**Y/TS-1948**

# COVENANT DEFERRAL REQUEST
# Y-12 NATIONAL SECURITY COMPLEX
# SITES A and B
# OAK RIDGE, TENNESSEE

November 2004

Prepared by
Tetra Tech, Inc.
Oak Ridge, Tennessee
under BWXT Y-12 subcontract 4300033853

Prepared for
BWXT Y-12 L.L.C.
managing the
Y-12 National Security Complex
under contract DE-AC05-00OR22800
for the
U.S. DEPARTMENT OF ENERGY

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## APPENDICES

## ACRONYMS

| | |
|---|---|
| AM | action memorandum |
| BERA | baseline ecological risk assessment |
| bgs | below ground surface |
| BWXT Y-12 | BWXT Y-12, L.L.C. |
| CA | Characterization Area |
| CDR | Covenant Deferral Request |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| COC | chemicals of concern |
| COPC | chemicals of potential concern |
| cpm | counters per minute |
| CSF | Carcinogenic Slope Factor |
| DOE | U.S. Department of Energy |
| EE/CA | Engineering Evaluation/Cost Analysis |
| EPA | U.S. Environmental Protection Agency |
| EPC | exposure point concentration |
| ETTP | East Tennessee Technology Park |
| FFA | Federal Facilities Agreement |
| FFS | Focused Feasibility Study |
| HEAST | Health Effects Assessment Summary Tables |
| HHRA | human health risk assessment |
| HI | hazard index |
| HQ | hazard quotient |
| ILCR | incremental lifetime cancer risk |
| IRIS | Integrated Risk Information System |
| MARSSIM | Multi-Agency Radiation Survey and Site Investigation Manual |
| MDL | method detection limit |
| NCEA | National Center for Environmental Assessment |
| NCP | National Contingency Plan |
| NEPA | National Environmental Policy Act |
| NNSA | National Nuclear Security Administration |
| NPL | National Priorities List |
| ORNL | Oak Ridge National Laboratory |
| ORO | Oak Ridge Operations |
| ORR | Oak Ridge Reservation |
| OSHA | Occupational Safety and Health Administration |
| OSWER | Office of Solid Waste and Emergency Response |
| PCB | polychlorinated biphenyl |
| PCCR | Partial Construction Completion Report |
| PRG | preliminary remediation goal |

| | |
|---|---|
| PRP | potentially responsible party |
| RAGS | Risk Assessment Guidance for Superfund |
| RAR | Remedial Action Report |
| RBC | risk-based concentration |
| RfD | reference dose |
| RGO | remedial goal option |
| RI | Remedial Investigation |
| RIWP | Remedial Investigation Work Plan |
| RL | remediation level |
| RME | reasonable maximum exposure |
| ROD | Record of Decision |
| SAP | sampling and analysis plan |
| SVOC | semivolatile organic compound |
| TDEC | Tennessee Department of Environment and Conservation |
| UCL | upper confidence limit |
| UCL-L | upper confidence limit lognormal |
| UCL-N | upper confidence limit normal |
| UEFPC | Upper East Fork Poplar Creek |
| UST | underground storage tank |
| VOC | volatile organic compound |
| WEMA | West End Mercury Area |
| Y-12 | Y-12 National Security Complex |

# 1. INTRODUCTION

In accordance with Sect. 120(h)(3)(c) of the Comprehensive Environmental, Response, and Compensation Act (CERCLA), the U.S. Department of Energy's (DOE's) National Nuclear Security Administration (NNSA) is submitting this Covenant Deferral Request (CDR) to support the transfer of two undeveloped parcels (Sites A and B) of property at the Y-12 National Security Complex (Y-12), in Oak Ridge, Tennessee. The transfer of property is needed to support NNSA's modernization plans to reduce risks to worker health and safety and to reduce operating costs. NNSA would transfer the property to a special purpose private entity, and the private entity would then obtain private financing to build two facilities at Y-12. Those facilities could then be leased for NNSA uses.

The property to be transferred is within the Oak Ridge Reservation (ORR), a National Priorities List (NPL) site since November 1989. Environmental investigation and cleanup activities are continuing at Y-12 in accordance with a 1991 Federal Facilities Agreement (FFA) entered into by DOE, the U.S. Environmental Protection Agency (EPA) Region 4, and the Tennesee Department of Environment and Conservation (TDEC). The FFA establishes the schedule and milestones for environmental remediation of the ORR, including the Y-12 Complex. The deferral and transfer of the property will not substantially delay any necesssary response action at the ORR NPL site.

When the federal government transfers property on the NPL, CERCLA requires that the deed must contain two covenants warranting that: (1) all remedial actions necessary to protect human health and the environment from hazardous substances remaining on the property have been taken before the date of the property transfer [CERCLA 120(h)(3)(A)(ii)(I)], and (2) any additional remedial action found to be necessary after the date of property transfer shall be conducted by the United States [CERCLA 120(h)(3)(A)(ii)(II)]. The deed will contain this last covenant. However, in certain circumstances, with concurrence of the governor of the state in which the facility is located, EPA may defer the covenant warranting all remedial actions necessary to protect human health and the environment have been taken. In order for EPA to defer the covenant requirement, CERCLA 120(h)(3)(C) requires that EPA determine that the property is suitable for transfer based on these findings:

1. The property is suitable for transfer for the expected use and such use is consistent with protection of human health and environment;

2. The deed proposed to govern the transfer between the United States and the Grantee of the property contains the Response Action Assurances described in CERCLA 120(h)(3)(C)(ii) with regard to a release or threatened release of a hazardous substance for which the federal agency is potentially responsible:

    A. to provide for any necessary restrictions on the use of the property to ensure the protection of human health and the environment;

    B. to provide that there will be restrictions on use necessary to ensure that required remedial investigations, response action, and oversight activities will not be disrupted;

    C. to provide that all necessary response actions will be taken and identify the schedules for investigation and completion of all necessary response actions as approved by the appropriate regulatory agency; and

    D. to provide that the federal agency responsible for the property subject to transfer will submit a budget request to the Director of the Office of Management and Budget that adequately

addresses schedules for investigation and completion of all necessary response action, subject to congressional authorizations and appropriations.

3. The federal agency requesting deferral has provided notice, by publication in a newspaper of general circulation in the vicinity of the property, of the proposed transfer and of the opportunity for the public to submit, within a period of not less than 30 days after the date of notice, written comments on the suitability of the property for transfer; and

4. The deferral and the transfer of property will not substantially delay any necessary response action at the property.

These findings are intended to assure that there is a sound basis for the proposed transfer because the expected reuse of the property does not pose an unacceptable risk to human health or the environment. Within this CDR, NNSA presents information and data to support the required findings. NNSA describes how the property will be used, provides a risk assessment and provides the deed containing numerous restrictions and prohibitions on the use of the property, provisions for access and remediation, as well as commitments to response actions, schedules, and budget requests as required.

NNSA believes that this CDR meets the conditions set forth above and hereby requests that the Regional Administrator for EPA Region 4 determine, with the concurrence of the Governor of the State of Tennessee, that the Property is suitable for transfer and that the CERCLA 120(h)(3)(A)(ii)(I) covenant may be deferred. Once the deferral request is granted, land parcels within Sites A & B will be conveyed while all necessary remediation at the Y-12 site in accordance with CERCLA, the NCP, and the FFA is continued. In accordance with CERCLA 120(h)(3)(B), this CDR request pertains solely to the transfer of this property or any portion thereof to a non-Potentially Responsible Party (PRP).

## 2. PROPERTY DESCRIPTION

The ORR hosts three major industrial research and production facilities originally constructed as part of the World War II-era Manhattan Project: East Tennessee Technology Park [(ETTP); formerly the K-25 Site], Oak Ridge National Laboratory (ORNL), and Y-12. Y-12's original mission was to chemically separate and produce fissile $^{235}U$ from $^{238}U$ using an electromagnetic separation process (alpha process) and to manufacture weapon components as part of the national effort to produce the atomic bomb. As other uranium enrichment processes were developed and implemented at other installations, the role of Y-12 expanded to include weapon components manufacturing and precision machining, research and development, lithium isotope separation, and special nuclear materials storage and management. The current mission of Y-12 includes manufacturing and reworking nuclear weapons components, dismantling nuclear weapons components, serving as the nation's stockpile for special nuclear materials, supporting nuclear non-proliferation, and providing special production support to other programs.

The 34,516-acre DOE ORR is located within and adjacent to the corporate limits of the city of Oak Ridge, Tennessee, in Roane and Anderson counties. The industrialized portion of Y-12 encompasses about 800 acres near the northeast corner of the ORR and is adjacent to the City of Oak Ridge. Y-12 is located within the Upper East Fork Poplar Creek (UEFPC) watershed. Boundaries of the UEFPC Characterization Area (CA), which encompasses the main Y-12 Complex area, extend along the base of Pine Ridge to the north, the base of Chestnut Ridge to the south, the eastern boundary of the Bear Creek watershed to the west, and Scarboro Road to the east (Fig. 2.1).

Sites A and B are undeveloped areas located within the UEFPC CA (Fig. 2.2). Site A is approximately 8.3 acres located on the north-central portion of Y-12, accessible from Bear Creek Road. Site B is approximately 8.9 acres located on the eastern portion of Y-12, accessible from Scarboro Road. Site A is situated on a knoll surrounded by parking lots, whereas Site B is a relatively flat (slightly sloping to the west towards UEFPC) and open grassy area. A legal description of Site A and Site B property is provided in Appendix A. The property to be transferred at this time will be land parcels within Sites A and B consisting of the building footprints, approximately 4.1 and 2.8 acres, respectively.

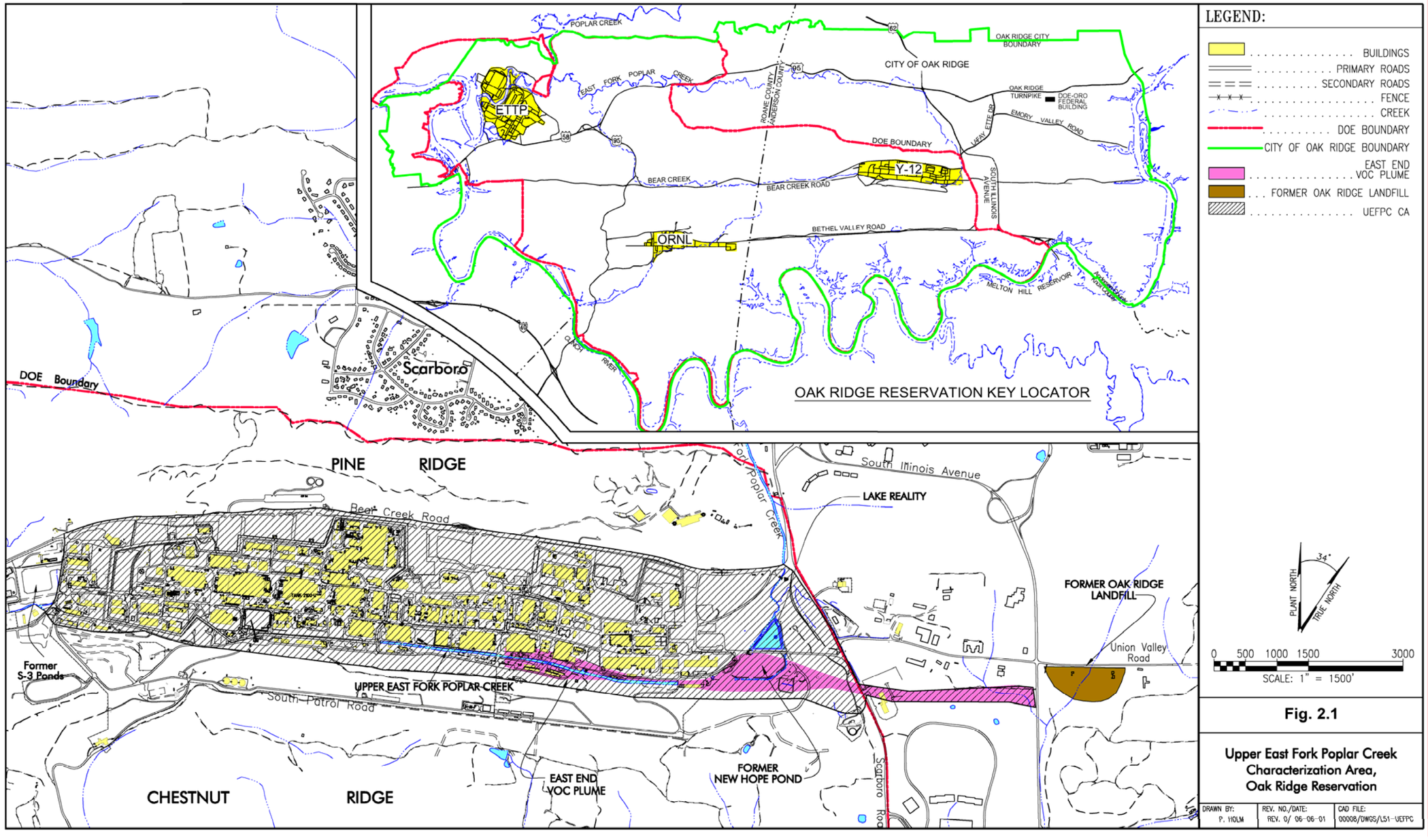


**Fig. 2.1. Upper East Fork Poplar Creek Characterization Area, Oak Ridge Reservation.**

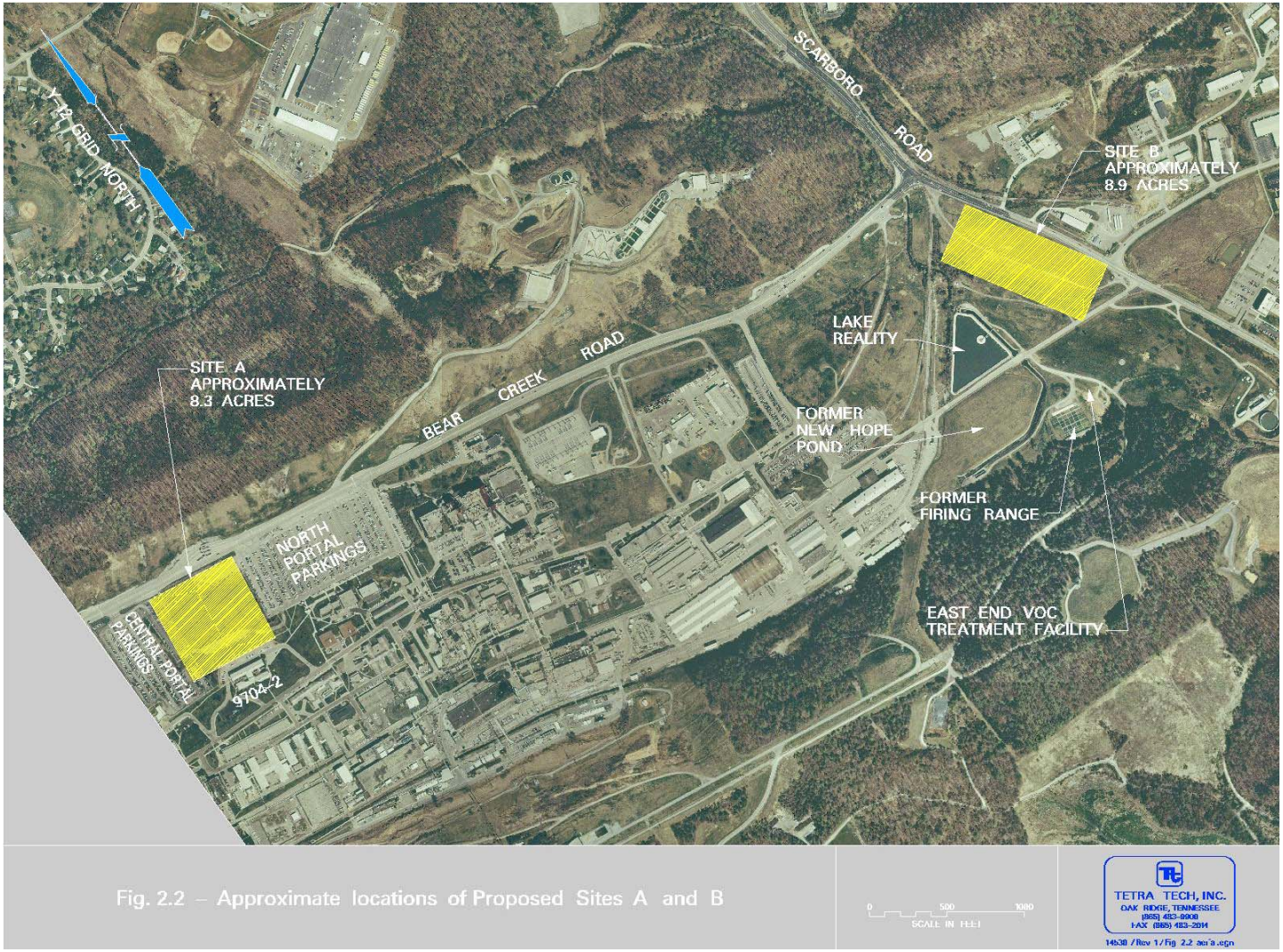


**Fig. 2.2. Approximate locations of proposed Sites A and B.**

## 3. NATURE/EXTENT OF CONTAMINATION

Historical missions of Y-12 resulted in the release of contaminants to the environment. UEFPC CA chemicals of concern (COCs) include radioactive isotopes, volatile organic compounds (VOCs) and semivolatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), cyanide, nitrate, and heavy metals (including mercury). Characterization and remediation of the UEFPC CA are addressed by the following documents:

- *Report on the Remedial Investigation of the Upper East Fork Poplar Creek Characterization Area at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee,* DOE/OR/01-1641/V1&D2 (DOE 1998);
- *Record of Decision for Phase I Interim Source Control Actions in the Upper East Fork Poplar Creek Characterization Area, Oak Ridge, Tennessee,* DOE/OR/01-1951&D3 (DOE 2002);
- *Land Use Control Implementation Plan for Phase I Interim Source Control Actions in the Upper East Fork Poplar Creek Characterization Area at the Y-12 National Security Complex, Oak Ridge, Tennessee,* DOE/OR/01-1987&D2 (DOE 2003);
- *Upper East Fork Poplar Creek Soil and Scrapyard Focused Feasibility Study,* DOE/OR/01-2083&D2 (DOE 2004a); and
- *Proposed Plan for Interim Actions for Contaminated Soils and Scrapyard in Upper East Fork Poplar Creek, Oak Ridge, Tennessee,* DOE/OR/01-2173&D0 (DOE 2004b).

Site A is 8.3 acres on a knoll roughly bounded by Central Portal Parking lot (west), Bear Creek Road (north), North Portal Parking lot (east), and former Building 9704-2 site (south). In comparing the current topography with the site topography that existed before construction of the Y-12 Complex, it is believed that fill was placed on the west side of the site, and the south and east sides were cut (excavated). The site is currently undeveloped but was formerly the location of Building 9705 and some smaller support facilities. Building 9705 was an office building that was serviced by an emergency generator supplied by fuel stored in an underground storage tank (UST). An accidental fire destroyed Building 9705 during the late 1950s or early 1960s, and the building was demolished and removed. The UST (approximately 100-gal capacity) remained until it was removed on July 21, 1995; the tank pit was sampled and backfilled. The tank was reported to be in excellent condition, and there was no indication from visual inspection and sampling results that a release had occurred during operation or removal. Subsequent handling of the removed tank resulted in the discovery that a portion of the tank was radiologically contaminated. However, there was no evidence of radiological contamination in the excavated area soil.

Between September 1985 and May 1987, a scoping survey was conducted at the request of Y-12 management by the Measurement and Development Group of the Health and Safety Research Division, ORNL, to characterize the outdoor surface environment at Y-12. The survey was designed to characterize trends in the surface environment over the entire Y-12 site. Its purpose was to locate and prioritize areas of concern both from a worker health/safety and environmental standpoint. The objectives of the survey were to specifically assess the gamma status of the site and to analyze surface soil samples for the presence of selected radionuclides and mercury. The presence of PCBs at selected areas was also considered. Information was published under the title *Results of the Outdoor Radiological and Chemical Surface Scoping Survey of the Y-12 Plant Site*, document # Y/TS-600 PART 1, Y/TS-600 PART 2 and Y/TS-600 PART 3, and is commonly referred to as the "k-man Database."

Included in the "k-man Database" are ten soil samples that were collected from the area within Site A, revealing a discrete location with radioactivity above background levels ($^{226}$Ra, 150 pCi/g). Two samples were also collected south of the site and were analyzed to contain $^{238}$U (560 pCi/g and 940 pCi/g).

Site B is adjacent to Scarboro Road between Second Street and Bear Creek Road. It is roughly bounded on the west by a line about 400 feet west of and parallel to Scarboro Road. The site is undeveloped except for a railroad spur that once transected the property. Walkover surveys, including the "k-man Database" survey, revealed that approximately 25% of the railroad bed surface was contaminated with $^{137}Cs$. Additional field characterization, including surface water, sediment, ballast, and soil sampling, was performed in 1992. An environmental cleanup action level of 50 pCi/g was established and sections of the contaminated rail, crossties, ballast, and soil were removed from 12 areas within Site B. Verification by walkover surveys and field sampling confirmed that the 50 pCi/g environmental cleanup action level was met. Uncontaminated soil was used to backfill excavations. The removal action was performed in January–May 1994 and documented in *Environmental Restoration Program Removal Action Report for Chessie Seaboard Multiplier (CSX) Railroad*, DOE/OR/02-1301&D1 (DOE 1994).

Remedial actions and closures (see Figs. 2.1 and 2.2) have been implemented near Site B, as follows:

- South of Site B, groundwater is contaminated with VOCs, and the plume extends eastward from the Y-12 Site. The plume is being treated by the East End VOC Treatment Facility. The treatment facility was installed in October 2000 as an early action in response to an engineering evaluation/cost analysis (EE/CA) and action memorandum (AM) prepared in 1999.
- New Hope Pond was closed and capped under the Resource Conservation and Recovery Act and replaced with Lake Reality in 1989.
- A lead-contaminated firing range was formerly located south of Site B. In response to an EE/CA and AM prepared in 1997, an early action to remediate the range was completed in 1998. The completed early action for the firing range resulted in excavation and off-site disposal of 864 $yd^3$ of lead-contaminated soil.

Neither Site A nor Site B appears to have been used for industrial process operations or waste disposal based on historical information. Documentation related to records review, personnel interviews, and aerial photographs are included in Appendices B, C, and D, respectively. In accordance with 40 CFR 373, hazardous substances that were stored, released, or disposed of at Sites A and B were researched and are addressed in Chap. 7.

Visual inspections of Sites A and B were performed on February 13 and February 23, 2004, respectively. Representatives from NNSA and BWXT Y-12, LLC (BWXT) Environmental Compliance, Engineering, Radcon, and Waste Management organizations were present. Potential locations of radiological contamination, physical features, and groundwater wells were identified as input to further site characterization.

A walkover gamma scan survey was conducted on Sites A and B from April 28 to May 13, 2004. Both sites were divided into 100 ft by 100 ft reference grids and 2 in. × 2 in. NaI detectors were used to perform the surface scanning. The detectors were held close to the ground (approximately 2 to 2.5 in.) and moved in a serpentine pattern approximately one foot per second while the technician walked at a rate of approximately one foot per second. As changes in count-rate were noted, the technician paused at the area and took a one-minute (approximate) reading. If the one-minute reading was distinguishable from background, then the count-rate for the anomalous area was noted on survey documentation. Dose rate measurements (at the ground surface and one meter above) were made at grid intersections and anomalous areas using a Bicron Micro Rem Tissue Equivalent meter.

Site A was divided into 36 grids (the same grids as used for subsequent soils sampling). NaI results ranged from 10,000 to 12,000 counts per minute (cpm)--consistent throughout all grids. Dose rate measurements range from 2 to 6 microrem per hour at one meter above the surface and 2 to 8.5 microrem per hour on contact with the surface. Several anomalous areas were noted, but these areas are associated with groundhog holes and the higher count-rates result from a change in source (ground) to detector geometry

(detector surrounded by soil). Paved areas were previously surveyed using gas-proportional floor monitors and were not surveyed with NaI detectors. Survey results for Site A are consistent with background, and no areas requiring further investigation or specific sampling were identified based on the survey.

Site B was divided into 40 grids (same grids as used for soil sampling). NaI results range from 6,000 to 12,000 cpm. Dose rate measurements in areas without anomalous readings range from 2.5 to 6 microrem per hour at one meter above the surface and 2.5 to 7.5 microrem per hour on contact with the surface. Three anomalous areas were identified: (1) grid location A2 – 26,000 cpm, 7 microrem per hour at one meter, 15 microrem per hour contact; (2) grid location D5 – 12,000 cpm, 2.5 microrem per hour at one meter, 4.5 microrem per hour contact; and (3) grid location D6 – 12,000 cpm, 5 microrem per hour at one meter, 3.5 microrem per hour contact. There was a noticeable variation in background within Site B. Grids B8-B10, C7-C10, and D7-D10 are 6,000 to 7,000 cpm background (these grids are adjacent to Scarboro Road and Second Street). The remaining grids are 10,000 to 12,000 cpm. This variation is most likely due to different geology and is not uncommon on the ORR.

With the exception of the area along the old railroad spur on Site B, existing soil data indicate no contamination pattern. Thus, it appears that soil contamination indicated by the old k-man data is random–maybe even anomalous in some cases based on the results of recent gamma scan walkovers. Due to the age of the data, the different objectives for which they were collected, and the results of recent confirmatory surveys, a prudent decision was made to conduct additional, current soil characterization to better support this CDR.

During July 2004, surface and subsurface soil samples were collected for laboratory analysis using stainless steel split-spoon samplers driven by a drill rig though hollow-stem augers. A total of 34 soil borings were installed at Sites A and B using 2-1/4 in. inside diameter hollow-stem augers. The layout of the grids and soil borings (Figs. 3.1 and 3.2) allowed for changes in orientation of the buildings during design or field modifications. Biased and statistically based samples were obtained. Locations of statistically based samples were determined by the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM). Depths of sampling were based on collecting samples in the soil that will be disturbed and below the proposed building floor elevations. The analytical methods were selected to detect COCs identified by the Remedial Investigation Report of the UEFPC CA (DOE 1998) and include analysis for radioisotopes, metals (including mercury), VOCs, SVOCs, PCBs, cyanide, and nitrate. Sampling and analysis were performed in accordance with the Sampling and Analysis Plan prepared for characterization of Sites A and B that was reviewed and commented by EPA and TDEC. The Human Health Risk Assessment (HHRA) included in Section 5.1 addresses the analytical data resulting from this characterization of soils at Sites A and B. Appendix E includes a summary and evaluation of analytical constituents.

Groundwater wells within and adjacent to Sites A and B (wells shown on Figs. 3.1 and 3.2) have been sampled. The groundwater analytical data were reviewed by EPA Region 4. The results of that review were E-mailed to BWXT Y-12 on June 1, 2004, and are summarized below.

- Analyses have been performed for VOCs, inorganics, and radioactivity. Although there is a VOC plume south of Site B, no VOC contamination was detected in wells near Site B.
- Review of the groundwater data indicates there is some localized groundwater metal contamination in and around Sites A and B, suspected to be associated with local well corrosion. This would only be a potential concern if very shallow wells were drilled in this area for a drinking water supply.
- No further groundwater sampling was required to support the property transfer of these two sites. However, groundwater land use controls will be required for these two sites.
- Because of the occurrence of VOCs in known contaminated groundwater plumes at Y-12, EPA Region 4 has recommended that land use controls and engineering controls be implemented to prevent vapor intrusion into any new buildings.


Fig. 3.1 AFD SITE A – SAMPLE LOCATIONS

**Fig. 3.1. Site A – sample locations.**

| PNT. | NORTH | EAST |
|---|---|---|
| 100 | 30192.20 | 64430.74 |
| 101 | 30144.11 | 64361.28 |
| 102 | 30092.32 | 64265.74 |
| 103 | 30040.54 | 164180.19 |
| 104 | 29988.76 | 64094.64 |
| 105 | 29903.21 | 64146.42 |
| 106 | 29954.99 | 64231.97 |
| 107 | 30006.78 | 64317.52 |
| 108 | 30058.56 | 64403.07 |
| 109 | 30108.82 | 64486.09 |
| 110 | 30024.79 | 64540.40 |
| 111 | 29973.01 | 64454.85 |
| 112 | 29921.23 | 64369.30 |
| 113 | 29869.45 | 64283.75 |
| 114 | 29817.66 | 64198.20 |
| 115 | 29732.11 | 64249.99 |
| 116 | 29783.90 | 64335.54 |
| 117 | 29835.68 | 64421.08 |
| 118 | 29887.46 | 64506.63 |
| 119 | 29939.24 | 64592.18 |
| 120 | 29853.70 | 64643.96 |
| 121 | 29801.91 | 64558.42 |
| 122 | 29750.13 | 64472.87 |
| 123 | 29698.35 | 64387.32 |
| 124 | 29646.57 | 64301.77 |
| 125 | 29561.02 | 64353.55 |
| 126 | 29612.80 | 64439.10 |
| 127 | 29664.58 | 64524.65 |
| 128 | 29716.36 | 64610.20 |
| 129 | 29768.15 | 64695.75 |
| 130 | 29682.60 | 64747.53 |
| 131 | 29630.82 | 64661.98 |
| 132 | 29579.03 | 64576.43 |
| 133 | 29527.25 | 64490.88 |
| 134 | 29475.47 | 64405.34 |
| 135 | 29389.92 | 64457.12 |
| 136 | 29441.70 | 64542.67 |
| 137 | 29493.49 | 64628.21 |
| 138 | 64713.76 | 64713.76 |
| 139 | 29597.05 | 64799.31 |

| PNT. | NORTH | EAST |
|---|---|---|
| 140 | 29511.50 | 64851.09 |
| 141 | 29459.72 | 64765.55 |
| 142 | 29407.94 | 64680.00 |
| 143 | 29356.15 | 64594.45 |
| 144 | 29304.37 | 64508.90 |
| 145 | 29218.82 | 64560.68 |
| 146 | 29270.61 | 64646.23 |
| 147 | 29322.39 | 64731.78 |
| 148 | 29374.17 | 64817.33 |
| 149 | 29420.46 | 64893.81 |
| 150 | 29328.71 | 64935.34 |
| 151 | 29288.62 | 64869.11 |
| 152 | 29236.84 | 64783.56 |
| 153 | 29185.06 | 64698.01 |
| 154 | 29152.55 | 64644.31 |
| 155 | 29155.23 | 64599.18 |

| I.D. | NORTH | EAST |
|---|---|---|
| SB1 | 29928.53 | 64321.86 |
| SB2 | 29779.40 | 64235.76 |
| SB3 | 29928.53 | 64494.05 |
| SB4 | 29779.40 | 64407.96 |
| SB5 | 29630.28 | 64321.86 |
| SB6 | 29779.40 | 64580.15 |
| SB7 | 29630.28 | 64494.05 |
| SB8 | 29481.16 | 64407.96 |
| SB9 | 29630.28 | 64666.25 |
| SB10 | 29481.16 | 64580.15 |
| SB11 | 29481.16 | 64752.34 |
| SB12 | 29332.03 | 64494.05 |
| SB13 | 29331.05 | 64665.27 |
| SB14 | 29332.03 | 64838.44 |
| SB15 | 29895.84 | 64174.75 |
| SB16 | 29919.52 | 64295.91 |
| SB17 | 29795.88 | 64362.87 |
| SB18 | 29589.73 | 64498.02 |

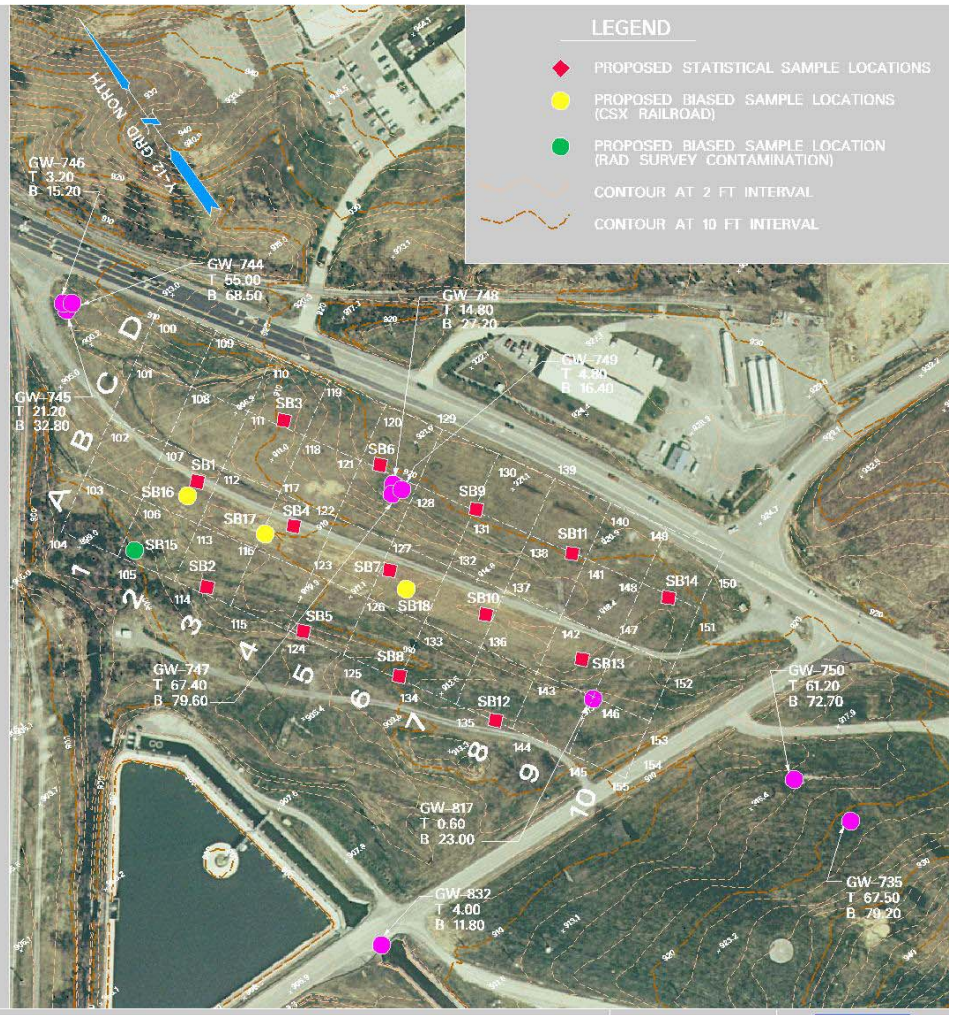


Fig. 3.2 AFD SITE B – SAMPLE LOCATIONS

**Fig. 3.2. Site B – sample locations.**

## 4. ANALYSIS OF INTENDED LAND USE DURING THE DEFERRAL PERIOD

The Y-12 National Security Complex will continue to be designated for industrial land use for CERCLA purposes. Current plans for continued operations and modernization of Y-12 indicate that the industrial land use designation will be applicable for several decades into the future. Access to Y-12 will be restricted and controlled, primarily for security reasons. However, restricted and controlled access for security also serves to control access to areas where workers and the public might risk being exposed to residual contamination. Sites A and B will not be used to construct residences, schools, day care centers, public recreation facilities, or any other facility inconsistent with the designation of industrial land use.

A new building for Y-12 employees will be constructed on the property to be transferred to a private developer at Site A. The new building at Site A will provide offices for management, administrative, engineering, technical, and laboratory personnel now residing in numerous buildings across Y-12. The Site A building will also provide conference, meeting, cafeteria, and medical space and facilities. Standard industrial laboratory facilities will be located in the new Site A building, but will not be used to perform radiological or beryllium work. The functions to be moved into the new Site A building typically require frequent interaction with the work conducted in the higher security areas of Y-12. Access to the new Site A building will require personnel to be badged for entry through security checkpoints on Bear Creek Road or New Hope Pond Road. A rendering of the proposed Site A building is shown in Fig. 4.1.

