	209.7845	209.7845
C (VF Dispersion Constant - Mass Limit)	209.7845	209.7845
foc (fraction organic carbon in soil) g/g	0.006	0.006
F(x) (function dependent on U_m/U_t) unitless	0.194	0.194
n (total soil porosity) L_{pore}/L_{soil}	0.43396	0.43396
p_b (dry soil bulk density) g/cm^3	1.5	1.5
p_b (dry soil bulk density - mass limit) g/cm^3	1.5	1.5
PEF (particulate emission factor) m^3/kg	1359344438	1359344438
p_s (soil particle density) g/cm^3	2.65	2.65
Q/C_{wind} (g/m^2-s per kg/m^3)	93.77	93.77
Q/C_{vol} (g/m^2-s per kg/m^3)	68.18	68.18
Q/C_{vol} (g/m^2-s per kg/m^3)	68.18	68.18
A_s (PEF acres)	0.5	0.5
A_s (VF acres)	0.5	0.5
A_s (VF mass-limit acres)	0.5	0.5
AF_{0-2} (mutagenic skin adherence factor) mg/cm^2	0.2	0.2
AF_{2-6} (mutagenic skin adherence factor) mg/cm^2	0.2	0.2
AF_{6-16} (mutagenic skin adherence factor) mg/cm^2	0.07	0.07
AF_{16-26} (mutagenic skin adherence factor) mg/cm^2	0.07	0.07

Output generated 22OCT2018:09:26:22

Site-specific
Resident Equation Inputs for Soil

*** Inputted values different from Resident defaults are highlighted.**

Variable	Resident Soil Default Value	Form-input Value
AF_{res-a} (skin adherence factor - adult) mg/cm ^{2}	0.07	0.07
AF_{res-c} (skin adherence factor - child) mg/cm ^{2}	0.2	0.2
AT_{res} (averaging time - resident carcinogenic)	365	365
BW_{0-2} (mutagenic body weight) kg	15	15
BW_{2-6} (mutagenic body weight) kg	15	15
BW_{6-16} (mutagenic body weight) kg	80	80
BW_{16-26} (mutagenic body weight) kg	80	80
BW_{res-a} (body weight - adult) kg	80	80
BW_{res-c} (body weight - child) kg	15	15
$DFS_{res-adj}$ (age-adjusted soil dermal factor) mg/kg	103390	103390
$DFSM_{res-adj}$ (mutagenic age-adjusted soil dermal factor) mg/kg	428260	428260
ED_{res} (exposure duration) years	26	26
ED_{0-2} (mutagenic exposure duration) years	2	2
ED_{2-6} (mutagenic exposure duration) years	4	4
ED_{6-16} (mutagenic exposure duration) years	10	10
ED_{16-26} (mutagenic exposure duration) years	10	10
ED_{res-a} (exposure duration - adult) years	20	20
ED_{res-c} (exposure duration - child) years	6	6
EF_{res} (exposure frequency) days/year	350	350
EF_{0-2} (mutagenic exposure frequency) days/year	350	350
EF_{2-6} (mutagenic exposure frequency) days/year	350	350
EF_{6-16} (mutagenic exposure frequency) days/year	350	350
EF_{16-26} (mutagenic exposure frequency) days/year	350	350
EF_{res-a} (exposure frequency - adult) days/year	350	350
EF_{res-c} (exposure frequency - child) days/year	350	350
ET_{res} (exposure time) hours/day	24	24
ET_{0-2} (mutagenic exposure time) hours/day	24	24
ET_{2-6} (mutagenic exposure time) hours/day	24	24
ET_{6-16} (mutagenic exposure time) hours/day	24	24

Site-specific
Resident Equation Inputs for Soil

*** Inputted values different from Resident defaults are highlighted.**

Variable	Resident Soil Default Value	Form-input Value
ET_{16-26} (mutagenic exposure time) hours/day	24	24
ET_{res-a} (adult exposure time) hours/day	24	24
ET_{res-c} (child exposure time) hours/day	24	24
THQ (target hazard quotient) unitless	1	1
$IFS_{res-adj}$ (age-adjusted soil ingestion factor) mg/kg	36750	36750
$IFSM_{res-adj}$ (mutagenic age-adjusted soil ingestion factor) mg/kg	166833.3	166833.3
IRS_{0-2} (mutagenic soil intake rate) mg/day	200	200
IRS_{2-6} (mutagenic soil intake rate) mg/day	200	200
IRS_{6-16} (mutagenic soil intake rate) mg/day	100	100
IRS_{16-26} (mutagenic soil intake rate) mg/day	100	100
IRS_{res-a} (soil intake rate - adult) mg/day	100	100
IRS_{res-c} (soil intake rate - child) mg/day	200	200
LT (lifetime) years	70	70
SA_{0-2} (mutagenic skin surface area) cm^2/day	2373	2373
SA_{2-6} (mutagenic skin surface area) cm^2/day	2373	2373
SA_{6-16} (mutagenic skin surface area) cm^2/day	6032	6032
SA_{16-26} (mutagenic skin surface area) cm^2/day	6032	6032
SA_{res-a} (skin surface area - adult) cm^2/day	6032	6032
SA_{res-c} (skin surface area - child) cm^2/day	2373	2373
TR (target risk) unitless	1.0E-04	1.0E-04
T_w (groundwater temperature) Celsius	25	25
$Theta_a$ (air-filled soil porosity) L_{air}/L_{soil}	0.28396	0.28396
$Theta_w$ (water-filled soil porosity) L_{water}/L_{soil}	0.15	0.15
T (exposure interval) s	819936000	819936000
T (exposure interval) yr	26	26
U_m (mean annual wind speed) m/s	4.69	4.69
U_t (equivalent threshold value)	11.32	11.32
V (fraction of vegetative cover) unitless	0.5	0.5

Site-specific
Resident Removal Management Levels (RML) for Soil

Key: I = IRIS; P = PPRTV; D = DWSHA; O = OPP; A = ATSDR; C = Cal EPA; X = APPENDIX PPRTV SCREEN (See FAQ #29); H = HEAST; F = See FAQ; E = see user guide Section 2.3.5; W = see user guide Section 2.3.6; L = see user guide on lead; M = mutagen; S = see user guide Section 5; V = volatile; R = RBA applied (See User Guide for Arsenic notice) ; c = cancer; n = noncancer; * = where: n SL < 100X c SL; ** = where n SL < 10X c SL; SSL values are based on DAF=1; m = Concentration may exceed ceiling limit (See User Guide); s = Concentration may exceed Csat (See User Guide); U = User-provided

Chemical	CAS Number	Mutagen?	Volatile?	Ingestion SF (mg/kg-day) $^{-1}$	SFO Ref	Inhalation Unit Risk (ug/m^3)$^{-1}$	IUR Ref	RfD (mg/kg-day)	RfD Ref	RfC (mg/m^3)	RfC Ref	GIABS	ABS	RBA	Soil Saturation Concentration (mg/kg)	S (mg/L)	K_{oc} \ (cm^3/g)
Arsenic, Inorganic	7440-38-2	No	No	1.50E+00	U	4.30E-03	U	3.00E-04	U	1.50E-05	U	1	0.03	0.6	-	-	-

Chemical	K_d \ (cm^3/g)	HLC (atm-m^3/mole)	Henry's Law Constant Used in Calcs (unitless)	H` and HLC Ref	Normal Boiling Point T_{boil} \ (K)	BP Ref	Critical Temperature T_{crit} \ (K)	T_{crit} \ Ref	chemtype	D_{ia} \ (cm^2/s)	D_{iw} \ (cm^2/s)	D_A \ (cm^2/s)	Particulate Emission Factor (m^3/kg)	Volatilization Factor (m^3/kg)	Ingestion SL TR=0.0001 (mg/kg)
Arsenic, Inorganic	2.90E+01	-	-		888.15	U	1670	U	INORGANIC	-	-	-	1.36E+09	-	7.72E+01

Chemical	Dermal SL TR=0.0001 (mg/kg)	Inhalation SL TR=0.0001 (mg/kg)	Carcinogenic SL TR=0.0001 (mg/kg)	Ingestion SL Child THQ=1 (mg/kg)	Dermal SL Child THQ=1 (mg/kg)	Inhalation SL Child THQ=1 (mg/kg)	Noncarcinogenic SL Child THI=1 (mg/kg)	Ingestion SL Adult THQ=1 (mg/kg)	Dermal SL Adult THQ=1 (mg/kg)	Inhalation SL Adult THQ=1 (mg/kg)	Noncarcinogenic SL Adult THI=1 (mg/kg)	Screening Level (mg/kg)
Arsenic, Inorganic	5.49E+02	8.88E+04	6.77E+01	3.91E+01	3.30E+02	2.13E+04	3.49E+01	4.17E+02	1.98E+03	2.13E+04	3.39E+02	3.49E+01 nc

Output generated 22OCT2018:09:26:22

Site-specific
Resident Risk for Soil

Chemical	Ingestion SF (mg/kg-day) $^{-1}$	SFO Ref	Inhalation Unit Risk (ug/m^3)$^{-1}$	IUR Ref	RfD (mg/kg-day)	RfD Ref	RfC (mg/m^3)	RfC Ref	GIABS	ABS	RBA	Soil Saturation Concentration (mg/kg)	S (mg/L)	K_{oc}\ (cm^3/g)	K_d\ (cm^3/g)	HLC (atm-m^3/mole)
Arsenic, Inorganic	1.50E+00	U	4.30E-03	U	3.00E-04	U	1.50E-05	U	1	0.03	0.6	-	-	-	2.90E+01	-
**Total Risk/HI*	-		-		-		-		-	-	-	-	-	-	-	-

Chemical	Henry's Law Constant Used in Calcs (unitless)	H` and HLC Ref	Normal Boiling Point T_{boil}\ (K)	BP Ref	Critical Temperature T_{crit}\ (K)	T_{crit}\ Ref	chemtype	D_{ia}\ (cm^2/s)	D_{iw}\ (cm^2/s)	D_A\ (cm^2/s)	Particulate Emission Factor (m^3/kg)	Volatilization Factor (m^3/kg)	Concentration (mg/kg)	Ingestion Risk	Dermal Risk
Arsenic, Inorganic	-		888.15	U	1670	U	INORGANIC	-	-	-	1.36E+09	-	2.03E+04	2.59E-02	3.70E-03
**Total Risk/HI*	-		-		-			-	-	-	-	-	-	*2.59E-02*	*3.70E-03*

Chemical	Inhalation Risk	Carcinogenic Risk	Ingestion Child HQ	Dermal Child HQ	Inhalation Child HQ	Noncarcinogenic Child HI	Ingestion Adult HQ	Dermal Adult HQ	Inhalation Adult HQ	Noncarcinogenic Adult HI
Arsenic, Inorganic	2.29E-05	2.96E-02	5.19E+02	6.16E+01	9.55E-01	5.82E+02	4.87E+01	1.03E+01	9.55E-01	5.99E+01
**Total Risk/HI*	*2.29E-05*	*2.96E-02*	*5.19E+02*	*6.16E+01*	*9.55E-01*	*5.82E+02*	*4.87E+01*	*1.03E+01*	*9.55E-01*	*5.99E+01*

Site-specific
Resident Equation Inputs for Soil

*** Inputted values different from Resident defaults are highlighted.**

Variable	Resident Soil Default Value	Form-input Value
A (PEF Dispersion Constant)	16.2302	16.2302
A (VF Dispersion Constant)	11.911	11.911
A (VF Dispersion Constant - Mass Limit)	11.911	11.911
B (PEF Dispersion Constant)	18.7762	18.7762
B (VF Dispersion Constant)	18.4385	18.4385
B (VF Dispersion Constant - Mass Limit)	18.4385	18.4385
$City_{PEF}$ (Climate Zone) Selection	Default	Default
$City_{VF}$ (Climate Zone) Selection	Default	Default
C (PEF Dispersion Constant)	216.108	216.108
C (VF Dispersion Constant)	209.7845	209.7845
C (VF Dispersion Constant - Mass Limit)	209.7845	209.7845
foc (fraction organic carbon in soil) g/g	0.006	0.006
F(x) (function dependent on U_m/U_t) unitless	0.194	0.194
n (total soil porosity) L_{pore}/L_{soil}	0.43396	0.43396
p_b (dry soil bulk density) g/cm^3	1.5	1.5
p_b (dry soil bulk density - mass limit) g/cm^3	1.5	1.5
PEF (particulate emission factor) m^3/kg	1359344438	1359344438
p_s (soil particle density) g/cm^3	2.65	2.65
Q/C_{wind} (g/m^2-s per kg/m^3)	93.77	93.77
Q/C_{vol} (g/m^2-s per kg/m^3)	68.18	68.18
Q/C_{vol} (g/m^2-s per kg/m^3)	68.18	68.18
A_s (PEF acres)	0.5	0.5
A_s (VF acres)	0.5	0.5
A_s (VF mass-limit acres)	0.5	0.5
AF_{0-2} (mutagenic skin adherence factor) mg/cm^2	0.2	0.2
AF_{2-6} (mutagenic skin adherence factor) mg/cm^2	0.2	0.2
AF_{6-16} (mutagenic skin adherence factor) mg/cm^2	0.07	0.07
AF_{16-26} (mutagenic skin adherence factor) mg/cm^2	0.07	0.07
AF_{res-a} (skin adherence factor - adult) mg/cm^2	0.07	0.07
AF_{res-c} (skin adherence factor - child) mg/cm^2	0.2	0.2

Output generated 31JAN2019:08:52:08

Site-specific
Resident Equation Inputs for Soil

*** Inputted values different from Resident defaults are highlighted.**

Variable	Resident Soil Default Value	Form-input Value
AT_{res} (averaging time - resident carcinogenic)	365	365
BW_{0-2} (mutagenic body weight) kg	15	15
BW_{2-6} (mutagenic body weight) kg	15	15
BW_{6-16} (mutagenic body weight) kg	80	80
BW_{16-26} (mutagenic body weight) kg	80	80
BW_{res-a} (body weight - adult) kg	80	80
BW_{res-c} (body weight - child) kg	15	15
$DFS_{res-adj}$ (age-adjusted soil dermal factor) mg/kg	103390	103390
$DFSM_{res-adj}$ (mutagenic age-adjusted soil dermal factor) mg/kg	428260	428260
ED_{res} (exposure duration) years	26	26
ED_{0-2} (mutagenic exposure duration) years	2	2
ED_{2-6} (mutagenic exposure duration) years	4	4
ED_{6-16} (mutagenic exposure duration) years	10	10
ED_{16-26} (mutagenic exposure duration) years	10	10
ED_{res-a} (exposure duration - adult) years	20	20
ED_{res-c} (exposure duration - child) years	6	6
EF_{res} (exposure frequency) days/year	350	350
EF_{0-2} (mutagenic exposure frequency) days/year	350	350
EF_{2-6} (mutagenic exposure frequency) days/year	350	350
EF_{6-16} (mutagenic exposure frequency) days/year	350	350
EF_{16-26} (mutagenic exposure frequency) days/year	350	350
EF_{res-a} (exposure frequency - adult) days/year	350	350
EF_{res-c} (exposure frequency - child) days/year	350	350
ET_{res} (exposure time) hours/day	24	24
ET_{0-2} (mutagenic exposure time) hours/day	24	24
ET_{2-6} (mutagenic exposure time) hours/day	24	24
ET_{6-16} (mutagenic exposure time) hours/day	24	24
ET_{16-26} (mutagenic exposure time) hours/day	24	24
ET_{res-a} (adult exposure time) hours/day	24	24
ET_{res-c} (child exposure time) hours/day	24	24

Site-specific
Resident Equation Inputs for Soil

*** Inputted values different from Resident defaults are highlighted.**

Variable	Resident Soil Default Value	Form-input Value
THQ (target hazard quotient) unitless	1	1
$IFS_{res-adj}$ (age-adjusted soil ingestion factor) mg/kg	36750	36750
$IFSM_{res-adj}$ (mutagenic age-adjusted soil ingestion factor) mg/kg	166833.3	166833.3
IRS_{0-2} (mutagenic soil intake rate) mg/day	200	200
IRS_{2-6} (mutagenic soil intake rate) mg/day	200	200
IRS_{6-16} (mutagenic soil intake rate) mg/day	100	100
IRS_{16-26} (mutagenic soil intake rate) mg/day	100	100
IRS_{res-a} (soil intake rate - adult) mg/day	100	100
IRS_{res-c} (soil intake rate - child) mg/day	200	200
LT (lifetime) years	70	70
SA_{0-2} (mutagenic skin surface area) cm^2/day	2373	2373
SA_{2-6} (mutagenic skin surface area) cm^2/day	2373	2373
SA_{6-16} (mutagenic skin surface area) cm^2/day	6032	6032
SA_{16-26} (mutagenic skin surface area) cm^2/day	6032	6032
SA_{res-a} (skin surface area - adult) cm^2/day	6032	6032
SA_{res-c} (skin surface area - child) cm^2/day	2373	2373
TR (target risk) unitless	1.0E-04	1.0E-04
T_w (groundwater temperature) Celsius	25	25
$Theta_a$ (air-filled soil porosity) L_{air}/L_{soil}	0.28396	0.28396
$Theta_w$ (water-filled soil porosity) L_{water}/L_{soil}	0.15	0.15
T (exposure interval) s	819936000	819936000
T (exposure interval) yr	26	26
U_m (mean annual wind speed) m/s	4.69	4.69
U_t (equivalent threshold value)	11.32	11.32
V (fraction of vegetative cover) unitless	0.5	0.5