Site A is approximately 1200 feet uphill from UEFPC, the nearest source of contaminated surface water or sediment. The *Proposed Plan for Interim Actions for Contaminated Soils and Scrapyard in Upper East Fork Poplar Creek, Oak Ridge, Tennessee*, DOE/OR/01-2173&D0 (DOE July 2004), shows three discrete locations with radiological contamination at or near Site A. One location with contamination is within the footprint of the property to be transferred; this location was sampled during the July 2004 environmental soil sampling work and the results indicate the contamination is no longer there. The other two locations with radiological contamination are just south of the property to be transferred and will be addressed separately if the area is to be disturbed during construction. Records from the removal of the UST at the old building 9705 indicate no residual contamination remained in the soil. Although historical information indicated some other shallow soil contamination by radionuclides at Site A, recent environmental soil sampling results reveal no significant radiological contamination at Site A**.** There is no indication that Site A is either a source area for groundwater contamination nor is it likely to be impacted by groundwater contamination. The EPA review of groundwater data at Site A noted some shallow groundwater contamination by inorganics, but it appears slight and unrelated to any residual contamination at Site A. There is no existing CERCLA response action on or underneath the property to be transferred; there is no planned CERCLA response action on or underneath the property to be transferred, and there is no indication that any remedial action will be needed on or underneath the property to be transferred.

Construction workers at Site A will be involved in soil excavation, will manage surface water runoff, and could possibly encounter groundwater. However, it is unlikely that any residual contamination will be encountered in concentrations sufficient to exceed risk levels established as protective under CERCLA. As with surface water runoff, construction workers would not ingest groundwater and direct contact with groundwater would be minimal if it is encountered at all. Surface water runoff would not be contaminated except for any contaminated soil it might transport as sediment. Construction workers would not ingest surface water runoff and direct contact with surface water would be minimal. Groundwater data reviewed indicated only local contamination likely associated with corrosion of well structures. Excavation work will be monitored by radiological technicians to determine if precautions in addition to those required by Occupational Safety and Health Administration (OSHA) are warranted for construction worker health and safety.

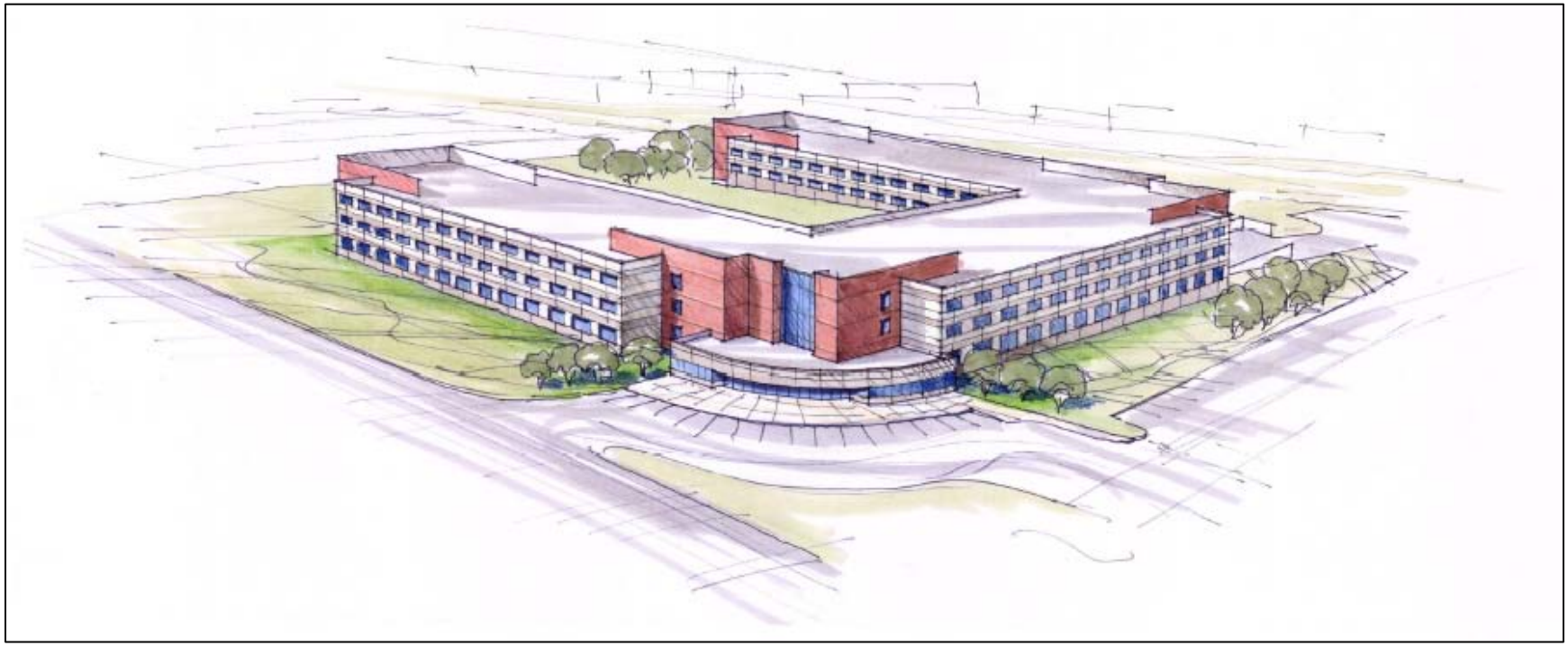

**Fig. 4.1. Conceptual rendering of proposed complex at Site A.**

Workers and visitors in the new Site A building will not be exposed to contaminated environmental media. Workers and visitors in the new Site A building will not need to disturb soil or use groundwater. The new Site A building will be designed and constructed to minimize vapor intrusion, using EPA guidance for building design and construction to reduce exposure to radon. The risk of exposure to residual hazardous substance contamination and other health and safety hazards will be reduced for workers moving from existing facilities at Y-12 to the new Site A building.

Maintenance or repairs to underground utilities serving the new Site A building may be required during the deferral period. However, the statements applicable to construction workers discussed earlier also apply to any future work requiring excavation on or adjacent to the property to be transferred at Site A.

A second new building will be constructed on the property to be transferred to a private developer at Site B. The new Site B building will include offices for management, administrative, technical, security, and laboratory personnel. The Site B building will also provide conference, meeting, and training space and facilities. The functions to be moved into the new Site B building typically required infrequent access to the high security areas at Y-12 and involve frequent interaction with the public or uncleared visitors. Relocating these functions to the new Site B building will enhance public interface at Y-12 and significantly reduce the difficulty and costs associated with security for uncleared workers, visitors, and foreign nationals at Y-12. A few standard chemical laboratories will be located in the new Site B building but will not be used to perform radiological or beryllium work. The new Site B building will contain a Y-12 Visitor's Center, including public information and displays depicting the history of Y-12. Public activity on the property to be transferred at Site B will be controlled to preclude risk of exposure to residual contamination. A rendering of the proposed Site B building is shown in Fig. 4.2.

Historical information at Site B indicates some soil contamination, primarily by radionuclides, particularly along the former railroad spur that transected Site B. Part of the area included in the CSX railroad removal action completed in 1994 will be covered by the new building at Site B. Recent environmental soil sampling results revealed no significant residual contamination at Site B, including the area of the former railroad spur. The EPA review of groundwater data at Site B noted some shallow groundwater contamination by inorganics, but it appears slight and unrelated to any residual contamination at Site B. Site B lies in proximity to the UEFPC floodplain; the northwest corner of Site B is approximately 100 feet from the UEFPC channel. There is no indication that any further remedial action will be needed on or underneath the property to be transferred.

Construction workers at Site B will be involved in soil excavation, will manage surface water runoff, and may encounter groundwater. However, it is unlikely that any residual contamination will be encountered in concentrations sufficient to exceed risk levels established as protective under CERCLA. As with surface water runoff, construction workers would not ingest groundwater and direct contact with groundwater would be minimal if it is encountered at all. Surface water runoff would not be contaminated except for any contaminated soil it might transport as sediment. Construction workers would not ingest surface water runoff and direct contact with surface water would be minimal. Groundwater data reviewed indicated only local contamination likely associated with corrosion of well structures. Excavation work will be monitored by radiological technicians to determine if precautions in addition to those required by OSHA are warranted for construction worker health and safety.

Workers and visitors in the new Site B building will not be exposed to contaminated environmental media. Workers and visitors in the new Site B building will not need to disturb soil or use groundwater. The new Site B building will be designed and constructed to minimize vapor intrusion, using EPA guidance for building design and construction to reduce exposure to radon. The risk of exposure to residual hazardous substance contamination and other health and safety hazards will be reduced for workers moving from existing facilities at Y-12 to the new Site B building.

**Fig. 4.2. Conceptual rendering of proposed complex at Site B.**

Maintenance or repairs to underground utilities serving the new Site B building may be required during the deferral period. However, the statements applicable to construction workers discussed earlier also apply to any future work requiring excavation on or adjacent to the property to be transferred at Site B.

Land use controls have been included in Chap. 7 of this CDR as deed and/or transfer agreement restrictions so that measures typically used at Y-12 to preclude unmanaged intrusion into soil or groundwater are also applicable to future owners and users of the property to be transferred at both Sites A and B.

The Quitclaim Deed for the Properties includes restrictions to ensure that the proposed transfer is protective of human health and the environment. The deed prohibits the use of the Properties in a manner inconsistent with the land use assumption of controlled industrial and non-residential use. Additionally, real property uses are restricted to those uses specified in the deed, in accordance with guidance from EPA, Region 4, and consistent with the Environmental Assessment for the proposed transfer of Y-12 land. The allowable property use is industrial use. Use of the property below a depth of 22.5 feet at Site A and a depth of 18.5 feet at Site B is prohibited by the deed restrictions unless approved in writing by the Grantor, the EPA, and the TDEC. The depth limitations for the respective sites were based upon the expected excavation depths for construction of the buildings and the extent of the site characterization performed to support this CDR. The construction of basements is also prohibited. To ensure the protection of human health from exposure to contaminants in groundwater plumes throughout the site, the deed prohibits the Grantee from extracting, consuming, or using in any way the groundwater underlying the Properties without prior written approval of NNSA, following approval by the EPA, TDEC, and other regulatory authorities, as applicable. NNSA will address the potential for vapor intrusion in the UEFPC Groundwater Record of Decision (ROD) scheduled to be developed and signed in 2017. Because of the occurrence of VOCs in known contaminated groundwater plumes at Y-12, EPA Region 4 has recommended that land use controls and engineering controls be implemented that would prevent vapor intrusion into any new buildings. This recommendation has been incorporated into the deed. Finally, the deed requires compliance with all applicable federal, state, and local laws and regulations with respect to any development of the properties.

# 5. RISK ASSESSMENT

## 5.1 HUMAN HEALTH RISK ANALYSIS

Site A and B are undeveloped areas located within the UEFPC CA. The HHRA results for Sites A and B are summarized below.

### 5.1.1 Data Evaluation/Selection of Chemicals of Potential Concern

As discussed in Chap. 3, it was deemed prudent to further characterize Sites A and B with additional soil sampling. Samples were analyzed for COCs identified in the Remedial Investigation (RI) Report of the UEFPC CA (DOE 1998) including radioisotopes, metals (including mercury), VOCs, SVOCs, PCBs, cyanide, and nitrate.

The analytical data were reviewed, validated and evaluated using the criteria specified in the data quality objectives of the Sampling and Analysis Plan (SAP) (Tetra Tech 2004). All unqualified positive detections and estimated values were considered as detected concentrations for this HHRA. All nondetects (indicated with a "U" qualifier) were retained in the HHRA data set.

Soil samples collected from 0 to 2 ft below ground surface (bgs) were considered surface soil. Samples collected at greater than 2 ft bgs were considered subsurface soil. Two samples collected from 1 to 3 ft bgs were included in both the surface and subsurface data set for each site.

Chemicals detected at least once were screened against their respective EPA Region IX Preliminary Remediation Goal (PRG) for target incremental lifetime cancer risk (ILCR) of $1 \times 10^{-6}$ and a hazard index (HI) of 0.1. Inorganic chemicals were also screened against their respective background value as determined in the RI (DOE 1998). Chemicals exceeding all screening criteria were considered chemicals of potential concern (COPCs). Separate COPCs were determined for residential and industrial land use by screening against residential PRGs and industrial PRGs, respectively.

The property will not be used for residential land use (only industrial land use). However, residential and industrial screening criteria provides a conservative approach for analyzing COPCs for both the hypothetical future resident, and industrial site workers respectively.

#### Chemicals without PRGs

Some chemicals did not have PRGs. Naturally occurring essential elements, including calcium, magnesium, potassium, and sodium, were not considered to be site-related chemicals and, consequently, were not selected as COPCs. EPA Region 4 industrial and residential risk-based concentrations (RBCs) were used for screening for nitrate. The remaining chemicals without PRGs were screened against a surrogate value. Surrogates used include pyrene for benzo(g,h,i)perylene and phenanthrene, naphthalene for 2-methylnaphthalene, 1,3,5-trimethylbenzene for 1,2-dimethylbenzene, 1,3-dimethylbenzene and 1,4-dimethylbenzene, chloromethane for iodomethane, and methanol for ethanol.

#### Potassium 40

Potassium 40 is a naturally occurring radionuclide and is commonly excluded in risk assessment because it is accumulated by living organisms and is the predominant radioactive component in human tissues and most food. Consequently, it was not selected as a COPC. For example, milk contains about 2,000 pCi/L of natural K-40. K-40 content in the body is constant, with an adult male having about

0.1 microcurie or 10,000 pCi. Each year, this isotope delivers doses of about 18 millirem to soft tissues of the body and 14 rem to bone.

**Screening for Lead**

EPA-approved toxicity criteria [i.e., carcinogenic slope factors (CSFs), reference doses (RfDs)] have not been published for lead. Consequently, a calculated toxicity criteria-based PRG is not available for this inorganic. The lead concentrations in soil at Sites A and B are compared to the lead soil screening guidance concentration of 400 mg/kg for residential soil published in Office of Solid Waste and Emergency Response (OSWER) Directive #9355.4-12 (EPA 1994).

**COPCs for Sites A and B**

COPC selection is shown in Tables E-1 through E-4 in Appendix E for comparing Site A surface soils to residential standards and industrial standards as well as subsurface soil to residential standards and industrial standards, respectively. COPC selection is shown in Tables E-5 through E-8 in Appendix E for comparing Site B surface soil to residential standards, and industrial standards as well as subsurface soil to residential standards and industrial standards, respectively.

At Site A, benzo(a)pyrene was identified as an industrial as well as a residential COPC in both the surface and subsurface soils. Manganese was also identified as a residential COPC. These results are shown in Table 5.1.

At Site B, benzo(a)pyrene was identified as an industrial COPC in the surface soil. No industrial COPCs were identified in the subsurface soil. Iron and manganese were identified as residential COPCs in Site B's surface and subsurface soil. These results are shown in Table 5.1.

**Table 5.1. Chemicals of Potential Concern**

| Industrial COPCs | Residential COPCs |
|---|---|
| **Site A** | |
| Surface soil | |
| Manganese and Benzo(a)pyrene | Barium, Manganese, Benzo(a)pyrene, Radium-226, and Uranium-235 |
| Subsurface soil | |
| Manganese and Benzo(a)pyrene | Manganese, Benzo(a)pyrene, Radium-226, and Uranium-235 |
| **Site B** | |
| Surface soil | |
| Manganese and Benzo(a)pyrene | Iron, Manganese, Mercury, Benzo(a)pyrene and Radium-226 |
| Subsurface soil | |
| Manganese | Iron, Manganese, and Radium-226 |

**Focused Feasibility Study Individual Remediation Levels**

As both Sites A and B lie within the UEFPC CA evaluated in the Focused Feasibility Study (FFS) (DOE 2004), individual soil remediation levels (RLs) developed and presented in Table 2.4 of that report were used for a secondary screen of COPCs. This second COPC screening step differs from the COPC selection methodology described in the SAP (Tetra Tech 2004). Results are presented in Table 5.2.

**Table 5.2. Chemicals of Potential Concern Compared to Remediation Levels**

| | Maximum Concentration | Industrial COPC? | Residential COPC? | FFS RL | Exceeds/ no RL? |
|---|---|---|---|---|---|
| Site A | | | | | |
| Surface Soil | | | | | |
| **Barium** | 735 mg/kg | | Yes | | Yes |
| **Manganese** | 3710 mg/kg | Yes | Yes | | Yes |
| **Benzo(A)Pyrene** | 0.23 mg/kg | Yes | Yes | | Yes |
| Radium-226 | 0.84 mg/kg | | Yes | 6 | No |
| Uranium-235 | 0.392 mg/kg | | Yes | 12 | No |
| Subsurface Soil | | | | | |
| **Manganese** | 9110 mg/kg | Yes | Yes | | Yes |
| **Benzo(A)Pyrene** | 0.9 mg/kg | Yes | Yes | | Yes |
| Radium-226 | 0.69 mg/kg | | Yes | 6 | No |
| Uranium-235 | 0.226 mg/kg | | Yes | 12 | No |
| Site B | | | | | |
| Surface Soil | | | | | |
| **Iron** | 70100 mg/kg | | Yes | | Yes |
| **Manganese** | 3480 mg/kg | Yes | Yes | | Yes |
| Mercury | 12.6 mg/kg | | Yes | 325 | No |
| **Benzo(A)Pyrene** | 0.25 mg/kg | Yes | Yes | | Yes |
| Radium-226 | 0.96 mg/kg | | Yes | 6 | No |
| Subsurface Soil | | | | | |
| **Iron** | 91200 mg/kg | | Yes | | Yes |
| **Manganese** | 6010 mg/kg | Yes | Yes | | Yes |
| Radium-226 | 0.84 mg/kg | | Yes | 6 | No |

Tables 5.3 and 5.4 identify the sample locations with detected concentrations of COPCs which exceed their respective industrial PRGs. Also refer to Figures 3.1 and 3.2 to identify borehole sample locations. Appendix E includes the range of contaminants detected (minimum and maximum concentrations) for Site A and Site B borehole soil samples.

**Table 5.3. Contaminants Exceeding Industrial Use Screening Values–Site A**

| Contaminant | Location | Depth (feet) | Concentration (mg/kg) |
|---|---|---|---|
| Manganese | SB10 | 0 – 2 | 2660 |
| Manganese | SB5 | 0 – 2 | 299 |
| Manganese | SB5 – dupe | 0 – 2 | 3710 |
| | | | |
| Benzo(a)pyrene | SB2 | 0 – 2 | 0.11 |
| Benzo(a)pyrene | SB15 | 0 – 2 | 0.19 |
| Benzo(a)pyrene | SB5 | 0 – 2 | 0.23 |
| Benzo(a)pyrene | SB5 – dupe | 0 – 2 | 0.33 |
| | | | |
| Radium-226 | SB11 | 0 – 2 | 0.38 |
| Radium-226 | SB6 – dupe | 0 – 2 | 0.42 |
| Radium-226 | SB8 | 0 – 2 | 0.43 |
| Radium-226 | SB15 | 0 – 2 | 0.45 |
| Radium-226 | SB10 | 0 – 2 | 0.46 |
| Radium-226 | SB14 | 0 – 2 | 0.47 |
| Radium-226 | SB3 | 0 – 2 | 0.48 |
| Radium-226 | SB1 | 1 – 3 | 0.50 |
| Radium-226 | SB6 | 0 – 2 | 0.51 |
| Radium-226 | SB3 – dupe | 0 – 2 | 0.53 |

**Table 5.3. Contaminants Exceeding Industrial Use Screening Values–Site A (continued)**

| Contaminant | Location | Depth (feet) | Concentration (mg/kg) |
|---|---|---|---|
| Radium-226 | SB14 – dupe | 0 – 2 | 0.55 |
| Radium-226 | SB9 | 0 – 2 | 0.55 |
| Radium-226 | SB4 | 0 – 2 | 0.56 |
| Radium-226 | SB2 | 0 – 2 | 0.57 |
| Radium-226 | SB12 | 0 – 2 | 0.58 |
| Radium-226 | SB5 – dupe | 0 – 2 | 0.59 |
| Radium-226 | SB7 | 1 – 3 | 0.59 |
| Radium-226 | SB13 | 0 – 2 | 0.61 |
| Radium-226 | SB5 | 0 – 2 | 0.71 |
| Radium-226 | SB16 | 0 – 2 | 0.84 |
| Uranium-235 | SB14 – dupe | 0 – 2 | 0.22 |
| Uranium-235 | SB6 | 0 – 2 | 0.373 |
| Uranium-235 | SB6 – dupe | 0 – 2 | 0.0849 |
| Uranium-235 | SB14 | 0 – 2 | 0.392 |
| Manganese | SB8 | 22 – 26 | 2660 |
| Manganese | SB7 | 12 – 16 | 9110 |
| Benzo(a)pyrene | SB4 | 4 – 8 | 0.24 |
| Benzo(a)pyrene | SB2 | 8 – 12 | 0.90 |
| Radium-226 | SB7 | 12 – 16 | 0.39 |
| Radium-226 | SB5 | 18 – 22 | 0.40 |
| Radium-226 | SB12 | 4 – 8 | 0.41 |
| Radium-226 | SB10 | 6 – 10 | 0.42 |
| Radium-226 | SB10 | 14 – 18 | 0.43 |
| Radium-226 | SB12 | 8 – 12 | 0.43 |
| Radium-226 | SB3 | 8 – 12 | 0.43 |
| Radium-226 | SB14 | 8 – 11 | 0.45 |
| Radium-226 | SB13 | 8 – 12 | 0.46 |
| Radium-226 | SB15 | 12 – 16 | 0.47 |
| Radium-226 | SB16 | 24 – 28 | 0.47 |
| Radium-226 | SB9 | 10 – 14 | 0.48 |
| Radium-226 | SB4 | 8 – 12 | 0.49 |
| Radium-226 | SB8 | 12 – 16 | 0.49 |
| Radium-226 | SB1 | 1 – 3 | 0.50 |
| Radium-226 | SB2 | 8 – 12 | 0.50 |
| Radium-226 | SB16 | 14 – 18 | 0.52 |
| Radium-226 | SB6 | 18 – 22 | 0.52 |
| Radium-226 | SB11 | 4 – 8 | 0.53 |
| Radium-226 | SB13 | 4 – 8 | 0.55 |
| Radium-226 | SB3 | 4 – 8 | 0.56 |
| Radium-226 | SB5 | 8 – 12 | 0.56 |
| Radium-226 | SB8 | 22 – 26 | 0.56 |
| Radium-226 | SB2 | 4 – 8 | 0.57 |
| Radium-226 | SB6 | 8 – 12 | 0.57 |
| Radium-226 | SB4 | 4 – 8 | 0.58 |
| Radium-226 | SB7 | 1 – 3 | 0.59 |
| Radium-226 | SB1 | 8 – 12 | 0.62 |
| Radium-226 | SB15 | 24 – 28 | 0.63 |
| Radium-226 | SB9 | 20 – 24 | 0.63 |
| Radium-226 | SB1 | 4 – 8 | 0.67 |
| Radium-226 | SB7 | 5 – 9 | 0.69 |
| Uranium-235 | SB4 | 4 – 8 | 0.226 |

**Table 5.4. Contaminants Exceeding Industrial Use Screening Values–Site B**

| Contaminant | Location | Depth (feet) | Concentration (mg/kg) |
|---|---|---|---|
| Manganese | SB10 | 0 – 1.5 | 1500 |
| Manganese | SB10 – dupe | 0 – 1.5 | 3260 |
| Manganese | SB15 | 0 – 2 | 3480 |
| | | | |
| Benzo(a)pyrene | SB5 | 0 – 2 | 0.051 |
| Benzo(a)pyrene | SB17 | 0 – 1.5 | 0.071 |
| Benzo(a)pyrene | SB17 – dupe | 0 – 1.5 | 0.073 |
| Benzo(a)pyrene | SB18 | 0 – 2 | 0.12 |
| Benzo(a)pyrene | SB16 | 0 – 1.5 | 0.14 |
| Benzo(a)pyrene | SB10 | 0 – 1.5 | 0.15 |
| Benzo(a)pyrene | SB10 – dupe | 0 – 1.5 | 0.21 |
| Benzo(a)pyrene | SB7 | 0 – 2 | 0.25 |
| | | | |
| Radium-226 | SB10 – dupe | 0 – 1.5 | 0.43 |
| Radium-226 | SB10 | 0 – 1.5 | 0.49 |
| Radium-226 | SB11 – dupe | 0 – 2 | 0.56 |
| Radium-226 | SB15 – dupe | 0 – 2 | 0.57 |
| Radium-226 | SB17 – dupe | 0 – 1.5 | 0.59 |
| Radium-226 | SB12 – dupe | 0 – 2 | 0.64 |
| Radium-226 | SB1 | 0.5 – 2 | 0.70 |
| | | | |
| Radium-226 | SB15 | 0 – 2 | 0.45 |
| Radium-226 | SB13 | 0 – 2 | 0.50 |
| Radium-226 | SB4 | 0 – 2 | 0.50 |
| Radium-226 | SB11 | 0 – 2 | 0.57 |
| Radium-226 | SB14 | 0 – 2 | 0.58 |
| Radium-226 | SB16 | 0 – 1.5 | 0.61 |
| Radium-226 | SB6 | 0 – 2 | 0.61 |
| Radium-226 | SB9 | 0 – 2 | 0.61 |
| Radium-226 | SB8 | 0 – 2 | 0.67 |
| Radium-226 | SB12 | 0 – 2 | 0.75 |
| Radium-226 | SB18 | 0 – 2 | 0.76 |
| Radium-226 | SB17 | 0 – 1.5 | 0.78 |
| Radium-226 | SB2 | 0 – 2 | 0.79 |
| Radium-226 | SB7 | 0 – 2 | 0.80 |
| Radium-226 | SB3 | 0 – 2 | 0.82 |
| Radium-226 | SB5 | 0 – 2 | 0.96 |
| | | | |
| Manganese | SB18 | 4 – 8 | 2370 |
| Manganese | SB11 | 9.5 – 12 | 4370 |
| Manganese | SB17 | 4 – 8 | 5490 |
| Manganese | SB4 | 4 – 8 | 6010 |
| | | | |
| Radium-226 | SB11 | 9.5 – 12 | 0.37 |
| Radium-226 | SB16 | 8 – 12 | 0.38 |
| Radium-226 | SB6 | 4 – 8 | 0.39 |
| Radium-226 | SB9 | 4 – 7 | 0.40 |
| Radium-226 | SB1 | 4 – 7 | 0.41 |
| Radium-226 | SB7 | 4 – 8 | 0.44 |
| Radium-226 | SB12 | 4 – 8 | 0.45 |
| Radium-226 | SB18 | 4 – 8 | 0.47 |

**Table 5.4. Contaminants Exceeding Industrial Use Screening Values–Site B (continued)**

| | | | |
|---|---|---|---|
| Radium-226 | SB10 | 4 – 8 | 0.48 |
| Radium-226 | SB3 | 8 – 12 | 0.48 |
| Radium-226 | SB6 | 8 – 11.5 | 0.50 |
| Radium-226 | SB7 | 8 – 11 | 0.50 |
| Radium-226 | SB15 | 8 – 10 | 0.51 |
| Radium-226 | SB3 | 4 – 8 | 0.52 |
| Radium-226 | SB8 | 4 – 8 | 0.52 |
| Radium-226 | SB5 | 9 – 11.5 | 0.53 |
| Radium-226 | SB10 | 8 – 12 | 0.54 |
| Radium-226 | SB13 | 8 – 11.5 | 0.54 |
| Radium-226 | SB17 | 8 – 12 | 0.54 |
| Radium-226 | SB2 | 8 – 12 | 0.54 |
| Radium-226 | SB12 | 8 – 12 | 0.55 |
| Radium-226 | SB14 | 8 – 11 | 0.55 |
| Radium-226 | SB5 | 6 – 9 | 0.55 |
| Radium-226 | SB4 | 8 – 12 | 0.57 |
| Radium-226 | SB14 | 4 – 8 | 0.59 |
| Radium-226 | SB2 | 4 – 8 | 0.59 |
| Radium-226 | SB13 | 4 – 8 | 0.62 |
| Radium-226 | SB9 | 8 – 12 | 0.63 |
| Radium-226 | SB4 | 4 – 8 | 0.65 |
| Radium-226 | SB16 | 4 – 8 | 0.68 |
| Radium-226 | SB8 | 8 – 12 | 0.68 |
| Radium-226 | SB17 | 4 – 8 | 0.69 |
| Radium-226 | SB18 | 8 – 11 | 0.72 |
| Radium-226 | SB15 | 4 – 8 | 0.74 |
| Radium-226 | SB11 | 7 – 9.5 | 0.84 |

**Summary**

Manganese and benzo(a)pyrene are industrial COPCs for Site A surface and subsurface soils. Iron and manganese are industrial COPCs for Site B surface and subsurface soils, and benzo(a)pyrene is an industrial COPC for Site B surface soils. Barium, manganese and benzo(a)pyrene are residential COPCs for Site A surface soils. Manganese and benzo(a)pyrene are residential COPCs for Site A subsurface soils. Iron and manganese are residential COPCs for Site B surface and subsurface soils, and benzo(a)pyrene is also a residential COPC for Site B surface soil.

### 5.1.2 Toxicity Assessment

The toxicity assessment for the COPCs examined information concerning the potential human health effects of exposure to COPCs. For each COPC, the goal of the toxicity assessment is to provide a quantitative estimate of the relationship between the magnitude and type of exposure and the severity or probability of human health effects.

It should be noted that the use of Region IX PRGs and FFS (DOE 2004) RLs for COPC selection incorporates the toxicity assumptions and assessments made in the derivations of those screening levels.

According to the methodology described in the SAP (Tetra Tech 2004) oral RfDs of 0.14 mg/kg/day for manganese and 0.07 mg/kg/day for barium were obtained from the EPA Integrated Risk Information System (IRIS) at http://ww.epa.gov.iris/. Likewise, a CSF of 7.3 mg/kg/day was obtained for benzo(a)pyrene from IRIS. There is no toxicity information available for iron in IRIS or the EPA Health Effects Assessments Summary Tables (HEAST) (EPA 1997), so the RfD listed in the Region IX PRG

table for iron, 0.3 mg/kg/day, was used for adults. This value from the National Center for Environmental Assessment is based on typical allowable intakes rather than adverse effect levels and is not considered risk based. Therefore, noncarcinogenic risks are overestimated for iron. The uncertainty for exposure to iron was lessened somewhat by the use of the typical allowable intake for children (1.1 mg/kg-day) as the oral RfD for child receptors rather than the default oral RfD of 0.3 mg/kg-day based on adult intakes.

### 5.1.3 Exposure Assessment

The exposure assessment evaluates the potential for human exposure to COPCs identified in environmental media at Sites A & B. This section presents a characterization of the exposure setting, characterizes the exposed populations, identifies actual or potential exposure routes, and summarizes the methods used to generate exposure estimates.

Both sites evaluated in this report are currently undeveloped and will be transferred to a special purpose private entity for construction of one building on each site to house Y-12 personnel and operations. Potential future receptors exposed to contaminants at this site include site workers, trespassers, site visitors, and hypothetical potential future residents.

**Site workers** may be exposed to surface soil at either Site A or Site B through incidental ingestion, dermal contact, and inhalation of particulates. Because subsurface soil may be exposed during construction activities, site workers may also be exposed to subsurface soil at either Site A or Site B through incidental ingestion, dermal contact, and inhalation of particulates.

The constructed buildings will not have basements and will have barriers to prevent indoor vapor intrusion; therefore, indoor inhalation of vapor from volatiles in soils or groundwater will not be a complete pathway. VOCs were detected infrequently and were found at relatively low concentrations at both sites.

**Trespassers and site visitors** are not expected to have significant access or exposure to media at Sites A and B. Exposure pathways for these receptors are not considered to be complete.

Exposure of a **hypothetical future resident** to surface soil and subsurface soil through incidental ingestion, dermal contact, and inhalation of particulates is evaluated for comparison purposes only. Future residential use of these sites is highly unlikely, and no action is expected based on evaluation of the residential scenario.

There are no **surface water** bodies or **sediments** within the proposed transfer areas of Site A or Site B, so exposure to contaminants in these media would not be a complete pathway. Additionally, **groundwater** use is restricted, and exposure to contaminants in groundwater would not be a complete pathway.

#### Summary

The only expected receptor for which there are complete exposure pathways is the site worker. For the purposes of completeness, exposure for a hypothetical future resident to surface soil and subsurface soil will be evaluated.

#### Exposure Point Concentrations

The exposure point concentration (EPC) is the concentration of a COPC used to best estimate the intake of a COPC detected in an environmental medium. Ideally, the EPC should be the true average concentration within the exposure unit for the medium. However, because of the uncertainty associated with estimating the true average concentration at a site, the 95 % Upper Confidence Limit (UCL) of the

arithmetic mean is selected as the EPC. The following protocol was used to determine EPCs in the HHRA for Sites A and B:

- If there were less than 10 samples, the maximum concentration was chosen as the EPC because, for small data sets, the UCL does not provide a good estimation of the upper bound of the mean concentration.
- If there were more than 10 samples, each data set was evaluated using the Shapiro-Wilk W test (Gilbert 1987) to determine if the data set more closely reflected a normal or lognormal distribution. If results were inconclusive, the data were assumed to be lognormally distributed. The 95% upper confidence limit lognormal (UCL-L) and 95% upper confidence limit normal (UCL-N) were calculated for each analyte in each data set using one-half the reporting limit for nondetect results and the average for samples with duplicates. The 95% UCL-N was used as the EPC if the Shapiro-Wilk W test indicated a normal distribution and the 95% UCL-L was used as the EPC if the Shapiro-Wilk W test indicated a lognormal distribution or if the distribution was undefined. If the calculated 95% UCL exceeded the maximum detected concentration, the maximum detected concentration was selected as the EPC.

  EPCs are presented in Table 5.5.

**Table 5.5. EPCs**

| | Surface soil | | Subsurface soil | |
|---|---|---|---|---|
| | **Goodness of Fit** | **95% UCL-L** | **Goodness of Fit** | **95% UCL-L** |
| *Site A* | | | | |
| Manganese | Lognormal | 1,283 mg/kg | Lognormal | 1,399 mg/kg |
| *Site B* | | | | |
| Iron | Lognormal | 27,182 mg/kg | Undefined | 32,949 mg/kg |
| Manganese | Lognormal | 1,384 mg/kg | Lognormal | 2,213 mg/kg |

**Exposure Quantification**

Intake or dose is defined as the amount of COPC that could be in contact with the body per unit body weight per unit time. For the Site A and Site B HHRA, the surface soil and subsurface soil ingestion and inhalation intakes for each receptor were calculated using methods presented in *Risk Assessment Guidance for Superfund* (RAGS) *Part A (Human Health Evaluation manual)* (EPA 1989), RAGS *Part B (Development of Risk-based Preliminary Remediation Goals)* (EPA 1991), and other standard guidance documents. The absorbed dose estimated for dermal contact with COPCs in soil was calculated primarily using methods from RAGS *Part E, Supplemental Guidance for Dermal Risk Assessment* (EPA 2001b).

Table E-9 in Appendix E presents the exposure assumptions and intake equations for the site worker in the standard EPA RAGS Part D format. Table E-10 in Appendix E presents the exposure assumptions and intake equations for the hypothetical future adult resident. Table E-11 in Appendix E presents the exposure assumptions and intake equations for the hypothetical future child resident. Table E-12 in Appendix E present the intake estimates, toxicity criteria (i.e., CSFs, RfDs), and cancer and noncancer risk estimates for the site worker exposed to soils at Site A, respectively. Tables E-13 and E-14 in Appendix E present the intake estimates, toxicity criteria (i.e., CSFs, RfDs), and cancer and noncancer risk estimates for the hypothetical adult and child future residents exposed to soils at Site A, respectively. Table E-15 in Appendix E present the intake estimates, toxicity criteria, and cancer and noncancer risk estimates for the site worker exposed to soils at Site B. Tables E-16 and E-17 in Appendix E present the intake estimates, toxicity criteria, and cancer and noncancer risk estimates for the hypothetical adult and child future residents exposed to soils at Site B, respectively.

### 5.1.4 Risk Characterization

Risk was evaluated for the site worker and the hypothetical future resident (adult and child).