Site-specific
Resident Removal Management Levels (RML) for Soil

Key: I = IRIS; P = PPRTV; D = DWSHA; O = OPP; A = ATSDR; C = Cal EPA; X = APPENDIX PPRTV SCREEN (See FAQ #31); H = HEAST; F = See FAQ; W = see user guide Section 2.3.5; E = see user guide Section 2.3.6; L = see user guide on lead; M = mutagen; S = see user guide Section 5; V = volatile; R = RBA applied (See User Guide for Arsenic notice) ; ca = cancer; nc = noncancer; * = where: nc SL < 100X ca SL; ** = where nc SL < 10X ca SL; SSL values are based on DAF=1; max = Concentration may exceed ceiling limit (See User Guide); sat = Concentration may exceed Csat (See User Guide); U = User-provided

Chemical	CAS Number	Mutagen?	Volatile?	SF_o (mg/kg-day) $^{-1}$	SF_o Ref	IUR (ug/m^3)$^{-1}$	IUR Ref	RfD (mg/kg-day)	RfD Ref	RfC (mg/m^3)	RfC Ref	GIABS	ABS	RBA
Arsenic, Inorganic	7440-38-2	No	No	1.50E+00	I	4.30E-03	I	3.00E-04	I	1.50E-05	C	1	0.03	0.6

Chemical	Soil Saturation Concentration (mg/kg)	S (mg/L)	K_{oc}\ (cm^3/g)	K_d\ (cm^3/g)	HLC (atm-m^3/mole)	Henry's Law Constant Used in Calcs (unitless)	H` and HLC Ref	Normal Boiling Point BP (K)	BP Ref	Critical Temperature TC (K)	TC Ref
Arsenic, Inorganic	-	-	-	2.90E+01	-	-		888.15	PHYSPROP	1673	CRC89

Chemical	Chemical Type	D_{ia}\ (cm^2/s)	D_{iw}\ (cm^2/s)	D_A\ (cm^2/s)	Particulate Emission Factor (m^3/kg)	Volatilization Factor (m^3/kg)	Ingestion SL TR=0.0001 (mg/kg)	Dermal SL TR=0.0001 (mg/kg)	Inhalation SL TR=0.0001 (mg/kg)	Carcinogenic SL TR=0.0001 (mg/kg)
Arsenic, Inorganic	INORGANIC	-	-	-	1.36E+09	-	7.72E+01	5.49E+02	8.88E+04	6.77E+01

Chemical	Ingestion SL Child THQ=1 (mg/kg)	Dermal SL Child THQ=1 (mg/kg)	Inhalation SL Child THQ=1 (mg/kg)	Noncarcinogenic SL Child THI=1 (mg/kg)	Ingestion SL Adult THQ=1 (mg/kg)	Dermal SL Adult THQ=1 (mg/kg)	Inhalation SL Adult THQ=1 (mg/kg)	Noncarcinogenic SL Adult THI=1 (mg/kg)	Screening Level (mg/kg)
Arsenic, Inorganic	3.91E+01	3.30E+02	2.13E+04	3.49E+01	4.17E+02	1.98E+03	2.13E+04	3.39E+02	3.49E+01 nc

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Site-specific
Resident Risk for Soil

Chemical	SF_o (mg/kg-day) $^{-1}$	SF_o Ref	IUR (ug/m^3)$^{-1}$	IUR Ref	RfD (mg/kg-day)	RfD Ref	RfC (mg/m^3)	RfC Ref	GIABS	ABS	RBA	Soil Saturation Concentration (mg/kg)	S (mg/L)	K_{oc}\ (cm^3/g)	K_d\ (cm^3/g)	HLC (atm-m^3/mole)
Arsenic, Inorganic	1.50E+00	I	4.30E-03	I	3.00E-04	I	1.50E-05	C	1	0.03	0.6	-	-	-	2.90E+01	-
*Total Risk/HI	-		-		-		-		-	-	-	-	-	-	-	-

Chemical	Henry's Law Constant Used in Calcs (unitless)	H` and HLC Ref	Normal Boiling Point BP (K)	BP Ref	Critical Temperature TC (K)	TC Ref	Chemical Type	D_{ia}\ (cm^2/s)	D_{iw}\ (cm^2/s)	D_A\ (cm^2/s)	Particulate Emission Factor (m^3/kg)	Volatilization Factor (m^3/kg)	Concentration (mg/kg)	Ingestion Risk
Arsenic, Inorganic	-		888.15	PHYSPROP	1673	CRC89	INORGANIC	-	-	-	1.36E+09	-	7.15E+02	9.26E-04
*Total Risk/HI	-		-		-			-	-	-	-	-	-	9.26E-04

Chemical	Dermal Risk	Inhalation Risk	Carcinogenic Risk	Ingestion Child HQ	Dermal Child HQ	Inhalation Child HQ	Noncarcinogenic Child HI	Ingestion Adult HQ	Dermal Adult HQ	Inhalation Adult HQ	Noncarcinogenic Adult HI
Arsenic, Inorganic	1.30E-04	8.06E-07	1.06E-03	1.83E+01	2.17E+00	3.36E-02	2.05E+01	1.71E+00	3.62E-01	3.36E-02	2.11E+00
*Total Risk/HI	1.30E-04	8.06E-07	1.06E-03	1.83E+01	2.17E+00	3.36E-02	2.05E+01	1.71E+00	3.62E-01	3.36E-02	2.11E+00

Site-specific
Resident Equation Inputs for Soil

*** Inputted values different from Resident defaults are highlighted.**

Variable	Resident Soil Default Value	Form-input Value
A (PEF Dispersion Constant)	16.2302	16.2302
A (VF Dispersion Constant)	11.911	11.911
A (VF Dispersion Constant - Mass Limit)	11.911	11.911
B (PEF Dispersion Constant)	18.7762	18.7762
B (VF Dispersion Constant)	18.4385	18.4385
B (VF Dispersion Constant - Mass Limit)	18.4385	18.4385
$City_{PEF}$ (Climate Zone) Selection	Default	Default
$City_{VF}$ (Climate Zone) Selection	Default	Default
C (PEF Dispersion Constant)	216.108	216.108
C (VF Dispersion Constant)	209.7845	209.7845
C (VF Dispersion Constant - Mass Limit)	209.7845	209.7845
foc (fraction organic carbon in soil) g/g	0.006	0.006
F(x) (function dependent on U_m/U_t) unitless	0.194	0.194
n (total soil porosity) L_{pore}/L_{soil}	0.43396	0.43396
p_b (dry soil bulk density) g/cm^3	1.5	1.5
p_b (dry soil bulk density - mass limit) g/cm^3	1.5	1.5
PEF (particulate emission factor) m^3/kg	1359344438	1359344438
p_s (soil particle density) g/cm^3	2.65	2.65
Q/C_{wind} (g/m^2-s per kg/m^3)	93.77	93.77
Q/C_{vol} (g/m^2-s per kg/m^3)	68.18	68.18
Q/C_{vol} (g/m^2-s per kg/m^3)	68.18	68.18
A_s (PEF acres)	0.5	0.5
A_s (VF acres)	0.5	0.5
A_s (VF mass-limit acres)	0.5	0.5
AF_{0-2} (mutagenic skin adherence factor) mg/cm^2	0.2	0.2
AF_{2-6} (mutagenic skin adherence factor) mg/cm^2	0.2	0.2
AF_{6-16} (mutagenic skin adherence factor) mg/cm^2	0.07	0.07
AF_{16-26} (mutagenic skin adherence factor) mg/cm^2	0.07	0.07
AF_{res-a} (skin adherence factor - adult) mg/cm^2	0.07	0.07
AF_{res-c} (skin adherence factor - child) mg/cm^2	0.2	0.2

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Site-specific
Resident Equation Inputs for Soil

*** Inputted values different from Resident defaults are highlighted.**

Variable	Resident Soil Default Value	Form-input Value
AT_{res} (averaging time - resident carcinogenic)	365	365
BW_{0-2} (mutagenic body weight) kg	15	15
BW_{2-6} (mutagenic body weight) kg	15	15
BW_{6-16} (mutagenic body weight) kg	80	80
BW_{16-26} (mutagenic body weight) kg	80	80
BW_{res-a} (body weight - adult) kg	80	80
BW_{res-c} (body weight - child) kg	15	15
$DFS_{res-adj}$ (age-adjusted soil dermal factor) mg/kg	103390	103390
$DFSM_{res-adj}$ (mutagenic age-adjusted soil dermal factor) mg/kg	428260	428260
ED_{res} (exposure duration) years	26	26
ED_{0-2} (mutagenic exposure duration) years	2	2
ED_{2-6} (mutagenic exposure duration) years	4	4
ED_{6-16} (mutagenic exposure duration) years	10	10
ED_{16-26} (mutagenic exposure duration) years	10	10
ED_{res-a} (exposure duration - adult) years	20	20
ED_{res-c} (exposure duration - child) years	6	6
EF_{res} (exposure frequency) days/year	350	350
EF_{0-2} (mutagenic exposure frequency) days/year	350	350
EF_{2-6} (mutagenic exposure frequency) days/year	350	350
EF_{6-16} (mutagenic exposure frequency) days/year	350	350
EF_{16-26} (mutagenic exposure frequency) days/year	350	350
EF_{res-a} (exposure frequency - adult) days/year	350	350
EF_{res-c} (exposure frequency - child) days/year	350	350
ET_{res} (exposure time) hours/day	24	24
ET_{0-2} (mutagenic exposure time) hours/day	24	24
ET_{2-6} (mutagenic exposure time) hours/day	24	24
ET_{6-16} (mutagenic exposure time) hours/day	24	24
ET_{16-26} (mutagenic exposure time) hours/day	24	24
ET_{res-a} (adult exposure time) hours/day	24	24
ET_{res-c} (child exposure time) hours/day	24	24

Site-specific
Resident Equation Inputs for Soil

*** Inputted values different from Resident defaults are highlighted.**

Variable	Resident Soil Default Value	Form-input Value
THQ (target hazard quotient) unitless	1	1
$IFS_{res-adj}$ (age-adjusted soil ingestion factor) mg/kg	36750	36750
$IFSM_{res-adj}$ (mutagenic age-adjusted soil ingestion factor) mg/kg	166833.3	166833.3
IRS_{0-2} (mutagenic soil intake rate) mg/day	200	200
IRS_{2-6} (mutagenic soil intake rate) mg/day	200	200
IRS_{6-16} (mutagenic soil intake rate) mg/day	100	100
IRS_{16-26} (mutagenic soil intake rate) mg/day	100	100
IRS_{res-a} (soil intake rate - adult) mg/day	100	100
IRS_{res-c} (soil intake rate - child) mg/day	200	200
LT (lifetime) years	70	70
SA_{0-2} (mutagenic skin surface area) cm^2/day	2373	2373
SA_{2-6} (mutagenic skin surface area) cm^2/day	2373	2373
SA_{6-16} (mutagenic skin surface area) cm^2/day	6032	6032
SA_{16-26} (mutagenic skin surface area) cm^2/day	6032	6032
SA_{res-a} (skin surface area - adult) cm^2/day	6032	6032
SA_{res-c} (skin surface area - child) cm^2/day	2373	2373
TR (target risk) unitless	1.0E-04	1.0E-04
T_w (groundwater temperature) Celsius	25	25
$Theta_a$ (air-filled soil porosity) L_{air}/L_{soil}	0.28396	0.28396
$Theta_w$ (water-filled soil porosity) L_{water}/L_{soil}	0.15	0.15
T (exposure interval) s	819936000	819936000
T (exposure interval) yr	26	26
U_m (mean annual wind speed) m/s	4.69	4.69
U_t (equivalent threshold value)	11.32	11.32
V (fraction of vegetative cover) unitless	0.5	0.5

Site-specific
Resident Removal Management Levels (RML) for Soil

Key: I = IRIS; P = PPRTV; O = OPP; A = ATSDR; C = Cal EPA; X = PPRTV Screening Level; H = HEAST; D = DWSHA; W = TEF applied; E = RPF applied; U = user provided; c = cancer; n = noncancer; * = where: n SL < 100X c SL; ** = where n SL < 10X c SL; SSL values are based on DAF=1; m = ceiling limit exceeded; s = Csat exceeded.

Chemical	CAS Number	Mutagen?	Volatile?	SF_o (mg/kg-day)$^{-1}$	SF_o Ref	IUR (ug/m^3)$^{-1}$	IUR Ref	RfD (mg/kg-day)	RfD Ref	RfC (mg/m^3)	RfC Ref	GIABS	ABS	RBA	Soil Saturation Concentration (mg/kg)	S (mg/L)	K_{oc} \ (cm^3/g)
Arsenic, Inorganic	7440-38-2	No	No	1.50E+00	U	4.30E-03	U	3.00E-04	U	1.50E-05	U	1	0.03	0.6	-	-	-

Chemical	K_d \ (cm^3/g)	HLC (atm-m^3/mole)	Henry's Law Constant Used in Calcs (unitless)	H` and HLC Ref	Normal Boiling Point BP (K)	BP Ref	Critical Temperature TC (K)	TC Ref	Chemical Type	D_{ia} \ (cm^2/s)	D_{iw} \ (cm^2/s)	D_A \ (cm^2/s)	Particulate Emission Factor (m^3/kg)	Volatilization Factor (m^3/kg)	Ingestion SL TR=0.0001 (mg/kg)
Arsenic, Inorganic	2.90E+01	-	-		888.15	U	1670	U	INORGANIC	-	-	-	1.36E+09	-	7.72E+01

Chemical	Dermal SL TR=0.0001 (mg/kg)	Inhalation SL TR=0.0001 (mg/kg)	Carcinogenic SL TR=0.0001 (mg/kg)	Ingestion SL Child THQ=1 (mg/kg)	Dermal SL Child THQ=1 (mg/kg)	Inhalation SL Child THQ=1 (mg/kg)	Noncarcinogenic SL Child THI=1 (mg/kg)	Ingestion SL Adult THQ=1 (mg/kg)	Dermal SL Adult THQ=1 (mg/kg)	Inhalation SL Adult THQ=1 (mg/kg)	Noncarcinogenic SL Adult THI=1 (mg/kg)	Screening Level (mg/kg)
Arsenic, Inorganic	5.49E+02	8.88E+04	6.77E+01	3.91E+01	3.30E+02	2.13E+04	3.49E+01	4.17E+02	1.98E+03	2.13E+04	3.39E+02	3.49E+01 nc

Site-specific
Resident Risk for Soil

Chemical	SF_o (mg/kg-day) $^{-1}$	SF_o Ref	IUR (ug/m^3)$^{-1}$	IUR Ref	RfD (mg/kg-day)	RfD Ref	RfC (mg/m^3)	RfC Ref	GIABS	ABS	RBA	Soil Saturation Concentration (mg/kg)	S (mg/L)	K_{oc}\ (cm^3/g)	K_d\ (cm^3/g)	HLC (atm-m^3/mole)
Arsenic, Inorganic	1.50E+00	U	4.30E-03	U	3.00E-04	U	1.50E-05	U	1	0.03	0.6	-	-	-	2.90E+01	-
**Total Risk/HI*	-		-		-		-		-	-	-	-	-	-	-	-

Chemical	Henry's Law Constant Used in Calcs (unitless)	H` and HLC Ref	Normal Boiling Point BP (K)	BP Ref	Critical Temperature TC (K)	TC Ref	Chemical Type	D_{ia}\ (cm^2/s)	D_{iw}\ (cm^2/s)	D_A\ (cm^2/s)	Particulate Emission Factor (m^3/kg)	Volatilization Factor (m^3/kg)	Concentration (mg/kg)	Ingestion Risk
Arsenic, Inorganic	-		888.15	U	1670	U	INORGANIC	-	-	-	1.36E+09	-	6.60E+03	8.54E-03
**Total Risk/HI*	-		-		-			-	-	-	-	-	-	*8.54E-03*

Chemical	Dermal Risk	Inhalation Risk	Carcinogenic Risk	Ingestion Child HQ	Dermal Child HQ	Inhalation Child HQ	Noncarcinogenic Child HI	Ingestion Adult HQ	Dermal Adult HQ	Inhalation Adult HQ	Noncarcinogenic Adult HI
Arsenic, Inorganic	1.20E-03	7.43E-06	9.75E-03	1.69E+02	2.00E+01	3.10E-01	1.89E+02	1.58E+01	3.34E+00	3.10E-01	1.95E+01
**Total Risk/HI*	*1.20E-03*	*7.43E-06*	*9.75E-03*	*1.69E+02*	*2.00E+01*	*3.10E-01*	*1.89E+02*	*1.58E+01*	*3.34E+00*	*3.10E-01*	*1.95E+01*