The risk characterization evaluates the information obtained through the exposure and toxicity assessments to estimate cancer risks and HIs. Total noncarcinogenic and carcinogenic risk estimates for each exposure to surface and subsurface soil for the site worker exposed to soils at Site A are presented in Table E-12 in Appendix E. Total noncarcinogenic and carcinogenic risk estimates for each exposure to surface and subsurface soil for the hypothetical future resident (adult and child) exposed to soils at Site A are presented in Tables E-13 and E-14, respectively, in Appendix E. Total noncarcinogenic and carcinogenic risk estimates for each exposure to surface and surface soil for the site worker exposed to soils at Site B are presented in Table E-15 in Appendix E. Total noncarcinogenic and carcinogenic risk estimates for each exposure to surface and surface soil for the hypothetical future resident (adult and child) exposed to soils at Site B are presented in Tables E-16 and E-17, respectively, in Appendix E.

**Methodology for Estimation of Carcinogenic Risks**

Carcinogenic risks can be estimated by combining information on the strength or potency of a known or suspected carcinogen (Carcinogenic Slope Factor) with an estimate of the individual exposure doses (or intakes) of a chemical. Carcinogenic risk may be estimated as follows:

$$Risk = 1 - \exp(-Dose \times CSF)$$

where:

CSF = Carcinogenic Slope Factor $(mg/kg\text{-}day)^{-1}$.

Dose = Amount of a contaminant absorbed by a receptor in mg/kg-day.

The equation presented above, however, is valid only at risk levels less than or equal to 1E-02. When the risk estimate is expected to be greater than 1E-02, an alternate equation, such as the following one-hit equation, may be used to estimate risk (EPA 1989):

$$Risk = 1 - \exp(-Dose \times CSF)$$

The resultant cancer risk value (e.g., 1E-06 or a 1-in-1,000,000 chance of developing cancer) can be applied to a given population to determine the number of excess cases of cancer that could be expected to result from exposure (e.g., 1E-06 is one additional case of cancer in 1,000,000 exposed persons).

The total risk resulting from exposure of an individual receptor to multiple compounds in a particular medium is the sum of the cancer risks for the individual contaminants in that medium. Cancer risks will be summed across media for an individual receptor if the following assumptions are met:

- There are no antagonist/synergistic effects between chemicals.
- All chemicals produce the same result (cancer).
- Cancer risks from various exposure routes (e.g., ingestion and dermal) are additive, if the exposed populations are the same (EPA 1989).

To interpret the quantitative risk estimates and to aid risk managers in determining the need for remediation, quantitative risk estimates are compared to typical EPA risk benchmarks and risk benchmarks agreed upon for the ORR. The EPA has defined a “target cancer risk” range of 1E-04 to 1E-06. ILCRs below 1E-06 are generally considered acceptable risks. ILCRs above 1E-04 are

considered unacceptable risks. Risk management decisions are necessary for ILCRs between 1E-06 and 1E-04. The accepted benchmark at the ORR is 1E-04.

**Methodology for Estimation of Noncarcinogenic Risks**

Potential health risks resulting from exposure to noncarcinogenic compounds are estimated by comparing the reasonable maximum daily intake dose calculated for an exposure to an acceptable intake dose, such as a chronic or subchronic RfD. The ratio of the exposure dose (intake) to the RfD is referred to as the Hazard Quotient:

Hazard Quotient = Dose/RfD

If the Hazard Quotient (HQ) exceeds unity, there may be a potential health risk associated with exposure to that chemical (EPA 1989). The Dose/RfD ratio is not a mathematical prediction of the severity or probability of toxic effects; it is simply a numerical indicator of the potential for adverse effects. The summation of HQs for several compounds is referred to as the HI.

Conservatively, a total HI for any exposure route is calculated by summing the dose/RfD ratios (HQs) for the individual COCs (EPA 1989). To provide a better indication of risks, dose/RfD ratios are summed according to the target organ affected. For example, the dose/RfD ratios for those chemicals affecting the liver should be summed separately from those chemicals affecting the central nervous system. An HI greater than 1 indicates potential adverse noncarcinogenic health effects (EPA 1989).

The COCs for a given medium are defined as those contaminants that have HIs greater than 1.0 within a land use scenario, and that are not eliminated during the uncertainty analysis.

**Risk Characterization Results**

For noncarcinogenic risks, HIs developed for the receptors are presented in Tables 5.6 and 5.7.

**Table 5.6. Site A**

| Receptor | Hazard index | Table in Appendix E |
|---|---|---|
| Site worker<br>surface soil (current/future) | 0.03 | E-12 |
| Site worker<br>subsurface soil (current/future) | 0.035 | E-12 |
| Hypothetical future resident adult<br>surface soil (future) | 0.036 | E-13 |
| Hypothetical future resident adult<br>subsurface soil (future) | 0.043 | E-13 |
| Hypothetical future resident child<br>surface soil (future) | 0.2 | E-14 |
| Hypothetical future resident child<br>subsurface soil (future) | 0.2 | E-14 |

**Table 5.7. Site B**

| Receptor | Hazard index | Table in Appendix E |
|---|---|---|
| Site worker<br>surface soil (current/future) | 0.11 | E-15 |
| Site worker<br>subsurface soil (current/future) | 0.17 | E-15 |
| Hypothetical future resident adult<br>surface soil (future) | 0.16 | E-16 |
| Hypothetical future resident adult<br>subsurface soil (future) | 0.25 | E-16 |
| Hypothetical future resident child<br>surface soil (future) | 0.49 | E-17 |
| Hypothetical future resident child<br>subsurface soil (future) | 0.77 | E-17 |

HIs calculated for all receptors are less than 1, indicating that adverse noncarcinogenic health effects are not anticipated under the conditions established in the exposure assessment. Therefore, there are no noncarcinogenic COCs for either site in this investigation.

For carcinogenic risks, ILCRs developed for the receptors are presented in Tables 5.8 and 5.9.

**Table 5.8. Site A**

| Receptor | ILCR | Table in Appendix E |
|---|---|---|
| Site Worker<br>Surface Soil | 6.3E-07 | E-12 |
| Site Worker<br>Subsurface Soil | 7.2E-07 | E-12 |
| Hypothetical future resident adult<br>Surface Soil | 7.5E-07 | E-13 |
| Hypothetical future resident child<br>Surface Soil | 1.4E-06 | E-14 |
| Hypothetical future resident adult<br>Subsurface Soil | 8.6E-07 | E-13 |
| Hypothetical future resident child<br>Subsurface Soil | 1.6E-06 | E-14 |
| Total Resident – Subsurface Soil | 2.5E-06 | |

**Table 5.9. Site B**

| Receptor | ILCR | Table in Appendix E |
|---|---|---|
| Site Worker<br>Surface Soil | 4.6E-07 | E-15 |
| Hypothetical future resident adult<br>Surface Soil | 7.7E-07 | E-16 |
| Hypothetical future resident child<br>Surface Soil | 1.4E-06 | E-17 |
| Total Resident – Subsurface Soil | 2.2E-06 | |

ILCRs calculated for all receptors are less than 1E-04, indicating that carcinogenic risks associated with exposure to COPCs at Sites A and B are within acceptable limits. Therefore, there are no carcinogenic COCs for either site in this investigation.

### 5.1.5 Uncertainty

Uncertainty in the selection of COPCs is related to the current status of the predictive databases, the grouping of samples, and the procedures used to include or exclude constituents as COPCs. Uncertainty associated with the exposure assessment includes the values used as input variables for a given intake route/scenario, the assumptions made to determine EPCs, and the predictions regarding future land-use and population characteristics. Uncertainty in the toxicity assessment includes the quality of the existing toxicity data needed to support dose-response relationships and the weight-of-evidence used for determining the carcinogenicity of COPCs. Uncertainty in the risk characterization includes that associated with exposure to multiple chemicals and the cumulative uncertainty from combining conservative assumptions made in earlier steps of the risk assessment process.

Whereas there are various sources of uncertainty as described earlier, the direction of uncertainty can be influenced by the assumptions made throughout the risk assessment, including selection of COPCs and selection of values for dose-response relationships. In general, assumptions, which consider safety factors, are made so that the final calculated risks are overestimated.

The following uncertainties should be considered when evaluating the results of the risk characterization conducted for Sites A and B:

**COPC Screening Levels**

The use of risk-based screening values should ensure that the significant contributors to risk from a site are not incorrectly screened out but are retained for evaluation. Screening values were based on conservative land-use scenarios (i.e., residential land use for soil) and protective levels of risk corresponding to an ILCR of $10^{-6}$ and an HI of 0.1. The maximum detected values of several noncarcinogenic COPCs do not exceed their respect Region IX PRGs based on an HI of 1.0. In addition, the toxicity values used in the derivation of PRGs are subject to change, as additional information (from scientific research) becomes available; these periodic changes in toxicity values may cause the PRG values to change as well.

**Absence of COPC Screening Levels**

Essential human nutrients (magnesium, potassium, calcium, and sodium) are considered toxic only at very high doses and do not have screening levels referenced in this report. These nutrients were eliminated from consideration as COPCs. Exclusion of these chemicals as COPCs is not expected to add significant

uncertainty to the risk. Several chemicals did not have screening levels listed in this report but were screened using a surrogate screening value (i.e., a screening value for a similar chemical). In each case, the surrogate screening value is conservative and is not expected to add significant uncertainty to the risk.

**Exposure Parameters**

The exposure factors (e.g., exposure frequency and duration) used to characterize the risk are based on reasonable maximum exposure (RME) assumptions. Generally, default and literature exposure factors are based on surveys of physiological and lifestyle profiles across the United States. The attributes and activities studied in these surveys generally have a broad distribution. Therefore, the risk is not likely to be underestimated for maximum exposed individuals and is more likely to be overestimated for the general populations exposed to the chemicals in the environmental media at the sites. Assumptions were conservative and are not likely to underestimate the exposure to the receptor.

**Use of Iron Toxicity Criteria**

Potential risks from exposure to iron were evaluated although the National Center for Environmental Assessment (NCEA) provisional RfD and are based on typical allowable intakes rather than adverse effect levels. Therefore, noncarcinogenic risks are overestimated for iron. The uncertainty for exposure to iron was alleviated somewhat by the use of the typical allowable intake for children (1.1 mg/kg-day) as the oral RfD for child receptors rather than the default oral RfD of 0.3 mg/kg-day based on adult intakes.

**Benzo(a)pyrene**

There is a significant amount of uncertainty associated with the benzo(a)pyrene detections at both Sites A and B. For Site A and Site B surface soil, the only detections were estimated "J" values less than the method detection limit (MDL) of 0.33 mg/kg. For Site A subsurface soil, 2 of the 24 samples had detections, one of which was an estimated "J" value less than the MDL, leaving only 1 sample of 34 with a detected value above the detection limit, a frequency of detection ratio less than 5 percent. Based on these uncertainties, benzo(a)pyrene was not considered further as a COPC.

Remedial goal options (RGOs) were set for benzo(a)pyrene in soil in the RI (DOE 1998) for industrial use (2.6 mg/kg) and residential use (1.2 mg/kg). All detected concentrations of benzo(a)pyrene at Sites A and B were below these RI RGOs. In addition, the means and 95% UCL for benzo(a)pyrene in the Site A surface and subsurface soil data sets and in the Site B surface and subsurface soil data sets are all less than the Region IX industrial PRG.

## 5.2 ECOLOGICAL RISK ASSESSMENT

A Baseline Ecological Risk Assessment (BERA) was conducted for the UEFPC CA and is included in *Report on the Remedial Investigation of the Upper East Fork Poplar Creek Characterization Area at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee*. DOE/OR/01-1641/V1&D2 (DOE 1998). Regulators (i.e., EPA and TDEC) concurred with the RI Report, including the results of the BERA. The UEFPC CA BERA provides an estimate of ecological risks posed by contaminants in the UEFPC CA, which includes primary and secondary sources, aquatic habitats, and terrestrial spring and seep areas. Various ecological receptors (e.g., fish, aquatic and benthic invertebrates, plants, and terrestrial fish-eating animals) in various habitats (i.e., surface water, sediments, springs and seeps) were considered. None of these various habitats are present at Sites A and B.

Significant current ecological risks from contaminants in water, sediments, and/or fish were identified for fish and macroinvertebrates in UEFPC, aquatic biota in seeps and springs, and piscivorous wildlife.

PCBs and metals, particularly mercury, are the primary contributors to risks. None of the radionuclide concentrations in UEFPC presents an unacceptable risk to any of the ecological receptors. Because, under current land-use conditions, there are few suitable habitats for terrestrial plant and animal populations, no evaluations of current risks to terrestrial receptors from exposure to UEFPC soils were made as part of the BERA.

*The Record of Decision for Phase I Interim Source Control Actions in the Upper East Fork Poplar Creek Characterization Area, Oak Ridge, Tennessee*, DOE/OR/01-1951&D3 (DOE 2002) addresses the impact of flow management of UEFPC, initiated in July 1996. After flow management was implemented, the number of contaminants observed at unacceptable concentrations decreased, and the number of fish in the creek increased. Recent trends have shown an overall improvement in aquatic communities. Levels of mercury and PCBs in fish, however, are still potentially presenting an unacceptable risk to fish and fish-eating birds.

Because of the relatively small areas that will be available for plant and wildlife habitat, the lack of any aquatic habitat, and the relatively low contamination of the transferred Sites A & B, the risks identified in the BERA are not associated with these sites, and there are no unacceptable ecological risks.

## 5.3 SUMMARY AND CONCLUSIONS

A summary of the risk characterization for Sites A and B is presented in the following items:

- ILCRs developed for the site workers exposed to Site A soils and Site B soils are less than 1E-06, indicating no unacceptable risks to that receptor.
- ILCRs developed for completeness for the hypothetical future residents (adult and child) exposed to Site A soils and Site B soils are greater than 1E-06 but less than 1E-04, indicating no actionable risk levels.
- Noncancer risk estimates (HIs) developed for the site worker and for completeness for hypothetical future residents (adult and child) are less than 1, indicating that adverse noncarcinogenic effects are not anticipated under the conditions considered in the risk assessment.
- There are no COCs (industrial or residential) for either site in this investigation.
- No unacceptable ecological risks.
- No remedial actions of soils are needed to address human or ecological health risks at Sites A and B.

# 6. RESPONSE/CORRECTIVE ACTION AND OPERATION AND MAINTENANCE REQUIREMENTS

Remediation of the UEFPC Watershed is being conducted using a phased approach. The ROD for Phase I Interim Source Control of UEFPC CA (DOE 2002) constitutes the initial phase and addresses interim actions to be implemented as follows:

- Hydraulic isolation actions in the West End Mercury Area (WEMA);
- Removal of mercury-contaminated sediments from UEFPC and Lake Reality;
- Treatment of mercury-contaminated groundwater from 9201-2 area (Big Spring Treatment Facility);
- Storm Sewer Piping Cleaning and Repair;
- Treatment of mercury-contaminated groundwater in the WEMA;
- Land use controls as detailed in *Land Use Control Implementation Plan for Phase I Interim Source Control Actions in the Upper East Fork Poplar Creek Characterization Area at the Y-12 National Security Complex Oak Ridge, Tennessee,* DOE/OR/01-1987&D2 (DOE 2003);
- Surface water monitoring at outfalls and stations along UEFPC;
- Short-term studies to evaluate potential response actions, including groundwater capture at WEMA, in-situ treatment of mercury-contaminated soil at 81-10, and treatment and disposal options for mercury-contaminated soils and sediment;
- Long-term studies to evaluate viability of large-scale treatment of mercury-contaminated surface water and groundwater studies to understand the dynamics of groundwater plumes underlying the UEFPC CA.

The second phase of remediation in UEFPC CA addresses contaminated soil, scrap, and buried materials. Decisions regarding final land use and final goals for surface water, groundwater, and soil for the watershed will be addressed in future decision documents. If finalization of the surface water and groundwater remediation goals require additional soil remediation, it will be addressed as part of those decisions.

The groundwater under portions of the Y-12 site is contaminated due to historical activities. While the Phase I ROD contains limited measures designed to address groundwater contamination within portions of UEFPC CA, none of the measures are expected to affect groundwater beneath the Site A and Site B properties. The land transfer will occur before all groundwater remediation is completed. Accordingly, the deed will contain restrictions on the extraction and use of groundwater by the Grantee. DOE will retain responsibility for any necessary future groundwater remediation. In order to ensure that all groundwater beneath Y-12 is addressed by appropriate remedial measures, an additional ROD addressing all site groundwater is scheduled for 2017.

The only remedial actions that have occurred within Sites A and B are the UST removal at Site A and the CSX railroad removal action at Site B. No future remedial actions are expected within the footprint of the buildings which will be located on Sites A and B.

## 7. CONTENTS OF DEED/TRANSFER AGREEMENT

As required by CERCLA section 120(h)(3), DOE shall include the following language in the deed:

THIS QUITCLAIM DEED, made between the UNITED STATES OF AMERICA, its successors, transferees and assigns, hereinafter referred to collectively as the GRANTOR, acting by and through the Secretary of the Department of Energy, under and pursuant to the powers and authority contained in Section 161g of the Atomic Energy Act of 1954, as amended (42 U.S.C. § 2011 et seq.) and OAK RIDGE PROJECT, LLC, a limited liability company organized under the laws of the State of Tennessee, and its successors, transferees, and assigns, hereinafter collectively referred to as GRANTEE. The GRANTOR and GRANTEE have agreed that in order to assure enforceability of land use restrictions, this Quitclaim Deed, including all of its exhibits, shall serve as a Notice of Land Use Restrictions pursuant to Tennessee Code Annotated § 68-212-225, having all the effectiveness and enforceability of such Notice.

- W I T N E S S E TH -

THAT THE GRANTOR, with the understanding that the GRANTEE will use the two parcels of property conveyed hereby consistent with and in furtherance of the missions of the GRANTOR in accordance with the Conditions hereinafter set forth, for **[insert purchase price]** and for other good and valuable consideration, the receipt and sufficiency of which is hereby acknowledged, by these presents does hereby remise, release, and quitclaim to the GRANTEE, subject to the exceptions, reservations, restrictions, covenants, and conditions hereinafter expressed and set forth, all the right, title, interest, claim or demand which the GRANTOR has or may have had in or to the property which is situated, lying and being in the State of Tennessee, County of Anderson, more particularly described as follows (the "Property"):

**{Survey descriptions to be inserted}**

This conveyance is made subject to the following covenants, restrictions, reservations, easements rights-of-way and conditions:

1. All recorded covenants, conditions, restrictions, rights-of-way, reservations and easements, including but not limited to, existing easements for public roads and highways, railroads, transmission lines, pipelines, and other public utilities.

2. Reserving to the GRANTOR the continuing rights to use GRANTOR's existing utility systems in such a manner as not to create any unreasonable interference with the use of the Property herein granted.

3. Reserving to the GRANTOR the right to construct, use, and maintain necessary communication, utility, or access facilities across, over, and/or under existing easements, cited in Condition 1 herein, lying within the parcels, in such manner as not to create any unreasonable interference with the use of the Property herein granted.

4. All construction within any 100-year floodplain and all construction within any floodway must comply with applicable Federal and State laws with respect to said construction. All construction must also comply with the State of Tennessee storm water construction requirements. All construction and use of the Property must comply with and not cause any violations of the Y-12 National Pollutant Discharge Elimination System Permit.

5. If any portion of the Property herein conveyed is deemed to be jurisdictional wetlands as determined by the Nashville District Corps of Engineers, any development thereon must comply with the Department of Army Wetlands Construction Restrictions contained in 33 CFR Parts 320 through 330, as amended, and any other applicable Federal, State, or local wetlands regulations.

6. The Property herein conveyed shall be used in a manner consistent with the Endangered Species Act of 1973, as amended (16 U.S.C. § 1531 et seq.).

7. The GRANTEE, its lessees and all sublessees, shall comply with all applicable Federal, State, and local laws and regulations with respect to any present or future development and use of the Property herein conveyed, including, but not limited to, those laws and regulations which govern sewage disposal, facilities, water supply, and other public health requirements. All structures, facilities, and improvements requiring a water supply shall not be required to be connected to the GRANTOR's approved water system for any and all usage and shall not be connected without GRANTOR's prior written approval. If GRANTEE elects to connect to public utility systems, GRANTOR may grant easements, licenses and such other rights necessary for GRANTEE to access and use such public utility systems at no cost to GRANTOR.

8. Except as provided in Condition 9, the Property herein conveyed shall be used by the GRANTEE for purposes consistent with and in furtherance of the Atomic Energy Act of 1954; provided, however, that, if

the GRANTEE is unable to use the Property for such authorized uses due to the actions or inactions of the GRANTOR, the GRANTEE may use the Property for other purposes which are not related to missions of the GRANTOR with prior written permission from the GRANTOR.

9. As indicated in separate provisions of this Quitclaim Deed, it is the intent of the GRANTEE to utilize the Property conveyed herein for purposes consistent with the mission of the GRANTOR. In the event the GRANTOR's management and operating contractor exercises its option to terminate its lease with the GRANTEE upon one year's notice to the extent expressly permitted by said lease, the GRANTOR agrees that the GRANTEE may engage in a use or retention of the Property which is not related to missions of the GRANTOR, if the GRANTOR consents to such use in writing. This consent will not be unreasonably withheld.

10. The GRANTEE may not further convey title to any portion of the Property to another party unless the provisions of Condition No. 11 cited are applicable. However, the GRANTEE may grant leases of the Property to third parties, with appropriate restrictions and reservations, subject to review and prior written approval of the GRANTOR in order to permit necessary development and operation of facilities for purposes consistent with the mission of the GRANTOR. Said leases of the Property may not be further conveyed or sublet by any sublessee(s) except in accordance with this provision. In addition, the GRANTEE shall have the absolute right to encumber its interest in the Property and any improvements thereto or thereon by a mortgage, deed of trust, lien or other encumbrance provided that the lender under such mortgage, deed of trust, lien or other encumbrance be fully bound by the provisions of this Quitclaim Deed.

11. In the event the GRANTOR elects not to repurchase the Property and facilities as set forth in Condition ## cited herein, title to the Property and facilities, which shall be vested in the GRANTEE pursuant to same Condition ##, shall remain with the GRANTEE and the restrictions or provisions set forth in Conditions 8 and ## shall no longer apply to the Property herein conveyed. If the repurchase is declined by the GRANTOR and title remains vested in the name of the GRANTEE, the GRANTEE's rights remain subject to all terms, obligations, restrictions, reservations, covenants and conditions set forth in this Quitclaim Deed, and these terms, obligations, reservations, covenants and conditions shall run with the land.

12. It is expressly understood that Bear Creek Road and First Street (as to the Production Interface Facility to be constructed on a portion of the Property) and Scarboro Road, Second Street and Bear Creek

Road (as to the Public Interface Facility to be constructed on a portion of the Property), which are adjacent to the portions of the Property herein conveyed are ingress/egress rights-of-way under the jurisdictional control of the GRANTOR. GRANTOR shall grant an easement to GRANTEE over and across such rights-of-way and other areas that may be reasonably necessary or desirable for GRANTEE's access to, and development and use of, the Property, and GRANTEE shall comply with GRANTOR's reasonable requirements regarding usage of that easement.

13. The GRANTEE acknowledges that the Oak Ridge Reservation has been identified as a National Priorities List Site under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) of 1980, as amended. The GRANTEE acknowledges that the GRANTOR has provided it with a copy of the Oak Ridge Reservation Federal Facility Agreement (FFA) effective on January 1, 1992, and relevant amendments entered into by the GRANTOR, Region 4 of the United States Environmental Protection Agency (EPA), and the Tennessee Department of Environment and Conservation (TDEC). The GRANTEE agrees that should any conflict arise between the terms of such agreement as it presently exists or may be amended and the terms of this Quitclaim Deed, the terms of the FFA will take precedence.

*NOTICE OF HAZARDOUS SUBSTANCE ACTIVITY*

14. In accordance with Section § 120(h)(3)(A)(i) of CERCLA and 40 CFR § 373.3, notification is hereby provided that based upon a complete search of agency files, the following provides notice of: (1) the type and quantity of hazardous substances that were known to have been released or disposed of or stored for one year or more on the Property; (2) the date such storage, release or disposal took place; and (3) a description of remedial action taken, if any:

- Site A: An underground storage tank (UST) contained fuel that serviced an emergency generator in Building 9705 from the mid-1950s through the late 1960s. Building 9705 was destroyed by fire and demolished in the late 1950s or early 1960s, but the UST was left in place. The UST, approximately 100-gallon capacity, was excavated and removed on July 21, 1995. The tank pit was sampled and backfilled. Visual observation and analytical results determined that no releases had occurred.
- Site B: Low-level radioactive contamination was released from railroad cars along a CSX railroad spur located at the east end of Y-12 during the 1960s and 1970s; no other information about the type and quantity of hazardous substances released is known. Materials and soil contaminated with Cesium 137 were removed from twelve areas along the railroad spur in January through May 1994,

meeting the cleanup action level of 50 picocuries per gram. The remediation is documented in DOE Environmental Restoration Program Removal Action Report for CSX Railroad, DOE/OR/02-1301&D1 (DOE 1994) and there is no further planned CERCLA response action and no indication of any additional remedial action needed on or underneath Site B.

15. GRANTOR makes a covenant warranting that any additional response action found to be necessary after the date of transfer for contamination on the Property existing prior to the date of this transfer will be conducted by GRANTOR. The foregoing covenant shall not apply in any case in which GRANTEE of the Property is a potentially responsible party (PRP) with respect to the Property before the date on which GRANTOR transferred the Property. The obligation of the GRANTOR under this warranty will be limited to the extent that a response action is required by an act or omission of any GRANTEE which either (1) introduces new contamination or (2) increases the cost or scope of the required response action by negligently managing any contamination present on the Property at the time of the initial transfer by the GRANTOR.

16. GRANTEE covenants that GRANTOR, its officers, agents, employees, contractors and subcontractors, in accordance with Section 120(h)(3) of CERCLA shall have access to all portions of the Property for environmental investigation, remediation or other corrective action. In the event the GRANTOR must access the Property, the GRANTOR must provide notice to and coordinate access with the GRANTEE and any authorized occupants of the Property. Any such entry, including such activities, responses or remedial actions, shall be coordinated with the GRANTEE or its tenants and shall be performed in a manner which minimizes, to the extent practicable, interruption with GRANTEE'S activities on the Property. GRANTOR's right to access the Property shall be exercisable in any case in which a remedial action, response action or corrective action is found to be necessary by the applicable regulatory authority after the date of conveyance of the Property, or in which GRANTOR determines access is necessary to carry out a remedial action, response action, or corrective action on adjoining property. Pursuant to this reservation, the GRANTOR and its officers, agents, employees, contractors and subcontractors shall have the right (upon reasonable notice to and coordination with the GRANTEE or the then-owner and any authorized occupant of the Property) to enter upon the Property and (1) conduct investigations and surveys, including but not limited to drilling, test-pitting, borings, sample collection, data and record compilation, and other activities related to environmental investigation and (2) to carry out any other response and/or corrective actions as required or necessary under CERCLA and other applicable authorities, including but not limited to installation and operation of monitoring wells and pumping wells, and conducting treatment required under CERCLA and other applicable authorities.

17. The GRANTEE covenants and agrees that it shall not disrupt or prevent the GRANTOR from required remedial investigations, response actions, or oversight activities including, but not limited to, properly constructing, upgrading, operating, maintaining and monitoring any groundwater treatment facilities or groundwater monitoring on the Property or adjoining property; provided, however, that this Condition 17 shall not be construed to be a limitation on, or waiver of, the rights of the GRANTEE, or duties of the GRANTOR.

18. GRANTEE, upon observing the covenants and conditions imposed in this Quitclaim Deed, may peaceably and quietly possess and enjoy the Property free from any interference or disturbance except for the rights expressly reserved by GRANTOR herein. **[The following language is under discussion:]** Should any future action by the GRANTOR, specifically including any actions taken pursuant to the covenants and commitments set forth in this Quitclaim Deed, substantially interfere with the GRANTEE's quiet use and enjoyment of the Property, the GRANTEE, its lessees and sublessees, and their contractors may seek recourse against the GRANTOR for any actual loss which such parties establish they have sustained solely as a result of the actions of the GRANTOR, including but not limited to (1) additional construction costs actually incurred as a result of construction delays, demobilization and remobilization, (2) additional interest costs incurred during any delay in construction resulting from such actions, (3) the expenses actually incurred for moving or relocating tenants, and (4) the additional rent expense incurred in connection with alternative space. This covenant shall not be construed to provide a basis for any claims for compensation by such parties arising out of the actions of any entity other than the GRANTOR.

19. GRANTOR makes a covenant warranting that when all response actions necessary to protect human health and the environment with respect to any hazardous substance remaining on the Property on the date of conveyance of the Property have been taken, GRANTOR shall execute and GRANTEE shall accept an appropriate document containing a warranty that all such response actions have been taken, which warranty GRANTEE may rely upon. The foregoing covenant shall not apply in any case in which the person or entity to whom the Property is transferred is a potentially responsible party with respect to such property.

20. The GRANTEE covenants and agrees that it shall not construct or permit to be constructed any well, and shall not extract, utilize, consume or permit to be extracted, any water from the aquifer below the surface of the ground within the boundary of the Property for the purpose of human consumption, or other use, unless such groundwater has been tested and found to meet applicable standards for human consumption, or such other use, and such GRANTEE or occupant shall first have obtained prior written approval of the GRANTOR and the applicable regulatory authorities including, but not limited to, the

regulator parties to the FFA. The costs associated with obtaining use of such water, including but not limited to the costs of permits, studies, analysis, or remediation, shall be the sole responsibility of the GRANTEE without any cost whatsoever to the GRANTOR.

21. The GRANTEE covenants and agrees that the Property shall not be used for any residential housing, any elementary or secondary school, any child care facility or children's playground, any recreational use, or developed in any manner inconsistent with the land use assumptions of industrial use contained in CERCLA Records of Decision (RODs) for the Upper East Fork Poplar Creek Characterization Area. Any of these uses or other use of the Property inconsistent with the "industrial use" limitation described in the RODs is prohibited.

22. GRANTEE covenants and agrees that it will not at any time cause or allow any excavation, use, or disturbance of any portion of the Property located more than 22.5 feet below ground surface within Site A or located more than 18.5 feet below ground surface within Site B without prior written approval from the GRANTOR, the EPA, and TDEC. GRANTEE covenants and agrees that any excavation on adjacent property is prohibited without prior written approval from the GRANTOR. GRANTEE covenants and agrees that any facilities constructed on the Property will not have basements.

23. The GRANTEE covenants and agrees that any buildings intended to be occupied by workers eight hours or more per scheduled work day or by unbadged public visitors will be designed and constructed to minimize exposure to volatile organic contaminant vapors using EPA/625/R-92/016 (January 1993) "*Radon Prevention in the Design and Construction of Schools and Other Large Buildings*" as guidance. In the event that Grantee has not commenced construction within two years of the date of transfer, Grantee shall notify EPA and request any additions or modifications to the 1993 guidance specified in this Condition. Additions or modifications documented by EPA shall be incorporated into the design and construction of buildings defined in the first sentence of this Condition.

24. The GRANTOR covenants and agrees that GRANTOR shall: (1) post signs providing notice or warning to prevent unauthorized access to the property being transferred, and (2) patrol the transferred property to control and monitor access by workers, badged visitors, and unbadged public visitors, in accordance with DOE/OR/01-1987&D2 (May 2003) "*Land Use Control Implementation Plan for Phase I Interim Source Control Actions in the Upper East Fork Poplar Creek Characterization Area at the Y-12 National Security Complex, Oak Ridge, Tennessee*." The GRANTEE covenants and agrees that it shall not hinder, obstruct, or otherwise interfere with GRANTOR's compliance with this Condition 24(1) and (2).

25. In the event the GRANTEE desires to use or take action on the Property for any use prohibited above, it shall delay doing so until such time as any environmental restoration activities necessary to remediate the prohibited use as required by law and the regulatory authorities have been performed, an appropriate document containing a warranty that all such response actions have been taken has been fully executed by GRANTOR and GRANTEE and the GRANTEE has complied with all laws, rules, regulations and ordinances pertaining to said use, including but not limited to applicable zoning requirements. GRANTEE shall obtain written approval of GRANTOR, EPA, and TDEC prior to initiating any environmental restoration activities relating to CERCLA hazardous substances and prior to obtaining relief from, or making changes to, any land use restrictions on the property contained in this deed. All costs associated with any such environmental restoration necessary for remediating the prohibited use shall be the sole responsibility of the GRANTEE.

26. The GRANTOR shall submit on an annual basis, through established channels, appropriate budget requests to the Director of the Office of Management and Budget that adequately address those agreed-upon schedules for investigation and completion of all necessary response actions required by the FFA until such time that all necessary remedial action has been taken. The actual amount available for such activities is subject to congressional authorizations and appropriations.

27. After notice and coordination with the GRANTEE as set forth in Condition (16) above, any response actions taken by the GRANTOR will be in accordance with schedules developed and included in the FFA, approved by the GRANTOR, Region 4 of the EPA, and TDEC. The following milestones, which are subject to modification by agreement of the FFA parties, for CERCLA response actions in the Upper East Fork Poplar Creek watershed are reflected in Appendix E (May 20, 2004) and/or Appendix J (April 15, 2004) of the FFA:

- Soils (and Scrapyard) Record of Decision (ROD) - 10/14/05
- Phase I ROD (Interim Surface Water Actions) Remedial Action Report (RAR) - Calendar Year 2016
- Final Surface Water Remedial Investigation Work Plan (RIWP) - Calendar year 2017
- Final Surface Water ROD - Calendar year 2018
- Soil and Scrapyard RAR - Calendar year 2013
- Groundwater RIWP - Calendar year 2015
- Groundwater ROD - Calendar year 2017

The following remediation milestone is in the process of being modified and will appear in the next update of Appendix E of the FFA:

- Building 9102-2 Water Treatment System (Big Spring) Partial Construction Completion Report (PCCR) - 1/19/05.

The following milestones, not yet included in the FFA, have been provided through the DOE Environmental Management contractor to meet requirements for a complete CDR:

- Final Surface Water RAR - 2019

- Groundwater RAR - 2019.

28. By acceptance of this Deed or any rights hereunder, the GRANTEE, for itself, its successors and assigns forever, agrees that the transfer of all the Property transferred by this deed is accepted subject to all terms, obligations, restrictions, reservations, covenants and conditions set forth in this Quitclaim Deed, and that these terms, obligations, reservations, covenants and conditions shall run with the land.

# 8. RESPONSIVENESS SUMMARY

***[Address comments received from regulators and public and responses to comments.]***

## 9. GRANTEE RESPONSE ACTION ASSURANCES AND AGREEMENTS

NNSA does not contemplate that the Grantee will assume any response actions at the Y-12 site unless the Grantee wishes to use the transferred property in a manner inconsistent with the restrictions in Chap. 7 of this CDR. If the Grantee does wish to use the transferred property in a manner inconsistent with any land use restriction on the property contained in this deed, the Grantee must obtain written approval from NNSA, EPA, and TDEC (1) before any environmental restoration activities relating to CERCLA hazardous substances are commencerd and (2) any relief is given from or change is made to any existing land use restriction. As discussed in Chap. 7, no site or building activities will be inconsistent with (or interfere with) the remedial actions selected under the UEFPC CA Phase I ROD and subsequent UEFPC CA RODs. The use of the transferred property will be restricted consistent with land use controls and remedial actions selected under the ROD(s). The Grantee is prohibited from utilizing, consuming or extracting any groundwater within the boundary of the Property unless permission is obtained from NNSA and the applicable regulatory authorities.

## 10. EFFECT OF COVENANT DEFERRAL REQUEST

Nothing in this CDR shall be construed to alter NNSAs or any PRP's obligation to complete all necessary response actions at Y-12 as required by CERCLA and the NCP. In accordance with CERCLA 120(h)(3)(B), this CDR pertains solely to the transfer of this Property to a non-PRP.

This CDR, including land use restrictions and assurances, applies to the property described in Appendix A. The two descriptions in Appendix A represent the land specifically characterized to support the risk analysis and this CDR. Parts of the CDR apply specifically to Site A, approximately 8.3 acres; parts of the CDR apply specifically to Site B, approximately 8.9 acres. Although the CDR applies to the property described in Appendix A, NNSA intends to transfer only a portion of the property to a special purpose private entity at this time. NNSA anticipates transferring approximately 4.1 acres within Site A and approximately 2.8 acres within Site B at this time.