Site-specific
Resident Equation Inputs for Soil

*** Inputted values different from Resident defaults are highlighted.**

Variable	Resident Soil Default Value	Form-input Value
A (PEF Dispersion Constant)	16.2302	16.2302
A (VF Dispersion Constant)	11.911	11.911
A (VF Dispersion Constant - Mass Limit)	11.911	11.911
B (PEF Dispersion Constant)	18.7762	18.7762
B (VF Dispersion Constant)	18.4385	18.4385
B (VF Dispersion Constant - Mass Limit)	18.4385	18.4385
$City_{PEF}$ (Climate Zone) Selection	Default	Default
$City_{VF}$ (Climate Zone) Selection	Default	Default
C (PEF Dispersion Constant)	216.108	216.108
C (VF Dispersion Constant)	209.7845	209.7845
C (VF Dispersion Constant - Mass Limit)	209.7845	209.7845
foc (fraction organic carbon in soil) g/g	0.006	0.006
F(x) (function dependent on U_m/U_t) unitless	0.194	0.194
n (total soil porosity) L_{pore}/L_{soil}	0.43396	0.43396
p_b (dry soil bulk density) g/cm^3	1.5	1.5
p_b (dry soil bulk density - mass limit) g/cm^3	1.5	1.5
PEF (particulate emission factor) m^3/kg	1359344438	1359344438
p_s (soil particle density) g/cm^3	2.65	2.65
Q/C_{wind} (g/m^2-s per kg/m^3)	93.77	93.77
Q/C_{vol} (g/m^2-s per kg/m^3)	68.18	68.18
Q/C_{vol} (g/m^2-s per kg/m^3)	68.18	68.18
A_s (PEF acres)	0.5	0.5
A_s (VF acres)	0.5	0.5
A_s (VF mass-limit acres)	0.5	0.5
AF_{0-2} (mutagenic skin adherence factor) mg/cm^2	0.2	0.2
AF_{2-6} (mutagenic skin adherence factor) mg/cm^2	0.2	0.2
AF_{6-16} (mutagenic skin adherence factor) mg/cm^2	0.07	0.07
AF_{16-26} (mutagenic skin adherence factor) mg/cm^2	0.07	0.07
AF_{res-a} (skin adherence factor - adult) mg/cm^2	0.07	0.07
AF_{res-c} (skin adherence factor - child) mg/cm^2	0.2	0.2

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Site-specific
Resident Equation Inputs for Soil

*** Inputted values different from Resident defaults are highlighted.**

Variable	Resident Soil Default Value	Form-input Value
AT_{res} (averaging time - resident carcinogenic)	365	365
BW_{0-2} (mutagenic body weight) kg	15	15
BW_{2-6} (mutagenic body weight) kg	15	15
BW_{6-16} (mutagenic body weight) kg	80	80
BW_{16-26} (mutagenic body weight) kg	80	80
BW_{res-a} (body weight - adult) kg	80	80
BW_{res-c} (body weight - child) kg	15	15
$DFS_{res-adj}$ (age-adjusted soil dermal factor) mg/kg	103390	103390
$DFSM_{res-adj}$ (mutagenic age-adjusted soil dermal factor) mg/kg	428260	428260
ED_{res} (exposure duration) years	26	26
ED_{0-2} (mutagenic exposure duration) years	2	2
ED_{2-6} (mutagenic exposure duration) years	4	4
ED_{6-16} (mutagenic exposure duration) years	10	10
ED_{16-26} (mutagenic exposure duration) years	10	10
ED_{res-a} (exposure duration - adult) years	20	20
ED_{res-c} (exposure duration - child) years	6	6
EF_{res} (exposure frequency) days/year	350	350
EF_{0-2} (mutagenic exposure frequency) days/year	350	350
EF_{2-6} (mutagenic exposure frequency) days/year	350	350
EF_{6-16} (mutagenic exposure frequency) days/year	350	350
EF_{16-26} (mutagenic exposure frequency) days/year	350	350
EF_{res-a} (exposure frequency - adult) days/year	350	350
EF_{res-c} (exposure frequency - child) days/year	350	350
ET_{res} (exposure time) hours/day	24	24
ET_{0-2} (mutagenic exposure time) hours/day	24	24
ET_{2-6} (mutagenic exposure time) hours/day	24	24
ET_{6-16} (mutagenic exposure time) hours/day	24	24
ET_{16-26} (mutagenic exposure time) hours/day	24	24
ET_{res-a} (adult exposure time) hours/day	24	24
ET_{res-c} (child exposure time) hours/day	24	24

Site-specific
Resident Equation Inputs for Soil

*** Inputted values different from Resident defaults are highlighted.**

Variable	Resident Soil Default Value	Form-input Value
THQ (target hazard quotient) unitless	1	1
$IFS_{res-adj}$ (age-adjusted soil ingestion factor) mg/kg	36750	36750
$IFSM_{res-adj}$ (mutagenic age-adjusted soil ingestion factor) mg/kg	166833.3	166833.3
IRS_{0-2} (mutagenic soil intake rate) mg/day	200	200
IRS_{2-6} (mutagenic soil intake rate) mg/day	200	200
IRS_{6-16} (mutagenic soil intake rate) mg/day	100	100
IRS_{16-26} (mutagenic soil intake rate) mg/day	100	100
IRS_{res-a} (soil intake rate - adult) mg/day	100	100
IRS_{res-c} (soil intake rate - child) mg/day	200	200
LT (lifetime) years	70	70
SA_{0-2} (mutagenic skin surface area) cm^2/day	2373	2373
SA_{2-6} (mutagenic skin surface area) cm^2/day	2373	2373
SA_{6-16} (mutagenic skin surface area) cm^2/day	6032	6032
SA_{16-26} (mutagenic skin surface area) cm^2/day	6032	6032
SA_{res-a} (skin surface area - adult) cm^2/day	6032	6032
SA_{res-c} (skin surface area - child) cm^2/day	2373	2373
TR (target risk) unitless	1.0E-04	1.0E-04
T_w (groundwater temperature) Celsius	25	25
$Theta_a$ (air-filled soil porosity) L_{air}/L_{soil}	0.28396	0.28396
$Theta_w$ (water-filled soil porosity) L_{water}/L_{soil}	0.15	0.15
T (exposure interval) s	819936000	819936000
T (exposure interval) yr	26	26
U_m (mean annual wind speed) m/s	4.69	4.69
U_t (equivalent threshold value)	11.32	11.32
V (fraction of vegetative cover) unitless	0.5	0.5

Site-specific
Resident Removal Management Levels (RML) for Soil

Key: I = IRIS; P = PPRTV; O = OPP; A = ATSDR; C = Cal EPA; X = PPRTV Screening Level; H = HEAST; D = DWSHA; W = TEF applied; E = RPF applied; U = user provided; c = cancer; n = noncancer; * = where: n SL < 100X c SL; ** = where n SL < 10X c SL; SSL values are based on DAF=1; m = ceiling limit exceeded; s = Csat exceeded.

Chemical	CAS Number	Mutagen?	Volatile?	SF_o (mg/kg-day)$^{-1}$	SF_o Ref	IUR (ug/m^3)$^{-1}$	IUR Ref	RfD (mg/kg-day)	RfD Ref	RfC (mg/m^3)	RfC Ref	GIABS	ABS	RBA	Soil Saturation Concentration (mg/kg)	S (mg/L)	K_{oc} \ (cm^3/g)
Arsenic, Inorganic	7440-38-2	No	No	1.50E+00	U	4.30E-03	U	3.00E-04	U	1.50E-05	U	1	0.03	0.6	-	-	-

Chemical	K_d \ (cm^3/g)	HLC (atm-m^3/mole)	Henry's Law Constant Used in Calcs (unitless)	H` and HLC Ref	Normal Boiling Point BP (K)	BP Ref	Critical Temperature TC (K)	TC Ref	Chemical Type	D_{ia} \ (cm^2/s)	D_{iw} \ (cm^2/s)	D_A \ (cm^2/s)	Particulate Emission Factor (m^3/kg)	Volatilization Factor (m^3/kg)	Ingestion SL TR=0.0001 (mg/kg)
Arsenic, Inorganic	2.90E+01	-	-		888.15	U	1670	U	INORGANIC	-	-	-	1.36E+09	-	7.72E+01

Chemical	Dermal SL TR=0.0001 (mg/kg)	Inhalation SL TR=0.0001 (mg/kg)	Carcinogenic SL TR=0.0001 (mg/kg)	Ingestion SL Child THQ=1 (mg/kg)	Dermal SL Child THQ=1 (mg/kg)	Inhalation SL Child THQ=1 (mg/kg)	Noncarcinogenic SL Child THI=1 (mg/kg)	Ingestion SL Adult THQ=1 (mg/kg)	Dermal SL Adult THQ=1 (mg/kg)	Inhalation SL Adult THQ=1 (mg/kg)	Noncarcinogenic SL Adult THI=1 (mg/kg)	Screening Level (mg/kg)
Arsenic, Inorganic	5.49E+02	8.88E+04	6.77E+01	3.91E+01	3.30E+02	2.13E+04	3.49E+01	4.17E+02	1.98E+03	2.13E+04	3.39E+02	3.49E+01 nc

Site-specific
Resident Risk for Soil

Chemical	SF_o (mg/kg-day) $^{-1}$	SF_o Ref	IUR (ug/m^3)$^{-1}$	IUR Ref	RfD (mg/kg-day)	RfD Ref	RfC (mg/m^3)	RfC Ref	GIABS	ABS	RBA	Soil Saturation Concentration (mg/kg)	S (mg/L)	K_{oc}\ (cm^3/g)	K_d\ (cm^3/g)	HLC (atm-m^3/mole)
Arsenic, Inorganic	1.50E+00	U	4.30E-03	U	3.00E-04	U	1.50E-05	U	1	0.03	0.6	-	-	-	2.90E+01	-
*Total Risk/HI	-		-		-		-		-	-	-	-	-	-	-	-

Chemical	Henry's Law Constant Used in Calcs (unitless)	H` and HLC Ref	Normal Boiling Point BP (K)	BP Ref	Critical Temperature TC (K)	TC Ref	Chemical Type	D_{ia}\ (cm^2/s)	D_{iw}\ (cm^2/s)	D_A\ (cm^2/s)	Particulate Emission Factor (m^3/kg)	Volatilization Factor (m^3/kg)	Concentration (mg/kg)	Ingestion Risk
Arsenic, Inorganic	-		888.15	U	1670	U	INORGANIC	-	-	-	1.36E+09	-	8.52E+01	1.10E-04
*Total Risk/HI	-		-		-			-	-	-	-	-	-	*1.10E-04*

Chemical	Dermal Risk	Inhalation Risk	Carcinogenic Risk	Ingestion Child HQ	Dermal Child HQ	Inhalation Child HQ	Noncarcinogenic Child HI	Ingestion Adult HQ	Dermal Adult HQ	Inhalation Adult HQ	Noncarcinogenic Adult HI
Arsenic, Inorganic	1.55E-05	9.60E-08	1.26E-04	2.18E+00	2.58E-01	4.01E-03	2.44E+00	2.04E-01	4.31E-02	4.01E-03	2.51E-01
*Total Risk/HI	*1.55E-05*	*9.60E-08*	*1.26E-04*	*2.18E+00*	*2.58E-01*	*4.01E-03*	*2.44E+00*	*2.04E-01*	*4.31E-02*	*4.01E-03*	*2.51E-01*

Site-specific
Resident Equation Inputs for Soil

*** Inputted values different from Resident defaults are highlighted.**

Variable	Resident Soil Default Value	Form-input Value
A (PEF Dispersion Constant)	16.2302	16.2302
A (VF Dispersion Constant)	11.911	11.911
A (VF Dispersion Constant - Mass Limit)	11.911	11.911
B (PEF Dispersion Constant)	18.7762	18.7762
B (VF Dispersion Constant)	18.4385	18.4385
B (VF Dispersion Constant - Mass Limit)	18.4385	18.4385
$City_{PEF}$ (Climate Zone) Selection	Default	Default
$City_{VF}$ (Climate Zone) Selection	Default	Default
C (PEF Dispersion Constant)	216.108	216.108
C (VF Dispersion Constant)	209.7845	209.7845
C (VF Dispersion Constant - Mass Limit)	209.7845	209.7845
foc (fraction organic carbon in soil) g/g	0.006	0.006
F(x) (function dependent on U_m/U_t) unitless	0.194	0.194
n (total soil porosity) L_{pore}/L_{soil}	0.43396	0.43396
p_b (dry soil bulk density) g/cm^3	1.5	1.5
p_b (dry soil bulk density - mass limit) g/cm^3	1.5	1.5
PEF (particulate emission factor) m^3/kg	1359344438	1359344438
p_s (soil particle density) g/cm^3	2.65	2.65
Q/C_{wind} (g/m^2-s per kg/m^3)	93.77	93.77
Q/C_{vol} (g/m^2-s per kg/m^3)	68.18	68.18
Q/C_{vol} (g/m^2-s per kg/m^3)	68.18	68.18
A_s (PEF acres)	0.5	0.5
A_s (VF acres)	0.5	0.5
A_s (VF mass-limit acres)	0.5	0.5
AF_{0-2} (mutagenic skin adherence factor) mg/cm^2	0.2	0.2
AF_{2-6} (mutagenic skin adherence factor) mg/cm^2	0.2	0.2
AF_{6-16} (mutagenic skin adherence factor) mg/cm^2	0.07	0.07
AF_{16-26} (mutagenic skin adherence factor) mg/cm^2	0.07	0.07
AF_{res-a} (skin adherence factor - adult) mg/cm^2	0.07	0.07
AF_{res-c} (skin adherence factor - child) mg/cm^2	0.2	0.2

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Site-specific
Resident Equation Inputs for Soil

*** Inputted values different from Resident defaults are highlighted.**

Variable	Resident Soil Default Value	Form-input Value
AT_{res} (averaging time - resident carcinogenic)	365	365
BW_{0-2} (mutagenic body weight) kg	15	15
BW_{2-6} (mutagenic body weight) kg	15	15
BW_{6-16} (mutagenic body weight) kg	80	80
BW_{16-26} (mutagenic body weight) kg	80	80
BW_{res-a} (body weight - adult) kg	80	80
BW_{res-c} (body weight - child) kg	15	15
$DFS_{res-adj}$ (age-adjusted soil dermal factor) mg/kg	103390	103390
$DFSM_{res-adj}$ (mutagenic age-adjusted soil dermal factor) mg/kg	428260	428260
ED_{res} (exposure duration) years	26	26
ED_{0-2} (mutagenic exposure duration) years	2	2
ED_{2-6} (mutagenic exposure duration) years	4	4
ED_{6-16} (mutagenic exposure duration) years	10	10
ED_{16-26} (mutagenic exposure duration) years	10	10
ED_{res-a} (exposure duration - adult) years	20	20
ED_{res-c} (exposure duration - child) years	6	6
EF_{res} (exposure frequency) days/year	350	350
EF_{0-2} (mutagenic exposure frequency) days/year	350	350
EF_{2-6} (mutagenic exposure frequency) days/year	350	350
EF_{6-16} (mutagenic exposure frequency) days/year	350	350
EF_{16-26} (mutagenic exposure frequency) days/year	350	350
EF_{res-a} (exposure frequency - adult) days/year	350	350
EF_{res-c} (exposure frequency - child) days/year	350	350
ET_{res} (exposure time) hours/day	24	24
ET_{0-2} (mutagenic exposure time) hours/day	24	24
ET_{2-6} (mutagenic exposure time) hours/day	24	24
ET_{6-16} (mutagenic exposure time) hours/day	24	24
ET_{16-26} (mutagenic exposure time) hours/day	24	24
ET_{res-a} (adult exposure time) hours/day	24	24
ET_{res-c} (child exposure time) hours/day	24	24

Site-specific
Resident Equation Inputs for Soil

*** Inputted values different from Resident defaults are highlighted.**

Variable	Resident Soil Default Value	Form-input Value
THQ (target hazard quotient) unitless	1	1
$IFS_{res-adj}$ (age-adjusted soil ingestion factor) mg/kg	36750	36750
$IFSM_{res-adj}$ (mutagenic age-adjusted soil ingestion factor) mg/kg	166833.3	166833.3
IRS_{0-2} (mutagenic soil intake rate) mg/day	200	200
IRS_{2-6} (mutagenic soil intake rate) mg/day	200	200
IRS_{6-16} (mutagenic soil intake rate) mg/day	100	100
IRS_{16-26} (mutagenic soil intake rate) mg/day	100	100
IRS_{res-a} (soil intake rate - adult) mg/day	100	100
IRS_{res-c} (soil intake rate - child) mg/day	200	200
LT (lifetime) years	70	70
SA_{0-2} (mutagenic skin surface area) cm^2/day	2373	2373
SA_{2-6} (mutagenic skin surface area) cm^2/day	2373	2373
SA_{6-16} (mutagenic skin surface area) cm^2/day	6032	6032
SA_{16-26} (mutagenic skin surface area) cm^2/day	6032	6032
SA_{res-a} (skin surface area - adult) cm^2/day	6032	6032
SA_{res-c} (skin surface area - child) cm^2/day	2373	2373
TR (target risk) unitless	1.0E-04	1.0E-04
T_w (groundwater temperature) Celsius	25	25
$Theta_a$ (air-filled soil porosity) L_{air}/L_{soil}	0.28396	0.28396
$Theta_w$ (water-filled soil porosity) L_{water}/L_{soil}	0.15	0.15
T (exposure interval) s	819936000	819936000
T (exposure interval) yr	26	26
U_m (mean annual wind speed) m/s	4.69	4.69
U_t (equivalent threshold value)	11.32	11.32
V (fraction of vegetative cover) unitless	0.5	0.5

Site-specific
Resident Removal Management Levels (RML) for Soil

Key: I = IRIS; P = PPRTV; O = OPP; A = ATSDR; C = Cal EPA; X = PPRTV Screening Level; H = HEAST; D = DWSHA; W = TEF applied; E = RPF applied; U = user provided; c = cancer; n = noncancer; * = where: n SL < 100X c SL; ** = where n SL < 10X c SL; SSL values are based on DAF=1; m = ceiling limit exceeded; s = Csat exceeded.