It is possible that remaining portions of Sites A and B might be transferred in the future. NNSA commits to include in the deed or other transfer agreement governing any future transfers of portions of Site A or Site B land use restrictions and assurances to protect public health and the environment functionally equivalent to those in Chap. 7 of this CDR as may be appropriate based upon consultation with EPA and TDEC, to the remediation status of the property or other circumstances at the date of any future transfer. NNSA will insure that such future transfers do not substantially delay any necessary response action at any property covered by this CDR (i.e., Sites A and B).

# APPENDIX A

# BOUNDARY SURVEY

**Property Descriptions**

Site A

Beginning at a point in the southern margin of Bear Creek Road and the northwest corner of the North Portal Parking lot at Y-12, having Y-12 grid coordinates of N-31043.01 and E-59175.87;

Thence South 07 deg. 06 min. 24 sec. West, 600.00 feet to a point;

Thence North 82 deg. 53 min. 36 sec. West, 600.00 feet to a point;

Thence North 07 deg. 07 min. 24 sec. East, 600.00 feet to a point in the southern margin of Bear Creek Road;

Thence along the southern margin of Bear Creek Road South 82 deg. 53 min. 36 sec. East, 600.00 feet to the point of beginning;

Containing 360,000 sq. ft or 8.26 acres.

Site B

Beginning at a point in the southwesterly margin of Scarboro Road, point being North 81 deg. 18 min. 57 sec. West, 29.75 feet from the intersection of Scarboro Road and Union Valley Road; and having Y-12 grid coordinates of N-29328.71 and E-64935-34;

Thence South 58 deg. 48 min. 48 sec. West, 340.19 feet to a point in the northerly margin of Second Street;

Thence along said Second Street North 86 deg. 36 min. 06 sec. West, 45.21 feet to a point;

Thence North 31 deg. 11 min. 12 sec. West, 974.33 feet to a point;

Thence North 58 deg. 48 min. 48 sec. East, 400.00 feet to a point in the southwesterly margin of Scarboro Road;

Thence along said margin of Scarboro Road South 29 deg. 53 min, 35 sec. East, 1000.26 feet to the point of beginning;

Containing 388,227 sq. ft or 8.91 acres.

# APPENDIX B

# RECORDS REVIEW

## Records Review

Pursuant to CERCLA 120(h)(3)(A)(i) and 40CFR373, agency records were reviewed for information pertaining to hazardous substance activity in the vicinity of Sites A and B. The UEFPC Remedial Investigation Report (DOE 1998), and the Soils and Scrapyard Focused Feasibility Study (DOE 2004a) indicated some contamination, primarily from radionuclides, at both Sites A and B. Researching the basis of the data in these documents led to the decision to perform further characterization of both sites, as this CDR discloses. However, other than the contamination along the old CSX railroad spur at Site B where the CERCLA removal action was performed and the site of the UST removal at the old Building 9705 at Site A, no other record was found that indicated any history of process operations, storage of hazardous substances, waste disposal, or other releases at either Site A or Site B. Numerous Y-12 databases were searched for records pertaining to the sites. The following list of references addresses the databases, documents reviewed that resulted from the database search, and other documents used to help characterize the nature and extent of contamination as well as meet requirements for review of records.

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# APPENDIX C

# PERSONNEL INTERVIEWS

## Interviews

Interviews and telephone conversations were conducted with many current and former employees who might have reason to know of the historical uses of Site A and Site B to prepare the draft Sampling and Analysis Plan and to identify information pertinent to notice requirements of CERCLA 120(h) and 40CFR373. A list of people interviewed and others who provided information follows.

Petroleum product was used in an Underground Storage Tank at Site A to provide fuel for an emergency generator for Building 9705. The removal of the UST is discussed elsewhere in this CDR. Otherwise, no one interviewed had knowledge of process operations, hazardous substance storage, waste disposal, or releases at Site A.

Regarding Site B, one or two people mentioned a “refueling station” near the intersection of what is now New Hope Pond Road (Second Street) and Scarboro Road, just southeast of Site B, but no one could provide any further information for such a facility. Some people knew about other facilities and remedial or corrective actions completed near Site B (e.g., the New Hope Pond closure and the firing range contamination excavation). Several people mentioned the CSX railroad spur contamination and the cleanup completed in the early 1990s on Site B. But, other than the railroad spur removal action, no one knew of any process operations, hazardous substance storage, waste disposal, or releases on Site B.

**People Interviewed Regarding Hazardous Substance Activity**

Sara Welch, ORNL Environmental Compliance Lead, Bechtel Jacobs Company LLC

John Powell, ORNL Manager of Lab Waste Services, UT-Battelle, LLC

Jim Bailey, Project Engineer, Bechtel Jacobs Company LLC

Ray Smith, Infrastructure Reduction Facilities Management, BWXT Y-12, L.L.C.

David Peebles, Facility Compliance Assessment Survey Program Manager, BWXT Y-12, L.L.C.

Clarence Hill, Environmental Coordinator, BWXT Y-12, L.L.C.

Lenny Vaughan, Clean Water Compliance Manager, BWXT Y-12, L.L.C.

Ed Ingram, Solid Waste Compliance Engineer, BWXT Y-12, L.L.C.

Don Bohrman, Environmental Sampling Manager, BWXT Y-12, L.L.C.

Ron Wilson, Facility Specialist, BWXT Y-12, L.L.C.

Bob Hummel, Building Manager, Pro-2-Serve

**People Who Provided Information Regarding Hazardous Substance Activity**

Bobby Oliver, Radiological Engineering Manager, BWXT Y-12, L.L.C.

Russ Harden, Clean Water Compliance Engineer, BWXT Y-12, L.L.C.

Steve Field, Clean Water Compliance Engineer, BWXT Y-12, L.L.C.

John Kubarewicz, Project Manager, Bechtel Jacobs Company LLC

Donna Wilson, Information Management Analyst, BWXT Y-12, L.L.C.

# APPENDIX D

# AERIAL PHOTOGRAPHS

## Site A and Site B Photographs

Photographs of the Y-12 Site have been taken over the past 60+ years and are archived by the BWXT Y-12 Photography Department. The archives have been searched and relevant photographs of Sites A and B and the surrounding area are included in Appendix D. The photographs depict the condition and usage of each site at different stages of development. Each photograph number or title, approximate date of photograph, and brief description is included below:

- **Photo 07 (1942)** – Aerial of the undeveloped area prior to construction of the Y-12 plant. Site B is highlighted; Site A is just outside of the photo frame.
- **Photo Anderson OB B125 South Side (early 1940s)** – Depicts homes and farmland on and adjacent to Site B prior to development of the Y-12 plant.
- **Photo 239257 (1940-1950)** – Bldg. 9705, which housed security operations, is shown at Site A. Site B in the background shows some nearby development that is thought to be a local gas station.
- **Photo 81-497-c (1965)** – Debris remains at Site A from a fire that destroyed Bldg. 9705 in 1964 or 1965 is shown.
- **Photo 93-700-c (1968)** – Site A has been cleared of debris from fire.
- **Photo 197769-c (1980)** – Site A is undeveloped and Site B is in the background.
- **Photo 197770-c (1980)** – Railroad cars are staged at the CSX railroad spur at Site B.
- **Photo 253379c (early 1980s)** – Boreholes of geotechnical investigation performed at Site A are shown.
- **Photo 232943 (early 1980s)** - Railroad spur at Site B is shown.
- **Photo 388626 (2003)** – Photo depicts recent or current state of Site B; note that railroad spur has been removed (removed in 1994).
- **Photo 388616 (2003)** – Photo shows recent or current state of Site A. Bldg. 9704-2 in the foreground was demolished in August – October 2004.


**Photo 07 (1942)**


**Photo Anderson OB B125 South Side (1940s)**

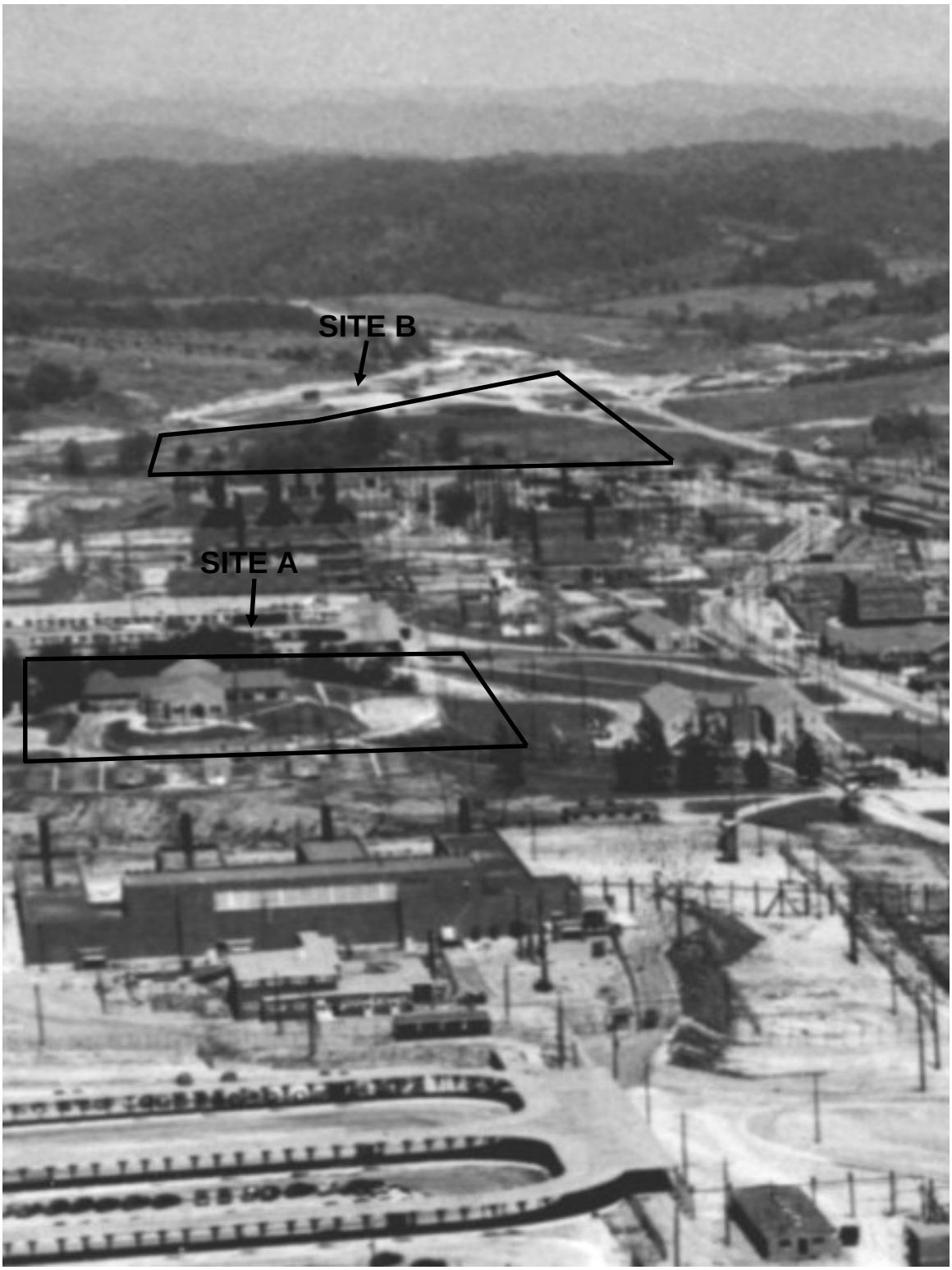


**Photo 239257 (1940-50)**

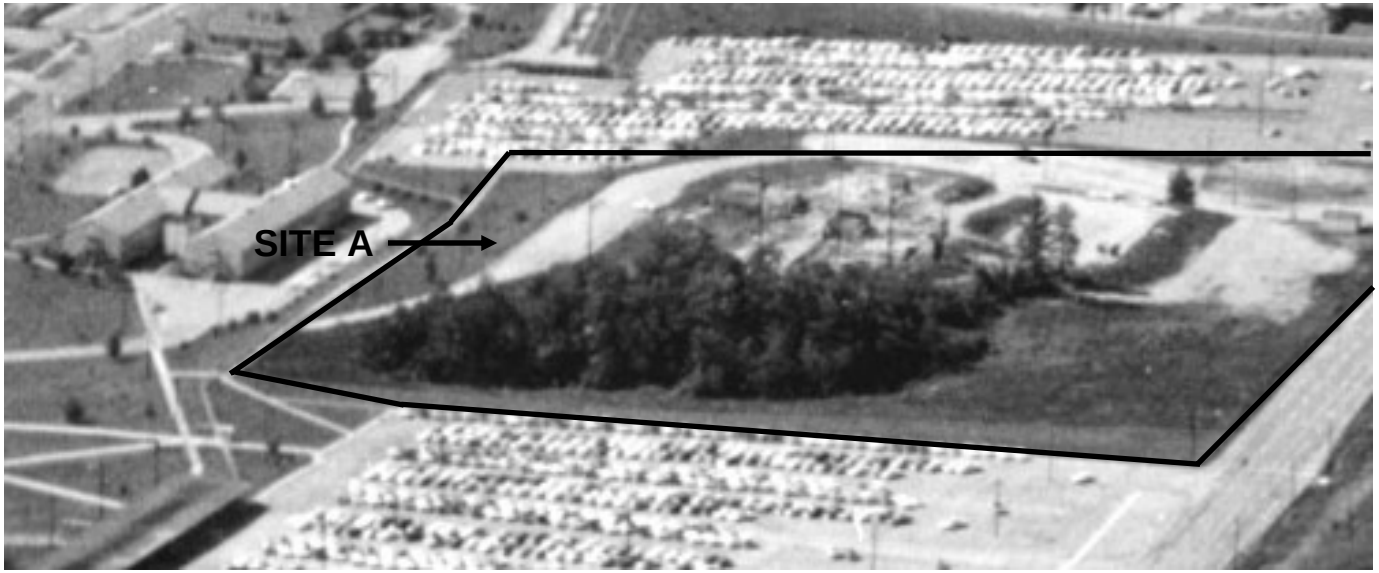


**Photo 81-497-C (1965)**

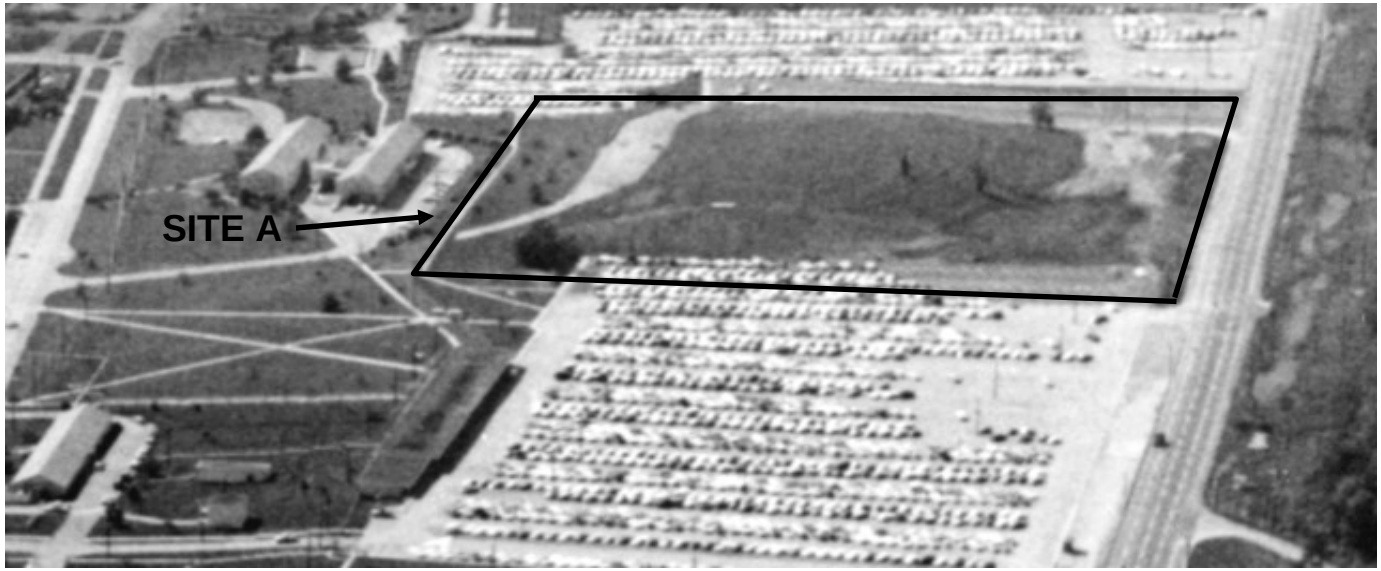


**Photo 93-700-C (1968)**

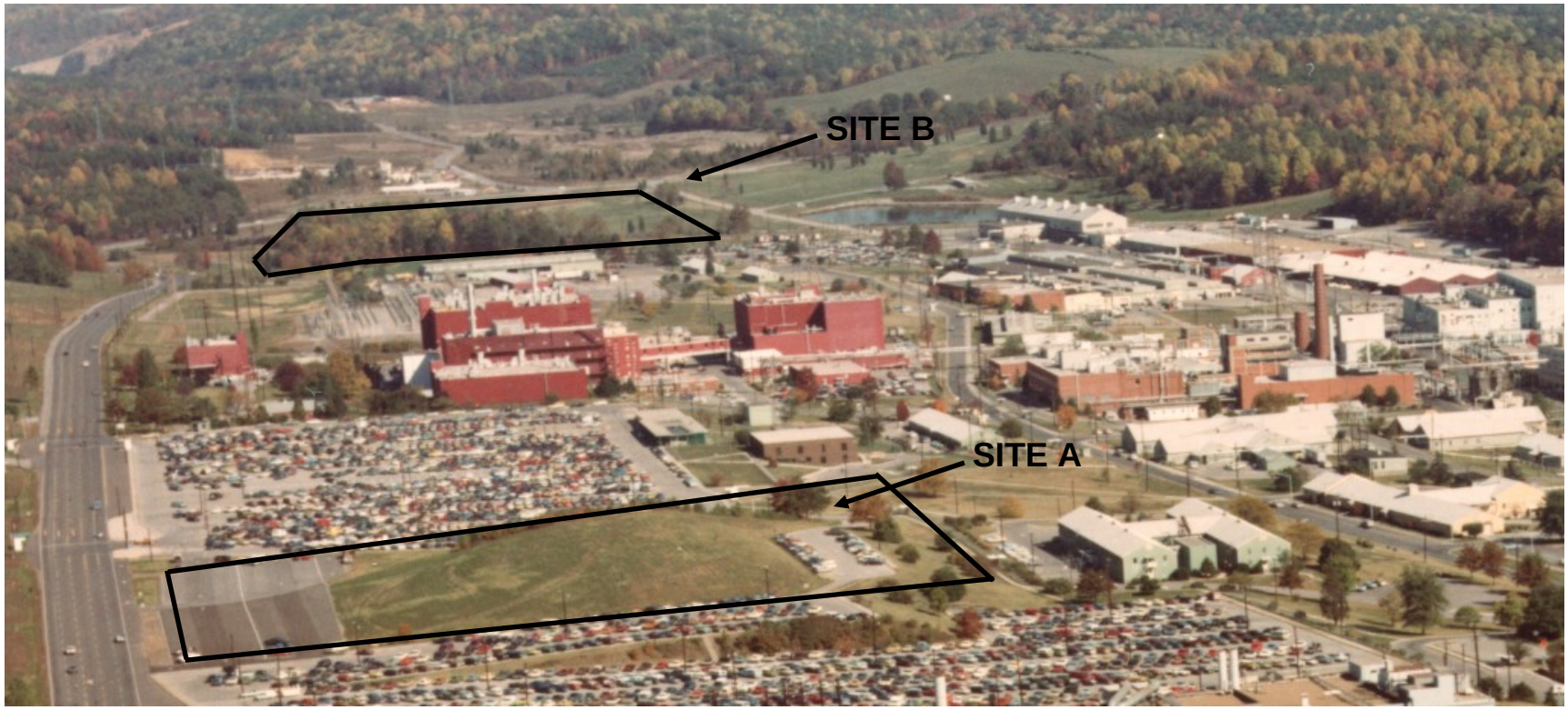


**Photo 197769-c (1980)**

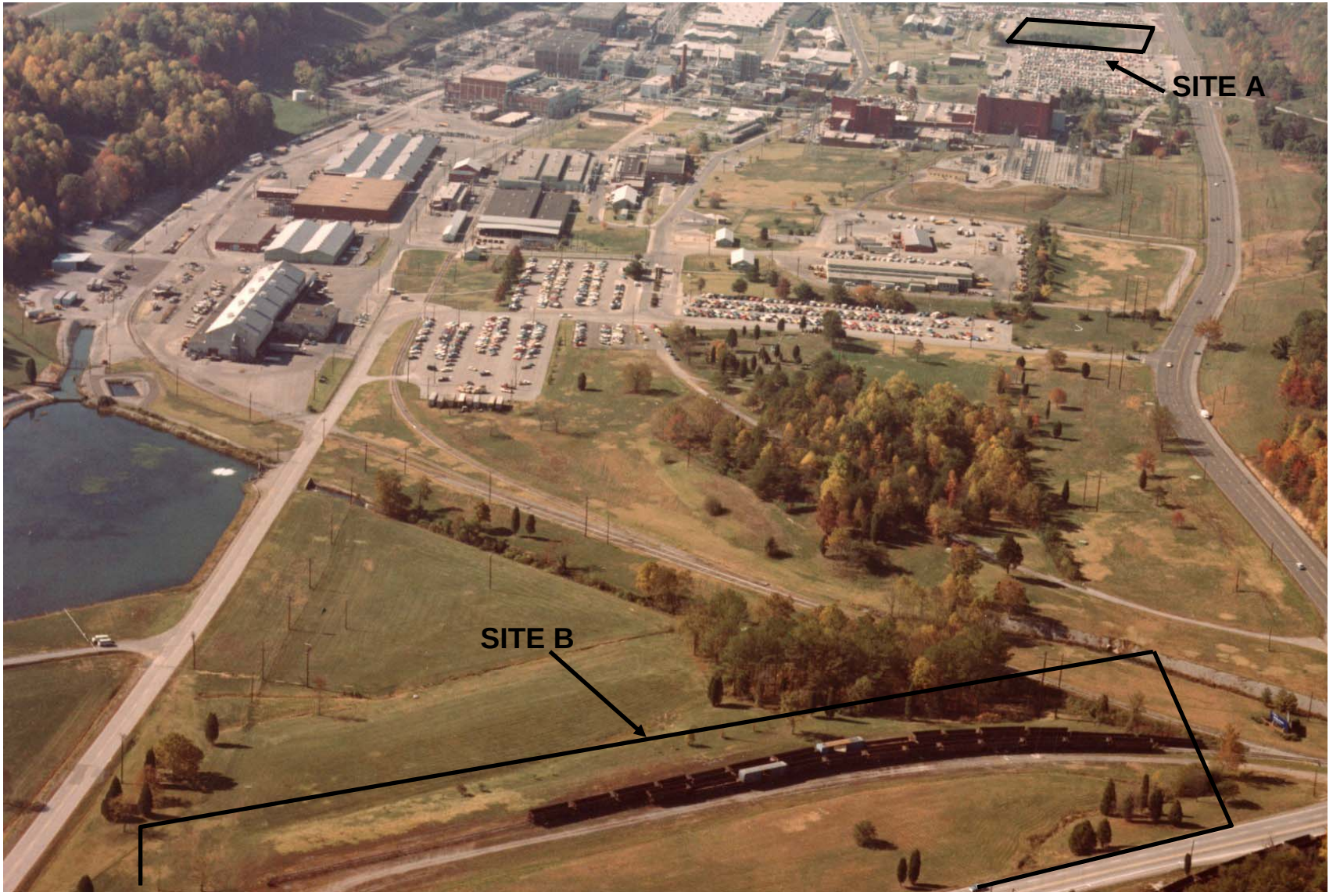


**Photo 197770-C (1980)**


**Photo 253379C (Early 1980s)**

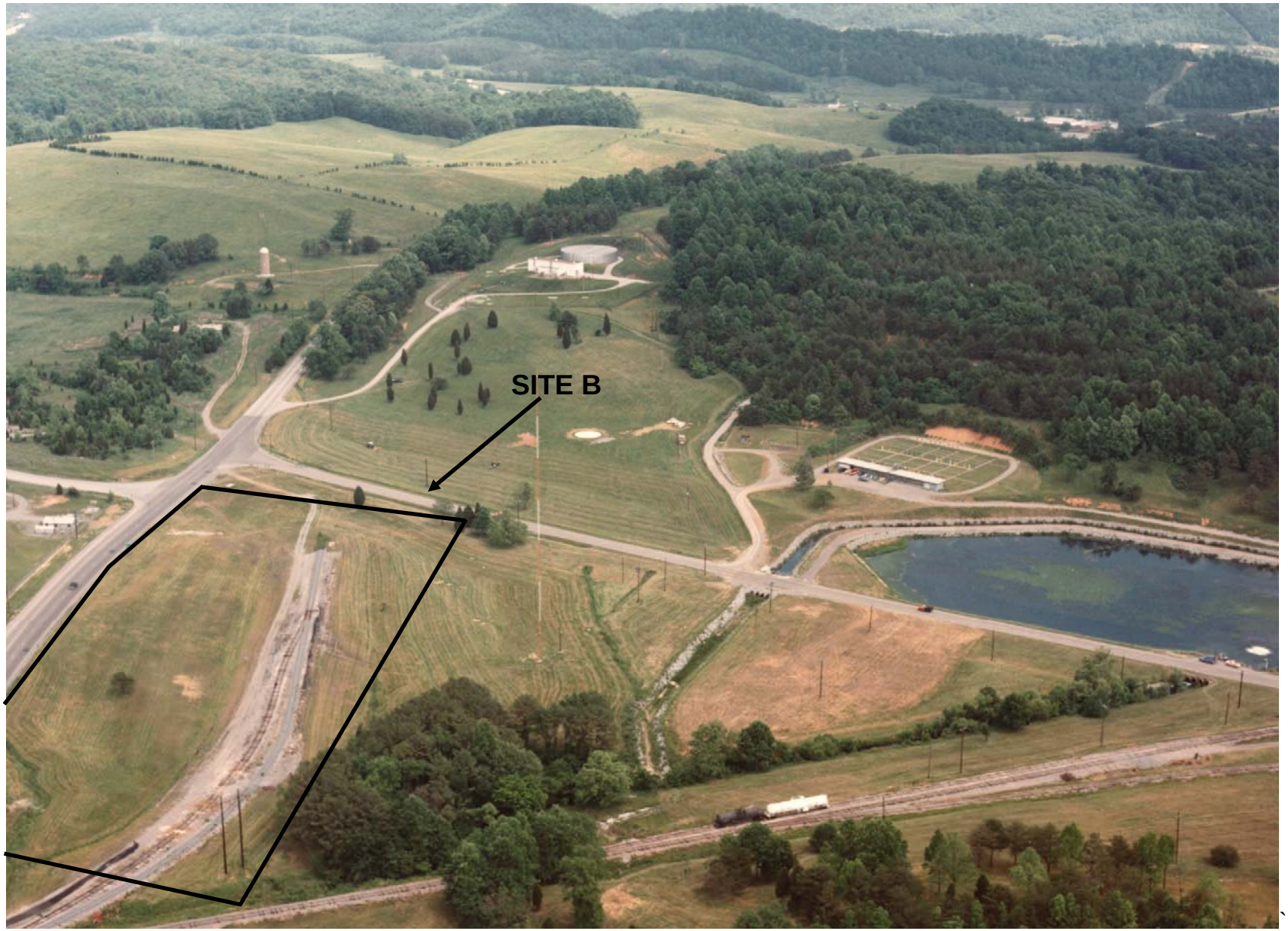


**Photo 232943 (Early 1980s)**

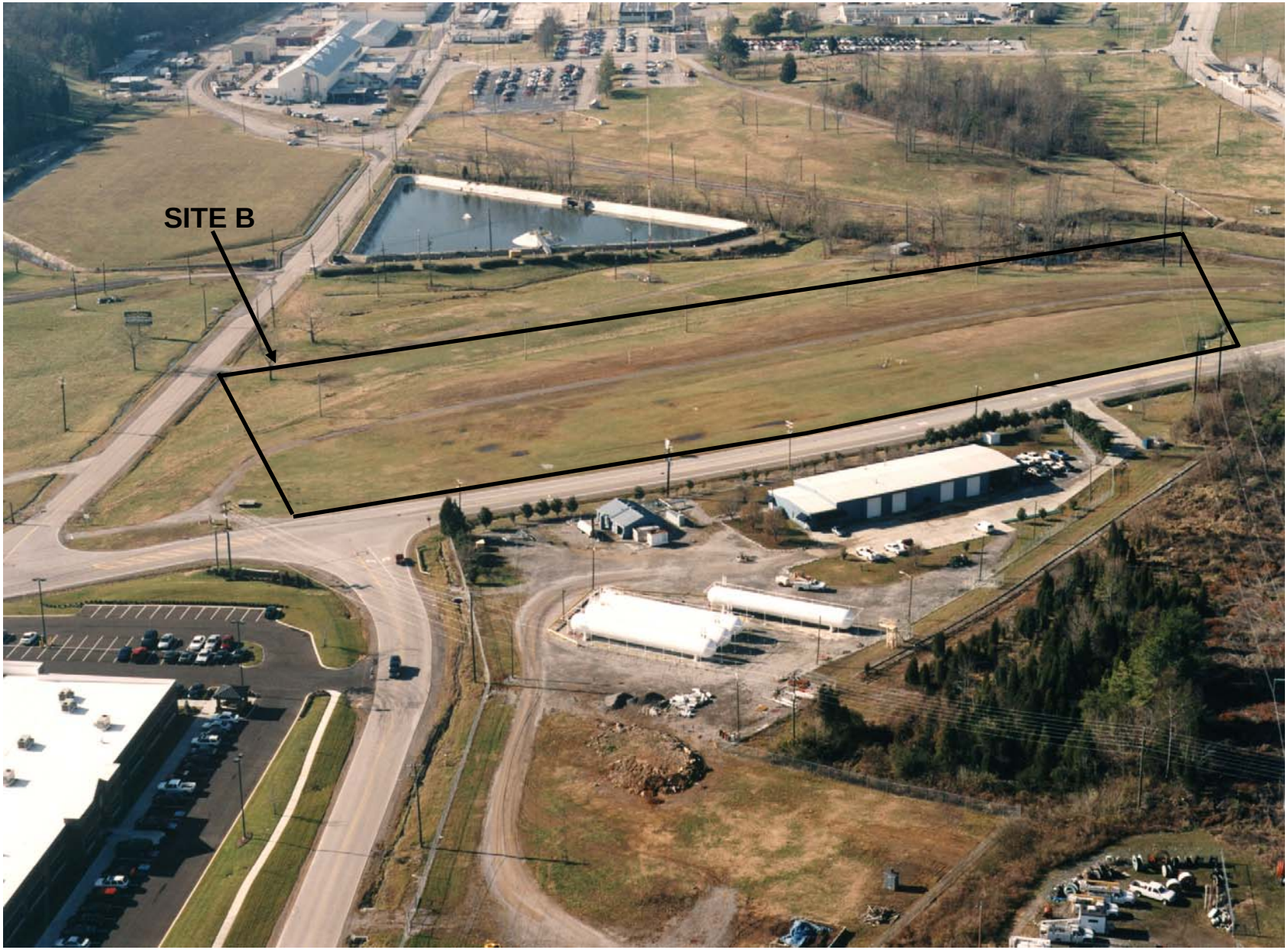


**Photo 388626 (2003)**


**Photo 388616 (2003)**

# APPENDIX E

# SUMMARY AND EVALUATION OF Y-12 SITE A AND SITE B SOIL ANALYTICAL DATA

**Table E-1, Occurrence, Distribution and Selection of Chemicals of Potential Concern (COPCs)**
**Surface Soil Residential**
**Site A**
**Y-12, Oak Ridge, TN**

Scenario Timeframe: Future
Medium: Surface Soil
Exposure Medium: Surface Soil

| Exposure Point | CAS Number | Chemical | Minimum [a] Concentration | Maximum [a] Concentration | Units | Location of Maximum Concentraion | Detection Frequency | Concentration Used for Screening [b] | Background Value [c] | Screening Toxicity Value [d] | COPC Flag | Rationale for [e] Contaminant Deletion or Selection |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Inorganics | | | | | | | | | | | |
| | 7429905 | Aluminum | 13700 | 31200 | mg/kg | AFD-A-SB14-0-2 | 20/20 | 31200 | 4.7E+04 | 7.6E+03 N | No | BKG |
| | 7440393 | Barium | 44.4 | 735 | mg/kg | AFD-A-SB5-0-2 | 20/20 | 735 | 2.1E+02 | 5.4E+02 N | Yes | ASL |
| | 7440417 | Beryllium | 0.754 | 1.59 | mg/kg | AFD-A-SB14-0-2 | 10/20 | 1.59 | 2.1E+00 | 1.5E+01 N | No | BSL |
| | 7440702 | Calcium | 321 | 28200 | mg/kg | AFD-A-SB5-0-2 | 19/20 | 28200 | 1.9E+03 | N/A | No | NUT |
| | 7440473 | Chromium | 19.5 | 33.1 | mg/kg | AFD-A-SB6-0-2 | 20/20 | 33.1 | 8.0E+01 | 2.1E+02 C | No | BSL |
| | 7440484 | Cobalt | 4.5 | 50.2 | mg/kg | AFD-A-SB10-0-2 | 20/20 | 50.2 | 4.0E+01 | 1.6E+02 N | No | BSL |
| | 7440508 | Copper | 4.75 | 27.3 | mg/kg | AFD-A-SB2-0-2 | 20/20 | 27.3 | 3.6E+01 | 3.1E+02 N | No | BSL |
| | 7439896 | Iron | 20700 | 49700 | mg/kg | AFD-A-SB6-0-2 | 20/20 | 49700 | 5.2E+04 | 2.3E+03 N | No | BKG |
| | 7439921 | Lead [t] | 10.2 | 54.8 | mg/kg | AFD-A-SB10-0-2 | 11/20 | 54.8 | 5.0E+01 | 4.0E+02 N | No | BSL |
| | 7439954 | Magnesium | 1570 | 14800 | mg/kg | AFD-A-SB6-0-2 | 20/20 | 14800 | 6.6E+03 | N/A | No | NUT |
| | **7439965** | **Manganese** | **78.4** | **3710** | **mg/kg** | **AFD-A-SB5-0-2** | **20/20** | **3710** | **2.2E+03** | **1.8E+02 N** | **Yes** | **ASL** |
| | 7439976 | Mercury | 0.032 | 0.0829 | mg/kg | AFD-A-SB13-0-2 | 11/20 | 0.0829 | 3.0E-01 | 2.3E+00 N | No | BSL |
| | 7440020 | Nickel | 8.19 | 30.1 | mg/kg | AFD-A-SB4-0-2 | 12/20 | 30.1 | 5.7E+01 | 1.6E+02 N | No | BSL |
| | 7440097 | Potassium | 1050 | 4470 | mg/kg | AFD-A-SB14-0-2 | 20/20 | 4470 | 5.6E+03 | N/A | No | NUT |
| | 7440235 | Sodium | 18.5 | 75.2 | mg/kg | AFD-A-SB7-1-3 | 18/20 | 75.2 | N/A | N/A | No | NUT |
| | 7440622 | Vanadium | 19.8 | 51 | mg/kg | AFD-A-SB6-0-2 | 20/20 | 51 | 6.0E+01 | 5.5E+01 N | No | BSL |
| | 7440666 | Zinc | 26.8 | 58 | mg/kg | AFD-A-SB14-0-2 | 20/20 | 58 | 1.1E+02 | 2.3E+03 N | No | BSL |
| | Organic Semivolatiles | | | | | | | | | | | |
| | 120127 | Anthracene | 0.046 | 0.058 | mg/kg | AFD-A-SB5-0-2 | 3/20' | 0.058 | N/A | 2.2E+03 N | No | BSL |
| | 56553 | Benzo(a)anthracene | 0.068 | 0.2 | mg/kg | AFD-A-SB5-0-2 | 4/20' | 0.2 | N/A | 6.2E-01 C | No | BSL |
| | **50328** | **Benzo(a)pyrene** | **0.11** | **0.23** | **mg/kg** | **AFD-A-SB5-0-2** | **3/20'** | **0.23** | **N/A** | **6.2E-02 C** | **Yes** | **ASL** |
| | 205992 | Benzo(b)fluoranthene | 0.086 | 0.19 | mg/kg | AFD-A-SB15-0-2 | 4/20' | 0.19 | N/A | 6.2E-01 C | No | BSL |
| | 207089 | Benzo(k)fluoranthene | 0.11 | 0.26 | mg/kg | AFD-A-SB5-0-2 | 4/20' | 0.26 | N/A | 6.2E+00 C | No | BSL |
| | 117817 | Bis(2-ethylhexyl)phthalate | 0.79 | 0.79 | mg/kg | AFD-A-SB7-1-3 | 1/20' | 0.79 | N/A | 3.5E+01 C | No | BSL |
| | 218019 | Chrysene | 0.1 | 0.3 | mg/kg | AFD-A-SB5-0-2 | 5/20' | 0.3 | N/A | 6.2E+01 C | No | BSL |
| | 84742 | Di-n-butylphthalate | 0.084 | 1.9 | mg/kg | AFD-A-SB4-0-2 | 5/20' | 1.9 | N/A | 6.1E+02 N | No | BSL |
| | 206440 | Fluoranthene | 0.065 | 0.42 | mg/kg | AFD-A-SB15-0-2 | 6/20' | 0.42 | N/A | 2.3E+02 N | No | BSL |
| | 193395 | Indeno(1,2,3-cd)pyrene | 0.12 | 0.18 | mg/kg | AFD-A-SB5-0-2 | 2/20' | 0.18 | N/A | 6.2E-01 C | No | BSL |
| | 85018 | Phenanthrene | 0.062 | 0.2 | mg/kg | AFD-A-SB8-0-2 | 4/20' | 0.2 | N/A | 2.3E+02 N | No | BSL |
| | 129000 | Pyrene | 0.1 | 0.58 | mg/kg | AFD-A-SB5-0-2 | 6/20' | 0.58 | N/A | 2.3E+02 N | No | BSL |