Chemical	CAS Number	Mutagen?	Volatile?	SF_o (mg/kg-day)$^{-1}$	SF_o Ref	IUR (ug/m^3)$^{-1}$	IUR Ref	RfD (mg/kg-day)	RfD Ref	RfC (mg/m^3)	RfC Ref	GIABS	ABS	RBA	Soil Saturation Concentration (mg/kg)	S (mg/L)	K_{oc} \ (cm^3/g)
Arsenic, Inorganic	7440-38-2	No	No	1.50E+00	U	4.30E-03	U	3.00E-04	U	1.50E-05	U	1	0.03	0.6	-	-	-

Chemical	K_d \ (cm^3/g)	HLC (atm-m^3/mole)	Henry's Law Constant Used in Calcs (unitless)	H` and HLC Ref	Normal Boiling Point BP (K)	BP Ref	Critical Temperature TC (K)	TC Ref	Chemical Type	D_{ia} \ (cm^2/s)	D_{iw} \ (cm^2/s)	D_A \ (cm^2/s)	Particulate Emission Factor (m^3/kg)	Volatilization Factor (m^3/kg)	Ingestion SL TR=0.0001 (mg/kg)
Arsenic, Inorganic	2.90E+01	-	-		888.15	U	1670	U	INORGANIC	-	-	-	1.36E+09	-	7.72E+01

Chemical	Dermal SL TR=0.0001 (mg/kg)	Inhalation SL TR=0.0001 (mg/kg)	Carcinogenic SL TR=0.0001 (mg/kg)	Ingestion SL Child THQ=1 (mg/kg)	Dermal SL Child THQ=1 (mg/kg)	Inhalation SL Child THQ=1 (mg/kg)	Noncarcinogenic SL Child THI=1 (mg/kg)	Ingestion SL Adult THQ=1 (mg/kg)	Dermal SL Adult THQ=1 (mg/kg)	Inhalation SL Adult THQ=1 (mg/kg)	Noncarcinogenic SL Adult THI=1 (mg/kg)	Screening Level (mg/kg)
Arsenic, Inorganic	5.49E+02	8.88E+04	6.77E+01	3.91E+01	3.30E+02	2.13E+04	3.49E+01	4.17E+02	1.98E+03	2.13E+04	3.39E+02	3.49E+01 nc

Site-specific
Resident Risk for Soil

Chemical	SF_o (mg/kg-day) $^{-1}$	SF_o Ref	IUR (ug/m^3)$^{-1}$	IUR Ref	RfD (mg/kg-day)	RfD Ref	RfC (mg/m^3)	RfC Ref	GIABS	ABS	RBA	Soil Saturation Concentration (mg/kg)	S (mg/L)	K_{oc}\ (cm^3/g)	K_d\ (cm^3/g)	HLC (atm-m^3/mole)
Arsenic, Inorganic	1.50E+00	U	4.30E-03	U	3.00E-04	U	1.50E-05	U	1	0.03	0.6	-	-	-	2.90E+01	-
*Total Risk/HI	-		-		-		-		-	-	-	-	-	-	-	-

Chemical	Henry's Law Constant Used in Calcs (unitless)	H` and HLC Ref	Normal Boiling Point BP (K)	BP Ref	Critical Temperature TC (K)	TC Ref	Chemical Type	D_{ia}\ (cm^2/s)	D_{iw}\ (cm^2/s)	D_A\ (cm^2/s)	Particulate Emission Factor (m^3/kg)	Volatilization Factor (m^3/kg)	Concentration (mg/kg)	Ingestion Risk
Arsenic, Inorganic	-		888.15	U	1670	U	INORGANIC	-	-	-	1.36E+09	-	6.94E+01	8.98E-05
*Total Risk/HI	-		-		-			-	-	-	-	-	-	*8.98E-05*

Chemical	Dermal Risk	Inhalation Risk	Carcinogenic Risk	Ingestion Child HQ	Dermal Child HQ	Inhalation Child HQ	Noncarcinogenic Child HI	Ingestion Adult HQ	Dermal Adult HQ	Inhalation Adult HQ	Noncarcinogenic Adult HI
Arsenic, Inorganic	1.26E-05	7.82E-08	1.03E-04	1.77E+00	2.11E-01	3.26E-03	1.99E+00	1.66E-01	3.51E-02	3.26E-03	2.05E-01
*Total Risk/HI	*1.26E-05*	*7.82E-08*	*1.03E-04*	*1.77E+00*	*2.11E-01*	*3.26E-03*	*1.99E+00*	*1.66E-01*	*3.51E-02*	*3.26E-03*	*2.05E-01*

Site-specific
Resident Equation Inputs for Soil

*** Inputted values different from Resident defaults are highlighted.**

Variable	Resident Soil Default Value	Form-input Value
A (PEF Dispersion Constant)	16.2302	16.2302
A (VF Dispersion Constant)	11.911	11.911
A (VF Dispersion Constant - Mass Limit)	11.911	11.911
B (PEF Dispersion Constant)	18.7762	18.7762
B (VF Dispersion Constant)	18.4385	18.4385
B (VF Dispersion Constant - Mass Limit)	18.4385	18.4385
$City_{PEF}$ (Climate Zone) Selection	Default	Default
$City_{VF}$ (Climate Zone) Selection	Default	Default
C (PEF Dispersion Constant)	216.108	216.108
C (VF Dispersion Constant)	209.7845	209.7845
C (VF Dispersion Constant - Mass Limit)	209.7845	209.7845
foc (fraction organic carbon in soil) g/g	0.006	0.006
F(x) (function dependent on U_m/U_t) unitless	0.194	0.194
n (total soil porosity) L_{pore}/L_{soil}	0.43396	0.43396
p_b (dry soil bulk density) g/cm^3	1.5	1.5
p_b (dry soil bulk density - mass limit) g/cm^3	1.5	1.5
PEF (particulate emission factor) m^3/kg	1359344438	1359344438
p_s (soil particle density) g/cm^3	2.65	2.65
Q/C_{wind} (g/m^2-s per kg/m^3)	93.77	93.77
Q/C_{vol} (g/m^2-s per kg/m^3)	68.18	68.18
Q/C_{vol} (g/m^2-s per kg/m^3)	68.18	68.18
A_s (PEF acres)	0.5	0.5
A_s (VF acres)	0.5	0.5
A_s (VF mass-limit acres)	0.5	0.5
AF_{0-2} (mutagenic skin adherence factor) mg/cm^2	0.2	0.2
AF_{2-6} (mutagenic skin adherence factor) mg/cm^2	0.2	0.2
AF_{6-16} (mutagenic skin adherence factor) mg/cm^2	0.07	0.07
AF_{16-26} (mutagenic skin adherence factor) mg/cm^2	0.07	0.07

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Site-specific
Resident Equation Inputs for Soil

*** Inputted values different from Resident defaults are highlighted.**

Variable	Resident Soil Default Value	Form-input Value
AF_{res-a} (skin adherence factor - adult) mg/cm ^{2}	0.07	0.07
AF_{res-c} (skin adherence factor - child) mg/cm ^{2}	0.2	0.2
AT_{res} (averaging time - resident carcinogenic)	365	365
BW_{0-2} (mutagenic body weight) kg	15	15
BW_{2-6} (mutagenic body weight) kg	15	15
BW_{6-16} (mutagenic body weight) kg	80	80
BW_{16-26} (mutagenic body weight) kg	80	80
BW_{res-a} (body weight - adult) kg	80	80
BW_{res-c} (body weight - child) kg	15	15
$DFS_{res-adj}$ (age-adjusted soil dermal factor) mg/kg	103390	103390
$DFSM_{res-adj}$ (mutagenic age-adjusted soil dermal factor) mg/kg	428260	428260
ED_{res} (exposure duration) years	26	26
ED_{0-2} (mutagenic exposure duration) years	2	2
ED_{2-6} (mutagenic exposure duration) years	4	4
ED_{6-16} (mutagenic exposure duration) years	10	10
ED_{16-26} (mutagenic exposure duration) years	10	10
ED_{res-a} (exposure duration - adult) years	20	20
ED_{res-c} (exposure duration - child) years	6	6
EF_{res} (exposure frequency) days/year	350	350
EF_{0-2} (mutagenic exposure frequency) days/year	350	350
EF_{2-6} (mutagenic exposure frequency) days/year	350	350
EF_{6-16} (mutagenic exposure frequency) days/year	350	350
EF_{16-26} (mutagenic exposure frequency) days/year	350	350
EF_{res-a} (exposure frequency - adult) days/year	350	350
EF_{res-c} (exposure frequency - child) days/year	350	350
ET_{res} (exposure time) hours/day	24	24
ET_{0-2} (mutagenic exposure time) hours/day	24	24
ET_{2-6} (mutagenic exposure time) hours/day	24	24
ET_{6-16} (mutagenic exposure time) hours/day	24	24

Site-specific
Resident Equation Inputs for Soil

*** Inputted values different from Resident defaults are highlighted.**

Variable	Resident Soil Default Value	Form-input Value
ET_{16-26} (mutagenic exposure time) hours/day	24	24
ET_{res-a} (adult exposure time) hours/day	24	24
ET_{res-c} (child exposure time) hours/day	24	24
THQ (target hazard quotient) unitless	1	3
$IFS_{res-adj}$ (age-adjusted soil ingestion factor) mg/kg	36750	36750
$IFSM_{res-adj}$ (mutagenic age-adjusted soil ingestion factor) mg/kg	166833.3	166833.3
IRS_{0-2} (mutagenic soil intake rate) mg/day	200	200
IRS_{2-6} (mutagenic soil intake rate) mg/day	200	200
IRS_{6-16} (mutagenic soil intake rate) mg/day	100	100
IRS_{16-26} (mutagenic soil intake rate) mg/day	100	100
IRS_{res-a} (soil intake rate - adult) mg/day	100	100
IRS_{res-c} (soil intake rate - child) mg/day	200	200
LT (lifetime) years	70	70
SA_{0-2} (mutagenic skin surface area) cm^2/day	2373	2373
SA_{2-6} (mutagenic skin surface area) cm^2/day	2373	2373
SA_{6-16} (mutagenic skin surface area) cm^2/day	6032	6032
SA_{16-26} (mutagenic skin surface area) cm^2/day	6032	6032
SA_{res-a} (skin surface area - adult) cm^2/day	6032	6032
SA_{res-c} (skin surface area - child) cm^2/day	2373	2373
TR (target risk) unitless	1.0E-04	1.0E-04
T_w (groundwater temperature) Celsius	25	25
$Theta_a$ (air-filled soil porosity) L_{air}/L_{soil}	0.28396	0.28396
$Theta_w$ (water-filled soil porosity) L_{water}/L_{soil}	0.15	0.15
T (exposure interval) s	819936000	819936000
T (exposure interval) yr	26	26
U_m (mean annual wind speed) m/s	4.69	4.69
U_t (equivalent threshold value)	11.32	11.32
V (fraction of vegetative cover) unitless	0.5	0.5

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Site-specific
Resident Removal Management Levels (RML) for Soil

Key: I = IRIS; P = PPRTV; D = DWSHA; O = OPP; A = ATSDR; C = Cal EPA; X = APPENDIX PPRTV SCREEN (See FAQ #29); H = HEAST; F = See FAQ; E = see user guide Section 2.3.5; W = see user guide Section 2.3.6; L = see user guide on lead; M = mutagen; S = see user guide Section 5; V = volatile; R = RBA applied (See User Guide for Arsenic notice) ; c = cancer; n = noncancer; * = where: n SL < 100X c SL; ** = where n SL < 10X c SL; SSL values are based on DAF=1; m = Concentration may exceed ceiling limit (See User Guide); s = Concentration may exceed Csat (See User Guide); U = User-provided

Chemical	CAS Number	Mutagen?	Volatile?	Ingestion SF (mg/kg-day)$^{-1}$	SFO Ref	Inhalation Unit Risk (ug/m^3)$^{-1}$	IUR Ref	RfD (mg/kg-day)	RfD Ref	RfC (mg/m^3)	RfC Ref	GIABS	ABS	RBA	Soil Saturation Concentration (mg/kg)	S (mg/L)	K_{oc}\ (cm^3/g)
Arsenic, Inorganic	7440-38-2	No	No	1.50E+00	U	4.30E-03	U	3.00E-04	U	1.50E-05	U	1	0.03	0.6	-	-	-

Chemical	K_d\ (cm^3/g)	HLC (atm-m^3/mole)	Henry's Law Constant Used in Calcs (unitless)	H` and HLC Ref	Normal Boiling Point T_{boil}\ (K)	BP Ref	Critical Temperature T_{crit}\ (K)	T_{crit}\ Ref	chemtype	D_{ia}\ (cm^2/s)	D_{iw}\ (cm^2/s)	D_A\ (cm^2/s)	Particulate Emission Factor (m^3/kg)	Volatilization Factor (m^3/kg)	Ingestion SL TR=0.0001 (mg/kg)
Arsenic, Inorganic	2.90E+01	-	-		888.15	U	1670	U	INORGANIC	-	-	-	1.36E+09	-	7.72E+01

Chemical	Dermal SL TR=0.0001 (mg/kg)	Inhalation SL TR=0.0001 (mg/kg)	Carcinogenic SL TR=0.0001 (mg/kg)	Ingestion SL Child THQ=3 (mg/kg)	Dermal SL Child THQ=3 (mg/kg)	Inhalation SL Child THQ=3 (mg/kg)	Noncarcinogenic SL Child THI=3 (mg/kg)	Ingestion SL Adult THQ=3 (mg/kg)	Dermal SL Adult THQ=3 (mg/kg)	Inhalation SL Adult THQ=3 (mg/kg)	Noncarcinogenic SL Adult THI=3 (mg/kg)	Screening Level (mg/kg)
Arsenic, Inorganic	5.49E+02	8.88E+04	6.77E+01	1.17E+02	9.89E+02	6.38E+04	1.05E+02	1.25E+03	5.93E+03	6.38E+04	1.02E+03	6.77E+01 ca**

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Site-specific
Resident Risk for Soil

Chemical	Ingestion SF (mg/kg-day) $^{-1}$	SFO Ref	Inhalation Unit Risk (ug/m^3)$^{-1}$	IUR Ref	RfD (mg/kg-day)	RfD Ref	RfC (mg/m^3)	RfC Ref	GIABS	ABS	RBA	Soil Saturation Concentration (mg/kg)	S (mg/L)	K_{oc}\ (cm^3/g)	K_d\ (cm^3/g)	HLC (atm-m^3/mole)
Arsenic, Inorganic	1.50E+00	U	4.30E-03	U	3.00E-04	U	1.50E-05	U	1	0.03	0.6	-	-	-	2.90E+01	-
*Total Risk/HI	-		-		-		-		-	-	-	-	-	-	-	-

Chemical	Henry's Law Constant Used in Calcs (unitless)	H` and HLC Ref	Normal Boiling Point T_{boil}\ (K)	BP Ref	Critical Temperature T_{crit}\ (K)	T_{crit}\ Ref	chemtype	D_{ia}\ (cm^2/s)	D_{iw}\ (cm^2/s)	D_A\ (cm^2/s)	Particulate Emission Factor (m^3/kg)	Volatilization Factor (m^3/kg)	Concentration (mg/kg)	Ingestion Risk	Dermal Risk
Arsenic, Inorganic	-		888.15	U	1670	U	INORGANIC	-	-	-	1.36E+09	-	3.97E+01	5.14E-05	7.23E-06
*Total Risk/HI	-		-		-			-	-	-	-	-	-	*5.14E-05*	*7.23E-06*

Chemical	Inhalation Risk	Carcinogenic Risk	Ingestion Child HQ	Dermal Child HQ	Inhalation Child HQ	Noncarcinogenic Child HI	Ingestion Adult HQ	Dermal Adult HQ	Inhalation Adult HQ	Noncarcinogenic Adult HI
Arsenic, Inorganic	4.47E-08	5.87E-05	1.02E+00	1.20E-01	1.87E-03	1.14E+00	9.52E-02	2.01E-02	1.87E-03	1.17E-01
*Total Risk/HI	*4.47E-08*	*5.87E-05*	*1.02E+00*	*1.20E-01*	*1.87E-03*	*1.14E+00*	*9.52E-02*	*2.01E-02*	*1.87E-03*	*1.17E-01*