**Table E-1, Occurrence, Distribution and Selection of Chemicals of Potential Concern (COPCs) (continued)**
**Surface Soil Residential**
**Site A**
**Y-12, Oak Ridge, TN**

Scenario Timeframe: Future
Medium: Surface Soil
Exposure Medium: Surface Soil

| Exposure Point | CAS Number | Chemical | Minimum [a] Concentration | Maximum [a] Concentration | Units | Location of Maximum Concentraion | Detection Frequency | Concentration Used for Screening [b] | Background Value [c] | Screening Toxicity Value [d] | COPC Flag | Rationale for [e] Contaminant Deletion or Selection |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Organic Volatiles | | | | | | | | | | | |
| | 78933 | 2-Butanone | 0.002 | 0.002 | mg/kg | AFD-A-SB1-1-3 | 1/20 | 0.002 | N/A | 7.3E+02 N | No | BSL |
| | 67641 | Acetone | 0.014 | 0.089 | mg/kg | AFD-A-SB5-0-2 | 2/20 | 0.089 | N/A | 1.6E+02 N | No | BSL |
| | 74839 | Bromomethane | 0.002 | 0.002 | mg/kg | AFD-A-SB1-1-3 | 2/20 | 0.002 | N/A | 3.9E-01 N | No | BSL |
| | 91203 | Naphthalene | 0.005 | 0.005 | mg/kg | AFD-A-SB15-0-2 | 1/1 | 0.005 | N/A | 5.6E+00 N | No | BSL |
| | Misc | | | | | | | | | | | |
| | 14797558 | Nitrate | 5.6 | 88 | mg/kg | AFD-A-SB15-0-2 | 8/20 | 88 | N/A | 1.3E+04 N | No | BSL |
| | Radiologica | | | | | | | | | | | |
| | 10045973 | Cesium-137 | -0.028 | 0.087 | pCi/g | AFD-A-SB5-0-2 | 20/20 | 0.087 | N/A | 5.1E+04 | No | BSL |
| | 15067284 | Lead-241 | 0.38 | 0.84 | pCi/g | AFD-A-SB16-0-2 | 20/20 | 0.84 | N/A | 4.6E+04 | No | BSL |
| | 13966002 | Potassium-40 | 9 | 24 | pCi/g | AFD-A-SB14-0-2 | 20/20 | 24 | N/A | 1.1E-01 | No | K |
| | **13982633** | **Radium-226 [g]** | **0.38** | **0.84** | **pCi/g** | **AFD-A-SB16-0-2** | **20/20** | **0.84** | **N/A** | **1.9E-01** | **Yes** | **ASL** |
| | 14274829 | Thorium-228 | 0.34 | 0.861 | pCi/g | AFD-A-SB9-0-2 | 20/20 | 0.861 | N/A | 2.4E+01 | No | BSL |
| | 14269637 | Thorium-230 | 0.127 | 0.465 | pCi/g | AFD-A-SB9-0-2 | 20/20 | 0.465 | N/A | 3.5E+00 | No | BSL |
| | N2608 | Thorium-232 | 0.228 | 0.687 | pCi/g | AFD-A-SB9-0-2 | 20/20 | 0.687 | N/A | 3.1E+00 | No | BSL |
| | 13966295 | Uranium-234 | 0.304 | 3.36 | pCi/g | AFD-A-SB6-0-2 | 20/20 | 3.36 | N/A | 4.0E+00 | No | BSL |
| | **15117961** | **Uranium-235** | **0.0232** | **0.392** | **pCi/g** | **AFD-A-SB14-0-2** | **20/20** | **0.392** | **N/A** | **2.1E-01** | **Yes** | **ASL** |
| | 24678828 | Uranium-238 | 0.0909 | 1.42 | pCi/g | AFD-A-SB1-1-3 | 20/20 | 1.42 | N/A | 4.5E+00 | No | BSL |

(a) Minimum/maximum detected concentration.
(b) Maximum concentration used as screening value.
(c) Background values presented in Y-12 Site-wide RI
(d) Screening Toxicity Value - Taken from USEPA Region 9 Preliminary Remediation Goals (PRGs) Table, USEPA, August 2002.
(e) Rationale Codes
Selection Reason: Above Screening Toxicity and Background Levels (ASL)
Deletion Reason: Essential Nutrient (NUT)
Below Screening Toxicity Level (BSL)
Below Individual Remediation Level (BIRL)
Potassium-40 is a naturally occurring radionuclide that is never considered site related. Predicted US background levels are 3-20 pCi/g (K)

N/A = Not Applicable
COPC = Chemical of Potential Concern
C = Carcinogenic
N = Non-Carcinogenic

(f) Lead is screened with values given in Office of Solid Waste and Emergency Response (OSWER) Directive #9355.4-12 (USEPA 1994c).
(g) Ra-226 activity was considered to be equal to Pb-214 activity as the two are assumed to be in secular equilibrium.
Surrogates used: pyrene for phenanthrene.

**Table E-2, Occurrence, Distribution and Selection of Chemicals of Potential Concern (COPCs)**
**Surface Soil Industrial**
**Site A**
**Y-12, Oak Ridge, TN**

Scenario Timeframe: Future
Medium: Surface Soil
Exposure Medium: Surface Soil

| Exposure Point | CAS Number | Chemical | Minimum [a] Concentration | Maximum [a] Concentration | Units | Location of Maximum Concentraion | Detection Frequency | Concentration Used for Screening [b] | Background Value [c] | Screening Toxicity Value [d] | COPC Flag | Rationale for [e] Contaminant Deletion or Selection |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Inorganics | | | | | | | | | | | |
| | 7429905 | Aluminum | 13700 | 31200 | mg/kg | AFD-A-SB14-0-2 | 20/20 | 31200 | 4.7E+04 | 1.0E+05 N | No | BSL |
| | 7440393 | Barium | 44.4 | 735 | mg/kg | AFD-A-SB5-0-2 | 20/20 | 735 | 2.1E+02 | 6.7E+03 N | No | BSL |
| | 7440417 | Beryllium | 0.754 | 1.59 | mg/kg | AFD-A-SB14-0-2 | 10/20 | 1.59 | 2.1E+00 | 1.9E+03 C | No | BSL |
| | 7440702 | Calcium | 321 | 28200 | mg/kg | AFD-A-SB5-0-2 | 19/20 | 28200 | 1.9E+03 | N/A | No | NUT |
| | 7440473 | Chromium | 19.5 | 33.1 | mg/kg | AFD-A-SB6-0-2 | 20/20 | 33.1 | 8.0E+01 | 4.5E+02 C | No | BSL |
| | 7440484 | Cobalt | 4.5 | 50.2 | mg/kg | AFD-A-SB10-0-2 | 20/20 | 50.2 | 4.0E+01 | 1.9E+03 C | No | BSL |
| | 7440508 | Copper | 4.75 | 27.3 | mg/kg | AFD-A-SB2-0-2 | 20/20 | 27.3 | 3.6E+01 | 4.1E+03 N | No | BSL |
| | 7439896 | Iron | 20700 | 49700 | mg/kg | AFD-A-SB6-0-2 | 20/20 | 49700 | 5.2E+04 | 1.0E+05 N | No | BSL |
| | 7439921 | Lead [(1)] | 10.2 | 54.8 | mg/kg | AFD-A-SB10-0-2 | 11/20 | 54.8 | 5.0E+01 | 7.5E+01 N | No | BSL |
| | 7439954 | Magnesium | 1570 | 14800 | mg/kg | AFD-A-SB6-0-2 | 20/20 | 14800 | 6.6E+03 | N/A | No | NUT |
| | **7439965** | **Manganese** | **78.4** | **3710** | **mg/kg** | **AFD-A-SB5-0-2** | **20/20** | **3710** | **2.2E+03** | **1.9E+03 N** | **Yes** | **ASL** |
| | 7439976 | Mercury | 0.032 | 0.0829 | mg/kg | AFD-A-SB13-0-2 | 11/20 | 0.0829 | 3.0E-01 | 3.1E+01 N | No | BSL |
| | 7440020 | Nickel | 8.19 | 30.1 | mg/kg | AFD-A-SB4-0-2 | 12/20 | 30.1 | 5.7E+01 | 2.0E+03 N | No | BSL |
| | 7440097 | Potassium | 1050 | 4470 | mg/kg | AFD-A-SB14-0-2 | 20/20 | 4470 | 5.6E+03 | N/A | No | NUT |
| | 7440235 | Sodium | 18.5 | 75.2 | mg/kg | AFD-A-SB7-1-3 | 18/20 | 75.2 | N/A | N/A | No | NUT |
| | 7440622 | Vanadium | 19.8 | 51 | mg/kg | AFD-A-SB6-0-2 | 20/20 | 51 | 6.0E+01 | 7.2E+02 N | No | BSL |
| | 7440666 | Zinc | 26.8 | 58 | mg/kg | AFD-A-SB14-0-2 | 20/20 | 58 | 1.1E+02 | 1.0E+05 N | No | BSL |
| | Organic Semivolatiles | | | | | | | | | | | |
| | 120127 | Anthracene | 0.046 | 0.058 | mg/kg | AFD-A-SB5-0-2 | 3/20' | 0.058 | N/A | 1.0E+05 N | No | BSL |
| | 56553 | Benzo(a)anthracene | 0.068 | 0.2 | mg/kg | AFD-A-SB5-0-2 | 4/20' | 0.2 | N/A | 2.1E+00 C | No | BSL |
| | 50328 | **Benzo(a)pyrene** | **0.11** | **0.23** | **mg/kg** | **AFD-A-SB5-0-2** | **3/20'** | **0.23** | **N/A** | **2.1E-01 C** | **Yes** | **ASL** |
| | 205992 | Benzo(b)fluoranthene | 0.086 | 0.19 | mg/kg | AFD-A-SB15-0-2 | 4/20' | 0.19 | N/A | 2.1E+00 C | No | BSL |
| | 207089 | Benzo(k)fluoranthene | 0.11 | 0.26 | mg/kg | AFD-A-SB5-0-2 | 4/20' | 0.26 | N/A | 2.1E+01 C | No | BSL |
| | 117817 | Bis(2-ethylhexyl)phthalate | 0.79 | 0.79 | mg/kg | AFD-A-SB7-1-3 | 1/20' | 0.79 | N/A | 1.2E+02 C | No | BSL |
| | 218019 | Chrysene | 0.1 | 0.3 | mg/kg | AFD-A-SB5-0-2 | 5/20' | 0.3 | N/A | 2.1E+02 C | No | BSL |
| | 84742 | Di-n-butylphthalate | 0.084 | 1.9 | mg/kg | AFD-A-SB4-0-2 | 5/20' | 1.9 | N/A | 6.2E+03 N | No | BSL |
| | 206440 | Fluoranthene | 0.065 | 0.42 | mg/kg | AFD-A-SB15-0-2 | 6/20' | 0.42 | N/A | 2.2E+03 N | No | BSL |
| | 193395 | Indeno(1,2,3-cd)pyrene | 0.12 | 0.18 | mg/kg | AFD-A-SB5-0-2 | 2/20' | 0.18 | N/A | 2.1E+00 C | No | BSL |
| | 85018 | Phenanthrene | 0.062 | 0.2 | mg/kg | AFD-A-SB8-0-2 | 4/20' | 0.2 | N/A | 2.9E+03 N | No | BSL |
| | 129000 | Pyrene | 0.1 | 0.58 | mg/kg | AFD-A-SB5-0-2 | 6/20' | 0.58 | N/A | 2.9E+03 N | No | BSL |

**Table E-2, Occurrence, Distribution and Selection of Chemicals of Potential Concern (COPCs) (continued)**
**Surface Soil Industrial**
**Site A**
**Y-12, Oak Ridge, TN**

Scenario Timeframe: Future
Medium: Surface Soil
Exposure Medium: Surface Soil

| Exposure Point | CAS Number | Chemical | Minimum [a] Concentration | Maximum [a] Concentration | Units | Location of Maximum Concentraion | Detection Frequency | Concentration Used for Screening [b] | Background Value [c] | Screening Toxicity Value [d] | COPC Flag | Rationale for [e] Contaminant Deletion or Selection |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Organic Volatiles | | | | | | | | | | | |
| | 78933 | 2-Butanone | 0.002 | 0.002 | mg/kg | AFD-A-SB1-1-3 | 1/20 | 0.002 | N/A | 2.7E+03 N | No | BSL |
| | 67641 | Acetone | 0.014 | 0.089 | mg/kg | AFD-A-SB5-0-2 | 2/20 | 0.089 | N/A | 6.0E+02 N | No | BSL |
| | 74839 | Bromomethane | 0.002 | 0.002 | mg/kg | AFD-A-SB1-1-3 | 2/20 | 0.002 | N/A | 1.3E+00 N | No | BSL |
| | 91203 | Naphthalene | 0.005 | 0.005 | mg/kg | AFD-A-SB15-0-2 | 1/1 | 0.005 | N/A | 1.9E+01 N | No | BSL |
| | Misc | | | | | | | | | | | |
| | 14797558 | Nitrate | 5.6 | 88 | mg/kg | AFD-A-SB15-0-2 | 8/20 | 88 | N/A | 1.6E+05 N | No | BSL |
| | Radiological | | | | | | | | | | | |
| | 10045973 | Cesium-137 | -0.028 | 0.087 | pCi/g | AFD-A-SB5-0-2 | 20/20 | 0.087 | N/A | 8.3E+04 | No | BSL |
| | 15067284 | Lead-241 | 0.38 | 0.84 | pCi/g | AFD-A-SB16-0-2 | 20/20 | 0.84 | N/A | 7.6E+04 | No | BSL |
| | 13966002 | Potassium-40 | 9 | 24 | pCi/g | AFD-A-SB14-0-2 | 20/20 | 24 | N/A | 2.7E-01 | No | K |
| | 13982633 | Radium-226 [g] | 0.38 | 0.84 | pCi/g | AFD-A-SB16-0-2 | 20/20 | 0.84 | N/A | 3.7E+00 | No | BSL |
| | 14274829 | Thorium-228 | 0.34 | 0.861 | pCi/g | AFD-A-SB9-0-2 | 20/20 | 0.861 | N/A | 1.3E+02 | No | BSL |
| | 14269637 | Thorium-230 | 0.127 | 0.465 | pCi/g | AFD-A-SB9-0-2 | 20/20 | 0.465 | N/A | 2.0E+01 | No | BSL |
| | N2608 | Thorium-232 | 0.228 | 0.687 | pCi/g | AFD-A-SB9-0-2 | 20/20 | 0.687 | N/A | 1.9E+01 | No | BSL |
| | 13966295 | Uranium-234 | 0.304 | 6.13 | pCi/g | AFD-A-SB6-0-2 | 20/20 | 6.13 | N/A | 3.2E+01 | No | BSL |
| | 15117961 | Uranium-235 | 0.0232 | 0.392 | pCi/g | AFD-A-SB14-0-2 | 20/20 | 0.392 | N/A | 4.2E-01 | No | BSL |
| | 24678828 | Uranium-238 | 0.0909 | 1.42 | pCi/g | AFD-A-SB1-1-3 | 20/20 | 1.42 | N/A | 3.7E+01 | No | BSL |

(a) Minimum/maximum detected concentration.
(b) Maximum concentration used as screening value.
(c) Background values presented in Y-12 Site-wide RI
(d) Screening Toxicity Value - Taken from USEPA Region 9 Preliminary Remediation Goals (PRGs) Table, USEPA, August 2004.
(e) Rationale Codes
Selection Reason: Above Screening Toxicity and Background Levels (ASL)
Deletion Reason: Essential Nutrient (NUT)
Below Screening Toxicity Level (BSL)
Below Individual Remediation Level (BIRL)

N/A = Not Applicable
COPC = Chemical of Potential Concern
C = Carcinogenic
N = Non-Carcinogenic

Potassium-40 is a naturally occurring radionuclide that is never considered site related. Predicted US background levels are 3-20 pCi/g (K)

(f) Lead is screened with values given in Office of Solid Waste and Emergency Response (OSWER) Directive #9355.4-12 (USEPA 1994c).
(g) Ra-226 activity was considered to be equal to Pb-214 activity as the two are assumed to be in secular equilibrium.
Surrogates used: pyrene for phenanthrene.

**Table E-3, Occurrence, Distribution and Selection of Chemicals of Potential Concern (COPCs)**
**Subsurface Soil– Residential**
**Site A**
**Y-12, Oak Ridge, TN**

Scenario Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil

| Exposure Point | CAS Number | Chemical | Minimum [a] Concentration (Qualifier) | Maximum [a] Concentration (Qualifier) | Units | Location of Maximum Concentraion | Detection Frequency | Concentration Used for Screening [b] | Background Value [c] | Screening Toxicity Value [d] | COPC Flag | Rationale for [e] Contaminant Deletion or Selection |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Inorganics | | | | | | | | | | | |
| | 7429905 | Aluminum | 15600 | 29200 | mg/kg | AFD-A-SB13-4-8 | 34/34 | 29200 | 4.7E+04 | 7.6E+03 N | No | BKG |
| | 7440393 | Barium | 80.3 | 526 | mg/kg | AFD-ASB8-22-26 | 34/34 | 526 | 2.1E+02 | 5.4E+02 N | No | BSL |
| | 7440417 | Beryllium | 0.82 | 1.47 | mg/kg | AFDASB15-12-16 | 17/34 | 1.47 | 2.1E+00 | 1.5E+01 N | No | BSL |
| | 7440702 | Calcium | 111 | 16100 | mg/kg | AFD-A-SB1-1-3 | 26/34 | 16100 | 1.9E+03 | N/A | No | NUT |
| | 7440473 | Chromium | 18.2 | 46.8 | mg/kg | AFDASB16-24-28 | 34/34 | 46.8 | 8.0E+01 | 2.1E+02 C | No | BSL |
| | 7440484 | Cobalt | 4.17 | 42.5 | mg/kg | AFD-ASB7-12-16 | 34/34 | 42.5 | 4.0E+01 | 1.6E+02 N | No | BSL |
| | 7440508 | Copper | 10.8 | 48.5 | mg/kg | AFD-A-SB6-8-12 | 34/34 | 48.5 | 3.6E+01 | 3.1E+02 N | No | BSL |
| | 7439896 | Iron | 20700 | 45500 | mg/kg | AFD-A-SB4-8-12 | 34/34 | 45500 | 5.2E+04 | 2.3E+03 N | No | BKG |
| | 7439921 | Lead [f] | 10.2 | 43.5 | mg/kg | AFD-ASB9-20-24 | 11/34 | 43.5 | 5.0E+01 | 4.0E+02 N | No | BSL |
| | 7439954 | Magnesium | 2240 | 9100 | mg/kg | AFD-A-SB1-1-3 | 34/34 | 9100 | 6.6E+03 | N/A | No | NUT |
| | **7439965** | **Manganese** | **43.3** | **9110** | **mg/kg** | **AFD-ASB7-12-16** | **34/34** | 9110 | **2.2E+03** | **1.8E+02 N** | **Yes** | **ASL** |
| | 7439976 | Mercury | 0.036 | 0.73 | mg/kg | AFD-A-SB1-4-8 | 5/34 | 0.73 | 3.0E-01 | 2.3E+00 N | No | BSL |
| | 7440020 | Nickel | 24.2 | 45.9 | mg/kg | AFDASB15-12-16 | 21/34 | 45.9 | 5.7E+01 | 1.6E+02 N | No | BSL |
| | 7440097 | Potassium | 2410 | 6100 | mg/kg | AFD-ASB8-12-16 | 34/34 | 6100 | 5.6E+03 | N/A | No | NUT |
| | 7440235 | Sodium | 40.9 | 115 | mg/kg | AFD-ASB8-12-16 | 33/34 | 115 | N/A | N/A | No | NUT |
| | 7440622 | Vanadium | 14.2 | 35.3 | mg/kg | AFD-A-SB3-4-8 | 34/34 | 35.3 | 6.0E+01 | 5.5E+01 N | No | BSL |
| | 7440666 | Zinc | 36.6 | 81.2 | mg/kg | AFDASB15-12-16 | 34/34 | 81.2 | 1.1E+02 | 2.3E+03 N | No | BSL |
| | PCBs | | | | | | | | | | | |
| | 11096825 | Aroclor 1260 | 0.028 | 0.028 | mg/kg | AFD-A-SB4-4-8 | 1/34 | 0.028 | N/A | 2.2E-01 C | No | BSL |
| | Organic Semivolatiles | | | | | | | | | | | |
| | 120127 | Anthracene | 0.039 | 0.012 | mg/kg | AFD-A-SB4-4-8 | 2/34 | 0.012 | N/A | 2.2E+03 N | No | BSL |
| | 56553 | Benzo(a)anthracene | 0.21 | 0.21 | mg/kg | AFD-A-SB4-4-8 | 1/34 | 0.21 | N/A | 6.2E-01 C | No | BSL |
| | **50328** | **Benzo(a)pyrene** | **0.24** | **0.9** | **mg/kg** | **AFD-A-SB2-8-12** | **3/34** | **0.9** | **N/A** | **6.2E-02 C** | **Yes** | **ASL** |
| | 205992 | Benzo(b)fluoranthene | 0.17 | 0.35 | mg/kg | AFD-A-SB2-8-12 | 2/34 | 0.35 | N/A | 6.2E-01 C | No | BSL |
| | 191242 | Benzo(ghi)perylene | 0.37 | 0.37 | mg/kg | AFD-A-SB2-8-12 | 1/34 | 0.37 | N/A | 2.3E+02 N | No | BSL |
| | 207089 | Benzo(k)fluoranthene | 0.2 | 0.27 | mg/kg | AFD-A-SB2-8-12 | 2/34 | 0.27 | N/A | 6.2E+00 C | No | BSL |
| | 117817 | Bis(2-ethylhexyl)phthalate | 0.79 | 0.79 | mg/kg | AFD-A-SB7-1-3 | 1/34 | 0.79 | N/A | 3.5E+01 C | No | BSL |
| | 218019 | Chrysene | 0.36 | 0.46 | mg/kg | AFD-A-SB2-8-12 | 2/34 | 0.46 | N/A | 6.2E+01 C | No | BSL |
| | 84742 | Di-n-butylphthalate | 0.09 | 0.49 | mg/kg | AFD-A-SB1-1-3 | 11/34 | 0.49 | N/A | 6.1E+02 N | No | BSL |
| | 206440 | Fluoranthene | 0.076 | 0.57 | mg/kg | AFD-A-SB4-4-8 | 4/34 | 0.57 | N/A | 2.3E+02 N | No | BSL |
| | 86737 | Fluorene | 0.049 | 0.049 | mg/kg | AFD-A-SB4-4-8 | 1/34 | 0.049 | N/A | 2.7E+02 N | No | BSL |
| | 193395 | Indeno(1,2,3-cd)pyrene | 0.15 | 0.29 | mg/kg | AFD-A-SB2-8-12 | 3/34 | 0.29 | N/A | 6.2E-01 C | No | BSL |
| | 85018 | Phenanthrene | 0.11 | 0.42 | mg/kg | AFD-A-SB4-4-8 | 3/34 | 0.42 | N/A | 2.3E+02 N | No | BSL |
| | 129000 | Pyrene | 0.073 | 1.1 | mg/kg | AFD-A-SB4-4-8 | 5/34 | 1.1 | N/A | 2.3E+02 N | No | BSL |

**Table E-3, Occurrence, Distribution and Selection of Chemicals of Potential Concern (COPCs) (continued)**
**Subsurface Soil– Residential**
**Site A**
**Y-12, Oak Ridge, TN**

Scenario Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil

| Exposure Point | CAS Number | Chemical | Minimum [a] Concentration (Qualifier) | Maximum [a] Concentration (Qualifier) | Units | Location of Maximum Concentraion | Detection Frequency | Concentration Used for Screening [b] | Background Value [c] | Screening Toxicity Value [d] | COPC Flag | Rationale for [e] Contaminant Deletion or Selection |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Organic Volatiles | | | | | | | | | | | |
| | 78933 | 2-Butanone | 0.002 | 0.005 | mg/kg | AFD-A-SB1-4-8 | 2/34 | 0.005 | N/A | 7.3E+02 N | No | BSL |
| | 108101 | 4-Methyl-2-pentanone | 0.001 | 0.001 | mg/kg | AFD-A-SB5-8-12 | 1/34 | 0.001 | N/A | 7.9E+01 N | No | BSL |
| | 67641 | Acetone | 0.003 | 0.063 | mg/kg | AFD-A-SB1-4-8 | 15/34 | 0.063 | N/A | 1.6E+02 N | No | BSL |
| | 74839 | Bromomethane | 0.002 | 0.006 | mg/kg | AFD-ASB8-22-26 | 4/34 | 0.006 | N/A | 3.9E-01 N | No | BSL |
| | Misc | | | | | | | | | | | |
| | 14797558 | Nitrate | 5 | 14.1 | mg/kg | AFD-A-SB3-8-12 | 9/32 | 14.1 | N/A | 1.3E+04 N | No | BSL |
| | Radiologicals | | | | | | | | | | | |
| | 10045973 | Cesium-137 | -0.038 | 0.046 | pCi/g | AFD-A-SB1-1-3 | 34/34 | 0.046 | N/A | 5.1E+04 | No | BSL |
| | 15067284 | Lead-241 | 0.32 | 0.69 | pCi/g | AFD-A-SB7-5-9 | 34/34 | 0.69 | N/A | 4.6E+04 | No | BSL |
| | 13966002 | Potassium-40 | 12 | 29 | pCi/g | AFD-ASB8-12-16 | 34/34 | 29 | N/A | 1.1E-01 | No | K |
| | **13982633** | **Radium-226 [g]** | **0.32** | **0.69** | **pCi/g** | **AFD-A-SB7-5-9** | **34/34** | **0.69** | **N/A** | **1.9E-01** | **Yes** | **ASL** |
| | 14274829 | Thorium-228 | 0.356 | 1.49 | pCi/g | AFD-ASB7-12-16 | 34/34 | 1.49 | N/A | 2.4E+01 | No | BSL |
| | 14269637 | Thorium-230 | 0.0393 | 0.509 | pCi/g | AFD-ASB8-22-26 | 34/34 | 0.509 | N/A | 3.5E+00 | No | BSL |
| | N2608 | Thorium-232 | 0.305 | 1.54 | pCi/g | AFD-ASB7-12-16 | 34/34 | 1.54 | N/A | 3.1E+00 | No | BSL |
| | 13966295 | Uranium-234 | 3.88 | 3.88 | pCi/g | AFD-A-SB4-4-8 | 34/34 | 3.88 | N/A | 4.0E+00 | No | BSL |
| | **15117961** | **Uranium-235** | **0.226** | **0.226** | **pCi/g** | **AFD-A-SB4-4-8** | **34/34** | **0.226** | **N/A** | **2.1E-01** | **Yes** | **ASL** |
| | 24678828 | Uranium-238 | 2.02 | 2.02 | pCi/g | AFD-A-SB4-4-8 | 34/34 | 2.02 | N/A | 4.5E+00 | No | BSL |

(a) Minimum/maximum detected concentration.
(b) Maximum concentration used as screening value.
(c) Background values presented in Y-12 Site-wide RI
(d) Screening Toxicity Value - Taken from USEPA Region 9 Preliminary Remediation Goals (PRGs) Table, USEPA, August 2004.
(e) Rationale Codes
Selection Reason: Above Screening Toxicity and Background Levels (ASL)
Deletion Reason: Essential Nutrient (NUT)
Below Screening Toxicity Level (BSL)
Below Individual Remediation Level (BIRL)
Potassium-40 is a naturally occurring radionuclide that is never considered site related. Predicted US background levels are 3-20 pCi/g (K)

N/A = Not Applicable
COPC = Chemical of Potential Concern
C = Carcinogenic
N = Non-Carcinogenic

(f) Lead is screened with values given in Office of Solid Waste and Emergency Response (OSWER) Directive #9355.4-12 (USEPA 1994c).
(g) Ra-226 activity was considered to be equal to Pb-214 activity as the two are assumed to be in secular equilibrium.
Surrogates used: pyrene for benzo[g,h,i]perylene and phenanthrene, napthalene for 2-methylnaphthalene, 1,3,5-trimethylbenzene for 1,2 -, 1,3- , and 1,4- dimethylbenzene, chloromethane for iodomethane.

**Table E-4, Occurrence, Distribution and Selection of Chemicals of Potential Concern (COPCs)**
**Subsurface Soil–Industrial**
**Site A**
**Y-12, Oak Ridge, TN**

Scenario Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil

| Exposure Point | CAS Number | Chemical | Minimum [a] Concentration (Qualifier) | Maximum [a] Concentration (Qualifier) | Units | Location of Maximum Concentraion | Detection Frequency | Concentration Used for Screening [b] | Background Value [c] | Screening Toxicity Value [d] | COPC Flag | Rationale for [e] Contaminant Deletion or Selection |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Inorganics | | | | | | | | | | | |
| | 7429905 | Aluminum | 15600 | 29200 | mg/kg | AFD-A-SB13-4-8 | 34/34 | 29200 | 4.7E+04 | 1.0E+05 N | No | BSL |
| | 7440393 | Barium | 80.3 | 526 | mg/kg | AFD-ASB8-22-26 | 34/34 | 526 | 2.1E+02 | 6.7E+03 N | No | BSL |
| | 7440417 | Beryllium | 0.82 | 1.47 | mg/kg | AFDASB15-12-16 | 17/34 | 1.47 | 2.1E+00 | 1.9E+03 C | No | BSL |
| | 7440702 | Calcium | 111 | 16100 | mg/kg | AFD-A-SB1-1-3 | 26/34 | 16100 | 1.9E+03 | N/A | No | NUT |
| | 7440473 | Chromium | 18.2 | 46.8 | mg/kg | AFDASB16-24-28 | 34/34 | 46.8 | 8.0E+01 | 4.5E+02 C | No | BSL |
| | 7440484 | Cobalt | 4.17 | 42.5 | mg/kg | AFD-ASB7-12-16 | 34/34 | 42.5 | 4.0E+01 | 1.9E+03 C | No | BSL |
| | 7440508 | Copper | 10.8 | 48.5 | mg/kg | AFD-A-SB6-8-12 | 34/34 | 48.5 | 3.6E+01 | 4.1E+03 N | No | BSL |
| | 7439896 | Iron | 20700 | 45500 | mg/kg | AFD-A-SB4-8-12 | 34/34 | 45500 | 5.2E+04 | 1.0E+05 N | No | BSL |
| | 7439921 | Lead [f] | 10.2 | 43.5 | mg/kg | AFD-ASB9-20-24 | 11/34 | 43.5 | 5.0E+01 | 7.5E+01 N | No | BSL |
| | 7439954 | Magnesium | 2240 | 9100 | mg/kg | AFD-A-SB1-1-3 | 34/34 | 9100 | 6.6E+03 | N/A | No | NUT |
| | **7439965** | **Manganese** | **43.3** | **9110** | **mg/kg** | **AFD-ASB7-12-16** | **34/34** | **9110** | **2.2E+03** | **1.9E+03 N** | **Yes** | **ASL** |
| | 7439976 | Mercury | 0.036 | 0.73 | mg/kg | AFD-A-SB1-4-8 | 5/34 | 0.73 | 3.0E-01 | 3.1E+01 N | No | BSL |
| | 7440020 | Nickel | 24.2 | 45.9 | mg/kg | AFDASB15-12-16 | 21/34 | 45.9 | 5.7E+01 | 2.0E+03 N | No | BSL |
| | 7440097 | Potassium | 2410 | 6100 | mg/kg | AFD-ASB8-12-16 | 34/34 | 6100 | 5.6E+03 | N/A | No | NUT |
| | 7440235 | Sodium | 40.9 | 115 | mg/kg | AFD-ASB8-12-16 | 33/34 | 115 | N/A | N/A | No | NUT |
| | 7440622 | Vanadium | 14.2 | 35.3 | mg/kg | AFD-A-SB3-4-8 | 34/34 | 35.3 | 6.0E+01 | 7.2E+02 N | No | BSL |
| | 7440666 | Zinc | 36.6 | 81.2 | mg/kg | AFDASB15-12-16 | 34/34 | 81.2 | 1.1E+02 | 1.0E+05 N | No | BSL |
| | PCBs | | | | | | | | | | | |
| | 11096825 | Aroclor 1260 | 0.028 | 0.028 | mg/kg | AFD-A-SB4-4-8 | 1/34 | 0.028 | N/A | 2.2E-01 C | No | BSL |
| | Organic Semivolatiles | | | | | | | | | | | |
| | 120127 | Anthracene | 0.039 | 0.012 | mg/kg | AFD-A-SB4-4-8 | 2/34 | 0.012 | N/A | 1.0E+05 N | No | BSL |
| | 56553 | Benzo(a)anthracene | 0.21 | 0.21 | mg/kg | AFD-A-SB4-4-8 | 1/34 | 0.21 | N/A | 2.1E+00 C | No | BSL |
| | **50328** | **Benzo(a)pyrene** | **0.24** | **0.9** | **mg/kg** | **AFD-A-SB2-8-12** | **2/34** | **0.9** | **N/A** | **2.1E-01 C** | **Yes** | **ASL** |
| | 205992 | Benzo(b)fluoranthene | 0.17 | 0.35 | mg/kg | AFD-A-SB2-8-12 | 2/34 | 0.35 | N/A | 2.1E+00 C | No | BSL |
| | 191242 | Benzo(ghi)perylene | 0.37 | 0.37 | mg/kg | AFD-A-SB2-8-12 | 1/34 | 0.37 | N/A | 2.9E+03 N | No | BSL |
| | 207089 | Benzo(k)fluoranthene | 0.2 | 0.27 | mg/kg | AFD-A-SB2-8-12 | 2/34 | 0.27 | N/A | 2.1E+01 C | No | BSL |
| | 117817 | Bis(2-ethylhexyl)phthalate | 0.79 | 0.79 | mg/kg | AFD-A-SB7-1-3 | 1/34 | 0.79 | N/A | 1.2E+02 C | No | BSL |
| | 218019 | Chrysene | 0.36 | 0.46 | mg/kg | AFD-A-SB2-8-12 | 2/34 | 0.46 | N/A | 2.1E+02 C | No | BSL |
| | 84742 | Di-n-butylphthalate | 0.09 | 0.49 | mg/kg | AFD-A-SB1-1-3 | 11/34 | 0.49 | N/A | 6.2E+03 N | No | BSL |
| | 206440 | Fluoranthene | 0.076 | 0.57 | mg/kg | AFD-A-SB4-4-8 | 4/34 | 0.57 | N/A | 2.2E+03 N | No | BSL |
| | 86737 | Fluorene | 0.049 | 0.049 | mg/kg | AFD-A-SB4-4-8 | 1/34 | 0.049 | N/A | 2.6E+03 N | No | BSL |
| | 193395 | Indeno(1,2,3-cd)pyrene | 0.15 | 0.29 | mg/kg | AFD-A-SB2-8-12 | 3/34 | 0.29 | N/A | 2.1E+00 C | No | BSL |
| | 85018 | Phenanthrene | 0.11 | 0.42 | mg/kg | AFD-A-SB4-4-8 | 3/34 | 0.42 | N/A | 2.9E+03 N | No | BSL |
| | 129000 | Pyrene | 0.073 | 1.1 | mg/kg | AFD-A-SB4-4-8 | 5/34 | 1.1 | N/A | 2.9E+03 N | No | BSL |