Site-specific
Resident Equation Inputs for Soil

*** Inputted values different from Resident defaults are highlighted.**

Variable	Resident Soil Default Value	Form-input Value
A (PEF Dispersion Constant)	16.2302	16.2302
A (VF Dispersion Constant)	11.911	11.911
A (VF Dispersion Constant - Mass Limit)	11.911	11.911
B (PEF Dispersion Constant)	18.7762	18.7762
B (VF Dispersion Constant)	18.4385	18.4385
B (VF Dispersion Constant - Mass Limit)	18.4385	18.4385
$City_{PEF}$ (Climate Zone) Selection	Default	Default
$City_{VF}$ (Climate Zone) Selection	Default	Default
C (PEF Dispersion Constant)	216.108	216.108
C (VF Dispersion Constant)	209.7845	209.7845
C (VF Dispersion Constant - Mass Limit)	209.7845	209.7845
foc (fraction organic carbon in soil) g/g	0.006	0.006
F(x) (function dependent on U_m/U_t) unitless	0.194	0.194
n (total soil porosity) L_{pore}/L_{soil}	0.43396	0.43396
p_b (dry soil bulk density) g/cm^3	1.5	1.5
p_b (dry soil bulk density - mass limit) g/cm^3	1.5	1.5
PEF (particulate emission factor) m^3/kg	1359344438	1359344438
p_s (soil particle density) g/cm^3	2.65	2.65
Q/C_{wind} (g/m^2-s per kg/m^3)	93.77	93.77
Q/C_{vol} (g/m^2-s per kg/m^3)	68.18	68.18
Q/C_{vol} (g/m^2-s per kg/m^3)	68.18	68.18
A_s (PEF acres)	0.5	0.5
A_s (VF acres)	0.5	0.5
A_s (VF mass-limit acres)	0.5	0.5
AF_{0-2} (mutagenic skin adherence factor) mg/cm^2	0.2	0.2
AF_{2-6} (mutagenic skin adherence factor) mg/cm^2	0.2	0.2
AF_{6-16} (mutagenic skin adherence factor) mg/cm^2	0.07	0.07
AF_{16-26} (mutagenic skin adherence factor) mg/cm^2	0.07	0.07

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Site-specific
Resident Equation Inputs for Soil

*** Inputted values different from Resident defaults are highlighted.**

Variable	Resident Soil Default Value	Form-input Value
AF_{res-a} (skin adherence factor - adult) mg/cm ^{2}	0.07	0.07
AF_{res-c} (skin adherence factor - child) mg/cm ^{2}	0.2	0.2
AT_{res} (averaging time - resident carcinogenic)	365	365
BW_{0-2} (mutagenic body weight) kg	15	15
BW_{2-6} (mutagenic body weight) kg	15	15
BW_{6-16} (mutagenic body weight) kg	80	80
BW_{16-26} (mutagenic body weight) kg	80	80
BW_{res-a} (body weight - adult) kg	80	80
BW_{res-c} (body weight - child) kg	15	15
$DFS_{res-adj}$ (age-adjusted soil dermal factor) mg/kg	103390	103390
$DFSM_{res-adj}$ (mutagenic age-adjusted soil dermal factor) mg/kg	428260	428260
ED_{res} (exposure duration) years	26	26
ED_{0-2} (mutagenic exposure duration) years	2	2
ED_{2-6} (mutagenic exposure duration) years	4	4
ED_{6-16} (mutagenic exposure duration) years	10	10
ED_{16-26} (mutagenic exposure duration) years	10	10
ED_{res-a} (exposure duration - adult) years	20	20
ED_{res-c} (exposure duration - child) years	6	6
EF_{res} (exposure frequency) days/year	350	350
EF_{0-2} (mutagenic exposure frequency) days/year	350	350
EF_{2-6} (mutagenic exposure frequency) days/year	350	350
EF_{6-16} (mutagenic exposure frequency) days/year	350	350
EF_{16-26} (mutagenic exposure frequency) days/year	350	350
EF_{res-a} (exposure frequency - adult) days/year	350	350
EF_{res-c} (exposure frequency - child) days/year	350	350
ET_{res} (exposure time) hours/day	24	24
ET_{0-2} (mutagenic exposure time) hours/day	24	24
ET_{2-6} (mutagenic exposure time) hours/day	24	24
ET_{6-16} (mutagenic exposure time) hours/day	24	24

Site-specific
Resident Equation Inputs for Soil

*** Inputted values different from Resident defaults are highlighted.**

Variable	Resident Soil Default Value	Form-input Value
ET_{16-26} (mutagenic exposure time) hours/day	24	24
ET_{res-a} (adult exposure time) hours/day	24	24
ET_{res-c} (child exposure time) hours/day	24	24
THQ (target hazard quotient) unitless	1	3
$IFS_{res-adj}$ (age-adjusted soil ingestion factor) mg/kg	36750	36750
$IFSM_{res-adj}$ (mutagenic age-adjusted soil ingestion factor) mg/kg	166833.3	166833.3
IRS_{0-2} (mutagenic soil intake rate) mg/day	200	200
IRS_{2-6} (mutagenic soil intake rate) mg/day	200	200
IRS_{6-16} (mutagenic soil intake rate) mg/day	100	100
IRS_{16-26} (mutagenic soil intake rate) mg/day	100	100
IRS_{res-a} (soil intake rate - adult) mg/day	100	100
IRS_{res-c} (soil intake rate - child) mg/day	200	200
LT (lifetime) years	70	70
SA_{0-2} (mutagenic skin surface area) cm^2/day	2373	2373
SA_{2-6} (mutagenic skin surface area) cm^2/day	2373	2373
SA_{6-16} (mutagenic skin surface area) cm^2/day	6032	6032
SA_{16-26} (mutagenic skin surface area) cm^2/day	6032	6032
SA_{res-a} (skin surface area - adult) cm^2/day	6032	6032
SA_{res-c} (skin surface area - child) cm^2/day	2373	2373
TR (target risk) unitless	1.0E-04	1.0E-04
T_w (groundwater temperature) Celsius	25	25
$Theta_a$ (air-filled soil porosity) L_{air}/L_{soil}	0.28396	0.28396
$Theta_w$ (water-filled soil porosity) L_{water}/L_{soil}	0.15	0.15
T (exposure interval) s	819936000	819936000
T (exposure interval) yr	26	26
U_m (mean annual wind speed) m/s	4.69	4.69
U_t (equivalent threshold value)	11.32	11.32
V (fraction of vegetative cover) unitless	0.5	0.5

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Site-specific
Resident Removal Management Levels (RML) for Soil

Key: I = IRIS; P = PPRTV; D = DWSHA; O = OPP; A = ATSDR; C = Cal EPA; X = APPENDIX PPRTV SCREEN (See FAQ #29); H = HEAST; F = See FAQ; E = see user guide Section 2.3.5; W = see user guide Section 2.3.6; L = see user guide on lead; M = mutagen; S = see user guide Section 5; V = volatile; R = RBA applied (See User Guide for Arsenic notice) ; c = cancer; n = noncancer; * = where: n SL < 100X c SL; ** = where n SL < 10X c SL; SSL values are based on DAF=1; m = Concentration may exceed ceiling limit (See User Guide); s = Concentration may exceed Csat (See User Guide); U = User-provided

Chemical	CAS Number	Mutagen?	Volatile?	Ingestion SF (mg/kg-day)$^{-1}$	SFO Ref	Inhalation Unit Risk (ug/m^3)$^{-1}$	IUR Ref	RfD (mg/kg-day)	RfD Ref	RfC (mg/m^3)	RfC Ref	GIABS	ABS	RBA	Soil Saturation Concentration (mg/kg)	S (mg/L)	K_{oc} \ (cm^3/g)
Arsenic, Inorganic	7440-38-2	No	No	1.50E+00	U	4.30E-03	U	3.00E-04	U	1.50E-05	U	1	0.03	0.6	-	-	-

Chemical	K_d \ (cm^3/g)	HLC (atm-m^3/mole)	Henry's Law Constant Used in Calcs (unitless)	H` and HLC Ref	Normal Boiling Point T_{boil} \ (K)	BP Ref	Critical Temperature T_{crit} \ (K)	T_{crit} \ Ref	chemtype	D_{ia} \ (cm^2/s)	D_{iw} \ (cm^2/s)	D_A \ (cm^2/s)	Particulate Emission Factor (m^3/kg)	Volatilization Factor (m^3/kg)	Ingestion SL TR=0.0001 (mg/kg)
Arsenic, Inorganic	2.90E+01	-	-		888.15	U	1670	U	INORGANIC	-	-	-	1.36E+09	-	7.72E+01

Chemical	Dermal SL TR=0.0001 (mg/kg)	Inhalation SL TR=0.0001 (mg/kg)	Carcinogenic SL TR=0.0001 (mg/kg)	Ingestion SL Child THQ=3 (mg/kg)	Dermal SL Child THQ=3 (mg/kg)	Inhalation SL Child THQ=3 (mg/kg)	Noncarcinogenic SL Child THI=3 (mg/kg)	Ingestion SL Adult THQ=3 (mg/kg)	Dermal SL Adult THQ=3 (mg/kg)	Inhalation SL Adult THQ=3 (mg/kg)	Noncarcinogenic SL Adult THI=3 (mg/kg)	Screening Level (mg/kg)
Arsenic, Inorganic	5.49E+02	8.88E+04	6.77E+01	1.17E+02	9.89E+02	6.38E+04	1.05E+02	1.25E+03	5.93E+03	6.38E+04	1.02E+03	6.77E+01 ca**

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Site-specific
Resident Risk for Soil

Chemical	Ingestion SF (mg/kg-day) $^{-1}$	SFO Ref	Inhalation Unit Risk (ug/m^3)$^{-1}$	IUR Ref	RfD (mg/kg-day)	RfD Ref	RfC (mg/m^3)	RfC Ref	GIABS	ABS	RBA	Soil Saturation Concentration (mg/kg)	S (mg/L)	K_{oc}\ (cm^3/g)	K_d\ (cm^3/g)	HLC (atm-m^3/mole)
Arsenic, Inorganic	1.50E+00	U	4.30E-03	U	3.00E-04	U	1.50E-05	U	1	0.03	0.6	-	-	-	2.90E+01	-
**Total Risk/HI*	-		-		-		-		-	-	-	-	-	-	-	-

Chemical	Henry's Law Constant Used in Calcs (unitless)	H` and HLC Ref	Normal Boiling Point T_{boil}\ (K)	BP Ref	Critical Temperature T_{crit}\ (K)	T_{crit}\ Ref	chemtype	D_{ia}\ (cm^2/s)	D_{iw}\ (cm^2/s)	D_A\ (cm^2/s)	Particulate Emission Factor (m^3/kg)	Volatilization Factor (m^3/kg)	Concentration (mg/kg)	Ingestion Risk	Dermal Risk
Arsenic, Inorganic	-		888.15	U	1670	U	INORGANIC	-	-	-	1.36E+09	-	8.06E+01	1.04E-04	1.47E-05
**Total Risk/HI*	-		-		-			-	-	-	-	-	-	*1.04E-04*	*1.47E-05*

Chemical	Inhalation Risk	Carcinogenic Risk	Ingestion Child HQ	Dermal Child HQ	Inhalation Child HQ	Noncarcinogenic Child HI	Ingestion Adult HQ	Dermal Adult HQ	Inhalation Adult HQ	Noncarcinogenic Adult HI
Arsenic, Inorganic	9.08E-08	1.19E-04	2.06E+00	2.45E-01	3.79E-03	2.31E+00	1.93E-01	4.08E-02	3.79E-03	2.38E-01
**Total Risk/HI*	*9.08E-08*	*1.19E-04*	*2.06E+00*	*2.45E-01*	*3.79E-03*	*2.31E+00*	*1.93E-01*	*4.08E-02*	*3.79E-03*	*2.38E-01*

Site-specific
Resident Equation Inputs for Soil

*** Inputted values different from Resident defaults are highlighted.**

Variable	Resident Soil Default Value	Form-input Value
A (PEF Dispersion Constant)	16.2302	16.2302
A (VF Dispersion Constant)	11.911	11.911
A (VF Dispersion Constant - Mass Limit)	11.911	11.911
B (PEF Dispersion Constant)	18.7762	18.7762
B (VF Dispersion Constant)	18.4385	18.4385
B (VF Dispersion Constant - Mass Limit)	18.4385	18.4385
$City_{PEF}$ (Climate Zone) Selection	Default	Default
$City_{VF}$ (Climate Zone) Selection	Default	Default
C (PEF Dispersion Constant)	216.108	216.108
C (VF Dispersion Constant)	209.7845	209.7845
C (VF Dispersion Constant - Mass Limit)	209.7845	209.7845
foc (fraction organic carbon in soil) g/g	0.006	0.006
F(x) (function dependent on U_m/U_t) unitless	0.194	0.194
n (total soil porosity) L_{pore}/L_{soil}	0.43396	0.43396
p_b (dry soil bulk density) g/cm^3	1.5	1.5
p_b (dry soil bulk density - mass limit) g/cm^3	1.5	1.5
PEF (particulate emission factor) m^3/kg	1359344438	1359344438
p_s (soil particle density) g/cm^3	2.65	2.65
Q/C_{wind} (g/m^2-s per kg/m^3)	93.77	93.77
Q/C_{vol} (g/m^2-s per kg/m^3)	68.18	68.18
Q/C_{vol} (g/m^2-s per kg/m^3)	68.18	68.18
A_s (PEF acres)	0.5	0.5
A_s (VF acres)	0.5	0.5
A_s (VF mass-limit acres)	0.5	0.5
AF_{0-2} (mutagenic skin adherence factor) mg/cm^2	0.2	0.2
AF_{2-6} (mutagenic skin adherence factor) mg/cm^2	0.2	0.2
AF_{6-16} (mutagenic skin adherence factor) mg/cm^2	0.07	0.07
AF_{16-26} (mutagenic skin adherence factor) mg/cm^2	0.07	0.07
AF_{res-a} (skin adherence factor - adult) mg/cm^2	0.07	0.07
AF_{res-c} (skin adherence factor - child) mg/cm^2	0.2	0.2

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Site-specific
Resident Equation Inputs for Soil

*** Inputted values different from Resident defaults are highlighted.**

Variable	Resident Soil Default Value	Form-input Value
AT_{res} (averaging time - resident carcinogenic)	365	365
BW_{0-2} (mutagenic body weight) kg	15	15
BW_{2-6} (mutagenic body weight) kg	15	15
BW_{6-16} (mutagenic body weight) kg	80	80
BW_{16-26} (mutagenic body weight) kg	80	80
BW_{res-a} (body weight - adult) kg	80	80
BW_{res-c} (body weight - child) kg	15	15
$DFS_{res-adj}$ (age-adjusted soil dermal factor) mg/kg	103390	103390
$DFSM_{res-adj}$ (mutagenic age-adjusted soil dermal factor) mg/kg	428260	428260
ED_{res} (exposure duration) years	26	26
ED_{0-2} (mutagenic exposure duration) years	2	2
ED_{2-6} (mutagenic exposure duration) years	4	4
ED_{6-16} (mutagenic exposure duration) years	10	10
ED_{16-26} (mutagenic exposure duration) years	10	10
ED_{res-a} (exposure duration - adult) years	20	20
ED_{res-c} (exposure duration - child) years	6	6
EF_{res} (exposure frequency) days/year	350	350
EF_{0-2} (mutagenic exposure frequency) days/year	350	350
EF_{2-6} (mutagenic exposure frequency) days/year	350	350
EF_{6-16} (mutagenic exposure frequency) days/year	350	350
EF_{16-26} (mutagenic exposure frequency) days/year	350	350
EF_{res-a} (exposure frequency - adult) days/year	350	350
EF_{res-c} (exposure frequency - child) days/year	350	350
ET_{res} (exposure time) hours/day	24	24
ET_{0-2} (mutagenic exposure time) hours/day	24	24
ET_{2-6} (mutagenic exposure time) hours/day	24	24
ET_{6-16} (mutagenic exposure time) hours/day	24	24
ET_{16-26} (mutagenic exposure time) hours/day	24	24
ET_{res-a} (adult exposure time) hours/day	24	24
ET_{res-c} (child exposure time) hours/day	24	24

Site-specific
Resident Equation Inputs for Soil

*** Inputted values different from Resident defaults are highlighted.**

Variable	Resident Soil Default Value	Form-input Value
THQ (target hazard quotient) unitless	1	1
$IFS_{res-adj}$ (age-adjusted soil ingestion factor) mg/kg	36750	36750
$IFSM_{res-adj}$ (mutagenic age-adjusted soil ingestion factor) mg/kg	166833.3	166833.3
IRS_{0-2} (mutagenic soil intake rate) mg/day	200	200
IRS_{2-6} (mutagenic soil intake rate) mg/day	200	200
IRS_{6-16} (mutagenic soil intake rate) mg/day	100	100
IRS_{16-26} (mutagenic soil intake rate) mg/day	100	100
IRS_{res-a} (soil intake rate - adult) mg/day	100	100
IRS_{res-c} (soil intake rate - child) mg/day	200	200
LT (lifetime) years	70	70
SA_{0-2} (mutagenic skin surface area) cm^2/day	2373	2373
SA_{2-6} (mutagenic skin surface area) cm^2/day	2373	2373
SA_{6-16} (mutagenic skin surface area) cm^2/day	6032	6032
SA_{16-26} (mutagenic skin surface area) cm^2/day	6032	6032
SA_{res-a} (skin surface area - adult) cm^2/day	6032	6032
SA_{res-c} (skin surface area - child) cm^2/day	2373	2373
TR (target risk) unitless	1.0E-04	1.0E-04
T_w (groundwater temperature) Celsius	25	25
$Theta_a$ (air-filled soil porosity) L_{air}/L_{soil}	0.28396	0.28396
$Theta_w$ (water-filled soil porosity) L_{water}/L_{soil}	0.15	0.15
T (exposure interval) s	819936000	819936000
T (exposure interval) yr	26	26
U_m (mean annual wind speed) m/s	4.69	4.69
U_t (equivalent threshold value)	11.32	11.32
V (fraction of vegetative cover) unitless	0.5	0.5

Site-specific
Resident Removal Management Levels (RML) for Soil

Key: I = IRIS; P = PPRTV; D = DWSHA; O = OPP; A = ATSDR; C = Cal EPA; X = APPENDIX PPRTV SCREEN (See FAQ #31); H = HEAST; F = See FAQ; W = see user guide Section 2.3.5; E = see user guide Section 2.3.6; L = see user guide on lead; M = mutagen; S = see user guide Section 5; V = volatile; R = RBA applied (See User Guide for Arsenic notice) ; ca = cancer; nc = noncancer; * = where: nc SL < 100X ca SL; ** = where nc SL < 10X ca SL; SSL values are based on DAF=1; max = Concentration may exceed ceiling limit (See User Guide); sat = Concentration may exceed Csat (See User Guide); U = User-provided

Chemical	CAS Number	Mutagen?	Volatile?	SF_o (mg/kg-day)$^{-1}$	SF_o Ref	IUR (ug/m^3)$^{-1}$	IUR Ref	RfD (mg/kg-day)	RfD Ref	RfC (mg/m^3)	RfC Ref	GIABS	ABS	RBA
Arsenic, Inorganic	7440-38-2	No	No	1.50E+00	I	4.30E-03	I	3.00E-04	I	1.50E-05	C	1	0.03	0.6

Chemical	Soil Saturation Concentration (mg/kg)	S (mg/L)	K_{oc}\ (cm^3/g)	K_d\ (cm^3/g)	HLC (atm-m^3/mole)	Henry's Law Constant Used in Calcs (unitless)	H` and HLC Ref	Normal Boiling Point BP (K)	BP Ref	Critical Temperature TC (K)	TC Ref
Arsenic, Inorganic	-	-	-	2.90E+01	-	-		888.15	PHYSPROP	1673	CRC89

Chemical	Chemical Type	D_{ia}\ (cm^2/s)	D_{iw}\ (cm^2/s)	D_A\ (cm^2/s)	Particulate Emission Factor (m^3/kg)	Volatilization Factor (m^3/kg)	Ingestion SL TR=0.0001 (mg/kg)	Dermal SL TR=0.0001 (mg/kg)	Inhalation SL TR=0.0001 (mg/kg)	Carcinogenic SL TR=0.0001 (mg/kg)
Arsenic, Inorganic	INORGANIC	-	-	-	1.36E+09	-	7.72E+01	5.49E+02	8.88E+04	6.77E+01

Chemical	Ingestion SL Child THQ=1 (mg/kg)	Dermal SL Child THQ=1 (mg/kg)	Inhalation SL Child THQ=1 (mg/kg)	Noncarcinogenic SL Child THI=1 (mg/kg)	Ingestion SL Adult THQ=1 (mg/kg)	Dermal SL Adult THQ=1 (mg/kg)	Inhalation SL Adult THQ=1 (mg/kg)	Noncarcinogenic SL Adult THI=1 (mg/kg)	Screening Level (mg/kg)
Arsenic, Inorganic	3.91E+01	3.30E+02	2.13E+04	3.49E+01	4.17E+02	1.98E+03	2.13E+04	3.39E+02	3.49E+01 nc

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Site-specific
Resident Risk for Soil

Chemical	SF_o (mg/kg-day) $^{-1}$	SF_o Ref	IUR (ug/m^3)$^{-1}$	IUR Ref	RfD (mg/kg-day)	RfD Ref	RfC (mg/m^3)	RfC Ref	GIABS	ABS	RBA	Soil Saturation Concentration (mg/kg)	S (mg/L)	K_{oc}\ (cm^3/g)	K_d\ (cm^3/g)	HLC (atm-m^3/mole)
Arsenic, Inorganic	1.50E+00	I	4.30E-03	I	3.00E-04	I	1.50E-05	C	1	0.03	0.6	-	-	-	2.90E+01	-
*Total Risk/HI	-		-		-		-		-	-	-	-	-	-	-	-

Chemical	Henry's Law Constant Used in Calcs (unitless)	H` and HLC Ref	Normal Boiling Point BP (K)	BP Ref	Critical Temperature TC (K)	TC Ref	Chemical Type	D_{ia}\ (cm^2/s)	D_{iw}\ (cm^2/s)	D_A\ (cm^2/s)	Particulate Emission Factor (m^3/kg)	Volatilization Factor (m^3/kg)	Concentration (mg/kg)	Ingestion Risk
Arsenic, Inorganic	-		888.15	PHYSPROP	1673	CRC89	INORGANIC	-	-	-	1.36E+09	-	5.54E+01	7.17E-05
*Total Risk/HI	-		-		-			-	-	-	-	-	-	*7.17E-05*

Chemical	Dermal Risk	Inhalation Risk	Carcinogenic Risk	Ingestion Child HQ	Dermal Child HQ	Inhalation Child HQ	Noncarcinogenic Child HI	Ingestion Adult HQ	Dermal Adult HQ	Inhalation Adult HQ	Noncarcinogenic Adult HI
Arsenic, Inorganic	1.01E-05	6.24E-08	8.19E-05	1.42E+00	1.68E-01	2.61E-03	1.59E+00	1.33E-01	2.80E-02	2.61E-03	1.63E-01
*Total Risk/HI	*1.01E-05*	*6.24E-08*	*8.19E-05*	*1.42E+00*	*1.68E-01*	*2.61E-03*	*1.59E+00*	*1.33E-01*	*2.80E-02*	*2.61E-03*	*1.63E-01*

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Site-specific
Resident Equation Inputs for Soil

*** Inputted values different from Resident defaults are highlighted.**

Variable	Resident Soil Default Value	Form-input Value
A (PEF Dispersion Constant)	16.2302	16.2302
A (VF Dispersion Constant)	11.911	11.911
A (VF Dispersion Constant - Mass Limit)	11.911	11.911
B (PEF Dispersion Constant)	18.7762	18.7762
B (VF Dispersion Constant)	18.4385	18.4385
B (VF Dispersion Constant - Mass Limit)	18.4385	18.4385
$City_{PEF}$ (Climate Zone) Selection	Default	Default
$City_{VF}$ (Climate Zone) Selection	Default	Default
C (PEF Dispersion Constant)	216.108	216.108
C (VF Dispersion Constant)	209.7845	209.7845
C (VF Dispersion Constant - Mass Limit)	209.7845	209.7845
foc (fraction organic carbon in soil) g/g	0.006	0.006
F(x) (function dependent on U_m/U_t) unitless	0.194	0.194
n (total soil porosity) L_{pore}/L_{soil}	0.43396	0.43396
p_b (dry soil bulk density) g/cm^3	1.5	1.5
p_b (dry soil bulk density - mass limit) g/cm^3	1.5	1.5
PEF (particulate emission factor) m^3/kg	1359344438	1359344438
p_s (soil particle density) g/cm^3	2.65	2.65
Q/C_{wind} (g/m^2-s per kg/m^3)	93.77	93.77
Q/C_{vol} (g/m^2-s per kg/m^3)	68.18	68.18
Q/C_{vol} (g/m^2-s per kg/m^3)	68.18	68.18
A_s (PEF acres)	0.5	0.5
A_s (VF acres)	0.5	0.5
A_s (VF mass-limit acres)	0.5	0.5
AF_{0-2} (mutagenic skin adherence factor) mg/cm^2	0.2	0.2
AF_{2-6} (mutagenic skin adherence factor) mg/cm^2	0.2	0.2
AF_{6-16} (mutagenic skin adherence factor) mg/cm^2	0.07	0.07
AF_{16-26} (mutagenic skin adherence factor) mg/cm^2	0.07	0.07

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Site-specific
Resident Equation Inputs for Soil

*** Inputted values different from Resident defaults are highlighted.**

Variable	Resident Soil Default Value	Form-input Value
AF_{res-a} (skin adherence factor - adult) mg/cm ^{2}	0.07	0.07
AF_{res-c} (skin adherence factor - child) mg/cm ^{2}	0.2	0.2
AT_{res} (averaging time - resident carcinogenic)	365	365
BW_{0-2} (mutagenic body weight) kg	15	15
BW_{2-6} (mutagenic body weight) kg	15	15
BW_{6-16} (mutagenic body weight) kg	80	80
BW_{16-26} (mutagenic body weight) kg	80	80
BW_{res-a} (body weight - adult) kg	80	80
BW_{res-c} (body weight - child) kg	15	15
$DFS_{res-adj}$ (age-adjusted soil dermal factor) mg/kg	103390	103390
$DFSM_{res-adj}$ (mutagenic age-adjusted soil dermal factor) mg/kg	428260	428260
ED_{res} (exposure duration) years	26	26
ED_{0-2} (mutagenic exposure duration) years	2	2
ED_{2-6} (mutagenic exposure duration) years	4	4
ED_{6-16} (mutagenic exposure duration) years	10	10
ED_{16-26} (mutagenic exposure duration) years	10	10
ED_{res-a} (exposure duration - adult) years	20	20
ED_{res-c} (exposure duration - child) years	6	6
EF_{res} (exposure frequency) days/year	350	350
EF_{0-2} (mutagenic exposure frequency) days/year	350	350
EF_{2-6} (mutagenic exposure frequency) days/year	350	350
EF_{6-16} (mutagenic exposure frequency) days/year	350	350
EF_{16-26} (mutagenic exposure frequency) days/year	350	350
EF_{res-a} (exposure frequency - adult) days/year	350	350
EF_{res-c} (exposure frequency - child) days/year	350	350
ET_{res} (exposure time) hours/day	24	24
ET_{0-2} (mutagenic exposure time) hours/day	24	24
ET_{2-6} (mutagenic exposure time) hours/day	24	24
ET_{6-16} (mutagenic exposure time) hours/day	24	24

Site-specific
Resident Equation Inputs for Soil

*** Inputted values different from Resident defaults are highlighted.**

Variable	Resident Soil Default Value	Form-input Value
ET_{16-26} (mutagenic exposure time) hours/day	24	24
ET_{res-a} (adult exposure time) hours/day	24	24
ET_{res-c} (child exposure time) hours/day	24	24
THQ (target hazard quotient) unitless	1	3
$IFS_{res-adj}$ (age-adjusted soil ingestion factor) mg/kg	36750	36750
$IFSM_{res-adj}$ (mutagenic age-adjusted soil ingestion factor) mg/kg	166833.3	166833.3
IRS_{0-2} (mutagenic soil intake rate) mg/day	200	200
IRS_{2-6} (mutagenic soil intake rate) mg/day	200	200
IRS_{6-16} (mutagenic soil intake rate) mg/day	100	100
IRS_{16-26} (mutagenic soil intake rate) mg/day	100	100
IRS_{res-a} (soil intake rate - adult) mg/day	100	100
IRS_{res-c} (soil intake rate - child) mg/day	200	200
LT (lifetime) years	70	70
SA_{0-2} (mutagenic skin surface area) cm^2/day	2373	2373
SA_{2-6} (mutagenic skin surface area) cm^2/day	2373	2373
SA_{6-16} (mutagenic skin surface area) cm^2/day	6032	6032
SA_{16-26} (mutagenic skin surface area) cm^2/day	6032	6032
SA_{res-a} (skin surface area - adult) cm^2/day	6032	6032
SA_{res-c} (skin surface area - child) cm^2/day	2373	2373
TR (target risk) unitless	1.0E-04	1.0E-04
T_w (groundwater temperature) Celsius	25	25
$Theta_a$ (air-filled soil porosity) L_{air}/L_{soil}	0.28396	0.28396
$Theta_w$ (water-filled soil porosity) L_{water}/L_{soil}	0.15	0.15
T (exposure interval) s	819936000	819936000
T (exposure interval) yr	26	26
U_m (mean annual wind speed) m/s	4.69	4.69
U_t (equivalent threshold value)	11.32	11.32
V (fraction of vegetative cover) unitless	0.5	0.5

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Site-specific
Resident Removal Management Levels (RML) for Soil

Key: I = IRIS; P = PPRTV; D = DWSHA; O = OPP; A = ATSDR; C = Cal EPA; X = APPENDIX PPRTV SCREEN (See FAQ #29); H = HEAST; F = See FAQ; E = see user guide Section 2.3.5; W = see user guide Section 2.3.6; L = see user guide on lead; M = mutagen; S = see user guide Section 5; V = volatile; R = RBA applied (See User Guide for Arsenic notice) ; c = cancer; n = noncancer; * = where: n SL < 100X c SL; ** = where n SL < 10X c SL; SSL values are based on DAF=1; m = Concentration may exceed ceiling limit (See User Guide); s = Concentration may exceed Csat (See User Guide); U = User-provided

Chemical	CAS Number	Mutagen?	Volatile?	Ingestion SF (mg/kg-day)$^{-1}$	SFO Ref	Inhalation Unit Risk (ug/m^3)$^{-1}$	IUR Ref	RfD (mg/kg-day)	RfD Ref	RfC (mg/m^3)	RfC Ref	GIABS	ABS	RBA	Soil Saturation Concentration (mg/kg)	S (mg/L)	K_{oc} \ (cm^3/g)
Arsenic, Inorganic	7440-38-2	No	No	1.50E+00	U	4.30E-03	U	3.00E-04	U	1.50E-05	U	1	0.03	0.6	-	-	-

Chemical	K_d \ (cm^3/g)	HLC (atm-m^3/mole)	Henry's Law Constant Used in Calcs (unitless)	H` and HLC Ref	Normal Boiling Point T_{boil} \ (K)	BP Ref	Critical Temperature T_{crit} \ (K)	T_{crit} \ Ref	chemtype	D_{ia} \ (cm^2/s)	D_{iw} \ (cm^2/s)	D_A \ (cm^2/s)	Particulate Emission Factor (m^3/kg)	Volatilization Factor (m^3/kg)	Ingestion SL TR=0.0001 (mg/kg)
Arsenic, Inorganic	2.90E+01	-	-		888.15	U	1670	U	INORGANIC	-	-	-	1.36E+09	-	7.72E+01

Chemical	Dermal SL TR=0.0001 (mg/kg)	Inhalation SL TR=0.0001 (mg/kg)	Carcinogenic SL TR=0.0001 (mg/kg)	Ingestion SL Child THQ=3 (mg/kg)	Dermal SL Child THQ=3 (mg/kg)	Inhalation SL Child THQ=3 (mg/kg)	Noncarcinogenic SL Child THI=3 (mg/kg)	Ingestion SL Adult THQ=3 (mg/kg)	Dermal SL Adult THQ=3 (mg/kg)	Inhalation SL Adult THQ=3 (mg/kg)	Noncarcinogenic SL Adult THI=3 (mg/kg)	Screening Level (mg/kg)
Arsenic, Inorganic	5.49E+02	8.88E+04	6.77E+01	1.17E+02	9.89E+02	6.38E+04	1.05E+02	1.25E+03	5.93E+03	6.38E+04	1.02E+03	6.77E+01 ca**

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Site-specific
Resident Risk for Soil

Chemical	Ingestion SF (mg/kg-day) $^{-1}$	SFO Ref	Inhalation Unit Risk (ug/m^3)$^{-1}$	IUR Ref	RfD (mg/kg-day)	RfD Ref	RfC (mg/m^3)	RfC Ref	GIABS	ABS	RBA	Soil Saturation Concentration (mg/kg)	S (mg/L)	K_{oc}\ (cm^3/g)	K_d\ (cm^3/g)	HLC (atm-m^3/mole)
Arsenic, Inorganic	1.50E+00	U	4.30E-03	U	3.00E-04	U	1.50E-05	U	1	0.03	0.6	-	-	-	2.90E+01	-
**Total Risk/HI*	-		-		-		-		-	-	-	-	-	-	-	-

Chemical	Henry's Law Constant Used in Calcs (unitless)	H` and HLC Ref	Normal Boiling Point T_{boil}\ (K)	BP Ref	Critical Temperature T_{crit}\ (K)	T_{crit}\ Ref	chemtype	D_{ia}\ (cm^2/s)	D_{iw}\ (cm^2/s)	D_A\ (cm^2/s)	Particulate Emission Factor (m^3/kg)	Volatilization Factor (m^3/kg)	Concentration (mg/kg)	Ingestion Risk	Dermal Risk
Arsenic, Inorganic	-		888.15	U	1670	U	INORGANIC	-	-	-	1.36E+09	-	5.79E+02	7.50E-04	1.05E-04
**Total Risk/HI*	-		-		-			-	-	-	-	-	-	*7.50E-04*	*1.05E-04*