**Table E-4, Occurrence, Distribution and Selection of Chemicals of Potential Concern (COPCs) (continued)**
**Subsurface Soil–Industrial**
**Site A**
**Y-12, Oak Ridge, TN**

Scenario Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil

| Exposure Point | CAS Number | Chemical | Minimum [a] Concentration (Qualifier) | Maximum [a] Concentration (Qualifier) | Units | Location of Maximum Concentraion | Detection Frequency | Concentration Used for Screening [b] | Background Value [c] | Screening Toxicity Value [d] | COPC Flag | Rationale for [e] Contaminant Deletion or Selection |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Organic Volatiles | | | | | | | | | | | |
| | 78933 | 2-Butanone | 0.002 | 0.005 | mg/kg | AFD-A-SB1-4-8 | 2/34 | 0.005 | N/A | 2.7E+03 N | No | BSL |
| | 108101 | 4-Methyl-2-pentanone | 0.001 | 0.001 | mg/kg | AFD-A-SB5-8-12 | 1/34 | 0.001 | N/A | 2.8E+02 N | No | BSL |
| | 67641 | Acetone | 0.003 | 0.063 | mg/kg | AFD-A-SB1-4-8 | 15/34 | 0.063 | N/A | 6.0E+02 N | No | BSL |
| | 74839 | Bromomethane | 0.002 | 0.006 | mg/kg | AFD-ASB8-22-26 | 4/34 | 0.006 | N/A | 1.3E+00 N | No | BSL |
| | Misc | | | | | | | | | | | |
| | 14797558 | Nitrate | 5 | 14.1 | mg/kg | AFD-A-SB3-8-12 | 9/32 | 14.1 | N/A | 1.6E+05 N | No | BSL |
| | Radiologicals | | | | | | | | | | | |
| | 10045973 | Cesium-137 | -0.038 | 0.046 | pCi/g | AFD-A-SB1-1-3 | 34/34 | 0.046 | N/A | 8.3E+04 | No | BSL |
| | 15067284 | Lead-241 | 0.32 | 0.69 | pCi/g | AFD-A-SB7-5-9 | 34/34 | 0.69 | N/A | 7.6E+04 | No | BSL |
| | 13966002 | Potassium-40 | 12 | 29 | pCi/g | AFD-ASB8-12-16 | 34/34 | 29 | N/A | 2.7E-01 | No | K |
| | 13982633 | Radium-226 [g] | 0.32 | 0.69 | pCi/g | AFD-A-SB7-5-9 | 34/34 | 0.69 | N/A | 3.7E+00 | No | BSL |
| | 14274829 | Thorium-228 | 0.356 | 1.49 | pCi/g | AFD-ASB7-12-16 | 34/34 | 1.49 | N/A | 1.3E+02 | No | BSL |
| | 14269637 | Thorium-230 | 0.0393 | 0.509 | pCi/g | AFD-ASB8-22-26 | 34/34 | 0.509 | N/A | 2.0E+01 | No | BSL |
| | N2608 | Thorium-232 | 0.305 | 1.54 | pCi/g | AFD-ASB7-12-16 | 34/34 | 1.54 | N/A | 1.9E+01 | No | BSL |
| | 13966295 | Uranium-234 | 3.88 | 3.88 | pCi/g | AFD-A-SB4-4-8 | 34/34 | 3.88 | N/A | 3.2E+01 | No | BSL |
| | 15117961 | Uranium-235 | 0.226 | 0.226 | pCi/g | AFD-A-SB4-4-8 | 34/34 | 0.226 | N/A | 4.2E-01 | No | BSL |
| | 24678828 | Uranium-238 | 2.02 | 2.02 | pCi/g | AFD-A-SB4-4-8 | 34/34 | 2.02 | N/A | 3.7E+01 | No | BSL |

(a) Minimum/maximum detected concentration.
(b) Maximum concentration used as screening value.
(c) Background values presented in Y-12 Site-wide RI
(d) Screening Toxicity Value - Taken from USEPA Region 9 Preliminary Remediation Goals (PRGs) Table, USEPA, August 2004.
(e) Rationale Codes
Selection Reason: Above Screening Toxicity and Background Levels (ASL)
Deletion Reason: Essential Nutrient (NUT)
Below Screening Toxicity Level (BSL)
Below Individual Remediation Level (BIRL)
Potassium-40 is a naturally occurring radionuclide that is never considered site related. Predicted US background levels are 3-20 pCi/g (K)

N/A = Not Applicable
COPC = Chemical of Potential Concern
C = Carcinogenic
N = Non-Carcinogenic

(f) Lead is screened with values given in Office of Solid Waste and Emergency Response (OSWER) Directive #9355.4-12 (USEPA 1994c).
(g) Ra-226 activity was considered to be equal to Pb-214 activity as the two are assumed to be in secular equilibrium.
Surrogates used: pyrene for benzo[g,h,i]perylene and phenanthrene.

**Table E-5, Occurrence, Distribution and Selection of Chemicals of Potential Concern (COPCs)**
**Surface Soil–Residential**
**Site B**
**Y-12, Oak Ridge, TN**

Scenario Timeframe: Future
Medium: Surface Soil
Exposure Medium: Surface Soil

| Exposure Point | CAS Number | Chemical | Minimum [a] Concentration | Maximum [a] Concentration | Units | Location of Maximum Concentraion | Detection Frequency | Concentration Used for Screening [b] | Background Value [c] | Screening Toxicity Value [d] | | COPC Flag | Rationale for [e] Contaminant Deletion or Selection |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Inorganics | | | | | | | | | | | | |
| | 7429905 | Aluminum | 12100 | 31000 | mg/kg | AFDBSB10-0-1.5 | 23/23 | 31000 | 4.7E+04 | 7.6E+03 | N | No | BKG |
| | 7440393 | Barium | 38.1 | 273 | mg/kg | AFD-B-SB15-0-2 | 23/23 | 273 | 2.1E+02 | 5.4E+02 | N | No | BSL |
| | 7440417 | Beryllium | 0.334 | 1.44 | mg/kg | AFD-B-SB15-0-2 | 23/23 | 1.44 | 2.1E+00 | 1.5E+01 | N | No | BSL |
| | 7440439 | Cadmium | 1.33 | 1.33 | mg/kg | AFD-B-SB4-0-2 | 1/23 | 1.33 | N/A | 3.7E+00 | N | No | BSL |
| | 7440702 | Calcium | 408 | 86200 | mg/kg | AFD-B-SB7-0-2 | 23/23 | 86200 | 1.9E+03 | N/A | | No | NUT |
| | 7440473 | Chromium | 13.5 | 89.7 | mg/kg | AFD-B-SB4-0-2 | 23/23 | 89.7 | 8.0E+01 | 2.1E+02 | C | No | BSL |
| | 7440484 | Cobalt | 4.33 | 44.7 | mg/kg | AFD-B-SB9-0-2 | 23/23 | 44.7 | 4.0E+01 | 1.6E+02 | N | No | BSL |
| | 7440508 | Copper | 5.78 | 28.4 | mg/kg | AFDBSB16-0-1.5 | 22/23 | 28.4 | 3.6E+01 | 3.1E+02 | N | No | BSL |
| | 7439896 | **Iron** | **14800** | **70100** | **mg/kg** | **AFD-B-SB15-0-2** | **23/23** | **70100** | **5.2E+04** | **2.3E+03** | **N** | **Yes** | **ASL** |
| | 7439921 | Lead [(1)] | 11.1 | 45.3 | mg/kg | AFD-B-SB15-0-2 | 20/23 | 45.3 | 5.0E+01 | 4.0E+02 | N | No | BSL |
| | 7439954 | Magnesium | 1020 | 17000 | mg/kg | AFD-B-SB4-0-2 | 23/23 | 17000 | 6.6E+03 | N/A | | No | NUT |
| | 7439965 | **Manganese** | **144** | **3480** | **mg/kg** | **AFD-B-SB15-0-2** | **23/23** | **3480** | **2.2E+03** | **1.8E+02** | **N** | **Yes** | **ASL** |
| | 7439976 | **Mercury** | **0.0339** | **12.6** | **mg/kg** | **AFD-B-SB12-0-2** | **15/23** | **12.6** | **3.0E-01** | **2.3E+00** | **N** | **Yes** | **ASL** |
| | 7440020 | Nickel | 8.09 | 44.8 | mg/kg | AFDBSB10-0-1.5 | 22/23 | 44.8 | 5.7E+01 | 1.6E+02 | N | No | BSL |
| | 7440097 | Potassium | 921 | 4170 | mg/kg | AFD-B-SB14-0-2 | 22/23 | 4170 | 5.6E+03 | N/A | | No | NUT |
| | 7440235 | Sodium | 23 | 84.2 | mg/kg | AFD-B-SB14-0-2 | 20/23 | 84.2 | N/A | N/A | | No | NUT |
| | 7440622 | Vanadium | 17.4 | 41.2 | mg/kg | AFD-B-SB15-0-2 | 23/23 | 41.2 | 6.0E+01 | 5.5E+01 | N | No | BSL |
| | 7440666 | Zinc | 17.3 | 320 | mg/kg | AFD-B-SB4-0-2 | 22/23 | 320 | 1.1E+02 | 2.3E+03 | N | No | BSL |
| | Organic Semivolatiles | | | | | | | | | | | | |
| | 91576 | 2-Methylnaphthalene | 0.044 | 2.8 | mg/kg | AFD-B-SB14-0-2 | 16/23 | 2.8 | N/A | 5.6E+00 | N | No | BSL |
| | 95487 | 2-Methylphenol | 0.047 | 0.047 | mg/kg | AFD-B-SB14-0-2 | 1/23 | 0.047 | N/A | 3.1E+02 | N | No | BSL |
| | 120127 | Anthracene | 0.078 | 0.078 | mg/kg | AFD-B-SB14-0-2 | 1/23 | 0.078 | N/A | 2.2E+03 | N | No | BSL |
| | 56553 | Benzo(a)anthracene | 0.062 | 0.25 | mg/kg | AFD-B-SB7-0-2 | 9/23 | 0.25 | N/A | 6.2E-01 | C | No | BSL |
| | 50328 | **Benzo(a)pyrene** | **0.051** | **0.25** | **mg/kg** | **AFD-B-SB7-0-2** | **8/23** | **0.25** | **N/A** | **6.2E-02** | **C** | **Yes** | **ASL** |
| | 205992 | Benzo(b)fluoranthene | 0.084 | 0.26 | mg/kg | AFD-B-SB7-0-2 | 6/23 | 0.26 | N/A | 6.2E-01 | C | No | BSL |
| | 191242 | Benzo(ghi)perylene | 0.19 | 0.24 | mg/kg | AFDBSB16-0-1.5 | 3/23 | 0.24 | N/A | 2.3E+02 | N | No | BSL |
| | 207089 | Benzo(k)fluoranthene | 0.071 | 0.27 | mg/kg | AFDBSB10-0-1.5 | 6/23 | 0.27 | N/A | 6.2E+00 | C | No | BSL |
| | 65850 | Benzoic acid | 0.12 | 0.12 | mg/kg | AFD-B-SB14-0-2 | 1/23 | 0.12 | N/A | 1.0E+05 | N | No | BSL |
| | 86748 | Carbazole | 0.09 | 0.09 | mg/kg | AFD-B-SB14-0-2 | 1/23 | 0.09 | N/A | 2.4E+01 | C | No | BSL |
| | 218019 | Chrysene | 0.076 | 0.38 | mg/kg | AFD-B-SB7-0-2 | 9/23 | 0.38 | N/A | 6.2E+01 | C | No | BSL |
| | 132649 | Dibenzofuran | 0.078 | 0.76 | mg/kg | AFD-B-SB14-0-2 | 9/23 | 0.76 | N/A | 2.9E+01 | N | No | BSL |
| | 84742 | Di-n-butylphthalate | 0.1 | 0.49 | mg/kg | AFD-B-SB15-0-2 | 7/23 | 0.49 | N/A | 6.1E+02 | N | No | BSL |
| | 206440 | Fluoranthene | 0.1 | 0.35 | mg/kg | AFDBSB10-0-1.5 | 9/23 | 0.35 | N/A | 2.3E+02 | N | No | BSL |
| | 193395 | Indeno(1,2,3-cd)pyrene | 0.097 | 0.2 | mg/kg | AFD-B-SB7-0-2 | 4/23 | 0.2 | N/A | 6.2E-01 | C | No | BSL |
| | 91203 | Naphthalene | 0.038 | 2.5 | mg/kg | AFD-B-SB14-0-2 | 16/23 | 2.5 | N/A | 5.6E+00 | N | No | ASL |
| | 85018 | Phenanthrene | 0.055 | 1.3 | mg/kg | AFD-B-SB14-0-2 | 14/23 | 1.3 | N/A | 2.3E+02 | N | No | BSL |
| | 129000 | Pyrene | 0.14 | 0.49 | mg/kg | AFD-B-SB7-0-2 | 9/23 | 0.49 | N/A | 2.3E+02 | N | No | BSL |

**Table E-5, Occurrence, Distribution and Selection of Chemicals of Potential Concern (COPCs) (continued)**
**Surface Soil–Residential**
**Site B**
**Y-12, Oak Ridge, TN**

Scenario Timeframe: Future
Medium: Surface Soil
Exposure Medium: Surface Soil

| Exposure Point | CAS Number | Chemical | Minimum [a] Concentration | Maximum [a] Concentration | Units | Location of Maximum Concentraion | Detection Frequency | Concentration Used for Screening [b] | Background Value [c] | Screening Toxicity Value [d] | COPC Flag | Rationale for [e] Contaminant Deletion or Selection |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PCBs | | | | | | | | | | | |
| | 11096825 | Aroclor 1260 | 0.081 | 0.15 | mg/kg | AFD-B-SB5-0-2 | 5/23 | 0.15 | N/A | 2.2E-01 C | No | BSL |
| | Organic Volatiles | | | | | | | | | | | |
| | 76131 | 1,1,2-Trichloro-1,2,2-trifluoroethane | 0.005 | 0.006 | mg/kg | AFD-B-SB14-0-2 | 2/23 | 0.006 | N/A | 5.6E+03 N | No | BSL |
| | 95476 | 1,2-Dimethylbenzene | 0.002 | 0.007 | mg/kg | AFDBSB17-0-1.5 | 5/23 | 0.007 | N/A | 2.1E+00 N | No | BSL |
| | N2813 | 1,3- and 1,4-Dimethylbenzene | 0.002 | 0.011 | mg/kg | AFDBSB17-0-1.5 | 6/23 | 0.011 | N/A | 2.1E+00 N | No | BSL |
| | 67641 | Acetone | 0.003 | 0.024 | mg/kg | AFD-B-SB7-0-2 | 5/23 | 0.024 | N/A | 1.6E+02 N | No | BSL |
| | 71432 | Benzene | 0.001 | 0.003 | mg/kg | AFD-B-SB7-0-2/AFDBSB17-0-1.5 | 5/23 | 0.003 | N/A | 6.0E-01 C | No | BSL |
| | 74839 | Bromomethane | 0.002 | 0.005 | mg/kg | AFD-B-SB7-0-2/AFD-B-SB4-0-2/AFD-B-SB14-0-2 | 17/23 | 0.005 | N/A | 3.9E-01 N | No | BSL |
| | 124389 | Carbon dioxide | 0.095 | 0.095 | mg/kg | AFD-B-SB3-0-2 | 1/23 | 0.095 | N/A | Not recognized as a human health hazard | No | BSL |
| | 74873 | Chloromethane | 0.003 | 0.003 | mg/kg | AFD-B-SB7-0-2 | 7/23 | 0.003 | N/A | 1.2E+00 C | No | BSL |
| | 75718 | Dichlorodifluoromethane | 0.004 | 0.004 | mg/kg | AFD-B-SB7-0-2 | 1/23 | 0.004 | N/A | 9.4E+00 N | No | BSL |
| | 100414 | Ethylbenzene | 0.001 | 0.002 | mg/kg | AFDBSB17-0-1.5 | 2/23 | 0.002 | N/A | 8.9E+00 C | No | BSL |
| | 74884 | Iodomethane | 0.009 | 0.009 | mg/kg | AFD-B-SB4-0-2 | 1/23 | 0.009 | N/A | 1.2E+00 C | No | BSL |
| | 75092 | Methylene chloride | 0.005 | 0.005 | mg/kg | AFDBSB10-0-1.5 | 1/23 | 0.005 | N/A | 9.1E+00 C | No | BSL |
| | 108883 | Toluene | 0.001 | 0.015 | mg/kg | AFD-B-SB7-0-2 | 7/23 | 0.015 | N/A | 5.2E+02 N | No | BSL |
| | 1330207 | Total Xylene | 0.005 | 0.019 | mg/kg | AFDBSB17-0-1.5 | 5/23 | 0.019 | N/A | 2.7E+01 N | No | BSL |
| | Misc | | | | | | | | | | | |
| | 14797558 | Nitrate | 5 | 14.2 | mg/kg | AFD-B-SB5-0-2 | 8/23 | 14.2 | N/A | 1.3E+04 N | No | BSL |
| | Radiologicals | | | | | | | | | | | |
| | 10045973 | Cesium-137 | -0.037 | 0.3 | pCi/g | AFDBSB16-0-1.5 | 23/23 | 0.3 | N/A | 5.1E+04 | No | BSL |
| | 15067284 | Lead-241 | 0.43 | 0.96 | pCi/g | AFD-B-SB5-0-2 | 23/23 | 0.96 | N/A | 4.6E+04 | No | BSL |
| | 13966002 | Potassium-40 | 5.6 | 18 | pCi/g | AFD-B-SB14-0-2 | 23/23 | 18 | N/A | 1.1E-01 | No | K |
| | **13982633** | **Radium-226 [g]** | **0.43** | **0.96** | **pCi/g** | **AFD-B-SB5-0-2** | **23/23** | **0.96** | **N/A** | **1.9E-01** | **Yes** | **ASL** |
| | 14274829 | Thorium-228 | 0.335 | 0.921 | pCi/g | AFDBSB10-0-1.5 | 23/23 | 0.921 | N/A | 2.4E+01 | No | BSL |
| | 14269637 | Thorium-230 | 0.178 | 0.522 | pCi/g | AFDBSB17-0-1.5 | 23/23 | 0.522 | N/A | 3.5E+00 | No | BSL |
| | N2608 | Thorium-232 | 0.177 | 0.786 | pCi/g | AFD-B-SB18-0-2 | 23/23 | 0.786 | N/A | 3.1E+00 | No | BSL |
| | 13966295 | Uranium-234 | 0.274 | 1.11 | pCi/g | AFD-B-SB5-0-2 | 23/23 | 1.11 | N/A | 4.0E+00 | No | BSL |
| | 15117961 | Uranium-235 | -0.01 | 0.152 | pCi/g | AFDBSB17-0-1.5 | 23/23 | 0.152 | N/A | 2.1E-01 | No | BSL |
| | 24678828 | Uranium-238 | 0.0861 | 0.69 | pCi/g | AFD-B-SB12-0-2 | 23/23 | 0.69 | N/A | 4.5E+00 | No | BSL |

(a) Minimum/maximum detected concentration.
(b) Maximum concentration used as screening value.
(c) Background values presented in Y-12 Site-wide RI
(d) Screening Toxicity Value - Taken from USEPA Region 9 Preliminary Remediation Goals (PRGs) Table, USEPA, August 2004.
(e) Rationale Codes
Selection Reason: Above Screening Toxicity and Background Levels (ASL)
Deletion Reason: Essential Nutrient (NUT)
Below Screening Toxicity Level (BSL)
Below Individual Remediation Level (BIRL)
Potassium-40 is a naturally occurring radionuclide that is never considered site related. Predicted US background levels are 3-20 pCi/g (K)

N/A = Not Applicable
COPC = Chemical of Potential Concern
C = Carcinogenic
N = Non-Carcinogenic

(f) Lead is screened with values given in Office of Solid Waste and Emergency Response (OSWER) Directive #9355.4-12 (USEPA 1994c).
(g) Ra-226 activity was considered to be equal to Pb-214 activity as the two are assumed to be in secular equilibrium.
Surrogates used: pyrene for benzo[g,h,i]perylene and phenanthrene, napthalene for 2-methylnaphthalene, 1,3,5-trimethylbenzene for 1,2 -, 1,3- , and 1,4- dimethylbenzene, chloromethane for iodomethane.

**Table E-6, Occurrence, Distribution and Selection of Chemicals of Potential Concern (COPCs)**
**Surface Soil–Industrial**
**Site B**
**Y-12, Oak Ridge, TN**

Scenario Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil

| Exposure Point | CAS Number | Chemical | Minimum [a] Concentration | Maximum [a] Concentration | Units | Location of Maximum Concentraion | Detection Frequency | Concentration Used for Screening [b] | Background Value [c] | Screening Toxicity Value [d] | | COPC Flag | Rationale for [f] Contaminant Deletion or Selection |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Inorganics | | | | | | | | | | | | |
| | 7429905 | Aluminum | 12100 | 31000 | mg/kg | AFDBSB10-0-1.5 | 23/23 | 31000 | 4.7E+04 | 1.0E+05 | N | No | BSL |
| | 7440393 | Barium | 38.1 | 273 | mg/kg | AFD-B-SB15-0-2 | 23/23 | 273 | 2.1E+02 | 6.7E+03 | N | No | BSL |
| | 7440417 | Beryllium | 0.334 | 1.44 | mg/kg | AFD-B-SB15-0-2 | 23/23 | 1.44 | 2.1E+00 | 1.9E+03 | C | No | BSL |
| | 7440439 | Cadmium | 1.33 | 1.33 | mg/kg | AFD-B-SB4-0-2 | 1/23 | 1.33 | N/A | 4.5E+01 | N | No | BSL |
| | 7440702 | Calcium | 408 | 86200 | mg/kg | AFD-B-SB7-0-2 | 23/23 | 86200 | 1.9E+03 | N/A | | No | NUT |
| | 7440473 | Chromium | 13.5 | 89.7 | mg/kg | AFD-B-SB4-0-2 | 23/23 | 89.7 | 8.0E+01 | 4.5E+02 | C | No | BSL |
| | 7440484 | Cobalt | 4.33 | 44.7 | mg/kg | AFD-B-SB9-0-2 | 23/23 | 44.7 | 4.0E+01 | 1.9E+03 | C | No | BSL |
| | 7440508 | Copper | 5.78 | 28.4 | mg/kg | AFDBSB16-0-1.5 | 22/23 | 28.4 | 3.6E+01 | 4.1E+03 | N | No | BSL |
| | 7439896 | Iron | 14800 | 70100 | mg/kg | AFD-B-SB15-0-2 | 23/23 | 70100 | 5.2E+04 | 1.0E+05 | N | No | BSL |
| | 7439921 | Lead [(1)] | 11.1 | 45.3 | mg/kg | AFD-B-SB15-0-2 | 20/23 | 45.3 | 5.0E+01 | 7.5E+01 | N | No | BSL |
| | 7439954 | Magnesium | 1020 | 17000 | mg/kg | AFD-B-SB4-0-2 | 23/23 | 17000 | 6.6E+03 | N/A | | No | NUT |
| | 7439965 | Manganese | 144 | 3480 | mg/kg | AFD-B-SB15-0-2 | 23/23 | 3480 | 2.2E+03 | 1.9E+03 | N | Yes | ASL |
| | 7487947 | Mercury | 0.0339 | 12.6 | mg/kg | AFD-B-SB12-0-2 | 15/23 | 12.6 | 3.0E-01 | 3.1E+01 | N | No | BSL |
| | 7440020 | Nickel | 8.09 | 44.8 | mg/kg | AFDBSB10-0-1.5 | 22/23 | 44.8 | 5.7E+01 | 2.0E+03 | N | No | BSL |
| | 7440097 | Potassium | 921 | 4170 | mg/kg | AFD-B-SB14-0-2 | 22/23 | 4170 | 5.6E+03 | N/A | | No | NUT |
| | 7440235 | Sodium | 23 | 84.2 | mg/kg | AFD-B-SB14-0-2 | 20/23 | 84.2 | N/A | N/A | | No | NUT |
| | 7440622 | Vanadium | 17.4 | 41.2 | mg/kg | AFD-B-SB15-0-2 | 23/23 | 41.2 | 6.0E+01 | 7.2E+02 | N | No | BSL |
| | 7440666 | Zinc | 17.3 | 320 | mg/kg | AFD-B-SB4-0-2 | 22/23 | 320 | 1.1E+02 | 1.0E+05 | N | No | BSL |
| | Organic Semivolatiles | | | | | | | | | | | | |
| | 91576 | 2-Methylnaphthalene | 0.044 | 2.8 | mg/kg | AFD-B-SB14-0-2 | 16/23 | 2.8 | N/A | 1.9E+01 | N | No | BSL |
| | 95487 | 2-Methylphenol | 0.047 | 0.047 | mg/kg | AFD-B-SB14-0-2 | 1/23 | 0.047 | N/A | 3.1E+03 | N | No | BSL |
| | 120127 | Anthracene | 0.078 | 0.078 | mg/kg | AFD-B-SB14-0-2 | 1/23 | 0.078 | N/A | 1.0E+05 | N | No | BSL |
| | 56553 | Benzo(a)anthracene | 0.062 | 0.25 | mg/kg | AFD-B-SB7-0-2 | 9/23 | 0.25 | N/A | 2.1E+00 | C | No | BSL |
| | 50328 | Benzo(a)pyrene | 0.051 | 0.25 | mg/kg | AFD-B-SB7-0-2 | 8/23 | 0.25 | N/A | 2.1E-01 | C | Yes | ASL |
| | 205992 | Benzo(b)fluoranthene | 0.084 | 0.26 | mg/kg | AFD-B-SB7-0-2 | 6/23 | 0.26 | N/A | 2.1E+00 | C | No | BSL |
| | 191242 | Benzo(ghi)perylene | 0.19 | 0.24 | mg/kg | AFDBSB16-0-1.5 | 3/23 | 0.24 | N/A | 2.9E+03 | N | No | BSL |
| | 207089 | Benzo(k)fluoranthene | 0.071 | 0.27 | mg/kg | AFDBSB10-0-1.5 | 6/23 | 0.27 | N/A | 2.1E+01 | C | No | BSL |
| | 65850 | Benzoic acid | 0.12 | 0.12 | mg/kg | AFD-B-SB14-0-2 | 1/23 | 0.12 | N/A | 1.0E+05 | N | No | BSL |
| | 86748 | Carbazole | 0.09 | 0.09 | mg/kg | AFD-B-SB14-0-2 | 1/23 | 0.09 | N/A | 8.6E+01 | C | No | BSL |
| | 218019 | Chrysene | 0.076 | 0.38 | mg/kg | AFD-B-SB7-0-2 | 9/23 | 0.38 | N/A | 2.1E+02 | C | No | BSL |
| | 132649 | Dibenzofuran | 0.078 | 0.76 | mg/kg | AFD-B-SB14-0-2 | 9/23 | 0.76 | N/A | 3.1E+02 | N | No | BSL |
| | 84742 | Di-n-butylphthalate | 0.1 | 0.49 | mg/kg | AFD-B-SB15-0-2 | 7/23 | 0.49 | N/A | 6.2E+03 | N | No | BSL |
| | 206440 | Fluoranthene | 0.1 | 0.35 | mg/kg | AFDBSB10-0-1.5 | 9/23 | 0.35 | N/A | 2.2E+03 | N | No | BSL |
| | 193395 | Indeno(1,2,3-cd)pyrene | 0.097 | 0.2 | mg/kg | AFD-B-SB7-0-2 | 4/23 | 0.2 | N/A | 2.1E+00 | C | No | BSL |
| | 91203 | Naphthalene | 0.038 | 2.5 | mg/kg | AFD-B-SB14-0-2 | 16/23 | 2.5 | N/A | 1.9E+01 | N | No | ASL |
| | 85018 | Phenanthrene | 0.055 | 1.3 | mg/kg | AFD-B-SB14-0-2 | 14/23 | 1.3 | N/A | 2.9E+03 | N | No | BSL |
| | 129000 | Pyrene | 0.14 | 0.49 | mg/kg | AFD-B-SB7-0-2 | 9/23 | 0.49 | N/A | 2.9E+03 | N | No | BSL |

**Table E-6, Occurrence, Distribution and Selection of Chemicals of Potential Concern (COPCs) (continued)**
**Surface Soil–Industrial**
**Site B**
**Y-12, Oak Ridge, TN**

Scenario Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil

| Exposure Point | CAS Number | Chemical | Minimum [a] Concentration | Maximum [a] Concentration | Units | Location of Maximum Concentraion | Detection Frequency | Concentration Used for Screening [b] | Background Value [c] | Screening Toxicity Value [d] | COPC Flag | Rationale for [f] Contaminant Deletion or Selection |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PCBs | | | | | | | | | | | |
| | 11096825 | Aroclor 1260 | 0.081 | 0.15 | mg/kg | AFD-B-SB5-0-2 | 5/23 | 0.15 | N/A | 7.4E-01 C | No | BSL |
| | Organic Volatiles | | | | | | | | | | | |
| | 76131 | 1,1,2-Trichloro-1,2,2-trifluoroethane | 0.005 | 0.006 | mg/kg | AFD-B-SB14-0-2 | 2/23 | 0.006 | N/A | 5.6E+03 N | No | BSL |
| | 95476 | 1,2-Dimethylbenzene | 0.002 | 0.007 | mg/kg | AFDBSB17-0-1.5 | 5/23 | 0.007 | N/A | 7.0E+00 N | No | BSL |
| | N2813 | 1,3- and 1,4-Dimethylbenzene | 0.002 | 0.011 | mg/kg | AFDBSB17-0-1.5 | 6/23 | 0.011 | N/A | 7.0E+00 N | No | BSL |
| | 67641 | Acetone | 0.003 | 0.024 | mg/kg | AFD-B-SB7-0-2 | 5/23 | 0.024 | N/A | 6.0E+02 N | No | BSL |
| | 71432 | Benzene | 0.001 | 0.003 | mg/kg | AFD-B-SB7-0- | 5/23 | 0.003 | N/A | 1.3E+00 C | No | BSL |
| | 74839 | Bromomethane | 0.002 | 0.005 | mg/kg | AFD-B-SB7-0-2/AFD-B-SB4-0- | 17/23 | 0.005 | N/A | 1.3E+00 N | No | BSL |
| | 124389 | Carbon dioxide | 0.095 | 0.095 | mg/kg | AFD-B-SB3-0-2 | 1/23 | 0.095 | N/A | Not recognized as a human | No | BSL |
| | 74873 | Chloromethane | 0.003 | 0.003 | mg/kg | AFD-B-SB7-0-2 | 7/23 | 0.003 | N/A | 2.6E+00 C | No | BSL |
| | 75718 | Dichlorodifluoromethane | 0.004 | 0.004 | mg/kg | AFD-B-SB7-0-2 | 1/23 | 0.004 | N/A | 3.1E+01 N | No | BSL |
| | 100414 | Ethylbenzene | 0.001 | 0.002 | mg/kg | AFDBSB17-0-1.5 | 2/23 | 0.002 | N/A | 2.0E+01 C | No | BSL |
| | 74884 | Iodomethane | 0.009 | 0.009 | mg/kg | AFD-B-SB4-0-2 | 1/23 | 0.009 | N/A | 2.6E+00 C | No | BSL |
| | 75092 | Methylene chloride | 0.005 | 0.005 | mg/kg | AFDBSB10-0-1.5 | 1/23 | 0.005 | N/A | 2.1E+01 C | No | BSL |
| | 108883 | Toluene | 0.001 | 0.015 | mg/kg | AFD-B-SB7-0-2 | 7/23 | 0.015 | N/A | 5.2E+02 N | No | BSL |
| | 1330207 | Total Xylene | 0.005 | 0.019 | mg/kg | AFDBSB17-0-1.5 | 5/23 | 0.019 | N/A | 4.2E+02 N | No | BSL |
| | Misc | | | | | | | | | | | |
| | 14797558 | Nitrate | 5 | 14.2 | mg/kg | AFD-B-SB5-0-2 | 8/23 | 14.2 | N/A | 1.3E+04 N | No | BSL |
| | Radiologica | | | | | | | | | | | |
| | 10045973 | Cesium-137 | -0.037 | 0.3 | pCi/g | AFDBSB16-0-1.5 | 23/23 | 0.3 | N/A | 8.3E+04 | No | BSL |
| | 15067284 | Lead-241 | 0.43 | 0.96 | pCi/g | AFD-B-SB5-0-2 | 23/23 | 0.96 | N/A | 7.6E+04 | No | BSL |
| | 13966002 | Potassium-40 | 5.6 | 18 | pCi/g | AFD-B-SB14-0-2 | 23/23 | 18 | N/A | 2.7E-01 | No | K |
| | 13982633 | Radium-226 [g] | 0.43 | 0.96 | pCi/g | AFD-B-SB5-0-2 | 23/23 | 0.96 | N/A | 3.7E+00 | No | BSL |
| | 14274829 | Thorium-228 | 0.335 | 0.921 | pCi/g | AFDBSB10-0-1.5 | 23/23 | 0.921 | N/A | 1.3E+02 | No | BSL |
| | 14269637 | Thorium-230 | 0.178 | 0.522 | pCi/g | AFDBSB17-0-1.5 | 23/23 | 0.522 | N/A | 2.0E+01 | No | BSL |
| | N2608 | Thorium-232 | 0.177 | 0.786 | pCi/g | AFD-B-SB18-0-2 | 23/23 | 0.786 | N/A | 1.9E+01 | No | BSL |
| | 13966295 | Uranium-234 | 0.274 | 1.11 | pCi/g | AFD-B-SB5-0-2 | 23/23 | 1.11 | N/A | 3.2E+01 | No | BSL |
| | 15117961 | Uranium-235 | -0.01 | 0.152 | pCi/g | AFDBSB17-0-1.5 | 23/23 | 0.152 | N/A | 4.2E-01 | No | BSL |
| | 24678828 | Uranium-238 | 0.0861 | 0.69 | pCi/g | AFD-B-SB12-0-2 | 23/23 | 0.69 | N/A | 3.7E+01 | No | BSL |

(a) Minimum/maximum detected concentration.
(b) Maximum concentration used as screening value.
(c) Background values presented in Y-12 Site-wide RI
(d) Screening Toxicity Value - Taken from USEPA Region 9 Preliminary Remediation Goals (PRGs) Table, USEPA, August 2004.
(e) Rationale Codes Selection Reason: Above Screening Toxicity and Background Levels (ASL)
Deletion Reason: Essential Nutrient (NUT)
Below Screening Toxicity Level (BSL)
Below Individual Remediation Level (BIRL)
Potassium-40 is a naturally occurring radionuclide that is never considered site related. Predicted US background levels are 3-20 pCi/g (K)

N/A = Not Applicable
COPC = Chemical of Potential Concern
C = Carcinogenic
N = Non-Carcinogenic

(f) Lead is screened with values given in Office of Solid Waste and Emergency Response (OSWER) Directive #9355.4-12 (USEPA 1994c).
(g) Ra-226 activity was considered to be equal to Pb-214 activity as the two are assumed to be in secular equilibrium.
Surrogates used: pyrene for benzo[g,h,i]perylene and phenanthrene, napthalene for 2-methylnaphthalene, 1,3,5-trimethylbenzene for 1,2 -, 1,3- , and 1,4- dimethylbenzene, chloromethane for iodomethane.

**Table E-7, Occurrence, Distribution and Selection of Chemicals of Potential Concern (COPCs)**
**Subsurface Soil–Residential**
**Site B–Y-12 CDR**
**Y-12, Oak Ridge, TN**

Scenario Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil

| Exposure Point | CAS Number | Chemical | Minimum [a] Concentration (Qualifier) | Maximum [a] Concentration (Qualifier) | Units | Location of Maximum Concentraion | Detection Frequency | Concentration Used for Screening [b] | Background Value [c] | Screening [d] Toxicity Value | COPC Flag | Rationale for [e] Contaminant Deletion or Selection |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Inorganics | | | | | | | | | | | |
| | 7429905 | Aluminum | 10100 | 32800 | mg/kg | AFD-B-SB18-4-8 | 35/35 | 32800 | 4.7E+04 | 7.6E+03 N | No | BKG |
| | 7440393 | Barium | 36.6 | 528 | mg/kg | AFD-B-SB4-4-8 | 35/35 | 528 | 2.1E+02 | 5.4E+02 N | No | BSL |
| | 7440417 | Beryllium | 0.256 | 1.69 | mg/kg | AFD-B-SB18-4-8 | 35/35 | 1.69 | 2.1E+00 | 1.5E+01 N | No | BSL |
| | 7440702 | Calcium | 801 | 25600 | mg/kg | AFD-B-SB3-8-12 | 35/35 | 25600 | 1.9E+03 | N/A | No | NUT |
| | 7440473 | Chromium | 13.4 | 50.5 | mg/kg | AFD-B-SB4-4-8 | 35/35 | 50.5 | 8.0E+01 | 2.1E+02 C | No | BSL |
| | 7440484 | Cobalt | 3.27 | 36.9 | mg/kg | AFD-B-SB4-4-8 | 35/35 | 36.9 | 4.0E+01 | 1.6E+02 N | No | BSL |
| | 7440508 | Copper | 3.65 | 41.3 | mg/kg | AFD-B-SB6-4-8 | 33/35 | 41.3 | 3.6E+01 | 3.1E+02 N | No | BSL |
| | **7439896** | **Iron** | **11300** | **91200** | **mg/kg** | **AFD-B-SB4-4-8** | **35/35** | **91200** | **5.2E+04** | **2.3E+03 N** | **Yes** | **ASL** |
| | 7439921 | Lead (f) | 8.79 | 93.5 | mg/kg | AFD-B-SB9-8-12 | 14/35 | 93.5 | 5.0E+01 | 4.0E+02 N | No | BSL |
| | 7439954 | Magnesium | 873 | 9170 | mg/kg | AFD-B-SB3-8-12 | 35/35 | 9170 | 6.6E+03 | N/A | No | NUT |
| | **7439965** | **Manganese** | **93.9** | **6010** | **mg/kg** | **AFD-B-SB4-4-8** | **35/35** | **6010** | **2.2E+03** | **1.8E+02 N** | **Yes** | **ASL** |
| | 7439976 | Mercury | 0.127 | 0.312 | mg/kg | AFD-B-SB15-4-8 | 2/35 | 0.312 | 3.0E-01 | 2.3E+00 N | No | BSL |
| | 7440020 | Nickel | 5.13 | 49 | mg/kg | AFD-BSB18-8-11 | 33/35 | 49 | 5.7E+01 | 1.6E+02 N | No | BSL |
| | 7440097 | Potassium | 719 | 8570 | mg/kg | AFD-B-SB14-4-8 | 34/35 | 8570 | 5.6E+03 | N/A | No | NUT |
| | 7440235 | Sodium | 23.3 | 110 | mg/kg | AFD-BSB18-8-11 | 32/35 | 110 | N/A | N/A | No | NUT |
| | 7440622 | Vanadium | 14.5 | 41.3 | mg/kg | AFD-B-SB8-4-8 | 35/35 | 41.3 | 6.0E+01 | 5.5E+01 N | No | BSL |
| | 7440666 | Zinc | 15.4 | 70.8 | mg/kg | AFD-B-SB3-8-12 | 33/35 | 70.8 | 1.1E+02 | 2.3E+03 N | No | BSL |
| | Organic Semivolatiles | | | | | | | | | | | |
| | 91576 | 2-Methylnaphthalene | 0.051 | 1.3 | mg/kg | AFD-B-SB8-4-8 | 7/35 | 1.3 | N/A | 5.6E+00 N | No | BSL |
| | 120127 | Anthracene | 0.035 | 0.035 | mg/kg | AFD-B-SB8-4-8 | 1/35 | 0.035 | N/A | 2.2E+03 N | No | BSL |
| | 56553 | Benzo(a)anthracene | 0.056 | 0.056 | mg/kg | AFD-B-SB8-4-8 | 1/35 | 0.056 | N/A | 6.2E-01 C | No | BSL |
| | 218019 | Chrysene | 0.069 | 0.069 | mg/kg | AFD-B-SB8-4-8 | 1/35 | 0.069 | N/A | 6.2E+01 C | No | BSL |
| | 132649 | Dibenzofuran | 0.11 | 0.31 | mg/kg | AFD-B-SB8-4-8 | 2/35 | 0.31 | N/A | 2.9E+01 N | No | BSL |
| | 84742 | Di-n-butylphthalate | 0.16 | 2 | mg/kg | AFD-BSB59-11.5 | 12/35 | 2 | N/A | 6.1E+02 N | No | BSL |
| | 206440 | Fluoranthene | 0.073 | 0.073 | mg/kg | AFD-B-SB8-4-8 | 1/35 | 0.073 | N/A | 2.3E+02 N | No | BSL |
| | 86737 | Fluorene | 0.048 | 0.048 | mg/kg | AFD-B-SB8-4-8 | 1/35 | 0.048 | N/A | 2.7E+02 N | No | BSL |
| | 91203 | Naphthalene | 0.05 | 1.1 | mg/kg | AFD-B-SB8-4-8 | 7/35 | 1.1 | N/A | 5.6E+00 N | No | BSL |
| | 85018 | Phenanthrene | 0.042 | 0.6 | mg/kg | AFD-B-SB8-4-8 | 3/35 | 0.6 | N/A | 2.3E+02 N | No | BSL |
| | 129000 | Pyrene | 0.12 | 0.12 | mg/kg | AFD-B-SB8-4-8 | 1/35 | 0.12 | N/A | 2.3E+02 N | No | BSL |

**Table E-7, Occurrence, Distribution and Selection of Chemicals of Potential Concern (COPCs) (continued)**
**Subsurface Soil–Residential**
**Site B–Y-12 CDR**
**Y-12, Oak Ridge, TN**

Scenario Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil

| Exposure Point | CAS Number | Chemical | Minimum [a] Concentration (Qualifier) | Maximum [a] Concentration (Qualifier) | Units | Location of Maximum Concentraion | Detection Frequency | Concentration Used for Screening [b] | Background Value [c] | Screening [d] Toxicity Value | COPC Flag | Rationale for [e] Contaminant Deletion or Selection |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Organic Volatiles | | | | | | | | | | | |
| | 76131 | 1,1,2-Trichloro-1,2,2-trifluoroethane | 0.003 | 0.005 | mg/kg | AFDBSB11-7-9.5 | 3/35 | 0.005 | N/A | 5.6E+03 N | No | BSL |
| | 78933 | 2-Butanone | 0.003 | 0.004 | mg/kg | AFD-B-SB12-4-8 | 4/35 | 0.004 | N/A | 7.3E+02 N | No | BSL |
| | 67641 | Acetone | 0.003 | 0.13 | mg/kg | AFD-B-SB9-8-12 | 10/35 | 0.13 | N/A | 1.6E+02 N | No | BSL |
| | 74839 | Bromomethane | 0.002 | 0.006 | mg/kg | AFD-BSB18-8-11 | 25/35 | 0.006 | N/A | 3.9E-01 N | No | BSL |
| | 74873 | Chloromethane | 0.002 | 0.004 | mg/kg | AFD-B-SB1-4-7 | 8/35 | 0.004 | N/A | 1.2E+00 C | No | BSL |
| | 64175 | Ethanol | 0.46 | 0.46 | mg/kg | AFD-BSB59-11.5 | 1/35 | 0.46 | N/A | 3.1E+03 N | No | BSL |
| | 75092 | Methylene chloride | 0.009 | 0.011 | mg/kg | AFD-BSB18-8-11 | 2/35 | 0.011 | N/A | 9.1E+00 C | No | BSL |
| | 108054 | Vinyl acetate | 0.001 | 0.001 | mg/kg | AFD-B-SB17-4-8 | 1/35 | 0.001 | N/A | 4.3E+01 N | No | BSL |
| | Misc | | | | | | | | | | | |
| | 14797558 | Nitrate | 5 | 7.4 | mg/kg | AFD-B-SB15-4-8 | 2/35 | 7.4 | N/A | 1.3E+04 N | No | BSL |
| | Radiological | | | | | | | | | | | |
| | 10045973 | Cesium-137 | -0.052 | 0.043 | pCi/g | AFD-B-SB8-4-8 | 35/35 | 0.043 | N/A | 5.1E+04 | No | BSL |
| | 15067284 | Lead-241 | 0.37 | 0.84 | pCi/g | AFDBSB11-7-9.5 | 35/35 | 0.84 | N/A | 4.6E+04 | No | BSL |
| | 13966002 | Potassium-40 | 5 | 35 | pCi/g | AFD-B-SB14-4-8 | 35/35 | 35 | N/A | 1.1E-01 | No | K |
| | **13982633** | **Radium-226 [g]** | **0.37** | **0.84** | **pCi/g** | **AFD-B-SB5-0-2** | **35/35** | **0.84** | **N/A** | **1.9E-01** | **Yes** | **ASL** |
| | 14274829 | Thorium-228 | 0.358 | 0.981 | pCi/g | AFD-B-SB13-4-8 | 35/35 | 0.981 | N/A | 2.4E+01 | No | BSL |
| | 14269637 | Thorium-230 | 0.151 | 0.421 | pCi/g | AFD-B-SB10-4-8 | 35/35 | 0.421 | N/A | 3.5E+00 | No | BSL |
| | N2608 | Thorium-232 | 0.302 | 0.815 | pCi/g | AFD-B-SB13-4-8 | 35/35 | 0.815 | N/A | 3.1E+00 | No | BSL |
| | 13966295 | Uranium-234 | 0.182 | 0.802 | pCi/g | AFD-B-SB4-4-8 | 35/35 | 0.802 | N/A | 4.0E+00 | No | BSL |
| | 15117961 | Uranium-235 | 0.00413 | 0.0656 | pCi/g | AFDBSB6-8-11.5 | 33/35 | 0.0656 | N/A | 2.1E-01 | No | BSL |
| | 24678828 | Uranium-238 | 0.0596 | 0.417 | pCi/g | AFD-B-SB4-4-8 | 35/35 | 0.417 | N/A | 4.5E+00 | No | BSL |

(a) Minimum/maximum detected concentration.
(b) Maximum concentration used as screening value.
(c) Background values presented in Y-12 Site-wide RI
(d) Screening Toxicity Value - Taken from USEPA Region 9 Preliminary Remediation Goals (PRGs) Table, USEPA, August 2004.
(e) Rationale Codes Selection Reason: Above Screening Toxicity and Background Levels (ASL)
Deletion Reason: Essential Nutrient (NUT)
Below Screening Toxicity Level (BSL)
Below Individual Remediation Level (BIRL)
Potassium-40 is a naturally occurring radionuclide that is never considered site related. Predicted US background levels are 3-20 pCi/g (K)

N/A = Not Applicable
COPC = Chemical of Potential Concern
C = Carcinogenic
N = Non-Carcinogenic

(f) Lead is screened with values given in Office of Solid Waste and Emergency Response (OSWER) Directive #9355.4-12 (USEPA 1994c).
(g) Ra-226 activity was considered to be equal to Pb-214 activity as the two are assumed to be in secular equilibrium.
Surrogates used: pyrene for phenanthrene, napthalene for 2-methylnaphthalene, and methanol for ethanol.

**Table E-8, Occurrence, Distribution and Selection of Chemicals of Potential Concern (COPCs)**
**Subsurface Soil–Industrial**
**Site B**
**Y-12, Oak Ridge, TN**

Scenario Timeframe: Current/Future
Medium: Subsurface Soil
Exposure Medium: Subsurface Soil

| Exposure Point | CAS Number | Chemical | Minimum [a] Concentration (Qualifier) | Maximum [a] Concentration (Qualifier) | Units | Location of Maximum Concentraion | Detection Frequency | Concentration Used for Screening [b] | Background Value [c] | Screening Toxicity Value [d] | COPC Flag | Rationale for [e] Contaminant Deletion or Selection |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Inorganics | | | | | | | | | | | |
| | 7429905 | Aluminum | 10100 | 32800 | mg/kg | AFD-B-SB18-4-8 | 35/35 | 32800 | 4.7E+04 | 1.0E+05 N | No | BSL |
| | 7440393 | Barium | 36.6 | 528 | mg/kg | AFD-B-SB4-4-8 | 35/35 | 528 | 2.1E+02 | 6.7E+03 N | No | BSL |
| | 7440417 | Beryllium | 0.256 | 1.69 | mg/kg | AFD-B-SB18-4-8 | 35/35 | 1.69 | 2.1E+00 | 1.9E+03 C | No | BSL |
| | 7440702 | Calcium | 801 | 25600 | mg/kg | AFD-B-SB3-8-12 | 35/35 | 25600 | 1.9E+03 | N/A | No | NUT |
| | 7440473 | Chromium | 13.4 | 50.5 | mg/kg | AFD-B-SB4-4-8 | 35/35 | 50.5 | 8.0E+01 | 4.5E+02 C | No | BSL |
| | 7440484 | Cobalt | 3.27 | 36.9 | mg/kg | AFD-B-SB4-4-8 | 35/35 | 36.9 | 4.0E+01 | 1.9E+03 C | No | BSL |
| | 7440508 | Copper | 3.65 | 41.3 | mg/kg | AFD-B-SB6-4-8 | 33/35 | 41.3 | 3.6E+01 | 4.1E+03 N | No | BSL |
| | 7439896 | Iron | 11300 | 91200 | mg/kg | AFD-B-SB4-4-8 | 35/35 | 91200 | 5.2E+04 | 1.0E+05 N | No | BSL |
| | 7439921 | Lead (f) | 8.79 | 93.5 | mg/kg | AFD-B-SB9-8-12 | 14/35 | 93.5 | 5.0E+01 | 7.5E+01 N | No | BSL |
| | 7439954 | Magnesium | 873 | 9170 | mg/kg | AFD-B-SB3-8-12 | 35/35 | 9170 | 6.6E+03 | N/A | No | NUT |
| | **7439965** | **Manganese** | **93.9** | **6010** | **mg/kg** | **AFD-B-SB4-4-8** | **35/35** | **6010** | **2.2E+03** | **1.9E+03 N** | **Yes** | **ASL** |
| | 7439976 | Mercury | 0.127 | 0.312 | mg/kg | AFD-B-SB15-4-8 | 2/35 | 0.312 | 3.0E-01 | 3.1E+01 N | No | BSL |
| | 7440020 | Nickel | 5.13 | 49 | mg/kg | AFD-BSB18-8-11 | 33/35 | 49 | 5.7E+01 | 2.0E+03 N | No | BSL |
| | 7440097 | Potassium | 719 | 8570 | mg/kg | AFD-B-SB14-4-8 | 34/35 | 8570 | 5.6E+03 | N/A | No | NUT |
| | 7440235 | Sodium | 23.3 | 110 | mg/kg | AFD-BSB18-8-11 | 32/35 | 110 | N/A | N/A | No | NUT |
| | 7440622 | Vanadium | 14.5 | 41.3 | mg/kg | AFD-B-SB8-4-8 | 35/35 | 41.3 | 6.0E+01 | 7.2E+02 N | No | BSL |
| | 7440666 | Zinc | 15.4 | 70.8 | mg/kg | AFD-B-SB3-8-12 | 33/35 | 70.8 | 1.1E+02 | 1.0E+05 N | No | BSL |
| | Organic Semivolatiles | | | | | | | | | | | |
| | 91576 | 2-Methylnaphthalene | 0.051 | 1.3 | mg/kg | AFD-B-SB8-4-8 | 7/35 | 1.3 | N/A | 1.9E+01 N | No | BSL |
| | 120127 | Anthracene | 0.035 | 0.035 | mg/kg | AFD-B-SB8-4-8 | 1/35 | 0.035 | N/A | 1.0E+05 N | No | BSL |
| | 56553 | Benzo(a)anthracene | 0.056 | 0.056 | mg/kg | AFD-B-SB8-4-8 | 1/35 | 0.056 | N/A | 2.1E+00 C | No | BSL |
| | 218019 | Chrysene | 0.069 | 0.069 | mg/kg | AFD-B-SB8-4-8 | 1/35 | 0.069 | N/A | 2.1E+02 C | No | BSL |
| | 132649 | Dibenzofuran | 0.11 | 0.31 | mg/kg | AFD-B-SB8-4-8 | 2/35 | 0.31 | N/A | 3.1E+02 N | No | BSL |
| | 84742 | Di-n-butylphthalate | 0.16 | 2 | mg/kg | AFD-BSB59-11.5 | 12/35 | 2 | N/A | 6.2E+03 N | No | BSL |
| | 206440 | Fluoranthene | 0.073 | 0.073 | mg/kg | AFD-B-SB8-4-8 | 1/35 | 0.073 | N/A | 2.2E+03 N | No | BSL |
| | 86737 | Fluorene | 0.048 | 0.048 | mg/kg | AFD-B-SB8-4-8 | 1/35 | 0.048 | N/A | 2.6E+03 N | No | BSL |
| | 91203 | Naphthalene | 0.05 | 1.1 | mg/kg | AFD-B-SB8-4-8 | 7/35 | 1.1 | N/A | 1.9E+01 N | No | BSL |
| | 85018 | Phenanthrene | 0.042 | 0.6 | mg/kg | AFD-B-SB8-4-8 | 3/35 | 0.6 | N/A | 2.9E+03 N | No | BSL |
| | 129000 | Pyrene | 0.12 | 0.12 | mg/kg | AFD-B-SB8-4-8 | 1/35 | 0.12 | N/A | 2.9E+03 N | No | BSL |

**Table E-8, Occurrence, Distribution and Selection of Chemicals of Potential Concern (COPCs) (continued)**
**Subsurface Soil–Industrial**
**Site B**
**Y-12, Oak Ridge, TN**

Scenario Timeframe: Current/Future
Medium: Subsurface Soil
Exposure Medium: Subsurface Soil

| Exposure Point | CAS Number | Chemical | Minimum [a] Concentration (Qualifier) | Maximum [a] Concentration (Qualifier) | Units | Location of Maximum Concentraion | Detection Frequency | Concentration Used for Screening [b] | Background Value [c] | Screening Toxicity Value [d] | COPC Flag | Rationale for [e] Contaminant Deletion or Selection |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Organic Volatiles | | | | | | | | | | | |
| | 76131 | 1,1,2-Trichloro-1,2,2-trifluoroethane | 0.003 | 0.005 | mg/kg | AFDBSB11-7-9.5 | 3/35' | 0.005 | N/A | 5.6E+03 N | No | BSL |
| | 78933 | 2-Butanone | 0.003 | 0.004 | mg/kg | AFD-B-SB12-4-8 | 4/35' | 0.004 | N/A | 2.7E+03 N | No | BSL |
| | 67641 | Acetone | 0.003 | 0.13 | mg/kg | AFD-B-SB9-8-12 | 10/35' | 0.13 | N/A | 6.0E+02 N | No | BSL |
| | 74839 | Bromomethane | 0.002 | 0.006 | mg/kg | AFD-BSB18-8-11 | 25/35' | 0.006 | N/A | 1.3E+00 N | No | BSL |
| | 74873 | Chloromethane | 0.002 | 0.004 | mg/kg | AFD-B-SB1-4-7 | 8/35' | 0.004 | N/A | 2.6E+00 C | No | BSL |
| | 64175 | Ethanol | 0.46 | 0.46 | mg/kg | AFD-BSB59-11.5 | 1/35' | 0.46 | N/A | 1.0E+05 N | No | BSL |
| | 108054 | Vinyl acetate | 0.001 | 0.001 | mg/kg | AFD-B-SB17-4-8 | 1/35' | 0.001 | N/A | 1.4E+02 N | No | BSL |
| | Misc | | | | | | | | | | | |
| | 14797558 | Nitrate | 5 | 7.4 | mg/kg | AFD-B-SB15-4-8 | 2/35 | 7.4 | N/A | 1.3E+04 N | No | BSL |
| | Radiologicals | | | | | | | | | | | |
| | 10045973 | Cesium-137 | -0.052 | 0.043 | pCi/g | AFD-B-SB8-4-8 | 35/35 | 0.043 | N/A | 8.3E+04 | No | BSL |
| | 15067284 | Lead-241 | 0.37 | 0.84 | pCi/g | AFDBSB11-7-9.5 | 35/35 | 0.84 | N/A | 7.6E+04 | No | BSL |
| | 13966002 | Potassium-40 | 5 | 35 | pCi/g | AFD-B-SB14-4-8 | 35/35 | 35 | N/A | 2.7E-01 | No | K |
| | 13982633 | Radium-226 [g] | 0.37 | 0.84 | pCi/g | AFD-B-SB5-0-2 | 35/35 | 0.84 | N/A | 3.7E+00 | No | BSL |
| | 14274829 | Thorium-228 | 0.358 | 0.981 | pCi/g | AFD-B-SB13-4-8 | 35/35 | 0.981 | N/A | 1.3E+02 | No | BSL |
| | 14269637 | Thorium-230 | 0.151 | 0.421 | pCi/g | AFD-B-SB10-4-8 | 35/35 | 0.421 | N/A | 2.0E+01 | No | BSL |
| | N2608 | Thorium-232 | 0.302 | 0.815 | pCi/g | AFD-B-SB13-4-8 | 35/35 | 0.815 | N/A | 1.9E+01 | No | BSL |
| | 13966295 | Uranium-234 | 0.182 | 0.802 | pCi/g | AFD-B-SB4-4-8 | 35/35 | 0.802 | N/A | 3.2E+01 | No | BSL |
| | 15117961 | Uranium-235 | 0.00413 | 0.0656 | pCi/g | AFDBSB6-8-11.5 | 33/35 | 0.0656 | N/A | 4.2E-01 | No | BSL |
| | 24678828 | Uranium-238 | 0.0596 | 0.417 | pCi/g | AFD-B-SB4-4-8 | 35/35 | 0.417 | N/A | 3.7E+01 | No | BSL |

(a) Minimum/maximum detected concentration.
(b) Maximum concentration used as screening value.
(c) Background values presented in Y-12 Site-wide RI
(d) Screening Toxicity Value - Taken from USEPA Region 9 Preliminary Remediation Goals (PRGs) Table, USEPA, August 2004.
(e) Rationale Codes
Selection Reason: Above Screening Toxicity and Background Levels (ASL)
Deletion Reason: Essential Nutrient (NUT)
Below Screening Toxicity Level (BSL)
Below Individual Remediation Level (BIRL)
Potassium-40 is a naturally occurring radionuclide that is never considered site related. Predicted US background levels are 3-20 pCi/g (K)

N/A = Not Applicable
COPC = Chemical of Potential Concern
C = Carcinogenic
N = Non-Carcinogenic

(f) Lead is screened with values given in Office of Solid Waste and Emergency Response (OSWER) Directive #9355.4-12 (USEPA 1994c).
(g) Ra-226 activity was considered to be equal to Pb-214 activity as the two are assumed to be in secular equilibrium.
Surrogates used: pyrene for phenanthrene, napthalene for 2-methylnaphthalene, and methanol for ethanol.

**Table E-9, Values of Daily Intake Calculations for Exposure of Site Worker to Surface or Subsurface Soil**
**Sites A & B**
**Y-12, Oak Ridge, TN**

Scenario Timeframe: Current/ Future
Medium: Soil
Exposure Medium: Soil/Air

| Exposure Route | Receptor Population | Receptor Age | Exposure Point | Parameter Code | Parameter Definition | Units | RME Value | RME Rationale/ Reference | Intake Equation/ Model Name |
|---|---|---|---|---|---|---|---|---|---|
| **Ingestion** | **Site Worker** | **Adult** | | Csoil | Chemical Concentration in Soil | mg/kg | -- | -- | Ingestion CDI (mg/kg-day) = |
| | | | | IR | Ingestion Rate of Soil | kg/day | 0.0001 | USEPA 1991 | $\frac{Csoil \times IR \times FI \times EF \times ED}{BW \times AT}$ |
| | | | | FI | Fraction ingested from contaminated source | unitless | 1.0 | USEPA Region 4 1995 | USEPA, December 1991 |
| | | | | EF | Exposure Frequency | days/year | 350 | USEPA 1991 | |
| | | | | ED | Exposure Duration | years | 25 | USEPA 1991 | |
| | | | | BW | Body Weight | kg | 70 | USEPA 1989 | |
| | | | | AT-C | Averaging Time (Cancer) | days | 25,550 | USEPA 1989 | |
| | | | | AT-N | Averaging Time (Non-Cancer) | days | 9,125 | USEPA 1989 | |
| **Dermal** | **Site Worker** | **Adult** | **Soils** | Csoil | Chemical Concentration in Soil | mg/kg | -- | -- | Dermal CDI (mg/kg-day) = |
| | | | | CF | Conversion Factor | $(kg\text{-}cm^{2)}/(mg\text{-}m^{2)}$ | 0.01 | -- | $\frac{Csoil \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$ |
| | | | | SA | Skin Surface Area Available for Contact | $m^2$/event | 0.33 | USEPA 2001 | |
| | | | | AF | Soil to Skin Adherence Factor | $mg/cm^2$ | 0.2 | USEPA 2001 | USEPA, December 1991 |
| | | | | ABS | Absorption Factor | unitless | chemical specific<br>default 0.1% (inorganics) | USEPA 2001<br>USEPA Region 4 1995 | |
| | | | | EF | Exposure Frequency | events/year | 250 | USEPA 1991 | |
| | | | | ED | Exposure Duration | years | 25 | USEPA 1991 | |
| | | | | BW | Body Weight | kg | 70 | USEPA 1989 | |
| | | | | AT-C | Averaging Time (Cancer) | days | 25,550 | USEPA 1989 | |
| | | | | AT-N | Averaging Time (Non-Cancer) | days | 9,125 | USEPA 1989 | |
| **Inhalation** | **Site Worker** | **Adult** | **Soils** | Csoil | Chemical Concentration in Soil | mg/kg | -- | -- | Inhalation $CDI^{(2)}$ (mg/kg/day) = |
| | | | | Cair | Chemical Concentration in Air | $mg/m^3$ | calculated | | $\frac{Cair \times IR \times ET \times EF \times ED}{BW \times AT}$ |
| | | | | IR | Inhalation Rate of Air | $m^3$/hour | 20 | USEPA 1991 | $Cair = Csoil \times (1/PEF + 1/VF)$ |
| | | | | EF | Exposure Frequency | days/year | 250 | USEPA 1991 | |
| | | | | ED | Exposure Duration | years | 25 | USEPA 1991 | |
| | | | | BW | Body Weight | kg | 70 | USEPA 1989 | USEPA, December 1991 |
| | | | | PEF | Particulate Emission Factor | $m^3$/kg | 1.32E+09 | USEPA 1996 - SSG | |
| | | | | VF | Volatization Factor | $mg^3$/kg | chemical specific | | |
| | | | | AT-C | Averaging Time (Cancer) | days | 25,550 | USEPA 1989 | |
| | | | | AT-N | Averaging Time (Non-Cancer) | days | 9,125 | USEPA 1989 | |

CDI = Chronic Daily Intake
RME = Reasonable Maximum Exposure
SSG = Soil Screening Guidance

**Table E-10, Values of Daily Intake Calculations for Exposure of Hypothetical Future Adult Resident to Surface or Subsurface Soil**
**Sites A & B**
**Y-12, Oak Ridge, TN**

Scenario Timeframe: Future
Medium: Soil
Exposure Medium: Soil/Air

| Exposure Route | Receptor Population | Receptor Age | Exposure Point | Parameter Code | Parameter Definition | Units | RME Value | RME Rationale/ Reference | Intake Equation/ Model Name |
|---|---|---|---|---|---|---|---|---|---|
| **Ingestion** | **Resident** | **Adult** | **Soils** | Csoil | Chemical Concentration in Soil | mg/kg | -- | -- | Ingestion CDI (mg/kg-day) = |
| | | | | IR | Ingestion Rate of Soil | kg/day | 0.0001 | USEPA 1991 | $\frac{Csoil \times IR \times FI \times EF \times ED}{BW \times AT}$ |
| | | | | FI | Fraction ingested from contaminated source | unitless | 1.0 | USEPA Region 4 1995 | USEPA, December 1991 |
| | | | | EF | Exposure Frequency | days/year | 350 | USEPA 1991 | |
| | | | | ED | Exposure Duration | years | 30 | USEPA 1991 | |
| | | | | BW | Body Weight | kg | 70 | USEPA 1989 | |
| | | | | AT-C | Averaging Time (Cancer) | days | 25,550 | USEPA 1989 | |
| | | | | AT-N | Averaging Time (Non-Cancer) | days | 10,950 | USEPA 1989 | |
| **Dermal** | **Resident** | **Adult** | **Soils** | Csoil | Chemical Concentration in Soil | mg/kg | -- | -- | Dermal CDI (mg/kg-day) = |
| | | | | CF | Conversion Factor | $(kg\text{-}cm^{2})/(mg\text{-}m^{2})$ | 0.01 | -- | $\frac{Csoil \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$ |
| | | | | SA | Skin Surface Area Available for Contact | $m^{2}$/event | 0.57 | USEPA 2001 | |
| | | | | AF | Soil to Skin Adherence Factor | $mg/cm^2$ | 0.2 | USEPA 2001 | USEPA, December 1991 |
| | | | | ABS | Absorption Factor | unitless | chemical specific<br>default 0.1% (inorganics) | USEPA 2001<br>USEPA Region 4 1995 | |
| | | | | EF | Exposure Frequency | events/year | 350 | USEPA 1991 | |
| | | | | ED | Exposure Duration | years | 30 | USEPA 1991 | |
| | | | | BW | Body Weight | kg | 70 | USEPA 1989 | |
| | | | | AT-C | Averaging Time (Cancer) | days | 25,550 | USEPA 1989 | |
| | | | | AT-N | Averaging Time (Non-Cancer) | days | 10,950 | USEPA 1989 | |
| **Inhalation** | **Resident** | **Adult** | **Soils** | Csoil | Chemical Concentration in Soil | mg/kg | -- | -- | Inhalation CDI (mg/kg/day) = |
| | | | | Cair | Chemical Concentration in Air | $mg/m^3$ | calculated | | $\frac{Cair \times IR \times ET \times EF \times ED}{BW \times AT}$ |
| | | | | IR | Inhalation Rate of Air | $m^3$/hour | 20 | USEPA 1991 | |
| | | | | EF | Exposure Frequency | days/year | 350 | USEPA 1991 | Cair = Csoil x (1/PEF + 1/VF) |
| | | | | ED | Exposure Duration | years | 30 | USEPA 1991 | |
| | | | | BW | Body Weight | kg | 70 | USEPA 1989 | USEPA, December 1991 |
| | | | | PEF | Particulate Emission Factor | $m^3/kg$ | 1.32E+09 | USEPA 1996 - SSG | |
| | | | | VF | Volatization Factor | $mg^3/kg$ | chemical specific | | |
| | | | | AT-C | Averaging Time (Cancer) | days | 25,550 | USEPA 1989 | |
| | | | | AT-N | Averaging Time (Non-Cancer) | days | 10,950 | USEPA 1989 | |

CDI = Chronic Daily Intake
RME = Reasonable Maximum Exposure
SSG = Soil Screening Guidance

**Table E-11, Values of Daily Intake Calculations for Exposure of Hypothetical Future Child Resident to Surface or Subsurface Soil**
**Sites A & B**
**Y-12, Oak Ridge, TN**

Scenario Timeframe: Future
Medium: Soil
Exposure Medium: Soil/Air

| Exposure Route | Receptor Population | Receptor Age | Exposure Point | Parameter Code | Parameter Definition | Units | RME Value | RME Rationale/ Reference | Intake Equation/ Model Name |
|---|---|---|---|---|---|---|---|---|---|
| **Ingestion** | **Resident** | **Child** | **Soils** | Csoil | Chemical Concentration in Soil | mg/kg | -- | -- | Ingestion CDI (mg/kg-day) = |
| | | | | IR | Ingestion Rate of Soil | kg/day | 0.0002 | USEPA 1991 | $\frac{Csoil \times IR \times FI \times EF \times ED}{BW \times AT}$ |
| | | | | FI | Fraction ingested from contaminated source | unitless | 1.0 | USEPA Region 4 1995 | USEPA, December 1991 |
| | | | | EF | Exposure Frequency | days/year | 350 | USEPA 1991 | |
| | | | | ED | Exposure Duration | years | 6 | USEPA 1991 | |
| | | | | BW | Body Weight | kg | 15 | USEPA 1989 | |
| | | | | AT-C | Averaging Time (Cancer) | days | 25,550 | USEPA 1989 | |
| | | | | AT-N | Averaging Time (Non-Cancer) | days | 2,190 | USEPA 1989 | |
| **Dermal** | **Resident** | **Child** | **Soils** | Csoil | Chemical Concentration in Soil | mg/kg | -- | -- | Dermal CDI (mg/kg-day) = |
| | | | | CF | Conversion Factor | $(kg\text{-}cm^{2})/(mg\text{-}m^{2})$ | 0.01 | -- | $\frac{Csoil \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$ |
| | | | | SA | Skin Surface Area Available for Contact | $m^{2}$/event | 0.28 | USEPA 2001 | |
| | | | | AF | Soil to Skin Adherence Factor | $mg/cm^2$ | 0.2 | USEPA 2001 | USEPA, December 1991 |
| | | | | ABS | Absorption Factor | unitless | chemical specific<br>default 0.1% (inorganics) | USEPA 2001<br>USEPA Region 4 1995 | |
| | | | | EF | Exposure Frequency | events/year | 350 | USEPA 1991 | |
| | | | | ED | Exposure Duration | years | 6 | USEPA 1991 | |
| | | | | BW | Body Weight | kg | 15 | USEPA 1989 | |
| | | | | AT-C | Averaging Time (Cancer) | days | 25,550 | USEPA 1989 | |
| | | | | AT-N | Averaging Time (Non-Cancer) | days | 2,190 | USEPA 1989 | |
| **Inhalation** | **Resident** | **Child** | **Soils** | Csoil | Chemical Concentration in Soil | mg/kg | -- | -- | Inhalation CDI (mg/kg/day) = |
| | | | | Cair | Chemical Concentration in Air | $mg/m^3$ | calculated | | $\frac{Cair \times IR \times ET \times EF \times ED}{BW \times AT}$ |
| | | | | IR | Inhalation Rate of Air | $m^3$/hour | 10 | USEPA 1991 | Cair = Csoil x (1/PEF + 1/VF) |
| | | | | EF | Exposure Frequency | days/year | 350 | USEPA 1991 | |
| | | | | ED | Exposure Duration | years | 6 | USEPA 1991 | |
| | | | | BW | Body Weight | kg | 15 | USEPA 1989 | USEPA, December 1991 |
| | | | | PEF | Particulate Emission Factor | $m^3/kg$ | 1.32E+09 | USEPA 1996 - SSG | |
| | | | | VF | Volatization Factor | $mg^3/kg$ | chemical specific | | |
| | | | | AT-C | Averaging Time (Cancer) | days | 25,550 | USEPA 1989 | |
| | | | | AT-N | Averaging Time (Non-Cancer) | days | 2,190 | USEPA 1989 | |

CDI = Chronic Daily Intake
RME = Reasonable Maximum Exposure
SSG = Soil Screening Guidance

**Table E-12, Calculation of Chemical Cancer Risks and Non-Cancer Hazards:**
**For Site Worker**
**Reasonable Maximum Exposure (RME)**
**Site A**
**Y-12, Oak Ridge, TN**