Chemical	Inhalation Risk	Carcinogenic Risk	Ingestion Child HQ	Dermal Child HQ	Inhalation Child HQ	Noncarcinogenic Child HI	Ingestion Adult HQ	Dermal Adult HQ	Inhalation Adult HQ	Noncarcinogenic Adult HI
Arsenic, Inorganic	6.52E-07	8.56E-04	1.48E+01	1.76E+00	2.72E-02	1.66E+01	1.39E+00	2.93E-01	2.72E-02	1.71E+00
**Total Risk/HI*	*6.52E-07*	*8.56E-04*	*1.48E+01*	*1.76E+00*	*2.72E-02*	*1.66E+01*	*1.39E+00*	*2.93E-01*	*2.72E-02*	*1.71E+00*

Site-specific
Resident Equation Inputs for Soil

*** Inputted values different from Resident defaults are highlighted.**

Variable	Resident Soil Default Value	Form-input Value
A (PEF Dispersion Constant)	16.2302	16.2302
A (VF Dispersion Constant)	11.911	11.911
A (VF Dispersion Constant - Mass Limit)	11.911	11.911
B (PEF Dispersion Constant)	18.7762	18.7762
B (VF Dispersion Constant)	18.4385	18.4385
B (VF Dispersion Constant - Mass Limit)	18.4385	18.4385
$City_{PEF}$ (Climate Zone) Selection	Default	Default
$City_{VF}$ (Climate Zone) Selection	Default	Default
C (PEF Dispersion Constant)	216.108	216.108
C (VF Dispersion Constant)	209.7845	209.7845
C (VF Dispersion Constant - Mass Limit)	209.7845	209.7845
foc (fraction organic carbon in soil) g/g	0.006	0.006
F(x) (function dependent on U_m/U_t) unitless	0.194	0.194
n (total soil porosity) L_{pore}/L_{soil}	0.43396	0.43396
p_b (dry soil bulk density) g/cm^3	1.5	1.5
p_b (dry soil bulk density - mass limit) g/cm^3	1.5	1.5
PEF (particulate emission factor) m^3/kg	1359344438	1359344438
p_s (soil particle density) g/cm^3	2.65	2.65
Q/C_{wind} (g/m^2-s per kg/m^3)	93.77	93.77
Q/C_{vol} (g/m^2-s per kg/m^3)	68.18	68.18
Q/C_{vol} (g/m^2-s per kg/m^3)	68.18	68.18
A_s (PEF acres)	0.5	0.5
A_s (VF acres)	0.5	0.5
A_s (VF mass-limit acres)	0.5	0.5
AF_{0-2} (mutagenic skin adherence factor) mg/cm^2	0.2	0.2
AF_{2-6} (mutagenic skin adherence factor) mg/cm^2	0.2	0.2
AF_{6-16} (mutagenic skin adherence factor) mg/cm^2	0.07	0.07
AF_{16-26} (mutagenic skin adherence factor) mg/cm^2	0.07	0.07

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Site-specific
Resident Equation Inputs for Soil

*** Inputted values different from Resident defaults are highlighted.**

Variable	Resident Soil Default Value	Form-input Value
AF_{res-a} (skin adherence factor - adult) mg/cm ^{2}	0.07	0.07
AF_{res-c} (skin adherence factor - child) mg/cm ^{2}	0.2	0.2
AT_{res} (averaging time - resident carcinogenic)	365	365
BW_{0-2} (mutagenic body weight) kg	15	15
BW_{2-6} (mutagenic body weight) kg	15	15
BW_{6-16} (mutagenic body weight) kg	80	80
BW_{16-26} (mutagenic body weight) kg	80	80
BW_{res-a} (body weight - adult) kg	80	80
BW_{res-c} (body weight - child) kg	15	15
$DFS_{res-adj}$ (age-adjusted soil dermal factor) mg/kg	103390	103390
$DFSM_{res-adj}$ (mutagenic age-adjusted soil dermal factor) mg/kg	428260	428260
ED_{res} (exposure duration) years	26	26
ED_{0-2} (mutagenic exposure duration) years	2	2
ED_{2-6} (mutagenic exposure duration) years	4	4
ED_{6-16} (mutagenic exposure duration) years	10	10
ED_{16-26} (mutagenic exposure duration) years	10	10
ED_{res-a} (exposure duration - adult) years	20	20
ED_{res-c} (exposure duration - child) years	6	6
EF_{res} (exposure frequency) days/year	350	350
EF_{0-2} (mutagenic exposure frequency) days/year	350	350
EF_{2-6} (mutagenic exposure frequency) days/year	350	350
EF_{6-16} (mutagenic exposure frequency) days/year	350	350
EF_{16-26} (mutagenic exposure frequency) days/year	350	350
EF_{res-a} (exposure frequency - adult) days/year	350	350
EF_{res-c} (exposure frequency - child) days/year	350	350
ET_{res} (exposure time) hours/day	24	24
ET_{0-2} (mutagenic exposure time) hours/day	24	24
ET_{2-6} (mutagenic exposure time) hours/day	24	24
ET_{6-16} (mutagenic exposure time) hours/day	24	24

Site-specific
Resident Equation Inputs for Soil

*** Inputted values different from Resident defaults are highlighted.**

Variable	Resident Soil Default Value	Form-input Value
ET_{16-26} (mutagenic exposure time) hours/day	24	24
ET_{res-a} (adult exposure time) hours/day	24	24
ET_{res-c} (child exposure time) hours/day	24	24
THQ (target hazard quotient) unitless	1	3
$IFS_{res-adj}$ (age-adjusted soil ingestion factor) mg/kg	36750	36750
$IFSM_{res-adj}$ (mutagenic age-adjusted soil ingestion factor) mg/kg	166833.3	166833.3
IRS_{0-2} (mutagenic soil intake rate) mg/day	200	200
IRS_{2-6} (mutagenic soil intake rate) mg/day	200	200
IRS_{6-16} (mutagenic soil intake rate) mg/day	100	100
IRS_{16-26} (mutagenic soil intake rate) mg/day	100	100
IRS_{res-a} (soil intake rate - adult) mg/day	100	100
IRS_{res-c} (soil intake rate - child) mg/day	200	200
LT (lifetime) years	70	70
SA_{0-2} (mutagenic skin surface area) cm^2/day	2373	2373
SA_{2-6} (mutagenic skin surface area) cm^2/day	2373	2373
SA_{6-16} (mutagenic skin surface area) cm^2/day	6032	6032
SA_{16-26} (mutagenic skin surface area) cm^2/day	6032	6032
SA_{res-a} (skin surface area - adult) cm^2/day	6032	6032
SA_{res-c} (skin surface area - child) cm^2/day	2373	2373
TR (target risk) unitless	1.0E-04	1.0E-04
T_w (groundwater temperature) Celsius	25	25
$Theta_a$ (air-filled soil porosity) L_{air}/L_{soil}	0.28396	0.28396
$Theta_w$ (water-filled soil porosity) L_{water}/L_{soil}	0.15	0.15
T (exposure interval) s	819936000	819936000
T (exposure interval) yr	26	26
U_m (mean annual wind speed) m/s	4.69	4.69
U_t (equivalent threshold value)	11.32	11.32
V (fraction of vegetative cover) unitless	0.5	0.5

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Site-specific
Resident Removal Management Levels (RML) for Soil

Key: I = IRIS; P = PPRTV; D = DWSHA; O = OPP; A = ATSDR; C = Cal EPA; X = APPENDIX PPRTV SCREEN (See FAQ #29); H = HEAST; F = See FAQ; E = see user guide Section 2.3.5; W = see user guide Section 2.3.6; L = see user guide on lead; M = mutagen; S = see user guide Section 5; V = volatile; R = RBA applied (See User Guide for Arsenic notice) ; c = cancer; n = noncancer; * = where: n SL < 100X c SL; ** = where n SL < 10X c SL; SSL values are based on DAF=1; m = Concentration may exceed ceiling limit (See User Guide); s = Concentration may exceed Csat (See User Guide); U = User-provided

Chemical	CAS Number	Mutagen?	Volatile?	Ingestion SF (mg/kg-day)$^{-1}$	SFO Ref	Inhalation Unit Risk (ug/m^3)$^{-1}$	IUR Ref	RfD (mg/kg-day)	RfD Ref	RfC (mg/m^3)	RfC Ref	GIABS	ABS	RBA	Soil Saturation Concentration (mg/kg)	S (mg/L)	K_{oc}\ (cm^3/g)
Arsenic, Inorganic	7440-38-2	No	No	1.50E+00	U	4.30E-03	U	3.00E-04	U	1.50E-05	U	1	0.03	0.6	-	-	-

Chemical	K_d\ (cm^3/g)	HLC (atm-m^3/mole)	Henry's Law Constant Used in Calcs (unitless)	H` and HLC Ref	Normal Boiling Point T_{boil}\ (K)	BP Ref	Critical Temperature T_{crit}\ (K)	T_{crit}\ Ref	chemtype	D_{ia}\ (cm^2/s)	D_{iw}\ (cm^2/s)	D_A\ (cm^2/s)	Particulate Emission Factor (m^3/kg)	Volatilization Factor (m^3/kg)	Ingestion SL TR=0.0001 (mg/kg)
Arsenic, Inorganic	2.90E+01	-	-		888.15	U	1670	U	INORGANIC	-	-	-	1.36E+09	-	7.72E+01

Chemical	Dermal SL TR=0.0001 (mg/kg)	Inhalation SL TR=0.0001 (mg/kg)	Carcinogenic SL TR=0.0001 (mg/kg)	Ingestion SL Child THQ=3 (mg/kg)	Dermal SL Child THQ=3 (mg/kg)	Inhalation SL Child THQ=3 (mg/kg)	Noncarcinogenic SL Child THI=3 (mg/kg)	Ingestion SL Adult THQ=3 (mg/kg)	Dermal SL Adult THQ=3 (mg/kg)	Inhalation SL Adult THQ=3 (mg/kg)	Noncarcinogenic SL Adult THI=3 (mg/kg)	Screening Level (mg/kg)
Arsenic, Inorganic	5.49E+02	8.88E+04	6.77E+01	1.17E+02	9.89E+02	6.38E+04	1.05E+02	1.25E+03	5.93E+03	6.38E+04	1.02E+03	6.77E+01 ca**

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Site-specific
Resident Risk for Soil

Chemical	Ingestion SF (mg/kg-day) $^{-1}$	SFO Ref	Inhalation Unit Risk (ug/m^3)$^{-1}$	IUR Ref	RfD (mg/kg-day)	RfD Ref	RfC (mg/m^3)	RfC Ref	GIABS	ABS	RBA	Soil Saturation Concentration (mg/kg)	S (mg/L)	K_{oc}\ (cm^3/g)	K_d\ (cm^3/g)	HLC (atm-m^3/mole)
Arsenic, Inorganic	1.50E+00	U	4.30E-03	U	3.00E-04	U	1.50E-05	U	1	0.03	0.6	-	-	-	2.90E+01	-
*Total Risk/HI	-		-		-		-		-	-	-	-	-	-	-	-

Chemical	Henry's Law Constant Used in Calcs (unitless)	H` and HLC Ref	Normal Boiling Point T_{boil}\ (K)	BP Ref	Critical Temperature T_{crit}\ (K)	T_{crit}\ Ref	chemtype	D_{ia}\ (cm^2/s)	D_{iw}\ (cm^2/s)	D_A\ (cm^2/s)	Particulate Emission Factor (m^3/kg)	Volatilization Factor (m^3/kg)	Concentration (mg/kg)	Ingestion Risk	Dermal Risk
Arsenic, Inorganic	-		888.15	U	1670	U	INORGANIC	-	-	-	1.36E+09	-	1.20E+02	1.56E-04	2.19E-05
*Total Risk/HI	-		-		-			-	-	-	-	-	-	*1.56E-04*	*2.19E-05*

Chemical	Inhalation Risk	Carcinogenic Risk	Ingestion Child HQ	Dermal Child HQ	Inhalation Child HQ	Noncarcinogenic Child HI	Ingestion Adult HQ	Dermal Adult HQ	Inhalation Adult HQ	Noncarcinogenic Adult HI
Arsenic, Inorganic	1.36E-07	1.78E-04	3.08E+00	3.65E-01	5.66E-03	3.45E+00	2.89E-01	6.09E-02	5.66E-03	3.55E-01
*Total Risk/HI	*1.36E-07*	*1.78E-04*	*3.08E+00*	*3.65E-01*	*5.66E-03*	*3.45E+00*	*2.89E-01*	*6.09E-02*	*5.66E-03*	*3.55E-01*

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Attachment 3

COST ESTIMATE FOR REMEDIAL AND REMOVAL ACTIONS
ARSENIC MINE SITE
KENT, PUTNAM COUNTY, NEW YORK

This initial cost analysis is to evaluate the cost effectiveness of the Remedial and Removal actions for addressing the arsenic contamination found in residential soils at the Arsenic Mine Site. This cost effectiveness evaluation satisfies the requirements under 40 CFR 300.425 (c)(3). The alternatives presented in this evaluation represent worst case scenarios and are not a reflection of actual short-term and long-term actions necessary to address the Site.

EPA cautions that this evaluation of the cleanup elements associated with the Arsenic Mine Site is for the purpose of NPL listing and by no means is a definitive evaluation of cleanup options. EPA anticipates it will conduct a complete evaluation of cleanup options as part of the remedial process at the Site.

The cost effectiveness criteria for Arsenic Mine consist of a permanent relocation (Remedial) of residents from elevated arsenic contamination found in residential soils and a series of interim actions (Removal). EPA anticipates there could be some issues regarding the remediation of the Site. These issues include the future land use at the properties and potential off-site migration of surface water runoff.

Remedial Action Cost Estimation

The remedial alternative consists of buyouts of each of the impacted properties within the areas of concern (AOC), and to remediate contaminated soils. EPA believes this remedial alternative of permanent relocation and soil cleanup is the most cost-effective solution to address the arsenic contamination in residential soils long term.

Property Information

X_{p001} : 2-acres; 3 Br, 2 Ba (2,380 ft^2); 100 ft^2 shed
X_{p002} : 1.40-acres; 3 Br, 2 Ba (1,727 ft^2); 528 ft^2 garage
X_{p003} : 3.17-acres; **(no house)**; 2,200 ft^2 barn
X_{p004} : 8.58-acres; **(no house)**; 1,596 ft^2 barn
X_{p005} : 2.68-acres; 3 Br, 1 Ba (1,422 ft^2); 192 ft^2 shed/chicken coop; 174 ft^2 shed; 413 ft^2 cabin; 400 ft^2 shed/cabin
X_{p006} : 6.42-acres; 4 Br, 2+ Ba (2,210 ft^2); 1,008 ft^2 barn; 1,300 ft^2 barn; 125 ft^2 shed/chicken coop
X_{p007} : 1.37-acres; **(no house)**
X_{p008} : 1.26-acres; 3 Br, 1 Ba (2,016 ft^2); 400 ft^2 garage
X_{p009} : 1.48-acres; 2 Br, 1 Ba (988 ft^2); 144 ft^2 shed
X_{p010} : 1.08-acres; 2 Br, 1 Ba (1,216 ft^2); 100 ft^2 shed; 225 ft^2 garage

Property Assessment – based upon taxable rates

X_{p001} = \$94,400*
X_{p002} = \$266,100
X_{p003} = \$159,000

X_{p004} = $181,600
X_{p005} = $325,700
X_{p006} = $465,500
X_{p007} = $75,000
X_{p008} = $428,100
X_{p009} = $310,900
X_{p010} = $330,100

* Based upon purchase price, not appraised value. Appraised value is expected to be approximately $250,000. The purchase price, not the appraised value, is included in the total cost below.

X_{TOTAL} = $2,636,400

Administrative Cost Estimate:
Buyouts/Permanent relocation: The following is an administrative estimate for the cost of acquisition of the required real estate interest of the ten (10) identified properties and relocation of residents.

Title-Attorney Review/Closings	$20,000 ($2000/property)
Negotiations	$25,000 ($2500/property)
Mapping/Survey	$10,000 ($1000/property)
Title Contract	$10,000 ($1000/property)
Moving Truck Cost	$3,500 ($500 per 7 occupied property)
Total	**$68,500**

Upkeep Cost Estimate:
The following cost estimate includes fences that are to be installed around the perimeter of each residential property, and to keep the public from accessing.

Material Cost/Fence Type:
Chain Link*
Wood
Vinyl
Aluminum/Steel
Wrought Iron

* EPA assumes a Chain Link fence will be installed for all 10 properties.