Scenario Timeframe: Current/Future
Receptor Population: Site Worker
Receptor Age: Adult

| Medium | Exposure Medium | Exposure Point | Exposure Route | Chemical of Potential Concern | EPC | | Cancer Risk Calculations | | | | | Non-Cancer Hazard Calculations | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Intake/ Exposure Concentration | | Cancer Slope Factor Unit Risk | | Cancer Risk | Intake/ Exposure Concentration | | Reference Dose Reference Concentration | | Hazard Quotient | |
| | | | | | Value | Units | Value | Units | Value | Units | | Value | Units | Value | Units | | |
| Surface Soil | Soil/Air | Exposed | Ingestion | Barium | 181 | mg/kg | 8.9E-05 | mg/kg-day | | (mg/kg-day)-1 | | 2.5E-04 | mg/kg-day | 7.0E-02 | mg/kg-day | 3.5E-03 | |
| | | | | Manganese | 1283 | mg/kg | 6.3E-04 | mg/kg-day | | (mg/kg-day)-1 | | 1.8E-03 | mg/kg-day | 1.4E-01 | mg/kg-day | 1.3E-02 | |
| | | | | Benzo(a)pyrene | 0.175 | mg/kg | 8.6E-08 | mg/kg-day | 7.3E+00 | (mg/kg-day)-1 | 6.3E-07 | 2.4E-07 | mg/kg-day | | mg/kg-day | | |
| | | | Exp. Route Total | | | | | | | | 6.3E-07 | | | | | 1.6E-02 | Dermal ABS |
| | | | Dermal | Barium | 181 | mg/kg | 4.2E-07 | mg/kg-day | | (mg/kg-day)-1 | | 1.2E-06 | mg/kg-day | 7.0E-02 | mg/kg-day | 1.7E-05 | 0.001 Region IV default |
| | | | | Manganese | 1283 | mg/kg | 3.0E-06 | mg/kg-day | | (mg/kg-day)-1 | | 8.3E-06 | mg/kg-day | 1.4E-01 | mg/kg-day | 5.9E-05 | 0.001 Region IV default |
| | | | | Benzo(a)pyrene | 0.175 | mg/kg | 5.2E-08 | mg/kg-day | | (mg/kg-day)-1 | | 1.5E-07 | mg/kg-day | | mg/kg-day | | 0.13 Region IV default |
| | | | Exp. Route Total | | | | | | | | 0.0E+00 | | | | | 7.6E-05 | Volitization factors |
| | | | Inhalation | Barium | 1.37E-07 | $mg/m^3$ | 9.6E-09 | mg/kg-day | | (mg/kg-day)-1 | | 2.7E-08 | mg/kg-day | 1.4E-04 | mg/kg-day | 1.9E-04 | na |
| | | | | Manganese | 9.72E-07 | $mg/m^3$ | 6.8E-08 | mg/kg-day | | (mg/kg-day)-1 | | 1.9E-07 | mg/kg-day | 1.4E-05 | mg/kg-day | 1.4E-02 | na |
| | | | | Benzo(a)pyrene | 1.33E-10 | $mg/m^3$ | 9.3E-12 | mg/kg-day | 7.3E+00 | (mg/kg-day)-1 | 6.8E-11 | 2.6E-11 | mg/kg-day | | mg/kg-day | | na |
| | | | Exp. Route Total | | | | | | | | 6.8E-11 | | | | | 1.4E-02 | |
| | | Exposure Point Total | | | | | | | | | 6.3E-07 | | | | | 3.0E-02 | |
| | Exposure Medium Total | | | | | | | | | | 6.3E-07 | | | | | 3.0E-02 | |
| Surface Soil Total | | | | | | | | | | | 6.3E-07 | | | | | 3.0E-02 | |
| Soil | Soil/Air | Excavations | Ingestion | Manganese | 1399 | mg/kg | 6.8E-04 | mg/kg-day | | (mg/kg-day)-1 | | 1.9E-03 | mg/kg-day | 1.4E-01 | mg/kg-day | 1.4E-02 | |
| | | | | Benzo(a)pyrene | 0.201 | mg/kg | 9.8E-08 | mg/kg-day | 7.3E+00 | (mg/kg-day)-1 | 7.2E-07 | 2.8E-07 | mg/kg-day | | mg/kg-day | | |
| | | | Exp. Route Total | | | | | | | | 7.2E-07 | | | | | 1.4E-02 | Dermal ABS |
| | | | Dermal | Manganese | 1399 | mg/kg | 3.2E-06 | mg/kg-day | | (mg/kg-day)-1 | | 9.0E-06 | mg/kg-day | 1.4E-01 | mg/kg-day | 6.5E-05 | 0.001 Region IV default |
| | | | | Benzo(a)pyrene | 0.201 | mg/kg | 6.0E-08 | mg/kg-day | | (mg/kg-day)-1 | | 1.7E-07 | mg/kg-day | | mg/kg-day | | 0.13 Region IV default |
| | | | Exp. Route Total | | | | | | | | 0.0E+00 | | | | | 6.5E-05 | Volitization factors |
| | | | Inhalation | Manganese | 1.51E-06 | $mg/m^3$ | 1.1E-07 | mg/kg-day | | (mg/kg-day)-1 | | 3.0E-07 | mg/kg-day | 1.4E-05 | mg/kg-day | 2.1E-02 | na |
| | | | | Benzo(a)pyrene | 2.18E-10 | $mg/m^3$ | 1.5E-11 | mg/kg-day | 7.3E+00 | (mg/kg-day)-1 | 1.1E-10 | 4.3E-11 | mg/kg-day | | mg/kg-day | | na |
| | | | Exp. Route Total | | | | | | | | 1.1E-10 | | | | | 2.1E-02 | |
| | | Exposure Point Total | | | | | | | | | 7.2E-07 | | | | | 3.5E-02 | |
| | Exposure Medium Total | | | | | | | | | | 7.2E-07 | | | | | 3.5E-02 | |
| Subsurface Soil Total | | | | | | | | | | | 7.2E-07 | | | | | 3.5E-02 | |

EPC = Exposure Point Concentration
ABS = Absorption Factor

**Table E-13, Calculation of Chemical Cancer Risks and Non-Cancer Hazards:**
**For Adult**
**Reasonable Maximum Exposure (RME)**
**Site A**
**Y-12, Oak Ridge, TN**

Scenario Timeframe: Future
Receptor Population: Hypothetical Future Resident
Receptor Age: Adult

| Medium | Exposure Medium | Exposure Point | Exposure Route | Chemical of Potential Concern | EPC | | Cancer Risk Calculations | | | | | Non-Cancer Hazard Calculations | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Intake/ Exposure Concentration | | Cancer Slope Factor Unit Risk | | Cancer Risk | Intake/ Exposure Concentration | | Reference Dose Reference Concentration | | Hazard Quotient | |
| | | | | | Value | Units | Value | Units | Value | Units | | Value | Units | Value | Units | | |
| Surface Soil | Soil/Air | Exposed | Ingestion | Barium | 181 | mg/kg | 1.1E-04 | mg/kg-day | | (mg/kg-day)-1 | | 2.5E-04 | mg/kg-day | 7.0E-02 | mg/kg-day | 3.5E-03 | |
| | | | | Manganese | 1283 | mg/kg | 7.5E-04 | mg/kg-day | | (mg/kg-day)-1 | | 1.8E-03 | mg/kg-day | 1.4E-01 | mg/kg-day | 1.3E-02 | |
| | | | | Benzo(a)pyrene | 0.175 | mg/kg | 1.0E-07 | mg/kg-day | 7.3E+00 | (mg/kg-day)-1 | 7.5E-07 | 2.4E-07 | mg/kg-day | | mg/kg-day | | |
| | | | Exp. Route Total | | | | | | | | 7.5E-07 | | | | | 1.6E-02 | Dermal ABS |
| | | | Dermal | Barium | 181 | mg/kg | 1.2E-06 | mg/kg-day | | (mg/kg-day)-1 | | 2.8E-06 | mg/kg-day | 7.0E-02 | mg/kg-day | 4.0E-05 | 0.001 Region IV default |
| | | | | Manganese | 1283 | mg/kg | 8.6E-06 | mg/kg-day | | (mg/kg-day)-1 | | 2.0E-05 | mg/kg-day | 1.4E-01 | mg/kg-day | 1.4E-04 | 0.001 Region IV default |
| | | | | Benzo(a)pyrene | 0.175 | mg/kg | 1.5E-07 | mg/kg-day | | (mg/kg-day)-1 | | 3.6E-07 | mg/kg-day | | mg/kg-day | | 0.13 Region IV default |
| | | | Exp. Route Total | | | | | | | | 0.0E+00 | | | | | 1.8E-04 | Volitization factors |
| | | | Inhalation | Barium | 1.37E-07 | $mg/m^3$ | 1.6E-08 | mg/kg-day | | (mg/kg-day)-1 | | 3.8E-08 | mg/kg-day | 1.4E-04 | mg/kg-day | 2.6E-04 | na |
| | | | | Manganese | 9.72E-07 | $mg/m^3$ | 1.1E-07 | mg/kg-day | | (mg/kg-day)-1 | | 2.7E-07 | mg/kg-day | 1.4E-05 | mg/kg-day | 1.9E-02 | na |
| | | | | Benzo(a)pyrene | 1.33E-10 | $mg/m^3$ | 1.6E-11 | mg/kg-day | 7.3E+00 | (mg/kg-day)-1 | 1.1E-10 | 3.6E-11 | mg/kg-day | | mg/kg-day | | na |
| | | | Exp. Route Total | | | | | | | | 1.1E-10 | | | | | 1.9E-02 | |
| | | Exposure Point Total | | | | | | | | | 7.5E-07 | | | | | **3.6E-02** | |
| | Exposure Medium Total | | | | | | | | | | 7.5E-07 | | | | | **3.6E-02** | |
| Surface Soil Total | | | | | | | | | | | 7.5E-07 | | | | | **3.6E-02** | |
| Soil | Soil/Air | Excavations | Ingestion | Manganese | 1399 | mg/kg | 8.2E-04 | mg/kg-day | | (mg/kg-day)-1 | | 1.9E-03 | mg/kg-day | 1.4E-01 | mg/kg-day | 1.4E-02 | |
| | | | | Benzo(a)pyrene | 0.201 | mg/kg | 1.2E-07 | mg/kg-day | 7.3E+00 | (mg/kg-day)-1 | 8.6E-07 | 2.8E-07 | mg/kg-day | | mg/kg-day | | |
| | | | Exp. Route Total | | | | | | | | 8.6E-07 | | | | | 1.4E-02 | Dermal ABS |
| | | | Dermal | Manganese | 1399 | mg/kg | 9.4E-06 | mg/kg-day | | (mg/kg-day)-1 | | 2.2E-05 | mg/kg-day | 1.4E-01 | mg/kg-day | 1.6E-04 | 0.001 Region IV default |
| | | | | Benzo(a)pyrene | 0.201 | mg/kg | 1.7E-07 | mg/kg-day | | (mg/kg-day)-1 | | 4.1E-07 | mg/kg-day | | mg/kg-day | | 0.13 Region IV default |
| | | | Exp. Route Total | | | | | | | | 0.0E+00 | | | | | 1.6E-04 | Volitization factors |
| | | | Inhalation | Manganese | 1.51E-06 | $mg/m^3$ | 1.8E-07 | mg/kg-day | | (mg/kg-day)-1 | | 4.1E-07 | mg/kg-day | 1.4E-05 | mg/kg-day | 3.0E-02 | na |
| | | | | Benzo(a)pyrene | 2.18E-10 | $mg/m^3$ | 2.6E-11 | mg/kg-day | 7.3E+00 | (mg/kg-day)-1 | 1.9E-10 | 6.0E-11 | mg/kg-day | | mg/kg-day | | na |
| | | | Exp. Route Total | | | | | | | | 1.9E-10 | | | | | 3.0E-02 | |
| | | Exposure Point Total | | | | | | | | | 8.6E-07 | | | | | **4.3E-02** | |
| | Exposure Medium Total | | | | | | | | | | 8.6E-07 | | | | | **4.3E-02** | |
| Subsurface Soil Total | | | | | | | | | | | 8.6E-07 | | | | | **4.3E-02** | |

EPC = Exposure Point Concentration
ABS = Absorption Factor

**Table E-14, Calculation of Chemical Cancer Risks and Non-Cancer Hazards:**
**For Child**
**Reasonable Maximum Exposure (RME)**
**Site A**
**Y-12, Oak Ridge, TN**

Scenario Timeframe: Future
Receptor Population: Hypothetical Future Resident
Receptor Age: Child

| Medium | Exposure Medium | Exposure Point | Exposure Route | Chemical of Potential Concern | EPC | | Cancer Risk Calculations | | | | | Non-Cancer Hazard Calculations | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Intake/ Exposure Concentration | | Cancer Slope Factor Unit Risk | | | Intake/ Exposure Concentration | | Reference Dose Reference Concentration | | Hazard Quotient | |
| | | | | | Value | Units | Value | Units | Value | Units | | Value | Units | Value | Units | | |
| Surface Soil | Soil/Air | Exposed | Ingestion | Barium | 181 | mg/kg | 2.0E-04 | mg/kg-day | | (mg/kg-day)-1 | | 2.3E-03 | mg/kg-day | 7.0E-02 | mg/kg-day | 3.3E-02 | |
| | | | | Manganese | 1283 | mg/kg | 1.4E-03 | mg/kg-day | | (mg/kg-day)-1 | | 1.6E-02 | mg/kg-day | 1.4E-01 | mg/kg-day | 1.2E-01 | |
| | | | | Benzo(a)pyrene | 0.175 | mg/kg | 1.9E-07 | mg/kg-day | 7.3E+00 | (mg/kg-day)-1 | 1.4E-06 | 2.2E-06 | mg/kg-day | | mg/kg-day | | |
| | | | Exp. Route Total | | | | | | | | 1.4E-06 | | | | | 1.5E-01 | Dermal ABS |
| | | | Dermal | Barium | 181 | mg/kg | 5.6E-07 | mg/kg-day | | (mg/kg-day)-1 | | 6.5E-06 | mg/kg-day | 7.0E-02 | mg/kg-day | 9.3E-05 | 0.001 Region IV default |
| | | | | Manganese | 1283 | mg/kg | 3.9E-06 | mg/kg-day | | (mg/kg-day)-1 | | 4.6E-05 | mg/kg-day | 1.4E-01 | mg/kg-day | 3.3E-04 | 0.001 Region IV default |
| | | | | Benzo(a)pyrene | 0.175 | mg/kg | 7.0E-08 | mg/kg-day | | (mg/kg-day)-1 | | 8.1E-07 | mg/kg-day | | mg/kg-day | | 0.13 Region IV default |
| | | | Exp. Route Total | | | | | | | | 0.0E+00 | | | | | 4.2E-04 | Volitization factors |
| | | | Inhalation | Barium | 1.37E-07 | $mg/m^3$ | 7.5E-09 | mg/kg-day | | (mg/kg-day)-1 | | 8.8E-08 | mg/kg-day | 1.4E-04 | mg/kg-day | 6.1E-04 | na |
| | | | | Manganese | 9.72E-07 | $mg/m^3$ | 5.3E-08 | mg/kg-day | | (mg/kg-day)-1 | | 6.2E-07 | mg/kg-day | 1.4E-05 | mg/kg-day | 4.4E-02 | na |
| | | | | Benzo(a)pyrene | 1.33E-10 | $mg/m^3$ | 7.3E-12 | mg/kg-day | 7.3E+00 | (mg/kg-day)-1 | 5.3E-11 | 8.5E-11 | mg/kg-day | | mg/kg-day | | na |
| | | | Exp. Route Total | | | | | | | | 5.3E-11 | | | | | 4.5E-02 | |
| | | Exposure Point Total | | | | | | | | | 1.4E-06 | | | | | **2.0E-01** | |
| | Exposure Medium Total | | | | | | | | | | 1.4E-06 | | | | | **2.0E-01** | |
| Surface Soil Total | | | | | | | | | | | 1.4E-06 | | | | | **2.0E-01** | |
| Soil | Soil/Air | Excavations | Ingestion | Manganese | 1399 | mg/kg | 1.5E-03 | mg/kg-day | | (mg/kg-day)-1 | | 1.8E-02 | mg/kg-day | 1.4E-01 | mg/kg-day | 1.3E-01 | |
| | | | | Benzo(a)pyrene | 0.201 | mg/kg | 2.2E-07 | mg/kg-day | 7.3E+00 | (mg/kg-day)-1 | 1.6E-06 | 2.6E-06 | mg/kg-day | | mg/kg-day | | |
| | | | Exp. Route Total | | | | | | | | 1.6E-06 | | | | | 1.3E-01 | Dermal ABS |
| | | | Dermal | Manganese | 1399 | mg/kg | 4.3E-06 | mg/kg-day | | (mg/kg-day)-1 | | 5.0E-05 | mg/kg-day | 1.4E-01 | mg/kg-day | 3.6E-04 | 0.001 Region IV default |
| | | | | Benzo(a)pyrene | 0.201 | mg/kg | 8.0E-08 | mg/kg-day | | (mg/kg-day)-1 | | 9.4E-07 | mg/kg-day | | mg/kg-day | | 0.13 Region IV default |
| | | | Exp. Route Total | | | | | | | | 0.0E+00 | | | | | 3.6E-04 | Volitization factors |
| | | | Inhalation | Manganese | 1.51E-06 | $mg/m^3$ | 8.3E-08 | mg/kg-day | | (mg/kg-day)-1 | | 9.7E-07 | mg/kg-day | 1.4E-05 | mg/kg-day | 6.9E-02 | na |
| | | | | Benzo(a)pyrene | 2.18E-10 | $mg/m^3$ | 1.2E-11 | mg/kg-day | 7.3E+00 | (mg/kg-day)-1 | 8.7E-11 | 1.4E-10 | mg/kg-day | | mg/kg-day | | na |
| | | | Exp. Route Total | | | | | | | | 8.7E-11 | | | | | 6.9E-02 | |
| | | Exposure Point Total | | | | | | | | | 1.6E-06 | | | | | **2.0E-01** | |
| | Exposure Medium Total | | | | | | | | | | 1.6E-06 | | | | | **2.0E-01** | |
| Subsurface Soil Total | | | | | | | | | | | 1.6E-06 | | | | | **2.0E-01** | |

EPC = Exposure Point Concentration
ABS = Absorption Factor

**Table E-15, Calculation of Chemical Cancer Risks and Non-Cancer Hazards:**
**For Site Worker**
**Reasonable Maximum Exposure (RME)**
**Site A**
**Y-12, Oak Ridge, TN**

Scenario Timeframe: Current/Future
Receptor Population: Site Worker
Receptor Age: Adult

| Medium | Exposure Medium | Exposure Point | Exposure Route | Chemical of Potential Concern | EPC | | Cancer Risk Calculations | | | | | Non-Cancer Hazard Calculations | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Intake/ Exposure Concentration | | Cancer Slope Factor Unit Risk | | Cancer Risk | Intake/ Exposure Concentration | | Reference Dose Reference Concentration | | Hazard Quotient | | |
| | | | | | Value | Units | Value | Units | Value | Units | | Value | Units | Value | Units | | | |
| Surface Soil | Soil/Air | Exposed | Ingestion | Iron | 27182 | mg/kg | 9.5E-03 | mg/kg-day | | (mg/kg-day)-1 | | 2.7E-02 | mg/kg-day | 3.0E-01 | mg/kg-day | 8.9E-02 | | |
| | | | | Manganese | 1384 | mg/kg | 4.8E-04 | mg/kg-day | | (mg/kg-day)-1 | | 1.4E-03 | mg/kg-day | 1.4E-01 | mg/kg-day | 9.7E-03 | | |
| | | | | Benzo(a)pyrene | 0.18 | mg/kg | 6.3E-08 | mg/kg-day | 7.3E+00 | (mg/kg-day)-1 | 4.6E-07 | 1.8E-07 | mg/kg-day | | mg/kg-day | | | |
| | | | Exp. Route Total | | | | | | | | 4.6E-07 | | | | | 9.8E-02 | Dermal ABS | |
| | | | Dermal | Iron | 27182 | mg/kg | 6.3E-05 | mg/kg-day | | (mg/kg-day)-1 | | 1.8E-04 | mg/kg-day | 3.0E-01 | mg/kg-day | 5.9E-04 | 0.001 | Region IV default |
| | | | | Manganese | 1384 | mg/kg | 3.2E-06 | mg/kg-day | | (mg/kg-day)-1 | | 8.9E-06 | mg/kg-day | 1.4E-01 | mg/kg-day | 6.4E-05 | 0.001 | Region IV default |
| | | | | Benzo(a)pyrene | 0.18 | mg/kg | 5.4E-08 | mg/kg-day | | (mg/kg-day)-1 | | 1.5E-07 | mg/kg-day | | mg/kg-day | | 0.13 | Region IV default |
| | | | Exp. Route Total | | | | | | | | 0.0E+00 | | | | | 6.5E-04 | Volitization factors | |
| | | | Inhalation | Iron | 2.06E-05 | $mg/m^3$ | 1.4E-06 | mg/kg-day | | (mg/kg-day)-1 | | 4.0E-06 | mg/kg-day | | mg/kg-day | | na | |
| | | | | Manganese | 1.05E-06 | $mg/m^3$ | 7.3E-08 | mg/kg-day | | (mg/kg-day)-1 | | 2.1E-07 | mg/kg-day | 1.4E-05 | mg/kg-day | 1.5E-02 | na | |
| | | | | Benzo(a)pyrene | 1.36E-10 | $mg/m^3$ | 9.5E-12 | mg/kg-day | 7.3E+00 | (mg/kg-day)-1 | 7.0E-11 | 2.7E-11 | mg/kg-day | | mg/kg-day | | na | |
| | | | Exp. Route Total | | | | | | | | 7.0E-11 | | | | | 1.5E-02 | | |
| | | Exposure Point Total | | | | | | | | | 4.6E-07 | | | | | 1.1E-01 | | |
| | Exposure Medium Total | | | | | | | | | | 4.6E-07 | | | | | 1.1E-01 | | |
| Surface Soil Total | | | | | | | | | | | 4.6E-07 | | | | | 1.1E-01 | | |
| Soil | Soil/Air | Excavations | Ingestion | Iron | 32949 | mg/kg | 1.2E-02 | mg/kg-day | | (mg/kg-day)-1 | | 3.2E-02 | mg/kg-day | 3.0E-01 | mg/kg-day | 1.1E-01 | | |
| | | | | Manganese | 2213 | mg/kg | 7.7E-04 | mg/kg-day | | (mg/kg-day)-1 | | 2.2E-03 | mg/kg-day | 1.4E-01 | mg/kg-day | 1.5E-02 | | |
| | | | Exp. Route Total | | | | | | | | 0.0E+00 | | | | | 1.2E-01 | Dermal ABS | |
| | | | Dermal | Iron | 32949 | mg/kg | 7.6E-05 | mg/kg-day | | (mg/kg-day)-1 | | 2.1E-04 | mg/kg-day | 3.0E-01 | mg/kg-day | 7.1E-04 | 0.001 | Region IV default |
| | | | | Manganese | 2213 | mg/kg | 6.6E-04 | mg/kg-day | | (mg/kg-day)-1 | | 1.9E-03 | mg/kg-day | 1.4E-01 | mg/kg-day | 1.3E-02 | 0.13 | Region IV default |
| | | | Exp. Route Total | | | | | | | | 0.0E+00 | | | | | 1.4E-02 | Volitization factors | |
| | | | Inhalation | Iron | 3.57E-05 | $mg/m^3$ | 2.5E-06 | mg/kg-day | | (mg/kg-day)-1 | | 7.0E-06 | mg/kg-day | | mg/kg-day | | na | |
| | | | | Manganese | 2.40E-06 | $mg/m^3$ | 1.7E-07 | mg/kg-day | | (mg/kg-day)-1 | | 4.7E-07 | mg/kg-day | 1.4E-05 | mg/kg-day | 3.3E-02 | na | |
| | | | Exp. Route Total | | | | | | | | 0.0E+00 | | | | | 3.3E-02 | | |
| | | Exposure Point Total | | | | | | | | | 0.0E+00 | | | | | 1.7E-01 | | |
| | Exposure Medium Total | | | | | | | | | | 0.0E+00 | | | | | 1.7E-01 | | |
| Subsurface Soil Total | | | | | | | | | | | 0.0E+00 | | | | | 1.7E-01 | | |

EPC = Exposure Point Concentration
ABS = Absorption Factor

**Table E-16, Calculation of Chemical Cancer Risks and Non-Cancer Hazards:**
**For Adult**
**Reasonable Maximum Exposure (RME)**
**Site A**
**Y-12, Oak Ridge, TN**

Scenario Timeframe: Future
Receptor Population: Hypothetical Future Resident
Receptor Age: Adult

| Medium | Exposure Medium | Exposure Point | Exposure Route | Chemical of Potential Concern | EPC | | Cancer Risk Calculations | | | | | Non-Cancer Hazard Calculations | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Intake/ Exposure Concentration | | Cancer Slope Factor Unit Risk | | Cancer Risk | Intake/ Exposure Concentration | | Reference Dose Reference Concentration | | Hazard Quotient | |
| | | | | | Value | Units | Value | Units | Value | Units | | Value | Units | Value | Units | | |
| Surface Soil | Soil/Air | Exposed | Ingestion | Iron | 27182 | mg/kg | 1.6E-02 | mg/kg-day | | (mg/kg-day)-1 | | 3.7E-02 | mg/kg-day | 3.0E-01 | mg/kg-day | 1.2E-01 | |
| | | | | Manganese | 1384 | mg/kg | 8.1E-04 | mg/kg-day | | (mg/kg-day)-1 | | 1.9E-03 | mg/kg-day | 1.4E-01 | mg/kg-day | 1.4E-02 | |
| | | | | Benzo(a)pyrene | 0.18 | mg/kg | 1.1E-07 | mg/kg-day | 7.3E+00 | (mg/kg-day)-1 | 7.7E-07 | 2.5E-07 | mg/kg-day | | mg/kg-day | | |
| | | | Exp. Route Total | | | | | | | | 7.7E-07 | | | | | 1.4E-01 | Dermal ABS |
| | | | Dermal | Iron | 27182 | mg/kg | 1.8E-04 | mg/kg-day | | (mg/kg-day)-1 | | 4.2E-04 | mg/kg-day | 3.0E-01 | mg/kg-day | 1.4E-03 | 0.001 Region IV default |
| | | | | Manganese | 1384 | mg/kg | 9.3E-06 | mg/kg-day | | (mg/kg-day)-1 | | 2.2E-05 | mg/kg-day | 1.4E-01 | mg/kg-day | 1.5E-04 | 0.001 Region IV default |
| | | | | Benzo(a)pyrene | 0.18 | mg/kg | 1.6E-07 | mg/kg-day | | (mg/kg-day)-1 | | 3.7E-07 | mg/kg-day | | mg/kg-day | | 0.13 Region IV default |
| | | | Exp. Route Total | | | | | | | | 0.0E+00 | | | | | 1.6E-03 | Volitization factors |
| | | | Inhalation | Iron | 2.06E-05 | $mg/m^3$ | 2.4E-06 | mg/kg-day | | (mg/kg-day)-1 | | 5.6E-06 | mg/kg-day | | mg/kg-day | | na |
| | | | | Manganese | 1.05E-06 | $mg/m^3$ | 1.2E-07 | mg/kg-day | | (mg/kg-day)-1 | | 2.9E-07 | mg/kg-day | 1.4E-05 | mg/kg-day | 2.1E-02 | na |
| | | | | Benzo(a)pyrene | 1.36E-10 | $mg/m^3$ | 1.6E-11 | mg/kg-day | 7.3E+00 | (mg/kg-day)-1 | 1.2E-10 | 3.7E-11 | mg/kg-day | | mg/kg-day | | na |
| | | | Exp. Route Total | | | | | | | | 1.2E-10 | | | | | 2.1E-02 | |
| | | Exposure Point Total | | | | | | | | | 7.7E-07 | | | | | 1.6E-01 | |
| | Exposure Medium Total | | | | | | | | | | 7.7E-07 | | | | | 1.6E-01 | |
| Surface Soil Total | | | | | | | | | | | 7.7E-07 | | | | | 1.6E-01 | |
| Soil | Soil/Air | Excavations | Ingestion | Iron | 32949 | mg/kg | 1.9E-02 | mg/kg-day | | (mg/kg-day)-1 | | 4.5E-02 | mg/kg-day | 3.0E-01 | mg/kg-day | 1.5E-01 | |
| | | | | Manganese | 2213 | mg/kg | 1.3E-03 | mg/kg-day | | (mg/kg-day)-1 | | 3.0E-03 | mg/kg-day | 1.4E-01 | mg/kg-day | 2.2E-02 | |
| | | | Exp. Route Total | | | | | | | | 0.0E+00 | | | | | 1.7E-01 | Dermal ABS |
| | | | Dermal | Iron | 32949 | mg/kg | 2.2E-04 | mg/kg-day | | (mg/kg-day)-1 | | 5.1E-04 | mg/kg-day | 3.0E-01 | mg/kg-day | 1.7E-03 | 0.001 Region IV default |
| | | | | Manganese | 2213 | mg/kg | 1.9E-03 | mg/kg-day | | (mg/kg-day)-1 | | 4.5E-03 | mg/kg-day | 1.4E-01 | mg/kg-day | 3.2E-02 | 0.13 Region IV default |
| | | | Exp. Route Total | | | | | | | | 0.0E+00 | | | | | 3.4E-02 | Volitization factors |
| | | | Inhalation | Iron | 3.57E-05 | $mg/m^3$ | 4.2E-06 | mg/kg-day | | (mg/kg-day)-1 | | 9.8E-06 | mg/kg-day | | mg/kg-day | | na |
| | | | | Manganese | 2.40E-06 | $mg/m^3$ | 2.8E-07 | mg/kg-day | | (mg/kg-day)-1 | | 6.6E-07 | mg/kg-day | 1.4E-05 | mg/kg-day | 4.7E-02 | na |
| | | | Exp. Route Total | | | | | | | | 0.0E+00 | | | | | 4.7E-02 | |
| | | Exposure Point Total | | | | | | | | | 0.0E+00 | | | | | 2.5E-01 | |
| | Exposure Medium Total | | | | | | | | | | 0.0E+00 | | | | | 2.5E-01 | |
| Subsurface Soil Total | | | | | | | | | | | 0.0E+00 | | | | | 2.5E-01 | |

EPC = Exposure Point Concentration
ABS = Absorption Factor

**Table E-17, Calculation of Chemical Cancer Risks and Non-Cancer Hazards:**
**For Child**
**Reasonable Maximum Exposure (RME)**
**Site A**
**Y-12, Oak Ridge, TN**

Scenario Timeframe: Future
Receptor Population: Hypothetical Future Resident
Receptor Age: Child

| Medium | Exposure Medium | Exposure Point | Exposure Route | Chemical of Potential Concern | EPC | | Cancer Risk Calculations | | | | | Non-Cancer Hazard Calculations | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Intake/ Exposure Concentration | | Cancer Slope Factor Unit Risk | | | Intake/ Exposure Concentration | | Reference Dose Reference Concentration | | Hazard Quotient | |
| | | | | | Value | Units | Value | Units | Value | Units | | Value | Units | Value | Units | | |
| Surface Soil | Soil/Air | Exposed | Ingestion | Iron | 27182 | mg/kg | 3.0E-02 | mg/kg-day | | (mg/kg-day)-1 | | 3.5E-01 | mg/kg-day | 1.1E+00 | mg/kg-day | 3.2E-01 | |
| | | | | Manganese | 1384 | mg/kg | 1.5E-03 | mg/kg-day | | (mg/kg-day)-1 | | 1.8E-02 | mg/kg-day | 1.4E-01 | mg/kg-day | 1.3E-01 | |
| | | | | Benzo(a)pyrene | 0.18 | mg/kg | 2.0E-07 | mg/kg-day | 7.3E+00 | (mg/kg-day)-1 | 1.4E-06 | 2.3E-06 | mg/kg-day | | mg/kg-day | | |
| | | | Exp. Route Total | | | | | | | | 1.4E-06 | | | | | 4.4E-01 | Dermal ABS |
| | | | Dermal | Iron | 27182 | mg/kg | 8.3E-05 | mg/kg-day | | (mg/kg-day)-1 | | 9.7E-04 | mg/kg-day | 1.1E+00 | mg/kg-day | 8.8E-04 | 0.001 Region IV default |
| | | | | Manganese | 1384 | mg/kg | 4.2E-06 | mg/kg-day | | (mg/kg-day)-1 | | 5.0E-05 | mg/kg-day | 1.4E-01 | mg/kg-day | 3.5E-04 | 0.001 Region IV default |
| | | | | Benzo(a)pyrene | 0.18 | mg/kg | 7.2E-08 | mg/kg-day | | (mg/kg-day)-1 | | 8.4E-07 | mg/kg-day | | mg/kg-day | | 0.13 Region IV default |
| | | | Exp. Route Total | | | | | | | | 0.0E+00 | | | | | 1.2E-03 | Volitization factors |
| | | | Inhalation | Iron | 2.06E-05 | mg/m$^3$ | 1.1E-06 | mg/kg-day | | (mg/kg-day)-1 | | 1.3E-05 | mg/kg-day | | mg/kg-day | | na |
| | | | | Manganese | 1.05E-06 | mg/m$^3$ | 5.7E-08 | mg/kg-day | | (mg/kg-day)-1 | | 6.7E-07 | mg/kg-day | 1.4E-05 | mg/kg-day | 4.8E-02 | na |
| | | | | Benzo(a)pyrene | 1.36E-10 | mg/m$^3$ | 7.5E-12 | mg/kg-day | 7.3E+00 | (mg/kg-day)-1 | 5.5E-11 | 8.7E-11 | mg/kg-day | | mg/kg-day | | na |
| | | | Exp. Route Total | | | | | | | | 5.5E-11 | | | | | 4.8E-02 | |
| | | Exposure Point Total | | | | | | | | | 1.4E-06 | | | | | 4.9E-01 | |
| | Exposure Medium Total | | | | | | | | | | 1.4E-06 | | | | | 4.9E-01 | |
| Surface Soil Total | | | | | | | | | | | 1.4E-06 | | | | | 4.9E-01 | |
| Soil | Soil/Air | Excavations | Ingestion | Iron | 32949 | mg/kg | 3.6E-02 | mg/kg-day | | (mg/kg-day)-1 | | 4.2E-01 | mg/kg-day | 1.1E+00 | mg/kg-day | 3.8E-01 | |
| | | | | Manganese | 2213 | mg/kg | 2.4E-03 | mg/kg-day | | (mg/kg-day)-1 | | 2.8E-02 | mg/kg-day | 1.4E-01 | mg/kg-day | 2.0E-01 | |
| | | | Exp. Route Total | | | | | | | | 0.0E+00 | | | | | 5.9E-01 | Dermal ABS |
| | | | Dermal | Iron | 32949 | mg/kg | 1.0E-04 | mg/kg-day | | (mg/kg-day)-1 | | 1.2E-03 | mg/kg-day | 1.1E+00 | mg/kg-day | 1.1E-03 | 0.001 Region IV default |
| | | | | Manganese | 2213 | mg/kg | 8.8E-04 | mg/kg-day | | (mg/kg-day)-1 | | 1.0E-02 | mg/kg-day | 1.4E-01 | mg/kg-day | 7.4E-02 | 0.13 Region IV default |
| | | | Exp. Route Total | | | | | | | | 0.0E+00 | | | | | 7.5E-02 | Volitization factors |
| | | | Inhalation | Iron | 3.57E-05 | mg/m$^3$ | 2.0E-06 | mg/kg-day | | (mg/kg-day)-1 | | 2.3E-05 | mg/kg-day | | mg/kg-day | | na |
| | | | | Manganese | 2.40E-06 | mg/m$^3$ | 1.3E-07 | mg/kg-day | | (mg/kg-day)-1 | | 1.5E-06 | mg/kg-day | 1.4E-05 | mg/kg-day | 1.1E-01 | na |
| | | | Exp. Route Total | | | | | | | | 0.0E+00 | | | | | 1.1E-01 | |
| | | Exposure Point Total | | | | | | | | | 0.0E+00 | | | | | 7.7E-01 | |
| | Exposure Medium Total | | | | | | | | | | 0.0E+00 | | | | | 7.7E-01 | |
| Subsurface Soil Total | | | | | | | | | | | 0.0E+00 | | | | | 7.7E-01 | |

EPC = Exposure Point Concentration
ABS = Absorption Factor