Property size (acre)	**Fence height(ft)**	**Gate type@**
P001=2-acres	6	double gate
P002=1.40-acres	6	double gate
P003=3.17-acres	6	double gate
P004=8.58-acres	6	double gate
P005=2.68-acres	6	double gate
P006=6.42-acres	6	double gate

P007=1.37-acres	6	double gate
P008=1.26-acres	6	double gate
P009=1.48-acres	6	double gate
P010=1.08-acres	6	double gate

P001 = 1539 L.F[++]	P006 = 1,150 L.F[++]
P002 = 1064 L.F[++]	P007 = 1,160 L.F[++]
P003 = 1,745 L.F[++]	P008 = 1,068 L.F[++]
P004 = 3,454 L.F[++]	P009 = 1120 L.F[++]
P005 = 1,450 L.F[++]	P010 = 939 L.F[++]

[+] EPA is assuming a cost of $10 per linear foot (L.F).
[+] EPA is approximating the measurements for each of the property perimeter obtained using the "add polygon" feature on Google Earth Pro.
[@] Gate install costs are included as part of the cost per linear foot of installation.

Cost of building a fence around the perimeter of each residential property
P001 = $15,390
P002 = $10,640
P003 = $17,450
P004 = $34,540
P005 = $14,500
P006 = $11,500
P007 = $11,600
P008 = $10,680
P009 = $11,200
P010 = $9,390

Total fencing Cost: $146,890

Permit Cost: **$8,000**
The estimated permit cost per property is $800.

Total Permit Cost: $8,000

Soil Remediation Cost Estimate

The following cost estimate is part of the remedial process for long term cleanup in addressing the source of arsenic contaminated soils. This proposed soil remedy would reduce the risks associated with exposure to contaminated soil by excavating the areas identified to contain elevated levels of arsenic above site-specific background concentrations.

Equipment cost: (45,000-pound excavator $9,000/month; off-road Dump Truck $8,500/month; Water Truck $500/month; Loader $5,900/month). (∑ of equipment cost * 12 months) = **$286,800**[*]

* EPA is assuming 12 months of on-site work.

Personnel Cost: (3 operators for 12 months, 40-hr weeks, rate of $135/hr)
($135/hr * 8hr/day * 5 days/week * 52 weeks) = $842,400

Excavation cost: A. 6 acres → 19,360 yd^3, estimated removal cost @ $115/$yd^3$
B. 19,360 yd^3 x $115/$yd^3$ = **$2,226,400**

Backfilling cost: EPA is assuming a rate of $40/ton for backfill: (29,040 tons * $40/ton) = **$1,161,600**

Transportation Cost Estimate

19,360 yd^3 x 1.5* = 29,040 tons
29,040 tons/30 tons per truck = 968 truck loads
968 truck loads * $750.00 = **$726,000**

* A density factor of 1.5 is most appropriate to convert cubic yards to tons due to the high variability of the pending weight of the material (gravel, brick, topsoil).

Capital Cost Estimate

Acquisition Costs (10 properties)	$2,636,400
Administrative Costs	$68,500
Fencing Costs	$146,890
Permit Cost	$8,000
Equipment Cost	$286,800
Personnel Cost (operators)	$842,400
Excavation Cost	$2,226,400
Backfilling Cost	$1,161,600
Transportation Cost	$726,000

O & M Cost Estimate
EPA considers buyouts of the residential properties as a permanent remedy, and therefore, long-term O&M was not required. Additionally, EPA assumes no future residential property will be built.

Total Present Worth (PW) Cost $8,102,990

Removal Action Cost Estimation

The removal cost estimation consists of several action elements that would eliminate the residents' exposure to arsenic at the Site. These actions consist of temporary relocation, excavation & backfilling of soil, storm water management, and operation and maintenance

(O&M) of a storm water and sediment collection system. Based on EPA's Removal Assessment, the AOC consists of a total of 10 properties located along Gipsy Trail Road and Mt. Nimham Court.

Temporary relocation element
This element includes the temporary relocation of the residents at the impacted properties along Gipsy Trail Road and Mt. Nimham Court and the elimination of exposure to contaminated soils while other elements of the Removal Action are conducted. EPA assumes all of the residents from the seven occupied structures will be placed in nearby rental units for approximately 12 months (duration of soil replacement).

Excavation & Backfilling (soil replacement)
A removal action to remove soils with concentrations greater than the defensible background concentration of 123.9 mg/kg arsenic to the maximum depth of two feet across the AOC of 10 properties will reduce exposures for those residents who live on the properties, those that visit the properties, and any trespassers. This removal action would effectively be only a 'hot spot' removal. Due to the property locations and the steep slopes of the terrain, there is a high risk of destabilization of the mountainside following tree removal (in preparation for excavation). Additional steps would be required to ensure integrity of the excavation and backfill efforts, including restoration of the hillsides. In addition, this limited removal will not be a permanent solution as surface water runoff and any management of the runoff may cause additional contamination/re-exposure of contaminated areas and/or result in washout of backfilled areas.

Storm Water and Sediment Management
A storm water management plan will be required to extend the removal action lifespan. This will need to include a storm water and sediment collection and diversion system capable of collection of water over the eastern side of the Mt. Nimham Mountains. An engineered remedy is likely to cost at least $1,000,000 for the engineering study, design, and implementation. Envisioned in this design is the installation of a knee wall between property P002 and P001, a six-foot (or higher) retaining wall behind the house on property P001, piping for areas around the knee and retaining walls and between the walls, and the installation of a retention basin. Additional property regrading will likely be necessary, as well as operation and maintenance of the system. The proposed cost does not include any maintenance activities or the property acquisition for the retention basin.

O&M
Even with a storm water and sediment management and soil replacement plan, it is highly likely that soils will wash out over a number of years due to the elevation change and surface water flow. The aforementioned retention basin, retaining and knee walls, piping, and any other components of the system will all need to be routinely maintained.

Incurred Cost
Incurred cost in for Removal Action only. This cost includes money already spent in prior years and recent Removal activities (i.e., cistern repair, sampling).

Contract Expenditures: $505,511.99

Indirect Cost:	$200,355.98
Miscellaneous Expenses:	$68,694.17
Payroll Cost:	$126,796.25
Travel Cost:	$6,424.15
Total Incurred cost:	**$907,782.54**

Capital Cost Estimate Summary

Temporary Relocation: **(rental cost):** ($3,531[+]/month * 12 months * 7 property owners) = **$296,604**

[+] ***EPA is assuming a range for rental cost by using the minimum and maximum rental cost in the area and calculating the average rental cost, as stated above.***

Equipment cost: (45,000-pound excavator $9,000/month; off-road Dump Truck $8,500/month; Water Truck $500/month; Loader $5,900/month). (∑ of equipment cost * 12 months*) = **$286,800**[*]

[*] EPA is assuming 12 months of on-site work.

Personnel Cost: (3 operators for 12 months, 40-hr weeks, rate of $135/hr)
($135/hr * 8hr/day*5 days/week * 52 weeks) = **$842,400**

Excavation/Disposal & Backfilling cost:
[*]**(Excavation/Disposal cost):** [A.]6 acres → 19,360 yd^3, estimated removal cost @ $115/$yd^3$
[B.]19,360 yd^3 x $115/$yd^3$ = **$2,226,400**

[*] ***EPA is assuming the use of the site-specific background for all 10 properties.***

Conversion factors:
1 acre = 43,560 ft^2

$$\frac{1 \text{ acre}}{43{,}560\ ft^2} = \frac{6\text{-acres}}{X_A}$$

X_A = 261,360 ft^2
(excavation of top 2 feet)
X_V = 261,360 ft^2 * 2 ft = 522,720 ft^3

1ft^3 = 0.03703704 yd^3 or 1 yd^3 = 27 ft^3

522,720 ft^3 * (1 yd^3 / 27 ft^3) = 19,360 yd^3

(Backfilling cost): EPA is assuming a rate of $40/ton for backfill: (29,040 tons * $40/ton) = **$1,161,600**

Transportation Cost Estimate

19,360 yd^3 x 1.5* = 29,040 tons
29,040 tons/30 tons per truck = 968 truck loads
968 truck loads * $750.00 = **$726,000**

*A density factor of 1.5 is most appropriate to convert cubic yards to tons due to the high variability of the pending weight of the material (gravel, brick, topsoil).

Storm Water Management:
EPA is assuming the following cost for implementing engineering control at the site is **$1,000,000.**

Removal Cost Summary

Rental Cost (temporary relocation) $296,604
Equipment Cost $286,800
Personnel Cost (operators) $842,400
Excavation Cost $2,226,400
Backfill Cost $1,161,600
Transportation Cost $726,000
Property Management $1,000,000
Incurred Cost $907,782.54

Capital Cost $7,447,587

O & M Cost Estimate

Annual Property Monitoring Program $1,000,000
Contingency (30%) $300,000

Annual O&M Cost $1,300,000
Total O&M Cost (n=30 years) $16,131,753
EPA assumes the following: interest rate at 7%, O&M period of 30 years

$$PV = A \times \frac{(1+i)^n - 1}{i(1+i)^n}$$

PV= Present Value
A= Annual Cost
i= interest/discount rate
n= number of years

Total Present Worth (PW) Cost (Capital and O&M) $23,579,340
*Total present worth (PW) costs includes the estimated Capital and 30-year O&M costs. The present worth calculations used a discount rate of 7%.

Property Maps

Figure 1:

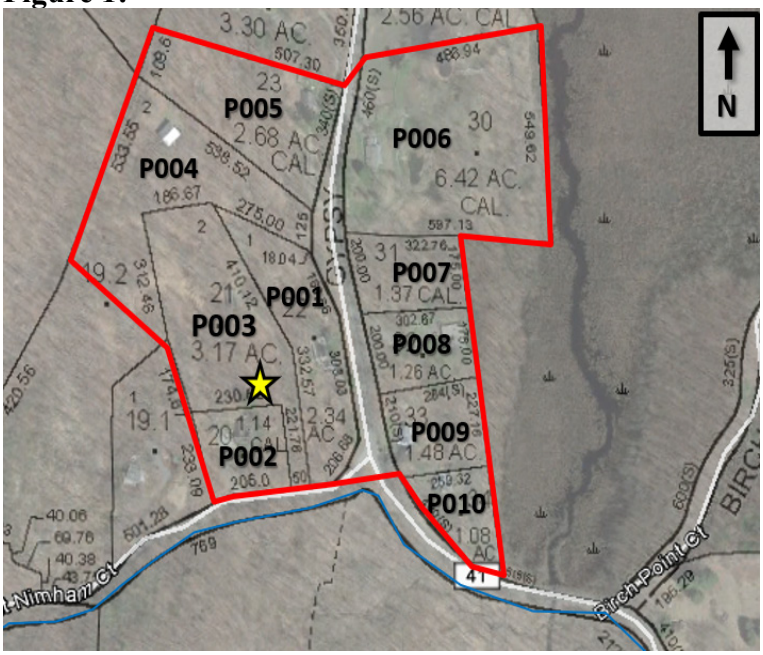
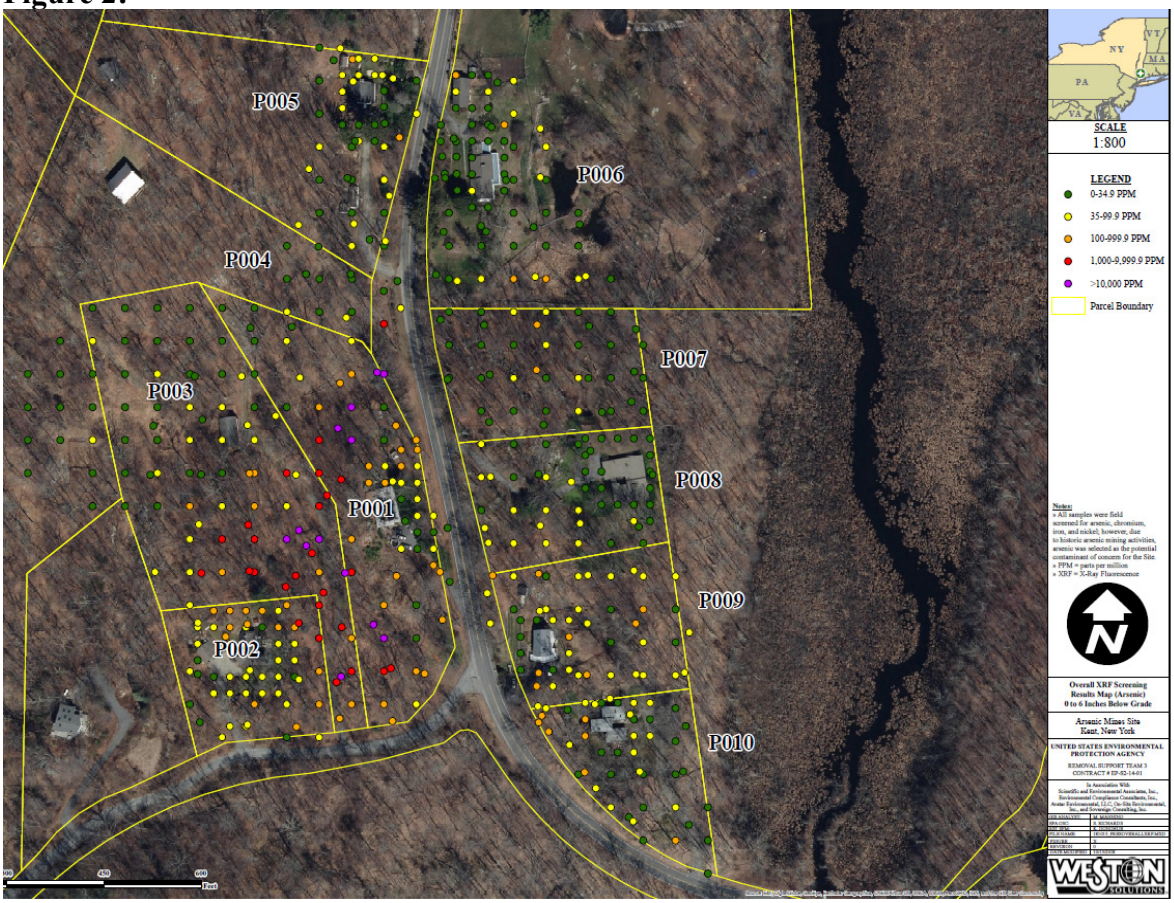


Figure 2:


P005
P006
P004
P007
P003
P008
P001
P009
P002
P010
NY
VT
MA
PA
SCALE
1:800
LEGEND
0-34.9 PPM
35-99.9 PPM
100-999.9 PPM
1,000-9,999.9 PPM
>10,000 PPM
Parcel Boundary
Notes:
Overall XRF Screening Results Map (Arsenic) 0 to 6 Inches Below Grade
Arsenic Mines Site East New York
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REMOVAL SUPPORT TEAM 3
CONTRACT # EP-S2-14-01
WESTON SOLUTIONS

Attachment 4

OFFICE OF THE COMMISSIONER

New York State Department of Environmental Conservation
625 Broadway, 14th Floor, Albany, New York 12233-1010
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May 3, 2019

Mr. Peter D. Lopez
Regional Administrator
United States Environmental Protection Agency
Region II
290 Broadway
New York, NY 10007-1866

Dear Mr. Lopez:

As you are aware, significantly elevated levels of arsenic have been detected in surface soil at a number of private residential properties, and in one private drinking water well, in the Town of Kent in Putnam County, New York. The United States Environmental Protection Agency (EPA) refers to this area as the Arsenic Mine Site. Sampling data from a 2017/2018 EPA investigation which was comprised of ten residential properties shows arsenic concentrations in soil as high as 56,000 parts per million (ppm). The residential soil cleanup objective (SCO) and protection of groundwater SCO in New York State are 16 ppm. Additionally, though an alternative drinking water source has since been provided, a contaminated well resulted in documented serious health impacts to prior property owners.

As the government agencies charged with protecting public health and the environment, it is imperative that the New York State Department of Health (DOH), New York State Department of Environmental Conservation (DEC), and the EPA work together on a full investigation of the nature and extent of arsenic contamination and then on any necessary cleanup. DEC and DOH stand ready to assist in this investigation by the EPA.

I am aware that the DOH, in partnership with the Agency for Toxic Substances and Disease Registry (ATSDR), recently prepared a health consultation for the Arsenic Mine Site. Based on the information presented in the health consultation, ATSDR, in consultation with DOH, determined that current and potential future exposures to arsenic in shallow residential soil on the Arsenic Mine Site is an urgent public health hazard. ATSDR has issued a public health advisory urging the EPA to take immediate actions to mitigate harmful exposures to arsenic.

I understand that the EPA plans to propose that residential properties impacted by the Arsenic Mine Site, where high levels of arsenic in soil have been observed, be included on the National Priorities List (NPL). I support this proposal. Should this site be added to the NPL, I understand that, in accordance with the Comprehensive Environmental Response, Compensation and Liability Act, DOH will remain responsible for all matters related to public health regarding the site.

Michael Ryan, Director of DEC's Division of Environmental Remediation, will contact your staff to followup on this matter and discuss next steps. Please do not hesitate to contact me if you would like to discuss further.

I look forward to continued collaboration at all levels of government to address the mine-related contamination and to ensure that there is no additional hardship for affected stakeholders and residents.

Sincerely,

Basil Seggos
Commissioner